Artificial Intelligence Introduction



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AI in the movies



"Intelligence: The ability to learn and solve problems" Webster's Dictionary.

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"Artificial intelligence (AI) is the intelligence exhibited by machines or software'

Wikipedia.

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"The science and engineering of making intelligent machines"

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"The study and design of intelligent agents, where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success." Russel and Norvig AI book.

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"Just as the Industrial Revolution freed up a lot of humanity from physical drudgery, I think AI has the potential to free up humanity from a lot of the mental drudgery."

Andrew Ng.

Four schools of thoughts (Russel & Norvig)

Thinking humanly	Thinking rationally				
"The exciting new effort to make computers think <i>machines with</i> <i>minds</i> , in the full and literal sense." (Haugeland, 1985)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985				
Acting humanly	Acting rationally				
"The study of how to make com- puters do things which, at the mo- ment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998)				

Thinking humanly: cognitive approach



Requires to determine how humans think!

1960's "cognitive revolution".

Requires scientific theories of internal activities of the brain

- What level of abstraction? "Knowledge" or "circuits"?
- How to validate?

Today, Cognitive Science and Artificial Intelligence are distinct disciplines.

Acting humanly:

• **Turing test (Alan Turing 1950)**: A computer passes the test of intelligence, if it can fool a human interrogator.



Credit: From Russel and Norvig slides.

• Major components of AI: knowledge, reasoning, language, understanding, learning.

Acting humanly:





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Thinking rationally: Laws of thoughts.

- Codify "right thinking" with logic.
- Several Greek schools developed various forms of logic: *notation* and *rules of derivation* for thoughts.
- Problems:
 - 1. Not all knowledge can be expressed with logical notations.
 - 2. Computational blow up.

Acting rationally:

- The right thing: that which is expected to maximize goal achievement, given the available information.
- A rational agent is one that acts so as to achieve the best outcome, or when there is uncertainty, the best expected outcome.
- Aristotle (Nicomachean Ethics):
 "Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good."

Four schools of thoughts (Russel & Norvig)

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Acting humanly	Acting rationally: Our approach
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Speech recognition

- Virtual assistants: Siri (Apple), Echo (Amazon), Google Now, Cortana (Microsoft).
- "They" helps get things done: send an email, make an appointment, find a restaurant, tell you the weather and more.
- Leverage deep neural networks to handle **speech recognition** and **natural language understanding**.



Handwriting recognition (check, zipcode)



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Machine translation

- Historical motivation: translate Russian to English.
- First systems using **mechanical translation** (one-to-one correspondence) failed!
- "Out of sight, out of mind" \Rightarrow "Invisible, imbecile".

Machine translation

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Oops!

Machine translation

- MT has gone through ups and downs.
- Today, **Statistical Machine Translation** leverages the vast amounts of **available translated corpuses**.
- While there is room for improvement, machine translation has made significant progress.

Machine translation

Google

Translate

	Detect language Afrikaans	Considen Croatien	Gujerati Haitian Crecke	Kazakh Khmer	Marathi Mongolian	Shona Sinchi	Undu Uzbek
	Albanian	Czech	Hausa	Korean	Myanmar (Burmese)	Sinhala	Vietnamese
	Amharic	Danish	Hawailan	Kurdish (Kurmanji)	Nepali	Slovek	Weish
	Arabic	Dutch	Hebrew	Kyngyz	Norwegian	Sipvenian	Xhosa
B *	Armenian	English	Hindi	Lao	Pashlo	Somal	Yiddish
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	Belarusian	Filipino	loelandic	Lithuanian	Portuguese	Swahili	
	Bengali	Finnish	lgbo	Luxembourgish	Punjabi	Swedish	
	Bosnian	French	Indonesian	Macedonian	Romanian	Tajik	
	Bulgarian	Frislan	Iriah	Malagaey	Russian	Tamil	
	Catalan	Galician	Italian	Malay	Semoen	Telugu	
	Cebuano	Georgian	Japanese	Malayalam	Scots Gaelic	Thai	
	Chichewa	German	Javanese	Maitese	Serbian	Turkish	
	Chinese	Greek	Kannada	Maori	Sesotho	Ukrainian	

Google Translate for Business: Translator Toolkit Website Translator Global Market Finder

100+ languages

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Machine translation

Google	I
Translate	Turn of indust transition
Arabic English French Detect language -	English Arabis French - Second
out of sight, out of mind ×	hors de vue, hors de l'esprit
43 858 - 25/5000	± ₩ 40 < Øregest av att

See also out of sight out of mind, out, of, mind, sight, out of, out of mind

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Robotics: Awesome robots today! NAO, ASIMO, and more!



Credit: By Momotarou2012, via Wikimedia Commons.

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Recommendation systems (collaborative filtering)



Customers Who Bought This Item Also Bought





SNG Party with WilU Microphone Nintendo

★★★★ (25) Nintendo Wi U \$15.99 -Prime



Wi U Microphone Nintendo. **** Nintendo Wi U \$8.98 -thim



Barble Dreamhouse Party -Wil Party U Nintendo Wil U Netendo Majesco Sales Inc. ***** (40) 会会会 (5) Nintendo WirU Ninlando Wi U \$39.99 _dhime

\$39.96 <Prime

Just Dance 2014 -Nintendo Wil U UDI Soft ****** (50) Nintendo Wi U \$35.21 -Finance



WILL



Just Dance 4 - Nintendo UBI Soft



Nintendo Wil U UDI Soft *** (24) Ninteinda Will U \$19.23 -Philms



ESPN Sports Connection -



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Search engines



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Sent Mail Drafts (1)	1-800-FLOWERS.COM	Free Shipping Today & Tomorrow! - Send a smile,	
. Circles	The Body Shop	Buy 3 Get 3 or Buy 2 Get 2 FREE All Beth & Body - Moga Moistant, Mini Pres. 8	9:35 am
Less +	🗅 🍲 🗁 WebMD	Have you logged your food and fitness today? - Food & Fitness Planner Dear fi	9:26 am
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Face detection



Viola-Jones method.

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Face detection



Viola-Jones method.

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Face detection



Viola-Jones method.

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Face recognition



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Detection of breast cancer in mammography images



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Chess (1997): Kasparov vs. IBM Deep Blue





(Left) Copyright 2007, S.M.S.I., Inc. - Owen Williams, The Kasparov Agency, via Wikimedia Commons (Right) By James the photographer, via Wikimedia Commons

Powerful search algorithms!

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Jeopardy! (2011): Humans vs. IBM Watson



By Rosemaryetoufee (Own work), via Wikimedia Commons

Natural Language Understanding and information extraction!

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Go (2016): Lee Sedol versus Google AlphaGo



(Left) By LG Electronics, via Wikimedia Commons (Right) By Google DeepMind, via Wikimedia Commons

Deep Learning, reinforcement learning, and search algorithms!

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Autonomous driving



By User Spaceape on en.wikipedia, via Wikimedia Commons

- DARPA Grand Challenge
 - 2005: 132 miles
 - 2007: Urban challenge
 - 2009: Google self-driving car

State-of-the-art applications

- Speech recognition
- Autonomous planning and scheduling
- Financial forecasting
- Game playing, video games
- Spam fighting
- Logistics planning
- Robotics (household, surgery, navigation)
- Machine translation
- Information extraction
- VLSI layout
- Automatic assembly
- Sentiment analysis

- Fraud detection
- Recommendation systems
- Web search engines
- Autonomous cars
- Energy optimization
- Question answering systems
- Social network analysis
- Medical diagnosis, imaging
- Route finding
- Traveling salesperson
- Protein design
- Document summarization
- Transportation/scheduling
- Computer animation

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Many more!



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• Philosophy

- Logic, methods of reasoning.
- Mind as physical system that operates as a set of rules.
- Foundations of learning, language, rationality.

• Mathematics

- Logic: Formal representation and proof.
- Computation, algorithms.
- Probability.

• Economics

- Formal theory of rational decisions.
- Combined decision theory and probability theory for decision making under uncertainty.
- Game theory.
- Markov decision processes.

• Neuroscience

- Study of brain functioning.
- How brains and computers are (dis)similar.

• Psychology

- How do we think and act?
- Cognitive psychology perceives the brain as an information processing machine.
- Led to the development of the field *cognitive science*: how could computer models be used to study *language, memory, and thinking* from a psychological perspective.

• Computer engineering

- Cares about how to build powerful machines to make AI possible.
- E.g., Self-driving cars are possible today thanks to advances in computer engineering.

• Control theory and cybernetics

- Design simple optimal agents receiving feedback from the environment.
- Modern control theory design systems that maximize an objective function over time.

• Linguistics

- How are language and thinking related.
- Modern linguistics + AI = Computational linguistics (Natural language processing).

History of AI

- **1940-1950**: Gestation of AI
 - McCulloch & Pitts: Boolean circuit to model of brain
 - Turing's Computing Machinery and Intelligence http://www.turingarchive.org/browse.php/B/9
- **1950-1970**: Early enthusiasm, great expectations
 - Early AI programs, Samuel's checkers program
 - Birth of AI @ Dartmouth meeting 1956.
 - Check out the MIT video "The thinking Machine" on youtube

https://www.youtube.com/watch?v=aygSMgK3BEM

- 1970-1990: Knowledge-based AI
 - Expert systems, AI becomes an industry
 - AI winter

History of AI

- 1990-present: Scientific approaches
 - Neural Networks: le retour
 - The emergence of intelligent agents
 - AI becomes "scientific", use of probability to model uncertainty
 - AI Spring!
 - The availability of very large datasets.
 - * Data will drive future discoveries and alleviate the complexity in AI.

Summary

- AI is a hard (computational complexity, language, vision, etc), and a broad field with high impact on humanity and society.
- What can AI do for us is already amazing!
- AI systems do not have to model human/nature but can act like or be inspired by human/nature.
- How human think is beyond the scope of this course.
- Rational (do the right thing) agents are central to our approach of AI.
- Note that rationality is not always possible in complicated environment but we will still aim to build rational agents.

Summary

- AI may be perceived as a scary area! Is AI a threat to our humankind?
- Professor Stephen Hawking, eminent scientist told BBC:

"The development of full artificial intelligence could spell the end of the human race."

- AI is a flourishing and exciting field: everyone can contribute.
- Looking forward for an exciting journey together!