BCS2313
ARTIFICIAL INTELLIGENCE
EXERCISES

SEMESTER I SESSION 2024/2025

LECTURER'S NAME	**: Ts. Dr. Nur Shazwani Kamarudin**
SECTION	**: 02**
NAME	**: Hendianto Mohammad Farid**
STUDENT ID	**: CB24153**
SUBMISSION	**: 02 December 2024**

<u>CASE BASED REASONING EXERCISE</u>

The Transportation Security Administration (TSA) began adding facial recognition technology to the security process at the airport across United States. Airport facial recognition aims to help the TSA more accurately identify known threats and prevent them from entering secure areas while making it easier for passengers to get through security efficiently. Their primary goal for this technology is to streamline the screening process of passengers. The idea is that by using facial recognition, they can focus on people who have higher threats scores rather than wasting time checking all passengers' details. **Table 1** shows data stored in one of Los Angeles Airport's databases for the passenger recognition specifically focusing on details of each passengers using the biometric data. This database contains details of passengers that were detected to be a threat or not. Predict the passenger's treat status (Table 2) and rounded your answer to **FOUR (4)** decimal places:

Table 1

Passenger details	Age	International Travelling Frequency (annually)	Income (annually)	Treat Status
Passenger 1	42	3	230000	No
Passenger 2	25	7	55000	Yes
Passenger 3	50	13	250000	No
Passenger 4	30	22	82000	No

Table 2

Passenger Details	**Passenger 5**
Age	45
International Travelling Frequency (annually)	11
Income (annually)	150000
Threat status	?

Answer:

1) First Cycle – **Retrieve**

In the first step of the Case-Based Reasoning (CBR) cycle, we need to retrieve cases from the case base that are similar to the current problem. The problem at hand involves predicting the threat status of Passenger 5 (Table 2) based on their attributes, age, International Travelling Frequency (annually), Income (annually), and threat status.

Table 2

Passenger Details	**Passenger 5**
Age	45
International Travelling Frequency (annually)	11
Income (annually)	150000
Threat status	?

We will retrieve all existing cases from the database that have the same set of attributes to use for comparison. The retrieved cases are:

Table 1: Retrieved Cases

Passenger details	Age	International Travelling Frequency (annually)	Income (annually)	Treat Status
Passenger 1	42	3	230000	No
Passenger 2	25	7	55000	Yes
Passenger 3	50	13	250000	No
Passenger 4	30	22	82000	No

These cases will serve as the basis for comparison to determine the most similar case to Passenger 5. By analyzing the similarities and differences in attributes such as age, travel frequency, and income, we can predict the threat status for Passenger 5.

2) Second Cycle – **Reuse**

In the second step of the Case-Based Reasoning (CBR) cycle, we aim to find the most similar case(s) from our case base to the new problem (Passenger 5) to predict the threat status. This involves several steps:

a) Finding the Maximum and Minimum Values for Each Attribute

First, we need to identify the maximum and minimum values for each attribute across all cases, including the new problem. This will be used to normalize the differences between attribute values.

Passenger details	Age	International Travelling Frequency (annually)	Income (annually)	Treat Status
Passenger 1	42	**3**	230000	No
Passenger 2	**25**	7	55000	Yes
Passenger 3	**50**	13	250000	No
Passenger 4	30	**22**	82000	No

b) Calculating the Local Similarity (LS) for Each Attribute

We use the following formula to calculate the local similarity between the problem and each case for every attribute:

$$LS = 1 - \frac{|a - b|}{Max - Min}$$

a = Value of the attribute in the problem (Passenger 5)

b = Value of the attribute in the case from the case base

Max = Maximum value of the attribute

Min = Minimum value of the attribute

Determining Attribute Weights

Based on the context, the International Travelling Frequency is crucial for assessing threat levels. Therefore, we assign it a weight twice that of the other attributes:

Weight of Age (w_1): 1

Weight of International Travelling Frequency (w_2): 2

Weight of Income (w_3): 1

The sum of the weights is:

$$\sum weights = w_1 + w_2 + w_3 = 1 + 2 + 1 = 4$$

Calculations for Each Case

Passenger 1

$$LS(Passenger_1, Age_1) = 1 - \frac{|45 - 42|}{50 - 25} = 1 - \frac{3}{25} = 0.8800$$

$$LS(Passenger_1, ITF_1) = 1 - \frac{|11 - 3|}{22 - 3} = 1 - \frac{8}{19} = \sim 0.5789$$

$$LS(Passenger_1, Income_1) = 1 - \frac{|150000 - 230000|}{250000 - 55000} = \frac{80000}{195000} = \sim 0.5897$$

$$GS_1(Passenger_1) = \frac{1}{Total\ Weights} \times (w_1 LS_1 + w_2 LS_2 + w_3 LS_3)$$

$$GS_1(Passenger_1) = \frac{1}{4} \times \big(1(0.8800) + 2(0.5789) + 1(0.5897)\big)$$

$$GS_1(Passenger_1) = \frac{1}{4} \times 2.6275$$

$$GS_1(Passenger_1) = 0.656875 = \sim \mathbf{0.6569}$$

Passenger 2

$$LS(Passenger_2, Age_2) = 1 - \frac{|45 - 25|}{25} = 1 - \frac{20}{25} = 0.2000$$

$$LS(Passenger_2, ITF_2) = 1 - \frac{|11 - 7|}{19} = 1 - \frac{4}{19} = 0.7895$$

$$LS(Passenger_2, Income_2) = 1 - \frac{|150000 - 55000|}{195000} = \frac{95000}{195000} = 0.5128$$

$$GS_2(Passenger_2) = \frac{1}{4}\big(1(0.2000) + 2(0.7895) + 1(0.5128)\big)$$

$$GS_2(Passenger_2) = \frac{1}{4}(0.2000 + 1.5790 + 0.5128)$$

$$GS_2(Passenger_2) = \frac{1}{4} \times 2.2918$$

$$GS_2(Passenger_2) = 0.57295 = \sim \mathbf{0.5729}$$

Passenger 3

$$LS(Passenger_3, Age_3) = 1 - \frac{|45 - 50|}{25} = 1 - \frac{5}{25} = 0.8000$$

$$LS(Passenger_3, ITF_3) = 1 - \frac{|11 - 13|}{19} = 1 - \frac{2}{19} = \sim\mathbf{0.8947}$$

$$LS(Passenger_3, Income_3) = 1 - \frac{|150000 - 250000|}{195000} = \frac{100000}{195000} = \sim 0.4872$$

$$GS_3(Passenger_3) = \frac{1}{4}\big(1(0.8000) + 2(0.8947) + 1(0.4872)\big)$$
$$GS_3(Passenger_3) = \frac{1}{4}(0.8000 + 1.7894 + 0.4872)$$
$$GS_3(Passenger_3) = \frac{1}{4}(3.0766)$$
$$GS_3(Passenger_3) = 0.76915 = \sim\mathbf{0.7692}$$

Passenger 4

$$LS(Passenger_4, Age_4) = 1 - \frac{|45 - 30|}{25} = 1 - \frac{15}{25} = 0.4000$$
$$LS(Passenger_4, ITF_4) = 1 - \frac{|11 - 22|}{19} = 1 - \frac{11}{19} = \sim 0.4211$$

$$LS(Passenger_4, Income_4) = 1 - \frac{|150000 - 82000|}{195000} = \frac{68000}{195000} = \sim 0.6513$$

$$GS_4(Passenger_4) = \frac{1}{4}\big(1(0.4000) + 2(0.4211) + 1(0.6513)\big)$$
$$GS_4(Passenger_4) = \frac{1}{4}(0.4000 + 0.8422 + 0.6513)$$
$$GS_4(Passenger_4) = \frac{1}{4}(1.8935)$$
$$GS_4(Passenger_4) = 0.473375 = \sim\mathbf{0.4734}$$

c) Comparing Global Similarity Scores

Now, we compare the Global Similarity (GS) scores of all cases:

Passenger details	Age	International Travelling Frequency (annually)	Income (annually)	Treat Status	GS
Passenger 1	42	3	230000	No	0.6569
Passenger 2	25	7	55000	Yes	0.5729

Passenger 3	50	13	250000	No	0.7692
Passenger 4	30	22	82000	No	0.4734

Passenger 3 has the highest Global Similarity score of 0.7692, indicating it is the most similar case to Passenger 5.

d) Predicting the Threat Status for Passenger 5

Passenger details	Age	International Travelling Frequency (annually)	Income (annually)	Treat Status
Passenger 5	**45**	**11**	**150000**	**No**

Since Passenger 3 is the most similar case and has a Threat Status of "No", we predict that Passenger 5 also has a Threat Status of "No".

3) Third Cycle – **Revise**

In this step, we assess whether the predicted solution—Passenger 5's threat status being "No"—is appropriate or requires any adjustments. Given that Passenger 5's attributes closely align with those of Passenger 3, who is not considered a threat, and considering there are only two possible threat statuses ("Yes" or "No"), the prediction seems accurate. Therefore, no revisions are necessary, and we accept the solution as is.

4) Fourth Cycle – **Retain**

Finally, we incorporate Passenger 5's case, along with the predicted threat status of "No," into the case base. By adding this new case to our database, we enhance the system's knowledge for future assessments. This updated case base will enable more accurate and efficient predictions when evaluating passengers with similar attributes in the future.

Table 1 with added new case.

Passenger details	Age	International Travelling	Income (annually)	Treat Status

		Frequency (annually)		
Passenger 1	42	3	230000	No
Passenger 2	25	7	55000	Yes
Passenger 3	50	13	250000	No
Passenger 4	30	22	82000	No
Passenger 5	**45**	**11**	**150000**	**No**

Conclusion:

The introduction of facial recognition technology by the Transportation Security Administration (TSA) aims to enhance security and streamline the screening process at airports. Using Case-Based Reasoning (CBR), we predicted the threat status of Passenger 5 based on their attributes: age, international traveling frequency, and annual income. The CBR process involved retrieving similar cases, reusing the knowledge from these cases, revising the solution, and retaining the case in the database for future use. Our analysis identified Passenger 3, who shares the highest similarity with Passenger 5, as the most relevant case. With **Passenger 3's threat status marked as "No,"** we **predicted that Passenger 5 also poses no threat**.