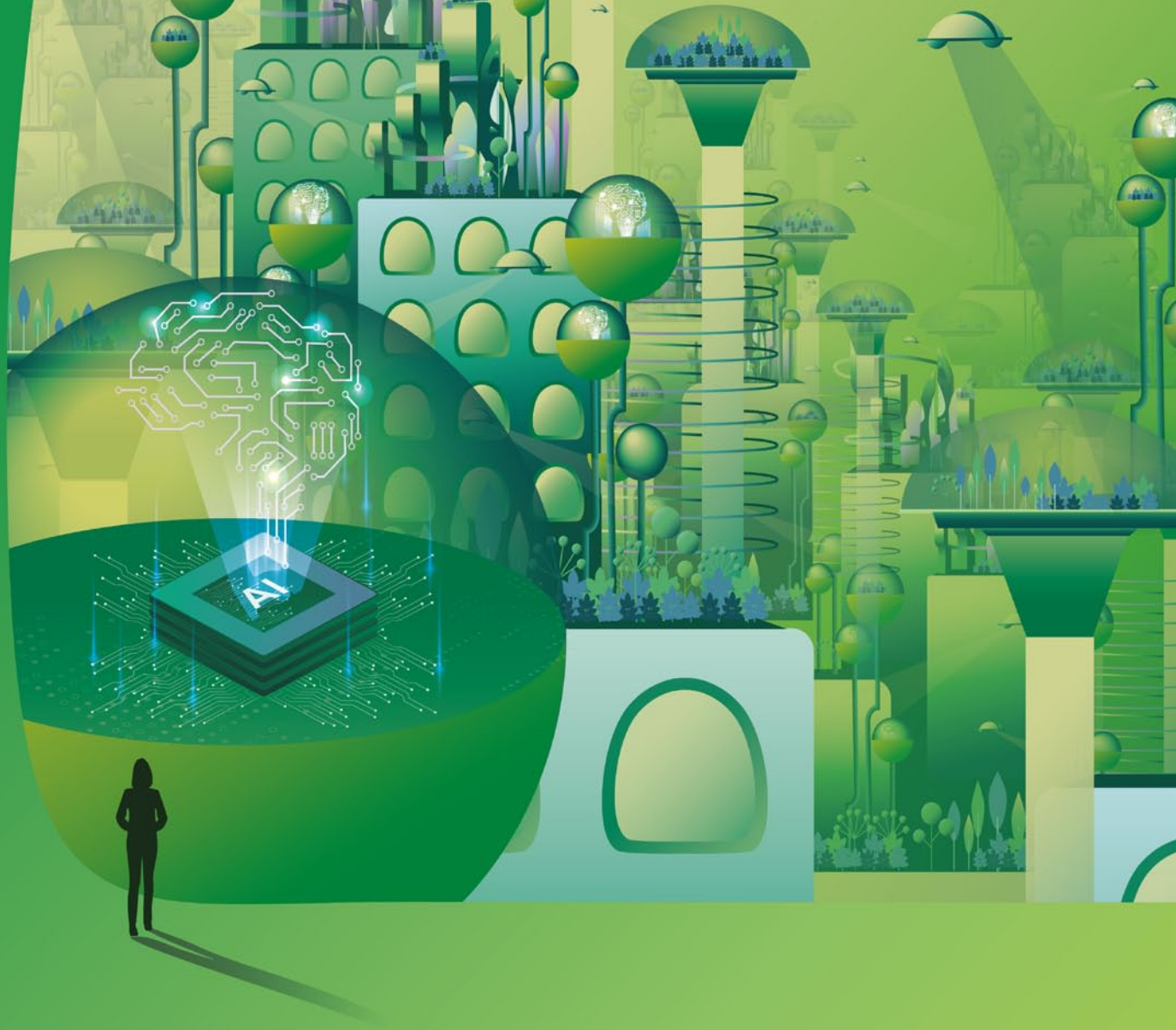

EU-LIFE

EU-LIFE UTOPIA Conference 2024

A Social Innovation Experiment with Artificial Intelligence

26 April 2024, Vienna, Austria

The grand, neo-baroque festival hall of the Federation of Austrian Industries, with its coffered ceiling and galleries, created a thematic bridge to the past. The historical ambiance was cleverly interrupted by several art installations: wildly intertwined cables, screens, LED lights, and computer components greeted conference visitors in the foyer, surrounding an antiquated needle printer that emitted conversation proposals for a specially designed social network called Catwork on endless paper. At the entrance of the festival hall, electronic waste formed an oversized mobile hanging from the gallery, complemented on the opposite stage by a wild array of colorful screens, whose images would play a role throughout the conference.

December 2024

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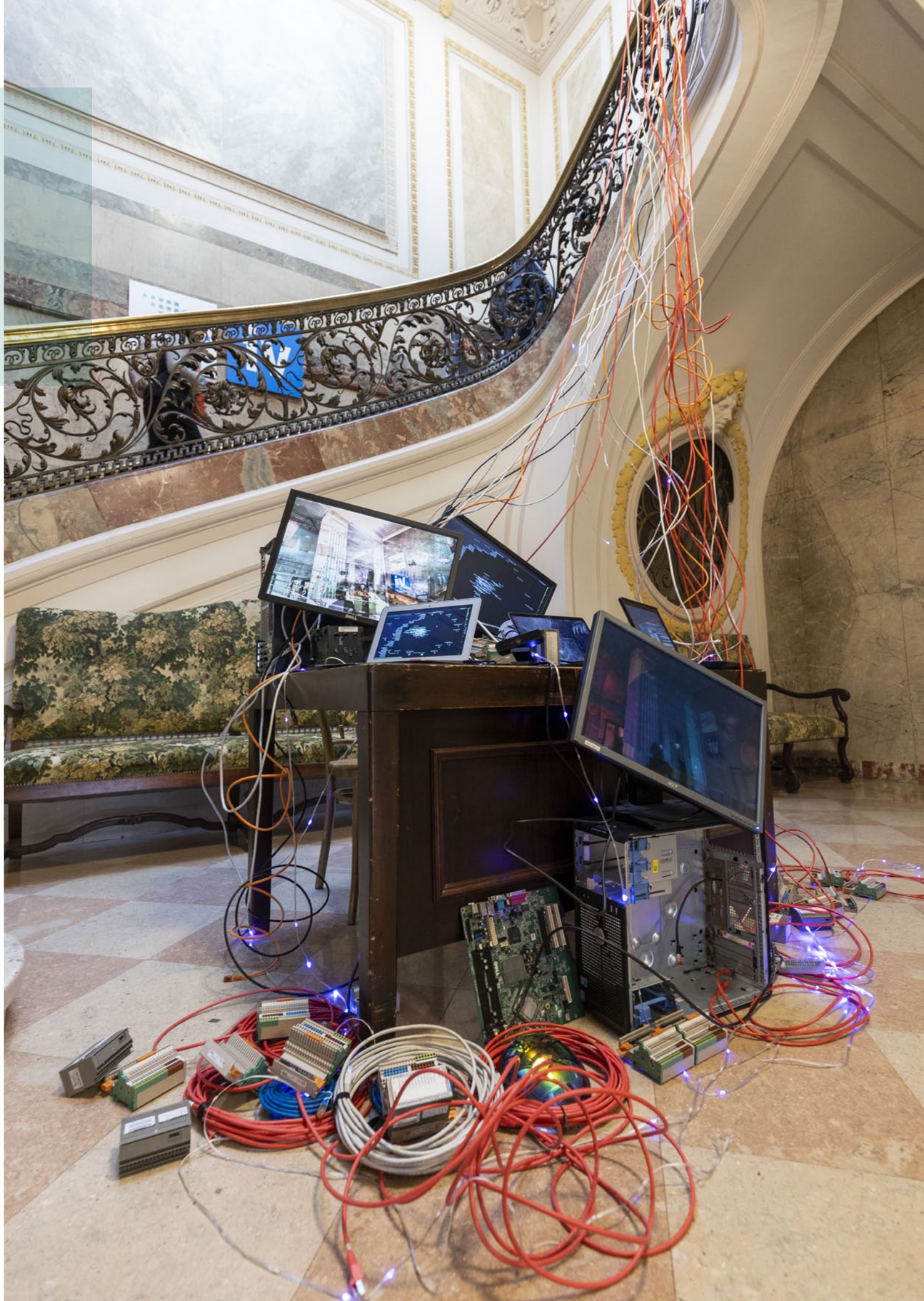

Conference's Organising Committee

- André Rendeiro, Principal Investigator at CeMM
- Jörg Menche, CeMM Adjunct Principal Investigator
- Giulio Superti-Furga, Co-Chair of EU-LIFE & Scientific Director of CeMM
- Anita Ender, Main Representative at EU-LIFE & Administrative Director of CeMM
- Andreas Angermayr, Head of the Scientific Office & Lab Manager at CeMM
- Marta Agostinho, EU-LIFE Executive Director
- Esther Dorado-Ladera, EU-LIFE Communications Officer
- Iris Uribesalgo, EU-LIFE Policy Officer
- Marijn Huiskamp, EU-LIFE Community Office

Acknowledgements

We are really grateful to CeMM and the Federation of Austrian Industries for being the most charming and generous hosts. We would also like to sincerely thank all the speakers for their valuable contributions and the attendees for their participation.

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Introduction

Artificial Intelligence (AI) is no longer a distant dream; it has become an integral part of our daily lives. Nearly every computer-assisted application today is somehow linked to AI or machine learning, and new generations of intelligent algorithms are being developed and commercialized at an accelerating pace. But what does this mean for science, particularly in biology and biomedicine? How is AI reshaping research, what opportunities does it offer, and what risks must we consider? These pressing questions took center stage at the EU-LIFE Utopia Conference 2024, hosted in the ceremonial halls of the Federation of Austrian Industries, and co-organized by the EU-LIFE office and CeMM, the Research Center for Molecular Medicine of the Austrian Academy of Sciences in Vienna.

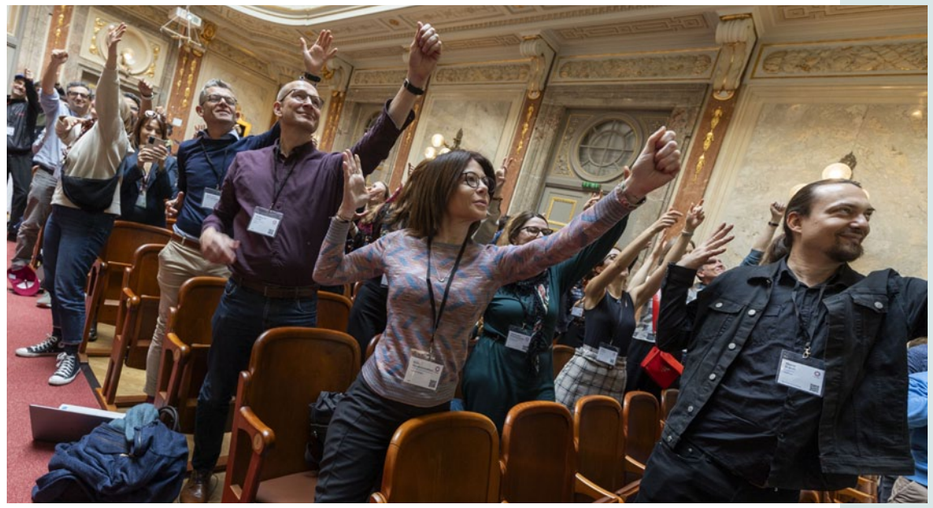
EU-LIFE

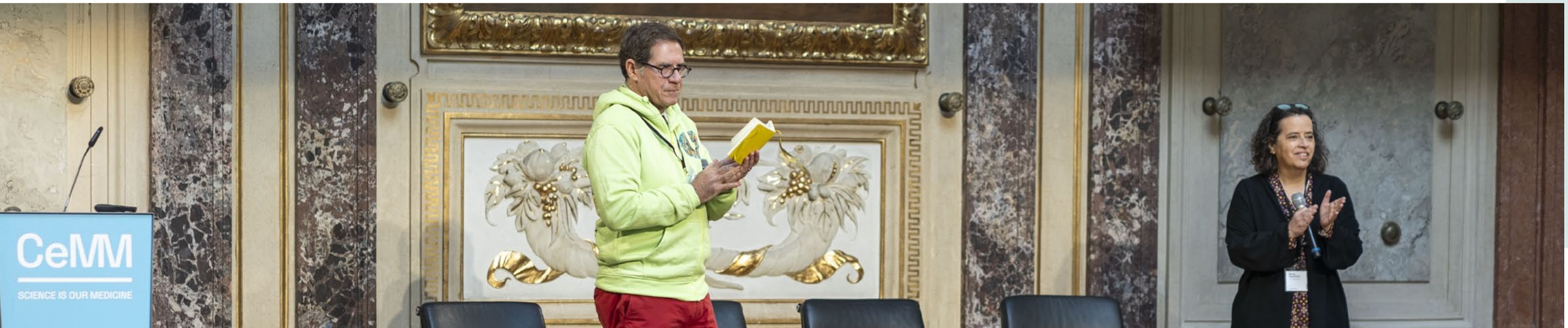
CeMM

SCIENCE IS OUR MEDICINE

Welcome

Marta Agostinho, Executive Director of EU-LIFE, and Giulio Superti-Furga, EU-LIFE Chair, gave a passionate welcome address and discussed the original purpose of EU-LIFE and its ability to provide a platform to envision the future — because things only happen when they can be imagined. They emphasized that the mission of EU-LIFE, and the conference on AI, is to dream big to enable innovative science. Together with the audience, Agostinho and Superti-Furga launched their dreams as imaginary arrows soaring far into the future.





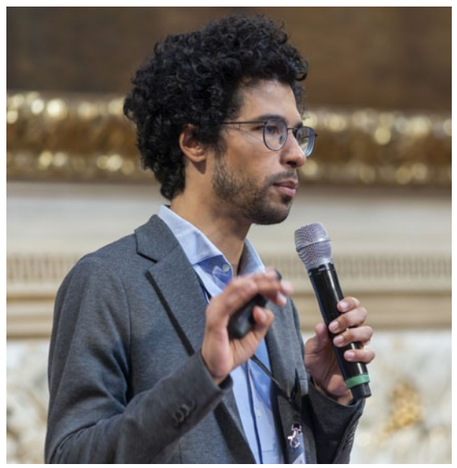
STATE OF THE ART

Regina Beets-Tan, NKI

Regina Beets-Tan introduced the session on the current state of biomedicine, providing an overview of AI's current applications in cancer imaging. AI is utilized to analyze radiology images and detect tumors at an early stage. In the future, Beets-Tan hopes that AI will not only analyze image data but also include molecules and cells.

By combining data from radiology and precision medicine with AI, not only can better prevention and treatment be achieved, but costs can also be reduced, significantly increasing the availability of cancer screening and treatment. This is also the goal of the European Cancer Imaging Initiative, part of Europe's Beating Cancer Plans.

André Rendeiro, CeMM

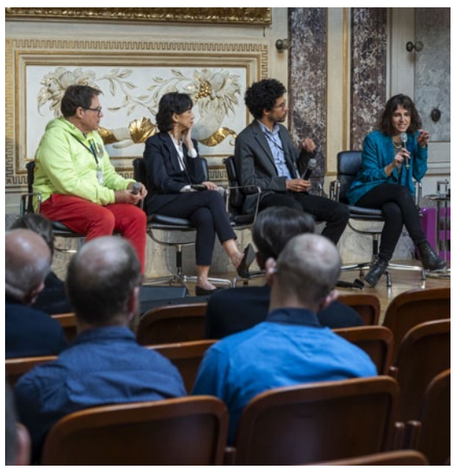


André Rendeiro demonstrated the remarkable capabilities of AI to combine different types of data through multi-modal models. This allows for the combination of the natural language of pathologists with images from histopathology, leading to more robust models with less bias. Histopathological models often suffer from biases related to the ethnic or socioeconomic backgrounds of the patients from whom the data is derived. Multi-modal models are not limited to text and image data; they can also include molecular data such as sequencing and gene expression data. Rendeiro concluded his talk by addressing the rapid advancements AI has made in recent years, but he also emphasized **areas where AI will not be able to replace human capabilities: creativity, intuition, subjective judgment, ethical considerations, and contextual knowledge**.

Mafalda Dias, CRG

Mafalda Dias illustrated how AI can assist in analyzing the diversity of life to gain insights into diseases. Her research group is developing models that evaluate the impact of genetic variations on the molecular function and phenotypes of various organisms. **Using deep learning algorithms that can consider entire genome sequences when analyzing complex conservation patterns, predictions about the pathogenicity of certain gene variants and their molecular functions within organisms can be made.** Dias aims to go beyond the currently available genomes; while around 150 mammalian genomes are currently accessible, she envisions incorporating the gene sequences of all eukaryotes on the planet into her research—potentially even including extinct species by accessing bioarchives.

Discussion with the audience

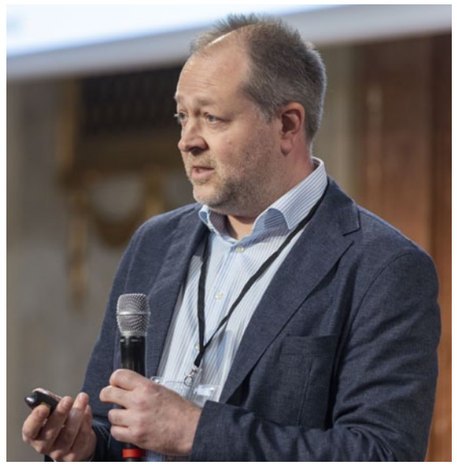


The panel discussion was moderated by Giulio Superti-Furga. Regina Beets-Tan provided the key advice for the next generation on how AI should be used in the future: AI should not be viewed as something that will change everything, but rather as a tool for more efficient and cost-effective work. It should be employed to deliver better outcomes while allowing more time for innovation. Whether AI is the right tool depends on the question one aims to answer with it, added Mafalda Dias. In any case, this tool should be used to make healthcare systems more affordable—a consensus among the speakers. They stressed that the benefits of AI must be accessible and transparent to the entire planet and not withheld from the global south, and that there must be information available at all levels, from patients to treating doctors.

GENERATIVE BIOLOGY

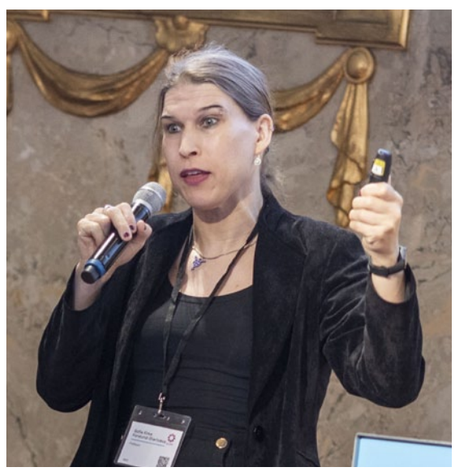
Generative AI can not only train on data or analyze and process it but also create new content. The following speakers offered a glimpse into the future of how generative AI will be applied in biology, shifting the boundaries of synthetic biology. Generative AI can invent new DNA sequences, among other capabilities.

Alexander Stark, IMP



Alexander Stark revealed how deep learning can be used to decode transcriptional regulation, a significant challenge for science since it often occurs over non-coding regions of DNA. The effects of mutations in these sequences are, in contrast to the coding regions that produce proteins, unpredictable. However, most single nucleotide polymorphisms (SNPs)—mutations at a single point in the genome associated with diseases—are found in these non-coding regulatory regions. **AI now enables a better understanding and prediction of the role of these regions and the effects of mutations.**

Sofia Forslund, MDC

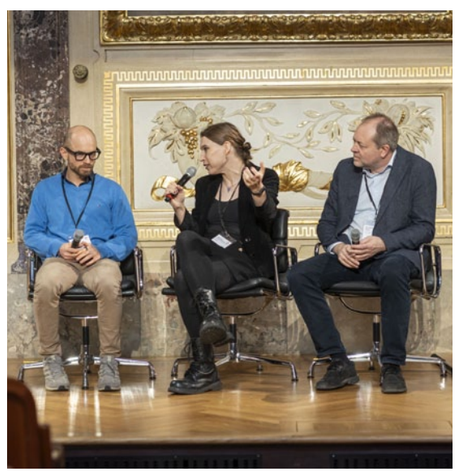


Sofia Forslund talked about high-throughput systems medicine. She focused on developing AI models that work with natural language, which she sees as promising generative AI approaches for biomedicine. Currently, this works well for datasets that have a directional reading, such as DNA, RNA, or protein sequences. Forslund aims to elevate this to a multidimensional, systemic level to capture the entire human organism and its internal and external interactions throughout the lifespan, enabling a comprehensive understanding and treatment of patients. **The challenge lies in extracting realistic and meaningful content from the vast amounts of data from blood or stool samples, as living organisms also exhibit chaotic processes that are difficult to model.** Therefore, her research aims to find a language for AI that minimizes this chaos.

Moritz Schäfer, CeMM

Moritz Schäfer discussed the potential of AI in managing the massive data generated by single-cell sequencing, particularly single-cell transcriptomics data. The cells need to be automatically clustered into increasingly smaller groups and mapped. AI is envisioned to be utilized in the future, guided by natural language. Users could ask AI, "What are the biological hallmarks of this cell?" and AI would respond, "This is an epithelial cell with strongly activated protein synthesis." Schäfer and his colleagues are working on a **system that combines transcriptomic and text data to train their AI models. He has already demonstrated that such a system can facilitate genuine conversations with the AI regarding an experimental dataset,** with AI providing the desired answers—a system Schäfer has dubbed the "cell whisperer."

Discussion with the audience



The panel discussio addressed a question posed by the AI programmed by the Menche group: What challenges do you see for AI to replace humans?

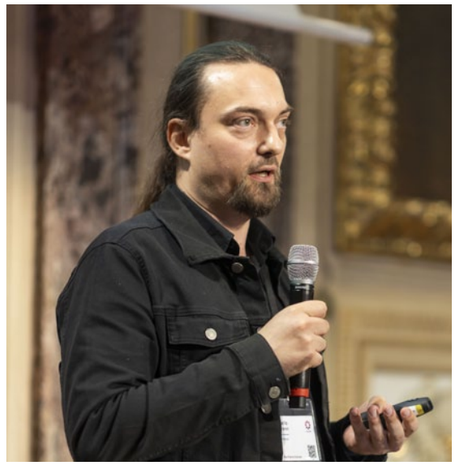
Another question from the previous session resurfaced: What is the impact of AI on the global south, and how can inequalities be addressed?

The speakers agreed that **AI is likely to follow a trajectory similar to that of mobile phones—eventually, everyone will use it. The key to this is an open-source mentality, as only this will ensure maximum accessibility**.

FUTURE OF RESEARCH

Speakers explored how AI could radically expand the boundaries of what we consider research, redefine curiosity, and reshape the way we pursue curiosity-driven endeavors. Moreover, the session touched upon the normative, ethical, and legal guidelines that will inevitably accompany the use of AI.

Mario Krenn, Max Planck Institute for Science of Light



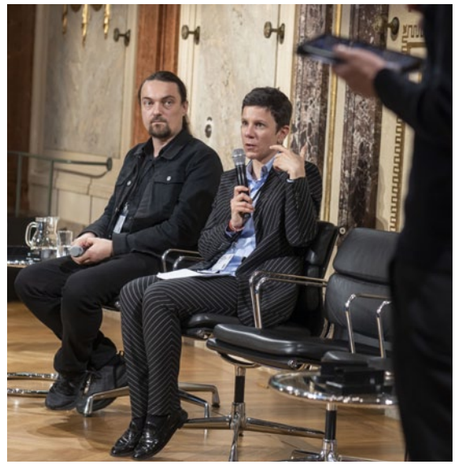
Mario Krenn talked about Artificial Intelligence as a muse for new ideas. His goal was to design a computer program that inspires surprising and interesting ideas, which led him to confront the question: what does it mean for something to be surprising and interesting? To objectively define these terms, he worked with a "knowledge graph" feeding it large datasets. This allowed Krenn to trace how quantum physics had developed over time and, with the help of machine learning, to make predictions about how research might evolve in the future. For Krenn, **AI is more than just a simple tool—he sees the potential to build an "artificial scientist." But to achieve this, we first need to better understand fundamental aspects of human nature, such as creativity, curiosity, and comprehension**.

Fruzsina Molnár-Gábor, Heidelberg University

Fruzsina Molnár-Gábor offered a legal perspective on artificial intelligence, with a particular focus on medical and biomedical applications. She outlined the current developments in the EU and highlighted what is still lacking or not fully considered when it comes to normative standards, whether ethical or legal obligations. She summarized the **AI Act, a binding regulation through which the EU aims to manage AI-associated risks in a unified way**. She then outlined **three key areas at stake: first, anonymization; second, bias and discrimination; and finally, the reliability of products**.

She also spoke about the European AI Office, which is embedded in the AI Act and intended to act as a market surveillance authority and develop codes of practice. Finally, she provided an outlook on how AI regulations should be shaped in the future.

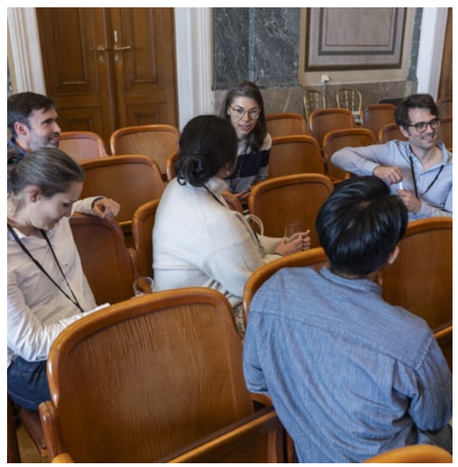
Discussion with the audience



Molnár-Gábor described mechanisms by which the legal system can respond to future developments that have yet to occur—a crucial issue, especially with AI, which is evolving rapidly and raising a myriad of ethical questions.

When asked if it would be possible to develop an ethically pure AI model, Molnár-Gábor answered that, in principle, yes — creating such AI is the goal of regulations. However, she noted that the greatest challenges lie in how such models are trained and who makes those decisions. Mario Krenn added that **one major problem is that common sense is extremely difficult for artificial intelligence to learn, particularly without accumulating bias**.

A social innovation experiment with AI



The conference included a social innovation experiment with AI, focusing on the connections among conference participants.

Following registration, **AI randomly assigned each participant a partner for this session** and printed out icebreaker questions for conversation. were given time to reflect and discuss the conference topics with their assigned partners.

If interesting thoughts or results emerged, they could feed them into the microphones provided by the Menche group, who were in charge of capturing the exchanges. It was a new and refreshing format that stimulated engagement and idea exchange.

IMPACT OF AI IN SCIENCE & SOCIETY

To conclude this report and provide some key takeaways, we asked the conference speakers two broad questions about the impact of artificial intelligence—here are their responses.

What do you think is the most imminent impact that AI will have in your field and for society?

André Rendeiro, CeMM

"Most imminently in my work is the acceleration of certain tasks like writing and programming (especially for non-routine things), as well as having a shallow understanding of an entirely new field. For example, the other day I wanted to remember how Wi-Fi radio antennas work and chatting about it was a good way. I also estimate my long-form writing is about 3x faster with AI for certain tasks."

Sofia Forslund, MDC

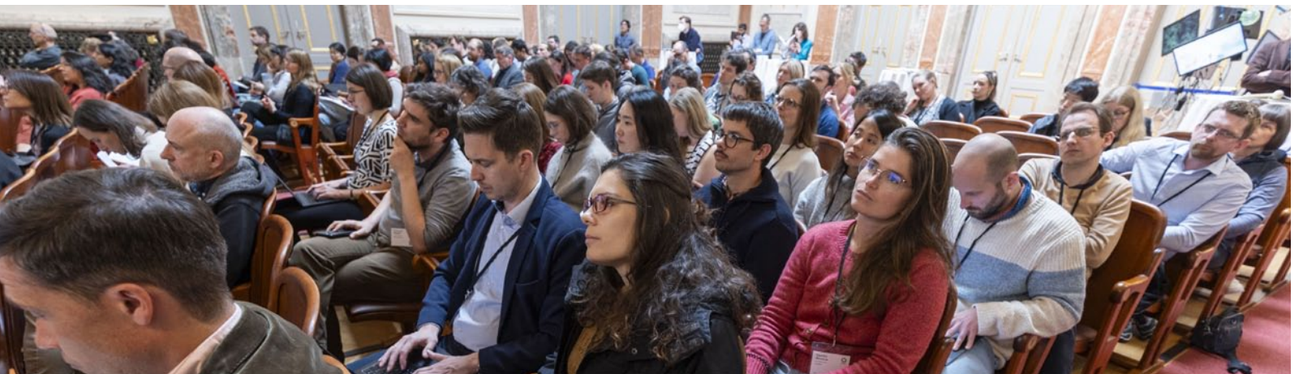
"In my field, there will no longer be an excuse to not scale work up as much as data allows, so the standard for comprehensiveness will go up. For society, many day-to-day tasks will become radically easier and that will change what people attempt and how. In addition, many ideas currently really poorly communicated will become moderately acceptably communicated."

Mario Krenn, Max Planck Institute for Science of Light

"In physics, we will learn more and more use cases of processes that can be automated. For instance, a lot of physics requires programming. Programming will very soon be completely automated and performed by ML models, that are interacted with natural language. The quick access to systems that can perform tasks that before were only performed by domain experts (programming, but also creative tasks such as image generation, text generation, music generation, and video generation) will completely transform society, democratizing intellectual and creative capabilities."

Moritz Schäfer, CeMM

"Modern Deep Learning (DL) methods became effective in embedding almost any data modality, many of which are hard to interpret for humans, given our limited senses. Humans have developed their languages as a strong interface to capture almost arbitrary concepts and information. AI has the potential to leverage language and function as an interface to all sorts of complex data. As for society, the impact will be learning! The 'early adopters' of Large Language Models (LLM) technology already realize the immense potential of LLMs to learn much more effectively than was previously possible with books and lectures. Having a personal assistant to ask instantly about not-yet-understood details within the learning matter of subject was a dream of mine during my university studies. This will relatively soon 'spread-over' to larger parts of society, especially the younger generations, with the potential to lead to an unprecedented surge in mental capabilities."



What do you think will be the most significant impact that AI will have in the future in your field and for society as a whole?

André Rendeiro, CeMM

"The most significant impact might be related to something we learn about ourselves. What is it that really is unique to humans? To think? To create? To have oneself? These questions are not new, but the debate has certainly broadened across society lately."

Sofia Forslund, MDC

"In my field, we will need to realize that much of what we do is simple and repetitive, and possible to automate. Not all can be automated, but the growth potential and long-term survival belongs to those who can guide and curate automated output as well as to add further sparks of creativity where they make a difference. In a way the same can be said for society, but that does mean that we have the same challenge as during the industrial revolution. We need an economic system that can let humans be useful as humans, guiding impersonal intelligences rather than competing with them. Universal basic income and/or universal equity of means of production may be necessary. We also must find ways of making AI carbon sustainable."

Mario Krenn, Max Planck Institute for Science of Light

"A lot of tasks in physics will be entirely automated. For example, theoretical physics might be the first that will see an enormous impact from AI, by tools that can find new representations and laws from data and literature. Experimental physics will require more time, because interaction with the real world is extremely difficult, as we see in the slow progress of robotics (compared to tools like GPT). However, AI tools can suggest new experiments to be performed, which can be implemented by experienced human researchers (which, to a rudimentary step, we already do today). For society, I think we are in the middle of an explosion, and it is extremely difficult to predict a long-term (5-10 years) future at this moment."

Moritz Schäfer, CeMM

"Biology is probably the most complex 'system' in the universe and we only understand small isolated aspects of it. More systemic biological understanding can arise with AI models, given their potential to seemlessly consume and combine large amounts of experimental data from diverse types of sources and modalities. Humans still perform a significant amount of their work performing 'manual labor'. Whereas Artificial General Intelligence (AGI) is the main hype topic these days, AI-driven advancements in robotics are probably much more realistic within the coming decade and can have an equally strong impact."

Alexander Stark, IMP

"For our field, AI will be able to link any functional property that can be measured in high throughput (e.g. genome wide) with the underlying sequence, e.g. the enhancer sequence. I also see efforts under way to link such associations to natural languages, as we saw for example for the cellwhisperer approach. Similarly, AI will reach human or superhuman performance in any prediction or classification task that can be learned on sufficiently large dataset. I feel that we'll witness tremendous progress in all these tasks and areas.."

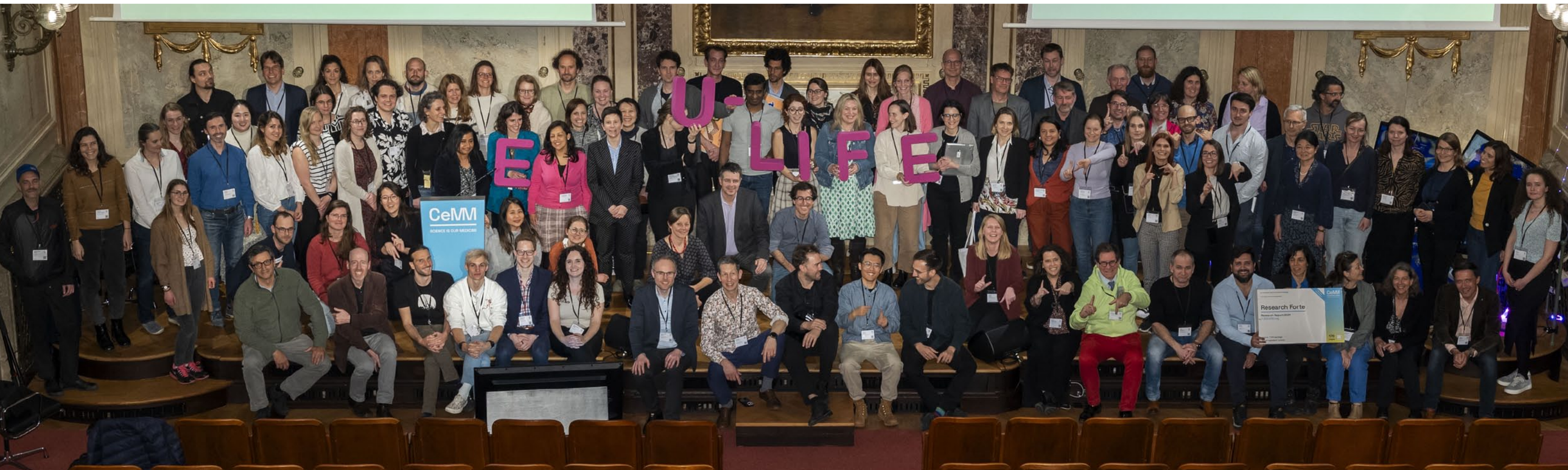
REFLECTIONS & INSIGHTS

The EU-LIFE Utopia Conference 2024 demonstrated the profound impact AI is poised to have on biomedicine, from enhancing cancer detection to driving the future of synthetic biology. The conference highlighted the potential of AI to make healthcare more efficient, accessible, and personalized, while also underscoring the ethical responsibilities that come with these advancements.

By blending insightful talks, innovative art, and collaborative experiences, the conference set a tone for what the future of research could look like: a future driven by technology but always guided by human values and global inclusivity.

The conference was co-located with the EU-LIFE Community Meeting 2024, which was hosted by our member institute CeMM in Vienna and attended by staff members of all EU-LIFE institutes who are involved in the alliance.

This event is organised annually and hosted by a different EU-LIFE member institute every year. Its main purpose is to provide the community with an update of EU-LIFE's activities, share the work carried out by the different working groups, align strategies for the upcoming year, and foster collaboration among the members of the alliance.



About EU-LIFE

EU-LIFE is an alliance of research centres whose mission is to support and strengthen European research excellence. EU-LIFE members are leading research institutes in their countries and internationally renowned for producing excellent research, widely transferring knowledge and nurturing talent. Since its foundation in 2013, EU-LIFE is a stakeholder in European policy participating regularly in the EU policy dialogue. More at www.eu-life.eu

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