Reversibility types

- A reversible reaction i is called fully reversible if there exists a flux vector $v \in C$ such that $v_i \neq 0$ and $v_j = 0$ for all $j \in Irr$.
- Otherwise, reaction i is called pseudo-irreversible.

Reaction classification

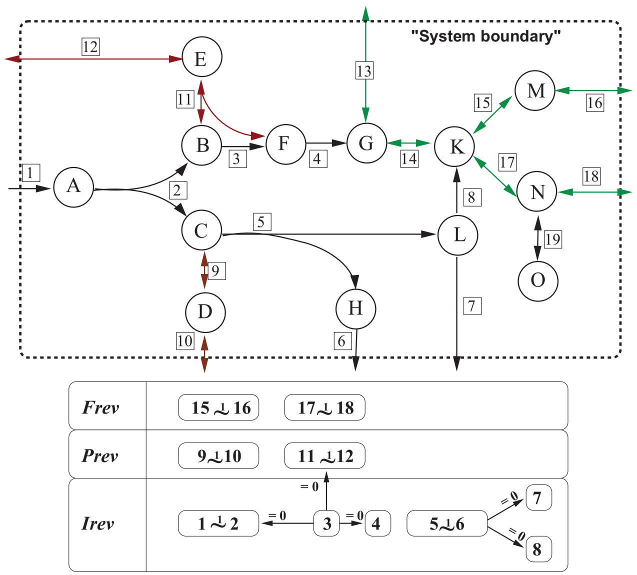
- $Blk = \{i \mid i \text{ is blocked}\}$.
- $Frev = \{i \mid i \text{ is fully reversible}\}$,
- $Prev = \{i \mid i \text{ is pseudo-irreversible and there exist } v^+, v^- \in C$ such that $v_i^+ > 0, v_i^- < 0\}$,
- $Irev = \{i \mid i \notin Frev \cup Prev \text{ and } v_i \neq 0 \text{ for some } v \in C\}$,

Possible coupling relations

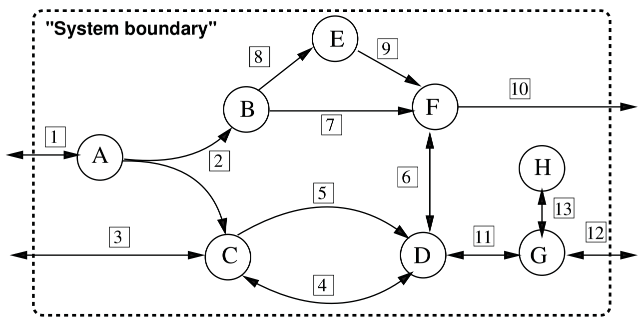
- If $i, j \in Irev$, all couplings are possible, i.e., $i \overset{=0}{\leftrightarrow} j$, $i \overset{=0}{\leftrightarrow} j$, $i \backsim^{\lambda} j$.
- If $i \in Irev$ and $j \in Prev$, the only possible coupling is $j \longrightarrow i$.
- If $i, j \in Prev$, the only possible coupling is $i \Longleftrightarrow j$.
- If $i, j \in Frev$, the only possible coupling is $i \Longleftrightarrow j$.

i/j	*Irev*			*Prev*			*Frev*		
	$\overset{=0}{\rightarrow}$	$\overset{=0}{\leftrightarrow}$	$\backsim^{\lambda}$	$\overset{=0}{\rightarrow}$	$\overset{=0}{\leftrightarrow}$	$\backsim^{\lambda}$	$\overset{=0}{\rightarrow}$	$\overset{=0}{\leftrightarrow}$	$\backsim^{\lambda}$
Irev	$\surd$	$\surd$	$\surd$	$\surd$					
Prev				$(\surd)$	$(\surd)$	$\surd$			
Frev							$(\surd)$	$(\surd)$	$\surd$

Example



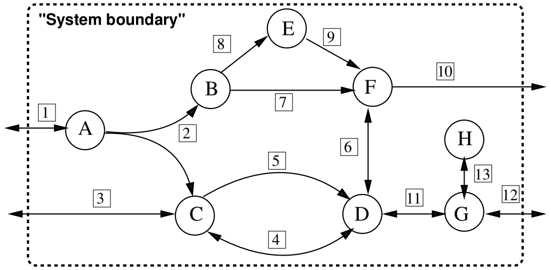
Network simplication

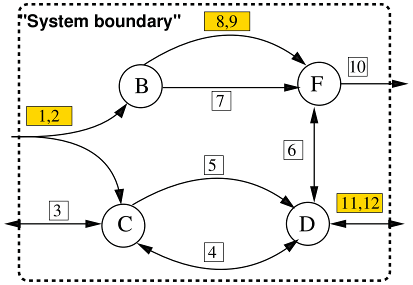


- Dead-end metabolites
- Blocked reactions
- Fully coupled reactions

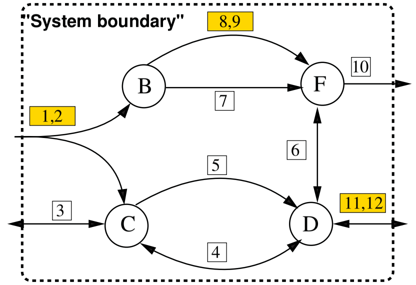
$\rightsquigarrow$ iterative reduction

Example





Reducing the number of LP problems



- ▷ Trivial uncoupling for "parallel" reactions (Lemma 2, F2C2)
- ▷ Trivial directional coupling (Obs. 5, F2C2)
- ▷ Reusing LP solutions
  If $v \in C$, $I_v = \{i \mid v_i = 0\}$, $J_v = \{j \mid v_j \neq 0\}$, then $i \stackrel{=0}{\not\rightarrow} j$, for all $(i,j) \in I_v \times J_v$.

Transitivity rules

Known flux coupling	$i \backsim j$	$i \stackrel{=0}{\leftrightarrow} j$	$i \stackrel{=0}{\rightarrow} j$	$j \stackrel{=0}{\rightarrow} i$
$k \backsim i$	$k \backsim j$	$i \stackrel{=0}{\leftrightarrow} j$	$k \stackrel{=0}{\rightarrow} j$	$j \stackrel{=0}{\rightarrow} k$
$k \stackrel{=0}{\leftrightarrow} i$	$k \stackrel{=0}{\leftrightarrow} j$	$k \stackrel{=0}{\leftrightarrow} j$	$k \stackrel{=0}{\rightarrow} j$	$j \stackrel{=0}{\rightarrow} k$
$k \stackrel{=0}{\rightarrow} i$	$k \stackrel{=0}{\rightarrow} j$	$k \stackrel{=0}{\rightarrow} j$	$k \stackrel{=0}{\rightarrow} j$	