

# Disclaimer

These slides are intended as presentation aids for the lecture. They contain information that would otherwise be too difficult or time-consuming to reproduce on the board. But they are incomplete, not self-explanatory, and are not always used in the order they appear in this presentation. As a result, these slides should not be used as a script for this course. I recommend you take notes during class, maybe on the slides themselves. It has been shown that taking notes improves learning success.

# Reading for this set of slides

- Probabilistic Robotics
  - Chapters 1-4, 7, 8-10 (please match the level of detail from the lectures, not all the material in these chapters is required)

Please note that this set of slides is intended as support for the lecture, not as a stand-alone script. If you want to study for this course, please use these slides in conjunction with the indicated chapters in the text books. The textbooks are available online or in the TUB library (many copies that can be checked out for the entire semester. There are also some aspects of the lectures that will not be covered in the text books but can still be part of the homework or exam. For those It is important that you attend class or ask somebody about what was covered in class.



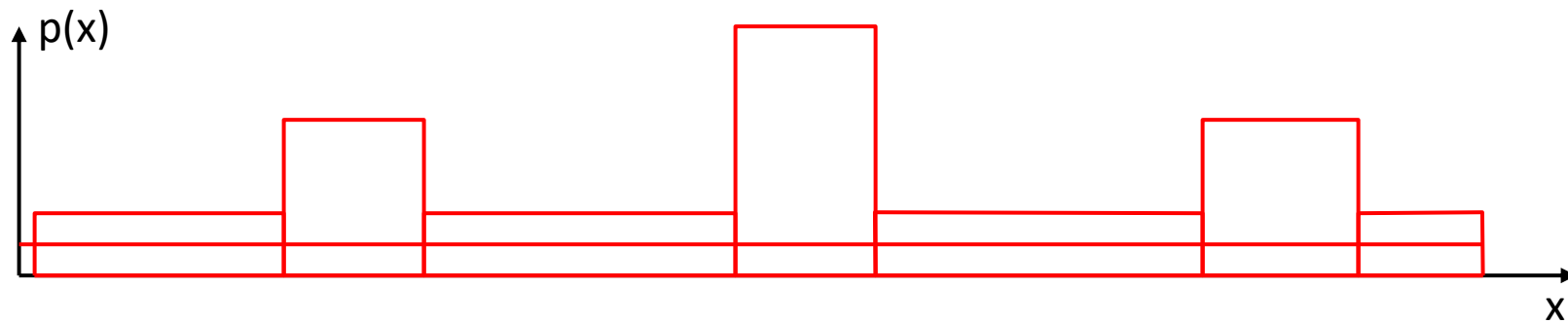
# Robotics

Localization with a Particle Filter

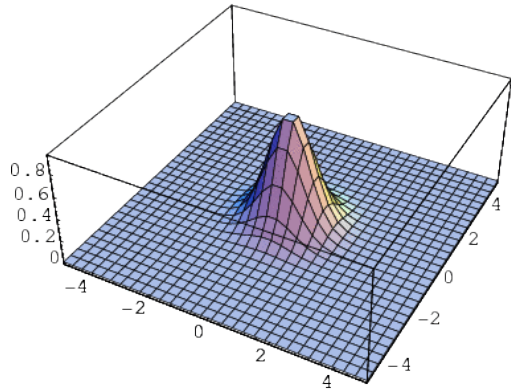
TU Berlin

Oliver Brock

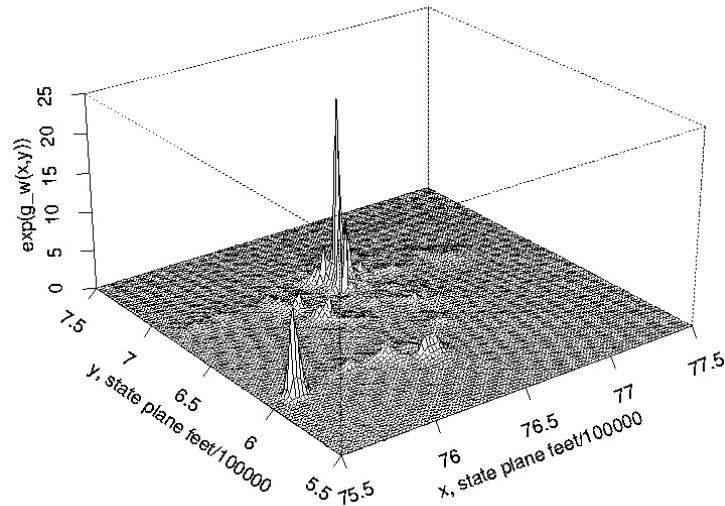
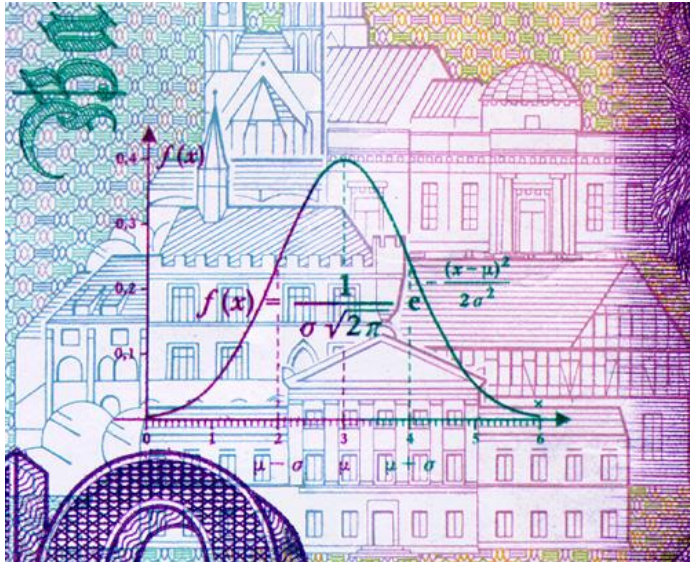
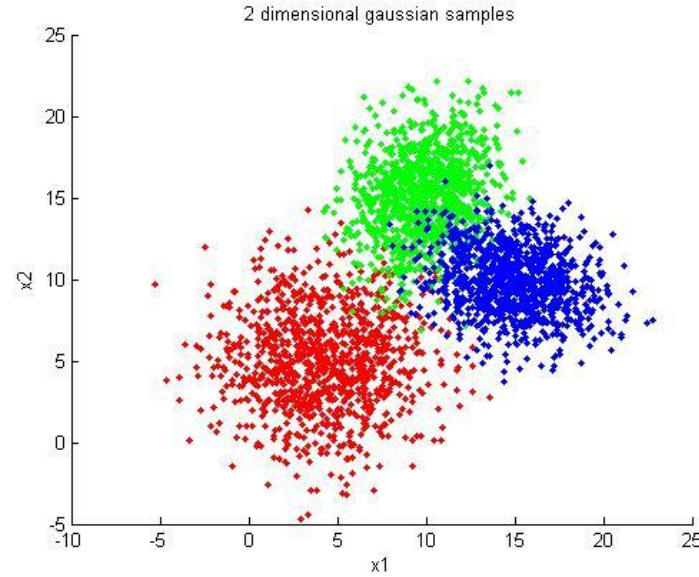
# Intuition



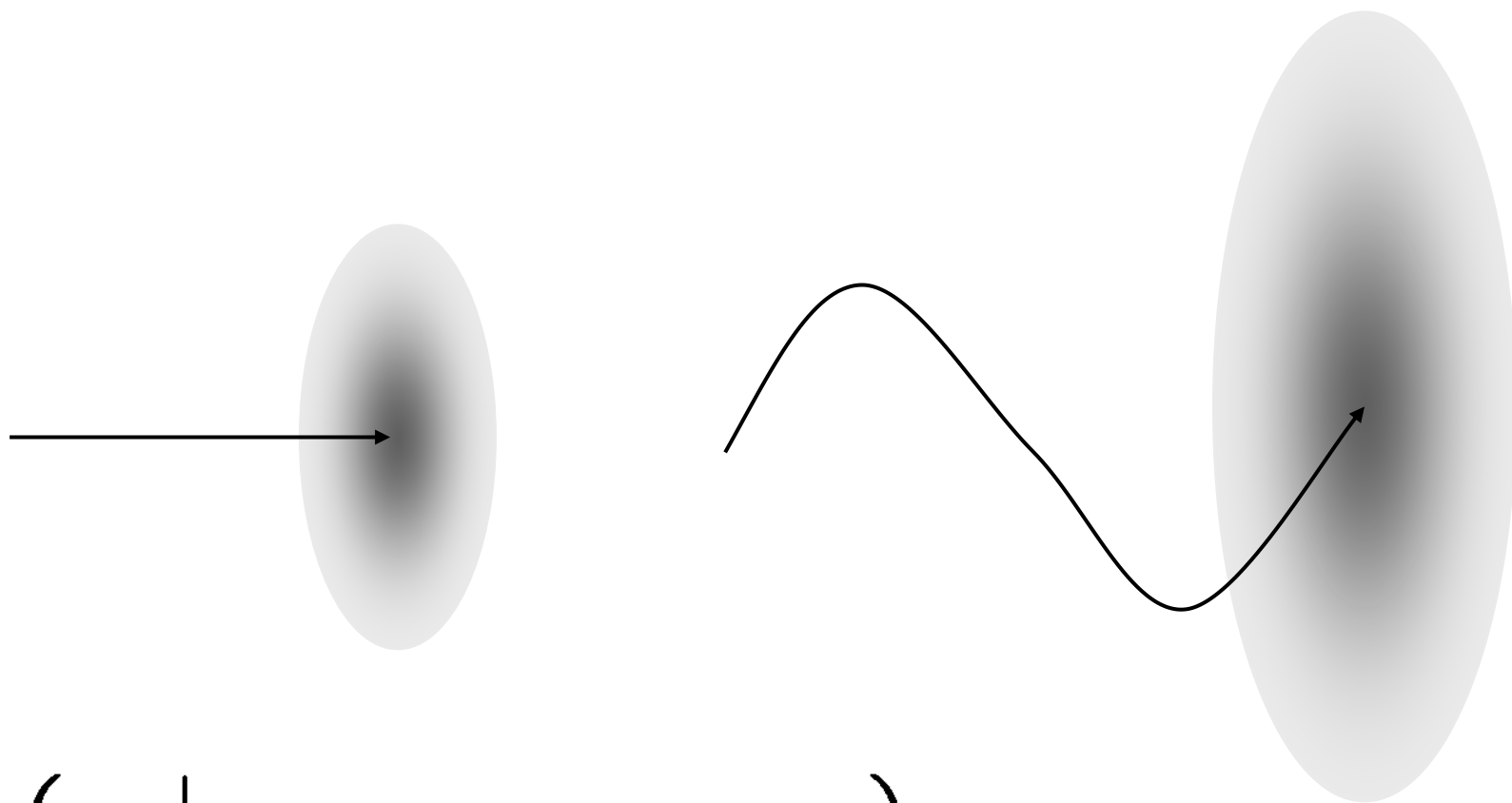
# Parametric vs. Nonparametric



$$\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

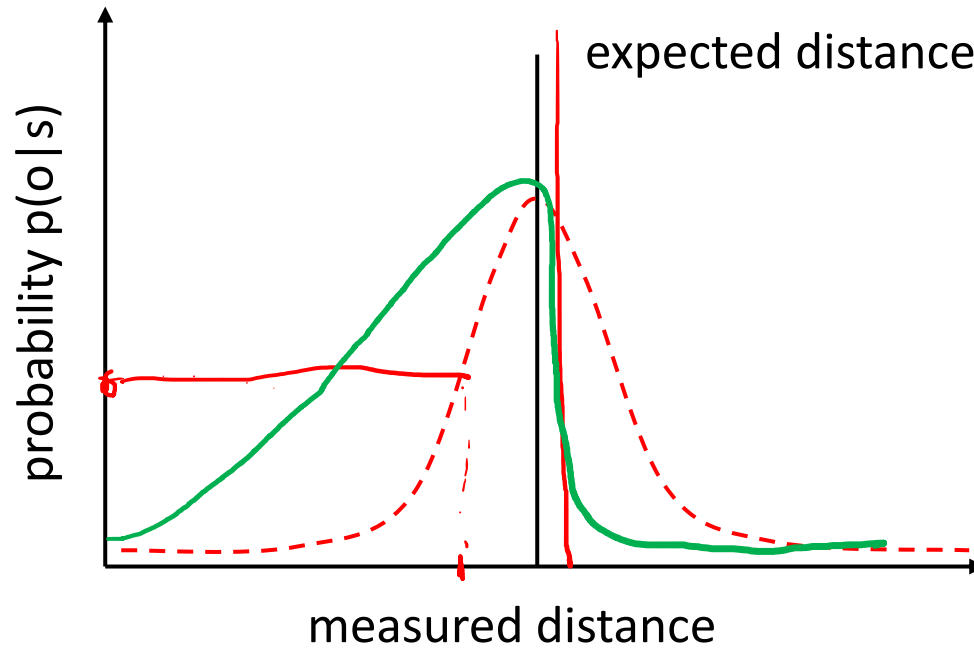


# Motion Model



$$p(s_t \mid a_{t-1}, s_{t-1}, m)$$

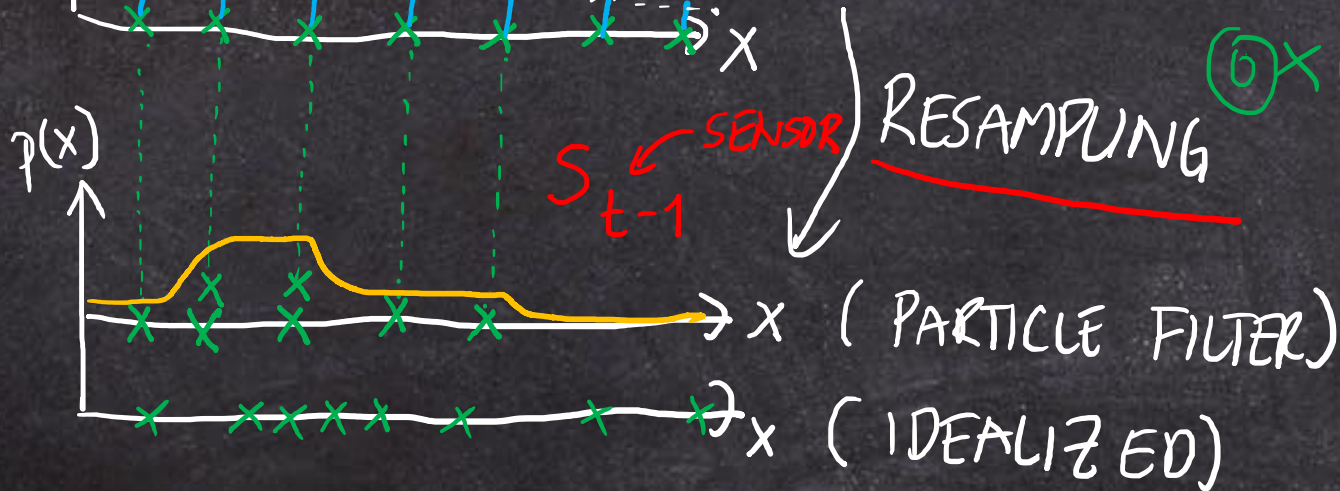
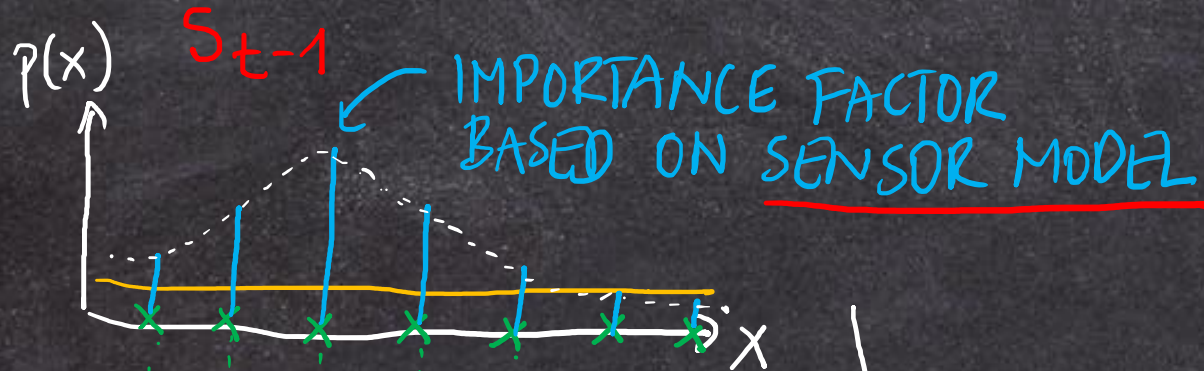
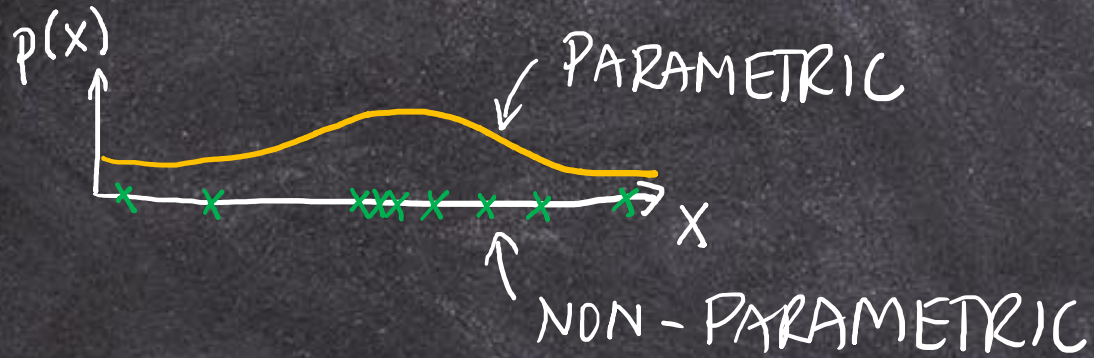
# Sensor Model



$$p(o \mid s_t, m)$$



# PARTICLE FILTER (NON-PARAMETRIC)

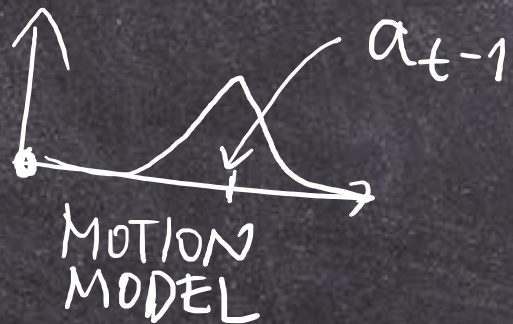


- 1) SENSOR MODEL
- 2) RESAMPLING
- 3) MOTION MODEL





ROBOT MOVES



APPLY  
MOTION MODEL







# Particle Filter Localization

- Represent continuous probability distribution by discrete set of samples  $S$  (particles)
- Samples have *importance factor*
- Initialize:
  - $m$  samples with importance factor  $m^{-1}$  (uniform distribution)
- Iterate:
  - ③ 1. predict samples forward in time using the *motion model*
  - ① 2. assign importance factors based on *sensor model*
  - ② 3. re-sample to adapt distribution of samples to importance factors



