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Transparent prediction based on decision tree superposition

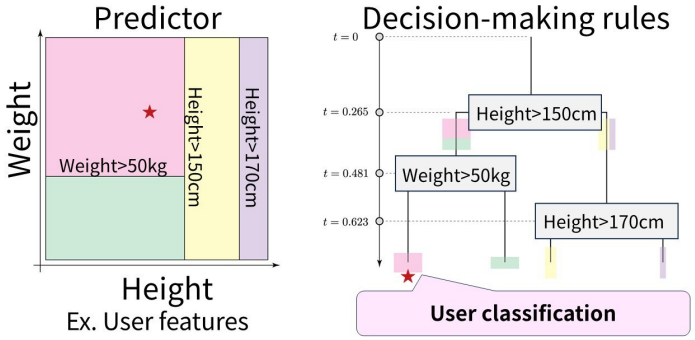
# Collaborative learning with multiple thoughts


## Abstract

Decision trees have been playing an important role in machine learning tasks that require interpretability and transparency, such as in finance and biomedical fields. In recent years, the existence of multiple decision tree candidates with comparable performance but different qualities, known as the Rashomon set, has attracted attention as a topic that further promotes the interpretability and transparency of decision trees. In this presentation, we explore a method for exploring the Rashomon set for decision trees. Specifically, we propose a quantum extension of decision trees in order to introduce quantum effects as a mechanism for multiple influential decision trees of seemingly different quality in a Rashomon set to share potentially useful clues with each other.


## Decision tree for classification/regression

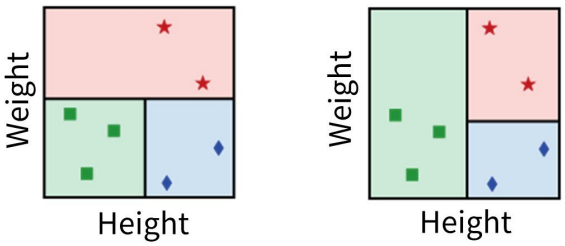
**Decision tree: AI model with explainable and interpretable decision-making rules.**




- **Challenge of general-purpose AIs：**
  - It is not easy for engineers to gain explainable and interpretable insights from the trained AIs.
- **Advantage of decision tree：**
  - It is tractable for engineers calculate the uncertainty of decision-making rules from AI.

## Existence of multiple influential trees

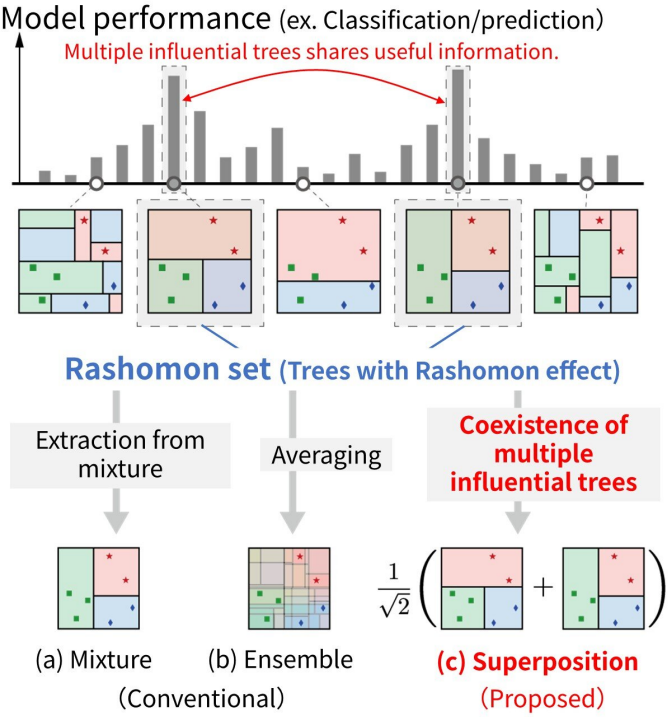
**Rashomon effect：** Multiple trees have the same level of model performance but are of different quality.




**Examples of decision trees that classify 6 data into 3 classes**

## Our insight: Quantum superposition

Inspired by quantum computation, we introduce the **quantum superposition** notion into the decision trees as a mechanism that **allows multiple influential decision tress to *coexist* as a single state**, whereas in classical system, a single state generally corresponds to a single decision tree.




- **Our demonstrations：**
  1. **Learning:** Illustrative animation shows how to share useful knowledge between multiple decision trees.
  2. **Visualization:** Our system shows illustrative 2Dembeddings of multiple influential decision trees for 5 biological real-world datasets.

## References


[1] M. Nakano, K. Komiya, H. Sakuma, T. Sato, T. Iwata, K. Kashino, “Mondrian Embeddings for Visualization of Decision Tree Ensembles,” in *Proc. the 47th annual international conference of the IEEE Engineering in Medicine and Biology Society.*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