Detection of Regulatory Circuits by Integration of Protein-Protein and Protein-DNA Interaction Data

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The post-genomic era is marked by huge amounts of data generated by large-scale functional genomic and proteomic experiments. These provide various types of genome-scale information, such as binding sites for transcription factors, mRNA expression levels, protein-protein interactions, and protein localization. A major challenge is to integrate these various types of information in order to reveal the intra- and inter-relationships between genes and proteins that constitute a living cell. We present a novel application of classical graph algorithms to integrate genome-wide data on regulatory proteins and their target genes with protein-protein interaction data. We demonstrate how integration of these two types of information enables the discovery of simple as well as complex regulatory circuits that involve both protein-protein and protein-DNA interactions. By applying our approach to data from the yeast Saccharomyces cerevisiae we were able to identify known simple and complex regulatory circuits and to discover many putative circuits. The computational scheme that we propose may be used to integrate additional functional genomic and proteomic data and to reveal other types of relations, in yeast as well as in higher organisms.