Data Sharing in Agriculture 4.0: Applications of AI for Access Control Decisions

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Abstract

Purpose: Following the recent advances of the information technology in a broad variety of areas and the availability of data in increased volume, in different forms and from various sources, not only digital and technological sectors have shown interest, but also more traditional sectors like agriculture try to benefit from this disruption of the industrial landscape. The wave of Industry 4.0, due to the evolution of Big Data Analytics and the associated capabilities, provides opportunities but also new challenges which the traditional farming has to overcome. The evolution of Industry 4.0 in the farming sector i.e. Agriculture 4.0 has been manifested in the field as new Big Data initiatives and applications in various areas (i.e. agriculture) are becoming economically viable. The proliferation of data and the associated applications has evolved due to the lower (comparatively to previous years) costs of sensor solutions, data storage and processing in cloud infrastructures, development and expansion of

mobile networks and the transmission of data sets from fields around the world. Data can improve not only individual farms, but also a larger group of farms that utilise information, technology, equipment and benefit from a wide range of services. The data evolution and the transformation of the agrarian operating models should not only focus on value creation for the consumers, but also for the individual farmer and the society through the use of Big Data.

Trying to expand the context of Industry 4.0 to the agricultural sector, as stated by CEMA (CEMA - European Agricultural Machinery, 2017a, p. 1) the *"Digital Farming is structurally similar to the concept of Industry 4.0".* In our study, we follow the definition of Industry 4.0 which *'entails a confluence of technologies ranging from a variety of digital technologies (e.g. 3D printing, Internet of Things, advanced robotics) to new materials (e.g. bio or nano-based) to new processes (e.g. data-driven production, artificial intelligence, synthetic biology) and these technologies will be available in the near future.'* (OECD, 2016, p. 3). Nonetheless, the notable distinguishing parameters in agricultural production processes are somewhat different from industrial processes, as agriculture is heavily determined by natural and biological factors (CEMA - European Agricultural Machinery, 2017a, 2017b), and therefore the 'physical' artefact should be strongly considered. The terms 'Digital Farming', 'Smart Farming', 'Farming 4.0' and 'Agriculture 4.0' are often referring to similar contexts and therefore are used interchangeably (Lamborelle, 2016; Weltzien, 2016; Yahya, 2018).

In our study, we follow the definition of 'Agriculture 4.0' (CEMA - European Agricultural Machinery, 2017a, p. 1) as the '*evolution in agriculture and agricultural engineering from Precision Farming to connected, knowledge-based farm production systems'.* Applying data-intensive practices and Internet-of-Things (IoT) technologies in the areas of agriculture and farming, due to the increasing benefits arising from the data evolution, can provide a lens for ensuring the transparency of the farming practices and sustainability of the food production processes. The focus of Agriculture 4.0 on digitalised ways of farming can generate renewed interest in transforming the traditional operating and process models to digital data-intensive ones focusing on Artificial Intelligence (AI), analytics and decision-making practices. The use of data analytics and associated technologies could create value for the businesses that could harness the innovation opportunities arising from this evolution (Duan, Cao, & Edwards, 2018; Pape, 2016), but also manage the challenges that come along this change (Hindle & Vidgen, 2017; Vidgen, Shaw, & Grant, 2017).

There is still an open discussion, and multiple challenges about Agriculture 4.0 and specifically a resistance wave from small farms due to data sharing concerns and access control policies of the data available among the multiple parties. Building on the background of data management and the data quality attributes; this paper proposes techniques from AI through an argumentation reasoning approach for bridging the data sharing concerns. This approach focuses on the attributes of agricultural data and defining Data Sharing Agreements (DSAs) around specified attributes.

Methodology: The proposed approach focuses on data processing by various entities and the associated data sharing agreements (DSAs). The study develops an expressive policy analysis language (Logic Programming) for representing the DSAs through argumentation reasoning. The proposed approach permits decisions around conflicting knowledge and the construction of correct and efficient DSAs that apply in different contexts during the processing of data.

Contributions and expected findings: The study proposes an approach for the data sharing problem in Agriculture 4.0, where data can be accessible by different entities. Through the

application of AI and Logic Programming, we aim to present through case scenarios new ways to build efficient Data Sharing Agreements (DSAs), thus eliminating data sharing concerns which hinder the wider adoption of the Agriculture 4.0 paradigm.

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References

CEMA - European Agricultural Machinery. (2017a). *Digital Farming: what does it really mean?* Retrieved from http://www.cema-agri.org/page/digital-farming-what-does-it-really-mean

CEMA - European Agricultural Machinery. (2017b). *FARMING 4.0: THE FUTURE OF AGRICULTURE?* Retrieved from http://www.cema-agri.org/page/farming-40-future-agriculture

Duan, Y., Cao, G., & Edwards, J. S. (2018). Understanding the impact of business analytics on innovation. *European Journal of Operational Research*. https://doi.org/10.1016/j.ejor.2018.06.021

Hindle, G. A., & Vidgen, R. (2017). Developing a business analytics methodology: A case study in the foodbank sector. *European Journal of Operational Research*. https://doi.org/10.1016/j.ejor.2017.06.031

Lamborelle, A. (2016). Farming 4.0: The future of agriculture?

OECD. (2016). Enabling the Next Production Revolution: the Future of Manufacturing and Services - Interim Report. *Meeting of the OECD Council at Ministerial Level*. https://doi.org/10.1787/eag-2017-en

Pape, T. (2016). Prioritising data items for business analytics: Framework and application to human resources. *European Journal of Operational Research*. https://doi.org/10.1016/j.ejor.2016.01.052

Vidgen, R., Shaw, S., & Grant, D. B. (2017). Management challenges in creating value from business analytics. *European Journal of Operational Research*. https://doi.org/10.1016/j.ejor.2017.02.023

Weltzien, C. (2016). Digital agriculture - or why agriculture 4.0 still offers only modest returns. *Landtechnik*. https://doi.org/10.15150/lt.2015.3123

Yahya, N. (2018). Agricultural 4.0: Its implementation toward future sustainability. In *Green Energy and Technology*. https://doi.org/10.1007/978-981-10-7578-0_5