Buildings Network for Urban System Diagnostic

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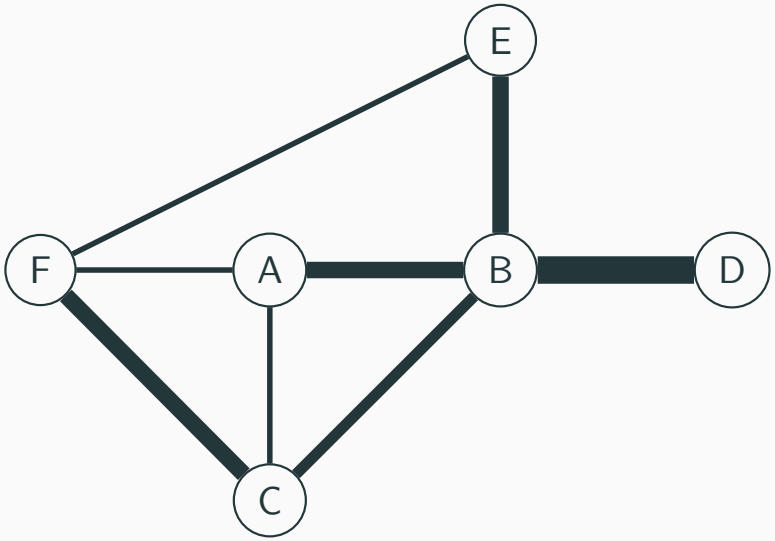
LAboratoire de MAthématiques - Université de Savoie Mont Blanc
Ampère - Unicersité Claude Bernard Lyon 1
IXXI - École Normale Supèrieure de Lyon

Introduction

Spatial networks



Graph: $G = (V, E)$

Nodes/vertices:

$V = \{i \mid i \text{ is a node}\}$

Links/edges:

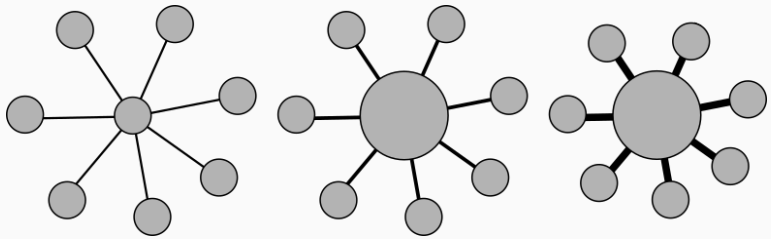
$E = \{(i,j) \mid i,j \in V \text{ and } \exists \text{ an } i-j \text{ interaction}\}$

Weighthed adjacency matrix:

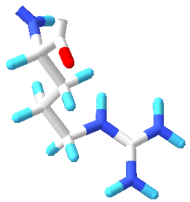
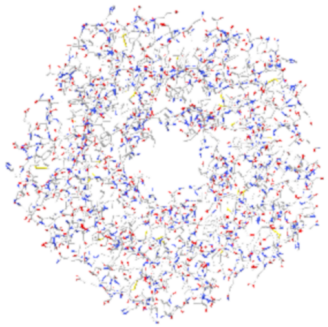
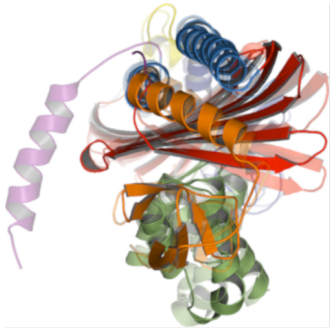
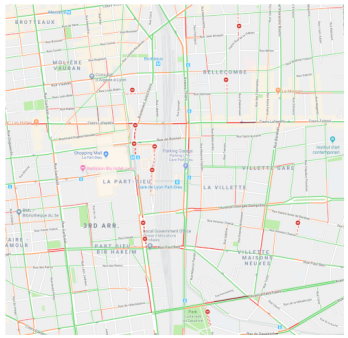
$$W_{ij} = \begin{cases} w_{ij} \text{ if } (i,j) \in E \\ 0 \text{ otherwise} \end{cases}$$

Spatial network:

$w_{ij} \leftrightarrow$ spatial proximity



Proteins vs. cities

	Protein	City
Building block		
Spatial arrangement		
Mobility		

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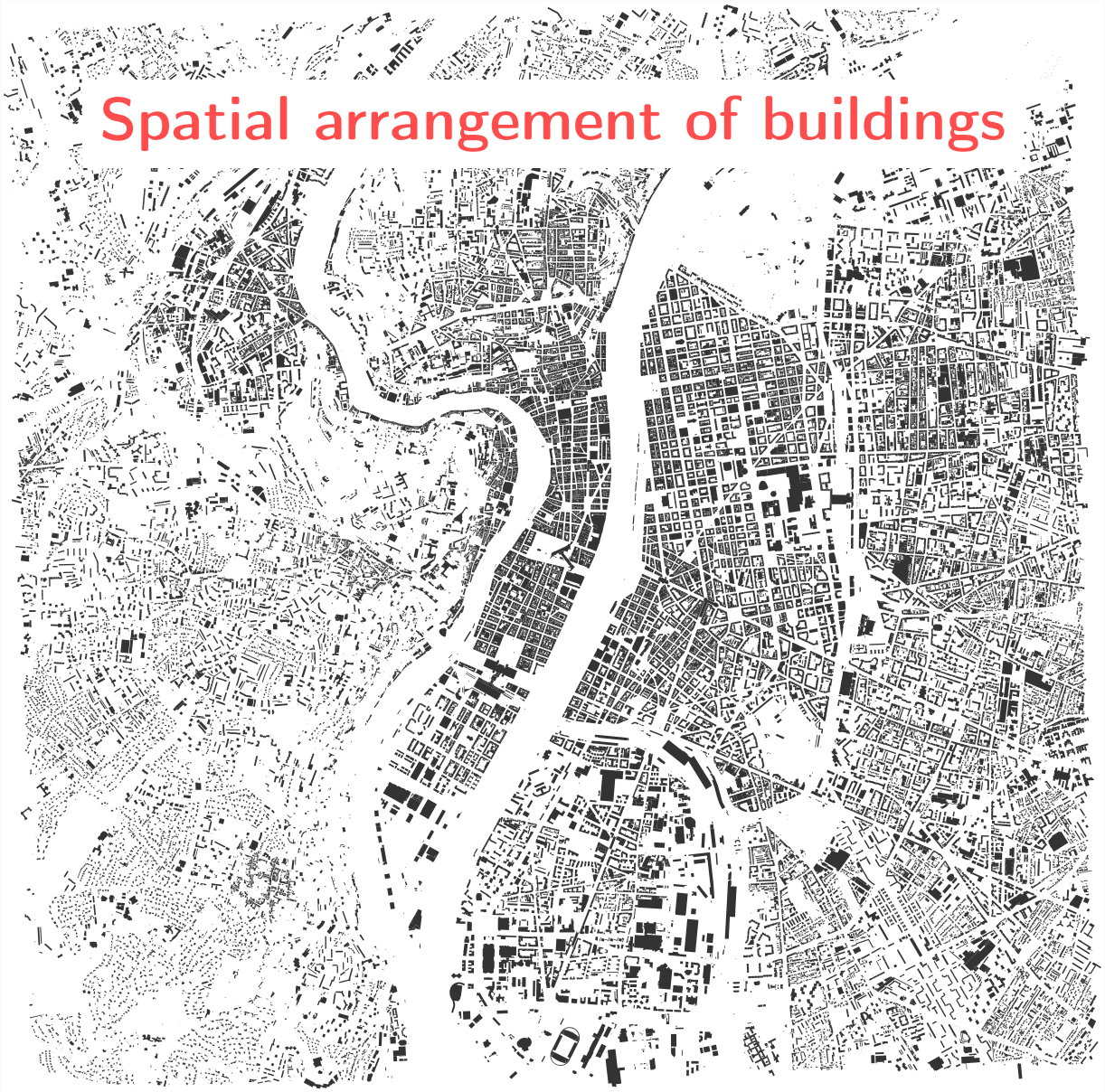
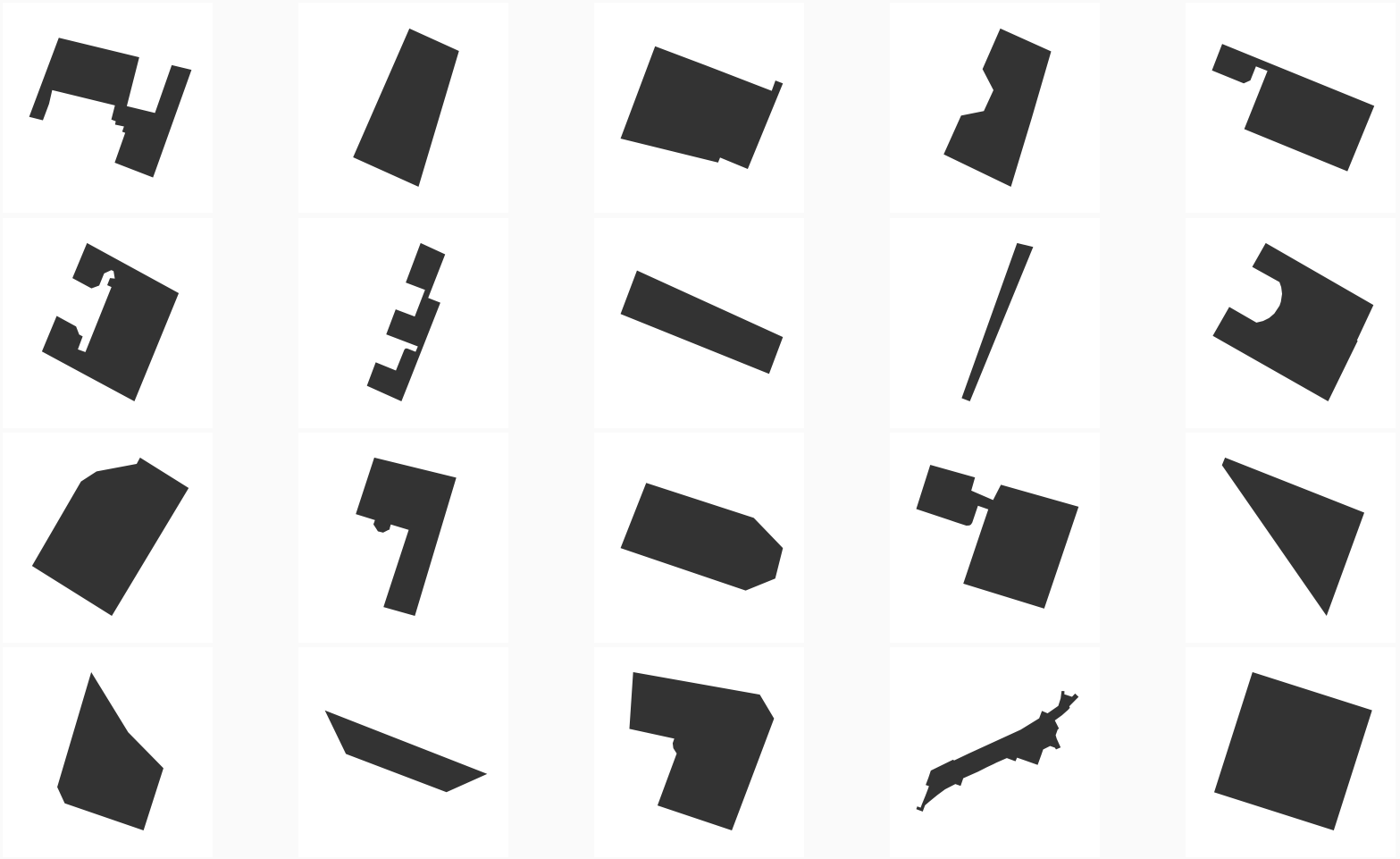
The urban system

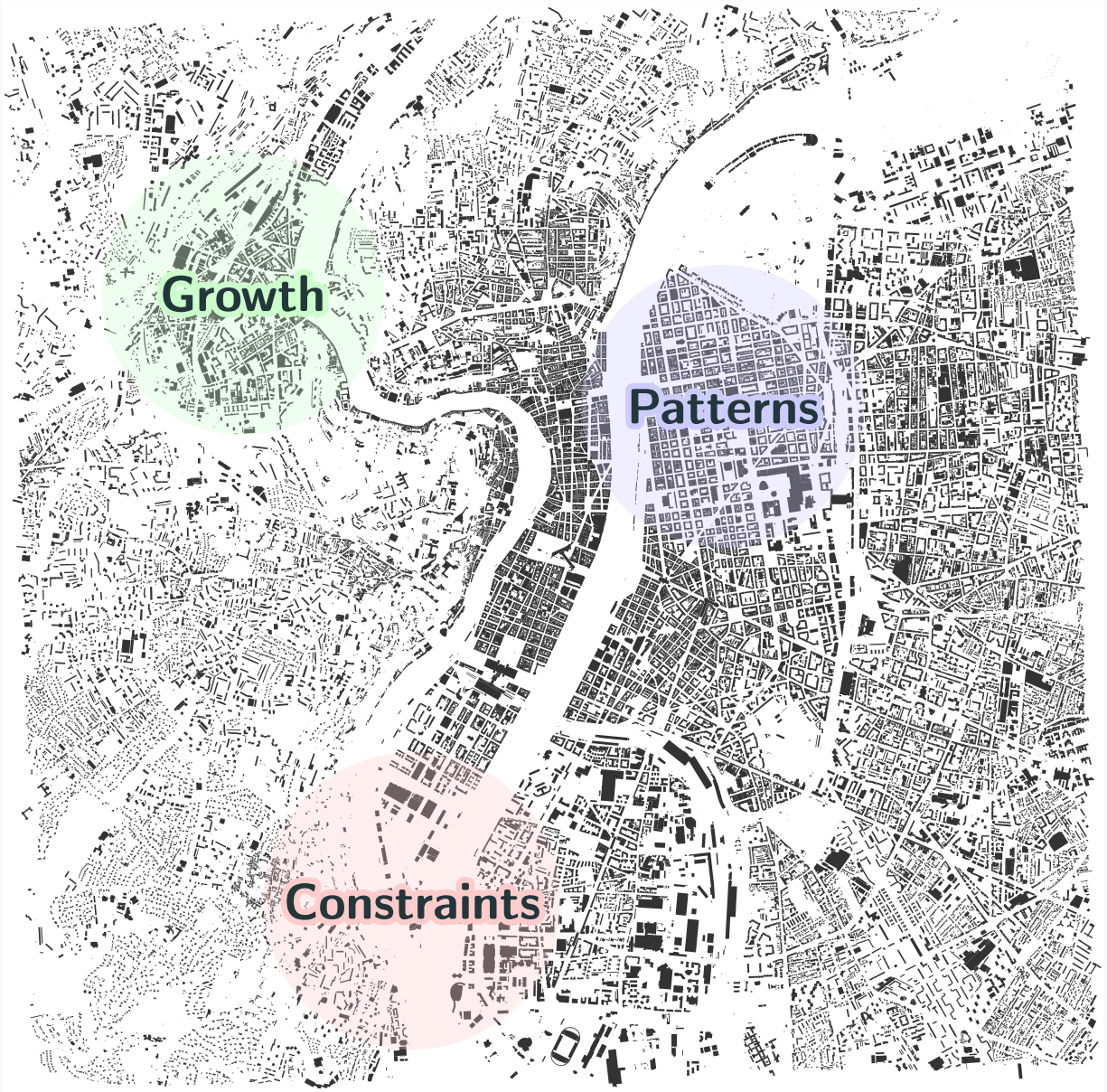
City



Individual components: buildings



City

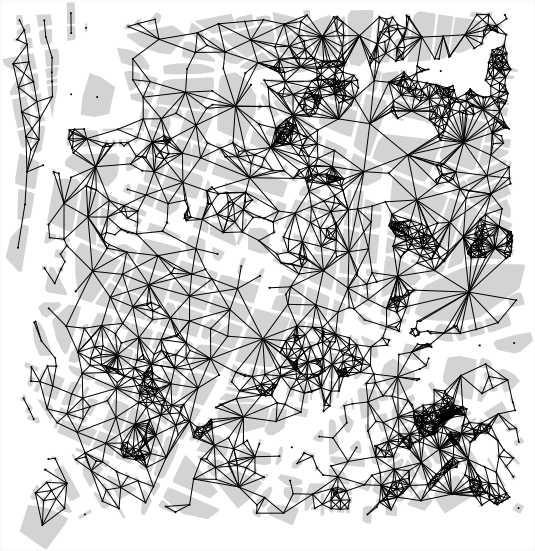


Model

Buildings network

Buildings

Nodes



Links

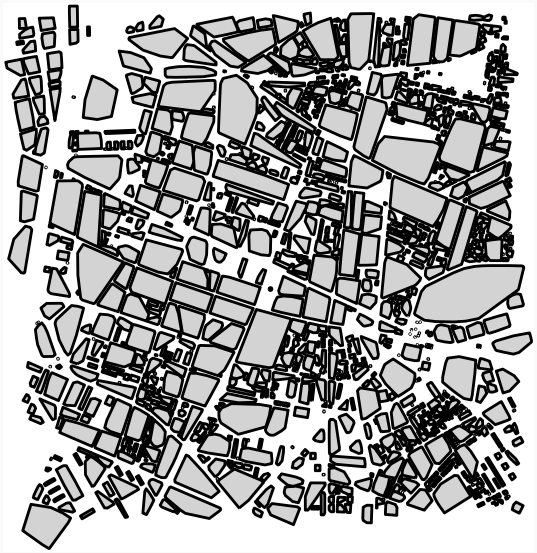
Montplaisir-Lumière, Lyon, France

$$G = (V, E), \quad V = \{i \mid i \text{ is a (merged) building}\}$$

$$E = \{(i,j) \mid i,j \in V \text{ and } \exists\, (\text{point}_i \in i, \text{point}_j \in j) \text{ with } \text{dist}(\text{point}_i, \text{point}_j) \leq 30\text{m and no other buildings in between.}\}$$

$$A_{ij} = \begin{cases} 1 \text{ if } (i,j) \in E \\ 0 \text{ otherwise} \end{cases} \qquad k_i = \sum_{j=1}^{N} A_{ij}$$

Merging of buildings



Iterative procedure:

REPEAT

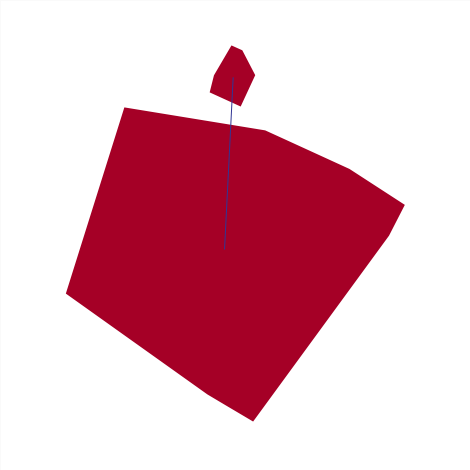
- Merge adjacent buildings
- Take convex hull

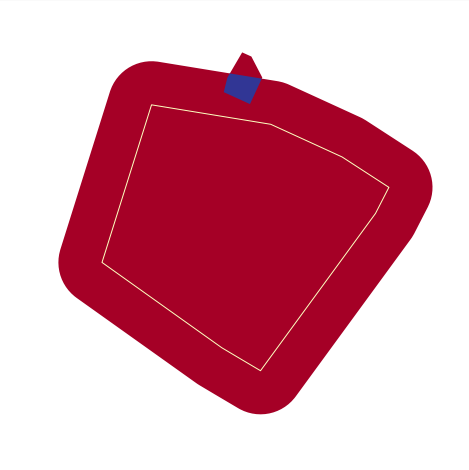
UNTIL no further merging is possible

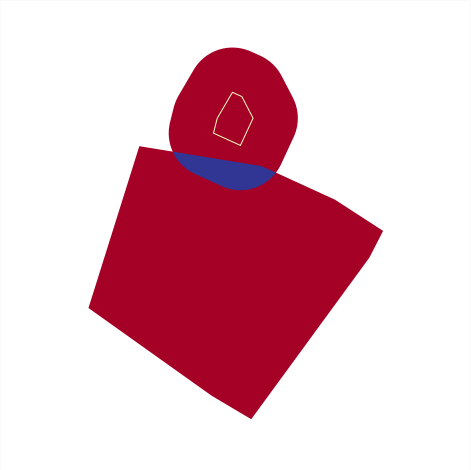
Buildings network

Link weight w_{ij}**:** buffer i (j) of 30m and calculate the area $S_{i^*,j}$ (S_{i,j^*}) of intersection with j (i).

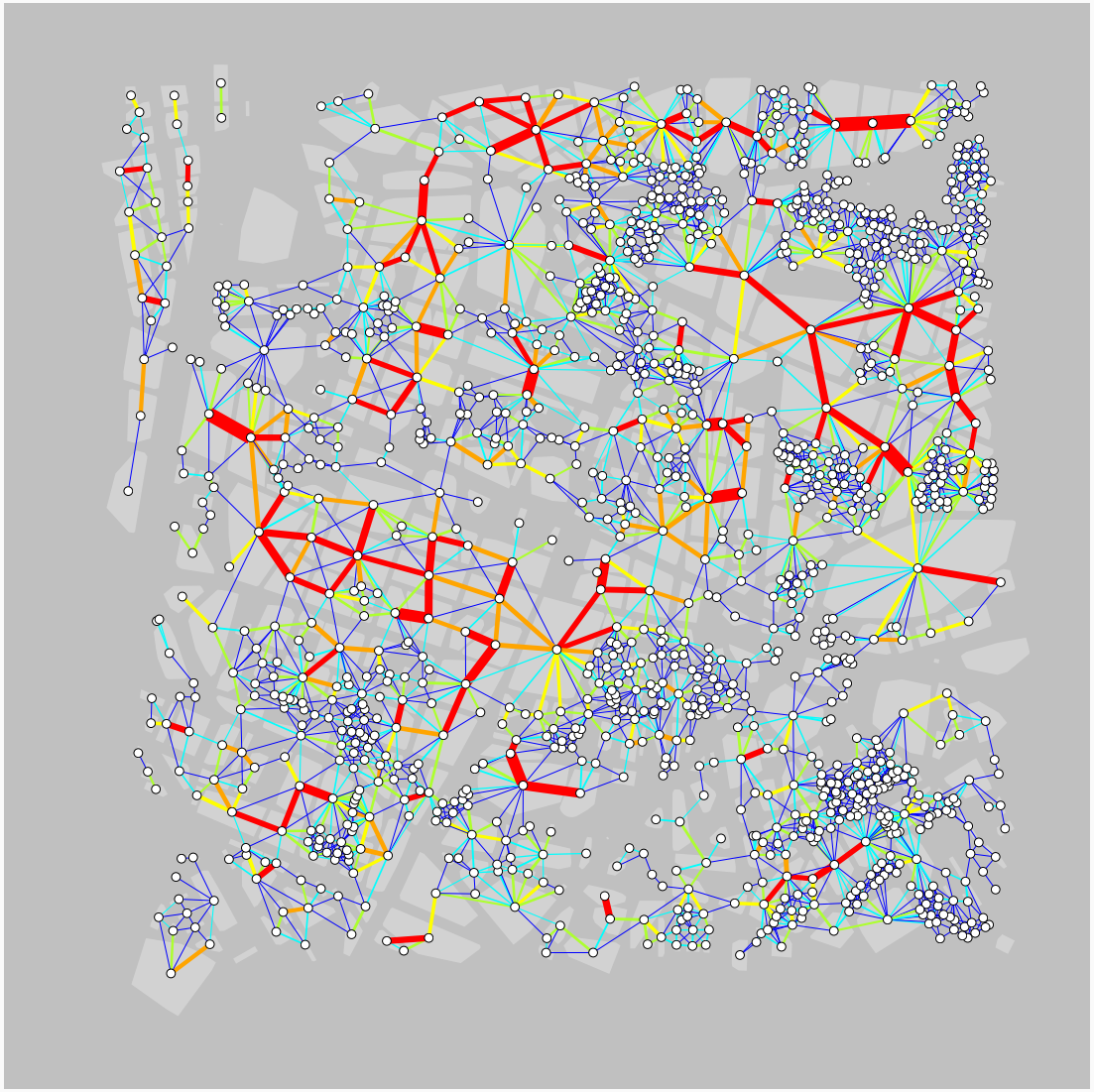
$$w_{ij} = S_{i^*,j} + S_{i,j^*} \qquad w_i = \sum_{j=1}^{N} w_{ij}$$





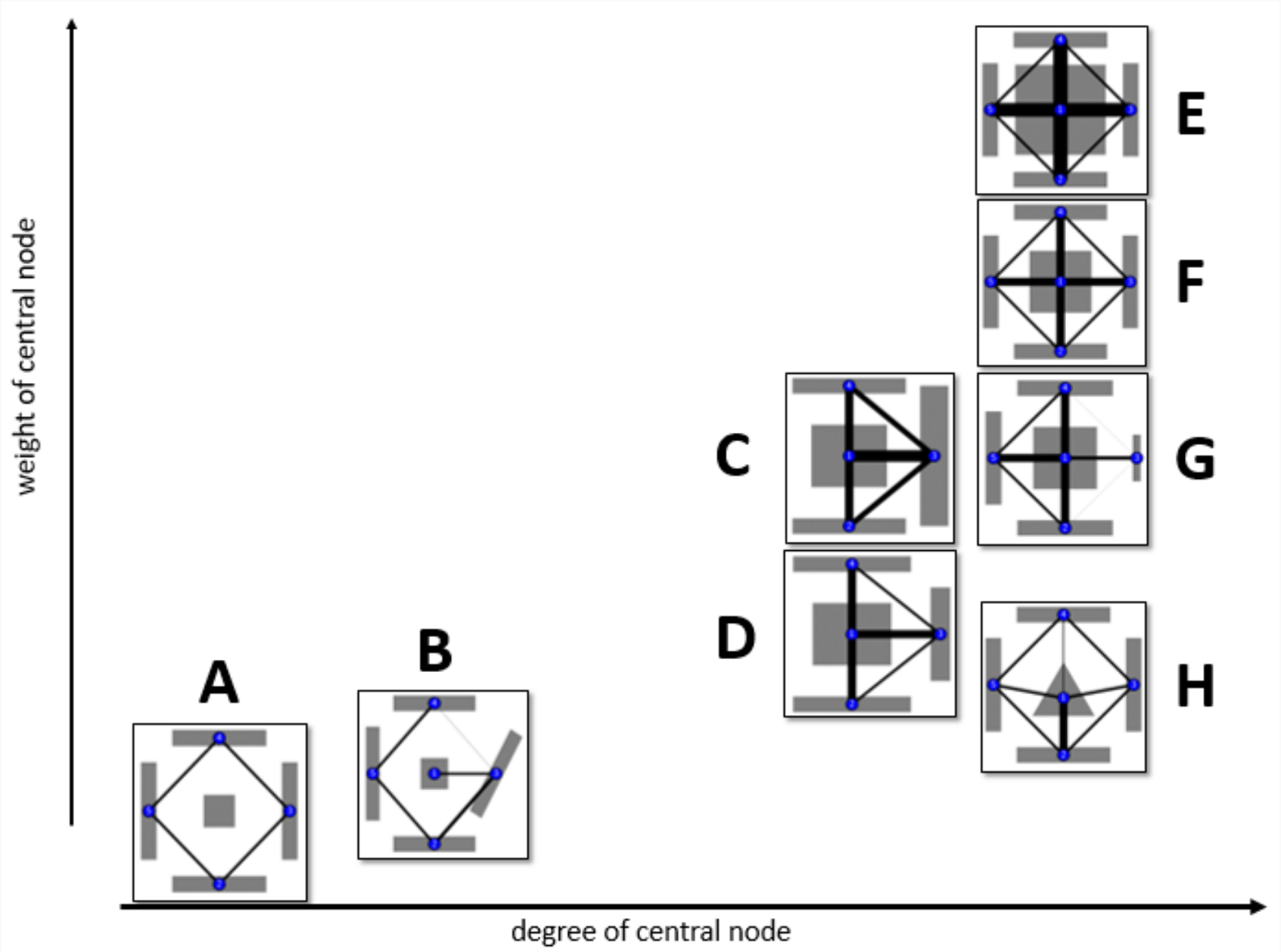


Buildings network of Montplaisir

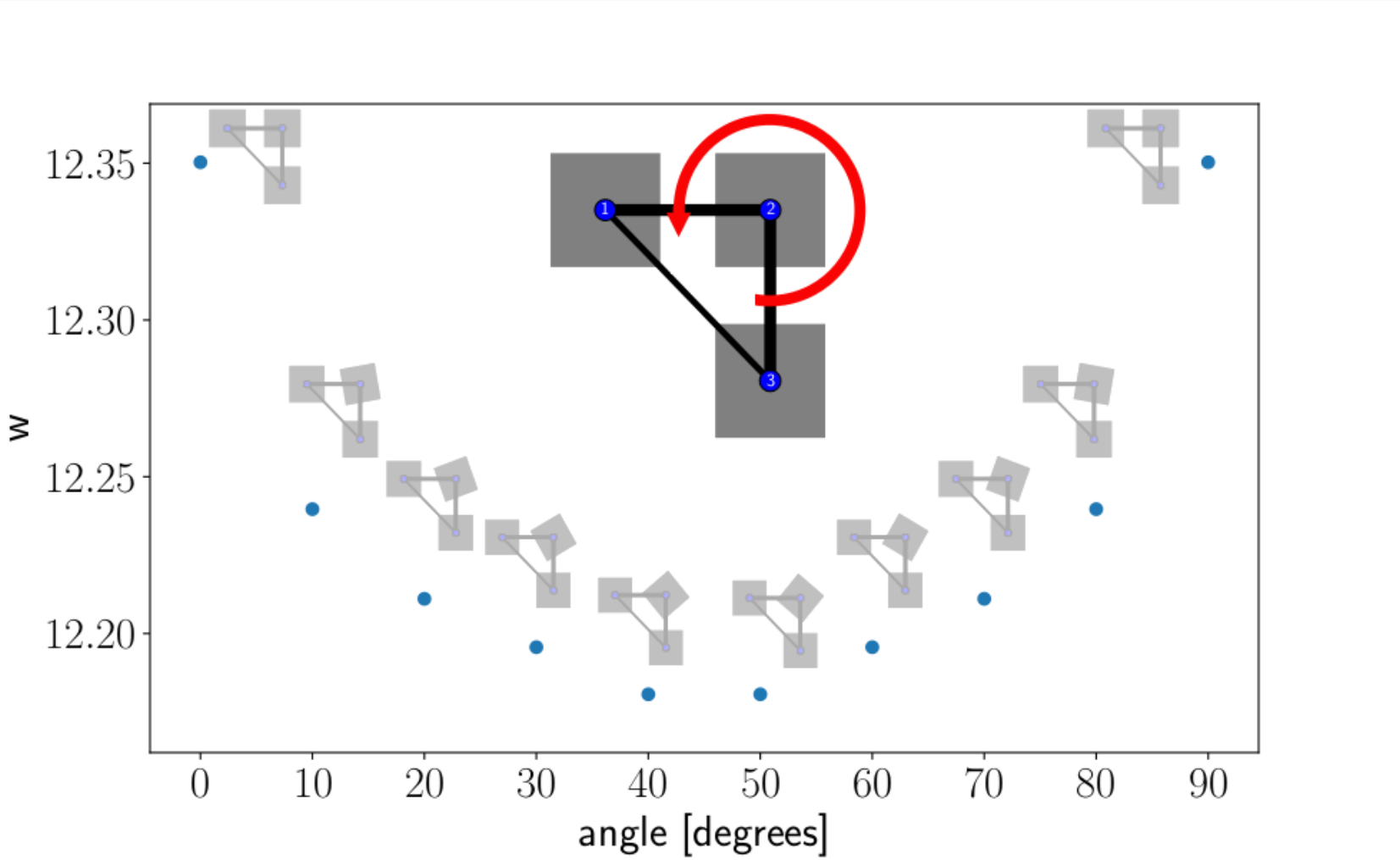


Try it! github.com/lorpac/building-network

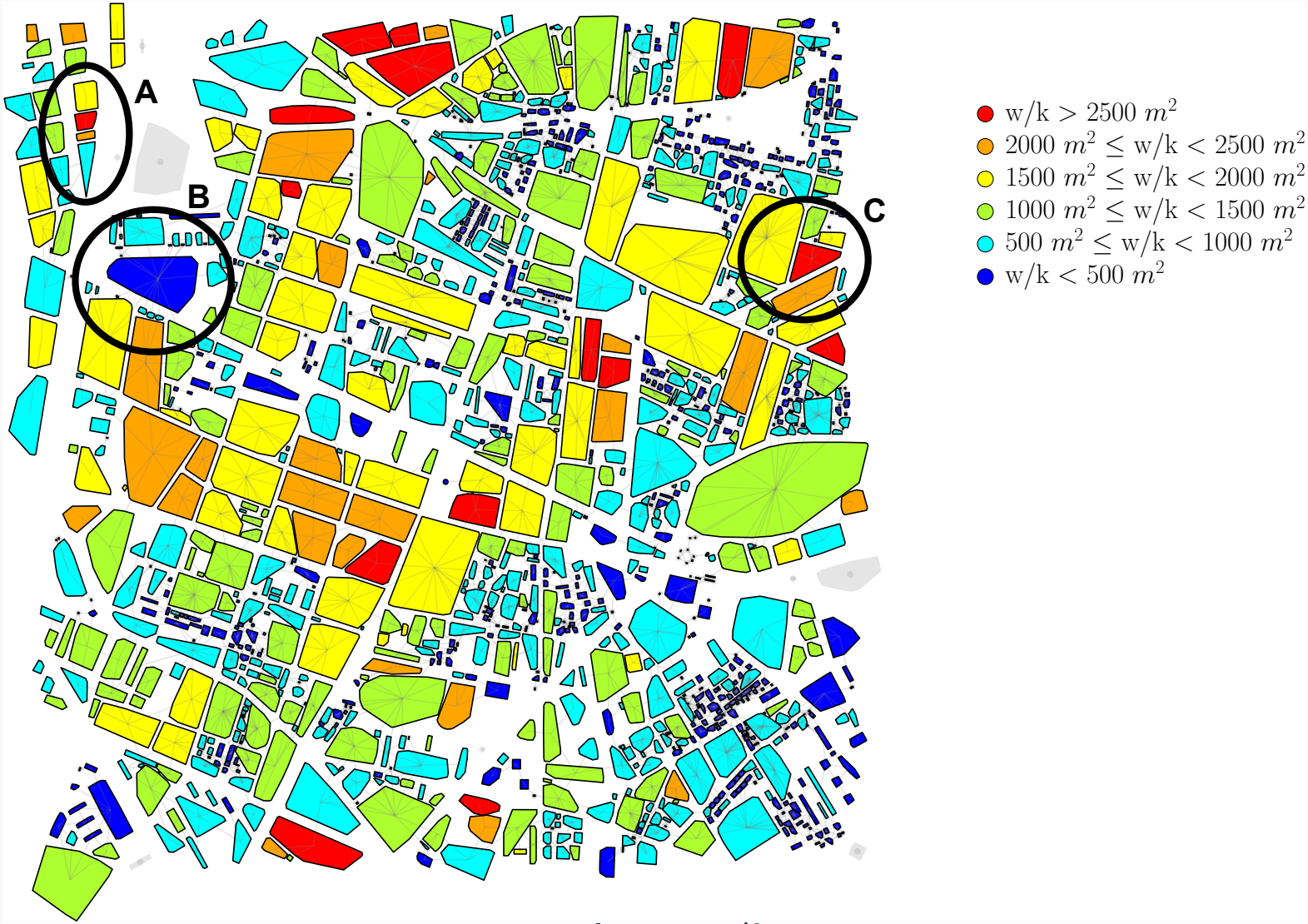
Node properties



Node properties



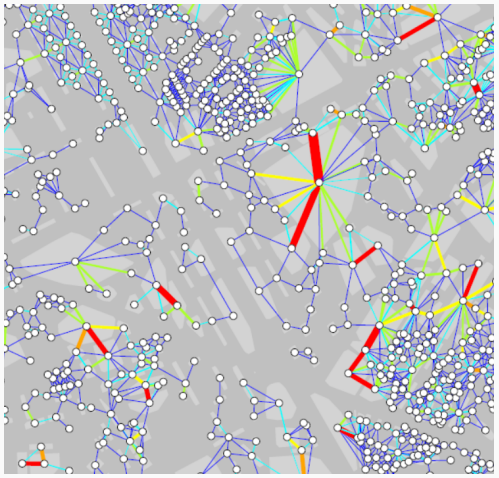
w/k $\leftrightarrow$ packing

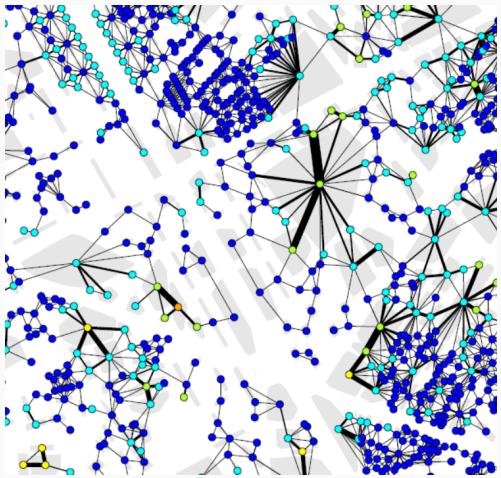


Color: w/k

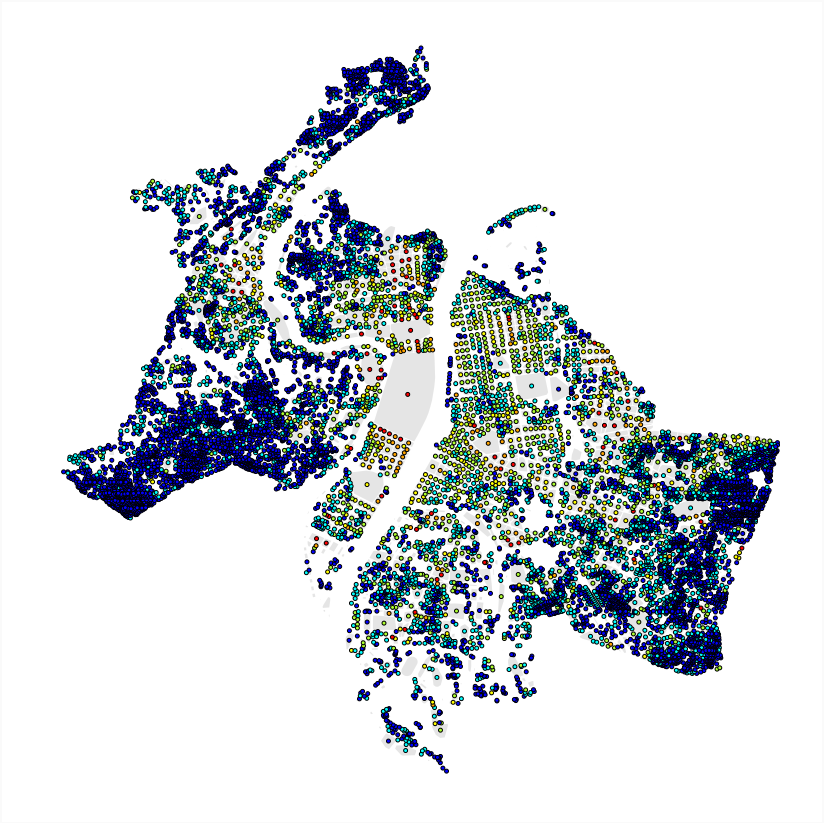
Usage: system diagnostic

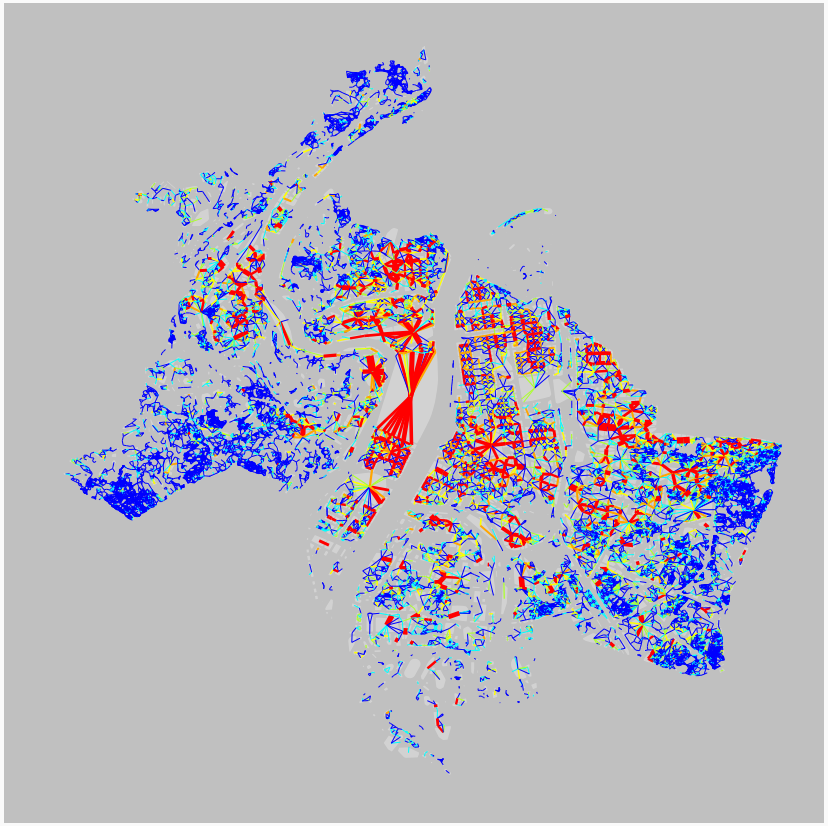
Case study: perturbation





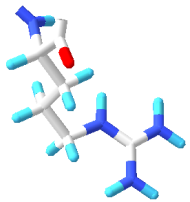
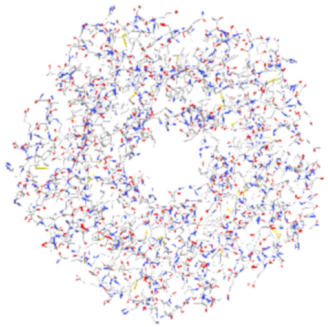
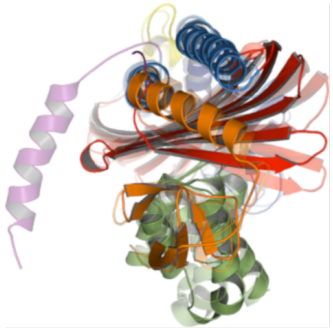
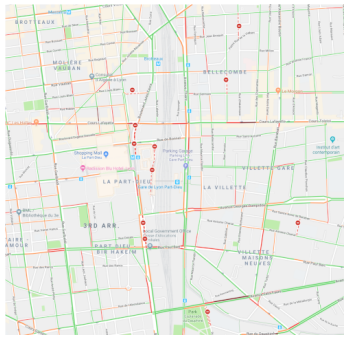
Lyon - w/k





A biomimicry approach

Proteins vs. cities

	Protein	City
Building block		
Spatial arrangement		
Mobility		

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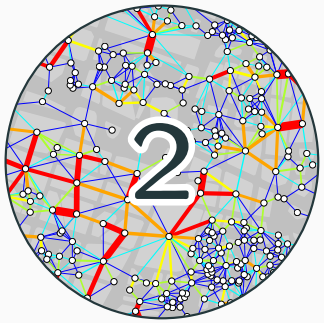
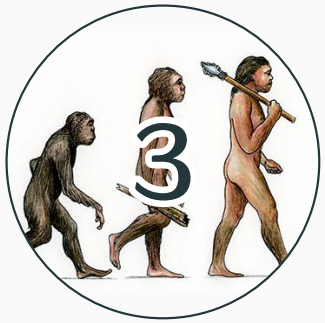
1. Problem analysis

2. Abstraction of the technical problem



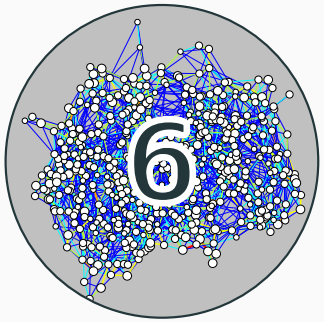
3. Transposition to biology



4. Identification of potential biological models

5. Selection of biological model(s)

6. Abstraction of biological strategies



7. Transposition to technology

8. Implementation and test

Save the date

Atelier "Biomimétisme pour la modélisation et la planification de systèmes urbains"

Friday 31st January, 2020

14h - 16h

Thank you for your attention.