

## Lecture 14: Hypothesis Testing Part I

### Chapter 4.3

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### Goals for Today

- ▶ Introduce Hypothesis Testing Framework
- ▶ Testing Hypotheses Using Confidence Intervals
- ▶ Types of Errors
- ▶ Testing Hypotheses Using p-Values

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## Statistical Hypothesis Testing

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### Example

We flip a coin many times and start to suspect that it is biased:

- ▶  $H_0$ : the coin is fair. i.e. the probability of heads is  $p = 0.5$
- ▶  $H_A$ : the coin is not fair. i.e.  $p \neq 0.5$

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## Crucial Concept: Conclusions of Hypothesis Tests

## Analogy: US Criminal Justice System

In the criminal justice system, the jury's verdict does NOT make any statement about the defendant being **innocent**, rather that there was not enough evidence to prove beyond a reasonable doubt that they were guilty.

## Analogy: US Criminal Justice System

Let's compare criminal trials to hypothesis tests:

Truth:

- ▶ Truth about the defendant: innocent vs guilty
- ▶ Truth about the hypothesis:  $H_0$  or  $H_A$

Decision:

- ▶ Verdict: not guilty vs guilty
- ▶ Test outcome: "Do not reject  $H_0$ " vs "Reject  $H_0$ "

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## Testing Hypotheses Using Confidence Intervals

The average 10 mile run time for the Cherry Blossom Run in 2006  $\mu_{2006}$  was 93.29 min. Researchers suspect  $\mu_{2012}$  was different:

- ▶  $H_0$ : average time was the same. i.e.  $\mu_{2012} = 93.29$
- ▶  $H_A$ : average time was different. i.e.  $\mu_{2012} \neq 93.29$

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## Testing Hypotheses Using Confidence Intervals

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## Decision Errors

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## Decision Errors

- ▶ Trade-off between these two error rates
  - ▶ procedures with lower type I error rates typically have higher type II error rates
  - ▶ vice-versa
- ▶ In other words, there is almost never a procedure that makes no type I errors and no type II errors. Some sort of balance between the two is required

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## Next Time

- ▶ More Hypothesis Testing

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