Open Innovation in Science (OIS)

Research Workshop

2019

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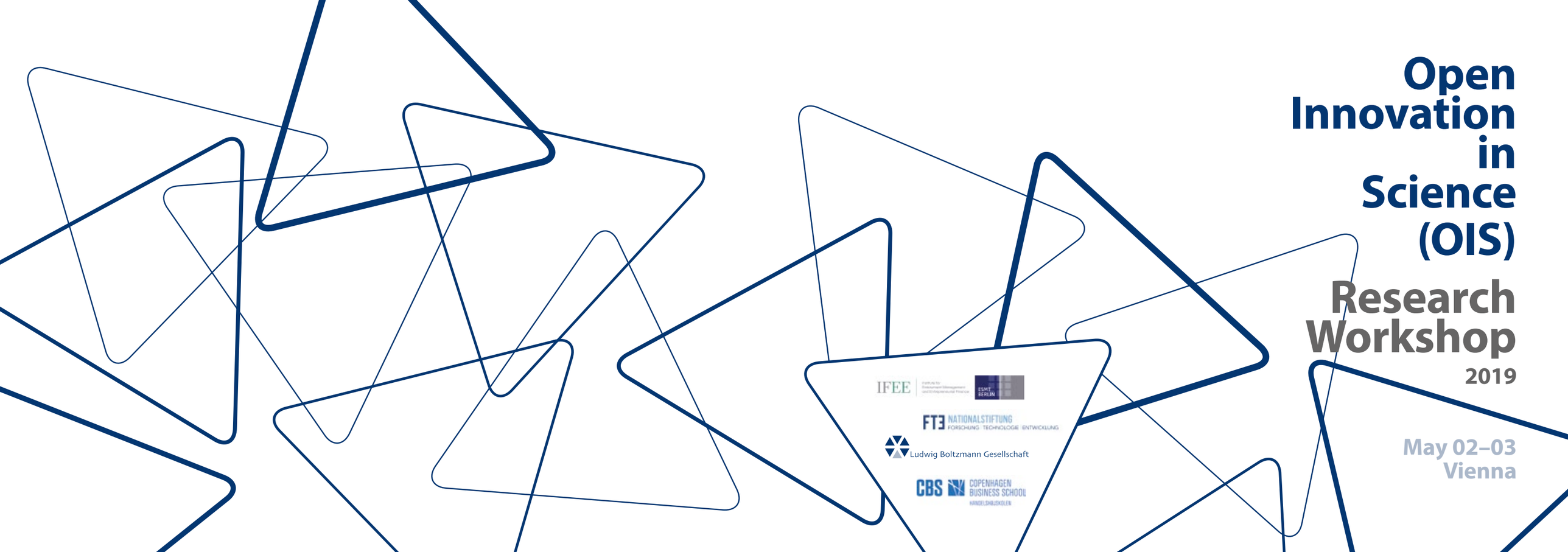
Vienna



Welcome to the first Open Innovation in Science (OIS) Research Workshop!

The OIS Research Workshop series aims at providing a discussion space for scientists and science enthusiasts from all kinds of disciplines who see value in better integrating Open Innovation and Open Science – for the purpose of improving novelty and impact of scientific research. To reflect this integration, the OIS concept refers to investigating and applying open and collaborative practices along the entire process of generating and disseminating scientific research, considering influencing factors on the individual, organizational and ecosystem level.

We particularly want to
- inspire discussions around this 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 and science-based innovation

In pursuit of these aims, the OIS Research Workshop purposively invited a highly diverse set of papers, including early-stage work as well as projects coming from different disciplinary backgrounds for being presented and discussed. Moreover, this year's OIS Research Workshop includes interactive elements for the purpose of collaboratively writing an overview article that maps the OIS research landscape for a Special Issue on OIS in Industry & Innovation. By jointly creating the backbone of this article during the workshop, we link and integrate different streams of research relevant for understanding antecedents, processes, consequences and contingencies of open and collaborative practices in science.

We hope to lay the foundation for fruitful discussions on these topics, and by doing so, contribute to shaping the science of science.

The Organizing Committee

MARION POETZ
Scientific Director & Associate Professor
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HENRY SAUERMANN
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Contents

* Early-stage projects

Key note speakers

Dr. Markus Nordberg

- Head of Resources Development at the Development and Innovation Unit at CERN, Switzerland
- Coordinates multidisciplinary innovation projects at IdeaSquare at CERN
- Coordinates a large EC-funded sensor and imaging R&D initiative called ATTRACT
- From 2001 to 2013, he was the Resources Coordinator of the ATLAS Project at CERN

Key note:
"Open Science, Open Innovation: A personal reflection"

Mag. Iris Ott

- Archaeologist, with emphasis on Early Stone Age and Museology.
- Lecturer at the Institute of Prehistory, University of Vienna
- Since 2008 Department of Exhibition & Education, Natural History Museum Vienna
- Manages the Citizen Science Research & Crowdsourcing Projects at NHM Vienna

Key note:
"Linking basic research, citizen science and science communication at NHM Vienna"

SESSION 1

Paper 1: Field-specific forms of open science

Theresa Velden

Open science advocates encourage researchers to publicly share the various instantiations of scientific knowledge that are generated during the research process, such as research data, computer code, method protocols, and material specimens. They argue that widely sharing these resources is desirable in order to increase the transparency of the research process and reproducibility of results, to make efficient use of research funding, and to enable new, innovative forms of research. Critical for the success of this vision is the readiness of research groups to share. Up to now, however, we have only a limited theoretical understanding of what drives the sharing of research data and other resources in different fields of science, and how variation across fields in the forms of sharing can be explained.

In my presentation I will review the state of the art in explaining field-specific forms of sharing, identify open research questions, and discuss research challenges. I will conclude by previewing the contributions to be expected from an ongoing comparative, mixed-method study conducted by the newly founded junior research group on "field specific forms of open science" at the German Center for Higher Education and Science Studies (DZHW). The group investigates field-specific forms of sharing in research specialties in chemistry, physics, biology and astrophysics in order to inform the development of open science policies that account for field-specific conditions for sharing.

Paper 2: The role of research funding in promoting openness in science

Kaare Aagaard, Carten Bloch, Maria Theresa Norn

Attracting external research funding is increasingly vital for researchers to undertake research projects. Funders may also seek to influence the scope, content and direction of public research. For instance, many research funders seek to promote greater openness among academic researchers, particularly with a view to stimulating increased collaboration with industry and users of their research. Yet we have limited knowledge of how different funding arrangements actually influence the openness and collaboration practices of academics.

A number of studies have examined the role of funding in promoting changes in researchers' behavior, including their engagement with external actors and their efforts to actively promote the application of their research. However, these studies typically have not probed the nature and intensity of this engagement or to what extent it has influenced the outcomes of research. Although recent studies have explored the impact of different types of research funding, this line of research is still in its infancy. We lack a deeper understanding of how research funders seek to stimulate openness and impact, and how different funding approaches – and different combinations of funding arrangements within a research group – influence the nature and outcomes of research.

The aim of this project is to explore how and to which extent funding arrangements aimed at stimulating openness among academic researchers and increasing socio-economic impact of their research influence the nature and outcomes of public research activities.

This will be done in a multilevel comparative design with two selected research fields in three countries (Denmark, Norway and the Netherlands). Within these three countries, a total of 12 in-depth case studies of research groups will be undertaken. The project will explore links between funders' focus and requirements in relation to openness and the impact of research – and examine how funding arrangements influences the behavior of academic researchers.

The project was started in January 2019 and will run for four years.

Paper 3: Measuring impact of Open Innovation in Science research: exploring the potentials of artificial intelligence-based text analysis

Andreas Distel, Christoph Grimpe, Sven Körner, Mathias Landhäuser, Marion Poetz

Researchers, research institutions and science foundations worldwide are increasingly forced to measure and demonstrate the societal impact of their (funded) research. However, established ways of assessing research impact focus on bibliometric statistics and journal impact factors, thereby overemphasizing the scholarly influence of scientific research and capturing insights into its social benefits only to a very limited extent. This may particularly bias impact measurement results of open and collaborative research activities that involve stakeholders that are supposed to benefit from or apply the research results in practice.

Building on this gap, this research project aims at conceptualizing, developing and testing a new form of measuring the societal impact of scientific research by applying artificial intelligence-based semantic processing (AI). Our approach assesses the extent to which published research results have influenced the development of new practices and policies through their direct or indirect usage in documents that inform such practices and policies (e.g., guidelines and policy documents). The AI method we apply is able to compare and match the meaning of different texts and sentences regardless of the words used. It develops a semantic model of a sentence and extracts and understands its meaning based on stocks of world knowledge and domain-specific training data.

We explore this method in the context of diabetes research based on a sample of journal publications that resulted from research projects funded by a major science foundation in the Nordics. We check the semantic similarity of the abstracts of these diabetes studies against a sample of the most important clinical practice guidelines that inform the prevention, diagnosis and treatment of diabetes (e.g., guidelines from the WHO). In doing so, our project follows a stepwise approach. First, based on a subsample of diabetes abstracts and citing passages in selected guidelines, we calibrate and validate the semantic similarity assessment provided by the AI method by comparing it with the similarity ratings of human diabetes experts. The findings of this validation round are used to train a best fitting language model for the AI method. Second, we use the trained language model and validate similarity thresholds to perform a comprehensive analysis on the actual use of the diabetes study results in clinical guidelines in terms of the semantics but also proper citations. That is, we examine whether the results are cited and actually used, cited but not really used, or used but not cited at all. Finally, based on expert discussions, we develop a framework that classifies the diabetes studies according to their influence in clinical guidelines into four categories: (a) proper influence, (b) legitimacy building, (c) hidden influence, and (c) no impact.

In sum, our project aims at providing a new, AI-based approach for identifying what type of research (e.g., research that involves different types of partners) is more impactful in the real world. On a more practical level, our project is intended to demonstrate the potentials and unveil the contingencies of applying AI to the assessment of research impact.

Paper 4*: Indicators, measurement and performance of quality management: third-mission-activities in the Social Sciences

Benedikt Fecher, Nataliia Sokolovska, Gert G. Wagner, Stefan Hornbostel

In knowledge societies, universities and non-university research institutions are partners and knowledge resources for the shaping of social change. This role appears more important than ever in the context of global transformation processes – accompanied by the buzz words digitization, climate change, migration, and demographic change. Relevant research policy expectations for science are expressed in national and supranational science and innovation strategies such as the British Research Excellence Framework, the European Initiative Responsible Research and Innovation (e.g., Hill 2016) or the New High-Tech Strategy – Innovations for Germany. This expectation of independent action knowledge is contrasted with academic production and utilization logics, which are in part challenged by digitization. In the production of knowledge, for example, new infrastructures and forms of collaboration (e.g., Citizen Science) are emerging, which until now have only been mapped to a limited extent in academic reputation logics and assessment procedures. Equally, the exploitation is characterized by information needs (e.g., direct communication via social media), which are (only partially) fulfilled by scientific communication. It reveals a tension between the increased need for knowledge transfer in society and the traditional scientific production and utilization logics.

For the social sciences, this problem is even more acute, because in the transfer they become a formative part of the subject, which they – by definition – examine (see Kaldewey 2016). Moreover, in contrast to patents in engineering, for example, effects of social science transfer are heterogeneous and often only indirectly tangible (Müller & Wolf 2017). Thus, the impact of economic and social science policy advice is difficult to measure. This raises the question of how scientific and effective transfer of knowledge from the social sciences can take place under these conditions. This question touches the intra-organizational quality assurance and the promotion of science in the core, which ensure good transfer, promote and at the same time avoid adverse effects (see Wissenschaftsrat 2016). There is an acute need to develop transfer quality criteria and adequate measurement and quality assurance procedures for the German science and innovation system. The project outlined aims to do this for the social sciences.

* *This is a translated version of the original abstract.*

SESSION 2

Paper 5: How a digital platform can trigger a European shared vision through co-creation? – A proposed model

Diletta Di Marco, Roberto Verganti

Focusing on a public-sector context, there is a growing disconnect between policy-making and citizens. Governments across Europe are challenged by techno-savvy citizens in need of more digital-friendly public services (Bason, 2010). At the same time, it is necessary to tackle unresolved problems incentivizing innovation policies and co-creating with citizens a shared vision, engaging them with technology and tool which leverage digital interconnectedness (OECD,2011). Co-creation is a form of open policy making where those implicated by the outcome are directly involved in its creation (Morse, 2010). Citizen engagement aims at opening up new avenues for empowering citizens to play an active role in the ongoing process of service innovation, the processes of interaction and decision-making that lead to the creation, reinforcement, or reproduction of new meanings (e.g., Verganti, 2009). Practically, this is represented by a co-creative and experimental approach to innovation policy, aimed at formulating and testing shared direction of new socio-technical challenges in a model under real-world conditions (e.g., van Oudheusden, 2011). The rationale behind is to open government boundaries toward their environment and to harvest creative ideas and work capabilities existing among different stakeholders.

Despite of a flourishing research on open innovation at a corporate level, there is quite restricted research examining open innovation strategies regarding citizen engagement (e.g., Fuglsang, 2008;) especially since the development of digital tools for crowd-policing is rather a new research area. How can a new public engagement framework enable the co-creation and deployment of innovation policies through a digital tool? What are the advantages/disadvantages for successful implementation of this online participatory method which provides input to policy and participatory foresight? The lack of a precise representation of an archetypal model for public engagement, through a digital tool, underlays a lack of common understanding of what this kind of instrument might precisely do, even more, if connected to innovation policies. For this reason, a conceptual theoretical paper is crucial to offer a comprehensive view that can direct attention to this evolving topic. The main result of the framework is the definition of an enhanced version of the policy-cycle which encompasses the engagement of citizens in the co-creation of a shared vision for future scenarios through digital-based co-creation experiences, specifically, in the phases of policy formulation, implementation, and evaluation. This is possible through the conceptual explanation of three different impact layers of this approach (conceptual, capacity building and instrumental) analyzed at three analytical levels: micro, meso, or macro. This conceptualization provides a multitude of new opportunities if the right network is leveraged into the creation of new inputs which can rapidly turn into useful policies for a more efficient direction for the policy-making process. The main result is the affirmation that co-creation has become a desired key resource in the innovation process to achieve responsible innovation and that the digital implementation is a condicio sine qua non.

Paper 6: Exploring the dynamics of Open Innovation in Science: a case of a continuous research collaboration

Sunny Mosangzi Xu, Gergana Romanova, Marcel Bogers

Introduction and Background: The increasing importance of addressing grand challenges requires more coordinated and collaborative efforts among various stakeholders (George et al., 2016). In science, this requires public and private partners to adopt an open innovation (OI) approach in research to purposefully manage knowledge flows across organizational boundaries (Chesbrough & Bogers, 2014). In this context, some scientists were recognized for having continuous success in establishing university-industry collaboration (UIC). While important aspects as seniority and credibility were identified, the dynamics behind such continuity are not yet fully understood (Perkmann et al., 2013). Therefore, our study sets out to investigate the dynamics of OI in science (OIS) with a focus on how researchers enable to maintain continuous collaboration.

Our focus on the micro-dynamics of UIC is in line with the emerging OI literature that studies various aspects of such processes at different levels, and calls for a better understanding of the "complex interplays of multiple OI mechanisms across different levels" (Bogers et al., 2017: 25). Such "microfoundations" perspective emphasizes the role of individual-level attributes in enabling organizational-level outcomes (Felin et al., 2015). In this study, we specifically focus on the interplay across the individual and project levels, and the dynamics that lead to a continuous UIC research collaboration.

Method: Adopting a process perspective to consider continuity as unfolding over time (Langley, 1999), we conducted five-month ethnographic fieldwork, following a continuous UIC project in real time, from September 2018 until January 2019. The project continues from a previous successful project with the same core group members, containing researchers from two Danish universities and staff from one private company in the insurance industry. We did observations on most Thursdays, when university researchers came into the private company and work in the same office, and wrote "thick" ethnographic fieldnotes which resulted in 100 pages (Geertz, 1973). We carried out 20 interviews with 11 project members, of which 14 were formal, about one hour long, and 6 were informal, conducted during lunch and coffee breaks. We also collected secondary data source such as press releases, project documents, and professional profiles. We followed an inductive process to analyze the data, adopting principles of grounded theory (Corbin & Strauss, 1990). We started the analysis by doing in vivo coding for all the fieldnotes and interviews, then grouped them into themes. Among others, individual characteristics and roles were two dominant themes, which we further dived into to identify arising patterns.

Preliminary Findings: We identify that individuals do role work as the core dynamics in the continuous collaboration process. Individual characteristics are shaped and learned during the process when individuals play others' role while performing their own roles. A growing deeper understanding of the role of oneself and of the others' roles in the collaboration process lays the foundation for an evolving trust relationship. We draw from individual's experiences in the daily pursuit of OI to propose a range of OIS practices that other UIC projects can implement for developing continuous effective engagements.

Paper 7: A CERN-inspired vision for a contemplative scientific collaboration, community and culture

Wolfgang Lukas

Collaboration is found to be abundant in nature and indispensable in human culture, including scientific research and open innovation. However, in contemporary research ecosystems, researchers face overly competitive environments, systemic lack of collaboration, and apparent scarcity of resources, visibility, manpower and expertise. Under chronic publication and career pressure this can give rise to studies with limited statistics, publication biases, replicability issues, and even researchers' burnout – yielding potentially harmful consequences for involved individuals as well as for science, humanity and our planet. To overcome such challenges, we propose a transition to a more collaborative culture in which the tension between competition and cooperation is harnessed for a common purpose (e.g. „coopetition", „structured adversarial collaboration"). Practices such as collaborative planning and performance, sharing data and resources, rigorous internal peer-review, and coordinated publication can significantly reduce overheads while leveraging available resources and expertise, facilitate rigorous „slow science", and safeguard replicable high-quality publications. This benefits the scientific community from the perspectives of researchers, stakeholders and the public.

Drawing inspiration from physics research communities at CERN who have demonstrated the effectiveness of their collaboration models over recent decades at the frontier of science and technology, as well as from the growing body of research in the field of Contemplative Science, we propose to co-create a Contemplative Scientific Collaboration (CSC) that is rooted in shared values and intentions, dedicated contemplative practice, rigorous scientific research, collaborative „coopetition", and skillful community-building. We turn our attention specifically to the microfoundations of collaboration, including the role of skillful practices of individuals, and support systems built into collaborative communities in order to help maintain and refine such training individually and collectively. We propose that such "contemplative scientific communities" co-create a set of shared values and intentions, and practice collaboratively to gradually embody them, thus increasing accountability, trust and well-being.

We explore how the "contemplative process" can enhance individuals' skills and capabilities for collaboration and open innovation, e.g. to familiarize themselves with their own conscious and unconscious patterns that may influence their capacity and propensity to engage in collaborative research environments. This involves contemplative practices (such as mindfulness meditation), as well as the cultivation of associated values and intentions that may become desirable character traits (such as pre-emptive generosity, epistemic and intellectual humility, integrity, skillful communication, compassionate and caring engagement, etc.), and the gradual familiarization with a perspective of wholeness and interdependence that counters prevailing cultural narratives of scarcity and separation.

Furthermore, moving from siloed specialized domains to inter- and trans-disciplinary research poses specific challenges (adversarial methodologies and paradigms, lack of common languages, etc.) that are leveraged by unique resources that a CSC can provide on individual, interpersonal, and systemic levels. We share our ongoing process of investigation into how the CERN model of collaboration might be complemented with contemplative-collaborative practices to benefit open science over coming decades. We invite researchers, practitioners and other interested parties to share experiences and to establish an ongoing dialogue for deeper collaborative exploration.

Paper 8: Gigantum: streamlining diverse collaborative processes as an open core, for-profit company

Dav Clark

A set of best practices for successful research collaboration and publication has been developed based on tools designed for professional programmers – tools like Git and Docker can be used to reliably share workflows in open source environments like Python or R. Using such tools, coordinated teams have been able to reliably share their work with each other. This coordination often comes in the form of training and also specialized support units at research institutions, and it remains quite challenging! It's hard enough that recent reports have indicated that attempts at computational reproduction of other scientists' work usually fail. As the scope of research collaborations becomes ever more diverse in the current wave of data-driven discovery, it becomes even more challenging to support teams with highly non-overlapping skill sets and orientations.

To support successful research collaboration and publication for the broadest set of people, Gigantum has developed an open core offering as a for-profit company. We have adapted complex command-line tools into a coherent graphical interface that streamlines and automates tracking of computational history and also modification and reproduction of the environment. Working within our system affords single-click reproducibility without any additional effort. Our open core approach allows us to maintain a contract of indefinite reproducibility for our users, requiring nothing more than the MIT-licensed Gigantum Client web application running on their own computers. Moreover, by designing Gigantum Projects around existing tools and best practices, researchers can also use tools like Docker and Git directly with these repositories. Organizationally, our for-profit approach allows us to be agile in collaborating with users across institutions.

To augment the utility of our approach, we provide an online repository for Gigantum Projects that works seamlessly with our Client and also provides an overview of projects like a user would see locally. We have additionally designed a high-performance Gigantum Dataset service that allows users to efficiently store their data compressed in our online data store, and cherry-pick only the data that's needed for a given task. Using these services, We'll see how a standardized foundation can allow efficient use of expensive resources like GPUs using the portable nature of Gigantum Projects and Datasets. We believe that this approach will make data-intensive research accessible to a truly broad community, and further provide a high level of transparency for novel and impactful research.

SESSION 3

Paper 9: The influence of leader's emotions in open science communities

Thomas Gillier, Olga Kokshagina, Alex Cayrol

This research is based on the detailed empirical analysis of Polymath, an online collaborative initiative started by a group of mathematicians to solve extremely difficult problems (Ball 2014). In the online collaborative projects participation is voluntary, many contributors have not meet in person and there is no authoritative division of labour (O'Mahony & Ferraro, 2007). Online leaders play essential roles to foster motivation and engagement of participants in collective problem solving project (Johnson et al. 2015). Prior studies argue that there is still a limited understanding held by those running open collaborative initiatives projects on what type of leadership is required to solve complex problems online. This research studies how leaders' emotion influence motivation and engagement of participants in open science communities. Although positivity is often recognized as important for creativity and innovation, little is known how positive emotion evolves within online interactions in collective problem solving (Harrison and Dossinger 2017, Lehmann-Willenbrock et al. 2017).

Based on the online data of four successful Polymath projects, this research aims to use a netnography research method and the Linguistic Inquiry and Word Count (LIWC) to investigate the emotional content of the online messages exchanged between the leaders and the participants. Our research demonstrates that the language used by the leaders play an important role for maintaining participations. In particular, we observe that positive emotions are not always beneficial for solving extremely difficult problems. Instead, an ambivalent emotional state (Fong 2006) is essential for sustaining participants' engagement online. Finally, we derive managerial implications regarding how leaders can set emotions in their communications online to effectively manage employees in innovative organizations.

Paper 10: ScienceAtHome: using citizen science to develop interfaces optimally supporting human creativity in an age of increasingly powerful algorithms

Jacob Friis Sherson

What is to become of humankind in the future digital age and is there a way to break the monopoly of big tech companies on large scale data on human behavior? With the advent of AI one of the most important things we can do to prepare for the best possible future is to become more deeply aware of what it means to be human.

The ScienceAtHome project within the Center for Hybrid intelligence uses online citizen science games (so far played by 300,000+ players worldwide) not just to solve complex natural science challenges such as the development of a quantum computer but also as an online laboratory to study human intuition, creativity and innovation on a scale vastly exceeding traditional lab-based social science investigations. Our portfolio of games ranging from physics, mathematics and chemistry to economics, psychology and cognitive science provides a unique tool to systematically map the difference between human and artificial intelligence. We believe that this will be an essential component of developing a future society characterized by not AI-dominance but an era of hybrid intelligence in which we become proficient at developing interfaces allowing us to make optimal use of both the unique powers of human and artificial intelligence.

We have published one paper demonstrating that players could compete with and augment complex algorithms in Nature in 2016 (Exploring the quantum speed limit with computer games, https://www.nature.com/articles/nature17620). Recently we have also demonstrated a unique mixture of natural and social science, citizen science by setting up another game in which players both solve a complex natural science challenge (directly remote-controlling and optimizing the lasers and magnetic fields of an actual quantum computer experiment in Aarhus, Denmark) and at the same time take part in a structured social science experiment. This result has just been published in Proceedings of the National Academy of Sciences (PNAS) (https://www.pnas.org/content/115/48/E11231).

We also have conducted first tests of a suite of game to conduct large scale social and cognitive science experimentation in the cloud involving both individual and collective processes. This infrastructure that we call the "social science super collider" (SSCS) aimed at allowed social science researchers from around the world easy access to perform large scale experimentation on our community of citizen scientists.

Our latest and most ambitious SSCS game is, Skill Lab, which aims to break the monopoly of large tech companies on large scale data of human behavior. It is a set of mini games that allows for game-based assessment of the cognitive profile of the players. So far, 20,000+ have signed up for our large scale mapping of cognitive profiles.

Our vision is to perform global data collection in an effort to provide researchers with amounts of data that can parallel that collected by the top tech companies. Unlike them, we will not use the knowledge to maximize profit but openly conduct large-scale science and publish all findings as a way to equip the general population with a shield of knowledge in this increasingly digital age.

Paper 11: What's the problem? How crowdsourcing contributes to identifying scientific research questions

Susanne Beck, Tiare-Maria Brasseur, Marion Poetz, Henry Sauermann

An increasing number of research projects successfully involves the general public (the crowd) in tasks such as collecting observational data or classifying images to answer scientists' research questions. Although such crowd science projects have generated great hopes among scientists and policy makers, it is not clear whether the crowd can also meaningfully contribute to other stages of the research process, in particular the identification of research questions that should be studied. We first develop a conceptual framework that ties different aspects of "good" research questions to different types of knowledge. We then discuss potential strengths and weaknesses of the crowd compared to professional scientists in developing research questions, while also considering important heterogeneity among crowd members. Data from a series of online and field experiments has been gathered and is currently analyzed to test individual- and crowd-level hypotheses focusing on the underlying mechanisms that influence a crowd's performance in generating research questions. Our results aim for advancing the literatures on crowd and citizen science as well as the broader literature on crowdsourcing and the organization of open and distributed knowledge production. Our findings have important implications for scientists and policy makers.

Paper 12: When citizens become science funders: how to engage citizens into the crowdfunding of science

Sally Bitterl, Martin Schreier

Crowdfunding has recently emerged as an alternative form of financing new ventures by relying on a relatively large number of individual project backers (Belleflamme, Lambert & Schwienbacher, 2014; Mollick, 2014). Crowdfunding of science, in particular, "allows the public to influence future research directions by directly providing funds" (Hui & Gerber, 2015). Compared to standard means of funding research, such as grants, crowdfunding offers opportunities for scientists (1) to raise funds relatively quickly, and (2) give life to research ideas that might otherwise go unfunded, e.g. new and riskier research ideas (Hui & Gerber, 2015). Moreover, crowdfunding not only answers the question "Where could I get funding from?" but also another: "Where can I effectively connect with my future customers?" (Bitterl & Schreier, 2018). Crowdfunding may thus represent a marketing tool for scientists to connect and interact with citizens in a more direct way. However, the majority of research projects do not succeed in raising enough funds through crowdfunding, and thus end up not being realized. For example, the chances for projects to fail in reaching their funding goal on experiment.com, one of the most popular crowdfunding platforms for science, can be as high as 93 percent (85 percent of projects created on the site were already rejected by the sites' owners; the share of launched projects failing is 52 percent; experiment.com, 2016). Given this big obstacle that crowdfunding scientists face in engaging individuals into crowdfunding their research ideas, it is all the more important to understand: (1) what motivates citizens to participate in crowdfunding for science, and (2) which factors influence scientific crowdfunding success. To answer these research questions, we are planning to first conduct one-on-one semi-structured interviews with individuals who have participated in the crowdfunding of a scientific project, as well as interviews with owners of crowdfunding science platforms. Furthermore, we will draw analogies from other crowdfunding domains, such as public goods or social good projects. Based on the findings of the interviews and the literature review we will analyze a sample of scientific crowdfunding projects to identify key factors of successful science crowdfunding that we further want to test in a series of experimental studies. We aim to contribute to the emerging crowdfunding literature by offering insights for scientists on how to engage citizens into the crowdfunding of scientific research.

SESSION 4

Paper 13: Learning how to do out-of-the-box research: an exploratory study on the value of capability building in open and collaborative science practices

Marion Poetz, Agnieszka Radziwon, Alexander Ruser

How to innovate the way we do science? This question is far from trivial given the fact that applying open and collaborative practices to science goes way beyond the standard skill set and training of the academic researcher. While most scientists know 'their box' – the traditional ways of how to develop research questions, apply popular methods and reach their peers through knowledge dissemination in conferences and journals; changing these routines and exploring completely new pathways can be quite challenging: On the one hand "doing" open and collaborative science itself can be a challenge: How to find partners outside the established contexts of scientific cooperation? How to engage stakeholders from different backgrounds, particularly non-academics? When and how to move from some form of communicating scientific results to actually co-creating research together with relevant stakeholder groups? Notwithstanding the risk of failure on the yet unknown territory. On the other hand, a deviation from the traditional practices within scientific communities, lack the acceptance of relevant peers, due to engaging in open and collaborative science activities can be a gamble for academics, especially in an early career stage.

In order to develop a better understanding of how learning about and experimenting with open and collaborative practices to generating and disseminating scientific knowledge affects the way scientists think about and practice scientific research, we conducted an exploratory individual-level impact study. The research sample consisted of 19 participants of a comprehensive vocational training course on Open Innovation in Science, the Lab for Open Innovation in Science (LOIS) over the period of 2015 (just before they entered the training) to 2019 (when 10 follow up interviews were completed). The study applied a mixed-method approach that combined classical qualitative approaches with data collection on ego-networks. We focused on the biographical and professional background, as well as on the motivation of the participants. Moreover, qualitative data was used to explore the potential impact of the training on individual professional networks and collaborative environments.

Initial analysis shows how the different learning-impact journeys are influenced by different starting configurations (e.g., participation motives, expectations, discontent with traditional academic practices) as well as interesting evidence with regard to collaborative activities of the participants after completion of the training: A considerable number of pre-existing collaborations intensified, while personal networks, in general, tend to expand.

In our contribution to the Open Innovation in Science Research Workshop, we aim at outlining the rationale of the study, elaborate on the methodological approach and put emphasize on the presentation of initial findings.

Paper 14: How open is innovation research? – Taking stock of open data

Gloria Barczak, Christian Hopp, Jermain Kaminski, Frank Piller, Gernot Pruschak

In this work, we investigate the prevalence of and attitudes towards Open Data in the academic innovation community. Existing research highlights the positive impact of data sharing. Closer collaborations between researchers (Walport and Brest, 2011), lower research costs (Uhlir and Schröder, 2007) as well as accelerated research processes (Fischer and Zigmond, 2010) represent only a few out of the manifold benefits that come along with Open Data. Additionally, transparency through data sharing increases the trustworthiness of scientific results by enabling precise replications (Gewin, 2016). However, empirical studies indicate that data sharing is not the norm. In fact, only a minority of scientists give access to their used data when being asked for (Kirwarn, 1997; Wicherts, Borsboom, Kats and Molenaar, 2006; Krawczyk and Reuben, 2012). Time and efforts needed to curate the data for publishing (Zuiderwijk and Janssen, 2014), "research parasites" (Fecher and Wagner, 2016) and data thievery (da Silva and Dobranszki, 2015) in combination with a lack of rewards (Fecher, Friesike, Hebing, Linek and Sauermann, 2015) might explain the low spread of Open Data. Therefore, we ask whether the community of innovation scholars, who puts great emphasis on "openness" in organizational contexts (e.g. West, Salter, Vanhaverbeke and Chesbrough, 2014; Bogers et al., 2017; Ramirez and Garcia-Penalvo, 2018), also upholds these values when it comes to their own innovation ecosystem, that is science.

In order to answer the research question we sent a questionnaire to more than 3,000 innovation scholars around the globe and received 253 useable replies (8,4%). We find that innovation scholars generally feel that data curation for publishing does not attest a too high burden. The bulk of innovation scholars also think that data sharing benefits like increasing transparency and discoursing misconduct should be considered in tenure procedures. Additionally, the majority of respondents agree that used data should be available to the reviewers during the review process and to the general public 12 months after publication. However, only about half of the scholars in our sample share their data regularly. The analysis suggests that they are afraid of the potential consequences of releasing flawed code and/or erroneous data.

To explain the findings in more depth, we investigate the correlates of data sharing among innovation scholars by applying ordered logistic regressions. While quantitative researchers are more likely to share their data, scholars publishing more articles in FT-50 journals are less likely to share their data. These researchers also less often agree that Open Data induces transparency, discourages misconduct and should be considered in tenure procedures. Furthermore, we note that full professors are marginally significantly less likely to engage in Open Data. The finding that full professors put less value on replications might point out the reasons behind this effect.

Overall, we show that, for innovation scholars, the perceived benefits of Open Data outweigh the perceived threats. Still, especially productive researchers tend to not sharing their data. Therefore, journals and institutions should design academic incentives in a manner that reward Open Data.

Paper 15: Microfoundations of inter- and transdisciplinary collaboration

Susanne Beck, Agnes Effert, Maria Theresa Norn, Marion Poetz, Alexander Ruser

Modern societies are faced with a paradox: Present day challenges (e.g. human made climate change, health care etc.) are increasingly "discovered" and framed by science. At the same time, traditional, disciplinary scientific research seems to be insufficient for addressing these ever more complex and interrelated topics let alone coming up with a "solution". Apparently, what is needed is inter- and transdisciplinary cooperation. The production of adequate and applicable knowledge requires the collaboration of researchers from different – often very distant – fields, with distinct research traditions and techniques as well as the collaboration with stakeholders from outside academia. Obviously, bridging the gap between different areas of expertise is neither an "easy", nor a "convenient" thing to do for the researchers involved. But why do researchers engage in inter- or transdisciplinary research? And what does it take to turn such "unusual efforts" into a success?

While structural factors have received some attention, the influence of the individual researchers' characteristics remain widely unexplored in the field of inter- and transdisciplinary scientific collaboration. Therefore, the aim of the present study is to identify, categorize, and analyse individual-level drivers and barriers as well as their interplay with structural and contextual contingencies (e.g., funding schemes or different dimensions of proximity) that affect a) successful collaboration with internal team members and external partners and b) the researcher's perceived satisfaction during the process and with the outcome. Hence, this project takes a step back and asks not only how inter- and transdisciplinary collaborations can be successful but also asks when and under which conditions can open and collaborative approaches be purposefully applied as means to contribute to more impactful scientific research practices.

To do so, exploratory case studies are conducted over a period of two years. The research team has unique access to collect exhaustive data from two independent and each inter- and transdisciplinary research groups, that are embedded in different institutional settings. To capture both latent variables (e.g., attitudes) but also behavioral aspects, a multi-method approach is applied. Our data sources are manifold and include among others interviews, surveys, self-reports, observations of activities and interactions carried out to enact knowledge sharing, knowledge network analysis and archival data analysis. This allows a thorough triangulation of the study's findings.

Paper 16: ScienceAtHome: the opportunities and challenges of open citizen science across disciplines

Carsten Bergenholtz

ScienceAtHome is an interdisciplinary citizen science platform, which produce scientific games. So far more than 300.000 citizen scientists have played these games. Originating in physics, the last project involved a collaboration between physics and social science, comparing how citizen scientists and physicists were able to cool down atoms in a remotely controlled, real-time experiment.

We present a new, ambitious and open collaboration, which involves researchers from management, economics, psychology, cognitive science and physics. The aim is to map the cognitive abilities of a population in order to investigate links been cognitive and problem-solving abilities, as well as associate individuals' abilities with an array of self-reported social science measures.

Studies on cognitive abilities are usually impeded by small samples or mainly consisting of male respondents (due to their participation in the military draft). In order to scale the data collection, ScienceAtHome has developed a range of games that capture basic cognitive abilities (such as executive function, working memory, spatial reasoning etc.). To validate the games, we compare answers from a smaller sample of citizen scientists that also have completed traditional, neuropsychological tasks. Very preliminary analysis indicates that the correlations are reasonable in strength, however further adjustments are needed to reduce noise. In total, the cognitive tasks require about 4-5 hours to complete, while the cognitive games only require about 15–20 min of game play. So far (spring 2019) +12.000 individuals have played the cognitive games (see https://www.scienceathome.org/games/skill-lab-science-detective/).

The citizen scientists are also asked to complete a survey consisting of a range of questions provided by researchers; e.g. entrepreneurial intention, political orientation, sleep behavior etc. This allows us to uncover which cognitive abilities (e.g. executive function) are associated with self-reported measures (e.g. entrepreneurial intentions). Due to the scope of the data (currently +1500 surveys completed), this leads to data that are descriptively interesting, as well as an opportunities to explore and test hypotheses about the links between cognitive micro-foundations and ability to solve the various natural science problems also hosted on the platform. These links are not analysed yet, and further data collection is ongoing.

The future aim is to develop a 'social science super collider', enabling the pursuit of various social science questions, going across national boundaries and beyond the student or Mturk participants social scientists often rely on. I will present the current status of the project, the effort to activate and involve citizen scientists, as well as identify opportunities and challenges of engaging in such a wide-ranging, open collaboration across scientific disciplines.

Paper 17: From contributory to co-created citizen science: how to engage citizen scientists in complex stages of the research process

Susanne Beck, Daniel Dörler, Florian Heigl, Marion Poetz, Henry Sauermann, Julia Süss-Reyes

Most current citizen science projects limit citizens' involvement to data collection, coding, processing or analysis tasks. However, a few citizen science projects also seek to involve citizens in other more complex stages of the research process such as the formulation of research questions, the development of research designs, or the writing process of papers. While co-created citizen science projects promise many potential benefits (e.g., the identification of novel problems, more efficient processes, better learning), they also face many challenges. Such challenges result, among others, from the complex nature of co-creation tasks. By learning from existing attempts to co-create with citizens in different stages of the research process, this project aims to develop, evaluate and practically apply a framework of how citizens can be effectively and efficiently involved in complex stages of the research process. In part 1 of the project, we identify and test antecedents and contingencies that facilitate (and hinder) the involvement of citizens in complex stages of the research process. This first part will include a literature review, a detailed analysis of 10–15 existing citizen science projects, as well as lab experiments to test different operationalizations of the resulting facilitating mechanisms. In part 2, we then develop, implement, and evaluate a framework that helps to guide citizens and project owners to successfully realize co-created citizen science projects. This part involves the implementation and evaluation of our framework in five co-created citizen science projects (these projects are e.g. related to human rights, ecology and human medicine). Overall, the project seeks to create both scientific knowledge on how to involve citizens in more complex tasks as well as practical tools to facilitate co-created citizen science projects.

Paper 18: Citizen science and sustainability transitions stages of the research process

Katrin Vohland, Henry Sauermann, Vyron Antoniou, Bálint Balázs, Claudia Göbel, Kostas Karatzas, Peter Mooney, Josep Perelló, Marisa Ponti, Roeland Samson, Silvia Winter

Citizen Science projects involve members of the general public as active participants in research. Proponents of this approach – including professional scientists, civil society groups, as well as policy makers – hope that it can increase scientific knowledge production and support transitions towards more sustainable practices in areas such as energy, health, or the environment. However, an integrated perspective on Citizen Science's potential role in sustainability transitions is missing. We first develop a conceptual model that highlights three pathways through which Citizen Science can support such transitions: (1) Identifying sustainability problems and influencing research agendas; (2) Increasing knowledge production through citizens' contributions of time and knowledge inputs; and (3) Facilitating the adoption of techno-scientific solutions and stimulating complementary socio-political changes. We then identify important tensions and challenges. First, integrating the traditional institution of science and Citizen Science approaches exacerbates important tensions such as that between scientific autonomy and outside influence, scientific versus educational goals, and social impact versus academic performance metrics. Second, to increase their effectiveness, Citizen Science projects need to find ways to sustain participation by a broader cross-section of the public, improve the quality of research processes and scientific results, and foster participant learning. Grounded in a review of academic literature and policy reports, case examples, as well as co-authors' experiences with Citizen Science, this article contributes to scholarship on science, innovation, and sustainability transitions. We also offer insights for actors involved in initiating or institutionalizing Citizen Science efforts, including project organizers, funding agencies, and policy makers.

SESSION 6

Paper 19: Disclosure of scientific results: the impact of norms, competition, and commercial orientation

Jerry Thursby, Carolin Haeussler, Marie Thursby, Lin Jiang

Based on a survey of 7,103 active faculty researchers in 9 fields, we examine the extent scientists disclose prepublication results, and when they do, why? Except in 2 fields, more scientists disclose than not, but there is significant variation in reasons to disclose, frequency, and withholding crucial results when presenting. They disclose for feedback, credit, and to attract collaborators. Particularly in formulaic fields researchers disclose to attract entry independent of collaboration and to deter others from working on their exact problem. A probability model shows 70% of field variation in disclosure is related to differences in respondent beliefs about norms, competition, and commercialization. Results suggest new research directions – e.g. do the problems addressed or the methods of scientific production, themselves shape norms and competition. Are the levels we observe optimal or simply path dependent. What is the interplay of norms, competition, and commercialization in disclosure and the progress of science?

Paper 20: Entry into external academic engagement

Cornelia Lawson, Alan Hughes, Ammon Salter, Michael Kitson

The question of how to incentivise academics or empower them to engage with non-academic actors is of continued importance to universities, policy and scholars alike, especially in the context of open science for innovation. Previous research has shown both individual and institutional factors that relate to various types of knowledge transfer activities of academic researchers (e.g. Grimpe and Fier, 2010; Lach and Schankerman, 2004; Link et al. 2007; Mowery et al. 2001). Moreover, academics are unlikely to engage with external sectors if personal attitudes towards engagement are negative and more likely when these are positive (Lam, 2011), and incentive schemes must be well aligned to support engagement efforts. Indeed, a number of studies have shown the impact that peers have on actions of academic researchers, may this be by shaping their attitudes or by setting an example (Bercovitz and Feldman, 2008; Aschhoff and Grimpe, 2014). Still, there is little empirical evidence on the dynamics and hence transition probability of individual academics' engagement with external organisations. Specifically, the question that remains unanswered is that of new entry, i.e., the take-up of engagement activities, and how it can be incentivised.

If decisions to engage are a question of motivation, then new entry may be explained by a change in opportunities, rewards or attitudes. Motivations of academics are moreover subject to and exploited by reward structures (Lam, 2011). For instance, many academics may lack the opportunities to engage externally, perhaps due to a lack of fit to external interests or a lack of resources. A change in research focus or resources may overcome this barrier. Moreover, a change in how rewards, such as prestige or promotion, are assigned could further impact academics' decision to engage with external actors. And finally, a change in the social context could provide new role models for knowledge transfer, impacting attitudes directly.

Using a panel of 4059 academics from all disciplinary backgrounds who responded to two waves of a UK-wide survey, we are able to explore the take-up of engagement activities and the circumstances under which it occurs. The two surveys were conducted in 2009 and 2015, referring to a three years' period prior to the survey, and enquired about a large number of different types of engagement activities. We find that engagement propensity is higher amongst those that were previously engaged, suggesting a high level of persistence in engagement. The source for engagement thus lies within the decision to engage in the first place. This decision is dependent upon individual motivations and attitudes as well as opportunities for engagement. For example, research council funding, a positive engagement attitude, and other types of prior engagement increase the likelihood of entry into engagement. The results thus suggest that while individual characteristics are important for first entry into engagement, once this is achieved such relationship endure even when attitudes are not favourable. Changes in context can affect motivations and opportunities and the next version of this paper will look in details at these changes and how they impact entry.

Paper 21: Innovators' preference structures for seizing scientific discoveries: a mixed-method approach

Susanne Beck, Karin Beukel, Marion Poetz

Innovators are confronted with a substantial amount of information on new scientific discoveries that could potentially be of interest to them. But how do innovators select the piece of scientific knowledge they are ready to spend time on investigating further, potentially resulting into university-industry collaborations or patenting-licensing deals? This multi-study mixed-method paper investigates what makes scientific knowledge attractive to innovators at first sight. Conceptually, innovators' early decision processes are portrayed from a Stimulus-Organisms-Response perspective. Empirically, we conduct in-depth interviews with a theoretical sample of international innovators (study 1; N=11) to identify determinants of innovators' perceived attractiveness of scientific discoveries and structure them along six categories (source of knowledge, knowledge characteristics, transfer channel, recipients' characteristics, expected outcome, and context). Based on this, we assess different preference bundles for seizing scientific discoveries in an adaptive choice-based conjoint analysis (study 2; N=95), revealing two major distinct clusters. While innovators in cluster 1 strongly prefer a bundle of determinants oriented towards generating immediate commercial value (exploitation focus), cluster 2 innovators value determinants related to collaboration and long-term learning (exploration focus). These findings hold essential implications for policy makers and universities, contributing to increasing the value captured for scientists, innovators and society in general.

Notes

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