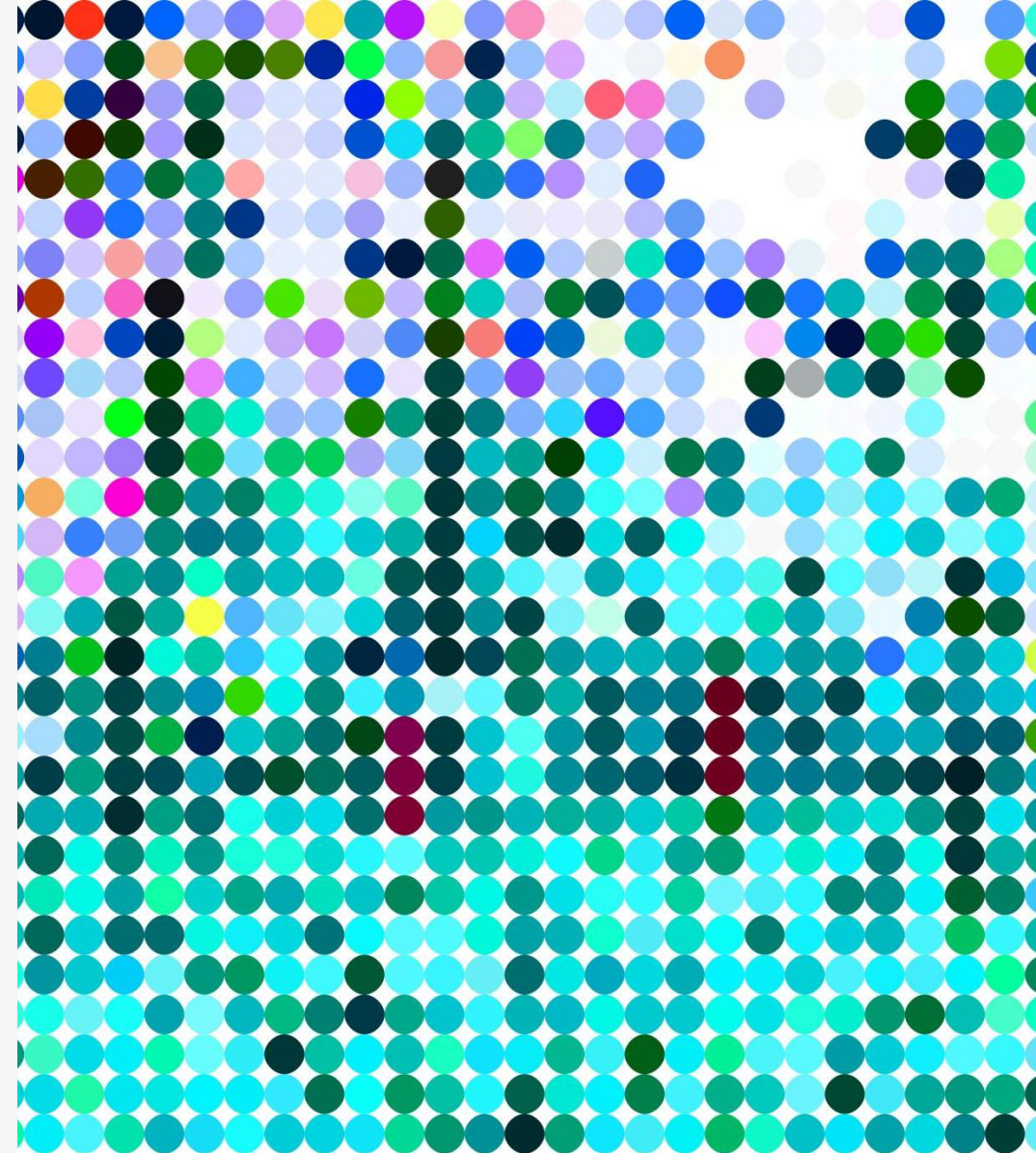


DecidArch

A game on making architecture decisions

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My background

- Managing partner, ArchiXL
- Research fellow 'Digital Architecture', Vrije Universiteit Amsterdam
- Lecturer 'Digital Architecture' course, Vrije Universiteit Amsterdam

Agenda

- Architecture and Decision Making
- Explanation of the Game
- Let's Play!
- Reflection

Question

- How would you define '(Digital) Architecture'?

Evolution of 'Architecture'



2000

2011

2022

- Architecture is:
 - The fundamental organization of **a system** embodied in its components, their relationships to each other, and **to the environment**, and the principles guiding its design and evolution.

(From IEEE 1471:2000 Recommended Practice for Architectural Description of Software-Intensive Systems)

Evolution of 'Architecture'

2000

2011

2022

- Architecture is:
 - The fundamental concepts or properties of a **system in its environment** embodied in its elements, relationships, and in the principles of its design and evolution

(From ISO/IEC/IEEE 42010:2011 Systems and software engineering – Architecture description)

Evolution of 'Architecture'

2000

2011

2022

- Architecture is:
 - the fundamental concepts or properties of **an entity** in its environment and governing principles for the realization and evolution of this entity and its related life cycle processes.

(From ISO/IEC/IEEE 42010:2022 Software systems and enterprise – Architecture description, 2022)

Examples (from 42010:2022):

Enterprise, organization, solution, **system (including software systems)**, subsystem, process, business, data, application, information technology, mission, product, service, software item, hardware item, product line, family of systems, system of systems, collection of systems, collection of applications.

Quiz intermezzo 1

Which of options A and B would you choose?

- A: you have a 100% chance to win \$9500
- B: you have a 95% chance to win \$10000, and a 5% chance to win nothing

Quiz intermezzo 2

Which of options A and B would you choose?

- A: you have a 100% chance to loose \$500
- B you have a 5% chance to loose \$10000, and a 95% chance to loose nothing

Architecture is Decision Making!

- Classical view on architecture:
 - Architecture is the blueprint of the system
 - Architecture describes the structure (components, connectors)
- Alternative (complementary) view:
 - Architecture is the manifestation of architectural design decisions

Architecture design as a “wicked” problem

- There is no definite formulation
- There is no stopping rule
- Solutions are not simply true or false
- Every wicked problem is a symptom of another problem

Interaction between problem and solution

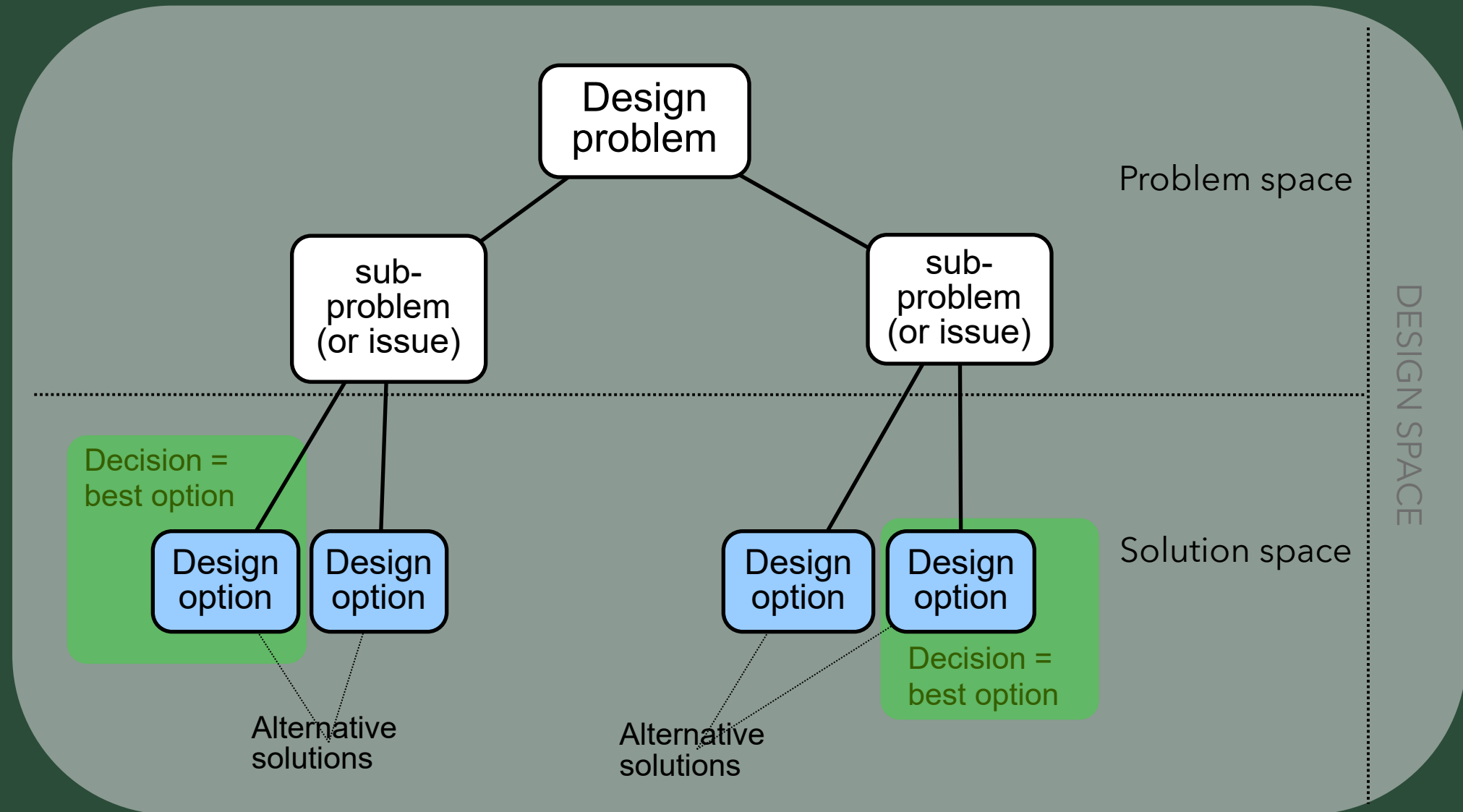
- “your requirement is my decision”
- Decisions lead to new problems and requirements, which need further decisions ...



Design as a series of decisions

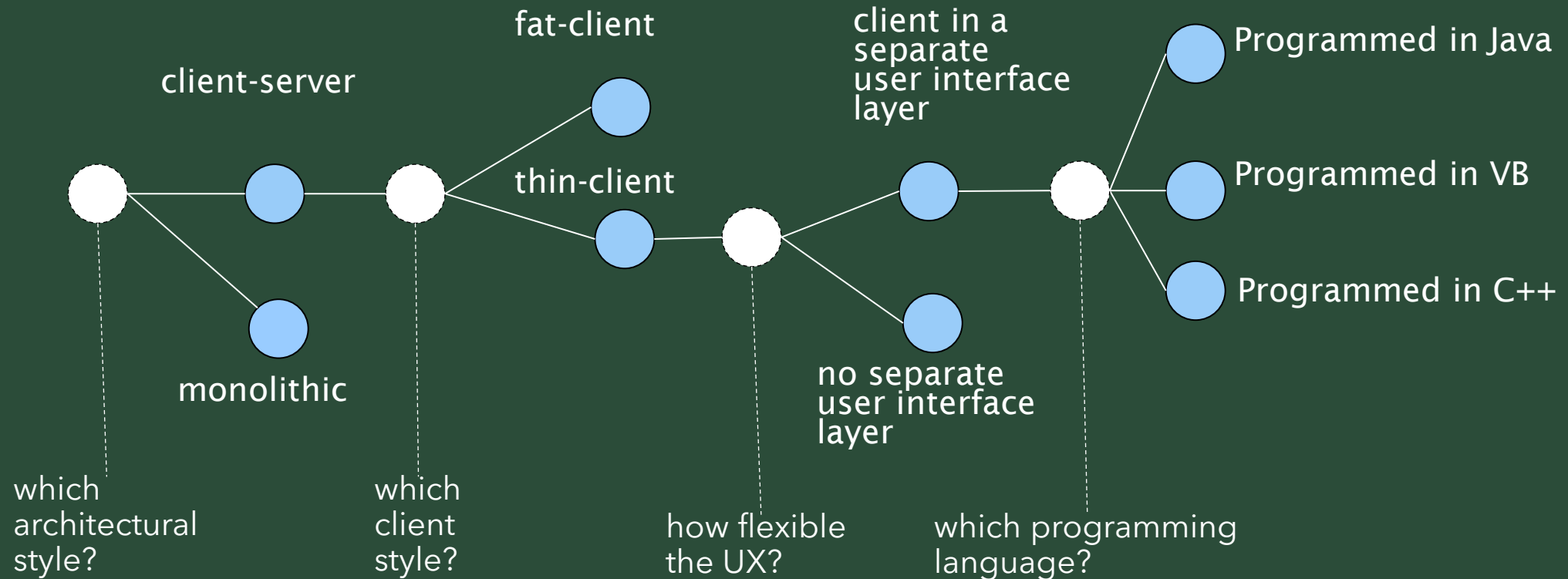
- An architect is faced with a series of **design issues** (or **concerns**)
 - These are sub-problems of the overall design problem
 - Each issue normally has several alternative solutions (or **design options**)
 - The architect makes a **design decision** to resolve each issue.
 - This **decision making process** involves choosing the “best” option among the possible alternatives.

Taking decisions



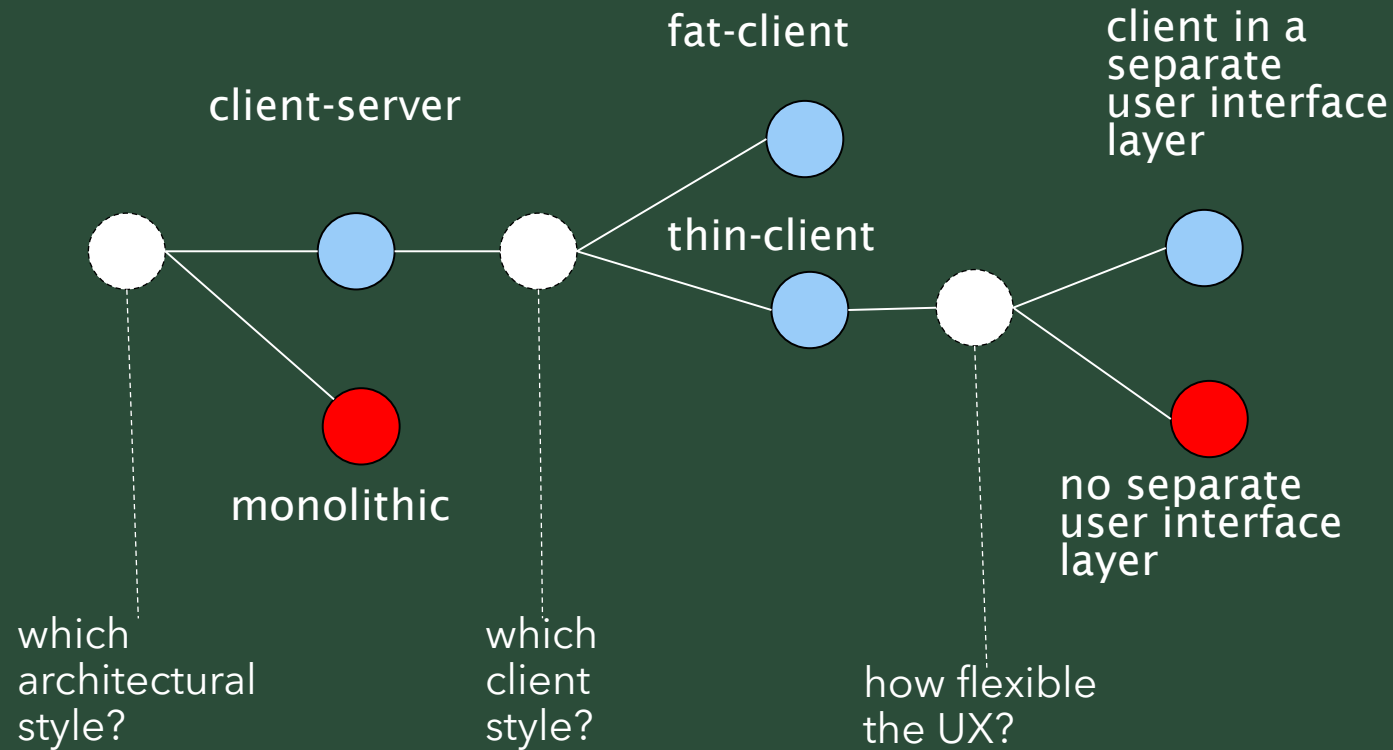
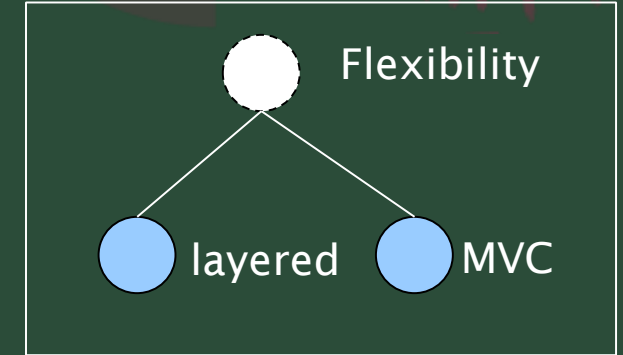
Design space

- The space of possible designs that can be achieved by choosing different sets of alternatives.
- Problem space + solution space



Tree or graph?

- Concerns and options are not independent



The game

- Focuses on the decision making process
 - Multiple stakeholders, each with their own concerns
 - Various design options, each with their own pros and cons

→ You will have to make trade-offs

+ You will have to co-operate

DecidArch

- In the game, you work together as a team of architects to design a software-intensive system for a project and its stakeholders.
- Your goal: address all stakeholders' concerns within the time limit, and ensure all stakeholders are satisfied.

Cards in the game



Project Card

Project:

Social News Platform

Purpose:

The Social News Platform is a digital system that allows users to write, share and read news articles.

Describes the project



Stakeholder Card

Stakeholder:

User

Goal:

The User reads news articles written or shared by other users. Those who write and share articles are often journalists or activists.

Quality Attributes:

Usability – QA-Priority: 2

The system should be easy to use.

Security – QA-Priority: 1

The system should protect the information of the user from unauthorized access.

Performance – QA-Priority: 2

The system should be able to process and fulfill the users' requests fast.

Describes a stakeholder



Concern Card

Concern-ID:

1

Concern:

The users need to be able to upload articles on the platform. How will the system store these articles?

Options:

1. Store the articles in multiple distributed databases owned by the Owner.

Security (+), Performance (+), Availability (+), Maintainability (-)

2. Upload the articles in the cloud owned by an external cloud provider.

Security (-), Performance (+), Availability (+), Maintainability (+ +)

3. Store the articles in a single local database owned by the Owner.

Security (+), Performance (-), Availability (-), Maintainability (+)

Describes a concern and design options



Event Card

Title:

New CTO

Description:

The owner hires a new CTO, who is not amused by the amount of money that is spent on code maintenance. She decides that maintenance is now the top priority for all projects, including yours.

Consequences:

The Owner's QA-Priority for *Maintainability* is set to 3.

Describes an event

Project and stakeholders

Project Card

Project:

Social News Platform

Purpose:

The Social News Platform is a digital system that allows users to write, share and read news articles.

Stakeholder Card

Stakeholder:

User

Goal:

The User reads news articles written or shared by other users. Those who write and share articles are often journalists or activists.

Quality Attributes:

Usability – QA-Priority: 2

The system should be easy to use.

Security – QA-Priority: 1

The system should protect the information of the user from unauthorized access.

Performance – QA-Priority: 2

The system should be able to process and fulfill the users' requests fast.

Stakeholder Card

Stakeholder:

Owner

Goal:

The Owner will maintain the system during its lifetime.

Quality Attributes:

Availability – QA-Priority: 2

The system is to remain available to achieve a high uptime.

Security – QA-Priority: 0

The system should protect the information of the user from unauthorized access.

Maintainability – QA-Priority: 1

The system is to take a minimum amount of effort by the owner to maintain it.

Templates

- Players use templates to record their design decisions
 - Decision Preparation Templates for individual suggestions
 - Decision Taking Template for group decisions

Decision Preparation Template (Individual)

Each player gets an individual template

Group-ID:

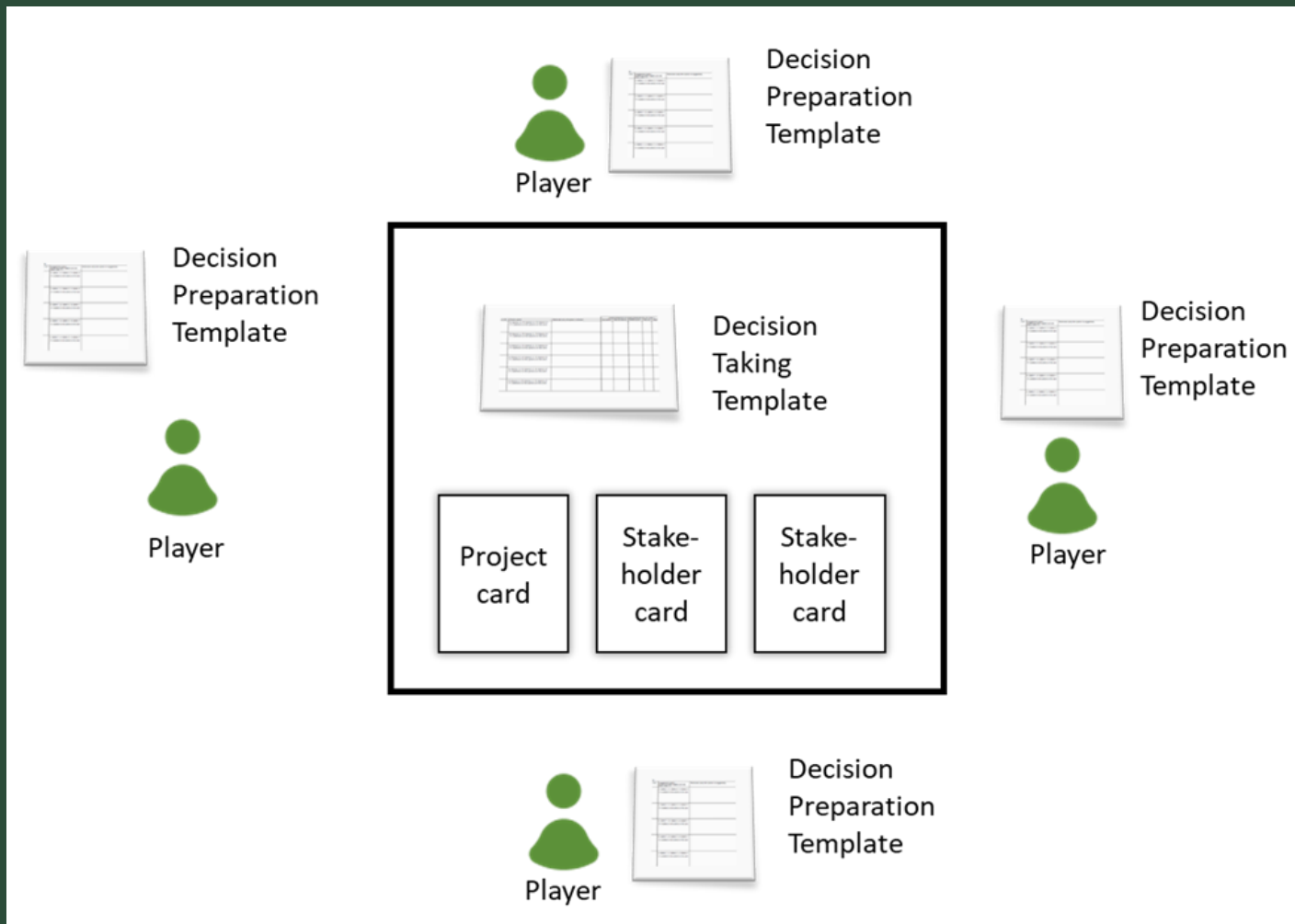
Concern-ID	Suggested Option <i>tick the box and/or suggest your own option under <?></i>	Rationale (why the option is suggested)
	☐ Option 1, ☐ Option 2, ☐ Option 3 <?> Additions to the options on the card:	
	☐ Option 1, ☐ Option 2, ☐ Option 3	

Decision Taking Template (Group)

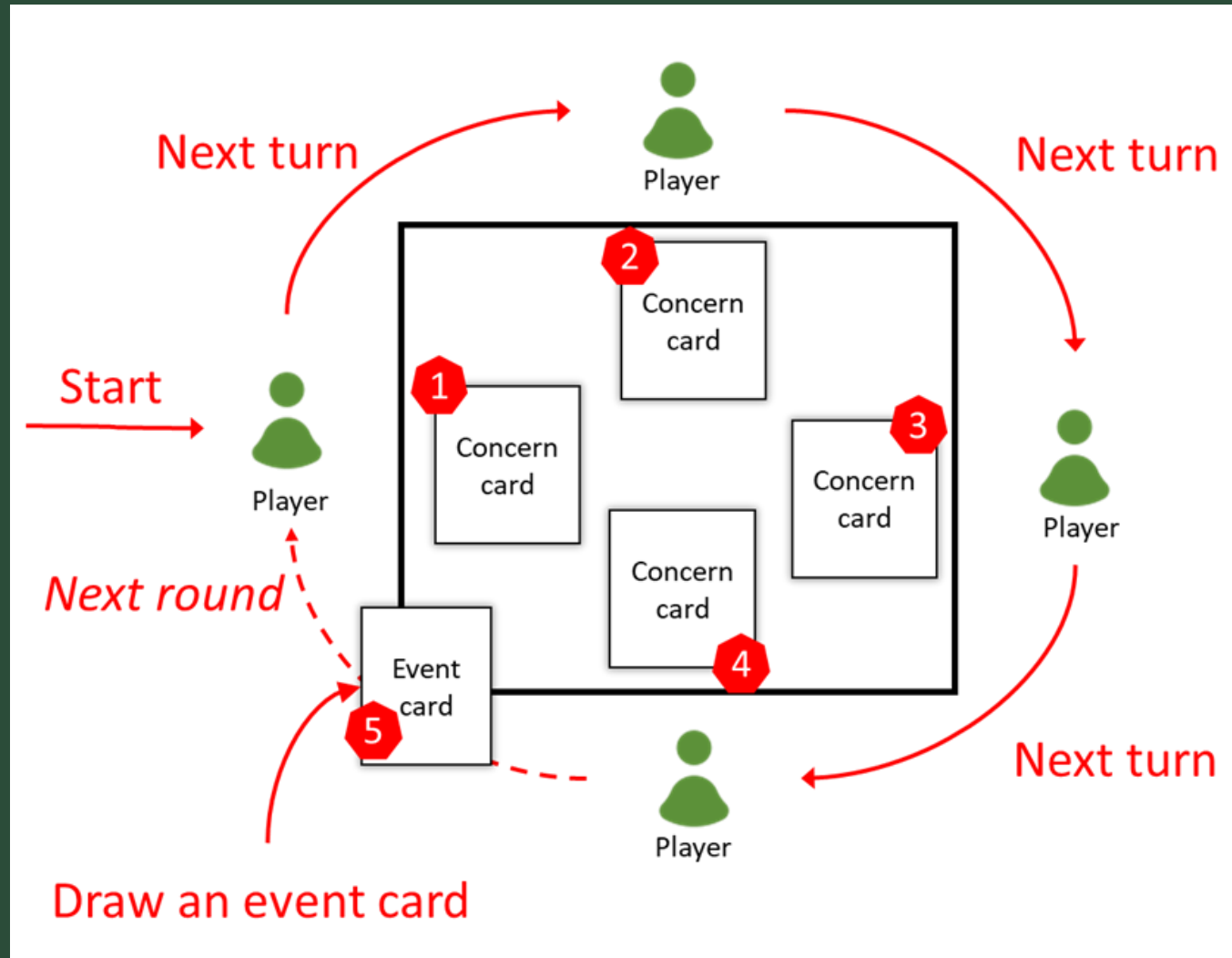
Records the group's decisions.

Concern-ID	Chosen option	Rationale (why the option is chosen)	Impact of decision on quality attributes (no. of + and -)				
			Availability	Maintainability	Performance	Security	Usability
	☐ Option 1, ☐ Option 2, ☐ Option 3 <?> Additions to the options on the card:						
	☐ Option 1, ☐ Option 2, ☐ Option 3 <?> Additions to the options on the card:						

Game preparation



How to play the game



Steps for each turn

- In a turn:
 - The group draws a concern card.
 - Each player, independently from each other, suggests a design option to address the concern.
 - The group discusses the suggestions and together decides which option should be chosen.

Concern

Options

Concern Card

Concern-ID:

1

Concern:

The users need to be able to upload articles on the platform. How will the system store these articles?

Options:

1. Store the articles in multiple distributed databases owned by the Owner.

Security (+), Performance (+), Availability (+), Maintainability (-)

2. Upload the articles in the cloud owned by an external cloud provider.

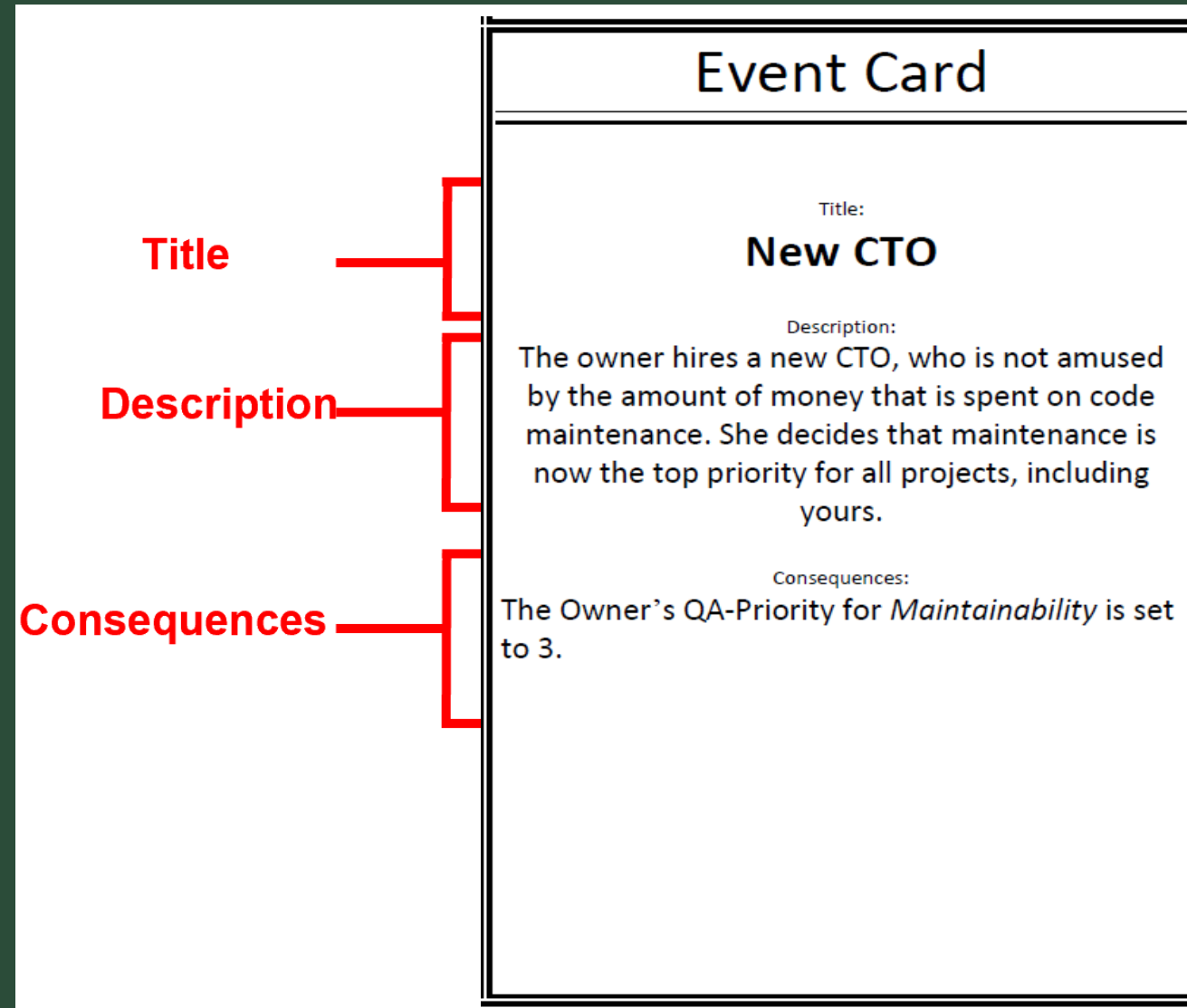
Security (-), Performance (+), Availability (+), Maintainability (+ +)

3. Store the articles in a single local database owned by the Owner.

Security (+), Performance (-), Availability (-), Maintainability (+)

Drawing an event card

- After every round, an event card is drawn.
- An event card describes some change for the project.
- You may have to reconsider your previous design decisions to address the effects of the event.



Reasoning about concerns and options

- Consider the impact that design options have on the system's quality
- Avoid inconsistencies between your design decisions
- Players may propose new design options

Stakeholder Card
Stakeholder: User
Goal: The User reads news articles written or shared by other users. Those who write and share articles are often journalists or activists.
Quality Attributes: Usability – QA-Priority: 2 The system should be easy to use. Security – QA-Priority: 1 The system should protect the information of the user from unauthorized access. Performance – QA-Priority: 2 The system should be able to process and fulfill the users' requests fast.
Quality Attributes

Concern Card
Concern-ID: 1
Concern: The users need to be able to upload articles on the platform. How will the system store these articles?
Options: 1. Store the articles in multiple distributed databases owned by the Owner. Security (+), Performance (+), Availability (+), Maintainability (-) 2. Upload the articles in the cloud owned by an external cloud provider. Security (-), Performance (+), Availability (+), Maintainability (+ +) 3. Store the articles in a single local database owned by the Owner. Security (+), Performance (-), Availability (-), Maintainability (+)
Quality Impacts

Adding options to the concern cards

The text '<?>' on a concern card prompts you to think of possible alternatives and/or effects on quality attributes.

On the decision preparation / decision taking template, write those additions in under the '<?>'

You may also use this to add additional options to 'complete' concern cards (without <?> on the card).

NB. Write on the template, NOT on the cards!

Performance (-), Security (+ +), <?>
2. <?> <?>
3. <?> <?>

Suggested Option <i>tick the box and/or suggest your own option under <?></i>
☐ Option 1, ☐ Option 2, ☐ Option 3
<?> Additions to the options on the card:

Winning the game

- After the game ends, calculate the final score and determine whether - as a group - you won the game.
- Step 1: Are all quality attributes positively affected?
- Step 2: Are all stakeholders sufficiently satisfied?
- Step 3: Did you succeed within the allotted time?

Step 1. QA-Scores		Usability	Security	Availability	Performance	Maintainability	
	Count the number of +'s						
	Count the number of -'s						
	QA-Score (number of +'s minus number of -'s)						
Step 2. Stakeholders- Score	Stakeholders	Quality Attribute (QA)	QA-Score	QA-Priority	Stakeholder Satisfaction Level (QA-Score minus QA-Priority)		
	User	Usability					
		Security					
		Performance					
	Owner	Availability					
		Security					
		Maintainability					
	Overall Stakeholder Satisfaction (Sum of all Stakeholder Satisfaction Levels)						
Step 3. Final Score	Number of unaddressed concern cards						
	Final Score (Overall Stakeholder Satisfaction minus # unaddressed concern cards)						

Quiz intermezzo 3:
Which of options A and B would you choose?

- A: you have a 100% chance to loose \$9500
- B you have a 95% chance to loose \$10000, and a 5% chance to loose nothing

Quiz intermezzo 4:

Which of options A and B would you choose?

- A: you have a 100% chance to win \$500
- B you have a 5% chance to win \$10000, and a 95% chance to win nothing

Originally

A table top card game



Online version: Card engine in Google Sheets

- Three Interactive Sheets:
 - Game table
 - Decision taking templates
 - Scoring sheet

A	B	C	D	E	F	G	H	I
	Start new game		PROJECT Project: Social News Platform Purpose: The Social News Platform is a digital system that allows users to write, share and read news articles.		STAKEHOLDER Stakeholder: User Goal: The User reads news articles written or shared by other users. Those who write and share articles are often journalists or activists. Quality Attributes: Usability – QA-Priority: 2 <i>The system should be easy to use.</i> Security – QA-Priority: 1 <i>The system should protect the information of the user from unauthorized access.</i> Performance – QA-Priority: 2 <i>The system should be able to process and fulfill the users' requests fast.</i>		STAKEHOLDER Stakeholder: Owner Goal: The Owner will maintain the system during its lifetime. Quality Attributes: Availability – QA-Priority: 2 <i>The system is to remain available to achieve a high uptime.</i> Security – QA-Priority: 0 <i>The system should protect the information of the user from unauthorized access.</i> Maintainability – QA-Priority: 1 <i>The system is to take a minimum amount of effort by the owner to maintain it.</i>	

Back to a table top game

- Let's play!

Reflection: What the game teaches you

- 3 learning objectives:
 1. Create awareness about the rationale involved in making trade-offs and choosing design options among alternatives
 2. Enable the appreciation of the design decisions proposed by others.
 3. Reconsideration: Create awareness about the dynamics of software architecture design.

Reflection: The game's primary reasoning model

- Absolute rationality ("rationality as optimization")
 - Purely logical chain of events and consequences
 - Time-consuming
- In the game (and in practice):
 - Explicitly weighing pros / cons
 - Attempts to 'calculate' the best decision given the circumstances (NB. This becomes harder and harder when the set of decisions becomes larger)

What the game *doesn't* teach you

- In practice, we do not always rely on absolute rationality
 - System 1 (intuition) vs System 2 (rational thinking) (Kahneman)
 - Bounded rationality (Herbert A. Simon)
 - Our capabilities are limited -> heuristics, rules of thumb, "this works because it worked last time"
 - Time-efficient
 - Social/cultural rationality
 - Our limits necessitate interdependence ("two know more than one")
 - Differences give new perspectives and solutions
 - Biases
 - *Example: blockchain (VU course)*
- How rational are the decisions we make in practice?

Some decisions are predictably irrational

- Menu options:
 - Fries: \$3,99
 - Hamburger/Vegaburger: \$9,99
 - Fries + Hamburger/Vegaburger: \$9,99
- Which one would you opt for?

Some decisions are predictably irrational

- Options to renew subscription:
 - Electronic version: \$59 per year
 - Paper version: \$129 per year
 - Electronic + paper version: \$129 per year

Prospect theory & the fourfold pattern

- High probability of a **high gain**: risk averse
 - Fear of disappointment, accept unfavorable settlement
- Low probability of a **high loss**: risk averse
 - Fear of large loss, accept unfavorable settlement (as in insurance premium)
- High probability of a **high loss**: risk seeking
 - Hope to avoid loss, reject favorable settlement (compare **tendency to continue hopeless IT projects**)
- Low probability of a **high gain**: risk seeking
 - Hope of large gain, reject favorable settlement (as in lottery tickets; also: **difficulty to stop an IT project**)

Quiz intermezzo... who chose?

1A

100% +\$9500

2A

100% -/-500

3A

100% -/-9500

4A

100% +500

1B

95% +10000
5% 0

2B

5% -/- 10000
95% 0

3B

95% -/- 10000
5% 0

4B

5% + 10000
95% 0

The majority chose

Risk averse

1A

100% +\$9500

High prob high gain

2A

100% -/-500

Low prob high loss

3A

100% -/-9500

High prob high loss

4A

100% +500

Low prob high gain

Risk seeking

1B

95% +10000
5% 0

2B

5% -/- 10000
95% 0

3B

95% -/- 10000
5% 0

4B

5% + 10000
95% 0

Prospect theory (Kahneman)

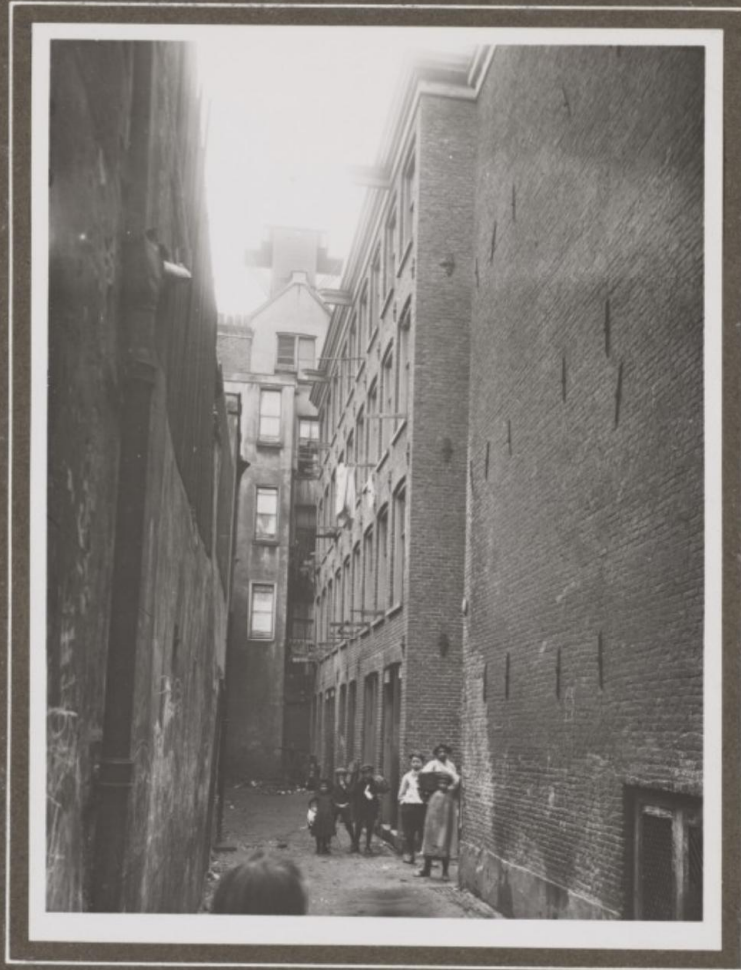
We **fear losses** more than we **value gains**

- We value based on reference points (e.g. it *feels* like a win)
- We are influenced by the *diminishing sensitivity principle*: the value we perceive maybe different from its actual worth (loosing after a win *feels* less bad)

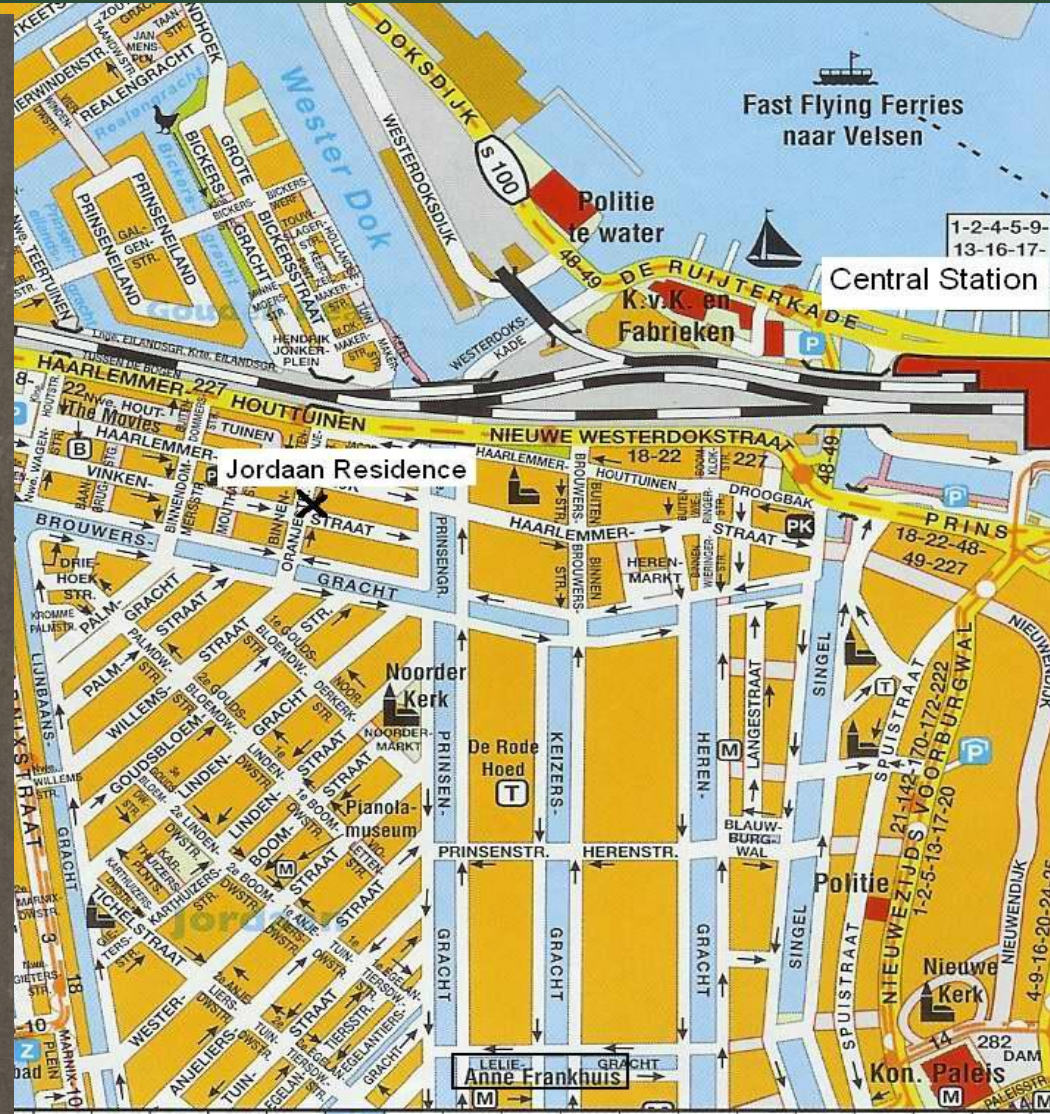
Types of design decisions

- Implicit, undocumented
 - Unaware, tacit, 'of course' knowledge
- Explicit, undocumented
 - Vaporizes over time
- Explicit, explicitly undocumented
 - Tactical, personal reasons
- Explicit, documented
 - Preferred, exceptional situation

Some design decisions are related to norms and values



Enge zijstraat tussen huizen in Amsterdam (ca. 1900)

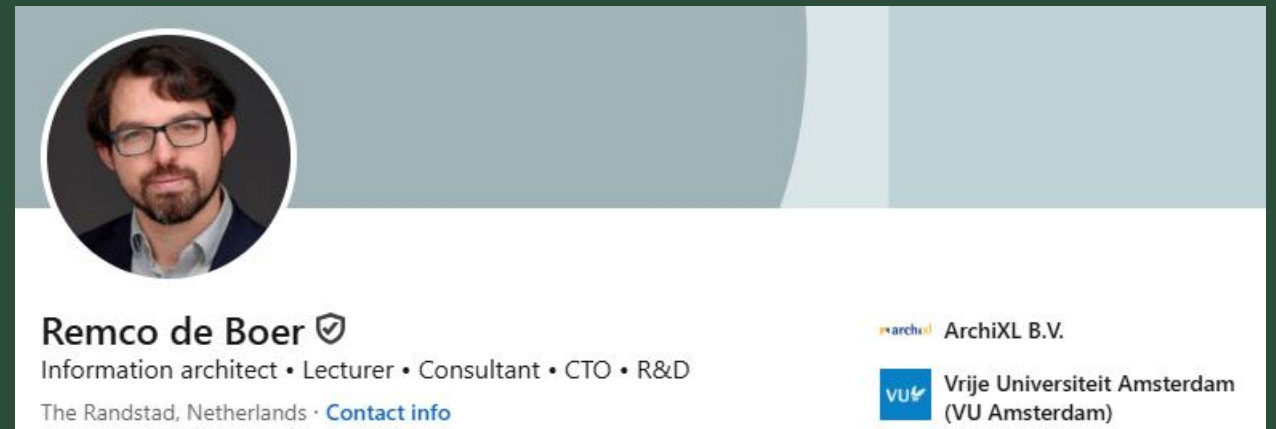


Resources and contact details

- Game material and links to publications:
 - <https://github.com/S2-group/DecidArch>

Reach me at

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- r.c.de.boer@vu.nl



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