

## 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 non-parametric 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  $\mathbf{X}$ ,  $\mathbf{x}_i$ ,  $\epsilon_i$ ,  $i = 1, \dots, n$  are independent, and  $\{\mathbf{x}_i\}$  and  $\{\epsilon_i\}$  are two sequences of identically distributed random variables.  $\mathbf{x}_i$  is distributed identically as  $\mathbf{X}$ .

**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

As illustrated in Figure 20.1,

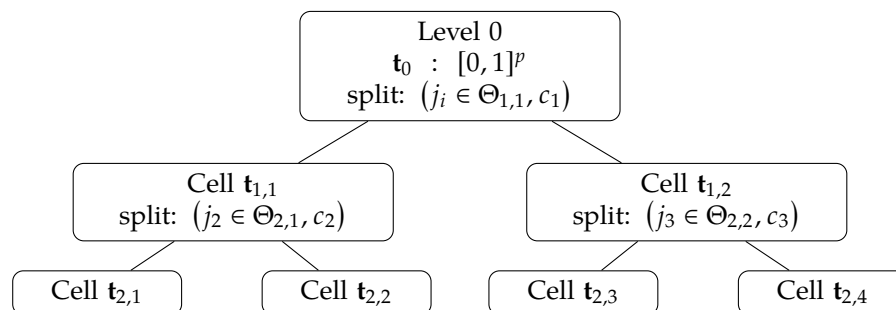


Figure 20.1: Level-2 Tree Example

Chi et al. (2022)

## 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.