Error Types

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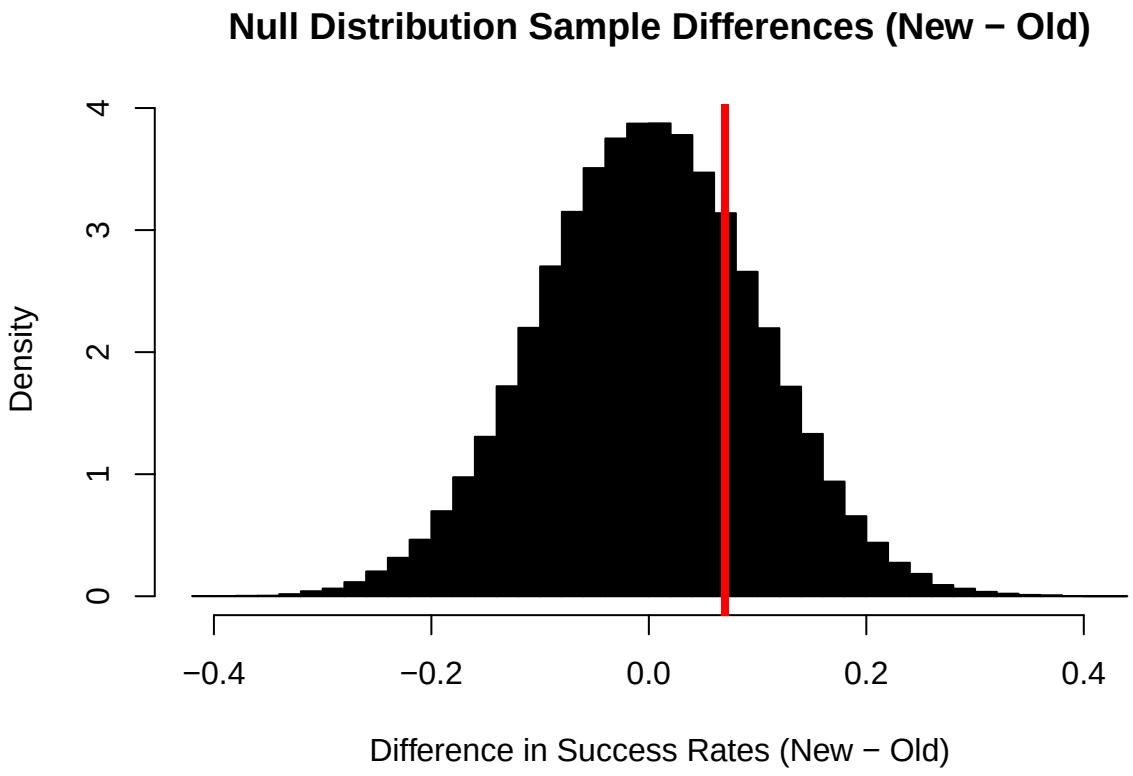
Scenario: In this example, you will assume that you've run a clinical trial to compare an Old treatment and a New treatment. Both treatments have 2 possible outcomes- either the treatment works (is successful) or does not work (is not successful).

You want to specify an appropriate cut-off value to help you determine when your results are significant. In this case, assume that the sample (observed) statistic is 7%.

Step 1: Run and visualize the simulation

```
# Both new and old treatments have same chance of success: (27+22)/(52+51) = 47.6%
set.seed(1) #set the seed so your results are reproducible

outcome = c("Worked", "Did not Work") #possible outcomes

# Run the simulation:
nsim = 100000
store_p_diff = rep(0, nsim)

p_new = 27/52 # Observed proportion of New treatment success
p_old = 22/51 # Observed proportion of Old treatment success
p_all = (27+22)/(52+51) # Proportion of successful treatments under the null hypothesis (27+22)/(52+51)

for (i in 1:nsim){
 result_new = sample(outcome, 52, replace = TRUE, prob = c(p_all, 1-p_all))
 p_new_sim = mean(result_new == "Worked")

 result_old = sample(outcome, 51, replace = TRUE, prob = c(p_all, 1-p_all))
 p_old_sim = mean(result_old == "Worked")

 p_diff = p_new_sim - p_old_sim
 store_p_diff[i] = p_diff

}
# Create the histogram:
hist(store_p_diff, breaks = 40, freq = FALSE, col = "black",
     main = 'Null Distribution Sample Differences (New - Old)',
     xlab = 'Difference in Success Rates (New - Old)')

# Plot the sample statistic of 7% on the histogram:
abline(v = 0.07, lwd = 4, col = "red")
```



Step 2: Determine how often the sample statistic is >7% by random chance.

```
mean(store_p_diff > 0.07)
```

```
## [1] 0.21609
```

A cut-off at 7% would correspond to 21.6% chance of a False Positive (FP or type-I error); this is high.

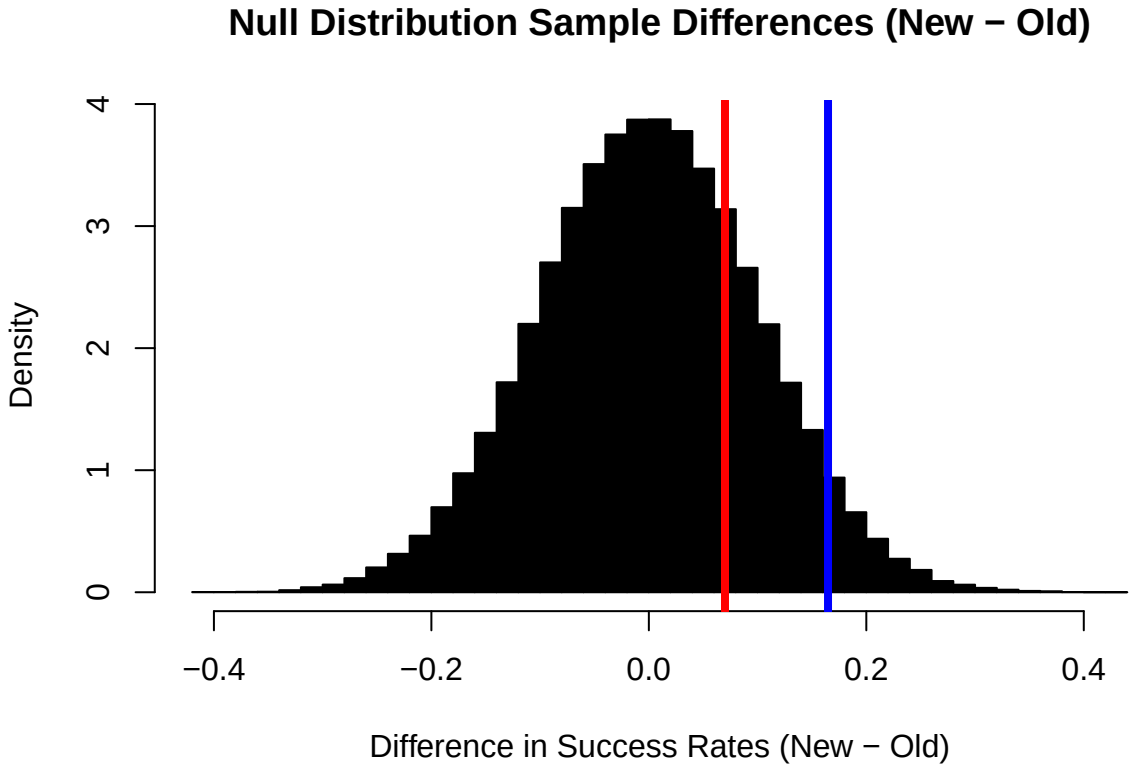
##Step 3: Pick a cut-off value with a 5% chance of a false positive.

Use the quantile() function to pick a cut-off that gives a lower chance of FP (say 5%).

```
# Create the histogram:
hist(store_p_diff, breaks = 40, freq = FALSE, col = "black",
     main = 'Null Distribution Sample Differences (New - Old)',
     xlab = 'Difference in Success Rates (New - Old)')

# Plot the sample statistic of 7% on the histogram:
abline(v = 0.07, lwd = 4, col = "red")
cutoff <- quantile(store_p_diff, prob = 0.95)
cutoff
```

```
##       95%
## 0.1647813
```

```
abline(v = cutoff, lwd = 4, col = "blue")
```



If we want to control the chance of FP at 5%, we should only go with the alternative (say the new treatment is 'promising enough') when the difference in the success rate of new treatment is at least 16.48% higher than the success of the old one.

Interestingly, a sample statistic $> 16.48\%$ is the same as a p-value $< 5\%$.