Exercises - May 6 2019

## Exercise 1

- a particle detector has a $\mu$ identification efficiency of 95%, and a probability of identifying a $\pi$ as a $\mu$ of 2%. If a particle is identified as a $\mu$, a trigger is fired. Knowing that the particle beam is a mixture of 90% $\pi$s and 10% $\mu$s, what is the probability that a trigger is really fired by a $\mu$ ? What is the signal-to-noise (S/N) ratio ?

## Exercise 2

- install the `faraway` package. The dataframe `uswages`[1] contains a set of weekly wages for US male workers sampled from the Current Population Survey in 1988[2]
- make a numerical and graphical summary of the data. Do you find any linear correlation between the variables ?

## Exercise 3

- the dataset `sat`[3] has been derived from a study entitled "Getting What You Pay For: The Debate Over Equity in Public School Expenditures." (Data were collected to study the relationship between expenditures on public education and test results.) Make a numerical and graphical summary of the data as in the previous question.

## Exercise 4

- Three boxes contain two rings each, but in one of them they are both gold, in the second both silver, and in the third one of each type. You have the choice of randomly extracting a ring from one of the boxes, the content of which is unknown to you. You look at the selected ring, and you then have the possibility of extracting a second ring, again from any of the three boxes. Let us assume the first ring you extract is gold. Is it then preferable to extract the second one from the same or from a different box?

## Exercise 5

- estimate the following three dimensional integral

$$\int_0^2 \int_3^6 \int_{-1}^1 \left(yx^2 + zlogy + \mathrm{e}^x\right) dx\ dx\ dz$$

  using at least two Monte Carlo methods

## Exercise 6

- estimate the area under the curve $y = \mathrm{e}^{-(x+1)^2}$ and inside a triangle with vertices $V_1(1,0)$ $V_2(0,1)$ and $V_3(-1,0)$ with a Monte Carlo algorithm

## Exercise 7

- given a region in the $x - y$ plane defined by the inequalities

$$\Omega = \begin{cases} \frac{1}{3} \leq 3x \leq 9 - y \\ \sqrt{x} \leq y \leq 3 \end{cases},$$

  estimate the integral

$$\int\int_\Omega (\mathrm{e}^x + \cos xy)\, dx\ dy$$

[1] load it with the command: `data(uswages)`
[2] get help with the command: `?uswages`
[3] use `?sat` for details on the dataset variables and `data(sat)` to load it for the analysis