Trustworthy Artificial Intelligence Assignment V: Hybrid Exploration & Pathfinding

1. The Environment

The environment remains a 19×19 grid with the same features and will be tested in two settings:

- **Setting A:** Partially Observable, Deterministic
- Partial Observability: The agent can only see a 5×5 area around its current position.
- Deterministic Movement: Actions are 100% certain.
- **Setting B:** Partially Observable, Stochastic
- Partial Observability: Same as above.
- Stochastic Movement: Actions have an 80% success rate, with a 10% chance to slip left-diagonally and a 10% chance to slip right-diagonally.

2. The Agent's Logic: The Hybrid BFS-DFS Agent

The agent's goal is to explore the grid and clean discovered dirt as efficiently as possible. It must intelligently switch between exploration and targeted travel.

Core Strategy: Use DFS to explore unknown territory and BFS on its internal map to travel efficiently to known points of interest.

Memory Map: The agent MUST build and maintain an internal memory map of the world based on its observations.

Logic Flow (Agent States):

- Exploration Mode (DFS): The agent uses a DFS-based strategy to systematically choose and move towards the nearest unexplored tile.
- Discovery: While exploring, the agent discovers and logs dirt locations on its map.
- Decision Point: The agent decides whether to continue exploring or to go clean a known patch of dirt.
- Pathfinding Mode (BFS): The agent treats its internal memory map as a complete world and uses BFS to calculate the most energy-efficient path to the target dirt patch.
- Execution & Cleaning: The agent follows the calculated BFS path and cleans the target area before switching back to Exploration Mode.

3. The Challenge: Constraints & Costs

Resource management is critical to the agent's success. All actions have a cost, which is deducted based on the actual move performed.

Energy Budget: The agent starts with 200 energy units.

Action & Movement Costs:

- Moving Horizontally or Vertically: 1.0 energy
- Moving Diagonally: 1.5 energy
- Moving onto a Sticky Mud tile: An additional +2.0 energy

- Cleaning a Dirty Tile: 1.0 energy

4. Experiment & Analysis

You will run your simulation in both the Deterministic and Stochastic environments. For consistent results, the simulation's random seed should be set to 42.

Performance Metrics: You must track and report on Tiles Cleaned, Energy Efficiency, Coverage, and Percentage of Map Explored.