

Introduction of AIRC

(Artificial Intelligence Research Center)

May 11, 2018

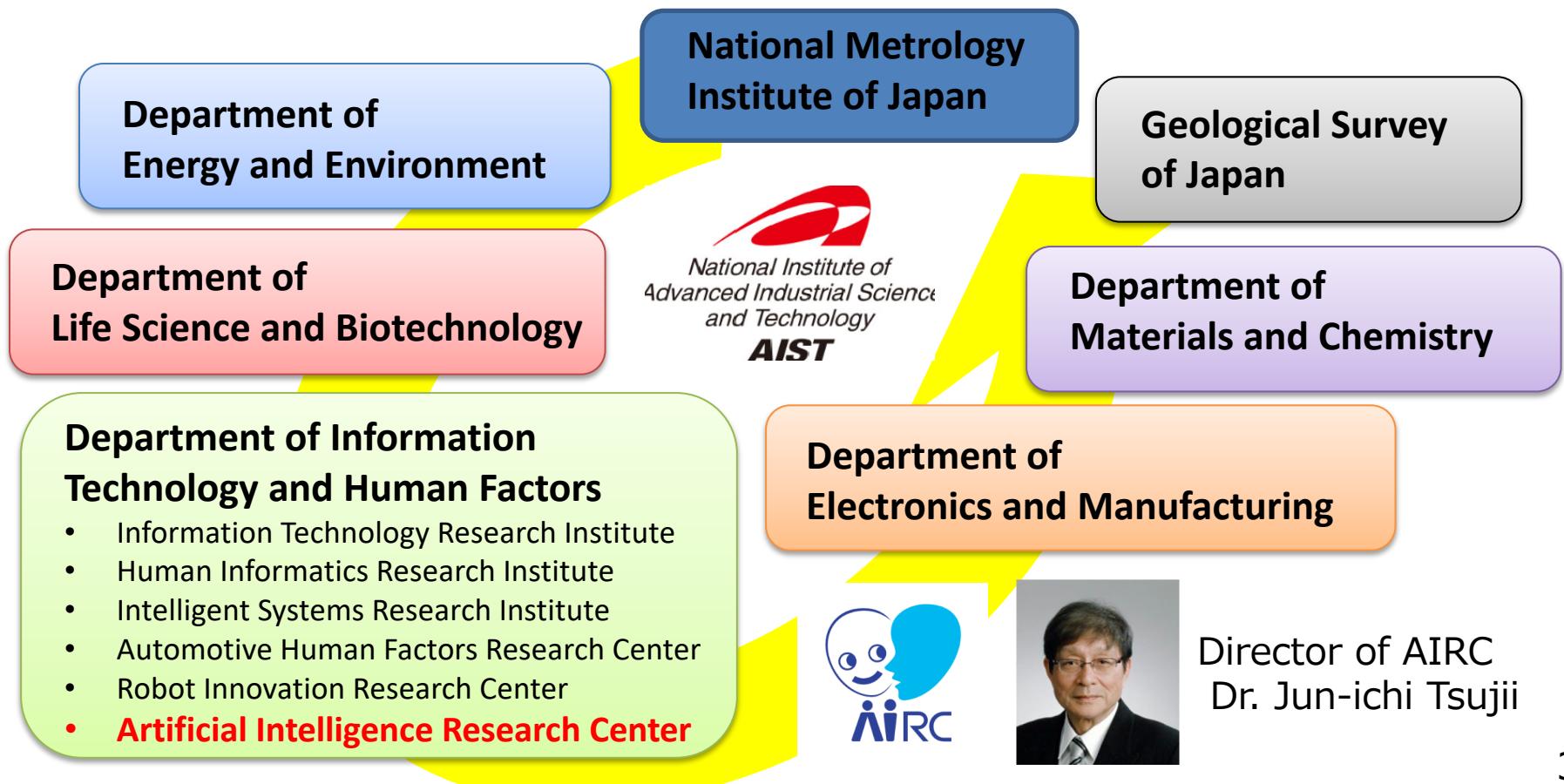
Yoshiki Seo
Director, AI Research Planning Office
Department of Information Technology and Human Factors
National Institute of Advanced Science and Technology (AIST)

Self - Introduction

- 1986 – 2017
 - Working at NEC Research Laboratories
 - SX-3, 4, 5, 6, Earth Simulator
 - Data Parallel Language (High Performance Fortran)
 - Grid Computing (Business Grid)
 - BigData Research, AI
- Joined AI Research Center, AIST this March!

AI Research in AIST

- AIST implements wide range of R&D, covering 7 range of fields.
- **AIRC**, under the Department of IT and Human Factors, is the one of the largest and rapidly growing centers/ institutes in AIST.
- Director of AIRC is Dr. Jun-ichi Tsujii, a prominent AI researcher.



AIRC at Odaiba (Tokyo Waterfront)



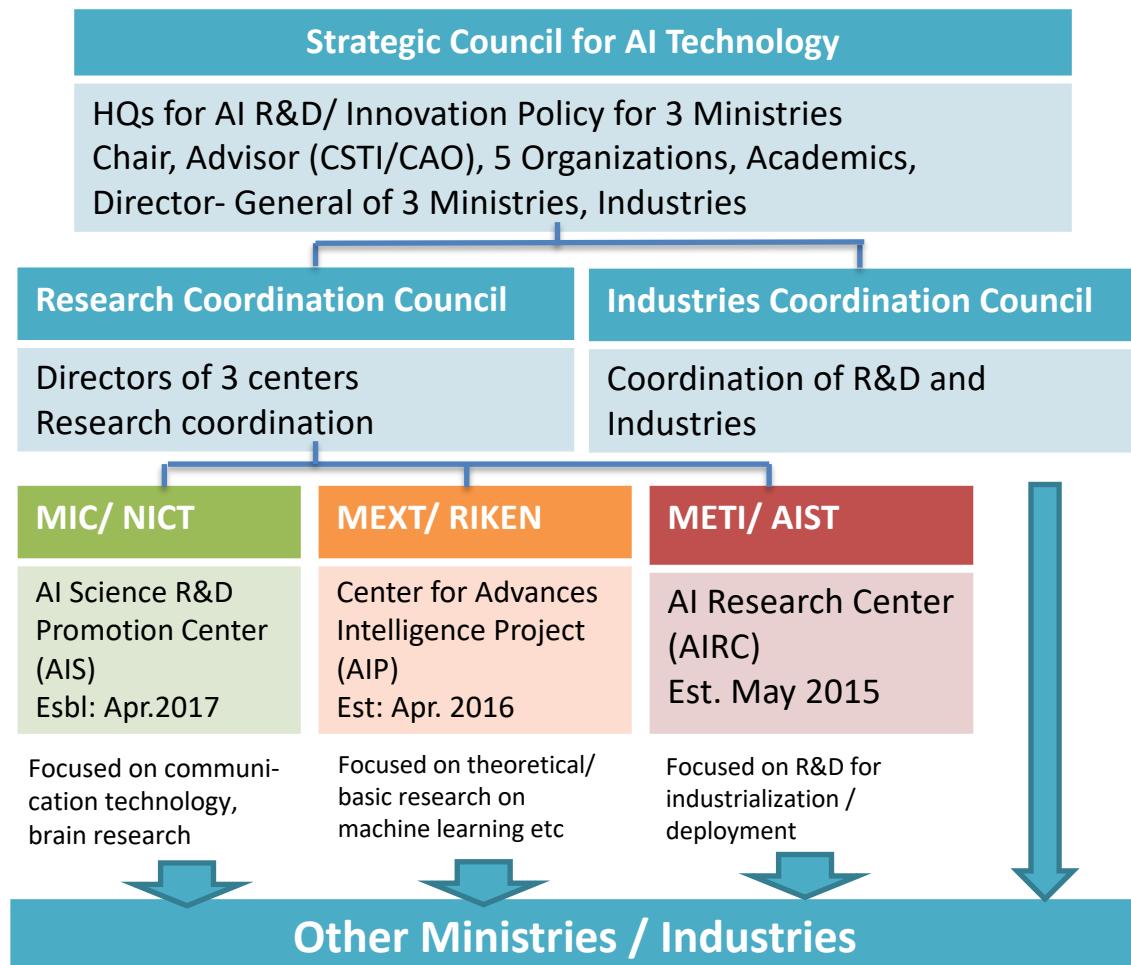
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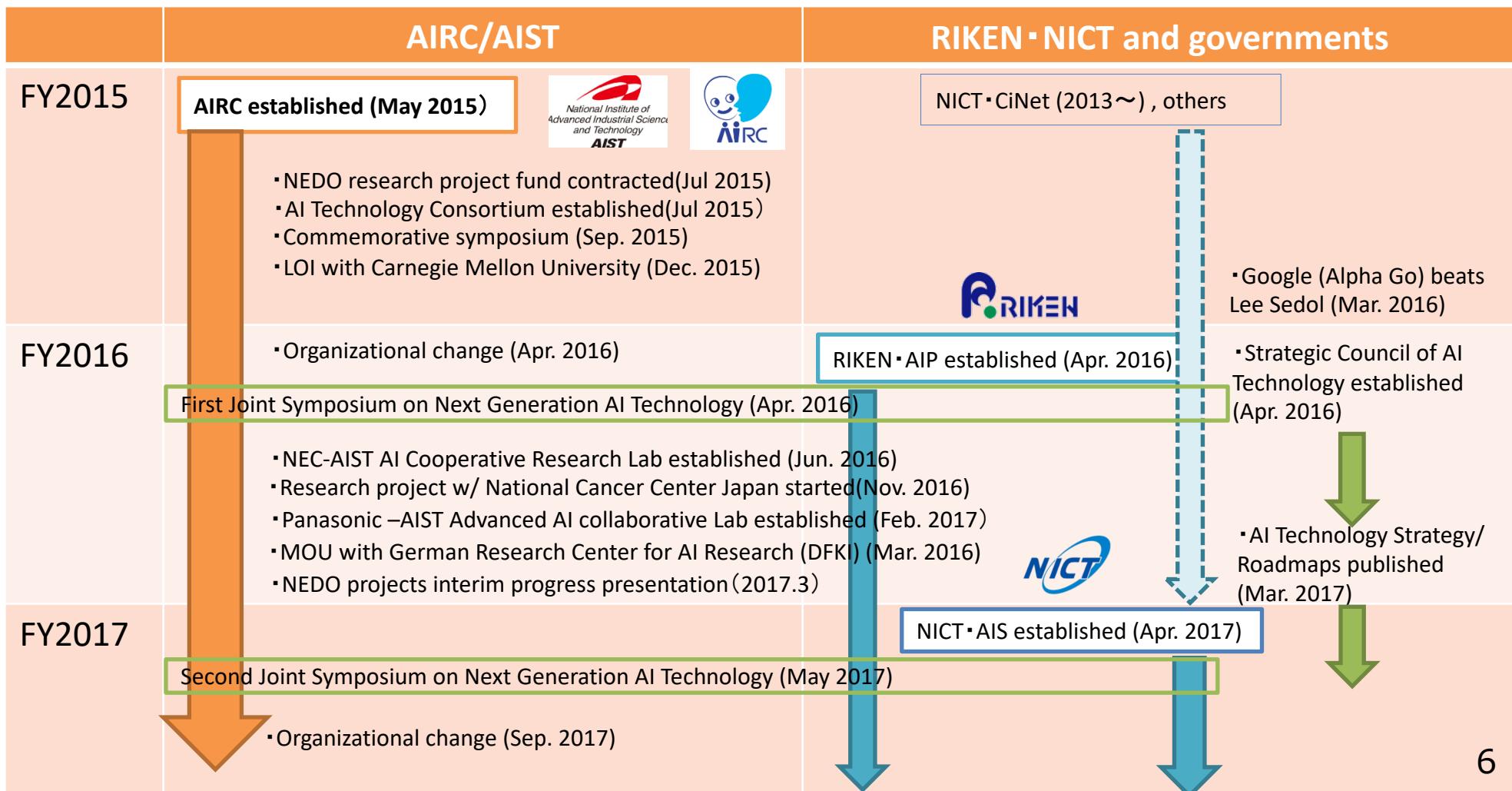
Japan's Government Institutions for AI Research

- **"Strategic Council for AI Technology"** was established by Japanese Government on Apr. 2016.
- **3 (three) AI Centers:** AIRC/AIST is the biggest AI center, which focused on R&D for industrialization/deployment by large scale-PPP projects.
- **"AI Technology Strategy/ Roadmaps"** was published in Mar. 2017.
 - Now reviewing this strategy is under way.



History of AIRC

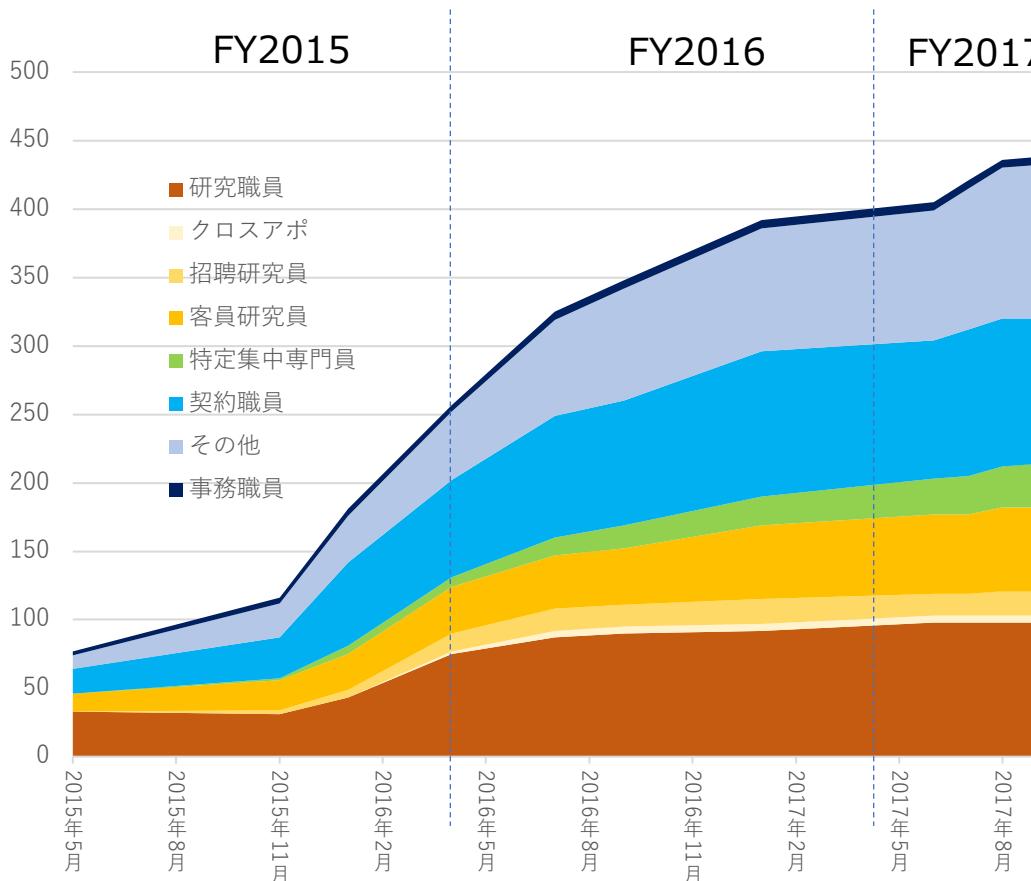
- AIRC/ AIST was established in May 2015 to be the largest AI research center in Japan for promoting large-scale AI research with PPP.
- Cooperating with RIKEN and NICT, AIRC/AIST accelerates AI R&D and deployment with industries and overseas research institutes.



Growth of AIRC

- When AIRC was established on May 2015, the numbers of persons at AIRC is 77. Currently it is 438 (Sep 2017)
- 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	May15	Sep. 17	
FT Researchers	33	98	Concurrent 30 Foreigners 20
Researchers from Univ.	13	84	
Cross Appointment	0	5	
Part-time Researchers	0	18	
Invited Researchers	13	61	
Part-time Researchers from Industries	0	32	
Post-Doctor, RA, technical staff, etc.	18	106	Foreigners 7
Technical trainee (students), collaborative researchers, other staffs	10	112	Students 60 Industries 42 Foreigners 24
Support Staffs (FT)	3	6	
Total	77	438	

AIRC's Organizations & 12 Research Teams

Department of Information Technology and Human Factors
(Director-General: Satoshi Sekiguchi)

Artificial Intelligence Research Center (AIRC)
Director: Jun-ichi Tsujii



Advisor Planning Team Leader

Supervisory Innovation Coordinator (X2)

Deputy Director (X4)

Prime Senior Researcher (X3)

Principal Research Manager

Research Manager



NEC-AIST AI Cooperative Research Laboratory
Leader: Takashi Washio

Knowledge and Information Research Team

Team leader: Hiroya Takamura



Service Intelligence Research Team

Team leader: Takuichi Nishimura

Probabilistic Modeling Research Team

Team leader: Yoichi Motomura



Social Intelligence Research Team

Team leader: Masaki Onishi

Data Platform Research Team

Team leader: Kyoungsook Kim



Living Intelligence Research Team

Team leader: Yoshifumi Nishida

Artificial Intelligence Applications Research Team

Team leader: Masahiro Murakawa



Geoinformation Science Team

Team leader: Ryosuke Nakamura

Artificial Intelligence Cloud Research Team

Team leader: Hirotaka Ogawa



Computational Omics Research Team

Team leader: Totai Mitsuyama

Machine Learning Research Team

Team leader: Jun Sese



Intelligent Bioinformatics Research Team

Team leader: Kentaro Tomii

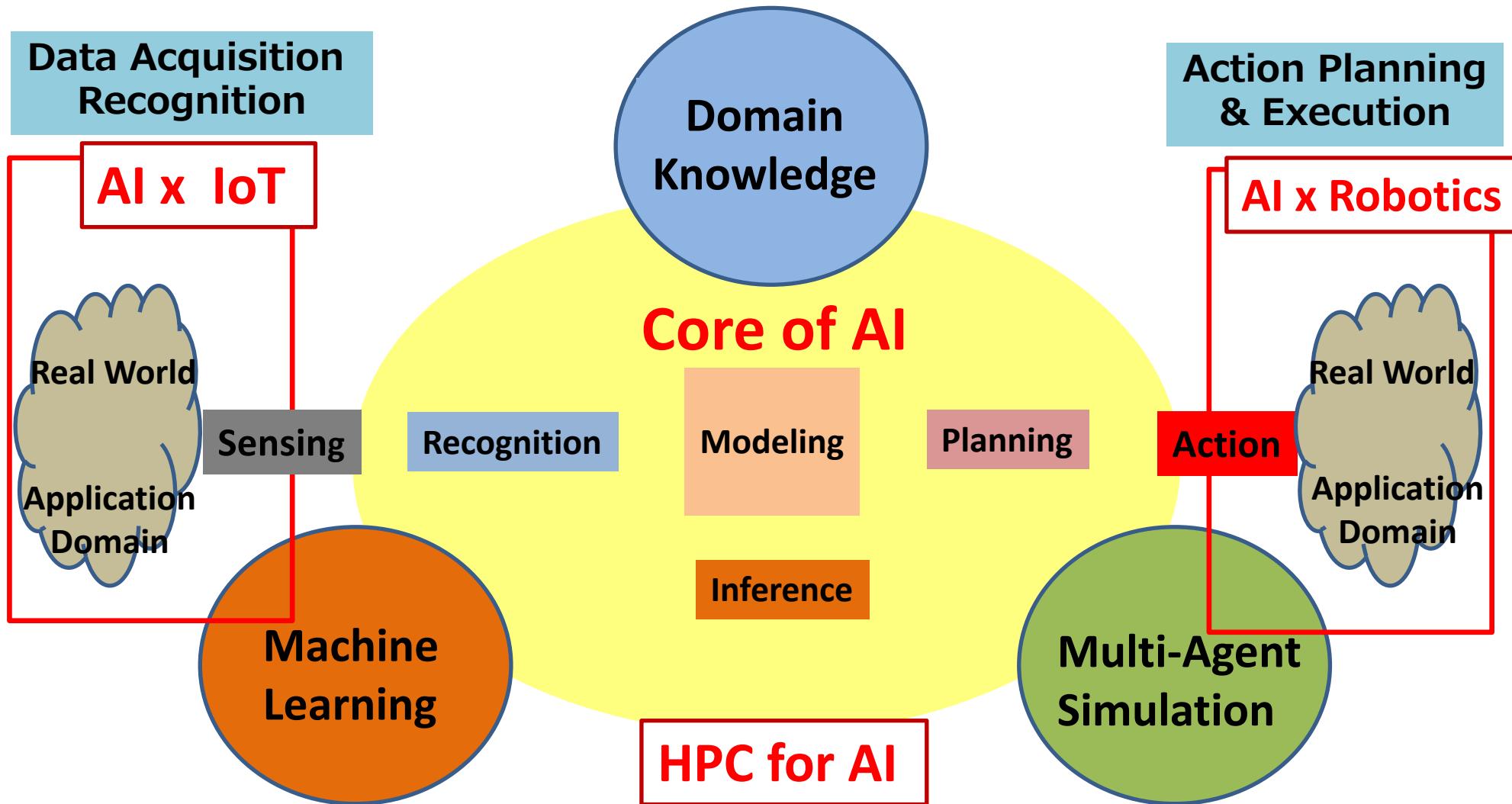
AI Embedded in the Real World

- from the Internet to the Real World -



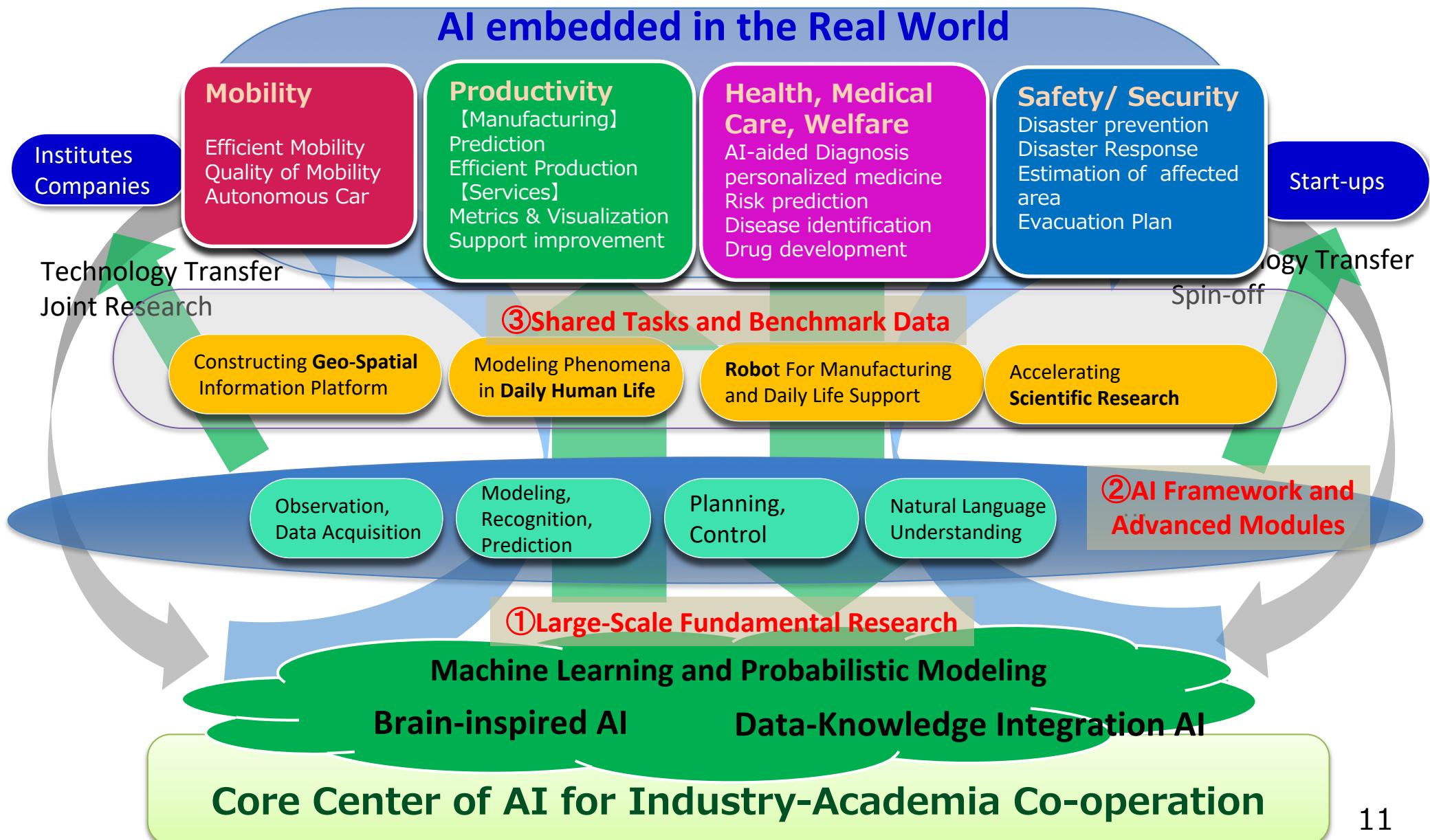
AI which cooperates with Human
Cooperative Autonomy, Explainable AI

AI Embedded in the Real World



Strategy for AI research

- Creating positive cycle of research and deployment of AI



Example of Research Results at AIRC

Observation, Data Acquisition

- Publish **satellite image data** (more than 1PB) in international standard format
- **Autonomous mobile robots** which move around and detect / follow other moving objects (human, vehicles) Modeling trajectories and predicting direction of motions
- Construct "Living Lab", which connect AIST and nursing facilities Data acquisition for personal precision care in living environments/fields
- Construct a VR-interaction data acquisition system

HPC – Large Scale Computing

- **AIST AI Cloud (AAIC)**, a HPC which is focusing on AI/ machine learning, attained **the 3rd position in the world in Green 500 List**
- Contribute to standardization of data access format which facilitates usage of moving features data

Modeling, Recognition, Prediction

- **Probabilistic modeling system** using Bayesian network and pLSA for supporting customers behavior and services
- Develop a system for recognize humans behavioral patterns by using **deep learning technology** from video of every day life. The training video data (more than 100 thousands) will be published soon (world largest)
- **Anomaly detection by modeling normal data**, Applications to medical images, videos, etc.
- Develop methods of **object/event detection and recognition in satellite images**
- Develop systems to identify **household items/ functions** from their **3D data**, Win 1st place at an international competition of 3D object retrieval
- Win 1st place at an international competition of **protein structure prediction**
- Develop a method of pedestrian flow measurement and large scale simulation of indoor and outdoor evacuation of people

Planning, Control

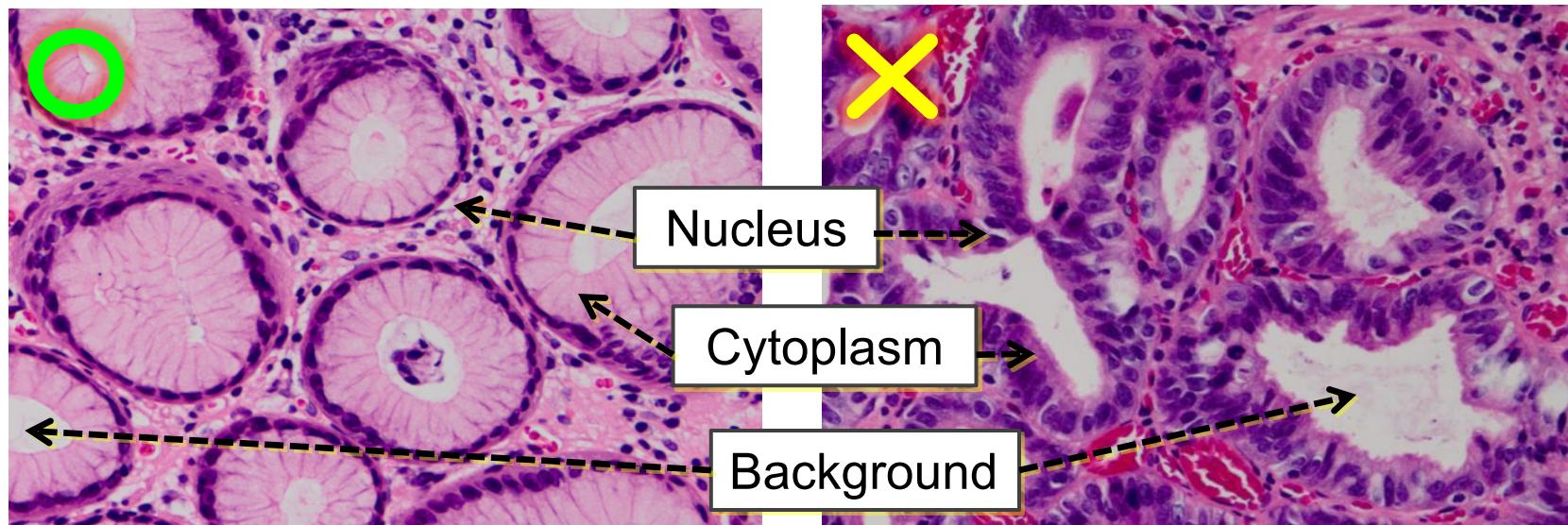
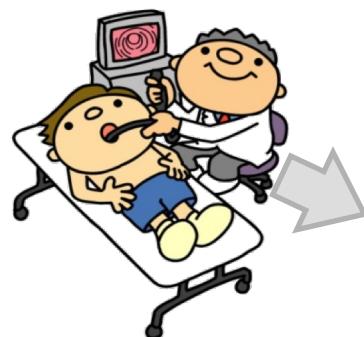
- Develop **robots that automatically assemble simple parts** by using database of humans behavior. Verified at three kinds of parts assembly
- Develop **robots to learn complex behavior** such as **folding towels** only by teaching several times (using deep learning technology)
- Enable of properly manipulating deformable object such as hanging a shirt to a hanger

Natural Language Understanding

- Construct and publish **elemental function modules of natural language processing**
- Realize **clustering and visualization of large scale scientific literature**. (world top level)
- **Automatically generate captions of short video or time-series data** using deep learning technology (world top level)
- Construct an **ontology for describing knowledge of elderly care** and apply to service improvement

Pathological Diagnosis

Pathologists diagnose abnormal biopsy tissues (e.g. cancer) through microscopic observation.



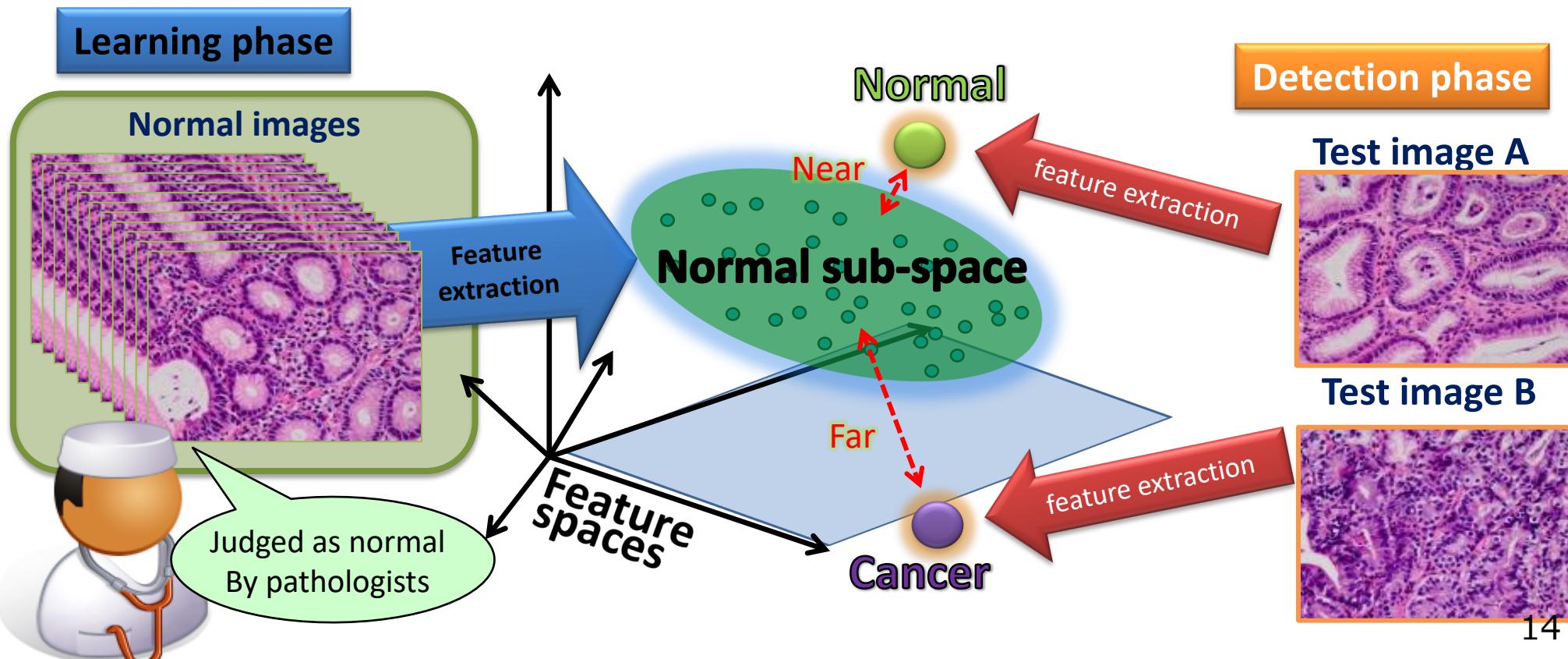
Example of healthy image

Example of cancerous image

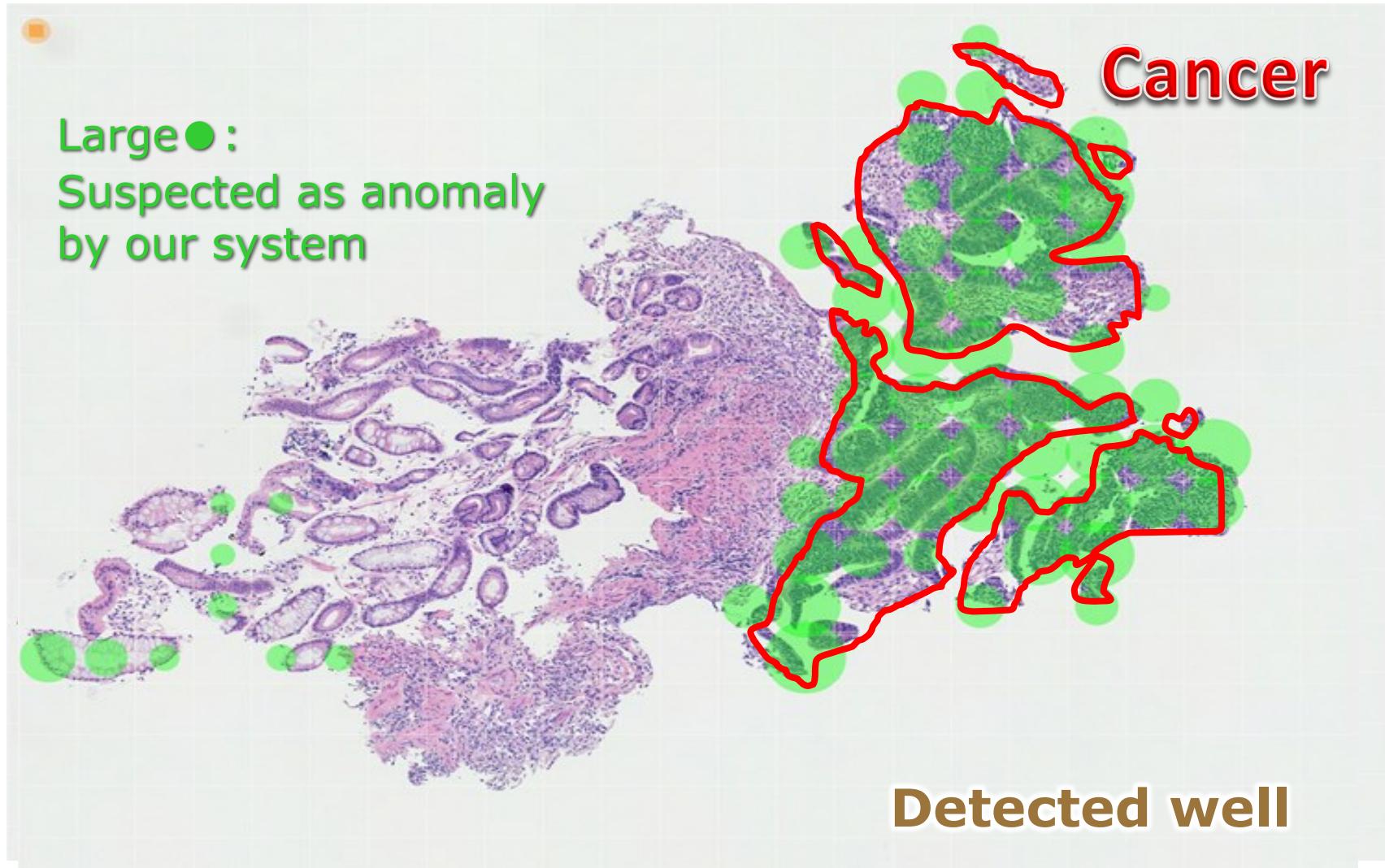
Very hard work for human: diagnosing 1 sample image takes 30 seconds.
Huge number of images should be diagnosed.

Learn Normality and Detect Anomaly

- Learn normality and detect anomaly as ‘anything strange’
 - ✓ No need to define what the cancer (anomaly) is

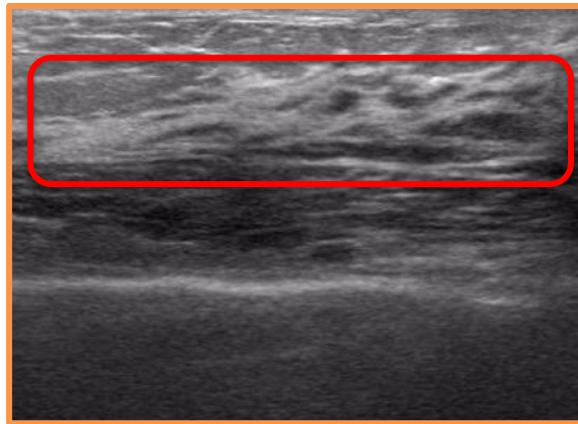


Example of Cancer Detection Result



Breast Ultrasonography Diagnosis

Breast Ultrasonography



Layered structure

Skin / Fat

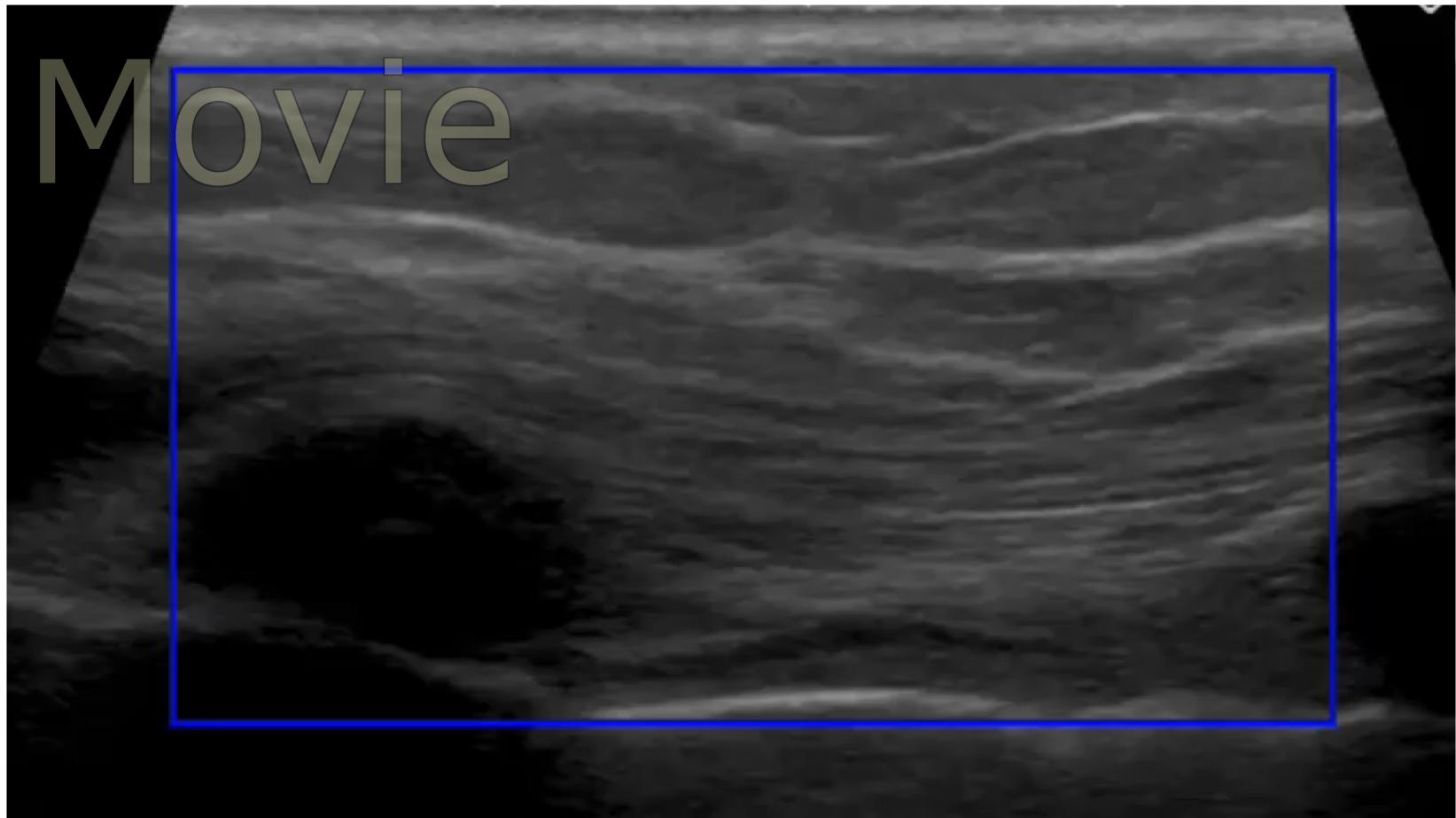
Mammary gland
(here cancer arises)

Muscle / Rib

Difficulties in the application of image recognition techniques

- **Noisy** image like a sandstorm
- Recognition of characteristics in the '**motion**'
- Fast processing needed for **real-time** support

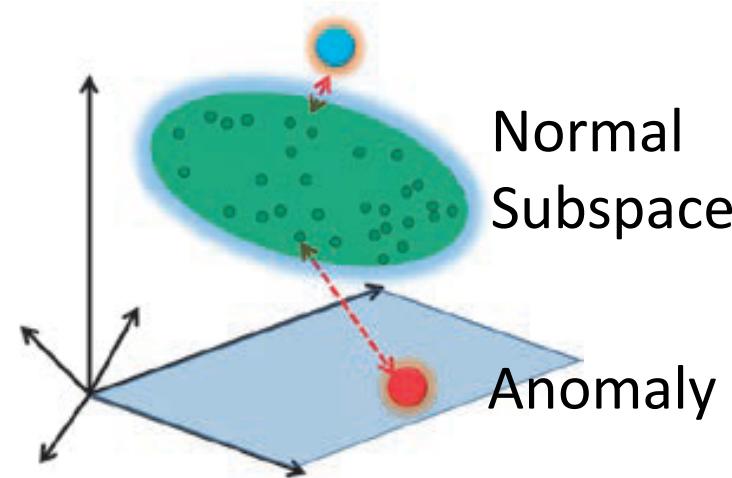
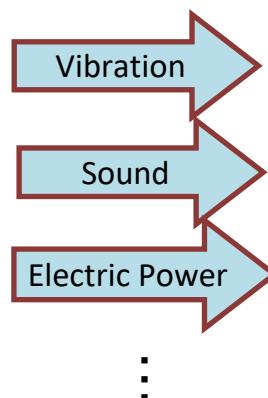
Example of Detection Result



Red rectangle : suspected area of abnormal tissue

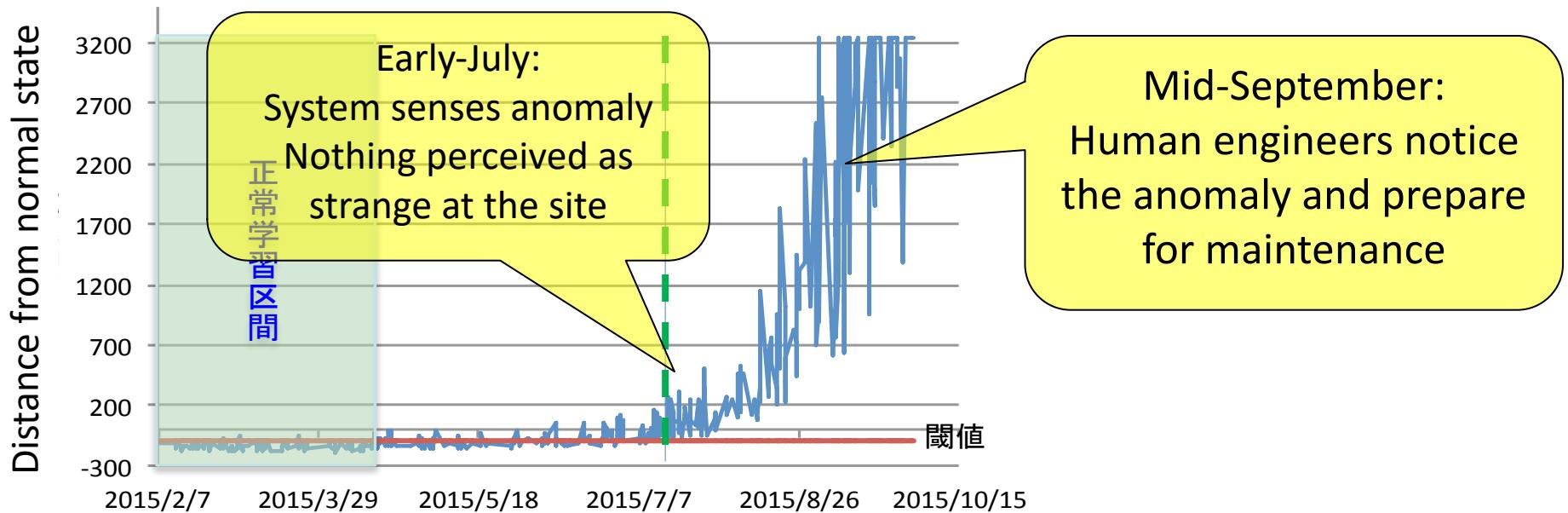
Predictive Detection of Windmill Disorder

Various Sensors (IoT)



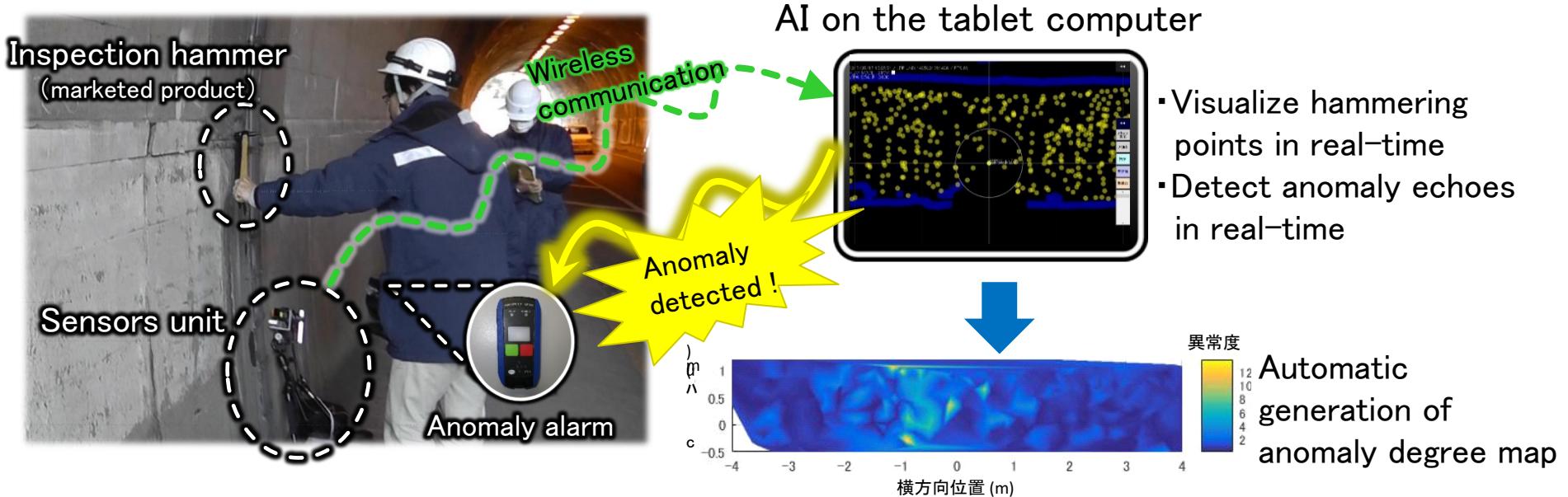
Example from Real Experiments:

Success to detect disorder **earlier than human engineers**



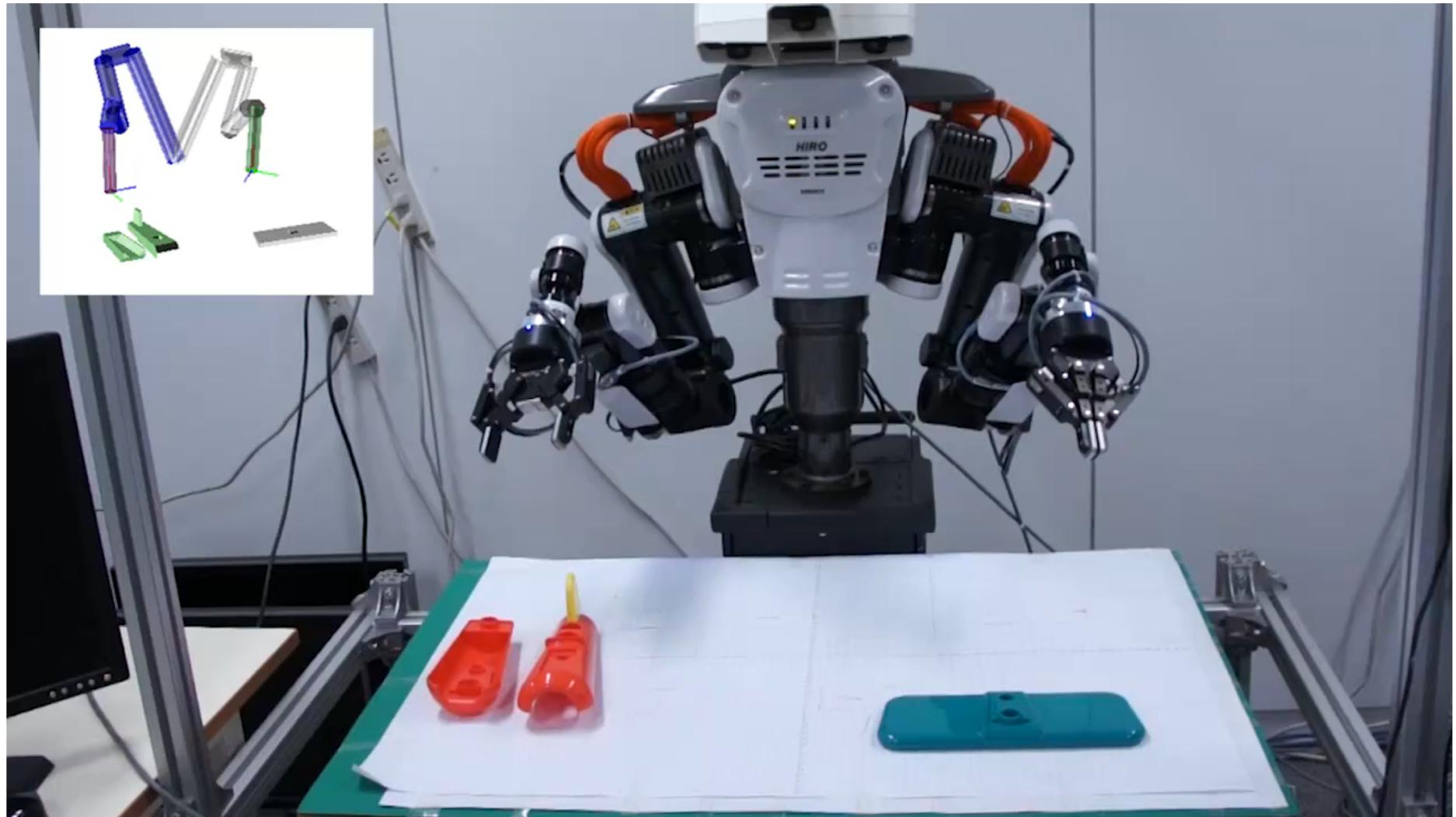
AI-aided hammering test system

- Alert anomaly in real-time using machine learning of difference in impact echoes with a inspection hammer
- Visualize anomaly degree maps automatically for inspection results and prevent missed hits on-site
- Reduce total man-hours including time for preparation of reports



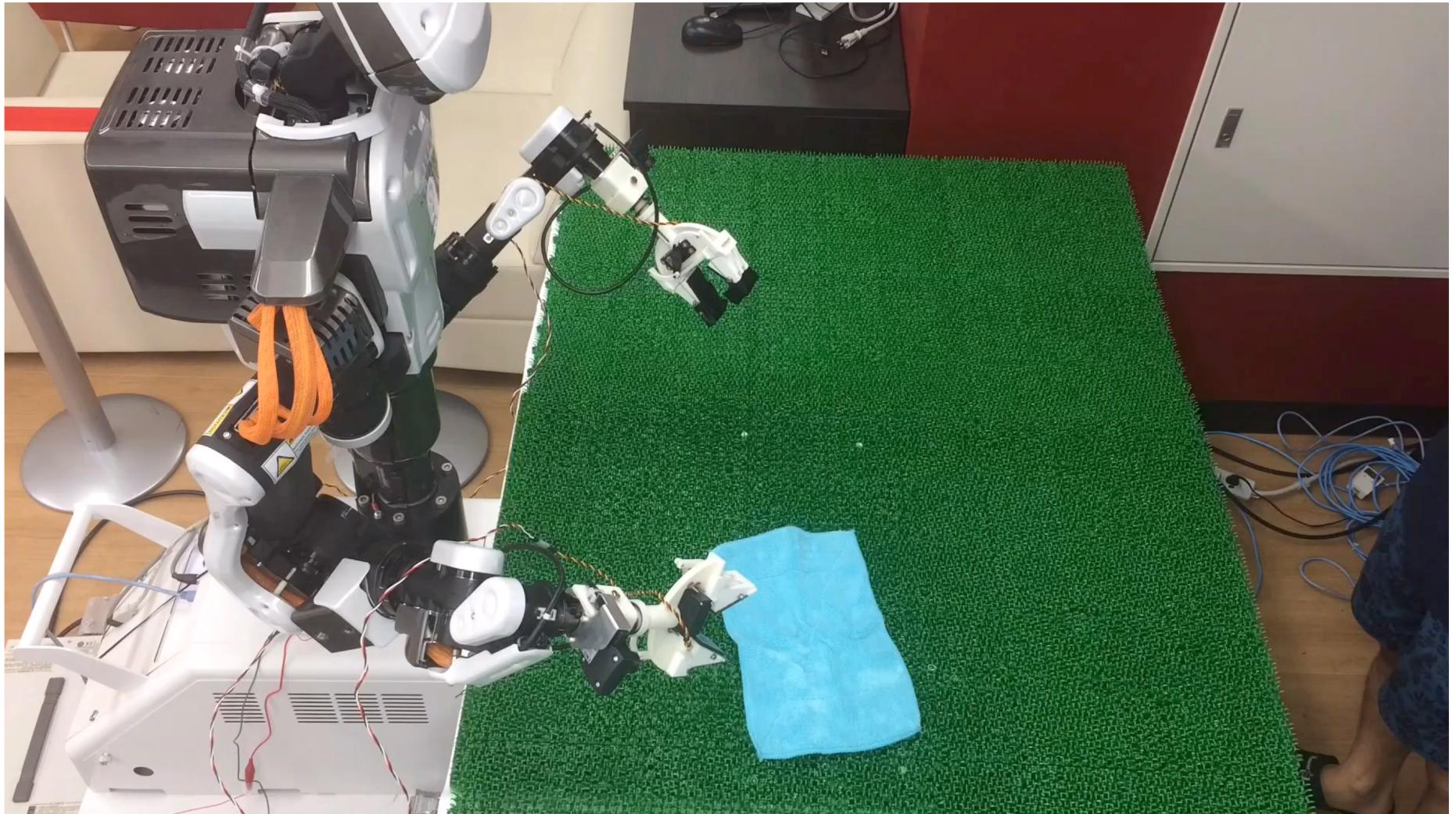


Complex Motion Planning for Assembly



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

Learning to Handle Flexible Object from Demonstrations



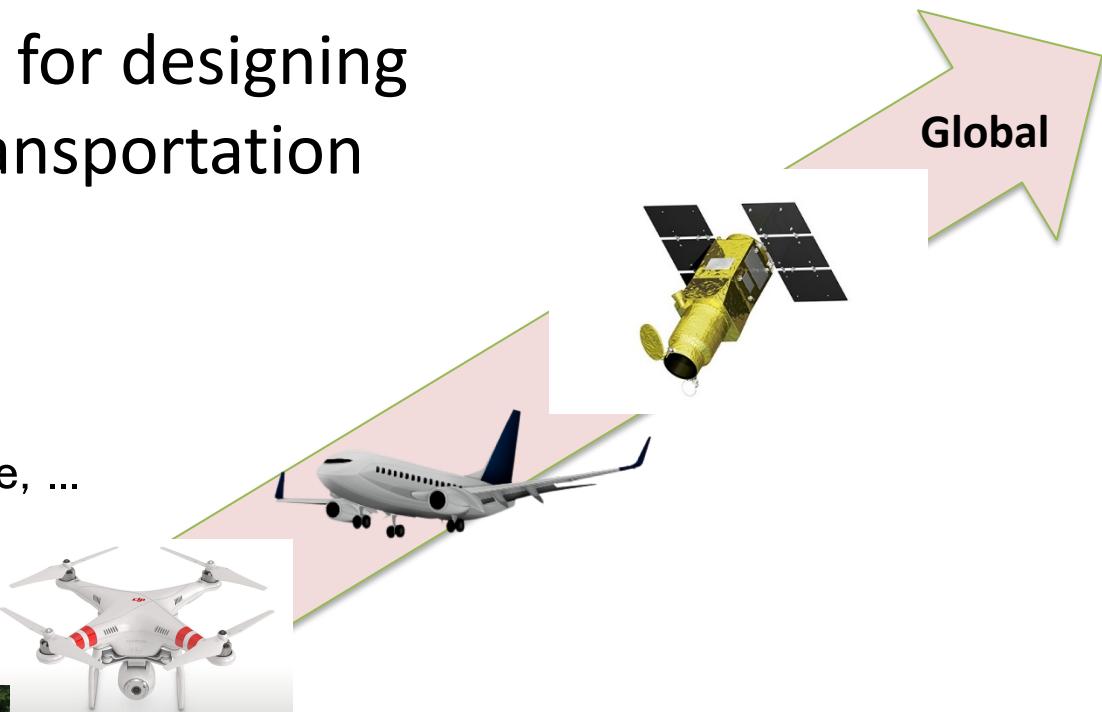
Movie from Prof. Tetsuya Ogata (Waseda University/AIRC)

国立研究開発法人

Multi-Scale Geo-Spatial Information Platform

- Fundamental platform for designing all kinds of efficient transportation

- Human flow
- Logistics
- Autonomous mobile robot, autonomous driving car, drone, ...
- Energy flow
- Information flow



- Constructing a digital replica of the physical world (digital twin)
 - Object detection/recognition
 - Change/Event detection/recognition
 - Large scale simulation with data assimilation

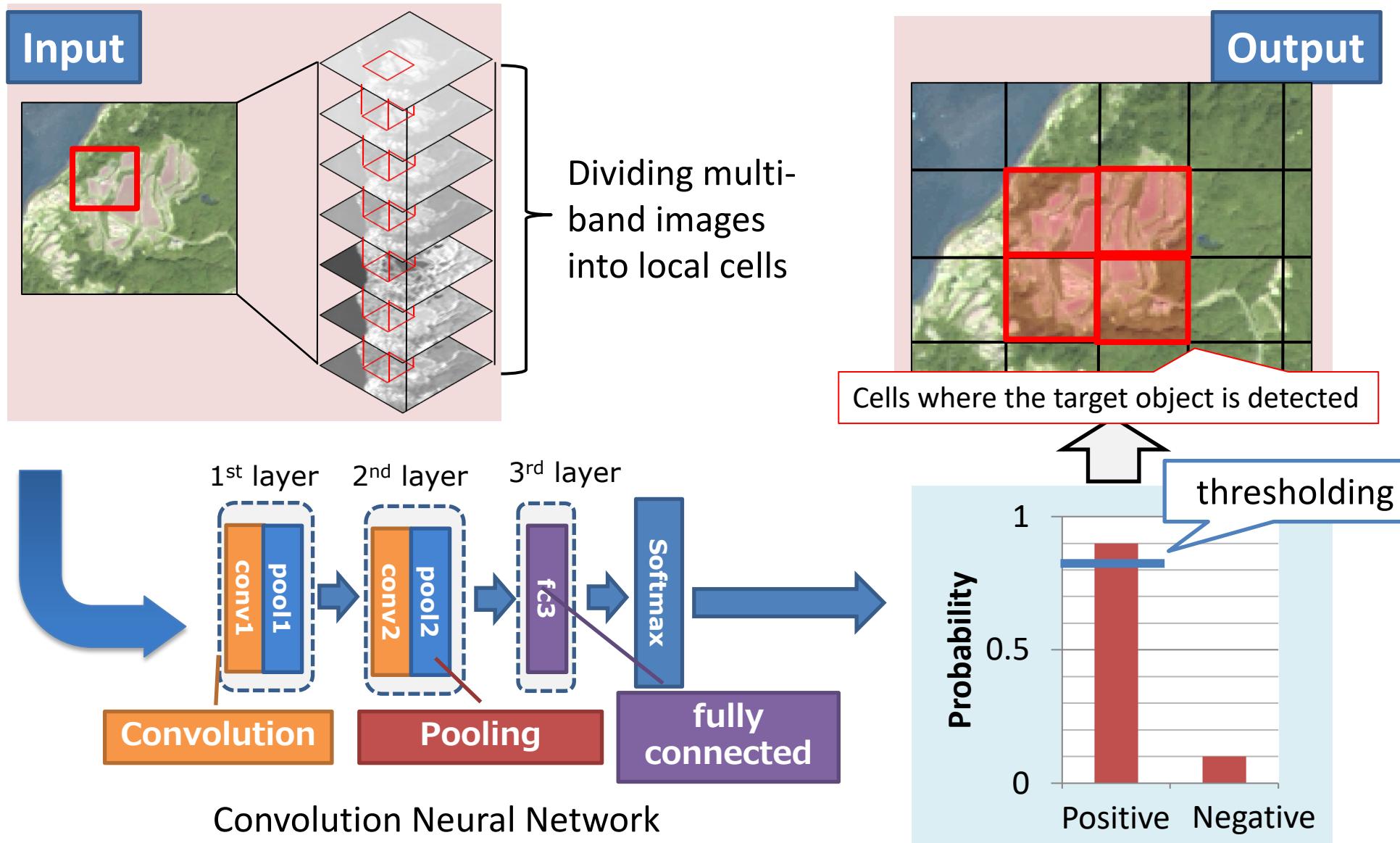
The geospatial platform on ABCI will cover the whole world like *Buddha's Hands* !



孫悟空 (Sūn Wùkōng) on 筋斗雲 (=Very fast cloud!)

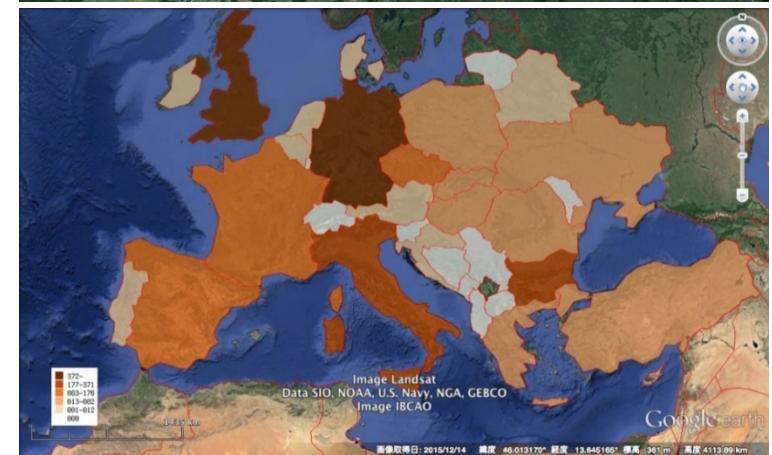
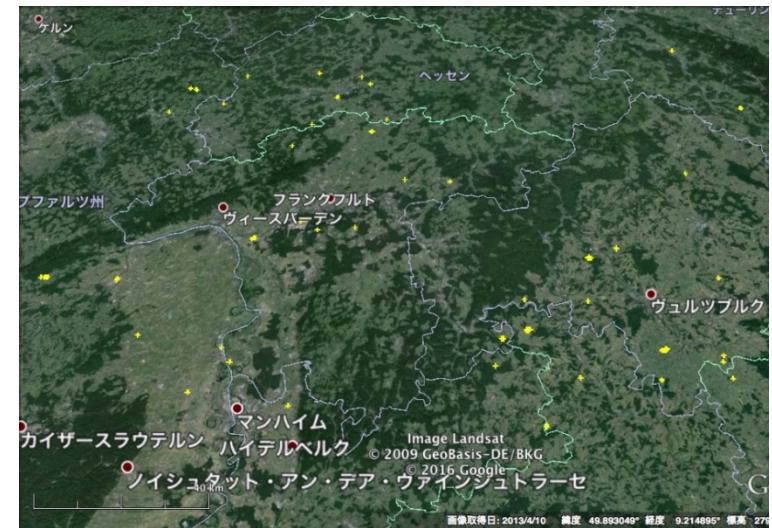
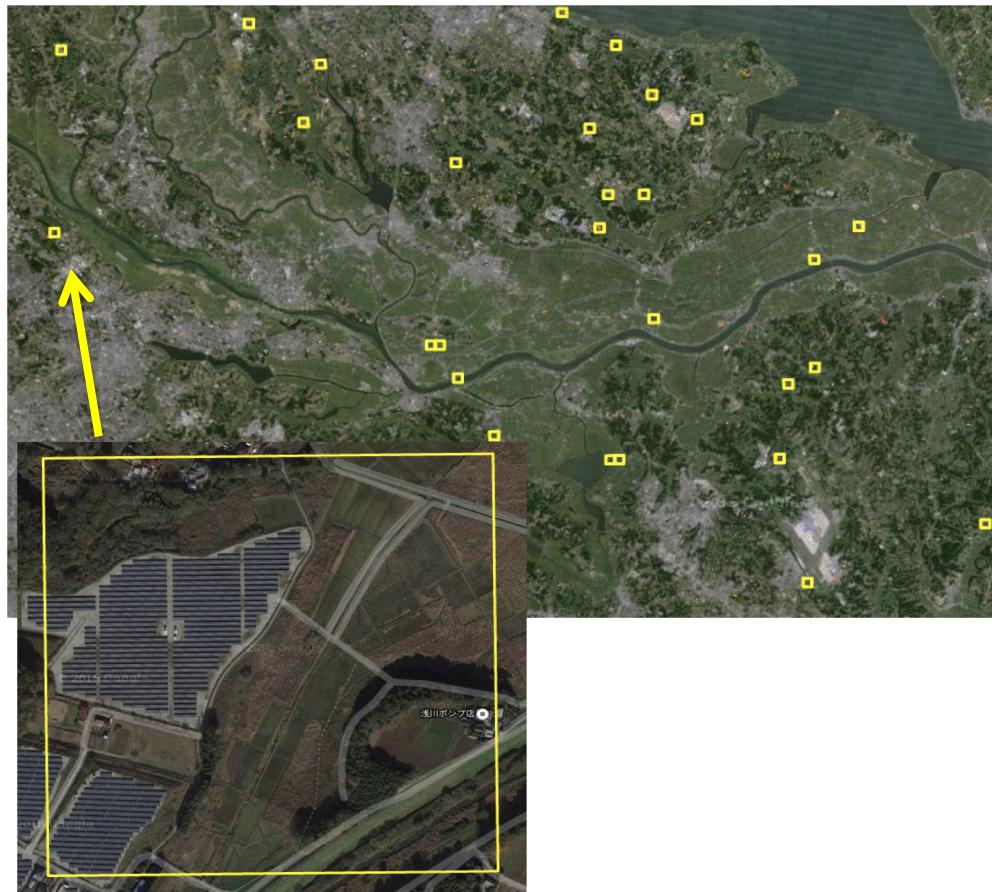
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Object Detection in Satellite Images

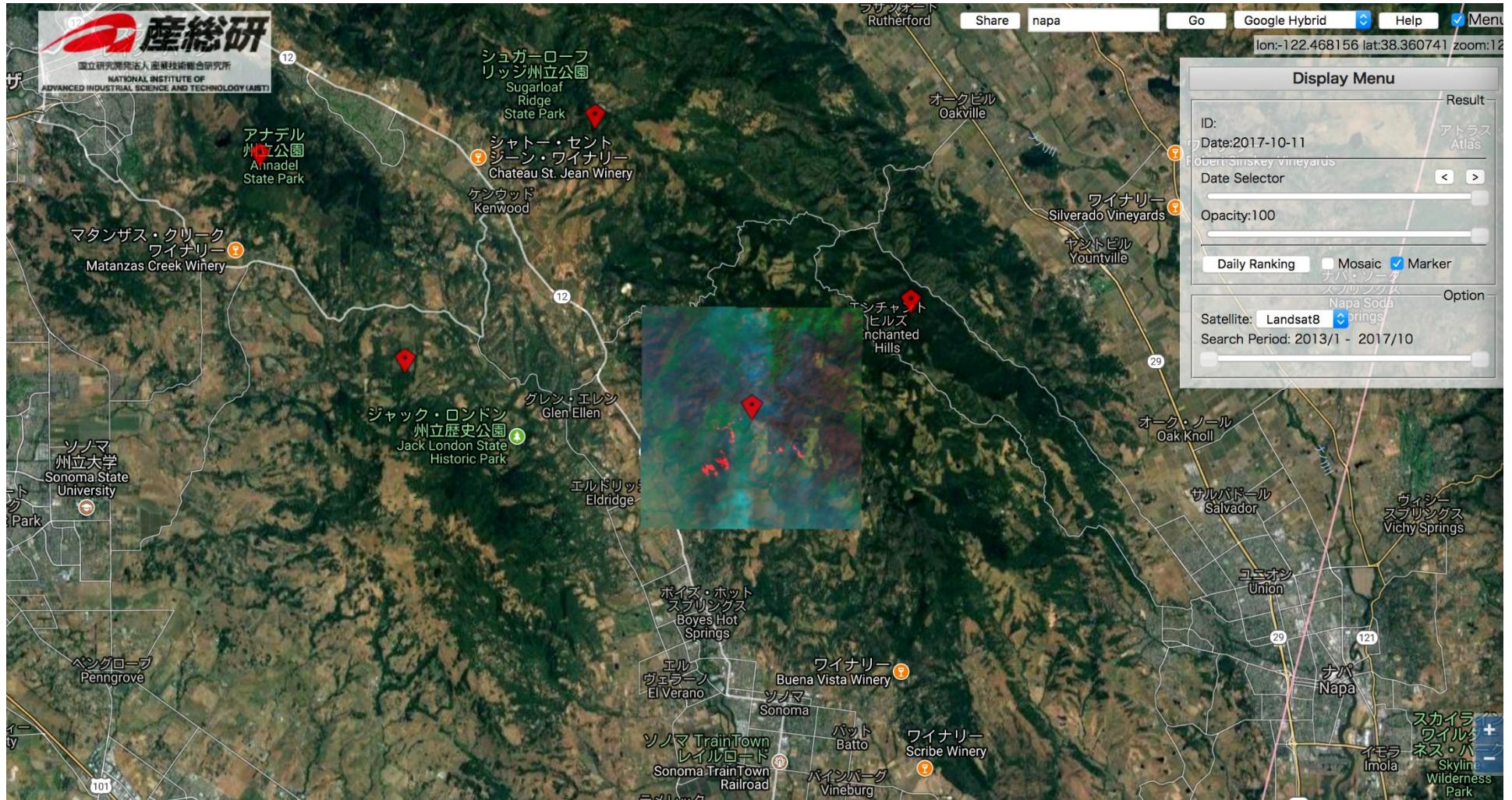


Applying AI to solar panel detection

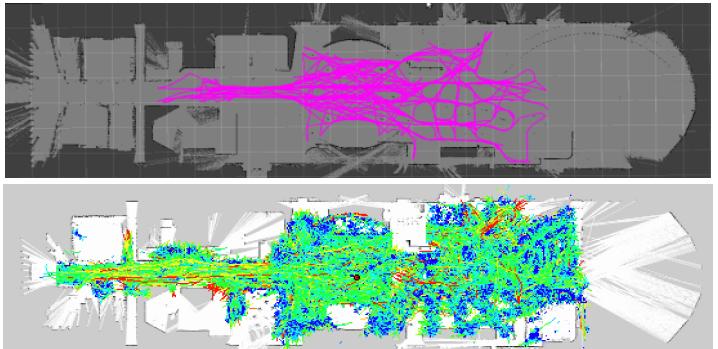
We can measure the power demand capability by solar light not only in Japan but also in the world.



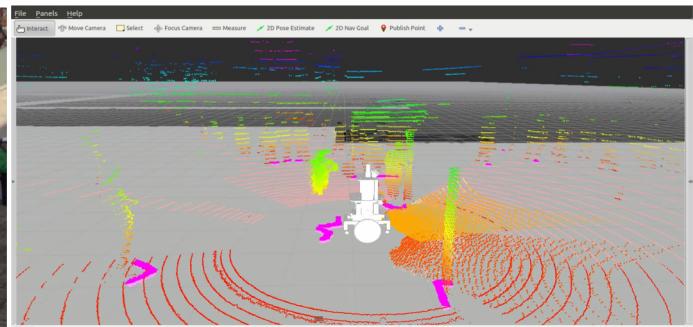
Detection example: Wildfire of California



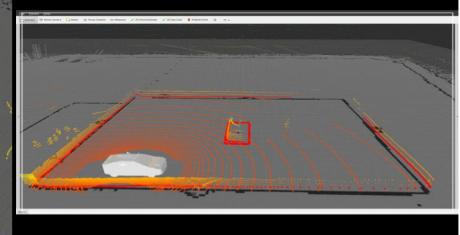
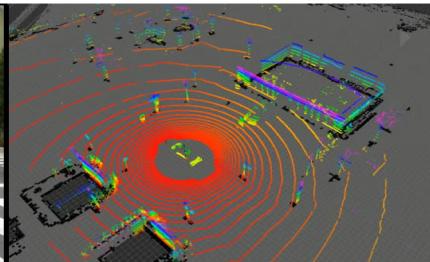
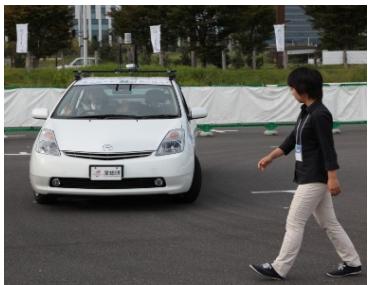
Modeling 3D Environment including Humans



Guidance robot at "Miraikan". Robot and human trajectories.

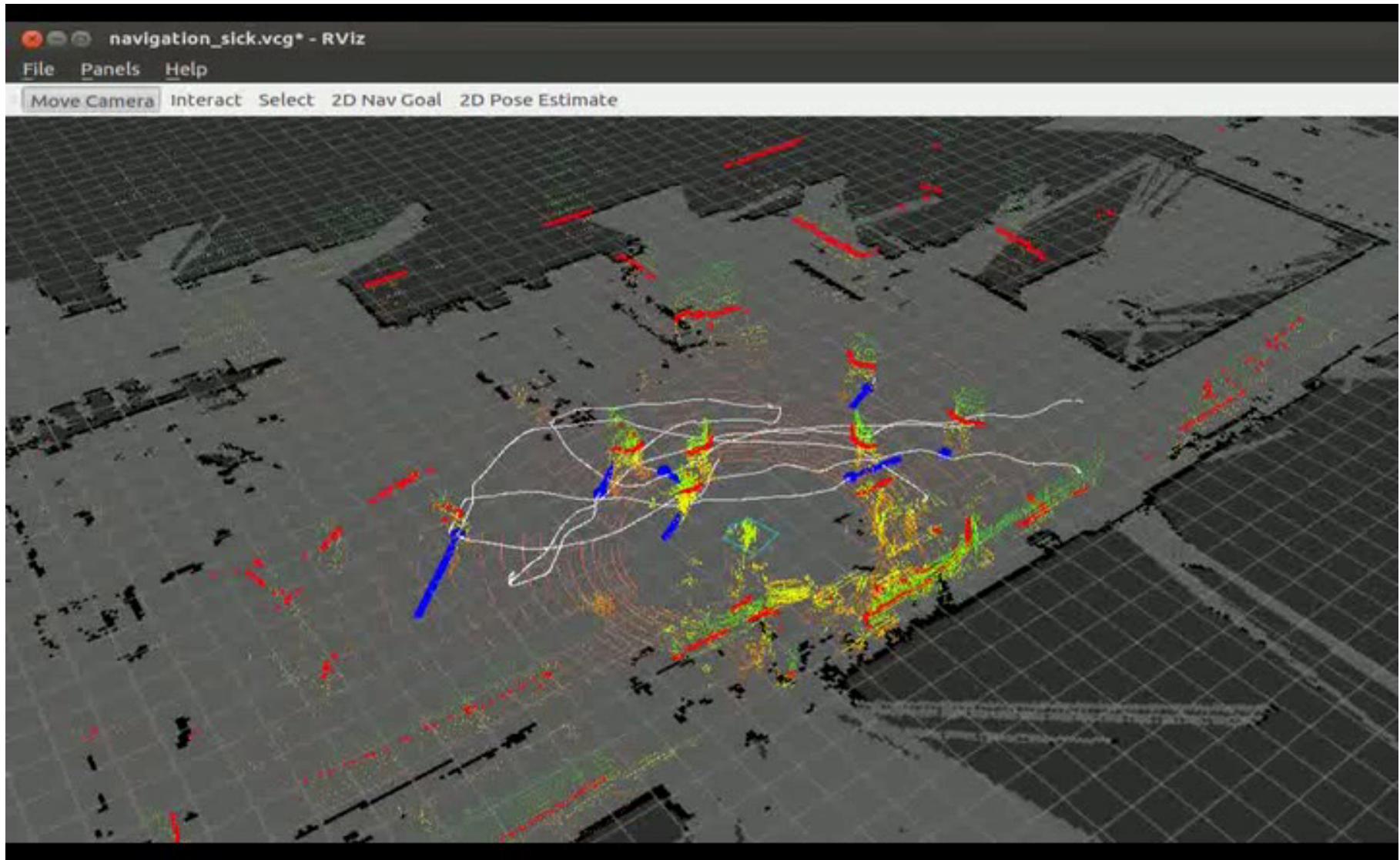


Tsukuba Challenge 2013.

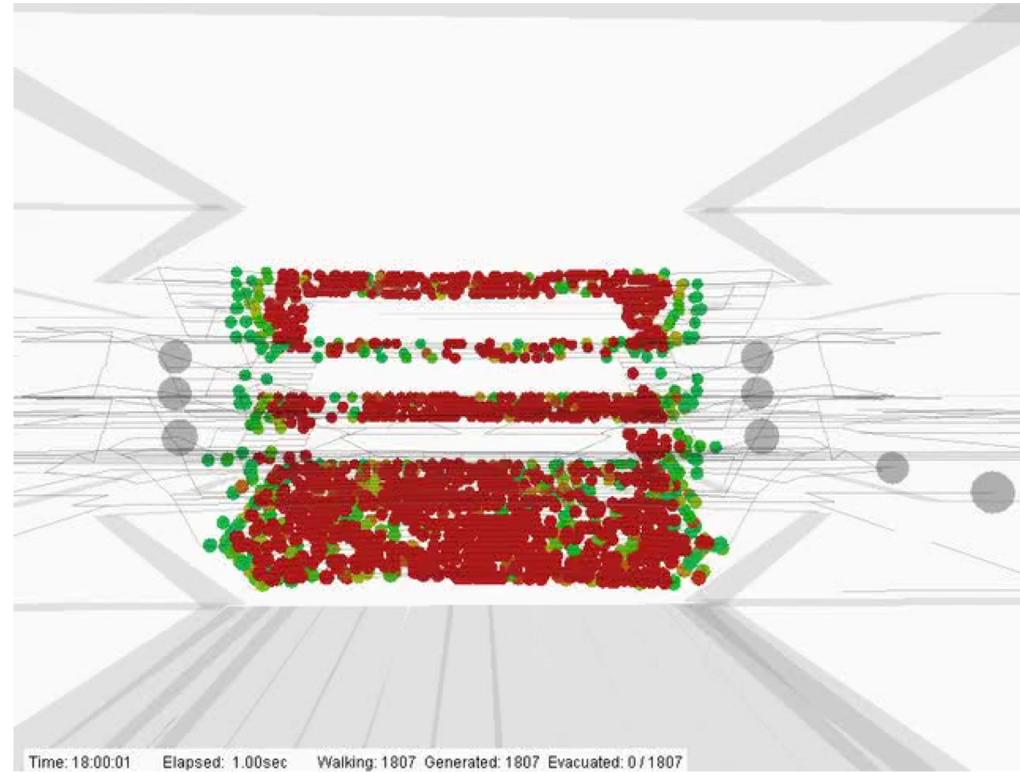
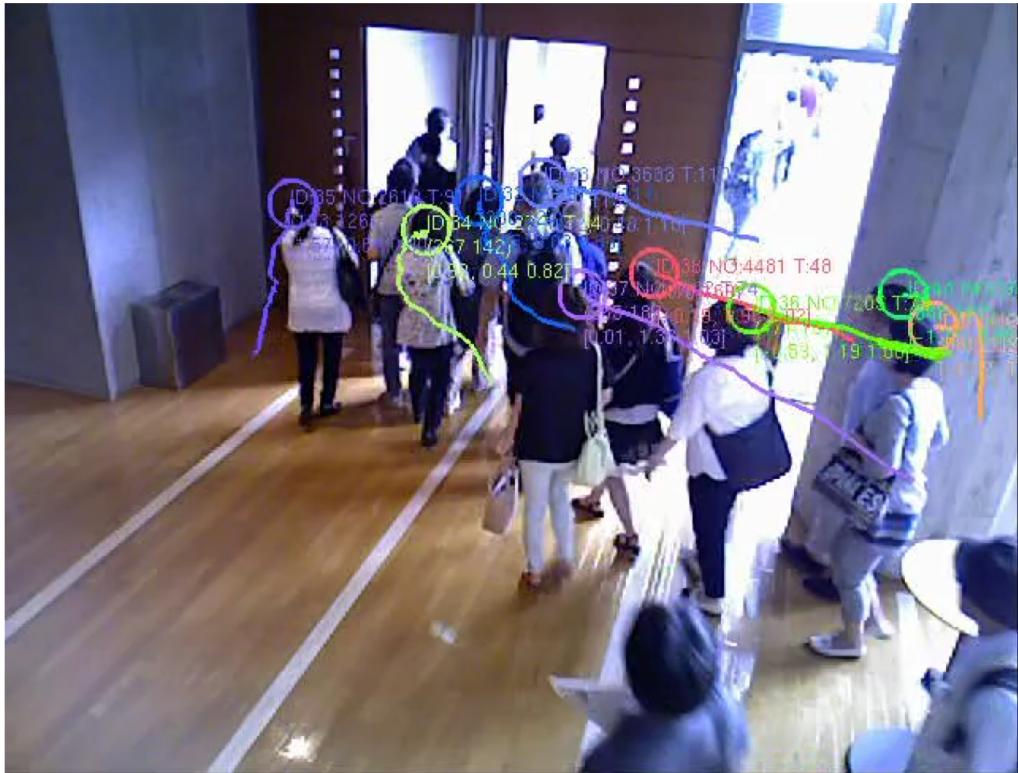


Autonomous drive followed by human driving trajectory. ITS world congress demo (right).

Predicting Human Movement



Peoples Flow and Simulation for Evacuation



Infrastructures for AI Computing



NEDO Future AI and Robot Project

Nairobi Cluster

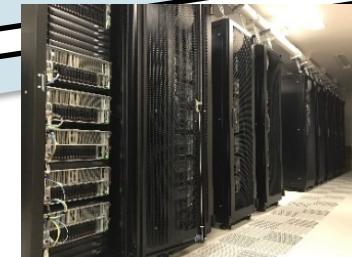
H28.6-
Testbed for AI R&D
in the NEDO project



Ranked #3 in Green 500

AIST AI Cloud
AAIC

H29.4-



Common platform for
R&D toward social
implementation of AI

AI Bridging Cloud
Infrastructure

ABCi (Kashiwa)

H30.3 or after
Open innovation platform
for AI related R & D in Japan

Deep Learning 0.5 PFlops → 8.6 PFlops → >130 PFlops
※Peak Performance of half-precision

HPC 0.2 PFlops → 2.1 PFlops → >12 PFlops

Storage 23 TiB → 4.5 PiB → >40 PiB

Future of AI and HPC

- AI Research Problems for handling Real World
 - Dependability of AI Solutions
 - How we can manage AI quality?
 - Understanding how AI works
 - Overcome DL Blackbox
 - Synergy of Machine learning and Human Knowledge
 - Thinking, Fast and Slow/Daniel Kahneman
 - Shortage of Real world Labeled Data
 - Transfer Learning, Frame Problem
 - Human – Machine(AI) Interaction
 - Transfer human skill to AI

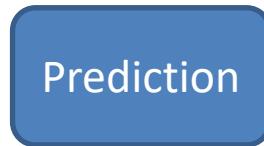
How can HPC accelerate research for those to be solved?

Future of AI and HPC

- Dependability
 - Same frame? Same probability distribution?



Big Computation



Big Computation, too

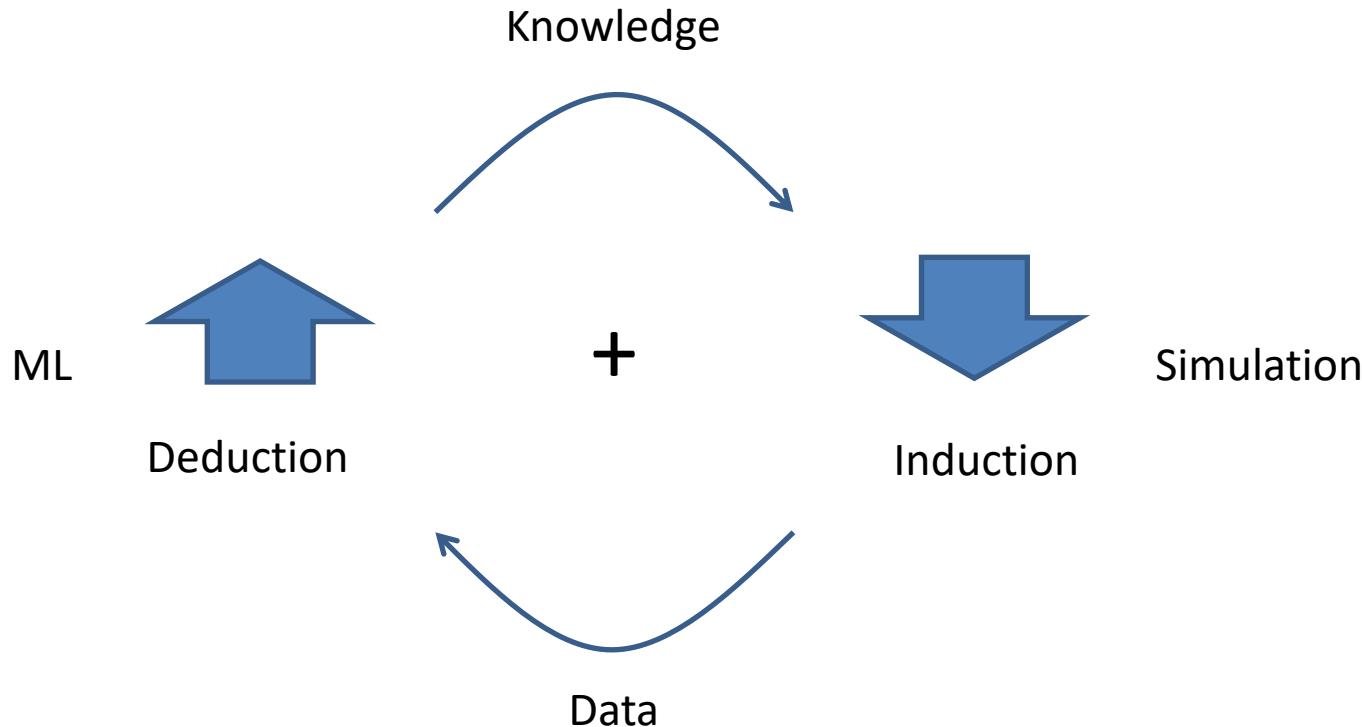
REAL TIME!

Future of AI and HPC

- Understanding How AI Works
 - Analyzing NN behavior
 - Big computation Needed!
 - Short turn-around time should accelerate research!

Future of AI and HPC

- Synergy of Machine learning and Human Knowledge
 - Thinking, Fast and Slow/Daniel Kahneman

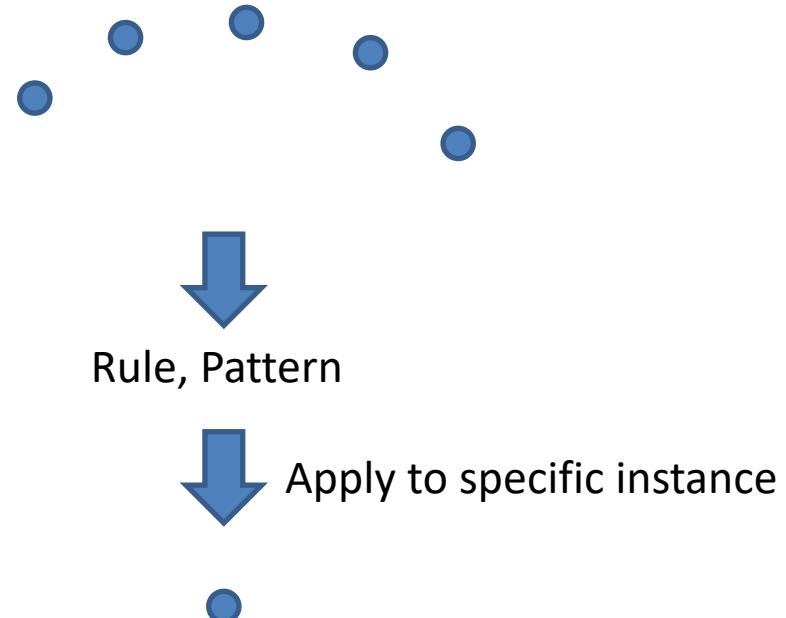


Future of AI and HPC

- Shortage of Real world Labeled Data
 - Transfer Learning, Frame Problem



Specific type of accidents does not occur
at all the places that have the same risk!

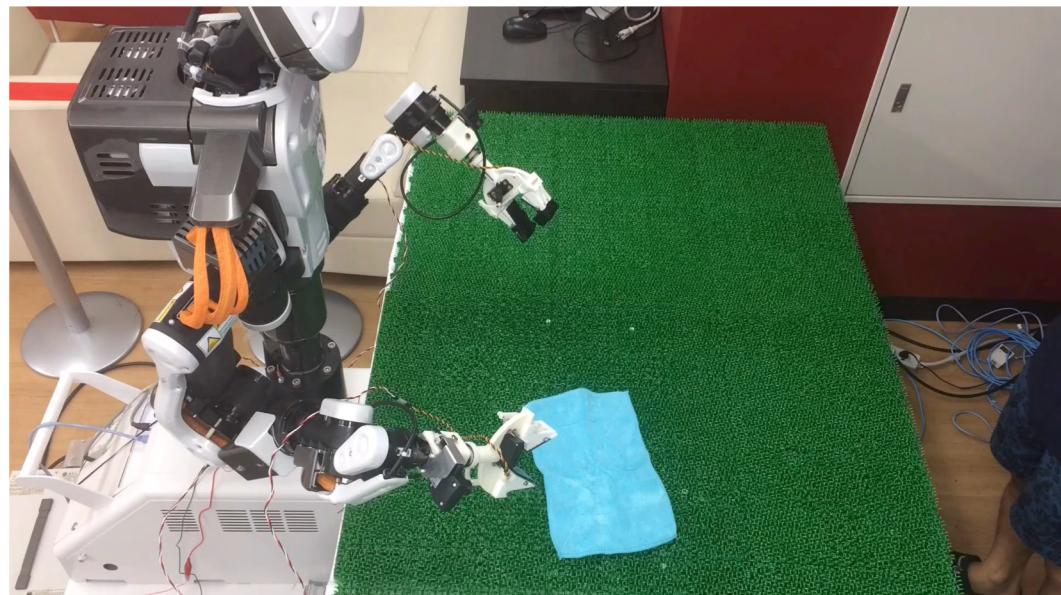


Future of AI and HPC

- Human – Machine(AI) Interaction
 - Transfer human skill to AI



I do not want to wait for a day
for a robot to learn properly!



Global Network of Partners



[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



[Domestic Univs.]

- 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

END

Questions?