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Metabolic interactions and dynamics in microbial communities

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Metabolism, in addition to being the engine of every living cell, plays a major role in the cell-cell and cell-environment relations that shape the dynamics and evolution of microbial communities, e.g. by mediating competition and cross-feeding interactions between different species. Despite the increasing availability of metagenomic sequencing data for numerous microbial ecosystems, fundamental aspects of these communities, such as the unculturability of many isolates, and the conditions necessary for taxonomic or functional stability, are still poorly understood. We are developing mechanistic computational approaches for studying the interactions between different organisms based on the knowledge of their entire metabolic networks. In particular, we have recently built an open source platform for the Computation of Microbial Ecosystems in Time and Space (COMETS), which combines metabolic models with convection-diffusion equations to simulate the spatio-temporal dynamics of metabolism in microbial communities. COMETS has been experimentally tested on small artificial communities, and is scalable to hundreds of species in complex environments. I will discuss recent developments and challenges towards the implementation of models for microbiomes and synthetic microbial communities.