# What is cluster analysis?

CLUSTER ANALYSIS IN R

**Dmitriy (Dima) Gorenshteyn**
Lead Data Scientist,

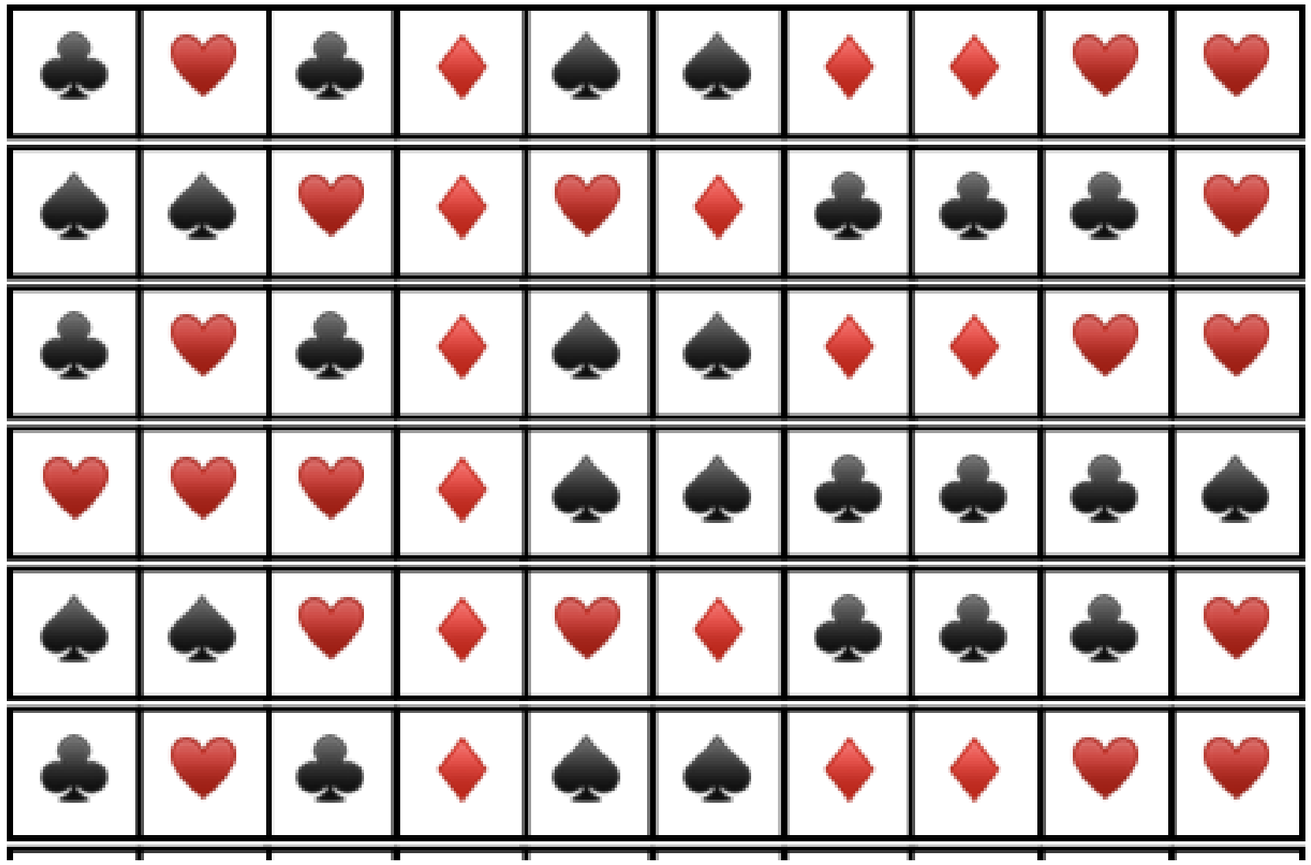
datacamp

# What is clustering?

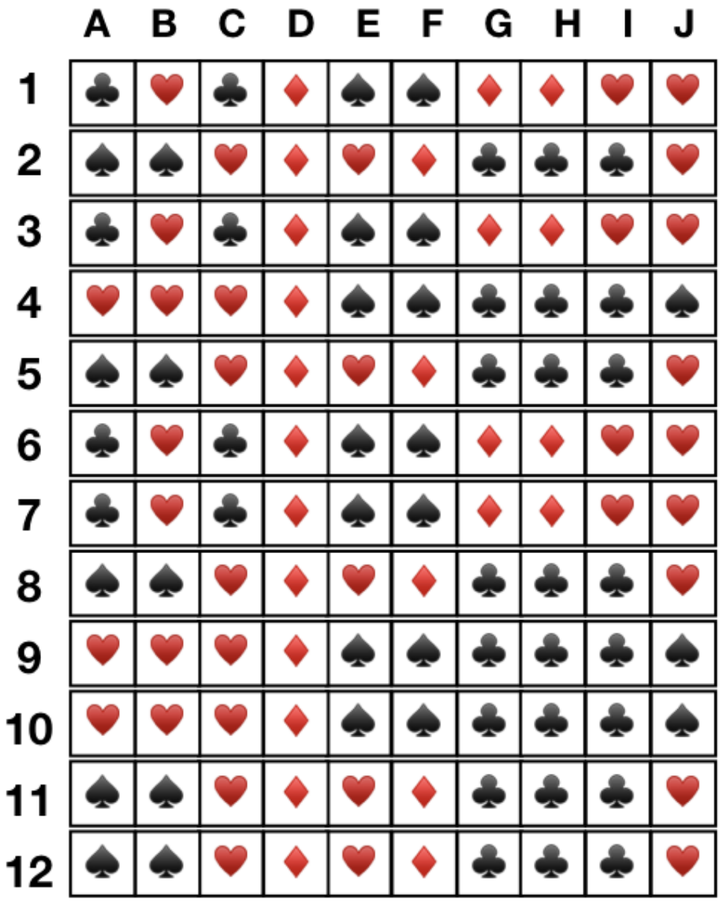
# What is clustering?

# What is clustering?

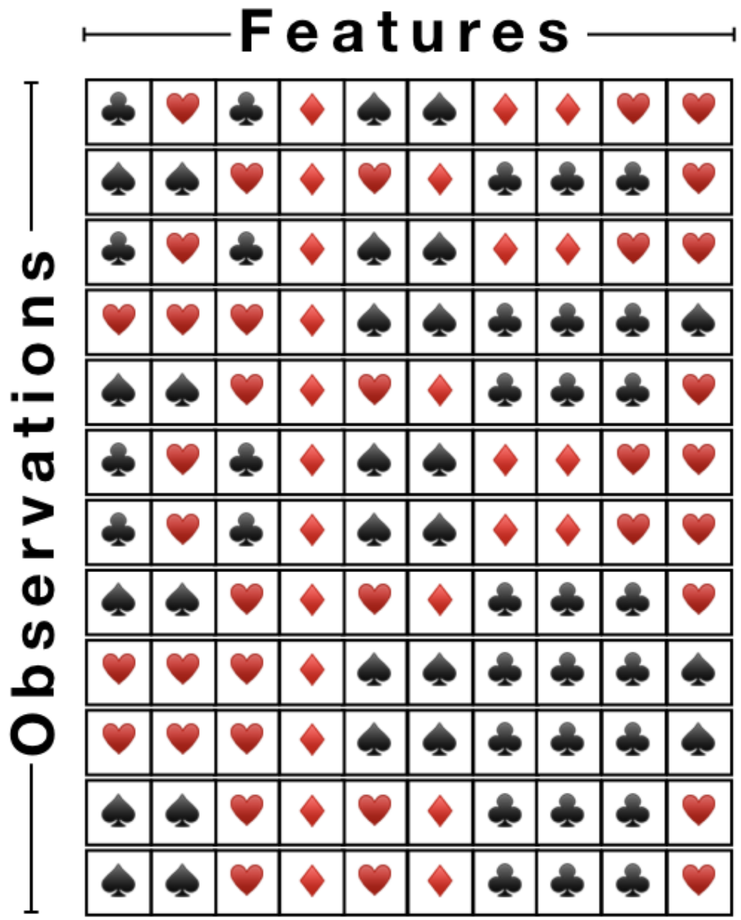
# What is clustering?



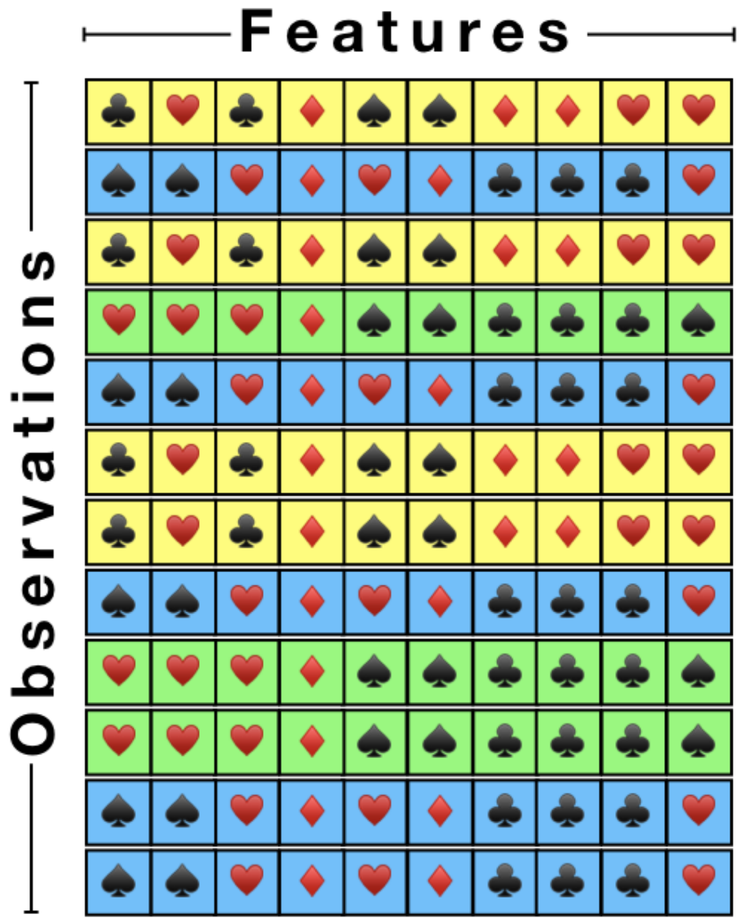
# What is clustering?



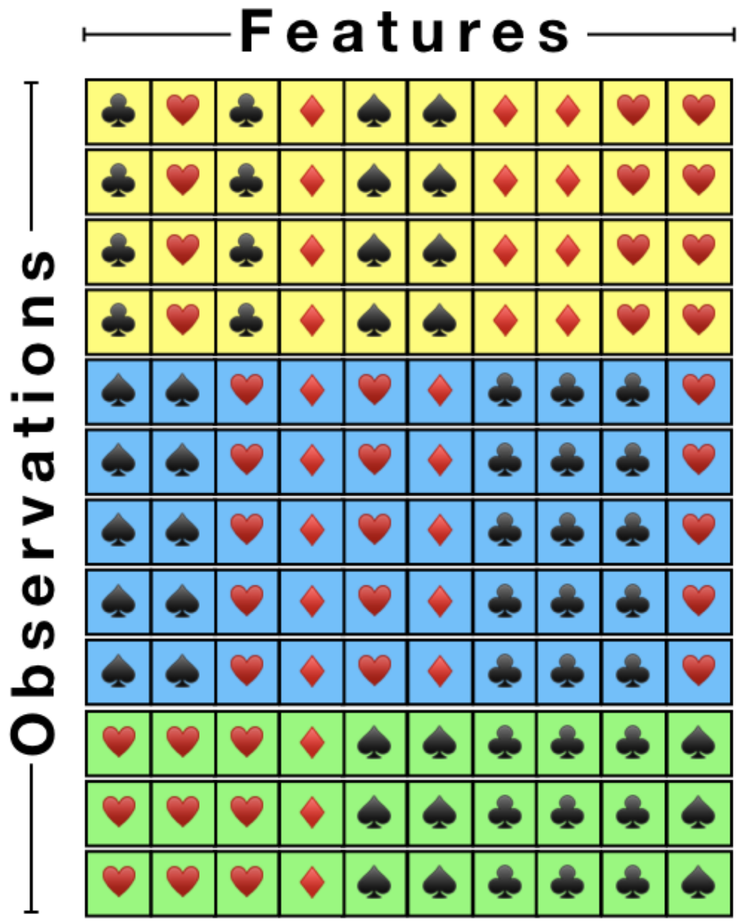
# What is clustering?



# What is clustering?



# What is clustering?

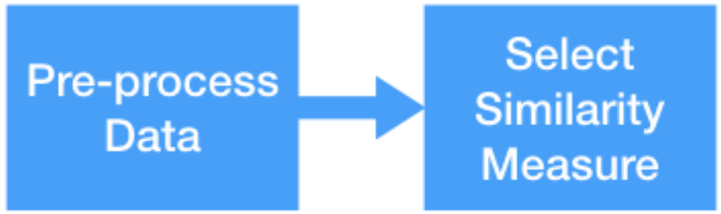


# What is clustering?

> A form of exploratory data analysis (**EDA**) where **observations** are divided into meaningful groups that share common characteristics (**features**).

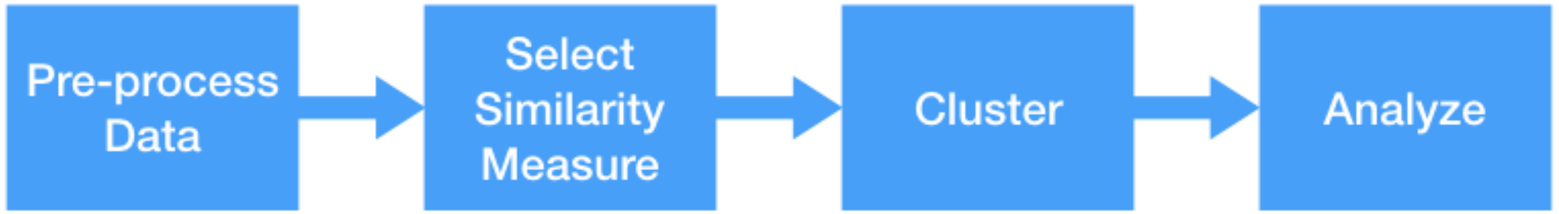
# The flow of cluster analysis

# The flow of cluster analysis

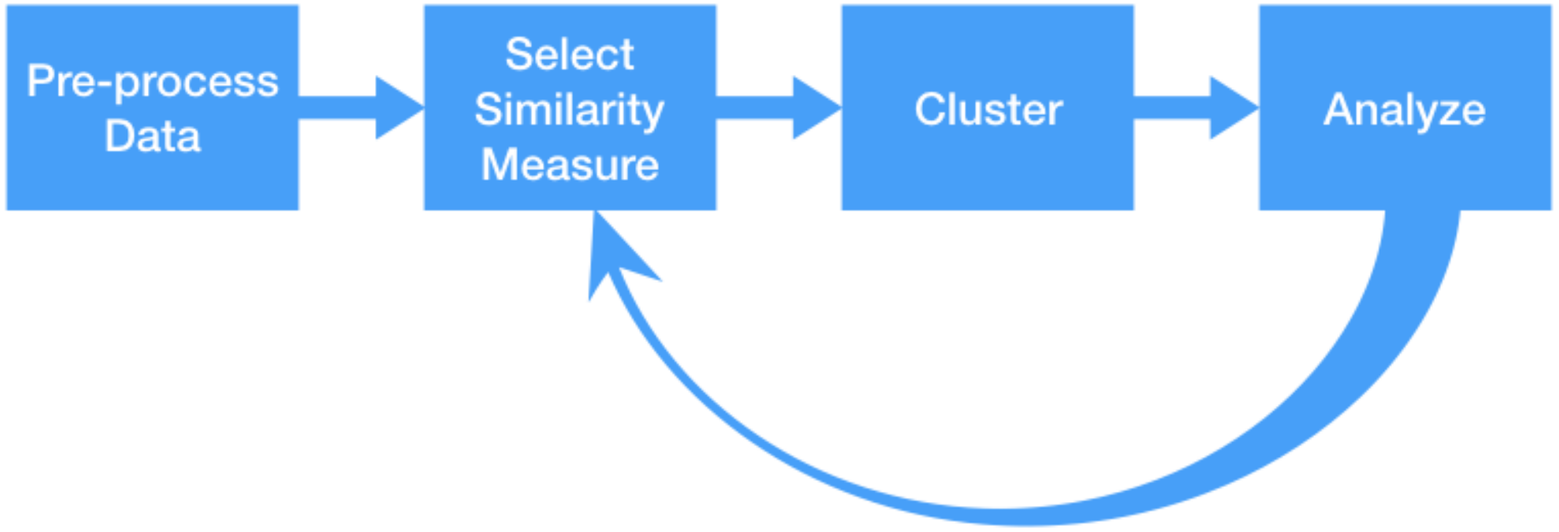


# The flow of cluster analysis

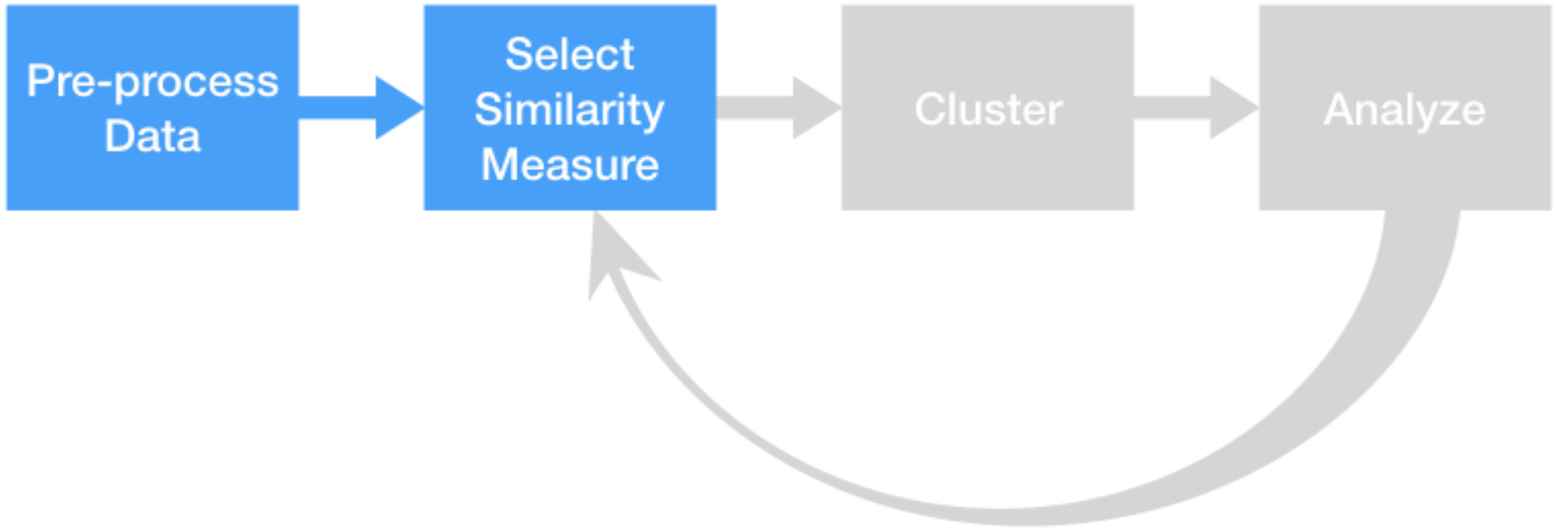
# The flow of cluster analysis



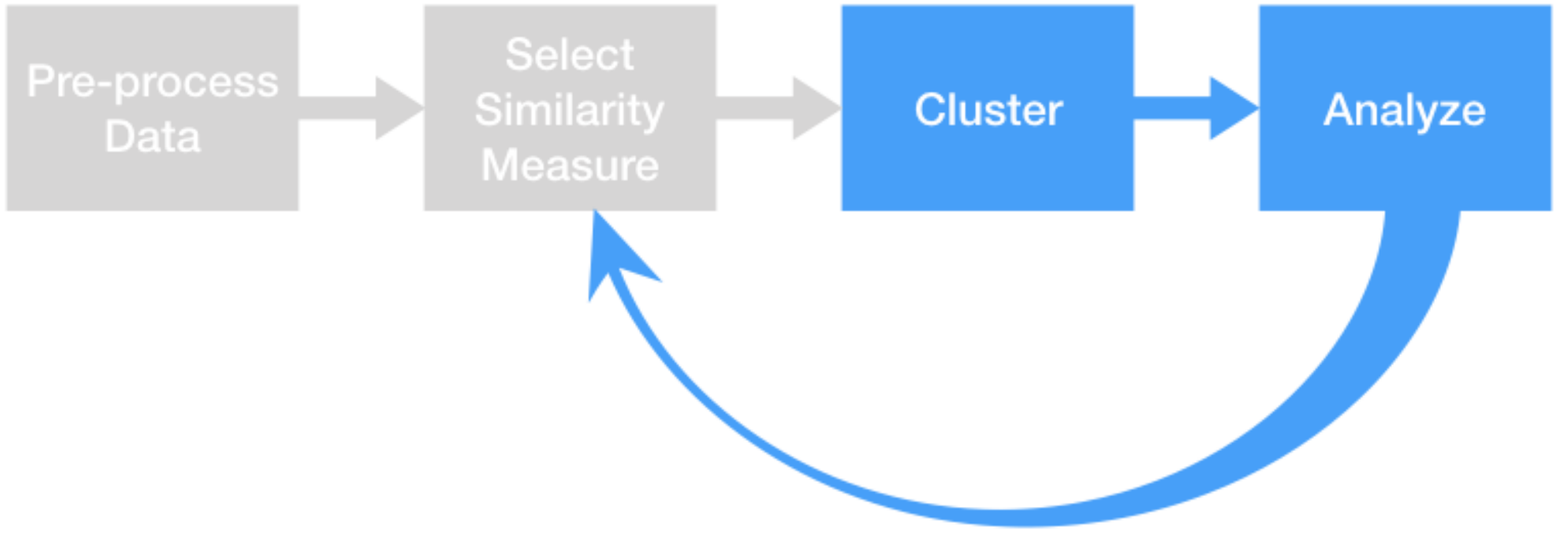
# The flow of cluster analysis



# Structure of this course



# Structure of this course



# Let's learn!

CLUSTER ANALYSIS IN R

datacamp

# Distance between two observations

CLUSTER ANALYSIS IN R

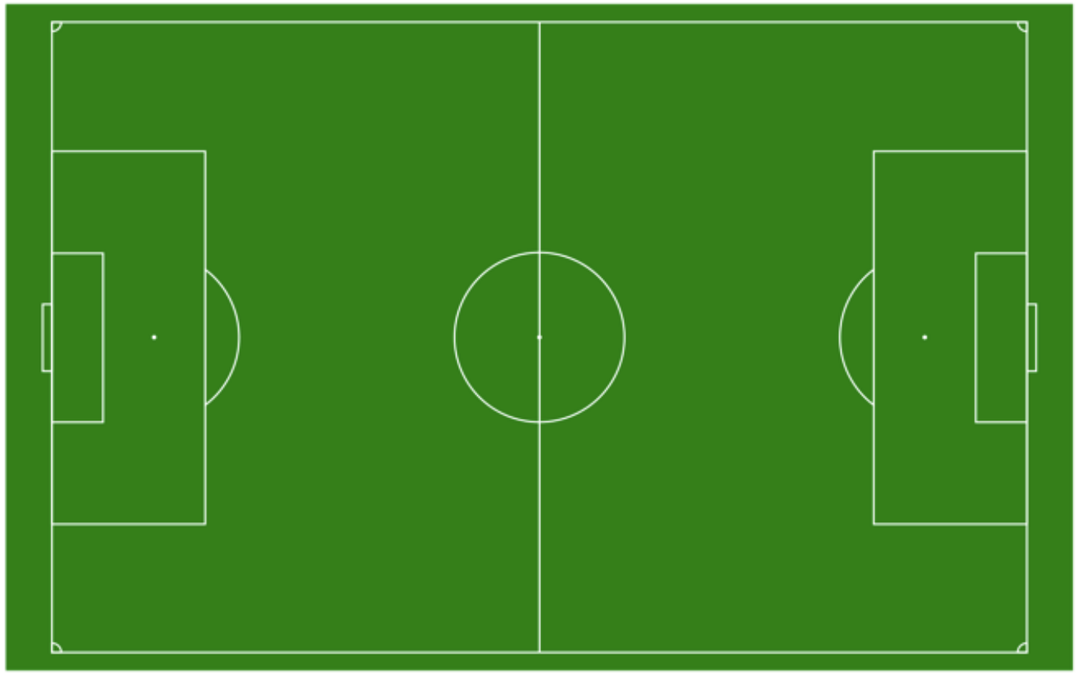
**Dmitriy (Dima) Gorenshteyn**
Lead Data Scientist, Memorial Sloan Kettering Cancer Center

# Distance vs. Similarity

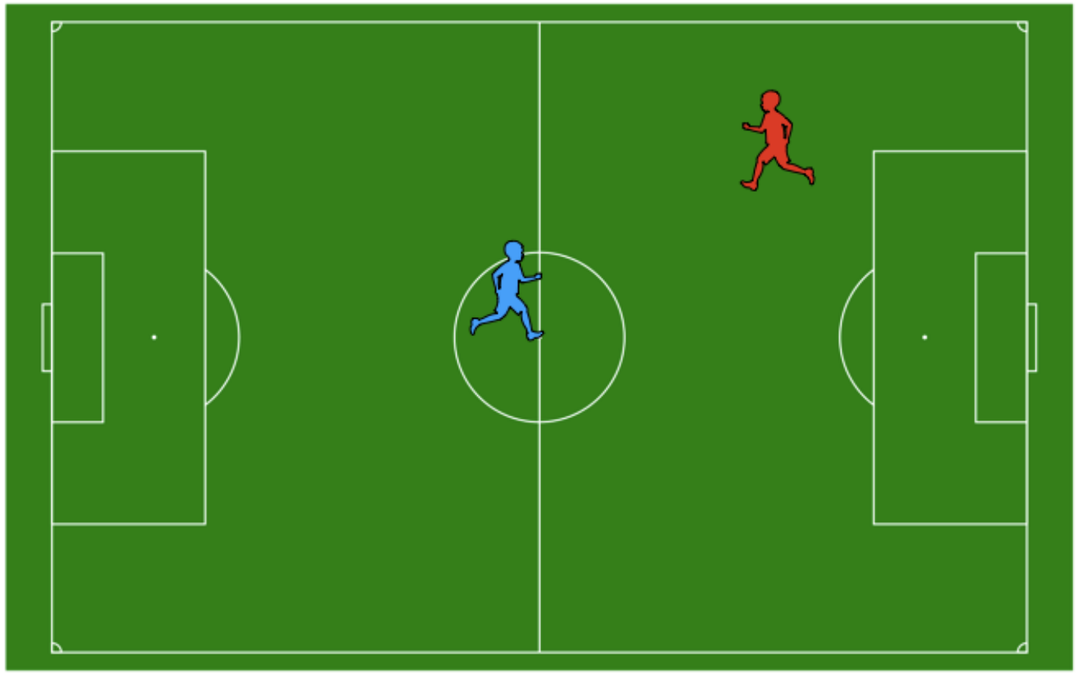
# Distance vs. Similarity

$$Distance = 1 - Similarity$$

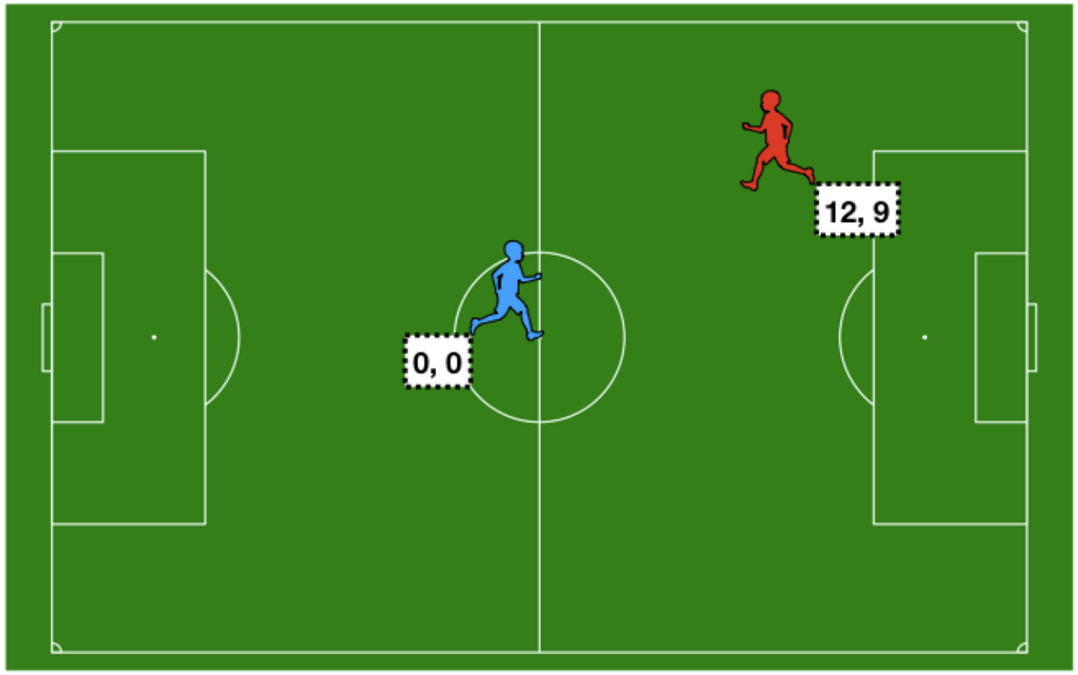
# Distance between two players



# Distance between two players

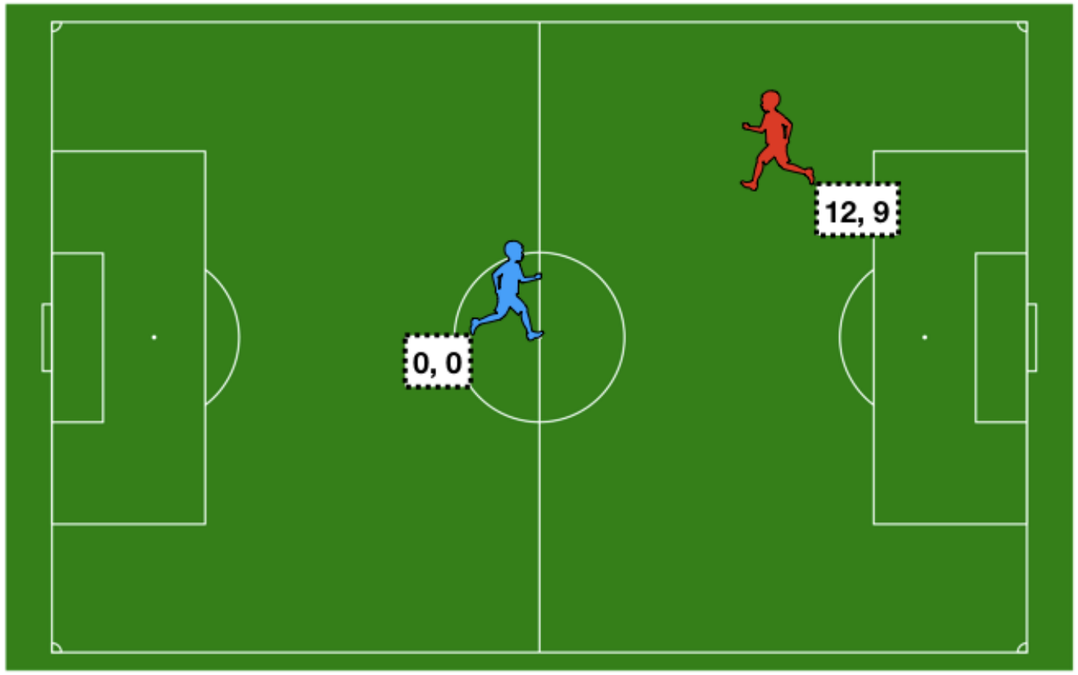


# Distance between two players



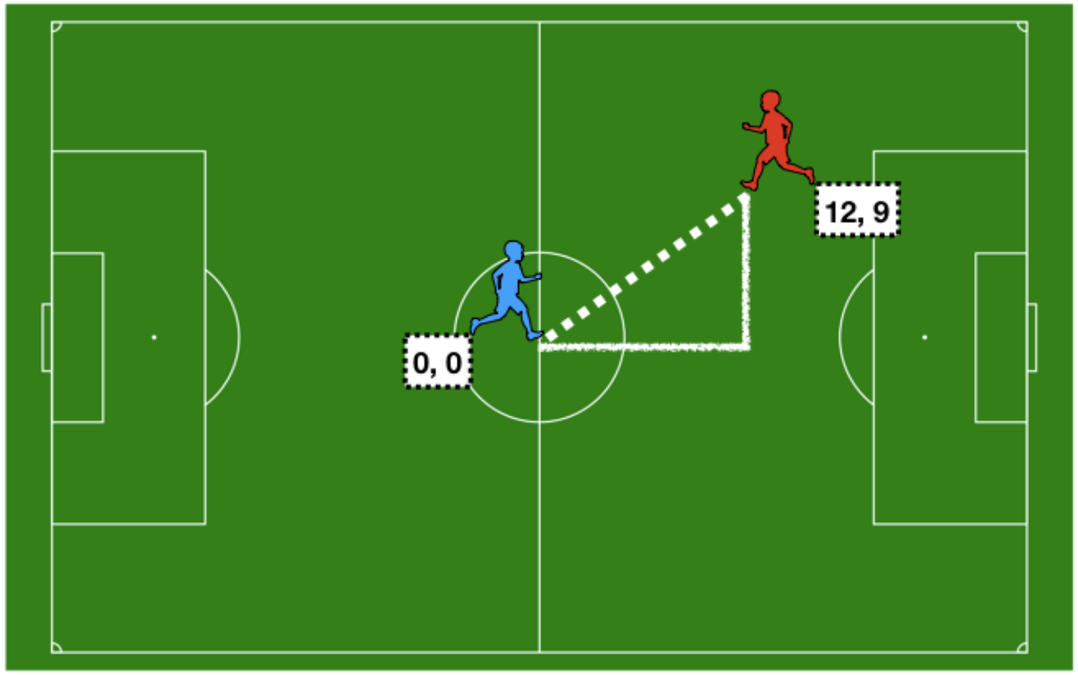
# Distance between two players

| | X | Y |
|---|---|---|
| Blue | 0 | 0 |
| Red | 12 | 9 |



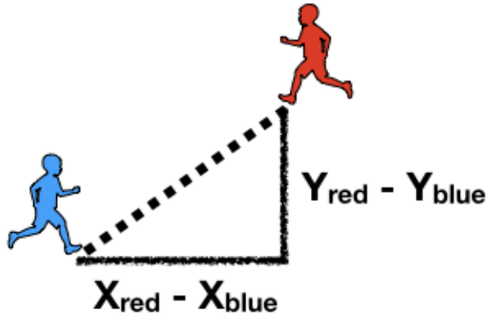
# Distance between two players

| | X | Y |
|---|---|---|
| Blue | 0 | 0 |
| Red | 12 | 9 |



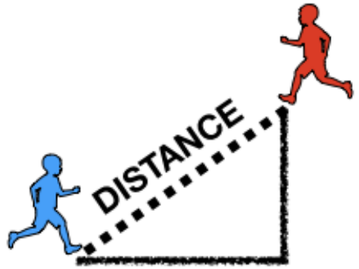
# Distance between two players

| | X | Y |
|---|---|---|
| Blue | 0 | 0 |
| Red | 12 | 9 |



# Distance between two players

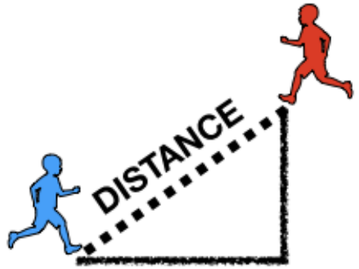
| | X | Y |
|---|---|---|
| Blue | 0 | 0 |
| Red | 12 | 9 |




$$= \sqrt{(X_{red} - X_{blue})^2 + (Y_{red} - Y_{blue})^2}$$

# Distance between two players

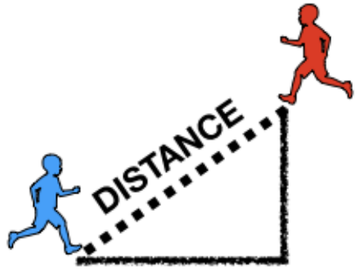
| | X | Y |
|---|---|---|
| Blue | 0 | 0 |
| Red | 12 | 9 |




$$= \sqrt{(12 - 0)^2 + (9 - 0)^2}$$

# Distance between two players

| | X | Y |
|---|---|---|
| Blue | 0 | 0 |
| Red | 12 | 9 |




= 15

# dist() function

```
print(two_players)
```

```
     X  Y
BLUE 0  0
RED  9 12
```

```
dist(two_players, method = 'euclidean')
```

```
     BLUE
RED    15
```

# More than 2 observations

```
print(three_players)
```

```
       X  Y
BLUE   0  0
RED    9 12
GREEN -2 19
```

```
dist(three_players)
```

```
          BLUE      RED
RED   15.00000
GREEN 19.10497 13.03840
```

# Let's practice!

CLUSTER ANALYSIS IN R

datacamp

# The importance of scale

CLUSTER ANALYSIS IN R

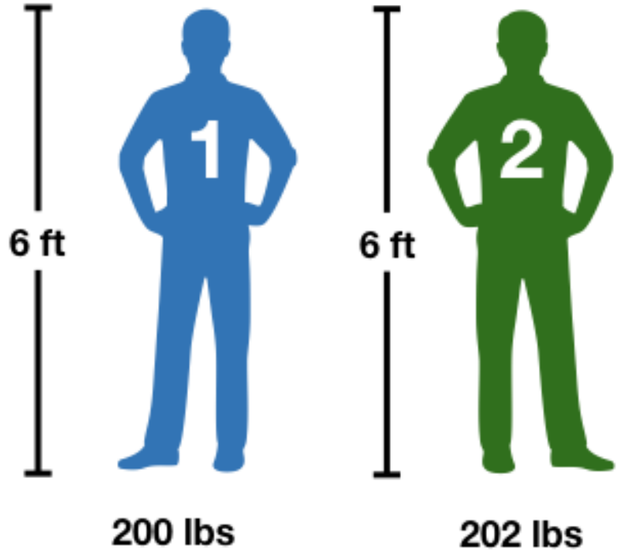
**Dmitriy (Dima) Gorenshteyn**
Lead Data Scientist, Memorial Sloan Kettering Cancer Center

datacamp

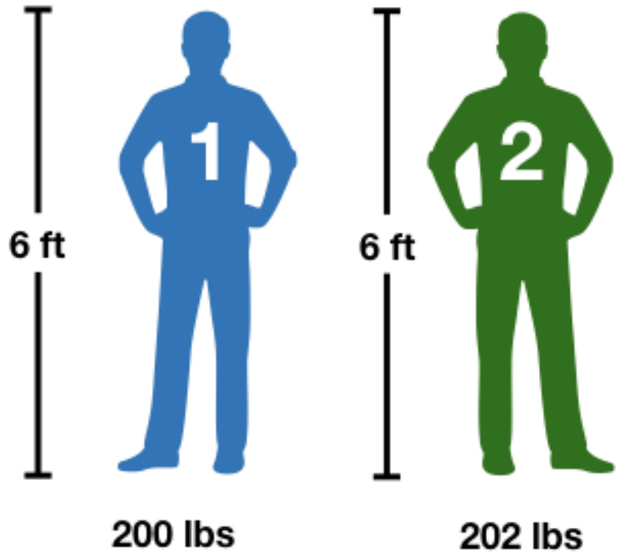
# Distance between individuals

| Observation | Height (feet) | Weight (lbs) |
|---|---|---|
| 1 | 6.0 | 200 |
| 2 | 6.0 | 202 |
| 3 | 8.0 | 200 |
| ... | ... | ... |
| ... | ... | ... |

# Distance between individuals

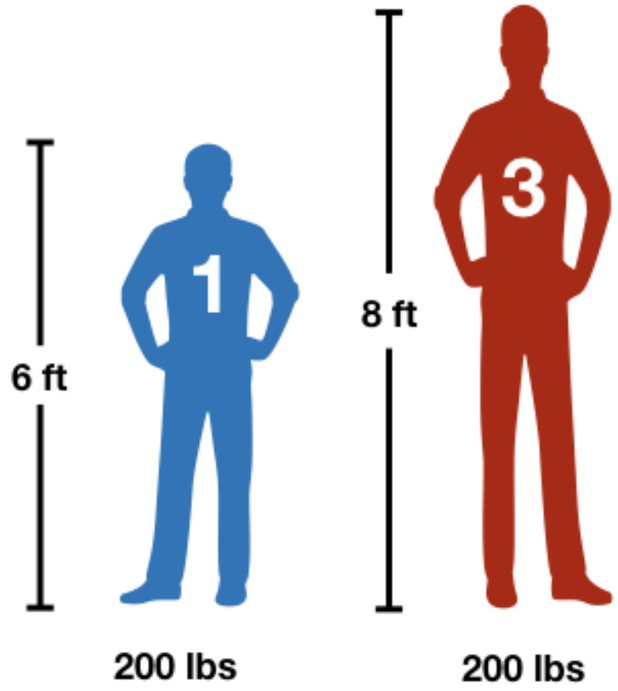


# Distance between individuals

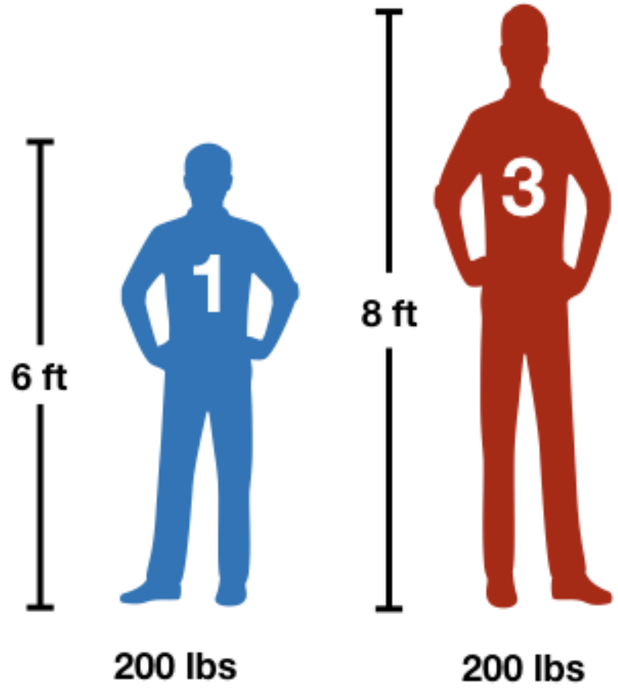



DISTANCE: **2**

# Distance between individuals

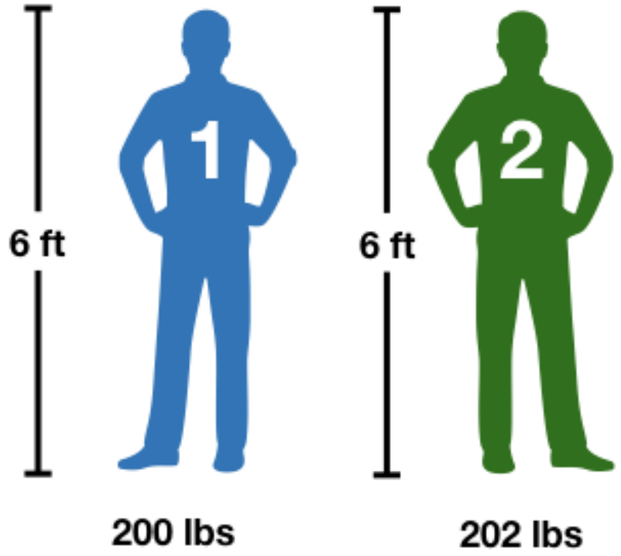


# Distance between individuals

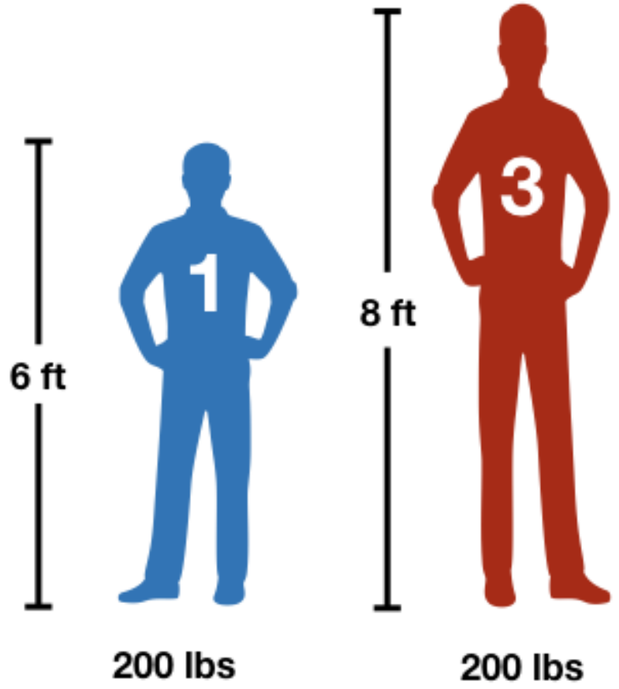



DISTANCE: **2**

# Distance between individuals




DISTANCE: **2**

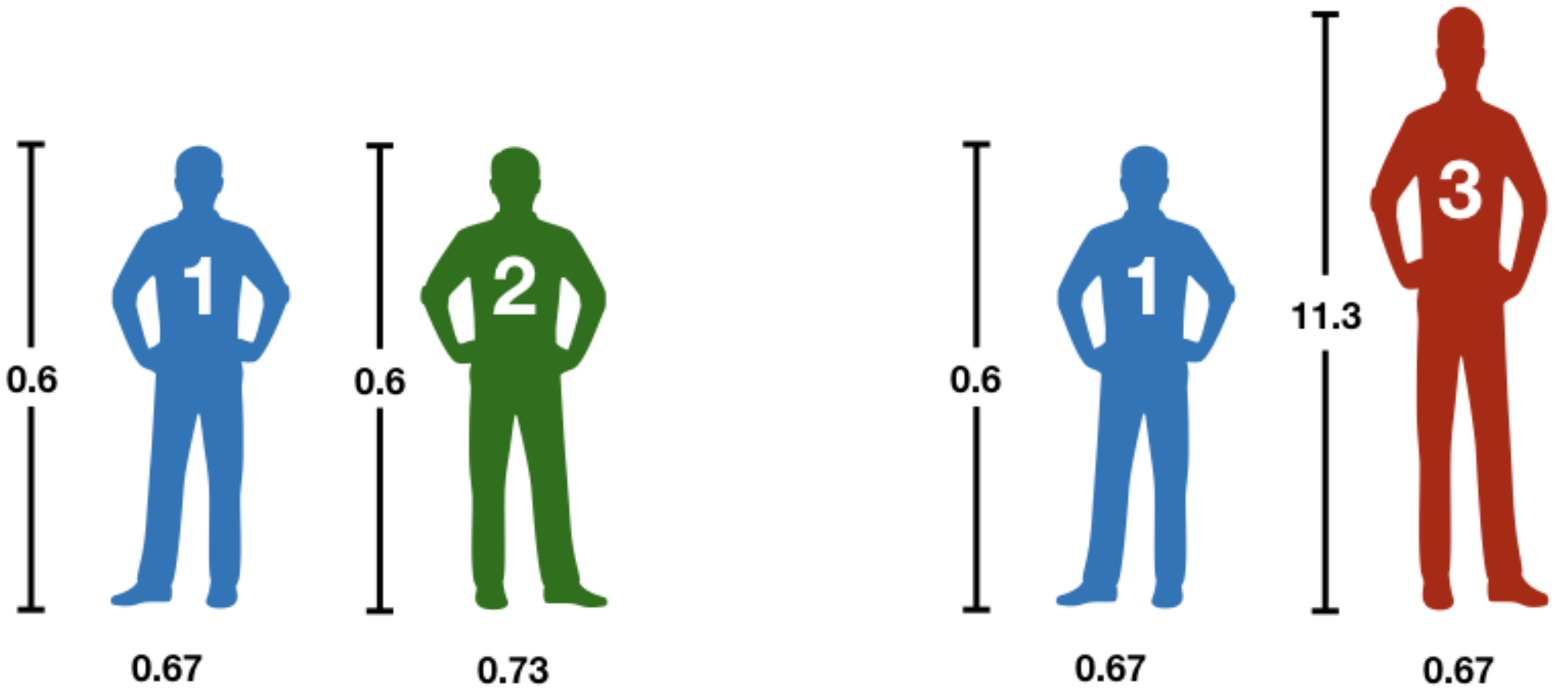



DISTANCE: **2**

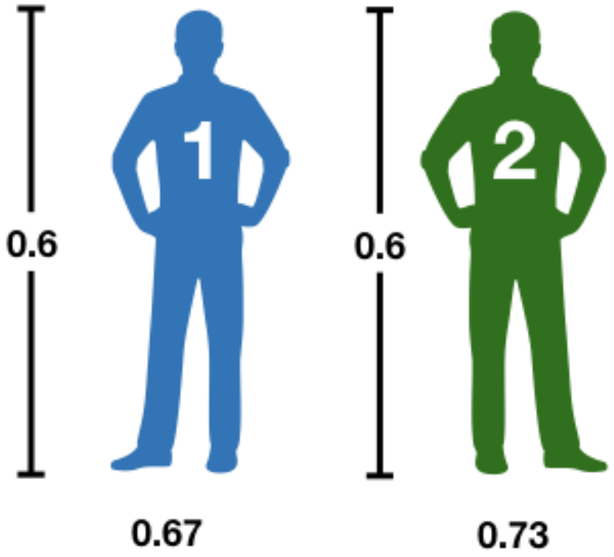
# Scaling our features

$$height_{scaled} = \frac{height - mean(height)}{sd(height)}$$

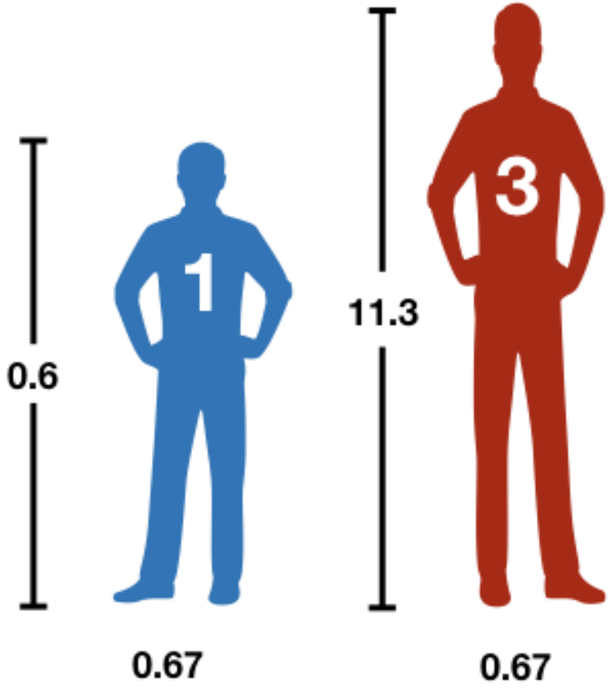
# Distance between individuals



# Distance between individuals




DISTANCE: **0.06**




DISTANCE: **10.7**

# scale() function

```
print(height_weight)
```

```
  Height Weight
1      6    200
2      6    202
3      8    200
...    ...    ...
```

```
scale(height_weight)
```

```
   Height   Weight
1    0.60    0.67
2    0.60    0.73
3    11.3    0.67
...    ...    ...
```

# Let's practice!

CLUSTER ANALYSIS IN R

datacamp

# Measuring distance for categorical data

CLUSTER ANALYSIS IN R

**Dmitriy (Dima) Gorenshteyn**
Lead Data Scientist, Memorial Sloan Kettering Cancer Center

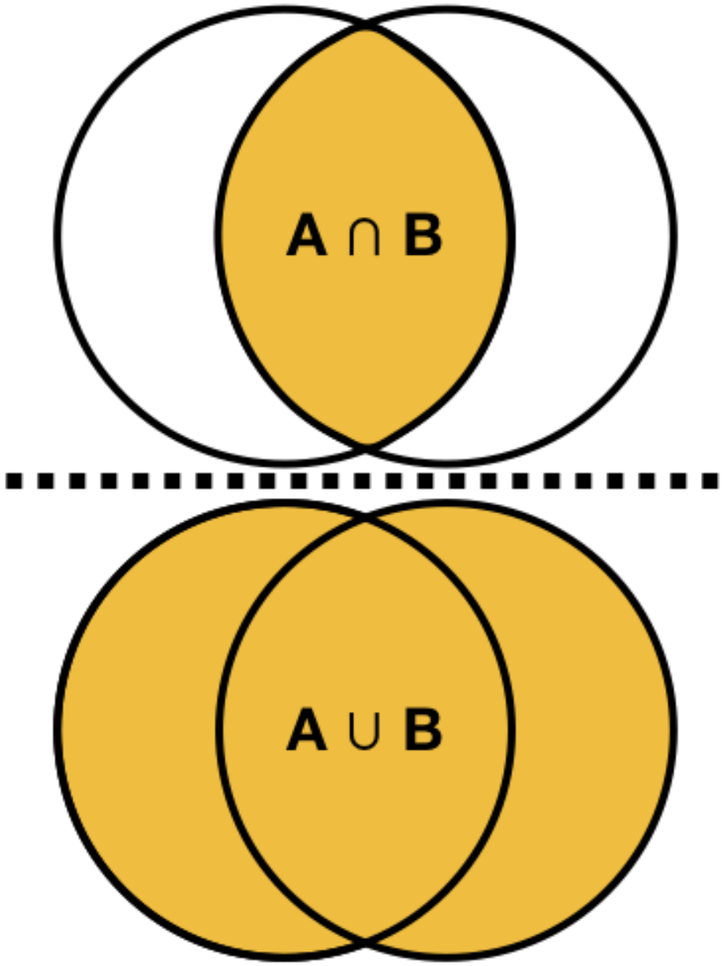
datacamp

# Binary data

| | wine | beer | whiskey | vodka |
|---|---|---|---|---|
| 1 | **TRUE** | **TRUE** | FALSE | FALSE |
| 2 | FALSE | **TRUE** | **TRUE** | **TRUE** |
| ... | ... | ... | ... | ... |

# Jaccard index

$$J(A, B) = \frac{A \cap B}{A \cup B}$$



# Calculating Jaccard distance

| | wine | beer | whiskey | vodka |
|---|---|---|---|---|
| 1 | **TRUE** | **TRUE** | FALSE | FALSE |
| 2 | FALSE | **TRUE** | **TRUE** | **TRUE** |

$$J(1,2) = \frac{1 \cap 2}{1 \cup 2} = \frac{1}{4} = 0.25$$

$$Distance(1,2) = 1 - J(1,2) = 0.75$$

# Calculating Jaccard distance in R

```
print(survey_a)
```

```
   wine  beer whiskey vodka
  <lgl> <lgl>   <lgl> <lgl>
1  TRUE  TRUE   FALSE FALSE
2 FALSE  TRUE    TRUE  TRUE
3  TRUE FALSE    TRUE FALSE
```

```
dist(survey_a, method = "binary")
```

```
          1         2
2 0.7500000
3 0.6666667 0.7500000
```

# More than two categories

| | color | sport |
|---|---|---|
| 1 | red | soccer |
| 2 | green | hockey |
| 3 | blue | hockey |
| 4 | blue | soccer |

| | colorblue | colorgreen | colorred | sporthockey | sportsoccer |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 1 |
| 2 | 0 | 1 | 0 | 1 | 0 |
| 3 | 1 | 0 | 0 | 1 | 0 |
| 4 | 1 | 0 | 0 | 0 | 1 |

# Dummification in R

```
print(survey_b)
```

```
  color  sport
1   red soccer
2 green hockey
3  blue hockey
4  blue soccer
```

```
library(dummies)
dummy.data.frame(survey_b)
```

```
  colorblue colorgreen colorred sporthockey sportsoccer
1         0          0        1           0           1
2         0          1        0           1           0
3         1          0        0           1           0
4         1          0        0           0           1
```

# Generalizing categorical distance in R

```
print(survey_b)
```

```
  color  sport
1   red soccer
2 green hockey
3  blue hockey
4  blue soccer
```

```
dummy_survey_b <- dummy.data.frame(survey_b)
dist(dummy_survey_b, method = 'binary')
```

```
          1         2         3
2 1.0000000
3 1.0000000 0.6666667
4 0.6666667 1.0000000 0.6666667
```

# Let's practice!

CLUSTER ANALYSIS IN R

datacamp