Comparing more than two observations

CLUSTER ANALYSIS IN R

Dmitriy Gorenshteyn
Lead Data Scientist, Memorial Sloan Kettering Cancer Center

The closest observation to a pair

	1	2	3
2	11.7		
3	16.8	18.0	
4	**10.0**	20.6	15.8

- Is 2 is closest to group 1,4?
- Is 3 is closest to group 1,4?

Linkage criteria: complete

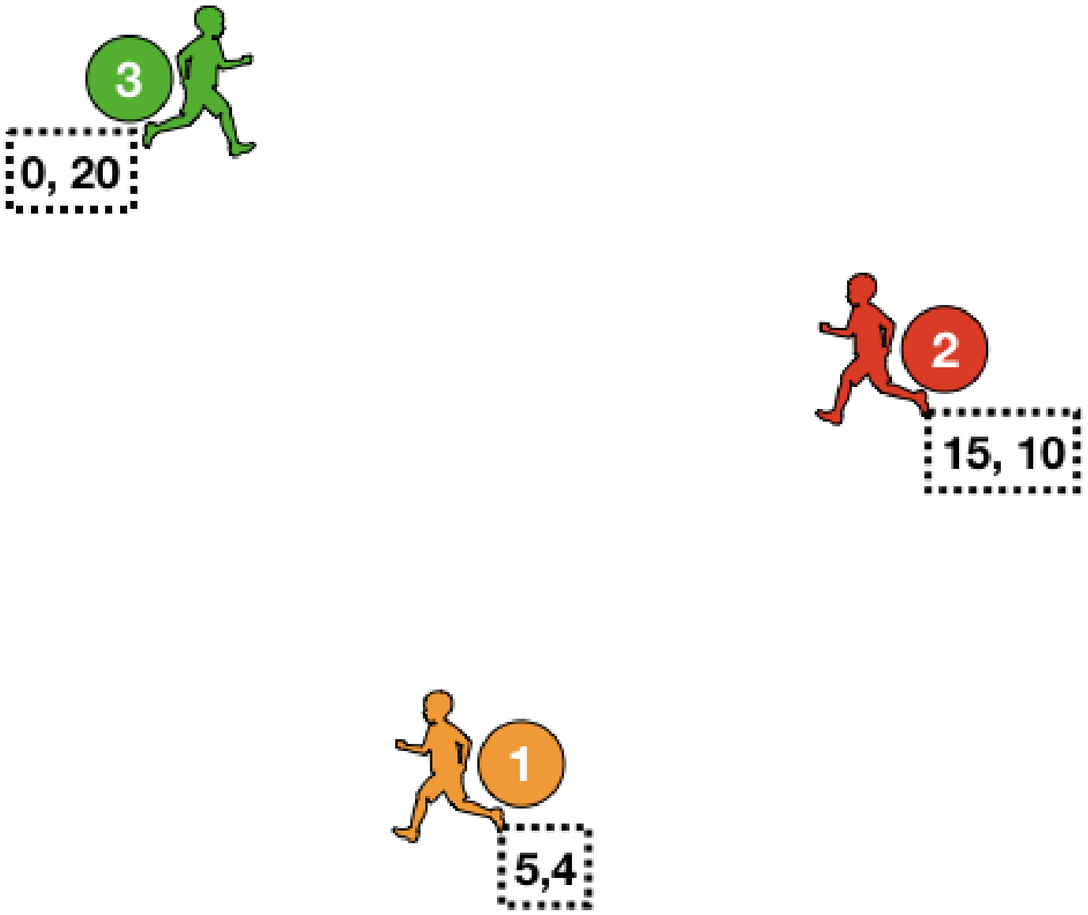
	1	2	3
2	11.7		
3	16.8	18.0	
4	**10.0**	20.6	15.8

- Is 2 is closest to group 1,4?
  - max(D(2,1), D(2,4)) = **20.6**
- Is 3 is closest to group 1,4?
  - max(D(3,1), D(3,4)) = **16.8**

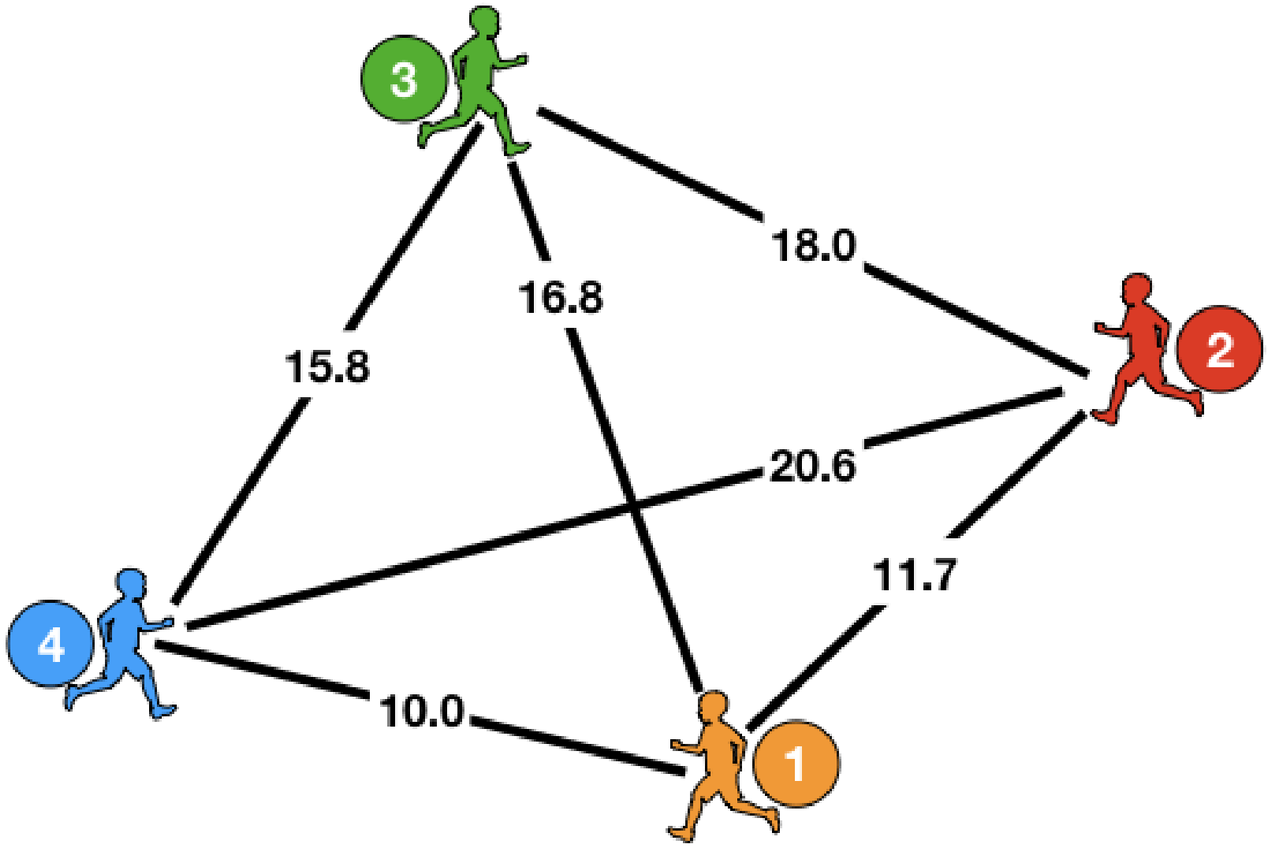
Hierarchical clustering

Complete Linkage: maximum distance between two sets

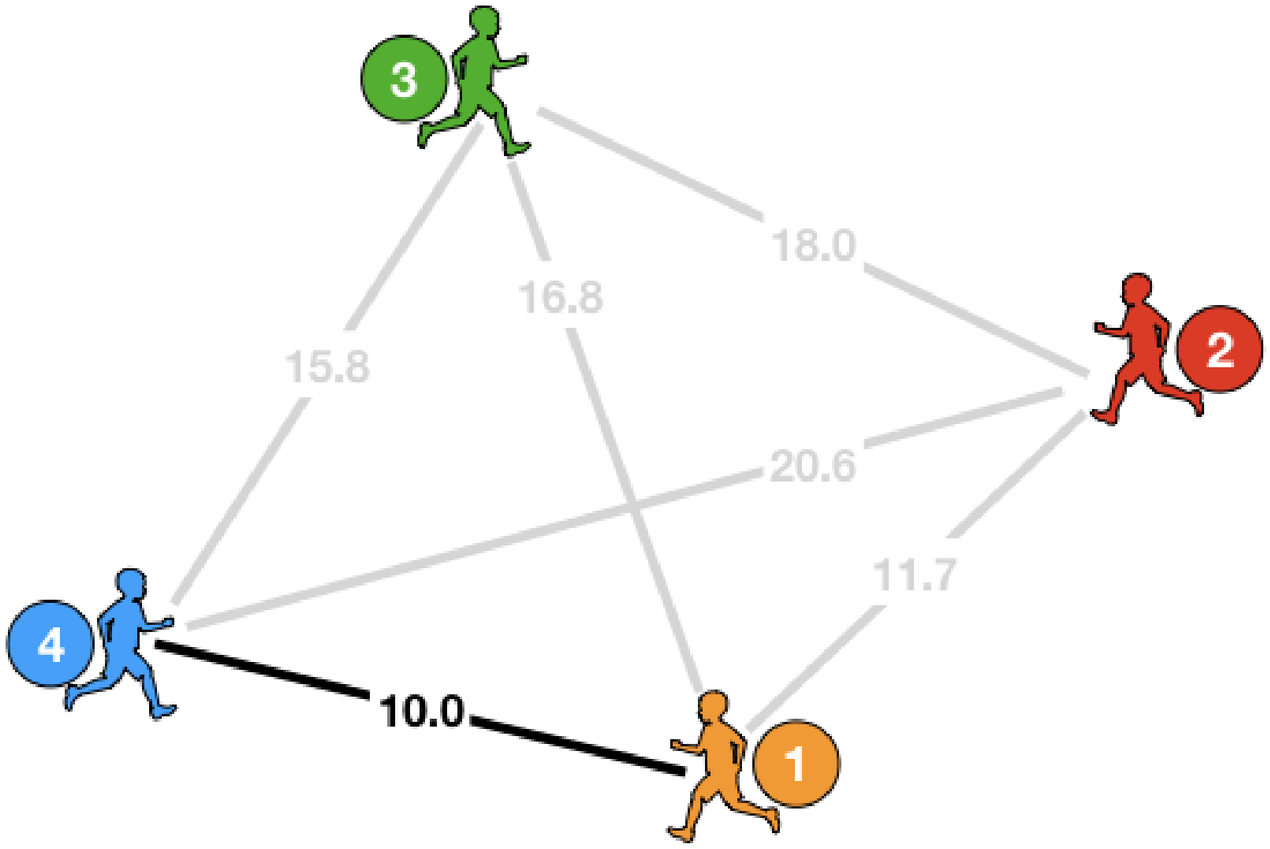
Grouping with linkage & distance



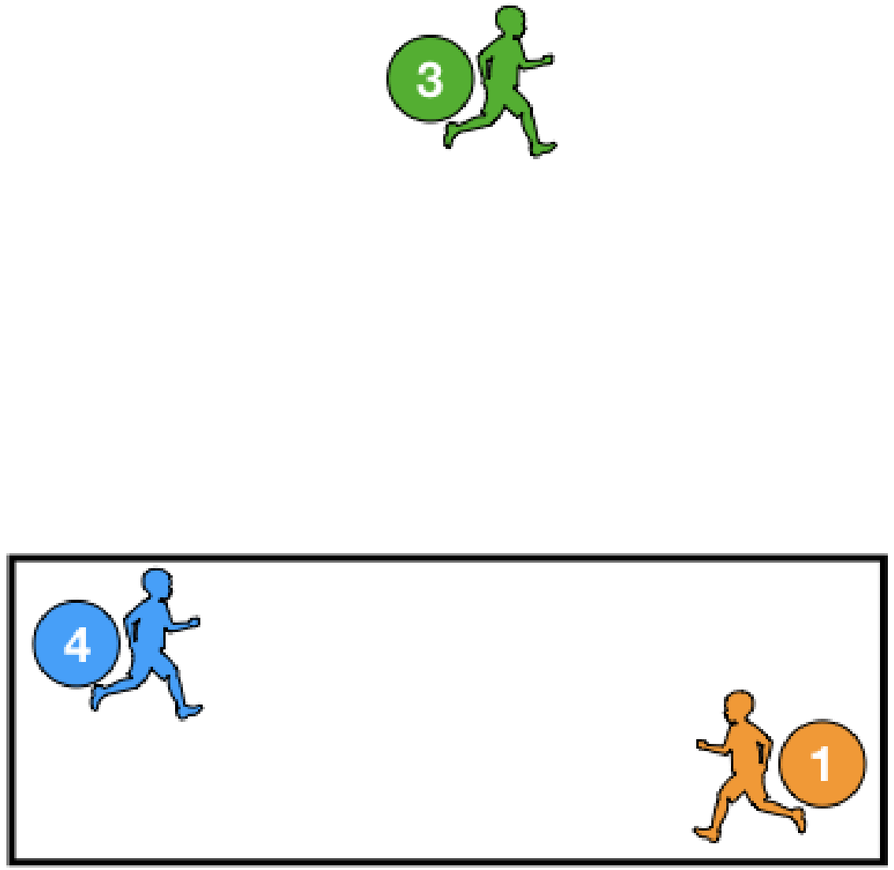
Grouping with linkage & distance



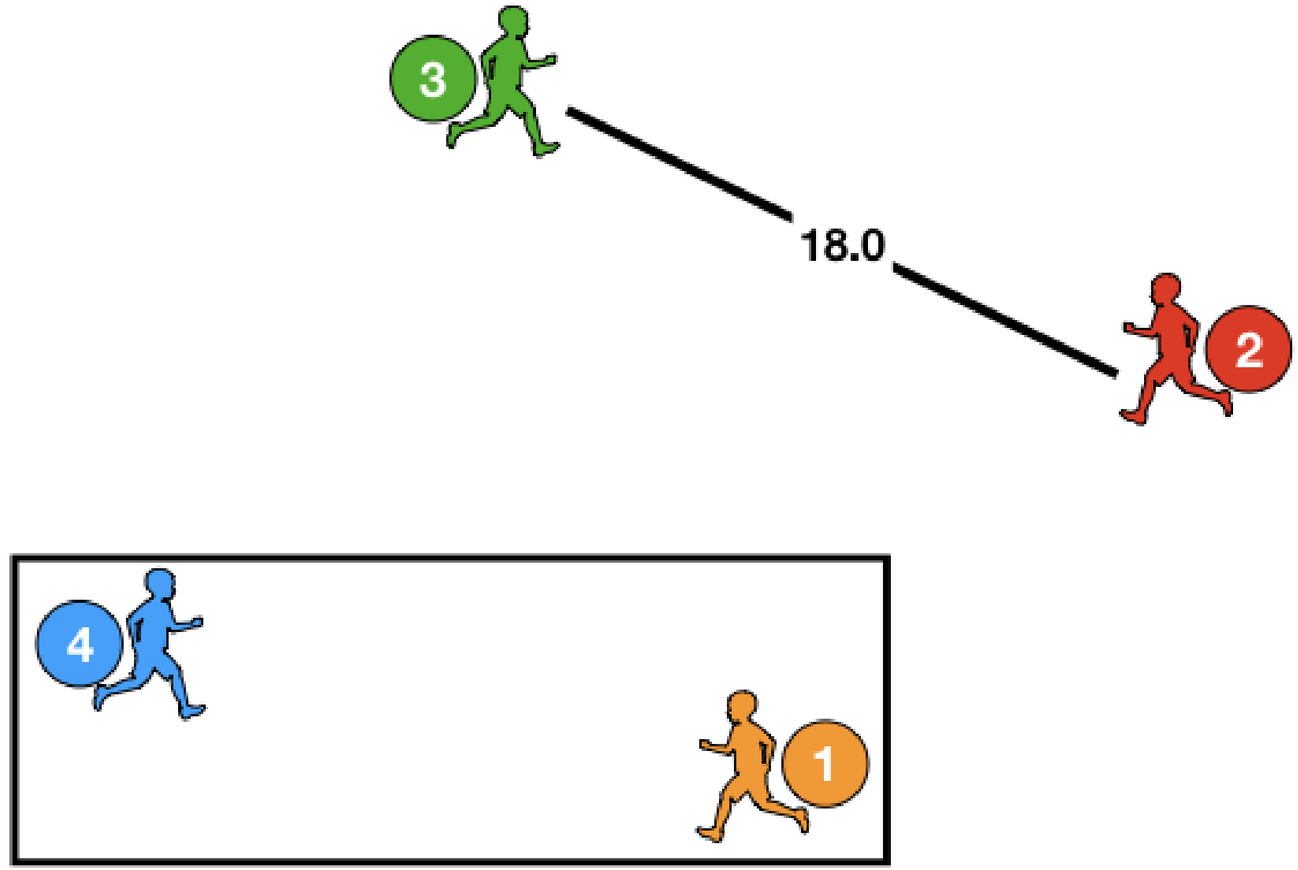
Grouping with linkage & distance



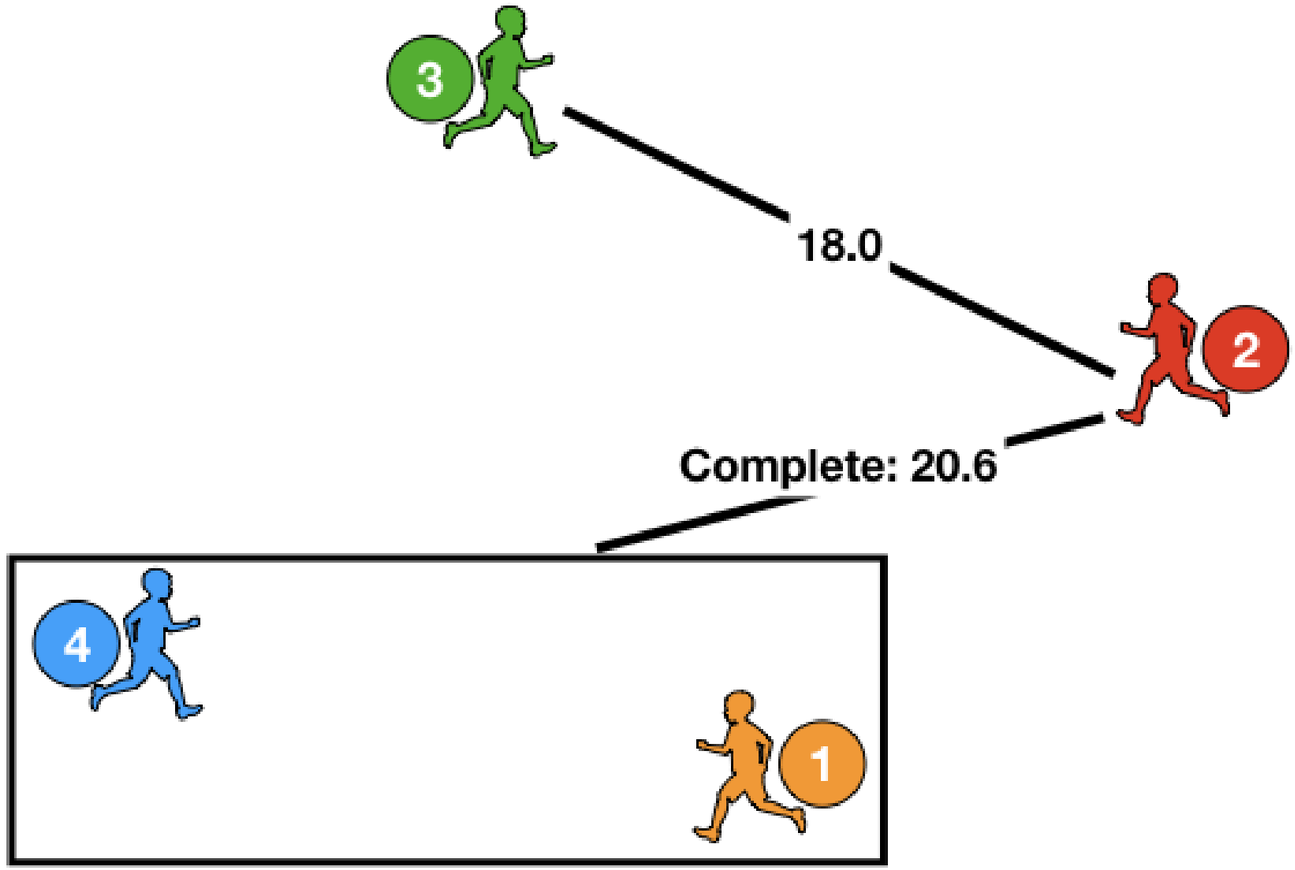
Grouping with linkage & distance



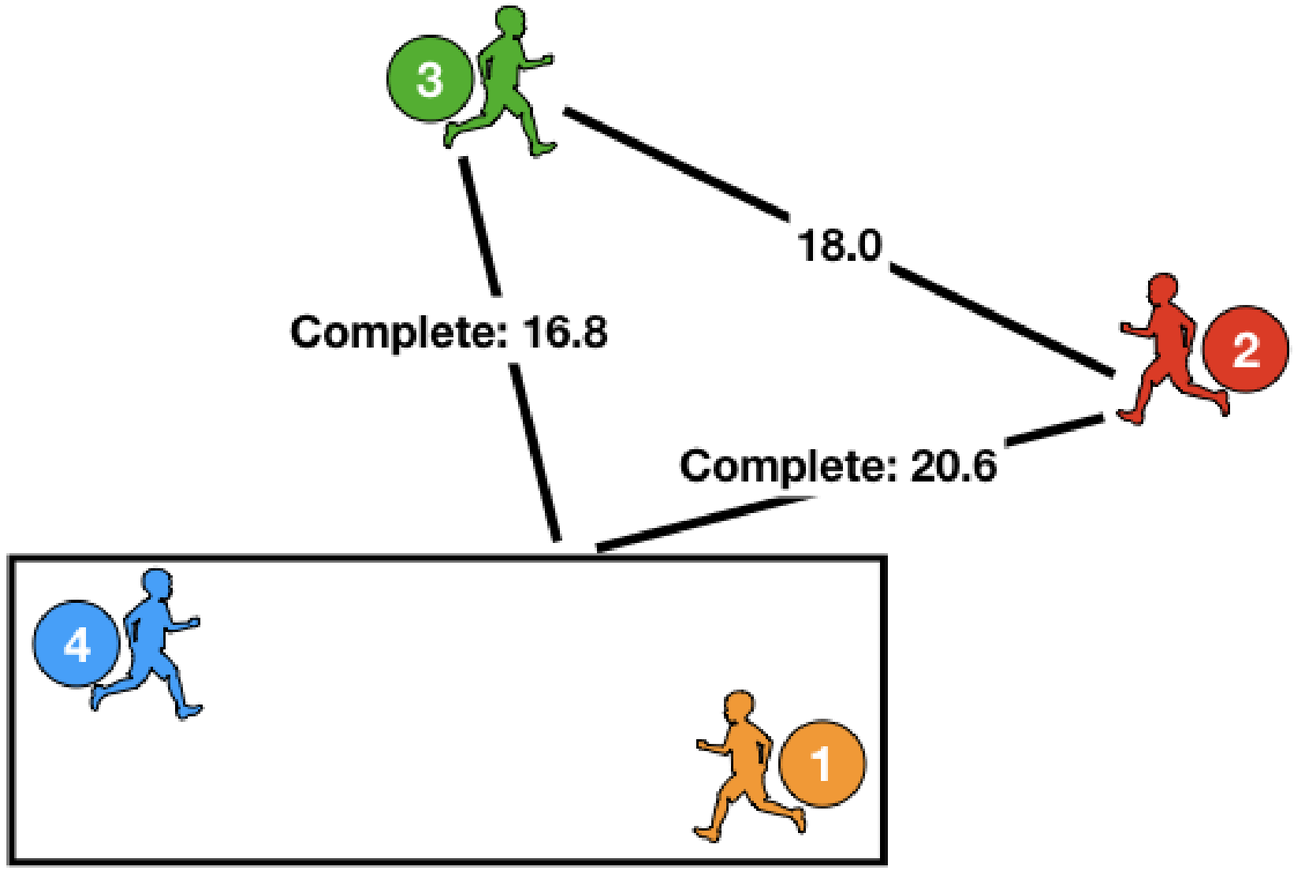
Grouping with linkage & distance



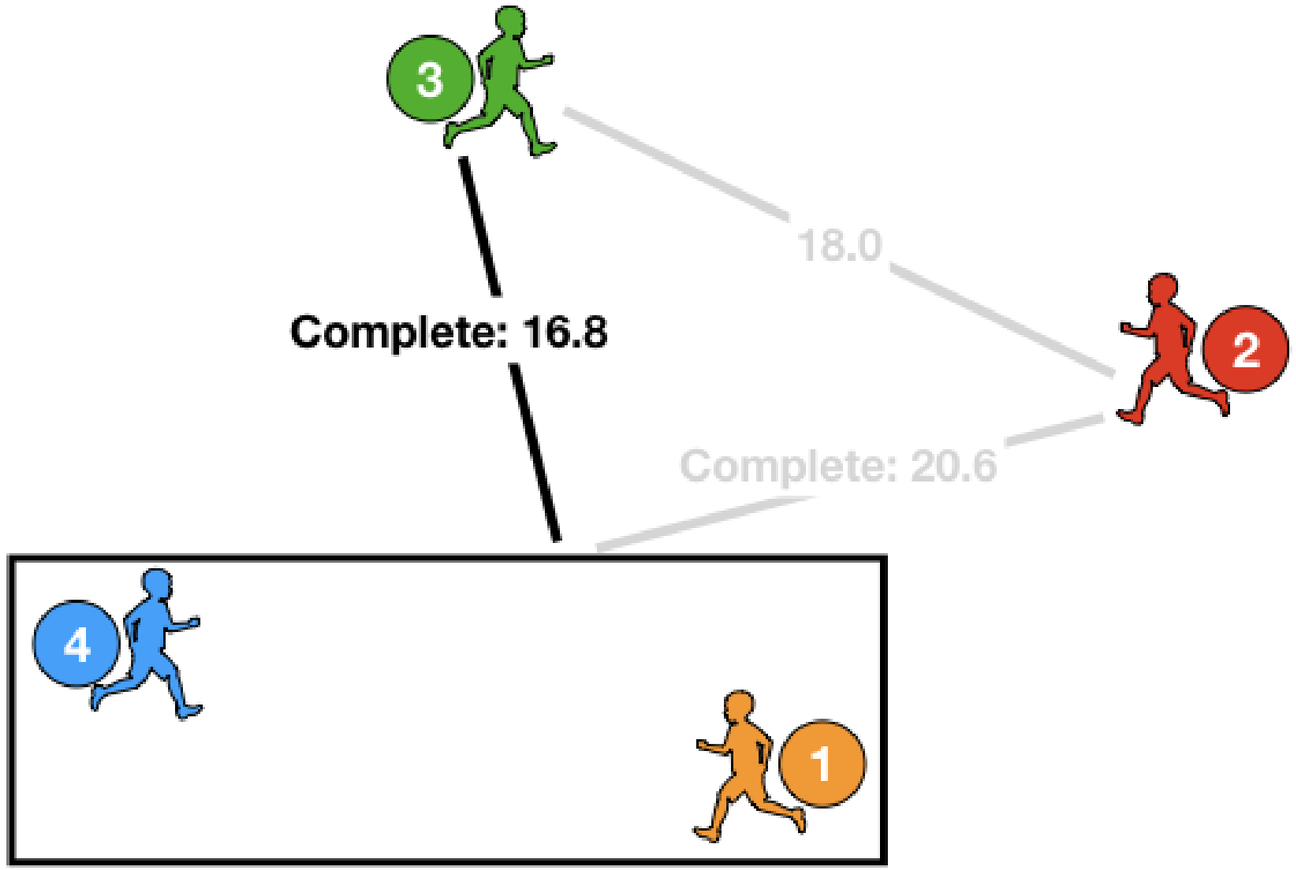
Grouping with linkage & distance



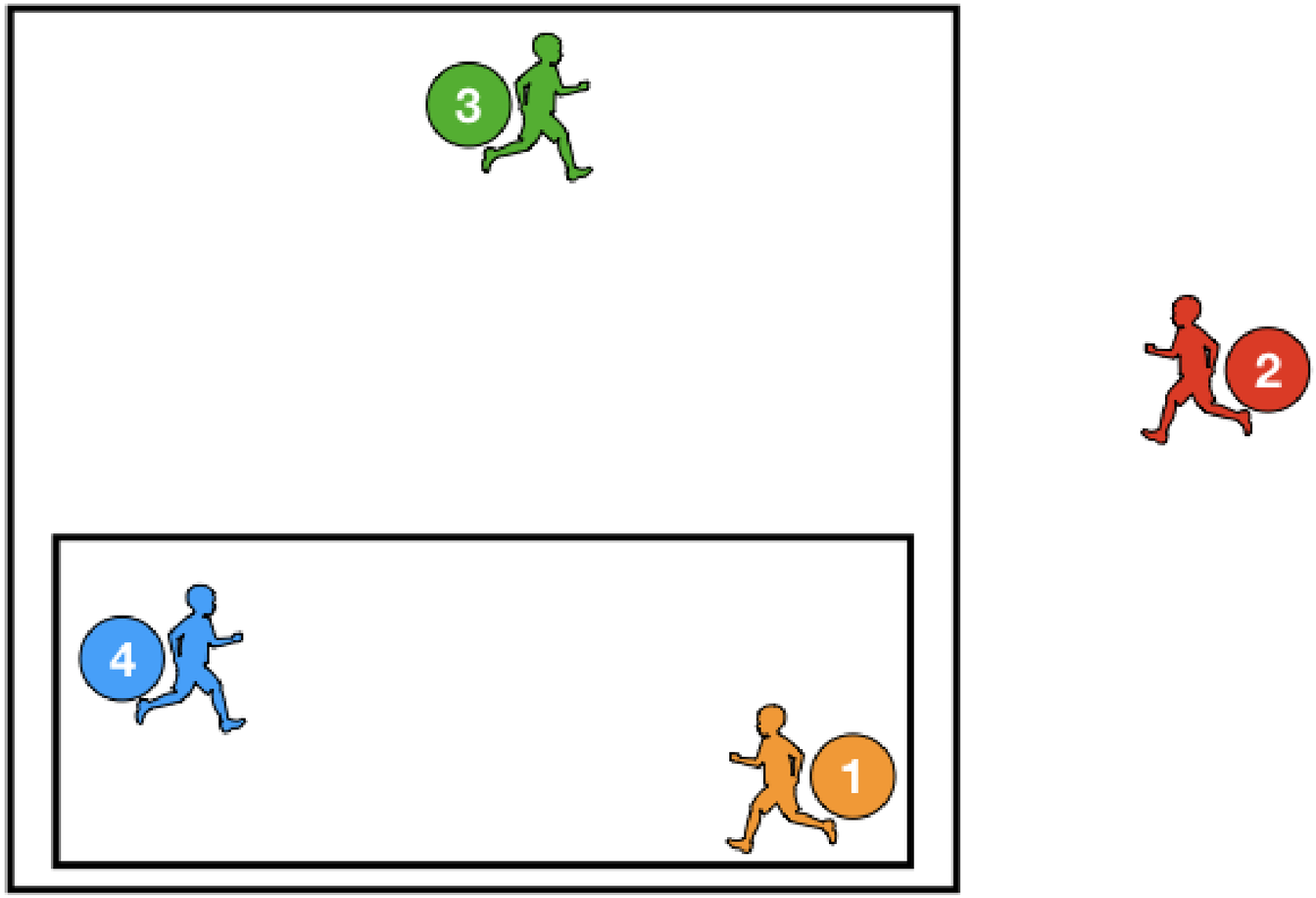
Grouping with linkage & distance



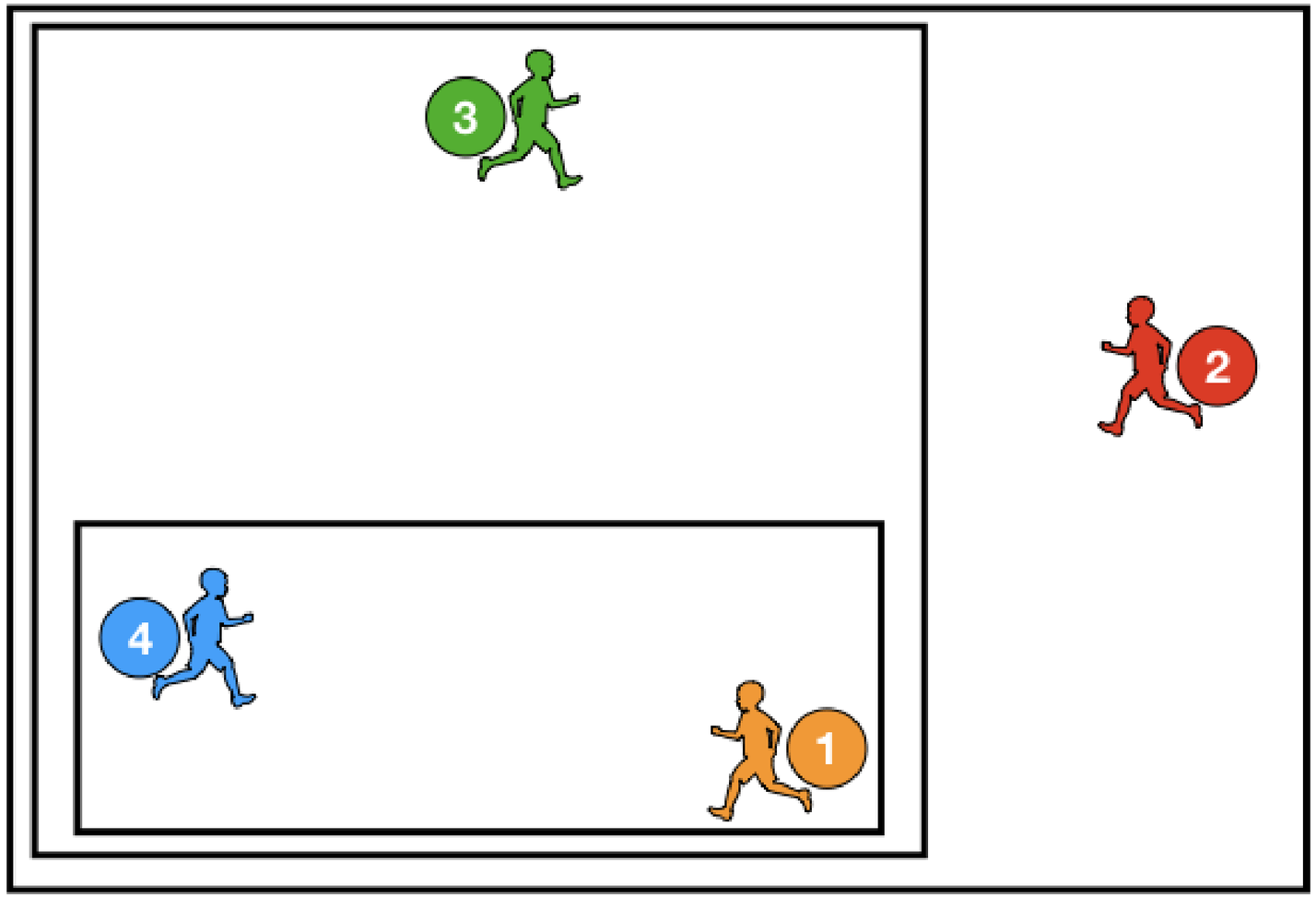
Grouping with linkage & distance



Grouping with linkage & distance



Grouping with linkage & distance



Linkage criteria

Complete Linkage: maximum distance between two sets

Single Linkage: minimum distance between two sets

Average Linkage: average distance between two sets

Let's practice!

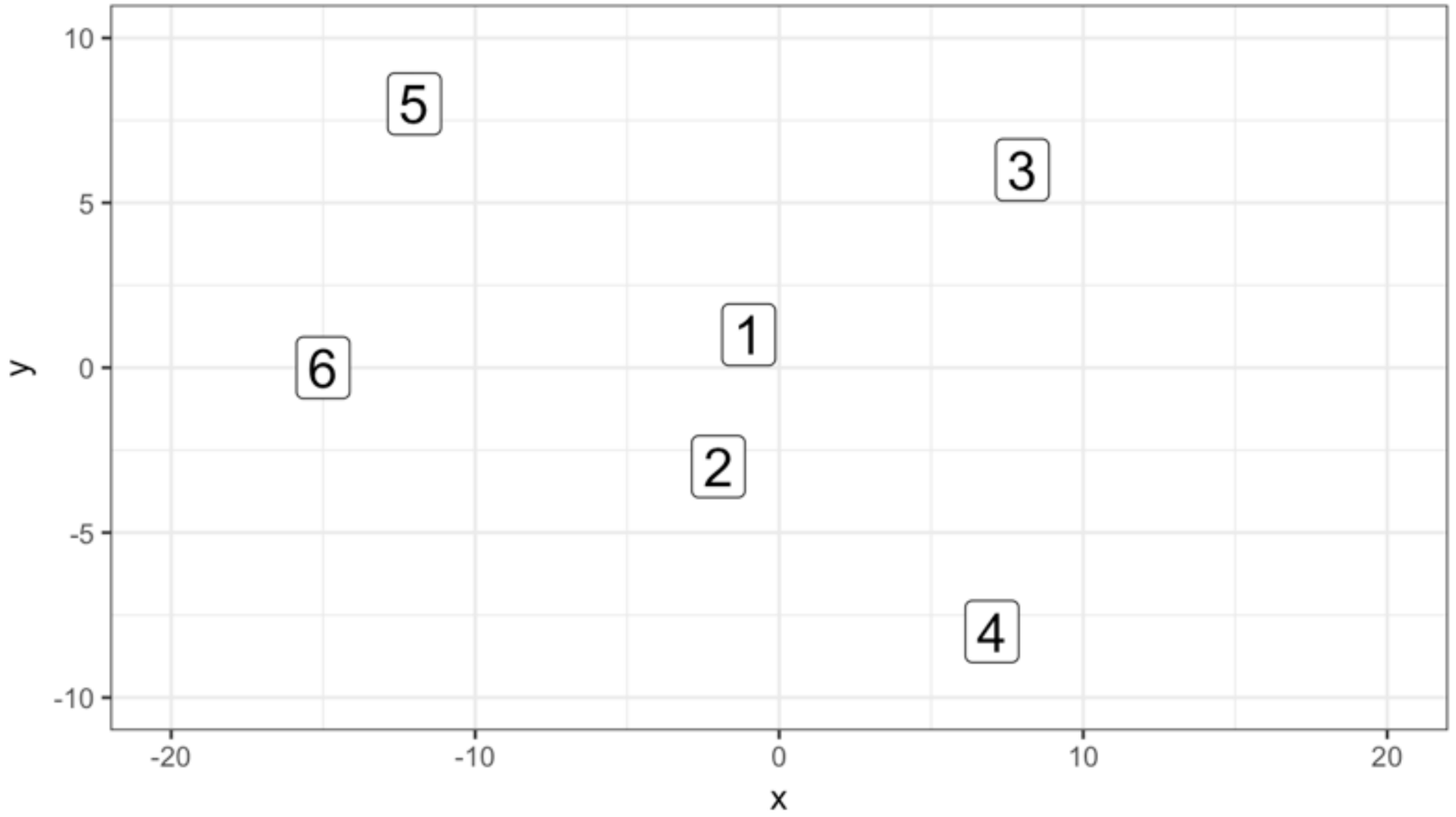
CLUSTER ANALYSIS IN R

Capturing K clusters

CLUSTER ANALYSIS IN R

Dmitriy Gorenshteyn

Lead Data Scientist, Memorial Sloan Kettering Cancer Center


10
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20
x
5
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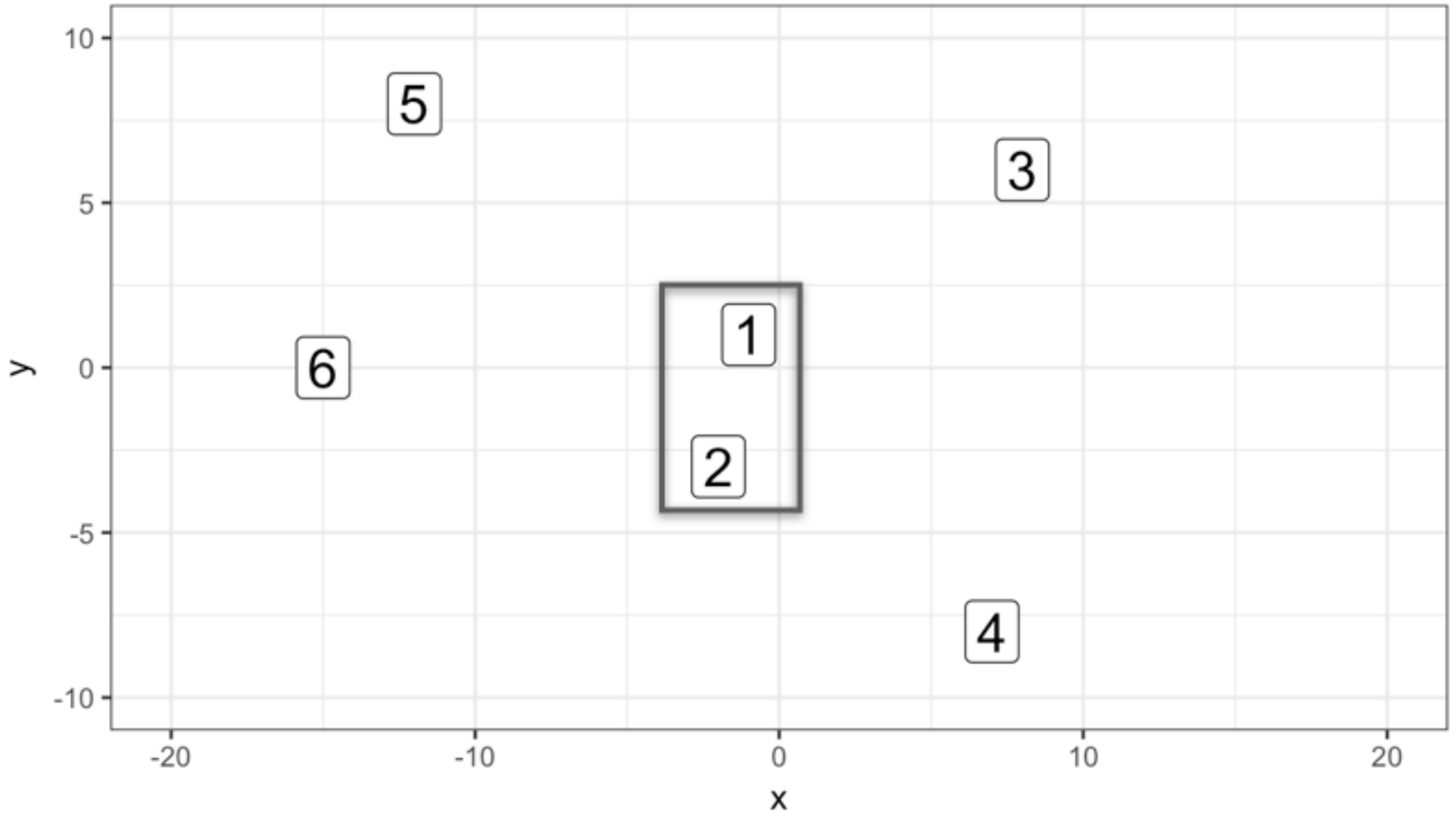
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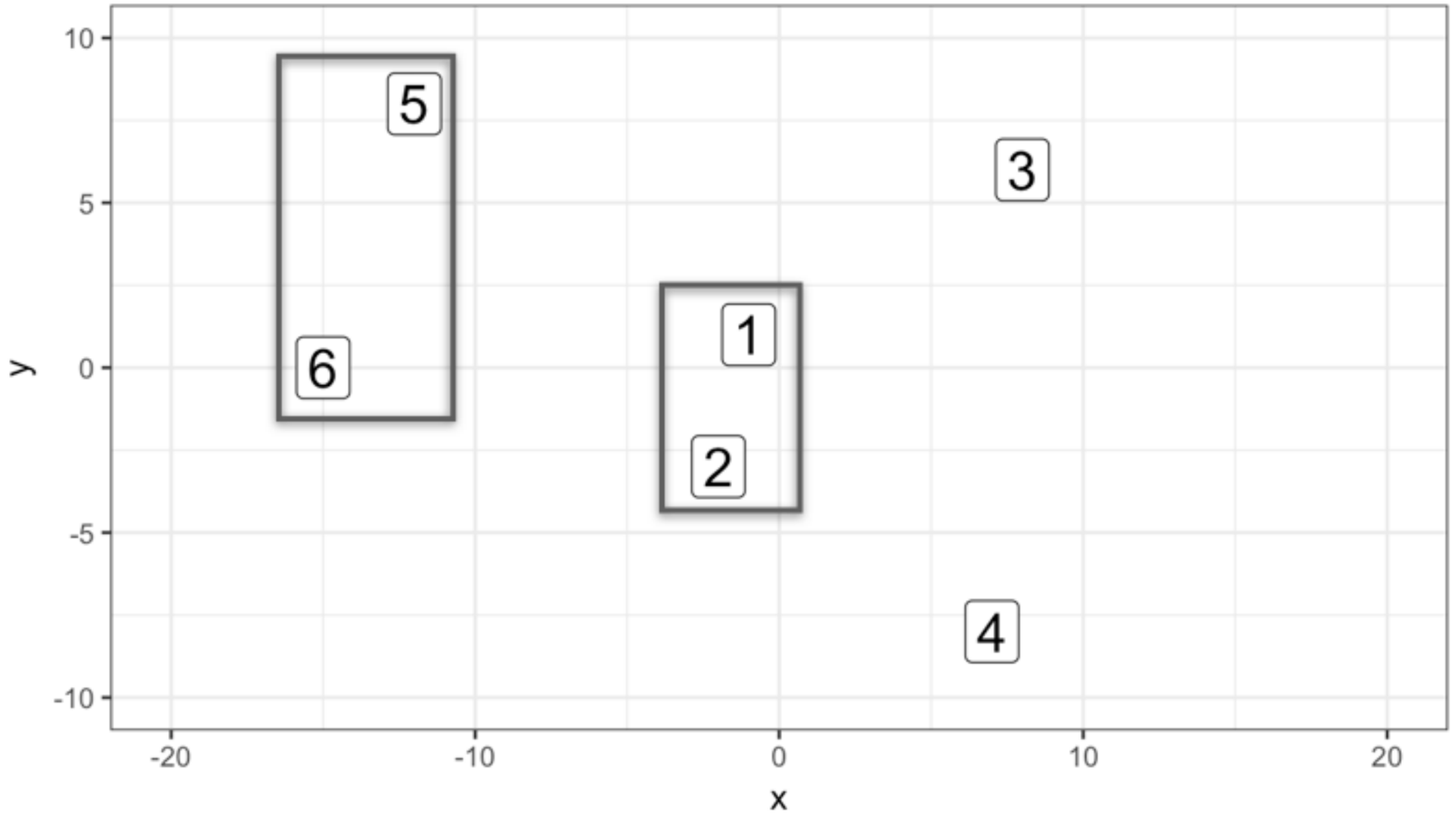
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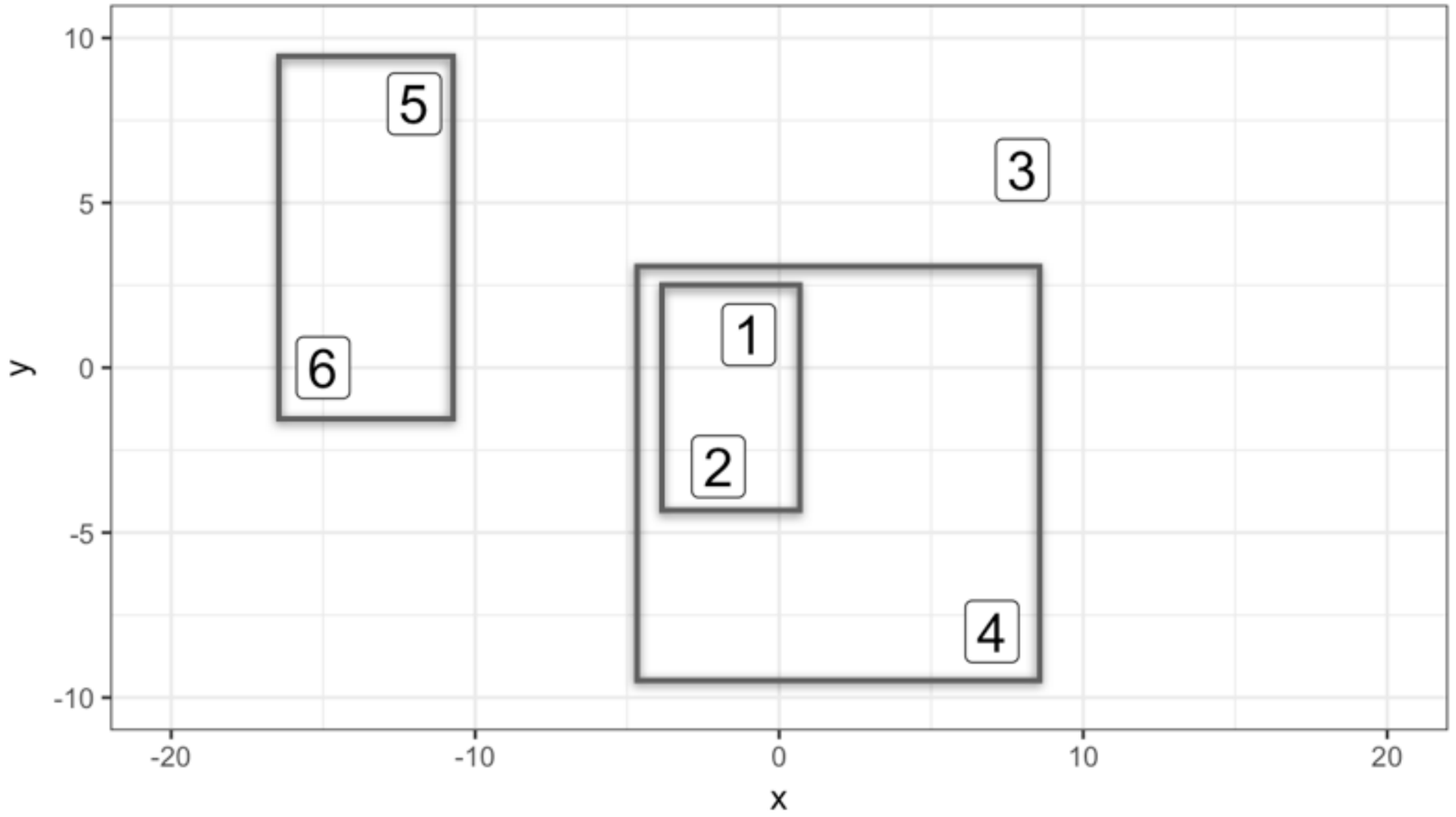
10
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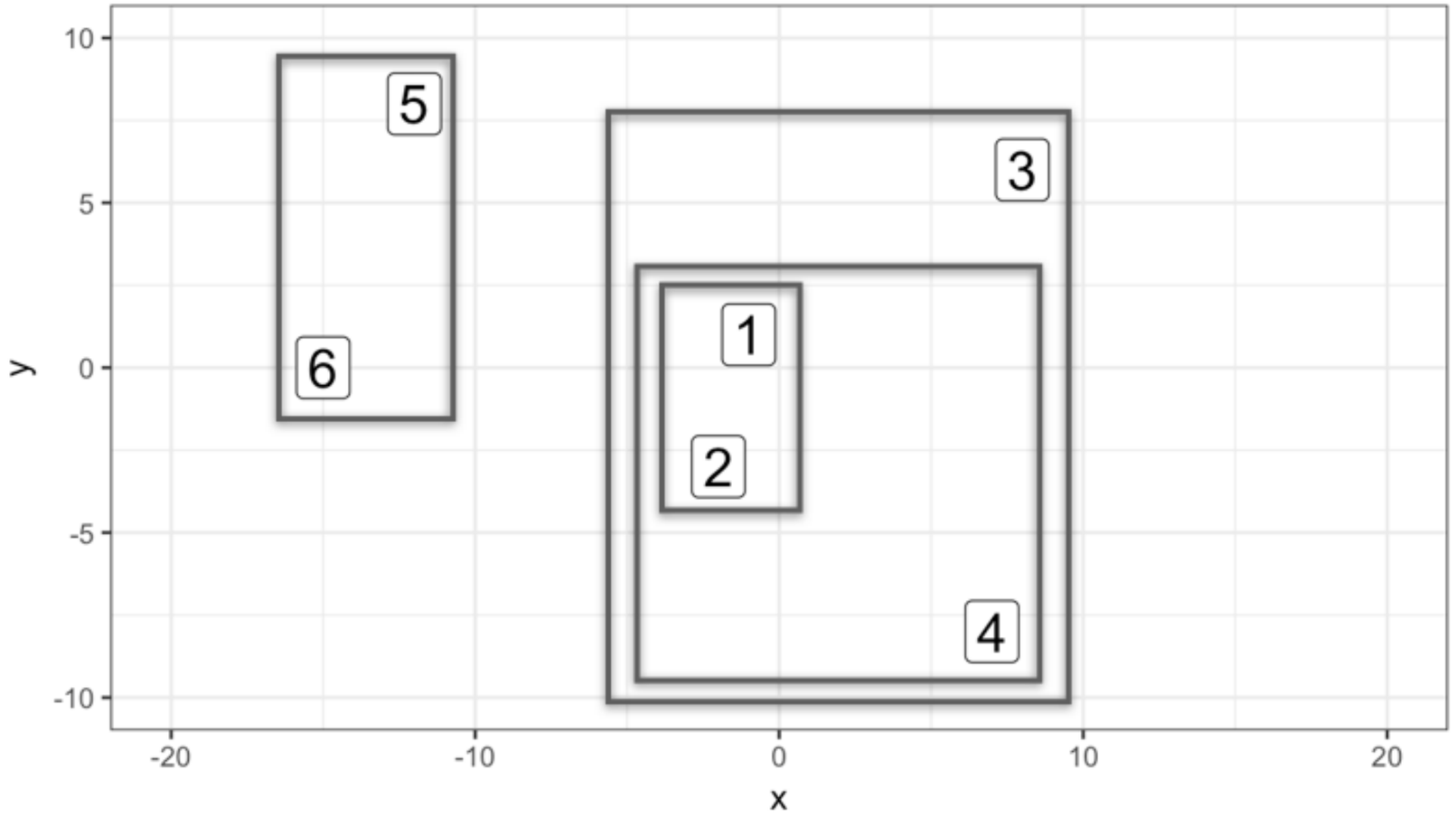
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y
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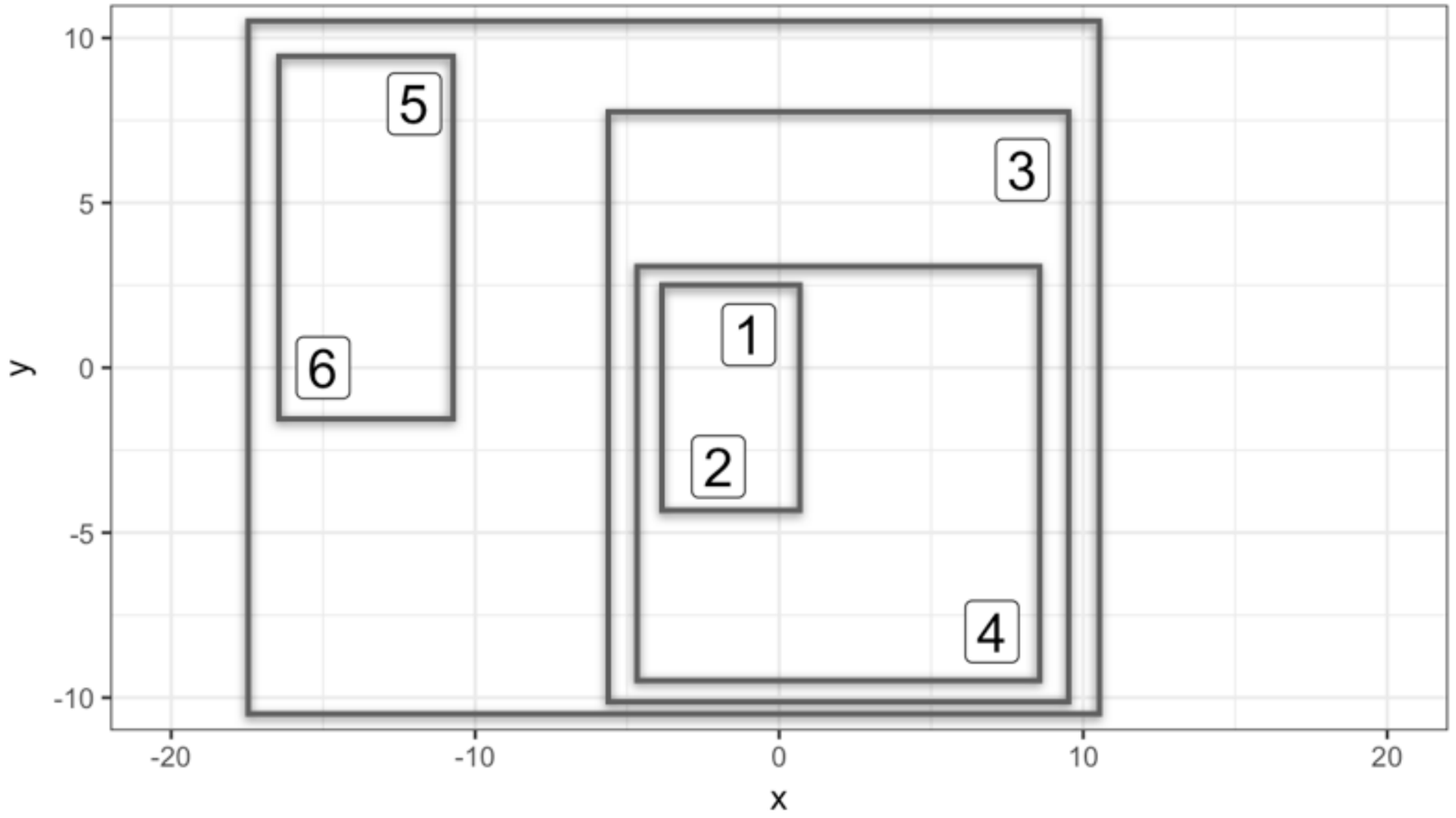
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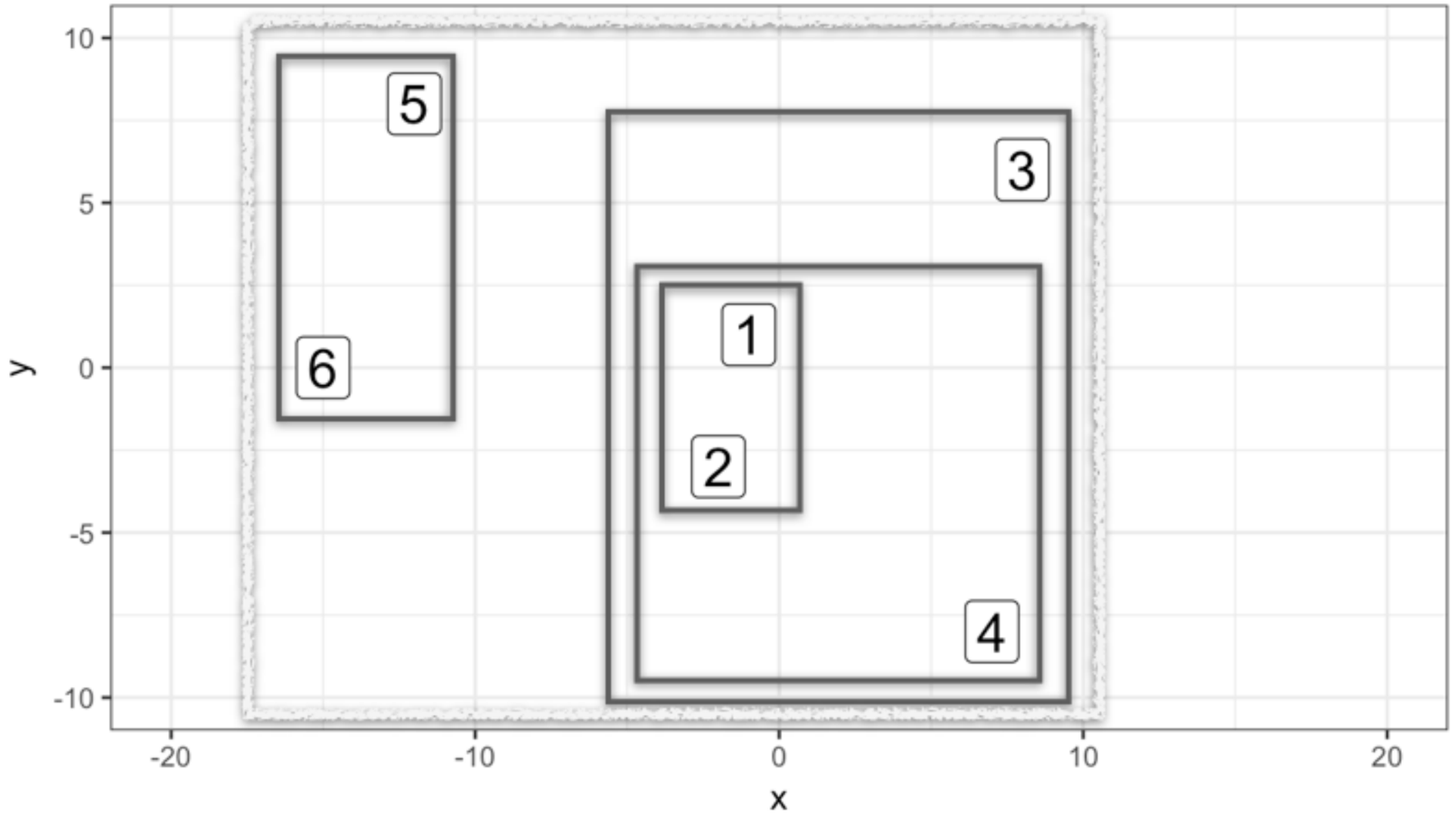
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20
x
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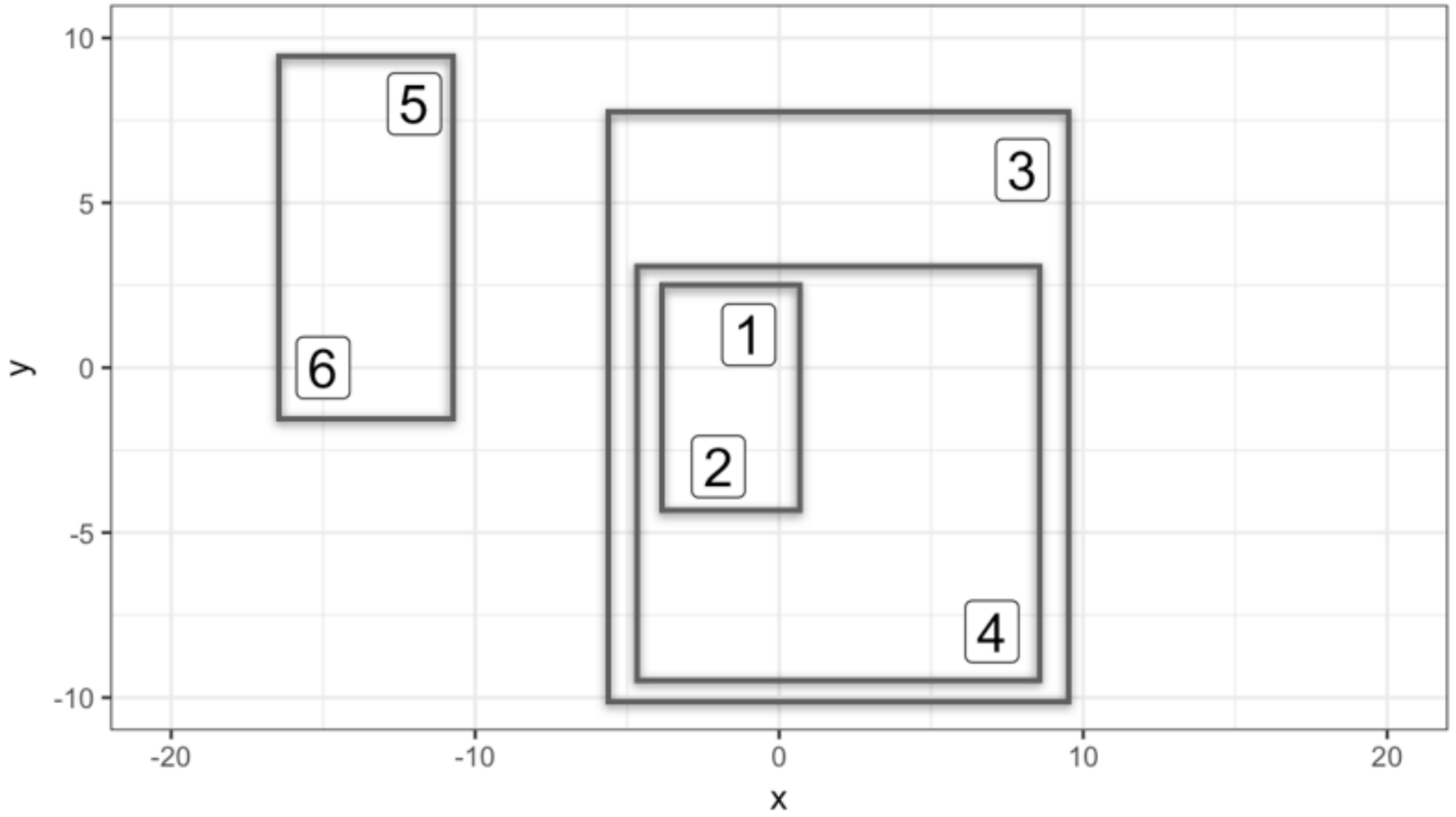
2
4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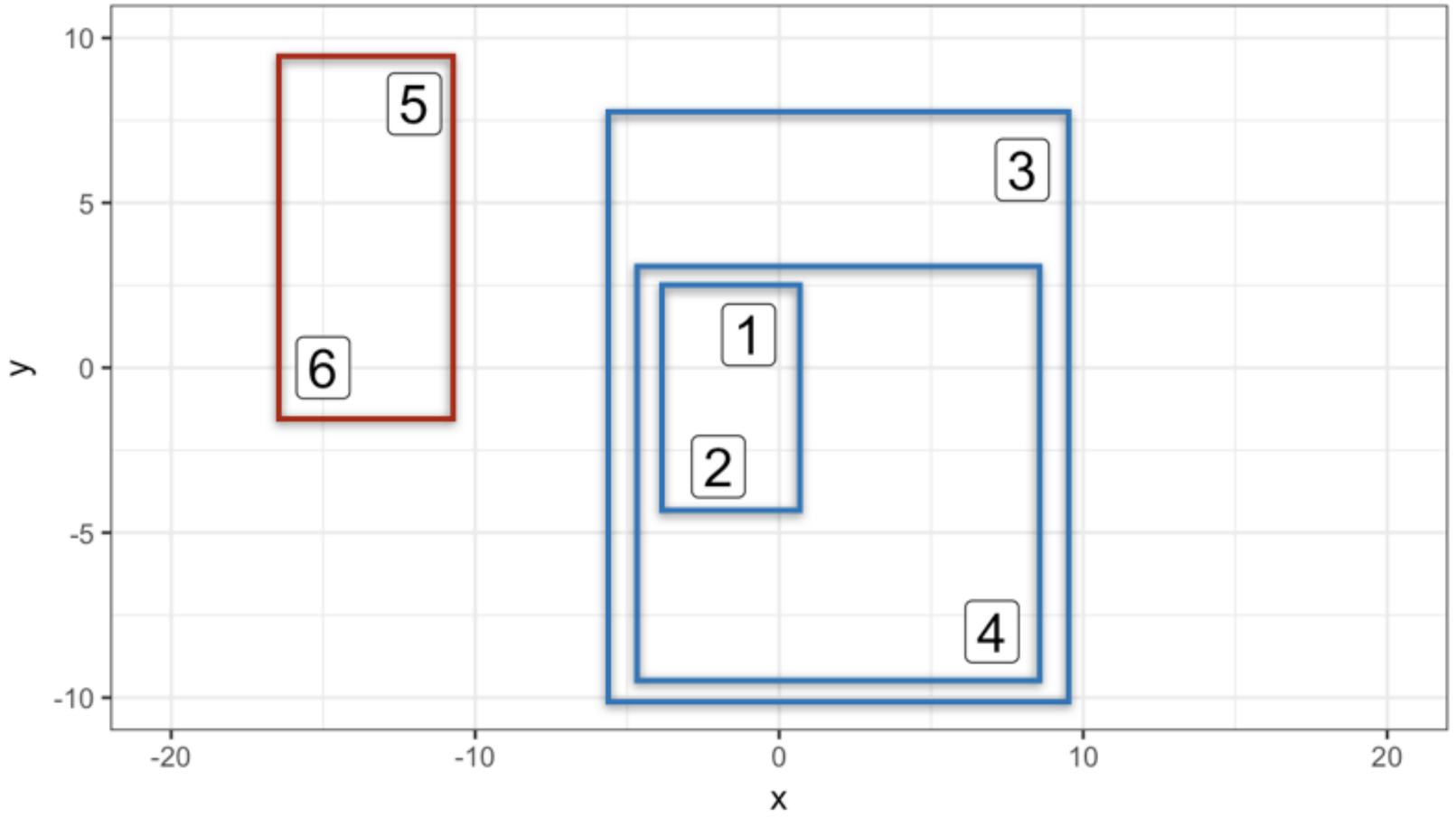
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y
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x
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3
1
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2
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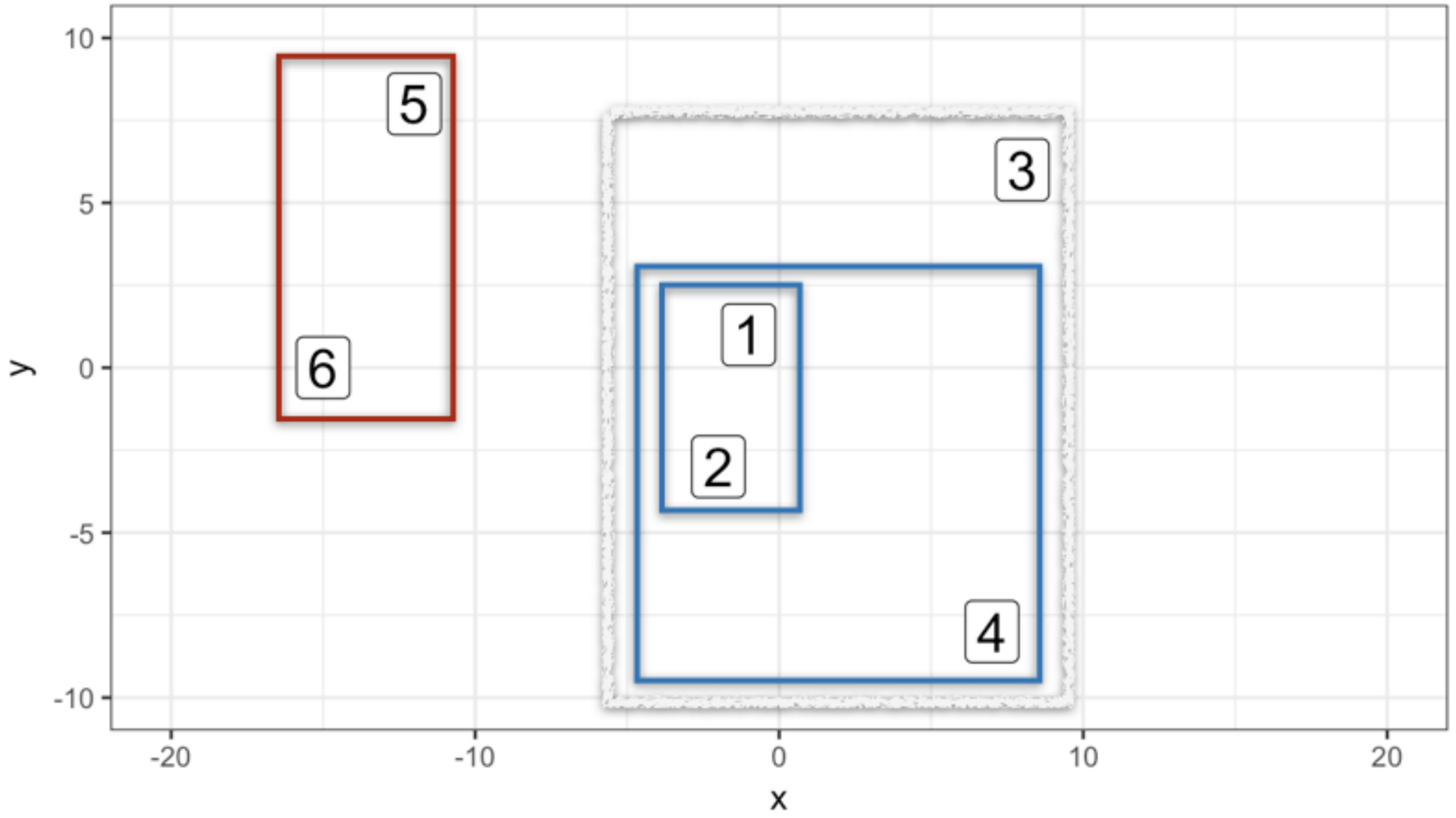
10
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y
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-10
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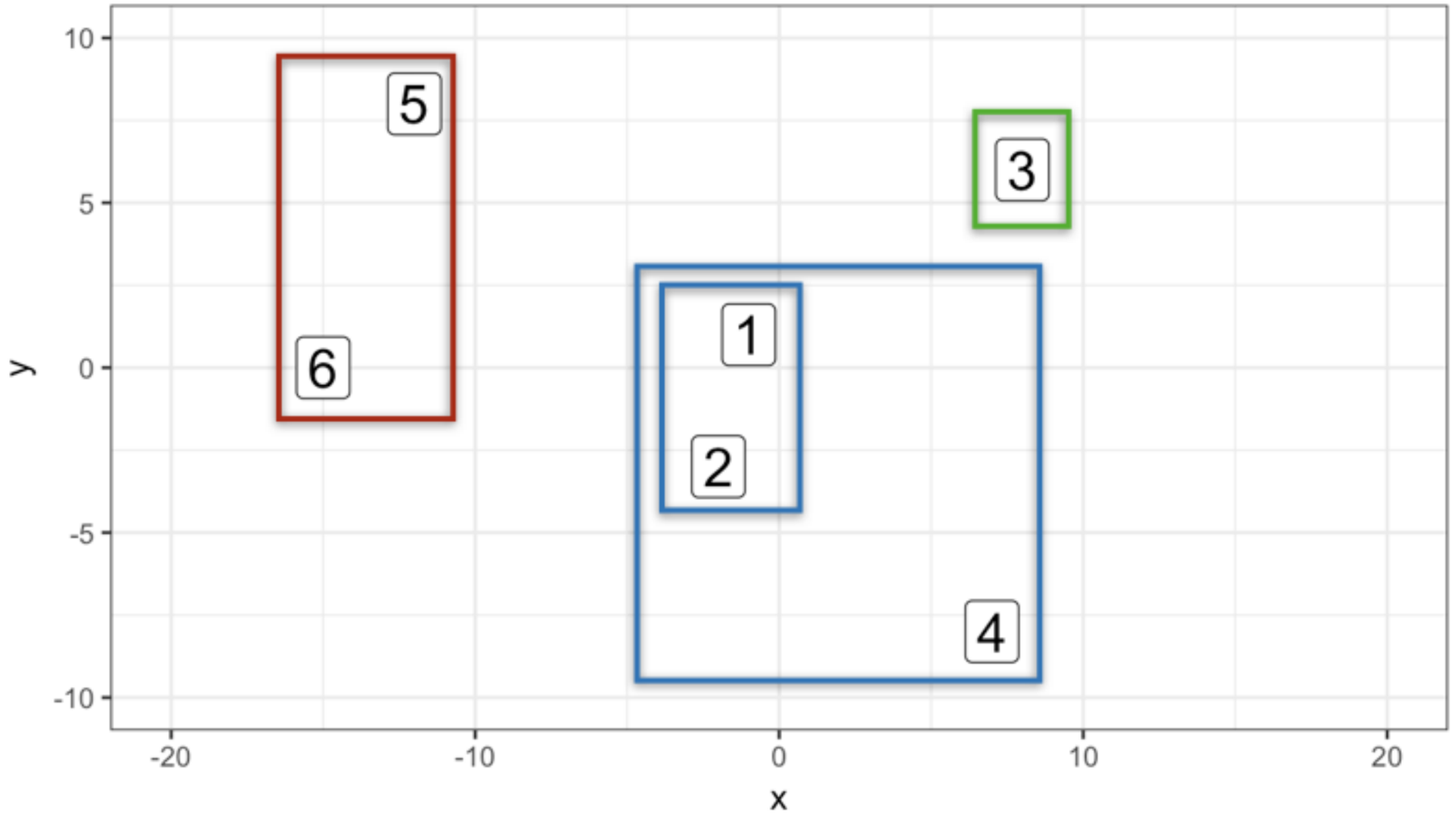
20
x
5
6
3
1
2
4


10
5
0
-5
-10
y
-20
-10
0
10
20
x
5
3
1
6
2
4

Hierarchical clustering in R

```
print(players)
```

```
      x     y
   <dbl> <dbl>
1    -1     1
2    -2    -3
3     8     6
4     7    -8
5   -12     8
6   -15     0
```

```
dist_players <- dist(players, method = 'euclidean')
hc_players <- hclust(dist_players, method = 'complete')
```

Extracting K clusters

```
cluster_assignments <- cutree(hc_players, k = 2)
print(cluster_assignments)
```

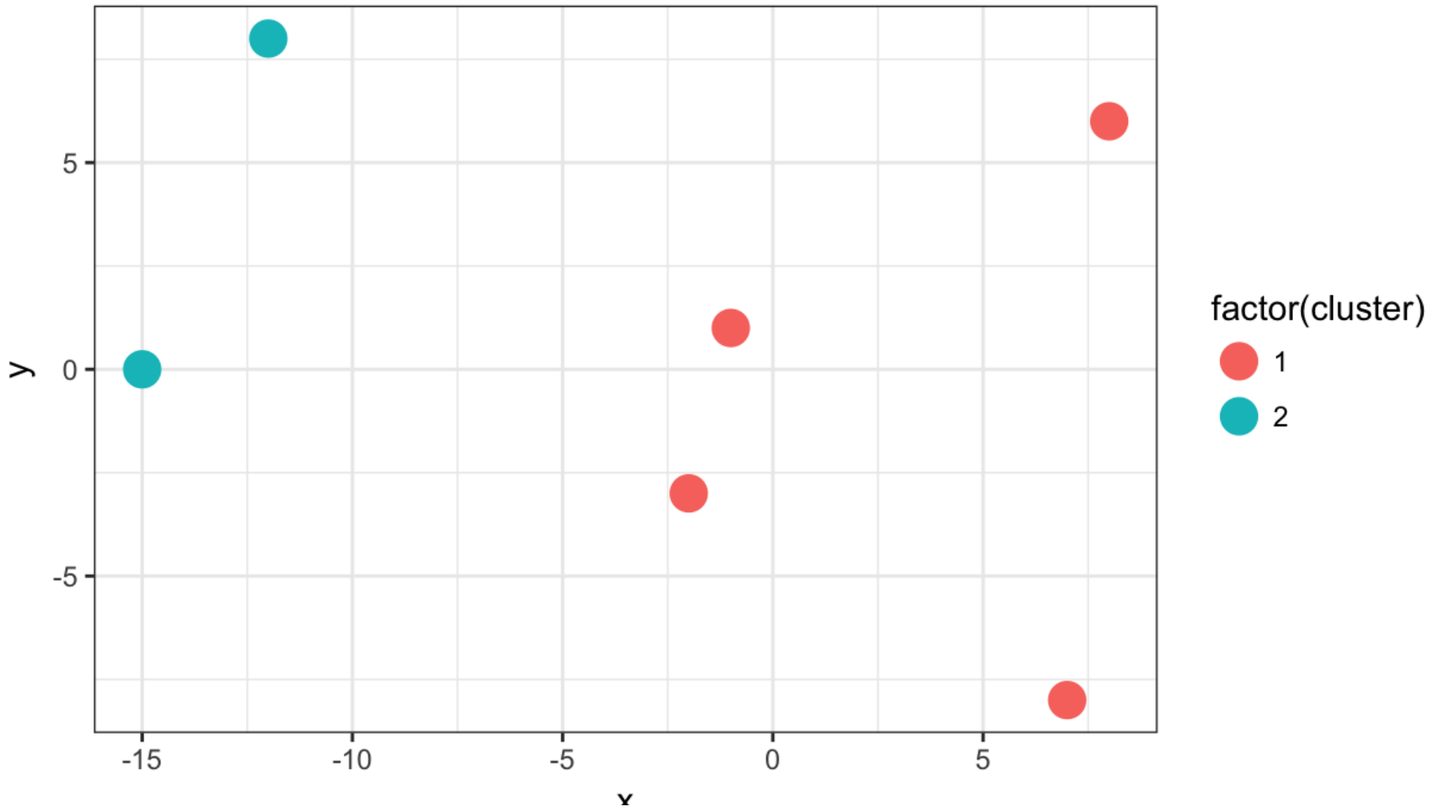
```
[1] 1 1 1 1 2 2
```

```
library(dplyr)
players_clustered <- mutate(players, cluster = cluster_assignments)
print(players_clustered)
```

```
      x     y cluster
  <dbl> <dbl>   <int>
1    -1     1       1
2    -2    -3       1
3     8     6       1
4     7    -8       1
5   -12     8       2
6   -15     0       2
```

Visualizing K Clusters

```
library(ggplot2)
ggplot(players_clustered, aes(x = x, y = y, color = factor(cluster))) +
  geom_point()
```



Let's practice!

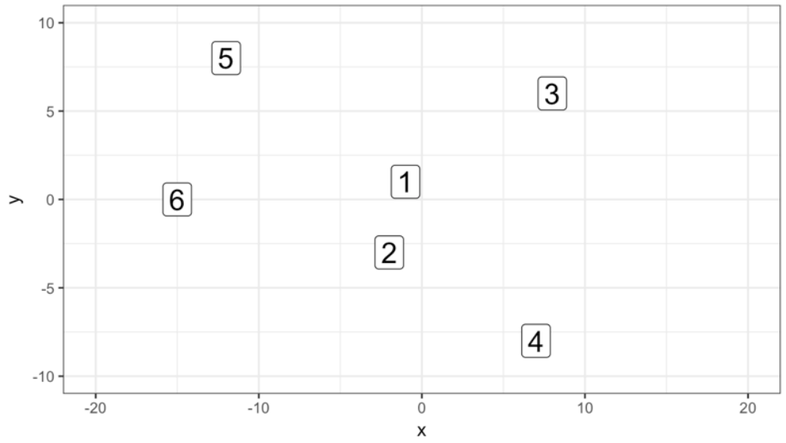
CLUSTER ANALYSIS IN R

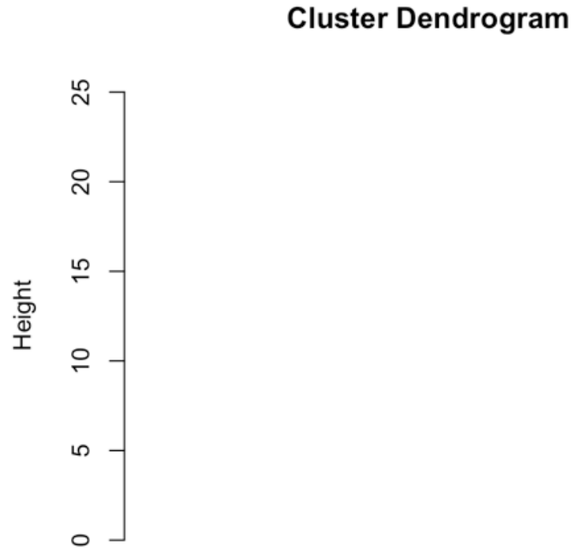
Visualizing the dendrogram

CLUSTER ANALYSIS IN R

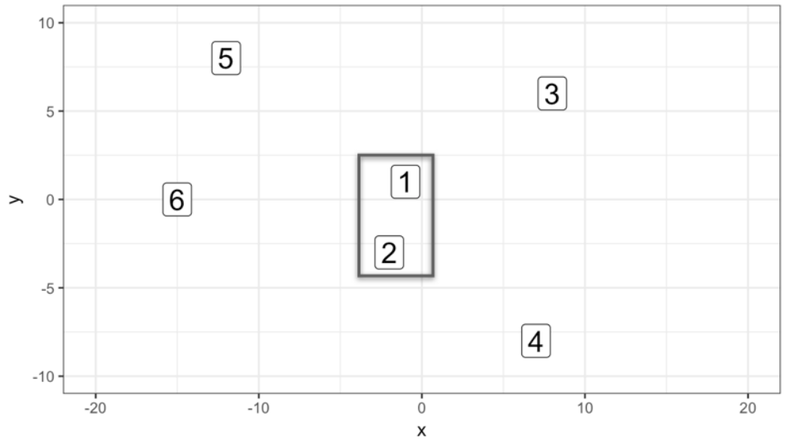
Dmitriy Gorenshteyn
Lead Data Scientist, Memorial Sloan Kettering Cancer Center

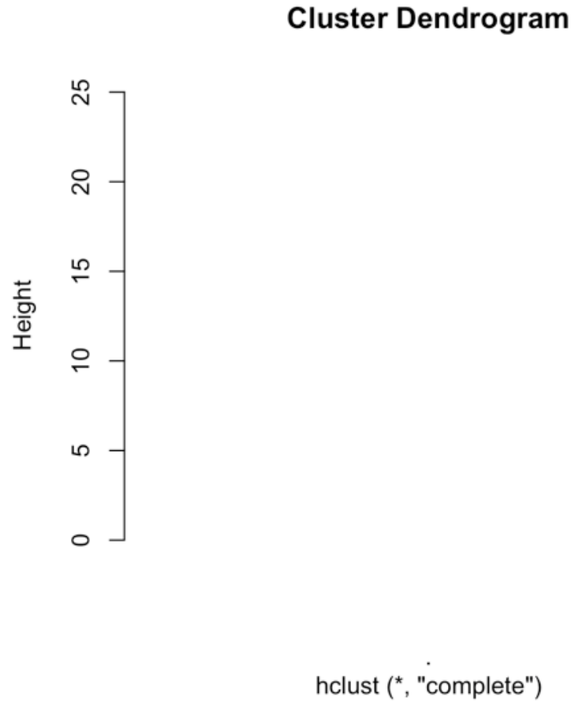
Building the dendrogram



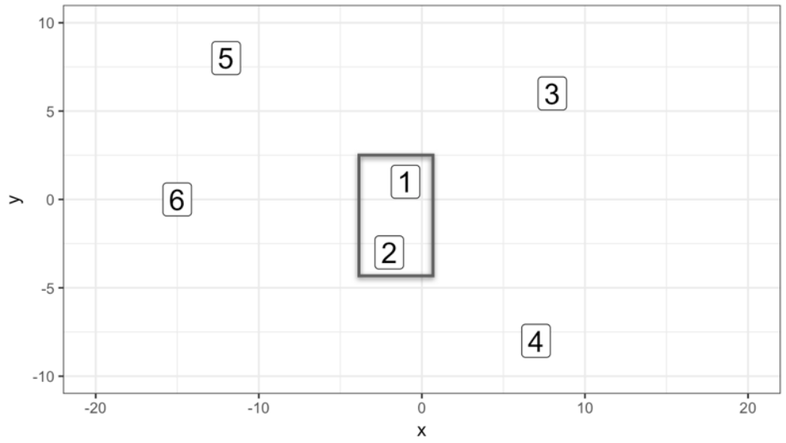


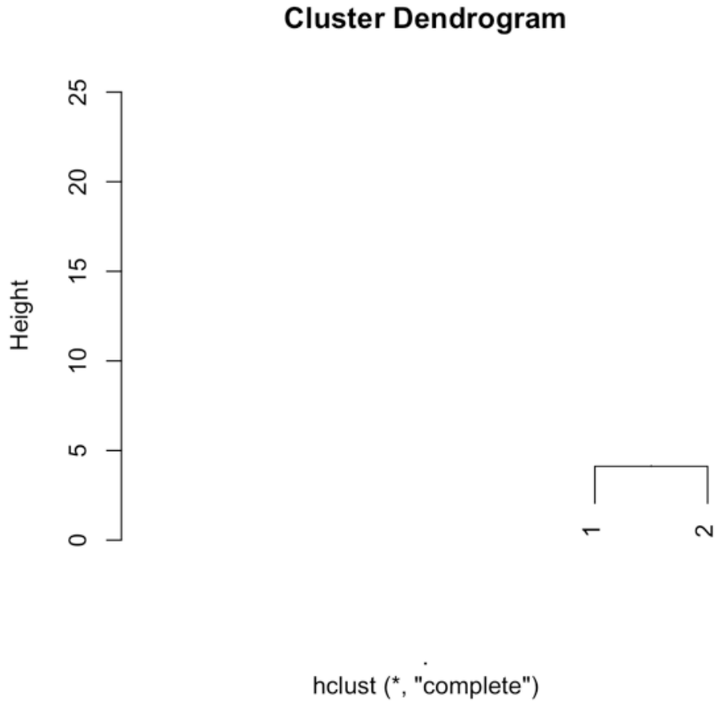
Building the dendrogram



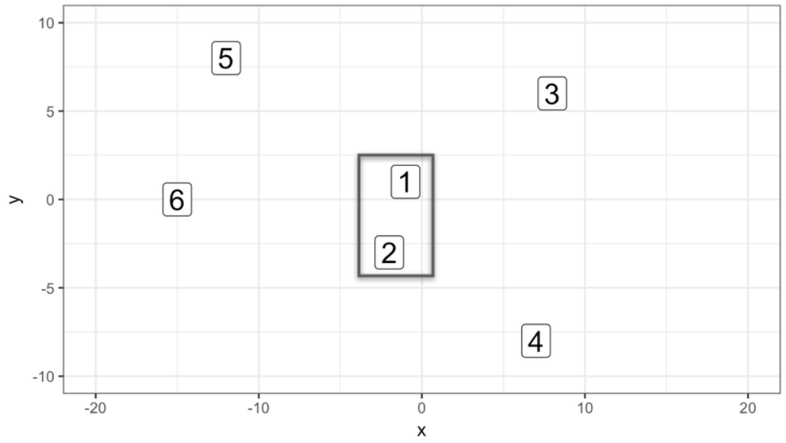


Building the dendrogram

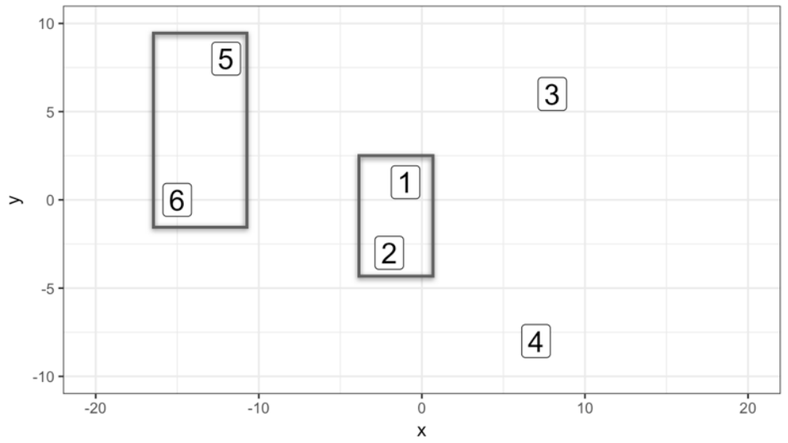


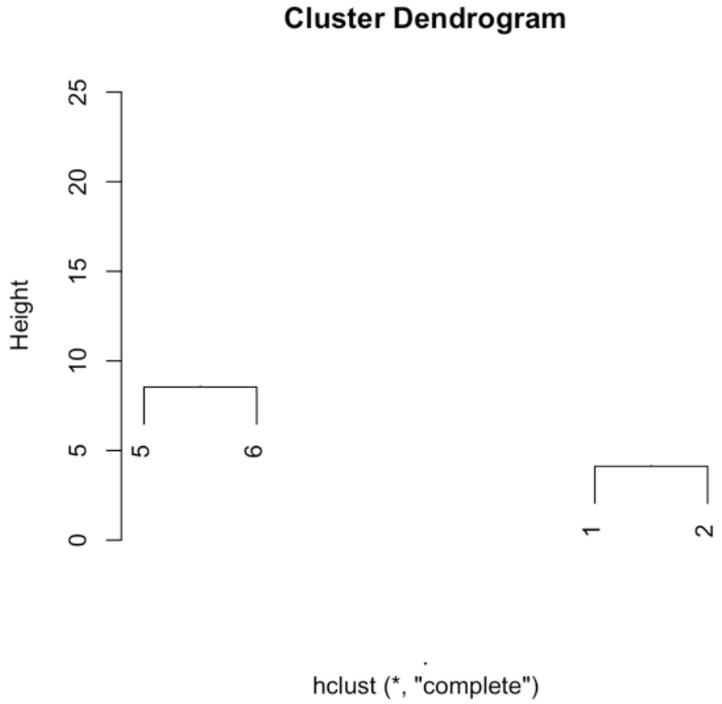


Building the dendrogram

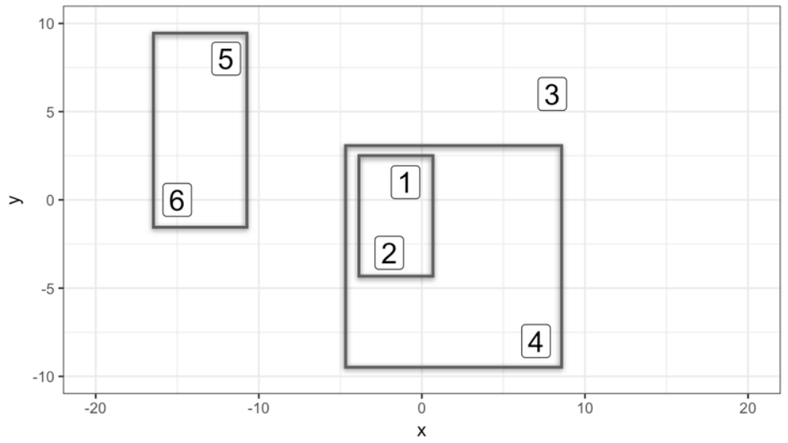


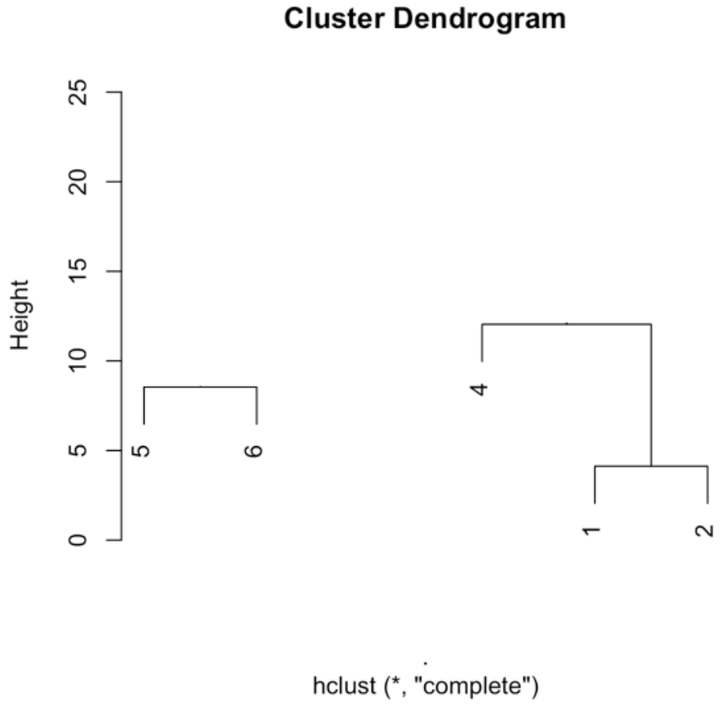
Building the dendrogram



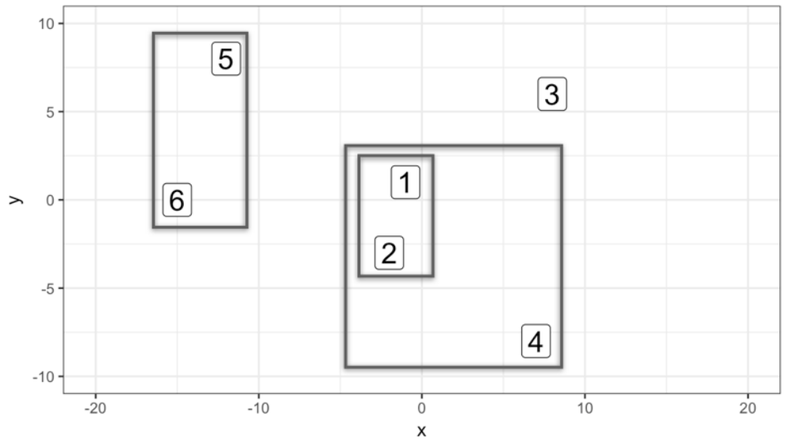


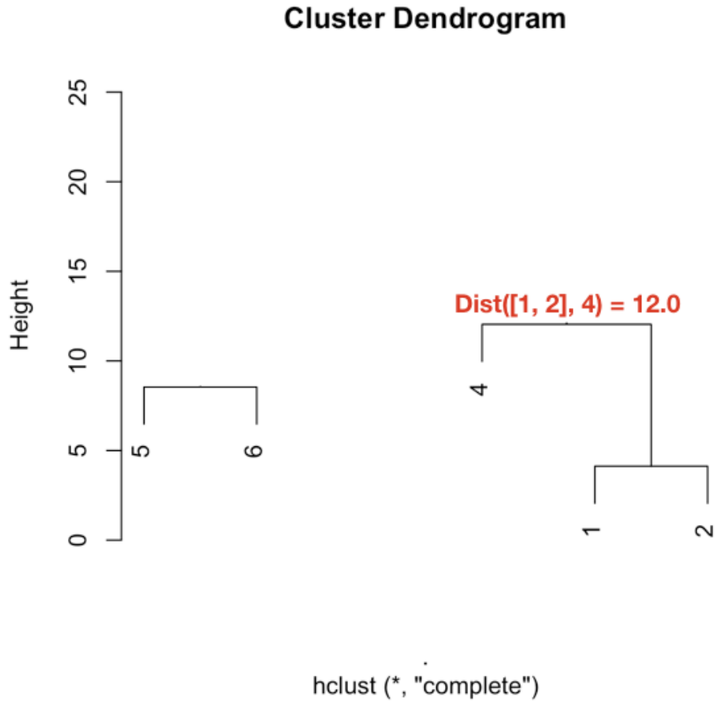
Building the dendrogram



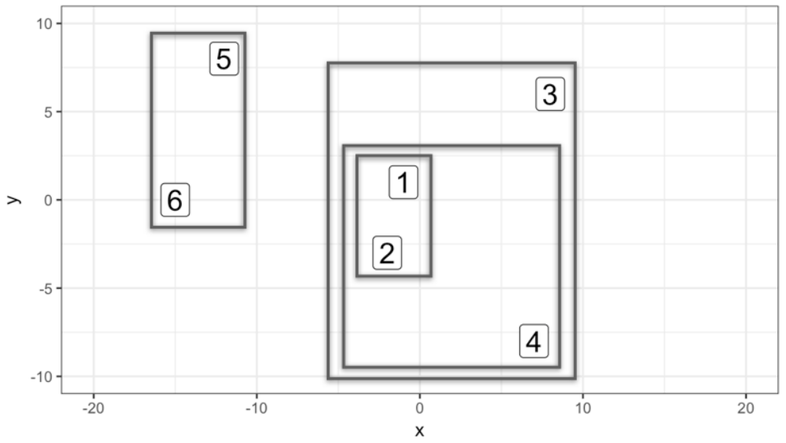


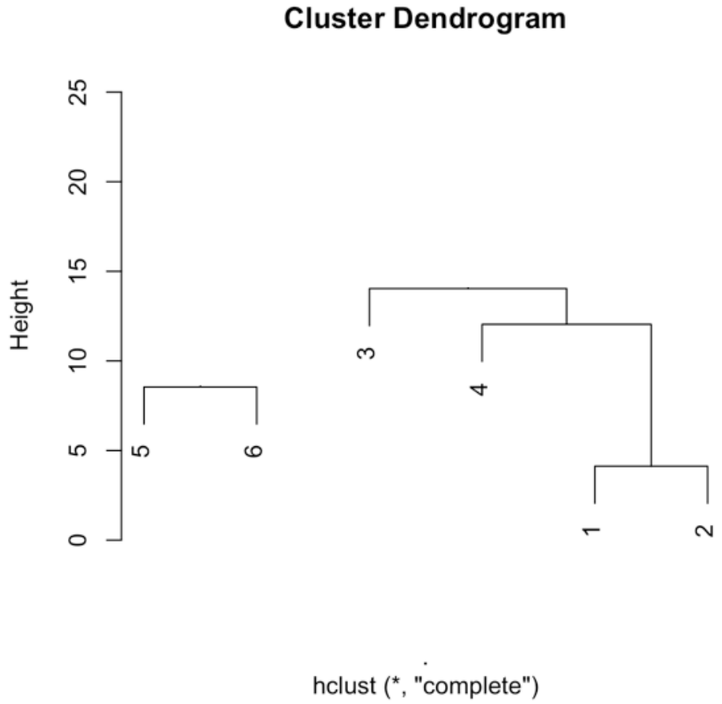
Building the dendrogram



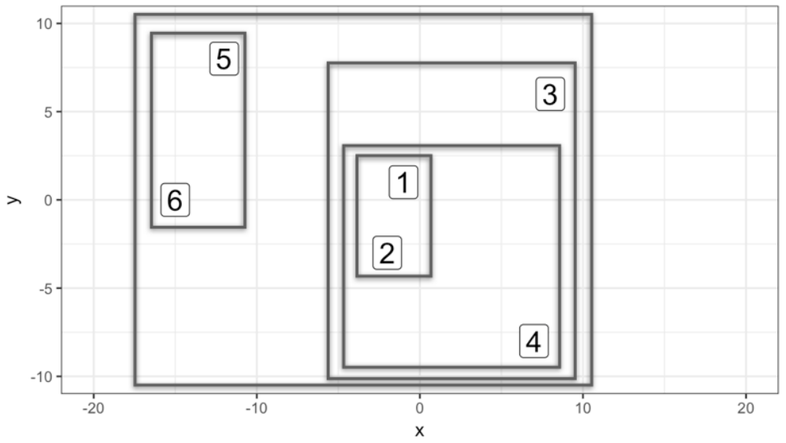


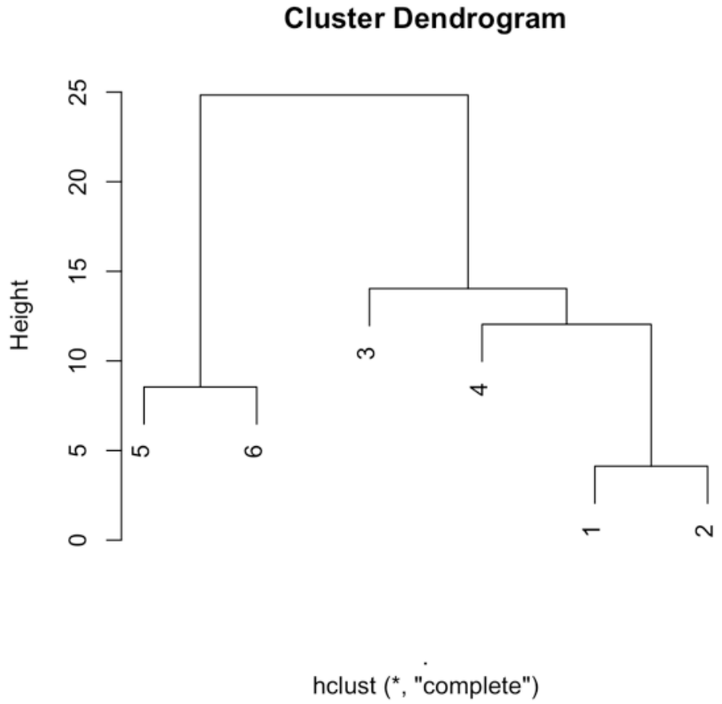
Building the dendrogram





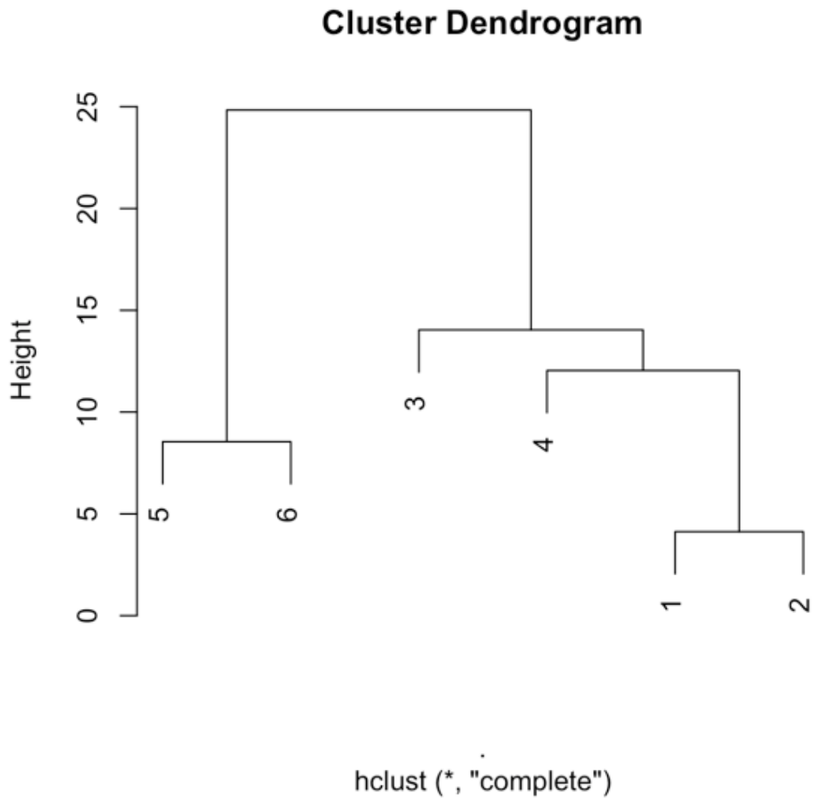
Building the dendrogram





Plotting the dendrogram

```
plot(hc_players)
```



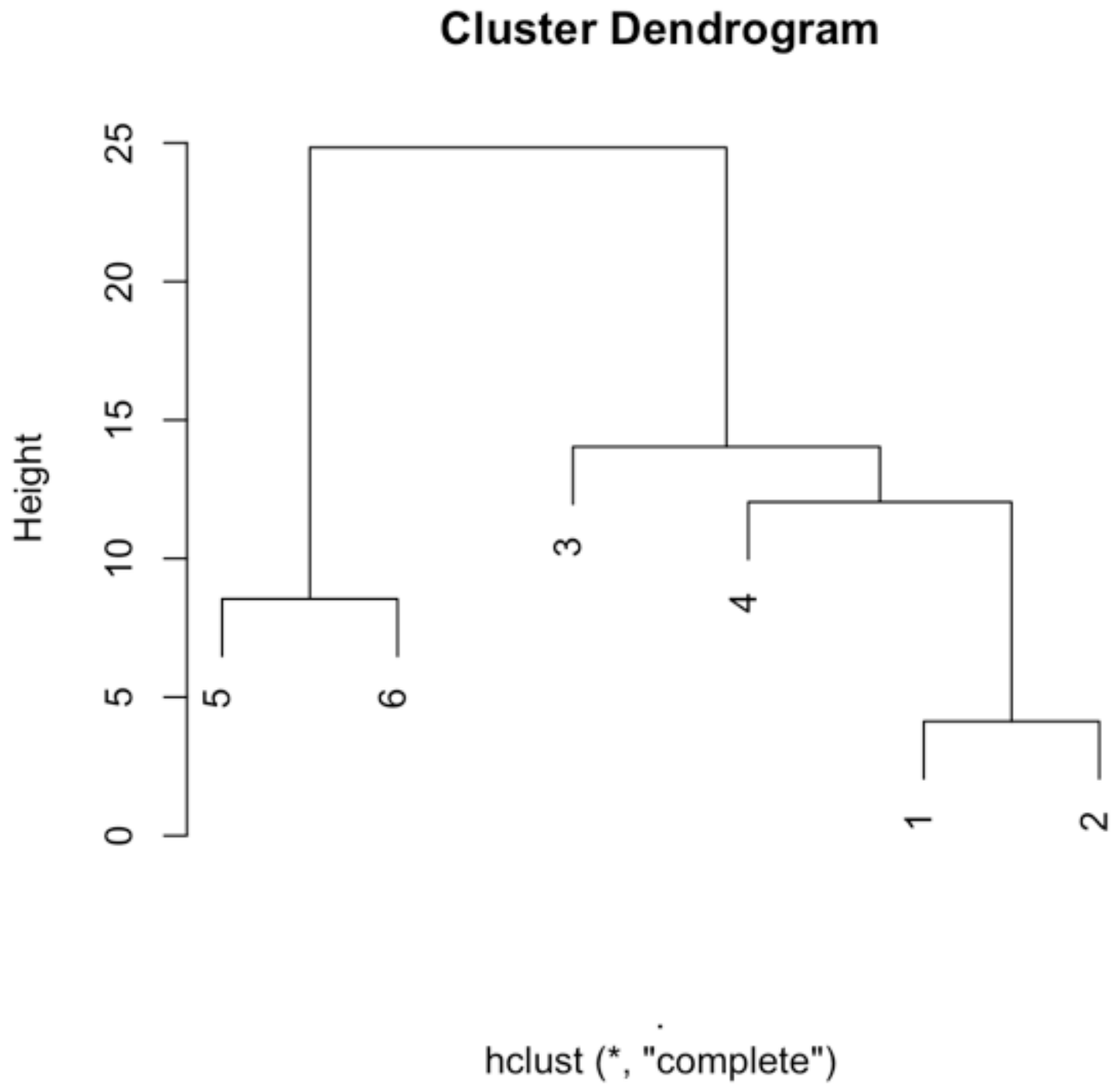
Let's practice!

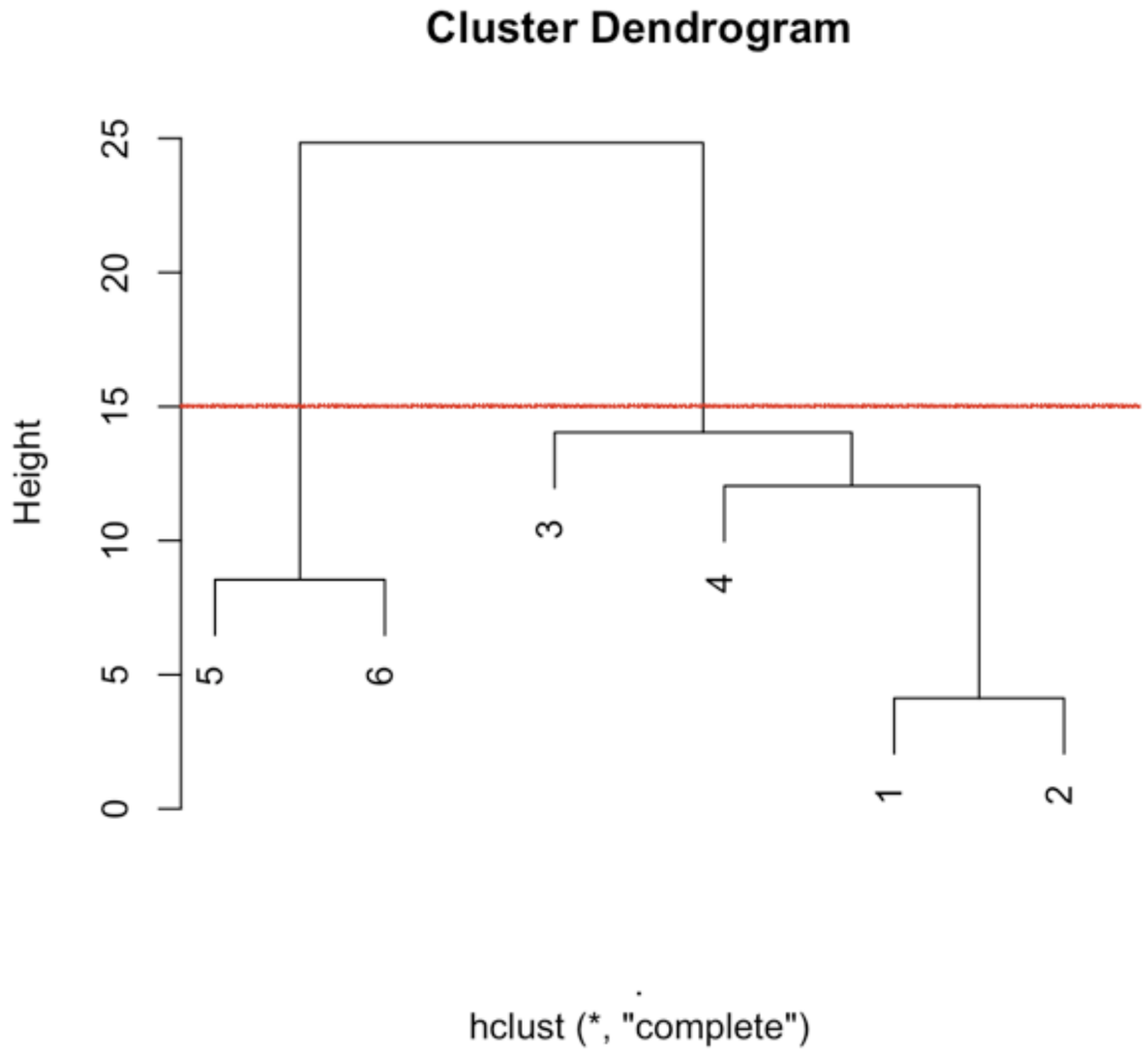
CLUSTER ANALYSIS IN R

Cutting the tree

CLUSTER ANALYSIS IN R

Dmitriy Gorenshteyn
Lead Data Scientist, Memorial Sloan Kettering Cancer Center


Cluster Dendrogram
Height
0
5
10
15
20
25
5
6
3
4
1
2
hclust (*, "complete")


Cluster Dendrogram
Height
0
5
10
15
20
25
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6
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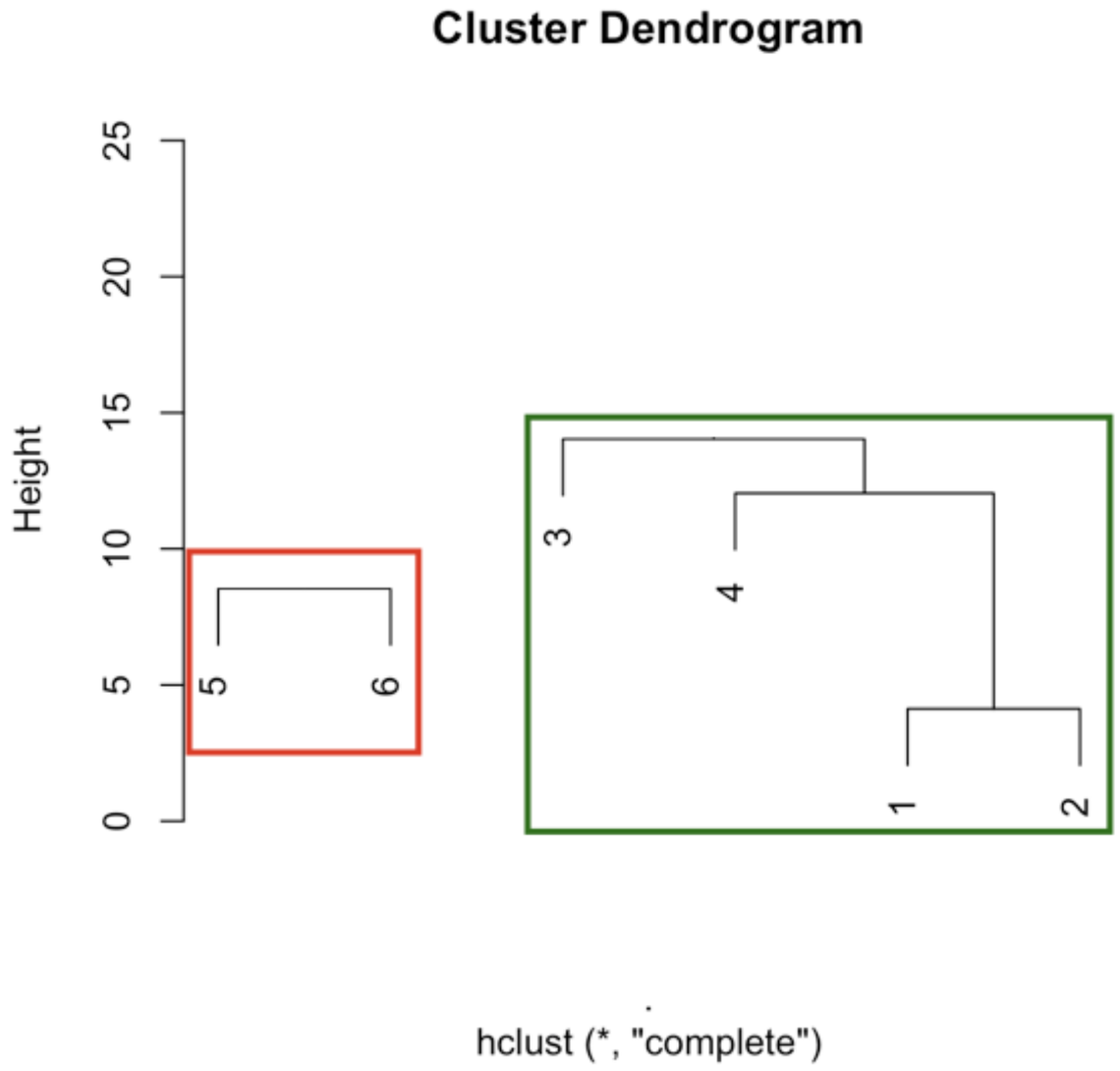
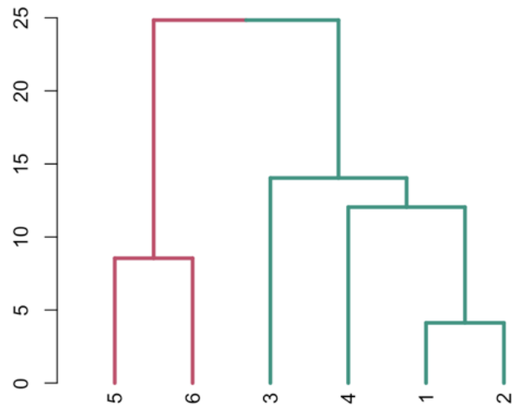
4
1
2
hclust (*, "complete")


Cluster Dendrogram
Height
0
5
10
15
20
25
5
6
3
4
1
2
hclust (*, "complete")

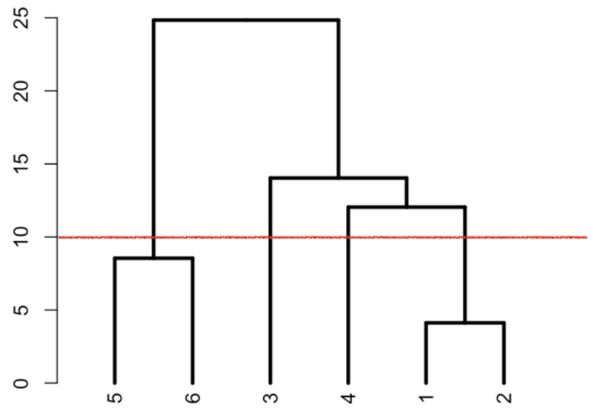
Coloring the dendrogram - height

```
library(dendextend)
dend_players <- as.dendrogram(hc_players)
dend_colored <- color_branches(dend_players, h = 15)
plot(dend_colored)
```



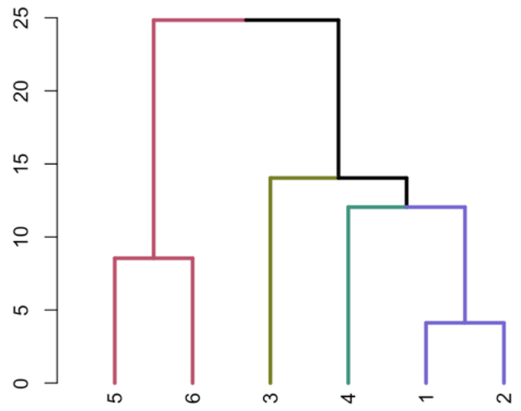
Coloring the dendrogram - height

```
library(dendextend)
dend_players <- as.dendrogram(hc_players)
dend_colored <- color_branches(dend_players, h = 15)
plot(dend_colored)
```



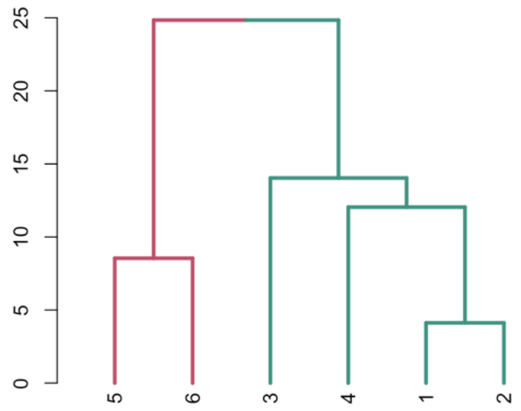
Coloring the dendrogram - height

```
library(dendextend)
dend_players <- as.dendrogram(hc_players)
dend_colored <- color_branches(dend_players, h = 10)
plot(dend_colored)
```



Coloring the dendrogram - K

```
library(dendextend)
dend_players <- as.dendrogram(hc_players)
dend_colored <- color_branches(dend_players, k = 2)
plot(dend_colored)
```



cutree() using height

```
cluster_assignments <- cutree(hc_players, h = 15)
print(cluster_assignments)
[1] 1 1 1 1 2 2
library(dplyr)
players_clustered <- mutate(players, cluster = cluster_assignments)

print(players_clustered)
      x     y cluster
  <dbl> <dbl>   <int>
1    -1     1       1
2    -2    -3       1
3     8     6       1
4     7    -8       1
5   -12     8       2
6   -15     0       2
```

Let's practice!

CLUSTER ANALYSIS IN R

Making sense of the clusters

CLUSTER ANALYSIS IN R

Dmitriy Gorenshteyn
Lead Data Scientist, Memorial Sloan Kettering Cancer Center

Wholesale dataset

- 45 observations
- 3 features:
  - Milk Spending
  - Grocery Spending
  - Frozen Food Spending

Wholesale dataset

```
print(customers_spend)
```

```
     Milk Grocery Frozen
1   11103   12469    902
2    2013    6550    909
3    1897    5234    417
4    1304    3643   3045
5    3199    6986   1455
...   ...     ...    ...
```

Exploring more than 2 dimensions

- Plot 2 dimensions at a time
- Visualize using PCA
- Summary statistics by feature

Segment the customers

CLUSTER ANALYSIS IN R