some thing wrong

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Introduction to Hypothesis Testing

Inferential Statistics

What is Inferential Statistics ?

Assess the strength of evidence for/against a hypothesis; evaluate the data.

- Inferential statistical methods provide a confirmatory data analysis.
- Generalize conclusions from data from part of a group (sample) to the whole group (population)
- Assess the strength of the evidence
- Make comparisons
- Make predictions Inferential statistical methods divide into 2 categories.

Hypothesis Testing

Hypothesis Testing:

Hypothesis testing is a formal procedure for investigating our ideas about the world using statistics. It is most often used by scientists to test specific predictions, called hypotheses, that arise from theories.

Model Fitting

Model Fitting:

Model fitting is a measure of how well a statistical learning model generalizes to similar data to that on which it was trained. A model that is well-fitted produces more accurate outcomes.

Inference

What is Inference?

The process of drawing conclusions about population parameters based on a sample taken from the population.

- A sample is likely to be a good representation of the population.
- There is an element of uncertainty as to how well the sample represents the population.
- The way the sample is taken matters.

Inference

What is Hypothesis?

- Proposed explanation for a phenomenon.
- A hypothesis is an educated guess about something in the world around you. It should be testable, either by experiment or observation.
- Proposed explanation
- Objectively testable
- Singular - hypothesis
- Plural - hypotheses

Examples

- A new medicine you think might work.
- A way of teaching you think might be better.
- A possible location of new species.

Hypothesis and Study Design

Hypothesis: seat belts decreases the fatality rate.

Study design: cross-sectional study of fatality outcome and seat-belt use of victims of motor vehicle accidents during a one-month time period in a large city

	Seat Belt	
Driver	Worn	Not Worn
Dead	10	20
Alive	40	30
Total	50	50
Fatality rate	10/50 (20%)	20/50 (40%)

Effect of Seat Belt Use on Accident Fatality

What is your conclusion?

The fatality rate is:

- 40% in the group of drivers who did not wear seat belts
- 20% in drivers who did wear seat belts

Seat belts appear to save lives

The Inferential Questions of Interest

The inferential questions of interest are:

- Are results applicable to the population of all drivers? (generalization)
- Does wearing seat belts decreases fatality rate? (assess strength of evidence)
- Is the fatality rate of those not wearing seat belts higher than the fatality rate of those wearing seat belts? (comparison)
- How many lives can be saved by wearing seat belts? (prediction)
- Do other variables influence the conclusion?
- For example: the age of driver, alcohol use, type of car, speed at impact (ask more questions)

Speed at Impact

	Speed at Impact			
	<= 30 Miles per Hour		> 30 Miles per Hour	
Driver	Seat Belt Worn	Seat Belt Not Worn	Seat Belt Worn	Seat Belt Not Worn
Dead	3	2	7	18
Alive	27	18	13	12
Total	30	20	20	30
Fatality rate	10%	10%	35%	60%

How Does This Influence Your Conclusion?

- How does this influence your conclusion?
  - The fatality rate is 10% at low-impact speeds regardless of seat-belt use.
- The fatality rate at high impact speeds is:
  - 60% in drivers not wearing seat belts
  - 35% in drivers wearing seat belts

Null and Alternative Hypothesis

- **Hypothesis 0 (H0):**
  Assumption of the test holds and is failed to be rejected at some level of significance.
- **Hypothesis 1 (Ha):**
  Assumption of the test does not hold and is rejected at some level of significance.

Errors in Statistical Tests

- **Type I Error:**
  The incorrect rejection of a true null hypothesis or a false positive.
- **Type II Error:**
  The incorrect failure of rejection of a false null hypothesis or a false negativ.

		Decision about Null Hypothesis	
		REJECT	DON'T REJECT
Null Hypothesis is actually	TRUE	Type I error	Correct Inference
	FALSE	Correct Inference	Type II error

Alpha α

- α is probability of rejecting H0 when H0 is true.
- $\alpha =$ Probability of Type-I error.
- Ranges from 0 to 1
- High α is not good

P-value

In statistics, the p-value is the probability of obtaining results at least as extreme as the observed results of a statistical hypothesis test, assuming that the null hypothesis is correct. Generally cut off value of alpha 0.05.

- If p-value >alpha: Fail to reject the null hypothesis (i.e. not significant result).
- If p-value <= alpha: Reject the null hypothesis (i.e. significant result).

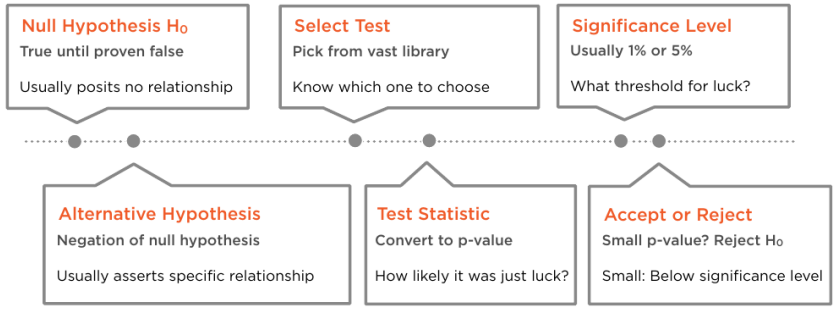
Hypothesis Testing Process (Con..)

- **Step-1:** Null Hypothesis H0
  → True until proven false
  → Usually posits no relationship
- **Step-2:** Select Test
  → Pick from vast library
  → Know which one to choose
- **Step-3:** Significance Level
  → Usually 1% or 5%
  → What threshold for luck?

Hypothesis Testing Process (Con..)

- **Step-4:** Alternative Hypothesis
  → Negation of null hypothesis
  → Usually asserts specific relationship
- **Step-5:** Test Statistic
  → Convert to p-value
  → How likely it was just luck?
- **Step-6:** Accept or Reject
  → Small p-value? Reject H0
  → Small: Bellow significance level

Hypothesis Testing Process



Common Statistical Tests

Variable Distribution Type Tests (Gaussian)

- Shapiro-Wilk Test
- D'Agostino's k^2 Test
- Anderson-Darling Test

Variable Relationship Tests (correlation)

- Pearson's Correlation Coefficient
- Spearman's Rank Correlation
- Kendall's Rank Correlation
- Chi-Squared Test

Compare Sample Means (parametric)

- Student's t-test
- Paired Student's t-test
- Analysis of Variance Test (ANOVA)
- Repeated Measures ANOVA Test

Compare Sample Means (nonparametric)

- Mann-Whitney U Test
- Wilcoxon Signed-Rank Test
- Kruskal-Wallis H Test
- Friedman Test

Statistical Test Selection

- Mann-Whitney U Test
- Wilcoxon Signed-Rank Test
- Kruskal-Wallis H Test
- Friedman Test

Statistical Test Selection

What we observe in our sample data	Is it real?(statistical test)
1 categorical variable	1 sample proportion test
2 categorical variables	chi squared test
1 numeric variable	t-test
1 numeric and 1 categorical variable	t-test or ANOVA
more than 2 categorical variables	ANOVA
2 numeric variables	correlation test

Reference

For learning more, visit -

1. https://machinelearningmastery.com/statistical-hypothesis-tests/
2. https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/

Thank You