Material 1

The Relationship between Artificial Intelligence and Finance

University of Tokyo, Yutaka Matsuo

Provisional Translation by the Secretariat
Please refer to the original material in Japanese

About Matsuo Lab in University of Tokyo

Yutaka Matsuo

1997 B.A. Information and Communication Engineering, The University of Tokyo, Japan.
2002 Ph.D. Information and Communication Engineering, The University of Tokyo. Japan.
Researcher, National Institute of Advanced Industrial Science and Technology, Japan.
2005 Visiting Scholar, Center for the Study of Language and Information, Stanford University
2007～ Associate Professor, Department of Engineering, The University of Tokyo, Japan
2014～ Director of “Chair for Global Consumer Intelligence”, The University of Tokyo, Japan
◆Primary Research Interests : Artificial intelligence, Deep learning, Web mining
◆Track Chair (Web Mining Track), World Wide Web Conference , 2013-
◆Member of program committee, International Joint Conference on Artificial Intelligence.
Editor-in-Chief, Transactions of the Japanese Society for Artificial Intelligence, 2012 – 2014.
Chair of ELSI committee, The Japanese Society for Artificial Intelligence, 2014-present.
◆JSAI Best Paper Award, Japanese Society for Artificial Intelligence(2002), IPSJ Nagao Special Researcher Award, Information Processing Society of Japan(2007), Docomo Mobile Science Award, NTT Docomo Inc.(2013), Remarkable Contributions to Science Technology Award (2015), The Okawa Prize (2015).
◆Professional Services : Member of Subcommittee, Industrial Structure Council, METI. Member of Information Economy Subcommittee, Commerce, Distribution and Information Committee, METI. Member of management committee, IoT Acceleration Consortium. Member of Committee on “Future Way of Working 2035”. Member of Conference on Genetic Technology, Cabinet Office. Member of Study Group concerning the Vision of the Future Society Brought by Accelerated Advancement of Intelligence in ICT.

＜About the Lab＞
◆Currently supervising 17 Doctorate students and 10 master and undergraduate students.
Research projects include (a) social network mining from the web, (b) big data analysis for companies and industries, and (c) application and advancement of deep learning.
◆Having had joint research with the companies such as Toyota, Recruit, Microsoft, CCC, IGPI, Mixi and so on. Consultants of Ministry like METI(Asia trend map) and Mext(Big date)
◆The career of the graduates : Google, DeNA, Rakuten, Cyberagent, Koe, Goldman Sachs , BCG, MITSUI & CO, Dentsu, etc. Some started new businesses and others operate and manage services like Gunosy and READYFOR.

Sho-gi Denno-sen

IBM Watson

http://venturebeat.com/2011/02/15/ibm-watson-jeopardy-2/, http://weekly.ascii.jp/elem/000/000/207/207410/

The deep learning revolution

- Winning on overwhelming victory in ILSVRC (2012)
- Technology in Google that can recognize a cat
- DeepMind purchased by Google(2013)
- FB and Baidu started AI research Lab（2013）
- AlphaGo（2016）

Application for a car and robot → Automated Driving, Pepper

Machine Learning — Web, Big date

Statistical natural language processing (mechanical translation. etc)

Application for search engine

MYCIN(medical diagnosis)
DENDRAL → Expert System → Ontology → Task Ontology

Watson(2011)

LOD（Linked Open Data)

Eliza → Research for system of communication → CALO Project → Siri(2012)

bot

Exploration, Maze and Puzzle → Planning, STRIPS → Chess（1997) Deep Blue → Sho-gi Denno-sen (professional shogi player's match against computer)(2012-) → Game of Go

1956 — 1970 — 1980 — 1995 — 2010 — 2015

the first boom of AI （deduction and exploration）

the second boom of AI （knowledge expression）

the third boom of AI （Machine Learning and Deep Learning）

The deep learning revolution

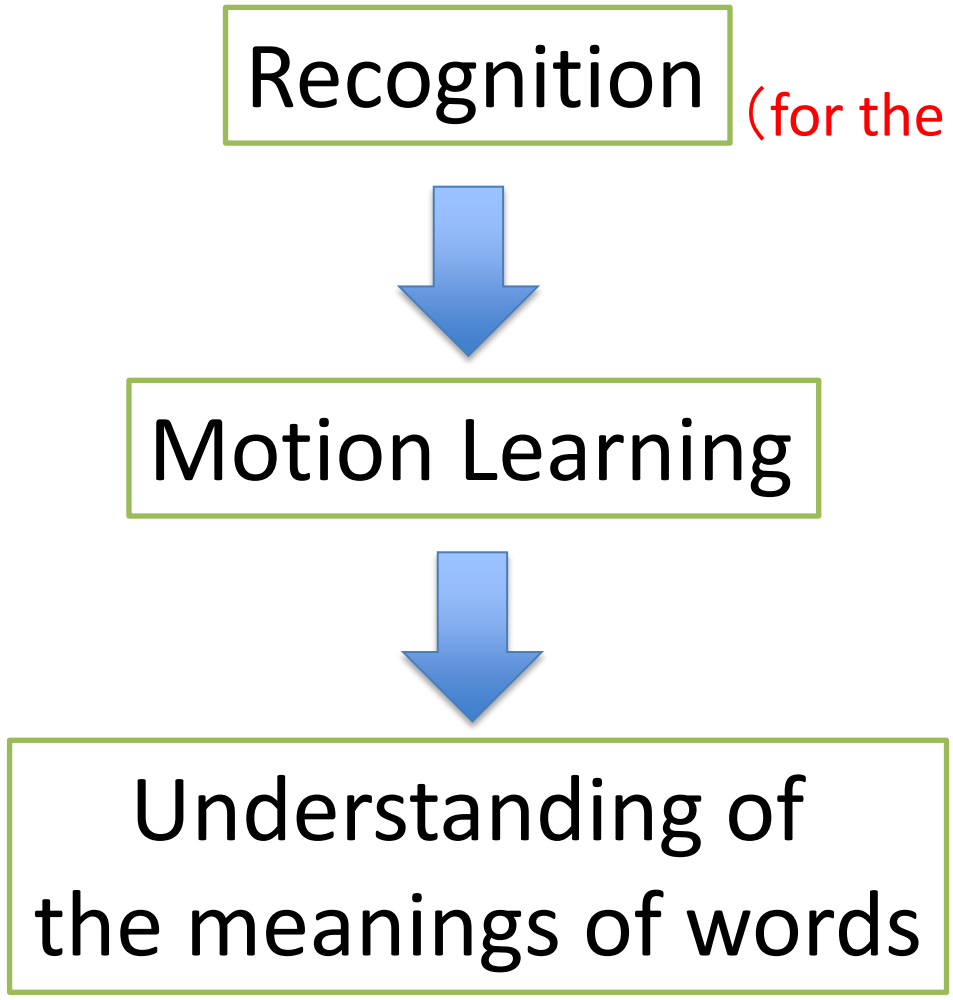


Image recognition
（for the first time since invention of computer!）

Robot and machine can exercise like human

Understanding of the meaning of words in a sentence
（Interconversion of words and pictures）

Recognition : Challenge

Dog

Cat

Wolf

- Trying to distinguish a dog from other animals
  - floppy ears and long eyes → Dog
  - pointy ears and round eyes → Cat
  - pointy ears and long eyes → Wolf

Dog

As long as computer recognize feature quantity , it is impossible to distinguish the animal correctly, because there is a exemption in any case. However, somehow human can do that.

Recognition：The achievement of deep learning（2012）

- ILSVRC2012：Large Scale Visual Recognition Challenge 2012

	Team name	Error	Description
Deep Learning	SuperVision	15.315%	Using extra training data from ImageNet Fall 2011 release
	SuperVision	16.422%	Using only supplied training data
Recognition of feature quantity for a long time	ISI	26.602%	Weighted sum of scores from classifiers using each FC
	ISI	26.646%	Naïve sum of scores from classifiers using each FV
	ISI	26.952%	Naïve sum of scores from each classifier with SIFT+FV, LBP+FV, GIST+FV and CSIFT+FV, respectively
	OXFORD_VGG	26.979%	Mixed selection from High-Level SVM scores and Baseline Scores, decision is performed by looking at the validation performance.
	…	…	…

In a completely different class

Recognition : After 2012

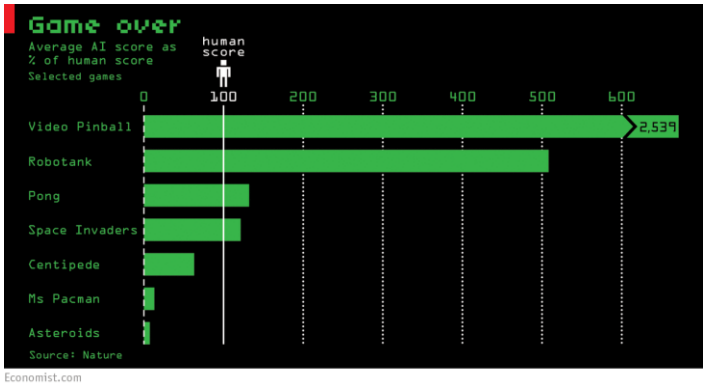
	Error
Before Deep Learning: Imagenet 2011 winner (not CNN)	25.7%
After Deep Learning: Imagenet 2012 winner	16.4% (Krizhesvky et al.)
Imagenet 2013 winner	11.7% (Zeiler/Clarifai)
Imagenet 2014 winner	6.7% (GoogLeNet)
Baidu Arxiv paper:2015/1/3	6.0%
Human: Andrej Karpathy	5.1%
Microsoft Research Arxiv paper: 2015/2/6	4.9%
Google Arxiv paper: 2015/3/2	4.8%
Microsoft Research CVPR paper: 2015/12/10	3.6%

In February 2015, Deep Learning exceeded human in accuracy at recognition of pictures

It had been impossible for several decades for computer to exceed human in accuracy at recognition of pictures

Motion Learning: Deep Learning + Reinforcement Learning (2013-)

- Reinforcement learning refers to a mechanism to learn actions.
  - When gaining rewards, the preceding action is reinforced
  - "State" and "action" → "Desirability" (with or without rewards)
  - This is a conventional technology, but so far, the state has been defined by humans.
- Motion learning has become possible.
  - Utilize deep learning for acknowledging the state
  - Developed by researchers of DeepMind (D. Hassabis, et.al) and later purchased by Google
- Motion is learned by trial and error.
  - Getting better through repetition from an awkward start
  - Finally become able to create a breakthrough in a breakout game and achieve a Nagoya attack in the game Space Invaders
  - Learn different games based on the exact same program and achieve higher scores than humans in half of the games

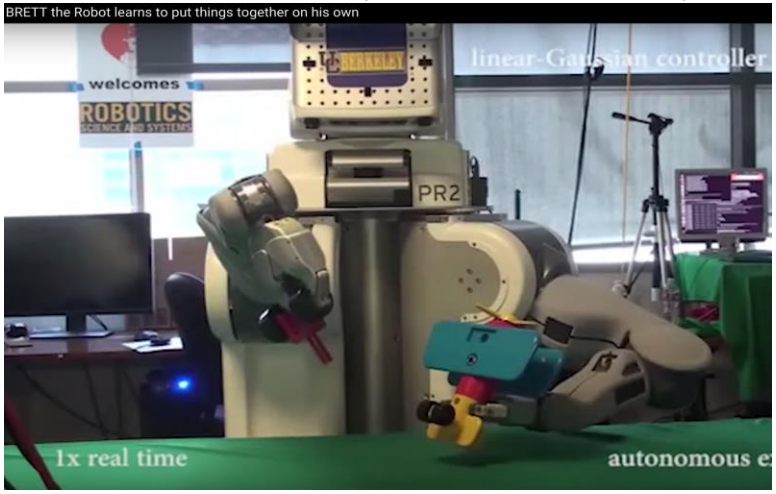


http://www.clubic.com/mag/actualite-756059-google-jeu-video.html
http://www.economist.com/news/briefing/21650526-artificial-intelligence-scares-peopleexcessively-so-rise-machines

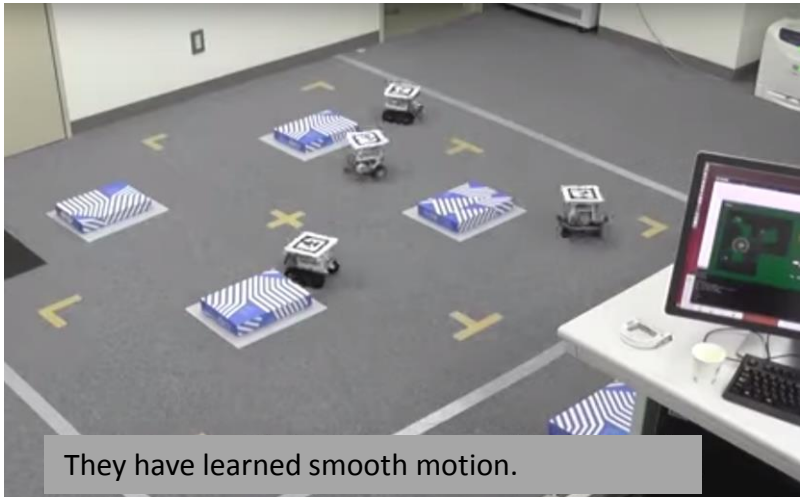
Motion Learning: Deep Learning + Reinforcement Learning is Applied in the Real World (2015-)

- Application in the real world
  - Developed a robot that learns the assembly of components by trial and error in May 2015 (UC Berkeley)
  - Developed a miniature car that learns driving by trial and error in May 2015 (PFN, Japan)
  - Developed a robot that becomes better at picking by trial and error in December 2015 (PFN and Fanuc, Japan)
  - Other projects by Maryland University, the EU, etc. are also progressing.
- Not at all surprising
  - Even dogs and cats learn motion. Higher-level linguistic competence is not required. The key was the recognition.
  - Historically, many AI researchers have insisted on this fact.

A robot that learns tasks by trial and error (UC Berkeley)



Miniature cars that learn driving by trial and error (PFN, Japan)



https://research.preferred.jp/2015/06/distributed-deep-reinforcement-learning/
http://news.berkeley.edu/2015/05/21/deep-learning-robot-masters-skills-via-trial-and-error/
http://www.nikkei.com/news/print-article/?R_FLG=0&bf=0&ng=DGXMZO83844520S5A300C1000000&uah=DF170520127709

Understanding the Meanings of Words : Automated Image Captioning (2014-)

"man in black shirt is playing guitar."

"construction worker in orange safety vest is working on road."

"two young girls are playing with lego toy."

"boy is doing backflip on wakeboard."

"girl in pink dress is jumping in air."

"black and white dog jumps over bar."

"young girl in pink shirt is swinging on swing."

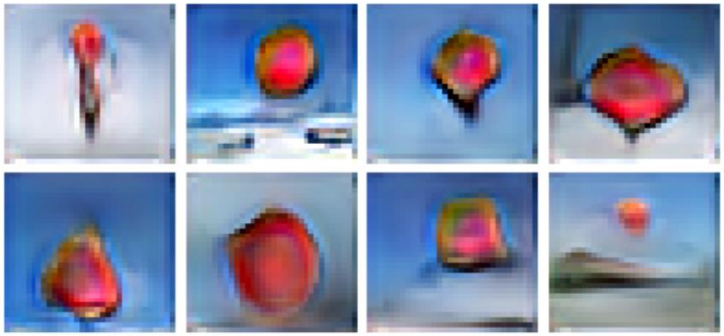
"man in blue wetsuit is surfing on wave."

http://cs.stanford.edu/people/karpathy/sfmltalk.pdf

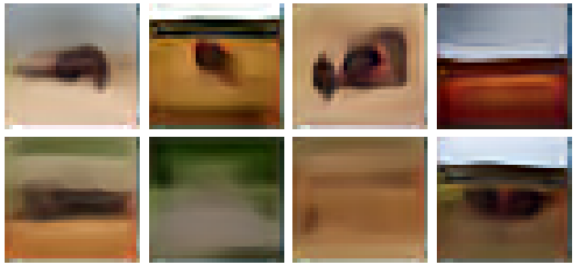
Understanding the Meanings of Words : Generating Images (December 2015-)

A very large commercial plane flying in blue skies.

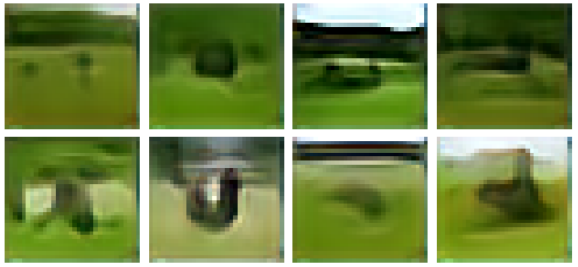
A very large commercial plane flying in rainy skies.



A stop sign flying in blue skies.



A herd of elephants walking across a dry grass field.



A herd of elephants walking across a green grass field.

Elman Mansimov et. al: “Generating Images from Captions with Attention”, Reasoning, Attention, Memory (RAM) NIPS Workshop 2015, 2015

Child AI and Adult AI

- Adult AI: Continuous innovation from big data to AI
  - Big data in general, IoT in general, Watson, Siri, Pepper, and so on
  - Seems to be able to perform what an expert (adult) can, but has been meticulously designed by a human
  - Can handle tasks concerning sales and marketing, etc.; Functions may be expanded to such fields as medical services, financial services and education in the future

- Child AI: Disruptive innovation through deep learning
  - Development mainly through deep learning
  - Becomes able to perform what a child can
  - Technological advancement in a similar manner as human growth: the technology develops in the order of the enhancement of cognitive power, enhancement of exercise capacity and understanding of the meanings of words.
  - Mainly utilized for manufacturing

Feature quantity needs to be designed by a human for adult AI, not for child AI.

Japan's Strategies

For solving social problems, Japan will apply AI technologies for recognition, motion learning and understanding of the meanings of words based on the idea of deep learning.

- By applying robots specialized in the agricultural field,
  - idled plots can be cultivated; weeding, pest control and harvesting become easier; and yields may increase.
- By applying robots in the nursing care field,
  - nursing care becomes easier; those in need of help can move around and go to the toilet by themselves and can have a more independent life.
- By applying robots for decommissioning work,
  - humans will no longer need to work under dangerous circumstances; required time will be shortened.
- By using robots for monitoring rivers and volcanoes,
  - dangerous situations or signs that may lead to a flood, landslide, eruption, etc. may be detected earlier.
- By marketing products utilizing these technologies overseas,
  - a new export industry may be created: GDP will increase.

Local industry to global industry

Further develop technologies for utilizing them in manufacturing and expand business overseas

Utilization of AI in Financial Services

- 1. Utilization of big data as adult AI
  - Asset management and trading
  - Loans and credit
  - Calculation of insurance rates and promotion of marketing
  - There is much room for introducing AI technologies in these fields.
- 2. Utilization of image data
  - Trading, estimation of credit rate and forecast of sales, etc. by using image data
  - Various ideas are available.
- 3. Insurance and financial instruments concerning AI
  - These instruments may become necessary in various situations in an increasingly automated society.

- The most significant change may occur when the automatic translation system is completed.

Challenges for Industry-Academia Collaboration

- Joint research and collaboration with more than 30 companies so far

- What universities can do
  - Data analysis and creation of algorithms
  - Evaluation of technologies and presentation of future image

- Focuses on the side of universities
  - Proper pricing and responsibility
  - Consulting functions

- Focuses on the side of companies
  - Proper awareness of the issue and how to make profits
  - Understanding of research activities