Deep Oblique Decision Tree (DODT): A Novel Approach for Multi-class Classification

Introduction

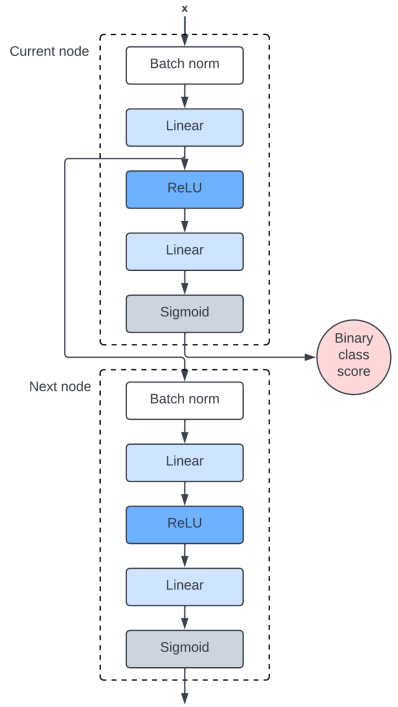
We present a novel machine learning architecture, the Deep Oblique Decision Tree (DODT), which combines the strengths of decision trees and deep learning techniques to address multi-class classification problems. The proposed DODT model integrates the interpretability and hierarchical structure of decision trees with the learning capacity and feature representation capabilities of deep neural networks. Our architecture employs oblique decision boundaries to enhance the flexibility and expressiveness of the decision tree's splitting criteria, resulting in improved classification performance.

Working Pipeline

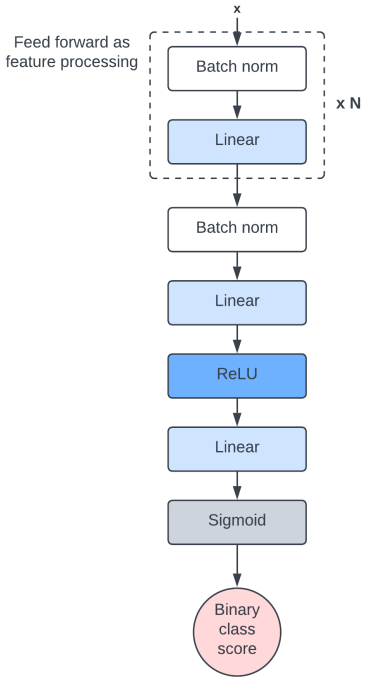
As shown in the figures, each node contains a simple feed-forward network that is trained to perform oblique split on the dataset. Each node will have a target class, at each split, the goal is to maximize the proportion of the target class in one split while minimizing it in the other. This process continues until it reaches the stop condition, similar to traditional decision trees.

Key Ideas

- Using simple feed-forward networks for dataset splitting instead of linear splitting in traditional decision tree (Feed-forward as oblique splitting).
- Class labels are being encoded as 1 and 0's where 1 is the class with the highest frequency within current partition.
- Each feature vector will pass through the entire feed-forward network to calculate the probability score for it being the '1' class. But feature vectors to the next node will be the output of the first linear layer.
- Underlying correlations can be complex that overwhelms a single feed-forward network. If the network is unable to partition the dataset at current node, pass the entire processed dataset to the next node (Feed-forward as deep learning).



Feed-forward as oblique splitting



Feed-forward as deep learning

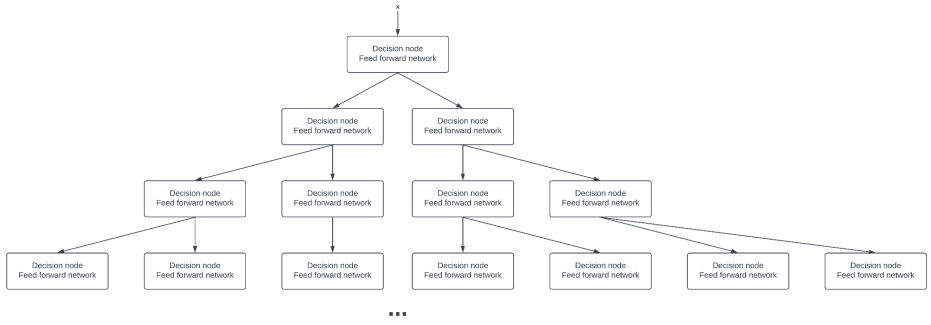


Illustration of an example resultant DODT structure