

Session-3 (Bias Variance _ Polynomial)John

Session 3 ML 11/22
Training Clarusway
Pear Deck - August 13, 2022 at 10:54AM

Part 1 - Summary

Use this space to summarize your thoughts on the lesson

Part 2 - Responses

Slide 1



Use this space to take notes:

Slide 2

► SUMMARY of PREVIOUS CLASS ➤

- **Residuals**
 - Sum and mean of the Residuals are always Zero
 - Residuals are normally distributed for Suitable Linear Regression.
- **Regression Error Metrics**
 - MAE, MSE, RMSE...
- **Scikit-learn Library and ML**
 - 5 Steps: Import, Split Data, Model Building and Fit, Prediction, Evaluation

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► SUMMARY of PREVIOUS CLASS ➤

Model Building

1- Import Library

```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
```

2- Data Preparation / Train-Test Split

```
df = pd.read_csv("Advertising.csv")
x = df.drop(columns = "sales") #["TV", "radio", "newspaper"]
y = df["sales"]
X_train, X_test, y_train, y_test = train_test_split(x, y, test_size = 0.3, random_state = 42)
```

3- Model Building and Fitting

```
model = LinearRegression()
model.fit(X_train, y_train)
```

4- Prediction

```
y_pred = model.predict(X_test)
```

5- Evaluation

```
mae = mean_absolute_error(y_true, y_pred)
mse = mean_squared_error(y_true, y_pred)
r2 = r2_score(y_true, y_pred)

print(f"MAE: {mae}")
print(f"RMSE: {mse**0.5}")
print(f"R2 Score: {r2}")
```

Model Performance Evaluation:

Metric	Value
MAE	8.868602802606
MSE	72.92020202020201
R2	0.348370262129

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Introduction to Bias-Variance Trade-Off

Underfitting and Overfitting Problems

Training Error vs. Validation Error (Test Error)

Polynomial Regression

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Your Response

I've completed the pre-class content?

Students, drag the icon!

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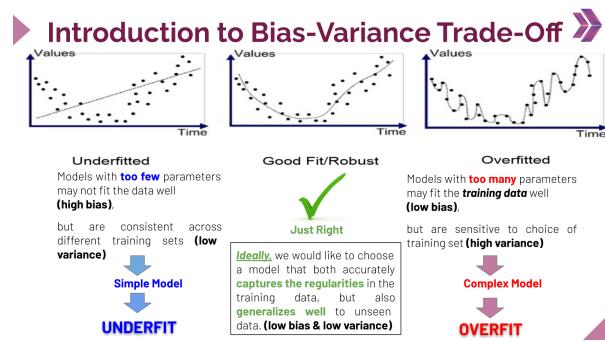
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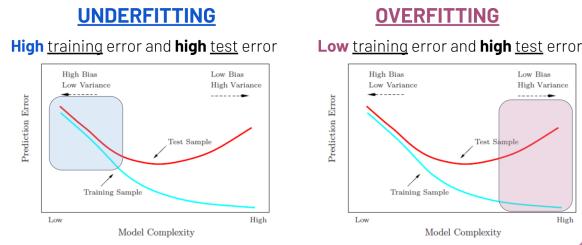
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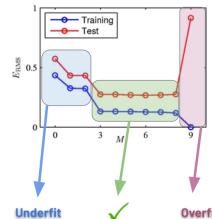
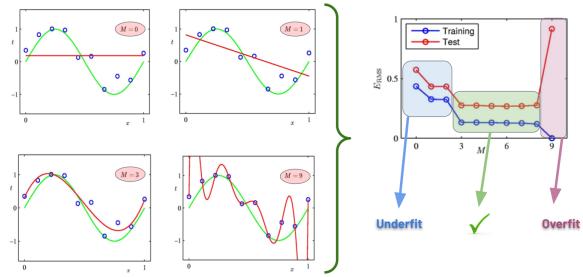
▶ Underfitting and Overfitting Problems ▶ HOW TO RECOGNIZE ?



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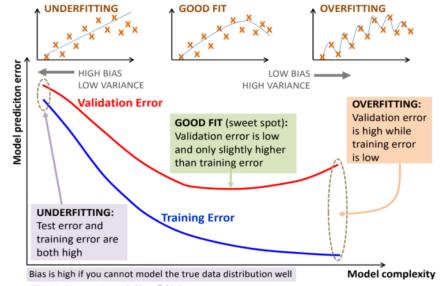
► Underfitting and Overfitting Problems ►



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► Training Error vs. Validation Error (Test Error) ►

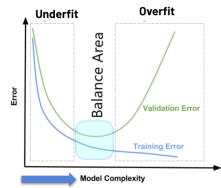


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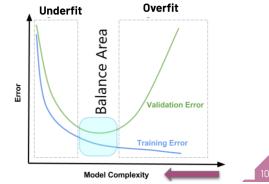
► Underfitting and Overfitting Problems ➤ HOW TO DEAL WITH UNDERFITTING ?

- Find a **more complex** model
- Increase the data, features



- Decrease the number of parameters
- More training data / **Cross Validation**

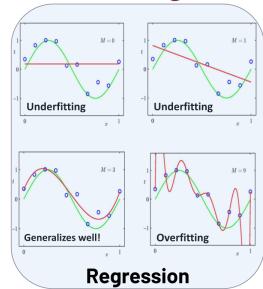
- **Regularization (Lasso&Ridge)**



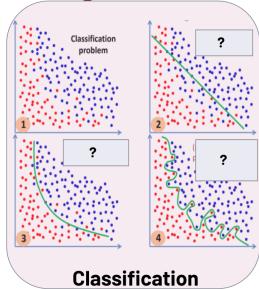
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► Underfitting and Overfitting Problems ➤



Regression

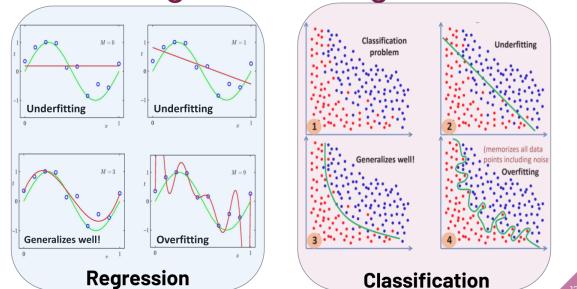


Classification

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▶ Underfitting and Overfitting Problems ▶



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Your Response

Is everything clear so far?



Students choose an option

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You Chose

- **clear**

Other Choices

- so so
- confused

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Regression (cont.)

Session-3



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Polynomial Regression



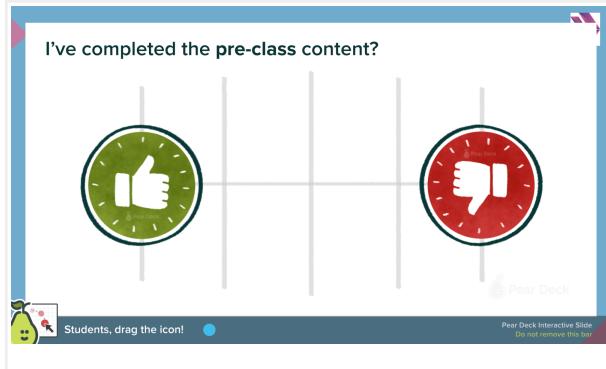
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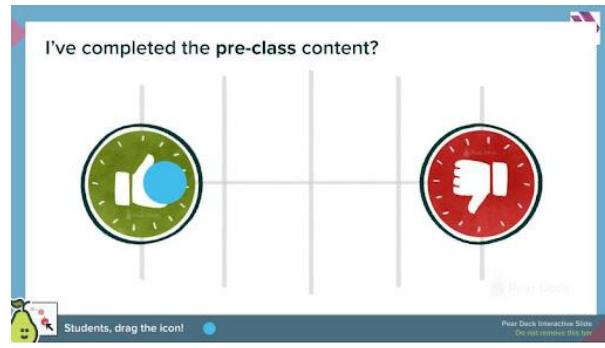
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Your Response

Slide 16

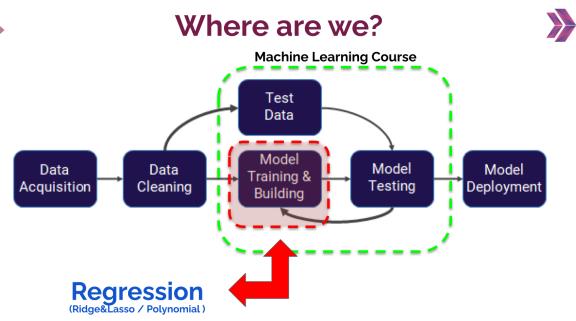


Your Response



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Polynomial Regression

Types of Regression Models

Simple Linear Regression	Multi Linear Regression	Polynomial Regression
A linear regression model that estimates the relationship between one independent variable and one dependent variable using a straight line. $Y = \theta_0 + \theta_1 x$	A linear regression model that estimates the relationship between several independent variables (features) and one dependent variable . $Y = \theta_0 + \theta_1 x_1 + \theta_2 x_2$	A special case of multiple linear regression. It also works with non linear relationship. The relationship between the independent variable x and dependent variable y is modeled as an nth degree polynomial in x . $Y = \theta_0 + \theta_1 x + \theta_2 x^2$
Advantages: <ul style="list-style-type: none">- Give info about the relevance of the features- Works good irrespective of data size Disadvantages: <ul style="list-style-type: none">- Assumptions of linear regression		Advantages: <ul style="list-style-type: none">- Works good on nonlinear probs. Disadvantages: <ul style="list-style-type: none">- Need to choose right polynomial degree for good bias/variance trade off.

Sources : www.geeksforgeeks.org & Towards Data Science - Aviral Agarwal

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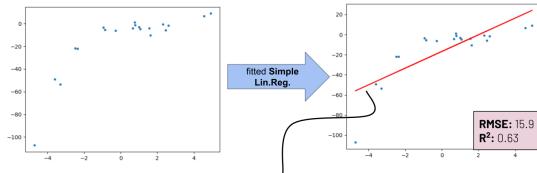
Link(s) on this slide:

- <http://www.geeksforgeeks.org/>

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Polynomial Regression



The regression line is **unable to capture the patterns** in the data. This is an example of **under-fitting**.

To overcome under-fitting, we need to **increase the complexity** of the model.

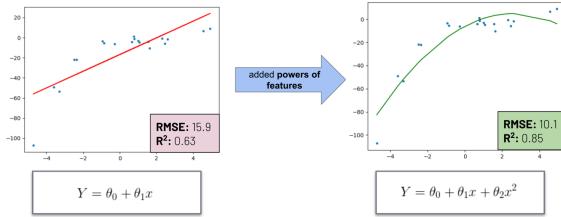
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Polynomial Regression

To generate a higher order equation we can **add powers of the original features as new features**.

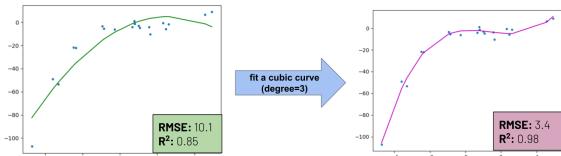


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Polynomial Regression

If we try to **fit a cubic curve (degree=3)** to the dataset, we can see that it is **more successfully generalized** than the quadratic (degree=2) and the linear plots (degree=1).

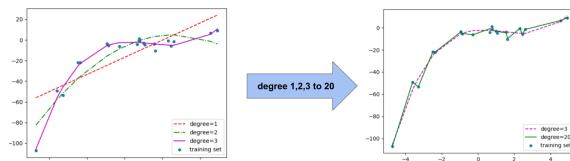


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Polynomial Regression

If we further **increase the degree to 20**, we can see that the curve memorize the data points. This is an example of **overfitting**.



How do we choose an optimal degree?
Bias Variance Trade-off

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Your Response

Is everything clear so far?



Students choose an option

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You Chose

- **clear**

Other Choices

- so so
- confused

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Your Response

Slide 24

How well did you like this lesson?



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Your Response

How well did you like this lesson?



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THANKS!
Any questions?

You can find me at:
johnbayway@gmail.com



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