

SC3000/CZ3005 Artificial Intelligence

Introduction

Prof Bo AN

Research area: artificial intelligence, computational game theory, reinforcement learning, optimization
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Schedule

- Introduction
- Intelligent agents
- Uninformed search
- Informed search
- Constraint satisfaction
- Adversarial search
- Markov decision process
- Reinforcement learning
- Computational game theory

Who Am I?

<http://www.ntu.edu.sg/home/boan/>



- President's Council Chair Professor, Assistant Chair (Innovation)
- Co-Director of Artificial Intelligence Research Institute (AI.R)
- Research interests: artificial intelligence, multi-agent systems, computational game theory, reinforcement learning, optimization
- Over 100 papers at top AI conferences AAAI, IJCAI, AAMAS, KDD, WWW, EC, NeurIPS, ICLR, UAI, ICML, AISTATS, EC
- Ph.D CS University of Massachusetts Amherst, 2006-2011
 - Advisor Victor Lesser, father of multi-agent systems, AAAI/IEEE Fellow
 - 2010 IFAAMAS (International Foundation for Autonomous Agents and Multiagent Systems) Distinguished Dissertation Award
- Postdoc, CS University of Southern California
 - Advisor Milind Tambe, AAAI/ACM Fellow
- Other selected awards
 - Best Innovative Application Paper award at AAMAS' 2011
 - 2012 INFORMS Daniel H. Wagner Prize for Excellence in Operations Research Practice
 - Innovative Application Award at IAAI-16
 - Early Career Spotlight Talk at UCAI/2017
 - Winner of the 2017 Microsoft Collaborative AI Challenge
 - 2018 IEEE Intelligent Systems' "AI's 10 to Watch"
 - 2018 Nanyang Research Award ('Young Investigator')
 - 2021 ACM Distinguished Member

CZ3005 Matters



- Lecturers: Bo An, Yu Han
- Optional Textbook: S. Russell and P. Norvig *Artificial Intelligence: A Modern Approach* Prentice Hall, 2010, [Third Edition](#)
- Grading: Programming/lab assignment (40%), Final exam (60%)
- During class: You may ask questions
 - Online (10:30-11:30 on Monday and 12:30-13:30 on Tuesday at LT1A)
- After class: visit my office, schedule a meeting, office hour
- Tutorials start from week 3
- 2 Lab Sessions: starts from week 5/6, details to be announced in week 4
- If you can follow lectures, you can do very well in the final exam
- Deal with students with different background
- For students who want to learn more:
 - Talk to me, visit my webpage & read papers, research opportunities

Schedule for the First Half



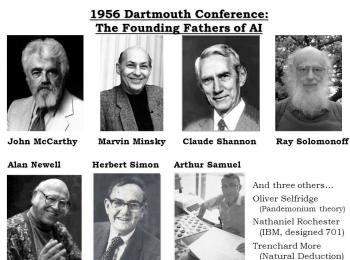
Week	Date	Lecture	Lecture Topic	Tutorial	Lab
1	August 14	1	Introduction		
	August 15	2	Intelligent agents		
2	August 21	3	Uninformed search		
	August 22	4	Informed search		
3	August 28	5	Constraint satisfaction		
	August 29	6	Adversarial search	Tutorial 1	
4	September 4	7	Markov decision process		
	September 5	8	Markov decision process	Tutorial 2	
5	September 11	9	Reinforcement learning		
	September 12	10	Reinforcement learning		
6	September 18	11	Computational game theory		
	September 19	12	Computational game theory	Tutorial 3	
7	September 25	E-learning			
	September 26	E-learning			
		RECESS			

One session in
week 5/6

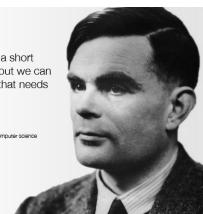
The Birth of AI



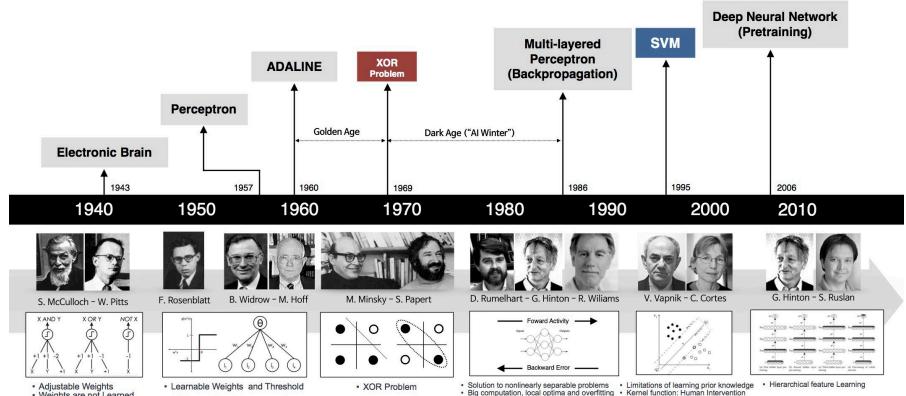
AI is intelligence demonstrated by machines, in contrast to the **natural intelligence (NI)** displayed by humans and other animals.



"We can only see a short distance ahead, but we can see plenty there that needs to be done."
~ Alan Turing
the father of modern computer science



Timeline of AI Development

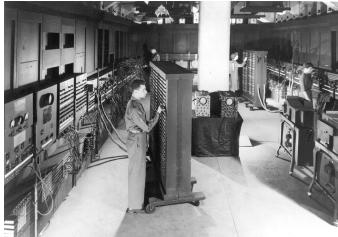


Outline

- A brief history of AI
- The state of the art
- Some recent research

Computer Chess

Garry Kasparov VS Deep Blue



ENIAC 1946

VS



Deep Blue 1997



Robot Soccer

TED talk by Peter Stone from UT Austin

http://www.youtube.com/watch?v=FXhw0_-iKwQ



Game Show



IBM's Watson Destroys Humans in Jeopardy
<https://www.youtube.com/watch?v=P18EdAKuC1U>



AlphaGo vs World Champions

March 9 – 15, 2016 (Lee Sedol)

- Time limit: 2 hours
- Venue: Seoul, Four Seasons Hotel
- AlphaGo Wins (4:1)

May 23 – 27, 2017 (Ke Jie)

- Venue: Wuzhen, China
- AlphaGo Wins (3:0)



Libratus vs World Champions

The first AI to defeat top human poker players

January 11 to 31, 2017

- Venue: Pittsburgh
- 120,000 hands
- Has nothing to do with deep learning
- Algorithms for solving large scale games



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Google Driverless Car

TED talk by Sebastian Thrun from Stanford

<https://www.youtube.com/watch?v=bp9KBrH8H04>

- AI is still at very early stage!



Boston Dynamics



<https://www.youtube.com/watch?v=4NzcB6TMzjw>
<https://www.youtube.com/watch?v=fn3KWM1kuAw>



- Hyundai (2020–present)
- SoftBank (2017–2020)
- Google (2013–2017)

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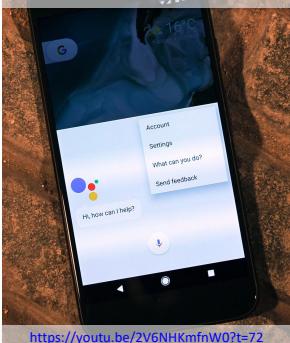
Natural Language Processing

Mi Box Voice Assistant



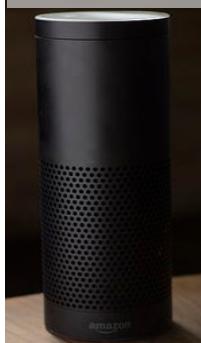
<https://youtu.be/S38ZIELrMmQ?t=16>

Google Assistant



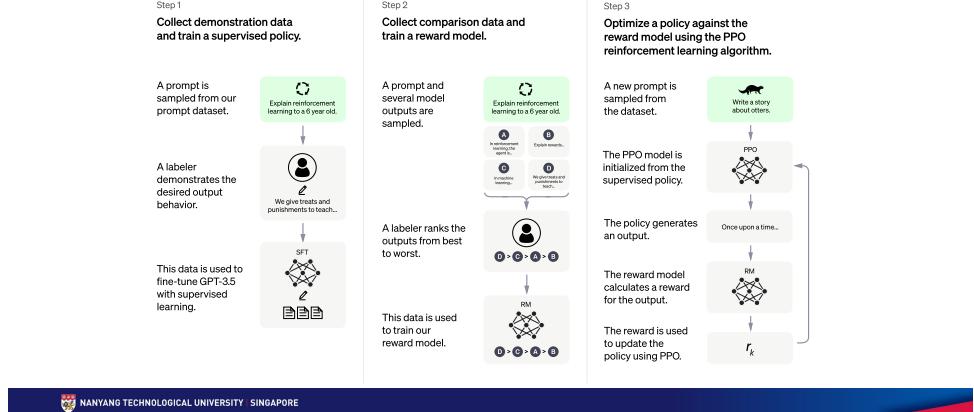
<https://youtu.be/2V6NHkmfnW0?t=72>

Alexa Amazon



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ChatGPT



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Amazing AIGC (AI Generated Content)

Input: A tissue box with word 'pytorch'



Input: A clock in shape of an avocado



Input: A 'pytorch' brand mouthwater



Input: A clock imitating a strawberry



Input: 'OpenAI' written on a T-shirt



Input: A teapot in style of pigs



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Manufacturing

Tesla

<https://www.youtube.com/watch?v=-Ds1xV7M2gl>

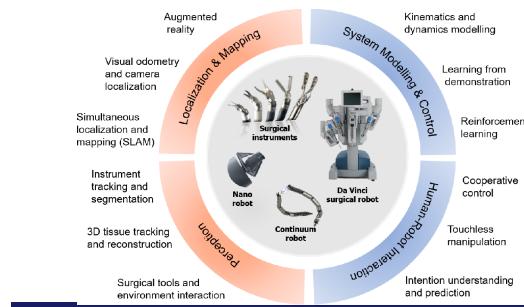
New factory



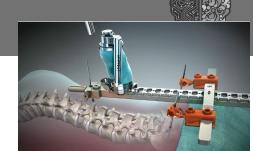
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AI for Surgical Robotics

- [Da Vinci](#) Surgical System: FDA approval in 2000
- Virtual Incision's MIRA Surgical Platform
- Mazor Robotics Renaissance



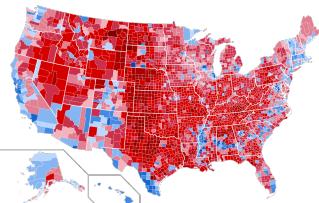
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AI Predicts Elections

An artificial intelligence system that correctly predicted the last 3 elections says Trump will win

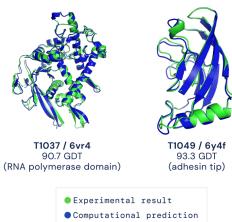
Pamela Engel, Business Insider US
October 29, 2016



- MogIA, uses 20 million data points from online platforms like Google, YouTube, and Twitter to come up with its predictions.
- MogIA correctly predicted the past three presidential elections as well as the Democratic and Republican primaries.

AI in Biology

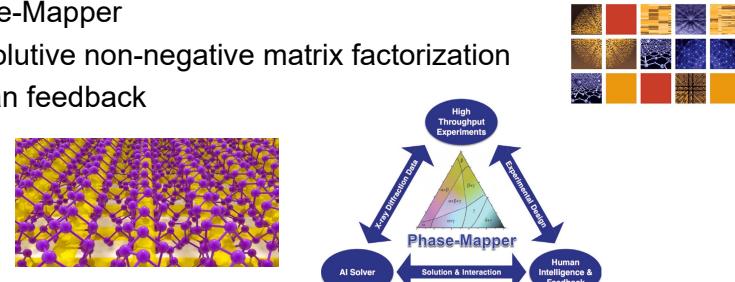
- A grand challenge in biology for the past 50 years
 - Predict a protein's unique 3D structure
- Traditional methods take years of laborious work per structure and multi-million dollar specialized equipment
- AlphaFold, 2020
 - High accuracy
 - Saving time and money



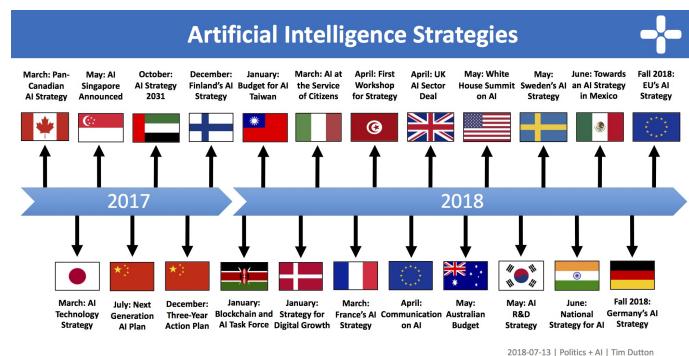
Accelerating Materials Discovery

- Phase map identification
- crystal structure of materials
- Phase-Mapper
- convolutive non-negative matrix factorization
- human feedback

materials DISCOVERY



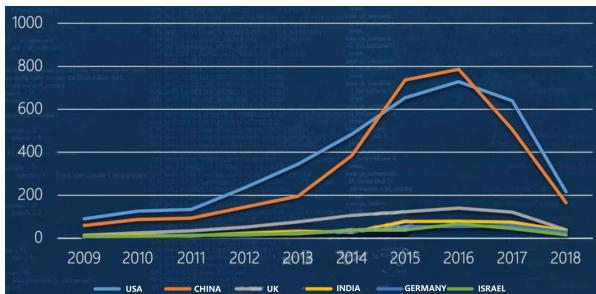
An Overview of National AI Strategies



Newly Added AI Companies in Main Countries



- Before 2016, it increases
- After 2017, it decreases



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Newly Added Financing of AI Companies

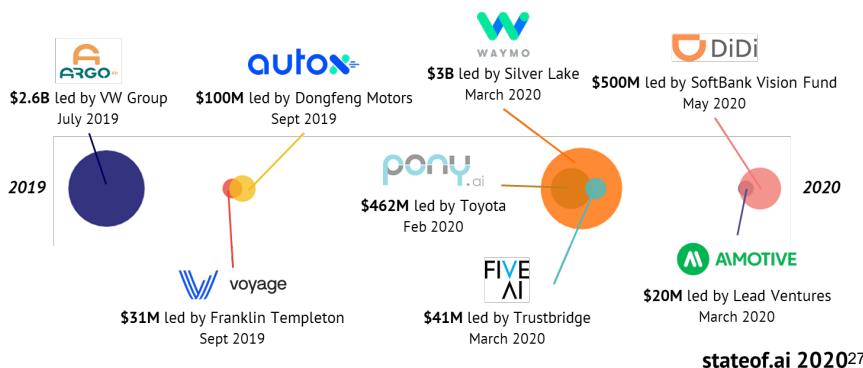


- Different from the newly added AI companies, the financing increases



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Self-driving Contenders Raised \$7B Since July 2019

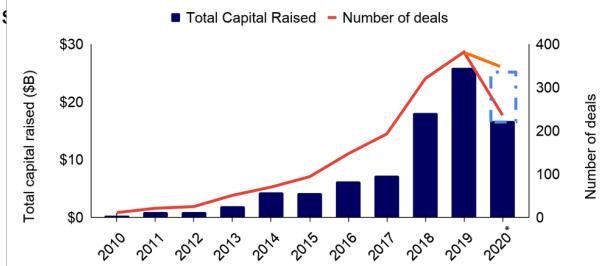


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Private >\$15M Funding Rounds for AI-first Companies Remain Strong in Spite of COVID-19



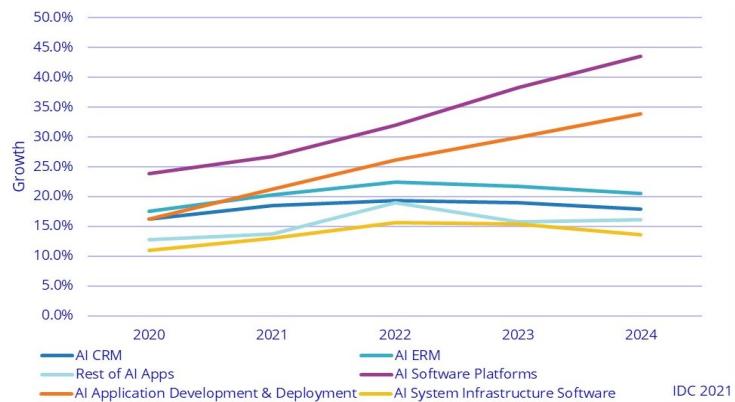
- 2020 is likely to hit \$25B+ in total volume and 350+ deals. Rounds >\$100M consistently account for ~10% of all funding rounds since 2018 onwards.



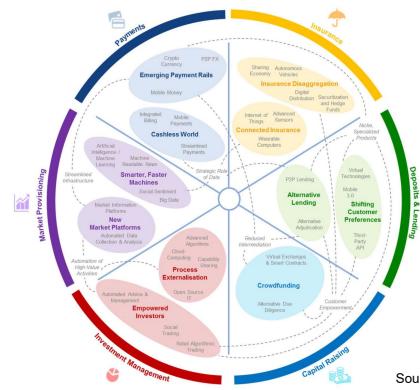
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*Data as of 15 August 2020. Asterisk indicates annualized figures for 2020 using light blue and orange.

Worldwide AI Software Forecast



Artificial Intelligence for Finance



Source: World Economic Forum, 2015

AI still at Very Early Stage

- Recent AI breakthrough



- What's next: AI for **complex** interaction

Stochastic, open environment



Multiple players



Sequential decision, online



Strategic (selfish) behavior



Distributed optimization

Some Recent Research

- Separate slides and will not be covered in any quiz/exam