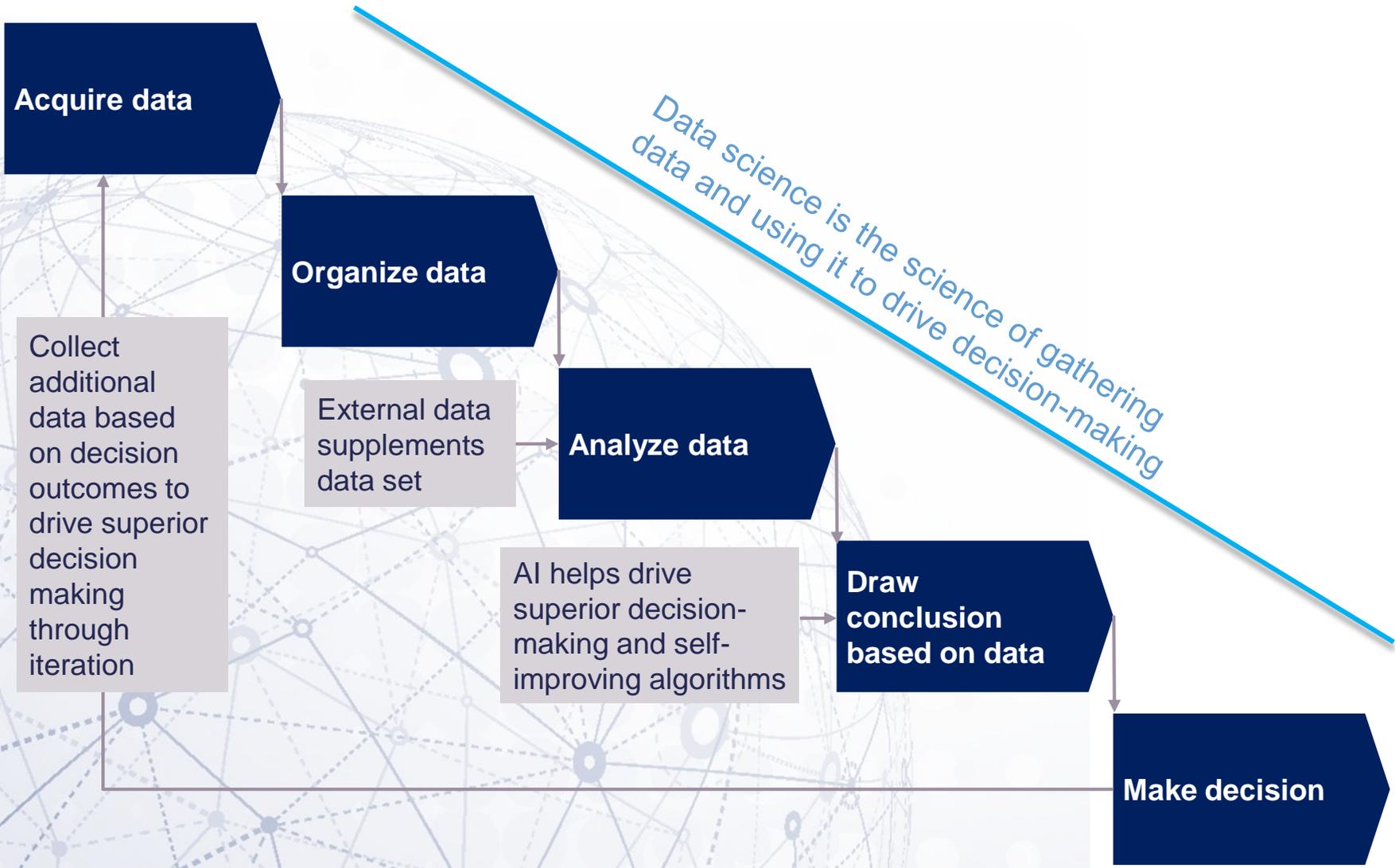


A conceptual image featuring a wooden ladder extending from the bottom towards a bright sun in a blue sky filled with white clouds. A rainbow is visible in the lower part of the sky, and there are several large, colorful, semi-transparent circular lens flare effects overlaid on the scene.

# Canada's impending AI revolution and the opportunity for Canadian business

February 2017

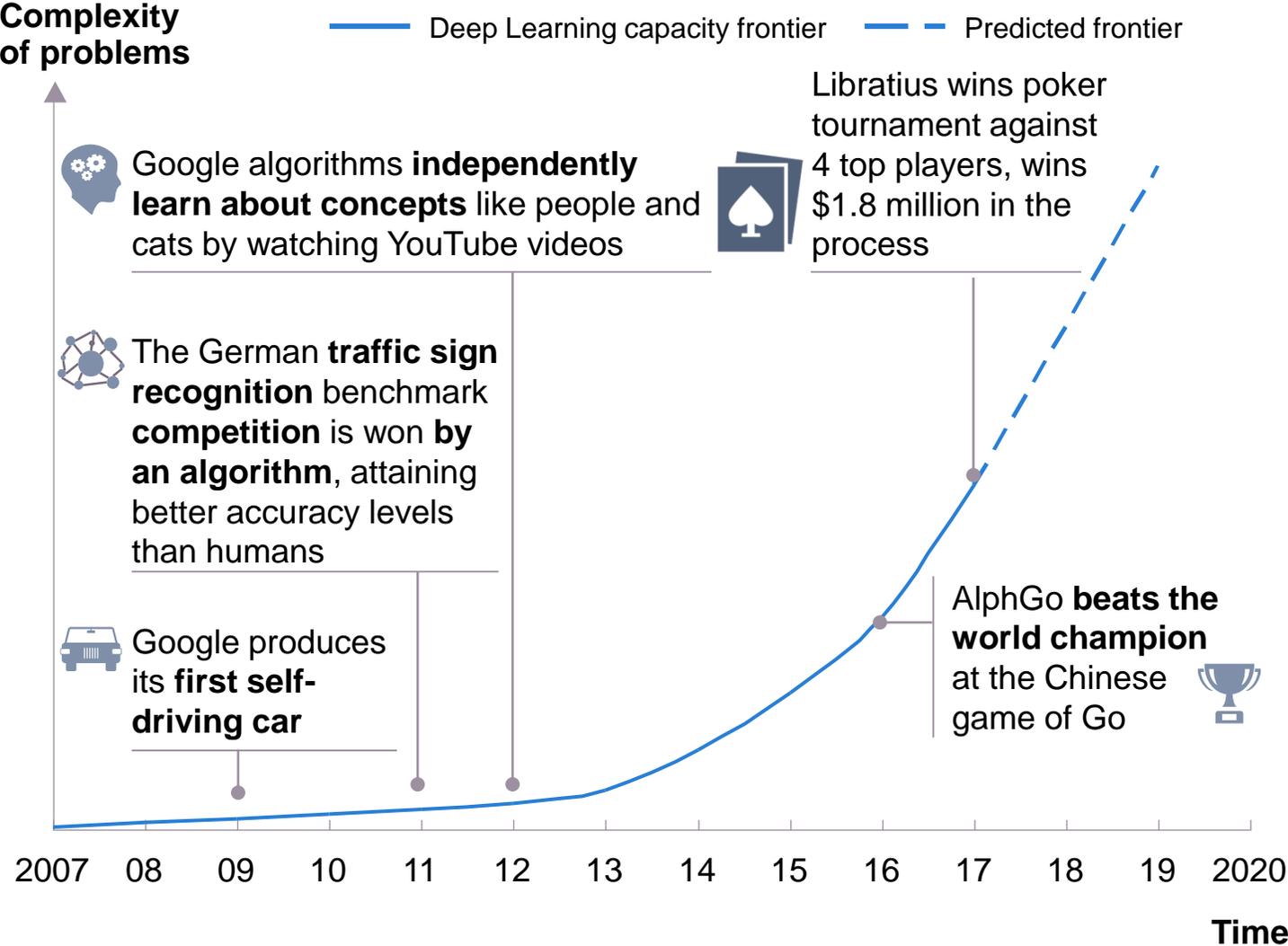
# The ability to acquire, organize, and draw conclusions from data with the help of Artificial intelligence will play a transformational role in business



SOURCE: Team analysis; Taylor B. et. al. (2007). The War Against Spam:A report from the front line, Neural Information Processing Systems; Somanchi, S. H. (2015). "The mail you want, not the spam you don't"

# Recent advances in deep learning, a subset of AI, have led to an exponential increase in its ability to predict outcomes and make decisions

## Deep Learning's ability to tackle problems over time Drivers



- Better hardware
- More data
- Better algorithms and training methods

SOURCE: Press Search

Many technologies are developing and commercializing simultaneously giving rise to significant disruptive forces and a generation of new companies



**Mobile Internet**



**Next-generation genomics**



**Automation of knowledge work**



**Energy storage**



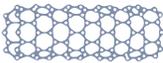
**The Internet of Things**



**3D printing**



**Cloud technology**



**Advanced materials**



**Advanced robotics**



**Advanced oil and gas exploration and recovery**



**Autonomous and near-autonomous vehicles**



**Renewable energy**

**Artificial intelligence will underpin the next industrial revolution**

# Artificial intelligence will create new markets and opportunities in industries ranging from healthcare to financial services

## Industries

## Example of opportunities

Automotive  
& Transport



- Autonomous vehicles to create a **\$87bn** solutions market

Aerospace  
& Defense



- Drone systems integration to create **\$82bn** in positive economic impact and generate **more than 100,000 jobs**

Financial  
Services



- Robo-advisors expected to have **~\$2.2tn in AUM** by 2025
- Personalized / dynamic financial advice and planning

Healthcare



- Global market for telehealth to reach **\$34bn**
- Global market for medical robotics to reach **\$18bn**
- Possibility of **better diagnostics personalized medicine**

Agriculture



- Global agribot market to reach **\$16.3bn**
- Significant improvements in yield management and better environmental management

Artificial intelligence will deliver most of its economic value by **eliminating waste** (e.g. asset underutilization) and **creating surplus opportunities** (e.g. accident avoidance, improved medical outcomes)

To capture this opportunity, nations and corporations have already begun massively investing to build their own capabilities

## Nations



**\$2.3bn** by 2016 in unclassified AI-related R&D



**\$1.2bn** for the development of AI in the next 5 years



Made AI development a “national strategy” level priority (investment numbers not public)

## Corporations



Purchased DeepMind, a 75-employee company, for **\$500mn**



**\$1bn** in “Cognitive Technologies”, which includes Deep Learning as its core technology



Deep Learning has become the central technology behind a large part of the service-offer of tech giants such as Google, Facebook, Samsung, IBM, and Panasonic

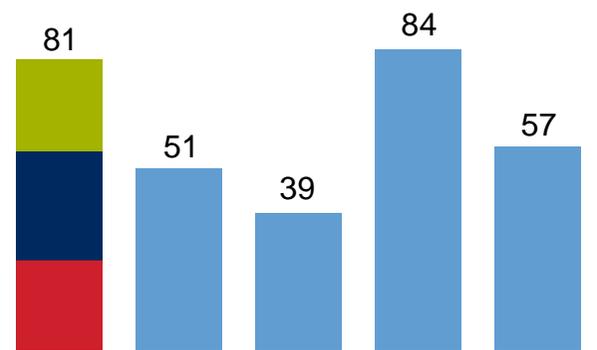
- Talent is a global market being exclusively tapped by a few early leaders;
- The price tag has gotten so high many organizations are essentially shut out from building capabilities from scratch

# By working together, Canada has the scale and expertise to win against leading global locations, but no single city is large enough on its own

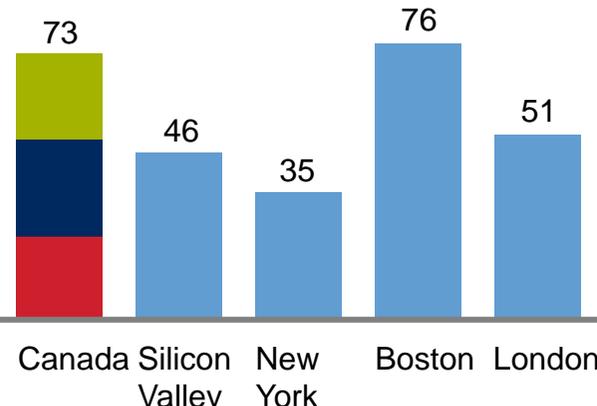
■ Edmonton ■ Toronto ■ Montreal

★ World-class capabilities    Ⓞ Strong capabilities    Ⓞ Non-distinctive capabilities

**PhD students graduating in AI per year**  
 Estimation of yearly graduating AI PhDs



**Total AI faculty**  
 # of faculty researching AI



AI expertise	Montreal	Toronto	Edmonton	Canada
Deep Learning	★	★	Ⓞ	★
Reinforcement Learning	Ⓞ	Ⓞ	★	★
Natural Language Processing	★	Ⓞ	Ⓞ	★
Automatic Speech Recognition	★	Ⓞ	Ⓞ	★
Computer Vision	Ⓞ	★	Ⓞ	★
Deep commercialization ecosystem	Ⓞ	★	Ⓞ	★

SOURCE: Press Search, Expert Interviews

# Montreal has been a data science pioneer for the past 40 years

## A base of leading research institutes in data science



- Founded in 1993, 9 faculty professors, 40 students, 5 post-docs and 5 researchers conducting cutting-edge research on artificial intelligence



- The Chair's mission is to combine knowledge acquisition through Machine Learning with decision making through Mathematical Optimization in a unified approach.



- Founded in 1971, brings together researchers working in managing logistics, supply chain and transportation networks



- Founded in 1979, brings together 70 experts on quantitative management, operational researchers, theoretical computer scientists, mathematicians and engineers



- Founded in 1968, brings together 1,500 visiting professors every year to work in its thirteen laboratories

**Polytechnique – Département de mathématiques et de génie industriel**

- A team of 57 researchers working on innovation, operation research, AI, applied mathematics and engineering.

**HEC - Département de sciences de la décision**

- 32 professors involved in mathematics for management (statistics, operation research, decision analysis, probabilities and financial mathematics).

**UdeM – Département de l'information et de recherche opérationnelle**

- Created in 1966 following the founding on the Université de Montréal's first computer laboratory.
- Now brings together 40 researchers and 3 Canada Research Chairs.



# This culminated in 2016 when UdeM/HEC/Poly were awarded the Canada First Research Excellence grant in data science



## Context



## Why this matters

### Awards

- In September 2016, IVADO received a **\$93.5 million grant** from the Federal Government for deep learning research
- The award is the **largest in the universities' history**
- Andrea Lodi received the **Canada Excellence Research Chair** in “Data Science for Real-Time Decision Making”

### Commitment

- Develop fundamental research using **massive data sets** from which to draw **useful information and develop actionable decisions**
- Prioritize **marketplace applications, industry partnerships and spin-offs** in health, transportation, ICT, and energy networks

- UdeM, HEC, and Polytechnique worked together to secure Montreal's leadership position in data science research
- A jury of academic peers selected Montreal, cementing Montreal's global academic reputation
- Montreal has the funding to develop world-leading fundamental research in data science and artificial intelligence
- IVADO reached out to University of Alberta and McGill to collaborate

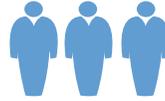
# The CFREF grant consecrated the Montreal ecosystem as a leading hub in data science and artificial intelligence

## #1 university hub in Canada



- At 900 researchers and doctoral students, Montreal has the **biggest and most prestigious group of data sciences researchers** in the world
- World-renowned academics, including Yoshua Bengio, one of the **founding fathers of the deep learning** movement
- The Institute for **Data Valorisation (IVADO)** was **created** to make Montréal a leader in data science and AI&OR
- Montreal got **\$93.5 million funding for AI&OR research** funding through IVADO in 2016, on top of **\$140 million from partners**

## Leading start-ups & scale-ups



- Presence of **Element AI, a world leading applied AI research company** that launches AI-first solutions in partnership with large corporations
- Up to **2,600 startups** with a pool of skilled talent of approximately 8,000 employees
- **125 technology-focused meet-up groups** connected to startups and 45,000 members
- **Large ecosystem of VC funds** focused on pre-seed to growth equity
- **Grassroots organizations** such as MTL Data, Data Driven MTL, MTL Machine Learning

## Strong corporate network



- Significant **investments from Google, Amazon and Microsoft** in the past year with a desire to make Montreal a central talent hub
- A robust data infrastructure system with at least **2,100 data specialists**
- 91,000 ICT professionals and ranked **1<sup>st</sup> for lowest ICT business operating cost in software development**
- **Leading cloud / datacenter market in Canada**; Amazon recently announced data center investment
- Headquarters to a number of large corporates looking to **invest in data science and integrate it in their business models**

# To reach its full potential, the Montreal ecosystem must create opportunities to increase collaboration and promote commercialization

## Levers to reach full potential

