Modelling Sustainable Systems and Semantic Web

Systemic Structures and Action Spaces

Lecture in the Module 10-202-2309
for Master Computer Science

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Systemic Structures

Systemic thinking means grouping closely interrelated processes into **systemic units**.

Such units as components are characterised by their eigentimes and eigenspaces in which stable, externally visible structures (limit cycles) reproduce themselves.

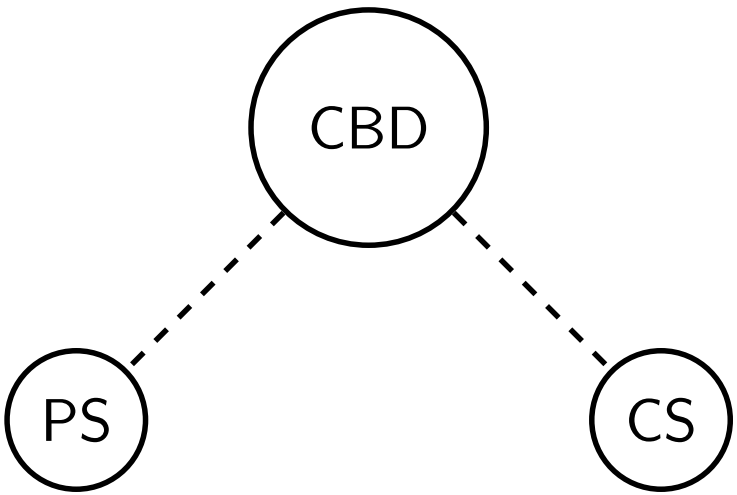
Combining such components into a new system means coupling these repetitive processes, usually resulting in systems whose characteristic eigentimes are common multiples of the eigentimes of the components.

Systemic Structures

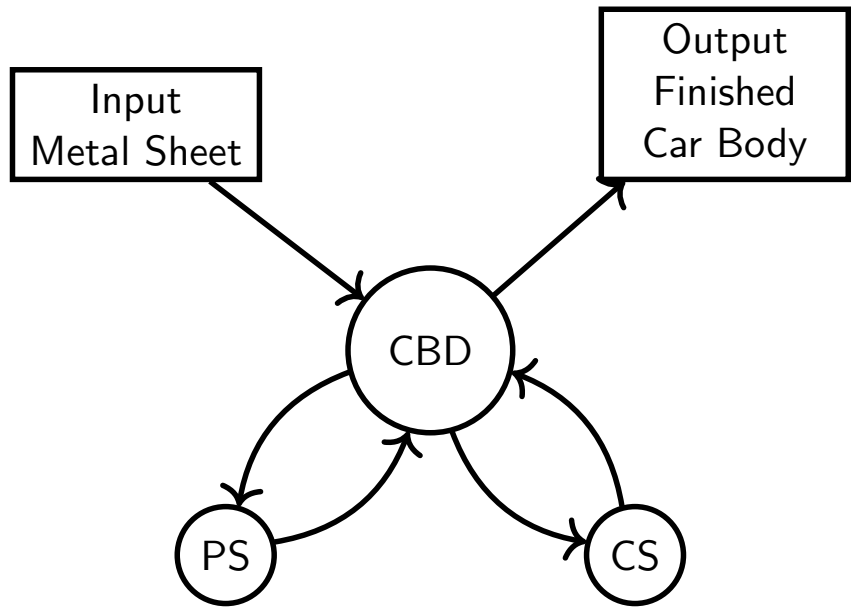
Of particular interest is the context in which fast-moving components are embedded in a slow-moving system. In this case, two clearly different dimensions of reduction to "essentials" arise: The external context can be considered largely static in the analysis of the components, while in the analysis of the external context, the behaviour of the components can be reduced to a statistical mean in which "chaotic noise" averages out and thus becomes irrelevant for the modelling at the level of the slow-moving system.

Systemic Structures

Example: A technical system with two components – the car body department of a car manufacturer with press subdepartment and coloring subdepartment.



Structural Organisation



Workflow Organisation

Systemic Structures

Spatial structures can be composed immersively, temporal structures can be projected submersively onto different time scales through Fourier transformations.

The temporal structures considered determine the reduction dimension and thus select the processes that are "essential" for the systemic context; the spatial structure of the flows of energy, matter and information moved in the process determines the spatial extent of the systemic context.

This does not only apply to models of technical or business systems but ...

Systemic Structures

... typically structures also models of socio-economic systems ...

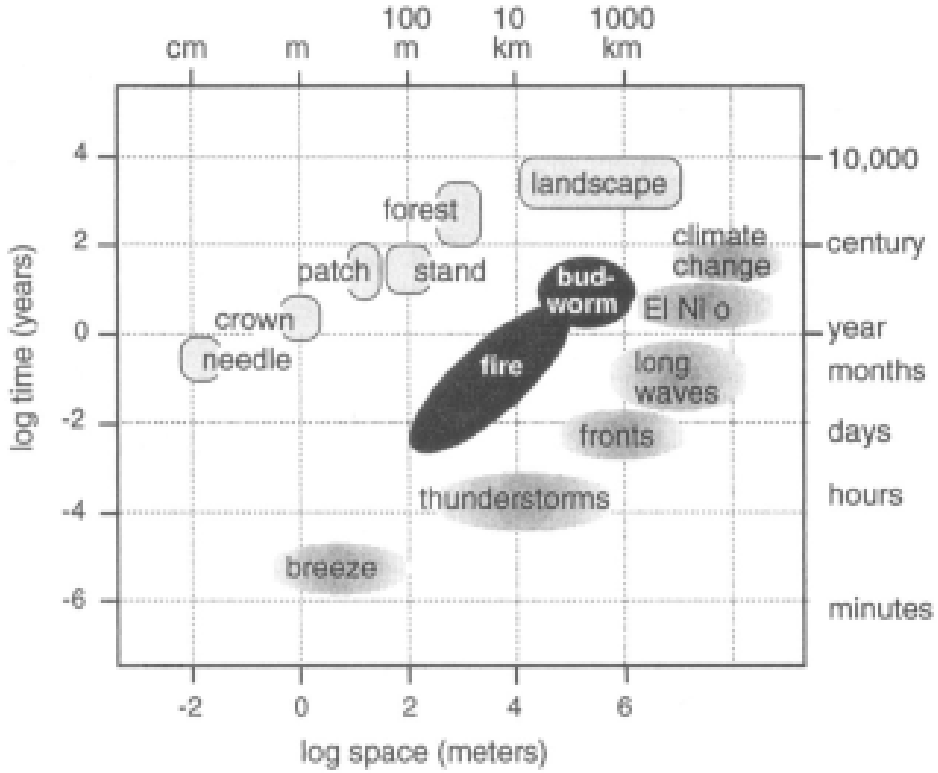


Diagram from (Holling 2001)

Systemic Structures

... of socio-cultural systems ...

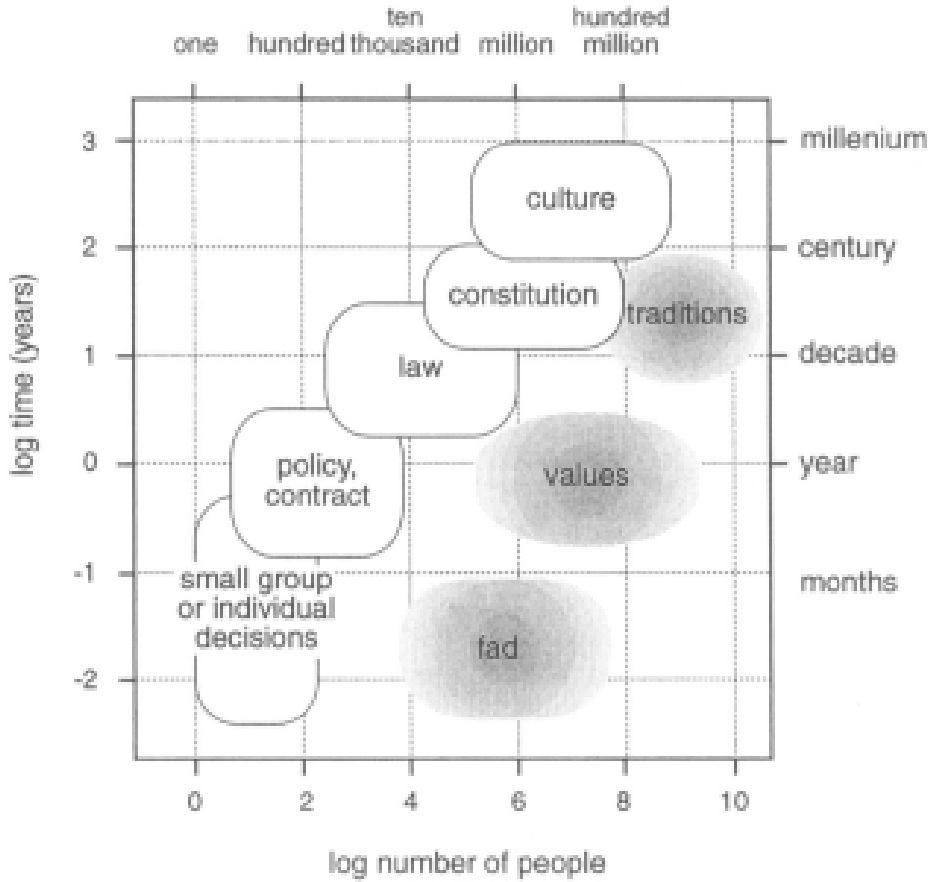


Diagram from (Holling 2001)

Systemic Structures

... and also of "natural" systems.

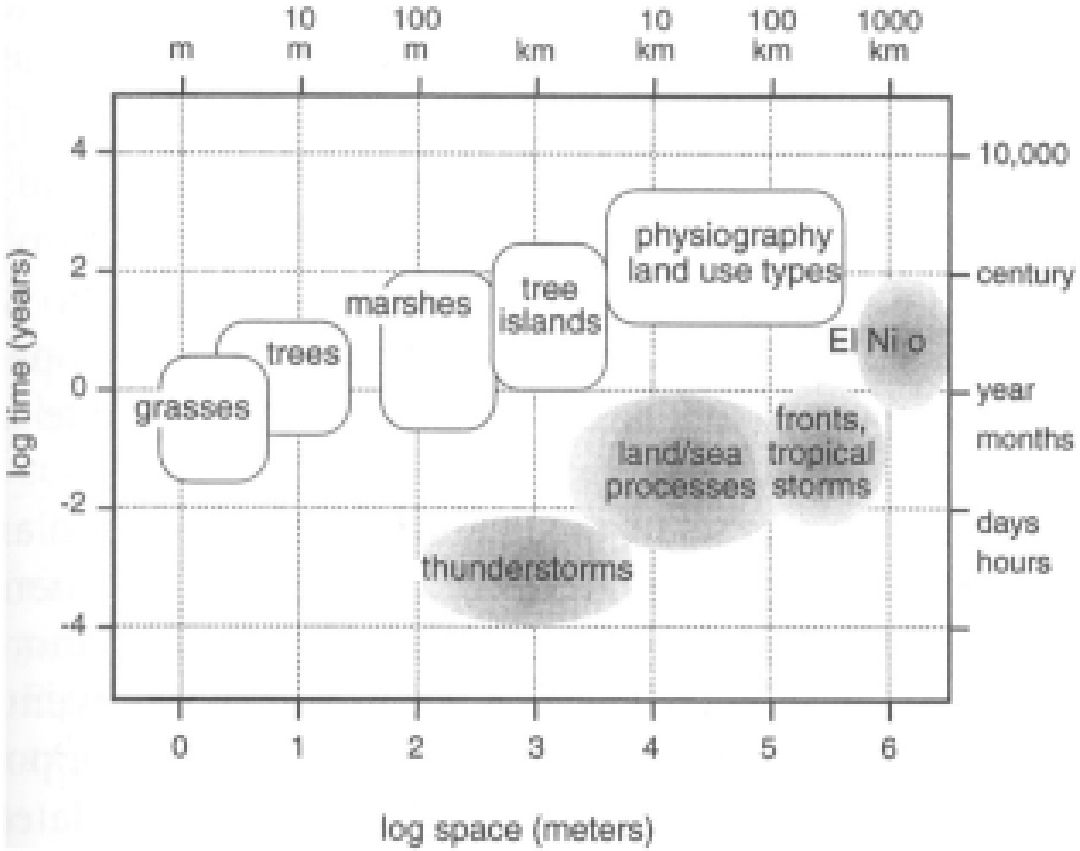


Diagram from (Holling 2001)

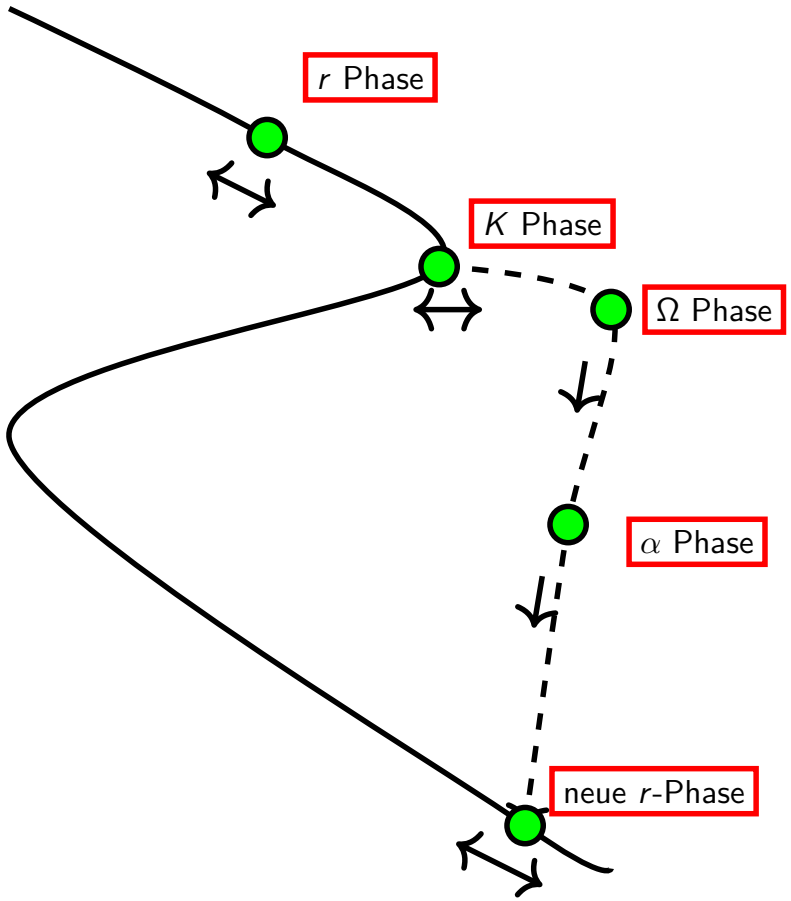
Development of Systemic Structures

Example: The press department is modernised, industrial robots are being used. How does that affect the other components of the systems?

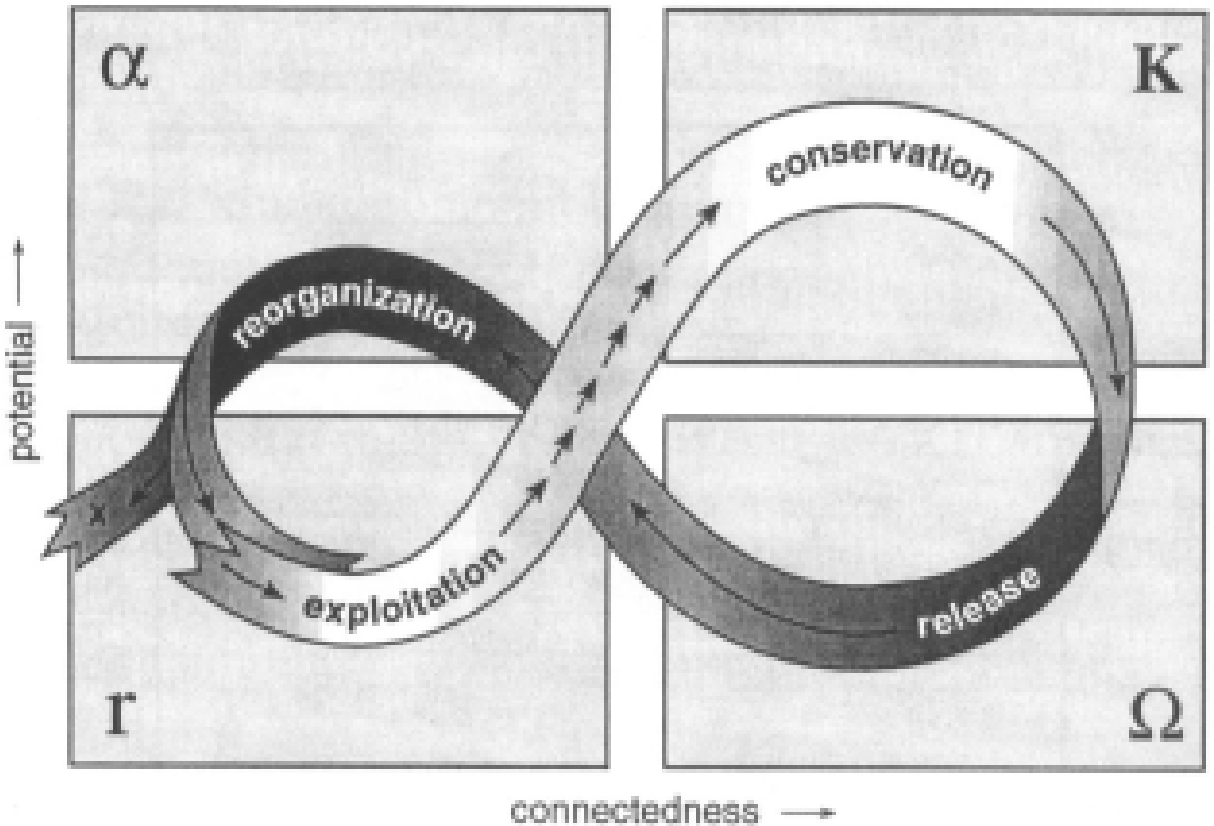
What scenarios are conceivable?

Development of Systemic Structures

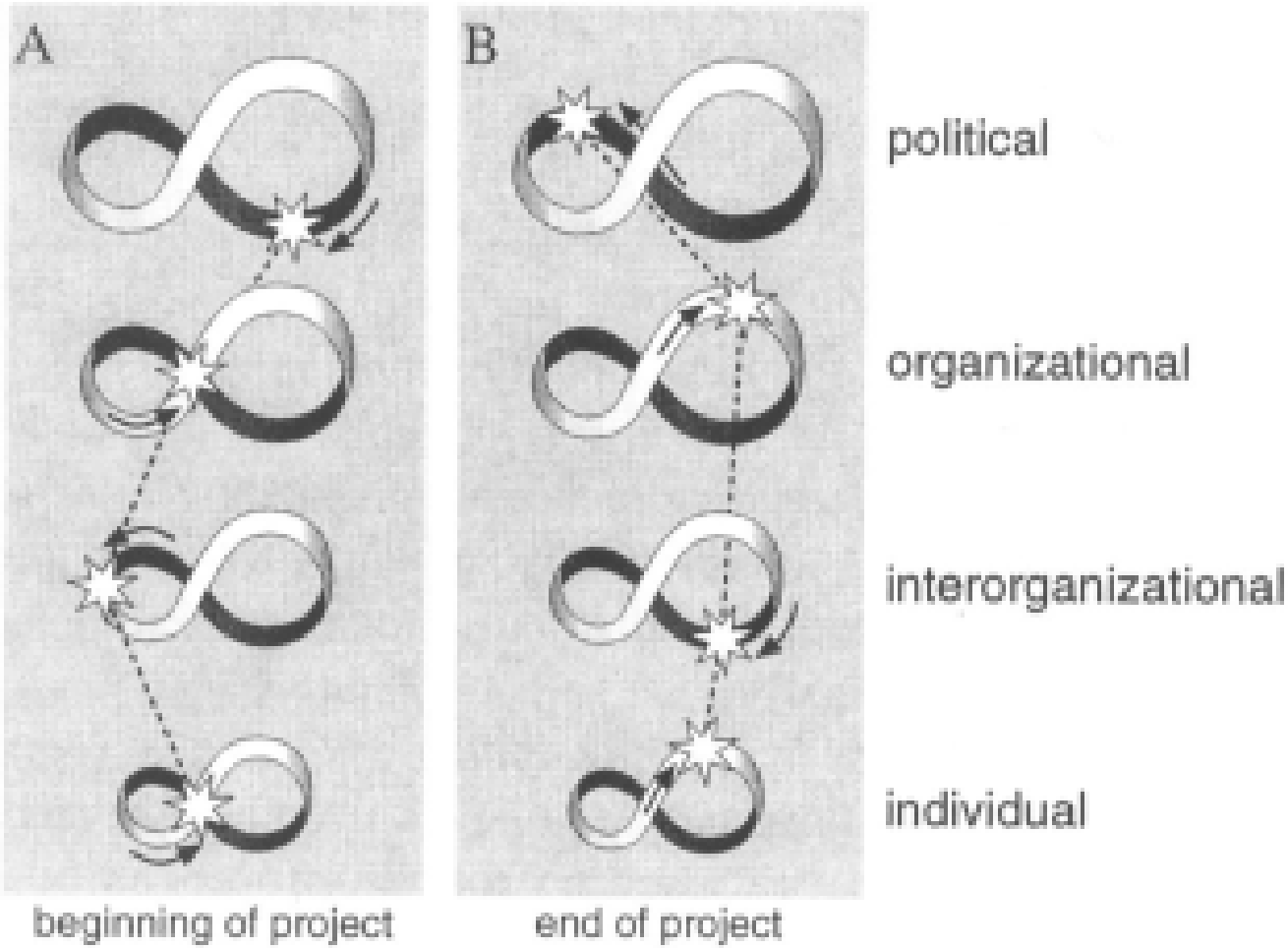
Which typical scenarios are to be distinguished for systems that develop along an attractor?



Development of Systemic Structures



Development of Systemic Structures



Action Spaces

This structuring of the world, however, is a view of the structures **from the outside**.

Even more, we have seen that the *decomposability* into parts associated with a structural view hides essential emergence phenomena and thus stands in dialectical contradiction to the *indecomposability* in the process view – a system can only be operated in an assembled state.

From the **internal perspective** of a system, processes can nevertheless be analysed more precisely in a local environment. This is also the basis of the **TRIZ concept of the operative zone**.

Action Spaces

Such a "view from within" shapes our perception of the world around us. Practical experience is gained in **local contexts**, and contextualisations always limit the meaning spaces of our generalisations.

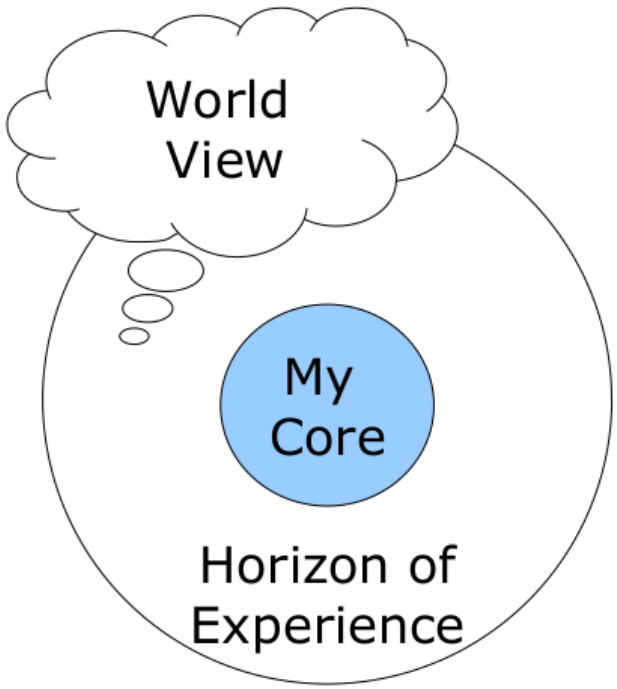
We call such a view on a system from inside an **action space**.

Oxford Reference:

> *It is the area in which individuals move and make decisions about her or his life.*

This definition is too narrow for a concept of cooperate action.

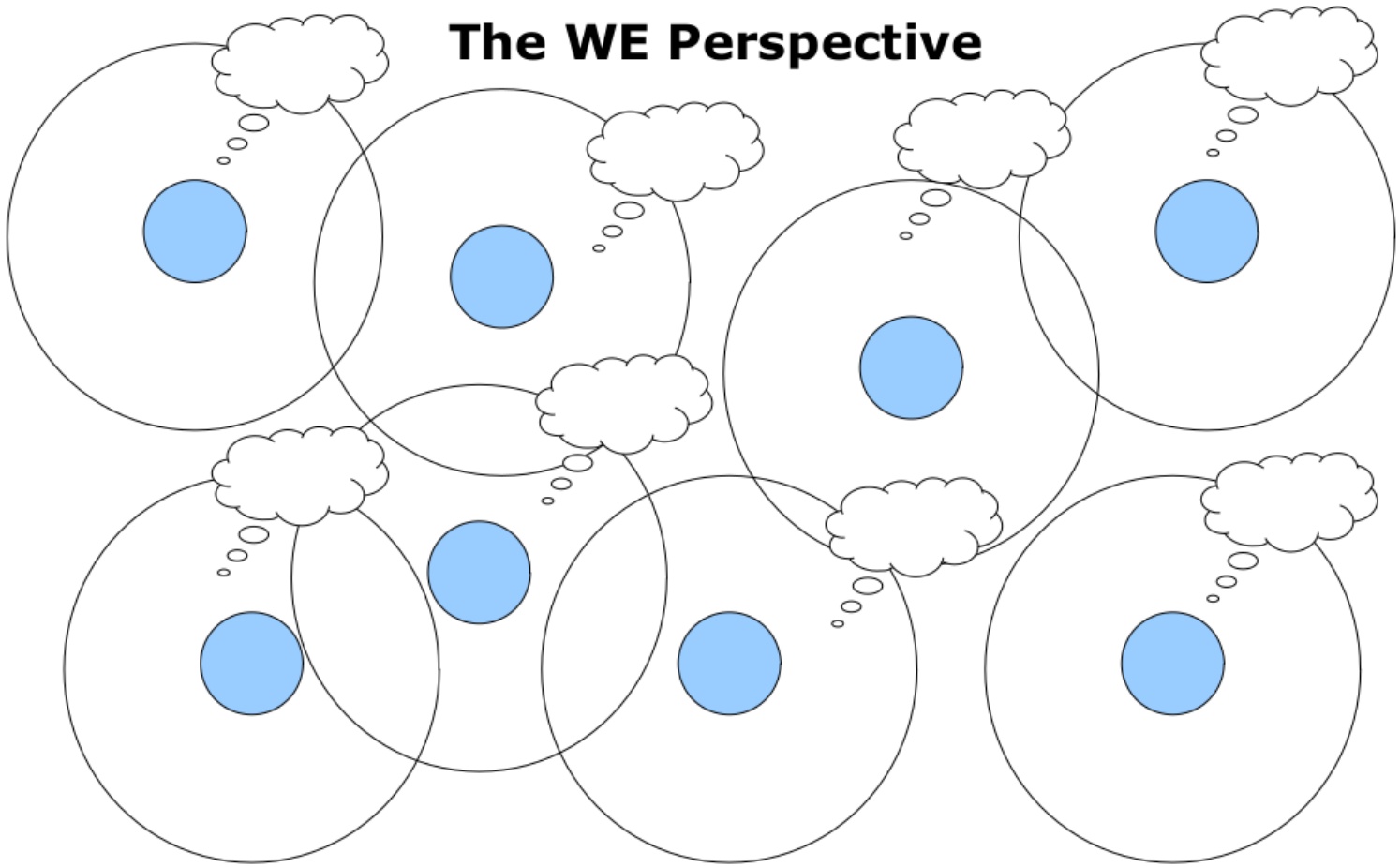
World and Reality



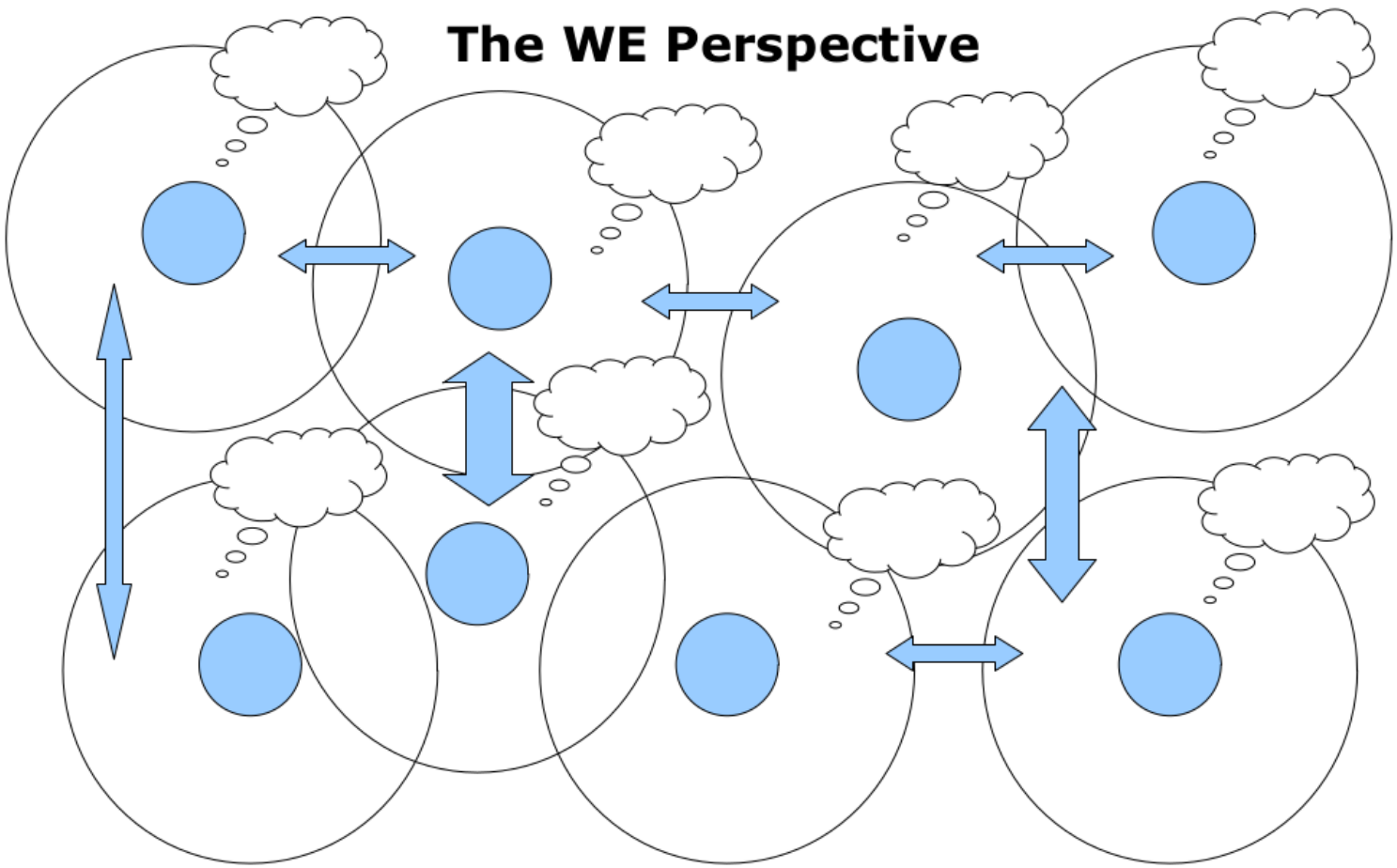
Private and Cooperative Action

- Art of living versus dealing with a structured world in a structured way
- Unpredictability versus predictability
- Constructability of "world"
- Me as a constructor
- (My) imagination and reality

World and Reality



World and Reality



World and Reality. Starting Point

- Forms of description (plural) and reality.
- Contradictoriness of the world (as reality perceived by us)
- Differences in the concept of *contradiction* in forms of description and forms of actions
- Descriptions and contextualisations
  - Creativity and conceptualisation
  - Concepts are a form of cooperative practices of people and thus themselves are to be *contextualised in a concrete-historical way*.
- Term *World View* for the complex context of the model-like reference *in the model* to reality.

World and Reality

World is *reality for us* and thus *reality in the process of conceptual comprehension*.

World and Reality. What is Data?

How objective are these world views? Do we all live in our own echo chambers and filter bubbles?

What is Data?

What is objective Data?

World and Reality. What is Data?

- Data as a specific form of description.
- Capturing data always means choosing what *not* to capture.
- Data as a link between world and reality.
- But what then is *objective* data?
  - Specific reflex of a positivistic understanding of science.
  - Use and misuse: Such an understanding (of science) is an important cultural achievement of humankind, which, however, also has to be *contextualised in concrete-historical terms*.
- Thus data is also a form of cooperative practices of people.