Modelling hospital visitors for the city of Leuven as input for a FEATHERS-MATSim simulation

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May 29, 2015

Introduction

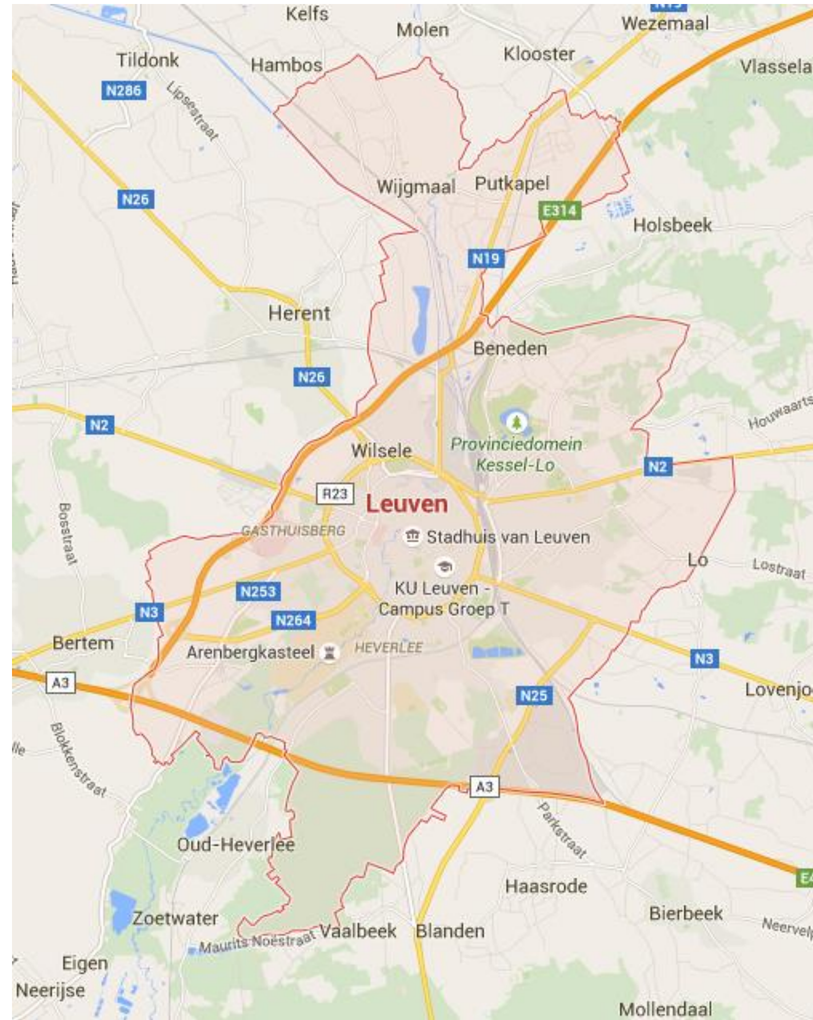
- Smart-PT
  - Research partially funded by the IWT 135026 Smart-PT : Smart Adaptive Public Transport (ERA-NET Transport III Flagship Call 2013 "Future Travelling").
  - Local effect of travel demand
  - Thin flows
  - Demand responsive
    - Public transport
    - Other collective transportation services

Introduction

- Activity-Based models
- Micro-simulations
- City
- Large attraction sites

Introduction

- Leuven
  - University Hospitals Leuven
  - College and university students
  - Company sites



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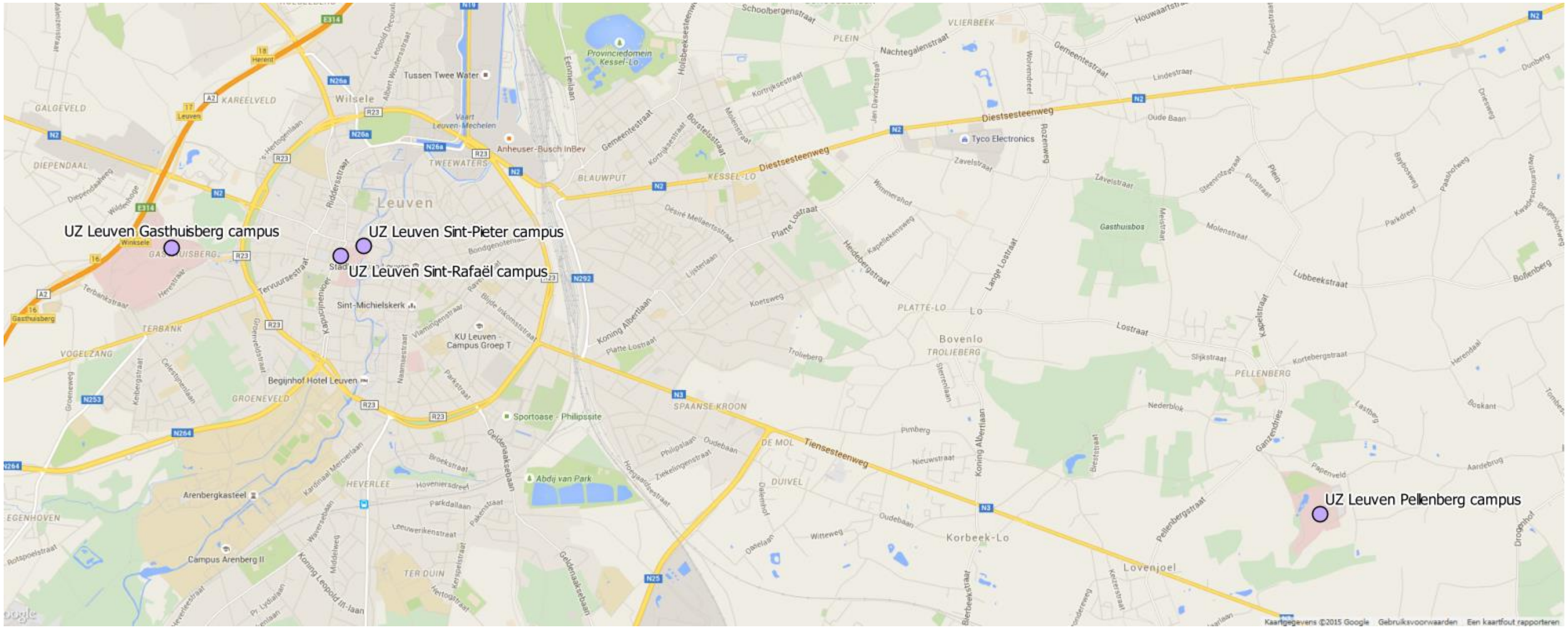
Introduction

- Leuven
  - **University Hospitals Leuven**
  - College and university students
  - Company sites



FEATHERS-MATSim Simulation

- FEATHERS
  - Forecasting Evolutionary Activity-Travel of Households and their Environmental RepercussionS
  - Activity-based schedule generator
  - TAZ (traffic analysis zone) based predictor
- MATSim
  - Multi-Agent Transport Simulation
  - Coordinate based micro-simulator

Hospital Attraction Site

- Patients
  - Critical: intensive care, palliative care, small children
  - Non-critical: all others + consultations
- Visitors
  - Critical patients
  - Non-critical patients
- Personnel

Hospital Attraction Site

- Patients: location sampling
  - Uniformly sampled
  - Independent of the individual’s characteristics

$$a_{h,p} \propto \; c_{h,p} \cdot (S_h)^{\alpha} \cdot \left(d_{p,h}\right)^{-\beta}$$

$a_{h,p}$ is the attraction of hospital h to a patient p

$c_{h,p}$ is the weight coefficient for the hospital to attract the patient

S_h is the hospital size (number of beds)

α is the coefficient that specifies the effect of the size on the attraction

$d_{p,h}$ is the distance [km] between the patient's home TAZ and the hospital TAZ

β is a coefficient modulating the contribution of the distance

Hospital Attraction Site

- Patients: location sampling

$$a_{h,p} \propto c_{h,p} \cdot (S_h)^{\alpha} \cdot \left(d_{p,h}\right)^{-\beta}$$

$$p(h,i) = \frac{a_{h,i}}{\sum_{h \in H} a_{h,i}}$$

Hospital Attraction Site

- Patients: schedule adaptation
  - People clear their schedule if they are hospitalized
  - Arrivals of critical patients are distributed uniformly over the day
  - Arrivals/departures of non-critical patients and departures of critical patients are uniformly distributed over the patient intake periods

Hospital Attraction Site

- Visitors: location sampling
  - Gravity model (Krings G.)
    - Square distance to correlate spatial distance to social closeness

$$f(d(a,b)) \propto \frac{k}{d^2(a,b)}$$

  - 0.99 of a person's acquaintances live at a distance less than 100 km from that person's home TAZ
  - Distance uniformly sampled

$$p(L_i) = \frac{pop(i)}{\sum_{L_i \in \mathcal{L}} pop(L_i)}$$

Hospital Attraction Site

- Visitors: schedule adaptation
  - Visitor for a non-critical patient
    - Minimally decrease utility of the given schedule
  - Visitor for a critical patient
    - Schedule will be adapted thoroughly

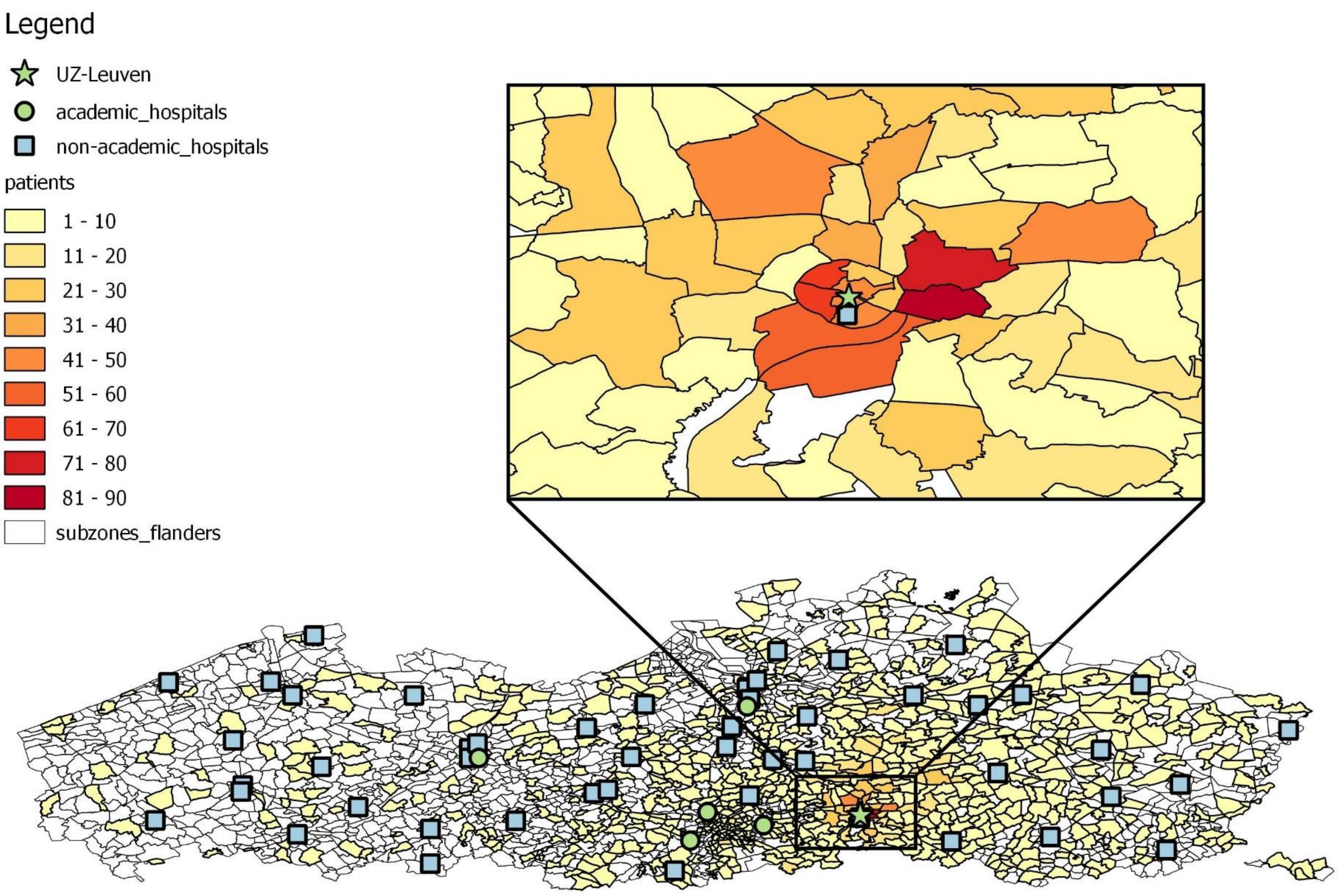
Preliminary Results

- Input data

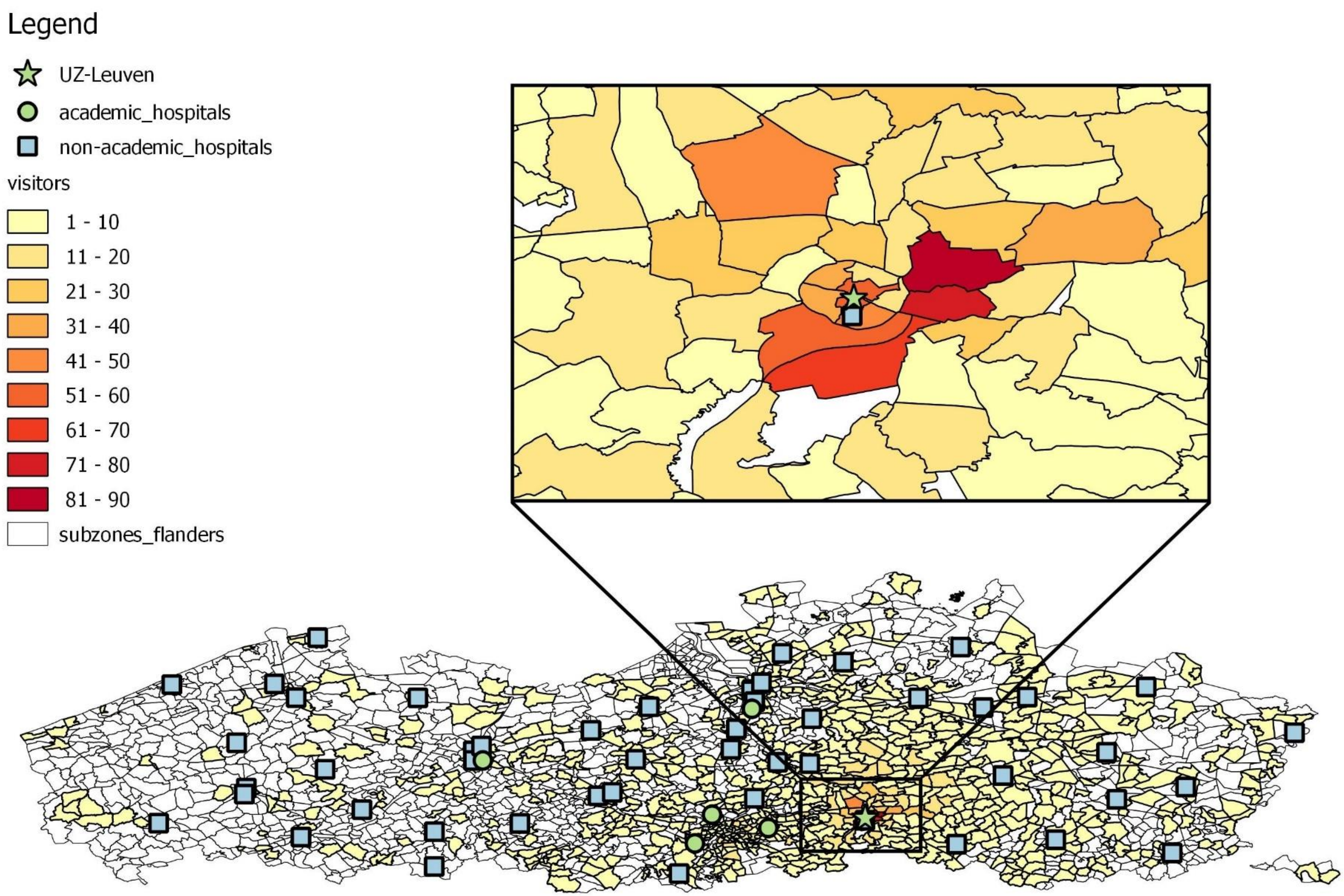
$$a_{h,p} \propto c_{h,p} \cdot (S_h)^{\alpha} \cdot (d_{p,h})^{-\beta}$$

Variable	Value
critPatientsFraction	0.03
hospitalWeightCritAcad	4
referenceHospitalPatients	3356
referenceHospitalVisitors	3213
α	1
β	2

Preliminary Results



Preliminary Results

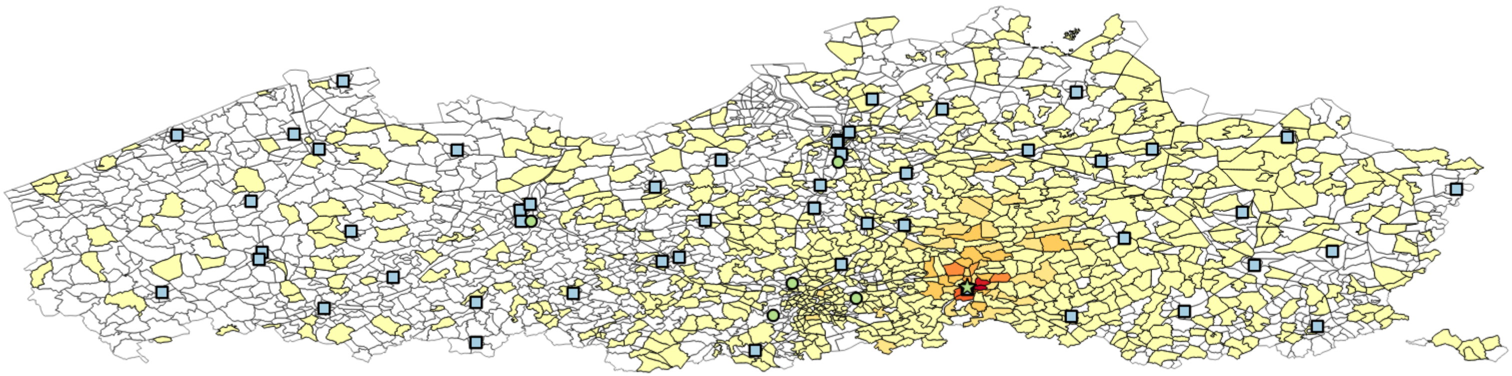


Preliminary Results

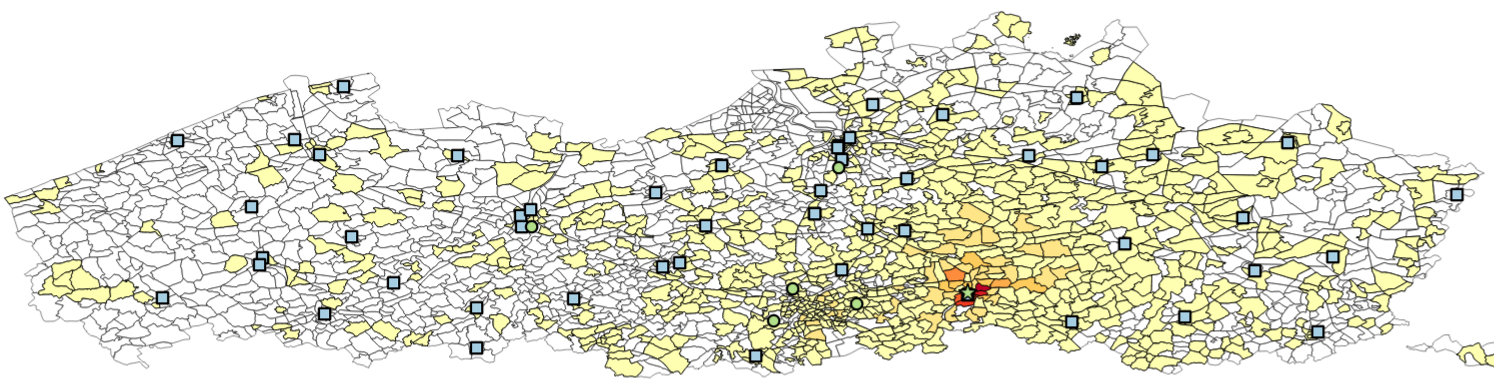
Legend

- UZ-Leuven
- academic_hospitals
- non-academic_hospitals
- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- subzones_flanders

Patients



Visitors



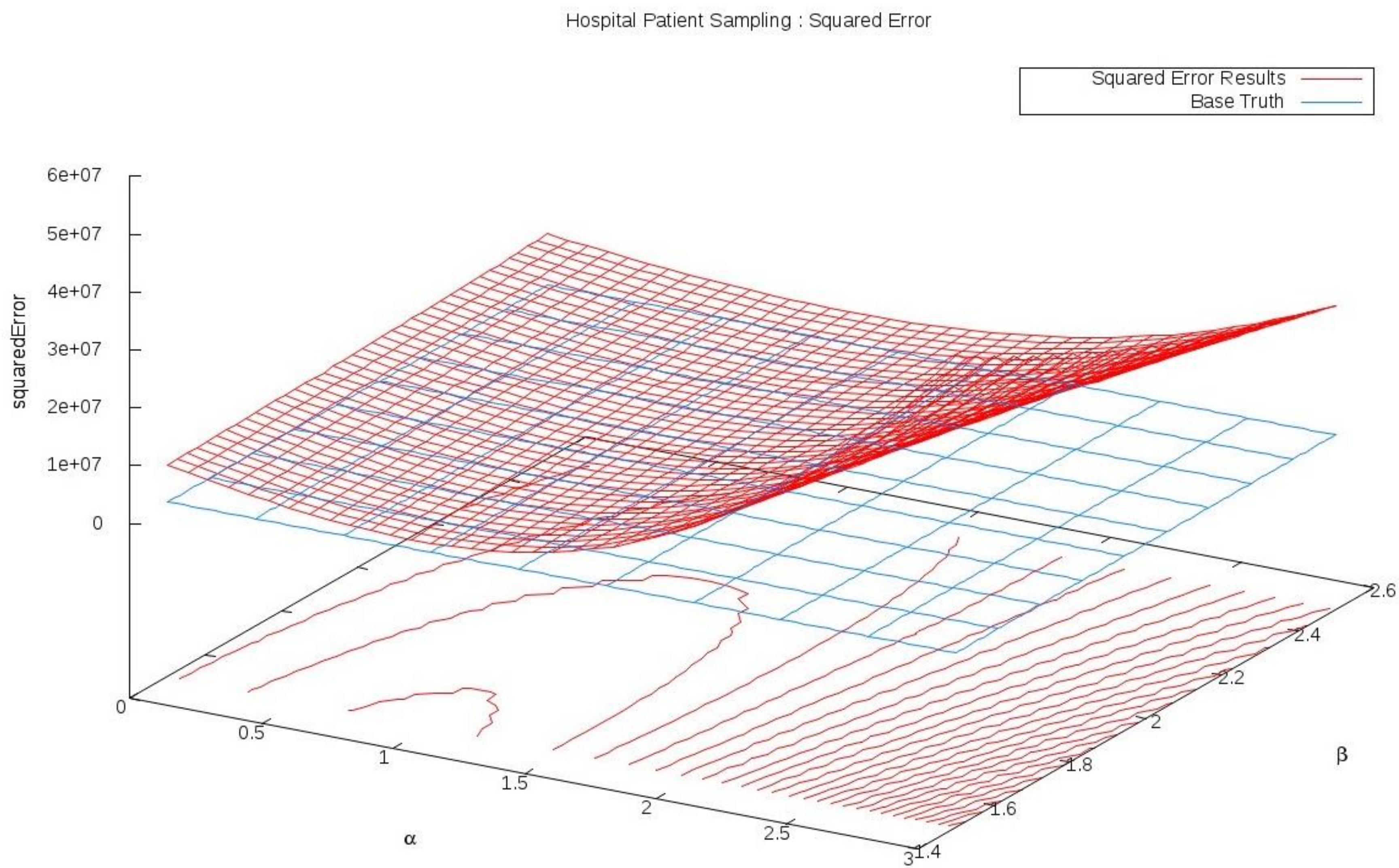
Results Validation

- The expected number of patients for each hospital should approximate the effective number of patients.

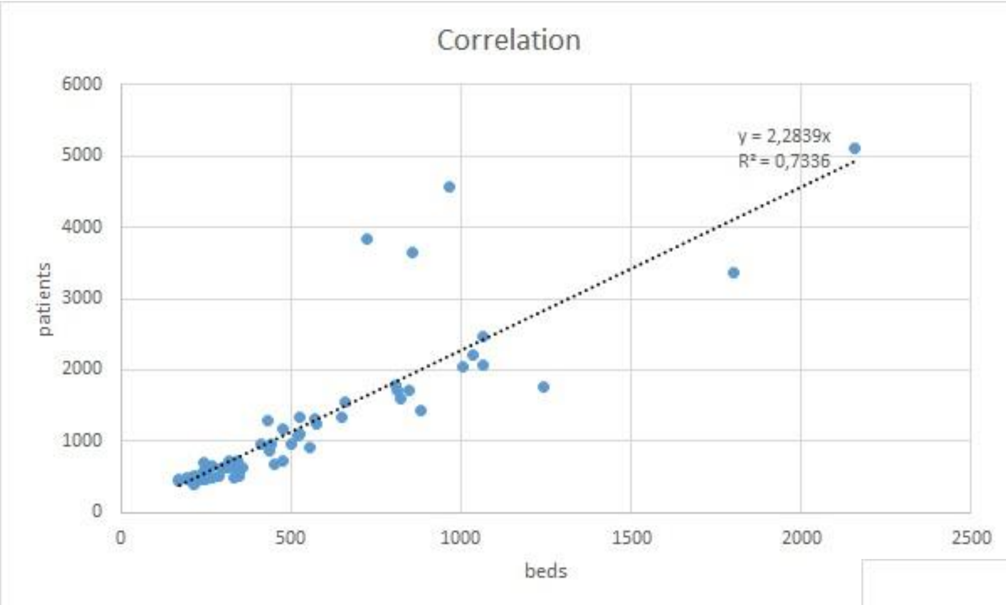
- The squared error between these two values for each hospital should be minimal.

$$(\alpha,\beta) = arg\ min_{\alpha,\beta} \sum_{h\in H} \left[\sum_{z\in Z} |N_z| \frac{(S_h)^{\alpha} \cdot (d_{z,h})^{-\beta}}{\sum_{x\in H} (S_x)^{\alpha} \cdot (d_{z,x})^{-\beta}} \cdot \frac{\sum_{x\in H} S_x \cdot \eta}{|P|} - S_h \cdot \eta \right]^2$$

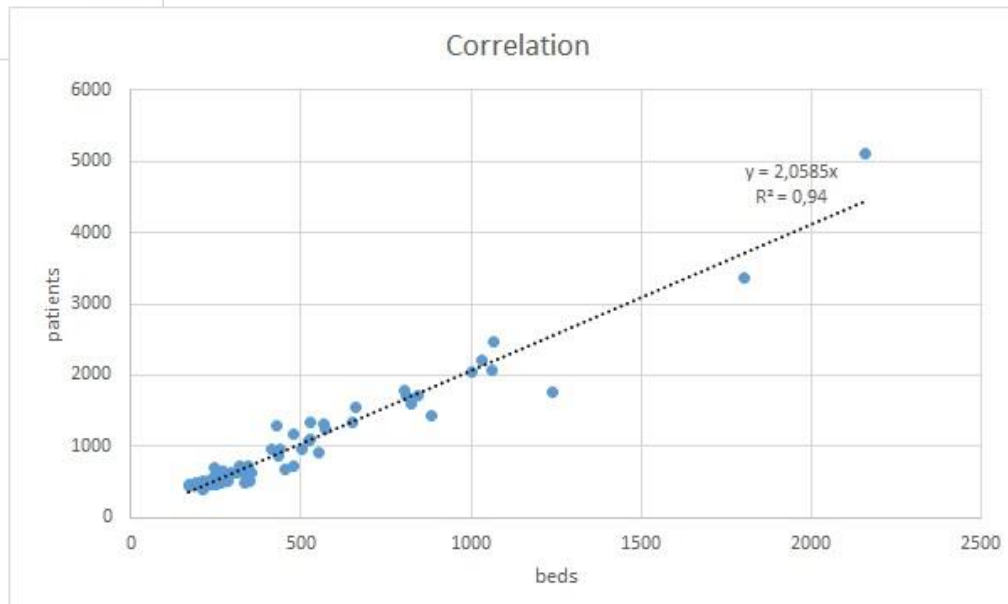
Results Validation



Results Validation



R = 0.8565



R = 0.9695

Conclusion

- FEATHERS
  - Synthetic population
  - Initial schedules
- Patients and their visitors are sampled

Future Work

- Sample hospital personnel
- Schedule adaptation

The End!

- Questions?