

Session 1 - Exercises

1. Download the notebook files from the github repository (https://github.com/AlexRogersCS/probabilistic_machine_learning). Either install the Python package from Anaconda (<https://www.anaconda.com/products/individual>) and PyMC3 (<https://docs.pymc.io>), or open them in Google Colab (<https://colab.research.google.com>).
2. Calculate by hand, and verifying in Python (by editing the `probability.ipynb` script as necessary) the following probabilities when two dice are rolled:
 - (a) $P(D_1 + D_2 = 6)$
 - (b) $P(D_1 + D_2 > 10)$
 - (c) $P(D_1 = 1, D_2 < 4)$
 - (d) $P(D_1 = 1 \mid D_1 + D_2 = 4)$
 - (e) $P(D_1 < 5 \mid D_1 + D_2 = 10)$
3. Use Bayes rule to answer each of these three settings:
 - (a) You are planning to go on a picnic but the morning is cloudy. This is bad as 50% of all rainy days start of cloudy. However, cloudy morning are common (about 40% of days start cloudy) and this is usually a dry month (only 3 out of 30 days, or 10% of days, tend to be rainy). What is the chance of rain during the day?
 - (b) Two production lines produce the same part. Line 1 produces 1,000 parts per week of which 100 are defective. Line 2 produces 2,000 parts per week of which 150 are defective. If you choose a part randomly from the stock what is the probability it is defective? If it is defective what is the probability it was produced by line 1?
 - (c) A robot tasked with patrolling an office building has a Lidar sensor to determine if any doors are open or closed. The sensor will successfully detect an open door 60% of the time. However, it will also mistake a closed door for open door 30% of the time. If half the doors in the office building are typically left open, and the robot's sensor detects that a particular door is open, what is the robot's belief state about this door?