1. Problem Statement

Some UTS students are from Asia, particularly Southeast Asia. Southeast Asia, often known as SEA, is Australia's neighbouring region that has worked together to prosper in times of difficulty (Morrison MP, 2021).

Southeast Asia is made up of 11 distinct nations and 674 million people. It is made up of the following countries: Indonesia, the Philippines, Vietnam, Thailand, Myanmar, Malaysia, Cambodia, Laos, Singapore, East Timor, and Brunei. Each country has its unique language. There are several reasons to visit Southeast Asia, including gastronomy, friendliness, and inexpensive cost (Shvili, 2021).

In this example, I will create a searching AI technique to travel around Southeast Asia. These below are the coordinate of Southeast Asia countries. This example is different from before, whereas the last searching they have a specific path from a country to another country, on this problem we assume that flight path will be available from any country to any country.

Country	Coordinate (x)	Coordinate (y)
Cambodia	12.57	104.99
Laos	19.86	102.50
Myanmar	21.91	95.96
Thailand	15.87	100.99
Vietnam	14.06	108.28
Brunei	4.54	114.73
Philippines	12.88	121.77
Indonesia	-0.79	113.92
Malaysia	4.21	101.98
Singapore	1.35	103.82
Timor-Leste	-8.87	125.73

*Coordinate may be inaccurate due to having multiple international airports and the huge size of a country.
*This coordinate is not created by me; Check the reference to find the sources

2. Selection of AI technique

To solve this problem, we ma Hill Climbing or Simulated Annealing to get the solution. To decide which algorithms are better to be used, we will need to check the minimum cost to travel around the SEA.

To decide optimal-cost search to solve this problem, I decide to test them. There will be five times test proceed on this selection process. On each test, I will randomly generate a country as the start country. Each algorithm must be tested in the same situation. Selection prove will be provided in the screenshot section along with test cases detail.

Number of Tests	From
First Test	TimorLeste
Second Test	Thailand
Third Test	Myanmar
Fourth Test	Indonesia
Fifth Test	Laos

In this test scenario, we can see that the agent will try to visit all cities at least once and provide the lowest-cost path in return. In this first test scenario, we can see Hill Climbing have a more efficient path than Simulated Annealing. The next test has a similar result. On the third test case, Simulated Annealing won over Hill Climbing by 1 point. Then in the fourth case, both of the algorithms show similar path costs. Lastly, Simulated Annealing can show better performance than Hill Climbing on this test scenario.

	Start City	Simulated Annealing (SA)	Hill Climbing (HC)
1st Test	TimorLeste	107.52942687742376	106.77150983530385
2nd Test	Thailand	107.52942687742376	107.89167793207004
3rd Test	Myanmar	106.77150983530385	107.89167793207004
4th Test	Indonesia	108.4112291363032	108.7734801909495
5th Test	Laos	107.52942687742376	108.4112291363032
Total		**537.771019603875**	**539.739575026695**
Average		**107.55**	**107.95**

On the total cost, Simulated Annealing has a total of 537.77 while Hill Climbing got 539.74 overall test cases. This shows that Simulated Annealing has better performance regarding this problem. Simulated Annealing has an average of 107.55, and Hill Climbing has a 107.95 minimum cost path to travel over all test cases.

3. Explanation of AI technique

a. Simulated Annealing

The Simulated Annealing Algorithm is the most preferred method used for optimization problems. This algorithm does not use any information gathered during the search—this algorithm is inspired by the physical annealing process of a metal (Yaghini, 2010).

The algorithm is basically implementing the technique of hill-climbing. However, most hill-climbing algorithms face a local maximum problem. The local maximum state is a state where both neighbours of the current state are worse.

Simulated Annealing uses a certain probability to move from local maximum into 'another neighbour'. In this case, 'another neighbour' could be worse than the local maximum. This will allow the agent to break free from the local maximum and find the global maximum point.

The main variable that modifies the algorithm is the temperature based on the real annealing process. The probability will be based on Loss and Temperature. Loss is a measure of neighbour state compared to the current state. The temperature will need to go down slowly to get a better result (Schirtzinger, 2018).

4. Solution Result

This AI technique could be used to find the shortest travel path in Southeast Asia in the assumption that aeroplanes can move to any international airport in SEA. In a certain circumstance, this agent may show a different path for each run due to mathematical distance calculation between each coordinate. Using a simulated Annealing algorithm, this agent will allow users to get the shortest travel path to travel across SEA.

5. References

Cohen, E. (2017). *Counties geographic coordinates*. Kaggle: Your Machine Learning and Data Science Community. https://www.kaggle.com/eidanch/counties-geographic-coordinates?select=countries.csv

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Shvili, J. (2021, April 11). *Southeast Asian countries*. WorldAtlas. https://www.worldatlas.com/articles/which-countries-are-considered-to-be-southeast-asia.html

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6. Screenshot

a. Simulated Annealing

Test 01 (Start Country: Timor-Leste)

```
In [12]: print(solution,cost)
['TimorLeste', 'Philippines', 'Vietnam', 'Cambodia', 'Laos', 'Myanmar', 'Thailand', 'Malaysia', 'Singapore', 'Brunei', 'Indones
ia', 'TimorLeste'] 107.52942687742376
```

Test 02 (Start Country: Thailand)

```
In [12]: print(solution,cost)
['Thailand', 'Myanmar', 'Laos', 'Cambodia', 'Vietnam', 'Philippines', 'TimorLeste', 'Indonesia', 'Brunei', 'Singapore', 'Malays
ia', 'Thailand'] 107.52942687742376
```

Test 03 (Start Country: Myanmar)

```
In [12]: print(solution,cost)
['Myanmar', 'Thailand', 'Cambodia', 'Malaysia', 'Singapore', 'Brunei', 'Indonesia', 'TimorLeste', 'Philippines', 'Vietnam', 'La
os', 'Myanmar'] 106.77150983530385
```

Test 04 (Start Country: Indonesia)

```
In [12]: print(solution,cost)
['Indonesia', 'TimorLeste', 'Philippines', 'Vietnam', 'Cambodia', 'Thailand', 'Laos', 'Myanmar', 'Malaysia', 'Singapore', 'Brun
ei', 'Indonesia'] 108.4112291363032
```

Test 05 (Start Country: Laos)

```
In [12]: print(solution,cost)
['Laos', 'Myanmar', 'Thailand', 'Malaysia', 'Singapore', 'Brunei', 'Indonesia', 'TimorLeste', 'Philippines', 'Vietnam', 'Cambod
ia', 'Laos'] 107.52942687742376
```

b. Hill Climbing

Test 01 (Start Country: Timor-Leste)

```
In [11]: print(solution,cost)
['TimorLeste', 'Philippines', 'Vietnam', 'Laos', 'Myanmar', 'Thailand', 'Cambodia', 'Malaysia', 'Singapore', 'Brunei', 'Indones
ia', 'TimorLeste'] 106.77150983530385
```

Test 02 (Start Country: Thailand)

```
In [11]: print(solution,cost)
['Thailand', 'Myanmar', 'Laos', 'Cambodia', 'Vietnam', 'Philippines', 'Brunei', 'TimorLeste', 'Indonesia', 'Singapore', 'Malays
ia', 'Thailand'] 107.89167793207004
```

Test 03 (Start Country: Myanmar)

```
In [11]: print(solution,cost)
['Myanmar', 'Laos', 'Cambodia', 'Vietnam', 'Philippines', 'Brunei', 'TimorLeste', 'Indonesia', 'Singapore', 'Malaysia', 'Thaila
nd', 'Myanmar'] 107.89167793207004
```

Test 04 (Start Country: Indonesia)

```
In [11]: print(solution,cost)
['Indonesia', 'Singapore', 'Malaysia', 'Myanmar', 'Laos', 'Thailand', 'Cambodia', 'Vietnam', 'Philippines', 'Brunei', 'TimorLes
te', 'Indonesia'] 108.7734801909495
```

Test 05 (Start Country: Laos)

```
In [11]: print(solution,cost)
['Laos', 'Thailand', 'Cambodia', 'Vietnam', 'Philippines', 'TimorLeste', 'Indonesia', 'Brunei', 'Singapore', 'Malaysia', 'Myanm
ar', 'Laos'] 108.4112291363032
```