Ghost Robotics

Estimation, Control and Planning for Aggressive Flight with a Small Quadrotor with a Single Camera and IMU

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- This Week
  - Today: Overview of Localization
  - Lab 4: Thursday
  - Some math review: on-line

- Next Week
  - Midterm graded: by next Tuesday
  - Localization
  - SLAM?

- Feedback
  - Guest Lecture?
  - Course survey

Mid-semester feedback

1. What do you think of the balance of theoretical vs. applied work?

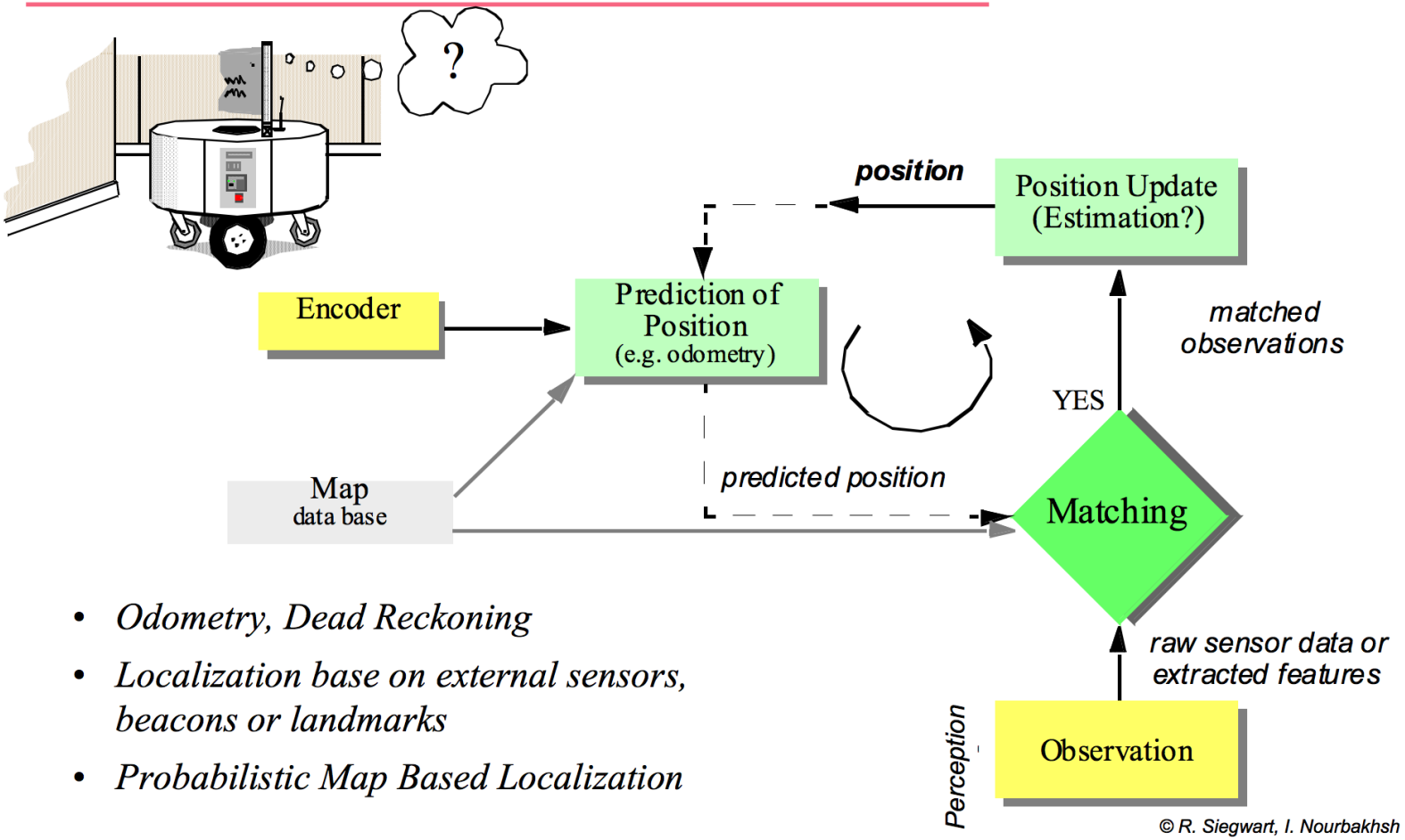
2. What's been most useful to you (and why)?

3. What's been least useful (and why)?

4. What could students do to improve the class?

5. What could Matt do to improve the class?

Localization, Where am I?

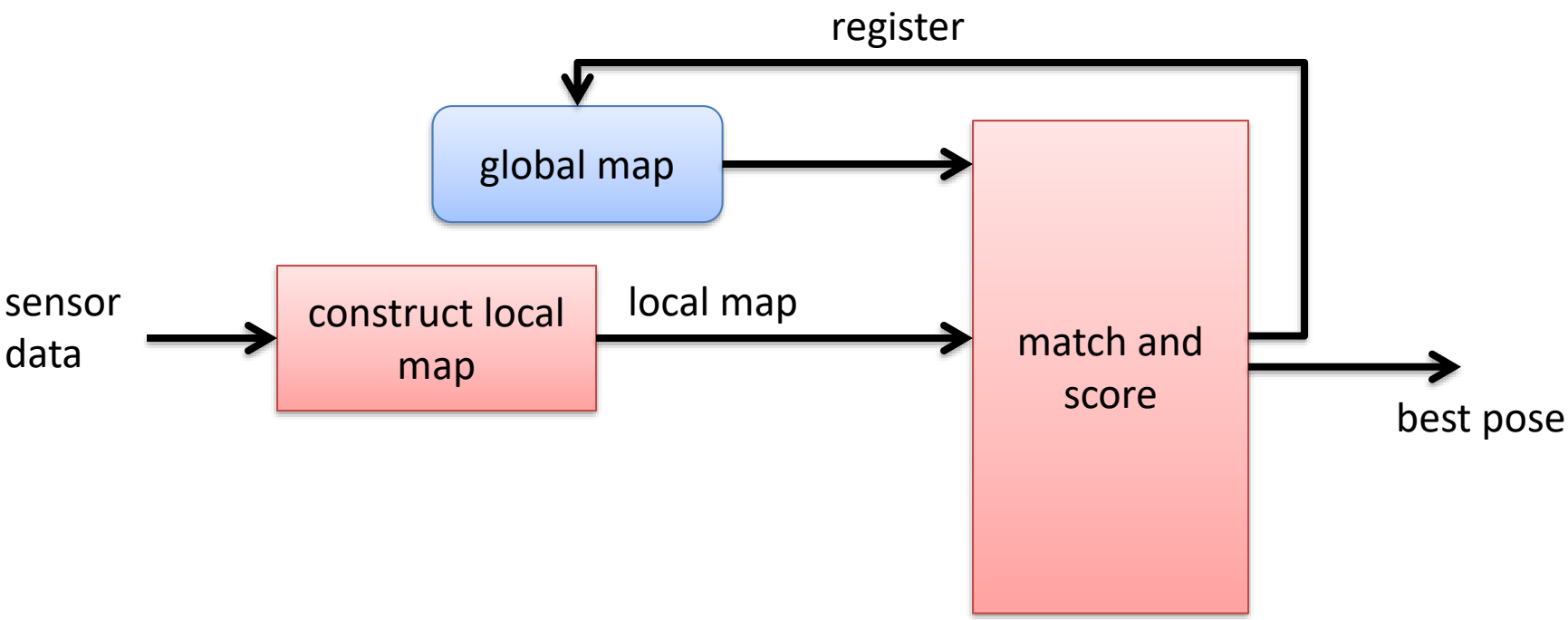


- *Odometry, Dead Reckoning*
- *Localization base on external sensors, beacons or landmarks*
- *Probabilistic Map Based Localization*

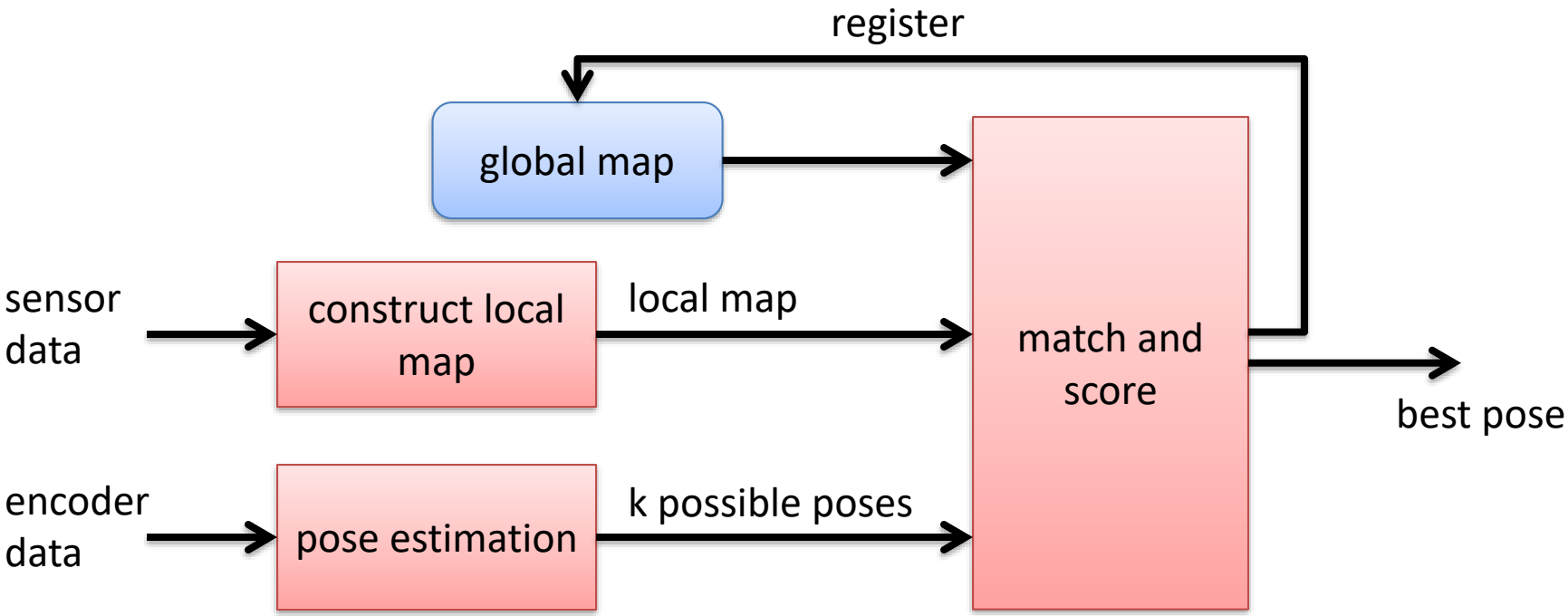
Localization

- Two types of approaches:
  - Iconic : use raw sensor data directly. Match current sensor readings with what was observed in the past
  - Feature-based : extract features of the environment, such as corners and doorways. Match current observations

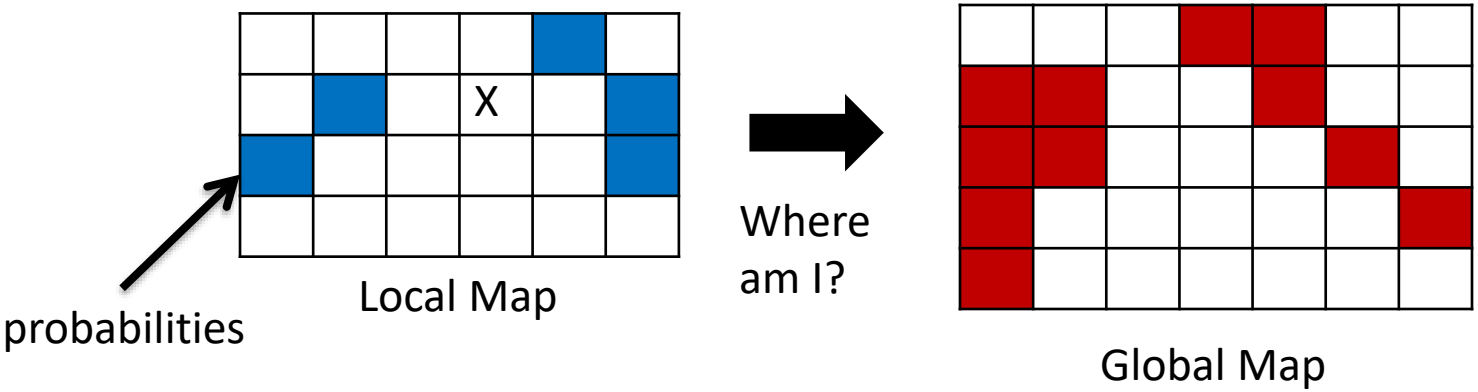
Continuous Localization and Mapping



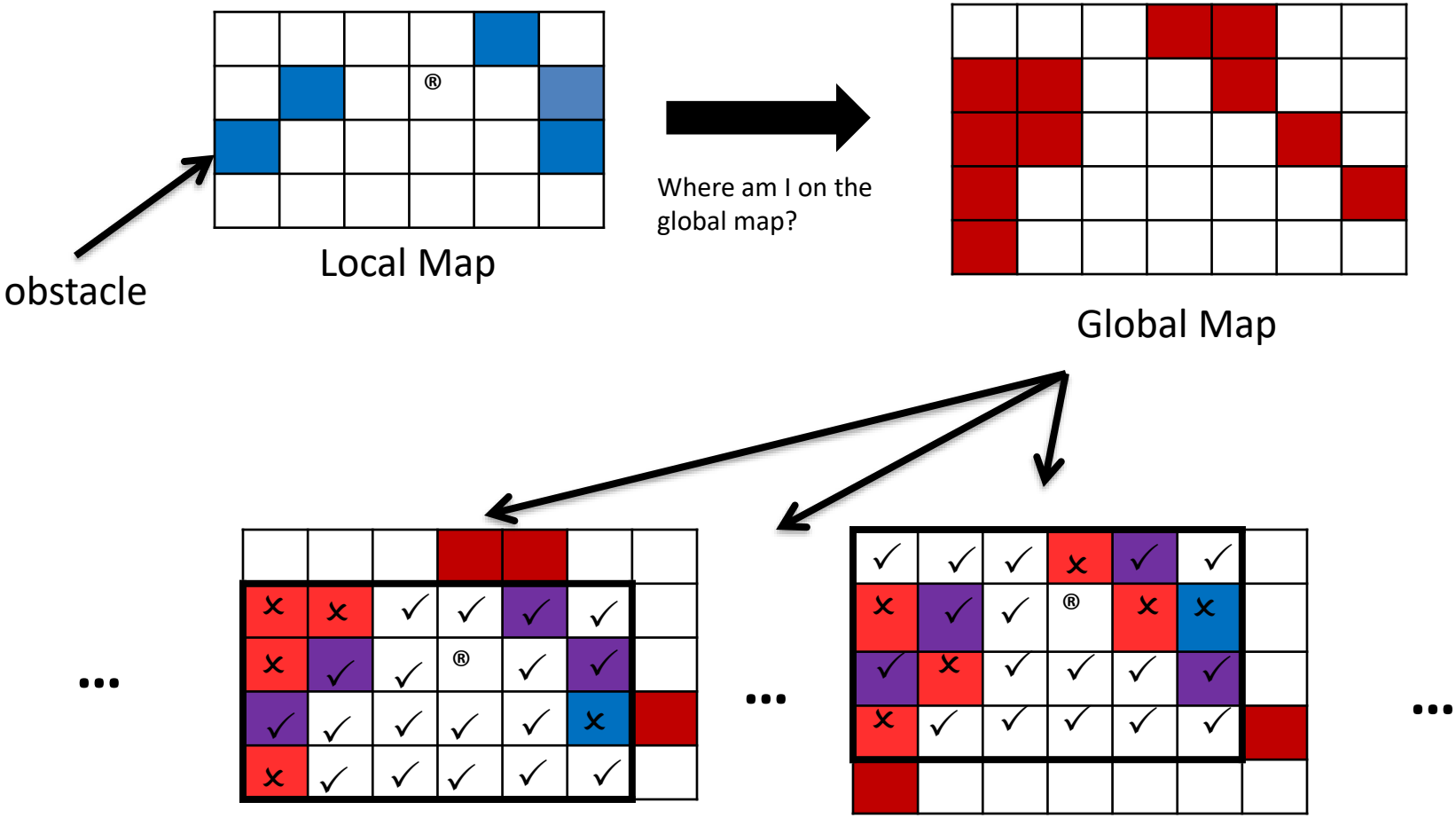
Continuous Localization and Mapping



Matching



Matching



Examine different possible robot positions.

This sounds hard. Example: Kiva (2011)

https://www.youtube.com/watch?v=6KRjuuEVEZs

Matching and Registration

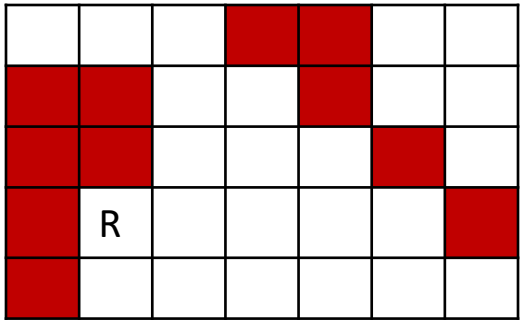
- Collect sensor readings and create a local map
- Estimate poses that the robot is likely to be in given distance traveled from last map update
  - In theory *k* is infinite
  - Discretize the space of possible positions (e.g., consider errors in increments of 5°)
  - Try to model the likely behavior of your robot. Try to account for systematic errors (e.g., robot tends to drift to one side)

Matching and Registration

- Collect n sensor readings and create a local map
- Estimate k poses (x, y, θ) that the robot is likely to be in given the distance travelled from the last map update
- For each pose k score how well the local map matches the global map at this position
- Choose the pose with the best score. Update the position of the robot to the corresponding (x, y, θ) location.

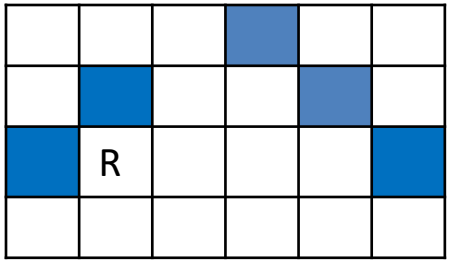
What if you were tracking multiple possible poses. How would you combine info from this with previous estimate of global position + odometry?

Example



Global Map

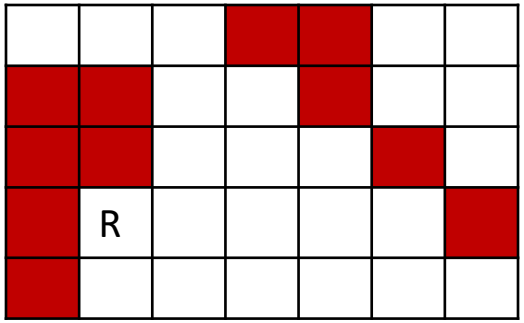
Attempt to move East



Local Map

Where is the robot?
What things would you need to know?

Example



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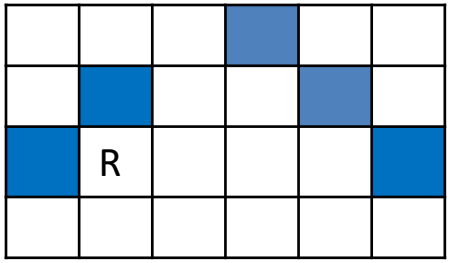
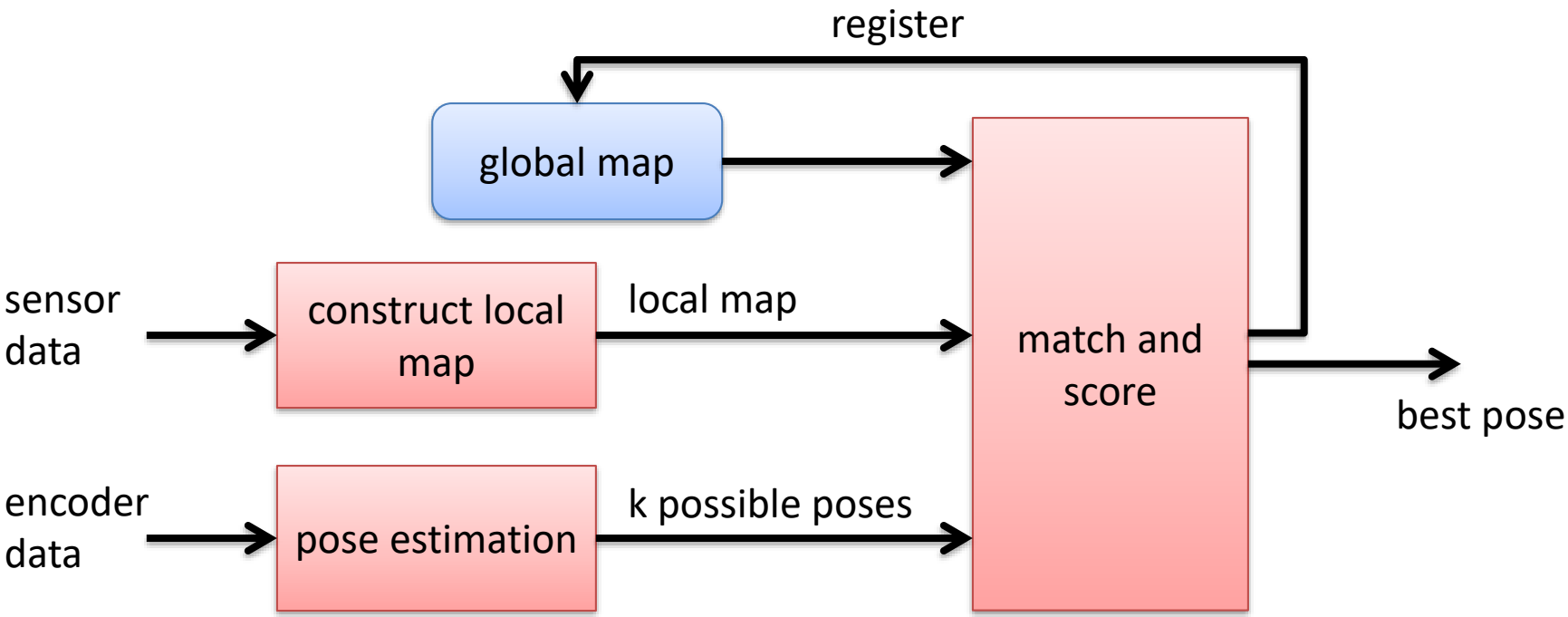
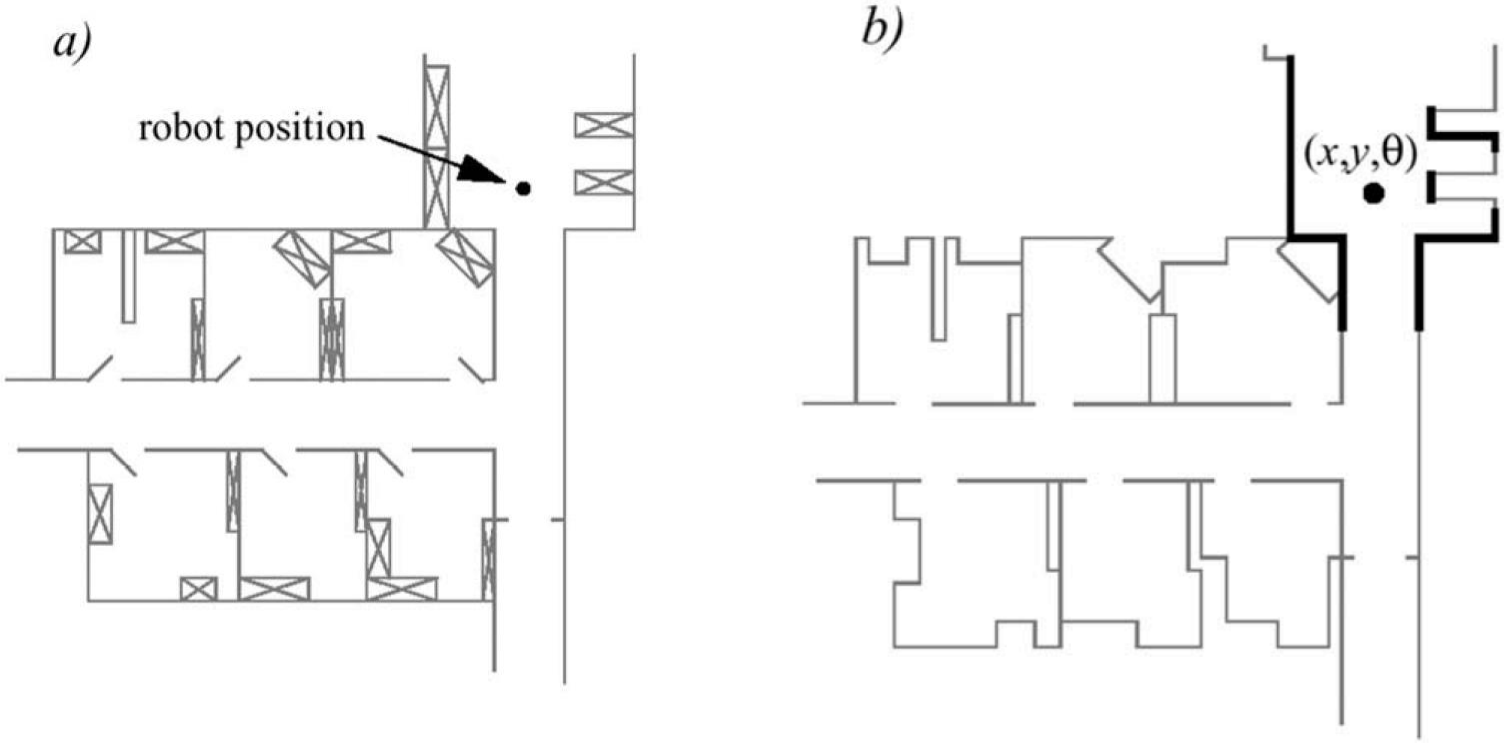


Local Map



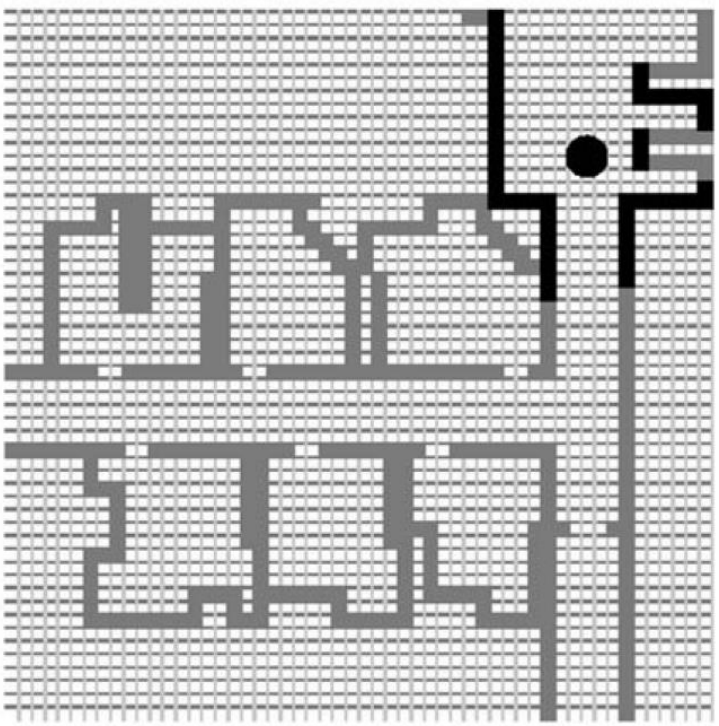
Representations



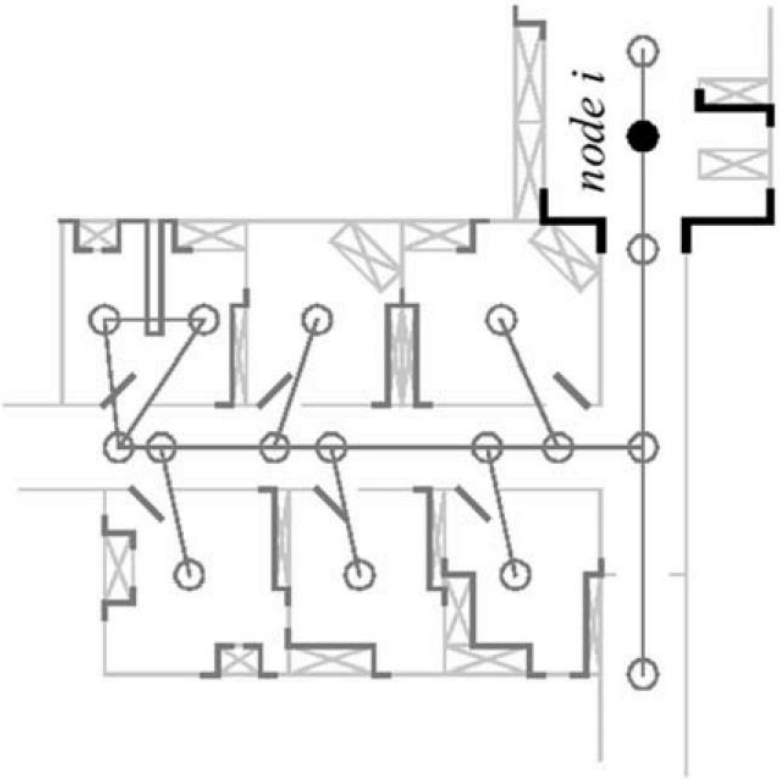
line-based map (~100 lines)

Representations

One location vs. location distribution



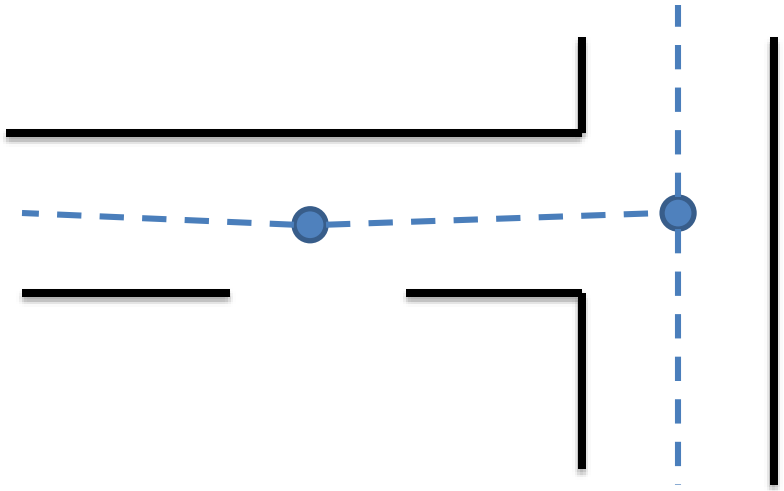
Grid-based map (3000 cells)



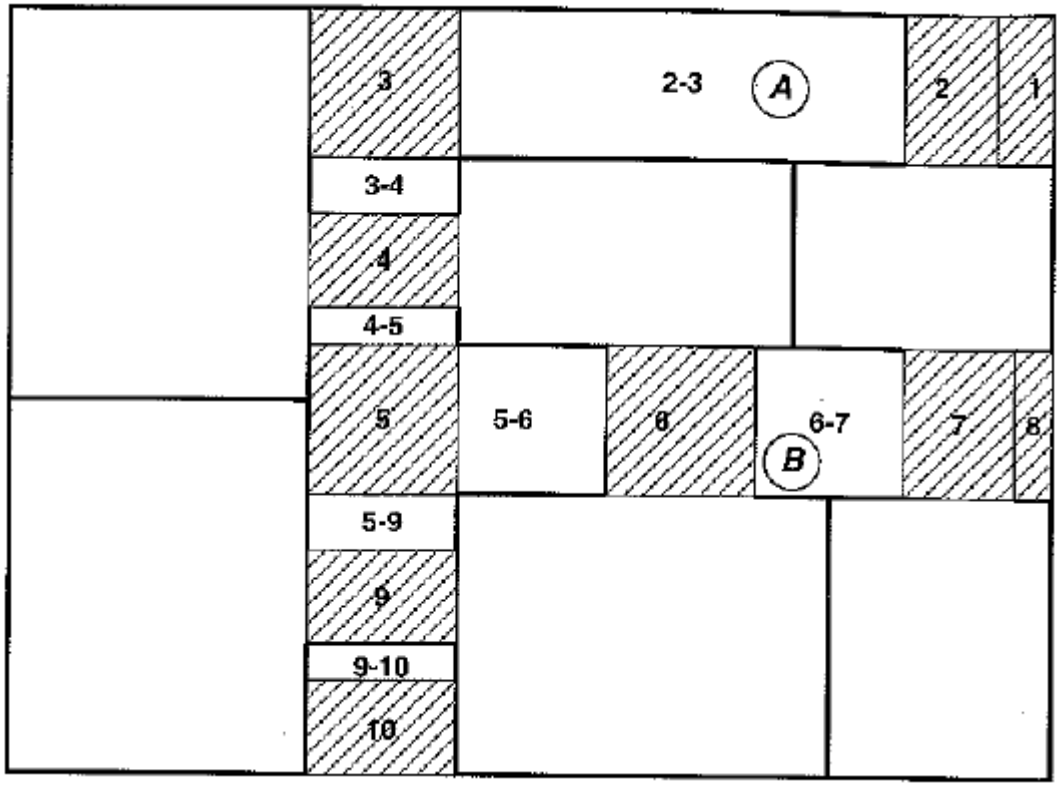
Topological map (50 features, 18 nodes)

Feature-Based Localization

- Extract features such as doorways, corners and intersections
- Either
  - Use continuous localization to try and match features at each update
  - Use topological information to create a graph of the environment

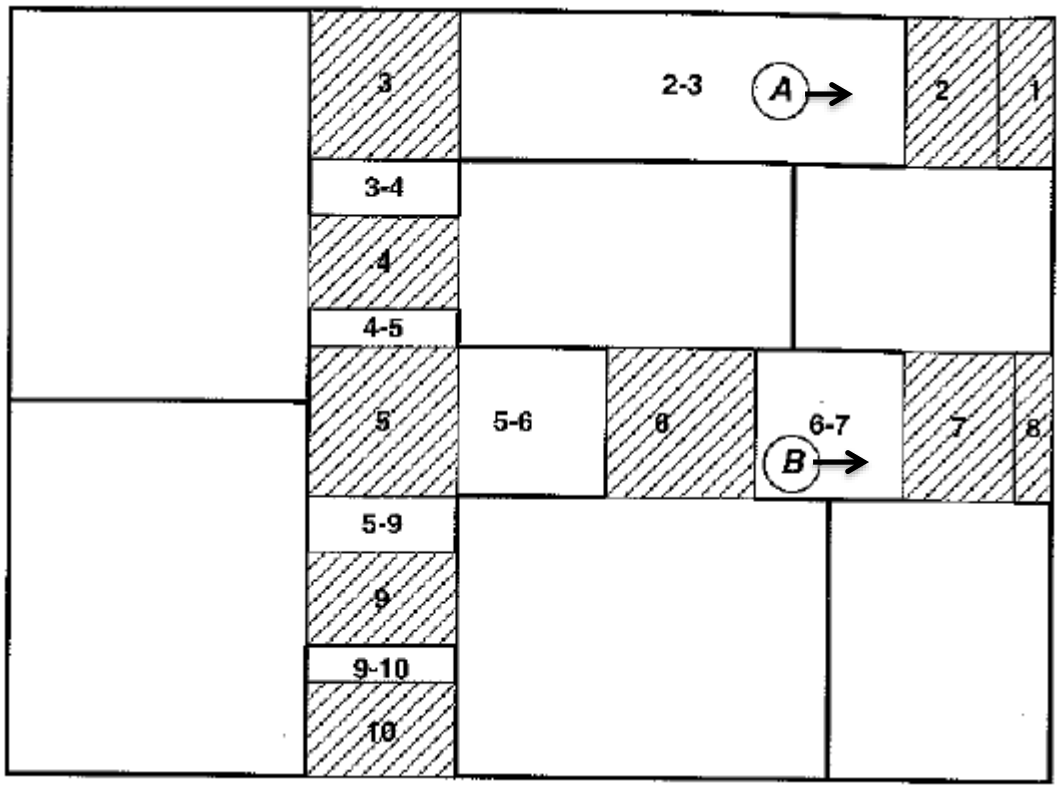


Topological Map of Office Building



- The robot has identified 10 doorways, marked by single number.
- Hallways between doorways labeled by gateway-gateway pairing.

Topological Map of Office Building

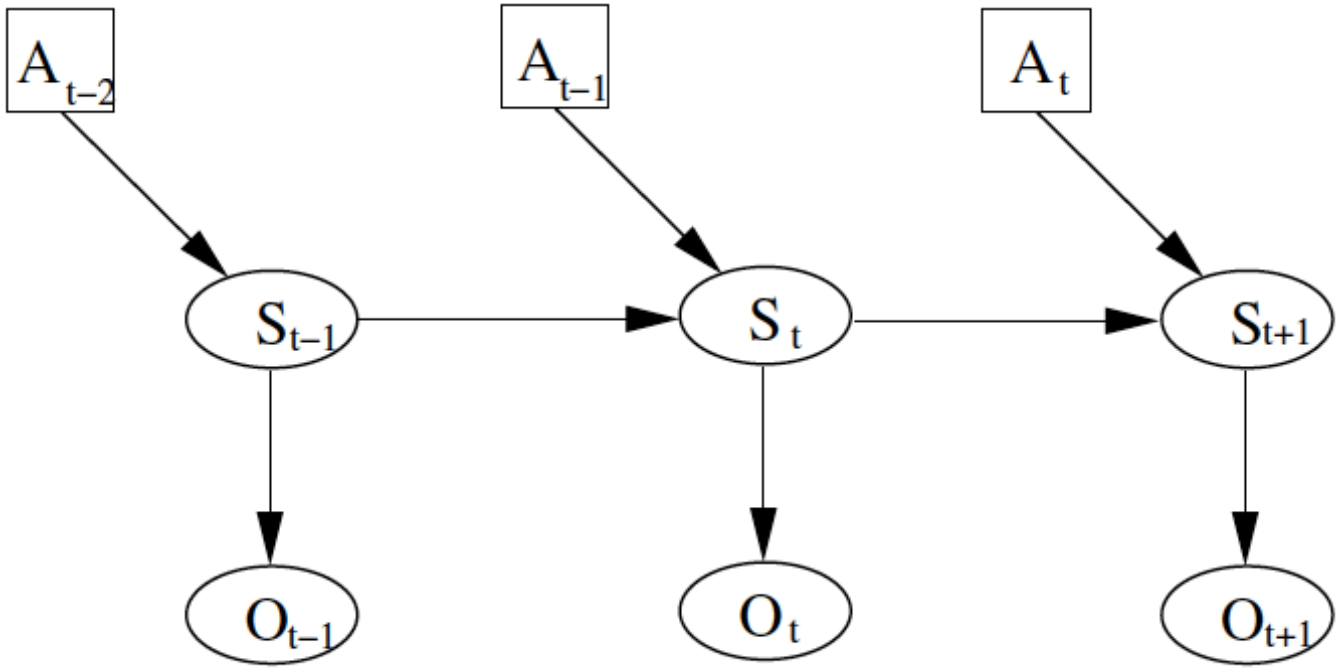


- What if the robot is told it is at position A but it's actually at B. How could it correct that information?

Localization Problem(s)

- Position Tracking
- Global Localization
- Kidnapped Robot Problem
- Multi-Robot Localization

- General approach:



- A: action
- S: pose
- O: observation

Position at time t depends on position previous position and action, and current observation