What is Modelling ?

real structures ⟷ abstract structures

congruent, true ?

actual behaviour ⟷ virtual behaviour

bisimilar, meaningful?

Two Modelling Paradigms

- **Functional model**
  - syntactic
  - Input- output analysis
  - Indicators of efficiency
  - Models need to be „true“ representations of reality
- **Interactive model**
  - semantic
  - comprehensive history
  - Indicators of robustness
  - Models need to be „meaningful“ representations of history

terminology

- Revolution:
  - Meaning of changes before and after the event
- Catastrophy
  - Meaning similar before and after

Seminar Overview

	Functional: Non-living Environment	**Interactive:** living Environment
Individuum check consistency	Extreme Sports & Ascetism (with U.Berner)	Animal-Human Relationships (with U.Berner)
Bio- und cultural Societies check consistency	Natural-Disasters (with D.Müller-Mahn) Resilience (with A. Jentsch)	**Collapses vs. Sustainability** (with G.Klute)

interesting under „extreme“ conditions

interesting under „normal“ conditions

Question

- Into which model class belong the notions of
  - Resilience, Stability
  - Ecosystem function, ecosystem services
  - Risk, Danger
  - **Vulnerability** „is the degree to which a system is susceptibel to or unable to cope with adverse effects of climate change, including climate variablity and extremes. Vulnerability is a **function** of the character, magnitude, and rate of climate variation to which a system is exposed its **sensitivity** and its **adapative** capacity.“
- Metaphorical or rigorous usage ?
  - External forces („pressure and release model“)
  - System variables and parameter

Definitions are often mixtures from two the model paradigms

Ecological terminology:

Not distinctive enough

- Functional
  - Mathematics: function (unique) versus relation
  - Computer science: computation as a recursive function
  - Physics: gravitation is a (causal) function of a state
  - Biology: heart has the (final) function to pump blood
  - Ecosystem functions: used in several sense

- Interaction:
  - Mathematics: ?
  - Computer science: computation as an ongoing behaviour (recursive service)
  - Physics: interacting particles form a dynamic (state) system
  - Biology: organisms interact, life is interaction
  - Ecosystem interactions: used in several sense

Physical language prevails in ecology

(Seminar with Anke Jentsch on stability and resilience)

- **Ecosystem Functions Regulate Change and Stability**
  - Multiple stable states characterize most ecosystems. If disturbances or perturbations occur from either internal or external sources which tend to drive an ecosystem away from its current equilibrium state, then the ecosystem's regulatory feedback mechanisms work to maintain the current state, or to bring the ecosystem to one of its other typical equilibrium states.

From: Sustainable Scale Project

Function and Service

- **Ecosystem Services (from Wikipedia)**
  - Humankind benefits from a multitude of resources and processes that are supplied by natural ecosystems. Collectively, these benefits are known as ***ecosystem services*** and include products like clean drinking water and processes such as the decomposition of wastes. Ecosystem services are distinct from other ***ecosystem products and functions*** because there is human demand for these natural assets.

  - Services can be subdivided into five categories:
    - *provisioning* such as the production of food and water;
    - *regulating*, such as the control of climate and disease;
    - *supporting*, such as nutrient cycles and crop pollination;
    - *cultural*, such as spiritual and recreational benefits; and
    - *preserving*, which includes guarding against uncertainty through the maintenance of diversity.

computational terminology:

adds a distinction

- Functional
  - Computer science: computation as a recursive function
  - Algorithmic computation:
    - you must input all data *before* a program runs,
    - the program does not accept any input while it is running and
    - all results can be retrieved after the program has halted. (e.g. most FORTRAN Programs)
- Interaction:
  - Computer science: computation as an ongoing behaviour (recursive service)
  - Interactive computation:
    - you may react to intermediate results while the program is running (e.g. an operating system, a data base)

I. Functional Paradigm
structure → behaviour (function)

- Typical of natural sciences:
  - Exo-perspective (passive observer)
- Prerequisites
  - identical, simple and universal building blocks
  - buildings blocks represented as state systems
  - observable states, facts, Natural Law
- Structure entails function
  - Model test based on congruence of structure
- Behaviour can be reduced to functions
  - Models are about syntax
- **Catastrophy**: What happened, What might happen?

II. Interactive Paradigm
behavior → structure (interface)

- Computer science (also cultural/social science ?)
  - Endo-observer (participator)

- Prerequisites :
  - complete set of behavioral possibilities
  - history can „be stopped“ (repeated)
  - memory and cultural norms

- Behavior entails evaluation of structure (at interface)
  - model test based on indistinguishable behavior

- relevant attributes at appear at interface
  - Models are about semantic (meaning)

- **Catastrophy**: What was the mistake? How to evaluate?

	Functional Paradigm	**Interactive Paradigm**
Test	Non-trivial prediction	Non-trivial decision
Example	Weather report	Chess computer
Landuse provides:	Production of **goods**	Continuation of **service**
Human picted as	Homo Oeconomicus „Mechanism of Self-Interest“	Homo Ludens
Nature picted as	Mechanistic, Exo-observer	participative, Endo-observer
Economical aspects	Neoclassic economy	Ecological economy
Legal aspects	Precautionary principle	Sustainability principle

Categories for Classifying
society/environment-interfaces?

endo-perspective

internal model Paradigm

	Functional Models	**Interactive Models**
Functional monitoring (mass, patterns)	al: complexity of environment (scaffolding for ?) features	
Interactive monitoring (symmetrical)	ve: Heterarchy or	Hierarchy (symmetrical or

capacity:

Case studies: low-high appropriate measures?

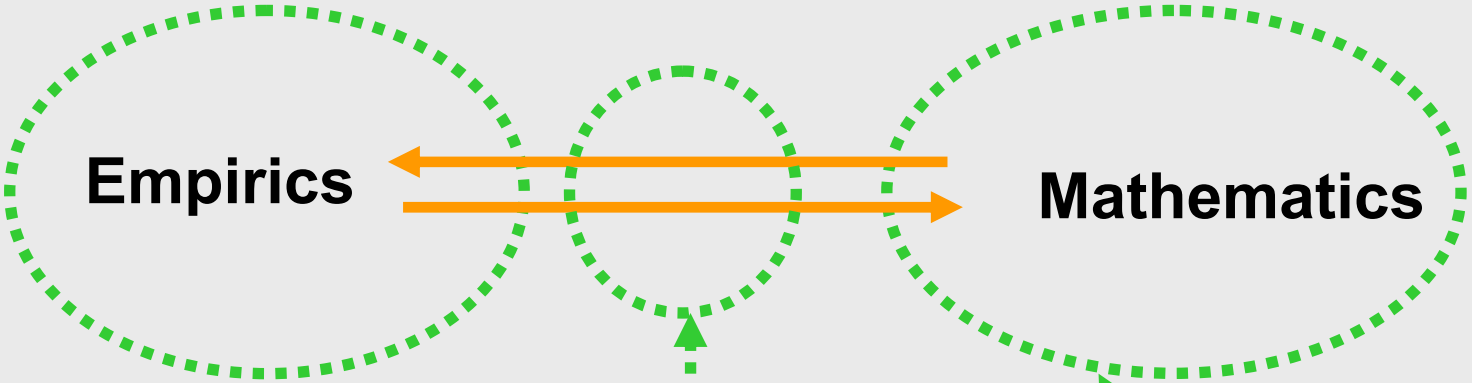
external model Paradigm

scientific exo-perspective

advantages and disadvantages

- Western (modern, functional, algebraic, dynamic, …) models
  - better explanations, „True“,
  - due to lack of meaning
  - helpful in assessing efficiency
- Traditional (e.g. African, interactive, …) models
  - better in assigning meaning
  - due to participation
  - helpful in organizing survival

Consistency: two out of three



1.
computer-modells:
helpfull for data
in ecology

3.
Ecosystems too complex:
for theory

2.
computer:
applied mathematics