# Hypothesis Testing

## Introduction

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13th March 2014

# Hypothesis Testing

| Product | Claim |
|---|---|
| Drug | Patients recover better with drug, than without it. |
| Coding system | Error rate is less than $10^{-9}$. |
| New road | Travel times will be reduced by at least 10 min. |

# The Fundamental Challenge

*How do we test a hypothesis?*

1. Define a null hypothesis.
2. Observation. Gather data.
3. Are the observed data plausible if the hypothesis be true?
   - Not plausible data. Reject the null hypothesis.
   - Plausible data. Keep the null hypothesis.

*How do we assess plausibility?*

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# The test statistic

## Assessing plausibility

1. Test statistic $S$
   - observable quantity (e.g. sample mean)
   - known probability distribution under the null hypothesis
2. Known expectation $E(S)$ under the null hypothesis $H_0$
3. Observed $s \approx E(S) \Rightarrow$ plausible null hypothesis
4. Observed $s \not\approx E(S) \Rightarrow$ implausible null hypothesis

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# For example — the mean

*Does the average student dring more than two pints of bear on a Saturday?*

1. $H_0$: $\mu = 2\text{pints}$
2. Sample statistic: $\bar{x}$
3. If $H_0$, then $E(\bar{x}) = 2\text{pints}$
4. If $\bar{x} >> 2\text{pints} \Rightarrow H_0$ implausible
5. If $\bar{x} << 2\text{pints} \Rightarrow H_0$ implausible
6. If $\bar{x} \approx 2\text{pints} \Rightarrow H_0$ plausible

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# Summary

1. Define null hypothesis $H_0$
2. Define test statistic with known probability distribution under $H_0$
3. Gather data, get an observation $s$ of $S$
4. Is the observed $s$ plausible under $H_0$?
   - Not plausible. Reject the null hypothesis.
   - Plausible. Keep the null hypothesis.

*In later videos, we will discuss how quantify the plausibility.*

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