null hypothesis: $H_0$
alternative hypothesis: $H_1$

Type I error
Type II error

$\alpha$ — level of significance
$\beta$ — chance of making type II error

Bag A: -1000 $\$10$  $H_0$: Bag A
Bag B: 1000 $\$60$  $H_1$: Bag B

Type I error = reject $H_0$ when $H_0$ is true
Type II error = accept $H_0$ when $H_1$ is true

Direction of extreme

Decision Rule #1:
Reject $H_0$ if you select $\$60$ or more, otherwise accept $H_0$. 
\[ \alpha = \text{type I error} = \text{chance of selecting } \$60 \text{ or more from Bag A.} = \frac{1}{20} = 0.05 \]
\[ \beta = \text{type II error less than} = \text{chance of selecting } \$60 \text{ from Bag B.} = \frac{10}{20} = 0.6 \]

**Decision Rule #2:**
Reject \( H_0 \) if \( \bar{X} \geq 55 \)
\[ \alpha = \frac{1}{20} = 0.05 \]
\[ \beta = \frac{6}{20} = 0.3 \]

**Decision Rule #3:**
Reject \( H_0 \) if \( \bar{X} \geq 40 \)
\[ \alpha = \frac{4}{20} = 0.2 \]
\[ \beta = \frac{4}{20} = 0.2 \]
Summary of the relationship between the decision rule and the significance level:

**Decision Rule** $\rightarrow$ **Significance Level** $\alpha$ $\rightarrow$ **Decision Rule**

**Definition:**
A rejection region is **one-sided** if its set of extreme values are all in one direction, either all to the right or all to the left.

A rejection region is **two-sided** if its set of extreme values are in two directions.

**How unusual are our data?**

**P-value**

**Definition:**
The p-value is the chance, computed under the assumption that H0 is true, of getting the observed value plus all of more extreme values.
1. $50 observed value
   \[ P(\$50, \$60, \$(100)) \text{ from Bag A.} \]
   \[ p\text{-value} = \frac{2}{20} = 0.1 \]

2. $40
   \[ p\text{-value} = \frac{4}{20} = 0.2 \]

A small \( p\text{-value} \) → data showing stronger evidence against \( H_0 \).

\( p\text{-value} \): calculated from observed data.
\( \alpha \): given as a requirement.

1. classical approach (\( \alpha \rightarrow \) decision rule)
2. \( p\text{-value} \) approach.

If \( p\text{-value} \leq \alpha \) → the data are statistically significant at the given level \( \alpha \)
   → we reject \( H_0 \)

If \( p\text{-value} > \alpha \) → the data are not statistically significant at the given level \( \alpha \)
   → we accept \( H_0 \)
\[ \alpha = 0.1 \quad \text{(requirement)} \]

1. $30 \quad \text{(observed data)}$

   - **Classical:** accept $H_0, \quad (\$30 < \$50)$
   - **p-value:** $p\text{-value} = \frac{6}{20} = 0.3 > \alpha$
     \[ \Rightarrow \quad \text{accept } H_0 \]

2. $60 \quad \text{(observed data)}$

   - **Classical:** $60 > 50 \Rightarrow \text{reject } H_0$
   - **p-value:** $p\text{-value} = \frac{1}{20} = 0.05 < \alpha$
     \[ \Rightarrow \quad \text{reject } H_0 \]

**Let's do it again (P30)**

a). Study C

b). $H_0$ is true \[ \Rightarrow \text{Type I error} \]

c). $H_0$. 