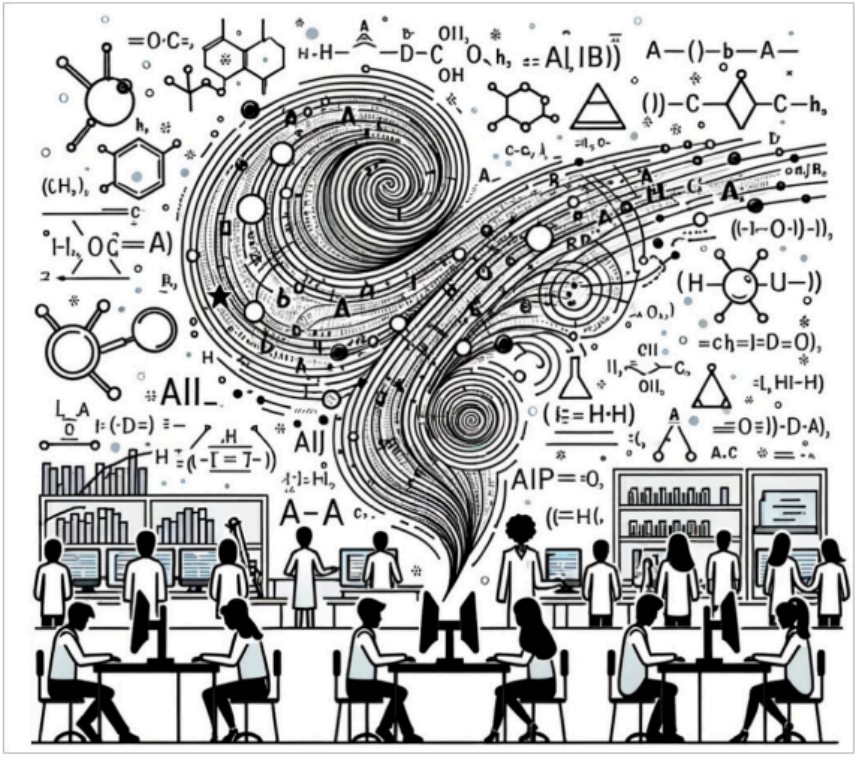
Artificial Intelligence in Universities: Challenges and Opportunities

Annual Report on AI and Higher Education

January 2024



Group 1million bot

Artificial Intelligence in Universities: Challenges and Opportunities.

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First edition: March 2024.

ISBN: 9798321075944.

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Artificial Intelligence as a Catalyst for University Renewal

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We are at a historic juncture marked by the incipient but decisive presence of Artificial Intelligence (AI) in all areas of our society. This phenomenon is not alien to the education sector, especially to universities, institutions that have been and must continue to be beacons of knowledge, innovation and social transformation.

The irruption of AI in the university landscape should not be just another step in the technological development, but a paradigm shift in the way we conceive education, research and university management. The personalisation of learning, for example, is emerging not only as a pedagogical ideal, but as a palpable possibility thanks to AI systems capable of adapting and responding to the individual needs of each student.

In the field of academic research, AI presents itself as a potential catalyst for discoveries and breakthroughs. Tools such as big data analytics and predictive systems open doors to research that were previously unthinkable due to human and technical limitations.

University management is also benefiting from the implementation of AI systems. Administrative efficiency, resource management, personalized attention to students and predictive analytics for decision-making are just a few examples of how AI can revolutionize this vital aspect of educational institutions.

However, with great opportunities also come great challenges. The ethics of AI, the digital divide, the adequacy of curricula, and staff training are issues that need to be addressed seriously and with commitment. Universities must lead not only in the adoption of these technologies but also in critical reflection on their impact and in the training of professionals capable of working ethically and effectively in this new era.

AI is not just a tool, it is a mirror of our capabilities, aspirations, and limitations as a society. Its integration into the university world is an opportunity to reimagine and redefine what it means to educate, research, and manage in the 21st century. Universities, therefore, must not only adapt to this new reality but must also be active protagonists in shaping a future where AI is a vector of equity, quality, and educational excellence.

This report is a call to action, an invitation to embark on a transformative journey, where AI is not the end, but the means by which universities can reach their full potential for the benefit of society.

Three decades of change... And now comes AI

Tomás Jiménez
Global Coordinator Metared (https://metared.org)
Fundación Universia

God moves the player, and he, the piece.
Which god behind God begets the plot
Of dust and time and dream and agonies?
(Jorge Luis Borges)

I don't think Jorge Luis Borges intuited that perhaps the answer to his philosophical poem "Chess" might be related to advances in AI, but certainly in chess, in higher education, and in virtually every area of our society, AI has set out to revolutionize what we thought were solidly established basic principles.

To date, we can agree without discrepancy that AI brings undoubtedly simple and rapid answers to previously tremendously complex problems; and yet, on the whole, we must also conclude that, for the time being, the panoramic view of what it can bring us contradictorily increases our uncertainties. In general, and also very especially in its application and impact on higher education.

Indeed, digital transformation has been impacting education for decades and revolutionizing the way teaching and learning is carried out. The integration of digital technologies in educational environments has led to significant changes:

- **Access to information**. The Internet and digital resources have exponentially increased the availability of educational content. Students and educators can access a vast array of information, including scholarly articles, interactive content and online courses, facilitating self-directed and lifelong learning.
- **Personalized learning**. Digital tools allow for personalized education that enables learning paths tailored to the individual needs and learning styles of each student. This personalization can lead to more effective results.
- **Collaboration and communication**. Digital platforms have enabled easier and more efficient communication and collaboration between students and teachers, both inside and outside the classroom. Tools such as forums, videoconferencing and collaborative documents support group work and global interaction.
- **Engagement and interactivity**. Technology, including gamification, interactive simulations and virtual or augmented reality, has introduced new

ways and opportunities to engage learners. These methods can make learning more interactive and enjoyable, potentially improving retention and comprehension.

- **Data-driven insights**. Digital education tools can track and analyze student performance, providing educators with data to better understand student progress and challenges. This data can help create better teaching strategies and interventions.
- **Globalization of education**. Digital technologies have broken down geographic barriers, allowing students from around the world to access quality education, participate in international programs and gain exposure to diverse perspectives.
- **Challenges and the digital divide**. While digital transformation in education offers many benefits, it also presents challenges. Not all students have the same access to digital tools and the Internet, resulting in a digital divide. In addition, educators need training and resources to effectively integrate technology into their teaching.
- **Preparing for a digital future**. Exposure to digital tools and learning environments prepares students for a workforce increasingly dependent on digital skills. This aligns education with the evolving demands of the labor market.
- **Change in the educational models**. There is a shift toward more blended and online learning models that integrate traditional classroom methods with digital platforms. This has been particularly accelerated by the COVID-19 pandemic.

In general, the digital transformation in education is not just about implementing new technologies, but a fundamental change in culture, mindset and approach to teaching and learning, aligning with the dynamic and interconnected world we live in.

And to all of the above, let's add now... Artificial intelligence!

The irruption of generative AI with popular tools such as ChatGPT and other proposals is now a year old. These tools have provoked a deep debate in society and also obviously in academia.

In Universia and in our collaborative work forums of Metared, always alive and close to any novelty that impacts on the digital transformation of our higher education institutions, the emergence of AI has awakened, as it could not be in any other way, a tremendous interest understanding that this technology of general utility that will already have a decisive impact on our economies, on our society and on our lives will also have an impact, of course, on our higher education institutions.

We have already shared early applications and success stories of AI in universities that are not only improving the efficiency and effectiveness of educational processes, but also helping students to thrive in an increasingly digital and data-driven world.

But we also know that it is crucial to address open and complex challenges, such as equity in access to technology, ethics in the use of student data, and teacher training in these new tools.

We observe and share reflections with our executives of Technological Strategy in the 10 chapters of the 14 Ibero-American countries that form Metared, but, although we aspire to feel like the conductor of a well-tuned orchestra, useful and necessary as a support for teaching, research and university management, however, the image increasingly resembles that of a circus tightrope walker forced to simultaneously handle dozens of cymbals in the air in a very complicated balance, and to which now, in a thunderous way, is added the revolutionary "complement" of the AI.

And furthermore, in this case, AI is a technology that not only turns our IT departments upside down, but also affects and makes us rethink all areas of university strategy.

On top of all this, let's not forget that our institutions of higher education are demanding the application of AI FOR EVERYTHING AND FOR TODAY.

Perhaps never has Lewis Carroll's Red Queen hypothesis been closer to the reality of our university institutions: "Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!".

In this frenzy, this report provides the necessary pause to reflect and address in a broad, comprehensive and enriching way the proposals for the use of AI in higher education through a perspective open to dialogue and the promotion of debate on such an exciting revolution.

1. BASIC CONCEPTS AND EXECUTIVE SUMMARY

a) Understanding artificial intelligence: basic concepts

Image: GPT-4/DALL-E.

The simplest and most widespread definition of artificial intelligence (AI) conceives it as "*machines capable of emulating certain functionalities of human intelligence*", including perception, learning, reasoning, problem solving, linguistic interaction and creative production.

Categorization of AI: narrow vs. general

Narrow AI and General AI

There are two main categories of AI: narrow and general (AGI).

The main difference between the two lies in their scope and capacity.

- **NARROW AI**: It is designed to perform specific and limited tasks. Its capability is focused on a particular task: speech recognition, machine translation, medical diagnosis… It cannot perform tasks outside its area of expertise.

- **AGI**: In contrast, AGI, also called strong or general AI, aspires to be as versatile as human intelligence. If achieved, it would be capable of performing any intellectual task that a human being can perform, without being limited to a single task or domain.

Level of adaptability

- **NARROW AI**: Generally, it cannot adapt to new tasks or new environments without significant reprogramming or task-specific redesign. Its adaptability is limited to its original function.

- **AGI**: In theory, it would be highly adaptable and able to learn and perform new tasks without extensive programming. You would be able to apply your skills in a broad and flexible manner.

Awareness and autonomy

- **NARROW AI**: Narrow AI lacks consciousness and self-awareness. It has no understanding of itself or its environment. It simply executes tasks as programmed or trained.

- **AGI**: In its theoretical definition, it would have the capacity to have some level of consciousness and self-awareness, meaning that it could understand its existence and make independent decisions beyond predefined instructions..

Complexity and reasoning skills

- **NARROW AI**: It usually relies on specific algorithms and does not perform deep reasoning. Its operation is based on patterns and pre-processed data.

- **AGI**: It would have the ability to reason, understand complex contexts and learn continuously, enabling it to tackle problems that require more abstract and deeper thinking..

In summary, the main difference between narrow AI and general AI lies in its ability to perform specific and limited tasks (narrow AI) versus the potential to perform a wide variety of intellectual tasks and show versatility similar to human intelligence (AGI). AGI is a research target in AI and, currently, most AI applications in use are examples of narrow AI.

Generative AI	**Predictive AI**
It focuses on producing new content or solutions, often in creative or innovative ways.	It uses machine learning algorithms to analyze existing data and make predictions about future events or outcomes.

AI development and growth	**Economic impact**
The rise of AI has been driven by the availability of large datasets, advances in algorithms and an increase in funding. Research in the field of AI is growing at exponential rates: in 2018, AI publications accounted for more than 2.2% of all scientific studies (Baruffaldi et al., 2020), and by 2021, the number rose to almost half a million in English and Chinese (Stanford University, 2023).	The economic potential of AI is impressive. It is projected that by 2030, AI could add $15.7 trillion to the global economy (PWC, 2019). This figure underlines the importance of investment in this field, both by the private sector and governments.

b) AI in universities

AI is redefining the framework of higher education, creating innovative opportunities to transform the way higher education is taught and learned.

Generative AI is sparking widespread curiosity and intense international debate about its impact on higher education. This must add to the trajectory of recent years where, through advanced AI tools such as intelligent tutoring systems, educational chatbots - and more recently augmented reality platforms - educators can now provide instruction that is tailored to the needs and pace of individual students. These tools are especially valuable for students with disabilities, offering resources such as text-to-speech, instant transcription, and translation tools, promoting a more inclusive and accessible education for all.

Furthermore, in the area of assessment and feedback, AI is making a difference. The ability to automate assessments and use advanced analytics gives teachers unprecedented insights into each student's performance and areas for improvement, allowing them to provide more personalized and efficient interventions. This student-centered approach empowers individualized learning and can improve retention and long-term academic success.

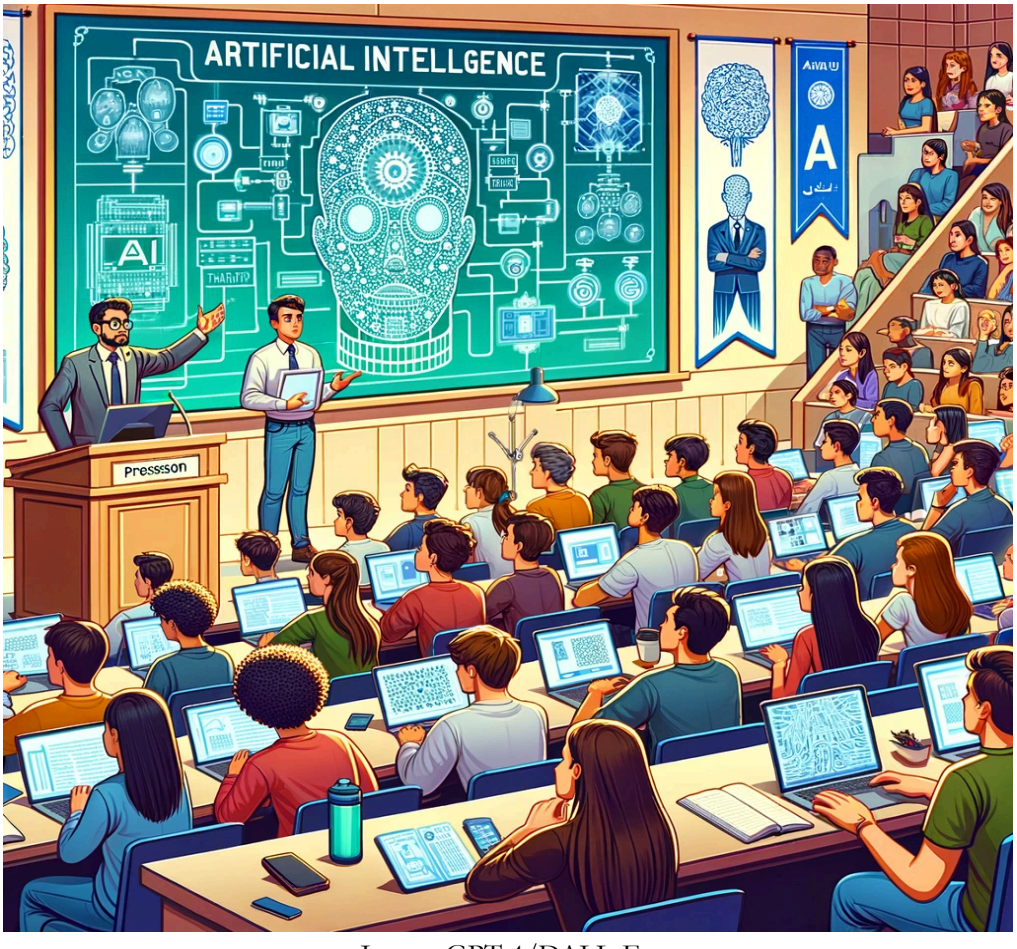


Image: GPT-4/DALL-E.

University students also face a major dilemma: predictive or generative AI, especially the latter, will be an indispensable tool in their professional future; those who do not use it in the classroom will be at a significant disadvantage in the labor market.

Along with these advances come significant challenges. There is a significant lack of knowledge among teachers and teachers in general about AI. Training and professional

development for teachers is essential to ensure that they can correctly assess and make the most of these technological tools.

Given the rapid evolution of AI in education, it is crucial that higher education institutions adopt a proactive and reflective approach, maximizing the benefits of AI while effectively addressing its inherent challenges.

The personalization of teaching

Through AI, personalized learning can be tailored to the individual needs of each student. AI-based systems detect areas where students may be struggling and adapt content as needed, providing valuable feedback for both students and teachers. Some more widespread applications and use cases:

- Intelligent Tutoring Systems: real-time guidance based on student needs.
- Educational assistants or chatbots: instant answers to questions and help with teaching.
- Virtual and Augmented Reality: immersive and adaptive learning experiences.
- NLP through generative AI for didactic document processing.

Learning analytics

AI-based analytics can identify trends and patterns in student progress, providing valuable information on how to optimize teaching.

Inclusion and support

AI tools can be particularly valuable for students with disabilities, offering personalized solutions that support inclusion. Some applications:

- Automatic translation and subtitling, which can benefit students with hearing or language disabilities.
- Sensory tools to support those with visual impairments.

Evaluation and feedback

AI systems can help to grade assignments, freeing up time for teachers to focus on teaching. In addition, these tools can provide constructive and quick feedback to students. Some use cases:

- Automated Scoring Platforms: Deliver fast and consistent results.
- Tools such as ChatGPT and virtual tutors: Support students in preparing for assessments.

Empowering students

Generative AI can provide critical tools to facilitate students' understanding of texts and enhance their ability and proactivity in following lessons, maximizing student success and reducing failure and dropout. However, education systems will need to adapt to preserve their integrity and ability to maximize the benefits of the increasingly advanced tools to which students and professionals will have access.

Challenges and professional development

The incorporation of AI in higher education is not without its challenges. It is vital that teaching staff are adequately trained and prepared to use these tools effectively and ethically. Academic integrity must remain at the forefront, and it is essential that higher education institutions (universities) provide continuous professional development in this area.

AI has the potential to revolutionize higher education, making learning more personalized, inclusive and efficient. However, the successful adoption of these technologies requires adequate training and careful reflection on the ethical and pedagogical implications.

c) AI and research

Equally, researchers will face a similar situation to students. No university professor is currently able to read everything that is published on a specific subject. Even if we talk about a specific cancer, it is impossible to assimilate thousands of published pages, clinical trials or huge volumes of raw data. AI is capable of doing so, and it can also provide syntheses or generate answers to specific questions that might go unnoticed among millions of data or pages.

Universities are central to the construction and ethical deployment of AI technologies. It is imperative that clear guidelines are embedded in these institutions, focusing on critical areas such as academic integrity, research ethics and the wider implications of incorporating AI in education. The insertion of AI into the university landscape brings with it a number of challenges that go beyond the technical and into the organizational realm.

These challenges range from the acquisition of appropriate hardware and software equipment, to staff training and concerns about information security and privacy, to effective data management strategies.

In any case, today's AI capabilities can create huge gaps between academic institutions worldwide. On the one hand, researchers empowered with advanced tools that help them manage and monetise large volumes of text and data versus those who, lacking such tools, are quickly left behind.

d) AI for efficiency in university administration and management

It is not only academia that will be influenced by AI. Its emergence is already transforming various administrative functions in universities. Information technology (IT) is obviously susceptible to this change, but so are other departments, such as admissions (pre-registration and enrolment), student services, libraries, marketing and finance, among others.

True AI integration will depend not only on technology, but also on quality training and a change in the organizational culture of the institution. Large administrative tasks, such as pre-enrolment, enrolment and admissions, can be overwhelming in terms of resources.

Image: GPT-4/DALL-E.

AI has the potential to alleviate this burden, especially in scenarios where extensive databases already exist. Chatbots, for example, which are already being used by students in educational tasks, are valuable tools to guide them through administrative procedures, which can often be tedious.

In addition, AI offers the possibility of early identification of students at risk of dropping out of their studies, allowing universities to act preventively and strategically.

The artificial intelligence revolution in higher education goes beyond the classroom. Its influence on administration and management transforms daily operations, improves efficiency and strengthens decision-making.

Improved decision-making	**Efficient administration**
AI tools can analyze large amounts of data to provide valuable information, making administrative and management decision-making more accurate and data-driven.	By automating repetitive administrative tasks with AI, universities can save time and resources, allowing employees to focus on more complex and higher-value tasks.
Student services/Student retention By improving the student experience, potential problems, such as attrition, can be proactively addressed. Chatbots and intelligent virtual assistants help with admissions procedures and general enquiries, providing fast and accurate responses. AI also enables proactive dropout detection by identifying students at risk of dropping out, allowing for early interventions.	

Challenges and institutional preparedness

Successful deployment of AI requires not only technical resources, but also organizational adaptation. Investment in hardware and software, proper data management and staff training are critical. In addition, security and privacy concerns must be addressed to protect student information and ensure trust.

AI, if properly integrated, can be an invaluable asset to higher education administration and management, offering faster, more accurate and data-driven solutions. However, it is essential that universities proactively address the associated challenges, ensuring that the technology is used ethically and responsibly.

e) Labour market and AI

Spain currently has a youth unemployment rate twice that of the EU. AI is bridging the gap between higher education and the changing demands of the labor market. As the relevance of AI in the professional world increases exponentially, the urgency to train more individuals in this area is evident.

This need is reflected in the growing labor supply, where AI and machine learning positions are among the fastest growing. Worryingly, however, only 22% of AI specialists are women, highlighting a gender inequality in the sector. From 2018 to 2022, the number of AI courses on offer has doubled, exceeding 6,000 for those taught in English alone. Likewise, Spanish universities are making a huge effort to offer a growing range of AI-related courses.

Faced with this scenario, universities must be at the forefront, adapting and creating curricula that not only address technology, but also foster interdisciplinarity or hybridisation of knowledge with all disciplines or areas of knowledge. Moreover, beyond technical knowledge, it is essential to focus on the meta-skills that will be crucial in the age of AI. These include skills such as creativity, critical analysis, effective communication and leadership.

In a world where algorithms give decisive comparative advantages, the ability to question and understand the workings and ethical implications behind technology becomes vital. Digital literacy and critical thinking are essential tools that enable students to decipher not only the "how" but also the "why" and ramifications of technology in society.

Image: GPT-4/DALL-E.

Universities have a mission to democratize access to education. To this end, they should design programmes that address AI at various levels, from basic introductions to specialized training, fostering inclusion and supporting those who wish to re-enter the education system. Using online and distance methods, powered by AI itself, can be a key strategy to expand the reach of education and promote continuous lifelong learning.

As mentioned above, universities need to monitor the pace of adoption of these tools in their institutions to avoid career gaps between graduates of some universities and others that are more diligent in adopting disruptive tools and innovations such as AI.

f) Challenges and perspectives of AI in higher education

The implementation of artificial intelligence (AI) in higher education is unevenly distributed geographically. While countries such as China and the United States lead in its adoption, Europe has lagged relatively far behind and regions such as sub-Saharan Africa, parts of Central and South Asia and Latin America are even further behind. Limitations in these areas, especially in terms of data availability and compatibility, exacerbate this disparity. In any case, AI opens up a huge opportunity for those lagging countries that are able to implement systems and tools while bringing about a cultural and educational revolution, as is the case in China and many Asian countries.

While AI can minimize biases in data interpretation, paradoxically it can also amplify them. The effectiveness of AI relies on the quality and diversity of data. Biased data can lead to AI systems with unfair results.

In addition, the lack of diversity among developers and researchers can result in the spread of bias. The under-representation of women in AI research and STEM fields is evident, influenced by both educational factors and social norms. Beyond gender inequality, there is a risk that AI will perpetuate or exacerbate forms of racial and ethnic discrimination.

> Only by cultivating a diverse and inclusive STEM environment can truly fair and impartial AI systems be designed.

The environmental impact of AI, with its intensive energy consumption, also raises questions of sustainability. For example, training a model such as the ChatGPT-3 model training involved a consumption of 78,487 kWh, which is equivalent to the average energy consumption of a single-family home in Spain. Efficient and responsible use of IA is a requirement from the perspective of sustainability.

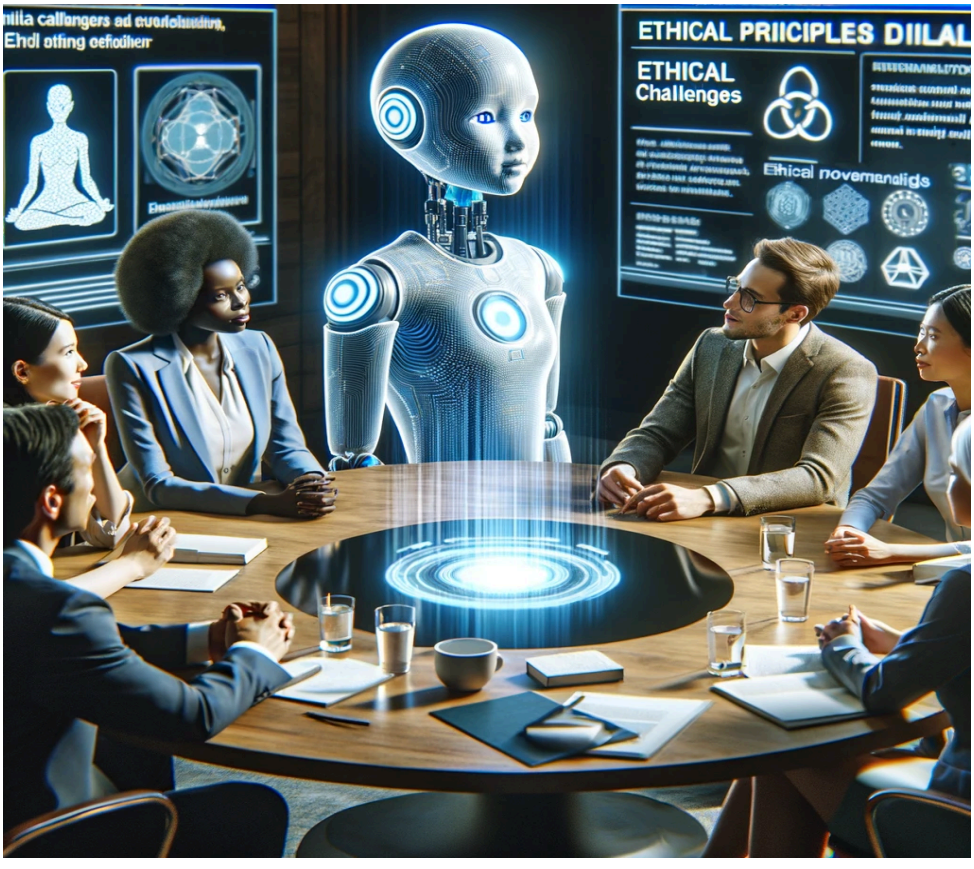


Image: GPT-4/DALL-E.

The 5 big challenges of AI

AI in Europe faces five major challenges in terms of its development and deployment. A country, its innovation ecosystems, its companies, the field of research and development are all relevant targets.

1. **Controlling and optimizing AI**. Today's AI, although with extraordinary performance and potential, has challenges that are opportunities for European companies, in the sense of achieving AI with human-controlled dashboards and solid resources to control the quality of its performance (biases, errors, hallucinations of generative AI...).
2. **Democratizing AI**. Promote the development of easy and low-cost intuitive tools that allow entities and agents with fewer resources to adopt and exploit them.
3. **Managing AI**. AI in its different aspects (generative, predictive, decision

making...) requires efficient, ethical, accountable and transparent management. This requires qualified personnel to undertake the creation and implementation of AI offices that establish priorities and build and collect data, in addition to applying the correct techniques and algorithms of generative AI (NLP) or predictive AI (machine learning, deep learning...), promoting its scalability and benefits.

4. **Developing customized solutions**. AI in the health sector is not the same as AI in defense, business productivity or education. In education, management, research or teaching, specific solutions with specific requirements are needed. Public-private collaboration is essential to achieve rapid and internationally competitive results with all the ethical guarantees we have mentioned.
5. **Empowering humans**. We must develop AI tools that empower people: professionals, workers, students...

Challenges for universities

More specifically, universities also have very relevant specific challenges, such as:

Challenges for universities (Unesco)	1MB Summary Report
- University policies on the use of AI. Universities should establish clear policies on the use of AI in pedagogy and assessment. **-Enriching the student experience.** It is imperative to enrich student experiences with AI tools, including chatbots and other generative tools to familiarize them with their use and exploitation. **- Impact assessment.** Roles and expectations within universities and their impact on leaders, staff and faculty must be redefined. **- Data-driven decision-making** will be strengthened in institutions with robust data infrastructures; therefore, the	**- Technological integration.** The adoption of AI requires an advanced technological infrastructure and the ability to integrate these tools into existing systems. -**Skills development.** To use AI effectively, teaching and administrative staff need specific training. This implies a challenge in terms of continuous training and updating of staff and students' skills. - **Ethical and privacy issues.** AI in the educational environment raises ethical concerns, especially with regard to the privacy of students' and teachers' data. Universities need to establish clear policies and ensure compliance with data protection regulations.

necessary means will have to be put in place. **- New avenues to be explored in AI under ethical principles**. Higher education research will delve deeper into unexplored areas of AI and training in AI ethics will be essential. **- Training on AI.** More courses on AI should be offered, not only for new students or specialists, but also to inform the public about its ethical and technical dimensions. Universities will have a responsibility to educate the community about AI as an integral part of their social engagement. **- Ongoing evaluation.** Assessment methodologies should be revised to incorporate or replace them with AI.	**- Personalizing teaching.** AI offers opportunities to personalize teaching and learning. However, developing systems that effectively adapt to the individual needs of learners is a challenge in terms of both design and implementation. **- Research and development.** AI can empower research, but universities face the challenge of keeping up with rapid changes in the field and integrating these technologies. **- Equity and access.** Ensuring that the benefits of AI are accessible to all students and teachers, regardless of their socio-economic background or geographical location, is a key challenge. **- Impact on employment and skills.** AI may change the demands of the labor market, requiring universities to adapt their programmes to prepare students. **- Evaluation and accreditation.** Adapting assessment and accreditation systems to incorporate AI-assisted learning developments and methods is another major challenge. **- Collaboration.** Universities must balance collaboration with other institutions and industry with the need to maintain a competitive edge. **- Innovation and cultural change**. Adopting AI implies a significant cultural change within the institution, which must be carefully managed to ensure acceptance and effective use of these technologies.

g) Ethics of AI in academia

Europe is a leader in recommendations and regulations around AI. In 2021, UNESCO established recommendations on the ethics of artificial intelligence, defining eleven strategic areas to guide states in incorporating ethical values and principles. This paper explores how these areas can be interpreted and integrated in the context of higher education, linking them to concrete actions that universities should consider.

Demands for universities to review and improve their standards in relation to the application of AI in teaching and assessment are on the rise. This clamor is coming from a variety of actors: educators, legislators and business leaders (especially in Europe) who are seeking clearer regulation and guidance.

The vast volume of data that is collected and used in the creation and maintenance of AI systems in universities can offer great benefits. But this same data, if misused, also poses threats. It is crucial to implement measures to protect against unauthorized access and data tampering. To this end, every university must establish a robust data management strategy when adopting AI technologies.

From an ethical perspective, there are three critical phases where data can introduce and magnify bias: during data labeling, in the selection of data sets and in the perpetuation of existing biases.

It is an emerging challenge today that industry, through the tech giants, is more proactive in the field of AI than academia, which may lead to misgivings and delays in AI deployment.

h) Good practices for the ethical integration of AI in academia

The artificial intelligence revolution is set to profoundly transform the world of higher education. This scenario promises numerous advantages, but also poses critical and pressing challenges on the road to AI-centric education.

Concrete measures are identified in areas such as internal skills strengthening, institutional management, pedagogy, research and community engagement. In addition, following UNESCO's recommendations, guidelines specifically aimed at promoting gender equality are incorporated in order to generate a transformative impact by addressing and resolving the root causes of the problem.

Image: GPT-4/DALL-E.

i) Some essential suggestions

Universities face a future in which the incorporation of artificial intelligence (AI) is imminent and essential. Regardless of their location or available resources, it is crucial that their leaders are prepared for an ethical and effective adoption of the technology. In essence, these proposals focus on:

- **Strengthen internal skills.**
- **Establish clear guidelines for AI adoption.**
- **Revolutionize education and training.**
- **Encourage research and proper use of AI.**
- **Empower AI in society in the right way. Raise awareness and connect communities around AI.**
- **Promote an egalitarian vision in AI and education.**

For government entities and policy makers

Institutions such as **UNESCO** make recommendations to government agencies and education policy makers aimed at strengthening understanding of AI, exploring its capabilities and limitations..

- **Providing the necessary funds and resources by establishing plans and allocations that promote a solid implementation of AI capable of maximizing its benefits. In this respect, Spain and Europe, with the Next Generation funds, have a unique opportunity to achieve world leadership in the implementation of AI in universities.**
- **Establish interdisciplinary forums to discuss AI and integrate multiple perspectives.**
- **Establish clear regulations around AI, especially in ethical and safety areas, and guide universities in this regard.**
- **Subsidize AI training and promote its ethical use in academia.**
- **Support interdisciplinary AI research and encourage international cooperation.**
- **Ensure that universities have the necessary technological infrastructure and connectivity.**
- **Ensure that educational quality standards include ethical aspects of AI.**
- **Design policies to counter exclusion based on gender, race, ethnicity or other factors in the field of AI.**

2. METHODOLOGY

This report on the relationship between higher education and AI is the result of a team effort from January 2023 to November 2023 that has been carried out with research for our Artificial Intelligence Observatory[1] and on the basis of a large number of meetings, seminars, debates, etc.[2]

As director of this report, **Andrés Pedreño** has a long history of commitment to education, universities, digitalisation, and artificial intelligence. He has been rector of the University of Alicante (1993-2000), CEO of Universia and director of Universia Holding (2000-2018), founder of the Miguel de Cervantes Virtual Library (Stanford University Award), advisory member of the Spanish Government for the white paper on AI and big data, founder of the Torre Juana OST campus specialized in AI and promoter of various projects and companies linked to artificial intelligence.

Pedreño has participated in more than a hundred institutional forums (Association of Presidents of Constitutional Courts of Latin America, Congress of Deputies, headquarters of the Partido Popular, Alternativas Foundation report for the summit of European heads of government in Granada and MEPs in Brussels). This experience and knowledge have been reflected in two books co-authored with Professor Luis Moreno: *Europe vs USA and China. How to reverse decline in the age of artificial intelligence* (2022, 2nd edition), with a foreword by Vinton Cerf, one of the fathers of the Internet; and, more recently, Spain in the cloud. Startup Nation or the country of youth unemployment. Facing the challenges in the age of artificial intelligence.

For the preparation of this report, he has led one of the most qualified and important AI and NLP teams in Europe, linked to the 1MillionBot group, specialized in AI, which currently works for more than 30 universities and is supported by almost a hundred universities, public institutions and leading technology companies in its speciality.

In the last year, Pedreño and his team have participated in more than fifty congresses, meetings, seminars and debates with groups, etc., presenting many of the ideas contained in this report and adjusting to the demands and needs of educational institutions. They have also supported or participated in the organization of six international conferences on AI, some of them focused on educational issues.

From 1MillionBot we are grateful for the invitations to participate in various forums, as well as the support and collaboration of the University of Murcia, the University of Alicante, the University of Lleida, the University of Barcelona, Grupo Planeta, CRUE, the International University of La Rioja (UNIR), the SEK Group, UAX, and the rest of universities that have given us their trust to work with us: University of Granada,

[1] https://observatorio-ia.com/
[2] https://ost.torrejuana.es/category/encuentros/

Polytechnic University of Valencia, Polytechnic University of Madrid, University of Alcalá, University of León, University of Cádiz, Rey Juan Carlos University, University of Almería, University of Seville, Pablo de Olavide University, Autonomous University of Madrid, University of Huelva, University of Oviedo, University of Buenos Aires (Argentina), University of Jaén, Federico Santa María Technical University (Chile), University of Castilla-La Mancha, Carlos III University of Madrid, University of Zaragoza, and Complutense University of Madrid, among others.

The purpose of this report is to shed light on the key issues linking AI and higher education and to explore them in more depth.

For its elaboration, we have drawn on a varied set of resources (academic literature, news of international university projects in specialized media and blogs, such as *UniversidadSi* or *Espacios de Educación Superior*...). We highlight the inclusion of UNESCO's contributions on AI, particularly in its ethical dimensions, and how these intertwine with higher education.

The report is enriched with practical examples of AI implementation in higher education institutions. The references used are mainly in English and Spanish.

Finally, we have tested the AI itself (GPT-4, Bard, Millie-1Millionbot Prompts...) with reports and data to assimilate a large amount of information and outputs. This has been of great help in systematizing and summarizing texts in the report. It leads by example. In all cases the texts have been reviewed and contrasted.

A great effort has therefore been made to identify the key trends and concepts of AI in the educational context, as well as to conduct a detailed search for studies and cases in academic and non-academic databases that generate qualified opinions worldwide. The UNESCO report Opportunities and Challenges of the Age of Artificial Intelligence for Higher Education: An Introduction for Higher Education Stakeholders has been of great help in terms of gathering sources.

The constantly evolving field of AI poses challenges to maintain a constant perspective, and the effort made with this report is intended to be continued in the coming years.

3. WHAT IS ARTIFICIAL INTELLIGENCE?

Artificial intelligence (AI) is a constantly evolving field of study and, as such, still lacks a single widely accepted definition. The diversity of interpretations and approaches to the term is evident from the definitions offered by various institutions, technology companies and experts in the field.

John McCarthy, from Stanford University, widely recognised as one of the pioneers in the conceptualisation of AI, considered this discipline as the intersection between science and engineering with the main objective of creating machines and programs that emulate human intelligence (Martínez-Ávila et al., 1998).

Stuart Russell and **Peter Norvig** (2021), in their book *Artificial Intelligence: A Modern Approach*, define AI as "the study of agents that perceive their environment and make decisions to maximize their chances of success". This definition focuses on autonomy and decision-making capabilities.

More succinctly, **Google** sees AI as the essence of creating intelligent entities. **AI Watch**, on the other hand, offers a more detailed and technical perspective, focusing its definition on systems that, based on data, can reason and decide how to act to achieve a goal. **Yoshua Bengio** of the University of Toronto refers to AI in terms of human abilities that traditional computers cannot yet replicate (2009). **Amazon** relates AI to cognitive problem solving, similar to those associated with human thinking.

Demis Hassabis (DeepMind) describes AI as the attempt to understand intelligence by exploring the construction of intelligent entities. This definition highlights the exploration and understanding aspect of AI.

How is AI itself defined?

GPT-4/DALL-E answers the question/prompt "Give me an image that answers the question what is artificial intelligence (definition)" as follows: "I have generated a conceptual image - the one below - that represents the definition of artificial intelligence (AI) by showing a digital brain composed of circuits and binary code, symbolizing the combination of machine learning, data analysis and algorithmic processes that define AI".

Image: GPT-4/DALL-E.

What are the differences and similarities between artificial neural networks and the biological networks in our brains?

Artificial neural networks (ANNs) are inspired by the functioning of biological neural networks. Both use basic units (artificial neurons in ANNs and biological neurons in the brain) that process and transmit information.

There are many differences between ANNs and biological networks (the human brain), both in terms of complexity and scale, processing or computational capacity, learning and adaptability, as well as neural functioning itself, among others, which are shown in the following synoptic table:

Human brain	Artificial neural networks
It contains approximately 86 billion neurons with an astronomically high number of synapses (connections).	While some networks may be large and complex, they are still a long way from the scale and complexity of the human brain.
It operates in a highly parallel and distributed manner. It is incredibly energy efficient and can perform complex tasks, such as pattern recognition, very efficiently.	Although they are designed for parallel processing, they do not achieve the level of energy efficiency or the ability to perform complex tasks as naturally as the human brain.
Learns and adapts continuously, integrating new and past experiences very efficiently. Has the ability to generalize and abstract information in a flexible way.	They learn from data and require large amounts of data to train. They may have difficulty with generalization and are less adaptable to new and unfamiliar situations or data.
Biological neurons have complex and dynamic mechanisms of information processing and transmission.	Artificial neurons are simplified mathematical models that do not fully capture the complexity of biological neurons.
Synapses are dynamic and can change in seconds or remain stable for a lifetime..	The weights of connections in artificial neural networks are more static and, although they adjust during training, they do not exhibit the same dynamics as synapses.
It evolved for a variety of survival and cognition tasks.	They are designed with specific purposes in mind, such as image classification, natural language processing, etc.
It is remarkably resistant to damage and can adapt and reorganize itself after injury..	They are less resistant to component damage or failure; a failure can significantly affect their performance.

In short, although artificial neural networks are inspired by the human brain, they differ significantly in terms of complexity, efficiency, learning and adaptability. ANNs are powerful tools for specific tasks, but they are still far from fully emulating the complexity and versatility of the human brain.

Inspirational definitions and uses of AI

British computer scientist **Andrew Ng** is an eminent thinker in the field of AI and has been a pioneer in its application for many years. He founded the Google Brain project, was chief AI scientist at Baidu and co-founded the online learning platform Coursera, linked to Stanford University:

> "AI is the new electricity. It will transform every industry and create huge economic value. Technology like supervised learning is automation on steroids. It is very good at automating tasks and will have an impact on every sector – from healthcare to manufacturing, logistics and retail."[3].

Some authors have highlighted the potential of AI for the benefit of humanity:

a) **Problem-solving potential.** AI has the ability to analyze large amounts of data quickly and with an accuracy that often exceeds human capability. This allows it to solve complex problems in diverse fields, such as medicine, where it can help in the diagnosis and treatment of diseases; engineering, where it can optimize designs and processes; and ecology, where it can contribute to the modeling of climate change and the preservation of biodiversity. This potential makes AI an invaluable tool for the advancement and well-being of humanity, capable of tackling some of the world's most significant challenges.

b) **Automation and efficiency.** AI can handle repetitive, high-volume tasks with an efficiency and accuracy that humans cannot match. This frees people to focus on more creative and strategic work, improving productivity in industries and businesses. For example, in manufacturing, AI can increase production line efficiency, while in the service sector it can automate responses to customer queries.

c) **Personalization and adaptation.** AI has the ability to learn and adapt to user behavior and preferences. This manifests itself in the personalisation of services, such as product recommendations in e-commerce or personalisation of learning experiences in education. This level of personalisation helps improve the user experience and can drive significant advances in personalized medicine and adaptive education.

d) **Human-machine collaboration.** AI is changing the way we interact with technology, potentially fostering closer collaboration between humans and machines. This can improve task efficiency and open up new forms of creativity and exploration. In fields such as graphic design, music composition or scientific research, AI is becoming a tool that significantly extends human capabilities.

e) **Advances in knowledge and discoveries.** AI has the power to analyze and find patterns in data sets that would be impossible to examine manually. This leads to new discoveries and insights in areas such as genomics, astrophysics and

[3] https://www.wipo.int/wipo_magazine/en/2019/03/article_0001.html

archaeology, among others. The ability to process and understand large volumes of information is leading to revolutionary discoveries that can change our very understanding of the world and the universe.

3.1. Types of AI: weak or narrow AI vs. general or strong AI

Although there are multiple ways of approaching and classifying AI, for ease of understanding, two main categories can be highlighted: **narrow or weak artificial intelligence (ANI) and general or strong artificial intelligence (AGI)**.

ANI is what technology has managed to develop so far. These machines or programmes are designed to perform specific tasks within predetermined parameters and frameworks. Common examples of ANIs include virtual assistants, biometric recognition systems and machine translation tools. Despite their ability to perform tasks with precision, ANIs lack the versatility and depth of reasoning of human intelligence.

In contrast, **artificial general intelligence (AGI)** is an as yet unrealised ideal that refers to machines or systems capable of performing any intellectual task that a human being can do. This form of AI would not only be capable of performing specific functions, but would also be able to learn, reason and adapt in a similar way as a human would in a variety of contexts.

The evolution of AI poses many opportunities and challenges, especially in higher education. It is essential to understand these categorizations and developments to prepare for and adapt to the era of AI in education and other fields.

Nick Bostrom, a prominent Swedish-born philosopher, introduces another category, **artificial superintelligence (ASI)**, which he describes as "an intellect that vastly exceeds human cognitive abilities in almost every field of study" (Bostrom, 2014: 24).

In addition to these orderings, AI can be organized by function or development: reactive machines, limited memory, theory of mind, and self-awareness.

Reactive machines. These are basic forms of AI that do not store past experiences, but simply respond to present situations (Chaudhari et al., 2020). An iconic example is **Deep Blue**, the IBM computer that defeated chess champion Gary Kasparov. However, its specialization is limited to playing chess; it cannot perform other tasks.	**Limited memory**. It represents a more advanced form of AI than reactive machines. These machines retain information temporarily and act on it. A contemporary example would be an **autonomous vehicle** that uses data from the environment to make real-time decisions, such as braking or turning (Vatan et al., 2019).

Theory of mind. It focuses on the ability to understand and empathize with emotions, beliefs and thoughts. Although this level has not yet been fully achieved in AI (Cuzzolin et al., 2020), certain advances, such as the **Kismet robot**, which can detect emotions based on facial expressions, indicate progress in this direction.	**Self-awareness**. It would represent the pinnacle of AI evolution, where a machine would not only be able to process information and emotions, but also to be aware of itself and its own thoughts (Chaudhari et al., 2020). This is still a theoretical stage, not present in current technology.

The development and categorization of AI demonstrates the vast potential and challenges of this evolving field.

3.2. Predictive AI vs. generative AI

AI currently manifests itself in two main dimensions: **generative and predictive**. While the **predictive** dimension relies on algorithms to interpret data and anticipate future events based on historical data, the **generative** dimension aims at developing unpublished content.

In education, **predictive AI** plays a key role in optimizing personalized learning platforms, managing student enrollment, and driving academic success. In contrast, **generative AI**, which uses advanced techniques such as artificial neural networks, is capable of generating content of a quality comparable to that of a human.

Generative adversarial networks (GANs) are central to this approach, where one network elaborates content and another evaluates it. **Variational autoencoders** (VAEs) are another relevant tool that processes and produces new data sets. In the educational context, **generative AI** provides teaching materials, automated feedback, and fundamental support. In addition, this modality allows educators to adapt and translate their materials for diverse audiences.

With the advent of tools such as **ChatGPT** in the education sector, the discussion about the role of **generative AI** has gained momentum. Despite being a relatively recent concept, the ease of access and use of these tools has driven their popularity. However, there is concern that they may exacerbate human biases.

It is vital that adopters exercise caution, especially in educational contexts, where problems such as inaccuracies in content or erroneous assessments may arise. Hence,

companies working for the education sector should focus on **controlled and optimized models** that use a variety of resources to provide the best possible guarantees for their operation.

When delving into AI techniques and subfields, it is important to note that, when we talk about AI, we are referring to **narrow AI (ANI)**, the most present modality today. Although machine learning is essential in this field, there are other very relevant techniques.

Prominent among these techniques is **symbolic logic**, which relies on pre-established logical rules to produce information. Chatbots or intelligent virtual assistants are notable examples that can employ this technique. During the recent COVID-19 pandemic, the demand for online solutions accelerated the adoption of chatbots, transforming the way society interacts and accesses different services.

3.3. Current status of AI

Although artificial intelligence (AI) does not yet possess self-awareness or theory of mind capabilities, its relevance has grown significantly in recent years.

Publications and patents

Publications in this field have increased dramatically, experiencing a jump in their annual growth rate from 10% between 2005 and 2015 to 23% after that period. In 2018, these publications accounted for 2.2% of all scientific research (Baruffaldi et al., 2020). In 2021, nearly half a million papers were published on AI, especially in English and Chinese (Stanford University, 2023).

However, it is noteworthy that most of this research comes from a few countries, mainly the United States, China, and the United Kingdom. Moreover, this research is concentrated in areas such as computer science, indicating a certain lack of a multidisciplinary approach to the subject.

The growing interest in AI is not only evident in publications, but also in the patent arena. Since 2015, AI-related patent applications have increased more than thirty-fold. In fact, more than half of all AI inventions have been published since 2013.

This boom in interest in AI is not limited to academia. The business sector has also invested significantly in the area. Deals and investments in AI startups increased by 75% annually between 2013 and 2018. In 2019, around $40 billion was invested in AI startups, and due to undisclosed transactions, the actual number could be as high as $74 billion.

Economic projections suggest that AI could contribute as much as $15.7 trillion to the global economy by 2030. The importance of AI in the business world is such that 84% of executives believe they will not achieve their growth goals if they do not implement AI

on a large scale. Furthermore, 75% feel they could become obsolete in the job market within five years if they do not adopt this technology.

A large part of the estimates indicate that AI will account for up to half of the GDP growth of advanced countries in the next 15 years. According to McKinsey, **generative AI** alone will generate a volume equivalent to the UK's GDP, through 62 use cases alone and without considering its impact on software.

The recent fascination with AI is due to several factors, including the availability of more reliable and abundant data, advances in algorithms, and robust funding.

Today, the world is awash in data from sources such as smartphones and smartwatches, social networks, online stores, security systems, educational platforms, and even thermostats. This data is collected at an unprecedented rate and this trend is expected to continue to increase (Reinsel et al., 2018). AI thrives on this data, using it as a basis for learning and offering services such as personalized streaming recommendations or online shopping. Some experts have compared the importance of data for AI to that of oil for industry (*The Economist*, 2017). This is why social networks, for example, offer free services to users but monetize their data by selling it for advertising or market research.

To manage this flood of information, the demand for computational capacity has grown exponentially. In addition to the proliferation of data and the increase in computational capacity, advances in algorithms have been crucial to the renaissance of AI (Executive Office of the President, 2016). An algorithm is basically a set of instructions designed to solve a specific problem (Negnevitsky, 2005), such as determining what content to display on a social network or how to filter unwanted emails. Without these algorithms, AI would not be possible. As computational power has increased, algorithms have become more sophisticated, which has facilitated the emergence of advanced AI techniques, such as deep machine learning.

3.4. How AI is applied

Artificial intelligence (AI) has permeated multiple facets of our daily lives, transforming the way we interact with technology and how it serves us.

Within the every day, we find classic virtual assistants, such as Siri and Alexa. These are not simple programs that respond to commands; in fact, they integrate machine learning algorithms that allow them to adapt, learn from their mistakes, and provide increasingly accurate and personalized responses as they interact with users.

In the field of digital communication, **chatbots** have revolutionized the way companies interact with their customers. And, beyond conventional chatbots, models like ChatGPT have stood out for their ability to have conversations that are almost, if not quite, human. Unlike basic chatbots that are driven by predefined responses, ChatGPT and other advanced large language models (LLMs) are powered by huge data sets, allowing them to understand the context and provide tailored responses to each situation. **This evolution in AI-based communication has been so significant that, in 2023, ChatGPT**

became an indispensable tool for university students with subjects some of whose professors acted with an open mind to this technology.

Everyday AI has also made its mark in areas such as email and social networks. Rather than simply serving as communication platforms, these technologies can now learn from user interactions and preferences, thus improving the overall experience, whether by organizing emails or suggesting content tailored to individual tastes.

In the world of entertainment, streaming platforms (Netflix, Spotify...) use AI algorithms to analyze user preferences and recommend content according to their tastes. Likewise, transportation applications (Uber, Cabify...) incorporate AI to optimize routes, assign drivers, and improve service efficiency.

The automotive industry is not lagging behind: it is moving towards the creation of semi-autonomous and, eventually, fully autonomous vehicles. These vehicles will not only offer comfort but also, at least potentially, higher levels of safety. However, the road to full autonomy is fraught with technical and ethical challenges.

The financial and healthcare sectors have also undergone transformations thanks to AI. While banks and other financial institutions use AI for predictive analytics and fraud detection, the medical sector uses it to provide more accurate diagnoses through medical image analysis and generative AI.

.

IMAGE GPT-4/DALL-E: Collage showing the positive impact of AI in healthcare, education, agriculture, finance, the automotive sector and entertainment.

In education, AI promises to revolutionize the way teaching and learning take place. AI-based tools, such as intelligent tutoring systems, offer adaptive solutions, providing students with a personalized learning experience. In addition, emerging technologies such as virtual reality (VR) and augmented reality (AR) are being integrated by the boldest entities into the educational curriculum, offering immersive and enriching experiences.

Chatbots against COVID

During the COVID-19 pandemic, 1MillionBot developed an intelligent virtual assistant to inform the public about the disease, provide preliminary diagnoses based on symptoms, and answer frequently asked questions.

Using as sources only the information disseminated by official entities, such as the World Health Organization (WHO), the European Centre for Disease Prevention and Control, and the Ministry of Health of the Government of Spain, the assistant, named Carina, was given free of charge to private companies and public administrations to insert it into their respective websites and thus help to contend with the avalanche of questions and information of dubious certainty that emerged from mid-March 2020.

The purpose behind the creation of Carina was to provide quick and accurate answers to the most common questions about the pandemic and the disease, as well as to alleviate the pressure on health systems and help in the dissemination of information based on scientific evidence. According to Raquel Pomares, Ph.D. in biology and director of the project, the aim was none other than, by applying AI, "to be able to resolve the general doubts about the coronavirus that are within our reach and provide an immediate and effective response, without going into questions that should be left to medical personnel and epidemiologists".

Following the great acceptance of Carina, in early 2021 1MillionBot launched Salva, a virtual assistant that provided information on issues related to the various vaccines against COVID-19 that had already then come onto the market, as well as on the vaccination process itself in Spain.

This assistant cleared up the unknowns about the vaccine and its protocols, appealing to the collective and adapting precisely to the singularities and guidelines of each autonomous community. In this way, Salva, in addition to providing updated information (the answers were based on information from the Ministry of Health of the Spanish Government) on a complex and particularly sensitive subject, helped to mitigate the misgivings that a certain part of the population had about the vaccination process, becoming a channel capable of communicating about the vaccines in circulation, the protocols against adverse reactions, the possible contraindications, the intrinsic benefits of getting vaccinated and the established deadlines.

3.5. AI and use of advanced applications

In recent years, AI has extended its applicability to countless use cases. With generative AI, there has been an explosion of relevant applications. But scientists and large companies have high expectations that AI will be able to tackle major challenges facing humanity, from the complexity of climate change to the progressive response to complex diseases such as cancer.

AI also empowers and is empowered by other digital technologies such as sensorization, IoT, specialized software (robotization), or future developments that will increase our capacity, such as quantum computing…

Two examples: AI applied to agriculture and climate change.

An example of an advanced use case is AI applied to agriculture for the purpose of regenerating land and promoting sustainable and environmentally friendly methods.

Advanced applications of AI in agriculture

The most advanced application of AI in agriculture, especially in the context of land regeneration and natural ecosystem design, combines several technologies and strategies. Here is an overview of how it can be integrated in this area:

1. **Data analysis and crop forecasting**. AI can analyze large data sets to predict optimal growing conditions for different crops. This includes using drones and satellites to monitor soil conditions, weather, and crop health.

2. **Optimization of water and nutrient use**. AI can help in the efficient management of water and nutrients with sensors and intelligent irrigation systems that automatically adjust the amounts of one and others according to plant needs.

3. **Permacultural ecosystem design**. Using AI models, ecosystems can be designed in a way that they mimic natural processes. Example: selecting combinations of mutually beneficial plants (beans, which fix nitrogen in the soil) and plants that naturally repel pests.

4. **Weed and pest control**. AI can identify and differentiate between crops and weeds, allowing selective weed control without damaging crops. It can also monitor and predict pest outbreaks, allowing earlier and more natural interventions.

5. **Regeneration of degraded land**. AI can analyze soil characteristics and propose concrete strategies for soil regeneration: crop rotation, planting of soil-enriching species, and minimum or no-tillage techniques.

6. **Integration with other sustainable technologies**. AI can be combined with other technologies (precision agriculture, robotics...) to improve the efficiency and sustainability of agricultural practices.

7. **Ecosystem modeling and simulation**. AI can create detailed ecosystem models that help to better understand how different agricultural practices affect the environment and biodiversity.

AI in sustainable and regenerative agriculture focuses on increasing efficiency and productivity and maintaining and improving ecosystem health, conserving natural resources and promoting biodiversity.

NaLamKI project, Germany	Collaboration between Microsoft and Danone, Europe	CiBO Technologies, Global: CiBO Technologies
The Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut (HHI) is working on the NaLamKI project to create a cloud-based software-as-a-service that will collect data from devices and machines to provide a database for forecasts and decision aids. Optimize agricultural processes (irrigation, fertilization, and pest control) with AI to improve crop yields, reduce emissions, and care for biodiversity[4].	In collaboration with EIT Food, Microsoft and Danone are working to accelerate the development of agricultural startups specializing in AI. Danone, in particular, focuses on regenerative agriculture practices, protecting the soil and empowering a new generation of farmers through long-term contracts and price management systems. This project seeks to optimize and simplify regenerative agriculture so that it is integrated into farmers' daily activities[5].	It uses data analysis, statistical modeling and AI to simulate field trials and agricultural ecosystems under different conditions. This allows farmers to avoid costly field trials and test regenerative farming practices virtually, without the risk of damaging the environment or sacrificing yield. In addition, they combine AI algorithms with robotic technologies to automate and control the agricultural process, such as determining the optimal time for harvesting and performing harvesting with autonomous robots[6].

AI and climate change
Efficiency in monitoring and reducing emissions. Companies such as Google and Microsoft and global consultancies such as BCG and PwC are using AI to improve efficiency in monitoring and reducing greenhouse gas emissions. **Forecasting and disaster recovery**. AI is being used to improve natural disaster forecasting and recovery capabilities, a crucial aspect given the increase in extreme weather events. **Decarbonization of industrial processes**. AI is helping industries to decarbonize their processes, thereby reducing their carbon footprint.

4 https://www.fraunhofer.de/en/press/research-news/2021/november-2021/ai-technologies-for-sustainable-agriculture.html

5 https://www.eitfood.eu/blog/farming-for-a-better-climate-five-examples-of-regenerative-agriculture-done-well

6 https://www.mckinsey.com/capabilities/sustainability/our-insights/feeding-the-world-sustainably

Reducing airline contrails. American Airlines has used AI to more than halve its contrails (condensation trails), which contribute to global warming.
Eco-friendly routes on Google Maps. Google claims that, thanks to AI-powered eco-friendly routes on Google Maps, more than 2.6 million tons of greenhouse gasses have been avoided.
Monitoring tools such as Climate Trace. Using AI and a network of satellites, tools like Al Gore's Climate Trace can monitor emissions from more than 350 million sites in detail.
Research and development of climate technologies. AI accelerates research and development of emerging climate technologies, such as nuclear fusion, by rapidly analyzing scientific literature and identifying promising materials and processes.
Nuclear fusion AI learning model. Google's DeepMind has developed an AI learning model for controlling plasma shapes in nuclear fusion reactors, a critical step toward the commercialization of fusion power.
Climate intelligence. Tools such as ClimateGPT, an AI chatbot, contribute to the formation of a global consensus on climate action and help to better understand the policies and actions needed to address climate change.

Source: ImpactAlpha (2023) *AI's killer app: Guiding humanity through the climate challenge*.

3.6. On strong AI and the debate on whether it would be achievable

Strong artificial intelligence, also known as artificial general intelligence (AGI), refers, as mentioned above, to a form of artificial intelligence that can understand, learn, and apply its intelligence to a wide range of problems, similar to the way a human being does. Unlike weak or narrow artificial intelligence (ANI), which is designed for specific tasks, AGI would have the ability to apply its intelligence in a flexible and adaptive manner.

As to when AGI will be achieved, there is currently no clear consensus in the scientific and technological community. It is a subject of great speculation and debate, and estimates vary widely. There is no consensus on a specific date; opinions range from cautious technological optimism to significant scientific skepticism. AGI remains a long-term goal in the field of AI, with many technical and ethical challenges to be resolved.

An interesting report on artificial intelligence, including aspects of strong artificial intelligence (AI) or general artificial intelligence (AGI), is the one presented by the European Parliament, entitled *Report on Artificial Intelligence in the Digital Age* (European Parliament A9-0088/2022). This report was developed by the Special Committee on Artificial Intelligence in the Digital Age (AIDA). It focuses on the impact and importance of AI in today's digital transformation and proposes a roadmap for the European Union to respond to the economic and societal challenges related to AI in the coming years.

This report highlights the need for a favorable regulatory environment for AI, including the regulation of high-risk applications and the importance of high-quality data. It also addresses the need for an integrated and harmonized digital single market, robust infrastructure, and connectivity to facilitate AI innovation. Furthermore, it underlines the importance of fostering an ecosystem of excellence in AI, where citizens can acquire digital and AI skills and international cooperation in these fields is promoted.

Stanford University and MIT have contributed significantly to the debate and research on strong artificial intelligence (AI) or artificial general intelligence (AGI). The following is a summary of their perspectives and findings:

Some important assets for the AGI

Advances in self-supervised learning and transformers. Stanford highlights significant advances in self-supervised learning and neural network architectures such as transformers[7]. These methods are emerging as promising tools for building more general AI systems, applicable to a wide variety of data.

MIT also highlights several approaches under development, such as the aforementioned self-supervised learning, transfer learning, commonsense inclusion and causal inference, and learning optimizers. These areas are based on deep learning. Meta-learning and multi-task learning are AI systems that can learn multiple tasks simultaneously, avoiding catastrophic interference between tasks. Meta-learning is contributing to implicit knowledge about the world and the ability to make analogies[8].

Both Stanford and MIT acknowledge significant progress towards AGI, although they also emphasize that we are still a long way from achieving it. There is growing interest and acceptance of the concept of AGI, but it is recognized that significant challenges remain, including the development of common sense in AI and the ability to learn more pervasively and flexibly.

Why Open AI developments, such as GPT-4, suggest that general AI is getting closer

GPT-4, with its advanced capabilities, has fuelled the debate on how close we are to achieving general AI. Some of the reasons for this enthusiasm include:

1. **Multidisciplinary skills**. GPT-4 shows a remarkable ability to perform tasks in a wide range of disciplines, from programming languages to creative writing, suggesting a step towards the flexibility of AGI…

7 https://ai100.stanford.edu/gathering-strength-gathering-storms-one-hundred-year-study-artificial-intelligence-ai100-2021-1/sq5

8 https://www.technologyreview.com/2020/10/15/1010461/artificial-general-intelligence-robots-ai-agi-deepmind-google-openai/

2. **Improved comprehension and text generation**. GPT-4 demonstrates a deeper understanding of natural language and an ability to generate coherent and contextual responses, coming closer to how humans process and use language.

3. **Ability to learn and adapt**. Although GPT-4 still relies on supervised learning and cannot learn autonomously as an AGI would, its ability to adapt to a wide range of tasks and questions shows remarkable versatility.

4. **More intuitive interface to humans**. The ease of interaction with GPT-4, where users can get detailed and contextualized answers, reflects a move towards AI systems that humans can interact with more naturally and effectively.

However, it is important to note that, although GPT-4 is a significant advance in AI, it is still far from being an AGI. GPT-4 does not possess conscious understanding, self-awareness, nor the ability to form intentions or goals of its own, all of which are key elements in the definition of AGI. Furthermore, GPT-4 operates within the limits of its training and cannot perform tasks outside this scope or learn new skills independently.

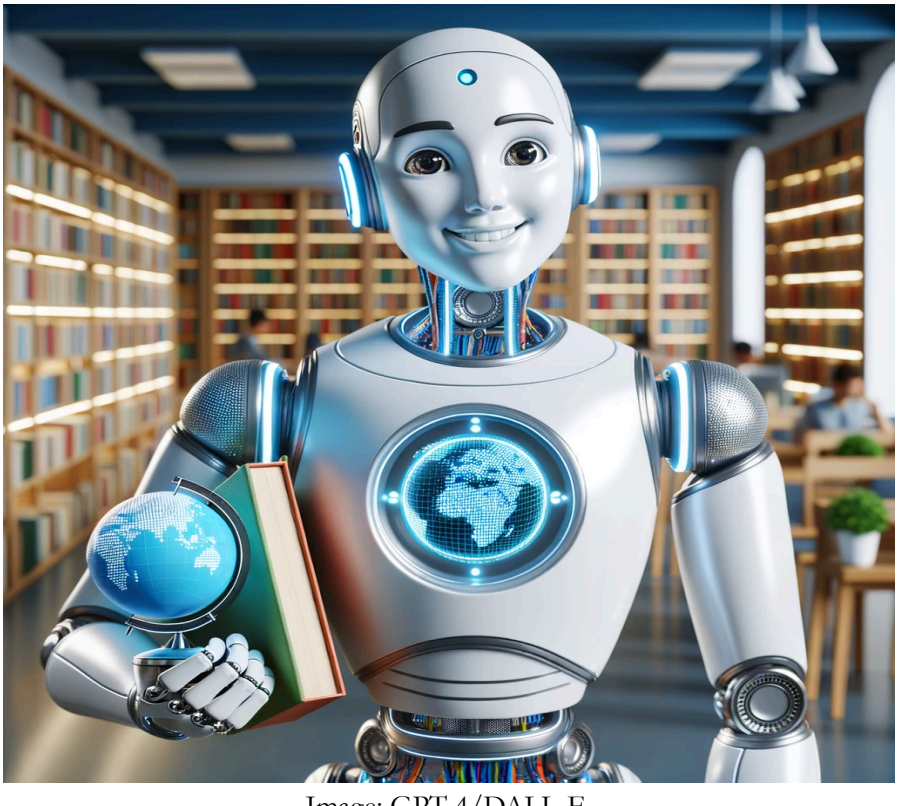


Image: GPT-4/DALL-E.

Yann LeCun's response to G. Hinton on the *risk of human extinction* due to AI

"LLMs obviously have *some* understanding of what they read and generate.
But this understanding is very limited and superficial. Otherwise, they wouldn't confabulate so much and wouldn't make mistakes that are contrary to common sense.

I have argued, since at least 2016, that AI systems need to have internal models of the world that would allow them to predict the consequences of their actions, and thereby allow them to reason and plan.
Current Auto-Regressive LLMs do not have this ability, nor anything close to it, and hence are nowhere near reaching human-level intelligence.
In fact, their complete lack of understanding of the physical world and lack of planning abilities puts them way below cat-level intelligence, never mind human-level.

AR-LLMs can accumulate large amounts of textual knowledge (if only approximately) and can retrieve it with appropriate context (if only approximately). More than a cat, certainly.

But how is that any 10 year-old can learn to clear up the dinner table and fill up the dishwasher in one shot, whereas we are nowhere near having robots capable of learning this in any amount of time? Obviously, we are still missing something really big to reach human-level AI.

I have written where I think AI research should go over the next decade or two to bridge that gap:
https://openreview.net/forum?id=BZ5a1r-kVsf

All my talks of the last couple of years have been on "objective-driven AI architectures" which are an attempt to bridge that gap while making AI systems controllable, safe, and subservient to humanity. E.g. this one:
https://www.youtube.com/watch?v=pd0JmT6rYcI".

4. ARTIFICIAL INTELLIGENCE IN EDUCATION

A joint study conducted by **Microsoft** and ***Times Higher Education*** revealed a shocking statistic: **approximately 90% of participants believe that AI will play a crucial role in changing both curriculum structure and pedagogical strategies in education** (Pells, 2019). This statistic highlights a growing trend towards the integration of advanced technology in education and reinforces the idea that we are in the early stages of a technological revolution in education.

Many universities have highlighted the impact of AI on higher education. For example, **Stanford University** (Claire Chen, 2023) has addressed the potential of AI to transform education in numerous papers, highlighting the potential to improve personalized support on a large scale, change what is important to students, and enable learning without fear of judgment. It also points to significant risks, such as the lack of cultural diversity in AI models and the possibility that AI may not optimize student learning.

MIT, through the **Sloan School**, has also explored the potential of AI to enhance teaching and learning, offering fundamental AI concepts, practical guides, subject-specific use cases, and expert training and insights. It stresses the importance of keeping up to date with the latest research and AI-driven changes in education.

The **Harvard Graduate School of Education** has examined how generative AI, especially since the launch of ChatGPT-3 by OpenAI, is impacting higher education. It addresses the spectrum of views on AI, from the need to limit its use to protect higher education to the adoption of this tool to improve it. The report also discusses the challenges and opportunities that generative AI presents for improving the quality of higher education.

The **AACSB** report[9] *How AI Is Reshaping Higher Education* emphasizes the need for students to develop new skills and for educators to adopt new ways of teaching. It stresses that AI is likely to become the primary way humans access information, requiring faculty to prepare students to use technology effectively in their lives and careers. The report also discusses the importance of 'cue engineering' to effectively interact with AI platforms and the disruptive role of AI in traditional teaching models, urging educators to adopt evolved pedagogical models that integrate AI.

[9] https://www.aacsb.edu/insights/articles/2023/10/how-ai-is-reshaping-higher-education

The **Beijing Consensus**, aware of this emerging reality, has taken a proactive stance on the issue. It urges government administrations, educational institutions, and other relevant actors to recognize and prepare for both the immense potential offered by AI and the challenges inherent in its integration. This preparation is not only about technological infrastructure but also about a thorough understanding of how these changes will affect the traditional dynamics of teaching and learning.

One of the most resonant positions of the **Beijing Consensus** is its emphasis on human interaction. We must remember that education, at its core, is a human act. **AI can be a valuable tool to complement and enhance teaching, but it should not, under any circumstances, attempt to supplant the essence and irreplaceable role of the educator**. We must empower students and teachers with AI but never undervalue the human components.

In this context, there is an inescapable need to explore the various facets in which AI can bring benefits. From personalized curriculum adaptation, which takes into account the individual needs and abilities of each student, to advanced tutorial systems and chatbots specifically designed to support and enrich teaching processes. Virtual and augmented reality technologies are also on the rise. These not only bring a whole new dimension to the learning process but also promote inclusion and student well-being by providing immersive and personalized learning environments.

Finally, **the importance of training and professional development for educators in this era of rapid technological advancement cannot be overlooked**. Tools are only as good as those who use them. Therefore, ensuring that educators are equipped and trained to make the most of these technologies is essential. Throughout this chapter, concrete examples of how various higher education institutions around the world have approached and adopted these AI tools will be provided. In addition, the challenges and potential issues that arise with the implementation of these advanced technologies will be discussed in depth.

Image generated by GPT-4/DALL-E: Shows AI in the field of education, empowering both teachers and students. The scene depicts a classroom where an AI system actively assists in teaching, with a diverse group of students interacting with AI-powered educational tools and a teacher using AI to enhance his teaching methods.

4.1. Personalized learning

Adaptive learning is an educational method that uses technology to personalize the learning experience based on the individual needs and abilities of each student. This approach relies on algorithms and data to adjust content, pace, and teaching style according to student progress and performance.

Key features of adaptive learning include:

1. **Personalization**. Content and activities are adapted to the learner's skills and prior knowledge.
2. **Continuous feedback**. Immediate and personalized feedback on student performance is provided.
3. **Dynamic adaptation**. The system adapts the content in real-time, based on the student's responses and progress.
4. **Learner-centered approach**. Prioritizes individual student learning needs.
5. **Use of data**. Collects and analyzes data on learner performance to inform and improve the learning experience.

Adaptive learning is particularly useful for addressing the diversity of learning styles and paces in a classroom and is increasingly used in online and digital learning environments…

Source: 1MillionBot Prompts/GPT-4.

Adaptive learning provides specific feedback for students and teachers, identifying those students with difficulties and potentially preventing them from dropping out, which in turn enhances overall learning (Keller et al., 2019; Rouhiainen L., 2019).

AI tools allow learners to progress at their own pace, suggest additional resources when needed, and provide educators with insight into the learner's progress (Vincent-Lancrin and Van der Vlies, 2020). This adaptability is crucial to avoid the limitations of a set pace based on an 'average' learner, which may be too fast for some and uninspiring for others.

Adaptive learning encompasses a variety of applications, categorized into three primary approaches: systems-based, learner-centered, and blended (Fake and Dabbagh, 2023).

A review of 39 studies in the university context (Fariani et al., 2023) showed that:

- **53%** of all models **emphasize customized e-learning**
- **21%** integrate with existing **learning management systems**
- **16%** relate to **recommender systems**
- **11%** relate to **smart tutoring**

Specific areas of higher education, such as biotechnology, have employed AI to meet the demands of **interdisciplinary learning**, using individualized teaching structures detected through AI (Goh and Sze, 2018). In subjects with defined learning objectives, such as **foreign language learning**, AI is a valuable tool to personalize and optimize the process. Thus, in a study of 82 Japanese English language learners, those who incorporated AI into their learning process improved by 32 points on the TOEIC (standardized English language test). The students' responses also supported the effectiveness of AI in their learning process.

One adaptive learning success story is that of **Florida International University (FIU)**. It used adaptive learning in an effort to reduce attrition rates among engineering students, as well as to help students better utilize the algebra content required in the Calculus for Engineering course and promote an engineering identity in students, especially among those from underserved backgrounds in the discipline. They planned to create a multi-level support program for the course through the use of adaptive learning, prioritizing cost and student access to course materials. They also planned an optional six-week extended semester of adaptive course material for students who had difficulty with the mathematical topics
See more at:
https://www.everylearnereverywhere.org/es/resources/adaptive-courseware-for-early-success-case-study-florida-international-university/

Arizona State University (ASU) has developed the first biology degree based on adaptive learning, marking a significant shift in undergraduate science education. This program, led by the School of Life Sciences, uses the BioSpine adaptive course, which customizes learning to the individual needs of students. The technology, co-created with CogBooks, focuses on adjusting the content and pace of learning in real-time, offering structured support throughout the four years of the degree program. Its initial results have been remarkable, with a 24% increase in pass rates and a 90% decrease in dropout rates in a biology course for non-majors. The program has transformed the role of teachers from lecturers to active leaders in the learning process.

Image GPT-4/DALL-E: Two students of different heights try to see over a wall. The shorter student is climbing on a pile of books to reach the same height as the taller student, symbolizing the support that personalized education provides for equal opportunities in learning. The scene represents how personalized education helps to overcome educational barriers, allowing both students to explore and discover on equal terms.

4.2. Intelligent tutoring

Intelligent tutoring systems (ITS)[10] use computer technology and rely on artificial intelligence to deliver personalized instruction, seeking to replicate the benefits of in-person tutoring.

An **intelligent tutoring system (ITS)** is a type of educational software designed to provide a personalized and adaptive learning experience to students. These systems use Artificial Intelligence techniques to simulate the personalized instruction that could be provided by a human tutor. Key features of an ITS include:

1. **Personalization**. ITSs adapt to the needs, abilities, and learning pace of the students; they offer a more personalized learning experience.

2. **Immediate feedback**. They provide instant feedback to students on their performance and progress, helping them to better understand their mistakes and improve in specific areas.

3. **Models to understand the learner**. They use models to understand and predict student needs and behaviors, adjusting instruction according to the student's level of knowledge and learning preferences.

4. **Dynamic content**. ITSs generate and present educational content based on student interaction with the system, ensuring that the material is relevant and challenging.

5. **Bidirectional interaction**. They allow two-way interaction between students and the system, allowing students to ask questions and receive explanations tailored to their needs.

6. **Continuous assessment**. Continuous evaluation of the student's progress to further adapt and personalize the teaching.

7. **Motivation and participation**. They can include elements of gamification and other methods to keep learners motivated and engaged.
In short, an intelligent tutoring system seeks to emulate the benefits of a human tutor through technology, providing an adaptive, personalized, and effective learning experience.

Source: 1MillionBot Prompts/GPT-4.

[10] They are designed to actively monitor and support learners (Amokrane et al., 2008). These systems provide tailored learning paths, while equipping the educator with tools to track learners' progress in real time and assist them when necessary. In turn, students access a wide set of educational resources tailored to their needs (Escotet, 2023).

Image: GPT4/DALL-E.

An essential feature of **ITSs** is their ability to manage personalized interactions in the educational process (Hone and El Said, 2016), track learning progress, develop content, and facilitate assessments. They use a system called "knowledge tracking," which grades students' responses during exercises and problems, allowing ITSs to assess their progress and understanding. Most of these models rely on student responses to predict and adapt future interactions (Fazlija, 2019). A significant advantage is the generation of tailored content, such as exercises that match the learner's skill level. They also excel in offering automatic grading and various assessment methods, allowing students to receive feedback on a constant basis and self-assess through self-generated tests (Fazlija, 2019).

ITSs are especially efficient in data-rich and well-defined domains, such as mathematics (UNESCO, 2018). By tailoring instruction based on individual student responses, these systems can provide highly personalized support, deriving better academic outcomes.

In the United Kingdom, the Open University has created **ITSs** for a variety of purposes (Marouf et al., 2018; Van Labeke et al., 2013).

A review of the literature indicates that the predominance of ITSs is in areas such as **engineering** (39%), followed by **science** (21%), **health sciences** (16%) and **mathematics** (12%). However, their presence is less frequent in fields such as social studies (2%), art and languages (7%), and business studies (3%) (Ambele et al., 2022).

4.3. Virtual assistants as facilitating tools in education

AI-powered chatbots offer opportunities for personalized learning and provide assistance to students. These technological tools are capable of handling student queries and directing them to the appropriate material and resources, mimicking the fluidity and naturalness of a human conversation.

In recent years, this tool has become increasingly popular in universities. Some have gained a lot of celebrity among students themselves in the most diverse countries. During the COVID-19 crisis, the Universidad Veracruzana in Mexico created a chatbot specifically aimed at students of the undergraduate degree in Computer and Administrative Systems of the Faculty of Accounting and Administration and dedicated to offer tutoring (Galindo Monfil et al., 2022). On the other hand, the University of Bolton (UK) implemented Ada, a chatbot that has provided tailored instruction and assessment to the needs of 70,000 students, also answering questions related to curriculum and attendance regulations (Bolton College AI Ada-chatbot, 2019).

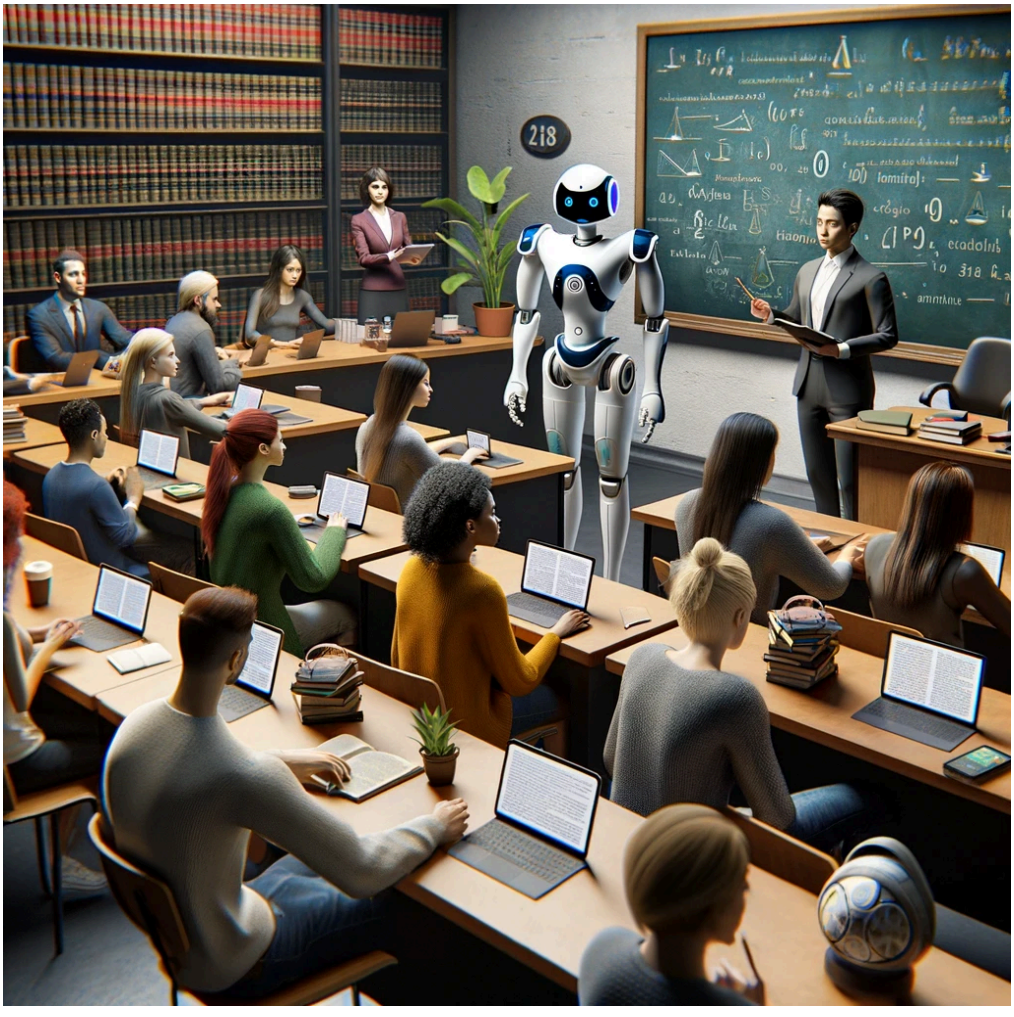


Image: GPT-4/DALL-E.

The chatbot QuestionBot, used by the University of New South Wales in Australia since 2019, is able to respond to students based on similar questions previously answered by humans. In addition, it locates course materials, such as lecture recordings, and pinpoints the exact segment where the answer might be found based on keywords. It can also answer specific student queries, such as tutorial dates or exam topics, by linking to relevant resources. The bot rates its level of confidence in each answer and collects feedback on its usefulness, thereby refining its accuracy over time (MSAUEDU, 2019). Such a level of adaptation, targeting many students simultaneously, would be an impossible feat for a traditional teacher.

The faculty of Information Technology at Ho Chi Minh City University of Science in Vietnam created the FIT-EBot in response to repeated student queries and the need to expedite responses. Despite its effectiveness, the creators acknowledge current

limitations related to university databases and the need for more data for training (Hien et al., 2018). It highlights the essential human collaboration in the evolution of AI.

The use of chatbots to support teaching is a growing trend. They act as tutors or virtual assistants, freeing the teacher from some administrative tasks and managing large student-to-instructor ratios (Essel et al., 2022). In 2016, the Georgia Institute of Technology in the United States surprised students by revealing that Jill Watson, an AI chatbot, had been answering their basic queries throughout the semester (Georgia Tech, 2016).

In 2021, a study at the Kwame Nkrumah University of Science and Technology in Ghana showed that the KNUSTbot chatbot improved the academic performance of students who interacted with it thanks to immediate feedback and its constant availability (Essel et al., 2022). However, students expressed concerns about the timeliness or depth of the chatbot's responses, questioning its applicability to conceptual learning beyond technical queries.

In Spain, the University of Alicante, through the Department of Private International Law and 1MillionBot, promoted the Bártolo project two years ago with a relevant involvement of faculty and students.

The first mission of this assistant was to collect for a year all the doubts that the subject presented among students, interacting with them 24/7 through a chatbot. This tool allowed students to raise doubts exhaustively at the moment they arose: in the classroom or during the collection of notes, reading texts, exam preparation…

The result was spectacular: more than 2,000 questions on a subject that revealed many lessons about the very different levels of understanding and monitoring of the subject with a view to a more personalized teaching.

The involvement of teachers and students in the generation of answers (with very involved students' undergraduate thesis) and the insertion of ChatGPT-type generative AI combined with the control of specific answers through the Millie platform with a dashboard for teachers has allowed very significant advances within the experiences carried out at national and international level.

Bártolo, la IA que revoluciona la enseñanza jurídica y desafía el abandono estudiantil

por evaperez | Ago 2, 2023 | Aplicaciones, Asistentes virtuales, Chatbots, General, Tecnologías IA

En un emocionante cruce de tecnología e innovación educativa, la Universidad de Alicante y 1Millionbot han unido fuerzas para crear Bártolo, una herramienta de inteligencia artificial destinada a revolucionar la enseñanza del Derecho Internacional Privado.

The central objective of Bártolo is to increase the retention rate of students, facilitating the understanding of complex content and preventing dropout. But it goes further: Bártolo is a virtual tutor that can recognize the knowledge deficits of each student, offering personalized answers and relating simple concepts to facilitate learning.

Read more:
https://1millionbot.com/bartolo-la-ia-que-revoluciona-la-ensenanza-juridica-y-desafia-el-abandono-estudiantil/

4.4. The disruption of generative AI: the era of LLM models (ChatGPT, Bard, Gemini.ai...): E-tutor[11]

Are the students *perfect strangers*? How many of them stop going to class in one or more subjects? How many of those who do go disconnect because they understand almost nothing and decide to binge-study notes and other materials at the last minute before an exam? What percentage of students lack the basis to follow a specific subject explained by a professor? How many students feel comfortable confessing in a public class that they have not understood an explanation? How many students stop studying a degree because of barriers that we do not know how to clearly identify?

Many questions remain unanswered. For many years, professors and universities have been ignoring the success of the Internet portal *El Rincón del Vago*, whose managers have fed leading publishers and digital companies.

It is no secret that our students remain to a large degree perfect strangers to many of their teachers even after a year of teaching them in any subject. We sense the reasons why a certain percentage of them stop coming to class, but we do not have an exact diagnosis. We also sense that only a minority keep up with their notes, comprehension, and review of the subjects and that in general a majority only concentrate their attention and work as the subject exam(s) approaches.

In Spain, one out of every three students leaves university without completing their studies. In some universities or centers, this figure is multiplied *n* times. It is a disturbing and disturbing statistic. Many of these young people (or not so many), perhaps with considerable frustration, enter the labor market with a feeling of failure and with the perception of being at a disadvantage throughout their working future for many years to come.

In this context, ChatGPT has emerged as a major disruptor. The new generative AI has been placed at the center of the university and educational debate for its potential to help the student to a greater and better understanding of the subjects to be assimilated. But also because of certain risks, such as the need to control its lack of accuracy, the generation of errors, or unethical practices. Among these, the use of ChatGPT to generate work that should be done by students has been a cause for concern.

Although there are still more questions than answers, many teachers and code developers around the world have jumped into creating applications of the large language models of which GPT and ChatGPT are currently the main examples.

The possibilities are endless, but there are also risks, sometimes excessively overestimated from the academic context, that can end up phagocytizing the innovative impulse. The focus of the application of generative AI to the educational problem should be on

[11] In this section, we have counted with the collaboration of the professor Pedro Pernías Peco, from the Department of Computer Languages and Systems of the University of Alicante.

increasing the quality of the educational process in a solid way, progressively strengthening the current systems.

Image: GPT-4/DALL-E.

In order to improve the quality of the educational process and guarantee a good result, there are proposals to intervene in **two areas**: the work of the teacher and that of the student.

E-tutor[12]

Description of the learner-oriented tool

This generative artificial intelligence-based learning platform is intuitive, interactive, and student-centered. Once the student loads the study material (which the teacher can provide in a specific library), he has access to a series of functionalities represented by buttons in an interactive study toolbox to facilitate his understanding and study. Some examples are:

- **Text Summary.** Generates a concise summary of the study material**.**
- **Key ideas from the text.** Extracts and highlights the most important ideas and key concepts from the text.
- **Outline.** Outlines the content**.**
- **Extending the text.** Provides additional information and context about the study material, as well as relevant bibliographic sources.
- **Bibliography of the text.** Generates a list of references and additional sources related to the study material.
- **Text quiz.** Generates a multiple-choice quiz based on the study material.
- **True-or-false quizzes.** Generates true-or-false questions based on the text.
- **Group game.** Allows students to organize knowledge competitions with their peers.
- **Text translation.** Translates the study material into another language.
- **Keywords contained in the text.** Extracts keywords and highlights them.
- **Explaining the text to a child.** Reinterprets and simplifies the study material.
- **Critique the text.** Generates constructive criticism of the study material.
- **Evaluating the text.** Allows students to self-evaluate based on the study material and rubrics provided by the teacher.
- **Complete a text.** Provides an incomplete sentence or text and the student is asked to complete it.
- **Counterargument** of the text as a way of reasoning and understanding the original text.

- **Explain code.** If the study material is a code, the tool provides a detailed explanation of the code.
- **Tests about code.** Generates questions based on the programming code.

[12] For months, university professors and the company 1MillionBot have been analyzing a ChatGPT-based tool that has the potential to positively impact university education and especially student academic performance.

Description of the E-tutor tool oriented to teachers

The tool can also be customized to meet the needs of the teacher's work. In this case, the list of options is extended with specific teaching functions. Some examples:

- Prepare exams.
- Evaluate students' work.
- Make introductory summaries to topics. Create abstracts and key word lists.
- Generate exercises to extend the work of advanced students or those requiring more attention.
- Adapt documentation to different levels of comprehension.
- Translating and grammatical review.
- Creation of didactic proposals on topics and contents of the educational program.

The inclusion of **generative artificial intelligence** in university learning is not just a trend, but a necessity. ChatGPT, with its variety of functions and possibilities, makes it possible to better adapt to different learning needs and prepare our students for the digital world we live in..

This type of tool not only has enormous potential to improve university education, but also familiarizes students with platforms that they will have to use intensively in their professional activity. It is foreseeable that lawyers, architects, economists, engineers, marketing specialists, etc., in short, all professionals, will make intensive use of generative AI in the same way as they use Google searches on the Internet today. The difference will be the ability to ask the most intelligent questions, which is no small matter in terms of transforming our educational systems.

4.5. Other advantages for students

Prior to the emergence of ChatGPT and generative AI, universities have proactively adopted artificial intelligence (AI) tools as a means to strengthen the inclusion and well-being of their students. One of the main advantages of AI is its ability to adapt to different forms of interaction, whether through text or voice commands. This adaptability proves, for example, to be an invaluable support for students with visual or hearing limitations.

For example, solutions that employ AI for speech recognition and transcription have emerged as essential allies for hearing-impaired students. These technologies can generate real-time captions during online classes using pre-recorded videos. They are also beneficial in the context of traditional lectures, especially in situations where lip-reading or sign language interpretation is unavailable or insufficient.

Additionally, these transcription tools could also potentially help international students who, although able to read and write in the local language, still face challenges in listening comprehension. This type of support can be crucial during their first semesters of adapting to a new academic and cultural environment. All this before the ChatGPT era. After the advent of generative AI at this level, translation into various languages has taken a giant leap forward.

In any case, beyond the realm of higher education, linguistic inclusion through generative AI has the potential to be a pillar in the struggle to ensure equity and access to information for all of society. All citizens, regardless of their abilities or backgrounds, should have equal opportunities to access and understand the information around them.

In another area, chatbots, powered by AI, have shown their ability to play a crucial role in the early identification of students who might be going through emotionally vulnerable situations. Through simple interactions, these chatbots can offer emotional support, guide students with appropriate resources and, in some cases, provide practical support. This technology integration represents a step toward creating educational environments that are more empathetic and aware of students' emotional needs.

Benefits of generative AI

A tool such as **E-tutor** based on models like ChatGPT/GPT-4 has the potential to generate relevant benefits for university education in multiple ways. Let's try to list them:

A. **Adaptation to different learning styles.** Its wide range of features can adapt to different learning styles, allowing each student to find a study approach that is most comfortable and effective for them. This alone could go a long way toward reducing the student dropout rate, which is very serious in some distance learning platforms.

B. **Encouraging cooperative learning**. This type of tool can encourage cooperative and competitive learning through features such as "group play," making study more engaging and fun.

C. **Pre-assessment.** It allows students to self-assess and receive instant feedback, which can improve both their understanding of the subject and their preparation for exams. These features can increase students' motivation and thus increase their success rate on exams or tests in general.

D. **Understanding complex concepts.** Features such as "explain the text to a child" and "text enlargement" can help students deepen their understanding of complex concepts and encourage critical thinking.

E. **Lowering language barriers in integrating foreign students.** For

international students or those studying in a second language, the "text translation" feature can make learning more inclusive and accessible, without language being a relevant barrier.

This type of tool can ease the workload not only of students but also of teachers, as they can use it as a supplement to assess students' understanding. This leaves them more time to focus on other important areas, such as lecture preparation and research.

Equally, they could have even more benefits if teachers help to use them appropriately, i.e. in a context where, in classrooms or in activities with teachers, students develop their own study and critical thinking skills; or if teachers and students themselves design challenges to question the results of the AI itself.

For teachers, the advantages would be determined by the savings of effort and time on the part of the teacher in the basic performance of tasks of great educational value, but intensive manual effort. For example, preparing objective test banks with good distractors for students to practice evaluation is a task of great educational value but very costly in time and effort. With the proposed tool, the teacher receives a list of possible questions from which he/she only has to discard those he/she does not like or modify elements that could be improved. It only takes a few hours to create a bank of hundreds of questions.

Likewise, for teachers, generative AI allows for consistent evaluation of all student work using standards or rubrics that the teacher prepares in advance, against which student work is compared. This ensures consistency from the first to the last work evaluated and a detailed analysis of all aspects that are relevant for a final weighting.

4.6. AI and the evaluation of student progress

A survey of 464 participants conducted by a private education company in 2022 suggests that AI will have the greatest impact on testing and assessment and **75% of respondents stated that the main reason for adopting AI in higher education is to improve student outcomes** (HolonIQ, 2023).

Standard online platforms for teaching and learning can already **analyze and monitor student progress**. Through AI, these platforms can also identify patterns such as why a student is not making progress, whether it may be related to lack of time, motivation to take tests or clarity of materials, or whether it is a matter of insufficient time and repetition, where short-term memory has not yet transitioned to long-term memory.[13].

[13] For example, a team of researchers in Malaysia and Oman applied a set of machine learning algorithms based on students' cumulative GPA, attendance and first exam grades, as well as required course grades, as a tool for monitoring academic progress (Khan et al., 2021). In a test of the model, it was found to be efficient, as it identified students whose final results were

The field of learning analytics, which studies how to use digital data and computational analysis techniques to measure, collect, analyze, and report data on learning, teaching, and assessment (Tsai, undated), is increasingly using AI to advance its analytical functions, for example, through the use of text mining and other natural language processing methods (Gašević et al., 2015).

However, any use of AI in learning analytics (and in general) must pay attention not only to outcomes but also to the **process of learning and teaching**; otherwise, there is a risk of focusing on weakly related measures.

Academic assessment is undergoing a significant transformation due to the impact of AI. With the increasing adoption of tools such as ChatGPT in 2023, many students are using it as a resource for learning and exploration.

While most use ChatGPT constructively and seek guidance from faculty and universities to integrate AI into their education, there are exceptions.

Unfortunately, there are students who manipulate these tools to gain undue advantage, as evidenced by a survey in the United States in 2023. In it, it was found that out of 1,000 college students, 43% had used AI tools such as ChatGPT, and half of them used it on assignments or exams.

Of these, some relied predominantly on AI, while others only used it for specific aspects of their assignments.

AI for evaluation

Automated platforms are emerging to assist teachers with remediation and feedback. Reinforced by AI, they have the potential to customize exercises to each student's individual needs, identifying and addressing their areas of weakness. As student progress is monitored, AI can suggest resources to reinforce their learning and ensure long-term retention by scheduling periodic reviews based on performance data. The promise is that, over time, these AI tools can guide students toward deeper and longer-lasting learning.

The use of AI tools to grade academic papers presents challenges and risks that should not be underestimated. Alam and Mohanty (2022) warn that "education, with its many facets and complexities, cannot be distilled and locked merely into quantitative parameters." A blind adherence to data and algorithms could lead us to a scenario in which the essence of teaching and learning is lost, prioritizing technologies over the real and human pedagogical approach.

unsatisfactory and allowed the instructor to offer personalized support to at-risk students (Khan et al., 2021).

This excessive automation can create a cycle where students turn to AI to create assignments and, in turn, another AI evaluates them. This process, while seemingly efficient, can erode the value of authentic learning and human interaction, fundamental aspects of any educational process.

While automated grading tools can be an attractive solution, especially in situations where there are large numbers of students and limited human resources, there are legitimate concerns about their impact. Having a student's effort and work evaluated solely by a machine can be depersonalizing and ultimately demoralizing. Although these systems can provide instant feedback, alleviating teachers' administrative responsibilities in terms of grade recording and reporting, it is vital that they do not become the sole assessment methodology.

AI tools certainly have a place in the modern educational landscape. It is accepted that they can be particularly useful for monitoring student progress, identifying areas requiring reinforcement, and providing immediate feedback. However, the continuing progress of generative AI and AI in general requires us to maintain an open-minded attitude.

4.7. Teachers and pedagogical strengthening and training

The role of faculty in universities is crucial, and as such, it is this group that may feel most keenly the advancement and implications of AI technologies in education. Research conducted in Canada involving 410 key participants in the higher education world found that **half of the faculty felt that AI significantly influenced their daily work**, much more than other groups, such as senior executives or those professionals who have direct contact with students (Janzen, 2023).

Although in the Canadian context a remarkable 72% of educators had had some experience with AI-based tools, it is important to consider that these numbers can vary significantly in different regions of the world. For example, a study conducted by UNESCO's IESALC, involving around 1,300 individuals (where 61% identified themselves as teachers or researchers in higher education), found that **less than half, 43%**, had had contact with ChatGPT (Janzen, 2023; UNESCO IESALC, 2023b).

Teacher attitudes

Reluctance or slowness in adopting these AI tools may be rooted in a variety of reasons:

- Some teachers may feel overwhelmed by the demands of their job and feel that they do not have enough time to incorporate and learn about new technologies.
- Others may harbor legitimate concerns about the ethical or pedagogical implications of AI in the classroom.

- Factors such as lack of adequate training, unfounded fears about the complexity of the technology, or simply the inaccessibility of tools such as ChatGPT in certain areas could explain this reluctance.

All indications are that it is essential for educational institutions to provide the necessary support to facilitate a smooth and effective transition to the integration of AI into contemporary pedagogy.

The findings obtained from both surveys underline the **essential role of teachers in the incorporation of AI technologies in higher education**.

This importance lies in how they must reconsider key aspects, such as assessment, teaching methodology, and sustaining academic integrity.

For UNESCO, university reactions to tools such as ChatGPT highlight the need to train both teachers and students. This training process involves an investment in time and resources (UNESCO, 2023c), a perspective supported by students who have requested specific support to ethically and responsibly leverage AI tools in their learning (Liu et al., 2023).

AI-based teacher professional development

In order to foster a favorable climate for teacher professional development in the university context, it is suggested that institutions...

a) **Educational resources**. Develop or provide educational resources starting from a basic level explaining "what is AI". These resources should include recommendations on their implementation while respecting the regulations and technological infrastructure of each university. Ideally, a combination of materials from trusted external sources, such as UNESCO's free IESALC online course on ChatGPT, with other MOOCs and resources designed specifically for each institution.
b) **Spaces for debate and dialogue**. Create spaces for dialogue where teachers, administrative staff, students, etc., can discuss the impact of AI on education and co-create strategies for adaptation and implementation.
c) **AI workshops and activities**. Organize training activities such as workshops and forums to learn about AI tools: their use, limitations, and university-specific application policies. These events can address different tools or focus on one in particular.
d) **Professional development**. Actively encourage and support faculty to devote time to professional development related to AI. This can be accomplished through peer support, informal mentoring, and other methods that enhance skills and share successful practices.

This training and development process can be carried out at different levels: faculties, institutions, or even knowledge communities that transcend the boundaries of a single institution.

Image: GPT-4/DALL-E.

In the United Kingdom, **Jisc**, a provider of digital services for the higher education sector, is establishing a new national center for artificial intelligence. This center aims to accelerate the adoption of AI in universities. Led by a small team of AI experts, the center will focus on piloting existing AI products in real-world educational contexts, recommending and helping institutions adopt the best products, providing on-site support and training to staff members at institutions, and identifying opportunities for new AI products in education

The center will seek institutions that are willing to be "early adopters" of AI technology and run pilots. It will be based at Jisc, but will collaborate with universities and colleges, startups, other AI expert bodies and government staff.

The center seeks to improve education by offering more personalized experiences for students, relieving staff of manual tasks, and leading to different types of courses and teaching approaches. It was noted that universities would be slow to adopt AI without this center, due to the lack of technical knowledge and skills, the absence of an ethical framework for the technology, and the disorganization of data at most institutions to benefit from AI

The first pilots will focus on testing AI approaches that already work well at individual institutions and trying to replicate them across multiple universities. These include chatbots and digital assistants, adaptive learning systems, and automated assessment. Subsequently, the center will explore initiatives that are not currently widely used in the UK sector but would be possible with current technology, such as dialogue-based tutoring systems, AI-assisted collaborative learning, recommendation engines, and AI-assisted content creation.

5. UNIVERSITY MANAGEMENT AND ARTIFICIAL INTELLIGENCE: THE ROAD TO EFFICIENCY

The irruption of AI into the university environment has begun to redefine many aspects of higher education, particularly in terms of how universities are structured and operate.

AI can optimize processes, improve efficiency, and offer innovative solutions that were previously not possible or required a large investment of resources and time.

5.1. University administration and management: effectiveness and efficiency

AI is a key element in optimizing administrative and management procedures, increasing their effectiveness and efficiency.

Digital technologies have led to a variety of management solutions. They have even adopted business intelligence (BI) systems that collect, analyze, and process vast volumes of data to support strategic decisions.

With digitization increasing in different processes carried out in universities, such as student records management, virtual platforms, and information systems, a vast amount of data is generated[14].

1MillionBot has successfully implemented chatbots in several universities, creating AI-based intelligent assistants that help students, and faculty and administrative staff. One outstanding example is **Lola**, the first chatbot created by 1MillionBot for a university, specifically the University of Murcia (UMU), which has been an international success story, referenced in Harvard Business Review and presented as a global pioneer by Google and UMU itself. The assistant was designed to provide valuable solutions through AI, adding value to the university experience.

Another case is **Ada**, a virtual assistant at the University of Jaén, which marked the first experience in Andalusia and the fourth in Spain to implement a chatbot. In a difficult year, such as 2020, Ada started answering questions about careers, credits, and degrees. In one year she managed to solve 12,000 doubts for 5,500 users in conversations that totaled 1,000 hours.

1MillionBot has had a significant impact on some thirty universities by implementing

[14] Such data, when processed with AI tools, provide valuable insights (Beerkens, 2022). Notably, nations that already had an inclination toward performance measurement in higher education lead in the adoption of AI tools for data analysis and visualization (Williamson, 2019; Beerkens, 2022).

AI-based virtual assistants. These chatbots have helped improve communication and efficiency, providing quick answers to frequently asked student questions and facilitating access to important information.

For publicly supported universities, transparency, accountability, and compliance are essential. These elements become even more important with the integration of AI, as it brings with it the imperative of proper data management (Jim and Chang, 2018)[15].

The correct use of AI-based tools can enhance the student experience, offering personalization and more informed choices. It is crucial to provide clear guidelines to guide their adoption and use, taking into account ethics, academic integrity, and collaboration. Although some institutions, such as 24 UK research universities, have adopted principles in this direction (MacGregor, 2023), many universities are still in the process of adapting to this technological revolution.

Recent surveys reveal that a significant portion of institutions and academic staff are unaware of or do not have specific policies for AI implementation (Janzen, 2023; UNESCO, 2023d). This lack of preparedness may result in challenges related to safety, diversity, and equity.

Large-scale administrative activities, ranging from admissions processes to purchasing operations, often consume significant university resources. These tasks, which intensify at certain times of the year, can benefit from the potential of artificial intelligence (AI), especially in contexts where large databases are already ready for machine learning techniques. Although AI represents a valuable tool, more basic solutions, such as automation applications, may be suitable for certain routine and predictable operations.

[15] Managing data at the institutional level involves technical and organizational challenges that encompass IT solutions, data protection, and understanding the purpose and use of the information collected..

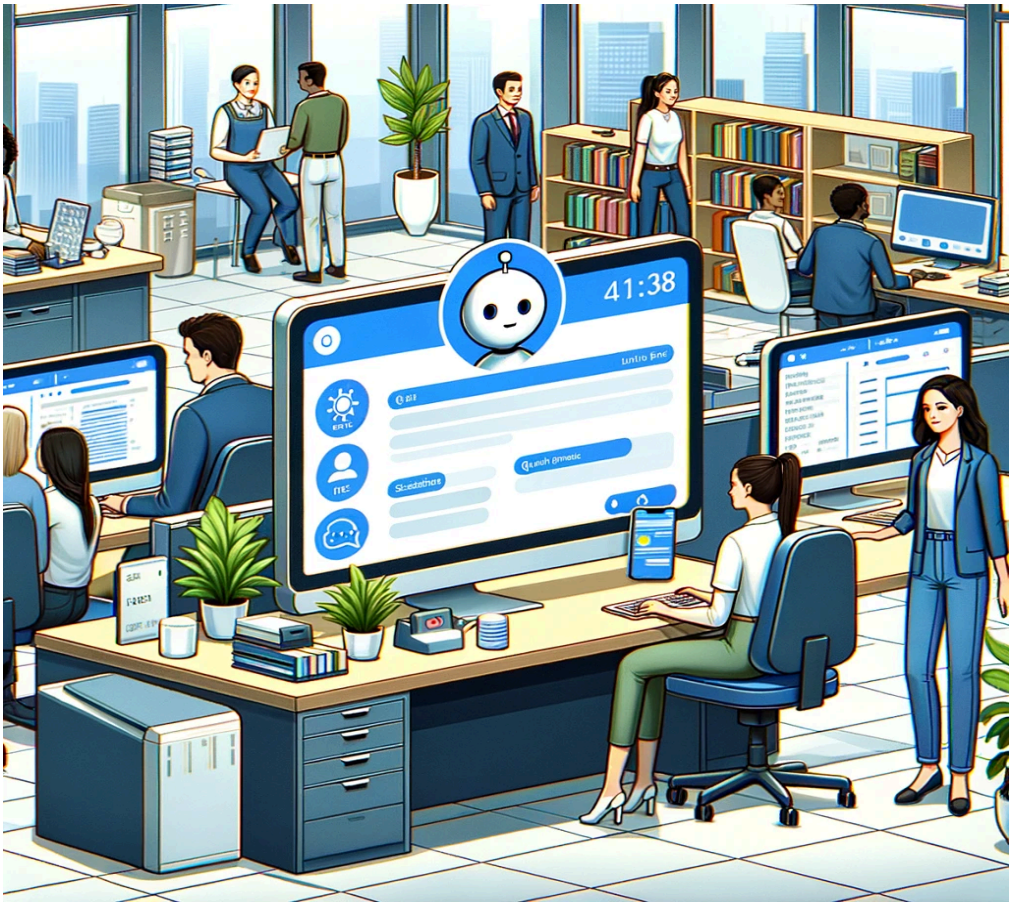


Image: GPT-4/DALL-E. A chatbot assists with administrative tasks at a university, with staff and students interacting with it through computer screens.

Chatbots for automation and back-office management

One of the most notable applications of AI in the automation of functions for the administration has been the introduction of chatbots that interact in real-time with the public and allow students to inquire about different aspects of university life, from schedules to ICT services.

Their presence reduces the burden on administrative staff, freeing them from routine tasks and allowing them to focus on essential functions. For example, the University of Murcia, the University of León, and the University of Cádiz use chatbots to resolve doubts about the campus and academic areas, handling large numbers of queries with high efficiency.

Regarding the relationship between AI and university administrative staff, according to a survey conducted by *Microsoft-Times Higher Education*, a considerable portion of participants believe that adopting AI will not lead to layoffs in the coming years.

Conversely, some university leaders anticipate an increase in hiring due to technological advances. AI is likely to redefine many administrative functions at universities, impacting areas such as IT, admissions, student services, libraries, marketing, and finance. However, historically, the adoption of technologies has not meant a drastic reduction in staff, but a reallocation of resources, moving employees from monotonous tasks to more strategic and meaningful roles.

5.2. IA and student services

One of the main advantages offered by AI is the constant availability to respond to inquiries, eliminating the need to wait in long lines or adjust to traditional business hours. This immediacy and accessibility prove to be of great value in a world where a quick response to information demands is expected.

AI and the ability to personalize responses

What really stands out about these AI-based tools is their ability to personalize answers. Instead of providing generic answers, AI can analyze each student's individual profile and adapt to it.

A student, instead of browsing multiple platforms or consulting various documents, simply asks, "Where do I have my next Biology class?". AI, having access to the student's database and schedule, can provide an accurate answer in a matter of seconds. This level of personalization can go even further: if a student wants to know if he or she can enroll in a specific course, the AI system will not only check the availability of the course but also examine the student's academic history, checking whether he or she has completed the prerequisites or has the necessary credits. This ability to provide personalized and contextualized responses significantly enhances the student experience, making the processes smoother and more efficient…

Of course, the adaptability and precision of AI do not diminish the importance of the human factor in education. While AI can handle routine and frequent queries, human interactions remain crucial to address more complex problems or situations that require a human touch. However, by freeing staff from repetitive tasks, these tools allow them to focus on providing more personalized and enriching service in areas where it really matters.

A success story: the Lola chatbot at the University of Murcia

The University of Murcia (UMU), like many other universities, faced a similar problem year after year: with the massive arrival of thousands of students after the entrance exams, the campus was overwhelmed by the demand for information and services capable of serving the new students aspiring to study at the University.

A small team was trying to respond to a large number of students requesting information on the range of courses on offer, access conditions, enrollment, career opportunities, etc.

The Lola chatbot, developed by 1MillionBot in 2018, started answering a large number of frequently asked and repetitive questions, helping students 24/7. *Harvard Business Review* referenced this chatbot as a "success story".

After its implementation, UMU staff had more time to assist students and their families with complex and more unique issues.

Lola is an example of how AI and chatbots can not destroy jobs, but complement employees and increase service quality.[16].

Just as chatbots facilitate administrative tasks for the current student body, aspiring students can also take advantage of these AI-based tools to simplify and better understand the sometimes complicated admissions procedures.

One factor that has contributed to its success is that users are aware that they are interacting with a machine, which allows them to ask questions without embarrassment or fear of judgment. (Pappano, 2020; McKenzie, 2019).

In South Africa, the University of Cape Town, for example, has launched a chatbot to assist in admissions and orientation processes, addressing issues ranging from connectivity problems to funding options (Somdyala, 2023).

Detection of students who may drop out of school

AI offers valuable tools to detect students who may be at risk of dropping out, providing universities with the opportunity to act early to support them (Vincent-Lancrin and Van der Vlies, 2020).

These tools can analyze accumulated data to identify early signs of underperformance that often precede dropout.

[16] Read more: https://www.um.es/web/sala-prensa/-/la-universidad-de-murcia-presenta-a-lola-un-asistente-de-inteligencia-artificial-para-ayudar-a-los-nuevos-alumnos

There are examples not only in the United States but even in Latin America. A particularly illustrative one comes from the Pontificia Universidad Javeriana de Cali, in Colombia, where an AI-based tool was used that, with 93% accuracy, detected certain patterns of underachievement and other factors related to academic dropout (Reinoso Castillo, 2019). In addition, the Complutense University of Madrid has implemented an AI model that considers gender variables, revealing that, in general, men tend to drop out more than women, especially in fields such as Arts and Health Sciences. (Segura et al., 2022).

Monitoring and analyzing student engagement in online educational platforms can provide insights for interventions to improve retention rates (Araka et al., 2020). While AI can identify behavioral patterns and risks, a human component is essential for personalized monitoring and appropriate intervention, as suggested by Barret et al. (Barret et al., 2019).

A practical example is the EDU.IA project at the University of Trás-os-Montes e Alto Douro in Portugal, which seeks to empower tutoring through the use of analytics and AI. By evaluating academic records from previous years and analyzing current and past grades, the system can predict future academic performance and, consequently, proactive actions can be designed to support at-risk students (Silva et al., 2022). Similarly, other institutions, such as the University of Canterbury in New Zealand, have employed similar approaches to drive early and personalized interventions by their academic advisors (New Zealand/1 News, 2020).

Another application of predictive algorithms lies in detecting incoming students who may be in danger of dropping out, based on the performance of previous students from the same middle-level institutions. At one U.S. university (whose name was not specified), the enrollment rate grew by 20% when an AI-based tool determined which students needed more preparation and redirected them to additional resources, such as summer courses, extra tutoring, or meetings with academic advisors (Gehring et al., 2018). Georgia State University in the United States, meanwhile, implemented seven-week summer sessions for selected students, resulting in nine out of ten participants successfully completing their first academic year (Marcus, 2014).

However, despite the growing popularity of these predictive systems, little research has been done on student expectations.

A study at the Open University of Catalonia analyzed student perception of a system that, based on previous data (grades or subjects enrolled), indicated with a traffic light system (green for low risk, amber for medium risk, and red for high risk) the probability of failing a subject (Raffaghelli et al., 2022). This research showed that those students with higher initial expectations about the system showed lower satisfaction after its use. This underscores the importance of providing adequate support to students and perhaps introducing technologies gradually so that they adapt progressively (Raffaghelli et al., 2022).

5.3. AI and student retention

Student retention: the fight against student dropouts

Student retention is another important area where artificial intelligence (AI) can play a crucial role in universities. The application of AI in this aspect can offer support in a number of ways.

Pathways to student retention through AI

1. **Early identification of at-risk students**. By analyzing data on academic performance, attendance, participation in activities, and other indicators, AI systems can identify students who are at risk of dropping out. This allows the university to intervene early with support strategies.

2. **Personalized advising**. AI can provide personalized advising to students, helping them make informed decisions about courses, majors, and career paths that align with their interests and abilities.

3. **Academic support and tutoring.** AI-based systems can offer personalized tutoring and academic support, adapting to each student's learning style, which can improve their understanding and performance in courses.

4. **Predictive analytics for program improvement**. AI algorithms can analyze historical data to predict trends and patterns in student retention, providing universities with valuable insights to improve their educational programs and policies…

5. **Behavioral interventions**. AI can help design personalized behavioral interventions to motivate students and encourage effective study habits, which can positively influence their retention.

6. **Emotional and wellness support**. AI applications such as chatbots and emotional support systems can offer immediate assistance to students facing emotional or mental health challenges, factors that often influence the decision to drop out of school.

7. **Effective communication and feedback**. AI systems can facilitate more effective communication between students and teachers, as well as provide continuous feedback, which can improve the educational experience and encourage student retention.

8. **Analysis of student needs and preferences**. AI can analyze student surveys and feedback to better understand their needs and preferences, enabling universities to tailor their academic services and offerings more effectively.

Incorporating AI into the student retention strategy can be a significant game changer for universities, improving not only the retention rate but also the overall educational experience for students.

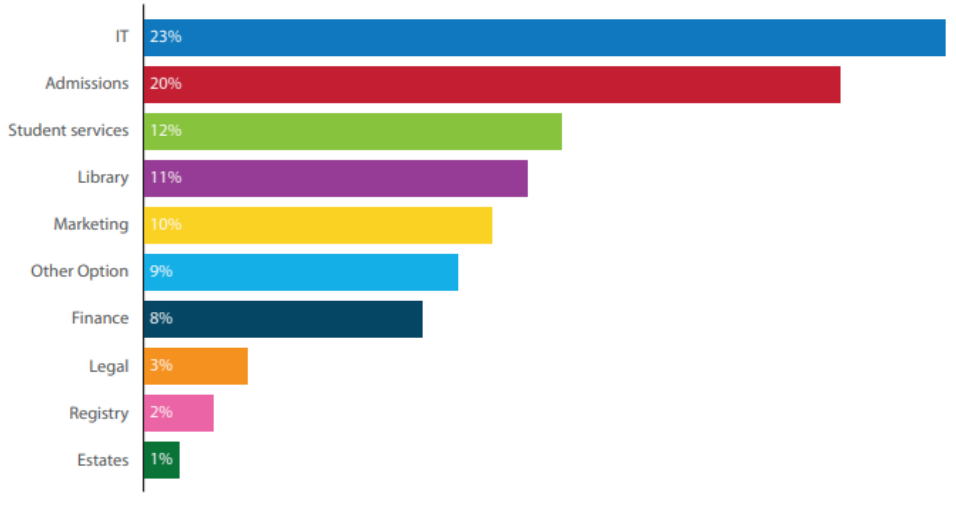
5.4. Other key services at universities

There are many university services that can be addressed with AI. Here are some significant examples of use cases that are spreading in universities around the world.

In universities, library services represent another scenario conducive to the incorporation of AI: chatbots on their library web portals to assist the student body with their questions (Young, 2019).

AI is used to analyze digital collections, highlight topics and entities, assign metadata, and facilitate non-text-based searches (Holland, 2020). An example of this is HAMLET (How About Machine Learning Enhancing Theses?), a tool that, using machine learning, provides experimental interfaces to explore MIT's thesis collection (Yelton, 2018).

Figure 9 – Which administrative roles within the university do you foresee being significantly affected by AI?



Source: UNESCO.

Libraries are also leveraging advanced AI automation to perform tasks such as checking out, organizing, and returning physical materials (Shoufani, 2022). In Singapore, a collaboration between librarians and experts resulted in the creation of robots such as Aurora, capable of scanning shelves to identify disordered, lost or missing books, generating post-scan reports (Senserbot, 2022). AI also enhances efficient space management in libraries, overcoming traditional thematic and alphabetical organizations. This is made possible by automated book circulation and management, randomized storage, and automated counting, checking, and sorting tasks (Yu et al., 2019).

AI and job placement of recent graduates

Within the educational framework, AI not only plays a role in pedagogy but also helps ease students' transition into the professional world. Higher education institutions, recognizing the changing demands of the labor market and the expectations of students, are increasingly incorporating artificial intelligence tools to support the job search and preparation of their recent graduates.

This assistance can start with something as basic, but essential, as the development of a resume. Through AI, institutions can offer platforms that analyze and match resumes to specific job openings, suggesting adaptations and improvements to make the document stand out and be relevant. In addition, with the wealth of information available online, AI can crawl LinkedIn profiles, extracting and highlighting accomplishments and skills that a candidate may have overlooked, but are essential to a specific job offer (Biron, n.d.).

But preparation for employment does not end with the written presentation. Interviews are a fundamental part of the selection process. This is where AI-powered supplemental training becomes vital. Mock interviews, in which an AI system analyzes recordings of candidates, can provide real-time feedback on multiple aspects: from tone and pace of voice to word choice and body language. These tools, such as those implemented by Duke University (Burke, 2019), can prepare students to face interviews with greater confidence and preparedness.

This feedback is particularly relevant in today's era, where virtual interviews are commonplace. In this scenario, AI not only serves to train candidates, but often plays a role in the selection process, evaluating interviewees' responses and behavior in real-time. Thus, being familiar with these technologies and being trained on how to interact with them can give recent graduates a competitive edge in the crowded job market.

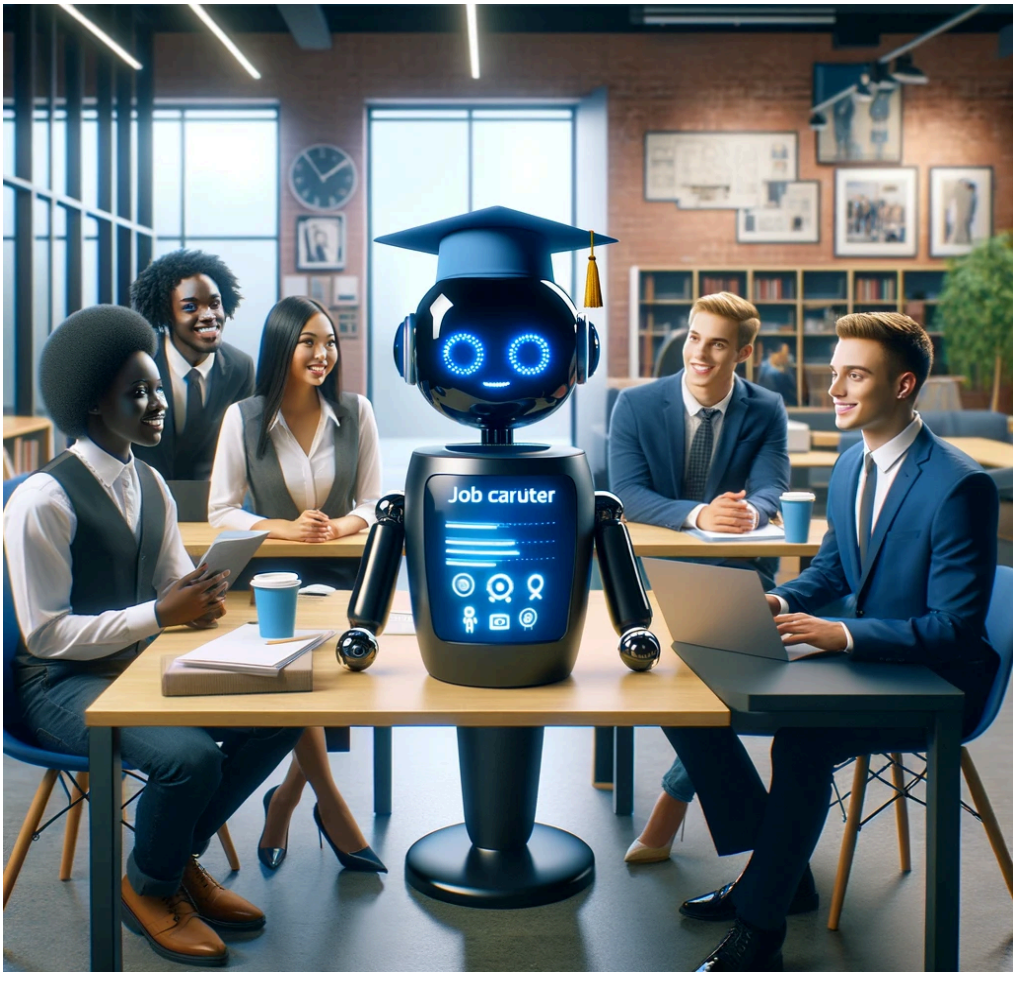


IMAGE GPT-4/DALL-E: AI helping in the job placement of young university graduates, showing a career center at a university where graduates interact with an AI system.

6. AI AND RESEARCH ACTIVITY IN UNIVERSITIES

The connection between artificial intelligence and research within the field of higher education has two fundamental facets.

In one dimension, research is oriented directly towards the development and understanding of AI itself. This branch of research delves into the design, function, and capabilities of algorithms, neural networks, and other components that constitute the essence of AI.

In contrast, the second dimension focuses on how research in various fields is taking advantage of AI tools and capabilities to improve, accelerate, or diversify its methods and results. Whether in the natural sciences, social sciences, or humanities, AI is offering new insights and tools to analyze data, model behaviors, or even simulate complex phenomena.

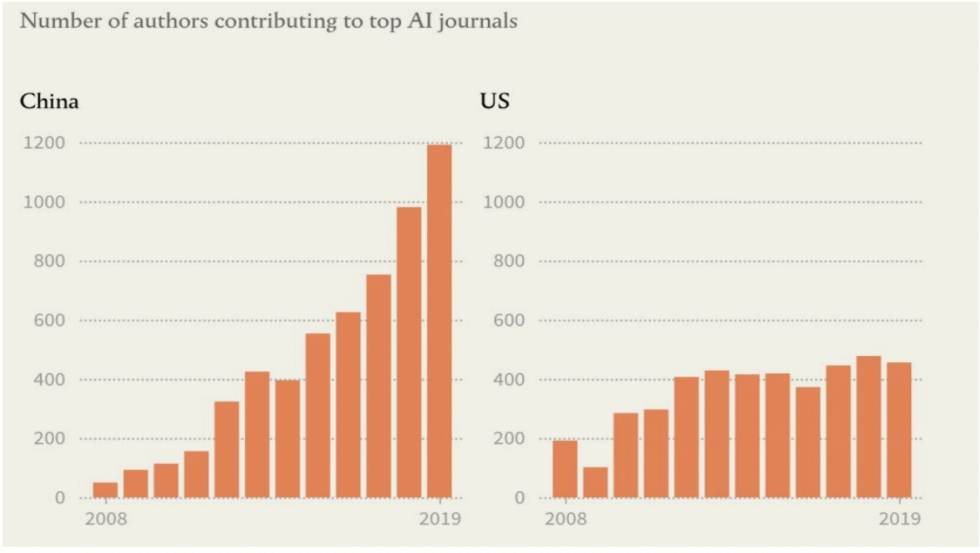
Over the last twenty years, interest and investment in AI-related research has grown exponentially. This is reflected not only in the proliferation of publications and patents but also in the emergence of conferences dedicated exclusively to discussing AI advances, challenges, and applications. In addition, the pre-publication culture has enabled faster and wider dissemination of ideas, facilitating collaboration and academic exchange at a global level. All of this has been documented and highlighted by various institutions, including Stanford University in 2021, which noted this growth and the relevance that AI has acquired in today's academic and research landscape.

6.1. Current status of AI research

Stanford University, in its *Artificial Intelligence Index Report* 2023 (HAI, 2023), indicated that, when it comes to AI research, "industry is moving faster than academia." Until 2014, most significant machine learning models were developed by Academia; since then, the industry has taken the lead: "In 2022, there were 32 significant machine learning models produced by industry, compared to only three produced by Academia".

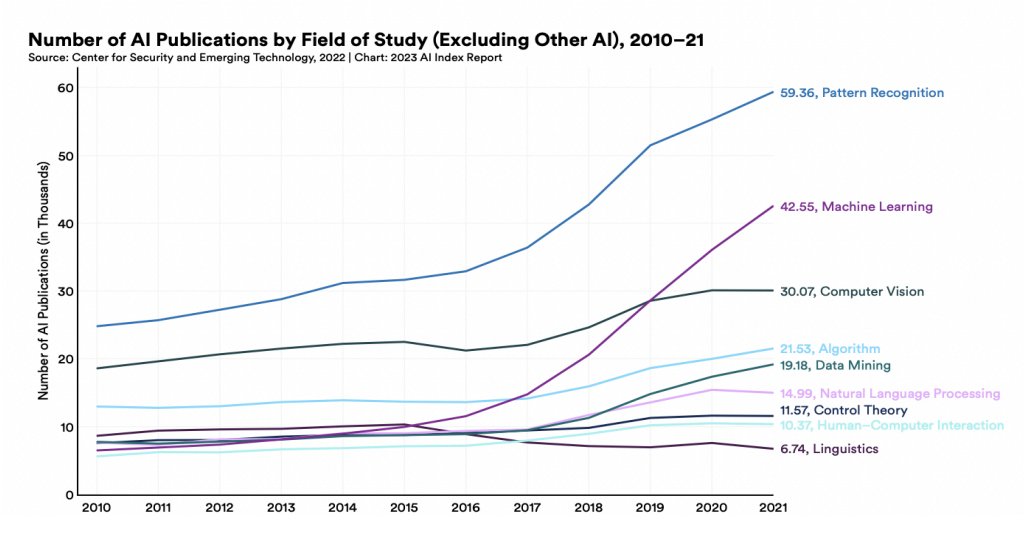
Building next-generation AI systems requires increasingly large amounts of data, computational power, and money resources that industry players inherently possess in greater quantities compared to nonprofits and academia.

The predominance of publications on artificial intelligence emanates mainly from universities in China, with nine of the ten leading institutions in number of publications. The remaining one is located in the United States (Stanford University, 2023). In addition, the growth of research in China and its stagnation in the United States is remarkable, despite the large research programs of the technological giants.



Source: Moreno, L. & Pedreño, A. (2020).

Within the featured topics, **pattern recognition** and **machine learning** have gained prominence in the last half-decade. Publications on pattern recognition have doubled since 2015 and those on machine learning have grown fourfold. In 2021, other outstanding research fields in AI were **computer vision**, with 30,075 publications, followed by research on algorithms, with 21,527 papers, and **data mining**, with 19,181 papers (Stanford University, 2023).



Source: HAI-Stanford University (2023).

However, it is notable that only 1.4% of the articles on AI applications in higher education addressed issues of ethics, challenges, and risks (Zawacki-Richter et al., 2019). Much of the research in this field seems to be in the hands of computer science experts, who focus on tools and algorithms, validations, and applications, rather than direct effects on learning (Bates et al., 2020).

Nevertheless, there is a growing focus on interdisciplinarity in AI. During the COVID-19 crisis, an interdisciplinary research framework was proposed to address the impact of AI on the pandemic, considering molecular, clinical, and social levels (Luengo-Oroz et al., 2020). As an interdisciplinary and constantly evolving domain, it is essential that researchers from diverse areas contribute.

Some experts suggest that the future of AI will be strongly linked to its interdisciplinary nature (Kusters et al., 2020; Zhuang et al., 2020; Hajibabaei et al., 2023).

6.2. AI tools for research

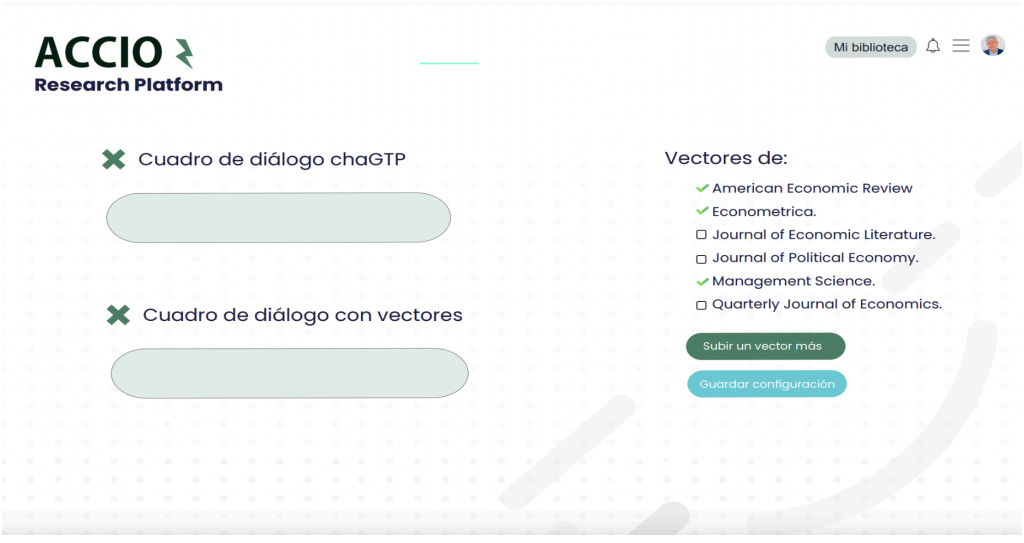
In the aforementioned *Artificial Intelligence Index Report 2023* (HAI, 2023), Stanford University posited, "The world's best new scientist ... AI?", adding that "AI models are beginning to rapidly accelerate scientific progress and in 2022 were used to aid in hydrogen fusion, improve the efficiency of matrix manipulation, and generate new antibodies".

Throughout an entire research project, artificial intelligence (AI) positions itself as a valuable tool, offering solutions and optimizations at various stages. From conceptualization and design to collection, analysis and, finally, dissemination of findings, AI plays a crucial role (Stanford University HAI (2023): *Artificial Intelligence Index Report*).

No university professor is currently capable of reading everything that is published on a specific subject. If it is, for example, a specific type of cancer, it is impossible to assimilate thousands of pages published worldwide, clinical trials, or huge volumes of raw data. AI can, and it is also capable of providing synthesis and generating answers to specific questions that are hidden in millions of data or pages.

One of the possibilities is to take advantage of the linguistic potential of multilingual generative AI to limit its information sources to scientifically validated information only. The **Accio**[17] project is working along these lines, que busca acotar la información y entrenamiento del modelo con vectores de información/conocimiento que el científico selecciona previamente.

[17] This is an experimental project of the 1MillionBot Group.



In the design phase, AI (especially these tools) can be of great help in formulating initial hypotheses and frameworks based on previous data and information, providing a variety of approaches and perspectives that may not be immediately apparent to a researcher.

These tools not only provide a foundation on which to work but can also foster creativity, lateral thinking, and critical analysis.

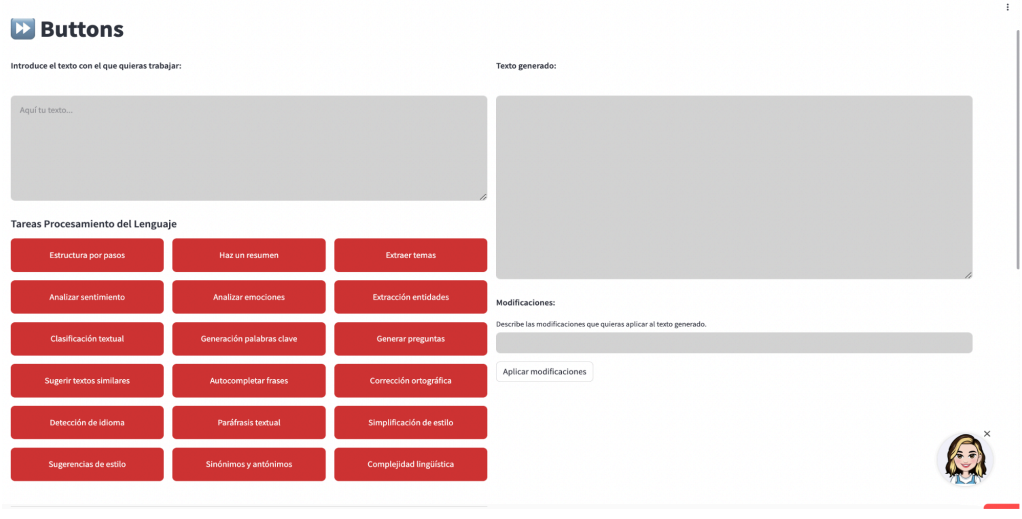
LLM models, such as ChatGPT, when fed with the right information, are able to outline preliminary research frameworks and provide insights. That is, the ability to deeply understand the intrinsic or essential characteristics of something, especially through an intuitive perception or a clear understanding of a complex situation.

However, it is essential to remember that the **effectiveness of the responses generated by AI depends to a large extent on the quality and relevance of the input provided by the user**. Therefore, human interaction and supervision remain crucial to ensure the relevance and validity of the generated responses.

AI tools are essential for accessing and analyzing large volumes of scholarly literature. Using AI-powered search engines, researchers can quickly analyze, summarize, and organize vast amounts of information, identifying relevant and up-to-date research.

Another tool can come through ChatGPT-like models with the right pre-design. 1MillionBot Prompts has designed an innovative web platform that allows users to interact directly with academic papers using AI technology. This tool makes it easy to identify key points, recommend related literature, and organize documents according to various criteria, from fields of study to specific date ranges.

When it comes to data collection and analysis, machine learning (ML) and deep learning (DL) techniques become fundamental tools. These technologies are able to decipher and understand patterns and relationships in large data sets that may be difficult or impossible to detect manually. These identified patterns allow researchers to make predictions, model future scenarios and make informed decisions, which is essential to advance any research. In addition, the ability of these tools to make projections based on identified patterns can be an invaluable asset, allowing researchers to formulate new questions and hypotheses.



6.3. Risks and implications of AI implementation in research

One of the most significant challenges is to ensure the originality of the work. Using tools such as ChatGPT could entail risks such as the generation of unverified references and vague texts, as well as the possibility of plagiarism. Such challenges could affect the authenticity of the knowledge generated, an essential pillar of academic research (Nakazawa et al., 2022; UNESCO, 2023c).

A transition from an individual approach to originality to a more collective or collaborative perspective encompassing humans, research environments, and AI has been proposed. This proposal seeks to address current ethical dilemmas (Nakazawa et al., 2022). Despite these ideas, the current consensus advocates that AI should act as a complementary tool, while the primary control of the research process should remain in human hands (Rahman et al., 2023).

Ethics is another critical aspect. Universities with ethics committees set standards to ensure the integrity of research, especially when it involves human subjects. However, these guidelines may not be tailored to AI-based research, given the complexities of

interpreting algorithms and ensuring their transparency (Jia, 2020; Samuel and Derrick, 2020).

As AI advances in higher education, other ethical challenges arise. These include dilemmas over whether ethical considerations should be limited to the researcher or extend to the technological tools used and how to balance innovation with ethics. In places like China, while some believe that a risk-based approach to ethics could slow scientific progress, others advocate more robust ethics training for researchers and practitioners (Jia, 2020).

7. AI, UNIVERSITIES AND PROFESSIONAL AND BUSINESS ENVIRONMENT

In the context of a constantly evolving labor market, marked by the growing demand for artificial intelligence (AI) skills, a significant transformation is observed in both the professional and educational spheres.

This chapter focuses on the interplay between AI, academia, and the workplace, exploring how AI development influences labor market trends and, in turn, how these trends impact higher education.

It also examines the role of women in the AI-related work sector and discusses essential skills in the AI era, both specific to train experts in the field and general skills relevant to all students and the general population.

The chapter concludes by addressing the implications of AI for lifelong learning.

7.1. AI, the future of the labor market and universities

The continued advancement of AI and its increasing integration into various sectors is redefining the labor market.

The demand for AI specialists and skilled professionals is experiencing exponential growth, evidenced by the proliferation of AI-related job openings around the world.

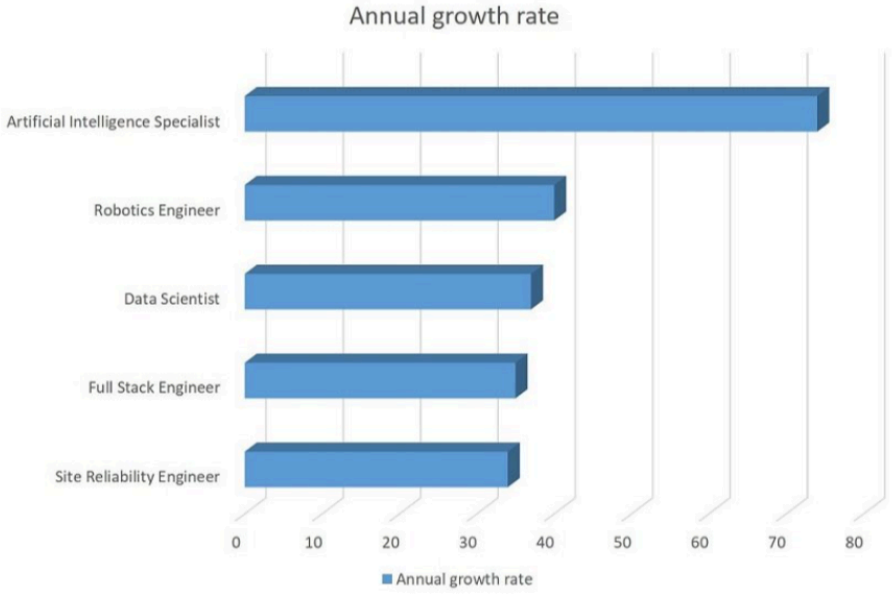
Countries in the northern hemisphere, in particular, have seen a steady increase in AI-related job opportunities over the past decade, reflecting its expansion and recognition globally.

AI and machine learning are not only at the forefront of job growth but are also transforming the nature of many occupations. A report by the World Economic Forum (2021) suggests that **up to 66% of current jobs could be automated in the next two decades**. Generative AI, an advanced branch of AI, has the potential to automate up to a quarter of the current workforce, implying a radical shift in the labor market. The AI-driven transformation resembles that introduced by earlier technologies (conveyor belts, automobiles, and the Internet), innovations that displaced certain jobs but created new roles.

Similarly, **AI is set to complement and empower highly specialized professions, freeing up experts to focus on more creative tasks linked to human reasoning and**

interaction. Growth is anticipated in the areas of cybersecurity, renewable energy, healthcare, data analytics, robotics, blockchain and e-commerce.

Higher education must adapt to this reality. A survey conducted by UNESCO (2021) revealed that most experts foresee an increase in demand for university graduates in computer-related fields. Educational institutions are trying to respond to this need by integrating AI into various areas of study and focusing on ethics and biases in algorithms to ensure a more comprehensive training.



Source: LinkedIn
https://www.jietjodhpur.ac.in/blog/is-ai-engineering-in-demand

The role of women in AI

Despite recent advances, female participation in the AI workforce remains in the minority. According to the World Economic Forum (2021), only 22% of AI specialists are women. This disparity extends to the funding of technology projects, with only 2.3% of venture capital going to women-led startups (UNESCO, 2021d). However, there are initiatives underway to address this gap, such as She Code Africa and Laboratoria, which seek to empower women in the tech sector.

Women are also underrepresented in the engineering sector in Spain. This is confirmed by the data collected in the latest Observatorio de la Ingeniería (*Engineering Observatory*) for 2022: only 20% of the 750,000 engineers are women. The specialty in which women

have the fewest employees is telecommunications, where they only account for 12%. This is followed by computer engineering and industrial engineering, with 16% and 19% respectively. These percentages are very low, even compared to international averages.

7.2. Continuous learning

The advancement of AI underscores the importance of continuous learning and adaptability in the labor market. A study by the World Economic Forum (2020) revealed that 94% of business leaders expect their employees to acquire new AI skills.

Higher education has a crucial role to play in this context, offering AI programs for a wide range of profiles and using online modalities to ensure equitable access to training.

AI is already a central tool in online education, with applications focused on predicting learning and improving the educational experience (Ouyang et al., 2022). Projects such as PAL3, from the University of Southern California, demonstrate how AI can deliver personalized learning paths, adapting to individual student needs.

In short, AI is emerging as a key ally in building lifelong learning ecosystems, preparing students to thrive in an ever-changing world of work.

7.3. Generative AI and labor impact

Generative AI will have a very high potential impact on employment and professions. A marketing specialist or a lawyer could see a tenfold or more increase in productivity.

Generative AI is a first-rate tool for managing documents of all kinds. It can help a marketing specialist, generating and publishing optimized content in just a few minutes for all social networks, designing campaigns on platforms such as Google Ads, etc. A lawyer, from a few pieces of data, can use generative AI to draft a lawsuit, legally grounded on the basis of large bodies of case law and other legal bases.

Any professional (architect, economist, property manager...) can use generative AI to create documents or graphics subject to your indications.

The professional expectations around generative AI have changed the professional paradigm in just a few months. Current university students are facing a professional job market that will intensively use generative AI.

From this perspective, the adoption of generative AI in universities is not an option; it is imperative to maintain the employability of current graduates.

Image GPT-4/DALL-E: Friendly and welcoming image showing the harmonious relationship between generative artificial intelligence and the professions of the future.

8. CHALLENGES OF THE IA IN HIGHER EDUCATION

Industry, healthcare, and defense, among many other sectors, are expected to make intensive use of AI in the coming years. Universities must take on challenges in the development of AI and the exploitation of its potential. Generative AI has been a major driver that poses challenges for universities in terms of ensuring its correct use.

8.1. Technological challenges of AI

AI in Europe has five major technological challenges in terms of its development and deployment. A country, its innovation ecosystems, its companies and the field of research and development have these challenges as relevant objectives to achieve a successful implementation of AI:

a) **Control and optimize AI**
b) **Democratize AI**
c) **Manage AI**
d) **Develop customized solutions**
e) **Empower people**

a) Control and optimize AI

Today's AI, although with extraordinary performance and potential, has outstanding challenges (e.g. biases and hallucinations) that are opportunities for European companies with a clear focus on achieving an AI with guarantees, i.e. with human-controlled dashboards and an AI optimized through solid resources that allow it to control the quality of its performance (biases, errors, hallucinations of generative AI...).

Let's imagine an informative chatbot in one of our government institutions. Is it assumable that ChatGPT responds to Spanish citizens on critical issues subject to legal interpretation? Undoubtedly, the institution must own its answers and not leave it to the discretion of a third party. Likewise, a physician cannot be guided by sources and recommendations that are not subject to the rigor that his profession demands.

Today it is possible to design systems that allow the coherent integration of generative AI and its high capabilities, conventional PLN (bounded and controlled) and even human action.

Ultimately, controlling data and leveraging the linguistic capabilities of generative AI is a very relevant challenge to harness the potential of AI applications.

Likewise, we must have resources that allow us to optimize artificial intelligence and the tools it provides us with, so that the necessary confidence can be generated around the many tools already available.

b) **Democratize AI**

In other words, to promote the development of easy and low-cost tools that allow entities and agents with fewer resources to adopt and exploit them.

On November 30, 2022, OpenAI opened AI to all users. Until that time, AI was the heritage of large companies that managed and exploited this type of model in a reserved way. It is said that this dedication was a fundamental step towards the "democratization" of AI and its exploitation by users, small companies, professionals, teachers, and students. Subsequently, other companies, such as Meta, released their LLM models for open-source exploitation. And Google followed in their footsteps with Bard and Gemini.ai.

Today, the potential of AI can be exploited by an SME or any student from their cell phone. A small business can integrate into its systems and networks (websites, WhatsApp...) assistants with capabilities unimaginable just a few months ago.

AI can and must reach small businesses, students, senior citizens, etc. so that the democratization of its use and the exploitation of its enormous potential becomes a reality without relevant social gaps.

But the challenges of controlling (providing answers subject to the interests and requirements of an institution or company) and optimizing (minimizing biases and errors) remain key to the exploitation of today's AI.

c) **Manage AI**

AI, in its different aspects (generative, predictive, decision-making...), requires efficient, ethical, responsible, and transparent management. For this, qualified personnel are needed to undertake these objectives with guarantees. Many institutions and companies are embarking on the creation and implementation of "AI Offices" that will enable them to exploit the full potential of the technology.

However, managing AI requires highly qualified personnel to set priorities and to build, collect, and process valuable data, as well as to apply the right generative (PLN) or predictive (machine learning, deep learning...) AI techniques

and algorithms, leading to validated results and subsequently their scalability and benefits (economic or social ROI).

Efficient AI management entails a multitude of requirements. Under public-private cooperation formulas, universities, with the human capital at their disposal, may be the most suitable places to develop solid AI management models.

d) **Develop customized solutions**

AI in healthcare or defense is not the same as AI for improving business productivity or education support systems. Not only tailored developments of functions and objectives but solid integrations into mainstream systems are needed.

Within education, management, research, and teaching require specific solutions with very specific requirements that not only respond to needs but also to the postulates of academic and ethical integrity.

Once again, public-private collaboration is essential to achieve rapid, internationally competitive results, with all the ethical guarantees that we have indicated.

e) **Empower people**

We must develop AI tools that empower people, whether they are professionals, workers, or students. AI, in its diversity, destroys repetitive jobs but generates more creative ones, and above all, well-designed and used, it empowers professionals.

The challenge lies in designing advanced tools that are controlled, optimized, and tailored to people (professionals, students, workers, citizens, etc.).

The E-tutor tool mentioned above is an example of design based on student empowerment. There are already available tools designed to empower lawyers, architects, property managers, marketing specialists, etc., in what is a generalization of tools that provide answers to the management of any professional.

This approach is essential for a rapid cultural acceptance of AI as a tool and will generate comparative advantages for companies, institutions, and even countries.

8.2. Artificial intelligence and economic impact

Most economic experts highlight the impact of AI on productivity growth, income inequality, and industrial concentration (Brynjolfsson and Unger, 2023). We can synthesize these contributions into these points:

1. **Impact on productivity growth**. AI can lead to a high productivity scenario, increasing efficiency in various tasks and complementing workers. In general terms, there may also be situations in countries with low productivity scenarios, where the impact of AI is limited and displaced workers end up in less productive jobs.

2. **Effects on income inequality**. Without redistributive policies, AI could increase income inequality, replacing high-paying jobs and relegating more workers to low-paying service jobs. It is also worth considering that AI could reduce inequality by helping less experienced workers improve their job performance.

3. **Effects on industrial concentration**. Without policies aimed at "democratizing AI", i.e., making its tools widely available to SMEs, AI may lead to greater industrial concentration, benefiting mainly large companies with the resources to develop and apply advanced AI. An interesting alternative is to counter a hypothetical concentration trend with open-source AI models that allow small companies to compete effectively. Universities are thus once again key.

Ultimately, economic analysis highlights a duality of very diverse effects that calls for smart policies and ongoing analysis of the effects. In this regard, it seems advisable to invest in research on the economic and social consequences of AI to help society move towards a future of sustained and inclusive economic growth, highlighting a current imbalance between technological research and understanding of its macroeconomic impacts.

8.3. Global gaps in adoption and access to AI

Gap between countries

UNESCO is concerned in its report about the inequitable distribution of AI teaching, learning, and research among different nations. According to the institution, the global incorporation and evolution of AI in higher education is not evenly distributed. This comports with the AI gap observed between countries such as China and the United States, where AI has a greater presence, and regions such as sub-Saharan Africa, parts of Central and South Asia, and parts of Latin America, where AI has not reached the same scale; even with respect to Europe, today a secondary player in business, investment and technological developments in the market.

IMAGE: GPT-4/DALL-E: Challenges of implementing AI in higher education, showing a college campus with elements that represent these challenges, such as AI complexity, adapting to diverse learning styles, and data privacy and security.

Countries with high GDP tend to have greater resources to fund research and development, enabling them to implement the most advanced AI technologies. But this is not always the case. Countries in the global South are also interested in benefiting from AI, as evidenced by multiple national strategies, including the AIForAll initiative in India. Europe may be relegated to a secondary position as a victim of a pincer formed by the US and China, on the one hand, which have a prominent leadership role, and by more impoverished but ambitious AI betting countries on the other.

Universities can be a key player in Europe in the face of the fragmentation that in practice underpins the so-called *digital market*.

In order for AI-based solutions to be effective and reliable, it is crucial to have a comprehensive set of local data for training and testing. This data will ensure that solutions are aligned with the local context, adequately reflecting its social dynamics.

The disparity in AI is further highlighted when evaluating academic publications in the area and comparing them with national economic indicators. From 2000 to 2020, there has been a steady but uneven increase in the number of AI articles in scientific journals. While North America, Europe, and Central Asia took the initial lead, since 2003, the East Asia and Pacific region has emerged as the global leader in AI publications. On the other hand, regions such as South Asia, the Middle East, North Africa, Latin America, the Caribbean, and Sub-Saharan Africa have lagged behind, with the latter two accounting for less than 2% of the global total of AI publications.

This unequal distribution in AI research and development is also evident when GDP is compared with the number of academic publications. There is an obvious correlation: the higher the GDP per capita, the more AI research publications per capita. While most countries conform to this trend, there are notable exceptions, with some countries exceeding or falling below expectations based on their GDP.

However, it is important to remember one important issue: publications and theoretical advances do not necessarily imply relevant implementation in society. China is a successful example of how an ambitious governmental commitment has been accompanied by a massive implementation below (Kai-Fu Lee, 2020). Europe, without a driving force such as universities, may be left behind, even if it has competitive research and a network of relevant talent diffused in different countries (Moreno L. and Pedreño, A., 2020).

The gap between teachers and students

Another important gap according to some studies is the one that could materialize between teachers and students. Students outpace professors in the use of AI according to the study conducted by Tyton Partners and sponsored by Turnitin, which included 1,600 students and 1,000 professors from more than 600 institutions in the United States. The study provides important insight into the growing gap between student and faculty use of AI, and its implications for education and the job market.

Among the conclusions worth noting:

1. **Extent of AI adoption among students and professors**. More than half of university students use AI tools, while less than 25% of professors do. Therefore, we are talking about a relevant difference.

2. **Propensity to use AI**. Students show more curiosity towards AI and use it both inside and outside the centers, suggesting a possible future generalization of this technology.

3. **Teacher awareness of the importance of AI**. Those teachers who are familiar with AI recognize its importance, with 75% believing that students will need generative AI skills for professional success.

4. **Rapid adoption in the use of AI**. There has been an increase in the use of AI tools by students and faculty in the last year. In spring 2023, 27% of students and 9% of teachers were using AI tools, figures that increased to 49% and 22% respectively in the fall.

5. **Type of AI applications for students and teachers**. Students use AI primarily to summarize texts and organize assignments, while teachers use it to better understand how students interact with these tools and to create more engaging activities.

6. **Institutional policies and attitudes toward AI**. Attitudes toward AI have improved, with a decrease in the number of teachers who believe that AI has a negative impact on learning. However, there is variation in the implementation of AI policies in educational institutions.

7. **Perception of the future impact of AI on the world of work**. There is a widespread belief that AI knowledge will be important in the labor market. However, there is a disconnect between this belief and the frequency with which teachers use AI in the classroom.

8. **Policy challenges in educational institutions**. There is concern about the lack of clear policies in educational institutions, especially community colleges, regarding access and equity.

8.4. The role of AI in the concepts of diversity and inclusion

This issue has been extensively addressed by UNESCO in its aforementioned report on AI. AI has the potential to mitigate biases in decision-making by eliminating human subjectivity in data interpretation. However, it can also magnify those biases if not handled properly. It is critical to understand that AI operates based on data; if that data contains biases, this can be reflected in AI results.

A clear example of this is how certain AI models process the gender experience, generally following a simple female/male dichotomy. This clearly marginalizes members of the LGTBIQ+ community whose gender identities are not adequately represented. In addition, there is evidence that AI-based facial recognition software can interpret emotions differently based on skin color, leading to misperceptions, such as black basketball players expressing more negative emotions than white basketball players. It has also been observed that facial recognition technology in many mobile devices works better for white men.

It is crucial to understand that, although these machines can detect facial expressions, they are not always reliable indicators of emotions, especially when decontextualized. In addition, AI systems applied to decisions, such as higher education admissions, can perpetuate inequalities if they replicate historical patterns. An example of this is the case of the University of Texas at Austin, which implemented AI algorithms for admissions

decisions based on past patterns and subsequently abandoned their use when it recognized biases against historically marginalized groups.

Beyond biases in the data, it is vital to consider the biases inherent in the developers of these systems themselves. If the AI field lacks diversity, the resulting products are likely to reflect and amplify existing biases.

Although significant progress has been made in terms of access to education to close the gender gap, challenges related to gender representation in STEM persist. These challenges not only originate within the education system but are also rooted in societal norms and expectations. According to OECD data, only 1% of 15-year-old girls showed interest in ICT-related professions, compared to 8% of young boys (Schleicher, 2019). This inequality in STEM education is amplified by influences from peers, parents, educators, and school counselors that perpetuate gender stereotypes. These biases undermine young women's confidence in such disciplines.

A 2019 study reflected the fact that less than 7% of AI-related publications with a single female author had been written by women. It was also found that the proportion of articles with at least one female author in some AI disciplines, such as machine learning and robotics, had stagnated at around 25% from the mid-1990s to the mid-2010s (Stathoulopoulos and Mateos-Garcia, 2019).

It is equally revealing to analyze the landscape of future AI researchers. According to the 2021 *Taulbee Survey*, which focuses on students in North America, the percentage of women earning PhDs in AI and computer science continues to stagnate at 20% (World Economic Forum, 2021. Only through the promotion of a truly diverse and inclusive STEM environment can we ensure the creation of AI systems that are fair and unbiased and that effectively serve all segments of society.

In tune with this concern, UNESCO has placed gender equality at the center of its *Recommendation on the Ethics of Artificial Intelligence*. Strategies suggested by UNESCO to ensure the inclusion and empowerment of women in all phases of the AI lifecycle include budgetary regulations and facilitation of support for women in research, academia, and entrepreneurial roles (UNESCO, 2023a). In addition, in 2023, UNESCO launched a platform of AI experts called *Women4Ethical* aimed at promoting gender equality in the field (UNESCO, 2023a).

In addition to gender inequality in representation in the artificial intelligence industry, it is important to note that this technology can also give rise to problems related to racism and discrimination. This phenomenon has been the subject of concern in various contexts and has been addressed in numerous studies and research.

In particular, artificial intelligence algorithms can inherit biases present in the data they are trained on. If the training data contains bias or discrimination, AI systems can perpetuate and amplify these biases in their decisions and results. This can have serious implications for different aspects of society, including higher education.

A prominent example is the study by Joy Buolamwini and Timnit Gebru in 2018, which revealed how facial recognition systems at some major technology companies performed poorly in identifying darker-skinned people, especially women. This underscores how biases in data collection and algorithm design can result in discrimination and inequity in the use of technology.

In the context of higher education, the COVID-19 pandemic led to an increase in the use of AI-driven proctoring systems for online exam administration. However, these systems also showed biases against people with darker skin tones. For example, at the University of Louisville, it was found that software used for automated proctoring was more likely to single out women with darker skin tones, despite finding no evidence of differential cheating rates. This type of algorithmic discrimination raises important ethical and practical questions in education.

To address these issues, it is critical that there is ongoing monitoring and evaluation of AI systems used in higher education and that steps are taken to mitigate bias and prevent discrimination. This includes reviewing and improving training data, designing more equitable algorithms, and promoting diversity in the AI industry by ensuring that development teams reflect a plurality of perspectives and experiences. In addition, educating students and professionals about the risks and ethical challenges associated with AI in education is essential to encourage responsible and conscientious use of this technology.

The lack of racial diversity among artificial intelligence students is also a major concern. Examining new Ph.D. enrollments in artificial intelligence in the United States, for example, reveals an uneven distribution in terms of race and ethnicity. In this context, 45.6% of students were of white descent, 22.4% were of Asian descent, 3.2% were of Hispanic descent, 2.4% were of black or African American descent, and 1.6% had a multiracial identity (based on data from Stanford University, 2021).

In Brazil, there is a trend whereby those who choose to pursue STEM (science, technology, engineering, and mathematics) subjects tend to come from a higher socioeconomic background. This may be related to the higher demand for STEM education and the advantage of wealthier white students who have attended prestigious private high schools. In addition, these students do not rely as much on social support to access higher education (as indicated by the findings of Machado et al., 2021).

In India, despite public policies that have implemented affirmative action through reserved allocations in higher education, students belonging to marginalized social groups, such as scheduled castes, scheduled tribes, and other categories, remain significantly underrepresented in most of the country's institutes of technology (as reported by *The Times of India*, 2019).

To address these challenges and promote greater racial and ethnic diversity in science, technology, engineering, and mathematics fields, targeted institutional programs have been implemented. A study focusing on STEM programs with a diversity focus in the United States has shown that support measures that combine supplemental learning

activities, mentoring, skills development, financial assistance, socialization, and bridging programs can have a positive impact on the performance of underrepresented minorities in these fields. However, researchers point to the need for further analysis to understand how to effectively support students who come from intersectional backgrounds, as not all characteristics and outcomes can be uniformly applied to all groups (as indicated by Palid et al., 2023).

8.5. Future perspectives of AI in higher education

It is critical to project into the future and reflect on the continuing impact of AI developments in higher education.

New generative AI tools have accelerated the perception of an AI capable of very rapid progress in technological achievements and milestones that represent significant breakthroughs. **UNESCO cites as the most significant transformation we could envision the achievement of general artificial intelligence, i.e., human-level AI**.

While there is a general consensus among experts on the feasibility of achieving such AI at the human level, there are still differences of opinion as to when this could materialize. One estimate points to a 50% probability of this happening within the next 50 years, i.e., before the end of the 21st century.

According to UNESCO, even before that milestone is reached, conventional approaches to higher education are likely to be challenged.

According to research conducted among 25 Western academics considered intellectual leaders in the field of AI, optimism about AI's ability to simplify routine administrative tasks, thereby opening up new avenues of knowledge and fostering greater collaboration, is countered by concerns that AI may promote bias and inequalities, especially if used without a proper understanding of its underlying principles. **Hence the need to consider the adoption of controlled, optimized, and well-managed AI**.

Excessive weighting of hypothetical risks and fears, cloaked in ethical and humanistic discourse, can lead to delays and significant gaps. On the contrary, rushing to adopt uncontrolled and optimized AI can generate skepticism and rejection.

In the immediate future, one of the crucial issues for universities, regardless of their location or level of resources, will be the **readiness of their leadership to carry out responsible AI implementation**.

This may in many cases require **significant investment in training and capacity building**. Dedicating time and resources to these processes is essential, not only for leadership but to fully realize the benefits of AI in higher education. For AI to be truly effective, its adoption must go beyond the understanding of a few faculty, staff members, or students who understand how it works and how it can improve higher education.

Trends and forecasts for AI in universities.

1. **Guidelines on the use of AI**. Universities will develop policies and guidelines on the use of AI in teaching, learning, and assessment, focusing on adapting AI rather than prohibiting it. Assessment methods will be rethought, seeking to integrate AI into assessment processes or identifying alternatives that increasingly use AI tools to address the limitations of existing assessment systems.
2. **Adoption of AI tools for students and personalization**. Institutions with financial resources will be able to enhance the student experience through the use of artificial intelligence tools, such as the personalization of academic programs and the implementation of virtual and augmented reality to enrich learning experiences. Chatbots are also expected to be widely used in higher education to provide information and support to students. To avoid gaps, in countries such as Spain, public administrations should provide universities with Next Generation resources.
3. **Generative AI at the heart of student empowerment**. The formation of generative AI tools to assist students in their learning process, especially in the question-answer format, will continue to be a trend (along the lines of E-tutor). The integration of AI will require technical and ethical competencies, which will imply changes in the roles within universities and the expectations of leaders, staff, and faculty regarding their understanding and knowledge of AI.
4. **Data-driven decision making: student retention**. Data-driven decision-making will become more prominent, especially in universities with a strong data infrastructure. This information will be used to develop strategies to improve student retention, especially in environments with high attrition rates.
5. **Public-private collaboration**. Most universities will need to acquire AI tools developed by private companies, which poses challenges in terms of allocating financial resources and fully understanding the capabilities of these tools.
6. **Multidisciplinary collaboration**. In an ideal scenario, universities with research functions will collaborate in forming interdisciplinary teams of researchers to work on AI, both in its technological development and in understanding its social implications. Interdisciplinary AI laboratories will be created and higher education research will contribute to knowledge about aspects of AI that have not yet been sufficiently explored.
7. **AI ethics training** will become common practice and part of research training. Universities will look for ways to teach AI ethics and critical thinking to all students, either through specific courses or as part of existing programs.
8. **Training in AI**. AI course offerings will be significantly expanded, not only to train specialists, but also to provide more general education on AI, ethics, and other related aspects. Educating the general public about AI will be incorporated into the community engagement mission of universities. As labor markets evolve, universities will diversify their programs in partnership with others, offering courses of different lengths and modalities. This flexibility may pose

challenges, especially in contexts where curriculum changes require lengthy processes and approval from relevant regulatory agencies.

8.6. STEM deficit: vocation vs. equal opportunities in the new AI era

Universities can provide more powerful answers to society if they train and develop talent that can respond to the enormous challenges generated by the AI era.

STEM skills are one of the surest doors to employability and wealth generation in today's world. This is reflected by agencies such as the U.S. Bureau of Labor Statistics (BLS), which estimates that in the 2019-29 period, STEM occupations will increase twice as much as the average for all other jobs (8% vs. 3.7%).

The report *The future of work in Europe* also estimates that jobs requiring STEM skills will increase in demand by 20% in a decade in the old continent. In Spain, a consultation conducted by Manpower indicated that 66% of companies had difficulties in incorporating professionals with digital skills into their workforces. After the virulent entry of generative AI, these figures may have been greatly underestimated.

Hence, a recurring question arises again in our society: Why does Spain, a country with a youth unemployment rate that doubles the European average, not carry out a comprehensive training strategy in digital skills?

<u>One step forward, two steps back</u>

Far from being the case, the fact is that in the last decade (up to COVID-19) Spain has lost relative positions in the volume of employees with technological specialization, according to data from the Eurostat website.

If in 2011 we were on a par with the EU average (3%), in 2020 we are 0.5 points below. This competitive loss is key to understanding the Spanish context as a whole: although it is true that Spain has increased its performance to reach a figure close to 4%, our year-on-year growth in the period described (2.5%) is much lower than that of Portugal (8%), Estonia (7%), France and Germany (5%) and the EU-27 as a whole (3.5%). This setback is a clear defeat in terms of economic and labor policy, especially in terms of youth employment.

In short, the example of Spain demonstrates the need to address the demands arising from the emergence of the digital economy in a context in which AI plays a fundamental role in the productivity and competitiveness of companies: the increase of human capital in STEM must be a fundamental strategic commitment.

9. ETHICS, AI, REGULATION AND UNIVERSITIES

The very definition implicit in AI (emulating through machines what human intelligence does) carries with it enormous challenges and demands. **Nuria Oliver** has collected these demands in eight points (Oliver, 2018):

1. **Autonomy & dignity**. Stresses the importance of individual autonomy in decision making, highlighting the risk of computational models subliminally influencing human behavior. AI systems should respect human autonomy and dignity by following a set of socially accepted ethical rules.
2. **Justice & solidarity**. Addresses the issue of non-discrimination and the need for fairness in algorithmic decision-making. It highlights the potential for algorithms to reproduce or intensify existing biases and the urgency of developing and validating algorithmic fairness metrics. Cooperation across sectors and nations is encouraged to maximize the potential of AI.
3. **Beneficence**. It emphasizes sustainability and environmental responsibility in AI development, as well as the importance of the veracity of the data and content generated by these systems. It also addresses the need for diversity in AI development teams and in the results of personalization and recommendation algorithms.
4. ***Explainability***. It focuses on the transparency and comprehensibility of AI models. Different types of opacity in algorithmic decisions are discussed and the need for transparency in interaction with artificial systems is emphasized. The responsibility and role of the human in relation to AI is also addressed.
5. **Non-maleficence**. It addresses reliability, safety, and the need for replication in AI systems. It suggests the creation of authorities to certify the quality and security of these systems. In addition, the importance of protecting privacy and personal data in a context of massive data use and advances in machine learning algorithms is mentioned.
6. **Prudence**. It underscores the need for a careful and thoughtful approach to AI development. Practitioners must ensure the availability of quality data, analyze hypotheses from multiple perspectives, and have the resources necessary for proper interpretation of models and results. This principle highlights the importance of considering all possible options in the design phases to maximize positive impact and minimize risks.
7. **Data protection & privacy**. Emphasizes the importance of personal data protection and privacy in the age of AI. Highlights how advances in algorithms allow private information to be inferred from non-personal data, raising significant ethical challenges. It suggests that certain personal attributes should remain private unless the individual chooses otherwise. The text also mentions the European Union's General Data Protection Regulation as an example of leadership in this area.

8. **Fundamental and new rights**. Addresses the need to consider fundamental rights in the application of AI, such as the right to establish human relationships, to technological disconnection, and to be free from surveillance. It proposes the inclusion of new rights, such as the right to meaningful human contact in environments dominated by automated systems (such as chatbots) and the right to be free from measurement, analysis, profiling, or subliminal influence by algorithms.

AI requires a strong ethical claim that projects itself well in efficient (and effective) regulations and in promoting ambitious educational policies for a country's population as a whole. Inefficient over-regulation can lead to inaction and hinder the development and application, and thus the benefits, of a particular technology.

For example, an overemphasis on privacy and data protection can result in significant restrictions that make it impossible or extremely complex and costly to make data available for artificial intelligence. Without data, there is no AI.

By way of illustration, the availability of medical data could advance the understanding, diagnosis, and design of personalized drugs. However, very strict regulation on privacy makes the availability and exploitation of data through AI very difficult. Even when adopting technologies that guarantee data anonymization. In Spain, it is easier and faster to donate a kidney or any vital organ than medical data. We are the country of reference in organ donation, for its ease and efficiency in an operational and efficient regulation. But for the development of AI, Spain and Europe are far from any kind of leadership standard.

However, it is clear that the potential of AI can be subject to misuse. According to Stanford University (HAI-Stanford 2023), the number of incidents related to AI misuse is rapidly increasing. Citing the AIAAIC database, which tracks incidents related to the ethical misuse of AI, **the number of AI incidents and controversies has increased 26-fold since 2012**.

Some notable incidents in 2022 included a deepfake video of Ukrainian President Volodymyr Zelenskyy surrendering and U.S. prisons using inmate call monitoring technology. This growth is evidence of both the increased use of AI technologies and awareness of the potential for misuse.

This situation has caused legislators' interest in AI to be on the rise. An AI index analysis of legislative records from 127 countries shows that the number of bills containing the term "artificial intelligence" that became law increased from just one in 2016 to 37 in 2022. An analysis of parliamentary records on AI in 81 countries also shows that mentions of AI in global legislative proceedings have increased nearly 6.5 times since 2016.

Perception of risks vs. benefits

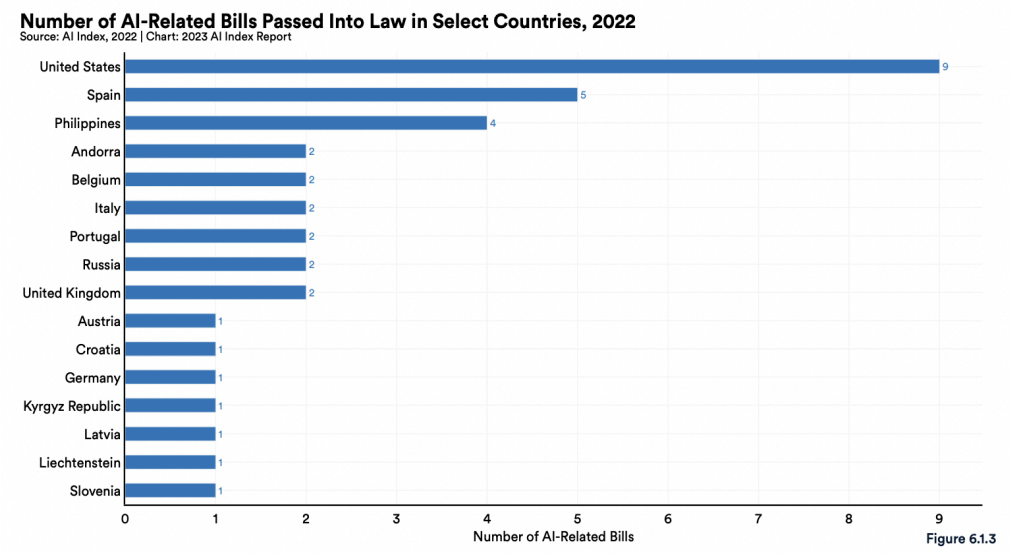
The media and the level of a country's development can influence the balance between the risk assessment of AI and its benefits.

Chinese citizens are among those with the most positive feelings about AI products and services. The American citizens..., not so much. In a 2022 IPSOS survey, 78% of **Chinese** respondents (the highest proportion of the countries surveyed) agreed with the statement that products and services using AI have more benefits than drawbacks. After Chinese respondents, those from **Saudi Arabia** (76%) and **India** (71%) felt more positive about AI products. Only 35% of **Americans** sampled (among the lowest of the countries surveyed) agreed that products and services using AI have more benefits than drawbacks.

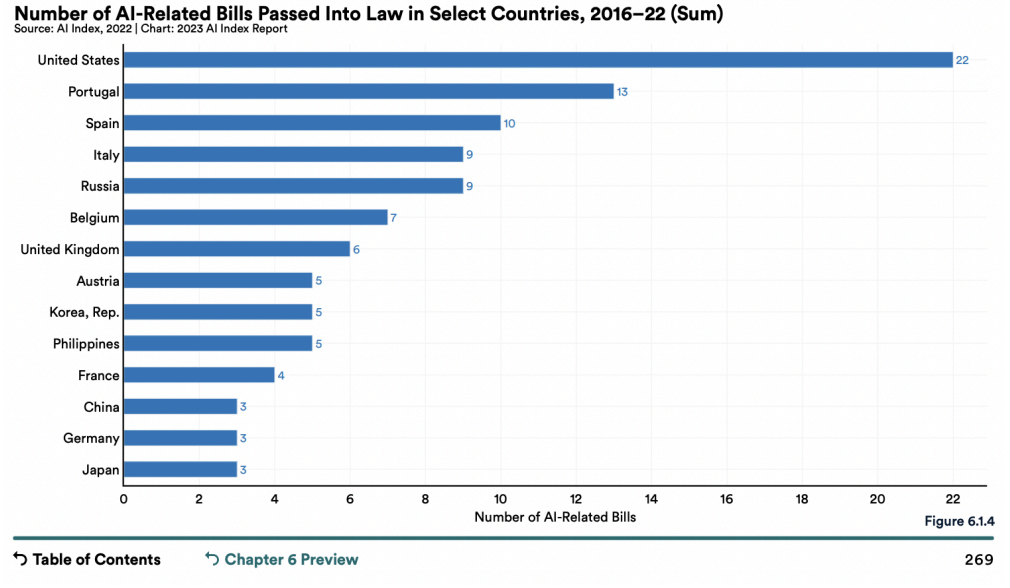
This state of public opinion on AI may give a significant advantage to certain countries, such as **China**, **India**, or **Saudi Arabia**, whose populations are favorable to AI compared to Europe, the United States, and other countries that are more inclined to impose major restrictions on its development. Safeguards versus risks must be weighed in an environment where AI is set to have a high impact on all productive sectors, businesses, and the economy of a country as a whole.

Regulatory activity

The charts below show the number of laws containing mentions of "artificial intelligence" that were enacted in 2022. The United States (a leader in AI development and innovation and large technology companies) topped the list with nine laws, followed by Spain and the Philippines, which passed five and four laws respectively. Similarly, the following chart shows the total number of laws passed since 2016. The United States tops the list with 22 laws, followed by Portugal, Spain, Italy, and Russia.



Spain and Southern Europe appear as regulatory *champions* at the global level, which undoubtedly seems to be evidence of an outstanding legal proactivity in the international context and a high level of awareness of regulatory needs.



In conclusion

In short, we face complex dilemmas, and it is precisely in universities where it is possible to delve into AI ethics (Escotet, 2023), defined as "a set of values, principles, and

techniques that use widely accepted standards of right and wrong to guide moral conduct in the development and use of AI technologies" (Leslie, 2019: 3).

The topic of ethics has received special attention by UNESCO in the field of higher education: aspects such as academic integrity, regulations and guidelines, data security and privacy, data biases, and issues related to AI commercialization. In the following sections, we follow the aforementioned report *Harnessing the Era of Artificial Intelligence in Higher Education: A Primer for Higher Education Stakeholders* (UNESCO, 2023).

Image: GPT-4/DALL-E: Focus on the intersection of artificial intelligence, ethics and universities, showing a modern university environment where a diverse group of people discuss ethics in AI.

9.1. European Union, the world's first AI regulator

On December 9 (2023), the Council and the European Parliament reached an agreement on the first global AI standards. With this, Europe, which lags far behind the United States and China in the development of AI, and even smaller countries (United Kingdom, Canada, Israel...), achieved regulatory leadership.

The aim of the EU-driven artificial intelligence law is to ensure that AI systems on the European market are safe and respect fundamental rights and EU values, as well as stimulate investment and innovation in AI in Europe.

According to the Spanish State Secretariat for Digitalization and Artificial Intelligence, the agreement attempts a delicate balance between boosting innovation and the use of AI in Europe, while respecting the fundamental rights of citizens.

Some features of the approved regulation (EU Council, 2023):

1. **Risk-based approach**. The law regulates AI based on its ability to cause harm to society, applying stricter rules to greater risk. It is the first legislative proposal of its kind in the world and could set a global standard for AI regulation.

2. **Main elements of the law (agreement):**

- Rules for general-purpose AI models and high-risk systems.
- Revised governance system with certain enforcement powers at the EU level.
- Extension of the list of prohibitions, with exceptions for remote biometric identification by law enforcement authorities under safeguards.
- Protection of rights by assessing the impact on fundamental rights before using a high-risk AI system.

3. **Classification of AI systems and prohibited practices**. The law introduces a horizontal layer of protection, including a high-risk classification and prohibiting certain AI practices, such as the manipulation of cognitive behavior.

4. **Exceptions when applying the law:**

- It does not apply in areas outside the EU legislative scope.
- Exclusion of systems used only for military or defense purposes.
- It does not apply to AI systems used only for research and innovation.

5. **Exceptions for law enforcement authorities**. Certain uses of AI systems by law enforcement authorities are permitted, subject to appropriate safeguards.

6. **AI systems and fundamental models**. New provisions have been added to address general-purpose AI systems and fundamental models, with specific transparency obligations.

7. **Governance**. Establishment of an AI Office within the Commission to oversee the most advanced AI models and an AI council for coordination and advice.

8. **Penalties and protection of fundamental rights**. Fines are set for violations and a fundamental rights impact assessment is required before putting a high-risk AI system on the market.

9. **Measures to support innovation**. Provisions have been modified to foster an innovation-friendly legal environment, such as regulatory sandboxes for AI.

The law should apply two years after it comes into force, with exceptions for specific provisions. The full text still needs to be confirmed and formally adopted by the co-legislators.

BASIC CHARACTERISTICS OF THE EUROPEAN AI REGULATION

- **Definition of AI**. Aligned with the recently updated OECD definition.
- **Extraterritorial**. It applies to organizations outside the EU.
- **Exemptions**. National security, military and defense; R&D; open source (partial).
- **Grace period in compliance**: between 6 to 24 months.
- **Risk-based**. Banned AI >> High-Risk AI >> Limited Risk AI >> Minimum Risk AI.
- **Requirements**. Extensive requirements for high-risk Al suppliers and users.
- **Generative AI**. Specific transparency and disclosure requirements.

Banned AI	High-risk AI
• Social credit rating systems. • Emotion recognition systems at work and in education. • AI to exploit people's opinions: vulnerabilities (e.g. age, disability). • Behavioral manipulation and circumvention of free will. • Undirected scraping of facial images for facial recognition. • Biometric categorization systems that use sensitive characteristics. • Specific predictive policing applications. • Police use of real-time, biometric identification in public (except in limited and previously authorized situations).	• Medical devices. • Vehicles. • Recruitment, HR, and worker management. • Education and vocational training. • Influencing elections and voters. • Access to services (e.g. insurance, banking, credit, benefits, etc.). • Management of critical infrastructure (e.g. water, gas, electricity, etc.). • Emotion recognition systems. • Biometric identification. • Law enforcement, border control, migration, and asylum. • Justice administration. • Specific products and/or safety of components of specific products.

KEY REQUIREMENTS: HIGH-RISK AI

- Impact assessment on fundamental rights and compliance.
- Registration in a public EU database for high-risk AI systems.
- Implement a risk and quality management system.
- Data governance (bias mitigation, representative training data, etc.).
- Transparency (such as instructions for use, technical documentation, etc.).
- Force-human supervision: *explainability*, auditable logs, human intervention...
- Accuracy, robustness, and cybersecurity (e.g., testing and monitoring).

GENERAL-PURPOSE AI (GPAI)

- Different requirements for general purpose AI (GPAI) and base models.
- Transparency for the entire GPAI (e.g. technical documentation, training data summaries, copyright and intellectual property safeguards, etc.).
- Additional requirements for high-impact models with systemic risk: model assessments, risk assessments, conflicting evidence, incident reports, etc.

- AI: people should be informed when they interact with AI (e.g. generative AI chatbots).
- All content must be tagged and detectable (e.g. deep fakes).

SANCTIONS AND COMPLIANCE

- Up to 7% of global annual turnover or €35 million for prohibited AI violations.
- Up to 3% of global annual turnover or €15 million for most other infringements.
- Up to 1.5% of global annual turnover or €7.5 million for providing incorrect information.
- The European 'AI Office' and 'AI Board' are established centrally in the EU.
- Limits on fines for SMEs and startups.
- Market surveillance authorities in EU countries to enforce the AI law.
- Any individual may file complaints about non-compliance.
- It has not yet been enacted. Political agreement date: December 8, 2023.

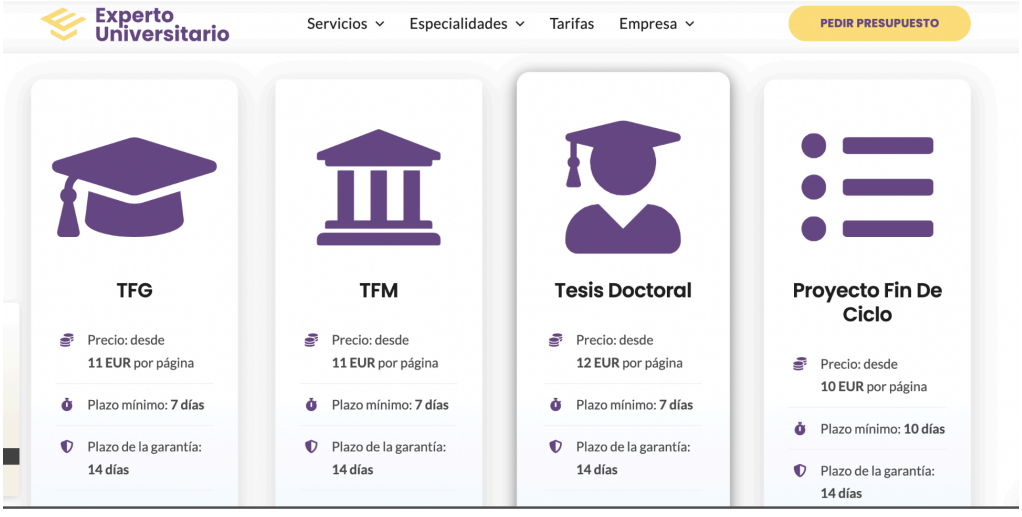
Source: Oliver Patel.

9.2. Ethics in the academic field

Ethics in education is an issue of global concern in the field of higher education (Bretag, 2016) and addresses fundamental values, such as honesty, fairness, and responsibility. The focus is often on the consequences of violations of educational ethics, such as plagiarism, cheating, or other inappropriate behavior committed by students or researchers.

These value-based concerns are influenced by sociocultural contexts and local educational traditions; and in the context of artificial intelligence (AI), they are shaped by research that mostly comes from Western (Anglocentric) educational systems (Prabhakaran et al., 2022).

Even before the popularization of ChatGPT in 2023, the proliferation of the Internet and rapid technological advancement had posed new challenges when it came to educational ethics (Eaton, 2022; Sullivan et al., 2023). There are numerous sites on the Internet that offer materials and even academic paper writing services. An example is shown in the image capture below.



Source: advertisement and web page with services on the Internet.

AI tools and *cheats*

AI tools that can generate texts similar to those written by humans or produce content in specific styles have put at risk the authenticity of certain forms of assessment, especially those based on the memorization of information.

This would have increased the risk of plagiarism and cheating by students. In response to these tools, new solutions have emerged capable of detecting AI-generated text, and existing plagiarism detection systems are being enhanced to include AI-produced content.

With the popularization of tools such as GPT and corresponding AI sensing technologies, there has been an increasingly loud call for higher education institutions to review their policies and guidance on the use of AI in teaching, learning, and assessment.

This topic has been discussed in "What do AI chatbots really mean for students and cheating?", written by Carrie Spector and published on October 31, 2023, where opinions and findings on the impact of artificial intelligence chatbots are presented, such as the use of ChatGPT, in the deception practices among the students of Stanford researchers Denise Pope and Victor Lee. Although referring to secondary education, its conclusions may be interesting in the topic at hand. The article addresses the common misunderstanding that AI, such as ChatGPT, is increasing cheating rates among students, and highlights the importance of understanding the real reasons behind cheating and educating students about the ethical and critical use of the technology.

The article reveals the concern of educators about the use of chatbots such as ChatGPT or Bard by students to cheat in their work.

Denise Pope and Victor Lee have investigated cheating among US high school students before and after the launch of ChatGPT, and their findings lead them to say that, to this point, they have not found an increase in cheating due to the AI. Cheating rates have been high for a long time. Some surveys show that 60 to 70 percent of students have engaged in cheating, a figure that has not increased with the emergence of AI. Surveys are anonymous, leading to honest responses from students. Many students find it acceptable to use AI chatbots for initial tasks, such as explaining a concept or generating ideas, but not for writing an entire paper. Cheating is seen as a symptom of deeper systemic problems in education. Students who feel respected and valued are less likely to cheat.

Pope and Lee's conclusion is that school leaders should teach students to use technology ethically and critically, rather than trying to block or ban it. They compare artificial intelligence education with driver's education: it is important to teach students to use this technology responsibly.

9.3. Standards and guidelines

The rapid development of ChatGPT, for example, has raised concerns among various key actors, including its own founder. The rise of ChatGPT also led to an open letter signed by more than a thousand academics and private sector leaders requesting a pause in the development of powerful AI systems for training (Future of Life Institute, 2023). This suspension in principle would allow us to investigate and better understand the possible risks and develop shared protocols. By April 2023, the letter had garnered more than 30,000 signatures.

However, this letter was the subject of critical responses opposing the moratorium from the most reputable experts in the AI sector. Yann LeCun, chief AI scientist at Meta, and Andrew Ng, founder of Deep Learning, opposed the pause proposal with compelling reasons and arguments.

Ng and LeCun, in a public debate, agreed that some regulation was necessary, but not at the expense of research and innovation. They argued that a pause in the development or implementation of these models was unrealistic and counterproductive. They also called for more collaboration and transparency between researchers, governments, and corporations to ensure the ethical and responsible use of these models.

The release of this type of LLM models (as was the case with Llama, from Meta) also fostered an environment where countries outside the United States or Europe, such as Russia, China, etc., had access to this type of AI models. and they could achieve greater hegemony and leadership in a key technology such as generative AI.

This environment is logically complex and strategic objectives are intertwined with concerns and cautions around AI.

UNESCO recommendations and international experience

UNESCO recognizes the need to establish legal frameworks and guidelines at all stages of the AI lifecycle (UNESCO, 2021c). This includes data regulation at the state level, covering data protection, ethical impact assessments, development of oversight mechanisms to evaluate algorithms, data and design processes, as well as AI systems. Although it is essential to carry out reforms at different levels to address the ethical challenges posed by AI in higher education, these reforms must be evaluated and monitored by States as part of their responsibility to guarantee human rights, peace, and security. (Roumate, 2023).

Internationally, some countries, such as China, have already established regulations that will guide the development of AI tools with principles that promote non-discrimination in data and content (Kharpal, 2023).

Other multilateral bodies have created or endorsed standards and legal frameworks related to the ethical use of AI. For example, the OECD recommendations on AI adopt a human-centered approach, with trustworthiness as its main principle (Roumate, 2023).

The European Union (EU), after proposing a regulatory framework for AI in 2021, has just agreed on the AI law. Perhaps when it comes to higher education, the two main constraints are biometric recognition and the need to identify AI-generated texts.

There are other routes at the international level. For example, the US-based nonprofit Partnership on AI has advocated for multi-stakeholder collaboration to develop guidelines on machine learning systems and establish industry standards on transparency in AI through an initiative called ABOUT ML (Partnership on AI, 2021).

9.4. Data security and privacy

The vast amount of data collected and used to build and maintain AI systems at higher education institutions can offer benefits to both students and institutions. However, it also poses risks if this data is abused (Johnson, 2014), such as misappropriation or exploitation of personal data during investigations (Roumate, 2023). The concentration of personal data can raise privacy and security concerns. It is therefore essential to implement appropriate safeguards to prevent data theft and misuse, following international and national standards.

UNESCO Recommendations

UNESCO (UNESCO, 2021c) underlines the importance of respecting, protecting, and promoting data privacy throughout the entire lifecycle of AI systems. In this sense, higher education institutions that use AI must have a data governance strategy. It is relevant to highlight that students are increasingly aware of the importance of protecting their data, so institutions must reassure them by ensuring that their data is collected and processed in a secure, transparent, and ethical manner (Rouhiainen, 2019).

Data ownership issues are also critical to security and privacy. Institutions must be aware of how data was generated, who created it, and where it is geographically located, as well as develop strategies to comply with local legislation and determine who can access that data.

Italy and ChatGPT

In April 2023, Italy became the first country to block ChatGPT due to privacy concerns (McCallum, 2023). The country's data protection authority argued that there was no legal basis for the collection and storage of personal data used to train ChatGPT. Additionally, he raised ethical concerns about the tool's inability to determine users' ages, which could expose minors to inappropriate responses. After a few weeks and harsh criticism, the tool was unblocked once the company behind ChatGPT agreed to provide a form so that users in the European Union could opt out of collecting personal data and offer a tool to verify users' age. recorded from Italy (Mukherjee and Vagnoni, 2023).

9.5. Promotion and commercialization

The involvement of private entities in higher education is a phenomenon that is not new and, in the context of AI, has undergone changes over time. Currently, the industry has a dominant role in both the development of AI and its results, including academic publications (Ahmed et al., 2023).

Concentrating efforts on AI development by the industry can help cover the rising costs of technological advances and computing power. It can also induce efficiencies in processes and products that reduce associated costs and efforts (Ahmed et al., 2023).

In some forums, it has been highlighted that there is a risk that the commercialization of AI limits its development only to those areas that are profitable for the industry. Furthermore, this concentration on industry, rather than academia, may have implications for future research, reducing the likelihood that academic-led basic research (without immediate applications) will play a significant role in knowledge creation, innovation and collaboration, as well as the generation of long-term social benefits.

It is relevant to note that only a small percentage of doctoral graduates choose to continue in academia, while an even smaller number continue their careers in the public sector (Stanford University, 2023). This can lead to the dilution of partnerships between industry and universities, as well as between international academic associations, undermining the essential role of collaboration between and within sectors.

The COVID-19 pandemic has accelerated commercialization in higher education, especially with the support of educational technology as a solution during campus closures. This, according to Williamson and Hogan, has led to the presentation of private sector entities as leaders in implementing reforms and transformations in higher education after the pandemic (Williamson and Hogan, 2021).

In this context, AI has advanced significantly with the use of data monitoring tools integrated into online learning management software, proctoring technologies for remote exams, and campus security systems. At the same time, higher education institutions are using AI-based technologies for their own educational and administrative purposes.

It is important that the education sector takes responsibility for developing pedagogically and culturally appropriate content materials, and rigorously evaluates AI models and applications that have a significant impact before their large-scale implementation (Giannini, 2023).

In short, ethical concerns related to the commercialization of AI also relate to equitable access to the technologies. Although many AI tools are offered free of charge, their availability and functionalities can vary, which can contribute to inequality in access and its consequences on learning outcomes and opportunities.

10. AI AND UNIVERSITIES IN SPAIN

10.1. Data and the Spanish universities

The Conference of Rectors of Spanish Universities (CRUE) has promoted a very interesting document called "Analíticas de Datos en la Universidad" -"Data Analytics at the University"- (CRUE, 2023). Various authors address different topics related to data. It is a first strategic step for the development of AI at the universities.

The document addresses several key points about a **data space and its management**. The main highlights are summarized below:

1. **A space for access and exchange of data**. The data space facilitates the access and exchange of data, not its ownership, promoting the creation of new products and services around data and encouraging fair competition.

2. **Compliance with EU Legislation**. Supports compliance with European Union legislation, including personal data protection, consumer protection legislation, and antitrust laws.

3. **Promotion of trust and ethics of data processing**. Promote trust among participants, beyond regulatory compliance, establishing data processing ethics based on principles of reliable administration, privacy, transparency, explainability, and fair and responsible use of AI.

4. **Sovereignty of participants over their data**. It ensures that data space participants decide with whom and under what contractual conditions they share information, emphasizing the prevention of unauthorized uses.

5. **Security**. It pays attention to data security, considering certification, and establishing identification systems for participants and software components.

6. **Open participation**. The space is open to the participation of actors from various sectors with an explicit and public governance code that guarantees transparency, equity, non-discrimination, and sustainability.

7. **Diverse roles of the participants**. It allows participants to take on different roles, such as data producers or consumers, service providers, developers, or data brokers.

8. **Governance and conflict resolution**. Establishes policies for access and use of information, as well as mechanisms to manage conflicts.

9. **FAIR data principles**. It makes it easy to find, access and use data under the FAIR principles (findable, accessible, interchangeable, reusable).

10. **Development of common semantics and vocabularies**. It encourages the development of commonly used semantics and vocabularies to facilitate the exchange of information.

In addition, other aspects are addressed, such as the accessibility of data for people with disabilities, the availability of the resulting final product, interoperability with other data spaces, external audits to verify compliance with policies, technological independence, and promotion of an innovative ecosystem. , use of software components under accessible licensing schemes and the implementation of innovative technologies for data processing and analysis.

Among the works included in the document, it is worth highlighting the contributions that Professor Ricard Martínez (2023) includes in his work, which we also summarize:

1. **EU delay in the digital race**. It is highlighted that the European Union (EU) is lagging in the field of artificial intelligence and the digital world, compared to the United States and China. The most influential companies in this sector are mainly in these two countries, while the EU lacks a leading business ecosystem in these fields**.**

2. **Regulation and innovation in the EU**. The need for the EU to implement more efficient regulations that encourage research, innovation, and entrepreneurship is emphasized. The experience of the 20th century has shown the importance of regulating technology, especially compared to Anglo-Saxon culture, which tends towards less regulation.

3. **Digital transformation and the role of universities**. The importance of digital transformation in the economy, administration, and society is highlighted. Spanish universities, both public and private, play a crucial role in this process and must face their own challenges of digital transformation in management and research.

4. **Challenges in data protection and regulatory compliance**. The need for a robust approach to the protection of personal and non-personal data, as well as regulatory compliance in the university environment, is addressed. It is mentioned that lack of compliance can lead to significant risks in terms of data quality and viability of research projects.

5. **Urgency of structural and cultural changes**. The need for profound structural and cultural changes in universities and in society in general to adapt to new digital and regulatory challenges is argued. This includes bringing in experts in digital law, data protection, and AI ethics to ensure an efficient and secure digital transition.

The opportunity to conceive a strategy for data and the considerations around the role of universities and AI provide a truly interesting basis for promoting the development of artificial intelligence in Spain.

10.2. Next Generation Funds as an opportunity

The Next Generation Funds open a unique opportunity for AI and universities in Spain. On the one hand, our country needs to develop a relevant technological sector around AI with internationally competitive companies; a business fabric that achieves the aforementioned challenges of controlling, optimizing, managing, democratizing, customizing, and empowering professionals and people in general.

Universities, as we have defended in the report, play a fundamental role in multiple aspects that must be a priority in Spain if we want to maximize the potential and benefits of AI.

It is especially worth highlighting:

a) **Train for the future**. The need to train university students of any discipline with tools that will be decisive in their professional future, with the potential to multiply "n" times the productivity of sectors and companies.
a) **Promote solid jobs for young people**. Spain doubles the youth unemployment rate of the European Union and is the country in Europe with the highest youth unemployment rate currently. Additionally, the Spanish youth labor market faces major problems, such as the "great resignation" and other phenomena widely covered in recent studies.[18].
b) **Demonstration effect**. Promote the *tractor effect* of AI in universities and its demonstration effect in the rest of the productive system.
c) **Achieve relevant academic and social objectives**. Strengthen Spanish universities through the lines discussed in the report.

Summarizing:

- Increase the efficiency of university management.
- Strengthen university research with AI instruments and the processing of large databases of scientific sources.
- Empower students and faculty with tools that enable knowledge assimilation, student success, and the integrity of higher education.
- Reduce the student dropout rate and failure in studies.
- Generate responsible, ethical, and sustainable use in the exploitation of AI.
- Achieve the greatest reputational prestige of universities around a general-purpose technology.

[18] Moreno, L. and Pedreño, A. (2023): *España en la nube. ¿Una Startup Nation o país del desempleo juvenil? Afrontando los retos en la era de la inteligencia artificial* (Amazon).

List of AI applications and use cases for Spain

As we have seen in this report, artificial intelligence has numerous applications in the university environment. Below are some of the main points where AI can be applied in universities in Spain:

1. **Admission and registration**. AI can help automate and optimize admissions and enrollment processes, analyzing student applications and making recommendations based on predefined criteria.

2. **Personalization of learning and generative AI tools for study**. Using AI algorithms, universities can offer personalized learning experiences for students, tailoring course material to their individual abilities and needs. Likewise, generative AI provides tools that allow adaptive learning.

3. **Virtual assistance for students**. AI-powered virtual assistants can provide support to students, answering frequently asked questions and offering real-time help for academic and administrative queries. Special importance for **student retention** programs.

4. **Educational data analysis**. AI can analyze large volumes of data to identify trends and patterns in student performance, which can help improve teaching strategies and academic programs.

5. **Smart libraries**. Applications of AI in academic libraries may include book recommendation systems, automated cataloging, and improved search of information resources.

6. **Investigation**. AI can be a valuable tool in research, assisting in the collection and analysis of data, as well as the simulation and modeling of complex scientific phenomena.

7. **Campus and resource management**. AI systems can optimize resource management on campus, from classroom assignments to energy management and security.

8. **Evaluation and feedback**. AI-based tools can assist in the evaluation of assignments and exams by providing personalized and objective feedback to students.

9. **Support for mental health and well-being**. AI can offer support in the area of mental health through chatbots and applications that provide immediate advice and assistance for student well-being.

10. **Detection of academic fraud**. AI systems can help detect plagiarism and other forms of academic fraud, ensuring the integrity of assignments and exams.

11. **Academic and study advice**. AI can assist in academic and career advising, analyzing students' skills and preferences, and suggesting possible academic and career paths.

12. **Accessibility and support for students with disabilities**. AI can improve accessibility for students with disabilities through technologies such as enhanced screen readers, automatic sign language translation, and other adaptive tools.

Each of these applications offers significant opportunities to improve the educational and operational experience at universities.

Other ways to advance AI in universities

The Spanish Government has already taken some measures to promote AI in universities, such as calls for aid to finance chairs and cooperative research plans. However, there are other actions you could take to make the most of Next Generation EU funds in this area.

One of the main lines of action would be the **training of AI researchers**. AI is a very complex discipline that requires specialized training. The Government could support the creation of master's and doctoral programs in AI, as well as the **training of professors and research staff** in this area.

Another important line of action would be the **promotion of AI research**. The Government could finance AI research projects both individually and in collaboration between universities, research centers, and companies. It could also support the creation and coordination of centers of excellence in AI that concentrate on research and training in this area. This has been the case of the ELLIS network of excellence in Europe.

Finally, the Government could **promote the transfer of knowledge in AI**. AI has the potential to transform many sectors of the economy and society. The Government could support the transfer of knowledge between universities and companies so that AI can be practically applied in the real world.

Some additional ideas to boost AI in universities:

- Create a national scholarship program for AI training aimed at master's and doctoral students.
- Promote the creation of AI programs in Spanish universities, both in their undergraduate and postgraduate study plans and their hybridization with various disciplines.
- Support the creation of centers of excellence in AI that concentrate on research and training in this area.

- Promote collaboration between universities, research centers and companies to carry out AI research projects.
- Promote the transfer of knowledge in AI through collaboration between universities and companies.

In conclusion

Universities can play an important role in the implementation of artificial intelligence. In the case of Spain, the availability of European Next Generation funds provides it with a unique opportunity to undertake notable leadership with the possibility of generating relevant synergies in the business and social spheres…

IMAGE GPT-4/DALL-E: AI as a key driver of the modern economy and society in Spain, with a focus on contemporary architecture and a modern university campus where students and teachers are committed to AI technology.

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Acknowledgments

We would like to thank the many institutions, entities, and individuals who have helped us directly and indirectly to develop the ideas contained herein, without, of course, holding them responsible for any shortcomings or errors that the report may contain..

IN CHRONOLOGICAL ORDER:

Fundación Alternativas and **European Government and Regulatory Affairs. Internet Society** for the discussion session in Brussels on Europe's strategic autonomy, AI and regulatory processes. Read more: https://ost.torrejuana.es/la-autonomia-estrategica-de-europa-a-debate-en-bruselas-necesidad-de-una-economia-digital-fuerte/

Asociación BigBan I. P. and **Victoria Majadas** for connecting us with the investor ecosystem and startups seen through the prism of artificial intelligence. Read more: https://ost.torrejuana.es/inteligencia-artificial-e-inversores-en-bigban-inversores-privados/

Grupo de Investigación sobre la Economía de la Innovación y la Inteligencia Artificial and its **III Congreso de la Sociedad de la Innovación y de la Inteligencia Artificial** for evaluating and promoting new lines of study and research contained in the report on AI, education and associated economic and social factors. Read more: https://ost.torrejuana.es/iii-congreso-de-la-sociedad-de-la-innovacion-y-de-la-inteligencia-artificial/

Cátedra de Ciencia y Tecnología (Fundación Rafael del Pino) for promoting the debate and application of generative AI in Spain in its "Las 10 tecnologías para impulsar España". Read more: https://ost.torrejuana.es/10-tecnologias-para-impulsa-espana-en-2024-un-clasico-de-la-fundacion-rafael-del-pino/

Asociación Multinacionales por España for enhancing on its 10th anniversary the debate on the role of education in the development and application of AI. Read more: https://ost.torrejuana.es/ia-impacto-enorme-necesidad-de-estrategias-muy-efectivas-en-multinacionales-por-espana/

Asociación Nacional Big Data y Analytics (ANBAN) for the opportunity to contrast proposals and ideas on AI and data. Read more: https://ost.torrejuana.es/1millionbot-en-anban-hablando-del-dato-y-la-ia-generativa/

Ateneu de Maó for the debate "Impacto de la Inteligencia Artificial en nuestra economía y sociedad". Read more: https://ost.torrejuana.es/impacto-de-la-inteligencia-artificial-en-nuestra-economia-y-sociedad-conferencia-en-el-ateneo-de-mahon-video-integro/

DigitalES and **Grupo ATU** for promoting the debate and analysis of educational proposals for SMEs. Read more:
https://ost.torrejuana.es/pymes-digitalizacion-e-inteligencia-artificial-jornada-grupo-atu-en-madrid/

Revista Telos de Telefónica for our participation in the monograph on generative AI. Read more:
https://ost.torrejuana.es/monografico-sobre-inteligencia-artificial-de-la-revista-telos-de-telefonica/

Consejo General del Notariado for our participation in the *VI Jornada del Consejo General del Notariado in Madrid* with a focus on "Technology, Cooperation and Human Rights" giving input to the debate on AI. Read more:
https://ost.torrejuana.es/debate-sobre-la-ia-en-la-vi-jornada-del-consejo-general-del-notariado/

VI Congreso Internacional de IA de Alicante for participation in the debate on "The potential of AI to improve employment, democratization of talent and regulatory challenges". Read more:
https://ost.torrejuana.es/el-potencial-de-la-ia-para-mejorar-el-empleo/

Ramón Casilda Béjar for the invitation to disseminate ideas in the monograph *América Latina en el cambio de era. Palancas estratégicas para el crecimiento económico y el desarrollo sostenible e inclusivo*, supported by the Spanish Institute for Strategic Studies. Read more:
https://ost.torrejuana.es/ia-y-ciudades-el-gran-activo-para-el-despegue-de-america-latina/

El Independiente for the publication and dissemination of the article "ChatGPT, nothing will ever be the same again". Read more:
https://ost.torrejuana.es/chat-gpt-nada-volvera-a-ser-igual-arto-en-el-independiente/

José Castro for the dissemination of tools and proposals in Brazil related to AI and education. Read more:
https://ost.torrejuana.es/1millionbot-inicia-su-andadura-en-brasil/

Club de Encuentro Manuel Broseta (Valencia) for organizing the debate "El desarrollo de la IA y cómo afecta a profesionales y empresas". Read more:
https://ost.torrejuana.es/conferencia-la-ia-como-afecta-a-profesionales-y-empresas/

Innotransfer and representatives of the **science parks of the universities of the Valencian Community** for the participation in the debate on talent and training as the most relevant vectors in the era of AI. Read more:
https://ost.torrejuana.es/especialistas-parques-cientificos-debaten-inteligencia-artificial/

Faculty of Tourism of the University of Murcia for the conference on the decisive role of AIl in the future of humanity, highlighting its potential to empower individuals, professionals and students. Read more:
https://ost.torrejuana.es/el-potencial-de-la-ia-y-el-data-el-turismo-en-la-facultad-de-turismo-de-la-umu/

Colegio Oficial de Ingenieros Industriales de la Región de Murcia (COIIRM) and Centro Europeo de Empresas e Innovación de Murcia (CEEIM). Read more:
https://ost.torrejuana.es/masterclass-sobre-ia-para-los-ingenieros-industriales/

Murcia City Hall for participating in the working day "La inteligencia artificial y las ciudades". Read more:
https://ost.torrejuana.es/la-inteligencia-artificial-y-las-ciudades-jornada-de-trabajo-con-el-ayuntamiento-de-murcia/

Cooperativa Metabogacía for enabling the dissemination of the potential of AI-based tools for legal professionals. Read more:
https://ost.torrejuana.es/1millionbot-presenta-en-metabogacia-su-ia-generativa-aplicada-al-derecho-e-law/

AIA-Programa Explorer, focused on artificial intelligence and its applications in the business environment. With the participation of Peláez Consulting, 1MillionBot, AlicanTec and the Spanish-Swedish Chamber of Commerce, with more than thirty leading companies to evaluate the applicability of advanced AI tools in the enterprise. Read more:
https://ost.torrejuana.es/aia-explorer-ii-contagiando-la-inteligencia-artificial-en-las-empresas-mas-emblematicas-de-alicante/

Asociación de Centros Autónomos de Enseñanza Privada (Acade) for the organization of the debate "La Universidad ante la Inteligencia Artificial" with Segundo Píriz (rector of the UNIE) and Andrés Pedreño. Read more:
https://ost.torrejuana.es/la-universidad-ante-los-retos-de-la-ia-coloquio-entre-segundo-piriz-rector-de-la-unie-y-andres-pedreno-tj-ost/

LARSEN Digital leaders for the event in Toledo where we were given the opportunity to contrast our opinions on AI analyzed from different points of view: defense, government, business, technology... Read more:
https://ost.torrejuana.es/encuentro-larsen-digital-leaders-sobre-inteligencia-artificial/

Instituto Murciano de Investigación Biosanitaria (IMIB) for the participation in the conference dedicated to the treatment of health research data. Read more:
https://ost.torrejuana.es/tratamiento-de-datos-de-investigacion-en-salud/

Club CFO-Asociación para el Progreso de la Dirección (APD) in Palma for the participation and debate around the challenges and opportunities of artificial intelligence in finance. Read more:
https://ost.torrejuana.es/la-inteligencia-artificial-en-el-sector-financiero-retos-y-oportunidades/

Andrea Corbalán and **R&A BUSINESS TRAINING** for the training and dissemination among advanced AI professionals and the identification of priorities and unmet needs. Read more:
https://ost.torrejuana.es/andrea-corbalan-y-ra-business-training-nueva-empresa-que-se-suman-a-torre-juana-ost/

UniversidadSI for the publication and dissemination of the article "Inteligencia artificial: ¿enemiga o amiga de la universidad?" on crucial questions about student disengagement and university dropout, as well as the design of AI-based tools to address these problems. Read more:
https://ost.torrejuana.es/la-inteligencia-artificial-al-servicio-de-la-universidad-y-los-universitarios/

Fundación Alternativas for facilitating the debate between Gonzalo León, Diego López Garrido and Andrés Pedreño in the context of the discussions on strategic digital autonomy for Europe and the submission of conclusions to the 3rd European Political Community Summit in Granada. Read more:
https://ost.torrejuana.es/estrategia-digital-europa-no-lo-esta-haciendo-bien/

Rafael Domenech and **EOI** for the debate between Fuencisla Clemares (Google) and Andrés Pedreño (1MillionBot) at the opening of the EOI course on the impact of AI. Read more:
https://ost.torrejuana.es/sesion-en-la-eoi-entre-fuencisla-clemares-google-y-andres-pedreno-ia-y-disrupcion-digital/

Club of Rome in Palma, host of an essential debate on the impact and opportunities of artificial intelligence with the title "España en la nube" (extended thanks to Professor **Llorenç Huguet**). Read more:
https://ost.torrejuana.es/espana-en-la-nube-afrontando-los-retos-en-la-era-de-la-inteligencia-artificial-en-el-corazon-de-palma/

Alfonso X El Sabio University (UAX) for the invitation to deliver the inaugural lecture on the potential of AI in the university environment and in society. Read more:
https://ost.torrejuana.es/la-uax-y-su-apuesta-por-la-excelencia-ia-deportes-y-uno-de-los-campus-mas-atractivos-de-espana/

Chair of Private International Law of the University of Alicante for the participation and support in the Bártolo Project, consisting of the design of a virtual tutor specialized in the subject for students of the Faculty of Law. Read more:
https://ost.torrejuana.es/tutorias-virtuales/

Fundación Banco Santander for the invitation to the discussion forum "Inteligencia Artificial y pensamiento crítico". Read more:
https://ost.torrejuana.es/ia-y-pensamiento-critico-debate-en-la-fundacion-banco-santander/

Ilustre Colegio Oficial de Economistas de Alicante (ICOEA) for inviting us to participate on the transformative role of economists in the era of artificial intelligence. Read more:
https://ost.torrejuana.es/el-rol-transformador-de-los-economistas-en-la-era-de-la-inteligencia-artificial/

University of Barcelona and **Cátedra Planeta Formación** for the invitation to participate in the 25th anniversary *Dels Juliols* with a presentation entitled "Artificial intelligence and university: challenges and opportunities". Read more:
https://ost.torrejuana.es/la-universidad-de-barcelona-juliols-25-anos/

12th Congress CIDUI at the **University of Lleida** on improving learning experiences and our participation on ways to empower students with generative AI. Read more:
https://ost.torrejuana.es/xii-congreso-internacional-cidui-2023/

Confederación Valenciana de Empresarios (CEV) and its invitation to debate with Nuria Oliver, Pepe Rosell and Vicente Bottí about AI and the need for its development with an active strategy to achieve it. Read more:
https://ost.torrejuana.es/debatiendo-sobre-ia-en-la-confederacion-valenciana-de-empresarios-cev/

15th Conference on Teaching in Economics at the **University of Murcia** for the presentation of the E-tutor tool. Read more:
https://ost.torrejuana.es/presentada-en-la-umu-e-tutor-una-herramienta-basada-en-ia-que-revoluciona-el-aprendizaje/

Elche and **Madrid Bar Associations,** and **Manuel Pomares** for the invitation to participate in the debate on ChatGPT/GPT-4 and its potential in the legal profession. Read more:
https://ost.torrejuana.es/chatgpt-gpt4-y-su-potencial-en-el-ambito-profesional-del-derecho/

TIMUR and **Instituto de Fomento de la CARM** for participating in the regional summit on the impact of AI on the environment and other critical sectors. Read more:
https://ost.torrejuana.es/lia-crisis-medioambiental-del-mar-menor-y-donana/

Alfonso González Hermoso de Mendoza and the journal ***Espacios de Educación Superior*** for the interview on AI and its impact on higher education. Read more:
https://ost.torrejuana.es/andres-pedreno-la-inteligencia-artificial-nos-obliga-a-replantear-la-educacion-superior/

Asociación Libre de Economía for the invitation to the *Jornadas sobre Docencia de Economía Aplicada* held in Madrid to speak on the future of education and AI. Read more: https://ost.torrejuana.es/el-futuro-de-la-educacion-esta-en-la-inteligencia-artificial/

37th Jornadas de Gerencia Universitaria, organized by **CRUE**, for the invitation to participate in the debate on the digitalization of universities. Read more: https://ost.torrejuana.es/transformacion-digital-de-las-universidades-xxxvii-jornadas-de-gerencia-universitaria/

Guillermo Taboada and **Foro Salamanca Startup Olé** for the bet to combine blockchain and AI in a future in which the processes of application, allocation and monitoring of funds are more transparent, efficient and accessible. Read more: https://ost.torrejuana.es/ia-tecnologia-digitales-para-transformar-el-acceso-a-fondos-europeos-para-las-pymes/