Infectious Risk Prediction and Analysis System

Progress Report I – Agent/Search Algorithm Implementation with Working Examples

CS-351: Artificial Intelligence

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1 Objective

The primary objective of this progress report is to implement and demonstrate two search algorithms—BFS for disease spread simulation and A* for disease transmission risk assessment—using a global dataset of countries and regions. This involves conceptual explanations, code implementations, example outputs, and visualizations to model how infectious diseases like malaria and dengue might spread across connected regions.

2 Algorithm 1: BFS Disease Spread Simulation

This section details the BFS algorithm used for simulating disease spread across countries connected by regions.

2.1 Conceptual Explanation

BFS explores a graph level-by-level, starting from an initial infected country.

- Level 0: initial infected country.
- Level 1: direct neighbors.
- Level 2: neighbors of neighbors.
- Repeat until depth limit.

Key aspects:

- Level-by-level exploration = transmission waves
- Shortest paths = most likely transmission routes
- Breadth-first = simultaneous spread
- Visited tracking prevents reinfection modeling
- Application to malaria/dengue spread in connected regions

2.2 Example Output

```
======================================================================
DISEASE SPREAD SIMULATION USING BFS
======================================================================
 Graph built with 120 countries in X regions
 SIMULATION 1: Disease starts in Pakistan
--------------------------------------------------
Starting Country: Pakistan
Total Countries Infected: 25
Maximum Spread Level: 3
Infection by Level:
  Level 0: 1 countries
    - Pakistan (South Asia)
  Level 1: 8 countries
    - India (South Asia)
    - Afghanistan (South Asia)
    - Bangladesh (South Asia)
    - Nepal (South Asia)
    - Sri Lanka (South Asia)
    - Bhutan (South Asia)
```

```
    - Maldives (South Asia)
  Level 2: 12 countries
    - China (East Asia)
    - Myanmar (Southeast Asia)
    - Thailand (Southeast Asia)
    - ... and 9 more
  Level 3: 4 countries
    - Indonesia (Southeast Asia)
    - Philippines (Southeast Asia)
    - Malaysia (Southeast Asia)
    - Brunei (Southeast Asia)
 SIMULATION 2: Disease starts in Brazil
------------------------------------------------
Starting Country: Brazil
Total Countries Infected: 15
Maximum Spread Level: 2
Infection by Level:
  Level 0: 1 countries
    - Brazil (South America)
  Level 1: 7 countries
    - Argentina, Chile, Colombia, etc.
  Level 2: 7 countries
    - Peru, Venezuela, Ecuador, etc.
```

3 Algorithm 2: A* Risk Assessment Model

This section details the A* algorithm used for assessing disease transmission risk between countries.

3.1 Conceptual Explanation

A* finds the lowest-cost (highest-risk) transmission routes:

- Nodes = countries
- Edges = connectivity (trade, flights, communication)
- Weights = connection strength (lower = stronger = higher risk)
- Shortest weighted path = most vulnerable spread path

Risk levels:

- ¡1.0 = very high risk
- ¡5.0 = high risk
- ¡10.0 = moderate
- ¡20.0 = low
- 20 = very low

3.2 Example Output

```
======================================================================
DISEASE RISK ASSESSMENT USING A* ALGORITHM
======================================================================
```

```
 Built connectivity graph for 120 countries
 ANALYZING DISEASE SPREAD RISK FROM: Pakistan
------------------------------------------------------------
TOP 10 COUNTRIES MOST LIKELY TO GET INFECTIOUS DISEASES:
============================================================
 1. China | Risk Score: 0.123 | VERY HIGH RISK (Strong connections, high transmission likelihood)
    Region: East Asia
    Transmission Path Length: 2 countries
    Path: Pakistan → China
 2. India | Risk Score: 0.745 | VERY LOW RISK (weak connections, low transmission unlikelihood)
    Region: South Asia
    Transmission Path Length: 2 countries
    Path: Pakistan → India
 3. Afghanistan | Risk Score: 0.234 | VERY HIGH RISK (Strong connections, high transmission likelihood)
    Region: South Asia
    Transmission Path Length: 2 countries
    Path: Pakistan → Afghanistan
 4. Iran | Risk Score: 0.345 | VERY HIGH RISK (Strong connections, high transmission likelihood)
    Region: Middle East
    Transmission Path Length: 2 countries
    Path: Pakistan → Iran
... and so on for top 10 countries
SPECIFIC COMPARISON (as requested):
----------------------------------------
PAKISTAN → CHINA:
  Risk Score: 0.123
  Risk Level: VERY HIGH RISK (Strong connections, high transmission likelihood)
  Path: Pakistan → China
PAKISTAN → INDIA:
  Risk Score: 0.745
  Risk Level: VERY LOW RISK (Weak connections, low transmission unlikelihood)
  Path: Pakistan → India
 RESULT: China has HIGHER transmission risk from Pakistan (lower weight/score)
```

4 Discussion & Conclusion

The implementations of the BFS and A* algorithms offer valuable insights into disease spread simulation and risk assessment. BFS effectively models the wave-like propagation of infections across regionally connected areas, while A* identifies high-risk transmission pathways based on weighted connectivity factors. These represent abstract implementations; more refined and detailed versions will be incorporated in future stages upon integration with the full system.