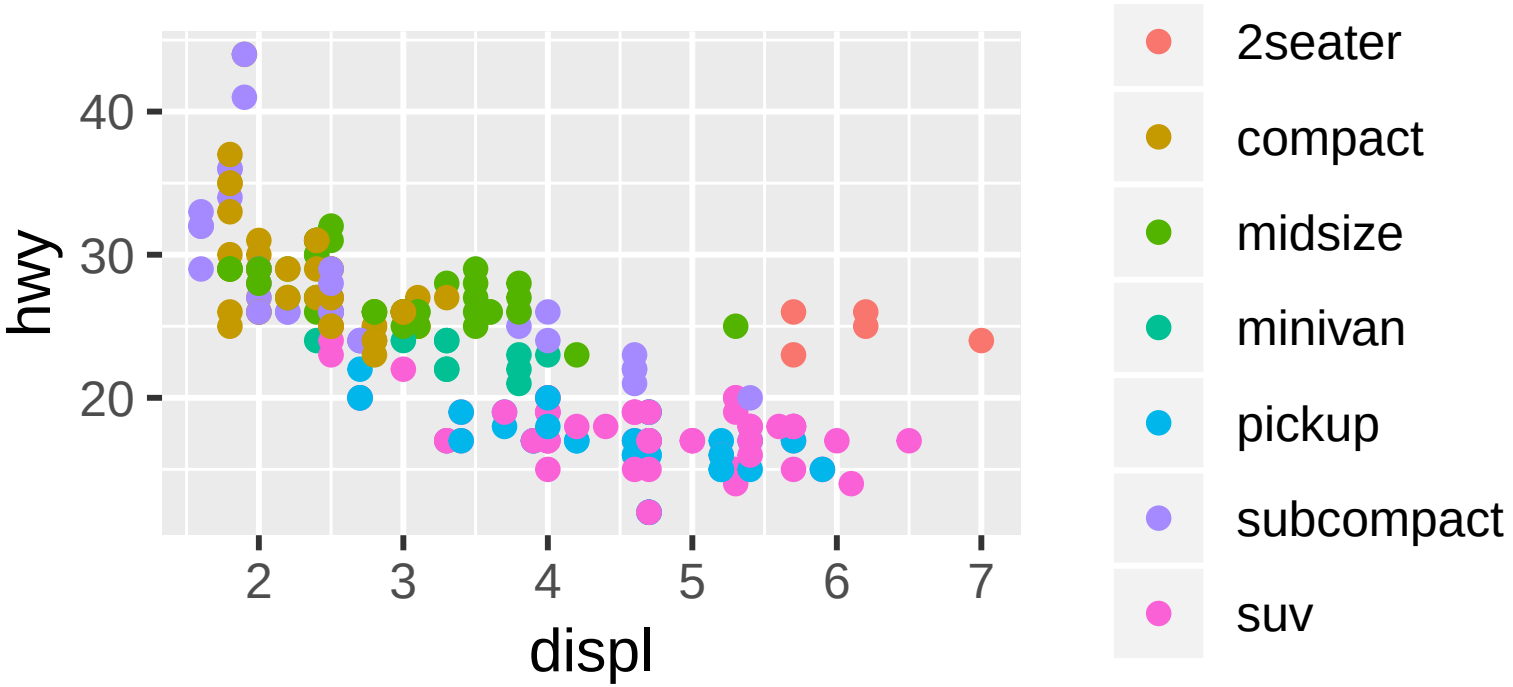
# 6. Exploring Data with ggplot2 (1)

CT1100 - J. Duggan

# Data Exploration

"Data exploration is the art of looking at your data, rapidly generating hypotheses, quickly testing them, then repeating again and again and again." (Wickham and Grolemund 2017).



# Data visualisation with ggplot2

"The simple graph has brought more information to the data analyst's mind that any other device." – John Tukey

```
d <- ggplot2::mpg  # get a copy of mpg
glimpse(d)  # show structure and some data
```

```
## Observations: 234
## Variables: 11
## $ manufacturer <chr> "audi", "audi", "audi", "audi", "audi"
## $ model        <chr> "a4", "a4", "a4", "a4", "a4", "a4", "a
## $ displ        <dbl> 1.8, 1.8, 2.0, 2.0, 2.8, 2.8, 3.1, 1.8
## $ year         <int> 1999, 1999, 2008, 2008, 1999, 1999, 20
## $ cyl          <int> 4, 4, 4, 4, 6, 6, 6, 4, 4, 4, 4, 6, 6,
## $ trans        <chr> "auto(l5)", "manual(m5)", "manual(m6)"
## $ drv          <chr> "f", "f", "f", "f", "f", "f", "f", "4"
## $ cty          <int> 18, 21, 20, 21, 16, 18, 18, 18, 16, 20
## $ hwy          <int> 29, 29, 31, 30, 26, 26, 27, 26, 25, 28
```

# Fuel Economy Data Set (ggplot2::mpg)

This dataset contains a subset of the fuel economy data that the EPA makes available on http://fueleconomy.gov. It contains only models which had a new release every year between 1999 and 2008 - this was used as a proxy for the popularity of the car.

| | | | |
|---|---|---|---|
| **manufacturer** | car manufacturer | **drv** | drive type |
| **model** | model name | **cty** | city miles per gallon |
| **displ** | engine disp (l) | **hwy** | highway miles per gallon |
| **year** | year of make | **fl** | fuel type |
| **model** | model name | **cty** | city miles per gallon |
| **cyl** | number of cylinders | **class** | "type" of car |
| **trans** | type of transm. | | |

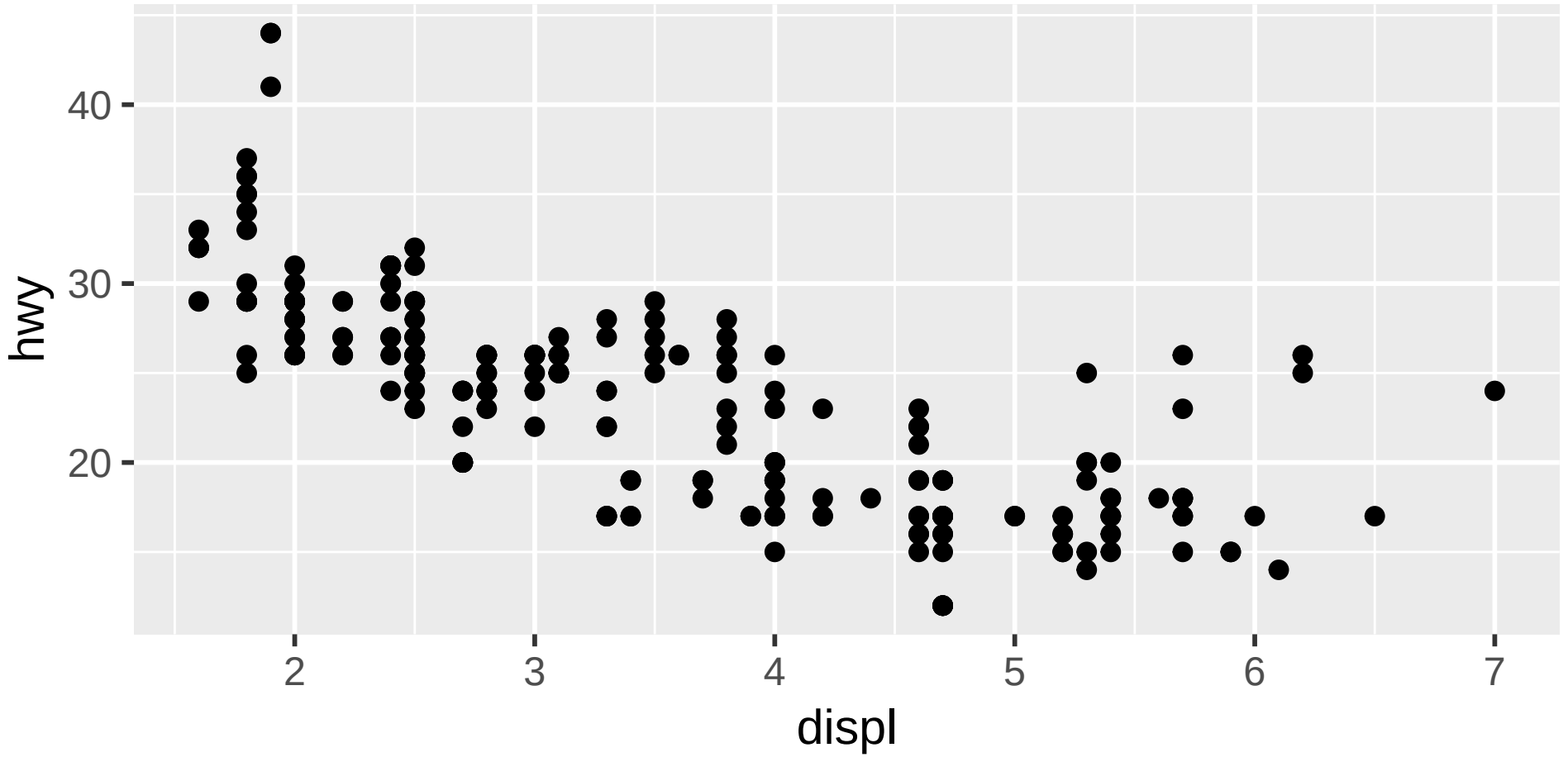
# Exploring Data

Generate a first graph to help answer the following question

- Do cars with big engines use more fuel than cars with small engines
- What might the relationship between engine size and fuel efficiency look like?
  - Positive or negative?
  - Linear or non-linear?
- Variable (scatter plot)
  - **displ**, a car engine size in litres (x)
  - **hwy**, a car's fuel efficiency on highway - (y)
- ggplot2: layered approach
  - ggplot(data=*tibble_name*) + geom_point(mapping=aes(x=*col1*,y=*col2*))

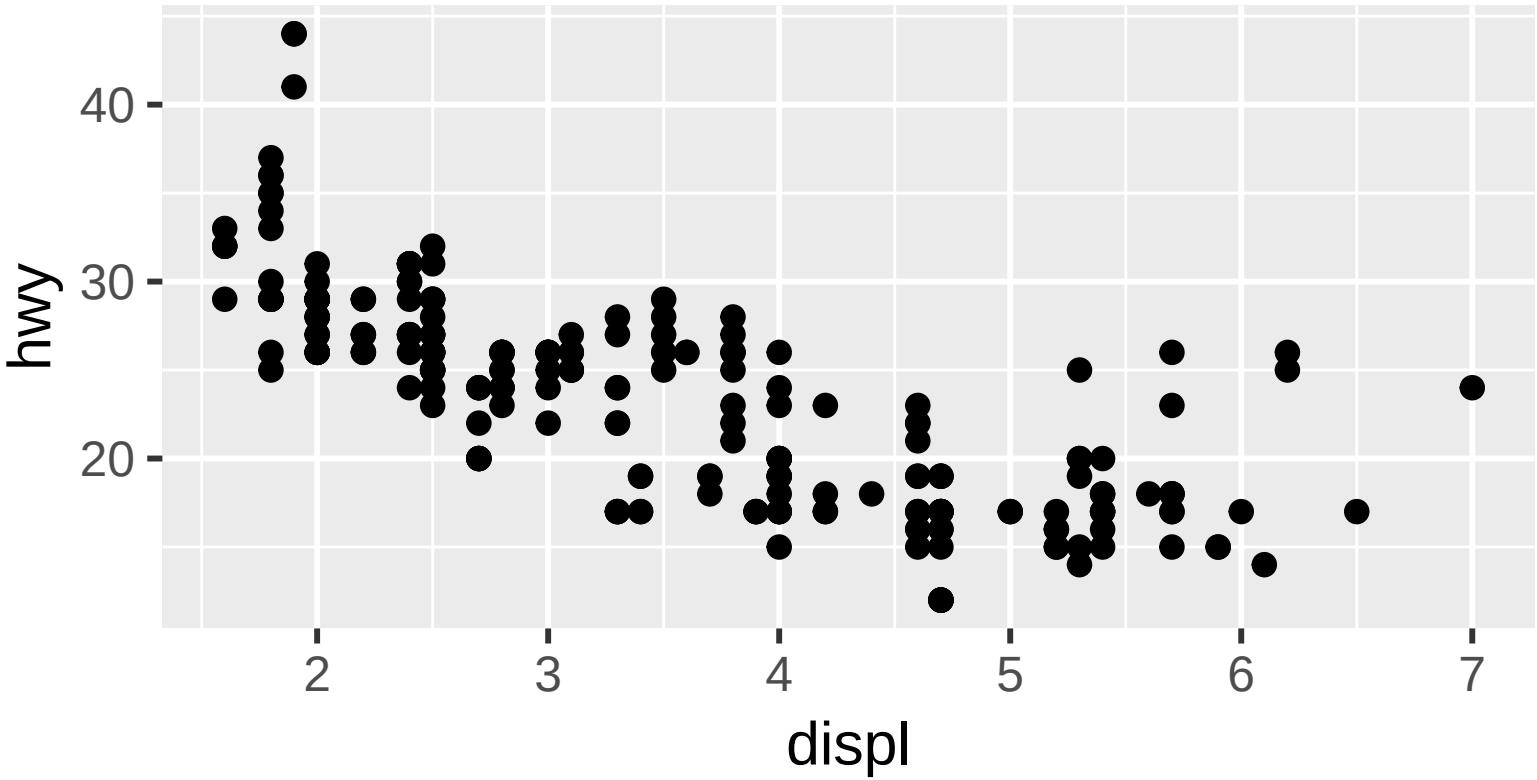
# Plotting with ggplot2

```
ggplot(data = d) +    # specify the source tibble
  geom_point(mapping=aes(x=displ,   # map x, y vars
                         y=hwy))
```



# Interpreting the plot

- The plot shows a negative relationship between engine size (displ) and fuel efficiency (hwy)
- Cars with big engines use more fuel
- Does this confirm or refute your hypothesis about fuel efficiency and engine size?



# Aesthetic Mappings

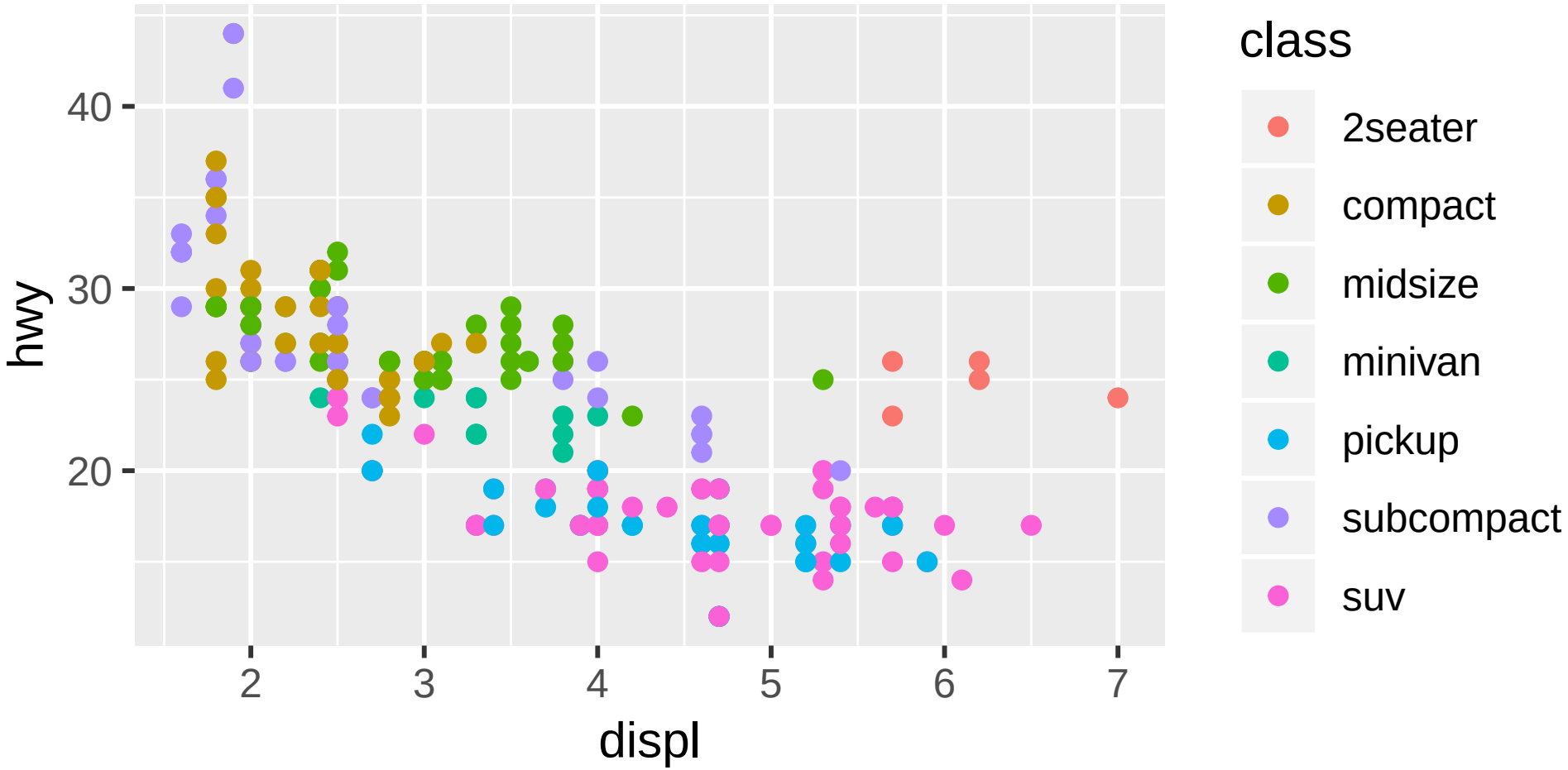
- A third variable can be added to a 2-D plot by mapping it to an aesthetic.
- An aesthetic is a visual property of the plot's objects.
- An aesthetic's level could be colour, size or shape

```
unique(d$class)
```

```
## [1] "compact"    "midsize"    "suv"        "2seater"    "mi
## [6] "pickup"     "subcompact"
```

# In ggplot2 - Adding the third variable

```
ggplot(data=d)+
  geom_point(aes(x=displ,y=hwy,colour=class))
```

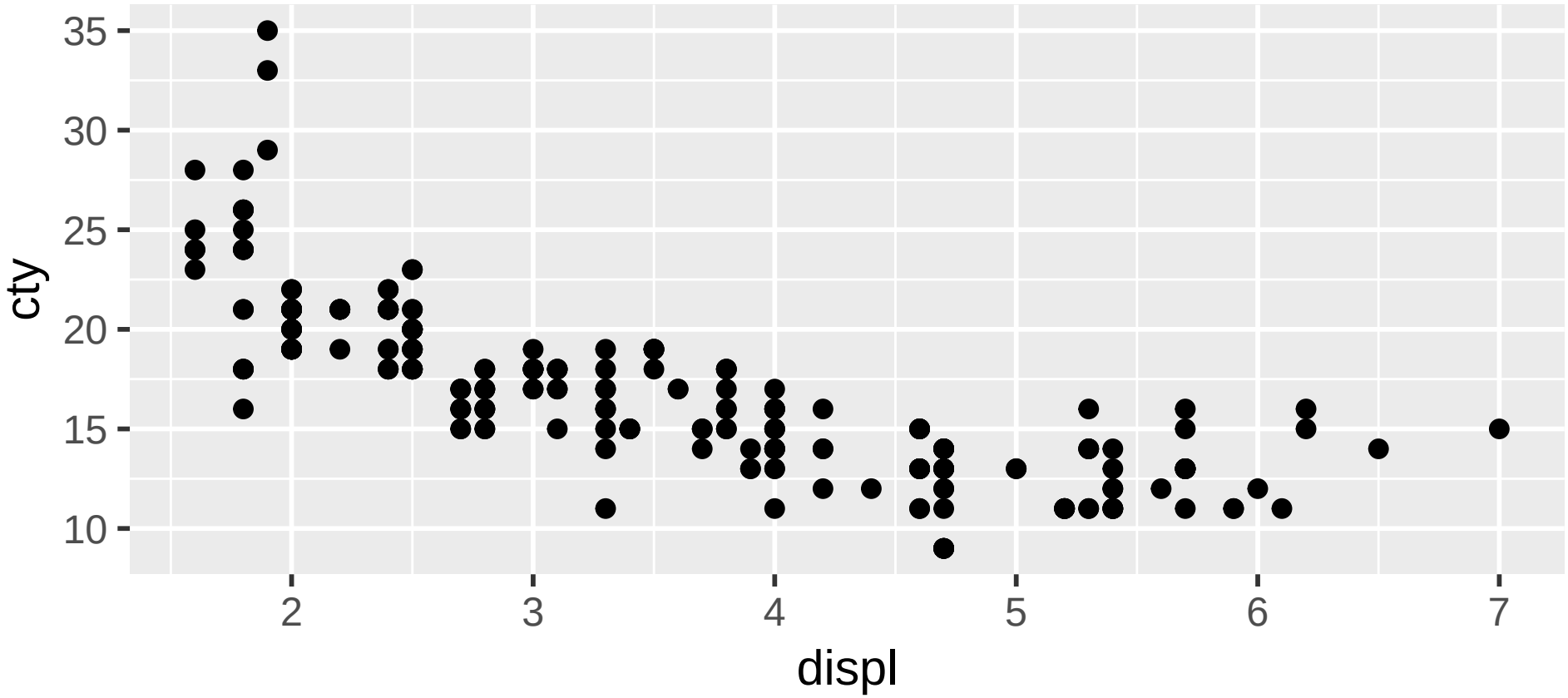


# Exploring Data Relationships

| Input (X) | Output (Y) | Hypothesis? | Reason |
|---|---|---|---|
| Displacement | City MPG | Negative? | Bigger cars,less efficient |
| Highway MPG | City MPG | Positive? | Should be closely related |
| Cylinders | Highways MPG | Negative? | More cylinders, less eff. |
| Cylinders | Displacement | Negative? | More cylinders, bigger eng. |

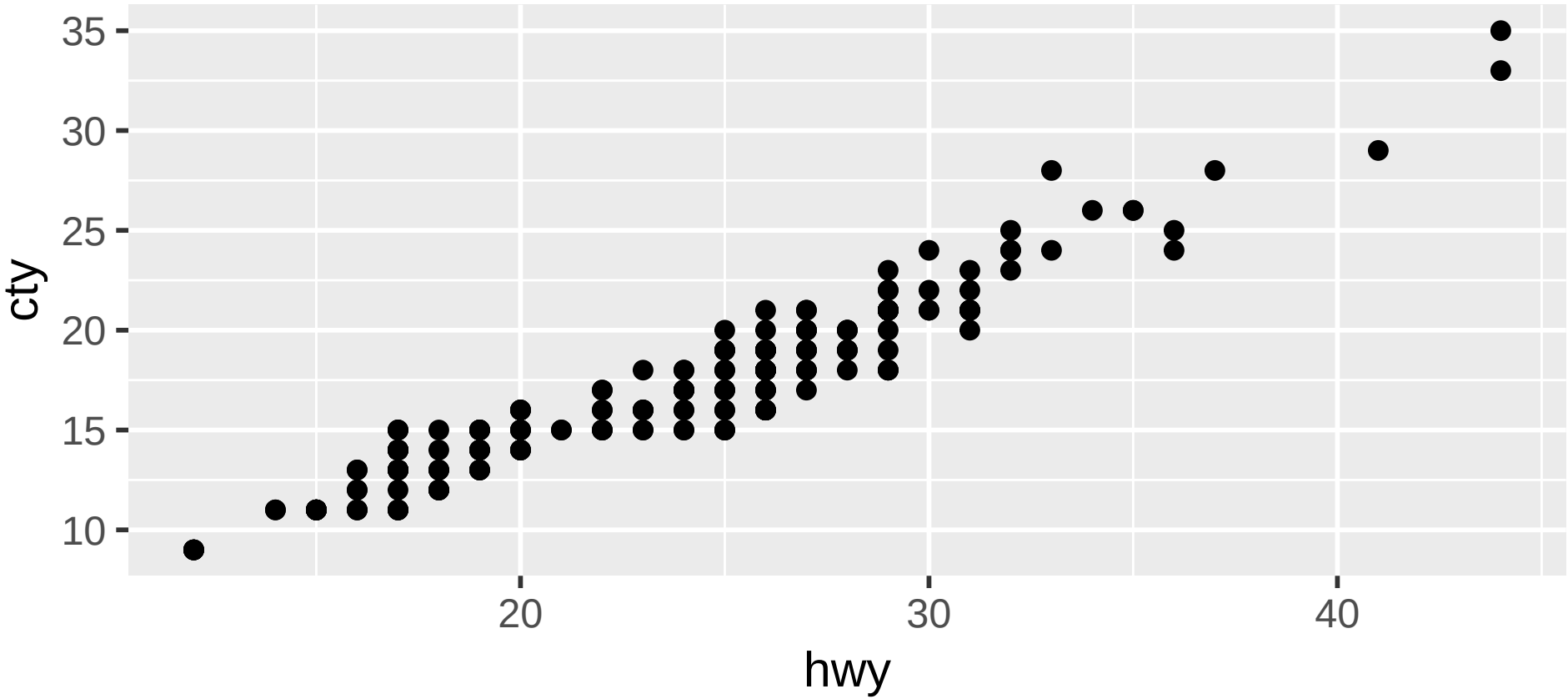
# x=displ, y=cty

```
ggplot(data = mpg) +    # specify the source tibble
  geom_point(mapping=aes(x=displ,   # map x, y vars
                         y=cty))
```



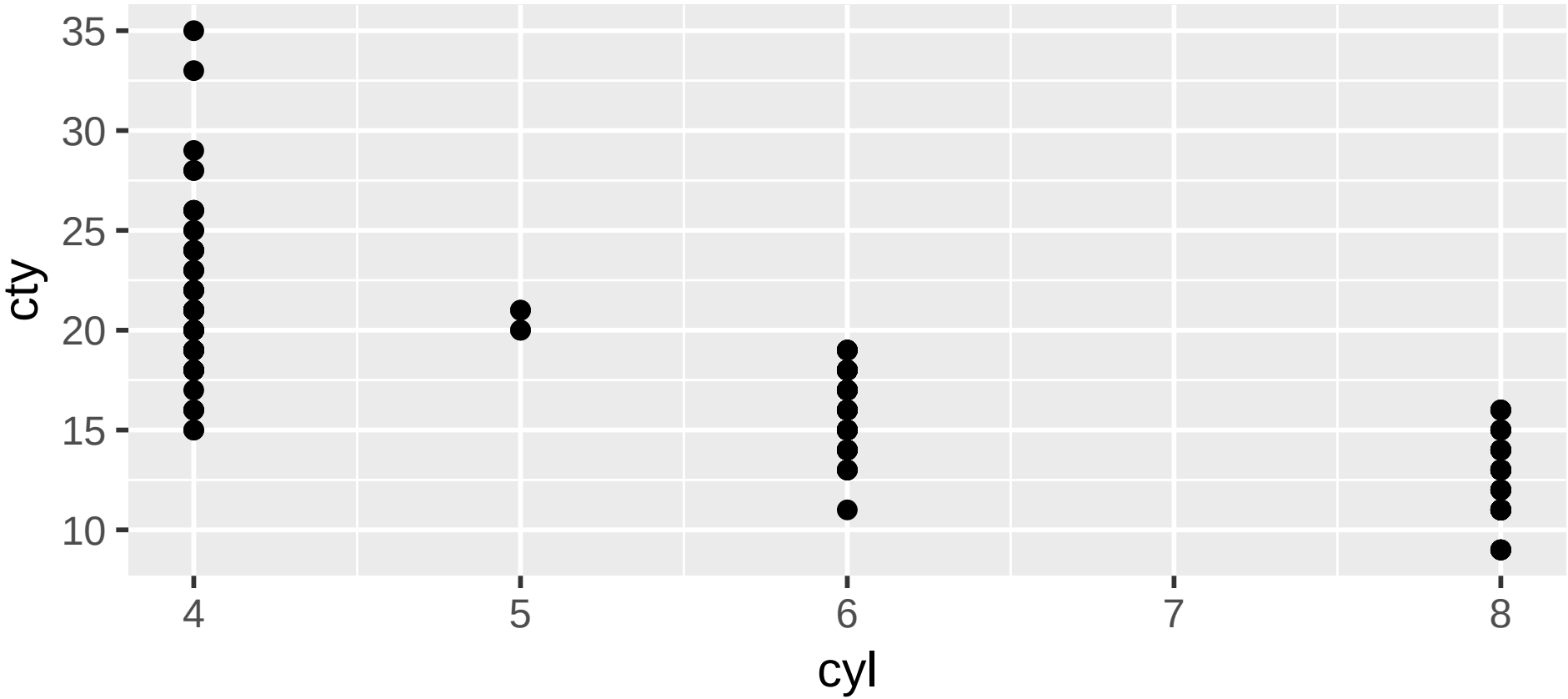
# x=hwy, y=cty

```
ggplot(data = mpg) +    # specify the source tibble
  geom_point(mapping=aes(x=hwy,   # map x, y vars
                         y=cty))
```



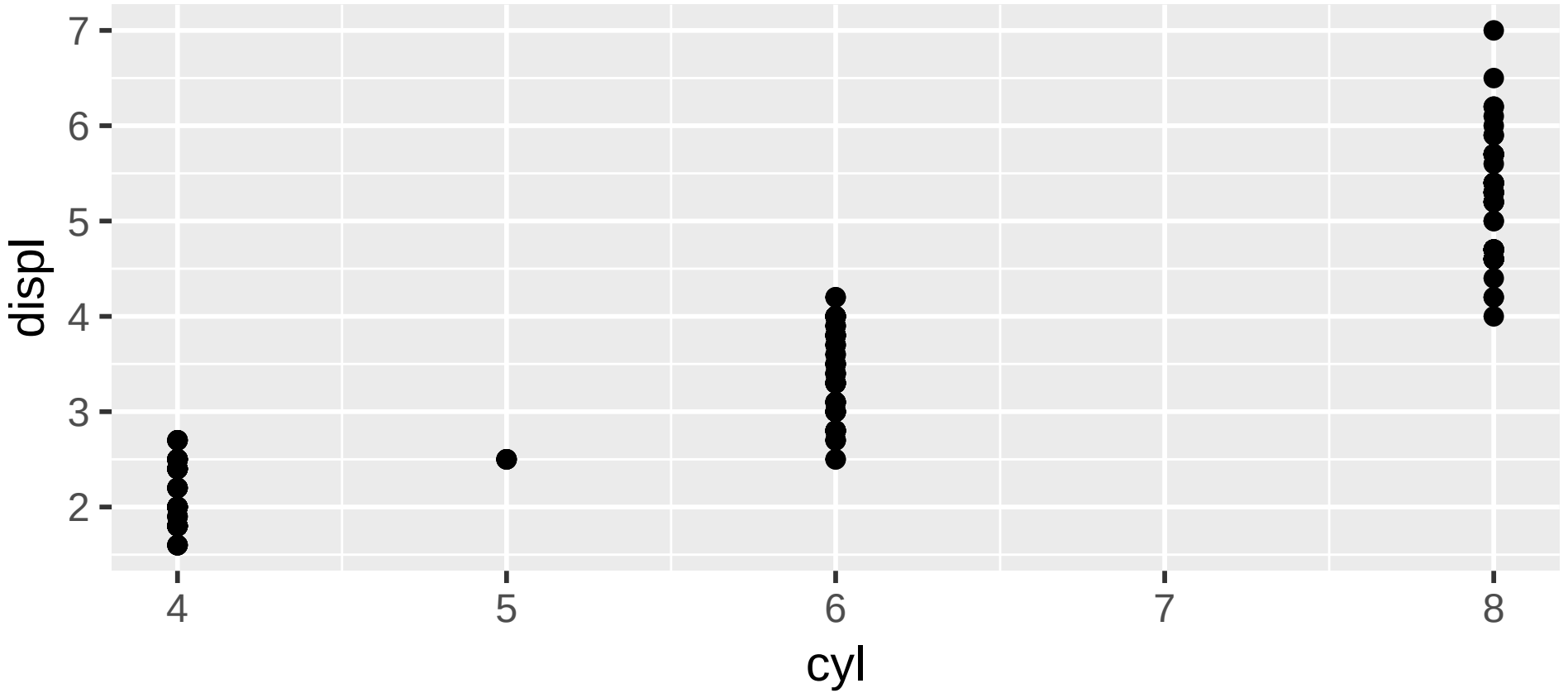
# x=cyl, y=cty

```
ggplot(data = mpg) +    # specify the source tibble
  geom_point(mapping=aes(x=cyl,   # map x, y vars
                         y=cty))
```



# x=cyl, y=displ

```
ggplot(data = mpg) +    # specify the source tibble
  geom_point(mapping=aes(x=cyl,  # map x, y vars
                         y=displ))
```



# Challenge 6.1

- Redraw the graphs, and colour by **car class**
- Vary the size of the point by using the number of cylinders

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| Highway MPG | City MPG | Positive? | Should be closely related |
| Cylinders | Highways MPG | Negative? | More cylinders, less eff. |
| Cylinders | Displacement | Negative? | More cylinders, bigger eng. |

# Summary

- "The simple graph has brought more information to the data analyst's mind that any other device." – John Tukey ]
- "Data exploration is the art of looking at your data, rapidly generating hypotheses, quickly testing them, then repeating again and again and again." (Wickham and Grolemund 2017).
- ggplot2 provides a layered approach to building charts