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A novel visualization framework for extracting insights from machine learning models

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AMCIS: A Novel Visualization Framework for Extracting Insights from Machine Learning Models

TREO Talk Paper

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Abstract

The increased availability of high-dimensional datasets allows machine learning (ML) models to uncover complex, nonlinear patterns in business data, thus increasing machine learning's utility for data-driven discovery. Rather than simply relying on models' 'black box' predictions, researchers and organizational decision makers should be able to see and understand these ML-discovered patterns to aid in hypothesis generation. This research presents a holistic visualization framework, which combines existing and novel ML metrics and plots, that allows for efficient pattern and interaction discovery in predictive ML models. As part of this framework, we introduce a novel set of feature importance metrics separately quantifying variables' linear, nonlinear, and interaction effects on patient outcomes, which are special cases of the commonly-used permutation feature importance metric. We also introduce an algorithm for estimating the magnitude of all pairwise interactions learned by ML models among k variables that runs in near-O(k) time (rather than O(k^2), as required by existing techniques), which facilitates interaction discovery even in high-dimensional datasets. Lastly, we present a novel algorithm for identifying the most relevant three-way interactions that each variable participates in. We combine these novel developments with partial dependence plots (an existing ML tool for visualizing variables' marginal effects on outcomes) to introduce a set of visualizations that allow decision makers to quickly identify the most important variables for predicting business or healthcare outcomes, and to quickly visualize the functional form of these effects. Finally, we discuss our framework's potential application to a real-world case study. Our proposed visualization framework is being implemented as an open-source dashboard available in Python, and code will be shared with interested attendees.