# Optimal Coverage Area in WSN

***Presentation 2 - Solution & Results***

**Ozan Oytun Karakaya**

# Overview

1 Problem Definition

2 Solution Mechanism

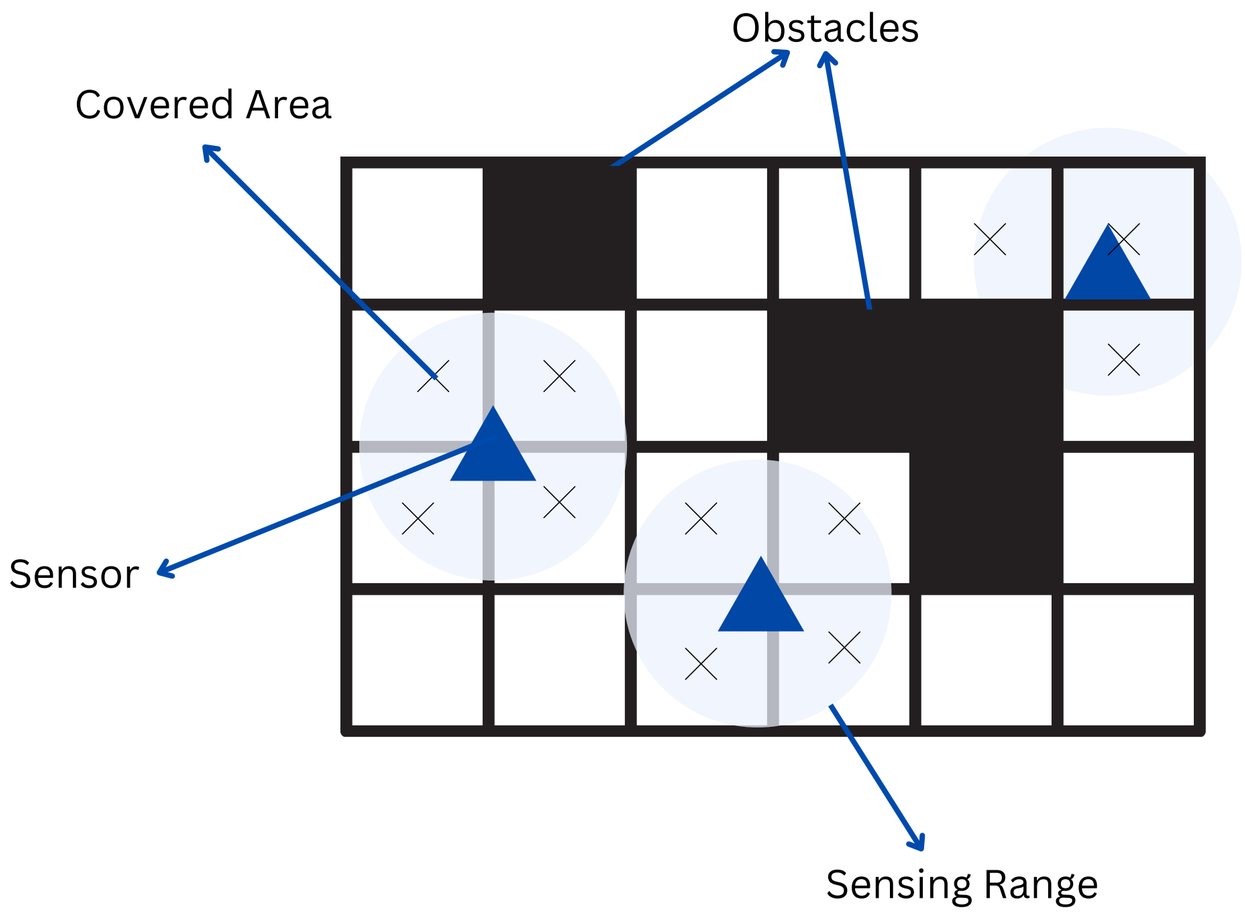
3 Sample Demo Run

4 Performance Testing

5 Solution Comparison

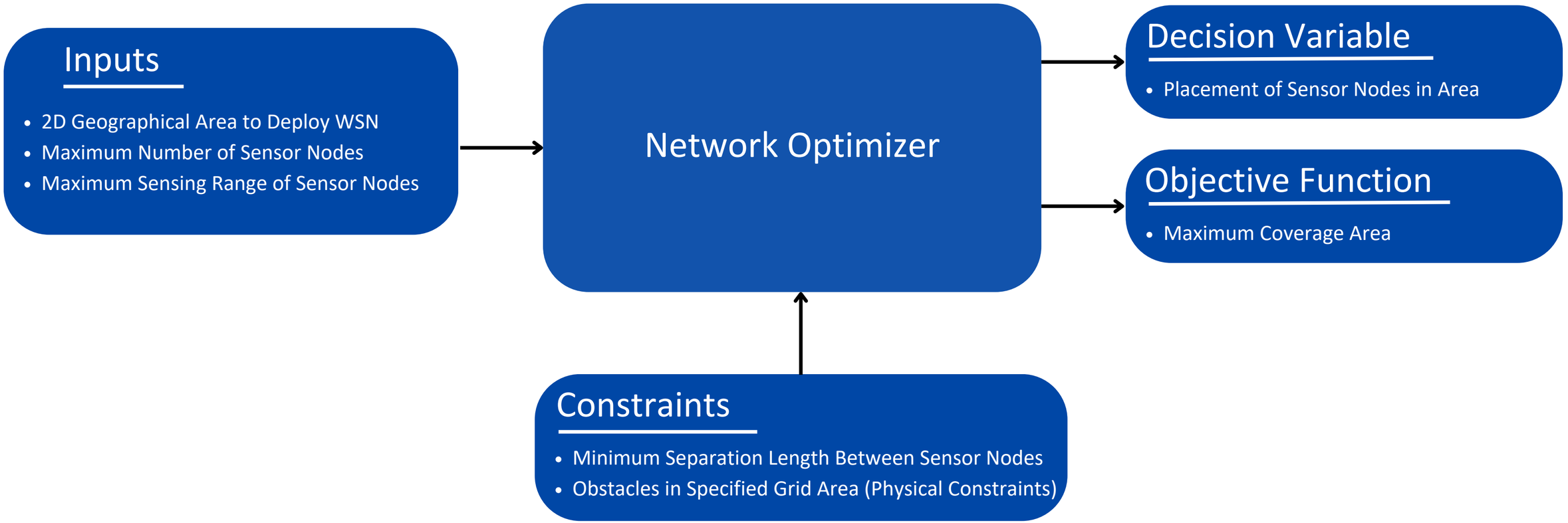
1

# Problem Definition




Uniformly Distributed Obstacles
Obstacles Opaque For Sensing
Coverage for Center of Grids
Sensing Ranges Can Exceed Area

# Problem Definition



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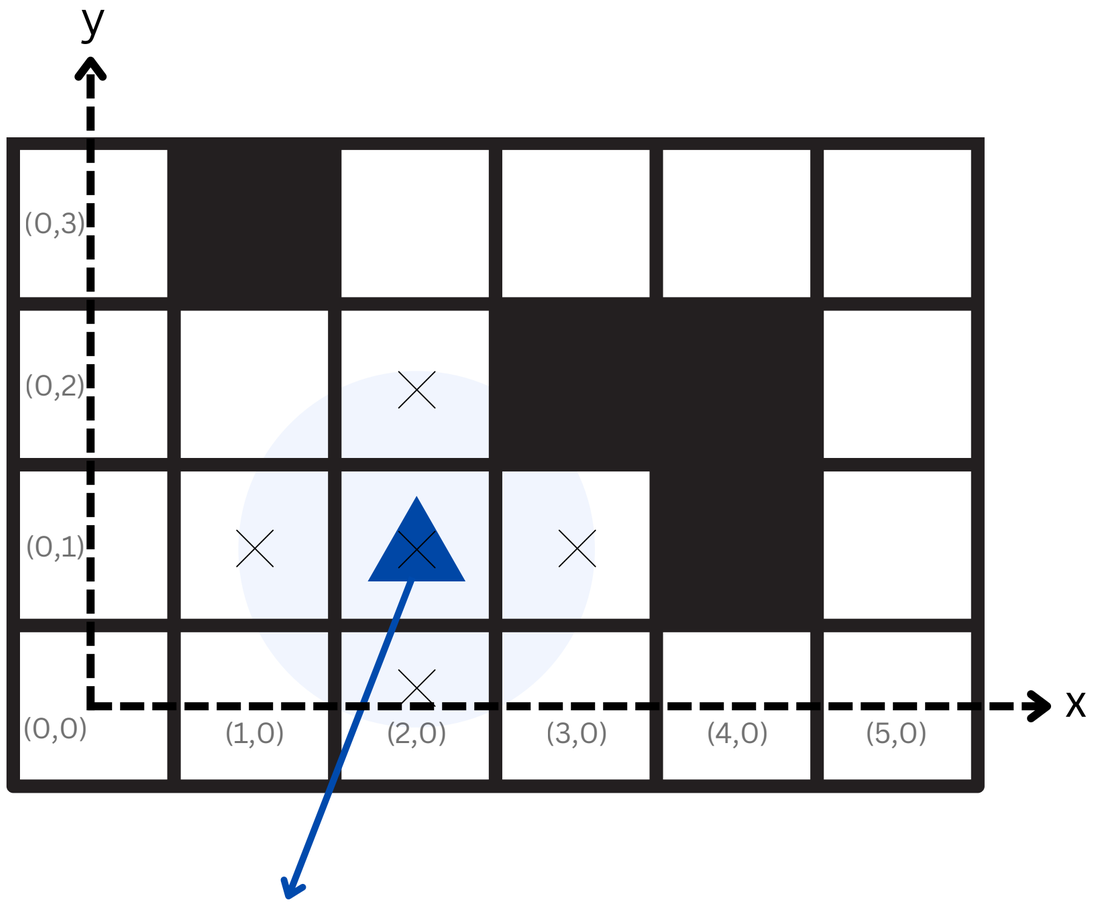
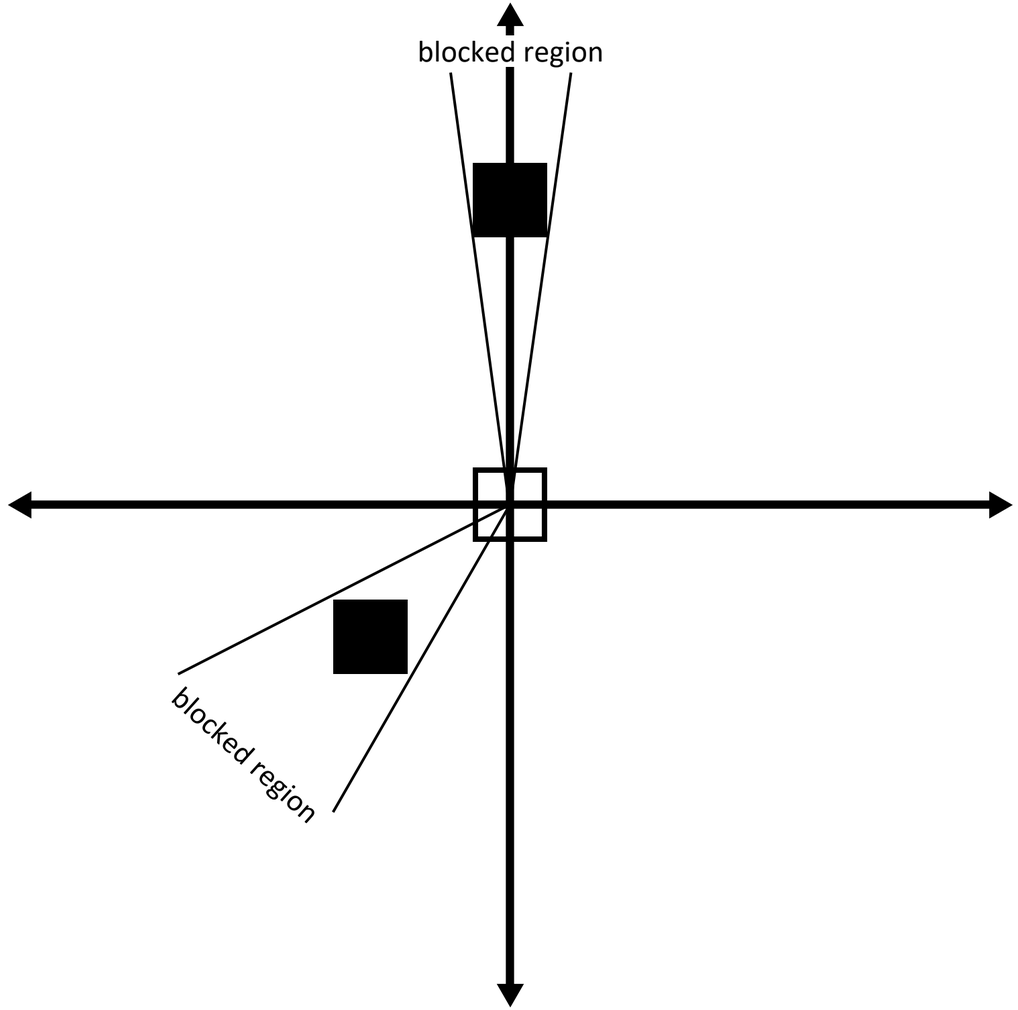
# Solution Mechanism



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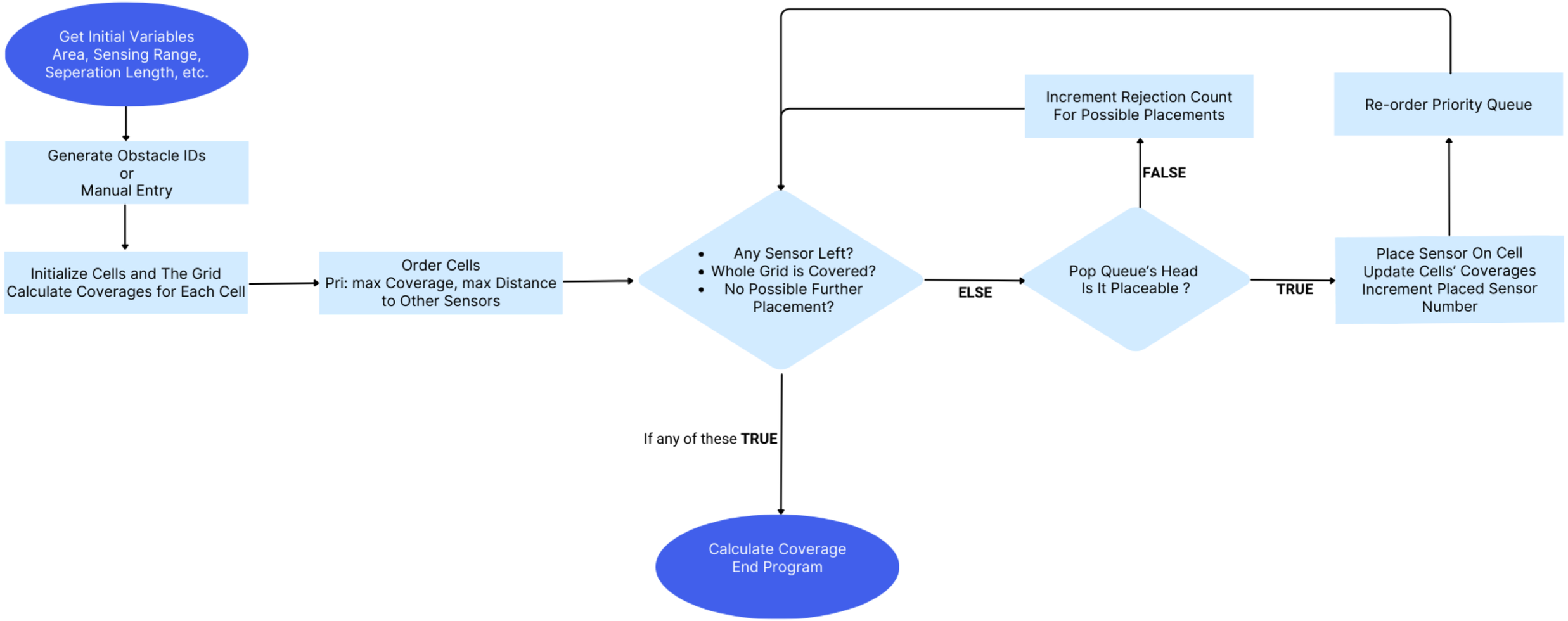
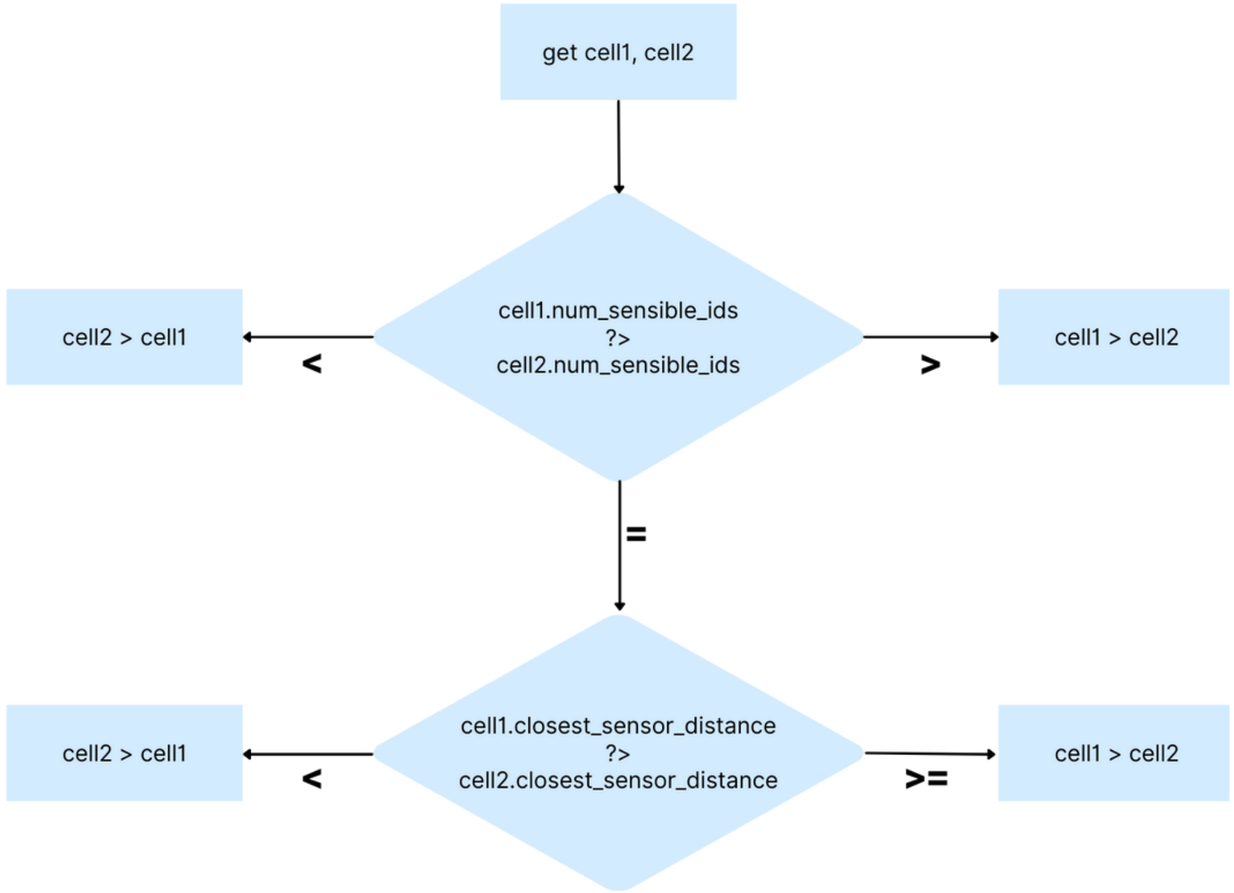
# Solution Mechanism



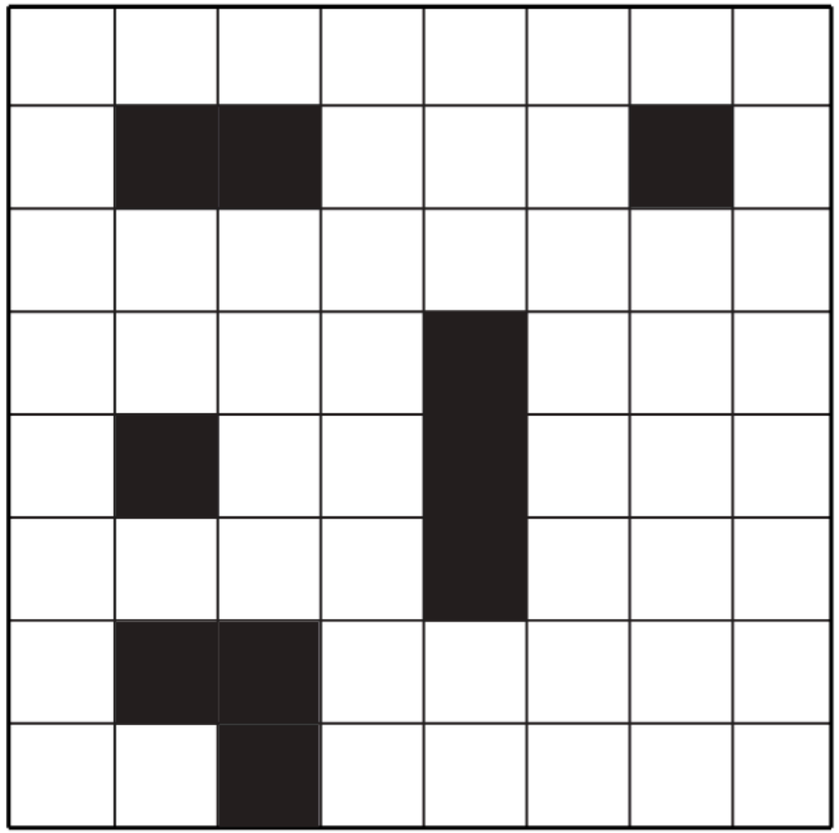
# Solution Mechanism

**Algorithm:** Sensor Placement Algorithm

```
temp_cell_list ← []
rejected_cell_count ← 0
while maximum_number_of_sensors > 0 and
rejected_cell_count < Number of Available Cells do
  if Whole Area is Covered then
    break
  end if
  top_cell ← cell_queue.pop()
  if is_placeable(top_cell) then
    sensor_placed_ids.add(top.cell)
    covered_ids.set_union(top_cell.sensible_ids)
    Update All Cell's Sensible ID Sets
    Dequeue All Elements in cell_queue and Add to temp_cell_list
    Push All Elements in temp_cell_list to cell_queue   {re-order
    the queue}
    temp_cell_list.empty_list()
    maximum_number_of_sensors ← maximum_number_of_sensors-1
  else
    rejected_cell_count ← rejected_cell_count+1
    continue
  end if
end while
```

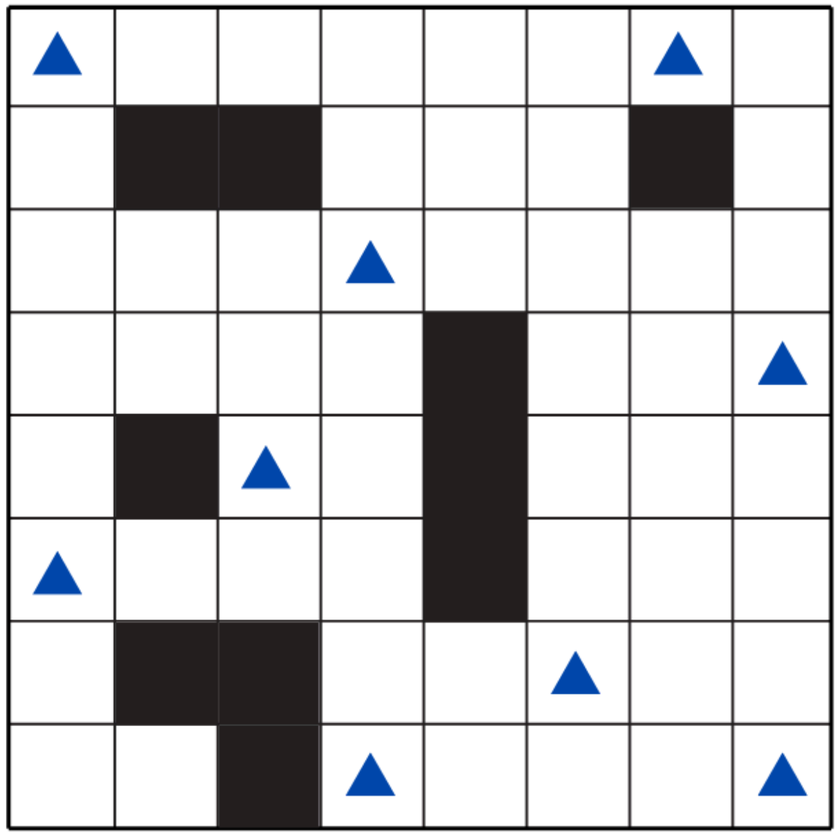


# Sample Demo Run



Width: **8**
Height: **8**
Maximum Number of Sensors: **10**
Maximum Sensing Range of Sensors (r): **2**
Minimum Separation Length: **1.1 r**
Obstacle IDs:
**[2, 9, 10, 20, 25, 28, 36, 49, 50, 54]**

# Sample Demo Run



Width: **8**
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Maximum Number of Sensors: **10**
Maximum Sensing Range of Sensors (r): **2**
Minimum Separation Length: **1.1 r**
Obstacle IDs:
**[2, 9, 10, 20, 25, 28, 36, 49, 50, 54]**
Sensor Placed IDs:
**[13, 43, 39, 16, 56, 62, 26, 3, 7]**
Coverage:
**%98.15**

# Performance Testing

## Independent Variables For $2^k$ Testing

- Square Area vs Rectangular Area - **100x100** vs **50x200**
- Obstacle Density - **5%** vs **50%**
- Minimum Separation Length - **1r** vs **2r**
- Maximum Number of Sensors - **32** vs **64**

## Constants

- Maximum Sensing Range (r) = 10
- Area = 1 (ha)

***1 unit is taken as 1 meter.***
***Maximum sensor numbers are obtained by the formula ⌈Area/(π*r²)⌉ vs 2*⌈Area/(π*r²)⌉***

# Performance Testing

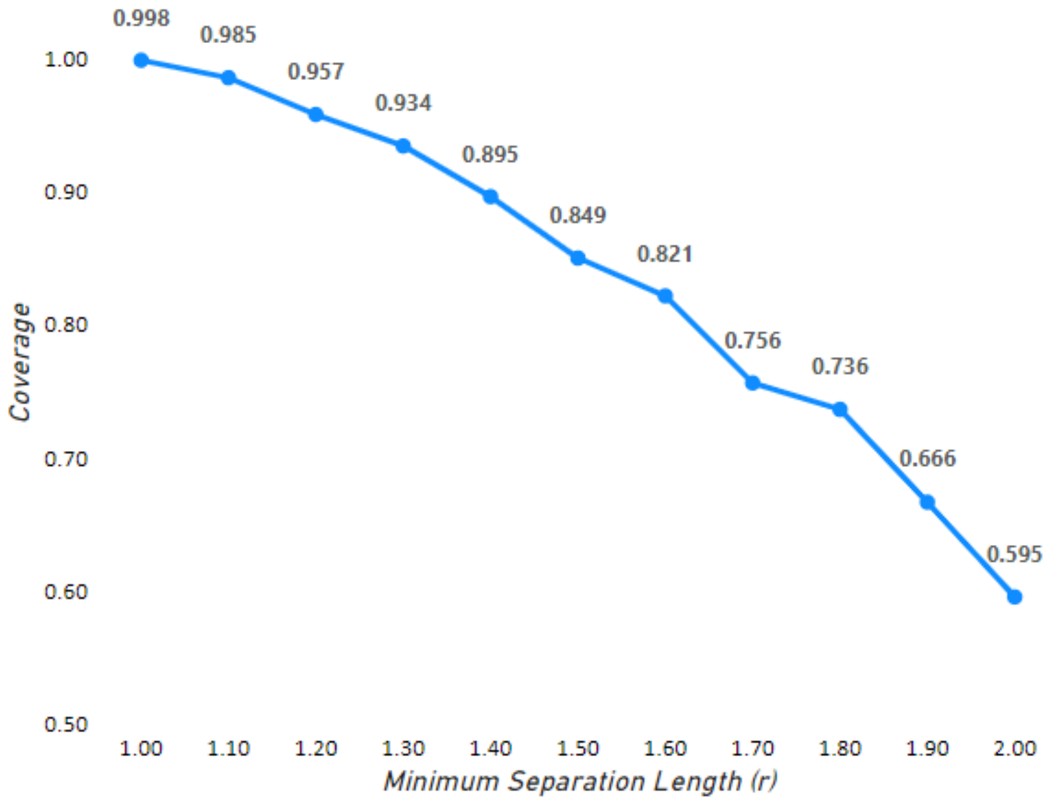
**Sensing Range (r) = 10**

| Height | Width | Obstacle Density | Minimum Separation Length (r) | Maximum Number of Sensors | Number of Placed Sensors | Coverage | Run Time (sec) |
|---|---|---|---|---|---|---|---|
| 100 | 100 | 5% | 1 | 32 | 32 | 85.80% | 19.5 |
| 100 | 100 | 5% | 1 | 64 | 64 | 99.76% | 24 |
| 100 | 100 | 5% | 2 | 32 | 21 | 61.34% | 18.3 |
| 100 | 100 | 5% | 2 | 64 | 21 | 61.34% | 18.3 |
| 100 | 100 | 50% | 1 | 32 | 32 | 83.86% | 19.2 |
| 100 | 100 | 50% | 1 | 64 | 64 | 99.08% | 23.5 |
| 100 | 100 | 50% | 2 | 32 | 21 | 59.40% | 18.2 |
| 100 | 100 | 50% | 2 | 64 | 21 | 59.40% | 18.2 |
| 50 | 200 | 5% | 1 | 32 | 32 | 83.45% | 66.9 |
| 50 | 200 | 5% | 1 | 64 | 64 | 99.71% | 58.5 |
| 50 | 200 | 5% | 2 | 32 | 23 | 64.65% | 58.4 |
| 50 | 200 | 5% | 2 | 64 | 23 | 64.65% | 56.9 |
| 50 | 200 | 50% | 1 | 32 | 32 | 82.40% | 58.4 |
| 50 | 200 | 50% | 1 | 64 | 64 | 98.56% | 65.8 |
| 50 | 200 | 50% | 2 | 32 | 22 | 60.54% | 56.7 |
| 50 | 200 | 50% | 2 | 64 | 22 | 60.54% | 56.8 |

# Performance Testing

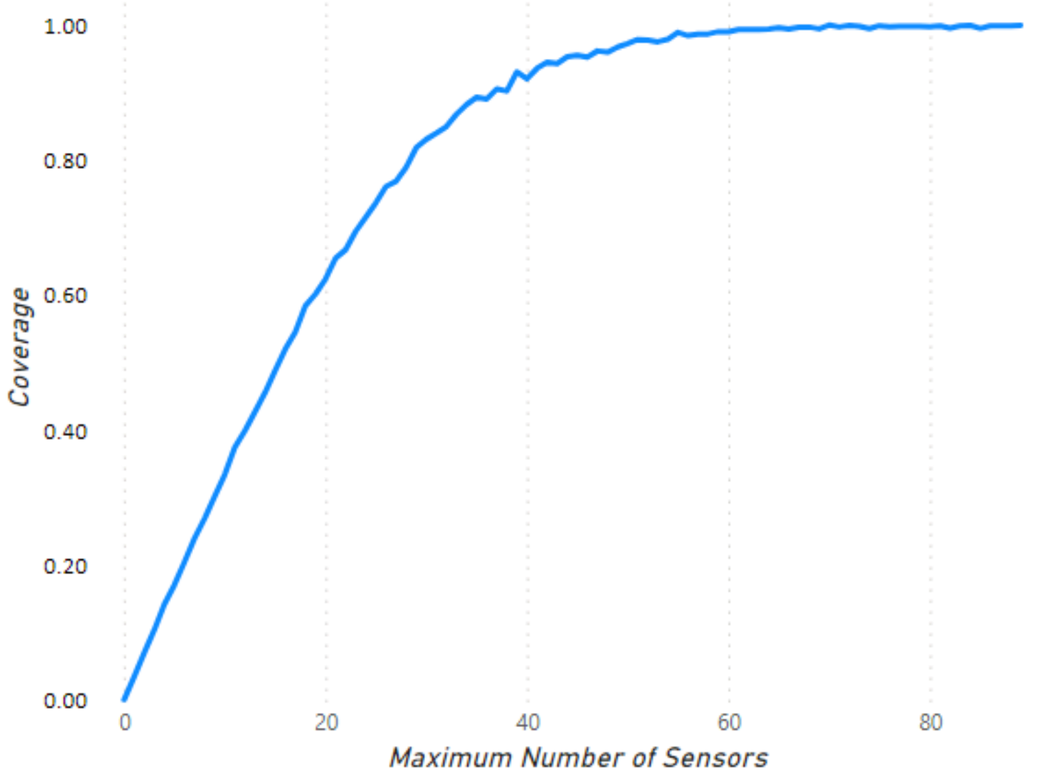
Height: 100
Width: 100
Obstacle Density: %20
Sensing Range: 10

Area Coverage wrt Minimum Separation Length




*Maximum Number of Sensors: 90

Area Coverage wrt Maximum Number of Sensors




*Minimum Separation Length: 1r

# Solution Comparison

## Efficient coverage for grid-based mobile wireless sensor networks

**Authors:** Valeria Loscri, Enrico Natalizio, Francesca Guerriero, Nathalie Mitton

Authors Info & Claims

PE-WASUN '14: Proceedings of the 11th ACM symposium on Performance evaluation of wireless ad hoc, sensor, & ubiquitous networks • September 2014 • Pages 53–60 • https://doi.org/10.1145/2653481.2653489

Transparent Obstacles

## Coverage Optimization of WSNs Based on Enhanced Multi-Objective Salp Swarm Algorithm

by **Dan-Dan Yang** [1], **Meng Mei** [2], **Yu-Jun Zhu** [1,*], **Xin He** [1], **Yong Xu** [1] and **Wei Wu** [1]

[1] School of Computer and Information, Anhui Normal University, Wuhu 241002, China

[2] School of Electronic and Information Engineering, Tongji University, Shanghai 200092, China

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Transparent Obstacles
Placement on Obstacles

*Appl. Sci.* **2023**, *13*(20), 11252; **https://doi.org/10.3390/app132011252**

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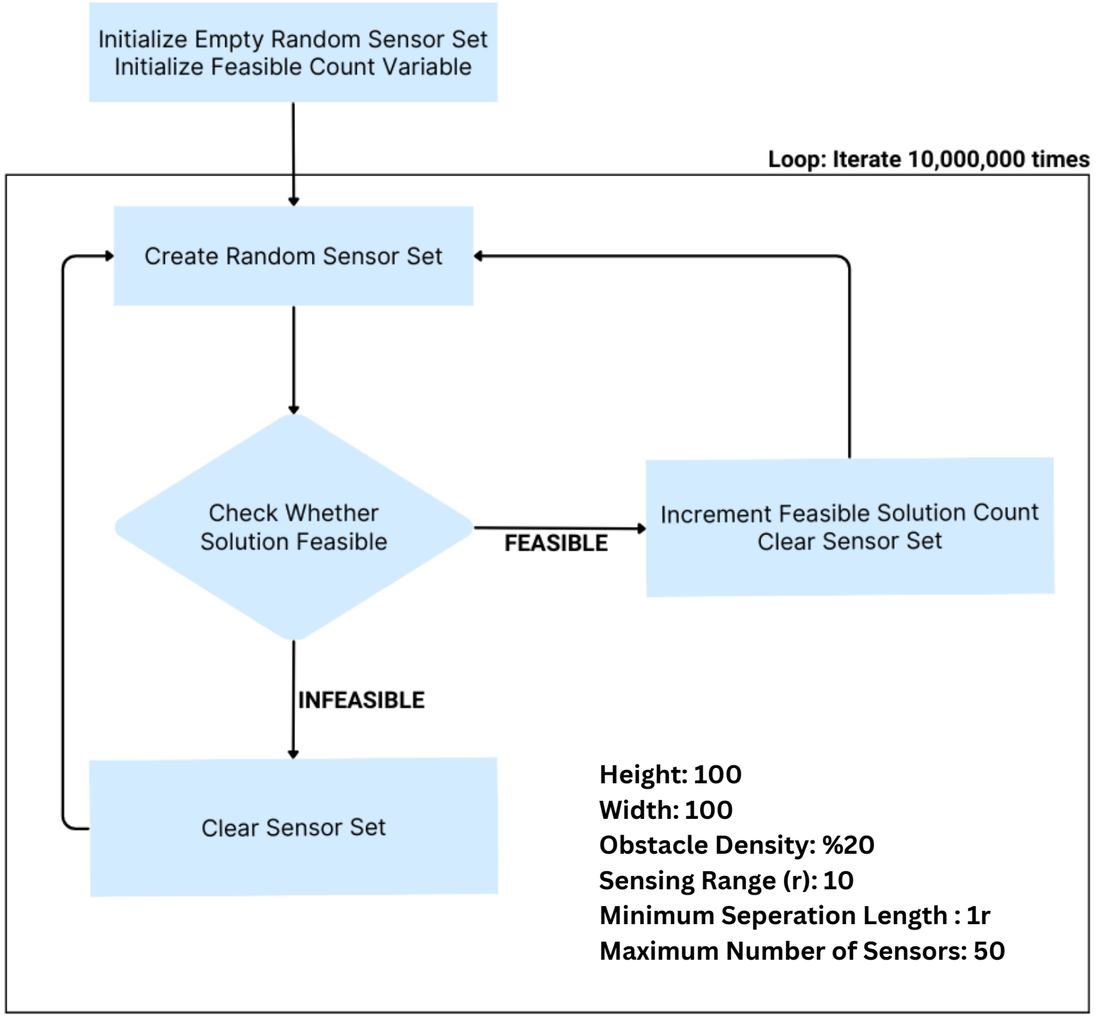
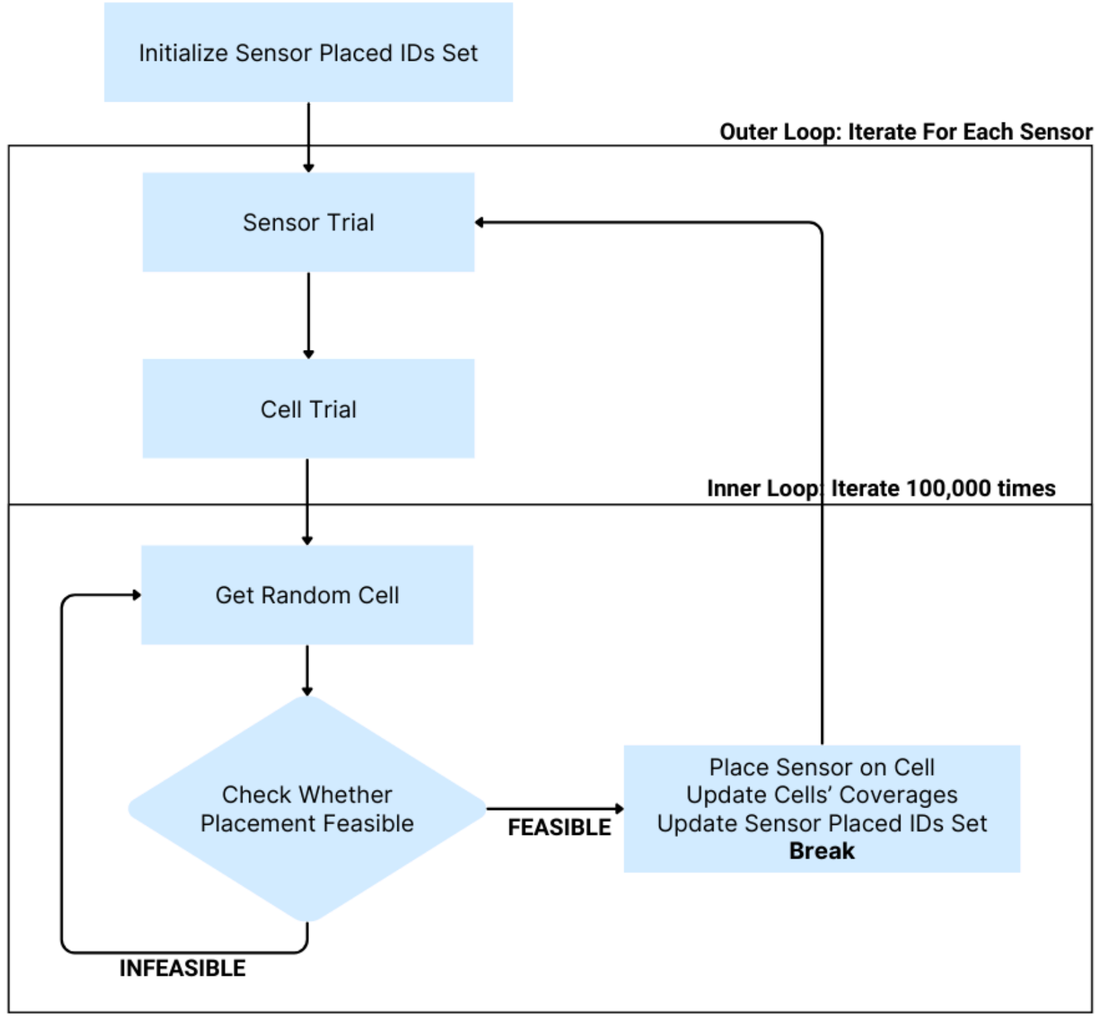
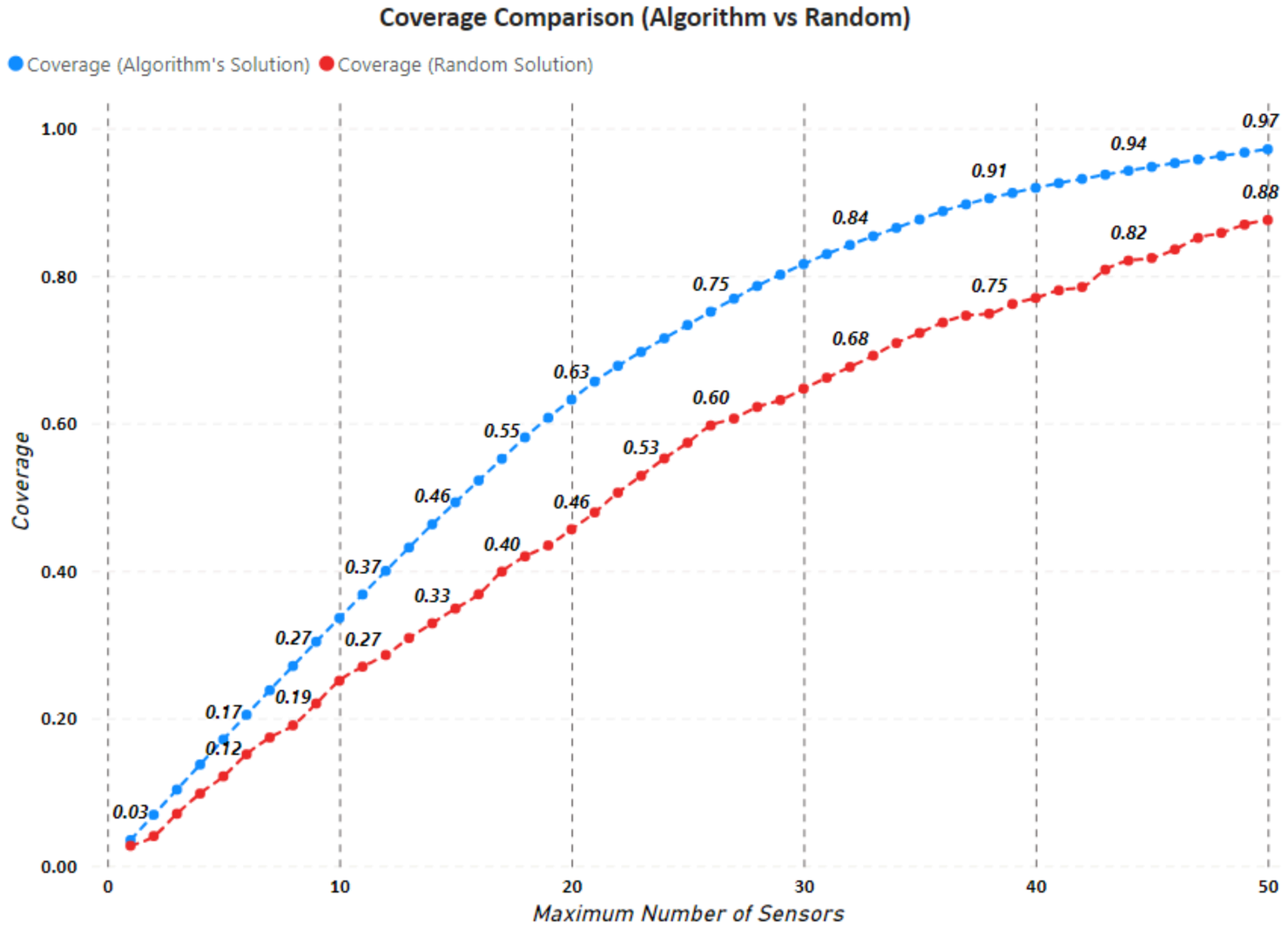
# Solution Comparison



# Solution Comparison




**Height: 100**
**Width: 100**
**Obstacle Density: %20**
**Sensing Range (r): 10**
**Minimum Seperation Length : 1r**
**Maximum Number of Sensors: 50**