NorwAI

ANNUAL REPORT 2022

NORWEGIAN RESEARCH CENTER
FOR AI INNOVATION

Contents

Research and innovation activities are picking up speed

We have had another exciting year with increasing research and innovation activities in NorwAI. Important in 2022 was the increase of manpower that has enabled us to pursue additional research ideas and explore innovation opportunities with our partners. With the ongoing Master thesis projects, we are now approaching 121 AI graduates that have impressed us with their competence and creativity.

There are currently 24 hard-working PhD students at the center, and at least another 13 are gradually coming in. Four post docs, two new adjunct associate professors and three research assistants are also in place in a substantially strengthened organization. At the end of 2022 we started negotiations with additional industrial companies that are interested in joining the research center.

The merging of our Language and Personalization work packages in 2021 was successful. We have continued this streamlining in 2022 and have now replaced the work package on Streaming and sensor-based data and the work package on Data and platforms with a new work package on Data Platforms and Streaming Data. We believe that these changes will lead to more collaboration and knowledge sharing, while also simplifying organizational communication and reporting.

In 2022 we organized our first NorwAI forum in Trondheim. The intention of this event was to improve communication and knowledge sharing and help partners work together and explore common ideas. After each work package presented some ongoing work, there was a small workshop that let the participants go into interesting scientific discussions that spanned numerous work packages. Since the participants were so happy about the forum, we have decided to host a research-oriented forum in Trondheim and an innovation-oriented forum in Oslo each year from now on.

Another important milestone in 2022 was the first innovation workshop organized by the INNOECO work package for the activities in the Language and Personalization work package. Following the latest research on innovation processes, the workshop organizers managed to help the partners think about possible innovations in a very systematic and constructive way. A follow-up workshop has been welcomed by the participants, and we plan to run similar workshops also for the other work packages. The research in NorwAI is intended to support innovation and lead to real products and services among our partners.

Our PhD candidates are of course aware of that, though they also need to make sure that their research addresses relevant research challenges, constitutes a valuable contribution to the research community, and is publishable in high-quality journals and conferences. Hopefully, these INNOECO workshops will help us bridge the gap between research and innovation for the mutual benefit to both industrial partners and individual PhD projects.

Professor Jon Atle Gulla
NorwAI Center Director
Trondheim 2023 – 03 –13

Statnett is joining NorwAI

Beate Sander Krogstad
Executive Vice President Transformation & Digital
Statnett

The green transition poses new challenges for the energy system and Statnett as transmission system operator (TSO) in Norway. In the years ahead we will see fundamental changes with regard to how we source our energy, how much energy we consume, and requirements for us and other grid operators in how we balance supply and demand for electricity.

Our participation and collaboration with NorwAI will benefit Statnett on several areas. It will provide us the opportunity to work on concrete issues where Statnett might benefit from AI-supported solutions, says Beate Sander Krogstad, executive president Beate Sander Krogstad, Transformation and Digital at Statnett. It will help us enhance the quality of our data, in evaluations of analytical models and in identifying topics for further research. Cooperation through NorwAI will also increase know-how and understanding of artificial intelligence, both within our organization and for external parties.

We are now experiencing a change of pace in the transition towards zero emissions.

The last couple of years we have seen a massive increase in the number of grid applications, the majority of which are related to plans for green industrialization.

At the same time, European countries need to move from fossil energy to renewables to reach their climate targets, and the growth in the countries around us in new renewable energy production continues at an ever more rapid pace.

Intermittent
We need more production in Norway as well, and the government has ambitious targets for new offshore wind production. New renewable energy production, either from solar, wind or offshore wind has in common that they are intermittent. Electricity can only be generated when there is energy from wind or the sun available. To meet the challenges posed by the shift towards a more intermittent and fluctuating energy supply and increased demand for electricity, a better understanding of how the power system is affected is necessary to utilize and develop our grid capacity as efficiently as possible.

To achieve this, digitalization plays a key role. A solid digital fundament is vital if we are to solve the challenges of tomorrow in the energy system.

The major changes both the Norwegian and European energy system is facing will require new technology and digital solutions.

Security of supply must be maintained in a power system with more variations in power flows and reduced margins in system operations. Operations will gradually be more automated, and we need to improve the quality and understanding of the power system data.

Large Language Models
as public goods

Large Language models have huge potential for value creation – but there is a strong need to address issues of control and risk mitigation.

Eivind Throndsen
Academic liason/product manager
Schibsted Products & Technology

We are now moving towards a huge change in intellectual value creation, powered by the weird and surprisingly sophisticated mimicry of intelligence powered by large language models (LLMs).

These models have unleashed a wave of creativity. They, and their model cousins that can process, transform and generate sound, images and any digitizable data, have enabled previously impossible products and services along with a torrent of hype.

Due to the enormous amounts of data, compute and brain power required, these important platforms are now mostly developed and controlled by a few very large private technology companies in the US. This is problematic, because along with all the interesting new functionality, large language models also suffer from serious and complicated challenges such as bias, hallucinations and toxicity. Private companies will invariably balance mitigating these issues with the need for profit. They are likely to do the bare minimum required to avoid regulatory retribution and public relations backlash.

Closed to scrutiny

Most private company models are black boxes, closed to scrutiny from independent researchers - so research on explainability, bias and other issues happen from the outside. Ideally the models would be open and transparent, enabling society to evaluate them more thoroughly for ethics compliance, bias and explainability. Openness also makes fine-tuning existing models for specific purposes easier. Finally, openness will help advancing researchers working on developing smaller, faster, cheaper and more performant models.

Single point of failure

Concentrated ownership also means that we are faced with single points of failure, both politically and commercially. As we move towards an economy where people, services

and business processes increasingly depend on language models, this is a serious concern.

The Open-Source software movement has shown that it is possible to create large, enduring, open alternative platforms (e.g. Linux).

This in turn ensures resilience and choice, even if open alternatives at any given time may be less advanced than the commercial ones.

There is also the issue of cultural and national sovereignty. Most current language models are based on available data, mostly English, with other languages treated as an afterthought. Some models perform adequately on less resource-rich languages , but their performance in them is inferior to English and other major languages. GPT-4 has been tested for 26 out of the approximately 7000 languages in use in the world now. We don't know yet how much better language models specifically trained to accommodate smaller cultures and languages could perform. This should be investigated.

The case for European models

An additional argument for openly available language models in Europe is privacy compliance. Chatbots are already being used as personal assistants, receiving detailed, information-rich prompts from users. Large US-based commercial providers may wish to use these prompts and the data they contain for model re-training and finetuning. This may present European companies with unacceptable levels of privacy and GDPR risk. Open models, running in controlled environments, mitigate this risk.

Some people will argue that the computing resources and data demands for large language models is so high that it is virtually impossible to compete with the likes of Google, Microsoft, Apple and Facebook. While cost is indeed a significant factor, the collective behind the Stable Diffusion models and Stanford's Alpaca LLM have shown that it is possible to create and make accessible high-quality models outside the research labs of the tech giants.

Increased use

In Schibsted we are already heavy users of language models, and expect to increase the use in the future. Therefore we are following advancements in this space with great interest. We are seeing ongoing initiatives in Norway (NorwAI, UiO, the Norwegian National Library), AI Sweden, and the international HPLT project, aiming at creating Norwegian, Nordic and European alternative language models. Cooperation between industry and academia and across countries can enable meaningful, high-performance language models.

As of the moment of writing this article, we don't know what the future holds for these projects - but we are actively contributing where we can.

We are hoping for a future where a wide variety of responsible, open, and publicly available useful AI models exist, as an alternative to closed commercial ones.

People talk about language models
– at NorwAI we build them

Professor Jon Atle Gulla
Director NorwAI

NorwAI is currently pursuing a series of generative GPT models for Norwegian language. An initial model of 350 million parameters was completed and tested in 2020. Even though the model was not of a satisfactory quality for real-world applications, the interests from our partners were overwhelming both from a research and innovation perspective. A separate project, NorGLM, was formed at the end of 2022 to build and benchmark consecutively larger generative language models in close collaboration with industrial partners.

NorGenerative Language Model (NorGLM) is an internal NorwAI project that includes three postdocs, three research assistants, and two adjunct associate professors from NTNU, with active weekly contributions from Schibsted and DNB. Technical experts from the NTNU support organization are helping us out with the NTNU Idun supercomputer cluster.

On the basis of a 200 GB dataset, a 3 billion parameter GPT-2 model is already trained and made available from the project. A 23 billion parameter model and larger ones are in the pipeline and will be benchmarked with industrial data against OpenAI GPT-3 and Google PaLM on summarization and other NLP applications important to our partners. All the models will be accessible to our NorwAI consortium over an inference API, and we are also in the process of training an InstructGPT model that should further improve its responses to human requests.

To help an AI-driven future

Large language models are not only important to NorwAI, but also central to the whole transformation of industrial applications and practices into an AI-driven future.

We often call them foundation models, since they are pretrained on a broad set of unannotated data at scale and can be adapted to a wide range of downstream services. Important to the NorwAI consortium, the models provide improved language support in NLP applications, more natural access to digital services, and better platforms for real hybrid work between man and computer.

Language support

As indicated by numerous research experiments, large language models improve the accuracy of traditional NLP applications like sentiment analysis, parts-of-speech tagging, named entity recognition, and content classification. They also help people write correctly and convincingly, personalize services and add predictive input functionality to for example search systems.

Access to digital services

As part of larger solutions the language models lower the barriers to digital services and make these more available to non-tech savvy people. Dialog systems and question-answering systems are increasingly powered by large language models, as recently seen in ChatGPT and Bard. Existing services are enhanced with new language features, like for example the smart compose functionality of Google's Gmail service. We may assume that language models – in combination with speech technologies, robots, IoT and other technologies – will enable entire new services that may prove very useful to anything from educational institutions to welfare systems for elderly people.

Hybrid work

So far the language models have seen the most widespread uptake in the creative industries like journalism and graphic design. Even though the models do not always respond with reliable and verifiable answers, they are surprisingly helpful when used with care. They help us draft summaries for human inspection and modification afterward, and they can be asked to systemize and structure complex events or research issues. In a sense, they allow man and computer to work as a real team, in which they together bring up and validate ideas and arguments.

Language concerns

Even though the language models coming out of Silicon Valley show impressive linguistic capabilities and can handle a multitude of languages, there are concerns about their role as the single source of knowledge for smaller languages like Norwegian. The NorGLM project was initiated as some of the limitations of these models became apparent:

INTER-LANGUAGE BALANCE

Since language models like GPT-3/4 and PaLM draw on web-based content, large languages are better covered, and the models produce superior texts and more reliable factual content for languages that are in widespread use on the Internet. It is not so surprising that ChatGPT – when asked about the internationally rather unknown author of Vårsøg in Norwegian, English and German – came up with plausible descriptions of three different candidates that were all wrong. What is maybe more serious is the long-term effect on the use of low-resource languages like Norwegian if users realize that recommendations, text completion features or systems in general work better if they switch from Norwegian to English.

INTRA-LANGUAGE BALANCE

Available textual data on the web is not necessarily representative for all the nuances and topics of Norwegian texts. A better balance of textual data requires that other sources also be incorporated, like books and news stories behind paywalls. In NorwAI we believe that content owners and technology experts should work together to allow high-quality balanced data to feed into the training process and compensate the content creators for their valuable contribution.

ETHICAL STANDARDS

A story in Time on 18 January 2023 claims that OpenAI paid Kenyan workers less than 2 USD per hour to build an annotated dataset for removing toxic language from ChatGPT. A text completion experiment showed that GPT-3 had a clear gender bias when asked about the jobs of male and female staff at hospitals. Biases and stereotypes tend to be represented in large datasets and can easily lead to unfair representations of certain groups unless special precautions are taken. Language models will not be sustainable unless we approach both the building process and the dataset quality in a responsible way that reflect cultural and ethical standards in our own community.

DEMOCRATIZATION

From a democratic perspective it is problematic that smaller European languages are under-represented in the prevalently English-centric language models. It is currently also quite unlikely that companies like OpenAI and Google will make the models free and open for everyone to inspect and build upon for their own downstream applications. Moreover, the companies decide themselves which data is used for training, what values should be emphasized, and which biases and stereotypes should be addressed. Are Bøe Pedersen's article i Khrono on 21 January 2023 clearly shows how unexpressed American values underly ChatGPT's unwillingness to discuss certain satirical texts, and it is not hard to imagine situations in which these companies' content moderation strategies conflict with our own values.

Models in the long run?

It is, however, not given that separate Norwegian language models are desirable in the long run. We see already now in NorwAI that it is demanding to train and host sufficiently large foundation models. Highly specialized AI competence is needed, very large datasets must be collected and processed, and tremendous computing resources need to be at our disposal. Moreover, recent experiments indicate that there is a transfer effect between related languages that may suggest that we should rather go for common Nordic language models or maybe even common Germanic language models. We are in touch with AI Sweden about these ideas, and we are also part of a northern European consortium that is now preparing an EU proposal on language models for Germanic languages.

Important to NorwAI

Still, language models are here to stay, and we will use them for many different tasks in the future. Computing resources and competence are not only needed for training new models, but also for understanding the internal workings of these models, exploring their potential and limitations, as well as making use of them in industrial solutions.

It is also worth noting that home-grown language models are an industrial opportunity by itself and an instrument for establishing fruitful and mutually beneficial collaboration between Norwegian content owners and AI technology developers. Research on language models, thus, will continue to be an important part of NorwAI's NLP activities.

The Nordic Pile
Supporting GPT3-SWE by including the Nordic family

Francisca Hoyer, PhD
Strategic Program Manager
NLU AI Sweden

AI Sweden, together with RISE and WASP WARA Media & Language, is developing large-scale generative language models for the Nordic languages, primarily Swedish: GPT-SW3. Their vision is to provide GPT-SW3 as a foundational resource for Swedish (and Nordic) NLP that is useful across various domains and use cases, ranging from academic research to public and private sector applications.

Previous research has shown that foundational models need to be large in terms of the number of parameters in the model and the amount of training data. As the project's goal is a model that can be representative of the Swedish-speaking population, AI Sweden aims for a final model with more than 100 billion parameters (so far, they have trained several models up to 40 B).

A bottleneck?

In addition, their ambition is to use training data that, as closely as possible, reflects the dialects, sociolects, demography and interests of the Swedish citizens.

Training data, however, can be a bottleneck for training large language models for small and medium resource languages such as Swedish.

Swedish is a relatively small language with a limited number of speakers. This means there is limited amounts of text data available in Swedish, particularly regarding readily available large-scale datasets.

AI Sweden addressed this challenge by leveraging the fact that Swedish is part of a family of languages - the North Germanic language group that includes Norwegian, Danish, Icelandic and Faroese.

By including data sources in these languages (except for Faroese), AI Sweden compiled a dataset large enough for training multi-billion generative language models: The Nordic Pile.

The Nordic language family

The Nordic Pile amounts to approximately 1.3 TB of data in total. It consists of existing Swedish data sources such as OSCAR, MC4, and OPUS, data collected from repositories such as DiVA, FASS, the Swedish government's open data portal, 1177, Wikipedia, Litteraturbanken, as well as from websites of Swedish authorities and some of the most prominent Swedish discussion forums such as Flashback, Familjeliv, and Swedish discussions on Reddit.

In addition, AI Sweden included existing datasets in Norwegian, Danish and Icelandic. Examples are the respective parts of OSCAR, MC4, OPUS, Wikipedia, and Reddit data sources, the Norwegian Colossal Corpus, the Danish Gigaword Corpus, and the Icelandic Gigaword Corpus. The Nordic Pile also contains a sample of English data from The Pile and programming code collected from CodeParrot.

In addition to being sufficiently large for training multi-billion parameter language models, the Nordic Pile dataset contains a rich typological variety. AI Sweden hypothesizes this will be useful for the models' performance in all Nordic languages.

6 key questions on
Large Language Models

Andreas Hafver
Team leader emerging technologies,
DNV, WP leader TRUST, NorwAI

Krisztian Balog
Professor, University of Stavanger
WP leader LAP, NorwAI

Question 1

Andreas and Krisztian, you are both work package leaders at NorwAI, Trustworthy AI and Language Personalization respectively. In what way have your work been affected by the developments of Large Language Models? Why – if so – is LLMs important to the research in your WP? In what way will you work on relating questions in the coming year?

Krisztian

Large Language Models (LLMs) have revolutionized the field of language technology, no less,and therefore play a significant role in LAP.

First, the availability of pre-trained LLMs has significantly improved the accuracy and efficiency of various language processing tasks, such as text classification, sentiment analysis, and named entity recognition. We have been leveraging these pre-trained models by fine-tuning them on specific tasks and domains, including conversational information access, sentiment analysis, and summarization. These efforts will continue in the coming year.

Second, recent developments in LLMs have opened new research opportunities, including text generation and zero-shot learning. ChatGPT has certainly been a game changer in the field. It's ability to generate coherent and fluent text has pushed the boundaries of what is possible with language models. It is our goal to leverage this technology for specific tasks in a safe and responsible manner. LLMs tend to generate nonsensical or irrelevant text, which is often referred to as "hallucinations." These can be difficult to spot when the model appears confident and produces text that is otherwise fluent and sounds plausible. The risk of hallucinations can be reduced by providing models with more focused domain- and task-specific training data. A main challenge for the work package is to figure out how to perform training with humans in the loop in a way that multiple stakeholders can benefit from it, without the use of copyrighted or sensitive material.

Andreas

The vast media attention on large language models such as ChatGPT has put trustworthy AI on the agenda in recent months. The public reaction has been amazement mixed with fear over what LLMs are capable of. Companies and institutions are grappling with the implications LLM technology in their domains, hunting for opportunities while trying to navigate pitfalls. It is clearer than ever that trust in AI is a necessary condition for acceptance in society and scalability in business.

In the TRUST WP in NorwAI we are trying to understand the trust needs and trust gaps of different actors in society and business. LLMs are making an impact in all industries, and going forwards, we will explore different perspectives, concerns, and innovation potential of LLMs with the other NorwAI partners.

Question 2

Seeing the potential impact on LLM technologies what are your reflections on some challenges to match high standards in ethics and governance?

Andreas

One impact is that LLMs may challenge our ethical boundaries, in education, academia and industry. On the one hand people and businesses can use this technology to become more productive, but they may also use it to take shortcuts and potentially commit plagiarism or other misconduct.

Another main challenge with LLMs, as I see it, is whether we can trust the content they produce. These models are very good at articulating themselves and may seem convincing even when the statements they make are factually or logically wrong. Inadvertent errors are bad, but on top of that we may also see actors that try to exploit LLMs to manipulate people through fake news, fraud emails, and so on. In principle, a lot of this can be managed through establishing good procedures and governance mechanisms around the use of such technology. But in practice it will be difficult to control all actors, especially as more powerful and lightweight LLMs are continuously released to the public.

Education of the public is maybe the best defense to make people alert to the fact that text they encounter may be computer generated, and aware of the limitations of this technology.

Question 3

Enormous datasets come with a greater risk using toxic language and racial slurs, they also contain bias and can prolong old social norms. Is this a concern for you and how do we deal with it?

Krisztian

Yes, it's a concern, especially when using open LLMs for text generation. For Norwegian language models that are created within LAP, we have full control over the input data that is being used for model training. This remedies some of the risks. Also, not all uses involve end-to-end text generation. Retrieval-based techniques may be used to generate an intermediate answer, which can then be turned into a fluent natural text response using LLMs, thereby minimizing the risk of harmful content or hallucinations.

Andreas

The saying "garbage in means garbage out" is true for LLMs as for other kinds of models. Even humans perpetuate biases that exist in our environment, so it is not special for AI. One "advantage" in this regard is that an LLM (probably...) has neither inhibitions, nor incentives to hide its biases, so meaning that they can be detected. And there is a lot of research going into the direction of "de-biasing" AI models.

Question 4

LLMs consume enormous quantity of data and there is a risk of containing sensitive information. What are your reflections on data leaks and privacy concerns?

Andreas

People and businesses should always be careful with any data they submit to a service provider. The additional challenge with LLMs is that even if the service provider has no bad intent or interest in the sensitive data per se, a model that is continuously updated based on collected user data could reveal sensitive information in response to future queries.

Krisztian

If an LLM is exposed to sensitive or copyrighted content during the training process, then it cannot currently be guaranteed that the data will not surface. Even though post-filtering of model responses is a possibility, the ultimate solution to avoid sensitive data leakage is to ensure that the model is never exposed to such data.

Question 5

Use of data comes with a cost. Even if LLMs will replace processes and make efficiency savings, an increase in energy consumption is likely. What should be our concern?

Krisztian

Indeed, there is a trade-off to be balanced between enhancing the effectiveness or accuracy of a task/process and the increase in related costs that arise from using larger models. For example, if a 10-fold increase in model size yields a 1% relative improvement in some task-specific performance metric, then it needs to be evaluated whether that increase is worth the extra cost. Analogously, if a model can be distilled into a smaller model that is a tenth of the original model's size while performs only 1-2% worse, then using a distilled model might be a viable alternative. If there are appropriate benchmarks in place, these decisions can be made in a data-driven manner.

Andreas

Training LLMs requires a lot of resources. In addition, a significant energy consumption might be needed for handling large numbers of requests to the models. But it is not possible yet to conclude if LLMs will have a net positive or negative effect on global energy use. A traditional web search also consumes energy, and one could imagine one query to a LLM replacing 10 web searches. On the other hand, we don't know yet what the volume of queries to LLMs will be and how this technology will impact how we work and live and consume computing resources.

Question 6

There are also other concerns, but to finish in a more optimistic way – what makes you most excited about LLMs?

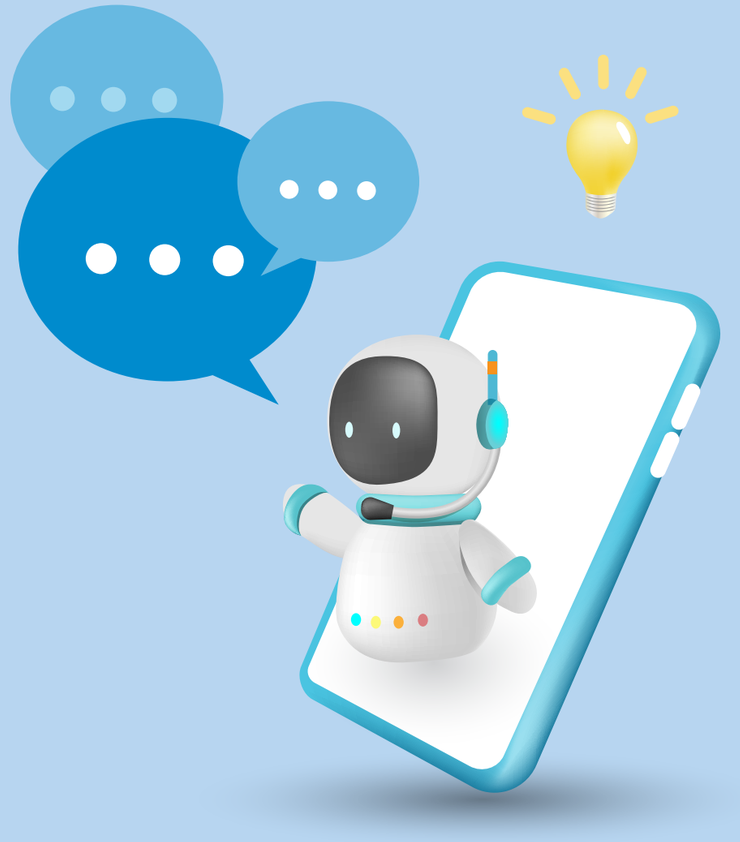
Andreas

LLMs can be a powerful tool to help us work more efficiently and creatively, if we are aware of the pitfalls and limitations. We cannot imagine all the uses it may have in the future. LLMs are clearly easing the communication between humans and computers by providing a new interface, and that will enable us to make more effective use of other technology. For example, one is able to ask a LLM more nuanced questions than one can do to a search engine or get answers to questions that would be difficult to query in a search engine. When people can interact more easily comfortably with technology in their natural language, that will ultimately improve trust. I think we just need to overcome some initial hurdles and gain more experience with generative AI and language models.

Krisztian

For a long time, we relied on machines to understand our preferences based on implicit signals, such as the content we interacted with (search queries, clicks, likes, etc.). With significant advances in natural language understanding, we can now state explicitly what we are looking for as well as what we are not interested in. Natural language is the most common form of communication. LLMs are making it increasingly feasible to use natural language as a means of interacting with machines for accessing information.

Thank you both!



In practice it will be difficult to control all actors, especially as more powerful and lightweight LLMs are continuously released to the public.

A POWERHOUSE

Some of the largest and technologically most ambitious companies and research institutes in Norway have joined the consortium.

Consortium

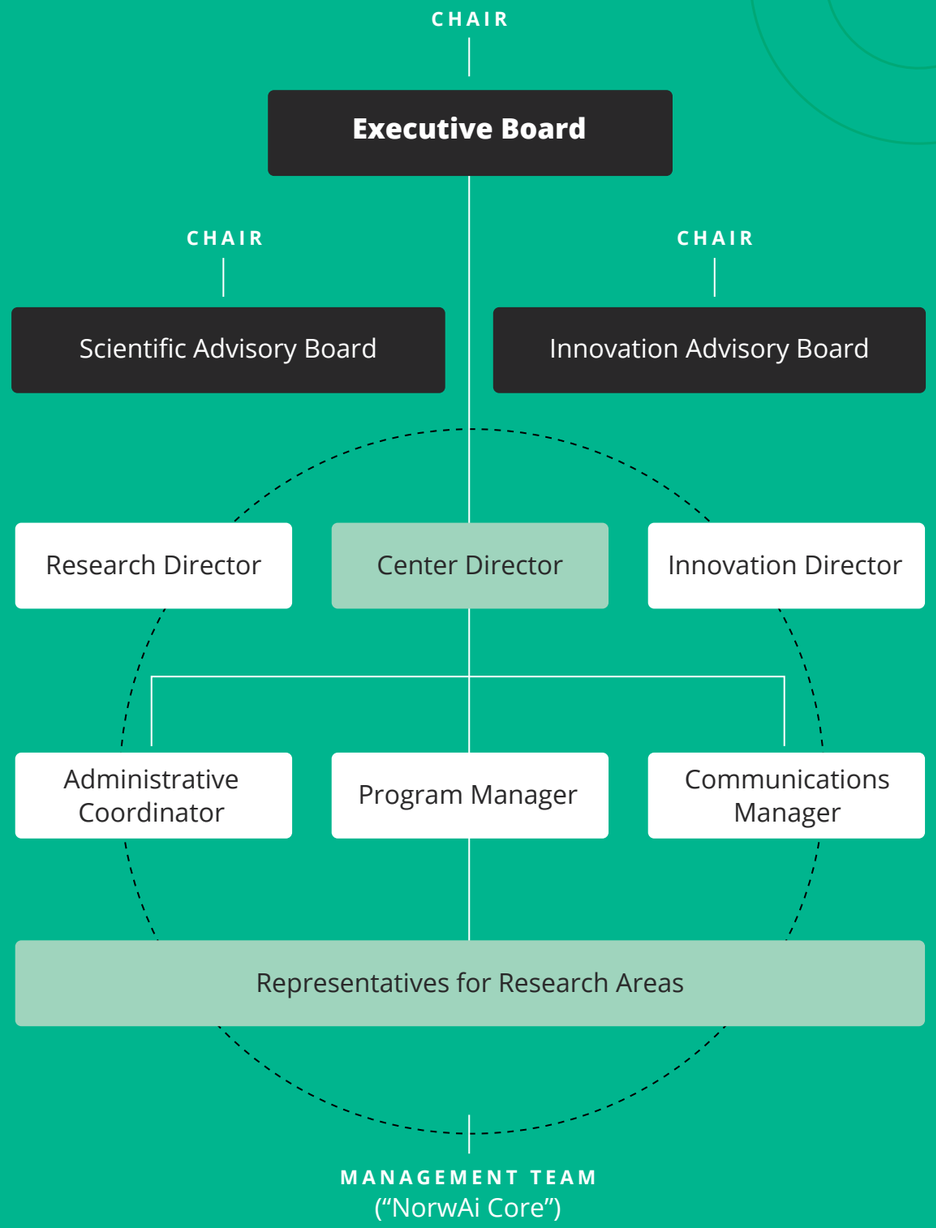
RESEARCH PARTNERS

NTNU, the Norwegian University of Science and Technology, Department of Computer Science is host for the center, the other research partners are Norwegian Computing Center (NR), SINTEF, University of Oslo and University of Stavanger.

INDUSTRIAL PARTNERS

The group of industrial partners in NorwAI consists of ANEO, Cognite, Digital Norway, DNB, DNV, Kongsberg Digital, NRK, Retriever Norway, Schibsted, SpareBank 1 SMN and Telenor.

Organization



Center management team

The Center Management Team is responsible for the day-to-day operation of the center and consists of:

Jon Atle Gulla
Professor, NTNU
Center Director

Kjetil Nørvåg
Professor, NTNU
Research Director

Arne Jørgen Berre
Chief Scientist, SINTEF
Innovation Director

Kerstin Bach
Professor, NTNU
Program Manager

Karolina Storesund
Senior Advisor, NTNU
Administrative Coordinator

Rolf Dyrnes Svendsen
Head of NxtMedia Lab
and affiliated to NTNU
Communications Manager

Helge Langseth
Professor, NTNU
Research Area Representative

Signe Riemer-Sørensen
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Frank Alexander Kraemer
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Professor, NTNU
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Terje Brasethvik
Adjunct Associate
Professor, NTNU
Research Area Representative

On Man & Machine
Reflections facing the GPT tsunami

Keith Downing
Professor
Department of Computer Science, NTNU

Despite the obvious temptation, when writing about ChatGPT, to let it compose an autobiography, I will go it alone. My writing is something that I take pride in, whereas my ability to navigate is not, so I'll let the GPS handle it. We all draw these lines between the personal and the outsourceable, but they are lines in the sand that technology's next wave threatens to obliterate; and ChatGPT looks to be a full-scale tsunami.

We (older) Artificial Intelligence (AI) researchers used to discuss the spectrum from data to information to full-fledged knowledge, with data being the raw signals, information arising when the data are compared to other data (recent and historical) and put into a statistical context, and knowledge resulting from connecting the new information to an agent's existing knowledge base, and thus, enhancing the intelligence of its behavior.

In its earlier days, the AI subfield of Machine Learning (ML) recognized this separation between data and knowledge; some ML systems began with significant knowledge and gradually integrated in more data, whereas others began with little more than an intelligence seed (in the form of programmer-determined biases to data processing) and generated all knowledge directly from the raw data. This latter approach, best exemplified by Deep Learning (DL), now dominates ML, which has become the golden child of AI.

True intelligence

Scientists in AI's sister field, Artificial Life (Alife), argue that true intelligence can only come from a deep understanding of reality via bonds between an agent's brain and body and the environment, bonds forged through a combination of evolution and learning by that brain-body in the world.

By many of these standards, then, DL systems lack intelligence but convincingly fake it with statistical information derived from enormous data troves. However, the world has never seen ChatGPT's level of deception, which lays waste to the Turing Test, and possibly to any of the philosophical debates about its true intelligence. Nobody really knows the limits of this approach. ChatGPT may just fake it 'til it makes it.

> *"The key to success is sincerity. Once you can fake that, you've got it made."*
>
> – *Woody Allen*

The black boxes

Unlike the older, knowledge-based systems, today's deep neural networks do not represent their knowledge in any human-interpretable form, just massive numeric matrices, thus justifying their characterization as black boxes. In addition, the large language models (LLMs) such as ChatGPT are privately owned by tech companies hoping to parlay them into fortunes, adding one more level of opacity: black boxes inside sealed vaults.

These multi-level mysteries will continue to have immense societal impacts, not least to the future of work. Now, I can draw as many lines in the sand as I want, but future employers will have their own boundaries, and my personal passions are little more than discarded clam shells on that beach. Whether it's soldering copper wires, driving cars, painting sunsets or writing tech reviews, we all have activities that provide significant meaning to our lives; and the lucky among us get paid for doing them. But across all sectors spreads a fear that luck could soon run out.

Disruption

Of course, these revolutions have occurred several times in the past two centuries, and society has responded by re-training humanity to perform new, and often more cognitively challenging tasks. However, spearheading this round of disruption is a technology that adapts very quickly, one that may become the eternal fast-learning young hire who threatens to shame the old pros into early retirement. Experience matters, you say? Yes, but we have never pitted experience against a newbie who has read and digested all the world's written documents.

As citizens, we must all push for more technological transparency. The repercussions of LLMs and other AI systems are too extreme and widespread, and opportunities for monopolization much too great in the digital world to allow "Open" AI Labs to remain sealed vaults. Governmental access and regulation seem necessary, just as it was to break the big US monopolies of the late 19th century.

As AI researchers, we will continue to scratch at the next layer of the enigma onion: discerning the knowledge buried deep within the matrices of DL nets. Still, that job only falls within the purview of a restricted group of AI researchers. All of us in the field can help by keeping humans (and their basic needs, passions and desires for self-fulfilling work) in the equation when designing silicon intelligences.

> *Our goals should be to enhance human experience and self-worth, not to reduce us to a global LLM maintenance team with a 10-hour work week.*

For decades, AI researchers here at NTNU and around the world were treated like snake-oil salesmen by many in the classic science and engineering disciplines. That changed when our AI toys (e.g., for playing chess) became tools and threats almost simultaneously. Our newfound legitimacy comes with the same societal responsibilities that other scientists have long accepted. We cannot outsource these to ChatGPT.

Bridging the gap between research and innovation

Two new adjunct associate professors are hired at NorwAI to mitigate the often too-long gap between research and industry. Jon Espen Ingvaldsen and Terje Brasethvik combine academic careers with long services as industrial consultants and other engagements. To NorwAI, recruiting competence at the highest level is vital when the task is to contribute to guiding Norway into the age of industrial use of new technologies.

At NorwAI, Jon Espen and Terje are set to assist the innovation ecosystem and the NorGLM language models currently built at the research center. They try to get competence and research prototypes from academia out to the companies and collect problems worth solving from the industry.

Goal: shape an arena where they all can collaborate on applied research tasks.

Research and innovation can be viewed as two sides of the same coin. Sometimes, however, there is too large a gap from the new knowledge and technical development brought forward by researchers to what can actually be applied and utilized by the industry in order to evolve their products or services. The main objective of the INNOwork packagekage is to create an ecosystem where researchers and partners can interact and form a foundation where innovation can happen, says Terje.

Jon Espen and Terje have experience from both environments and understand their differences, incentives and mindsets. This understanding is very useful in the work of building relations and collaboration between industry and academia. They both think it is rewarding to work within a research area with significant interest from the society around us.

At the start

Also, they like to collaborate and be involved in a team where they push the frontiers of technology with high impact.

We are just at the start of a larger technology wave of generative AI. This wave is changing most of the digital tools we interact with every day, and we are starting to see generative AI in everything from internet search, mail clients, MS Office, to photo and programming tools, says Jon Espen.

He says machine learning has traditionally been used to solve simpler tasks. With generative AI, the field of machine learning has taken a giant leap forward and machines can now perform tasks that have been done by knowledge workers and creative professions.

To give an example: one important reason for why we need generative AI models is our demographic development. We live in a time with an increasingly aging population and welfare costs. To keep up the living standards we have today, we need tools that can assist all professions and make us more productive, Jon Espen says.

There are two major challenges related to pushing the frontiers of large language models further. One is access to costly hardware and computing infrastructure. Another challenge is access to large volumes of data. Both large volumes of training data and contents written in Norwegian language are actually a limited data source. Another important data source is significant volumes of human feedback describing the quality of the generated output. This latter data source is important to optimize language models and make them behave more human-like.

NorwAI is hiring

NorwAI hires new personnel and its host institution, the Department of Computer Science at NTNU educates more students than the rest of Norway in computer science. Currently three adjunct associate professors works here (the third one in addition to Terje and Jon Espen is Boye Høverstad from Statnett).

NorwAI has three postdoctorals fellows and more to be hired. The number of PhD candidates were 22 by the end of 2022 and expects to educate 30-40 PhDs. 121 submitted or ongoing master students in AI are educated in AI out of a total of 500 master students.

Generative language models can be seen as simple mechanisms that basically are just designed to predict sequences of words. It is very impressive how word prediction mechanisms create output that is unique, of human-like quality and can solve problems that have not been addressed before, says Terje Brasethvik (right) and Jon Espen Ingvaldsen (left).

NorwAI Innovation Ecosystem

Building the foundations for future success

Nhien Nguyen
Associate professor,
Department of Industrial Economics and Technology Management (IØT)
NTNU

In 2023, NorwAI will accelerate development of our AI innovation ecosystem through an ambitious program of work. The most important task of the year is to create a common understanding of what AI innovation means at NorwAI and then build a shared vision for its development over the next 5 years. This vision will be the foundation for a strategic framework and guidelines for collaboration across work packages.

Another important task is to organize workshops to facilitate the innovation activities happening around NorwAI use cases. We are developing many exciting AI technologies at the centre, including the Norwegian language model NorGLM (Generative Language Model), which is poised to become a critical stepping-stone for developing innovation with our company partners.

We also plan to recruit two PhD candidates this year to research the topic of AI-driven business models, with the aim of contributing state-of-the-art knowledge on the strategic impact of AI on business model innovation. This work has important implications for both theory and practice in the center.

Extensive work in 2022

Our work plan follows the extensive work we did in 2022 when the innovation ecosystem was initiated. Internally, we organized brainstorming sessions between work package leaders in combination with other events taking place at NorwAI. We also kicked off a series of workshops bringing both academic and industry leaders together to explore the potential direction of innovation, developing use cases tailored to our latest AI technology development.

Externally, we participated in seminars, and held field trips with other innovation research centers in Norway, Scandinavia and internationally.

For example, we joined the workshop with the Kavli Institute to discuss healthy aging, visited AI Sweden to develop possible collaboration on the development of Scandinavian language models, and organized a meeting with Pfizer to explore joint work on digital healthcare and AI in labelling.

Unlocking innovation

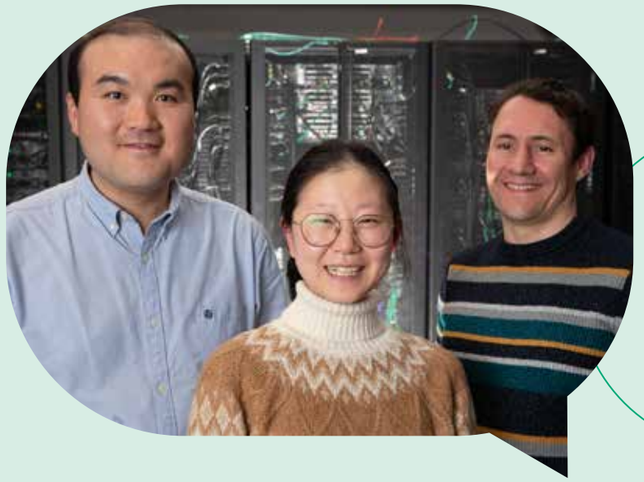
During the brainstorming sessions with NorwAI work package leaders, we shared lessons learned and agreed that innovation is a challenging task, especially in the rapidly changing field of AI. Trans-disciplinary collaboration is the key to success as we need to combine specialized knowledge and expertise from different domains to unlock innovation. This also ensures that we can exploit the synergies between work packages to avoid overlapping activities for company partners.

The most important take-away is that industry partners need to be involved at an early stage since they are the driving forces of innovation. To do so, we plan to organize more joint activities across work packages such as workshops, seminars, and brainstorming sessions to solve innovation challenges emerging from the use cases proposed by our company partners. We will also find ways to increase day-to-day interactions across work packages and partners, continuing to develop the common framework and guidelines at NorwAI so everyone can share a common understanding of the foundations needed to develop collaborative innovation.

A virtual cycle of collaboration

Our goal is to make NorwAI a best-in-class AI innovation ecosystem by becoming a platform for shared knowledge and expertise.

Based on this model, innovation activities will be facilitated around use cases of real value to industry and society, driven by a virtual cycle of collaboration across work packages and partners. NorwAI is also committed to spreading useful AI knowledge from both research and practice to a broader audience, particularly to small and medium sized business.



What is exciting, difficult, important on NorGLM

– and even worth telling your grandchildren?

Among the large group of staff responsible for the NorwAI GPT-project, three of our postdoctoral fellows play a key part in the team. Benjamin Kille is the project leader, Peng Liu is the technical leader and Lemei Zhang is responsible for the training program for the model. What are their feelings and visions on taking on this enterprise?

Q1 What is your responsibility in the NorwAI GPT-project?

BENJAMIN:
I am the project leader. I coordinate our activities and communicate with different stakeholders and partners.

PENG:
I am the technical leader in the NorwAI GPT-project. I am responsible for the development of the NorwAI GPT language model and working closely with the project team to ensure that the system meets the project objectives and requirements.

LEMEI:
I am responsible for NorwAI GPT model training and help to deal with technical problems. Also look into possible technical trend in Large-scale language model training and application.

Q2 What is the most exciting experience (in your work) for you?

PENG:
I am excited about working on such large-scale language models. In the beginning, we had no idea on how many resources we required to train such a big Norwegian language model from scratch. It is exciting to explore the uncertainty of each factor in the model training.

LEMEI:
We successfully trained a model and looked into its generalization results.

BENJAMIN:
I am excited when I discover new use cases that our work can help to address.

Q3 What is the most difficult question you have faced?

LEMEI:
How to deploy the model with large parameters on multi-nodes.

PENG:
The most difficult things are high-quality data collection and how to effectively utilize our current resources to train the language model with huge amounts of parameters.

BENJAMIN:
Is occupying all of Idun's A100 80GB GPUs for our project for several months morally justified?

Postdoc fellows

Lemei Zhang
Postdoc

Peng Liu
Postdoc

Benjamin Kille
Postdoc

Q4 Is there a moment in your work that you will remember, maybe worth telling your grandchildren?

PENG:
My most impressive moment is when the large-scale language model started to be trained successfully on our Idun clusters.

LEMEI:
Maybe after we have trained the large version of NorwGPT and get its summarization results.

BENJAMIN:
That moment might come in the future when we engage with the large model for the first time.

Q5 Why is your work important to you (and the wider society)?

LEMEI:
I am quite happy to be a part of the trend in this large-scale language model training and application in the real-life. We can see how ChatGPT and its variations have brough revolution to people and online environment, and I'm expecting to see what we can do from it.

BENJAMIN:
Curiosity drives science, and I want to learn more about using AI to improve society.

PENG:
We can contribute to a trustworthy low-resource Norwegian generative language model comparable to the English GPT-3. This model can be used as a basic tool to advance Norwegian language technologies.

Q6 Where do you see the future for GPT-applications for industry in Norway?

BENJAMIN:
I expect GPT-based applications to become a tools that we use in our workflow to solve problems and speed up processes.

LEMEI:
I believe GPT-based model can be used for many domains and application. Media companies, health-care, educational domain and even legal domain to name a few.

PENG:
Our NorGPT language models can be used in many applications, such as media companies, e-commerce, economics and healthcare. We provide new opportunities and novel methods to improve their products and services.

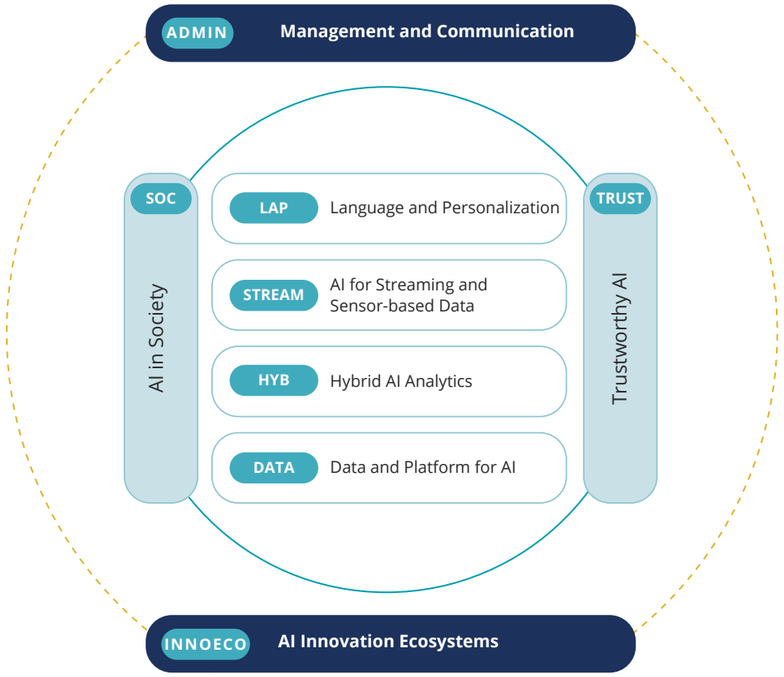
Q7 And what is your vision for GPT in daily life?

BENJAMIN:
In the future, we should control our machines by talking to them instead of using keyboards and mouses.

LEMEI:
It can be asked to summarize the recent news, to give inspiration on writing, to give suggestions on coding, to give recommendations, to chat in free form conversations, etc.

PENG:
GPT can be a useful assistant in our daily life. For example, we can ask it to recommend some interesting news or movies matching the customer's preference. Besides, the commonly used search engines can also benefit from the knowledge learned from such language models.

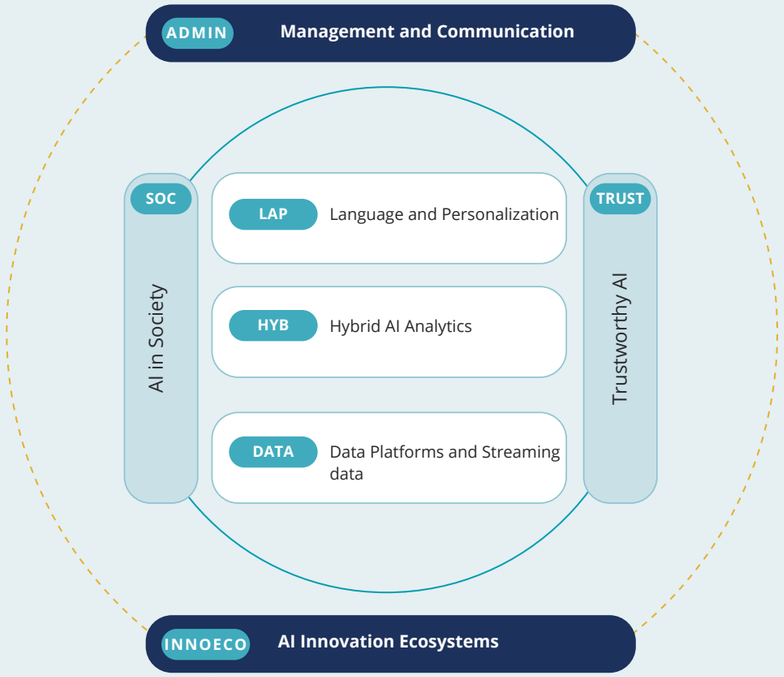
2022 (OLD) WORK PACKAGE STRUCTURE



We have geared up for innovation in 2022 with innovation workshops, increased partner interaction and we have brought in additional resources that have extensive experience with turning research into innovation.

From 2023 the work packages STREAM and DATA will be merged as it has become evident that significant synergies are to be gained by merging these work packages and will increase interaction and collaboration with each other. These organizational changes lead to a structure with seven work packages.

2023 (NEW) WORK PACKAGE STRUCTURE



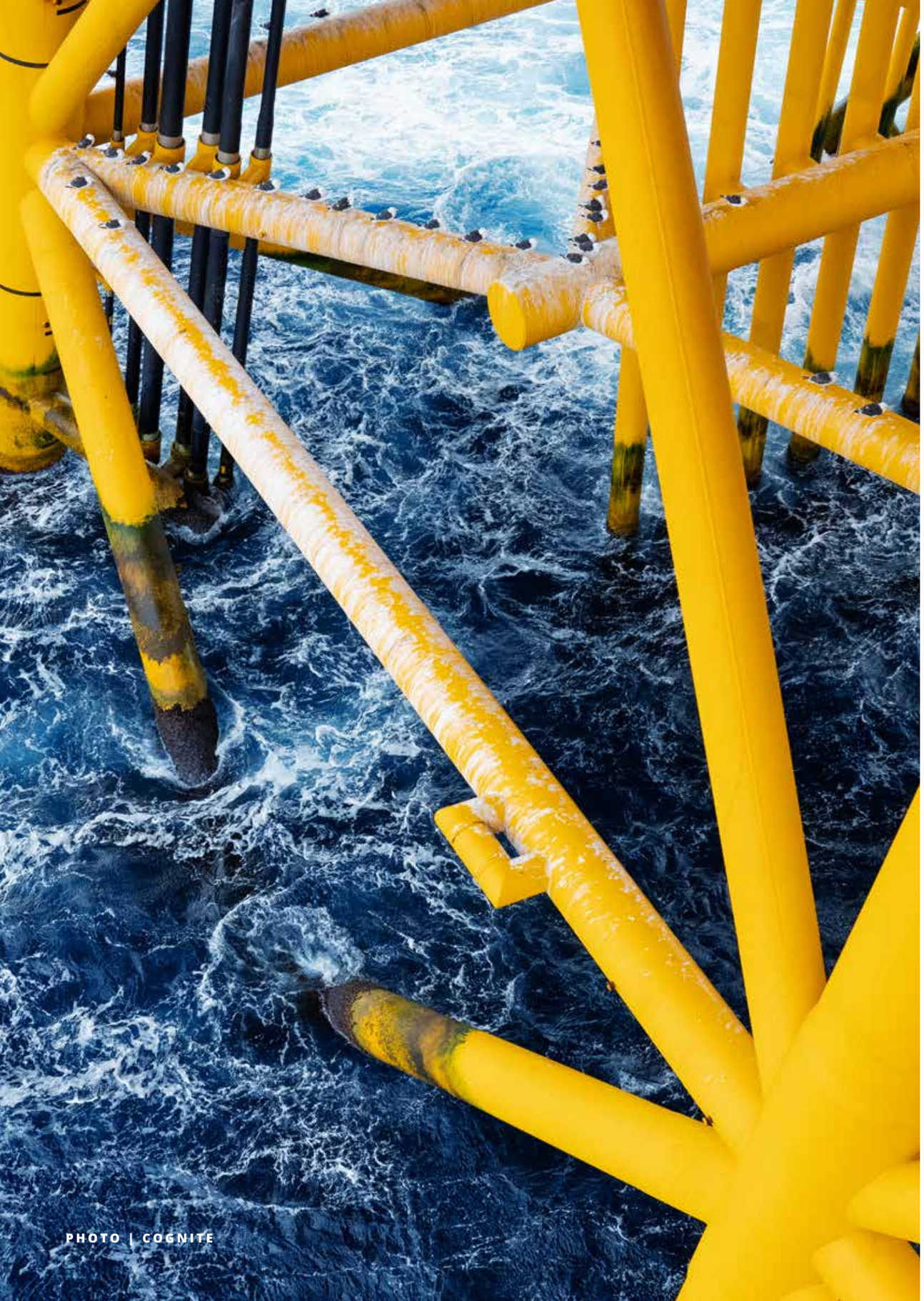


PHOTO | COGNITE

NorwAI objectives

The objective of the NorwAI research center is to provide a strong and robust arena for industry, research and academic institutions to collaborate on the development of AI ideas and techniques, share results, and iteratively explore how technology can transform existing businesses and enable entirely new business avenues.

The primary objective – or mission – of NorwAI is to:

Accelerate the innovation of sustainable and trustworthy artificial intelligence solutions across Norwegian industries.

This primary objective is further broken down into objectives and secondary objectives, as shown on the next page.

Artificial intelligence constitutes a paradigm shift in computer science, enabling substantially shorter development cycles, extremely powerful solutions, and immediate transfer of technologies from one domain to another. The innovation cycles become very dynamic, representing both challenges and opportunities at the same time. New systems may completely transform existing practices, render old value chains worthless, or open for brand new business opportunities. NorwAI supports innovation as a platform for continuous interaction between industry and academia, and will act as an ecosystem for creating alliances, joint venturing and building synergies among all partners. NorwAI will thereby enhance the ability of the business sector to innovate and create value through a greater focus on long-term research.

NorwAI acknowledges that the deep impact of AI makes it necessary to ensure efficient sharing of knowledge and enable businesses to adapt their innovation processes to this new situation and provides the skills for business transformation. At the same time, it is critical that the technology is applied with care and with respect for the needs of individuals and societies. The objectives of true personalization of services by providing data and platforms for AI innovations address the AI research needed to implement, deploy and evaluate companies' use case innovations. Finally, the overall quality and reputation of the research center will affect the center's ability to help companies develop and deploy research-based innovations and establish NorwAI as an international leading AI research and innovation center.

NorwAI objectives

OBJECTIVES	SECONDARY OBJECTIVES
O1 Understanding impact on society	**O1.1** Understanding how contributions from NorwAI can affect society at large **O1.2** Understanding fear of unethical AI uses and consequences
O2 Reinforce common understanding of safe and responsible AI	**O2.1** Validate need for trust in AI **O2.2** Establish trust in safe and responsible AI **O2.3** Create guidelines for sustainable and beneficial use of AI **O2.4** Ensure privacy-preserving technologies **O2.5** Develop principles for explainable and transparent AI **O2.6** Develop principles for independent assurance of AI deployment
O3 Provide true personalization of services	**O3.1** Develop truly explainable, fair and transparent personalization techniques **O3.2** Enable proactivity in customer relations **O3.3** Provide and individualized experience that provably respects privacy concerns
O4 Develop language processing capabilities for Scandinavian languages	**O4.1** Develop large-scale Scandinavian language models **O4.2** Enable human-like content creation and conversations **O4.3** Develop individualized content

OBJECTIVES	SECONDARY OBJECTIVES
O5 Develop modern AI for streaming and sensor-based data analysis	**O5.1** Provide anomaly detection and predictions with low quality streaming data **O5.2** Provide uncertainty quantification and explainability with streaming data **O5.2** Enable combinations of streaming and static data for efficient data analysis
O6 Merge physical models and AI systems	**O6.1** Use machine learning to increase understanding of physical systems **O6.2** Quantify uncertainty from non-representative training data **O6.3** Apply machine learning on imperfect data **O6.4** Ensure robustness and explainability of model predictions
O7 Provide data and platforms for AI innovations	**O7.1** Develop mechanisms for preparing business data for sharing **O7.2** Establish platforms for efficient AI development processes **O7.3** Provide infrastructure for sharing data and implementations
O8 Cultivate an AI-based innovation culture	**O8.1** Transfer AI knowledge and expertise in short innovation cycles **O8.2** Establish an innovation arena for effective value creation
O9 Establish NorwAI as an internationally leading AI research and innovation center	**O9.1** Attract additional funding **O9.2** Attract additional partners to NorwAI **O9.3** Establish PhD research school on responsible AI **O9.4** Increase number of AI PhD and MSc graduates **O9.5** Establish networks with leading AI communities

Members of the board

CHAIR EXECUTIVE BOARD

Sven Størmer Thaulow
Chief Data and Technology Officer,
Schibsted Media Group

MEMBERS OF THE EXECUTIVE BOARD

Ingrid Schjølberg
Dean and Professor, Faculty of Information Technology and Electrical Engineering, NTNU
(Ingelin Steinsland, Vice Dean Research fra 1/1-2023)

Sergei Savenko
CTO, Retriever

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Head of Department for
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Astrid Undheim
Executive Director, Sparebank1 SMN

Tom Ryen
Head of Department for
Informatics, University of Stavanger

Anders Løland
Research Director, NR

Innovation Advisory Board

Exclusive group of innovaters to advise NorwAI on innovation

The Innovation Advisory Board (IAB) will provide advice on how to create innovations from research for the NorwAI partners. The IAB will follow up on the innovation results on a regular basis and help to monitor the overall progress following SFI success criteria for innovation and commercialization. The Innovation Advisory Board is planned to meet with the Center director and the Innovation director twice a year.

Ieva Martinkenaite, SVP, Head of Research and Innovation at Telenor.
the Innovation Advisory Board.

The Innovation Advisory Board consists of a generous mix of internationally recognized experts from both abroad and Norway as its advisors. The Norwegians are well connected to the industry partners in NorwAI. The other two are prominent members of the AI community in both Europe and the US East Coast.

CHAIR OF THE AI INNOVATION ADVISORY BOARD

Ieva Martinkenaite
SVP, Head of Research and Innovation at Telenor

MEMBERS OF THE INNOVATION ADVISORY BOARD

Sophie V. Vandebroek
Board Director, Trustee, Advisor

John Markus Lervik
Founder & Chief Strategy and development officer

Saskia Steinacker
Global Head Strategy & Digital Transformation, Bayer

Øystein Larsen Indrevær
Senior Vice President Data-driven Sales, DnB

The Scientific Advisory Board

An Ambitious Board

The overall goal of the Scientific Advisory Board of NorwAI is to provide external scientific reviews of research activities, evaluate plans and progress, and contribute to shaping the center's research ambitions. The Scientific Advisory Board meets with the NorwAI Management Team once a year and reports to the Executive Board. The chairperson of the Scientific Advisory Board is professor Christian S. Jensen at Aalborg University.

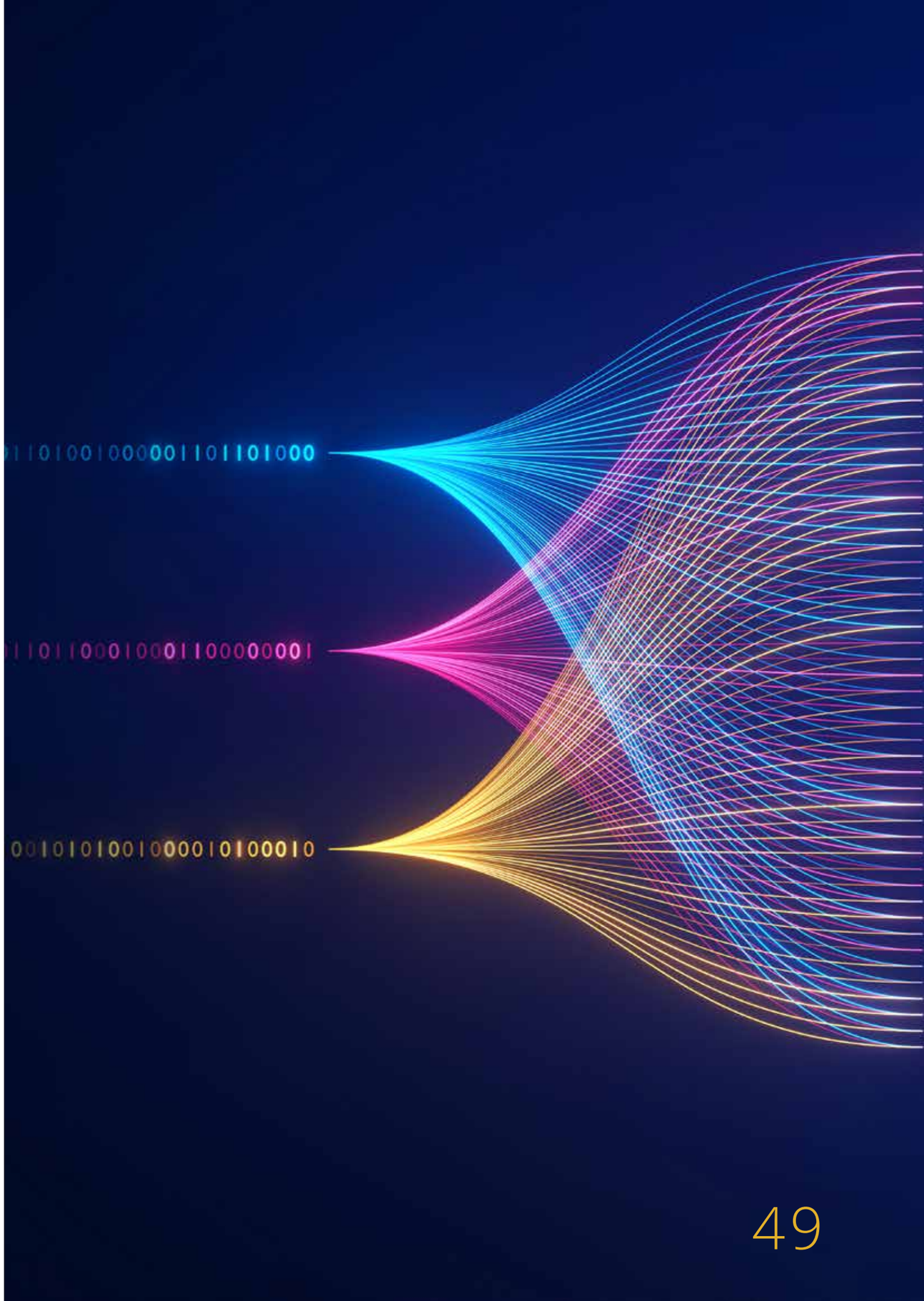
MEMBERS OF THE SCIENTIFIC ADVISORY BOARD

Christian S. Jensen
Chair and Professor,
Aalborg University

Concha Bielza
Professor,
Technical University of Madrid

Maarten de Rijke
Professor, University
of Amsterdam

Virginia Dignum
Professor,
Umeå University



Digital Twins
allow better predictions to industry

Arne Jørgen Berre
NorwAI Director of Innovation
SINTEF Chief Scientist

Applying AI technologies to enable intelligent digital twins for real world situations will allow the industry partners to better predict the behavior of their facilities and improve their simulations, e.g. for condition monitoring, predictive maintenance and optimal operation of wind turbines, energy networks, oil & gas production, and telecom operator networks.

NorwAI industry partners Aneo, Cognite, DNV, Kongsberg and Telenor within the areas of energy, industry 4.0 and telecom are exploiting the potential for innovation with AI technologies to progress towards Intelligent Digital Twins for managing industrial assets and infrastructures.

Digital Twins minimize the exposure of risk to a business daily operation, and ultimately increase efficiency throughout.

Digital pipeline

Intelligent digital twins enhance the digital twin pipeline from data acquisition to digital twin data representation by adding digital twin models for visualisation and control using various AI technologies. Research in the areas of STREAM, DATA, HYB and TRUST is laying foundations for research-based AI innovation in the area of digital twins as follows:

The research area STREAM supports innovation of predictive and prescriptive digital twins through AI for streaming and sensor-based data analysis of IoT data. This will allow for predictions and anomaly detection in multivariate time series including areas with variations in data availability and data quality.

Ensuring safe AI

The research area DATA provides a basis for innovation of data driven digital twins through techniques and tools for efficient data handling. This encompasses automatic creation and management of knowledge graphs, including how to efficiently store and process complex graph-based structures.

The research area HYB enables innovation of hybrid digital twins through hybrid AI which combines methods in the field of physics-informed machine learning, with AI techniques such as physics-informed neural networks (PINNs), physics constrained learning (Hamiltonian neural networks) or deep operator neural networks (DeepONets). The models will be constrained by existing knowledge, allowing to interpret the model (explainable AI) and reducing the amount of required training data, while still exploiting the flexibility of data driven methods for undescribed parts of the system.

The research area TRUST provides methods to innovate trustworthy intelligent digital twins by ensuring the AI to be safe and responsible as well as explainable and transparent AI. Here, the focus has been development of methodology and principles for independent assurance of AI deployment.

Helping NorwAI partners
to their data-driven future

David Baumgartner
PhD Candidate
NorwAI

Industries such as Telenor, Statnett and ANEO work with complex multivariate time series data from various sources such as sensor networks, machines or power plants. That data must be processed in real-time and leads to decision-making.

Therefore, companies or institutions must identify anomalies in their systems or operations. However, developing an effective anomaly detection system is complex and expensive. There is no guarantee that the benefits of an anomaly detection system will outweigh its costs. Economic challenges are one aspect of this process. In contrast, technical challenges, such as the absence of labels for guided AI/ML training and the high interactions between different signals in sequences from the same or different data sources, add to the complexity of anomaly detection.

We develop

Noise and missing data further increase the complexity of anomaly detection, requiring resistance, such as lower sensitivity, which reduces the number of successful detections. We have developed an unsupervised density estimation approach focusing on constraining systems for time series and physical conditions to address these challenges. We let an AI/ML model transform datasets with unknown data distribution to a known prior distribution while maintaining complete invertibility for additional downstream tasks such as forecasting and sampling in the unknown data distribution.

Our team is finalising a theoretical proof of concept on time-conditioned unsupervised density estimation with normalizing flows.

This approach highlights the capabilities and limitations of the method. It will benefit our partners, including Telenor in detecting unusual phone behaviour, Statnett in observing and detecting issues in the electricity grid and ANEO with their wind power. Collaborating with these partners allows us to work together more efficiently, help them adapt to new technologies, and better understand their challenges.

David Baumgartner and Shiva Shadrooh, PhD Canditates at NorwAI.

Graph technologies are game changers
in combating money laundering

Shiva Shadrooh
PhD Candidate
NorwAI / DNB

Money laundering is technique criminals use to cover their financial footpaths after illegally obtaining money from an illegitimate source that costs financial organizations millions of dollars annually.

Due to the sensitivity of anti-money laundering (AML) tasks, mistakes in examining reputed entities can lead to unexpected customer turnover. This explains why anti-money laundering departments remain on rule-based techniques.

Rule-based techniques used in AML can be inaccurate and time-consuming, leading to customer turnover and wasted resources. Therefore, financial organizations seek to speed up the examination process.

Graphs

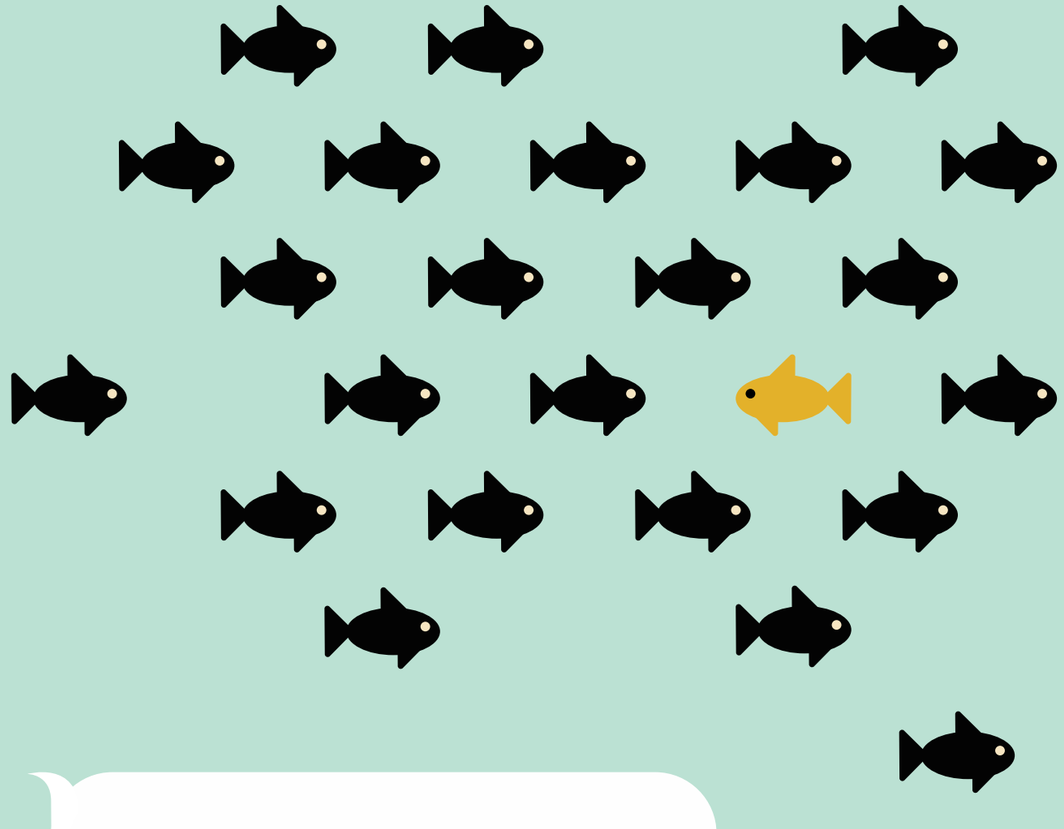
Graph technologies, however, are game changers in combating money laundering. Advances in graph tools and techniques can vastly improve AML efforts by extracting complex relationships between entities, places, and accounts, enabling a better understanding of data misbehaviours in context.

Often referred to as anomaly detection, the technology aims to identify rare items or observations that stand out from normal or common patterns found in data. Such observations are important in financial data because they can indicate money laundering, system failures, or potential risks.

Fraud patterns

Our team in NorwAI is focusing on designing novel graph algorithms to find fraud patterns in financial networks in a reasonable time to help auditors with faster decision-making.

The high capability of graph algorithms enabled us to discover accurate answers with considerably fewer errors.



Developed graph-based methods can vastly benefit our finance-related industrial partners in DNB and Sparebank 1 SMN; also, with few adjustments, these algorithms have the potential to perform well on other graph industrial datasets that share similar characteristics.

According to Gartner's research, the usage rate of graph technologies is anticipated to increase from 10% to 80% from 2021 to 2025.

Hence, we encourage industries to adopt graph analytics to push the boundaries in their businesses.

NorwAI Innovate ’22
The AI cross borders meet

Our ambition for NorwAI was to launch the largest and the most interesting AI tech conference in Norway for partners and company professionals, researchers, students, and technology interested citizens. With close to 230 participants and an extraordinary line-up of keynotes, NorwAI Innovate lived up to its expectations.

HOSTS

Professor Jon Atle Gulla
NorwAI Center Director

Rolf Dyrnes Svendsen
NorwAI Communications Manager

For the second year in a row, more than 200 people heeded the call physically to visit NorwAI Innovate. The mixed audience included company professionals, researchers, students, and technology interested citizen.

NorwAI Innovate is a unique showroom for what to expect from the research center itself. The conference also examines specific AI verticals. The 2022 version focused on personalization, cross border cooperation within the Nordics and industrial energy research and innovation work.

The conference also welcomed Statnett as a new member of the NorwAI consortium. In the initial keynote at stage, President and CEO Hilde Tonne underlined the company’s green ambitions when explaining why the grid giant would join NorwAI.

Sidekicks like poster demos, prototype demos and a hackaton fueled NorwAI Innovate with the next generation AI talents. An extraordinary line of keynotes from the Nordics, Europe and Asia proved that technology in general, and AI in particular, are superchargers of change and innovation in society.

Francisca Hoyer
AI Sweden

KEY NOTE SPEAKERS

Hilde Tonne
Statnett

Bjørn Taale Sandberg
DNA

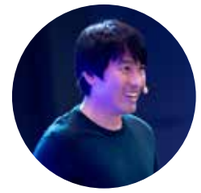
Paolo Rosso
University of Valencia

Sven Størmer Thaulow
Schibsted

Ståle Gjersvold
Aneo

Kjersti Løken Stavrum
Tinius Trust

Nhien Nguyen
NTNU



Hiroto Nakajima
Nikkei

Odd Erik Gundersen
Aneo

Eirik Thorp Eythorsson
Cognite

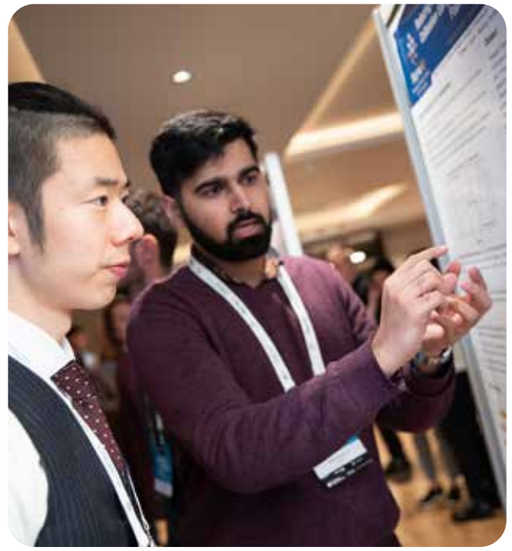
Johan Dahl
Cognite

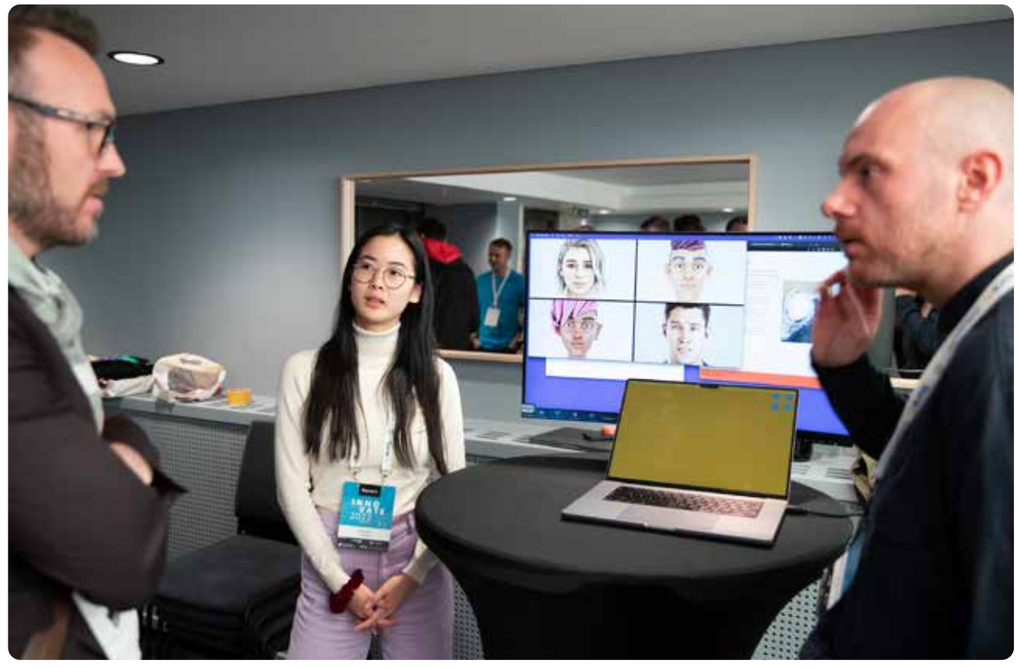
Fiona Coath
Thoughtworks

Aana Ramallo
Zalando

Martin Svensson
AI Sweden

Simen Eide
Schibsted





NorwAI Innovate ’23
Trondheim
Oct 31st and Nov 1st

SAVE THE DATE

Successful **hackathon**

Bjørnar Vassøy
PhD Candidate, NorwAI

NorwAI partner Cognite is all about new ideas and ways of operating for industrial companies. This resonates with technology students who are boiling over with creativity - and the oil & gas data unicorn was excited to run the NorwAI Innovate 2022 Hackathon.

Cognite is a global key player in industrial digitalization. At the hackathon, the company presented some real-world industrial problems it was currently working on. Cognite presented this year's dataset, which also was used in an actual project at the company itself.

The 2022 hackathon was kicked off some days before the conference itself. The organizers provided the hackathoners some ideas on relevant challenges or directions they could look into in addition to mentors from Cognite.

The competition was divided into two tracks, an innovator and a developer class respectively. Both winners were offered prize awards of NOK 10 000 for the best ideas.

The winners were picked by a committee of judges from both NTNU and Cognite and presented their work on stage at NorwAI Innovate, day 2.

HACKATHON INNOVATION AWARD WINNER

Team «Intelligence» with Hans Jakob Håland, Arild Strømsvåg and Vegard Sjåvik

HACKATHON DEVELOPER AWARD WINNER

Team «HKK» with Kristian Brudeli, Khan Mohammad Rashedun Naby and Hawraa Razzaq

More on Cognite

Cognite is a global industrial SaaS company that was established with a clear vision: to rapidly empower industrial companies with open, contextualized, trustworthy, and accessible data to help drive the full-scale digital transformation of asset-intensive industries around the world. Our core Industrial DataOps platform, Cognite Data Fusion®, enables industrial data and domain users to collaborate quickly and safely to develop, operationalize, and scale industrial AI solutions and applications to deliver both profitability and sustainability.

Best Hackaton Contributors were presented on stage at NorwAI Innovate.

Winners of the development prize Kristian Brudeli and Hawraa Razzaq flanked by with jury members (from left) Kerstin Bach, NorwAI, Johan Dahl, Cognite, Jon Espen Ingvaldsen, NorwAI and Anne Gunn Kraabøl, Hafslund Eco.

Winners of the innovation prize Hans Jakob Håland and Vegard Sjåvik flanked by the jury.

Poster/Demo Session
at NorwAI Innovate 2022

Benjamin Kille
NTNU postdoctoral fellow
NorwAI / DNB

In 2022, we received twenty submissions for the session dedicated to posters and demonstrations of research on artificial intelligence. The session is primarily focused on showcasing the outcome of the research of master and PhD students. Due to space and time limitations, we could accept fifteen contributions (four demonstrations and eleven posters).

The topics ranged across a wide spectrum of artificial intelligence approaches and use cases. On the more research-focused side, attendees could learn about machine learning, deep neural networks, large language models, personalization, and explainability. On the more use-case-specific side, attendees learned about underwater inspection and welding, digital twins and conversational agents.

The venue allowed us to put the posters further from one another and left attendees sufficient space to engage in conversations with the researchers. The room with the demonstrations was always packed, showing great interest in the diverse, fascinating showcases.

Håkon Hukkelås, Frank Lindseth, and Rudolf Mester received the best poster/demo award for their demonstration of image anonymization technology.

CONTRIBUTIONS

AUTHORS	TITLE
Elias Elfarri and Adil Rasheed	Machine Learning Powered Digital Twin in Virtual Reality
Jawad Tayyub, Muhammad Sarmad and Nicolas Schönborn	Explaining Deep Neural Networks for Point Clouds using Gradient-based Visualisations
Rabia Ali, Muhammad Sarmad, Jawad Tayyub and Alexander Vogel	Accurate Detection of Weld Seams for Laser Welding in Real-World Manufacturing
Tu My Doan, Benjamin Kille and Jon Atle Gulla	Using Language Models for Classifying the Party Affiliation of Political Texts
Joseph Hirsch, Brian Elvesæter, Alexandre Cardaillac, Bernhard Bauer and Maryna Waszak	Fusion of Multi-modal Underwater Ship Inspection Data with Knowledge Graphs
Timo Peter, An Ngoc Lam, Bernhard Bauer and Maryna Waszak	Spread your Wisdom — Cross-Asset Pattern Matching for Digital Twins through Knowledge Graphs and Similarity Measures
Maryna Waszak, Alexandre Cardaillac, Brian Elvesæter, Frode Rødølen and Martin Ludvigsen	Semantic Segmentation in Underwater Ship Inspections: Benchmark and Dataset
Muhammad Sarmad, Mishal Fatima and Jawad Tayyub	Reducing Energy Consumption of Pressure Sensor Calibration Using Polynomial HyperNetworks with Fourier Features
Vilde Gjærum and Inga Strümke	Visual explanations of a deep reinforcement learning docking agent
Stella Maropaki, Sean Chester, Christos Doulkeridis and Kjetil Nørvåg	Diversifying Top-k Point-of-Interest Queries via Collective Social Reach
Aleksej Logacjov, Sverre Herland, Astrid Ustad and Kerstin Bach	SelfPAB: Self-supervised Physical Activity Representation Learning Based on Accelerometer Data
Håkon Hukkelås , Frank Lindseth and Rudolf Mester	DeepPrivacy: A Framework for Realistic Image Anonymization
An Ngoc Lam, Timo Peter, Marita Bjaaland Skjuve and Maryna Waszak	Chat with your factory: A Knowledge Graph Based Conversational AI Agent
Emanuel Alexander Lorenz and Xiaomeng Su	Real-time Human Motion Capture for Clinical Multi-Modal Brain-Computer-Interfaces
Betül Bayrak , Paola Marin Veites and Kerstin Bach	Explaining Black-Box Models Using a Multi-agent CBR System

International cooperation

AI will affect economies, societies, and cultures profoundly at a national, international and global level. Achieving the global benefits of artificial intelligence will require international cooperation.

Already there is a global AI network of relations, cooperation and partnerships, both academically and in business. Companies, institutions, professionals, professors and students are all, either individually or via projects, connected to the international ecosystem of AI communities.

NorwAI is poised to further extend these relations. In 2022, NorwAI gave priority to develop its relations in the Nordics, initially targeting Sweden as the first and most natural country to collaborate with.
Early 2019, AI Sweden was established as a national center for AI related research and innovation. AI Sweden provides resources and service across industries and is the engine for the Swedish AI ecosystem. The NLU program is similar to NorwAI's own NLP project. In 2022, the two organizations exchanged visits and attended events in both countries.

AI Sweden invited NorwAI to take part in the Horizon Europe application IJAP - Investigative Journalism AI in the EU programCREA-CROSS-2022-JOURPART. The two research centers in Stockholm and Trondheim are now connected exchanging experiences as their Large Language Model programs are progressing.

A majority of NorwAI's business partners have international ambitions and are already active in the Nordic region. NorwAI will emphasize its cooperation and participation in the growing Nordic scientific and business AI ecosystem.

Also, beyond the Scandinavian borders, the NorwAI consortium is well connected to outstanding research communities worldwide. Europe is our center of gravity along with attractive partners in North America. Academically, selected researchers, which are among the leaders in their fields, will cooperate on tasks in the projects, and our planned extensive exchange program will enable researcher exchange between NorwAI and their research groups.

A tangible result of these efforts is the exchange program with the University of Waterloo in Canada. 16 MSc and PhD students from NTNU will have a 6-12 month applied research internship at the University of Waterloo just outside Toronto, Canada with their research

network and industry partners. The program planning began late 2022.
Vice versa the Canadian university will send bachelor students to NTNU and the partners SINTEF Digital, Cognite and Aneo. The two universities partner to focus on talent development in artificial intelligence (AI) through co-operative education and work-integrated learning (WIL).
Together with strong European and American universities we plan to establish an international PhD school on Data-Driven AI. All PhD students in NorwAI are expected to have a research stay abroad for 6 months, funded by NorwAI. The first student benefitted from a stay at Brown University at Rhode Island, USA in the autumn of 2022 until summer 2023. Countrywise NorwAI is especially well connected to universities and research centers throughout Europe and also in US and China.

NorwAI's scientific and innovation boards have attracted international experts within their domains.

Europe is paving its own way for AI research and innovations. The EU ranks among global leaders in AI Science. In the Commissions' own words its innovation performance in AI could be revamped. At the same time, the EU has been leading in promoting trustworthy, ethical and human-centric AI – values deeply integrated in NorwAI's goals as well.

NorwAI partners NTNU and Telenor are among participants in AI4EU with a goal of mobilize the entire European AI community to make AI promises real for European society and economy, and nurture economic growth.

NorwAI partner SINTEF is the technical lead of the SNK 586 Standard Norway Committee for AI; a national mirror to the international ISO SC42 AI and the European CEN JTC21 AI zation committees. There is further good collaboration and leadership with the European BDVA – Big Data Value Association, and the European ADRA – AI, Data and Robotics Association. To further support AI Innovation for SMEs and public organizations in Norway, NorwAI partner DigitalNorway is leading the new Norwegian EDIH (European Digital Innovation Hub) for AI, called Nemonoor, together with among others SINTEF, NTNU and UiO.

Cooperation between
the center's partners

More interaction
More collaboration

The NorwAI consortium consists of 11 companies, most of them from different industries and in some cases even competitors. In addition, the consortium also organizes five research institutions.

The consortium represents considerable breadth with respect to business needs, experience with artificial intelligence and capabilities for commercializing technological research results to capture value.

NorwAI's research strategy has a sensitivity towards this variety. Consequently, all NorwAI's work packages always have more than one partner in every research area to promote cross industry and industry- academic cooperation.

Joint efforts

Building Norwegian based language models has intensified collaboration between partners in this innovation area. As the work to build the NorGLM model was organized in the autumn of 2022, our major partners Schibsted and DNB from the media and finance sectors respectively, joined the joint industrial and academic core working committee for the project to take active part in the operations. Both business sectors are believed to be beneficiaries of the new technologies currently unfolding.

Furthermore, reorganizing the work package structure of NorwAI, has contributed to more interactions. Merging personalization and language work packages, formerly headed by NTNU and University of Stavanger respectively, have put researchers and industry closer together.

Personal relations

Organizing the internal NorwAI Forum for partners twice a year has accelerated knowledge exchange between partners. The forums also build personal relations between the many people involved in NorwAI increasing opportunities to collaborate in new ways.

Merging the workpackage for Streaming and sensor-based Data and the one for Data and Platform for AI at the start of 2023 will add additional strength to further cooperation between partners and between the research institutions and business.

The innovation ecosystem for NorwAI was initiated in 2022. Internally, brainstorming sessions was organized between work package leaders in combination with other events taking place at NorwAI. The ecosystem designers also kicked off a series of workshops bringing both academic and industry leaders together to explore the potential direction of innovation, developing use cases tailored to our latest AI technology development.

NorwAI have strived to balance leadership in the work packages. Both experienced industry leaders and senior researchers are appointed leaders for the different groups. This applies for all three research areas such as trustworthy AI and AI in society, the language technologies as well as the work packages for asset industries.

Cooperation between research and business is key to a research-driven innovation center. To NorwAI, the industry's own use cases identifying possibilities for innovation, is the foundation for the work. Industry partners have listed their use cases, and efforts are invested in coordinating and establishing a common ground for use case owners and the researchers on the research needs among AI and domain experts.

NorwAI Forums
to accellerate collaboration

NorwAI's annual schedule gives room for two NorwAI Forum events. They are internal meetings for partners, work package leaders, project participants and NorwAI personnel. NorwAI Forums are designed for sharing ideas and experiences across work package boundaries on selected activities.

The Forums are also organized to improve communications and increase collaboration in the large NorwAI consortium. NorwAI Forums take place in both Trondheim and Oslo to ease access for as many as possible. Priority is given to physical attendance to further stimulate activity and both maintain and develop relation.

The spring event in Trondheim has a research focus highlighting results and research activities, presenting interesting findings with an opportunity to discuss and dive deeper into the topics. The program responsibility rests with the NorwAI Core team in Trondheim.

The early autumn event in Oslo is organized by SINTEF Digital with a clear innovation perspective. Many NorwAI partners are situated in Oslo, and meetings there will attract more people to take part in person.

Speakers at the NorwAI Spring Forum

Tanja Knaus
PhD Candidate
University of Oslo
AI in Society

Krisztian Balog
Professor
University of Stavanger
On the role of human annotation in the era of large language models

Simone Casolo
Researcher, Cognite
Topological data analysis of industrial time-series - Topological data analysis for industrial data science

Shiva Shadrooh
PhD Candidate
NorwAI / DNB
Graph-based anomaly detection

Nhien Nguyen
Associate professor NTNU
Creating shared understanding of AI Innovation for NorwAI

Research strategy

Our approach to research at NorwAI is fundamentally multi-disciplinary, consisting of both technical-oriented and socio-economic research. Current research on AI is diverse and reflect many disciplines or perspectives covering theoretical contributions from a wide range of disciplines together with more applied work from system designers and application developers working with data from many different domains.

Our research is partner-driven and rooted in a strategic and systematic approach towards innovation to create lasting value and impact. The consortium represents considerable breadth on the problem owner side with respect to business needs, experience with artificial intelligence and capabilities for commercializing technological research results to capture value. Sensitivity towards this variety necessitates tailoring of the innovation processes for each user partner. We adopt a user driven innovation process both with respect to needs common to several partners and needs that are unique to a single partner. The foundation for our approach is dynamic and continual collaboration between partners to iteratively understand strategic needs, research and design solutions and test resulting technologies, tools and methods. It is simple yet effective.

Research in NorwAI focus on generic research areas within AI that can support the innovation activities in the center. The research areas will be evaluated every year in the center's lifetime, making sure new areas can be added based on research needs from future innovation areas or in case of integrating new partners. Existing areas might also be merged or concluded and come to an end.

Our research is partner-driven and rooted in a strategic and systematic approach towards innovation to create lasting value and impact.

PHOTO | COGNITE

Recruitment
Phd Candidates

STARTED IN 2021

Egil Rønningstad

Nationality:	Norway
Topic:	Norwegian opinion summarization and Entity-level sentiment analysis
Started:	October 2021
Main supervisor:	Prof. Erik Velldal, University of Oslo
NorwAI Work Package:	WP LAP

David Baumgartner

Nationality:	Austria
Topic:	Data analysis with noisy and low-quality data streams
Started:	September 2021
Main supervisor:	Prof. Heri Ramampiaro, NTNU
NorwAI Work Package:	WP STREAM

Bjørnar Vassøy

Nationality:	Norway
Topic:	Fairness, accountability, transparency and privacy in personalization/recommender systems
Started:	August 2021
Main supervisor:	Prof. Helge Langseth, NTNU
NorwAI Work Package:	WP LAP

Katarzyna Michalowska

Nationality:	Poland
Topic:	Informed machine learning
Started:	January 2021
Main Supervisor:	Prof. Morten Hjort-Jensen, University of Oslo
NorwAI Work Package:	WP HYB

Nikolay Nikolov

Nationality:	Bulgaria
Topic:	Flexible deployment of big data pipelines on the cloud/edge/fog continuum
Started:	January 2021
Main Supervisor:	Dr. Dumitru Roman (Senior Research Scientist at SINTEF Digital and Assoc. Professor at University of Oslo, Norway)
NorwAI Work Package:	WP DATA

STARTED IN 2022

Nolwenn Bernard

Nationality:	France
Topic:	Study of fairness and transparency in conversational recommender systems
Started:	February 2022
Main Supervisor:	Prof. Krisztian Balog, University of Stavanger
NorwAI Work Package:	WP LAP

Weronika Łajewska

Nationality:	Poland
Topic:	Personalizing conversational informational access
Started:	February 2022
Main Supervisor:	Prof. Krisztian Balog, University of Stavanger
NorwAI Work Package:	WP LAP

Tanja Knaus

Nationality:	Austria
Topic:	The materialization of the human voice into affective data - data practices of ai cloud services using vocal emotion recognition systems
Started:	April 2022
Main Supervisor:	Prof. Susanne Bauer, University of Oslo
NorwAI Work Package:	WP SOC

Web and social media

INSTAGRAM
@sfi_norwai

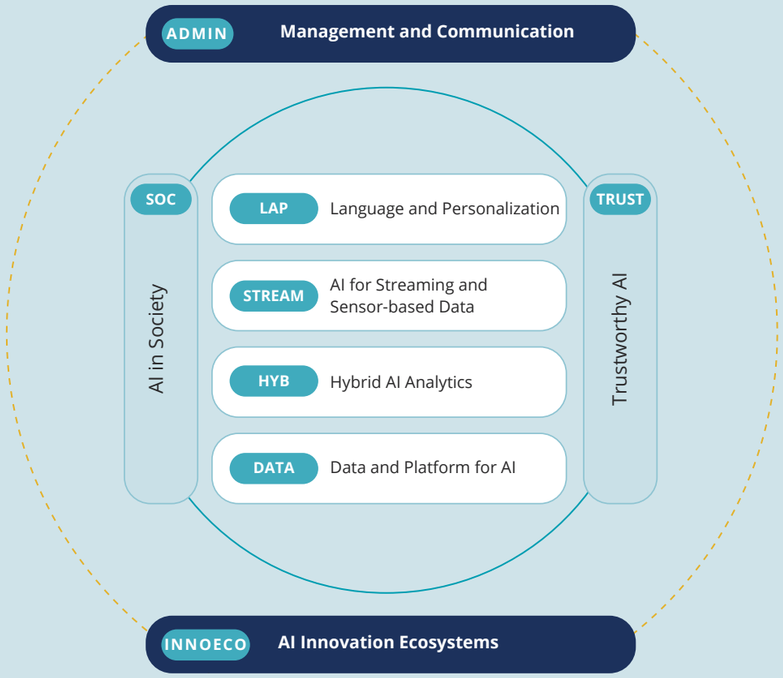
WEBPAGE
norwai.org

LINKEDIN
www.linkedin.com/company/ norwai

TWITTER
@SFI_NorwAI

The workpackages

NorwAI has until end of 2022 consisted of 8 work packages, which have been organized as described in this figure:



ADMIN: MANAGEMENT AND COMMUNICATION

This work package concerns the day-to-day operations of the center as well as communication.

Work package leader: Jon Atle Gulla, Professor, NTNU

SOC: AI IN SOCIETY

The purpose of work package SOC is to:

- Understand AI technologies in their societal aspects as they are implemented across domains
- Examine the social shaping of AI technologies within ongoing valuation and standardization processes
- Study emergent AI infrastructures together with their publics

This work package investigates broader societal challenges that arise with development and implementation of AI technologies. It combines close-up case studies of selected AI devices and examines the societal stakes, as AI technologies shape problem solutions and enter everyday lives. We will follow how AI technologies are implemented in automation, predictive modeling, and machine learning and examine how they configure societal relations more broadly. By opening up AI matters to broader publics, we will enable transdisciplinary engagements and deliberation.

Work package leader: Susanne Bauer, Professor, University of Oslo

TRUST: TRUSTWORTHY AI

The purpose of work package TRUST is to reinforce a common understanding of safe and responsible AI, specifically:

- Establish trust in safe and responsible AI
- Ensure privacy-preserving in AI technologies
- Create guidelines for sustainable and beneficial use of AI
- Develop principles for explainable and transparent AI
- Develop principles for independent assurance of AI deployment

Trust in AI is a necessary condition for the scalability and societal acceptance of these technologies. Without trust, innovation can be stalled. This research investigates, from an interdisciplinary perspective, the multiple dimensions of trust raised by the deployment of AI and builds tools, methods, and a framework for assuring the safe and responsible deployment of AI in industry and society. This work package aims to answer the question: How can such tools address the safety and needs of individuals, organizations and society at large, addressing both non-technical and technical issues? The research will address issues related to safety, explainability, transparency, bias, privacy and robustness, as well as human-machine interactions and co-behavior all in the context of industry regulations and societal expectations.

Work package leader: Andreas Hafver, Team Leader - Emerging Technologies, Group Research & Development, DNV

LAP: LANGUAGE AND PERSONALIZATION

This work package is a new construct, made up by the combination of the previous work packages on personalization (PERS) and natural language processing (LANG). The work in the work package will initially follow these two directions somewhat separately, for later to be tighter combined.

The purpose for this work package is to develop personalization techniques and Scandinavian language processing capabilities to provide personalized content generation and:

- Develop truly explainable, fair and transparent personalization techniques
- Enable proactivity in customer relations
- Provide an individualized experience that provably respects privacy concerns
- Develop individualized content
- Develop large-scale Scandinavian language models
- Enable human-like content creation and conversations

Personalization and contextualization have been successfully employed in diverse applications over the past decade, and currently see an extended usage, for instance in proactive interaction with customers and individualization of news stories. LAP will contribute to developing such systems while ensuring that the system usage will be ethical and respecting users' requirements for privacy, fairness and accountability.

Building Scandinavian language models requires the compilation of large-scale reusable language resources, including general-purpose corpora from public sources (e.g., news and social media) as well as industry- and domain-specific text collections. We will address the scarcity of the latter by pre-training on the former and developing transfer learning methods. These large-scale language models will then be utilized in real-life scenarios by formulating a number of specific summarization, explanation, and conversational tasks based on our partners' use-cases. LAP will develop appropriate evaluation methodology with user-oriented evaluation measures and objectives. It will thus contribute to providing measurable quantification of the amount of domain-specific training material needed in order to provide a language service that is of sufficiently high quality.

Krisztian Balog, Professor University of Oslo

STREAM: AI FOR STREAMING AND SENSOR-BASED DATA

The purpose of work package STREAM is to develop modern AI for streaming and sensor-based data analysis. This will be done by:

- Providing anomaly detection and predictions with low quality streaming data
- Providing uncertainty quantification and explainability with streaming data
- Enabling combinations of streaming and static data for efficient data analysis

Streaming data can be used for automation, recommendations and decision making. Often this involves predictions and anomaly detection in multivariate time series, as well as providing explanations for the conclusions drawn. IoT sensors are increasingly instrumenting the physical world, and efforts have been made to use AI for solving these tasks also in low-quality data regimes. This research area will identify robust techniques for analysis of streaming data within several domains (including telco network, industrial IoT), with a particular focus on improving interpretability for cases with multivariate time series with low quality data.

Solving the research problems in WP6 is crucial to successfully innovate how IoT data can be fully used in anomaly detection and contribute to breakthrough in applying AI in predictive maintenance and operational availability.

Work package leader: Kenth Engø-Monsen, Research Fellow, Telenor

HYB: HYBRID AI ANALYTICS

The purpose of work package HYB is to:

- Develop robust, stable and explainable data-driven models for physical systems
- Constrain models to enforce meaningful predictions
- Transfer data-driven models from simulations to reality
- Characterize and quantify uncertainty of data-driven models

This work package will develop methods to predict and reduce the uncertainty of data-driven models. The models will be constrained by existing knowledge, allowing to interpret the model (explainable AI) and reducing the amount of required training data. Applying these methods on real world applications will allow the industry partners to better predict the behavior of their facilities and improve their simulations, e.g. for condition monitoring, predictive maintenance, optimal utilization.

Work package leader: Signe Riemer-Sørensen, Research Manager, SINTEF

DATA: DATA AND PLATFORM FOR AI

The purpose of work package DATA is to develop techniques and tools for the automatic creation and management of knowledge graphs.

Real impact of data-driven AI depends on the availability of live data of sufficient quality and quantity in an automatically discoverable format that both humans and machines can understand. WP8 will investigate how the semantics of data, through automatic creation and mapping of suitable knowledge graphs, can be leveraged to scale AI models from one situation to all similar situations and how complex graph-based structures can be efficiently stored and processed.

Work package leader: Andris Piebalgs, Data Science Lead,
Energy Production and Operations, Cognite

INNOECO: AI INNOVATION ECOSYSTEMS

The purpose of work package INNOECO is to:

- Create an Innovation Ecosystem among NorwAI partners for sharing both research findings, innovations, business solutions and change models within the AI domain.
- Share this knowledge with a broader audience, emphasizing small and medium sized businesses.

This work package will convey state of the art knowledge on AI-driven business models to a wide audience, including non-AI experts. This will be achieved by case analysis, conference presentations, and provision of a range of educational materials spanning from short tutorials to full university courses. The following topics will be covered: what AI is, its strategic impact on business model innovation, the business opportunities and limitations, implication on HR and teamwork, and innovation team dynamics, etc. To achieve these objectives, both AI and HR expertise will be convened.

Work package leader: Nhien Nguyen, Associate Professor, NTNU

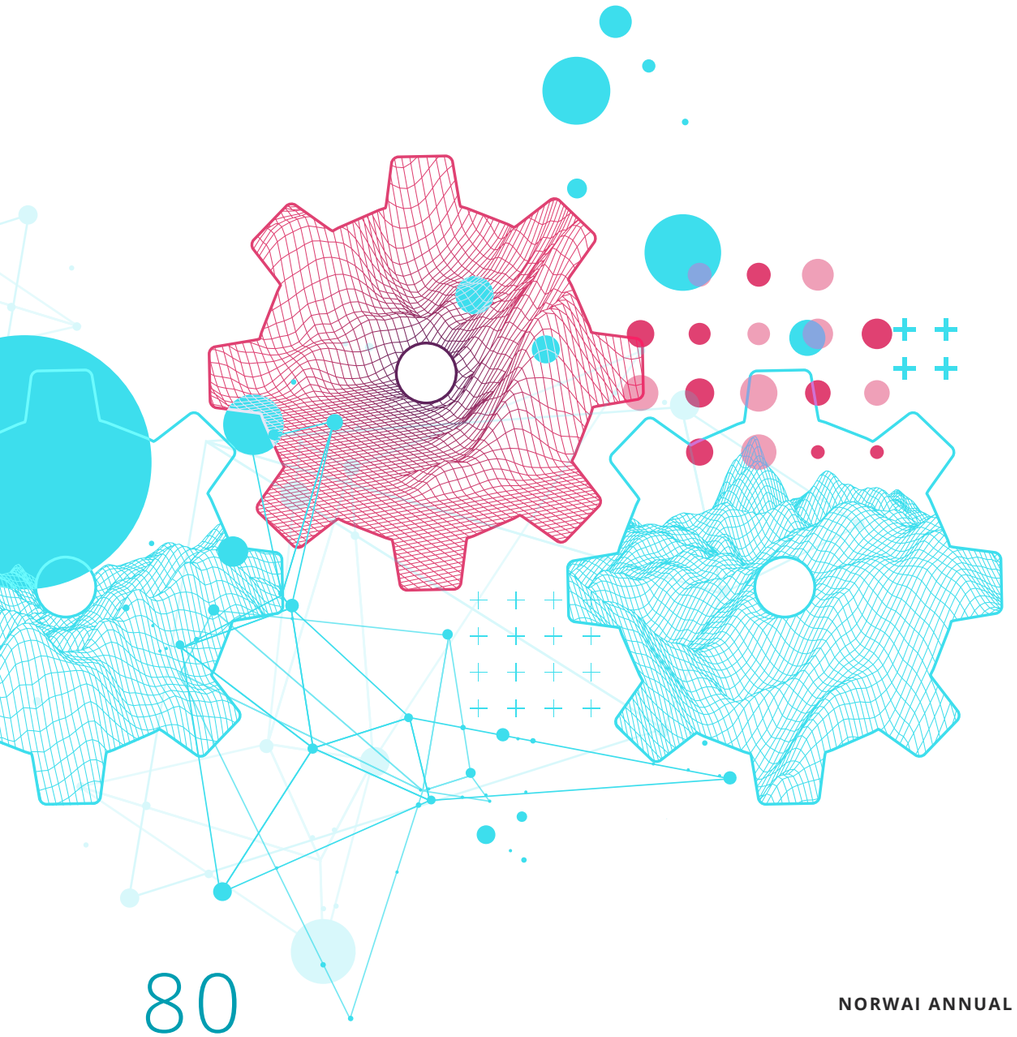


PHOTO: KAI DRAGLAND, NTNU

Presentations and communication

NAME	TITLE	TYPE / PLACE	DATE
Simen Eide (Finn.no)	Recommender systems, bandits and Bayesian neural networks	NAIL&NorwAI Friday Webinar series	2022-01-21
Kerstin Bach	The new research center NorwAI in Trondheim - business-oriented research and innovation under the leadership of NTNU and Sintef.	Regional digital forsknings-konferanse i Helse Midt-Norge RHF 2022	2022-02-09
Benjamin Kille, Jon Atle Gulla	Artificial Intelligence in NorwAI	CatchIDI	2022-03-01
Kerstin Bach	Innovasjonsfrokost: Framtidens helse-teknologi by Trondheim Tech Port.	Innovasjonsfrukost Trondheim Techport	2022-03-10
Benjamin Kille	NorwAI Presentation	Visit at Mazemap	2022-04-05
Kerstin Bach	NorwAI: presentation of the research center	BRAIN Interactive Talks	2022-04-06
Benjamin Kille, Even Flem Hagen, Lars Ådne Heimdal, Christian Riksvold	Demo, Kaia the social robot	BRAIN Interactive Talks	2022-04-06
Anders Løland	(Hvordan) kan kunstig intelligens endre forskerrollen? – hvor er kunstig intelligens + fire tankekors	Transportøkonomisk institutt: Instituttsamling med fokus på AI	2022-04-22
Kerstin Bach	Femais mentorship program, Kickoff welcome	FEMAIS Kickoff meeting	2022-04-28
Signe Riemer-Sørensen	Hybrid AI for predictive maintenance of wind turbines	NorthWind webinar: Efficient Operation and Maintenance – Offshore Wind	2022-04-28
Lisa Reutter	The Norwegian Data Rush: A Brief Introduction to the Datafication of Public Administration	NorwAI and NAIL AI Seminar Series	2022-05-20
Keith L. Downing	Stupididity Emerging	NorwAI and NAIL AI Seminar Series	2022-06-03
Sølve Eidnes	Port-Hamiltonian Neural Networks	Seminar: Physics-informed machine learning	2022-06-07
Benjamin Kille	Language Models	Meeting at NRK	2022-06-09
Mikko Kurimo	Machine learning in ASR at Aalto University	NorwAI and NAIL AI Seminar Series	2022-06-10
Håkon Bygdås, Even Flem Hagen, Lars Ådne Heimdal	Demo Kaia - The social robot	IE-dagen	2022-06-15
Nirmalie Wiratunga	The iSee project: Building the AI you trust	NorwAI and NAIL AI Seminar Series	2022-06-17
Benjamin Kille	NorwAI Presentation: Language Models	Meeting at DIGS	2022-08-22
David Baumgartner	NorwAI Presentation: PhD research	Meeting at DIGS	2022-08-22
Susanne Bauer	STS and the Digital: Studying AI, algorithms and infrastructures	NorwAI in lecture and research -based teaching in TIK4011	2022-08-31
Benjamin Kille	Demo, Kaia the social robot	eLADDA meeting	2022-09-02
Stelios Kapetanakis and Kerstin Bach	ICCBR DC'22: Doctoral Consortium at ICCBR-2022	CEUR workshop proceeding	2022-09-12
Signe Riemer-Sørensen	Hybrid AI	Bilateral AI U.S Norway Forum	2022-10-17
Anders Løland	Hva er egentlig kunstig intelligens – og hvor er fallgruvene?	Personvernombudsnettverket	2022-10-19
Kerstin Bach	AI in Healthcare - an interdisciplinary journey	Webinar series Friday talks at IE	2022-10-21
Arne J. Berre	NorwAI Achievements	NorwAI Innovate 2022	2022-11-01
Betül Bayrak, Paola Marin Veites and Kerstin Bach	Explaining Black-Box Models Using a Multi-agent CBR System	Poster at NorwAI Innovate 2022	2022-11-01
Erik Johan Nystad, Dumitru Roman, Francisco Martin-Recuerda, Maryna Waszak	Dashboard and Data Pipeline for Academic Network	Poster at NorwAI Innovate 2022	2022-11-01
Håkon Bygdås Høgset, Marte Eggen, Alexander Michael Ås	Demo Kaia - The social robot	Demo at NorwAI Innovate 2022	2022-11-01
Hilde Tonne, Statnett	Digitalization – a key requisite for the green transition	NorwAI Innovate 2022	2022-11-01
Simen Eide	Recommender systems, cold start and language models @Schibsted	NorwAI Innovate 2022	2022-11-01
Stella Maropaki, Sean Chester, Christos Doulkeridis and Kjetil Nørvåg	Diversifying Top-k Point-of -Interest Queries via Collective Social Reach	Poster at NorwAI Innovate 2022	2022-11-01
Tu My Doan, Benjamin Kille, and Jon Atle Gulla	Using Language Models for Classifying the Party Affiliation of Political Texts	Poster at NorwAI Innovate 2022	2022-11-01
Aiko Yamashita (DNB)	Career Reflections	FEMAIS Mid-term workshop	2022-11-02

Presentations and communication

NAME	TITLE	TYPE / PLACE	DATE
Johan Løwig Rambech Dahl	Solving the industrial data problem	NorwAI Innovate 2022	2022-11-02
Ståle Gjersvold, Odd Erik Gundersen	Aneo - a new player in the Nordic greren energy market	NorwAI Innovate 2022	2022-11-02
Sven Størmer Thaulow	Schibsted - a Nordic player	NorwAI Innovate 2022	2022-11-02
Jon Atle Gulla, Jon Espen Ingvaldsen	Greier oversetter-roboten å lure redaktørene?	NxtMedia conference 2022	2022-11-10
Benjamin Kille	Kaia - the Social Robot developed at NorwAI	Furhat conference - creators edition	2022-11-17
Jon Atle Gulla	NorwAI	IDI Fifty years anniversary	2022-11-22
Benjamin Kille	Using Language Models for Smart Text Processing	Make Data Smart Workshop	2022-11-23
Kerstin Bach	AI in Healthcare - an interdisciplinary journey	AI Agora Seminar series, Bergen	2022-11-23
Bjørnar Vassøy	Consumer-side Fairness in Recommender Systems	Faglunsj at Sopra Steria	2022-12-14
Kerstin Bach	AI-module at IT6205 - Muliggjørende teknologier for digitalisering	Forelesning ved EVU-kurs	Høst 22/ Vår 23
Jon Atle Gulla	NorwAI	Presentation for studentgruppe fra NTNU Entreprenørskolen	2022-11-23
Lars Ailo Bongo	Medical machine learning: from basic research to startups	NorwAI and NAIL AI Seminar Series	2022-12-01
Rosina Weber	XAI: Roadblocks, Trends, and Directions	NorwAI and NAIL AI Seminar Series	2022-08-29

Internal seminars

NAME	TITLE	TYPE / PLACE	DATE
Shiva Shadrooh	Money Laundry Detection using Graph Analytics	NorwAI Partner Lunch Seminar	2022-03-09
Mateja Stojanovic	Recommending Learning Objects: Design and Challenges	NorwAI Partner Lunch Seminar	2022-03-23
Shweta Tiwari	Detection of Potential Manipulations in Electricity Market using Machine Learning Approaches	NorwAI Partner Lunch Seminar	2022-04-06
Ludvig Killingberg	Bayesian Exploration in Reinforcement Learning	NorwAI Partner Lunch Seminar	2022-04-20
Bjørnar Vassøy	Fair Variational Autoencoders for Recommendation	NorwAI Partner Lunch Seminar	2022-05-04
Christian Agrell	Probabilistic ML for safety-critical systems	NorwAI Partner Lunch Seminar	2022-05-18
Egil Rønningstad	Entity-level sentiment analysis	NorwAI Partner Lunch Seminar	2022-06-01
Zhenyou Zhang	Estimate the RUL based on environmental and performance data	HYB workshop	2022-08-26
Even Pettersen	The Valhall Compressor	HYB workshop	2022-08-26
Sølve Eidnes	Port-Hamiltonian Neural Networks	HYB workshop	2022-08-26
Andreas Hafver	Draft framework for assurance of AI	NorwAI Forum	2022-08-31
Andris Piebalgs	WP8 - Data and Platforms for AI	NorwAI Forum	2022-08-31
David Baumgartner	Anomalies and time-series data	NorwAI Forum	2022-08-31
Egil Rønningstad	Entity-level Sentiment Analysis	NorwAI Forum	2022-08-31
Helge Langseth	Language and Personalization (LAP)	NorwAI Forum	2022-08-31
Jon Atle Gulla	NorwAI Forum	NorwAI Forum	2022-08-31
Kenth Engø-Monsen	WP6 STREAM: AO for streaming and sensor-based data	NorwAI Forum	2022-08-31
Nhien Ngyuen	AI Innovation Ecosystems	NorwAI Forum	2022-08-31
Signe Riemer-Sørensen	HYB: When will my system break? WP HYB: Hybrid AI models for physical systems	NorwAI Forum	2022-08-31
Susanne Bauer	Accountability in AI development and innovation: social science approaches	NorwAI Forum	2022-08-31
Tanja Knaus	The materialization of the human voice into affective data - data practices of vocal emotion recognition systems for call centres	NorwAI Forum	2022-08-31
Abdulmajid Murad (IIK, NTNU)	Uncertainty-Aware Autonomous Sensing with Deep Reinforcement Learning	NorwAI Partner Lunch Seminar	2022-09-28
Mila Dimitrova Vulchanova (ISL, NTNU)	Early Language Development in the Digital Age: State-of-the-Art and why is new research needed	NorwAI Partner Lunch Seminar	2022-10-05

NorwAI in the media
in 2022

Kunstig intelligens og læringsanalyse for læring og vurdering
(utdanningsnytt.no, 2022-01-12)

Hør på meg! Episode 4 (Teknologi=Frihet?)
(HLF's podcast series on impaired hearing in the work life)

Taleteknologi
(Teknologirådet, 2022-05-31)

Neste generasjons chatboter kan komme fra forskningssenteret NorwAI
(digi.no, 2022-07-16)

Ny AI vil skape fundamentale endringer, sier professor
(Aftenposten, 2022-10-17)

Schibsted oppretter egen framtidslab
(pressemelding Schibsted, 2022-10-24)

Schibsted oppretter egen framtidslab
(Ny Teknikk, 2022-10-26)

Kunstig intelligens i praksis
(pressemelding NorwAI, 2022-10-31)

Imponert over smarte svar fra chatboten?
Ny AI får plusspoeng for å lure deg
(Aftenposten.no, 2022-12-09)

Populær chatbot gir faktafeil
(Aftenposten (papiravis), 2022-12-11)

Taleteknologi og kunstig intelligens
(Teknologirådet, 2022-12-29)

Personnel

KEY RESEARCHERS

NAME	INSTITUTION	MAIN RESEARCH AREA
Piebalgs, Andris	Cognite	Big Data, Information Retrieval, Machine Learning, Hybrid Analytics
Hafver, Andreas	DNV	Trustworthy AI
Løland, Anders	Norsk Regnesentral	Machine Learning, Statistics
Lison, Pierre	Norsk Regnesentral	NLP, Privacy and Security, Machine Learning, Information Retrieval, Semantics, AI and Society, Big Data
Pilán, Ildiko	Norsk Regnesentral	NLP, Privacy and Security, Machine Learning
Teigland, André	Norsk Regnesentral	Machine Learning, Statistics
Barnes, Jeremy	Norsk Regnesentral	NLP, Machine Learning
Bach, Kerstin	NTNU	AI and Society, Innovation Processes, Personalization, Machine Learning, Trustworthy AI
Gulla, Jon Atle	NTNU	NLP, Personalization
Høverstad, Boye	NTNU	Machine Learning
Ingvaldsen, Jon Espen	NTNU	Innovation processes
Kraemer, Frank Alexander	NTNU	Machine Learning, Internet of Things
Langseth, Helge	NTNU	Machine Learning, Probabilistic AI
Nguyen, Nhien	NTNU	Innovation processes
Nørvåg, Kjetil	NTNU	NLP, Data Mining, Database Systems, Big Data, Information Retrieval
Özgöbek, Özlem	NTNU	Personalization
Berre, Arne Jørgen	SINTEF Digital	AI Innovation, Semantics and Standardization
Bervig, Joel	SINTEF Digital	Data analysis, Machine learning
Hoffman, Volker	SINTEF Digital	Streaming Data Analytics, AI Innovation
Lech, Till Christopher	SINTEF Digital	Natural Language Processing, Language Models, AI Innovation
Michalowska, Katarzyna	SINTEF	Machine Learning, Hybrid Analytics
Reimer-Sørensen, Signe	SINTEF Digital	Machine Learning, Hybrid Analytics
Roman, Dumitru	SINTEF Digital	Data Pipelines, Data Processig, Data for AI
Rustad, Anne Marthine	SINTEF Digital	Hybrid Analytics, Cybernetics
Stasik, Alexander Johannes	SINTEF Digital	Machine Learning, Hybrid Analytics
Thomas, Aleena	SINTEF Digital	Natural Language Processing, Language models, Fake News, AI Innovation
Engø-Monsen, Kenth	Telenor	Big data, AI and Society, Privacy and Security, Machine Learning
Martinkenaite, Ieva	Telenor	Innovation processes
Bauer, Susanne	UiO	AI in Society
Velldal, Erik	UiO	NLP, Machine Learning
Øvrelid, Lilja	UiO	NLP, Machine Learning
Balog, Krisztian	UiS	NLP, Semantics, Personalization, Information Retrieval, Machine Learning

VISITING RESEARCHERS

NAME	AFFILIATION	NATIONALITY	DURATION	TOPIC
Ławrynowicz, Agnieszka	Poznan University of Technology	Poland	2022-10-17 – 2021-10-21	Research collaboration on CBR for Nutrition/Recipe Recommendation
Rosso, Paolo	Universitat Politecnica de Valéncia	Italy	2022-08-08 – 2022-08-12	
Wrembel, Robert	Poznan University of Technology	Poland	2022-11-03 – 2022-11-04	

POSTDOCTORAL RESEARCHERS

Postdoctoral researchers with financial support from the center budget:

NAME	NATIONALITY	PERIOD	TOPIC
Liu, Peng	China	2020-12-07-2023-12-06	Language models for natural language processing, Conversational systems

Postdoctoral researchers working on projects in the center with financial support from other sources:

NAME	FUNDING	NATIONALITY	PERIOD	TOPIC
Kille, Benjamin	NTNU	Germany	2021-05-01-2023-04-30	Personalization, Natural Language Processing, and Machine Learning for Banking and Finance
Zhang, Lemei	NTNU	China	2022-04-04 – 2025-04-30	Streaming Data Analytics

PHD STUDENTS

PhD students with financial support from the center budget:

NAME	NATIONALITY	PERIOD	TOPIC
Baumgartner, David	Austria	2021-09-21—2025-08-31	Data analysis with noisy and low-quality data streams
Bernard, Nolwenn	France	2022-02-01 – 2025-01-31	Study of fairness and transparency in conversational recommender systems
Knaus, Tanja	Austria	2022-04-01 – 2025-04-30	The materialization of the human voice into affective data - data practices of AI cloud services using vocal emotion recognition systems
Łajewska, Weronika	Poland	2022-02-01 – 2025-01-31	Personalizing Conversational Informational Access
Michałowska, Katarzyna	Poland	2021-01-01 – 2024-12-31	Informed machine learning
Nikolov, Nikolay	Bulgaria	2021-01-01 – 2024-12-31	Flexible Deployment of Big Data Pipelines on the Cloud/ Edge/Fog Continuum
Rønningstad, Egil	Norway	2021-10-14 – 2024-10-13	Entity-level Sentiment Analysis
Vassøy, Bjørnar	Norway	2021-08-02 – 2025-08-01	Fairness, Accountability, Transparency and Privacy in Personalization/ Recommender systems

PHD STUDENTS

PhD students working on projects in the center with financial support from other sources:

NAME	FUNDING	NATIONALITY	PERIOD	TOPIC
Barlaug, Nils	RCN/Cognite	Norway	2019-08-01 –	Data Integration
Bayrak, Betül	NFR/NTNU (Exaigon)	Turkiye	2022-01-19 – 2025-01-18	Explainable Case-Based Reasoning
Bekkemoen, Yanzhe	NTNU	Norway	2019-10-01 – 2024-09-30	Probabilistic approaches to explainable AI and reinforcement learning.
Bjøru, Anna Rodum	NTNU	Norway	2021-11-11 – 2025-11-10	Explainable deep bayesian learning
Doan, Tu My	NTNU	Vietnam	2020-01-06 – 2024-01-05	Political Text Mining
Firouzjaei, Hassan Abedi	NTNU	Iran	2019-06-20 – 2023-06-19	Querying and mining location-based social network data
Killingberg, Ludvig	NTNU	Norway	2019-10-01 – 2024-09-30	Bayesian deep learning and reinforcement learning
Logacjov, Aleksej	NTNU	Germany	2021-02-01 – 2024-01-31	Self-supervised learning for Human Activity Recognition
Maropaki, Stella	RCN	Greece	2016-05-01 – 2022-05-31	Database systems
Shadrooh, Shiva	DNB	Iran	2020-02-20 – 2024-09-30	Anomaly detection in streaming graphs
Stojanovic, Mateja	NTNU	Serbia	2020-12-01 – 2024-11-30	Recommender Systems for Enhancing Students' Learning in Higher Education
Xing, Yujie	DNB	China	2021-01-30 – 2023-01-27	Informed Machine Learning

MASTER DEGREES (2022)

Master students obtaining their degree on NorwAI topics in 2022:

NAME	PERIOD	PROJECT
Aas, Sebastian	2021-08-01 – 2022-06-30	Modular Actor-Critic System for Automated Security Trading
Andersen, Alexander Meldal	2021-08-01 – 2022-06-30	Sequence Input Aggregation
Bhaiji, Nora Andrea	2021-07-01 – 2022-05-31	Governing Speech in Digital Era: Norwegian Policy Responses to Disinformation and Digital Educational Tools for Increasing Critical Thinking Skills
Bynke, Mathias	2021-08-01 – 2022-06-30	Multi-label image classification with language-image models: an approach for a fine-grained domain-specific dataset
Caprioli, Emanuele	2021-08-01 – 2022-06-30	Classification of Birdsong using semi-supervised deep learning
Carlsen, Theodor	2021-08-01 – 2022-06-30	Tempura: A GraphX extension for temporal graphs in Apache Spark
Falch, William	2021-08-01 – 2022-06-30	Measuring the Effect of Recommender Systems in Online Video Learning Platforms: A Case Study with Utdannet.no
Fredheim , Alexander Nes	2021-08-01 – 2022-06-30	Group Betweenness Centrality on Dynamic Graphs
Gundersen, Lars Hegg	2021-08-01 – 2022-06-30	Analyzing and Predicting Performances and Playing Styles of Football Players
Hatløⱥ, Andreas Moe	2021-08-01 – 2022-06-30	Å lære No-Press Diplomacy fra Selvspill: Dyp Reinforcement Learning med Fokus på Samarbeid mellom Agenter
Hernandez, Andres Javier Estevez	2021-08-01 – 2022-06-30	Combining question answering models with transformer -based generative conversational agents
Høijord, Espen Hansen	2021-08-01 – 2022-06-30	Explainable AI (XAI) for grid loss forecasting
Ingstad, Magnus Sikora	2021-07-01 – 2022-05-31	Fast generation of realistic SZ maps using machine learning methods
Johannessen, Albert	2021-08-01 – 2022-06-30	Motion Classification with Neural Ordinary Differential Equations
Jørgensen, Victor	2021-08-01 – 2022-06-30	Predictive Modeling Using Pseudo-Social Networks Derived from Transaction Data
Kim, Markus Malum	2021-08-01 – 2022-06-30	Analyzing and Predicting Performances and Playing Styles of Football Players
Kopperud, Eivind	2021-08-01 – 2022-06-30	Tempura: A GraphX extension for temporal graphs in Apache Spark
Langseth, Adrian W.	2021-08-01 – 2022-06-30	Use of Spatial Information in News Recommenders

MASTER DEGREES (2022)

Master students obtaining their degree on NorwAI topics in 2022:

NAME	PERIOD	PROJECT
Løtuft, Stig André	2021-08-01 – 2022-06-30	Water management
Merola, Marco Antonio	2021-08-01 – 2022-06-30	Artificial Intelligence for assessing road usage e-scooters
Moan, Martin Andreas	2021-08-01 – 2022-06-30	Noise in the sea: the quest to detect and classify animal and man-made sounds
Nilsen, Daniel	2021-08-01 – 2022-06-30	Leveraging Natural Language Processing in Data Synthesis for use in Entity Matching
Ohr, Vebjørn	2021-08-01 – 2022-06-30	NASH: Range Search over Temporal, Numerical, and Geographical Annotated Documents
Pram,Christopher Stundal	2021-08-01 – 2022-06-30	Web-based dashboard for physiotherapy recommendations
Sande, Hans Kristian	2021-08-01 – 2022-06-30	Predictive Modeling Using Pseudo-Social Networks Derived from Transaction Data
Simmersholm, Aleksander	2021-08-01 – 2022-06-30	Leveraging Natural Language Processing in Data Synthesis for use in Entity Matching
Sivertsvik, Matias	2021-08-01 – 2022-06-30	Deep Learning for Robotic Manipulation of Soft Objects
Skjelvik, Thomas Christian Dahle	2021-07-01 – 2022-05-31	Artificial intelligence with artificial futures. A case study of Norwegian tech-firms and the developmental trajectory of a novel technology
Smith, Peder	2021-08-01 – 2022-06-30	Systems for Efficient Storage and Retrieval of Dynamic Networks
Stensaker, Mina Takle	2021-08-01 – 2022-06-30	Political Categorization of Norwegian Text
Strobel, Eliot Karlsen	2021-08-01 – 2022-06-30	Analyzing and Predicting Performances and Playing Styles of Football Players
Trygstad, Mattis Levik	2021-08-01 – 2022-06-30	Modular Actor-Critic System for Automated Security Trading
Ulve, Hedda Sofie	2021-08-01 – 2022-06-30	Utilizing Fine-Grained Transaction Data for Predicting the Life Event of Residential Change
Welle-Vatne, Pernille Nødtvedt	2021-08-01 – 2022-06-30	Popularity Bias in Job Recommender Systems
Yu, Jenny Jinyi	2021-08-01 – 2022-06-30	Utilizing Fine-Grained Transaction Data for Predicting the Life Event of Residential Change
Østerhus, Siri Bjåland	2021-08-01 – 2022-06-30	Omsorg gjennom skjermen? En kvalitativ casestudie om hvordan psykisk behandling endres ved digitalisering

MASTER'S STUDENTS ASSISTANTS

NAME	PERIOD	PROJECT
Lars Ådne Heimdal	2021-06-01 – 2022-05-31	Research assistant: "Kaia" the social robot
Christian Riksvold	2021-06-01 – 2021-07-31	Research assistant: "Kaia" the social robot
Even Flem Hagen	2021-09-01 – 2022-05-31	Research assistant: "Kaia" the social robot
Håkon Bygdås Høgset	2022-09-01 – 2023-05-31	Research assistant: "Kaia" the social robot API development in NorwAI GPT Language Modeling
Alexander Michael Ås	2022-09-01 – 2023-05-31	Research assistant: "Kaia" the social robot API development in NorwAI GPT Language Modeling
Marte Eggen	2022-09-01 – 2023-05-31	Research assistant: "Kaia" the social robot API development in NorwAI GPT Language Modeling
Elizabeth Ainan Pan	2022-09-01 – 2023-05-31	Student assistant, communication and student marketing

Accounts

2021	FUNDING	COSTS
The Research Council	6916	
The Norwegian University of Science and Technology (NTNU)	7716	9096
Research Partners*)	3111	8647
Enterprise partners**)	8753	8753
Total	26496	26496

*) Norwegian Computing Center (NR), SINTEF, University of Oslo and University of Stavanger.

**) ANEO, Cognite, Digital Norway, DNB, DNV, Kongsberg Digital, NRK, Retriever Norway, Schibsted, Sparebank1 SMN, Telenor

All figures in 1000 NOK.

Reports
in 2022

NAME	TITLE	SOURCE	DATE
Tore Tennøe / Jonas Engestøl Wettre. (Jon Atle Gulla medlem i ekspertgruppen) medforfatter	Taleteknologi og kunstig intelligens	Kortrapport: Teknologirådet - Fra rådet til tinget, desember 2022	2022-12-29

Publications
in 2022

JOURNAL PAPERS

Casolo, S. (2022)
Severe slugging flow identification from topological indicators.
Digital Chemical Engineering.

Doan, T. M., Gulla, J. A. (2022)
A Survey on Political Viewpoints Identification.
Online Social Networks and Media.

PUBLISHED CONFERENCE PAPERS

Bayrak, B., Bach, K. (2022)
When to Explain? Model Agnostic Explanation Using a Case-based Approach and Counterfactuals. Proceedings of the 34th Norwegian ICT conference for research and education – NIKT 2022. (In press)

Knaus, T. (2022)
The automation of affective data — Infrastructure and database practices of speech recognition software systems. Infrastructures of Autonomy Conference, Berlin, Germany

Rønningstad, E., Øvrelid, L., Velldal, E. (2022).
Entity-Level Sentiment Analysis (ELSA): An Exploratory Task Survey. Proceedings of the 29th International Conference on Computational Linguistics

Mæhlum, P., Haug, D. T. T., Jørgensen, T.E., Kåsen, A., Nøklestad, A., Rønningstad, E., Solberg, P. E.; Velldal, E.; Øvrelid, L. (2022). NARC – Norwegian Anaphora Resolution Corpus. Proceedings of the 29th International Conference on Computational Linguistics

Asad, H. A., Kraemer, F. A., Bach, K., Renner, C., Veiga, T. S. (2022).
Learning attention models for resource-constrained, self-adaptive visual sensing applications. RACS '22: Proceedings of the Conference on Research in Adaptive and Convergent Systems.

Chiusano, S., Cerquitelli, T., Wrembel, R, Nørvåg, K., Catania, B., Vargas-Solar, G. Zumpano E. (2022)
New Trends in Database and Information Systems in ADBIS 2022 Short Papers, Doctoral Consortium and Workshops: DOING, K-GALS, MADEISD, MegaData, SWODCH, Turin, Italy, September 5–8, 2022, Proceedings.

Bayrak, B., Marin-Veites, P., Bach, K. (2022)
Explaining your Neighbourhood: A CBR Approach for Explaining Black-Box Models. CEUR workshop proceedings (In press)

Flogard, E. F., Mengshoel, O. J., Bach, K. (2022)
Creating Dynamic Checklists via Bayesian Case-Based Reasoning: Towards Decent Working Conditions for All. Proceedings of the Thirty-First International Joint Conference on Artificial Intelligence AI for Good.

Vlachou, A., Doulkeridis, C., Rocha-Junior, J. B., Nørvåg, K. (2022)
On Decisive Skyline Queries in Lecture Notes in Computer Science book series (LNCS,volume 13428).

Zhou, B., et al. (2022)
The Data Value Quest: A Holistic Semantic Approach at Bosch in The Semantic Web: ESWC 2022 Satellite Events. ESWC 2022. Lecture Notes in Computer Science, vol 13384.

Xing, Y., Cai, J., Barlaug, N., Liu, P., Gulla J. A. (2022)
Balancing Multi-Domain Corporate Learning for Open-Domain Response Generation. Findings of the Association for Computational Linguistics: NAACL 2022 (pp. 2104–2120), Seattle, United States. Association for Computational Linguistics.

Liu, P., Marco, C., Gulla, J. A. (2022)
Building Sentiment Lexicons for Mainland Scandinavian Language Using Machine Translation and Sentence Embedding. Proceedings of the13th Conference on Language Resources and Evaluation (LREC 2022) (pp. 2816-2825).

Doan, T. M., Kille, B., & Gulla, J. A. (2022)
Using Language Models for Classifying the Party Affiliation of Political Texts. In International Conference on Applications of Natural Language to Information Systems (pp. 382-393). Springer, Cham.

eds. Hagen, M., Verberne, S., Macdonald, C., Seifert, C., Balog, K., Nørvåg, K. Setty, V. (2022)
Advances in Information Retrieval 44th European Conference on IR Research, ECIR 2022, Stavanger, Norway, April 10–14, 2022, Proceedings, Part II eds. Hagen, M., Verberne, S., Macdonald, C., Seifert, C., Balog, K., Nørvåg, K. Setty, V. (2022). Advances in Information Retrieval 44th European Conference on IR Research, ECIR 2022, Stavanger, Norway, April 10–14, 2022, Proceedings, Part I.

NorwAI Norwegian Research Center for AI Innovation

The Research Council of Norway

NTNU

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