AI for Medical Diagnosis and Treatment Use Case - Digital Healthcare

Statement of Work (SoW)

Overview on Digital Healthcare

Digital health refers to the use of information and communications technologies in medicine and other health professions to manage illnesses and health risks and to promote wellness. Digital health has a broad scope and includes the use of wearable devices, mobile health, telehealth, health information technology, and telemedicine. Digital Health has been gaining momentum because it is envisioned to:

- Improve access to healthcare
- Reduce any inefficiencies in the healthcare system
- Improve the quality of care
- Lower the cost of healthcare
- Provide more personalized health care for patients

There is some evidence to show that the use of digital medicine allows patients to better track their own health and wellness. For example, the use of digital devices like the smartphone not only helps with communication, but these devices now have a huge number of apps that can help monitor blood pressure, record blood sugars, ensure compliance with medications, and track the amount of physical activity [1].

The broad scope of digital health includes categories such as mobile health (mHealth), health information technology (IT), wearable devices, telehealth and telemedicine, and personalized medicine. From mobile medical apps and software that support the clinical decisions doctors make every day to artificial intelligence and machine learning, digital technology has been driving a revolution in health care. Digital health tools have the vast potential to improve our ability to accurately diagnose and treat disease and to enhance the delivery of health care for the individual [2].

Technology and Architecture

Digital health, or digital healthcare, is a broad, multidisciplinary concept that includes concepts from an intersection between technology and healthcare. Digital health applies digital transformation to the healthcare field, incorporating software, hardware and services. Under its umbrella, digital health includes mobile health (mHealth) apps, electronic health records (EHRs),

electronic medical records (EMRs), wearable devices, telehealth and telemedicine, as well as personalized medicine. Stakeholders in the digital health field include patients, practitioners, researchers, application developers, and medical device manufacturers and distributors [4].

Digital Healthcare architecture consists of a complex set of technologies, policies, standards, and user sets. A general framework for understanding the levels of health IT from a technical perspective is as follows [3]:

- Application Level

  Computerized Provider Order Entry (CPOE), Clinical Decision Support (CDS), Electronic Prescribing (e-prescribing), Electronic Medication Administration Records (eMAR), Results Reporting, Electronic Documentation, Interface Engines, and so on

- Communication Level

  Messaging Standards: HL7, ADT, NCPDP, X12, DICOM, ASTM, and so on

  Coding Standards:LOINC, ICD-9, CPT, NDC, RxNorm, SNOMED CT, and so on

- Process Level

  Health Information Exchange (HIE), Master Patient Index (MPI), HIPAA Security/Privacy, and so on

- Device Level

  Tablet PCs, Application Service Provider (ASP) models, Personal Digital Assistants (PDAs), Bar Coding, and so on.

One flow of data within health care organizations begins with multiple specialized systems that efficiently collect and store specific data within hospital information systems. For instance, a patient may have blood drawn and analyzed by the hospital laboratory. Specialized laboratory information systems have been developed to collect all the data about processed specimens. Similar systems have been developed for radiology, billing, pharmacy, and other services. These hospital information systems are designed to serve narrow functions with great efficiency, but this situation results in multiple silos of information.

Medical Diagnosis and Treatment

Medical diagnosis is the process of determining which disease or condition explains a person's symptoms and signs. It is most often referred to as diagnosis with the medical context being implicit. The information required for diagnosis is typically collected from a history and physical examination of the person seeking medical care. Often, one or more diagnostic procedures, such

as medical tests, are also done during the process. Sometimes the posthumous diagnosis is considered a kind of medical diagnosis.

Diagnosis is often challenging because many signs and symptoms are nonspecific. For example, redness of the skin (erythema), by itself, is a sign of many disorders and thus does not tell the healthcare professional what is wrong. Thus differential diagnosis, in which several possible explanations are compared and contrasted, must be performed. This involves the correlation of various pieces of information followed by the recognition and differentiation of patterns. Occasionally the process is made easy by a sign or symptom (or a group of several) that is pathognomonic [5].

A therapy or medical treatment is the attempted remediation of a health problem, usually following a medical diagnosis. As a rule, each therapy has indications and contraindications. There are many different types of therapy. Not all therapies are effective. Many therapies can produce unwanted adverse effects. Therapy comes in many different forms, and may target mental or physical problems. These types of therapy include cognitive behavioral therapy, dialectical behavior therapy, mindfulness-based cognitive therapy, and physical therapy [6].

Other Types of Challenges

Improved Healthcare Access.

Personalized and Precision Medication.

Patient Engagement and Assistance.

Public Healthcare Management.

Pandemics and Fatal Diseases Control.

Fraud Detection and Risk Management.

AI Solution Specifications

To address the medical diagnosis and treatment as amin pillar in enabling digital healthcare transformation – leveraging the huge investment made in the national healthcare system including hospitals, clinics, physicians/specialists, pharmacists, laboratories, equipment, communications/infrastructure, regulations, technology applications/data and so one – many topics need to be covered where AI solutions could be of excellent fit. In this use case, we are including the following main topics under each could be several areas of implementation. The reset of the activities in this project from 2 to 18 are focusing on detailed process of getting real-life solution in place:

- Topic #1: Accurate Diseases Detection: Helping practitioners and consultants to - more accurately - evaluate, discover, and detect critical diseases. Models built upon results of different patient diagnosis methods like radiology, electrophysiologic, electromyography, nerve conduction velocity, clinical, voice, differential among others.

- Topic #2: Early Diagnosis of Critical Diseases: Prediction of potential illness at the earliest stage by leveraging patients' longitudinal diagnosis data combined with current diagnosis results. The consideration of critical disease like chronic, cardiomyopathy, cancer, Parkinson, cardiovascular, scleroderma – is priority goal to prevent permanent effects.

- Topic #3: Clinical Genomics: With the advancement in human genomic methods and tools like next generations sequencing, many clinical applications can leverage data-driven genetic models. Some of them cover genome variant identification, genetic screening, coding and non-coding classification, phenotype prediction and mapping, personalized medicine, drug interaction, drug discovery.

- Topic #4: Electronic Health Records (EHR): Improving data discovery and extraction while linking past diagnosis, treatments, multiple infections, potential severity, recommended actions, clinical notes, high risk conditions and risk impact. Applying advanced models like EHR to genetic diagnosis, generative models on EHR text and images and evidence-based recommendations, and deadly diseases alerting.

- Topic #5: Smart Treatment: Planning, defining, and monitoring effective therapy, modeling treatment effects, estimating individualized effects, progression of disease, analysis of anomalies, drug interaction, personalized medication results, algorithmic clinical trials, and medical errors prevention/reduction.

- Topic #6: Virtual Health Assistants: Supports patients and practitioners in conversational dialogue for inquires answering, symptoms collection, telehealth, follow-up after visits/treatment actions, update/link medical records, generate reports, collect monitoring sensors data – by language models on medical/healthcare domain knowledge using text, image, and voice data.

- Topic #7: Statistical Modeling and Simulation of Events: set of models to analyze, predict, and simulate important events for data extracted from above topics including columnar and graph structures for example associating rare and undiscovered disorders, infectious disease , spatial distribution, seasonality, simulating change impact in medical and healthcare services.

References & Resources

#	Topic	Source
1	Introduction on Digital Healthcare by National Library of Medicine	https://www.ncbi.nlm.nih.gov/books/NBK470260/
2	Scope, domain, applications, and technologies for Digital Healthcare	https://www.fda.gov/medical-devices/digital-health-center-excellence/what-digital-health
3	Architecture of Digital Healthcare and Open Challenges	https://digital.ahrq.gov/architecture-health-it
4	Different patterns, applications, technologies in Healthcare industry	https://www.techtarget.com/searchhealthit/definition/digital-health-digital-healthcare
5	Detailed discussion of medical diagnosis for non-specialized audiences	https://en.wikipedia.org/wiki/Medical_diagnosis
6	Detailed discussion of medical treatment for non-specialized audiences	https://en.wikipedia.org/wiki/Therapy
7	Important 24 examples of data-driven applications in Healthcare	https://www.datapine.com/blog/big-data-examples-in-healthcare/