AI Collaborating with Humans in the Real World

Junichi Tsujii
Director
Artificial Intelligence Research Center AIST, Japan

Professor
School of Computer Science
University of Manchester, UK

Plan of the Talk

- Background
- Examples of Research and Development
- Infrastructures and Future Directions

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History of AIRC

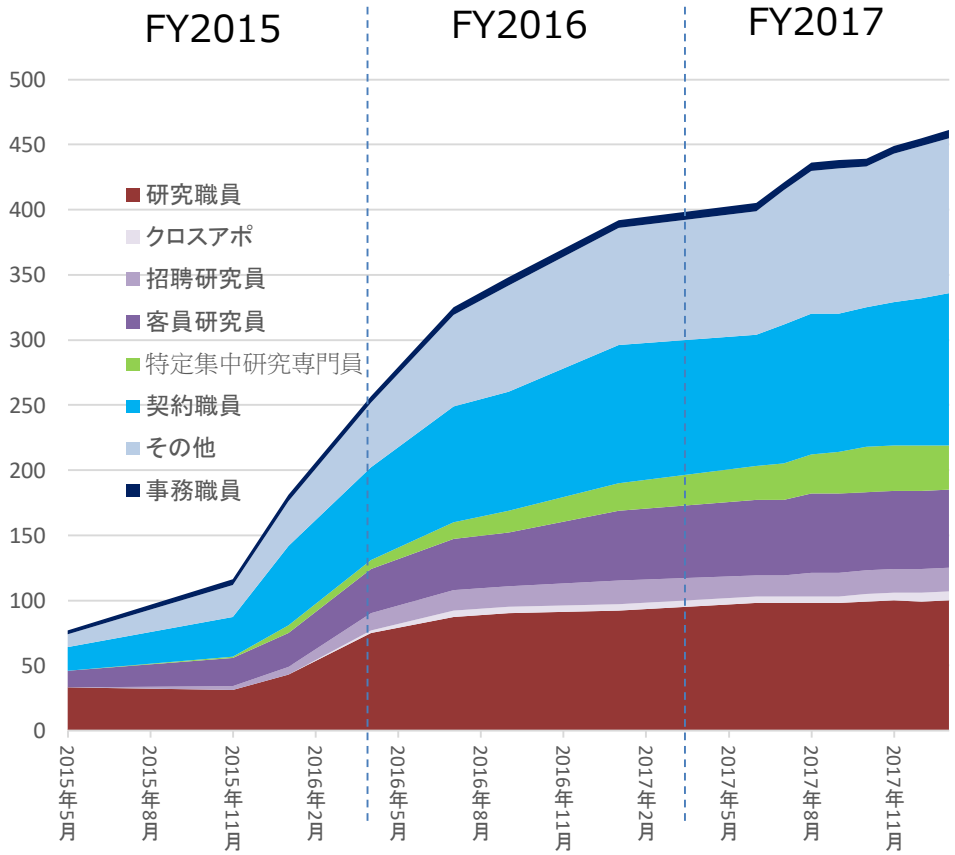
- AIRC/ AIST was established in May 2015 to be the largest AI research center in Japan for promoting large-scale AI research with PPP.
- Cooperating with RIKEN and NICT, AIRC/AIST accelerates AI R&D and deployment with industries and overseas research institutes.

	AIRC/AIST	RIKEN・NICT and governments
FY2015	**AIRC established (May 2015)** ・NEDO research project fund contracted(Jul 2015) ・AI Technology Consortium established(Jul 2015) ・Commemorative symposium (Sep. 2015) ・LOI with Carnegie Mellon University (Dec. 2015)	NICT・CiNet (2013～) , others ・Google (Alpha Go) beats Lee Sedol (Mar. 2016)
FY2016	・Organizational change (Apr. 2016) First Joint Symposium on Next Generation AI Technology (Apr. 2016) ・NEC-AIST AI Cooperative Research Lab established (Jun. 2016) ・Research project w/ National Cancer Center Japan started(Nov. 2016) ・Panasonic –AIST Advanced AI collaborative Lab established (Feb. 2017) ・MOU with German Research Center for AI Research (DFKI) (Mar. 2016) ・NEDO projects interim progress presentation（2017.3）	RIKEN・AIP established (Apr. 2016) ・Strategic Council of AI Technology established (Apr. 2016) ・AI Technology Strategy/ Roadmaps published (Mar. 2017)
FY2017	Second Joint Symposium on Next Generation AI Technology (May 2017) ・Organizational change (Sep. 2017)	NICT・AIS established (Apr. 2017)

Growing AIRC

- When AIRC was established on May 2015, the numbers of persons at AIRC is 77. Currently it is 461 (Jan 2018)
- FT Researchers are around 100. Of which, around 20 are foreign researchers.
- Large networks with universities and industries researchers.

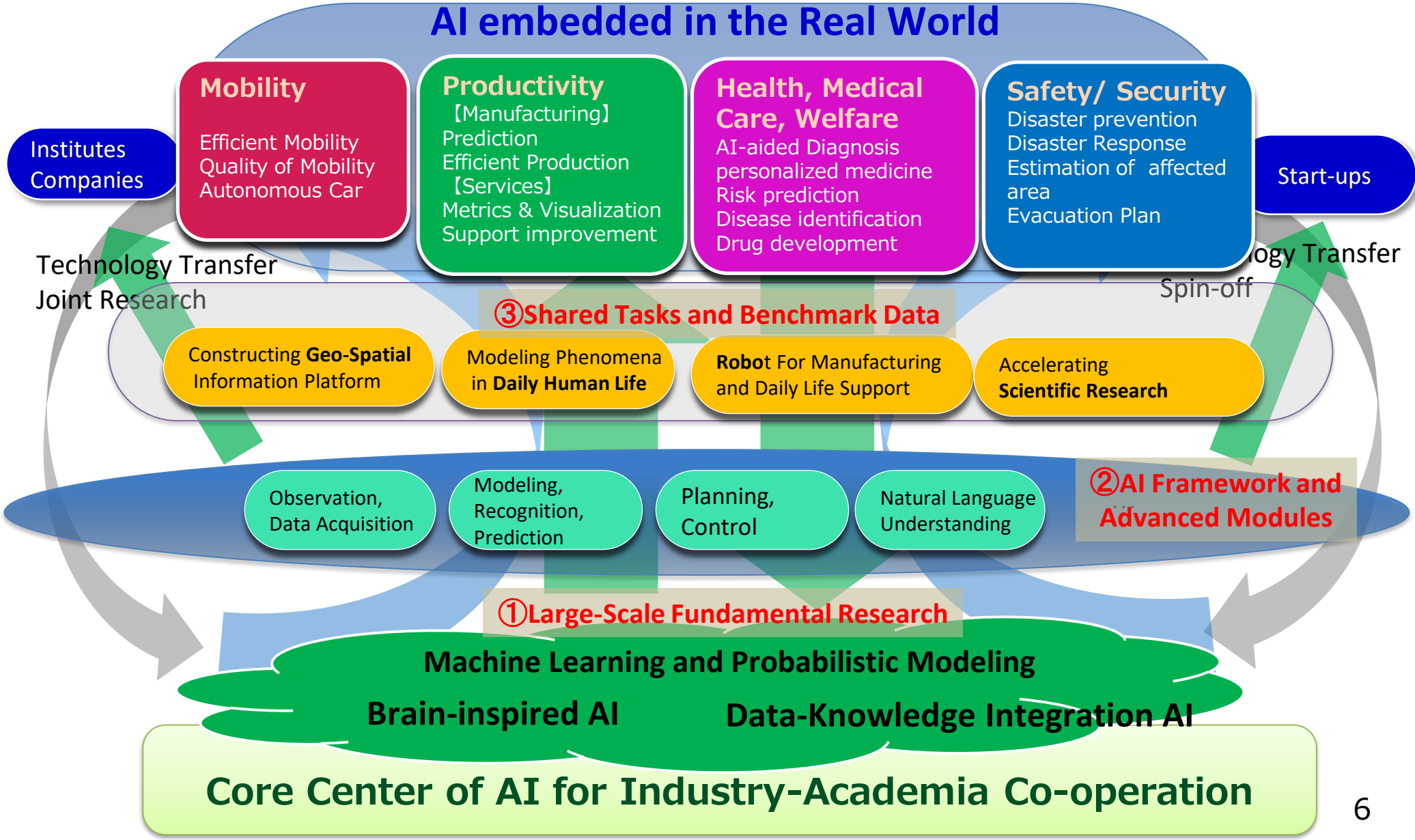
Numbers of persons at AIRC (History and it's breakdown)



Category	May 15	Jan. 18	
FT Researchers	33	100	Concurrent 30 Foreigners 21
Researchers from Univ.	13	85	
Cross Appointment	0	7	
Part-time Researchers	0	18	
Invited Researchers	13	60	
Part-time Researchers from Industries	0	34	
Post-Doctor, RA, technical staff, etc.	18	117	Foreigners 9
Technical trainee (students), collaborative researchers, other staffs	10	119	Students 65 Industries 47 Foreigners 30
Support Staffs (FT)	3	6	
Total	77	461	

Strategy for AI research

- Creating positive cycle among research and deployment of AI



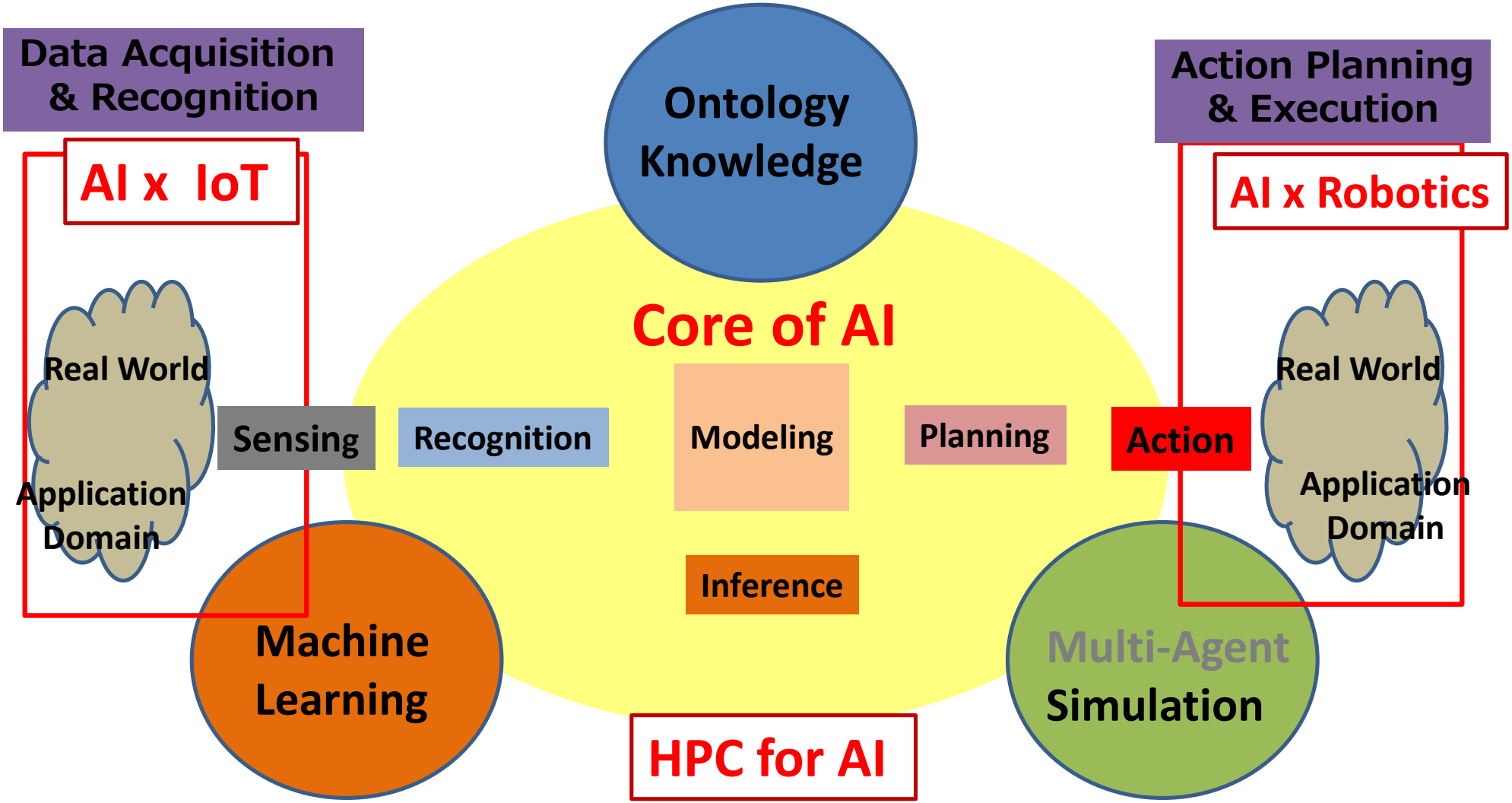
AI Embedded in the Real World

- from the Internet to the Real World -

AI which cooperates with Human

Cooperative Autonomy, Explainable AI

AI Embedded in the Real World



Plan of the Talk

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- **Examples of Research and Development**
- Infrastructures and Future Directions

Sensing and Recognition

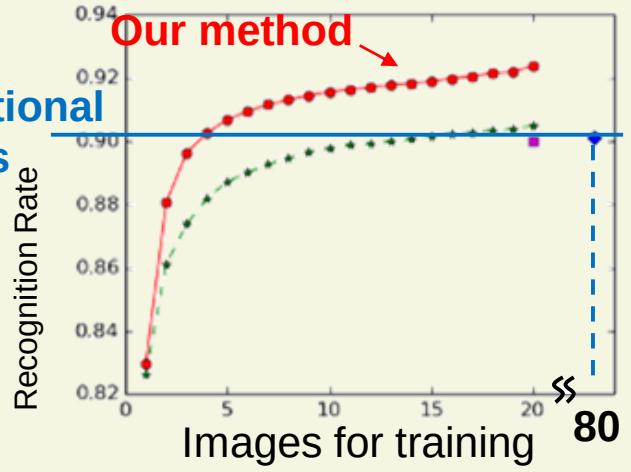
Object Recognition by Multiple Views

Robot Platform　Deep Learning Robot

Competition of 3D object identification at Stanford（SHREC2017）The best Performance

Better recognition rates with less training images

90%⇒92%、80 images⇒ less than 20

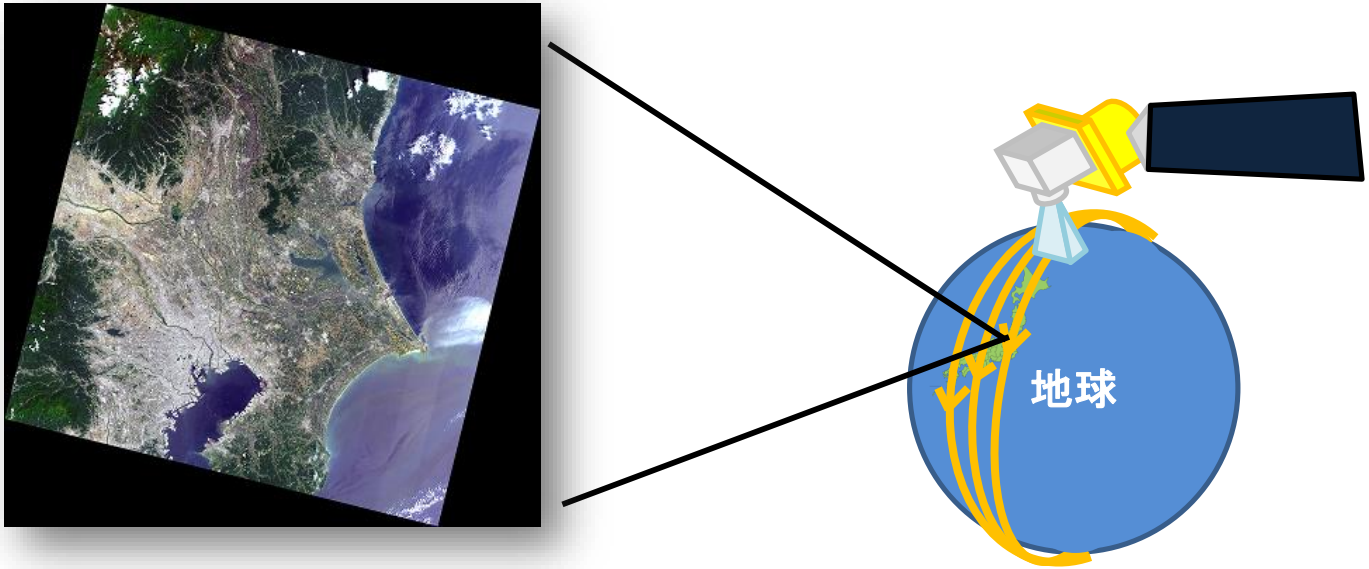


★12 categories, 132 objects, trained by 21,120 images of objects in everyday life

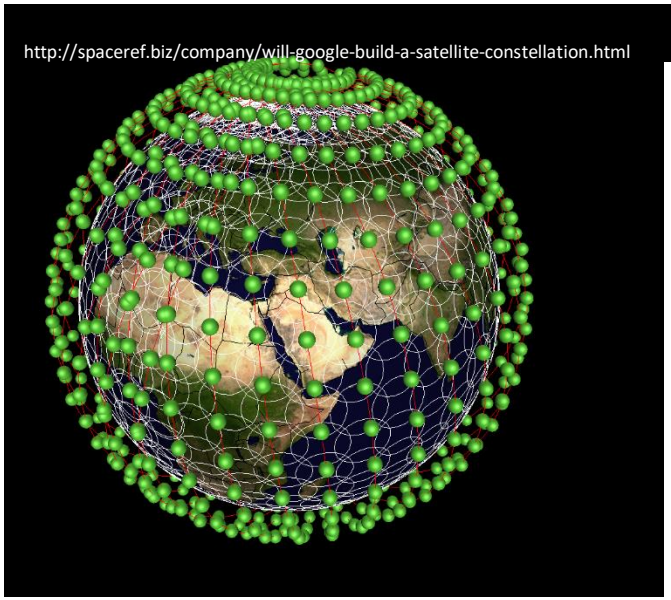

Cup

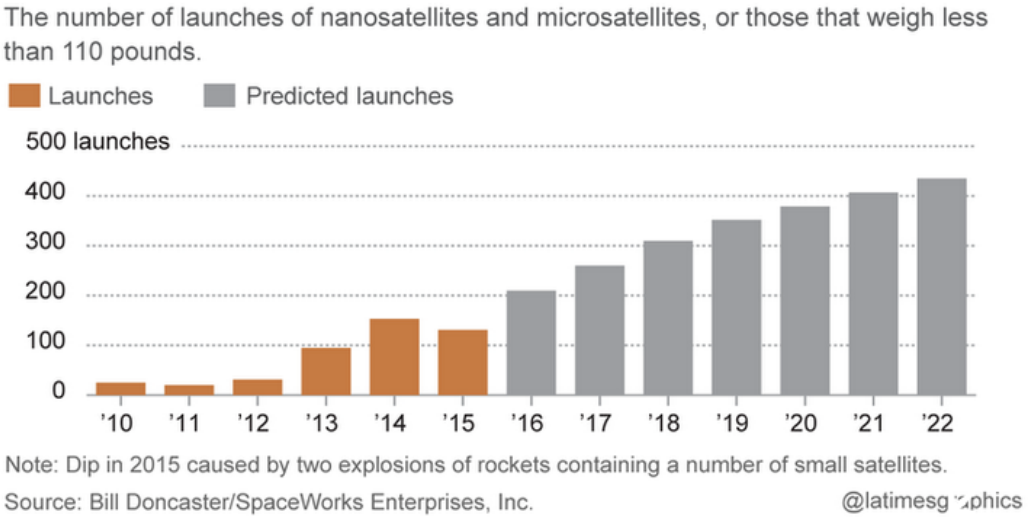
Everyone can use a lot of satellite images.

- ASTER archive at AIST
  - It covers the whole world from 1999 to the present. The cumulative data volume is about 1 PB
- Amazon offers satellite imagery free of charge in the West.
  - Landsat8 (USA) : from 2013, 300TB
  - Sentinel-2(EU):from 2015, Several TB / day
- Both are open data that anyone can use freely, but the volume is enormous, so exhaustive analysis by humans is difficult.



Tiny Satellite = Sensor Network in space



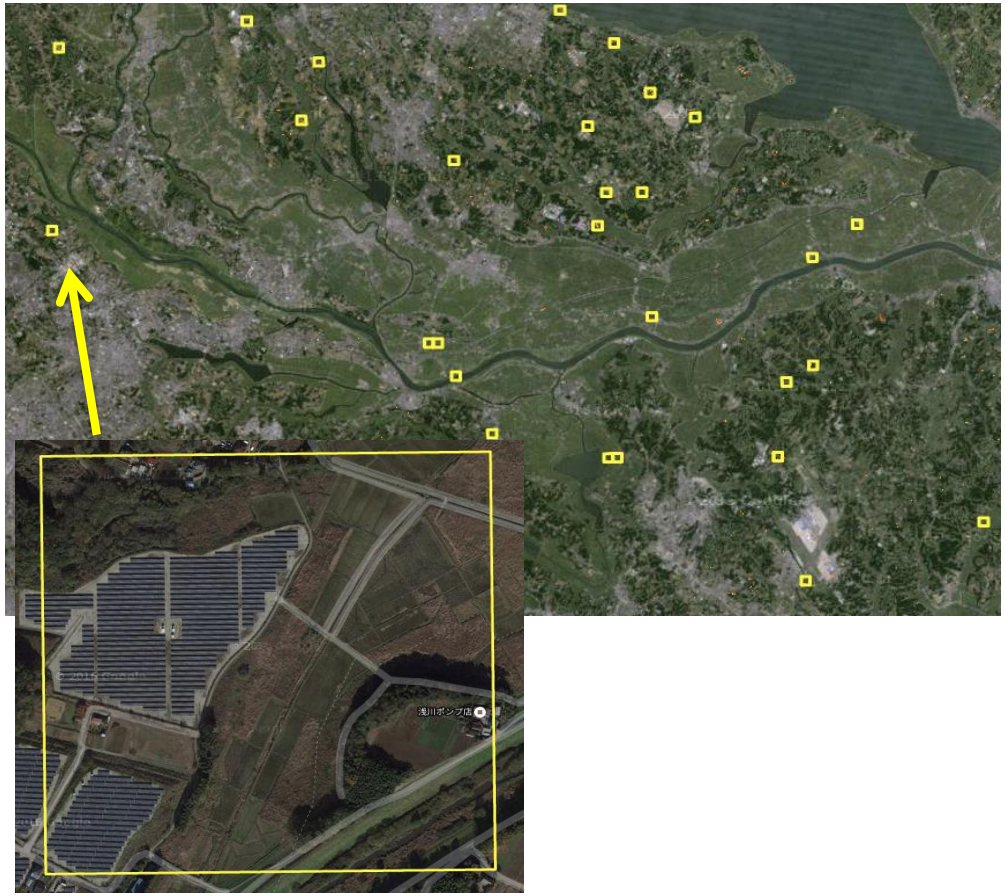


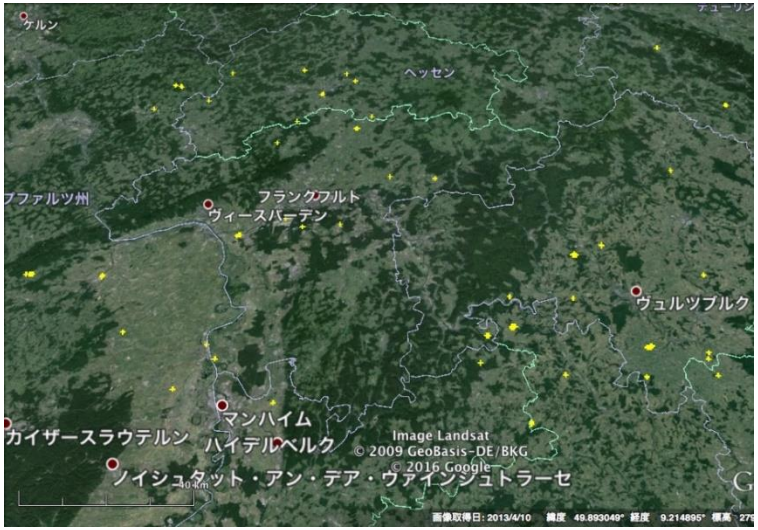
Along with the recent miniaturization of satellite hardware, the number of micro satellite launches sharply increased.
Within 10 years any point on the earth will be able to observe several times a day with resolution of a few meters.

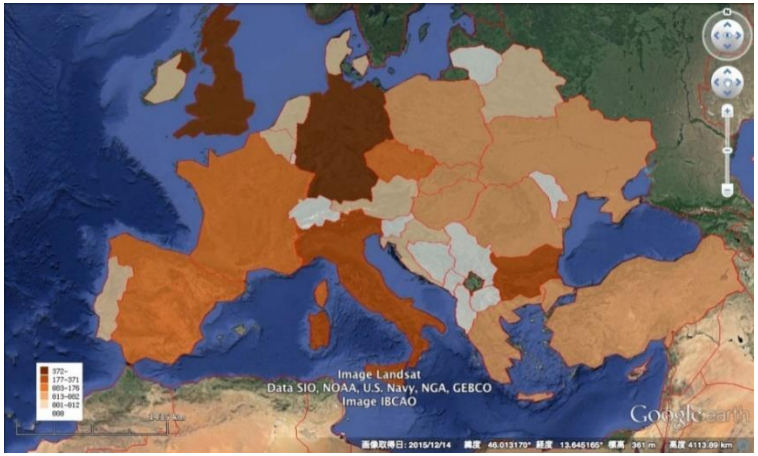
→ AI, which finds useful "knowledge" from enormous image data, is important in the future.

Applying AI to solar panel detection

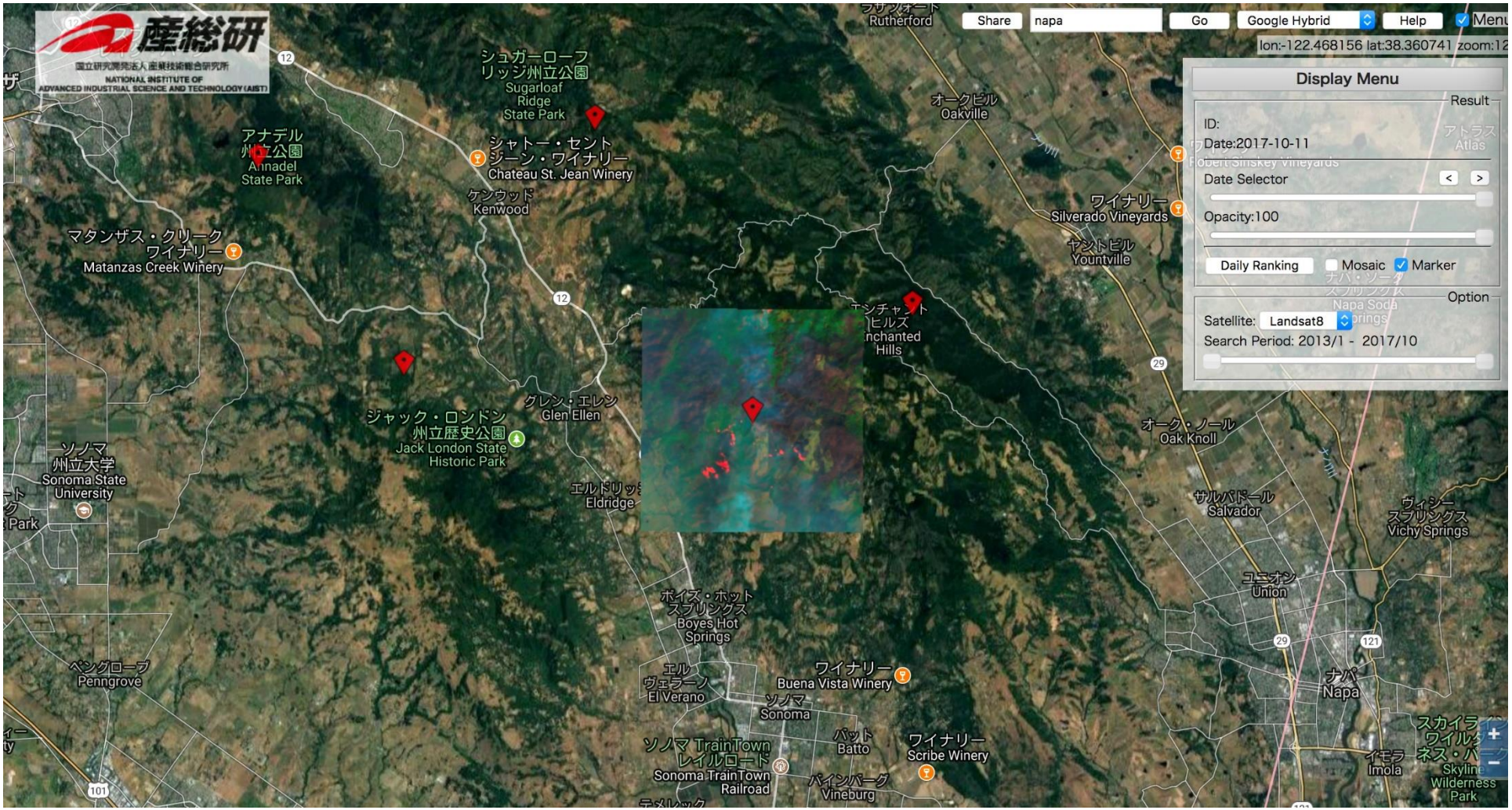
We can measure the power demand capability by solar light not only in Japan but also in the world.





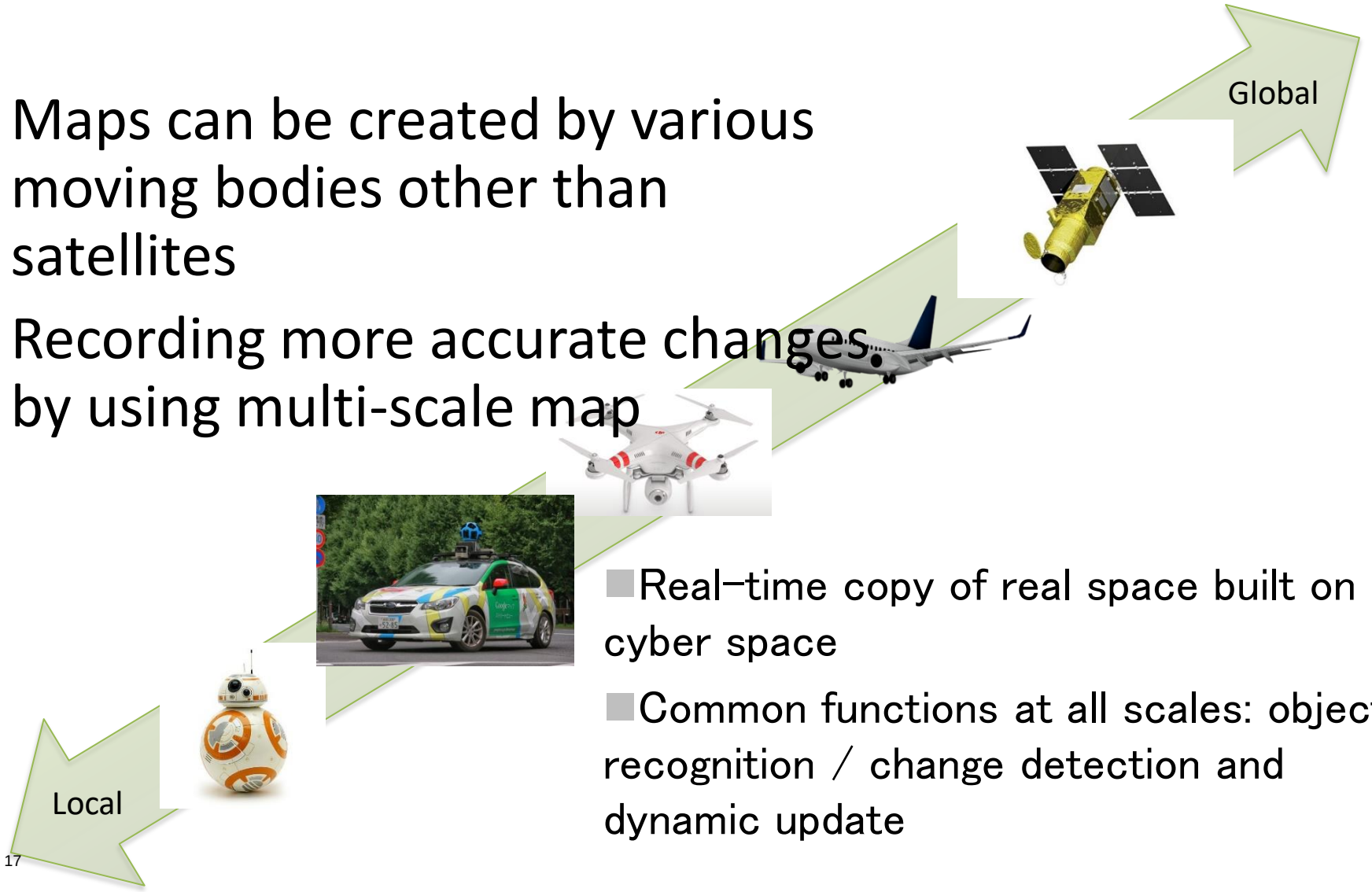


Detection example: Wildfire of California



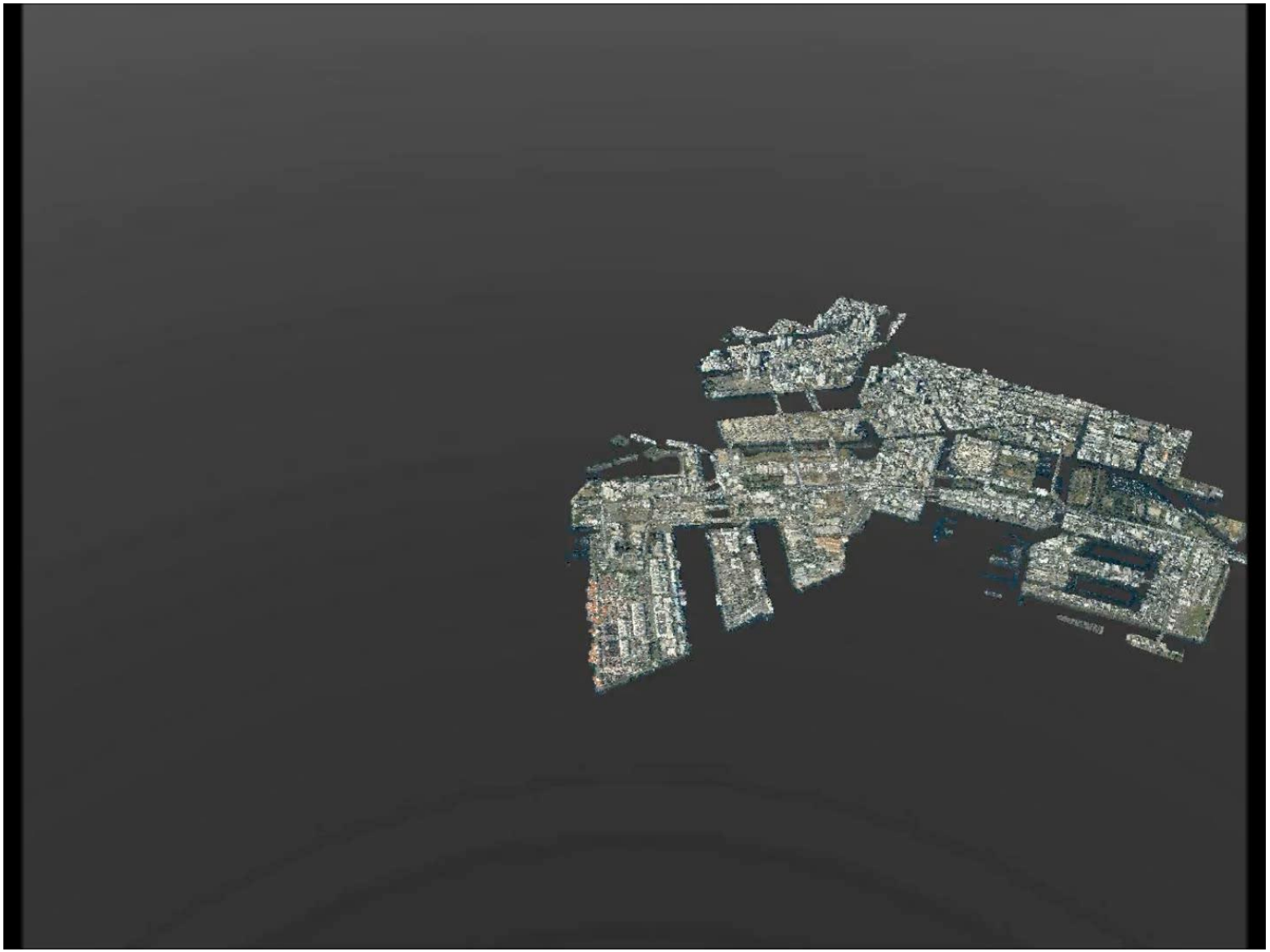
Construction of multiscale geospatial information platform

- Maps can be created by various moving bodies other than satellites
- Recording more accurate changes by using multi-scale map



- Real-time copy of real space built on cyber space
- Common functions at all scales: object recognition / change detection and dynamic update

“Odaiba“ seamless 3D map



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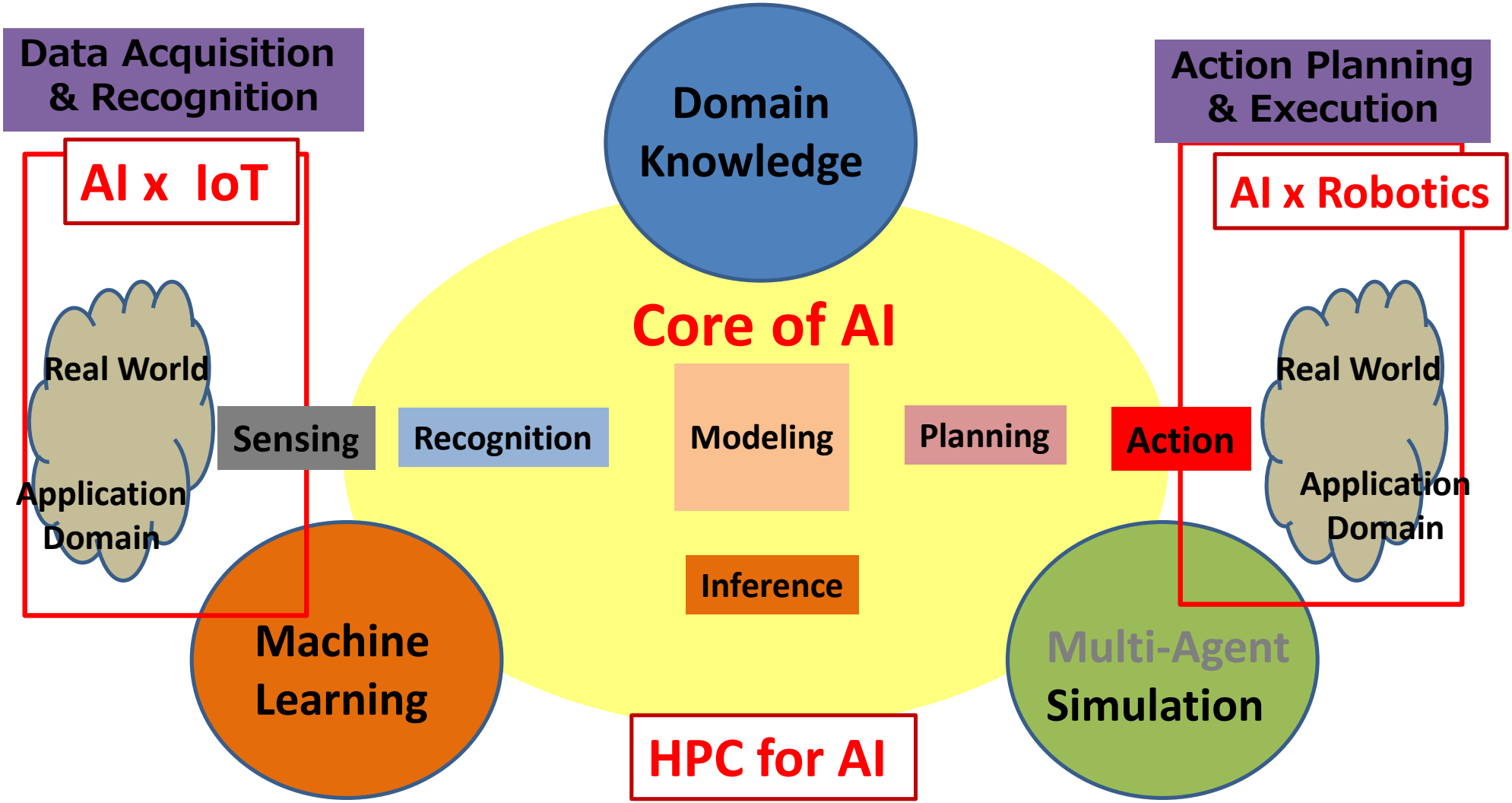
NEDO

AIRC

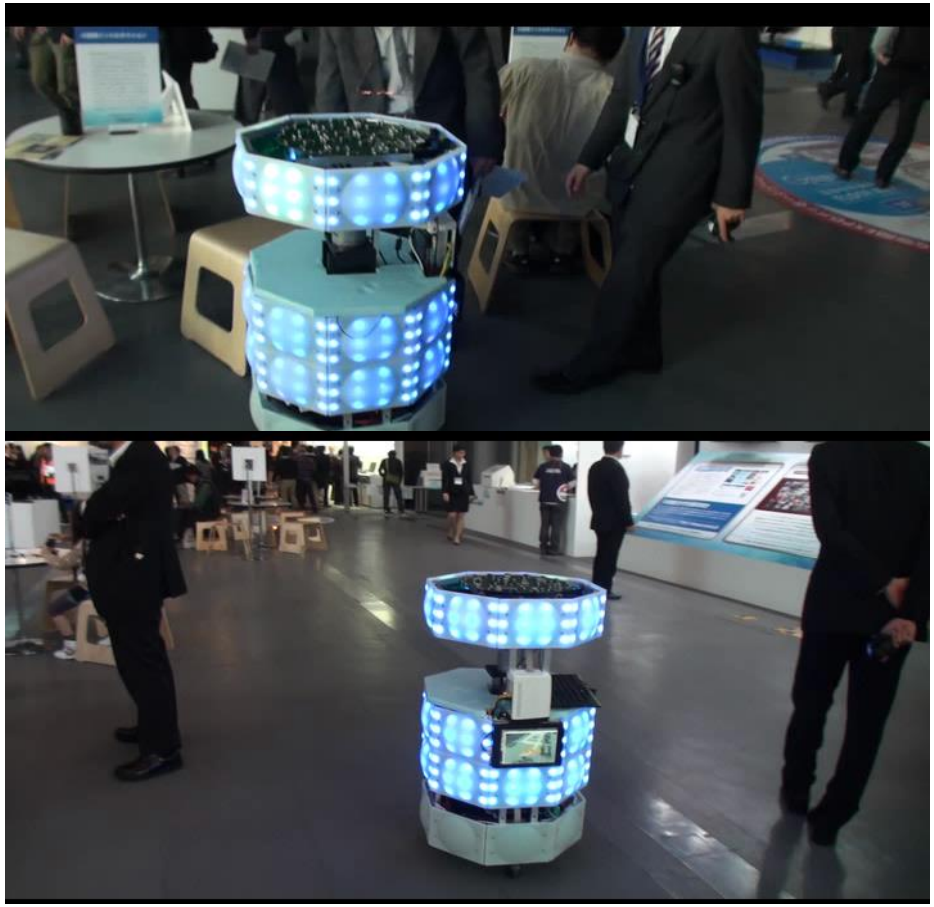
Recognition, Model of the World, and Action

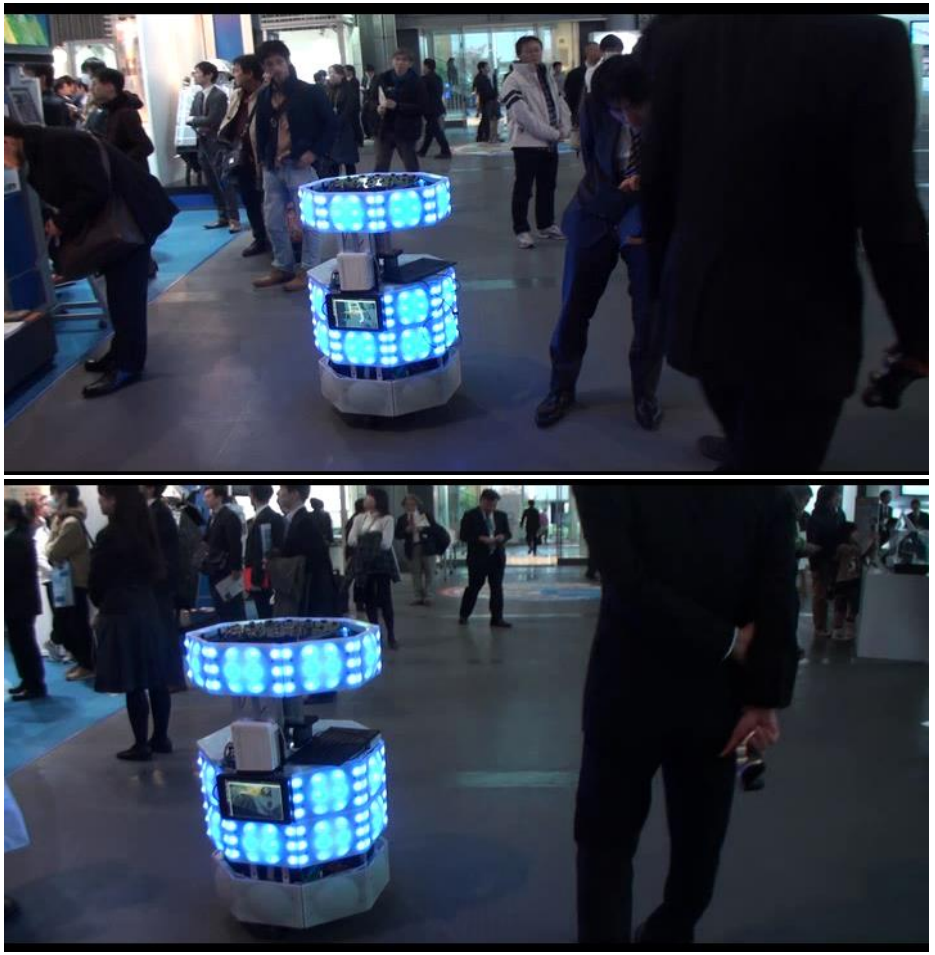
Self-Navigation

AI Embedded in the Real World



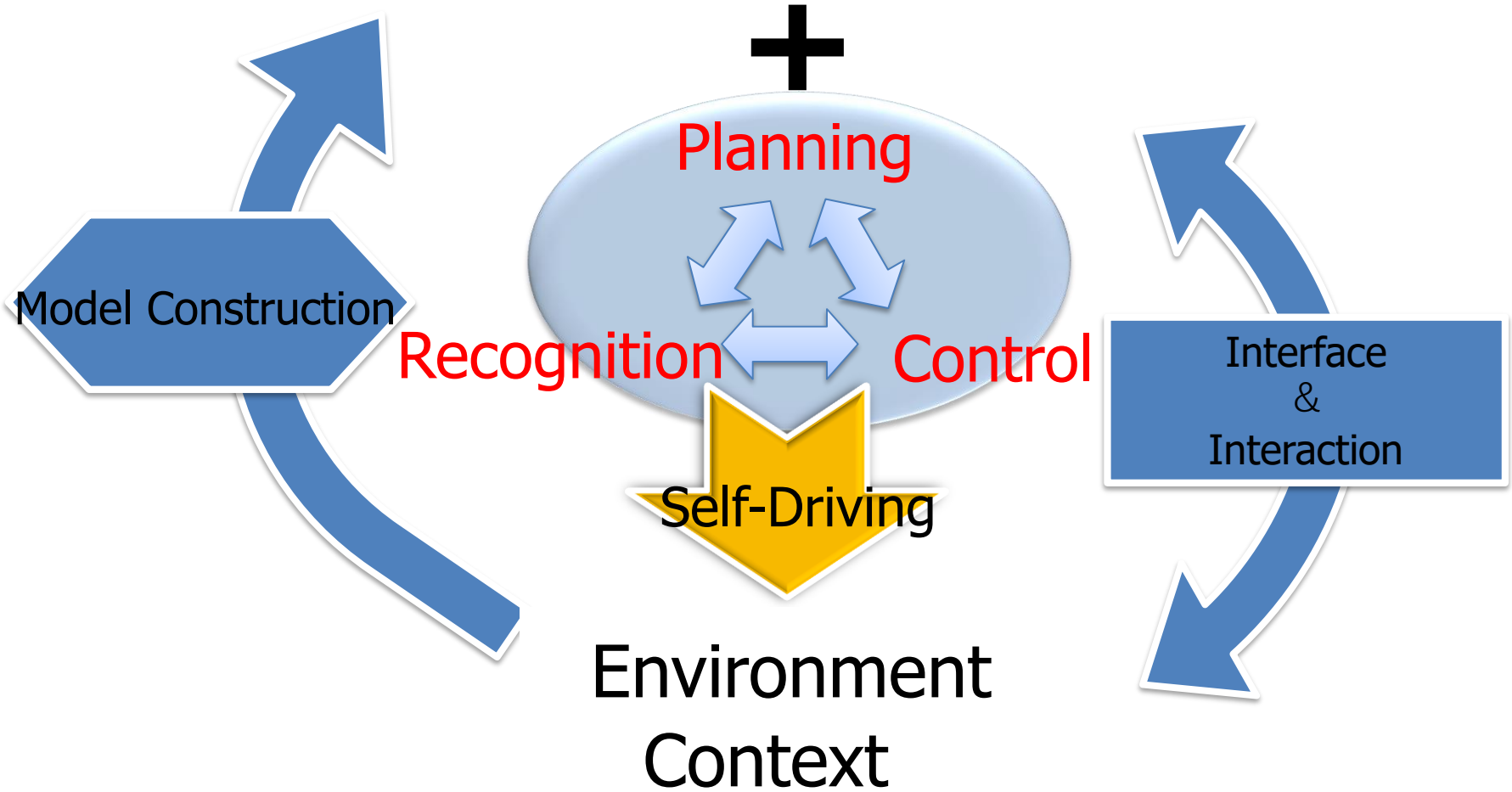
Demonstration at a Business Expo



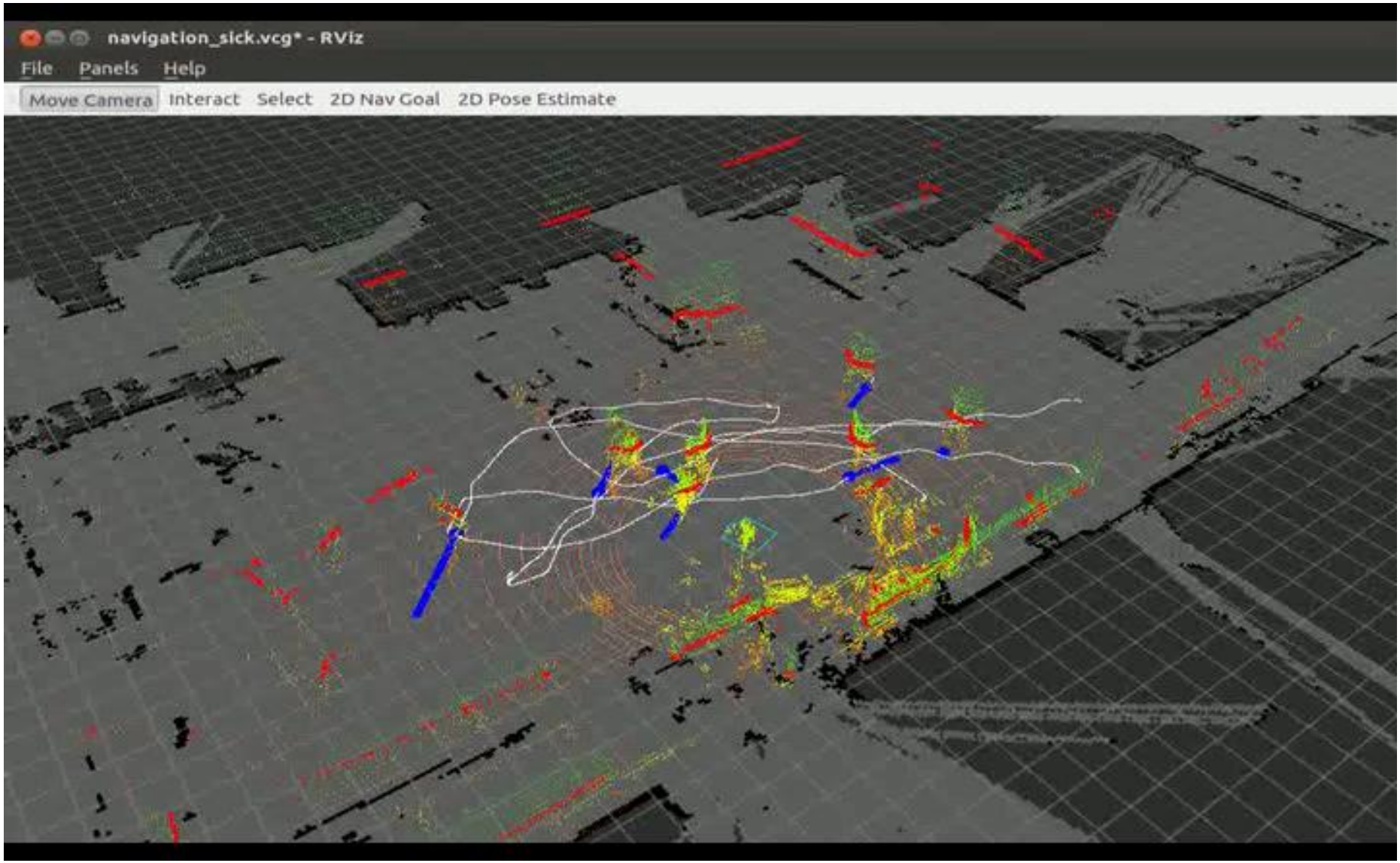


Intelligent agent which cohabits and cooperates with human

Human Model (faces, bodies, movements, location)
Model of Movements (map, paths, changes)
Model of Environment (shapes, locations, changes)



Human Tracking using Laser Range Sensor



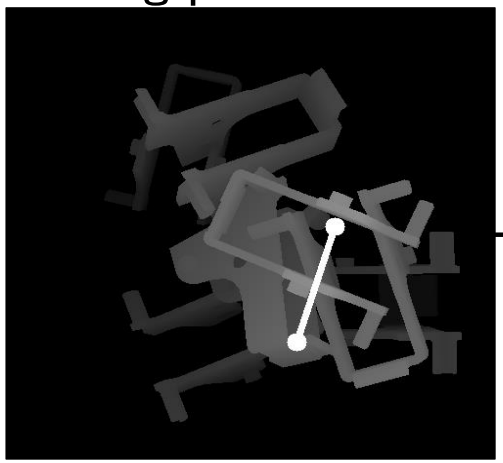
From Simulation to a Real Robot

Research Topics

- Treatment of incomplete Visual Information
- Re-training by Real Trial Data

Learning of the best picking positions

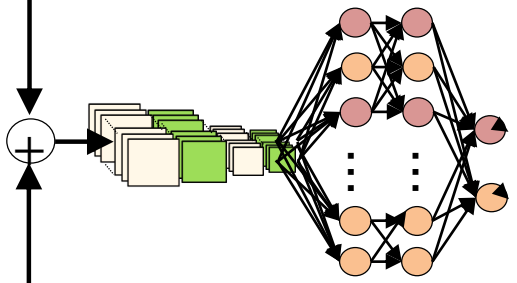
Depth images＋
Picking positions



Depth Images

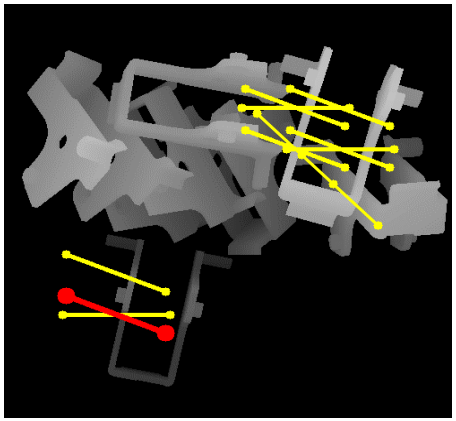
Convolution Layers＋Pooling Layers

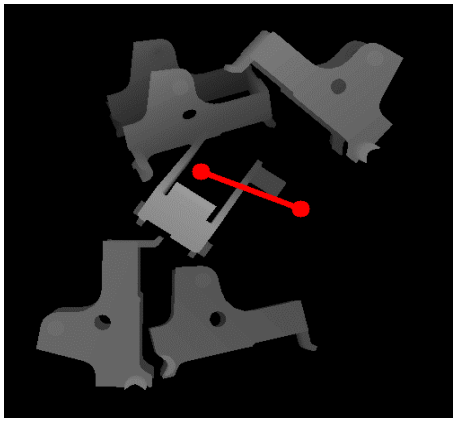
Picking positions

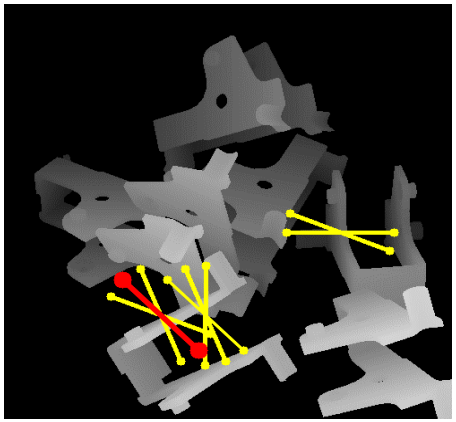


Learning Times ：17hrs
Traning data：64,800 samples

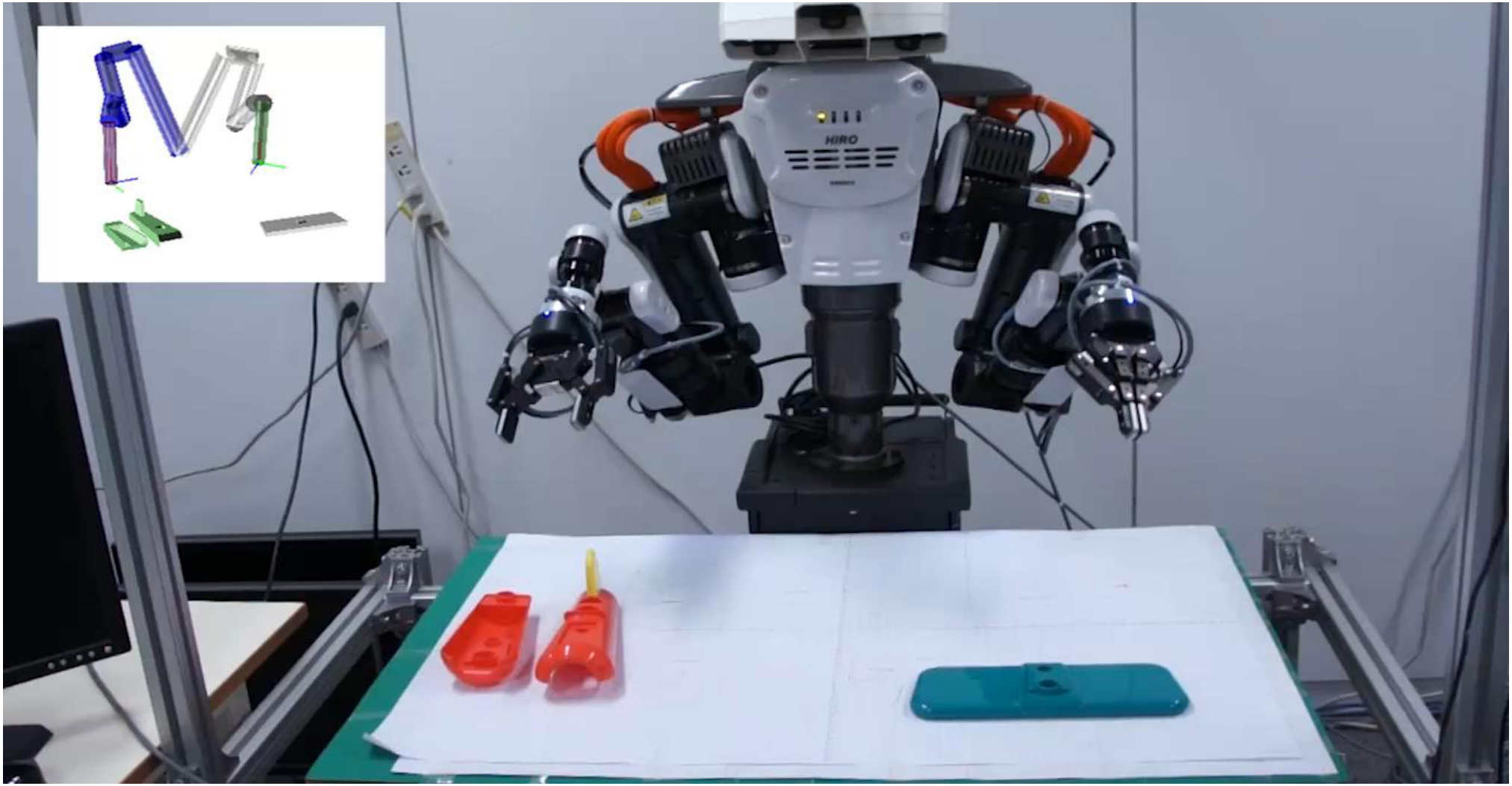
Red：Best
Yellow：90%







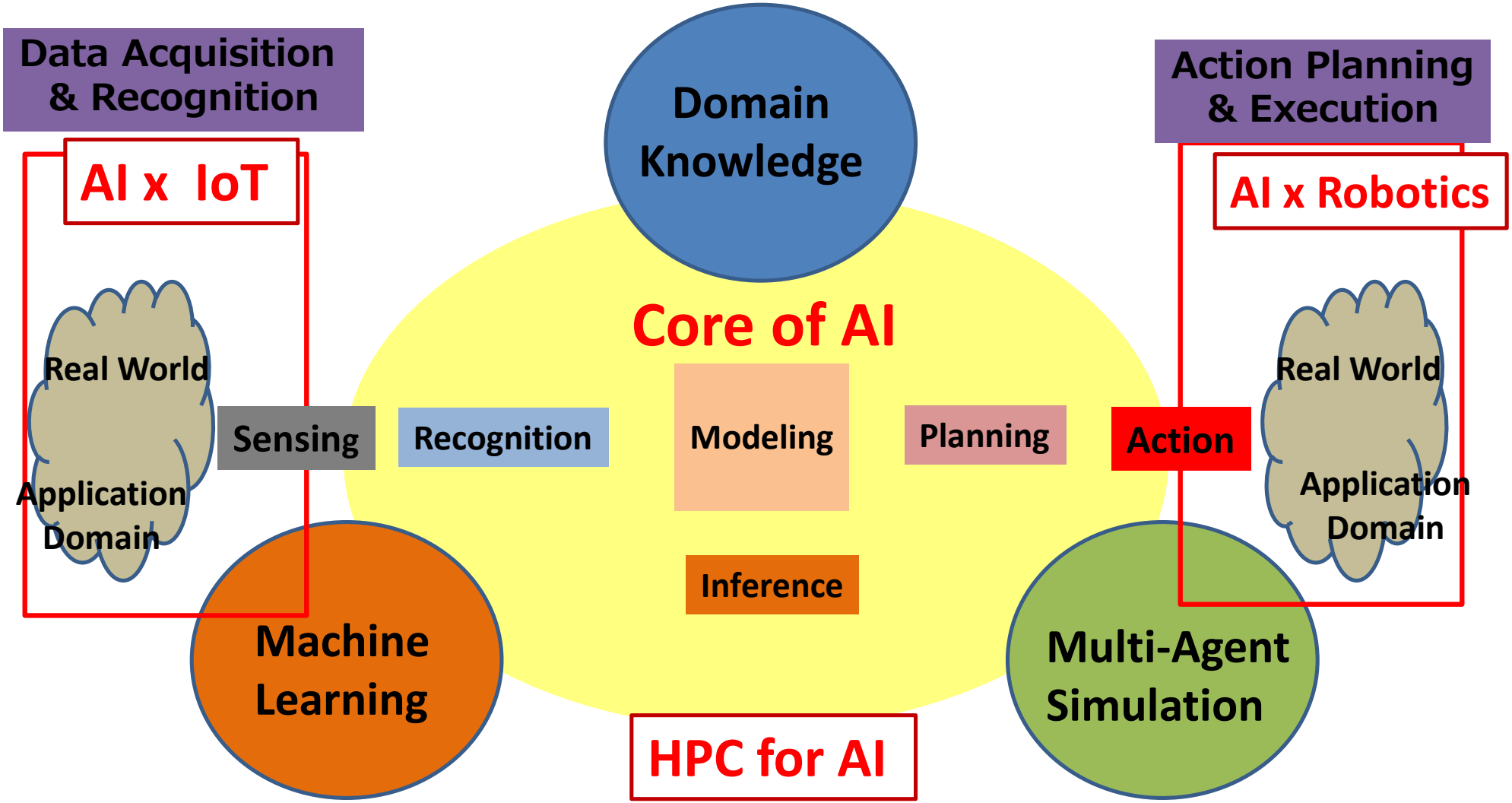
Planning Complex Motion Sequence for Assembly Task



Movie from Prof. Kensuke Harada (Osaka University/AIRC)

Understanding and Language

AI Embedded in the Real World



From Video to textual explanation

Output="A monkey is doing a karate with a man."

Video Captioning

Recognition of sequences of actions with fine-grained object detection
Significant error reduction by sequence recognition

Baseline method : A man is drinking.
Proposed method : A girl is doing makeup.

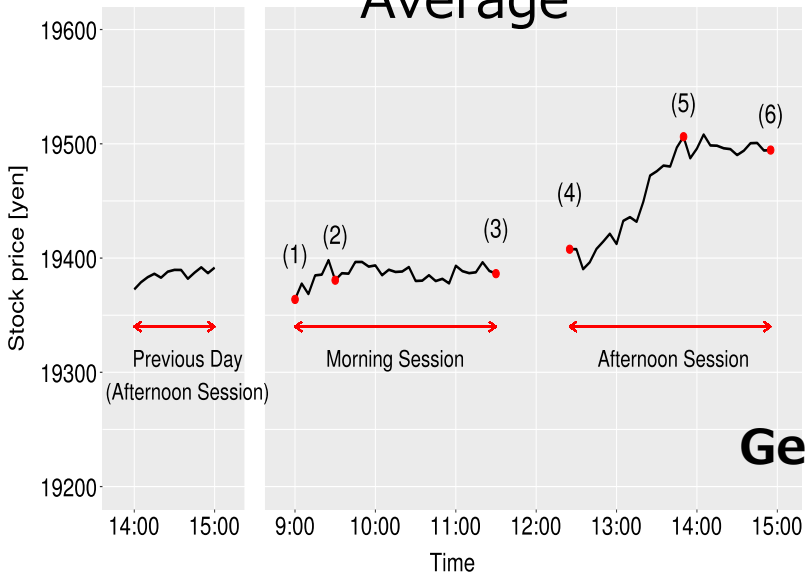
Baseline Method : A dog is playing with a dog.
Proposed Method : A boy is playing with a dog.

Baseline Method : A man is riding a car.
Proposed Method : A woman is riding a boat.

Baseline Method : A man is riding a bicycle.
Proposed Method : A man is riding a bike.

Stock market report generation

Time Sequence of Nikkei Average



Text Generation

Reports by human

(1)	09:00	日経平均、続落で始まる
(2)	09:29	日経平均、上げに転じる
(3)	11:30	日経平均、続落 前引けは５円安の19386円
(4)	12:30	日経平均、午後は上昇で始まる
(5)	13:54	日経平均、上げ幅100円超える
(6)	15:00	日経平均、反発　大引けは102円高の19494円

Characteristics of Market Repo

1. Changes in short term and long term affects choices of expressions
2. Context (Time of the day) affects choices of expressions
3. References to actual figures

- Reference to the historical context
- Reference to the context of utterances
- Reference to numeriacl values

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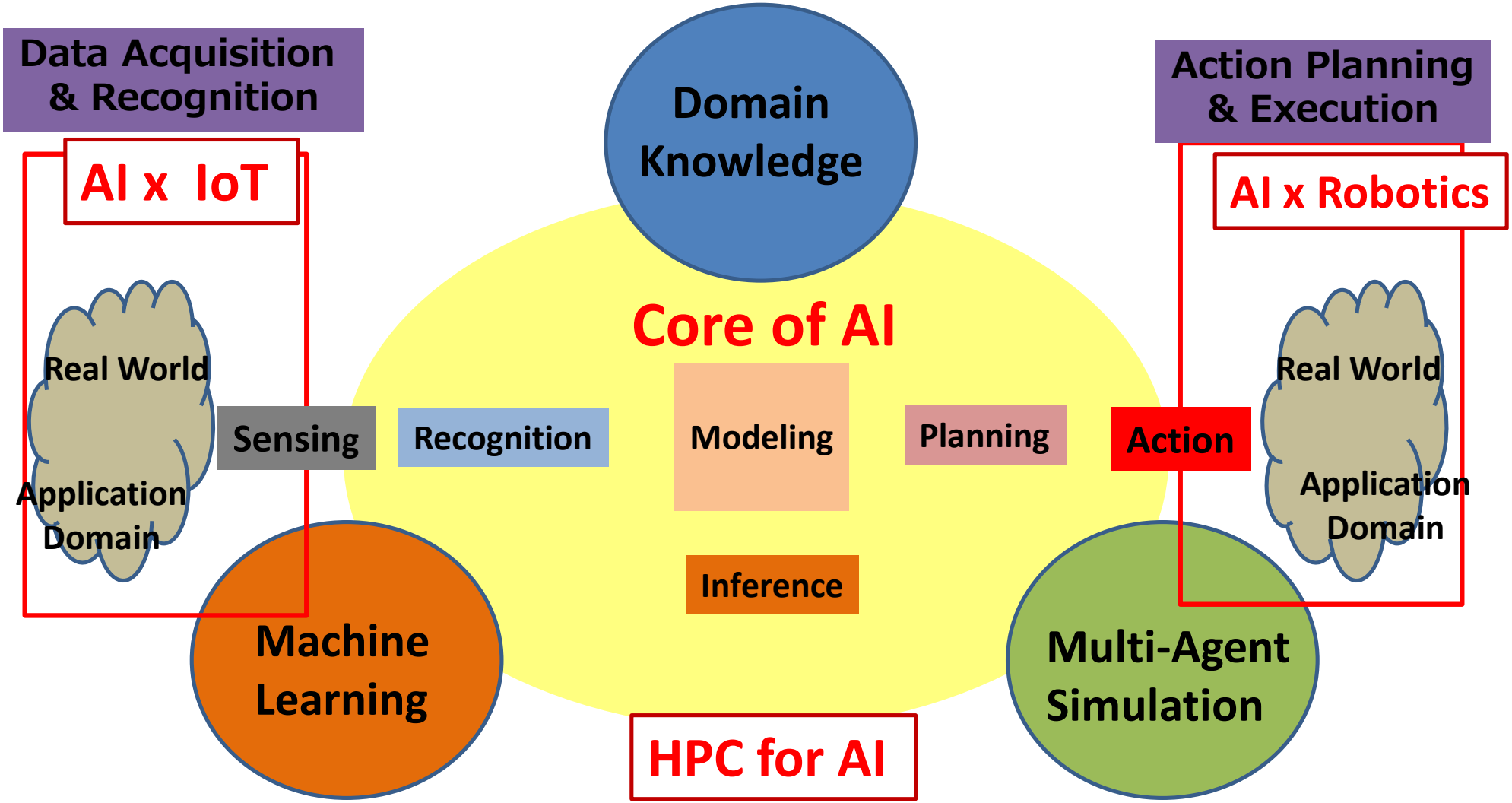
Revolution in Science/Engineering

AI Embedded in the Real World



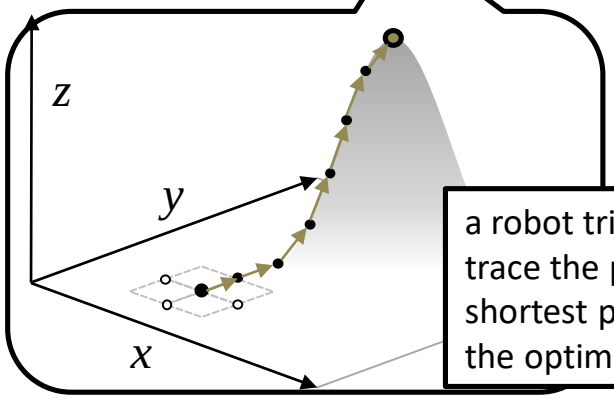
Maholo

RBI, Start-Up by Researchers of AIST

NEDO F.S. AIxRobot 2017~2018

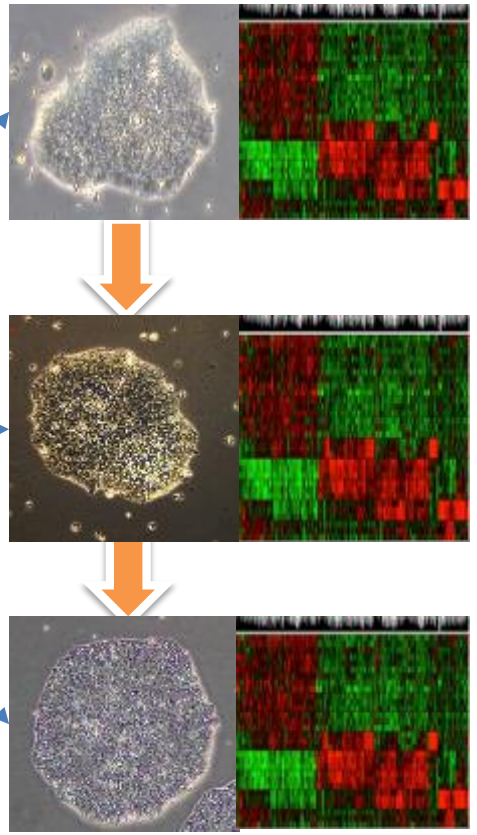
Autonomous Cell Culturing System

A robot culture cells under observation with a microscope and omics data. By changing culturing conditions dynamically according to its observation, it brings cells into the optimal condition.



a robot tries to trace the predicted shortest path to the optimal point.

microscope omics



PubMed

Need to have knowledge from the journal database to get a clue to find a direction of modifying culture condition for a type of cell.

This optimization problem is an open problem and is a part of open innovation = a process of science

Big Mechanism（AI for Sciences)

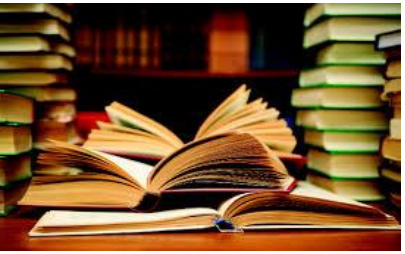
DARPA　Chicago Univ.　Manchester Univ.　Microsof

Robot Scientist

Reading

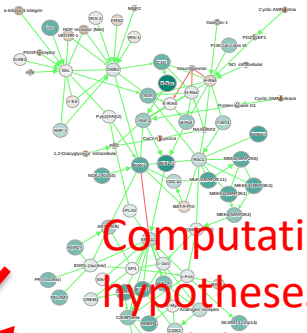
Assembly

Explanation



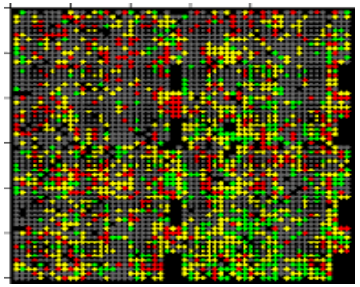
Very large conflicting (probabilistic) network

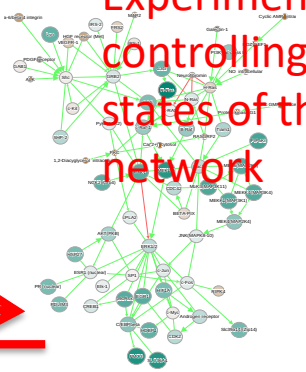
Experimental Data



Computational hypotheses/ wet lab Experiments controlling states of the network

Experimental Data





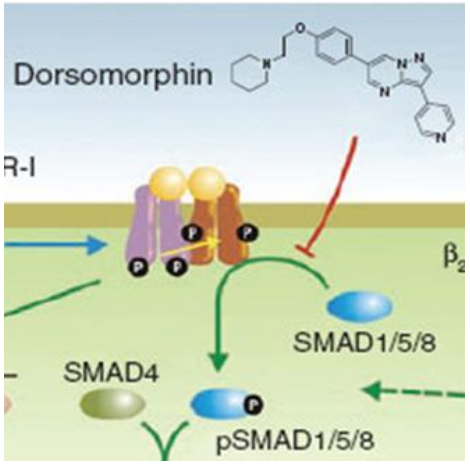
Smaller (relevant) grounded model

A.Rzhetsky(U.Chicago)

Knowledge Acquisition from Text

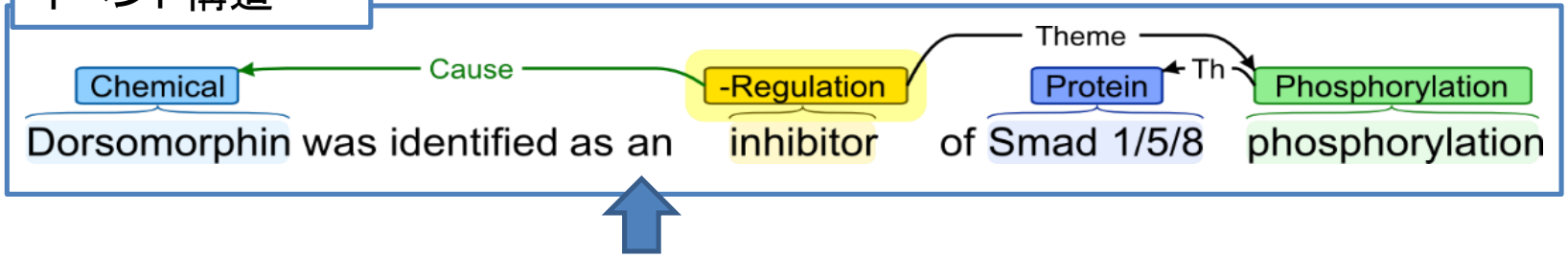
Complex Knowledge
Systems Biology: **Pathway**

Event Type: Inhibition
Modified Substance: Dorsomorphin
Protain: SMAD 1/5/8
Prodcut: pSMAD 1/5/8 (phosphorylated)



Text and Knowledge

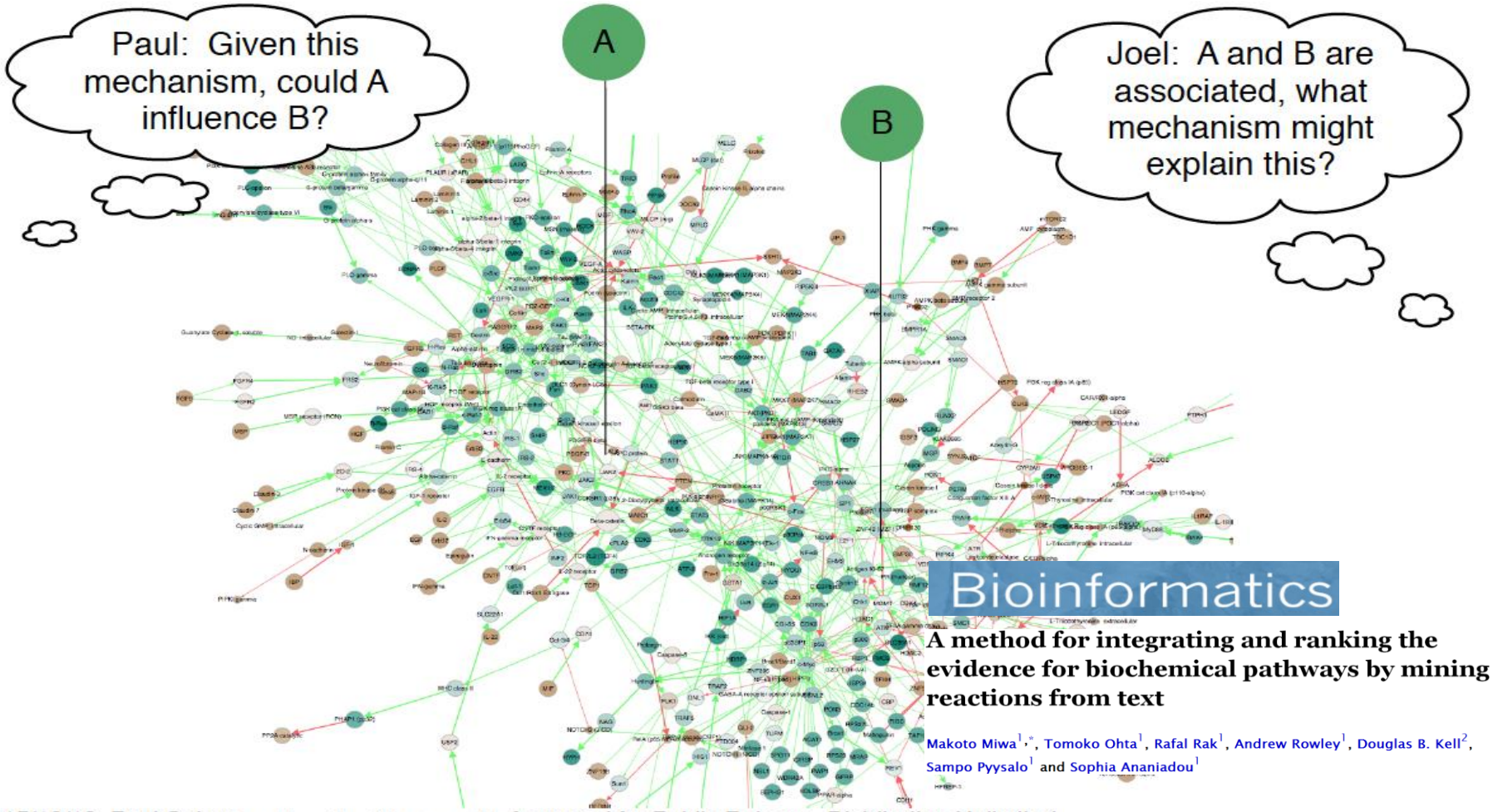
イベント構造



Dorsomorphin was identified as an inhibitor of Smad 1/5/8 phosphorylation

Technologies for System-level Understanding

Big Mechanism needs Big Data and vice versa.



Bioinformatics

A method for integrating and ranking the evidence for biochemical pathways by mining reactions from text

Makoto Miwa[1,*], Tomoko Ohta[1], Rafal Rak[1], Andrew Rowley[1], Douglas B. Kell[2], Sampo Pyysalo[1] and Sophia Ananiadou[1]

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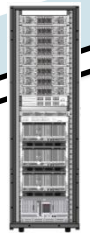
Computing Environment

NEDO

FY2016 Supplementary Budget
Global Research Hub for AI研究
ABCI（Kashiwa）

FY2015 Supplementary Budget
AAIC (Tsukuba)

NEDO Project
Nairobi（Tsukuba）



2016.6-
Research Prototype, Internal use
By NEDO project

2017.4-
A System being used for
Joint Projects with Industry and
Other Research Institues

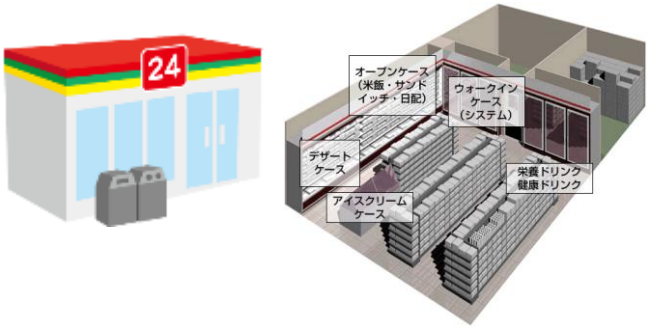
2018.3
Open Innovation Hub used by
Funded by Private and Public
Sectors

DL	0.5 PFlops	16 times	8.6 PFlops	64 times	> 550 PFlops ※半精度演算のピーク性能
HPC	0.2 PFlops	10times	2.1 PFlops	18 times	>37 PFlops
Storage	23 TiB	200 times	4.5 PiB	5 times	> 22 PiB

AI × Robotics

- Formalization study of craftsmanship
- Cooperating Autonomous Working Robot
- Intelligence and robots for human cooperative work

Retail store mock environment



Material handling with AI x robot

Target: Labor saving of store management

Bio research robotics

Demonstrated improvement of drug discovery productivity through AI robot bio-scientist development

Goal: R & D expenses such as drug discovery to 1/10!

Repeated expert skill work by humanoid type robot

AI provides multiple cooperative tasks

Factory Robotics

Demonstrate advanced model of distribution of products and information by linking various processing machines and robots and optimizing them by AI technology.

Processing (Bending, cutting etc.)

+

manipulation (Assembly, picking, transportation)

×

optimizing by AI

"Shared testing factory" that enables verification of "connecting factory"

Global Networks as a world AI Center

【RIKEN & NICT】

- Priority based on “AI Technology Strategy”
- Consistent from basic to deployment

【Research Labs.】

- Cooperation with National Cancer Center Japan
- Cooperation with national laboratories of MLIT, MOAA etc

【Industries】

- Joint laboratories w/ NEC etc.
- Cooperative researches w/ industries : ～40 (Total ～80)
- AI Technology Consortium: ～120 firms participated

AIST/AI Research Center

National Institute of Advanced Industrial Science and Technology
AIST

AIRC

【Domestic Univ.】

- Network with university researchers : more than 80 (～20 domestic universities , national laboratories, basic private research institutes)
- Students attended : ～60

【Overseas Labs.】

- Invite Excellent researchers from overseas (U of Manchester from this fall)
- Cooperation w/ CMU, TTI-C, DFKI etc. Cooperation w/ Asian univs. /institutes
- Foreign FT researchers : ～30%, foreign researchers & students: ～50 (from 20 countries)

【Outreach - Diffusion & HR dev.】

- Conference for start-ups – 5 times
- AI seminar – 20 times in total, Lecturers at various kinds of seminars.
- Cooperation w/ universities for HR resources development

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- from the Internet to the Real World -

AI which cooperates with Human

Cooperative Autonomy, Explainable AI