Econometrics September 27, 2023

Topic 20: Random Forest

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Key points: .

Disclaimer: The note is built on Prof. Jinchi Lv's lectures of the course at USC, DSO 607, High-Dimensional Statistics and Big Data Problems.

20.1 Motivation

Denote by $m(\mathbf{X})$ the measurable nonparametric regression function with p-dimensional random vector \mathbf{X} taking values in $[0,1]^p$. The Random Forest algorithm aims to learn the regression function in a nonparametric way based on the observations $\mathbf{x}_i \in [0,1]^p$, $y_i \in \mathbb{R}$, $i = 1, \dots, n$, from the model

$$y_i = m(\mathbf{x}_i) + \epsilon_i$$

where X, x_i , ε_i , $i = 1, \dots, n$ are independent, and $\{x_i\}$ and $\{\varepsilon_i\}$ are two sequences of identically distributed random variables. x_i is distributed identically as X.

Why Random Forest (RF)? RF has gained significant popularity due to its

- High accuracy: RF consistently rank among the top performer, often surpassing more complex models
- Robustness: RF are less subject to overfitting due to the ensemble nature leveraging multiple decision trees
- Interpretability: RF provide rankings of feature importance

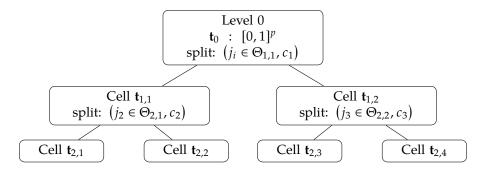


Figure 20.1: Level-2 Tree Example

Chi et al. (2022)

20-2 Week 20: Random Forest

References

Chien-Ming Chi, Patrick Vossler, Yingying Fan, and Jinchi Lv. Asymptotic properties of high-dimensional random forests. *The Annals of Statistics*, 50(6):3415–3438, 2022.