



SUPERVISED LEARNING WITH SCIKIT-LEARN

Preprocessing data

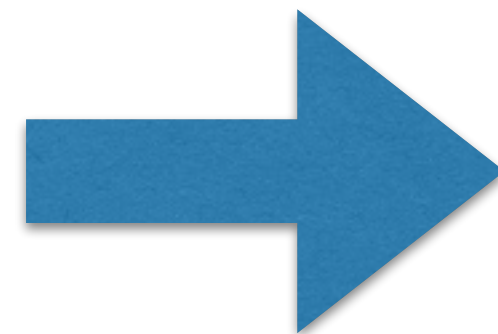
Dealing with categorical features

- Scikit-learn will not accept categorical features by default
- Need to encode categorical features numerically
- Convert to ‘dummy variables’
 - 0: Observation was NOT that category
 - 1: Observation was that category



Dummy variables

Origin
US
Europe
Asia



origin_Asia	origin_US	mpg	origin_US
0	1		1
0	0		0
1	0		0



Dealing with categorical features in Python

- scikit-learn: `OneHotEncoder()`
- pandas: `get_dummies()`



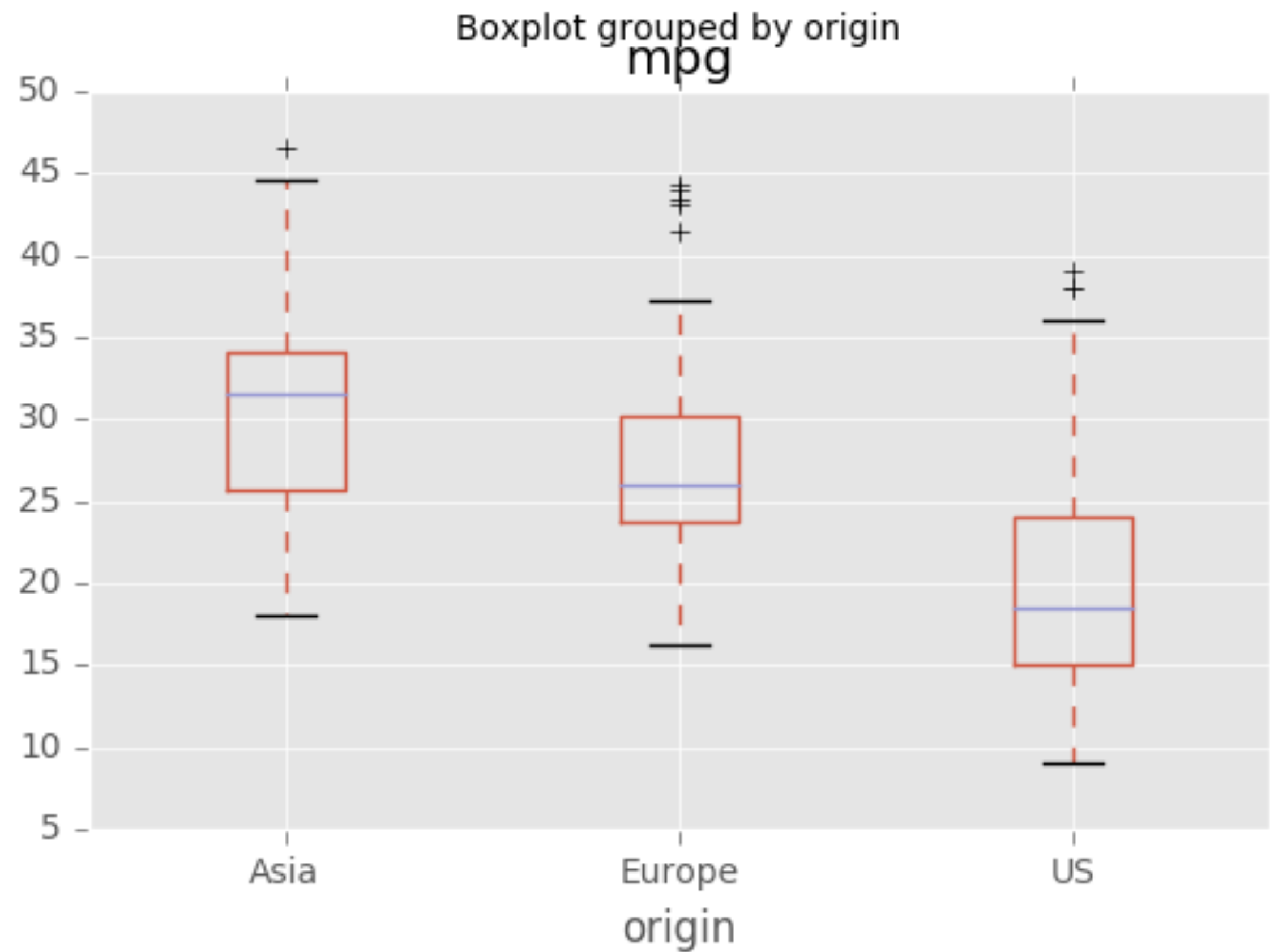
Automobile dataset

- mpg: Target Variable
- Origin: Categorical Feature

	mpg	displ	hp	weight	accel	origin	size
0	18.0	250.0	88	3139	14.5	US	15.0
1	9.0	304.0	193	4732	18.5	US	20.0
2	36.1	91.0	60	1800	16.4	Asia	10.0
3	18.5	250.0	98	3525	19.0	US	15.0
4	34.3	97.0	78	2188	15.8	Europe	10.0



EDA w/ categorical feature





Encoding dummy variables

```
In [1]: import pandas as pd
```

```
In [2]: df = pd.read_csv('auto.csv')
```

```
In [3]: df_origin = pd.get_dummies(df)
```

```
In [4]: print(df_origin.head())
```

	mpg	displ	hp	weight	accel	size	origin_Asia	origin_Europe	\
0	18.0	250.0	88	3139	14.5	15.0	0	0	
1	9.0	304.0	193	4732	18.5	20.0	0	0	
2	36.1	91.0	60	1800	16.4	10.0	1	0	
3	18.5	250.0	98	3525	19.0	15.0	0	0	
4	34.3	97.0	78	2188	15.8	10.0	0	1	

	origin_US
0	1
1	1
2	0
3	1
4	0



Encoding dummy variables

```
In [5]: df_origin = df_origin.drop('origin_Asia', axis=1)
```

```
In [6]: print(df_origin.head())
```

	mpg	displ	hp	weight	accel	size	origin_Europe	origin_US
0	18.0	250.0	88	3139	14.5	15.0	0	1
1	9.0	304.0	193	4732	18.5	20.0	0	1
2	36.1	91.0	60	1800	16.4	10.0	0	0
3	18.5	250.0	98	3525	19.0	15.0	0	1
4	34.3	97.0	78	2188	15.8	10.0	1	0



Linear regression with dummy variables

```
In [7]: from sklearn.model_selection import train_test_split

In [8]: from sklearn.linear_model import Ridge

In [9]: X_train, X_test, y_train, y_test = train_test_split(X, y,
...: test_size=0.3, random_state=42)

In [10]: ridge = Ridge(alpha=0.5, normalize=True).fit(X_train,
...:                                                    y_train)

In [11]: ridge.score(X_test, y_test)
Out[11]: 0.719064519022
```



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Let's practice!



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Handling missing data



PIMA Indians dataset

```
In [1]: df = pd.read_csv('diabetes.csv')
```

```
In [2]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 768 entries, 0 to 767
```

```
Data columns (total 9 columns):
```

```
pregnancies      768 non-null int64
```

```
glucose          768 non-null int64
```

```
diastolic        768 non-null int64
```

```
triceps          768 non-null int64
```

```
insulin          768 non-null int64
```

```
bmi              768 non-null float64
```

```
dpf              768 non-null float64
```

```
age              768 non-null int64
```

```
diabetes         768 non-null int64
```

```
dtypes: float64(2), int64(7)
```

```
memory usage: 54.1 KB
```

```
None
```



PIMA Indians dataset

```
In [3]: print(df.head())
```

	pregnancies	glucose	diastolic	triceps	insulin	bmi	dpf	age	\
0	6	148	72	35	0	33.6	0.627	50	
1	1	85	66	29	0	26.6	0.351	31	
2	8	183	64	0	0	23.3	0.672	32	
3	1	89	66	23	94	28.1	0.167	21	
4	0	137	40	35	168	43.1	2.288	33	

	diabetes
0	1
1	0
2	1
3	0
4	1



Dropping missing data

```
In [8]: df.insulin.replace(0, np.nan, inplace=True)
```

```
In [9]: df.triceps.replace(0, np.nan, inplace=True)
```

```
In [10]: df.bmi.replace(0, np.nan, inplace=True)
```

```
In [11]: df.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
pregnancies      768 non-null int64
glucose          768 non-null int64
diastolic        768 non-null int64
triceps          541 non-null float64
insulin          394 non-null float64
bmi              757 non-null float64
dpf              768 non-null float64
age              768 non-null int64
diabetes         768 non-null int64
dtypes: float64(4), int64(5)
memory usage: 54.1 KB
```



Dropping missing data

```
In [12]: df = df.dropna()
```

```
In [13]: df.shape
```

```
Out[13]: (393, 9)
```



Imputing missing data

- Making an educated guess about the missing values
- Example: Using the mean of the non-missing entries

```
In [1]: from sklearn.preprocessing import Imputer
```

```
In [2]: imp = Imputer(missing_values='NaN', strategy='mean', axis=0)
```

```
In [3]: imp.fit(X)
```

```
In [4]: X = imp.transform(X)
```




Imputing within a pipeline

```
In [1]: from sklearn.pipeline import Pipeline
```

```
In [2]: from sklearn.preprocessing import Imputer
```

```
In [3]: imp = Imputer(missing_values='NaN', strategy='mean', axis=0)
```

```
In [4]: logreg = LogisticRegression()
```

```
In [5]: steps = [('imputation', imp),  
....:            ('logistic_regression', logreg)]
```

```
In [6]: pipeline = Pipeline(steps)
```

```
In [7]: X_train, X_test, y_train, y_test = train_test_split(X, y,  
....: test_size=0.3, random_state=42)
```



Imputing within a pipeline

```
In [8]: pipeline.fit(X_train, y_train)
```

```
In [9]: y_pred = pipeline.predict(X_test)
```

```
In [10]: pipeline.score(X_test, y_test)
```

```
Out[10]: 0.75324675324675328
```



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Centering and scaling



Why scale your data?

```
In [1]: print(df.describe())
```

	fixed acidity	free sulfur dioxide	total sulfur dioxide	density \
count	1599.000000	1599.000000	1599.000000	1599.000000
mean	8.319637	15.874922	46.467792	0.996747
std	1.741096	10.460157	32.895324	0.001887
min	4.600000	1.000000	6.000000	0.990070
25%	7.100000	7.000000	22.000000	0.995600
50%	7.900000	14.000000	38.000000	0.996750
75%	9.200000	21.000000	62.000000	0.997835
max	15.900000	72.000000	289.000000	1.003690

	pH	sulphates	alcohol	quality
count	1599.000000	1599.000000	1599.000000	1599.000000
mean	3.311113	0.658149	10.422983	0.465291
std	0.154386	0.169507	1.065668	0.498950
min	2.740000	0.330000	8.400000	0.000000
25%	3.210000	0.550000	9.500000	0.000000
50%	3.310000	0.620000	10.200000	0.000000
75%	3.400000	0.730000	11.100000	1.000000
max	4.010000	2.000000	14.900000	1.000000

Why scale your data?

- Many models use some form of distance to inform them
- Features on larger scales can unduly influence the model
- Example: k-NN uses distance explicitly when making predictions
- We want features to be on a similar scale
- Normalizing (or scaling and centering)

Ways to normalize your data

- Standardization: Subtract the mean and divide by variance
 - All features are centered around zero and have variance one
- Can also subtract the minimum and divide by the range
 - Minimum zero and maximum one
- Can also normalize so the data ranges from -1 to +1
- See scikit-learn docs for further details



Scaling in scikit-learn

```
In [2]: from sklearn.preprocessing import scale
```

```
In [3]: X_scaled = scale(X) 
```

```
In [4]: np.mean(X), np.std(X)
```

```
Out[4]: (8.13421922452, 16.7265339794)
```

```
In [5]: np.mean(X_scaled), np.std(X_scaled)
```

```
Out[5]: (2.54662653149e-15, 1.0)
```




Scaling in a pipeline

```
In [6]: from sklearn.preprocessing import StandardScaler
```

```
In [7]: steps = [('scaler', StandardScaler()),  
....:             ('knn', KNeighborsClassifier())]
```

```
In [8]: pipeline = Pipeline(steps)
```

```
In [9]: X_train, X_test, y_train, y_test = train_test_split(X, y,  
....: test_size=0.2, random_state=21)
```

```
In [10]: knn_scaled = pipeline.fit(X_train, y_train)
```

```
In [11]: y_pred = pipeline.predict(X_test)
```

```
In [12]: accuracy_score(y_test, y_pred)
```

```
Out[12]: 0.956
```

```
In [13]: knn_unscaled = KNeighborsClassifier().fit(X_train, y_train)
```

```
In [14]: knn_unscaled.score(X_test, y_test)
```

```
Out[14]: 0.928
```



CV and scaling in a pipeline

```
In [14]: steps = [('scaler', StandardScaler()),  
....:              (('knn', KNeighborsClassifier()))]
```

```
In [15]: pipeline = Pipeline(steps)
```

```
In [16]: parameters = {'knn__n_neighbors': np.arange(1, 50)}
```

```
In [17]: X_train, X_test, y_train, y_test = train_test_split(X, y,  
....: test_size=0.2, random_state=21)
```

```
In [18]: cv = GridSearchCV(pipeline, param_grid=parameters)
```

```
In [19]: cv.fit(X_train, y_train)
```

```
In [20]: y_pred = cv.predict(X_test)
```



Scaling and CV in a pipeline

```
In [21]: print(cv.best_params_)  
{'knn__n_neighbors': 41}
```

```
In [22]: print(cv.score(X_test, y_test))  
0.956
```

```
In [23]: print(classification_report(y_test, y_pred))
```

	precision	recall	f1-score	support
0	0.97	0.90	0.93	39
1	0.95	0.99	0.97	75
avg / total	0.96	0.96	0.96	114



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Final thoughts

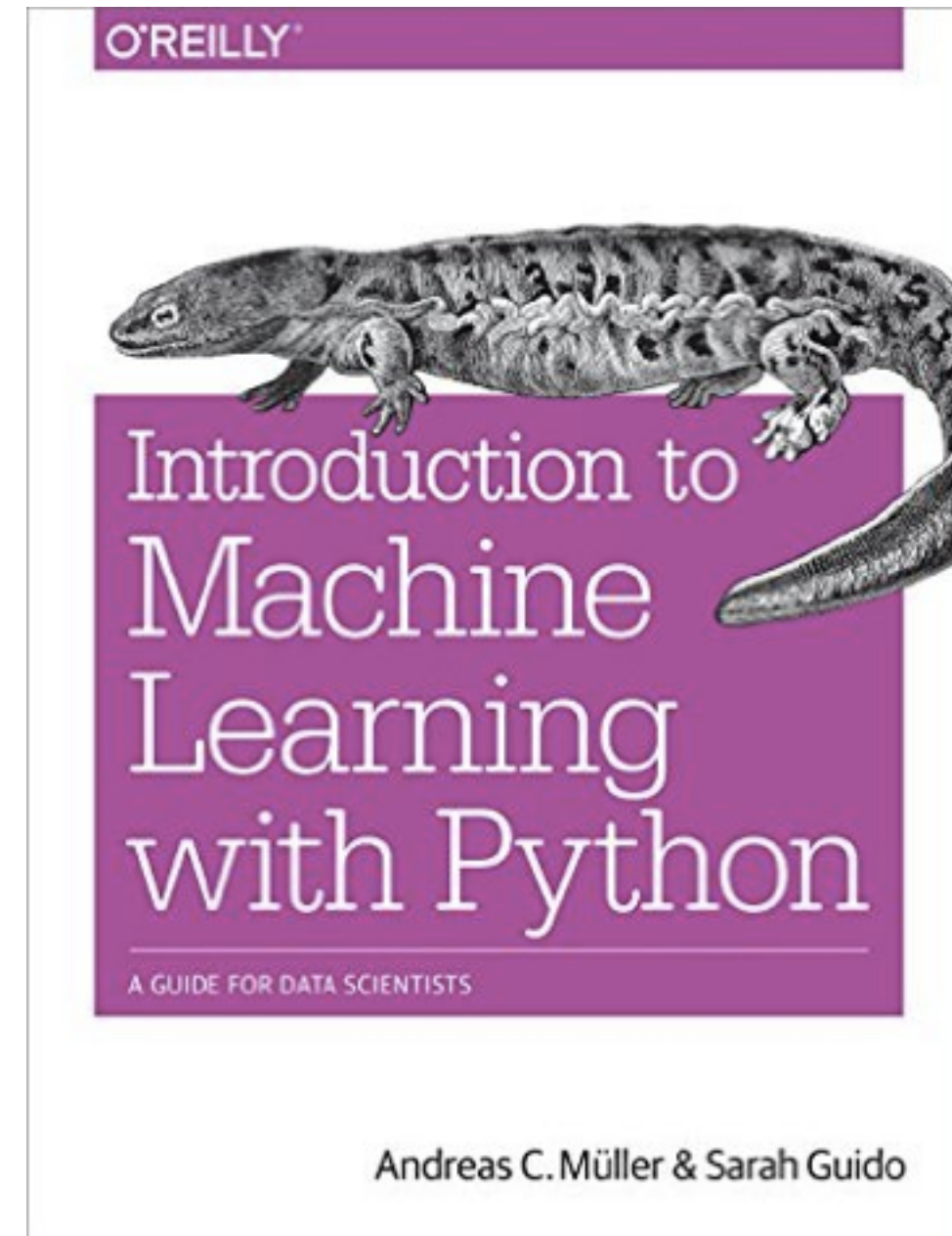
What you've learned

- Using machine learning techniques to build predictive models
 - For both regression and classification problems
 - With real-world data
- Underfitting and overfitting
- Test-train split
- Cross-validation
- Grid search



What you've learned

- Regularization, lasso and ridge regression
- Data preprocessing
- For more: Check out the scikit-learn documentation





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Congratulations!