



**CEE AI**  
Dresden

**Center for Explainable  
and Efficient AI Technologies**



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**CEE AI**  
Dresden

### CEE AI

The CEE AI center is an alliance of high-performance organizations in the Dresden region and reflects the goals of the Artificial Intelligence Strategy of the Federal Government and the European Union. The participating partners would like to lay the foundation to bundle the forces for funding measures and large-scale projects in the Dresden region.

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## Greeting



### Rector of Technische Universität Dresden

The digital transfer is often described as the most comprehensive innovation since electrification. Artificial Intelligence (AI) is seen as the next level to meet the greatest challenges of our time. In the future, AI will permeate all areas of our lives and influence how we produce, work, consume and, of course, research.

Since the underlying challenges for AI range across several scientific areas, TU Dresden and Fraunhofer Society – have teamed up in a unique center, in order to bundle their expertise in a unified way and thus exploit the concentrated potential of scientists and practitioners.

The Center for Explainable and Efficient AI Technologies (CEE AI) already bears its vision in its name. When people recognize the methods and above all the advantages of Artificial Intelligence, for example in the interaction between human and machine, prejudices can be eliminated and acceptance in society can be improved. A well-known fact is that optimizing energy efficiency in conjunction with ever-increasing amounts of data is of great importance. With the unique regional advantages of the strongest microelectronics location in Europe, an excellent university and strong industrial applications, however, one can draw on the full potential of the DRESDEN-concept.

I wish the CEE AI much success and good luck!

Prof. Dr.-Ing. habil. DEng/Auckland  
Hans Müller-Steinhagen  
Rector of Technische Universität Dresden



### President of Fraunhofer-Gesellschaft

Artificial Intelligence, cognitive systems, learning machines – these powerful factors are currently transforming business and society. They offer vast potential; potential that could solve mankind current and future challenges. We can feel the impact of AI technologies on our everyday lives; we can see how it is shaping business and organizations. AI touches on many topics and fields of research. If we want to make the most of its potential, we will have to bring together research expertise and application skills in these diverse fields. This is why we opted to pool the skill-sets of TU Dresden and Fraunhofer-Gesellschaft in the CEE AI, the new AI center.

In this center, we are focusing on two main topics. The first is explainable – which helps us to convey a better understanding of AI by explaining how and why AI-based systems arrive at the decisions they make. The other focal point is enhancing these systems' efficiency with energy-conserving, embedded AI and high-performance computing. We will put the Dresden region's assets and resources to good use – particularly those of TU Dresden and the Fraunhofer-Gesellschaft – to accomplish these aims. Fraunhofer IAIS has the brief to set up a new location at Dresden to research AI for human-machine interaction. The Fraunhofer IWU, IVI and EAS institutes will join in as application partners, putting down stakes at the center to facilitate knowledge transfer to the world outside.

The CEE AI center marks a major stride towards consolidating our strengths and establishing Dresden as yet another German region with a technology lead in Artificial Intelligence.

Prof. Reimund Neugebauer  
President of Fraunhofer-Gesellschaft

## OUR MOTIVATION

# Why did we start CEE AI?

The past years have shown that AI when used responsibly, can help to solve some of the world's biggest challenges. Its development affects all our lives and cuts across different organisations. Since the underlying challenges for AI range across several scientific areas, we can only exploit its full potential when we bring researchers and practitioners from different fields together. Within CEE AI, two large research organisations – TU Dresden and Fraunhofer Society – have teamed up to achieve this.

Moreover, Artificial Intelligence has become a major economic driver. By building a strong network around this topic, CEE AI will contribute to the training of AI experts and secure jobs in the region by rolling out efficient future-proof technologies for a wide range of use cases. This will allow Silicon Saxony to sharpen its competitive edge vis-à-vis other strong regions on a national, European and worldwide level. For this, we use the unique regional advantages of the strongest microelectronics location in Europe, an excellent university and strong industrial applications. Based on these foundations, we aim to build AI methods which are among the most efficient worldwide.

Another reason for starting CEE AI is the disruptive potential of Artificial Intelligence: While society can greatly benefit from it, it needs to be used responsibly. Within CEE AI, we believe that explainable AI (XAI) is a major requirement for achieving this. XAI allows humans to understand what AI methods are doing, why AI recommends particular decisions and how to safeguard it against malicious attacks. Again, TU Dresden and Fraunhofer together can combine the expertise to jointly develop these methods.

Last but not least, on a global scale CEE AI will contribute to the digital sovereignty of Germany and Europe: Only those who control the AI infrastructure and data can influence the use of AI in society including data protection, moral/ethical concerns and security. However, most AI players reside outside of Europe, which poses a risk to these values. Within CEE AI, we can build the entire AI technology stack from chip fabrication, 5G communication, algorithms and transfer into applications. If successful, CEE AI can build sovereign, independent AI platforms and services.

**"Artificial Intelligence if used responsibly can help to solve mankind greatest problems."**

OUR MISSION

# What is CEE AI doing?

CEE AI supports the following types of actions:



- Collaborative projects following the DRESDEN-concept vision, in particular among TU Dresden and Fraunhofer by an:
  - Increased involvement in joint projects,
  - Bilateral excellence via scientific exchanges,
  - Joint transfer of research results into practical applications
- Improving AI education and increasing the sensitivity of AI topics in the society
- Attracting world-class talent in AI to Dresden
- Building bridges between related lighthouse activities of the region
- Connecting to AI and Big Data competence centers such as SCaDS and KI.NRW
- Exploitation of synergies with the platform "Lernende Systeme"
- Excellent scientific research spanning the whole spectrum from hardware support, device communication, AI approaches and transfer into practice – a particular focus will be on efficient (in terms of energy efficiency but also efficient human-robot co-working) and explainable (human understandable) AI
- Building networks of strong AI partners in the region for new projects



# Where do we want to be in 2030?

We pursue two main goals: Higher efficiency and better explainability of AI technologies.

## OUR VISION

### Efficiency

Current AI techniques suffer several bottlenecks in terms of efficiency:

- Hardware and software are decoupled rather than embedded
- Neural networks and other structures are very large and often need to capture all details rather than making use of background knowledge

*VISION: By the Year 2030, CEE AI aims to make several modern AI approaches up to 100 times more energy efficient, which will allow much wider adoption of AI techniques.*

### Explainability

Current AI techniques are often black boxes which makes them:

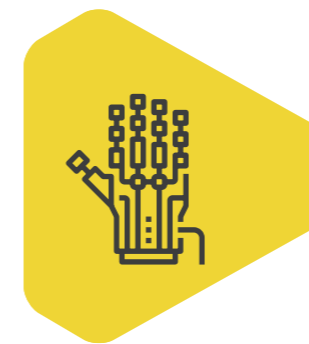
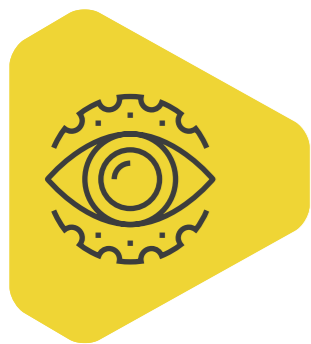
- hard to understand and improve
- vulnerable to maliciously attack

*VISION: We aim to make AI approaches more understandable and certified in order to improve their acceptance in society and reduce the risks when employing AI technology. By 2030, we aim to have AI approaches which outperform current state-of-the-art AI techniques across many application areas while providing the additional advantage of being explainable.*

# How will CEE AI work?

Built on the Strengths of the Dresden region

"If we want to make the most of AI, we will have to bring together research expertise and application skills in diverse fields."



## SUPPORTING AI LIGHTHOUSES

**Efficient:** embedded AI-chip co-design for very low power consumption  
**Scalable:** Big Data and high performance computing for AI algorithm

**Connected:** low latency, high resilience, secure 5G networking  
**Cooperative:** cyberphysical system infrastructures

**Partners:** Bosch, cfead, ZIH, ScaDS infrastructure, 5G Lab, CeTI

## AI APPROACH LIGHTHOUSES

**Explainable:** techniques that allow humans to understand AI solutions  
**Knowledge-driven:** efficient AI algorithms via usage of domain knowledge

**Certified:** incremental certification of AI algorithms  
**Groundbreaking:** efficient next generation machine learning problem solvers

**Partners:** Fraunhofer IAIS, CS next Generation ML lab, ScaDS services

## AI APPLICATION LIGHTHOUSES

**Human-centric:** human-machine co-working and interaction  
**Flexible:** AI-driven individual manufacturing processes

**Mobile:** intelligent transport and infrastructure  
**Reliable:** reliable and safe electronics supporting humans and the economy

**Partners:** Fraunhofer IWU + IVI + EAS, CeTI, CPS

## AI FOR US

**Social:** comprehensible presentations of the value and risks of AI for society  
**Educated:** teaching AI concepts for a responsible and informed society

**Applied:** transfer of AI knowledge into practical advances for organisations  
**Excellent:** attracting world-class talent to our excellent research organisations

**Partners:** DRESDEN-concept, Smart System Hub, CS Faculty, Fraunhofer IWU + IAIS

# Supporting AI Lighthouses

CEE AI can build on strong existing facilities at the TU Dresden campus. Especially the activities in the fields of microelectronics, connectivity, Big Data and cyber-physical systems are assets which support the CEE AI from the beginning. CEE AI exploits the existing infrastructures given below:

## Efficient

Germany and Europe are very well positioned in industries which require embedded AI solutions that are efficient regarding energy and cost. However, today many AI systems are implemented on large hardware platforms, which consume too much power and are too costly for realizing them in markets. An example is autonomous driving, where some project that the energy consumption of the AI hardware could easily double the energy consumption of vehicles, questioning the whole idea of autonomous driving. Society requires to find solutions which unlock the full potential of AI by providing efficient solutions. Examples of markets which must be addressed imminently are manufacturing (Industrie 4.0), robotics, mobility, agriculture, construction, and health & care. To remain competitive, Germany and Europe must

quickly have access to efficient AI embedded system solutions. The idea is to use our strong experience in hardware/software codesign, customizing hardware to application domains. In addition, targeted algorithm design will enable an efficient implementation. Domain specific efficient solutions shall generate at least two orders of magnitude improvement in energy consumption as well as cost.

**"With the unique regional advantages of the strongest micro electronics location in Europe."**

## Scalable

Machine learning (ML) / AI methods are data-intensive applications and place a huge demand on computer systems. In order to improve validity or predictive quality of machine learning methods, the models require a sufficient large amount of data, the handling of which is still a challenge. Modern high performance computing (HPC) systems with powerful computer nodes, fast connectivity and memory components represent an ideal architecture for the execution of large-scale machine learning applications. In order to shorten development and analysis cycles by doing many analysis tasks in short time will improve the ML model, either its predictive or descriptive capabilities. This can only be done if ML applications can be efficiently executed in parallel in order to use a large number of computing elements in the data processing, but required to increase insights and explainability of ML algorithms. To improve the parallel execution of ML applications, i.e. to ensure a scaling behavior of the application and thus an efficient processing time, a good characterization of the requirements of the machine learning algorithm on the given computing infrastructure and its distributed execution is required. Furthermore, a strong reduction of the runtime of ML applications allows faster human interaction with the model outcome, thus leading to faster insights.

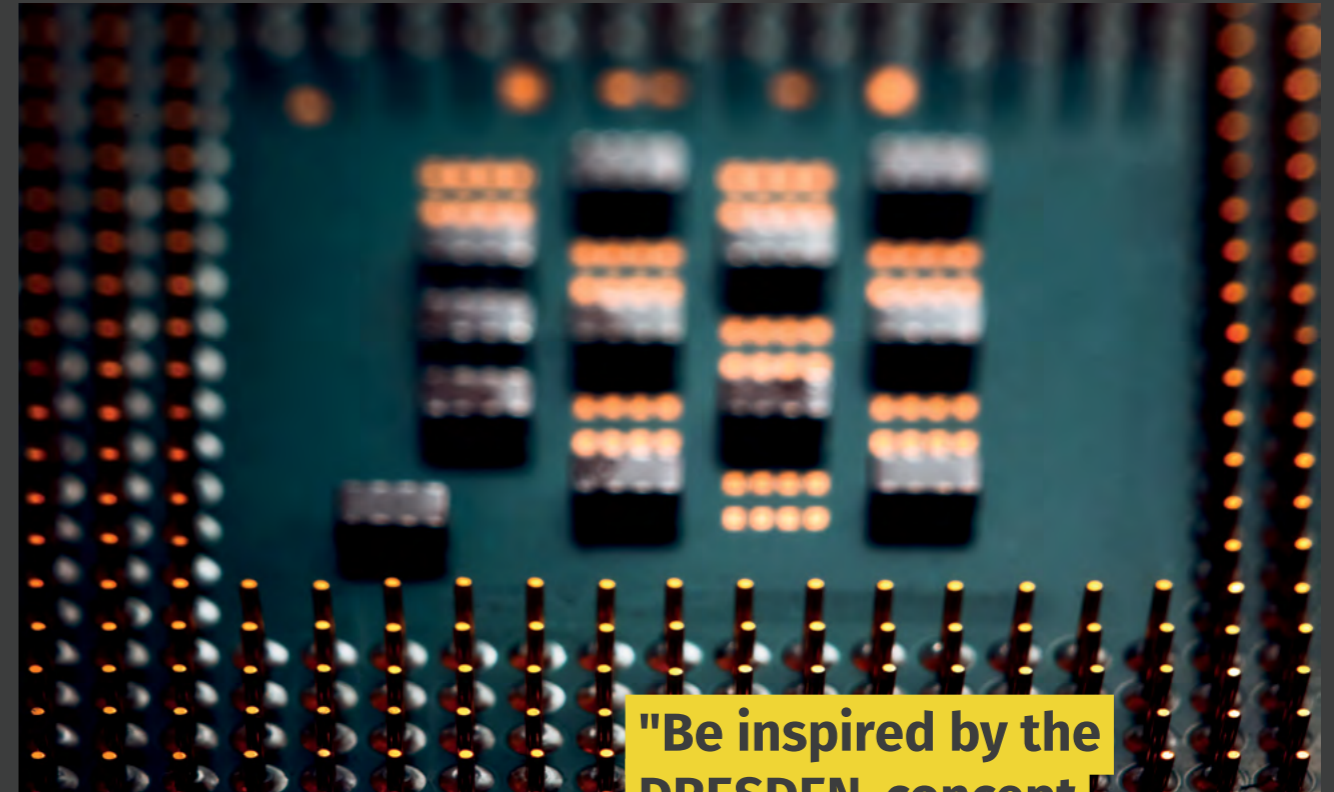
## Connected

CEE AI will benefit from TU Dresden's excellence in communication systems. With the 5G Lab Germany (5GLG), the world leading center for next generation mobile communication is based in Dresden. More than 20 professors with their teams and 18 industry partners are members of the 5GLG. Future mobile system will not only provide ultra-reliable and low-latency communication enabling novel applications fields, communication will not only convey bits, but also offer storage and computing at almost all communication nodes. Therefore, each communication node becomes candidate for efficient AI technologies. Future communication systems will not only benefit from AI technologies, but also support novel AI concepts due to the communication characteristics. With respect to the

first point, AI technologies are needed to adapt softwarized networks to perpetually changing optimization targets, such as optimal placement of mobile edge clouds or management of network slices. An example for the second point is the possible usage of patterns detected inside the network to allow for privacy-preserving learning, where higher-order features effectively anonymize the data, only returning the most effective features to base conclusions on. This complements transfer learning, leveraging high computational investments in the core cloud, e.g. on simulated data and fine-tuning on the unmasked data

## Cooperative

Over the last five years TU Dresden has become a world-wide visible hotspot for human-machine co-working in cyber-physical production systems, both in theory and applications with over 30 cooperating multidisciplinary teams. Excellent basic research on human cognition met excellent basic and applied research on digital transformation processes in agriculture, discrete manufacturing, process industries and robotics and led to exciting questions about how we want to work and live with smart machines in highly digitalized and networked eco systems. This long standing tradition of understanding automation and digitalization as a joint human-machine endeavor is the common DNA of highly innovative and world-wide visible research clusters such as CeTI, CD-CPPS, or Farm 4.0 that investigate essential questions on human-machine co-working and co-creation such as mutual trust, development and maintenance of competencies, detection and utilization of human states, or shared intentionality.



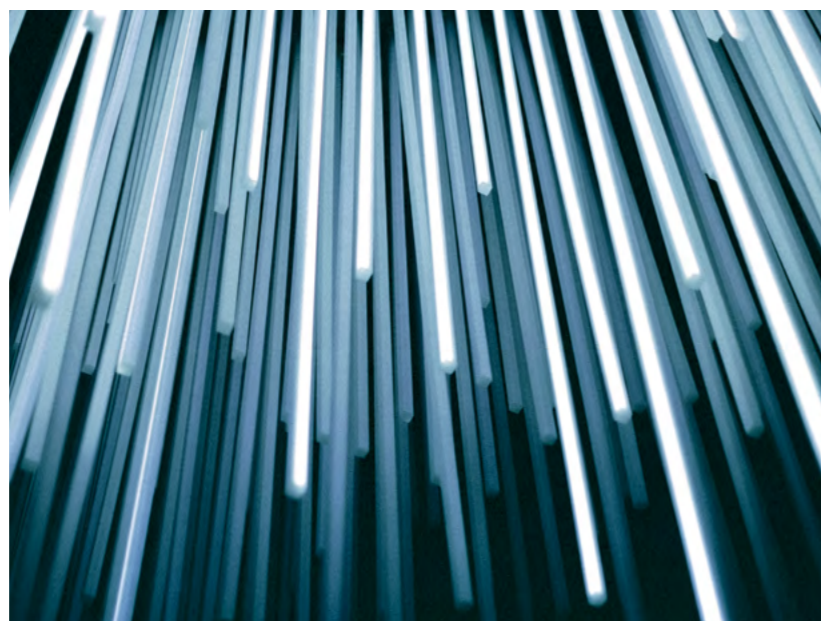
**"Be inspired by the DRESDEN-concept research alliance and draw from the vast potential of the Dresden science hub."**



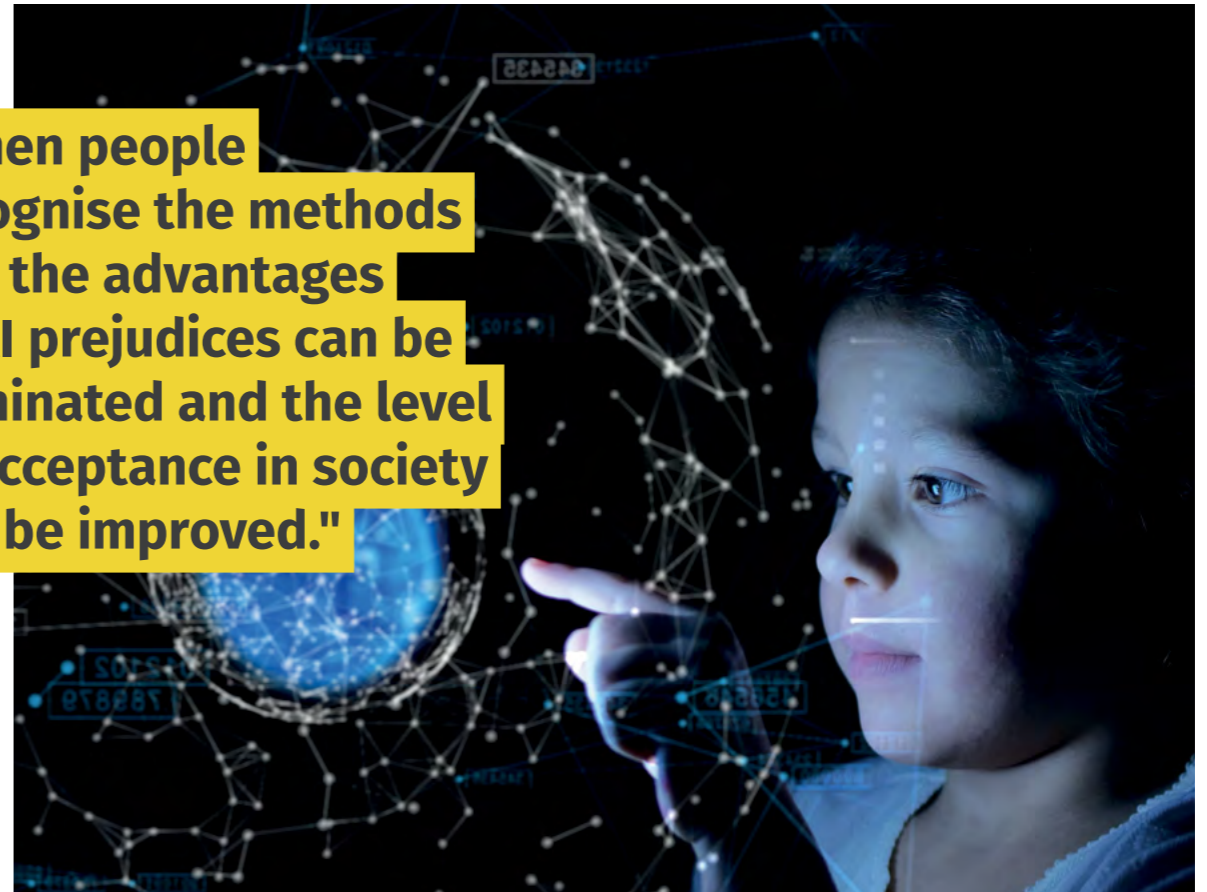


# AI Approaches Lighthouses

In CEE AI, we will draw on the expertise of the Next Generation Machine Learning Lab of TU Dresden and Fraunhofer IAIS as the leading Fraunhofer institute on Artificial Intelligence. We will devise algorithms that are explainable, i.e., allow humans to understand them, and embody algorithmic innovation. The algorithms will draw on the state-of-the-art computing and communication infrastructure of CEE AI. Examples of novel fundamental approaches include description logic classifiers, trace explanation for Petri nets, grammar and formula learning, robust and high-dimensional learning.



"When people recognise the methods and the advantages of AI prejudices can be eliminated and the level of acceptance in society can be improved."



## Explainable

Many AI approaches that became popular over the past years are "black boxes" – we do not understand why they take particular actions or make certain predictions. Within CEE AI, we aim to make AI more transparent and explainable. This serves many purposes: 1.) It makes it harder to trick AI systems into manipulated decisions. 2.) Understanding AI systems allows us to improve them. 3.) Regulatory and legal requirements can be satisfied, for example for certification. 4.) For many use cases, the insights we can obtain are more valuable than the predictions made by the AI itself. Within CEE AI, explainable AI (XAI) will benefit from symbolic

machine learning techniques and equation-based inference. Symbolic techniques output formulas (decision trees, description logics, differential equations, etc.), which experts can understand as interpretable "laws". Therefore, their inferences and conclusions can be used to generate explanations. For instance, traces of trained Petri nets can be memorized and visualized to understand and simulate the decision process. XAI has become one of the most important fields of AI and CEE AI is well positioned to further develop this field, e.g. via the expertise of TU Dresden's GRK "Quantitative Logics and Automata (QuantLA)".

**"We develop future-oriented technologies for broad fields of application and thus secure jobs."**



## Knowledge-driven

Intelligent systems such as the human brain can process both unstructured (text, images, videos, sensor data etc.) as well as structured knowledge (facts, rules, knowledge graphs etc.). Machine learning (ML), in particular deep learning, has its strengths primarily in the analysis of unstructured data, while the structured side remained rather simplified. For rich structured domains, despite some efforts, there have been few powerful and scalable ML algorithms so far. However, we believe that both levels of knowledge – structured and unstructured – need to interact in order to create intelligent systems that go beyond the current state of the art. Early research results by leading AI organizations, such as Deepmind, support this hypothesis. Moreover, this combination will facilitate the explainable AI approaches developed in the center. CEE AI is uniquely positioned to achieve this by having a) a rich background in knowledge representation and logics, b) scalable services developed within the ScaDS BMBF competence center and c) researchers who have started to develop modern AI architectures that incorporate structured knowledge.



## Certified

One of the grand challenges of AI in embedded computing is the incremental certification of AI algorithms. For certification, software processes, testing processes and explanation techniques have to generate an extensive documentation used by external agencies to judge on and certify the quality of a product. Explainability, the property of an AI algorithm output being human understandable, is a prerequisite for the certification of AI algorithms so that they can be used in cars, trains, airplanes, smart cities and other environments. However, certification is extremely expensive. Incremental certification of XAI, i.e., the certification of the changes in a development step of an AI-based product, would be desirable, but only few methods for incremental certifications are known. This implies that incremental certification of explainability procedures must be developed. Here, CEE AI faces one of its great challenges. Particularly challenging is that certification must cover transversal system properties such as data security, encryption, secure network coding, etc. However, here CEE AI has an important strength because its researchers can investigate many levels of the system stack holistically.

Paradigm-shifting progress in AI and ML is often brought about by new theoretical, algorithmic, or mathematical capabilities. Neural networks were made practical by the invention of the backpropagation algorithm, and statistical learning theory enabled optimal classification. The next revolution in AI is likely to again result from ground-breaking theoretical results. Here, Dresden offers a unique combination of world-class expertise, combining computational logic, knowledge representation, applied mathematics, and computational statistics all with an AI orientation. In CEE AI, we will research potentially ground-breaking theoretical and algorithmic advances, including high-dimensional nonlinear interpolation algorithms, formulating ML tasks as design-centering problems which needs much less training data, learning Petri nets, learning context-sensitive grammars, and inference on content-adaptive data representations, which will emerge in the coming years from our foundational research and hold promise for future innovation. We will also use the unique strength of the Dresden region within Europe for microelectronics and scalable computing in order to build efficient next-generation machine learning methods. This includes both distributed computing techniques in clusters as well as fog-computing-based machine learning that draws on energy-efficient embedded edge devices.



# Lighthouse AI Applications



**"In all developments we have to take the people with us."**

The Dresden region provides an ideal testbed for applied AI research. It is the city with most Fraunhofer institutes which provide applications for industry as a central part of their mission. Moreover, TU Dresden reaches out to other research organisations and industry via its DRESDEN-concept initiative and excellence clusters.

## Human-centric

CEE AI will benefit from TU Dresden's excellence in human-robotic interaction and co-working. To keep humans safe and sound in a robotic co-working space, it must trace human movements, guess their future behavior, adapt the robots' actions, and preplan the next steps of the collaboration. For tracing humans, innovative sensor technology is being developed in Dresden, e.g., body area networks aggregate positional data of humans reliably and efficiently (CeTI). For predicting human behavior, next-generation machine learning techniques such as learning with description logics (IAIS, NGML Lab) or hardware-based neural nets (NGML Lab) are being researched into. Furthermore, we research dialogue systems which allow voice interaction that can serve to steer or correct the behaviour of the robot. The decisive technology for adaptation

of robotic behavior is the Dresden "smart rooms" software technology for self-adaptive and context-sensitive cobotic cells (INF, Wandelbots). Finally, for preplanning collaboration steps, the CeTI cluster develops new techniques for human-robot synchronization, which mirror haptic feedback from robots to humans, and which let a robot feel resistance and guidance of humans. CeTI will enable new co-learning apps, in which robots teach haptic behaviors to humans, tele-operation apps, where humans work from remote via robots in dangerous situations, self-adaptive robotic manufacturing cells, in which robots re-plan their operations based on human actions, as well as manufacture-assistance cells, in which robots form intelligent assistants to human operations, such as surgery or watch manufacture.

## Flexible

Production is currently undergoing a change. Volatile demands on materials and products as well as the trend towards individualization require autonomous, flexible and product-adaptive production systems. Prospectively, they will comprise distributed embedded components, components with embedded Artificial Intelligence and a powerful but flexible network also on component level. Artificial Intelligence will be implemented both, on a local component and on a global level in terms of Connected Reality. Cognitive algorithms guarantee a fast and efficient plant startup and efficient reconfiguration strategies for collaborative production of multiple plants. Special attention must be paid to the interaction of autonomous systems due to cross-connected measures on component level and the arising possibility of instabilities and contrary adaptation. The structure and functionality of the implemented Artificial Intelligence takes this into account and spawns transdisciplinary research needs.

Through Open Innovation Fraunhofer IWU speeds up research processes by combining real production and applied research a Fab in Lab setup. Maker Hubs open the developed technology to highly innovative partners with unconventional production requirements and short development cycles. Digital Eco Systems provide AI-functionality on demand for distributed intelligent components and support Open Source approaches but also facilitate new business models. This is complemented by TU Dresden's Process-to-Order Lab that has been founded in 2018 to create an academic-industrial co-creation space that makes the process industries fit for higher variety and lower volumes; challenges that inevitably result from megatrends such as urbanization, globalization and individualization.

## Mobile

In the coming years, mobility will increasingly benefit from intelligent autonomous systems, such as connected and automated vehicles and connected intelligent traffic infrastructure. Artificial Intelligence will help to coordinate real-time cooperative driving maneuvers between vehicles in order to optimize traffic flows. The intelligent transport infrastructure will use new AI methods to optimize traffic at large scale in order to increase the capacity and accelerate traffic for reducing pollutant emissions.

The foundation of these applications is real-time data on traffic and traveler behavior from vehicles and infrastructure. The secure and sovereign provision and protected utilization of this data with AI methods in distributed Data Spaces will be a crucial success factor for tomorrow's mobility. Further AI applications will focus on the underlying digital and critical infrastructure with risk analysis and event monitoring as well as functional safety.

The mobility applications, supported with the CEE AI, will strongly benefit from the Digital Testbed Dresden for connected and automated urban driving, which is created under the initiative "Synchronous Mobility 2023", as well as two new chairs at the TU Dresden, faculty of electrical and computer engineering, for autonomous systems and cooperative systems, which will be shared with Fraunhofer IVI.



## Reliable

In the future, there will be a tremendous number of connected sensors, components for signal processing, decision making and control as well as drivers and actuators in all industrial sectors. Economic goods and human life will depend on reliable electronics and robust communication. From the application perspective functional safety, security, dependability etc. have to be ensured considering the failure of single components, dynamic changes in the system structure as well as disturbances from the environment. AI-based approaches for self-monitoring of components, adaptive resource allocation, intelligent application mapping and component migration will be necessary to deal with complexity, heterogeneity and dynamics of applications. The utilization of Artificial Intelligence will be supported in different ways. Hence, the integration of monitoring structures and machine learning algorithms

including AI-specific hardware accelerators will enable aforementioned functionality. In addition, new system design methods are necessary to develop efficient and reliable systems. This requires innovative verification approaches to ensure functional safety despite of the systems' inherent variability, e.g. by utilizing explainable AI-methods.

Applications within CEE AI will benefit from the research infrastructure provided by "Forschungsfabrik Mikroelektronik Deutschland", especially from the measurement and test environments for functional safety and semiconductor reliability, which are available at Fraunhofer IIS/EAS.



# AI for us Social

comprehensible presentations of the value and risks of AI for society

## Digital sovereignty

Both the Federal Government (AI Strategy of November 2018) and the European Commission (Communications "Artificial Intelligence for Europe" of 25 April 2018, "Coordinated Plan for Artificial Intelligence" of 7 December 2018) have set the goal of developing and building a trustworthy, human-oriented AI in Germany and Europe. Such a human-centered AI, which is committed to European ethical values (see now the "Draft Ethics Guidelines for Trustworthy AI" of the High-Level Expert Group on AI of 18 December 2018), is characterised in particular by the fact that it preserves and promotes the data sovereignty and data security of citizens. However, this goal of an "AI made in Europe" can only be achieved if state institutions and companies also have an independent and autonomous capacity to act in the digital space. This presupposes own capabilities with regard to digital key technologies, services and platforms. Dependencies on third parties can only be avoided by technological sovereignty with regard to essential hardware and software components and by competitiveness on a global level. What is also required is a well-functioning data ecosystem that enables the use of high-quality data while taking account of data protection ethical and legal requirements. In order to be able to develop and use an innovative, yet secure and trustworthy AI, it is therefore necessary to build up and further expand one's own digital infrastructure. This is the goal of CEE AI.

**"It's important to secure the digital independence of Germany and Europe by bundling competencies and promoting our own innovations."**

## Educated

TU Dresden is engaged in teaching AI concepts for a responsible and informed society. All Bachelor students in Computer Science take the course "Intelligent Systems" on the most interesting AI concepts. The International Master program "Computational Logic" offers a broad spectrum of AI courses in the symbolic and structured fields of AI, including cognitive reasoning, AI-related logics, and knowledge representation. The international Master program "Computational Modeling and Simulation" offers courses in Machine Learning and Data Mining, as well as distributed and high-performance computing and mathematical foundations of data science. It also includes specializations in visual computing (computer vision), computational mathematics, biomedical machine learning, and logic modeling (starting fall 2020). Our department is a world-wide leader in teaching knowledge representation by description logics, a basic technology for AI.

## Applied

The Fraunhofer model combines excellent research with practical applications and has been very successful over the past decades. The AI center combines Fraunhofer institutes, which provide highly relevant technology for the region, e.g. for manufacturing (Fraunhofer IWU) and mobility (Fraunhofer IVI). Moreover, the leading AI institute of Fraunhofer – Fraunhofer IAIS – with its new branch in Dresden is also a key player of CEE AI. Furthermore, The Smart Systems Hub fosters exciting start-ups, excellent research and innovative established companies, both metropolises are building on established structures.

## Excellent

Since 2012, TU Dresden has been one of eleven "Universities of Excellence". Its core elements are the Institutional Strategy "The Synergetic University" with the unique research alliance DRESDEN-concept, the Clusters of Excellence "Center for Tactile Internet with Human-in-the-Loop" (CeTI), "Center for Complexity and Topology in Quantum Matter" (ct.qmat) and "Centre for Physics of Life" (PoL), "Center for Advancing Electronics Dresden" (cfaed), Center for Regenerative Therapies Dresden (CRTD) as well as the Graduate School "Dresden International Graduate School for Biomedicine and Bioengineering" (DIGS-BB). TUD stands for values such as tolerance and cosmopolitanism and expresses these regularly, publicly and visibly.

# Partner Descriptions



## Faculty of Computer Science

TU Dresden has one of the largest departments of Computer Science in Germany. With 26 professors, it hosts 2000 students and educates 220 graduates per year, as well as 30 PhDs. The department earns more than 10M€ third-party funds per year, being the second-best grant-raising department in Germany. It takes part in three excellence clusters, two Collaborative Research Centers (SFB 356 and 248), as well as three PhD training groups (Graduiertenkolleg) and a Max-Planck IMPRS Graduate School.



## Faculty of Electrical and Computer Engineering

Tradition and innovation, successful education and research, distinguished scientists and highly motivated young researchers define the profile of the Faculty of Electrical and Computer Engineering at the TU Dresden. In teaching and research, the faculty covers the complete field of electrical engineering and information technology.



## Faculty of Mechanical Science and Engineering

The Faculty of Mechanical Science and Engineering has been at the core of the development of TU Dresden and it is today the largest faculty at this university.



## Center for the Physics of Life

PoL is a cluster of excellence of the TU Dresden. The central vision is to understand the physical principles and laws that underlie the dynamic organization of living matter across scales, from molecules to organs. This constitutes a formidable learning and inference task from very large data (petabytes at several GB/s). Therefore, an entire Research Avenue (RA5) of PoL is dedicated to AI and ML research for the biomedical sciences, including the development of self-learning autonomous microscopes, data-driven model inference, inference of mathematical equations and physical laws from biomedical image data, and ML-based computer vision for the life sciences, as well as immersive analytics of dynamic multidimensional datasets.



## Centre for Tactile Internet with Human-in-the-Loop

CeTI ([www.ceti.one](http://www.ceti.one)) is a cluster of excellence of the TU Dresden. The central vision is to enable people to interact in quasi-real time with cyberphysical systems (CPS) in the real or virtual world via intelligent wide area communication networks in order to enable people and machines to exchange skills and expertise globally.



## Center for Advancing Electronics Dresden

The Cluster "cfaed" addresses breakthroughs in advancing electronics in order to enable hitherto unforeseen innovations. The main research foci result from the Excellence Cluster phase 2012–2018 and the existing excellence here in Dresden. The Cluster aims at impacting the future of electronics by initiating revolutionary new applications such as electronics featuring zero-boot time, THz imaging, and complex biosignal processing.



## Process-to-Order Lab

TU Dresden's School of Engineering founded the Process-to-Order Lab in 2018 for the digital transformation of the process industries. The lab unites researchers from Mechanical Engineering, Electrical Engineering and Computer Science who contribute to this field of research from product to process design, from process simulation to process automation and from information modelling to integration. The lab's mission is to bridge the unconnected disciplinary digital technology lakes both in academia and industry.



## Next Generation ML Lab

The faculties of Computer Science and Electrical Engineering and Information Technology have agreed to found an interdisciplinary lab for next-generation machine learning in spring 2019. The lab will unite all researchers developing future machine learning techniques, as well as using machine learning techniques in application areas, such as computer vision or data science. The lab's particular mission is to develop generalized machine learning techniques such as model inference, symbolic learning techniques, distributed and hardware-based learning techniques.



## Center for Information Services and High Performance Computing

The research orientation of ZIH on parallel and data intensive computing is based on its powerful system for high performance computing and high-performance storage. Its focus is on the development of new methods and algorithms for solving the growing challenges of science and research. Moreover, ZIH covers important research challenges in data acquisition, management, and exploitation of large data sets for a broad spectrum of users.



## Scalable Data Services and Solutions

The BMBF-funded national competence center for Big Data ScaDS Dresden/Leipzig started its second funding phase in October 2018. ZIH, the faculty of Computer Science of the TUD, and Fraunhofer IVI are part of its expert team. The unique feature of the center is its integrated service center concept. As a central point of contact for interested parties, it pushes the development of Big Data applications and acts as a connecting element between the application areas and methodical Big Data research on a large scale.



## Fraunhofer IAIS

Fraunhofer Institute for Intelligent Analysis and Information Systems (IAIS) is the leading institute for AI within the Fraunhofer Society and one of Europe's leading applied research institutions. With the new office of Fraunhofer IAIS in Dresden, the institute expands their expertise to our region with a focus on conversational AI allowing humans to communicate efficiently with machines.



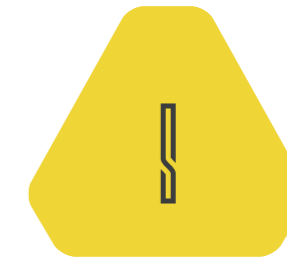
## Fraunhofer IWU

The Fraunhofer Institute for Machine Tools and Forming Technology IWU is an engine for innovations in the research and the leading institute for resource-efficient production. Around 600 employees at our locations in Chemnitz, Dresden and Zittau open up potentials for competitive manufacturing. Our scientific research and contract research focuses on components, processes and the associated complex machine systems – the entire factory.



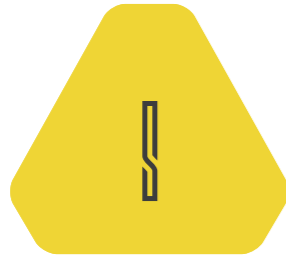
## Fraunhofer IVI

The Fraunhofer Institute for Transportation and Infrastructure Systems IVI employs over 120 researchers in three departments. The institute is operating in a wide array of transport-related research and development topics, ranging from the fields of connected and automated vehicles, intelligent transport systems, while also incorporating information and communication sectors. Many of these fields already use AI methods, such as machine learning and semantic technologies, in today's applications and are seeking to use more versatile and more efficient AI technologies in the future.



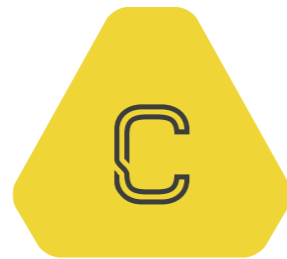
## Fraunhofer IIS/EAS

Fraunhofer Institute for Integrated Circuits (IIS) is one of the most important industrial applied research facilities for the development of microelectronic systems. More than 100 employees design reliable microchips and complex electronic systems in leading-edge semiconductor technologies and develop corresponding design methods in the Division Engineering of Adaptive Systems EAS in Dresden. Further research areas are the development of intelligent sensor systems, data analytics and new approaches for distributed control.



## Infineon

End of 2018, Infineon has opened a design center for AI-related chips and automotive electronics in Dresden. The center is headed by Dr. Uwe Gäbler, member of the network Silicon Saxony and initiator of several working groups for IoT applications. It shall grow up to 250 employees and engineers.



## RTG Conducive Design of Cyber-Physical Production Systems

The CD-CPPS focuses on the conducive design of the cooperation between human operators and technology in cyber-physical production systems. The core research question is how to achieve optimal performance of the entire socio-technical system via the combination of the unique potentials provided by humans and machines for co-working and co-creation.



## Center for Systems Biology Dresden

The Center for Systems Biology Dresden is a joint center between the Max Planck Society and TU Dresden. It researches theoretical and computational approaches to living systems with a methodological focus on theoretical modeling, deep learning, data-driven equation inference, smart microscopy, genome learning, and numerical computer simulations and high-performance computing.



## 5G Lab Germany

The 5G Lab Germany is a world leading research center focusing on the fifth generation of mobile communication system with more than 20 TU Dresden professors and around 20 industry partners. The focus is to carry out research on low latency, resilient, and secure communication to boost the digital transfer in Germany.



## Smart Systems Hub

The Smart Systems Hub is part of the national hub initiative of the Federal Ministry of Economics, de:hub. Dresden and Leipzig promote smart solutions and enable the Internet of Things. With exciting start-ups, excellent research and innovative established companies, both metropolises are building on established structures.



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