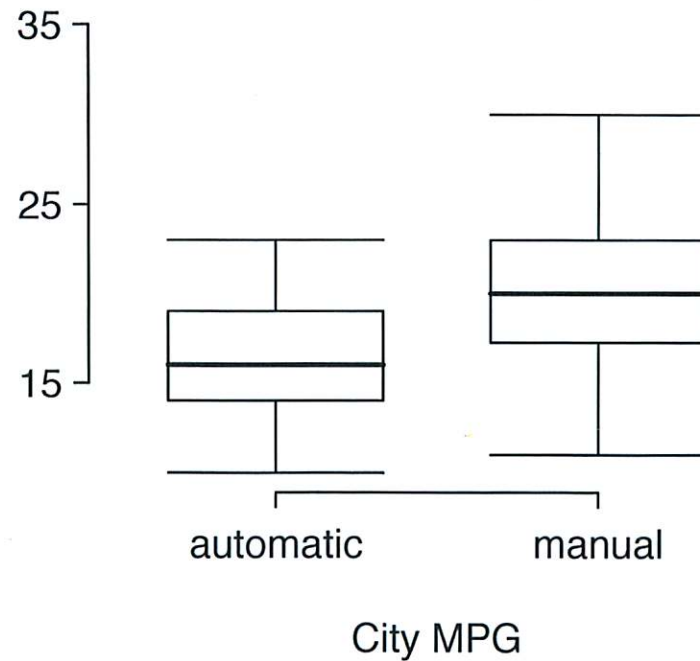


# from OpenIntro

**5.30 Fuel efficiency of manual and automatic cars, Part I.** Each year the US Environmental Protection Agency (EPA) releases fuel economy data on cars manufactured in that year. Below are summary statistics on fuel efficiency (in miles/gallon) from random samples of cars with manual and automatic transmissions manufactured in 2012. Do these data provide strong evidence of a difference between the average fuel efficiency of cars with manual and automatic transmissions in terms of their average city mileage? Assume that conditions for inference are satisfied.<sup>45</sup>

	City MPG	
	Automatic	Manual
Mean	16.12	19.85
SD	3.58	4.51
n	26	26



population  
① = Automatic      population  
② = Manual

①

$$\bar{Y}_2 - \bar{Y}_1 = 19.85 - 16.12 = 3.73 \quad \text{our estimate of the difference in mean fuel efficiency}$$

$$\begin{aligned} \text{pooled standard deviation, } s_p &= \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}} \\ &= \sqrt{\frac{25(3.58^2) + 25(4.51^2)}{50}} \\ &= 4.07 \end{aligned}$$

$$\begin{aligned} SE_{\bar{Y}_2 - \bar{Y}_1} &= 4.07 \sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \\ &= 4.07 \sqrt{\frac{1}{26} + \frac{1}{26}} \\ &= 1.13 \end{aligned}$$

95% confidence interval for  $\mu_2 - \mu_1$ :

$$\bar{y}_2 - \bar{y}_1 \pm t_{50}(0.975) 1.13 \quad (\text{in R: } qt(0.975, 50) = 2.01)$$

$$= 3.73 \pm 2.01(1.13)$$

$$= (1.46, 6.00)$$

With 95% confidence, the mean efficiency of manual cars is between 1.46 and 6.00 mpg higher than the mean efficiency for automatic cars.

Test of the null hypothesis  $\mu_2 - \mu_1 = 0$ :

$$t\text{-stat} = \frac{\bar{y}_2 - \bar{y}_1}{SE_{\bar{y}_2 - \bar{y}_1}} = \frac{3.73}{1.13} = 3.30$$

Compare to  $t_{50}$  for p-value, in R  $2 * (1 - pt(3.30, 50))$

$$p\text{-value} = 0.0018$$

There is convincing evidence manual cars have a higher mean fuel efficiency than automatic cars in 2012 (two sample t-test, p-value = 0.0018,  $n_1 = n_2 = 26$ )