IBM Watson Health Database: Artificial Intelligence's Impact on Precision Medicine

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Introduction

Imagine entering a patient waiting room, accompanied by your doctor or nurse, as a child or young adult. Do you remember what was in your doctor's hands? It was a folder or clipboard with paper forms on which the doctor took notes with a PENCIL or PEN. I repeat, doctors used HANDWRITTEN notes to evaluate your health. In the past couple of years Medicine and health care have revolutionized and incorporated many advanced technological medical devices that have improved the quality of care. In 2015, IBM launched the widely used medical database, IBM Watson Health ("Watson Health," 2018). IBM Watson Health is an artificial intelligent database that empowers health care providers, doctors, and hospitals, by giving them value-based solutions to optimize medical performance, encourage communication among doctors and patients, deliver effective and accurate care, and manage the health of the community ("Watson Health," 2018). With the introduction of IBM Watson Health, doctors and medical scientists are able to input medical data into this system and in return, the database produces an output consisting of recommendations of medical care plans or suggestions doctors should consider when providing care to each unique patient. IBM Watson has 4 main functions: 1) it is a annotator for clinical data – read and understand unstructured data and applies it to known information; 2) insight for patient data – it analyzes a patient's medical history and provides a summary of key points and health problems; 3) patient similarity – identifies patient switch similar medical stats and uses their data to compare clinical similarities. This allows doctors to understand different views on treatments; and 4) medical insights – helps doctors find information in medical literature and discover new insights ("Watson Health: Get the Facts", 2018). In order to understand the influence IBM Watson Health has had and will continue to

have on Modern Medicine, it is crucial to understand how it functions, how it is used, and why it is important to continue researching and utilizing the system for the benefit of patient care.

Technology

IBM's intention for Watson was always to create an interactive system that would allow medical professionals to interact with artificial intelligence and communicate ideas and advice ("Watson Health," 2018). However, before being able to apply it to Medicine, IBM needed to test it at a lower level. In the AI Magazine article, *Building Watson: An overview of the DeepQA Project* David Ferrucci and his colleagues defined Watson as a question-answering (QA) /machine learning technology that aids medical professionals in time restricted medical care decision making (Ferrucci et al., 2010). Machine learning is when a technology system is programmed to learn new information by itself, rather than needing a human to input the data. It is programming the computer to have its own "brain" by which it communicates with itself. Ferrucci and his colleagues determined the best way to test IBM Watson's intelligence and accuracy was to make it compete in Jeopardy game (Ferrucci et al., 2010). Since Jeopardy has a 3 second time limit for players to answer a question, the test was to determine if IBM Watson was not only smarter than the human brain, but if it could *accurately* answer questions with detailed information in a timely manner (Ferrucci et al., 2010). IBM Watson follows a strict format when attempting to answer a question/provide feedback: 1) Determine *category* of question; 2) Identify and understand the *clue* or *sub clues*; and 3) Output an *answer* (Ferrucci et al., 2010). An example, provided by Ferrucci is as follows (Ferrucci et al., 2010):

Category: General Science

Clue: When hit by electrons, a phosphate gives off electromagnetic energy this form

Answer: Light (or Photon)

After the *Jeopardy Challenge* was complete, data scientists determined that Watson answered about 30-60% of the questions correctly when it was 80% confident it knew the answer (Ferrucci et al., 2010). This means that Watson answered more than half of the questions correctly only if it was confident it knew the answer. Now, applying this information into the medical system, if a doctor needed to find an answer to a question using his own brain and no resources, it would take him longer than 3 seconds with less than 50% confidence to find *one* treatment option. IBM Watson provides a range of most beneficial options that a doctor can further research and compare to see if it will complement the patient's health history and provide him or her the greatest chance of survival. The QA system is charged with Practical Intelligent Question Answering Technology (PIQUANT) software that was researched by IBM for 6 years prior to the *Jeopardy Challenge* (Ferrucci et al., 2010). The PIQUANT software was programmed to only access information from a local database and not the internet (Ferrucci et al., 2010). This is a crucial aspect of IBM Watson because when doctors are using this system they want accurate and board-certified information that is legal and ethical to use in their care. IBM Watson functions as database that analyzes a question, decomposes it to its main keywords and topics, filters its database, and provides an estimated or "best-possible" answer. However, DeepQA system follows multiple steps and is shown in Figure 1, below, developed by Ferrucci and his team (Ferrucci et al., 2010).
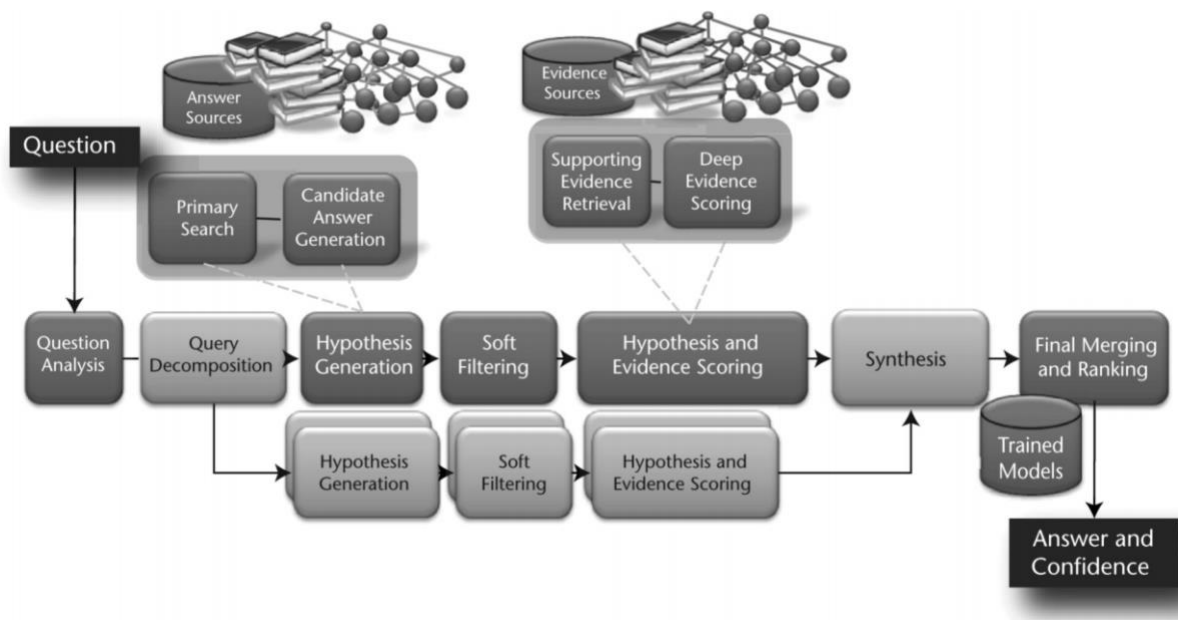
Figure 1. IBM Watson DeepQA Architecture

IBM Watson's technology and interactions with itself are crucial to the success and performance of the database. However, there is another interaction part that is equally essential: interaction with its users. Users and can input data into the system, but how can others access it and how is the data transmitted? IBM solved this issue through its release of cloud capabilities, reported by *Target News Service*, "IBM Unveils Expanded Watson Platform for Health Cloud Capabilities, Introduces Watson Consulting Services at HIMSS17" (IBM Unveils Expanded Watson Platform for Health Cloud Capabilities, Introduces Watson Health Consulting Services Unit at HIMSS17, 2017). IBM Watson is a cognitive service that annotates clinical data and organizes physician notes, discharge summaries, and pathology reports, and uses the information about the patient's and past patients' histories about the disease, symptoms, and medications to produce insights for effective care (IBM Unveils Expanded Watson Platform for Health Cloud Capabilities, Introduces Watson Health Consulting Services Unit at HIMSS17, 2017). With the

secure cloud, authorized doctors, scientists, and researchers have permission to access

information on test results, patient history, medications used, and more information that is related

to a specific disease or illness the scientists in researching. The IBM cloud allows doctors to

share and access patient information to not only doctors within the hospital, but also across the

country who use the same system.

The software system, PIQUANT and DeepQA, are the two driving forces in IBM Watson

that runs the system, organizes and stores the data, and interacts with the system and the users

(Ferrucci et al., 2010). The IBM cloud is the platform that focuses on the user interaction. Both

software's work together to form IBM Watson and aid doctors in providing precision medicine –

ability for doctors to access precise data that aid doctors to understand the disease and select the

most beneficial treatment(s) that compliments the patient's health and body.

Legal/Ethical/Security Aspect

The major legal issue connected to IBM Watson Health is the storage, analyzation, and

software of personal patient medical data (Greenberg, 2017). The actual Watson database is

legal, since it is just a data system (Greenberg, 2017). IBMs A.I. software falls under the Civil

Code of Quebec (CCQ, art.1457) that implies a physician using artificial intelligent technology

may be liable for its diagnosis (Greenberg, 2017). Article 1457 is reinforcing the idea that

doctors must not use Watson's artificial intelligence as another "doctor" or a "master of

medicine". Doctors and administrator must remember that Watson's purpose is to function as a

source by which doctors can use to test their treatment ideas and see previous data about that

treatment. It is an artificial intelligent system that provides feedback and suggestions that help

doctors make decisions for their patients; it does NOT make decisions for the doctors. Another

liability noted under the CCQ (art. 1468,1469) that if a problem with the system, misdiagnosis,

or misinformation by the system occurs, then the evidentiary burden will be placed on the manufacturer of the AI software, in this case IBM (Greenberg, 2017). Since the AI system learns from the information inputted by the doctor, the "guardian of the AI" is the physician, an could be responsible for the information outputted by the IBM Watson (Greenberg, 2017). A news article by Frank Roylance from the *Calgary Herald*, "Will IBM's 'Watson' become Dr. Watson?" summarizes an interview of Dr. Elliot Siegal, director of Maryland Imaging Research Technologies Lab at University of Maryland School of Medicine, regarding the major ethical problem of IBM Watson AI – will it replace doctors? (DRoylance, 2011). Many people have the misconception that IBM Watson wants to replace doctors and that their life is going to be in the hands of a computer doctor, "Dr. Watson". IBM Watson cannot relate to a patient on a personal and emotional level that a human doctor can. Dr. Siegel clearly refutes this misconception, when he says, "In the future, I see the software sitting with the physician as he is interviewing the patient, and processing information in real time, and correlating that with the patient's medical record and other records" (DRoylance, 2011). As previously stated, IBM Watson is supposed to function as a "support system" or "partner". It primarily serves as an assistant that searches, organizes, and evaluates medical records and suggest diagnoses and treatment options. Dr. Siegal says, "I don't see Watson ever replacing physicians" because IBM Watson is not a robot; it is a computer system (DRoylance, 2011). We are in a society that is introduced to new advanced technologies and robots, but it is the responsibility of the leaders of Medicine to not allow Watson's AI to be introduced to robots. Human-human interaction, or at least human supervision, is essential during medical care, because the body is unpredictable, and a robot will not be able to understand a patient's emotional response to a procedure and therefore may put the patient at risk. In order to avoid the legal issues, protect the security of patient's information, and

follow the laws of medical ethics, current and future medical professionals must understand that

IBM Watson, and similar AI systems, are to be used as an aid, and cannot and should never be

used to replace doctors. In the article, *The Impact of Artificial Intelligence on Medical Innovation*

in the European Union and United States, published in the *Intellectual Property and Technology*

Law Journal, in the U.S. AI medical devices fall under the Food and Drug Administration (FDA)

regulatory jurisdiction (Tsang et al., 2017). The FDA has determined that IBM Watson is FDA

and HIPAA compliant, and hospitals must constantly monitor the database to ensure that patient

data is safe (Tsang et al., 2017).

<div align="center">Current Use and Impact</div>

IBM Watson has been introduced in several hospitals around the country and is becoming

the primary AI database in Medicine. On June 26, 2018 IBM made a presentation at the

American Diabetes Association (ADA), regarding how IBM Watson Health's AI technology can

be used to help people with diabetes make more informed and safe decisions ("IBM Watson

Health Showcases Health Technology Advancements at American Diabetes Association's 78th

Scientific Sessions," 2018). IBM, with a partnership with Medtronic, created a app, Sugar.IQ[TM],

that helps individuals with diabetes track and manage their intake, while using advice provided

by the app ("IBM Watson Health Showcases Health Technology Advancements at American

Diabetes Association's 78th Scientific Sessions," 2018). Diabetes patients must constantly

manage their sugar intake and keep track of the food they consume. Sugar.IQ[TM] transfers the

data and interacts with the Guardian[TM] Connect Continuous Glucose Monitoring (CGM) system

which analyzes glucose, insulin, food, and other data in real time and provides users feedback on

how to improve their lifestyle and manage their diabetes ("IBM Watson Health Showcases

Health Technology Advancements at American Diabetes Association's 78th Scientific Sessions,"

2018). The app is a tool for patients to receive personalized insights about their daily diet and advice to make informed and healthy decisions based on their glucose levels. This is a major advancement in Modern Medicine, because apps like Sugar.IQ^{TM} encourage patients to monitor and have knowledge about their own health in real time, rather than being updated only when visiting the doctor, a couple months or days in the year. In a presentation by Medtronic, they found that diabetes patients using Sugar.IQ^{TM} spent 36 more minutes per day in a healthy glucose range, 30 minutes less time in hyperglycemia (>180 mg/dL) and 6 minutes less time in hypoglycemia (<60 mg/dL) ("IBM Watson Health Showcases Health Technology Advancements at American Diabetes Association's 78th Scientific Sessions," 2018). Diabetes is a global illness that affects many around the Earth in all different ages and requires 24-hour attention. Utilizing Sugar.IQ^{TM} as a digital doctor is helping people take better control of their daily health, while also allowing doctors to monitor their patient's health through a cloud, decreasing the number of visits and allowing doctors to have an up-to-date health status of patients who may have high-risk diabetes. IBM Watson has improved efficiency and increased successful treatments, therefore increasing more out-patient success. Currently, IBM Watson is primarily being used as a data storage for patient medical information. However, IBMs goal is to continue advancing the system and use it to scan genetic information of brain cancer patients, identify patient mutation data, and match the information to tailored clinical plans (Tsang et al., 2017).

Conclusion

Medicine, in recent years has become heavily focused on acquiring and storing data and using that data to make medical inferences. Medicine has millions of data and research archives that have contributed to improving Medicine and the quality of care that medical professionals provide. Medicine has become a fast-paced environment in which answers to questions and test

results need to be found and completed in a restricted time period. IBM found and developed an aid that increases the efficiency of medical care and aids doctors in successfully treating their patients. IBM Watson Health Database is an artificial intelligent system that runs on PIQUANT and DeepQA, two operating systems, that allow interaction between patient and Watson, and doctor and Watson (Ferrucci et al., 2010). These two software's/systems are the brain to IBM Watson that allows it to understand the inputs from humans, dissect the keywords, analyze the information, and provide accurate and helpful information/advice based on the data provided and data already stored in the cloud. Since IBM Watson deals with personal patient information and is serving as a doctor's "assistant" there are legal issues regarding security of personal information and ethical concerns about the possibility of the AI becoming too smart that is replaces doctors; however, there are strict laws that are regulating its use and ensuring that it is not used unethically. It is the responsibility of medical professionals and the government that medical AI does not get abused and transformed into what some people fear: robotic doctors. Currently, IBM Watson and medical AI is heading in the right direction by utilizing its technology in hospitals to help doctors make more accurate and effective decisions for the benefit of their patient's health. Slowly, IBM Watson's mature AI is being introduced to the public in health aids, such as the Sugar.IQ^{TM} app that is allowing diabetes patients to monitor their own health and get real-time advice on how to improve their health ("IBM Watson Health Showcases Health Technology Advancements at American Diabetes Association's 78th Scientific Sessions," 2018). IBM Watson is a prime role model about how patient data can be utilized to treat patients in specific manners using precision medicine that provides the patient with the highest chance of survival.

Bibliography

DRoylance, F. (2011, Feb 24). Will IBM's 'watson' become dr. watson?; computer could help

doctors diagnose patients. *Calgary Herald* Retrieved October 1, 2018 from

https://search.proquest.com/docview/854032859?accountid=14541

In this Calgary Herald news article, Frank D Roylance summarizes his interview with Dr.

Eliot Siegal, director of Maryland Imaging Research Technologies Lab at University of

Maryland School of Medicine. The topic regraded the ethical issues of IBM Watson and

the misconception of it "replacing" doctors. This source benefits my argument because

provides direct quotes and information from an expert and researcher in medical

technologies and IBM Watson. Roylance and Dr. Siegal discuss that Watson has

revolutionized the way doctors interacts with medical records and has made analyzing the

records easier and more efficient. Watson is serving as a personal assistant to the doctor,

that provides information and recommendations that are essential to the care of a patient.

One doctor does not know all the answers or approaches to one medical problem; IBM

Watson steps in and provides extra information so the doctor can evaluate and think

about several different treatment plans before implementing one.

Ferrucci, D., Brown, E., Chu-Carroll, J., Fan, J., Gondek, D., Kalyanpur, A. A., … Welty, C.

(2010). Building Watson: An Overview of the DeepQA Project. *AI Magazine*, *31*(3), 59–

79. Retrieved on September 23, 2018 from https://doi.org/10.1609/aimag.v31i3.2303

In this magazine article, Ferrucci explains the software and inspiration behind the

invention of IBM Watson. IBM Watson is a QA – Question Answering data interface.

When Watson was being developed, developers had a mindset of first, trying to make

Watson "smart" enough to compete in a Jeopardy. The system follows 3 basic steps: 1) Determine the Category; 2) Find the clue(s) in the question; and 3) output the answer. The software behind Watson is called PIQUANT (Practical Intelligent Question Answering Technology). Ferrucci provides raw data and graphs showing how precise IBM Watson was during the Jeopardy challenge, which is a effective and reliable source for my paper.

Greenberg, A. (2017, October 6). Artificial Intelligence in Health Care: Are the Legal Algorithms Ready for the Future? Retrieved September 23, 2018, from https://mjlh.mcgill.ca/2017/10/06/artificial-intelligence-in-healthcare-are-the-legal-algorithms-ready-for-the-future/

It is important to understand that the system and software itself is completely legal and safe to use. The actual algorithm used in EMRs and other medical AI devices and the user are heavily recorded and could be liable for any misconduct. There is also another liability act, CCQ (art. 1468, 1469) which would place the evidentiary burden on the manufacture of the AI software, meaning they would have proven that their system did not cause the misdiagnosis. There is one last rule (art. 1465), which states that AI learn semi autonomously, which suggests that there is always a physician nearby or regulating the system. Therefore, a prosecutor could say the doctor's negligence in watching the system caused a misdiagnosis and malpractice.

IBM Unveils Expanded Watson Platform for Health Cloud Capabilities, Introduces Watson Health Consulting Services Unit at HIMSS17. (2017, February 20). *Targeted News*

Service; Washington, D.C. Retrieved on September 23, 2018 from

http://search.proquest.com/pqrl/docview/1870214267/abstract/DBA4DC449EEE4CDAP
Q/1

IBM Watson functions as a "annotator" for clinical data. It is a cognitive service that

allows physician access to physician notes, discharge summaries, and pathology reports,

in a quick and secure manner. Using the data and data analytic functions of IBM Watson,

physicians may come by important insights on the care and treatment for their patient.

Rather than a physician being limited to his or her own expert treatment methods,

physicians can now search the various treatment plans that other doctors have conducted

across the country and implement a treatment plan that puts the patient's safety first and

gives the patient the highest chance of survival. Watson is a AI healthcare consultant that

serves as an aid to doctors to ensure that he or she approaches a patient's illness with

resources and the greatest amount of knowledge to improve the quality, patient

satisfaction, and treatment success rate. This source is very effective because it explains

how IBM Watson's cloud service is being utilized and how its use actually helps the

doctor solve and approach a patient's health issue.

IBM Watson Health Showcases Health Technology Advancements at American Diabetes

Association's 78th Scientific Sessions: New mobile app from Medtronic, Sugar.IQ^{TM},

applies AI technology from IBM Watson Health to help people with diabetes make more

informed decisions. (2018, June 26). *PR Newswire; New York*. Retrieved on September

23, 2018 from https://search.proquest.com/docview/2059094134?accountid=14541

IBM Watson is large, intelligent database that is mostly used among doctors only,

because of ethical issues regarding patient data safety. All the records in the database

hold patient SSN and medical information, that if it was hacked and released, a major

lawsuit would be handed to the hospital. However, IBM realized that patients have

become interested and adamant about knowing how their health is throughout the day,

rather than being told the couple of times a year he or she goes to their physician. So,

they partnered with Medtronic, to create an app, Sugar.IQ, that applies IBM Watson

Health's technology, to allow diabetes patients to track their sugar intake. The app has the

A.I. to read the sugar intake and determine if the user has gone above their limit or

reaching a critical and provide feedback to user of options to lower their sugar level and

control their diet. This source shows how AI is interreacting with patients and how its

medical intelligence can now not only be used in hospital. But now is the outside world.

Most of my focuses on its use in the hospitals, but this article, provides me evidence that

it is slowly being introduced to the public and now individuals themselves can track and

control their own health.

Tsang, L., Kracov, D. A., Mulryne, J., Strom, L., Perkins, N., Dickinson, R., … Jones, B. (2017).

The Impact of Artificial Intelligence on Medical Innovation in the European Union and

United States, 8. Retrieved September 23, 2018 from https://www.arnoldporter.com/-

/media/files/perspectives/publications/2017/08/the-impact-of-artificial-inteelligence-on-

medical-innovation.pdf

This *Intellectual Property and Technology Law* Journal article explains how AI Medical

Innovations have impacted the Medicine of two of the largest nations: Europe and United

States. IBM Watson can be used to scan genetic data from the tumors of brain cancer

patients, reducing the time taken to do so from weeks or months to only minutes. IBM

Watson is allowing to doctors use their time more efficiently by focusing on preparing

the patient for the treatment, rather than focusing on how to treat the patient. Patent data

can be matched to other known data to develop a plan that keeps the patient safe and

gives him or her the greatest chance of survival. The source also talks about the

regulations of medical AI software in the United States. FDA has a major stand on the

use of IBM Watson because they argue that while it is ok to use IBM Watson, it must be

heavily controlled and constantly reviewed to ensure that it is accurate and is used to help

doctors, not take over the role of a doctor. HIPPA is also connected, because the system

contains private patient data, and hospitals and IBM must ensure that the system is

heavily encrypted to lower the chance of it ever being hacked.

Watson Health: Get the Facts. (2018, July 26). Retrieved September 22, 2018, from

https://www.ibm.com/blogs/watson-health/watson-health-get-facts/

IBMs own website regarding the IBM Watson Health provides a precise discussion of

what IBMs goal and intent for Watson is in the workforce. Their approach is divided into

three subtopics: Data, Cloud, and Artificial Intelligence. Data itself does not provide

insight – IBM wants to provide a system that clean, organizes, and evaluates data through

intelligent analytical power that creates cloud-based health care programs, with models

and data sets, societal health problems may be solved. The Cloud protects data and is

implemented so that a patient can only access THEIR data. The artificial intelligent

aspect is the most important. It is composed of 80 AI services that allow 4 major

functions: 1) it is a annotator for clinical data – read and understand unstructured data and

applies it to known information, 2) insight for patient data – it analyzes a patient's

medical history and provides a summary of key points and health problems, 3) patient

similarity – identifies patient switch similar medical stats and uses their data to compare

clinical similarities. This allows doctors to understand different views on treatments, and

4) medical insights – helps doctors find information in medical literature and discover

new insights. These 3 approaches summarize the purpose of IBM Watson, and helps

create a general, uncomplicated description of what IBM is and how it is being used.