WIRTSCHAFTS INFORMATIK

Call for Theses
(Bachelor, Master)

TECHNISCHE UNIVERSITÄT DARMSTADT

Artificial Intelligence in Organizations and Society

In recent years, artificial intelligence (AI) has beaten the world's best human Go player (Silver et al. 2017), managed to recognize objects better than the average human (He et al. 2015), and defeated the world's best professional players in a complex strategic online game (Vinyals et al. 2019). Today, comparable AI is not only subject to exceptional research projects anymore—AI already influences our lives crucially by helping us to diagnose diseases (Kourou et al. 2015) or control natural disasters (Pourghasemi et al. 2020). Due to its widely recognized transformative potential, organizations have already started to adopt AI in a wide variety of their business functions to increase their efficiency and effectiveness (e.g., Forbes Insights 2018; Bean 2019). However, high uncertainty remains on how to manage this new technology in order to leverage its full potential and on potential consequences may emerge (Rzepka and Berger 2018; Rai et al. 2019). With machine learning (ML) being the major driver of modern AI-based information systems (ISs), the uncertainty of managing AI is further spurred: ML marks an alternative programming paradigm that allows to derive IS functionality from data instead of having humans explicitly translating their solutions into code (Samuel 1959). AIs that make use of data and ML algorithms behave intelligently by deriving patterns from data, which are then applied to new data to perform actions (Bishop 2006). The resulting handover of solution design to data-driven algorithms and arising technological particularities make it necessary to revisit our existing knowledge on how to manage IS successfully.

I. What We Seek for our Theses:

Our criteria lean on the paper criteria of the MISQ Special Issue on “Managing AI” (Berente et al. 2019): Our goal is to assess how we need to adapt and reinvent our knowledge of IS management to deal effectively with the challenges and opportunities of AI. We are looking for theses that draw upon and contribute to the stock of knowledge on the management and use of ISs, but to do so with full appreciation of the disruptive potential of AI-based innovations. Do our assumptions about managing and using ISs still hold? What is different about AI resources and contexts? How do we manage intra- and interorganizational processes interspersed with AI-based agency and control? What is different in technology, product, and process design and innovation through AI?

In sum, bachelor theses, student research projects (i.e., “Studienarbeiten”), or master theses on AI should meet four criteria (Berente et al. 2019):

1	**Theses must distinguish fundamentally between AI and other forms of digital technologies, and theorize on the specific differences.** Direct applications of existing theory on IT, individuals, organizations, and society (without differentiating AI from generic IT) are not suitable.
2	**Theses must focus on practices of AI to enhance value or mitigate harm in the development, implementation, management, use and/or governance of AI.** As boundaries between human and machine become increasingly blurry, we particularly encourage studies on new forms on the interactions between humans, AI, and other material resources.
3	**Theses must provide novel contributions to knowledge about the management or use of AI.** Any form of theoretical (conceptual or empirical) or practical contribution using any scholarly method is welcome.
4	**Theses can consider the social and/or technical aspect of AI**. We encourage studies on AI at and across a variety of levels of analysis, including individuals, organizations, institutions, platforms, ecosystems, and societies.

Potential topics include, but are not limited to:

- **Explainable AI**: Currently, the adoption of AI-based systems requires expert personnel with knowledge on how to train models and how to interpret their results. New approaches of explainable AI aim to generate output that explains the reasoning behind predictions in a human-understandable manner. The main goal of research efforts in this field is to enable AI applications in areas of high-stakes decision-making (e.g., medicine or finance). Theses could address the following questions: How do humans perceive different forms of explanations? How should user interfaces for AI-based systems be designed in order to create user trust? Can explanations be used to mitigate cognitive biases in human decision-making (e.g., through the use of digital nudging)? How much are Explainability features worth for users?
- **Sustainable AI**: AI will play a driving role in solving the big problems of our time. In the field of environmental science for example, AI will have a major impact on how we deal with global warming, the energy transition, species extinction and other pressing challenges. Furthermore, AI could be used to deal with social topics such as poverty or hunger. Large software companies such as Microsoft have already prepared themselves for the use of AI for sustainability with programs such as "AI for Earth" (Microsoft 2020). Scientists even assume that only AI will enable us to deal with the big challenges of today. For example, applying ML to available data on climate, energy supply, poverty, illiteracy, vaccination rates etc. will help us to identify correlations earlier and make helpful predictions more profoundly. Projects from this field such as eMammal, BasinScout or Zamba Cloud are first steps in this direction (Microsoft 2020). In addition, however, the negative impact of AI on sustainability must also be considered. For instance, necessary computing capacities to train ML consume large amounts of energy, biases in the data used can lead to an unfair distribution of resources, and so on. This leads to the following questions: What are the net benefits of AI in terms of sustainability? How can we ensure that AI becomes sustainable? What are the potential uses of AI to protect for example the environment or fight poverty? How can AI be used to analyze and predict environmental impacts or poverty rates? Which ethical issues do we need to consider?
- **AI Strategy:** More and more organizations are targeting to apply AI within their processes. In this regard, many organizations have already developed initial AI prototypes and conducted proof of concepts. However, the road to an AI-driven organization is often long and difficult, and prototypes are only the first step toward an AI strategy. This is particularly problematic because AI—as a general purpose technology—does not only pose technical challenges (e.g., data preparation, selection and parametrization of algorithms), but also needs to be embedded meaningfully in existing organizational processes in order to generate value. In this sense, it is necessary to develop an AI-strategy that, in addition to technical details, also allows for a strategic orientation of companies. However, what are the dimensions of such a strategy? Which use cases are being followed? What does an organization need to do to ensure employees are ready for and accept AI (e.g., data culture, trust in AI)? How should organizational processes be adapted to implement AI in the long term? What organizational structures/archetypes are being pursued and how do they affect AI effectiveness?
- **AI-based Business Models:** Exploring the potentials of AI solutions for tackling humanity's current challenges has been of great interest for stakeholders from both business and scientific backgrounds in recent years. To date, however, little research has been done on the required adjustments to the business models of companies seeking to sell AI-based products. Students seeking to fill this gap might attempt to answer questions such as: How do companies transitioning into the field of AI adapt their business models? Which components of business models are critical for the success of AI solutions? How do AI-based business models differ from business models for other IT products?
- **Human-Machine Learning in Organizations:** Human learning constitutes a key driver of innovation and routines in organizations. With ML enabling ISs to learn on their own and thus contribute their own knowledge, humans no longer exclusively act as a single source of organizational knowledge. Following theories of machine, human, and organizational learning, many questions arise that surround the creation, retention, and transfer of organizations' knowledge (Argote and Miron-Spektor 2011; Argote et al. 2020; Ransbotham et al. 2020), such as: How can organizations make use of ML knowledge? Which role can ML take in organizational learning processes and how does ML change the role of human learners? How can organizations manage the interplay between machine and human learning? How does ML affect the emergence of organizational routines and innovations?

- **Machine Learning Operations (MLOps):** Training an ML model is only the first step of getting it into production. In practice, ML deployments incorporate unique challenges such as reproducibility, testing, or model and data versioning. While best practices exist for some applications such as autonomous driving (e.g., Tesla Autopilot), research in this area is still scarce. Thus, potential theses could address the following questions: How can ML models and datasets be tested using traditional software engineering approaches and which new techniques are required? How can efficient data pipelines be designed in order to ensure steady performance improvements, e.g., through active learning or sourcing of edge cases? Please be aware that theses in this field require coding experience, preferably in ML frameworks such as PyTorch, TensorFlow or Scikit-learn.
- **AI in Medicine:** The use of AI in the medical environment has gained immense importance in recent years. It has already been shown that ML-based models can be used to support diagnoses, make predictions in emergency services or optimize process flows in hospitals. Even though many feasibility studies already exist in research, the adoption of AI in medical practice is still in its infancy. Ethical, legal, technical and organizational hurdles have so far prevented the everyday use of AI in hospitals and medical practices. In addition to the use of AI by professional users (e.g., physicians, hospital management, emergency medical services), the use of AI for private end-users is becoming increasingly important in the context of mobile applications as well. In this regard, first products (e.g. Ada, Isabel Healthcare) already show what the healthcare system of tomorrow could look like. Again, the above-mentioned challenges need to be solved in order to enable a meaningful use of AI in healthcare. Fruitful research directions on the use of AI in the medical environment could include the following: What ethical requirements must be met for the use of AI in medicine? Which aspects of transparency and fairness are relevant for the use of AI in medicine? Can medical diagnostics be supported with the help of AI, if so, how (e.g., PoCs)? Can ML/Natural Language Processing be applied to find relationships between certain data from social networks, medical crowdsourcing websites, etc. and possible diagnoses? Which criteria determine the acceptance of end users or professional users for AI in medicine? How can other technologies (e.g. Augmented Reality, sensors, surgical robots) be combined with AI to optimize medical processes?

II. Possible Methodologies

Theses should cover one or more methodologies, such as:

- *Structured literature reviews*
- *Quantitative online surveys*
- *Implementations of AI solutions*
- *Qualitative interviews*
- *Experiments*
- *…*

III. Application Requirements

Important: If you are interested in writing a thesis on AI, please send an email application that includes:

1. a **brief CV,**
2. a current **performance record** (can be downloaded in TUCaN),
3. a **short description** of your proposed topic including a **research question**, and
4. the **time period** in which you would like to work on the thesis

to: ai-team@is.tu-darmstadt.de.

References

Argote, L., and Miron-Spektor, E. 2011. “Organizational Learning: From Experience to Knowledge,” Organization Science (22:5), pp. 1123–1137.

Argote, L., Lee, S., and Park, J. 2020. “Organizational Learning Processes and Outcomes: Major Findings and Future Research Directions,” Management Science.

Bean, R. (2019). “Demystifying Artificial Intelligence in the Corporation.” URL: https://www.forbes.com/sites/ciocentral/2019/10/09/demystifying-artificial-intelligence-ai-inthe-corporation-forbes/#76f168df6016 (visited on 11/12/2019)

Berente, N., Gu, B., Recker, J., and Santhanam, R. 2019. “MISQ Special Issue on ‘Managing AI,’” *MIS Quarterly*, pp. 1–5.

Bishop, C. M. (2006). *Pattern recognition and machine learning*. New York, NY: Springer Science and Business Media.

Forbes Insights. (2018). “On your marks: business leaders prepare for arms race in Artificial Intelligence.” URL: https://www.forbes.com/sites/insights-intelai/2019/05/22/welcome-fromforbes-to-a-special-exploration-of-ai-issue-6/#67864c574650 (accessed on 11/13/2020).

He, K., Zhang, X., Ren, S., and Sun, J. 2015. “Delving Deep into Rectifiers: Surpassing Human-Level Performance on Imagenet Classification,” in *IEEE ICCV Proceedings*, pp. 1026–1034.

Kourou, K., T. P. Exarchos, K. P. Exarchos, M. V. Karamouzis and D. I. Fotiadis. (2015). “Machine learning applications in cancer prognosis and prediction.” *Computational and Structural Biotechnology Journal*, 13, 8–17.

Microsoft (2020). “Take part in AI for Earth.” URL: https://www.microsoft.com/en-us/ai/ai-for-earth (accessed on 11/12/2020)

Pourghasemi, H. R., N. Kariminejad, M. Amiri, M. Edalat, M. Zarafshar, T. Blaschke and A. Cerda. (2020). “Assessing and mapping multi-hazard risk susceptibility using a machine learning technique.” *Scientific Reports*, 10(1), 1–11.

Rai, A., P. Constantinides and S. Sarker. (2019). “Editor’s Comments: Next-Generation Digital Platforms: Toward Human–AI Hybrids.” *MIS Quarterly*, 43(1), iii–ix.

Ransbotham, S., Khodabandeh, S., Kiron, D., Candelon, F., Chu, M., and LaFountain, B. 2020. “Expanding AI’s Impact With Organizational Learning,” MIT Sloan Management Review (62270).

Rzepka, C. and B. Berger. (2018). “User interaction with AI-enabled systems: a systematic review of IS research,” in *Proceedings of the 39th International Conference on Information Systems*. San Francisco, CA.

Samuel, A. L. (1959). “Some Studies in Machine Learning Using the Game of Checkers.” *IBM Journal of Research and Development*, 3(3), 210–229.

Silver, D., Schrittwieser, J., Simonyan, K., Antonoglou, I., Huang, A., Guez, A., Hubert, T., Baker, L., Lai, M., Bolton, A., Chen, Y., Lillicrap, T., Hui, F., Sifre, L., Van Den Driessche, G., Graepel, T., and Hassabis, D. 2017. “Mastering the Game of Go without Human Knowledge,” *Nature* (550:7676), pp. 354–359.

Vinyals, O., Babuschkin, I., Czarnecki, W., Mathieu, M., Dudzik, A., Chung, J., Choi, D. H., Powell, R., Ewalds, T., Georgiev, P., Oh, J., Horgan, D., Kroiss, M., Danihelka, I., Huang, A., Sifre, L., Cai, T., Agapiou, J. P., Jaderberg, M., Vezhnevets, A. S., Leblond, R., Pohlen, T., Dalibard, V., Budden, D., Sulsky, Y., Molloy, J., Paine, T. L., Gulcehre, C., Wang, Z., Pfaff, T., Wu, Y., Ring, R., Yogatama, D., Wünsch, D., McKinney, K., Smith, O., Schaul, T., Lillicrap, T., Kavukcuoglu, K., Hassabis, D., Apps, C., and Silver, D. 2019. “Grandmaster Level in StarCraft II Using Multi-Agent Reinforcement Learning,” *Nature* (575:7782), pp. 350–354.