
BIOLOGICAL TRANSFORMATION

Patrick Dieckhoff Fraunhofer-Gesellschaft, Berlin

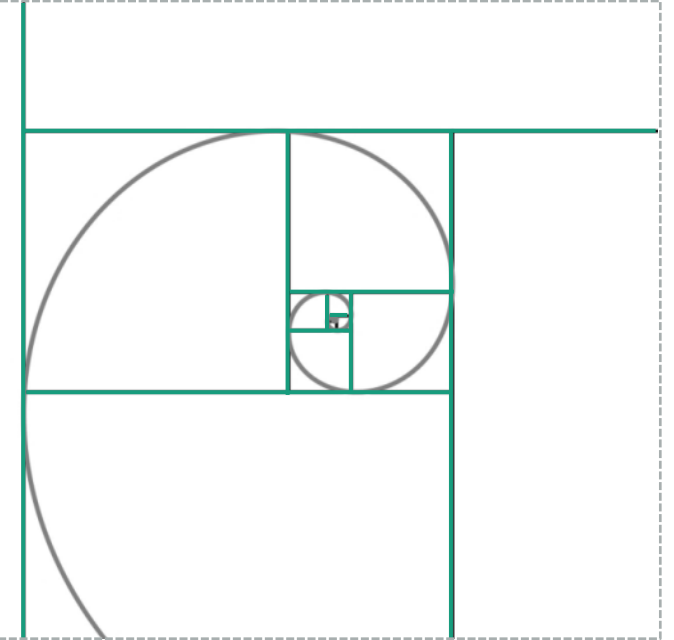




Biological Transformation

From Living Nature to Innovation – Enlarging the Concept of Bioeconomy

Biological Transformation is the increasing utilization of **materials, structures** and **processes** of **living nature** in technologies with the goal of **sustainable added value**.



- **Insights** from the **life sciences** are increasingly better **understood** and widely **applied**.
- **Digitization** and **biological transformation** are mutually **enforcing** each other and **converge**.



Biological Transformation

Biology + Technology Promises Innovation

Nobel Prize for Chemistry for **Directed Evolution** and **Phage Display**, research by Frances Arnold, George Smith and Gregory Winter

- > Survival of the fittest proteins (or most productive)
- > Adaptation of natural principles, transfer into technology



Biological Transformation

Updated EU Bioeconomy Strategy Embraces Biological Transformation

“By capitalising on unprecedented **advances in life sciences** and biotechnologies, as well as innovations **merging the physical, digital and biological worlds**, the European industrial base can maintain and **enhance its global leadership.**”

Biological Transformation

Global challenges and goals for sustainability

2050 if we continue like today:



World population: **9.8 billion**
1.3 times more people



2 times **material resource extraction**



1.6 times demand for **water**



1.8 times demand for **energy**



1.5 times **greenhouse gas emissions**

UN: 17 **sustainable development goals**, especially:



Elements of **Sustainable Production**

- Use resources efficiently
- Reduce waste generation and pollution
- Resilience

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High tech silk fiber for medical technologies

Challenge:
Highly resilient fibers from **biological** raw material

Solution:
Production of **silk proteins** in the **lab** on an **industrial scale**

- University Bayreuth:
Utilization of **bacteria** as basis for **producing** the **proteins** in a **fermenter**, “**Upscaling**”
- Cooperation Fraunhofer IAP and AMSilk: Optimization of the process for **industrial dimensions**

Applications:

- **Lightweight construction:** High performance fabric for parachutes; integration of material into glass fiber composites
- **Medicine:** Cartilage and tendon implant, biological wound covering, surgical suture material



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Optimization algorithms based on ant colonies

Challenges:

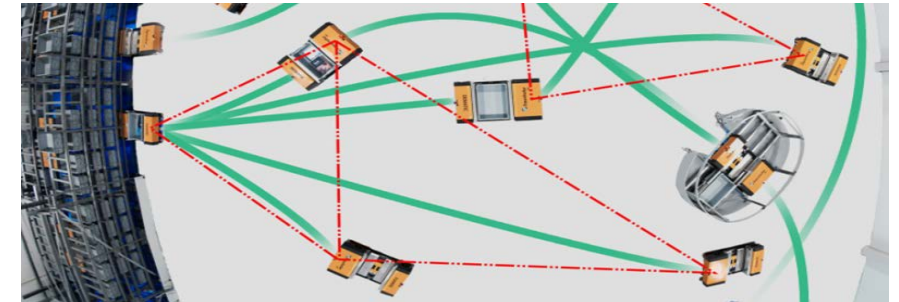
- Solving complex optimization problems
- Planning of most efficient routes
- Necessity for decentralized and adaptive organization

Solution: Ant colony optimization algorithms

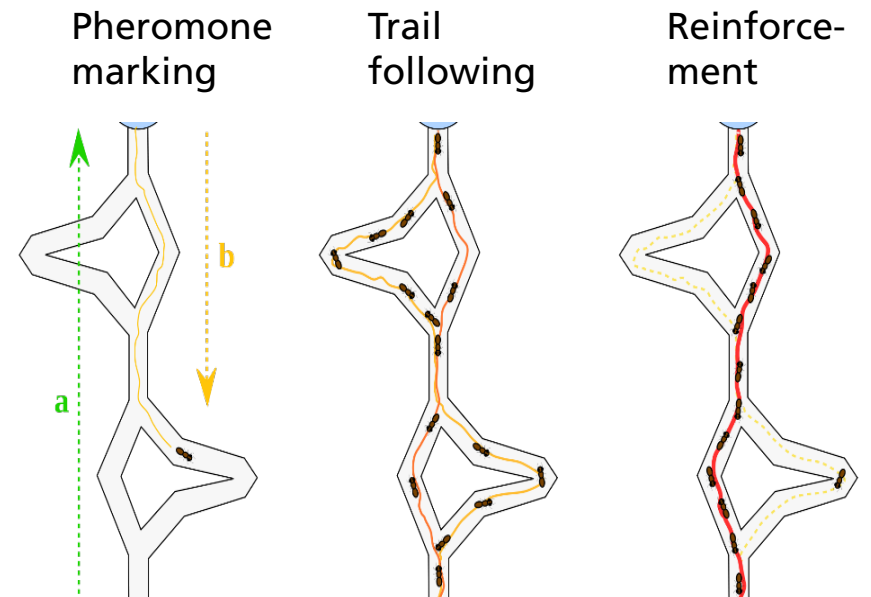
- Bio-inspired computational method using virtual ant colonies:
 - Each ant moves at random from the nest to a food source
 - Ants leave temporary pheromone trails along the way
 - More pheromones are left on optimal paths→ reinforcement of the best strategies (e.g. shortest path)

→ Meta heuristic with applications for e.g.:

- Vehicle routing (logistics)
- Predicting protein folding geometries
- Network modelling (e.g. load balancing)



Picture: Fraunhofer IML





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Challenges for the implementation



Economy

- Overcome **path dependencies**
- Supporting systemic restructuring through change **management**
- Dealing **with new requirements** for the **working environment**
- Identifying **economic advantages** for **value creation**



Ecology

- **Disclosing** the **environmental** effects of existing technologies
- Considering **risks** and **chances** and **communicate openly**
- **Combining economic** growth and **ecology**; paying attention to **ecological limits**



Society

- Ensuring **agile governance**, early addressing of ethical aspects
- Enabling **understanding** of **biology technology symbiosis**, technology assessment
- Timely involvement of **stakeholders** and **social sciences**