Chapter 1

Introductory Chapter: Making Health Care Smart

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1. Introduction

The age of eHealth and Smart Medicine is upon us, but what exactly does this mean? As technology advances, we are able to create electronic devices that collect and analyze data, electronic communication methods that alert health care providers immediately when adverse events arise, and electronic algorithms that help automate and speed up clinical decision-making.

A primary leader in smart medicine is the use of wearable technology. These electronic devices enable the collection of important medical data. Combining wearable devices such as heart rate monitors, pulse oximeters, and sleep monitors with blockchain technology allows this important patient information to be recorded accurately, remain immutable over time, and interact with algorithms designed to improve medical diagnosis and treatment. Wearable technology is already well developed. Making this technology interoperable with electronic medical records in a manner allowing smart execution of health care protocols becomes possible with the use of blockchain technology.

Satoshi Nakamoto set forth the initial implementation of blockchain technology in the white paper "Bitcoin: a peer-to-peer electronic cash system" in 2008 [1]. This white paper presented a method to create an Internet-based currency that did not require a trusted third-party intermediary such as a bank, government, or Federal Reserve. Instead of using a third-party intermediary, the blockchain method utilized computers hooked up to the Internet to confirm transactions in a manner that would prevent malicious hacking, cheating, or double-spending. Bitcoin was subsequently created, with the first transaction occurring in January, 2009. Nakamoto's blockchain method serving as the foundation for bitcoin has proven to be widely successful, with the market capitalization of bitcoin as of early 2018 equal to approximately $150 billion USD.

The backbone for bitcoin is a simple blockchain of transactions that is immutable and secure due to a global distributed network of computer nodes (also known as miners) that confirms new transactions and secures old transactions. This distributed ledger technology works well, powering about $2 billion USD in transactions per day, with a total number of financial transactions to date of over 300 million [2, 3]. The success of bitcoin has created a wide expansion of blockchain technology, to the point where distributed computers around the world now confirm smart contracts [4], provide cloud storage [5], and facilitate communications between small devices (e.g., wearable wrist health bands) that make up the Internet of Things [6].

Through the integration of electronic devices with blockchain technology, the utility of wearable monitors increases tremendously [7]. By creating an immutable, trusted ledger of patient data, blockchain technology not only allows monitors to trigger human responses but also collects important physiologic information that can be analyzed later by both human doctors and also by "digital doctors," i.e., smart algorithms that would trigger actions based upon the input. In the blockchain world, these smart algorithms that trigger actions are called smart contracts [8].

Digital doctors can serve multiple purposes. First of all, alarms set off by existing monitors in most hospitals can be missed for example when the medical ward is busy making hearing the alarm more difficult. Monitors displaying bells or popups are only effective when a human is actively monitoring the screen in a focused, non-distracted way. Digital doctors, however, act according to algorithms, which execute instantaneously. Digital doctors do not get distracted, they do not require sleep, and they have an infinite attention span.

What can these digital doctors do, and why do they require blockchain technology? First of all, digital doctors can instantly initiate codes. For example, a "code sepsis" can instantly be initiated whenever a patient's vital signs become unstable; a "rapid response code" could be instantly initiated whenever the cardiac monitor displayed a malignant arrhythmia. In some cases, these digital doctors could act spontaneously without human intervention (e.g., this is done with wearable insulin pumps and implanted cardiac defibrillators), and in other cases they could trigger initiation of a medical treatment protocol that would require physician review before implemented.

The key to digital doctors becoming useful and effective is trustworthy, accurate, immutable, and private data. Medical care requires accurate collection of patient health data. Scans must be done properly, blood tests must be processed appropriately, and real-time monitors must be calibrated. This is where blockchain technology can really help, because it allows the collection of data in a prompt manner that can be trusted and immutable. Recording data for digital doctors in a centralized database would result in a system that was vulnerable to a single point attack, whether it be an electricity failure or human hacker. Blockchain technology, on the other hand, would make the data more interoperable by ensuring it is readily accessible to digital doctors. It would make the data more reliable through blockchain consensus mechanisms that would be strongly resistant against hacking. It would also make the data easier to audit for quality improvement purposes. Finally, using cryptography inherent in blockchain technology, patient confidentiality is prioritized [9].

Blockchain technology creates trustworthy data that is reliably stored, easily accessed, and resistant to corruption. Wearable technology such as heart rate monitors, bed monitors, and pulse oximeters collect important information that when entered into a blockchain ledger can be processed by digital doctors that not only can be programmed by expert physicians, but can ultimately learn and improve through artificial intelligence. As we have seen in the home, the Internet of Things (IOT) has led to considerable advances in the creation of smart homes. Now, this technology is being applied to monitoring health with wrist monitors, blood glucose monitors, temperature monitors, and more. The time is right for not only having smart homes, but having smart hospitals. IOT along with blockchain technology is leading the way.

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