



# CSCI 1108



## Localization



# Where am I

- Localization is one of the fundamental problems in robotics
- This includes the terrestrial coordinates of a mobile robot as well as the pose of a robot
- Modern solution: Bayes Localization
- Principle method for SLAM (simultaneous mapping and localization)
- We can use two ways to “measure” where we are:

# Sensor Model

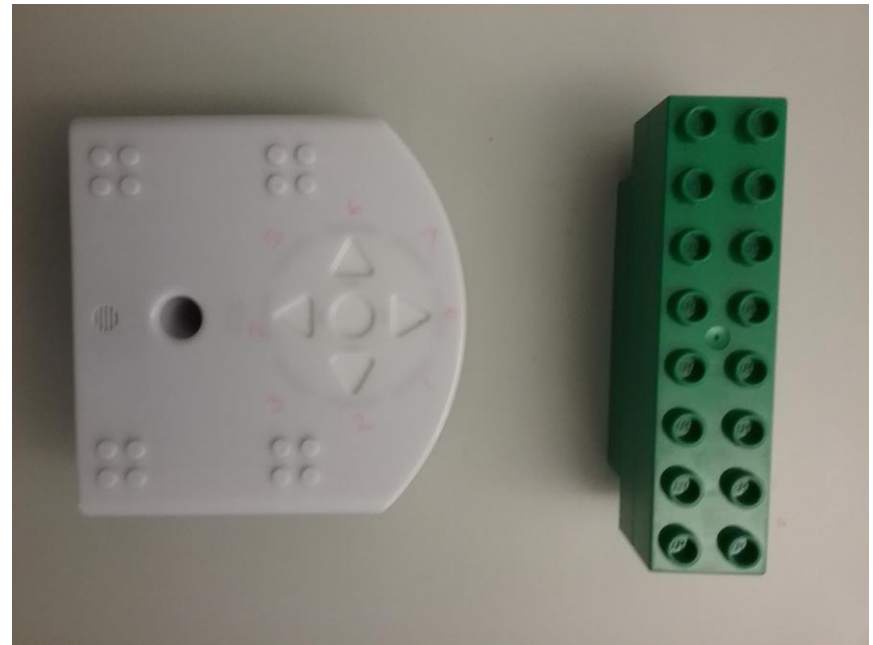
We can use a sensor to tell us where we are such as the distance from a known object

For example sensor model:  $x(t) = x_0 + 3 * s(t)$

$X(t)$  = estimated position at time  $t$

$X_0$  = bias parameter

$S(t)$  = sensor value at time  $t$

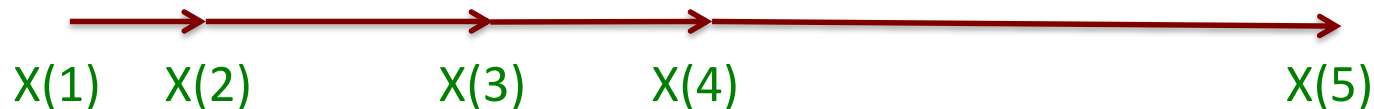


# Motion model

- If we know our initial position and move the robot by a specific motor command, then we can keep track (calculate) the new position

Example motion model:  $x(t) = x(t-1) + v * t$

`motor.left.target = speed`  
`motor.right.target = speed`

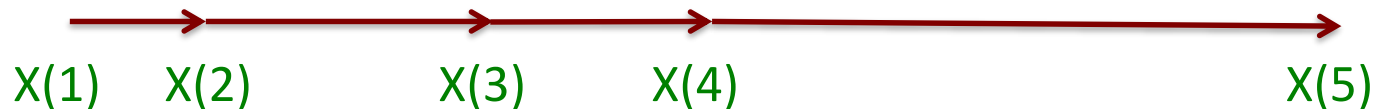


# Motion model with Sensor reading

- There are usually even more options, such as using an odometer to measure the velocity instead of assuming it from the motor command

Example motion model:  $x(t) = x(t-1) + v * t$

velocity measure



This is also called dead reckoning in robotics or path-integration

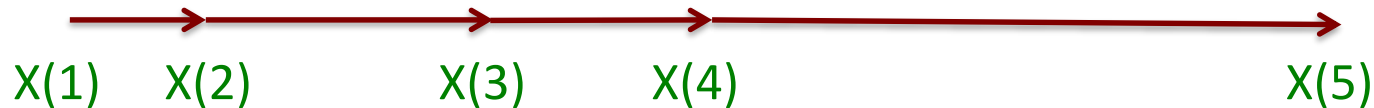
# Model (Sensor) Fusion

- What do we do when the different methods of estimating the position localization disagree?
- Principle Idea: Combine the information proportionally to how much you trust them (uncertainty, probability)

# Point Estimate vs Probability Map

- In previous example we estimate the most likely position, which then is the starting point for the next step

Observation: error will add up over time



- Better method: Keep track of all possible positions and their probability

# Probability Distributions

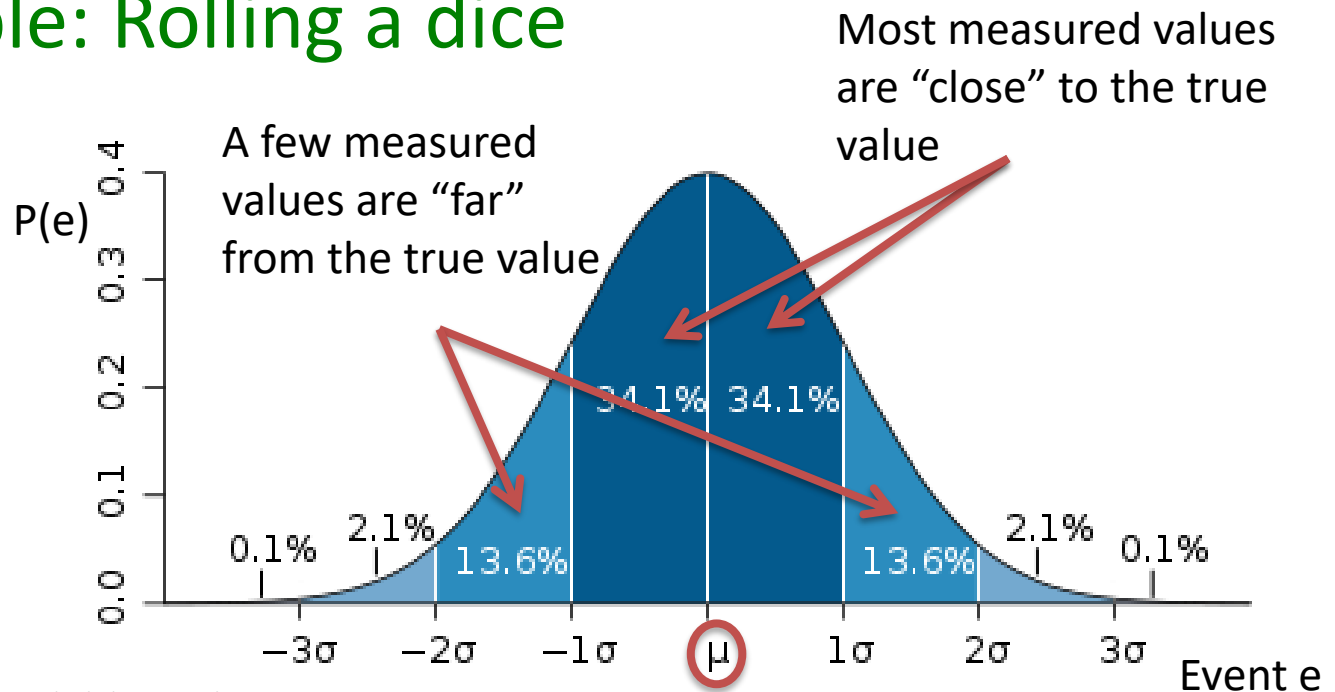
- Discrete versus continuous events

For example states versus location

- Uniform

Example: Rolling a dice

- Normal





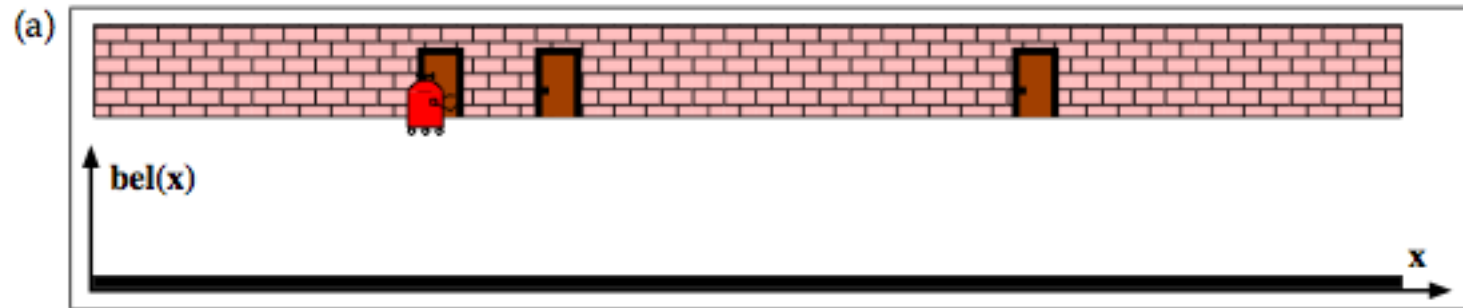
# Probability

- Probability  $P(e)$  is a specification how likely the event  $e$  is
- Measured by fraction between  $P(e)=0$  (event does not happen) and  $P(e)=1$  (certainty)
- Aseba allows only integer number

Solution: multiply by 100 and hence measure in percentage:  $P(e) = (P \text{ in percent}) / 100$

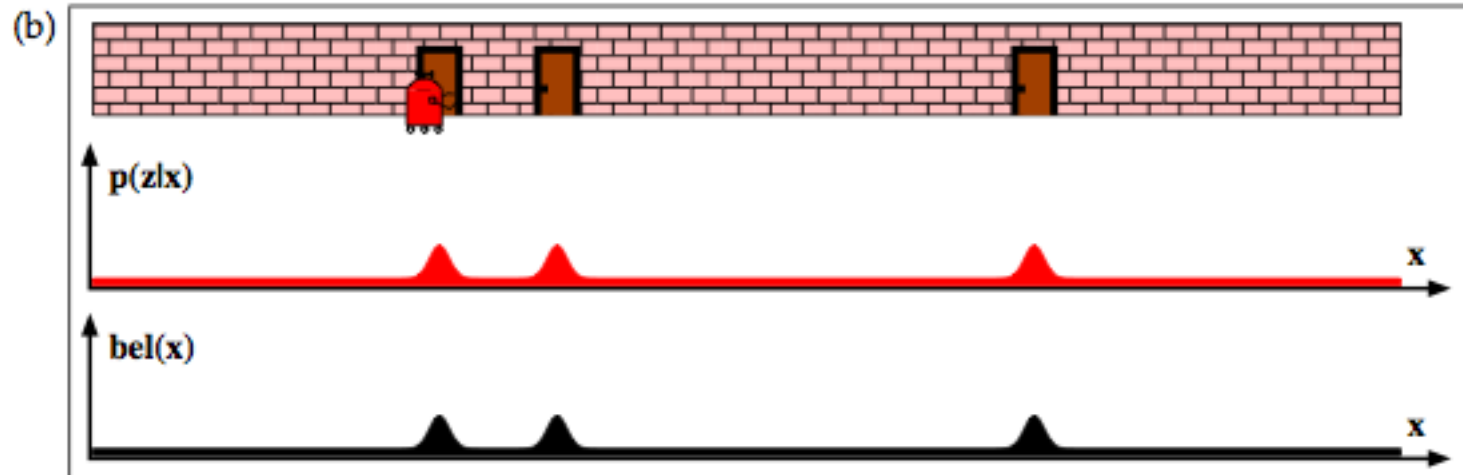
- Can you multiply with another number?

# Markov Localization



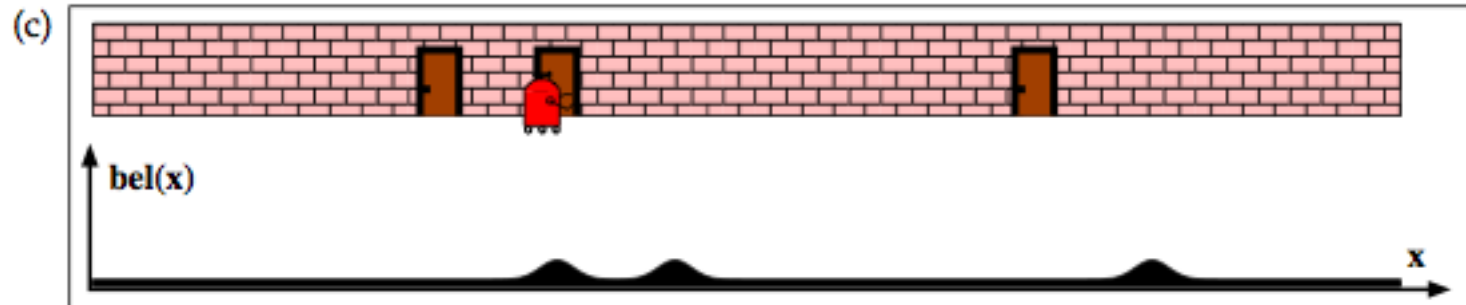
The robot doesn't know where it is. Thus, a reasonable initial believe of it's position is a uniform distribution.

# Markov Localization



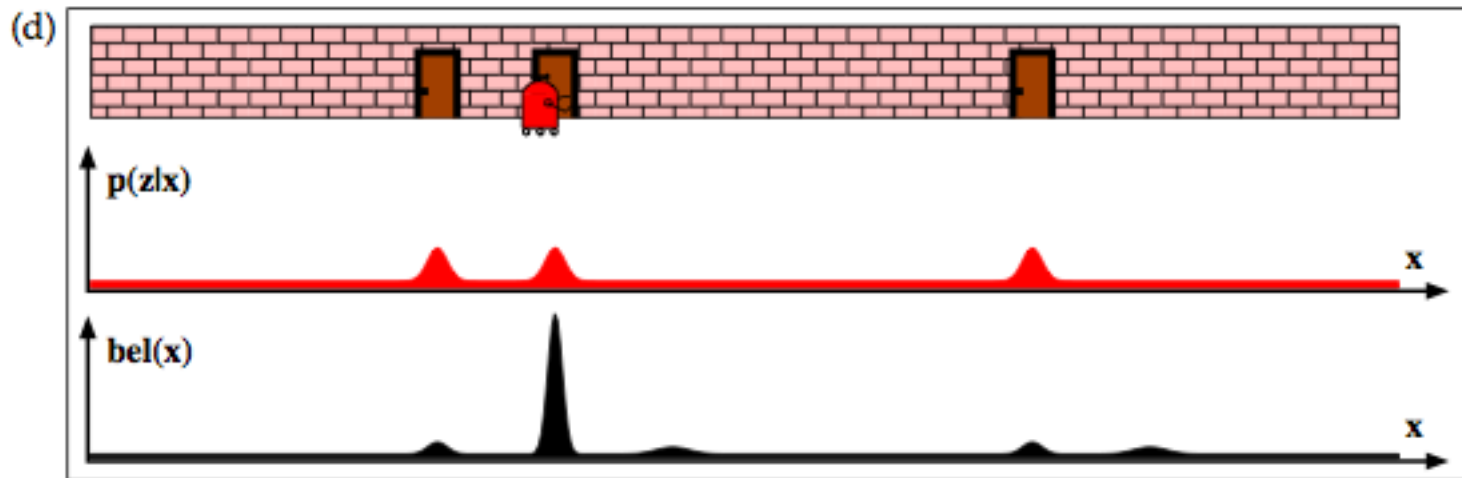
A sensor reading is made (USE SENSOR MODEL) indicating a door at certain locations (USE MAP). This sensor reading should be integrated with prior believe to update our believe (USE BAYES).

# Markov Localization



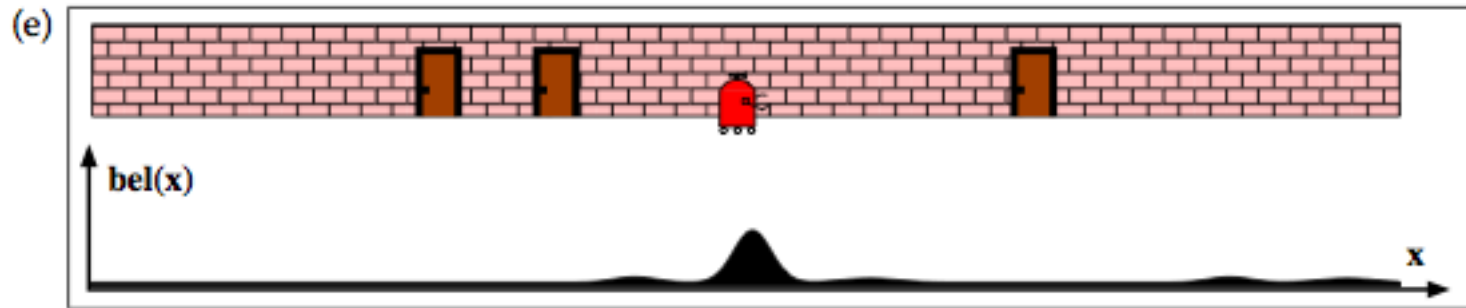
The robot is moving (USE MOTION MODEL) which adds noise.

# Markov Localization



A new sensor reading (USE SENSOR MODEL) indicates a door at certain locations (USE MAP). This sensor reading should be integrated with prior believe to update our believe (USE BAYES).

# Markov Localization



The robot is moving (USE MOTION MODEL) which adds noise. ...

# Localization Tutorial

