Assignment 2
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Course: Statistical Inference
Code: PMDS503P Slot: L33+L34

# 1 Question 1

```
library(BSDA)

## Loading required package:  lattice
##
## Attaching package:  'BSDA'
## The following object is masked from 'package:datasets':
##
##     Orange

# Null hypothesis(H0): new medication does not reduce recovery time. (mean = 14)
# Alternative hypthesis (HA): medication reduces recovery time. (mean < 14)

# This is a left-tailed test

sample_mean <- 13.5
sample_sd <- 3
n <- 60
mu_0 <- 14  # Population mean under H0
alpha1 <- 0.05
alpha2 <- 0.01

# Performing a one-sample t-test
test_result <- tsum.test(mean.x = sample_mean, s.x = sample_sd, n.x = n,
                         mu = mu_0, alternative = "less", conf.level = 1-alpha1)

## Warning in tsum.test(mean.x = sample_mean, s.x = sample_sd, n.x
= n, mu = mu_0, : argument 'var.equal' ignored for one-sample test.

print(test_result)

##
##  One-sample t-Test
##
## data:  Summarized x
## t = -1.291, df = 59, p-value = 0.1009
## alternative hypothesis: true mean is less than 14
## 95 percent confidence interval:
##        NA 14.14721
```

```
## sample estimates:
## mean of x
##      13.5

# Compute test statistic manually
t_stat <- test_result$statistic

# Compute rejection regions (critical t-values)
critical_value_05 <- qt(alpha1, df = n-1, lower.tail = TRUE)
critical_value_01 <- qt(alpha2, df = n-1, lower.tail = TRUE)

cat("Test statistic (t) =", t_stat, "\n")

## Test statistic (t) = -1.290994

cat("Critical value at alpha = 0.05:", critical_value_05, "\n")

## Critical value at alpha = 0.05: -1.671093

cat("Critical value at alpha = 0.01:", critical_value_01, "\n")

## Critical value at alpha = 0.01: -2.391229

# Decision-making
if (t_stat < critical_value_05) {
  cat("Reject H0 at alpha = 0.05\n")
} else {
  cat("Fail to reject H0 at alpha = 0.05\n")
}

## Fail to reject H0 at alpha = 0.05

if (t_stat < critical_value_01) {
  cat("Reject H0 at alpha = 0.01\n")
} else {
  cat("Fail to reject H0 at alpha = 0.01\n")
}

## Fail to reject H0 at alpha = 0.01
```

Since t $= -1.29$ is not less than either critical value, we fail to reject H0 at both significance levels.

# 2 Question 2

Null Hypothesis (H0): meanA >= meanB (Company A's drying time is not shorter than Company B's drying time)

Alternative Hypothesis (HA): meanA < meanB (Company A's drying time is shorter than Company B's drying time)

```r
library(BSDA)

# Given summary statistics
x_bar <- 63.5  # Mean drying time of Company A
s1 <- 5.4      # Standard deviation of Company A
n1 <- 45       # Sample size of Company A

y_bar <- 66.2  # Mean drying time of Company B
s2 <- 5.8      # Standard deviation of Company B
n2 <- 60       # Sample size of Company B

alpha1 <- 0.05  # Significance level 1
alpha2 <- 0.01  # Significance level 2

test_result <- tsum.test(mean.x = x_bar, s.x = s1, n.x = n1,
                         mean.y = y_bar, s.y = s2, n.y = n2,
                         alternative = "less", var.equal = FALSE, conf.level = 1 - alpha1)

print(test_result)
```

```
##
##  Welch Modified Two-Sample t-Test
##
## data:  Summarized x and y
## t = -2.4559, df = 98.235, p-value = 0.007905
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##          NA -0.8744421
## sample estimates:
## mean of x mean of y
##      63.5      66.2
```

```r
# Extract t-statistic and degrees of freedom
t_stat <- test_result$statistic
df <- test_result$parameter

cat("Test Statistic (t) =", t_stat, "\n")
```

```
## Test Statistic (t) = -2.455899
```

```r
cat("Degrees of Freedom (df) =", df, "\n")
```

```
## Degrees of Freedom (df) = 98.23525
```

```r
# Compute critical values for both significance levels
critical_value_05 <- qt(alpha1, df = df, lower.tail = TRUE)
critical_value_01 <- qt(alpha2, df = df, lower.tail = TRUE)

cat("Critical value at  = 0.05:", critical_value_05, "\n")

## Critical value at  = 0.05: -1.660513

cat("Critical value at  = 0.01:", critical_value_01, "\n")

## Critical value at  = 0.01: -2.364908

# Decision-making
if (t_stat < critical_value_05) {
  cat("Reject H0 at alpha = 0.05: Company A's drying time is significantly shorter.\n")
} else {
  cat("Fail to reject H0 at alpha = 0.05: No significant evidence that Company A's drying ti
}

## Reject H0 at alpha = 0.05: Company A's drying time is significantly shorter.

if (t_stat < critical_value_01) {
  cat("Reject H0 at alpha = 0.01: Company A's drying time is significantly shorter.\n")
} else {
  cat("Fail to reject H0 at alpha = 0.01: No significant evidence that Company A's drying ti
}

## Reject H0 at alpha = 0.01: Company A's drying time is significantly shorter.
```

Hence, from the results it is clear that we are rejecting our null hypothesis. And Company A's drying time is indeed shorter.

# 3 Question 3

Null hypothesis (H0): The cure rates are the same.
Alternative hypothesis (HA): The cure rates are different.

This is a two tailed test.

```r
library(BSDA)

# Data for Drug A and Drug B
n1 <- 190
x1 <- 100
n2 <- 65
```

```r
x2 <- 55

p_hat1 <- x1 / n1
p_hat2 <- x2 / n2
p_pooled <- (x1 + x2) / (n1 + n2)

# Calculate z-statistic
z_stat <- (p_hat1 - p_hat2) / sqrt(p_pooled * (1 - p_pooled) * (1/n1 + 1/n2))

critical_value_05 <- qnorm(1 - 0.05 / 2)
critical_value_01 <- qnorm(1 - 0.01 / 2)

# Print results
cat("Test Statistic (z):", z_stat, "\n")
```

```
## Test Statistic (z): -4.558982
```

```r
cat("Critical Value at alpha = 0.05:", critical_value_05, "\n")
```

```
## Critical Value at alpha = 0.05: 1.959964
```

```r
cat("Critical Value at alpha = 0.01:", critical_value_01, "\n")
```

```
## Critical Value at alpha = 0.01: 2.575829
```

```r
cat("At   = 0.05: ", ifelse(abs(z_stat) > critical_value_05, "Reject H0. Cure rates are sign
```

```
## At   = 0.05:  Reject H0. Cure rates are significantly different.
```

```r
cat("At   = 0.01: ", ifelse(abs(z_stat) > critical_value_01, "Reject H0. Cure rates are sign
```

```
## At   = 0.01:  Reject H0. Cure rates are significantly different.
```

Hence the data provides enough evidence that the cure rates are different between the two drugs.

# 4 Question 4

Null Hypothesis (H0): Supporters are less than or equal to 65 percent. (p <= 65 percent)
Alternate Hypothesis (HA): Supporters are greater than 65 percent. (p > 65 percent)

```r
library(BSDA)

# Data
```

```
n <- 600
X <- 414
p0 <- 0.65
alpha_05 <- 0.05
alpha_01 <- 0.01

p_hat <- X / n
p_0 <- 0.65
SE <- sqrt(p_0 * (1 - p_0) / n)
Z <- (p_hat - p_0) / SE

z_alpha1 <- qnorm(1 - alpha_05)
z_alpha2 <- qnorm(1 - alpha_01)

cat("Sample proportion (p):", p_hat, "\n")

## Sample proportion (p): 0.69

cat("Calculated Z value:", Z, "\n")

## Calculated Z value: 2.05421

cat("Critical Z value for alpha 0.05:", z_alpha1, "\n")

## Critical Z value for alpha 0.05: 1.644854

cat("Critical Z value for alpha 0.01:", z_alpha2, "\n")

## Critical Z value for alpha 0.01: 2.326348

cat("At   = 0.05: ", ifelse(Z > z_alpha1, "Reject H0. Support is greater than 65%.", "Fail t

## At   = 0.05:  Reject H0. Support is greater than 65%.

cat("At   = 0.01: ", ifelse(Z > z_alpha2, "Reject H0. Support is greater than 65%.", "Fail t

## At   = 0.01:  Fail to reject H0. Insufficient evidence.
```

At the 5 percent significance level, there is sufficient evidence to conclude that support for starting schools after Labor Day exceeds 65 percent.
At the 1 percent significance level, there is insufficient evidence to conclude that support exceeds 65 percent.