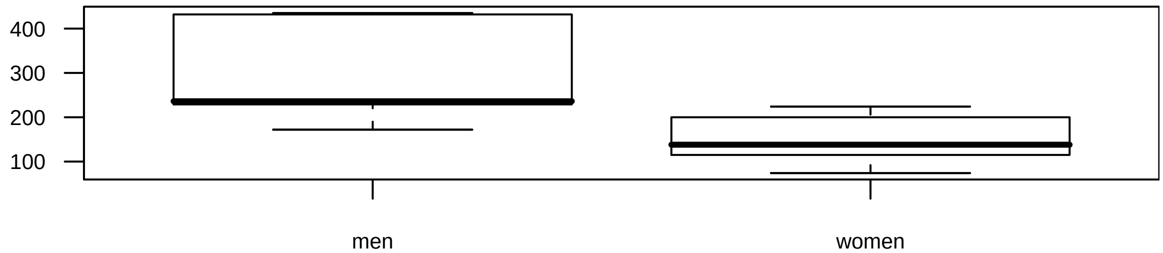
Histidine is an amino acid that is a component of urine. The parallel boxplots show total histidine excretion (mg) from 24-hour urine samples for five men and ten women.



Summary statistics are as follows.

Group	n	$\bar{y}$	s
men	5	300.8	123.7
women	10	153.2	49.8

(a) Test the hypothesis that the two population mean histidine excretion totals are equal versus the two-sided alternative. State hypotheses, calculate a test statistic, and report a p-value (with a range). There are 4.66 degrees of freedom. Summarize your conclusions in the context of the problem.

For each problem, circle TRUE or FALSE. Briefly justify your response.

(b) TRUE or FALSE:

Based on the graph alone, we can be essentially certain that the mean histidine excretion levels in men is greater than that in women in this population.

(c) TRUE or FALSE:

We could compute using R the exact p-value for the hypothesis test in (a) by finding the area to the right of the t test statistic (men minus women) under a t distribution with 4.66 degrees of freedom.

(d) TRUE or FALSE:

The one-sided test with alternative hypothesis that the mean for men is greater than the mean for women is significant at the 5% level.

(e) TRUE or FALSE:

A p-value of 0.06 means that the null hypothesis is true.

Solution:

(a) The hypotheses are $H_0 \colon \mu_1 = \mu_2$ versus $H_A \colon \mu_1 \neq \mu_2$ where μ_1 and μ_2 are the population mean 24-hour histidine excretion levels (mg) for men and women, respectively. The test statistic is

$$t = \frac{300.8 - 153.2}{\sqrt{\frac{123.7^2}{5} + \frac{49.8^2}{10}}} \doteq 2.57$$

Rounding 4.66 degrees of freedom down to 4 to use the table, we find a one-sided p-value between 0.03 and 0.04 corresponding to two-sided p-values between 0.06 and 0.08. In the context of the problem, There is weak evidence of a difference in mean 24-hour histidine excretion levels between men and women ($p < 0.08$, two-sided independent sample t-test with unequal variances).

(Note that with R we can use 4.66 degrees of freedom and find $p = 0.053$.)

(b) FALSE. We cannot be essentially certain about a hypothesis test from graphs alone, especially when the sample sizes are so small. That is why we have quantitative inference procedures.

(c) FALSE. The right p-value would be two-sided. We would need to double the calculated area under the curve.

(d) TRUE. The one-sided p-value was between 0.03 and 0.04, thus less than 0.05.

(e) FALSE. P-values do *not* measure the probabilities of hypotheses. A p-value of 0.06 means that if the null hypothesis is true, then the probability of observing a new test-statistic at least as extreme as that actually observed is 6 percent.