UNIVERSITÄT ZU LÜBECK
INSTITUTE FOR ROBOTICS
AND COGNITIVE SYSTEMS

Humanoid Robotics
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Exercise sheet 1 - Movement Representations

Please prepare the following exercises for the upcoming tutorial.

Task 1: Dynamical Systems

Dynamical Systems Movement Primitives shall be analyzed, therefore give answers to the following questions

a) Derive the general form of a parameterized trajectory generator based on a second order dynamical system (simple damped-spring model) and point out at least one advantage and one disadvantage of such an approach!

b) Define the forcing function using Radial Basis Functions (RBFs) and explain the structure of this type of basis functions!

c) Derive the equation for linear regression using the ordinary least square method an show how to compute the weights for the forcing function!

Hint: Either write a short text, use some formulas or draw a sketch to give the answer.

Task 2: Probabilistic Systems

Probabilistic representations shall be analyzed, therefore give answers to the following questions

a) State the Bayes' Theorem and name all parts properly! Give an example why the Bayes' Theorem is useful for robotic applications!

b) Get an intuition about probabilities! Use the Bayes' Theorem!
Imagine you are going to a blood donation. For security reasons a blood probe for every participant is checked for AIDS. The control of your probe using a standard AIDS test gives back a positive result. Please estimate without any calculation how likely it is, that you are really infected with AIDS. Therefore you may need some more information:
A standard AIDS test is 99.9% sensitive and 99.7% specific. Thus it gives back a positive result with a probability of 99.9% for infected persons and a negative result with a probability of 99.7% for non-infected persons. About 0.1% of the german population are infected by AIDS.
If you have given an estimation of the probability that you are really infected by AIDS, please calculate now the correct probability using the Bayes' Theorem!

c) Explain Gaussian Processes and show the derivation for the posterior mean and variance!

d) Explain how you could use Gaussian Processes to generate movement trajectories!

Hint: Either write a short text, use some formulas or draw a sketch to give the answer.

Graded Assignment 02: Movement Representations

In this assignment you have to teach the simulated KUKA robot how to write an infinity sign ∞ into the air. Therefore, you have to record how you write such an infinity sign into the air using the OptiTrack system in our laboratory. We will define 2-3 appointments where you can do this. You will get the recorded data as csv–file. Based on the recordings, you have to use Dynamical Systems Movement Primitives (DMPs) to generate a desired trajectory for the end-effector of the KUKA robot. You can then use the inverse kinematic from the first assignment in order to steer the robot along the desired trajectory.

In order to pass the assignment you have to write a Matlab code which steers the KUKA robots end-effector along the desired trajectory. The desired trajectory has to be calculated with both DMPs and GPs using generated data from the OptiTrack system. The Matlab code has to be executable with the running V-Rep Environment. In addition, 2-3 pages as a PDF document have to be submitted. In this document the principles you used as well as your results shall be presented.

The submission deadline for this assignment is June 08, 2018, 10am. Please send your submission as a Zip data named RO5300_TeamNumber to Nils.Rottmann@rob.uni-luebeck.de with the subject RO5300_TeamNumber. Other submissions will not be considered.

If you have any problems with the assignment feel free to get in touch. You will find me in Building 64, Room 85.