Metabolic tree-of-life based on chemical complexity measures derived from complexity theory

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Metabolism, i.e., the series of reactions needed to convert a substrate in a product present in one organism, represents the cornerstone of every living organism. Due to its life-sustaining nature and niche specification, metabolism is at the core of every cell; metabolism defines cells. Because of this, evolutionary pressure has been able to perpetuate metabolic pathways that showcase optimal solutions for specific cellular needs, e.g., those related to energy generation and conservation. We propose the use of this information to uncover relationships between organisms in the Tree of Life, ToL.

Previous studies have shown that metabolic pathways can serve as a proxy for describing and relating organisms. Efforts in reconstructing ancestry using organism metabolism have shown promising results in elucidating novel relationships between organisms and generating consistent relationships with the ones seen in a classical tree of life. However, they lack the integration of biological, i.e, enzymes, and chemical, i.e., substrates and products, dimensions of the problem.

Complexity-based studies intend to assess what variables or behaviors make a particular system unique and uncertain. Due to the nature of biological systems, studying them through the lens of this theoretical framework represents a novel point of view for relating organisms, which may result in previously undescribed relationships.

We propose to redefine the ToL based on a novel measure of organism complexity. This novel metric of an organism's complexity will incorporate its metabolic pathways and products. We hope to uncover previously undescribed organism relationships and further improve our understanding of the ToL.

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