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MLOps Training

MACHINE LEARNING OPERATIONS

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Day 3 Agenda

Regularization & Deep Learning

- Recap
- Quiz for the previous Day
- Overfitting, Underfitting
- Workshop
- L1/L2 regularization
- Intro to neural networks and deep learning flow
- Quiz

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Recap

EXPLORATORY DATA ANALYSIS (EDA)

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Q1: The syntax df.shape returns a tuple representing ___ of the dataset.

A. correlation and variance

B. mean and median

C. number of rows and columns

D. size in memory

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Q2: To check the percentage of missing values column-wise, we use df.isnull().mean(), which gives us values between ____ and ____.

A. 1 and 100

B. 0 and 1

C. -1 and 1

D. 0 and 100

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Q3: The line

df = df.drop(columns=null_percent[null_percent > 0.3].index) is used to remove columns with more than ____% missing values.

A. 3

B. 10

C. 30

D. 50

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df = df.drop(columns=null_percent[null_percent > 0.3].index) is used to remove columns with more than ____% missing values.

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Q4: To examine the summary statistics of numerical features, the code `df[num_cols].describe().T[:5]` is used. The .T stands for ____.

A. table format

B. trimming values

C. transpose

D. top values

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Q5: The function sns.boxplot() is used to detect ___ and visualize distribution characteristics.

A. duplicates

B. outliers

C. nulls

D. categories

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Q6: A histogram with KDE (Kernel Density Estimation) is plotted using `sns.histplot(df['SalePrice'], kde=True)`. The KDE line helps to understand the ___ of the data.

A. completeness

B. sparsity

C. central tendency

D. probability density

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Q7: The df.select_dtypes(include='object') line is used to select ___ features in the dataset.

A. numerical

B. categorical

C. Boolean

D. missing

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Q8: The correlation matrix is created using df.corr(numeric_only=True). Setting numeric_only=True ensures that only ____ data types are used in the computation.

A. float and bool

B. object and float

C. int and float

D. datetime and object

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Q9: The sns.heatmap() function with annot=True overlays ____ on the heatmap cells.

A. feature names

B. colors

C. correlation values

D. histogram bars

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Q10: In the context of EDA, the main reason to remove columns with high null percentages is to avoid ___ during model training.

A. faster execution

B. better styling

C. bias and error

D. overfitting

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Model’s Quality

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Model’s Quality

A machine learning model is considered "good" when it performs well on both the training data and unseen (test) data.

What does that mean?

- Effectively captures meaningful patterns from the training dataset
- Performs reliably on new, unseen data through strong generalization
- Strikes a balance by avoiding both overfitting and underfitting

Regression Model Metrics

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Regression

- Mean Absolute Error (MAE)
- Mean Squared Error (MSE)
- Root Mean Squared Error (RMSE)
- R^2 Score (Coefficient of Determination)

Classification Model Metrics

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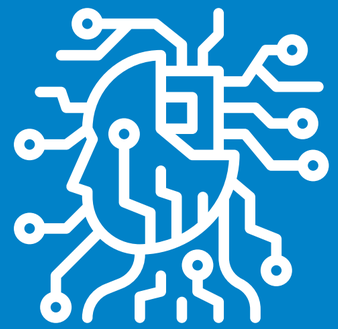
Classification

- Accuracy
- Precision
- Recall
- F1 Score
- Confusion Matrix



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Bias & Variance

Bias

Bias

Bias refers to the error introduced when a machine learning model is overly simplistic and fails to capture the underlying patterns in the data.

Bias Example

If a model learns that every two-wheeler is a motor bike, it's making a high-bias assumption. In reality, a two-wheeler could be a scooty, moped, or even a bicycle.

This oversimplification leads to incorrect predictions — and that’s what bias is: the model makes generalized assumptions that miss important distinctions in the data.

Motor Bike

Motor Bike

Motor Bike

Bias Usecase

Medical Diagnosis

A model only uses basic symptoms (like fever or cough) to predict diseases.

It ignores more specific indicators (blood tests, scan reports).

Result: Predicts many patients incorrectly → high bias.

Bias Pros/Cons

High bias typically leads to underfitting, where the model performs poorly on both training and testing data because it fails to learn enough from the data.

Pro: It’s simple, fast, and less prone to overfitting.

Cons: It misses important patterns, leading to inaccurate predictions.

Variance

Variance

Variance is the error that happens when a machine learning model learns too much from the training data, including the noise, and fails to perform well on new data.

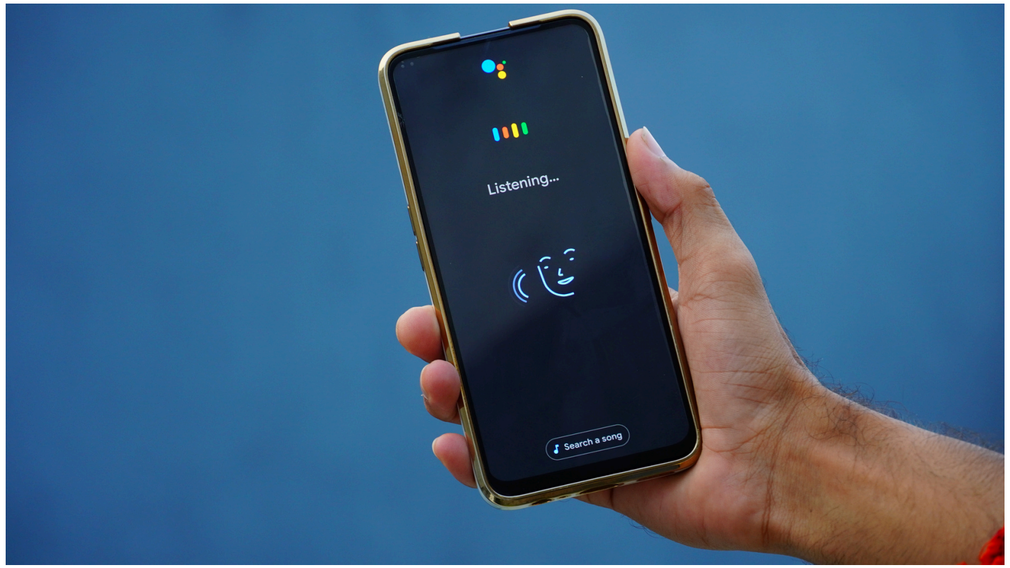
Variance Usecase

Voice Assistant Personalization

A voice assistant is trained heavily on one user's voice patterns.

When used by another person, it struggles to understand commands.

Result: Overfit to one voice → high variance.

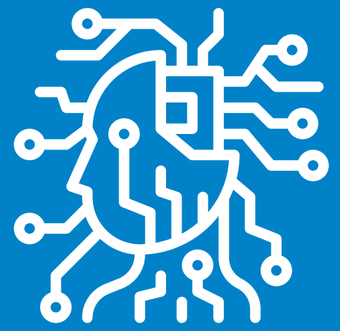


Variance Pros/Cons

High variance typically leads to overfitting, where the model performs well on training data but poorly on testing data.

Pro: It captures complex patterns in the data.

Con: It struggles to generalize to new, unseen data.



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Underfitting & Overfitting

Underfitting

What is Underfitting ?

Underfitting occurs when the model hasn’t learned enough from the training data — either due to insufficient training time or because the input features lack the significance or volume needed to capture a meaningful relationship with the target variable.

Underfitting usecases

1. Housing price prediction
2. Weather forecasting
3. Image recognition
4. Movie Recommendation System
5. Speech Recognition System
6. Loan Approval Prediction

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Reasons of Underfitting

- The model is too simple, so it can’t understand the real patterns in the data.
- The input features don’t give enough useful information to make good predictions.
- There’s not enough training data, so the model can’t learn well.
- Too much regularization is applied, which limits the model from learning properly.
- The features are not scaled, making it hard for the model to find correct relationships.

Overfitting

What is Overfitting?

The situation where any given model is performing too well on the training data but the performance drops significantly over the test set is called an overfitting model..

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Overfitting usecases

1. Online Ad Click Prediction
2. Credit Card Fraud Detection
3. Medical diagnosis model
4. Stock price prediction

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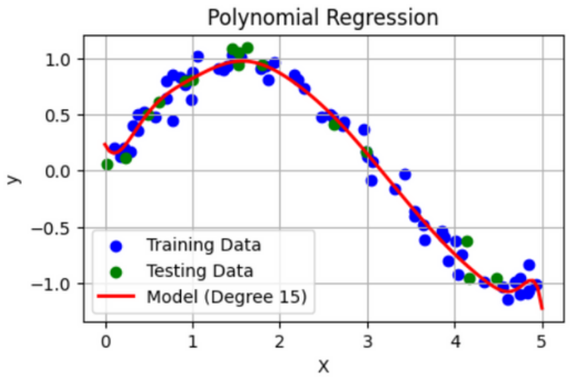
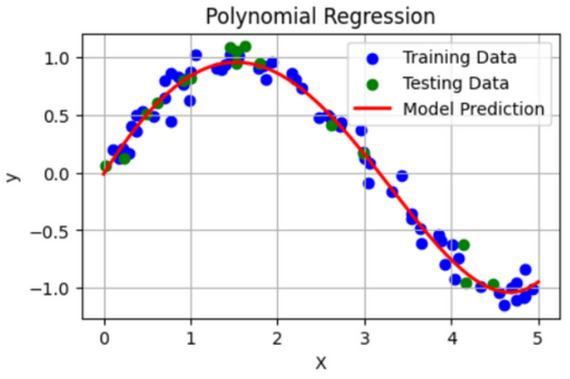
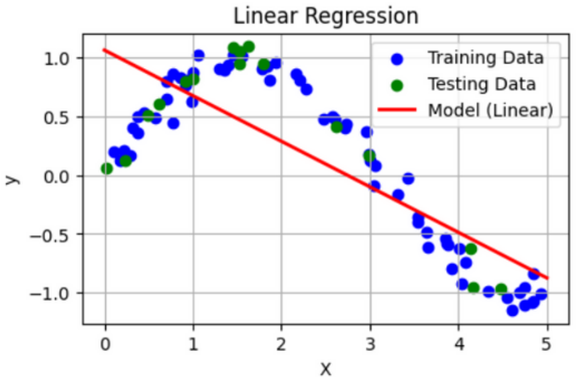
Reasons of Overfitting

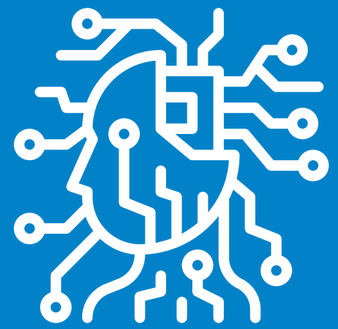
1. The model is too complicated and tries to learn everything, even the noise.
2. There is not enough training data, so the model just memorizes what it sees.
3. The model is very sensitive to the data, which means small changes confuse it easily.

Underfit & Overfit









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Regularization

Need of Regularization

- Regression models can overfit when features are highly correlated or too many features exist.
- Overfitting leads to poor generalization.
- Regularization combats overfitting by penalizing large coefficients.

What is Regularization ?

- Regularization adds a penalty to the loss function
- Helps control model complexity
- Common in linear models: modifies OLS (Ordinary Least Squares)

Type of Regularization ?

- Ridge Regression or L2 Regularization
- Lasso Regression or L1 Regularization
- Elastic Net: Combining L1 & L2

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Ridge Regression
or
L2 Regularization

- Adds squared magnitude of coefficients to loss.
- Penalizes large coefficients.
- Doesn't eliminate features but shrinks them.
- Best for multicollinearity.

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Ridge Regression
or
L2 Regularization

```python
from sklearn.linear_model import Ridge

# alpha is the regularization strength
ridge = Ridge(alpha=1.0)
ridge.fit(X_train, y_train)
```

```python
from sklearn.linear_model import SGDRegressor

# Initialize SGDRegressor with L2 penalty
sgd_reg = SGDRegressor(penalty='l2')
sgd_reg.fit(X_train, y_train)
```

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When to Use Ridge Regression ?

- You have **many correlated features**
- You want to **retain all**, but in controlled amounts

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Lasso Regression
or
L1 Regularization

- Adds absolute value of coefficients to loss
- Can zero out coefficients — helps in feature selection
- Good when we believe only some features are relevant

When to Use Lasso Regression ?

- You need feature selection
- You suspect some features are noise

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Elastic Net

- Mixes Ridge and Lasso penalties
- Helps when features are correlated and selection is needed
- Controlled by parameters **λ** (lambda) and **α** (alpha)

When to Use Elastic Net ?

- You want a **flexible balance**
- You’re unsure which approach is best

Regularization Summary

- Regularization reduces overfitting
- Ridge shrinks, Lasso selects, ElasticNet balances
- Tuning λ (lambda) and α (alpha) is essential
- Use cross-validation to pick best model

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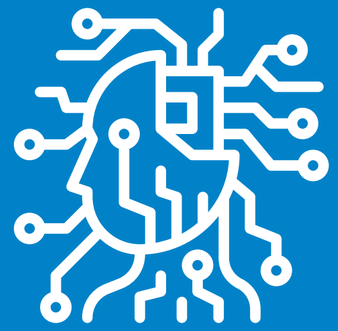

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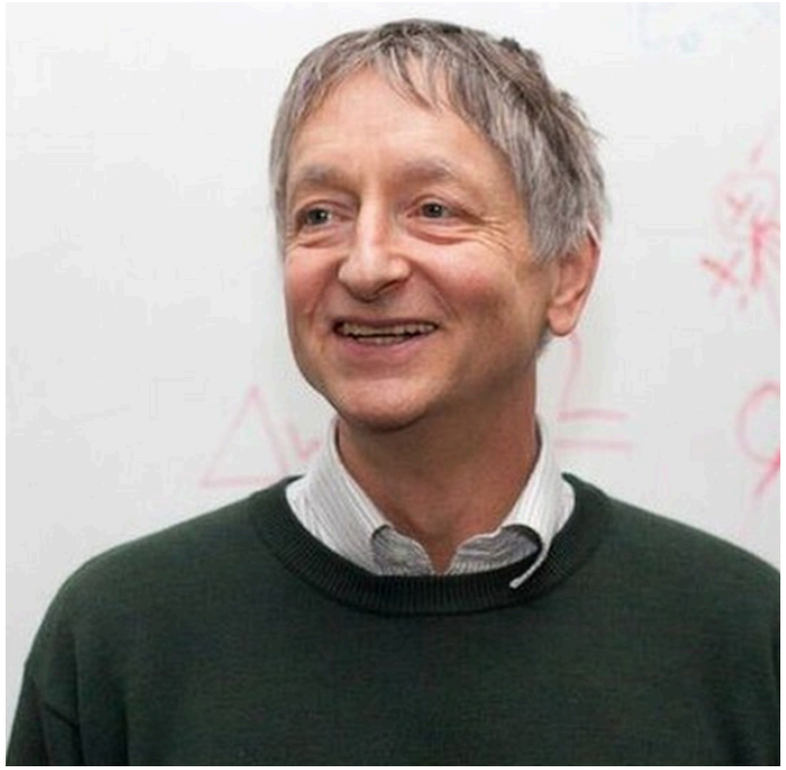
Deep Learning & Neural Network

Heroes of Deep Learning



Geoffery Hinton

Andrew NG

AI is the new electricity – By **Andrew NG**

Deep Learning

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What is Deep Learning ?

- Subset of Machine Learning that mimics the **human brain**
- Uses neural networks with **multiple layers** ("deep" means many layers)
- Learns features **automatically** from raw data

Fact: The term “deep” in Deep Learning refers to the **number of layers** in a neural network.

Why Deep Learning now ?

- Explosion of data (Big Data)
- Increased compute power (GPUs, TPUs)
- Better algorithms (Activation functions, Optimizers)
- Open-source tools (TensorFlow, PyTorch)

Fact: Training a deep network that once took weeks can now be done in **minutes** using modern hardware.

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Why Traditional ML is not enough ?

- Requires manual **feature engineering**
- Doesn’t scale well with **unstructured data** (images, audio, video)
- Performance plateaus as data grows

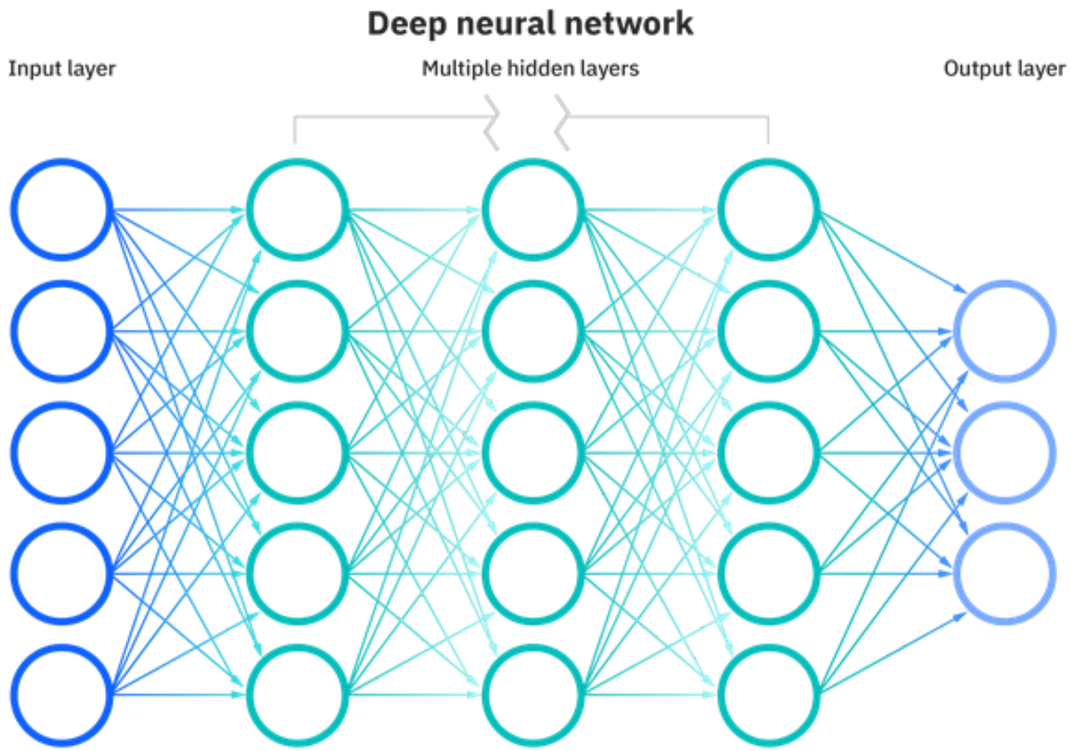
Examples:

- Predicting stock prices with regression
- Image classification using SVM

Fact: Deep learning **improves with more data**, while classical ML often hits a performance ceiling.

What is Neural Network ?

- Inspired by the human brain’s neurons
- Made up of **layers of nodes** (neurons): Input → Hidden → Output
- Each neuron applies a weighted sum and activation function



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Deep Learning Applications

- Image Recognition (Face ID, Self-driving cars)
- Natural Language Processing (ChatGPT, Google Translate)
- Speech Recognition (Alexa, Siri)
- Healthcare (Disease detection from X-rays/MRIs)

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Deep Learning Summary

- Deep learning is ideal for complex, high-dimensional data
- Neural networks can learn **hierarchical representations**
- Classical ML still has its place, but deep learning is driving the **future of AI**

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Quiz

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Q1. Overfitting occurs when a model performs well on training data but poorly on test data because it ____ the training patterns.

A. ignores

B. generalizes

C. memorizes

D. transforms

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Q2. Underfitting typically happens when the model is too ____ to capture the underlying structure of the data.

A. large

B. simple

C. complex

D. deep

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Q4. L1 regularization encourages ____ by forcing some weights to become exactly zero.

A. sparsity

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C. weight duplication

D. normalization

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Q5. In L2 regularization, the penalty added to the loss function is proportional to the ___ of the weights.

A. mean

B. square

C. absolute value

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Q7. In deep learning, the term “deep” refers to the presence of ___ layers in the network.

A. very wide

B. many hidden

C. few output

D. multiple input

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A. validation

B. learning rate

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A. scaling

B. deleting

C. updating

D. deactivating

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