- **Initialization**
    - Initialise a set of ants at a random city
    - Initialise pheromone levels to 1
- **Ant Movement**
    - Each ant selects the next city to visit based on a probabilistic rule. This rule considers both the amount of pheromone and the distance to the next city. Ants tends to prefer paths with higher pheromone levels and shorter distances/
    - Ants continue visiting cities until they have visited all cities exactly once.
- **Pheromone Update**
    - After all ants have completed their tours pheromones levels are updated. Best path deposits pheromone on the edges they traverse.
    - Pheromone evaporates over time.
- **Termination**
    - Repeat steps 2 and 3 for a fixed number of iterations or until a termination condition is met (Number of iterations end).
- **Solution Construction**
    - After a certain number of iterations, the algorithm selects the best solution found.

- **For the set of 10 cities**
    - **For 1 ant**

```
[[0.    0.    0.037 1.874 0.    0.    0.    0.    1.759 0.206]
 [0.    0.    0.946 0.    0.    0.    0.    0.117 1.934 0.   ]
 [0.037 0.946 0.    0.    1.968 0.    0.    0.    0.002 0.   ]
 [1.874 0.    0.    0.    0.    0.125 0.001 2.    0.    0.   ]
 [0.    0.    1.968 0.    0.    1.375 0.032 0.    0.    0.   ]
 [0.    0.    0.    0.125 1.375 0.    0.002 0.    0.235 1.501]
 [0.    0.    0.    0.001 0.032 0.002 0.    1.883 0.063 1.937]
 [0.    0.117 0.    2.    0.    0.    1.883 0.    0.    0.   ]
 [1.759 1.934 0.002 0.    0.    0.235 0.063 0.    0.    0.004]
 [0.206 0.    0.    0.    0.    1.501 1.937 0.    0.004 0.   ]]
[1, 7, 3, 0, 9, 6, 5, 4, 2, 8, 1]

[[0.    0.    0.    2.    0.    0.    0.    0.    0.246 0.   ]
 [0.    0.    1.897 0.    0.    0.    0.    0.    2.    0.   ]
 [0.    1.897 0.    0.    1.875 0.    0.    0.    0.    0.   ]
 [2.    0.    0.    0.    0.    0.    0.    2.    0.    0.   ]
 [0.    0.    1.875 0.    0.    1.999 0.    0.    0.    0.   ]
 [0.    0.    0.    0.    1.999 0.    0.    0.    0.    1.984]
 [0.    0.    0.    0.    0.    0.    0.    1.998 0.    2.   ]
 [0.    0.    0.    2.    0.    0.    1.998 0.    0.    0.   ]
 [0.246 2.    0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.984 2.    0.    0.    0.   ]]
[1, 7, 3, 0, 9, 6, 5, 4, 2, 8, 1]

[[0.    0.    0.    2.    0.    0.    0.    0.    0.481 0.   ]
 [0.    0.    1.875 0.    0.    0.    0.    0.    2.    0.   ]
 [0.    1.875 0.    0.    2.    0.    0.    0.    0.    0.   ]
 [2.    0.    0.    0.    0.    0.    0.    2.    0.    0.   ]
 [0.    0.    2.    0.    0.    1.906 0.    0.    0.    0.   ]
 [0.    0.    0.    0.    1.906 0.    0.    0.    0.    2.   ]
 [0.    0.    0.    0.    0.    0.    0.    1.738 0.    2.   ]
 [0.    0.    0.    2.    0.    0.    1.738 0.    0.    0.   ]
 [0.481 2.    0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    2.    2.    0.    0.    0.   ]]
[1, 7, 3, 0, 9, 6, 5, 4, 2, 8, 1]

[[0.    0.    0.    2.    0.    0.    0.    0.    1.999 0.   ]
 [0.    0.    1.125 0.    0.    0.    0.    0.    2.    0.   ]
 [0.    1.125 0.    0.    1.996 0.    0.    0.    0.    0.   ]
 [2.    0.    0.    0.    0.    0.    0.    2.    0.    0.   ]
 [0.    0.    1.996 0.    0.    1.906 0.    0.    0.    0.   ]
 [0.    0.    0.    0.    1.906 0.    0.    0.    0.    2.   ]
 [0.    0.    0.    0.    0.    0.    0.    0.974 0.    2.   ]
 [0.    0.    0.    2.    0.    0.    0.974 0.    0.    0.   ]
 [1.999 2.    0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    2.    2.    0.    0.    0.   ]]
[1, 7, 3, 0, 9, 6, 5, 4, 2, 8, 1]
```

- **For 5 ants**

```
[[0.    0.    1.698 1.691 0.    0.    0.    0.    0.    0.01 ]
 [0.    0.    0.    1.697 0.001 0.001 0.    1.699 0.    0.   ]
 [1.698 0.    0.    0.    0.    0.    0.284 0.    0.    0.   ]
 [1.691 1.697 0.    0.    0.    0.    0.008 0.    0.    0.   ]
 [0.    0.001 0.    0.    0.    1.431 0.    1.688 0.    0.   ]
 [0.    0.001 0.    0.    1.431 0.    0.    0.    1.699 0.   ]
 [0.    0.    0.284 0.008 0.    0.    0.    0.001 0.    1.689]
 [0.    1.699 0.    0.    1.688 0.    0.001 0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.699 0.    0.    0.    1.699]
 [0.01  0.    0.    0.    0.    0.    1.689 0.    1.699 0.   ]]
[7, 1, 3, 0, 2, 6, 9, 8, 5, 4, 7]
```

ggle output scrolling

```
[[0.    0.    1.885 1.885 0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    1.432 0.    0.    0.    1.885 0.    0.   ]
 [1.885 0.    0.    0.    0.    0.    0.861 0.    0.    0.   ]
 [1.885 1.432 0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.593 0.    1.885 0.    0.   ]
 [0.    0.    0.    0.    1.593 0.    0.    0.    1.885 0.   ]
 [0.    0.    0.861 0.    0.    0.    0.    0.    0.    1.769]
 [0.    1.885 0.    0.    1.885 0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.885 0.    0.    0.    1.885]
 [0.    0.    0.    0.    0.    0.    1.769 0.    1.885 0.   ]]
[7, 1, 3, 0, 2, 6, 9, 8, 5, 4, 7]

[[0.    0.    1.815 1.815 0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    1.813 0.    0.    0.    1.815 0.    0.   ]
 [1.815 0.    0.    0.    0.    0.    0.752 0.    0.    0.   ]
 [1.815 1.813 0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.065 0.    1.815 0.    0.   ]
 [0.    0.    0.    0.    1.065 0.    0.    0.    1.815 0.   ]
 [0.    0.    0.752 0.    0.    0.    0.    0.    0.    1.815]
 [0.    1.815 0.    0.    1.815 0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.815 0.    0.    0.    1.815]
 [0.    0.    0.    0.    0.    0.    1.815 0.    1.815 0.   ]]
[7, 1, 3, 0, 2, 6, 9, 8, 5, 4, 7]

[[0.    0.    1.808 1.808 0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    1.803 0.    0.    0.    1.808 0.    0.   ]
 [1.808 0.    0.    0.    0.    0.    0.959 0.    0.    0.   ]
 [1.808 1.803 0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.854 0.    1.808 0.    0.   ]
 [0.    0.    0.    0.    0.854 0.    0.    0.    1.808 0.   ]
 [0.    0.    0.959 0.    0.    0.    0.    0.    0.    1.808]
 [0.    1.808 0.    0.    1.808 0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.808 0.    0.    0.    1.808]
 [0.    0.    0.    0.    0.    0.    1.808 0.    1.808 0.   ]]
[7, 1, 3, 0, 2, 6, 9, 8, 5, 4, 7]
```

-
- **For 10 ants**

```
[[0.    0.    0.    0.    1.465 0.    0.    0.    0.    1.465]
 [0.    0.    1.465 0.    0.    0.    0.    1.434 0.    0.   ]
 [0.    1.465 0.    0.    0.    0.    0.    0.    1.465 0.   ]
 [0.    0.    0.    0.    0.    0.003 0.    1.414 0.    1.465]
 [1.465 0.    0.    0.    0.    0.001 0.    0.    0.049 0.   ]
 [0.    0.    0.    0.003 0.001 0.    1.463 0.083 0.    0.   ]
 [0.    0.    0.    0.    0.    1.463 0.    0.    1.416 0.   ]
 [0.    1.434 0.    1.414 0.    0.083 0.    0.    0.    0.   ]
 [0.    0.    1.465 0.    0.049 0.    1.416 0.    0.    0.   ]
 [1.465 0.    0.    1.465 0.    0.    0.    0.    0.    0.   ]]
[2, 8, 6, 5, 7, 3, 9, 0, 4, 1, 2]

[[0.    0.    0.    0.    1.472 0.    0.    0.    0.    1.472]
 [0.    0.    1.472 0.    0.    0.    0.    1.472 0.    0.   ]
 [0.    1.472 0.    0.    0.    0.    0.    0.    1.472 0.   ]
 [0.    0.    0.    0.    0.    0.    0.    1.472 0.    1.472]
 [1.472 0.    0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    1.472 0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.472 0.    0.    1.472 0.   ]
 [0.    1.472 0.    1.472 0.    0.    0.    0.    0.    0.   ]
 [0.    0.    1.472 0.    0.    0.    1.472 0.    0.    0.   ]
 [1.472 0.    0.    1.472 0.    0.    0.    0.    0.    0.   ]]
[2, 8, 6, 5, 7, 3, 9, 0, 4, 1, 2]

[[0.    0.    0.    0.    1.319 0.    0.    0.    0.    1.319]
 [0.    0.    1.319 0.    0.    0.    0.    1.319 0.    0.   ]
 [0.    1.319 0.    0.    0.    0.    0.    0.    1.319 0.   ]
 [0.    0.    0.    0.    0.    0.    0.    1.316 0.    1.319]
 [1.319 0.    0.    0.    0.    0.    0.    0.    0.003 0.   ]
 [0.    0.    0.    0.    0.    0.    1.319 0.003 0.    0.   ]
 [0.    0.    0.    0.    0.    1.319 0.    0.    1.316 0.   ]
 [0.    1.319 0.    1.316 0.    0.003 0.    0.    0.    0.   ]
 [0.    0.    1.319 0.    0.003 0.    1.316 0.    0.    0.   ]
 [1.319 0.    0.    1.319 0.    0.    0.    0.    0.    0.   ]]
[2, 8, 6, 5, 7, 3, 9, 0, 4, 1, 2]

[[0.    0.    0.    0.    1.406 0.    0.    0.    0.    1.406]
 [0.    0.    1.406 0.    0.    0.    0.    1.406 0.    0.   ]
 [0.    1.406 0.    0.    0.    0.    0.    0.    1.406 0.   ]
 [0.    0.    0.    0.    0.    0.    0.    1.406 0.    1.406]
 [1.406 0.    0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    1.406 0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.406 0.    0.    1.406 0.   ]
 [0.    1.406 0.    1.406 0.    0.    0.    0.    0.    0.   ]
 [0.    0.    1.406 0.    0.    0.    1.406 0.    0.    0.   ]
 [1.406 0.    0.    1.406 0.    0.    0.    0.    0.    0.   ]]
[2, 8, 6, 5, 7, 3, 9, 0, 4, 1, 2]
```

-
- **For 20 ants**

```
[[0.    0.008 0.    1.101 0.    0.    0.    0.    0.    0.002]
 [0.008 0.    0.    0.    0.    1.104 0.    0.    0.    1.095]
 [0.    0.    0.    1.104 1.104 0.    0.    0.    0.    0.   ]
 [1.101 0.    1.104 0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    1.104 0.    0.    0.    0.    1.104 0.    0.   ]
 [0.    1.104 0.    0.    0.    0.    0.002 0.    0.    0.008]
 [0.    0.    0.    0.    0.    0.002 0.    1.102 1.099 0.   ]
 [0.    0.    0.    0.    1.104 0.    1.102 0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    1.099 0.    0.    1.104]
 [0.002 1.095 0.    0.    0.    0.008 0.    0.    1.104 0.   ]]
[3, 2, 4, 7, 6, 8, 9, 5, 1, 0, 3]

[[0.    0.    0.    1.202 0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.202 0.    0.    0.    1.202]
 [0.    0.    0.    1.202 1.202 0.    0.    0.    0.    0.   ]
 [1.202 0.    1.202 0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    1.202 0.    0.    0.    0.    1.202 0.    0.   ]
 [0.    1.202 0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    0.    1.202 1.202 0.   ]
 [0.    0.    0.    0.    1.202 0.    1.202 0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    1.202 0.    0.    1.202]
 [0.    1.202 0.    0.    0.    0.    0.    0.    1.202 0.   ]]
[3, 2, 4, 7, 6, 8, 9, 5, 1, 0, 3]

[[0.    0.    0.    1.191 0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.191 0.    0.    0.    1.191]
 [0.    0.    0.    1.191 1.191 0.    0.    0.    0.    0.   ]
 [1.191 0.    1.191 0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    1.191 0.    0.    0.    0.    1.191 0.    0.   ]
 [0.    1.191 0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    0.    1.191 1.191 0.   ]
 [0.    0.    0.    0.    1.191 0.    1.191 0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    1.191 0.    0.    1.191]
 [0.    1.191 0.    0.    0.    0.    0.    0.    1.191 0.   ]]
[3, 2, 4, 7, 6, 8, 9, 5, 1, 0, 3]

[[0.    0.    0.    1.255 0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    1.255 0.    0.    0.    1.255]
 [0.    0.    0.    1.255 1.255 0.    0.    0.    0.    0.   ]
 [1.255 0.    1.255 0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    1.255 0.    0.    0.    0.    1.255 0.    0.   ]
 [0.    1.255 0.    0.    0.    0.    0.    0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    0.    1.255 1.255 0.   ]
 [0.    0.    0.    0.    1.255 0.    1.255 0.    0.    0.   ]
 [0.    0.    0.    0.    0.    0.    1.255 0.    0.    1.255]
 [0.    1.255 0.    0.    0.    0.    0.    0.    1.255 0.   ]]
[3, 2, 4, 7, 6, 8, 9, 5, 1, 0, 3]
```

- **For 10 cities:**

    - **With only 1 ant agent, the exploration of the search space is limited, resulting in relatively similar pheromone levels on all edges.**
    - **As the number of ant agents increases more paths are explores, leading to faster convergence towards better solutions.**
    - **The optimal solution should gradually emerge as more iterations are performed and more pheromones are deposited on shorted paths**
- **For 20 cities**
    - **Similar observations apply as for the 10 cities case, but with a larger search space.**
    - **With 20 cities, there are more possible paths to explore, making the convergence slower.**
    - **The optimal solution might take longer to converge due to the increased complexity of the problem**

- **In both cases, increasing the number of ants agents leads to faster exploration of the search space and convergence towards better solutions**
- **However, with a large number of cities (20 cities), the convergence might be slower due to the increased complexity**