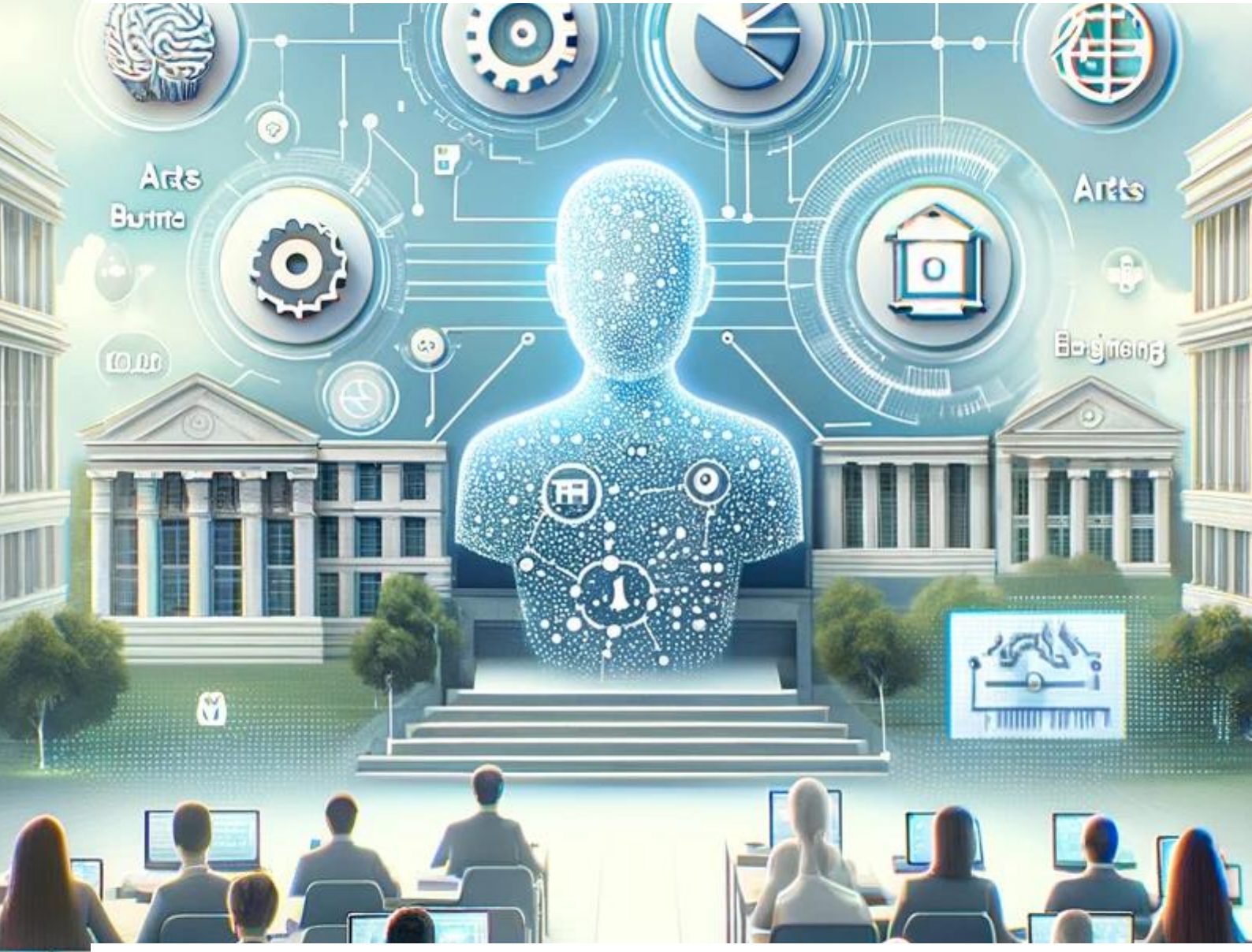
(Generative) AI Competencies for Future-Proof Graduates

Inspiration for Higher Education Institutions



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(Generative) AI Competencies for Future-Proof Graduates

Inspiration for Higher Education Institutions

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February 19, 2024

Executive Summary

The widespread use of **Artificial Intelligence (AI)** in various areas of professional and private life makes us thoroughly re-evaluate and update the competencies university students should acquire. This whitepaper focuses on what these changes mean for **higher education**, helping individuals responsible for curricular and extracurricular courses at higher education institutions integrate new competencies.

Competencies are a combination of **skills, knowledge, and attitudes** that enables a person to perform a task or an activity successfully in a specific context. Basic competencies such as literacy and numeracy are integral to a wide array of professions and in various aspects of daily life. Furthermore, this discourse extends to advanced competencies, such as training machine learning (ML) models or preparing annual financial statements, which are indispensable for certain specialized professions or tasks.

Especially the advent of **Generative AI** (GenAI) is catalyzing a transformative shift in the landscape of competencies. While established overarching competency areas such as literacy or numeracy are likely to remain relevant, their significance is changing, with some areas increasing and others decreasing in relevance. At a more detailed level, specific knowledge areas, skills, and attitudes are becoming outdated as new ones emerge in response to evolving technological demands. In particular, new competency areas specifically related to AI, such as AI Management or AI Innovation, are emerging. In summary, the competency profiles required for success in the business world, society, and life are undergoing rapid changes, mirroring the swift pace of technological advancements in AI.

Consequently**, higher education institutions such as universities** should reconsider their pedagogical approaches, considering a future deeply interwoven with AI technologies. **Students**, in turn, should plan their educational trajectories to align with this AI-shaped future. Given the constrained scope and duration of higher education degree programs, it is important to utilize these resources in a manner that is both goal-oriented and efficient. As the objectives regarding competencies evolve, there is a corresponding necessity for transforming both teaching offers and learning opportunities.

This whitepaper motivates the topic and emphasizes the relevance of **AI as a general-purpose technology** in sections 1 and 2. Readers familiar with AI might want to skip these preliminaries. Section 3 details **basic and advanced competencies**, shifting relevance, and novelties due to AI. Section 4 poses **nine key questions** for higher education institutions to answer regarding their current and future teaching with the omnipresence of AI. Section 5 presents **examples** of AI competency models and their integration into teaching and learning from three different universities. Sections 3 to 5 are the core of this whitepaper and shall inform and inspire the debate about AI competencies in higher education. Section 6 is a brief **conclusion**.

Feedback on how you approach AI competencies is highly welcome. **Let us jointly work towards integrating AI competencies into higher education to train future-proof graduates!**

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About this Whitepaper

Acknowledgments

We gratefully acknowledge funding by the German Federal Ministry of Education and Research (BMBF), the Ministry of Science, Research and the Arts of Baden-Württemberg (MWK), the Bavarian State Ministry of Science and Art (STMWK), and the Hessian Ministry of Higher Education, Research, Science and the Arts (HMWK) for the ABBA project (Grant Numbers 16DHBKI002, 16DHBKI003, 16DHBKI004, 16DHBKI005). Further, we gratefully acknowledge funding by Stiftung Innovation in der Hochschullehre for the project DeLLFi (Grant Number FBM2020-EA-1670-01800) and the Concerted Qualification on Artificial Intelligence in Higher Education. Lastly, we gratefully acknowledge funding by the Ministry of Labor, Economy and Tourism of Baden-Württemberg (WM BW) for the project WeLearnAI as part of the initiative Invest BW (Grant Number BW1_3061/02).

The logos of the authors' institutions on the cover page are included to acknowledge the academic environment that shapes their thinking. The contents of this whitepaper are not statements by these institutions but by the individual authors.

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Feedback

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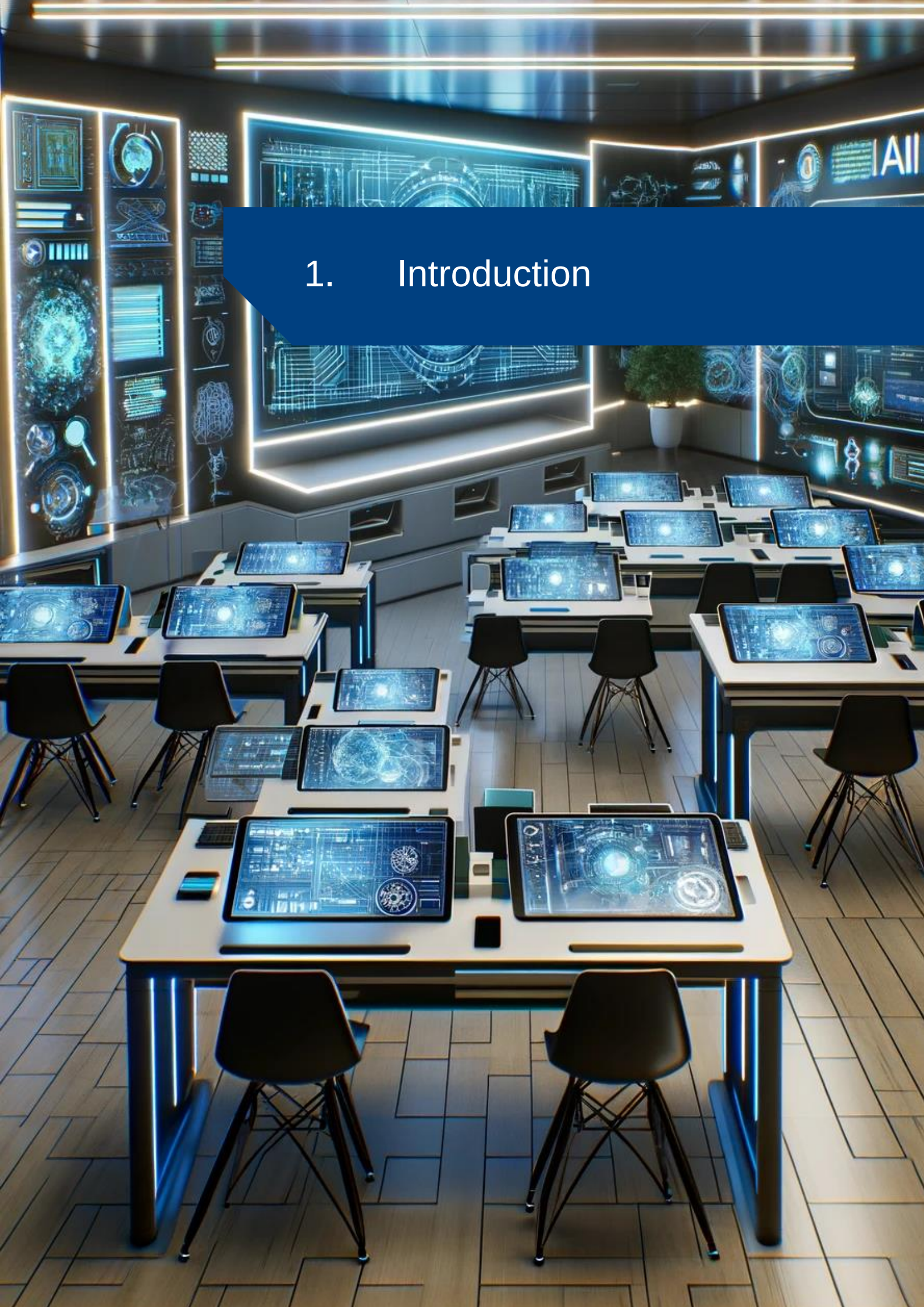
About the Projects ABBA, DeLLFi, and Concerted Qualification on AI in HE.

Using Artificial Intelligence (AI) technologies in business requires specific skills. In addition to technical expertise, the business world demands knowledge to embed AI technologies in business processes, decision-making, work systems, products and services, design and evaluate business cases, and manage AI-based information systems in the long term. Managers primarily perform this bridge-building task as the central decision-makers in the company. To prepare future managers for this task, the project ABBA (AI for Business / Business for AI) develops and provides a modular cross-university teaching toolkit for AI competencies for courses of study in business administration, management, economics, information systems, and others relating to socio-economic and socio-technical topics. The German Federal Ministry of Education and Research funds ABBA. The goals of the joint project are developing and providing a modular teaching toolkit for AI, which teaches business students interdisciplinary AI competencies in a scientifically sound and practice-oriented manner. The modular toolkit supports teaching for Bachelor, Master, Executive Master's degree programs and doctoral candidates at universities and universities of applied sciences. To achieve that goal, the joint project unites twelve professors and their research groups from three universities and one university of applied sciences, who share the focus on supporting the development of AI competencies: University of Hohenheim, University of Bayreuth, Frankfurt University of Applied Sciences, Karlsruhe Institute of Technology. Fraunhofer FIT is an associated partner. Teaching contents and formats are jointly developed and used and, in part, made publicly available. Compared to individual creations by each university and/or professor, this joint approach substantially strengthens the breadth and depth of the offering and the efficiency and quality of teaching. The German Federal Ministry of Education and Research (BMBF), the Ministry of Science, Research and the Arts of Baden-Württemberg (MWK), the Bavarian State Ministry of Science and Art (STMWK), and the Hessian Ministry of Higher Education, Research, Science and the Arts (HMWK) provide financial support for the ABBA project.

DeLLFi is a project at the University of Hohenheim funded by the Foundation for Innovation in University Teaching. It stands for integrating digitalization into teaching, learning, and research. The project integrates three departments of the Faculty of Business, Economics and Social Sciences, the CareerCenter Hohenheim, and two organizational units that support teaching, namely the University Didactic Unit and Humboldt Reloaded.

With the project "Concerted Qualification on Artificial Intelligence in Higher Education," the Foundation for Innovation in University Teaching promotes information, qualification, and support services for digital university teaching at state institutions. As part of this funding, the Baden-Württemberg University Network for the Digitalization of Teaching (HND-BW) offers needs-based workshops for members of state universities and other interested parties. In this context, Henner Gimpel and Mareike Schoop have shared approaches to the curricular integration of AI skills with the community and gained insights that have been incorporated into this white paper.



1. Introduction

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As AI becomes more ingrained in our everyday work and private lives, universities should reflect on and update their current teaching methods and offerings. They should recognize the competencies required to succeed in an AI-driven future and ensure their offerings help students develop these competencies. With AI evolving rapidly and tools such as OpenAI's ChatGPT, DALLE, Sora, Google's Gemini, and Microsoft's Copilots showcasing what is possible, educational programs should be adaptable and innovative to keep up.

The quest for AI integration into higher education is driven by recognizing AI's profound implications on the job market and society. AI technologies are a moving target, continuously expanding the capabilities of AI applications. The increasing intelligence enables digital agents on all levels of intelligence, such as mechanical, analytical, intuitive, and even empathetic intelligence (Huang & Rust, 2018; Jarrahi, 2018). Consequently, AI affects every job requiring any form of intelligence and cognition. The recent lawsuit filed by The New York Times against OpenAI underscores the transformative and, at times, contentious nature of AI. This legal action highlights the complex considerations of intellectual property and the ethical and professional competencies that future professionals should be equipped with to navigate the AI-influenced landscape.

To effectively integrate AI competencies, higher education institutions like universities should adopt a multifaceted approach. This may include fostering partnerships with tech giants and AI pioneers, developing ethical frameworks for studying and applying AI and promoting interdisciplinary research and teaching that combines technical knowledge with a deep understanding of managerial and societal impacts. Teaching methods should adapt and evolve to promote not just technical skills but also increasingly, for example, critical thinking, adaptability, ethical reasoning, and appropriate reliance on AI (Schemmer, Kühl, Benz, Bartos, & Satzger, 2023).

Higher education institutions stand at the crossroads of a paradigm shift, where the fusion of AI into higher education can be seen as a discouraging challenge or an unprecedented opportunity. By embracing the latter perspective, higher education institutions can lead the charge in cultivating a workforce and society that are not only AI-savvy but also capable of utilizing the novel capabilities of AI beneficially and responsibly.

The imperative for integrating AI competencies into higher education is underscored by four key developments in the field of technology. First, the increasing digitalization has generated enormous datasets, which are the basis of machine learning as an important subset of AI. The vast number of interactions in the digital sphere have culminated in a rich tapestry of data that provides the raw material for AI applications when harnessed through big data technologies. This abundance of data not only empowers AI systems but also requires the future architects of these systems (i.e., our students) to understand how to navigate this landscape ethically and effectively.

Second, the AI field has dramatically transformed due to major advancements in machine learning algorithms, especially deep learning. The revival of artificial neural networks has given machines a form of "intuition," enabling them to process data in a manner akin to human thought. These developments are substantial, marking significant leaps in machine capability and paving the way for new, previously unthinkable opportunities for innovation.

Third, cloud services have democratized access to computing power. No longer the preserve of well-funded laboratories, these services allow individuals and institutions to tap into vast computational resources on demand. This democratization ensures that the need for significant capital does not constrain the pursuit of AI outlays, thereby lowering the barrier to entry for experimentation, development, and use.

Fourth, the field of AI has been rendered more approachable through the availability of powerful (and, in part, open-source) software programs, toolkits, libraries, and application programming interfaces (APIs). These resources have made the application of AI less an esoteric art and more a science accessible to a broader part of academia, industry, and society. The veil of complexity that once masked AI has been lifted, inviting lecturers and students alike to engage with this transformative technology. Thus, the integration of AI competencies into higher education is not only highly relevant but also practically feasible.

The potential of AI in academic proficiency is currently shown in the performance of GPT-4, OpenAI's most sophisticated large language model so far. As shown in Figure 1, GPT-4 scored within the top 10% of test-takers on a simulated bar exam. To illustrate, it scored 298 out of 400, a marked improvement over its predecessor, GPT-3.5, which scored around the bottom 10%. Furthermore, GPT-4 demonstrated its capability across other standardized tests, scoring in the 88th percentile on the LSAT and achieving near-perfect scores on the GRE Verbal section (OpenAI, 2023).

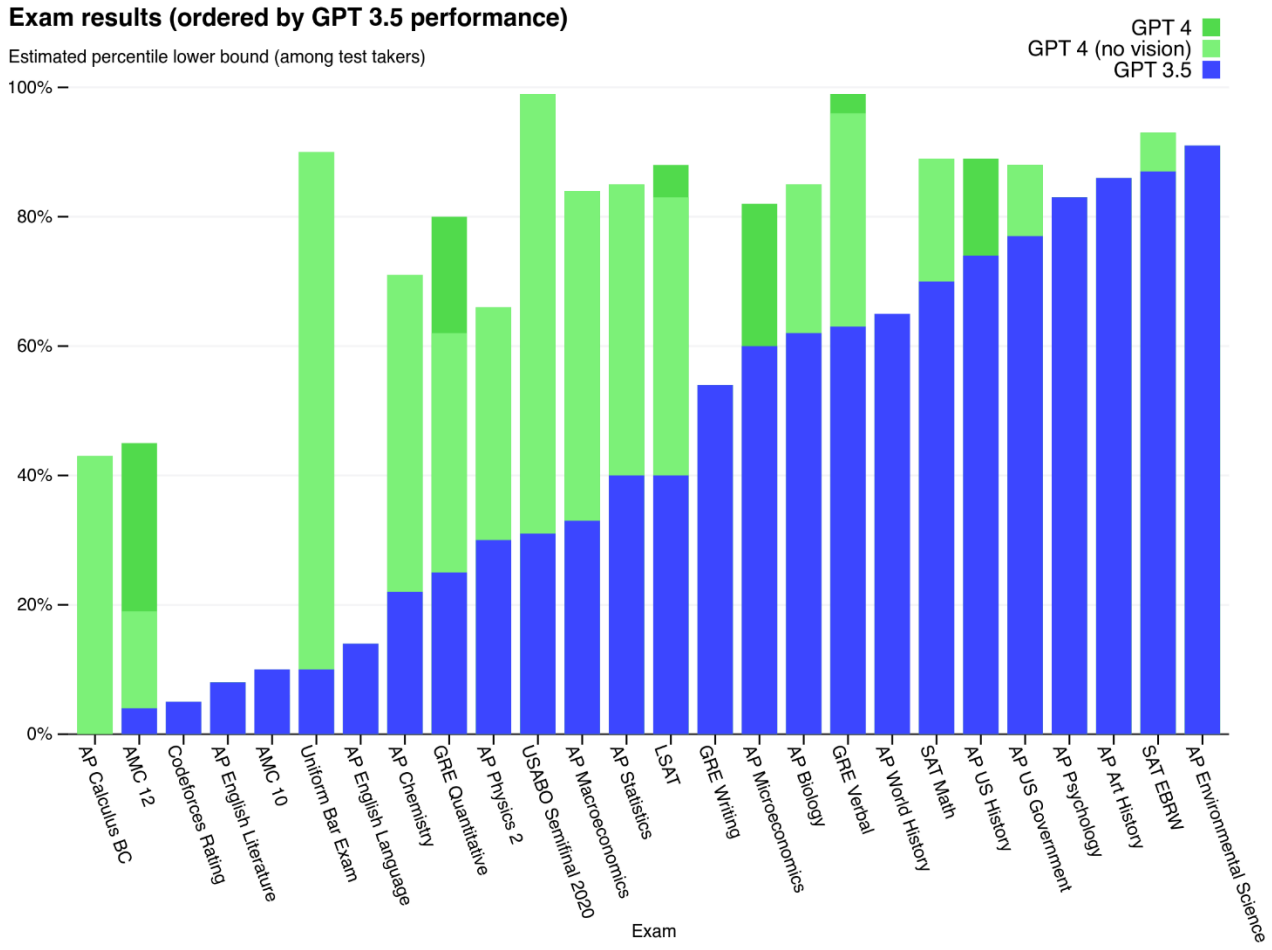


Figure 1. Exam results of GPT3.5 and GPT-4 (OpenAI, 2023)

This convergence of AI with human-level test performance opens Pandora's box of pedagogical questions. If an AI can now perform at such high levels on university entrance and professional accreditation exams, what does this indicate for the transformation of education? It forces us to consider the roles and objectives of higher education in an age where the advancement of AI is continually redefining existing competencies. Hence, higher education institutions should answer the question: *How should curricula and extracurricular higher education offerings evolve to train future-proof graduates possessing the competencies to succeed in an AI-driven future?*

Universities should deliberate on which areas of competency development need expansion and which may be rendered obsolete. They should explore integrating AI competencies into existing courses and consider whether the traditional academic success metrics are adequate or require an overhaul. Furthermore, the effect of competency development should be individually assessed for the different higher education disciplines. The challenge extends beyond merely incorporating AI into educational paradigms; it is about fostering an environment where AI complements human intelligence, catalyzing a symbiotic relationship between technology and human creativity and leading to hybrid intelligence. What modalities exist to promote and prioritize these emergent and crucial competencies? These are some questions that lecturers, policymakers, and students should collectively navigate as we enter an era where AI systems and human-AI interaction are omnipresent.

2. AI as General-Purpose Technology

2. AI as General-Purpose Technology

AI is a significant milestone in technological advancement, marking the intersection of human cognitive capabilities and machine computation. AI can be understood as a collective term for computer systems that imitate human abilities such as logical thinking, learning, planning and creativity (Jaschke et al., 2023). It has a broad impact, driving changes across industries, altering societal norms, and expanding the limits of what can be achieved with machines.

To grasp the essence of AI, one can envision its scope through a 2x2 matrix that intersects two paradigms of thought (human and rational) against two modes of action (thinking and behaving), as shown in Figure 2. This matrix yields four distinct perspectives: *human-like thinking, rational thinking, human-like behavior*, and *rational behavior* (Russell & Norvig, 2016). *Human-like thinking* represents AI's ability to mimic human thought processes, learning from experience and making decisions based on incomplete information. *Rational thinking* refers to AI's capacity to make decisions based on logic and optimization, devoid of the emotional heuristics that color human cognition. *Human-like behavior* signifies the capacity of AI to perform tasks in a manner that imitates human behavior, adapting to nuanced social cues and environmental contexts. Lastly, *Rational behavior* encompasses AI's ability to execute tasks precisely and efficiently, often surpassing human capabilities.[1]

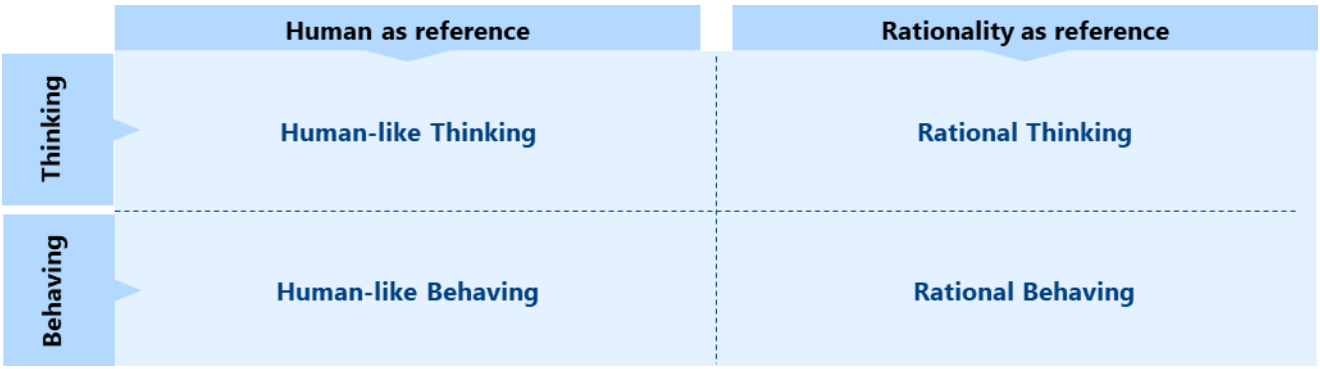


Figure 2. Four perspectives on AI (adapted from Russell & Norvig, 2016)

Delving deeper into the mechanics of AI, we encounter the domain of machine learning (ML), a subset of AI (see Figure 3) that equips systems with the ability to learn and improve from experience without explicit programming (Kühl, Schemmer, Goutier, & Satzger, 2022). The most prominent example of ML currently is GenAI. GenAI refers to algorithms that generate novel content, from poetry text and software code to complex theories, audio files, images, videos, digital models of chemical molecules, and construction plans. Shaping raw information into structured outputs, GenAI can mimic human creativity (Russell & Norvig, 2016). Its importance in society stems from its technological functioning and ease of use through interfaces like ChatGPT or Copilots. Thereby, AI is usable for everyone (who possesses Internet access and an account for these systems), not only for technology-savvy individuals.

Central to the progress of GenAI are large language models (LLMs). These are highly sophisticated models trained on diverse text corpora, enabling them to predict and generate human-like text based on the patterns they have learned. LLMs like GPT-4 represent a new peak of this progression due

[1] In these perspectives on AI, it should be noted that using the term "thinking" in relation to an AI signals some level of human-likeness that is denied by some people. The same holds true for the terms "learning" and "understanding" in the following. Further, the concept of rationality can have several specifications. Telling humans as reference and rationality as reference apart should not be taken as indication that humans would be irrational but rather signal humans' bounded rationality as compared to, for example, the rationality concept in economics.

to their size and profound ability to deal with language nuances and contexts. The architecture of GPT-4, with its 175 billion parameters, allows it to generate text that can be indistinguishable from that written by a human, providing insights, answering queries, and engaging in dialogue with an uncanny semblance of naturalness.

Conversational agents, or chatbots, are applications that may use such LLMs. They are designed to simulate human conversation. They leverage the underlying model's ability to process and generate language to interact with users in an informative and engaging way. ChatGPT, currently built upon the GPT-3.5 and GPT-4 models, is one such agent that has garnered attention for its ease of use and ability to engage in complex conversations across various domains. Figure 3 sketches the interrelations of all these concepts.

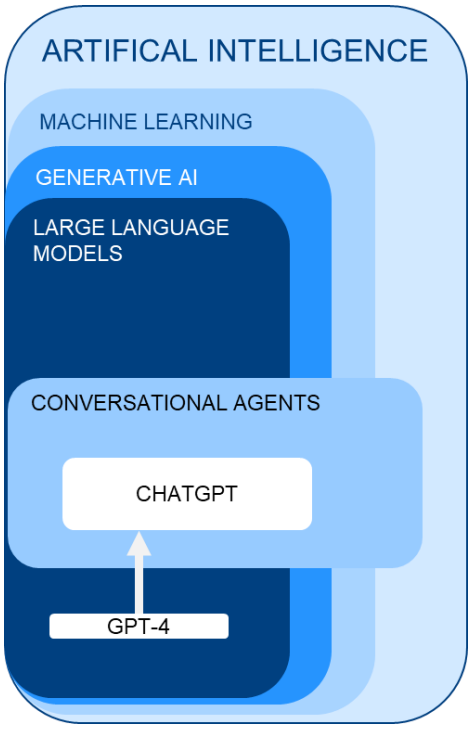
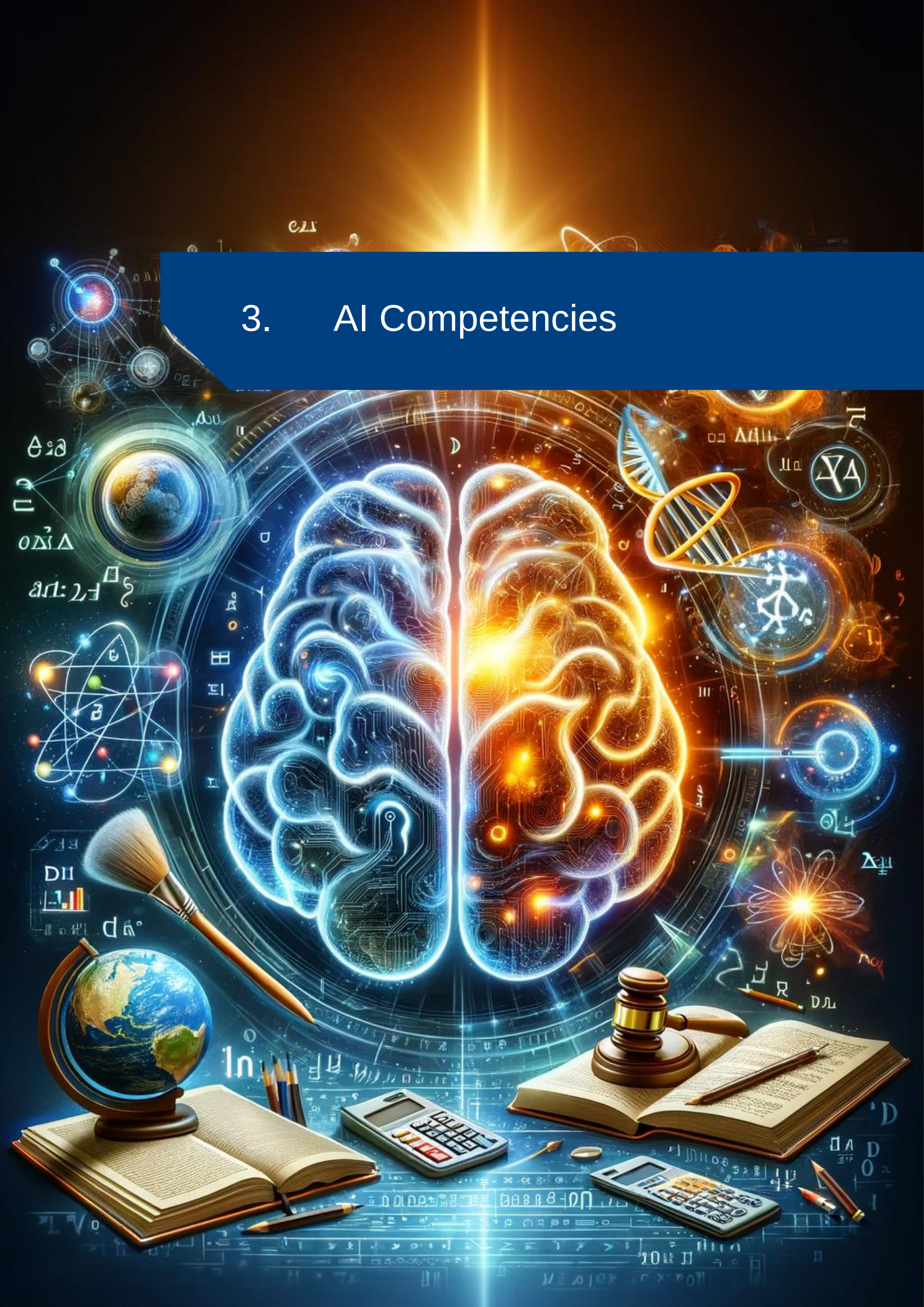


Figure 3. AI and subdomains (Gimpel et al., 2023)

An important point is that AI is more than just ChatGPT, LLMs, GenAI, or ML. ChatGPT and LLMs go to the core of (higher) education and lead to many stakeholders questioning numerous processes, standards, and habits, for example, for the design of (unsupervised) written exams. Undoubtedly, the diffusion of GenAI leads to changes in the competencies students should possess or develop (Gimpel et al., 2023; Jaschke et al., 2023). However, AI is broader than ChatGPT. Hence, considering AI competencies should include but also transcend the current hype around GenAI.

Further, AI offers numerous opportunities to improve many aspects of our lives, but AI is not only positive for society. AI is a general-purpose technology. Its application can have and already does have manifold adverse effects. Future-proof graduates need to be able to identify and navigate AI's bright and dark sides to contribute to the responsible and value-creating development and use of AI.

3. AI Competencies



3. AI Competencies

In the dynamic terrain of modern business and life, the concept of competencies has emerged as a beacon, guiding individuals and organizations toward performance and sustainable success. Scholars have extensively studied and dissected this concept into three core components: knowledge, skills, and attitudes (Klemp, 1979; Organisation for Economic Co-Operation and Development [OECD], 2019; Vuorikari, Kluzer, & Punie, 2022).

Knowledge, the first pillar of competencies, encompasses the theoretical understanding and information individuals acquire through education and continuous learning (Bloom, 1956). For example, knowledge in the business context may range from an understanding of market dynamics and organizational behavior to financial acumen and technological savvy. It is the groundwork upon which skills and attitudes are built, enabling professionals to navigate the complex labyrinth of the corporate world with acumen and foresight (Zack, 1999).

Skills, as the second component, are the practical applications of knowledge, turning theory into action. As Katz (1974) argued, managerial effectiveness in business, for example, hinges on technical, human, and conceptual skills. These skills enable professionals to apply their knowledge dynamically, driving innovation and operational efficiency.

Attitudes are the third and perhaps most nuanced component of competencies. Attitudes reflect an individual's mindset and behavioral approaches to their (professional) life. This includes moral values, adaptability, motivation, and a collaborative spirit. In an era where corporate cultures and ethical standards are increasingly scrutinized, the right attitude can be the distinguishing factor that propels individuals and organizations toward sustainable success (Schein, 2016).

When these facets are brought together, **competency** is commonly defined as a combination of skills, knowledge, and attitudes that enables a person to perform a task or activity successfully in a specific context, as shown in Figure 4. This trifecta of knowledge, skills, and attitudes relates to graduates knowing what, how, and why (Leidig & Salmela, 2021).

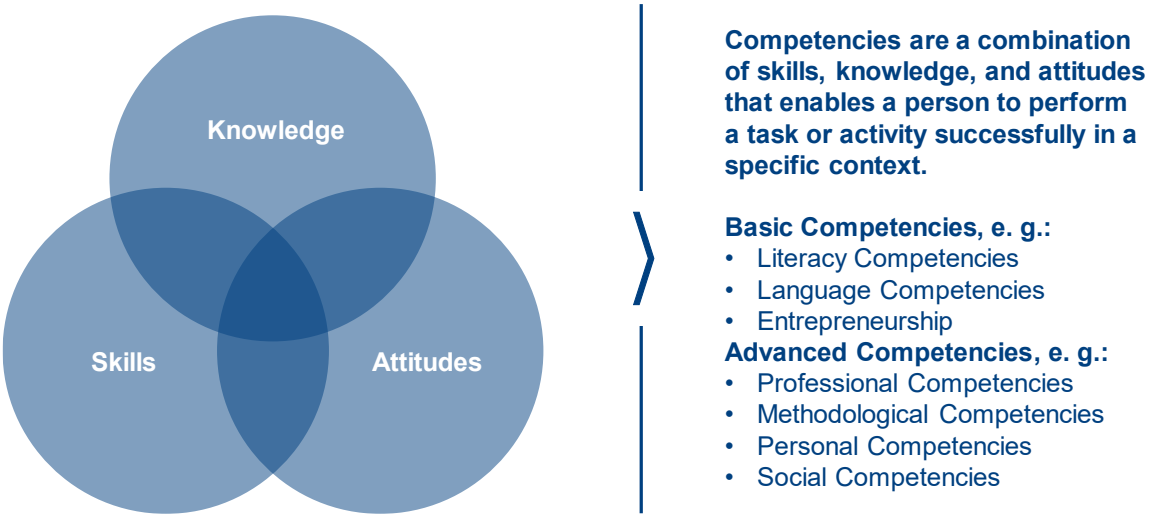


Figure 4. Overview on competencies

Competencies can roughly be divided into **basic competencies** (also termed key, core, or foundational competencies) and **advanced competencies** (in some contexts also termed professional or managerial competencies) like professional competencies, methodological competencies, personal competencies, and social competencies (Eraut, 1998; Tahirsylaj & Sundberg, 2020). **Basic compe-**

tencies, as discussed by Rychen and Salganik (2003), are fundamentals required in any professional field and most domains of life. These include literacy, numeracy, and the ability to create and exchange information, forming universal competencies required to perform tasks and activities in almost any context and acting as a gateway for other competencies (Organisation for Economic Co-Operation and Development [OECD], 2019). Beyond that, **advanced competencies** are those tailored to roles or industries. They can have a professional, methodological, personal, or social nature. For a financial analyst, for example, this might include a deep understanding of financial modeling and risk assessment. For a marketing professional, it could involve mastery of digital marketing tools and consumer behavior analysis. These competencies are the differentiators, the elements that distinguish a layperson from a competent professional in their specific domain (Westera, 2001).

3.1 Basic Competencies: Shifting Relevance and Novelties

Considering **basic competencies**, the Council of the European Union recommended key competencies for lifelong learning (European Commission & Directorate-General for Education, Youth, Sport and Culture, 2019; Figure 5 left-hand side). Among the suggested basic competencies is digital competency. Detailing this area, the European Commission's Science and Knowledge Service published the Digital Competence Framework for Citizens (DigComp 2.2; Vuorikari et al., 2022). Here, basic digital competencies comprise five areas: (1) information and data literacy, (2) communication and collaboration, (3) digital content creation, (4) safety, and (5) problem-solving (Figure 5 right-hand side).

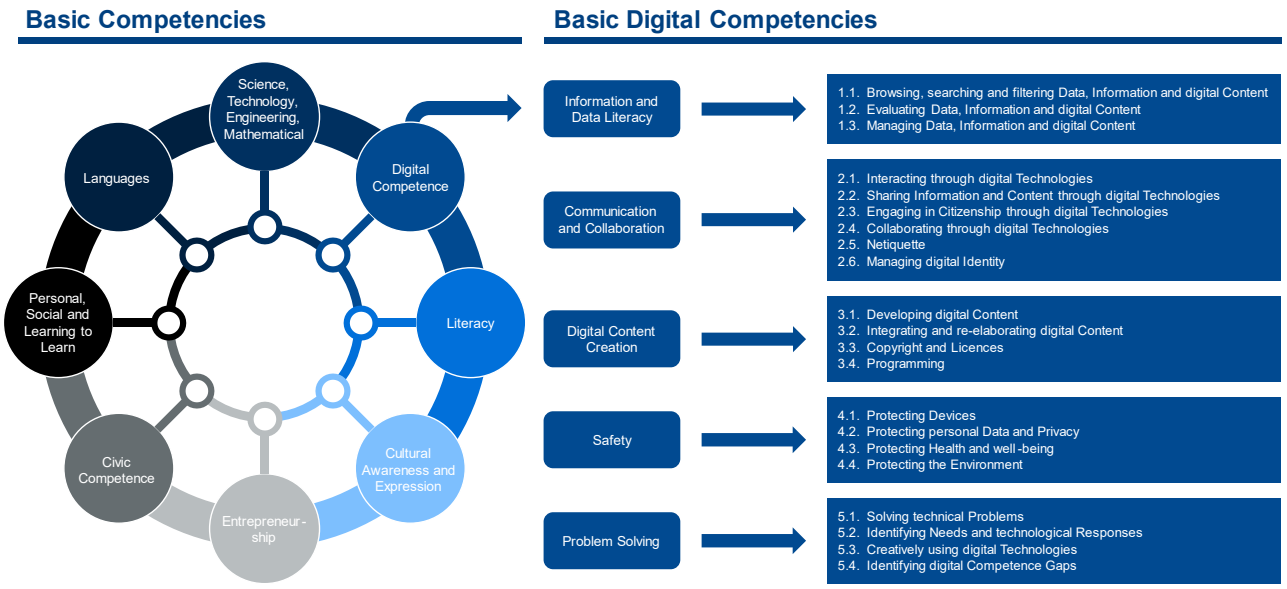


Figure 5. Overview of basic competencies and basic digital competencies (adapted from Vuorikari et al., 2022)

GenAI affects **digital content creation,** amongst other things. Developing, integrating, and re-elaborating digital content looks significantly different today than before the wide availability of GenAI tools. Nowadays, students readily use AI tools to structure, write, or revise text for seminar, Bachelor, and Master theses. They use AI to produce images to illustrate their work, synthesize speech, create videos, and develop software code. Using tools based on GenAI is also already widespread in, for example, press agencies, media agencies, and software programming departments. A large amount of content on social media is generated or edited by GenAI. Competency to create digital content might become less relevant in times of readily available digital content developed by GenAI tools. More importantly, the knowledge and skills required for prompting and using GenAI tools for digital content creation are different from the knowledge and skills required without such tools (Dang,

Mecke, Lehmann, Goller, & Buschek, 2022; Kaya, Zirnig, Blaurock, Zechiel, & Schoop, 2023).

However, digital content creation is not the only basic digital competency affected by GenAI or AI in general. All other areas of basic digital competencies suggested by Vuorikari et al. (2022) and several areas of basic non-digital competencies are affected by AI. To name but two examples:

Literacy, the knowledge of vocabulary and functional grammar (European Commission & Directorate-General for Education, Youth, Sport and Culture, 2019), is traditionally a basic competency of high importance. Until now, it has generally been very difficult to go through life as an illiterate person. With increasingly better tools to translate written text into spoken language and vice versa, the ability to read and write might become less relevant. General literacy, which does not include information and data literacy as digital competencies, loses relevance for digital content automatically checked, corrected, and improved.

Languages, the ability to understand and master different languages, has been an important basic competency to date (European Commission & Directorate-General for Education, Youth, Sport and Culture, 2019). It facilitates access to information and improves (often international and intercultural) communication. Increasingly better tools that not only translate written language in real-time and in high quality but also translate spoken language in real-time and in high quality will make the ability to speak foreign languages appear less important for many people.

We are not arguing that all people should become illiterate and only express themselves in their mother tongue. Becoming literate and multilingual has value in, for example, a cultural sense and likely broader effects on cognitive development. Literacy includes an awareness of the impact of language on others, and multilingual competency includes the appreciation of cultural diversity (European Commission & Directorate-General for Education, Youth, Sport and Culture, 2019). These aspects remain highly important in times of increasing AI diffusion. However, focusing only on the instrumental benefits of basic competencies in literacy and languages, the relevance shifts with the increasing use of AI. Similar arguments can be made for other traditional basic competencies.

Exploring the shift of competency relevance, Eloundou, Manning, Mishkin, and Rock (2023) assessed the impact of LLMs on the U.S. labor market, finding that 80% of workers could see over 10% of their tasks strongly affected, with 19% of workers potentially seeing at least half of their tasks strongly affected by LLMs. This highlights the broad economic influence of LLM-powered tools. Eloundou et al. (2023) analyzed the impact of LLMs on various occupations. From that, they forecasted the change in importance of some basic competencies. Specifically, they found a statistically significant effect of increasing exposure to LLMs for ten basic competencies (Eloundou et al., 2023, Table 5a), which they selected from the Occupational Information Network (O*Net) database sponsored by the US Department of Labor. The labels and descriptions of competencies in the following list are direct quotes from https://www.onetonline.org/. The competencies combine knowledge, skills, and attitudes as described above. Some focus on attitudes, while others emphasize skills, and all build on knowledge. Unfortunately, the list of competencies in O*Net and the subset studied by Eloundou et al. (2023) do not fully match the competency models introduced above. Nevertheless, the study by Eloundou et al. (2023) provides compelling evidence for the shifting relevance of basic competencies.

According to Eloundou et al. (2023), basic competencies with increasing importance are:

- **Critical thinking:** Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
- **Active learning:** Understanding the implications of new information for both current and future problem-solving and decision-making.
- **Mathematics:** Using mathematics to solve problems.

- **Science:** Using scientific rules and methods to solve problems.
- **Learning strategies:** Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.
- **Monitoring:** Monitoring/assessing the performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Basic competencies with decreasing importance are:

- **Programming:** Writing computer programs for various purposes.
- **Writing:** Communicating effectively in writing as appropriate for the needs of the audience.
- **Reading comprehension:** Understanding written sentences and paragraphs in work-related documents.
- **Active listening:** Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Higher education does not only educate for the labor market. When considering the relevance of developing competencies in higher education, one should also consider general education, societal roles outside the labor market, and the opportunity to lead a good life. Hence, whether assumed shifts in job relevance of basic competencies should manifest in higher education curricula is a question to be debated. However, the limited scope of a higher education degree program, the limited opportunity to develop competencies within this frame, and shifting job relevance suggest that we should have this debate.

For that debate, we would like to point out two areas that we believe are relevant basic competencies for a world permeated by AI, being fundamental in any professional field and most domains of life. These basic competencies should be considered alongside the ones presented in Figure 5.

AI Literacy focuses on the dynamics between AI systems and human users. Examples are the knowledge to understand where and how the usage of AI may help humans, skills to efficiently give input to AI tools for high-quality results, and attitudes to critically inspect the outputs of AI tools, including appropriate reliance and not suffering from phenomena like automation bias. It is important to be adept at daily efficient and goal-directed interaction with AI systems.

AI Reflection involves understanding how AI impacts society, adhering to legal standards, and navigating the moral complexities it presents. It is about being provided with the relevant knowledge to recognize the responsibilities that come with AI use, including issues of privacy, bias, and fairness. Further, it expands on the necessary skills to take responsibility and the attitudes to implement them correctly. This competency is essential for ensuring AI is used in a way that is beneficial and respectful to society, upholding ethical integrity and legal compliance.

3.2 Advanced Competencies: Evolving with AI

Advanced competencies are specific to certain roles or sectors. Thus, advanced competencies are a broad field with many special characteristics depending on the context. Hence, they are not discussed at the same level as basic competencies. Many professional associations and study programs define which professional, methodological, personal, and social competencies are required for success in the respective field. Some of these competencies will remain unaffected. However, we posit that many of these competencies will experience changes in their relative relevance and, thus, the time and effort spent on them in higher education. Therefore, the crux of the matter lies in discerning which competencies are becoming indispensable when AI is used in specific contexts. GenAI is not rendering competencies fully obsolete; rather, it is steering us towards a new set of

relevant competencies when AI-driven systems complement humans.

As the field is too broad for general discussion, we turn to advanced business administration and management competencies. Informed by extensive research, we have identified relevant AI-related competencies for business students. These competencies are based on analyzing university curricula, labor market requirements, existing literature, and socio-technical trends. Hence, we identified AI Innovation, AI Technology, AI Management, and AI Application areas as advanced AI competencies (adapted from Kaya et al., 2023). They seek to adapt business education to the evolving needs of the AI era. While competencies may differ across fields, this approach serves as a foundation, highlighting the vast possibilities across various domains.

AI Innovation is about understanding the nuts and bolts of AI and using this knowledge to develop new, creative solutions. It is about seeing beyond the current uses of AI and imagining how it can be applied in new ways to solve real-world problems. Essentially, AI innovation includes the skill of merging technical AI know-how with an attitude of out-of-the-box thinking to drive progress and innovation.

AI Technology involves deep knowledge and understanding of the technical aspects of AI, including algorithms, data analysis, and ML processes. AI technology is about having the skills to develop, implement, and operate AI systems effectively. This competency enables individuals to handle the practical challenges and technical demands of these sophisticated systems.

AI Management includes AI strategy, AI application management, and AI governance. It revolves around the skill of effectively overseeing AI projects and initiatives within an organization. It requires a blend of strategic planning, knowledge of AI's impact on business processes and workforce, enabling human-AI collaboration in task fulfillment, and the ability and attitude to facilitate collaboration between technical teams and other departments. This competency is essential for ensuring that AI implementations are aligned with business goals and are executed smoothly, responsibly, and ethically.

AI Application Areas is about understanding the various fields and industries where AI can be applied, from healthcare to finance and from customer service to manufacturing. It involves recognizing each area's specific challenges and opportunities and how AI can be tailored to meet those needs. This competency is crucial for identifying potential AI solutions that can drive innovation and efficiency in diverse sectors.

4. Key Questions for Training Future-Proof Graduates

4. Key Questions for Training Future-Proof Graduates

The preceding sections elucidated the evolution of AI, delineating its role in the change of pertinent competencies and formulating novel AI-specific competencies, for example, within business and management studies. Higher education institutions, however, still confront the task of identifying and imparting these competencies to their student body. To facilitate this endeavor, we articulate nine questions instrumental in embedding AI competencies within higher education. The target group who should approach these questions involves everybody in higher education institutions involved with developing curricula and teaching offers on a strategic level. This can, for example, affect people in charge at the level of an entire university with its management and staff departments, faculties, study programs, institutes or chairs, or even individual lecturers.

The first four questions focus on the design of the education, while questions five and six integrate the impact on the teaching environment. Although questions seven through nine do not directly influence the educational offerings, they hold relevance in structuring innovative academic modules. The idea of the nine key questions is to provide inspiration and serve as guardrails for higher education institutions. Nevertheless, the answers to these questions depend on the institutions themselves.

1. **Which AI competencies should be integrated?**
   Determining whether the focus should be imparting knowledge, developing skills, or nurturing attitudes toward AI is essential. Here, a discussion of basic and advanced AI competencies for specific target groups is required.
2. **Which educational level should be targeted?**
   This discerns the educational stratum (Bachelor, Master, professional development, or doctoral/Ph.D.) that will benefit from including AI competencies.
3. **How extensive should the offer be?**
   Institutions must decide on the breadth and depth of AI competency integration, ranging from establishing new degree programs and specializations to creating new modules or courses or incorporating new chapters in existing courses.
4. **How binding and documented should the competency be anchored?**
   The commitment level to AI competencies can vary from mandatory integration to optional or elective courses, with acknowledgment via additional certificates or remaining undocumented as voluntary, untested extracurricular engagement.
5. **Which traditional competencies should be cut?**
   It is crucial to identify which conventional competencies — basic, professional, methodological, social, personal, or none — may need to be curtailed to accommodate AI competencies. This is important when considering mandatory courses in study programs that do not allow for increased student workload. Further, this is important if teaching personnel and resources are limited.
6. **Who does the teaching?**
   The higher education institution must decide on who will deliver the AI competency curriculum, be it professors from the university, other lecturers, external experts, or through external courses, and how to allocate the necessary capacities and potential resources.

7. **How to keep teaching up to date given the highly dynamic nature of AI?**
   This question addresses the mechanisms and strategies required to maintain the currency of AI education, considering its rapid evolution.
8. **How should lecturers train themselves?**
   This question probes the continuous professional development of lecturers to ensure they remain adept in the latest AI advancements. Higher education institutions need to determine how they can enable lecturers to remain up to date in their knowledge, skills, and attitudes.
9. **How to ensure access to AI tools for students and lecturers?**
   Providing opportunities to use AI tools and resources for both students and faculty is vital for a hands-on, experiential learning environment and an equal distribution of tools across different life circumstances (e.g., “plus accounts” for students).

Debating answers to these questions may help higher education institutions in planning how to update their offerings for training future-prof graduates well equipped for navigating a world infused with AI systems. After identifying whether the AI competency should be knowledge, skills, attitude, or a combination thereof, different event formats stand out. Figure 6 serves as a specific inspiration for decision-makers on integrating AI competencies, even if mapping knowledge, skill, and attitude to different formats is not as clear-cut as the figure suggests.

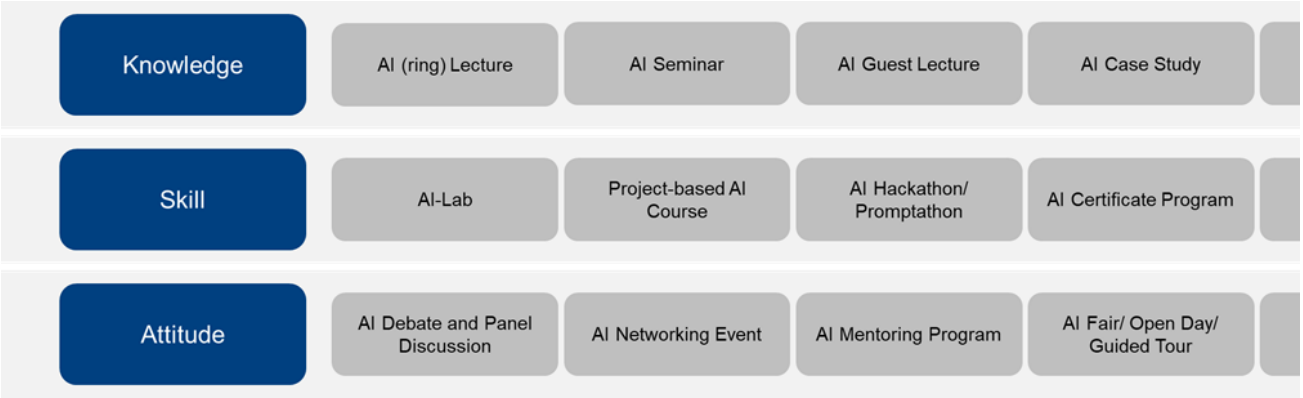


Figure 6. Inspiration for different events for different AI competencies

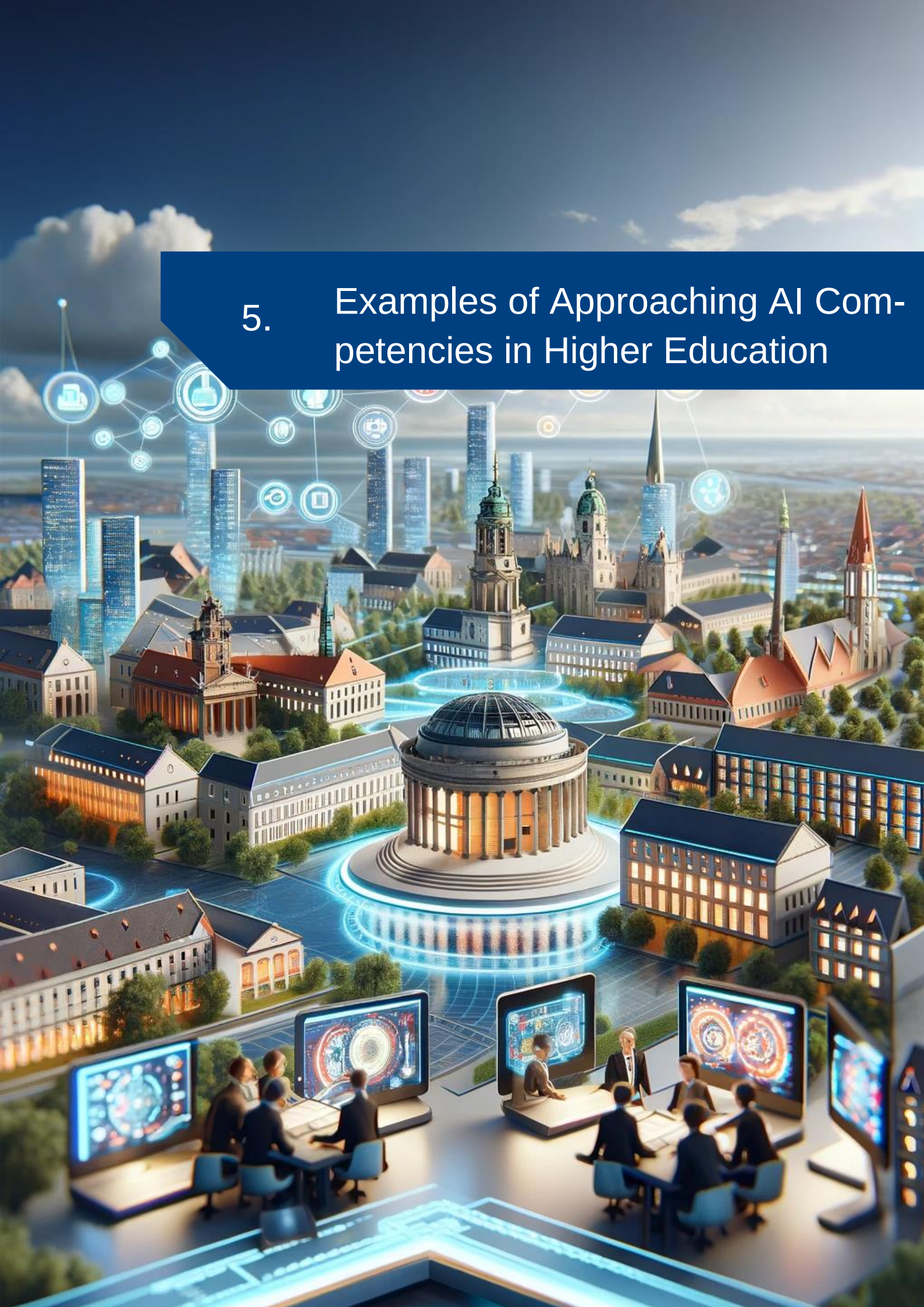
For the dissemination of **knowledge**, the university can employ a variety of pedagogical methods. An “AI (Ring) Lecture” series can provide a comprehensive overview, while “AI Seminars” offer a more interactive and discussion-oriented format. “AI Guest Lectures” bring external expertise to the campus, infusing the academic environment with fresh perspectives, and “AI Case Studies” ground theoretical knowledge in the pragmatic soil of real-world applications.

The cultivation of **skills** requires a more hands-on approach. An “AI-Lab” can allow students to engage with AI systems directly. “Project-based AI Courses” foster an environment where theoretical learning meets practical application, enabling students to develop their skills through experiential learning.

When fostering an **attitude** towards AI, the approach must transcend the classroom. “AI Debates and Panel Discussions” challenge students to consider ethical, social, and philosophical implications, shaping their perspectives and critical thinking. “AI Networking Events” and “AI Mentoring Programs” build communities of practice that extend learning beyond the academic sphere, fostering relationships that bridge the gap between education and industry. Lastly, “AI Fairs, Open Days, and Guided Tours“ may provide a platform to showcase the university’s engagement with AI, inviting curiosity and fostering an institutional ethos that embraces AI’s potential.

Each event type is a strategic choice to build robust and multidimensional AI-related competencies. It is of significant note that the examples depicted in Figure 6 provide a foundational framework upon which educational institutions may construct their portfolio. The feasibility of combining knowledge, skills, and attitudes within a singular lecture format or adapting pedagogical methodologies depends on the specific context and parameters of the higher education institution in question.

5. Examples of Approaching AI Competencies in Higher Education



5. Examples of Approaching AI Competencies in Higher Education

The following three examples illustrate how different universities tackle AI competencies. They do not represent formal university-level or faculty-level strategies. Instead, they are the perspectives of the authors of this whitepaper. Given that the authors manage these study programs and offers, these are informed perspectives. The examples are inherently linked to their respective universities and may not be directly replicable in other academic contexts. Nonetheless, they serve as a source of inspiration for educational institutions aspiring to integrate AI competencies into their curricula, illustrating practical applications of theoretical concepts.

5.1 Example 1: A Bachelor of Science Degree Program

The **University of Hohenheim** in Stuttgart, Germany, has a broad portfolio of degree programs in business, economics, social sciences, natural sciences, and agricultural sciences. One example is the **Bachelor of Science in Digital Business Management (DBM)** at the Faculty of Business, Economics and Social Sciences (https://www.uni-hohenheim.de/en/digital-business-management-bachelors). Given the relevance of AI for digital business managers, the curriculum contains several courses addressing different competencies. The first year starts with an introductory course in DBM, offering a foundational overview of various AI competencies. Progressing through the program, students engage with more advanced modules such as “Applied AI,” “Tools for AI & Data Science,” or “AI Law and Digital Law,” thereby acquiring a comprehensive skill set in these areas. Beyond such courses dedicated specifically to AI, many other courses build the foundation for AI Technology (e.g., two introductory courses in statistics or a course in data management) and address specific aspects of AI along with other topics (e.g., Economic Analysis of the Digital Economy or Digital Work, Digital Life). The program is rounded off towards the end with, for example, a research internship, a course on practical work in DBM, and the Bachelor thesis. These courses offer a broad opportunity to focus on various topics, including AI.

Figure 7 presents a simplified representation of the courses in the DBM curriculum that relate to AI competencies. Courses that build the foundation for AI Technology are also labeled as AI Technology. In total, 10 out of 18 mandatory courses (56%) in the DBM curriculum and an additional 10 out of 20 compulsory elective courses (50%) relate to AI. Further, an elective internship and the Bachelor’s thesis may relate to AI. Depending on a student’s choice of courses and specific topics in the courses, 33% to 77% of the student’s Bachelor’s education is somewhat related to AI and foundations for mastering AI Technology.

Several courses in the DBM curriculum are offered in multiple degree programs. An example is the **Applied AI course**, mandatory in the Bachelor of Science in Business Administration and Economics (University of Hohenheim’s largest degree program), the Bachelor of Science in Education for Business and Economics, and the Bachelor of Science in Information Systems. With this, the Applied AI course targets over 700 students with varying degrees of technical interest and expertise. The Applied AI course teaches AI concepts and shows that AI exists in the everyday life of students. Having discussed the importance of data and data characteristics, the focus shifts to the fundamentals of ML before teaching classification and clustering as the first ML techniques in detail. RapidMiner is introduced as a process-oriented ML tool. Students use this tool in various consecutive exercises where real-world applications of AI are discussed, and the first ML models are developed by conducting the process of Knowledge Discovery in Databases from Fayyad et al. (1996). The

course introduces and discusses AI Application Areas that fit the students' business background. Finally, the potential and limitations of AI are evaluated.

	AI Literacy	AI Reflection	AI Innovation	AI Technology	AI Management	AI Application Areas
Introduction to DBM	✓	✓	✓	✓	✓	✓
Digital Work, Digital Life	✓	✓				✓
Seminar on DBM	✓					✓
Economic Analysis of the Digital Economy		✓			✓	
Work and Organization in the Dig.Transformation		✓			✓	
AI Law and Digital Law		✓				
Innovation Project – The Challenge			✓			
Applied AI			✓	✓		✓
Programming and Program Development				✓		
Introduction to Statistical Data Analysis				✓		
Sample-based Data Analysis				✓		
Machine Learning			✓	✓		✓
Introduction to System Design			✓	✓		
Data Management				✓		
Tools for AI & Data Science				✓		
Introduction to Data Science with R and R-Studio				✓		
Introduction to Financial Data Science				✓		✓
Research Internship	✓	✓	✓	✓	✓	✓
Practice in Digital Business Management	✓	✓	✓	✓	✓	✓
Internship	✓	✓	✓	✓	✓	✓
Bachelor Thesis	✓	✓	✓	✓	✓	✓

Figure 7. Courses in the Bachelor of Science Digital Business Management curriculum at the University of Hohenheim that relate to AI competencies. Plain font indicates mandatory courses, *and italic font indicates elective courses.*

Beyond such curricular offers, the University of Hohenheim has an extracurricular certificate for all students. The aim of the "**AI & Data Science Certificate Hohenheim (AIDAHO)**" is to increase the expertise of its participants in the fields of AI, Data Science, and Scientific Computing (https://ai-daho.uni-hohenheim.de/en). Students can enroll in the certificate in addition to their main course of study. After passing three basic modules, they can choose from various specializing modules to set their priorities on which AI competencies to expand.

The DBM program started in 2021 with a clear focus on digitalization, including a focus on AI. Since then, some courses have been updated to keep pace with developments, especially in the field of GenAI. Developing a novel academic program, such as DBM, presents distinct benefits. One primary advantage is the avoidance of replacing certain key challenges associated with curriculum revision, as integrating new courses does not necessitate the elimination of existing courses. Creating a new study program from the ground up entails a significantly increased workload. The University of Hohenheim managed this by redesignating professorships and hiring new professors focused on digitalization which aligns with a strategic research topic at the university and faculty levels. Further, the AIDAHO certificate and the creation and alteration of courses in the DBM program as part of the ABBA and DeLLFi projects were supported with third-party funds.

5.2 Example 2: A Certificate Program Complementing Regular Master Programs

At the **University of Bayreuth**, Germany, AI competencies are conveyed in several degree programs and formats. Higher education institutions extend their role beyond formal undergraduate and graduate degree courses by offering a range of extracurricular activities and professional development programs to current students and alumni, industry partners, and individuals. In line with this

general trend, the University of Bayreuth offers the **Digital Leadership Academy (DLA;** https://www.digitalleadershipacademy.de/). The DLA is designed for high-performing, passionate Master's students looking for in-depth competency development in digitalization and leadership to be equipped for leadership responsibility in their future professional environment. The University of Bayreuth heads the DLA and runs in cooperation with partners from academia and industry. This close cooperation allows participants to network interdisciplinary and transdisciplinary with academics and practitioners. The certificate program lasts one year, running concurrently with regular studies and comprising two mandatory three-week attendance phases. Digital networking, mentoring, internships, and other offerings complement these.

The DLA focuses on two core subject areas, Thought Leadership and People Leadership, forming the foundation for its comprehensive event and teaching portfolio. **Thought Leadership** involves developing and refining competencies related to digitalization, particularly in Digital Transformation, Digital Business and innovation, and Digital Disruption. Soft skills and leadership competencies are fostered through People Leadership. As part of Thought Leadership, AI competencies are covered in depth in various modules, as shown in Figure 8. Basic competencies in AI Literacy are only developed selectively and sparsely in the DLA, as these are typically already sufficiently developed for the students or acquired elsewhere.

	AI Literacy	AI Reflection	AI Innovation	AI Technology	AI Management	AI Application Areas
Ethics, Leadership, Digitalization		✓			✓	
Megatrends: Digitalization & Beyond		✓		✓		✓
Explainable AI and Fair Machine Learning	✓	✓		✓	✓	
AI & Data Analytics			✓	✓	✓	✓
Digital Health, Sports and Society						✓
Work in the Digital Age						✓
Research Crash Course						✓

Figure 8. Mandatory thought leadership courses in the Digital Leadership Academy that relate to AI competencies

The development of AI competencies is complemented by other digital competencies (e.g., relating to the Internet of Things, Blockchain, Industry 4.0, and agile work). At a time when AI increasingly assumes routine tasks and skills such as text composition and other basic competencies diminish in relevance, the training of other basic and advanced competencies gains significance. Hence, the DLA aims to improve basic competencies like critical thinking, active learning, science, and monitoring oneself and others (see section 3.1 and Eloundou et al. 2023 for the increasing relevance of these competencies due to the diffusion of GenAI). The overarching theme of **People Leadership** in the DLA contains courses selected and designed with the backdrop that AI shifts the relevance of individual competency areas. A specific focus lies on advanced social competencies and reflection of one's current competencies, learning goals, and trajectory. The development of competencies in self-management is honed through targeted reflection and practice-oriented exercises, while interpersonal communication and teamwork are deepened through in-depth discussions, personal exchanges, and philosophical conversations. The versatility of the events enables addressing all three components of competencies: knowledge, skills, and attitudes.

5.3 Example 3: An Individual Lecture Covering a Broad Set of AI Competencies

Several professorships teach AI competencies at the **Frankfurt University of Applied Sciences** (Frankfurt UAS), Germany. In the ABBA project, they developed a landscape of AI subject areas (aligned with the competencies in Section 3), which they then adapted to the student body at Frankfurt UAS. The adapted framework distinguishes between six subject areas closely related to AI competnecies introduced above: AI Innovation, AI Technology, AI Management, AI Application Areas, Ethical, Legal, and Social Implications, and Human-AI Interaction (Figure 9). The supply and use of AI Infrastructure and Services supports this.

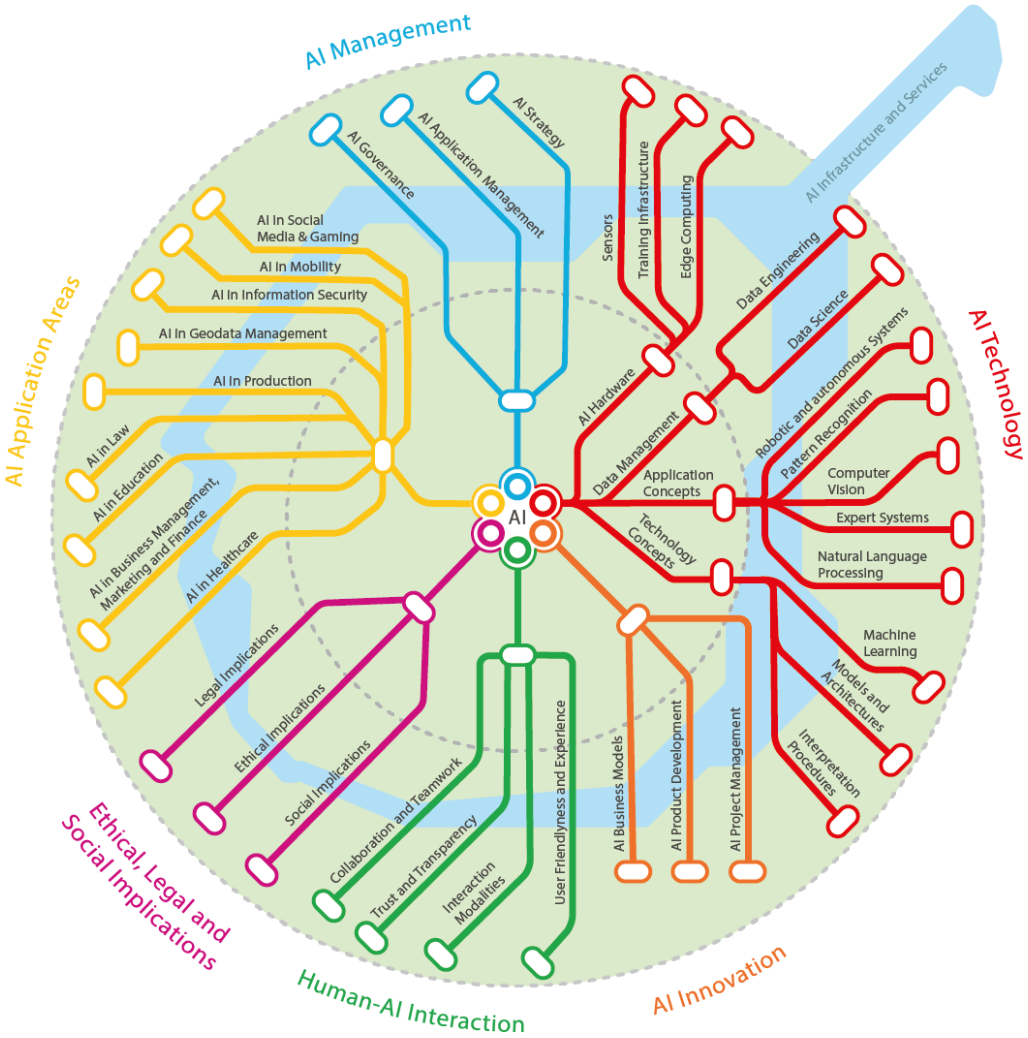


Figure 9. The exemplary landscape of AI competencies in business-related studies at Frankfurt University of Applied Sciences

The Professorship for Information Systems, Digital Business and Mobility at Frankfurt UAS designed the Bachelor lecture "**Management of AI-based Systems**" for B. Sc. Information Systems students. This lecture addresses the AI subject areas included in the framework at an introductory level. It equips students with an understanding of AI technologies, starting from the operational mechanics of neural networks to the broader application potentials across various sectors. It emphasizes the critical evaluation of AI use cases, assessing their strategic impact while fostering organizational readiness for AI adoption. The curriculum also instills proficiency in measuring AI performance

through robust metrics, guiding techno-economic decision-making processes. A significant focus is placed on AI systems' governance and ethical monitoring to ensure responsible use. Lastly, it explores the nuances of human-AI interaction, preparing students to design and navigate the interface between AI tools and their human counterparts. The structure of the lecture is sketched in Figure 10.

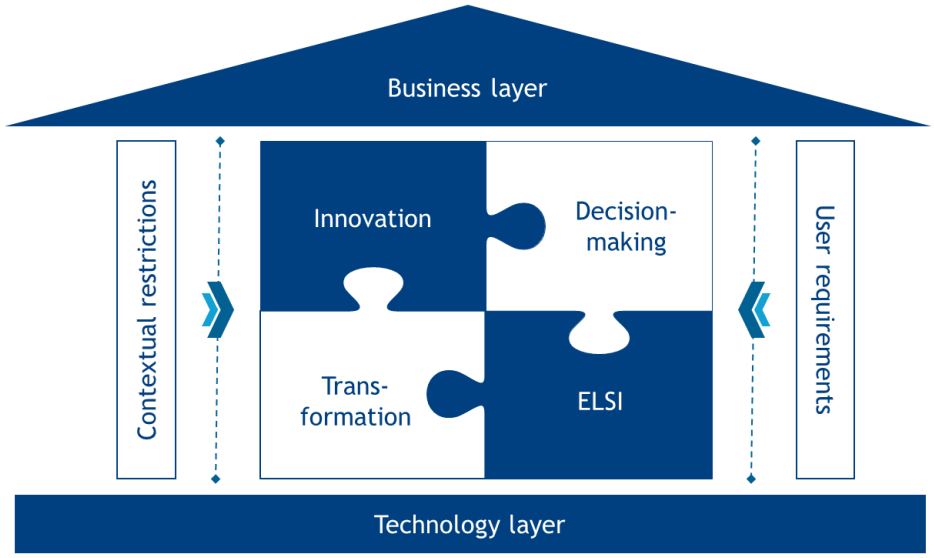
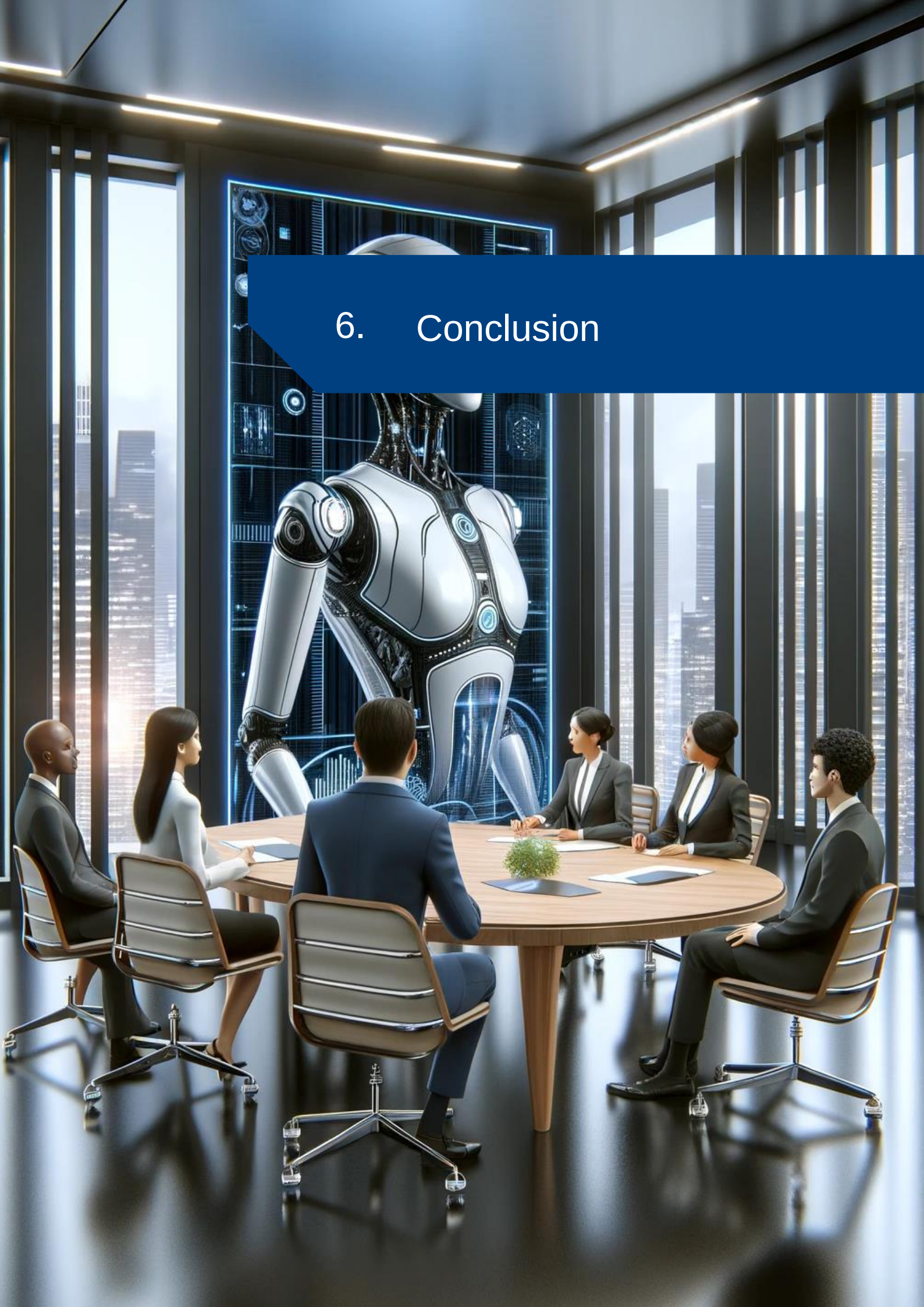


Figure 10. Structure of the lecture "Management of AI-based systems" at Frankfurt University of Applied Sciences



6. Conclusion

6. Conclusion

AI is a general-purpose technology and a dynamic concept capturing the cognitive abilities of machines. The interaction with such machines is changing how we work and live and, hence, what competencies people should acquire to succeed in work and private life. In 2023, GenAI made us rethink how we assess classical competencies when some traditional formats, such as unsupervised written exams (e.g., a Bachelor's thesis), could be affected by the availability of tools such as ChatGPT. Now, AI makes us rethink what we teach, the knowledge, skills, and attitudes we aim to develop, and how we prepare students for an AI-infused world.

This whitepaper outlined how AI impacts the competencies we should foster in higher education. We discussed the basic and advanced competencies it requires and touched upon competencies that might become less relevant, freeing up time and resources to focus on future-oriented competencies. We posed nine key questions that higher education institutions should answer to make sure future graduates can succeed and lead, not just follow behind. Higher education institutions can support integrating AI competencies through curricular and extracurricular initiatives by answering the questions. Lastly, we showcased multiple ways universities have integrated AI competencies into curricula.

The discussion of different competencies and shifts in relevance, the guiding questions, and the examples can inspire others to integrate AI competencies into their offerings. The higher education system needs to do more than react to AI; it should get ahead and act as a catalyst for our future with AI. Universities and other institutions should be quick and forward-thinking, creating courses that keep up with AI's rapid technological changes and the far-reaching implications for our economy and society. Lecturers should keep up with technological progress and its implications on students' future jobs' underlying competency requirements. Students should be taught how to use AI and understand how it works, reflect on its impact, and influence where AI is heading. Engaging deeply with AI is how we can make sure it benefits everyone.

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