AI AND HEALTHCARE: A CASE STUDY ON GOOGLE DEEPMIND'S USE OF AI TO DIAGNOSE ACUTE KIDNEY INJURY

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

In 1989, Feng-Hsiung Hsu, Murray Campbell, and Thomas Anantharaman, three PhD graduates of Carnegie Mellon University, were working on creating a chess-playing computer that would outperform the best human chess player. Eight years later, in 1997, Hsu and Campbell in addition to a team of other IBM researchers had the pleasure of their aspirations manifesting into reality. Their computer, Deep Blue, defeated World Champion Garry Kasparov in a six-match game. The contentious aftermath of Deep Blue vs. Kasparov gave rise to many different reactions, as Monty Newborn put it, "IBM celebrated, the chess grandmasters of the world went into a state of shock, and the average person on the street wondered what it was all about" (Newborn, 2003, Preface). Since Deep Blue, research into creating machines to mimic human intelligence have been undertaken by countless scientists around the world. Artificial intelligence has the potential to revolutionize the modern world, and this capability is not lost on many who dedicated their lives to making further advancements. One field that artificial intelligence could be particularly useful is that of healthcare. Mustafa Suleyman, a British entrepreneur, realized this and created DeepMind with the intention of developing such technologies. In this paper I will examine DeepMind's work, specifically its partnership with the Royal Free London Foundation NHS Trust in developing a way to diagnose acute kidney injury. I will be looking to answer what their partnership initially planned to accomplish, how their plans were executed, and any issues that arised within.

I. An (Extremely) Brief History of Artificial Intelligence

As defined by the Oxford English Dictionary (2024), "AI" is the capacity of computers or other machines to exhibit or simulate intelligent behavior. A question of importance deduced by the definition of artificial intelligence is: how can these machines, or computers, become capable

of exhibiting intelligent behavior. When artificial intelligence first came to fruition in the 1960s with ELIZA, a chatbot that read input and applied a set of rules to generate an appropriate response, researchers implemented a knowledge-based approach more commonly known as classical AI. The method of classical AI involved researchers manually coding the knowledge an artificial intelligence machine would need to complete a specific task, and then writing it into a computer program that would apply that knowledge to solve challenging tasks. This method has been enhanced by machine learning, in which these artificial intelligence systems are trained on large amounts of data. Generally, for machine learning these systems are given an input and the output is known, but the procedure to reach the output from a given input is not specified i.e. the machine has to learn how to take the input and produce the output. More specifically, these systems employ deep learning which is a subset of machine learning that consists of correlated machine learning algorithms that have more than one layer of data (Ongsulee, 2017). The purpose of these layers is to train the system more efficiently and accurately, as Onguslee puts it, "deep neural nets have demonstrated an ability to out-perform other machine learning algorithms on tasks such as object recognition in the field of computer vision" (Onguslee, 2017, pg. 4). With the nuances between machine learning and deep learning established, it is clear that deep learning is the favored approach for researchers of artificial intelligence because of its efficiency and accuracy. The authors of *Rebooting AI: Building Artificial Intelligence We Can Trust* emphasize the popularity of deep learning, "Between GPUs and the size of the ImageNet library, deep learning was off to the races. Not long after that, Hinton and some grad students formed a company and auctioned it off. Google was the high bidder, and it also bought a startup called DeepMind for more $500 million two years later. The deep learning revolution began" (Marcus & Davis, 2020, pg. 43).

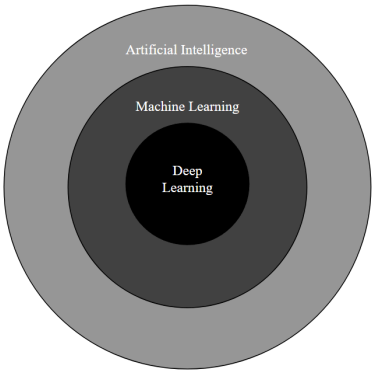

Figure 1: Venn diagram depicting hierarchy between deep learning, machine learning, and artificial intelligence

II. Actor-Network Theory

The technological systems that engineers create are interconnected with many other facets of the world. These systems become part of our daily lives and it is crucial to understand and analyze the effects of these systems across multiple facets. One method of analyzing the relation of technology with respect to other disciplines is the actor-network theory, abbreviated as ANT. Actor-network theory was developed by Michel Callon, Bruno Latour, and John Law in an attempt to understand science and technology, or colloquially known as *technoscience* to scholars of science and technology studies (Sismondo, 2009).

ANT is a social theory that expresses technoscience as a product of the formation of networks. These networks are very broad and are unique in the sense that they contain both human and non-human actors that form associations with one another. “Both humans and non-humans form associations, linking with other actors to form networks. Both humans and

non-humans have interests that cause them to act, that need to be accommodated, and that can be managed and used" (Sismondo, 2009).

Actor-network theory can be applied to Google DeepMind's efforts to create a technology that can detect acute kidney injury. "Google DeepMind, the tech giant's London-based company most famous for its groundbreaking use of artificial intelligence, is developing a software in partnership with NHS hospitals to alert staff to patients at risk of deterioration and death through kidney failure" (Reed, 2016). The human actors in question are the founders of Google DeepMind, and hospital patients, while the non-human actors are the NHS hospitals, patient records, privacy laws, the software developed for detecting acute kidney injury, and the procedures required to diagnose acute kidney injury. There are many methods for diagnosing acute kidney injury such as: urine output measurements, urine tests, blood tests, imaging tests, and removing a sample of kidney tissue for testing (Mayo Clinic, 2022).

Human Actors	Non-Human Actors
Google DeepMind Founders	NHS Hospitals
Hospital Patients	Privacy Laws & Patient Records
	Software
	Diagnosing Procedures

Figure 2: Table depicting human and non-human actors

III. Google DeepMind Founders

DeepMind has its origins in 2010 as a start-up founded by Demis Hassabis, Shane Legg, and Mustafa Suleyman. In his youth, Demis Hassabis was a child-chess prodigy and finished his A-levels, the English equivalent of the SAT, two years early before coding Theme Park, a

multi-million selling simulation game. Hassabis attended Cambridge University and graduated with a degree in computer science. After graduation, Hassabis successfully managed technology start-ups before returning to University College London to complete a PhD in cognitive neuroscience followed by postdocs at MIT and Harvard. He founded DeepMind shortly after.

Mustafa Suleyman has a unique connection to Demis Hassabis that traces back to his childhood. Suleyman's best friend was Hassabis' younger brother and Suleyman shared that he and Hassabis would have conversations about making a positive impact on the world. Suleyman matriculated into the University of Oxford, however his degree was not awarded due to him dropping out at the age of nineteen. He co-founded DeepMind alongside Hassabis and became the chief product officer. In February of 2016, Suleyman created DeepMind Health at the Royal Society of Medicine to "build clinician-led technology for the NHS to improve frontline healthcare services" ("Mustafa Suleyman", 2024). Furthermore, under the supervision of Suleyman, DeepMind established research collaborations with healthcare organizations in the United Kingdom, including Moorfields Eye Hospital NHS Foundation Trust. ("Mustafa Suleyman", 2024). Suleyman ended up leaving DeepMind to officially work for Google and eventually ended up leaving Google in 2022.

Shane Legg is from New Zealand and holds a PhD from the University of Lugano on theoretical models of super intelligent machinery. Legg met Hassabis in 2010 as an assistant researcher in the Gatsby Computational Neuroscience Unit of University College London. These three individuals are some of the brightest minds of our generation and have combined efforts with the intention of using their capabilities to make a positive impact.

IV. NHS Hospitals

The NHS, an abbreviation for National Health Service, was established in the United Kingdom on July 5, 1948. The motivation behind the implementation of the NHS was due to the effects of the First and Second World War on the United Kingdom. During the Second World War, the citizens of the United Kingdom experienced destruction, damage to property, evacuation, and rationing. The period of time after the First World War and the Second World War were very devastating because of the worldwide economic depression induced by the Wall Street Crash of 1929. The hardships endured by the United Kingdom made it difficult, if not impossible, for the nation to institute any form of provisions. At the time, the prime minister of the United Kingdom, Clement Attlee, along with his Cabinet recognized these issues, especially since they lived through and fought in both World Wars. Clement and his Cabinet realized the need for reconstruction and expansion in which a comprehensive welfare system would be the heart of their solution. The NHS was revolutionary because it "was the first western country to offer free at the point of use medical care to the whole population" (Clement, 2023). An NHS leaflet from 1948 boasts "Anyone can use it- men, women, and children. There are no age limits, and no fees to pay. You can use any part of it, or all of it, as you wish" (Clement, 2023).

Seventy-six years later, the purpose of the NHS has not changed. The first sentence of the NHS constitution , updated 17 August 2023, is: "The NHS belongs to the people" (NHS Constitution, (n.d.)). In their constitution, the NHS defines seven key principles that guides the institution:

1. *The NHS provides a comprehensive service, available to all.*
2. *Access to NHS services is based on clinical need, not an individual's ability to pay.*
3. *The NHS aspires to the highest standards of excellence and professionalism.*

4. *The patient will be at the heart of everything the NHS does.*
5. *The NHS works across organizational boundaries.*
6. *The NHS is committed to providing best value for taxpayers' money.*
7. *The NHS is accountable to the public, communities, and patients that it serves.*

Furthermore, arguably of more significance, the NHS clarifies the rights bestowed upon its patients. The rights concerning privacy are described by four stipulations:

1. *You have the right of access to your own health records and to have any factual inaccuracies corrected.*
2. *You have the right to privacy and confidentiality and to expect the NHS to keep your confidential information safe and secure.*
3. *You have the right to be informed about how your information is used.*
4. *You have the right to request that your confidential information is not used beyond your own care and treatment and to have your objections considered, and where your wishes cannot be followed, to be told the reasons including the legal basis.*

It is self-evident that the NHS prides itself on its commitment to providing accessible health services to its citizens, regardless of their financial situation, while also ensuring that patient's rights are not infringed upon.

With respect to DeepMind, NHS Trusts are of interest and not the entire NHS system. The NHS Trust as defined by the NHS dictionary is "a legal entity, set up by order of the Secretary of State under Section 25 of, and Schedule 4, to the National Health Service Act 2006, to provide goods and services for the purposes of the health service" (NHS Data Model and Dictionary, (n.d.)).

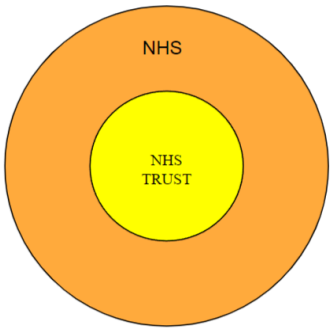

Figure 3. NHS Trusts can be envisioned as subsets of the NHS

Schedule 4 enumerates upon Section 25 of the National Health Service Act of 2006. It contains a section titled: *Provision to be made by first NHS trust order* that lists out a set of specifications that need to be met when a trust is created. One specification of interest is that of Schedule 4 Section 5 (1)(d) which states that any NHS trust must specify: *where the NHS trust has a significant teaching commitment, a provision to secure the inclusion in the non-executive directors referred to in paragraph (c) of a person appointed from a university with a medical or dental school specified in the order.* It is of particular concern that an NHS trust should have some sort of association or commitment to teaching. Furthermore, Schedule 4 Section 5 (3)(a) and (3)(b) clarify what qualifies as a significant teaching commitment:

(3) For the purposes of sub-paragraph (1)(d), an NHS trust has a significant teaching commitment in the following cases-

(a) if the NHS trust is established to provide services at a hospital or other establishment or facility which, in the opinion of the Secretary of State, has a significant teaching and research commitment, and

(b) in any other case, if the Secretary of State so provides in the order

(3)(a) elaborates that the qualification of a significant teaching commitment is determined by the opinion of the Secretary of State on the entity in question. Additionally, hospitals are defined as one clear entity while the other can be an "establishment" or "facility", an ambiguous term that allows much leniency.

DeepMind worked in collaboration with the Royal Free London NHS Foundation Trust. "In 2015, the Royal Free started a project with DeepMind to help detect acute kidney injury: (Linklaters LLP, 2018, pg. i.). The Royal Free Trust consists of three hospitals in London: Barnet Hospital, Chase Farm Hospital, and Royal Free Hospital. As stated above, NHS trusts place a significant emphasis on research. The 2015 version of the Royal Free's website states under their research page, "We aim to bring the best researchers from around the world to work alongside our patients, providing world-class expertise delivered locally" (Royal Free London, 2015, Accessed May 7, 2024). Additionally, in the *About our research* section of their 2015 website they state many areas of research one activity, one of which is renal medicine or otherwise known as nephrology, the study of kidneys (Royal Free London, 2015, Accessed May 7, 2024). However, in the *Our research partners* page it is worthy of attention that there is no mention of DeepMind, considering the project for detecting acute kidney injury was already taking place.

From their own website, Deepmind admits to being a trailblazer for the use of deep learning, "The lab achieved early success by pioneering the field of deep reinforcement learning- a combination of deep learning and reinforcement learning-" (About Google DeepMind, (n.d.), Accessed May 7 2024). In 2014, DeepMind was bought by Google for more than $500 million and merged into Google DeepMind (Shu, 2014). Their current mission statement expands on the increasing prevalence of AI and their dedication to build these systems safely and responsibly in hopes of a better future, "By solving some of the hardest scientific and engineering problems of

our time, we're working to create breakthrough technologies that could advance science, transform work, serve diverse communities- and improve billions of lives (About Google DeepMind, (n.d.), Accessed May 7, 2024).

V. Hospital Patients

The demographic of hospital patients is of particular concern because acute kidney injury differs in both incidence and treatment among races. According to Hassan and Balogun, black patients have a higher risk of acute kidney injury compared to white patients. Furthermore, it was reported that the relationship between race and acute kidney injury weakened significantly with socio-economic factors such as access to health insurance and total family income (Hassan & Balogun, 2022). Statistics that represent a disparity among races are taken into account when technological systems are built, however these statistics can result in inaccurate conclusions as a result of these biases. With respect to DeepMind, their data was taken from three hospitals: Barnet Hospital, Chase Farm Hospital, and Royal Free Hospital.

These three hospitals are located in North Central London and serve an approximate population of 1.45 million people. According to the Royal Free London's Annual Equality Information Act from 2015-16, North Central London has a very diverse population with black and minority ethnic groups making up a larger part. Additionally, it is reported by Royal Free London that "people from some BME communities, including black Caribbean, African and Irish, use more hospital services. "

In regards to the socio-economic conditions of North Central London, "Deprivation and inequalities are widespread in North Central London" (Annual Equality Information Report 2015-16). This is of significance because, as reported by Hassan and Balogun, socio-economic factors such as total family income play a role in acute kidney injury. Royal Free London

highlights this point in their report by writing, “Higher levels of deprivation are linked to many health problems, such as prevalence of long term health conditions, and are key drivers of poor health and wellbeing outcomes, affecting life expectancy; ” (Annual Equality Information Report 2015-16). In a report published by the UK Kidney Association in 2023 on ethnic disparities in patients with kidney failure across England and Wales, it was reported that the primary cause of kidney failure amongst all ethnic groups in the nation was diabetes. The data for this report was taken between the years of 2014 to 2020. Additionally, it was found that, “Adults whose ethnicity is Other, Asian, or Mixed have a much higher likelihood of kidney failure, and develop the disease at a younger age on average, than those of White ethnicity” (Lyon et.al, 2023, pg. 11).

Children make up about thirty-percent of the population of North Central London, however the conditions the children are brought up in are detrimental to their health. “NCL children do not always get the best start to life. 30% of children grow up in child poverty and 6% live in workless households. 60 children take up smoking everyday ” (Annual Equality Information Report 2015-16). In addition to this, London, as a whole, has the highest rates of childhood obesity nationally. In the report on ethnic disparities in patients with kidney failure across England and Wales, it is stated that “more boys than girls get kidney failure across ethnic groups” (Lyon et.al, 2023, pg. 12).

A majority of people that were admitted under in-patient care throughout all three of the hospitals that make up the Royal Free were white. It was reported that 64% of in-patient stays were for patients that identified themselves as white (Annual Equality Information Report 2015-16). Only 7% of all in-patient admissions identified themselves as black. In contrast to what was written previously that North Central London has a diverse population with black and minority ethnic groups making up a larger part and that “people from some BME communities

use more hospital services", the majority of their in-patient admissions were white. Royal Free explains this as a result of differences in age composition among ethnic groups, "According to projections for 2016 from the Greater London Authority, 20% of the White British population and 29% of the Irish population of our core catchment area (Barnet, Camden, and Enfield) is aged 65+" (Annual Equality Information Report 2015-16).

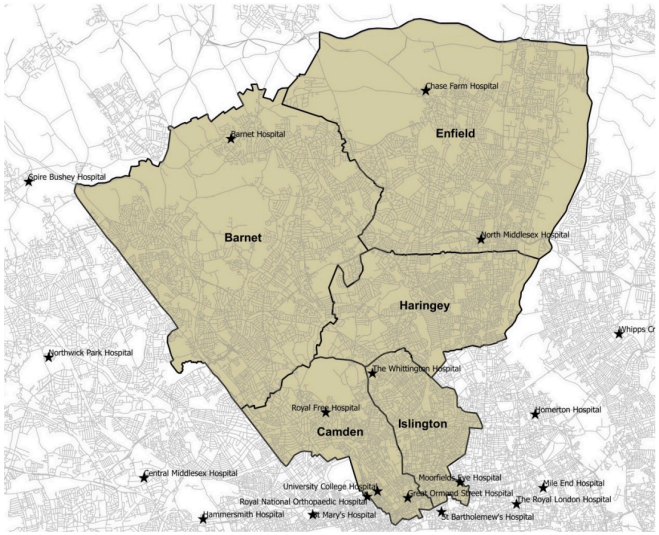

Figure 4: North Central London (Taken from Royal Free London's Annual Equality Information Report 2015-16)

VI. Privacy Laws & Patient Records

DeepMind used hospital patient records as the data for their machine learning model. The question of how these records are kept and what is on them needs to be explored to determine if there might be any malpractice. The Records Management Code of Practice guides the handling of patient records for any institution of healthcare across England. It is updated when it is needed, but the relevant guidelines are the ones from Records Management Code of Practice 2009 since the next version was updated in 2016, a year after DeepMind had already started their data collection.

The type of information stored on patient records differs on what it is that patient went to the hospital for and there is no universal amount of time in which any recorded information is kept. There is a maximum amount of time that records are kept, “However, records should not ordinarily be retained for more than 30 years” (Records Code of Management). Acute kidney injury requires secondary care, meaning that when a diagnostic test is conducted and the patient tests positive for AKI they are then referred to a trained specialist who can treat them i.e. secondary care. There are many different tests for diagnosing AKI such as blood or urine tests, but according to the Records Code of Management 2009, the NHS considers the results of these tests as just normal hospital records, specifically hospital records for secondary care. The minimum retention period for these records, according to the Code, is eight years after the conclusion of treatment or death of the patient (Records Code of Management 2009).

The significance behind looking at the time period in which hospital records are kept is that much of the general public expresses significant concern when their personal health records are subject to large corporations and their technological systems. It is characterized by feelings of fear and skepticism behind the true intentions of using such personal information over a vast period of time, however research shows that these types of records have to be kept for such a long period of time in the best interest of the patient.

VIII. Software

The software in question plays a crucial role in the actor-network theory analysis because the patient data is being fed directly into it. Additionally, the software harbors the most concern from the public because it involves concepts that the general public is not familiar with and with a lack of basic understanding of machine learning and artificial intelligence, the public’s mind is left to wander. It is common in these cases for people to assume the worst case scenario, that

their private information is being fed to these grand, futuristic artificial intelligence systems that plan on using their capabilities for malicious purposes. However, in the case of DeepMind, despite the articles that arise from a quick Google search, the software they are using is not an artificial intelligence system. In fact, according to the legal investigation conducted, the NHS was implementing a simple decision tree (Linklaters LLP, 2018).

XIV. Diagnosing Procedures

There are many different procedures for diagnosing acute kidney injury, however the NHS primarily uses blood tests. The principle behind the procedure is analyzing the level of creatinine in the blood. High or low levels of creatinine signify that the kidneys are not getting rid of waste products as efficiently as they should. There are various factors that can affect the levels of creatinine present within the body such as muscle mass, diet, creatine supplements, etc. These factors can cause the blood test to yield different results for both men and women, in addition to different races. To account for the variance, a quantity called the estimated Glomerular Filtration Rate is calculated. eGFR is a mathematical equation that accounts for a patient's serum creatinine level, age, sex, and race. The UK Kidney Association, UKKA, does set some guidelines in terms of caution for interpreting eGFR results, however the only factor it mentions is race, not age or sex . In fact, their website states, "In the 2021 NICE chronic kidney disease (CKD) guideline the recommendation to adjust for ethnicity, present in the 2014 version, has been removed. On review of the evidence, NICE agree that adjusting for ethnicity when calculating eGFR may not be valid or accurate. The UKKA supports NICE and recommends that the adjustment for black ethnicity for eGFR be removed from UK practice" (UK Kidney Association, 2024). However, the UKKA does agree that further evidence is needed to support the decision.

XV. Interactions Between Actors

The acute kidney injury project between the Royal Free Trust and Google DeepMind began in 2015. As stated in the section on NHS hospitals, the Royal Free Trust consists of three hospitals: Barnet, Chase Farm, and Royal Free. All three hospitals are located in North Central London and have a predominantly black and minority population. However, from their own reports, a majority of the in-patient stays were white, contrary to the expectations of the patient demographics due to having a majority black and minority population. Even more unexpected than the patient demographics is DeepMind's solution to diagnosing AKI. News articles and DeepMind's own website give the pretense that the company is primarily interested in applying artificial intelligence to solve real-world problems. An article titled *Using AI to give doctors a 48-hour head start on life-threatening illness* and co-authored by Mustafa Suleyman in 2019 states: "Streams doesn't use artificial intelligence at the moment, but the team now intends to find ways to safely integrate predictive AI models into Streams in order to provide clinicians with intelligent insights into patient deterioration" (Suleyman & King, 2019). Streams was DeepMind's software solution to determining if an NHS patient had AKI or not. Contrary to what was being reported and what the public was being led to believe, Streams did not use any form of artificial intelligence. Streams is able to determine if a patient is at the risk of, or has developed, AKI by taking the results of the blood tests, presumably the tests that employ eGFR, using a decision tree that had already been developed by the NHS. Figure 4 depicts the AKI algorithm used across NHS hospitals and, upon inspection, it can be seen that race or socioeconomic conditions do not play a role in diagnosing AKI. The only factors that are accounted for are the age and sex of the patient, if those two qualities happen to be available.

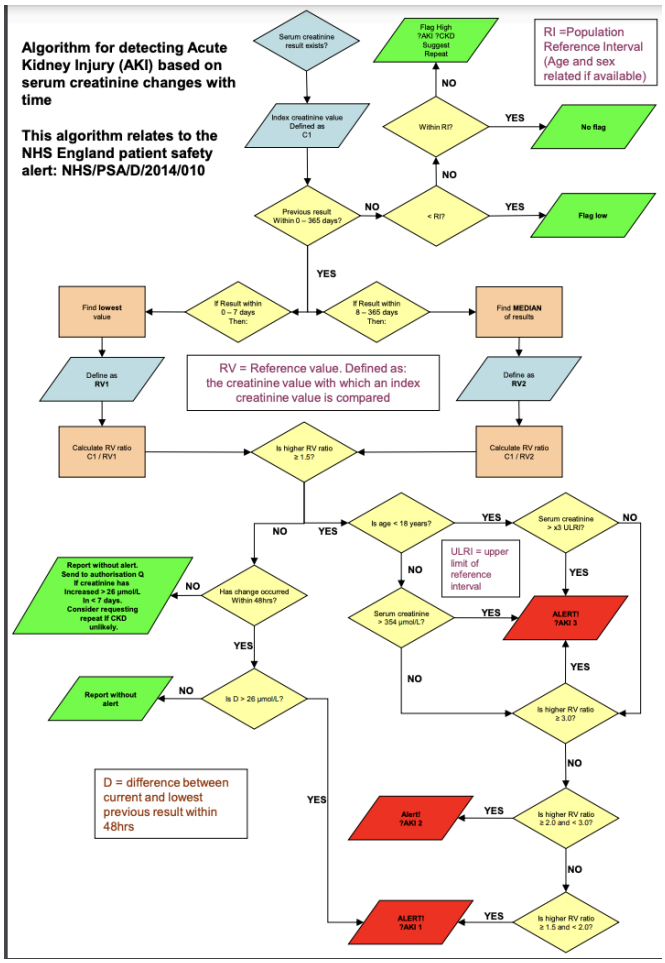

Figure 5. NHS AKI Algorithm

Furthermore, the app also provides information regarding a patient's previous medical history and thus has access to years of medical records.

The arrangements between Royal Free and DeepMind were specified in a contract that prohibited DeepMind from using any of the information outside of the guidelines specified by the Royal Free. The Royal Free itself has to abide by the clauses within the NHS Constitution that state the patient has a right to know if their information is being used and that it is kept confidential. Given that DeepMind merged with Google to form Google DeepMind and that Google is heavily involved in artificial intelligence research, this could be a potential cause for concern. However, this concern is mitigated by the fact that DeepMind has to act in accordance

with the Royal Free who, again, specified that only data is only to be used by DeepMind and not shared.

The partnership between Google DeepMind and the Royal Free is in many respects, completely opposite that what was to be expected. There was no artificial intelligence involved, the agreement heavily emphasized data protection and privacy, and there was no foul play involved with attempting to tamper with data from patients of different backgrounds and ethnicities.

XVI. Analysis of Interactions Between Actors

The articles published online reporting on DeepMind researching intentions and both human and non-human actors involved in the entire ordeal have contributed to an unpleasant feeling within the general public. I will analyze how the partnership between DeepMind and Royal Free, in addition to the surrounding enenvironment and type of research taking place, have contributed to its distorted perception. Furthermore, I will explain the true nature of the agreement between the two entities.

Mustafa Suleyman, an ambitious entrepreneur hoping to transform the world predominantly with the use of artificial intelligence, had already created the start-up in 2010, but did not have any association with Google until the latter bought the former in 2014, merging into what is now known as Google DeepMind. This opportunity allowed Suleyman much more freedom in working with larger corporations, and it found a breakthrough when it partnered with Royal Free to detect and diagnose AKI. Suleyman went on to do interviews about the affair and in one interview he explicitly states that DeepMind, “wouldn’t be in this if we didn’t believe that in 10 years time we could radically transform healthcare” (Digital Health, 2017). The nature of such statements leaves the general public wondering what sort of transformations are going to be

implemented and, naturally, fearing for their own well-being and privacy due to not fully understanding the intricacies of the situation, especially involving artificial intelligence. These feelings of fear are further exacerbated by articles claiming that artificial intelligence is planning on being used. An article published in 2015 titled *Documents detail DeepMind's plan to apply AI to NHS data in 2015* writes that the ethics application submitted by DeepMind expresses the aim of "using machine learning to improve prediction of acute kidney injury and general patient deterioration" (Lomas, 2015). A decision tree falls within the realm of machine learning and is actually a form of supervised learning, however in the case of the NHS, it is more appropriate to refer to it as something akin to a flowchart. In fact, the legal investigation conducted by Linklaters LLP emphasizes this point, "The NHS AKI algorithm itself consists of a simple and deterministic decision tree based on a limited number of input variables relating to the patient's creatinine results, and age. It would be trivial for anyone with even basic programming skills to implement the NHS AKI algorithm. Without intending any disrespect to DeepMind, we do not think the concepts underpinning Streams are particularly ground-breaking. It does not, by any measure, involve artificial intelligence or machine learning or other advanced technology" (Linklaters LLP, 2018, pg. 23). The issue here is that the general public, understandably, does not understand the nuances of artificial intelligence. Using terms like machine learning and AI can mislead the general person because they automatically associate these words with a sort of futuristic dystopian world in which humans do not have control over the things they ought to have control of.

The location of the hospitals of the Royal Free Trust are also of particular interest since they are located in North London, where there is a lot of deprivation and inequalities. Conducting such research in these areas gives rise to safety concerns of minorities and

African-American populations, since they have historically been treated unfairly. However, the partnership between DeepMind and the Royal Free was not a calculated move with racially motivated intentions. In fact, Suleyman himself states that the offer came about during a conversation over coffee with the associate medical director (Digital Health, 2017). Furthermore, as stated in the section on NHS hospitals, NHS trusts should have a research commitment, so DeepMind partnering with the Royal Free meant partnering with a corporation that shares similar interests. The Information Commissioner's Office, in 2017, ruled that the data-sharing agreement between the two failed to comply with data protection laws (Shead, 2021). However, a year later, the legal investigation done by Linklaters concluded that they had no reason to suspect that patients would be at risk of their own security and wellbeing. Linklaters writes, "We have seen nothing to cast doubt on the safety and security of the patient information used in Streams. There are systems and controls used to protect patient information. The teams at both the Royal Free and DeepMind clearly understand the confidential and sensitive nature of health information and act accordingly" (Linklaters LLP, 2018, pg. i). The only downfall is that the Royal Free did not properly communicate with its patients regarding their personal information which raised suspicions. The process was still legal, just not communicated effectively. Linklaters recognizes this downfall, "We have reviewed the use of Streams and the remedial steps taken by the Royal Free. We consider the Royal Free's use of Streams is lawful. However, the audit has identified some areas in which further improvements should be made. For example, the Royal Free needs to do more to tell patients who visit its hospitals about how their information will be used. The Royal Free has accepted our recommendations and is working to implement them" (Linklaters LLP, 2018, pg. i).

The final issue is that of DeepMind having access to years of medical records and storing up to eight years of records in Streams. In light of their intentions of developing a method to diagnose AKI, having access to years of medical records does not seem to be particularly useful. AKI occurs when creatinine levels are either too high or too low, it is not something where years of medical history always need to be consulted in order to make a diagnosis. Again, this plays into the distrust of scientists and large corporations by the general public because it gives the people more reason to suspect foul play. Linklaters addressed this discrepancy in their investigation, writing that access to years of medical records is justified for two reasons. The first reason is that Streams does not only detect AKI but also provides details on a patient's previous medical history. This is significant because there are some conditions in which a patient might need extra care, "For example, if the patient has had a nephrectomy (removal of a kidney) or diabetes, they are more likely to be a priority if they trigger an AKI alert. Similarly, knowing the patient suffers from other conditions, such as kidney stones or hyperkalemia (elevated potassium levels), will help the management of the patient" (Linklaters LLP, 2018, 2). With it established that it is in the best interest of the patient for Streams to have access to their prior history, the question of such a long period of time is still left unanswered. In the investigation, Linklaters reveals that there is no current retention period for confidential information in Streams. Furthermore, this same information is kept for longer in other systems belonging to Royal Free that have not been specified. Linklaters states that it is not a matter of just Streams having access to this information, but also other systems belonging to the Royal Free. In addition, it recommends that Royal Free should set an upper-bound on the age of information, "The information is currently approximately eight years old, a retention period that is within the guidelines from the Department of Health. However, the Royal Free should consider this issue in

detail and set an upper limit on the age of the information contained in Streams" (Linklaters LLP, 2018, pg. 2). Articles published online about the massive access to confidential data by DeepMind were extremely skeptical of the company's intention. One article titled *Revealed: Google AI has access to huge haul of NHS patient data* expresses the concerns of MedConfidential, a health data privacy group, writing that "This is not just about kidney function. They're getting the full data" (Hodson, 2016). This is not the case, as shown by the legal investigation by Linklaters. The access to years of confidential information was intended by DeepMind to be in the best interest of the patient.

Conclusion

The partnership between Google DeepMind and the Royal Free is one that was filled with controversy and much misunderstanding by the general public as to what was actually going on. Distrust of scientists and large corporations by the public and the historical treatment of African-Americans and minorities added to the cause for concern, especially taking into account that the research was taking place in the deprived areas of North London. The comments made by Mustafa Suleyman in his interviews added to this perpetual loop of misunderstanding due to him using terms such as artificial intelligence and machine learning, many of whom do not know the difference.

The most recent investigation done by Linklaters arrived at the verdict that there was no foul play involved and that DeepMind is not guilty of violating data protection laws. In order to prevent these misunderstandings in the first place, Linklaters suggested that the Royal Free should have communicated more effectively with its patients in terms of what their personal information was going to be used for. Furthermore, this is a classic case of an ambitious entrepreneur who has been caught in their own aspirations that has actually played to their

weakness. Suleyman envisioned his company to be one that is on the frontier of groundbreaking artificial intelligence research and this has set a precedent for everyone else to associate DeepMind with AI research. Suleyman should have made it clear that, at the end of the day, Streams did not use any sort of artificial intelligence research and implemented a simple decision tree. These two resolutions could have prevented much backlash from the public and possibly allowed DeepMind and Royal Free to have made much more significant progress.

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