

# Machine Learning & Deep Learning with MATLAB



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## Agenda

#### Part I: Introduction to Machine Learning

- Overview of Machine Learning
- Machine Learning Algorithms
- Demo: Detecting Human Activity

#### Part II: Introduction to Deep Learning

- Why Deep Learning
- Deep Learning vs Machine Learning
- Demo: Object classification with ALEXNET

#### Key takeaways Q&A



## Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL)



The **simulated intelligence** that tries to mimic human actions or decision making.

The use of **statistical methods** that enables computer to learn from data without explicitly programmed to do so.

A subfield of machine learning that uses **multi-layer neural networks** in the architecture



## **Machine Learning**

#### Most common tool for Data analytics modelling



Use features in the data and to create a predictive model



## **Used Across Many Application Areas**





## **Motivation for Machine Learning**

- Do you want to create a model of a system?
  - Understand dynamics
  - Predict Outputs
- How do you create model?
  - Develop an equation
    - Takes time to develop, sometimes even years
    - Unknown if there is actually an equation at all
- Another option, Machine Learning



#### **Overview – Machine Learning**





### **Unsupervised Learning**





## **Supervised Learning**





### Supervised Learning Workflow





### **Machine Learning**

#### Machine learning uses **data** and produces a **program** to perform a **task**

Task: Human Activity Detection







### **Demo 1: Human Activity Learning Using Mobile Phone Data**





#### **Train a Model with the Classification Learner App**

-	Set Up Classification							
Import Data	Step 1		Step 2	sponse				Step 3
	T_mean T_pca	*	Name Wmean_total_acc_x_t	Type	Range -0.3707 1.05533	Import as Predictor	-	Cross Validation
	L_stov humanActivityData rawSensorDataTrain body_gyro_y_train body_gyro_y_train body_gyro_z_train total_acc_x_train		Wmean_total_acc_y_t Wmean_total_acc_z_t.	double double	-0.494512 1.005 -0.988372 0.977	Predictor Predictor	-	Select a number of folds (or divisions) to partition the into. Each fold is held out in turn for testing. The app a model for each fold using all the data outside the f The app tests each model performance using the d inside the fold, then calculates the average test error all folds. This method gives a good estimate of the emodiative average of the feat mercial burged rules.
			Wmean_body_gyro_x Wmean_body_gyro_y Wmean_body_gyro_z	double double double	-0.914161 0.790 -0.351097 0.485 -0.437807 0.404	Predictor Predictor Predictor	*	
	total_acc_y_train total_acc_z_train		Wstd_total_acc_x_train Wstd_total_acc_y_train	double double	0.00134528 0.6 0.00151609 0.3	Predictor Predictor	-	<ul> <li>Holdout</li> </ul>
			Wstd_body_gyro_x_tr Wstd_body_gyro_y_tr	. double . double	0.00169888 1.7 0.00201112 1.5	Predictor Predictor	-	Select a percentage of the data to use as a test set. T app trains the model on the training set and assesses performance with the test set. Since the resulting mod
			Wstd_body_gyro_z_tr. Wpca1_total_acc_x_t	double double	0.0021924 0.97 -13.2982 2.85553	Predictor Predictor	÷	based on only a portion of the data, it is recommended only for large data sets.
			Wpca1_total_acc_yt Wpca1_total_acc_z_t Wpca1_body_ovro_x	double double	-5.92044 11.0487 -12.1606 10.0782 -9.18752 8.79436	Predictor Predictor Predictor	-	No Validation
_			Wpca1_body_gyro_y Wpca1_body_gyro_z	double double	-10.0066 10.9679 -9.08108 9.22596	Predictor Predictor	÷	Use all the data for training and compute the error rate the same data. The estimated error rate is likely to be unrealistically low. The actual error rate when the mo-
5			activity	categorical	5 unique	Response	•	is used to predict new data is likely to be higher.
	Use columns as variables							Cross Validation Folds: 5
	Use rows as variables							4

#### **Classification Learner App with data: Step 1**

1. Data import and Cross-validation setup



#### **Train a Model with Classification Learner App**



#### **Classification Learner App with data: Step 2**

- 1. Data import and Cross-validation setup
- 2. Data exploration and feature selection



#### **Train a Model with the Classification Learner App**



#### **Classification Learner App with data: Step 3**

- 1. Data import and Cross-validation setup
- 2. Data exploration and feature selection
- 3. Train multiple models



#### **Train a Model with Classification Learner App**

Search P = 🖼 ×	
DECISION TREES	
SUPPORT VECTOR MACHINES TOP	
Fine KNN Medium KNN Coarse KNN Cosine KNN Cubic KNN Weighted KNN	
ENSEMBLE CLASSIFIERS	
Boosted Bagged Subspace Subspace Trees Trees Discriminant KNN RUSBoost	

#### Classification Learner App with data: Step 3 cont'd

- 1. Data import and Cross-validation setup
- 2. Data exploration and feature selection
- 3. Train multiple models



#### Train a Model with the Classification Learner App



#### Classification Learner App with data: Step 3 cont'd

- 1. Data import and Cross-validation setup
- 2. Data exploration and feature selection
- 3. Train multiple models



#### **Train a Model with the Classification Learner App**



#### **Classification Learner App with data: Step 4**

- 1. Data import and Cross-validation setup
- 2. Data exploration and feature selection
- 3. Train multiple models
- 4. Model comparison and assessment



### **Train a Model with Classification Learner App**



Classification Learner App with data: Step 5

- 1. Data import and Cross-validation setup
- 2. Data exploration and feature selection
- 3. Train multiple models
- 4. Model comparison and assessment
- 5. Share model



#### **Train a Model with the classification Learner App**



#### Classification Learner App with data: Step 5 Cont'd

- 1. Data import and Cross-validation setup
- 2. Data exploration and feature selection
- 3. Train multiple models
- 4. Model comparison and assessment
- 5. Share model or automate process



# **Deep Learning**

MEDICA

HEALTH



#### **Deep Learning**

**Definition:** Deep learning is a **machine learning** technique that learns **features and tasks** directly from data.

Data can be **images**, text or sound.





## Why is Deep Learning So Popular Now?





### **Factors promoting Deep Learning**





### **Machine Learning vs Deep Learning**





#### **Machine Learning vs Deep Learning**

#### **Question: Machine Learning or Deep Learning?**

	<b>Machine Learning</b>	Deep Learning
Training dataset	Small	Large
Choose your own features	Yes	No
# of classifiers available	Many	Few
Training time	Short	Long



## Neural Network





## **Multilayer Neural Network**



Hidden Layers



### ALEXNET





## **Classification with 11 lines of codes**

%% Get Webcam webcaminfo = webcamlist; vid = webcam(webcaminfo{2}); % preview(vid)

%% Define Alexnet net = alexnet;

while true

im = snapshot(vid); image(im) im = imresize(im,[227 227]); label = classify(net,im); title(string(label)) drawnow end













#### **Additional Resources**

#### Documentation



mathworks.com/machine-learning

Training





# Thank you

See you next time

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