

Comparing the Expert System and Decision Tree Model

1. **Validation Set Evaluation (Performance on Unseen Data)**
2. **Accuracy Comparison**
3. **Explainability: Decision Trees vs. Human-Defined Rules**

Validation Set Evaluation: Performance on Unseen Data

- The **Decision Tree** was trained and tested using a **data-driven approach** and was evaluated on unseen data using standard machine learning metrics (accuracy, precision, recall, and F1 score).
- The **Expert System** uses predefined **if-then rules** and is tested by manually inputting facts (patient data).
- The **Decision Tree** was evaluated on a dataset, whereas the **Expert System** was tested on an individual patient case.
- To make a fair comparison, the expert system should be tested on multiple patients and analyzed for consistency in detecting heart disease.

Key Difference:

- The **Decision Tree** generalizes from data, while the **Expert System** relies only on predefined rules.

Accuracy Comparison

```
[ ] print("Predictions saved successfully!")
    print(f"Accuracy: {accuracy:.4f}")
    print(f"Precision: {precision:.4f}")
    print(f"Recall: {recall:.4f}")
    print(f"F1 Score: {f1:.4f}")
```

```
➡ Predictions saved successfully!
   Accuracy: 0.9854
   Precision: 1.0000
   Recall: 0.9714
   F1 Score: 0.9855
```

Decision Tree Model Metrics:

- **Accuracy: 98.54%**
- **Precision: 100.00%**
- **Recall: 97.14%**
- **F1 Score: 98.55%**

Expert system model Metrics:

. **Accuracy: 49.95%**

The decision tree model outperforms the expert system by a large margin in terms of accuracy. The decision tree model is able to generalize well to unseen data, while the expert system struggles to make accurate predictions.

◆ Challenges with the Expert System:

- The rules in the expert system are **hand-crafted**, meaning **they may not cover all possible cases** in real-world data.
- The expert system **does not learn** from new patient data, whereas the Decision Tree adapts to new patterns.
- **Precision and recall cannot be directly measured** for the expert system unless it is tested on a large dataset.

Key Difference:

- The **Decision Tree is objectively better** in terms of measurable performance (**98.54% accuracy**), whereas the **Expert System lacks a quantitative evaluation method**.

Explain ability: Decision Tree vs. Expert System

Decision Tree Explain ability

- Decision Trees are **interpretable** because they mimic human decision-making using **feature-based splits**.
- The tree can show **why** a decision was made (e.g., **if cholesterol > X, then heart disease risk increases**).
- However, **deep decision trees** can become **complex and harder to interpret**.

Expert System Explain ability

- The **rules are fully human-readable**, making it **100% explainable**.
- It follows **clear medical logic** (e.g., **if blood pressure > 130, then hypertension risk**).
- However, **it may miss complex patterns** that a machine learning model can learn from data.

Key Difference:

- The **Expert System is fully explainable** but **lacks adaptability**.
- The **Decision Tree is mostly explainable** and can **automatically learn patterns from data**.

- **Decision Tree Model:** The decision tree model is the better choice if the primary goal is to achieve high accuracy and good generalization on unseen data. It is also relatively interpretable, making it a good choice for applications where both performance and explain ability are important.
- **Expert System:** The expert system is a good choice if interpretability and transparency are the most important factors, and if the accuracy requirements are not as stringent. However, in this case, the expert system's performance is significantly lower than that of the decision tree model.