Biological Networks

Introduction to Bioinformatics
Dortmund, 16.-20.07.2007

Lectures:
Sven Rahmann

Exercises:
Udo Feldkamp, Michael Wurst

Different Kinds of Networks

- Networks model interactions
- Mathematical basis: Graphs
  (as for phylogenetic trees)
- Examples of Networks
  - social (contact, friendship): Xing, studivz
  - WWW (dynamically created content?)
  - biological, chemical,
  - ...
- Vertices, edges of networks contain information (annotations), e.g., reaction rates, ...

Biological Networks

- Transcriptional regulation (protein – DNA)
- Protein-protein interaction
- Protein-ligand interaction
- Metabolomic networks

“Random Networks”

- Mathematical models of networks
- “Algorithms” for creating networks according to certain rules
  - e.g., uniform random networks
  - “growing a network”
- Mathematical analysis of properties
  - scale free?:
    Properties do not change with view level
- Comparison to real networks

“Network Motifs”

- Network motifs :=
  Subgraphs in a network that appear more frequently than expected (in a random graph model)
- Idea: All biological networks can be built from a small number of building blocks (motifs)
- Methods from data mining:
  e.g., frequent itemset mining
  (items bought together in the supermarket)

Pathways

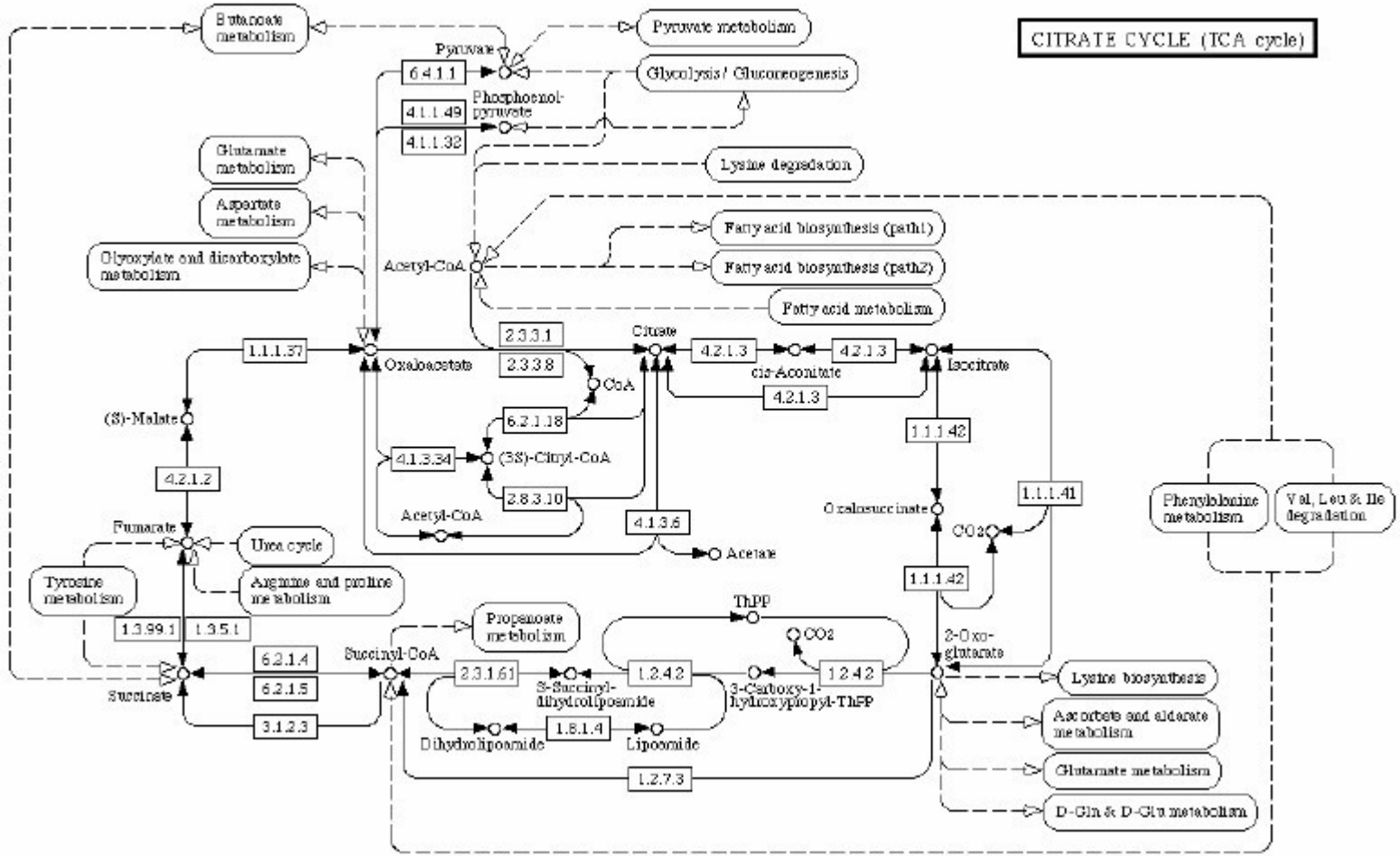
- pathway :=
  part of a network
  (no unique more specific definition possible)

Pathway Databases

- Pathway Resource List
  http://www.cbio.mskcc.org/prl/index.php
- Expasy
- KEGG
- TransPATH
- BioCyc
- BindDB
- MIPS
- Reactome

KEGG

- Kyoto Encyclopedia of Genes and Genomes
- Pathways manually entered, stored as images (.gif)



BioCyc (EcoCyc)

- URL: http://www.biocyc.org
- The primary database was EcoCyc (E. coli)
- Several curated pathway/genome databases (PGDB)
  - each focusing on one organism (ca. 600 organisms) (e.g. HumanCyc, AraCyc)
- MetaCyc database contains non-redundant reference pathways
- Supports
  - “Pathway Tools” software suite to analyze PGDBs
  - “PathoLogic” pathway prediction program for new genomes

BioCyc Pathway Tools

- Full metabolic map
  - paint gene expression data on metabolic network
  - compare metabolic networks
- Pathways
  - pathway prediction (PathoLogic)
- Reactions
  - balance checker
- Compounds
  - chemical substructure
- Comparison

CoryneRegNet

- Transcriptional regulation in Corynebacteria