0.1 Performance Metrics

All experiments were repeated 5 times, with random seeds 1-5, and the average of each metric was taken over all repetitions. While their deployment position was constant, each agent's deployment orientation was randomized for each repetition. We ran experiments with varying swarm sizes (N_A) of 2, 4, 6, 10, and 15 agents.

0.1.1 Coverage Metrics

Coverage is a significant metric for exploration. The coverage percentage $CP(t)$ at time t is defined as

$$CP(t) = \frac{N_{cc}(t)\rho^2}{AA} \tag{1}$$

where $N_{cc}(t)$ is the number of covered cells in the agent's map. Note that when there are pose estimation or distance sensor inaccuracies, cells outside the map borders or in IA might be added to an agent's map. These are counted towards N_{cc}. Cells merged by our algorithm are divided into cells of size ρ.

We also compare the coverage metric of the final gathered map from the agent, in which we do ignore cells outside the arena, and in IA:

$$CP_m = \frac{N_{mc}\rho^2}{AA} \tag{2}$$

where N_{mc} is the number of covered cells inside the map boundaries and outside IA in the map.

To compare which configuration results in the fastest increase in coverage, we also include the average coverage percentage during the mission, ACP:

$$ACP = \frac{\sum_{t=0}^{T_{end}} CP(t)}{T_{end}} \tag{3}$$

As officially FSP considers cells with fully evaporated pheromones uncovered, we include previously covered but evaporated pheromone-cells in N_{cc} for a fair comparison.

0.1.2 Confidence Metrics

For BICLARE it is interesting to observe the average certainty at time t, $AC(t) = |\varphi(z,t) - 0.5|$. To compare which configuration can ensure the highest overall certainty, we define the mean average certainty during the entire mission:

$$AAC = \frac{\sum_{t=0}^{T_{end}} AC(t)}{T_{end}} \tag{4}$$

0.1.3 Mapping accuracy

To evaluate the accuracy of the created maps, we use the precision and recall metrics. Here, we define cell z in a generated map to be an obstacle cell if

$\varphi(z,t) < 0.5$, and free if $\varphi(z,t) \geq 0.5$. Splitting the actual map up in cells of size ρ, we define cells to be truly occupied when obstacles cover 10% of their area. Given the number of correctly identified obstacle cells TP, falsely identified obstacle cells FP, and falsely identified free cells FN:

$$\text{precision} = \frac{TP}{TP + FP} \tag{5}$$

and

$$\text{recall} = \frac{TP}{TP + FN} \tag{6}$$

To determine TP, FP, and FN, only cells in N_{cc} that were at any point reachable during the experiment are considered. To get a more general impression of the accuracy of the created map for comparison between algorithms, we use the F_1-score, which is the harmonic mean of precision and recall:

$$F1 = \frac{2 \cdot \text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}} \tag{7}$$

For each experiment, we take the map of the agent who finished first ($S_i = 4$), at its finish time.