**1. Overview**

In unknown environments, the robot explores by continuously selecting a **frontier cell**—a reachable free cell adjacent to at least one unknown cell—and navigating toward it.  
Our approach involves two stages:

1. **Frontier Detection** – Identify all reachable frontiers based on occupancy information using BFS.
2. **Frontier Selection** – Score each frontier by heuristic metrics and choose the one with the lowest total cost.

**2. Frontier Selection Strategy**

Each candidate frontier is scored according to four factors:

1. **Heading Penalty** – Measures how much the robot must rotate to face the frontier. Smaller angular differences between current heading and target direction imply smoother, faster motion.
2. **Traversal Cost** – Uses BFS distance (in meters) as the travel cost. Closer frontiers are preferred for efficiency and reduced risk of detours.
3. **Goal Proximity** – Favors frontiers that lie closer to the ultimate goal, guiding exploration in the desired direction.
4. **Progress Toward Goal** – Rewards frontiers that reduce the robot-to-goal distance:

Frontiers improving goal proximity receive lower total cost.

The combined score is defined as:

The frontier with the minimum score is selected as the next navigation target.  
If no valid frontier exists (e.g., map nearly complete), the robot proceeds directly toward the goal.

**3. Rationale**

This strategy is chosen for the following reasons:

1. **Prevents Local Dithering** – Integrating goal awareness avoids oscillation among nearby frontiers, ensuring purposeful outward exploration.
2. **Accounts for Motion Efficiency** – Penalizing large turns and long paths respects the robot’s kinematics, reducing wasted energy and time.
3. **Balances Exploration and Goal Progress** – Prioritizes frontiers that both reveal new space and advance the mission objective.
4. **Lightweight and Real-Time** – Relies on simple geometric and BFS computations, making it suitable for embedded systems.
5. **Graceful Degradation** – When exploration is complete, the system seamlessly transitions to goal-directed navigation.

**In summary:**  
This frontier selection policy offers a **goal-oriented, motion-efficient, and computationally lightweight** solution for real-time exploration, ensuring both efficient mapping and consistent progress toward the final destination.