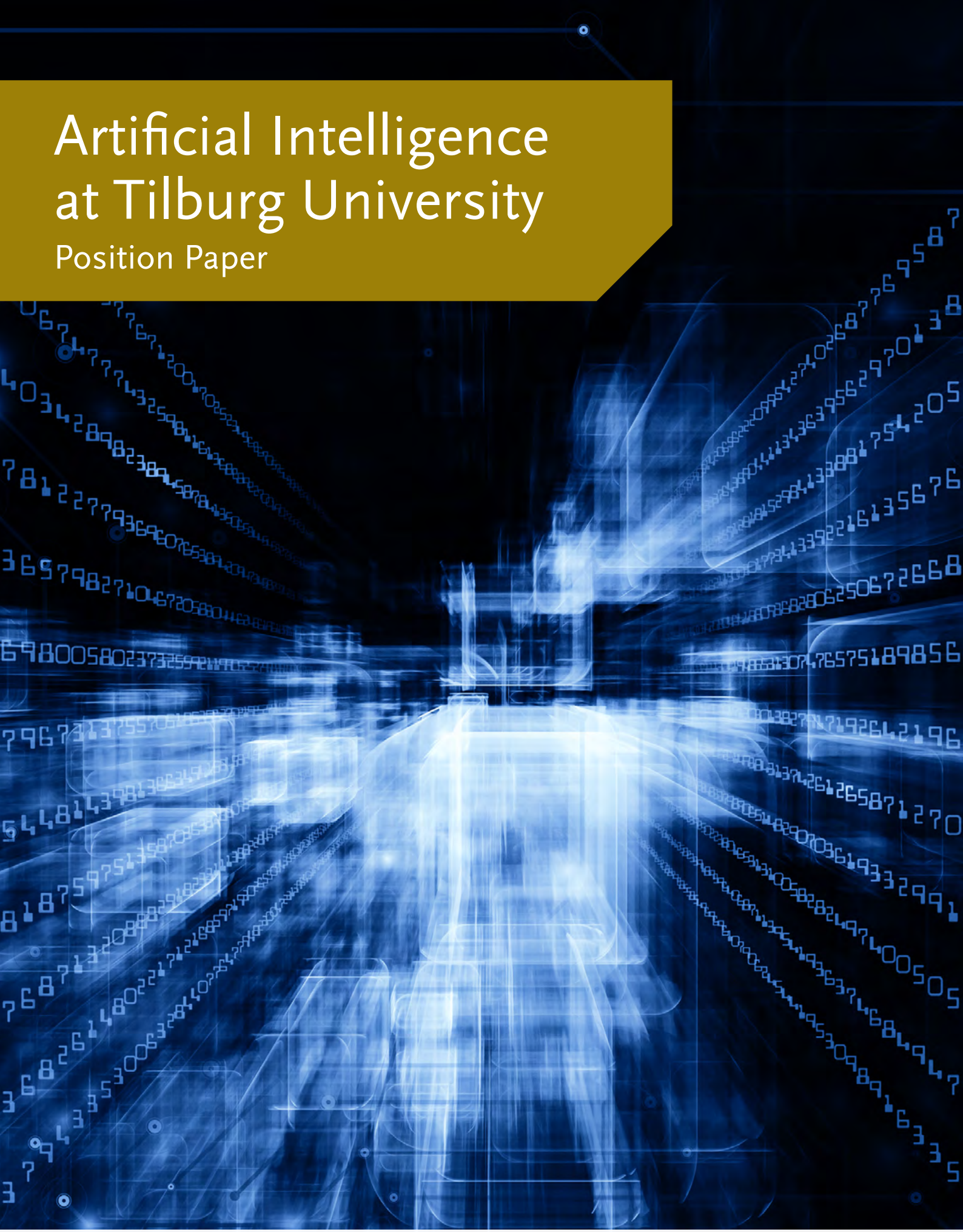
Artificial Intelligence at Tilburg University

Position Paper



TILBURG UNIVERSITY

Understanding Society

Artificial Intelligence at Tilburg University

Position Paper

TAISIG
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Editors:
Emile Aarts
Martin van der Broek
Esther Keymolen
Kenny Meesters
Marie Postma
Mirjam Siesling

Content

1 Introduction and Scope

Artificial intelligence (AI) refers to the study of artificial digital objects that demonstrate a functional behavior that is perceived as intelligent by human beings. Over the past hundred years, this interdisciplinary field of science and innovation has strongly developed itself through a multitude of groundbreaking discoveries and inventions. Since the dawn of the 21st century, AI is generally considered as an important driving force beyond what is known as the digital transformation, i.e., the total and overall societal effect that results from the digitalization of business models, consumption patterns, socio-economic structures, legal and policy measures, organizational patterns, cultural barriers, and ultimately society itself.

Many organizations worldwide are organizing and preparing for this transformation, and for academia, these are challenging times as, from their origin and nature, they are considered guiding institutions for this formidable task. Moreover, they need to assume a responsibility in educating a new generation of students and academics that can interpret and guide the transition. Consequently, universities worldwide are organizing themselves to assume a position and role in the multitude of networks and organizations that are being set up to organize the change process. To engage and participate in the various initiatives, individual universities must make clear what their offerings are and how that is rooted in their profiles and academic traditions.

With this AI position paper, Tilburg University (TiU) presents a statement on the role it wants to play in the field of artificial intelligence. It provides the university's vision and mission on artificial intelligence and demonstrates in which areas and subfields TiU intends to play a leading role and how it will collaborate with other stakeholders to achieve its goals and objectives.

This position paper sets of with a short history of artificial intelligence research at Tilburg University. Next, it presents the university's view on the structure of the field and the most relevant fields of investigation along the lines of the following tri-partition: (1) *Research Methods & Techniques*, (2) *Ethical, Legal & Societal Aspects*, and (3) *AI Application Domains*. The position paper concludes with an overview of the university's scientific strengths, project portfolio, and stakeholder networks in artificial intelligence.

2 A Brief History of Artificial Intelligence at Tilburg University

Most experts consider the 1956 Dartmouth Summer Conference as the seminal event giving birth to the interdisciplinary field of AI, combining disciplines including robotics, planning, knowledge engineering, cognition, machine learning, language processing, and vision. The meeting indeed was groundbreaking. As the best scientists at that point in time gathered for more than six weeks to discuss—under the leadership of John McCarthy and Marvin Minsky—all relevant aspects in this novel scientific domain using the notion of "artificial intelligence" for the first time. In many institutes across the globe, including at Tilburg University, research in the various disciplines had been going on for several decades prior to the event.

As early as 1933, just four years after the start of Tilburg University (*the Roomsch Katholieke Handelshoogeschool* at that time), the psychologist Jan de Quay (1901–1985), later to become prime minister of the Netherlands, was appointed as professor of psychotechnics. This novel field of research, which had just been established in the United States, investigated cognitive processes in the analysis of man-machine interaction as part of the relation between behavioral sciences and technology. De Quay also founded the Psychotechnics Laboratory within the school of psychology. The word "Laboratory" was added to explicitly indicate the relation with technical developments and experimentation, which was novel in the field of the Dutch gamma sciences at that time. De Quay left the university in the 1940s to pursue a full-time political career. Psychotechnics as a field of early AI research developed over time, resulting in the opening of a Psychotechnics Laboratory at the Dutch PTT (former KPN) research division in 1971.

In 1964, the mathematician Max Euwe (1901-1981) was appointed professor of automation of information processing in Tilburg. Euwe, who became a world chess champion in 1935, was one of the pioneers in computer science in the Netherlands. As an advisor for Remington Rand, he had been involved in the early developments of the design of electronic computers in the 1950s. In Tilburg, he introduced information processing as a research field and published about computer chess.

In 1984, the mathematician Harry Bunt was appointed professor of language processing and computer science to study the interconnection between language, logic, and cognitive science. He was a lead scientist of the PHLIQA project that was commissioned by the Philips electronics company to investigate the formal semantics of speech processing.

In 1994, Tilburg Law School started the Tilburg Institute for Law, Technology, and Society (TILT, CRBI at the time). Over the years, this institute established a widely recognized interdisciplinary leadership position in the exploration and understanding of the interplay between technology, regulation, and fundamental values. Over the past years, the focus of the studies at TILT has shifted to include the study of Ethical, Legal, and Societal Aspects (ELSA) of artificial intelligence, which has become an important field of study in the design of human-centric AI solutions.

In 2008, the Tilburg Center for Creative Computing (TICC) was founded. This Center, which was later renamed into Center for Communication and Cognition, focuses on communication and technology, information visualization, and language production and understanding. In addition, it has built a reputation in the design and analysis of virtual reality applications. In 2017, the Tilburg School of Humanities and Digital Sciences created the specialized Department of Cognitive Science and Artificial Intelligence to strengthen research into core activities in the field of AI.

Over the past forty years, the Tilburg School of Economics and Management has hosted several research institutes and departments in a variety of fields related to operations research, information processing, and knowledge engineering. This work meets very high international standards and can be viewed to provide a solid mathematical basis for the recent scientific research field referred to as data analytics or data science, which in turn has a strong connection to machine learning. These activities have contributed to the start of the Jheronimus Academy of Data Science (JADS), launched in 2016 as a strategic collaboration between Tilburg University and the Eindhoven University of Technology in the field of data science and entrepreneurship. The JADS initiative was supported by the municipality of Den Bosch and the province of North Brabant. JADS focusses its activities on data science and entrepreneurship and has built a strong position based on its educational programs both at the master and postmaster levels including professional training. JADS also has developed an extensive research project portfolio in a diversity of area's including crime and safety, agriculture and food, and digital and social entrepreneurship. In addition, JADS has a data science lab for the incubation of startup activities.

MindLabs, the interdisciplinary research center where Minds, Media, and Technology meet, was founded in 2019 as a multi-partner initiative in the field of interactive technologies and human behavior, focusing on an optimal collaboration between human minds and artificial minds.The other partners are Fontys University of Applied Sciences, ROC Tilburg DPG Media , the Tilburg Municipality, and the province of North Brabant. It is an initiative that brings together knowledge and expertise in areas related to human-centered AI, including robotics and avatars, serious games and learning, virtual and augmented reality and language and data technologies. It hosts a series of large AI-related projects, including the Tilburg University ICAI Lab "MasterMinds". MindLabs functions complementary to other initiatives in the province, including JADS and EAISI, and is located in a dedicated building in the Tilburg city center to house all relevant AI partners.

Contrary to popular belief, Tilburg University has a longstanding history and experience in working with and developing of techniques related to artificial intelligence. More than that. Over time, Tilburg University has continuously invested, researched, and innovated in AI technologies, including their use, impact and relevance for society. With the (re)new(ed) interest in AI in our society, Tilburg can build on this history and expand into a university that can bridge existing gaps. In hindsight, Tilburg University has an interesting history in artificial intelligence, covering almost the full lifecycle and all disciplines represented at the university. Together, the various disciplines cover most of the relevant AI subfields.

3 AI in TiU Perspective

By means of its education and research, Tilburg University has an unquestionable impact on society, contributing to society's understanding and improvement in various areas. Artificial Intelligence ensures that many major challenges can be addressed more efficiently. In combination with the domain expertise of Tilburg University's researchers, these issues can be tackled in an informed way and from multidisciplinary angles.

Artificial intelligence is everywhere, from predicting how a virus spreads to recognizing works of art. It helps to address complex societal issues better, faster, and more efficiently in domains such as energy transition, mobility, and personalized treatment in healthcare. At the same time, AI also challenges us to think about how to develop and use these promising applications in a responsible and sustainable manner.

In the pursuit of creating an impact on society, Tilburg University collaborates with local, national, and international partners both in the private and the public sector. We develop AI tools and techniques on a foundational level, exploring the social, legal, ethical, and economic requirements and impact of AI as a technology and its artifacts and applications and developing and studying human-machine configurations in concrete applications. We collaborate with other knowledge institutions in consortia, smaller partnerships, and in MindLabs, JADS, and the DAF Technology Lab.

Within Tilburg University, several Departments, researcher clusters, and programs engage in AI-related projects. The Tilburg University AI Special Interest Group[1] (TAISIG) pools together and strengthens the university's AI activities by bringing together researchers from different disciplines, initiating and accelerating the development of new research proposals and grant applications.

[1] See also TAISIG webpage TAISIG organises AI activities at Tilburg University | Tilburg University

It has a broad scope of (scientific) activities, and it addresses all three primary university domains, i.e., education, research, and impact.

TAISIG executes the following agenda.

1. Develop an inclusive community of practice at TiU for researchers and students in the field of AI. We pursue this ambition by organizing events and activities, including the TAISIG Talks for the broader Tilburg University community and the outside world.
2. Set up a TAISIG sounding board of active TiU members who reflect on the university's strategy regarding a long-term AI vision and corresponding action plan.
3. List and categorize all the relevant scientific AI strengths and competences of TiU, including the various application domains and responsible contact persons; list all the running collaboration projects, stakeholder relations, and memberships in AI.
4. Formulate a multi-annual AI innovation strategy for TiU to realize ambitions based on a SWOT analysis and offer advice on how to proceed in terms of profiling, thematic choices, resource funding, and partnerships in the context of quadruple helix AI innovation ecosystems.
5. Communicate the TAISIG activities to a broader audience both internally, including the student community, and externally. In doing so, we foster a culture that is open for those who are not AI experts but, for example, are interested in the application possibilities in their fields of expertise.

These actions are guided by the following statements.

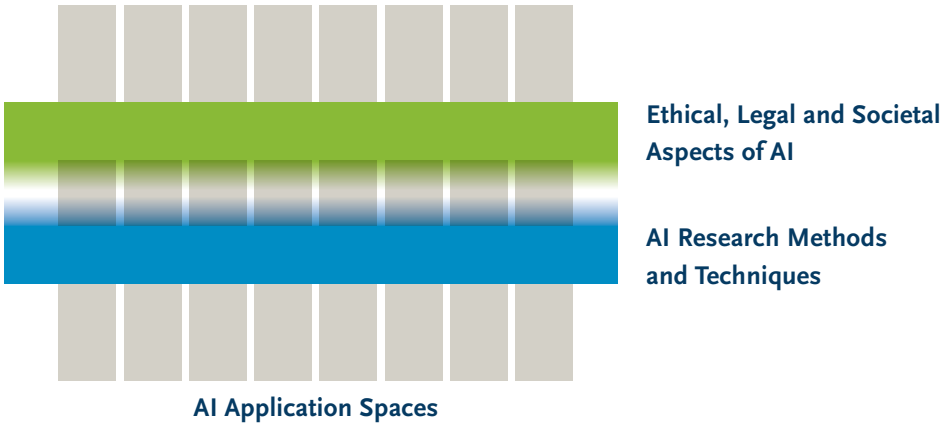
- TiU aims at leveraging its scientific knowledge and skills base in artificial intelligence (AI) in the domains of the social sciences and humanities. It builds on its strong reputation in these domains

and pursues an internationally recognized position as a leading AI university.

- The focus is on human-centric AI, thus building on and contributing to the strategic direction that is pursued by the European Commission and by the Netherlands Artificial Intelligence Coalition (NLAIC). More specifically, we adhere to such general principles as FAIR data concepts and explainable intelligent algorithms.
- The approach is holistic and interdisciplinary, thus combining all relevant elements into an integrated human-centric approach from the following three perspectives:
  - Data, algorithmic, and methodological aspects,
  - Ethical, legal, and societal aspects, and
  - Application domain related aspects.
- We seek to advance the scientific AI knowledge base in pursuit of the university's three primary processes, i.e., education, research, and societal impact. In all three primary processes, we seek strategic partnerships with relevant stakeholders at local, regional, national, and EU level to consolidate our position as an academic leader in AI and to develop a solid and sustainable financial basis to secure long-term execution of our activities in a co-creation setting. In this respect, we will leverage the strong position of our main AI partners, including CentERdata, JADS, and Mindlabs. In the regional arena, TAISIG is a strategic partner in the Brainport AI-Hub, a network organization of key public and private organizations in this field.
- We invest in efforts to develop and sustain an attractive academic environment that attracts and retains talented people in the field of AI who can work and perform at an internationally competitive level. To this end TAISIG is organized in three clusters.
  - AI Research Methods and Techniques;
  - Ethical, Legal, and Societal Aspects of AI (ELSA); and
  - AI Application Spaces.
- AI Algorithms and Methods focuses on fundamental aspects of AI, ELSA focuses on the necessary preconditions and AI's impact on society, and AI Applications deals with meaningful and impactful applications. Tilburg University stands out for its holistic, multidisciplinary approach. It tackles AI issues collectively, across the board. The figure below shows the interrelationship between the two disciplinary work areas and the application spaces.

FUTURE PERSPECTIVE

In recent years, the importance of AI has grown substantially in all three primary university domains (education, research, and impact). The social and economic relevance of AI is also increasing, and TiU, therefore, wants to leverage and build on its integral knowledge and expertise. To this end, the university will participate in several new regional, national, and international initiatives to contribute to societal challenges.



The integration of various disciplines, existing knowledge, and societal need means that AI has the potential to develop into a research focal point at TiU. The ambition for this is to further develop existing study programs and initiate new ones and to carry out research in co-creation with social partners more progressively. We can achieve this through our holistic approach, for which expertise in technical and social sciences reinforce each other.

Many contemporary issues for which AI techniques are deployed are complex (wicked) problems that require a multi-disciplinary approach. For instance, some applications built on sound technologies are not necessarily adopted by the intended audience; some ideas are good in principle but break down because of valid legal constraints; some applications that are within the legal boundaries are morally questionable; some problems can be solved by means of AI techniques, but it does not make sense from an economic perspective. We need to understand the full scope of issues and potential solutions and integrate the various perspectives to make things that work. Our ambition is to foster collaboration between the various disciplines represented at TiU and its external stakeholders through meaningful dialogue and targeted action, for instance, through joint grant proposals and projects; co-authored papers; TiU-wide organized conferences, workshops, and student activities; and concerted contributions to the public debate.

4 AI Research Methods and Techniques

Supported by the increasing computational power, the broad impact of artificial intelligence research methods and techniques has been mainly due to the breakthroughs achieved by the implementation of deep neural networks. This fact illustrates the traditionally tight connection between AI and research in cognitive science, two disciplines that study intelligent behavior from different perspectives: the perspective of a machine on the one hand and of a human in its individual and collective settings on the other. Historically, models of neural networks that served as precursors to deep learning were fundamentally inspired by the neural architecture of the human brain. Recently, research of the human brain has greatly profited from the power of deep learning models. These models provide cognitive scientists with the capacity to make sense of vast amounts of complex data produced by the brain and for an approximation of highly complex biological functions such as perception, speech and language processing, and decision making. The outcome of this scientific endeavor provides, in turn, valuable insights for advancements in robotics and brain-computer interfacing.

The close relation between artificial intelligence and the social sciences is one of the reasons why, until recently, research and education in the domain of AI in the Netherlands has traditionally been conducted and offered mainly by general universities rather than purely technical institutions. In the same vein, core AI research at Tilburg University is supported by multidisciplinary teams that connect expertise in computer science with knowledge of human cognition. It currently distinguishes six focal areas, defined in line with the Dutch AI Manifesto1. All six research themes rely heavily on using and developing emerging technologies, including machine learning, deep learning, virtual/mixed reality, and robotics. Our research not only evaluates the utility and viability of these technologies in new domains but also contributes to improvements in these technologies. In many of our research projects, these technologies are used in conjunction with computational cognitive models to improve our understanding of human and artificial intelligence systems. This research is often done in collaboration with non-academic partners, including corporate, governmental, and not-for-profit organizations.

The theme of **Natural Language Processing** (NLP) represents an uninterrupted long-standing research line at Tilburg University, originating in the 80s of the 20th century. It involves the study of how humans comprehend and generate speech and language and the creation and study of computational models that mimic human language in its spoken, written, and signed form. Even though the desire to equip machines with the same language capabilities as displayed by humans has been at the core of the AI endeavor from the very beginning, this goal has proven to be one of the most difficult to achieve. The aim to provide a natural human-machine communication interface has proven to be elusive although the use of deep neural networks in the NLP domain has led to an improved performance on several tasks. In general, NLP research focuses on the representations and biases learned by state-of-the art language comprehension and machine translation models, network analysis of large corpora of human language judgments, and building and testing of cognitive models for language-related tasks that vary from word segmentation to meaning and multi-sentence reading. Interestingly, the techniques can be applied not just on human but also on programming languages. For example, an NLP-based analysis of code can support automatic detection of inconsistencies and violations of good programming practices, thereby uncovering potential indicators of software weaknesses, and even generate code for particular applications. Other projects in this theme conducted at Tilburg University include building

new frameworks to understand visually grounded spoken language via multi-tasking, creation of multi-language intelligent virtual tutors who are capable of limited interaction with the user using naturalistic synthesized speech, and research and development of innovative machine translation frameworks that can be implemented on mobile applications to facilitate the exchange of information between deaf, hard of hearing, and hearing individuals.

The theme of **Machine Learning** primarily focuses on the customization, application, and automatic interpretation of deep learning networks. This theme spans research as diverse as developing techniques for more explainable AI, state-of-the-art classification of signals and images, learning multi-modal representations, capturing sequential information from transactional records, and generating useful synthetic data. The two uniting goals of this research line are the applications of unsupervised and semi-supervised learning architectures, such as Variational Auto-Encoders, and the improvement of our understanding of the benefits and costs of over-parametrization and parameter constraints on deep networks. An important application domain explored by Tilburg University researchers concerns the segmentation and analysis of 2D/3D time-lapse biomedical videos and images using deep learning architectures. The insightful information that is extracted from these models serves as input for medical experts, for example, to detect tiny bone fractures in radiography images or to identify cell changes for early cancer detection. Traditional and advanced machine learning techniques, such as convolutional neural networks, have been used to assess effects of different medical treatments, e.g., techniques to treat chronic stress and psychopathologies such as obsessive-compulsive disorder. Considerable effort is devoted to the development and testing of algorithms that provide both a high performance score and interpretability, for example, by building classifiers able to explain their decision process rather than black-box solutions.

Autonomous Agents & Robotics involves both the study of human and artificial minds and their interaction in virtual, mixed, and augmented reality as well as the development of autonomous agents. This research line focuses on building and studying interfaces that are non-invasive, ethical, and engaging, for example, by employing intelligent interactive agents in mixed reality environments, robots that interact socially to support learning, and sensor-based interfaces between brains and computers. The use of robots and agents in our daily lives requires that they have the ability to automatically sense and interpret human social behavior such as gestures, facial expressions, and prosodic qualities of speech. At the same time, the use of VR agents in lab settings allows for the detection of other neurocognitive and behavioral markers including EEG, eye tracking, heart rate variability, and skin conductance change that allow for the development of rich user models to improve human-AI interaction and potentially support other goals including learning and collaboration.

Planning and Search/Decision Making examines reasoning in real-world environments that are characterized by high levels of uncertainty. Passively logged human data are modeled using AI and computational cognitive models and are used to extend existing theoretical accounts of behavior. The computational techniques employed include pattern recognition, anomaly detection, network analysis, classification, prediction, and recommendation. The resulting models provide insights into learning, memory, individual preferences, as well as collective behavior. For example, information collected from wearable sensors can be used to create models of human socio-spatial networks providing explanations for information transfer and collective decision making. A particularly challenging task lies in understanding collaborative problem solving in work domains that require fast decisions for complex problems, such as aviation and healthcare.

Computer Vision attempts to apply existing algorithms and to develop new approaches to automatic visual understanding of the world, traditionally building on knowledge of human visual perception. Making sense of visual data is achieved by deep learning architecture with applications in image classification and video recognition. For instance, deep learning algorithms are developed to estimate body shape characteristics from images or videos. Computer vision solutions are integrated

with natural language processing for the purposes of automated image and video description.

Data Engineering and Analytics involves the study of methods and techniques developed to extract relevant information from complex unstructured or semi-structured data sets. These techniques include data mining, machine learning, text mining, network analysis approaches, and visual analytics to provide insights to stakeholders. An active area of interest in this research line concerns temporal analysis methods for time-series data. A recent application area for this theme involves analysis of data that are collected to monitor relevant environmental features represented in the soundscape, such as animal vocalizations, for research lines focusing on sustainable and healthy living communities.

A unifying factor in the projects conducted by Tilburg University AI researchers is the focus on the creation of computational models that are fair and human centric. Rather than perpetuating biases often present in real world datasets due to social prejudices, they strive to develop and apply solutions and algorithms that produce unbiased output and are interpretable for the human user.

5 Ethical, Legal, and Societal Aspects (ELSA)

One of the key tenets of AI at Tilburg University is that AI is always part of a socio-technical context and that this context matters. AI may be developing fast; it does not do that in splendid isolation. Throughout its lifecycle, from the moment data is collected and models are developed until AI is widely used in everyday life, AI remains an integral part of a socio-technological context. This environment is not a passive recipient of AI, slavishly molding itself to what AI needs to function properly.

On the contrary, machine learning experts, data scientists, citizens, companies, NGOs, and public actors, all in their own roles and capacities, influence the way in which AI takes shape; whether it is used and how it is used. Also, AI developments do not evolve in a regulatory void. Legal, economic, and social agreements create a normative, societal action space in which AI is welcomed (or not). Many existing laws and regulations touch upon AI, not by mentioning it per se, but simply because regulation often aims to be technology neutral and the AI artifacts enter the scope of existing norms. Even the bare, physical environment—in which AI ultimately must find its place—takes up a crucial role, as our eco-system both enables and limits what AI can and should do.

While AI takes shape in interaction with this socio-technical environment, it simultaneously also transforms it; for the good and the bad. The disruptive power of AI changes the way we work, care, conduct research, and organize society, challenging many of the key values and frameworks that underpin the socio-technical context. AI, therefore, requires us to rethink aims and means of understanding and regulating human behavior and that of the tools and techniques used.

In recent years, we have witnessed how AI can bring about unwanted consequences, e.g., opaque and unexplainable decision making, manipulation, discrimination, challenging solidarity, and privacy intrusions. Considering AI's promises and perils, we are required to rigorously reimagine what it means to be human and what it means to live in a democratic society. How can we ensure that AI is grounded in shared values and fundamental rights?

At Tilburg University, this crucial branch of AI research in the domain of the social sciences and humanities is brought together under the header of ELSA: Ethical, Legal, and Societal Aspects of AI. As a university founded on humanistic values, we build on decades of experience in society-driven research, enabling us to critically assess the complex interplay of AI and society and provide fruitful avenues to developing human-centric AI.

HUMAN-CENTRIC AI

Human-centric AI is high on both the research and political agenda in the Netherlands as well as in Europe. The basic idea underpinning human-centric AI is that AI should be used "in the service of humanity and the common good, with the goal of improving human welfare and freedom." AI should not be seen as a substitute for humans but as a strategy to effectively assist and augment humans. Human-centric AI, therefore, puts the interaction between humans and AI firmly into the spotlight. At Tilburg University, we engage with human-centric AI at three levels: the individual, organizational, and societal level. This means that we not only investigate what is needed for a fruitful interaction between people and AI in a specific user context but also how AI can be properly embedded in organizational processes and how, at the national and international level, structures (legal and otherwise) need to be interpreted, adapted, and developed to ensure that effective checks and balances are set in place to introduce AI applications worth wanting.

To develop human-centric AI that is ethical, sustainable, and respects fundamental rights and values, three key themes are distinguished: explainable, fair, and trustworthy AI. At Tilburg University, these themes are explicitly identified as multidisciplinary themes. We are committed to bringing together our technical, legal, ethical, and societal expertise to gain a rich understanding of these themes.

EXPLAINABLE AI

Transparency, understood as making the operation and outcome of AI models and applications accessible, is an important prerequisite to counteract bias and discrimination through AI. Developing technical instruments for post-hoc explanations or deploying glassbox ML models are just two of the many strategies that have been created in the technological domain to deal with these problems.

Through our ELSA lens, we investigate how these instruments are deployed. Do experts blindly rely on these instruments? Can they critically assess and correct them? How do these interventions impact the decision-making process? Acquiring this knowledge is of utmost importance for successful adoption of these crucial tools.

Another fundamental question concerning explainable AI is what we mean by a meaningful explanation. Which requirements need to be set in terms of content and procedure to ensure that an explanation effectively leads to understanding? Here, the socio-technical context comes into play again. At Tilburg University, for instance, we are investigating, in the context of healthcare, which levels of explainability in ML algorithms are needed to ensure a trusting doctor-patient relationship.

Whereas, for AI experts, explainable AI is important to develop robust systems, on the work floor, employees engaging with AI applications will have completely different demands. They want to know how they should interpret the outcomes of the AI application and how responsibility and accountability for decisions is organized. Such questions involve legal scholars (liability law, labor law), ethicists, social scientists (organizational sociology and psychology), and public administration (policies).

From an ethical point of view, explanations are needed to ensure that people can develop some form of meaningful autonomy in a data-driven society that respects their human dignity. This is particularly of interest in the health domain where AI applications are increasingly used in diagnosis and treatment and where patients are in a vulnerable and dependent position. But, also in the judiciary, where AI expert systems are introduced to assist judges and clerks, explanations are a *sine qua non* for a responsible uptake.

From a data protection perspective, explanations are required to ensure that data subjects can exercise control over what happens with their personal data and, simultaneously, hold companies and public actors accountable for their decisions. For regulatory bodies, explainable AI is key to developing meaningful oversight and auditable AI systems.

The deep-felt need to “open up the black box” is also intrinsically intertwined with fundamental questions in the domain of intellectual property law: If and how can you “own” a deep learning model and to what extent are you obliged to share information on that model? At Tilburg University, we are well equipped to tackle these questions from a multidisciplinary perspective.

FAIR AI

From facial recognition systems that are biased against black persons to fraud detection systems that predominantly target people with a lower socio-economic background: increasingly, incidents lay bare the discriminatory impact AI can have. Stopping AI-induced unfair treatment by developing “discrimination-aware data mining” or “fairness-aware machine learning” is, therefore, high on the agenda of the ML community. At Tilburg University, we investigate if and how it is possible to translate legal principles into non-discrimination constraints, which could become part of the actual design of algorithms.

We understand that fairness covers a variety of ideas and definitions, such as, equity, impartiality, egalitarianism, non-discrimination, and justice to name just a few. Building on our work in

political philosophy and ethics, we are developing a rich understanding of what fairness entails, not merely focusing on the outcomes of data-driven decisions, providing equal treatment between individuals or between groups of individuals, and at the same time addressing questions concerning procedural fairness. Specific attention is paid to *data justice:* how to ensure that people are "made visible, represented, and treated as a result of their production of digital data" in a fair way.

We combine this stance of theoretical and conceptual research with hands-on, bottom-up approaches, e.g., citizen-science projects, ethnographic research, and collaborations with public and private stakeholders. By replenishing our theoretical knowledge with on-the-ground insights and experiences of communities affected by AI applications, we get a nuanced understanding of how AI takes shape in practice and to what extent fairness formalizations hold up in real life.

Fairness objectives are also central to the design of an inclusive digital market; where different legal regimes like competition, data protection, and consumer law are becoming increasingly interconnected. Due to new data analytics technologies, companies can manipulate consumers by exploiting their biases and vulnerabilities, or they can engage in unfair competition by homogenizing and personalizing prices. Our legal researchers work on regulatory mechanisms such as licensing regimes, competition remedies, data-sharing obligations, property rights, and community engagement to operationalize fairness in the market context. Specific attention is paid to platformization, the arrival of new gatekeepers, commodification, and the autonomy of both individuals and businesses in the market.

TRUSTWORTHY AI

Trust is a crucial building block for a flourishing democratic society. Citizens must be confident that their fundamental rights are protected, their interests are represented, and their freedoms are respected. Since AI is increasingly shaping that society, it is no surprise that building trust in the development, deployment, and use of AI and data-driven applications has become a focal point of AI policies. However, as individuals might trust certain technologies that should not be trusted, it is of utmost importance that AI is also worthy of that trust. To what extent are people, for instance, willing to engage in self-disclosure when interacting with chatbots? The benefits of AI can only be reaped if risks are addressed simultaneously.

A first and fundamental question that we address in our philosophical and ethics research is: what are we actually talking about when we talk about trustworthiness? Which conditions need to be met to speak of genuine, trustworthy, and responsible AI? Although trustworthy AI has been widely embraced as an important prerequisite for AI developments, what it means to be trustworthy (as a technology and as an actor employing that technology) remains rather vague. At Tilburg University, we believe that we can only engage in state-of-the art AI research if we are clear about the meaning and reach of the concepts that we adopt. Therefore, we invest in a firm conceptual basis for our ELSA AI research.

Trustworthy AI is intrinsically intertwined with reliability and safety. After all, AI can only take the interests of citizens truly at heart if it does not cause harm or act in undesirable ways. However, the growing autonomous and complex behavior of AI applications challenges our ability to maintain meaningful oversight and control. For instance, our philosophers explore how the use of AI tools in the military context interact with responsibility and accountability as these tools increasingly act independently. Also, the growing complexity of AI-driven supply chains leads to the need for more and new forms of accountability and cooperation between economic actors. In addition, the growing distance between the decisions made by AI developers and how these outcomes impact real life challenges our ideas of responsibility in a moral, social, and legal sense.

Broader governance issues regarding AI systems are part of Tilburg University's ELSA AI research as well, for instance, involving governance structures, the

allocation of responsibility, liability, and duty of care in the AI context. Practical examples include what the role of Institutional Review Boards or shareholder engagement could be to ensure that companies use AI in a trustworthy manner.

Specific attention is also paid to corporate social responsibility, the moral competences of data scientists and ML experts to develop trustworthy AI, public-private partnerships in the domain of cybersecurity, and the role of public actors in safeguarding rule of law principles (e.g., in the domain of taxation and law enforcement).

Do we need AI specific regulation to ensure trustworthy AI? This question has tentatively been answered now that the European Commission has launched its proposal for an AI Act in April 2021, regulating the whole sphere of high-risk AI systems. Is this the right approach? Are the proposed distinctions and regulatory and enforcement mechanisms adequate, effective, and efficient? Do they (unnecessarily) hamper innovation? What do measures such as these mean for practice? Questions such as these form part and parcel of the ELSA research within Tilburg University, where not only regulation but also its impact in different contexts, from self-driving cars to new data intermediaries, healthcare robots, and chatbots, is considered.

6 AI Application Spaces

Tilburg University's education and research have a strong connection with and focus on society. The possibilities, potential, effects, and impact, among others, of new innovations and technologies is a key aspect of doing socially relevant research at Tilburg University. AI is increasingly intersecting with various aspects of our society in an increasing range of fields and application domains. Vice versa, an increasing number of fields, domains, and sectors are looking to artificial intelligence to further advance their performance and open up new possibilities. These not only include the valorization of knowledge to explore new avenues of innovation, develop business models, and improve the performance of organizations but also provide insights and solutions to strengthen our society against threats, boost the resilience of our communities, and support the development of an equal and inclusive society. In short, the advancement of the AI field brings about new possibilities to advance society.

However, to successfully leverage this potential, manage the associated risks, and bring about societal chance, having knowledge about AI is a necessary but insufficient condition. The analogy can be made with a carpenter's toolbox. When a painting needs to be hung, there are various tools available in the carpenter's toolbox to achieve the task, ranging from hammers to drills and from nails to anchors. However, it depends on the size and weight of the painting, the wall on which the painting needs to be hung, the quality of the work needed, and the skills of the carpenter to decide which tools are best suited for the job. Similarly, the "AI toolbox" is ever expanding as more possibilities and tools get added. Nevertheless, the impact depends on the ability to use the right tool for the right job. This requires not only knowledge of what is available in the toolbox but also an understanding of the situation in which an AI solution would be applied.

The various AI technologies and their implementations provide a set of diverse and versatile tools that can be used in a wide range of challenges. Nevertheless, it requires knowledge about the situation and the context to provide a "best fit." If we want to tap into the potential of AI to move society forward, we need to combine and connect the AI specific knowledge with the specific requirements, needs, and challenges of various application domains. Tilburg University, with is broad societal interest, its academic profile, and longstanding research focus on the intersection of technologies and society, is perfectly positioned to research, facilitate, and develop this "fit." Therefore, the intersection of AI development and our society in the broadest sense is a key focus at Tilburg University and closely aligned with its overall research and educational agenda. In fact, programs such as Mindlabs (education) and We Care and Tranzo (healthcare) have shown how Tilburg University is already exploring these domain-specific connections with success.

A TAXONOMY OF APPLICATION DOMAINS

To further support these developments, the AI application spaces provide a common frame of reference both for researchers, staff, and students within the university and for external partners of the university, serving to bring people with shared interests together as well as identifying potential areas for development. These spaces are based on the classification structure of the AI Sectors introduced by The Dutch AI Coalition[2]. These application spaces have been adopted to the various fields of study, interests, and expertise of Tilburg University stated in the table below. In the appendix, a more extensive overview of this mapping can be found.

[2] Toepassingsgebieden Nederlandse AI Coalitie https: //nlaic.com/toepassingsgebied/https://nlaic.com/toepassingsgebied/

Application space	Description
Agriculture and Nutrition	Artificial intelligence has an impact on the Agro Food sector in how agriculture is executed as well as on the consumption of food. Digitalization of the production, trade, and consumption of food offers opportunities to use AI for more efficient and sustainable food systems.
Built Environment	The design, construction, and engineering sectors contribute considerably to solving major social problems. This includes realizing affordable housing; the construction of sustainable buildings; contributing to the energy transition; water safety in the Netherlands; and realizing the infrastructure for self-propelled cars and super-fast trains
Culture & Media	For a structural and efficient application, more demand-driven AI research is needed. Within the Culture and Media sector, content is produced for a variety of groups and distributed through a variety of channels such as television programs, exhibitions, debates, and concerts
Defense	The Dutch Ministry of Defense is keen to act on the following developments: decision support systems, data analysis, information-controlled action, predictive maintenance, and the improvement of sensors such as radar and sonar.
Education	Artificial intelligence will play an essential role in innovation of education, education logistics, and cooperation within and outside the education chain. AI can accelerate the current development of personalization of education by supporting students in their learning pathways.
Energy & Sustainability	The ambition is to use AI to achieve a reduction in energy use and to strengthen the energy infrastructure and transition to infrastructure projects with a favorable climate impact, thus benefiting the environment.
Financial Services	The financial services industry has gone through enormous developments often signaled by the increased use of (digital) technologies such as big data, APIs, cloud computing, and robotization. These developments—together with significant changes in regulation—have a substantial impact on the financial sector.
Healthcare	AI is changing the daily work of healthcare professionals and the way we manage the health of our citizens and care for patients. The pace of this change is accelerating. AI offers opportunities to improve the population's health and alleviate the ever-increasing pressure on the healthcare systems.
Mobility, Transport & Logistics	Mobility, Transport, and Logistics are prime drivers of the Dutch economy. There is a need to strengthen the Dutch competitive position and provide solutions to social issues such as employment, traffic safety, sustainability, congestion, comfort, and air quality and stimulate innovation in mobility developments.
Port & Maritime	The urgency for the Dutch port/maritime industry to remain at the forefront digitally is enormous. Opportunities for international cooperation are expected, and at the same time, there is fierce competition. Consequently, it is vital that the sector is autonomously able to apply state-of-the-art AI technology and further develop the necessary knowledge and skills in this field.
Public Services	Artificial intelligence offers many opportunities for optimizing public services. As more and more good quality data become available, the possibilities for governments to make use of this will increase in the coming period. These opportunities must be fully exploited, taking into account the risks and public values as well as fundamental rights.
Security, Peace & Justice	Safety in the Netherlands is under pressure, not only the physical safety of citizens and our infrastructure but also our digital safety. The threat from professional criminals is growing, and there are "state actors" who focus on digital economic and political espionage as well as digital sabotage. The deployment of AI offers excellent opportunities in a digitalizing era strengthening our security, in both the judicial and the defense chain.
Technical Industry	Dutch industry is in the midst of a digitalization transformation that offers many new opportunities, and AI plays a vital role—both in the field of applications and in business models. The technology industry as a whole must succeed in this transformation as technology is necessary to meet a number of the significant societal challenges we face now, such as energy, environment, climate, care, and safety.

CREATING CONNECTIONS

The initial exploration of the various application spaces shows the tremendous potential that AI and related applications have for our society but also illustrates the challenges ahead in successfully leveraging this potential to advance these sectors. At the same time, ongoing projects, research, and various initiatives at Tilburg University show that also within the university these domain-specific AI applications are already being explored.

Within and around the university there is a large potential to leverage academic knowledge in the field of the artificial intelligence. To build on this potential, these application areas need to be further developed and explored by creating meaningful connections within and around the university. TAISIG aims to establish these connections through three steps: (1) identifying the potential, (2) combining & gathering expertise, (3) advancing society.

IDENTIFYING POTENTIAL

There are various application areas, and within each of these spaces, there are multiple sub questions, challenges, and opportunities to be found. One approach is to look outward towards funding opportunities, developments in society, and questions arising in the various application domains. Tilburg University could adapt to external opportunities and, subsequently, mobilize and develop the necessary resources, knowledge, and capacities to connect to these opportunities. At the same time, there are various initiatives and research activities ongoing within the university. Therefore, a second, more introspective approach, can be followed as well, in which the *existing* Tilburg University capacities, research, and developments are the starting point.

A more outward looking approach will likely result in higher relevance, new opportunities, and stronger connections with the relevant challenges in the application areas but would require the mobilization of resources while building on the existing developments within the university provides a strong base and connection. Therefore, a combined approach is needed: finding both the relevant challenges and opportunities as they occur in the application spaces as well as identifying the ongoing work within the university in these application areas.

A first exercise of identifying the potential has been conducted during the TASISIG event on July 1, 2021. In this online event, we presented the participants with the above-mentioned application spaces and asked them to assess the opportunity (extrospective) as well as the relevance (introspective). See the inset below for more details. It is recommended that this would be a continuous and recurring exercise to ensure the (continuous) alignment between Tilburg University's expertise, profile, and focus and the development in the application domains, technical fields, and society in general.

COMBINING EXPERTISE

Applying and leveraging AI technology in specific application domains requires different expertise to be brought together. This pertains to both the expertise within the university and those outside. Building a successful collaboration with external stakeholders in the different application domains requires the combination of various AI knowledge areas, including those listed in the previous sections.

To bring together this different expertise, infrastructures and modalities are needed. These allow experts to connect, exchange ideas, articulate challenges, and mobilize additional resources. Tilburg University has successfully provided such modalities for a range of fields. Tranzo, the scientific center for care and well-being of Tilburg University's School of Social and Behavioral Sciences builds a bridge between science and practice[3]. MindLabs[4] provide a virtual and physical space where staff, students, and partners can meet to work on technologies, including AI, and their interaction with human behavior.

ADVANCING SOCIETY

At Tilburg University, there are several examples that have successfully used such infrastructures to make these connections and deliver projects that *advance society* with the use of AI and related technologies. Here, we mention the following two impactful examples from the large set of possible

[3] https://www.tilburguniversity.edu/research/institutes-and-research-groups/tranzo

[4] https://www.mind-labs.eu/

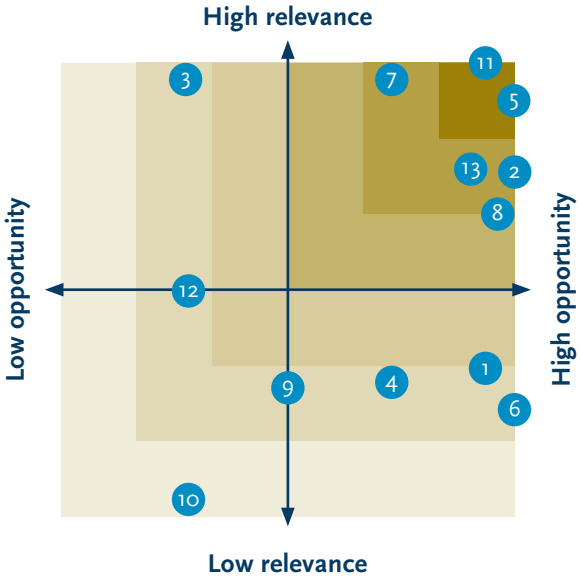
alternatives. In the field of *healthcare,* for example, Dr. Elisabeth Huis in 't Veld of the Tilburg School of Humanities and Digital Sciences has developed a game app that, based on thermal images of the face, can predict whether somebody is about to faint[5]. In the application domain of *Culture & media,* Prof. Eric Postma at the Jheronimus Academy of Data Science in 's-Hertogenbosch has developed a Neural Network that attributes works of art to artists based on visual recognition[6].

Tilburg University has a long track record of leveraging the potential of technologies for various societal challenges. Artificial intelligence represents and provides a new opportunity to address societal challenges on a scale that has rarely been seen before. Various initiatives in and around Tilburg University are already investigating this potential, including the dangers. To further enhance these efforts and expand in new areas, it is essential to bring together various expertise related to the technology in question, the ethical and legal considerations, and the domain specific knowledge. Much of this expertise and knowledge already exists or can be developed within the university community and its wider ecosystem and partnerships. To bring this knowledge together, the application domains play an important role. The introduced application domains can help to focus on the ongoing efforts and provide a central point of reference for researchers and students from across the university and external stakeholders.

EXERCISE: IDENTIFYING RELEVANCE & OPPORTUNITIES

On July 1, 2021, the Tilburg University AI Special Interest Group hosted a special event to present and discuss the advancement of AI interests at the university. Part of this program was an interactive session in which participants were asked to reflect on the various application spaces and their relationship with and potential for Tilburg University. For each application area, participants were asked to indicate (1) the *relevance*, i.e., how close the application domain is to Tilburg university's existing interest, expertise, and research, and (2) the *opportunity*: i.e., to what extend can Tilburg be involved.

In the online session, the 75 participants provided their input through an online survey, followed by a brief discussion about the outcomes and how to move forward. The input related to areas that are close to the ongoing initiatives within Tilburg University in the field of AI application domains, such as public services and education. Participants also indicated that that some areas are currently not sufficiently explored although they could have a higher



1. Agriculture and Nutrition
2. Built Environment
3. Culture and Media
4. Defense
5. Education
6. Energy and Sustainability
7. Financial Services
8. Healthcare
9. Mobilty, Transport and Logistics
10. Port and Martime
11. Public Services
12. Security, Peace and Justice
13. Technical Industry

5 https://www.tilburguniversity.edu/magazine/needle-fear

6 https://ericpostma.nl/publications/NoordHendriksPostma2015.pdf

potential (Port & Maritime for example) or areas that have a high potential but could be given more relevance (Healthcare, Technical industry).

Of course, these results are not representative for the entire university. Nevertheless, it shows how the application domains can be used to identify potential areas for development. The assessment itself can be conducted not only on a larger scale but also over time to see how the university is developing in various areas. In any case, an exercise like this supports the discussion on strategic areas for development and exploration for the university.

Appendix 1. Scientific Strengths

Strength	School	Department
Affective Computing	TSHD	CSAI
	TSHD	CC
Algorithms Versus Human Decision Making	TLS	TILT
AI for Gaming	TSHD	CSAI
Autonomous Agents	TSHD	CSAI
Brain and Bio-Signals	TSHD	CSAI
	TSB	CNP
Cognitive (Neuro-)Science	TSB	CNP
	TSHD	CSAI
	TSHD	CC
Computational Linguistics & Psycholinguistics	TSHD	CSAI
	TSHD	CC
Computer Vision	TSHD	CSAI
Cybersecurity	TLS	TILT
Data-Driven Markets	TiSEM	ECO
Data-engineering and Analytics	TiSEM	EOR
	TSHD	CSAI
Data Protection & Privacy	TLS	TILT
Decision Making	TiSEM	EOR
	TSHD	CSAI
Deep Learning	TSHD	CSAI
e-Health and e-coaching	TSB	TRANZO
	TSHD	CC
Explainable, Fair, and Trustworthy AI	TLS	TILT
	TSHD	CSAI
Face Analysis and Synthesis	TSHD	CSAI
Human - AI Interaction	TSHD	CSAI
	TSHD	CC
Intelligent Supply Chains	TiSEM	MGMT
Legal Analytics	TLS	TILT
Moral Improvement With AI	TLS	TILT
Regulation of Socio-Technical change	TLS	TILT
Robotics	TSHD	CSAI
“Smart” Surveillance	TLS	TILT
Statistical Analysis of Big Data & Streaming Data	TiSEM	MAR
	TSB	M&T
Vocal and Speech Analytics	TSHD	CSAI
Virtual, Augmented & Mixed Reality	TSHD	CSAI
	TSHD	CC
Wearable Devices: Data Collection & Data Analysis	TSB	TESC
	TSHD	CSAI

Appendix 2. Network Participation

NETWORKS

1	KION (*Kunstmatige Intelligentie Opleidingen Nederland*).	Emmanuel Keuleers, Henry Brighton
2	VSNU Knowledge Table AI	Emile Aarts, Boudewijn Haverkort
3	Brainport AI Hub	Boudewijn Haverkort
4	Netherlands AI Coalition (NL AIC)	Emile Aarts, Marie Postma
5	KPMG Lighthouse board of advisors.	Linnet Taylor
11	ICAI Labs	Eric Postma (JADS), Max Louwerse (MindLabs)
12	ELSA Labs (NL AIC)	Emile Aarts
13	VSNU Digital Society	Emile Aarts, Max Louwerse, Ton Wilthagen
15	Commit2Data	Boudewijn Haverkort
16	Dutch Research Council (NWO)	Emile Aarts
17	CLAIRE	Emile Aarts, Eric Postma, Pieter Spronck, Max Louwerse, Marie Postma
18	Big Data Value Association (BDVA)	Mirjam Siesling
23	European Association for AI	Eric Postma en Pieter Spronck
25	Benelux Association for AI (BNVKI)	Eric Postma en Pieter Spronck

Appendix 3. Project Overview (selection)

1.	Virtual Humans in the Brabant Economy (VIBE)	Max Louwerse (MindLabs)
2.	MasterMinds: Interactive Technologies and Human Behavior, ICAI Lab	Max Louwerse (MindLabs)
3.	'Schola Ludus': About the Use of Virtual Reality and AI for Education, NRO-NWO project	Marie Postma
4.	Digital Twins, TTW-project	Boudewijn Haverkort
5.	Better Informing Citizens About Current Debates: Moderating and Summarizing Online Discussions, with VU and KNAW Meertens, and DPG Media, NWO project	Emiel Krahmer
6.	Look Who's Talking: Towards Engaging Long-Term Interactions with Conversational Agents, with UvA, RU, Trimbos and SOA/Aids, NWO SGW project	Emiel Krahmer
7.	Producing Affective Language: Content Selection, Message Formulation and Computational Modeling, with TU Twente, NWO project	Emiel Krahmer
8.	Data-Driven Shared Decision Making on Cancer Treatment for Individual Patients, with TSB and IKNL, NWO-ENW project	Emiel Krahmer
9.	SignON: Sign Language Translation Mobile Application and Open Communications Framework, EU Horizon 2020 Research and Innovation Programme	Dimitar Shterionov
10.	CERTIF-AI: Using data generated by production equipment and machines to certify processes, improve product quality and diagnose problems. NWO project with TU/e and HU.	Eric Postma (JADS)
11.	KPN Responsible AI, ICAI Lab	Eric Postma (JADS)
12.	Global Data Justice, NWO project	Linnet Taylor
13.	Virtual and Augmented Reality project, with Fiona Macpherson and Neil McDonnell (University of Glasgow, Philosophy) and the Centre for the Study of Perceptual Experience (Glasgow), international collaboration project	Nathan Wildman
14.	Ontology of Artificial Agents, with Martin Vacek (Slovak Academy of Sciences, Philosophy), international collaboration project	Nathan Wildman
15.	"Blockchain in the network society: in search of transparency, trust and legitimacy", NWO-MVI project	Jurgen Goossens
16.	Algorithmic Rule- and Decision-Making by Governments, Including Self-learning, Data-Driven Algorithms using AI, with Jurgen de Poorter and Johan Wolswinkel	Jurgen Goossens
17.	Observing Team Dynamics and Communication Using Sensor-Based Social Analytics, NWO project	Travis Wilthsire
18.	Opening the Black Box of Deep Learning for Language, Speech and Music, NWO-ORC project with UvA.	Afra Alishahi, Grzegorz Chrupala

For recent projects of the Departments mentioned in Appendix 1, see also

School	Department	Hyperlink
TiSEM	ECO	Research at Tilburg School of Economics and Management | Tilburg University
	EOR	Research at Tilburg School of Economics and Management | Tilburg University
	MAR	Tilburg Science Hub
	MGM	Department of Management | Tilburg University
TLS	TILT	Research TILT | Tilburg University
TSB	CNP	Research Department of Cognitive Neuropsychology | Tilburg University
	M&S	Research Program Department Methodology and Statistics | Tilburg University
	TESC	TESC - Tilburg Experience Sampling Center
	TRANZO	Tranzo | Tilburg University
TSHD	CC	Research laboratories Communication and Cognition | Tilburg University
	CSAI	Current projects | Tilburg University

Appendix 4. Strategic Stakeholders

INSTITUTES AND CENTERS

DAF Technology Lab
The DAF Technology Lab provides high-tech facilities for students, researchers, and the business community. The combination of technology and behavioral sciences expertise offers unique possibilities for innovative education and research. The DAF Technology Lab consists of two spaces: the Experience Room and the Research Room.

MindLabs
MindLabs is a partnership in which four knowledge institutions, governments and a growing group of business partners, social institutions, and startups participate. Together, MindLabs partners strengthen the development of technologies that interact with human behavior; in other words, human-centered AI. With the unique possibilities of these technologies, partners want to help solve societal challenges.

Jheronimous Academy of Data Science (JADS)
JADS is a unique collaboration between the Province of North Brabant, the Municipality of 's-Hertogenbosch, Tilburg University, and the Eindhoven University of Technology. We offer data science Bachelor's and graduate programs, PDEng education, and incorporate our knowledge into existing ecosystems. At JADS, researchers and students work closely with the business community. In addition to education and research, JADS also offers space for innovative, data-driven entrepreneurship and public-private partnerships.

CentERData
Centerdata is an independent non-profit research institute, located on the campus of Tilburg University (TiU). Answering research questions in the area of people and society has been its mission since 1997. It collects, analyzes, and disseminates reliable data for the academic community and the government and private sector to support and contribute to scientific, social, and policy-relevant research. It also develops models and draws up forecasts for a better future.

Tilburg Institute for Law, Technology and Society
TILT is one of the leading research groups in Europe at the intersection of law, technology, and society. It is premised on the multidisciplinary study of socio-technical change, aiming at understanding the interaction of technology and social and normative practices in order to clarify how regulatory challenges of socio-technical change can be addressed.

ECOSYSTEMS

Brainport AI Hub
In the ecosystem around Eindhoven, Helmond, Den Bosch, Tilburg and Breda, the AI-hub Brainport was launched. The AI-hub Brainport brings together regional businesses, educational and knowledge institutions, and public organizations in Brabant to strengthen activities in artificial intelligence (AI) by connecting them better.

High Tech Campus Eindhoven
High Tech Campus Eindhoven is a hub of technological development with more than 165 companies and technical institutes conducting joint research. The research is divided into five clusters: Nano- and Microsystems, Life Tech, Infotainment, Embedded Software, and High-Tech Systems.

Netherlands AI Coalition
The Netherlands AI Coalition (NL AIC) has been set up to substantiate and stimulate AI activities in the Netherlands. The NL AIC is a public-private partnership in which the government, the business sector, educational and research institutions, as well as civil society organizations collaborate to accelerate and connect AI developments and initiatives. The ambition is to position the Netherlands at the forefront of knowledge and application of AI for prosperity and well-being. We are continually doing so with due observance of both the Dutch and European standards and values. The NL AIC functions as the catalyst for AI applications in our country.

ICAI

ICAI, the Innovation Center for Artificial Intelligence, is a national network aimed at technology and talent development between knowledge institutes, industry, and government in the area of artificial intelligence. Tilburg University researchers lead two ICAI Labs: the KPN Responsible AI Lab in Den Bosch (JADS) and the MasterMinds ICAI Lab in Tilburg (MindLabs).