PntML: AI-powered Geospatial Data Platform

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AIST

National Institute of
Advanced Industrial Science and Technology

https://www.aist.go.jp/index_en.html

Independent Administrative Institute

- METI - Economy Trade and Industry
- Does rather applied research
- Do support industries

The first computer related department, Electrotechnical Laboratory (1891)

AIST

AIRC

AIST
NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

Energy and Environment | Life Science and Biotechnology | Information Technology and Human Factors | Materials and Chemistry | Electronics and Manufacturing | Geological Survey of Japan | National Metrology Institute of Japan

HOME > About AIST

AIST:About

The National Institute of A
organizations in Japan, foc
industry and society, and

For this, AIST is organized
comprehensive strength.

AIST, as a core and pione
research and developmen
formulated with the chang

AIST is also actively buildi
comprehensive research c

Initiatives for

Research Unit

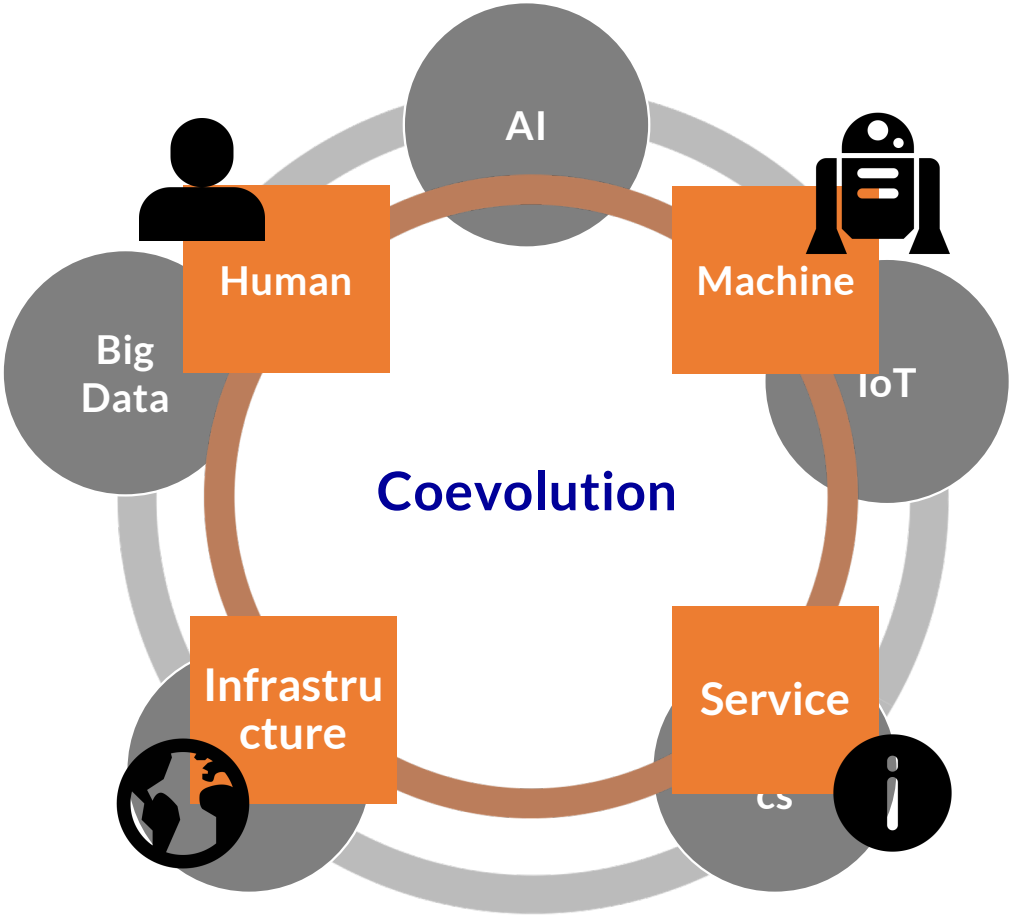
- Human Informatics and Interaction Research Institute
- Cyber Physical Security Research Center
- Human Augmentation Research Center
- Human-Centered Mobility Research Center
- Artificial Intelligence Research Center
- Industrial Cyber-Physical Systems Research Center
- Digital Architecture Promotion Center

About AIST

- Greetings from President
- Employees and Budget
- Charter and Gender Equality
- Organization
- Research Bases
- History

Director of AIRC
Dr. Junichi Tsujii

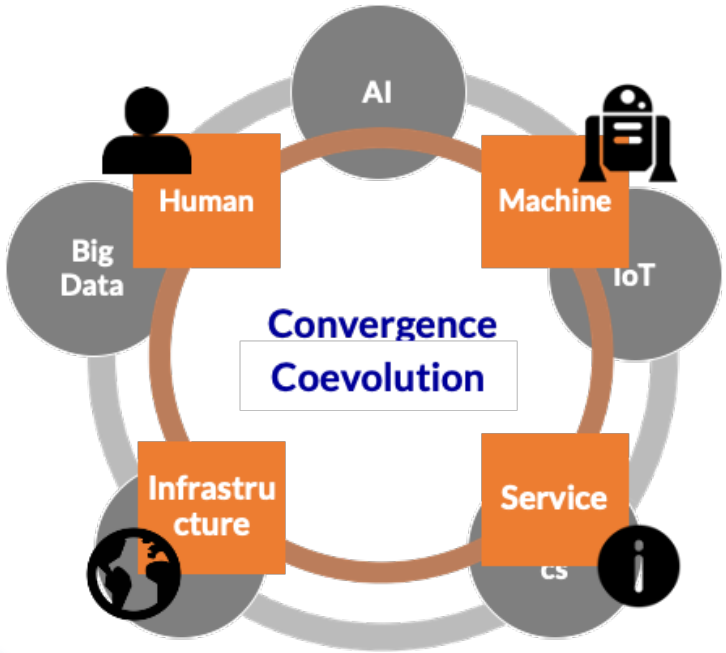
AIRC: AI Embedded in the Real World



AIRC: AI Embedded in the Real World

Foundmental technologies

- Action
- Planning
- Inference
- Modeling
- Recognition
- Sensing



Solving real-world problems

Smart mobility

Smart manufacture

Smart (public) health

Smart safe environment

AIRC Infrastructures for Smart Settlements

Digital Infrastructure
(at Univ. Tokyo / Kashiwa Campus)

- Top-Level SC compute & data capability, 0.55 EFLOPS (HP), 37 PFLOPS (DP)
- Open, Public & Dedicated infrastructure for AI & Big Data algorithms, software, and applications
- Platform to accelerate joint academic-industry R&D for AI in Japan

Data Collection → Data Integration → Data Analysis → Data Optimization → Data Deployment

Domain-dependent Data

Real-time Synchronization

Raw Data

Actionable Intelligence

Cognition

Action

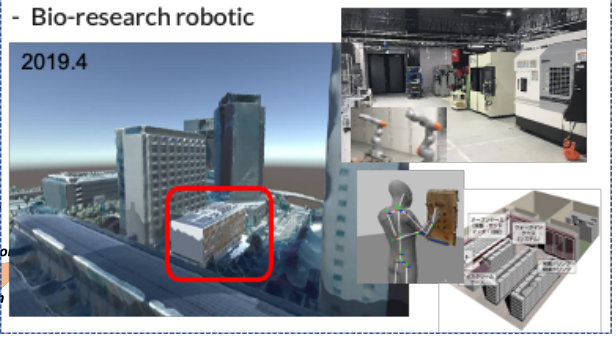
Perception

Digital Infrastructure

Physical Infrastructure

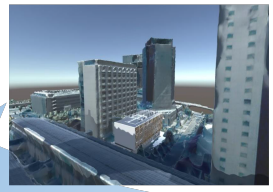
Physical Infrastructure
(new building at Tokyo Waterfront)

- Collect human and machine data with various types of IoT sensors for the collaboration by AI
- Mock environments of a connected factory and retail store for human-robot collaboration
- Bio-research robotic



CONNECTED IOT

Edge Computing
5G Infrastructure

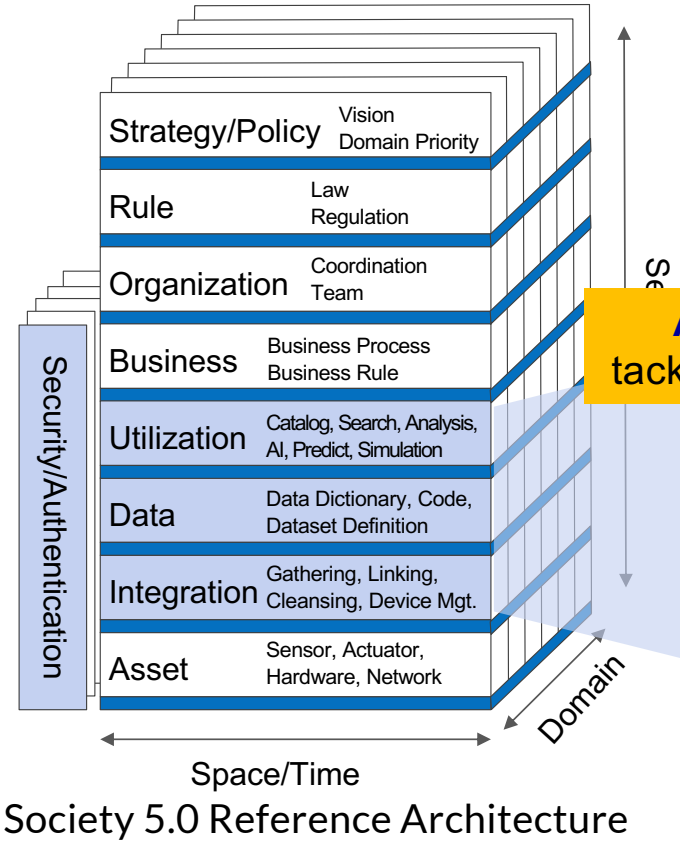


Cyber-Physical System Building

SERVICE INNOVATION

Data Platform Research Team

https://www.airc.aist.go.jp/en/dprt/



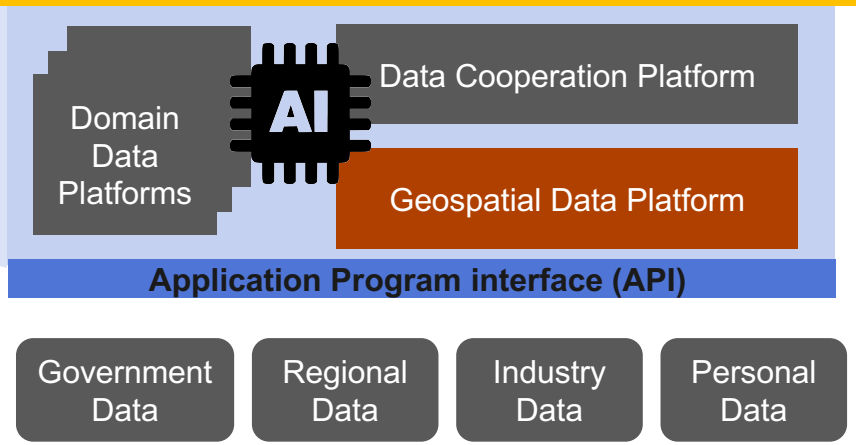
Society 5.0 Reference Architecture

Big data management and advanced data analytics

Standardization of interfaces and data models (formats)

Improvement of the utilization of existing data

AI-embedded data platforms are promoted for tackling strong requirements in new smart settlements.

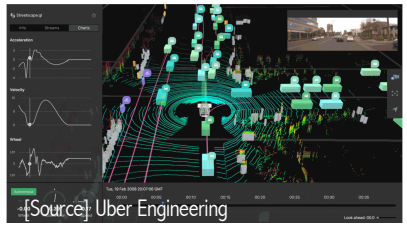


GeoAI Data Platform

supported by NEDO

To support **SMART Mobility** of not only human beings but also things for their Perception, Automation, and Optimization of space where they can safely and efficiently keep geographically referenced activities.

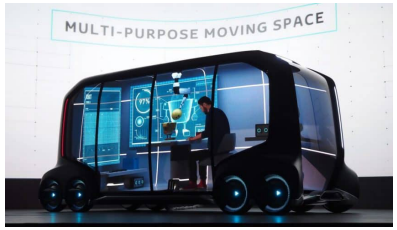
Autonomous vehicles/robots



Source]https://news.livedoor.com/article/detail/18764375/?fbclid=IwAR2QlgHTso9JPrzCrYIiaioOLmBJhRNemTN5EQL8voT1YaYCSweRJ9fdlmw

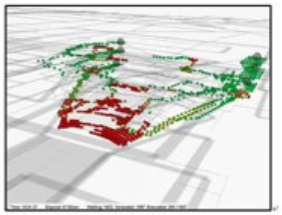
Augmented experiences

[Source]https://www.youtube.com/watch?v=eQXKEnrHMxw&app=desktop



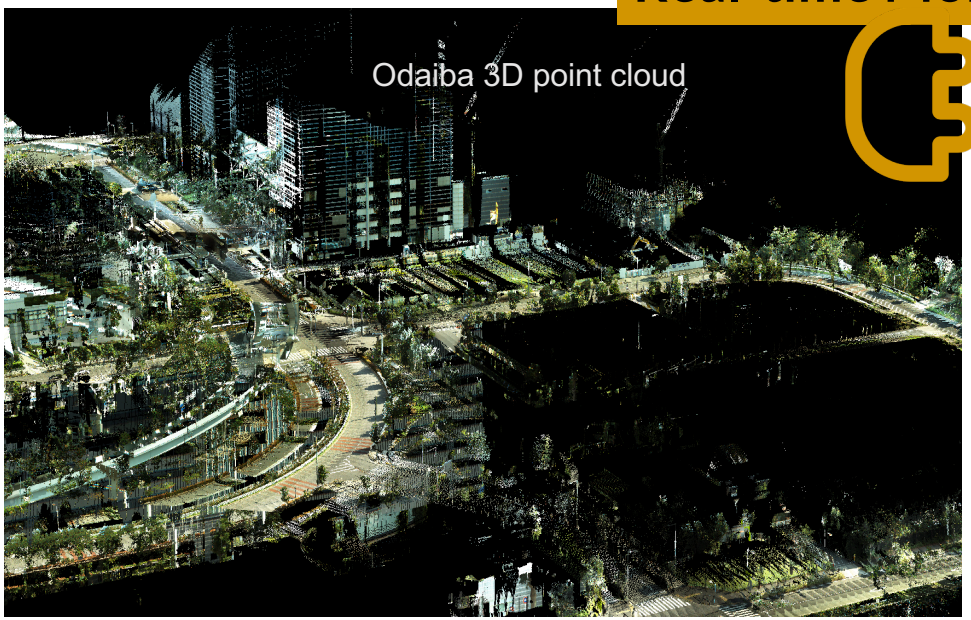
[Source]https://www.businessmaas.com/data/%E2%80%8Btoyotas-e-palette-5-reasons-reinvent-commerce/

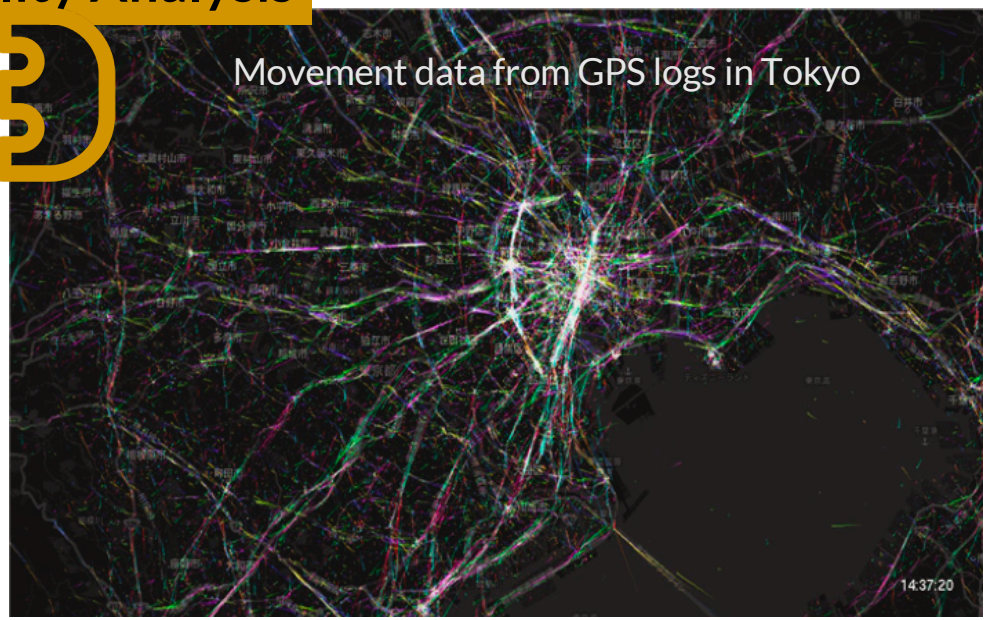
Sustainable urban planning



Challenges

High-precision 3D Maps
Real-time Mobility Analysis





Big Geospatial Data (Volume, Variety, Velocity, Variability)

3D Point Cloud Data

- Digital city models
- A set of 3D (x, y, and z) data points in space.
- A measure of a large number of points on the external surfaces of objects
- **Big Data challenges**
  - **Volume**: more than 10 million points in a few minutes by a handheld LiDAR scanner
    Ex) 750m x 15pt/m2, 47,856 (miles): 15.4TB, 850 billion pts
  - **Variety**: very difference in extension, scale, density, and accuracy

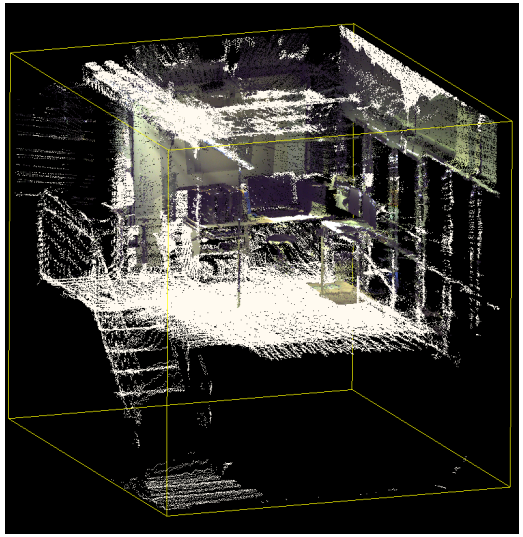

Satellite


Drone

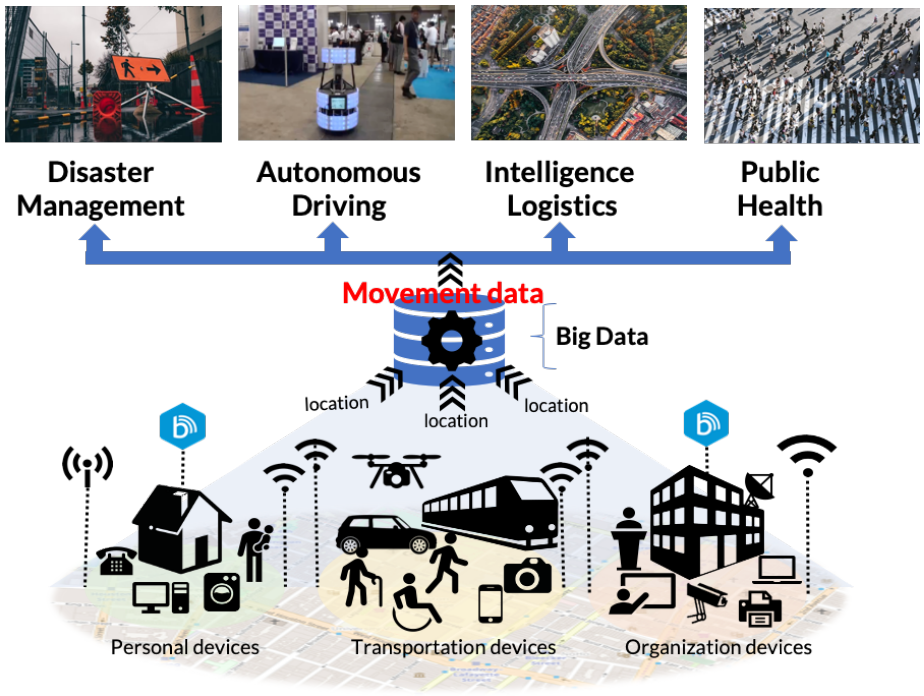
MMS


Handheld

  - **Variability:** irregular data distribution containing missing, noise, distortion data
  - **Velocity:** containing time dimension by mobile agents

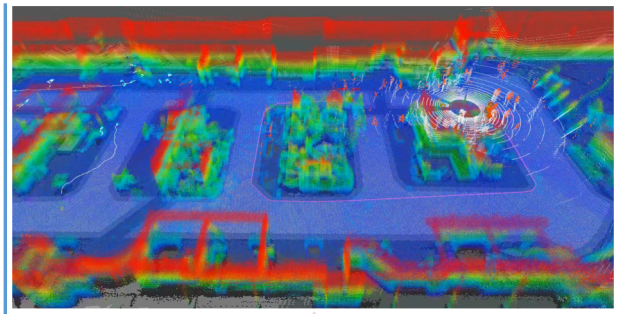


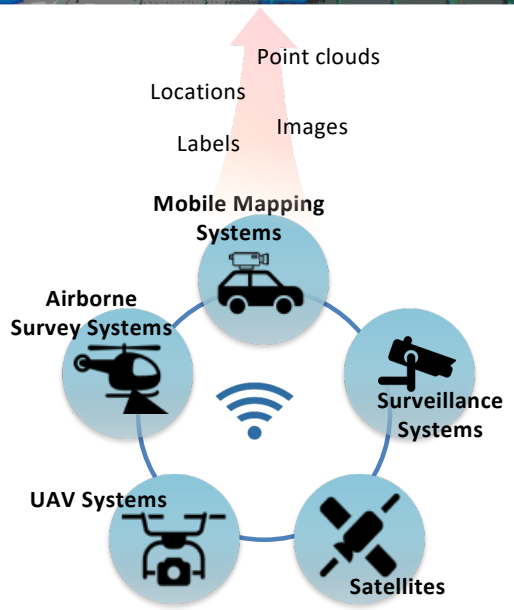
Movement Data



- Dynamic (spatiotemporal) representation of the real world (moving features)
- Historical location information (trajectory) continuously changes over time of moving features
- Understanding of individual and collective behaviors
- **Big Data challenges**
  - **Volume and Velocity**: GPS locations at the rate of 10Hz to 1Hz
    - About 5 billion locations in a day / 1km^2 (Tokyo)
  - **Variety**: difference moving features
    - road accidents, administrative boundaries, vehicles, typhoons, floods, etc.
  - **Variability:** uncertainty(noise and missing data) due to GPS and network connections

Massive & Heterogenous Data Sources





AIRC GeoAI Data Platform

PntML

Place and Time for Machine Learning

On-demand Map Generation for Highly Automated Driving (PntML-3DMap)

REST API

Distributed Data Management

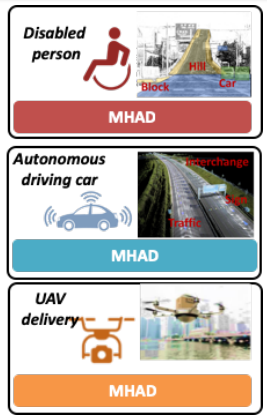
AIST Artificial Intelligence Cloud (AAIC)
prototype of ABCI

Mobility Allocation for Preactive Resource Planning (PntML-MF)

REST API

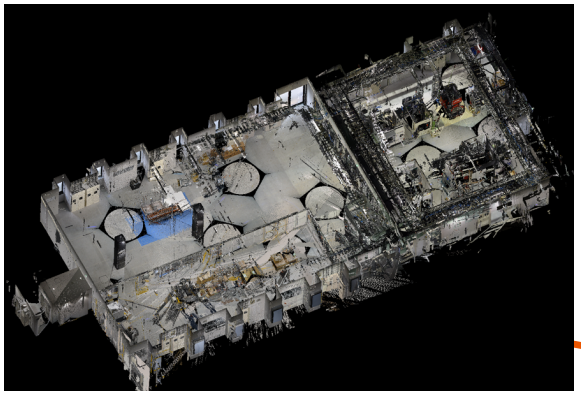
Target Applications

Personalized Navigation Services



Personalized Experience Services

On-demand Map Generation for Highly Automated Driving

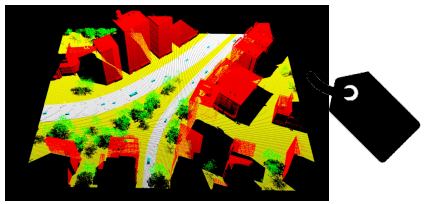


Unstructured point cloud

Point Cloud captured by RIEGL
- Original dataset (3GB)
  # of points: 348,354,918
- Subsampled by octree level 11
  # of points: 14,218,318
- Subsampled by octree level 12
  # of points: 130,521,327

Parallel Processing

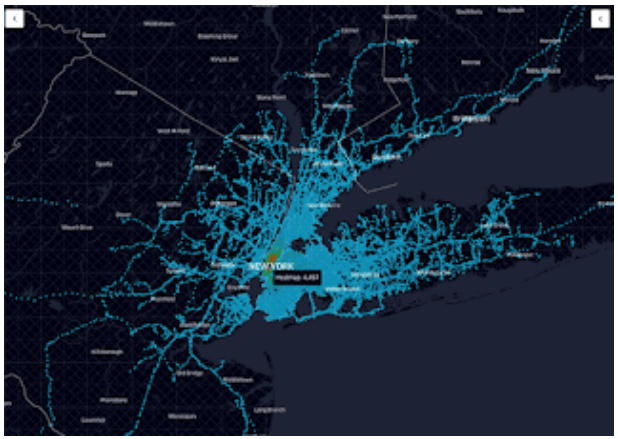
Deep Learning-based annotation



Deep-learning segmentation & 3D Model Construction (Geometric, Topological, Semantic)

Structured 3D model data (678MB)
Face: 2,948,784 Vertex: 3,090,988

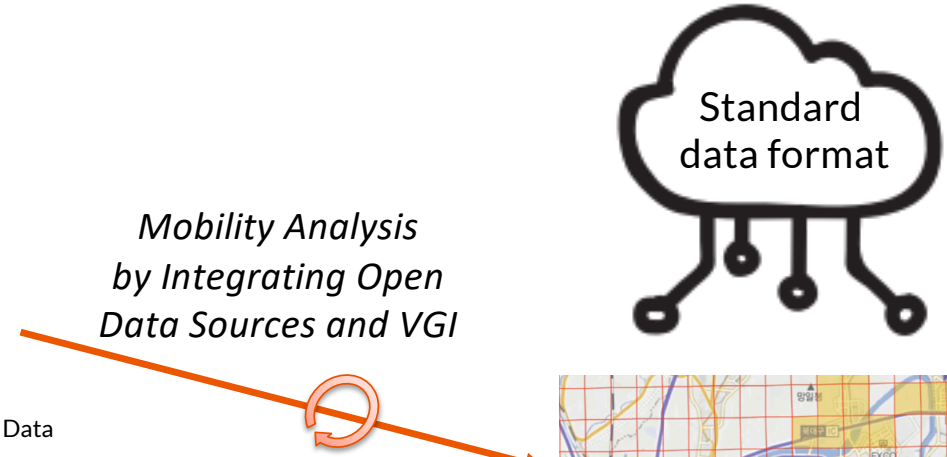
Mobility Allocation for Preactive Resource Planning



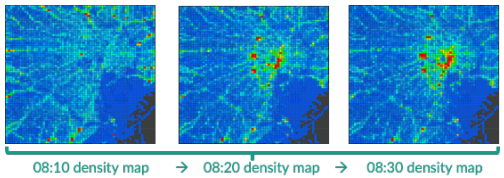
[SOURCE] New York's cab data visualization from Uber's Engineering blog https://blog.rabimba.com/2018/11/visualizing-large-scale-uber-movement.html

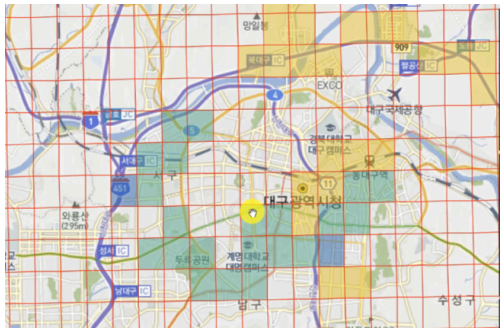
Movement Data

Mobility Analysis by Integrating Open Data Sources and VGI



Video-Like Urban Flow Computing





Prediction Flow

OGC Moving Features

Open Geospatial Consortium

What is the OGC?

- *Hub for thought leadership and innovation*
- *Neutral forum for communities to address interoperability issues within and across communities*
- *Global consortium of members (industry, government and academia)*
- *Open location standards organization*

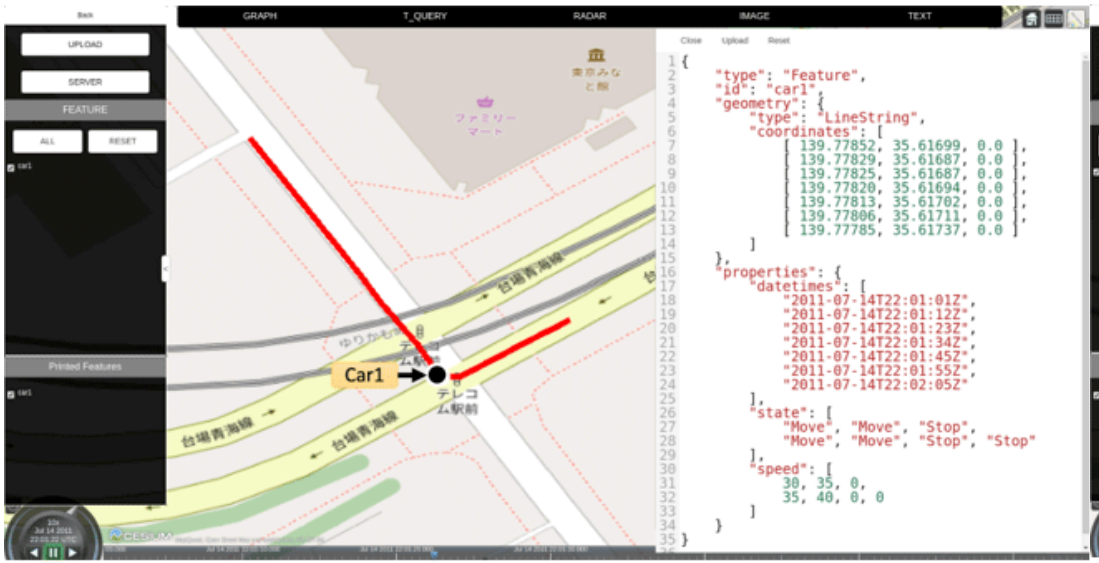
OGC® Moving Features Standards https://www.ogc.org/standards/movingfeatures

Interoperability for spatiotemporal data and services

Version	Document Title (click to download)	Document #	Type
1.0.2	OGC® Moving Features Encoding Part I: XML Core	18-075	**ISC**
1.0	OGC® Moving Features Encoding Part I: XML Core	14-083r2	**IS**
1.0	OGC Moving Features Access	16-120r3	**IS**
1.0	OGC® Moving Features Encoding Extension: Simple Comma Separated Values (CSV)	14-084r2	**ISx**
1.0	OGC® Moving Features Encoding Extension - JSON	19-045r3	**ISx**

OGC Moving Features JSON

- A new OGC standard for encoding and exchanging movement data of 2D and 3D objects



MF-JSON Trajectory

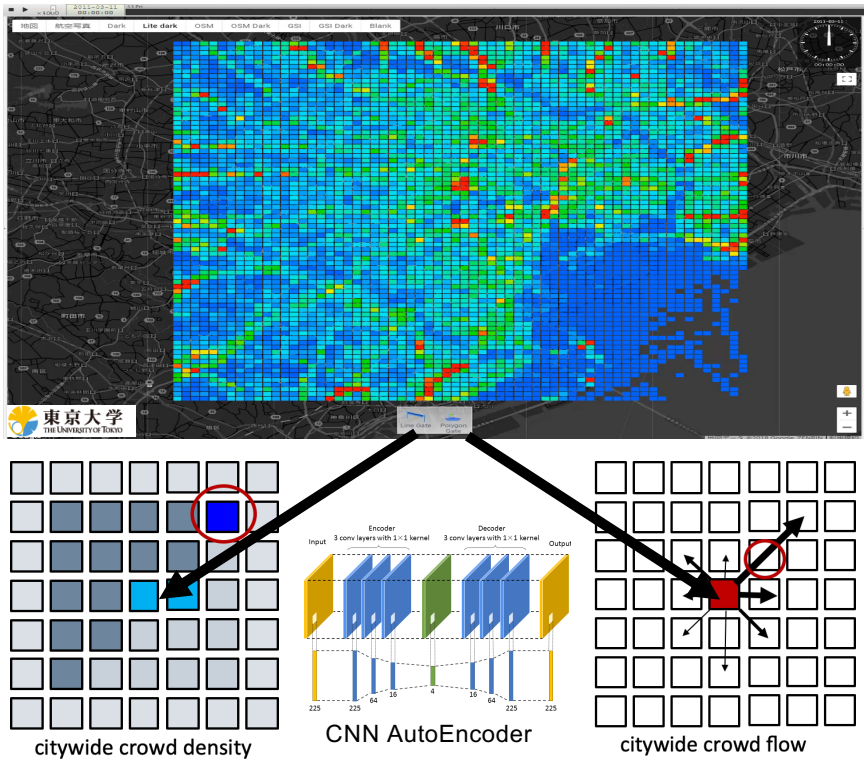
MF-JSON Prism

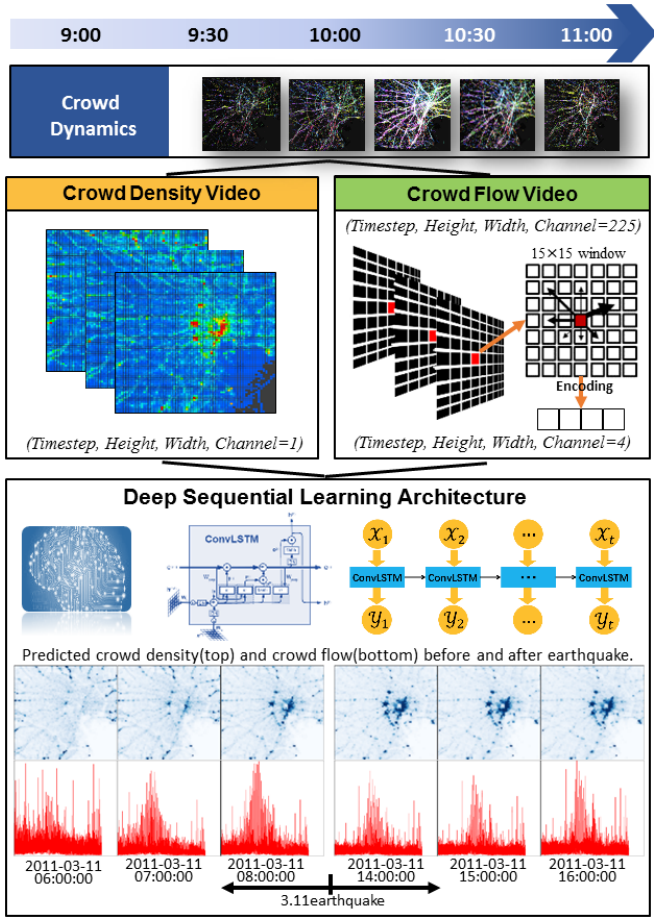
Github: https://github.com/opengeospatial/mf-json

Deep-learning based Mobility Prediction

- DeepUrbanEvent: A system for predicting citywide crowd dynamics at big events (collaboration with Tokyo Univ.)

(ACM SIGKDD 2019)





Thank you for your attention!

Welcome to Joining

AIRC Technical Intern Training Program

- For domestic and international (under, master, PhD) students
- To address this challenge, we are creating an international hub for research and cultural training for students

Contact me: ks.kim@aist.go.jp