AI in Research: Predictive Practices

Final Conference of the HiAICS Research Group

How is Artificial Intelligence Changing Science? Research in the Era of Learning Algorithms

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The dominant narrative surrounding AI describes its impact across scientific disciplines as a significant shift—one that extends beyond mere tooling to influence the very fabric of research practices and epistemic cultures (Falk 2019; Fösel et al. 2019; Gethmann et al. 2022). This narrative is rooted in new and expanded types of prediction. Such capabilities require scientific disciplines to accommodate two interrelated challenges: uncertainty and simulated data. Both of these factors will be investigated at this conference across various methodological traditions.

The key question for this conference is how the impact of new AI-based research practices of prediction should be assessed. To test this narrative, we suggest to take a close look at the "doing, crafting, and toiling of scientists" (Heyman et al. 2017, 22). The conference seeks to capture realistic shifts in the forms of data usages and futurities with a focus on current European research projects. Specifically, we ask: How do AI-enhanced methodologies play out in forecasting, modeling, and pattern recognition?

To avoid treating 'AI' primarily as a punctuated innovation story, we have proposed to foreground the level of data practices and scientific methodologies, and to read current developments against longer histories of data, statistics, formalization, modeling, and simulation (Sudmann et al. 2023; Sudmann, Echterhölter & Schröter 2025).

To that end, we consider it essential to conceptualize AI neither as a value-neutral instrument nor as an epistemic authority in its own right. Instead, we examine how its transformative effects are mediated by the methodologies, infrastructures, and disciplinary norms through which it is implemented. Our extensive media ethnographies of AI-based research suggest that these implementations rarely remain uncontested. Recent methodological work has begun to explore agentic, multi-stage pipelines, in which specialized agents are assigned distinct roles across an end-to-end workflow for AI-supported qualitative analysis, while retaining space for critical human intervention (Retkowski et al. 2025). How then do validation, application, and critique in specific contexts of forecasting and future orientation play out?

To accomplish this task, we do not only suggest a focus on the predictive practices which enable scientists to leverage AI to understand and increasingly anticipate complex research problems.

Adopting a more critical stance, we will also interrogate the hypothesis that the increasing reliance on simulated data fosters a progressive decoupling from empirical grounding. This perspective directly addresses the concern that AI-driven research may be developing selfreferential epistemic loops, where models are trained and validated against synthetic dataverses that are themselves simulated, rather than against direct measurement. This raises urgent questions about a potential 'profound loss of indexicality' and the introduction of new, deeply embedded biases originating from a simulation's core assumptions. We will therefore probe whether this shift does not merely augment traditional methods but actively redefines the status of evidence, potentially promoting a 'blur' or 'illusion' in relation to scientific truth claims. The challenge of uncertainty is thus transformed: it becomes less a question of managing known imprecision and more a fundamental doubt about the veracity of the simulated worlds from which predictions increasingly originate.

These tensions are particularly evident in fields heavily reliant on modeling. In climatology, for instance, while AI-enhanced methods refine projections, their dependence on vast simulated dataverses brings the questions of embedded bias and indexical loss to the forefront, especially when forecasting unprecedented disruptive weather events (Dagon et al. 2022). Medical research likewise leverages AI for personalized medicine and diagnostics, yet this raises critical concerns about the veracity of predictive models trained on synthetic patient data, which may not capture the full spectrum of human biology (Fröhlich et al. 2018; Lebedev et al. 2018; Bhatt et al. 2020; Bahado-Singh et al. 2021; Kose et al. 2021; Zhong 2024). Economics, in turn, confronts market volatility with AI, but here the risk of self-referential loops is acute, as models might not only predict but also influence market behavior, creating the very systemic risks they are meant to anticipate (Athey 2018; Xiong 2021). Perhaps the most direct engagement with these issues occurs in the humanities and cultural studies, where the implementation of AI's predictive potential explicitly catalyzes critical discussions about method, interpretation, and the very nature of humanistic inquiry itself (Franken 2022; Prescott 2023; Guo 2024; Petit 2024; Chaves et al. 2025; Wang et al. 2025).

A fundamental challenge, and thus a critical area of inquiry for AI's predictive practices across the sciences, lies in engaging with uncertainty and the inherent 'fuzziness'. As scientific discovery and decision-making increasingly lean on AI-generated predictions, crucial questions arise: What novel conceptual frameworks and practical methodologies are emerging in fields from climatology to medicine and from economics to sociology? What are key desiderata to adequately quantify, interpret, and communicate the multifaceted uncertainties embedded in AI models? How do researchers grapple with the 'fuzziness' of input data, the opacity of certain algorithms, or the probabilistic nature of outputs, and finally: what are the implications for the trustworthiness, ethical deployment, and utility of these predictions, especially when informing high-stakes decisions? This exploration highlights crucial socio-technical needs: the development of robust and interpretable uncertainty quantification techniques tailored for AI, the establishment of new scientific norms for reporting and critically evaluating predictive

uncertainty, and the profound epistemological considerations that arise when navigating a spectrum of possibilities rather than singular, deterministic outcomes.

We are looking for contributions on two interlinked phenomena within the field of AI-based predictive practices: high degrees of uncertainty and simulated dataverses.

Rising Levels of Uncertainty and Risky Environments

The idea of prediction has always come with the idea of intervention and prevention. The basis of this prediction is usually a form of science-based calculation, which depends on given data.

Consequently, new methods for accessing the future gain momentum in times of socio-political crises for which existing scientific theories and practices seem unable to provide satisfying answers. With reference to major failures like the economic crisis of 2008, scholars of economics and system sciences suggest machine learning as one remedy for addressing elusive, non-linear relationships (Casabianca et al. 2019). It remains to be seen if new predictive practices can live up to that (old) promise. However, these discourses should not be reduced to matters of guessing the future more accurately but should be extended to an analysis of the very sphere of intervention which is created by engaging in those practices. For the idea of the 'environment', environmental historians have argued that "expertise and environment are coproduced: as a series of efforts to establish predictive authority based on aggregating local data sets to suggest a global condition undergoing dangerous, quantifiable change." (Warde and Sörlin 2025, 49). Similar arguments can be made with reference to the establishment of 'the state' in connection with the use of statistics. And while machine learning is essentially rooted in statistical techniques, it is often described as being more concerned with forecasting outcomes than with uncovering causal explanations (Esposito 2021). If one accepts this assessment, the question remains how a turn away from underlying causes reconfigures notions of 'the environment' or 'the economy' and how an approach of pattern recognition is altering the perception of crises in these domains with explanation becoming ever more "a thing of the past" (Rindzeviciute 2023, 36). Does academic work move closer to action and intervention via the focus on prediction and does the concept of "orchestration" of ever more challenging layers of complexity in researching the future change academic positionalities via an "open epistemology"?

Simulated Data and Brave New Empiricism

The data-intensive infrastructures, which facilitate AI-enhanced predictive practices, have been identified as a precondition and the most crucial limiting factor of current developments. More often than not, the data that are being analysed are no longer "measured" against an entity, but themselves simulated, artificial likelihoods (Maiwöger 2020). We want to investigate the relation of scientific simulations and deep learning. Of course, simulated data are not new in the history of empiricism. In traditional weather forecasts, only 10% of data for a global weather prediction model are instrument readings (Edwards 2010, 21). Thus, weather forecasts never

had a simple empirical structure but are described as a “collage,” or “a process of assembling, appropriating, superimposing, juxtaposing, and blurring information” (Daipha 2015, 15, 21).

This makes the question whether the new talk of “blur”, “illusion” in relation to simulationbased AI all the more urgent (St. Pierre et al. 2016; Dippel and Warnke 2025). Rebecca Lemov even sees the destabilisation of truths in modern information technology in the light of older cold war brainwashing strategies (Lemov 2025). Do the current developments prolong established practices or do they alter them? Is there a profound loss of indexicality of the datapoints and how much materialism can be safely discarded with?

General approaches of the research project “How is AI Changing Science”

As in our past research, we suggest to emphasize the crucial nexus between infrastructures and practices. Predictive operations in AI research do not exist in a vacuum; they depend on vast computational resources, curated datasets, algorithmic frameworks, already established practices like computer simulation, and the development of new collaborative workflows. We are interested in how these infrastructures enable, constrain, and shape the emerging predictive practices, and conversely, how the demands of these practices drive infrastructural development. The central focus of our research group, “How is AI Changing Science? Research in the Era of Learning Algorithms,” has been the impact of modern AI on scientific methodologies and practices as opposed to the mere digitalization of various sciences. This inquiry was pursued through an interdisciplinary approach, integrating Media Studies, which examined the epistemic and infrastructural roles of media in AI applications for research; History of Science, which contributed data-critical perspectives on the history of statistics and computerized large-scale politico-economic modelling; and Computer Science, primarily responsible for developing 'tools' or 'epistemic media' to employ AI in the study of AI research.

This conference invites contributions that address the new perspectives and challenges arising from AI’s role in the scientific field. What are the epistemological consequences when prediction precedes or even supplants explanation? How do we ensure fairness, accountability, and transparency in predictive systems that have a significant societal impact (e.g., in predictive policing or medical allocation)? What new literacies and skills are required for scientists in an AI-driven research environment? What methods are needed to study the use of AI in science and its transformative nature?

AI, the Sciences and the Future of Impacts on Society

Broader issues such as algorithmic bias, data ownership, and the political economy of AI do, of course, affect the academic uses of AI (Noble 2018; Apprich 2019). The primary emphasis of the conference, however, takes predictive practices in various sciences as its point of departure. By examining how AI reshapes predictive practices and knowledge production within scientific research the social context will not be lost and can turn out to be an integral part, as discussions around FairML show (Benbouzid 2018, 2023). Contributions engaging in these wider societal concerns are welcome. These include reflections on how AI methodologies might be

reconfiguring core scientific values, norms of objectivity, and the very telos of scientific inquiry. Does an intensified focus on predictive power, for instance, inadvertently promote a more instrumentalist or calculative rationality within science, potentially marginalizing qualitative understanding, serendipitous discovery, or research oriented towards complex, non-quantifiable societal needs? (Elam 2023; Chatzichristos 2025).

AI in Research: Predictive Practices aims to foster a dynamic dialogue across disciplines, charting the evolving landscape of science in an age where the capacity to predict is increasingly becoming a defining feature of knowledge production. We seek to understand not only what AI can do for science, but also how it is fundamentally changing what it means to conduct science.

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