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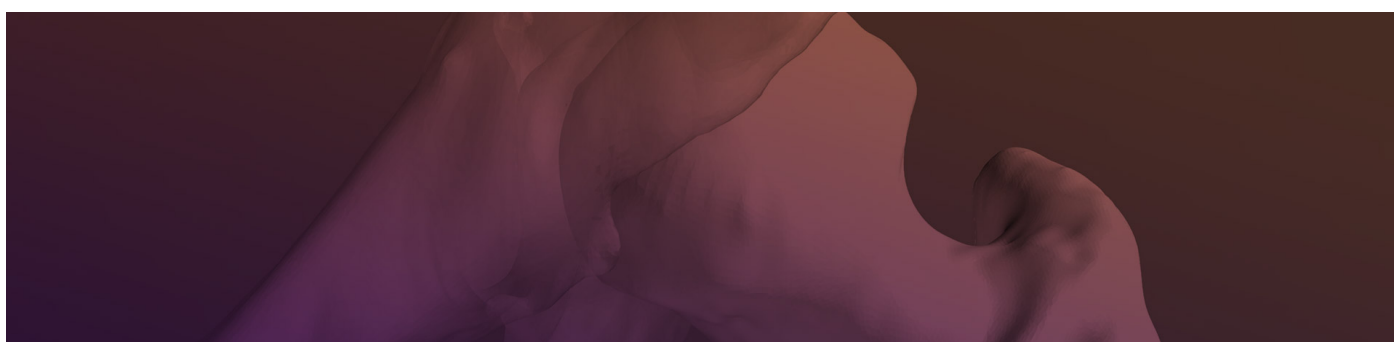
THE PERSONALISATION OF HEALTHCARE

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The Personalisation of Healthcare

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Long waits, short appointments and limited resources. Sound familiar? Today's healthcare system is beginning to feel the strain of a growing and ageing population. The solution: personalised medicine, a policy proposed by the European Commission to place the individual citizen at the centre of healthcare decision-making. While there are many challenges to the implementation of a personalised healthcare system, artificial intelligence offers a solution to overcome these and action the policy.

Problems Faced by Patients

Let's get into the specifics of the problems faced by individuals in today's healthcare system. First of all, many people feel anxious about going to the doctors. Imagine that you notice a mark on your skin and are concerned that it might be a melanoma. You might worry that you're making a fuss about nothing. As a result, you avoid going to the doctor for a few weeks out of a fear of getting dismissed. If it turns out that the mark is actually a malignant melanoma, the time you waited might mean a lot in terms of treatment and recovery.

You might also worry whether the doctor will fully understand your problem, as generally, patients face very limited appointment times of only ten or fifteen minutes. For some patients, depending on their problem, this might not be enough time for the GP to go into the problem in depth and perform examinations. This problem will only increase as the population grows, as there will be more patients that a doctor has to manage; it may become increasingly harder to get appointments and they might get shorter. So, the prospect of such a short time with the doctor might increase your anxieties. You might feel that the appointment is rushed and worry that the doctor has missed something and so not feel completely confident with the diagnosis.

A further problem is that people face long waiting times to see specialists. Overall, getting a problem fixed is a time-consuming process; from booking the appointment with the GP to actually seeing the correct specialist, a patient might have to wait some weeks, which could worsen the problem or increase their pain. So, by the time you've decided to see the GP about the mark on your skin, you might face a long wait until you finally get to see a skin specialist and receive a diagnosis confirming whether the mark is benign or malignant. During this time, you will likely worry a great deal about the mark. All that worry could be saved if you were able to receive a positive or negative diagnosis faster.

Additionally, healthcare resources are limited which means that they are not able to reach everyone. Certain drugs, types of scan, treatments, operation techniques and equipment are not available for everyone. This is because healthcare systems have to be cost-effective and so are forced to be restrictive to try to ensure that limited resources reach the people who need them most. This could lead to inequalities in the healthcare system as doctors are forced to become increasingly selective with their treatments. Again, the problem will increase as the demand for healthcare from a growing and ageing population increases. So, if it turns out that your spot is malignant, there might be certain treatments unavailable to you. Outcomes for skin cancer are generally positive, but the lack of certain resources might affect the speed and ease of your recovery.

Credit: Samsung Insights

Healthcare studies confirm the long waiting times and limited resources which are problematic for patients. For example, in *Health at a Glance 2016,* researchers investigated the wait times for elective surgery across eleven countries. Measuring from the time when a specialist adds a patient to the waiting list until the time they receive treatment, they found that the average waiting times in 2014/2015 for cataract surgery, for example, ranged from about 40 days in the Netherlands, to around 100 in Portugal, Spain and Finland and up to over 400 days in Poland. Researchers also studied the availability of MRI and CT scanners across EU countries. They argue that while there is no ideal number of scanners, too few units can lead to access problems for patients. They observed variations both across and within countries. For example, in the UK, they observed a four-fold variation between the Primary Care Trusts that had the highest and lowest rates of CT scanners and MRI units in 2010/2011. These findings indicate that patients might face long waiting times or problems accessing certain healthcare resources depending on the country or region that they live in.

A personalised healthcare system could eliminate these problems. Personalised healthcare is a new paradigm in medicine. In a truly personalised healthcare system, the individual patient's needs take centre stage and they become an active participant in the management of their own health.

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Personalised Medicine

Last year, the European Commission held a conference (https://ec.europa.eu/research/conferences/2016/permed2016/pdf/permed-2016_report.pdf) titled 'Personalised Medicine' which addressed the challenges in involving patients more directly in their healthcare. Commissioners emphasised that for too long the healthcare system has viewed the patient as a subject of research or treatment, rather than an active partner. The personalisation of medicine policy aims to challenge this by placing the individual citizen at the centre of healthcare decision-making.

Several challenges to the implementation of the policy were raised at the conference. Firstly, speakers claimed that we don't yet know how to optimise the consultations between patients and doctors. Secondly, the policy requires a major shift away from a healthcare system which reacts to disease to one that seeks to prevent diseases. In order to achieve this, there needs to be a greater emphasis on prediction. Finally, patients need to agree to manage their own healthcare, which could be problematic because it will require a large adjustment on their part. They may feel as though taking a more active role in their healthcare decision-making is too much of a burden for them to take on and consider this to be part of a doctor's role.

Speakers emphasised that the smart use of technology is crucial to the policy. Taking this emphasis further, the healthcare system could be augmented with artificial intelligence to overcome these challenges and help to implement the personalised medicine policy. AI could play a crucial role in realising a truly personalised healthcare system, by shifting the focus of the system onto the individual patient's needs. AI could be used to optimise the consultation between the doctor and patient and to predict diseases with greater accuracy, which will enable a shift towards a preventative approach to diseases. We could also use AI to support patients in managing their own healthcare, empowering them to be an active participant in a personalised healthcare system.

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An Optimised Diagnosis

Imagine that we implement an AI as one of the links in the chain for when you want to get that mark on your skin checked out. Rather than waiting for several weeks to see a specialist after being referred by a GP, the GP will be able to take a picture of the mark. The machine will then be able to accurately state whether the mark is benign or malignant. You'd receive your diagnosis earlier, which would save you a lot of waiting and worrying. If the mark is malignant, you'd be able to start treatment faster than if you'd waited many weeks to see a specialist. Placing an AI as an early point of contact for patients means that doctors will only need to see the ones with malignant melanoma, allowing them to give more time and attention to those who need it the most. So, the consultation between doctor and patient can be optimised by the AI's ability to be selective. Saving time in this way will make the healthcare system more cost-effective and so more equipped to handle a growing, ageing population. A more cost-effective system will mean that resources will become more widely available; AI can contribute to the democratisation of healthcare.

The predictive capacity of AI can also optimise the diagnostics process, allowing it to diagnose diseases with greater accuracy than human doctors. For example, a Google AI project has developed technology to scan retinal images in order to earlier detect signs of diabetic blindness. It began with a Kaggle diabetic retinopathy detection competition which ran from February to July 2015. Since then, Google researchers have worked with doctors to create an AI which can automatically detect signs of diabetic retinopathy. In a study published in *The Journal of the American Medical Association,* it succeeded at about the same rate as human ophthalmologists. The technology can screen far more people than doctors previously could. So, AI will encourage people to feel more at ease when they go to the doctor, as having an opinion from both a doctor and an AI machine will give them confidence in their diagnosis. The enhanced predictive abilities of AI will help to shift the healthcare system towards a more predictive and preventative approach to diseases. A more accurate diagnostics system will also ease the burden on the healthcare system. Emphasising the prediction of diseases and diagnosing patients more accurately will reduce the number of false diagnoses, saving money for the healthcare system in the long run.

Encouraging Independence

AI can give support to individuals in managing their own health. This support will make the transition to a more personalised healthcare system easier for patients, as they will not suddenly feel the burden of managing their healthcare alone. Instead, AI will encourage and empower them to do so.

Mabu, the personal healthcare robot. Credit: Catalia Health.

Personal healthcare robots, like Catalia Heath's Mabu, are just one way that AI can be used to support patients. Mabu is designed for patients with chronic illnesses so that they can better manage their health; she reminds her users to take their medication and can also send messages to their doctor, who will monitor their health in the long-term. Mabu can even make eye-contact with her users, adding a personal touch to the support that they receive. Patients are more likely to take their medication when they are reminded by a robot like Mabu, preventing complications further down the line and improving their outlook for the future.

Another way of supporting patients is through smartphone apps. For example, last year OLVG developed an iPhone app that allows its users to see if their heart arrhythmia is atrial fibrillation, which is the most common heart arrhythmia. Now, Cardiogram have developed an algorithm that uses the Apple Watch to detect atrial fibrillation. They trained a deep neural network on the Apple Watch's heart rate readings and was able to obtain an AUC of 0.97, enabling users to detect atrial fibrillation with 98.04% sensitivity and 90.2% specificity. With this technology, a user can keep an eye on their own heart using a device that they can carry around with them, removing the need for multiple trips to the hospital. Along with an increase in the detection of atrial fibrillation, the device will also decrease health anxieties in users with a high risk of heart complications.

Concerning diabetic healthcare, Medtronic, a medical tech company based in Minneapolis, recently won US Food and Drug Administration regulatory approval for its Minimed 670G device, a unique diabetic pump which programs the user's insulin levels. It is the world's first hybrid closed-loop system. Users still have to program their meals and plan ahead for exercise, but the device represents a huge step forward in diabetic healthcare. For its users, the MiniMed will take away some of the burden of managing their condition, so that they can get on with their lives without being chained to the doctor's surgery or emergency room. Remaining in good control of their glucose levels will also reduce the chance of complications further down the line which would increase the necessity of medical treatment.

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Over time, as patients become increasingly active in the management of their own healthcare, the reliance on doctors for things that an AI can handle will decrease. The support they receive from AI technology will empower patients to take charge of their own health. This will, in turn, save the healthcare system time, money and resources that could be used elsewhere.

The Challenge

AI has the potential to optimise the healthcare system by shifting the focus onto the individual patients who need it the most. However, as the speakers at the personalised medicine conference point out, transforming the healthcare system in this way will require a big adjustment on the part of all of its participants. The healthcare system itself needs to be open and accepting of new advances in technology, while doctors themselves have to adjust to using them. Patients also have to agree to manage their own healthcare. But, the rewards of this adjustment are considerable: significantly better and more affordable healthcare.

Scyfer's Contribution

Scyfer is a part of this push to personalise healthcare. For example, we designed a bone segmentation service. Normally, 3D CT scans of hip bones require manual processing in order to segment an accurate representation of the bone structure. This means that between 50-200 images have to be processed for a single 3D CT scan, which is a time-consuming and expensive process, not to mention repetitive and tedious. Furthermore, current tools are inaccurate in the critical areas of the bone. With this challenge in mind, Scyfer has developed a bone segmentation service to segment and annotate the hip and femur bone. You just upload your DICOM file and we deliver a file in which the different bones are segmented. The trained solution focuses on the area of greatest interest: the intersection between the hip and femur. This is where we explicitly trained the algorithm to be highly accurate; we achieved rates of between 90 and 95%. The benefits of this automatic classification are convenience and service in improving accuracy and saving time, work and cost. The service is useful for both the post-processing of 3D CT scans and for medical research.

Scyfer also built a model to predict the likelihood of patients experiencing complications following their surgery. The project aimed to explore the perioperative data of hospitals and its usefulness for developing a machine learning model which could predict postoperative complications. Fields were derived from diagnosis complications, such as *diagnosis type*, medication complications, such as *medication duration* and surgery admissions, such as *anaesthesia duration* and *time after surgery.* We found that the best approach combined an ensemble of classifiers. Overall, this classifier achieved an accuracy rate of 78%. The Resurge project emphasises the importance of predicting complications rather than reacting to them.

Towards the future of AI

AI technology offers a compelling solution to overcoming some of the challenges faced in the implementation of the personalised medicine policy. The realisation of this policy will not only make the current healthcare system more efficient and cost-effective, but also remove many of the problems faced by patients when they interact with the healthcare system. Personalised healthcare will put the individual citizen at the centre of healthcare decision-making, where AI will empower and support them to take a more active role in the management of their health.

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