ECE657 Tools of Intelligent Systems Design
Assignment 4 Question 2

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Question 2: Naive Bayes

Q2.1

Based on Naive Bayes theorem, we have:

$$P(PlayTennis|Weather, Temperature) = \frac{P(Weather, Temperature|PlayTennis) \cdot P(PlayTennis)}{P(Weather, Temperature)}$$

Since we are comparing the probabilities of the classes "Yes" and "No", the denominator $P(Weather, Temperature)$ is the same for both classes and can be ignored. We only need to calculate the numerator for each class and then compare them.

In the Naive Bayes, we assume conditional independence between features:

$$P(Weather, Temperature|PlayTennis) = P(Weather|PlayTennis) \cdot P(Temperature|PlayTennis)$$

The probability of play tennis and not play tennis are

$$P(PlayTennis = Yes) = \frac{5}{10}$$
$$P(PlayTennis = No) = \frac{5}{10}$$

The probability of Sunny Weather given play tennis and not play tennis are:

$$P(Sunny|PlayTennis = Yes) = \frac{1}{5}$$
$$P(Sunny|PlayTennis = No) = \frac{3}{5}$$

Similarly for Cool Temperature:

$$P(Cool|PlayTennis = Yes) = \frac{3}{5}$$

$$P(Cool|PlayTennis = No) = \frac{2}{5}$$

For $P(Yes|Sunny, Cool)$:

$$P(Yes|Sunny, Cool) = P(Sunny|Yes) \cdot P(Cool|Yes) \cdot P(Yes)$$

$$= 0.2 \cdot 0.6 \cdot 0.5$$

$$= 0.06$$

For $P(No|Sunny, Cool)$:

$$P(No|Sunny, Cool) = P(Sunny|No) \cdot P(Cool|No) \cdot P(No)$$

$$0.6 \cdot 0.4 \cdot 0.5$$

$$= 0.12$$

Since $P(PlayTennis = No|Weather = Sunny, Temperature = Cool) > P(PlayTennis = Yes|Weather = Sunny, Temperature = Cool)$, the model predicts the decision to **not play tennis** when the weather is **Sunny** and the temperature is **cool**.