k-nearest neighbors distance score

ANOMALY DETECTION IN R

Alastair Rushworth
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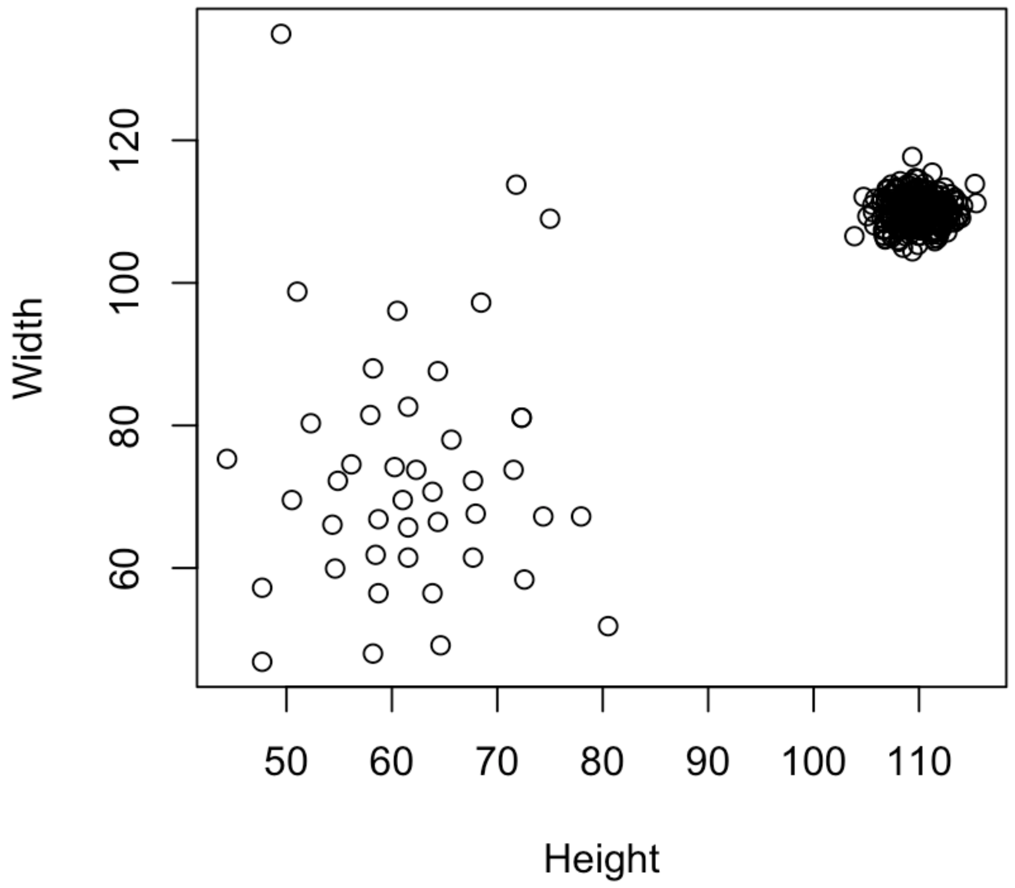
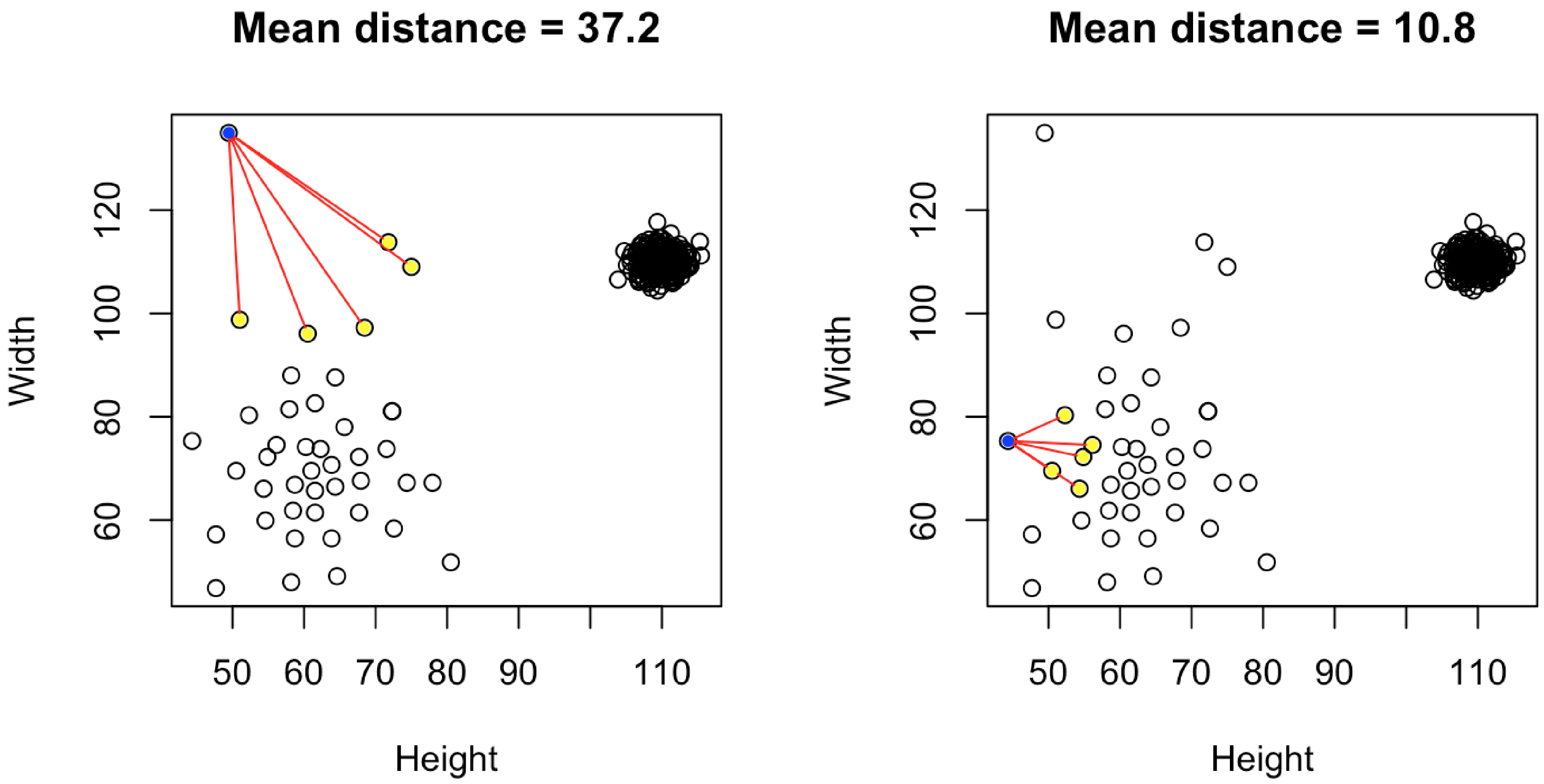
Furniture dimensions

```
plot(Width ~ Height, data = furniture)
```



k-nearest neighbors (kNN) distance

Anomalies usually lie far from their neighbors



Mean distance = 37.2

Mean distance = 10.8

Inputs for distance matrix calculation

```r
library(FNN)
furniture_knn <- get.knn(data = furniture, k = 5)
```

Arguments

- `data` : matrix of data
- `k` : the number of neighbors

Distance matrix output

`get.knn()` **returns two matrices**

```
names(furniture_knn)
```

```
"nn.index" "nn.dist"
```

Distance matrix

```
head(furniture_knn$nn.dist, 3)
```

```
         [,1]     [,2]     [,3]     [,4]     [,5]
[1,] 5.128300 5.367791 5.390801 5.740713 8.477025
[2,] 4.300093 5.367791 6.159139 7.091966 7.428176
[3,] 3.047502 3.545978 4.426266 5.006570 5.654202
```

kNN distance score

Average distance to nearest neighbors

```
furniture_score <- rowMeans(furniture_knn$nn.dist)
```

Largest score?

```
which.max(furniture_score)
```

```
29
```

Let's practice!

ANOMALY DETECTION IN R

Visualizing kNN distance score

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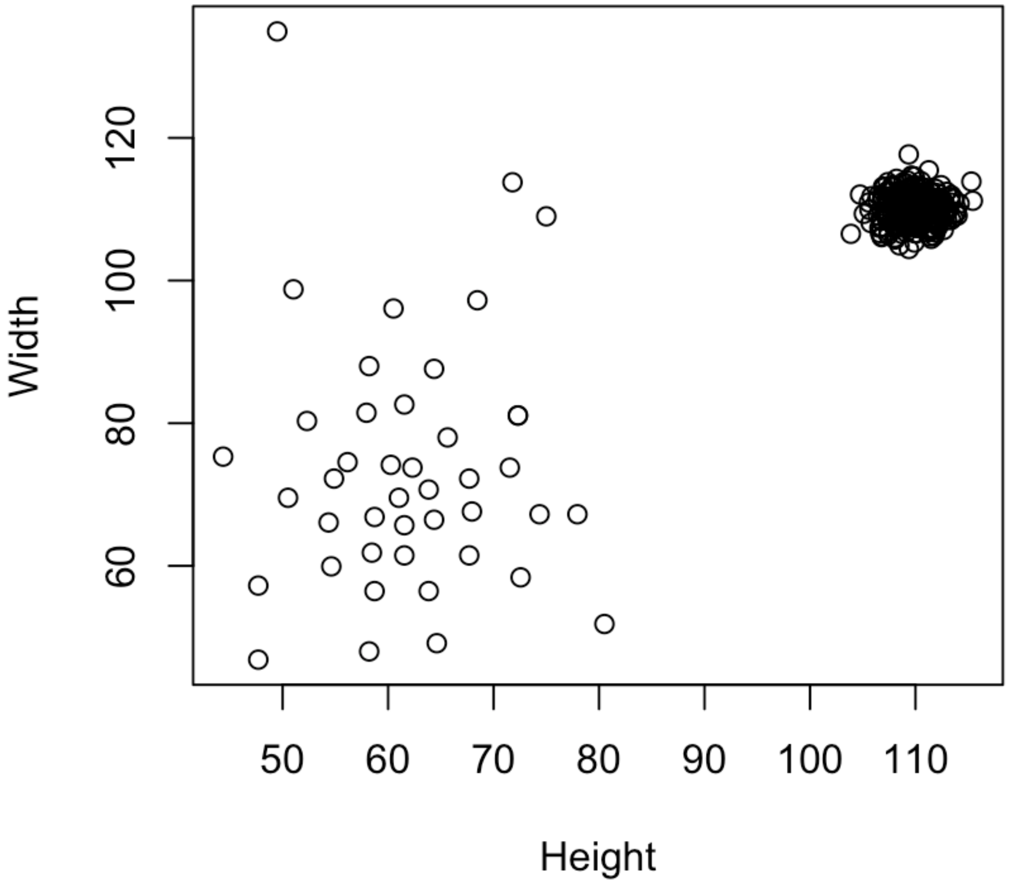
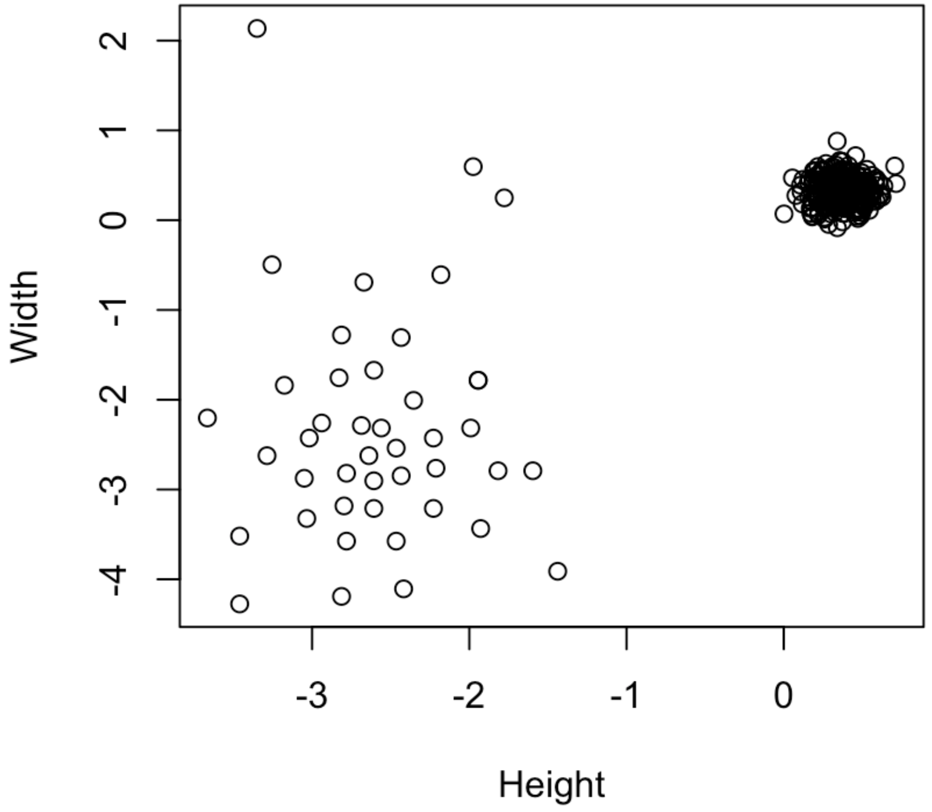
Standardizing feature scales

```
plot(Width ~ Height, data = furniture)
```



Standardizing features

```
furniture_scaled <- scale(furniture)
plot(Width ~ Height, data = furniture_scaled)
```



Create and append distance score

Distance matrix

```r
furniture_scaled <- scale(furniture)
furniture_knn    <- get.knn(furniture_scaled, 5)
```

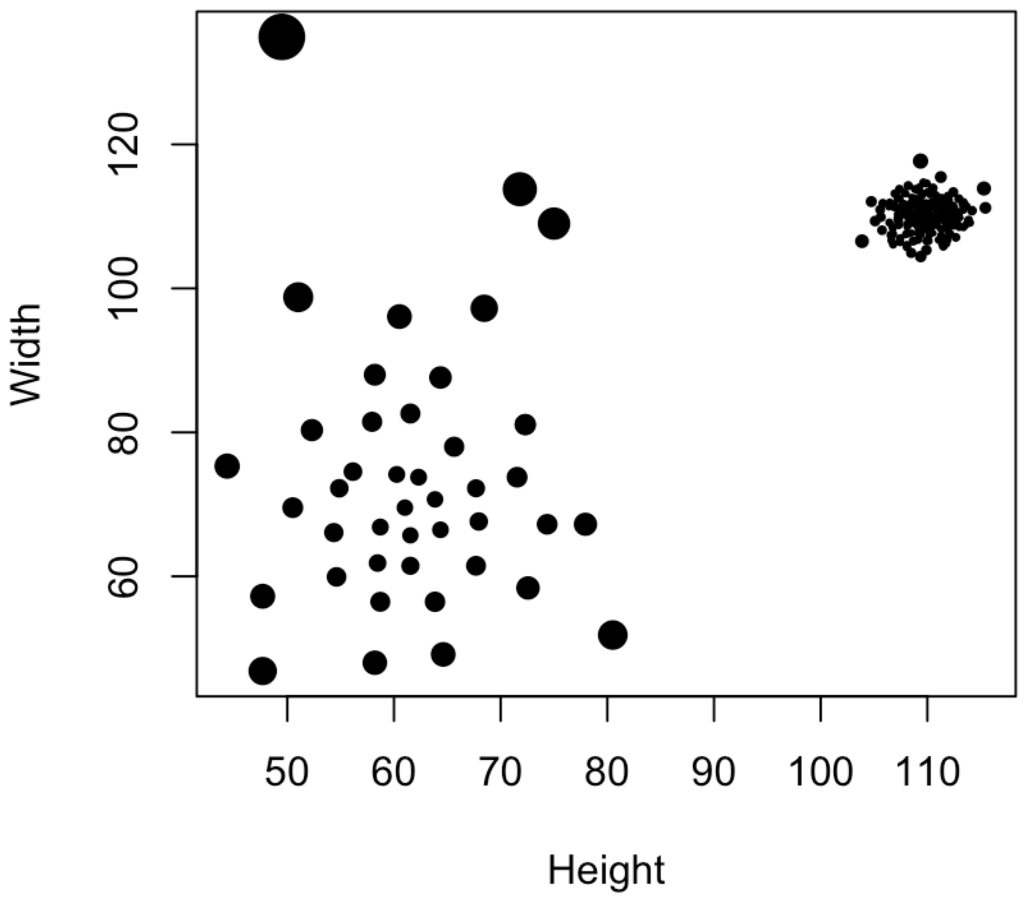
Calculate and append score

```r
furniture$score  <- rowMeans(furniture_knn$nn.dist)
head(furniture, 4)
```

```
   Height   Width     score
1 58.7179 56.4663 0.4170000
2 54.6154 59.9279 0.3981695
3 58.7179 66.8510 0.2845042
4 63.8462 56.4663 0.4376807
```

Visualizing distance score

```
plot(Width ~ Height, cex = sqrt(score), data = furniture, pch = 20)
```



Let's practice!

ANOMALY DETECTION IN R

The local outlier factor (LOF)

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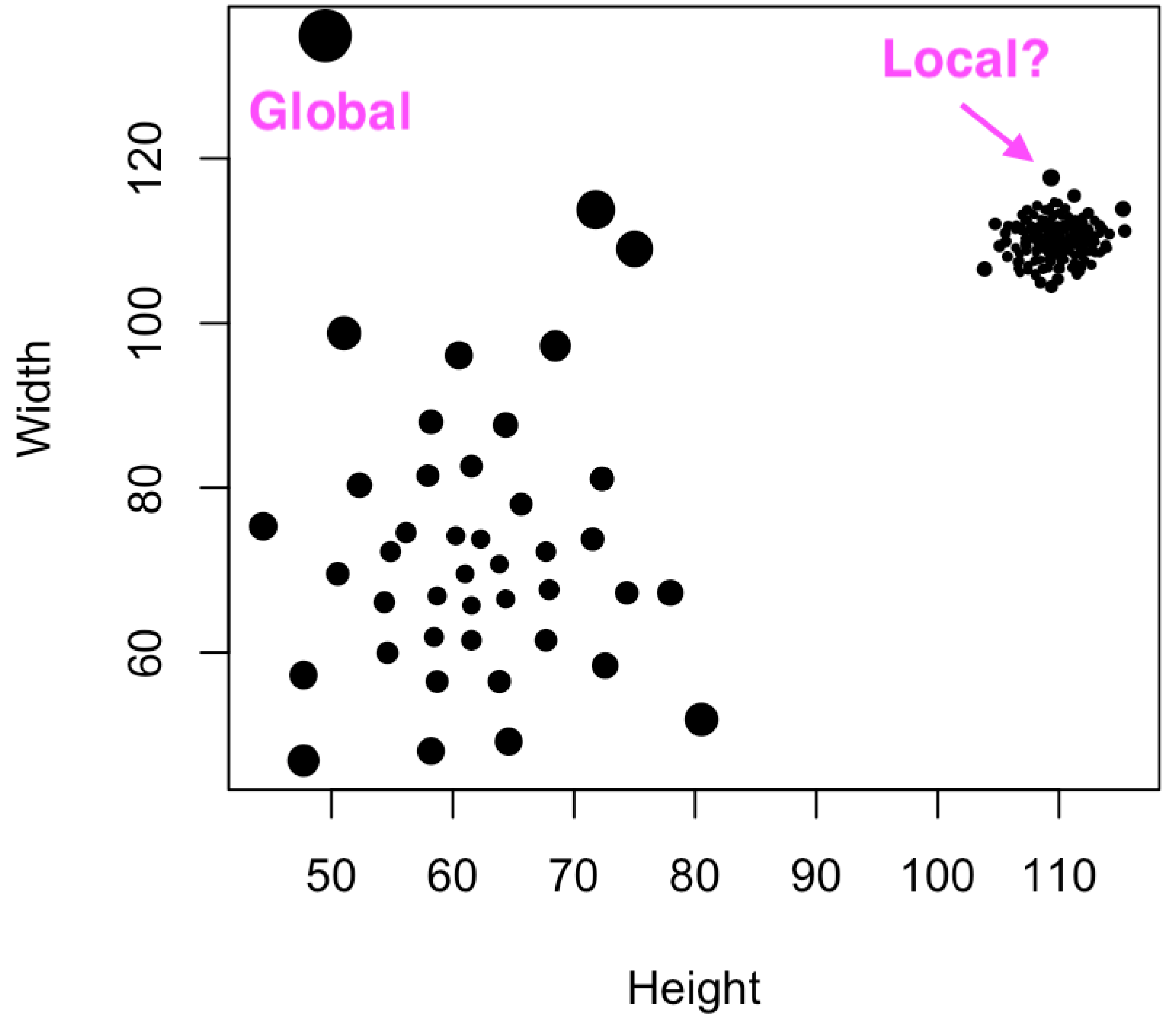
Postmortem of kNN distance

Global versus **local** anomalies



Calculating LOF

Obtain LOF for furniture data

```
library(dbscan)
furniture_lof <- lof(scale(furniture), k = 5)
```

View the scores

```
furniture_lof[1:10]
```

```
[1] 1.0649669 1.1071205 0.9980290 1.0392385 0.9725305
[6] 1.1933199 1.3210459 1.1409659 1.0613144 1.0805445
```

Interpreting LOF

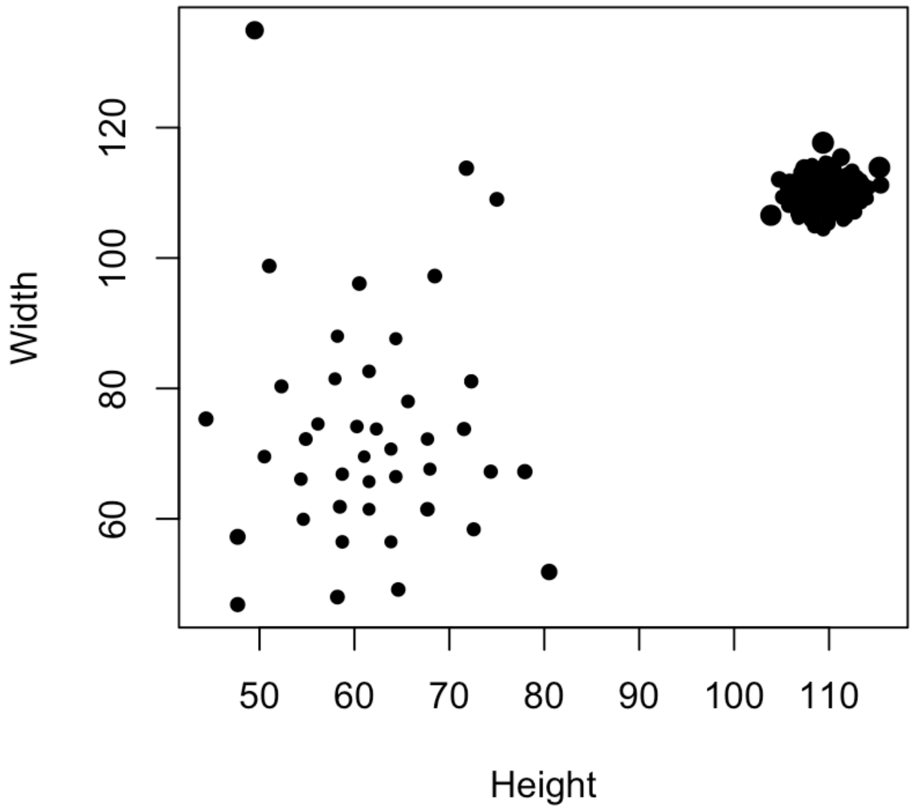
LOF is a ratio of densities

- LOF > 1 more likely to be anomalous
- LOF ≤ 1 less likely to be anomalous

Large LOF values indicate more isolated points

Visualizing LOF

```
furniture$score_lof <- furniture_lof
plot(Width ~ Height, data = furniture, cex = score_lof, pch = 20)
```



Let's practice!

ANOMALY DETECTION IN R