Introduction to the Grammar of Graphics II

Nate Wells

Math 141, 1/31/22

Outline

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- Introduce the ggplot2 package for R graphics
- Create scatterplots and linegraphs

Section 1

The ggplot2 Package

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- The code for graphics will (almost) always take the following general form:

```
ggplot(data = ---, mapping = aes(---)) +
  geom_---(---)
```

- For brevity, the above code can also be written as:

```
ggplot(---, aes(---)) +
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```

- R will assume that the first argument is the data argument and the second argument is the mapping argument.

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- Several other applications have capability of plotting graphics.
  - Excel and Google Spreadsheets each have separate buttons to produced bar plots, scatter plots, line plots, etc. from data sets.
- What advantages does ggplot2 (and the Grammar of Graphics) have over these other tools?
  - Control
  - Intentionality
  - Consistency
  - Ability to create publication quality graphs with minimal tuning

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  2. Linegraphs (`geom_line`)
  3. Histograms (`geom_histogram`)
  4. Boxplots (`geom_boxplot`)
  5. Barplots (`geom_bar`)
- Other common graph types you may encounter:
  - Violin plots (`geom_violin`)
  - Interpolation (`geom_smooth`)
  - Geographic maps (`geom_map`)
  - Polygon areas (`geom_poly`)
  - Density plots (`geom_density`)

Portland Biketown

- We'll use a common data set to investigate each graph: the Portland Biketown data:

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- Users can purchase a single-ride fare, a day pass, or an annual membership. They can borrow a bike from any bike station, and return the bike to any station.
- Bike stations automatically log data on each trip.
- The `biketown` data was obtained from the `BiketownPDX` website and contains a random sample of all bike share rides between June and August, 2017.

Biketown Preview

- First, let's preview the data frame:

```
glimpse(biketown)
```

```
## Rows: 9,999
## Columns: 19
## $ RouteID          <dbl> 4074085, 3719219, 3789757, 3576798, 3459987, 3947695,~
## $ PaymentPlan      <chr> "Subscriber", "Casual", "Casual", "Subscriber", "Casu~
## $ StartHub         <chr> "SE Elliott at Division", "SW Yamhill at Director Par~
## $ StartLatitude    <dbl> 45.50513, 45.51898, 45.52990, 45.52389, 45.53028, 45.~
## $ StartLongitude   <dbl> -122.6534, -122.6813, -122.6628, -122.6722, -122.6547~
## $ StartDate        <chr> "8/17/2017", "7/22/2017", "7/27/2017", "7/12/2017", "~
## $ StartTime        <time> 10:44:00, 14:49:00, 14:13:00, 13:23:00, 19:30:00, 10~
## $ EndHub           <chr> "Blues Fest - SW Waterfront at Clay - Disabled", "SW ~
## $ EndLatitude      <dbl> 45.51287, 45.52142, 45.55902, 45.53409, 45.52990, 45.~
## $ EndLongitude     <dbl> -122.6749, -122.6726, -122.6355, -122.6949, -122.6628~
## $ EndDate          <chr> "8/17/2017", "7/22/2017", "7/27/2017", "7/12/2017", "~
## $ EndTime          <time> 10:56:00, 15:00:00, 14:42:00, 13:38:00, 20:30:00, 10~
## $ TripType         <lgl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, N~
## $ BikeID           <dbl> 6163, 6843, 6409, 7375, 6354, 6088, 6089, 5988, 6857,~
## $ BikeName         <chr> "0488 BIKETOWN", "0759 BIKETOWN", "0614 BIKETOWN", "0~
## $ Distance_Miles   <dbl> 1.91, 0.72, 3.42, 1.81, 4.51, 5.54, 1.59, 1.03, 0.70,~
## $ Duration         <dbl> 11.500, 11.383, 28.317, 14.917, 60.517, 53.783, 23.86~
## $ RentalAccessPath <chr> "keypad", "keypad", "keypad", "keypad", "keypad", "ke~
## $ MultipleRental   <lgl> FALSE, FALSE, FALSE, FALSE, TRUE, FALSE, FALSE, FALSE~
```

A Deeper Dive I

What do the first few entries look like?

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```
head(biketown)
```

```
## # A tibble: 6 x 19
##   RouteID PaymentPlan StartHub  StartLatitude StartLongitude StartDate StartTime
##     <dbl> <chr>       <chr>             <dbl>          <dbl> <chr>     <time>
## 1 4074085 Subscriber  SE Ellio~          45.5          -123. 8/17/2017 10:44
## 2 3719219 Casual      SW Yamhi~          45.5          -123. 7/22/2017 14:49
## 3 3789757 Casual      NE Holla~          45.5          -123. 7/27/2017 14:13
## 4 3576798 Subscriber  NW Couch~          45.5          -123. 7/12/2017 13:23
## 5 3459987 Casual      NE 11th ~          45.5          -123. 7/3/2017  19:30
## 6 3947695 Casual      SW Moody~          45.5          -123. 8/8/2017  10:01
## # ... with 12 more variables: EndHub <chr>, EndLatitude <dbl>,
## #   EndLongitude <dbl>, EndDate <chr>, EndTime <time>, TripType <lgl>,
## #   BikeID <dbl>, BikeName <chr>, Distance_Miles <dbl>, Duration <dbl>,
## #   RentalAccessPath <chr>, MultipleRental <lgl>
```

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```
biketown$Distance_Miles
```

```
##   [1]  1.91  0.72  3.42  1.81  4.51  5.54  1.59  1.03  0.70  1.72  1.79  3.15
##  [13]  0.81  0.55  5.78  0.41  3.76  2.22  1.77  4.96  3.19  2.56  2.55  0.68
##  [25]  0.59  0.71  3.15  5.89  1.34  1.56  3.50  1.81  2.74  4.56  3.99  1.03
##  [37]  1.51  2.87  2.60  1.48  0.96  2.82  0.66  0.37  2.38  5.92  1.27  0.78
##  [49]  0.79  3.38  1.73  3.64  1.40  2.61  1.85  1.04  1.55  0.63  3.41  4.94
##  [61]  3.93  0.40  1.00  7.19  7.15  0.96  0.33  0.79  2.80  1.08  2.27  0.62
##  [73]  0.50  2.15  0.23  3.06  1.85  5.00  0.42  3.05  0.42  1.00  4.09  0.45
##  [85]  2.53  0.66  0.26  1.89  1.63  0.99  1.62  1.87  6.73 12.95  3.44  0.43
##  [97]  0.82  0.72  1.51  1.70  0.34  0.55  2.84  1.31  2.78  1.09  1.25  5.04
## [109]  1.18  1.15  1.62  0.63  3.88  4.67  1.25  0.34  3.11  5.29  1.00  1.67
## [121]  0.61  0.47  0.68  0.66  0.71  0.02  0.87  1.61  4.50  1.47  4.53  0.10
## [133]  0.25  5.50  2.05  4.98  0.66  0.12  4.79  0.47  4.19  0.43  1.57  0.27
## [145]  0.17  1.08  0.36  5.16  6.74  2.54  0.48  0.91  1.80  0.19  2.71  1.32
## [157]  2.75  1.14  0.65  2.58  3.77  0.66  3.55  1.37  0.98  1.41  1.01  1.87
## [169]  0.51  0.37  1.12  0.84  0.55  0.12  3.64  4.69  0.15  2.94  5.06  1.24
## [181]  0.83  2.32  1.25  2.82  0.61  1.80  1.41  1.16  1.09  2.03  1.34  0.55
## [193]  0.45  4.79  4.30  0.45  2.05  0.71  0.16  0.31  0.01  1.49  3.27  3.11
## [205]  0.78  2.62  0.63  2.09  1.83  0.35  0.82  1.39  2.39  0.58  0.36  0.28
## [217]  1.65  0.79  1.90  1.27  3.71  2.96  7.12  3.20  0.40  1.50  0.93  1.97
## [229]  0.73  0.68  0.91  3.20  2.27  2.67  2.37  0.05  0.82  2.50  2.17  0.44
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```
names(biketown)
```

```
##  [1] "RouteID"          "PaymentPlan"      "StartHub"         "StartLatitude"
##  [5] "StartLongitude"   "StartDate"        "StartTime"        "EndHub"
##  [9] "EndLatitude"      "EndLongitude"     "EndDate"          "EndTime"
## [13] "TripType"         "BikeID"           "BikeName"         "Distance_Miles"
## [17] "Duration"         "RentalAccessPath" "MultipleRental"
```

Section 2

Types of Graphics

Scatterplots

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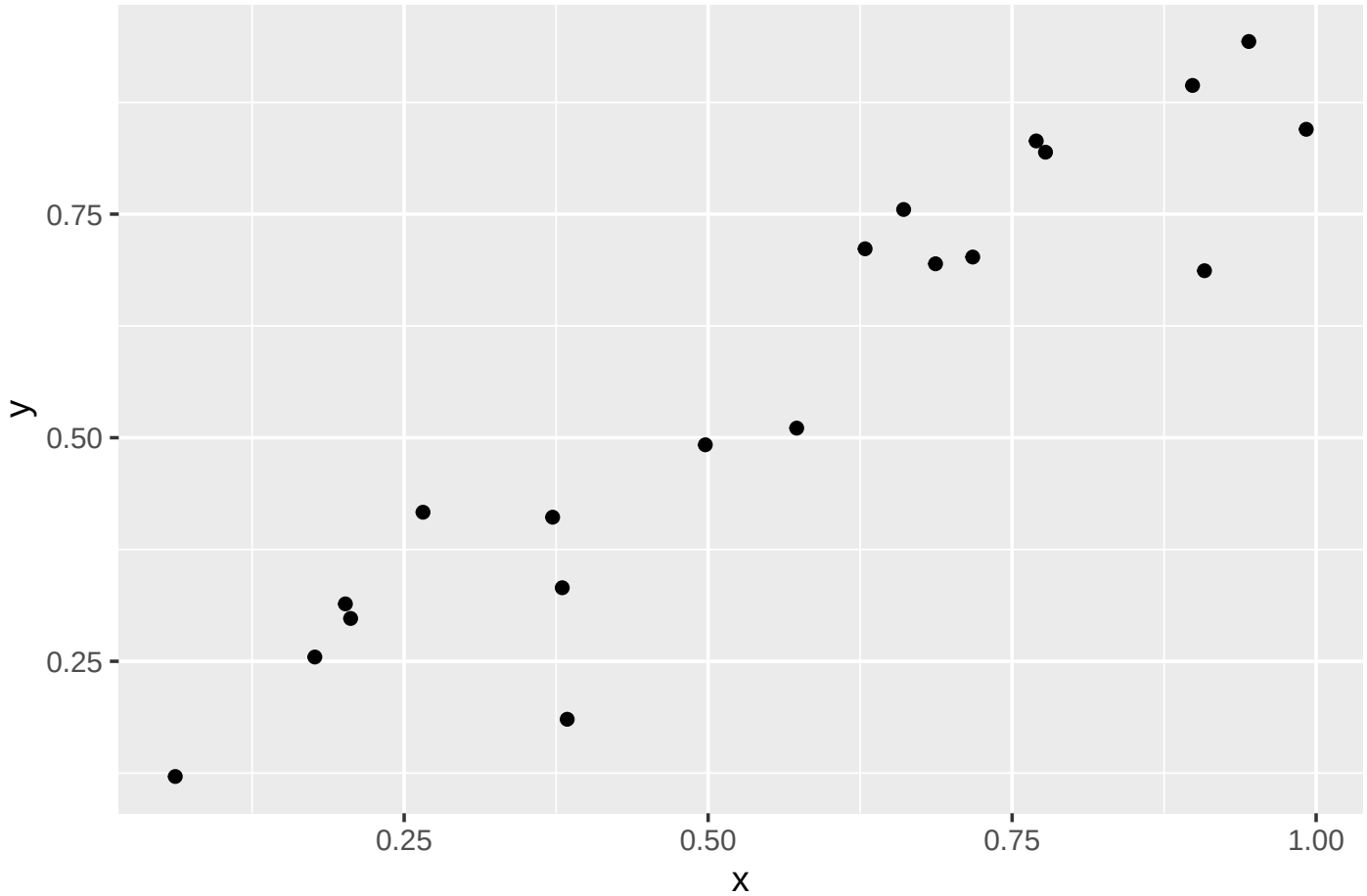

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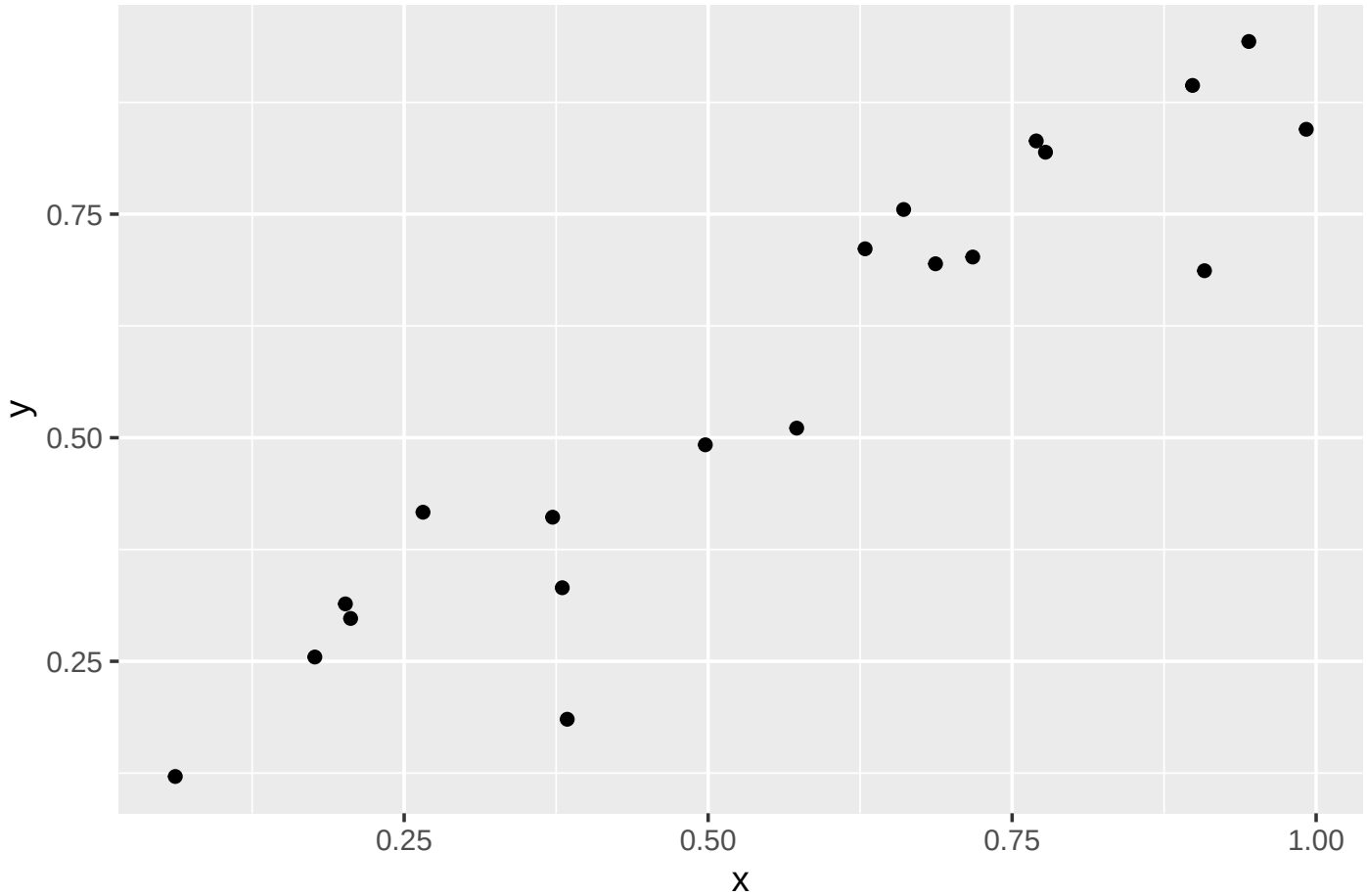

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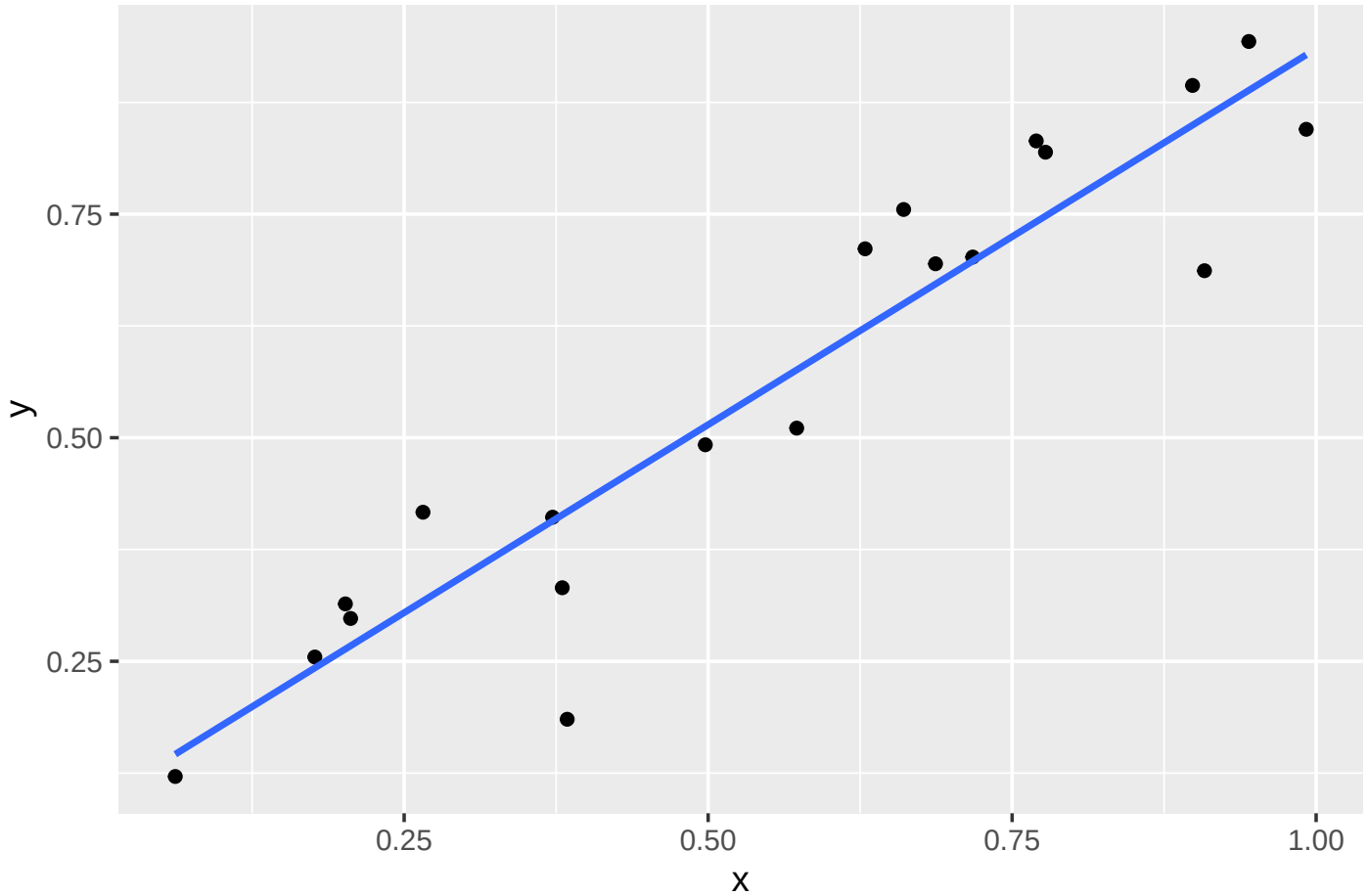

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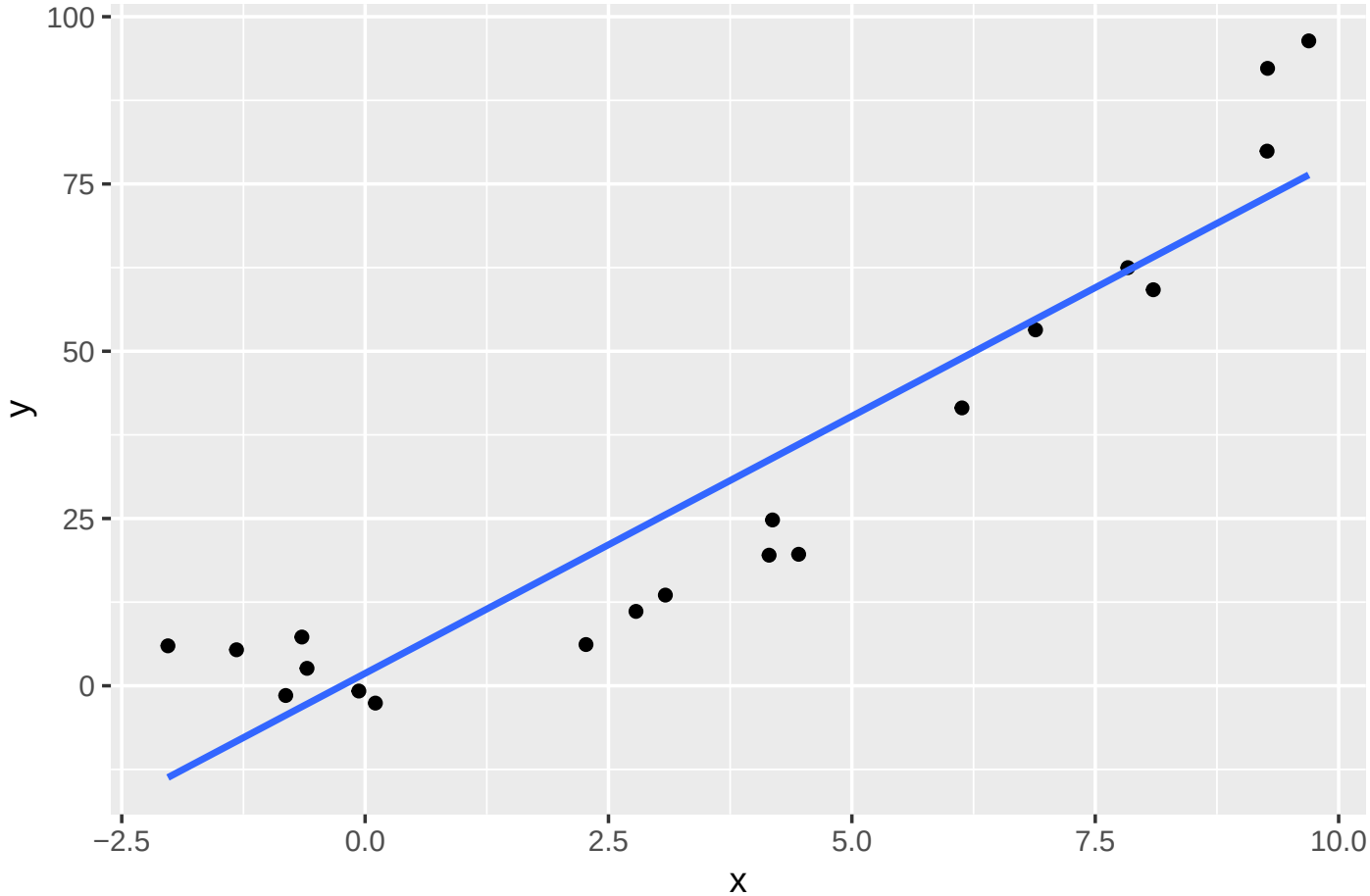

Linear Relationships

- Two variables have a **negative** relationship provided the values of one decrease as the values of the other also increase.

Linear Relationships

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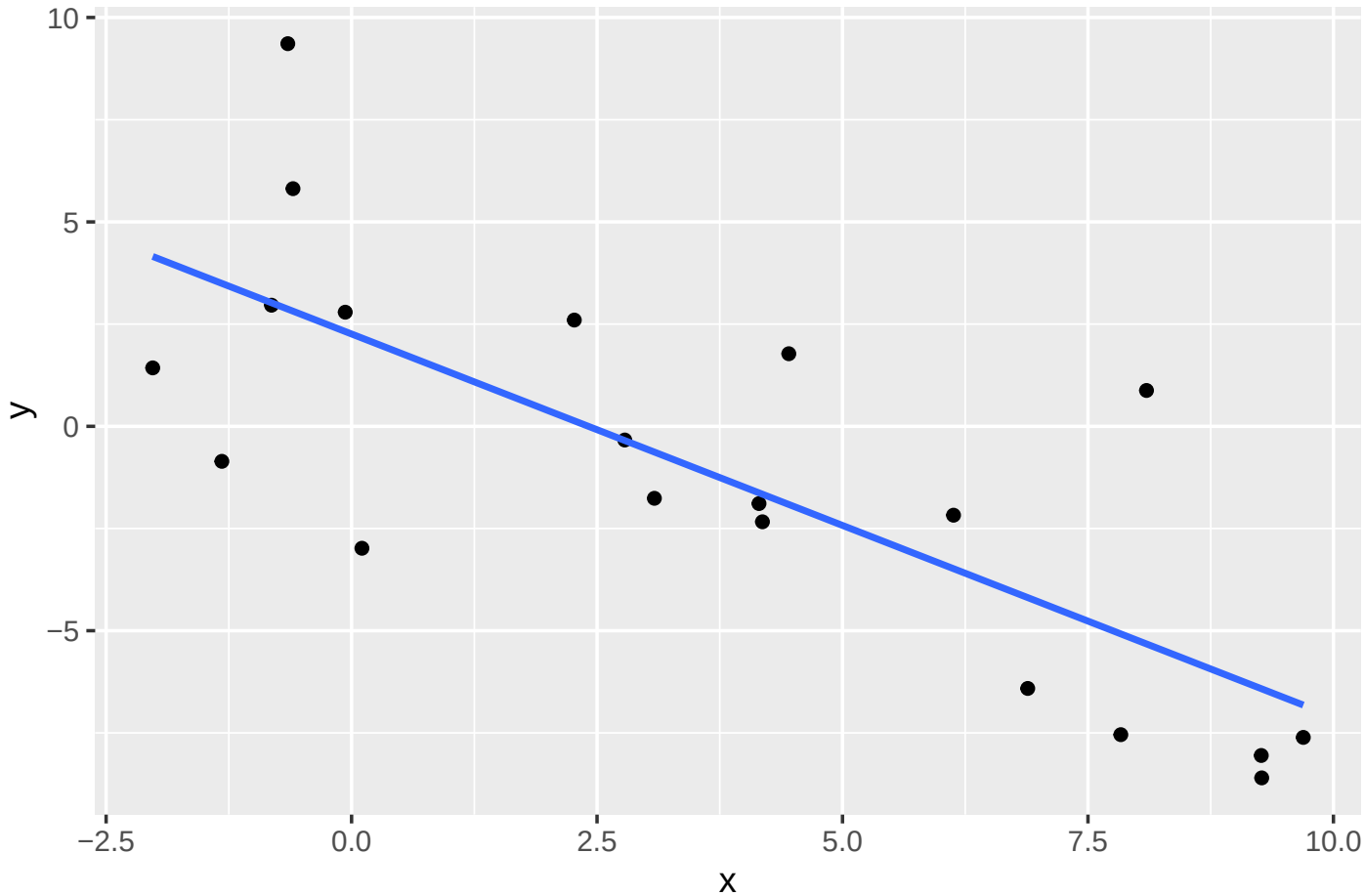

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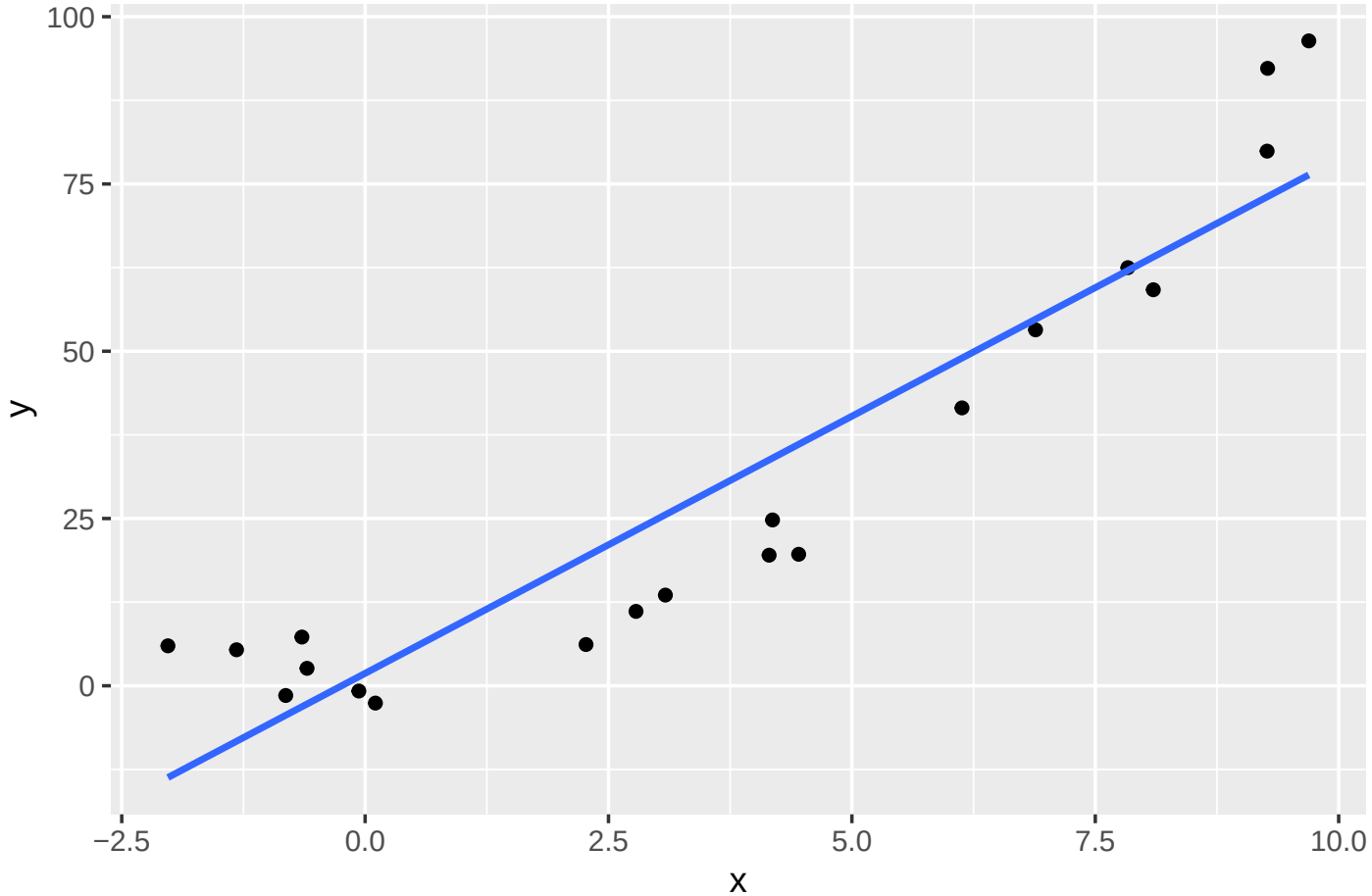

Non-Linear Relationships

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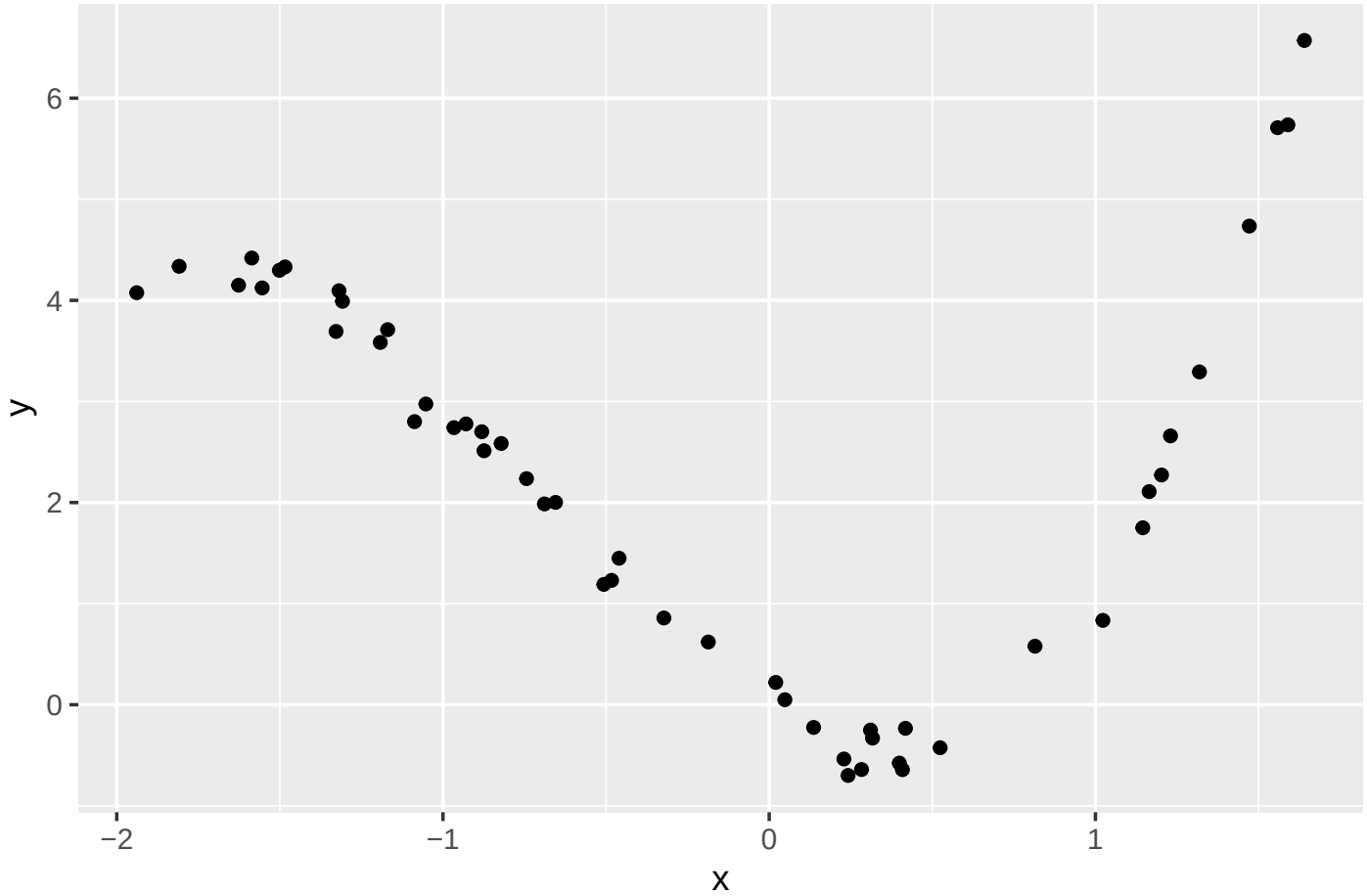

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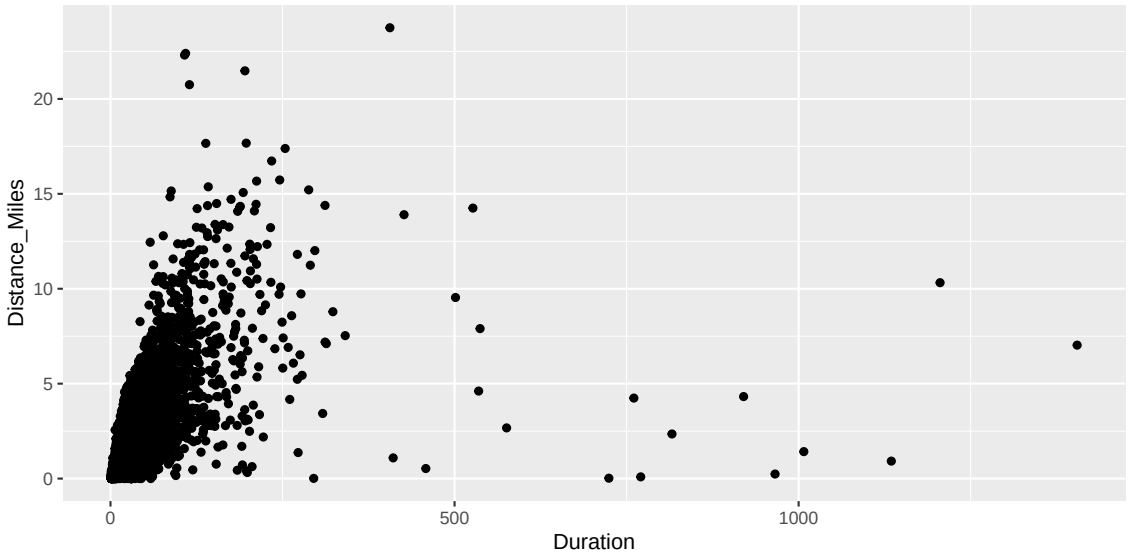

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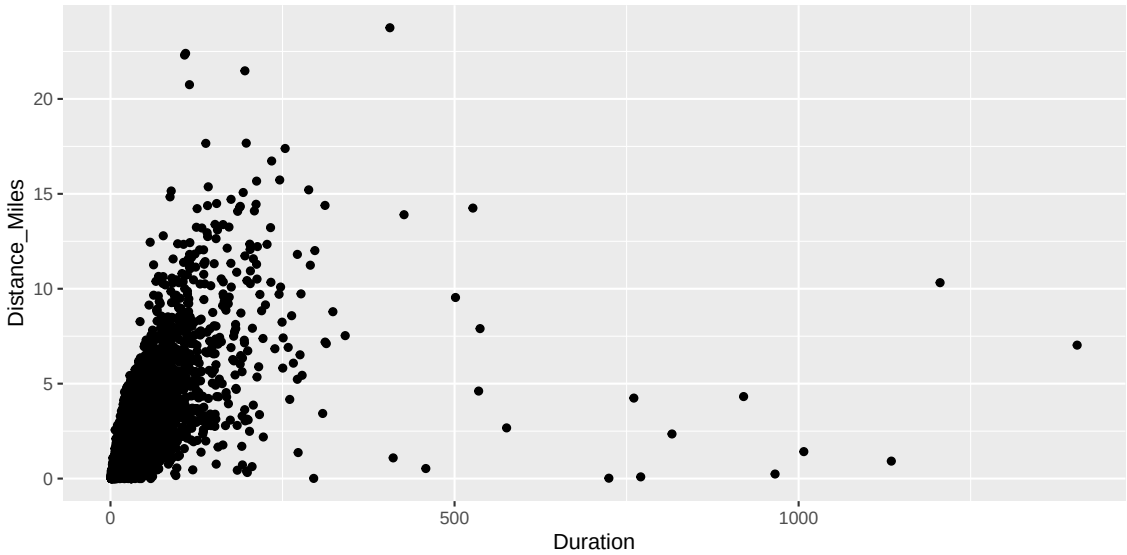

- Problems with the graphic?

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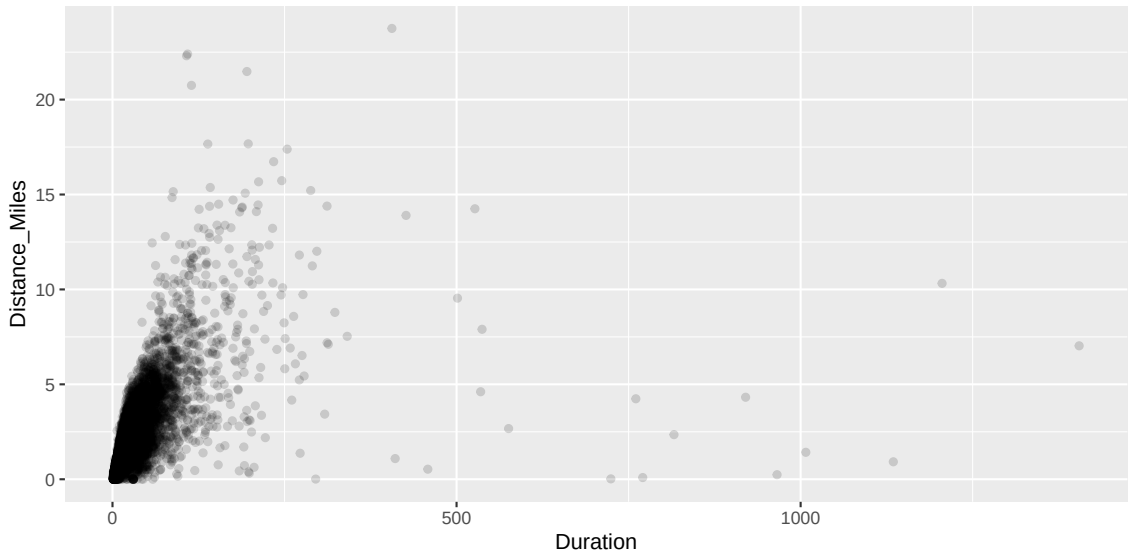
  - Can be corrected by making points more transparent via the `alpha` aesthetic:

```
ggplot(data = biketown, mapping = aes(x = Duration, y = Distance_Miles)) +
  geom_point(alpha = 0.15)
```



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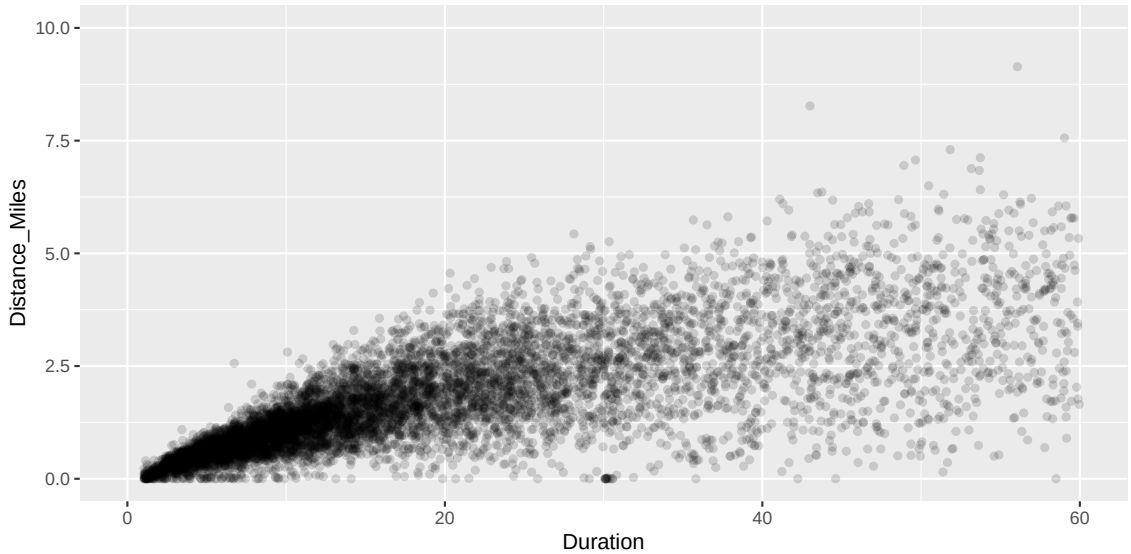
```
ggplot(data = biketown, mapping = aes(x = Duration, y = Distance_Miles)) +
  geom_point(alpha = .15)+
  scale_x_continuous(limits = c(0, 60))+
  scale_y_continuous(limits = c(0, 10))
```



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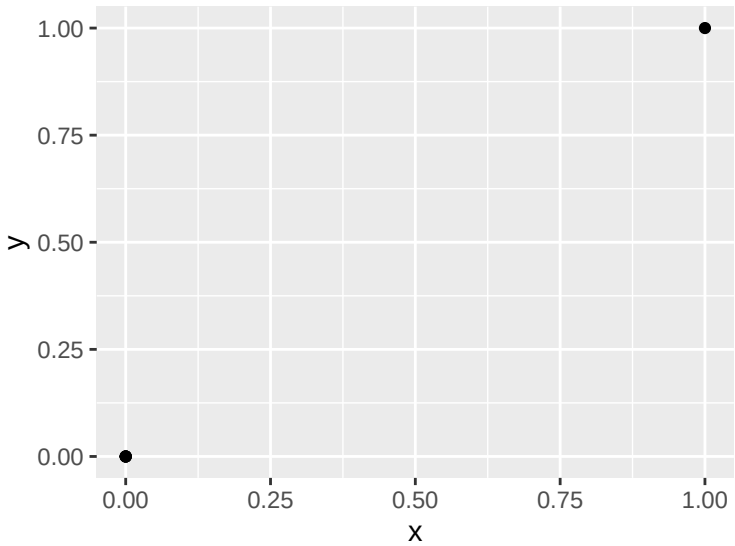
```
ggplot(data = jiggle_df, mapping = aes(x = x, y = y)) +
  geom_point()
```



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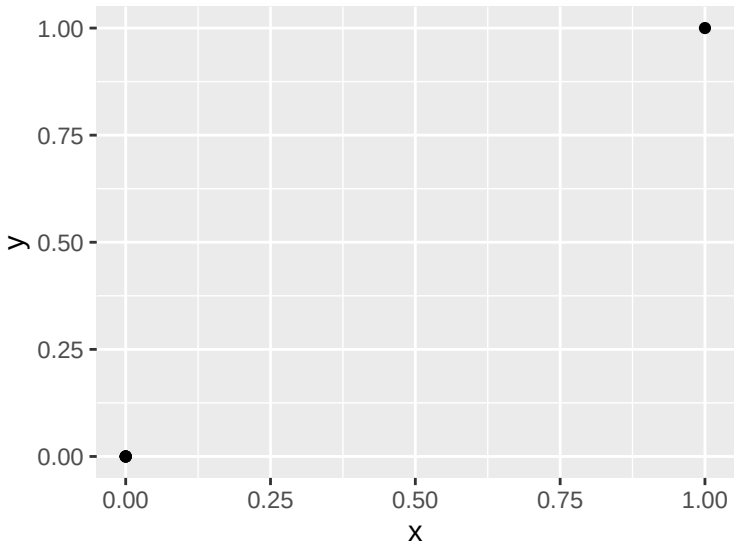

- It looks like there are just 2 observations!

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```
ggplot(data = jiggle_df, mapping = aes(x = x, y = y)) +
  geom_jitter(width = .05, height = .05)
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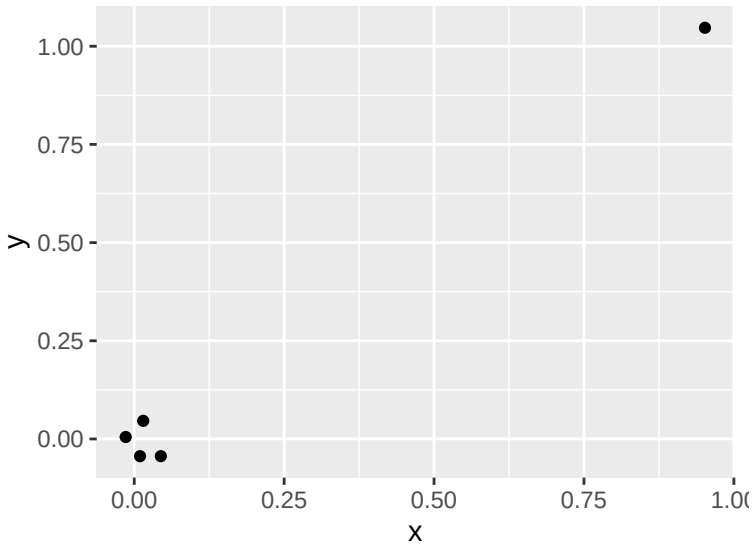

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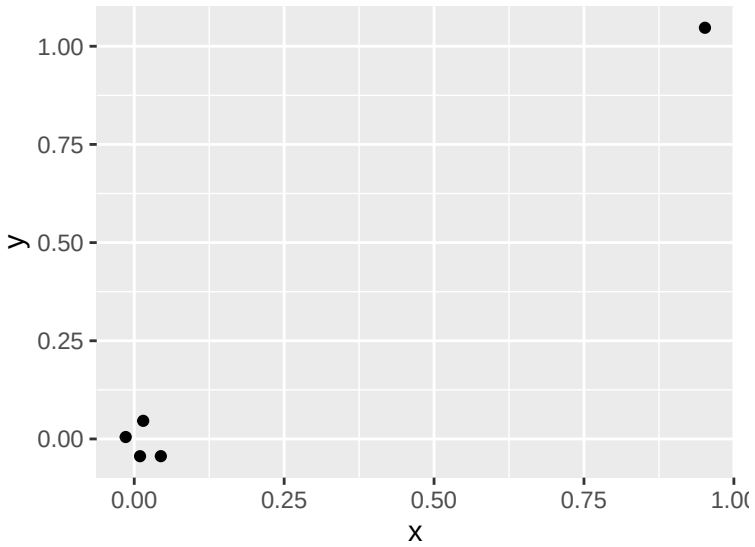
```



- To jitter points, use the layer `geom_jitter(width = ..., height = ...)` instead of `geom_points()`

Line Graphs

- How do bike use patterns change throughout the day?

Line Graphs

- How do bike use patterns change throughout the day?
- Consider the following summary information:

```
## # A tibble: 24 x 2
##    StartHour     n
##        <int> <int>
##  1         0   118
##  2         1    69
##  3         2    50
##  4         3    20
##  5         4    35
##  6         5    71
##  7         6   104
##  8         7   270
##  9         8   492
## 10         9   392
## # ... with 14 more rows
```

Line Graphs

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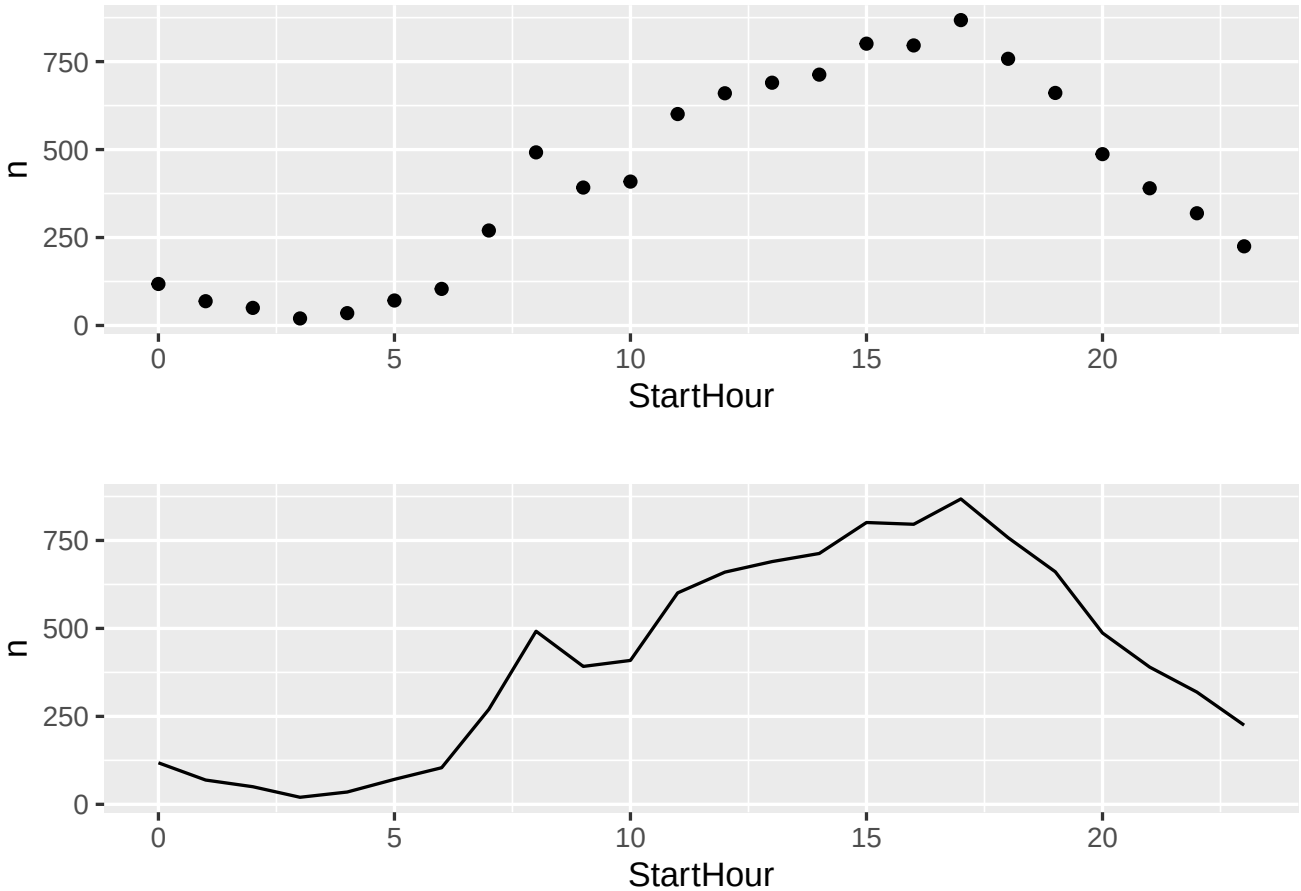
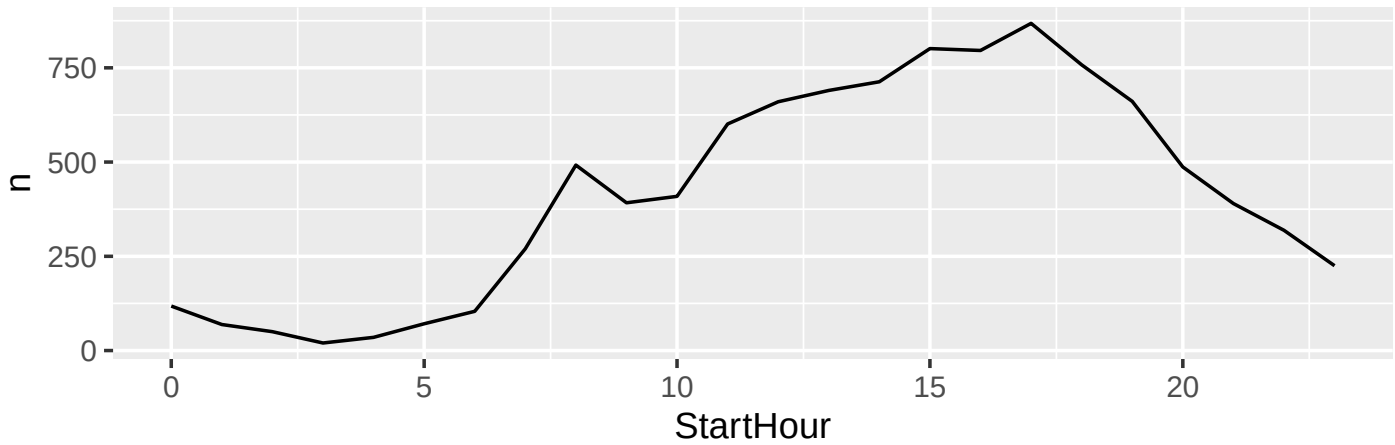
- Compare the following:



Making Line Graphs

- To construct a line graph , use `geom_line()` with the aesthetic mapping `aes(x = ... , y = ...)`.

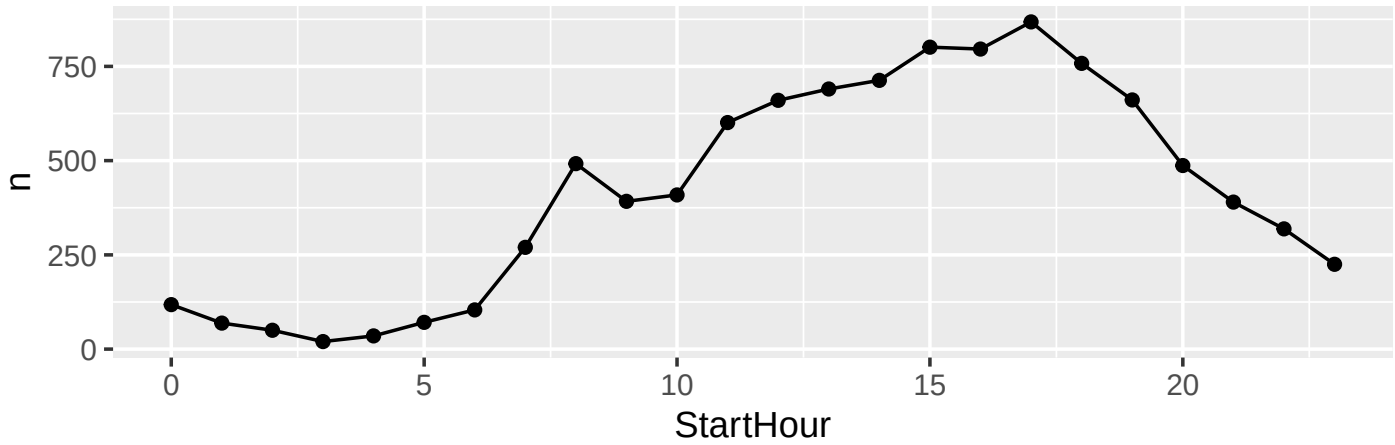
```
ggplot(data = biketown2, mapping = aes(x = StartHour, y = n)) +
  geom_line()
```



Combining Plots

- We can also overlay points on the lines by *adding* a `geom_point` layer!

```
ggplot(data = biketown2, mapping = aes(x = StartHour, y = n)) +
  geom_line()+
  geom_point()
```



Combining Plots

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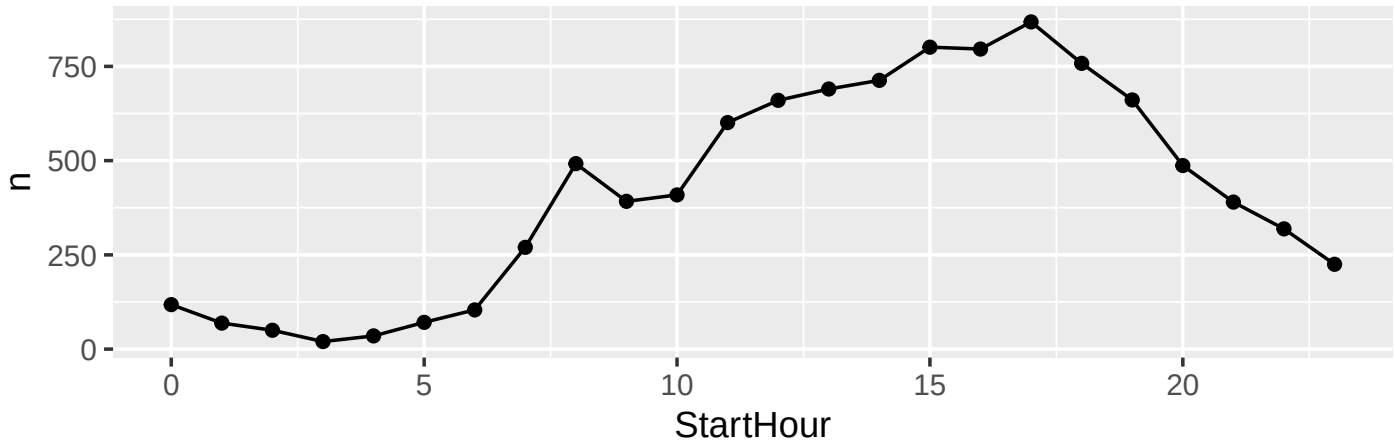
```
ggplot(data = biketown2, mapping = aes(x = StartHour, y = n)) +
  geom_line()+
  geom_point()
```



- Note that both `geom_line` and `geom_point` inherit the data and mapping arguments specified in the original `ggplot` function.

ggplot2 summary

The guiding principle of the grammar of graphics is

> *A statistical graphic is a mapping of data variables to aesthetic attributes of geometric objects.*

- The code for graphics will (almost) always take the following general form:

```
ggplot(data = ---, mapping = aes(---)) +
  geom_---(---)
```