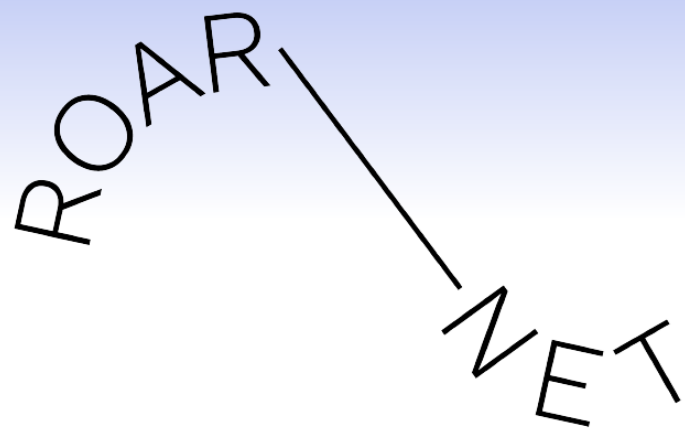
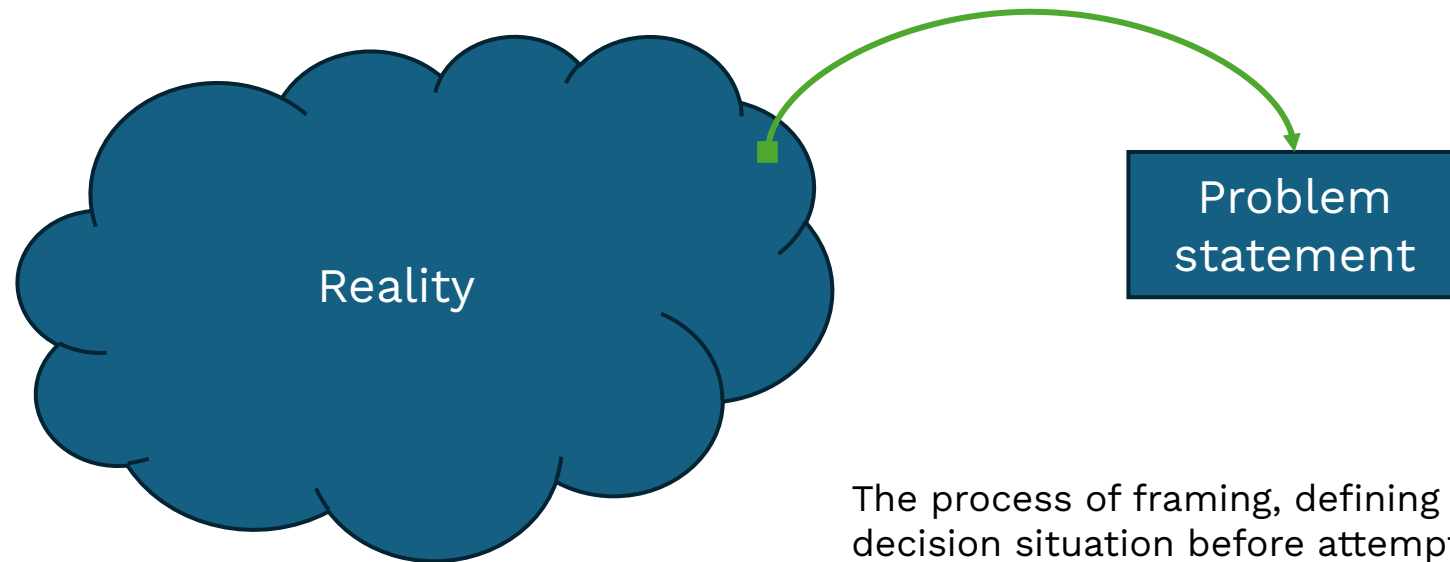




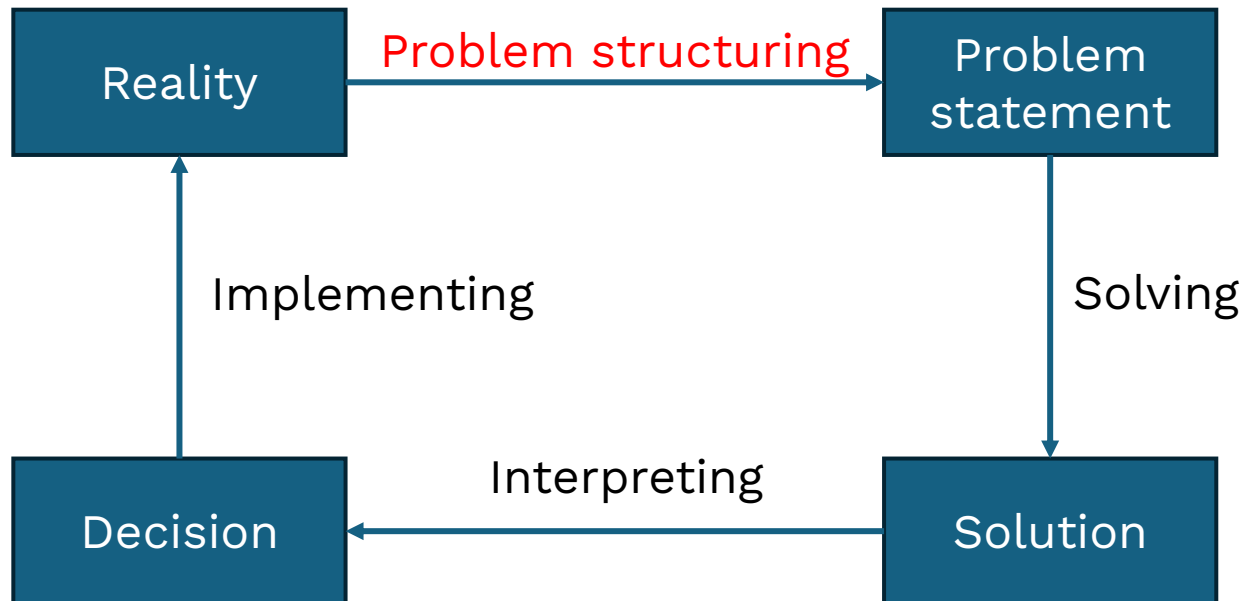
Problem structuring

Pieter Smet pieter.smet@kuleuven.be



The process of framing, defining and organizing a complex decision situation before attempting a solution.

Or, going from a messy real-world situation to a well-defined optimization task.

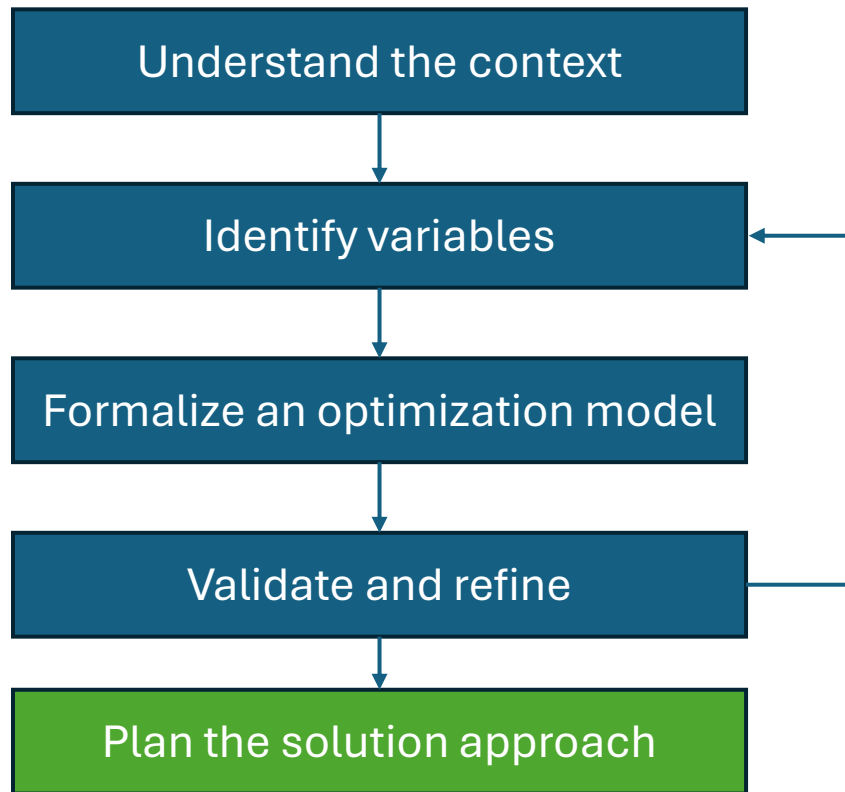


- More qualitative than quantitative.
- Focuses on what the problem is, not how to solve it.
- Usually the first phase of an OR project.
- Poor structuring can lead to solving the wrong problem.
- Identifies goals, constraints, stakeholders and uncertainties.
- Maps out data requirements

The goal is to create a detailed description of the optimization task

Problem statement

- Which decisions make up a solution? (the decision variables)
- How is the quality of a solution defined? (the objective function(s))
- Which restrictions are there on the decisions? (the constraints)
- The (known) data that characterizes a problem instance
- The data that defines a solution



Who is involved or affected? What is the organization trying to achieve?

What decision can be made? What can actually be changed?

What are suitable decision variables? How are they constrained? What is the objective function?

Does the optimization model match the stakeholder understanding?

3 application cases

- District heating and cooling design
- Event organization
- Hospital management

6 groups (2 per case)

Task: to derive a problem statement from a scenario

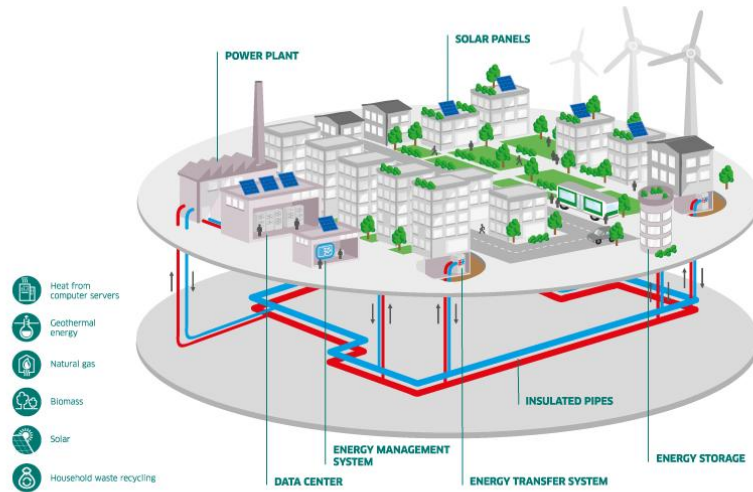
Presentation tomorrow of the outcome

- Focus on the process, lessons learned
- 10 minutes per group + 5 minutes Q&A

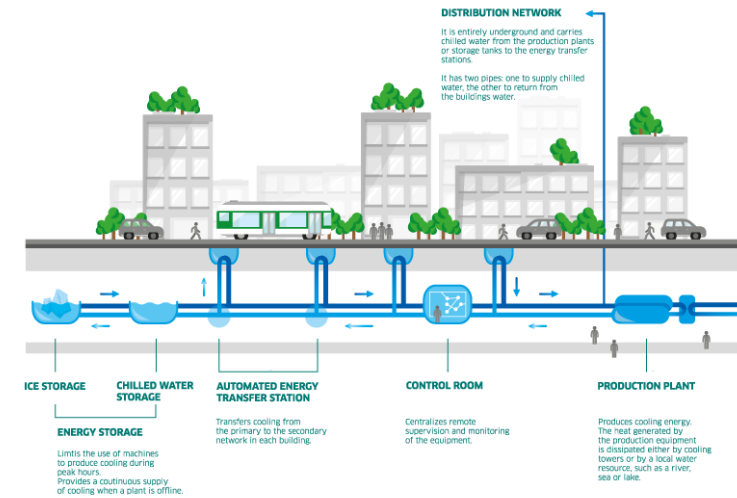
District heating and cooling

District heating and cooling networks

Heating Networks

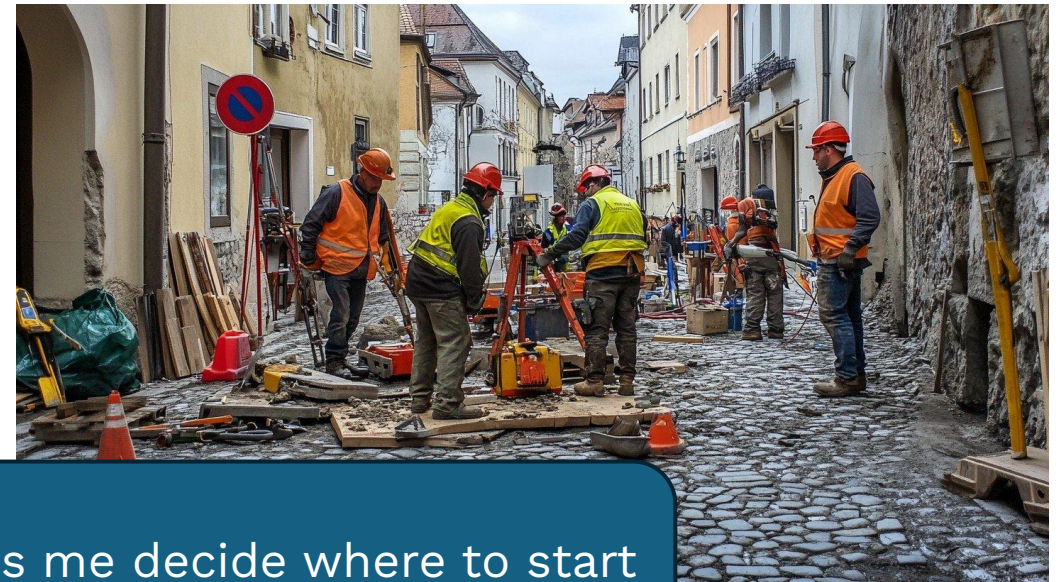


Cooling Networks



<https://www.thermalearth.co.uk/blog/172/What-is-a-District-Heating-Network?>
<https://www.engie.com/en/businesses/district-heating-cooling-systems>

District heating and cooling networks



“As a manager, I need a tool that helps me decide where to start construction on network extensions to connect new buildings.”

There are several practical aspects to construction of DHC networks:

- New pipes must follow public roads (as much as possible)
... but pre-existing pipe does not strictly follow public roads.
- You cannot lay pipes under buildings (except the one you want to connect).
- Laying pipes 'off-street' (i.e. not following public roads) is much more costly than laying pipes under public roads.
- Some buildings have multiple connection points.
- Different buildings have different demand requirements, which impact pipe diameter.

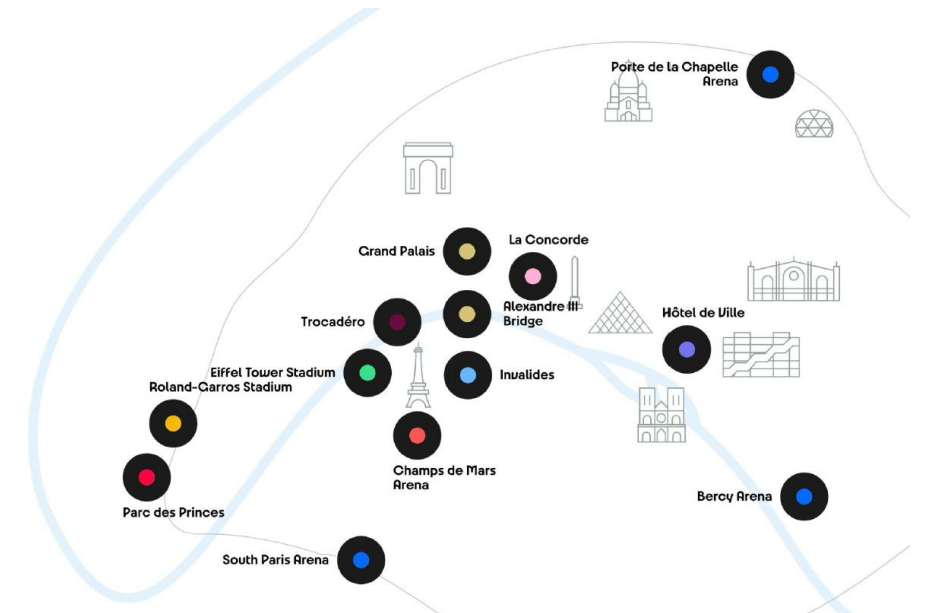
Event organization

145k volunteers for 50k positions

Examples of positions:

- 5 volunteers for traffic flow at Roland Garros, parking A, August 3, 14:00-19:00
- 3 volunteers for crowd management at La Concorde, June 27, 17:00-22:00

“As an event organizer, I need help in filling in the positions with suitable volunteers.”



<https://www.olympics.com/>

Since we are dealing with people, it is important to consider several aspects:

- Their skills
 - This includes hard skills such as driving license, language proficiency, medical qualifications, but also soft skills such as crowd management, leadership.
- Their preferences
- Their availability
- Their location
- Gender balance
- Other fairness aspects

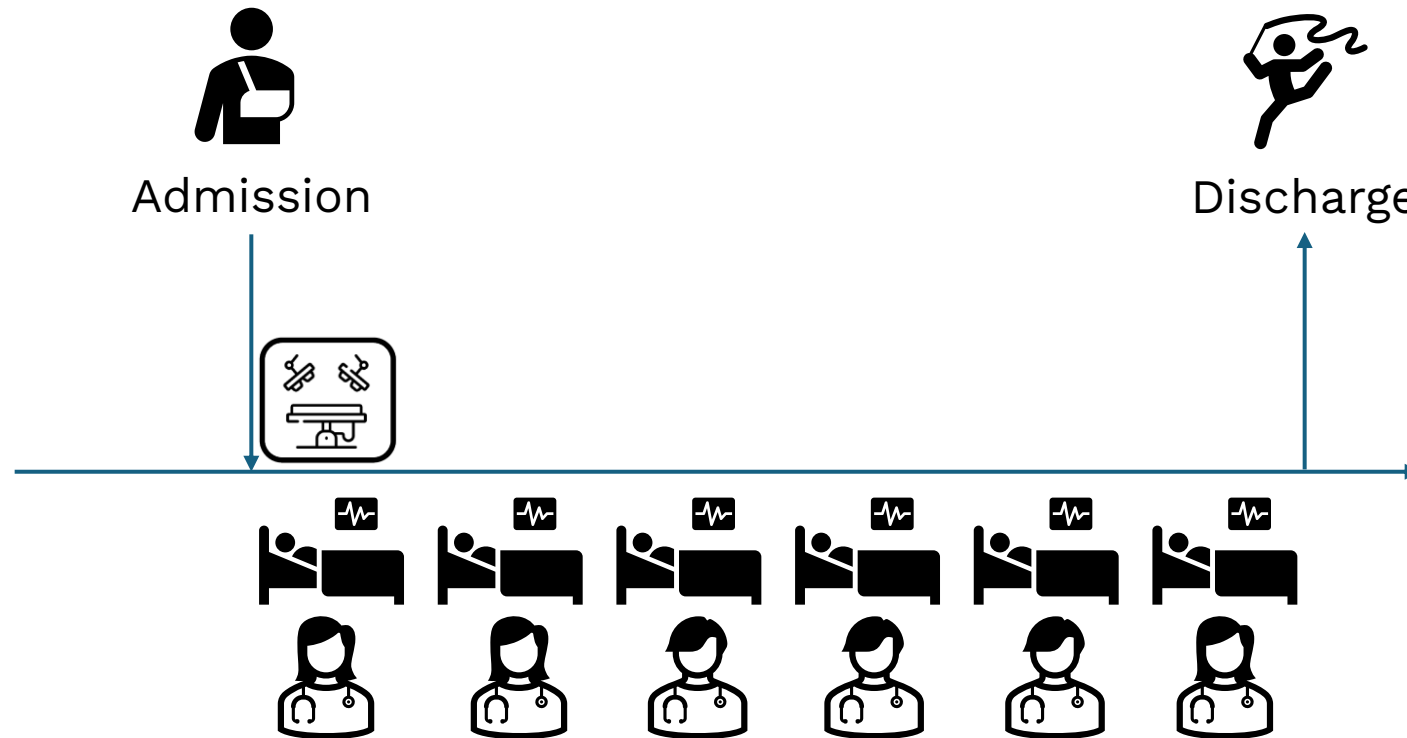


<https://www.olympics.com/>

Some skill requirements are proportional: only some of the volunteers in a position must have certain skills, rather than everyone.

For example, at least 80% of volunteers assigned to entrance A of Stade de France on July 29 should be French-speaking.

Hospital management





Nurses



Beds



Operating
theaters

Clinical pathways of patients require multiple resources from different departments

“As a hospital manager, I need a tool to support me in efficiently deploying the scarcest resources in my hospital.”

Some considerations:

- Operating theaters are the profit centers of hospitals.
- Some surgeries are more urgent than others.
- The required care during recovery typically varies from patient to patient, from day to day, and from hour to hour.
- Nurses know their rosters long before patient admission dates are determined.
- There is a lot of uncertainty concerning the patients: their length of stay, their surgery duration...
- Not all surgeons (and their teams) are not available 24/7.

Acknowledgments

This presentation is based upon work from COST Action Randomised Optimisation Algorithms Research Network (ROAR-NET),CA22137, supported by COST (European Cooperation in Science and Technology).

COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

