

Summary of chapter 15 – Inference in practice

I strongly suggest that you read both this summary and the chapter itself. I tried here to emphasize what things I consider most important and to put them in the context of our classes, but the chapter gives you more examples.

We now know two procedures that allow us to do inference about a value of a parameter (or to predict (infer) something about the value of the parameter). They are the confidence intervals and the hypothesis testing for the population mean μ , when a random sample is drawn from a Normal distribution with known standard deviation σ . The examples that we have considered are all carefully formulated so that our procedures are directly applicable. This is not always the case. In real life situations there are often things that may interfere with your procedure working correctly. This chapter tells you what things to be careful about, what things to watch out for.

Any confidence interval or significance test can only be used under specific conditions. It is up to your judgment whether the conditions are met. If they are not the results that you get from an inference procedure will be meaningless. For the inference procedures that we have covered in class (called z-procedures in your book, for the z-statistic) the most important conditions are the following:

1. The data must be a **random sample** or at least you have to be reasonably sure that your sample is representative of the population. Make sure there are no biases (e.g. as in voluntary response sample, or due to non-responses, under-coverage, or badly-worded questions, see Chapter 7 and ex. 15.2c and 15.4c of the homework).
2. There are procedures that will work for (un-biased and well-prepared) designs of data collection **other than a simple random sample**, and we will discuss some of them in class, but the point is: always try to know what you would like and what you will or will not be able to do with the data, before it is collected.
3. The procedures that we have learned involve the sample mean \bar{x} , which, as you know, is sensitive to outliers. So, the **outliers would greatly influence your results** both for the confidence interval and for hypothesis testing. Therefore, always check your data for outliers and see if you can justify removing them from the sample (for example, do you have evidence that they are mistakes?) If your outliers cannot be removed, you would have to look for different procedures to use.
4. The procedures that we learned assume that the **population distribution is Normal**. However, in reality they only need the distribution of \bar{x} to be Normal. So, if the population distribution is only mildly skewed without strong outliers, the procedures will still work well for medium and large sample sizes. They will also work even with stronger skewed distributions, when the sample size is large, due to the central limit theorem (chapter 10). We will talk a little more about how large is large in chapter 16 (ex. 15.2b and 15.4a of the homework).
5. Our procedures require that we **know σ** , which is usually not known in practice. Chapter 16 will show what to do when σ is not known, but these new procedures will build on the simplest cases we have just learned.

6. Other inference procedures (whether covered in this class or not) have similar lists of warnings, especially regarding the careful choice of the methods (designs) for data collection
7. It is usually a good idea to do the exploratory data analysis (such as we covered in Chapters 1-5) in parallel with the formal inference procedures. Plot your data in a stemplot, boxplot or a histogram, look at its shape, center and spread, look for outliers; or if you are concerned with the relation between two quantities, do a scatterplot. Think whether you can see in your plots what you plan to find out with inference procedures. Just remember – exploratory data analysis (looking at your data in various ways) and formal inference procedures (tests of significance, confidence intervals) do not replace one another and are useful in different ways.

Specific caution for the confidence intervals:

Even if the margin of error (size of the confidence interval) is small, the result can still be trustworthy or not, depending on how accurately the data was collected. Remember: the margin of error only accounts for the fact that different random sample would give you a different parameter estimate, not for errors of data collection, errors of computation, etc.

Specific cautions for the tests of significance:

- What should be the significance level, or how small should P be to be convincing? This basically depends on who you need to convince. If the consequences of small P (i.e. of rejecting H_0) are large (e.g. expensive, or will shatter a common opinion, or will require changes in public policy), then the evidence need to be more convincing (P needs to be smaller).
- Remember that even if P is small, i.e. you can reject the hypothesis, i.e. in other words your data is significantly different from what is stated by the null hypothesis, it does not mean that the difference is large. The difference can be very small, and of no practical significance to you whatsoever, and yet it can be picked up by the significance test (this is especially true for large samples, see Ex. 15.6 in the homework).
- Confidence intervals and significance tests can and should work together: test of significance tells you whether your data is different from what is stated by the null hypothesis, and the size confidence interval tells you by how much it is different (ex. 15.7 in the homework)

Homework: 15.2, 15.4, 15.6, 15.7