Statistics for Engineering, 4C3/6C3, 2012

Assignment 3

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Assignment objectives: working with confidence intervals (calculations and interpretation)

Question 1 [2]

The confidence interval for the population mean takes one of two forms below, depending on whether we know the variance or not. At the 90% confidence level, for a sample size of 13, compare and comment on the upper and lower bounds for the two cases. Assume that $s = \sigma = 3.72$.

$$-c_n \quad \leq \quad \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} \quad \leq \quad c_n$$

$$-c_t \quad \leq \quad \frac{\bar{x} - \mu}{s/\sqrt{n}} \quad \leq \quad c_t$$

Question 2 [2]

You are responsible for the quality of maple syrup produced at your plant. Historical data show that the standard deviation of the syrup viscosity is 40 cP. How many lab samples of syrup must you measure so that an estimate of the syrup's long-term average viscosity is inside a **range** of 60 cP, 95% of the time.

Question 3 [4]

The best method of testing for a significant difference is to use an external reference data set. The data I used for the example in class are available on the dataset website, and it only contains the 300 data points from feedback system A.

1. Use these data and repeat for yourself (using any software) the calculations described in class. Reproduce the dot plot, but particularly, the risk value of 11%, from the above data. Note the observations 291 to 300 are the same as 10 "group A" observation in the course slides. The 10 yields from group B are: $[83.5, 78.9, 82.7, 93.2, 86.3, 74.7, 81.6, 92.4, 83.6, 72.4]$.

2. The risk factor of 11% seems too high to reliably recommend system B to your manager. The vendor of the new feedback has given you an opportunity to run 6 more tests, and now you have 16 values in group B:

   $$[83.5, 78.9, 82.7, 93.2, 86.3, 74.7, 81.6, 92.4, 83.6, 72.4, \mathbf{70.8}, \mathbf{77.7}, \mathbf{80.7}, \mathbf{81.4}, \mathbf{86.1}, \mathbf{77.9}]$$

   Recalculate the average difference between 2 groups of 16 samples, redraw the dot plot and calculate the new risk factor. Comment on these values and *make a recommendation to your manager*.

   Use bullet points to describe the factors you take into account in your recommendation.

Note: You can construct a dot plot by installing the `BHH2` package in R and using its `dotPlot` function. The `BHH2` name comes from Box, Hunter and Hunter, 2nd edition, and you can read about their case study with the dot plot on page 68 to 72 of their book. The case study in class was based on their example.

Question 4 [2]

You are planning a series of experiments to test alternative conditions in a store and see which conditions lead to higher sales.

Which practical steps would you take to ensure independence in the experimental data, when investigating:

1. adjustable halogen lighting: **A** = soft and dim lighting and **B** = brighter lighting
2. alternative shelving: **A** = solid white metal shelves and **B** = commercial stainless steel racking

Question 5 [3]

There are two analytical techniques for measuring biochemical oxygen demand (BOD). You wish to evaluate the two testing procedures, so that you can select the test which has lower cost, and fastest turn-around time, but without a compromise in accuracy.

These are the data:

Dilution method	Manometric method
11	25
26	3
18	27
16	30
20	33
12	16
8	28
26	27
12	12
17	32
14	16

1. Is there a statistical difference in accuracy between the two methods?
2. Any other thoughts on the results from the statistical test?

Question 6 [600-level students] [3]

A common unit operation in the pharmaceutical area is to uniformly blend powders for tablets. In this question we consider blending an excipient (an inactive magnesium stearate base), a binder, and the active ingredient. The mixing process is tracked using a wireless near infrared (NIR) probe embedded in a V-blender. The mixer is stopped when the NIR spectra stabilize. A new supplier of magnesium stearate is being considered that will save $ 294,000 per year.

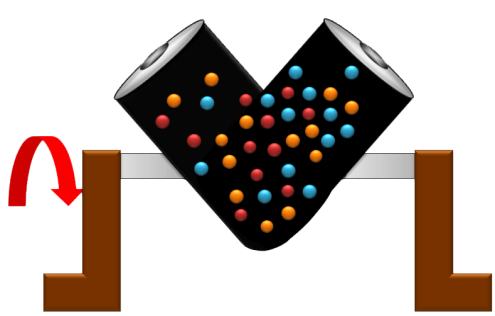

Illustration from Wikipedia (http://en.wikipedia.org/wiki/Industrial_mixer)

The 15 most recent runs with the current magnesium stearate supplier had an average mixing time of 2715 seconds, and a standard deviation of 390 seconds. So far you have run 6 batches from the new supplier, and the average mixing time of these runs is 3115 seconds with a standard deviation of 452 seconds. Your manager is not happy with these results so far - this extra mixing time will actually cost you more money via lost production.

The manager wants to revert back to the original supplier, but is leaving the decision up to you; what would be your advice? Show all calculations and describe any additional assumptions, if required.

END