Multi-Robot/Coordinated SLAM with Particle Filters

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Overview

Single Robot/Multi-Robot SLAM

- Single Robot
  - Very slow to map a large area
  - Increase speed $\rightarrow$ increase noise/decrease accuracy
  - Not robust: single point of failure
- Multi-Robot SLAM (MRSLAM)
  - SLAM with multiple robots searching the space and communicating with each other
  - May still use slower robots
  - May have robot failure, but still achieve mapping objective

Challenges of MRSLAM

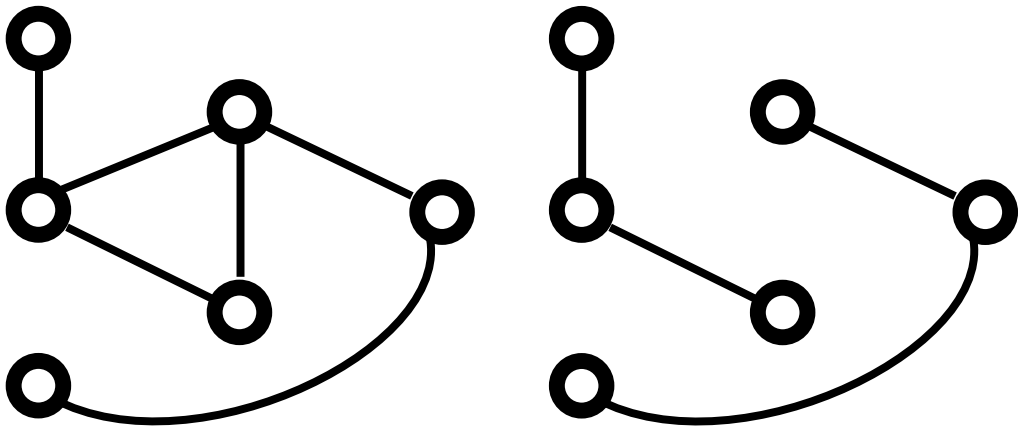
- Often do not know initial poses
  - Need to calculate relative poses
- Complexity
  - Exploration/Coordination, efficiently move with little overlap and to get as much coverage as possible
- Each robot is taking measurements in its own frame
  - How to transform the pose data?
  - How to combine the data?
  - How to create a global map?

Solving MRSLAM

- Most papers solve 1 problem at a time
  - Coordination
  - Map Merging
- Focus: Howard, 2006
  - Answers map merging problem
  - All robots store sensor data for both odometry and measurements
  - Starts with a single robot, stored data integrated transformed data into the map posterior post encounter

MRSLAM Assumptions

- Robots move independently of each other
- Can determine the relative poses of each robot perfectly on an encounter
- Continued communication post encounter
- Robot encounters form a connected graph



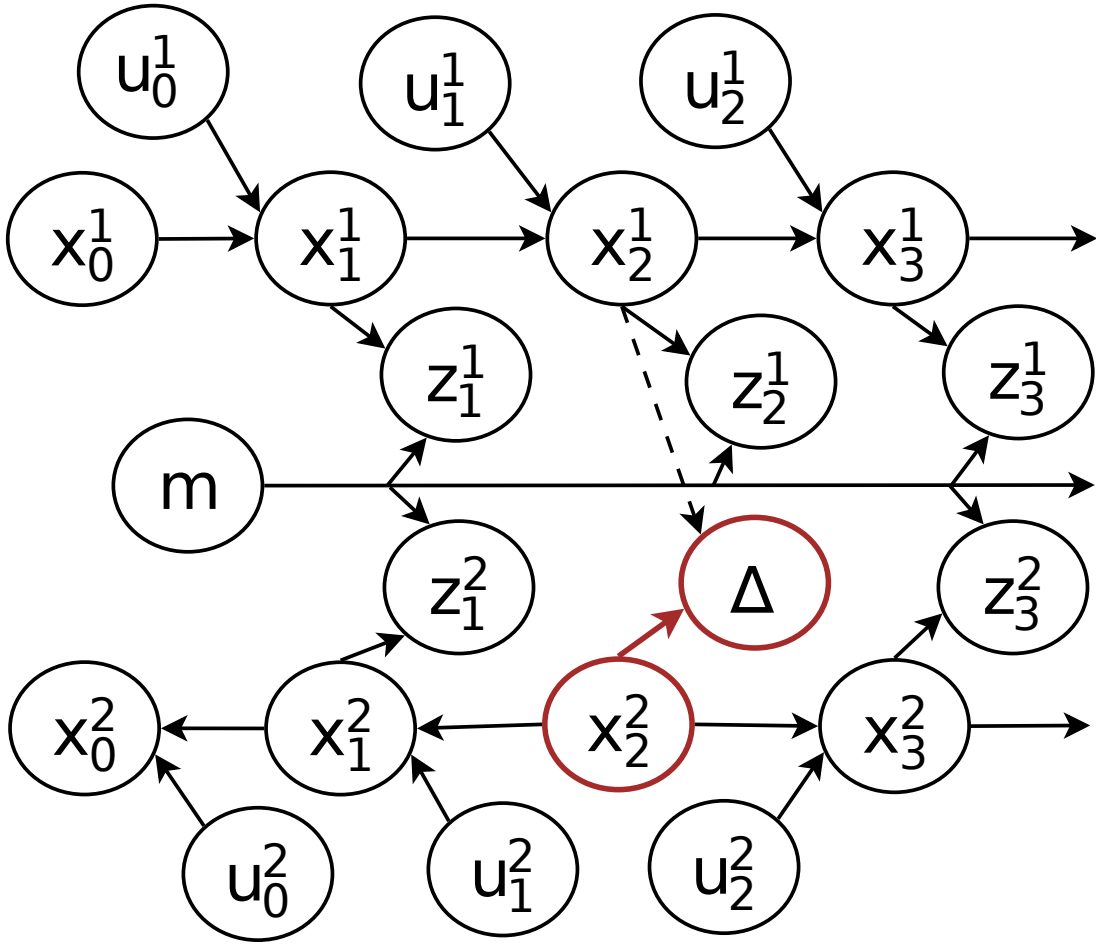
Connected Not Connected

[Howard, 2006] Algorithm

- Occupancy Grid FastSLAM
- Store $(u_t, z_t, encounter_t)$ data
- On encounter, replay past data in reverse order
- Post encounter integrate stored information into the map posterior in an acausal update
- Continue communication to integrate future odometry and encounters

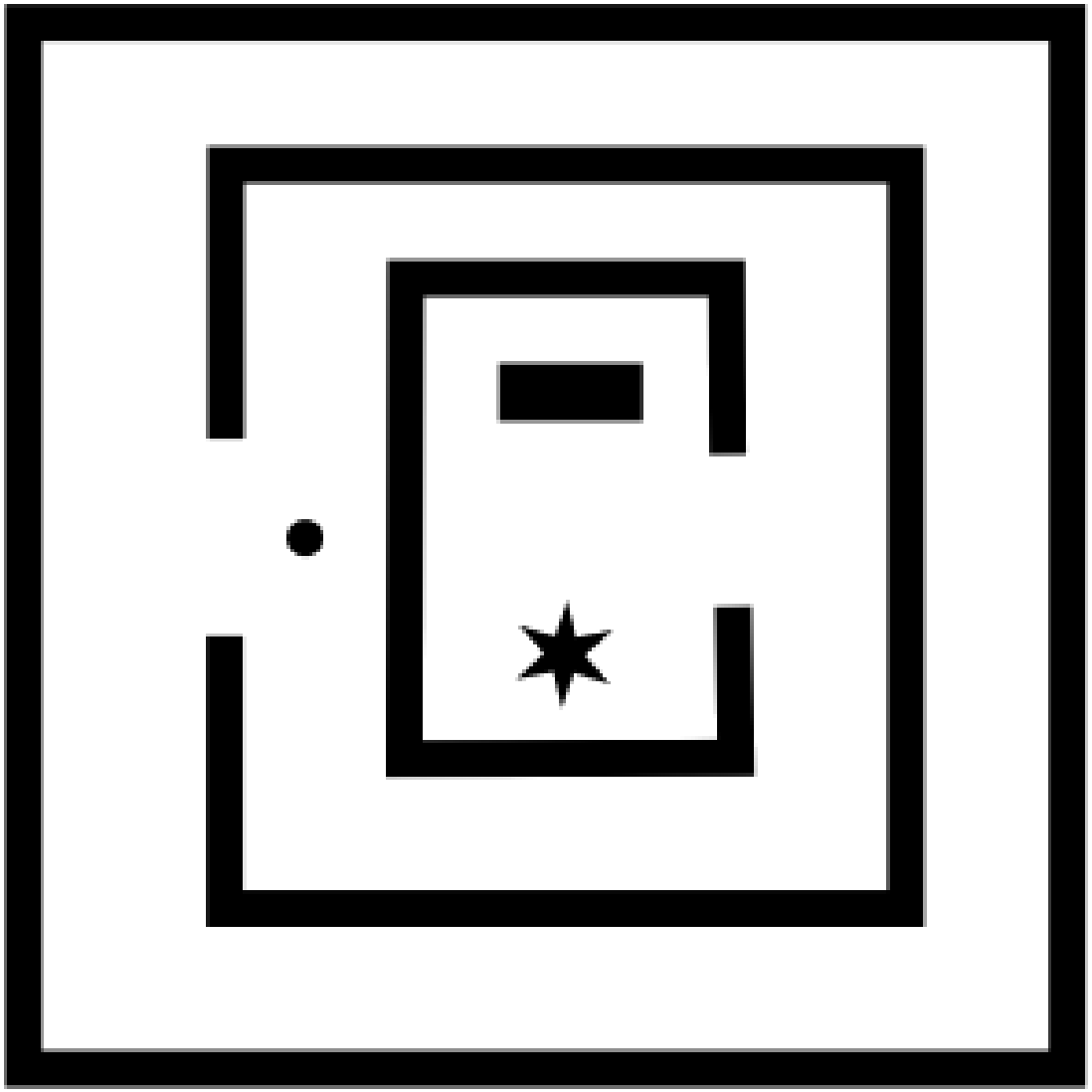
[Howard, 2006] Algorithm

Causal/Acausal Updates

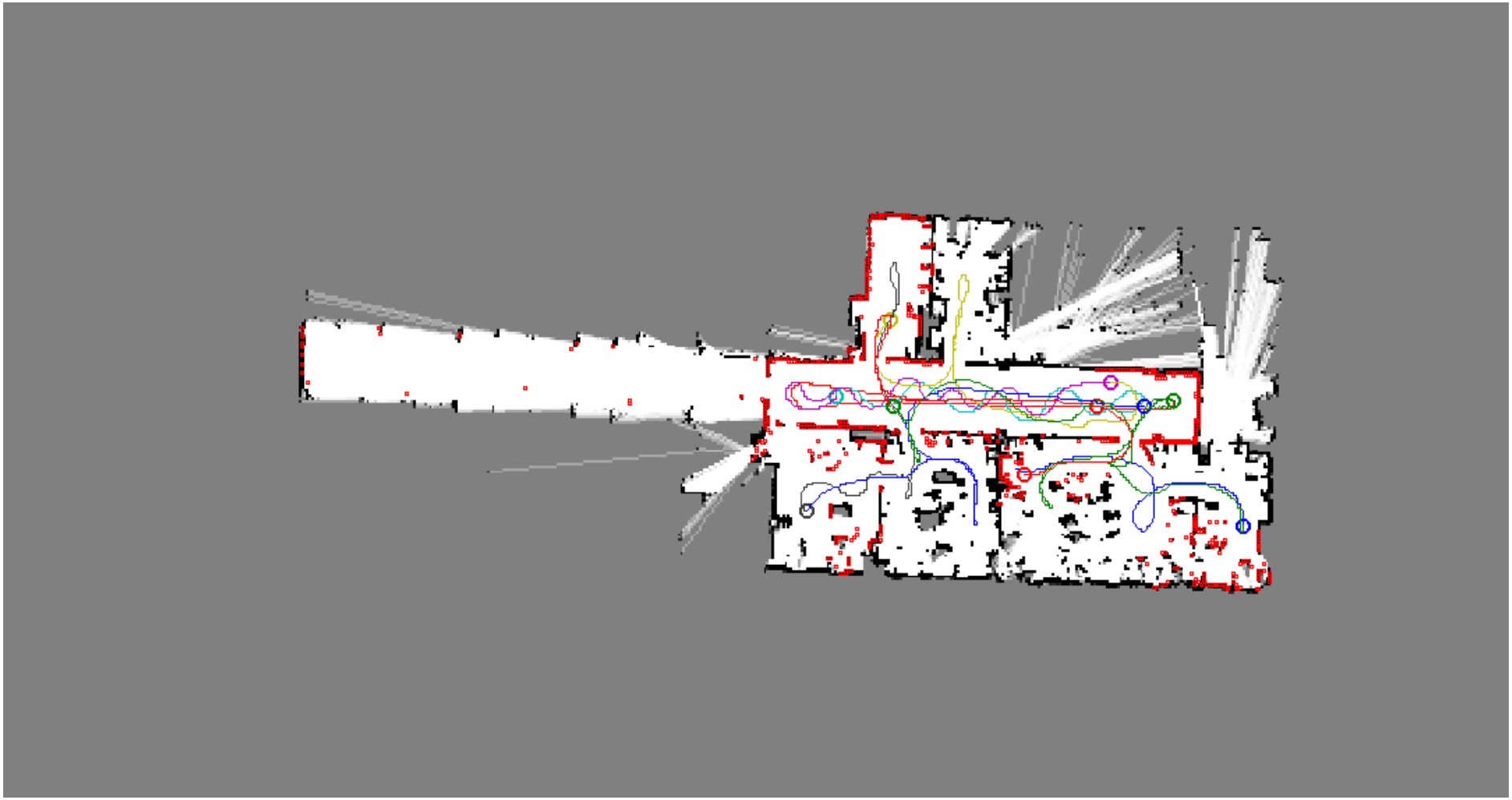


The Tests

- Occupancy Grid
  - Custom Map
  - m robots



Validation



Conclusions

- Conclusions:
  -
- Future work:
  - Decrease
  - Make it work on Albert B data set

Further Reading

[1] S. Thrun, W. Burgard, and D. Fox
"Probabilistic Robotics."
MIT press, 2005.

[2] A. Howard.
"Multi-robot simultaneous localization and mapping using particle filters."
The International Journal of Robotics Research, 2006.

[3] A. Birk, and S. Carpin.
"Merging occupancy grid maps from multiple robots."
Proceedings of the IEEE, 2006.

Questions...