OPEN INNOVATION IN SCIENCE

OIS research conference

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2022
May 11–13

Geneva
Switzerland

Welcome to the Open Innovation in Science (OIS) Research Conference 2022!

While the past years have greatly challenged our professional and personal lives, they have also triggered extra-ordinary solidarity both within and beyond the scientific community. In the face of a pandemic, vast amounts of publications and data are being shared openly, and remote collaborations have become daily routines. More recently, researchers, research institutions, and funding agencies have stepped up to provide ad-hoc jobs and emergency grants to fellow scientists affected by the war in Ukraine.

Increasingly sophisticated technologies, from Google Workspace to Starlink, have helped to facilitate these responses. New machine learning techniques and the use of artificial intelligence (AI) are providing opportunities to improve the ways in which scientific research is conducted – from identifying research gaps to facilitating scientific paper writing. What is more, they may also help promote a more inclusive and collaborative approach towards the production and dissemination of scientific research.

In light of these developments, this year's conference specifically seeks to explore the "relationships between artificial intelligence and openness and collaboration in science". And where would be a better place to talk about this important topic than at the CERN IdeaSquare?

Integrating this special theme into the overall focus, the OIS Research Conference continues to
- Inspire discussions around an integrated and contingent view on the role and value of openness and collaboration in the context of science,
- Connect researchers across various disciplines, and
- Link different streams of research on open and collaborative science as well as science-based innovation

In addition to high-quality research paper sessions and projects applying OIS practices, this year's OIS Research Conference features a variety of interactive sessions dedicated to the special theme, including an exciting OIS debate, an inspiring keynote speech, and, as has become tradition, an OIS experimentation session. This year, we will again "walk the talk" by experimenting with a series of novel AI-based tools that have been designed to facilitate particular steps of the research process and we will explore the tools' potential to make the scientific research process more open and collaborative.

Thank you for being a part of the OIS research community! We are very grateful for your contributions and we are thrilled to have you join us as we continue to build the foundations of more open and collaborative approaches to studying science and innovation!

Yours sincerely,

The Organizing Committee

The Organizing Committee

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Conference Organizational Support

LAËTITIA VEYRAT

BENJAMIN BUSSER

Contents

KEYNOTE

Keynote
by Dashun Wang
May 11 | 16:15 – 17:15

Dashun Wang

- Dashun is Professor of Management & Organizations at the Kellogg School of Management, Professor of Industrial Engineering & Management Sciences (Courtesy) at the McCormick School of Engineering, at Northwestern University, and Director of the Center for Science of Science and Innovation (CSSI).
- As Founding Director of the Center for Science of Science and Innovation (CSSI), he leads a group of highly interdisciplinary researchers who are extremely passionate about data.
- His current research focus is on Science of Science, a quest to turn the scientific methods and curiosities upon ourselves, hoping to use and develop tools from complexity sciences and artificial intelligence to broadly explore the opportunities and promises offered by the recent data explosion in science. A core question driving his research is "How can Big Data help us understand human behavior, social networks, and success?"
- His research has been published repeatedly in journals like *Nature* and *Science*, and has been featured in virtually all major global media outlets, including *The New York Times, Wall Street Journal, Financial Times, World Economic Forum, Harvard Business Review,* and *The Today Show*, among others.

OIS DEBATE

OIS Debate:
Will artificial intelligence make science more open and collaborative?

May 12 | 16:45 – 18:15

Moderator: Henry Sauermann

Panelists

Kevin Crowston

- Kevin is a distinguished Professor of Information Science and Associate Dean for Research at the School of Information Studies at Syracuse University.
- He is Co-Editor-in-Chief of the journal *Information, Technology and People* and editor-in-chief of *ACM Transactions on Social Computing*.
- His research examines new ways of organizing made possible by the use of information technology. Specific domains of interest include free/libre open source software development projects, citizen science projects, and research data management.
- His most recent and NSF funded research focuses on intelligent support for non-experts to navigate large information spaces and the use of human-technology collaborative approaches to re search. He also heads a Research Coordination Network to develop a socio- technical perspective on work in the age of intelligent machines.

James Evans

- James is a Professor of Sociology and Faculty Director of the Masters Program in Computational Social Sciences at the University of Chicago and an external Professor at the Santa Fe Institute.
- He is the Founding Director of the Knowledge Lab, which seeks to accelerate scientific progress by conceiving of and implementing revolutionary computational approaches to reading, reasoning, and hypothesis design.
- His research focuses on the collective system of thinking and knowing, especially with regards to innovation – how new ideas and practices emerge – and the role that social and technical institutions (e.g., the Internet, markets, collaborations) play in collective cognition and discovery.
- His work has been published in a number of prominent journals, including *Nature*, *Science*, and *Administrative Science Quarterly*, and has also been featured in the *Economist*, *Atlantic Monthly*, *Wired*, *NPR*, *BBC*, *El País*, *CNN*, *Le Monde*, and many other outlets.

Hila Lifshitz-Assaf

- Hila is an Associate Professor of Information, Operations and Management Sciences at New York University Stern School of Business and faculty associate at Harvard University, at the Lab for Innovation Science.
- Her research focuses on developing an in-depth empirical and theoretical understanding of the micro-foundations of scientific and technological innovation and knowledge creation processes in the digital age.
- She investigates new forms of organizing for the production of scientific and technological innovation such as crowdsourcing, hackathons, and AI.
- Her research has received a number of awards, including Best Administrative Science Quarterly (ASQ) paper based on dissertation (2018) and Best published paper elected by organizational communication and information systems division of Academy of Management (2018). Her work has received the prestigious INSPIRE grant from the National Science Foundation.

Anita Schjøll Brede

- Anita is the CEO and Co-Founder of Iris.ai, an innovative artificial intelligence company that has set out to build an "AI Researcher". They have developed a range of AI-based tools to automate search, filtering, summarization, and extraction and systematizing of data from research documents.
- Her work sets out to democratize access to science by removing requirements to have deep domain expertise in every field you work with, thus allowing more people to solve more difficult and interdisciplinary problems.
- Her career has spanned over 9 industries including developing an e-learning tool in Silicon Valley, performing theatre for babies, facilitating solar light business creation in Kenya, and trying to disrupt the recruitment industry.
- She was listed by Forbes as of the World's Top 50 Women in Tech in 2018, has been named one of InspiringFifty Nordics' most inspiring women in tech, has done two TEDx talks, and has founded several startups. She is also alumni of the SU Global Grand Challenges Award and TechCrunch Disrupt Startup Battlefield.

OIS EXPERIMENTATION SESSION

OIS Experimentation Session:
Experimenting with Artificial Intelligence for openness and collaboration in science

May 12 | 13:45 – 16:15

Each year, participants of the OIS Research Conference are given the opportunity to experiment with novel approaches to incorporating open and collaborative practices into their own research. This year, participants experiment with artificial intelligence (AI) tools that have been developed to facilitate specific aspects of scientific research and reflect on their potential.

Contributing to the trend in exploring opportunities for AI-inspired solutions in science, we hope that the OIS experimentation session further shapes the research agenda by pointing towards the untapped potential, undiscovered risks, and boundary conditions for the **relationships between AI and openness and collaboration in science**.

OIS research conference

SESSION 1

Paper Session 1: Open data and infrastructure sharing
May 11 | 13:00 – 14:15

Chair: Susanne Beck
Discussants: Gaétan de Rassenfosse & Benedikt Fecher

Paper 1:
Responding to unavoidable challenges: Balancing GDPR and openness in the research commons

Leighann Kimble

As open science is increasingly encouraged due to its value in advancing research and innovation (Ayre & Craner, 2017; Beck et al., 2019; Corrales-Garay et al., 2019; Dai et al., 2018), the European Union General Data Protection Regulation (GDPR) has presented a means of ensuring protection and primary of data (Hallinan, 2020; Peloquin et al., 2020; Ursin & Bentzen, 2021). Despite the importance of ensuring data privacy and protection in research, GDRP presents barriers to openness in data sharing and collaboration within the commons environment (Clarke et al., 2019; Mondschein & Monda, 2019; Philipps & Knoppers, 2019). Although data sharing and collaboration are central to the scientific commons, in project design, the barriers associated with ensuring GDPR compliance and implications for practice may be easily overlooked. In the interdisciplinary commons environment, in which multiple organizations are involved, each organization may have its own internal approaches for interpreting GDPR and developing responses for ensuring data protection. These differences in interpretation of and actions in response to GDPR, in turn, present potential challenges to openness, particularly when conflicting interpretations exist. Although GDPR remains essential in ensuring data protection and privacy, GDPR remains in tension with open science (Mondschein & Monda, 2019; Philipps & Knoppers, 2019; Staunton et al., 2019 Suman & Pierce, 2018) due to the constraints it poses to open collaboration and sharing of data and resources. Moreover, compliance with GDPR and its associated barriers has been recognized as an unavailable aspect of data sharing and collaboration (Peloquin et al., 2020).

In this paper, we explore the challenges that emerge in interpreting and responding to GDPR within a large interdisciplinary research consortium that consists of nine organizations across 12 countries in Europe. We demonstrate how responses to GDPR differ by actor, discipline, and organizational structures and implications for data sharing and collaboration within the consortium. As will be reflected in this research, the challenges associated with GDPR within the context of this consortium result in time delays in gaining the needed permissions to share data between actors. Due to time delays, which impede developments within the research, GDPR compliance is placed in tension with achieving time-sensitive project objectives. Within this context, we explore how responses to GDPR are balanced with project objectives and how such responses are reflected in the practice of data sharing and collaboration within the consortium. We conclude with a discussion of the balance between open science and data protection and implications for practice.

Paper 2:

Safe crossings: The role of scientific support occupations in attenuating secrecy in core facilities

Danielle Bovenberg

Shared scientific facilities or "core facilities" have become increasingly important to science (Nielsen 2012, Tuertscher et al. 2014, Lippens et al. 2019). These technically advanced shared laboratories are often envisioned as places where scientists share knowledge with each other around shared instrumentation to advance their field as a whole (Owen-Smith 2018, Meder et al. 2016). We know, however, that scientists often hesitate to share knowledge about ongoing work – particularly with close peers or competitors – because they want to gain credit for their own work and to win potential priority disputes (Haas and Park 2009, Nelson 2016). What is often overlooked in discussions of knowledge sharing in these scientific communities is the role that the scientific support staff play, not only in moving knowledge across the field to advance the field, but in enabling the diffusion of valuable technical knowledge among competing scientists (Barley and Bechky 1994, Milojevic et al. 2018). This study examines the role of scientific support staff in competitive science through an ethnography of two nanofabrication facilities, large core facilities that provide semiconductor fabrication cleanrooms and equipment to a regional community of researchers. The study examines how the facilities' staff engineers sought to achieve "safe crossings" between projects of facility users: occasions when operationally useful information was transferred between potentially competing research groups in ways that were strategically innocuous. The findings contribute to research on the changing scientific workforce, scientific secrecy, and technical communities of practice by showing the strategies by which technical intermediaries share and withhold information to increase the potential for open innovation in competitive scientific communities.

Paper 3:
Biological repositories: Feeding a virtuous cycle of inter-institutional research co-creation

Carolin Haeussler, Fabian Hans, Riold Furtuna, Samantha Zyontz

Open science, a central pillar of the Republic of Science, impacts research design, sharing and reusing of scientific inputs and results, as well as the overall scientific output (e.g., Furman & Stern, 2011; Murray et al., 2016). Additionally, it builds on the importance of openly sharing and accessing knowledge, data, or scientific tools (e.g., Mukherjee & Stern, 2009; Murray et al., 2016).

Access to inputs has become more important as the increasing complexity of science requires a combination of specialised skills and knowledge, often accompanied by access to data and lab-equipment (Haeussler & Sauermann, 2020). As a result, we have seen an increase in collaborative research (Wuchty et al., 2008) that often spans institutional boundaries (e.g., Adams et al., 2005; Jones et al., 2008), resulting in growing collaborative networks (e.g., Newman, 2001; 2004).

Typically, both access to scientific tools and team formation are shaped by societal and geographic networks, which can become entrenched over time due to, amongst other factors, homophily, status (e.g., McPherson et al., 2001; Ruef et al., 2003), inertia (McFarland & Dahlander, 2014), geographical proximity (Catalini, 2018; Chai & Freeman, 2019), and social networks (e.g., Jones et al., 2008; Ding et al., 2010).

However, open science spurs new channels facilitating sharing. These channels may even be able to crack societal and geographical factors that have determined who engages with whom, potentially resulting in new interinstitutional and international co-creation patterns.

To investigate how open science channels, such as biological repositories, affect the importance of proximity and established networks for-creation, we focus on the role of Addgene, a key biological repository for plasmid sharing (LaManna & Barrangou, 2018). Specifically, we investigate how the use of Addgene influences interinstitutional co-creation, defined as co-authored publications. Our main interest is in examining whether such platforms break or erode entrenchment factors to scientific access by decoupling network positions from access to research inputs.

Our empirical analysis builds on a unique data set on the rapidly evolving DNA-editing technology, CRISPR. The data set includes depositing and ordering information on more than 12,000 plasmids from Addgene and more than 14,000 publications in this research field accessed from Microsoft Academic. We apply regression and network analysis at an institutional level to investigate how (inter)national research collaborations emerge and evolve considering sharing events.

Preliminary results indicate that Addgene users, when compared to non-users, create and co-create significantly more. Furthermore, Addgene users that also publish on the CRISPR field, compared to non-publishing Addgene users, are significantly more active in terms of their ordering and depositing behavior. Our next step is to apply network analysis techniques to trace the development of co-creation networks as well as difference-in-difference estimation to analyze the impact of Addgene depositing and ordering on co-creation. Our study aims to contribute to the science in science (e.g., Wuchty et al., 2007; Jones et al., 2008) and Open Science literature (e.g., Mukherjee & Stern, 2009) by, mainly, examining whether and how sharing platforms diminish the impact of proximity and make social networks more permeable for outsiders.

SESSION 2

Paper Session 2: Linkages between science and industry
May 11 | 14:30 – 15:45

Chair: Henry Sauermann
Discussants: Katrin Hussinger & Martin Wörter

Paper 4:
Structure and dynamics of regional research landscape

Indira Yarullina

The core proposition of the Triple Helix concept is that universities play an enhanced role in innovation in knowledge-based societies (Etzkowitz and Leydesdorff, 2000). However, empirical research on the embeddedness of actors in the regional knowledge base lacks a comprehensive approach towards the structure and the dynamics of the interaction of academic actors with non-academic actors. First, scholars approach the topic in particular via university-industry co-publishing with the main focus on the broad scientific disciplines, where the collaboration takes place (Abramo et al., 2009; Bloch et al., 2019). Second, the role of universities under knowledge and technology transfer (KTT) is mainly evaluated from the economic perspective (patenting, academic spin-outs) (Trencher et al., 2014b,a). Therefore, there is a need to extend the traditional assessment of the regional knowledge creation and exchange for KTT.

To provide means for this more general assessment, I develop a methodology that evaluates the research capabilities of the region to measure and investigate the field-specific contribution of the university and non-university actors. Thus identifying the potential 'room' to intervene and improve the embeddedness of actors in the regional knowledge base system. I apply bibliometric analysis on scientific knowledge produced in the German regions to re-create the structure and dynamics of the regional knowledge base (Bloch et al., 2017). The data is extracted from the Dimensions database and it consists of scientific papers with abstracts and authors' affiliations for the period 2000-2020. Germany consists of several NUTS1 regions and I look at the development of these regions over three periods of time. I apply topic modelling on words and bigrams extracted from the titles and abstracts of the papers to divide the broad disciplines into smaller parts (Asmussen and Møller, 2019). Then, I use the revealed comparative advantage index (Balland and Boschma, 2021; Nesta and Patel, 2005) to measure the specialisation of the region in particular topics. Finally, I estimate what actors contribute to the creation of these topics.

When exploring the regional perspective, I estimate the performance of the region in terms of collaboration and specialisation in KTT attractive areas. This approach allows for pinpointing the level of KTT (collaboration) in the region and identifying potential areas for development. The paper provides a methodological basis for the potential application of publication data in analysing the regional competencies in the research area and identifying the target areas for KTT and Smart Specialisation Strategy.

This research tries to turn the traditional approach toward universities as 'servants' of firms and society and explore closely what is actually going on in the academic sphere. This is especially relevant for KTT studies that try to explore the obstacles of University-Industry interaction: by exploring the possible mismatch of when regional universities offer and what other actors are doing. Such composition of knowledge specialization of the region can create priorities for Smart Specialization in a region: setting priorities towards some specific research areas (e.g. via funding) and not dispersing focus on all actors and activities (Foray and Goenaga, 2013; Balland and Boschma, 2021).

Paper 5:
Openness in industry-science collaborations: An assessment of contractual provisions

Christoph Grimpe, Knut J. Egelie, Haakon Thue Lie, Roger Sørheim

Industry-science collaboration in research and development (R&D) constitutes an important channel for academic knowledge to reach the industrial domain. However, industry participation in or sponsorship of academic research has frequently been shown to limit the disclosure of research results, methods, or materials. Industry may strive to avoid or delay the public release of knowledge and research results, for maybe even longer than the time needed to file a patent, in order to secure private financial returns. Secrecy imposed by firms can therefore threaten the norms of "open science", a paradigm for creating a cumulative, reliable, and publicly available stock of scientific and technical knowledge.

Since the Bayh-Dole Act in the US and similar legislation in most European countries have been implemented several decades ago, however, firms may not be the only partners in research consortia seeking secrecy. Universities increasingly strive for success in both academic research and exploitation of research results in order to generate income. In fact, this may lead universities to promote secrecy, infringing the norms of open science themselves.

Despite the importance to understand the conditions under which secrecy in collaborative research may emerge, however, our understanding of when universities may limit the openness of knowledge and research results is incomplete. In this research, we focus on the contractual agreements that the partners in a consortium have negotiated among themselves. Based on an analysis of the full text of the contractual agreements of 484 projects funded by the Research Council of Norway in the period from 2009 to 2017, we code the provisions associated with the handling of knowledge and intellectual property (IP). We then estimate the relationship between the contractually agreed openness of the project and the distribution of ownership and use rights among industrial and university partners, controlling for project and partner characteristics.

We find that, not surprisingly, industry ownership of project IP and industry ownership of the use rights to the IP are negatively associated with the project's openness. While we cannot establish a significant relationship for joint IP ownership, we find that joint IP use rights are negatively associated with project openness, too.

In that sense, our research uncovers two interesting findings. First, while exclusive university ownership and use rights to IP would not infringe a project's openness, use rights to IP that are jointly allocated to industry and universities do in fact associate with lower openness, indicating that in such circumstances universities impose secrecy because they want to profit from commercializing the research. Second, the findings seem to be driven by the question of who is assigned the use rights to the IP and the mere ownership to the IP. This is another indication that the motivation to commercialization hinges on the rights to use the research commercially, not necessarily the ownership to them.

Paper 6:
Addressing complex problems through industry-academic collaboration: A temporal perspective on scientific knowledge production

Susan Hilbolling, Pernille Smith

Open science collaborations, such as research consortia, are particularly suited for tackling complex problems or grand challenges because they bring together dispersed knowledge. At the same time however, when open science collaborations involve a heterogeneity of parties, this can create tensions in the knowledge production process. For example, industry partners' involvement potentially impairs university scientists' opportunities to do basic research (e.g., Beck at al., 2021) because they are driven by commercial incentives (e.g., patents, innovation). This raises the question of how scientific knowledge production activities for complex problems can be organized in open science collaborations, so that it accommodates both individual parties and collective knowledge goals. This question might not be completely new, however, as in recent years we are witnessing a growth in huge and much more complex industry-university collaborations, and we believe that we are dealing with a different kind of collaboration setting than traditionally more confined industry-university collaborations. By adopting a process research approach (e.g., Langley et al., 2011), we aim to unpack how parties accommodate differences in interests as the collaborative process unfolds over time.

To address our research question, we perform an in-depth longitudinal case study of a large international and inter-disciplinary research consortium in the healthcare sector. The goal of the consortium is to advance knowledge on a serious but understudied complication of diabetes that has severe consequences for patients' health and well-being and society at large. We have been following the work between scientists from universities and companies for over three years through meeting observations, interviews, and documents (data collection and analysis are still ongoing).

Our preliminary analysis revealed that while the consortium is "pre-competitive", the parties were highly strategic about their involvement, yet this didn't create the expected tensions but instead fostered the scientific collaborations. We explain this empirical surprise through analyzing three complementary types of knowledge production activities that were key in the collaborative process: (1) "knowledge organization and validation" aimed at collecting prior research evidence through e.g., pooling past clinical data in a big database and literature reviews, (2) "knowledge expansion" aimed at building a foundation for future research (i.e., basic science), and (3) "knowledge alignment" aimed at bringing together dispersed knowledge together through e.g., creating new standards and measurement tools. Interestingly, the (strategic) relevance and impact of the knowledge output of each of these activities had a time-horizon that spanned far beyond the duration of the consortium (4 years), i.e., long after the collaboration would officially be dissolved. Stated differently, the relatively short time frame of the consortium enabled collaboration that would benefit the involved parties in the long term. This study provides insight into how open science collaboration with industry partners can be designed by balancing knowledge work within and outside the temporal boundaries of the collaboration. By doing so we address a call for more research on industry-academia collaboration on scientific activities that are not aimed at innovation (Heimstadt and Friesike, 2020).

Paper 7:

The potential impact of Open Science Partnerships on scientific research and its uptake in industry

Maria-Theresa Norn, Irene Ramos-Vielba, Louise Isgaard Saugstrup, Massimo Graae Losinno, Thomas Kjeldager Ryan, Carter Walter Bloch

In recent years, a small but growing number of Open Science Partnerships (OSPs) have emerged. OSPs are a novel form of public-private research collaborations that adhere to principles of openness, including free and wide dissemination of research outputs and the absence of intellectual property rights (IPR). OSPs differ in their aims but share objectives such as the advancement of science, accelerating the uptake of research outputs in industry, and bolstering the contribution of science to the development of solutions to unsolved challenges in industry and society. OSPs are described as part of a response to challenges in industrial R&D, such as declining productivity of R&D and limitations of closed, IPR-reliant innovation models.

With the exception of a handful of studies focused on the Structural Genomics Consortium, OSPs have been the subject of limited, systematic study. Given the growing interest in OSPs, there is a need for further research on their defining features and their outcomes for the development and application of scientific research.

This paper presents the preliminary findings from an impact assessment of the Open Discovery Innovation Network (ODIN) at Aarhus University, an ongoing three-year project funded by a philanthropic foundation that provides competitive funding for open basic research collaborations between academic researchers and private firms with the aim of accelerating drug discovery.

We investigate in what respects and to what extent ODIN differs from conventional frameworks for university-industry collaboration, and what motivates academic researchers and private firms, respectively, to enter into ODIN-funded projects. Implications for the potential impact of ODIN on scientific research and its use and uptake in industry are discussed. The paper draws on a document study of ODIN and the 11 projects that have been funded and initiated under ODIN, as well as on interviews with principal investigators and industry participants in the projects.

SESSION 3

Paper session 3: Crowds, citizens, and AI in science

May 12 | 11:30 – 13:00

Chair: Egor Burda
Discussants: Sabine Brunswicker & Chiara Franzoni

Paper 8:
AI and citizen science for serendipity

Marisa Ponti, Anastasia Skarpeti, Bruno Kestemont

Polyak (2020) argued that introducing AI to creative practices destroys spontaneity, intuition and serendipity in favour of deliberate and premeditated outcomes. However, the design of systems that leverage complex interactions between citizen scientists and computational AI methods have the potential to facilitate creative exploration and chance encounters.

Citizen science – when the general public is actively engaged in research tasks – is already well established in fields such as astronomy and astrophysics, ecology and biodiversity, archaeology, biology, and neuroimaging (Vohland et al., 2021). Citizen scientists are often untrained amateurs recruited by scientists to collect or classify large volumes of data, or solve challenging puzzles (Gura, 2013). Citizen scientists significantly outnumber professional scientists and are rarely experts in the field of the citizen science projects in which they participate. However, curious and dedicated citizen scientists have often shown abilities that can lead to serendipitous encounters (Beaumont et al., 2014). The sheer amount of data potentially generated by citizen science projects, in combination with large numbers of participants, can result in serendipitous discoveries, such as the formation of a novice star, the discovery of a new species, the detection of human neurons, or the formation of a new protein (Parrish et al. 2019).

So far, few studies have investigated how computational methods such as machine learning (ML) could facilitate serendipity in citizen science as well as optimize accuracy and efficiency (Trouille, Lintott, & Fortson, 2019). This perspective paper considers the design of hybrid citizen science systems to demonstrate their potential for serendipitous discovery. Hybrid systems should be designed to stimulate participants' serendipitous encounters, rather than to detect serendipitous occurrences without human intervention. Serendipity should be considered a collective endeavor comprising individual cognitive agency coupled with external representations and cognitive artefacts, such as ML models. The effort should be shared between humans and technology because it is the integration of humans and machines that holds the potential for serendipitous scientific discovery, rather than the former or the latter individually.

We present three aspects to be considered to design serendipity-oriented hybrid systems: (1) the task environment, (2) the characteristics of citizen scientists, and (3) anomalies and errors. They are important because the integration of humans and machines in citizen science has been acknowledged to produce results superior to either one alone while allowing for serendipitous discovery (McClure et al., 2020; Beaumont et al., 2014). Technology design and ML present opportunities for serendipity, if applied with care. Future citizen science projects should therefore reflect on the technology environment, characteristics of citizen scientists and anomalies and errors to encourage serendipity. Further research could include a survey of serendipity-oriented algorithms to examine existing approaches used in science and innovation; deeper investigation of delegation of tasks in human-machine integration; and recommendations for the design of computational assistance to support serendipity and human agency.

Paper 9:
Crowdfunding of science: Career trajectories and performance of individuals seeking crowdfunding funding for their research projects

Morena Rivato, Lars Frederiksen, Michael A. Zaggl

New avenues to obtain funding for scientific work are emerging. Among these, one of the most alternative forms is crowdfunding of science. In crowdfunding of science, individuals with or without a scientific education propose research projects to a crowd of self-selected individuals seeking to attract donations from these 'backers'. Projects are realized only if they obtain the amount initially asked for. Projects are extracted from the platform if they do not meet the threshold for the amount applied for.

Although crowdfunding of science indicates a critical institutional change potentially influencing the type and quality of research conducted as well as the kind of researchers who conduct it, we have only a few accounts that describe and explain in detail how (well) this channel for research funding works for fund-seeking individuals. In this paper, we empirically and conceptually explore two streams of inquiry. First, we study how participating by proposing a project on a crowdfunding of science platform rather than winning a grant on a platform affects researchers' subsequent performance (i.e., number and diversity of publications, citations, grants awarded, etc.). Based on a series of arguments, we hypothesize that for crowdfunding of science, the learning effects from the research proposal formulation and writing process itself for unsuccessful fund-seekers trump the success of obtaining funding.

Second, we examine questions about if winning or not-winning funding for a proposed research project (i.e., an idea) exerts an effect on the career choice of fund-seeking individuals. For example, we hypothesize that fund-seekers who receive funding (e.g., social signal) more often than unsuccessful seekers: 1) are inspired to enter academia (e.g., Master students at the time of asking for crowdfunding engage in a PhD education) as well as 2) to a larger degree are motivated to stay in academia (e.g., PhD students, assistant professors) rather than to leave academia for other types of jobs. These latter questions view crowdfunding of science as being a type of talent accelerator or incubator for academic researchers.

We employ unique web-scraped data from the world's largest crowdfunding of science platform. We link this data of individuals launching more than 461 research project campaigns to Scopus data on these fund-seekers' performance as well as connect this to their LinkedIn profiles and available CV data to gather information about career trajectories. First, we use regression methods to analyze observations in our established database and next, we supplement these findings with qualitative interviews of successful and unsuccessful fund-seekers to infer about the direction of potential mechanisms at play.

Paper 10:
Machines and crowds: Artificial Intelligence as manager in large-scale scientific collaborations

Maximilian Koehler, Henry Sauermann

AI is receiving increasing attention in both research and management practice. Much of the attention has focused on the capabilities of AI in particular functional areas such as medical diagnosis, prediction of equipment failure in production, or game play versus human champions. We expand research on AI by focusing on a qualitatively different kind of application: The management of human teams, especially in knowledge-intensive settings such as industrial R&D or academic science. Knowledge production poses unique management challenges because knowledge work consists of unstructured and complex tasks that often require collaboration in teams of highly specialized individuals. The unstructured nature of tasks and the high degree of specialization implies that there is information asymmetry between managers and knowledge workers that makes it difficult for managers to assign workers to tasks, observe effort inputs or outputs, and provide support in the case of problems. The collaborative nature of knowledge work implies that it is not enough to manage employees individually, but managers also have to consider the interactions among team members as well as social processes that can affect productivity.

We build on prior organizational research to conceptualize key functions of management, focusing on activities that are particularly salient in knowledge-intensive settings. Our preliminary model distinguishes four core aspects:

- Division of tasks and task allocation: The overall knowledge production task (e.g., developing a new drug against Covid-19) is typically too complex for a single worker and needs to be broken down into sub-tasks.
- Provision of rewards: Individual workers and teams need to be incentivized to perform their work at the necessary levels of quality and speed.
- Coordination and information: The larger the number of team members, the more challenging it is to coordinate and integrate their contributions.
- Learning and adjustment: Most prior work takes a static perspective, e.g., focusing on the optimal division of labor or provision of rewards at a given point in time. However, we argue that in uncertain and complex knowledge settings, both the nature of the task as well as team members' skills and motivations may change over time.

Based on this conceptual framework, we consider potential benefits and challenges of using AI as a "manager". We will illustrate this discussion using examples from a unique context that poses extreme organizational challenges: large-scale collaborations between professional scientists and non-professional scientists in "crowd science" projects. Such projects involve thousands of individuals who contribute effort and knowledge by performing research activities such as collecting data, classifying digital objects, or solving complex problems. It appears that AI as a "manager" has enabled crowd science projects to increase significantly in both scope and scale. We conclude with plans for future research, including interviews and field observations as well as a large-scale survey involving both professional scientists and crowd members.

SESSION 4

Paper session 4: Inter- and transdisciplinary research collaborations
May 12 | 11:30 – 13:00

Chair: Susanne Beck
Discussants: Christoph Grimpe & Maria-Theresa Norn

Paper 11:
"My own private climate change" – Towards a systematic involvement of personal climate knowledge

Alexander Ruser

"I don't need to read your graphs and tables to know that climate change is real. There was always snow on top of the Säntis. I have always lived here. Now, in summer, it´s gone".

It was this casual conversation with my then 92-year-old neighbor in the small southern German town of Friedrichshafen that first made me aware of the unique and significant qualities of personal, non-scientific climate knowledge.

Climate change – and "climate" itself- is notoriously hard to describe (Ruser 2018). As phenomena that escape direct observation and experience, they only come alive in scientific definitions, long-term observations, and statistical averages. Given the consequentiality and urgency of meaningful and "bold" climate politics, this creates a scientific and political dilemma: Climate change poses an unprecedented, global challenge and is likely to require ambitious political plans that will affect the everyday lives of citizens. At the same time, climate change is strangely removed from our everyday experience, which means that respective perspectives on it corresponds with trust/mistrust in science.

Scholarly work on the social and political dimension of climate change has pointed out that this dependency on science is likely to lead to a gridlock: Climate activism, including prolific movements like Fridays for Future and Extinction Rebellion are rooted in a firm belief in climate science while climate skeptics and climate change deniers draw on expressions of science skepticism or outright "anti-science" sentiment. In fact, this stalemate between science sceptics and science believers increasingly provokes climate scientists to adopt the role of social and political activists (for instance, "scientists for future"). At the same time, (climate) scientists are only beginning to grasp that non-scientific, first-hand-emotional knowledge and everyday experience are crucial to bridge the gap between authoritative expert knowledge and authentic personal experiences. In my presentation I would like to draw on existing initiatives such as the "climate stories" (https://www.climatestoriesproject.org) or "10.000 Tuvaluans" (http://10000.tv/to-photographer/) and present preliminary findings of local citizen science projects which took place in Arendal (South Norway) in 2019/20. The presentation will then focus on outlining a structure for collecting personal and "emotional" climate knowledge and discuss how open and collaborative approaches can break the gridlock on climate politics, provide a unique source of research for the social impact of climate change and facilitate political and social innovation "from below".

Paper 12:

Access to problems through networks as a driver of innovation: Evidence from nonprofit research institutes

Peter Inho Nahm

Interorganizational network research has shown that knowledge can flow between organizations to facilitate organizational knowledge creation and innovation. Advancing this line of research, this paper proposes an organization's access to problems – as opposed to knowledge – through interorganizational networks as a driver of organizational knowledge creation and innovation. To demonstrate this, I will study an underexplored type of organization engaged in innovation – i.e., nonprofit research institutes. Nonprofit research institutes are independent, private not-for-profit organizations whose primary organizational mission is to conduct and advance research. These organizations tend to engage in problem-solving research and both publish and patent considerably, which make these organizations ideal for the empirical explorations of this paper. Specifically, I will show that a nonprofit research institute's higher levels of network centrality and brokerage give the nonprofit research institute access to a greater amount of novel and diverse problems to solve. This access to problems through networks will have a significant effect on the nonprofit research institute's basic and applied research activity (i.e., publishing and patenting, respectively) that is distinct from the effect which the nonprofit research institute's access to novel and diverse knowledge may create, especially because nonprofit research institutes tend to engage in problem-solving research. More specifically, the differential effect between access to problems and access to knowledge will be established by exploiting the contingency where the alters of a nonprofit research institute in its network are for-profit firms, which tend to outsource basic research to collaborators. That is, for-profit firm alters will interact with the nonprofit research institute to provide the nonprofit research institute access to more basic-research problems to solve, which will increase nonprofit research institute's basic research activity (i.e., publishing) while decreasing its applied research activity (i.e., patenting) as its focus can shift according to the nature of the problems it solves. This result will show that access to problems through networks has an effect that is distinct from that which access to knowledge has on organizational knowledge creation and innovation. This article will mainly contribute to network theory and problem-solving perspective.

Paper 13:

Scientists' collaboration with third sector partners: Motivations and expected benefits

Oscar Llopis, Pablo D'Este

The engagement of academics with non-academic partners has long been an important line of inquiry for scholars and policymakers. Encouraging activities related to academic engagement among researchers is crucial, as it contributes to the greater economic and social impact of academic knowledge. The existing literature on the topic is wide, and has identified a wide variety of formal (e.g. patent licensing) and informal (e.g. research stays) activities associated to academic engagement (Perkmann et al., 2021).

Most existing studies in the topic focus on academic engagement with industrial partners. However, the generation of societal value from academic knowledge increasingly requires researchers' collaboration with different types of non-academic partners, such as members of the third sector or the general citizenship. In this paper, we address this question by analyzing researchers' motivations for collaborating with third sector partners. Specifically, we propose that the researcher's pro-social motivation (Grant, 2008a, 2008b) is an important determinant behind collaboration with third sector partners. The academic engagement literature has recently acknowledged that prosocial behaviors and prosocial or altruistic motivations partly explain researchers' collaboration with non-academic partners (Atta-Owusu and Fitjar, 2021; Iorio et al., 2017). Departing from there, our study shows that prosocial motivation is particularly crucial in researchers interacting with third sector partners, as compared to other forms of motivation. Another complementary aspect addressed in this study refers to the specific benefits that academics themselves obtain when collaborating with non-academic partners. We know from prior studies that often, academic engagement is a gateway for scientists to gather new ideas, more funding for research, or other valuable tangible and intangible resources. However, it is less understood whether such potential benefits depend on the degree and/or type of scientist' motivation, or on the type of non-academic partner with whom the interaction takes place.

Our study addresses these questions through a quantitative survey of almost 10,000 Spanish researchers, from multiple disciplines and affiliated to different types of institutions. Through a questionnaire, we quantified motivations, academic engagement, and perceived benefits, as well as other relevant individual and institutional variables. Our preliminary findings show that 53% of our respondents interacted with non-academic actors during the last two years. Within this group, 34% reported interactions with third-sector partners, such as non-profit organizations or associations. Moreover, our results also highlight that, on average, collaborating with third-sector partners brings the greatest perceived benefits to the respondents, as compared to interaction with other type of partners.

SESSION 5

Paper Session 5: Networks within and beyond academia
May 13 | 09:00 – 10:30

Chair: Marion Poetz
Discussants: Lars Frederiksen & Valentina Tartari

Paper 14:
The use of social networking amongst academics

Cornelia Lawson, Mayra Morales Tirado

Social networking sites represent an increasingly important tool for academics for networking and to communicate activities (in research and teaching) to a wide professional audience. LinkedIn has emerged as amongst the most popular, especially with regard to student engagement. In this research we set out to understand (1) who uses LinkedIn, paying attention to demographic and research profiles, and (2) how the use of LinkedIn relates to other approaches of open and collaborative research, including joint research, consulting, teaching collaborations, executive teaching, public lectures, exhibitions, and many more. Our empirical study makes use of a large-scale survey of UK academics (15,000 responses) that investigated the knowledge exchange activities of individual researchers within different sectors. This information was complemented with detailed publication records and information on LinkedIn accounts. Approximately half the respondents had a public LinkedIn profile at the time of the survey, but usage differed substantially, something we can exploit in our analysis.

The investigation will help to understand the usefulness of LinkedIn as a data source and measure for science and innovation studies. We can further identify the profiles of academics that use the platform and provide insights into the types of researcher that are visible on LinkedIn. We will finally also be able to shed light on the open and collaborative research approaches that could be supported with LinkedIn. For instance, it is possible that LinkedIn is particularly useful to academics as a tool for student exchanges, but less useful for supporting joint research. This research is ongoing and we hope to present the project and first results at the conference.

Paper 15:
Search within and across disciplinary boundaries in a scientific consortium

Ekaterina Mavrina

When solving novel and complex problems, one might adopt different search strategies ranging from local search to broad search. Scholars acknowledged that neither strategy is optimal, because the former leads to competency traps and local optima (Dunne & Dougherty, 2016), while the latter increases uncertainty in decision-making (Dunbar et al., 1996). Ideally, one would be able to "delve into details yet be open to surprises" (Dougherty & Dunne, 2012). In reality, local search within disciplinary boundaries is more frequent than broad search across boundaries. Ignorance of other fields is a less costly strategy (Postrel, 2002), because bridging boundaries inherits costs of giving up old knowledge and acquiring new one (Bruns, 2013; Henderson & Clark, 1990), threatens one´s reputation (Kaplan et al., 2017), generates tensions due to epistemic differences (Dougherty & Dunne, 2012).

The aim of the ongoing study is to understand why in some situations search unfolds within disciplinary boundaries, while in others - across them. We are conducting a longitudinal inductive study exploring a rich context of the dementia research consortium where the teams of experimental and computational scientists from different organizations perform projects. Each team faces novel and complex problems within their projects. Moreover, interdependencies between the teams are difficult to foresee from the start. During the first year of field work, we conducted and analyzed data from the two rounds of interviews with the consortium participants, as well as observational and textual data.

Comparing search processes of different teams brought about the dual role of modularity for search and learning across disciplinary boundaries. On the one hand, organizing work in projects with unclear interdependencies is fraught with the formation of insulated, highly specialized modules, where search activities are confined within one´s team boundaries. Shifting search outside one´s team boundaries was initially facilitated by the consortium coordinator who linked the teams to "external" individuals, both within and outside the consortium. Another important mechanism for encouraging cross-disciplinary collaboration was the annual training week that afforded collective exposure of the teams to each other´s projects. However, the scientists exhibited different search behavior following the training week. We propose that the degree of tasks´ modularity within a project of a certain team could explain why some researchers started exploring possibilities for collaboration across disciplinary boundaries, willing to change their search activities and utilize inputs from other fields in their projects. In addition, search and learning across boundaries seems to be aided by epistemic proximity between the fields, which makes costs of boundary-spanning and cross-boundary learning lower.

Paper 16:

Negotiating knowledge: The advantages of a hedging networking behavior for high scientific impact

Adrián A. Díaz-Faes, Anne ter Wal, Pablo D'Este

Extant research on networks has shown that networks with greater diversity and richer in structural holes are conducive to advancing science and innovation. In tune with Schumpeter's notion that scientific progress stems from recombinatorial processes, it is argued that individuals whose networks span more diverse groups or whose contacts are less tightly interconnected have a vision advantage in spotting opportunities for novel recombination that those with less diverse or overly closed networks are ill-placed to see.

We argue that such a brokerage-as-a-structure advantage is, however, only half the story. The sheer presence of diversity or structural holes in networks does not take explicitly into consideration the content accessed through the network. However, the type of content accessed from disparate parts of the network is likely to be critical for the capacity to identify and act upon novel recombinations of knowledge. The brokerage-as-a-structure arguments leave unresolved the question if an individual, with a given network structure, is better placed to advance science and innovation if they attain the same type of input from multiple of their network contacts, or if they rely on different contacts for different types of input. In other words, is network behavior whereby individuals "hedge" or triangulate input across their contacts more – or less – conducive to science and innovation outcomes than network behavior whereby individuals leverage different contacts for different reasons?

In this paper, we argue that individuals will be better able to advance science and innovation if they exploit their network for greater hedging. Specifically, we predict that scientists who hedge to a greater extent – i.e. who consult multiple of their network contacts for the same input – will be better able to generate high-impact science outputs, and that such an effect should manifest above and beyond the widely established impact of network structure and diversity.

Using granular data of the network mobilization decisions of 826 biomedical scientists, we contrast the effect of brokerage-as-a-structure and brokerage-as-a-behavior. We find support for our prediction that network hedging is positively associated with the production of high-impact scientific output, and that this effect is manifest above and beyond the benefits of having more diverse networks and networks richer in structural holes.

Paper Session 6: Perspectives on crowdsourcing in science
May 13 | 11:00 – 12:30

Chair: Julia Suess-Reyes
Discussants: Carsten Bergenholtz & François Grey

Paper 17:
How firms influence citizen science?

Camille Doche

How can firms influence the due course of citizen science to fulfil their own agenda? Citizen science (also called open science, participative science or crowd science) is a key enabler of Open Innovation in Science (OIS). While science has been usually conceptualized as knowledge produced by scientists abiding by the norms of their community (Merton, 1942), citizen science broadens science by opening the scientific production to everyone. Yet, it is also open to every firm, and they may have their own agenda. These firms can, genuinely or not, contribute to citizen science. Non-genuine participation describes the situation in which firms participate with the objective to affect or change the development of an open project to serve their interests and not the scientific community or society at large. By doing so, these firms break the norms of science, and pushed to an extreme case, citizen science might become only a means for firms to fulfil their agenda. Citizen science is particularly exposed to firms' influence as virtually everyone is a participant, and actions aiming at limiting influence would negates the principles of citizen science and more generally scientific standards (e.g., exclusion of participants, non-revelation of results).

The core feature of citizen science – openness – not only enables science to be more transparent to novel ideas and participants, but also makes it more vulnerable to firm influence, which may in the end jeopardize the quality and legitimacy of citizen science as well as affect its participants. In this paper, I examine how firms may influence citizen science to serve their interests, and how this can be detrimental to citizen science itself. To address this question, I build a conceptual framework which distinguishes three sequential stages during which firms can influence citizen science in their strategic interest: ex-ante, during the project selection and before the project is publicly released; during the project development, when participants are involved in knowledge creation; and ex-post, when results or findings have emerged and are disseminated. For each of these stages, I examine the different drivers of influence as well as their associated outcomes. First, I consider these stages independent of each other; next, I relax this assumption to explore the effect of firms' influence on participants. The contribution of this study lies in the consideration of firms as participants, and the negative consequences their action can have on citizen science in general and more particularly on other participants. With this framework, I aim to lay the ground for future empirical studies on the influence of firms on citizen science.

Paper 18:
Crowd science projects: Leaders' emotions and participation

Alex Cayrol, Olga Kokshagina, Thomas Gillier

A growing number of scientists tackle complex scientific problems with online communities. Crowd science projects allow scientists to access a large pool of diverse skills at a low cost. However, maintaining a high level of voluntary-based participation is difficult. Prior research has shown that leaders with strong technical, social and communicational skills can motivate participants to contribute. Much less is known about how much their emotions influence online participation. The objective of the study is to examine the influence of leaders' positive and negative emotions on the quantity and quality of participation in crowd-science projects.

First, we review the role of leaders in shaping the dynamics of online participation in crowd-science and open source projects (Ali-Khan et al., 2017; Faraj et al., 2015; Franzoni & Sauermann, 2014; Johnson et al., 2015; Nov et al., 2011; Sauermann & Franzoni, 2015). Then, we review the interpersonal effects of emotions in online projects (Ekman, 2009; Ekman et al., 1976; Parkinson, 2008).

Our theoretical framework is based on EASI theory (Van Kleef, 2009, 2016). This theory posits that someone's emotions may exert influence on other people's actions either through emotional contagion or cognitive inference. We propose that the effect of leaders' positive emotions on participation is mediated by emotional contagion while the effect of leaders' negative ones are mediated by cognitive inferences. We then hypothesize opposite effects of positive and negative emotions on the quantity and quality of participation. Polymath are crowd science projects that aim at solving extremely difficult mathematics problems. Our study is based on four Polymath projects. Multilevel structural equation modeling (MLSEM) is used to examine the effect of leaders' emotions on the quality and quantity of participation. Linguistic Inquiry and Word Count (LIWC) text analysis application is used to measure the emotional tone of leaders' messages (Pennebaker et al., 2007). The quality of participation is measured with LIWC as the number of cognitive words written per day (Becker et al., 2021). The quantity of participation is measured by counting the number of participants per day.

Our data reveals an inverted U-shape relationship between leaders' negative emotions and the quality and quantity of participation. We find that the cognitive complexity of participants, which decreases with the rise of leaders' negative emotions, mediates this effect. In contrast, we find that a positive relationship between leaders' positive emotions and the quality and quantity of participation. This effect is mediated by emotional contagion – leaders' positive emotions increase participants' positive emotions.

By examining the role of leaders' affective dimension in crowd-science based projects, our research brings theoretical contributions to the literature of online community leadership and open innovation in science (Beck et al., 2020). This work studies the boundaries of EASI theory and underscores the role of leader's emotional intensity. Our results particularly suggest that the leaders should control their emotion during crowd-science projects. Leaders should either communicate very positively or display no positive emotions. Leaders should express a moderate amount of negative emotions.

Paper 19:
Temporary teams' work in extreme crowdsourcing: A case of crowd science program on big data for cancer

Olga Kokshagina

This article reports on a longitudinal study of temporary teams' work in extreme crowdsourcing. Researchers became more interested in temporary teams' formation and work during crowdsourcing projects. Yet, the literature so far sheds light only on the impact of individual team engagement in the temporary teams and their performance in traditional organizational settings. Here we exhibit a case of temporary teams' work in extreme crowdsourcing where participants collaboratively contribute to problem definition, data collection and analysis, interpretation, and knowledge development (Franzoni and Sauermann, 2014). Furthermore, participation is open to anyone regardless of their discipline or level of expertise. Participants come together voluntarily to complete a set of tasks and design projects that are not precisely determined, where they can choose to contribute selected knowledge and resources and can join or leave at any point in time.

Established in 2016, the program on big data for understanding cancer epidemiology built a multidisciplinary community of more than 1300 contributors resulting in more than 31 projects that run over three seasons, each taking place for 6 months. This research takes a process perspective to analyze how the teams were formed during each season, how the community evolved over time and how organizers steered the community. We analyze how participants with diverse backgrounds collaborate to find new ways of understanding cancer-related data when coordination through the hierarchy is not feasible.

This paper adds to the temporary teams literature by exhibiting a case of interdisciplinary team formation in a temporary teams context. This paper also contributes to the extreme crowdsourcing literature by theorizing how interdisciplinary teams formed over time relying heavily on the coordination team who played the role of knowledge orchestrators to capitalize on participants' inputs. We find that to account for the emerging nature of coordination processes, capturing and processing critical incidents, adjusting organization, and making sure that changes are embedded within the organization appear as key activities of the coordination team. The coordination team is critical to maintaining the fluid nature of the community and orchestrating knowledge collaboration. The necessity for such a heavy involvement of the coordination teams points to a potential inefficiency of the extremely open settings where participation is open to anyone at any time. Our findings are of practical relevance for organizations seeking to deal with complex challenges like cancer using open forms of organizing.

SESSION 7

Paper session 7: Institutional perspectives on openness and collaboration

May 13 | 11:00 – 12:30

Chair: Christoph Grimpe
Discussants: Carolin Haeussler & Philipp Tuertscher

Paper 20:
Deep tech and translational action

Jonathan Wareham, Laia Pujol Priego, Angelo Romasanta, Gozal Ahmadova

"Deep tech" is a term used by venture capital and policymakers to refer to sophisticated technologies with the potential to address many of the challenges of economic development, public health, and climate change (Romasanta et al., 2022). Deep tech often emerges from Basic Science Research Infrastructures (BSRIs) or engineering organizations required to develop novel technology solutions based on substantial scientific research or engineering challenges (Wareham et al., 2021). As such, they often operate between the intersection of a physical measurement and the acquisition of information and data; or alternatively, the actuation of some data or bitstring into a physical effect. Hence, unlike consumer-facing digital startups, deep tech typically requires advanced integration of both hardware and software, encompassing fundamental functions such as sensing, imaging, detection, connectivity, computation, inference, actuation, and control (Siegel and Krishnan, 2020). While they are often upstream, enabling technologies, their downstream applications include automated transportation, advanced manufacturing, robotics and Industrial Internet, cybernetics, and health monitoring/therapeutic systems (Romasanta et al., 2021).

Our study examines the specific attributes of deep technologies to better understand their nature and implications for engineers, developers, entrepreneurs, policymakers and regulators. Our specific research questions are:

- What are the defining characteristics of deep technologies coming from Big Science Research Infrastructures (BSRIs)?
- Do they have a nature or essence that warrants specific classification/ontologies?
- For whom and how would such a differentiation be useful?

Data for our analysis comes from the ATTRACT project, a recent policy experiment funded by the European Commission that brings Europe's largest research infrastructures together to commercialize breakthroughs in imaging, detection, and computational technologies in alternative industrial applications. We analyze 170 of the projects selected to enter ATTRACT Phase 1 to inductively derive attributes of their core functions. Our study finds that these key enabling technologies serve as translational or mediating entities; that is, technologies that arbitrate a transition between physical- and data- centric phenomena. This translational function is central to many emergent Industry 4.0 applications, which is premised on the integration of physical and computational technology layers. As such, this study on deep tech contributes to our understanding of how scientific research generates impacts to industries downstream. Our findings should inform important topics in engineering, technology development, entrepreneurship, venture capital and policy.

Paper 21:
Open approaches for ethical technology

Despoina Filiou

This research will explore the role of open approaches in ethical technology development (Sauermann et al., 2020). The research will focus on the development of AI technologies and will explore the role of individuals and organisations in increasing public awareness around biases in AI. Specifically, the research will explore, first, the activities of individuals, that after identifying potential biases in AI acted to alleviate such limitations and second, the activities of organisations formed to advocate for 'ethical AI'. As such, the research will explore antecedents and microfoundations of openness and the open practices of advocacy organisations (Beck et al., 2020). The research gives opportunities to see how ethical issues in AI can be alleviated through engaging marginalised groups and through collaborations with established organisations using AI in areas where biases can be more prevalent.

The research will be based first on interviews with computer scientists working at the frontier of AI, either at academic or corporate organisations, that belong to minority groups (e.g. women of minority race and ethnic groups) and second, on interviews with the founders and members of organisations formed to advocate and act for 'ethical AI' by empowering, educating and engaging minority groups in AI development. The research will also explore the role of collaborations between advocacy organisations and established organisations implementing AI in decision making (e.g. firms in recruitment) in influencing a process of change, as reflected on a lowering of biases in the outcomes of AI implementation. The research will contribute to literature on open innovation and open innovation in science by looking at activism as an antecedent to openness (e.g., the role of individuals as activists) and at advocacy organisations and their collaborations in bringing outcomes of societal impact (Beck et al., 2020).

Paper 22:

Organizing for inter- and transdisciplinary collaboration in science: The role of autonomy and control

Susanne Beck, Marcel LaFlamme, Marion Poetz

Academic scientists are increasingly expected to conduct their research in an open and collaborative manner, crossing disciplinary, organizational, and even functional boundaries to increase the productivity and impact of their research. Yet, such inter- and transdisciplinary collaborations bear multiple risks for the scientists involved, including career threats in case projects fail or get delayed. At the same time, a progressive trend toward managerialism in scientific research organizations such as universities or research institutes is enmeshing organizational priorities with individual researchers' agendas and workflows. This raises the question of whether and how scientific organizations can act as facilitators of implementing collaborative research practices on the part of individual scientists.

We shed light on how organizational design choices – related to exercising control vs. granting autonomy – influence the scientists' engagement in inter- and transdisciplinary research collaborations. We investigate this question by exploring two in-depth case studies of scientific organizations in Europe with a total of 63 interviews with scientists, 4,129 pages of secondary material, and field observations. Our analysis shows that control-related design choices are 1) more frequently applied than those related to granting autonomy but 2) also bear the risk of (unintentionally) blocking or deterring scientists from collaborating at all, in particular when scientists' norms and values are not sufficiently considered. Interestingly, 3) granting scientists autonomy in their collaboration activities seems to predominantly encourage collaborations with close (compared to distant) collaborators and lead to collaborations with low levels of decision rights on the side of the collaboration partners. Our findings contribute to the literature on the organization of science and hold meaningful implications for research policy and managers of scientific organizations.

Paper 23:
The substitution between public science and corporate scientific research

Lia Sheer, Sharon Belenzon, Ashish Arora, Larisa Cioaca

Is public science a substitute for corporate investment in scientific research? We explore this question using novel data on the relevance of public science to corporate invention for a sample of publicly-traded manufacturing firms headquartered in the United States from 1980 to 2015. Identification is based on firm-specific exposure to changes in federal agency funding for R&D. We present three main findings. First, we find that public science and corporate science are substitutes. However, there are circumstances when the substitution or "crowding out'' effect dominates. We show that the substitution depends on strategic interactions in the use of public science and how far the focal firm is from the technology frontier. The private value of public science, and its impact on corporate participation in scientific research, declines as the same public science is cited both by the focal firm and its product-market rivals. Also, substitution is weaker for firms on the technology frontier versus firms behind it.

We contribute to the literature that investigates the social value of public research by providing new evidence on the interaction between private and public science. Though the social returns of public science operate through many channels, we focus on its effect on private investment in scientific research. Furthermore, we contribute to the literature on knowledge spillovers. Our findings advance the understanding of the role of rivalry in shaping private returns to private and public R&D. Lastly, we contribute by developing new data and measures of the flow from public funding for science to the resulting public science and, ultimately, to private invention.

OIS cases and applications
May 11 | 17:15 – 19:00

In this session, researchers from different disciplines will showcase novel approaches to and tools for practicing openness and collaboration in diverse fields of research. Conference participants can learn about the cases by engaging with the case owners as part of an interactive exhibition setting (online and offline).

Project 1:
Converging responsible research and innovation and crowdsourcing in prospective cohort studies (JoinUs4Health)
Birgit Schauer, Ana Barbosa Mendes, Andrea Camila Diaz Perez, Pawel Sowa, Natalie Terzikhan, Lukasz Kiszkiel, Silvan Licher, Hub Zwart

Project 2:
amai! Co-creating AI-based solutions for societal challenges
Karen Verstraelen, Annelies Duerinckx, Pieter Duysburgh, Jef Van Laer, Kristien Rombouts, Michiel Vaes, Carina Veeckman

Project 3:
Mindful researchers – A values-and-practices based initiative to support open and collaborative research
Wolfgang Lukas, Mary Rees

Project 4:
Co-creating digital environments for improved quality of life – The PATIO health guide
Amelie Dorn, Markus Mitterhauser, Sanja Moldovan, Ekkehard Büchler

Project 5:
Societal readiness thinking tool
Tung Tung Chan, Michael Bernstein, Ingeborg Meijer, Niels Mejlgaard

Project 6:
Defining discovery: On the need for a new approach to scholarly discovery and scientific crowdfunding in the age of open science
Suzanne Dumouchel, Francesca Di Donato, Emilie Blotiere, Kelly Achenbach, Stefano De Paoli, Paula Forbes, Peter Kraker, Michela Vignoli, Marta Błaszczyńska, Arnaud Gingold

Project 7:
CERN Science for Open Data
Anna Ferrari, Ivan Knezevic, Tomas Roun, Diamantis Patsidis, Ines P. P. Da Cruz, Nihal E. Yuceturk, Alexandros Ioannidis, Pedro Ferreira

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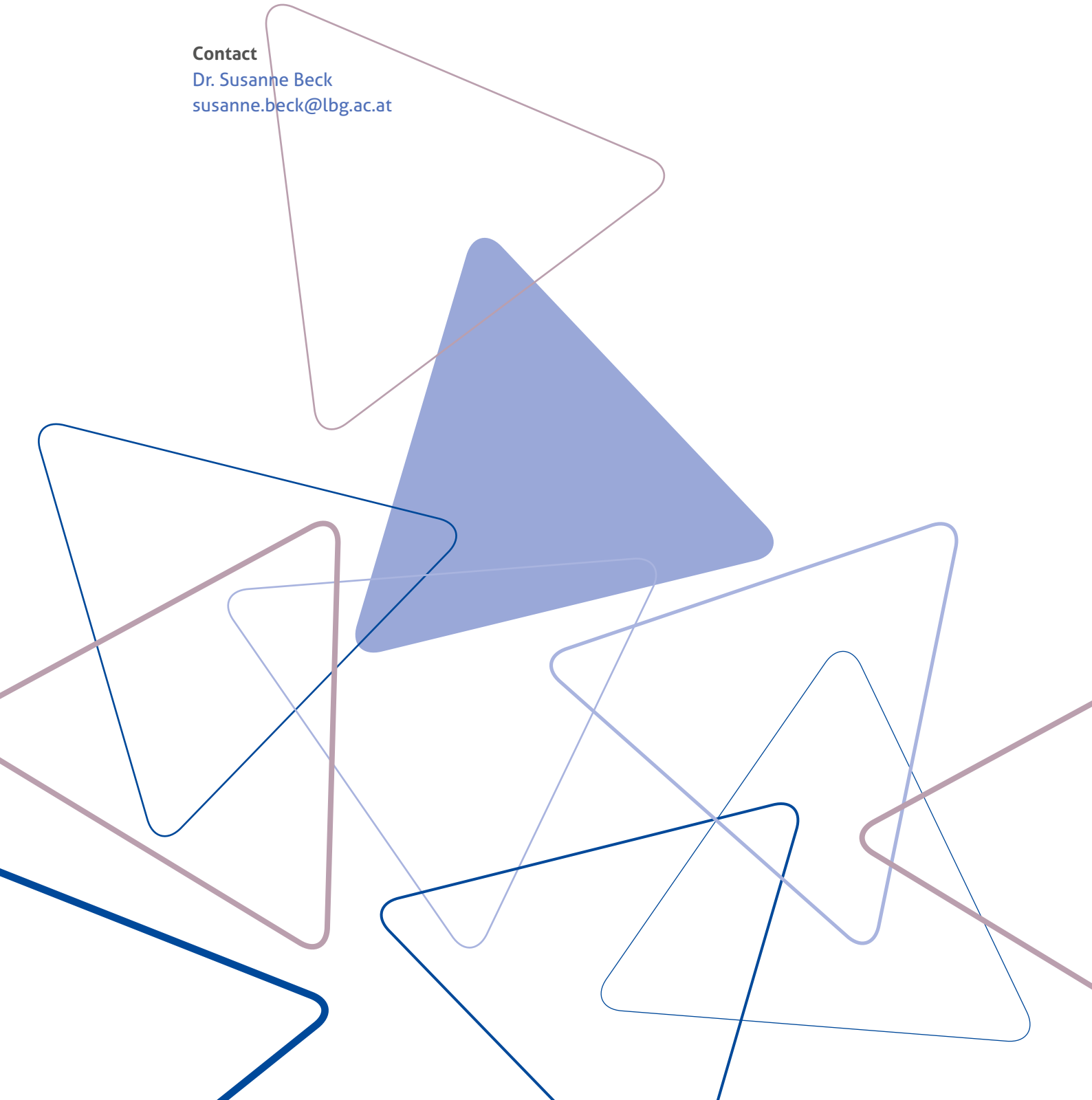

OIS research conference

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