Development of a Nowcast Activity-based Simulation Framework To Evaluate Travel Behavior Changes

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i-Transport Lab. Co., Ltd.

Contents

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Introduction of i-Transport Lab.

Foundation:

- October 2000
- investigated by 10 university professors.

Business:

- R & D in traffic engineering
- Consulting with traffic simulation
- Developing a new market for traffic simulation and probe information

Background and Research Purpose

Background

- The number of tourists to Japan have been increased rapidly after the pandemic.
- Need for countermeasures to unexpected crowd situations in urban activities and in tourist attractions.
  - Redesign urban space, transport services and travel information, etc. for comfortable tourism.

https://twitter.com/Leo111417/status/1653906840478941188

Purpose of this study

- Development of a nowcast activity-based simulation framework.
  - To reproduce the current traffic situation and forecast the future traffic situation.
  - Using the data assimilation process of activity-based simulation model and observed data.

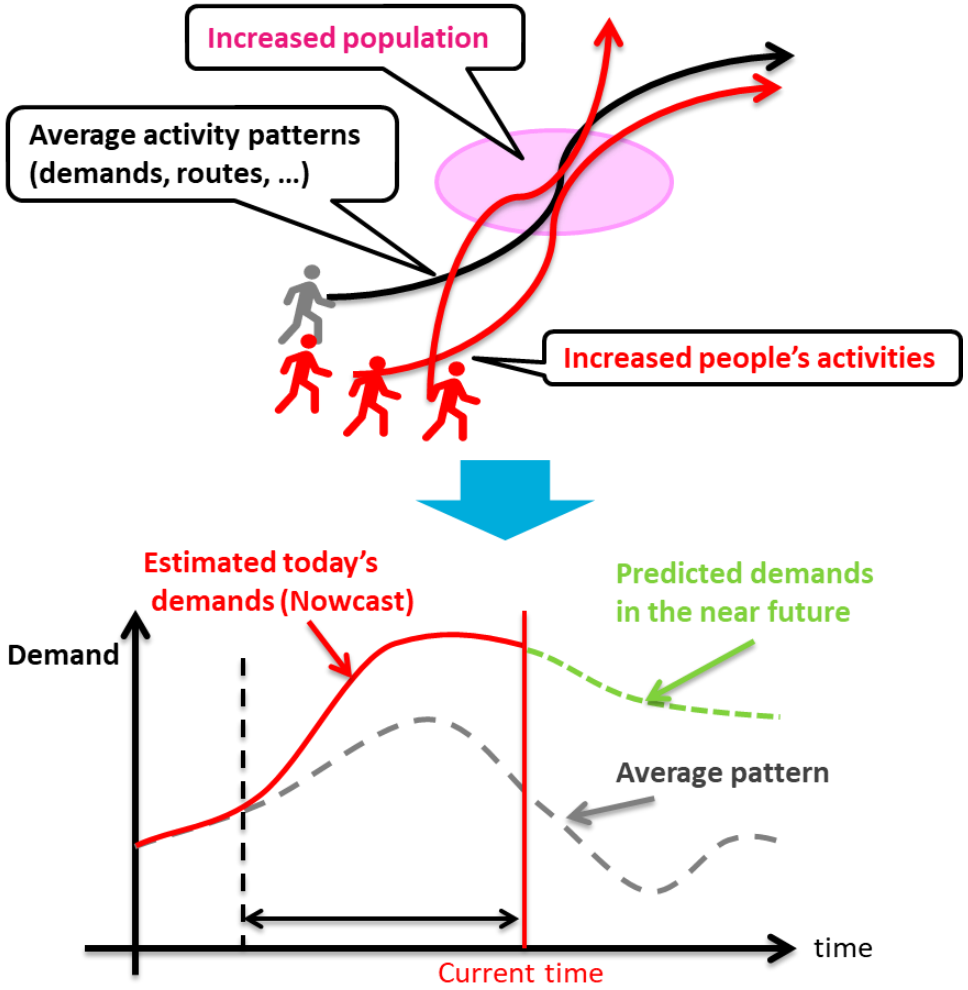
Requirements for “Nowcast Simulation”

Grasping the demand for tourist activities of all populations in the target area and the resource usage situation in spatiotemporal and continuous.

- Data collection in real-time
- Activity-based simulation model
- Data assimilation methodology

Preparing for the prediction of tourist activities and the crowd situation.

- Basic parameter settings according to the current (in the recent past) situation.



Nowcast Simulation Framework

LocationMind

City Activity Database

Multi-modal transport network

Road network

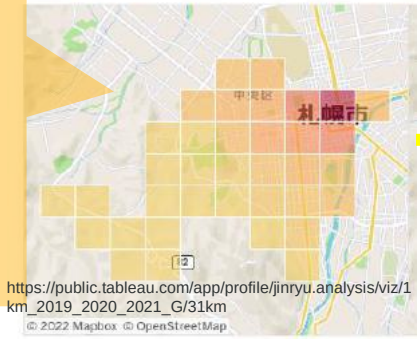
Bus network and schedules

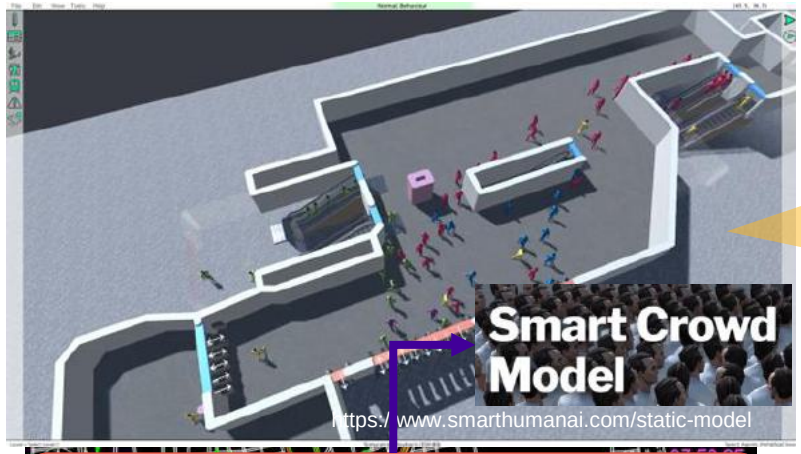
Railway network and schedules

Facility location (POI)

Activity patterns

Live transport data
- People density from mobile phone data
- People counts with video image processing
- Probe person trajectories, etc.





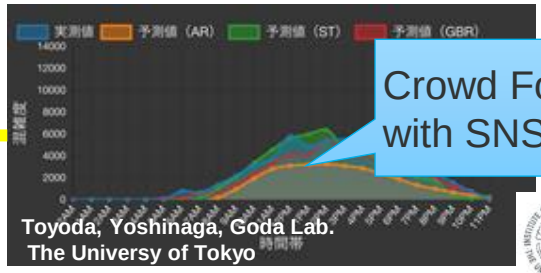
Micro-scale nowcast & forecast with crowd simulator

Evaluate QoS of walkable space
- Comfortability/dangerousness based on density,
- Time loss, etc.

SOUND + MATSim Multi-Agent Transport Simulation
https://www.matsim.org/

Macro-scale nowcast & forecast with the activity-based agent simulator

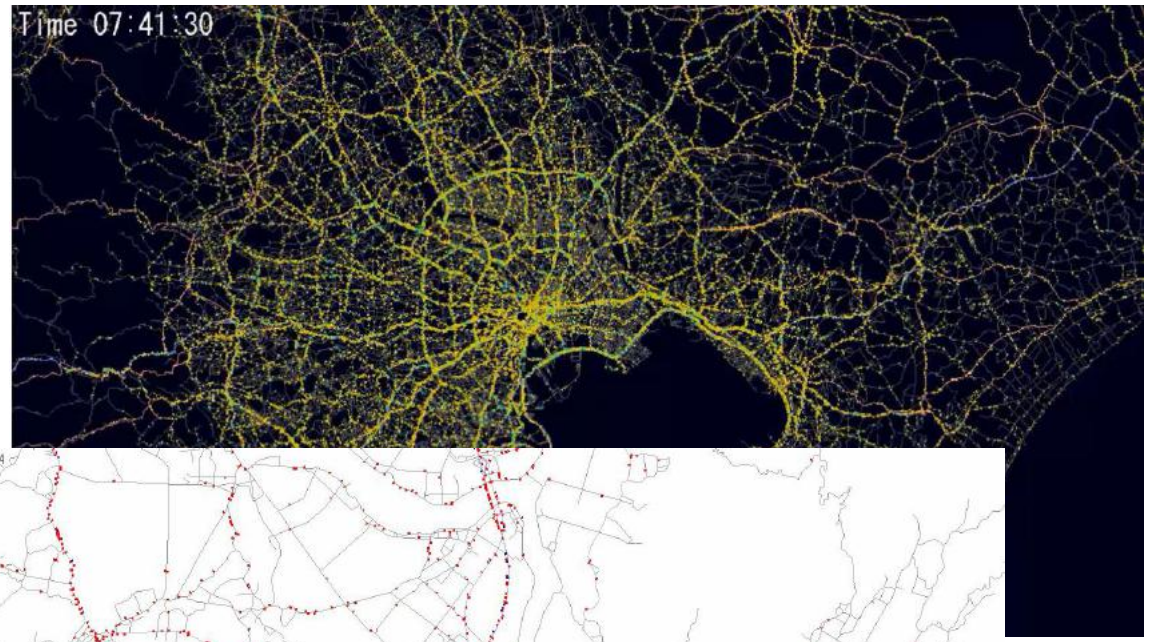
Evaluate KPIs
- Travel time, trip fare
- Time loss, congestion
- Road traffic efficiency, etc.

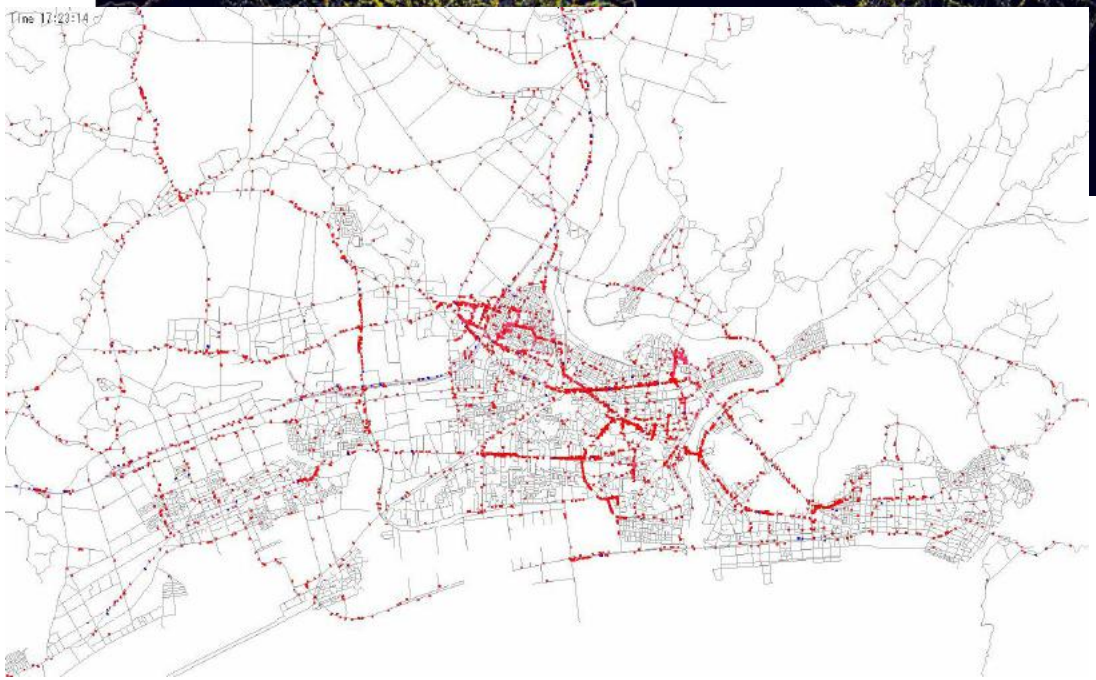


Crowd Forecasting with SNS tweets

SOUND (Simulation on Urban road Network with Dynamic route choice)

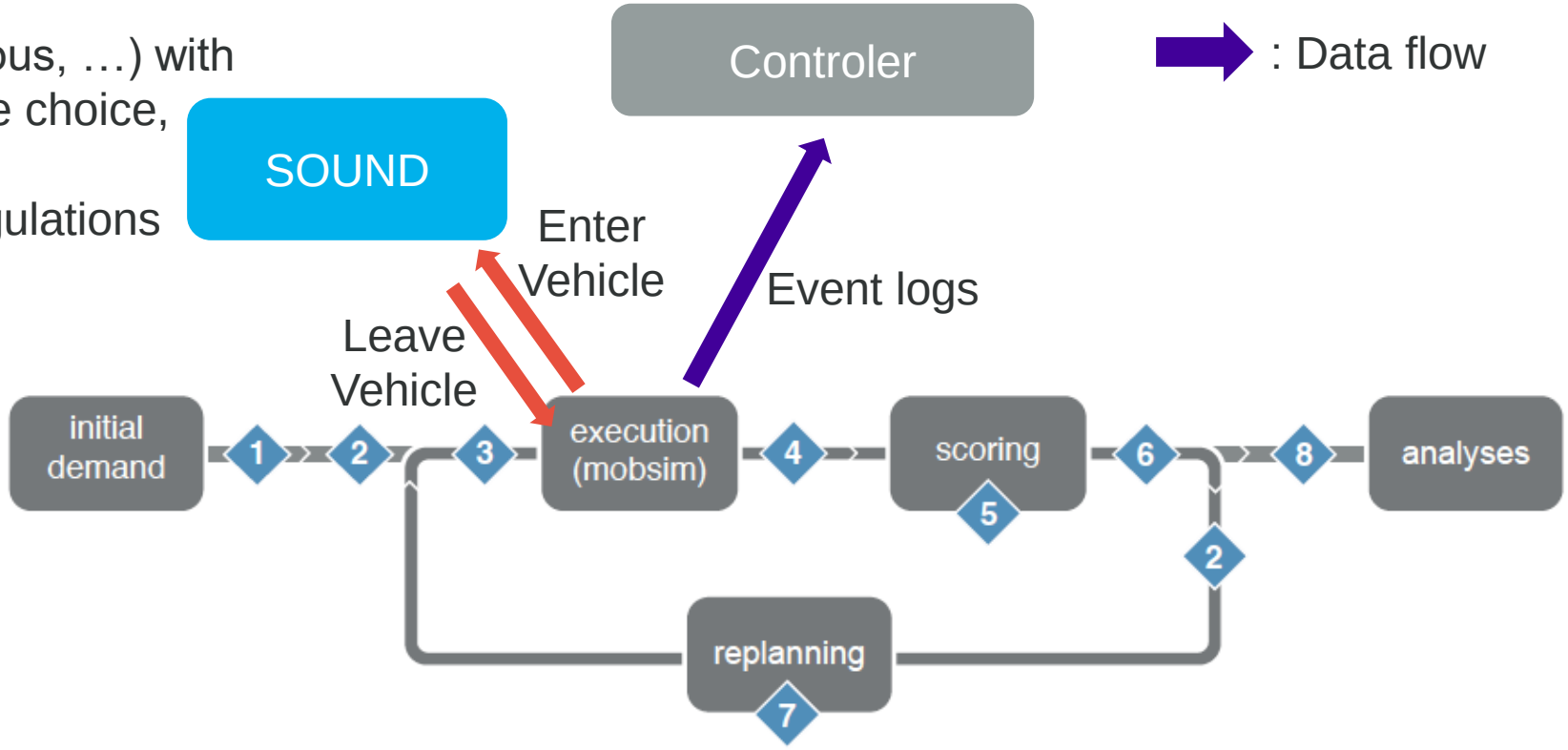
- SOUND is designed to consider the dynamism of traffic congestion phenomena and can reproduce over-saturated traffic conditions.
- A macroscopic model that calculates vehicle movements using fundamental diagram characteristics given for each link and for the application to large-scale networks.
- SOUND includes dynamic route choice models, which allow the evaluation of operational measures such as information provision, dynamic route guidance, and dynamic road pricing.
- SOUND handles individual vehicles with various attributes such as vehicle type, allowing evaluation of traffic operation measures limited to target vehicles.





Hybrid Model of MATSim and SOUND

Mobility(car, bus, …) with
dynamic route choice,
signal control
and traffic regulations

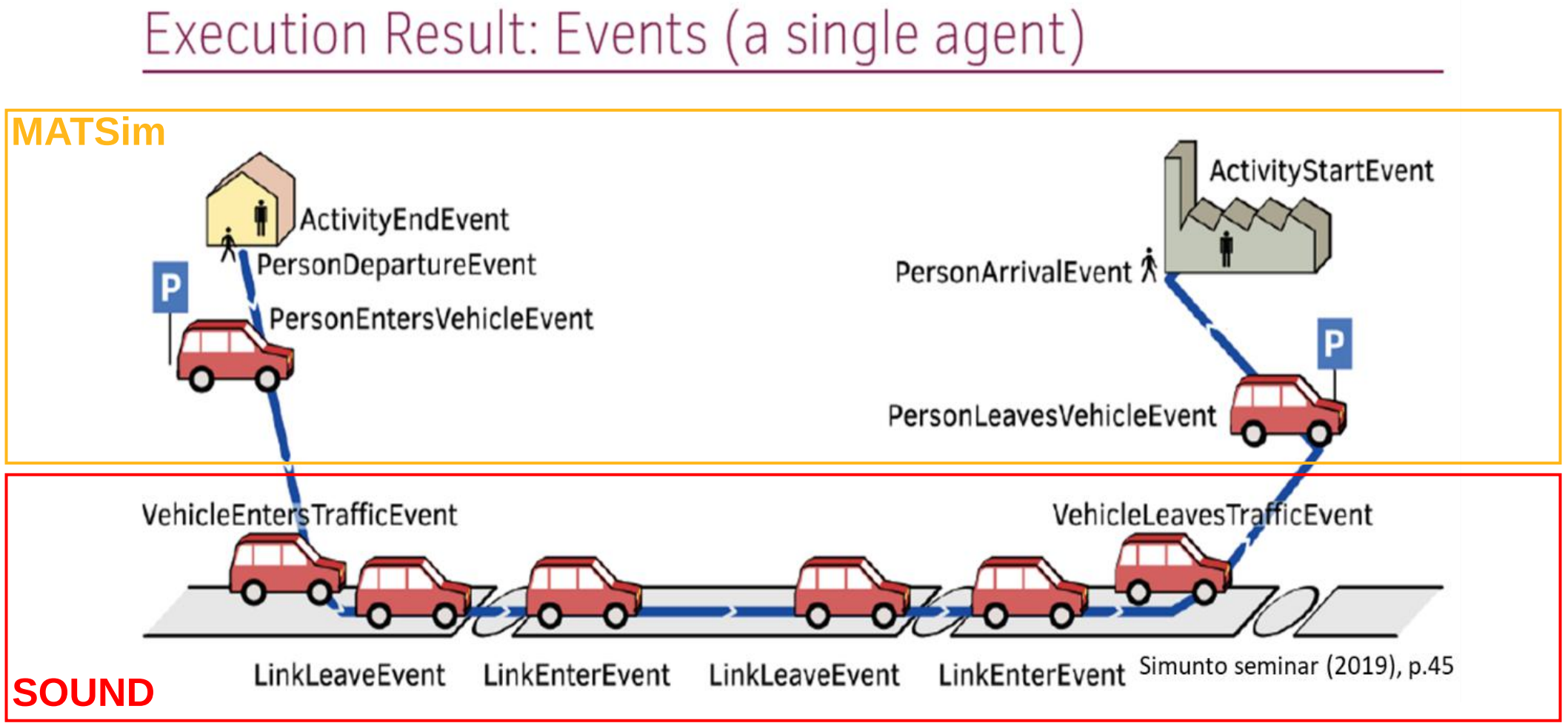


Controler Events:

1 Simulation Starts (“Startup”)
2 Iteration Starts
3 Before Mobsim
4 After Mobsim
5 Scoring
6 Iteration Ends
7 Replanning
8 Simulation Ends (“Shutdown”)

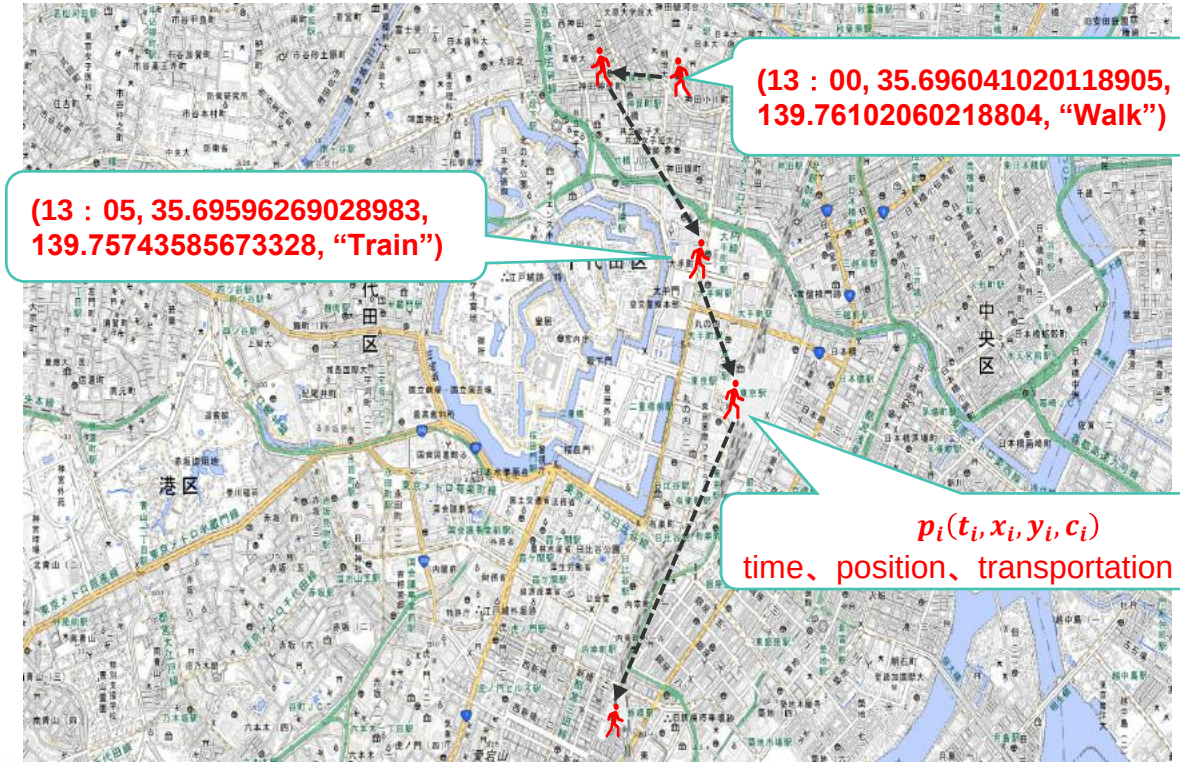
MATSim book (2016) p. 300

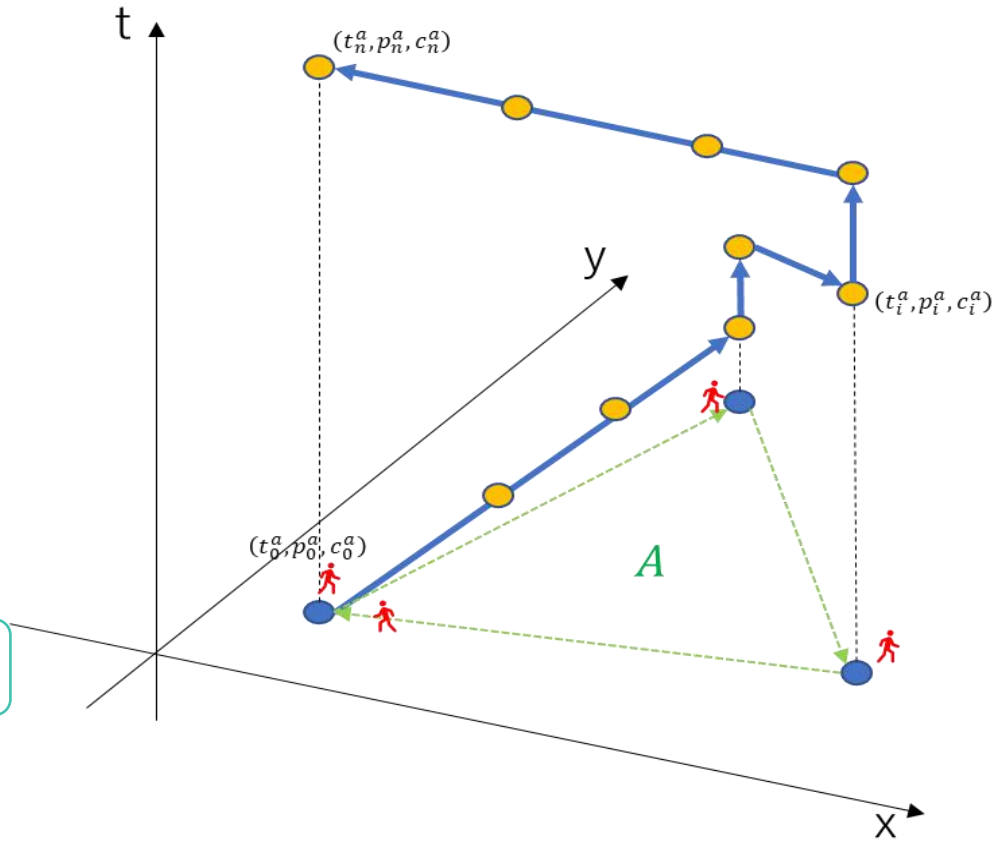
Interactions between MATSim and SOUND



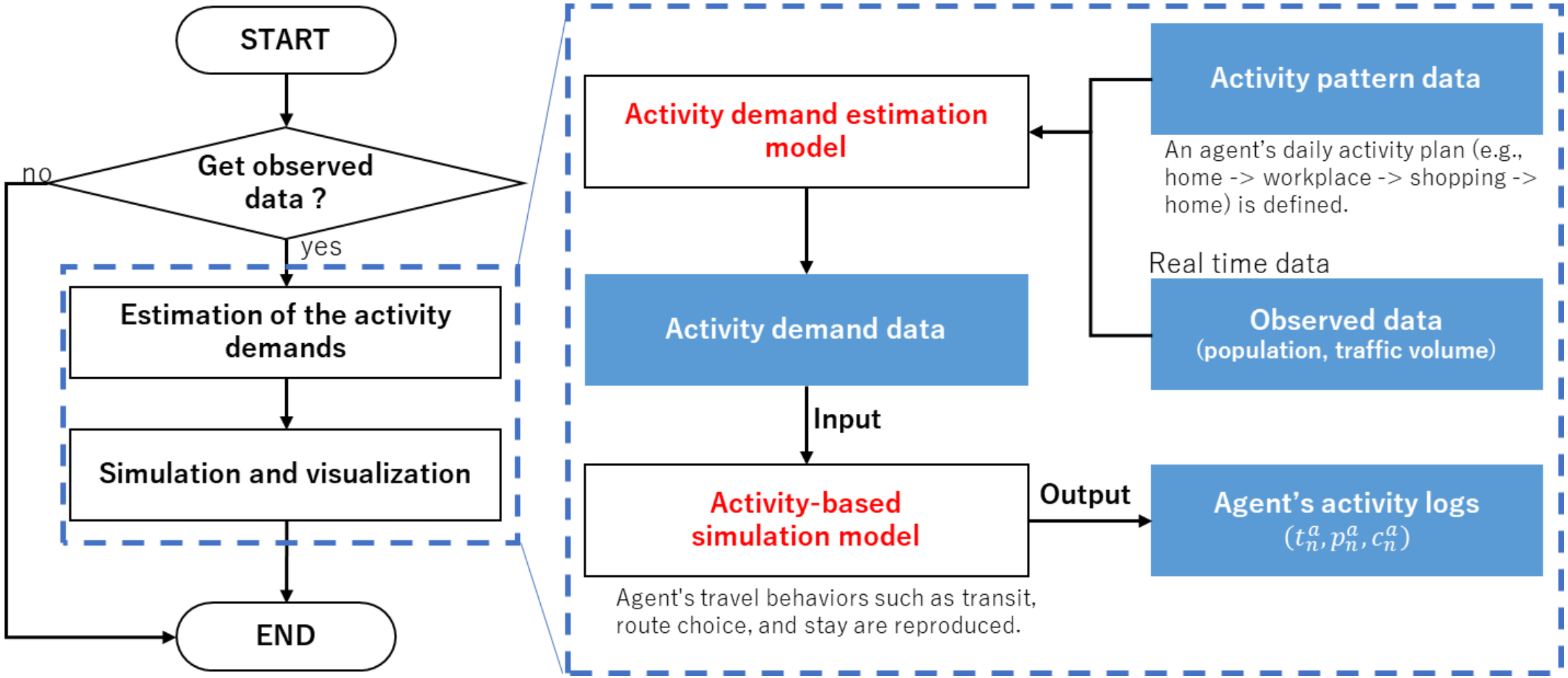
Definition of “Activity”

Activity: The activity consists of trip chains with time, position, and transportation modes for the individuals.



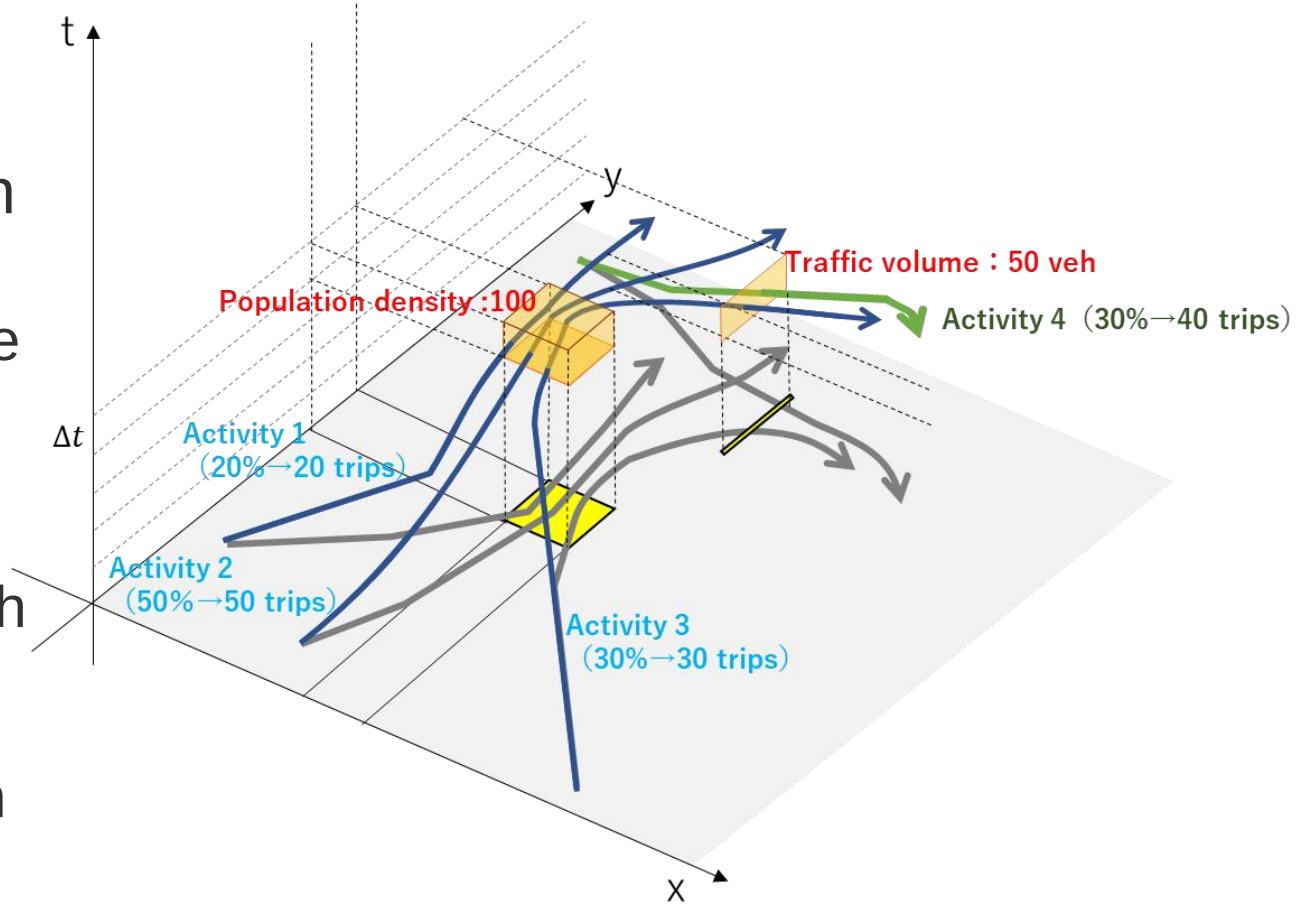


Methodology of Macro-scale Nowcast



Activity Demand Estimation Model

- The activity demand is inversely estimated by the entropy maximization method.
  - Formulated the relationship between the activity demand, the dynamic population, and the traffic volume.
  - Using the total activity demand in the target area as an unknown variable, with the constraint that it must match the population staying in a certain time and area and the observed traffic volume on the transportation network.



Demonstration

[1] Toyoda, Yoshinaga, Goda Labo. The Universy of Tokyo, https://www.tkl.iis.u-tokyo.ac.jp/new/?lang=en. Ryotaro Tsukada, Haosen Zhan, Shonosuke Ishiwatari, Masashi Toyoda, Kazutoshi Umemoto, Haichuan Shang, and Koji Zettsu:Crowd Forecasting at Venues with Microblog Posts Referring to Future Events, 5th IEEE International Workshop on Big Spatial Data (BSD 2020), 3147-3155, 2020.12.

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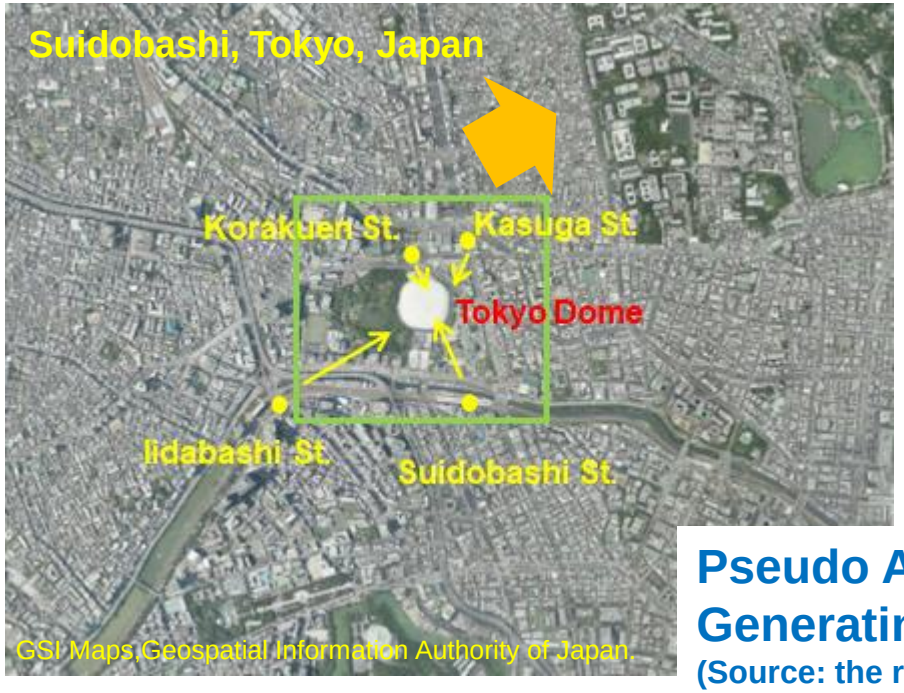
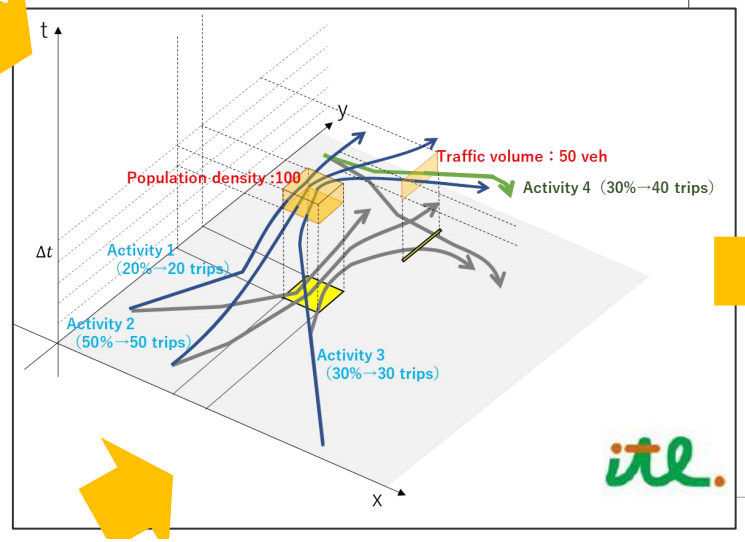
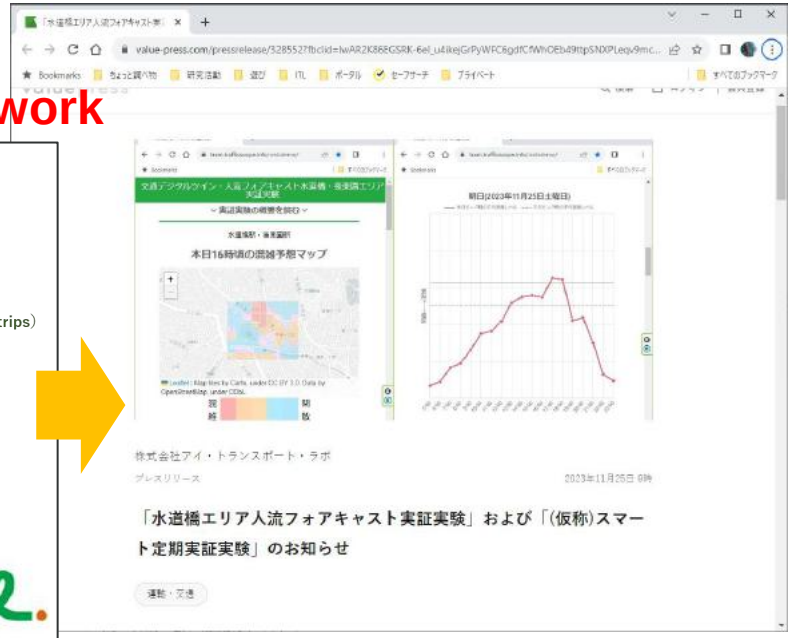
Crowd Forecasting[1]

(Source: the research output of The University of Tokyo in the project of NICT [2])



Nowcast Simulation Framework





Crowd Forecast Information

Pseudo Activity Data Generating

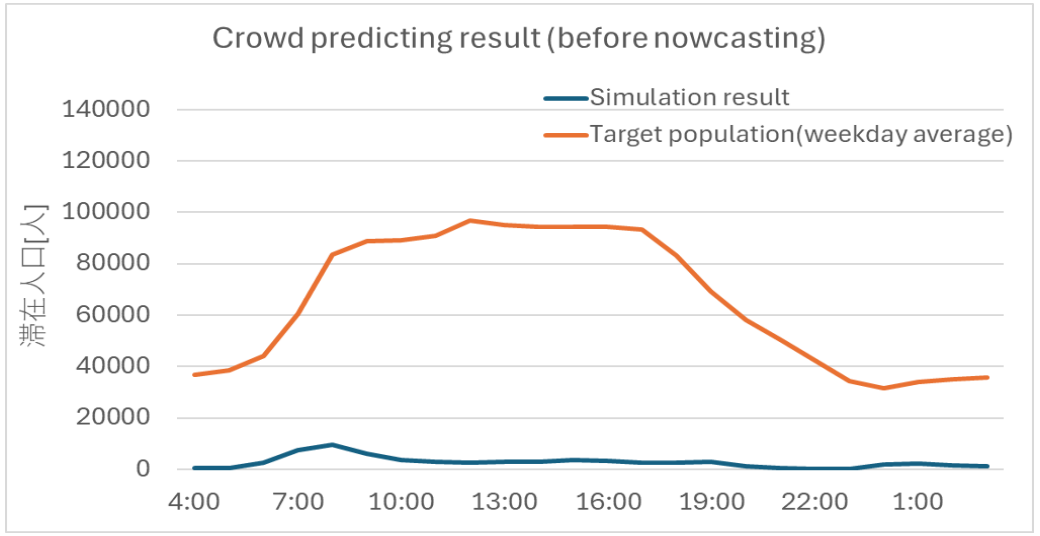
LocationMind

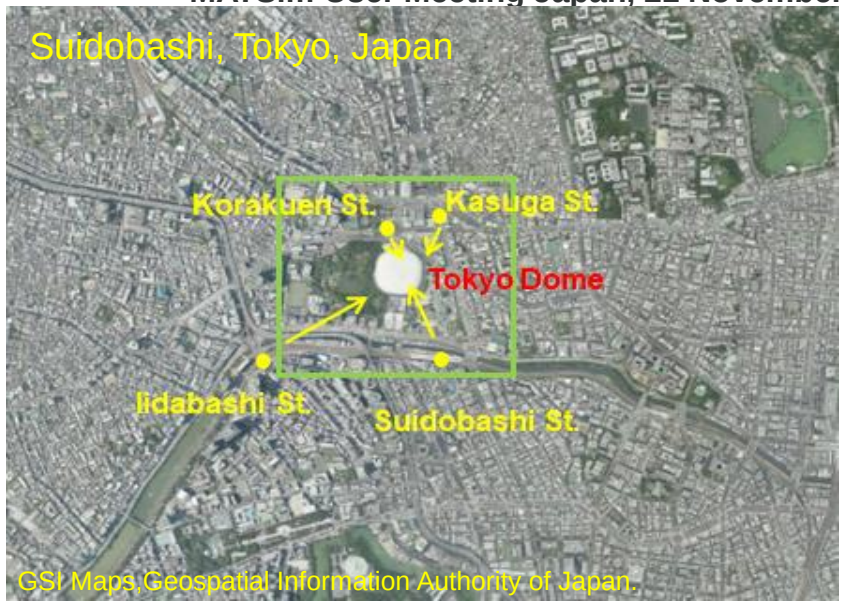
(Source: the research output of LocationMind Inc. in the project of NICT [2])

[2] The study of the nowcast simulation framework started in 2021 under the project “Research and development of information communication technology that contributes to measures against infectious diseases such as viruses, Issue C: ICT to form a post-corona society “(No.222C0201, project title: “Research and development of prediction information sharing type spatiotemporal resource effective utilization technology that supports various urban activities”).

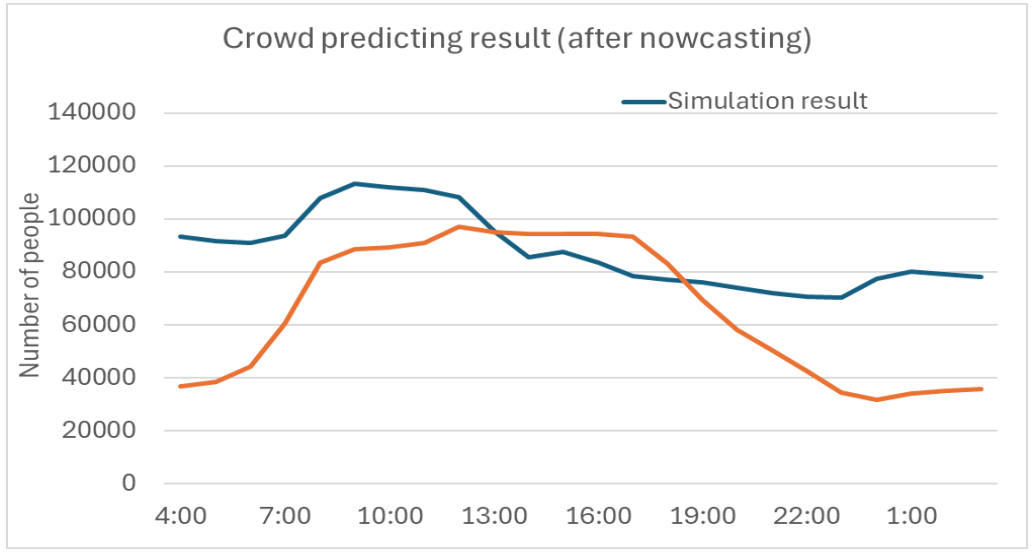
Macro-Scale Nowcast Simulation

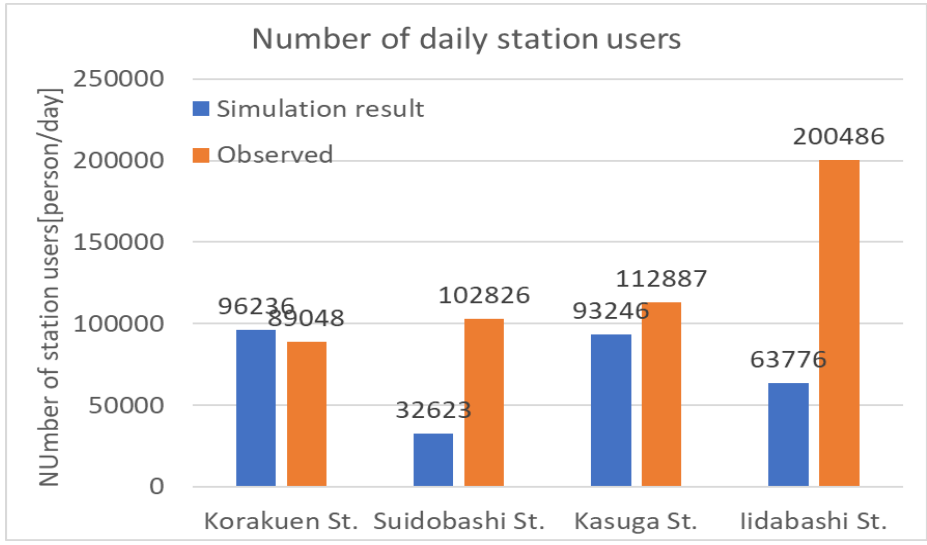
Before Nowcasting





After Nowcasting





Conclusion (tentative)

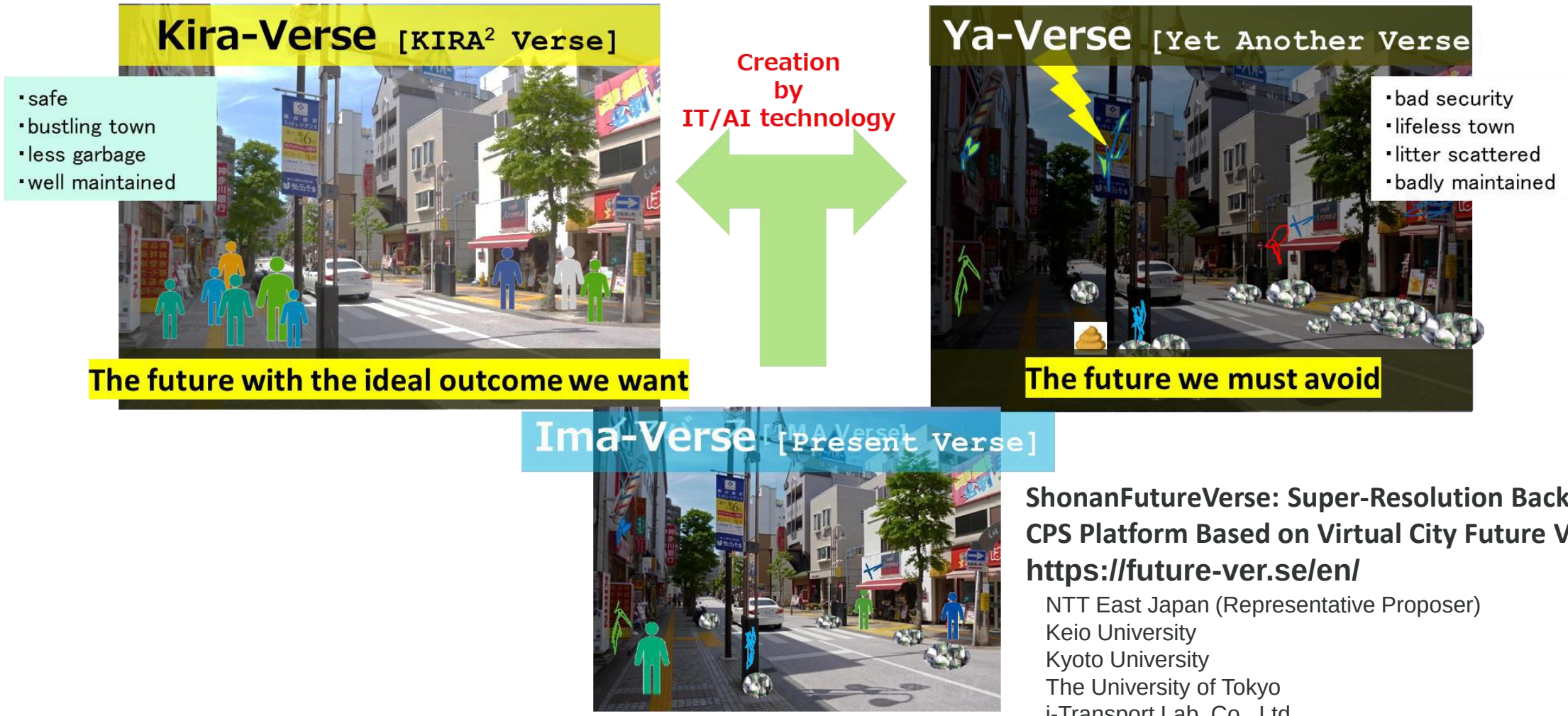
Research outcome

- Development of the nowcast simulation framework
- Demonstration experiment (crowd forecasting website)

Issues to be tackled

- Improvement of the nowcast simulation framework
  - Accuracy of the activity demand estimation
- Application
  - The “Shonan Future Verse” project

Future works: “Shonan Future Verse” Project



ShonanFutureVerse: Super-Resolution Backcasting CPS Platform Based on Virtual City Future Vision
https://future-ver.se/en/

NTT East Japan (Representative Proposer)
Keio University
Kyoto University
The University of Tokyo
i-Transport Lab. Co., Ltd
Kadinche Corporation
Zenrin Datacom Co., Ltd

Future Works: overview of “backcast system”

Nowcast

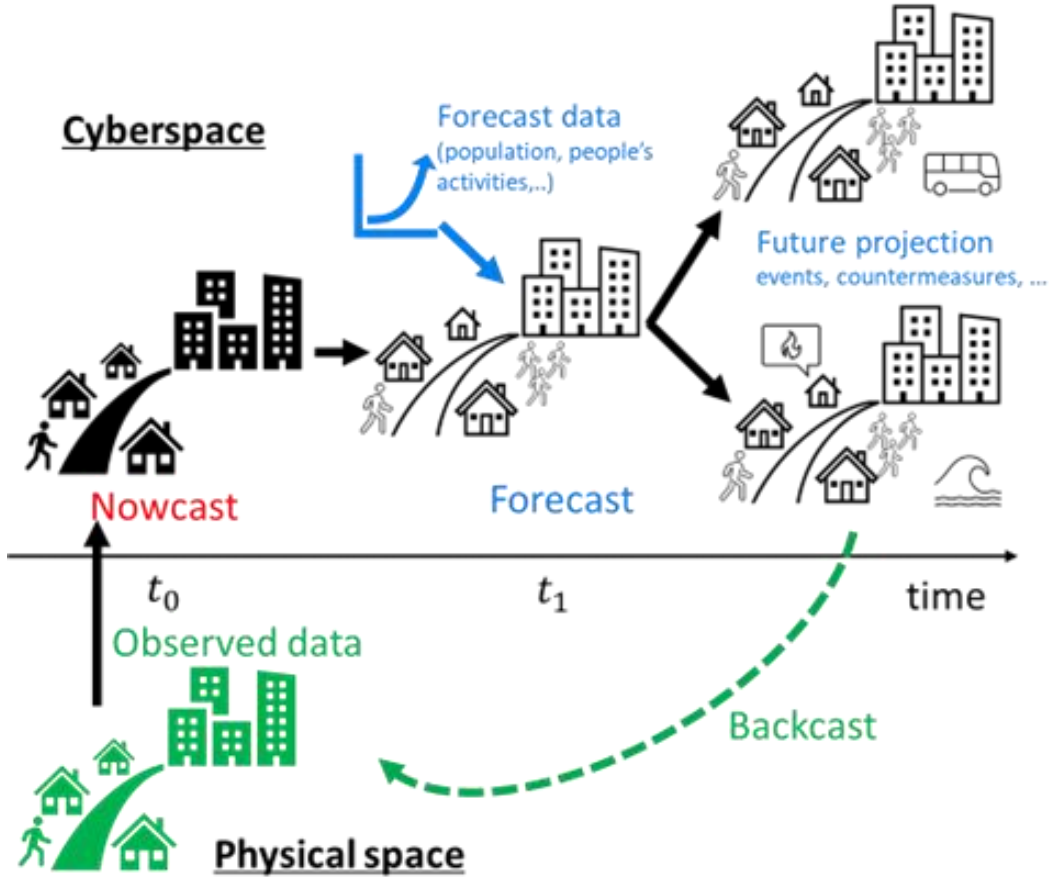
- Reproduce the current situation in the city in cyberspace (metaverse)

Forecast

- Predict future situations incorporating various conditions
- Visualize in cyberspace (future projection)

Backcast

- Derive the feedback (countermeasures, tasks, etc.) for the present in physical space



H. Hanabusa, T. Komiya, K. Ichinose, K. Takahashi, R. Horiguchi: Development of a Nowcast Crowd Simulation Framework, Journal of Information Processing, Vol.65, No.6, 2024, DOI:https://doi.org/10.2197/ipsjjip.32.498.

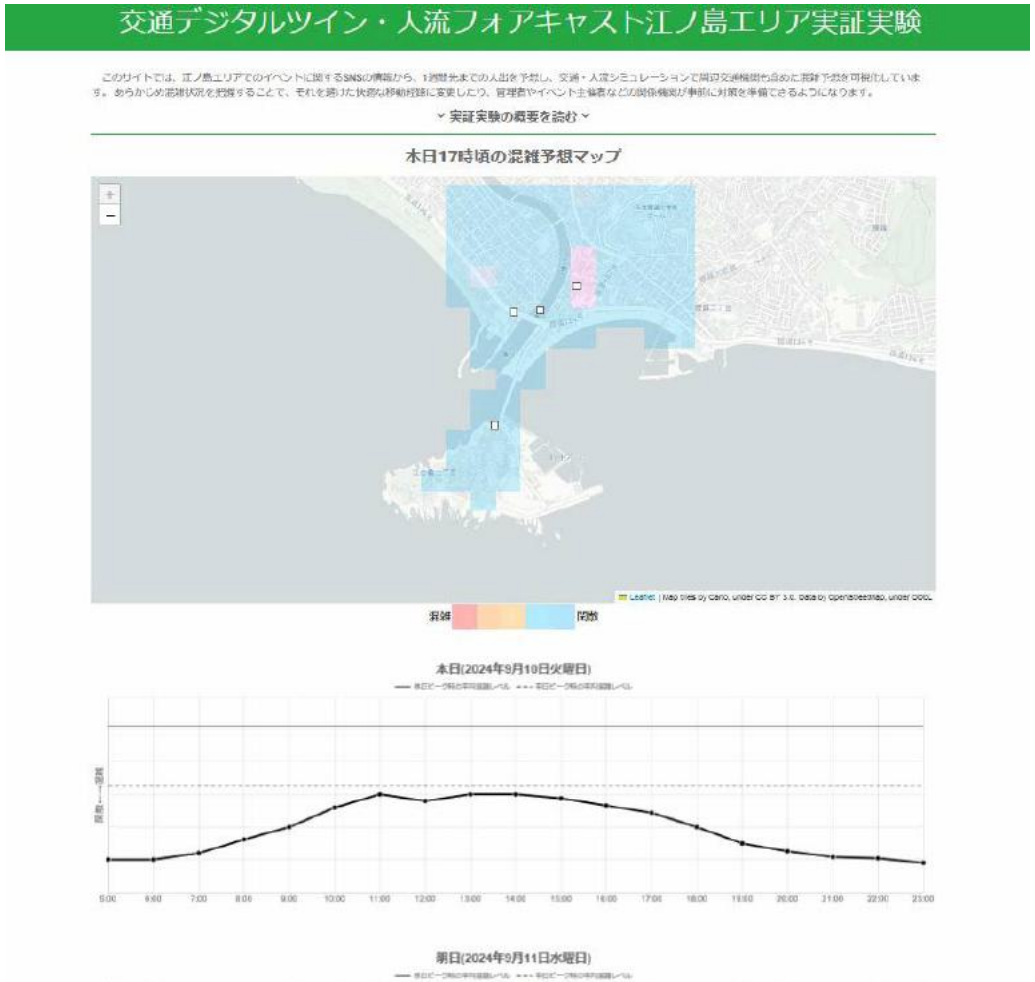
Future works: Shonan-Enoshima “Digital Twin” Demonstration Experiment

Demonstration in Fujisawa

- **Implementation of the crowd forecasting model and the nowcast simulation framework**

Crowd forecast map and crowd flow visualization

- For Travelers
  - Behavior changes to travel comfortably
- For Public Organizations
  - Consideration of countermeasures to guide the travelers coming to the Shonan-Enoshima area.



https://sfv.trafficscope.info/webdemo/

Thank you!

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https://future-ver.se