# Workshop 8 Solutions

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We'll begin by loading all the packages we might need.

```
library(MASS)
library(plyr)
library(reshape)  # You may need to install this one first!
```

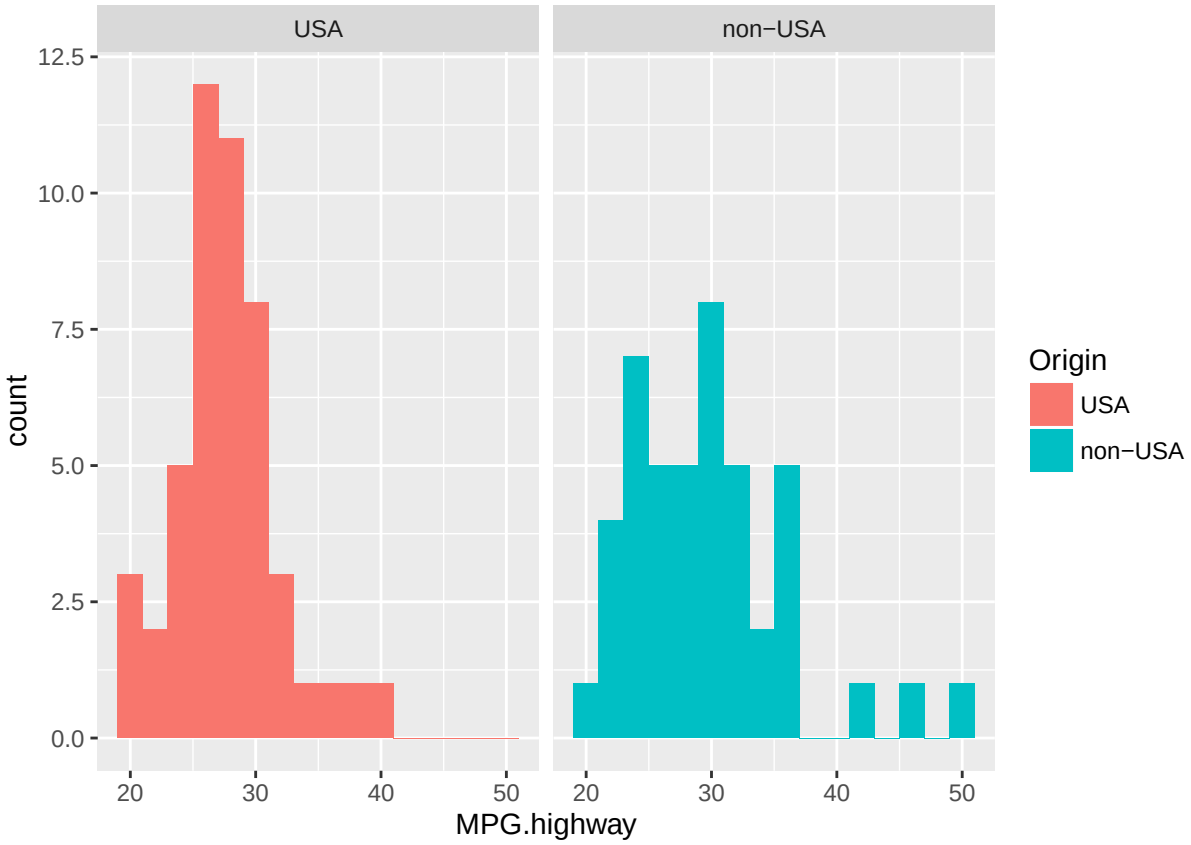
```
##
## Attaching package: 'reshape'

## The following objects are masked from 'package:plyr':
##
##     rename, round_any
```

```
library(ggplot2)
```

**Is the data normal?**

**(a)** Construct histograms of `MPG.highway`, one plot for each `Origin` category.

```
qplot(x = MPG.highway, data = Cars93, facets = ~Origin, geom = "histogram", fill = Origin, binwidth = 2)
```

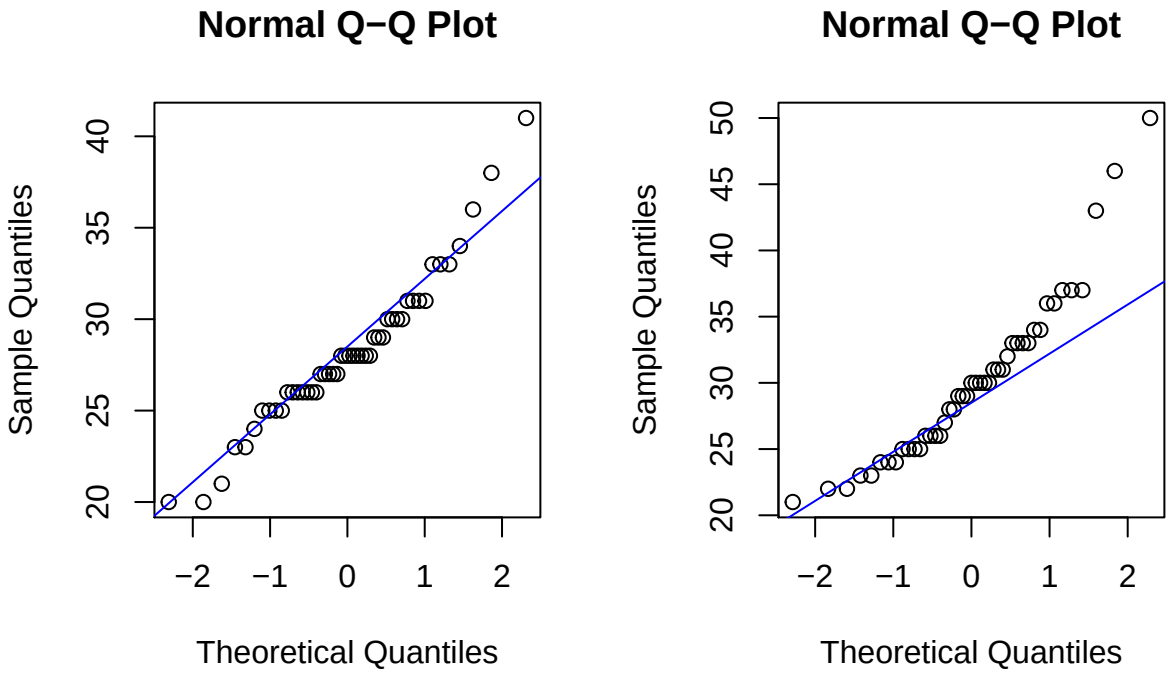


**(b)** Does the data look to be normally distributed?

The histograms don't really look normally distributed, so we might be better off using the non-parametric test.

**(c)** Construct qqplots of `MPG.highway`, one plot for each `Origin` category. Overlay a line on each plot using with `qqline()` function.

```
par(mfrow = c(1,2))
# USA cars
with(Cars93, qqnorm(MPG.highway[Origin == "USA"]))
with(Cars93, qqline(MPG.highway, col = "blue"))
# Foreign cars
with(Cars93, qqnorm(MPG.highway[Origin == "non-USA"]))
with(Cars93, qqline(MPG.highway, col = "blue"))
```




**(d)** Does the data look to be normally distributed?

The non-USA MPG.highway data looks very far from normally distributed.

### Testing means between two groups

**(a)** Using the Cars93 data and the `t.test()` function, run a t-test to see if average `MPG.highway` is different between US and non-US vehicles.

Try doing this both using the formula style input and the `x`, `y` style input.

```
# Formula version
mpg.t.test <- t.test(MPG.highway ~ Origin, data = Cars93)
mpg.t.test
```

```
##
##  Welch Two Sample t-test
```

```
##
## data:  MPG.highway by Origin
## t = -1.7545, df = 75.802, p-value = 0.08339
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -4.1489029  0.2627918
## sample estimates:
##     mean in group USA mean in group non-USA
##              28.14583              30.08889
```

### at confident level = 90%

```
mpg.t.test <- t.test(MPG.highway ~ Origin, data = Cars93, conf.level = 0.90)
mpg.t.test
```

```
##
##  Welch Two Sample t-test
##
## data:  MPG.highway by Origin
## t = -1.7545, df = 75.802, p-value = 0.08339
## alternative hypothesis: true difference in means is not equal to 0
## 90 percent confidence interval:
##  -3.78725073 -0.09886038
## sample estimates:
##     mean in group USA mean in group non-USA
##              28.14583              30.08889
```

## x, y version

with(Cars93, t.test(x = MPG.highway[Origin == "USA"], y = MPG.highway[Origin == "non-USA"])) "'

**(b)** What is the confidence interval for the difference?

```
mpg.t.test$conf.int
```

```
## [1] -3.78725073 -0.09886038
## attr(,"conf.level")
## [1] 0.9
```

**(c)** Repeat part (a) using the `wilcox.test()` function.

```
mpg.wilcox.test <- wilcox.test(MPG.highway ~ Origin, data = Cars93)
```

```
## Warning in wilcox.test.default(x = c(31L, 28L, 25L, 27L, 25L, 25L, 36L, :
## cannot compute exact p-value with ties
```

```
mpg.wilcox.test
```

```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  MPG.highway by Origin
## W = 910, p-value = 0.1912
## alternative hypothesis: true location shift is not equal to 0
```