Spatial model-aided indoor tracking P5

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Content

- Introduction
- Research objectives and questions
- Spatial model
- Tracking algorithm
- Implementation and testing
- Conclusions

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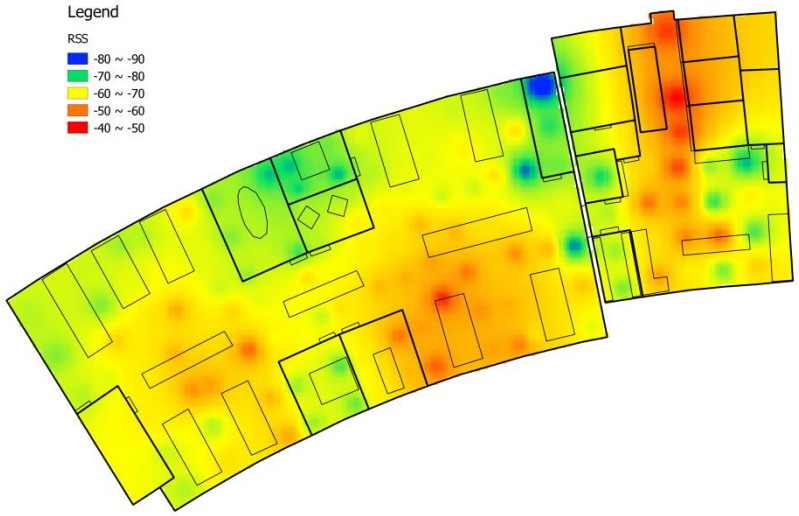
Indoor positioning technology

- Indoor localization and tracking are the basis of location based services .
- GPS doesn’t work well indoor .
- Wi-Fi- based positioning technology is an alternative solution.

Wi-Fi positioning system

How does Wi-Fi positioning system work?

It measures the received signal strength (RSS) from Wi-Fi access points in two phases: Offline phase and Online phase.

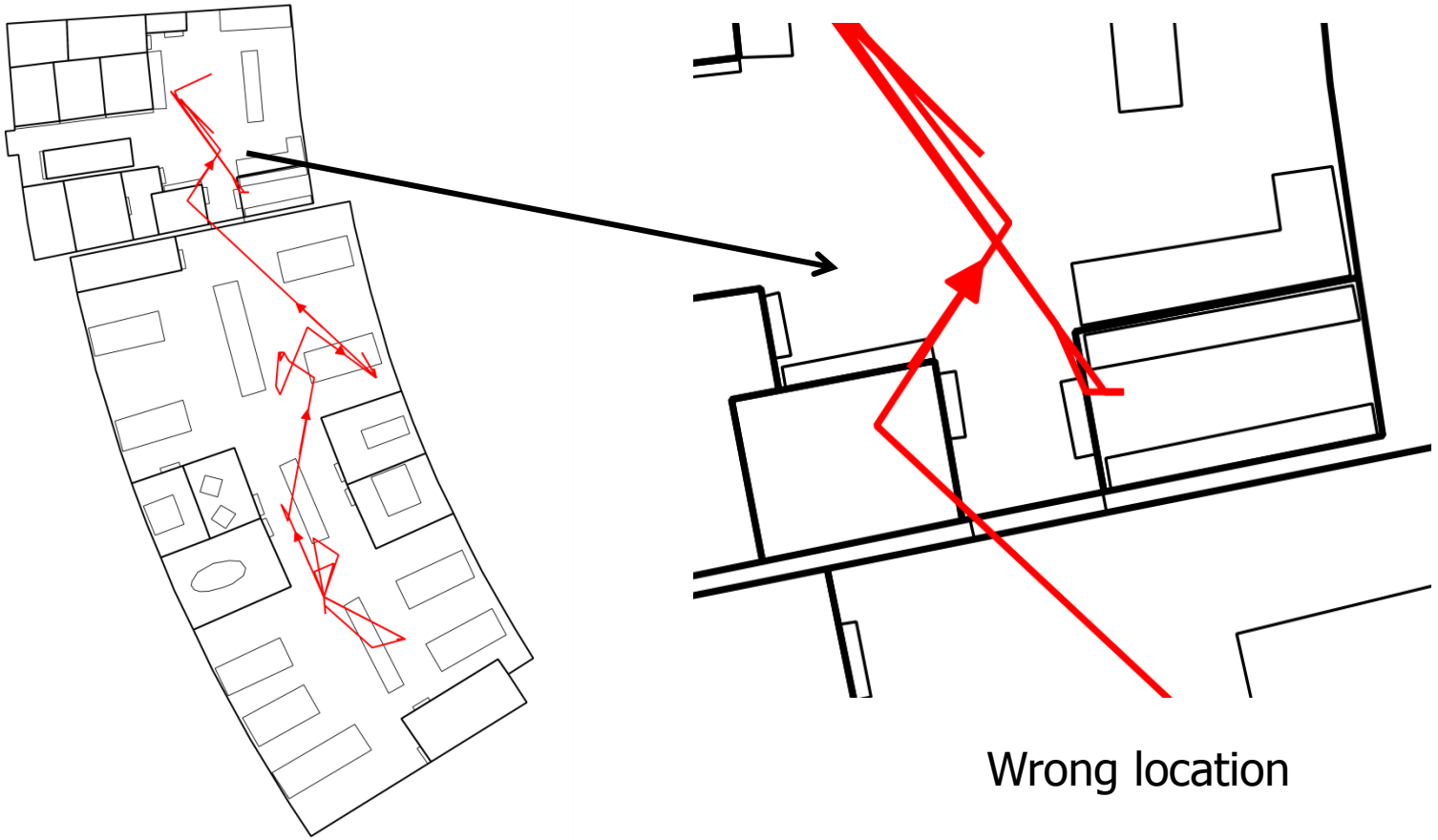


radio map

Problems in Wi-Fi positioning system

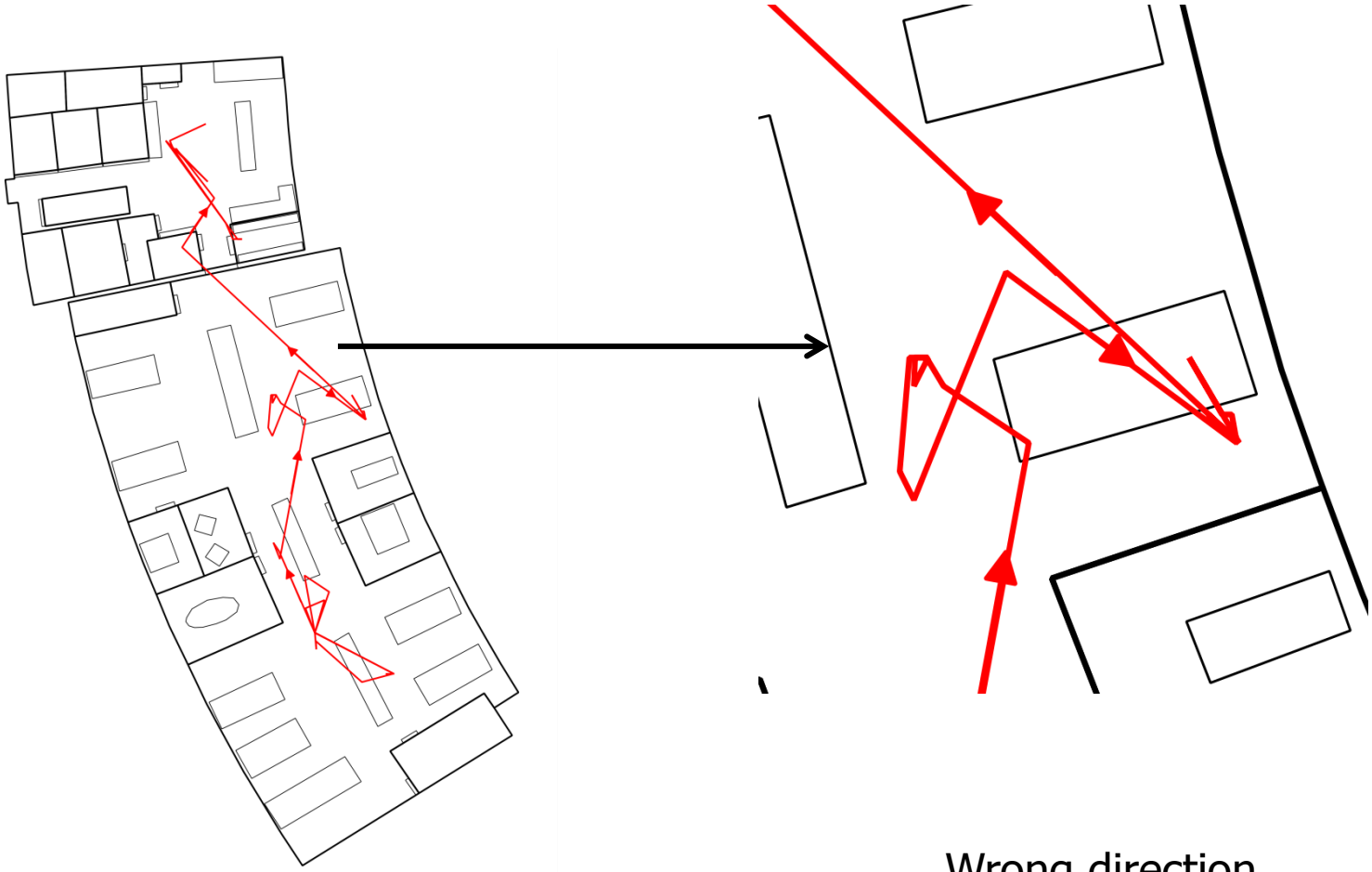
- It suffers electromagnetic interference.
- It has RSS variance problem between two phases.
- It is very time consuming to create and maintain the radio map.

Problems in tracking



Wrong location

Problems in tracking



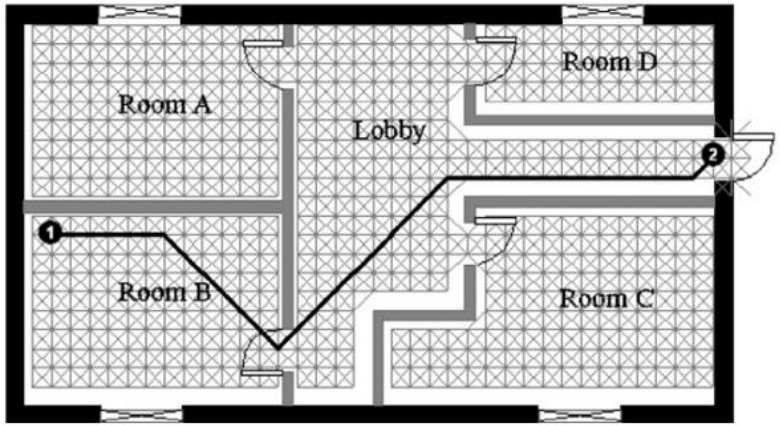
Wrong direction

Problems in tracking

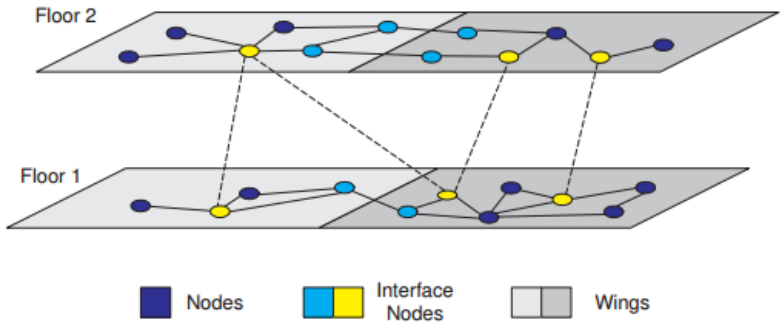
Jump of location

Spatial model

- Geometry
- Topology
- Semantics



Grid-based model



Network-based model

Research objectives and questions

Research question:

What contributions can a spatial model make to decrease tracking errors of WiFi technology for indoor navigation?

Objectives:

- Find useful features of spatial models for tracking purposes
- Design a tracking algorithm which can make use of geometry, topology and semantics of the spatial model
- Implement and test the tracking system

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- Reflections

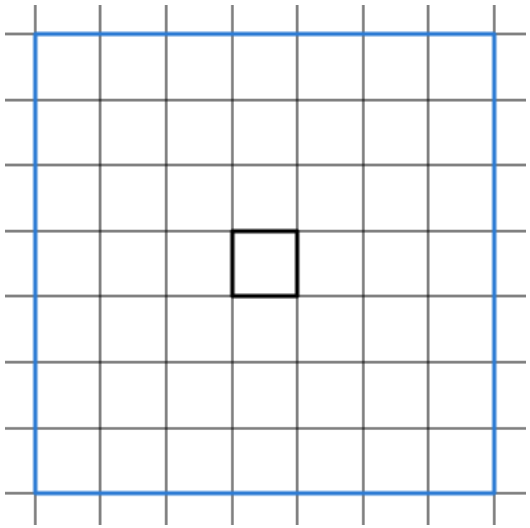
Spatial model

Grid model is chosen because:

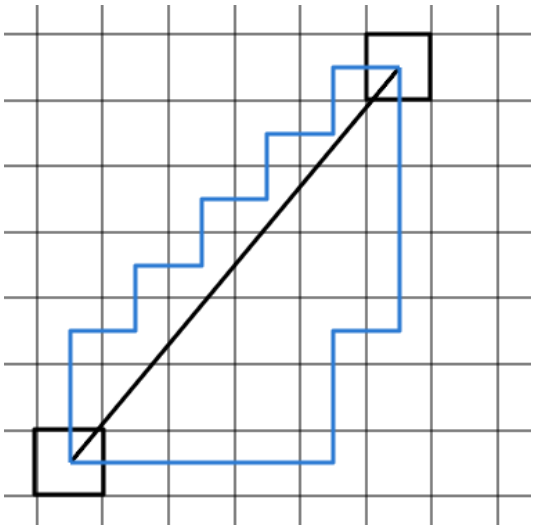
- The grid model is able to describe accurate location.
- The grid model has high flexibility on the granularity.
- The grid model is suitable for computation.
- The grid model is easy to implement and maintain.

Geometric features

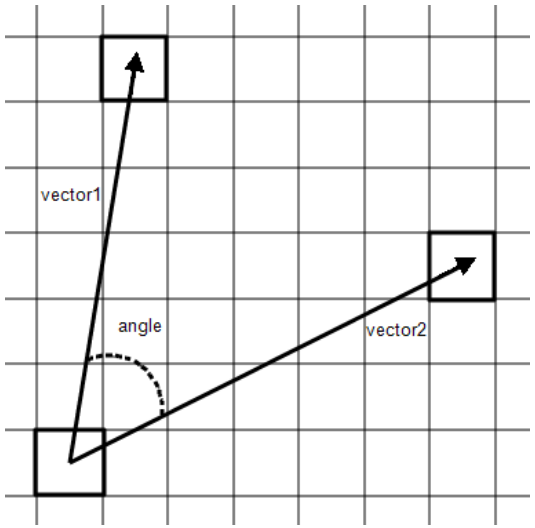
- Geometric coordinates
- Buffer
- Distance
- Orientation vector



Buffer



Distance



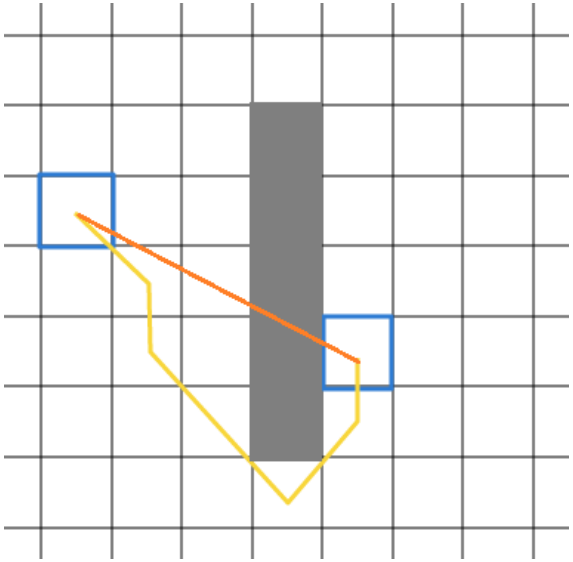
Orientation vector

Semantic features

- Floor
- Space
- Obstacle
- Door

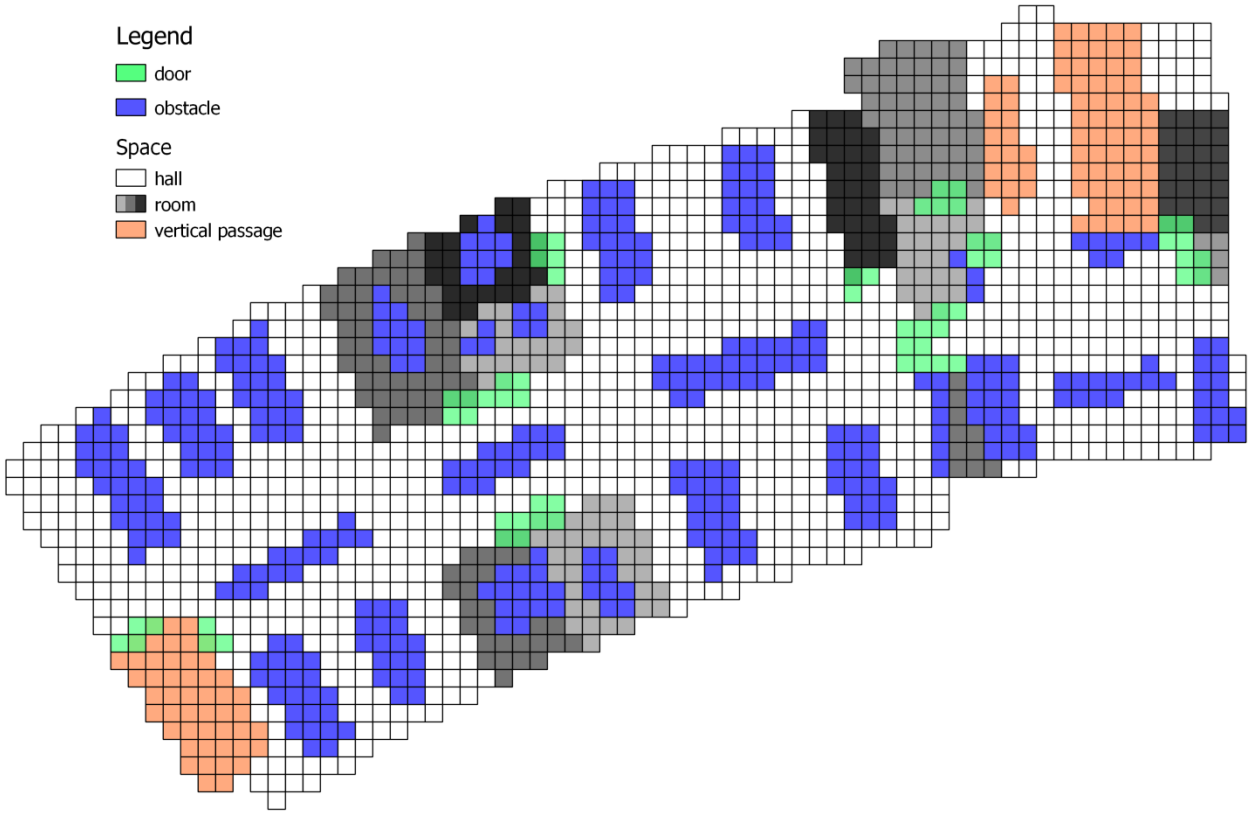
Topological features

- Connectivity Graph
- Shortest path
- Distance difference (between straight-line distance and shortest path distance)



Distance difference

Grid model



Grid granularity :0.7 meter

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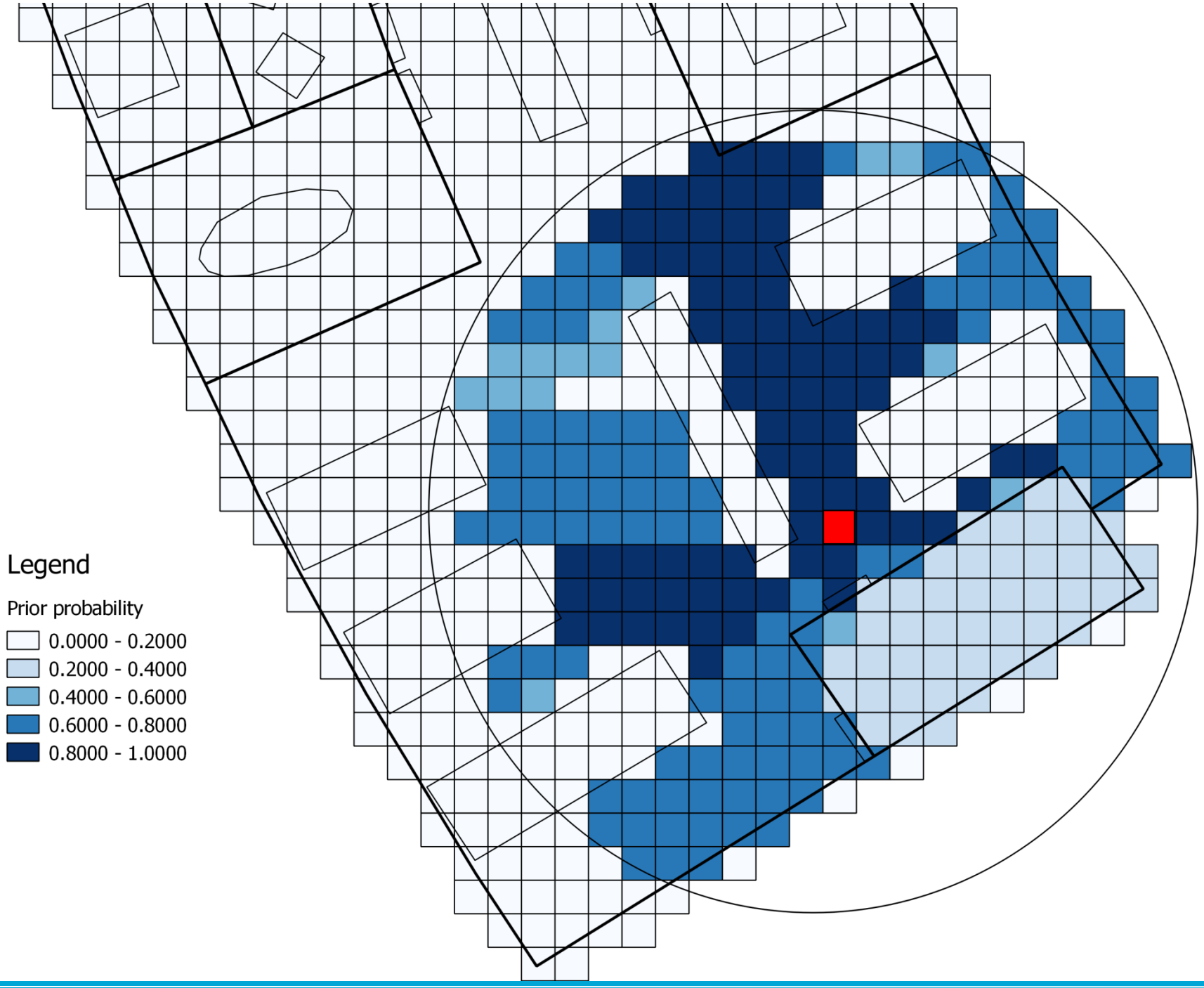
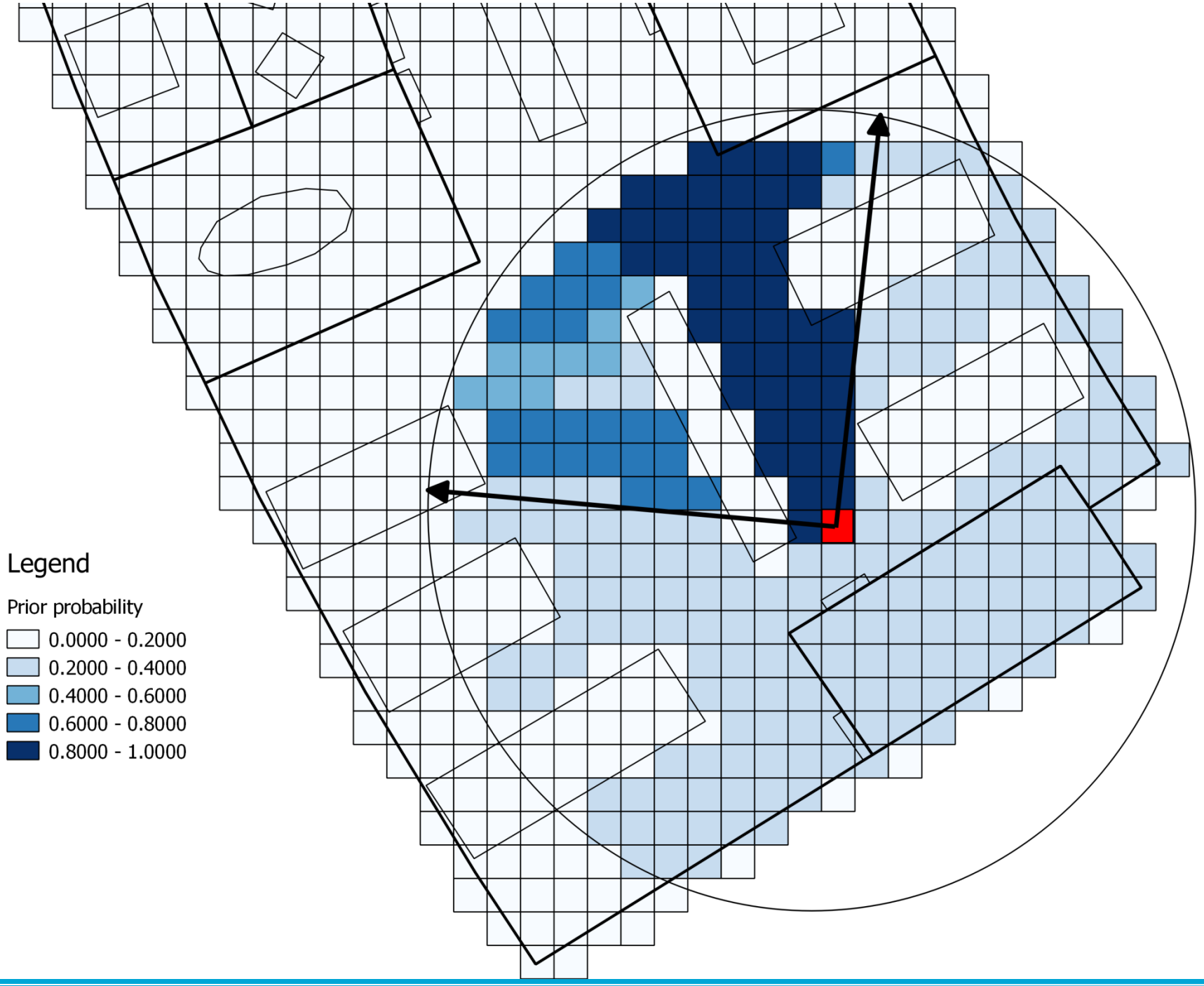
Algorithm overview

General process
- Initialization
- Prediction
- Update
  - Collect measurements
  - Remove outliers
  - Determine space
  - Update probability
  - Find maximum probability

Special process
- No Wi-Fi measured location
- Turning case
- Floor change


Legend
Prior probability
0.0000 - 0.2000
0.2000 - 0.4000
0.4000 - 0.6000
0.6000 - 0.8000
0.8000 - 1.0000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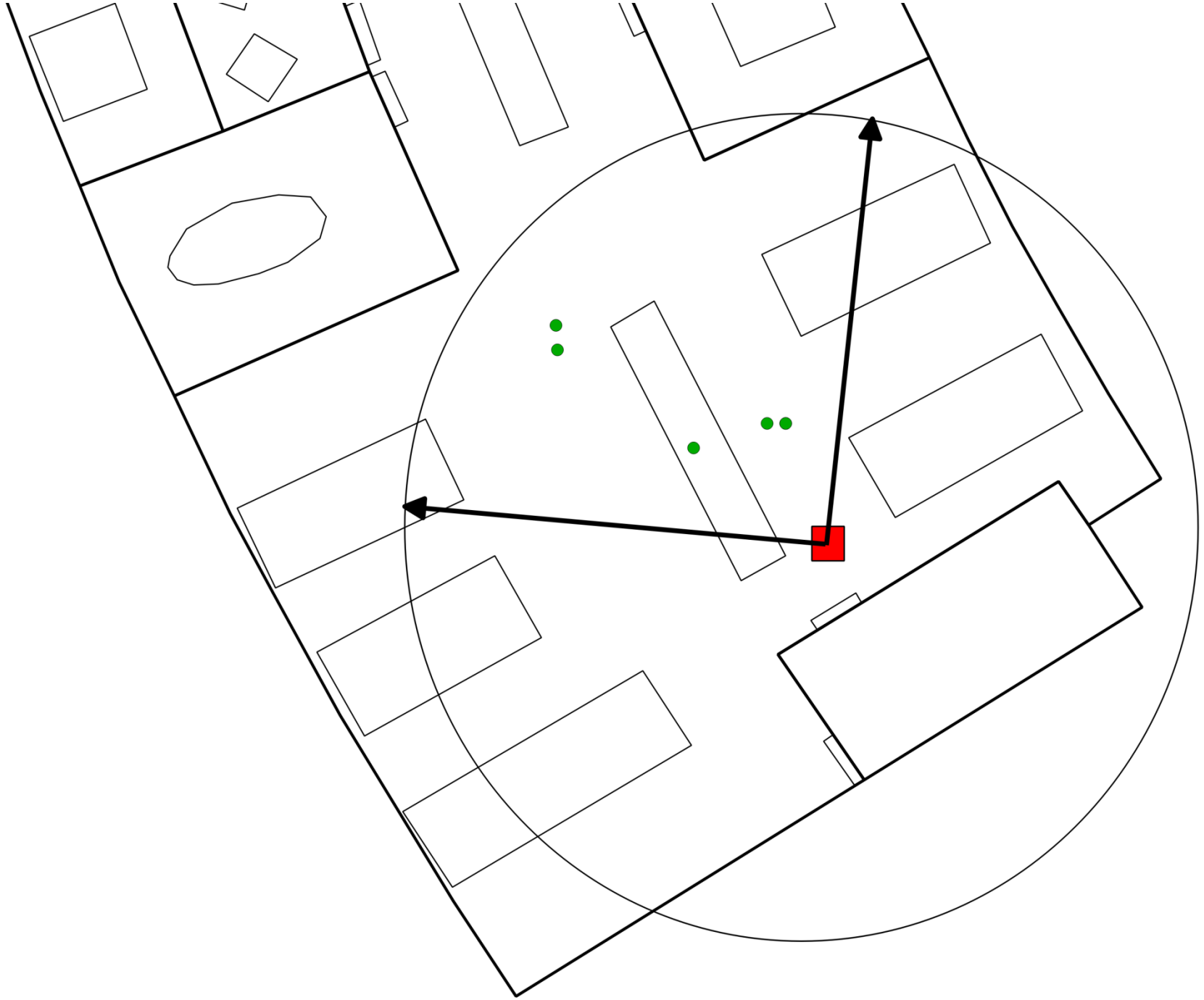

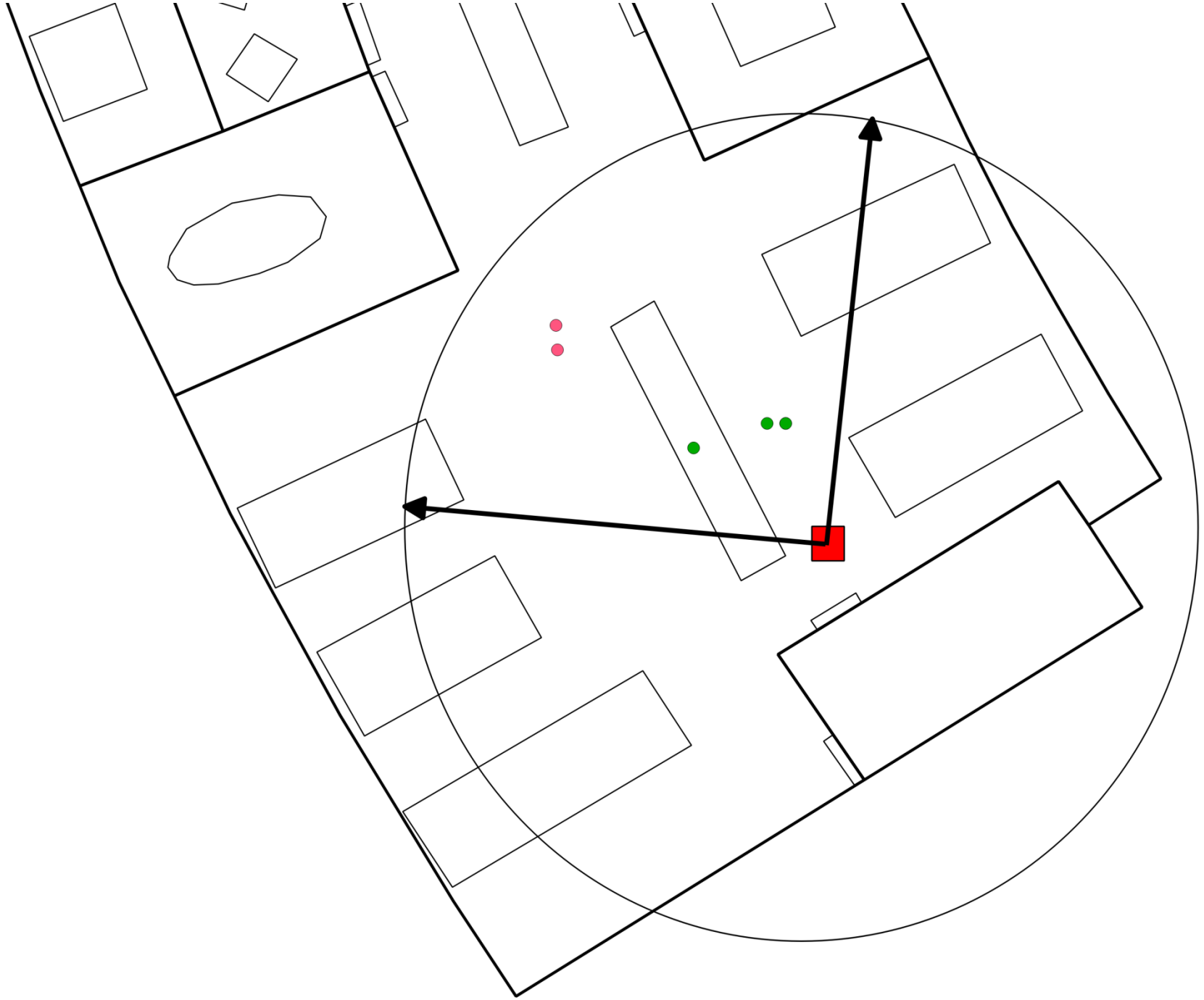

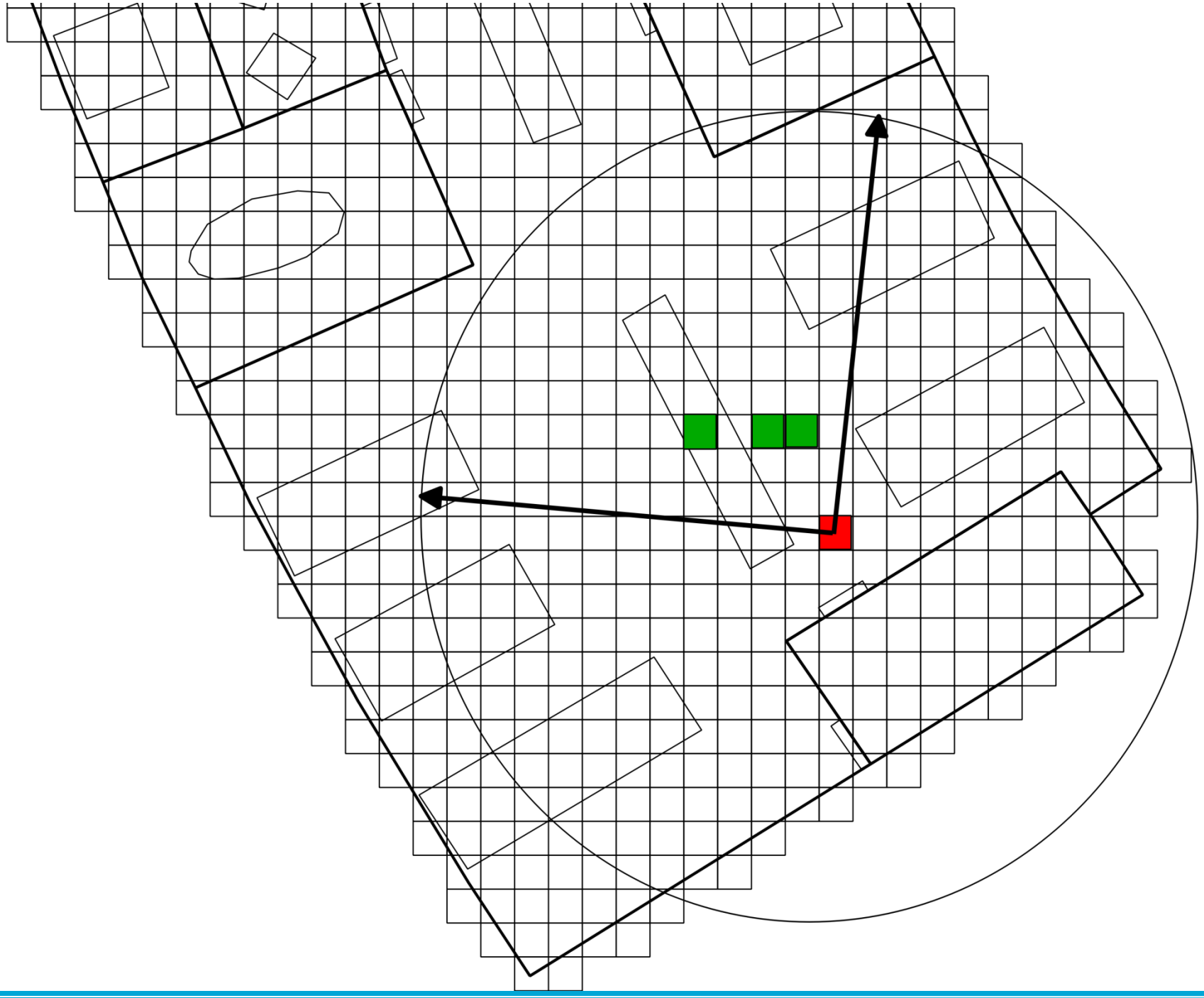

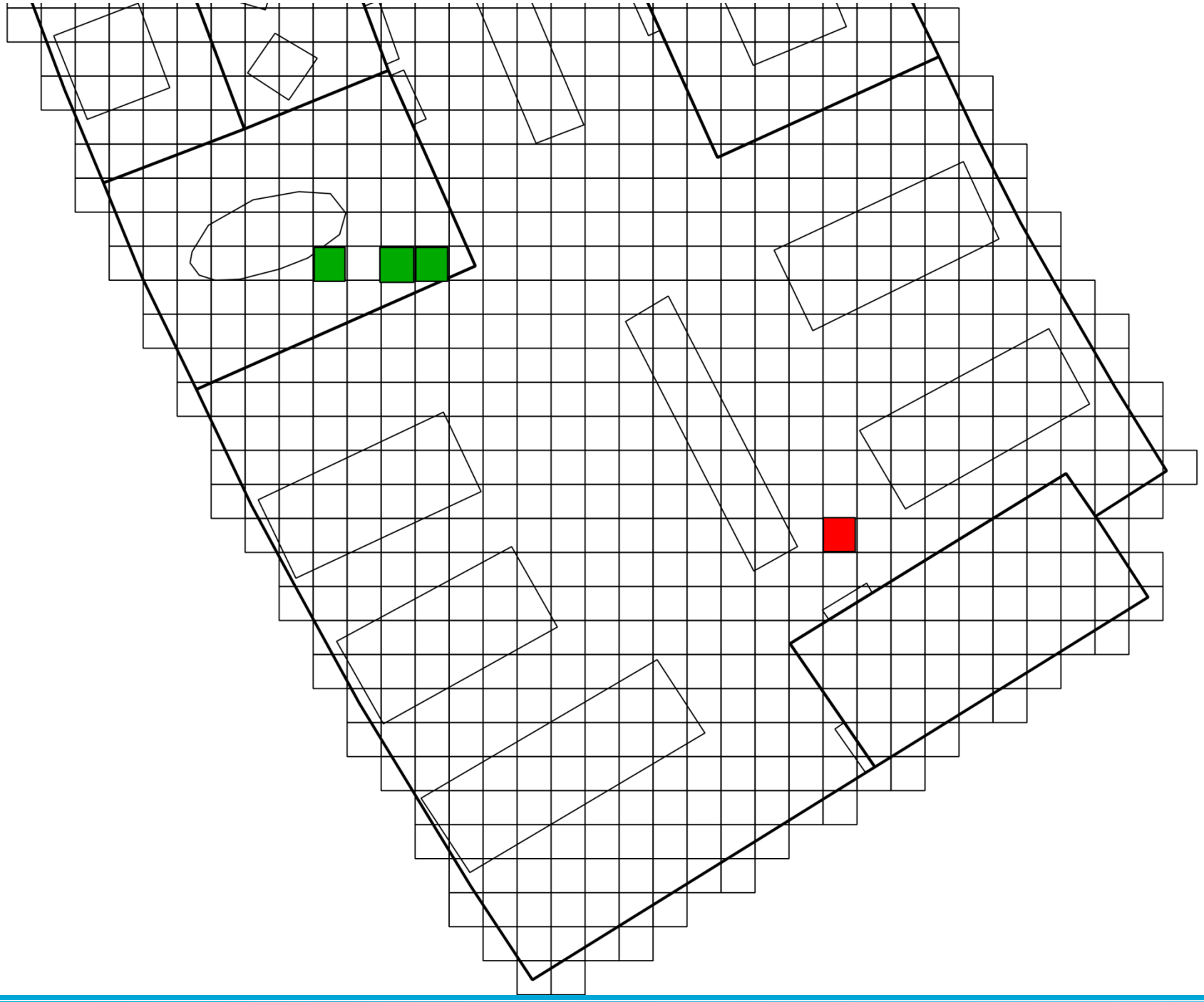

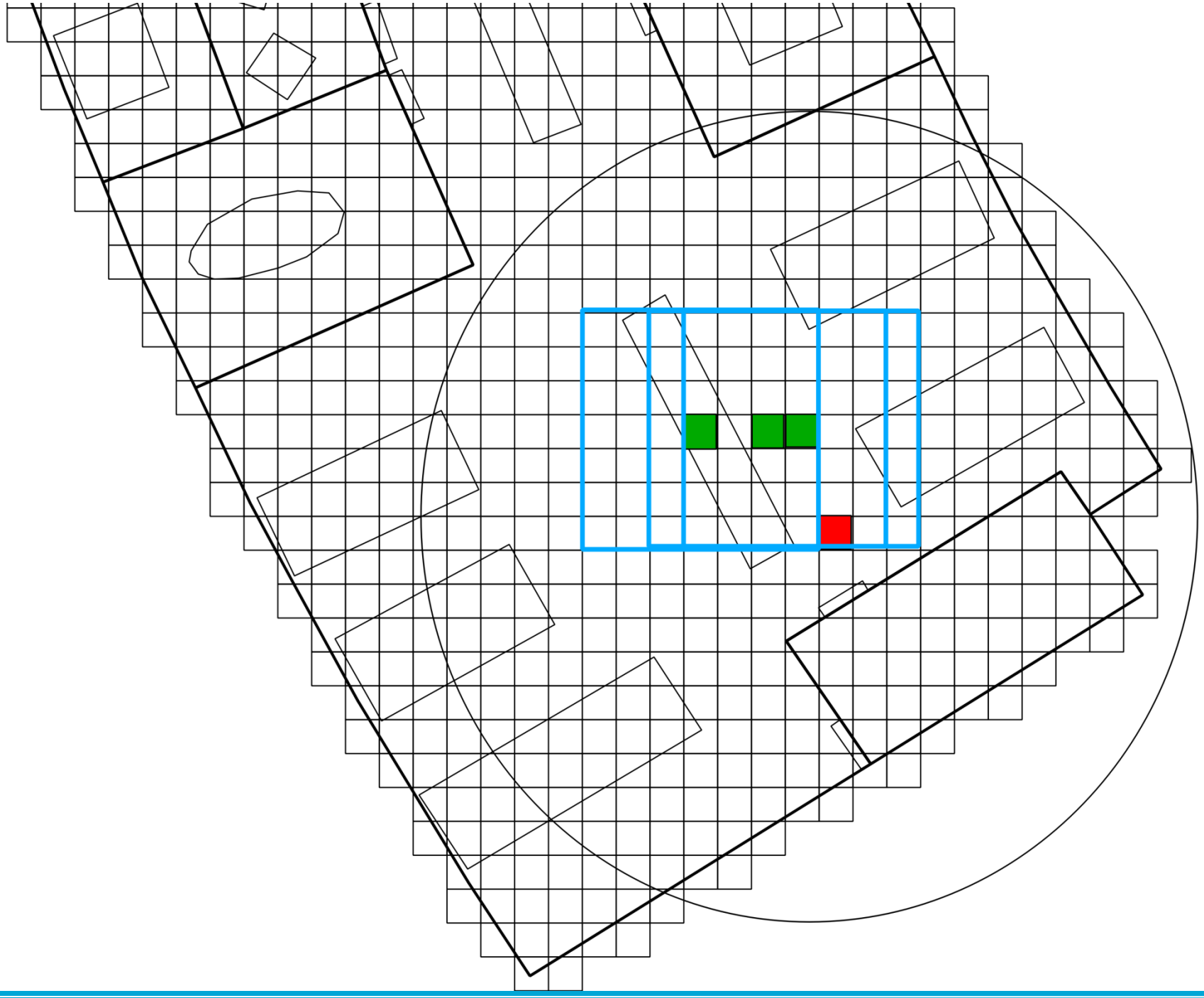

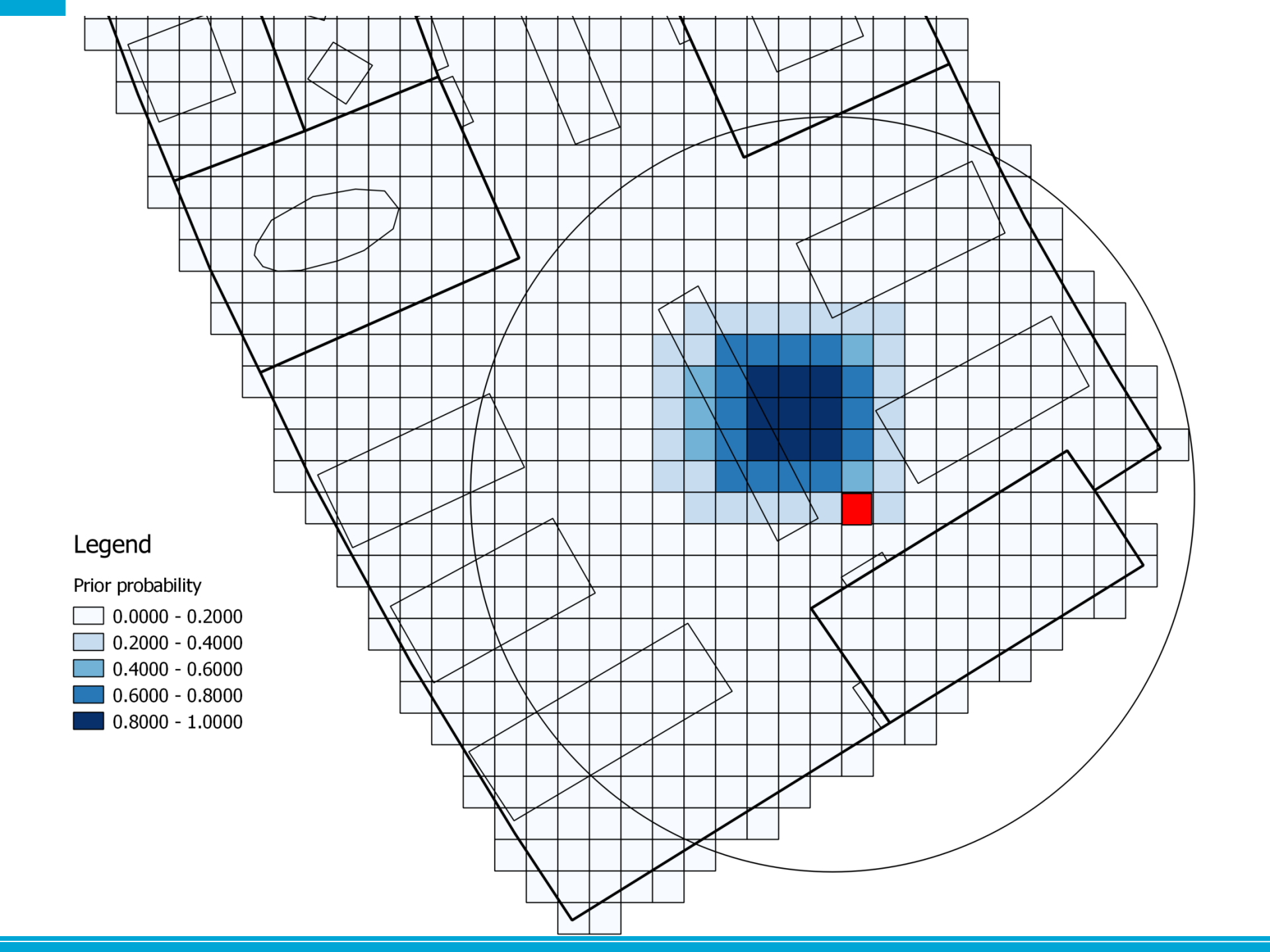
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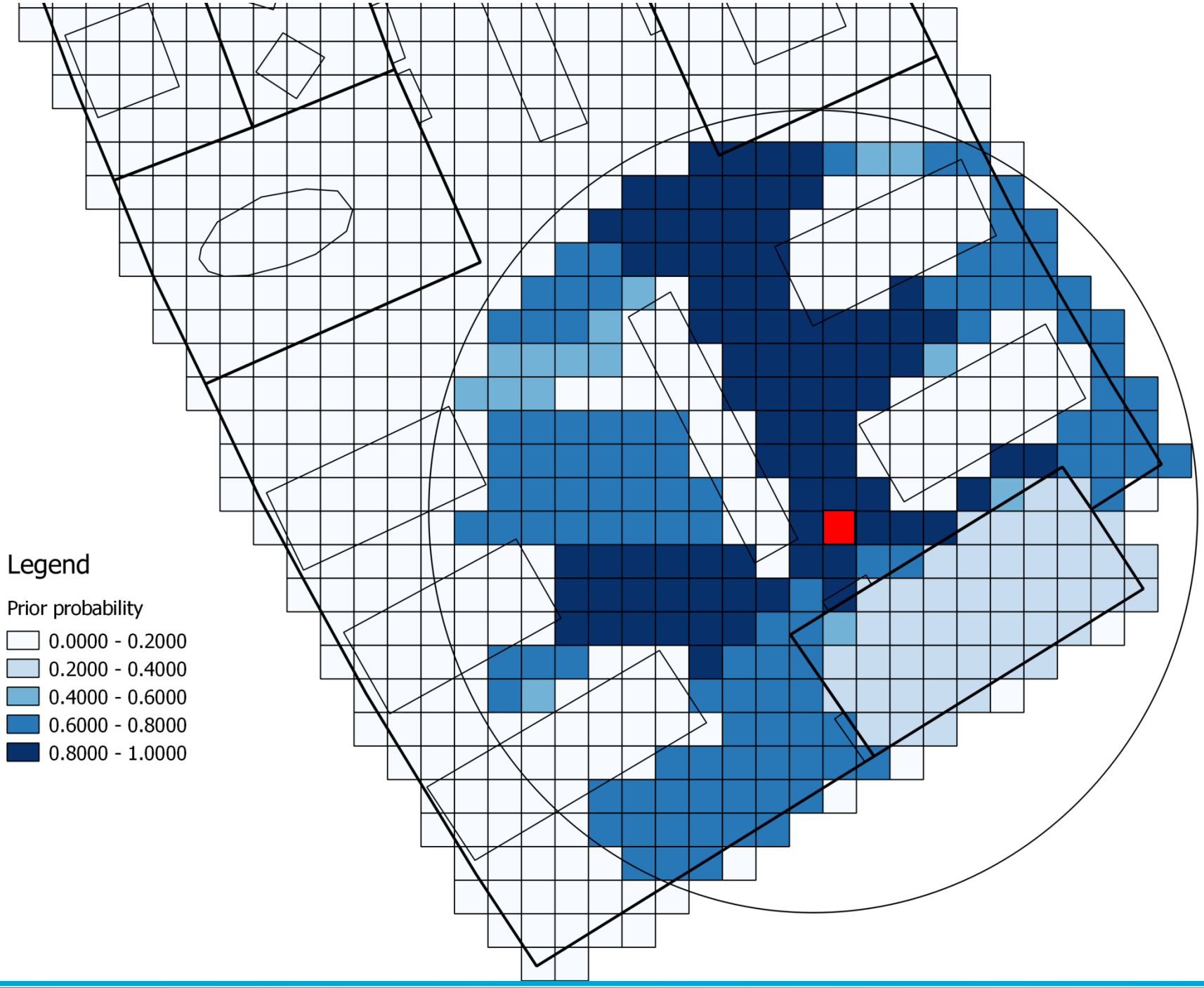
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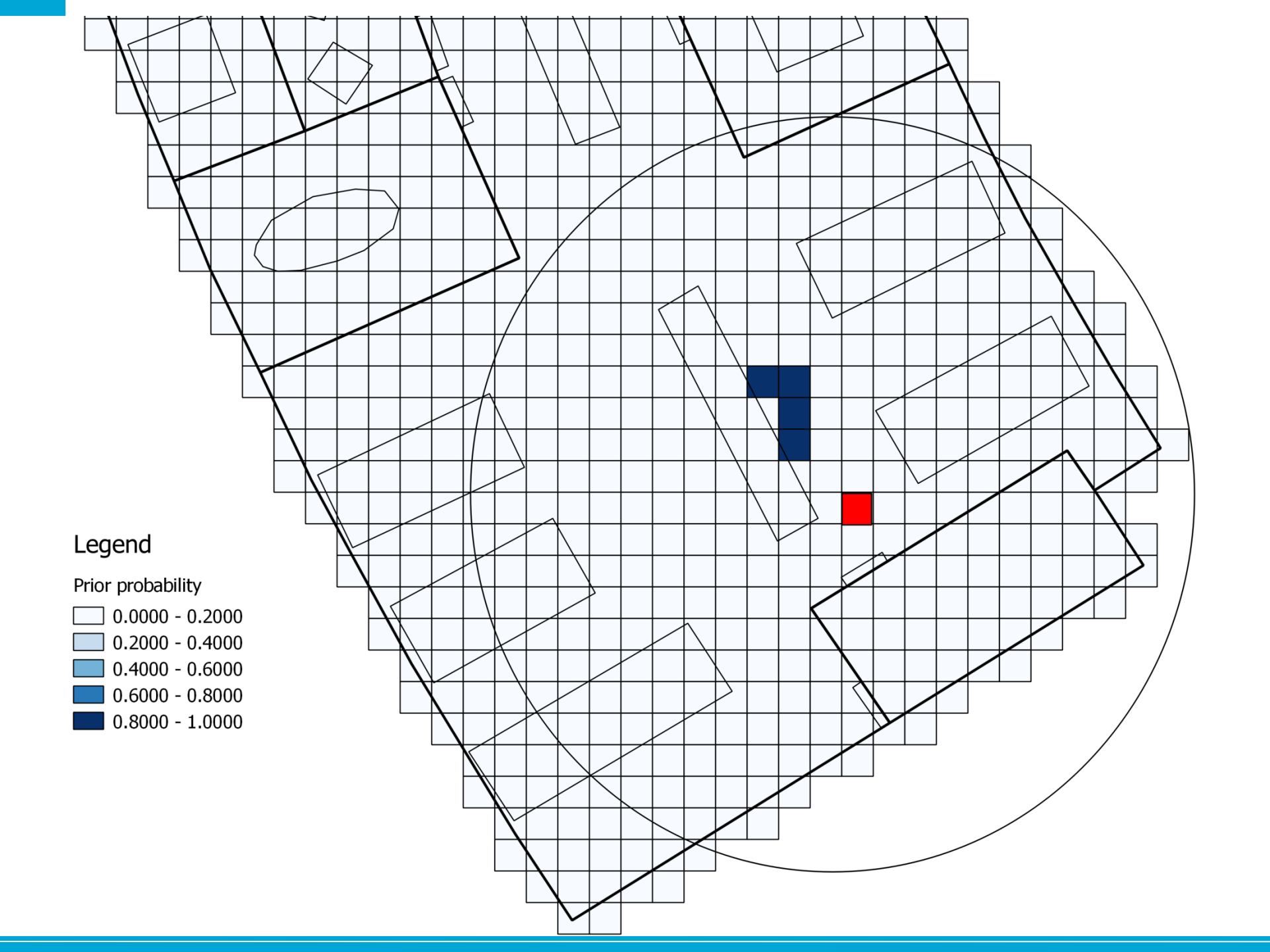
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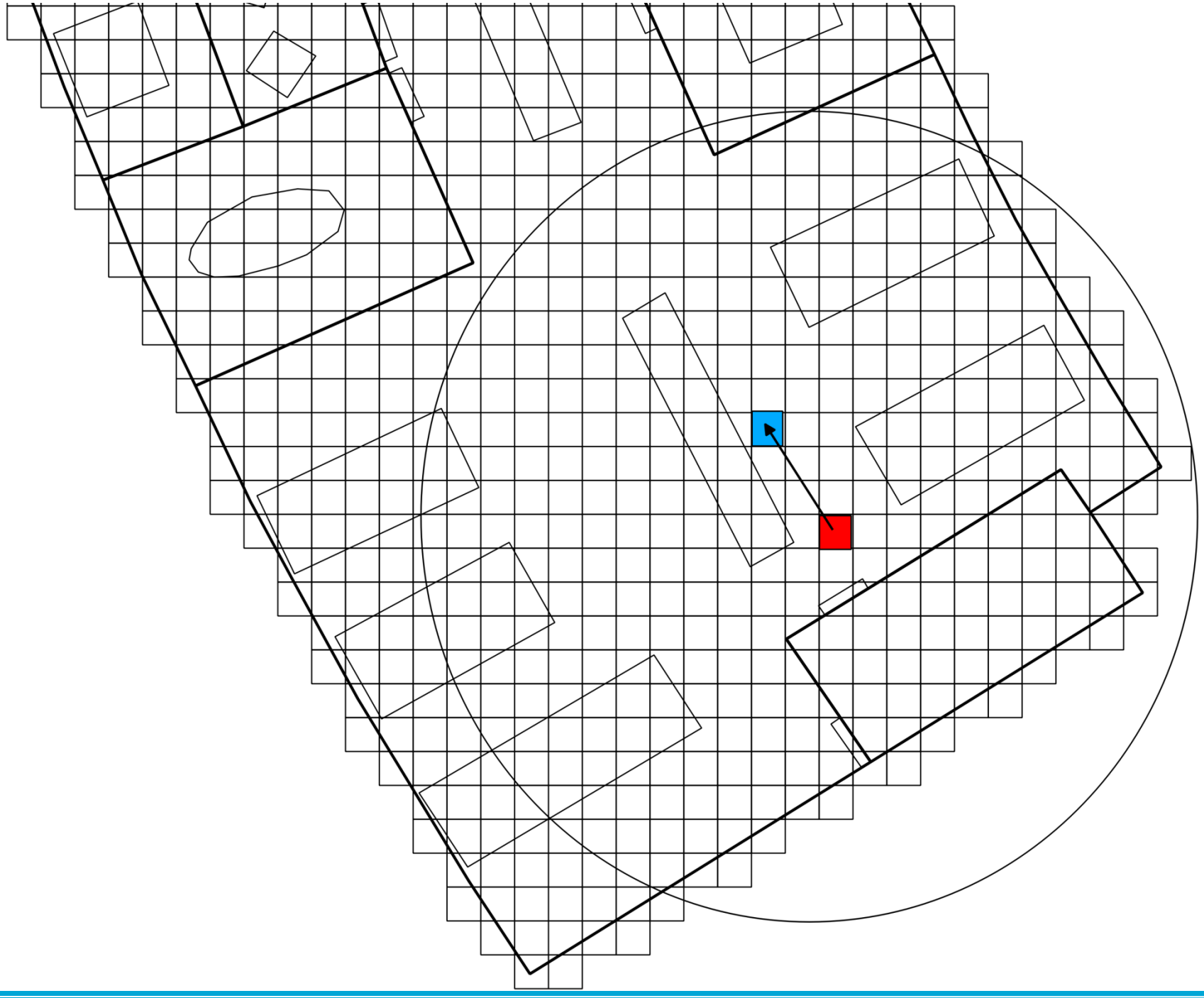


Prediction-general process

The priori position probability is computed based on three aspects:

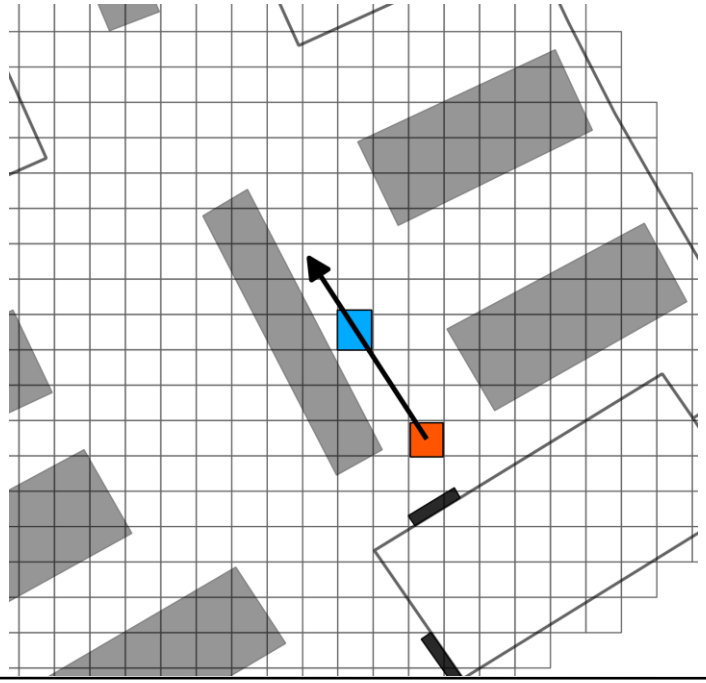
- The previous location (buffer)
- The grid model (obstacle, space, distance difference)
- The previous moving direction

Update-general process

1. Collect measurements
2. Remove outliers of WiFi locations
3. Determine the space property of the current location
4. Update position probability grids based on WiFi locations
5. Find the location with the maximum probability

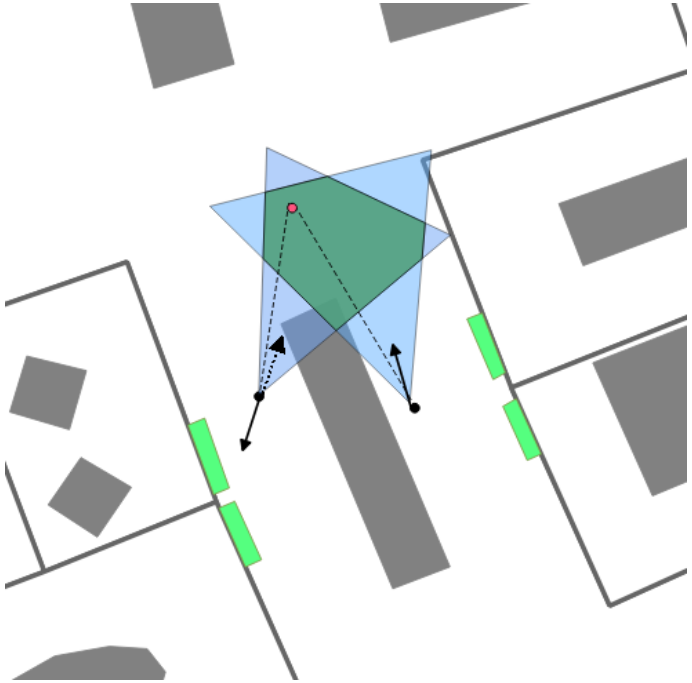
Special case: no WiFi location

- Predication (general process)
- Update based on the current moving direction(estimation)
- Check estimation error



Special case: turning

- Find the turning point
- General process



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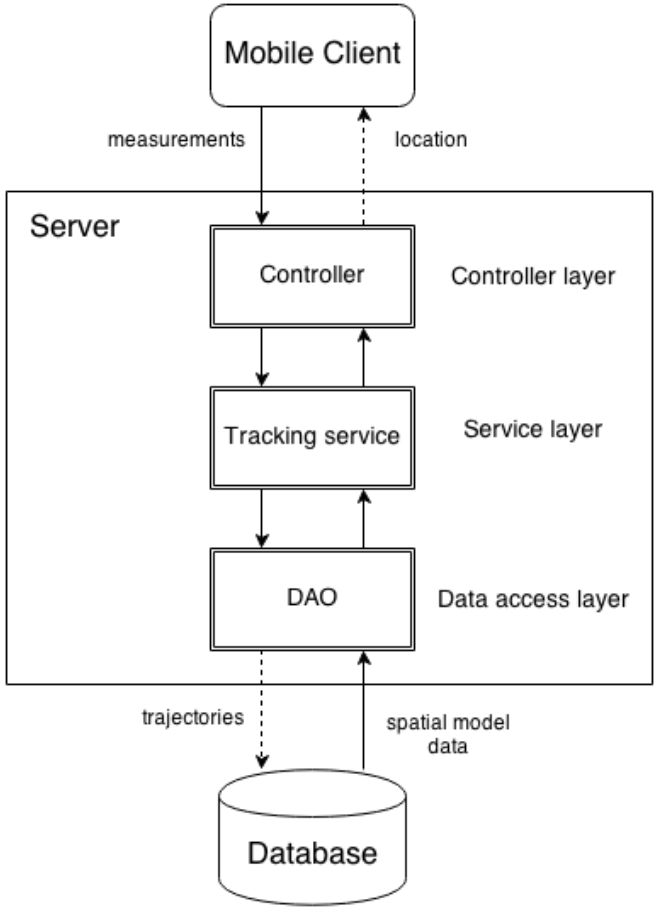
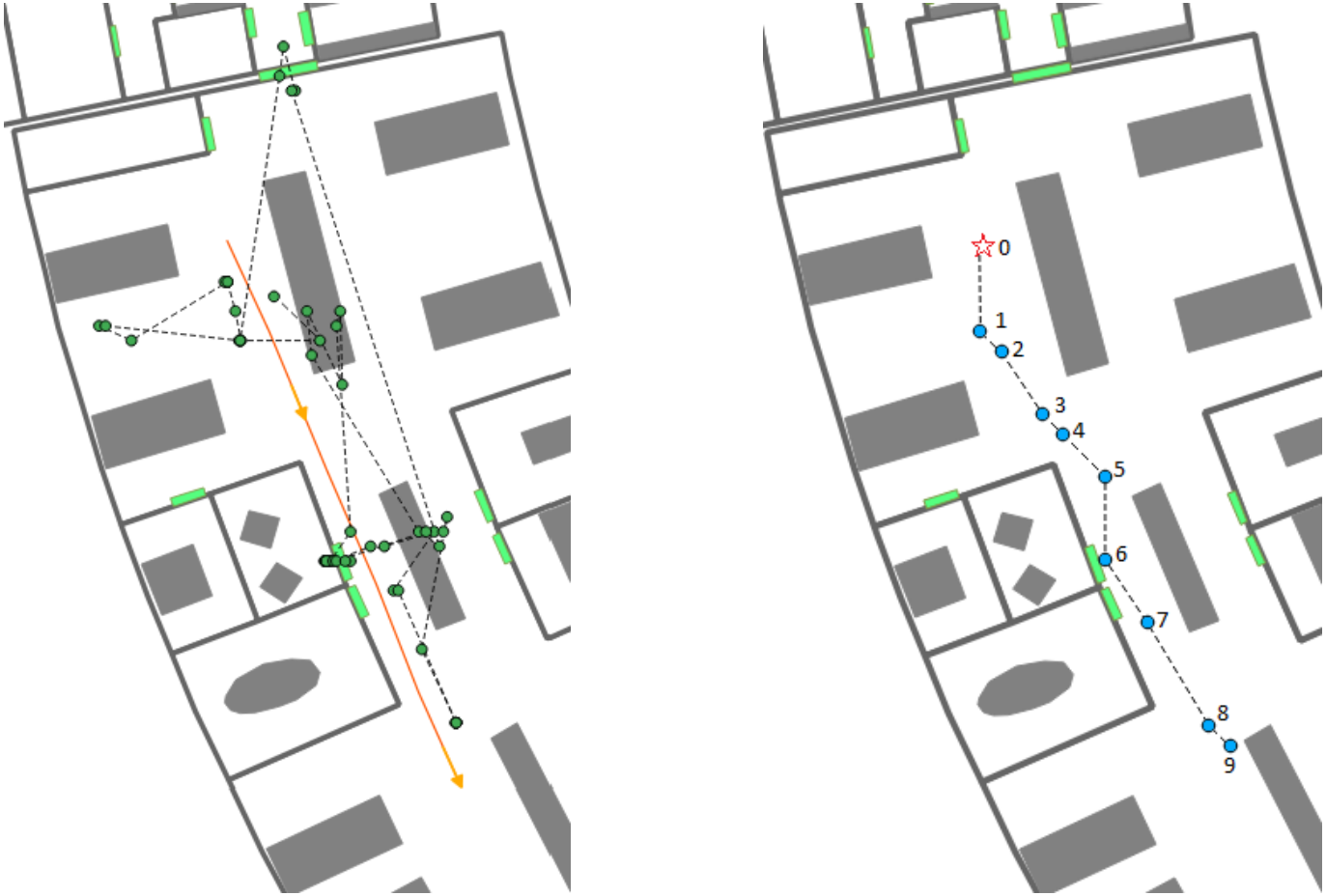
System implementation

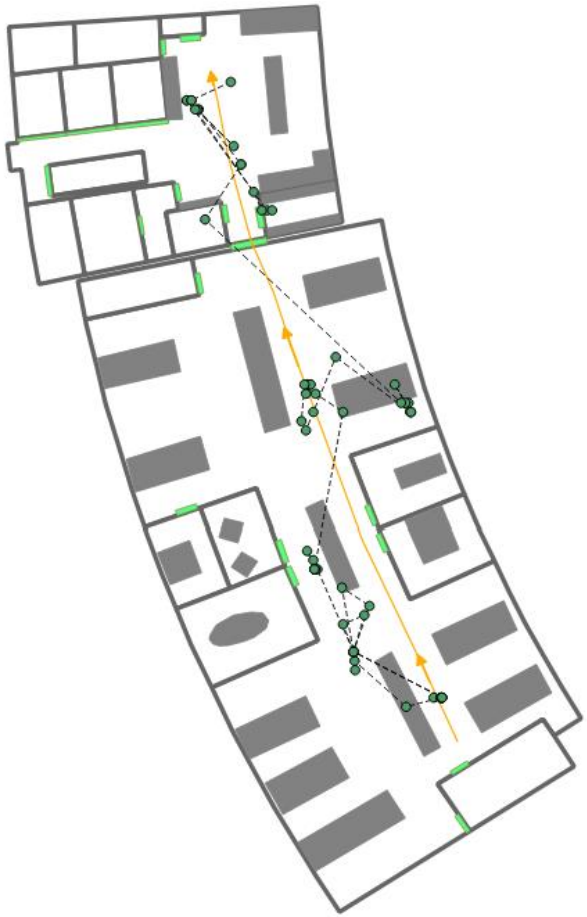


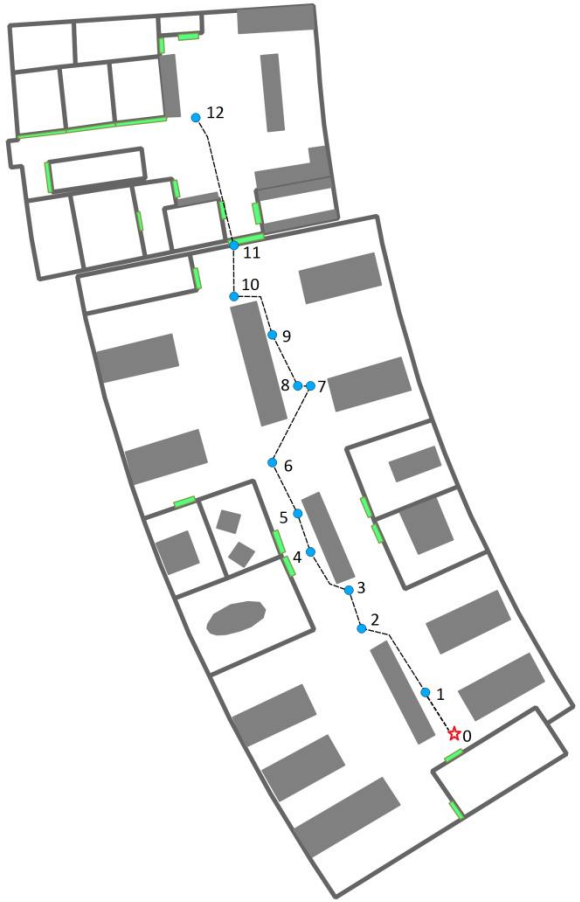
- Mobile client
  - Collect measurements
- Server
  - Connect mobile client and database
  - Implement tracking algorithm
- Database
  - Store the grid model

Experiment – Tracking in one space

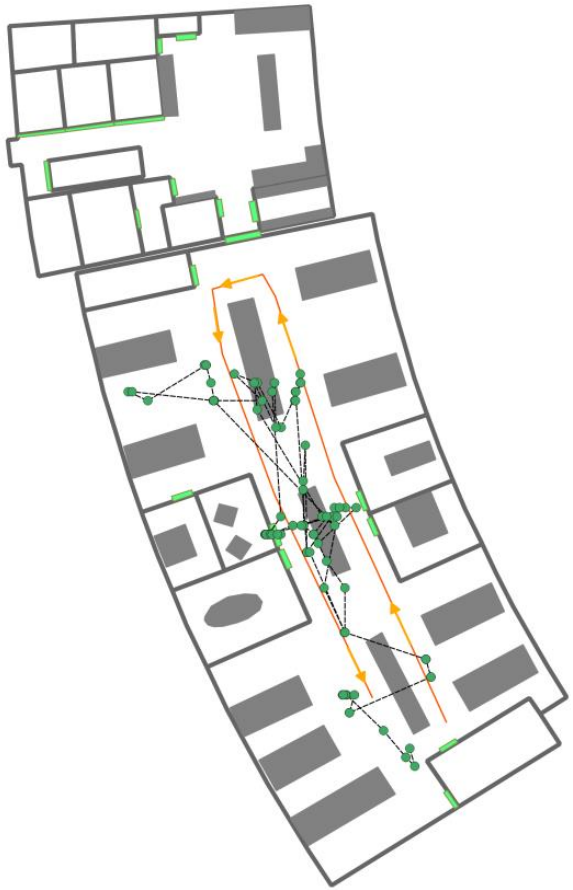


Experiment – Tracking between spaces

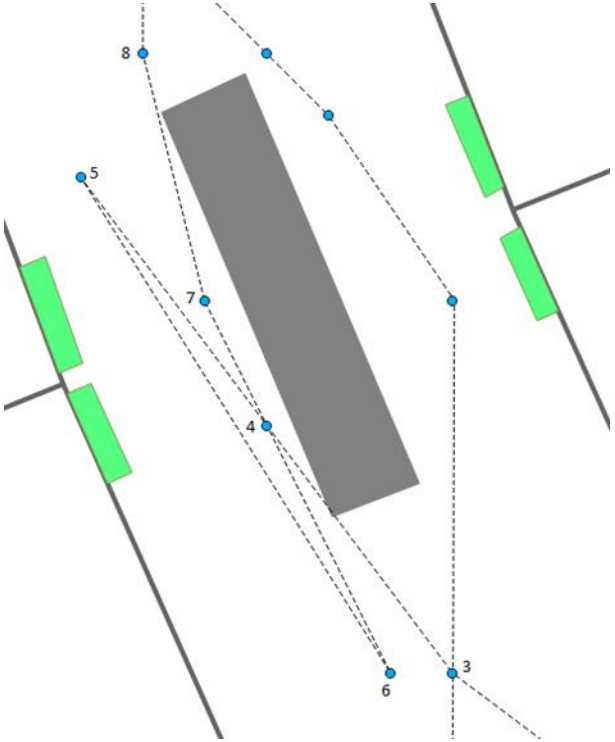




Experiment – Tracking with turning



Experiment – Tracking with turning



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Conclusion

What contributions can spatial models make to reducing tracking errors of WiFi technology for indoor navigation?

The grid model is suitable for tracking purpose.

The geometry, topology and semantics are used to predict position probability, determine the space property of the current location, and find the turning point.

The experiments show the algorithm can reduce tracking errors.

Future work

The spatial model:

- 2D to 3D ?

The algorithm:

- Parameter optimization
- No constant walking speed
- Device rotation

The experiment:

- larger and more complex environment

Questions?

Thanks!