General Hypothesis Design

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Objectives

- Understand how to properly formulate a null and alternative hypothesis

- Define the two main types of hypothesis testing errors

Quiz

An employee of a gelateria has developed a new ice-cream additive: (Gorgonzola / Anchovy) He wants to start full production of the additive to the chocolate ice-cream. The owner of the gelateria is skeptical, as refitting the existing factory will be expensive.

He asks the employee to provide proof that the new additive will sell better.

Quiz

1. Write down the appropriate research hypotheses for the experiment.

2. What are the two possible hypothesis errors in this experiment?

Definition

Hypothesis: a claim or assertion about the value of a single parameter, the value of several parameters, or the form of a probability distribution.

Null Hypothesis

The claim that is initially assumed
to be true.

- "Prior Belief"
- "Standard of practice"

Usually labeled as: H_0

State as an equality:

H_0: X=50

Null Hypothesis

Why do we choose the status quo as the null hypothesis?

Null Hypothesis

Why do we choose the status quo as the null hypothesis?

- "Innocent until proven guilty"
- Burden on the experimenter to prove that the null hypothesis is false
- Most research hypotheses are wrong
- Cost of falsely rejecting null hypothesis can be high

Alternative Hypothesis

Often called the "researchers hypothesis"

An assertion contradictory to the null hypothesis

Usually labeled as: H_A

State as an inequality

$X \neq 50$ or $\mu_1 < \mu_2$ or $P > 0.8$

Hypothesis Testing

Give some example of hypotheses:

Example Hypotheses

H_0: $\mu_2 = \mu_1$

(True average score is equal on pre and post test)

H_A: $\mu_2 \neq \mu_1$

(True average score is not equal on pre and post-test)

Example Hypotheses

H_0: $P_2 = P_1$

(Proportion of correct triage is
  equal for START and CTAS)

H_A: $P_2 \neq P_1$

(Proportion of correct triage is not
  equal for START and TRIAGE)

Example Hypotheses

H_0: X=18

(Ideal number of beds in an influenza
assessment center is 18)

H_A: X≠18

(Ideal number of beds in an influenza
assessment center is not 18)

Hypothesis Testing

The null hypothesis will be rejected only if *strong* evidence suggests that H_0 is false.

(Innocent until proven guilty)

There are two possible conclusions:

1. Reject H_0
2. Fail to Reject H_0

Hypothesis Testing

Alternative hypothesis may be one
  sided or two sided:

What does this mean?

One and Two Sided Alternatives

Alternative hypothesis may be one sided or two sided:

One Sided:
H_0: X=35
H_A: X>35

Two Sided:
H_0: X=35
H_A: X≠35

One and Two Sided Alternatives

Alternative hypothesis may be one sided or two sided:

One Sided:	Two Sided:
H_0: X=35	H_0: X=35
H_A: X>35	H_A: X≠35

Usually rejecting null hypothesis in the opposite direction is useful information.

Just "hoping" the new treatment is better is not enough

Maxim

Generally a two sided alternative hypothesis should be used unless there is a CLEAR reason to not do so.

(Also check journal requirements)

Hypothesis Testing

Questions?

Reducing Errors

Reducing Type 1 and Type 2 Errors

Hypothesis Errors

What are the two possible hypothesis
   errors?

Types of Errors

Type 1: Rejecting the null hypothesis when it is in fact true

Type 2: Fail to reject the null hypothesis when it in in fact false

Test Error Matrix

		"TRUTH"	
		H0 is True	H0 is not true
Test Result	**Reject H0**	Type 1 Error	Correct
	Fail to Reject	Correct	Type 2 Error

Alpha (α)

What does an experiments alpha level mean?

Alpha (α)

What does an experiments alpha level mean?

- Probability of committing a type 1 error

- Probability of accidently rejecting the null hypothesis if it is indeed true

- P(Rejecting Null | Null is true)

Beta (β)

What is an experiments Beta level?

Beta (β)

What is an experiments Beta level?

- Probability of committing a type 2 error

- Probability of failing to reject the null hypothesis when it is in fact false

- P(Not rejecting Null | Null false)

Power

What does the term power mean in statistics?

Power

Power is 1-P(type 2 Error)

Is the probability of rejecting the null hypothesis when it is false

Type 1 or Type 2

In generally, which type of error is likely to be more harmful?

Type 1?

Type 2?

Harm

If we phrased the null hypothesis correctly (status quo)

Then… Type 1 error tends to be more harmful

Type 2 Errors

What are possible consequences of
Type 1 error?

Type 1 Errors

What are possible consequences of Type 1 error?

- Giving an treatment that does not work

- Re-tooling the gelateria when the new ice-cream is not actually better

- Starting production of a product that does not work

Type 2 Errors

What are possible consequences of a
   type 2 error?

Type 2 Errors

What are possible consequences of a type 2 error?

- Missed opportunity

- Not pursuing production of a beneficial therapy

- Not capturing increased gelato sales

Errors in Hypothesis Testing

Questions?

Quiz Answers

1. What are the appropriate Hypotheses?

H_0: $\mu_1 = \mu_0$ (Mean daily chocolate gelato sales are the same with and without the additive)

H_A: $\mu_1 \neq \mu_0$ (Mean daily chocolate gelato sales are not the same with and without additive)

Quiz Answers

2. Two types of errors:

Type 1 error: Concluding that the number of scoops sold is different with the additive when in fact it is not.

Type 2 error: Failing to conclude that the number of scoops sold with additive is different when in fact it is.

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Math Lesson (Optional)

The interaction between rate of type 1 and type 2 errors