

# Summaries and visualization of relationships

## Reflection on the last lecture

### Objectives

At the end of the lecture, you will know how to...

- Describe relationship of quantitative and qualitative variable.
- Create and read **box plots** and **violin plots**.
- Understand relationship of two quantitative variables.
- Count and interpret **correlation**.
- Create and understand **scatterplots**.
- Assess what **relationship** (covariation) occurs between your variables.

## Relationship of quantitative and qualitative variables

### Boxplot

```
g <- ggplot(dartpoints) +  
  aes(x = Name, y = Width)
```

### Boxplot

```
g <- ggplot(dartpoints) +  
  aes(x = Name, y = Width)  
  
g + geom_boxplot()
```



## Boxplot

Also *box and whisker plot*, displays *five-number summary*.



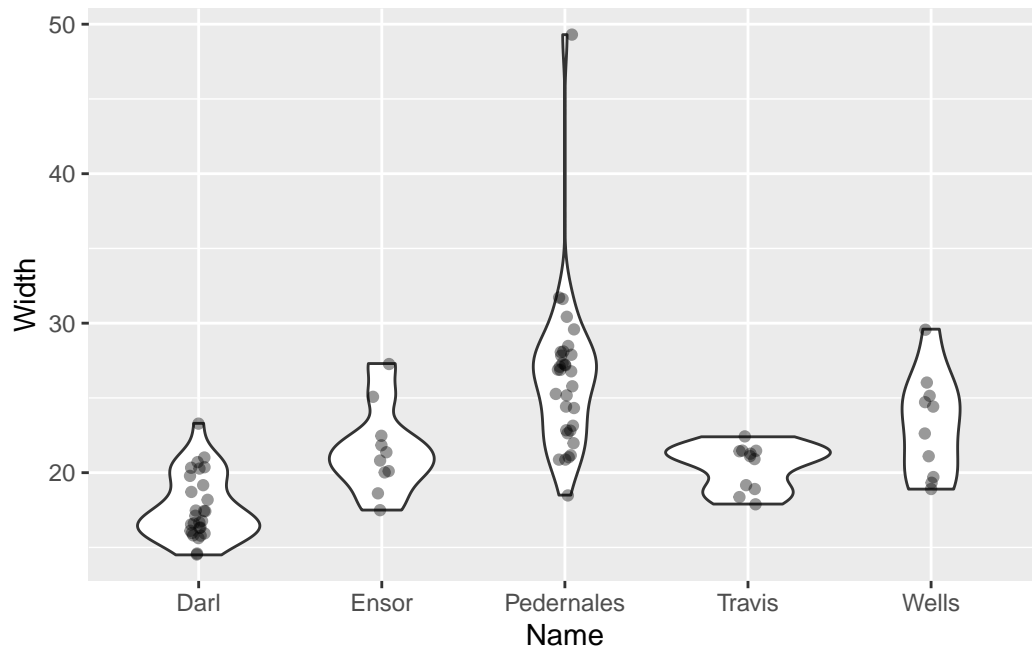
## Violin plot

```
g + geom_violin()
```



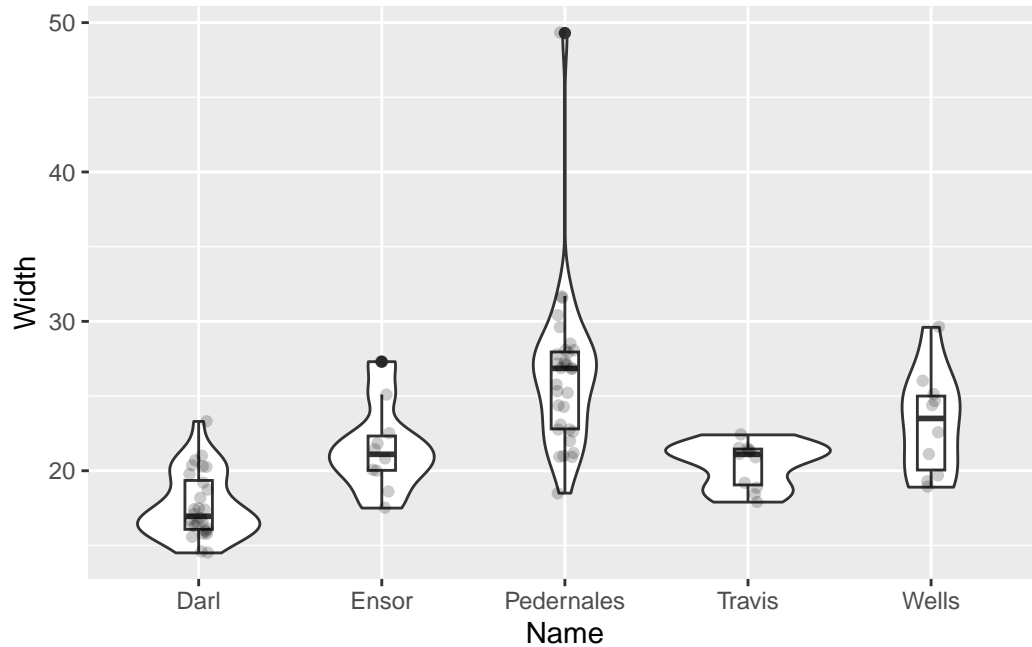
## Violin plot

```
g + geom_violin() +  
  geom_jitter(width = 0.05, alpha = 0.4)
```



### Violin plot

```
g + geom_violin() +  
  geom_boxplot(width = 0.15) +  
  geom_jitter(width = 0.05, alpha = 0.2)
```



## Relationship of two quantitative variables

### Correlation

- A statistic describing a relationship between two continuous variables.
- To what degree is a variable  $y$  explained by  $x$ ?
- Correlation coefficient  $r$ , from **-1 to +1**.
- **Correlation does not imply causation!**
- $r = 1$  – strong positive correlation
- $r = 0.5$  – moderately strong positive correlation
- $r = 0$  – variables are not correlated
- $r = -0.2$  – weak negative correlation
- $r = -1$  – strong negative correlation

Function `cor()`

```
cor(dartpoints$Length, dartpoints$Width)
```

```
[1] 0.7689932
```

```
cor(dartpoints$Length, dartpoints$Weight)
```

```
[1] 0.879953
```

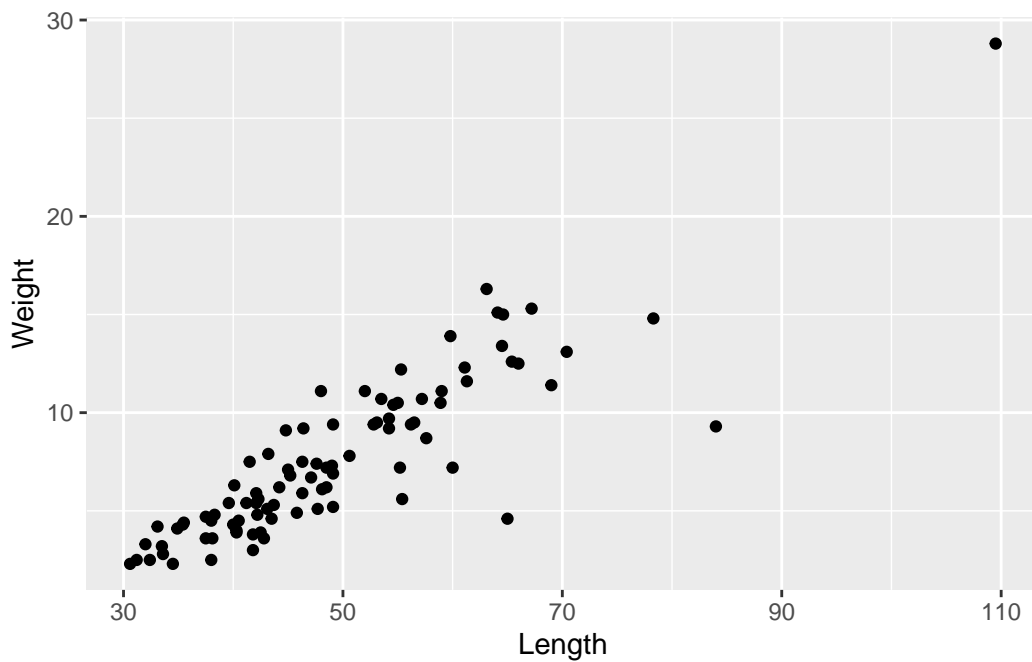
```
cor(dartpoints$Width, dartpoints$Thickness)
```

```
[1] 0.5459291
```

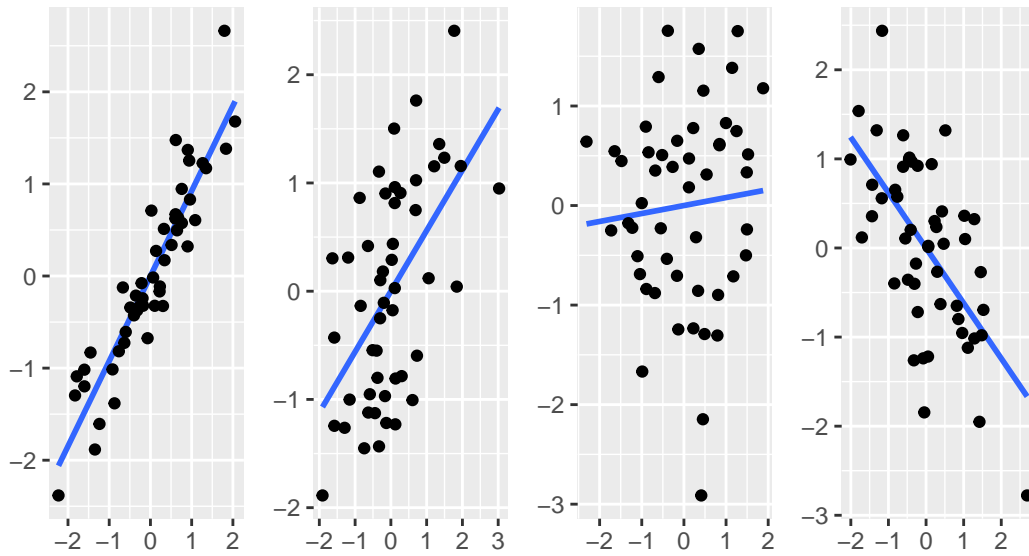
## Scatter plot

- Plot displaying **two continuous** variables, x and y.
- *x axis*: explanatory variable, independent, predictor.
- *y axis*: dependent variable, response.

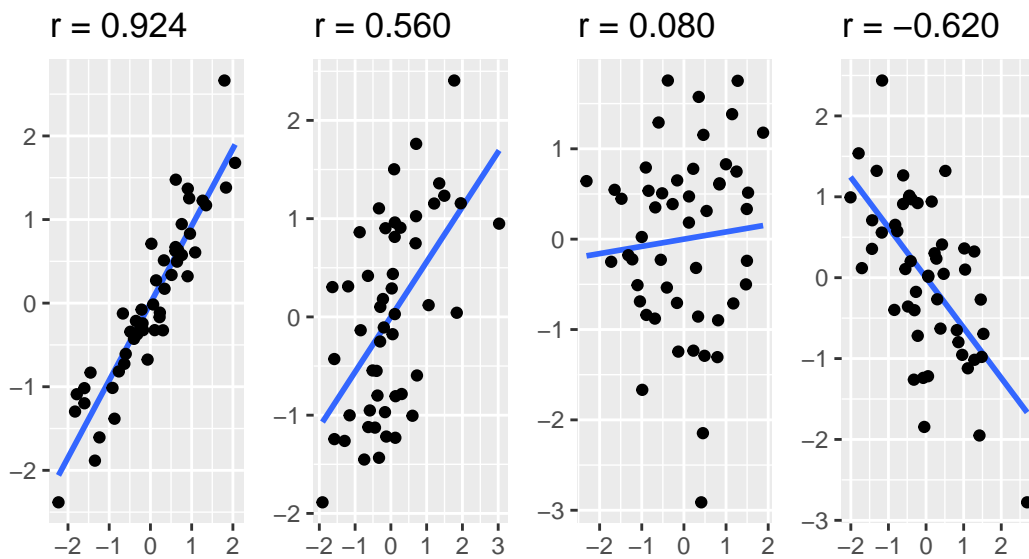
```
ggplot(dartpoints) +  
  aes(x = Length, y = Weight) +  
  geom_point()
```



## Correlation examples



## Correlation examples



## Scatter plots

```
ggplot(data = dartpoints) +  
  aes(x = Weight, y = Length) +  
  geom_point()
```



## Scatter plots

```
ggplot(data = dartpoints) +  
  aes(x = Weight, y = Length, color = Name) +  
  geom_point(size = 3, alpha = 0.5)
```





## Scatter plots

```
1 ggplot(data = dartpoints) +  
2   aes(x = Weight, y = Length, color = Name) +  
3   geom_point(size = 3, alpha = 0.5) +  
4   labs(x = "Weight (g)", y = "Length (mm)", color = "Type",  
5         title = "Relationship of weight and length of dart points") +  
6   theme_light()
```



## Scatter plots

```
1 ggplot(data = dartpoints) +  
2   aes(x = Weight, y = Length, size = Width, color = Name) +  
3   geom_point(alpha = 0.5) +  
4   labs(x = "Weight (g)", y = "Length (mm)", color = "Type",  
5         title = "Relationship of weight and length of dart points") +  
6   theme_light()
```



## Trends

```

1 ggplot(data = dartpoints) +
2   aes(x = Weight, y = Length) +
3   geom_point(size = 3, alpha = 0.5) +
4   geom_smooth() +
5   labs(x = "Weight (g)", y = "Length (mm)", color = "Type",
6         title = "Relationship of weight and length of dart points") +
7   theme_light()

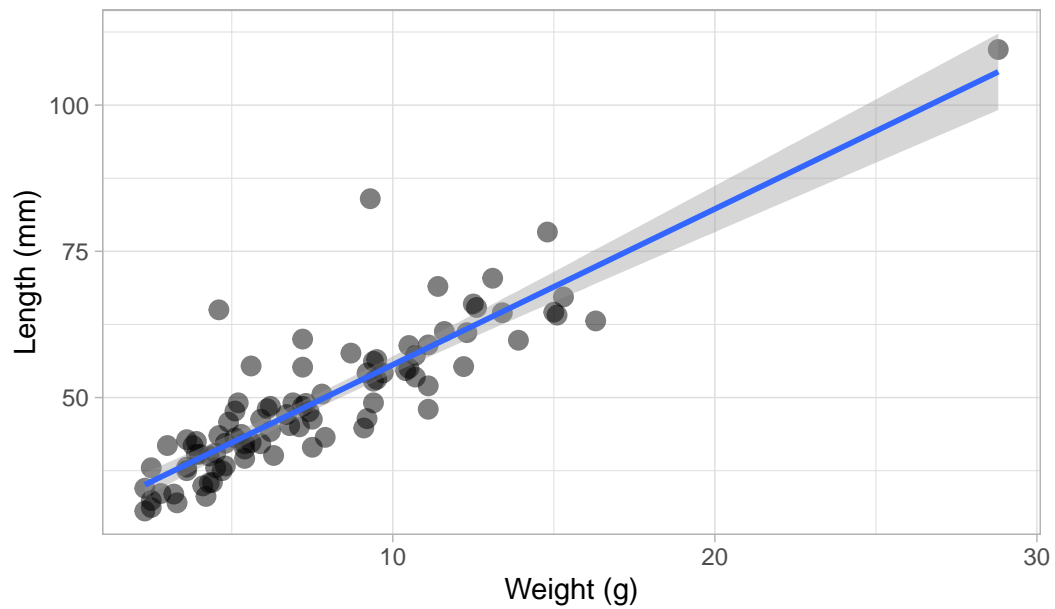
```



## Trends

```
1 ggplot(data = dartpoints) +  
2   aes(x = Weight, y = Length) +  
3   geom_point(size = 3, alpha = 0.5) +  
4   geom_smooth(method = "lm") +  
5   labs(x = "Weight (g)", y = "Length (mm)", color = "Type",  
6         title = "Relationship of weight and length of dart points") +  
7   theme_light()
```

Relationship of weight and length of dart points



## Trends

```
1 ggplot(data = dartpoints) +  
2   aes(x = Weight, y = Length) +  
3   geom_point(size = 3, alpha = 0.5) +  
4   geom_smooth(method = "lm", se = FALSE) +  
5   labs(x = "Weight (g)", y = "Length (mm)", color = "Type",  
6         title = "Relationship of weight and length of dart points") +  
7   theme_linedraw()
```



### Small multiples

```
1 ggplot(data = dartpoints) +  
2   aes(x = Weight, y = Length) +  
3   geom_point(size = 3, alpha = 0.5) +  
4   geom_smooth(method = "lm", se = FALSE) +  
5   labs(x = "Weight (g)", y = "Length (mm)", color = "Type",  
6         title = "Relationship of weight and length of dart points") +  
7   theme_linedraw() +  
8   facet_wrap(~Name)
```

## Relationship of weight and length of dart points



## Exercise

- Download data set with bronze age cups ([bacups.csv](#)).
- Create a project in RStudio and load the data set.
- Explore the data set and its structure.
- What are the observations?
- What types of variables are there?
- Create a plot showing distribution of cup heights (H).
- Create a boxplot for cup heights divided by phases (Phase).
- Are there any outliers?
- Count correlation between cup height (H) and rim diameter (RD).
- Create a plot showing relationship between cup height and its rim diameter.
- Color cups from different phases (Phase) by differently.
- Describe the relationship, add a linear model to the plot.
- Label the axes sensibly.

Hints:

```
read.csv(),
str(),
colnames(),
summary(),
cor(),
```

```
ggplot() +  
aes() +  
geom_* + stat_*
```