A reusable, sharable, and transferable smart data platform for collaborative development of data-driven smart city

Minh-Son DAO

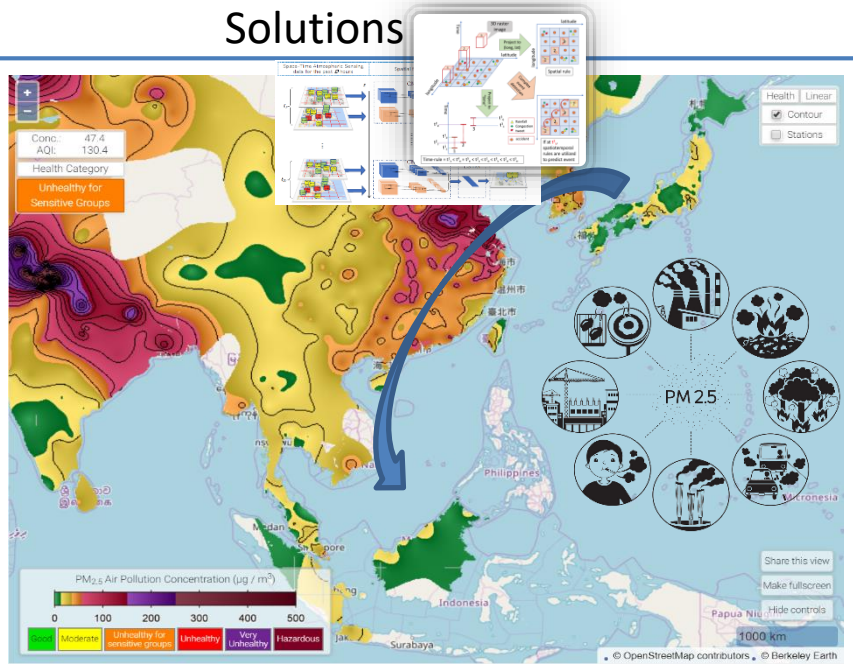
National Institute of Information and Communications Technology, Japan

Background

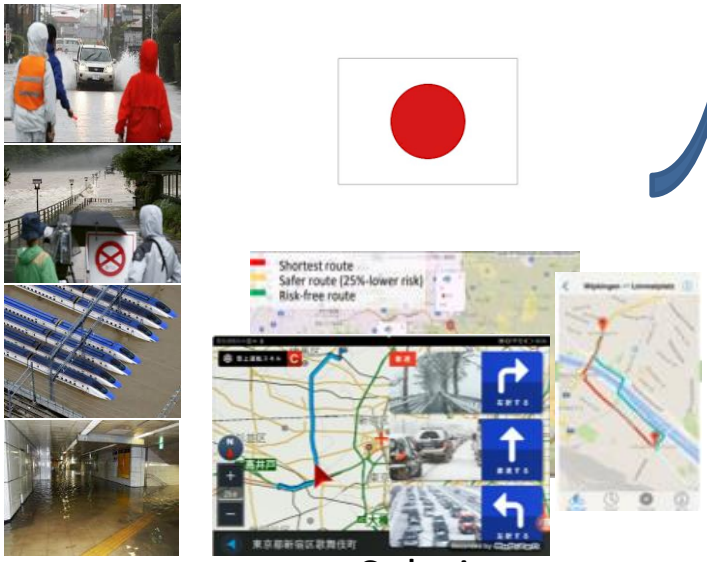
Impact of heavy rain on Traffic Operation

Environment Disaster

Local Situation



Impact of Air pollution on Health



Solutions

The necessity for

- sharing and aggregating predictive modelling of risks caused by same/similar environment disaster
- transferring and customizing the model based on local situation

Target: smart data platform for collaborative development

Environment Disaster

Local Situation

Consortium

Building

ICT platform

New knowledge

share

aggregate

Sharable database

transfer

customize

Predictive Models

Independently Development

Collaborative Development

Scientific and Technological Aspects

NICT xData Platform

Correlation analysis, prediction

Forecast result distribution

Cryptography

Processed data required for correlation analysis

Customize prediction models and prediction results

API mashup

Information Portal

Participatory sensing

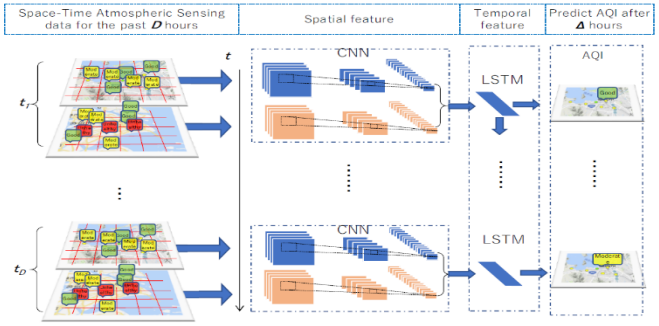
Heterogeneous big data

Applications

Users

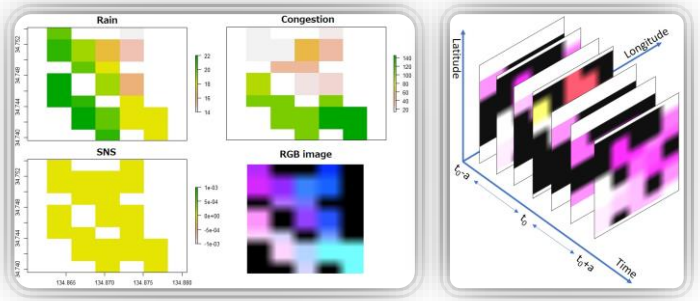
Implementation

Predictive Models (NICT)



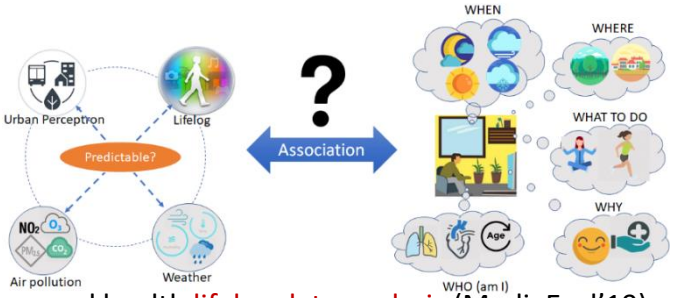
Convolution Recurrent Neural Networks Based Dynamic Transboundary Air Pollution Prediction (ICDBA' 19)

Heterogeneous big data Abstracting (NICT)



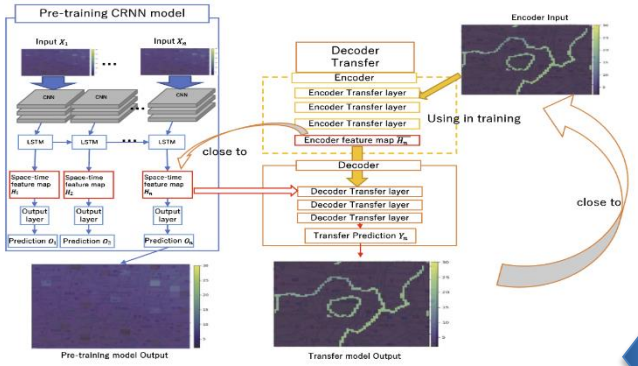
Complex Event Analysis of Urban Environmental Data based on Deep CNN of Spatiotemporal Raster Images (BigData'18)

Participatory Sensing (NICT)



Multimodal personal health lifelog data analysis (MediaEval'19)

Transfer Learning (NICT)



Decoder Transfer Learning for Predicting Personal Exposure to Air Pollution (BigData'19)

Correlation Analysis (NICT)

time	SID	Pt	$PM_{2.5}$
00:00	1	p1	19
00:00	2	p2	7
00:00	3	p3	7
00:00	5	p4	5
01:00	1	p1	21
01:00	2	p2	6
01:00	3	p3	22
01:00	4	p4	32
...	...	...	...

(a) real-world sensor data

Spatiotemporal database

time	transactions
00:00	(1,1), (1,2), (1,3), (1,5)
01:00	(1,1), (1,2), (1,3), (1,4)

(b) temporal database

Pt\SID	1	2	3	4	5
	p1	p2	p3	p4	p5

(c) spatial database

time	1	2	3	4	5
00:00	19	7	7	0	5
00:05	21	6	22	32	0

(d) external utility database

Discovering Spatial High Utility Itemsets in Spatiotemporal Databases (SSDBM'19)

API mashup

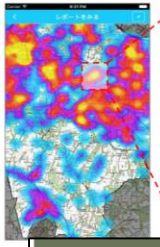
Consortium

- Models and Results Customizing (e.g., transfer learning, local environment adapting)
- Data Gathering, Processing, and Visualizing

Experiments including field testing

Environment Beautification for Everyone

Air Quality Prediction



User Report

Smart Sustainable Mobility

- Driving navigation with prediction of traffic risks in an unusual weather

- Route guide with prediction of health risks in an atmospheric environment

Shortest route (red): 1.5km long
Health-optimal route (green): 49m longer distance 4.5% less air pollution exposure

Sustainable & Resilient Smart City

Smart Tourism

- Tourism information portal
- Mobile apps, smart map, AR
- Traveler data analysis

Adaptive planning & navigation

Environment awareness

City-wide Smartness

Risk-sensitive optimal mobility

Environment Management

- Environment monitoring
- Prediction of pollution and infection
- Garbage surveillance

Smart XXXXX

Smart Transportation

- Surveillance camera system
- Transportation management
- Smart e-ticket, smart parking

Smart & Comfortable Tourism

- Today's recommended course

Select

Prepare

- Wears, goods, places recommended for today's plan

Share

Record

- Social networking by experience sharing

- Monitoring of my activity, trajectory and atmosphere

Quote: Runtastic, Foursquare

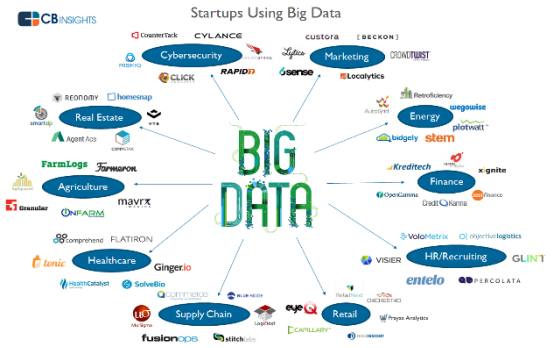
Multi-modal Air Quality Prediction

- Local observation data

- Personal measurement data

Adaptive Prediction

Scientific and Technological Impact



cbinsights.com

Web summit 2015

VS

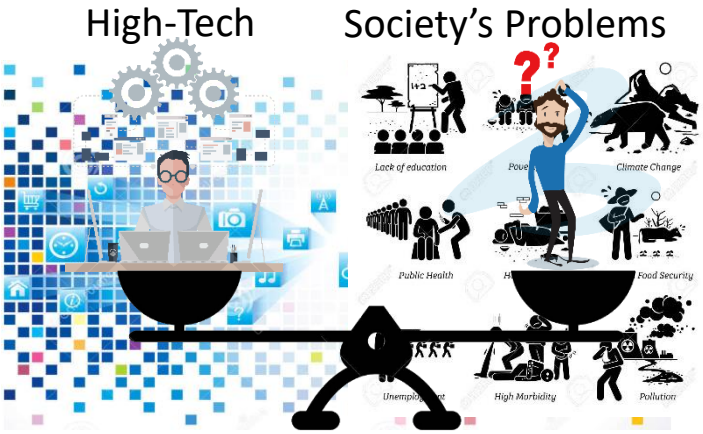
Decentralized and collaborative approaches (ASEAN-IVO)

Centralized and data-dominant approaches (US/EU)

- New perspectives of reusable, sharable, and transferable smart data platform
- New technologies in complex event analytics, correlation analysis, prediction, lifelog, and cryptography
- New solutions for fast developing a same-target but different-perspective application
- New solutions for local adapting of common or trans border problems

Societal Impact:

In General



High-tech distribution balancing

Fast and economy application development

In Particular

- **Vietnam**: *smart environmental tourism* and *smart sustainable mobility* contribute to improve citizens' living environment as well as behaviors, to attract more tourists, and to decrease the significant loss from traffic problems.
- **Singapore**: *smart outdoor activities* bring citizens more options to enjoy outdoor activities while having subjective ways to protect from sun's effect.
- **Brunei**: smart cultural-environment tourism helps to protect the local culture and religion as well as support tourists avoid problems from confliction.
- **Philippines**: *smart medicare* guarantees every citizen having proper medical care
- **ASEAN-Japan:** propagate these applications to each member so that all citizens can have benefited equally.

Collaborative Impact:

In General

- Strengthening and encouraging *collaborative development* among members by sharing the smart data-driven platform and common social problems.
- Sharing *knowledge* for research and education purposes (e.g., dataset, courses, papers, seminars, conferences).

In Particular

- **NUS-NICT**: take advantage of open and vibrant local data, especially 3D GIS and UV, to build precise predictive models. Introduce a new exciting research direction by integrating 3D GIS and environment data.
- **UTB-NICT**: encourage the trans-border disaster research, especially haze disaster due to fire forest from neighbor countries.
- **Cauayan-NICT**: support to improve the qualification of medical health for citizens by leveraging
- **Dalat-Consortium**: transfer knowledge from different partners (e.g., NICT, NUS) to contribute to the development of smart city's project, especially environment and mobility domains
- **New partners-consortium**: contribute by bringing more scenarios, data, models, and workforce to strengthen the consortium and enrich the knowledge.

Scientific Output/Outcome

- New ASEAN-wide testbed for smart data utilization.
  - Smart data: IoT big data that are transformed to actionable information for intelligent monitoring, navigation, and decision making.
- New technologies for correlation analysis and prediction as well as complex event analytics
  - CRNN for predictive models
  - 3D-CNN for complex event analytics
  - Spatial High Utility Itemsets for correlation analysis
  - Co-occurrence patterns for explaining prediction results.
- New applications will be built by creating, sharing, transferring and customizing predictive modeling with local data on the testbed effectively and efficiently.
  - Smart environmental tourism (Vietnam)
  - Smart sustainable mobility (Vietnam)
  - Smart cultural-environmental tourism (Brunei)
  - Smart beautification outdoor activities (Singapore)
  - Smart medicare (Philippines)

Societal and Collaborative Output/Outcome:

Societal:

- Data set for public use
  - ASEAN-wide testbed (include dataset and baseline) contains high-level semantic heterogeneous big data that can be shared for research on different domains such as tourism, healthcare, mobility, culture, and environment
  - SEPHLA: a personal health archives (published already) for understanding the relationships between human and their living environment.
- Technologies which will be transferred to members
  - APIs manual documents
  - xData platform architecture

Collaborative:

- Promote collaborative prediction and countermeasure of social risks caused by environmental disasters common to ASEAN countries

Conclusion:

1. Target

   Collaboratively developing a data-driven smart city using a reusable, sharable, and transferable smart data platform

2. Method (idea)

   Extend xData Platform developed by NICT for collaborative development of data-driven smart city, particularly

   - *Correlation analysis, prediction, and cryptography*: complex event analytics and security
   - *Information portal*: gather, share, and visualize high-level semantic data
   - *APIs mashup*: reuse, share, and transfer techniques developed by members to fast create a new application

3. Scientific and Societal Impact

   - New technologies in complex event analytics, big data analytics, correlation analysis and prediction, and cryptography
   - New ASEAN-wide testbed (data and baseline) for research
   - New platform for fast developing applications for human benefits
   - Open opportunities for all ASEAN-IVO members to contribute to and/or to get benefit from the consortium