

1. X_A = time taken to make starter A

$$X_A \sim N(\mu_A, \sigma^2)$$

$$n_A = 7$$

X_B = time taken to make starter B.

$$X_B \sim N(\mu_B, \sigma^2)$$

$$n_B = 7$$

$$H_0: \mu_A = \mu_B$$

$$H_1: \mu_A \neq \mu_B.$$

Assume H_0 to be true

$$\alpha = 5\%$$

two tail test

$$\text{we know } \bar{x}_A = 7$$

$$s_A^2 = 0.711805^2$$

$$\bar{x}_B = 6.22857$$

$$s_B^2 = 0.505682^2$$

$$\text{pooled } s^2 = \frac{(7-1)0.712^2 + (7-1)0.506^2}{12}$$

$$= 0.617406^2$$

$$\text{test statistic, } t = \frac{(7 - 6.22857) - (0)}{s \sqrt{\frac{1}{7} + \frac{1}{7}}} \quad \text{where } t \sim t_{12}$$

$$= 2.33754$$

$$p\text{-value} = 2 \times P(t_{12} > 2.33754)$$

$$= 2 \times 0.018777$$

$$= 0.037553$$

$$< 0.05$$

Hence, we have evidence to reject H_0 and conclude that the meantime taken is not the same for both starters.

2. referring to data in Ex 4A Q21

we shall assume that standard deviation of both samples' populations are equal.

X_A = quantity of dust in boiler A

$$n_A = 13$$

$$X_A \sim N(\mu_A^2, \sigma^2)$$

X_B = quantity of dust in boiler B.

$$n_B = 9$$

$$X_B \sim N(\mu_B^2, \sigma^2)$$

$$H_0: \mu_A = \mu_B$$

$$H_1: \mu_A \neq \mu_B.$$

Assume H_0 to be true.

$$\alpha = 5\%$$

two tailed test

$$\text{we have } \bar{x}_A = 63.8308$$

$$\bar{x}_B = 52.8889$$

$$s_A = 10.6307$$

$$s_B = 9.00437$$

$$\text{pooled } s^2 = \frac{(13-1) \times 10.6307^2 + (9-1) \times 9.00437^2}{12+8}$$

$$= 10.0119^2$$

$$\text{test statistic, } t = \frac{(63.8308 - 52.8889) - (0)}{s \sqrt{\frac{1}{13} + \frac{1}{9}}} \quad \text{has } t_{20} \text{ distribution}$$

$$= 2.52032$$

$$p\text{-value} = 2 \times P(t_{20} > 2.52032)$$

$$= 2 \times 0.010165$$

$$= 0.020331$$

$$< 0.05$$

Hence we have evidence to reject H_0 and conclude that the mean quantity of dust is not equal between boilers of the two types.

3. referring to data in Ex4A Q12
testing for equality at 1% level.

we will assume that the standard deviations of the two samples' populations are equal

let X_1 = original machine mass filled

$$n_1 = 10$$

$$X_1 \sim N(\mu_1, \sigma^2)$$

X_2 = new machine mass filled

$$n_2 = 12$$

$$X_2 \sim N(\mu_2, \sigma^2)$$

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

Assume H_0 to be true

$$\alpha = 1\%$$

two tailed test

$$\text{we have } \bar{x}_1 = 295.62$$

$$s_1 = 6.24176$$

$$\bar{x}_2 = 296.483$$

$$s_2 = 12.8053$$

$$\begin{aligned} \text{pooled } s^2 &= \frac{(10-1) \times 6.24176^2 + (12-1) \times 12.8053^2}{9+11} \\ &= 10.3788^2 \end{aligned}$$

$$\begin{aligned} \text{test statistic, } t &= \frac{295.62 - 296.483 - (0)}{s \sqrt{\frac{1}{10} + \frac{1}{12}}} \quad \text{which } \sim t_{20} \\ &= -0.194273 \end{aligned}$$

$$p\text{-value} = 2 \times P(t_{20} < -0.194273)$$

$$= 2 \times 0.423961$$

$$= 0.847922$$

$$> 0.01$$

so we do not have evidence to reject H_0

We do not have evidence to suggest that the mean masses filled by the two machines are different.

4 referring to Ex4A q2 3

we shall assume that the standard deviations of the samples' populations are equal

Testing for equal means, at 1% level

X_1 = arm reach measured by worker

$$n_1 = 10$$

$$X_1 \sim N(\mu_1, \sigma^2)$$

X_2 = arm reach measured by assistant

$$n_2 = 8$$

$$X_2 \sim N(\mu_2, \sigma^2)$$

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

Assume H_0 to be true

$$\alpha = 1\%$$

two tail test

$$\text{we have } \bar{x}_1 = 705.8$$

$$\bar{x}_2 = 668.125$$

$$s_1 = 27.704$$

$$s_2 = 22.7874$$

$$\text{pooled, } s^2 = \frac{(10-1) \times 27.704^2 + (8-1) \times 22.7874^2}{9+7}$$

$$= 25.6691^2$$

$$\text{test statistic, } t = \frac{705.8 - 668.125 - (0)}{s \sqrt{\frac{1}{10} + \frac{1}{8}}} \sim t_{16}$$

$$t = 3.09422$$

$$p\text{-value} = 2 \times P(t_{16} > 3.09422)$$

$$= 2 \times 0.003482$$

$$= 0.006964$$

$$< 0.01$$

Hence, we have evidence to reject H_0 and conclude that the mean measured functional arm reaches are different from the two members of the research team.

5 referring to EX4A q=5

test for equality at 5% level

we shall assume that the standard deviations of the samples' proportions are equal

we shall assume that the samples are from normal populations.

X_1 = percentage from photometric method

X_2 = percentage from photographic method

$$X_1 \sim N(\mu_1, \sigma^2)$$

$$X_2 \sim N(\mu_2, \sigma^2)$$

$$n_1 = 6$$

$$n_2 = 7$$

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

Assume H_0 to be true

$\alpha = 5\%$, two tailed test

$$\text{we have } \bar{x}_1 = 86.2333$$

$$\bar{x}_2 = 84.7$$

$$s_1 = 0.804156$$

$$s_2 = 1.83303.$$

$$\text{pooled } s^2 = \frac{(6-1) \times 0.804156^2 + (7-1) \times 1.83303^2}{6+7-2}$$

$$= 1.45831^2$$

$$\text{test statistic, } t = \frac{86.2333 - 84.7 - (0)}{1.45831 \sqrt{\frac{1}{6} + \frac{1}{7}}} \sim t_{11}$$

$$= 1.8899$$

$$p\text{-value} = 2 \times P(t_{11} > 1.8899)$$

$$= 2 \times 0.042698$$

$$= 0.085396$$

$$> 0.05$$

so, no evidence to reject H_0

We do not have evidence that the mean percentages of the two measuring techniques are different.