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The Snow infectious disease forecast service

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Overview

- Motivation
- Background (geographic area, dataset)
- Mathematical model
- Forecast service
- Discussion

Motivation

- Globalization (travel, trade)
- Increased infectious diseases threats
- Considerable burden to healthcare

Motivation (2)

- Improve public health preparedness
- Increase community awareness
- Support decision making

Introduction

- Infectious disease forecast service in north Norway
- Inspired by weather forecasts

Geographical area

- 44 municipalities in Troms and Finnmark counties
- Sparsely populated area
- Population size range from <1000 to 69,000
- Population density 0.3 to 63.9 per km^2

Disease data

- Lab test results as a proxy for disease incidence
- Microbiology laboratory, University Hospital of North Norway (UNN)
- Weekly aggregated (from Jan 2008-to date)

Mathematical model[1]

- Multivariate time series model
- Forecast spatiotemporal spread of infectious diseases
- All the lab data available prior to the prediction
- One week a head prediction

Geilhufe M, Held L, Skrøvseth SO, Simonsen GS, Godtliebsen F. Power law approximations of movement network data for modeling infectious disease spread. Biometrical journal 2013 (accepted)

Travel network

- Define the disease spread between municipalities
- Power law approximation
- TM1: travel count between two municipalities i and j

$$air(a_{i,j}) + road(r_{i,j}) + sea(s_{i,j})$$

- TM2: adjacency between municipalities

  + neighbors of higher order (i.e. x municipalities in between)

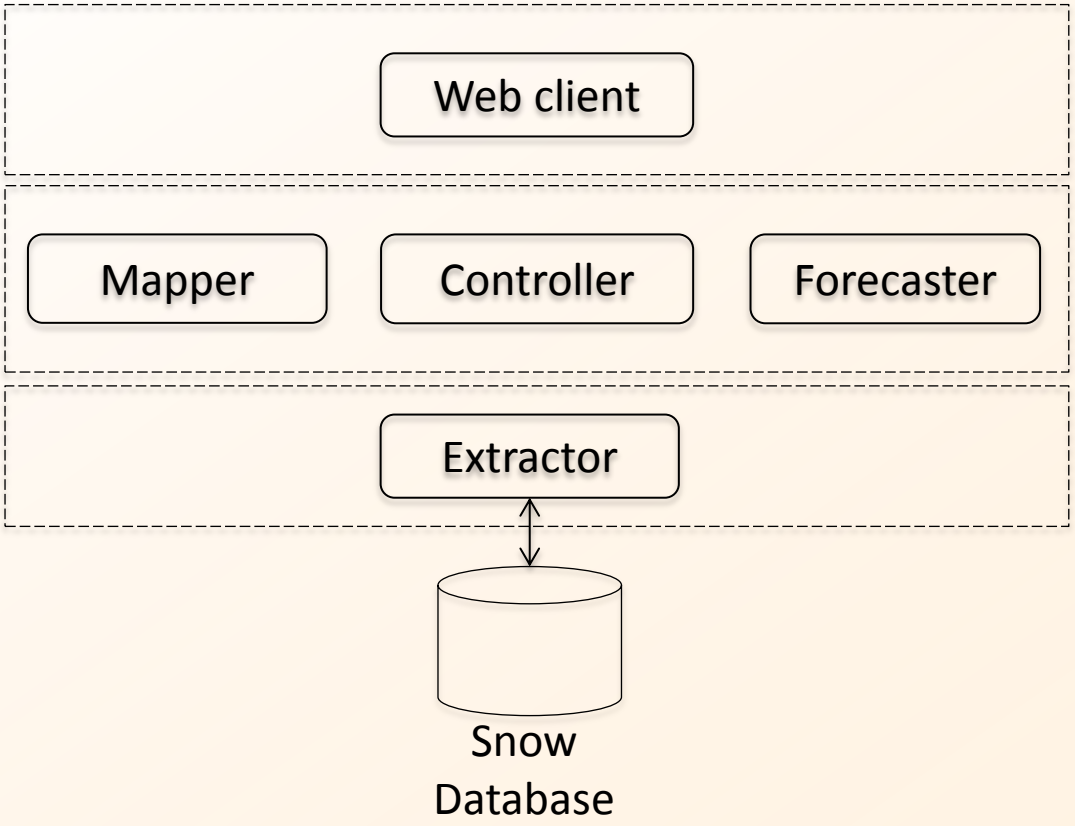
Other considerations

- Population:
  - Size of population in municipality i is used as an offset value
  - Account in TM1, as more people travel from small to large municipalities
- Immigration:
  - Air and road traffic from outside (both Norway and abroad) to municipality i

Other considerations (2)

- Proportion of positive tests:
  - ➢ Reporting and testing property varies with time
  - ➢ More lab tests are requested at the beginning of a disease season and winter

Forecast service - Architecture



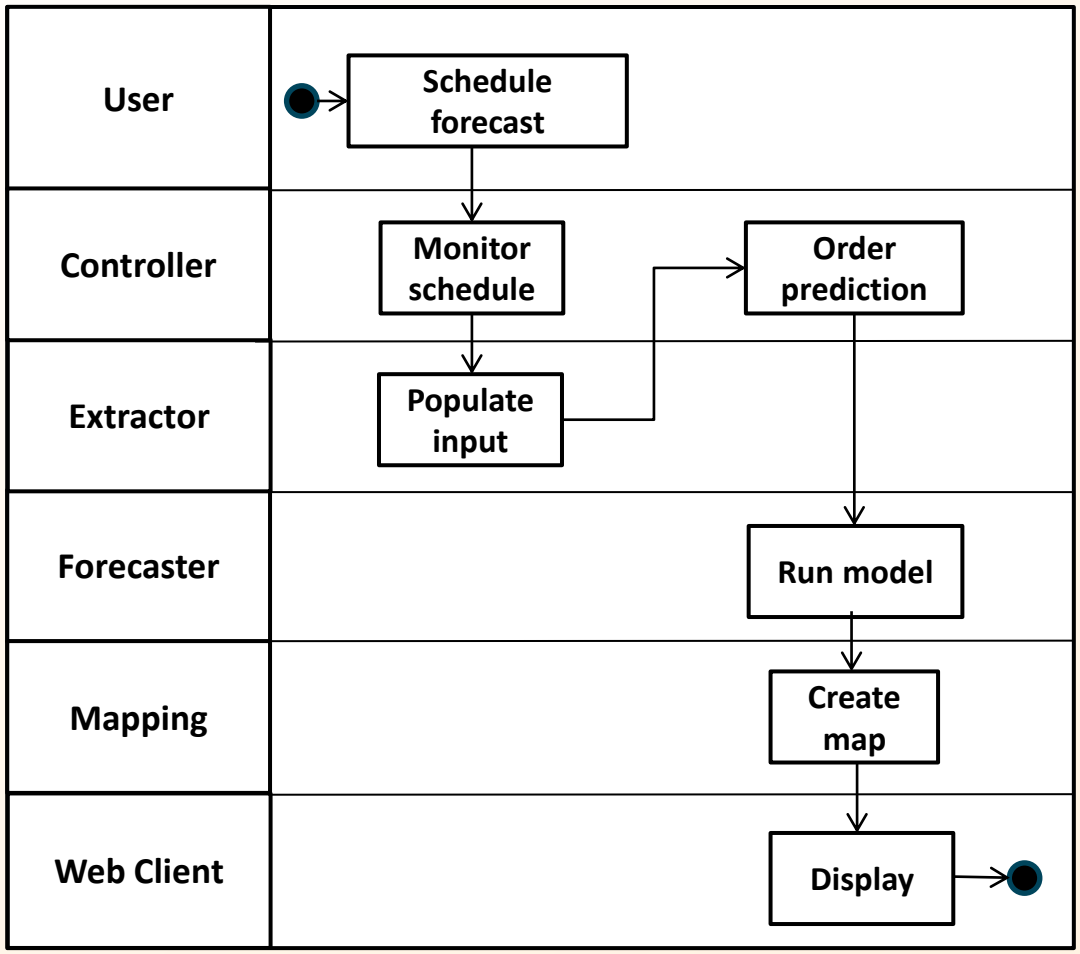
Forecast service

- Developed using Java to ensure platform-independence
- Currently run on Linux
- The Snow database is MySQL
- The data is stored in XML format

Forecast service (2)

- Forecast the spatiotemporal spread of infectious diseases
- Results are visualized on map and table
- Also stored into database

Forecast flowchart



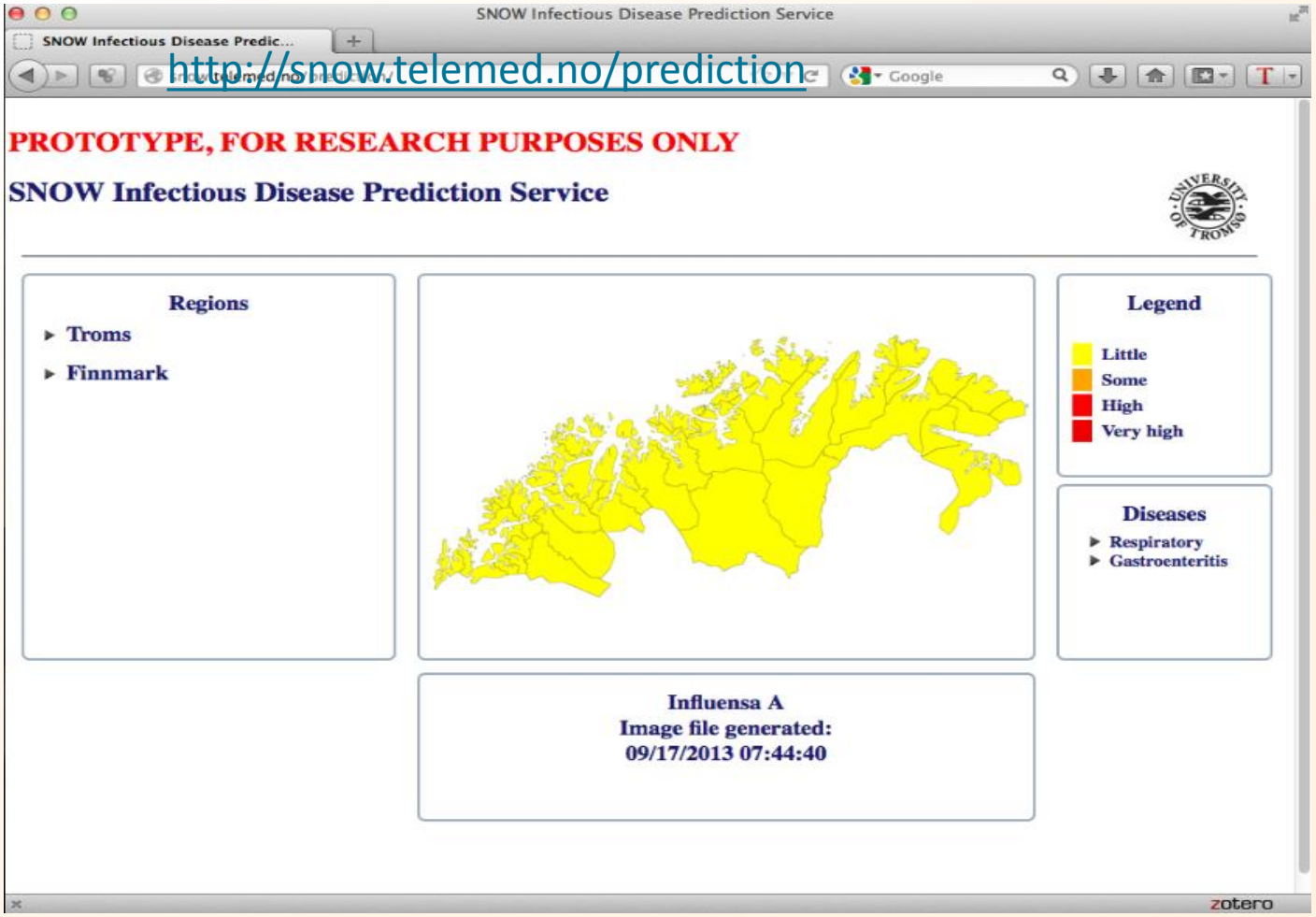
Scheduling

- One time and periodic schedule
- Specify which diseases to forecast
- Mathematical model to be used
- Time for forecast (CRON expression)

Extraction

- The extraction component extract XML file from the Snow database
- Update the model inputs with the available new information

Web Client


SNOW Infectious Disease Prediction Service
SNOW Infectious Disease Predic...
http://snow.telemed.no/prediction
Google
PROTOTYPE, FOR RESEARCH PURPOSES ONLY
SNOW Infectious Disease Prediction Service
Regions
Troms
Finnmark
Legend
Little
Some
High
Very high
Diseases
Respiratory
Gastroenteritis
Influensa A
Image file generated:
09/17/2013 07:44:40
zotero

Discussion

- The system currently run for five diseases (Influenza A, RS-Virus, Rhinovirus, Mycoplasma, Norovirus)
- Targets users include parents, schools, healthcare providers, laboratory technicians, pharmacies, and public health officials
- Provides time to enable mitigation
- Facilitates proactive, cost effective and quality healthcare
- Creates community awareness

Infectious disease forecasts

- Haiti Epidemic Advisory System (HEAS) (1)
  - ✓ Created following the 2010's massive earthquake in Haiti.
  - ✓ The world's first infectious disease forecasting centre.
  - ✓ It integrates forecasting and real-time warning system.
  - ✓ No publication about the system design is found

(1) http://www.scidev.net/en/opinions/social-networks-can-warn-of-disease-after-disasters.html

Infectious disease forecasts (2)

- Black Canyon infectious disease forecast station [1]
- US national infectious disease forecast center
- Began forecast in 2012
- Ascel Bio is a private disease forecasting company founded in 2010

[1] Wilson JM, Koehler B, Sramek K, Henwood T. The Black Canyon Forecast Station: Experiences And Lessons Learned. Online J Public Health Inform 2013;5.

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Thank you!

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