Exercise for Constraint-based Modeling of Cellular Networks
24 November 2022

Homework should be sent to Anika (ankueken@uni-potsdam.de)

From now on, we will not distinguish between exercise and homework. Everything is also homework!

Hand in your commented code for all exercise tasks as homework.

Exercise

Load the *E. coli* core model

1. **Remove reactions that are blocked at any feasible solution.**

2. **Manipulating growth conditions**

- Which metabolites are imported?
- Is the model simulating aerobic or anaerobic growth? What is the carbon source?
- Change the model such that it simulates anaerobic growth with glucose as only carbon source.

3. **Calculate the optimal growth rate under aerobic (original model) and anaerobic growth (model obtained from previous step).**

4. **Write MATLAB code to classify reactions based on their relation to optimal specific growth rate using FVA under the aerobic and aerobic growth conditions.**

   (Compare lecture 5 slides 27 and following)

   Assume that z^* is the optimum of the objective $z = max\ v\_biomass$

   And α is a percentage of z^* which we are willing to sacrifice, here use 90%

   A reaction is

   - Hard-coupled to objective if its flux varies exactly like objective
   - Partially-coupled to objective if its flux is non-zero, but can vary
   - Not coupled to objective if its flux can take a zero value
   - Blocked at objective if its flux takes only a value of zero

   Are there reactions that are classified differently under both scenarios?

5. **Find reactions whose flux is highly correlated to biomass flux under aerobic and anaerobic conditions.**

   Again, let z^* be the optimum of the objective $z = max\ v\_biomass$.

   Sample 100 **unique** values b uniformly at random from the interval $[0.1 \cdot z^*,\ z^*]$ using function rand().

For each value b sampled in the previous step, solve the LP below and store the obtained flux distribution v.

$$\min_{v} \sum_{i} v_i$$

$$Nv(s) = 0$$
$$v_{biomass} = b$$
$$lb \leq v \leq ub$$

Use the obtained set of 100 flux distributions to calculate the correlation of each reaction to the biomass reaction. Do all reactions in the model correlate equally to biomass reaction?
Which reactions are highest correlated to biomass under the respective conditions?