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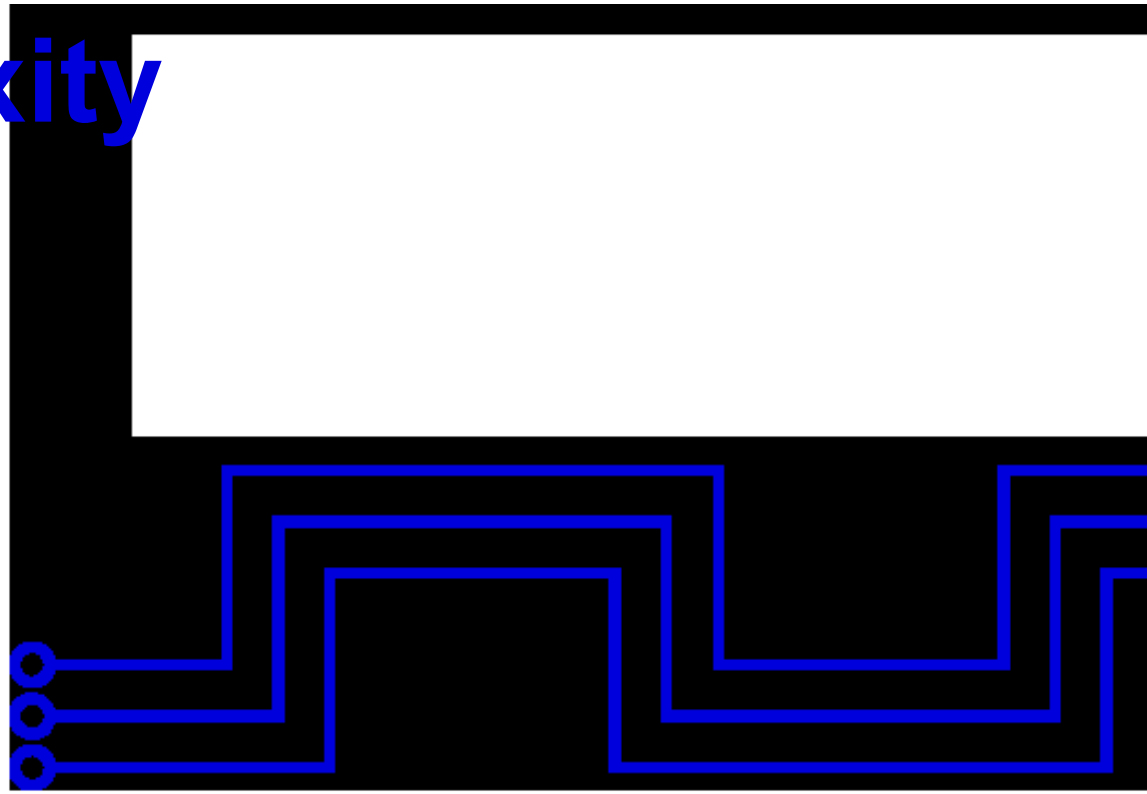
Smart City and Complexity

How to understand complexity of Services



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Smart City – example of service complexity

- Correct definition of Smart City
- Role of ICT in Smart City Structure
- Role and design of Services within the Smart City

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Definition of Smart City

Why do we need „correct“ definition of Smart City?

Many cities claim to be smart

Obviously, the implementation of ICT plays key role in city „smartness“

Smart City Council definition:

- A smart city is one that has digital technology embedded across all city functions

But just usage of ICT does not mean the city is smart

The usage of ICT should have been used in a way to improve city efficiency, usability and sustainability

Possible definitions

The use of smart computing technologies to make the critical infrastructure components and services of a city – which includes city administration, education, healthcare, public safety, real estate, transportation and utilities – more intelligent, interconnected and efficient

- Where Smart Computing means:
  A new generation of integrated hardware, software, and network technologies that provide IT systems with real-time awareness of the real world and advanced analytics to help people make more intelligent decisions about alternatives and actions that will optimize business processes and business balance sheet results
- WASHBURN, Doug; SINDHU, Usman; BALAOURAS, Stephanie; DINES, Rachel A; HAYES, Nicholas M; NELSON, Lauren E. Helping CIOs Understand "Smart City" Initiatives. 2010.

Smart City is a service, containing different sets of advanced services, using ICT in an innovative way that enables city management and the whole society to meet the challenges of city development with the aim to improve its efficiency, habitation, resilience, and sustainability, to bring its citizens (and all other stakeholders) the highest value possible, formulated in an understandable value proposition.

- Based on Lucie Ševanková: Analysis of the Smart City from IT management point of view, Master thesis, 2018, Dean's award
- Improved by Chat GPT

Main research questions

- Do the Smart City Services have any structure?
- How to design and realize Smart City services in the most efficient and complex way?
- What competencies and knowledge are necessary to understand complexity of services?
- What are necessary inputs, implementation processes, limits, forms of financing and other constrains to create valuable structure of services within Smart City?
- How to formulate the rules to create effective, flexible and complex Smart City, fulfilling the requests of administration, citizens and other related stakeholders?

Smart City Services

There are many different services, used in Smart City, with different role and customers

- Traffic control
- Route optimization
- Waste services

We can find there many IT services, but in the basic level, we can recognize two main elements

- Software
- Hardware

How they are related or connected? What tasks do they really fulfill?

Is there any methodology we can use?

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How do we model Smart City?

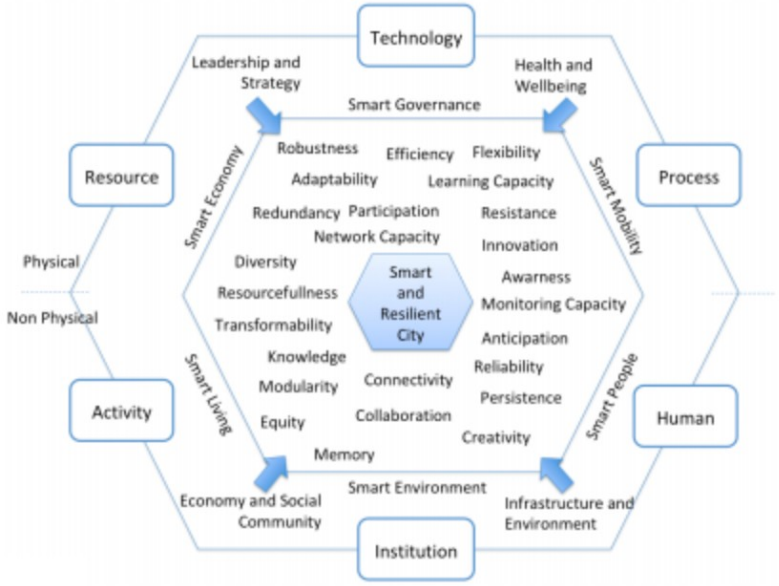
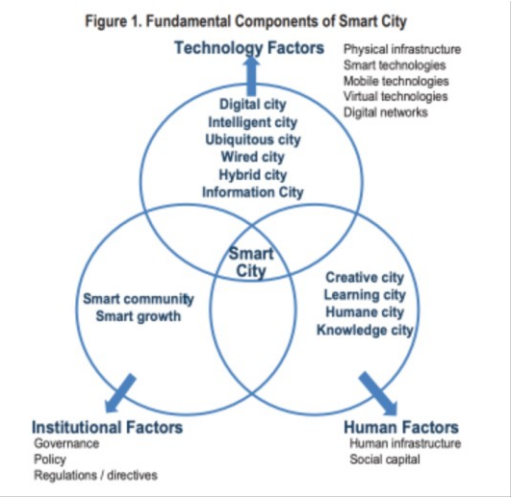


Figure 4. Smart and resilient city model.



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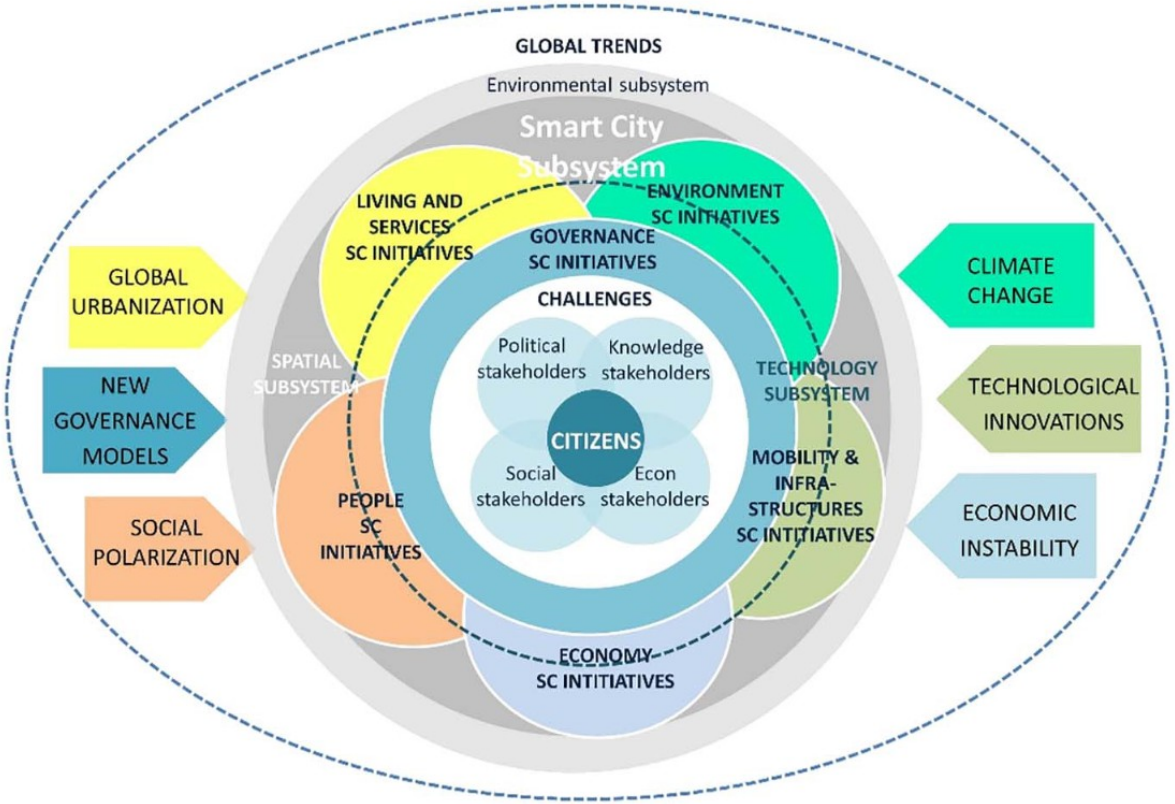
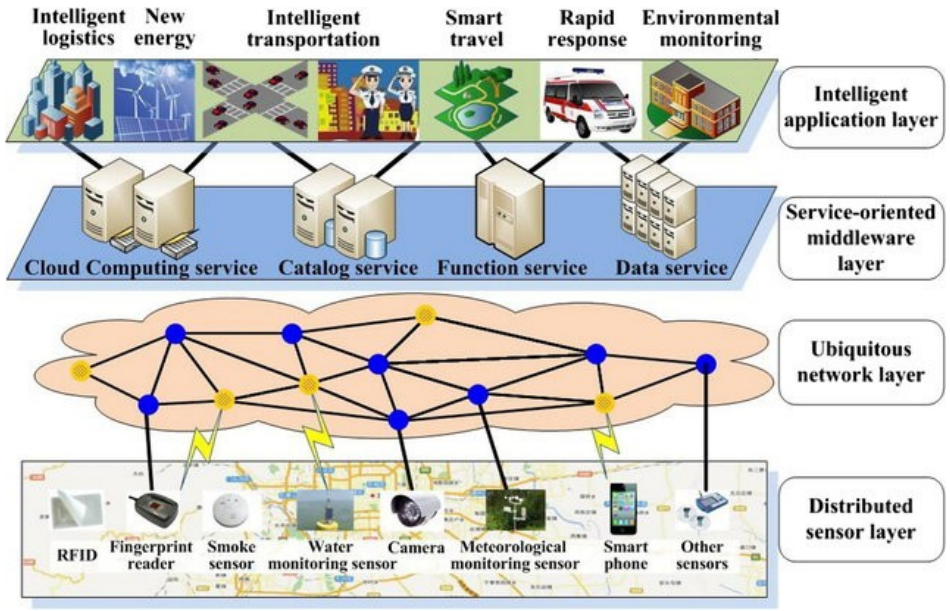
How do we model Smart Cities?





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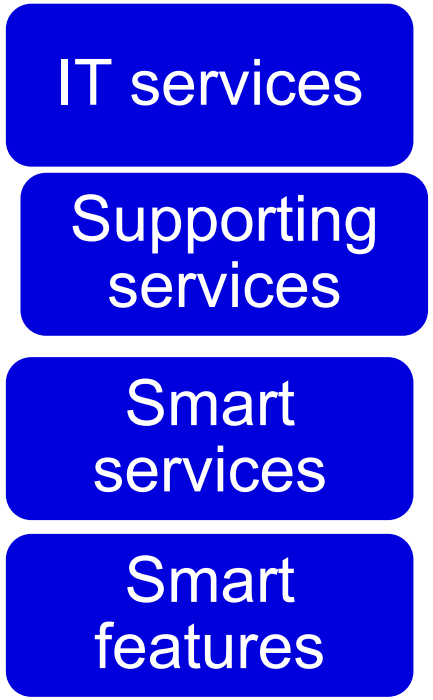
Service Science inspiration

The key element of all services is:

- Value – usefulness or utility for the receiver of the service
- Value proposition – description of the value in the language of receiver

Based on this we divided the Smart City services to the layers depending on their value proposition.

- Do they serve for final user (citizen, administration) or are they just „inputs“ for other services?



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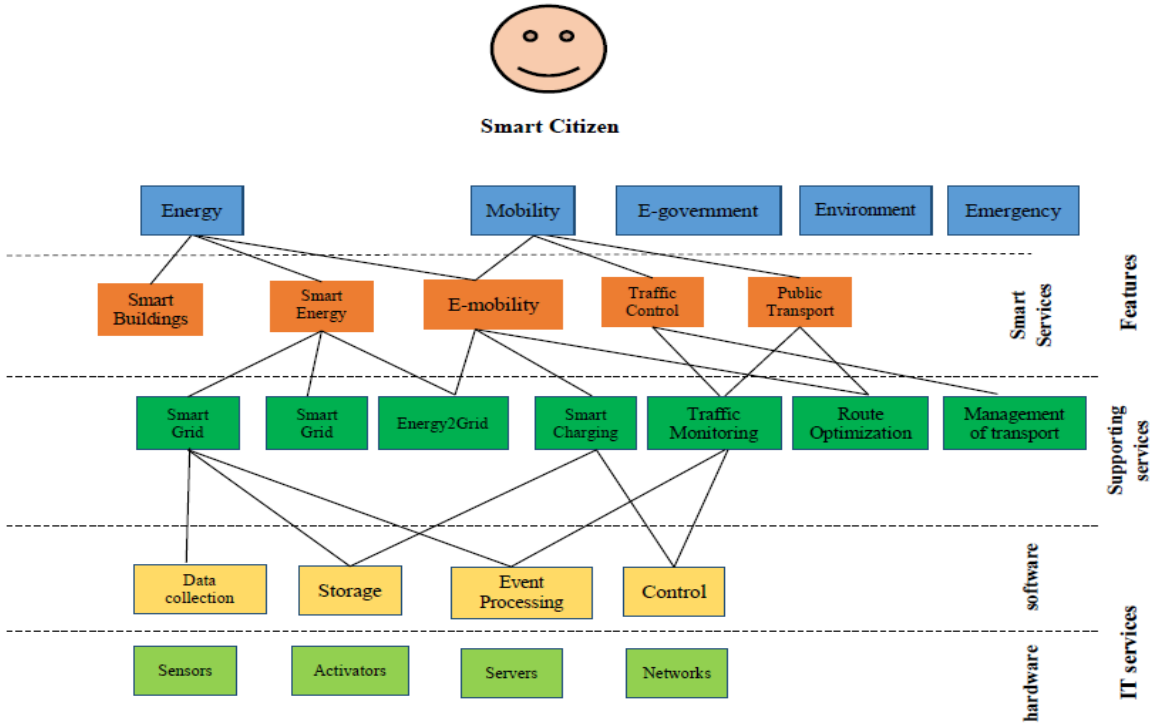
Layer model of Smart City



Walletzky L., Buhnova B., Carrubbo L. (2018) Value-Driven Conceptualization of Services in the Smart City: A Layered Approach. In: Barile S., Pellicano M., Polese F. (eds) Social Dynamics in a Systems Perspective. New Economic Windows. Springer, Cham

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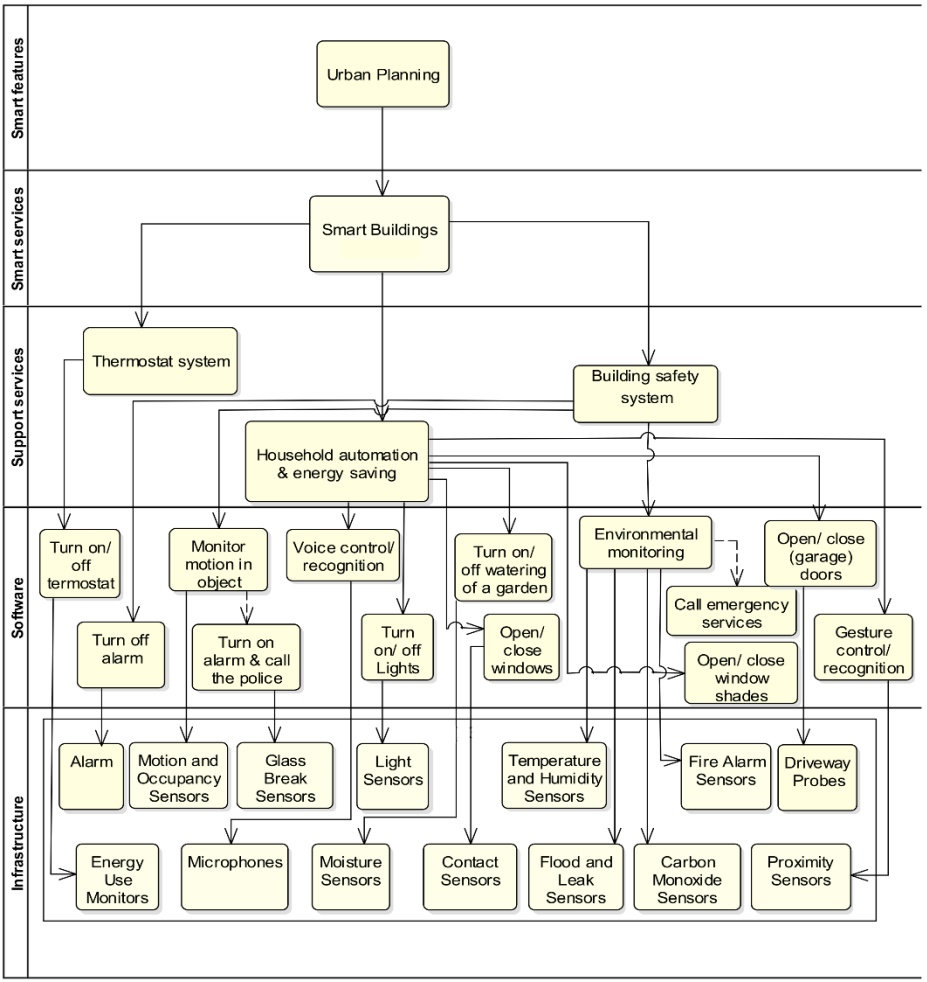
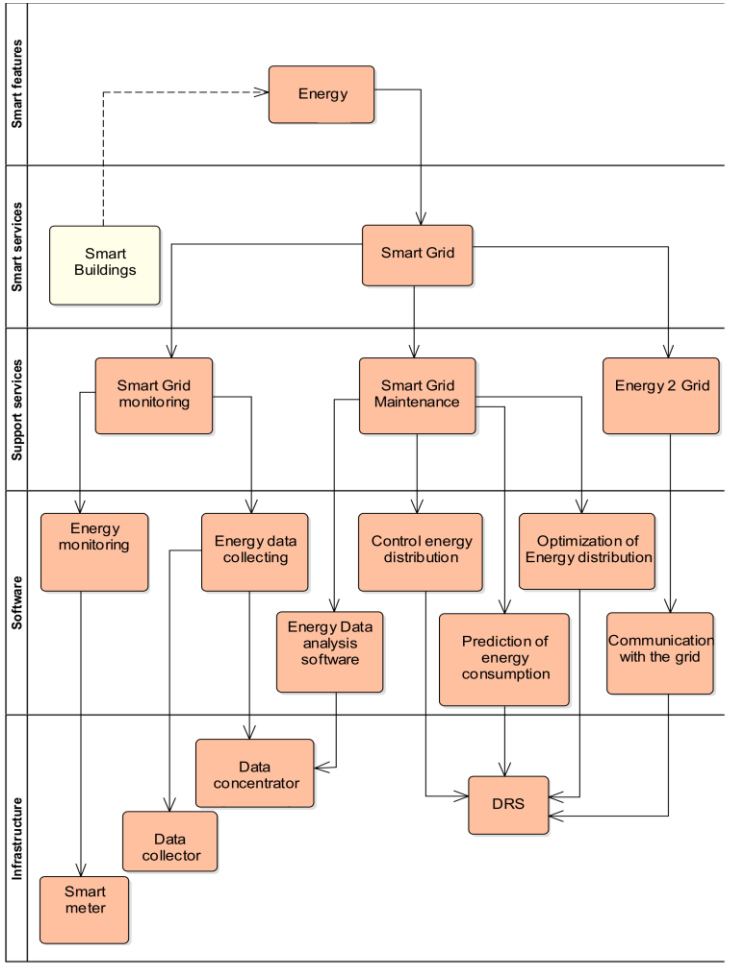
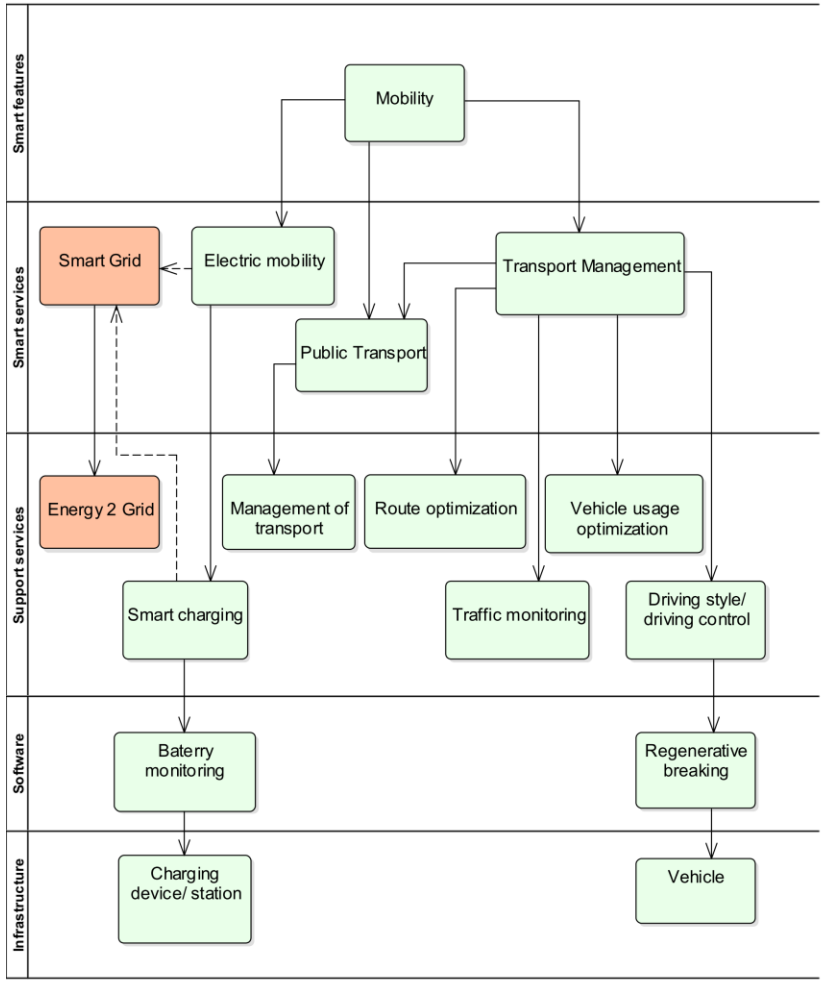
Detailed Layer analysis



Urban planning



Smart Energy



Mobility

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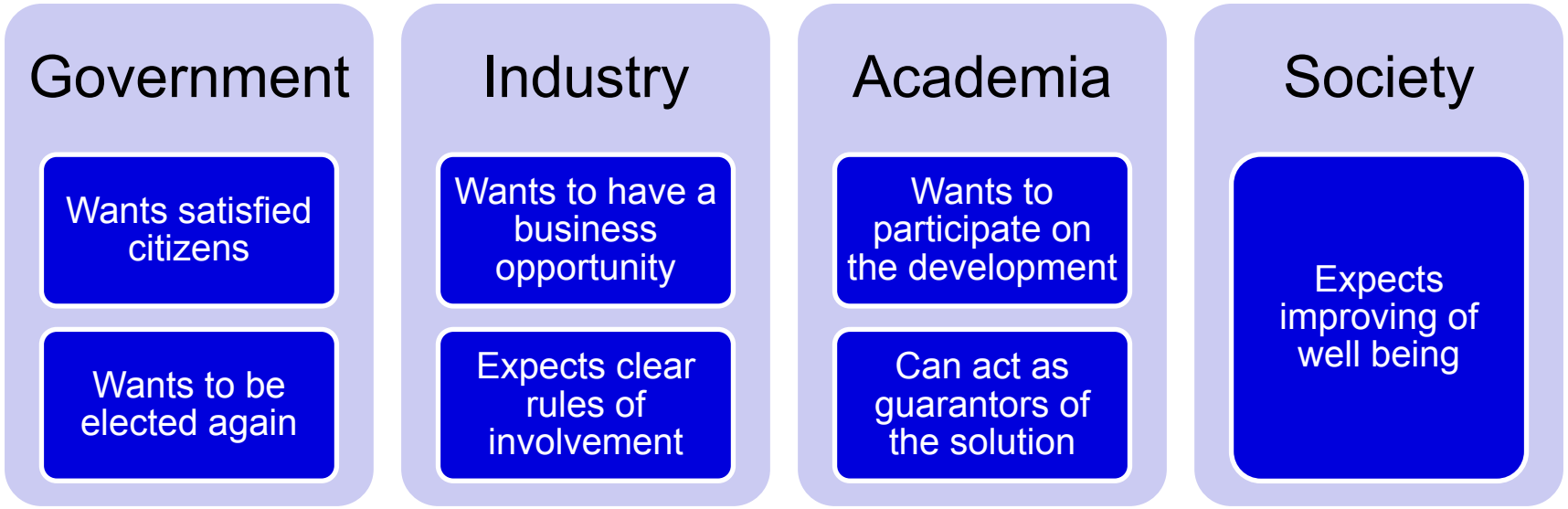
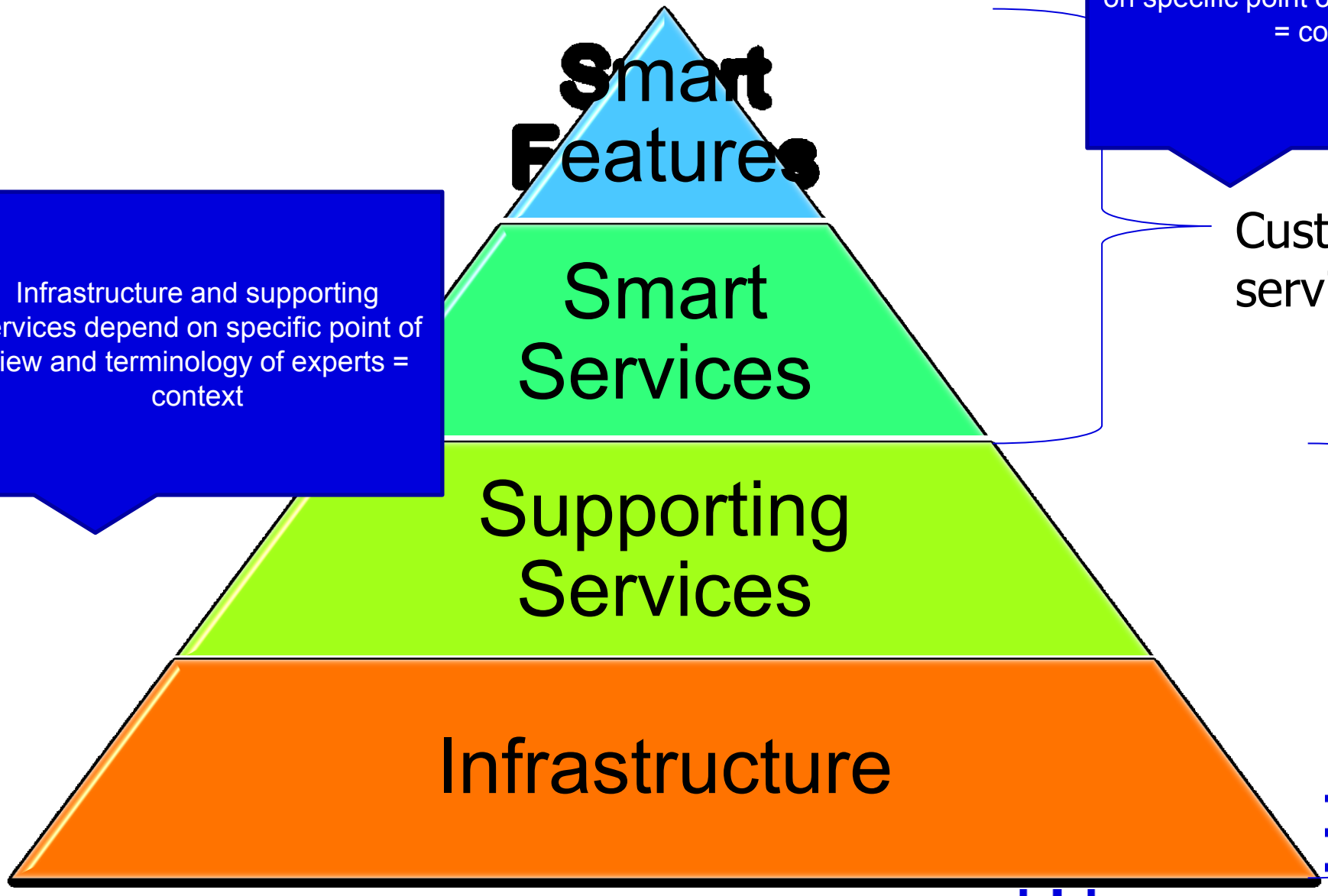
Complexity of Smart City

- the environment of Smart City is not truly objective – it is a mix of different contexts, based on the interactions of actors in a stated moment
- the main problem is how to merge different perspectives described by the quadruple helix



New developed model



Smart feature and services depend on specific point of view of customer = context

Customer facing services

Infrastructure and supporting services depend on specific point of view and terminology of experts = context

Background services

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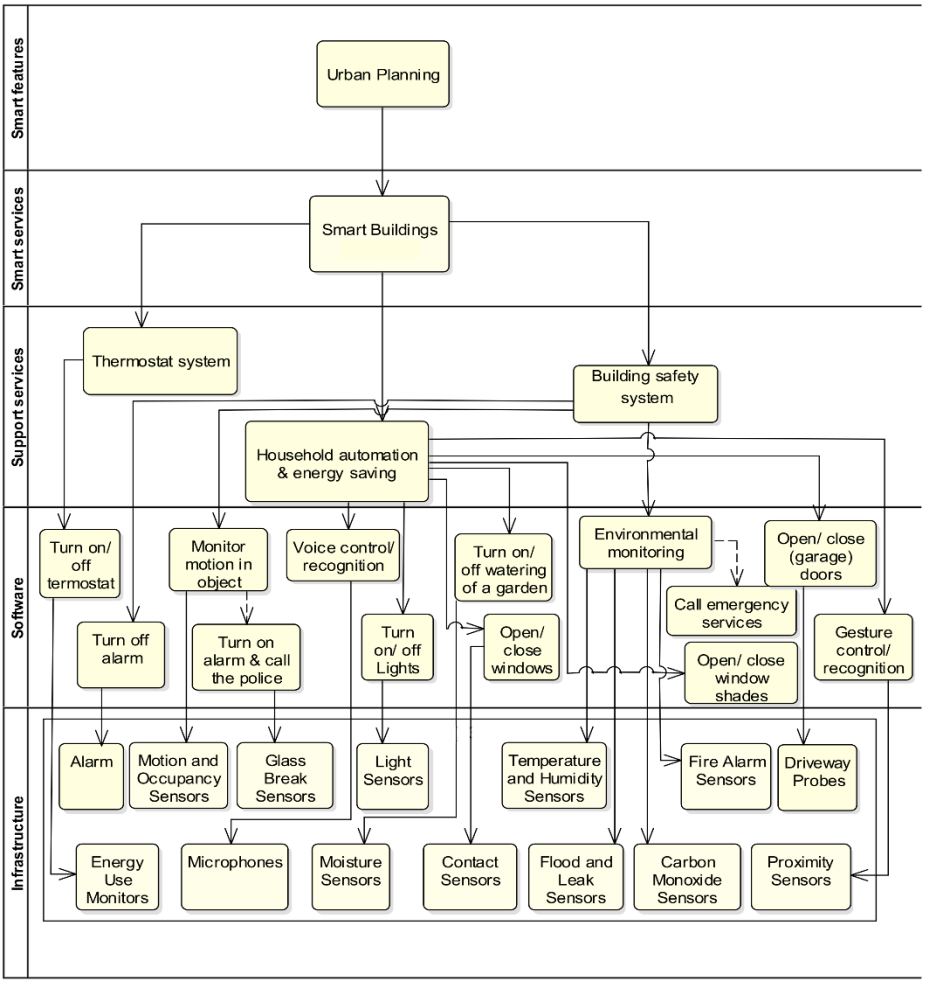
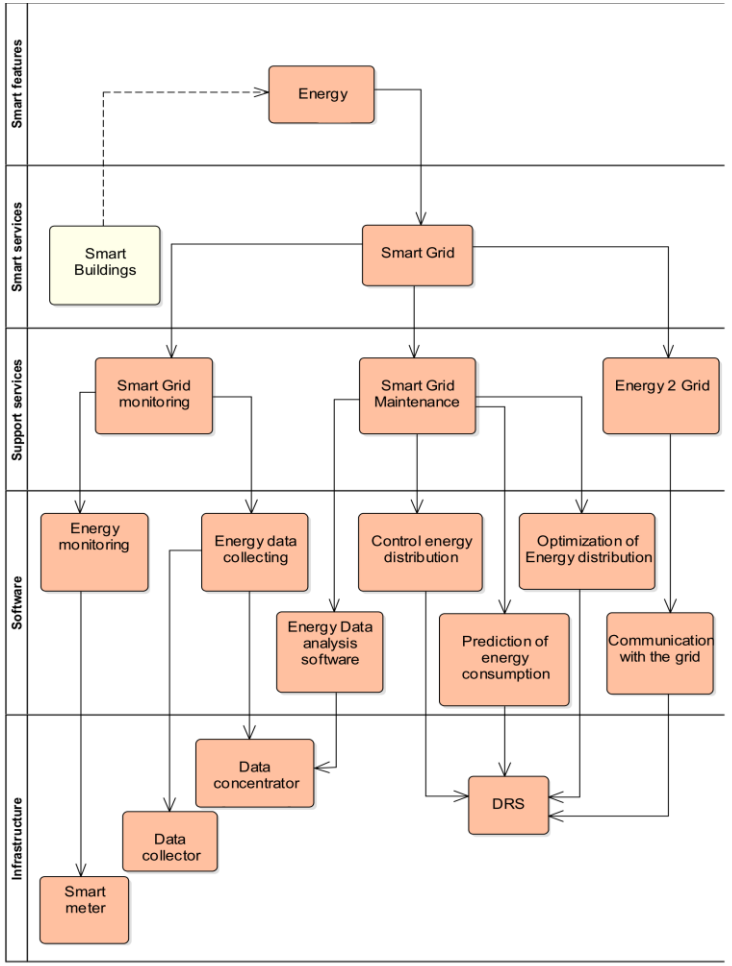
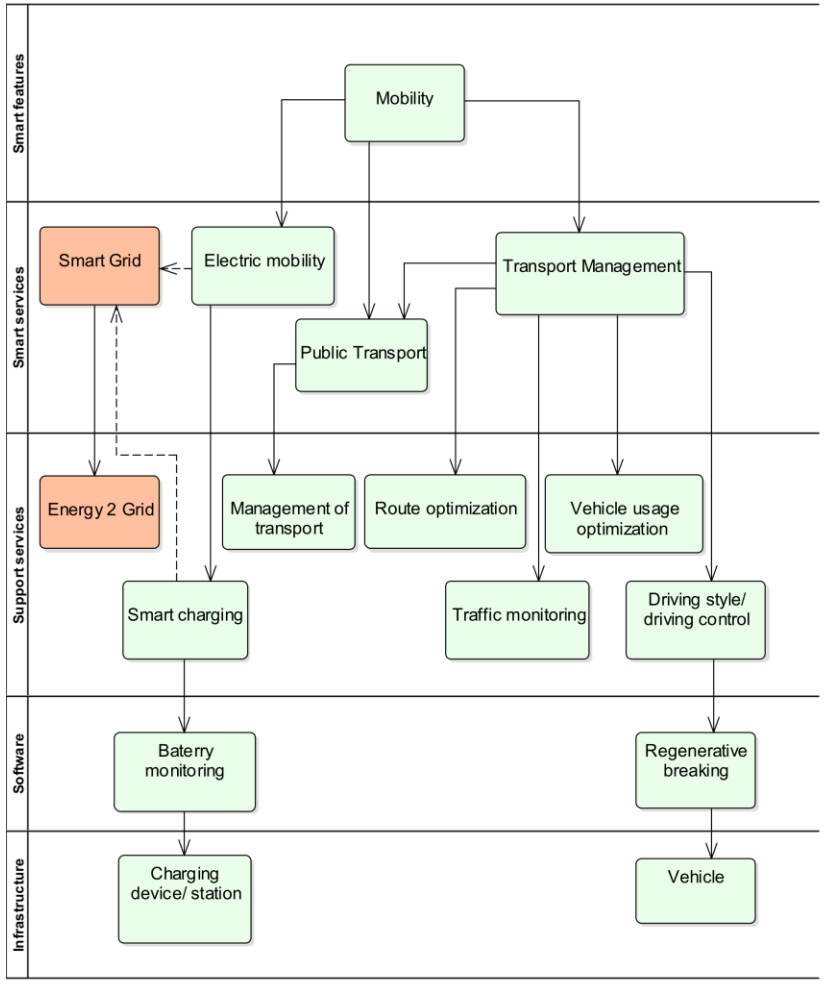
Detailed Layer analysis



Urban planning



Smart Energy



Mobility

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How to model such complex environment?

We need to have universal tool to catch multicontextual relations

It should contain

- Analysis of perception
- Analysis of stakeholders´ motivation
- Analysis of service provision

The main questions

- Do we really understand the models?
- Are the models readable for others?
- What if we need to communicate with people from other domains?
- And what if we need to achieve understanding across domains?
- How we can model in multidisciplinary way?

Solution is to go back to our roots and ask

- What are we modeling?
- The answer is – objects from the real world
- Where are we modeling?
- The answer is - in our mind!
- How does any person build own mind model?

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How do we model reality in our heads?

We identify...

Object-s

...we find interesting

Relationship-s find...

...between our...

Object -s

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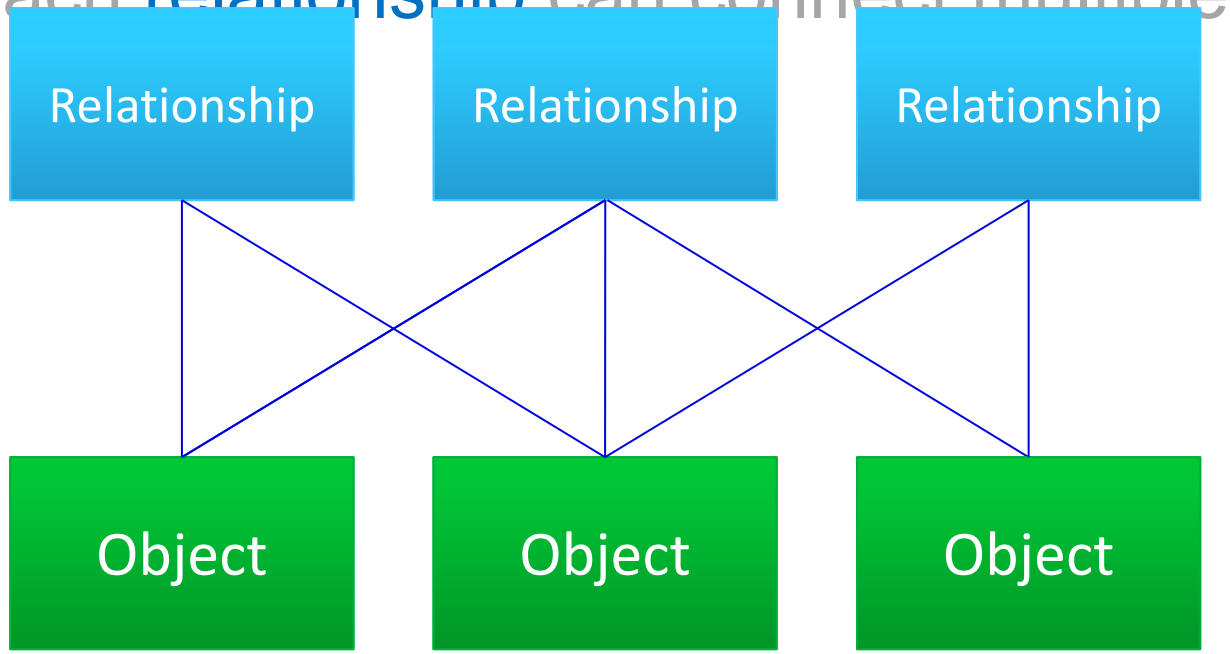
Each relationship can connect multiple objects...



...and each object can be present in multiple connections.

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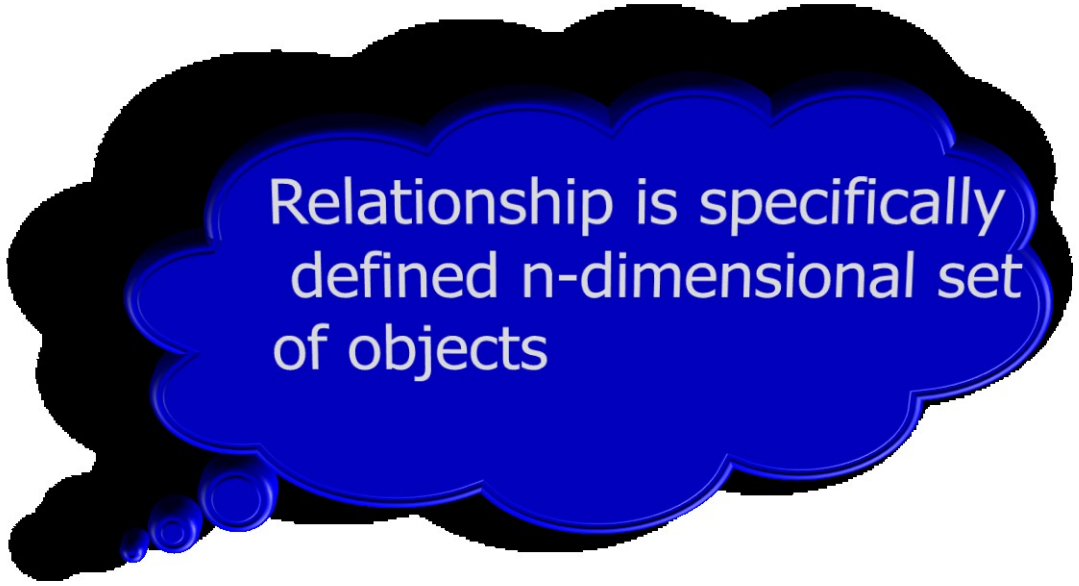
Each relations



...and each object can be present in multiple connections.

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ects

Relationship

nteres

Category

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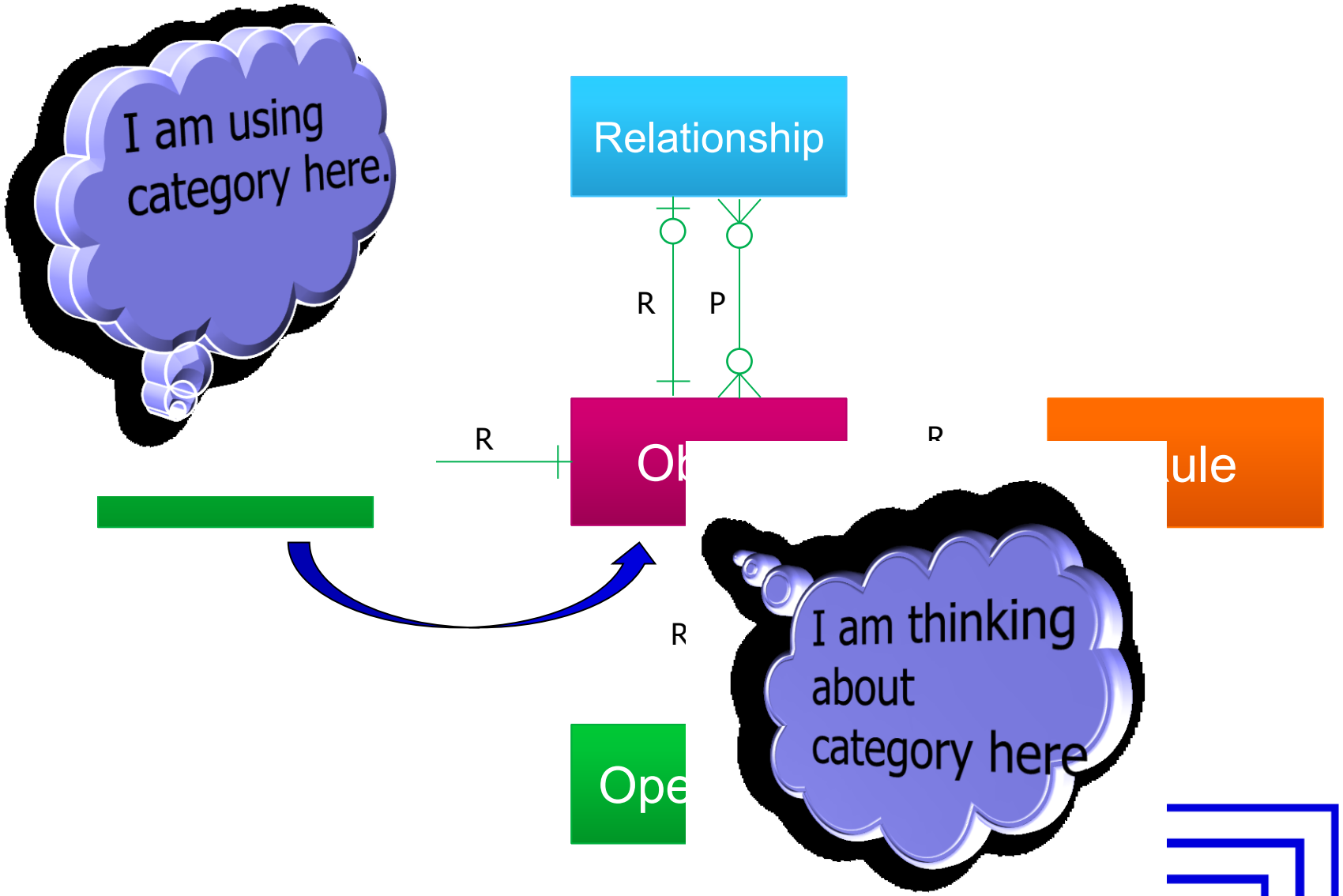
MENTION – USE duality



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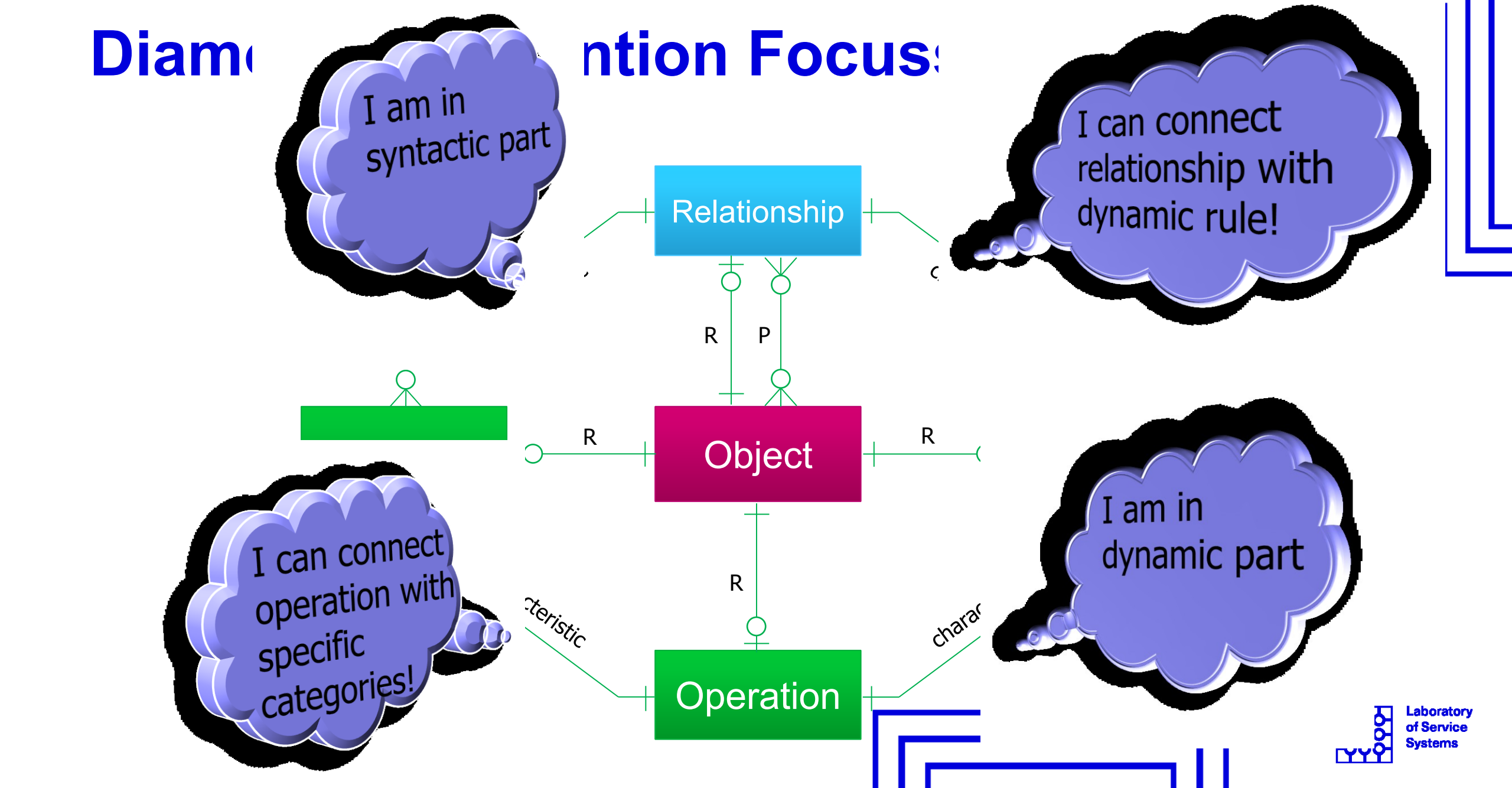
Diam ntion Focus



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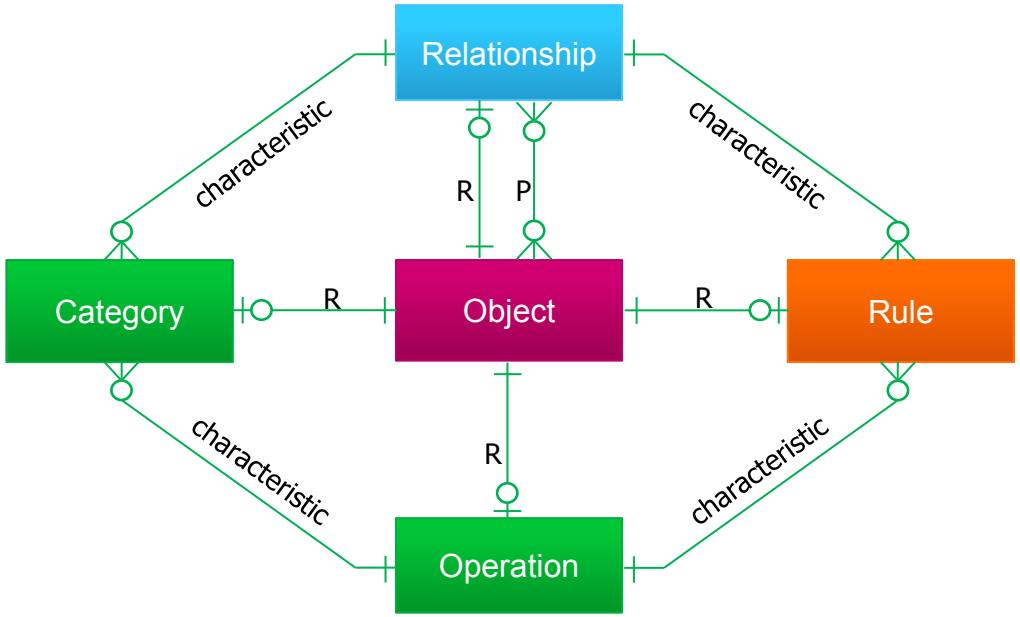
Diamond of Attention Focussing

- Objects and relationships between them
- Mention-use duality
  - Modelling a modelling tool
  - Referring to itself



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Road (street) - Objects and relationships

Name	Relationship	Name
Car	Is on	Road
Bus	Is on	Road
Bicycle	Is on	Road
Pedestrian way	Is on	Road
Driving lines	Are dividing	Road
All vehicles	Are using	Driving lines
Trafic on the road	contains	All vehicles
Trafic lights	Are managing	Traffic on the road

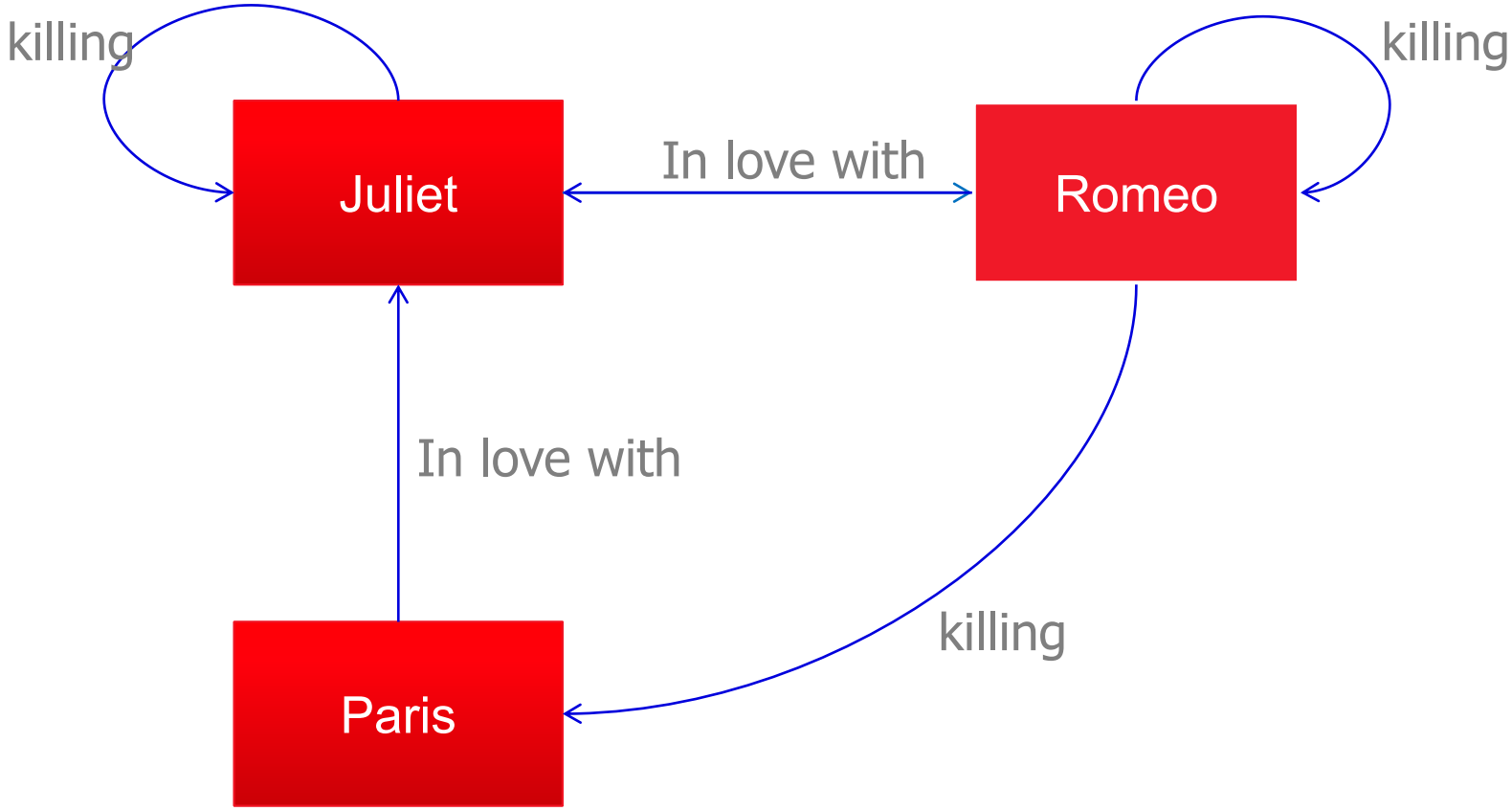
What to do next

If we want to understand complexity, we need to have holistic approach

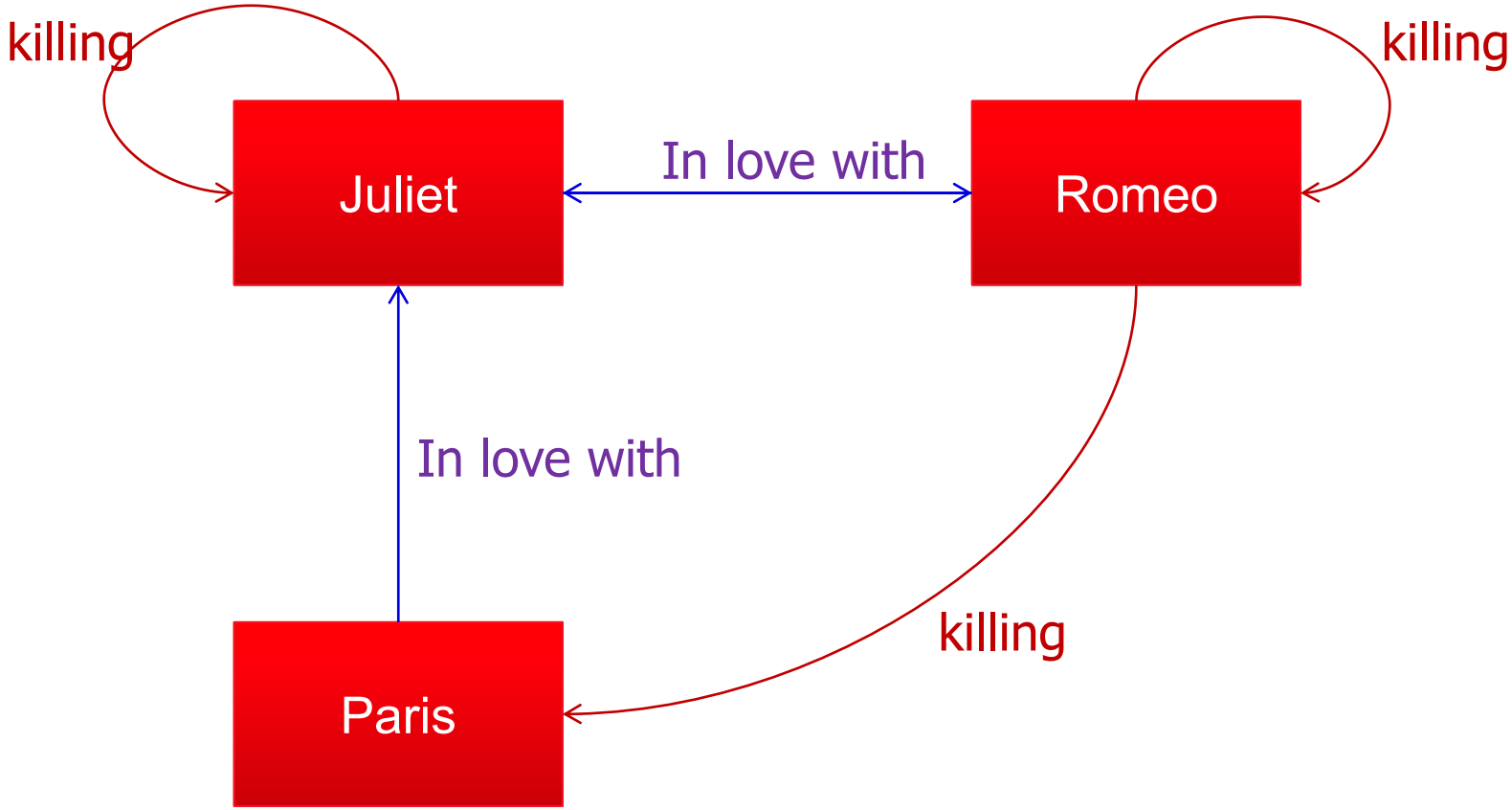
What is a holistic approach?

- In a medical setting, a holistic approach to problem solving refers to addressing the whole person, including their physical, mental, and emotional health, while taking social factors into consideration.
- In problem solving, a holistic approach starts by first identifying an obstacle, then taking a step back to understand the situation as a whole.
- In service environment, a holistic approach means to understand the value of the service from different perspectives, from the all important stakeholders point of view, to analyze overlaps to the other domains and take them into the consideration
  - Interdisciplinary approach
  - we are facing to the **problem of classification**

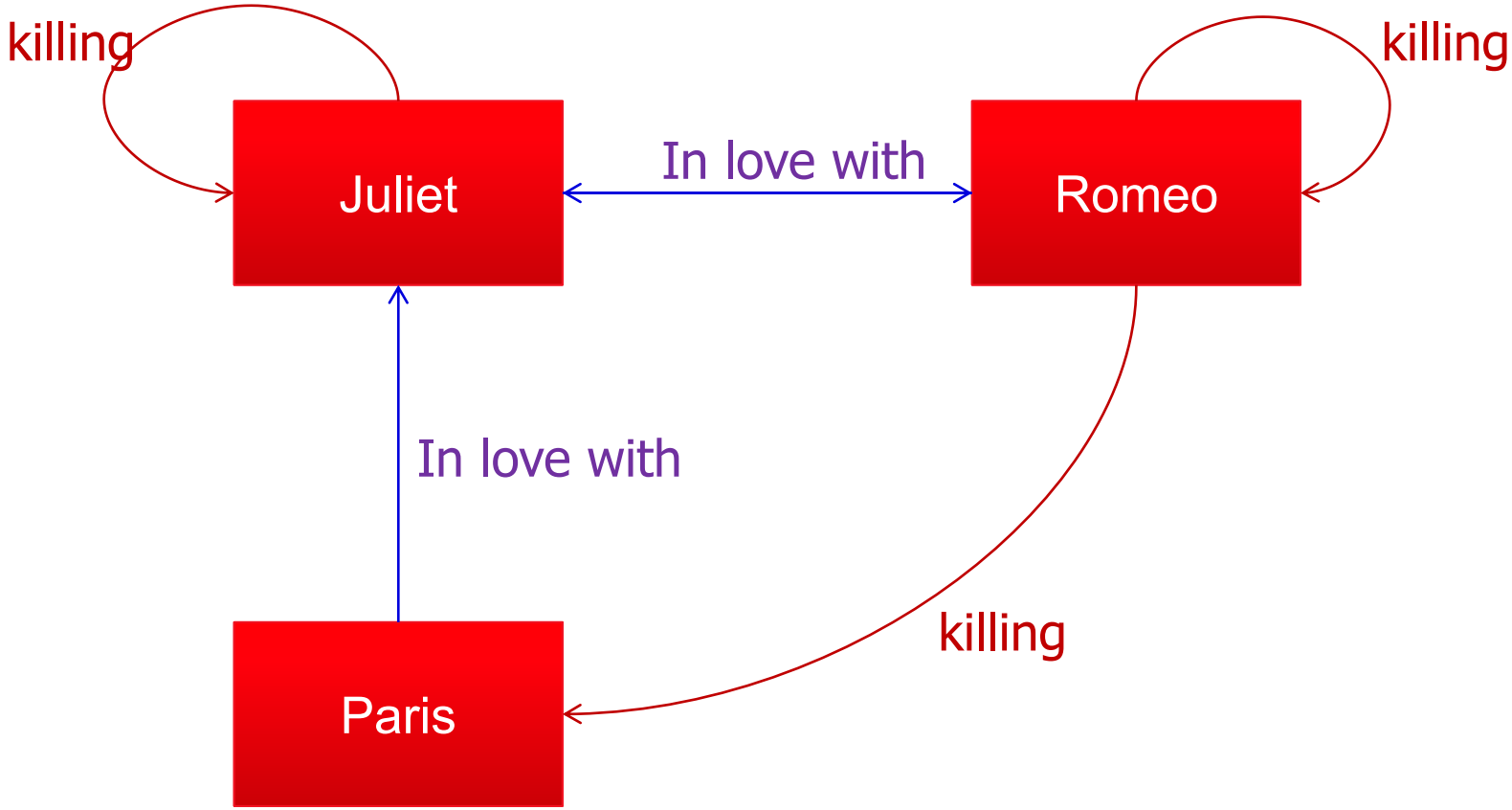
Classification example



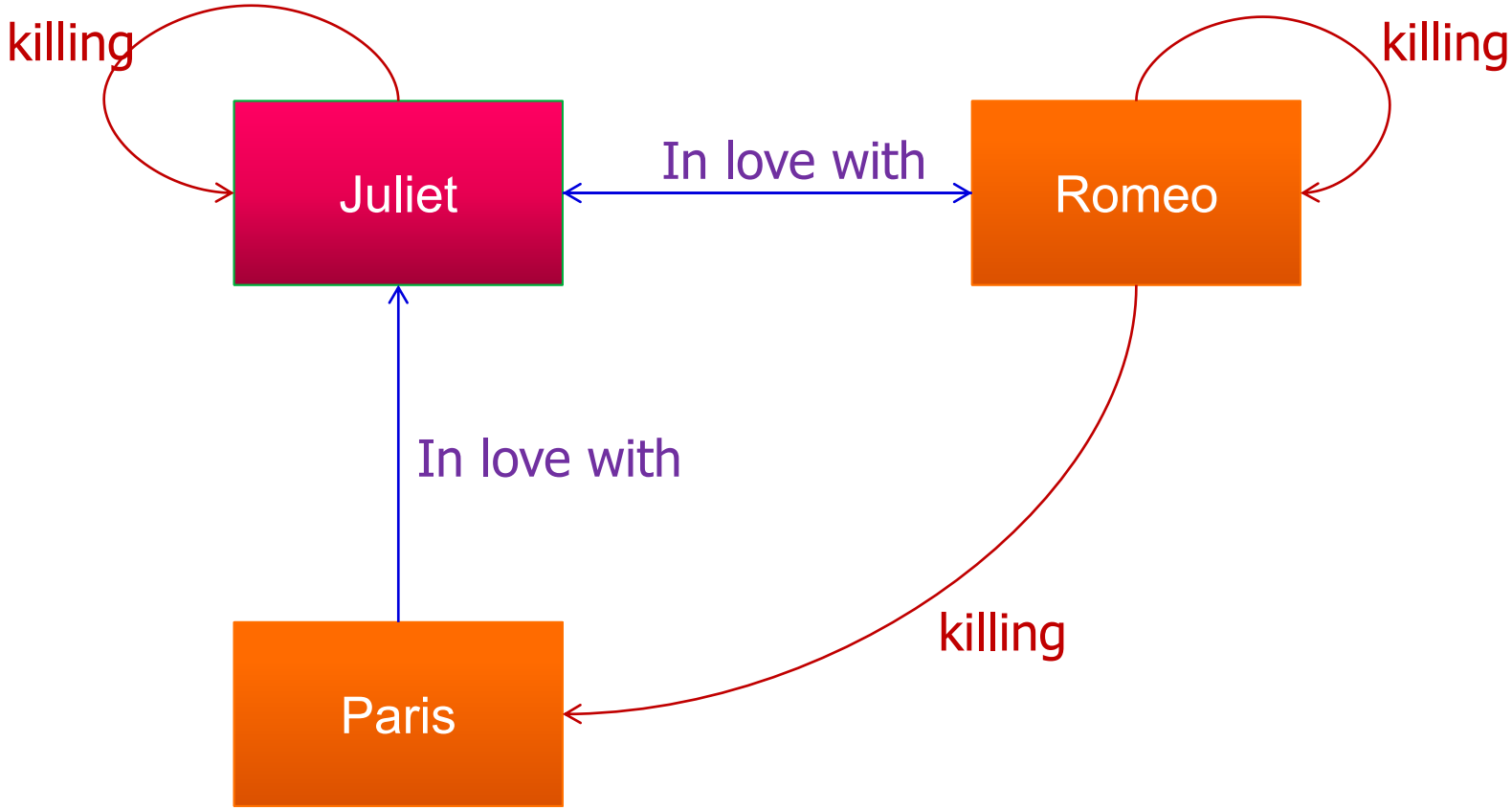
We can see that some connections are somehow similar – they belong to the same category:



It‘s possible to classify everything we see in the diagram. But how to classify our objects?



We could certainly divide the objects to men and women:



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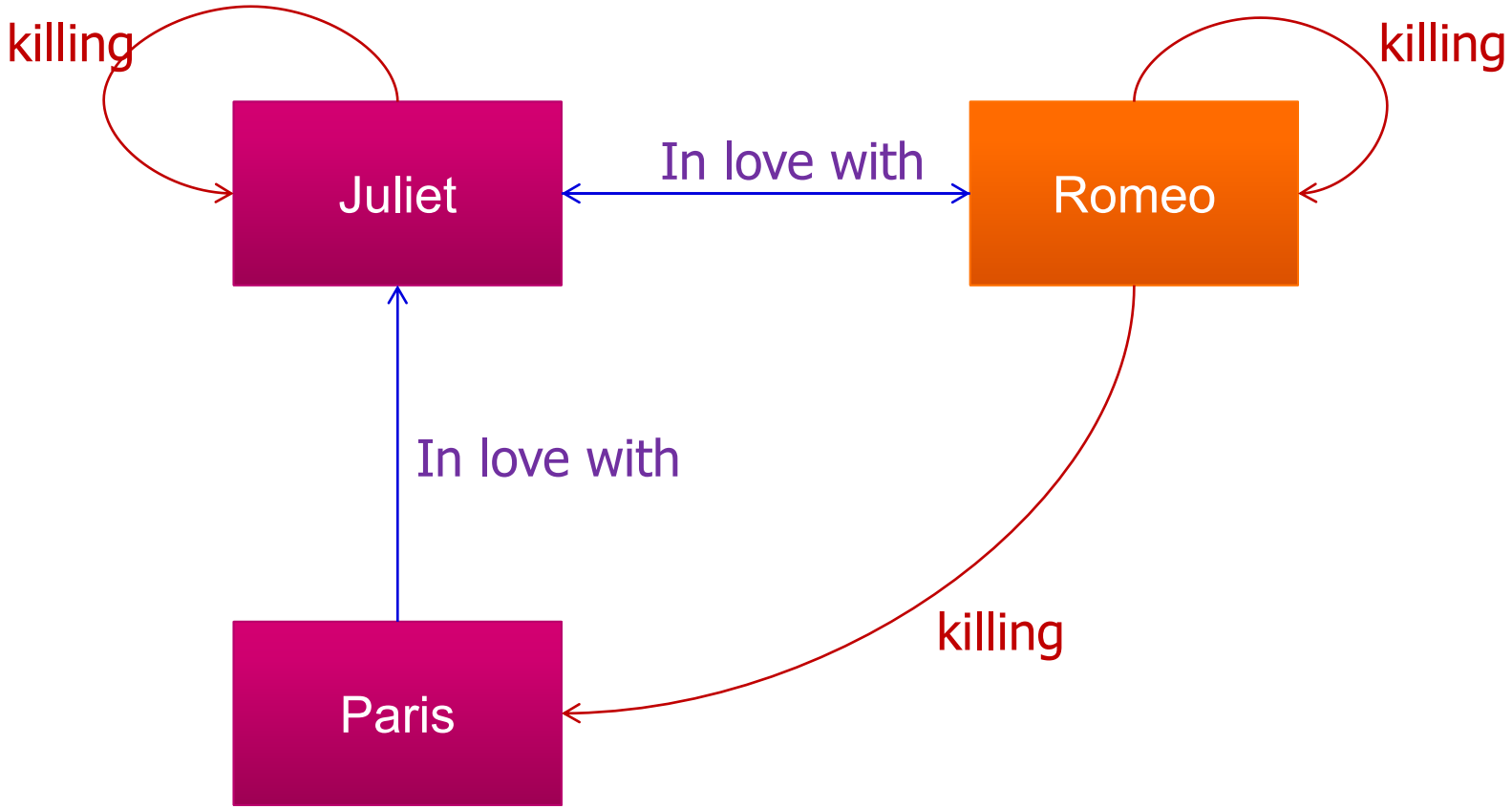
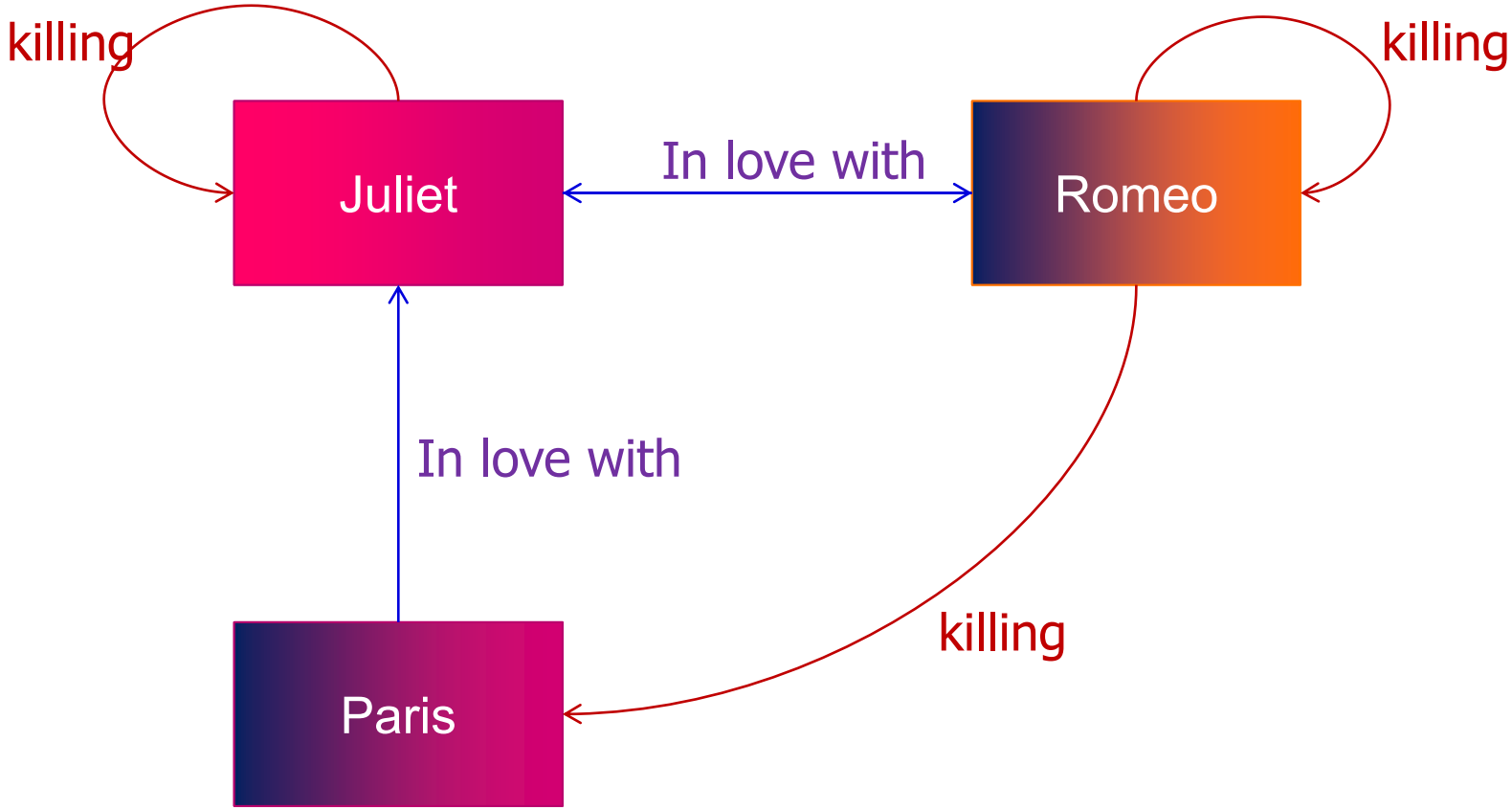
But won‘t it be more useful to show, which character belongs to the house of Montague and which one to the house of Capulet?



It probably depends on a context – a mental model we want to build. Sometimes, both categorizations may be useful:



Classifications are blurred

Good or bad?

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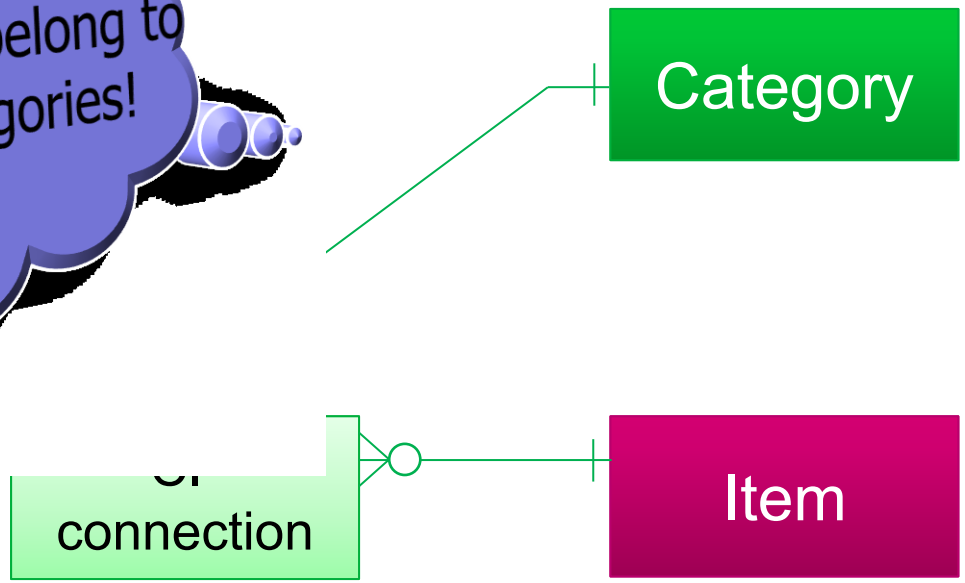
Certainty

ns (= objects as such, not their constructs) belongs to a
egory with a given certainty



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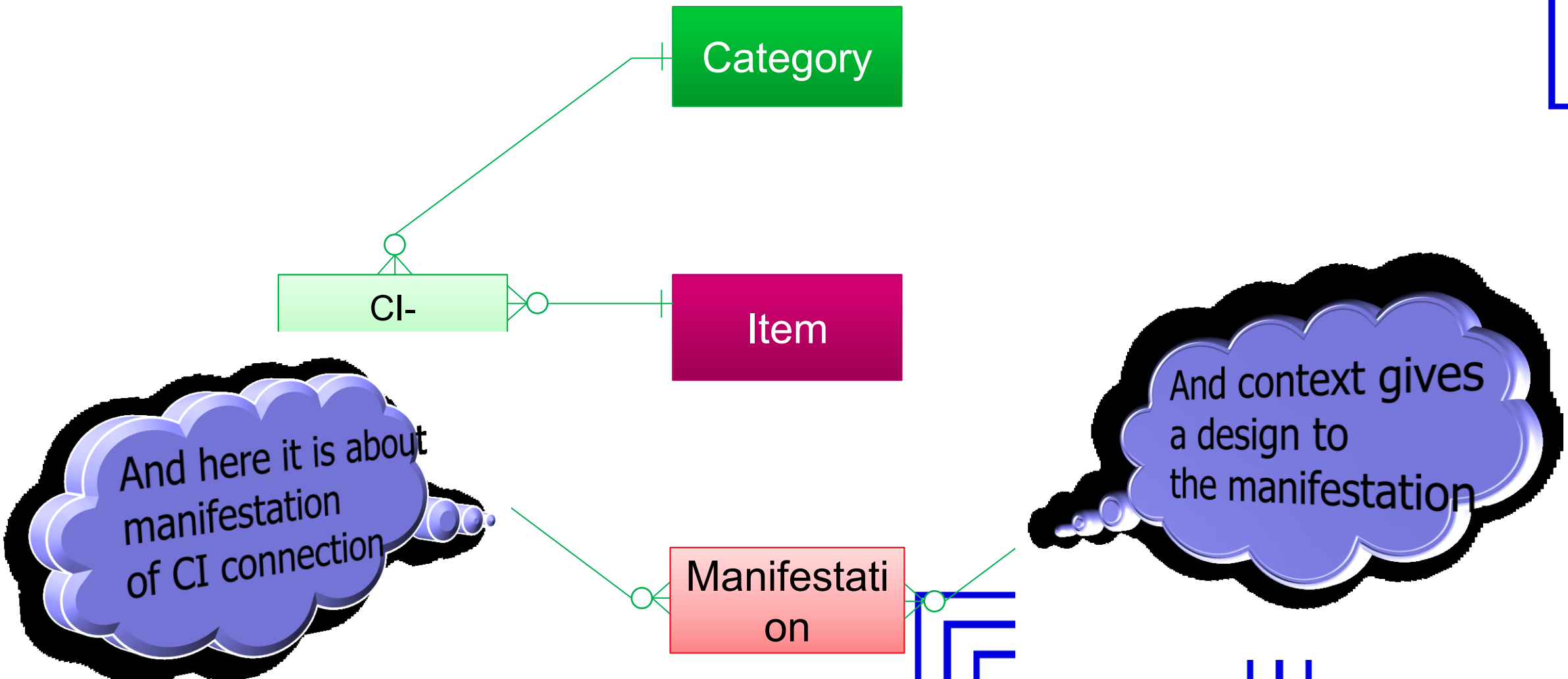
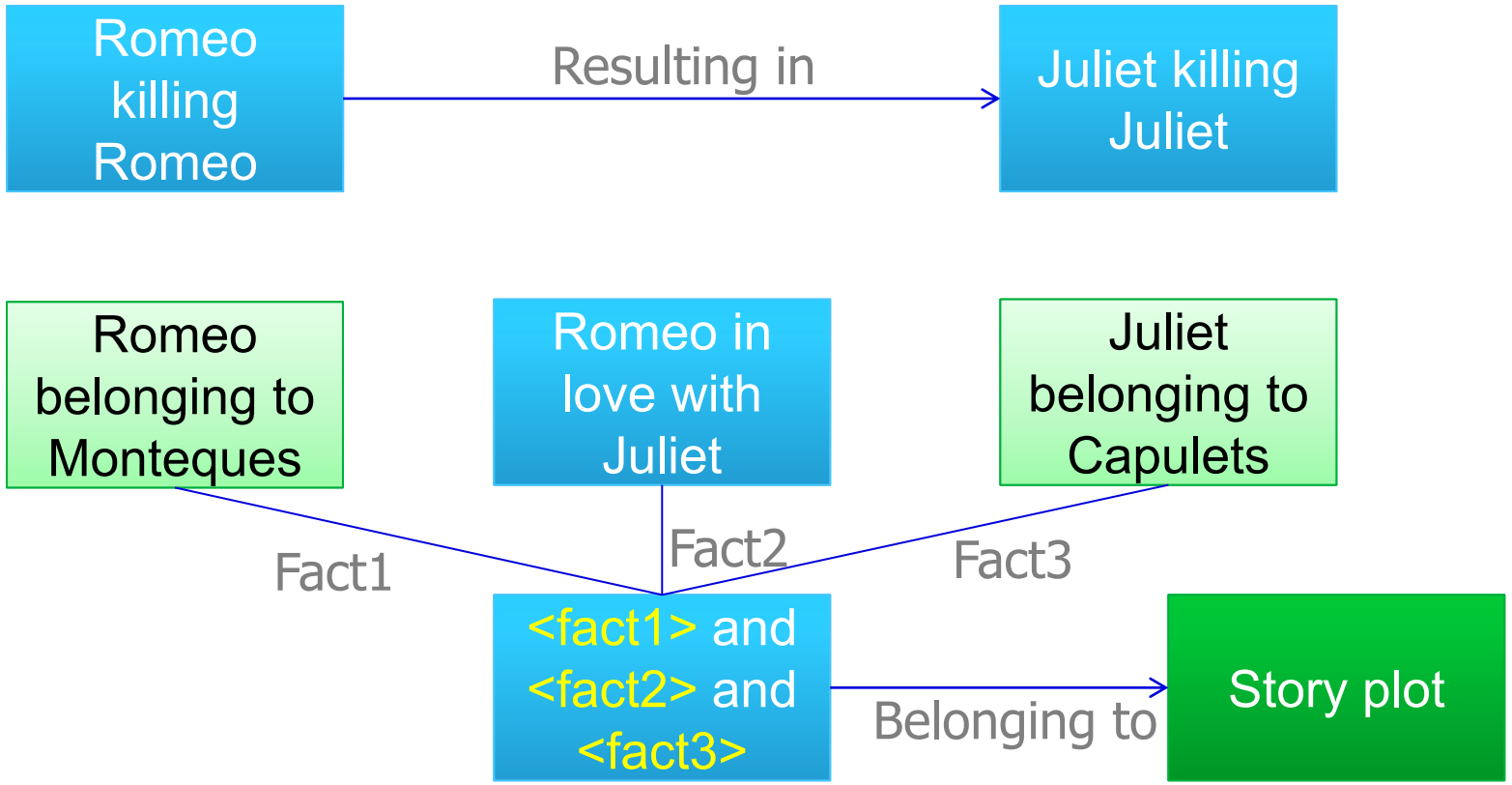
Attention

The fact is manifested with a certain attention in a given context

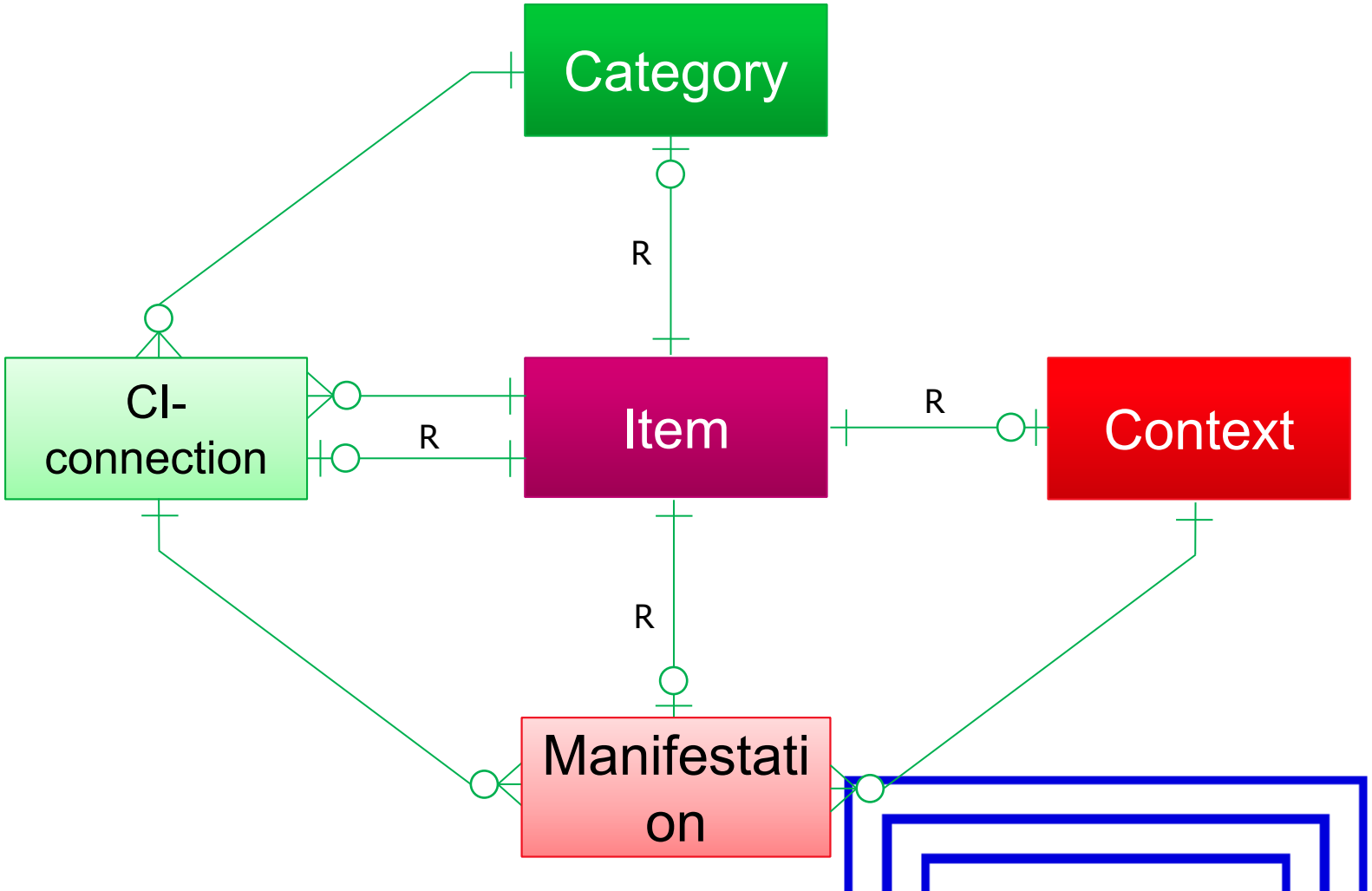


R-edges

- In some cases, it might be also useful to mention non-trivial concepts – contexts, categories, classifications or manifestations



R-edges



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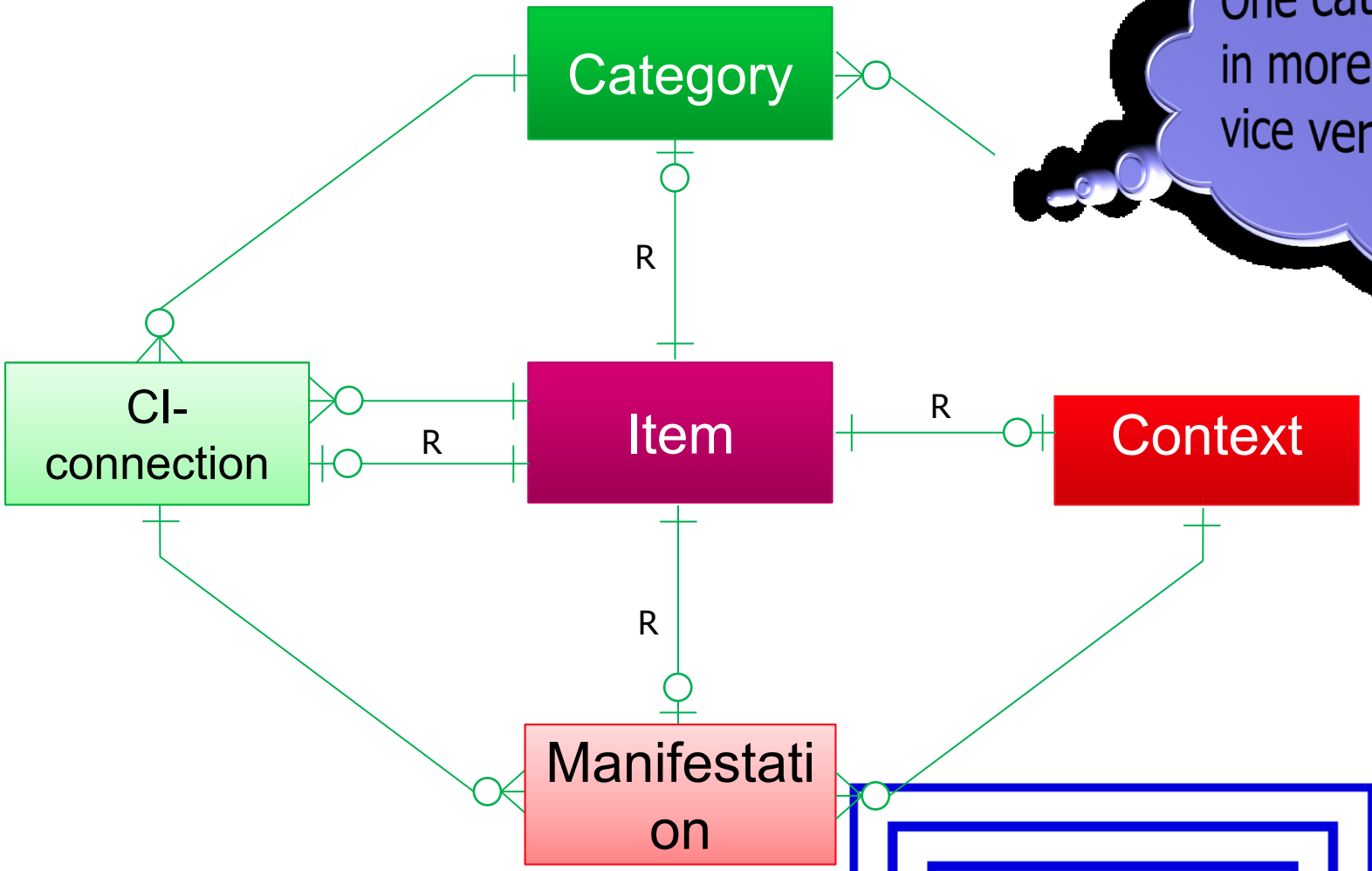
Context base

Context serves as a mode
the set of categories to cla



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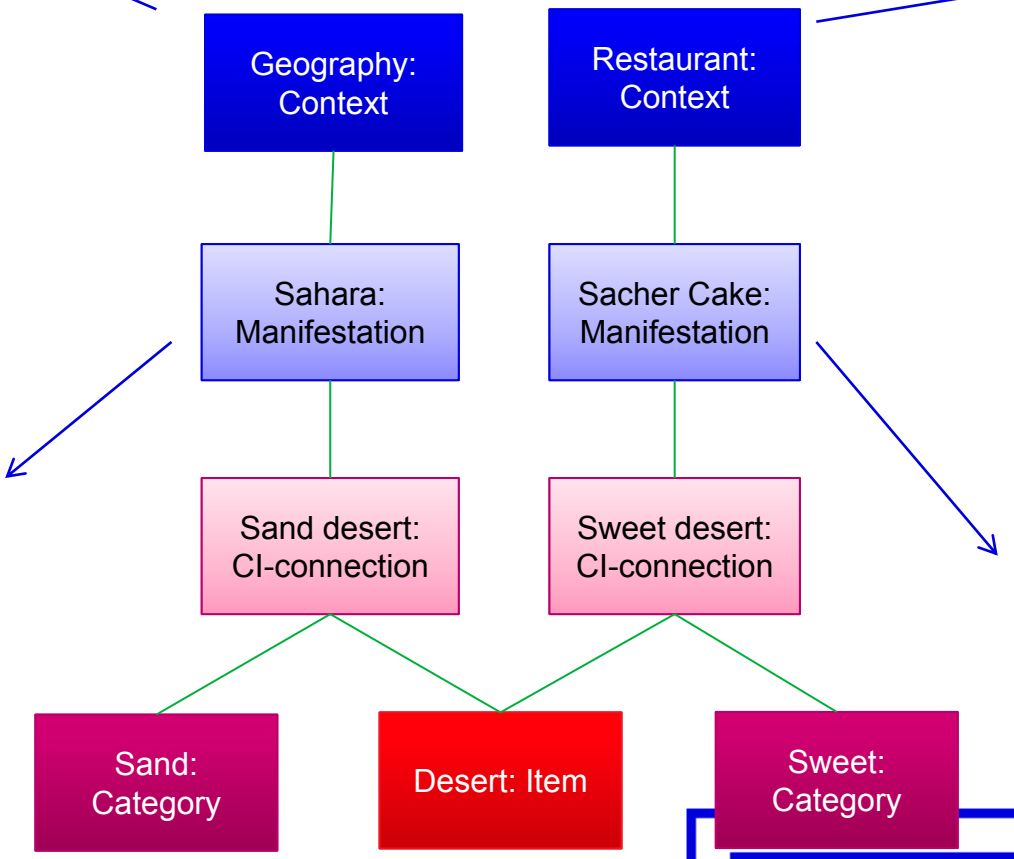
Independent models

Geography

Restaurant



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Examples of manifestation of DATA

IT	• is any sequence of one or more symbols given meaning by specific act(s) of interpretation
Common understanding	• individual units of information.
Star Trek	• A character

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Why we need it?

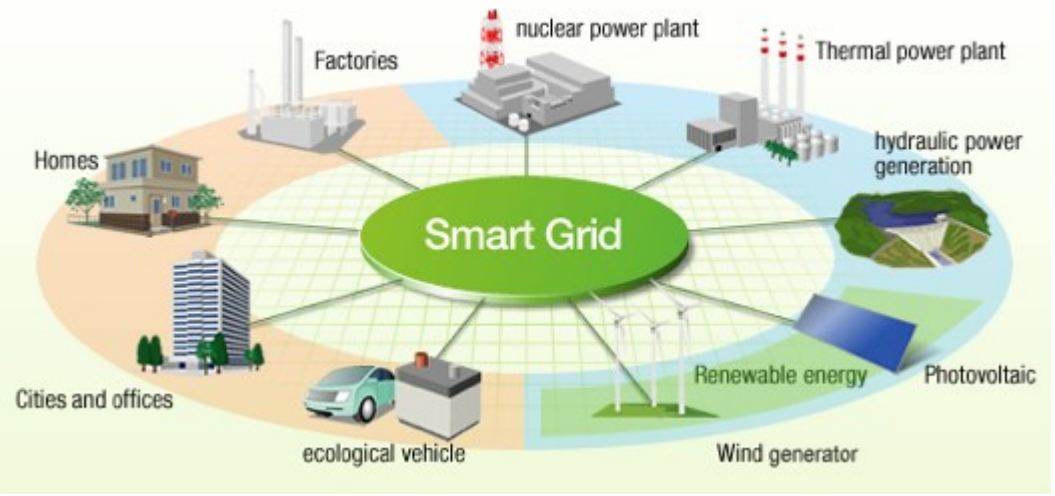
In the complex service environment (like Smart City) only one perspective is not enough

Already in a very simple applications we need to work with different manifestation of the same item

If we add the relation to other Services, environments (e.q. contexts) we get very complex model

To understand we need to have the possibility to analyze the manifestation of each item in all contexts

Examples



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Example of smart street categories and objects

Street parts	Safety	Public transport	IT Devices	Vehicles
• Driving lines • All vehicles • Traffic on the road • Traffic lights • Parking slots	• Cameras • Pedestrian way • Pedestrian blocks • Speed sensor • Smart Screen	• Bus • Bus stop • Ticket machine • Tram line • Smart Screen	• Cameras • Smart Screen • Traffic lights • Traffic sensor • Pollution sensor • Ticket machine	• Car • Bicycle • Bus • Tram

Conclusion

Contexts

Diamond See and Recognize, their elements and relationships

Mention and Use duality

Examples and differences

Acknowledgement

- This presentation was improved by using Microsoft Copilot