Variance R Code

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2025-09-21

```
# Data (reaction times in seconds)
female <- c(
  0.588, 0.403, 0.293, 0.377, 0.613, 0.377, 0.391,
  0.367, 0.442, 0.274, 0.434, 0.403, 0.636, 0.481,
  0.652, 0.443, 0.380, 0.646, 0.340, 0.617
)

male <- c(
  0.375, 0.477, 0.374, 0.465, 0.402, 0.337, 0.655,
  0.488, 0.427, 0.373, 0.224, 0.654, 0.563, 0.405, 0.256
)
```

```
# Calculate key values
nF  <- length(female); dfF <- nF - 1
nM  <- length(male);   dfM <- nM - 1

s2F <- var(female)
s2M <- var(male)

round(c(nF = nF, nM = nM, s2F = s2F, s2M = s2M), 4)
```

```
##      nF      nM     s2F     s2M
## 20.0000 15.0000  0.0150  0.0155
```

Problem 1: 95 % C.I for Female Variance:

We want a 95% confidence interval for the variance of female reaction times.

```
alpha <- 0.05
chi_lower <- qchisq(1 - alpha/2,dfF)
chi_upper <- qchisq(alpha/2,dfF)

c(chi_lower, chi_upper)
```

```
## [1] 32.852327  8.906516
```

```
CI_var_F <- c((dfF * s2F) / chi_lower, (dfF * s2F) / chi_upper)
round(CI_var_F, 5)
```

```
## [1] 0.00869 0.03205
```

Interpretation: The 95% confidence interval for the female variance was **0.00869** to **0.03205**. This means we are 95% confident that the true variance of female reaction times is within this range. Based on the interval this means female reaction times appear to be consistent.

Problem 2: Male variance:

We test if the male variance is different from 0.02 sec². **Null Hypothesis (H_0)** $H_0 : \sigma^2 = 0.02$ **Alternative Hypothesis (H_1)** $H_1 : \sigma^2 \neq 0.02$

```
sigma0_sq <- 0.02

chi_stat <- dfM * s2M / sigma0_sq
crit_lo  <- qchisq(alpha/2,     dfM)
crit_hi  <- qchisq(1 - alpha/2, dfM)

p_left  <- pchisq(chi_stat, dfM)
p_right <- 1 - pchisq(chi_stat, dfM)
p_val_two <- 2 * min(p_left, p_right)

round(c(chi_stat = chi_stat, crit_lo = crit_lo, crit_hi = crit_hi, p_val = p_val_two), 4)
```

```
## chi_stat  crit_lo  crit_hi    p_val
##  10.8718   5.6287  26.1189   0.6078
```

Interpretation: The test statistic for male variance was **10.8718** with a p-value of **0.6078**. Since the p-value is much greater than 0.05 we fail to reject the null hypothesis. The male variance **is not significantly different** from 0.02 seconds squared.

Problem 3: Ratio of variances:

We compare the variability by building a CI for the ratio of variances.

```
s2_top <- max(s2F, s2M)
s2_bot <- min(s2F, s2M)
df_top <- ifelse(s2F >= s2M, dfF, dfM)
df_bot <- ifelse(s2F >= s2M, dfM, dfF)

R <- s2_top / s2_bot
c(s2_top = s2_top, df_top = df_top, s2_bot = s2_bot, df_bot = df_bot, R = R)
```

```
##      s2_top      df_top      s2_bot      df_bot           R
##  0.01553110 14.00000000  0.01502561 19.00000000  1.03364172
```

```
F_u <- qf(1 - alpha/2, df_top, df_bot)
F_l <- qf(1 - alpha/2, df_bot, df_top)
c(F_u, F_l)
```

```
## [1] 2.646928 2.860722
```

```
CI_ratio <- c(R / F_l, R * F_u)
round(CI_ratio, 4)
```

```
## [1] 0.3613 2.7360
```

Interpretation: The 95% confidence interval for the ratio of female to male variances was **0.3613** to **2.7360**. So yes the interval includes 1. This shows that the males and females have similar variability in reaction times.

Problem 4: F-test for equal variances:

This test directly checks if the two variances are the same.

```
F_stat <- R

crit_upper <- qf(1 - alpha/2, df_top, df_bot)
crit_lower <- qf(1 - alpha/2, df_bot, df_top)
c(F_stat, crit_upper, crit_lower)
```

```
## [1] 1.033642 2.646928 2.860722
```

```
p_left_F  <- pf(F_stat, df_top, df_bot)
p_right_F <- pf(F_stat, df_top, df_bot, lower.tail=FALSE)
p_two <- 2 * min(p_left_F, p_right_F)

round(c(F_stat = F_stat, crit_lower = crit_lower, crit_upper = crit_upper, p_two = p_two), 4)
```

```
##     F_stat crit_lower crit_upper      p_two
##     1.0336     2.8607     2.6469     0.9276
```

```
crit_upper2 <- qf(1 - alpha/2, 24, 21); crit_upper2
```

```
## [1] 2.367526
```

```
crit_lower2 <- qf(1 - alpha/2, 21, 24); crit_lower2
```

```
## [1] 2.310919
```

Interpretation: The F-test gave a statistic of **1.0336** with a p-value of **0.9276**. Since the p-value is greater than 0.05, **we fail to reject**. The male group has more variability but only by a tiny bit so I would conclude that there is no significant difference in female and male reaction times.

Conclusion: The 95% CI for female variance was **0.00869** to **0.03205**. This shows consistent female times. The male variance test gave a p-value of **0.6078**, so it is **not significantly different** from **0.02 sec²**. The confidence interval for the variance ratio contains 1. This means the two groups could have similar variability. The F-test p-value was **0.9276** leading us to fail to reject. This helps us conclude that there is **no meaningful difference** in variances between male and female reaction times.