ANOMALY DETECTION IN R

What is an anomaly?

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Defining the term anomaly

Anomaly: *a data point or collection of data points that do not follow the same pattern or have the same structure as the rest of the data*

Point anomaly

- A single data point
- Unusual when compared to the rest of the data

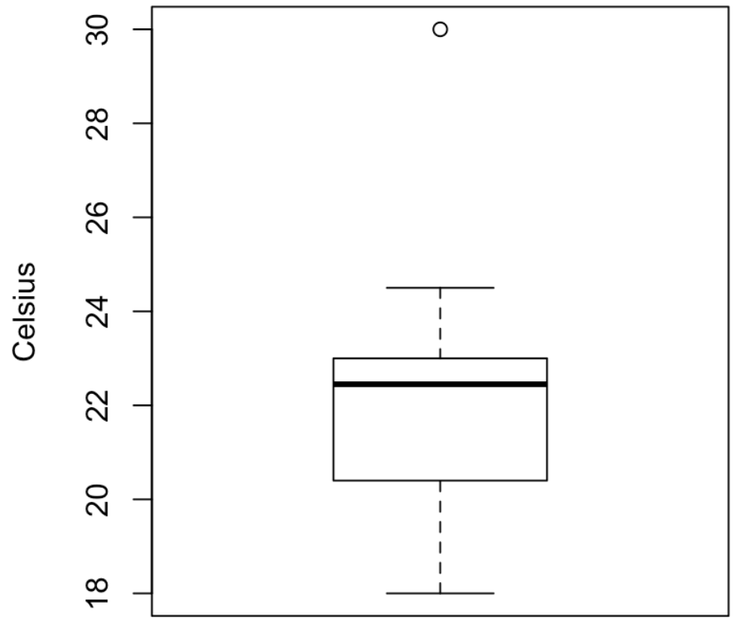
Example: A single 30C daily high temperature among a set of ordinary spring days

```
summary(temperature)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  18.00   20.45   22.45   22.30   22.98   30.00
```

Visualizing point anomalies with a boxplot

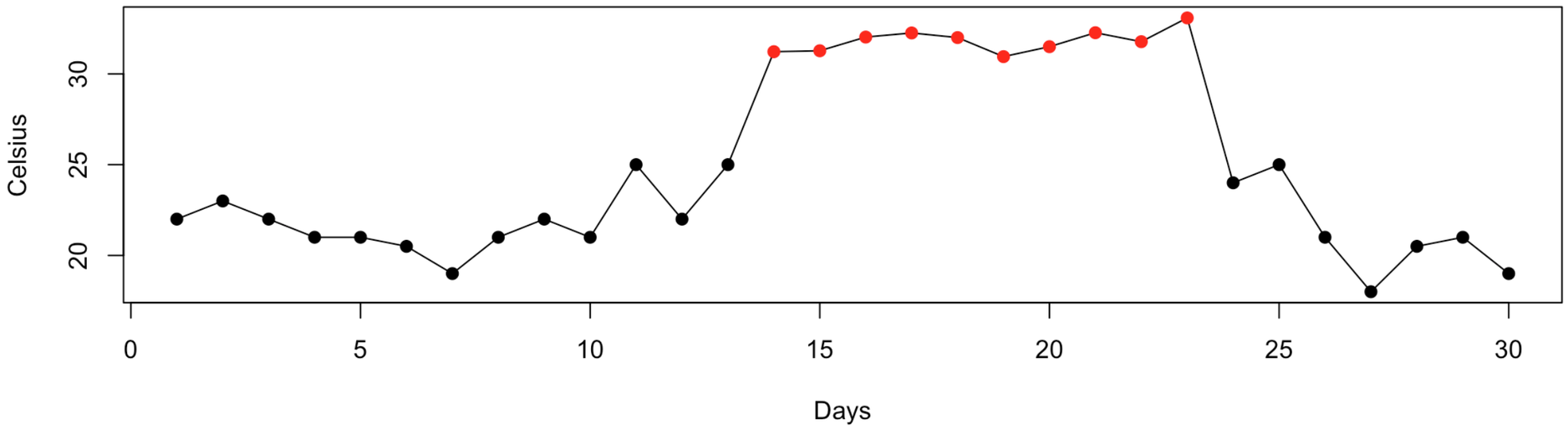
```
boxplot(temperature, ylab = "Celsius")
```



Collective anomaly

- An anomalous collection of data instances
- Unusual when considered together

Example: 10 consecutive high daily temperatures



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Let's practice!

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Testing the extremes with Grubbs' test

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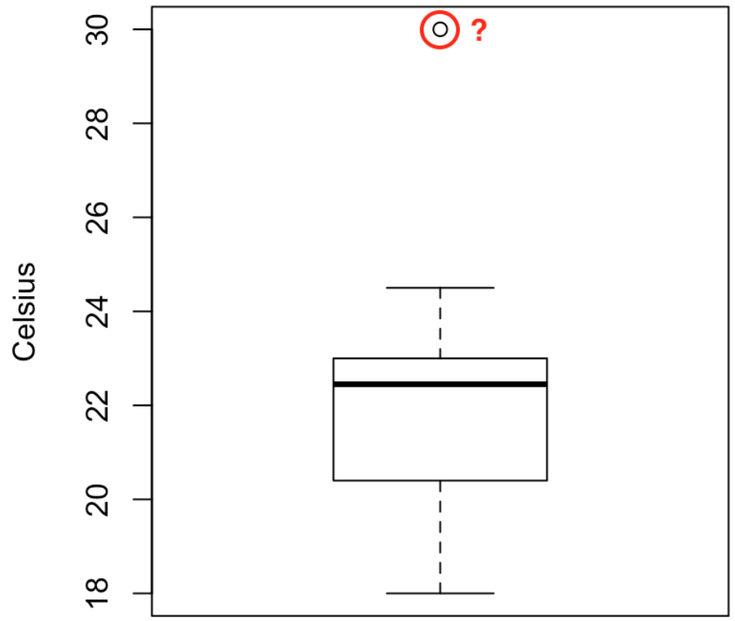
Visual assessment is not always reliable!

```
boxplot(temperature, ylab = "Celsius")
```

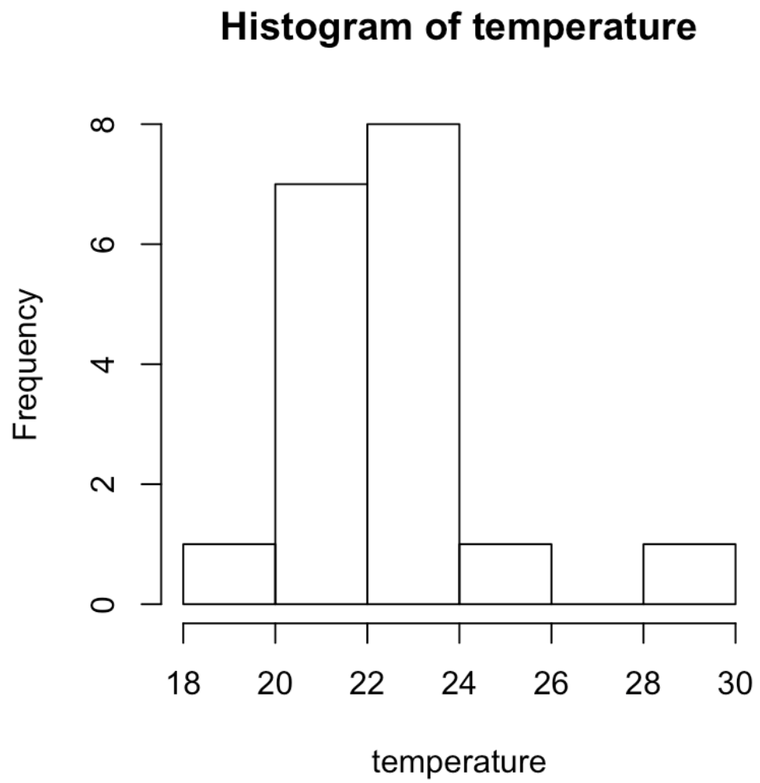


Grubbs' test

- Statistical test to decide if a point is outlying
- Assumes the data are normally distributed
- Requires checking the normality assumption first

Checking normality with a histogram

```
hist(temperature, breaks = 6)
```



Symmetrical & bell shaped?

Running Grubbs' test

Use the `grubbs.test()` function:

```
grubbs.test(temperature)
```

```
    Grubbs test for one outlier
data:  temp
G = 3.07610, U = 0.41065, p-value = 0.001796
alternative hypothesis: highest value 30 is an outlier
```

Interpreting the p-value

```
grubbs.test(temperature)
```

```
    Grubbs test for one outlier

data:  temperature
G = 3.07610, U = 0.41065, p-value = 0.001796
alternative hypothesis: highest value 30 is an outlier
```

`p-value`

- Near 0 - *stronger* evidence of an outlier
- Near 1 - *weaker* evidence of an outlier

Get the row index of an outlier

Location of the **maximum**

```
which.max(weights)
```

```
[1] 5
```

Location of the **minimum**

```
which.min(temperature)
```

```
[1] 12
```

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Detecting multiple anomalies in seasonal time series

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Monthly revenue data

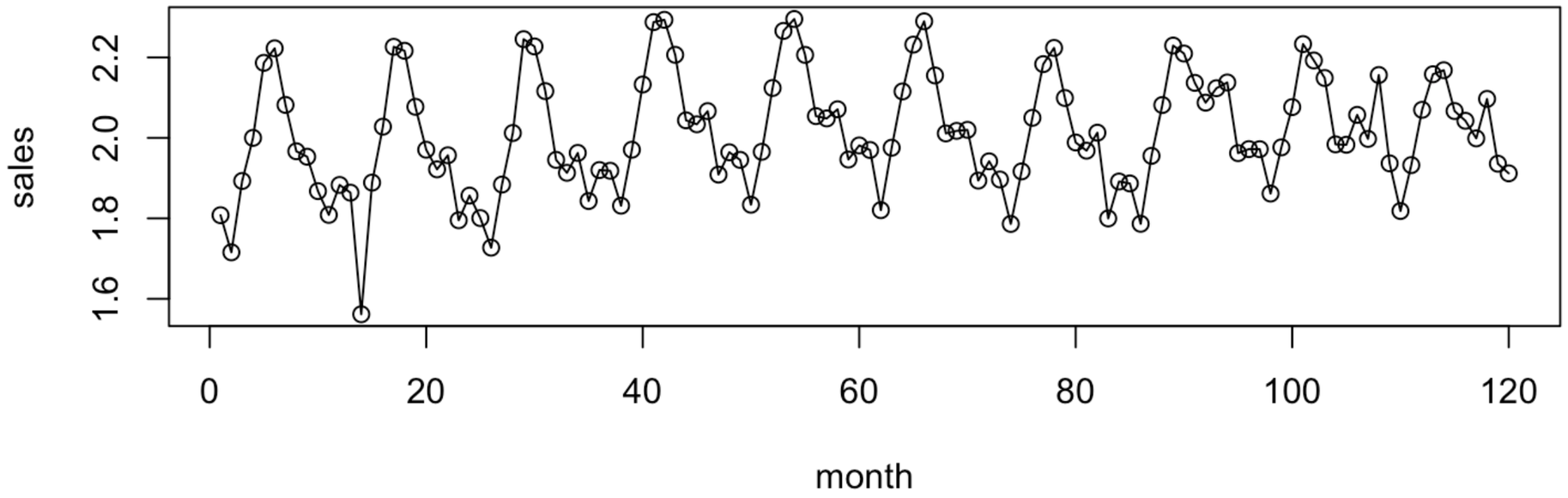
```
head(msales)

  sales month
1 6.068     1
2 5.966     2
3 6.133     3
4 6.230     4
5 6.407     5
6 6.433     6
```

Grubbs' test not appropriate here

- Seasonality may be present
- May be multiple anomalies

Visualizing monthly revenue

```
plot(sales ~ month, data = msales, type = 'o')
```



Seasonal-Hybrid ESD algorithm usage

```
library(AnomalyDetection)

sales_ad <- AnomalyDetectionVec(x = msales$sales, period = 12,
                                direction = 'both')
```

Arguments

- `x`: vector of values
- `period`: period of repeating pattern
- `direction`: find anomalies that are small, large, or both

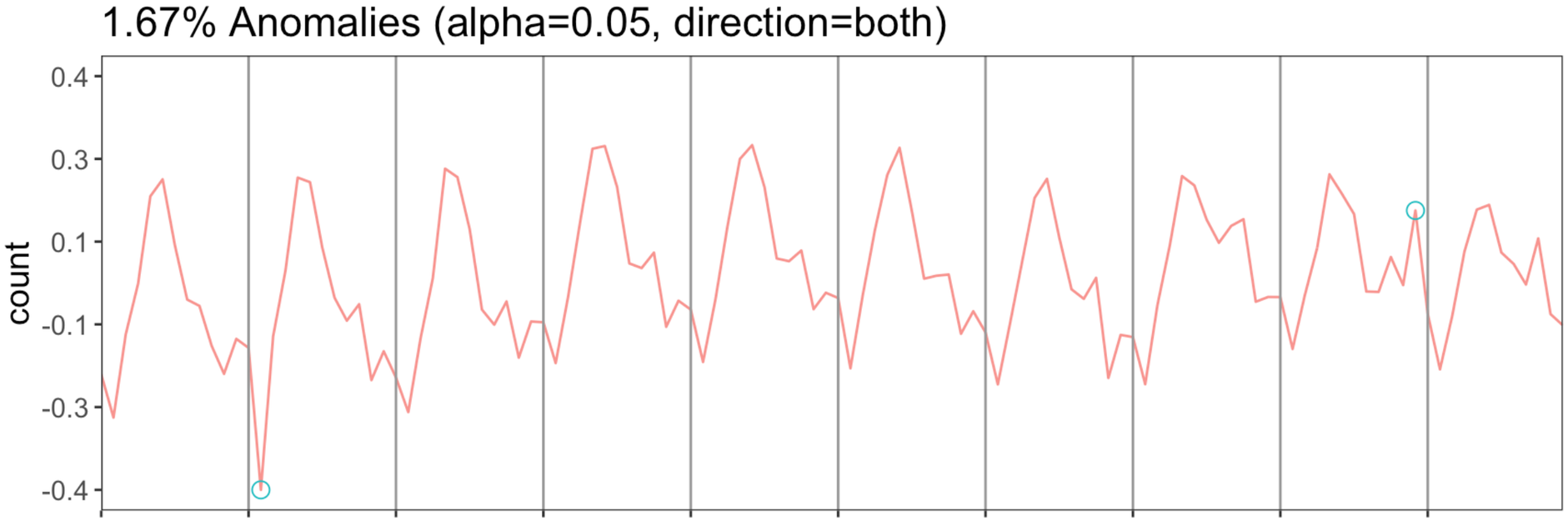
Seasonal-Hybrid ESD algorithm output

```
sales_ad <- AnomalyDetectionVec(x = msales$sales, period = 12,
                                direction = 'both')
```

```
sales_ad$anoms

  index anoms
1    14 1.561
2   108 2.156
```

Seasonal-Hybrid ESD algorithm plot

```
AnomalyDetectionVec(x = msales$sales, period = 12,
                    direction = 'both', plot = T)
```



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