732A96/TDDE15 ADVANCED MACHINE LEARNING

LAB 4: STATE SPACE MODELS

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1. INSTRUCTIONS

- **Deadline for individual and group reports**
  See LISAM.
- **What and how to hand in**
  Each student must send a report with his/her solutions to the lab. Submission is done by using the functionality 'Submit' of the respective lab in LISAM/Submissions. See above for the submission deadline. The file should be named Name_LastName.pdf. The report must be concise but complete. It should include (i) the code implemented or the calls made to existing functions, (ii) the results of such code or calls, and (iii) explanations for (i) and (ii).

  In addition, students must discuss their lab solutions in a group. Check LISAM for the groups. Each group must compile a collaborative report that will be used for presentation at the seminar. The report should clearly state the names of the students that participated in its compilation and a short description of how each student contributed to the report. This report should be submitted to LISAM by using the functionality 'Submit' of the respective group lab submission in LISAM/Submissions. See above for the submission deadline. The file should be named Group_X.pdf where X is the group number. Please, upload a copy of the group report to the folder LISAM/Collaborative workspace. The collaborative reports are corrected and graded. The individual reports are also checked, but feedback on them will not be given. A student passes the lab if the group report passes the seminar and the individual report has reasonable quality, otherwise the student must complete his/her individual report by correcting the mistakes in it.

  Attendance to the seminar is obligatory. In the seminar, some groups will be responsible for presenting their group reports. Each student in these groups must be prepared to individually present an arbitrary part of the report. The selection of the speakers is done randomly during the seminar. In the seminar, some groups will act as opponents to the reports provided by the presenters. The opponent group should examine the group report of the presenter group before the seminar (available at LISAM/Collaborative workspace), and prepare a minimum of three questions, comments and/or improvements. The opponent group will ask these questions during the seminar. Check LISAM for the list of presenter and opponent groups.

2. QUESTIONS

The purpose of the lab is to put in practice some of the concepts covered in the lectures. To do so, you are asked to implement the particle filter for robot localization. For the particle filter algorithm, please check Section 13.3.4 of Bishop's book and/or the slides for the last lecture on SSMs. The robot moves along the horizontal axis according to the following SSM:

$$p(z_t|z_{t-1}) = \Big(\mathcal{N}(z_t|z_{t-1},1) + \mathcal{N}(z_t|z_{t-1}+1,1) + \mathcal{N}(z_t|z_{t-1}+2,1)\Big)/3 \quad \text{// Transition model}$$

$$p(x_t|z_t) = \Big(\mathcal{N}(x_t|z_t,1) + \mathcal{N}(x_t|z_t-1,1) + \mathcal{N}(x_t|z_t+1,1)\Big)/3 \quad \text{// Emission model}$$

$$p(z_1) = Uniform(0,100) \quad \text{// Initial model}$$

Implement the SSM above. Run it for $T = 100$ time steps to obtain $z_{1:100}$ (i.e. states) and $x_{1:100}$ (i.e. observations). Use the observations (i.e. sensor readings) to identify the state (i.e. robot location) via particle filtering. Use 100 particles.

For each time step, show the particles, the expected location and the true location. Repeat the exercise after replacing the standard deviation of the emission model with 5 and then 50. Comment on how this affects the results.