Network Analysis

Alexander Bockmayr
Martin Vingron
SS 2014, FU Berlin

bockmayr@mi.fu-berlin.de
http://page.mi.fu-berlin.de/~bockmayr

Organisational issues

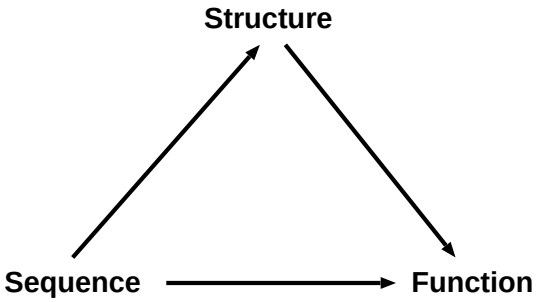
- Slides and additional material will be made available through the course pages

  http://www.mi.fu-berlin.de/w/AgMathLife/Netzwerk14

- Note that these slides are not a script.
- Please take notes and look up the references.
- Time slots: Monday 10-12, Friday 10-12, Friday, 14-16
  Precise schedule will be announced on course page
- Related courses
  - Computational systems biology (Praxisseminar)
  - Metabolic networks (Forschungsmodul)

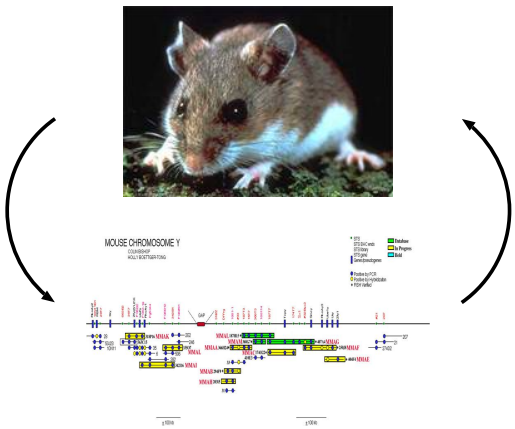
Computational biology

- Biological macromolecules



- Macromolecular interactions
- Pathways, networks, systems

Systems biology

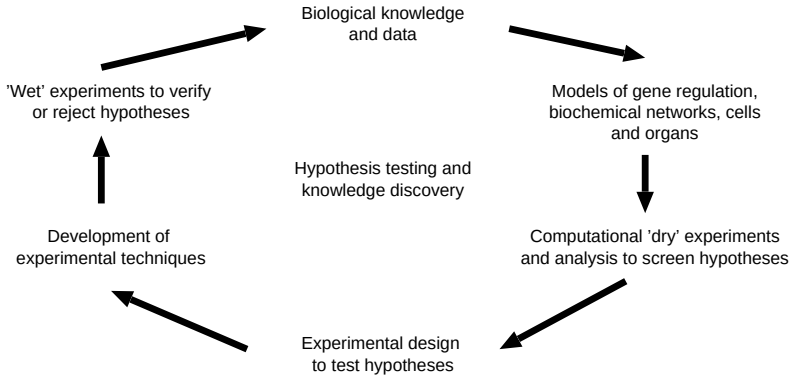


Computational systems biology

- **Systems biology:** Understand how *components* of a biological system *interact* to perform complex biological function
- Different levels of complexity
  - Many components, huge amount of data
  - Non-trivial interactions: non-linearity, feedback, ...
- Intuitive reasoning not sufficient
- Need for mathematical and computational models and tools

Systems biology research cycle

Kitano 2002



Biological networks

- Various network types: Syntax and semantics
- Structure/topology vs. dynamics:
  How does the dynamic behavior depend on the topology?
- Mathematical and computational study

  - Modeling
  - Simulation
  - Analysis $\rightsquigarrow$ formal methods
  - Optimization

Mathematical modeling approaches

- Network topology
  - Graph-based modeling
  - Stoichiometric/constraint-based modeling
- Network dynamics
  - Continuous modeling
  - Discrete modeling
  - Stochastic modeling
  - Hybrid modeling

Important issues

- Abstraction vs. precision
- Quantitative vs. qualitative
- Deterministic vs. non-deterministic

Some activities

- DFG Research Center MATHEON and Einstein Center for Mathematics ECMATH
- DFG Research and Training Group “Computational Systems Biology” (HU, FU, Charité, MDC)
- IMPRS “Computational Biology and Scientific Computing”
- Berlin Institute for Medical Systems Biology (BIMSB)

Outline

1. Continuous models
2. Discrete models
3. Constraint-based models
4. Stochastic models