Chapter 3

Architecting IoT based Healthcare Systems Using Machine Learning Algorithms:

Cloud-Oriented Healthcare Model, Streaming Data Analytics Architecture, and Case Study

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ABSTRACT

The rapid innovations in technologies endorsed the emergence of sensory equipment's connection to the Internet for acquiring data from the environment. The increased number of devices generates the enormous amount of sensor data from diversified applications of Internet of things (IoT). The generation of data may be a fast or real-time data stream which depends on the nature of applications. Applying analytics and intelligent processing over the data streams discovers the useful information and predicts the insights. Decision-making is a prominent process which makes the IoT paradigm qualified. This chapter provides an overview of architecting IoT-based healthcare systems with different machine learning algorithms. This chapter elaborates the smart data characteristics and design considerations for efficient adoption of machine learning algorithms into IoT applications. In addition, various existing and hybrid classification algorithms are applied to sensory data for identifying falls from other daily activities.

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INTERNET OF THINGS AND HEALTHCARE INTERNET OF THINGS: AN INTRODUCTION

The IoT is an outcome of the technological revolution which interrelates the unified computing devices, mechanical instruments, hi-tech electronic machines and humans that are equipped with the capacity to exchange data over a network. The IoT was first formulated with the back support of Radio Frequency Identification (RFID) that can be applied to track the location of objects. For example, products in the shopping malls are interconnected to their own network, which enables tracking the location of products and increases the billing process flexible at the point of sales depots. Every individual product is exclusively identified and categorized based on its RFID. This uses machine-to-machine networks and these resemble the IoT through network connected systems and data/information. The likelihood of connecting objects to the network allows tagging, tracking and reading of data from objects with greater technical efforts, the technology of this era established called as IoT.

The essentials that emerged the IoT in current and future applications have been elaborated comprehensively and have been characterized by many authors. Gubbi et al., and Li et al., have discussed the major components and architectural elements in IoT (Gubbi, 2013) (Li, 2015). The millions of sensing elements, actuators, and other devices exist at the lowest level of the IoT. Each of which requires a unique identification and addressing schemes because of their deployment are at large scale and also have a high degree of constraints such as energy and computational resources. Communication is another important element which interconnects ‘n’ number of heterogeneous devices for providing smart services. Some of the short and long-range technologies used for communications in IoT applications which may include Wireless Sensor Networks (WSNs), Radio Frequency Identification (RFID), IETF Low power Wireless Personal Area Networks (6LoWPAN) and protocols like IEEE 802.11 (Wi-Fi), IEEE 802.15 (Bluetooth). As IoT devices generate a vast amount of raw data, thus increases the need for data storage and analytics. The data analytics, processing and machine learning in most of the IoT applications are deployed via cloud services. The IoT services are classified as identity-related, information aggregation, collaboration-aware and ubiquitous services (Montenegro, 2007). Identity-related services provide unique identification for every deployed thing. Information aggregation services are responsible for collecting and storing the data received from sensors. Collaborative aware services make use of the data provided by information aggregation services to take decisions and to provide smartness to the system. Ubiquitous services enable users to access services without geographical restrictions (Montenegro, 2007). Li et al., 2015 categorized the generic service-oriented architecture as sensing layer, network layer, service layer and interface layer (Al-Fuqaha, 2015).

The healthcare domain is in a state of a highly miserable situation, where its services are becoming more costly than ever before due to an increase in global population and a huge rise of chronic diseases. Even the basic healthcare services are out of reach to the people and this would be prone to chronic diseases. The technological revolution could never eradicate the population from aging and chronic diseases completely. But the accessibility to the healthcare services can be made easier with incomparable innovation and applicability of the Internet of things (IoT) in the healthcare domain. The application of IoT technology in healthcare allows doctors to communicate with their patients via smart wearable gadgets and devices without human interventions. On the other hand, major two crucial purposes of Healthcare Internet of things (HIoT) are: (i) Enhanced disease management that satisfies the patients and offers a better experience. (ii) Offers a higher level of interaction which allows patients to gain more information and medical intervention at every situation.

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