Perturbation Theory Model of Metabolic Reaction Networks

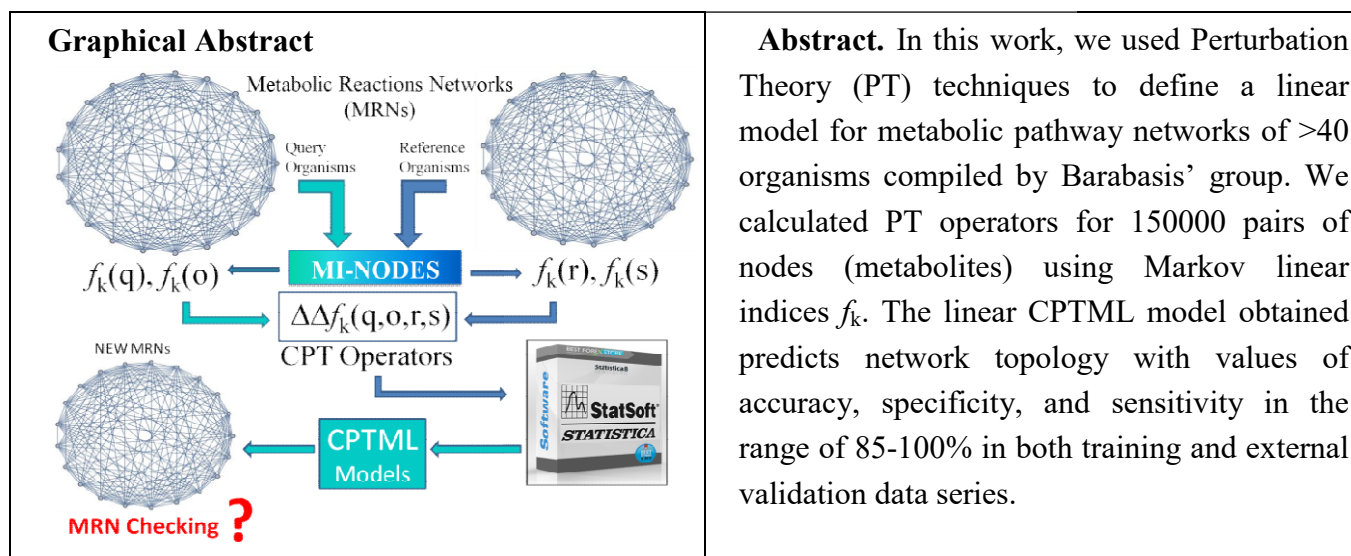Casañola-Martin G.M.,[1,2,3,*] Pérez-Giménez F,[2] Merino-Sanjuán M.,[3] and Green J.R. [1]

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Graphical Abstract

Abstract. In this work, we used Perturbation Theory (PT) techniques to define a linear model for metabolic pathway networks of >40 organisms compiled by Barabasis' group. We calculated PT operators for 150000 pairs of nodes (metabolites) using Markov linear indices f_k. The linear CPTML model obtained predicts network topology with values of accuracy, specificity, and sensitivity in the range of 85-100% in both training and external validation data series.

References.

References

1. Jeong, H.; Tombor, B.; Albert, R.; Oltvai, Z. N.; Barabasi, A. L., The large-scale organization of metabolic networks. Nature 2000, 407, 651-4.
2. Boccaletti, S.; Latora, V.; Moreno, Y.; Chavez, M.; Hwang, D. U., Complex networks: Structure and dynamics. Phys. Rep. 2006, 424, 175-308.
3. Box, G. E. P.; Jenkins, G. M., Time series analysis. Holden-Day: 1970; p 553.
4. Casanola-Martin, G. M.; Le-Thi-Thu, H.; Perez-Gimenez, F.; Marrero-Ponce, Y.; Merino-Sanjuan, M.; Abad, C.; Gonzalez-Diaz, H., Multi-output Model with Box-Jenkins Operators of Quadratic Indices for Prediction of Malaria and Cancer Inhibitors Targeting Ubiquitin-Proteasome Pathway (UPP) Proteins. Current Protein & Peptide Science 2016, 17, 220-227.

5.   Marrero Ponce, Y.; Castillo Garit, J. A.; Torrens, F.; Romero Zaldivar, V.; Castro, E. A., Atom, atom-type, and total linear indices of the "molecular pseudograph's atom adjacency matrix": Application to QSPR/QSAR studies of organic compounds. Molecules 2004, 9, 1100-1123.

6.   Marrero-Ponce, Y., Linear indices of the "molecular pseudograph's atom adjacency matrix": Definition, significance-interpretation, and application to QSAR analysis of flavone derivatives as HIV-1 integrase inhibitors. Journal of Chemical Information and Computer Sciences 2004, 44, 2010-2026.

7.   Casañola-Martin, G. M.; Le-Thi-Thu, H.; Pérez-Giménez, F.; Marrero-Ponce, Y.; Merino-Sanjuán, M.; Abad, C.; González-Díaz, H., Multi-output model with Bob-Jenkins operators of linear indices to predict multi-target networks of ubiquitin-proteasome system inhibitors. Mol. Divers. 2015, 19, 347-356.

8.   Hill, T.; Lewicki, P., STATISTICS Methods and Applications. A Comprehensive Reference for Science, Industry and Data Mining. StatSoft: Tulsa, 2006 Vol. 1, p 813.

9.   Casañola-Martín, G. M.; Khan, M. T. H.; Marrero-Ponce, Y.; Ather, A.; Sultankhodzhaev, M. N.; Torrens, F., New tyrosinase inhibitors selected by atomic linear indices-based classification models. Bioorg. Med. Chem. Lett. 2006, 16, 324-330.