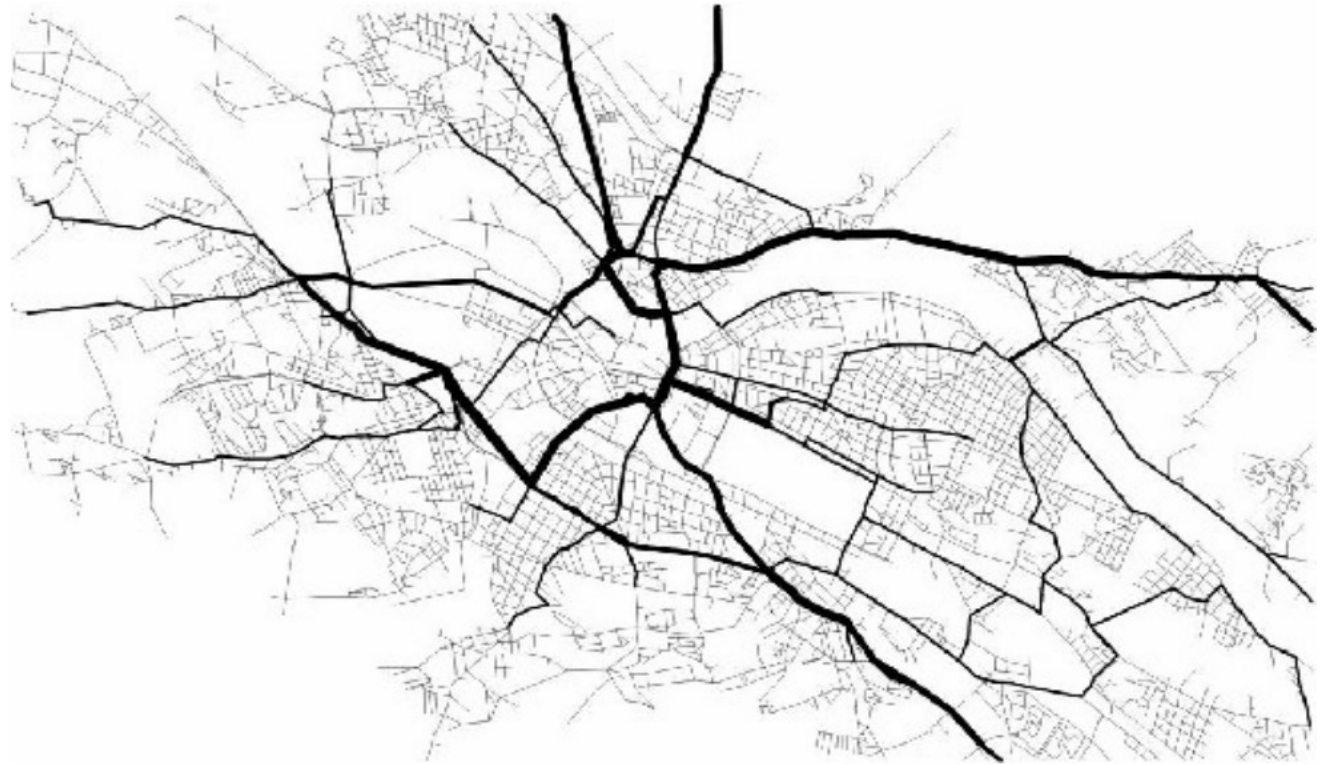


# Networks embedded in space

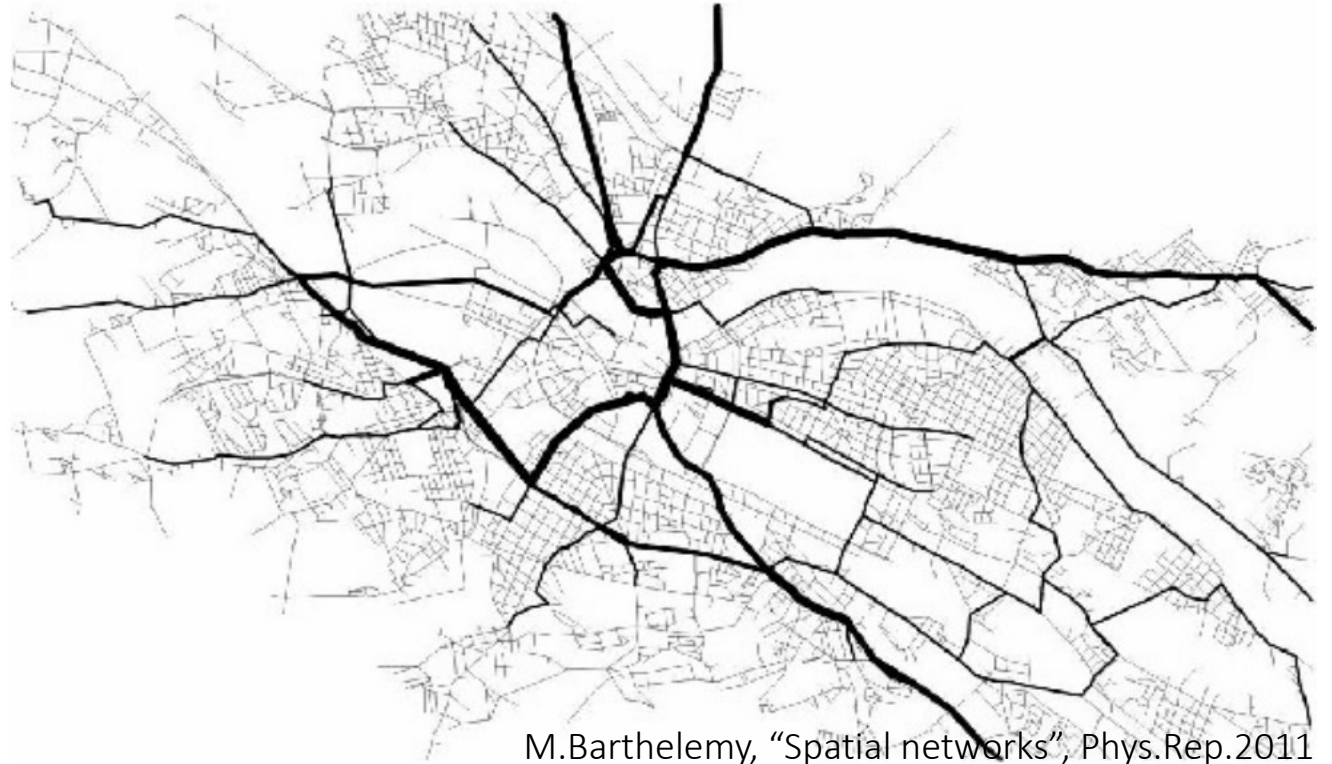


M.Barthelemy,  
“Spatial networks”, Phys.Rep.2011

# Networks spatially embedded\*

Questions: what are properties of networks spatially

-- Time: 7:00



M.Barthelemy, "Spatial networks", Phys.Rep.2011

\*embedding of a network – assigning spatial coordinates to nodes/edges

# Networks spatially embedded\*

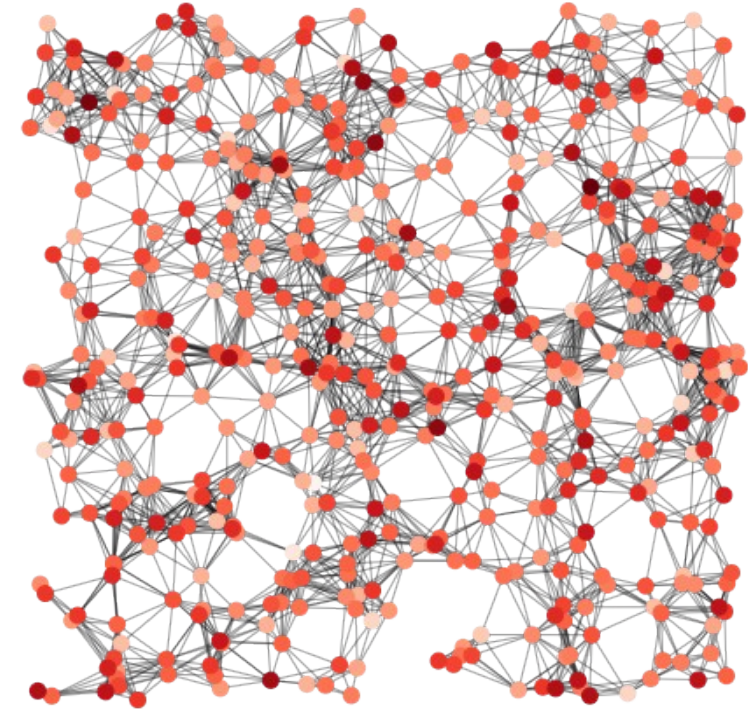
Questions: what are properties of networks spatially

-- Time: 7:00



Train network

loading graph of city

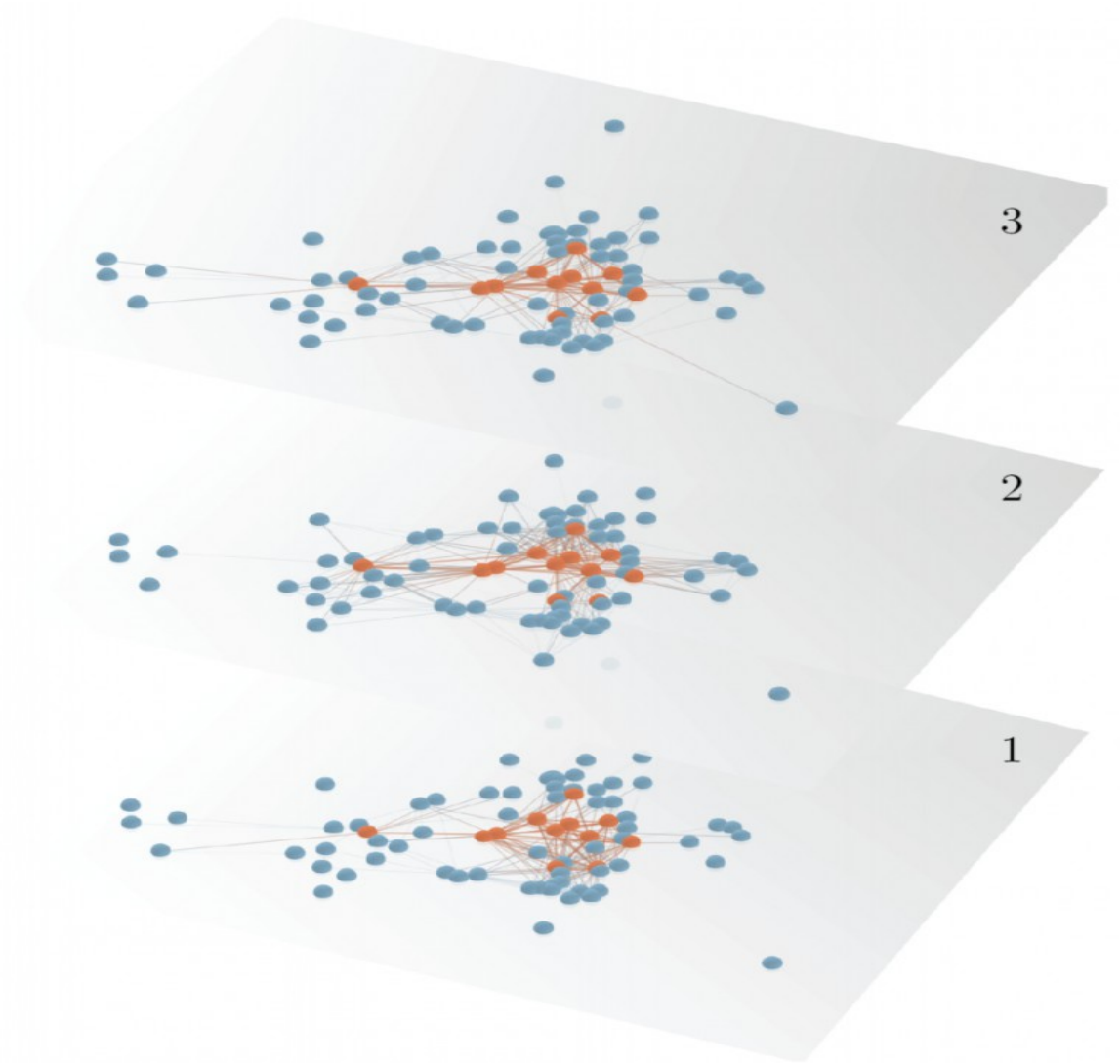
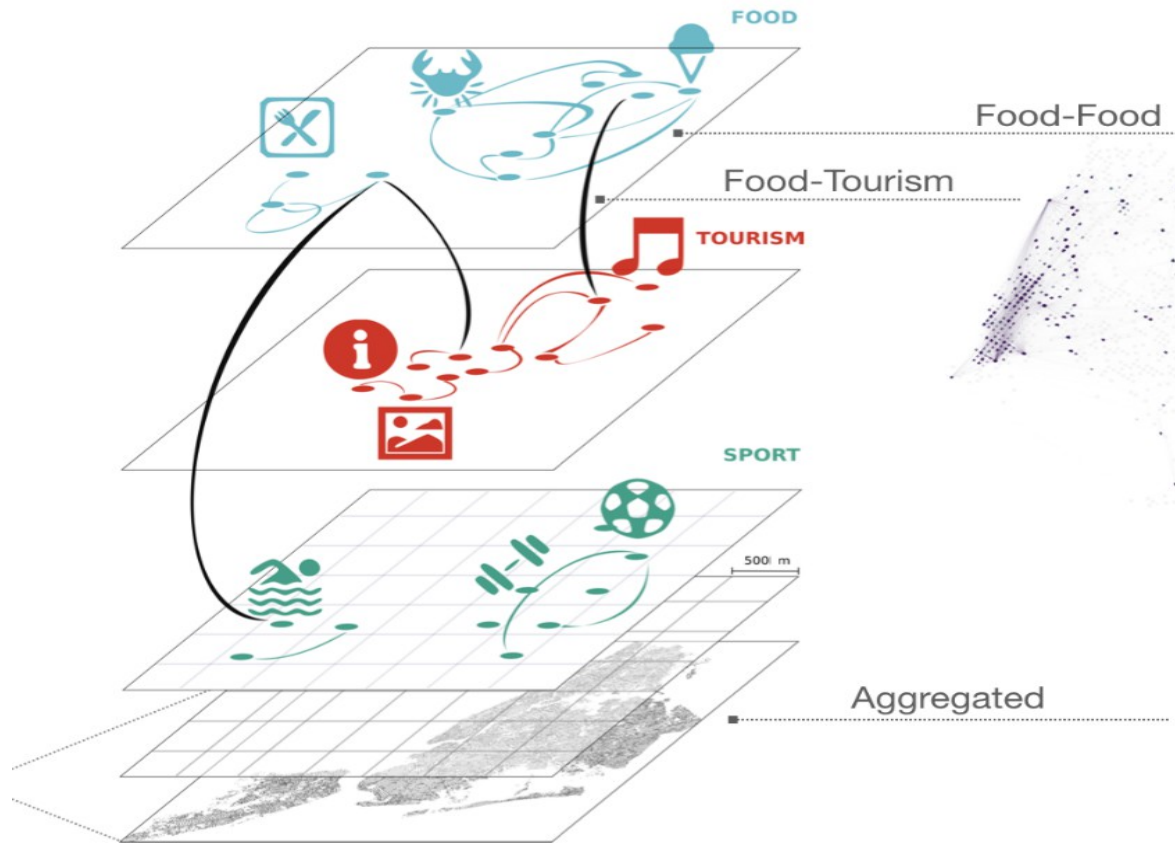


Geometric graphs

\*embedding of a network – assigning spatial coordinates to nodes/edges



# Geography of social networks



Data source:

Foursquare - Location-Based Social Networking

Network model:

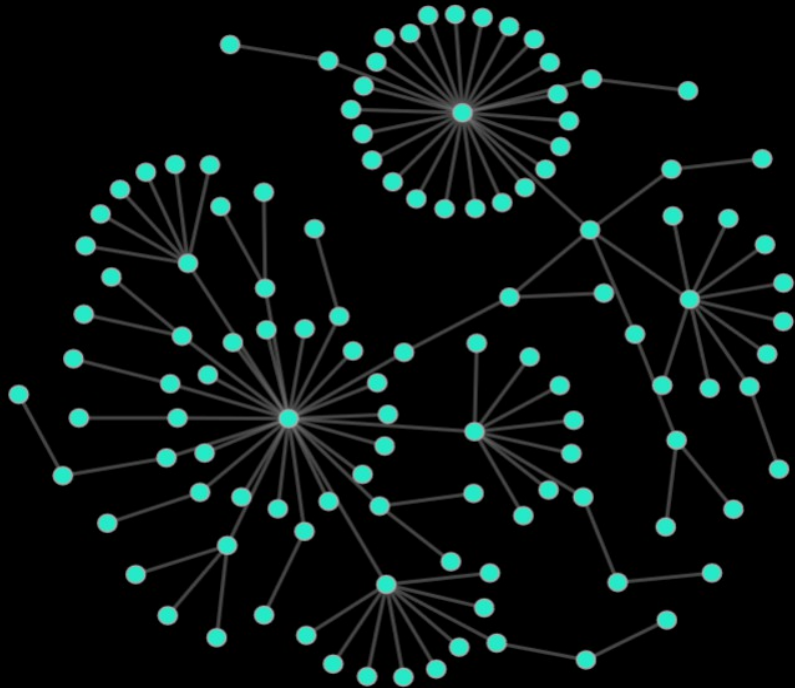
Multilayer structure

M.Domenico et al. "Disentangling activity-aware human flows reveals the hidden functional organization of urban systems"

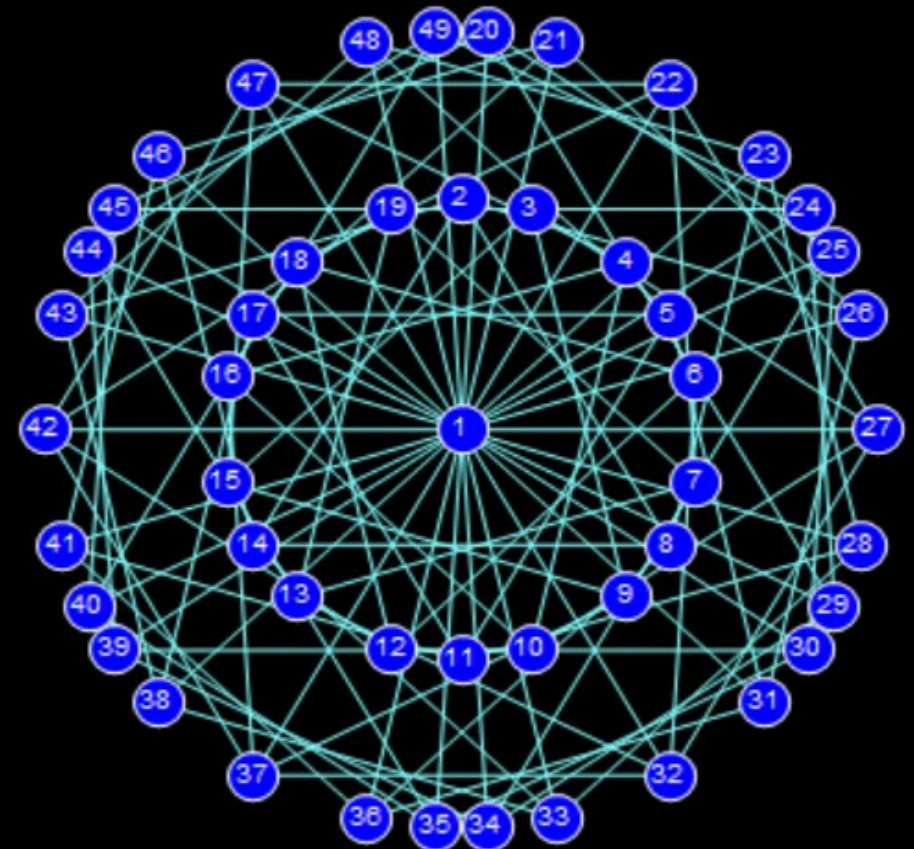
# Different types of networks

## Tree graph

is a graph in which any two vertices are connected by exactly one path.



## Cycles in networks





How to choose an idea of a project?  
Choose the topic.

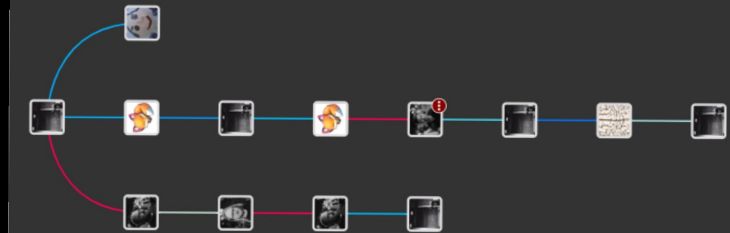
Biology and bioinformatics

Education and learning analytics

Mobility and urbanism

Technology and AI

Social networks analysis



# Networks geographically embedded

## A. Transportation networks:

1. Representations
2. Airline networks
3. Bus, subway, railway, and commuters, Cargo-ship

## B. Infrastructure networks:

1. Road and street networks
2. Power grids and water distribution networks, the Internet
3. Geography in social networks

## C. Origin-destination matrix and mobility networks:

1. Importance of human mobility
2. Distribution of the trip duration and length
3. The gravity law

## D. Neural networks

