PMPC Tutorial Sheet 1

1. How are you going to get an A in this class? What is your strategy to achieve this goal? Write it down!

2. (a) I pay you \$10 if you roll a 6 with a six-sided die. What should your stake be for the bet to be fair? (b) You suggest to pay me \$25 if I roll a 6 with a six-sided die—but only if you like the stakes that I offer you in case I don't roll a six. For which stakes should you accept the bet? (c) I offer you a bet with my stake being s_1 and your stake being s_2. For what probability would the bet be fair?

3. Neural correlates of decision variables in parietal cortex [5, 1]. Single cell responses are recorded from LIP (lateral intra-parietal area) while a monkey is performing the following saccadic decision task. The monkey is fixating. With a change of colour of the fixation spot the monkey is instructed to perform a saccade to one of two possible targets. Say red indicates that the monkey should saccade to the red target—and blue to the blue target. Each of the two instructions can come up with different probabilities. Furthermore, the correct execution of the instruction (which is not difficult for the monkey after training) results in different juice-rewards—depending on whether the target was red or blue. It is suspected that the reward that the monkey expects to receive after having seen the target correlates with the firing rate of neurons in LIP.
   You want to set up an experiment in which the average amount of juice a monkey receives is 1 ml per trial. You want to fix the probability with which each instruction (red or blue) comes up. Say, the probability for red should be p. How much juice should be given on the red trials? And the blue trials?

4. Linda Problem [6]. Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.
   Sort the following statements with regard to their probability, starting with the most probable statement:
   (a) Linda is a teacher in elementary school
   (b) Linda works at a bookstore and takes Yoga classes
   (c) Linda is active in the feminist movement
   (d) Linda is a psychiatric social worker
   (e) Linda is a bank teller
   (f) Linda is an insurance salesperson
   (g) Linda is a bank teller and is active in the feminist movement

5. In an experiment on visual working memory subjects are shown a display with N squares of different and easily distinguishable colors at random locations. The screen goes blank for some time during which the subjects are asked to remember the display. After a short while the screen is again showing a display with squares that is almost identical to the first display. The only

difference is that a randomly picked square has changed color. The task of the subjects is to report whether they have seen a change or not and to report which square has changed (if they didn't see a change they are forced to guess). For each trial the experimenter records whether the subject reported seeing a change or not and whether the square the subject chose was the correct one (the experimenter is lazy and does not keep records of the square that changed and the square that was chosen by the subject). Assume that the subject can remember the colors of exactly M squares. What do you expect the joint distribution of the responses to be? How does the probability of a correct response change as a function of the number of squares? (Exercise was inspired by [4])

6. Recommended reading to accompany the course: John Kruschke has written a very accessible book on Bayesian statistics for psychology and cognitive science students [2]. Michael Lee and Eric-Jan Wagenmakers' book is also very readable and features many direct applications in cognitive modeling [3]. Although I don't follow these two books each of them is a good complement to this course. Another good—and still developing—source for additional reading for the first half of this class is *Probabilistic Progamming and Bayesian Methods for Hackers.*[1] The second half of the course is somewhat similar to part IV in [3] and will focus more concretely on cognitive models. Another good online source for the second half of the course is *Probabilistic Models of Cognition.*[2]

References

[1] P. W. Glimcher. *Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics*. Bradford Book, 2004.

[2] J. K. Kruschke. *Doing Bayesian Data Analysis*. Academic Press, Burlington, MA, 2011.

[3] M. D. Lee and E.-J. Wagenmakers. *Bayesian Cognitive Modeling: A Practical Course*. Cambridge University Press, 2013.

[4] S. J. Luck and E. K. Vogel. The capacity of visual working memory for features and conjunctions. *Nature*, 390:279–281, 1997.

[5] M. L. Platt and P. W. Glimcher. Neural correlates of decision variables in parietal cortex. *Nature*, 400:233–238, 1999.

[6] A. Tversky and D. Kahneman. Extension versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological Review*, 90(4):293–315, 1983.

[1] https://github.com/CamDavidsonPilon/Probabilistic-Programming-and-Bayesian-Methods-for-Hackers

[2] https://www.probmods.org/