Internet of Things and the Governance of Big Data and Artificial Intelligence

Günter Knieps
Albert-Ludwigs-Universität Freiburg, Germany

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The complementary role of big data and AI in smart network industries

- The collection and processing of large data sets (big data) does not come in isolation but is evolving based on a combination of data collection innovations due to rapidly decreasing (camera based) sensor technologies, strongly increasing computer processing and storage capacities as well as innovations in communication technologies. In meantime, big data cloud computing is gaining increasing relevance for local, regional, and cross-country data traffic driven by the high bandwidth capacities of 5G networks.

- Cloud computing is gaining a pivotal function in the entrepreneurial design of data value chains for real-time, adaptive sensor-based applications in many use cases of the Internet of Things (IoT). Classes of use cases requiring a tactile Internet (e.g., driverless networked vehicles, smart manufacturing, augmented and virtual reality) are concomitant with massive and high-velocity data sets challenging the traditional approaches (e.g., statistical analysis or optimization theories) to derive the relevant decisions based on the insights from this data. This is the very reason why Artificial Intelligence (AI) relying on algorithms-based pattern recognition becomes so relevant within the network industries of the future.

The EU regulations of big data and artificial intelligence (AI)

- An important precondition for the development of AI is the access to big data. The focus is therefore on two topical complementary waves of reform initiatives, the “EU data strategy” on one hand (European Commission (2020a, 2020b, 2020c) and the “AI for Europe strategy” on the other hand (European Commission 2021a, 2021b, 2021c).
- The nature and design of AI systems is concomitant with the creation of European data pools enabling big data analytics and machine learning, taking into account data protection legislation and competition law for the emergence of data-driven ecosystems.
- The important role of AI systems based on big data increases the role of data sharing and open data for AI applications in many areas of the App economy such as transport, agriculture, financial services, marketing and advertising, in science, in health, in criminal justice , in security in the public sector, for applications using augmented and virtual reality etc. (OECD 2019, pp. 47-80).

AI, big data, and the search for innovative algorithms (1)

- The history of AI dates back to the 1950s, Turing (1950) raising the question whether machines can think developed the so called “Turing test” whether a suspicious human could have a conversation with a (hidden) computer and would be convinced it would be a human. In the same year Shannon (1950) proposed the creation of a computer that could learn to play chess pointing out its possible relevance for many other areas such as machines for translating languages or for routing of telephone calls, etc. The Dartmouth Summer Research Project workshop in summer 1956 is nowadays considered as the birthplace of AI.

- Strong increase in computation power due to transistor innovations, networked computing based on broadband capacities and the associated computational and storage capacity during the 1980s and 1990s strongly increased the potentials for AI. These developments become even more disrupting due to the 5G innovations of QoS differentiated broadband capacities together with the big data driven Internet of Things (IoT).

AI, big data, and the search for innovative algorithms (2)

- Although AI has the character of an umbrella term with different meanings its basic principle is the interaction of big data and algorithms in the search for automated decision making. For a well-defined set of objectives, the operational logic of data trained algorithms is depending on the sensor-based data inputs a set of actuator decisions is chosen.

- Basic ingredients for definitions of AI are sensor-based data collection, reasoning/information processing by algorithms and concomitant proposed action in the search for human-centered values and fairness; transparency and self-explanatory; robustness, security and safety and accountability (European Commission, 2019a, OECD 2022a, 2022b, ITF 2021).

AI, big data, and the search for innovative algorithms (3)

- High volumes of raw data are typically available in many areas of IoT applications. The real challenge arises to transform high volumes of data under the requirements of real-time processing into decision relevant information by means of algorithm-based big data analytics.
- Algorithms that learn and self-evolve warrant particular attention, because these algorithms are no longer programmed by human beings, but “increasingly” learn, self-evolved and adaptive (EPFL IRGC, 2018). The meaning of self-learning mechanisms is twofold: “AI self-learning” may take place during the training, but there is also the possibility that AI machines continue learning after they are deployed (European Commission, 2020b).
- In contrast to well-established static algorithms in optimization theory dynamic deep learning algorithms based on so called neural networks gain relevance for complex big data real time applications (Emmert-Streib et al., 2020). The ongoing challenge for the public acceptance of AI systems is to make AI explainable and interpretable (Rudin, 2019).

The governance of AI-powered big data virtual networks (1)

- IoT is characterized by the complementary role of physical networks and virtual networks. To fulfill the requirements of IoT applications (networked vehicle applications, shared mobility service, microgrids etc.) it is important that the virtual network providers have the entrepreneurial decision competences to design the big data value chains according to the requirements of the IoT applications, combining QoS differentiated bandwidth capacities with the different complementary dimensions of virtual networks such as sensor networks, geo-positioning services and the division of labor between central cloud and edge cloud (Knieps, 2017).
- The focus is on the requirements of 5G and concomitant 5G-based big data virtual networks also enabling the strong QoS requirements of bandwidth capacities of the tactile Internet. Heterogeneity of AI algorithms and machine learning is depending on the big data value chains of big data virtual networks.

The governance of AI-powered big data virtual networks (2)

- To analyze the potentials of AI in network industries the analytical concept of AI-powered big data virtual networks is introduced. Although several actors may be involved such as broadband traffic service providers, cloud service providers, geopositioning-service providers, or sensor network service providers, the final responsibility for bundling these different service components lies in the hand of the AI-powered big data virtual network providers.
- Platform operators responsible for the performance guarantees on the physical side of IoT applications may be horizontally integrated with such virtual network providers. The entrepreneurial task of the big data virtual network provider is to decide over the specificities of the AI system in combination with the relevant data value chains implemented according to the requirement of the physical IoT applications.
- In addition to the required data privacy and security regulations the elaboration of new liability rules for AI interacting with traditional technologies is becoming relevant considering AI-specific ethical and transparence obligations.

Big data and AI in road transportation (1)

- In recent years big data in transport gains particular relevance, with a large potential of reporting mobility data (ITF 2022). The requirements for AI systems vary strongly.

- Intelligent traffic information systems such as real-time distribution of information are real-time without latency guarantees and no requirements for camera-based sensors.

- AI in proactive road infrastructure safety management requires the sensing and sharing of safety-relevant data on the entire road network (ITF, 2021). The focus is on accurate risk prediction and guidance for proactive road network safety management. Data often remain in “silos” instead of being shared, a barrier for AI implementation is the fear of litigation for disclosure of identifiable personal information pointing to the necessities of problem-solution adequate aggregation of data. Automotive industry produces high volumes of “floating car data” including indicators of traffic volume, speed, and data from active safety systems. Recommendation is to enable market platforms for heterogeneous data from vehicles and smartphone apps. A start with risk predictions models based on aggregated instead of real-time date, which are not critical for private data protection is recommended resulting in less complex AI algorithms compared to the big data processing of real-time data sets.

Big data and AI in road transportation (2)

- Networked fully automated (driverless) vehicles need guarantees for ultra-low latencies , ultra-high requirements for sharing of sensor data together with edge cloud local processing of data.

- The important role of sharing real-time data among different developing firms gathered in the course of their trials to train AI algorithm has been pointed out. Role of large-scale deep learning is based on massive-scale dataset collected from the instrumental vehicle fleet (Fridman, Brown, Glazer et al., 2017).

Appendix: References

Chivot, E., Castro, D (2019), The EU Needs to Reform the GDPR to Remain Competitive in the Algorithmic Economy, Center For Data Innovation, May 13

Emmert-Streib, F., Yang, Z., Feng, H., Tripathi, S., Dehmer, M. (2020), An Introductory Review of Deep Learning for Prediction Models With Big Data, Frontiers in Artificial Intelligence, 28 February, Vol.3/4 , 1-23,

EPFL IRGC (2018), The Governance of Decision-Making Algorithms, Lausanne: EPFL International Risk Governance Center, irgc.org

European Commission (2018), Artificial Intelligence for Europe, Communication from the Commission to the European Parliament, the European Council, The Council, The European Economic and Social Committee and the Committee of the Regions, Brussels, 25.4.2018, COM (2018) 237 final

European Commission (2019a)), A Definition of AI: Main capabilities and disciplines, Independent High-Level Expert Group on Artificial Intelligence, Set up by the European Commission

European Commission (2019b), Liability for Artificial Intelligence, Report from the Expert Group on Liability and New Technologies – New Technology Formation

European Commission (2020a), A European strategy for data, Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions, Brussels, 19.2.2020 COM(2020) 66 final.

European Commission (2020b). Proposal for a Regulation of the European Parliament and of the Council on European data governance (Data Governance Act), Brussels, 25.11.2020,COM (2020) 767 final

Appendix: References

European Commission (2020c), Report on the safety and liability implications of Artificial Intelligence, the Internet of Things and robotics, Report from the Commission to the European Parliament, the Council and the European Economic and Social Committee, Brussels, 19.2.2020 COM(2020) 64 final.

European Commission (2020d), White Paper on Artificial Intelligence – A European approach to excellence and trust, Brussels, 19.2.2020 COM(2020) 65 final.

European Commission (2021a), Proposal for a Regulation of the European Parliament and of the Council: Laying down harmonized rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union Legislative Acts, Brussels 21.4.2021, COM (2021)206 final

European Commission (2021b), Commission Staff Working Document Impact Assessment, , Accompany the Proposal for a Regulation of the European Parliament and of the Council: Laying down harmonized rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union Legislative Acts, Brussels, 21.4. 2021, SWD (2021)84

European Commission (2021c), Commission Staff Working Document Impact Assessment, Annexes, Accompany the Proposal for a Regulation of the European Parliament and of the Council: Laying down harmonized rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union Legislative Acts, Brussels, 21.4. 2021, SWD (2021)84 final, Part 2/2

European Commission (2021d), Proposal for a Regulation of the European Parliament and of the Council on machinery products, Brussels , 21.4.2021, COM (2021) 202Final

Appendix: References

European Commission (2022 a), Proposal for a Regulation of the European Parliament and of the Council on harmonized rules on fair access to and use of data (Data Act), Brussels, 23.2. 2022, COM (2022) 68 final

European Commission (2022b), Commission Staff Working Document on Common European Data Spaces, Brussels, 23.2. 2022 SWD(2022)45 final

European Commission, (2022c), Commission Staff Working Document Impact Assessment Report, Accompanying the document: Proposal for a Regulation of the European Parliament and of the Council on harmonized rules on fair access to and use of data (Data Act), Brussels, 23.2. 2022 SWD(2022) 34 final

Fridman L., Brown, D.E., Glazer, M. et al (2017), MIT Autonomous Vehicle Technology Study: Large-Scale Deep Learning Based Analysis of Driver Behavior and Interaction with Automation, arXiv: 17.11.06976v1 (cs.CY) 19 Nov.

ITF (2021), Artificial Intelligence in Proactive Road Infrastructure Safety Management: Summary and Conclusions, ITF Roundtable Reports, No. 187, OECD Publishing, Paris

ITF (2022), Reporting Mobility Data – Good Governance Principles and Practices, International Transport Forum Policy Papers, No. 101, OECD Publishing, Paris

Knieps, G. (2017), Internet of Things, future networks and the economics of virtual networks, Competition and Regulation in Network Industries, 18 (3-4), 240-255

Knieps, G. (2021), Digitalization Technologies - The evolution of smart networks,
in: J.J. Montero, M. Finger (Eds.), A Modern Guide to the Digitalization of Infrastructure, Edward Elgar, Cheltenham et al., Chapter 2,43-58

Appendix: References

OECD/ITF (2015), Big Data and Transport – Understanding and assessing options, Paris. https://www.itf-oecd.org/big-data-and-transport

OECD/ITF (2016), Data-Driven Transport Policy, International Transport Forum, Paris. https://www.itf-oecd.org/data-driven-transport-policy

OECD (2019), Artificial Intelligence in Society, OECD Publishing, Paris, https://diu,irg/10.1787//eedfee77-en.

OECD (2021), Recommendation of the Council on enhancing access to and sharing of data

OECD (2022a), Recommendation of the Council on Artificial Intelligence, OECD/LEGAL/0049

OECD (2022b) , The OECD Framework for Classifying AI Systems to assess policy challenges and ensure international standards for AI

Rudin, C. (2019) Stop explaining black box machine learning models for high stakes decisions and use interpretable models instead, in : nature machine intelligence 1, 206-215

SWIPO AISBL. (2020), Code of Conduct for Data Portability and Cloud Service Switching for Infrastructure as a Service (Iaas) cloud services, version: 2020, 08-07-2020

Turing, A. M. (1950), I. — Computing Machinery and Intelligence, Mind: A Quarterly Review of Psychology and Philosophy, Vol. LIX. No.236, October

Shannon, Claude E. XXII. (1950), Programming a Computer for Playing Chess[FN] , Philosophical Magazine, Ser.7, Vol. 41. No. 314-March