# Examples

## LED bulb

* The manufacturer of an LED bulb claims that the average power rating of the bulb is 10 Watts.
  + How does the quality inspector test this claim?

## Solid propellant

* For a certain application, the average burning rate of a solid propellant should be 50 cm/sec, higher or lower rates are unacceptable
  + What statistical test must be performed by the end-user?

## Nylon connector

* An automotive engineer claims that the average pull-off force of two nylon connectors (of different wall thicknesses) are 13 and 13.4 pounds, respectively, based on an experiment
  + Do these two connectors truly differ in their average pull-off forces?

## Training methods

* Two different groups of teachers of a school are trained by two different methods, Method A and Method B. It is intended to determine whether Method B is more effective than Method A on an average
  + What statistical procedure should be adopted to compare these training methods?

## Automated filling machine

* The performance of an automated filling machine is acceptable if the variation in filling < 0.01 (fluid ounces)2 .
  + What statistical test is required to assess the performance of the machine?

## Oxide layer thickness

* Oxide layers on semiconductor wafers are etched in a mixture of gases to achieve proper thickness. It is required to determine whether one mixture of gases is superior to another in achieving lower variability.
  + How do we statistically compare the performance of these two mixture of gases?

## Automobile engine controller

* A semiconductor manufacturer produces controllers for automobile engines and claims that the proportion of defective controllers does not exceed 0.05
  + How does the end-use test the manufacturer claim?

In each of the above statements there is a postulate or claim and we claim this as hypothesis, in the above example, the manufacturer hypothesis is that, “proportion of defective controllers does not exceed 0.05”

## Soft drink

* It is contended that students from different campuses have same proportion of students preferring a particular soft drink
  + What is a statistically sound way of comparing proportions?

# In general

Any statistical test of hypothesis consists of

* Hypothesis or a claim
* Specification of the error that we are willing to tolerate in the decision [also known as significance level, it is always present, since we are only testing samples]
* And other important elements of the test itself, a data set being the most important

# Hypothesis

A statistical hypothesis is a statement (postulate or assertion) concerning one or more parameters of the population (of variables or models).

The philosophy in hypothesis testing is before I collect the data, I make a certain claim, even if the claim is not made, there is a default understanding.

Eg: In most countries, there is a default law, that every citizen of the country is innocent before any evidence is provided. Here the idea behind this, is the innocent should not be punished, the guilty may be scot-free.

Alternate hypothesis is a complimentary thing, that typically constitutes, what we want to fall back on, if the null hypothesis is rejected.

Eg: If manufacturer claims that the proportion of defective controllers is 0.05, as an end-user of these controllers, I would be interesting in knowing whether the proportion of defective controllers is 0.05 and I would like to refute this claim, the intention or purpose will determine the alternate hypothesis

## Two types of hypothesis are involved

1. Null hypothesis, H0: The “default” or “status-quo” claim that is assumed to be true if the data does not provide sufficient evidence
2. Alternate hypothesis, Ha: A suitable complimentary hypothesis that one rejects H0 in favor of, what we would be interested in if H0 is rejected.

# Examples revisited

Typically what we want to test will be alternate hypothesis, and what is status quo would be null hypothesis, and in all examples the null hypothesis is of equality type

|  |  |  |
| --- | --- | --- |
|  | Null hypothesis [ H0 ] | Alternate hypothesis [ Ha ] |
| LED bulb |  |  |
| Solid propellent |  |  |
| Nylon connector |  |  |
| Training methods |  |  |
| Automated filling machine |  |  |
| Oxide layer thickness |  |  |
| Automobile engine controller |  |  |
| Soft drink |  |  |

# Hypothesis in linear regression

## Physical attribute

* In a particular part of the world it was a common belief that the finger length of a human has a relation with the cranial circumference.
  + Given data from randomly sampled individuals, how do we test for presence of a linear relation?

For linear regression, the null hypothesis would be that the slope = 0.

## Highway mileage – Engine capacity

* In an automobile study, it is premised that the highway mileage is a linear function of the engine capacity
  + What hypothesis test is to be set up to determine if the correlation [linear dependence] is non-zero?

# General procedure

1. **Identify the parameter of interest** : Average, variability, correlation etc.
2. **State the null hypothesis** : is generally of equality type
3. **Alternate hypothesis** : choose appropriately (one or two-sided)
4. **Test statistic**: Construct a mathematical function of observations and parameters under examination
5. **Set the rejection criterion**: Choose an appropriate criterion, essentially a critical value for test statistic. Usually specified as the level of acceptable error
6. **Decision**: Compute the test statistic and apply the rejection criterion. If the test statistic falls into the “rejection region”, reject in favor of

# A few facts

1. Every dataset contains some amount of randomness (uncertainties)
2. No statistical hypothesis test is accurate , i.e., free of error
3. The goodness of a hypothesis test depends on a few factors:
   1. Extent or “level” of randomness (variability) in data
   2. Sample size
   3. Statistic (“lens”)
   4. Tolerance error in the decision (critical value)