

Artificial Intelligence in Action:

Triaging Cardiologist Referrals from General Practitioners

*Case Study: Precision Driven
Health*

June 2019

TOWARDS OUR INTELLIGENT FUTURE TE ARA MŌ TĀTOU ATAMAI O ĀPŌPŌ

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Special Study

Artificial Intelligence in Healthcare: Triaging Cardiologist Referrals from General Practitioners

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In the future, New Zealand will have more older people that live longer, with a higher spend on healthcare per capita, than younger people. It follows that the way we provide healthcare now will become unsustainable over time.

People are living longer than in previous generations. According to the Ministry of Social Development, 12% of New Zealand's population was aged above 65 at the end of 2016, expected to rise to 22% by 2036. The median age of people living in New Zealand has risen from 25.6 years in 1970 to 37.1 years in 2016.

According to health.govt.nz, in 2016, people aged 65 and over used 42% of health services despite only making up 15% of the population. The government expects the proportion to grow to 50% by 2025.

In New Zealand both public and private healthcare providers must find ways to operate more efficiently, providing better outcomes for patients, faster. Overseas studies show wasted spend is a significant cost in the healthcare business. Healthcare companies can find ways to do more for less and become more sustainable into the future.

Waitemata District Health Board (WDHB) comprises North Shore Hospital, Waitakere Hospital and other facilities. WDHB has identified a problem where cardiologists spend too high a proportion of their time triaging patient referrals. The referrals include paperwork to review. The cardiologist then assigns a priority to the patient. The cardiologist would prefer to spend more time treating patients and less time triaging referrals.

HOW AI HELPS TO SOLVE THIS

Artificial intelligence can reduce waste and enable more effective healthcare. IDC research highlights the key use cases for AI in healthcare. This includes those that augment clinicians' diagnoses and treatment, intelligent process automation, and systems that augment enterprise resource planning (ERP) capabilities. For example:

- **Diagnoses and treatment:** AI extracts insights from diverse data sets, for example, medical records, lab tests, clinical studies, and medical images.
- **Automating paperwork and workflows:** AI reduces errors and speeds up processes such as admitting and discharging patients.
- **Literature review and research:** AI can perform intelligent filtering and cross-reference between publications and medical records.

- **Digital assistants:** Healthcare digital assistants can undertake background work for clinicians, letting the latter focus more on their conversation with the patient.

Further use cases include digital teachers for medical coursework and training, robotic surgery, digital assistants for patient enquiries, fraud-detection AI, intelligent radiology systems, and intelligent pacemaker systems.

PRECISION DRIVEN HEALTH

Founded in 2016, Precision Driven Health (PDH) is a research partnership between Orion Health, the University of Auckland, and Waitemata District Health Board. PDH is investing \$38 million over seven years in collaborations. PDH develops tools to personalise healthcare by running machine learning on data. It seeks to provide research and development for precision health initiatives. Studies and early technology adoption are key focuses of this partnership.

The Solution

Health data is diverse and complex. Often, machine learning projects that use health data are speciality and hospital-specific. This is expensive and time consuming to build. Siloed projects create overlaps in knowledge and uses. PDH is improving the approach to data-driven health by solving business problems using the 'transfer learning' technique. This is where developers re-use a machine learning model for a new purpose rather than build a new model.

PDH aims to use transfer learning to reduce the time taken for hospital cardiologists to triage patient referrals from general practitioners (GPs). Cardiologists triage these referrals by prioritising them according to risk level. However, GP referrals are large documents; this a time-consuming task. Reducing the triage time allows cardiologists to spend more time with patients instead of with paperwork. This will reduce patient waiting time and improve the delivery of the right treatment and care.

A challenge in health care industry machine learning is the large variety of data types. Referrals can include images, such as scans, text-based data, such as handwritten notes, and structured data such as laboratory test results. PDH data scientist Dr. Edmond Zhang has solved this challenge. In previous research he investigated using different machine learning models on different data types. The key was to combine the outputs, merging them into one unified model. Zhang will apply this research to develop the machine learning models for this project.

PDH will use 14,000 existing WDHB cardiology triage records to create the base machine learning model for this project. To complete the transfer learning aspect of the project, this base model will then be fine-tuned for other contexts, such as other DHBs. Transfer learning will leverage the base machine learning model knowledge and add data from other New Zealand hospitals. This will create a feedback loop that fine-tunes the model. This example demonstrates how developers can use existing learning instead of building a new model. As at June 2019, PDH is currently mid-way through base model production. The next steps are machine training and learning. PDH expects that a functional triaging model for cardiologists should be ready later this year.

This case study is focuses on solving the GP referrals triage problem but transfer learning has potential to serve many other purposes. For example, the base model may be fine-tuned to solve problems for other health care specialities besides cardiology. It could also be fine-tuned for other hospitals which serve populations with different characteristics.

Ultimately, PDH will develop the research outputs into a commercial platform. This Orion Health's Smart Data Platform will enable clinicians to use these tools to support their decision-making.

OVERCOMING CHALLENGES: PRECISION DRIVEN HEALTH'S LEARNINGS

The specific challenges that PDH are facing on their journey are:

- **Data Access.** PDH has access to 14,000 cardiology triage records from WDHB, however getting access to a wider set of historical triage records has proven challenging. PDH needed to gain data ethics approval as well

as anonymising this data. Anonymising free text data has proved challenging as links to individual's identities are difficult to find. Unlike tabular data, there is no column that can be removed to anonymise free text data, instead private details such as names and date of births need to be identified from the text, then redacted.

- **Moving the models into clinical practice.** The time delay between a proof of concept and productionising a model can be a challenge. Over time, situations change, inconsistencies develop, or datasets may look different. PDH may need to rework the model before it can be productionised.
- **Gaining access to a high-performance computer.** For the project, the computer must be on-premise because WDHB require private patient information to remain on site for security reasons. This helps to lessen the risk of a data breach.

THE BENEFITS

The benefits of using the Smart Data Platform according to PDH include:

- **Time and cost savings.** By employing machine learning to assist in triaging referrals it allows clinicians to spend more time with patients, speeds up patients' experiences of the health system and allows for smaller teams of engineers and data scientists within hospitals, thereby reducing costs.
- **Combining Multiple Data Sets Means Better Insights.** Dr Zhang's prior research combines multiple data outputs into one model. This lets user derive better insights than separate data sets.
- **Transferring results.** One of the largest benefits is the ability to transfer a base model to different specialisations and hospitals. This allows for faster access to machine learning models as well as granting access to hospitals that serve smaller populations. For example, if a hospital had only 2,000 cases a year, which is not enough to train a model, PDH could build a model on top of the base model, allowing smaller hospitals to leverage the model.

WHAT THE FUTURE HOLDS

The plan for the Smart Data Platform is to include a base model that will apply to specific industries. Tech buyers can select from a list of base models to pick from and fine tune the model with their own machine learning datasets. PDH will offer "Data Science as a Service" with the product, with data scientists available to help fine-tune the model. This product could be an on-premise or cloud-based deployment.

The advantage of being able to transfer results is the ability to apply the model to a wide range of fields. Healthcare is the first goal; however, any data-centric vertical holds opportunity.

IDC'S GUIDANCE

The PDH case study provides a few examples of challenges faced by employing AI:

Further guidance includes:

- Healthcare has sensitive data sets. Overcome barriers to adoption by clearly and openly addressing data management and privacy concerns.
- The public sector is not the only place for machine learning solutions. Private health organisations from dentists to medical clinics to aged care will seek AI-based solutions for competitive differentiation.
- Healthcare organisations should carefully consider the benefits of buying rather than building AI-based solutions. Why build a full stack when it is faster and more effective to use vendor expertise and fine tune models on top of existing technology?



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The rapid development of AI technologies presents major opportunities and challenges for our country: from creating world leading AI businesses, nurturing a pool of talented AI engineers, applying AI technologies to our agriculture, government, manufacturing and service industries to holding a meaningful national debate on the broader implications for society, New Zealand needs to actively engage with AI now in order to secure our future prosperity.

The Forum brings together citizens, business, academia and the government connecting, promoting and advancing the AI ecosystem to help ensure a prosperous New Zealand.

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