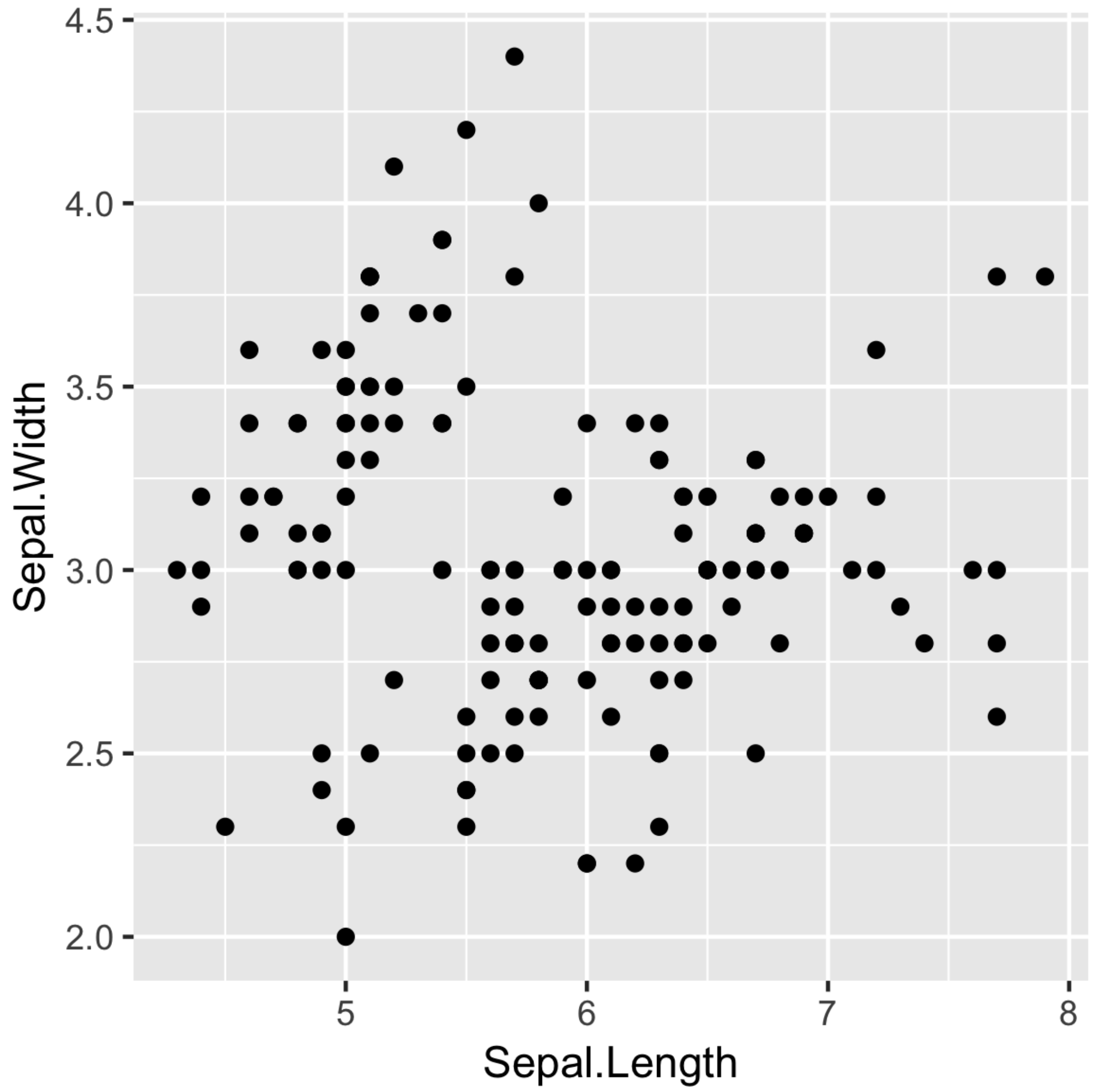
Visible aesthetics

INTRODUCTION TO DATA VISUALIZATION WITH GGPLOT2

Rick Scavetta
Founder, Scavetta Academy

Mapping onto the X and Y axes

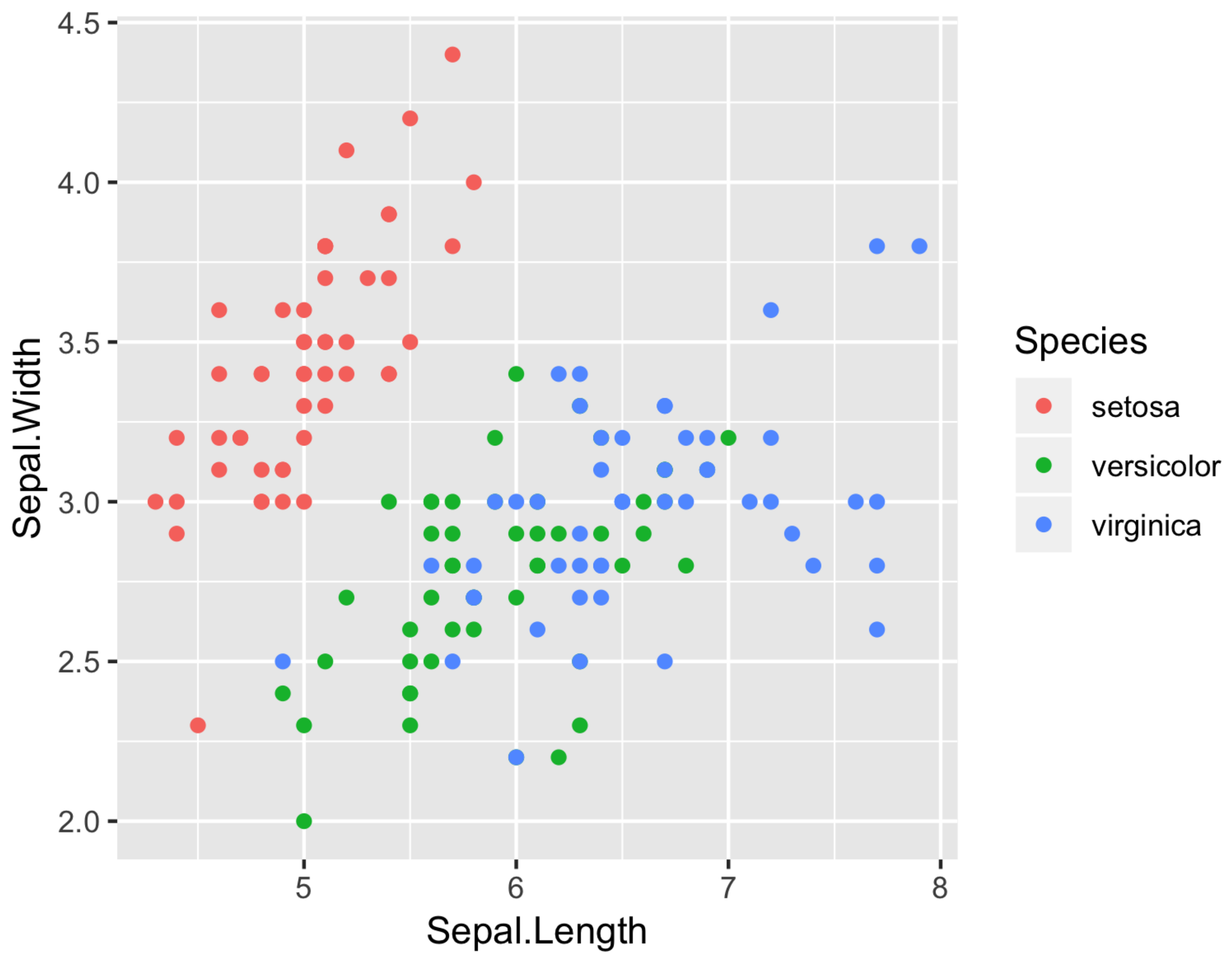
```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width)) +
  geom_point()
```



Mapping onto color

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point()
```

Type	Variable
Color	Species

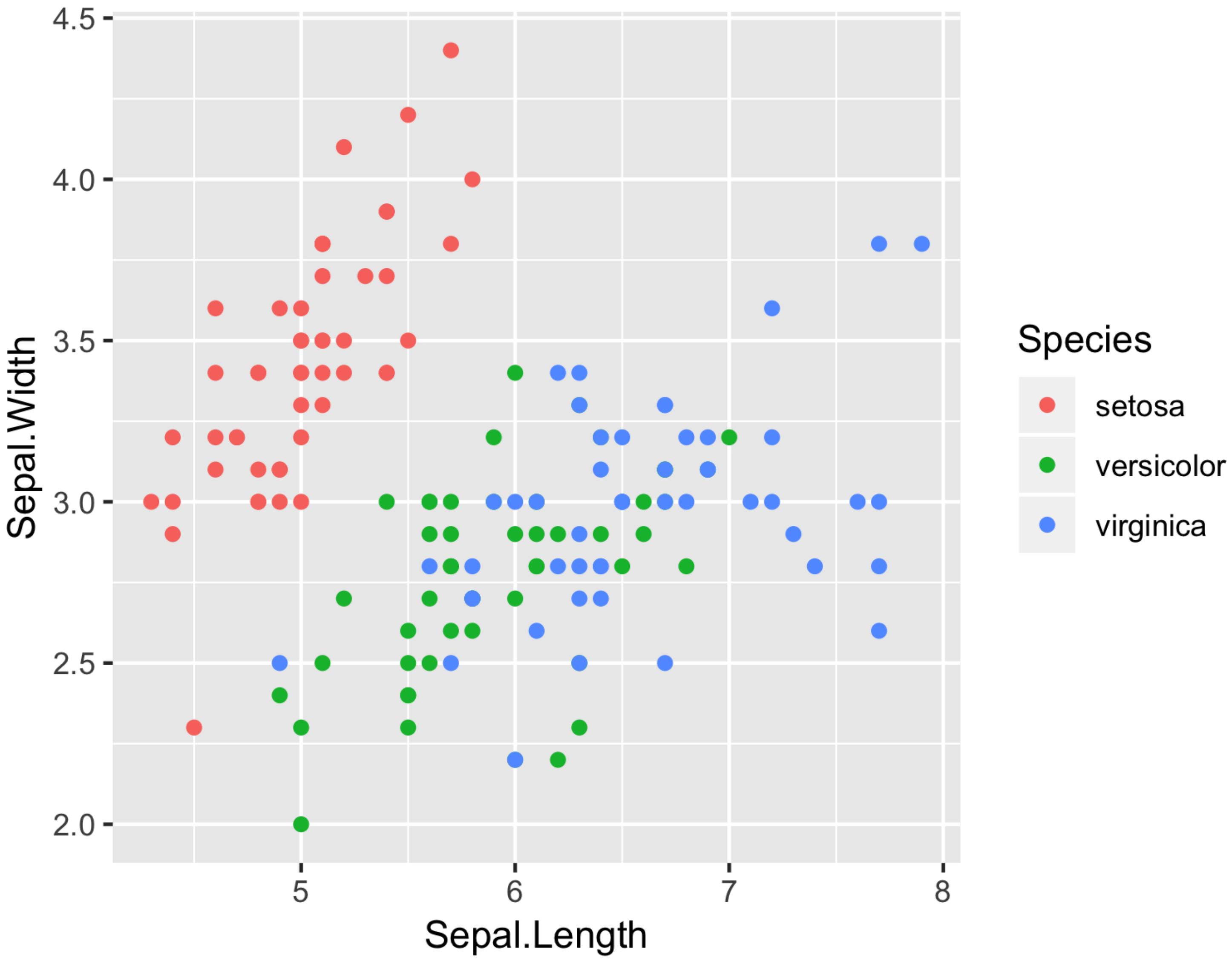


Mapping onto the color aesthetic

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point()
```

Type	Variable
Color	Species

Species, a dataframe column, is *mapped onto* **color**, a visible aesthetic.



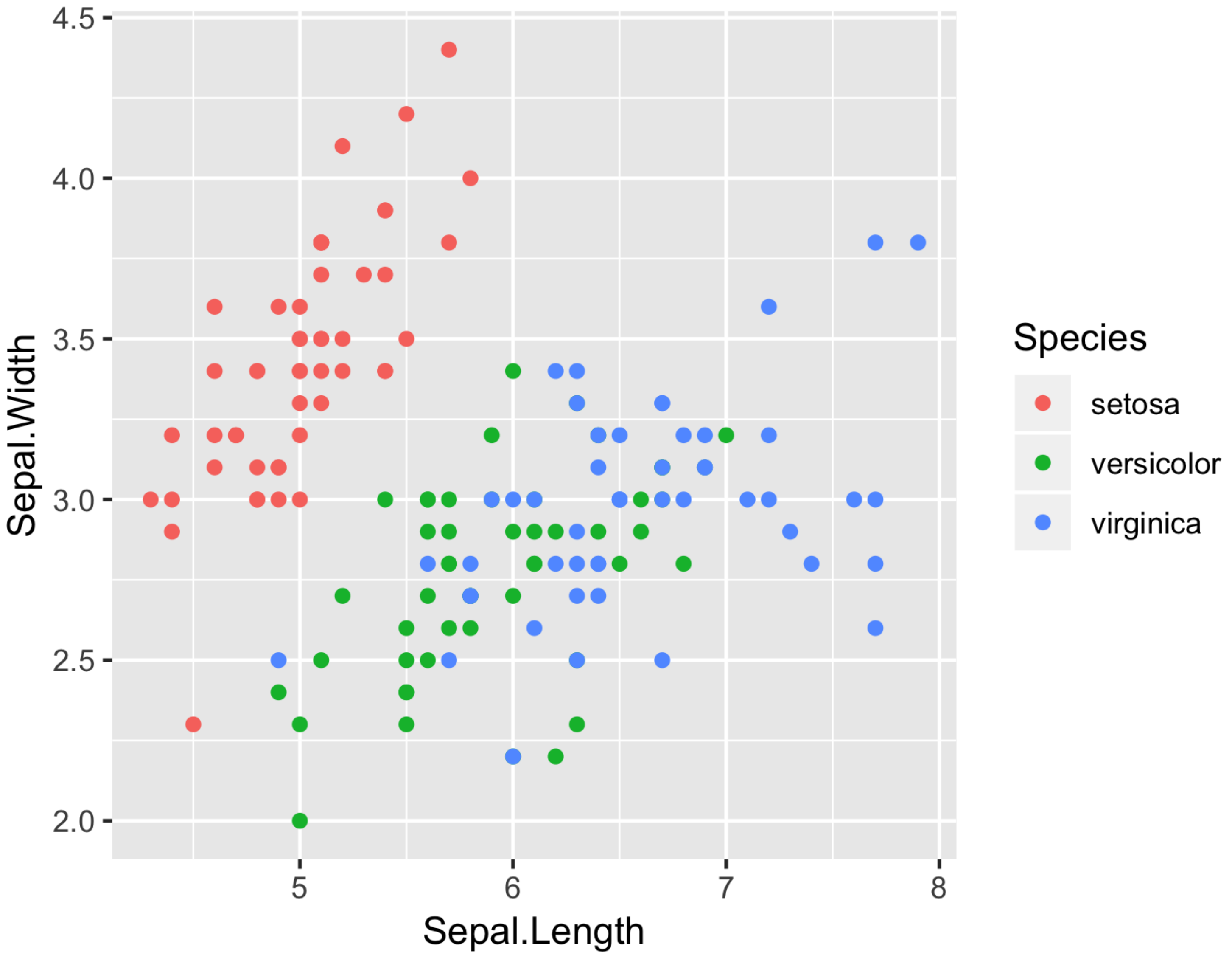
Mapping onto the color aesthetic

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point()
```

Type	Variable
Color	Species

Species, a dataframe column, is *mapped onto* **color**, a visible aesthetic.

Map aesthetics in `aes()` .

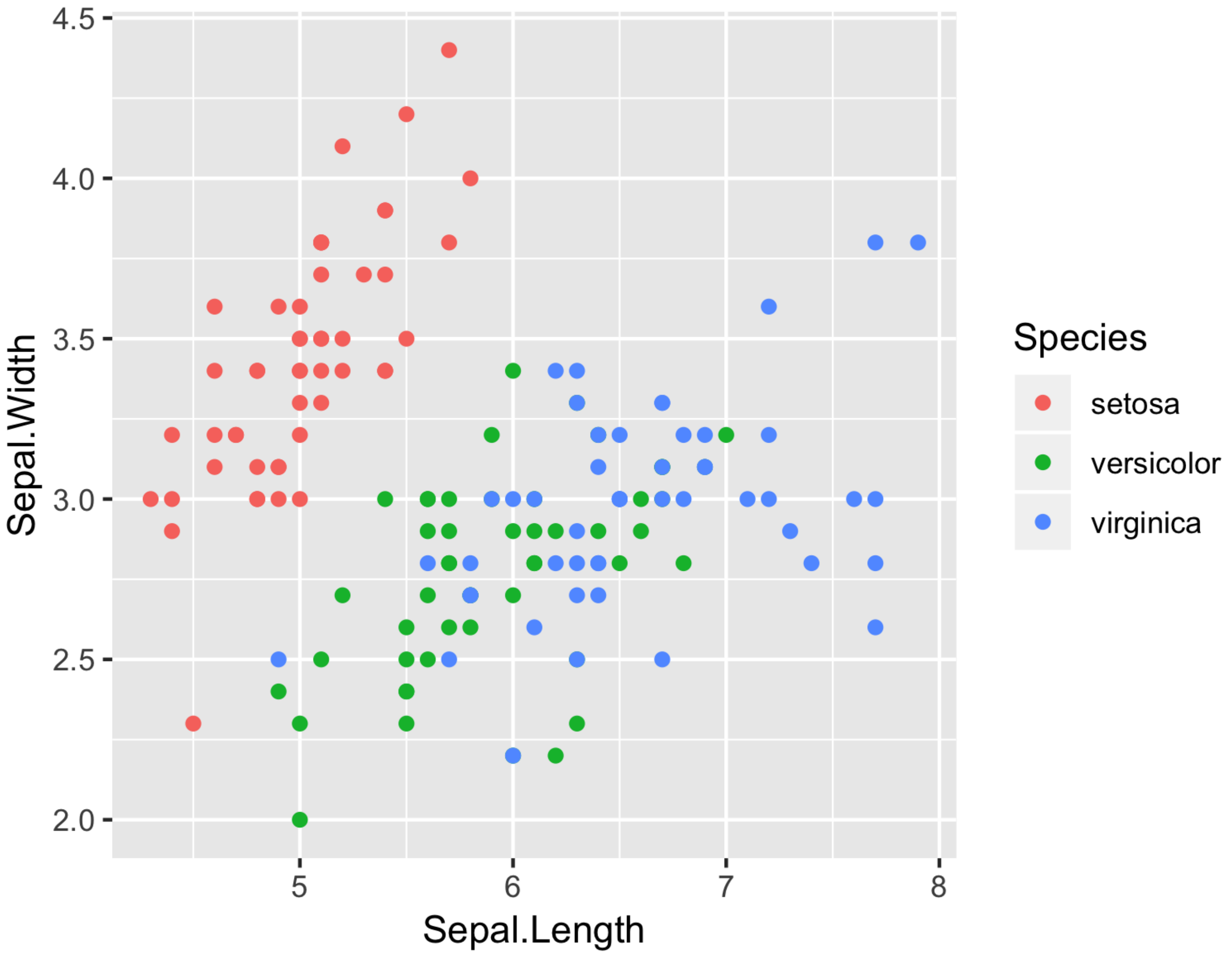


Mapping onto the color aesthetic in geom

```
ggplot(iris) +
  geom_point(aes(x = Sepal.Length,
                 y = Sepal.Width,
                 col = Species))
```

Only necessary if:

- All layers should *not* inherit the same aesthetics
- Mixing different data sources



Typical visible aesthetics

Aesthetic	Description
x	X axis position
y	Y axis position

Typical visible aesthetics

Aesthetic	Description
x	X axis position
y	Y axis position
fill	Fill color

Typical visible aesthetics

Aesthetic	Description
x	X axis position
y	Y axis position
fill	Fill color
color	Color of points, outlines of other geoms

Typical visible aesthetics

Aesthetic	Description
x	X axis position
y	Y axis position
fill	Fill color
color	Color of points, outlines of other geoms
size	Area or radius of points, thickness of lines

Typical visible aesthetics

Aesthetic	Description
x	X axis position
y	Y axis position
fill	Fill color
color	Color of points, outlines of other geoms
size	Area or radius of points, thickness of lines

Aesthetic	Description
alpha	Transparency

Typical visible aesthetics

Aesthetic	Description
x	X axis position
y	Y axis position
fill	Fill color
color	Color of points, outlines of other geoms
size	Area or radius of points, thickness of lines

Aesthetic	Description
alpha	Transparency
linetype	Line dash pattern

Typical visible aesthetics

Aesthetic	Description
x	X axis position
y	Y axis position
fill	Fill color
color	Color of points, outlines of other geoms
size	Area or radius of points, thickness of lines

Aesthetic	Description
alpha	Transparency
linetype	Line dash pattern
labels	Text on a plot or axes

Typical visible aesthetics

Aesthetic	Description
x	X axis position
y	Y axis position
fill	Fill color
color	Color of points, outlines of other geoms
size	Area or radius of points, thickness of lines

Aesthetic	Description
alpha	Transparency
linetype	line dash pattern
labels	Text on a plot or axes
shape	Shape

Let's Practice

INTRODUCTION TO DATA VISUALIZATION WITH GGPLOT2

Using attributes

INTRODUCTION TO DATA VISUALIZATION WITH GGPLOT2

Rick Scavetta

Founder, Scavetta Academy

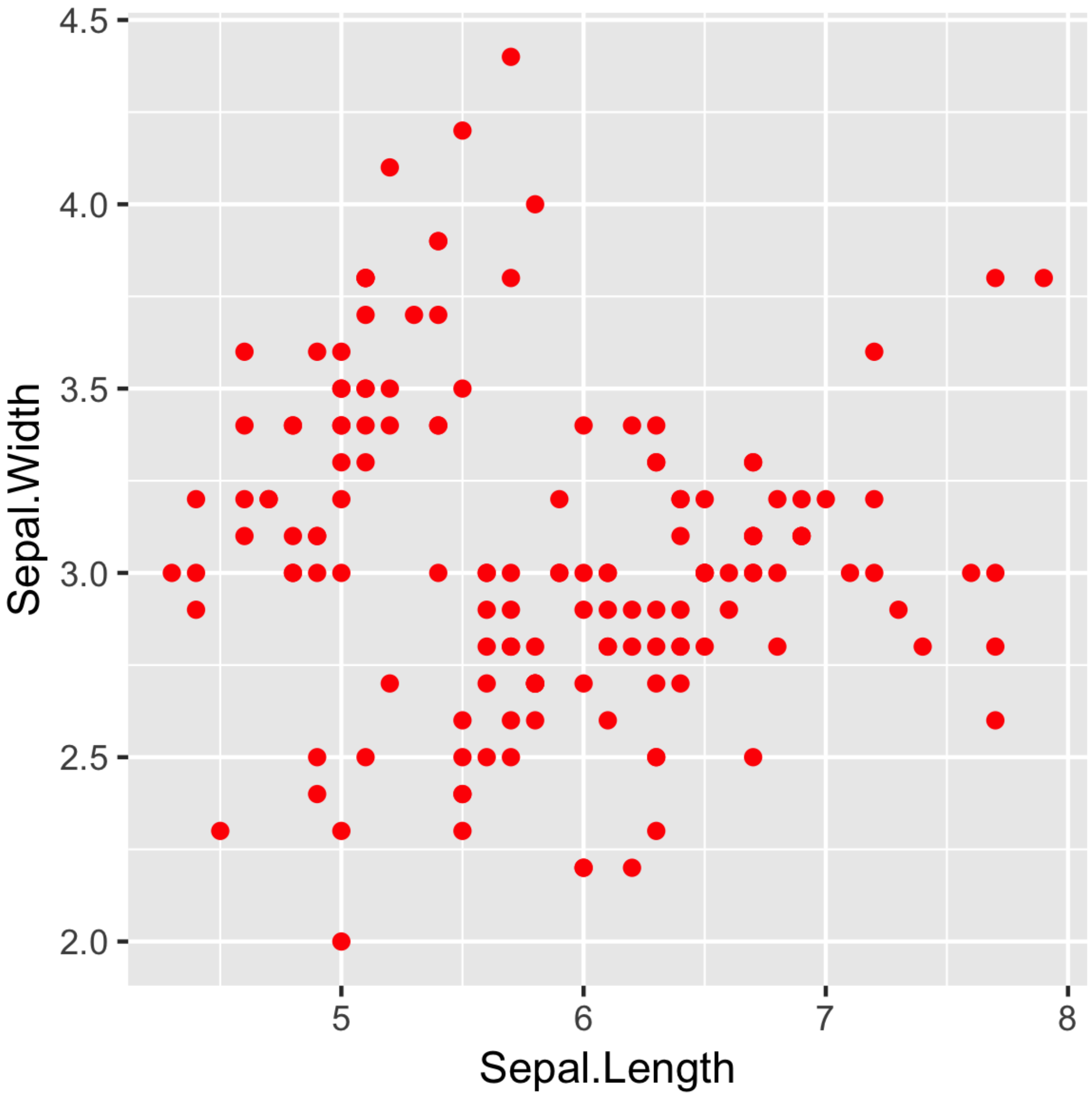
Aesthetics? Attributes!

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width)) +
  geom_point(color = "red")
```

Type	Property
Color	"red"

Set attributes in `geom_*()` .

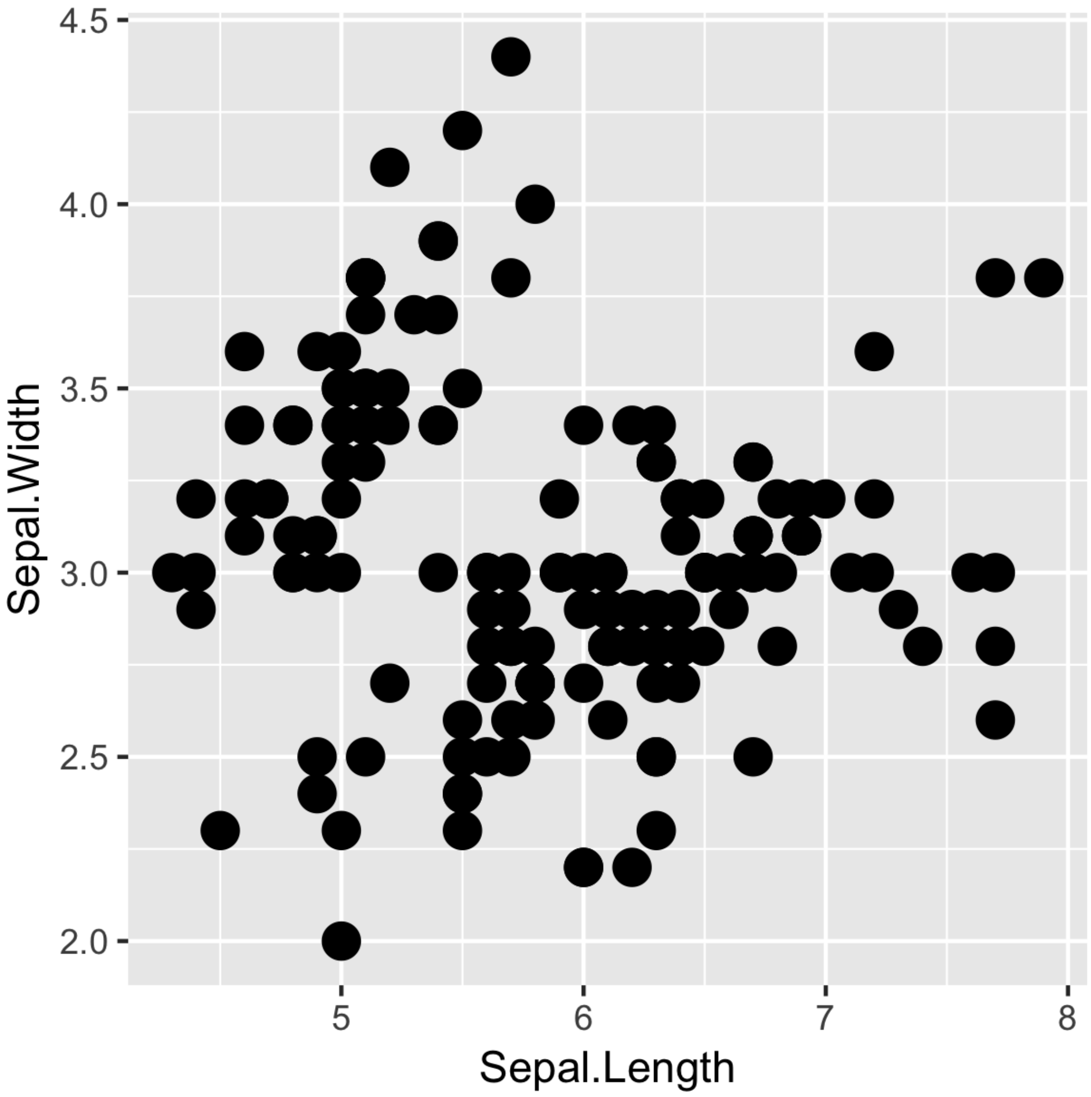
The **color** attribute is *set* to **"red"**.



Aesthetics? Attributes!

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width)) +
  geom_point(size = 10)
```

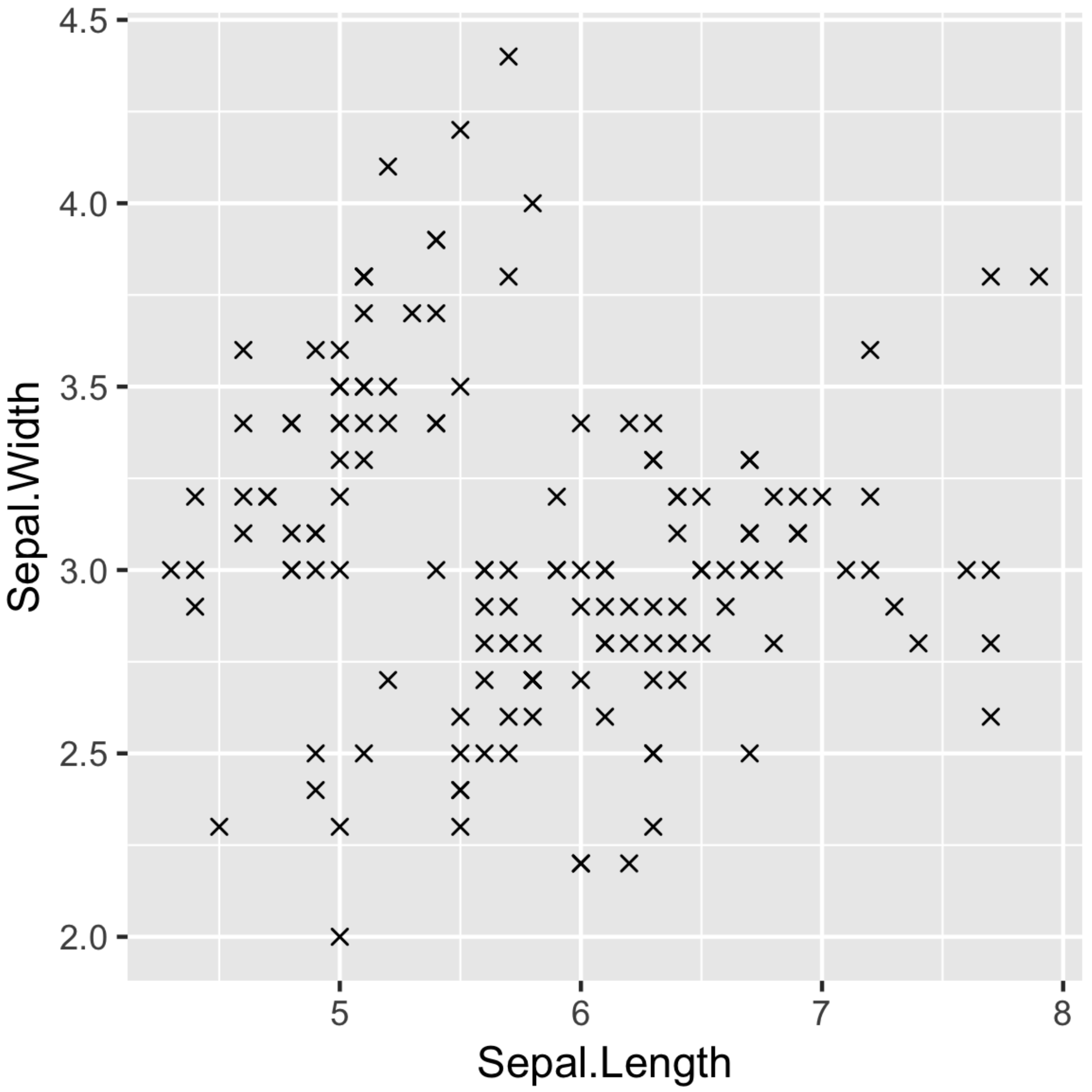
Type	Property
Size	4



Aesthetics? Attributes!

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width)) +
  geom_point(shape = 4)
```

Type	Property
Shape	4



Let's practice!

INTRODUCTION TO DATA VISUALIZATION WITH GGPLOT2

Modifying Aesthetics

INTRODUCTION TO DATA VISUALIZATION WITH GGPLOT2

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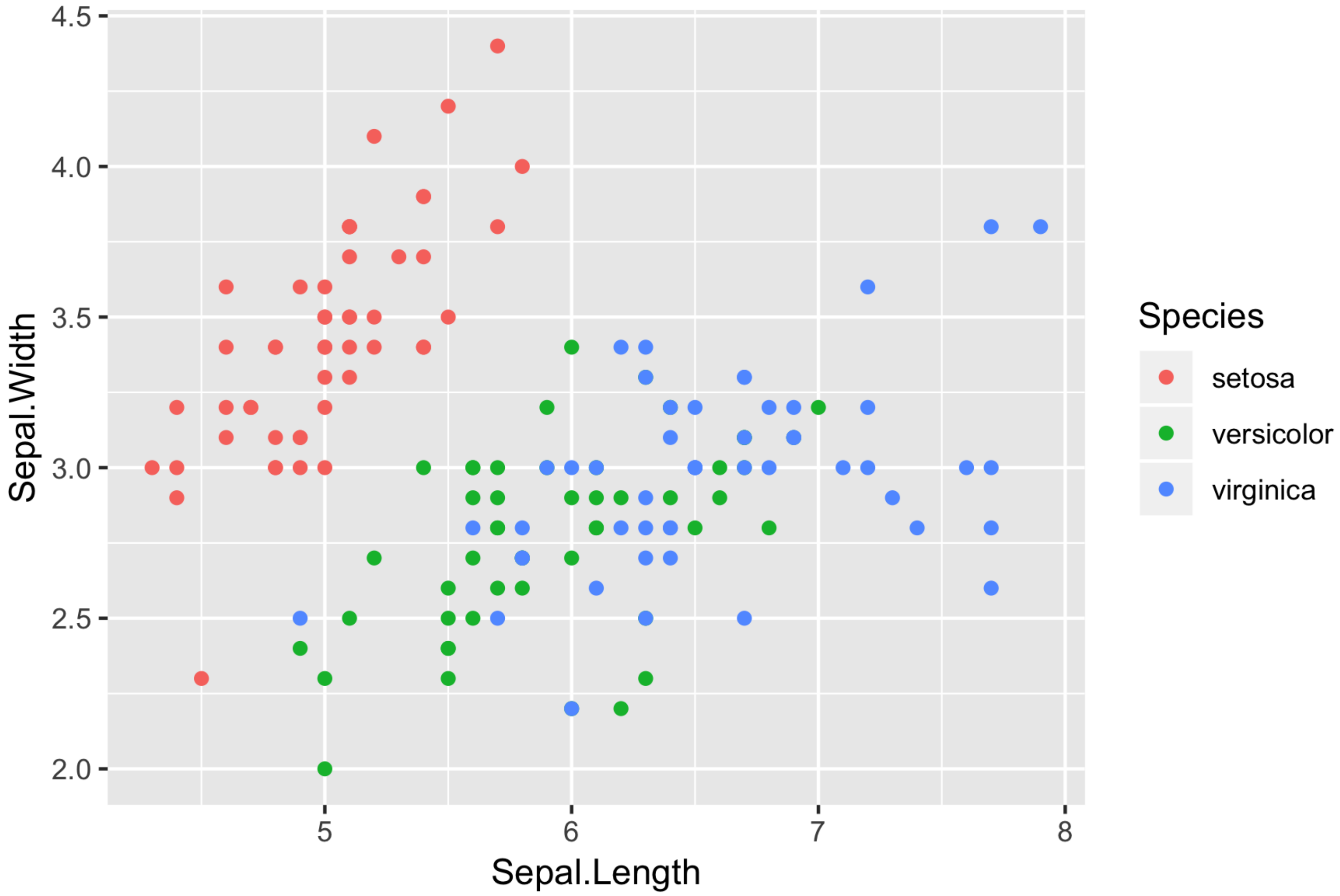
Positions

Adjustment for overlapping

- identity
- dodge
- stack
- fill
- jitter
- jitterdodge
- nudge

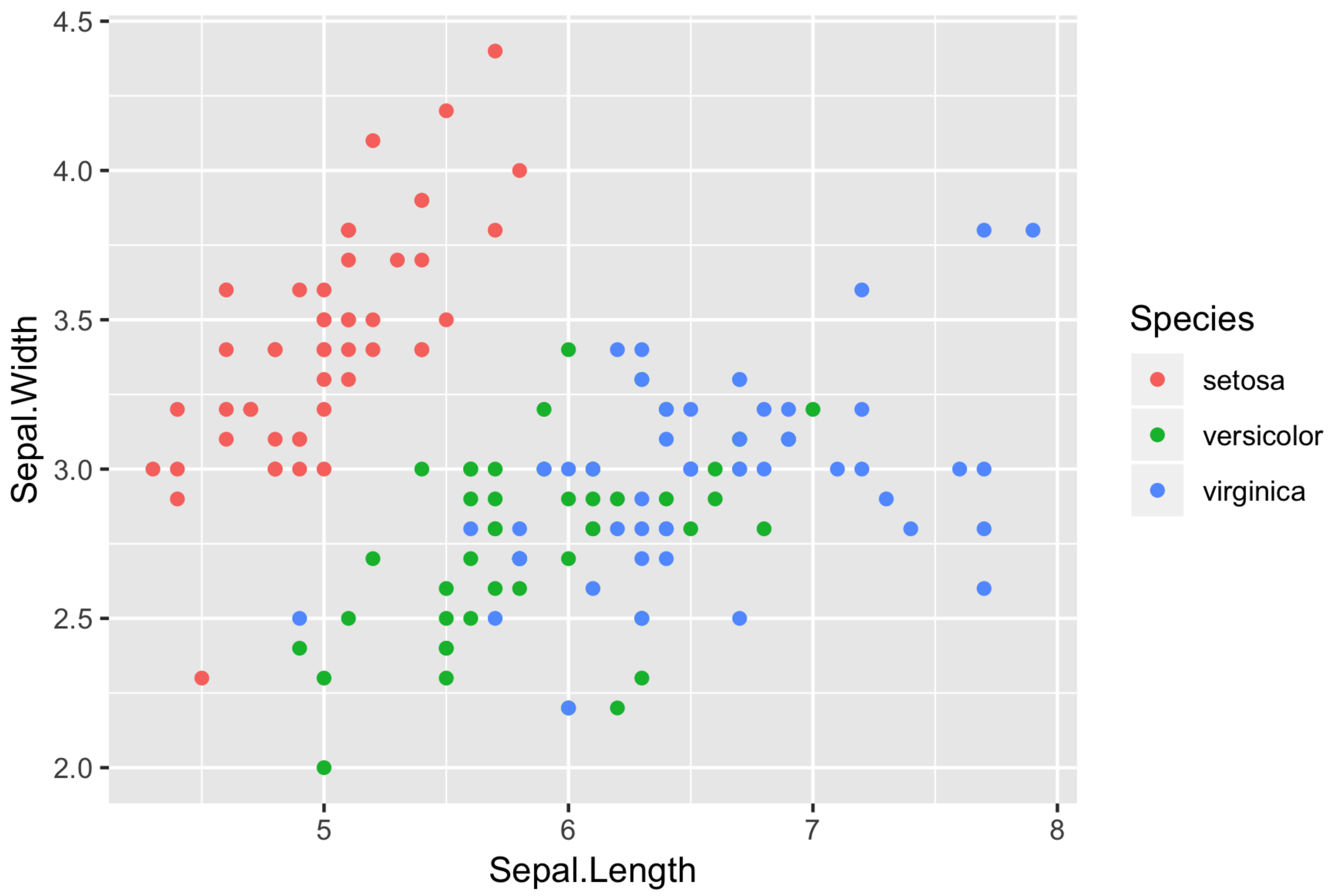
position = "identity" (default)

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point()
```



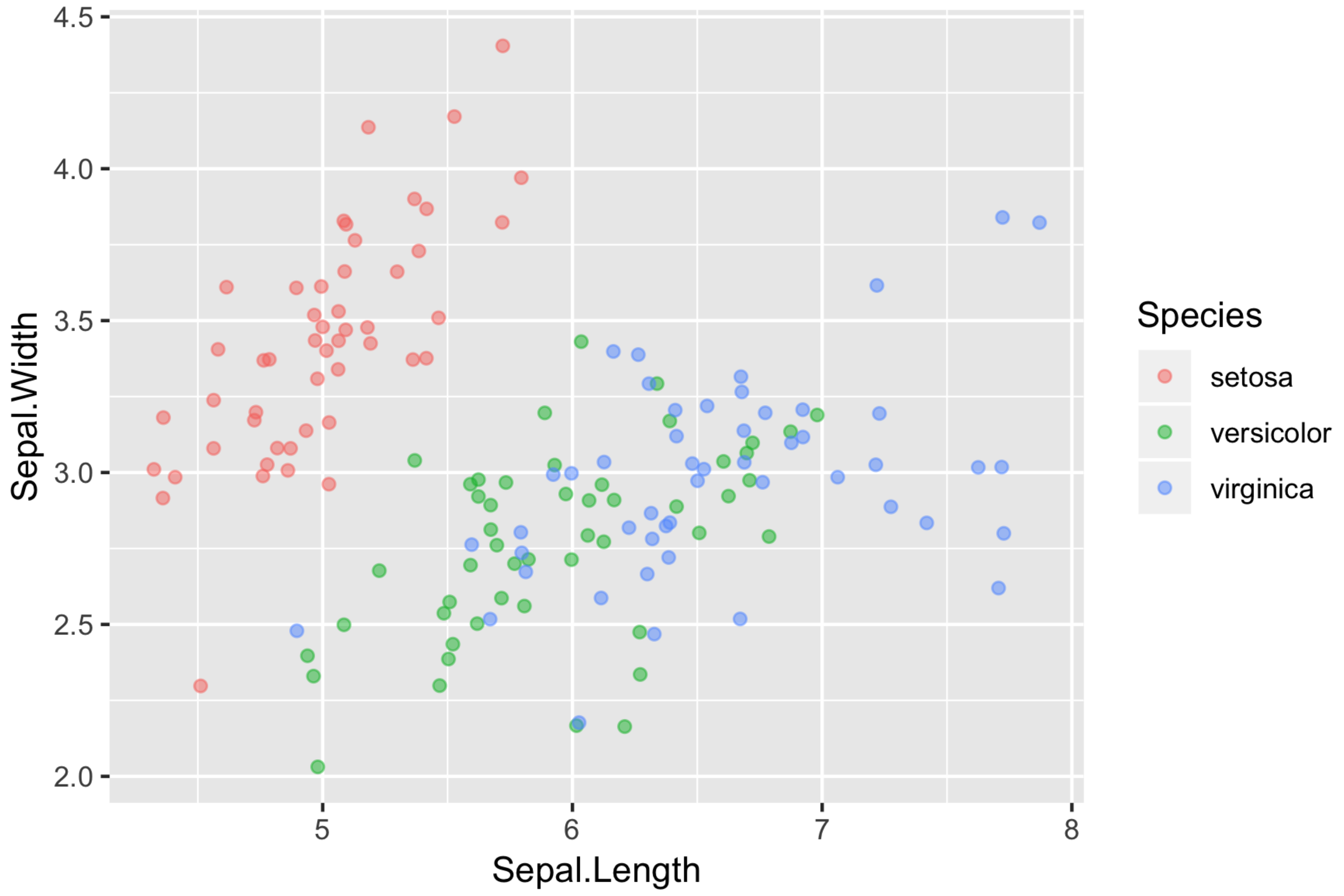
position = "identity" (default)

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point(position = "identity")
```



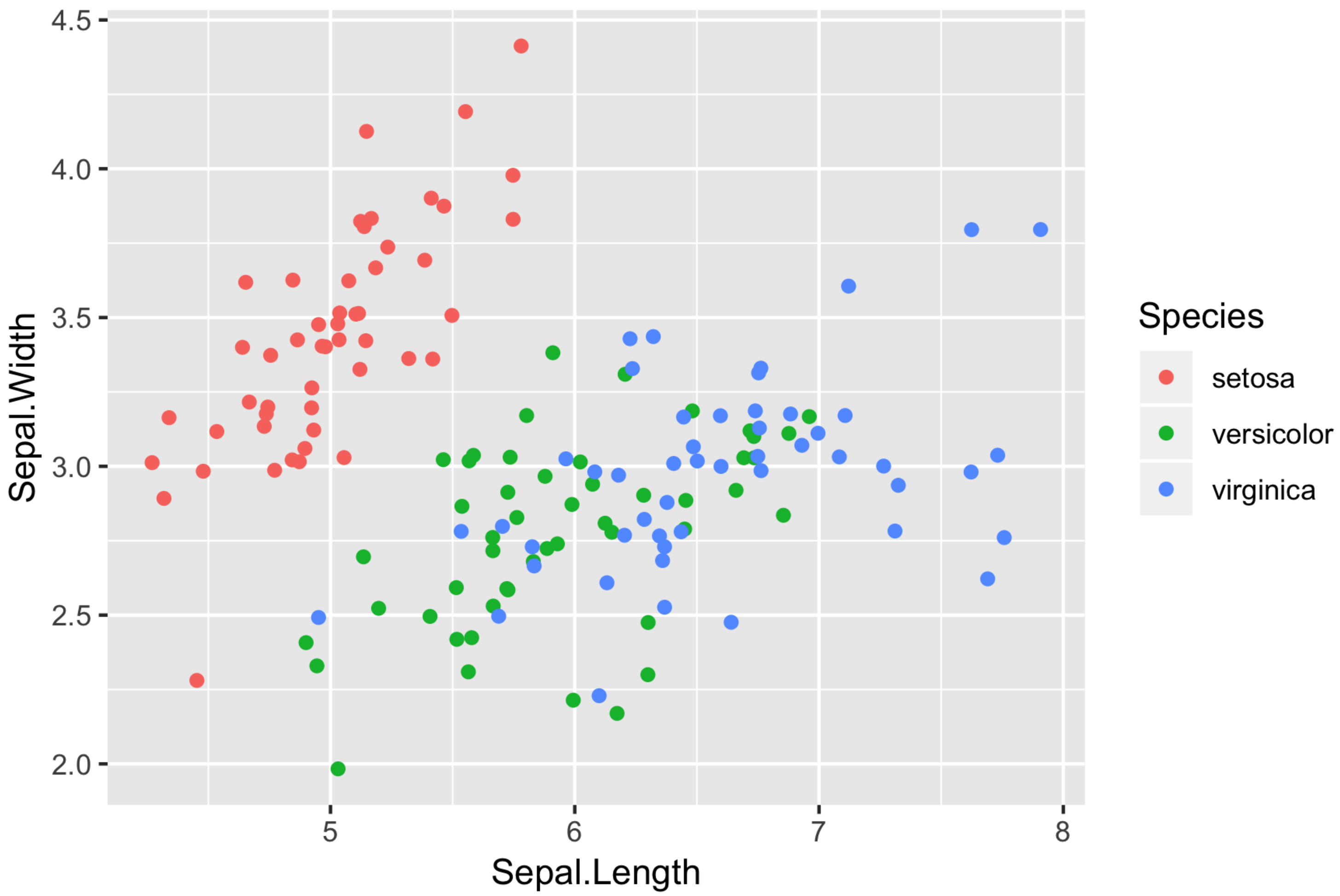
position = "jitter"

```r
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point(position = "jitter")
```



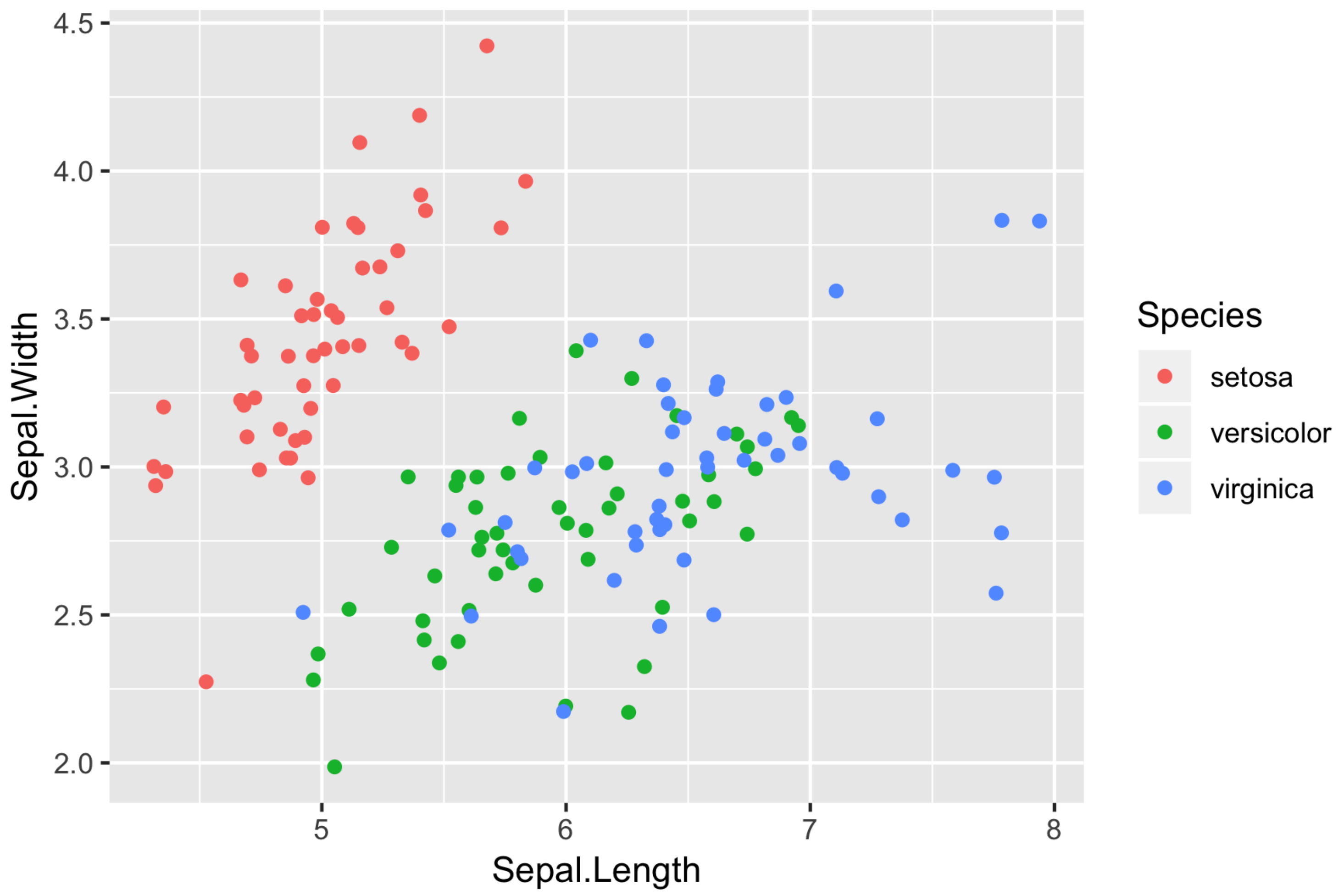
position_jitter()

```
posn_j <- position_jitter(0.1)

ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 col = Species)) +
  geom_point(position = posn_j)
```



position_jitter()

```
posn_j <- position_jitter(0.1,
                          seed = 136)

ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point(position = posn_j)
```



- Set arguments for the position
- Consistency across plots & layers

Scale functions

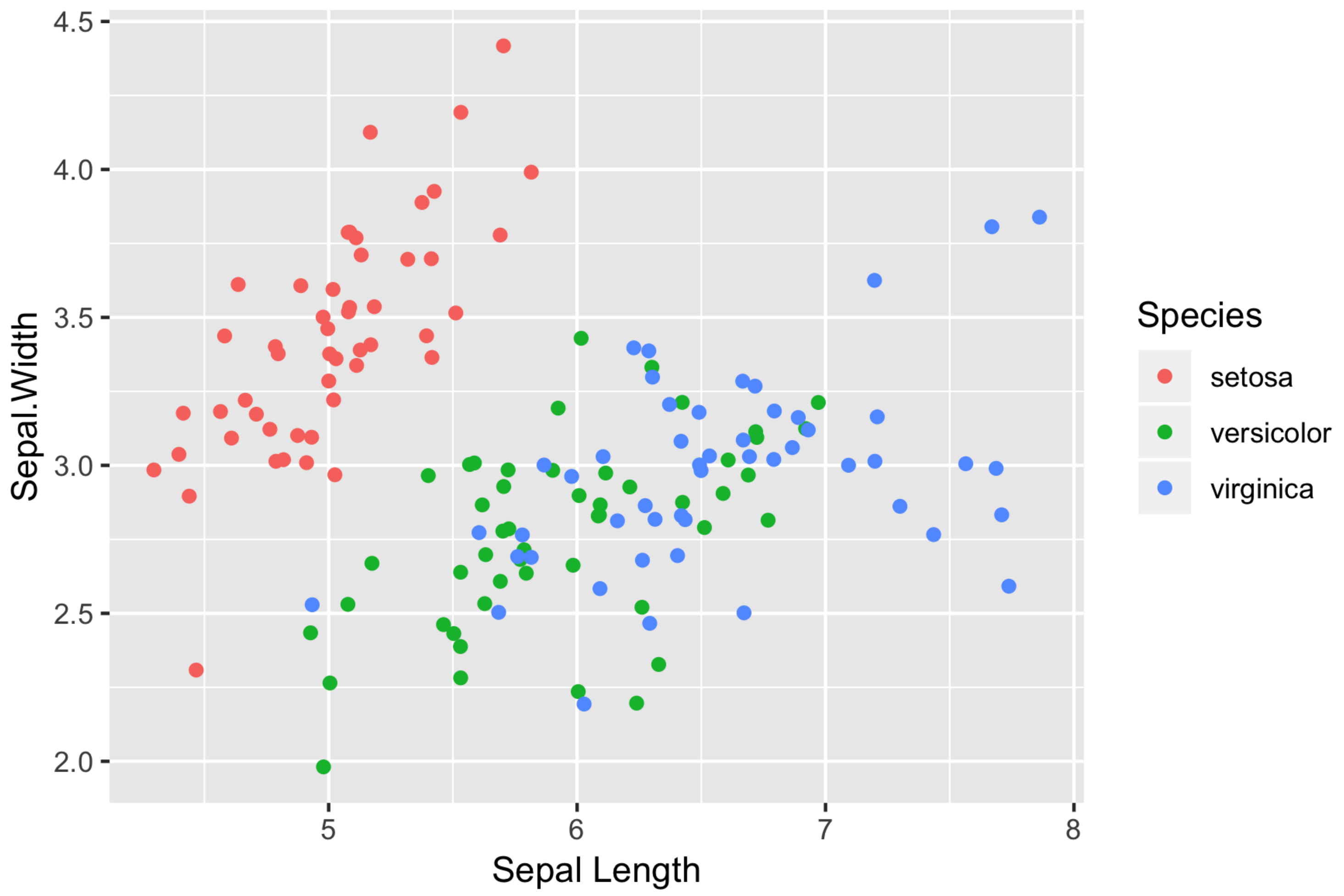
- `scale_x_*()`
- `scale_y_*()`
- `scale_color_*()`
  - Also `scale_colour_*()`
- `scale_fill_*()`
- `scale_shape_*()`
- `scale_linetype_*()`
- `scale_size_*()`

Scale functions

- **`scale_x_continuous()`**
- `scale_y_*()`
- **`scale_color_discrete()`**
  - Alternatively, `scale_colour_*()`
- `scale_fill_*()`
- `scale_shape_*()`
- `scale_linetype_*()`
- `scale_size_*()`

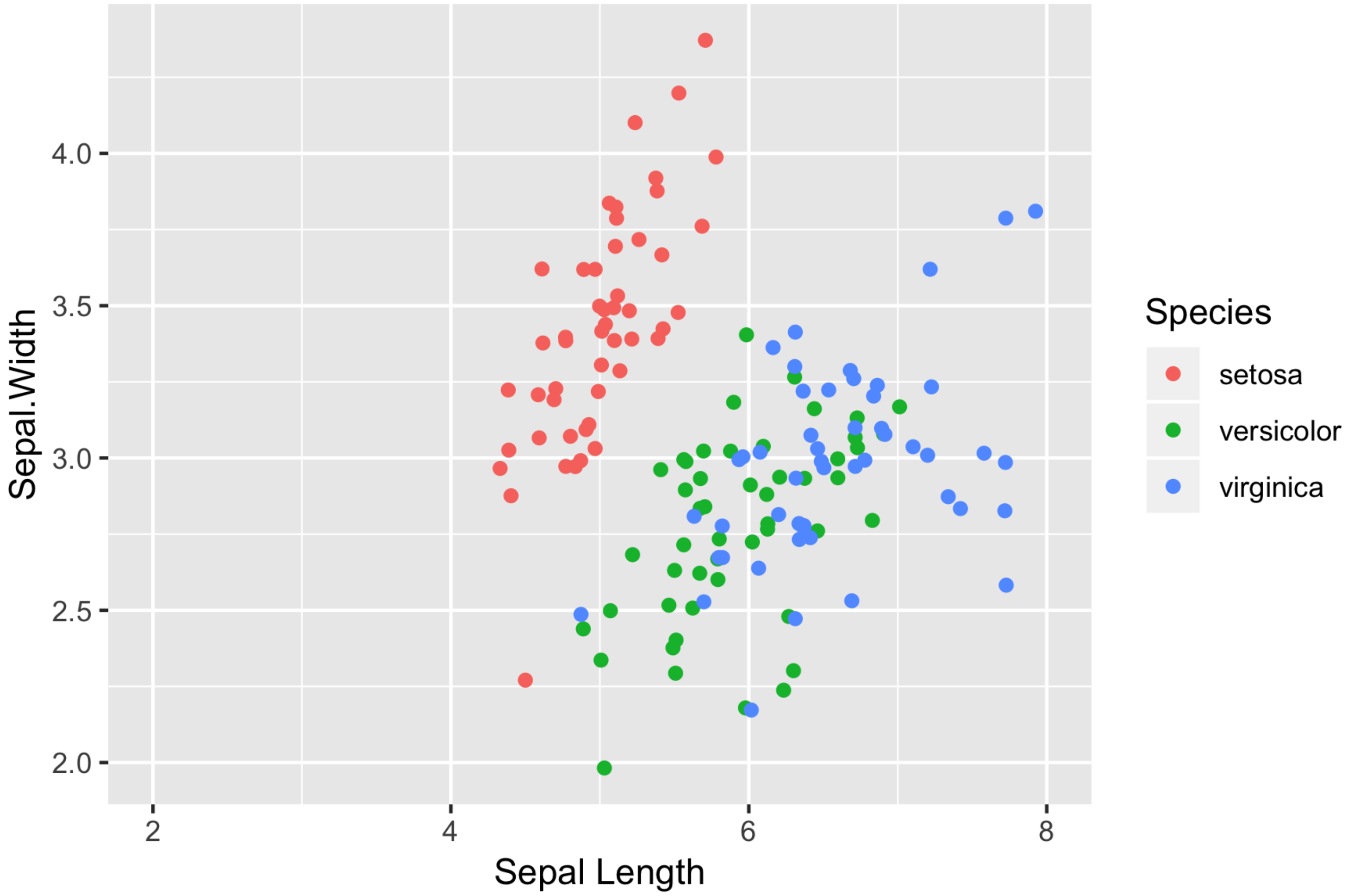
scale_*_*()

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point(position = "jitter") +
  scale_x_continuous("Sepal Length") +
  scale_color_discrete("Species")
```



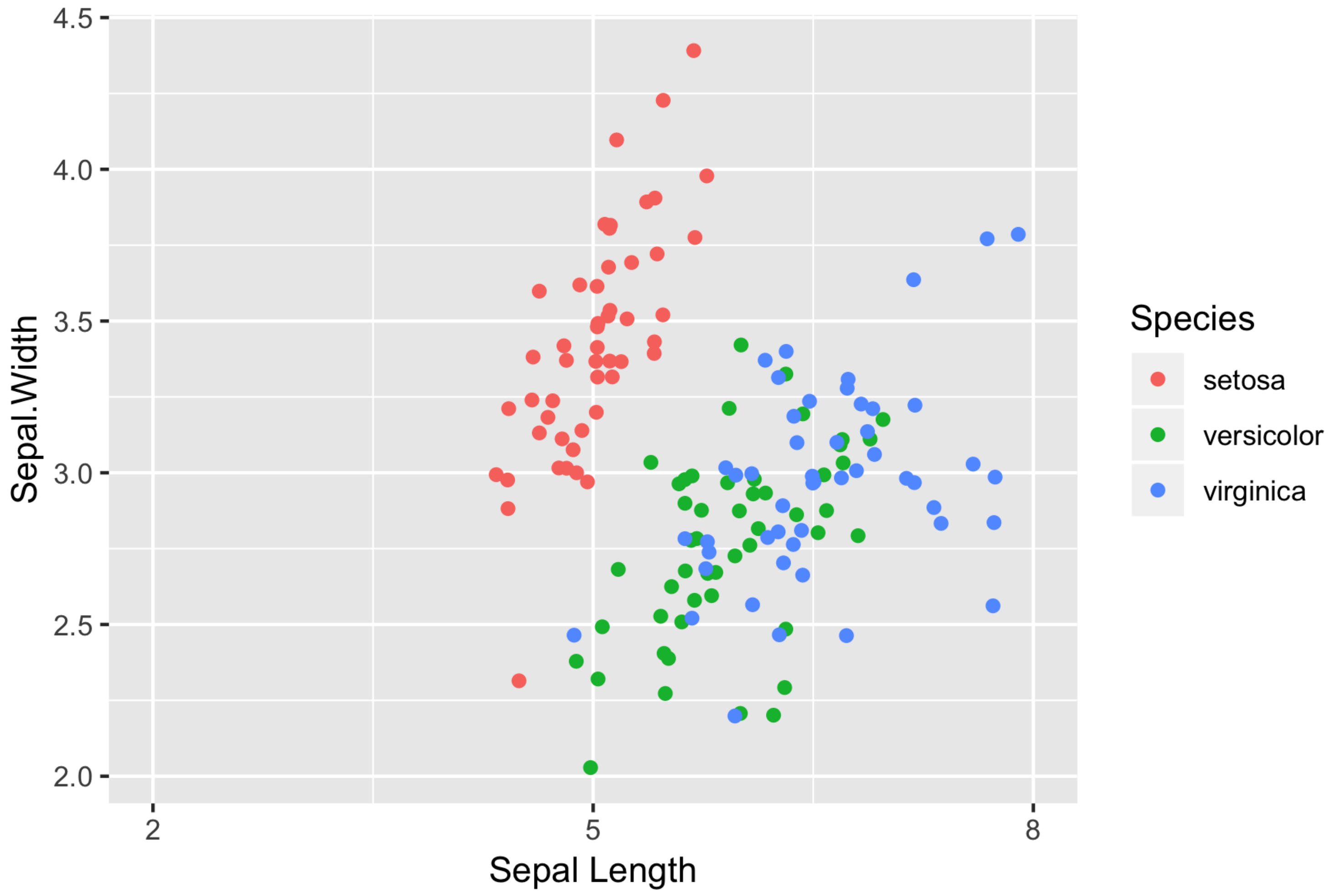
The limits argument

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point(position = "jitter") +
  scale_x_continuous("Sepal Length",
                     limits = c(2,8)) +
  scale_color_discrete("Species")
```



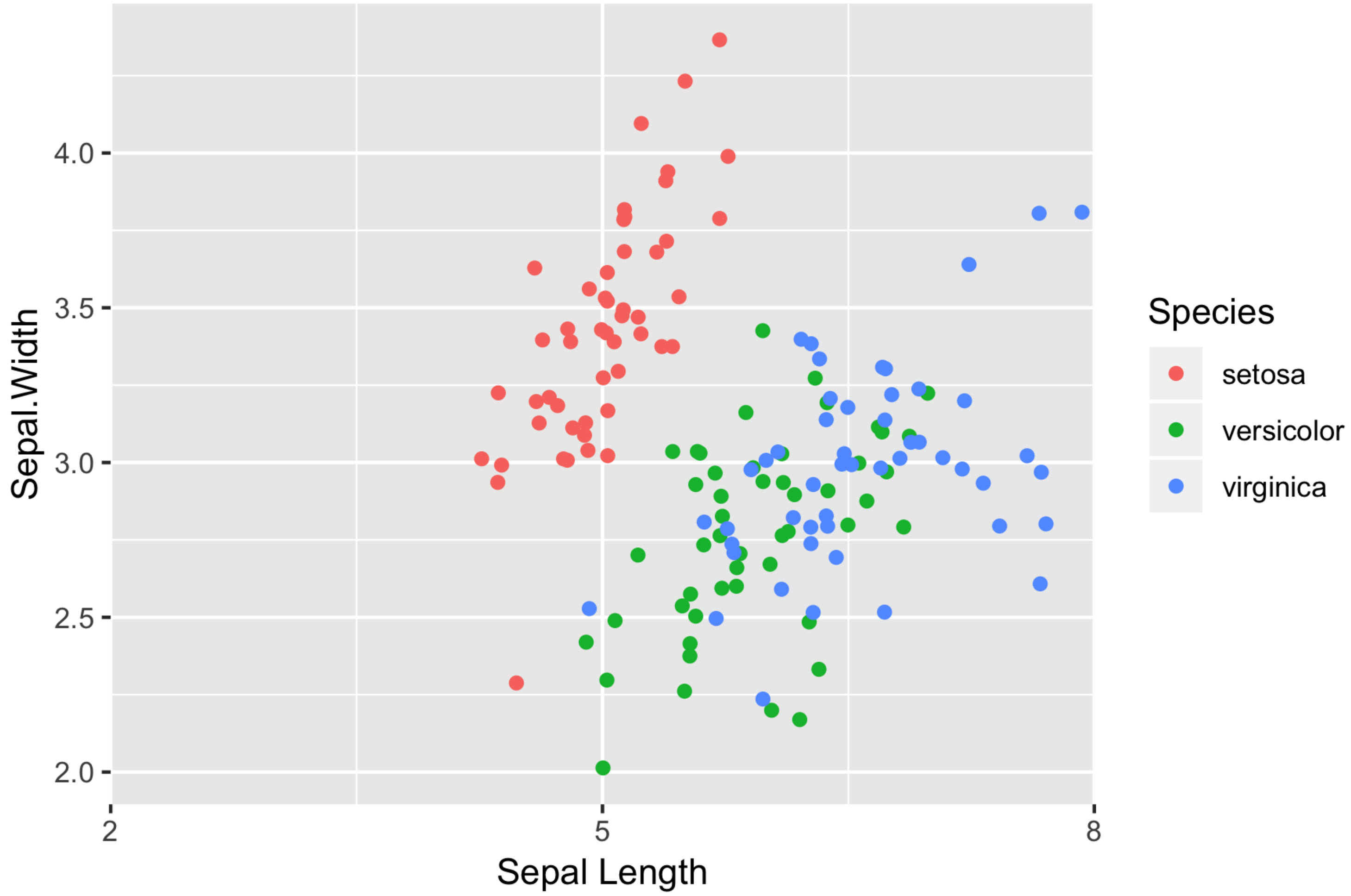
The breaks argument

```
ggplot(iris, aes(x = Sepal.Length,
                  y = Sepal.Width,
                 color = Species)) +
  geom_point(position = "jitter") +
  scale_x_continuous("Sepal Length",
                     limits = c(2, 8),
                     breaks = seq(2, 8, 3)) +
  scale_color_discrete("Species")
```



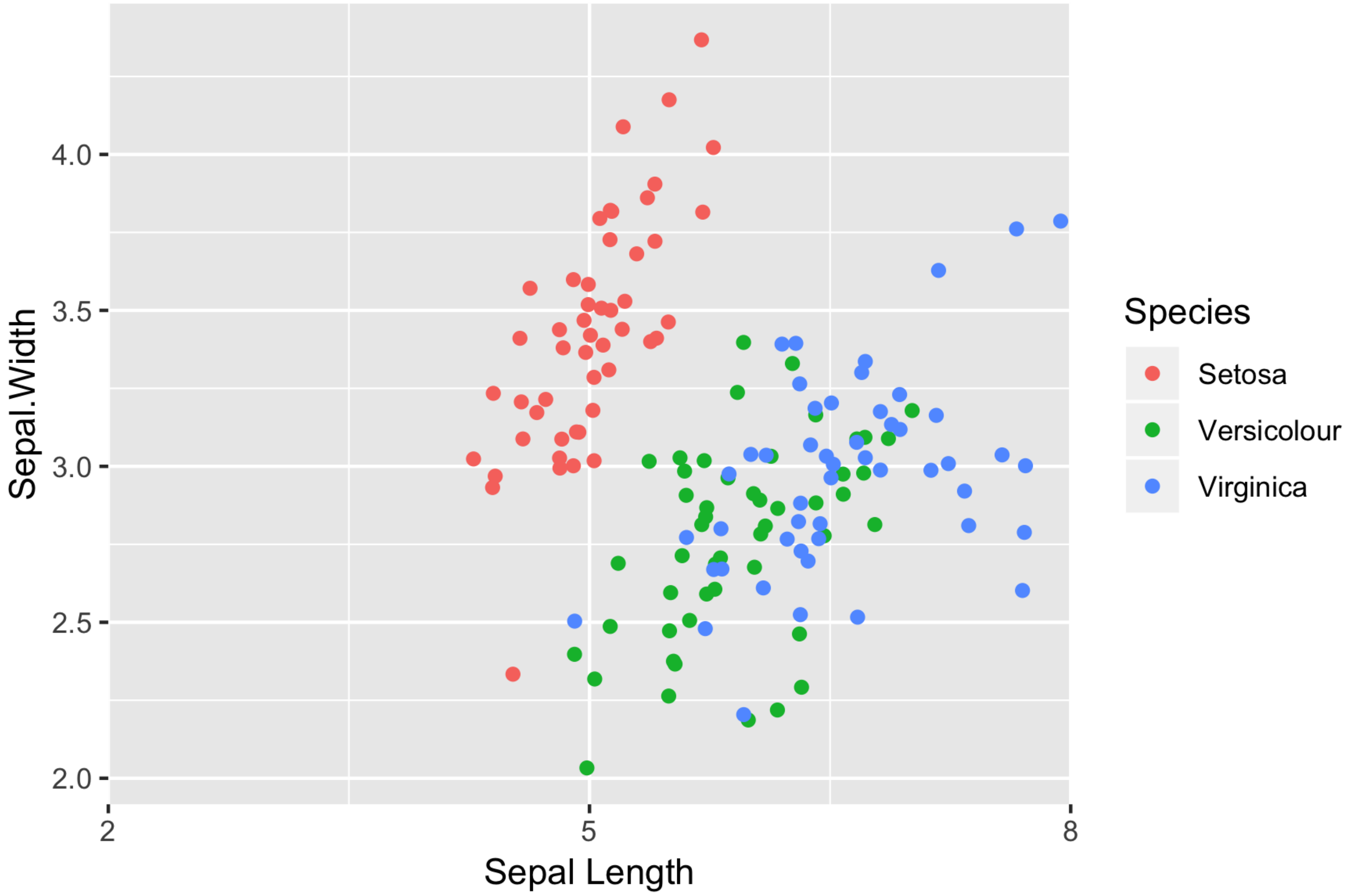
The expand argument

```
ggplot(iris, aes(x = Sepal.Length,
                  y = Sepal.Width,
                 color = Species)) +
  geom_point(position = "jitter") +
  scale_x_continuous("Sepal Length",
                     limits = c(2, 8),
                     breaks = seq(2, 8, 3),
                     expand = c(0, 0)) +
  scale_color_discrete("Species")
```



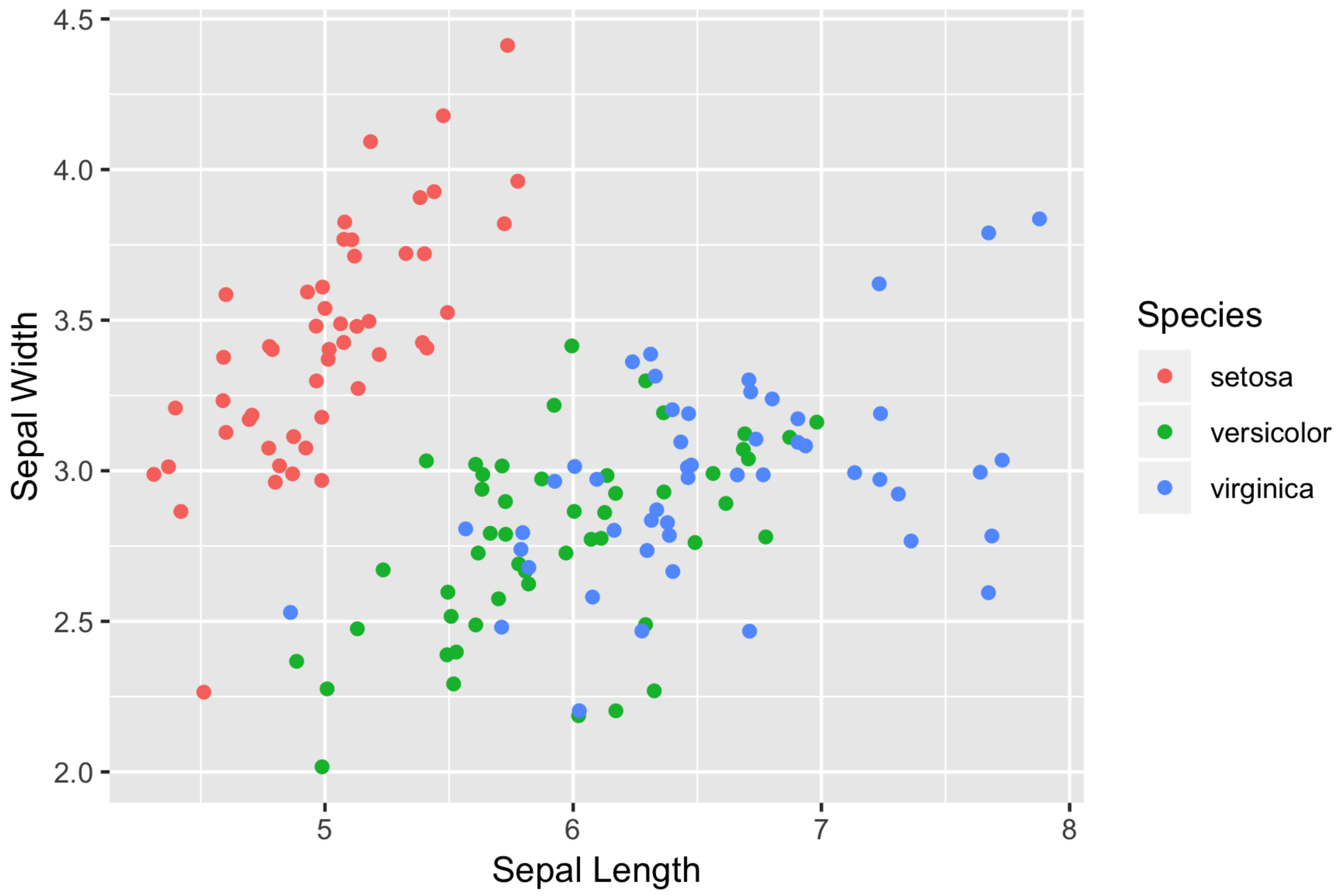
The labels argument

```
ggplot(iris, aes(x = Sepal.Length,
                  y = Sepal.Width,
                 color = Species)) +
  geom_point(position = "jitter") +
  scale_x_continuous("Sepal Length",
                     limits = c(2, 8),
                     breaks = seq(2, 8, 3),
                     expand = c(0, 0),
                     labels = c("Setosa",
                                "Versicolor",
                                "Virginica")) +
  scale_color_discrete("Species")
```



labs()

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point(position = "jitter") +
  labs(x = "Sepal Length",
       y = "Sepal Width",
       color = "Species")
```



Let's try it out!

INTRODUCTION TO DATA VISUALIZATION WITH GGPLOT2

Aesthetics best practices

INTRODUCTION TO DATA VISUALIZATION WITH GGPLOT2

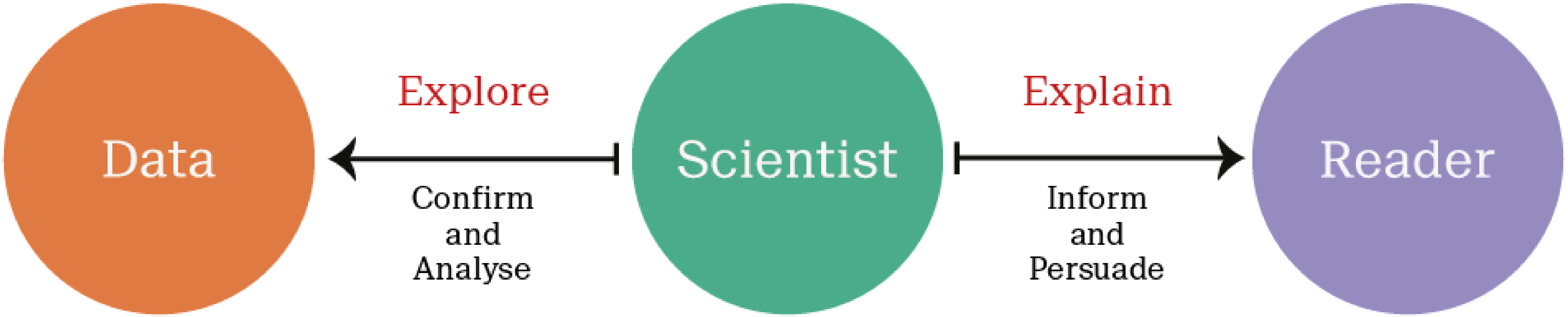
Rick Scavetta

Founder, Scavetta Academy

Which aesthetics?

- Use your creative know-how, and
- Follow some clear guidelines
- Jacques Bertin
  - The Semiology of Graphics, 1967
- William Cleveland
  - The Elements of Graphing Data, 1985
  - Visualizing Data, 1993

Form follows function



Form follows function

Function

Primary:

- Accurate and efficient representations

Secondary:

- Visually appealing, beautiful plots

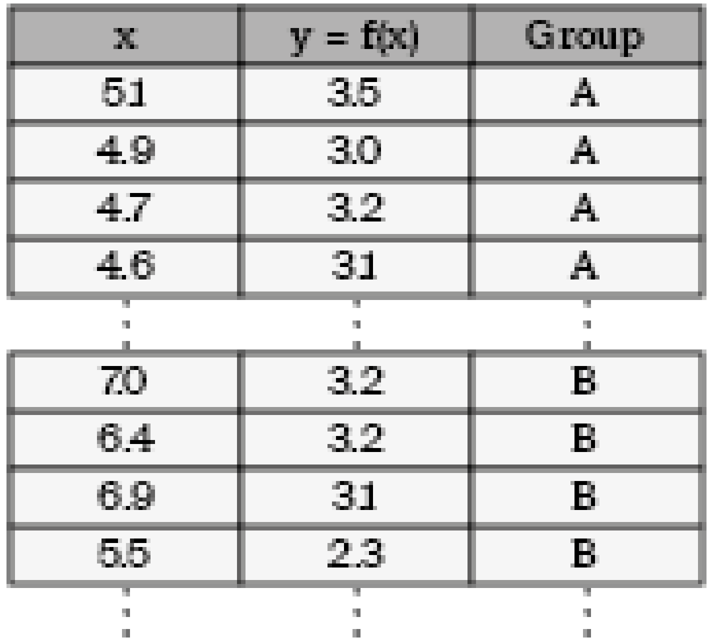
Guiding principles

Never:

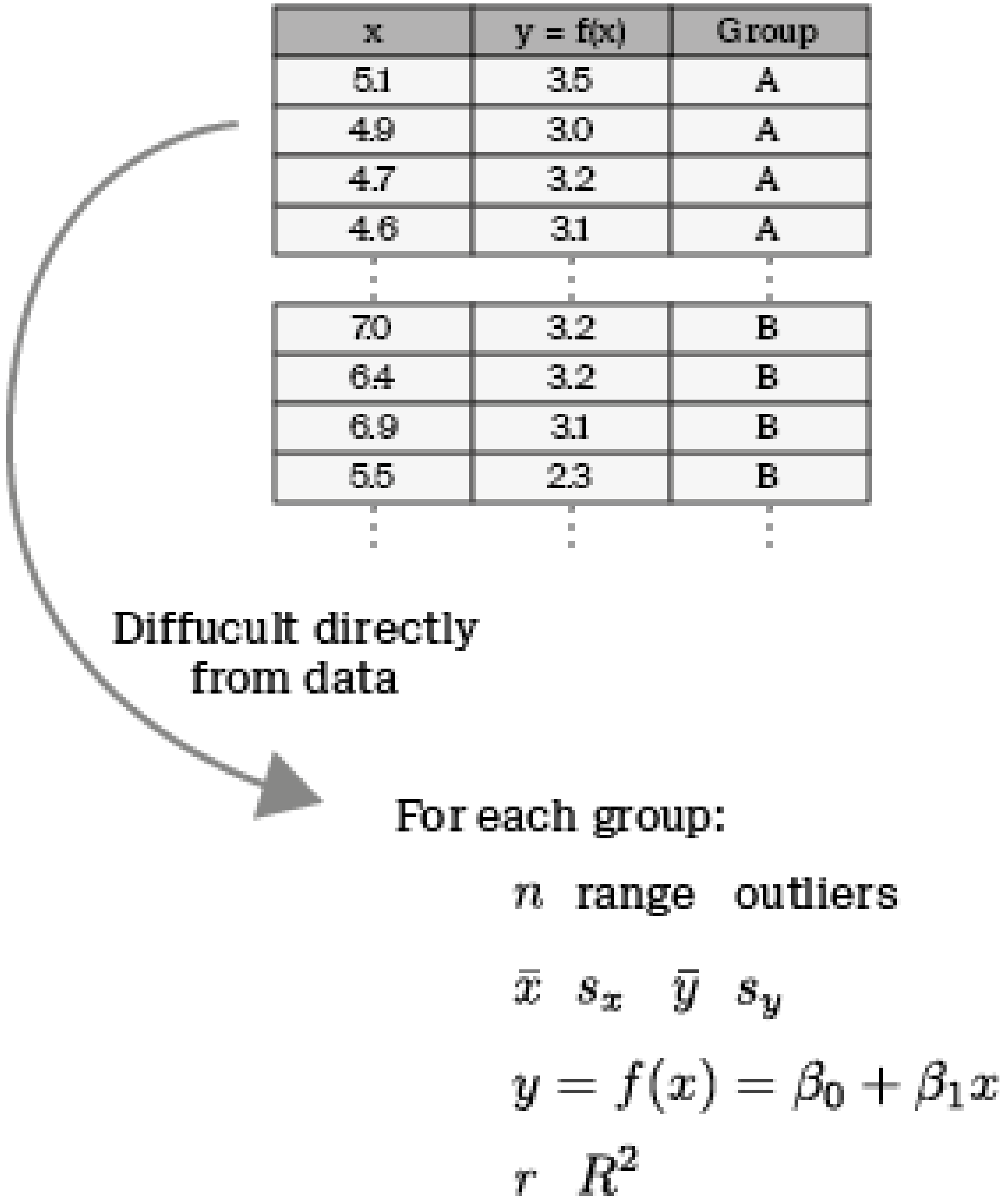
- Misrepresent or obscure data
- Confuse viewers with complexity

Always:

- Consider the audience and purpose of every plot



x	y = f(x)	Group
5.1	3.5	A
4.9	3.0	A
4.7	3.2	A
4.6	3.1	A
⋮	⋮	⋮
7.0	3.2	B
6.4	3.2	B
6.9	3.1	B
5.5	2.3	B
⋮	⋮	⋮



x	y = f(x)	Group
5.1	3.5	A
4.9	3.0	A
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4.6	3.1	A
⋮	⋮	⋮
7.0	3.2	B
6.4	3.2	B
6.9	3.1	B
5.5	2.3	B
⋮	⋮	⋮

Diffucult directly from data

For each group:

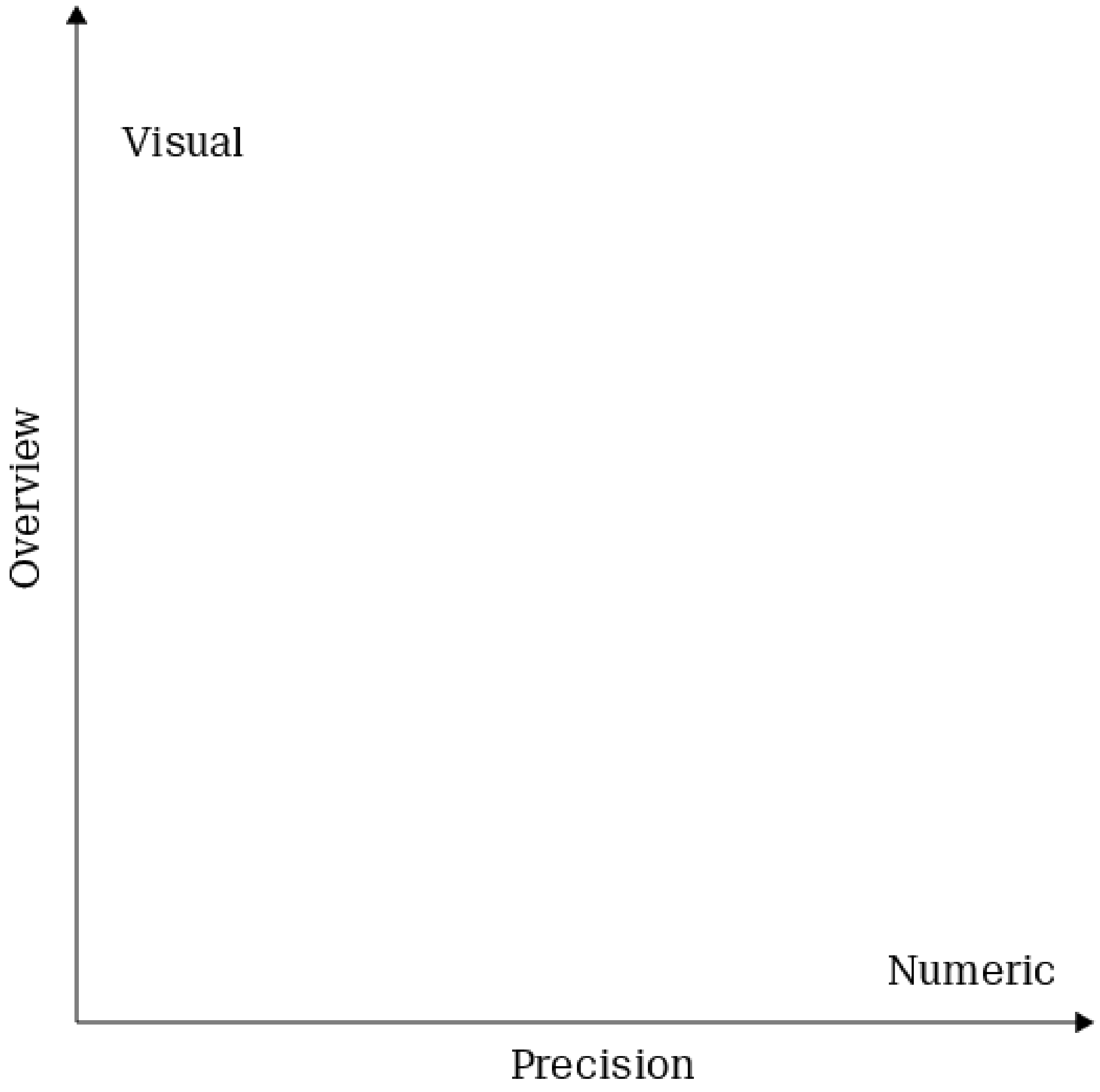
n range outliers

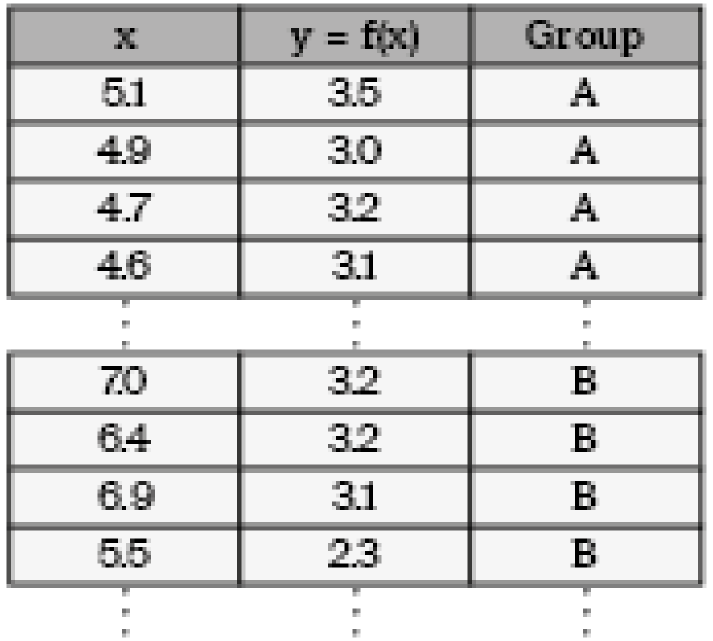
$\bar{x}$ s_x $\bar{y}$ s_y

$y = f(x) = \beta_0 + \beta_1 x$

r R^2

Extracting information from Data





x	y = f(x)	Group
5.1	3.5	A
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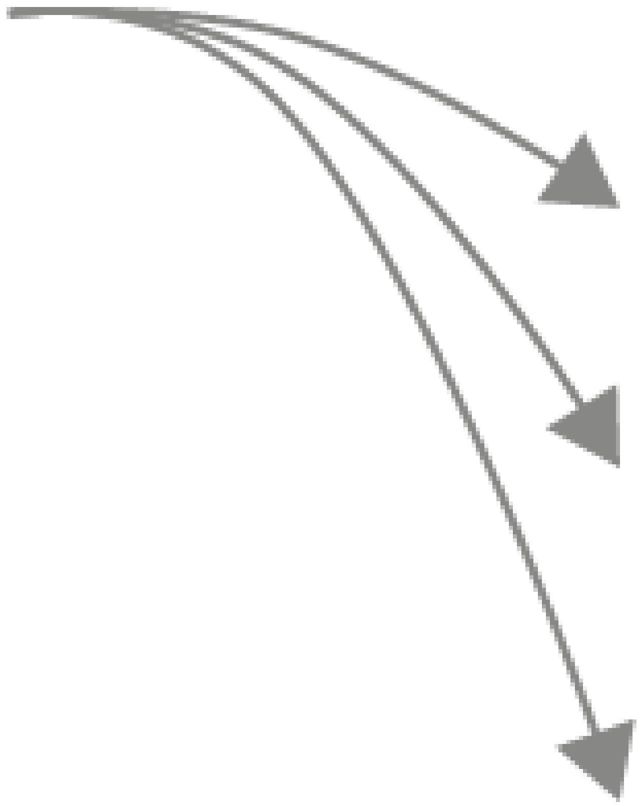
4.6	3.1	A
⋮	⋮	⋮
7.0	3.2	B
6.4	3.2	B
6.9	3.1	B
5.5	2.3	B
⋮	⋮	⋮

ENCODE



For each group:

n range outliers

$\bar{x}$ s_x $\bar{y}$ s_y

$y = f(x) = \beta_0 + \beta_1 x$

r R^2

x	y = f(x)	Group
5.1	3.5	A
4.9	3.0	A
4.7	3.2	A
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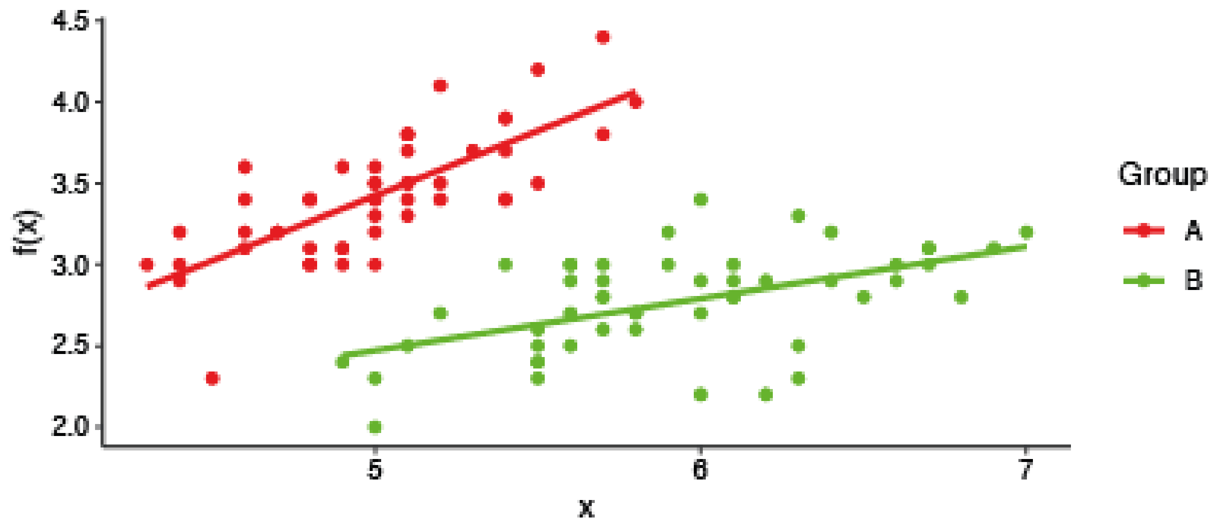
⋮	⋮	⋮
7.0	3.2	B
6.4	3.2	B
6.9	3.1	B
5.5	2.3	B
⋮	⋮	⋮

ENCODE



For each group:

n range outliers

$\bar{x}$ s_x $\bar{y}$ s_y

$y = f(x) = \beta_0 + \beta_1 x$

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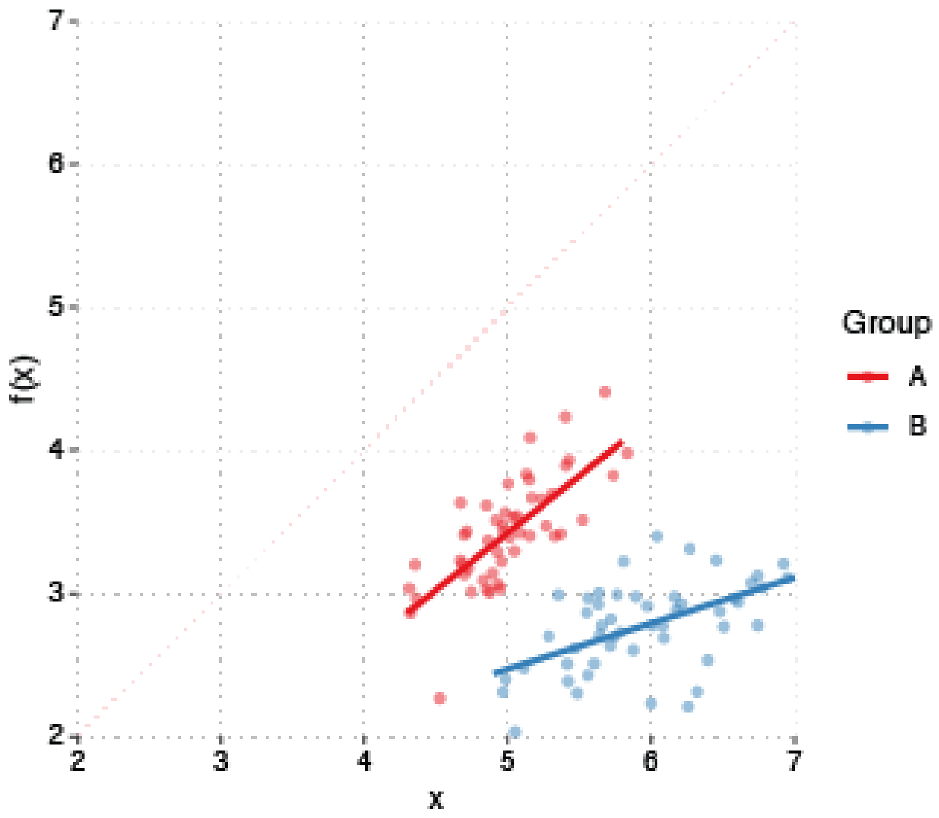

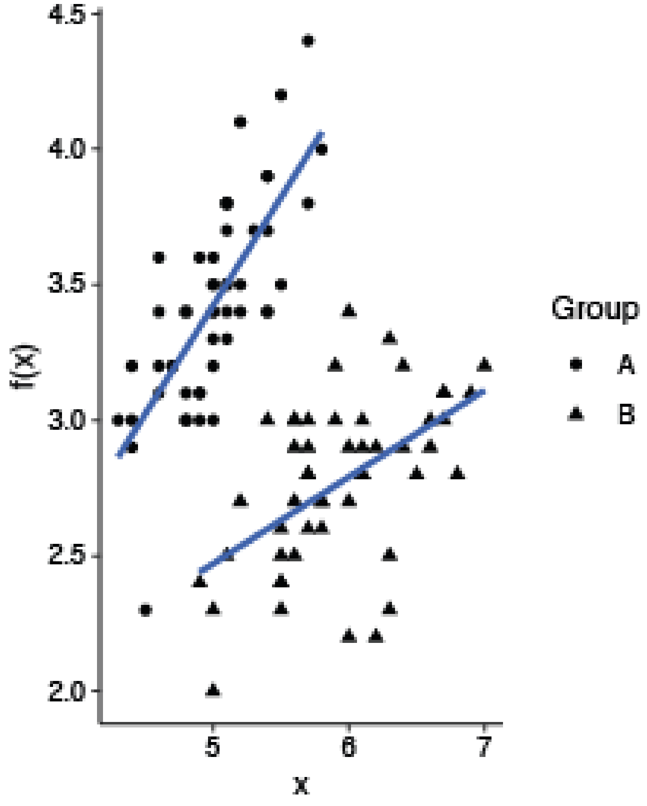

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5.1	3.5	A
4.9	3.0	A
4.7	3.2	A
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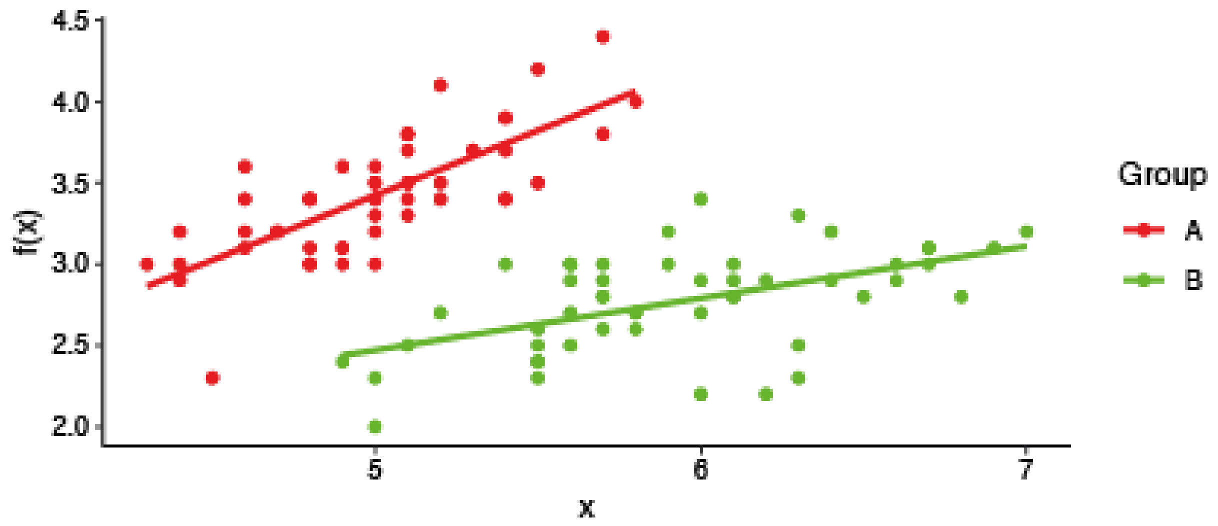
7.0	3.2	B
6.4	3.2	B
6.9	3.1	B
5.5	2.3	B
⋮	⋮	⋮

ENCODE



For each group:

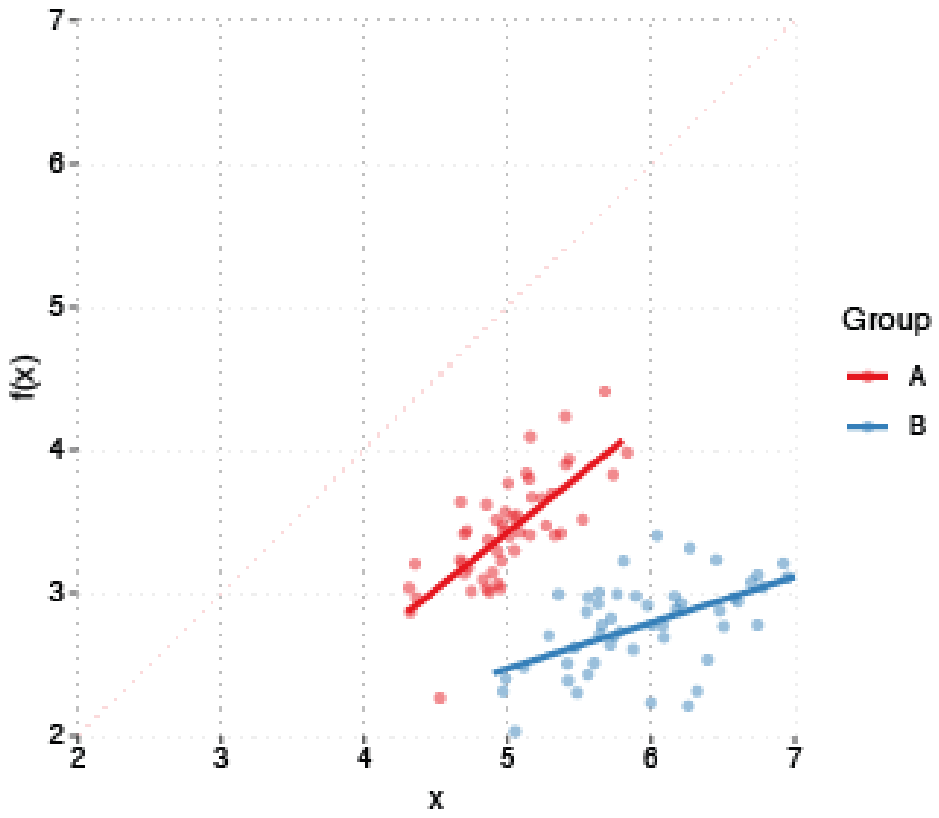
n range outliers

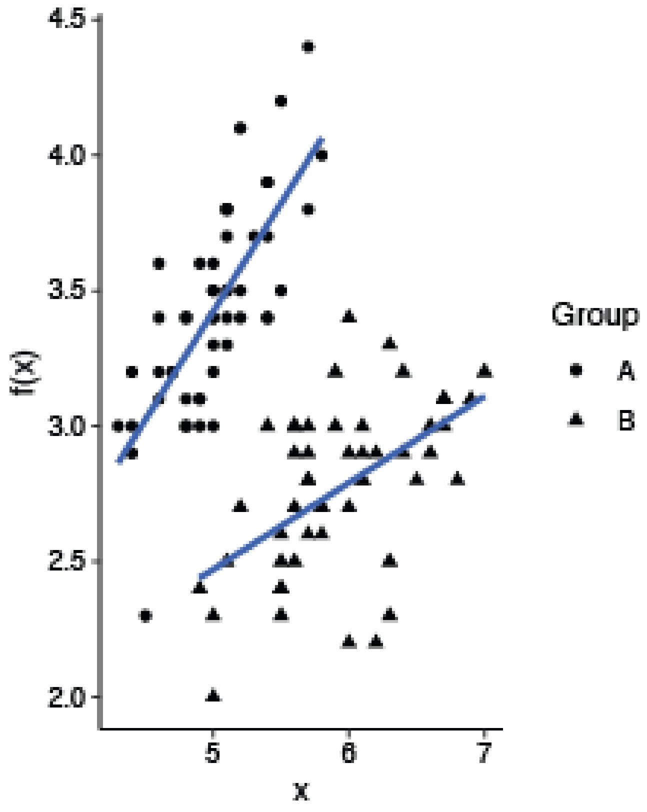
$\bar{x}$ s_x $\bar{y}$ s_y

$y = f(x) = \beta_0 + \beta_1 x$

r R^2

DECODE



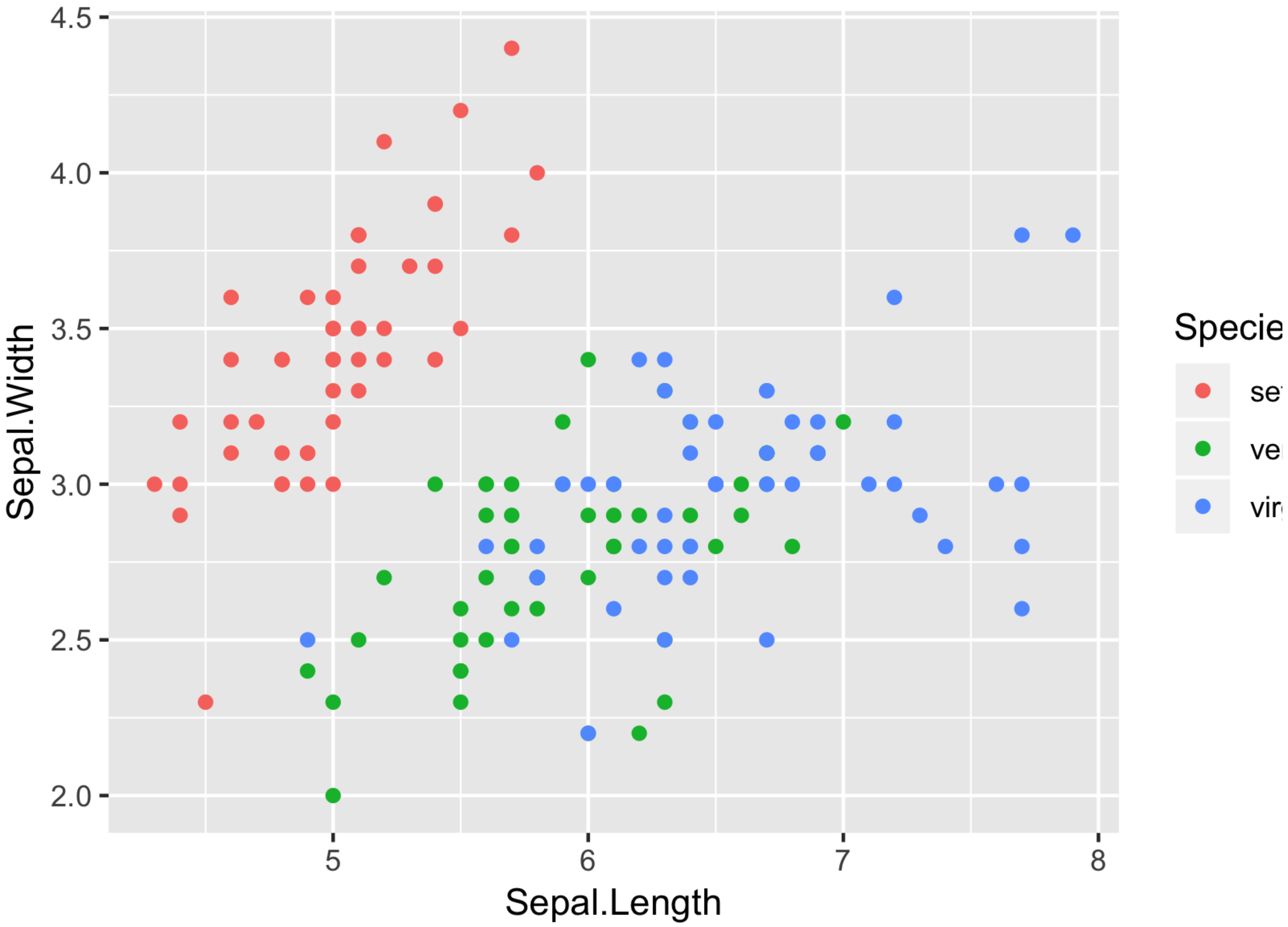


The best choices for aesthetics

- Efficient
  - Provides a faster overview than numeric summaries
- Accurate
  - Minimizes information loss

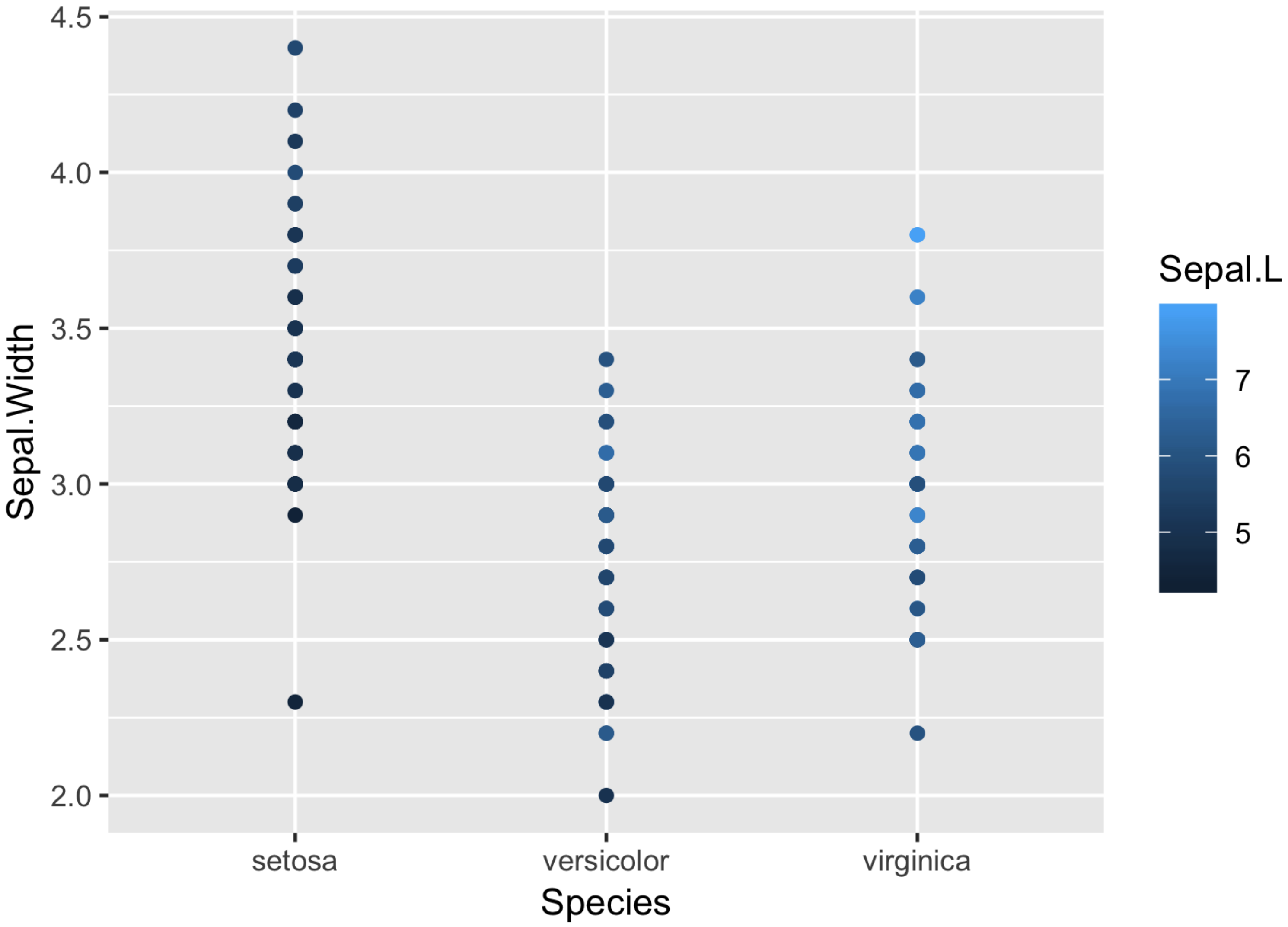
Aesthetics - continuous variables

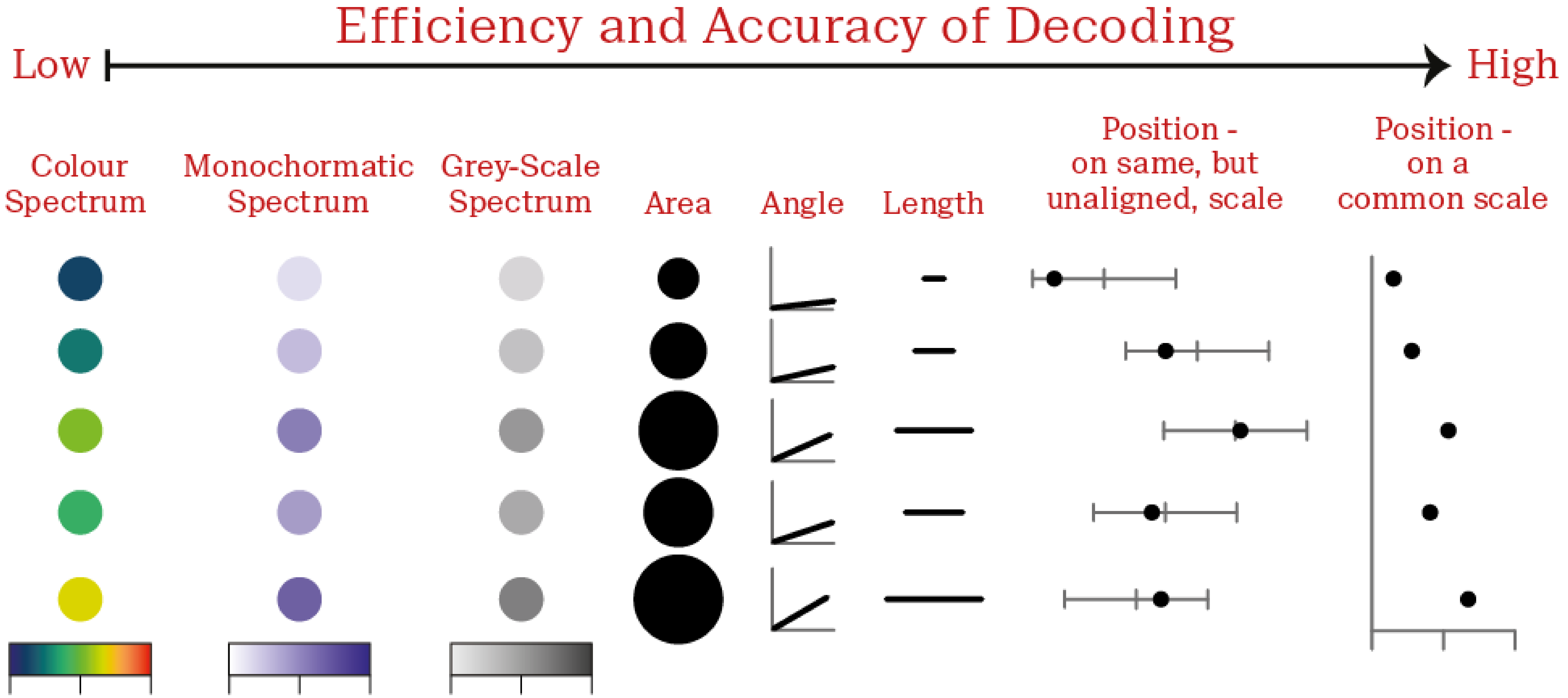
```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 color = Species)) +
  geom_point()
```



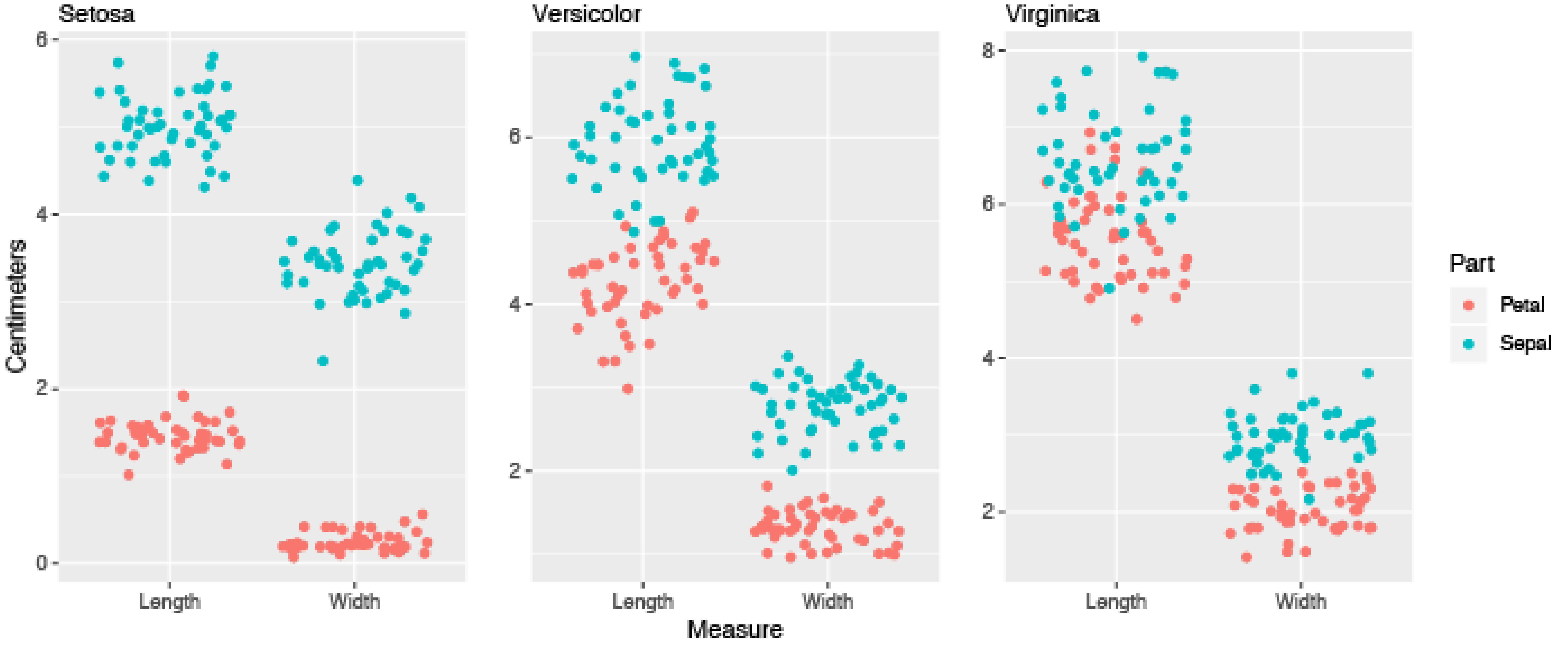
Aesthetics - continuous variables

```
ggplot(iris, aes(color = Sepal.Length,
                 y = Sepal.Width,
                 x = Species)) +
  geom_point()
```

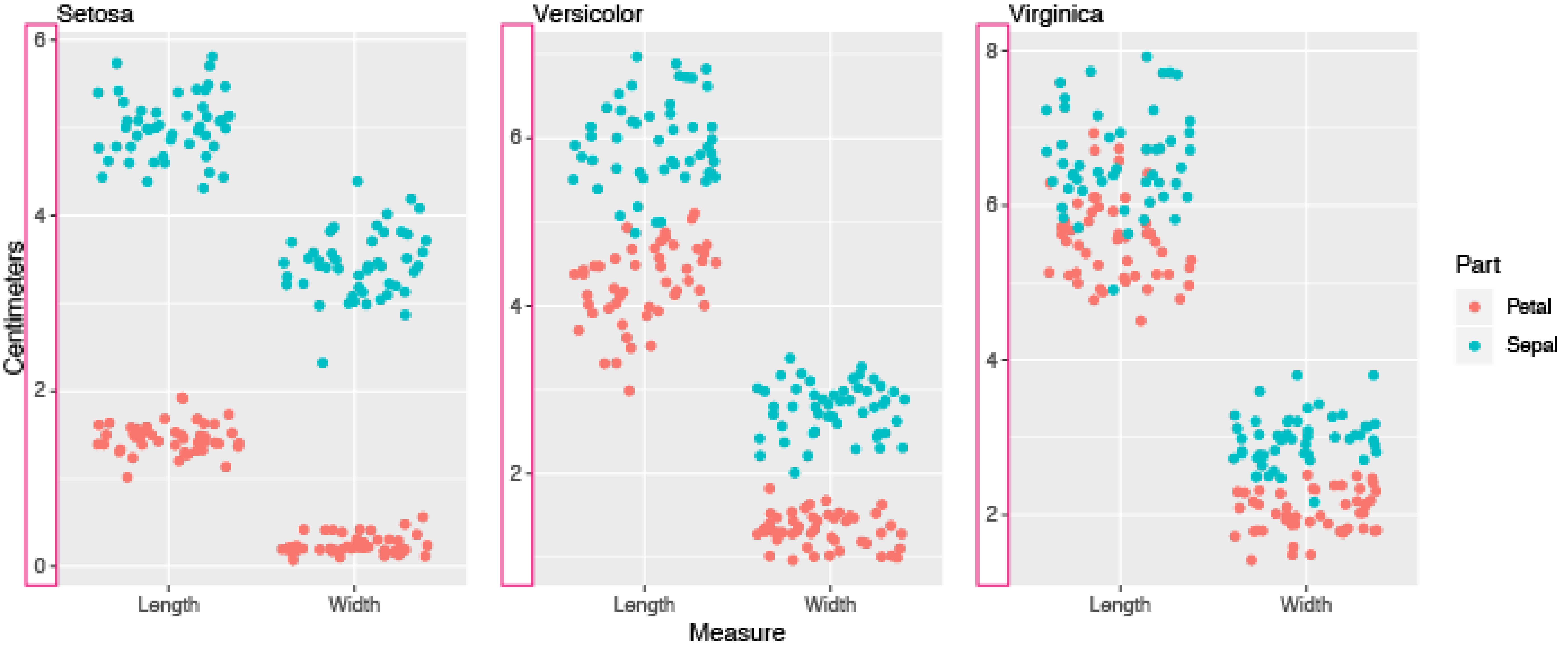



Efficiency and Accuracy of Decoding
Low
High
Colour Spectrum
Monochormatic Spectrum
Grey-Scale Spectrum
Area
Angle
Length
Position - on same, but unaligned, scale
Position - on a common scale

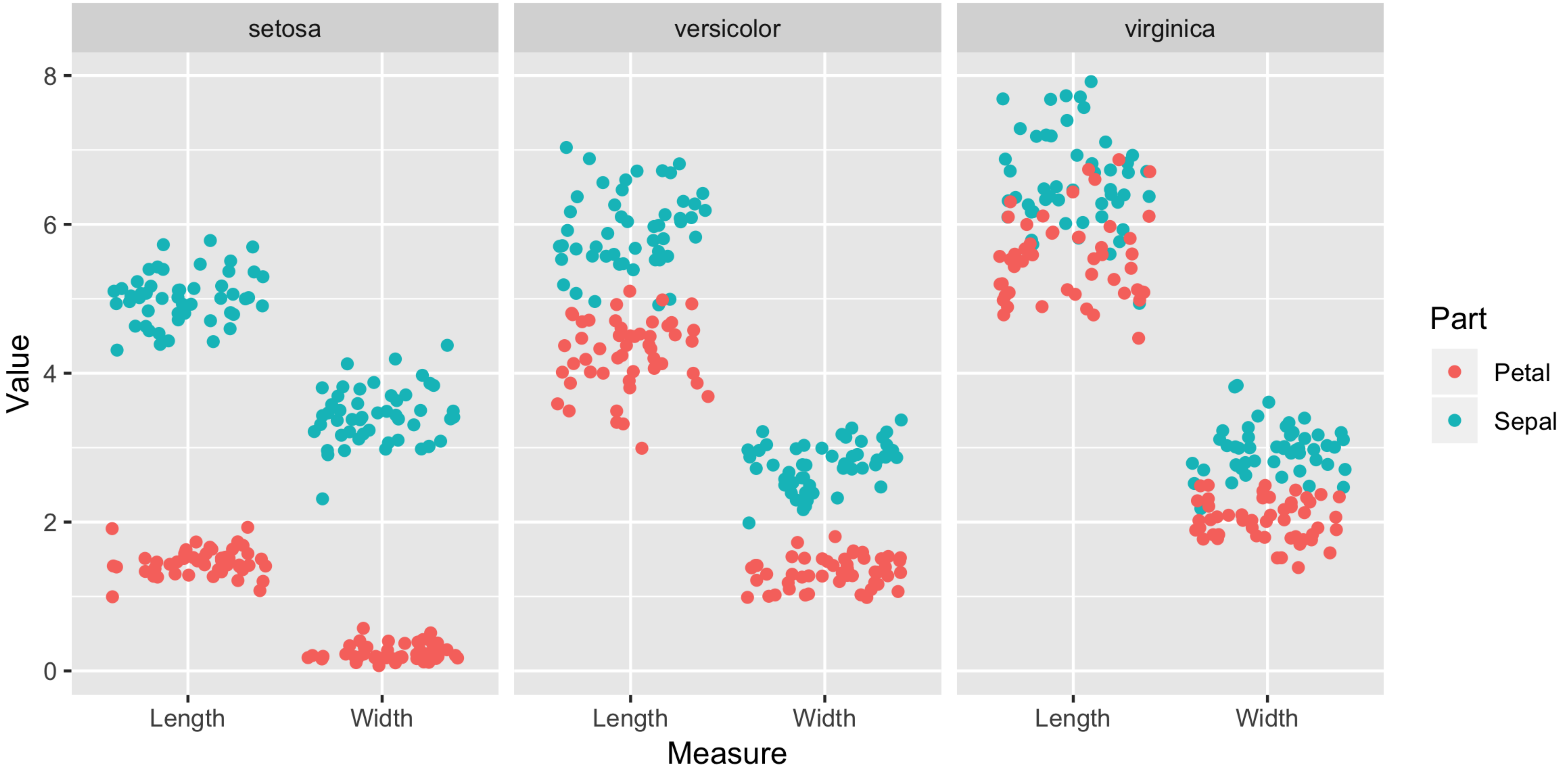
Three iris scatter plots



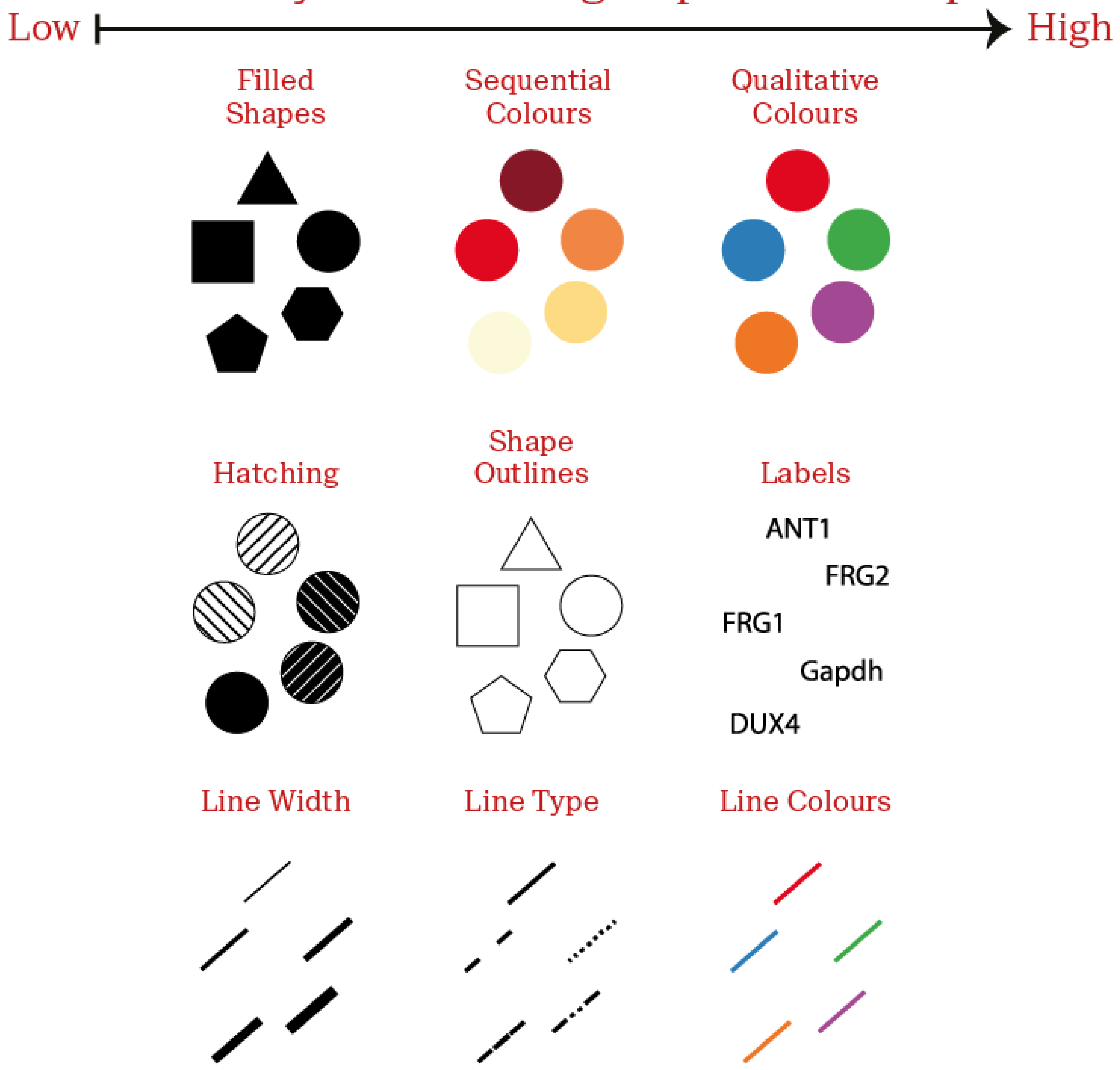
Three iris scatter plots, unaligned y-axes



Single faceted plot, common y-axis



Efficiency in Decoding Separate Groups



Low → High

Filled Shapes

Sequential Colours

Qualitative Colours

Hatching

Shape Outlines

Labels

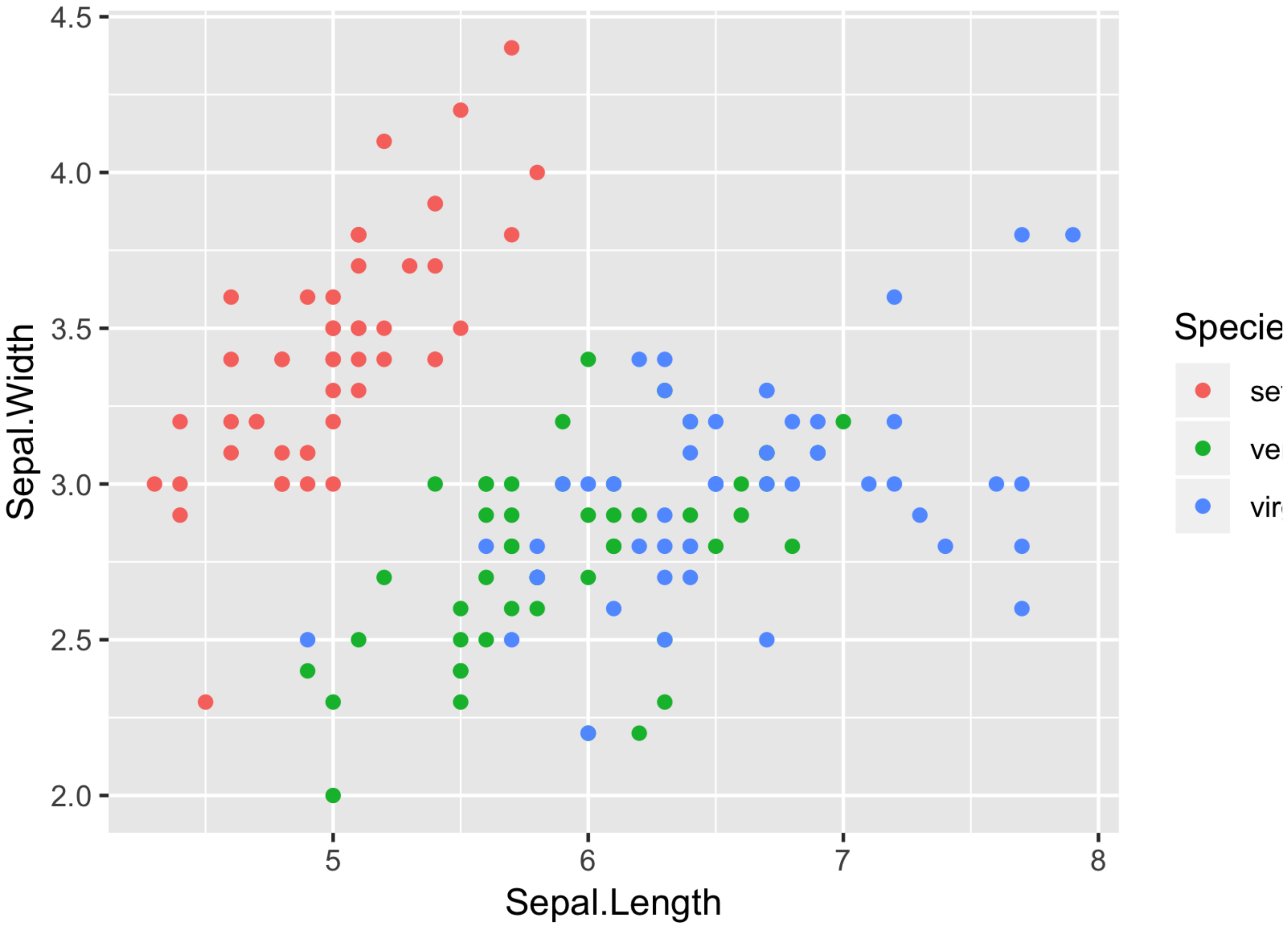
Line Width

Line Type

Line Colours

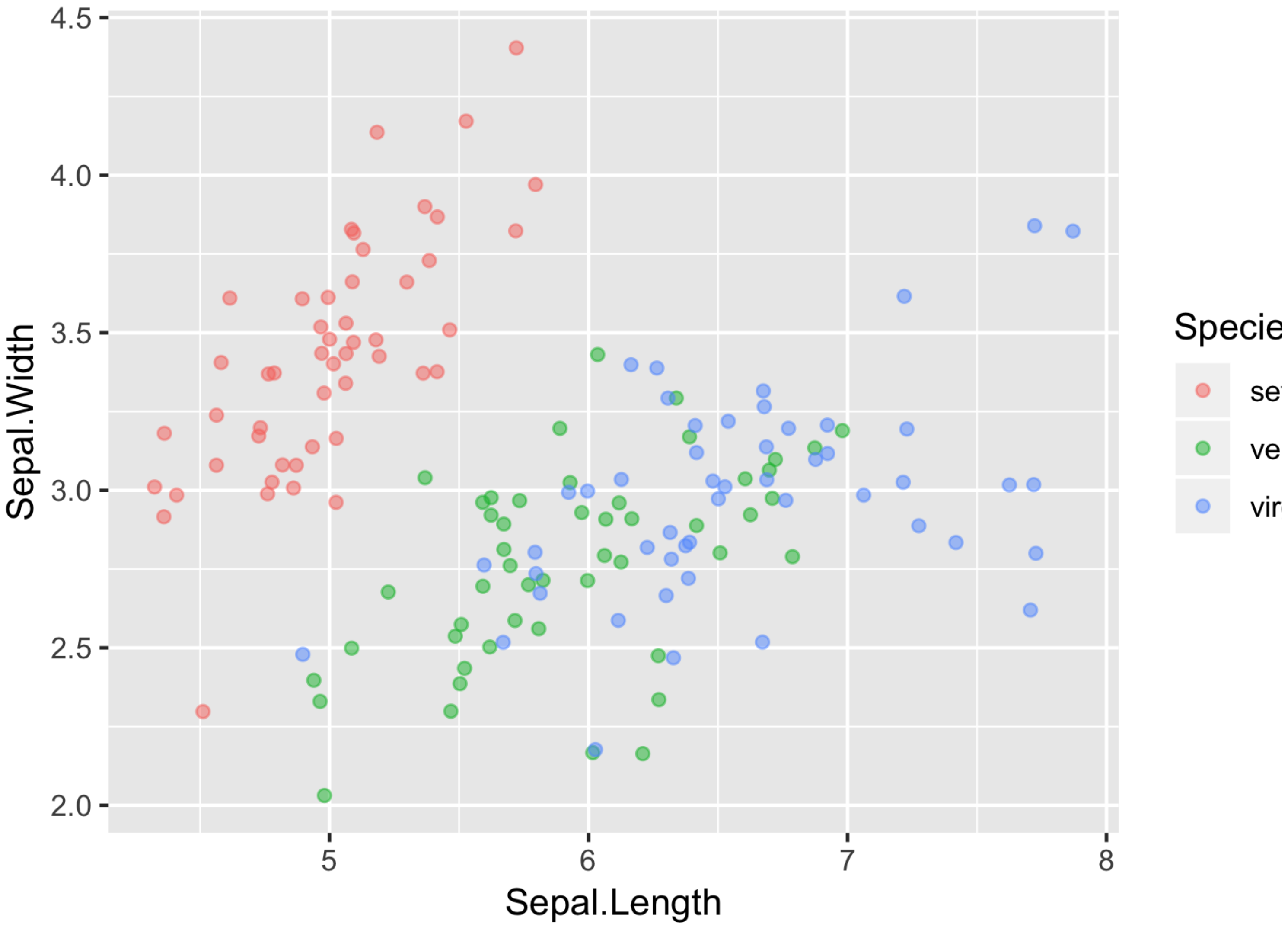
Aesthetics - categorical variables

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 col = Species)) +
  geom_point()
```



Aesthetics - categorical variables

```
ggplot(iris, aes(x = Sepal.Length,
                 y = Sepal.Width,
                 col = Species)) +
  geom_point(position = "jitter",
             alpha = 0.5)
```



Now it's your turn

INTRODUCTION TO DATA VISUALIZATION WITH GGPLOT2