**EXPERIMENT – 3.2**

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| **Semester:** 6th | **Date of Performance:** 09/04/24 |
| **Subject Name:** Cloud Computing and | **Subject Code:** 21CSP-378 |

Distributed System

**Aim:** Case studies on Cloud based machine-learning solutions in healthcare.

# Theory:

Cloud-based machine learning (ML) solutions have gained significant traction in healthcare due to their ability to handle large datasets, facilitate collaboration, and provide scalable computing resources. Here are some key ways in which cloud-based machine learning is being applied in healthcare:

1. Diagnostic Imaging:
   * Image Recognition: ML algorithms on the cloud can analyze medical images, such as X- rays, MRIs, and CT scans, to aid in the diagnosis of diseases like cancer, fractures, or neurological disorders.
   * Deep Learning Models: Deep learning models, particularly convolutional neural networks (CNNs), are employed for tasks like tumor detection, segmentation, and classification.
2. Clinical Decision Support Systems:
   * Predictive Analytics: Cloud-based ML models can analyze patient data to predict disease progression, readmission risks, and potential complications.
   * Decision Support: ML algorithms assist healthcare professionals in making more informed decisions based on patient history, current symptoms, and relevant medical literature.
3. Drug Discovery and Development:
   * Virtual Screening: ML algorithms assist in virtual screening of potential drug candidates, saving time and resources in the drug discovery process.
   * Biomarker Discovery: Cloud-based ML tools help identify potential biomarkers for diseases and predict responses to specific treatments.
4. Remote Patient Monitoring:
   * Wearable Devices: ML algorithms analyze data from wearable devices to monitor and predict health conditions, enabling timely interventions and reducing hospital readmissions.
   * Continuous Monitoring: Cloud-based solutions facilitate continuous monitoring of patients with chronic conditions, improving the overall management of health.
5. Natural Language Processing (NLP) in Healthcare:
   * Electronic Health Record (EHR) Analysis: NLP algorithms on the cloud extract valuable information from unstructured clinical notes, aiding in clinical research and decision- making.
6. Collaboration and Data Sharing:
   * Interoperability: Cloud platforms allow for seamless integration and sharing of healthcare data, fostering collaboration among healthcare providers, researchers, and institutions.
   * Multi-Center Studies: Cloud-based solutions facilitate multi-center studies by providing a centralized platform for data storage, processing, and analysis.
7. Security and Compliance:
   * Data Security: Cloud service providers implement robust security measures to protect sensitive healthcare data, often meeting industry-specific compliance standards such as HIPAA (Health Insurance Portability and Accountability Act).
   * Scalability: Cloud infrastructure allows for the scalability of resources based on demand, ensuring that healthcare organizations can adapt to changing computational needs.

It's essential to address privacy and security concerns when implementing cloud-based solutions in healthcare, given the sensitivity of patient data. Additionally, compliance with regulatory standards is crucial to ensure the ethical and legal use of healthcare information.

# 1st Study:

From electronic health records to medical imaging, healthcare is an industry with an unprecedented amount of data. At Google Cloud, we want to help more healthcare organizations turn this data into health breakthroughs, through better care and more streamlined operations. Over the past year, we’ve enhanced Google Cloud offerings with healthcare in mind, expanded our compliance coverage, and welcomed new customers and partners. Here’s a look at a few milestones along the way.



Welcoming new healthcare customers to Google Cloud

The challenges of healthcare are increasingly data challenges—creating it, storing it, and analyzing it to find meaningful insights. This year we welcomed many new healthcare customers to Google Cloud, and we’re continually inspired by how these customers use data to benefit both patients and providers. Here are a few examples:

* National Institutes of Health (NIH) is [bringing the power of Google Cloud](https://www.blog.google/products/google-cloud/building-a-global-biomedical-data-ecosystem-with-the-national-institutes-of-health/) to biomedical research as a part of their [STRIDES](https://www.nih.gov/news-events/news-releases/nih-makes-strides-accelerate-discoveries-cloud) (Science and Technology Research Infrastructure for Discovery, Experimentation, and Sustainability) Initiative. As NIH’s first industry partner on this initiative, Google Cloud made some of the most important NIH-funded datasets available to users with appropriate privacy controls and have helped to simplify access to these datasets.
* The BARDA DRIVe Solving Sepsis initiative is partnering with a research consortium consisting of Emory University School of Medicine, Massachusetts General Hospital (MGH), University of California San Diego (UCSD) School of Medicine, and Atlanta’s Grady Health System to [leverage](https://blog.google/products/google-cloud/google-cloud-offers-global-support-for-academic-research/) [Google Cloud](https://blog.google/products/google-cloud/google-cloud-offers-global-support-for-academic-research/) to develop interoperable learning software for early prediction of sepsis in hospital intensive care units. Now DRIVe can help develop and implement that platform to reduce the approximately 270,000 deaths from sepsis in the United States each year.
* Hurley Medical Center is increasing operational efficiencies, reducing costs and improving patient outcomes [by moving to G Suite](https://cloud.google.com/blog/products/g-suite/how-hurley-medical-center-uses-gsuite-to-cut-it-costs-increase-security-and-earn-a-top-himss-ranking) from on-premises productivity software and email. Moving to G Suite has saved the organization $150,000 in annual software costs.
* Hunterdon Healthcare [uses G Suite](https://cloud.google.com/customers/hunterdon-healthcare-gcp/) to improve collaboration and efficiency, reclaiming 30% of caregivers’ time for patient interactions while reducing costs by $1.3 million over three years.

Imagia is [leveraging GCP](https://cloud.google.com/customers/imagia/) in its mission to help predict patient outcomes and detect disease specific markers from imaging data. With GCP, the company has reduced test processing time from 16 hours to one hour, and has improved time to discovery for researchers.

* Wellframe [uses GCP](https://cloud.google.com/customers/wellframe-looker) to power their platform that connects people and care teams, helping them build trusted relationships that drive early interventions. Automating care intelligence empowers Wellframe providers to scale care delivery and optimize care strategy, which has already resulted in an 80 percent increase in weekly patient care plan engagement.

We’re excited to see how these and other organizations in the healthcare space utilize data to solve their most pressing challenges.

Working with partners for better patient outcomes

Our Google Cloud partners play a critical role in helping healthcare providers and organizations embrace and evolve their cloud strategies. Today, we are pleased to announce several new partnerships established to accelerate our commitment to data interoperability.

* Our relationship with Health Level 7 (HL7), an international standards body for clinical data, builds upon our existing work with the FHIR Foundation to include the broader set of standards managed by the organization. Representatives from Google are joining the standards community.
* By partnering with the SMART Advisory Council, a group designed to facilitate applications integrated directly into electronic health records, Google Cloud developers will be able to share feedback to improve the SMART specification and help maintain a robust set of tools for application designers, engineers, and users.
* As a partner of Rock Health, an industry leader in digital health research and new venture support, we will incorporate integration requirements from novel and fast-growing companies, share best practices for scalable and compliant product development around the world, and consult with investors, industry executives, regulators, legislators, and academics shaping the future of digital health.
* MITRE, a not-for-profit organization that operates federally funded research and development centers, is collaborating with Google Cloud to give developers access to [SyntheticMass](https://syntheticmass.mitre.org/about.html) through [Cloud Healthcare API](https://cloud.google.com/healthcare/) and [Apigee Edge](https://docs.apigee.com/api-platform/get-started/what-apigee-edge). SyntheticMass is a population-level, FHIR- formatted dataset that contains realistic but fictional residents of the state of Massachusetts. It statistically mirrors the real population in terms of demographics, disease burden, vaccinations, medical visits, and social determinants, which makes it a risk-free environment for experimenting and exploring new healthcare solutions. SyntheticMass is generated by [Synthea,](https://synthetichealth.github.io/synthea/) an open-source, synthetic patient generator that models the medical history of patients. The FHIR dataset will be made publicly available to developers soon.
  + Flywheel is [integrating Google's Healthcare API,](https://globenewswire.com/news-release/2019/02/11/1716456/0/en/Flywheel-Partners-with-Google-Cloud-to-Provide-Clinical-Researchers-with-Advanced-Cloud-Technology-and-Machine-Learning-for-Medical-Imaging.html) as well as BigQuery and [AutoML](https://cloud.google.com/vision/automl/docs/tutorial) [Vision,](https://cloud.google.com/vision/automl/docs/tutorial) with their platform to capture multi-modality images and data, boost the productivity of data classification, and securely collaborate with peers to manage analysis and metadata.
  + Life Image and the Athena Breast Health Network at the University of California [selected Mammosphere on GCP](https://cloud.google.com/customers/athena-breast-health-network/) for its breakthrough WISDOM Study to determine the optimal frequency and methods of breast cancer screening. Life Image is also using our Healthcare API to bridge the gap between care systems and applications built on Google Cloud.
  + Our [partnership with Imprivata,](https://cloud.google.com/blog/products/chrome-enterprise/chrome-enterprise-announces-new-partners-and-patient-experiences-to-help-improve-healthcare-services) the healthcare IT security company, makes it possible for Chrome devices to work seamlessly with Imprivata’s single sign-on and

virtual desktop access platform for healthcare. This will enable secure mobile workstations and patient devices.

* + Elastifile [launched Elastifile Cloud File Service,](https://www.elastifile.com/introducing-elastifile-cloud-file-service/) a fully-managed file storage service. With scalable, high-performance, pay-as-you-go file storage at their fingertips, healthcare organizations are empowered to burst data-intensive NFS workloads to Google Cloud for accelerated processing.

Unlocking the power of data with our products

At Google Cloud, we’re always looking to expand our healthcare product offerings—and help our customers do the same. Many organizations host datathon events as a way to collaboratively tackle data challenges and quickly iterate on new solutions or predictive models. To help, we’re announcing the [Healthcare Datathon Launcher,](https://github.com/GoogleCloudPlatform/healthcare/tree/master/datathon/organizer) which provides a secure computing environment for datathons. And if you want to learn how to do clinical analysis, University of Colorado Anschutz Medical Campus has just launched a [Clinical Data Science specialization](http://www.learnclinicaldatascience.org/) on Coursera, with 6 online courses, giving you hands-on experience with Google Cloud.

Additionally, we've enhanced our healthcare offerings in numerous ways over the past year, including making [radiology datasets publicly available](https://cloud.google.com/blog/topics/healthcare-life-sciences/unlocking-whats-possible-medical-imaging-data-cloud) to researchers with the Google Healthcare API, and hosting over 70 public datasets from the Cancer Imaging Archive (TCIA) and NIH. With these [datasets,](https://cloud.google.com/healthcare/docs/resources/nih-chest) researchers can quickly begin to test hypotheses and conduct experiments by running analytic workloads on GCP—without the need to worry about IT infrastructure and management.

Helping healthcare providers meet their security and compliance needs

Security and compliance are fundamental concerns for healthcare providers, and are among Google Cloud’s topmost priorities. To date, more than three dozen Google Cloud Platform products and services [enable HIPAA compliance,](https://cloud.google.com/security/compliance/hipaa/) including Compute Engine, Cloud Storage, BigQuery, and most recently, Apigee Edge and AutoML Natural Language. In addition, Google Cloud Platform and G Suite are [HITRUST CSF](http://cloud.google.com/security/compliance/hitrust) certified. Google Cloud is also committed to supporting compliance with requirements such as the [GDPR,](http://cloud.google.com/security/compliance/gdpr) [PIPEDA,](http://cloud.google.com/security/compliance/pipeda) and more. We recently published a whitepaper on [Handling Healthcare](http://services.google.com/fh/files/misc/handling_healthcare_data_uk.pdf) [Data in the UK](http://services.google.com/fh/files/misc/handling_healthcare_data_uk.pdf) that provides an overview of [NHS information governance requirements.](https://cloud.google.com/security/compliance/uk-healthcare/)

# 2nd Study:

Takeda, a leading global R&D pharmaceutical company, was seeking to improve the accuracy of its prediction models for various disease states. They believed AI could be a powerful tool in this effort, but needed to create a model that could prove their hypothesis. To achieve their goals, they enlisted the help of Deloitte to create a cloud solution. Using a small, proven real world data set on Treatment Resistant Depression and NASH, a severe form of hepatitis, Takeda and Deloitte deployed a scalable, AWS cloud- based machine learning solution called Deep Miner to rapidly test predictive models.

Cloud delivered—accelerating the development of the solution and delivering insights faster. Just as Takeda hoped, the solution generated unprecedented insights their teams can now apply across a range of data to refine drug development and planning of clinical trials. The model proved highly accurate in its predictions, outperforming previously tested traditional analyses. Accuracy jumped almost 40%, which will inform drug development, product pipeline planning, and help Takeda to appreciate unmet needs of patients and improve patient outcomes. And, Cloud made it happen.

# 3rd Study:

Prescribing ML for new use cases

In our use and exploration of AI/ML in our platform, we go beyond pure AI tools by including human- in-the-loop programs and treatments. For example, we provide coaches, therapists, and dieticians that work with each individual patient, providing tips, strategies, and accountability. Our patient-provider interactions are digitized and stored, giving us a robust training dataset that we can now operationalize using all of the Google tools available. Using these provider interactions, we can track a patient’s progress to ensure they’ve improved their health outcomes, whether it’s weight loss, stress reduction, blood sugar management or beyond.

We want to endow our providers with superhuman powers, which means using AI/ML to manage and automate all of the tasks that aren’t member-facing, freeing up the providers to focus their time and energy on their patients. We’re currently experimenting with our Google tools around transcribing the provider’s consultation notes and then applying data analysis to uncover insights that will lead to better health outcomes. Other time-saving solutions on our roadmap for providers include pre-filling standard fields in the chat function and managing end- of-day approvals.

We’re currently using BigQuery ML for our “next action recommender,” a member-facing feature on our mobile app that recommends the next step a patient can take in their treatment, based on past datasets of information provided by the patient. At the start of their journey, the steps might be basic, such as scheduling a consultation, adding a health tracker, or watching a health video. But the longer a patient uses our platform, the more sophisticated the recommendation system gets.

**LEARNING OUTCOMES:**

* Cloud-based ML in Healthcare: Understanding its Impact
* Clinical Decision Support Systems: Advancements Enabled by Cloud-based ML
* Personalized Healthcare with AI/ML: Enhancing Patient Outcomes