

Participatory Sensing

–Concept and Application Examples–

by

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Lecture Outline

- Sustainable development
- Participatory sensing
 - concept
 - case study 1: active (individual) participation
 - case study 2: latent (individual) participation
 - case study 3: societal-level participation
- Summary

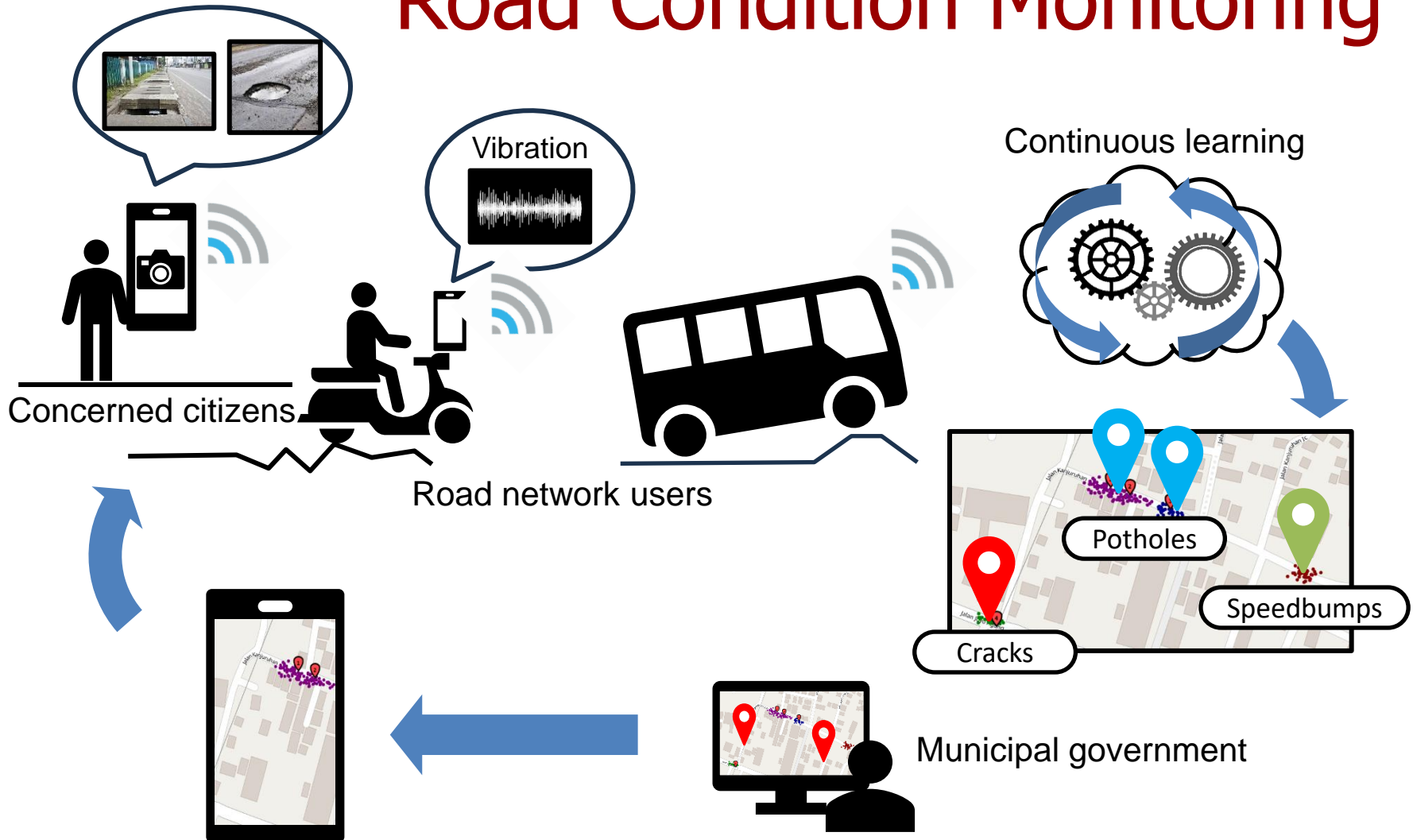
Sustainable Development

- Sustainable development goals (SDG) set by the United Nations in 2015 – global efforts towards a more sustainable and equitable future
- 17 goals, 169 specific targets, 232 indicators
- AI and ICT are seen as the main “driving forces”
- Risks and issues
 - environmental impact (more energy for ICT, etc.)
 - extra costs (data collection, sensors, etc.)
 - digital divide (digital literacy, etc.)

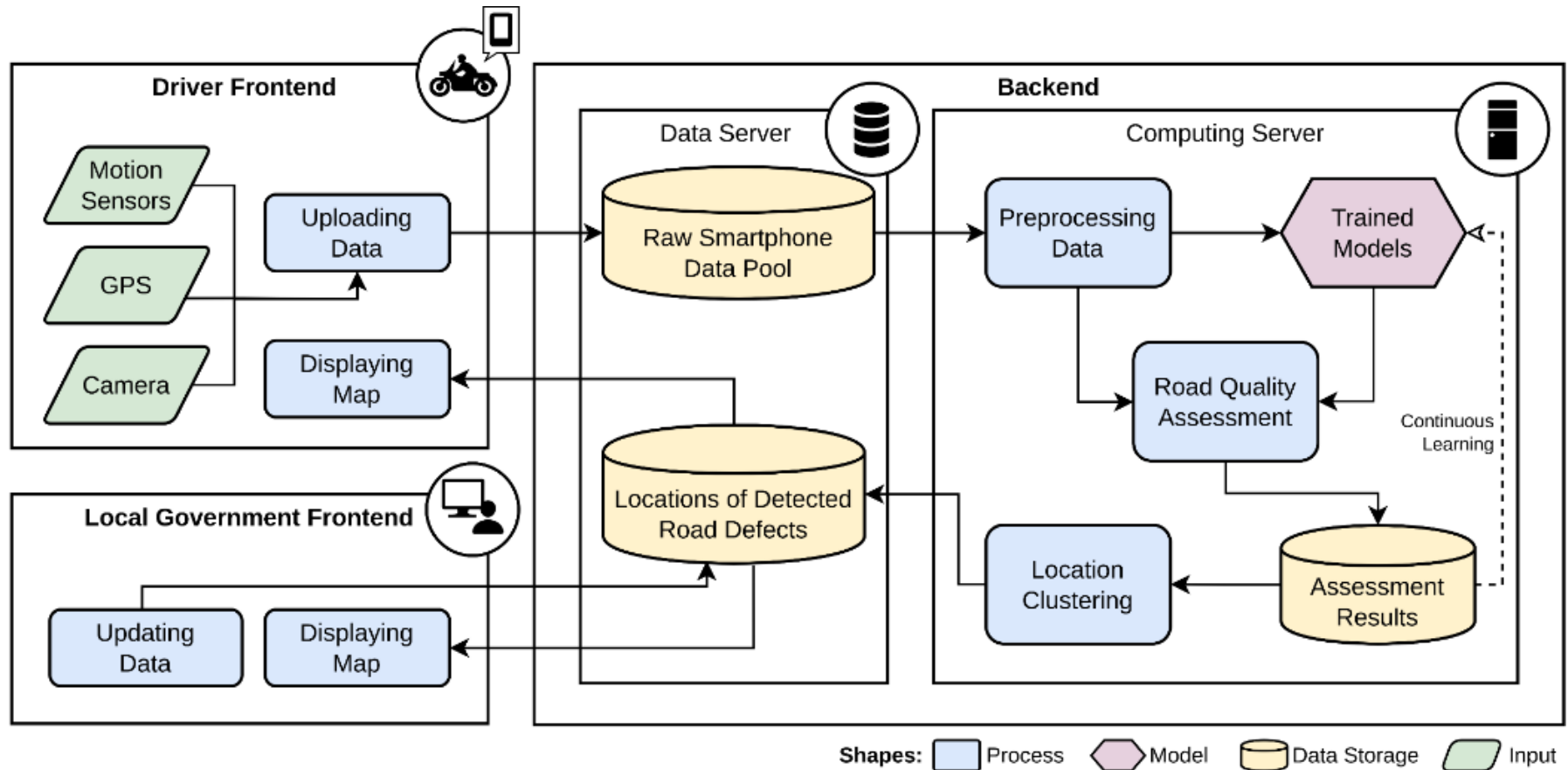
Participatory Sensing

- Concept: Individuals, as well as communities contribute sensory information to build a body of knowledge
- Can be active (contribute purposefully) and latent (unintended, e.g. based on data reuse)
- Many applications exist for **Smart City** and **Smart Transportation** (route planning, smart traffic lights, smart public transportation, etc.)
- Problems
 - data quality
 - maintenance costs

Participatory Sensing for Road Condition Monitoring



Road Condition Monitoring: Design and Implementation



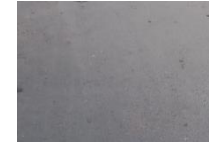
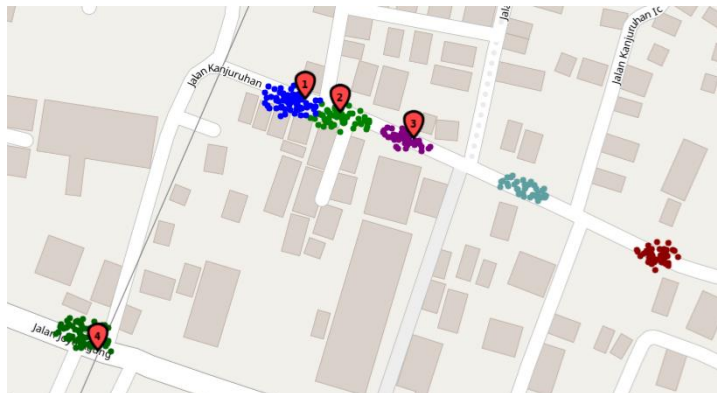
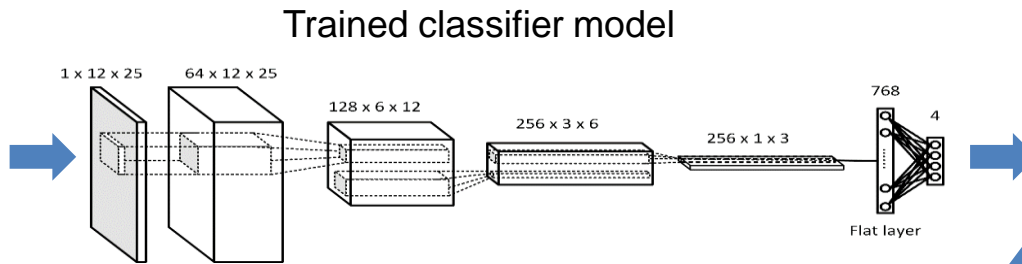
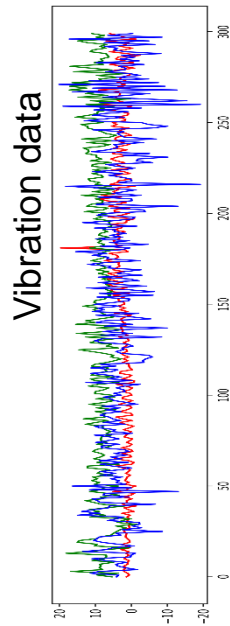
Case Study

- In collaboration with FILKOM UB and Malang municipal government
- Android application for data collection
- Data collected by volunteers in Malang, Indonesia, and Bangkok, Thailand
 - 639 motorcycle rides (2,723 km)
 - 138 car trips (561 km)



 A screenshot of the Android application interface. At the top, there are three tabs: "MAP", "HOME", and "UPLOAD". Below these are three buttons for vehicle selection: "Bicycle", "Motorcycle", and "Car". The "Motorcycle" button is currently selected. Below the buttons, there is a "Remark:" field and a "Press START before driving" instruction. A large blue "START" button is prominently displayed. At the bottom, there are sections for "Accelerometer" (X: 0.00, Y: 0.00, Z: 0.00), "Gyroscope" (X: 0.00, Y: 0.00, Z: 0.00), and "Location" (Latitude: 0.00, Longitude: 0.00).

Case Study: Processing and Visualization



Flat Surface: 0.003



Pothole: 0.73



Speedbump: 0.10



Rough Surface: 0.14

Case Study: Results and Implications

- Two different models developed:
 - Deep CNN (window-based classification) for seldom-visited areas
 - Unrolled GAN to balance training sets
 - 1D-BiLSTM Skip-Unet (semantic segmentation) for areas with heavy traffic

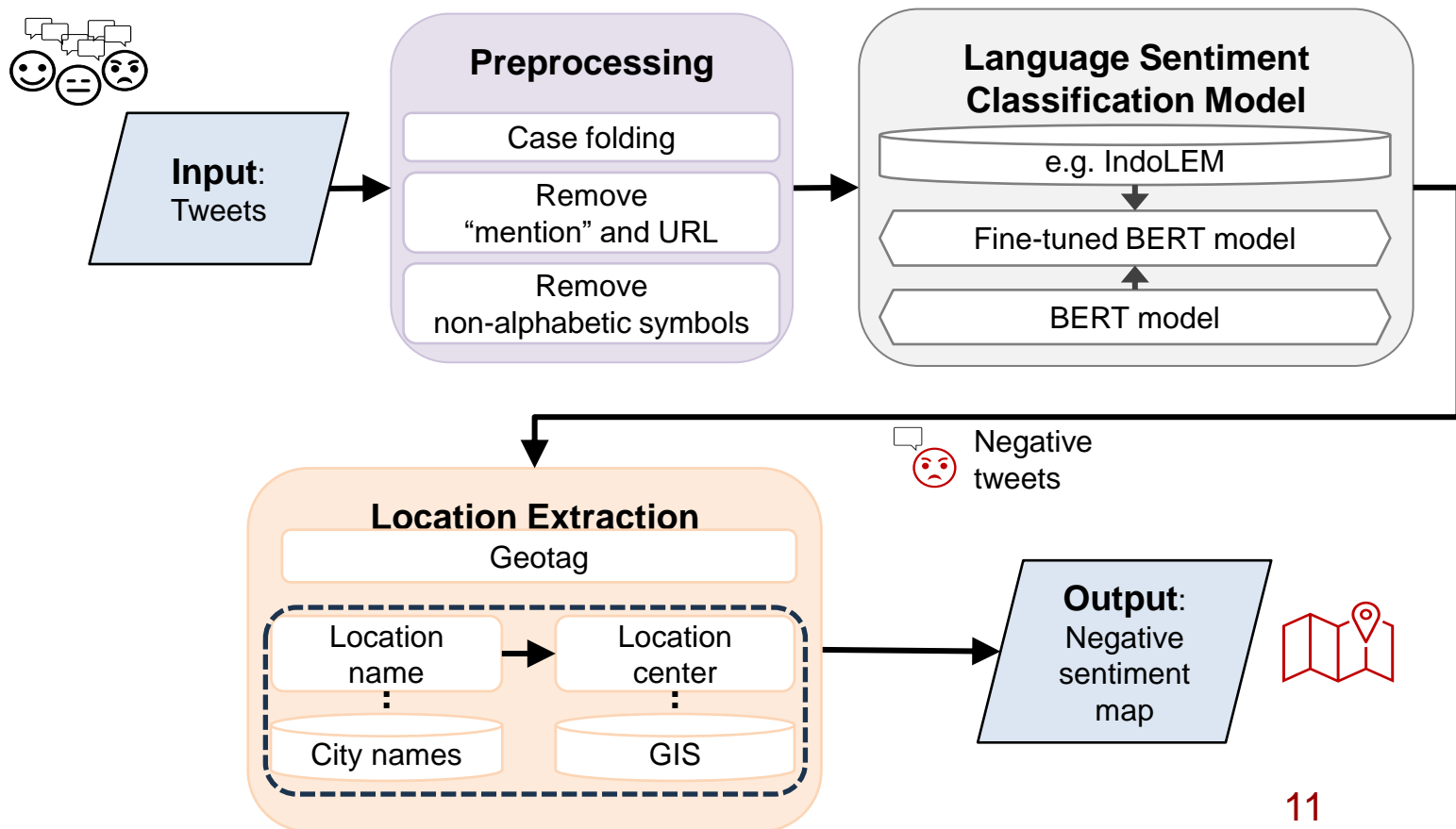
- Prototype:

<https://dadangsudadang.github.io/road-monitoring-map/>

Participatory Sensing for Service Improvements: Concept

- Governments, as well as businesses need to know opinions of their “customers” about various services they provide
- Service quality assessment
 - quality of service: provider’s view
 - operational data
 - quality of experience: customer’s view
 - surveys
 - customer support centers
 - social media

Participatory Sensing for Service Improvements: Design and Implementation

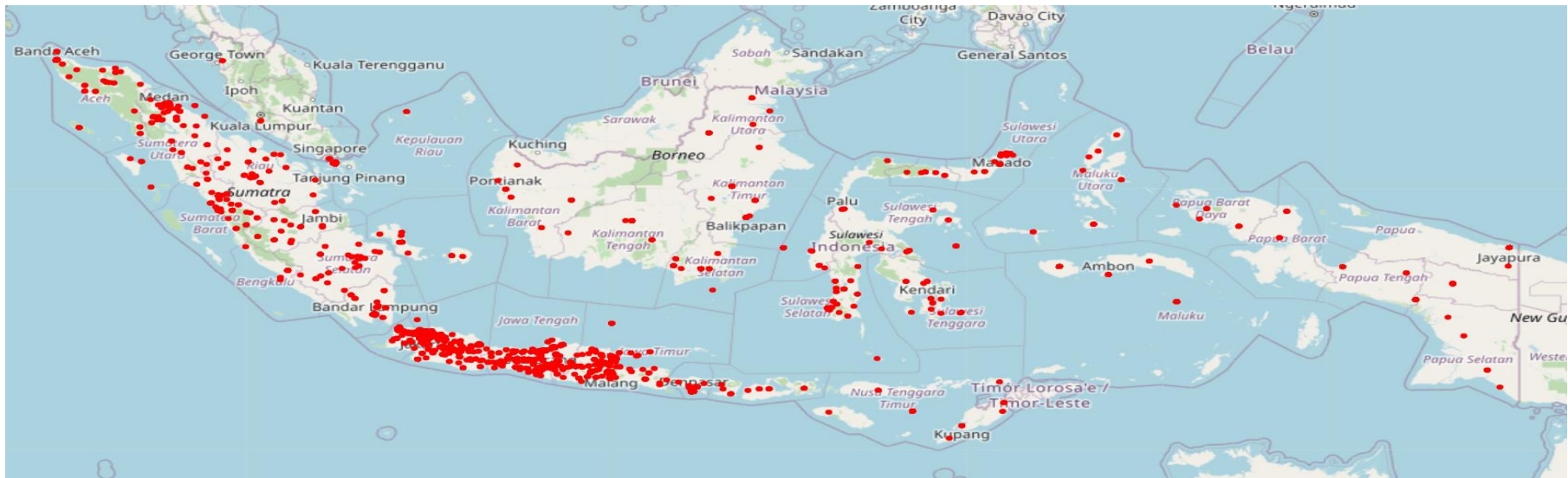


Case Study

- In collaboration with Telkomsel, a major telecommunication service provider in Indonesia
 - 176 million customers, 120.5 million data users in 2021
- Data collected
 - 78,246 tweets with '@Telkomsel' as the keyword posted on July 21 through October 10, 2022

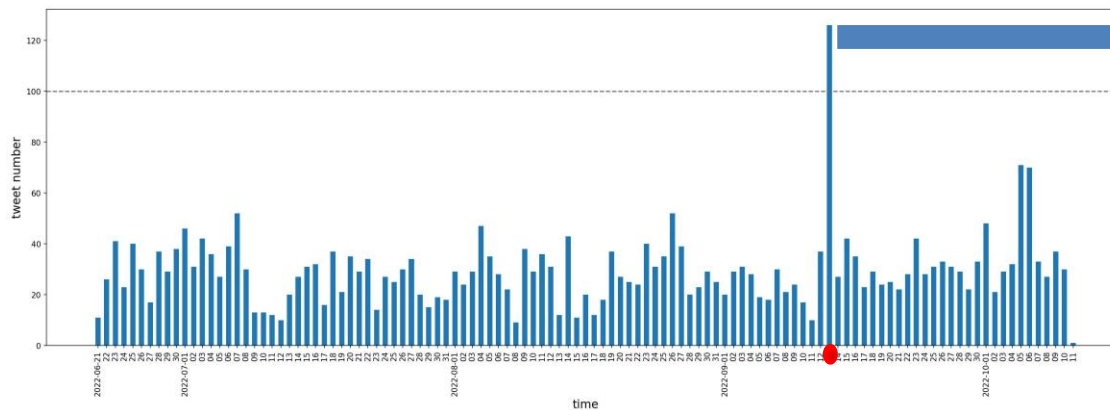
Case Study: Processing and Visualization

- Sentiment analysis: Open source pre-trained IndoBERTweet model fine-tuned on the IndoLEM open-source dataset
- Location coordinates: From geotags (when available) and using a dictionary of municipalities

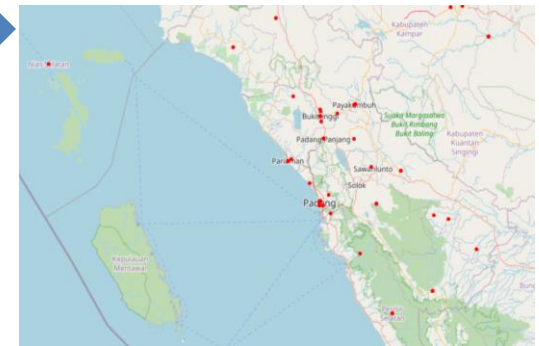


Case Study: Results

- Positive sentiments: 5,345 tweets (6.8%)
- Negative sentiments: 72,900 tweets (93.2%)
 - 1,733 tweets with geotags
 - 1,587 tweets with location names



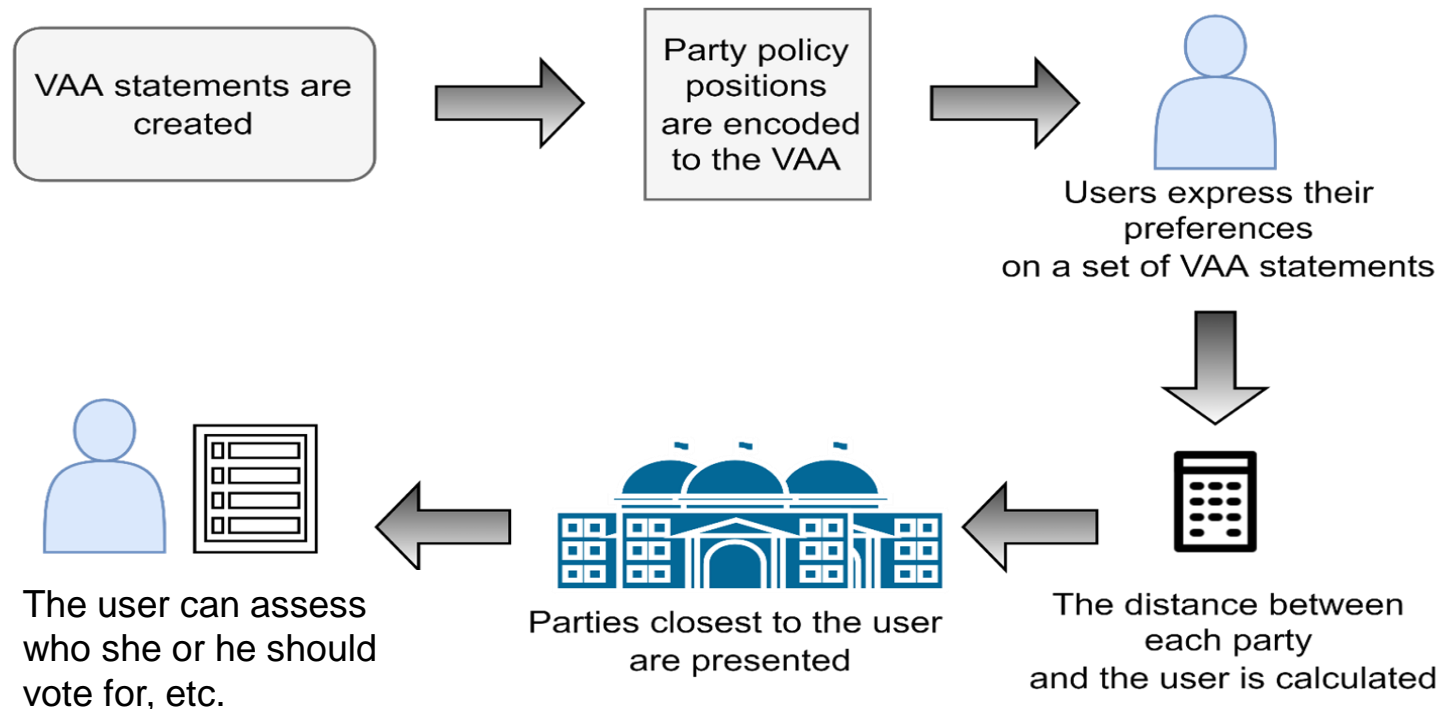
September 13, 2022



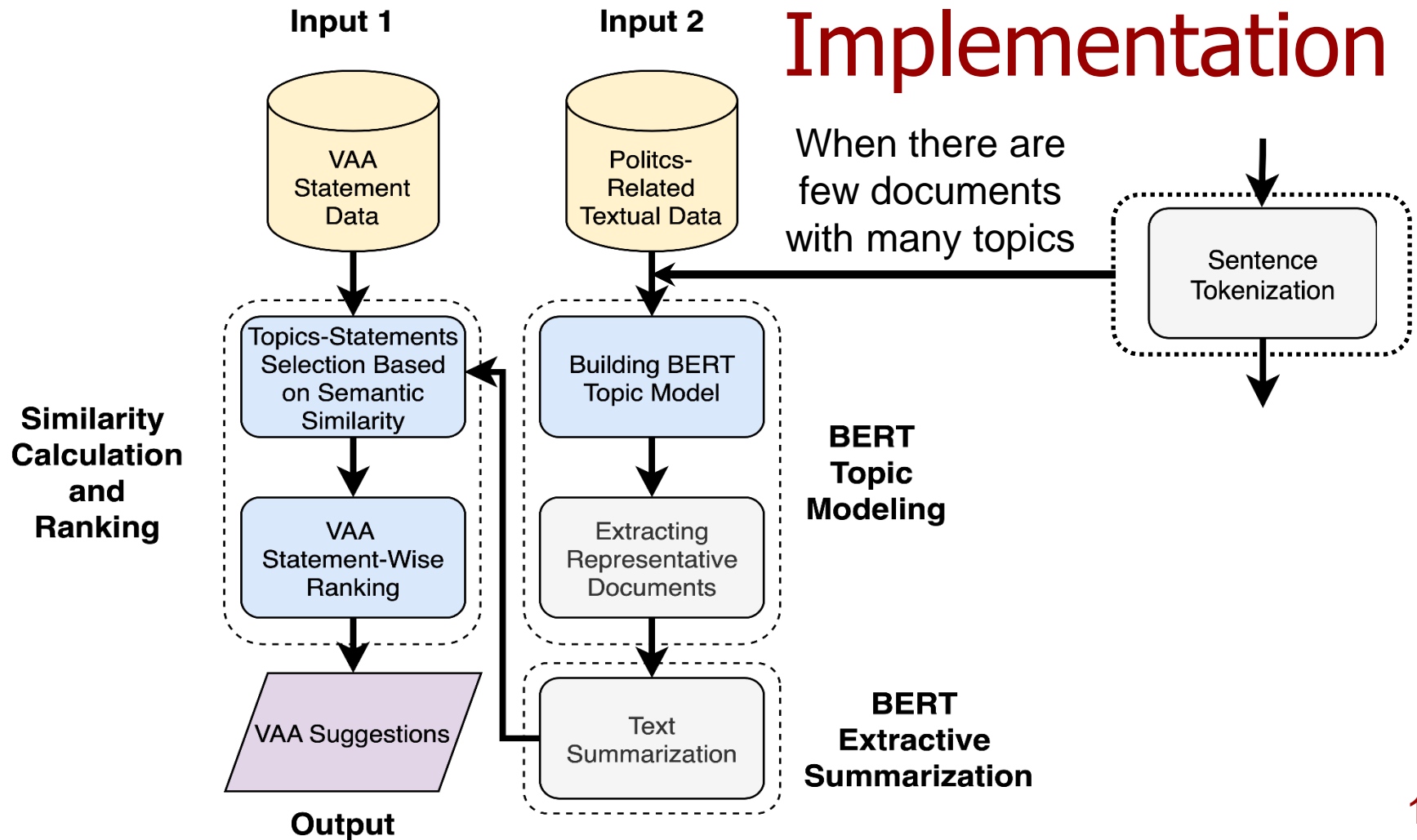
- partial validation via local media reports: faulty fiber optics in the area including Padang, Bukittinggi, and Payakumbuh

Participatory Sensing for Political Education: Concept

- Voting Advice Application (VAA) is a tool that helps citizens find political parties that stand closest to her or his political preferences



Participatory Sensing for Political Education: Design and Implementation



Case Study

- 3,998,590 YouTube comments from 18 most popular politics-related channels uploaded between two elections in Japan (January 2021-July 2022)
- Party manifestos (9 political parties participated in the elections) uploaded before the 2021 Japanese Upper House and the 2022 House of Councilors elections
- VAA statements from six different Japanese VAAs (135 statements)

Case Study: Results

VAA statement

Higher education should be completely free of charge.

System suggestion 1

[JCP] We are aiming for free education, halving tuition, abolishing entrance fees, and eliminating school lunch fees - halving tuition at universities and vocational schools, and making them free in the future.

System suggestion 2

[Japan Innovation Party] Zero educational burdens for the next generation of children, all education such as early childhood education, high school, university, etc., so that we can receive an equal quality education regardless of the financial situation of the family.

System suggestion 3

[Reiwa Shinsengumi] We will create a society where people can go to graduate school for free without owing debt if students are willing to learn.

System suggestion 4

[Komeito] Expand the scholarship program and tuition reduction/exemption to middle-income families, including families with multiple children and students studying science, engineering, and agriculture, who especially need to reduce their burden, so that anyone can enter university if they wish, regardless of their family's financial situation.

System suggestion 5

[DPP] Reduce tuition fees for higher education, including universities and graduate schools, and extend non-repayment scholarships to average families.

Case Study: Existing VVA Verification

Statement \ VAA	Mainichi Shimbun	Zero Senkyo	Asahi Shimbun	FokusJapan	Japan Choice	Shimotsuke Shimbun
1	✓ Manifestos	✗	✓ Comments	✗	✗	✓ Comments
2	✗	✗	✓ Comments	✓ Manifestos	✓ Manifestos	✗
3	✗	✗	✓ Comments	✗	✗	✗
4	✗	✓ Manifestos	✗	✗	✗	✓ Manifestos
5	✓ Both	✓ Comments	✓ Manifestos	✗	✓ Manifestos	✗
6	✓ Manifestos	✗	✓ Comments	✗	✓ Manifestos	✓ Manifestos
7	✓ Comments	✗	✓ Comments	✓ Manifestos	✗	✓ Manifestos
8	✗	✓ Manifestos	✗	✗	✓ Manifestos	✓ Manifestos
9	✗	✓ Manifestos	✓ Manifestos	✗	✓ Manifestos	✓ Manifestos
10	✗	✗	✗	✓ Manifestos	✓ Comments	✓ Both
11	✓ Comments	✓ Comments	✓ Manifestos	✗	✓ Manifestos	✗
12	✓ Manifestos		✓ Manifestos	✗	✓ Both	✓ Comments
13	✓ Manifestos		✓ Manifestos	✓ Manifestos	✓ Manifestos	✗
14	✓ Manifestos		✗	✓ Manifestos	✗	✓ Manifestos
15	✓ Manifestos		✗	✓ Manifestos	✗	✓ Manifestos
16	✗		✗	✗	✗	✓ Both
17	✓ Manifestos		✓ Manifestos	✗		✗
18	✓ Manifestos		✗	✓ Manifestos		✗
19	✓ Manifestos		✓ Comments	✗		
20	✗		✓ Manifestos	✗		
21	✗		✗			
22	✓ Manifestos		✓ Manifestos			
23	✗		✓ Manifestos			
24	✓ Comments		✓ Manifestos			
25	✓ Both		✗			

Case Study: VVA FokusJapan Application Results

(Japanese VAA) Statement 1

Economic activity should be prioritized over infection control of coronavirus.

(Japanese VAA) Statement 2

A carbon tax should be introduced to reduce greenhouse gases.

(Japanese VAA) Statement 3

Nuclear power plants should be decommissioned in advance.

(Japanese VAA) Statement 4

The consumption tax should be reduced to 5% or less.

(Japanese VAA) Statement 5

Taxation on the rich should be strengthened.

(Japanese VAA) Statement 6

The minimum wage should be raised to 1500 yen or more.

(Japanese VAAs) Statement 7

The amount of pension payment should be gradually reduced.

(Japanese VAA) Statement 8

Higher education should be completely free.

(Japanese VAA) Statement 9

The eligibility age to be elected should be lowered.

Conclusions

- The deployment of participatory sensing helps address the issue of high cost of smart infrastructure, as well as contributes to reducing the digital divide
- Modern AI technologies allow for cost-effective reuse of both, sensors and data accumulated
- Participatory sensing offers a sustainable solution for many AI-powered ICT applications