Statistical Methods Exercises 1 Autumn 2020

Return your solutions by 12.00 Finnish time on Thursday 17.9.2020 to Moodle course page: `https://moodle.helsinki.fi/course/view.php?id=30207`

1. (i) **Probability & Bayes' theorem**. Using Kolmogorov axioms, show that

$$P(A \cup B) \;=\; P(A) + P(B) - P(A \cap B)\ .$$

(hint: express $A \cup B$ as the union of three disjoint sets).

(ii) Suppose 12 % of desktop computers have MacOS installed, 80 % have Windows, 3 % Chrome OS and 5 % have Linux. 3 % of the MacOS users have been infected by a computer virus, 8 % of the Windows users, 5 % of the Chrome OS users and 1 % of the Linux users. A person is chosen at random and it is found that his or her computer system is infected with a virus. What is the probability that he/she is a MacOS user? What is the probability that he/she is not a Windows user?

2. **Expectation value & variance**. A silicon micro strip sensor is a reverse biased p-n semiconductor junction, where electron-hole pairs produced in the n-type bulk by traversing ionizing particles, are collected on p^+-type implants that are usually long strips on the n-bulk surface covered by aluminum for a good electrical contact (see Figure below).

Show that the spatial resolution, i.e. the uncertainty on the position where the particle traversed the detector, in a micro strip sensor with a binary readout (i.e. a readout only indicating whether a strip has collected charged from the produced electron-holes pairs or not) is equal to $d/\sqrt{12}$, where d is distance between two strips. Hint: assume that the particles enter the plane of the strips perpendicularly according to a uniform distribution. Estimate the variance of the particle position when it's determined as being the position of the closest strip.