**Intro to Hypothesis**

3.7, 5.1

Hypothesis

* A model or proposition that we adopt in order to test
* A guess or belief that we adopt to verify
* The notation of hypothesis in statistics: H
* Hypothesis testing: assess the plausibility of a hypothesis by using the sample data

Null Hypothesis and Alternative Hypothesis

Two models or guesses for the same research question

* Null hypothesis Ho: the claim that states “no changes”, “no effect”, “no difference”, “no relationship”
* Alternative hypothesis: the alternative claim we should conclude when we reject the null hypothesis
* Cannot and DO NOT “accept” or “prove” the null hypothesis
* But, reject or disprove null hypothesis

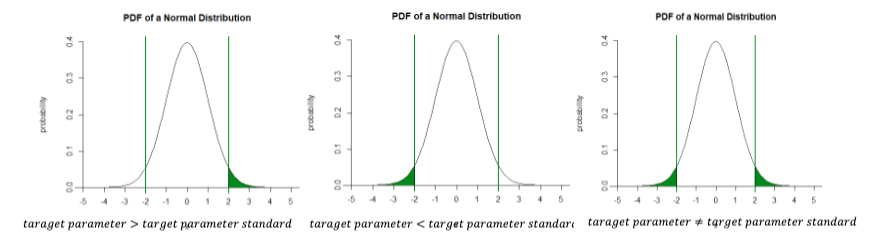
One-tailed or Two-tailed Test

Ho: target parameter = target parameter standard

Ha: Depending in on your research question, the alternative hypothesis can be

(one-tailed) target parameter > target parameter standard

Target parameter < target parameter standard

(two-tailed) target parameter does not equal target parameter standard 

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P-value

* The probability that the sample you collected actually come from the population that the null hypothesis describes, if the null hypothesis is true
* The smaller a p-value is, the less likely the sample is from the population of the null hypothesis
* Improbable sample
* Assumption is incorrect: reject the null hypothesis

Alpha Level

* Significance label is used for the threshold value of a hypothesis test
* The risk we would be willing to take when the sample rejects the null hypothesis even if it is true
* When we reject the null hypo, the test is significant at alpha level
* common values of alpha level: 0.1, 0.05, 0.01, 0.001

The 8 steps for ALL Inference problems

* first, identify which of the tests you should use
* then, follow the 8 steps to solve the inference problem:

1. check assumptions
2. set the null & alternative hypotheses
3. set alpha level, the level of significance
4. calculate test statistic
5. draw a picture
6. find the p-value (in R)
7. draw conclusion

* is the p-value smaller than the alpha level?
* Yes, reject the null hypothesis

1. Double check

* Compute the CI
* Do the test in R

**T-test for One Mean: One sample t-test**

**3.5, 5.1, 5.2**

* Set the null and alternative hypothesis

Ho: µ = µ0

Ha: µ > µ0

µ < µ0

µ =/ µ0 Choose the proper one for Ha based on research question. Only one Ha

If your RQ is “larger than”, go with >

Less than, <

Not equal to, =/

Find the p-value of one mean one sample t-test in R

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**Power of a Test**

* Power is the probability that
* We detect an effect that is real
* We have enough data to reject the null hypothesis
* We DO NOT get a false negative, 1 – beta
* Table

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How to increase power

* Increase sample size
* Increase level of significance, alpha
* Increasing alpha reduces beta
* Increase effect size
* Effect size: the difference between the Ho value (the standard value) and the corresponding value that you observed (the data value)
* How big a difference would matter
* Use covariates or blocking variables

[Power Analysis in R (Links to an external site.)](https://www.statmethods.net/stats/power.html)

Lab exercise 7 – one sample t-test

Quiz 9:

* T.test: function to use for hypothesis testing for mean(s) in R
* Mu is target parameter in hypothesis for one mean
* Pt is function to get p-value with test statistic t for HT for one mean
* Type I error also called false positives, probability of type I error is alpha and occurs when we reject the null hypothesis when the null hypothesis
* Type II error has probability is beta and also called false negatives
* Power, 1-beta, is the probability that you do detect an effect that is real

**Hypothesis testing for two means**

**5.3, 5.4, 5.5**

* Comparing the means of two groups
* The difference between the averages of the two groups
* What is the true difference?
* Are the two groups statistically different?
* The sampling distribution for the difference between two means
* Normal distribution for the sampling distribution of x1 – x2

Two means Assumptions and conditions

* Independence and randomization
* Independent observations within each group
* Independent between the two groups
* Sample size
* Small enough (each group)
* Large enough (each group)
* when both groups have large sample size, CLT starts to work
* nearly normal condition
* when sample sizes are small
* check it for each group
* check whether there are outliers
* equal variance assumption for pooled or NOT

Text

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* example comes from two different groups with equal variance
* if you have data, you need to use “ ”: to determine whether the variances are equal or not

n1, x1, s1, n2, x2, s2A picture containing text

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HT for Paired Means

* paired data: an observation of a quantitative variable in one group is paired with an observation in the second group
* dependent observations within each pair
* weight before and after a diet of same person
* certain measure before and after of a patient
* grade of first and second exam for student
* the sampling distribution for the mean difference between the observations in each pair
* d = mean (di), where di = xi – yi and I from 1 to n
* n is the number of pairs
* normal distribution of d (mean: mu of d and stand dev

Paired Means Assumptions and conditions

* paired data condition
* understand how the data were collected
* Independence
* The differences must be independent
* Pairs are random samples
* Independent individual observations
* Sample size
* Small enough
* Large enough
* When the number of pairs is large enough, CLT starts to work
* Near normal condition
* When sample is smaller
* Check the distribution of the differences

Text

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Testing with R?

•Process: Whenever possible, you can solve the problems analytically (using equations) and also varwith R

–The more ways you can solve a problem and get the same answer, the more confident you can be

•However, sometimes R is not as helpful. R need all the datato perform statistical inference tests

•If you are just given summary of data or statistics (e.g., the mean and standard deviation of the values in your sample) but notthe actual data), you will have to solve the problem using the equations rather than using R

HT for One Proportion:

5.6, 5.7

**Basic Ideas and Notations about Proportions**

**•Binary Reponses**

**•# of observations or subjects: n**

**•# of “successes”: the number of observations or subjects give the answer you are interested in**

**•# of “failures”: n -# of successes**

**•proportion of successes (”sample proportion”): !𝑝=#ofsuccesses/ n**

**"•proportion of failures: !𝑞=#offailures"=1−!𝑝**

**•The population proportion (truth or true value): p**

**•q = 1-p**

**•Always z-Distribution!**

HT for One proportion Assumptions and conditions

* Independence assumption or randomization condition
* Sample size is small enough
* 10% condition
* Less than 10% of the population
* Sample size is large enough (to use the Normal distribution)
* Success/failure condition
* At least 10 successes and at least 10 failures

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HT for two proportions

HT for two proportion assumptions and conditions:

•Independence Assumption or Randomization Condition

•Independent Groups

•Sample size is small enough

–10% Condition

•Less than 10% of the population (check each group)

•Sample size is large enough (to use the Normal Distribution)

–Success/Failure Condition

•At least 10 successes and at least 10 failures in each group

Text, letter

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* Set alpha as 0.01Diagram

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3.7 p-values, confidence intervals, and controversy

5.1 which statistical test should I use?

3.5 Power analysis and sample sizes

5.1

5.2 one sample t-test

**5.3 two sample t-test with equal variances**

**5.4 two sample t-test (unequal variances)**

**5.5 paired t-test**

5.6 one proportion z-test/exact binomial

5.7 two proportion z-test