Combining taxonomies for classification: when are sharks and dolphins similar?

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We present novel methods of fusing taxonomies in an effort to resolve conflicts that arise when designing taxonomies. Current taxonomies are often expert-created structures, which can produce bias towards certain classes. For instance, a taxonomy system for classifying living organisms may look different if the expert used biomes or species relationships. We focus on taxonomies which can be represented as labeled rooted directed trees, also called arborescences. We present methods of fusing arborescences in a way that preserves underlying structure using a set-theoretic perspective. Hierarchical classification considers class relationships and can give a coarser result if a specific class is unable to be determined. We compare whether fused arborescences improve hierarchical classification compared to the original expert-defined trees. Our findings suggest that these fused graphs show some improvement in metrics such as tree-induced error.

Keywords: Taxonomy, Trees, Algorithms, Classification, Fusion

Cost-Benefit Analysis for PMU Placement in Power Grids

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Power domination is a graph-theoretic model for the observance of a power grid using phasor measurement units (PMUs). There are many costs associated with the installation of a PMU, but also costs associated with not observing the entire power grid. In this work, we propose and study a power domination cost function, which balances these two costs. Given a graph G, a set of sensor locations S, and a parameter β (which is the ratio of the cost of a PMU to the cost of non-observance of any given vertex), we define the cost function

$$\mathrm{C}(G; S, \beta) = |S| + \beta \cdot (|V(G)| - |\mathrm{Obs}(G; S)|)$$

where $|\mathrm{Obs}(G; S)|$ is the number of vertices observed by sensors placed at $S \subseteq V(G)$ in the power domination process. We explore the values of k for which there is a set S of size k that minimizes this cost function, and explore which values of β guarantee that it is optimal to observe the entire power grid to minimize cost. We also introduce notions of marginal cost and marginal observance, providing tools to analyze how many PMUs one should install on a given power grid.

Keywords: Power domination, cost function, graph theory