Centre For Autonomous Systems Technology

Machine Learning:
Formulating an Innovation Policy for the 4th Industrial Revolution

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Introduction

In 1959, Arthur Samuel defined machine learning as a *"Field of study that gives computers the ability to learn without being explicitly programmed"* (Simon 2013, p. 89). Machine learning solidified as a subfield of computer science in the late 1990s, when advances in cheaper and greater computer power allowed computer scientists to endow computer systems to learn from data without relying on rules-based programming. Today the sheer volume and complexity of the big data have raised both the need for and potential of machine learning systems (Kitchin 2014). Indeed, the benefits of teaching machines how to learn has recently attracted considerable news media coverage following [the victory of AlphaGo over Lee Sedol](). Overstating the capabilities of machines may lead to sowing the seeds for public mistrust and ultimately prevent proper consideration of how society can and should engage with new capabilities of software and machines.

Machine learning is deeply implicated in what has come to be known as the Fourth Industrial Revolution. As is known, the First Industrial Revolution was driven by the introduction of mechanical production equipment powered by the then newly invented steam engines in the second half of the 18th century. More than a century later, the Second Industrial Revolution occurred, when innovation in the form of mass production of goods was made possible through a combination of reorganization of economic activity (i.e. division of labour) and electrification. The integration of technological processes into business cycles illustrates the extent to which the potential of innovation could be leveraged. The Third Industrial Revolution occurred around 1970, when increasing modularization of technological productivity was made possible through innovations in hardware and software (Baldwin 2015). Now, however, we are on the cusp of yet another industrial revolution in the making – the Fourth Industrial Revolution – driven by the digitization, cybernetics and automation (Schwab 2016).

Machine learning poses a host of legal, ethical and political issues that should be addressed in a timely manner. For instance, systems which are trained on datasets collected with biases may exhibit these biases upon use, thus digitizing socio-cultural prejudices such as institutional racism (Bostrom 2011). Consider for instance image recognition algorithms. In May 2015, Google launched its image recognition software – the Photos application, announcing its machine learning capability to recognize people, places and events on its own. Soon after, however, Google had to apologize to Jacky Alciné, an African American programmer, after its Photos application identified Alciné and a friend as "gorillas" (Finley 2015). Responsible collection of data is therefore a critical part of fostering public trust in machine learning.

Machine learning also poses numerous legal and policy challenges. For example, as volumes of data are collected to address health, transport, energy and public services issues, we may need to reassess the role of privacy and data protection law. Furthermore, the design of autonomous systems and intelligent machines will enable machines to develop new knowledge and prediction capabilities, and as a consequence, may require a reassessment of how we think about rules, laws and regulations. More broadly, at political and societal levels, as algorithms and smart communication platforms make available to industry, governments and local authorities considerable resources to create a "good society", its implications for local and national democracy are unclear and not fully understood.

Liverpool Symposium on Machine Learning: Formulating an Innovation Policy for the 4th Industrial Revolution

To address these issues outlined above and to lay a groundwork for the future development of inter-disciplinary collaborations by promoting greater dialogue among various stakeholders, Mr. Joseph Savirimuthu (Senior Lecturer in the School of Law and Social Justice and Member of The Centre for Autonomous Systems Technology) organized a Symposium titled *"Machine Learning: Formulating an Innovation Policy for the 4th Industrial Revolution"* on 11 July 2016, and generously sponsored by The Centre for Autonomous Systems Technology (CAST).

Machine learning, big data and artificial intelligence hold out the prospect for innovation and help realise social and welfare goals. The Royal Society recently commenced a [Machine Learning Project]() and Joseph Savirimuthu was invited to provide testimony at an evidence gathering Workshop early in 2016. The Symposium in Liverpool builds on this Workshop and aims to increase awareness of this technology. The delegates and panel members gathered for the Symposium comprised academics from Law, Computer Science, Philosophy, Social Sciences, Medicine and Electrical Engineering.

Early in the Symposium, Dr. Nolen Gertz (Department of Philosophy, University of Twente) reminded the audience in his Policy Provocation *"Machine Learning: The Next Step on the Path to Ethical Life or to Nihilism?"* of the need to reflect carefully on the question – "Why do we teach machines to learn?" This may strike many as a strange question at first glance. It is however an important question as it challenges conventional accounts that are overly optimistic (Anderson 2008) does place the focus on whether the optimism that surrounds machine learning may lead us to overestimate the capacity for technological innovations to solve problems, create new knowledge and promote economic prosperity and growth. Prof. Ronald Leenes (Institute for Law, Technology, and Society, Tilburg University) provided an expansive and considered view of machine learning processes and its implications for individuals' ability to manage their privacy and choices. Machine learning, he suggested, allows data controllers the power to not only map the social world but also to categorise and profile individuals in a way that conceal normative political and commercial biases. His talk echoed the complexities involved in the algorithmic-big data thicket. The concerns about the concentration of knowledge and power in global entities such as Facebook, Google and corporations engaged in embedding digital infrastructures were a pervasive theme. Both presentations formed the basis of discussion and debate throughout the day.

Dr. Paul Hepburn (Heseltine Institute for Public Policy and Practice) and Dr. James Organ (School of Law and Social Justice) articulated the challenges technologies such as machine learning pose for orthodox conceptions of democratic engagement, participation and accountability. More specifically, their interventions highlighted the uncertainty that surrounds the role of technological capabilities such as machine learning to re-arrange the relationships between citizens and the State and consumers and corporations. In a similar vein, Mr. Joshua Hughes (Law Department, University of Lancaster), Dr. Christopher Till (School of Social Sciences, Leeds Beckett University), and Mr. Simon McKay (Barrister & Honorary Fellow, School of Law, University of Leeds) emphasised the problems of transparency and attributing responsibility in areas such as national security, law enforcement, military and healthcare. Their contributions bring to mind the longstanding tensions associated with technological mediation and its challenges for the constitution of social meaning, identity formation and constitutionalism (Cheney-Lippold, 2011). Machine learning capabilities revolve around privileged access to volumes of personal data and there is an uneasy relationship between privacy and discoverability.

Mr. Christopher Graham, the outgoing UK Information Commissioner, captured the general tone of the Symposium very nicely by pointing out the need for reassessing the role of privacy and data protection law, as volumes of data are collected to address health, transport, energy and public services issues. Mr. Graham, a former graduate of the University of Liverpool, in his speech "Brave New World? How to avoid Dystopia", emphasised the value of inter-disciplinary engagement and his hope that the University of Liverpool continues to raise public awareness of machine learning technology and how it impacts industries, communities and society.

In the final talk of the Symposium, Dr. Faridun Sattarov (External Collaborator, The Centre for Autonomous Systems Technology) presented his paper, titled 'Coded power: A crossdisciplinary framework for understanding algorithmic power'. Dr. Sattarov began his talk by drawing attention to the fact that the notion of algorithmic power had frequently been employed throughout the symposium discussions, while different speakers had different conceptions of algorithmic power in mind. This, in his opinion, demonstrates the need for the creation of a crossdisciplinary and integrative framework for understanding different conceptions of algorithmic power.

All in all, the symposium discussions lent to a vibrant and engaging Symposium. In closing the Symposium, Mr. Joseph Savirimuthu assured delegates and panel members that efforts would continue to be made to develop inter-disciplinary collaborations and promote greater dialogue between various stakeholders.

We learnt a number of things from this Symposium. First, machine learning processes raise some interesting scientific, research and policy issues. Second, we must not accept readily the narratives of technological and scientific optimism and regard being steered towards market oriented goals as a natural process of the creative forces of innovation. Third, innovations and emerging technologies are increasingly being funded by global actors in a wide range of domains, which include, energy, military and life sciences, and have the potential to influence the vision for the emerging society, its priorities and direction for scientific research and policymaking (Rosenberg 1994). As we look forward to a future of the wisdom of machine learning we need a better understanding of the value of agency and the role of the individual in the emerging data landscape.

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