Introduction to Probability, Statistics and Data Handling	**Confidence intervals, hypothesis testing**
Tutorial 7	

1. *Interval estimation in large and small samples. Normal distribution.*
   a) A random sample of 120 students from a large university yields mean grade 2.7 with **population standard deviation σ =0.5.** Construct a 90%, 95% and 98% confidence interval for the mean grade of all students at the university. Assume that the population from which the sample is taken has a normal distribution of grades.
   b) Solve the above problem when the number of students is only 12
   c) How many students we need to randomly surveyed to be 95% confident that sample mean grade is within 0.2 of the true population grade?
   d) Solve b) but assume that you have **calculated the standard deviation s from the sample** and s =0.5. You need to use **t-Student distribution**.
2. *Interval estimation in large samples. Unknown distribution.*

   Suppose that an accounting firm does a study to determine the time needed to complete one person's tax forms. It randomly surveys 100 people. The sample mean is 23.6 hours. There is a known standard deviation of 7.0 hours.
   a) Construct a 90% confidence interval for the population mean time to complete the tax forms.
   b) If the firm wished to increase its level of confidence and keep the error bound the same by taking another survey, what changes should it make?
   c) If the firm did another survey, kept the error bound the same, and only surveyed 49 people, what would happen to the level of confidence? Why?
   d) Suppose that the firm decided that it needed to be at least 99% confident of the population mean length of time to within one hour. How would the number of people the firm surveys change? Why?
3. A random sample of statistics students were asked to estimate the total number of hours they spend looking at their mobiles during an average day. The responses are: 0, 3, 1, 20, 9, 5, 10, 1, 10, 4, 5, 14, 4, 5, 2. Use this sample data to construct a 98% confidence interval for the mean number of hours statistics students will spend on the mobiles.
4. It is hoped that a newly developed pain reliever will more quickly produce perceptible reduction in pain to patients after minor surgeries than a standard pain reliever. The standard pain reliever is known to bring relief in an average of 3.5 minutes with standard deviation 2.1 minutes. To test whether the new pain reliever works more quickly than the standard one, 50 patients with minor surgeries were given the new pain reliever and their times to relief were recorded. The experiment yielded sample mean $\bar{x}$ =3.1 minutes and sample standard deviation s =1.5 minutes. Is there sufficient evidence in the sample to indicate, at the 5% level of significance, that the newly developed pain reliever does deliver perceptible relief more quickly?
5. Statistics students believe that the mean score on the first statistics test is 65. A statistics instructor thinks the mean score is higher than 65. He samples ten statistics students and obtains the scores 65; 65; 70; 67; 66; 63; 63;68; 72; 71. Perform a hypothesis test using a 5% level of significance to support the instructor opinion. The data are assumed to be from a normal distribution. Calculate and interpret the *p*-value using the Student's *t*-distribution.
6. A new blood test is being developed to screen patients for cancer. Positive results are followed up by a more accurate (and expensive) test. It is assumed that the patient does not have cancer. Describe the null hypothesis, the Type I and Type II errors for this situation, and explain which type of error is more serious.
7. In the past the average length of an outgoing telephone call from a business office has been 143 seconds. A manager wishes to check whether that average has decreased after the introduction of policy changes. A sample of 100 telephone calls produced a mean of 133 seconds, with a standard deviation of 35 seconds. Perform the relevant test at the 1% level of significance.