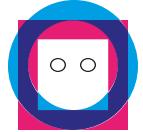




# URBAN COMPUTING

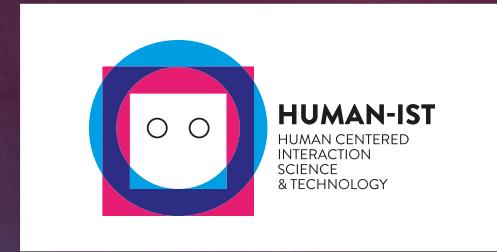
## AUTUMN TERM 2025

# LET'S START WITH AN ICEBREAKER

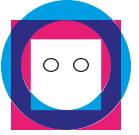


- To kick off this seminar, **please introduce yourself** (in two minutes):
  - With your **name**,
  - Your origin **university**, as well as
  - Your major **field of study**.
- And just for fun, **what's something about the next teammate you appreciate?**

When you are content to be simply yourself and don't compare or compete, everybody will respect you.



# URBAN COMPUTING AT25 KICKOFF



# LEARNING OUTCOMES

- Obtain an overview of public services and infrastructure challenges,
- Immerse to a specific **problem** of Swiss network industries (e.g., energy, transport, communications, and water) ,
- Work as a **teammate of an inclusive team** (of two),
- Learn how to approach the problems with new soft services, models and technologies,
- Jointly **develop an artifact** (i.e., algorithm, human-computer interface, methodology, design principle, etc.), and
- **Be able** to present and write scientific research in English.

Humans can perform better with assistive technology. Therefore, it is allowed to seek help from ChatGPT et al, but you should declare this.



# TODAY'S CONTENT

01

## Introduction to the seminar

Addressing public service challenges with design science

02

## Introduction to public services-to-be

Providing usable solutions to complex network problems

03

## Your design science research project

Quests and ideas for your own project

04

## Annex

Useful resources for you and your project

01

# INTRO TO THE URBAN SYSTEMS SEMINAR

# WHAT ARE WE DOING IN THIS COMPUTATIONAL SEMINAR?



**Moshe Vardi**

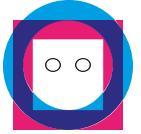
“Mathematics does not transcend computation; rather, computation is at the very heart of mathematics.”

- Once upon a time, **mathematics and computing were developed** by humans to reason about the world.
- Both have been entwined for the past 40,000 years and will continue to be so. So, **we aim to continue with this success story** in this computational seminar.
- The idea of this seminar is to give you **insights into computational public services challenges**.
- Thereby, our **focus is on the soft design of new public services, technologies, and models**.
- At today's kick-off session, **public service quests** from the Swiss network industries and infrastructures are introduced.
- For each quest, **a project is supposed to be developed** by student groups to get a deeper knowledge.
- At the end, in the **final presentation**, the compiled data, information and knowledge will be shared with the fellow students.



# YOU WILL HAVE TO DELIVER TWO PRESENTATIONS

- **Midterm presentation**
  - 5-10 minutes to present the state of your research followed by 5 minutes discussion.
  - More info during the brainwriting session (please wait a few more slides).
  - You only must be present during your session in Zoom.
  - Session **Thursday, 16th of October 2025, 14:15 to 16:15**, online on zoom, time slots TBD.
- **End presentation**
  - 10-15 minutes to present and 5 minutes to discuss.
  - **Structure:** 1. Introduction to the topic, 2. research questions and methods, 3. use-case and scenarios, 4. evaluation and lessons learned, and 5. conclusion and outlook.
  - You must be present also during other teams' presentations. You will also give **peer feedback!**
  - Session **Thursday, 18th of December 2025, 14:15 to 17:00**, in person in room D130, time slots TBD.
  - Both presentations is **50% of final grade.**



# AND YOU WILL HAVE TO SUBMIT A DESIGN SCIENCE RESEARCH REPORT

- Your **report** contains summary of your project of maximum 30 pages.
- **Have a line of argumentation**
  - What is the problem? What are your research questions?
  - Why is it necessary to go into the topic? What are your theses or hypothesis?
  - What is your approach to solve the problem? And finally, answer the research question(s).
- Reports to be handed in until **Sunday, 4-th of January 2026, 24:00**, through ILIAS as PDF file.
- Project report is **50% of the final grade**.
- Plus, **individual contribution report** (MAX one page).

Please consider, what might go into your design science research report!



# AN EVALUATION GRID FOR YOUR PROJECT

CRITERIA OF EVALUATION	Knowledge & skills	Systematic & scientific research	Initiative & effort, autonomy	Quality of the results	Presentation of the results
Level A (★★)	Very profound knowledge and very interested to learn	Very systematic and scientific research	Very high initiative & effort, many own ideas, all objectives achieved or exceeded	Outstanding results, interesting findings, high scientific contribution	Exemplary & excellent presentation of the results
Level B (★)	Profund knowledge, interested	Systematic and scientific research	Quite high initiative & effort, some own ideas, most objectives achieved	Good results quite interesting findings, some scientific contribution	Competent & Careful presentation of the results
Level C (±)	Basic knowledge, partially interested	Not very systematic and scientific research	Certain Initiative & effort, no own ideas, objectives partially achived	Moderate results, poor Interestign findings, low scientific contribution	It was only done what is absolutely necessary
Level D (-)	Poor Knowledge, not interested	Systemless and not scientific research	Low initiative & effort, plagiarism, objectives not achieved	Bad results, no findings, no scientific contribution	Presentation was bad & sloppy



# ... AND CRITERIA FOR EVALUATING THE PROTOTYPES

Knowledge & skills	Scientific research	Quality of results	Presentation of results
<ul style="list-style-type: none"><li>Used programming language</li><li>Developer tools used</li><li>Standards</li><li>Etc.</li></ul>	<ul style="list-style-type: none"><li>Methods &amp; development approach used</li><li>Documentation of system analysis &amp; design</li></ul>	<ul style="list-style-type: none"><li>Usability</li><li>Robustness</li></ul>	<ul style="list-style-type: none"><li>Program delivery, installation and presentation</li><li>Installation manual</li><li>User manual</li></ul>

Grading:

- Project presentations (50%)**
- Scientific report (50%)**

Both tables are from:

- Theses Guidelines (see ILIAS)**

Please see **syllabus** for details and criteria!



# HOW IS YOUR PERFORMANCE GRADED?

## Project presentations (50%)

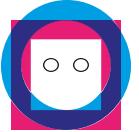
- Midterm Presentation
- Final Presentation
- Group Deliverables

50%

## Project report (50%)

- Scientific project report

**Note:** Individual contribution report (including individual deliverables) can optionally adjust the partial grade by  $\pm 0.5$  for exceptionally good or poor performance.



# USE OF GENERATIVE AI TOOLS

## Effective use

GenAI tools can help you to...

- Learn about a new topic
- Brainstorm and prototype ideas
- Debug LaTeX code
- Improve presentation/writing structure and clarity

## Precautions

But they also can...

- Plagiarize
- Produce convincing nonsense
- Use huge amounts of energy
- Breach data protection regulations
- Not replace your brain

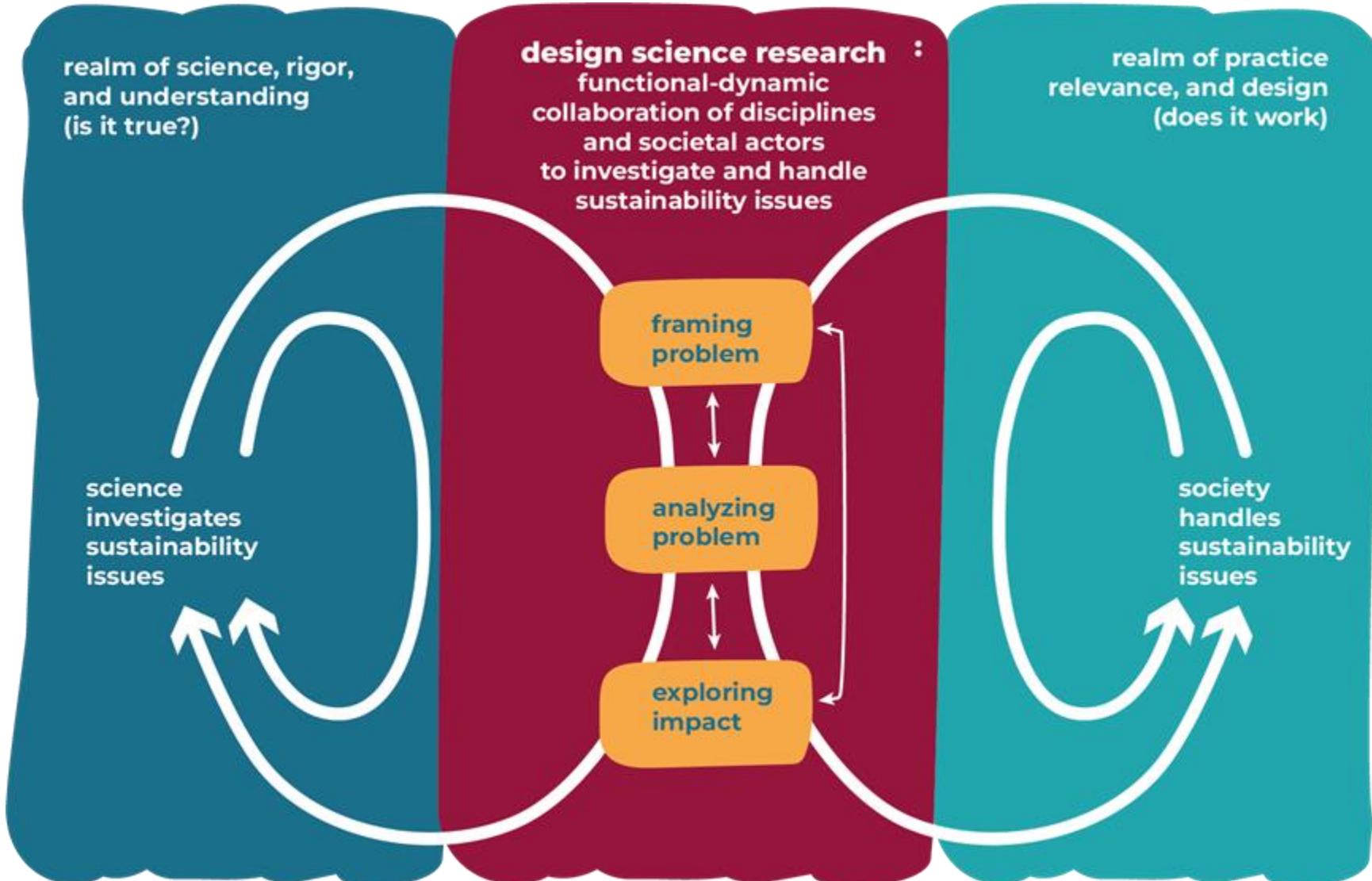
## How not to fail

**Plagiarism** is one of the worst sins in academia and must be taken seriously.

- Cite all sources
- Check licenses of figures (attribution may not be sufficient)
- Be honest and transparent and document for which tasks you have used GenAI tools



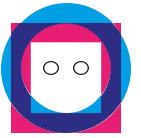
# DESIGN-SCIENCE RESEARCH IS BOTH INTER-/ TRANSDISCIPLINARY AS WELL AS INTEGRAL



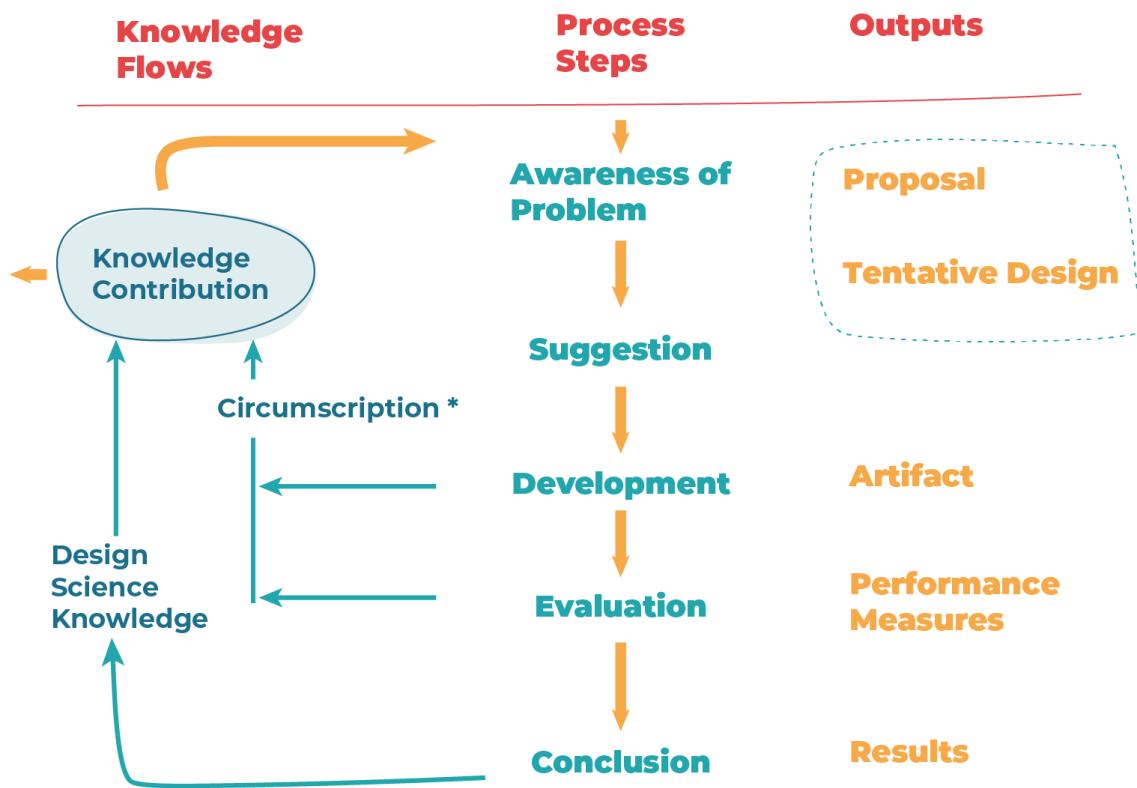
# DESIGN SCIENCE RESEARCH IN INFORMATION SYSTEMS



- As you know, there are **different types of research**, which may be distinguished as descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical, etc.
- **Information system research** must respond to a dual mission:
  - First, it should make a theoretical contribution, and
  - Second, it should assist in solving current and anticipated problems of practitioners
- **Design science research is a paradigm:**
  - Let you answer questions human-centered via the creation of innovative artifacts, thereby
  - Contributing new knowledge to the body of scientific evidence.
- A **design science research** approach provides a construction-oriented view **in information systems** research:
  - It is centered around designing and building innovative artifacts (i.e., material and organizational features that are socially recognized as bundles of hardware and/or software), and
  - Provides a schema to do research, while providing knowledge relevant for practitioners.
- **Artifacts** can be algorithms, human-computer interfaces, methodologies, design principles, etc.



# THE FIVE STEPS OF A DESIGN SCIENCE RESEARCH PROCESS



- Awareness of a problem is addressed with a proposal.
- A suggestion is the creative part wherein you envision new functionality; it follows your proposal, to which it is connected (cf. dotted line).
- The development doesn't involve novelty beyond the state-of-practice for an artifact (novelty is in design, not in the construction; cf. asterisk).
- After construction, an artifact is evaluated according to criteria that are implicit but made explicit in the proposal.
- The conclusion could be the end of a research cycle, or it is the finale of a specific research effort:
  - Typically, when results are “good enough”, then
  - They are consolidated and written up (cf. arrow).



# GUIDELINES AND EVALUATION OF THE PROCESS

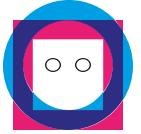
**Table 1. Design Science Research Guidelines**

<b>1. Design as an Artifact</b>	Must produce a construct, a model, a method or a instantiation.
<b>2. Problem relevance</b>	Develop tech-based solutions to important and relevant problems.
<b>3. Design Evaluation</b>	Utility, quality, and efficacy of a design artifact must be rigorously evaluated.
<b>4. Research Contributions</b>	Provide clear and verifiable contributions in the areas of the design artifact.
<b>5. Communication of Research</b>	Must be presented effectively both to technology-oriented as well as management-oriented audiences.

Please see **syllabus** for details and criteria!

**Table 2. Design Evaluation Methods**

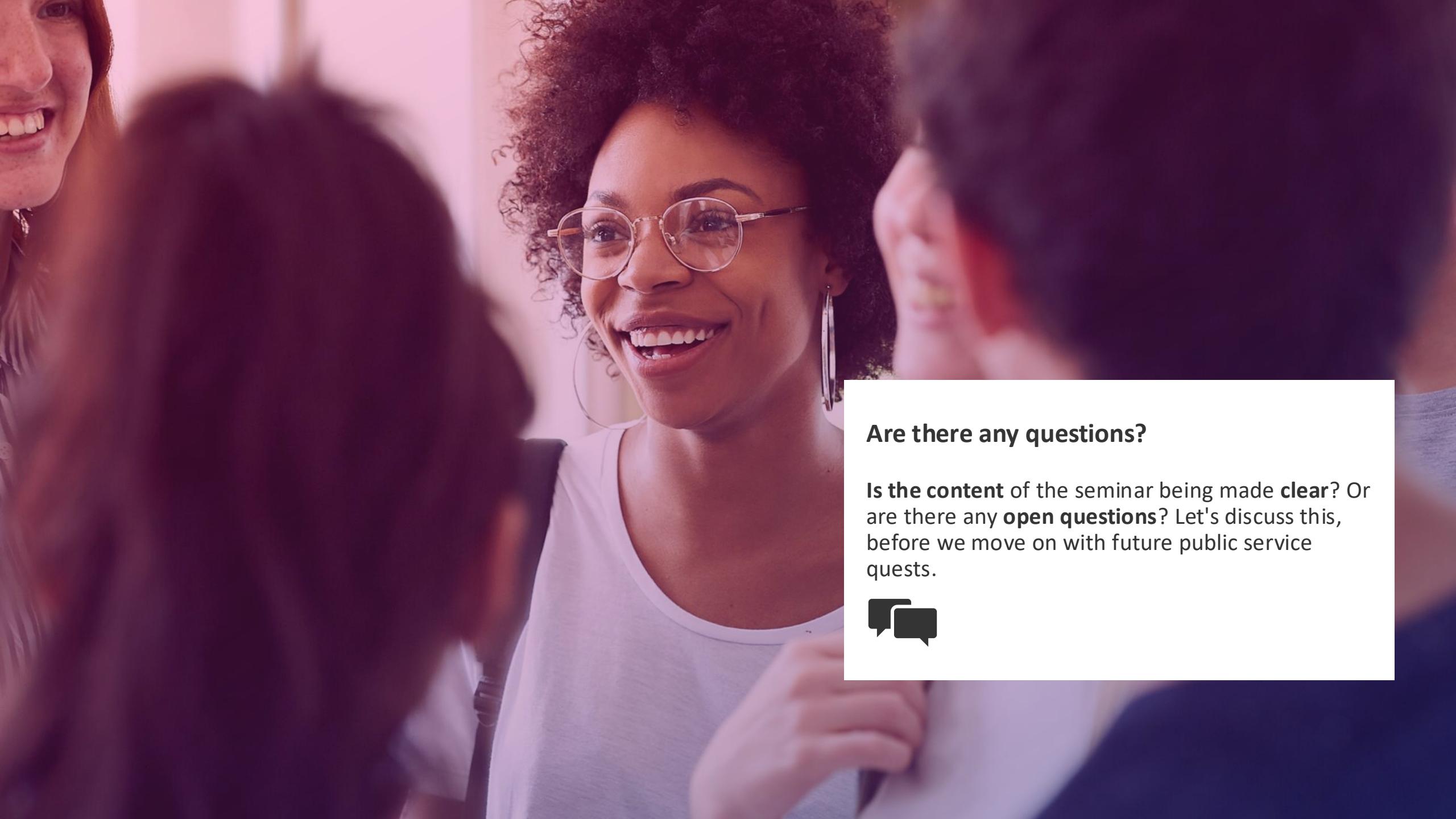
<b>1. Observational</b>	Case Study: Study artifact in depth in business environment
	Field Study: Monitor use of artifact in multiple projects
<b>2. Analytical</b>	Static Analysis: Examine structure of artifact for static qualities (e.g., complexity)
	Architecture Analysis: study fit of artifact into technical IS architecture
	Optimization: Demonstrate inherent optimal properties of artifact or provide optimality bounds on artifact behavior
	Dynamic Analysis: Study artifact in use for dynamic qualities (e.g., performance)
<b>3. Experimental</b>	Controlled Experiment: Study Execute artifact interfaces to discover failures and identify defects
	Simulation - Execute artifact with artificial data
<b>4. Testing</b>	Functional (Black Box) Testing: Execute artifact interfaces to discover failures and identify defects
	Structural (White Box) Testing: Perform coverage testing of some metric (e.g., execution paths) in the artifact implementation
<b>5. Descriptive</b>	Informed Argument: Use information from the knowledge base (e.g., relevant research) to build a convincing argument for the artifact's utility
	Scenarios: Construct detailed scenarios around the artifact to demonstrate its utility



# PROTIP ON DISCOUNT USABILITY

- The Nielsen Norman Group advocated 3 main components of **usability engineering at a discount**:
  1. **Simplified user testing**: includes exactly the five right participants, a focus on qualitative studies, and use of the thinking-aloud method.
  2. **Narrowed-down prototypes**: that support a single path through the user interface. Thereby it's much faster to design paper prototypes than something that embodies the full user experience. You can thus test very early and iterate through many rounds of design.
  3. **Heuristic evaluation**: in which you evaluate user interface designs by inspecting them relative to established usability guidelines.
- Discount usability often gives **better results** than deluxe usability because its methods drive an **emphasis on early and rapid iteration** with frequent usability input.

Note, bad user testing still beats no user testing.



Are there any questions?

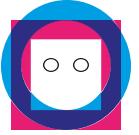
Is the content of the seminar being made clear? Or are there any open questions? Let's discuss this, before we move on with future public service quests.





**02**

**FUTURE PUBLIC  
SERVICES WILL BE  
NATURAL AND SOFT**



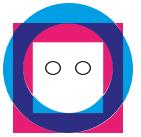
# HOW PUBLIC SERVICES, INFRASTRUCTURES AND PLATTFORMS SHOULD LOOK LIKE

- The four cornerstones of **Swiss public services**:
  1. **Needs-oriented**: oriented on the needs of Swiss society and economy and they protect the natural foundations of our life.
  2. **Adaptable to social change**: incorporates changes in the needs of citizens and their businesses.
  3. **Multiplicity of providers**: provided by the state, service-public companies, private-sector companies, and/or civil-society organizations.
  4. **Politically defined**: continuous, accessible, high-quality, and affordable basic provision of essential infrastructure, goods, and services to all sections of the population and regions of the country.

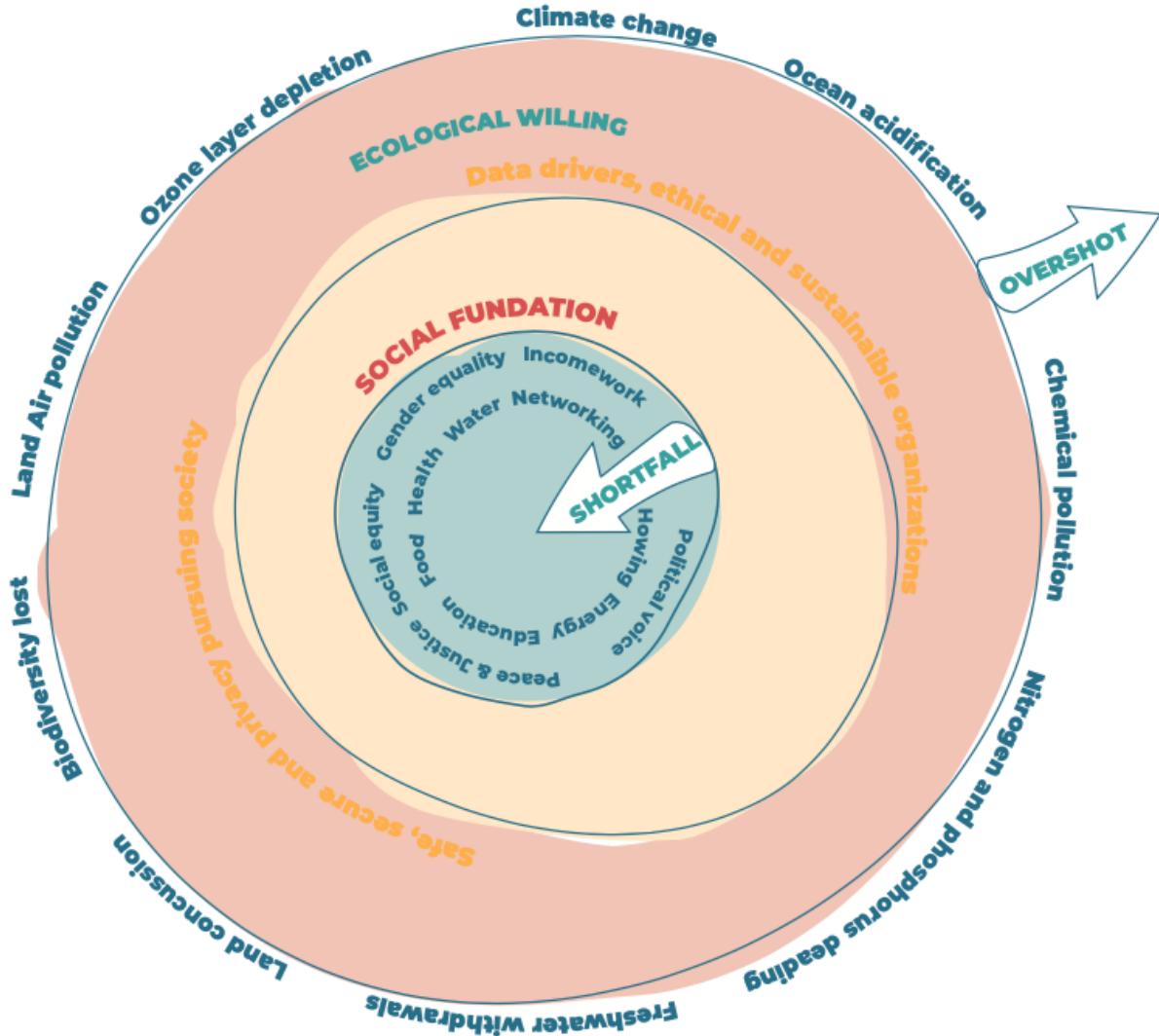


Jaron Lanier

“The public library gave everyone access to literature. If that solution was available before the Internet, I’m convinced that we can come up with new solutions.”



# A DOUGHNUT OF SOCIAL AND PLANETARY BOUNDARIES

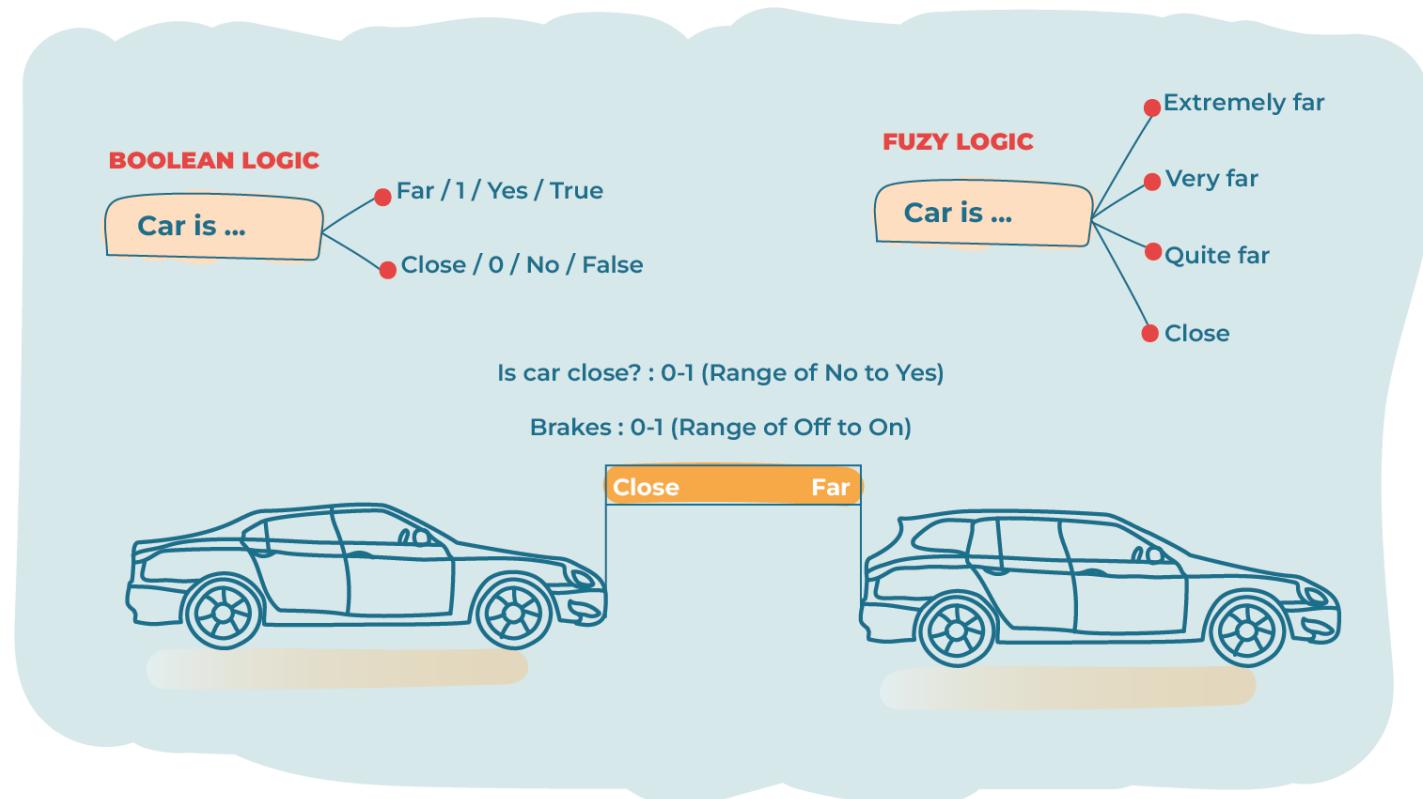


- Our 21st century challenge is to **meet the needs of all** within the means of the planet.
  - To ensure that no one falls short on life's essentials (food and housing to healthcare and political voice),
  - While ensuring that we do not overshoot our pressure on Earth's life-supporting systems (stable climate, fertile soils, and a protective ozone layer).
- The Doughnut of social and planetary boundaries is an approach to framing that challenge, and it **acts as a compass for human progress** this century.
- In this seminar, we seek its ethical and moral grounds for the **development of service public services, infrastructures and platforms**.
- With that in mind, we build on **fuzzy logic**, which uses **natural methods to provide usable solutions** to complex problems.



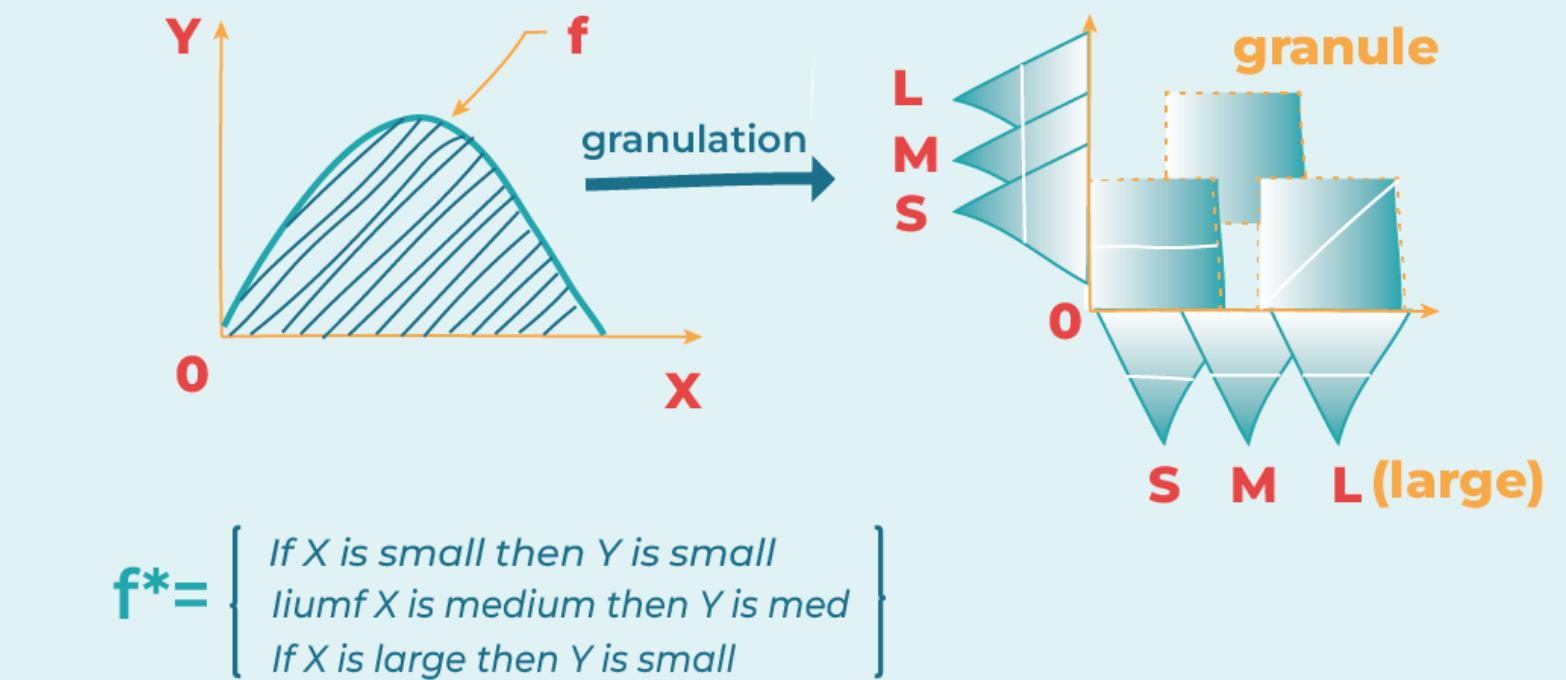
# FUZZY LOGIC SUPPORTS A NATURAL AND THUS, SOFT FUTURE PUBLIC SERVICE DESIGN

- Fuzzy logic
  - A form of logic where the truth values of variables can be any real number between 0 and 1,
  - as opposed to sharp logic, where they can only be 0 or 1.
- Plays a key role in **computing with words**
  - A necessity when the **available information is too imprecise** to justify the use of numbers, and/or
  - A **tolerance for imprecision** that can be exploited to achieve tractability.

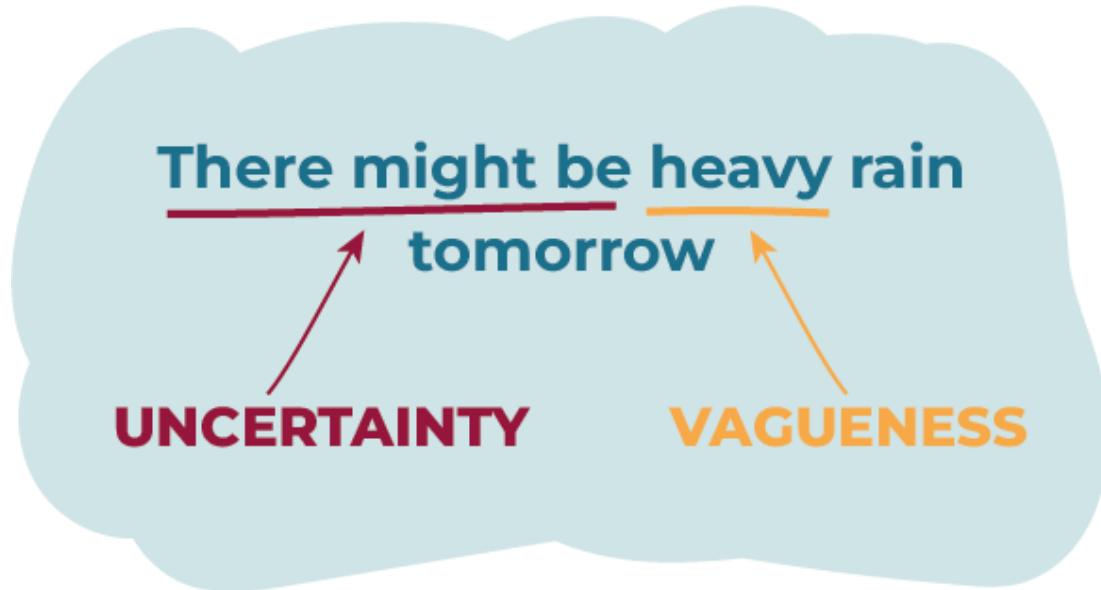




# LINGUISTIC SUMMARI- ZATION WITH GRANULATION



# ADDRESSING UNCERTAINTY AND VAGUENESS WITH (A BETTER) LINGUISTIC SERVICE DESIGN



- **Fuzzy linguistic summaries** provides a methodology for computers to deal with uncertainty and vagueness.
- This can help **bridge the gap between human cognition and computation** (machines).
- Young and few in our example are labels representing **fuzzy numbers**. Their sum can be found by using fuzzy arithmetic.
- A **fuzzy number** is a generalization of a regular, real number in the sense that it does not refer to one single value but rather to a connected set of possible values, where each possible value has its own weight between 0 and 1



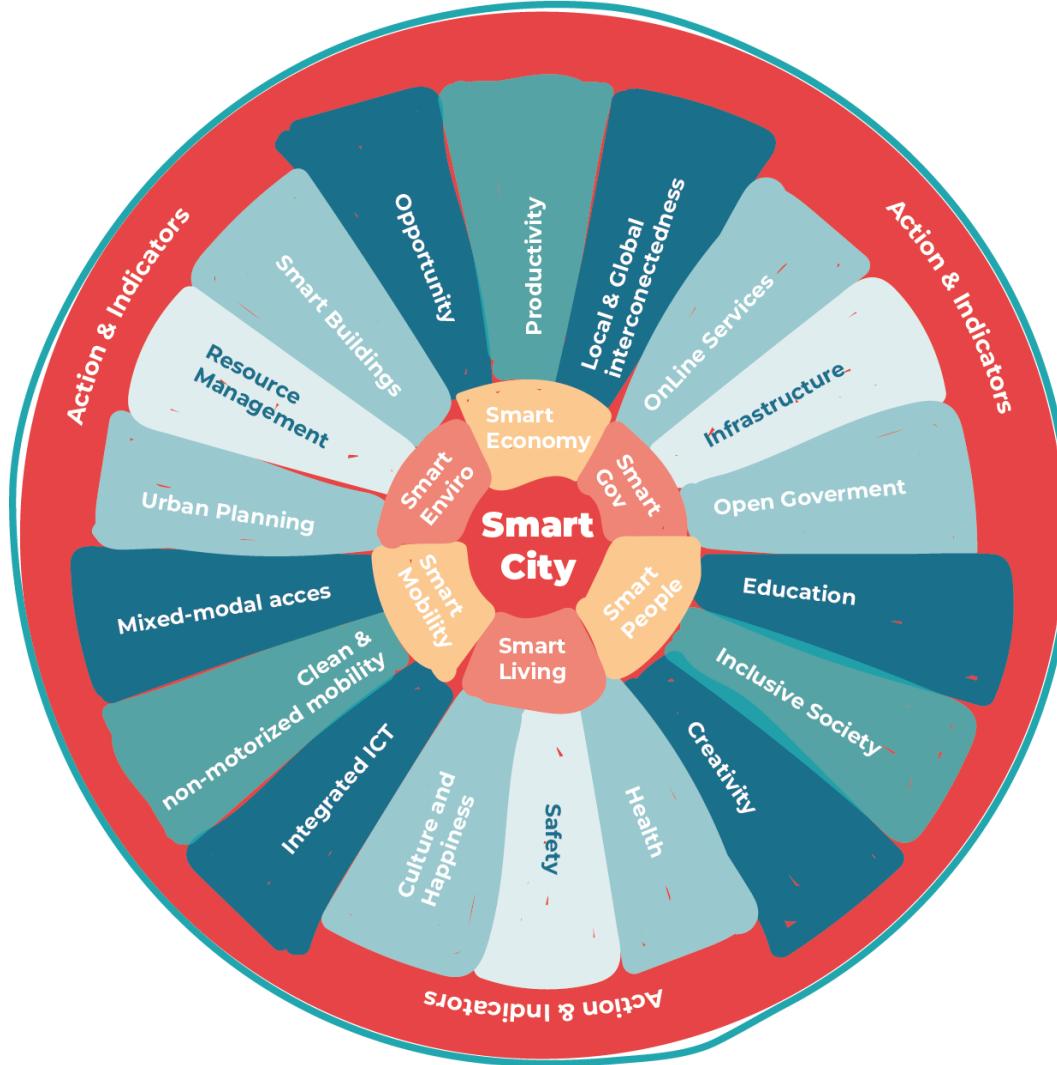
# SOFT DESIGN MAY PROVIDE FUTURE PUBLIC SERVICES

- Basic:** soft design is imprecision , partial truth, approximation tolerant, but the hard one is accurate and certain.
- Based on:** soft design employs fuzzy logic and probabilistic reasoning while hard one is based on binary or crisp systems.
- Features:** hard design features precision and categoricity, as against, approximation are the characteristics of soft design.
- Nature:** soft design approaches are probabilistic in nature whereas hard ones are deterministic.
- Works on:** soft design can be operated on noisy and ambiguous data, in contrast to hard ones, which work only on exact data.
- Computation:** parallel computations can be performed in soft, and sequential computation is performed on hard environments.
- Result:** soft computing can produce approximate results while hard computing generates precise results.

BASIS FOR CAPARSION	HARD COMPUTING DESIGN	SOFT COMPUTING DESIGN
Basic	Uses precisely stated analytical model.	Tolerant to imprecision, uncertainty, partial truth and approximation.
Based on	Binary logic and crisp system	Fuzzy logic and probabilistic reasoning
Features	Precision and categoricity	Approximation and dispositionalty
Nature	Deterministic	Stochastic
Works on	Exact input data	Ambiguous and noisy data
Computation	Sequential	Can perform parallel computations
Result	Produces precise outcome	Approximate

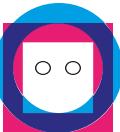
Table 3.

# FUTURE PUBLIC SERVICES FOR HUMAN SMART CITIES, REGIONS AND NATIONS

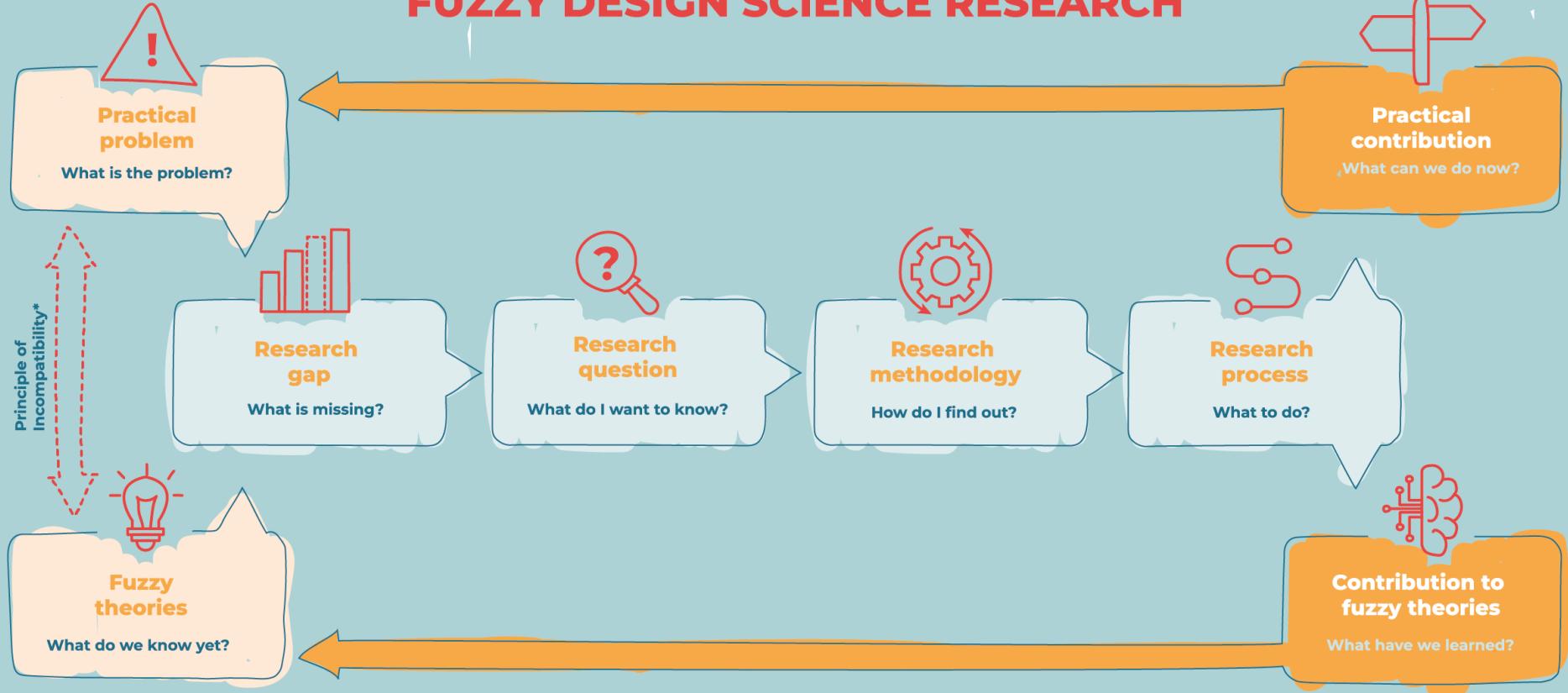


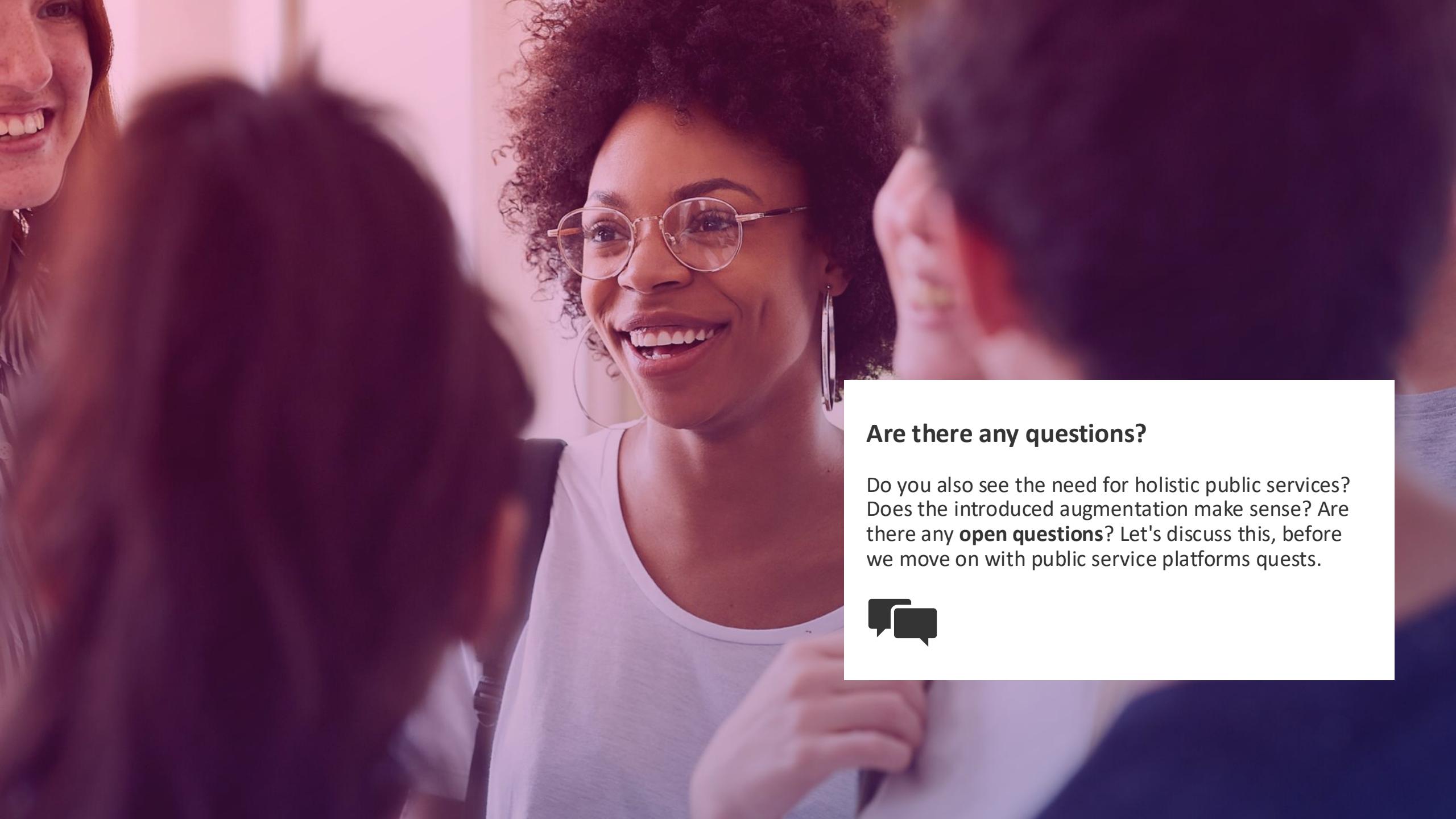
- **Smart Economy:** describes actions aimed at transforming and strengthening the economy.
  - **Smart Environment:** describes how a government manages the environment to improve livability for citizens and visitors.
  - **Smart Mobility:** focuses on increasing the efficiency and quality of transportation to enhance the use of mobility solutions and to increase citizens mobility.
  - **Smart Living:** aims at increasing quality of life for residents and visitors by following an inclusive strategic approach.
  - **Smart People:** aims at transforming the way citizens interact with the public and private sector. The inclusion with smart forms of education for all are a fundamental aspect.
  - **Smart Government:** is about strengthening the connections and interactions between the government and citizens, businesses and other organizations of the civil society.

# A QUICK NOTE ON FUZZY DESIGN SCIENCE RESEARCH



## FUZZY DESIGN SCIENCE RESEARCH





## Are there any questions?

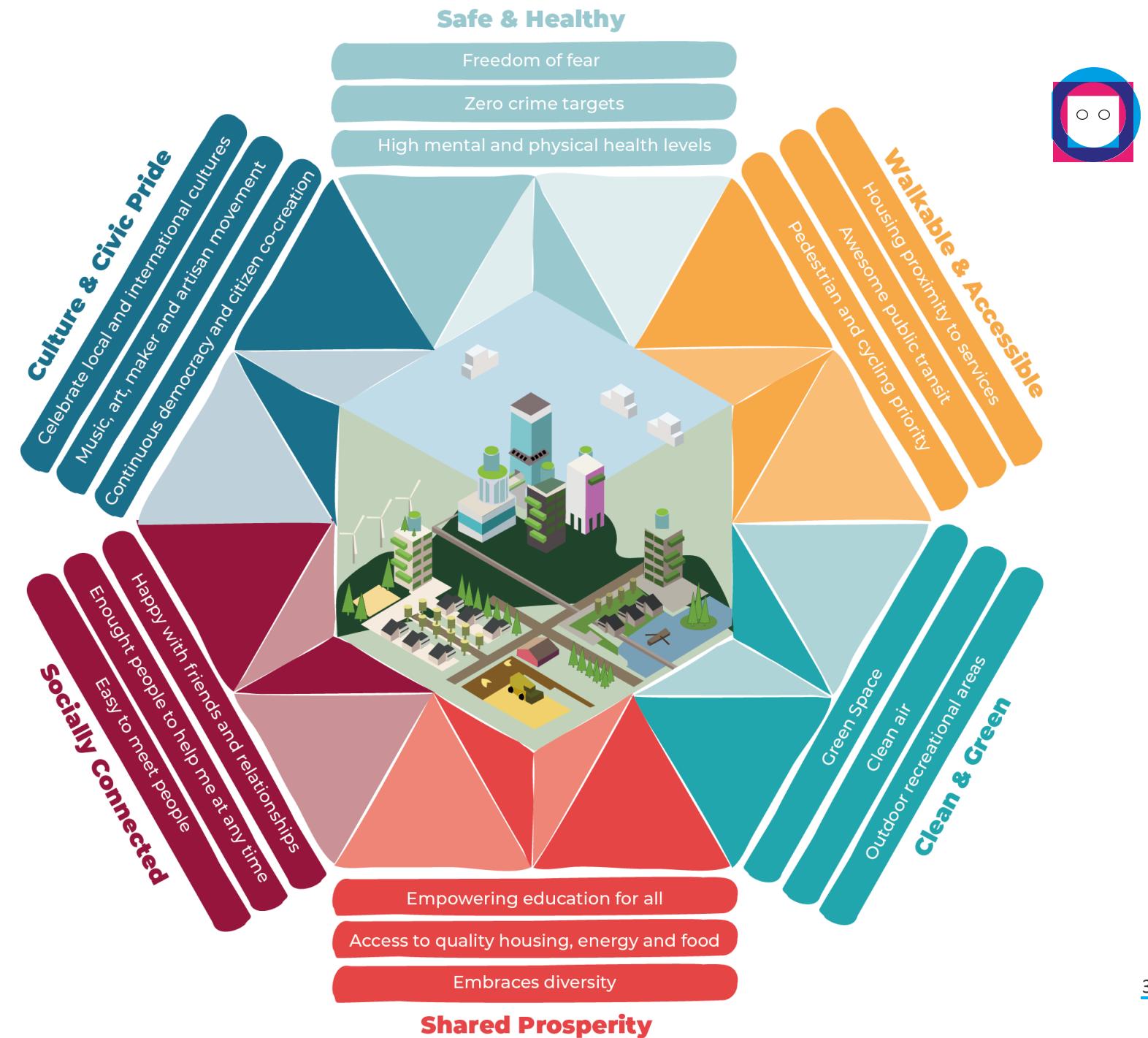
Do you also see the need for holistic public services? Does the introduced augmentation make sense? Are there any **open questions**? Let's discuss this, before we move on with public service platforms quests.



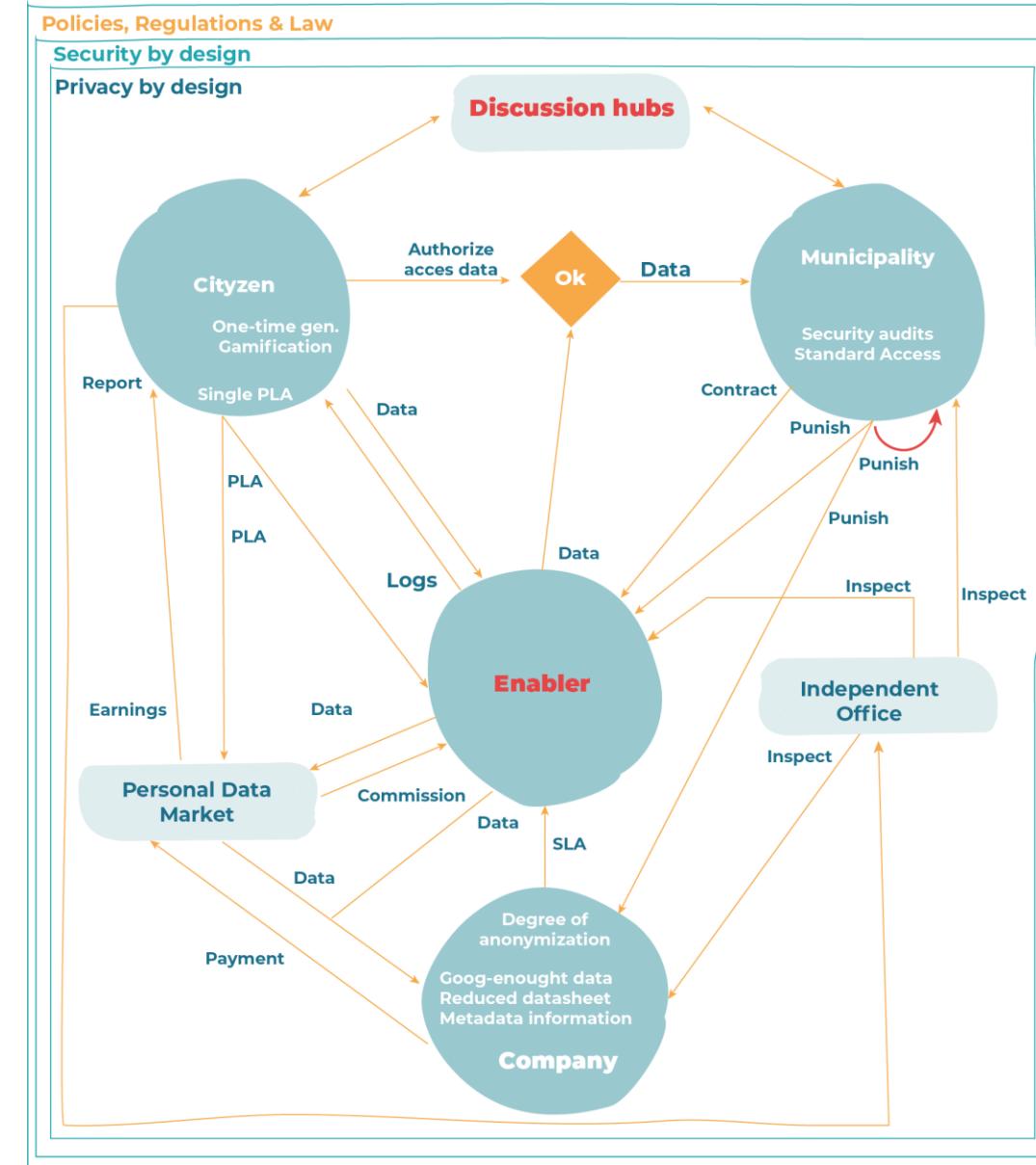
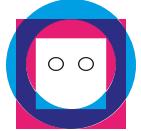
03

# YOUR DESIGN SCIENCE RESEARCH PROJECT

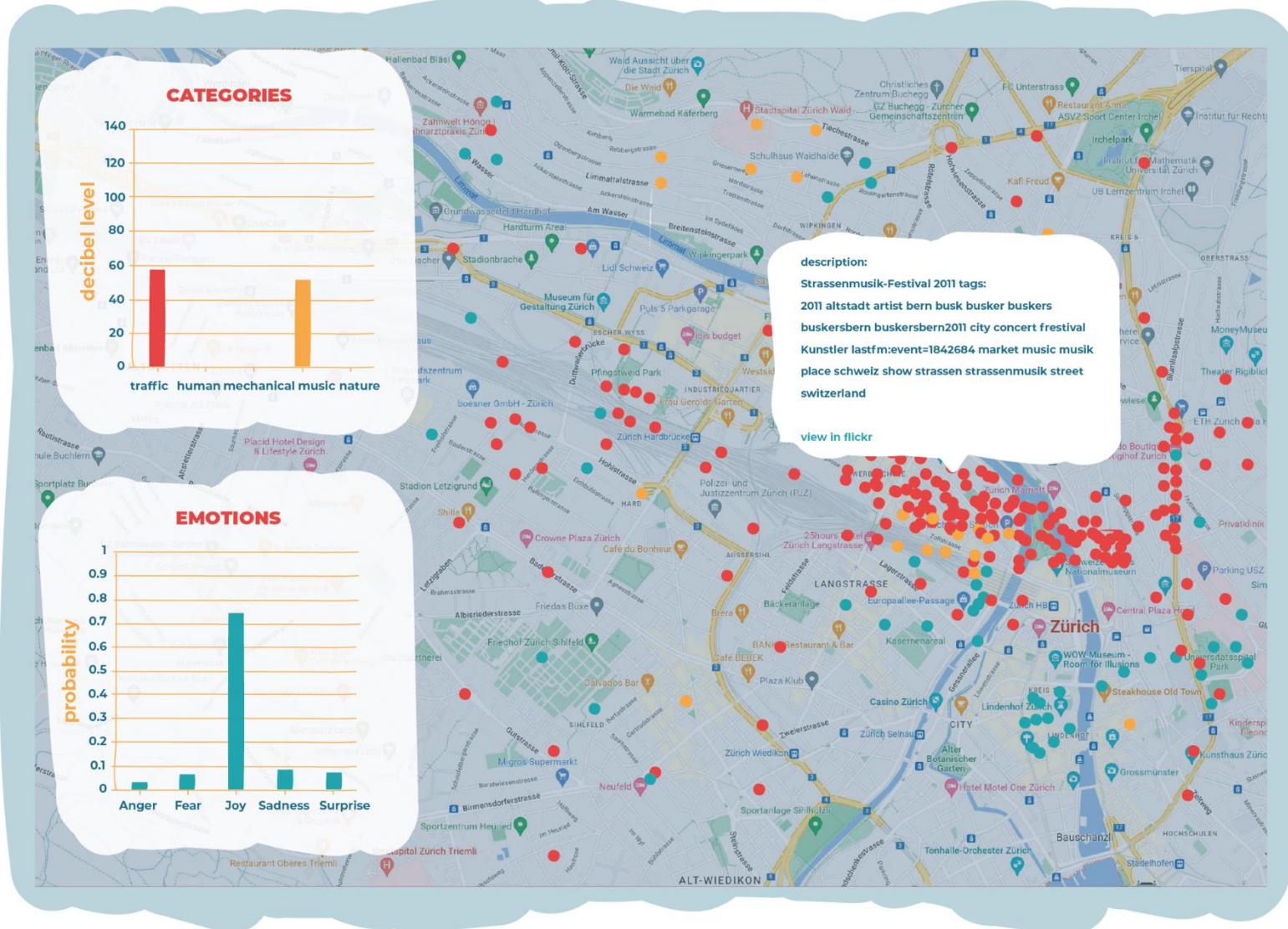
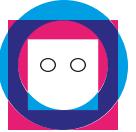
# PUBLIC SERVICE TAXONOMY FOR HAPPY CITIZENS



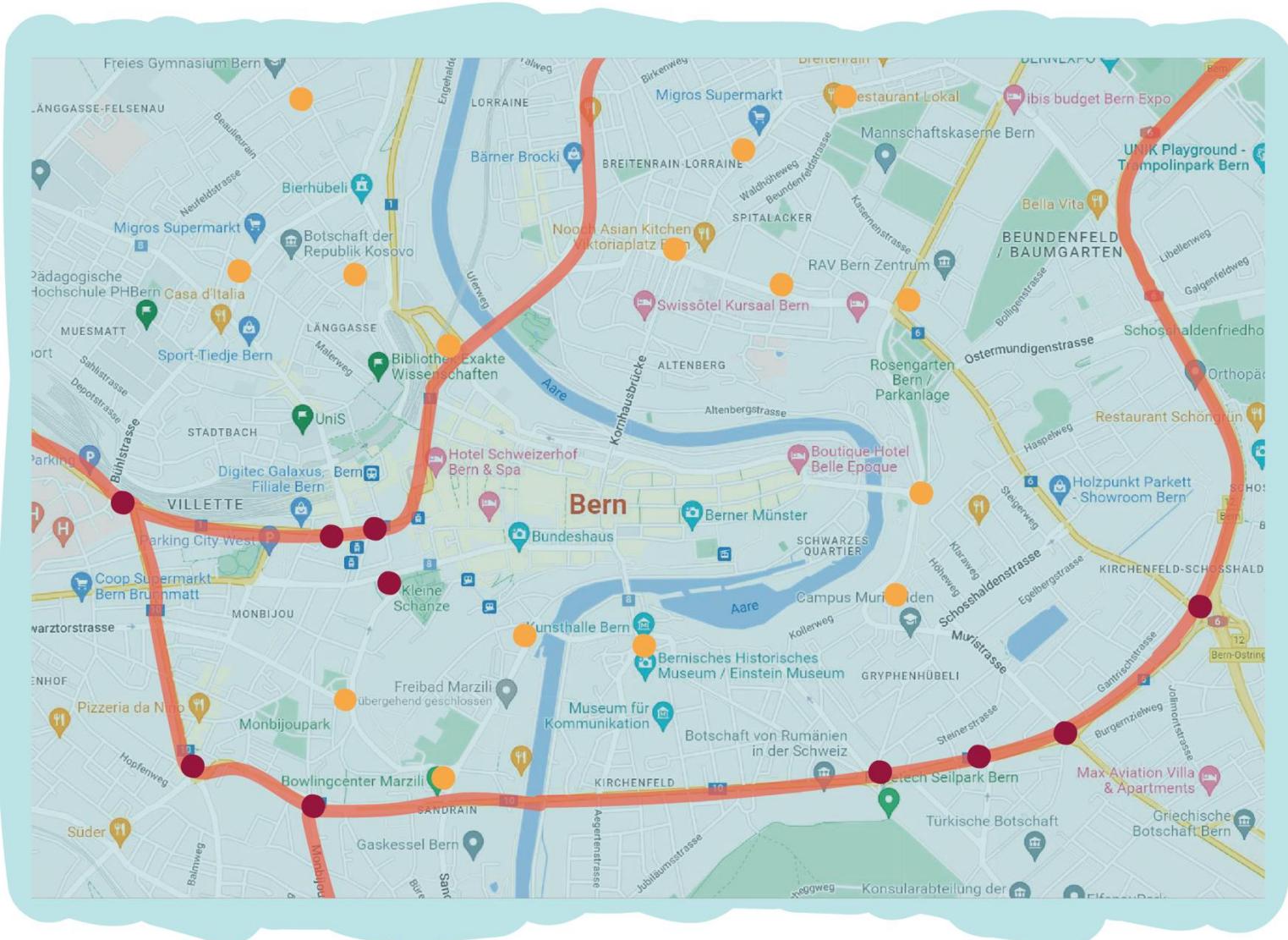
# HANDLING CITIZEN DATA IN HUMAN SMART CITIES



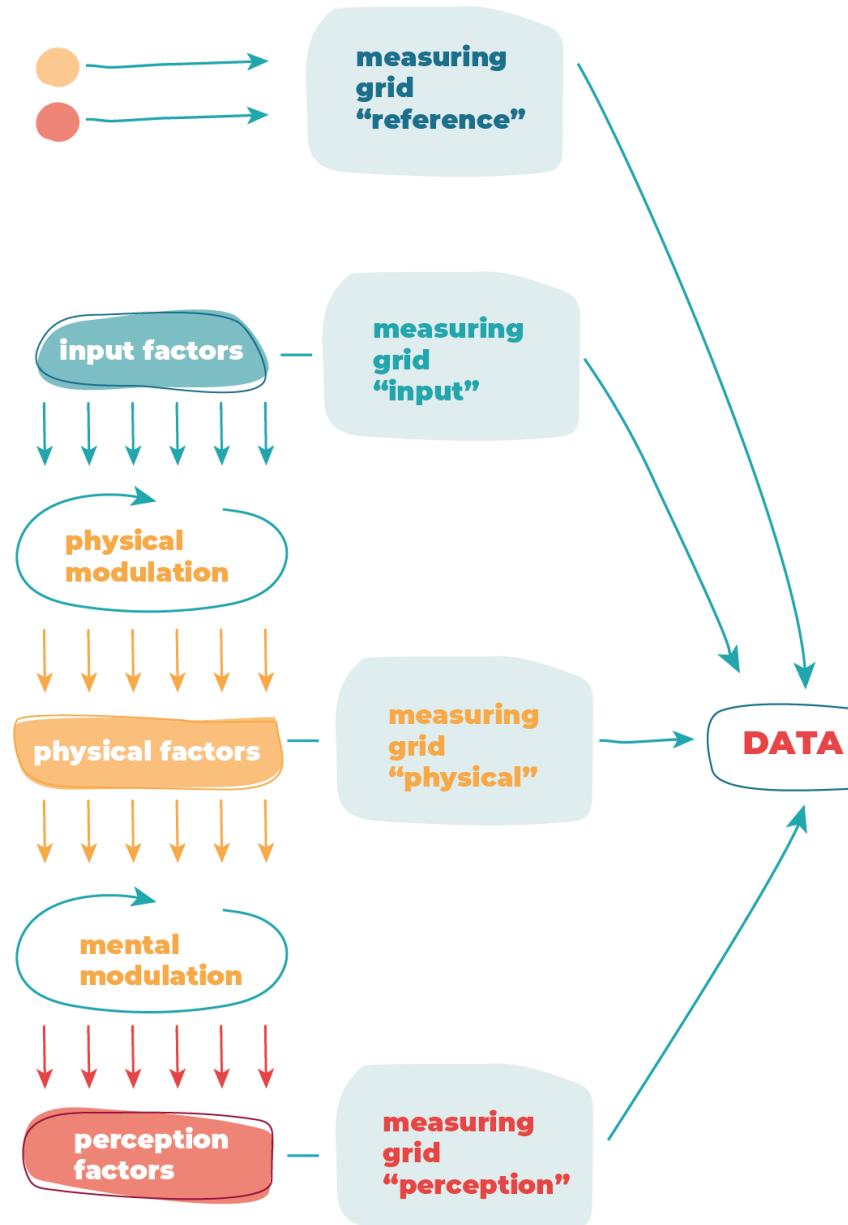
# JINGLE JUNGLE ANALYSIS OF SOCIAL MEDIA DATA TO ESTIMATE CITYS NOISE LANDSCAPE



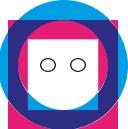
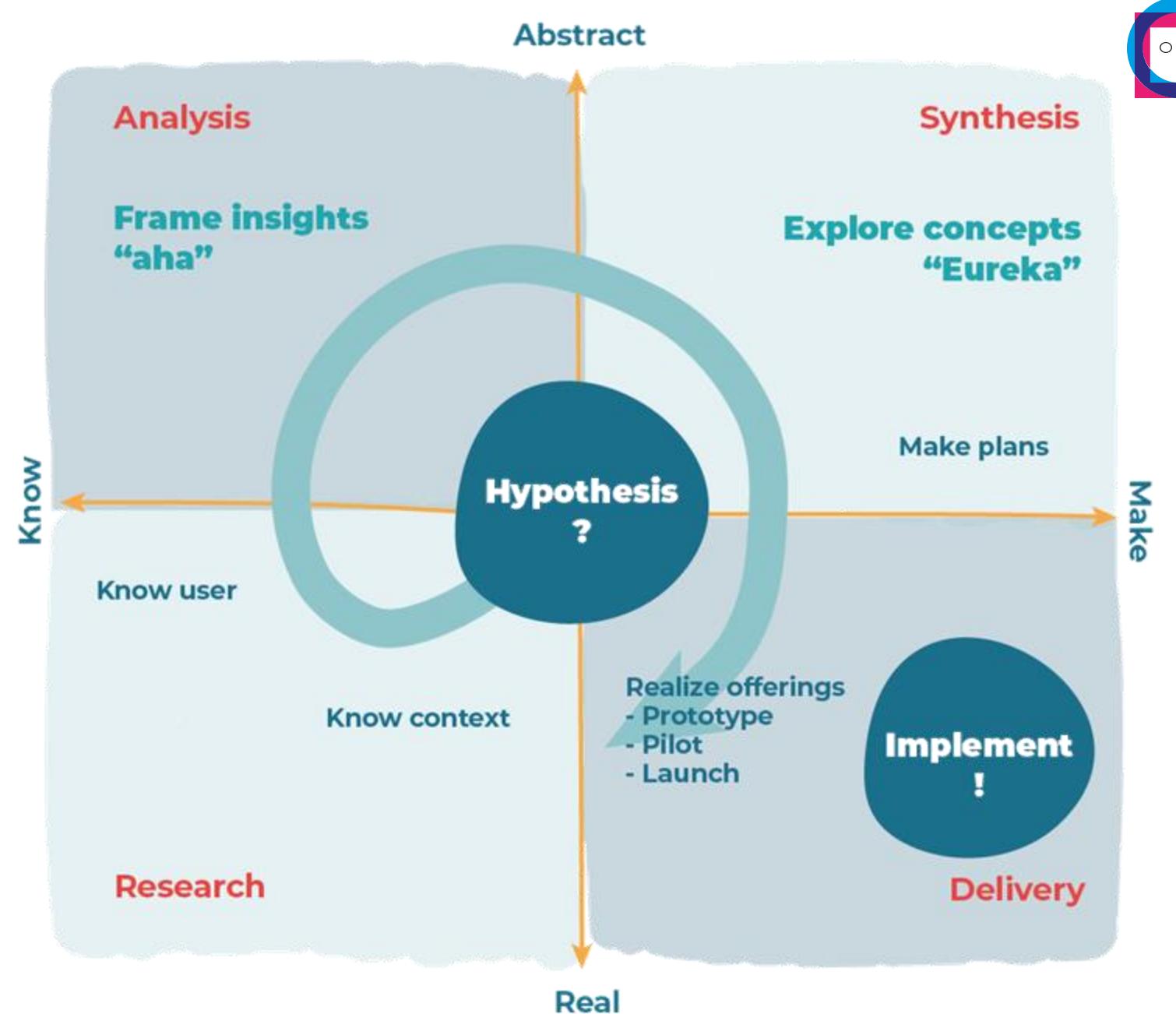
# TRAFFIC DATA VISUALIZATION FOR HUMAN SMART CITIES



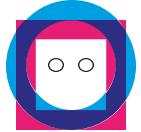
# EFFICIENT COOLING METHODS FOR HEATED CITIES



# HOW DO WE TACKLE SOCIAL COMPUTING QUESTS?



# FIRST WITH BRAINWRITING IN YOUR NEWLY BUILT TEAM



1. **Teambuilding:** Form a team of two, maybe just with the classmate sitting next to you? For this task you have two to three minutes at the maximum.
2. **Pain:** With respect to a chosen topic (see public services taxonomy for happy citizens), individually write down the felt pain mainly caused by today's public services. For this task you have five minutes.
3. **Swap:** Share your identified pain points with your teammate, so (s)he can expand on your pain points. For this you also have five minutes.
4. **Discussion:** Together with your teammate, discuss the identified pain points and distill them to expose today's public services underlying values (frame insights). Again, you have five minutes for this.
5. **Share:** Share your findings with all other classmates in a minute per team.

A journey of a thousand miles begins with your first step!

# YOUR NEXT TEAMTASK FOR THE MIDTERM PRESENTATION

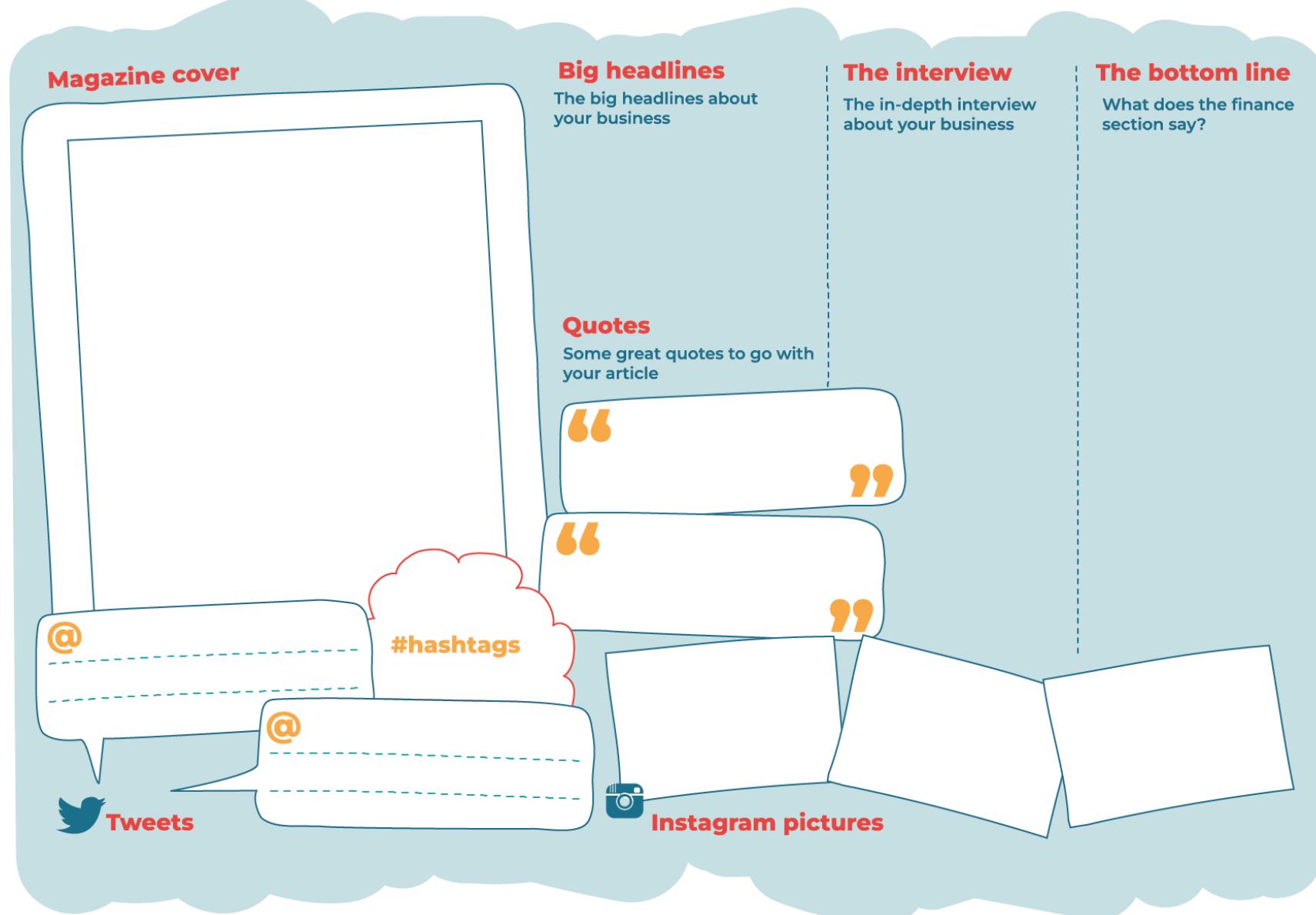


- **Together:** Elaborate on the pains (your hypothesis) by researching the concrete and abstract (see also research and analysis in the conversation theory). And then wait for the “aha-effect”!
- **Pitch Deck:** Deduce a counter (a synthesis) with alternative, humanistic concepts and values (human-centered design, democratic and participative, fair systems, etc.). “Eureka” means “we have found (it)”!
- **Present:** Present your pitch deck (research plan) in the midterm presentation session as a story (online over zoom, team after team). Thereby use your very own cover story (see next point).
- **Story:** is thought of as a cover of a magazine (incl. image, head-line, quote, facts). Presents your envisioned artifact (implementation) as the future hero.
- **Takeaway:** of the midterm presentation should be a good feeling for your artifact building (delivering of prototype, pilot, launch, etc.). Of course, this artifact must then be evaluated for your final presentation.

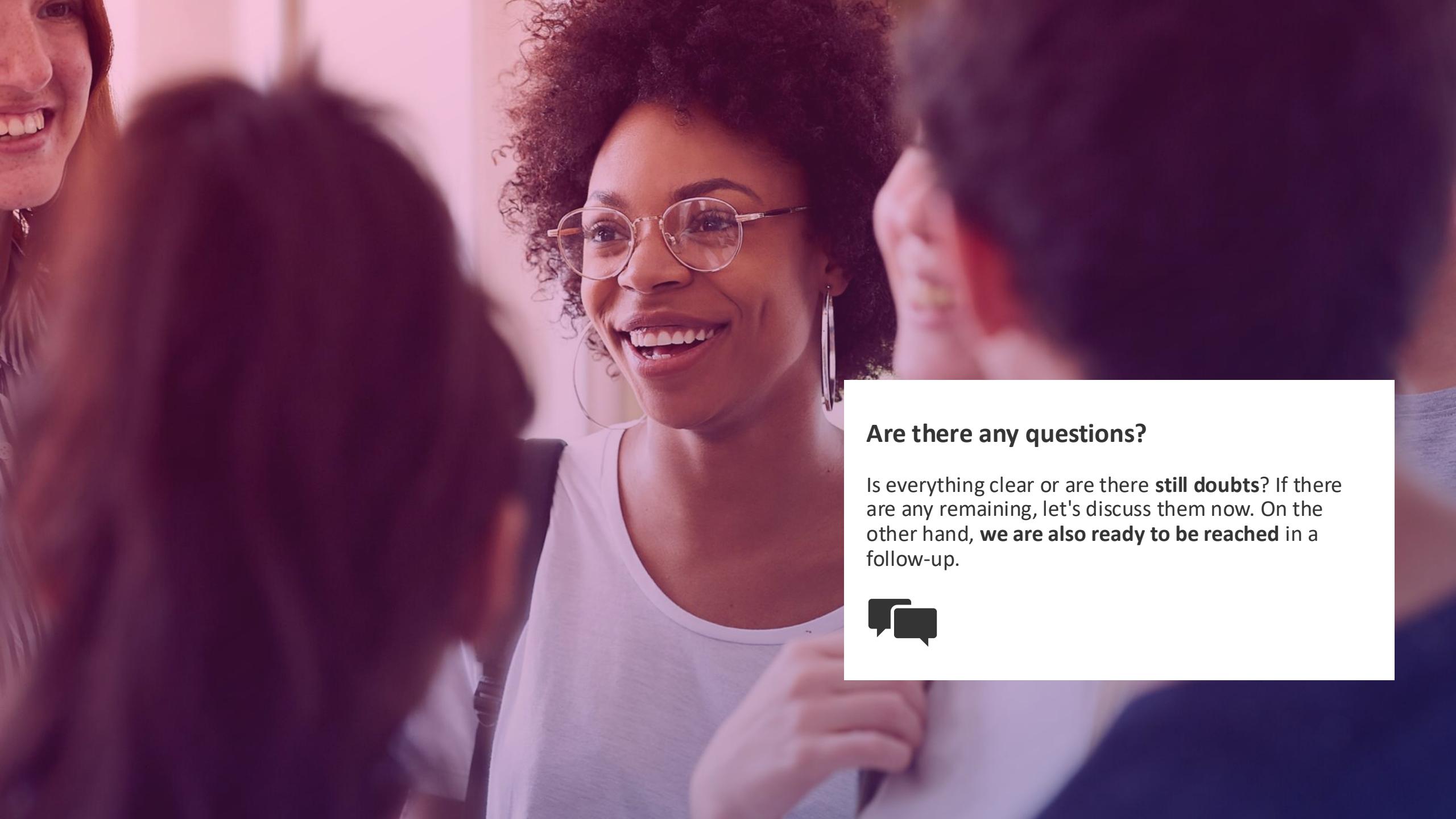
You on your journey is our main goal!

# YOUR TURN

# CREATE YOUR COVER STORY BY MIDTERM



Your artifact is the hero of your story!

A woman with curly hair and glasses is smiling during a presentation. She is wearing a white t-shirt and large hoop earrings. In the background, other people are visible, some with their hands raised. A white callout box is positioned in the lower right corner.

## Are there any questions?

Is everything clear or are there **still doubts**? If there are any remaining, let's discuss them now. On the other hand, **we are also ready to be reached** in a follow-up.



**04**

# **ANNEX OF USEFUL RESOURCES**

# BOOKS AND REFERENCES FOR PUBLIC SERVICES I



## Resource to learn about fuzzy methods

- (1) Interval Type-3 Fuzzy Systems: Theory and Design, Oscar Castillo, Juan R. Castro, Patricia Melin.: Studies in Fuzziness and Soft Computing 418, Springer 2022, ISBN 978-3-030-96514-3
- (2) Fuzzy Control Systems Design and Analysis: A Linear Matrix Inequality Approach, Kazuo Tanaka, Hua O. Wang, 2001, Wiley
- (3) Lendek, Zsófia, Thierry Marie Guerra, Robert Babuska, and Bart De Schutter. Stability analysis and nonlinear observer design using Takagi-Sugeno fuzzy models. Vol. 262. Springer Berlin Heidelberg, 2011.
- (4) L. A. Zadeh, K. Fu, K. Tanaka, and M. Shimura, Fuzzy Sets and Their Applications to Cognitive and Decision Processes, Academic Press, Inc., Chestnut Hill, 1975.
- (5) D. Dubois, and H. Prade, Fuzzy Sets and Systems: Theory and Applications, Academic Press, Inc., Chestnut Hill, 1980.
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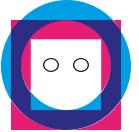
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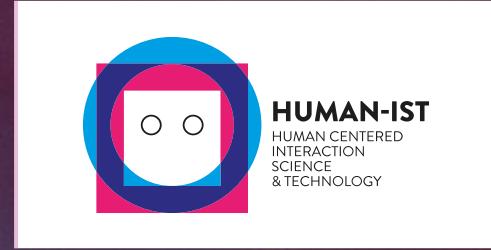
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# THANK YOU!