MATH 10

INTRODUCTORY STATISTICS

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Week 7

- **Chapter 12 – Test of Means** ← **today's lecture**

More hypothesis testing!

- **Chapter 13 – Interestingly titled "Power"** ← **today's lecture?**

The idea of the "power" of a test.

- **Chapter 14 – (brief introduction to) Regression** ← *Maybe?*

Chapter 11, Section 8 – Steps in Hypothesis Testing

1. Specify a null hypothesis.
2. Specify a significance level.
3. Compute probability value.
4. Compare p-value and significance level.

Lower the p-value, the more confidence you have in rejecting the null hypothesis. It is not a clear cut binary decision.

Erratum – Binomial Hypothesis Testing

- I will tell the grader to give you credit in case you used the wrong version of the standard error for homework.

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- H_0: $\pi = 0.50$, H_A: $\pi > 0.50$, is male proportion greater than 0.50?
- Sample proportion $p = 0.60$, sample size $n = 25$.

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- H_0: $\pi = 0.50$, H_A: $\pi > 0.50$, is male proportion greater than 0.50?
- Sample proportion $p = 0.60$, sample size $n = 25$.
- Assuming that the null hypothesis is true, the population proportion is $\pi = 0.50$.
- Applying Normal approximation to the binomial distribution, the sampling distribution is Normal with mean $\pi = 0.50$ and variance $n\pi(1 - \pi)$.
- Z-statistic/value is $\frac{p - mean}{standard\ error} = \frac{p - \pi}{\sqrt{\frac{\pi(1-\pi)}{n}}} = \frac{0.1}{0.1} = 1.$

Erratum – Binomial Hypothesis Testing

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- p-value is $P(p \geq 0.6) = P(Z \geq 1) = 1 - P(Z < 1) = 1 - 0.8413 = 0.1587.$
- Rejecting null or not depends on your significance level.

Chapter 11, Section 10 – Misconceptions

Extremely important for the exams.

- Is the p-value the probability that the null hypothesis is false?
- Does a low p-value indicate a large effect?
- If an outcome is not statistically significant, does it mean that the null hypothesis is true?

p-value and Bayes Theorem

- p-value = P(D = data or more extreme | H = null hypothesis is true)

- But $P(\ H \mid D\ ) \ = \ \frac{P(\ D \mid H\ )\ P(H)}{P(D)}$.

- We can go further: $P(\ H \mid D\ ) \ = \ \frac{P(\ D \mid H\ ) P(H)}{P(D \mid H\ ) P(H) + P(H \mid D) P(D)}$.
- So p-value is NOT the probability that the null hypothesis is true, which is P(H|D).

- Technically, we are using $P(\ D \mid H\ )$ to “guess” whether $P(\ H \mid D\ )$ would be small.

Psychology journal bans *P* values

Test for reliability of results 'too easy to pass', say editors.

Chris Woolston

26 February 2015 | Clarified: 09 March 2015

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A controversial statistical test has finally met its end, at least in one journal. Earlier this month, the editors of *Basic and Applied Social Psychology* (*BASP*) announced that the journal would no longer publish papers containing *P* values because the statistics were too often used to support lower-quality research [1].

Authors are still free to submit papers to *BASP* with *P* values and other statistical measures that form part of 'null hypothesis significance testing' (NHST), but the numbers will be removed before publication. Nerisa Dozo, a PhD student in psychology at the University of Queensland in Brisbane, Australia, tweeted:

NATURE | NEWS

Statisticians issue warning over misuse of *P* values

Policy statement aims to halt missteps in the quest for certainty.

Monya Baker

07 March 2016

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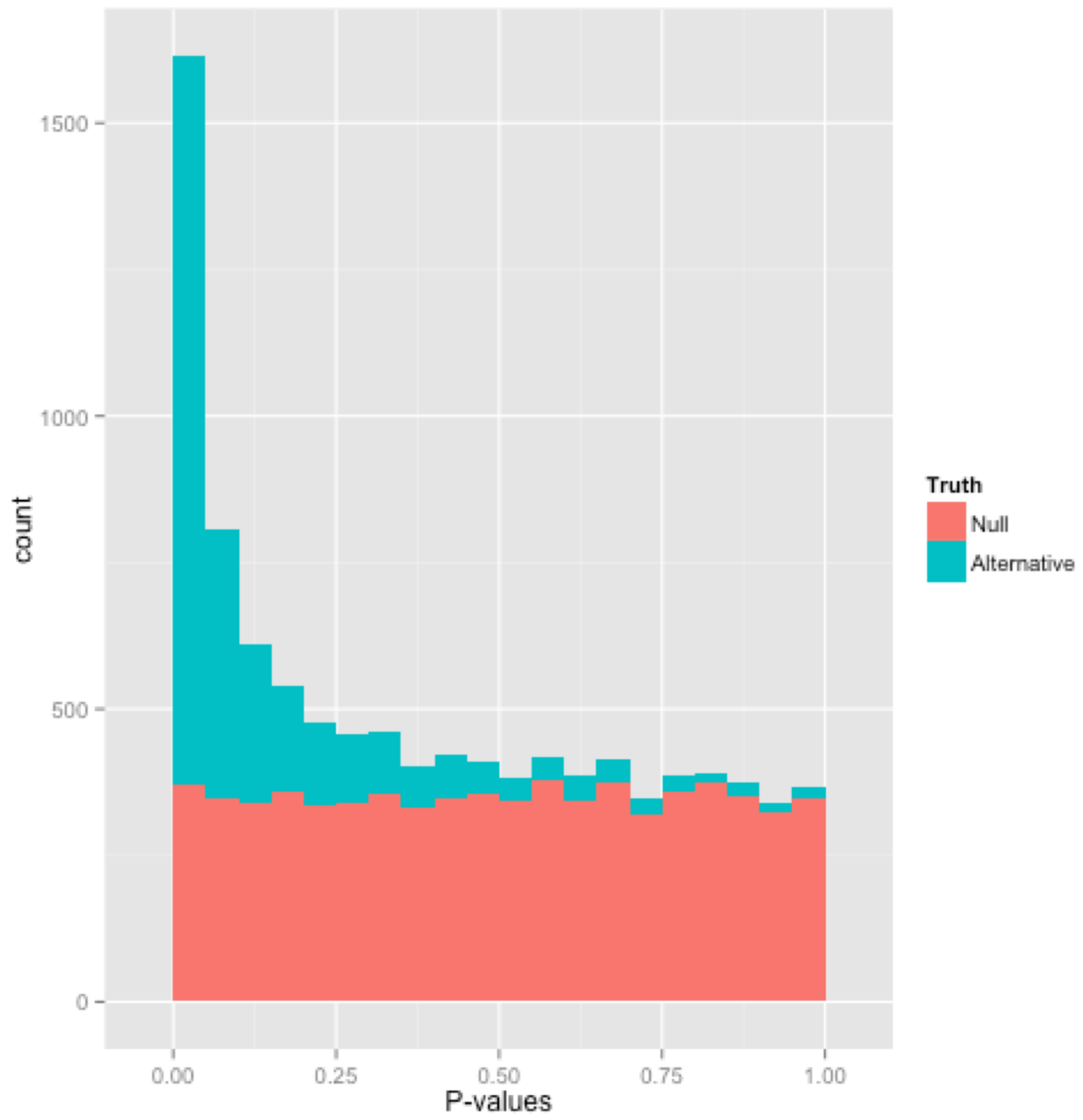
Misuse of the *P* value — a common test for judging the strength of scientific evidence — is contributing to the number of research findings that cannot be reproduced, the American Statistical Association (ASA) warns in a statement released today[1]. The group has taken the unusual step of issuing principles to guide use of the *P* value, which it says cannot determine whether a hypothesis is true or whether results are important.



Chapter 11, Section 9 – Confidence Intervals

- Confidence intervals are connected to significant tests.

- If a $(1 - \alpha)\%$ confidence interval constructed from the data does not contain the mean in the null hypothesis…

- Then you will reject the null hypothesis at the α significance level (*for a two tailed test*).

- You can see this using an illustration.

Chapter 12, Section 4 – Hypo. Test For Difference Between Means

- The general strategy :

$$z \text{ or } t = \frac{sample\ mean\ - hypothesized\ mean}{standard\ error}$$

- Use z when population variances are given. Sampling distribution is normal.

- Use t when population variances are not given. Sampling distribution is the t-dist.

Chapter 12, Section 4 – Hypo. Test For Difference Between Means

Assumptions for the t-dist case

1. Both populations are normally distributed with the same unknown variance.
2. Both simple random samples are independent and have same size n.

$$\text{MSE} = \frac{S_1^2 + S_2^2}{2}$$

$$\text{Standard Error, SE} = \sqrt{\frac{2\,MSE}{n}}.$$

Skipped Chapters

- Chapter 12, Section 6, Pairwise Comparisons (Tukey HSD test),
- Chapter 12, Section 7, Specific Comparisons,
- Chapter 12, Section 8 , Correlated Pairs
- Chapter 12, Section 11, Pairwise (Correlated) (Bonferroni correction),

- are not required!

→ Syllabus on the website has been updated.

Chapter 13 - Power

- Probability of falling to reject a false null hypothesis $= \beta$.

- Power $= 1 - \beta$.

- Cannot be calculated unless we specific a particular value for the alternative hypothesis.

Chapter 13, Section 6 – Factors Affecting Power

- Sample size.
- Standard deviation.
- Difference between hypothesized and true mean.
- Significance level.
- One vs. Two-tailed tests.