Where am I?

Triangulation, Kalmanfilter and Monte-Carlo localization

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Overview

Triangulation

Kalmanfilter

Monte-Carlo localization

Problems

Errors in sensor information

„kidnapped robot problem“

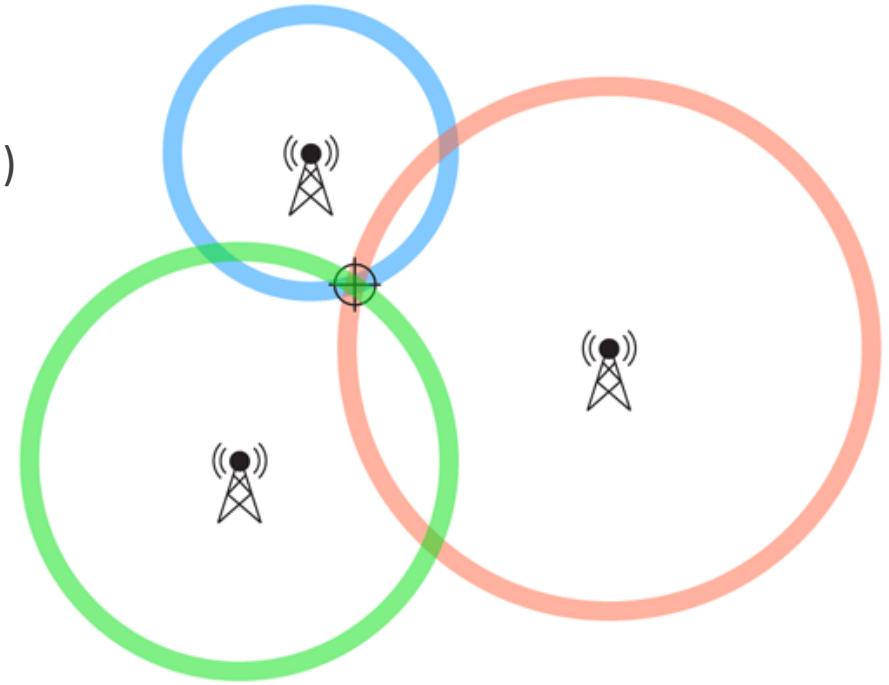
Finding the right pose (direction + position of the robot)

Triangulation

Typically three landmarks (more are possible)

Multiple ways to detect

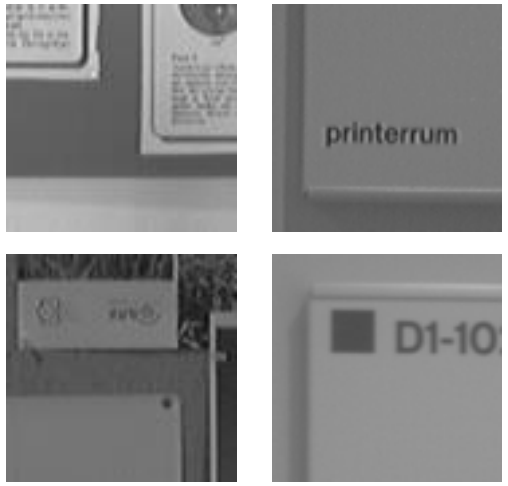
- GPS
- Images (Poster, light switches, traffic lights, light sources, …)



https://i2.wp.com/bigpicturequestions.com/wp-content/uploads/2014/04/triangulation.png

Triangulation

Images

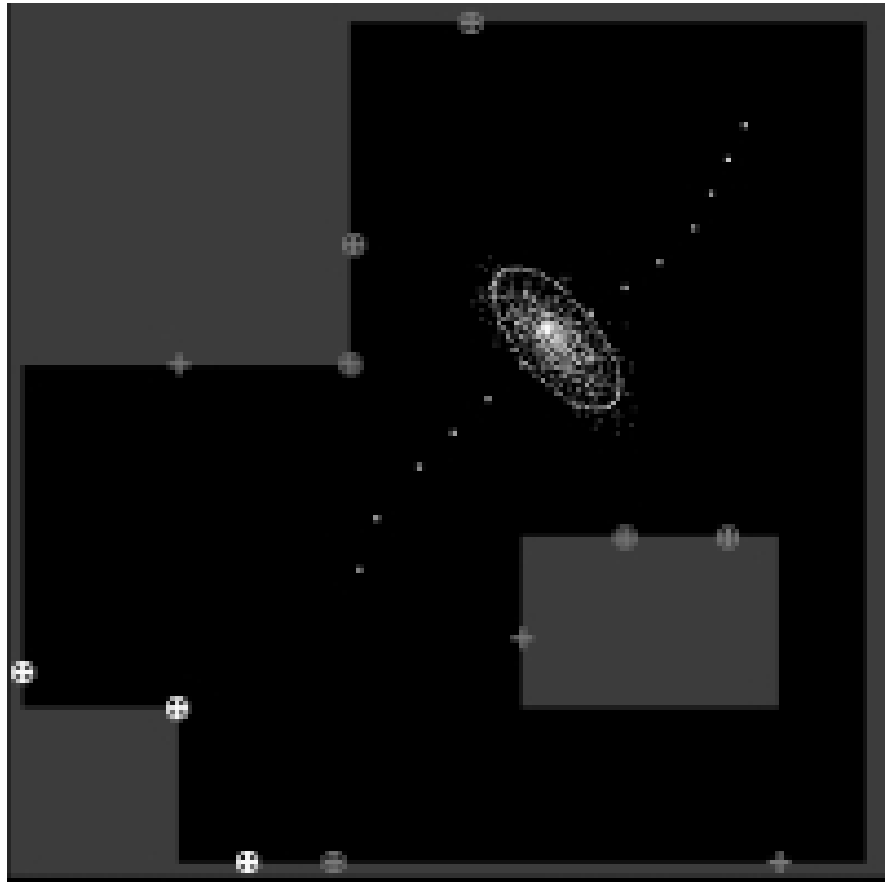


Triangulation

Limitations

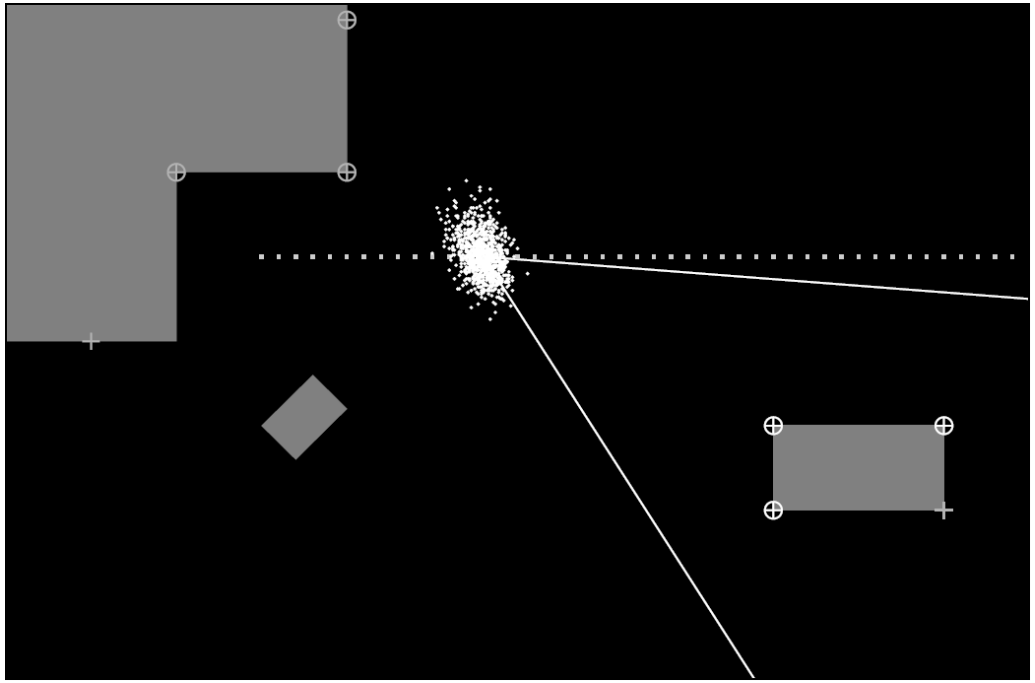
15m x 15m

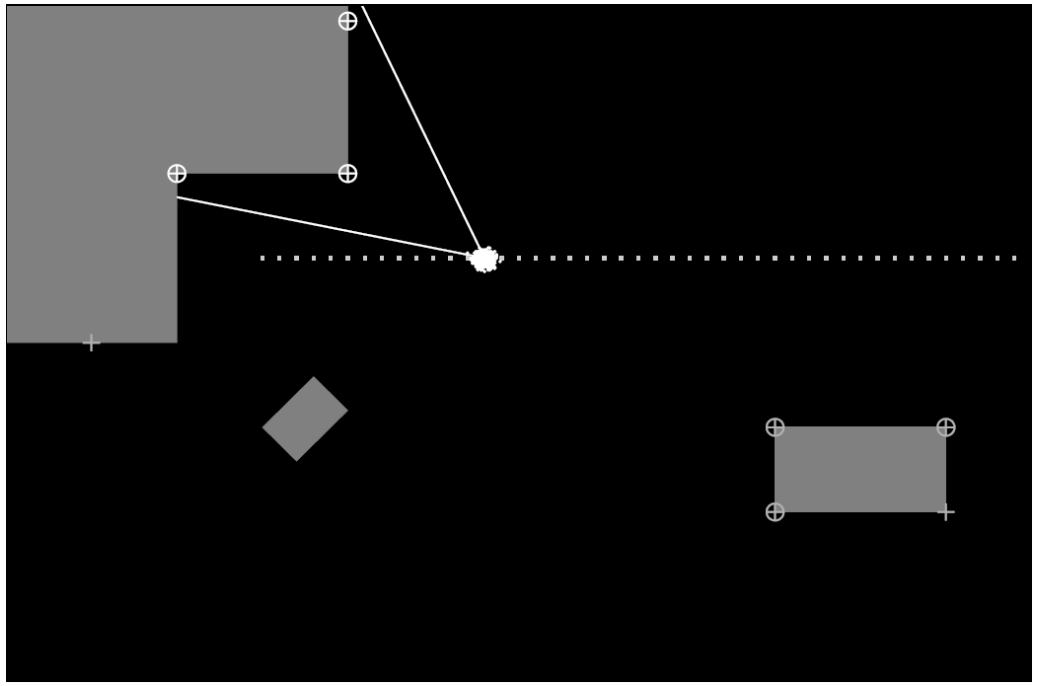
~2m x 1m area



Triangulation

Choose the right landmarks





Triangulation

Choose the right landmarks

1. Determine the set of visible landmarks using the current position estimate
2. Find all possible combinations (not permutations) of three visible landmarks (triplets)
3. Determine the set of landmark triplets that are within the same field of view
4. Compute a goodness measure for all such triplets
5. Rank triplets according to goodness measure and choose best

Triangulation

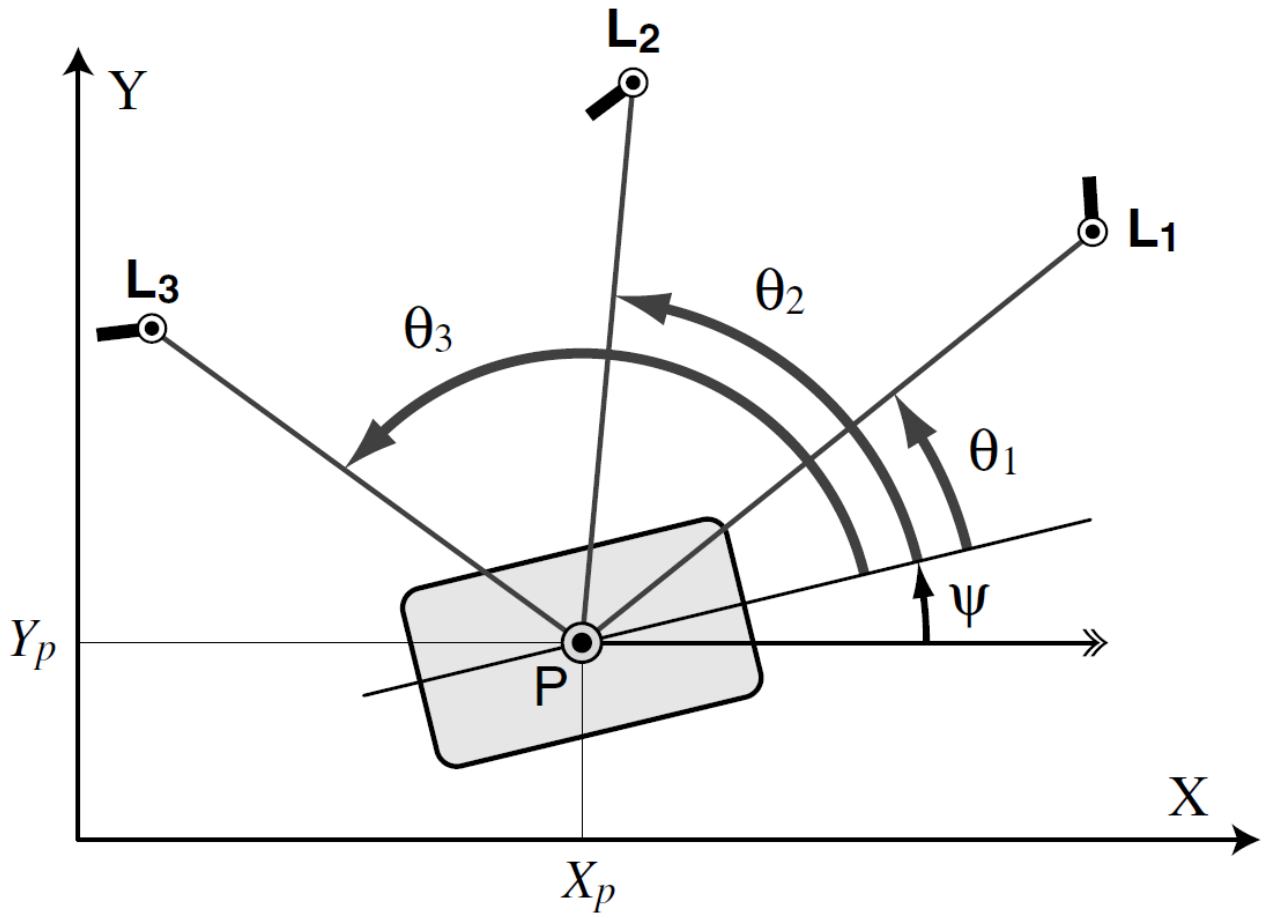
Straight lines intersection

P: robot

L_i: landmark

Ψ: angle of robot

Θ_i: angle of landmark

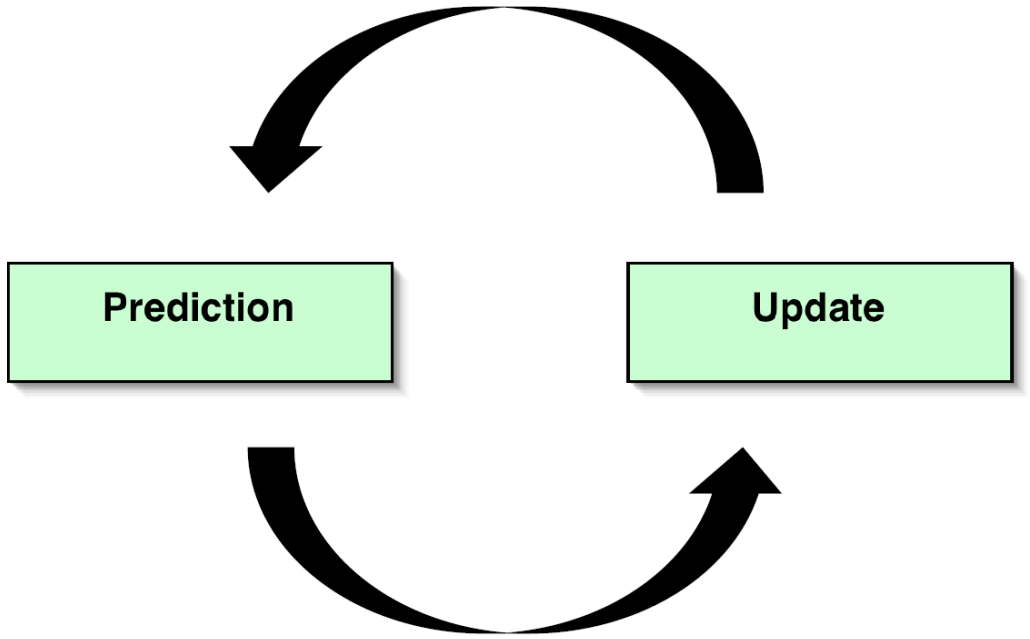


Kalmanfilter

Gaussian filter

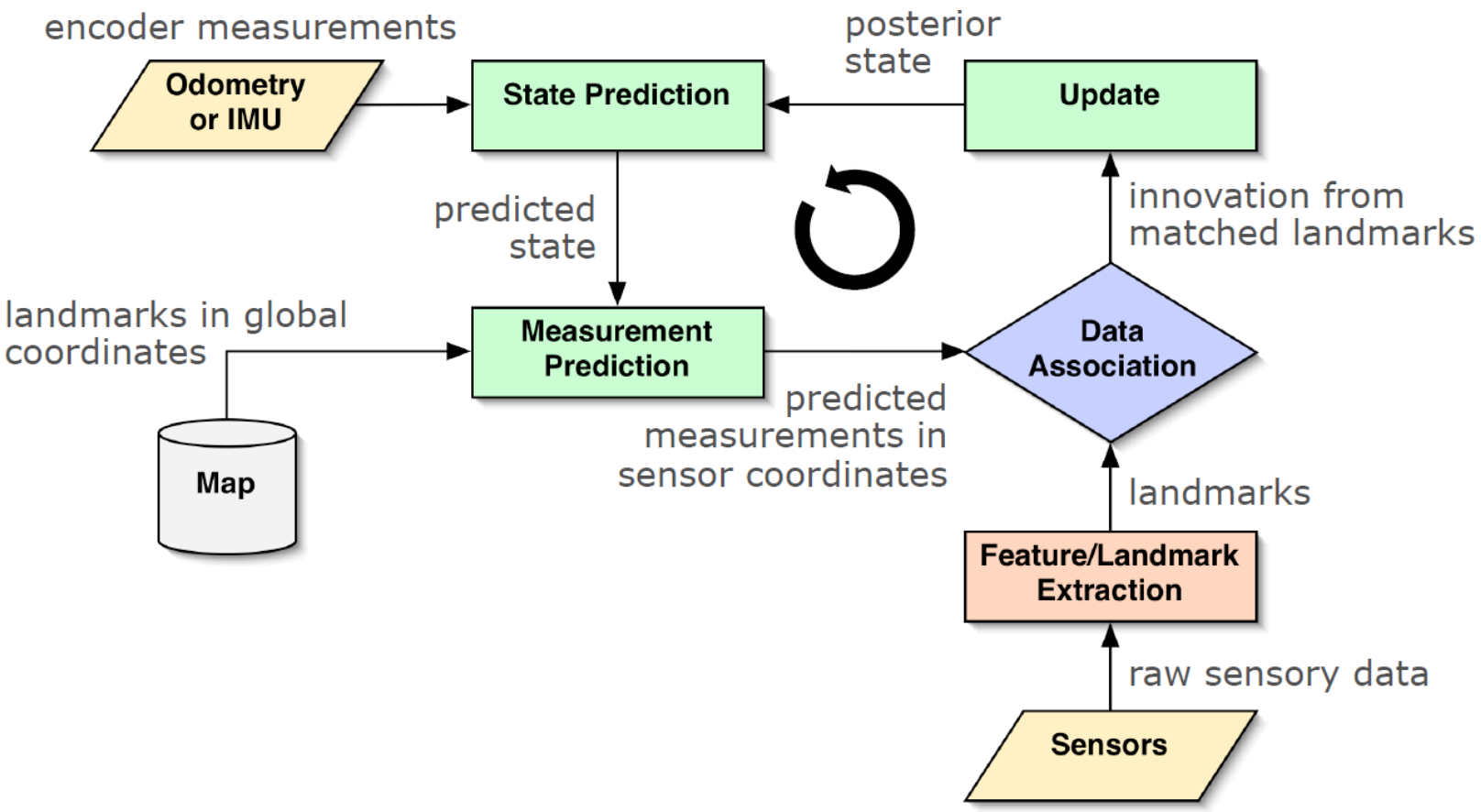
Reduces errors caused by measurement

Basic cycle:



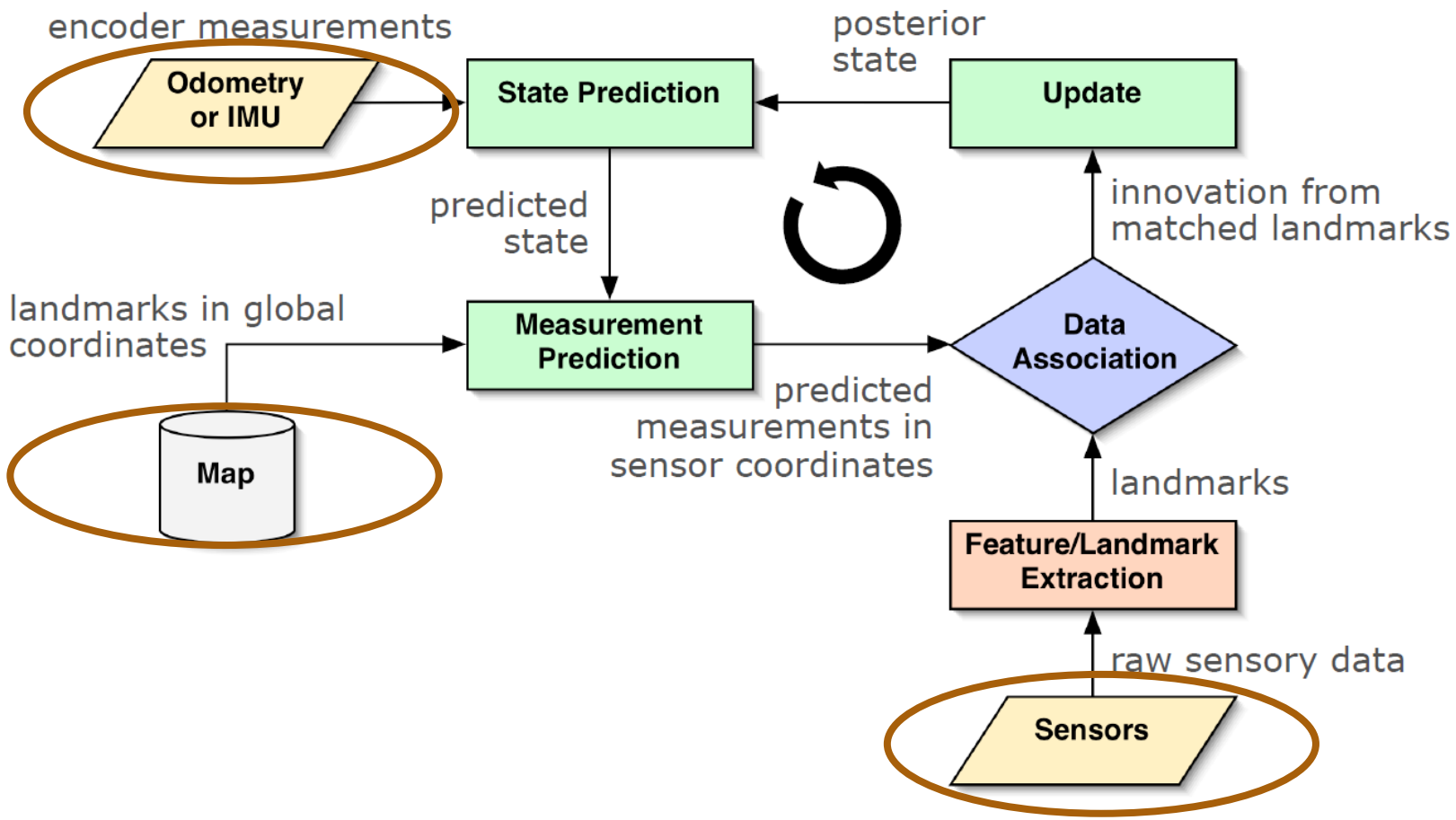
Kalmanfilter

Basic cycle:



Kalmanfilter

Basic cycle:



Kalmanfilter

Advantages

- Robust
- Efficient
- Accurate

Disadvantages

- „kidnapped robot problem“
- Can‘t handle multi-modal densities

Monte-Carlo localization

Also known as particle filter

Problem: sensor data is inaccurate/noisy

Can handle nonlinear systems

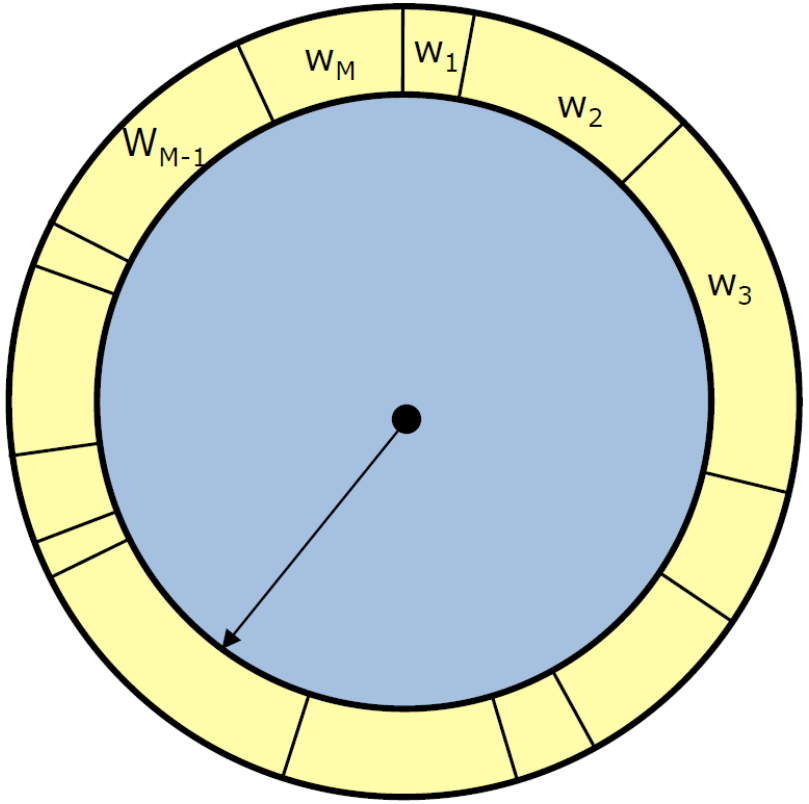
Monte-Carlo localization

1. Generate sample

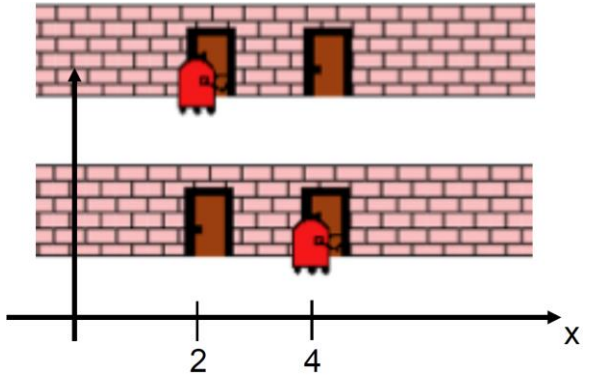
Create random possible poses

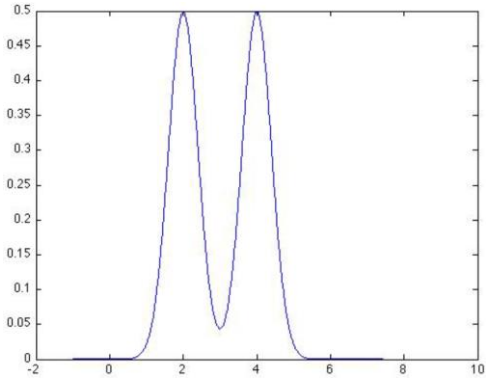
Monte-Carlo localization

1. Generate sample
2. Move and calculate probability of each sample



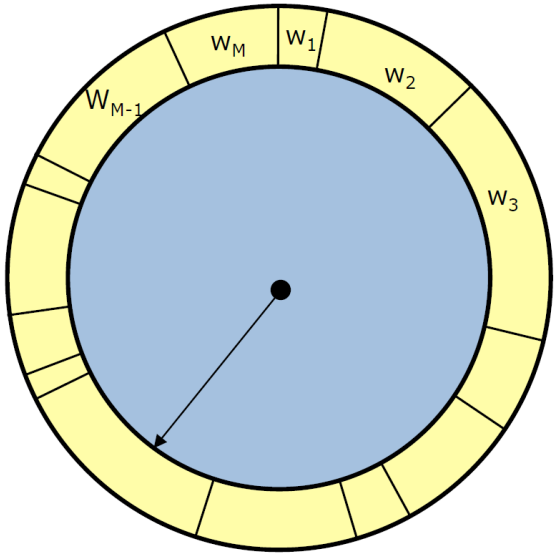
Calculate possibility of each sample with data from sensors





Monte-Carlo localization

1. Generate sample
2. Move and calculate probability of each sample
3. Resampling

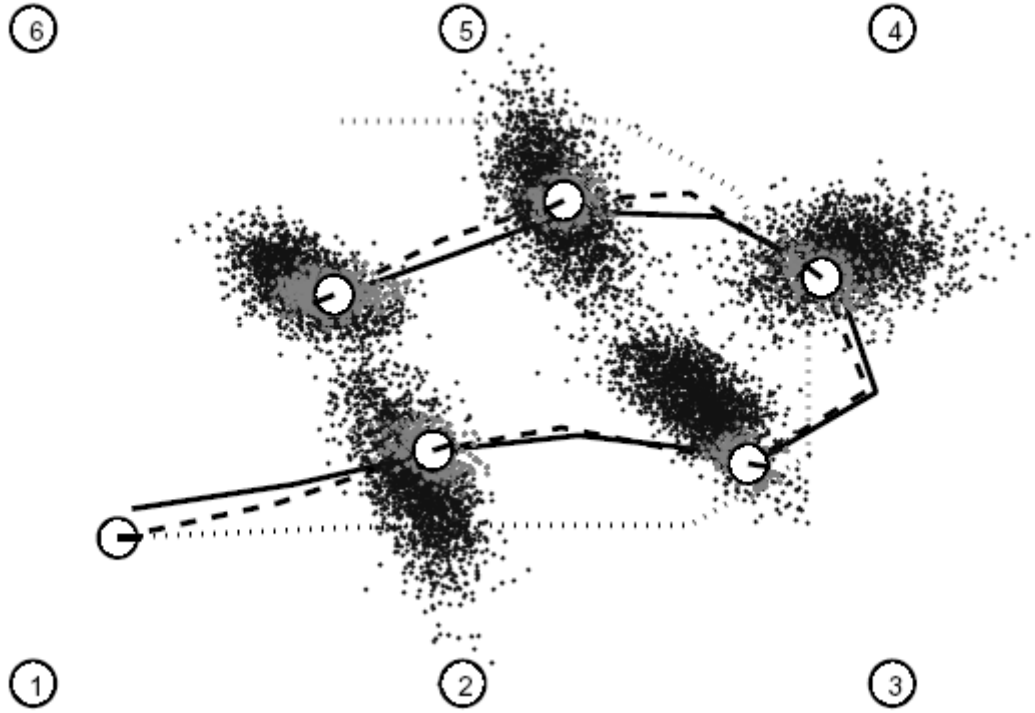


Monte-Carlo localization

Actual movement

Monte-Carlo localization

Odometry



Kalmanfilter vs. Monte-Carlo

Kalmanfilter	Monte-Carlo
More accurate	Many possible particles
Linear	Nonlinear
Difficulties to handle wrong sensor data	Can handle problems in sensor data
Difficulties after respositioning	Gets actual position relatevely fast after failure

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