A Universal Model of Commuting Networks

Maxime Lenormand

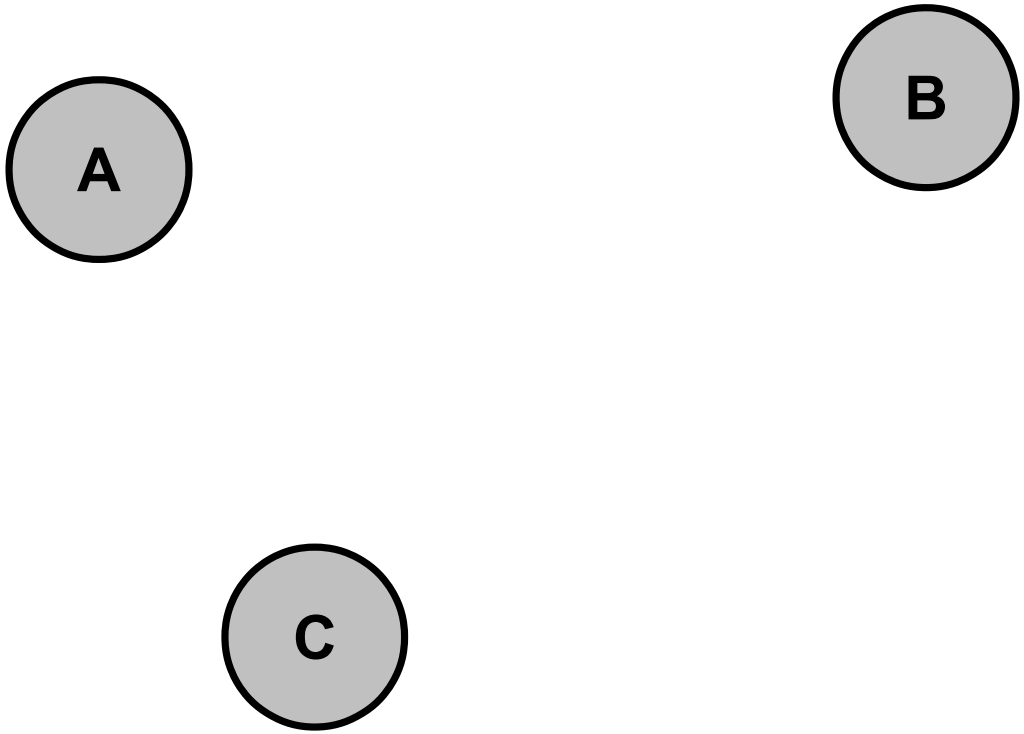
A Universal Model of Commuting Networks

Maxime Lenormand, Sylvie Huet, Floriana Gargiulo and Guillaume Deffuant

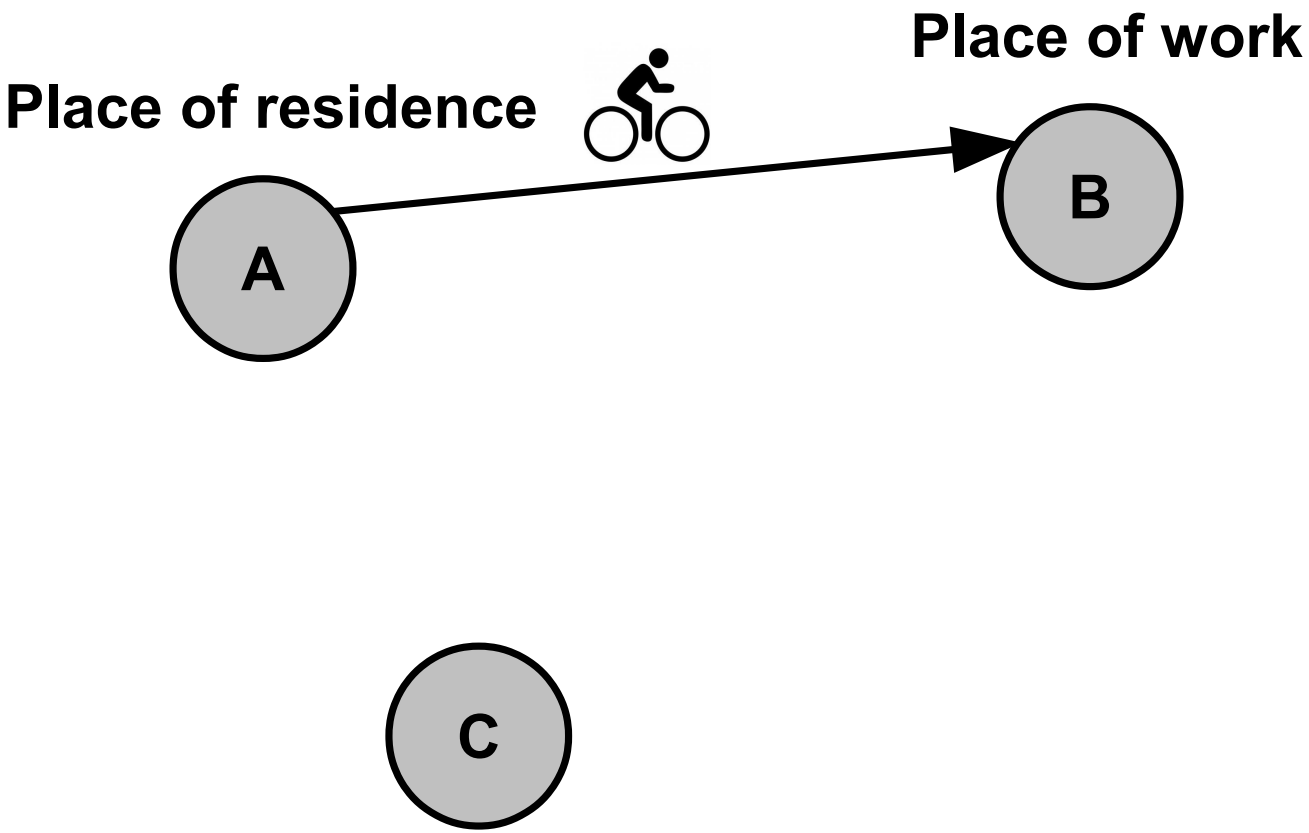
Urbannet 2013, Barcelona

18th of September, 2013

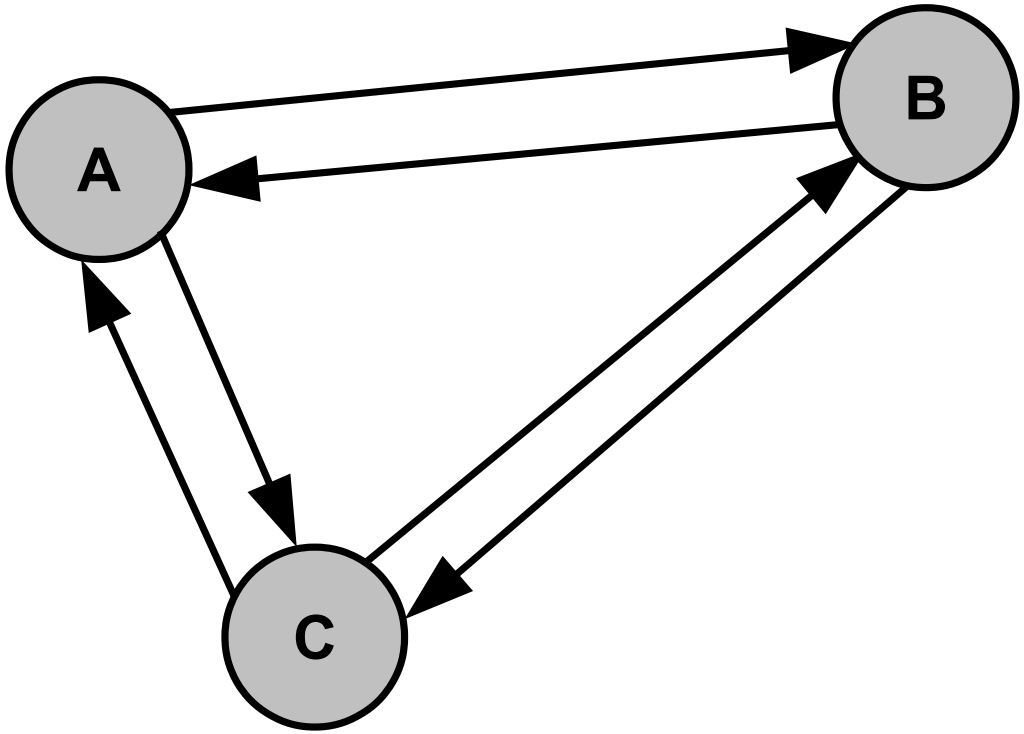
Motivation



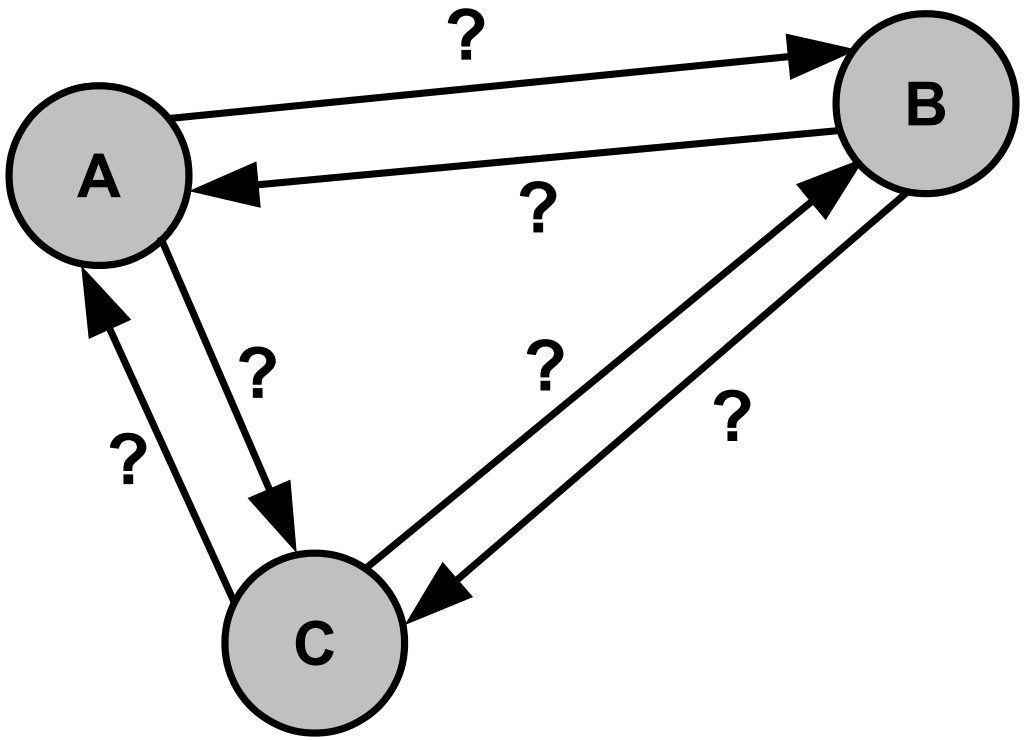
Motivation



Motivation

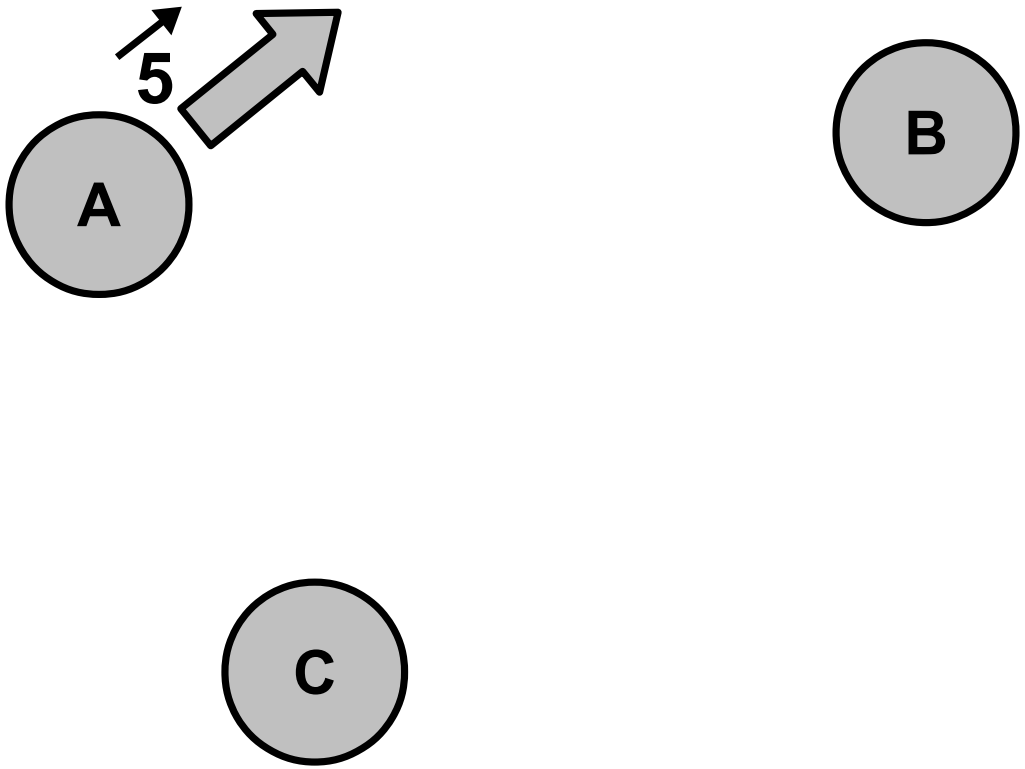


Motivation



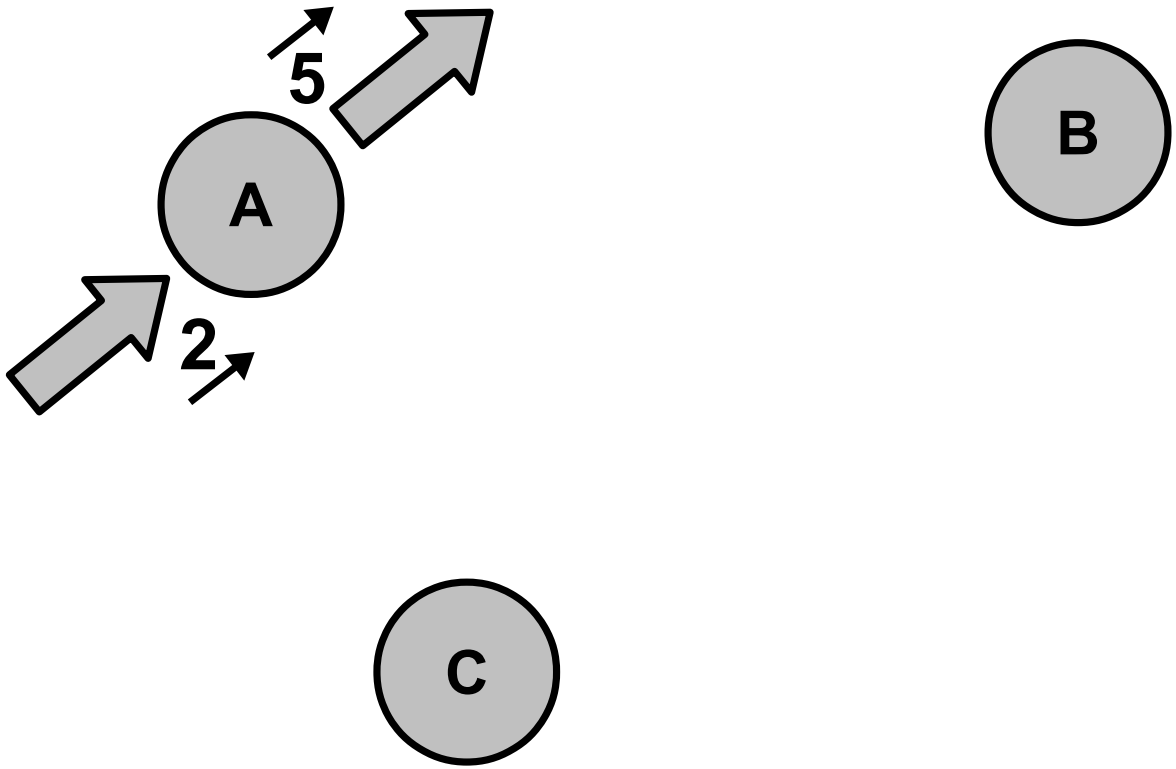
Motivation

Number of out-commuters

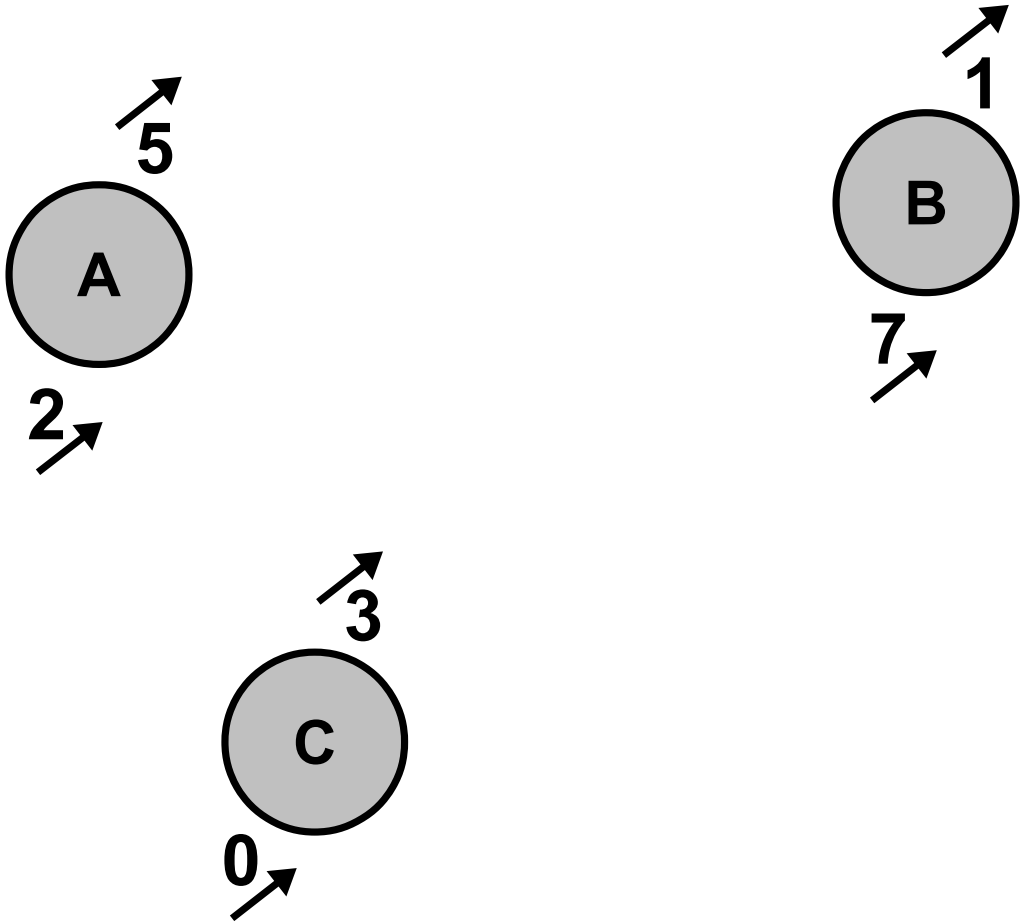


Motivation

Number of in-commuters

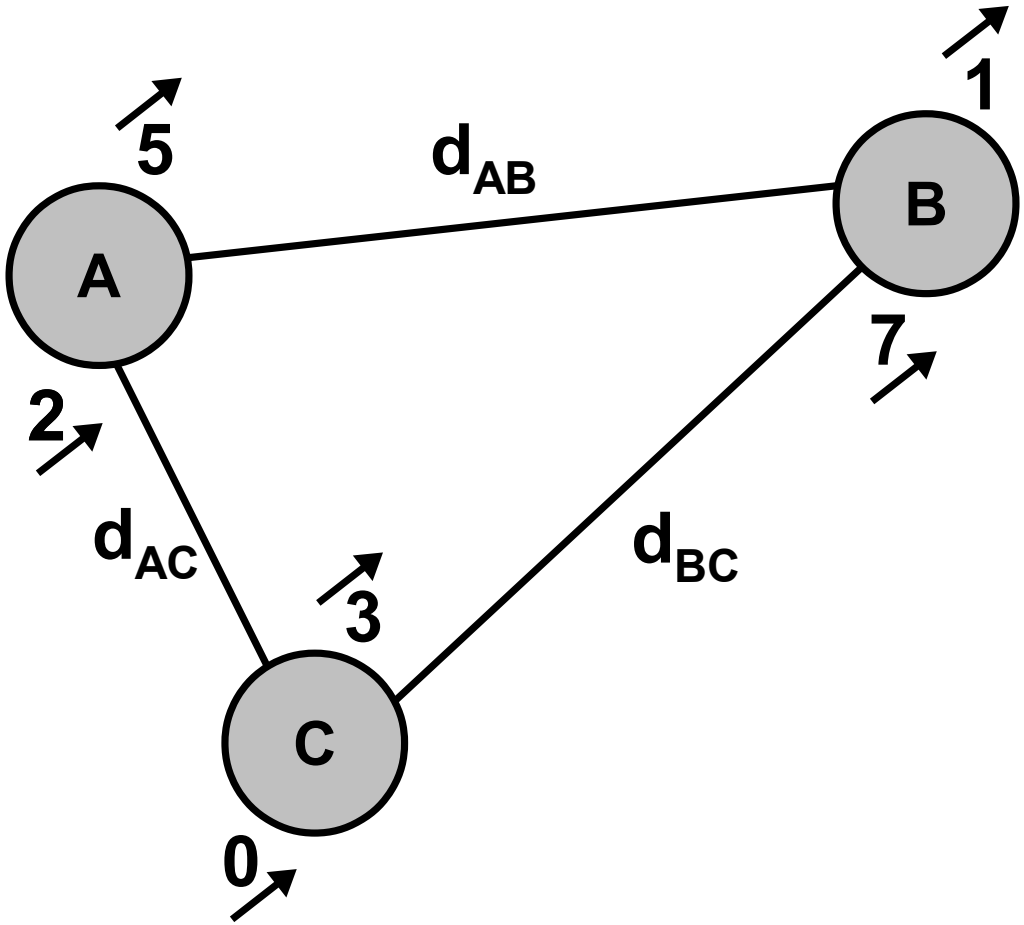


Motivation

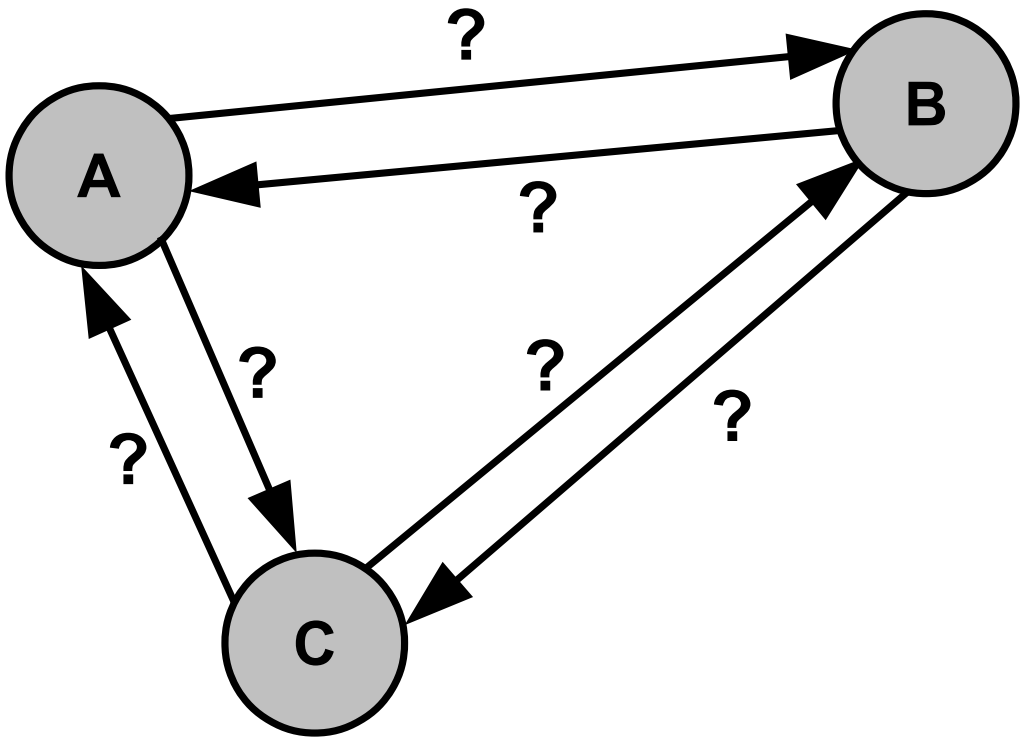


Motivation

Euclidean distances between municipalities



Motivation



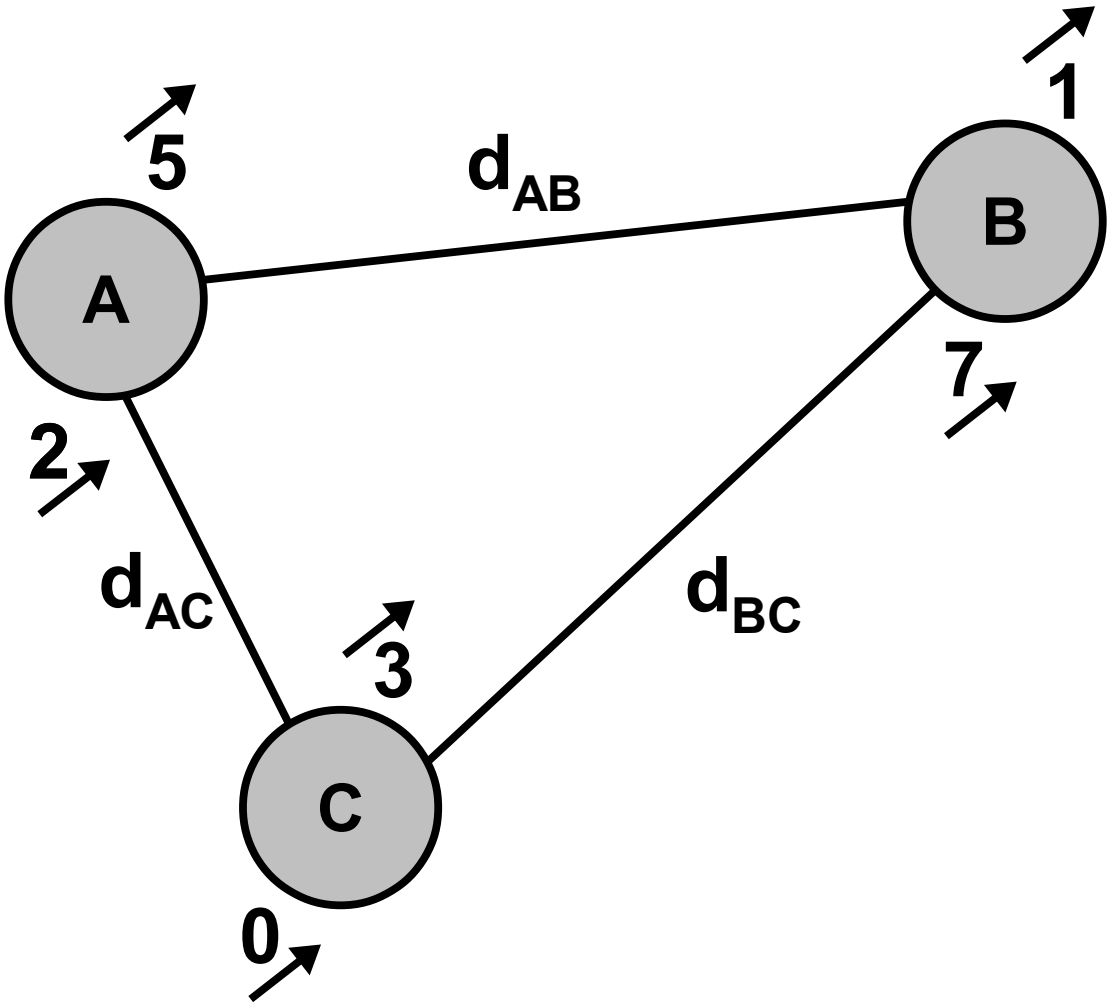
Outline

- The Model
- Calibration of β
- Results
- Comparison with the "radiation model"

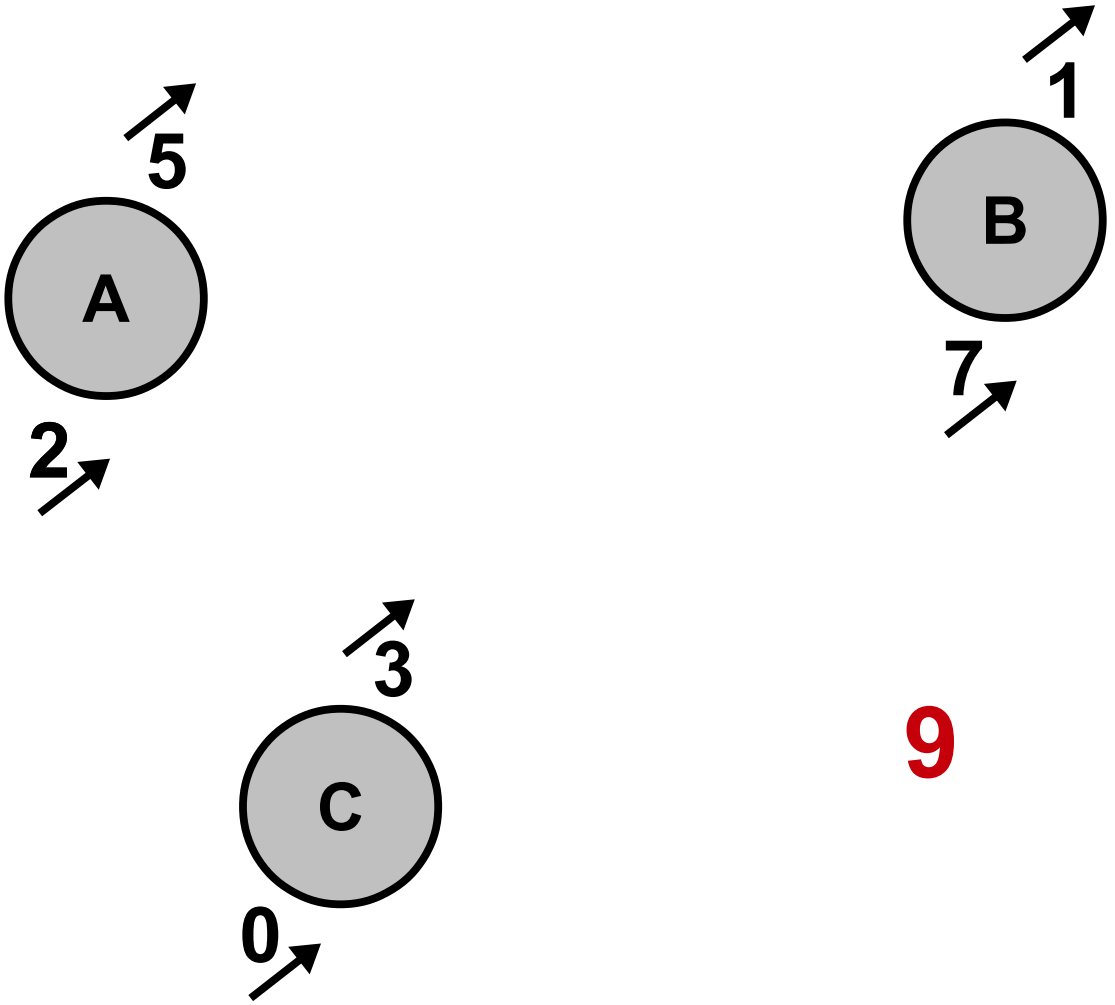
Outline

- The Model
- Calibration of β
- Results
- Comparison with the "radiation model"

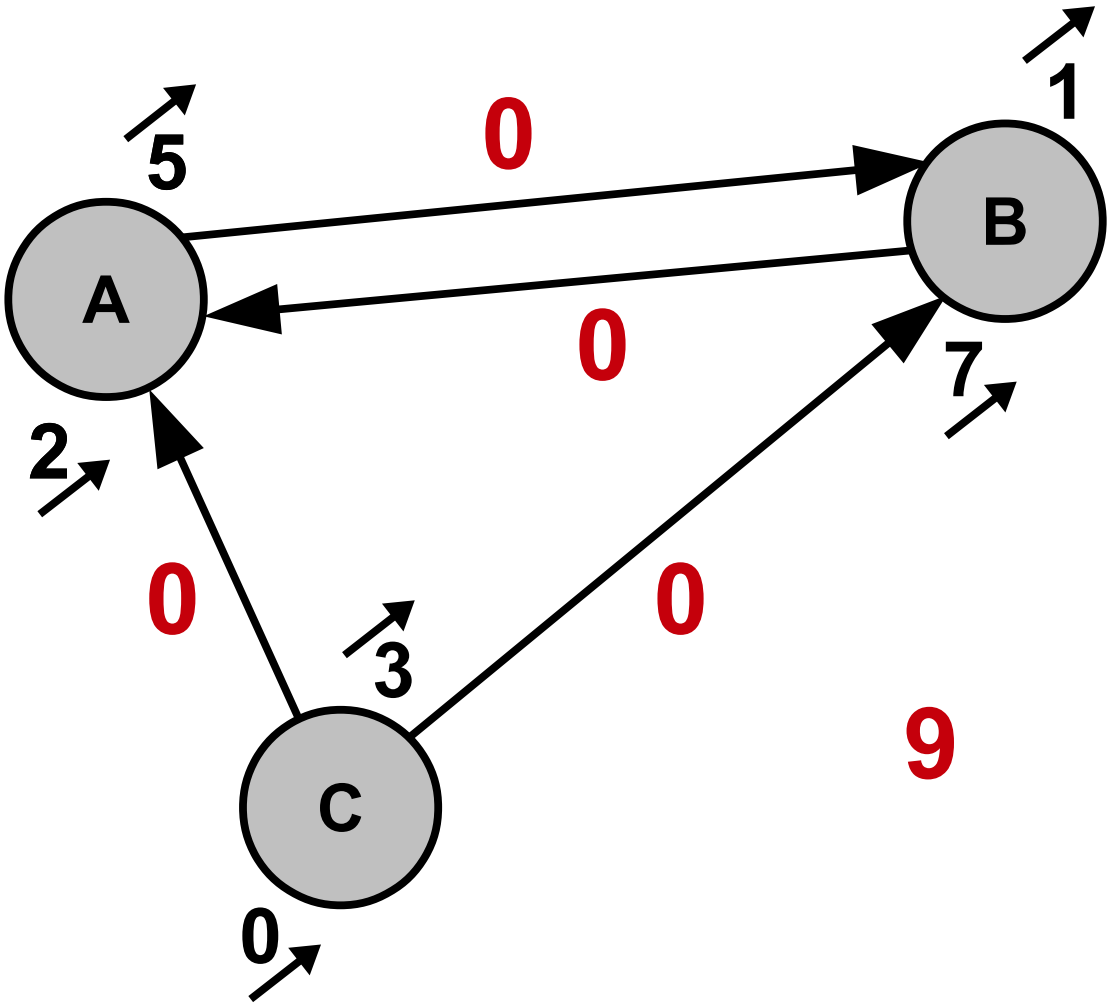
The Model



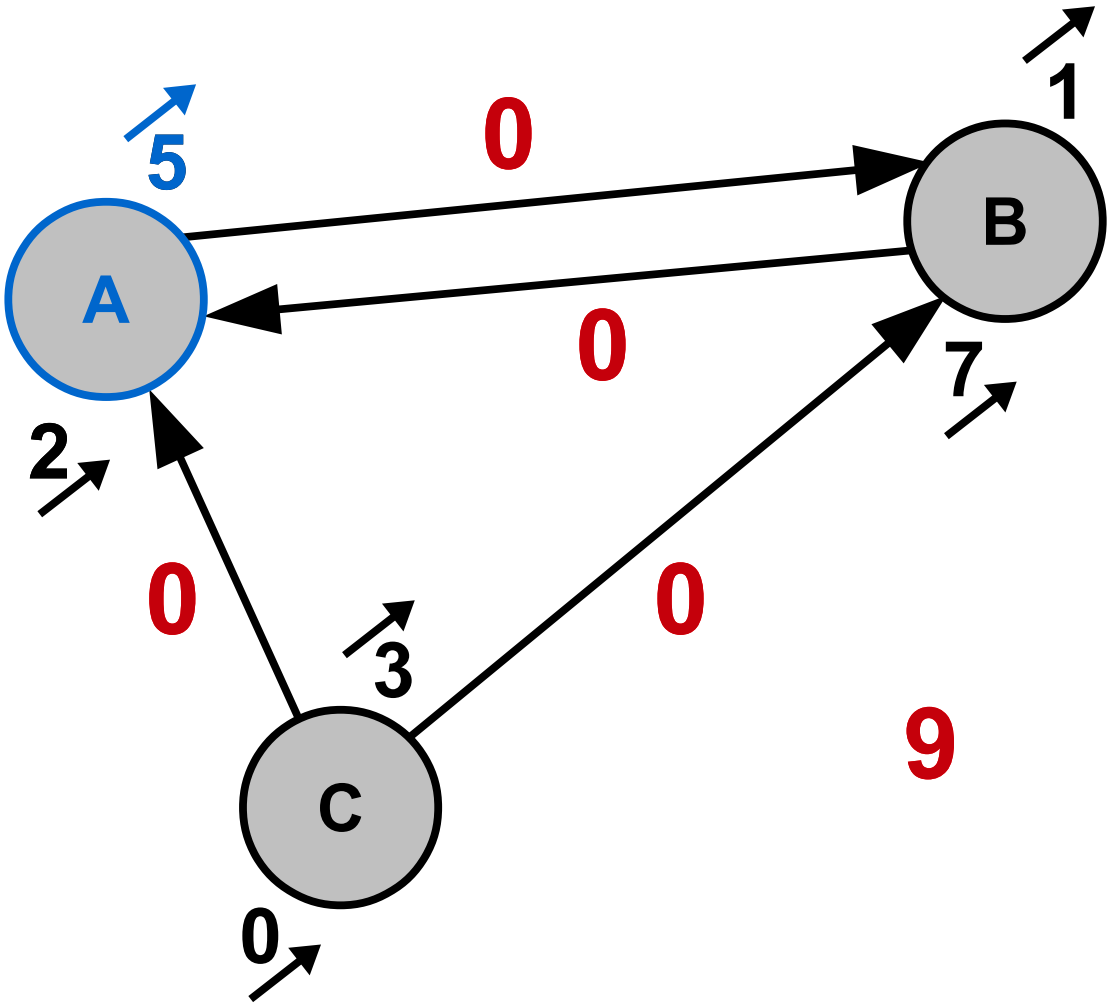
The Model



The Model



The Model



The Model

$$P_{A\to B} \sim 7 \cdot e^{-\beta d_{AB}}$$

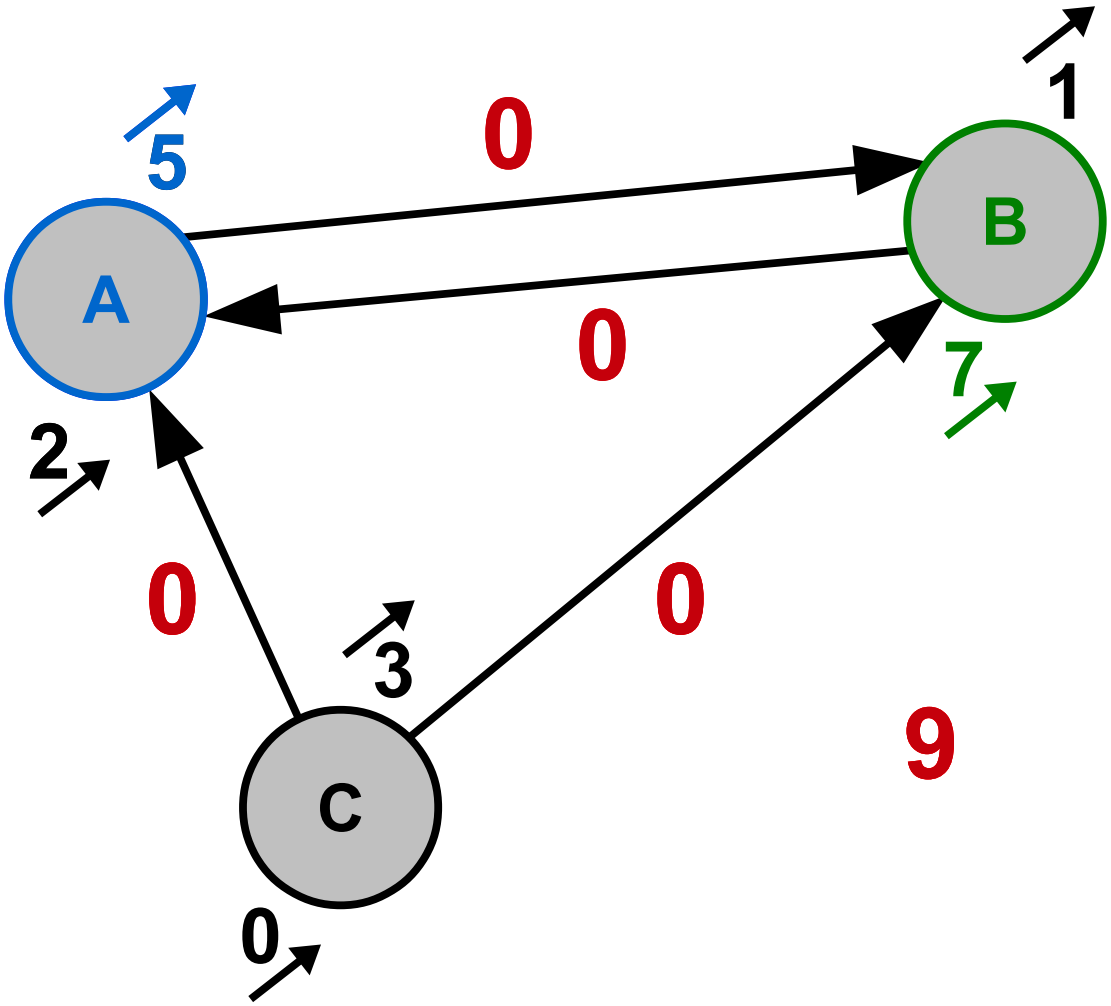
$$P_{A\to C} \sim 0 \cdot e^{-\beta d_{AC}}$$

The Model

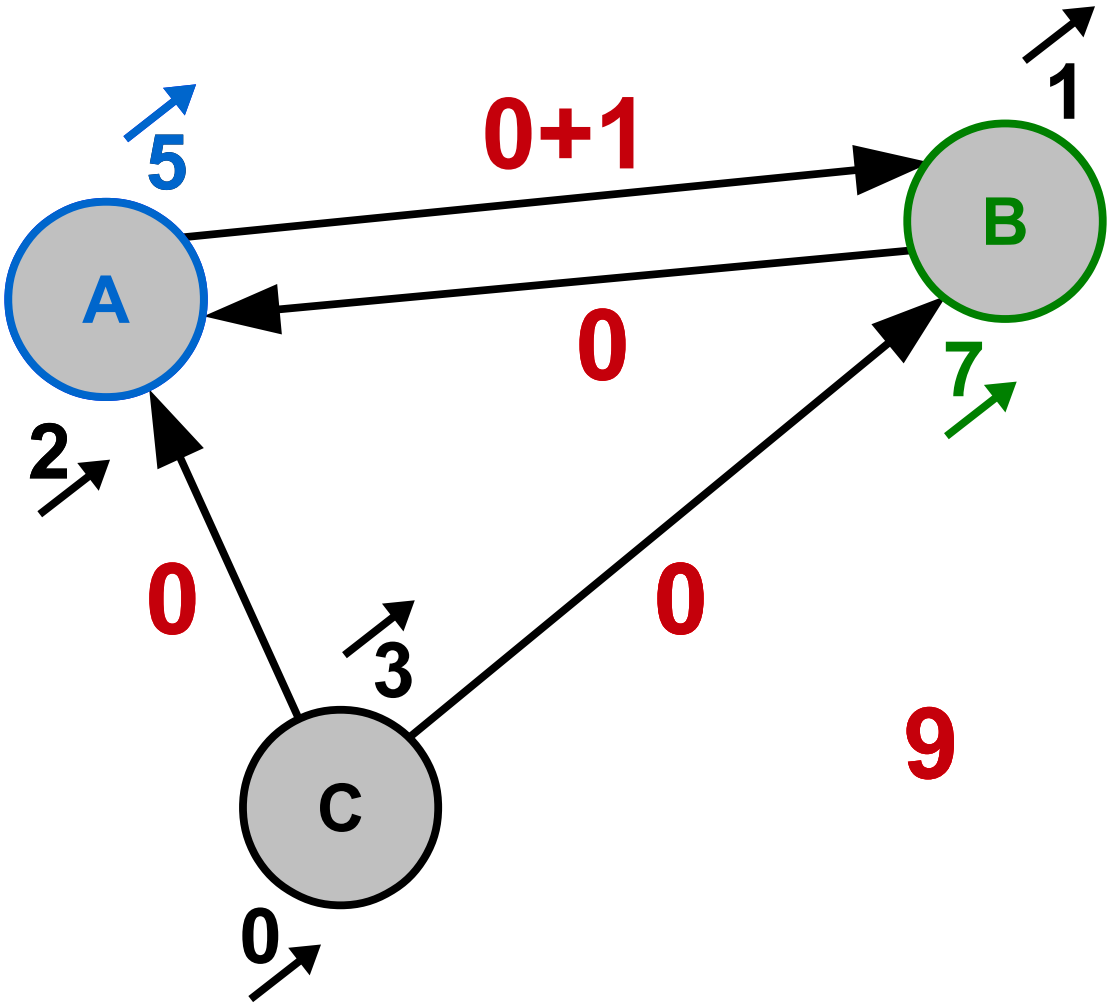
$$P_{A\to B} \sim 7 \cdot e^{-\beta d_{AB}}$$

$$P_{A\to C} \sim 0 \cdot e^{-\beta d_{AC}}$$

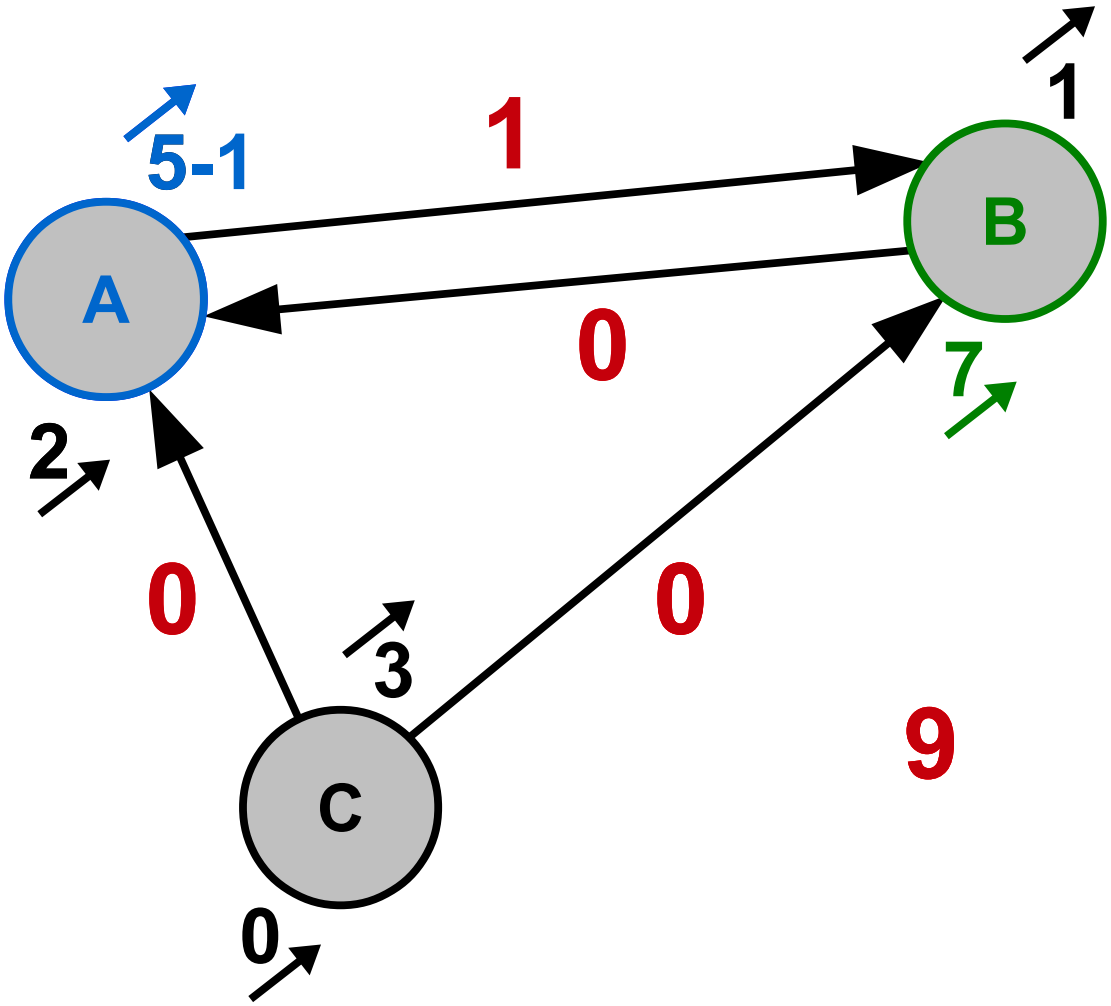
The Model



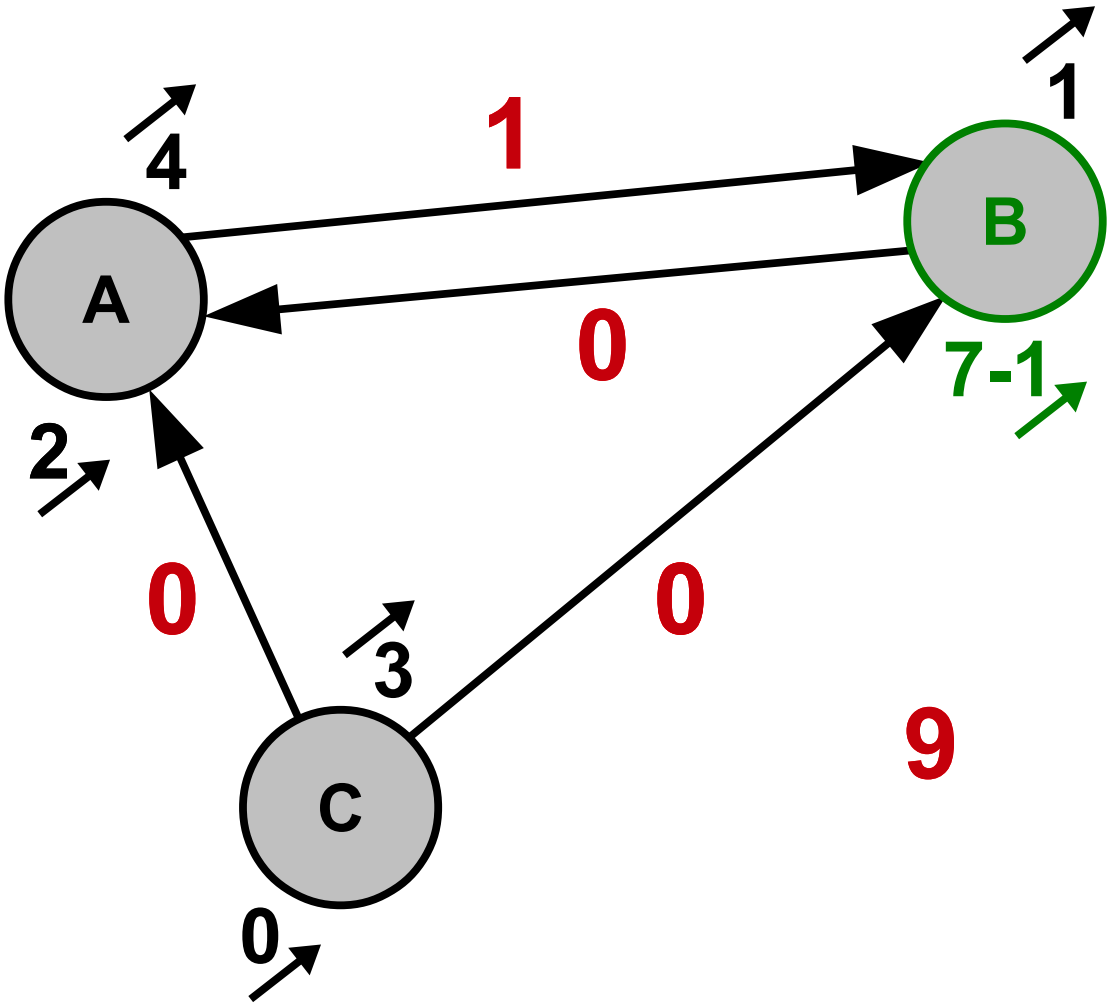
The Model



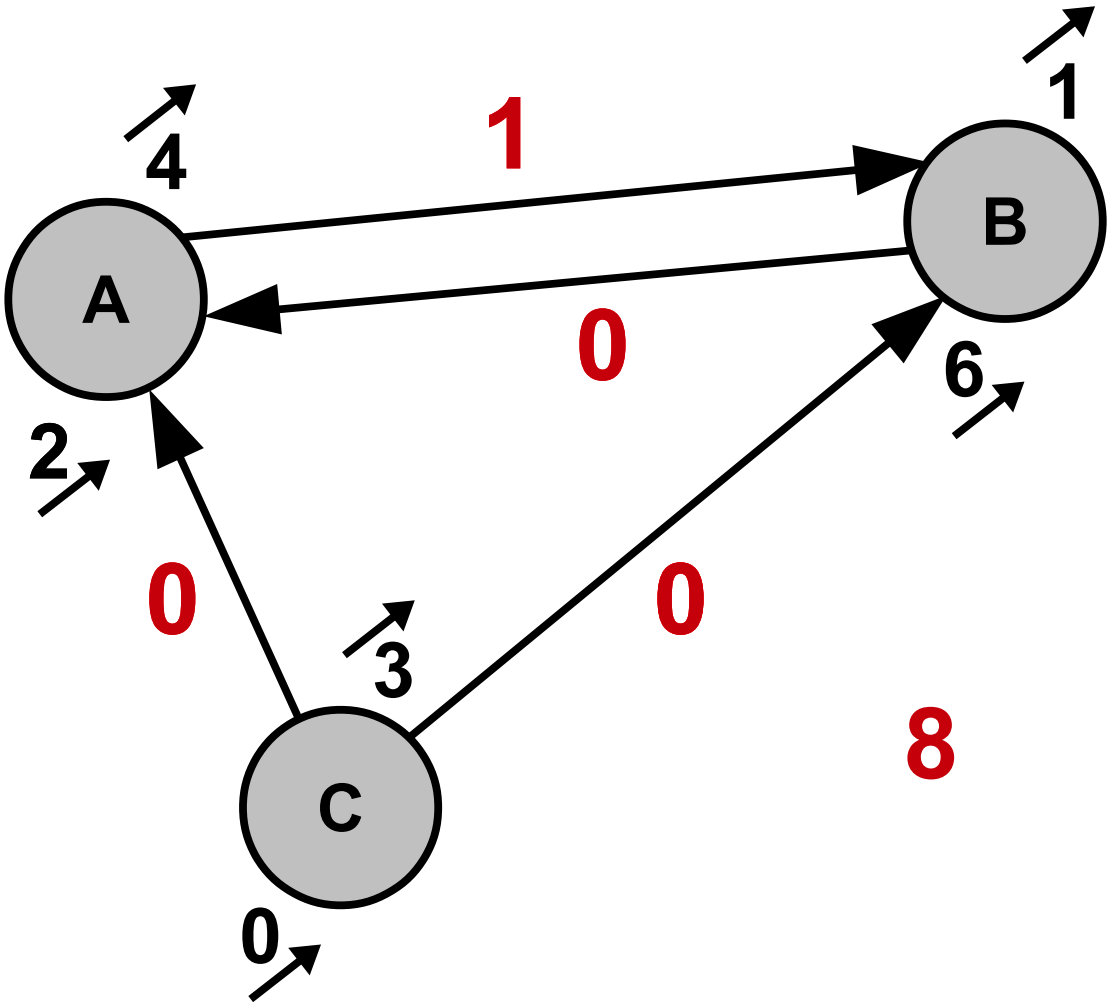
The Model



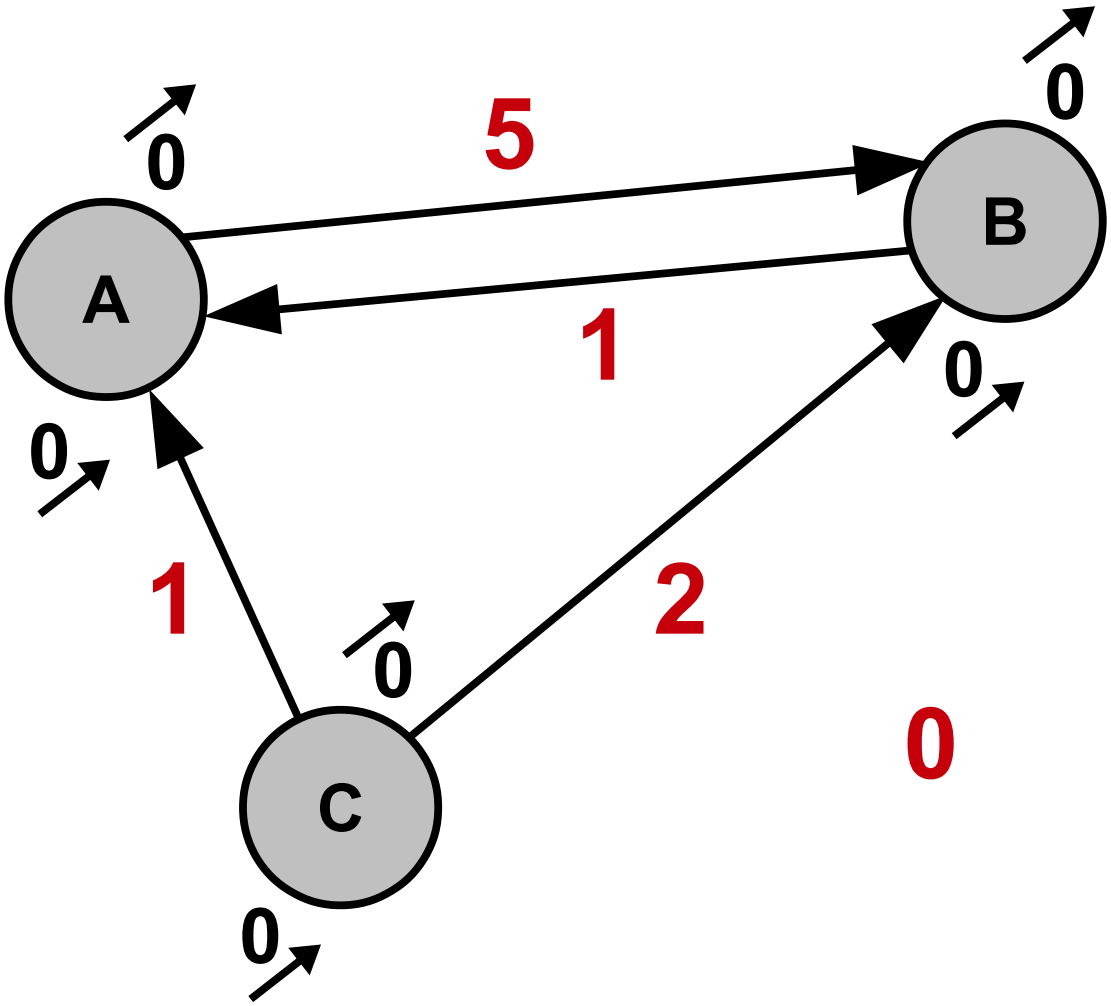
The Model



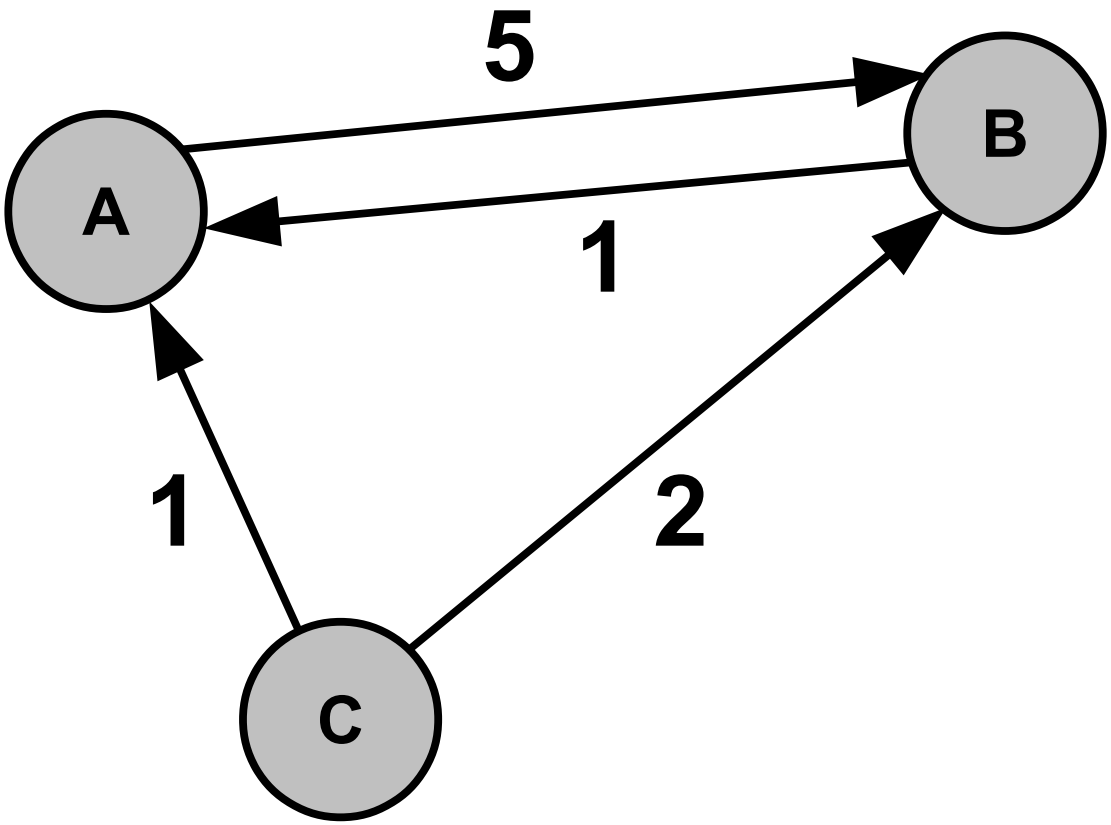
The Model



The Model



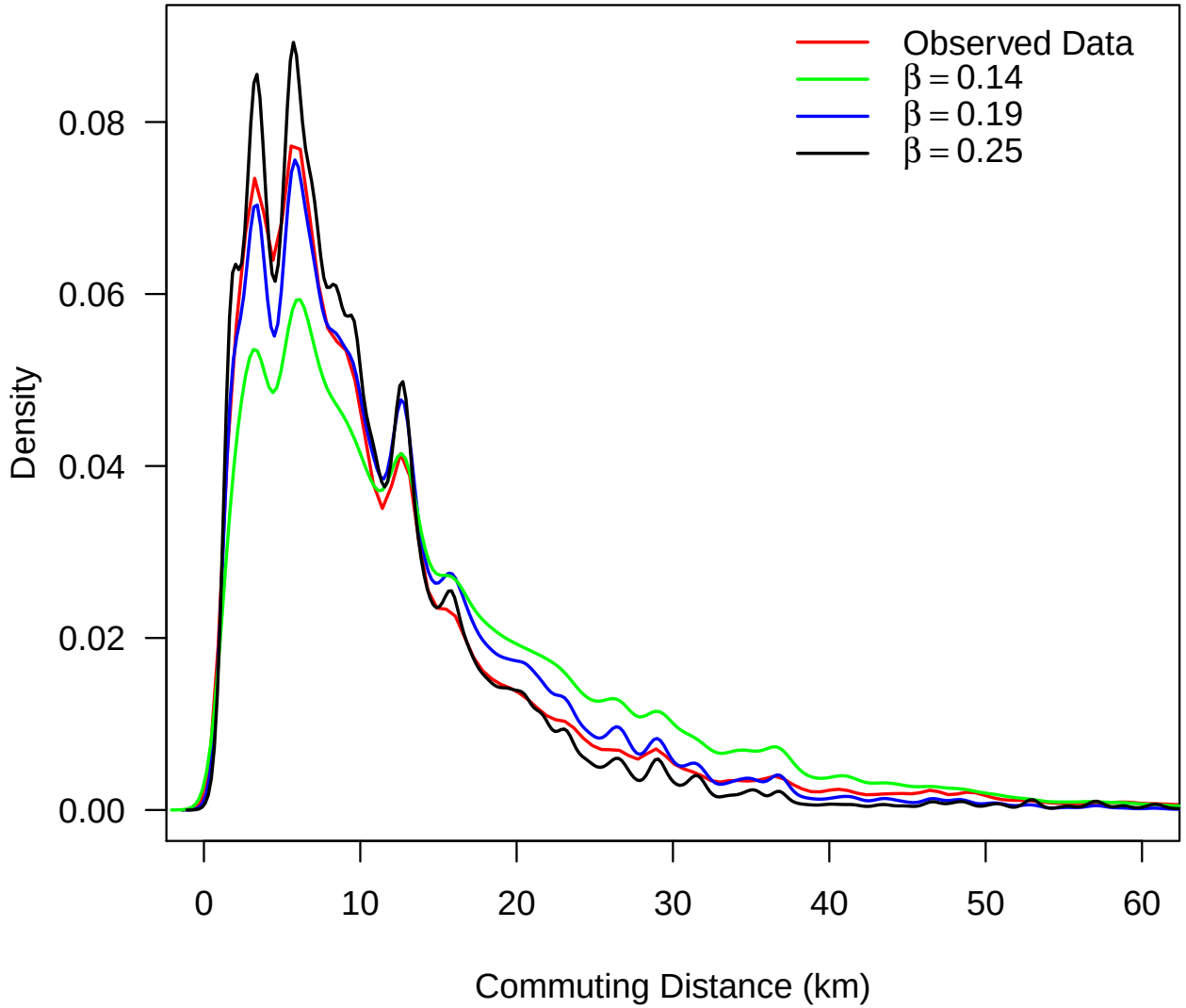
The Model



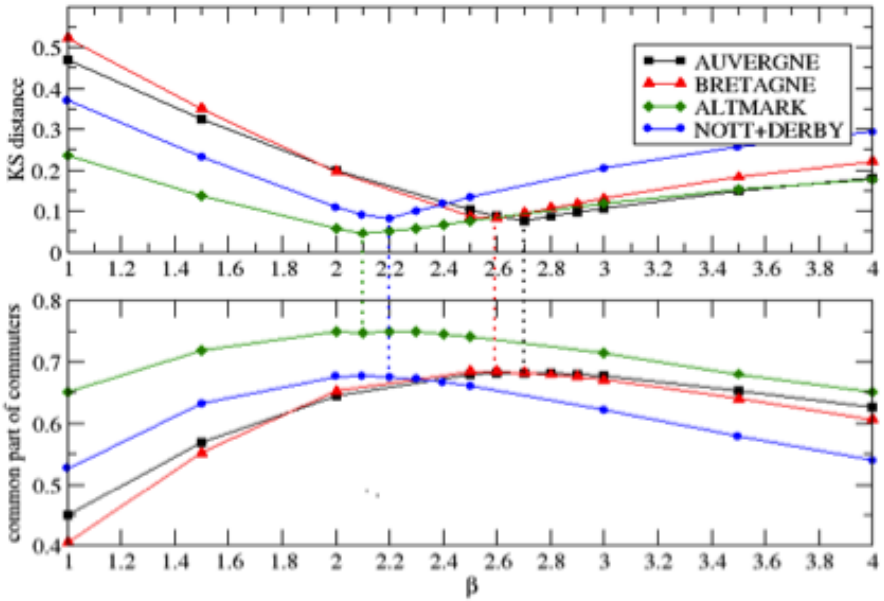
Outline

- The Model
- Calibration of β
- Results
- Comparison with the "radiation model"

Calibration of β



Calibration of β



$$D_{KS} = \sup_d |F_O(d) - F_S(d)|$$

$$CPC = \frac{2\sum_i \sum_j min(S_{ij}, O_{ij})}{\sum_i \sum_j O_{ij} + \sum_i \sum_j S_{ij}}$$

Outline

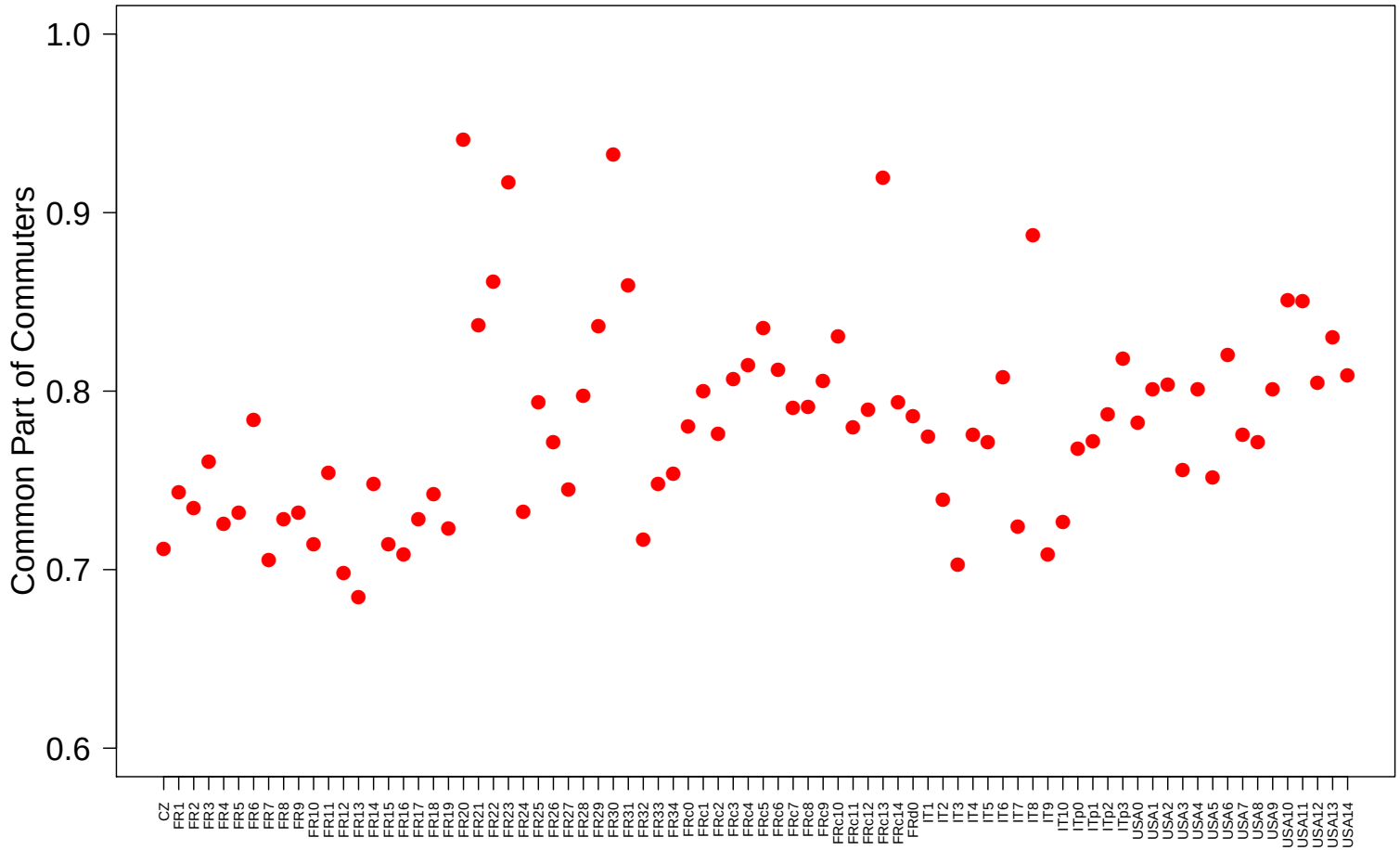
- The Model
- Calibration of β
- Results
- Comparison with the "radiation model"

Results
Datasets

1. Czech Republic - 1 region - municipality - 2001
2. France - 34 regions - municipality - 1999
3. France - 15 regions - canton - 1999
4. France - 1 region - département - 1999
5. Italy - 10 regions - municipality - 2001
6. Italy - 5 regions - provincia - 2001
7. USA - 15 regions - county - 2000

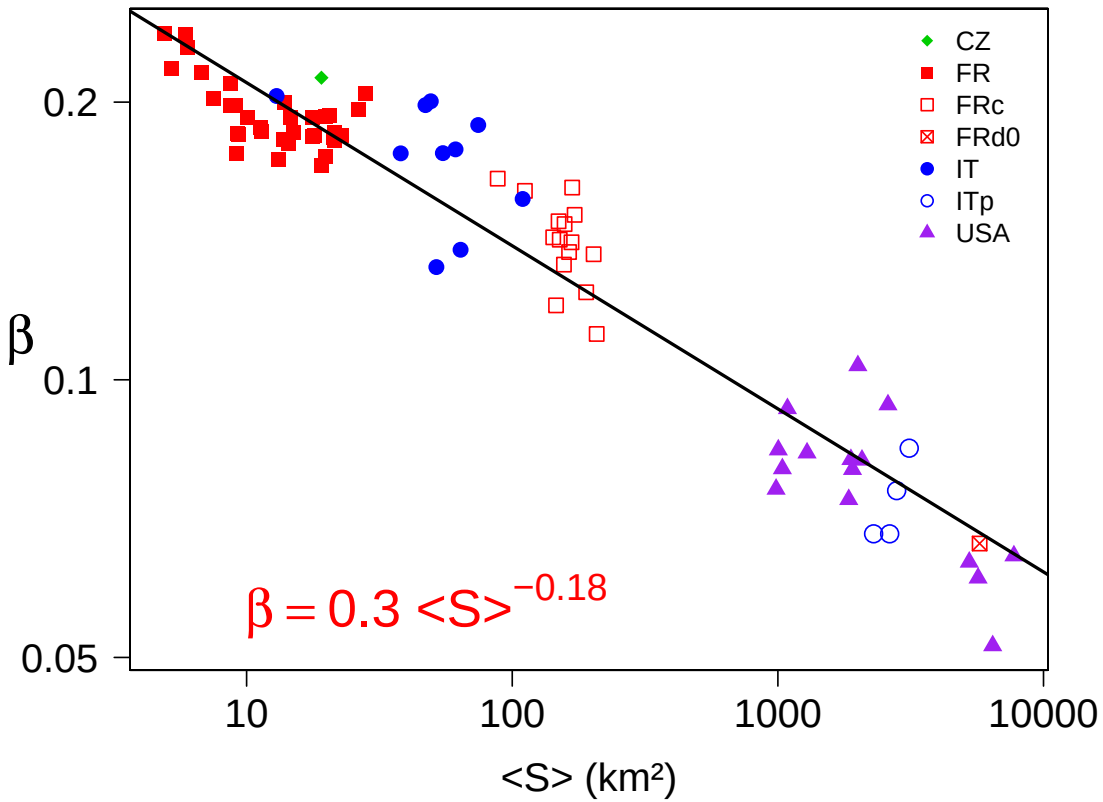
Results

Model evaluation



Results

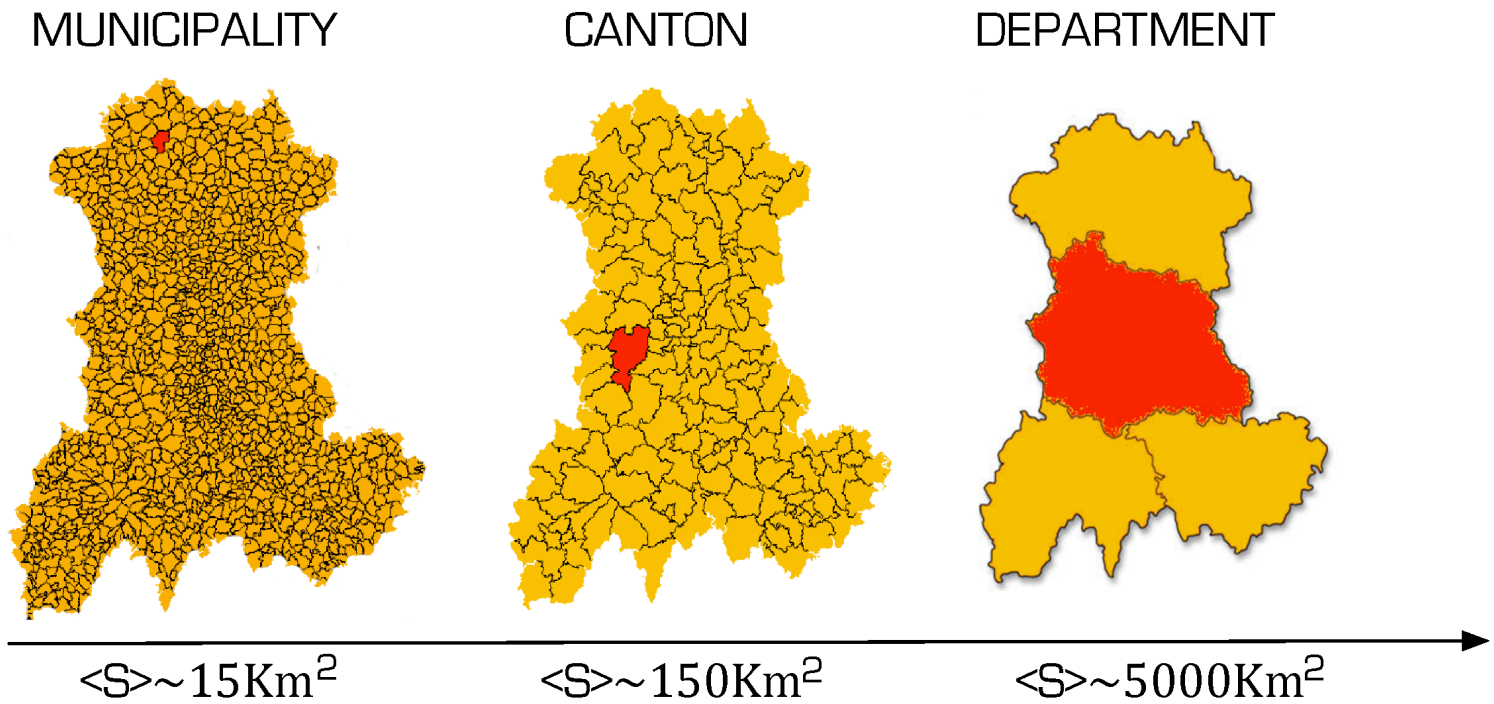
Estimation of β



Lenormand, M., Huet, S., Gargiulo, F., and Deffuant, G. A Universal Model of Commuting Networks. *Plos One*, 2012, .

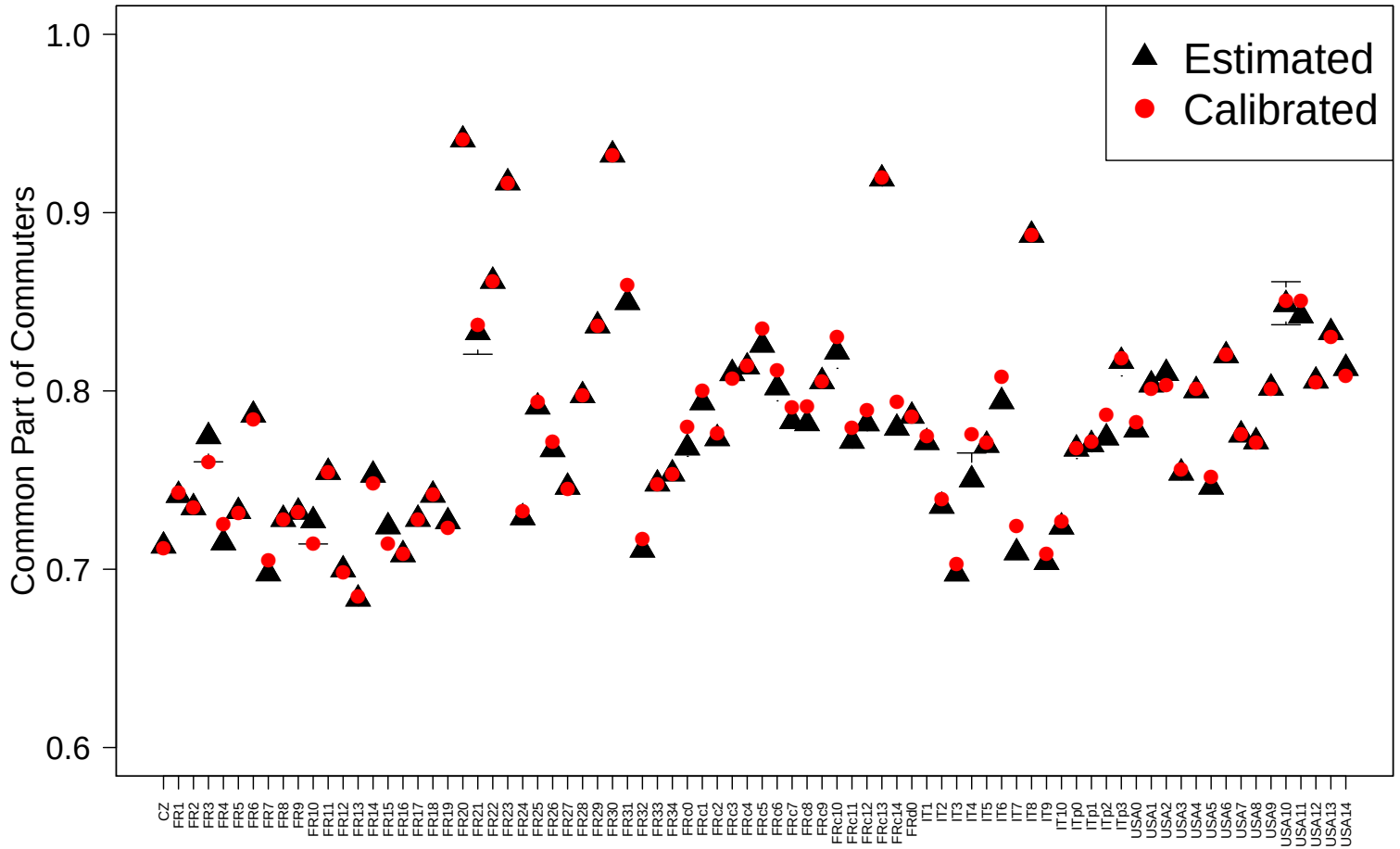
Results

Estimation of β



Results

Estimation of β



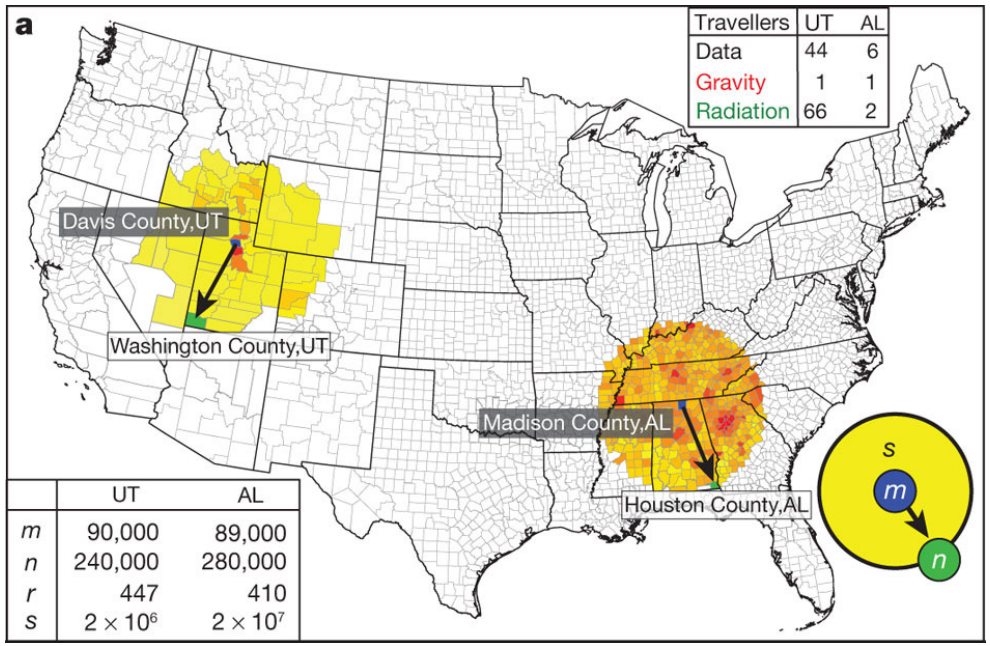
Outline

- The Model
- Calibration of β
- Results
- Comparison with the "radiation model"

Comparison with the "radiation model"

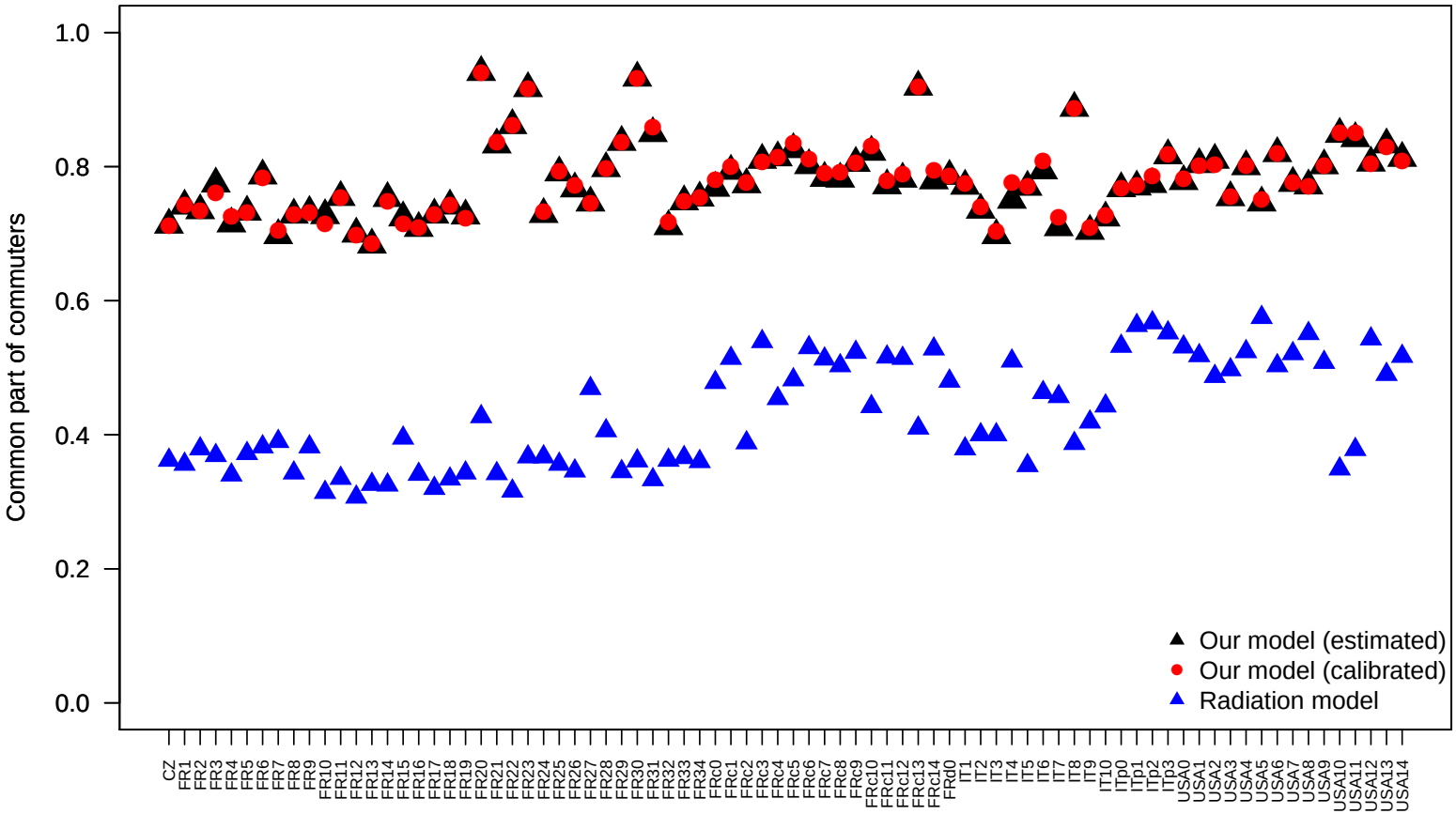
Radiation Model

$$\langle T_{ij} \rangle = \left(m_i \frac{P_c}{P} \right) \frac{m_i n_j}{(m_i + s_{ij})(m_i + n_j + s_{ij})}$$

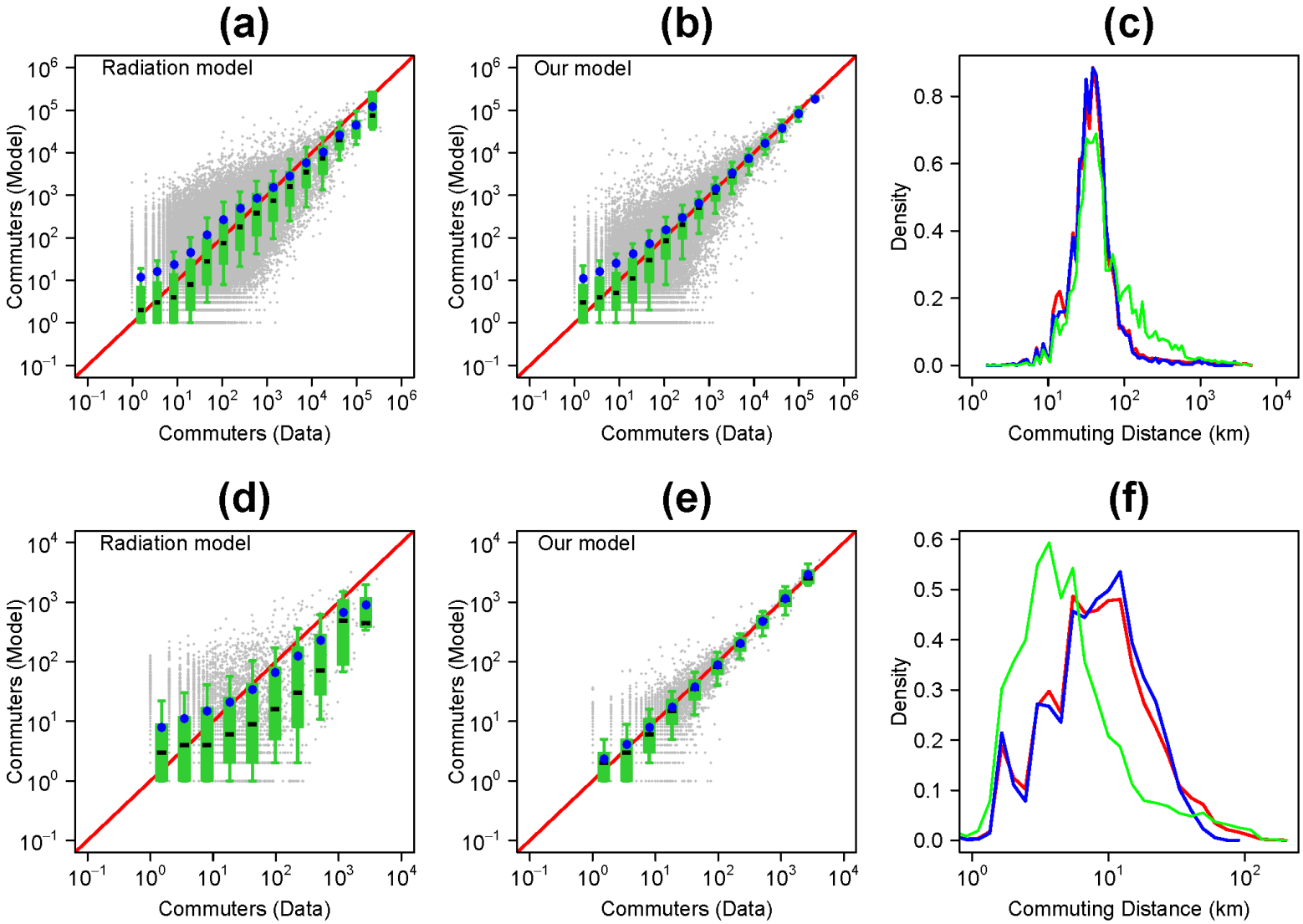


Simini, F., Gonzalez, M. C., Maritan, A., and Barabasi, A.-L. A universal model for mobility and migration patterns. *Nature*, 2012, 484(7392):96-100.

Comparison with the "radiation model"



Comparison with the "radiation model"



Summary

- Model tested on 80 different regions (size and scale).

Summary

- Model tested on 80 different regions (size and scale).
- Estimation of β tested on 80 regions.

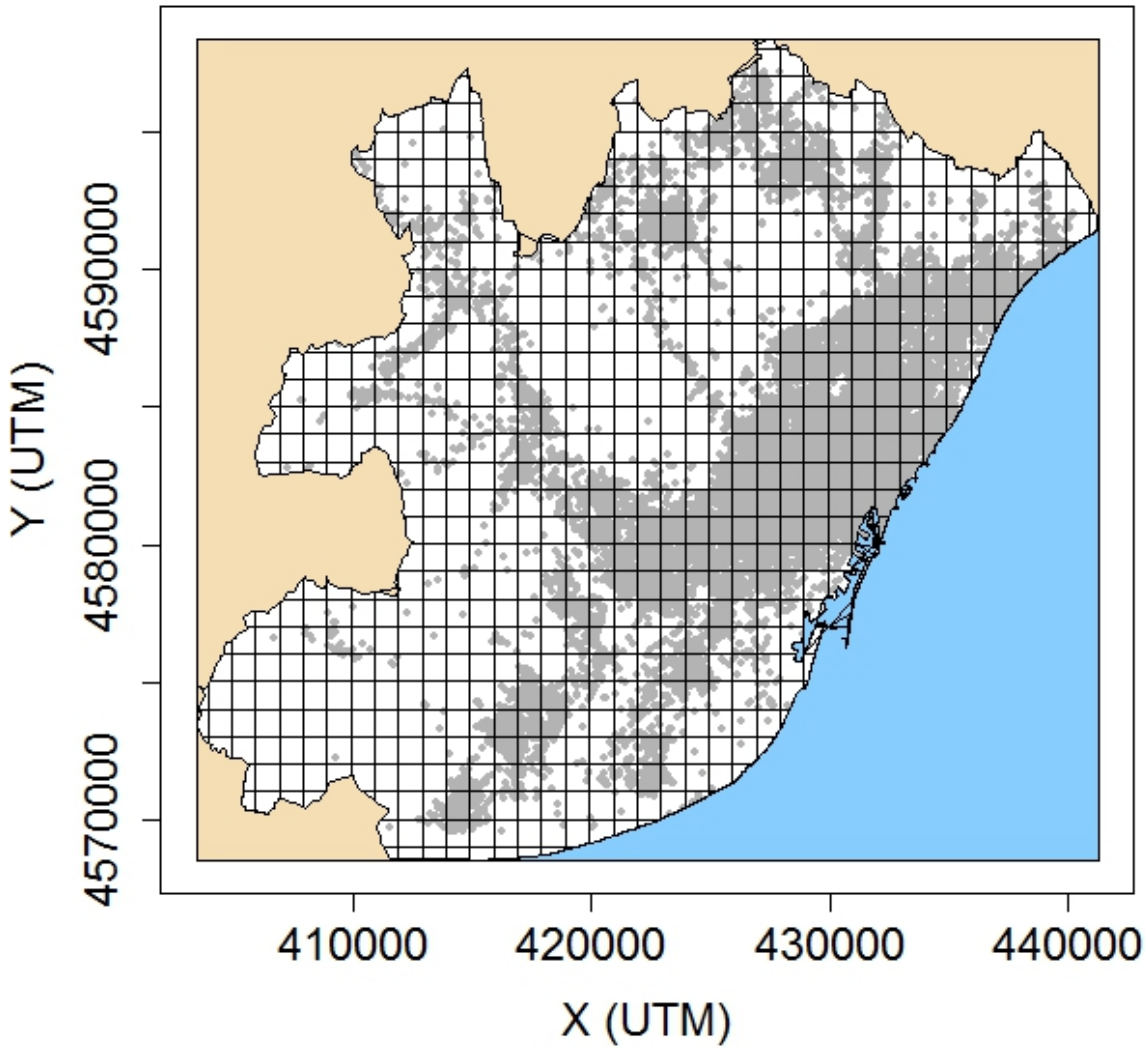
Summary

- Model tested on 80 different regions (size and scale).
- Estimation of β tested on 80 regions.
- Comparison with the "radiation model".

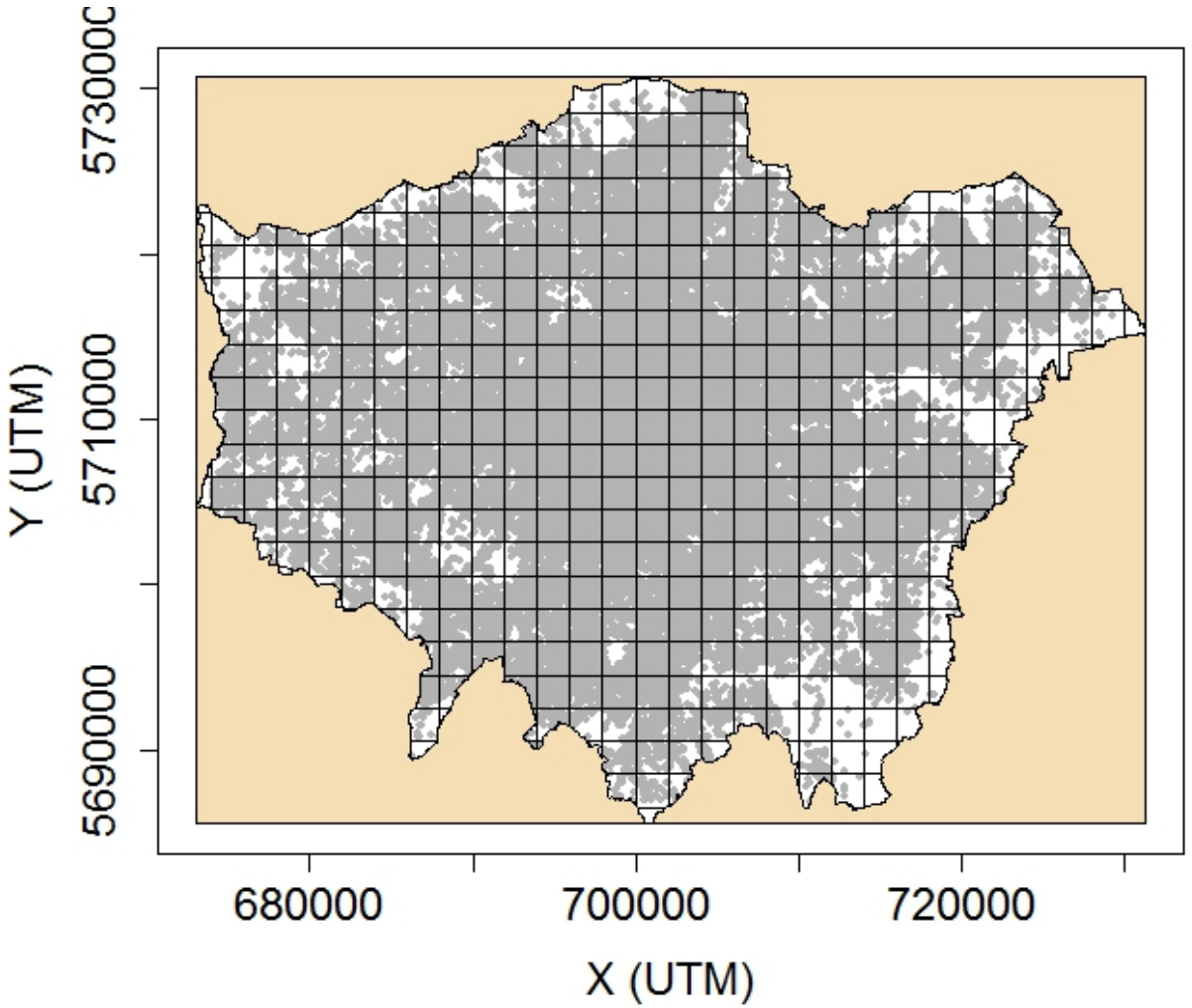
Summary

- Model tested on 80 different regions (size and scale).
- Estimation of β tested on 80 regions.
- Comparison with the "radiation model".
- **Does it works at urban scale?**

Barcelona


Y (UTM)
4570000
4580000
4590000
410000
420000
430000
440000
X (UTM)

London



Results