Statistical Methods Exercises 2 Autumn 2020

Return your solutions by 12.00 Finnish time on Thursday 24.9.2020 to Moodle course page: `https://moodle.helsinki.fi/course/view.php?id=30207`

1. **Error propagation & correlation**. A newlywed couple wants to improve the interior of their bedroom and decides to buy new wallpaper and carpet. The required quantities are equal to the area of the floor and the walls. They measure the height, $h \pm \sigma_h$, the length, $l \pm \sigma_l$ and the width, $w \pm \sigma_w$ of the room, with the uncertainties being uncorrelated. For simplicity assume the room to be rectangular and ignore any windows, doors etc ... Find the uncertainty on the required amounts of carpet and wallpaper. Show that these two uncertainties are correlated by calculating the covariance and correlation coefficient. Plot the dependence of the correlation coefficient on the bedroom length and width. Hint: assume σ_h, σ_l and σ_w to be equal, $h = 2.40$ m and calculate (or draw) the correlation coefficient for bedroom lengths and widths from 2 m up to 10 m. When is the correlation coefficient largest?

2. **Poisson & binomial distribution**. (a) Saariselkä in Finnish Lapland is an excellent place to observe aurora borealis. Assume they occur 1 nights out of 2, that the sky is sufficiently cloudless for observing them during 3 night out of 5 and that you will spend 3 nights in Saariselkä.
   (i) What is the probability to observe aurora borealis every night?
   (ii) What is the probability to return home disappointed without having observed aurora borealis at all? Hint: assume the probability of Northern lights and probability of cloudless sky to be independent.

   (b)(i) Compare a Poisson distribution with a mean of 7 with the corresponding Gaussian distribution (the one having the same mean and variance as the Poisson distribution) by plotting them on top of each other in the same histogram.

   (ii) Do the same for two binomial distributions each at a time: one with $p = 0.5$ and 14 trials and another one with $p = 0.005$ and 1400 trials. What are the discrepancies between the two on-top-of-each-other plotted distributions? Which one of the binomial distributions is approximated better by the Gaussian distribution?

   (iii) Finally plot the Poisson distribution on top of each of the binomial ones. Which of the two binomial distributions resembles more the Poisson distributuion?