

Managing Distributed Machine Learning Lifecycle for Healthcare Data in the Cloud

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This work has been partially supported by COST Action CA22104 Bringwise, Cybersecurity Research Program Flanders - second cycle

(VOEWIC202) project, the Science Foundation Ireland under CONNECT phase 2 (Grant no. 13/RC/2077_P2) project, the Spanish

Ministry of Economy and Competitiveness (MINECO)—Program UNICO I+D under Grant TS1-063000-2021-54, Grant

TS1-063000-2021-55, “ERDF A way of making Europe” project funded by MCIN/AEI/ 10.13039/501100011033 under grant

PID2021-126431GB-I00 and Generalitat de Catalunya grant 2021 SGR 00770.

ABSTRACT

The main objective of this paper is to highlight the research directions and explain the main roles of current Artificial Intelligence (AI)/Machine Learning (ML) frameworks and available cloud infrastructures in building end-to-end ML lifecycle management for healthcare systems and sensitive biomedical data. We identify and explore the versatility of many genuine techniques from distributed computing and current state-of-the-art ML research, such as building *cognition-inspired learning pipelines* and *federated learning (FL) ecosystem*. Additionally, we outline the advantages and highlight the main obstacles of our methodology utilizing contemporary distributed secure ML techniques, such as FL, and tools designed for managing data throughout its lifecycle. For a robust system design, we present key architectural decisions essential for optimal healthcare data management, focusing on security, privacy and interoperability. Finally, we discuss ongoing efforts and future research directions to overcome existing challenges and improve the effectiveness of AI/ML applications in the healthcare domain.

INDEX TERMS Machine Learning, Healthcare, Biomedicine, Data Management, Federated Learning, Cloud, Coded Computation, Distributed Systems

1. INTRODUCTION

TRADITIONAL healthcare, as a mission-critical domain, is in flux for various reasons: Cost and capacity concerns, ageing populations, personalized treatments, and technological advancements that enable speedy pattern analysis. Data analytics and Artificial Intelligence (AI)/Machine Learning (ML) techniques are paving the way for many use cases in medicine that are quite critical today. At the same time, healthcare and biomedical applications are constantly generating increasingly large and diverse datasets. Information can include a variety of data types, spanning from genetic information to Electronic Health Records (EHRs), which can cover details like patient medical records, important physiological measurements, results from labora-

tory tests, inherited disorders, behavioural tendencies, and more. This information can also be gathered from wearable gadgets utilizing headgear (AR and VR technologies) or networks of body sensors, largely constituting time-series biomedical data. The range of modern biomedical applications is already huge and growing each day. AI in healthcare is shown to help transform medical techniques into better disease treatment and prevention, therapy recommendations, and health management that considers various factors such as a patient's genetic, environmental, and usual lifecycle behaviors. In the present era, AI/ML methods are employed for diverse purposes: Foreseeing illnesses in high-risk patients requiring additional support [1], aiding individuals with motor impairments [2], uncovering potential drug combinations

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