# Development of an Integrate E-Medical System Using Software Defined Networking and Machine Learning

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## Abstract

Scholars and medical professionals have recognizes the importance of electronic medical monitoring services for tracking elderly people's health. These platforms generate a large amount of data, requiring privacy and data security. on the contrary, Using Software Defined Networking (SDN) to maintain network efficiency and flexibility, which is especially important in the case of healthcare observation, could be a viable solution. Moreover, machine learning can additionally utilized as a game changing tool which incorporated with SDN for optimal level of privacy and security. Even so, integrating SDN into machine learning, which heavily relies on health sensors of patients, is incredibly difficult. In this paper, an Integrate Medical Platform (IMP) with a focus on SDN and Machine learning integration is proposed. We produce a platform that reduces complexity by identifying high level SDN regulations based on the extracted flow classes and utilizing machine learning traffic flow classification techniques. F or various types of traffic, We employ supervised learning approaches based on models that have already been trained. We use four algorithms for supervised learning: Random forest, Logistic

Regression classifiers, K-NN, and SVM, with different characteristics. Finally, we evaluated IMP by using accuracy, precision, TPR, TNR, FPR, MAE, and energy consumption.

## Keywords

SDN, e-Health, Traffic Classification, Supervised Machine Learning.

## Introduction

According to the definition of e-Health is "an relatively new field at the interface of medical informatics and information technology." (B.D. Deebak et al., 2019), Health services and information given or enhanced via the Internet and other similar technologies are referred to as public health and business." The unique control/data plane isolation of SDN enables very efficient and remote monitoring of healthcare devices (Pankaj Berde, et al., 2014). As a result, integrating various technologies such as SDN can be a solution with a significant positive impact. An integrated IMP is suggested in this study to stop any insider/foreigner from adding data, manipulating it, infringe the privacy of the patients, or executing a denial-of-service against with the IMP.

However, in addition to verifying the suggested architecture via simulations, we executed a modular trust management solution relying on SDN technology in this work which called IMP and validated the benefits of depending on this technology in the context of IMP. Our proposition strengthens the properly considered goals of trust management concerns. By constructing a secure environment in which separate security modules coexist to ensure a consistent IMP, we hope to protect various healthcare monitoring system components even while protecting patient privacy. Machine learning provides techniques, tools, and methods for assisting in the resolving of prognostic and diagnostic problems in different medical domains (Qiao Yan, et al., 2015 & Rashid Amin, et al., 2018).

Machine learning has been used to assess the importance of clinical parameters and their combinations for prognosis, such as disease progression prediction, as well as to extract medical knowledge for results of the research, remedy planning and support, and patients' overall management (Xian-Da Zhang, 2020). ML can also be used for data analysis, such as detecting data regulation by dealing with imperfect data appropriately, interpreting data continuity that used in the Intense Care Unit, and intelligent alarming, which results in efficient and effective monitoring (Atsuto Seko, et al., 2017 & Konstantina Kourou, et al., 2015).

## Materials and Methods

### Software Defined Network

Dissimilar to conventional IP networks, which have decentralized functionalities, SDN is centralized to provide network connection domains between the data planes and the control in the similar infrastructure (Laura Galluccio, et. al., 2015). SDN also permits for backward compatibility with the available protocols and standards (e.g., Ethernet, IP, VLAN, ARP, etc.). SDN's core architecture is depicted in Figure 1 as three layers. The application layer of SDN architecture which is the upper layer defines rules and provides various services such as access control, firewall, quality of service, IDS/IPS, routing, monitoring balancer, and proxy service. This layer is responsible for abstracting SDN managing of network control via northbound API (for example, OpenDaylight) (Advait Dixit, et al., 2013). The control plane, is the second layer which is an abstraction of the network topology. The controller is the primary component in charge of data handling policies, creating flow tables as well as abstracting complexity of the network, going to collect information of the network via the south - bound API, and maintaining an up-to-date network broader picture. (Myung-Ki Shin, et al., 2012).

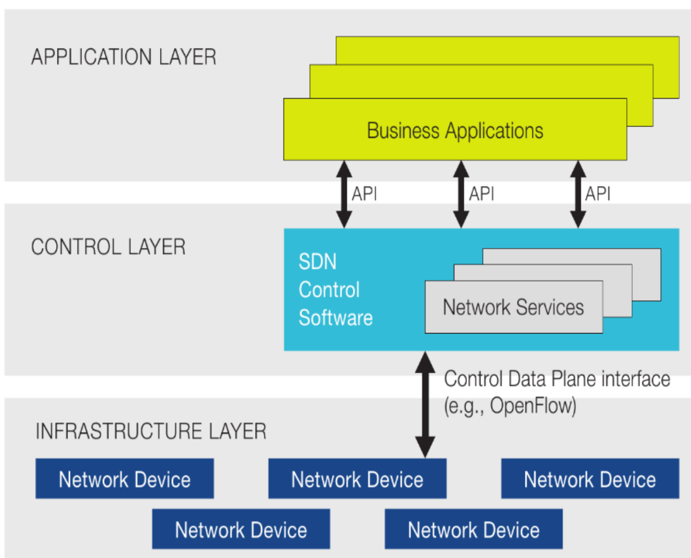


**Figure 1 SDN Layers**

### E- Medical System

E-Medical (even spelled e-health) is a new emerging healthcare process propped by electronic processes and communication that dates back to at least 1999. The term's usage varies because it not only includes "Internet medicine" as it was understood at the time, but it also "virtually anything related to medicine and computers" (L. Ebony Boulware, et al., 2016 & XiLiPhD, et al., 2017). A 2005 study discovered 51 distinct definitions. Many argue that it is exchangeable with health informatics in the general sense of having to cover Health-related electronic/digital procedures, whereas others use it in the narrow sense of Internet-based health care. It may also consist of links and health applications in mobiles which denoted by m-Health or mHealth. The security layer benefits shown in figure 2 (David Blumenthal, et al., 2020 & Kristen M. J. Azar, et al., 2020).

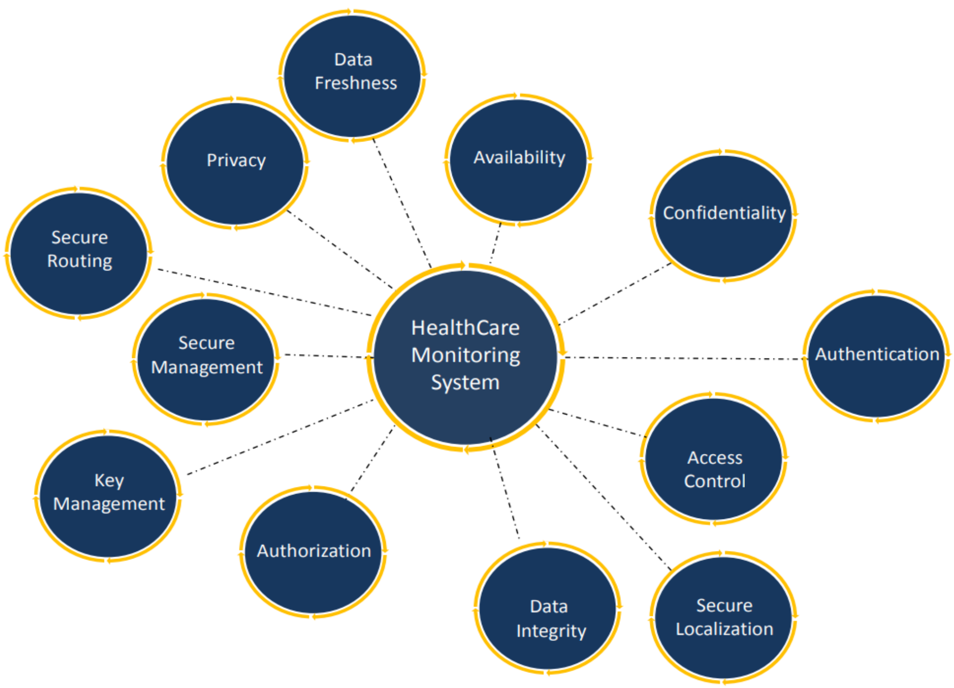


**Figure 2 Security layer of E-Medical System (Ezedin Barka, et al., 2021)**

## Machine Learning

Machine Learning intends to provide computational techniques for changing, accumulating, and developments in intelligent systems, with a focus on learning mechanisms that will assist us in inducing knowledge from data and examples. Methods of m achine learning are useful when algorithmic solutions are unavailable, formal models are lacking, or knowledge of the application domain is imperfectly defined (*Nidaa Ghalib Ali, et al., 2021 & Mohammed Rasool Jawad, et al., 2021)*. The involvement of various scientific communities in Machine learning research has led to the incorporation of ideas from various areas, like artificial neural networks, computational learning theory, stochastic modeling, statistics, pattern recognition, and genetic algorithms. As a result, ML encompasses a broad range of methods that can be approximately divided into symbolic and subsymbolic (numeric) categories based on the nature of the manipulation that occurs during learning. (Refed Adnan Jaleel, et al., 2021).

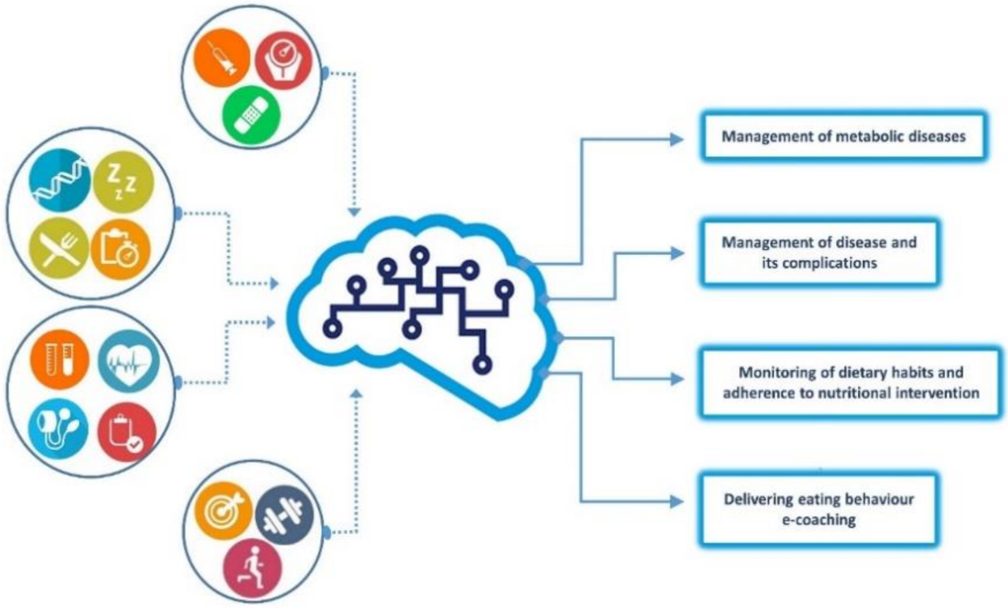


**Figure 3 Machine Learning**

## Results and Discussion

Figure 4 depicts the use of linear regression to predict continuous numerical data. It is a commonly used statistical principle that can be manually applied to small data sets with few elements and two variables. While processing large data sets containing multiple variables and a large number of elements, regression is performed by importing data containing data sets into coding platforms and performing a number of codes. Figure 5 depicts the distribution of medical data produced by IMP. In seeing how does the classifier performs in a regular situations (the only traffic that is simulated is that which is specified in the applications profile.) vs. abnormal conditions (as well traffic generated by the application profile, we calculate the global six performance indicators (precision, true positive rate (TPR), accuracy (ACC), mean absolute error (MAE), false positive rate (FPR), and F measure for all models of classifier by adding the true and false positive or negative values produced by each classification model), we furthermore imitate intrusion attempts and botnets). The F measure is a measurement of a test's binary classification accuracy. statistical analysis. It computes a score by taking into account both the test's precision and recall, which is interpreted as an average weighted for recall and precision. Maximum F-score value at 1 and a minimum at 0. By adding these values together producing automatic account for the actual flow distribution defined in the profile of the application.

Figure 6 depicts the performance of classification algorithms under normal traffic conditions.

The F-scores for each application profile drop when attack traffic is introduced, but they stay high enough for the system to be useful. The fact that the additional attack traffic we're sending is identical to the traffic seen in the application profile is one reason for the drop. Figure 7 compares the IMP's average energy consumption with and without SDN.

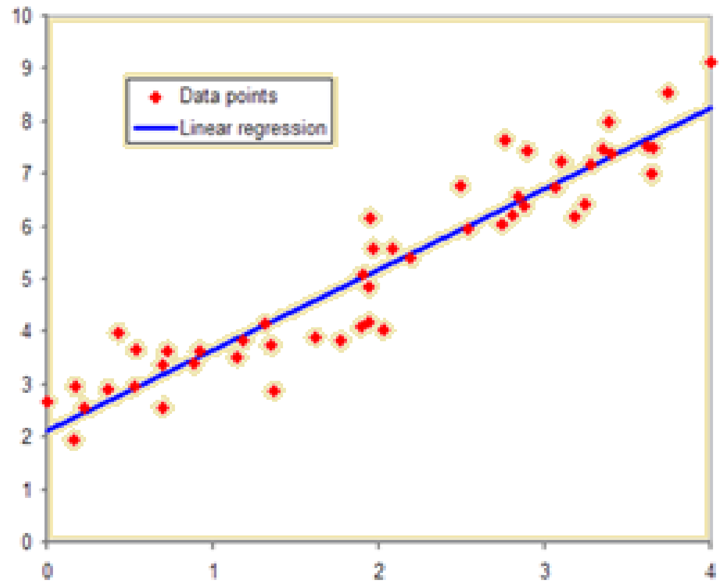


**Figure 4 Linear Equation Rogation for E-Medical Platform**

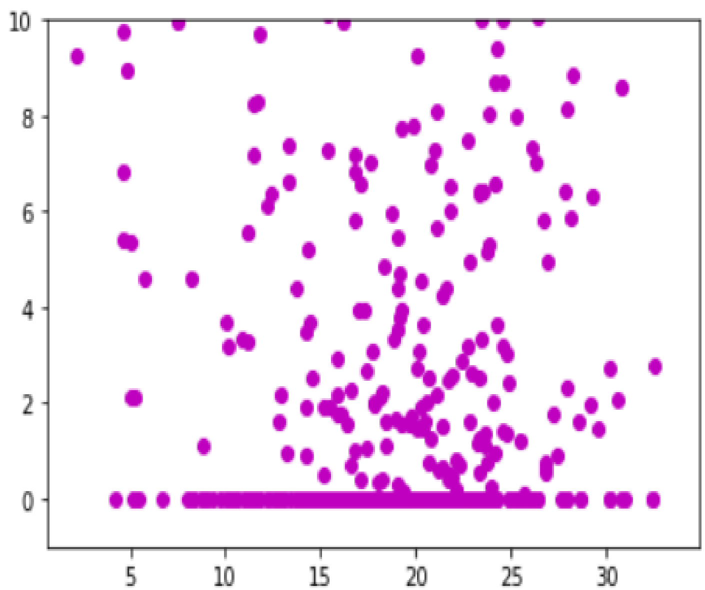


**Figure 5 Visualization of Medical Data**

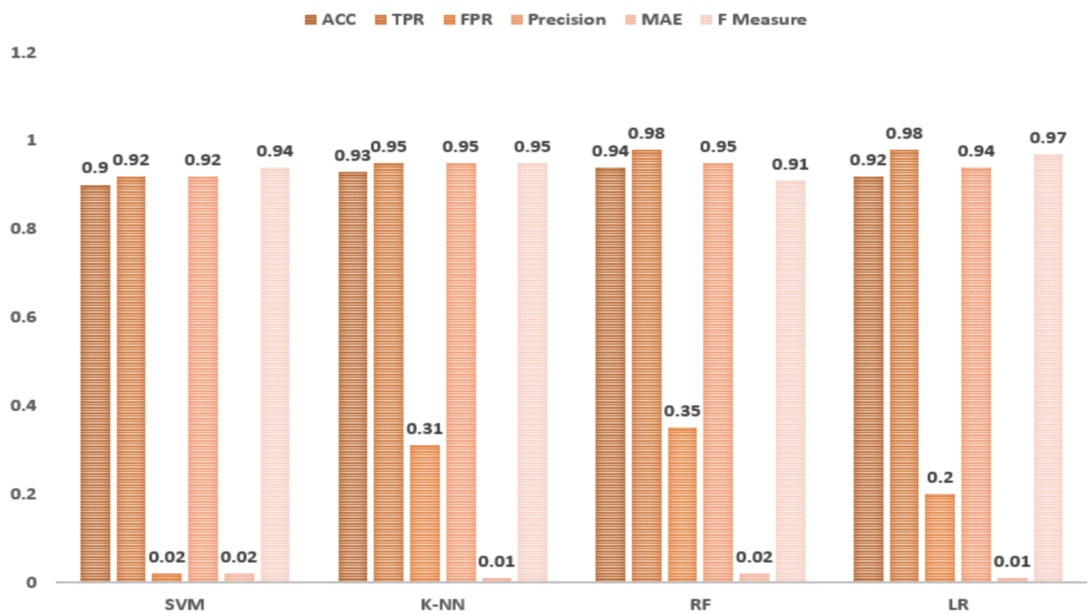


**Figure 6 Performance Measures**

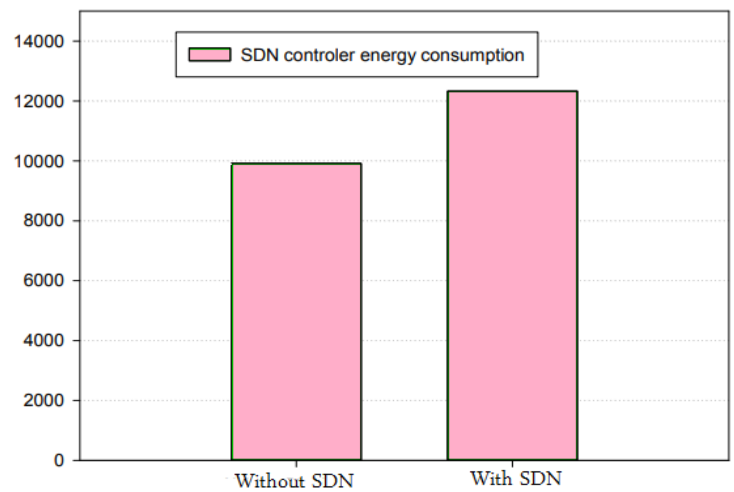


**Figure 7 Energy Consumption of SDN**

## Conclusions

When it comes to mentoring and evaluating patients' well-being, IMP are especially useful. Furthermore, they expose patients' relative information to computer hacking. In this study, we created an architecture known as IMP. Our proposal aims to protect all IMP components. Patient's privacy is protected by building a secure framework which enables various modules of security to work with each other, relying on secure IMP, and SDN technology. Moreover, communication support is provided by using the SDN, allowing for greater flexibility and control across the monitored healthcare devices. We also showed how to employ four machine learning classification algorithms in conjunction with SDN to perform complicated network security tasks including botnet detection, honeypot rerouting, and anomaly detection and in this article. We also looked at the architecture of such a system and how we might grow both machine learning processes and the SDN control using existing solutions. We've also looked into the overall system's supervised learning component. We examined the classification accuracy attained for normal traffic vs. normal plus attack traffic circumstances and discovered that the classifier is still useful even when dealing with network assaults with comparable traffic patterns to regular traffic.

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