ITU Kaleidoscope 2015

Trust in the Information Society

Network Failure Detection System for Traffic Control using Social Information in Large-Scale Disasters

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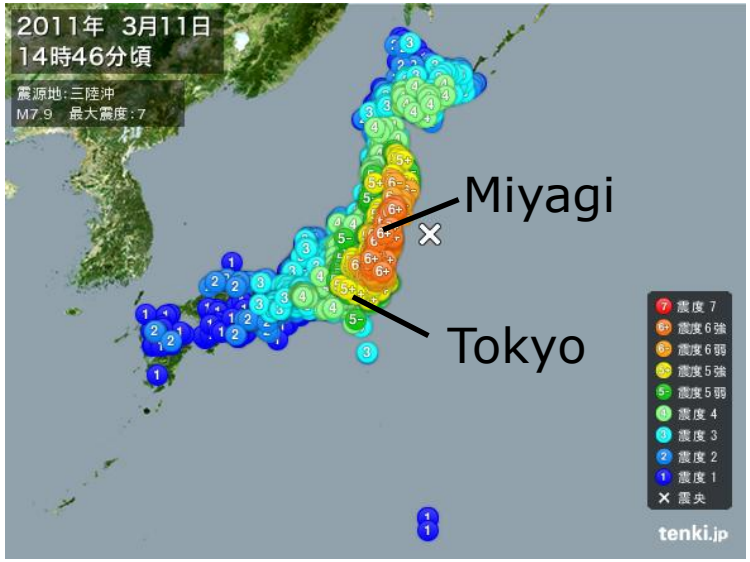
Outline

- Background
- Problem
- Objective
- Novelty
- Network Failure Detection System
  - Telephony Failure Detection
  - Location-aware Prioritization
- Network Control System
- Contributions

Overview of the Great East Japan Earthquake

- Occurred at 14:46 JST on 11 March 2011
- Magnitude 9.0
- 15,893 dead and 6,152 injured
- Wiped out by “Tsunami” (huge wave)



http://www.tenki.jp/

Otsuchi town

http://www.47news.jp/photo/

Problem

- Difficult to grasp all network condition immediately using only information from sensors

Role of SNS (e.g., Twitter)

- Users care network condition and provide such information through social networking service (SNS)
- Twitter is one of the most widely used SNS's

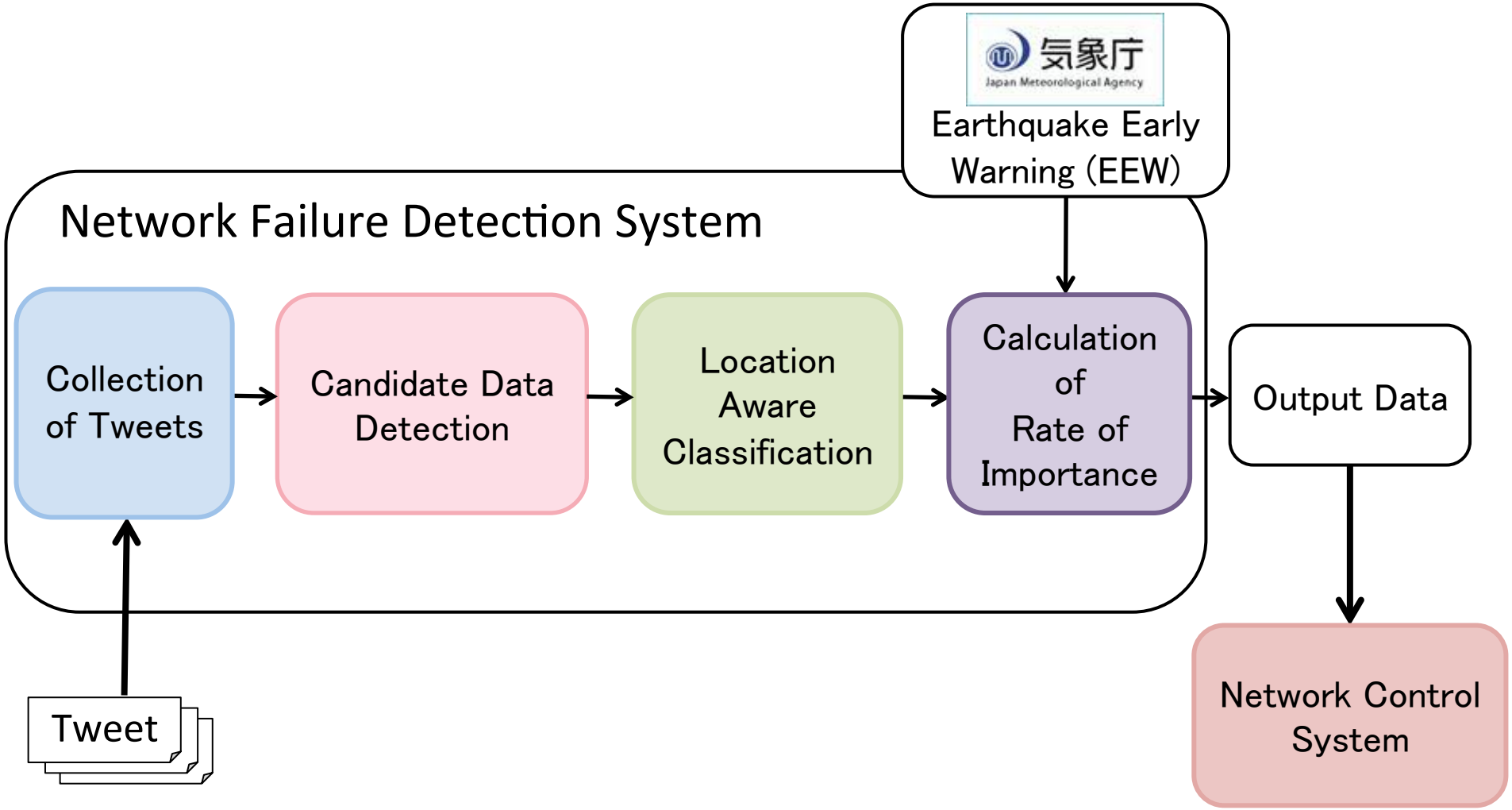
Objective

Achieve automatic/autonomic network control
utilizing collective knowledge
analyzed from social networking services

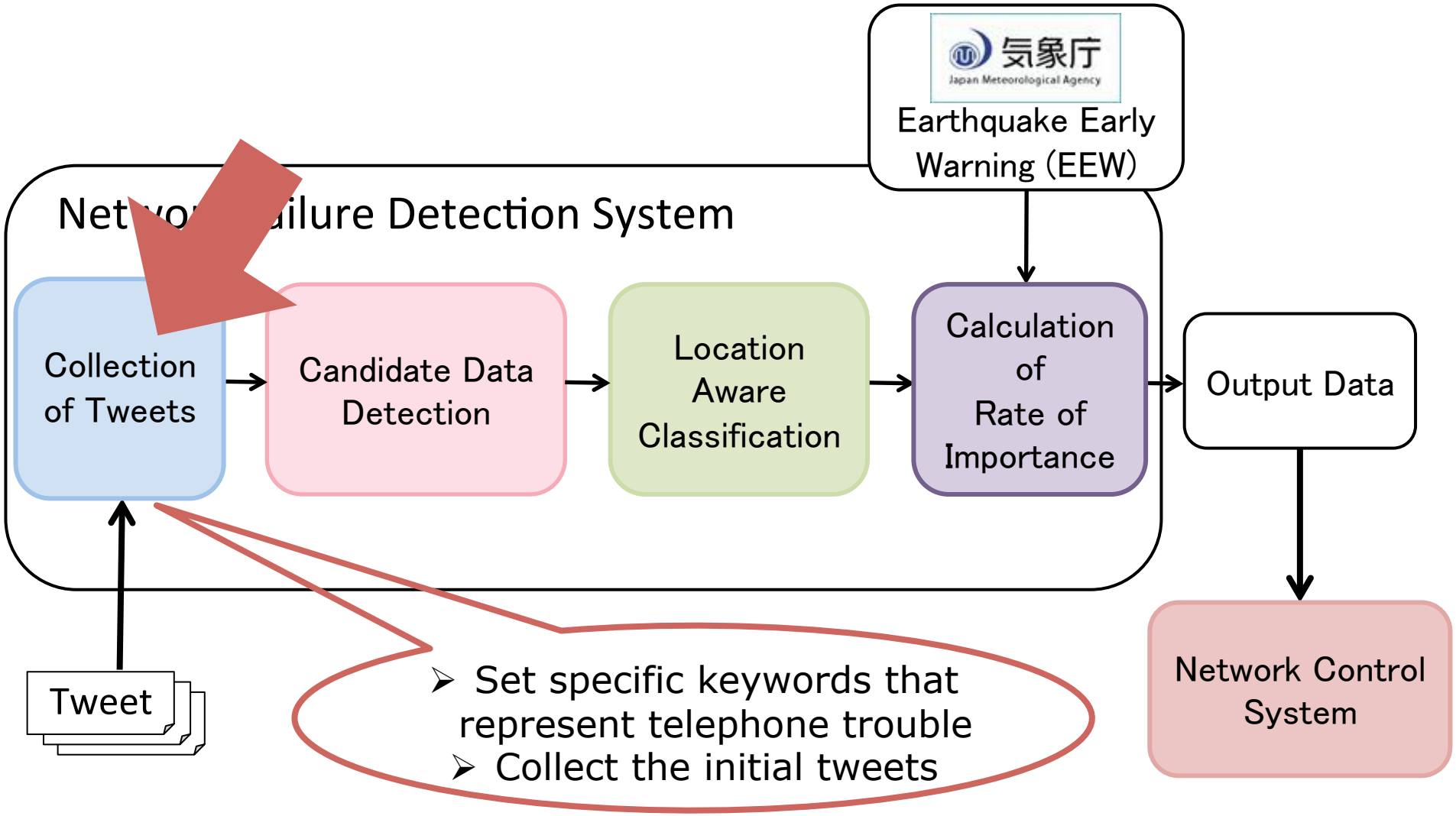
Novelty of this work

- We perform the network control using the collective intelligence of social networking service
- ITU-T Focus Group on Disaster Relief Systems performs the network control using wireless sensor networks
- Our approach is complementary to ITU-T Focus Group on Disaster Relief Systems

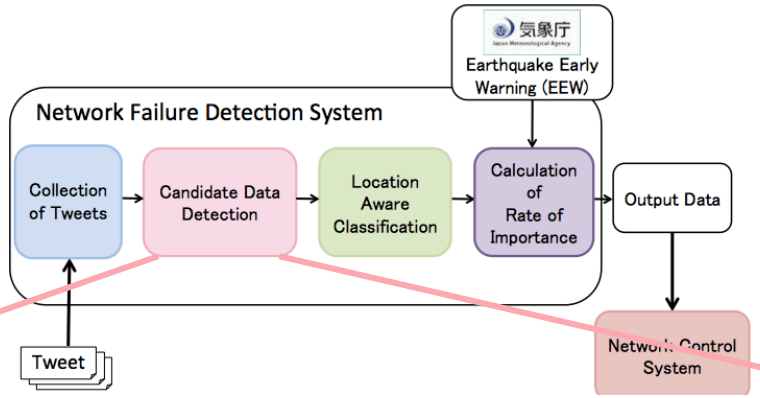
Network Failure Detection System

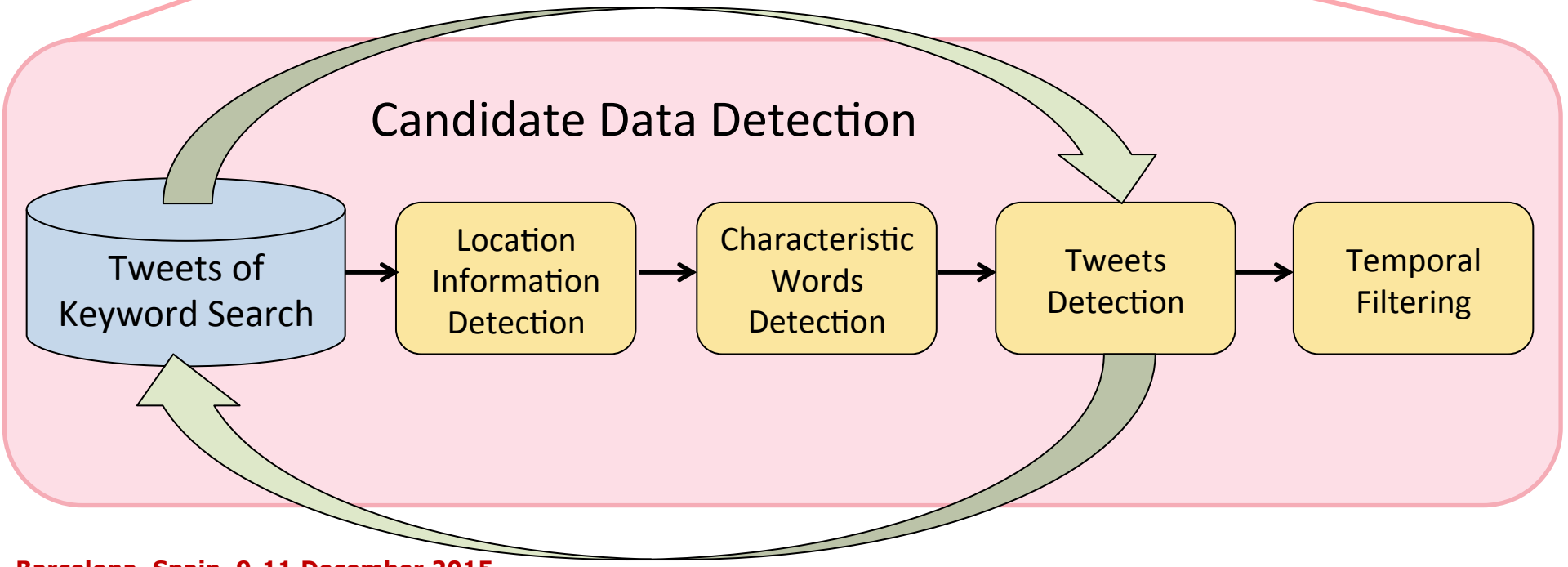


Keyword Search

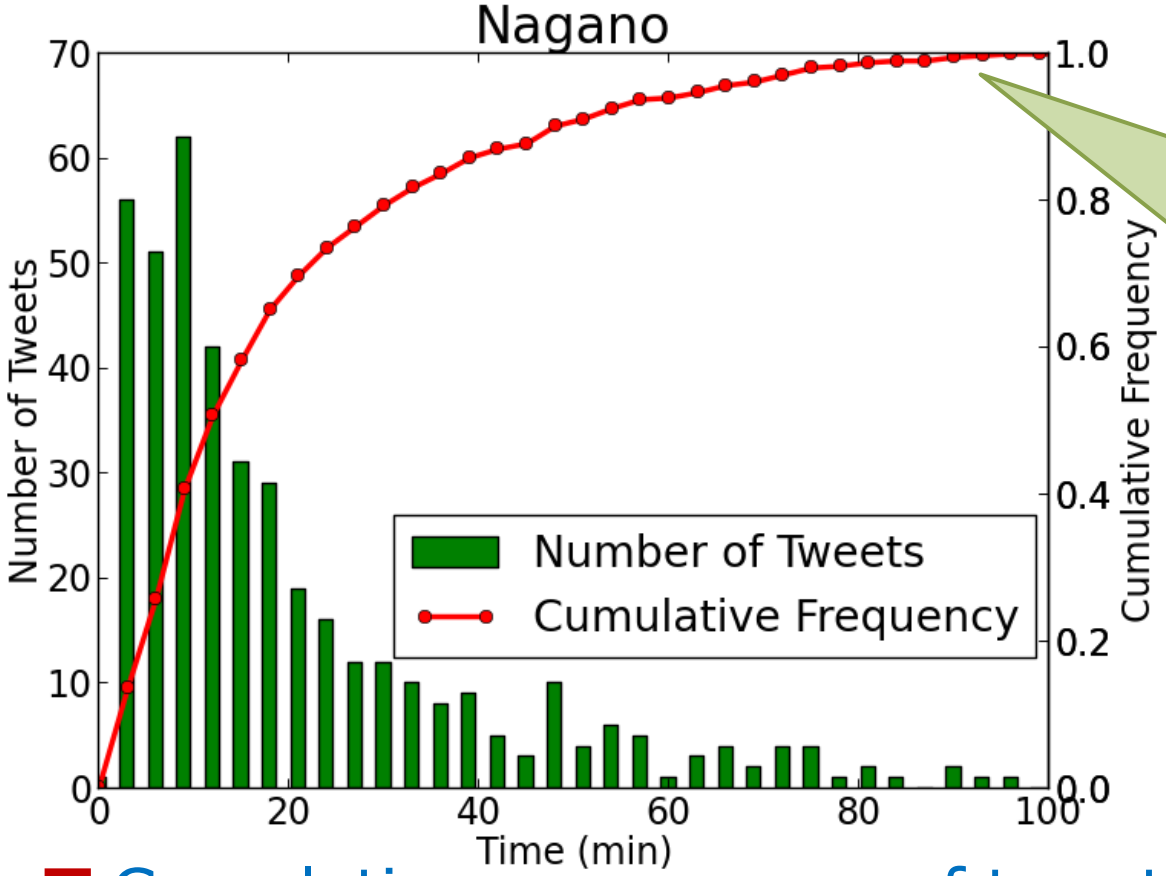


Candidate Data Detection Method





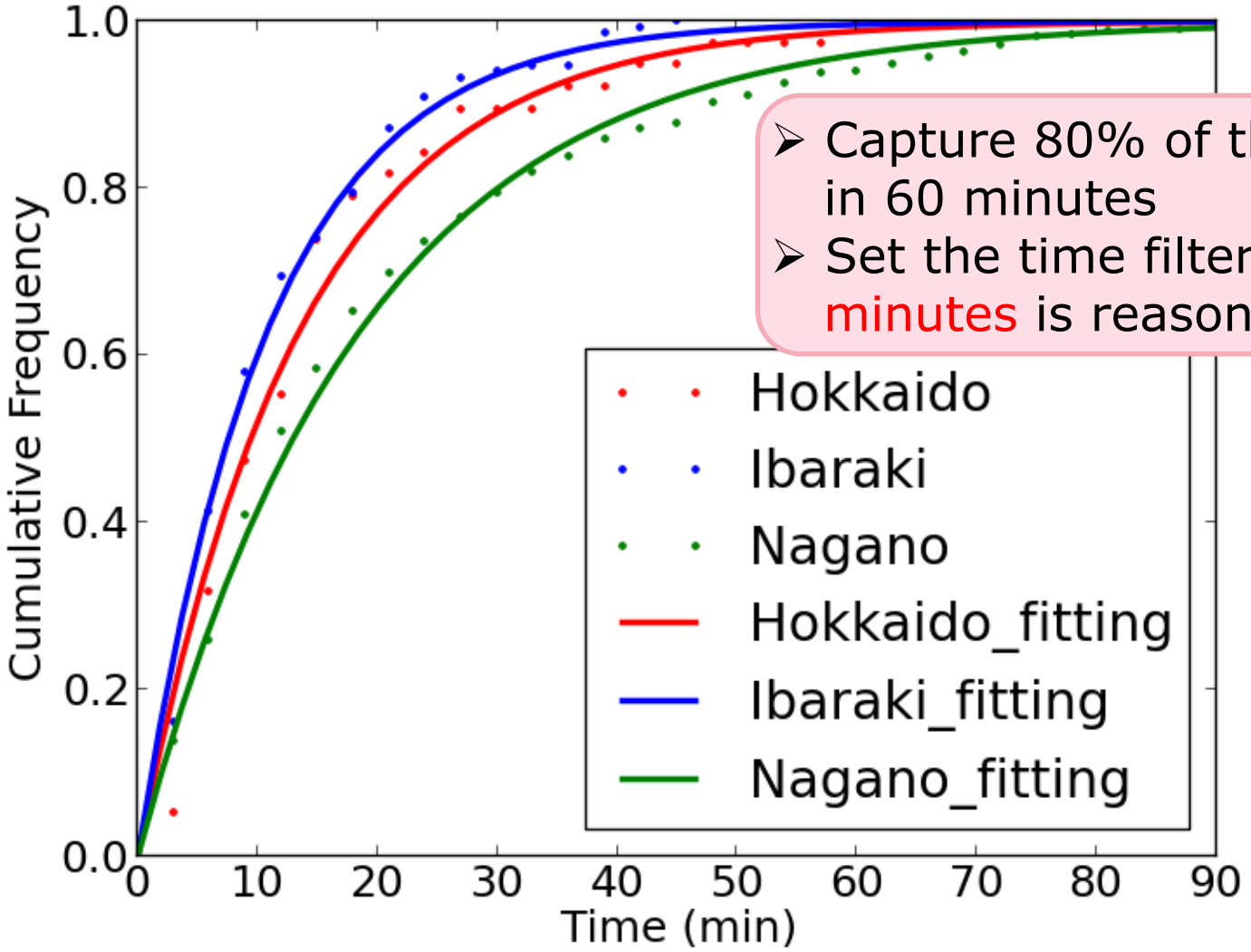
Time Variation of Tweets



Time variation of cumulative frequency is similar to the cumulative distribution of an exponential distribution

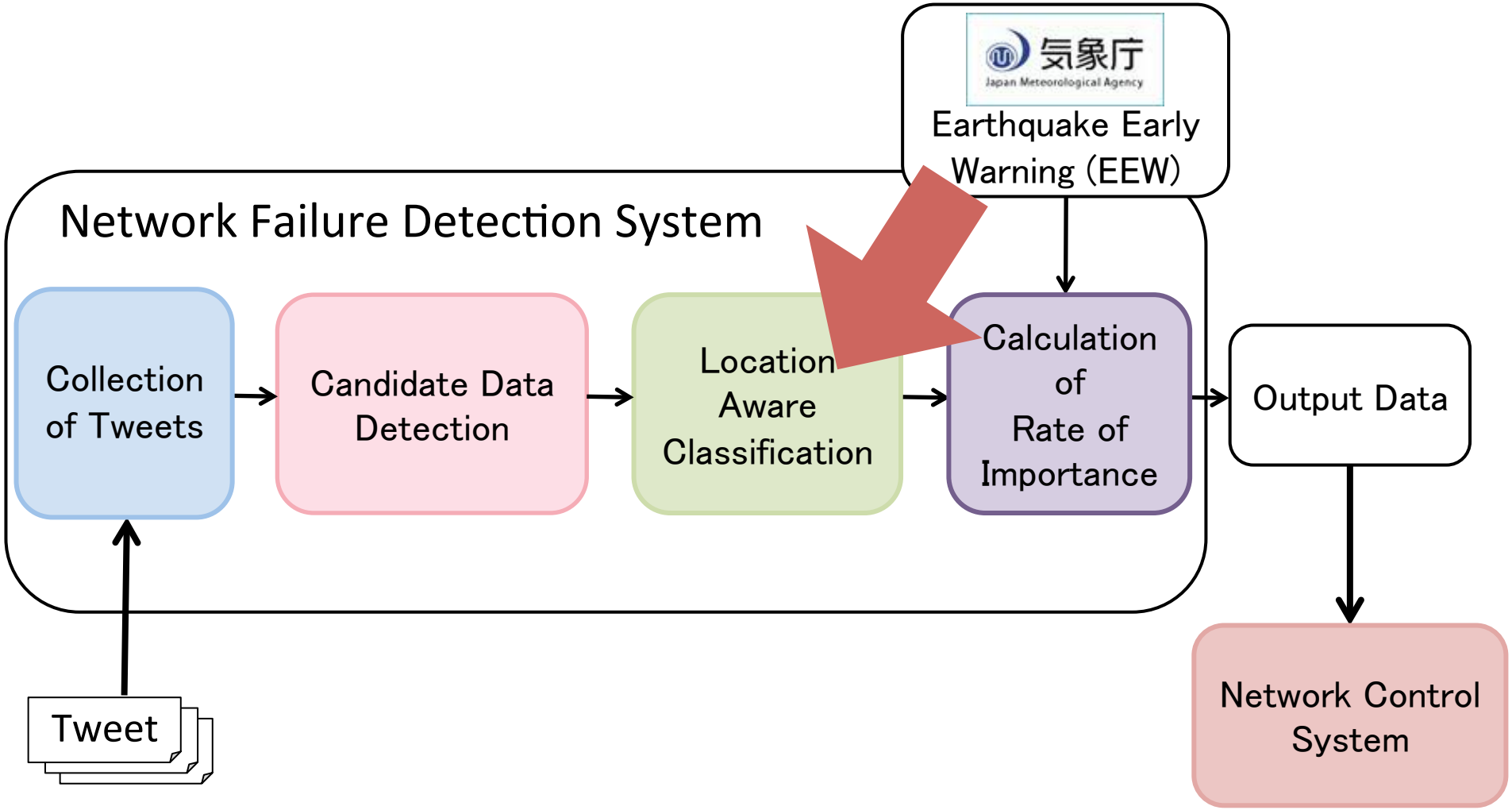
- Cumulative occurrences of tweets exhibit exponential distributions
- Determine a certain threshold to discard tweets

Temporal Filtering

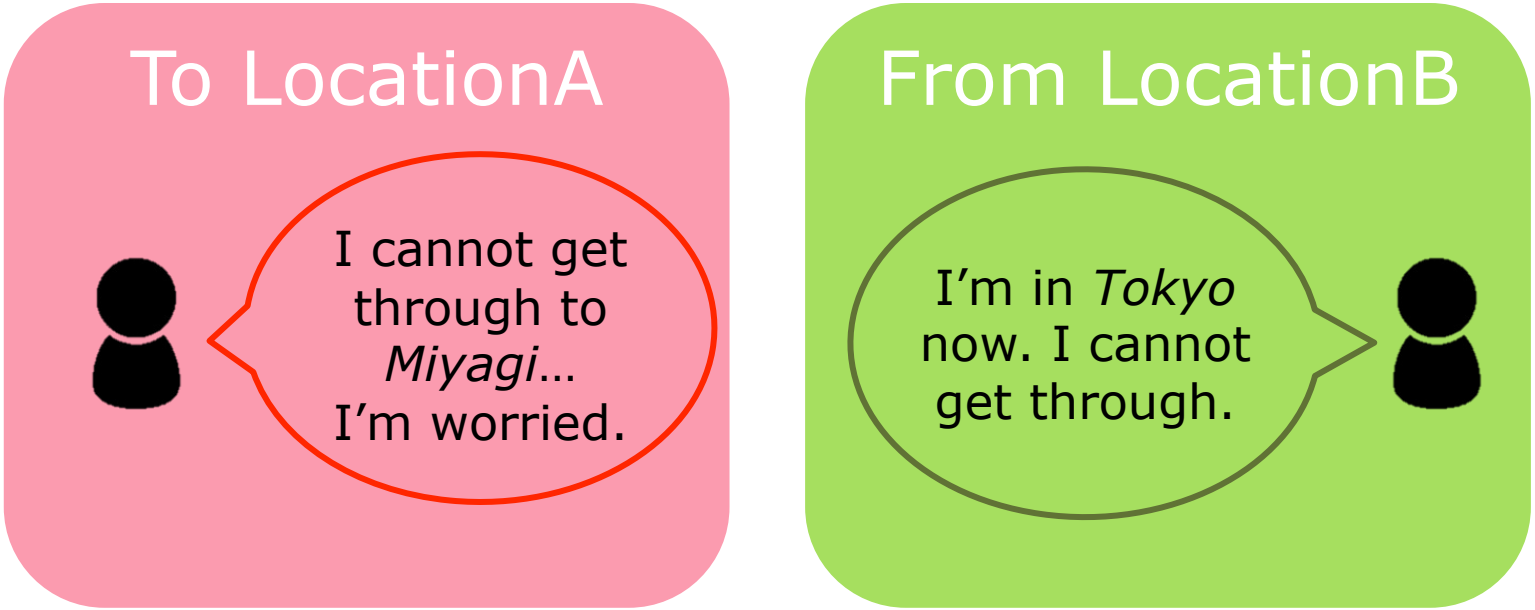


- Capture 80% of the event in 60 minutes
- Set the time filter to 60 minutes is reasonable

Location Aware Classification

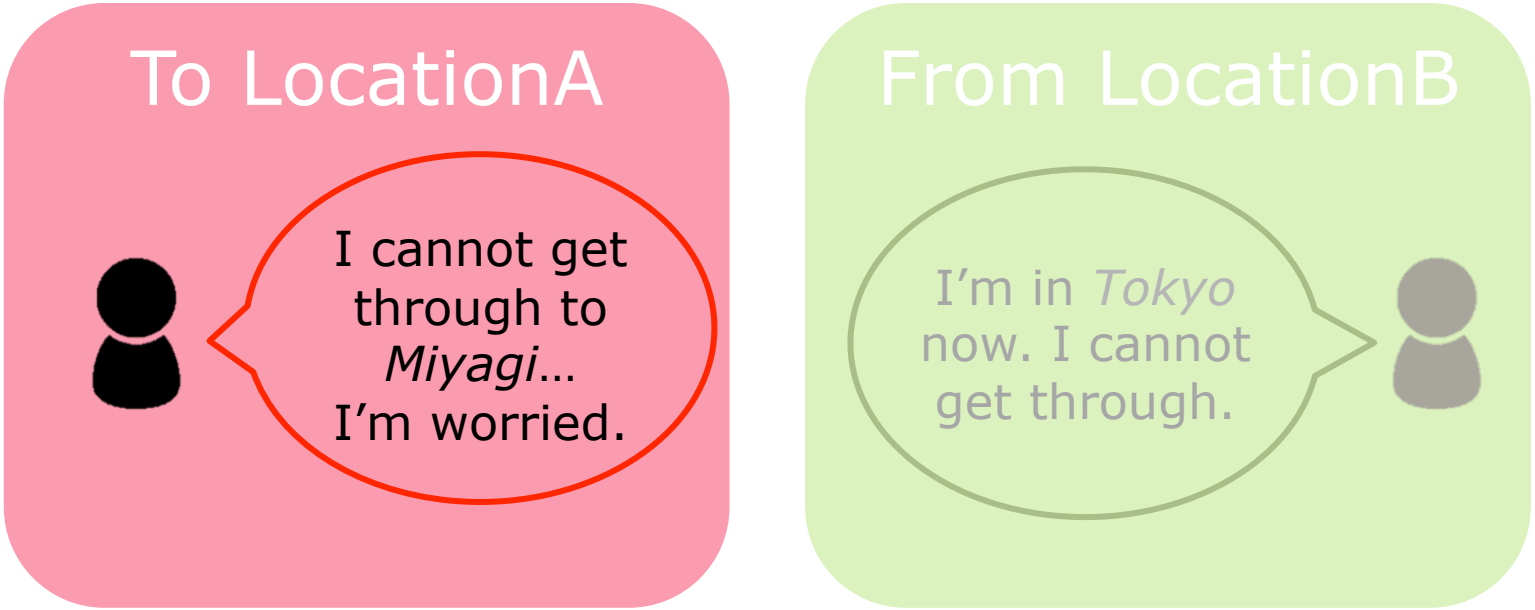


Location Classification



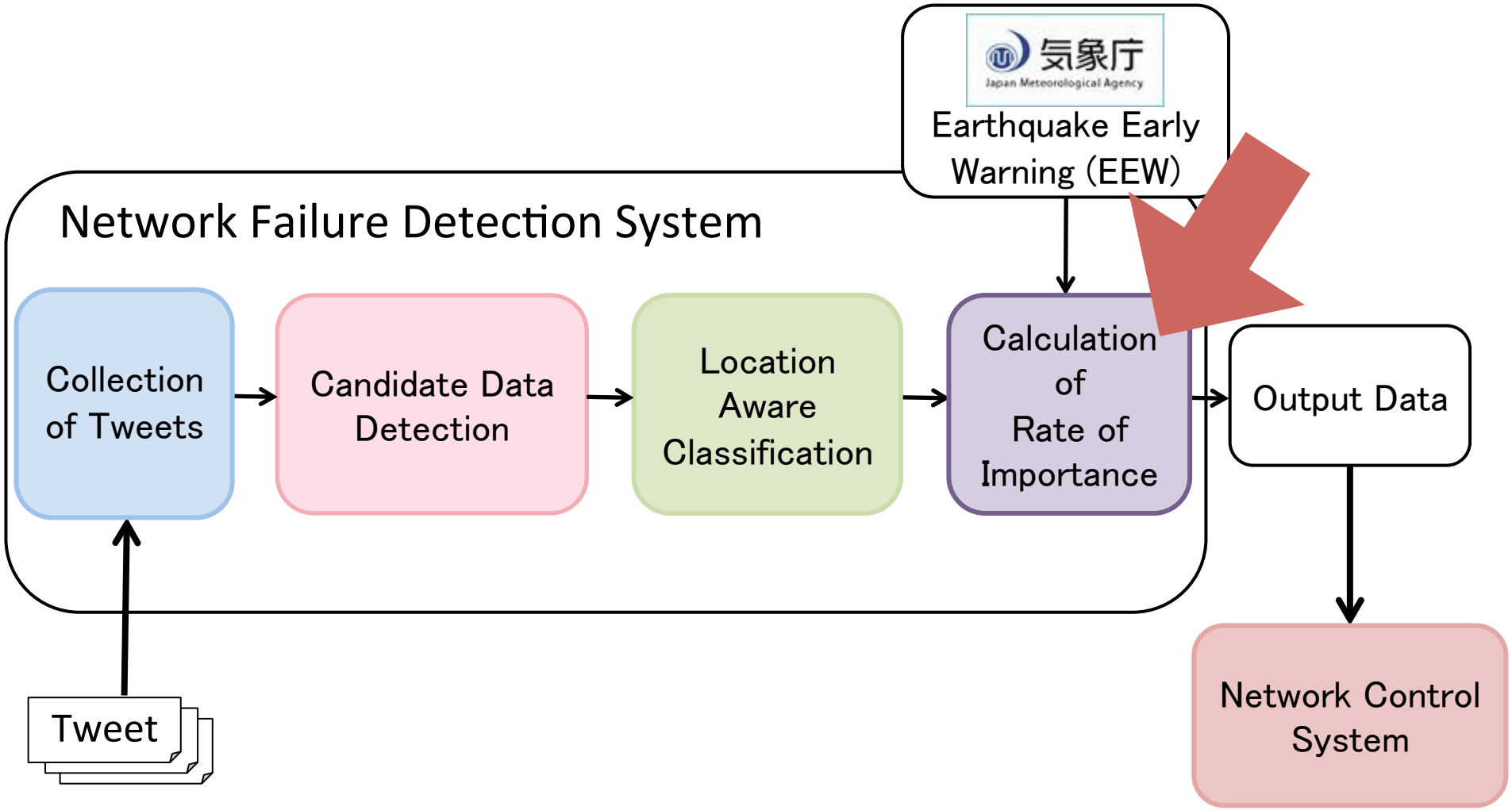
- Filter out tweets reporting telephony failures

Location Classification



- Filter out tweets with information on location associated with failures

Prioritization

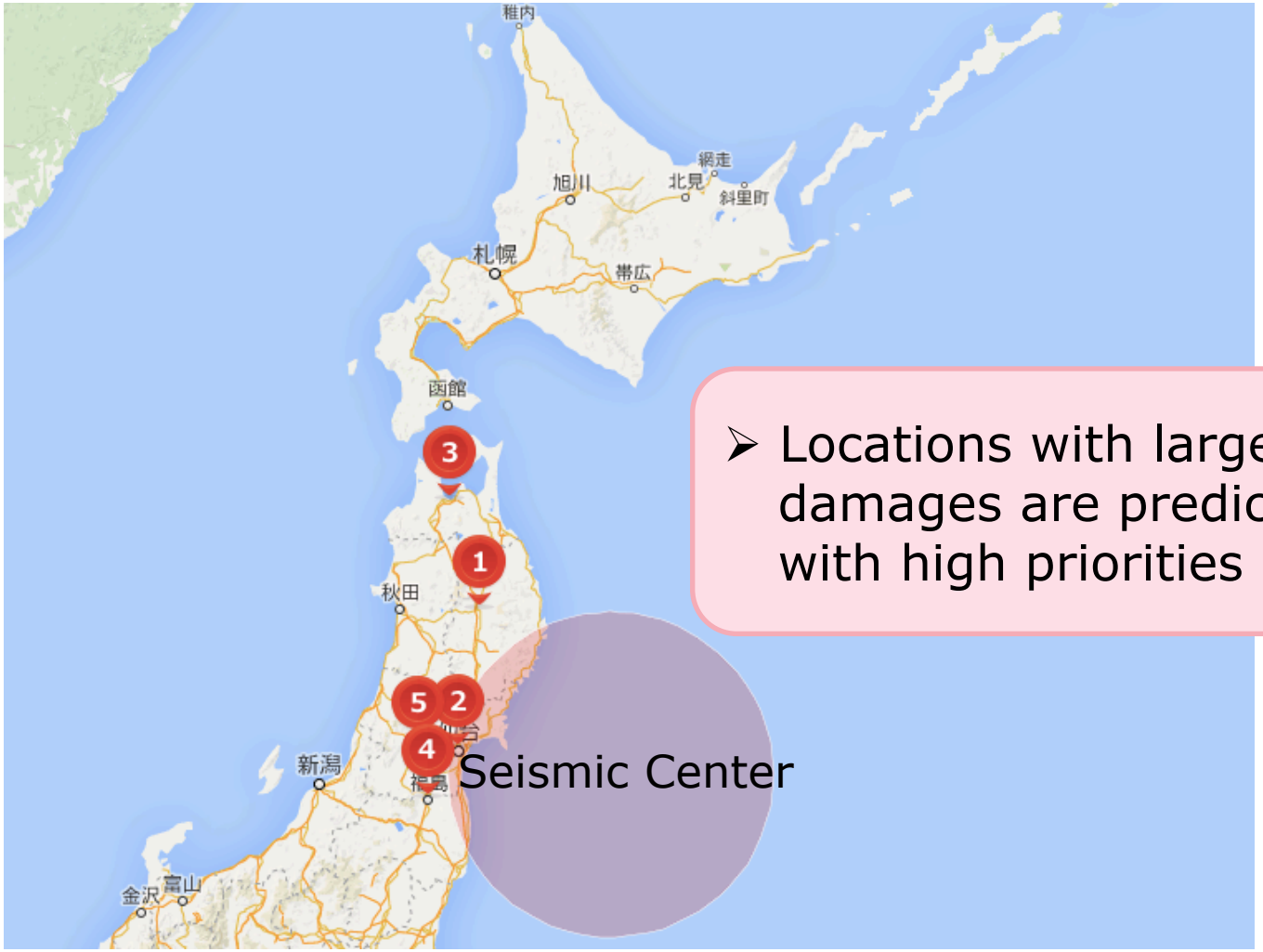


Calculation of Rate of Importance about Location Information

- It has three indicators
  1) Prediction of seismic intensity on the detected locations
  2) Rate of tweets reporting telephony failures to the detected locations
  3) Rate of increase of tweets in emergency

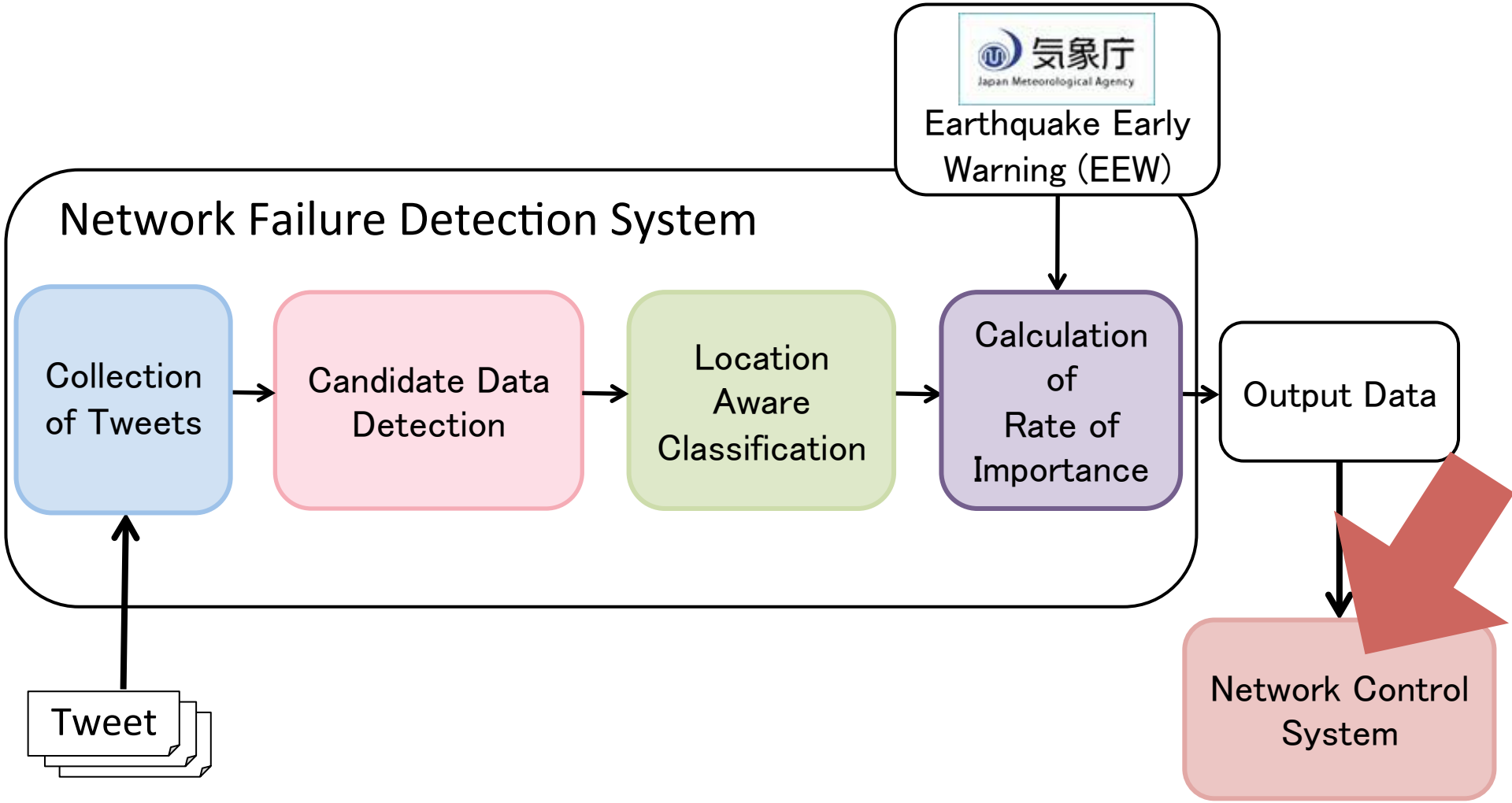
- Prioritize locations for the efficient area restoration

Rate of Importance in the Great East Japan Earthquake



- Locations with large damages are predicted with high priorities

Network Control System

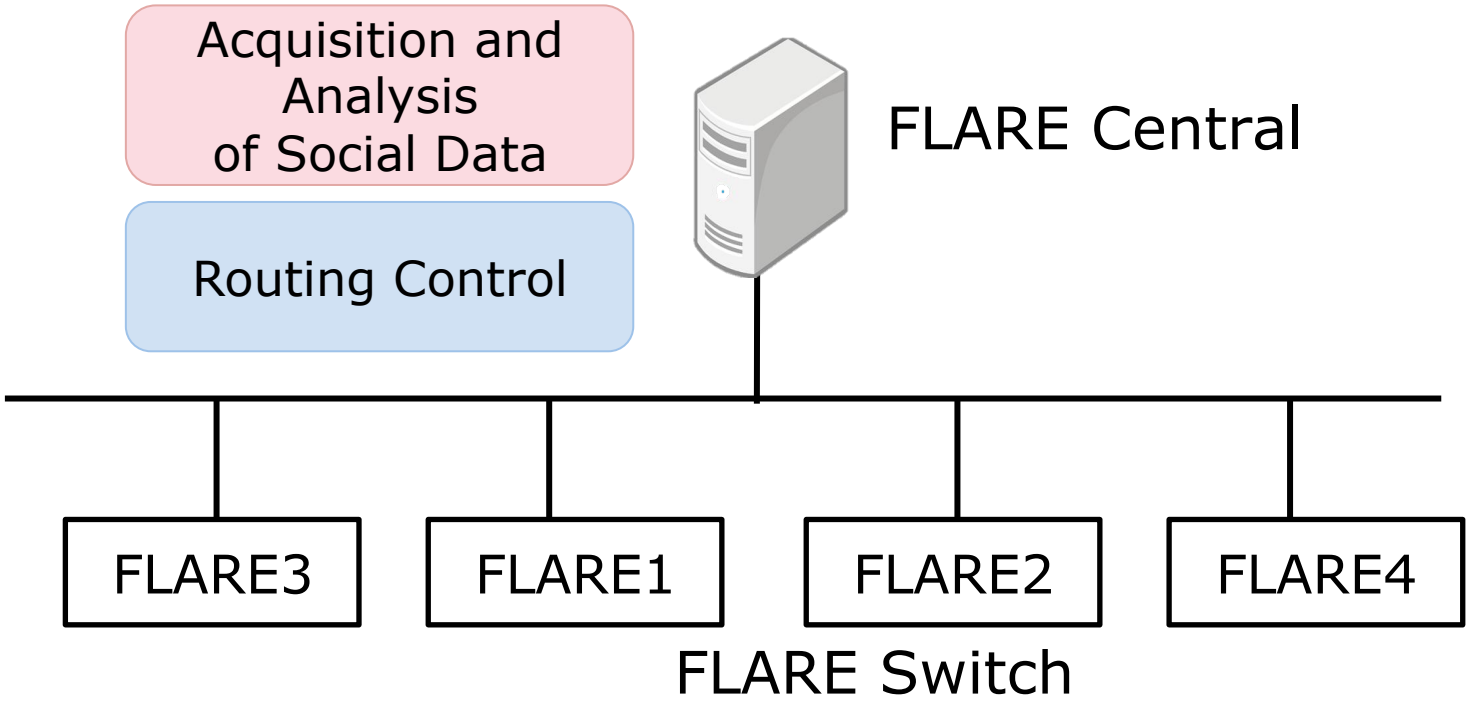


Network Control System based on Analysis of SNS

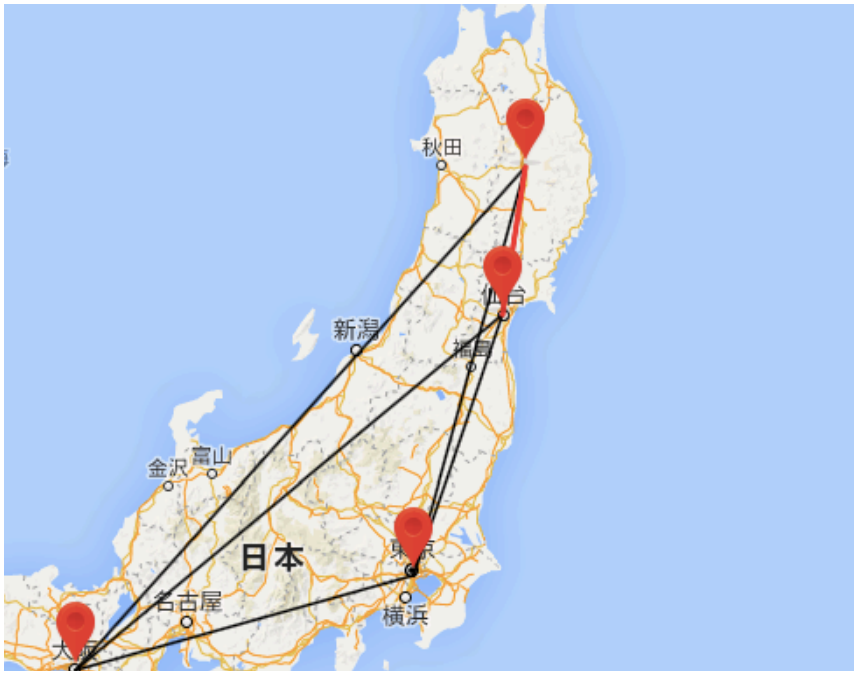
- Use information on network condition detected by our system
- Optimize the network traffic automatically
- Use an architecture called FLARE[1]
  - Can access data in application layer
  - Compatible with our system that try to use social information

Implementation with Programmable Nodes : FLARE

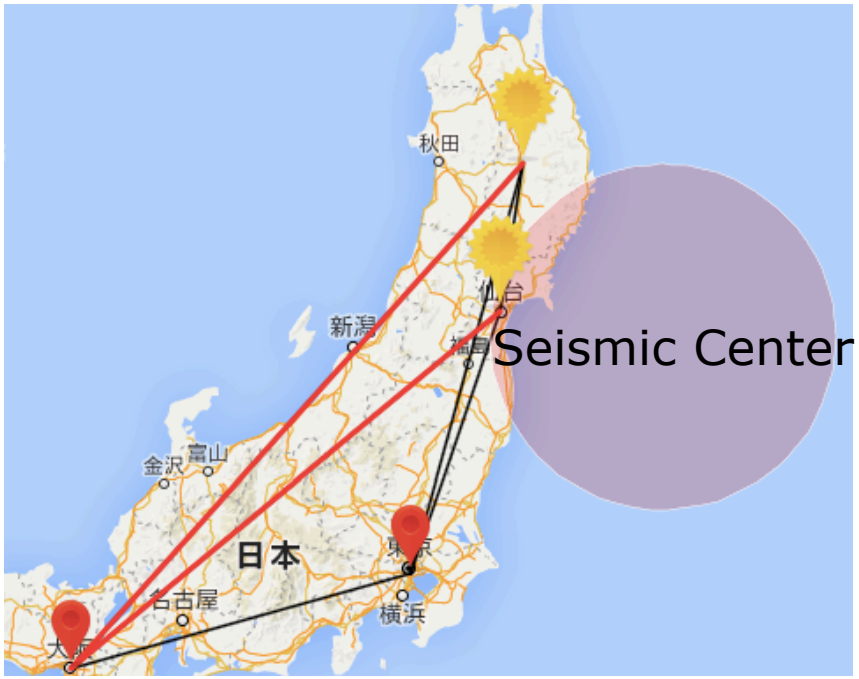
- Integrate Network Failure Detection System into FLARE Central



Routing Control based on Information of Social Networking Service



Before the earthquake



After the earthquake

- Automatic route control with our system

Contributions of this work

- Design and Prototype of SNS-based Network Failure Detection System
  - Detect telephony failures with a high degree of accuracy
  - Prioritize locations using three indicators for the efficient area restoration
- Integration on SNS-based Failure Detection into Network Control
  - Perform the network control automatically using the collective intelligence of social networking service

References

[1] FLARE, “http://www.pilab.jp/ipop2013/exhibition/iPOP2013_uTokyo_panel.pdf”