Wrap-up

Requirements

Parts 1-17 of this lecture

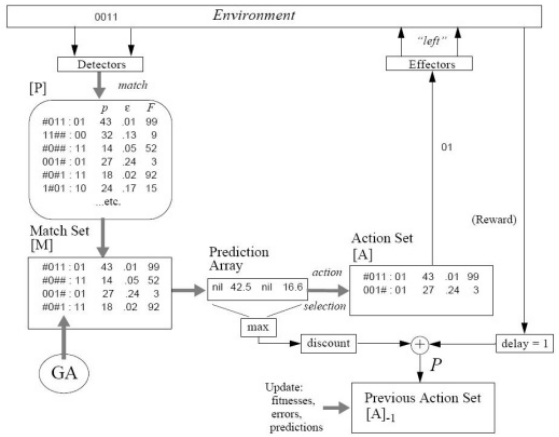
Goals

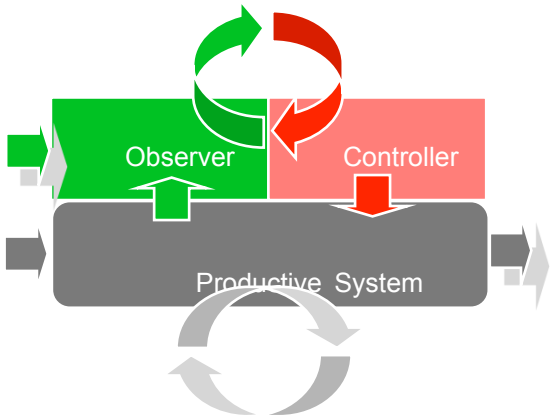
Organic Computing: The big picture

Content

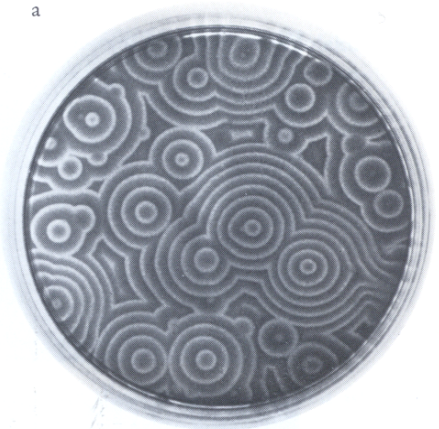
- Summary: What is it all about?

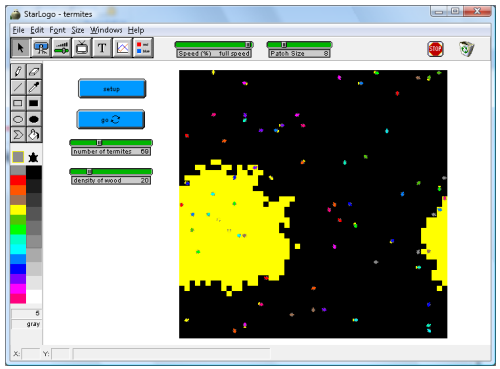
- What is the story behind Organic Computing?
  - Balinese water temples?
  - Ant? Fireflies?
  - Observer/Controller architectures?
  - Machine Learning?

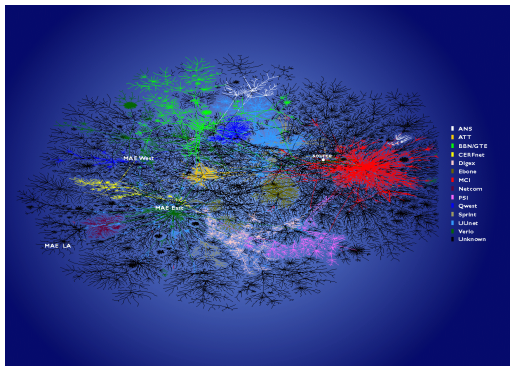




- Multiple phenomena which are difficult to model with standard techniques
  - Balinese water temples
  - Dissipative structures
  - Ants
  - Small World Phenomenon:
    - Social systems
    - Internet
  - Alife, for example Tierra







1. „Autonomous agents“ use local knowledge, behave locally.
2. Agents interact in large populations.
3. Learning by non-deterministic state exploration: evolution
4. Local behaviour leads to complex global behaviour: Emergence.
5. Global order evolves without control from „outside“: Self-organisation.

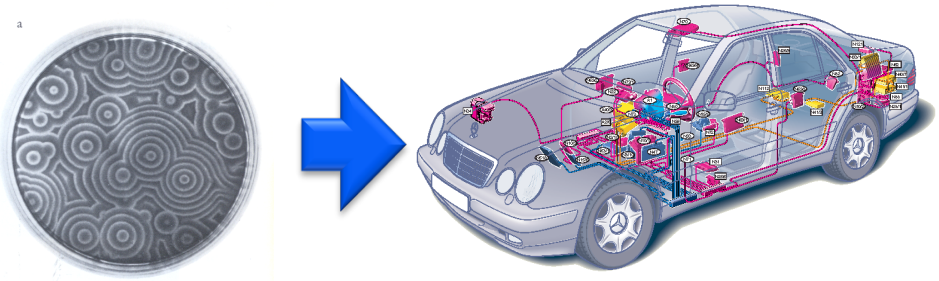
Local autonomy, interaction, evolution and non-determinism, emergence, self-organisation

What for?

Local autonomy, interaction, evolution and non-determinism, emergence, self-organisation

What for?

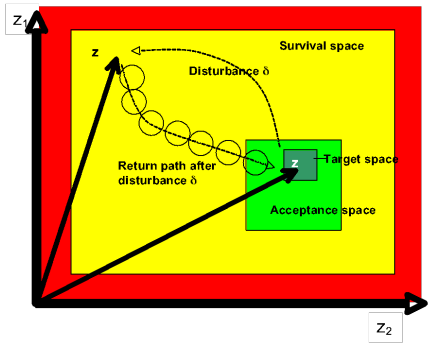
- The problem: Complexity of technical systems
- Technical systems
  - Large populations ✔
  - Autonomy ✔
  - Interaction ✔
  - Locality ✔
  - Adaptivity and learning ✘
  - Evolution ✘
  - Self-organization ✘
  - Emergence ?
- → Apply natural principles to technical systems!

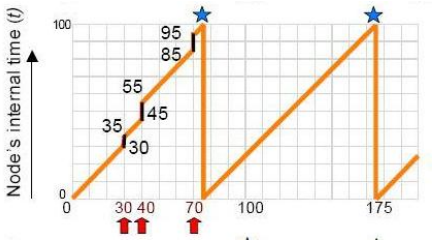


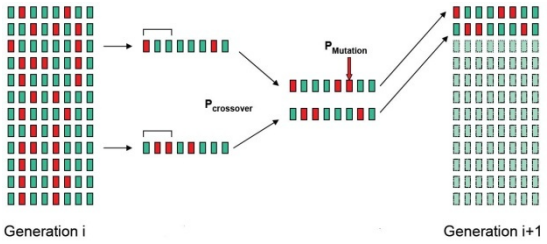
- What is state-of-the-art in systems engineering/design? For example
  - V-model
  - Y-Chart
  - 4D Design
  - Waterfall
  - …
- → Working hypothesis: In the future we will encounter problems building complex systems with standard techniques.

Organic Computing Ingredients (partial list)

- Common understanding of terms
  - Emergence
  - Self-x
  - {acceptance, configuration,…}-space
- Applied techniques
  - Multi-agent systems
  - Ant Colony Optimization
  - Sync: Firefly Reach-back algorithm
  - Observer/Controller architecture
  - Learning classifier systems
  - Genetic algorithms
  - Neural Networks
  - ...

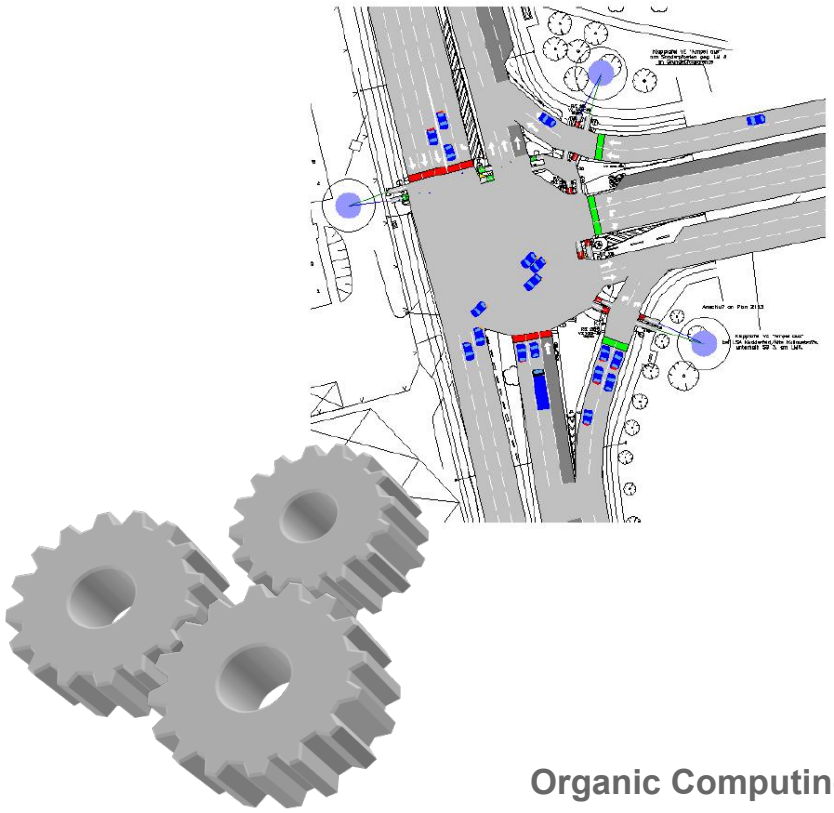


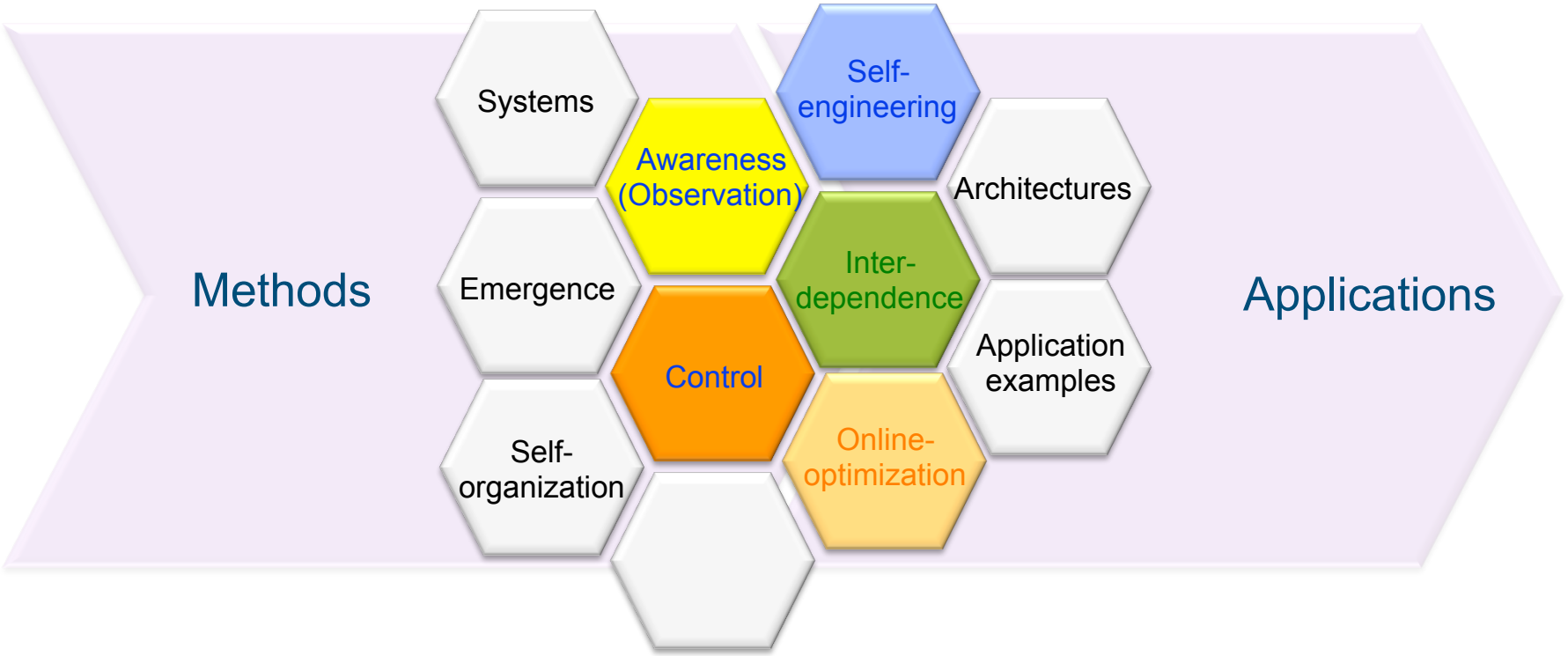


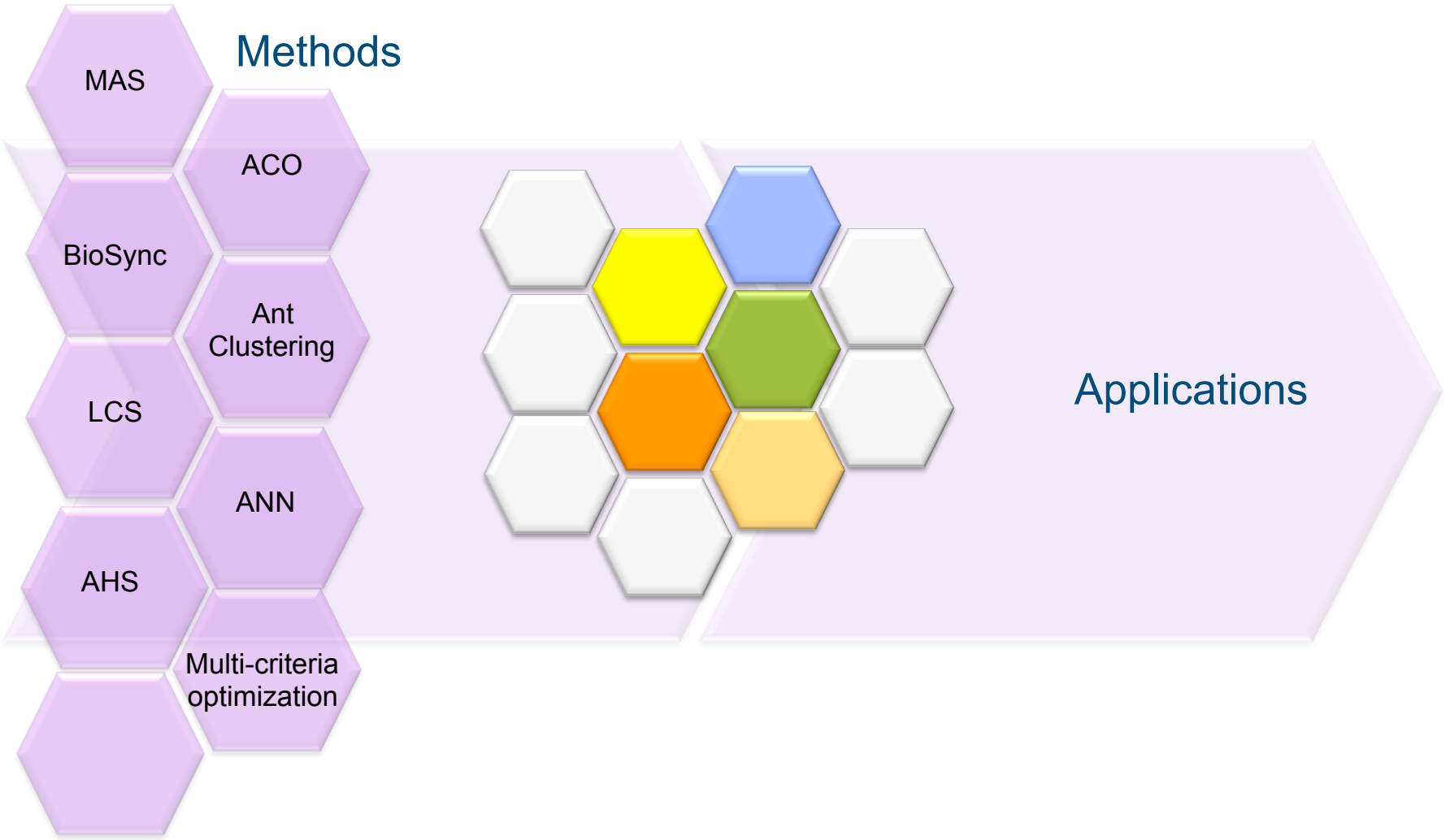


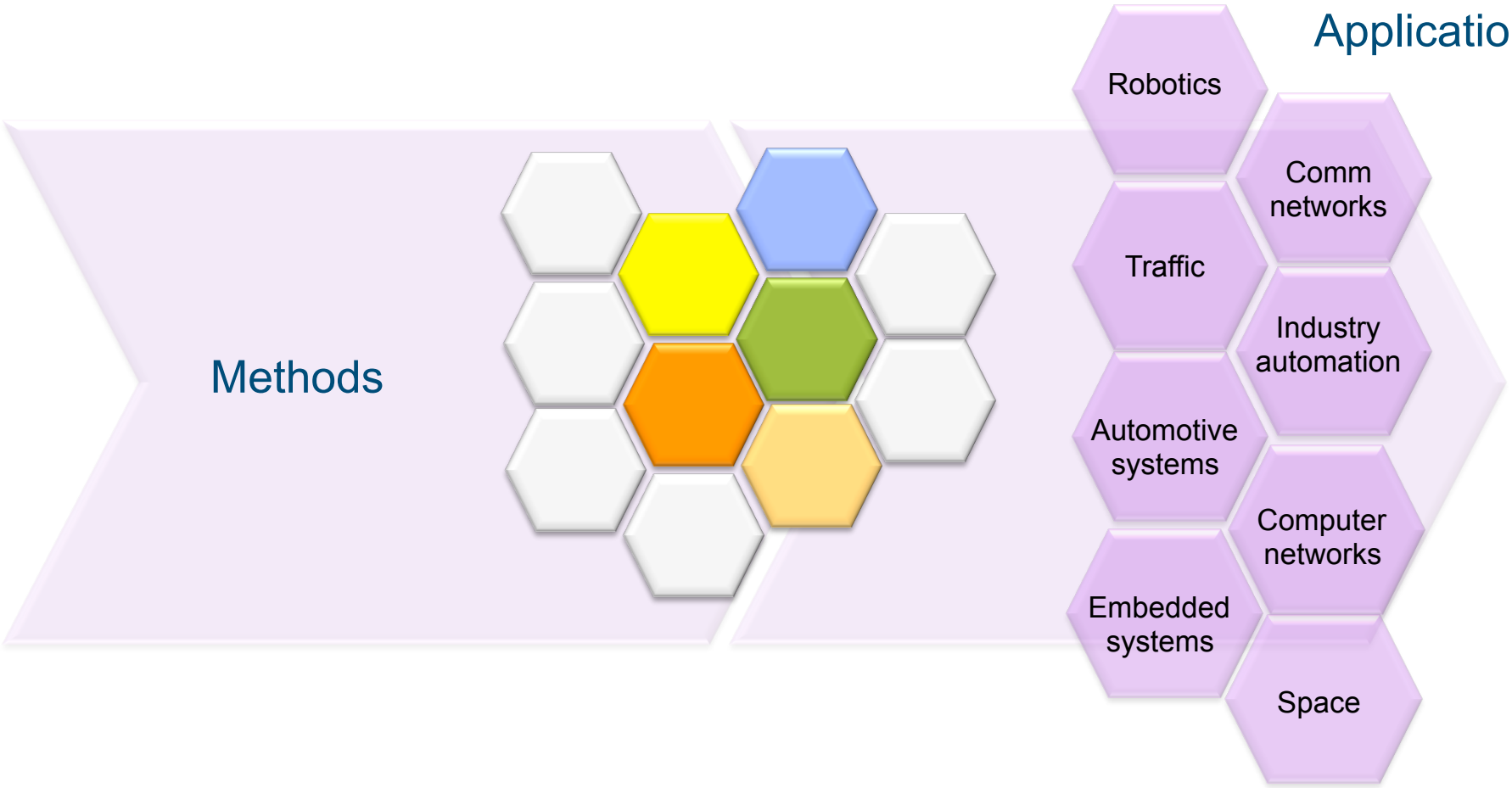
Organic Traffic Control

- Complex system
  - Incomplete knowledge
  - Cannot be optimized for all possible situations
- Properties
  - It is learning!
  - It is adaptive!
- Applied techniques
  - Observer/Controller architecture
  - LCS
  - Genetic Algorithms









The future: Three dimensions of OC

Design-time to runtime

Engineering

Inter-dependence

Methods

Applications

Optimization

Online optimization

Social OC

- There is no checklist (yet) to decide whether “something is Organic Computing” or not.
- Aspects discussed in the lecture provide some indicators.
- After all, Organic Computing is a young research area!
  - Very dynamic
  - Three dimensions of OC under investigation
  - Lots of work to be done, e.g.

In your Master thesis ☺

www.organic-computing.de/