Role of Decision Trees in Adaptive IELTS Preparation

To enable data-driven decision-making within the system, we integrate decision tree models at two key stages of the learner journey: initial difficulty level assignment and ongoing plan adjustment. Decision trees are a form of supervised machine learning used for classification and regression tasks. They provide a transparent and interpretable structure for modeling decisions based on input data.

Structure of a Decision Tree

A decision tree is composed of several key elements:

1. **Nodes**:
    - **Root Node**: This is the first decision point of the tree and represents the starting condition, typically encompassing the entire dataset.
    - **Internal Nodes**: These nodes perform tests on input features (e.g., test scores or band results) and define intermediate decision points.
    - **Leaf Nodes**: The final nodes in the tree, which provide the predicted class or decision outcome, such as assigning a study plan or recommending a revision focus.

2. **Branches**:
    - Each branch signifies an outcome of the test at an internal node. For instance, a branch might represent whether a writing score falls below or above a certain threshold.
3. **Working Mechanism**:
    - The process begins at the root node and proceeds down the tree.
    - At each internal node, a feature condition is evaluated, such as “Is the Reading score < 6.0?”.
    - Based on the result, the path follows the corresponding branch to the next node.
    - This continues recursively until a leaf node is reached, which yields the final recommendation (e.g., Maintain Plan or Focus Writing).

Decision Tree Structure and Its Application

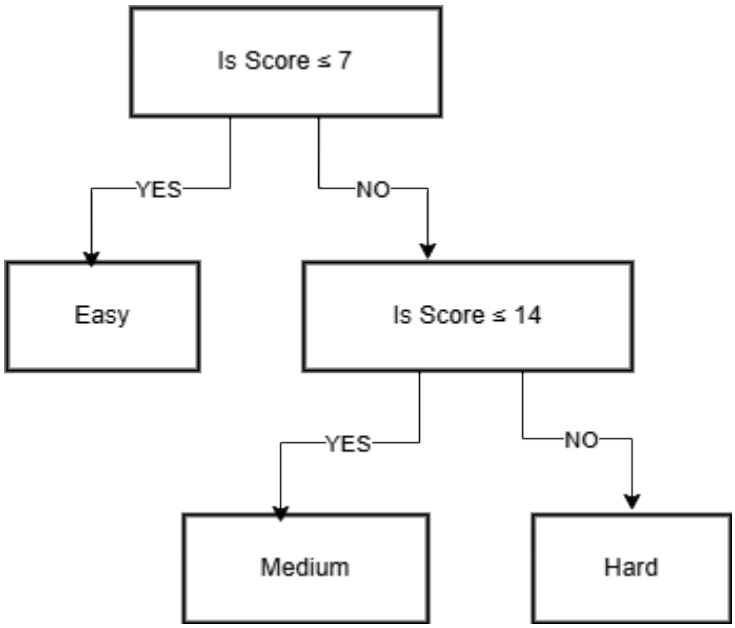
The decision tree model serves as the core logic engine behind both the initial assignment of learners to difficulty-based study plans and the dynamic reassessment of those plans based on ongoing performance. Due to its interpretable nature and structured decision-making capabilities, the decision tree is particularly suitable for guiding personalized learning paths in a transparent and explainable manner.

1. Initial Plan Assignment

At the point of user registration, learners are required to take a 20-mark diagnostic test that assesses their baseline English proficiency across grammar, vocabulary, reading, and listening. The resulting score is used as input to a decision tree classifier that assigns one of three study plans: Easy, Medium, or Hard.

The structure of this decision tree is relatively simple, with a single feature (total score) guiding the path to a specific plan. The decision boundaries are defined as follows:

- Score ≤ 7 → Easy Plan
- Score between 8 and 14 → Medium Plan
- Score ≥ 15 → Hard Plan



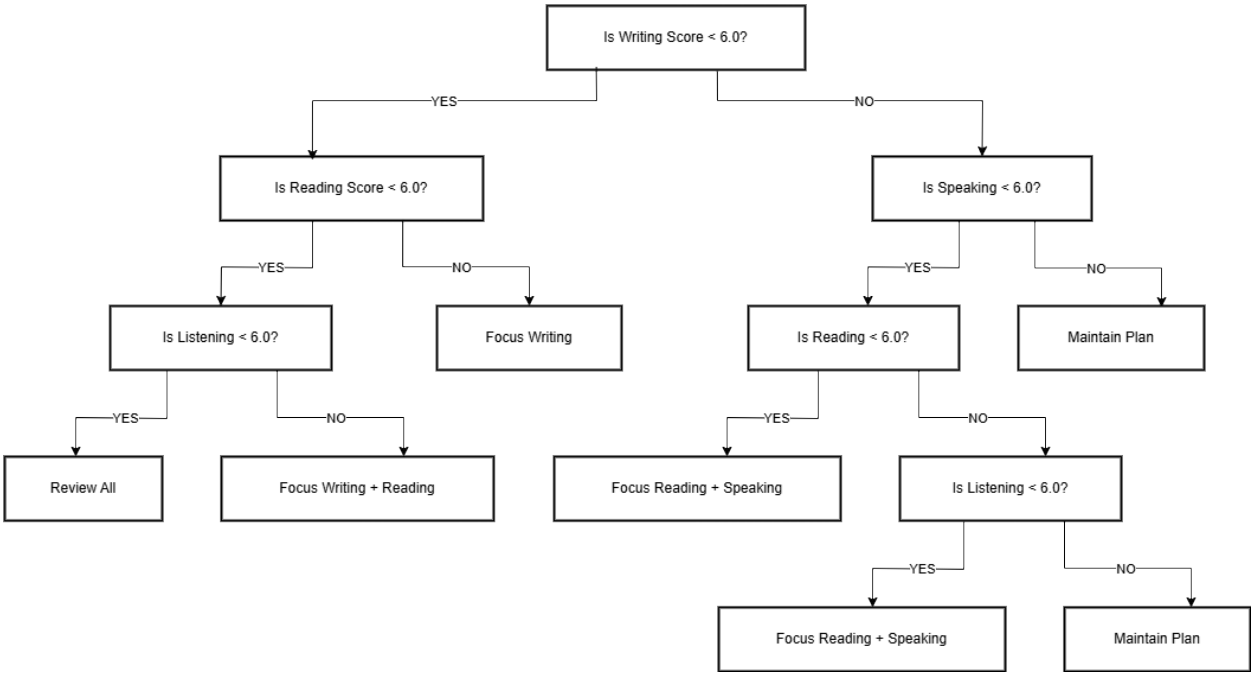
This decision is executed once during onboarding and provides a personalized starting point that aligns with the learner's current capabilities.

2. Dynamic Plan Reassessment

As learners progress through their preparation, the system periodically evaluates their performance using LLM-assisted band scoring in key IELTS components: Reading, Writing,

Speaking, and Listening. These scores are used as input features to a second decision tree model, which assesses whether the learner is on track or requires adjustments in their study plan.

The structure of this tree is more complex, incorporating multiple features and supporting nuanced outcomes such as targeted module focus or comprehensive revision. The decision-making path is based on whether each skill score falls below a defined performance threshold .



This hierarchical evaluation process enables the system to diagnose specific weaknesses and deliver tailored feedback, such as “Focus on Writing and Reading” or “Review All Modules.” If all scores meet or exceed the threshold, the model recommends maintaining the current study trajectory.

Benefits of Tree-Based Adaptation

By using decision trees at both stages, the system ensures that learners receive recommendations grounded in observable data and interpretable rules. Unlike opaque neural network classifiers, decision trees provide clarity in how recommendations are derived, which is essential for both learner trust and educational transparency.