Reduction techniques for validation of metabolic networks in *Arabidopsis thaliana*

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Large complex networks have been developed based on the growing amount of experimental data in Systems Biology. Heterogenous data of different quality from various experiments are compiled to larger and larger networks. Some of the data are true only with a given probability score, or are just erroneous. The model as a whole has to be self-consistent and several techniques have been established to validate the network structure and to identify missing or incorrect reactions [5].
Standard approaches adopt algorithms which were developed over the last decades in Mathematics and Technical Informatics for the analysis of concurrent systems. Here, especially Petri nets have been shown as a valuable methodology [7]. We utilize the relevance of t-invariants for the analysis of biological networks [6]. In worst case the solution of the corresponding diophantine equations [1] requires exponential space [8] and this fact confines the application to small to medium sized networks [3]. In order to enable the analysis of large networks the reduction [9] or decomposition [4, 2] of networks is advisable. With decomposition of networks a new problem arises: Whereas each isolated component may seem to work perfectly, the whole system may fail to show essential properties as e.g. being covered by t-invariants (CTI). An alternative approach is the reduction of a network which preserves properties of the net as being CTI.
We study transformations of net which will reduce the computational effort for the the solution of the diophantine equations. The t–invariants of the original net can be constructed by simple combinatorial rules from the t–invariants of the reduced net. The reduction and analysis of a network based on experimental data is demonstrated for a metabolic network of *Arabidopsis thaliana*, see Table 1. Reduction techniques can also be proven to be worthwhile for the biological interpretation of the network.

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Arabidopsis thaliana	not reduced	reduced	percentage reduced
#Places	130	61	$\sim 53\%$
#Transitions	232	123	$\sim 47\%$
#Edges	539	309	$\sim 43\%$

Table 1: Effect of net reductions of a metabolic network of *Arabidopsis thaliana*.

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