Seminar 8

1. Use data about average temperatures per month in the Czech Republic from the following table.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	-1.7	1.7	5.6	9.4	10.7	20.7	18.8	18.9	13.3	9.5	5.6	1.9
Long-term average	-2.8	-1.1	2.5	7.3	12.3	15.5	16.9	16.4	12.8	8.0	2.7	-1.0

   Test the hypothesis that the temperatures in the year 2019 were the same as the long-term average against the right-sided alternative that temperatures in the year 2019 were higher than the long-term average. Test this using:

   (a) test statistic and critical region (visualize them together with a student density function),

   (b) p-value (visualize it together with the density of t-distribution),

   (c) confidence interval,

   (d) built-in function `t.test`.

   Assume that the temperature differences are normally distributed.

2. An operator measures the length of one given operation in the production process in seconds. He measured the data on the old and new machine. Data are in the following tables.

old machine	29	27	29	35	29	32	28	34	32	33
new machine	31	28	30	28	37	29	27	27	39	33
	31	32	31	29	32	28	27	28	24	34

   Test the following hypotheses (under the assumption of normality of both data samples):

   (a) Variances of the both measurements are the same against two side alternative (both manually and using build in function `var.test`).

   (b) The usual time is the same for both machines against two side alternative assuming the equality of the variances of the data samples distributions (both manually and using the built-in function `t.test`).

   (c) For both tests, create a plot of a critical region together with a density function and value of test statistic. Create a plot of a density function and value of test statistic, visualize p-value in that graph.

3. During the second world war South London was often bombing by the German army. The area of South London were divided into 576 equal-sized areas. Assume the number of bombs hitting each area is following Poisson distribution. The number of bombs in each area was the following:

number of bombs	0	1	2	3	4	7
number of areas	229	211	93	35	7	1

   Test a hypothesis that the expected number of bombs per sector is equal to 1 against two-sided alternative. Create a plot of a critical region together with a density function and value of test statistic. Create a plot of a density function and value of test statistic, visualize p-value in that graph.

4. EXTRA TASK (for volunteers): Test the normality of the data samples from the tasks 1 and 2.