# Comparison of Classification Metrics: AUC vs F1, Precision, Recall, Sensitivity, Specificity

## 1. AUC (Area Under the ROC Curve)

- What it means: Measures how well the model distinguishes between positive and negative classes overall.  
- Interpretation: Closer to 0.5 means random, closer to 1.0 means perfect classification.  
- Pros:  
 • Does not depend on classification threshold.  
 • Very useful for imbalanced datasets (when class distribution is skewed).

## 2. F1 Score

- What it means: Harmonic mean of Precision and Recall.  
 [ F1 = 2 × (Precision × Recall) / (Precision + Recall) ]  
- When to use:  
 • When you need a balance between Precision and Recall.  
 • Useful in cases like medical diagnosis where both false positives and false negatives matter.

## 3. Recall (Sensitivity)

- What it means: Measures how many actual positives were correctly identified.  
 [ Recall = TP / (TP + FN) ]  
- When important:  
 • When missing a positive case is critical (e.g., cancer detection).

## 4. Precision

- What it means: Of all instances predicted positive, how many were truly positive.  
 [ Precision = TP / (TP + FP) ]  
- When important:  
 • When false positives are costly (e.g., terrorist suspect detection).

## 5. Specificity

- What it means: Measures how many actual negatives were correctly identified.  
 [ Specificity = TN / (TN + FP) ]  
- When important:  
 • When avoiding unnecessary follow-up tests is important.

## Summary Comparison

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metric | Focus | Threshold Dependent | Handles Imbalance | Typical Use Case |
| AUC | Overall classification ability | No | Yes | Evaluating general model performance |
| F1 | Balance of Precision & Recall | Yes | Moderate | When both FP and FN matter |
| Recall | Catching all positives | Yes | Moderate | Critical case detection (e.g. cancer) |
| Precision | Avoiding false positives | Yes | Moderate | High cost for FP (e.g. spam filter) |
| Specificity | Correctly identifying negatives | Yes | Moderate | Avoid over-diagnosis |