

Vector's Health Strategy

March 2019

The Vector Institute



World-class research

- Hiring top AI scientists and giving them flexibility
- Publishing & presenting in top conferences and journals
- Talks & seminars at Vector
- Collaborative office space
- Computing resources
- Growing community of Vector faculty, affiliates and students



Work with industry

Help companies become better AI users via:

- Training for technical professionals
- Training for executives
- Connections between companies and researchers where interests align
- Match-making to help small AI companies find new customers and grow
- Job fairs and postings to help companies fill AI-related roles



Training and education

- Hiring more faculty to teach more students
- Working with universities to deliver more AI Master's programs
- Training industry professionals



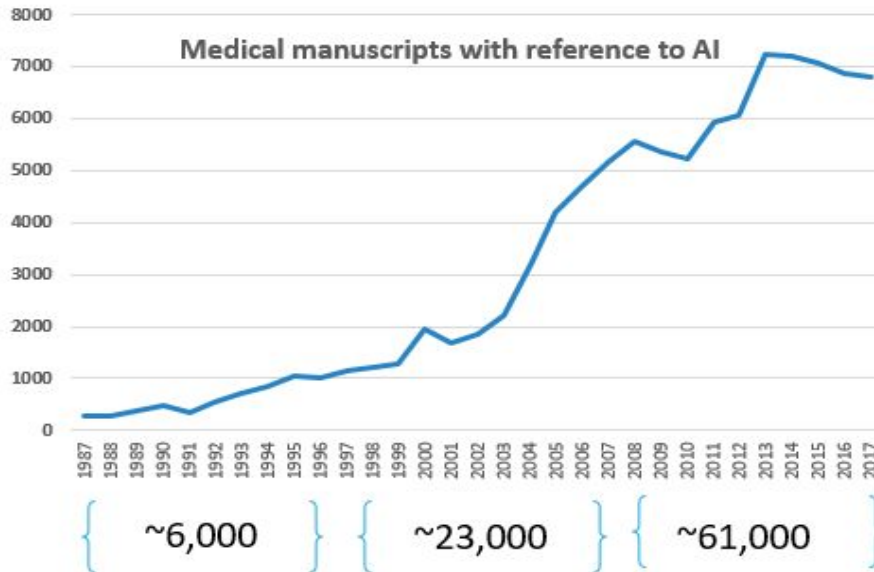
Work with the health sector

- Connecting AI scientists with health sector researchers and decision makers
- Contributing to policies and projects aimed at increasing health AI application
- Establishing multi-site or province-wide data infrastructure

How AI Can be Applied to Health

- Discovery science – for example, using AI to identify previously unknown associations in population and patient data, to generate research hypotheses
- Personalized products and services – for example, using AI to tailor treatment and prevention interventions based on personal (e.g., genetic) and/or sub-group (e.g., sociodemographic) characteristics rather than aggregate population-level statistics
- Efficiency of health sector operations – for example, taking AI-based technologies that are used in other sectors, like chatbots and smart scheduling systems, and tailoring them for use in the health sector

Current Impact of AI on Health



- Precise and individualized patient care
- Data-driven clinical care and patient management
- Diagnosis, trajectory and prognosis
- Improve operational & safety-related decision support
- Monitoring of key quality & performance indicators

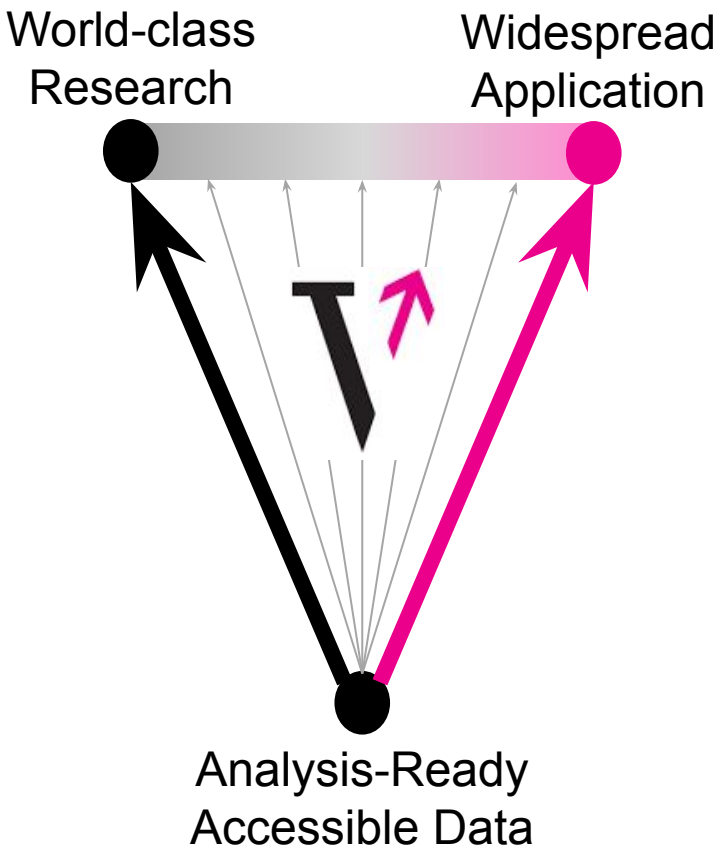
VIEWPOINT Deep Learning—A Technology
With the Potential to Transform Health Care

Geoffrey Hinton, PhD
Google Brain Team and
Department of
Computer Science,
University of Toronto,
Ontario, Canada.

JAMA September 18, 2018 Volume 320, Number 11

Estimated use in the clinic
<0.1%

Vector's Health Strategy



Phase I

Build the foundation across [three workstreams](#):

- Attract and retain world-class faculty
- Convener events, e.g., Health AI Rounds
- Health AI implementation “Pathfinder Projects”
- Interns in health organizations
- Data infrastructure including the Health AI Data Analysis Platform (HAIDAP)

Phase II

Multi-year strategic objectives for AI related to specific health topics

Jan 2019 Selected Updates on Health Strategy Implementation

World-class Research

- New Frontiers in Research Fund (NFRF) submissions: 3 NOIs submitted, full applications due 7Feb19
- Anna Goldenberg Varma Family Chair Announced
- May 2019 Marzyeh Ghassemi-led “ML4H Unconference” bringing together junior ML researchers and clinicians



Widespread Application

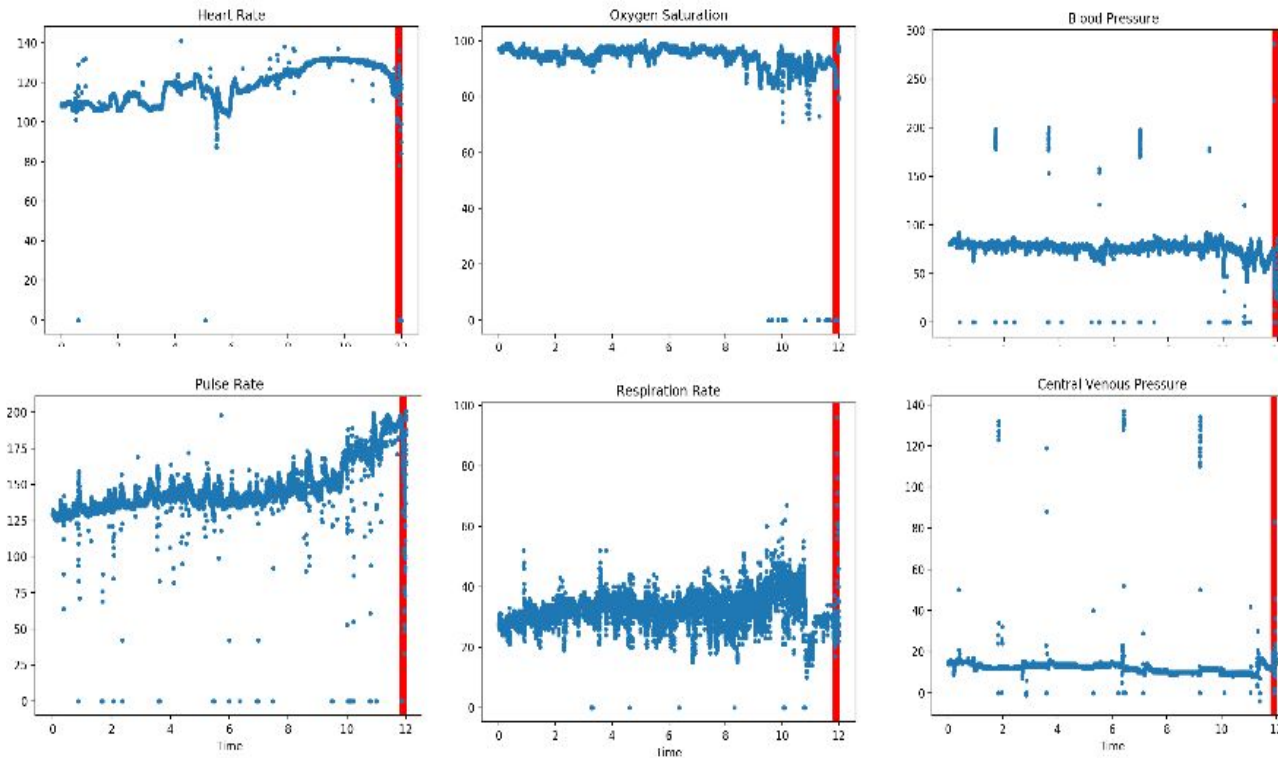
- Five agreements for Pathfinder Projects close to being executed
- Initial meetings with MOH and Premier’s Council about potential 6th Pathfinder Project
- Fall 2019 Anna Goldenberg-led Health ML Deployment Symposium
- 3 Health AI internship postings developed with health stakeholders (but not yet filled)

Analysis-ready Accessible Data

- First two tranches of \$3.75M for Health AI Data Analysis Platform (HAIDAP) received
- 27Feb19 Health Data Protection Law in the Era of Big Data conference co-led by Vector
- Early discussions with CIFAR about large proposal for enhanced Pan-Canadian AI with strong emphasis on investment in data

Example of Vector Faculty Research

Early predictors of Cardiac Arrest:



SickKids

Machine learning using data from T3 System has 70% accuracy predicting cardiac arrest five minutes in advance.



Dr. Laussen,
MD



Dr. Goldenberg,
PhD

Tonekaboni et al, PMLR, 2018

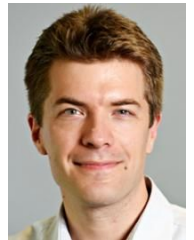
Example of Vector Faculty Research

Helping to tailor care for patients with dementia



Ludwig -
talks to elderly,
monitors speech capabilities
assesses cognitive decline

Partnered with Revera
senior care home



Dr Rudzicz

Risk Dashboard Program of Machine Learning Research

With scientific leadership from Dr. Walter Wodchis (ICES, IHPME at U of T, Trillium Health Partners) and Dr. Anna Goldenberg (Vector's Associate Research Director, Health, Dept of Computer Science at U of T, and the Hospital for Sick Children) Vector and ICES have established the Risk Dashboard Program of Machine Learning Research.

Vector faculty are leading studies using the Phase I infrastructure of the HAIDAP. Three studies have or will have first results within weeks.

Supervising Vector Scientist	Student Name	Project Title
Quaid Morris	Haoran Zhang	Derivation and Validation of an Electronic Medical Record Text-based Tool for Identification of High Cost Users
Anna Goldenberg	Soren Sarvestany	Machine Learning to Predict Compensated Cirrhosis
Laura Rosella	Mathieu Ravaut	Deep Learning Framework for Diabetes Sub-Classification

Other Ongoing Vector Health AI Projects

- Operating Room (OR) Blackbox - deep analysis of surgical OR performance at St Mike's
- Assessing malignancy of thyroid nodules prior to surgery at SickKids
- Identification of uncompensated cirrhosis at UHN
- Risk assessment of diabetes development post liver transplant at UHN
- Patient Risk Dashboard
- Emergency Department assessment of return patients at SickKids
- Modeling trajectories and variations in pregnancy Mt Sinai (NY)
- Modelling stress in pregnant women, nurses and midwives (Oxford)
- Alzheimer's disease detection from speech
- Dynamic measurement scheduling for adverse event forecasting in ICU
- Risk assessment and early detection of cancer in children with cancer predisposition syndromes
- Single cell analyses including cancer genomics
- Making health data available for the scientific community in secure and accessible format

Pathfinder Projects

A Pathfinder Project is an implementation project aimed at demonstrating the positive impact of a specific health AI application within ~12-18 months

Vector has been approached by many external health stakeholders who have ideas about health projects that would benefit from machine learning

Since July 2018, Vector has been working with these stakeholders to identify potential Pathfinder Projects

Of 40 proposed projects, agreements are being developed for a short-list of 4-5 projects which will be announced in early 2019

Health AI Data Analysis Platform (HAIDAP)

The HAIDAP is a **secure high performance computing environment** under ICES governance which enables the application of AI, **machine learning** and other **compute-intensive advanced analytics**

ICES, HPC4Health (at the Hospital for Sick Children) and Vector are **all contributing their expertise to the design, build and operation** of the HAIDAP; within that partnership:



- HPC4Health is the primary lead for **infrastructure** build and maintenance



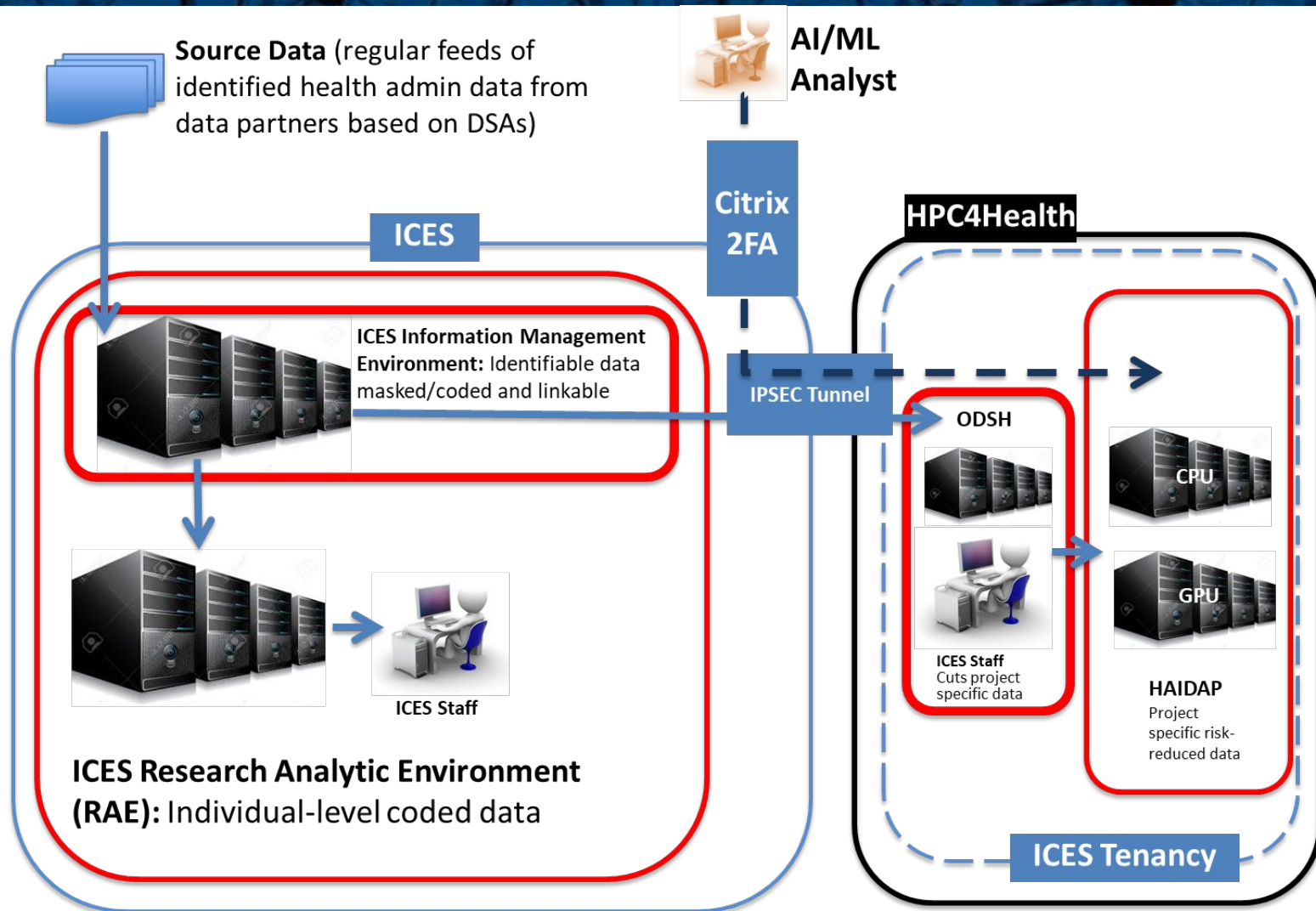
- ICES is the primary lead for **data**, **data access** and **clinical/subject matter expertise**



- Vector brings machine learning expertise, has a lead role in **defining essential functions/specifications** and **priority datasets** to bring into the HAIDAP, and ICES-approved Vector faculty and students are key **users**

Next steps: Complete the procurement of ~\$2 million hardware and prepare for additional projects in spring 2019

HAIDAP Configuration



HAIDAP: Province-wide Data + High Performance Computing → World Class AI

With generous funding from Compute Ontario and the Government of Ontario, we are moving population-wide longitudinal health data holdings into a secure environment with the compute power required for modern machine learning research

Infrastructure Element	ICES Research Analytic Environment	Planned HAIDAP Infrastructure by Spring 2019
Annual Analytic Projects	300-500	TBD
CPU Cores	80	400+
GPU Clusters	1 (<100TFLOPS)	13 (1.26 PFLOPS)
Storage	200 TB	2+ PB (est)

Harmonization of Data Sharing Agreements

Data sharing agreements (DSAs) are becoming increasingly more **complex and lengthy** with growing variability across agreements

A **standardized DSA** between Health Information Custodians (HICs) and Prescribed Entities (PEs) has the potential to improve the **quality, consistency** and **ease of implementation** of DSAs

Creation of a standardized HIC-PE DSA, with accompanying educational materials, could **streamline/simplify** the process for sharing health data, ultimately **reducing privacy risks** while enabling new knowledge creation and improved health

Next Steps: Working with HICs, PEs and other stakeholders, Vector to co-lead work to create a HIC-PE DSA template and accompanying educational materials

De-identified Sample of a Dataset Concept

Ontario (and Canada) have a **data advantage** stemming from our large single payer health system(s) covering ethnically diverse populations

With partners, Vector is exploring the idea of establishing one or more accessible **large de-identified samples of datasets** (DSDs) that would increase the availability of a subset of health data for research, training of students and innovation more broadly

The DSD would adapt the US MIMIC model to the Canadian context, taking a percentage sample of a very large dataset and removing variables or converting them into derived variables so as to keep the **re-identification risk below a pre-set threshold**

Next Steps: Consultation, including with data partners, data providers, researchers and members of the public, before the DSD concept goes further

Increased Focus on Values and Ethics Related to Health AI

- Ethical and responsible health AI is the focus, or a major component of, a growing number of initiatives including:
 - G7 Innovation Ministers' Statement on AI, March 2018
 - Canada-France Statement on AI, June 2018
 - CIHR-funded "Ethics and AI for Good Health" symposium, June 2018
 - UHN Techna Symposium panel on "Social Licence on the Use of Data in AI", Nov. 2018
 - Collaborative Health Research Projects (CHRP) special call [issued jointly by CIHR, SSHRC and NSERC] for AI, Health and Society, decisions expected March 28, 2019
 - CIFAR workshop on AI and Public Health Equity, Jan. 25, 2019
 - National Research Council-led Canada-UK Ethics in AI Symposium, Feb. 21-22, 2019 (with second symposium planned in March 2019)
 - UOttawa Machine MD Conference, May 31 – June 1, 2019, and others....

Social Licence for Data-intensive Health Research

A recent Ontario study¹ found that members of the public **support research based on linked administrative health data**, but there is **no blanket approval**

The main themes were:

- Need for **assurance about privacy and security** about data (in any sector)
 - Generic skepticism about the ability of any organization to ensure privacy
 - External oversight for health data was appreciated
- **General support** for research based on ICES data with some **conditions**
 - Public's data seen as an asset that should be used
 - Important that there be a public benefit
 - Concerns about potential of research to disadvantage certain groups
- **Mixed and more negative** reaction when there is **private sector** involvement
 - Concern that R&D would focus on profit
 - Appreciation of the skills/expertise that private sector could bring
 - Desire to see reciprocity (or benefits sharing) when public data used by private sector organizations

Next steps: Vector and partners will expand this work to learn more about public views on specific uses of health data (including for health AI)