20th May 2020
APPG AI Evidence Meeting

BIG INNOVATION CENTRE

Public Health

How can AI help in the fight against COVID-19?

PARLIAMENTARY BRIEF

Public Health: How can AI help in the fight against COVID-19? *is a* Parliamentary Brief based upon the All-Party Parliamentary Group on Artificial Intelligence (APPG AI) Evidence Meeting held online on the 6th of April 2020.

This Evidence Meeting was chaired by **Stephen Metcalfe MP** and **Lord Clement-Jones CBE**.

We would like to express our appreciation to the following people for their evidence:

- **Professor Tim Spector**, Professor of Genetic Epidemiology at King's College London and Honorary Consultant Physician at Guys and St Thomas' Hospitals
- **Chris Harbron**, Expert Statistician within the Methods, Collaboration and Outreach (MCO) Group of the Biostatistics Function, Roche
- **Professor Shannon Vallor**, Baillie Gifford Chair in the Ethics of Data and Artificial Intelligence, Futures Institute, The University of Edinburgh
- **Dr Richard Dybowski**, AI Researcher, St John's College, University of Cambridge
- **James Kingston**, Deputy Director, HatLab
- **Adam Ricco**, CEO, Critical Future

Big Innovation Centre is the appointed Secretariat for APPG AI

- CEO, **Professor Birgitte Andersen**
- Rapporteur: **Dr Désirée Remmert**

The video recording of the Evidence Meeting can be found on our websites.

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PARLIAMENTARY BRIEF

Public Health:
How can AI help in the fight against COVID-19?

APPG AI Sponsors

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Introduction – Mitigating the effect of Covid-19 with the help of AI

The APPG AI held an extraordinary Evidence Meeting ***"Public health: How can AI help in the fight against Covid-19?"*** on April 6th, 2020. The session was moved from Parliament to be hosted as a webinar due to the Covid-19 lockdown. The online meeting had more than 150 attendees.

The Evidence Meeting was a response to the urgent need of policymakers to learn about the benefits and challenges of applying AI technologies to mitigate the effects of the Covid-19 pandemic. Specifically, the evidence session addressed the question of how data-driven technologies can support the development of pharmaceutical and non-pharmaceutical methods to contain the spread of viruses and to prevent epidemic diseases in the future.

As countries race to implement methods to eliminate the Covid-19 virus, great hopes are put into data-driven technologies to combat the disease. AI could be supportive in areas as diverse as the development of antiviral drugs and vaccines, in tools that support epidemiological methods of assessing the distribution of viral infections, as well as those that detect the emergence of new types of viral infections before they can become endemic in human populations.

However, as with any data driven tools and especially those that depend on sensible biomedical data and other types of personal highly identifiable data, legal, social and ethical considerations must be made to guarantee the protection of individuals' privacy and to maintain public trust. In the case of the Covid-19 global health crisis, the urgency with which these complex questions must be resolved to harness the benefits that data-driven tools can provide in an optimal way calls for a transparent dialogue between experts and policymakers

The APPG AI Evidence Meeting convened a group of experts in epidemiology, machine learning, data science, and AI ethics:

- **Professor Tim Spector**, Professor of Genetic Epidemiology at King's College London and Honorary Consultant Physician at Guys and St Thomas' Hospitals
- **Chris Harbron**, Expert Statistician within the Methods, Collaboration and Outreach (MCO) Group of the Biostatistics Function, Roche
- **Professor Shannon Vallor**, Baillie Gifford Chair in the Ethics of Data and Artificial Intelligence, Futures Institute, The University of Edinburgh
- **Dr Richard Dybowski**, AI Researcher, St John's College, University of Cambridge

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APPG AI Evidence Meeting - webinar 6th of April 2020

Parliament has appointed Big Innovation Centre as the **Secretariat of the APPG AI**, led by **CEO, Professor Birgitte Andersen**. The Project Manager and Rapporteur for the APPG AI is **Dr Désirée Remmert**.

The expert panel addressed the following questions in their evidence and the subsequent discussion:

1. How can AI technologies contribute to the early detection of an epidemic?

2. How can AI contribute to the rapid development of vaccines against new types of viruses in the future?

3. How can AI support the early diagnosis of viruses and in taking measures that will prevent viruses from spreading?

In the following, the above questions will be critically discussed in the context of different technologies that assist in the containment and prevention of viral infections. The brief will first address AI technologies in non-pharmaceutical measures to contain Covid-19. It will then discuss how AI can contribute to the creation of anti-viral drugs and vaccines, and then address its potential for detecting viral infections in the early phases and thus preventing the emergence of global pandemics in the future. The brief will conclude with evidence-based recommendations for policymakers.

1. AI-driven strategies in epidemiology to track and contain the transmission of Covid-19

Contact tracking and the monitoring of symptoms are epidemiological strategies for mitigating the impact and spread of viral infections that can be effectively facilitated by AI technologies. However, many of these AI-driven apps require vast amounts of citizens' personal data to deliver reliable results. For this reason, the benefits of these technologies must be carefully weighed against the risks that the collection of sensitive personal data such as location and biomedical data imply for the user.

Tim Spector, Professor of Genetic Epidemiology at King's College London, presented preliminary results of the recent introduction of the **Covid Symptom Tracker**, an app that was designed by health experts at King's College London and Guys and St. Thomas Hospitals in cooperation with the health science company Zoe Global, a spin-out from King's[1]. The Covid Symptom Tracker has gained considerable traction within a short time. With more than two million users who regularly report the state of their physical health**, the tracker promises to deliver reliable predictions not only about transmission trends but also provide important insights into the spectrum of Covid-19 symptoms and their distribution among different demographics**. Further, the collected data which is anonymised and then shared with the responsible NHS units allows for reliable predictions of required health services several weeks in advance.

Whereas **data-driven symptom tracking applications** have so far had a **positive impact on efforts to control the spread and gravity of Covid-19,** other AI supported applications have received criticism for their **alleged inefficiency** in helping containing the spread of the virus as well as for the **potential risks** that the **relatively unrestricted access to highly identifiable personal data at a large scale** could mean to the individual as well as to the whole of society.

Moreover, recent research has shown that **to provide reliable results any contact tracing app would have to be adopted by 56% of the overall population or 80% of all smart-phone users in the UK**[2]. The success of a contact tracing app relies on its comprehensive use throughout all demographics. This however would presuppose equal access to mobile devices and, as outlined in a recent paper on the ethics of contact tracing, "well-founded public trust and confidence"[3]. Public trust, the authors recommend, can be obtained by establishing

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[1] https://www.kcl.ac.uk/news/new-symptom-tracking-app-aims-to-slow-spread-of-coronavirus. Accessed 1st May 2020.
[2] Hinch et al. (April 2020). "Effective Configurations of a Digital Contact Tracing App: A report to NHSX", pp.17-18.
[3] Parker et a. (April 2020). "The ethics of instantaneous contact tracing using mobile phone apps in the control of the COVID-19 pandemic", p. 7.

transparent oversight of the technology regarding data ownership and use (ibid.).

Shannon Vallor, Baillie Gifford Chair in the Ethics of Data and Artificial Intelligence at the Futures Institute, The University of Edinburgh, **warns against the security risks that location tracking apps imply while, according to preliminary reviews, only having a marginal impact on containing Covid-19**. Vallor draws on the example of Singapore to illustrate the limited success of contact-tracing apps even in countries where trust in the government is relatively high:

> *"Singapore's aggressive digital contact tracing campaign did not prevent a recent resurgence of the virus from contacts unable to be identified by their app, which never gained even a third of the approximately 60-75% level of citizen adoption necessary to enable lasting suppression or containment."*

The app TraceTogether, launched by the Singaporean government in March, was initially downloaded by 1.1 million users, almost a fifth of the country's population[4]. However, grappling with concerns around data privacy and susceptible to a relatively high rate of false positives due to its Blue Tooth technology the app has proven controversial and its efficiency in limiting the spread of Covid-19 has since then been questioned (ibid.). A recent report on by the Ada Lovelace institute further warns of issues around transparency and accountability that might occur with the use of contact-tracing apps:

> *"As with any technology, digital contact tracing will be vulnerable to all forms of fraud and abuse – from people using multiple devices, false reports of infection, to denial of service attacks by adversarial actors."*[5]

From this follows that **data-driven applications that operate with vast amounts of sensitive personal data of users create considerable challenges around data security, accuracy, and accountability which have to be weighed against the potential benefits these technologies can bring** to the fight of viral diseases like Covid-19.

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[4] https://qz.com/1842200/singapore-wants-everyone-to-download-covid-19-contact-tracing-apps/ Accessed 30th April 2020.
[5] Ada Lovelace Institute (April 2020): *Exit through the App Store? A rapid evidence review on the technical considerations and societal implications of using technology to transition from the COVID-19 crisis*, p. 26.

2. AI in the development of diagnostic tools and pharmaceutical measures to contain the spread of Covid-19

APPG AI Evidence Meeting - webinar 6th of April 2020

The potential dangers of the AI-based non-pharmaceutical public health measures described in the previous section centre primarily around privacy concerns and the risk that tracking technologies could be abused for surveillance purposes. However**, it is mainly the scarcity of reliable data as well as inaccuracies and biases within the available data that complicate the application of AI-technologies in the development of diagnostic tools, vaccines, and anti-viral drugs in the case of Covid-19**. Chris Harbron, Expert Statistician within the Biostatistics Function at Roche asserts:

> *"Data is the underlying driver behind any AI or modelling activities and as such is a highly valuable commodity in ensuring informed decision making. Clearly, the volume of data is of key importance, which within this context speaks to the criticality of continually increasing the number of tests performed and rapidly procuring a reliable antibody test."*

Testing data would ideally be supplemented with softer data such as patients' self-reported symptom records that might lack the veracity of systematically assessed medical data, but which would deliver a more comprehensive picture of Covid-19.

The lack of methodological coherency in the collection of clinical and non-clinical data since the onset of the pandemic compromises the comparability and accuracy of the available research data and may distort modelling results. **Uncertainties around the properties and behaviour of the virus additionally complicate predictive modelling**.

Harbron explains:

> *"Any modelling process, including the choice of the underlying model itself, will be based on both explicit and implicit assumptions that will impact its outcome. This will create uncertainty in the outcome of any modelling process, especially as the choice of model will generally not be clear cut. This uncertainty both in both data and model fitting and should be reflected in the presentation of any predictions and considered in the decision making based upon them."*

Further, **certain powerful AI methods such as deep neural networks or ensembling methods are highly data-intensive and a lack of sufficient volume of data could limit or even prevent their use**. **Additionally, these complex methods are difficult to interrogate as to their decision-making process**.[6] For this reason, so Harbron, simpler models that come with the added benefit of more transparency in how the AI system generates predictions might be more suitable for working with the limited data available at this stage. Even though multiple types of AI-driven diagnostic software have been developed that claim to detect Covid-19 on CT-scans with impressive accuracy[7], a recent review of prediction models suggests that the accuracy of many AI-driven diagnostic tools might be questionable due to the inherent biases of the modelling data and lack of independent external validation:

> *"Diagnostic and prognostic models for covid-19 are available and they all appear to show good to excellent discriminative performance. However, these models are at high risk of bias, mainly because of nonrepresentative selection of control patients, exclusion of patients who had not experienced the event of interest by the end of the study, and model overfitting. Therefore, their performance estimates are likely to be optimistic and misleading"* (Wynants et al.: 9).[8]

Whereas AI-driven methods in the development of preventive and curative interventions have to overcome the challenge of data limitations in the early stages of the Covid-19 pandemic, they can make significant contributions in the analysis of medical research databases due to their ability to process vast amount of different types of data in a short time. Building upon previous research that has been shared in the medical community, Google's DeepMind division released **structure predictions of proteins related to the virus that caused Covid-19**.[9] Similarly, the Chinese tech giant Baidu made its

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[6] See Poole, David L. and Alan K. Mackworth. 2017 [2010]. Artificial intelligence: foundations of computational agents, pp. 298-308. Cambridge UK et a.: Cambridge University Press.
[7] Alibaba Cloud (March 2020). *Alibaba Cloud helps fight Covid-19 through technology*. Downloaded 1st May 2020. https://resource.alibabacloud.com/whitepaper/fighting-coronavirus-disease-2019-covid-19-with-alibaba-cloud_1555?spm=a3c0i.13983400.1687618720.2.2cad278acntmi7
https://www.med-technews.com/news/ai-tool-which-analysed-covid-19-in-wuhan-available-to-nhs/. Accessed 2nd May 2020.
https://www.delft.care/cad4covid/. Accessed 2nd May 2020.
[8] Wynants, Laura et al. (2020): 'Prediction models for diagnosis and prognosis of covid-19 infection: systematic review and critical appraisal.' *BMJ* 369: m1328.
[9] https://deepmind.com/research/open-source/computational-predictions-of-protein-structures-associated-with-COVID-19. Accessed 1st May 2020.

Linearfold[10] **algorithm available which is capable of quickly predicting the secondary RNA structure of a virus** and thus can give important clues as to how it is spreading across species.[11] At the same time, data-scientists at the London think tank Benevolent AI developed an AI **system that scanned research publication for biological processes associated with Covid-19**.[12] These could later be related to specific human genes which facilitates the search of a drug that targets these genes.

The above-mentioned early successes in the AI-supported search for anti-viral drugs and vaccines were built on **strong collaborative efforts, between and within the medical research community and international tech corporations** that combined their expertise, data, and powerful computing technologies. Further, **AI technologies can only deliver accurate results when they are run with adequate quantities of reliable data**. For this reason, it emerged from the evidence given at the meeting**, systematic and designed testing is of vital importance to the successful development of anti-viral drugs and vaccines for Covid-19**. The expert speakers at the APPG AI evidence meeting echoed the call for strong interdisciplinary and international collaboration and encouraged an increased collection and flow of relevant data to harness the full potential of the available AI technologies in the fight against Covid-19.

[10] Huang, Liang et al. (2019): "LinearFold: linear-time approximate RNA folding by 5'-to-3' dynamic programming and beam search". *Bioinformatics*, 35: i295–i304.
[11] https://www.technologyreview.com/2020/03/11/905366/how-baidu-is-bringing-ai-to-the-fight-against-coronavirus/. Accessed 1st May 2020.
[12] https://www.nytimes.com/2020/04/30/technology/coronavirus-treatment-benevolentai-baricitinib.html. Accessed 1st May 2020.

3. How can AI contribute to the prevention of pandemics in the future?

The evidence presented in this APPG AI session demonstrates that AI technologies play a pivotal role in epidemiological strategies of containing the virus as well as in advancing biomedical research methodologies and clinical diagnostics that facilitate knowledge about the behaviour and properties of Covid-19. Beyond these application areas**, AI technologies have proven crucial in the early detection and tracing of viral strains in human populations before they can develop into epidemics or pandemics**. **By analysing online media, travel data, and government documents, they pick up early clues of an emerging epidemic and can estimate the characteristics and spreading trends of viruses.**

Further, new AI-based applications can **assist citizens in taking measures to prevent** a resurgence of Covid-19 after lockdown restrictions have been loosened. **However, for epidemic prediction and prevention technologies to provide reliable references to researchers, policymakers and citizens, they must be able to draw on a large quantity of different data sources** to draft a comprehensive picture of the characteristics of a new virus. Data sharing and collaboration among members of the tech and research community is therefore indispensable.

In late December 2019, an outbreak risk software developed by the Canadian AI-start up BlueDot first reported a cluster of unusual pneumonia cases that had allegedly emerged in the central Chinese city Wuhan.[13] The software draws on a combination of AI and ML to analyse information from multiple types of international online sources to detect and trace the emergence of new viral diseases globally. Whereas BlueDot's AI-driven methods can give clues about the outbreak of new viral diseases and anticipate their dispersion and impact, the open-source project Nextstrain provides genomic analyses of pathogens and creates genetic maps that trace the spread of virus as well as the mutations they accumulate to their genomes.

Knowledge about these mutations can give important insights into the "spatial spread, introduction timings and epidemic growth rate"[14]. However, the data-intensive methods applied by BlueDot as well as open-source projects like NextStrain are only possible with the international collaboration of experts and the sharing of relevant data. **The need for close collaboration and access to relevant data has been stressed repeatedly during the**

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[13] Bogoc, Isaac I. et al. (2020): 'Pneumonia of unknown aetiology in Wuhan, China: potential for international spread via commercial air travel'. *Journal of Travel Medicine* 00: 1-3.
The Lancet. April 2020 (Vol. 2): 'COVID-19 and artificial intelligence: protecting health-care workers and curbing the spread'.
https://www.wired.com/story/ai-epidemiologist-wuhan-public-health-warnings/ accessed 3rd May 2020
https://diginomica.com/how-canadian-ai-start-bluedot-spotted-coronavirus-anyone-else-had-clue Accessed 3rd May 2020.
[14] https://nextstrain.org/#philosophy Accessed 4th May 2020.

APPG AI evidence session. David Bray, Director of the GeoTech Center of the Atlantic Council and expert observer at the meeting stresses:

> *"the only one way through this crisis is through it together, […] We have to figure out a way to work across countries, we have to figure out a way to work across sectors - not just with the immediate response. […] I think there is a huge opportunity and we should consider how we could work across sectors and nation's […] to figure out which test's specificity and sensitivity is working the best, which therapies are working the best and if the virus is mutating. Are we seeing multiple strains going across the world that we're thinking is just one?"*

The strength of collaborative efforts in finding methods to manage and prevent the spread of viral diseases like Covid-19 has been demonstrated by the success of hackathons and other community-led projects that harness the potential of citizen science. Successful examples of such collaborative projects are the Covid-19 Open Research Dataset Challenge by Kaggle, The Global Hack organised by the Estonian start-up community, and WirVSVirus, a hackathon organised by the German government in cooperation with the local tech community. James Kingston, Deputy Director of HatLab emphasises the value of civic technology in the fight against Covid-19:

> *"We set up our own hackathon, 'Hack from home', [..] where we observed three strains of work: the first is 'citizen science', which is empowering individuals to contribute their personal data, rather like the ZOE application. The second is 'care in the community' which is empowering individuals and ensures that with or without governmental authorities, vulnerable people can be cared for using personal data to triage care and their personal needs. The third is 'mass coordination' through applications that enable people to adjust their behaviour to the needs of the day. We saw this especially relevant in enabling the loosening approach where people can start going back to work"*

AI-driven technologies designed in collaborative projects that combine expert knowledge and citizen science can contribute importantly to the prevention of a resurgence of Covid-19 as well as in averting another pandemic. They can do so by **detecting the emergence of new viruses, anticipating their dispersion, and by assisting citizens in taking necessary precautions in their everyday life to contain their transmission**.

However, as the evidence provided at this meeting has illustrated, **none of these efforts would be effective without the collaboration** of the scientific and tech communities, citizens, and governments in the sharing of expertise and relevant data.

4. Policy recommendations

The evidence presented at the APPG AI session points to crucial areas that need regulation to ensure that AI technologies are applied responsibly and in the interest of the collective good in the fight against Covid-19. It further highlights the need for the creation of a collaborative environment in which knowledge and relevant data can be securely shared to facilitate AI-driven methodologies in the fight against viral diseases. The evidence provided suggests that an independent oversight body would be essential in the safeguarding of citizens' data and the preservation of public trust.

Data Sharing

While citizens' privacy must be maintained and protected, **mechanisms that make aggregated anonymised data publicly available** would positively **contribute to research collaborations and facilitate the swift peer-reviewing** of academic publications. Having high quality data available in the onset of an epidemic would **significantly improve the accuracy of scientific modelling** in epidemiological and bio medical research and thus **improve pandemic-response measures**.

Data Safety

Any data-driven method in the fight against Covid-19 relies on the **strengthening and maintenance of public trust**. Policies must ensure that **citizens' personal data is governed responsively** and that the use of symptom-tracking or contact-tracing apps that collect sensitive personal data will not subject them to any short-term or long-term risks. Legal structures like **data trusts** that grant users the **opportunity to save and share their data in a fair and ethical way** cannot only contribute to the **empowerment of citizens** but can also be of **great benefit to the research community**.

Collaboration

Collaborative projects have yielded **important results in the search for preventive and curative methods** in the fight of Covid-19. To harness the full potential of knowledge and data in the future, **government regulations must facilitate the formation of international and interdisciplinary collaboration of experts, the sharing of relevant data** as well as the **engagement of the public in citizen science projects**.

Data Accountability & Accreditation

In order to **maintain public trust** and to guarantee the **fair and ethical application of any data-driven public health measures** an **oversight body should be established**. This body should be multi-disciplinary and include representatives from vulnerable groups. It will **oversee the quality and governance of data** and **guarantee that data-driven measures in the pandemic response will serve the public good**. It will also **check and approve (or accredit) new data-driven tools** and will be granted the **authority to discontinue programs**. **Transparency and responsiveness to the public** must be maintained during the entire process.

5. Evidence

Professor Timothy Spector, Professor of Genetic Epidemiology, King's College London

APPG AI webinar 6th of April 2020

I would like to give you a real life example instead of a theoretical one: Just over two weeks ago when my department at King's College London was being closed down, we decided to come up with an idea of how we could look at Covid-19 using our skills as well as our twin data base. We came up with an app which could quickly capture research participants in real time and work out what symptoms they were having and track those over the next weeks and months. This enabled us to get a real picture of what was going on and we could link these results to our other data.

I went to a local biotech company we have been working with, ZOE Global, which are experts in data science and AI that we have been working on nutrition with. They said: "Yes, let's do an app". The whole company got shut down and worked on this app pro bono. In three and a half days ZOE Global produced an app that we then advertised on social media and got out there. Amazingly, it went viral and within 48 hours we had a million people signed up and using it. It was the number one health app in the UK. After two weeks, we have 2.1 million people as of today using this app. Most of them are tracking every single day whether they have symptoms or not and what type of symptoms. This has been an amazing act of citizen science; we have appealed to the altruism of British people to do this. They effectively create a radar in their particular areas to help the local NHS services.

We have come up with various maps that we can help the NHS with. We are also documenting the symptoms that haven't been out there. Officially you only have Covid-19 -according to the NHS and the Public Health England Guidelines - if you have basically two symptoms. We know that at least a dozen symptoms are important and we highlighted one – the lack of taste and smell – that was the most specific one based on 1.5 million people.

We have already got some results. We have done very well all over the country. We are getting data back from all over the country and we have produced these maps. On our website we are providing up to date maps of the country showing which regions are most effected, those which have relatively little disease, and we stratified these in terms of the population base. We have a good generalisable view of 20-69-year olds across the country. We obviously do not get as many older people and people who are very sick because it is app-based. We think this is an amazing tool that is already starting to give us answers.

We have not yet got any official government or NHS backing. This is only done on the base of citizen science and driven by social media. However, as we are interacting with people and tell them what their results are, they can see how their local area is doing. If you go to these maps, you can see that they are interactive, you can see exactly how many people in your district or in your borough of London are reporting and what percentage they constitute.

Every day we are exporting the data in a secure way to the NHS data repository called HDR UK – Health Data Research UK – and we have a data dump. The idea is that this data can be shared with researchers and local NHS regions. The NHS is getting our data and we are interacting well with some of the key ones, especially the Welsh and the Scottish offices being particularly interested in our data. Some of these maps are showing hot spots, we see a hot spot in South Wales, we also picked up areas like Liverpool that have particularly high rates, another one is in the Midlands.

All this is done with AI, our algorithms designed by our data science teams puts all the symptoms we found together, particularly the one of loss of taste and smell which until now hasn't been recognised by the government as a bona fide symptom, is the most specific one in the 30,000 or so people that have reported it – linking that also with positive viral tests.

Putting this all together, we are getting scores every day of predicted Covid-19 symptoms across the country and we think this is incredibly important data that is telling us two or three weeks ahead of time what the NHS is going to expect in the hospital because these are early and mild symptoms. We would like to

spread the word and everyone out there you are important influencers, make sure to download the app yourselves and spread it among colleagues. We are trying to get up to five million to get a true radar picture in every part of the country.

Chris Harbron, Expert Statistician (MCO), Biostatistics Function, Roche

APPG AI webinar 6th of April 2020

I would like to address four topics: Data, Uncertainty, Appropriate Methodology and Collaboration

Data

Data is the underlying driver behind any AI or modelling activities and as such is a highly valuable commodity in ensuring informed decision making. Clearly, the volume of data is of key importance, which within this context speaks to the criticality of continually increasing the number of tests performed and rapidly procuring a reliable antibody test. But once the immediate medical and operational needs are addressed, the opportunity for systematic and designed testing for surveillance and to address specific scientific questions should be taken up in a way which optimises the information that can be obtained from the tests. Additionally, supplementing this increased testing data with systematically collected softer data, for example individual symptom records, whilst of lower quality and veracity than testing data will allow integration to form a more informed overall picture

Uncertainty

In a scenario such as a pandemic there will be far more unknowns than knowns, and typically data will be sparse and subject to biases, many of which will not be obvious. Additionally, any modelling process, including the choice of the underlying model itself, will be based on both explicit and implicit assumptions that will impact its outcome. This will create uncertainty in the outcome of any modelling process, especially as the choice of model will generally not be clear cut. This uncertainty both in both data and model fitting and should be reflected in the presentation of any predictions and considered in the decision making based upon them.

Appropriate Methodology

Following from the inherent uncertainty of the situation some more complex AI/ML models are especially at risk of overfitting and can lack generalisability and transparency. Whilst complex AI may be the only solution for challenges such as functional genomics, in many scenarios with limited data, established, simpler models may be more fit-for-purpose giving more robust predictions with the advantage of greater transparency and understanding to increase their credibility and the ease of their communication.

Collaboration

The AI community has a natural affiliation with collaboration, with hackathon-style events being a regular way of working as well as having a comfort with remote working and collaboration tools. As well as tackling the immediate issue these activities also leave a legacy by acting as concentrated learning and development opportunities for participants as well a network of contacts, strengthening the UK's global position in AI well beyond the pandemic.

Recommendations

1) Increase the collection and flow of data, both through expanding testing once the immediate needs have been addressed to more designed collections to understand the disease dynamics and predict potential future outbreaks, whilst also collecting softer self-reported data allowing a more comprehensive picture to be developed.

2) Whilst maintaining patient privacy, set up mechanisms to make anonymised aggregated data publicly available to enable both collaboration and rapid peer review ensuring scientific quality and rigour is maintained.

3) Beyond this pandemic, recognise public concerns about how medical data and AI will be shared and used, and lead a public conversation around this.

Professor Shannon Vallor, Baille Gifford Chair, Futures Institute, The University of Edinburgh

APPG AI webinar 6th of April 2020

It is well established that to be effective, public health measures require broad civic cooperation and trust in government authorities—yet AI use cases for surveillance and health faced a grave ethics and trust gap in the public mind before COVID-19. AI can accelerate and amplify pandemic control in a multitude of ways, from hotspot detection to contact tracing to patient risk assessment; however, each carries substantial risks of unintended harm or abuse. Nor are these risks guaranteed to be balanced by the hoped-for benefits. Singapore's aggressive digital contact tracing campaign did not prevent a recent resurgence of the virus from contacts unable to be identified by their app, which never gained even a third of the approximately 60-75% level of citizen adoption necessary to enable lasting suppression or containment.

If the UK bypasses ethical safeguards in a rush to deploy AI tools as aggressively as possible, we risk worse outcomes—not only from overconfidence in quick technical fixes, but by sparking distrust of public health authorities among the very communities we are trying to protect. This could well undermine the efficacy of all our public health efforts, not just those targeting COVID-19. More broadly, we face a critical test of the UK's ability to secure two increasingly fragile dimensions of civic health: trust in scientific and technical expertise, and faith in the resilience and protection of democratic values in times of crisis.

My recommendations for preserving trust in public health deployments of AI are threefold:

1) Approval of AI tools for pandemic response involving sensitive or high-risk data must be selective, evidence-based, and subject to a rapid feasibility, safety and ethical risk analysis from an independent multi-disciplinary team with expertise in identifying and

safeguarding against AI's technical and social failure modes. AI's potential hinges upon quality of the data and accuracy of the assumptions used to build the model, both acute challenges with a novel phenomenon like COVID-19. Justifications for approved uses, recommendations for safeguards (e.g. encryption, anonymisation, decentralisation or aggregation techniques, data deletion schedules, and strict access and use controls fitting for the application and need), and underlying risk assessments should be open to public review and commentary. Authorities should disclose which tools are being adopted and where, how recommended safeguards will be enacted, and who is accountable for their enforcement.

2) Because any rapid approval mechanism will fail to identify or underestimate some harms, sensitive or risky deployments of AI (or other data-intensive tools) should be monitored by an independent oversight body empowered to gather evidence on their use and ongoing impact within the UK broadly and on particular groups and communities, especially the most vulnerable. This body must have the authority to publicly recommend modifications or discontinuations of AI or other data-intensive deployments determined to be insufficiently beneficial, no longer warranted by public health emergency, unjust in their effects on vulnerable populations, or otherwise detrimental to the public interest. Precedent for these functions can be found in The Privacy and Civil Liberties Oversight Board created in the US after 9/11 to monitor federal anti-terrorism efforts.

3) Transparency and responsiveness to the public must be prioritized and given visibility. In addition to independent approval and oversight mechanisms, public officials should maintain an open channel for citizens or public interest advocates to make inquiries, report abuse or unexpected harms linked to these tools, contest the legitimacy of their use, or seek remedy for unjust outcomes. Regular government summaries of and responses to these inputs should be mandated. Government openness, accountability and responsiveness to public criticism are not to be feared in a free society; they are its very lifeblood.

Dr Richard Dybowski, AI Researcher, St. John's College, The University of Cambridge

APPG AI webinar 6th of April 2020

I am an AI researcher based at Cambridge University, and have been in the field for over 25 years. In fact, I was the first to promote the use of machine learning for infectious diseases. The main focus of my work continues to be the application of AI to medicine, including the development of methods to support doctors' decision-making. As my first degree was in chemistry, I have also returned to the application of AI to chemistry, particularly where medicine and chemistry come together. I am currently involved with three research projects in response to COVID-19: (a) policy optimization for outbreaks in developing countries; (b) drug-drug interactions with antiviral drugs; and (c) Bayesian networks in the context of COVID-19.

I will give evidence in two areas; namely, the use of AI to support clinical decisions, and AI for drug discovery.

1) The WHO has listed the probability of various symptoms if a person has COVID-19; for example, they have an 88% chance of fever and 68% chance of a persistent dry cough. But how can information be combined correctly to support clinical decision making? For example, what is the probability of COVID-19 if a persistent cough is present but fever is absent? And what if they also had an antibody test result that is not 100% reliable? Such questions can be can be answered correctly by using a simple but powerful mathematical expression called Bayes' Theorem, which can overcome cognitive bias in clinicians. And this calculation can be implemented using a Bayesian network, a technique that has been in the AI tool chest for over 25 years.

   A joint Chinese-US group developed an AI system to predict acute respiratory distress syndrome (ARDS) from a set of observed features, but a drawback of their approach

is that it does not allow for the possibility that some information about a patient may not be immediately available, such as a lung CT scan. In contrast, a Bayesian network can handle partial information. Therefore, what needs to be built, from both published and patient data, is a single Bayesian network for health workers that brings all the relevant attributes together. This would allow predictions regarding patient severity to be made in a sound manner with whatever information is currently available for a patient. What's more, such a system is transparent, and it can guide the user as to what is the most informative feature to next pursue.

2) Developing new vaccines takes time, and they must be rigorously tested and confirmed to be safe via clinical trials before they can be routinely used in humans. Because of the anticipated long delay with having an effective and safe vaccine, a number of alternative non-vaccine therapies are being considered. One approach is to search through all the approved pharmaceutical drugs available and predict which of these will interfere with the virus; for example, by blocking the virus's spike protein. In principle, such a prediction can be based on the 3D shapes of the drug and target protein. DeepMind's AlphaFold can predict the 3D structure of a protein from its amino-acid sequence, and DeepMind has recently released structure predictions of several proteins associated with the COVID-19 virus.

   The idea of using AI for drug discovery for diseases such as cancer has been explored for the past three years, but those methods that utilise the 3D shapes drugs and proteins, such as AtomNet, should now be applied to discover which pharmaceuticals can be re-purposed as antivirals for the coronavirus. There are challenges given that the target proteins are new, but there are ways of handling these challenges

James Kingston, Deputy Director, HatLab

APPG AI webinar 6th of April 2020

In recent years, artificial intelligence has driven a wave of innovation in health and medicine. In face of the global pandemic, attention has turned therefore to the utility of AI in aiding the struggle against Covid-19.

In fighting the coronavirus, A.I. techniques have been applied in areas including:

1) Medical Imagery: scanning, imaging, analysing parts of the human body to help identify to aid diagnosis and treatment of covid symptoms

2) Drug Discovery: identifying, developing and scaling new treatments and vaccines at speed.

3) Public health: developing and deploying technology tools and applications that seek to promote public health

Public Health focus

We wish to focus on uses of AI in public health. Whilst there may be great benefit in using such tools, the use of A.I. driven technology in the public health domain has been subject to scrutiny amongst policy makers, academics, health authorities and the general public.

With A.I. systems requiring vast quantities of data, such scrutiny has often focussed on the privacy of the personal data that is collected, stored and analysed by systems that aim to promote public health.

Many raise the prospect of a conflict between promoting public health on the one hand, and maintaining privacy rights on the other.

We believe that there does not need to be a contradiction between public health and personal privacy - that public health can be assured with privacy maximising methods. In particular, we highlight the opportunities offered by technologies like the HAT Microserver, which enables individuals to own and control their personal data. This creates the opportunity to empower citizens and communities to use their personal data to fight the spread and social effects of the virus.

Civic Response

It is crucial that civil society is mobilised to fight the pandemic. Around the world, recent months have seen an unprecedented and multilateral collaboration between academics, business people, responsible citizens and government bodies.

The tech sector has been very active in this civic response. Example initiative include: hackathons (an example here being HAT-LAB's own 'Hack From Home' over 4th and 5th April, open source collaboration projects (such as the Just One Giant Lab project which aims to develop and test applications, tools, and processes to fight the virus) and university research driven technology development (such as King's College London's ZOE symptom tracking application)

Empowerment and trust as key themes of Civic Tech

For technology to empower citizens and communities to fight Covid-19 on their own terms, it is crucial that we give people the technological tools to make positive contributions - and ensure that people can trust in the technology that serves them.

Hence our emphasis on 'Civic Tech': trustworthy technology tools and applications that are built to empower citizens so that they can mobilise for the public good.

In the context of COVID-19, Taiwan has been a flagbearer for civic technology through. With a trustworthy and empowering technology ecosystem that includes bottom-up information sharing, "hacktivism", strong public-private partnerships, and participatory collective action, Taiwan has positioned itself as a leader in tech for democracy. The comparatively effective containment of the virus can be attributed to the success of these transparent and consent driven set of coronavirus initiatives.

A.I as an enabler of 'Civic Tech'

Artificial Intelligence can be an enabler of Civic Tech - especially in a time of crisis. This was highlighted during the HAT-LAB's Hack from Home hackathon where participants were invited to collaborate and submit solutions that corresponded to 3 streams on the axis of Civic Tech: Citizen Science; Care and The Community; Mass Coordination.

The final project submissions from the hackathon exemplify the use of A.I. in building Civic Tech and we can identify three notable submissions which proposed to leverage current A.I. capabilities to build civic focussed applications.

1) Drug Repurposing: a project which used machine intelligence to analyse a database of existing drugs to predict and identify which drugs might be effective in treating coronavirus

2) Refugee Simulator: using agent-based and compartment A.I. modelling techniques to simulate refugee camp environments with the aim to help NGOs and policymakers develop effective containment strategies.

3) Health Traffic Lights: a risk-scoring and contact tracing app that is privacy-preserving by design thanks to the use of a PDA (personal data account)

Civic tech in practice

Assisted by HAT-LAB, the third of these submissions, Health Traffic Lights, has since been moved forward to an MVP stage under the name of ShareTrace.

Sharetrace provides infection risk scores calculated for individuals on the basis of the symptoms they have reported, and those of people with whom they have come into contact - and the contact of their contacts. Data on symptoms and encounters is held on the cloud in Personal Data Accounts issues by Dataswift, and legally owned and controlled by the individual ShareTrace app user. ShareTrace users can contribute risk scores calculated in the PDA to an anonymous digital twin run on the ShareTrace server; risk scores are compared and updated based on encounters, and then propagated back down to the app user.

By legally owning their data through the PDA citizens are truly empowered to exercise individual agency and autonomy over their personal data. This approach provides for decentralised storage, and the capacity for network calculations to understand population-level risk.

We believe that by putting control in the hands of individuals - rather than the managers of centralised databases - we can both ensure trust in this technology and protect the individual freedoms that undergird our democratic system. Civic tech, for civil society.

Adam Riccoboni, CEO, Critical Future

APPG AI webinar 6th of April 2020

I am Adam Riccoboni, the CEO of Critical Future, a company with a track record of developing new AI solutions including in healthcare, and I am the author of the book "The AI Age". I am going to talk about how AI can help fight against Covid-19 and prevent future epidemics. First we have to travel back a few years to 2016.This is the year the British founded company, DeepMind, used AI to beat the world champion at the ancient Chinese game Go. This British founded company, headquartered in London, being crowned world champion at the ultimate Chinese strategy game of Go, gave China a “Sputnick” moment. Mirroring the frenzy of investment and activity of the US in the space race following Russia’s launch of the Sputnick satellite, China became determined to lead world in AI. From 2017, China began investing billions in AI research, with an explicit government strategy to become the pre-eminent AI nation by 2030. Today in 2020, we already see the fruits of that strategy, as China (and other countries in Asia) have effectively used AI to fight against the global pandemic of Covid-19. I hope this striking example of how Asia has used AI to manage a healthcare and economic crisis, gives us in Britain, our own “Sputnick” or “AI moment”, and puts rocket fuel in our ambition to be a pre-eminent AI nation.

AI can help fight Covid-19 and prevent future epidemics 5 main ways:

1) Firstly, **containment**, AI is being used effectively for virus containment: A mobile phone app called called Alipay Health Code in China operates a traffic light system to determine who can go out or be quarantined. While this may raise privacy concerns in the UK, MIT has developed a mobile app called Safe Paths, which uses GPS data for virus containment, while importantly safeguarding privacy and human rights. I interviewed Safe Paths as preparation for this meeting, and their free mobile app is already available for roll out in the UK.

2) Secondly, AI is being used for virus **detection.** In China, smart helmets and cameras detect fever amongst people in public places. AI diagnostics for Covid-19 using chest radiology scans have also been developed in China, South Korea and Canada. We can prof. Tim Spector fantastic tool here

3) **Drug discovery**: AI can identify suitable viral therapies. Gero in South Korea has already used their AI platform to identify existing drugs which can be repurposed for Covid-19.

4) **Patient care**: AI can be used for patient care, such as the nurse robot Tommy which has been donated by China to Italy and is monitoring key parameters of patients in hospitals and reducing human to human transmission. Also, AI triage platforms like Vital in the US, which provides a coronavirus checker, reduce the burden on healthcare systems.

5) Finally, AI can be used to **predict future epidemics**. BlueDot, a Canadian company used AI to send an alert and early warning about the threat of Covid-19 in December 2019. I interviewed BlueDot in preparation for this meeting and their system is human + machine. AI is used to process vast amounts of media data to identify threats, and human physicians then make judgement about the risk. I am sure we can create a far more powerful AI epidemic prediction engine ourselves in Britain with access to the right data.

So what do we need from Parliament to leverage all of these immensely useful AI technologies in Britain?

Government Leadership - The 1918 Spanish Influenza Pandemic led directly to the creation of the Ministry of Health in the UK in 1919. This early 20th century viral pandemic showed that the UK's healthcare system needed better organization. Today in the early 21st century, the lesson to be learned from the Covid-19 crisis is that the UK's healthcare system needs better technology, specifically better AI.

Therefore, I propose to Parliamentarians that AI is put at the top of the political agenda. Parliamentary groups such as this are crucial and should be expanded and resourced into a Ministry for AI, a department for Artificial Intelligence, supporting a strategy for Britain to lead the world in AI. If a Department for AI is too ambitious in the near term, then an AI Epidemic Task Force can be operationalized. This AI Epidemic Task Force should oversee 3 activities Data Access, AI Development & AI Deployment:

The first and most important phase is the Data Access –

1) **Data Access** - AI technologies already exist, and Britain already has some of the best AI talent in the world. What we lack is the data. Data access is the bottle neck on our progress. We need parliamentary support to get access to the data we need through partnership with the public for mobile phone data – a campaign to persuade public to share data, partnership with the private sector for drug discovery data, and partnership with the NHS for live healthcare data.

2) **Development** – The next phase is developing new AI solutions. To stimulate funding, government can expand grants such as Innovate UK, but also funding can come from the private sector such as the EIS scheme with greater tax incentives for AI epidemic technology.

3) **Deployment** – the final phase is deployment, as these AI solutions are rolled out in real time, by teams integrated into the health service for feedback and continuous improvement.

This 3-step process will develop innovative new AI solutions precisely targeted at preventing and managing future epidemics in Britain.

It will require much more access to data for AI developers, but Safe Paths of MIT exemplifies how such data can be retrieved whilst maintaining the privacy safeguards. We in Britain should build our own equivalent of Safe Paths so we hold the data and follow data privacy guidelines and human rights charters. But we do need to act fast, and we do need the public, private companies and public sector to share data we have the AI community.

Can we in Britain really be a world leader in AI? Can we compete with giants like China & the US in AI? Yes we can.

While Artificial Intelligence is an American term, it was the British genius and war hero Alan Turing, who invented the field. Turing invented digital computers and did the pioneering work on what he called “thinking machines” including providing a blueprint for what become known as “machine learning”. It was the British innovator Geoffrey Hinton who made the key for breakthroughs such as backpropagation which enabled Deep Learning to become such as powerful technology. It was the British Demis Hassabis whose London based company DeepMind gave China it’s Sputnick moment.

Britain has contributed as much to AI as any nation in the world. We can and should lead the world in AI, with a government and parliamentary ambition to match our potential.

The benefits of a greater AI ambition, funding and resources, in Britain will be profound for healthcare but go much further. AI can increase the UK’s GDP by 22% by 2030 according to independent research by McKinsey. Following the negative economic consequences of the Covid-19 crisis and lockdo, this AI spurred economic growth & productivity boost, will also be vital.

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