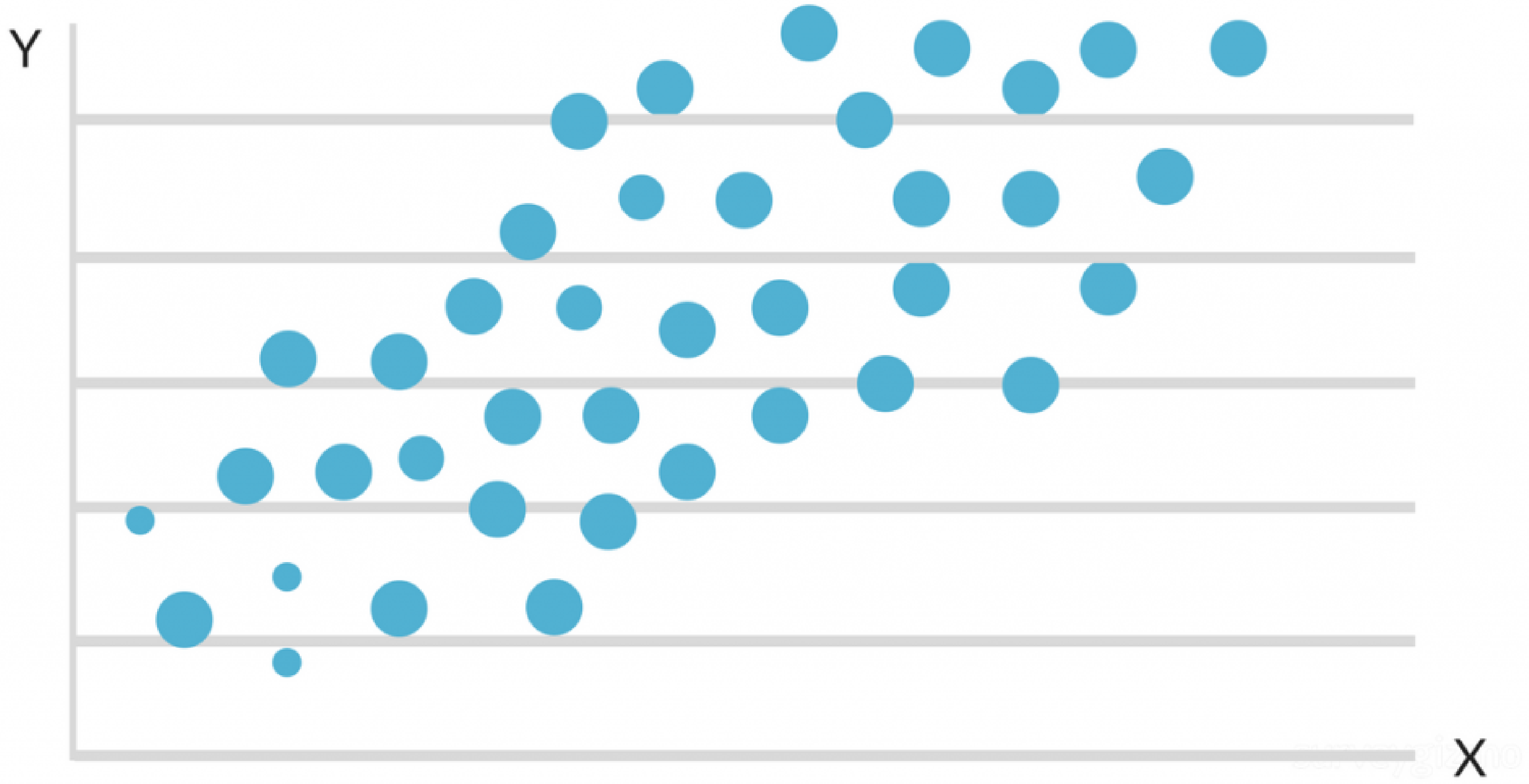
Regression models

PRACTICING STATISTICS INTERVIEW QUESTIONS IN PYTHON

Conor Dewey
Data Scientist, Squarespace

Getting started

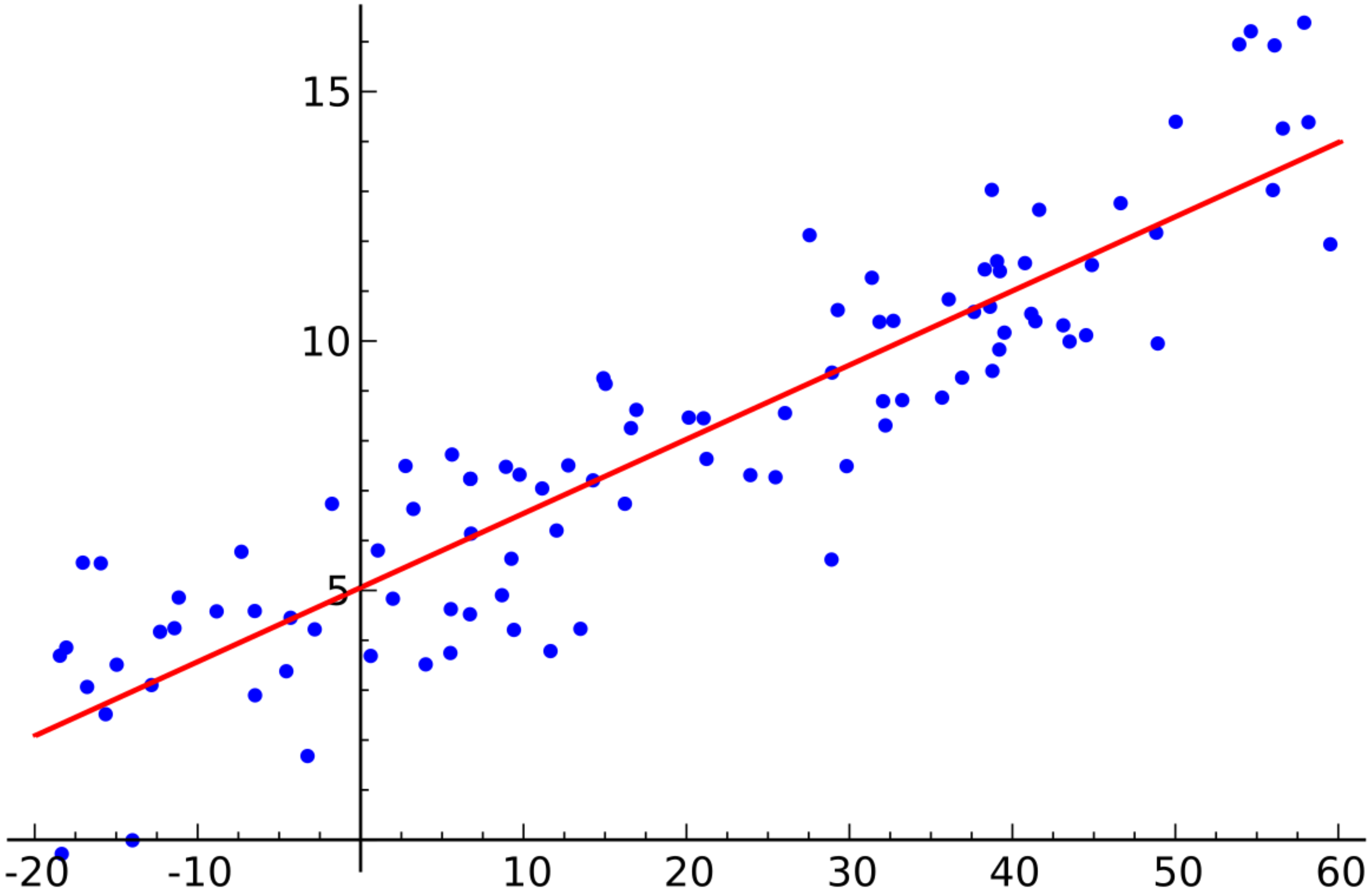


[1] Wikimedia

Assumptions

- Linear relationship
- Errors are normally distributed
- Homoscedasticity
- Independent observations

Linear regression



[1] Wikipedia

Linear regression

$$\overset{\text{Dependent Variable}}{Y_i} = \underbrace{\overset{\text{Population Y intercept}}{\beta_0} + \overset{\text{Population Slope Coefficient}}{\beta_1} \overset{\text{Independent Variable}}{X_i}}_{\text{Linear component}} + \underbrace{\overset{\text{Random Error term}}{\varepsilon_i}}_{\text{Random Error component}}$$

Example: linear regression

```
from sklearn.linear_model import LinearRegression
lm = LinearRegression()
lm.fit(X_train, y_train)
```

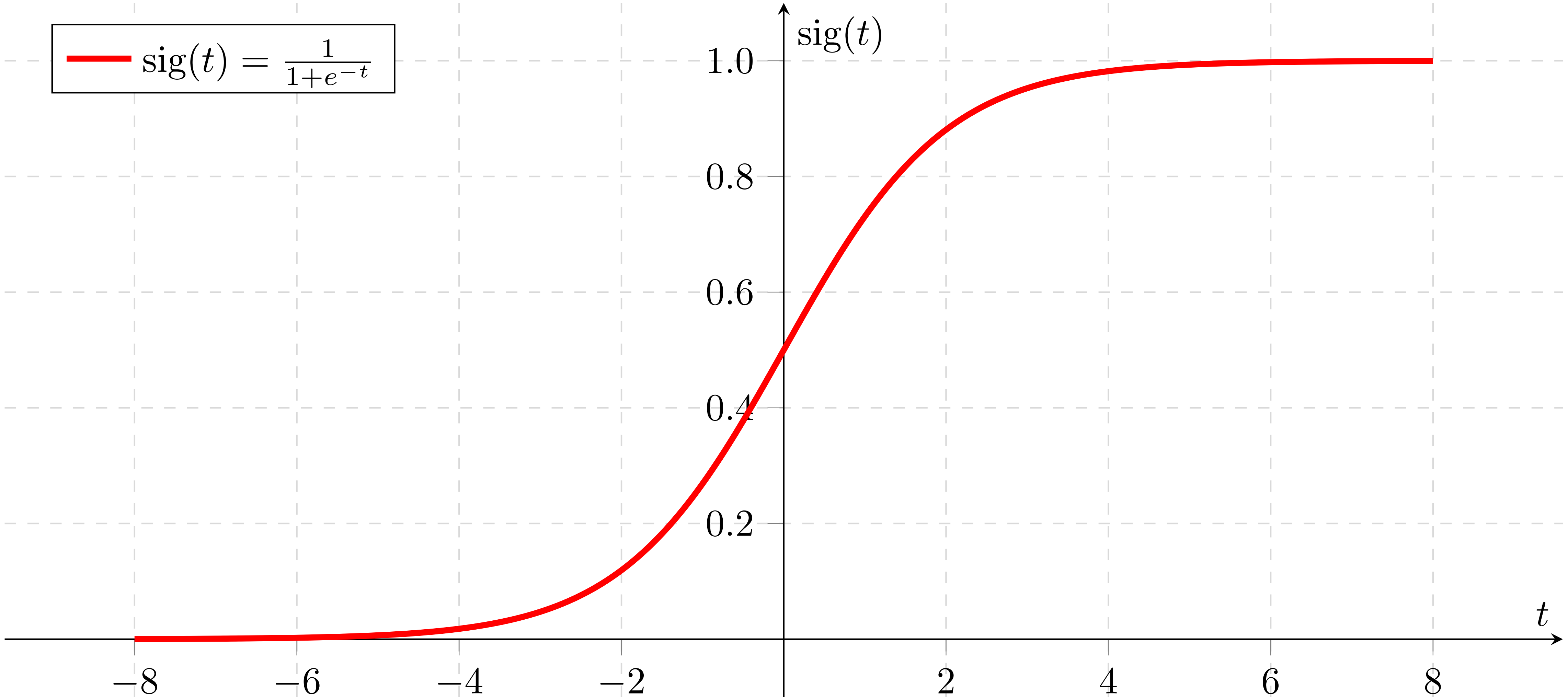
```
LinearRegression(copy_X=True, fit_intercept=True,
                 n_jobs=None, normalize=False)
```

Example: linear regression

```
coef = lm.coef_
print(coef)
```

```
[0.79086669]
```

Logistic regression



[1] Wikimedia

Logistic regression

$$f(x) = \frac{1}{1 + \mathrm{e}^{-(x)}}$$

Example: logistic regression

```python
from sklearn.linear_model import LogisticRegression
clf = LogisticRegression(solver='lbfgs')
clf.fit(X_train, y_train)
```

```
LogisticRegression(C=1.0, class_weight=None,
                   dual=False, fit_intercept=True,
                   intercept_scaling=1,
                   max_iter=100, multi_class='warn',
                   n_jobs=None, penalty='l2',
                   random_state=None, solver='lbfgs',
                   tol=0.0001, verbose=0,
                   warm_start=False)
```

Example: logistic regression

```
coefs = clf.coef_
print(coefs)
```

```
[[0.4015177  3.85056451]]
```

```
accuracy = clf.score(X_test, y_test)
print(accuracy)
```

```
0.8583333333333333
```

Summary

- Review
- Assumptions
- Linear regression
- Logistic regression

Let's prepare for the interview!

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Evaluating models

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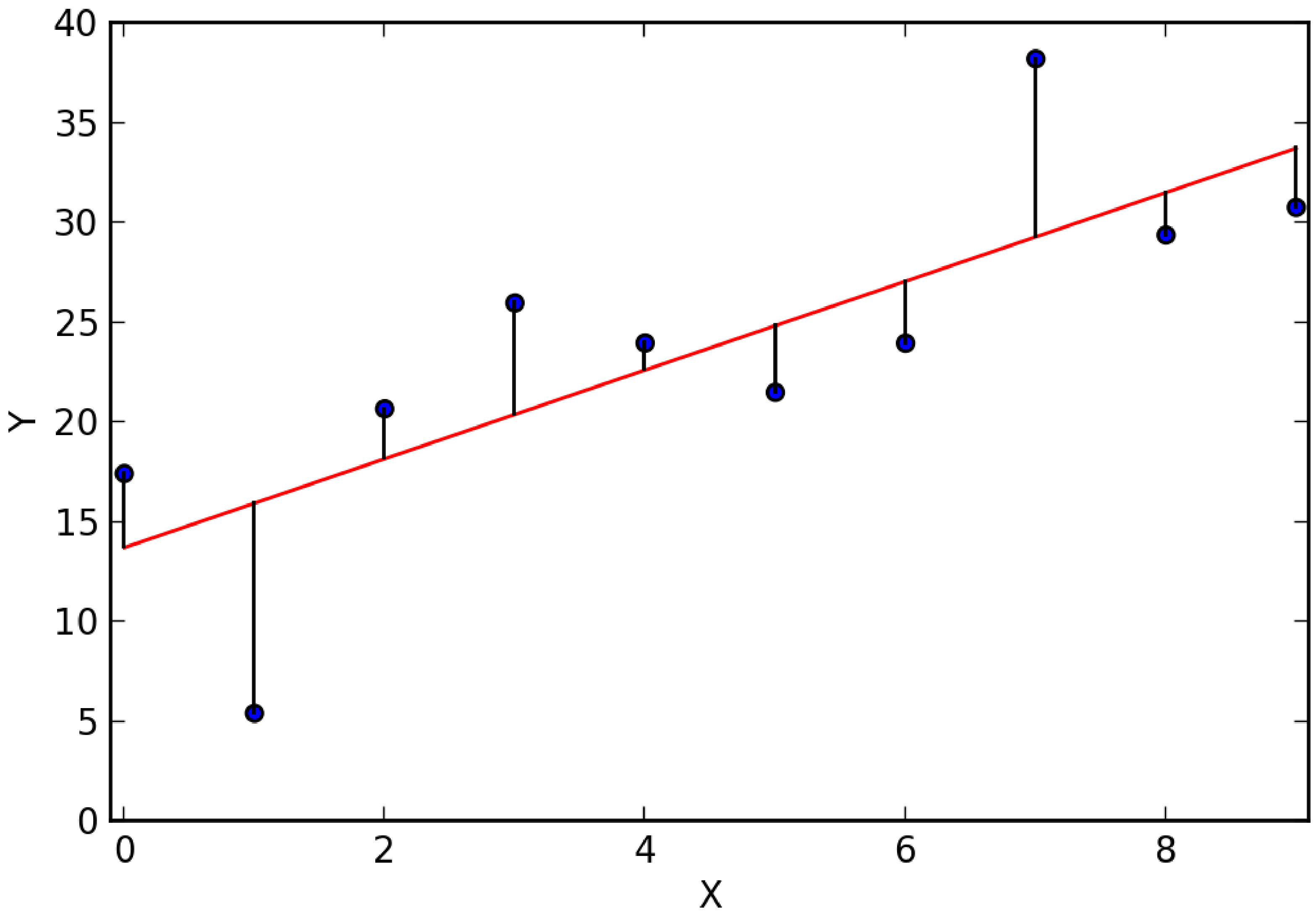
Regression techniques

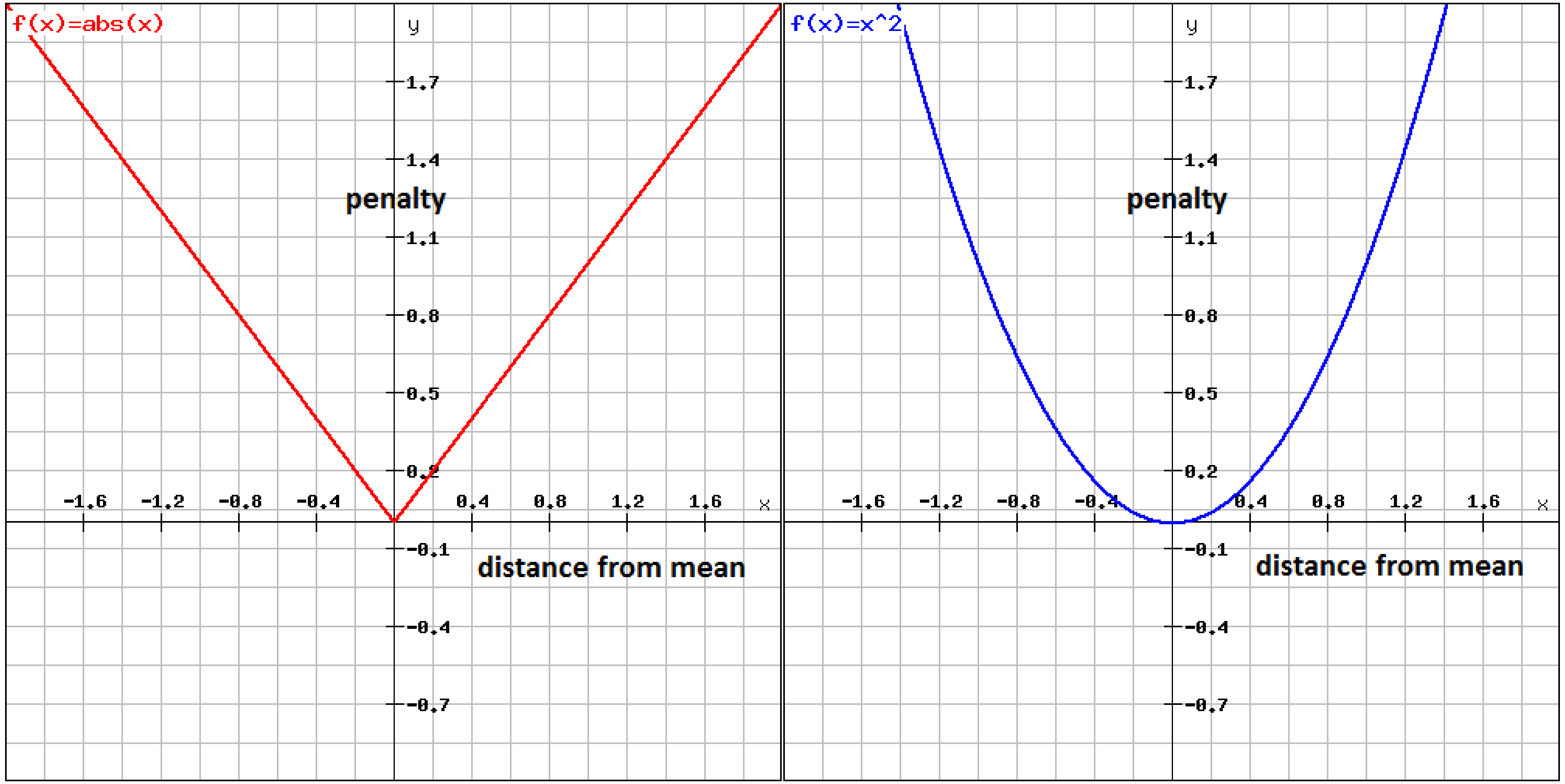
- R-squared
- Mean absolute error (MAE)
- Mean squared error (MSE)

R-squared



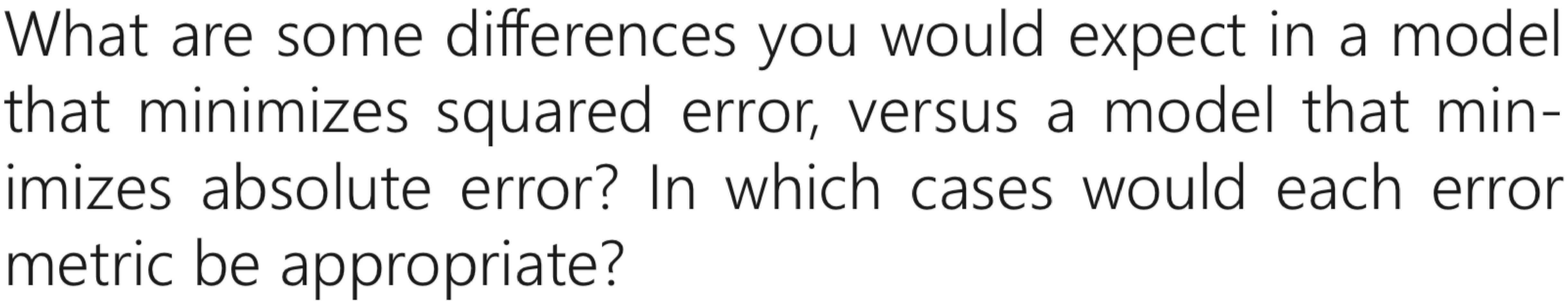
[1] Wikimedia

MAE vs. MSE



[1] Wikimedia

MAE vs. MSE



What are some differences you would expect in a model that minimizes squared error, versus a model that minimizes absolute error? In which cases would each error metric be appropriate?

[1] 120 Data Science Interview Questions

Classification techniques

- Precision
- Recall
- Confusion matrices

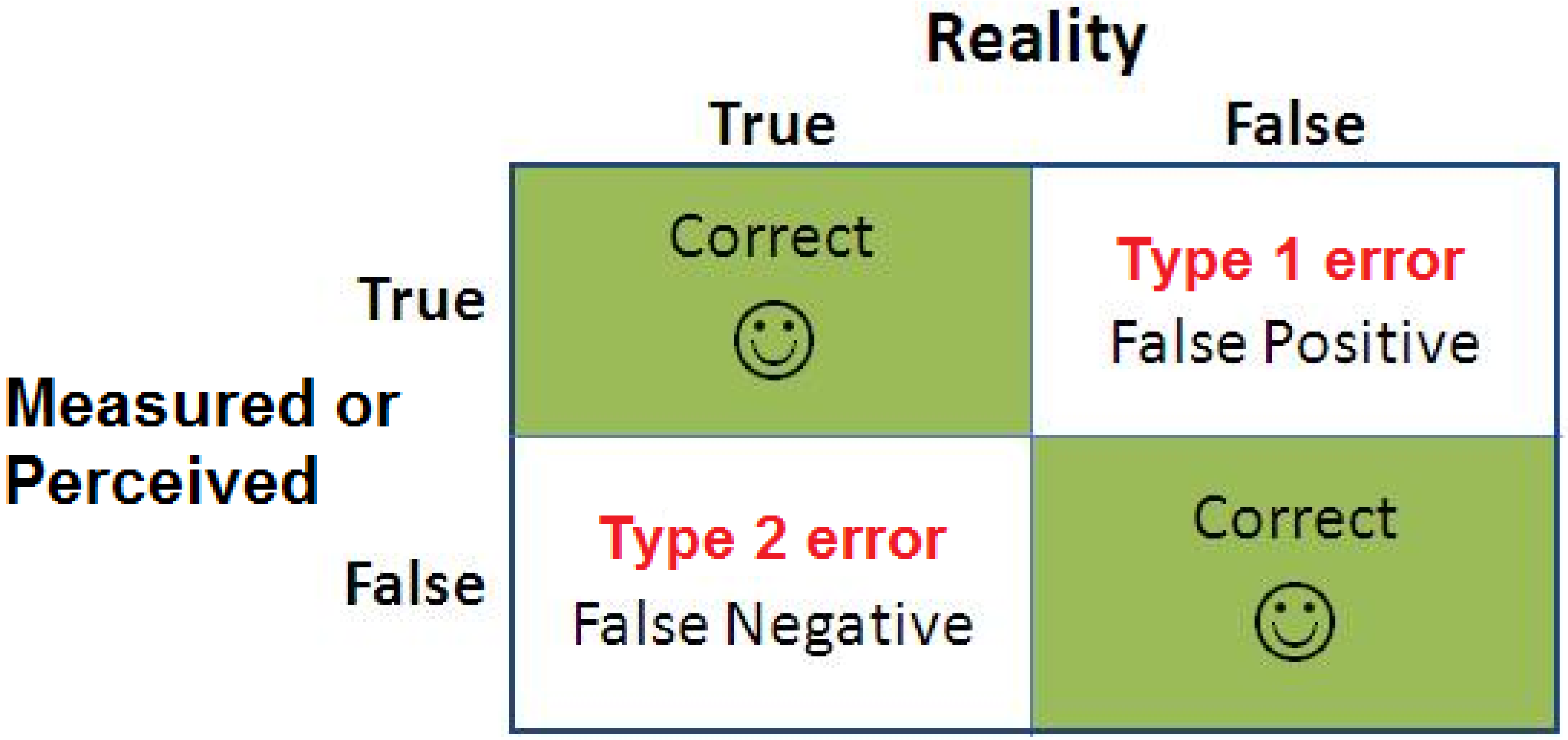
Precision

$$\text{Precision} = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

Recall

$$\text{Recall} = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

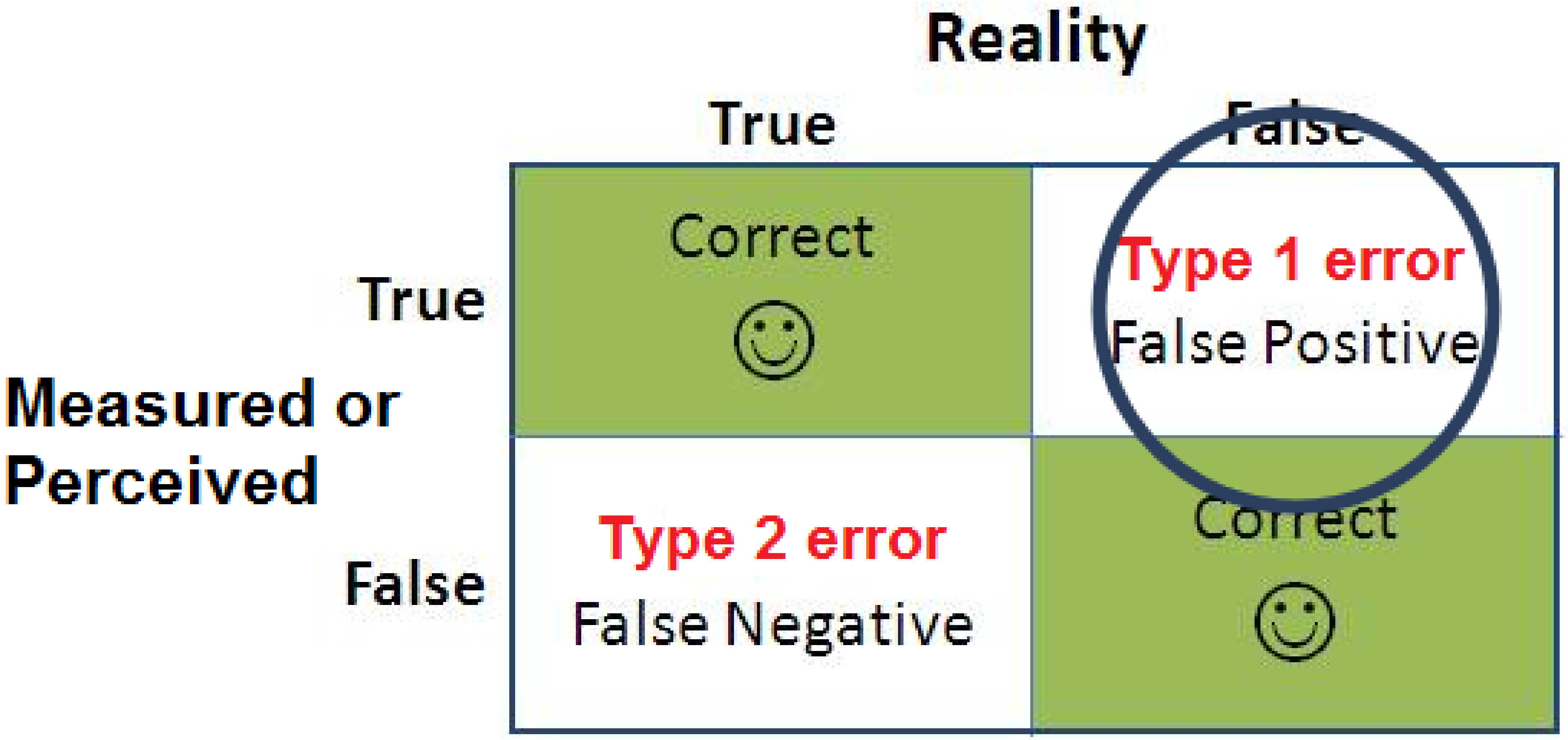
Confusion matrix



		Reality	
		True	False
Measured or Perceived	True	Correct ☺	Type 1 error False Positive
	False	Type 2 error False Negative	Correct ☺

[1] AB Tasty

Confusion matrix



		Reality	
		True	False
Measured or Perceived	True	Correct ☺	Type 1 error False Positive
	False	Type 2 error False Negative	Correct ☺

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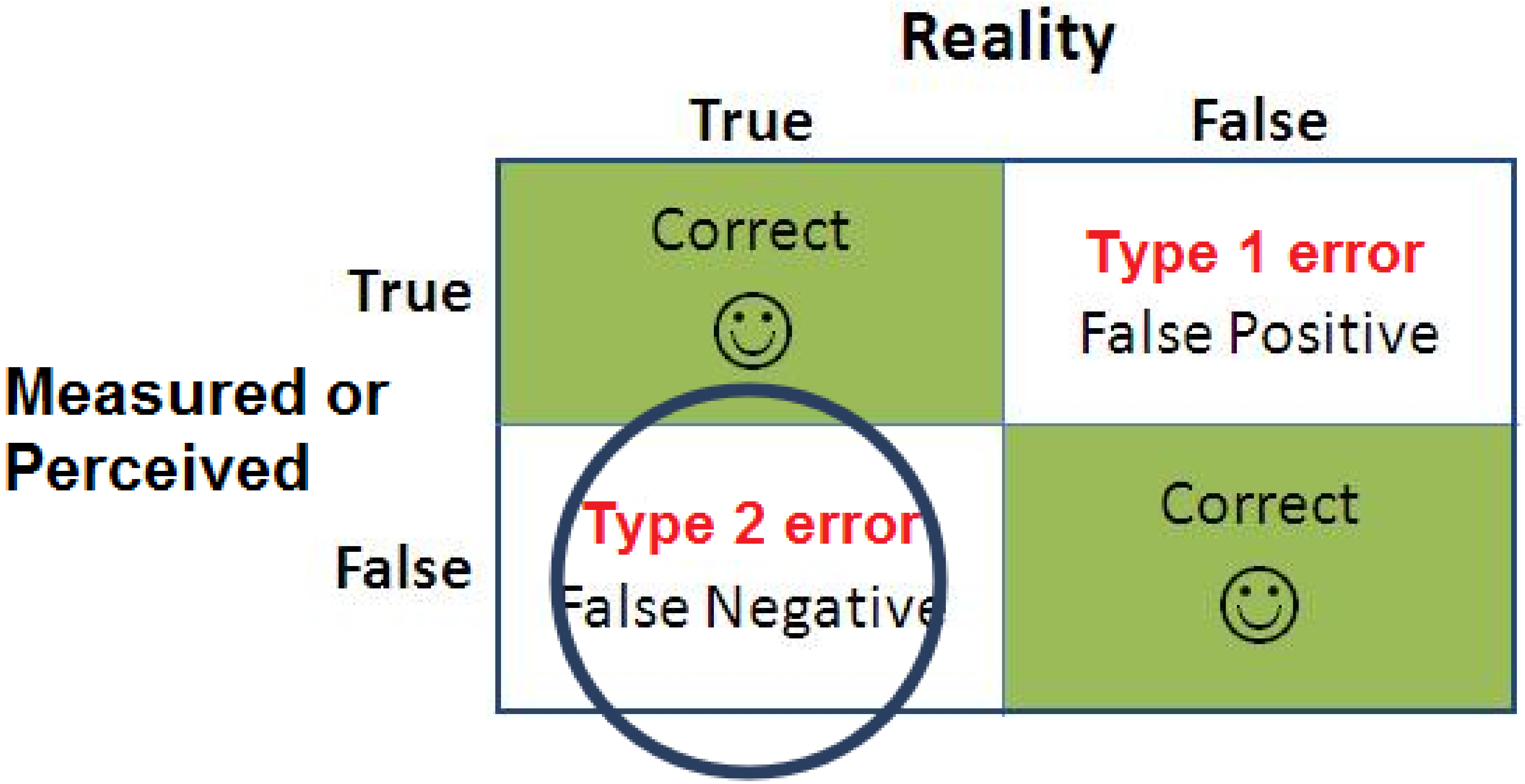
Confusion matrix



		Reality	
		True	False
Measured or Perceived	True	Correct ☺	Type 1 error False Positive
	False	Type 2 error False Negative	Correct ☺

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Summary

- R-squared
- Mean absolute error (MAE) vs. mean squared error (MSE)
- Precision and recall

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Missing data and outliers

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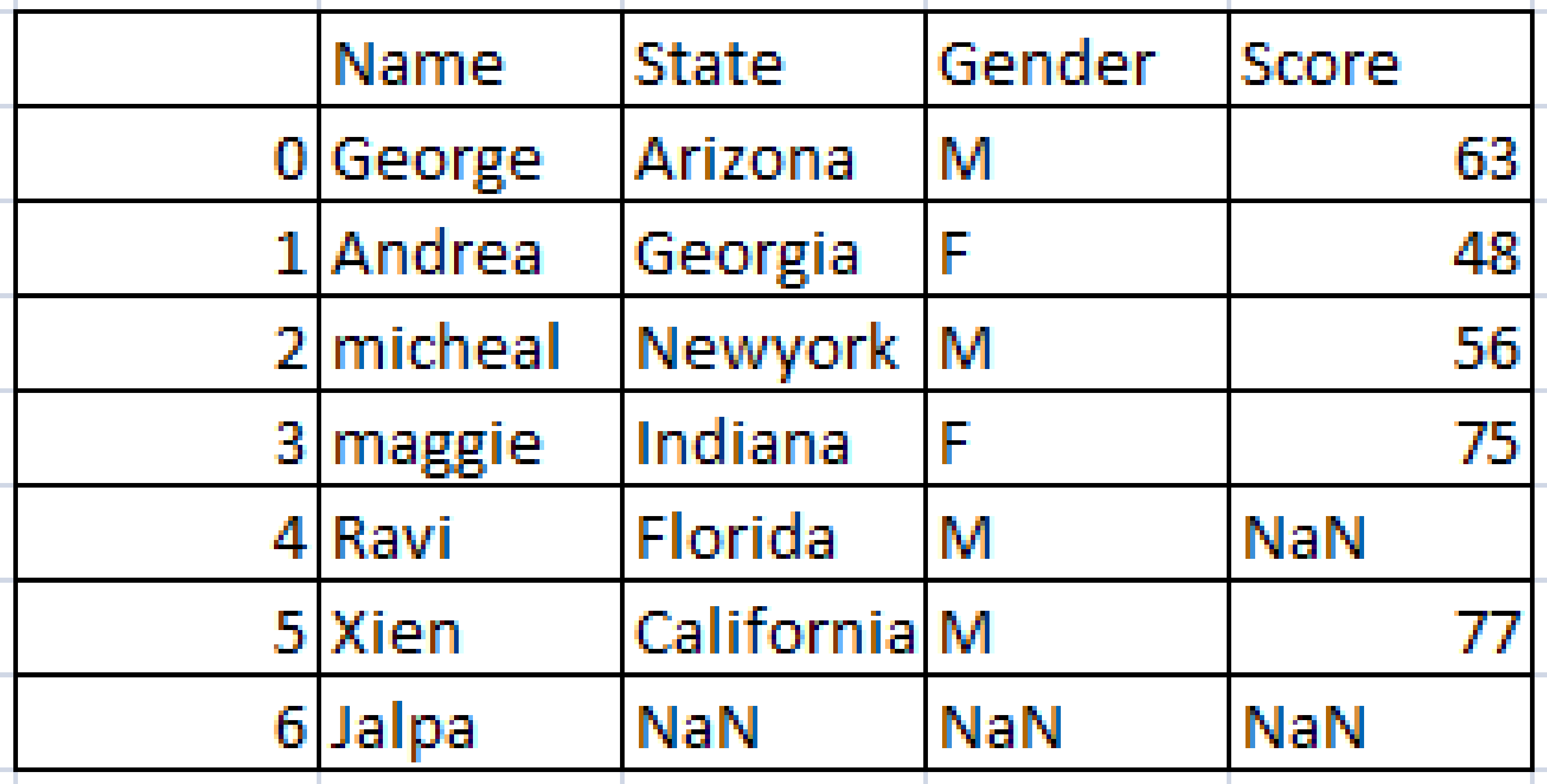
Handling missing data

- Drop the whole row
- Impute missing values

Drop the whole row

```
df.dropna(inplace=True)
```



	Name	State	Gender	Score
0	George	Arizona	M	63
1	Andrea	Georgia	F	48
2	micheal	Newyork	M	56
3	maggie	Indiana	F	75
4	Ravi	Florida	M	NaN
5	Xien	California	M	77
6	Jalpa	NaN	NaN	NaN

Impute missing values

- Constant value
- Randomly selected record
- Mean, median, or mode
- Value estimated by another model

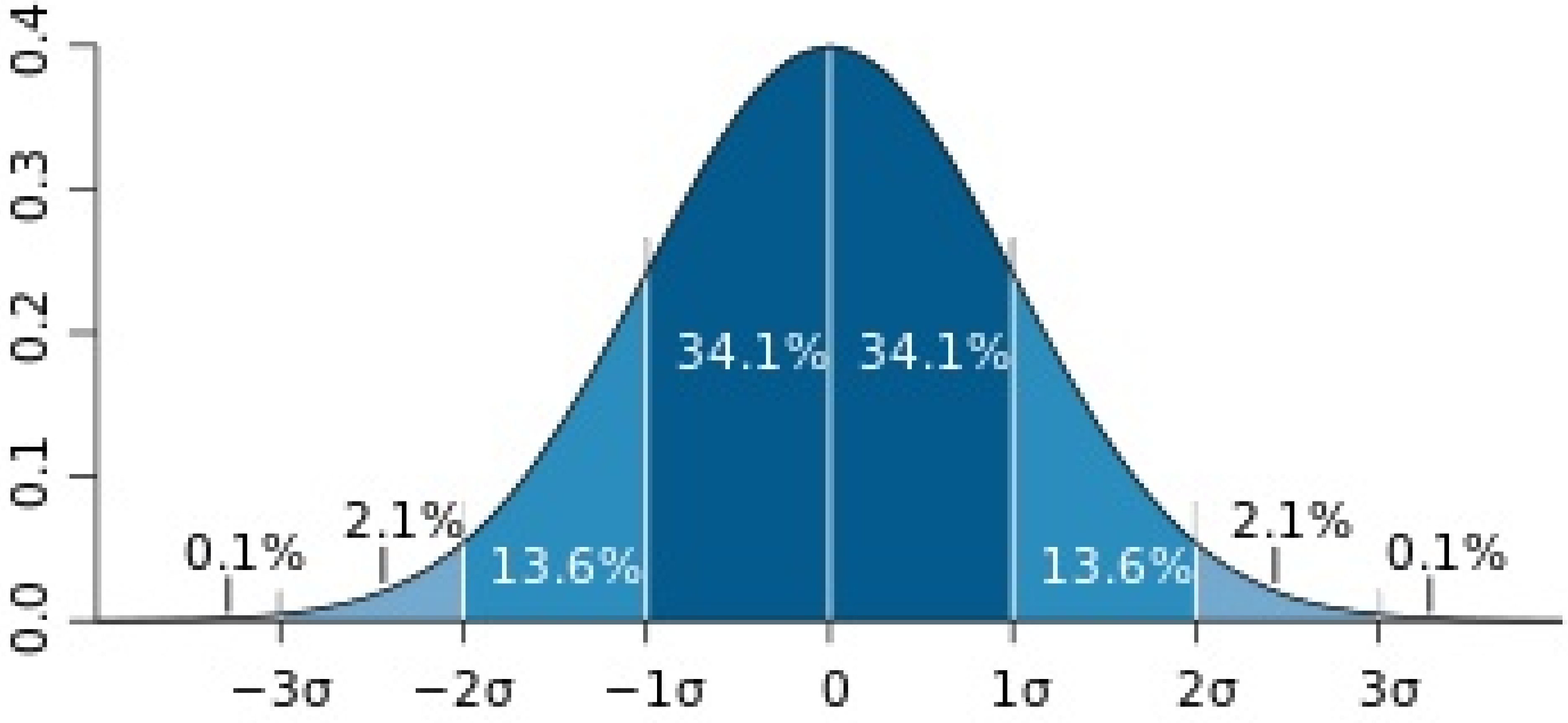
A few useful functions

- `isnull()`
- `dropna()`
- `fillna()`

Dealing with outliers

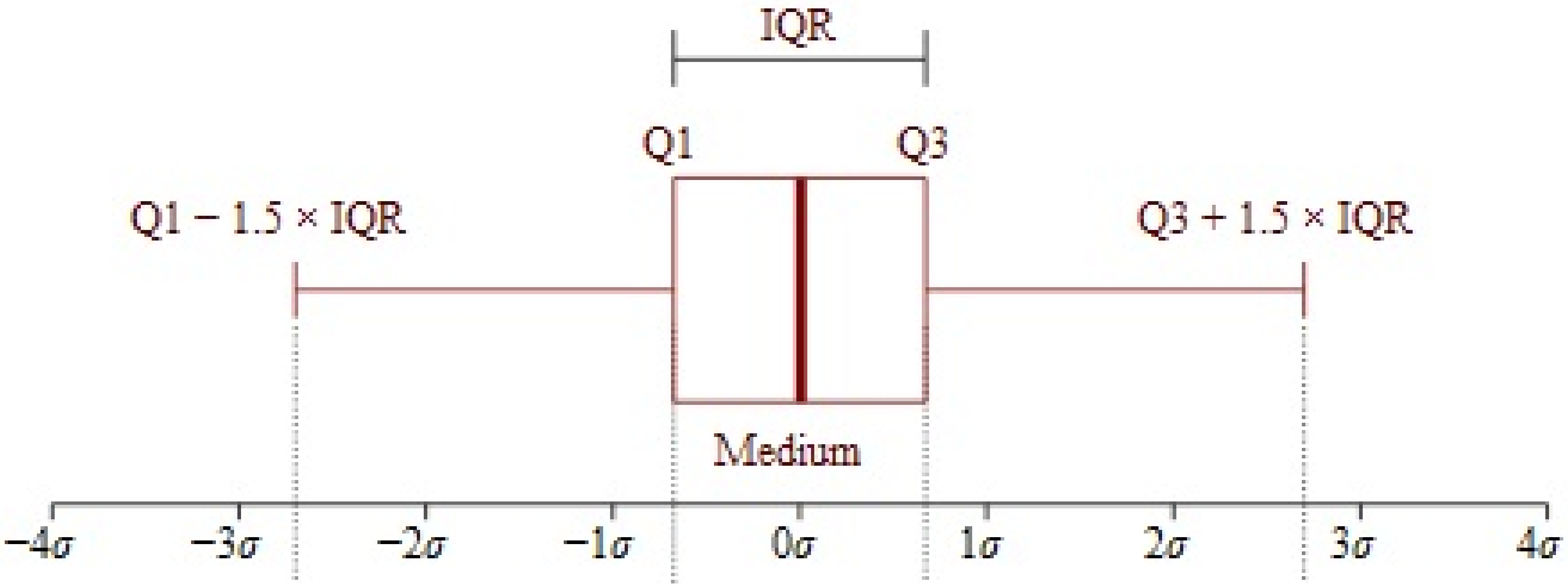
- Standard deviations
- Interquartile range (IQR)

Standard deviations



[1] Wikimedia

Interquartile range (IQR)



[1] Wikimedia

Summary

- Drop the whole row
- Impute missing values
- Standard deviations
- Interquartile range

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Bias-variance tradeoff

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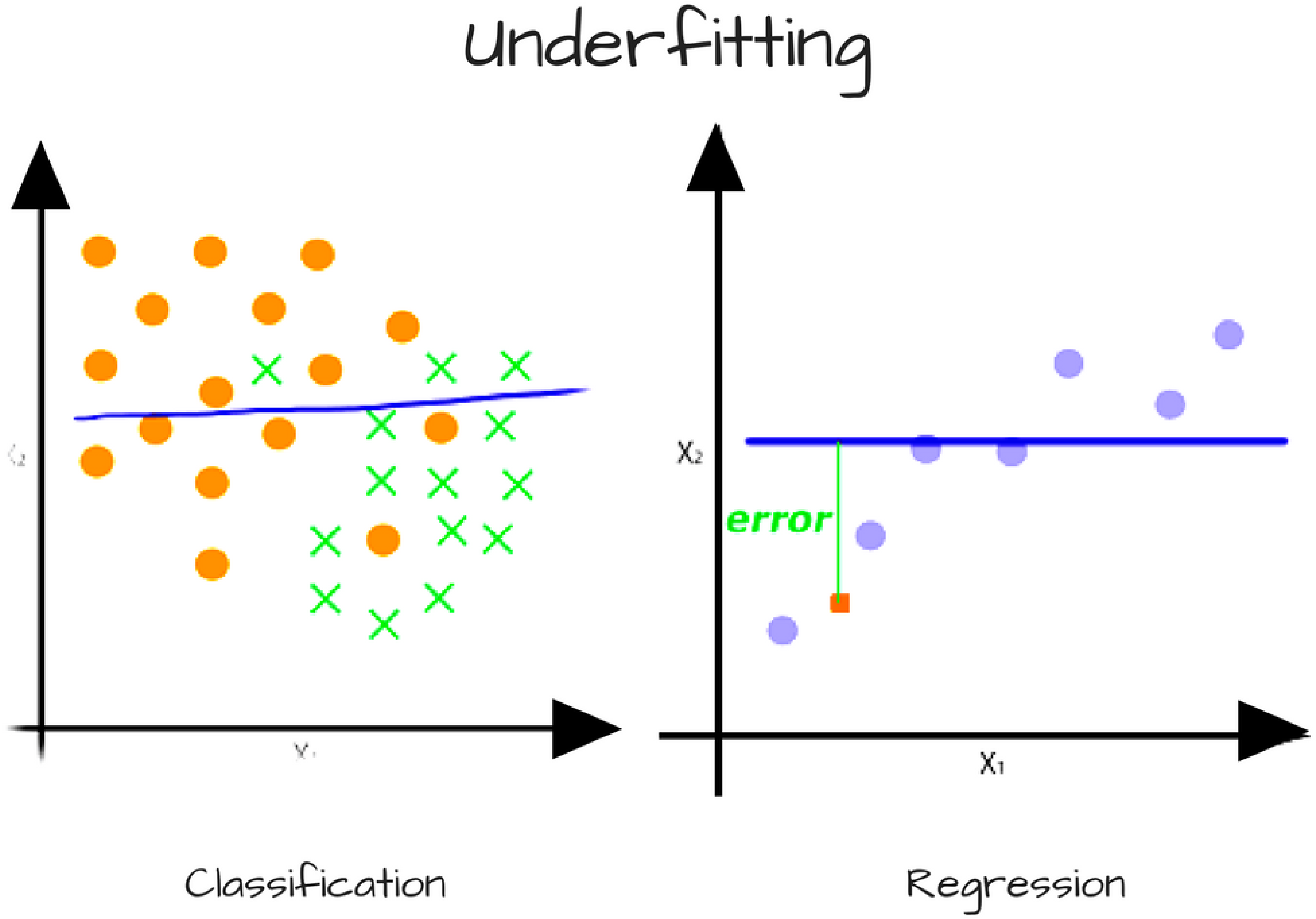
Types of error

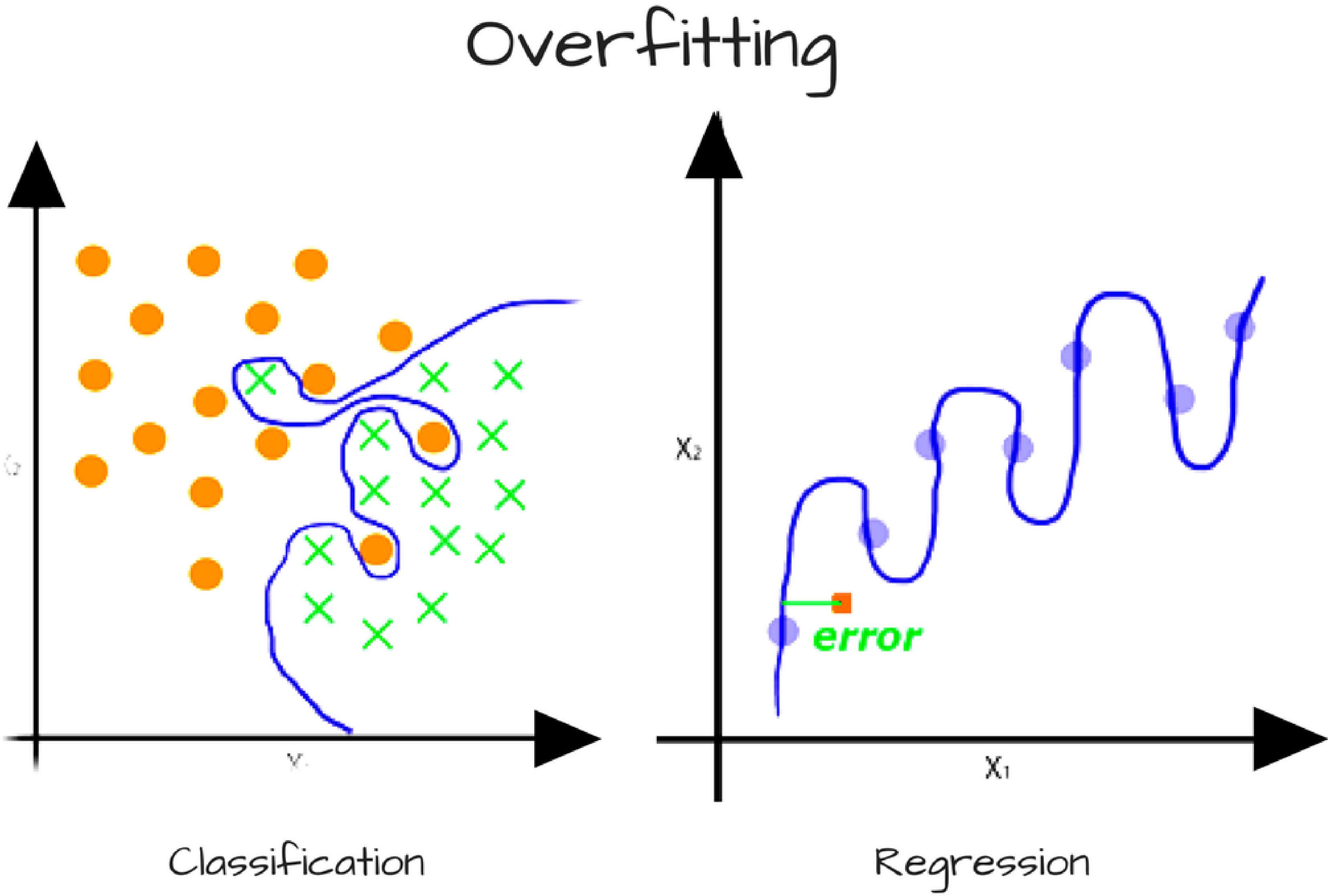
- Bias error
- Variance error
- Irreducible error

Bias error



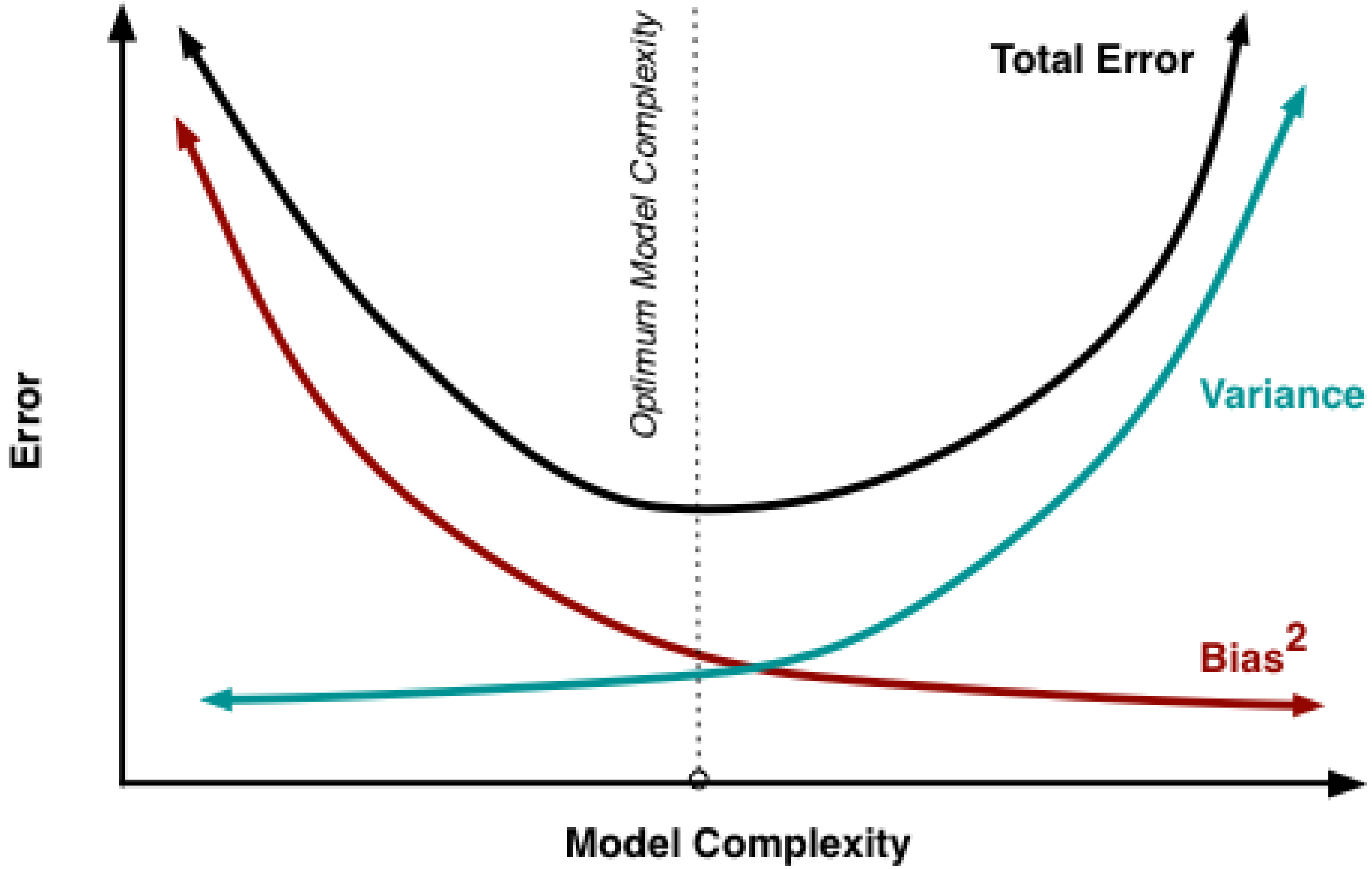
[1] How to Use Machine Learning to Predict the Quality of Wines

Variance error



[1] How to Use Machine Learning to Predict the Quality of Wines

Bias-variance tradeoff



[1] Scott Fortmann

Summary

- Types of error
- Bias error
- Variance error
- Bias-variance tradeoff

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Wrapping up

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Chapter 1: Probability and sampling distributions

- Conditional probabilities
- Central limit theorem
- Probability distributions

Chapter 2: Exploratory data analysis

- Descriptive statistics
- Categorical data
- Encoding techniques
- Multivariate relationships

Chapter 3: Statistical experiments and significance testing

- Confidence intervals
- Hypothesis testing
- Power analysis
- Multiple comparisons

Chapter 4: Regression and classification

- Linear regression
- Logistic regression
- Missing data and outliers
- Bias-variance tradeoff

Some advice

- Simulate the interview environment
- Practice explaining big concepts
- Know the business or product well
- Come prepared with ideas

Resources

- Data Science Career Resources Repo
- Practical Statistics for Data Scientists
- 120 Data Science Interview Questions
- Advice Applying to Data Science Jobs

Good luck and thank you!

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