**International Roundtable on AI and COVID-19**
**Meeting Summary**
**March 23, 2020**

**Attendees:** See the participant list in Appendix A.

## 1. Introductory Remarks

Alan Bernstein opened the meeting by articulating its key goal: to discuss challenges in slowing and stopping the COVID-19 pandemic, and identifying where AI can play a role in addressing some of the most pressing questions. Peter Singer reiterated the World Health Organization's message about the need for rapid testing and contact tracing, in addition to physical distancing, in containing this pandemic. Samira Asma pointed out the significant gaps in the current reported data, for example, in terms of sex and age desegregation. Mona Nemer emphasized the importance of articulating what kind of data is needed, the accessibility of this data for researchers, and the need for ideas and approaches on how to exit from this crisis.

## 2. Theme: Public Health/Mathematical Modelling

The group identified that lack of access to high-quality, high-dimensional data was a major limitation of research right now. We need to be collecting and curating much larger and multi-dimensional data sets and sharing those internationally and we need to address the policy issues around the use of those data sets for research and health system planning.

Two broad families of data are currently needed: 1) epidemiological data, to understand how the disease spreads (stratified by sex, age, location, etc.); and 2) clinical data, to understand how cases evolve, so we can better plan for resource allocation within healthcare systems. This includes disaggregated anonymized case history, comorbidities, etc. One challenge is the types of data that are needed for countries at different stages of the epidemiological curve; the needs can change quickly.

WHO is considering refreshing its data sharing policy and what should be the global standard in such an emergency situation.

Testing needs to be done in a much more comprehensive way, massively scaled up across Canada and around the world. Data on things such as the number of positive and negative test results need to be collected and made available in order to get closer to an idea about population-level trends of this pandemic.

A priority right now is to couple the prediction modelling of the disease dynamic with our health system capacity. The choke point for most health systems is ICU bed capacity, and our

healthcare systems will drown quite quickly in the face of exponential growth in the spread of the virus. There is a stark gap between the data that is available to governments and what is available to epidemiologists and modellers. A secondary concern is surveillance -- how do we keep tracking the disease when we know we are not able to test everyone? This data will be important for a cyclical strategy where we can press the "gas pedal" on and off for measures such as physical distancing. Predictive models to, for example, quantify where testing is needed will be critical in the next 2-12 months.

It is estimated that many countries are currently reporting less than 20% of their symptomatic cases, so there needs to be a way to track mild community cases. This kind of real-time data will be useful for designing peer-to-peer AI apps for contact tracing and maybe even to encourage behavioural change to reduce risk. Singapore has now rolled out an app for contact tracing, which would be worthwhile to be modified and deployed globally as soon as possible.

AI could help for the following public health purposes:

- Disease surveillance - how can we track disease activity (beyond testing) during social distancing to reduce ICU burden
- Case prediction models - the likelihood of someone having COVID before test results are available, to help with prioritizing patient beds
- Mortality risk - for example, to decide which patients should be prioritized for ventilators
- Assessing clinical displacement - what is the impact on patients who are not receiving clinical care for other illnesses during this pandemic and what are the implications over the increasingly longer term
- Tracking how patients can be moved between different health regions or hospitals based on different demands / system stress

There is a need to look beyond traditional public health data in central repositories to "non-traditional" data such as surveys (to ask if people are changing their behaviour) or Big Data from apps such as Citymapper. Platforms such as Facebook and Google have very high resolution data on user location and movement, but there are current legal and privacy hurdles that prevent the sharing of such data. Some platforms such as Google TakeOut and Uber allow users to download their own data and voluntarily share with researchers -- this could be a useful model. Other possibilities that may be worth exploring include programming digital assistants such as Alexa to use cough as a wake word, or to geotag internet searches as a symptom checker, but all of these have legal and ethical issues that need to be tackled.

Organizations such as CIFAR and NSERC want to help as much as possible with these initiatives and coordinate and connect researchers in public health, AI, mathematical modelling, etc.

By the end of this week, Element AI will provide full-text access to the recent CORD-19 dataset within a (beta) semantic search engine front-end developed internally, to allow researchers to identify similarities across articles or individual research results. Their goal is to then progressively integrate additional unstructured and structured datasets to this engine, and enable asking natural language questions against them.

In South Korea, there were difficult questions initially about how to organize data for immediate intervention and future planning. When cases began to skyrocket, the central health authorities had no capacity to coordinate, but data (such as those on mortality) from different sites are now linked. Interdisciplinary researchers are beginning to analyze this data using models, to inform diagnostic practice and the best way to handle patients in critical condition.

Serological tests based on antibodies with rapid turnaround (10-15 min) are about to be rolled out, first in South Korea. A better understanding of immunity will help with predicting a second wave of the disease, as well as potentially to identify an immune cohort of health workers.

**3. Theme: Biology, Drug and Vaccine Development**

From the industry perspective, several vaccine candidates are currently being studied at an accelerated pace, but it will still take 12-18 months to deploy to the population. Helpful applications of AI for drug and vaccine development would include:

- Prediction models to help manufacturers accurately assess how much vaccine to manufacture to ensure equitable access and the right number of doses to protect at-risk populations
- Using AI to unravel large/complicated datasets that could indicate correlates of protection or biomarkers of harm
- The ability to model vaccine impact to make decisions on coverage and deployment

Drug cocktails have been known to be helpful in treating coronaviruses. The modelling of drug cocktails is challenging with limited methods for looking at combined data sets, so the capacity offered by AI would be very useful.

The MIT team develops AI tools designed to help identify or generate compounds against viral, bacterial or other similar threats. Regarding COVID-19 specifically, in order to contribute in the short term, their goal is to search for effective and safe therapies from among already approved drugs or those that have already passed phase 1 clinical trials. In particular, they are looking for effective combinations or cocktails of such drugs. For larger initiatives, Wellcome Trust, Mastercard & Gates Foundation have launched a joint effort to accelerate the screening of

therapeutics for COVID-19. Currently, only more traditional screening approaches are being used, and AI would significantly accelerate analysis of the data.

A team headed by Alán Aspuru-Guzik is using AI to work on the following:

- Scaling up the production of current small molecules in pipeline (synthesis routes for them)
- Developing surface coatings and new soaps to remove the virus
- Attacking a specific receptor

Gerry Wright from McMaster University and Michael Tyers from Université de Montréal have been working with Yoshua Bengio to apply AI toward drug development. Ways that AI may contribute to drug development include chemical structural modelling to build compounds; interrogation of genetic or protein-protein interactions; and correlation of clinical and cellular data to study off-target effects and adverse reactions.

JEDI (Joint European Disruptive Initiative) is preparing a competition in the field of COVID-19 drug discovery that will combine molecular dynamics and machine learning.

AI could also help to determine whether existing drugs can be repurposed. Anti-inflammatory drugs may be effective in reducing the mortality from pneumonia. Clinical trials with several IL-6 inhibitors are currently ongoing or being planned, but the benefit or harm will be unclear until then (e.g., corticosteroids were used against SARS, but were later found to be harmful).

We can make an effort to understand coronavirus and treatment from domestic animals and other animal models, including Rhesus macaques, which are recapitulating the disease much like humans.

A team led by Bo Wang is collaborating with researchers at Sunnybrook Hospital who have isolated SARS-CoV2 viral particles to study the genetics of the virus, trace transmission and predict mutations that may lead to a second wave of the infections.

A current major limitation is synthetic chemistry capacity, as many university labs are currently closed and unable to produce and examine potential treatments. Individual universities and funding agencies are examining the possibility of reopening some labs and mobilizing research. The Chief Science Advisor of Canada will be discussing this with the U15 universities.

**4. Theme: Clinical Trials Design**

The WHO announced a large global trial, called Solidarity, to find out whether any promising existing medications (including antivirals, interferon beta, and chloroquine) work against COVID-19. Participants of this group are encouraged to think about how AI can help in this effort.

One difficulty with extrapolating from clinical trials in the Global South to countries with G7-type demographics is their younger population distributions, which may be affecting disease severity. However, it is currently unclear if this age distribution of COVID-19 cases being observed right now is due to the distribution of comorbidity (such as chronic diseases, smoking). AI could be helpful in teasing these factors apart. Machine learning can also help with tackling effect heterogeneity in clinical trial design.

**5. Theme: Health System Capacity and Resilience**

When looking at regions that seem to have made better progress in containing COVID-19, such as South Korea, Singapore and Taiwan, we need to disentangle the relative contribution or effectiveness of different public health strategies. AI could be helpful in teasing these apart, for example, by analyzing between-region variability.

AI could be used to optimize patient intake, queuing and circuit/flow within hospitals to avoid contamination of non-COVID-19 patients. AI can also be useful for high-resolution modelling for resource planning by hospitals -- not just for physical resources such as PPEs, but also for scheduling for doctors and nurses to avoid burnout. Another potential application of AI may be to help in understanding the global supply of testing -- sourcing of reagents, transportation, prediction of surges in demand, etc.

**6. Policy Implications**

The participants of this working group came to a consensus that access to data is critical. One key issue is to balance privacy concerns with the benefits of having real-time data on the whereabouts of individuals from companies such as Facebook and Google in an urgent emergency situation such as this one. One recommendation was opt-in with an app using existing software (e.g., Facebook, Google) and allow people to volunteer information. This is a conversation that will need to involve ethicists as well as legal and policy experts.

Policy and health systems experts at the Roundtable also pointed out the importance for researchers to engage with public health organizations and health ministries about their actual needs at this time. Economics is also another area of concern, and data is needed for devising an exit strategy from this crisis.

**7. Next Steps**

CIFAR will invite call participants and others to join sub-committees to work together. One area of interest is drafting a statement emphasizing the importance of sharing COVID-19 data across nations and organizations and working collectively to accelerate progress toward fighting this pandemic.

An AI COVID-19 Briefing for Canadian policy-makers on the outcomes of today's Roundtable is taking place on March 24th from 1-2pm EDT and attendees of this working group are welcome to join.

If there are collaborations that arise from today's meeting, attendees are encouraged to keep CIFAR informed and should not hesitate to make a funding request.

CIFAR will coordinate future calls and meetings and will administer a survey to determine frequency of future meetings, additional invitees, and possible sub-committee participation.

**8. Resources Identified by Roundtable Participants**

Singapore contact-tracing app TraceTogether
https://www.straitstimes.com/singapore/coronavirus-spore-government-to-make-its-contact-tracing-app-freely-available-to

Yoshua Bengio: Peer-to-peer AI-based tracing of COVID-19
https://docs.google.com/document/d/1xx5ePG-jjYng6RLcwZJzZzwulYeIEU0RAdGWMDbGOls/edit

WHO data sharing policy
https://www.who.int/publishing/datapolicy/en/

Center for Data and Computing – has existing partnerships providing data for developing apps for mobility tracing, happy to collaborate
https://cdac.uchicago.edu/

Crowdsourced symptom report and tracking sites:
covidnearyou.com (USA)
flatten.ca (Canada)

Updated COVID info from Korea:
http://ncov.mohw.go.kr/en/

Adam Kucharski: Rough initial estimates of case under-testing/reporting
https://cmmid.github.io/topics/covid19/severity/global_cfr_estimates.html

Gates - Wellcome - Mastercard initiative for coronavirus therapeutics screening
https://www.statnews.com/2020/03/10/125m-effort-to-find-coronavirus-drugs-started-by-gates-foundation-wellcome-and-mastercard/

WHO Solidarity trial
https://www.sciencemag.org/news/2020/03/who-launches-global-megatrial-four-most-promising-coronavirus-treatments

South Korea hospital bed triage
https://www.wsj.com/articles/how-south-korea-solved-its-acute-hospital-bed-shortage-11584874801?mod=searchresults&page=1&pos=1

Economic impact of social distancing / WFH
https://www.nytimes.com/interactive/2020/03/23/opinion/coronavirus-economy-recession.html

MIT initiative on drug discovery
https://www.aicures.mit.edu/

## Appendix A: Participants in the Roundtable

| First Name | Last Name | Organization/Affiliation | Role |
|---|---|---|---|
| Alejandro | Adem | NSERC | President |
| Samira | Asma | World Health Organization | Assistant Director-General for the Data, Analytics and Delivery for Impact Division |
| Alán | Aspuru-Guzik | University of Toronto; Vector Institute | Professor of Chemistry and Computer Science; CIFAR Lebovic Fellow Bio-inspired Solar Energy Program;<br>Canada CIFAR AI Chair, Vector Institute;<br>Canada 150 Research Chair in Theoretical Chemistry |
| Regina | Barzilay | Massachusetts Institute of Technology | Delta Electronics Professor of Electrical Engineering and Computer Science, Faculty Co-lead of J-Clinic,<br>MIT Initiative for machine learning in health |
| Marc | Bellemare | Google; McGill University; Mila | Research Scientist; Adjunct Professor;<br>Canada CIFAR AI Chair |
| Yoshua | Bengio | Université de Montréal; Mila; CIFAR | Professor, Department of Computer Science and Operations Research; Scientific Director; ACM Turing Award Laureate; Canada CIFAR AI Chair, Program Co-Director of the Learning in Machines & Brains Program |
| Alan | Bernstein | CIFAR | President & CEO |
| John | Brownstein | Boston Children's Hospital/Harvard Medical School | Chief Innovation Officer/Professor |
| Sean | Caffrey | University of Toronto | Executive Director, Strategic Initiative Development, Office of the VP Research & Innovation |
| Nick | Cammack | Wellcome | Head of Snakebite Priority Area |
| Masha | Cemma | Office of Canada's Chief Science Advisor | Policy Advisor |

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| Nicolas | Chapados | Element AI | Chief Scientist |
| Dan | Drexler | Klick Health | Managing Director |
| Audrey | Durand | Université Laval/Mila | Assistant Professor in Computer Science and Software/Computer/Electrical Engineering; Canada CIFAR AI Chair |
| Rosalind | Eggo | London School of Hygiene and Tropical Medicine | Assistant Professor |
| Kim | Elmslie | Public Health Agency of Canada | Vice-President |
| Tim | Evans | McGill University | Inaugural Director and Associate Dean of the School of Population and Global Health (SPGH) in the Faculty of Medicine and Associate Vice-Principal (Global Policy and Innovation) |
| Rebecca | Finlay | CIFAR | VP, Engagement & Public Policy |
| Rita | Finley | Public Health Agency of Canada | Senior Policy Advisor |
| David | Fisman | Dalla Lana School of Public Health ,University of Toronto, University Health Network | Professor, Division of Epidemiology |
| Matthew | German | BlueDot | Director, Product Innovation |
| Marzyeh | Ghassemi | University of Toronto, Vector Institute | Assistant Professor, Computer Science and Medicine; Canada CIFAR AI Chair |
| Garth | Gibson | Vector Institute | President and CEO |
| Nick | Jackson | Coalition for Epidemic Preparedness Innovations | Head of Programs and Technology, Vaccine R&D |
| Kamran | Khan | BlueDot | Founder & CEO |
| Douglas | Kingsford | British Columbia Ministry of Health | Chief Medical Information Officer |

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| Yann | LeCun | Facebook; New York University; CIFAR | VP and Chief AI Scientist;<br>Silver Professor of Computer Science, Data Science, Neural Science, and Electrical and Computer Engineering; ACM Turing Award Laureate; Program Co-Director of the Learning in Machines & Brains Program |
| Gabriel | Leung | Hong Kong University | Dean of Medicine |
| Arnie | Levine | Institute for Advanced Study<br>The Simons Center for Systems Biology | Professor Emeritus;<br>School of Natural Sciences<br>Biology |
| Cam | Linke | Amii | CEO |
| Joanne | Liu | Doctors Without Borders | Past President |
| Muhammad | Mamdani | St. Michael's Hospital | Director, Li Ka Shing Centre for Healthcare Analytics Research and Training (CHART) |
| Leslie | McCarley | CIFAR | Vice-President, Advancement |
| Sara | Mostafavi | University of British Columbia; Vector Institute | Assistant Professor, Statistics & Medical Genetics; Canada CIFAR AI Chair, CIFAR Fellow in Child & Brain Development Program |
| Mona | Nemer | Government of Canada | Chief Science Advisor |
| Nathaniel | Osgood | University of Saskatchewan | Professor, Department of Computer Science<br><br>Associate Faculty, Department of Community Health & Epidemiology<br><br>Associate Faculty, Bioengineering Division |
| Marc-Etienne | Ouimette | Element AI | Head, Public Policy and Government Relations |
| Antoine | Petit | Centre National de | Chairman and CEO |

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| Joelle | Pineau | Facebook; McGill University; Mila | Lead, Facebook's Artificial Intelligence Research lab; Associate Professor and William Dawson Scholar at the School of Computer Science; Canada CIFAR AI Chair |
| Valerie | Pisano | Mila | President and CEO |
| Mike | Poole | Biomatics Capital, Inc./ Gates Foundation | Venture Partner, previous Director, Global Health @ Gates |
| Catherine | Riddell | CIFAR | Vice-President, Strategic Communications |
| Laura | Rosella | ICES/University of Toronto, Dalla Lana School of Public Health | Assistant Professor (Cross-appointment) |
| Beate | Sander | University of Toronto; University Health Network | Scientist and Director of Population Health Economics Research, Toronto Health Economics and Technology Assessment Collaborative |
| Bernhard | Schölkopf | Max Planck Institute for Intelligent Systems; ETH Zürich | Director; Department of Empirical Inference; Fellow of the CIFAR Learning in Machines & Brains Program |
| Michael | Schull | ICES | President & CEO |
| Sebastian | Seung | Princeton University | Evnin Professor in Neuroscience, Professor of Computer Science and Princeton Neurosciences Institute; Advisor, Learning in Machines & Brains Program, CIFAR; International Scientific Advisory Council, CIFAR |
| Peter | Singer | World Health Organization | Special Advisor to Director General |
| Elissa | Strome | CIFAR | Interim VP Research and Executive Director, Pan-Canadian AI Strategy |
| Shirley | Tilghman | Princeton University | President of the University, Emeritus Professor of Molecular Biology and Public Affairs |

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| Ashleigh | Tuite | University of Toronto | Assistant Professor, Epidemiology Division |
| Mike | Tyers | Institute for Research in Immunology and Cancer; Université de Montréal | Principal Investigator, Systems Biology and Synthetic Biology Research Unit<br><br>Professor, Department of Medicine, Faculty of Medicine |
| Harold | Varmus | Cornell University | Lewis Thomas University Professor & Senior Advisor to the Dean & Provost |
| Marian | Vermeulen | ICES | Senior Director, Research & Data |
| Charles | Victor | ICES | Senior Director, Strategic Partnerships & External Services |
| Joshua | Vogelstein | Johns Hopkins University | Assistant Professor, Institute for Computational Medicine<br>Center for Imaging Science |
| Bo | Wang | Peter Munk Cardiac Centre and the Techna Institute at the University Health Network; Vector Institute | Lead Artificial Intelligence Scientist; Canada CIFAR AI Chair |
| Gerry | Wright | McMaster University | Director of the Michael G. DeGroote Institute for Infectious Disease Research; Professor in the Department of Biochemistry and Biomedical Sciences; CIFAR Fellow in Fungal Kingdom: Threats & Opportunities |
| Pauline | Yick | CIFAR | Chief Financial & Administrative Officer |
| Bill | Young | CIFAR Board | Chair |
| Asaph | Young Chun | Statistics Korea | Director-General, Statistics Research Institute |
| Rich | Zemel | University of Toronto; Vector Institute | Professor, Computer Science; Research Director |