Ridout & Maybee LLP

CANADA'S INTELLECTUAL PROPERTY AND TECHNOLOGY LAW FIRM

Patent and R&D Trends in Artificial Intelligence, Machine Learning, and Big Data

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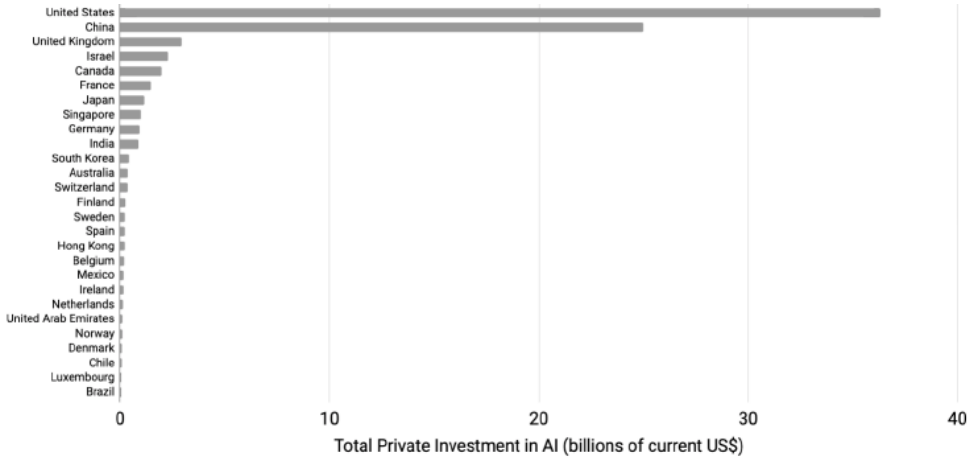
Total Private Investment in AI Jan 2018 – Oct 2019

- **In 2019, the global private AI investment was over $70B**
- AI-related startup investments was over $37B, M&A $34B, IPOs $5B, and Minority Stake valued around $2B
- Globally, investment in AI startups increased from a total of $1.3B raised in 2010 to over $40.4B in 2018; funding has increased at an average annual growth rate of over 48%
- **58% of large companies surveyed report adopting AI in at least one function or business unit in 2019, up from 47% in 2018**



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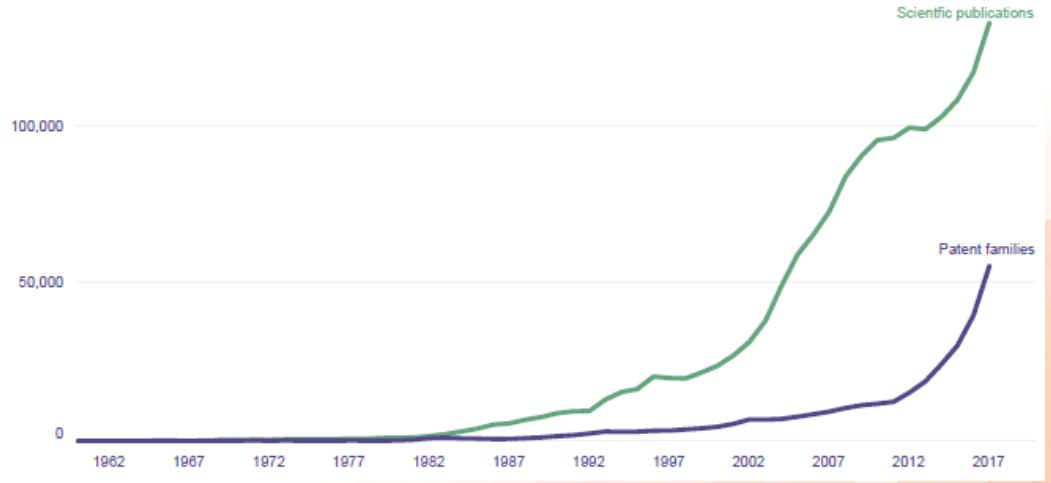
Growth of Global AI Innovation

- The number of AI journal publications grew by 34.5% from 2019 to 2020
- By 2019, nearly 340,000 AI patent families and more than 1.6 million AI scientific papers were published from 1960 until early 2018
- This figure compares patent filings with scientific publications since 1960 – the boom in AI related research in the last decade is clear

AI patent families grew by an average of 28 percent and scientific publications by 5.6 percent annually between 2012 and 2017



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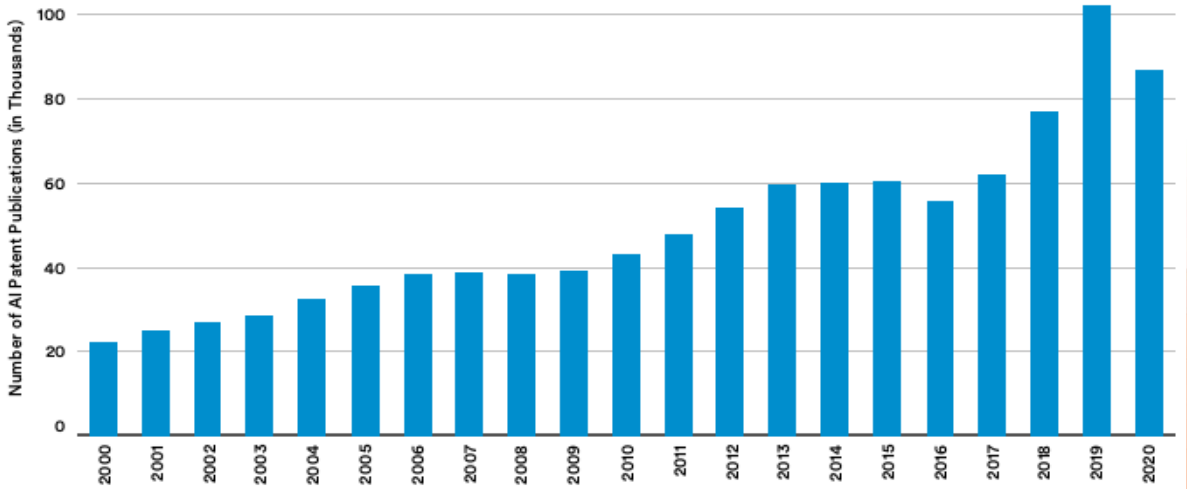
Growth of AI Patent Applications

- Number of AI patents published has been steadily increasing in the past two decades
- 21,806 patent applications published in 2000 to 101,876 published in 2019 (4.5 times)
- NOTE: 2020 in this chart may not be complete due to publication restrictions
- There are 85,144 (from 1998 to 2017) AI patented inventions worldwide, and Canada accounts for 1,516 AI patented inventions – 1.8%
- **Worldwide patent filings in AI increased on average by 31% annually between 2011-2017**



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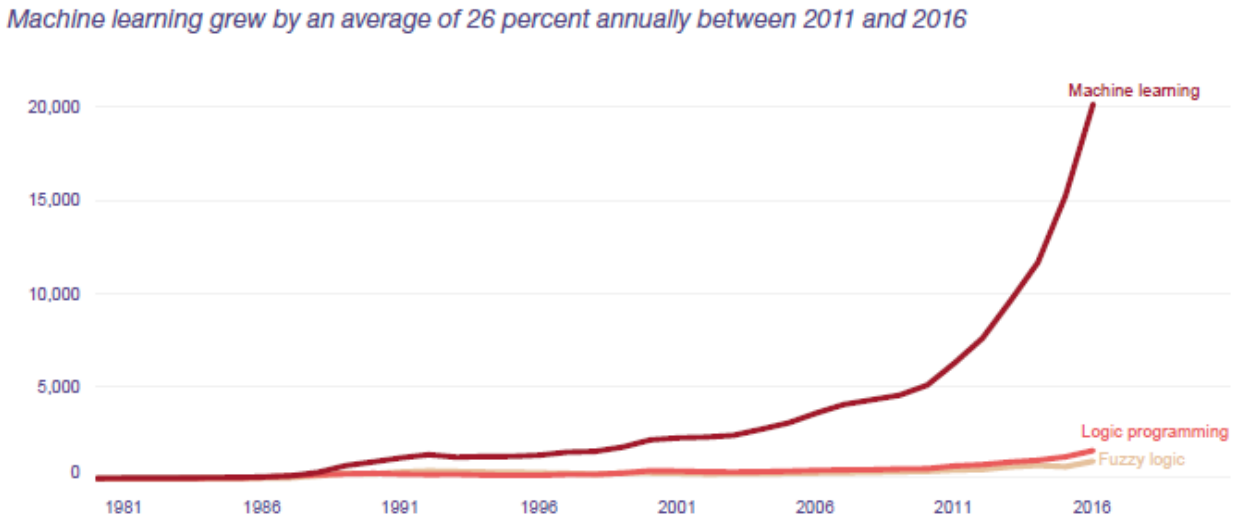
Growth Driven by Machine Learning & Big Data

- Machine learning and AI are not two terms for the same thing; AI is a broad concept, and machine learning is a technique for AI
- Logic programming and fuzzy logic are other AI techniques; however, machine learning grew significantly in the last two decades
- Machine learning is the study of algorithms that automatically improve through experience
- **Machine learning relies on large datasets for training – data is the limiting factor in building competitive machine learning technologies**



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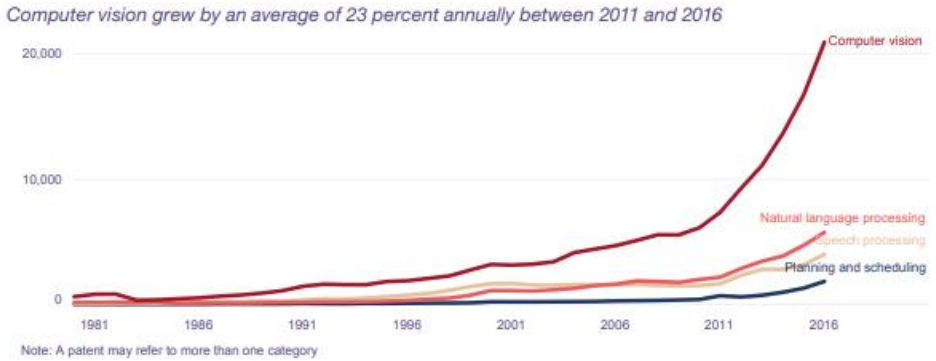
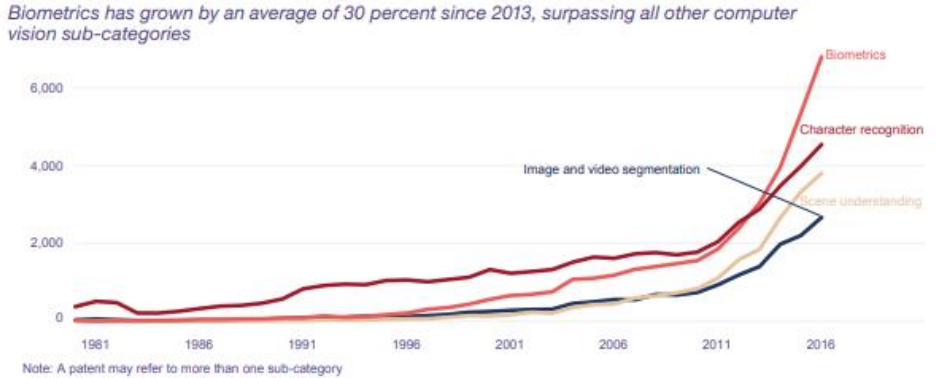
Computer Vision is the #1 AI Application

- Computer vision is mentioned in 49 percent of all AI-related patents (167,038 patent documents), growing annually by an average of 23 percent from 2011-2016 (21,011 patent applications filed in 2016).
- Within computer vision, Biometrics is the most-patented application, followed by character recognition, scene understanding, and image and video segmentation





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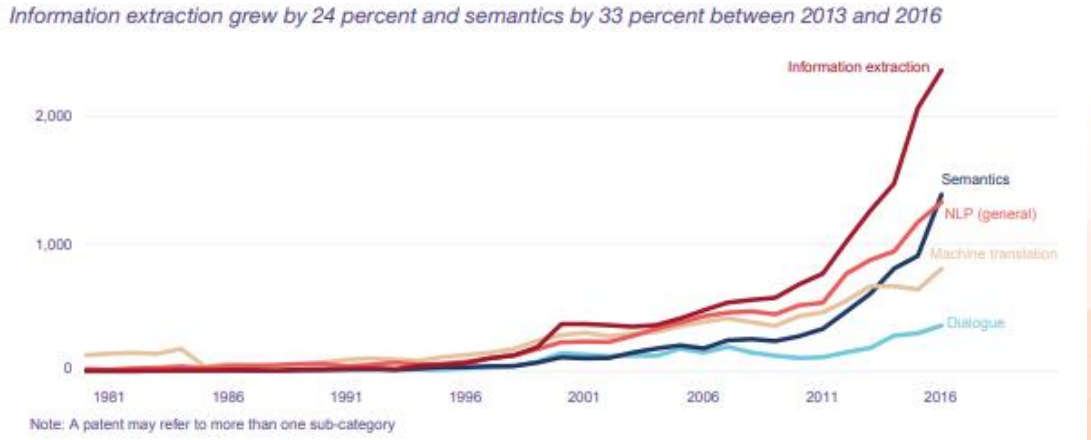
Natural Language Processing (NLP) is #2

- Natural language processing (NLP) accounts for 14 percent of all AI-related patents, followed by speech processing (13 percent)
- Within NLP, the most patented application is information extraction, followed by semantics, general NLP, machine translation, and dialogue



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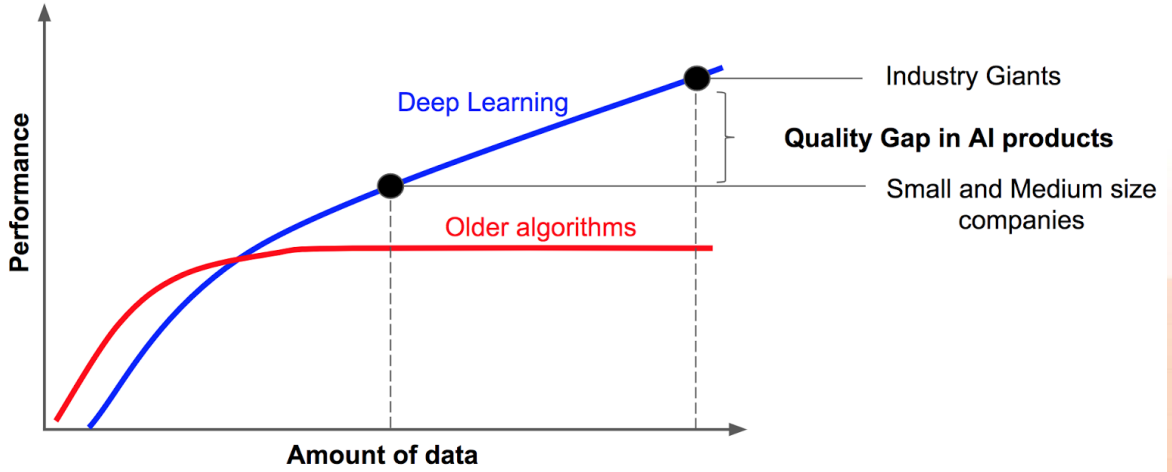
Deep Learning and Big Data

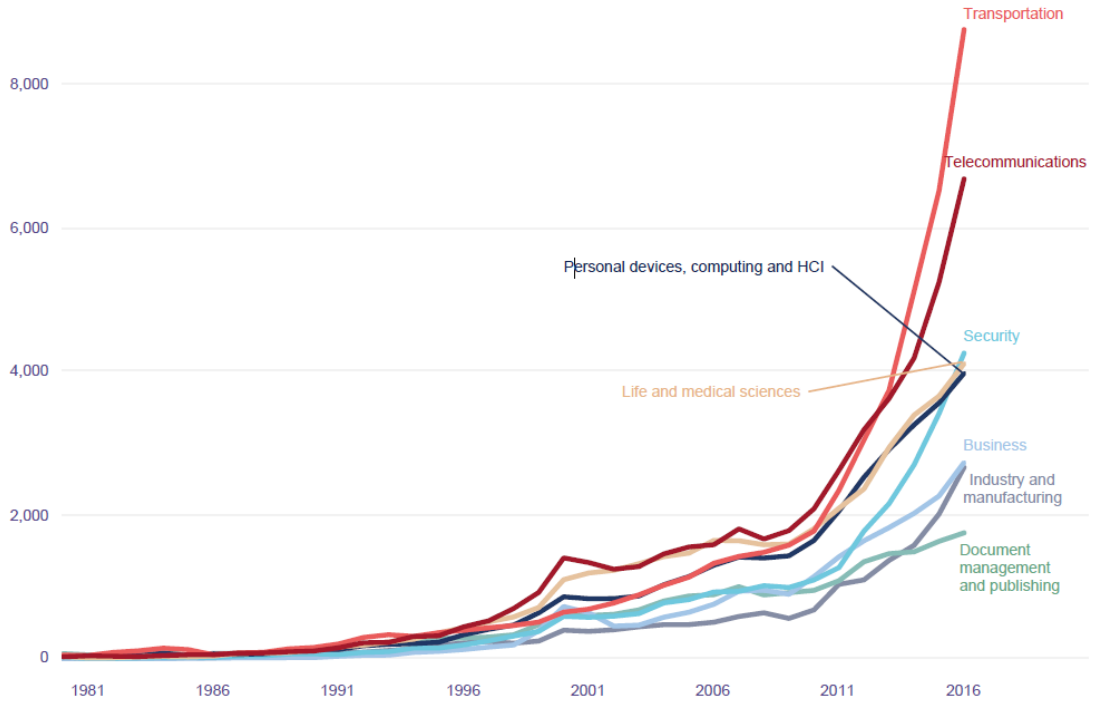
- The most marked increase in patenting activity between 2013 and 2016 features deep learning, a branch of machine learning
- "Garbage in, garbage out": as more and better data is collected, AI gets smarter
- Industry giants have much more data than others
- The quality of an AI product is defined by the amount and quality of the data used for training
- Google, Facebook, and others may share their algorithms, for **FREE**, but they won't share their data!



Hacker Noon – Big Challenge in Deep Learning: Training Data

Global AI Patent Families by Industry

- AI applications emerged in the 1990's but boomed after 2011
- This figure illustrates emerging trends until 2016



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Top AI Patent Applicants by Industry

- Patent applications by companies outnumber universities and public research organizations
- This table shows individual companies' AI patent portfolio sizes for a wide range of applications
- These are the top 20 players for AI applications, with patent portfolio counts broken down by industry sector

	Transportation	Personal devices, computing and HCI	Telecommunications	Document management and publishing	Life and medical sciences	Security	Business	Industry and manufacturing	Physical sciences and engineering	Energy management	Arts and humanities	Networks	Education	Cartography	Entertainment	Computing in government
Alphabet	333	709	593	521	119	206	463	61	53	18	163	241	67	361	55	38
Bosch	1,469	137	185	17	129	184	14	58	230	155	9	13	25	21	10	3
Canon	56	293	195	496	380	118	56	50	33	15	89	28	31	11	11	18
Fujitsu	299	200	253	326	401	351	173	110	55	25	73	54	66	8	22	34
Hitachi	735	306	338	270	447	297	168	199	256	141	98	61	90	23	13	37
IBM	424	1,050	759	1,223	553	486	935	546	112	43	150	308	215	184	82	81
LG Corporation	451	409	524	71	113	212	94	49	57	93	84	43	15	9	13	10
Microsoft	278	1,438	754	944	319	377	780	192	155	22	209	332	151	218	236	96
Mitsubishi	501	130	179	119	171	121	50	88	148	94	42	45	49	17	17	14
NEC	190	203	438	351	368	317	197	105	69	51	97	58	63	21	17	47
NTT	42	72	273	177	129	107	61	27	23	21	55	57	36	14	11	22
Panasonic	487	323	494	251	322	261	115	96	101	97	145	53	80	21	45	31
Ricoh	163	176	134	367	55	72	95	81	22	6	62	44	24	10	7	24
Samsung	538	922	755	265	595	446	183	131	165	140	176	135	73	42	62	44
SGCC	184	160	374	43	158	322	194	518	36	646	6	148	14	114	1	55
Sharp	88	153	142	203	92	54	21	28	33	7	74	14	35	7	8	16
Siemens	415	268	458	170	1,127	293	60	266	323	164	51	58	58	39	11	31
Sony	209	495	538	196	372	299	194	46	85	34	267	88	106	67	314	32
Toshiba	286	336	274	439	390	161	232	132	108	142	158	73	37	12	12	50
Toyota	1,987	169	198	14	188	92	26	36	267	173	40	30	80	31	15	19

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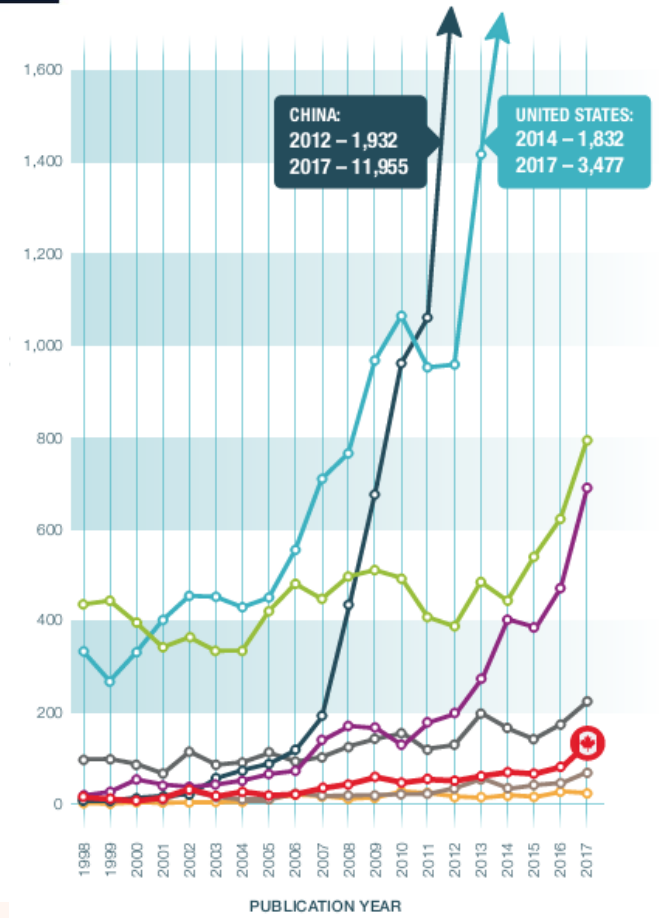
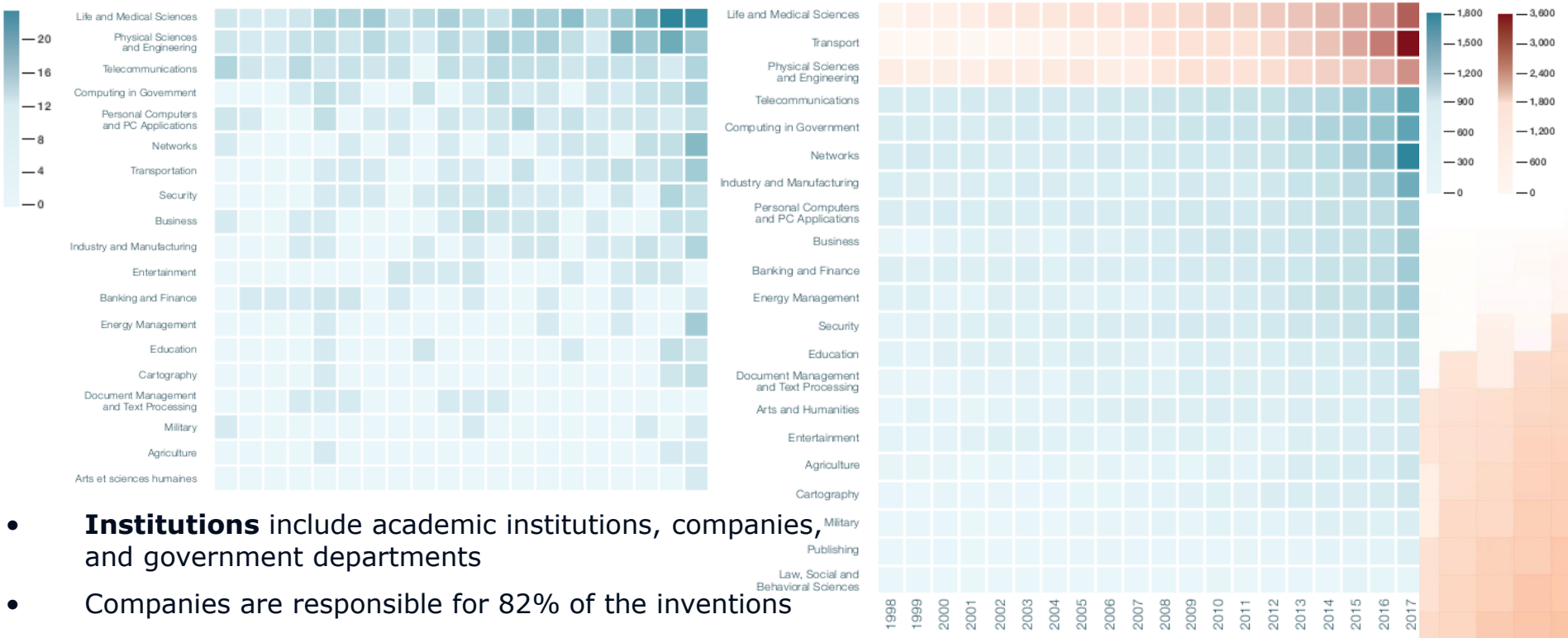
Patented Inventions Published Over Time Based on Country of Origin of Assignee

- China has made a considerable headway in patenting AI inventions
- Canada ranks sixth overall



Processing Artificial Intelligence: Highlighting the Canadian Patent Landscape, pg 13

Applications of AI Inventions, by Industry, Patented by: Canadian Institutions and International Institutions



- **Institutions** include academic institutions, companies, and government departments
- Companies are responsible for 82% of the inventions

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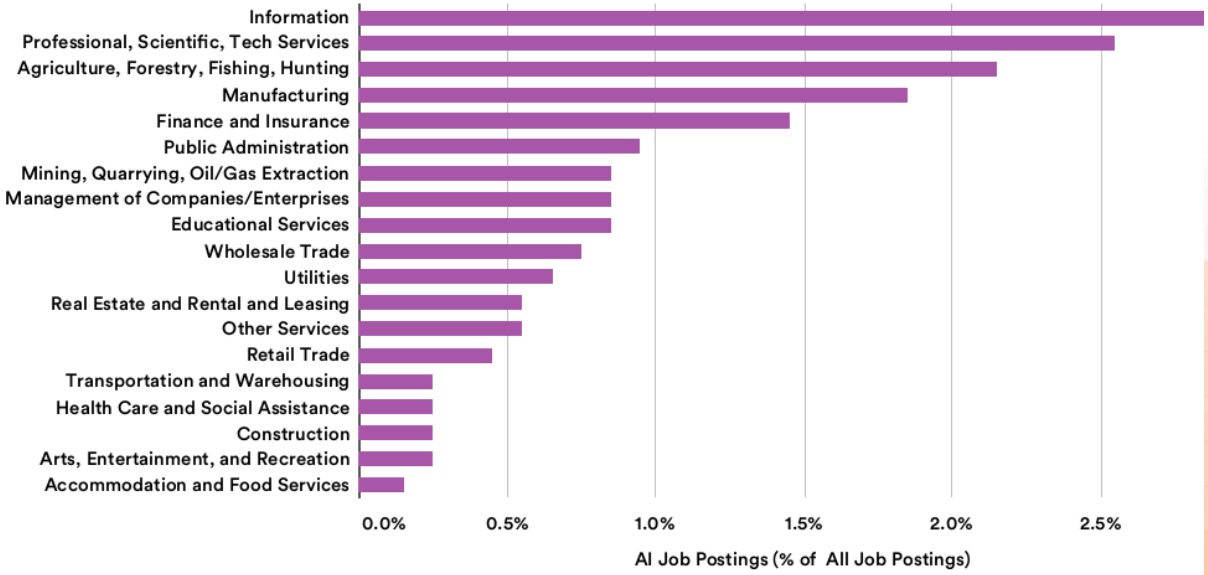
AI Job Postings (AI as share of jobs in each industry) in the US, 2020

- Brazil, India, **Canada**, Singapore, and South Africa are the countries with the highest growth in AI hiring from 2016 to 2020
- This figure demonstrates AI's share of job postings in each industry in the United States



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Thank you!

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