Network Analysis SS 14
Constraint Modeling

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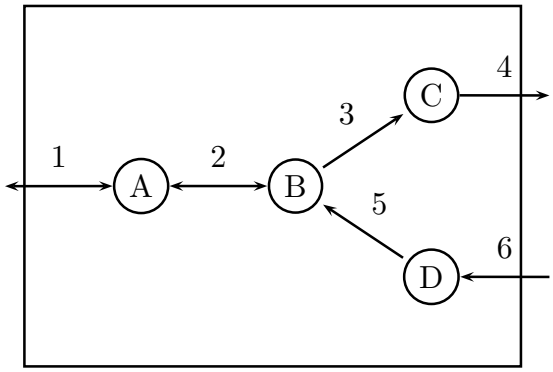
06 June 2014

1 Exercise

Consider the following network:



1. Give an inequality description of the steady-state flux cone of $\mathcal{N}$, assuming that all stoichiometric coefficients belong to $\{-1, 0, 1\}$.
2. Determine the elementary modes of $\mathcal{N}$.
3. Determine for all pairs of reactions i and j, $i \neq j$, whether i is directionally coupled to j.
4. Which pairs of reactions are fully coupled?

2 Exercise

Give a linear programming algorithm to determine in a metabolic network $\mathcal{N}$ with stoichiometric matrix S and set of irreversible reactions Irr whether

1. a reaction j is blocked, i.e., $v_j = 0$, for all $v \in C$.
2. two (non-blocked) reactions i and j are directionally coupled, i.e., $v_i = 0$ implies $v_j = 0$, for all $v \in C$. Here, C denotes the steady-state flux cone of $\mathcal{N}$.

3 Exercise

Consider a metabolic network $\mathcal{N}$ given by its stoichiometric $(m \times n)$-matrix S and the set of irreversible reactions Irr.

1. What is an elementary flux mode in $\mathcal{N}$?
2. What is a blocked reaction in $\mathcal{N}$?
3. Show that a reaction j in $\mathcal{N}$ is blocked if and only if $e_j = 0$, for all elementary modes e in $\mathcal{N}$.
4. Give a mixed integer linear program to compute a shortest elementary flux mode in $\mathcal{N}$ involving some particular reaction j_0 (you may assume $Irr = \{1, \ldots, n\}$).
5. Consider two unblocked reactions i, j in $\mathcal{N}$. What does it mean that i is directionally coupled to j?
6. For the example the following network determine all pairs of directionally coupled reactions.