Imagine/project how A.I. will improve people's lives by 2035. Propose the role of natural Scientists in making this happen.

Over the entire history of mankind there have been only a select few who have greatly improved the lives of many. However, with the creation of AI., “computer systems able to perform tasks normally requiring human intelligence” [1], many more ‘minds’ can be created which can be used to solve many specific problems more quickly.

By 2035, I believe AI will greatly improve people’s lives in the field of health, more specifically in the prevention of disease and the extension of human life. For example analysing people’s DNA to identifying any variants in their DNA which has been identified as pathogenic, allowing clinicians to take preventative action to the reduce the risk or severity of the disease. The technology to identify pathogenic genes already exists in systems like DeepVaraint, a project developed by Google that “uses a deep neural network to call genetic variants from next-generation DNA" [2]. Genetic variants are differences in an individual’s DNA compared to a reference sample [3]. AI could also be used to suggest changes to diet and lifestyle using data provided by the user (e.g weight). It has also been suggested that AI could be used in to make medical decisions with much higher accuracy and greater speed than doctors (Guo and Li, 2018). This would result in better advice being given earlier and would relieve some of the stress doctors face and reduce the ever increasing strain on the NHS. AI like this may also be implemented into low income countries, where there are shortages of skilled healthcare professionals [4]. This has the potential to save many lives.

These predictions, however, are based on the assumption that the improvement in the power of computational devices e.g Graphics Processing Units will increase at the same rate now or at an increased rate, as anticipated by Moore’s law. Gordon Moore, a co-founder of the semiconductor chip maker Intel, suggested that every year twice as many transistors could be placed on a chip although he later revised this to doubling every 18 months [5]. Moore’s Law is beginning to deteriorate in the field of Graphical Processing Unit (GPU) production, meaning there will be less of an increase in the number of transistors per integrated circuit and thus less of an increase in the performance of GPUs with each generation [6]. This is a problem, as AI relies heavily on GPUs, for training. Thus if the performance of GPUs drops so will the speed at which AI is trained and therefore the rate of

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[1] ‘Artificial Intelligence | Definition of Artificial Intelligence in English by Oxford Dictionaries’, accessed 16 January 2019, https://en.oxforddictionaries.com/definition/artificial_intelligence.
[2] *DeepVariant*, Python (2017; repr., Google, 2019), https://github.com/google/deepvariant.
[3] ‘Genomic Variation Program’, National Human Genome Research Institute (NHGRI), accessed 11 January 2019, https://www.genome.gov/10001551/genomic-variation-program/.
[4] Jonathan Guo and Bin Li, ‘The Application of Medical Artificial Intelligence Technology in Rural Areas of Developing Countries’, *Health Equity* 2, no. 1 (1 August 2018): 174–81, https://doi.org/10.1089/heq.2018.0037.
[5] ‘Moore’s Law | Computer Science’, Encyclopedia Britannica, accessed 27 December 2018, https://www.britannica.com/technology/Moores-law.
[6] Akhil Arunkumar et al., ‘MCM-GPU: Multi-Chip-Module GPUs for Continued Performance Scalability’, in *Proceedings of the 44th Annual International Symposium on Computer Architecture - ISCA ’17* (the 44th Annual International Symposium, Toronto, ON, Canada: ACM Press, 2017), 320–32, https://doi.org/10.1145/3079856.3080231.

AI progress by 2035. GPU companies, including Nvidia, are developing new designs to further increase the performance of GPUs [7].

One way that natural scientists will help to improve people's lives by 2035 is by providing computer scientists with a large volume of high quality data which, in the context of AI, is "fit for [its] intended uses in operations, decision making, and planning" [8]. This is important as if an AI system is to be successful; a large volume of high quality data is needed to construct more accurate models and thus be more helpful. A notable example of an AI system failing due to low quality data is IBM's Watson, which suggested incorrect and possibly dangerous treatments for cancer patients. It "suggested a cancer patient with severe bleeding be given a drug that could cause the bleeding to worsen" (Chen, 2018). The data used was synthesised by only a few specialist doctors, instead of using large amounts of real world data. Natural scientist could facilitate machine learning by providing computer scientists with the data from many of their studies.

Another way natural scientists will help makes this happen is by studying and modelling biological systems which AI algorithms could be modelled on. An example of this already in use today is artificial neural networks (ANNs). ANNs are based on the structure of neurons within animal brains, where neurons receive impulses through dendrites, which are attached to the cell body. The signals received can be of two types; inhibitory or excitatory. Inhibitory signals prevent the neuron from firing and excitatory signals promote the neuron to fire. Whether a neuron fires is dependent on the sum of all the signals received. If it does fire an action potential is sent through the axon. The axon splits into numerous axons at an axon terminal which connects to other neurons respectively. ANNs work in a similar way. Each node in an ANN receives inputs from other nodes (similar to dendrites). Each of these inputs has a weighting assigned to them (similar to inhibitory or excitatory signals), which are then modified during training to produce a more accurate output (it determines the importance of that input). The node then applies a function to the weighted sum of the inputs to determine if the node should fire. ANNs have been used in the field of AI with great success. For example an ANN was used to predict heart attacks from electrocardiograms with a diagnostic sensitivity of 96.0% using the ANN, 22.7% higher than the physicians in the study [9].

More biological systems that may allow for more powerful AI are being researched and in recent news, researchers at Keio University used *Amoeba* to solve approximate solutions to the Travelling Salesman Problem (TSP) [10]. The TSP is an optimization problem, in which a computer must find the shortest distance between N points and return to its starting point. The *Amoeba* used was *a Physarum polycephalum*, a type of slime mold that is able to extend its body to maximise the amount of nutrients it can absorb. In the experiment the *Amoeba* was placed within a chip with 64 channels surrounding it on top of a nutrient rich

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[7] Arunkumar et al.
[8] Joseph M. Juran and A. Blanton Godfrey, *Juran's Quality Handbook* (McGraw Hill, 1999).
[9] Jayesh Ahire, *Artificial Neural Networks: The Brain behind AI* (Lulu.com, n.d.).
[10] Zhu Liping et al., 'Remarkable Problem-Solving Ability of Unicellular Amoeboid Organism and Its Mechanism', *Royal Society Open Science* 5, no. 12 (n.d.): 180396, https://doi.org/10.1098/rsos.180396.

agar plate. The 64 channels were divided into lettered groups (A - H) that represent the city and assigned a value from 1 - 8 in within that group. The number represents the order that the city should be visited. A neural network is used to ensure a valid solution is found. For example, once a particular ‘city’ has been visited, that group of channels are illuminated to prevent the *Amoeba* from visiting it again. The neural network also increases the probability for a certain channel to illuminate if it represents a trip to a city with a comparatively longer distance. The researchers were able to solve the TSP for up to 8 cities, which has a possible 2520 routes. This is impressive in of itself, but the fact that the time to solve the problem increased linearly is pioneering, as the TSP is an NP hard problem. That means as the number of cities increases the time taken for a computer to calculate the route increases exponentially. This may encourage greater research into the *Amoeba* to understand how it solves the problem and how this can be implemented in computers. If research like this continues then there is a possibility more powerful AI algorithms can be developed that are based on nature.

Overall, AI has the potential to improve a vast number of lives by 2035. In my opinion its impact will be felt the most in health and more specifically disease prevention. By 2035, I believe that the a significant proportion of people in high income countries will have an AI health assistant and that hospitals in these countries will use AI as an aid to doctors when making decisions. However, I remain sceptical that AI will have as big an impact by 2035 in lower income countrie; the infrastructure and expertise required to implement AI systems are not available in these countries currently and the time taken to implement them could exceed 16 years. I believe that natural scientists will have a huge role in making this happen. They will not only provide data to computer scientists to create the AI, something of huge importance but they will also provide computer scientists with novel ways to create AI, leading to potentially huge breakthroughs.