Models of Higher Brain Function
Computer Course

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Decision Making I

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The solutions for these exercises (comprising source code, discussion and interpretation as an IPython Notebook) should be handed in before **May 31, 2018 at 10:15 am** through the Moodle interface (in emergency cases send them to mathias.schmerling@bccn-berlin.de).

Exercise 1: Extended drift-diffusion model

In this exercise we will explore the reaction time distribution of the drift diffusion model for perceptual decision making.

1. Use the Euler-Maruyama method to implement the stochastic differential equation

$$dX = \mu dt + \sigma dW \,,$$

   which is a simple form of the drift diffusion model. Start with $X = 0$. Choose $\sigma = 0.5$, $\mu = 0.2$. Run five simulations of 10 seconds length with $\Delta t = 0.01s$ and plot the results.

2. Plot the percentage of "up" (X=+a) responses as a function of the drift μ by simulating 200 trials for $a = 1$ and the following μ values: -0.1, 0, 0.1, 0.2, 0.5. Resimulate trials in which no decision boundary is reached during the simulation. Plot the results. What happens to this curve if you double, what if you halve the value of a?

3. Use the results from the last exercise to pick a value of μ (with $\sigma = 0.5$) for which about 70% of the trials result in an "up" response. Run 2000 trials and record the reaction times, i.e. the moment when the decision variable X crosses one of the two decision thresholds at $X = \pm a$ (for $a = 1$), as well as the choice, i.e. which of the boundaries was hit.

4. Plot a histogram of the reaction times for each of the choices separately, and compare the distributions. Calculate their individual mean reaction times and discuss whether (and why) this is what you would have expected.

5. Implement an extended version of the drift-diffusion model, in which the drift μ for each trial is drawn from a Gaussian distribution with mean m_μ and standard deviation s_μ. Find values for m_μ and s_μ that keep 70% "up" rate but have reaction time distributions that (qualitatively) fit experimental results better. Plot your resulting distributions and mean reaction times for "up" and "down" responses from 2000 trials.