Chapter 3
Explainable Artificial Intelligence (xAI) Approaches and Deep Meta-Learning Models for Cyber-Physical Systems

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ABSTRACT

Today, the effects of promising technologies such as explainable artificial intelligence (xAI) and meta-learning (ML) on the internet of things (IoT) and the cyber-physical systems (CPS), which are important components of Industry 4.0, are increasingly intensified. However, there are important shortcomings that current deep learning models are currently inadequate. These artificial neural network based models are black box models that generalize the data transmitted to it and learn from the data. Therefore, the relational link between input and output is not observable. For these reasons, it is necessary to make serious efforts on the explanability and interpretability of black box models. In the near future, the integration of explainable artificial intelligence and meta-learning approaches to cyber-physical systems will have effects on a high level of virtualization and simulation infrastructure, real-time supply chain, cyber factories with smart machines communicating over the internet, maximizing production efficiency, analysis of service quality and competition level.

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INTRODUCTION

The principle of "interoperability" in Industry 4.0 design is the most important feature that can be provided by all components (Alcaraz & Lopez, 2020). Thanks to the virtual office and remote access facilities, time, and space constraints are eliminated for doing business together. The principles of "virtualization" and "dissemination of responsibility" are realized through Cyber-Physical Systems (CPS) and Smart factories (Waschull, Bokhorst, Molleman, & Wortmann, 2020). The future of the business world, namely organizational development, management styles, and organizational charts, infrastructure changes, employee qualifications and perceptions, labor cost / financial processes, customer profiles, behaviors, and demands will be shaped by Cyber-Physical Systems (CPS) embodied with new generation artificial intelligence approaches (Mittal & Tolk, 2020).

The fourth version of the industrial revolution is quite different from all other stages. While the first industrial revolution was based on the production mechanism working with water and steam power, it was followed by the transition to mass production with the help of the second industrial revolution, electrical energy. Later, the third industrial revolution, the digital revolution, was realized and electronic use was increased. However, version 4.0 is expressed as a project to encourage the existing industry towards computerization and to equip it with high technology. With this project, machines will be able to understand what is happening around them and communicate with each other via internet protocols (Yin, Kaynak, & Karimi, 2020). To save resources in industrial environments, an integrated receiver/actuator equipment, communication between machines, and active smart product memories will be expanded with new optimization methods (Delicato, 2020). In other words, industry 4.0, together with the Internet of Things (IoT) and cyber-physical systems (CPS), aims to transfer this new technology to business models, product production chains, and industry by combining artificial intelligence, machine learning, and embedded system technology with smart product production processes (Shishvan, Zois and Soyata, 2020).

The explainable artificial intelligence - XAI is one of the examination points that has been captivating as of late (Dağlarli, 2020). Today, regardless of whether we are toward the start of understanding this kind of model, the investigations that show fascinating outcomes about this issue are getting an increasingly serious topic. Sooner rather than later, it is anticipated that there will be years when the interpretability of artificial consciousness and meta-learning models is now and again investigated (Adadi and Berrada, 2018). It is believed to be an answer to defeat limitations in old-style deep learning techniques.

In traditional deep learning methodologies, we much of the time experience deep learning strategies accessible today. At present, in classic deep learning techniques, input information and target (class) data can be prepared with the elite and tried with new information input (Došilović, Brčić, and Hlupić, 2018). These deep learning strategies can yield exceptionally viable outcomes as per the informational index size, informational collection quality, the techniques utilized in include extraction, the hyper boundary set utilized in deep learning models, the enactment capacities, and the improvement calculations (Center et al., 2006). Numerous layers in a profound system permit it to perceive things at various degrees of deliberation. For instance, in a structure intended to perceive hounds, the lower layers perceive basic things, for example, diagrams or shading; the upper layers perceive increasingly complex things like hiding or eyes, and the upper layers characterize them all as a canine. A similar methodology can be applied to different information sources that lead a machine to educate itself. For instance, it tends to be effortlessly applied to the sounds that make up the words in the discourse, the letters, and words that structure the sentences in the content, or the controlling developments required to drive.