# How data and data science can help to deal with natural disaster?

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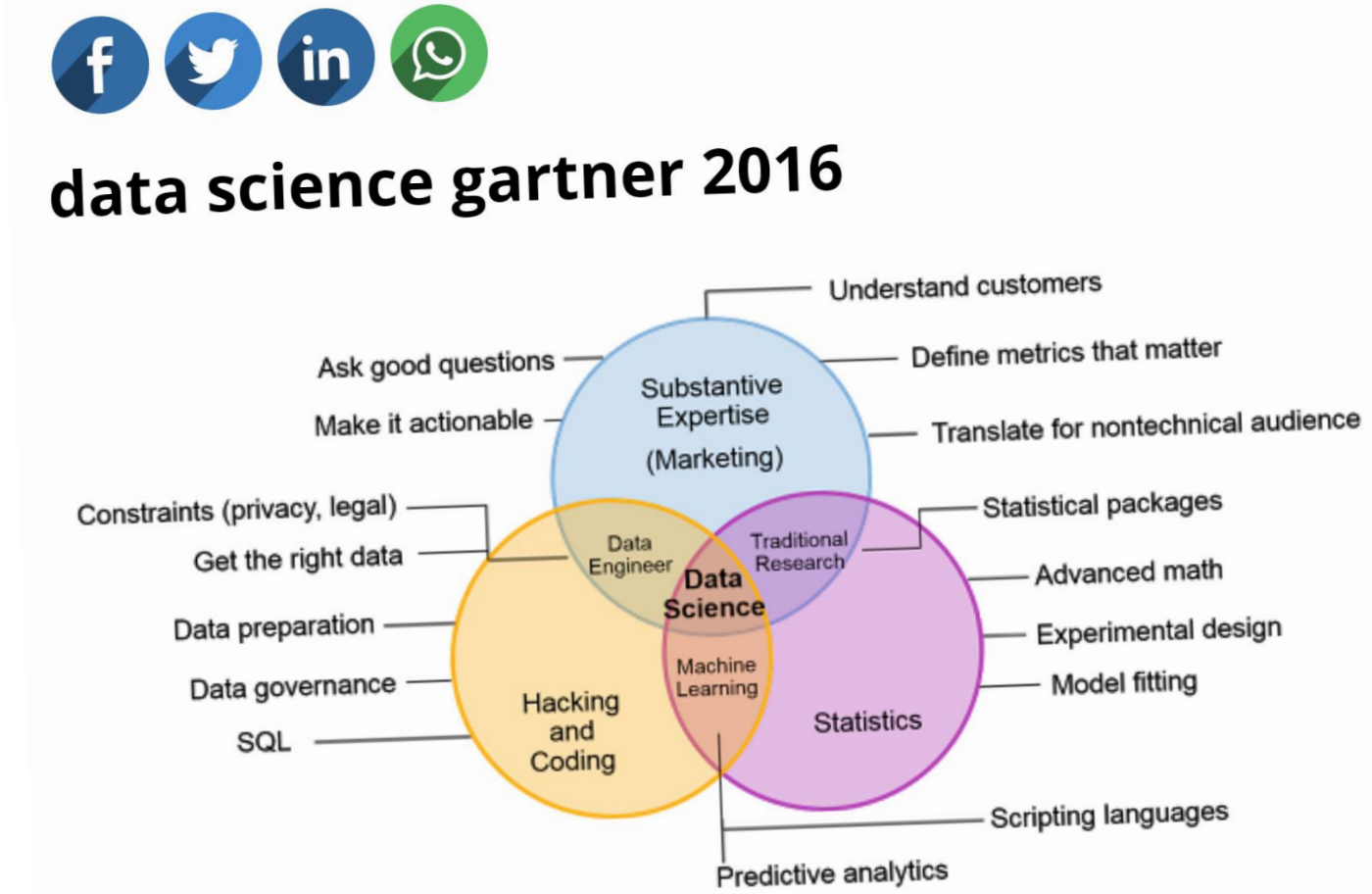





Big Data: cosa sono, come utilizzarli per il business

# Data Science

- "... we see the emergence of a new field—**data science**—that focuses on the processes and systems that enable us to **extract knowledge or insight from data in various forms and translate it into action**. In practice, data science has evolved as an **interdisciplinary field** that integrates approaches from such data-analysis fields ... **as a discipline, data science is only in its infancy**."

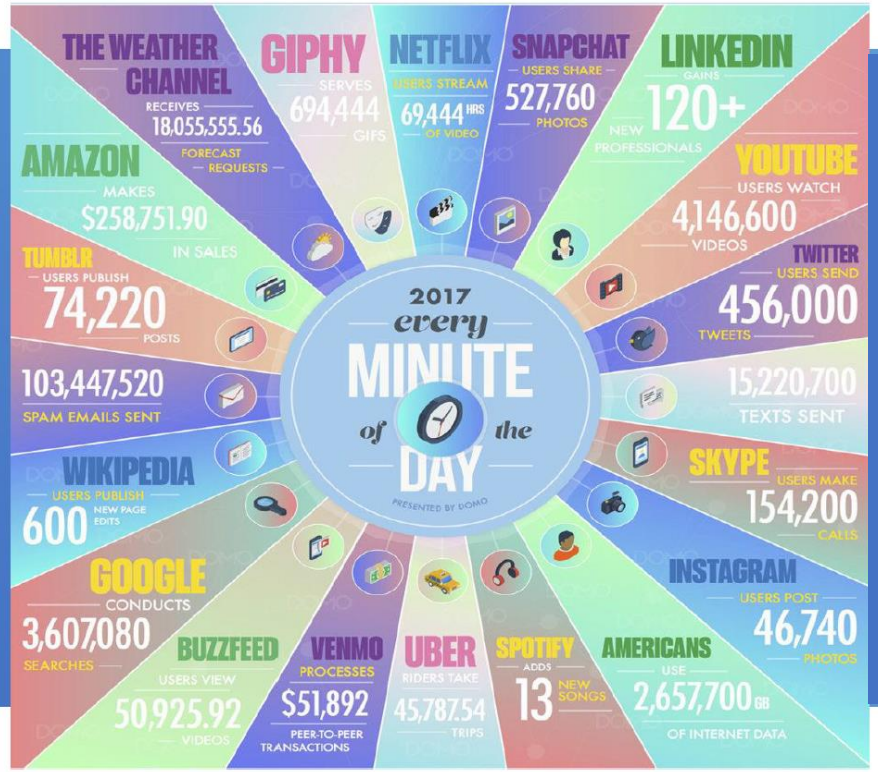
**Realizing the Potential of Data Science.**
F. Berman, R. Rutenbar, B. Hailpern, H. Christensen, S. Davidson, D. Estrin, M. Franklin, M. Martonosi, P. Raghavan, V. Stodden, A. S. Szalay. Communications of the ACM, April 2018, Vol. 61 No. 4, Pages 67-72

# Data Science

- Data science is an **inter-disciplinary field** that uses scientific methods, processes, algorithms and systems to **extract knowledge and insights from many structural and unstructured data**.
- Data science is related to data mining, machine learning and big data.
- Data science is a "concept to unify statistics, data analysis and their related methods" in order to **"understand and analyze actual phenomena" with data** [1].
- It uses techniques and theories drawn from many fields within the context of mathematics, statistics, computer science, domain knowledge and information science.


- [1] Hayashi, Chikio (1 January 1998). "What is Data Science? Fundamental Concepts and a Heuristic Example". In Hayashi, Chikio; Yajima, Keiji; Bock, Hans-Hermann; Ohsumi, Noboru; Tanaka, Yutaka; Baba, Yasumasa (eds.). Data Science, Classification, and Related Methods. Studies in Classification, Data Analysis, and Knowledge Organization. Springer Japan. pp. 40–51. doi:10.1007/978-4-431-65950-1_3. ISBN 9784431702085.

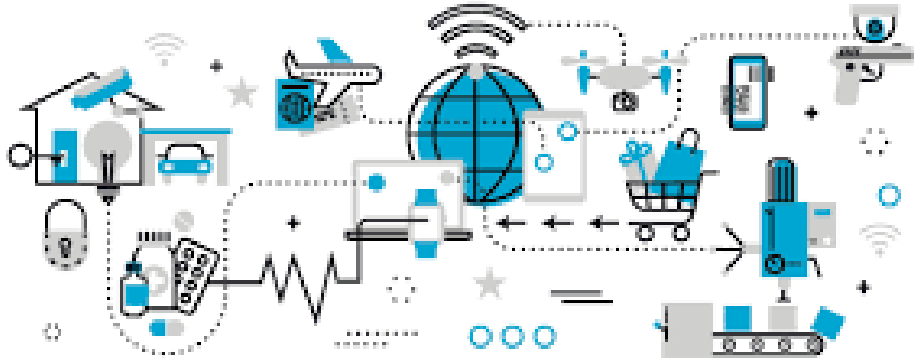
# Why do we need data science?




**Each minutes on Internet:**

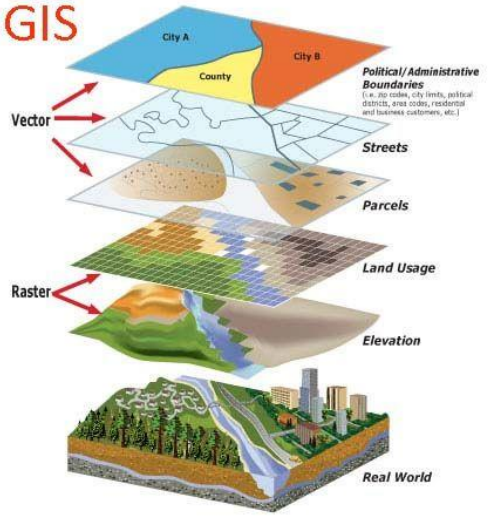
- **More than 4 millions of viewed films**
- **More than 3.5 millions of requests on research engines**
- **15 millions of messages**
- **103 millions of spam email**

# Where are Big Data from?

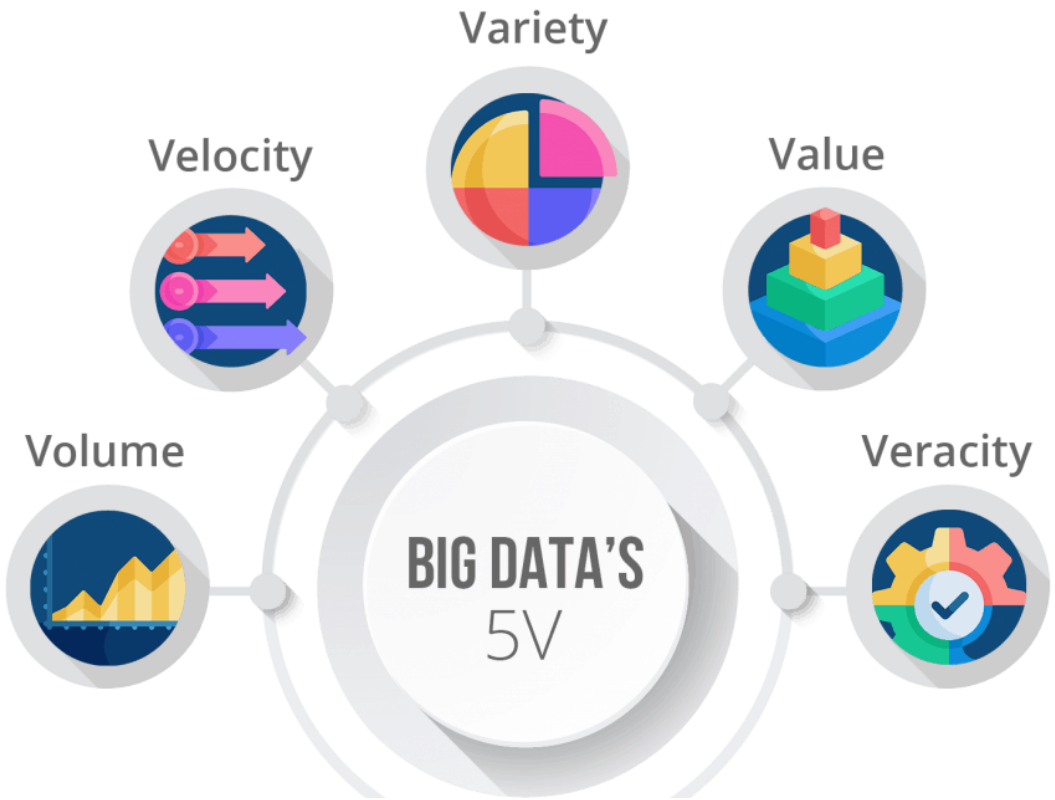
INTERNET OF THINGS

**Knowledge and value!**

# Big data and Data science


- Data are usually available in large volumes, which are presented in different formats (often without structure) and with heterogeneous characteristics, produced and disseminated generally with a high frequency, and which often change over time




- With the advent of big data and the idea of "data value", Data Science becomes a holistic science, which has as its objective the extensive enhancement of the large heterogeneous amount of data from different sources.
- Data science helps make informed and sustainable decisions based on data through the use of models (multi-objective) and different analytical approaches (optimization and / or machine learning).

# Data science and Big data

# DATA SCIENCE

PROBLEMS



EXTRACTION

CLEANING

OPTIMIZATION

ANALYSIS

PREDICTION

VISUALIZATION

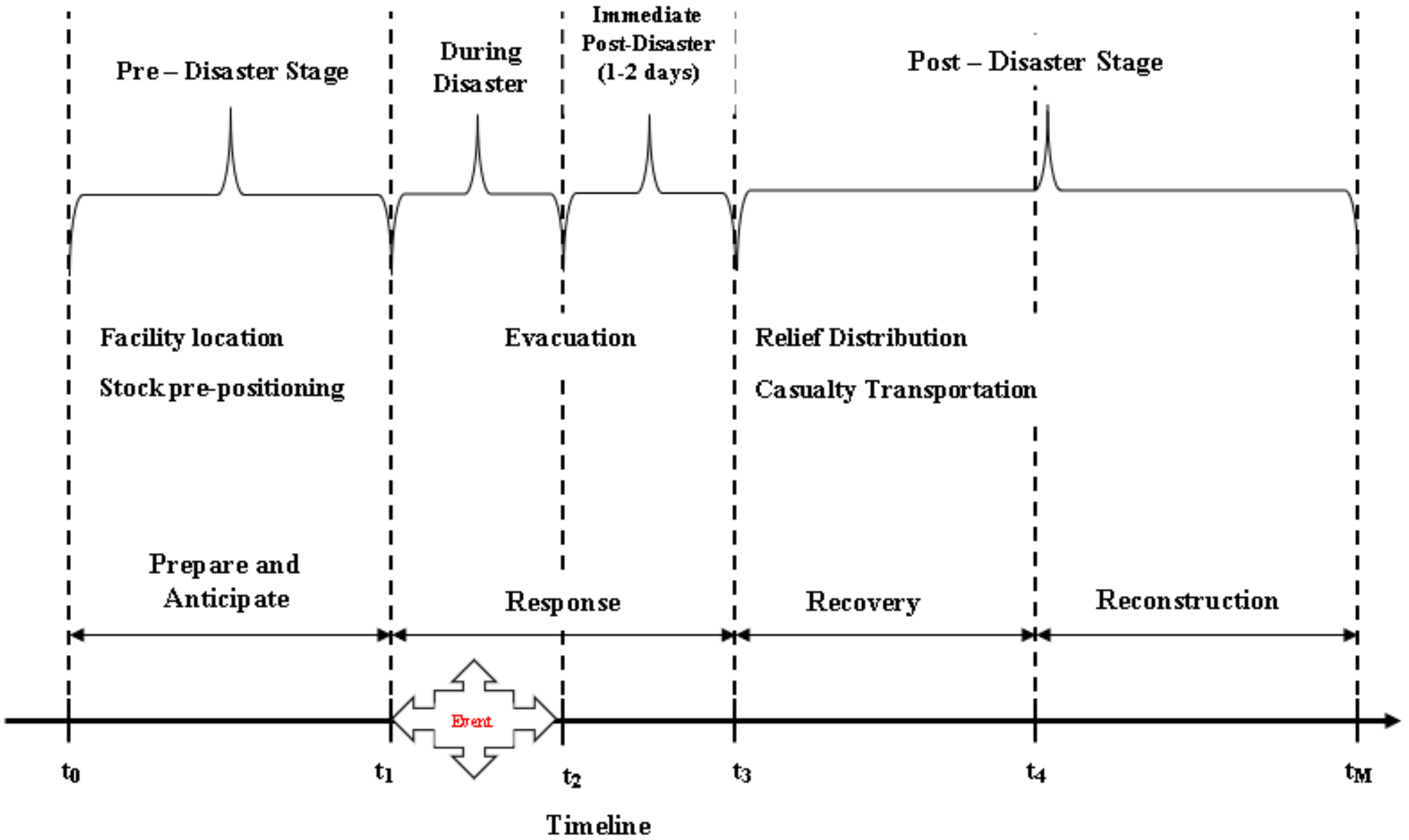
# Data Science for Emergency

How data and data science can help to deal with natural disaster?

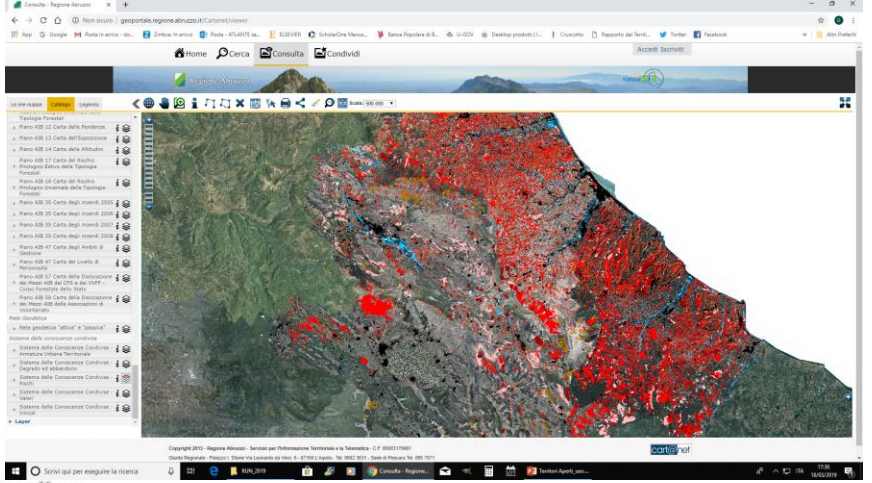
IoT4Emergency

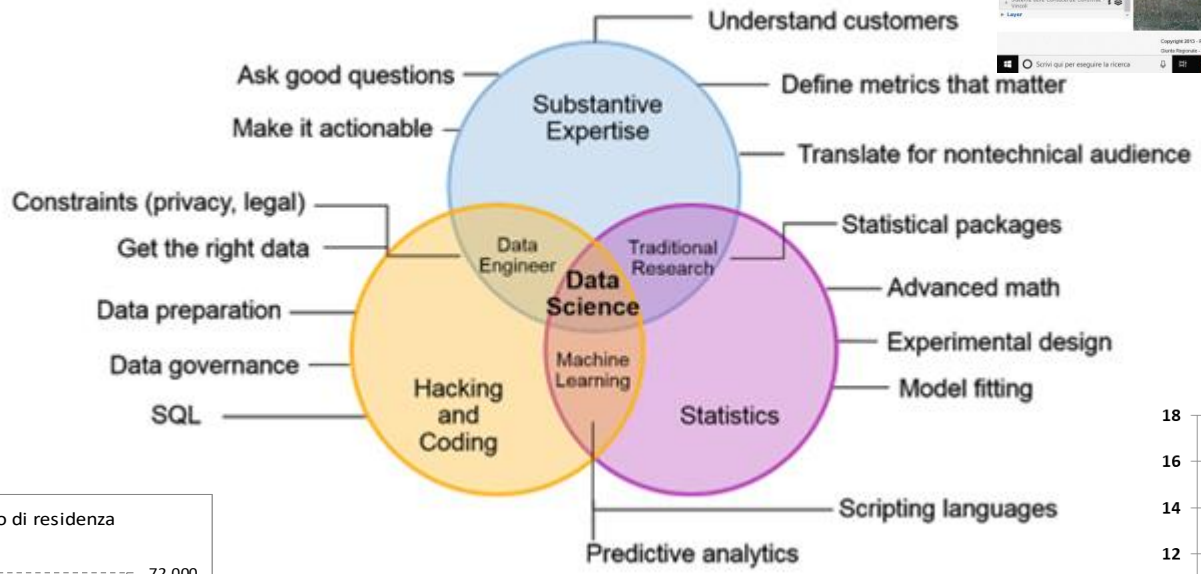
10/7/2020

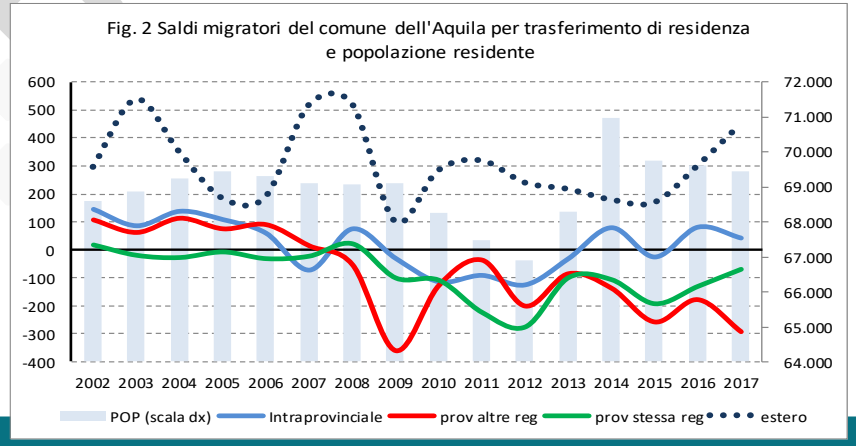
# Phases of a natural disaster

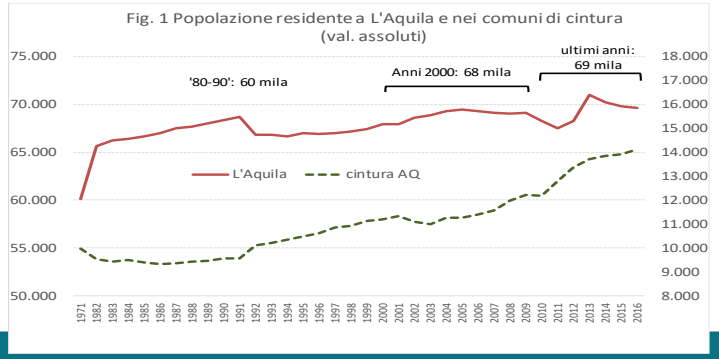


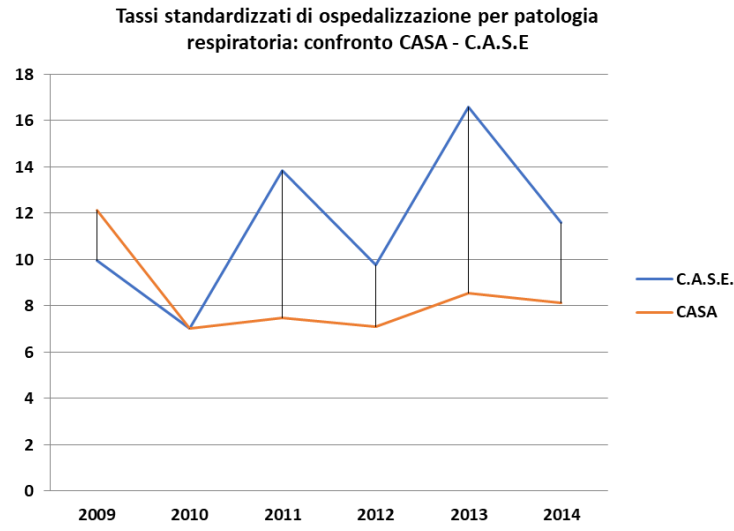
# How data science can help?



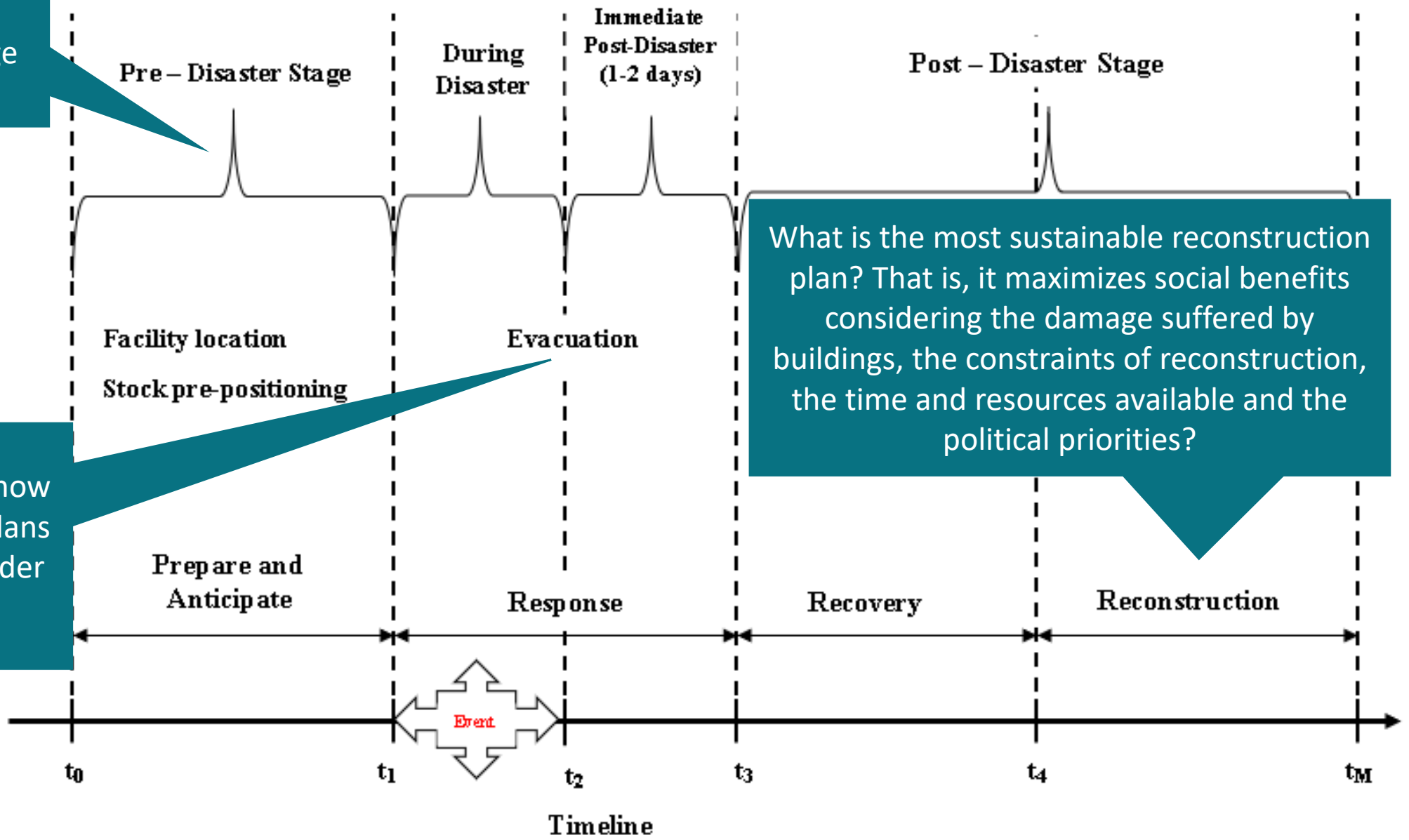



What is the best positioning of the emergency and storage facilities?

## How data science can help?

How to choose the available shelters and how to define evacuation plans (humas and cars) in order to minimize total evacuation times?



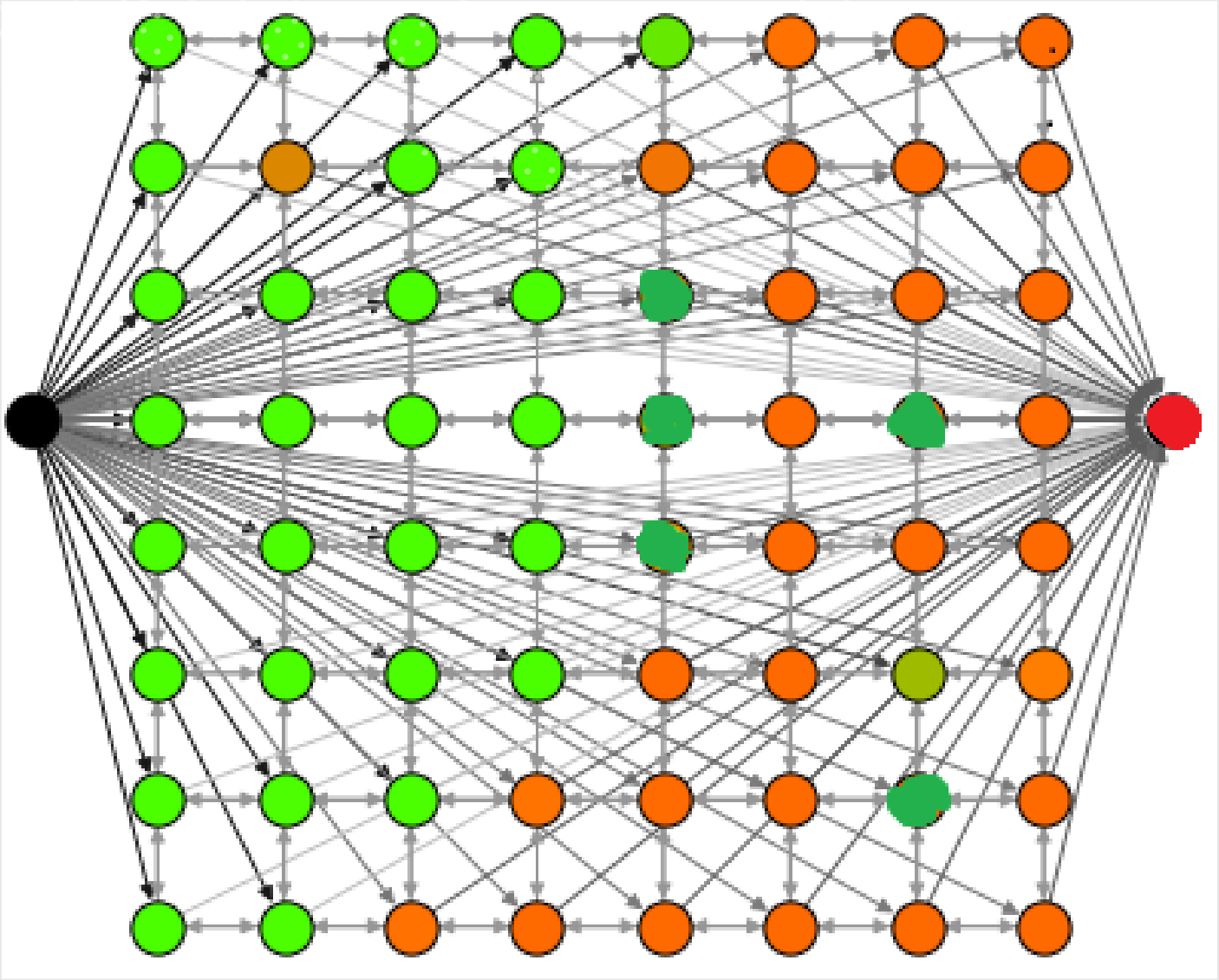

What is the most sustainable reconstruction plan? That is, it maximizes social benefits considering the damage suffered by buildings, the constraints of reconstruction, the time and resources available and the political priorities?

# Evacuation Plan

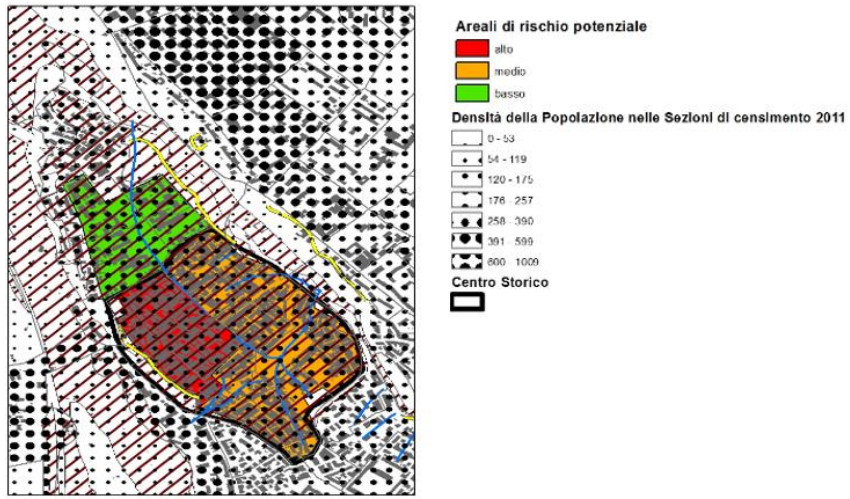
# Evacuation Plan definition

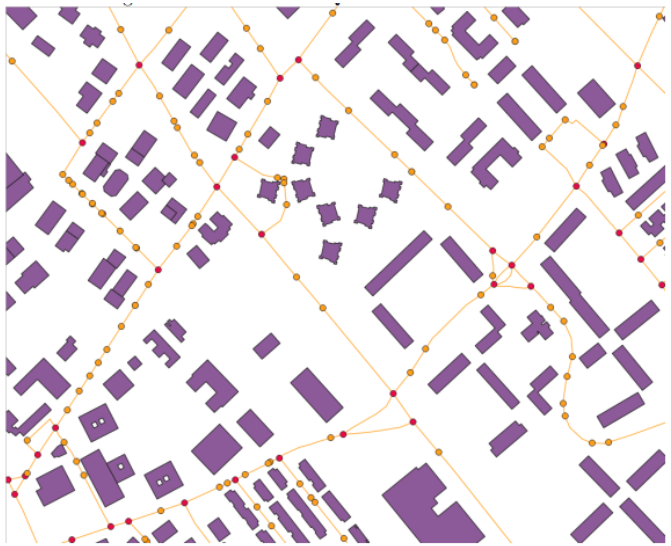
- Emergency evacuation plan needs to
  - find the safe area at nearby location,
  - Find the safe route to reach there
  - Correct division of evacuees proceeding to safe areas
  - Guide people using the plan

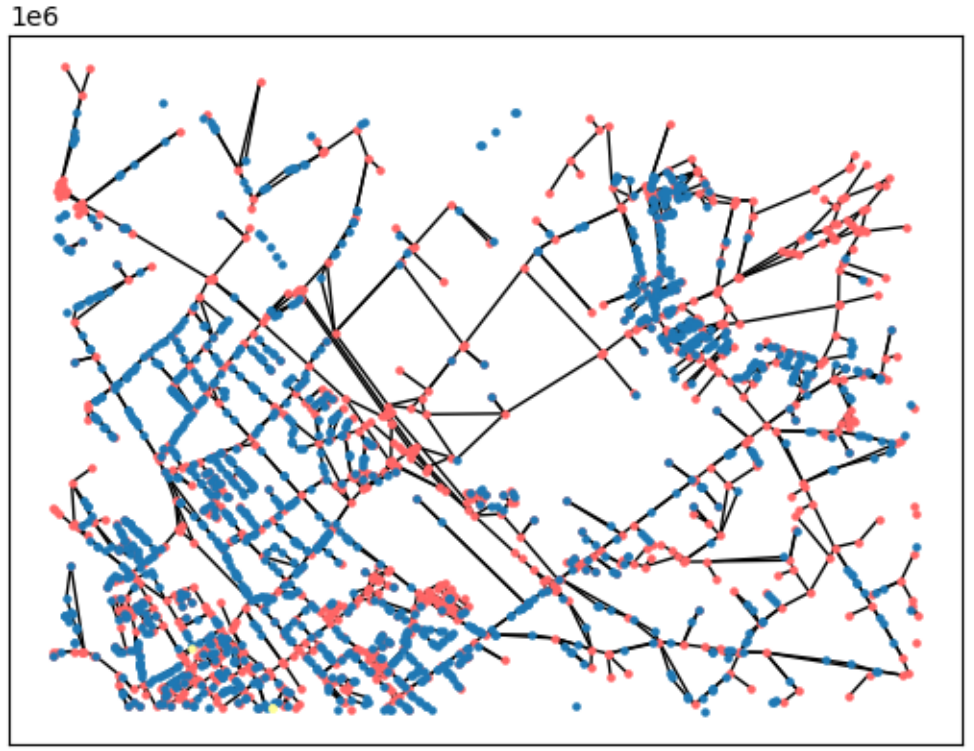
# Evacuation plan definition: Multi-source multi-sink maximum flow problem with capacity

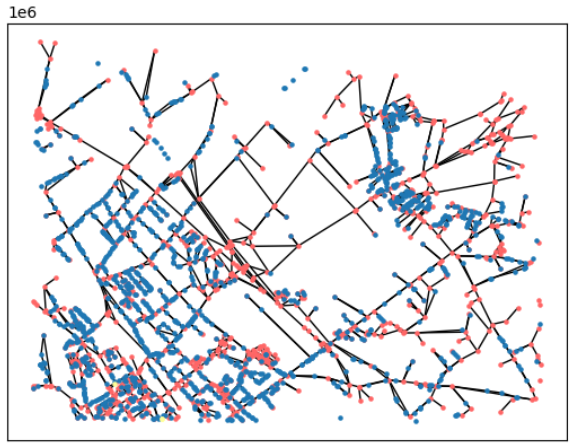


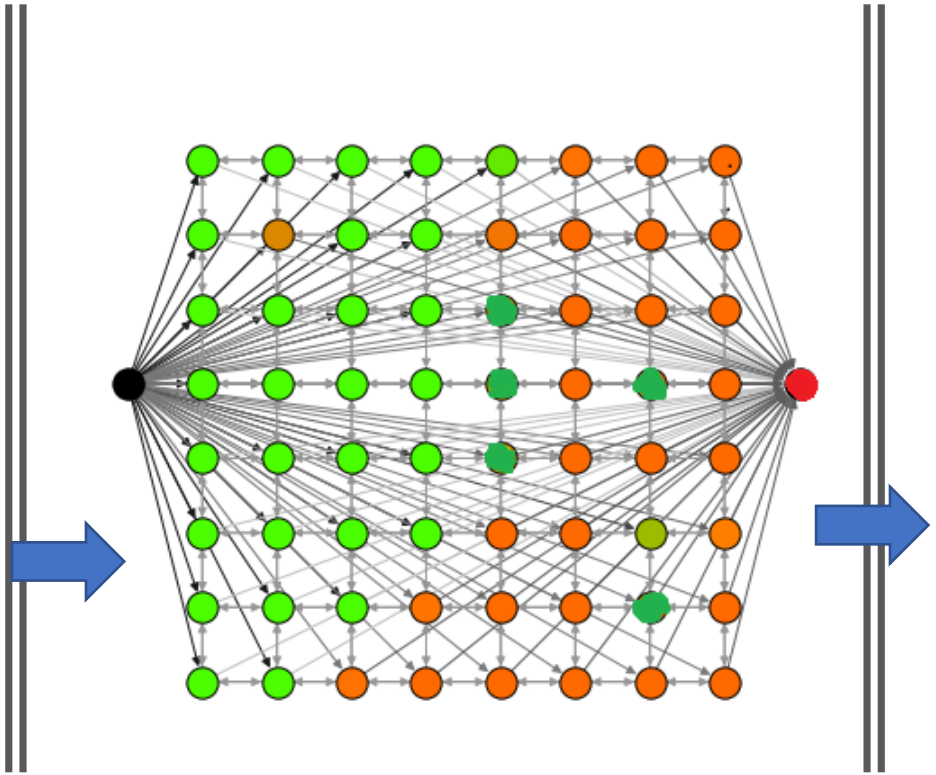
# From data to graph



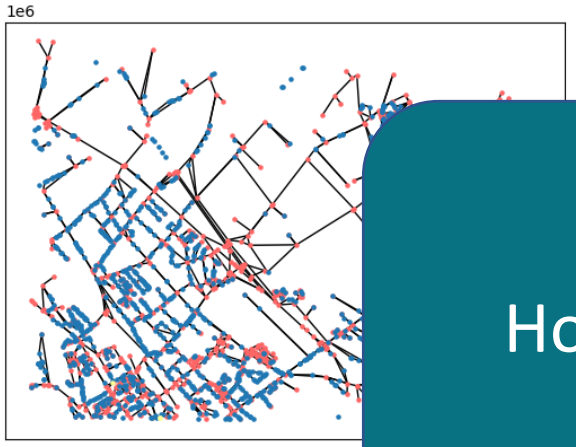







# The graph is used as network for the Multi-source multi-sink maximum flow problem with capacity




How to consider the human behavior?

The graph is used as network for the Multi-source multi-sink maximum flow problem with capacity

# Social-based Physical Reconstruction Planning

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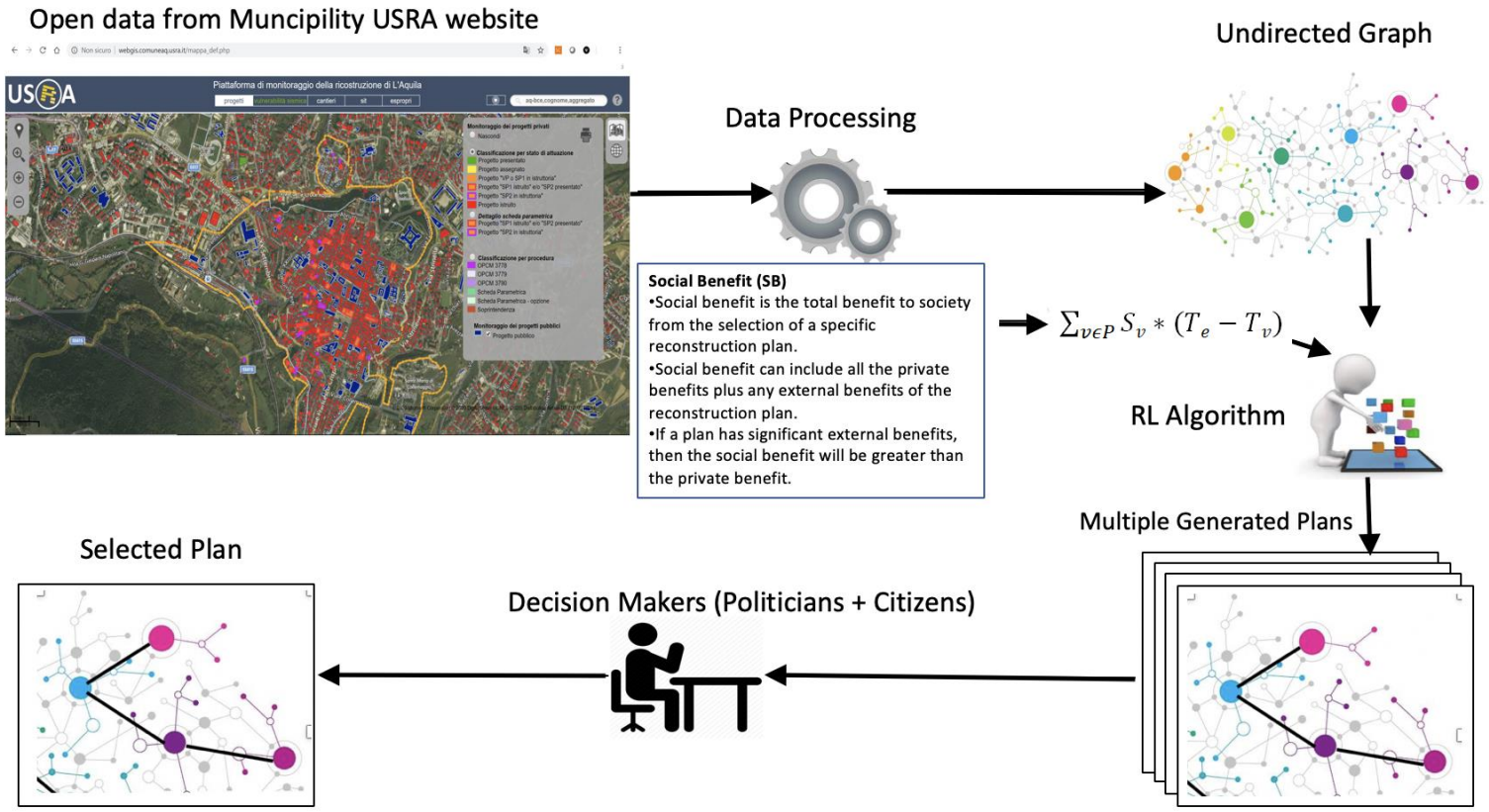
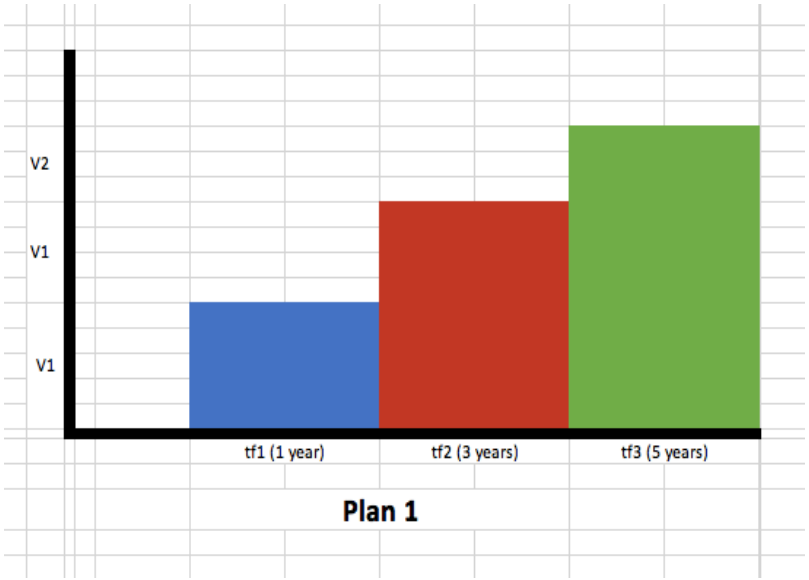
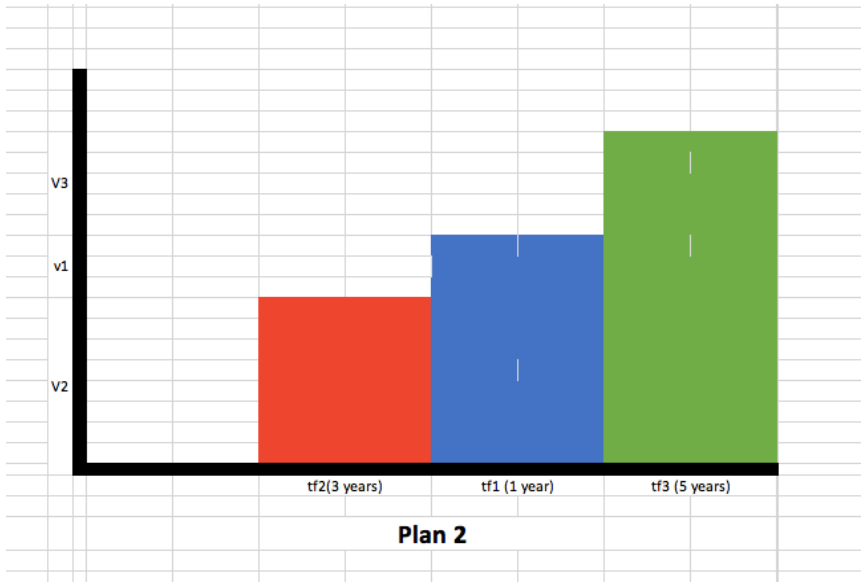
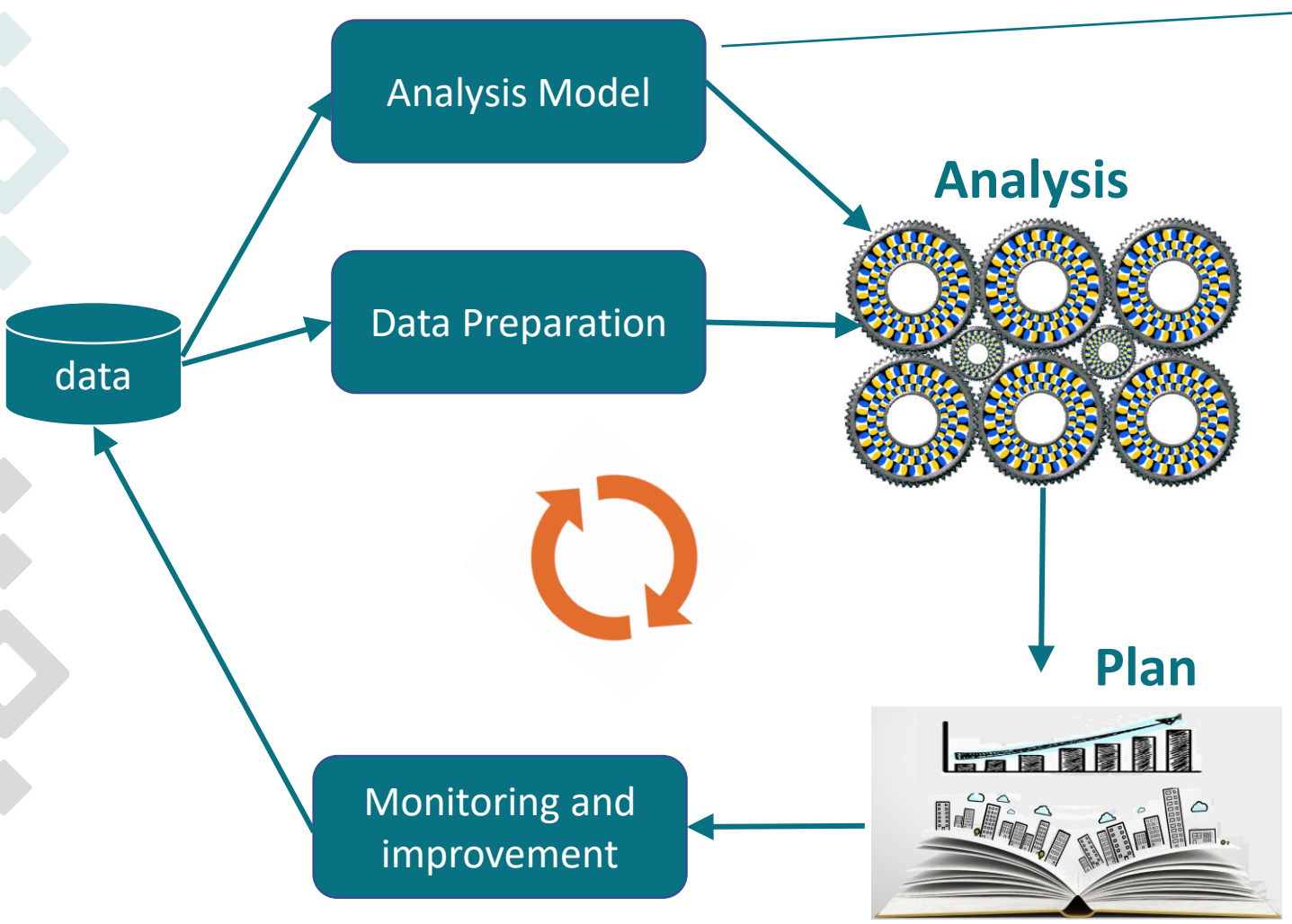


# It is not enough to identify the units to be rebuilt: the order is important

- Plan $P_1 = \{(v_1,t_{f1}), (v_2,t_{f2}) , (v_3,t_{f3})\}$
- Plan $P_2 = \{(v_2,t'_{f2}), (v_1,t'_{f1}) , (v_3,t'_{f3})\}$






$$P = \{(t_0, v_0), (t_1, v_1)(t_2, v_2)(t_3, v_3)....\}$$

$$max \sum_{p \in P} S_b(t_p, v_p).(t_e - t_p)$$

$$S_b(t, v) = \left[\alpha.b_v + \beta \left( \sum_{u \in N_v, S_u^t == 1} \frac{S_u(t)}{d(u, v)} \right)\right]^{\gamma(\Delta t)}$$

$$\Delta t = (t_e - (t + t_v))$$

$$\gamma \in [0 \ldots \infty \in R^t]$$

$$\alpha, \beta \in [0, 1], \ \alpha + \beta = 1$$

# Data Science Process

# Conclusion

- A multitude of data available by nature, source, semantics
- Established data analytics approaches (based on machine learning and optimization) available to be adapted
- Data science can support to outline new and better reconstruction processes and emergency management.
- Difficult task: to extract useful data
- Open issue: Consider human preferences and behavior in disaster management and emergency. We can and we have to put people in the center of processes!