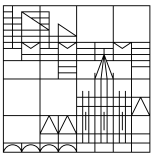
Task Sheet 5

Universität Konstanz



AI for autonomous robotics

Deadline 10:00am May 24, 2024

Review on June 4 & 5, 2024

Lecture: *AI for Autonomous Robotics*, Summer Term 2024

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Tutor: Jonas Kuckling & Paolo Leopardi

Task 5.1 Theoretical questions

a) Explain the difference between aleatory and epistemic noise. Name one example each (*2 points*).

b) Explain why uncertainty poses such a big challenge for robotics (*3 points*).

c) Explain the exploration-exploitation trade-off in your own words (*3 points*).

d) Explain the concept of risk and risk-averse operation in the context of robotics (*2 points*).

Task 5.2 Multi-armed bandit as prediction variant

We want to implement the multi-armed bandit variant with rewarding correct predicitions instead of collecting maximal rewards from part 4 of the course. We are not minmizing regret but minimizing prediction error.

We have $k = 3$ arms. Their feedback x (previously 'reward') is normal distributed $x \in \mathcal{N}(\mu_i, \sigma_i^2)$. We play $T = 300$ rounds. In each round t, your algorithm chooses an arm to play $a(t)$ and makes a prediction $\rho(t)$. It collects the error of the round $e_t = |x(a(t)) - \rho(t)|$ with $x(a(t)) \in \mathcal{N}(\mu_{a(t)}, \sigma_{a(t)}^2)$. After all T rounds are played, your algorithm receives a total cumulated prediction error of $E = \sum_{t=1}^{T} |x(a(t)) - \rho(t)|$.

a) Write code to randomly initiate the $k = 3$ normal distributions $\mathcal{N}(\mu_i, \sigma_i^2)$ with uniformly distributed distribution parameters $\mu_i \in [-1, 1]$ and $\sigma_i \in [0.2, 1.2]$ at the beginning of each new experiment run.

b) Design an algorithm that explores the $k = 3$ arms and their feedback distributions. Decide whether you want to have a defined exploration phase for $T_1 < T$ rounds followed by an exploitation phase for the remaining $T - T_1$ rounds or whether you want to alternate between exploration and exploitation phases.

c) Test several variants of strategies. To do so, derive an experiment protocol that allows you to statistically test the resulting prediction errors. For example, you should do several independent runs for each strategy, collect the summed prediction errors E, and compare them.

Submission instructions:

For your submission, please submit the answers to the theoretical questions (as a machine typed PDF file), the code (and some short documentation on how to execute it), as well as some documentation of your results. The presentation of your results is up to you and can take many forms. For example, you could submit a short PDF file with plots or screenshots from your terminal. Alternatively, you could submit a video of the screen capture, where you explain what is happening. The spirit should be to not just complete the programming task and done - but to play with your little sim a bit. Explore for yourself. Let us know if you found something interesting. Have fun!