ECE 108 - Assignment 9

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Question 1a

- Suspension: soft, firm
- Steering: comfort, sport
- Throttle response: eco, normal, sport
- Transmission: efficient, dynamic

How many different driving mode combinations can be created?

Solution

The new SUV can have 24 different driving mode combinations.

This is calculated by multiplying the number of options for each aspect of the driving system:

- Suspension: 2 options (soft/firm)
- Steering: 2 options (comfort/sport)
- Throttle response: 3 options (eco/normal/sport)
- Transmission: 2 options (efficient/dynamic)

Therefore: $2 \times 2 \times 3 \times 2 = 24$ total possible combinations.

Question 1b

An autonomous vehicle has 8 different types of sensors (LIDAR, radar, cameras, etc.). For reliable operation in adverse conditions, engineers determine the vehicle needs data from:

- at least 5 different sensor types in total

- of the 5 different types of sensors, at least 2 must come from the set {LIDAR, radar, ultrasonic}
- of the 5 different types of sensors, at least 1 must come from the set {infrared cameras, visible light cameras}

How many different sensor configurations satisfy these requirements?

Solution

Given:

- Total of 8 different sensor types
- Must use at least 5 different sensor types
- At least 2 must come from {LIDAR, radar, ultrasonic}
- At least 1 must come from {infrared cameras, visible light cameras}

Let's identify our sets:

- Set A = {LIDAR, radar, ultrasonic} (3 sensors)
- Set B = {infrared cameras, visible light cameras} (2 sensors)
- Set C = remaining 3 sensors

The problem asks for exactly 5 different sensor types satisfying the conditions. For set A, we need to select at least 2 sensors:

- Choose 2 from set A: $\binom{3}{2} = 3$ ways
- Choose 3 from set A: $\binom{3}{3} = 1$ way

For set B, we need to select at least 1 sensor:

- Choose 1 from set B: $\binom{2}{1} = 2$ ways
- Choose 2 from set B: $\binom{2}{2} = 1$ way

Let's count the valid combinations:
Case 1: 2 from A, 1 from B, 2 from C $\binom{3}{2} \times \binom{2}{1} \times \binom{3}{2} = 3 \times 2 \times 3 = 18$ configurations
Case 2: 2 from A, 2 from B, 1 from C $\binom{3}{2} \times \binom{2}{2} \times \binom{3}{1} = 3 \times 1 \times 3 = 9$ configurations
Case 3: 3 from A, 1 from B, 1 from C $\binom{3}{3} \times \binom{2}{1} \times \binom{3}{1} = 1 \times 2 \times 3 = 6$ configurations
Case 4: 3 from A, 2 from B, 0 from C $\binom{3}{3} \times \binom{2}{2} \times \binom{3}{0} = 1 \times 1 \times 1 = 1$ configuration
Total number of valid configurations = $18 + 9 + 6 + 1 = 34$ configurations.