BLG456E
Robotics
Particle Filter (simple version)

- Particle Filter Algorithm
  - Reweighting.
  - Resampling.
  - Prediction.
- Application to laser-based localisation.

Lecturer:	Damien Jade Duff
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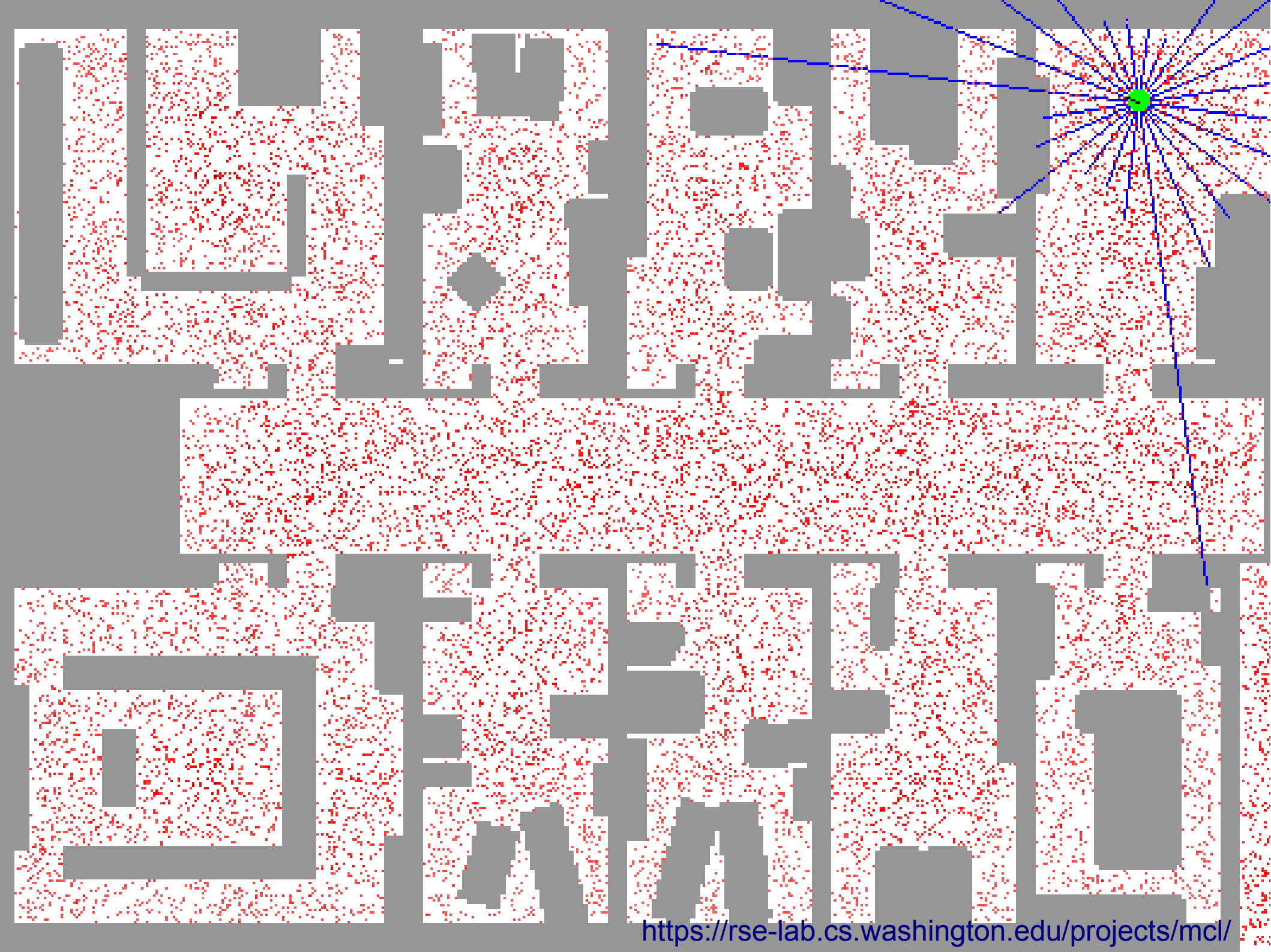
Office:	EEBF 2316
Schedule:	http://djduff.net/my-schedule
Coordination:	http://ninova.itu.edu.tr/Ders/4709

Particle Filter:
A generate and test algorithm

- Generate hypotheses.
- Loop:
  - Score hypotheses against observed data.
  - Select and reproduce according to score.
  - Perturb them.

- Hypotheses ←→ particles.
- Related concept: Kalman Filter.


https://rse-lab.cs.washington.edu/projects/mcl/

Particle Filter Algorithm for localisation (simple version)

Generate a set H of N location hypotheses $(x_1, y_1, \theta_1) ... (x_N, y_N, \theta_N)$

For each new laser scan:

Reweighting:

Calculate a score $p_1 ... p_N$ for each hypothesis by comparing it to the scan

Ensure that these to sum to 1

Resampling:

Make a new empty set G of hypotheses.

For i in $1 ... N$:

Pick a j from $1..N$ with probabilities $p_1 ... p_N$

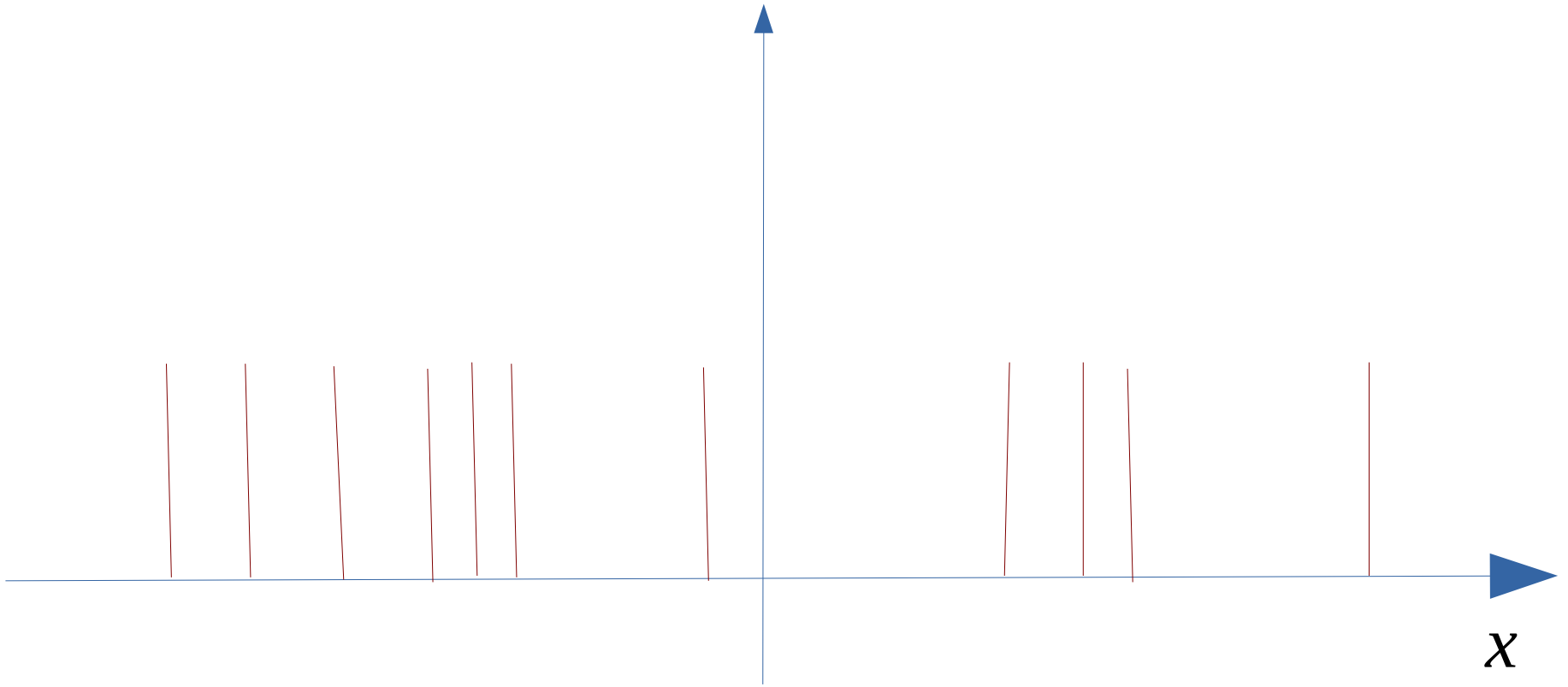
Add (x_j, y_j, θ_j) to G

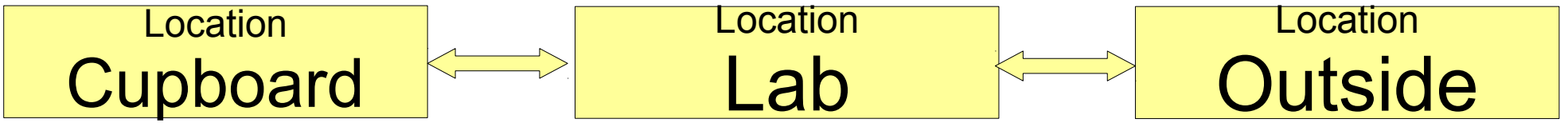
There should now be N hypotheses in G

Prediction:

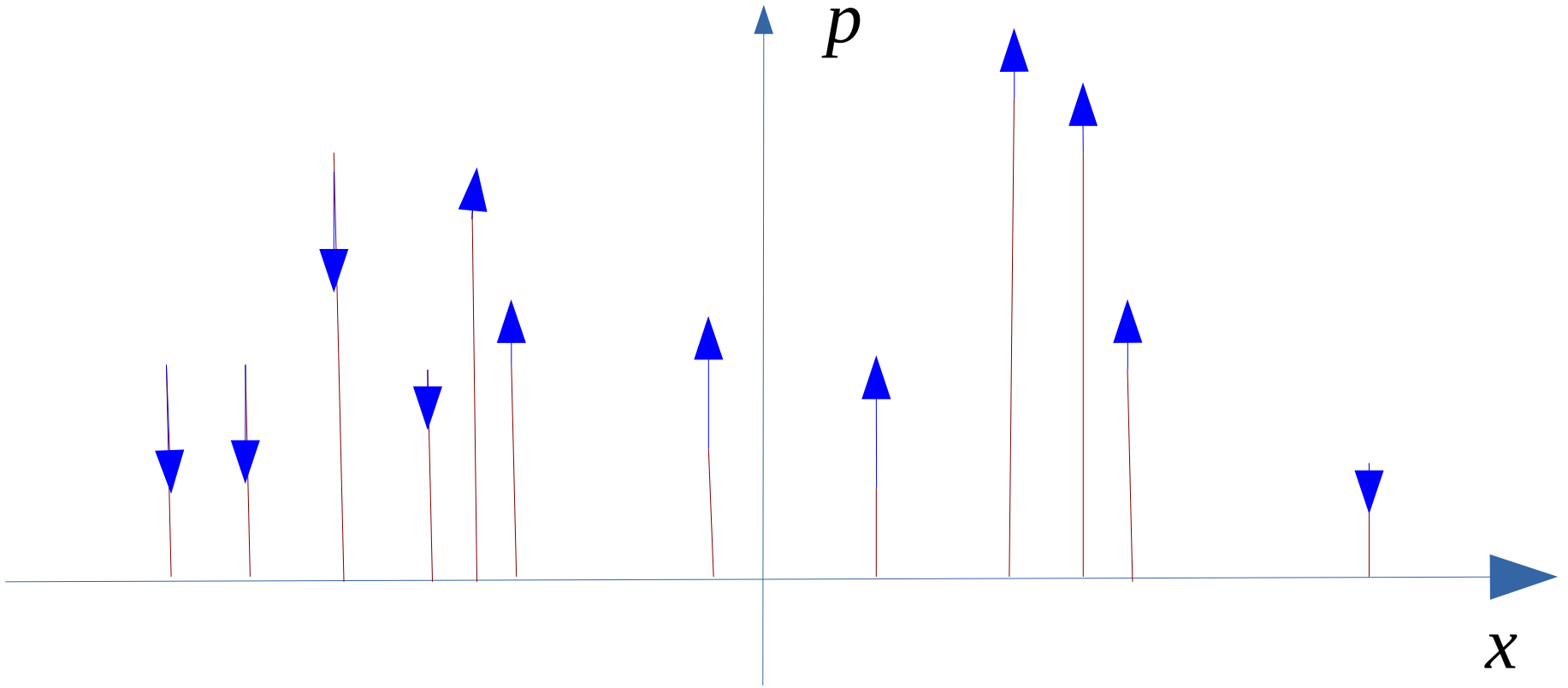
Move each (x_i, y_j, θ_j) randomly

Initial poses





Reweighting

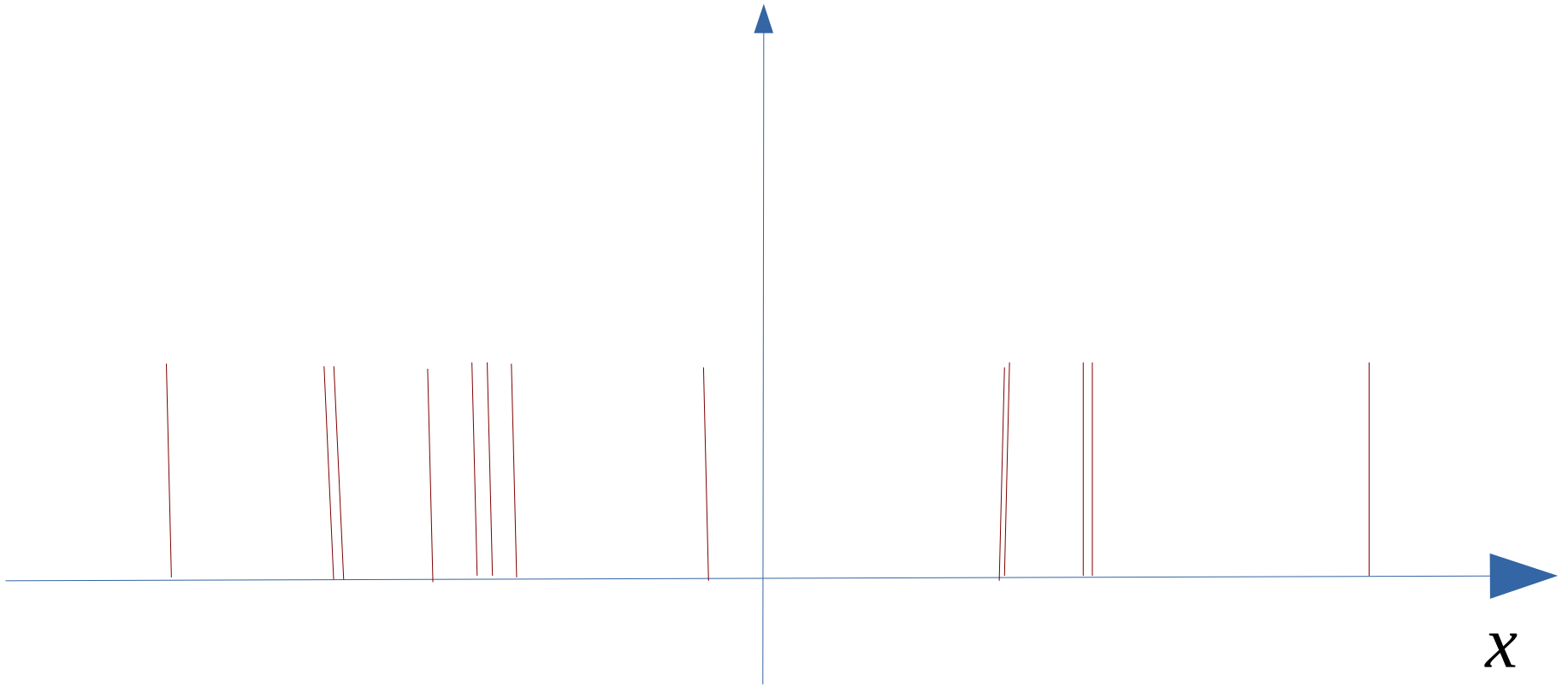


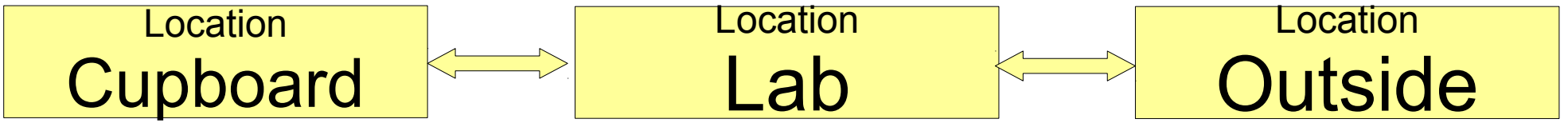
Location
Cupboard

Location
Lab

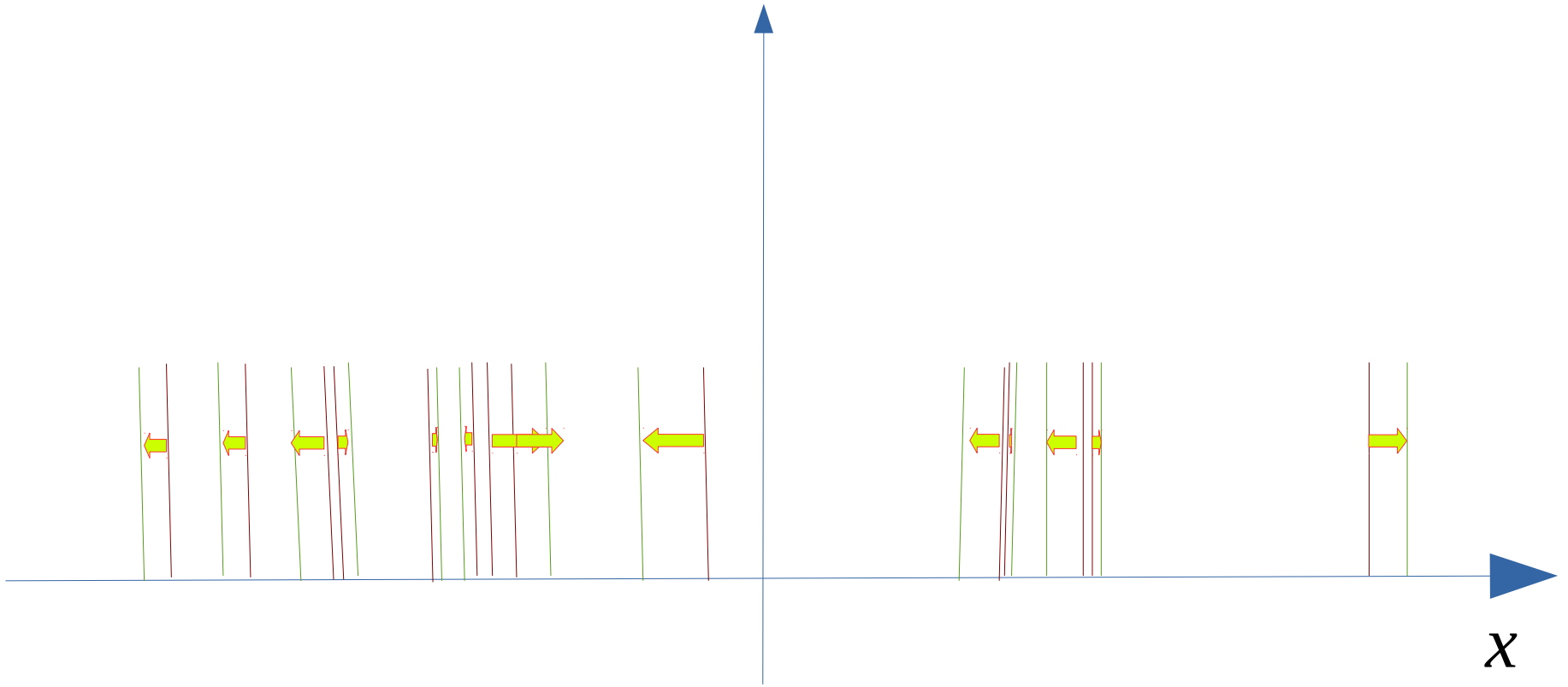
Location
Outside

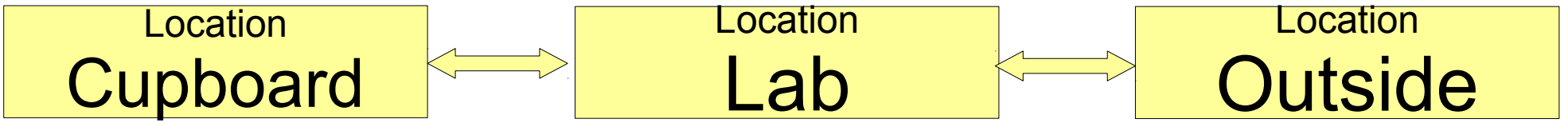
Resampling





Prediction





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Reweighting using laser scans?

A simple scheme

$$Score_1 = \frac{\text{num values correctly classfied as NAN}}{\text{num actual NAN values}}$$

$$Score_2 = \frac{\text{num values correctly classfied as OK}}{\text{num actual OK values}}$$

$$Score_3 = \frac{\text{num estimated values closer than } 0.5 \text{ to actual values}}{\text{num actual OK values}}$$

$$Score_4 = \frac{\text{num estimated values closer than } 0.03 \text{ to actual values}}{\text{num actual OK values}}$$

$$\boldsymbol{total} = \left(\frac{Score_1 + Score_2 + Score_3 + Score_4}{4} \right)^4$$

Predicting new random poses
A simple scheme

prediction (x, y, θ):

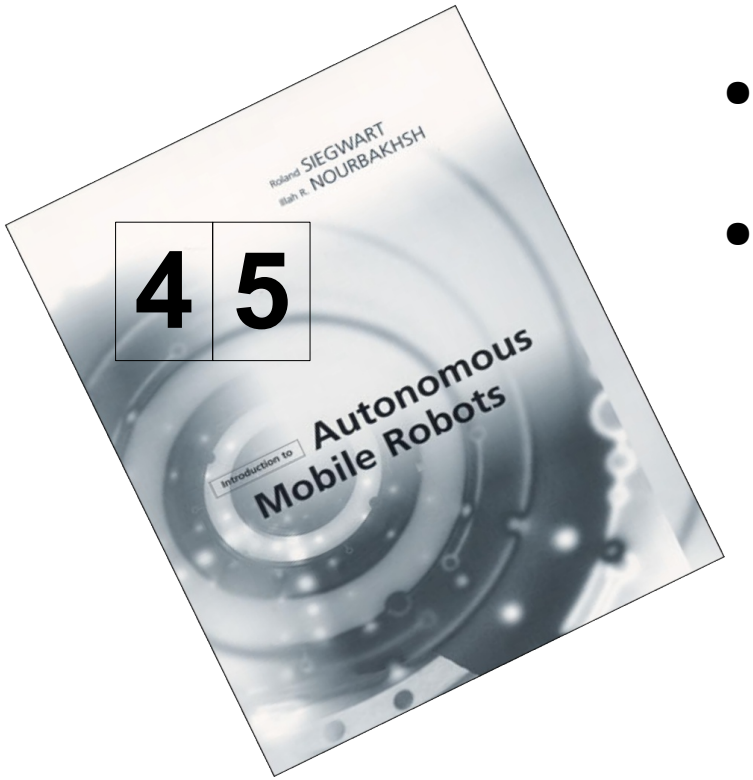
$\Delta x \sim$ Random Normal Distribution $(\sigma = 0.1)$

$\Delta y \sim$ Random Normal Distribution $(\sigma = 0.1)$

$\Delta \theta \sim$ Random Normal Distribution $(\sigma = 0.2)$

return $(x + \Delta x, y + \Delta y, \theta + \Delta \theta)$

Reading



- **Chapter 4**. Perception.
- **Chapter 5**. Mobile Robot Localization.

Also:
https://rse-lab.cs.washington.edu/projects/mcl/