

# Course Introduction

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## MATLAB進階程式語言與實作

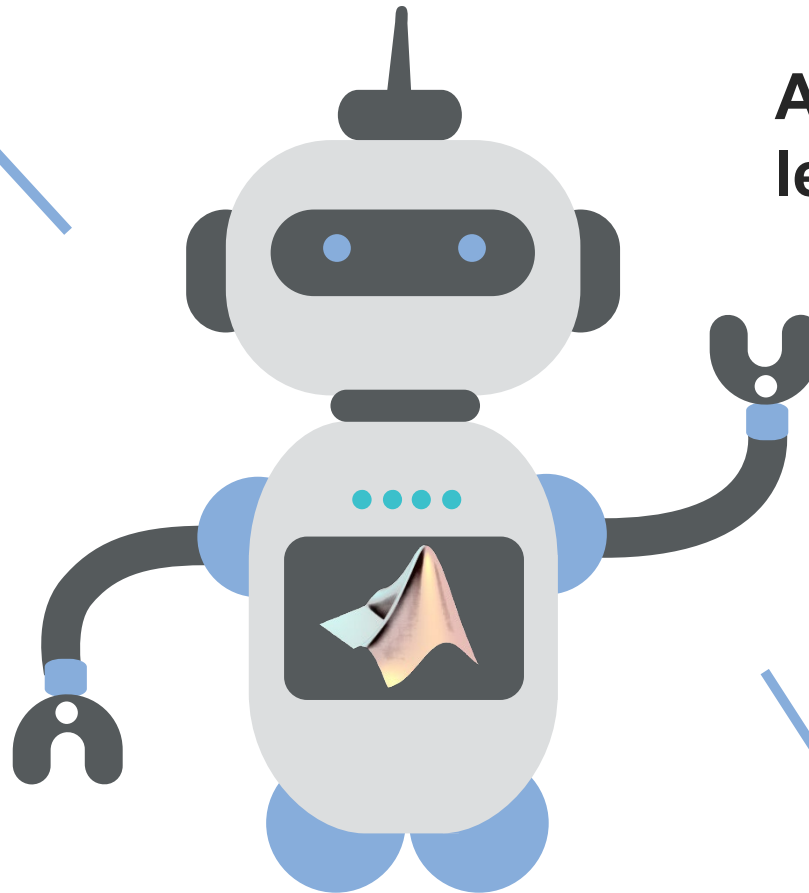
**盧家鋒** Chia-Feng Lu, Ph.D.  
Department of Biomedical Imaging and  
Radiological Sciences, NYCU  
[alvin4016@nycu.edu.tw](mailto:alvin4016@nycu.edu.tw)

# What will you learn in this course?

**New data formats and functions in MATLAB**

**Application of machine learning using MATLAB**

**Basic concepts of machine learning (ML)/ deep learning (DL)**

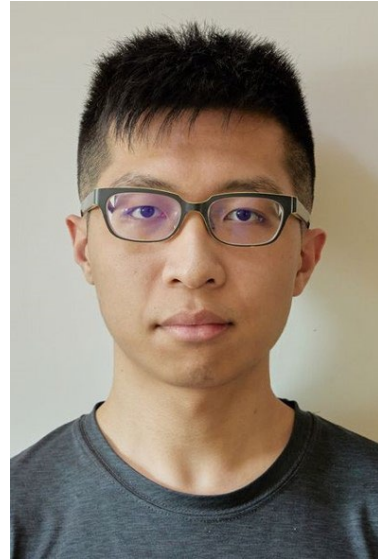


**MATLAB App designer (graphic user interface)**

# Teaching Assistants (TAs)



**Associate Professor**  
**盧家鋒 (Chia-Feng Lu)**



**柏勳 (Michael)**



**楊薇 (Vivian)**

**Department of Biomedical Imaging  
and Radiological Sciences**



**Help!**

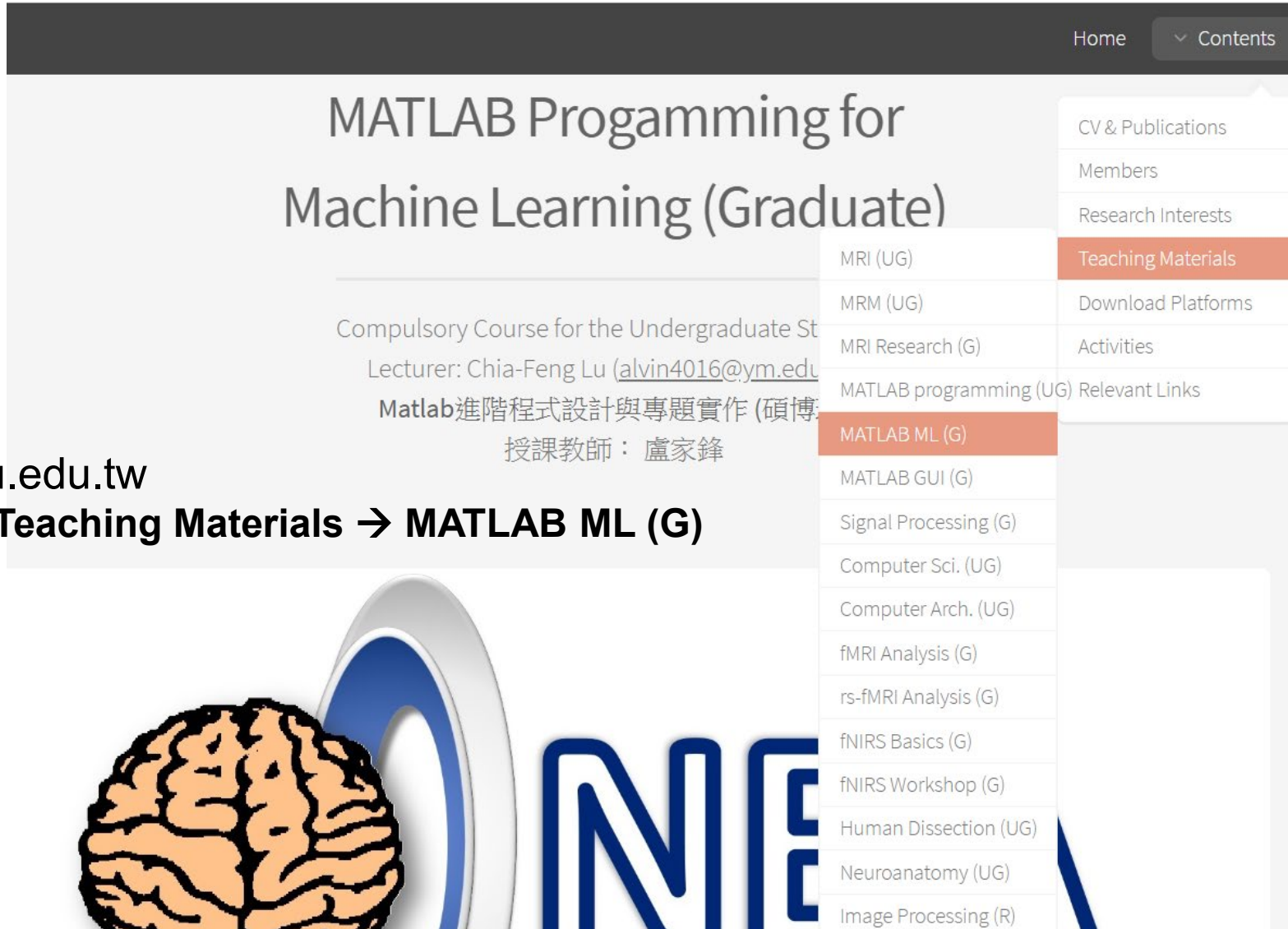




# Teaching Materials

cflu.lab.nycu.edu.tw

**Contents → Teaching Materials → MATLAB ML (G)**



The screenshot shows a website for a course titled "MATLAB Programming for Machine Learning (Graduate)". The page includes a navigation bar with "Home" and "Contents" links. A dropdown menu is open, listing various topics. The "Teaching Materials" link is highlighted in orange. Below it, the "MATLAB ML (G)" link is also highlighted in orange. The page content includes the course title, a description as a "Compulsory Course for the Undergraduate Students", the lecturer's name "Chia-Feng Lu" with an email address, and the course title in Chinese "Matlab進階程式設計與專題實作 (碩博)". The lecturer's name in Chinese "授課教師：盧家鋒" is also present. At the bottom, there is a graphic of a brain and the letters "NIE".

Home Contents

## MATLAB Programming for Machine Learning (Graduate)

Compulsory Course for the Undergraduate Students  
Lecturer: Chia-Feng Lu ([alvin4016@ym.edu.tw](mailto:alvin4016@ym.edu.tw))  
Matlab進階程式設計與專題實作 (碩博)  
授課教師：盧家鋒

- CV & Publications
- Members
- Research Interests
- Teaching Materials
- Download Platforms
- Activities
- Relevant Links

- MRI (UG)
- MRM (UG)
- MRI Research (G)
- MATLAB programming (UG)
- MATLAB ML (G)**
- MATLAB GUI (G)
- Signal Processing (G)
- Computer Sci. (UG)
- Computer Arch. (UG)
- fMRI Analysis (G)
- rs-fMRI Analysis (G)
- fNIRS Basics (G)
- fNIRS Workshop (G)
- Human Dissection (UG)
- Neuroanatomy (UG)
- Image Processing (R)

# Syllabus

Week	Topics	Lecturer
1	Course introduction	盧家鋒
2	An overview of machine learning	盧家鋒
3	Representation of data for machine learning	盧家鋒
4	Linear and nonlinear regression	盧家鋒
5	Unsupervised learning: clustering	盧家鋒
6	Classification: tree-based methods	盧家鋒
<b>7 (4/4)</b>	<b>off</b>	--
8	Classification: support vector machines	盧家鋒
9	MATLAB Graphic User Interface: App designer	盧家鋒

# Syllabus

Week	Topics	Lecturer
10	Classification: neural networks	盧家鋒
11	Introduction of deep learning	盧家鋒
<b>12 (5/9)</b>	<b>MATLAB Deep network designer (online video)</b>	<b>盧家鋒</b>
13	Deep learning applications I (Object detection, lesion segmentation, Image transformation)	盧家鋒
14	Deep learning applications II (Object detection, lesion segmentation, Image transformation)	盧家鋒
15	Resampling methods and model validation	盧家鋒
<b>16 (6/6)</b>	<b>Final project report</b>	<b>盧家鋒</b>
17	Survey of Machine Learning Applications	盧家鋒
18	Survey of Deep Learning Applications	盧家鋒

# Textbooks

## [Textbook 1]

- **A First Course in Machine Learning, 2nd edition, 2017**
- Simon Rogers, Mark Girolami
- **Online resources:** <https://github.com/sdrogers/fcmlcode>

## [Textbook 2]

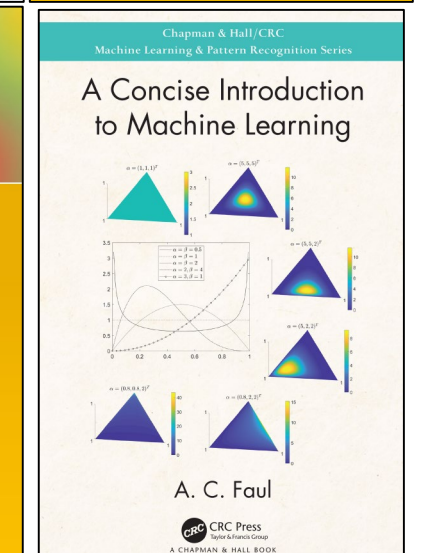
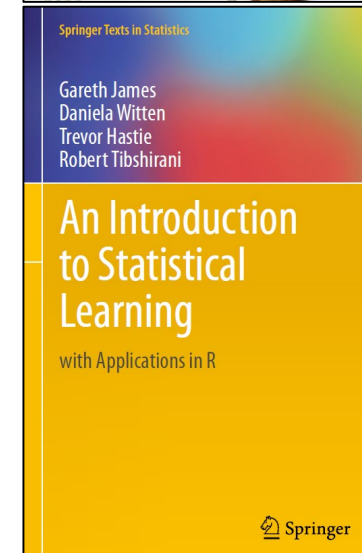
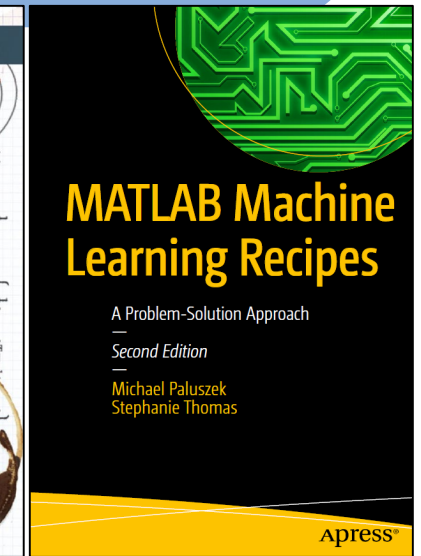
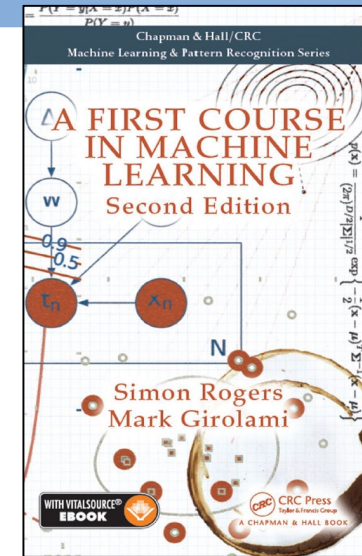
- **MATLAB Machine Learning Recipes, 2nd edition, 2018**
- Michael Paluszek, Stephanie Thomas
- **Online resources:** <https://github.com/Apress/matlab-machine-learning-recipes>

## [Textbook 3]

- **An Introduction to Statistical Learning, 2nd edition, 2013**
- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani

## [Textbook 4]

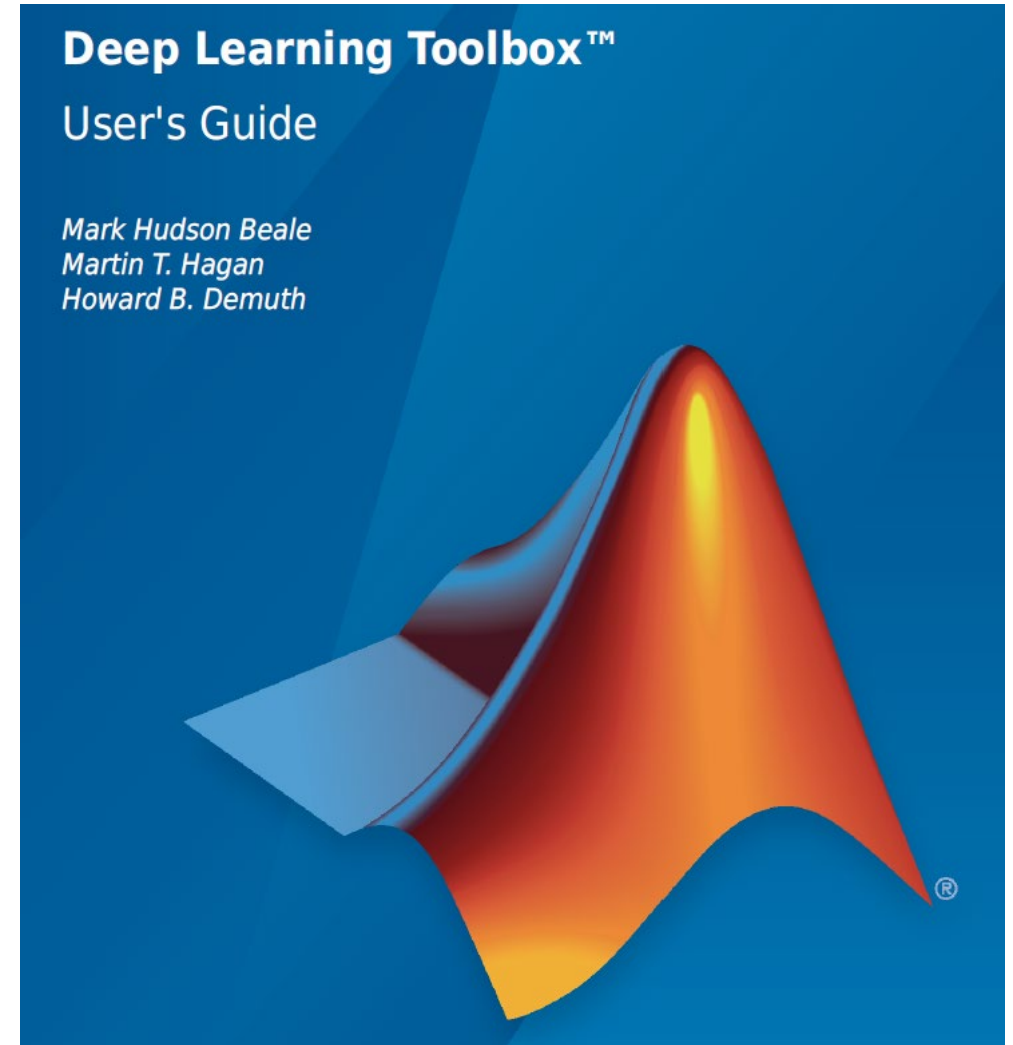
- **A Concise Introduction to Machine Learning, 2020**
- Anita C. Faul



# Reference

- MATLAB Deep Learning Toolbox  
User's Guide (2192 pages)

Mark Hudson Beale  
Martin T. Hagan  
Howard B. Demuth





# Grading Policy

- **Attendance and participation: 30%**
- **Midterm written proposal** (1 to 2 pages, before Week 10): **30%**
- **Final project report** (10-15 min oral presentation): **40%**

- **Team members:** 2 to 3 people
- **Machine learning applications using MATLAB**
  - Open datasets or your own study datasets
  - With specific problem definition
- **MATLAB App (Graphic User Interface)**
  - Data import and display
  - Parameter setup
  - Model validation (hyperplane/boundary, confusion matrix, ROC curve,...)

# Diagnostic Assessment

[https://miro.com/app/board/uXjVPmwVwfw=/?share\\_link\\_id=883388245361](https://miro.com/app/board/uXjVPmwVwfw=/?share_link_id=883388245361)

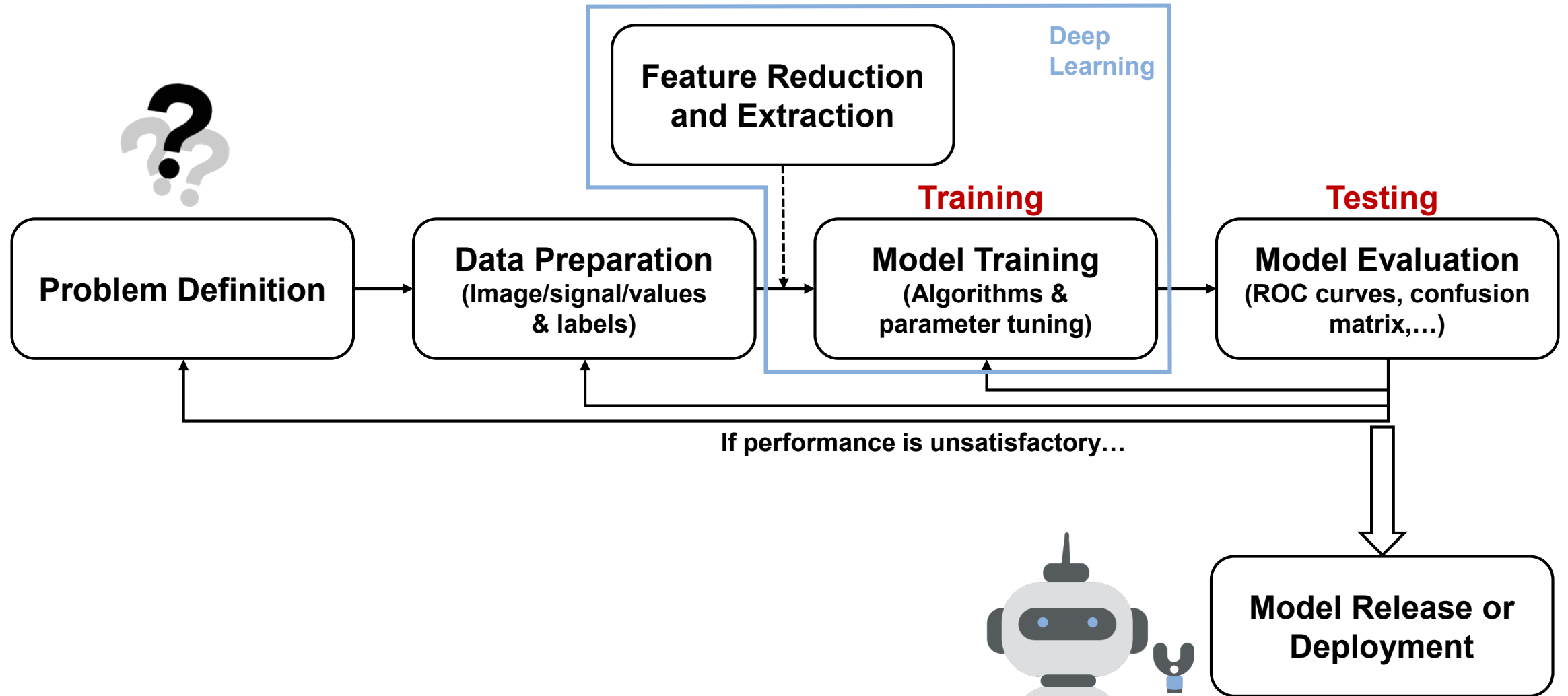


Using App or Chrome

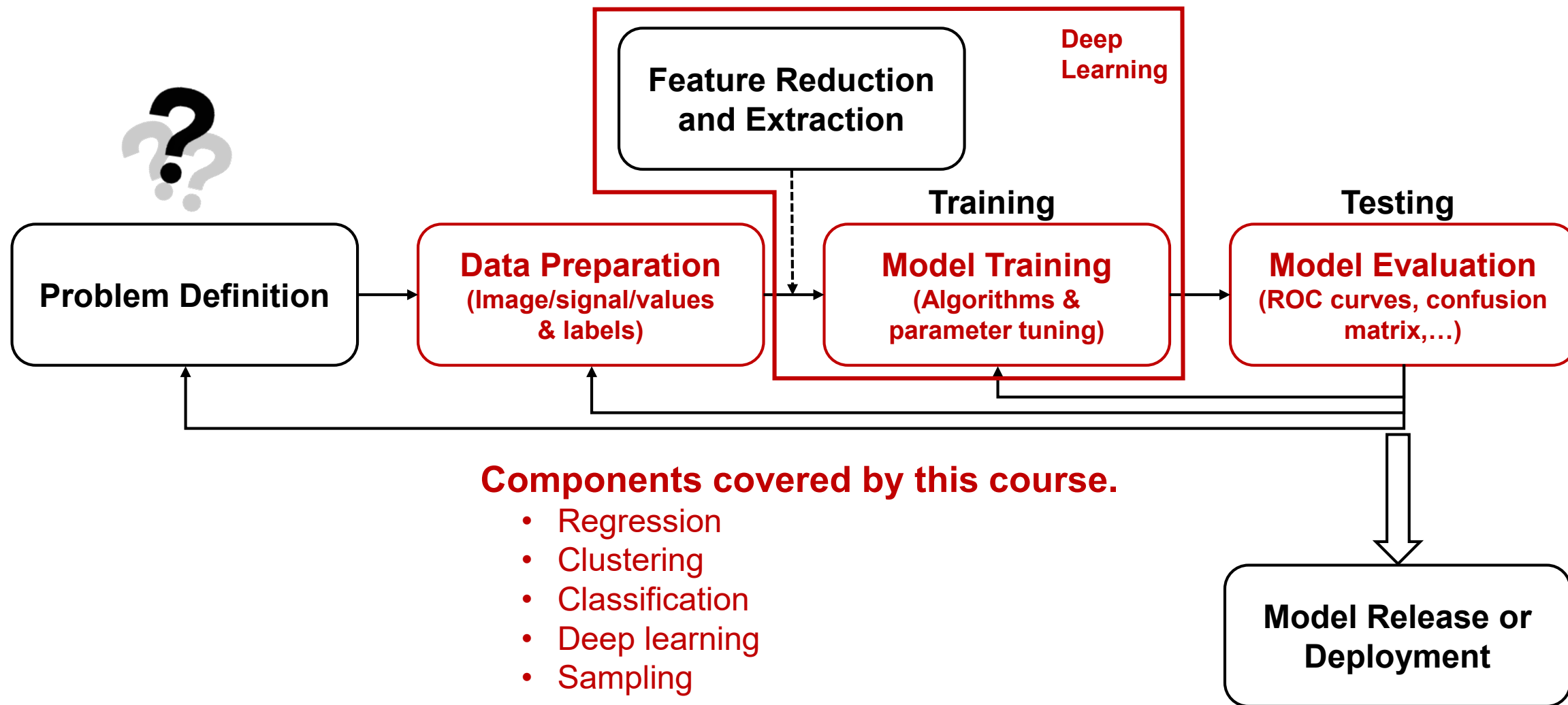
Password: **ilovematlab**



# Processing Flow of ML



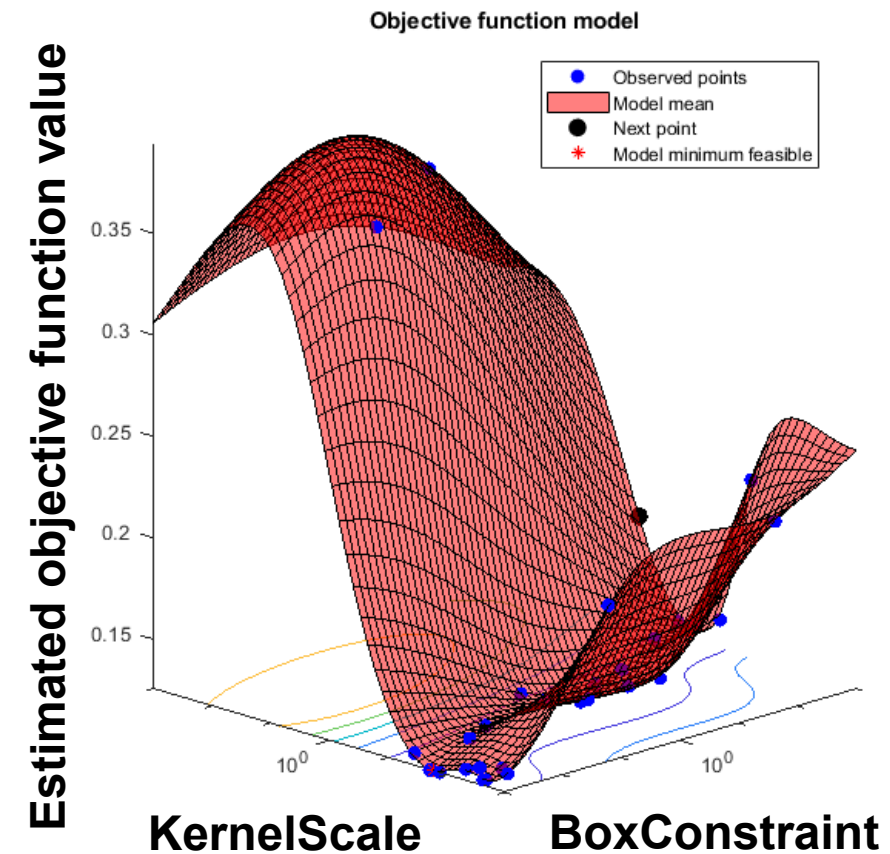
# Processing Flow of ML



# SVM as an Example

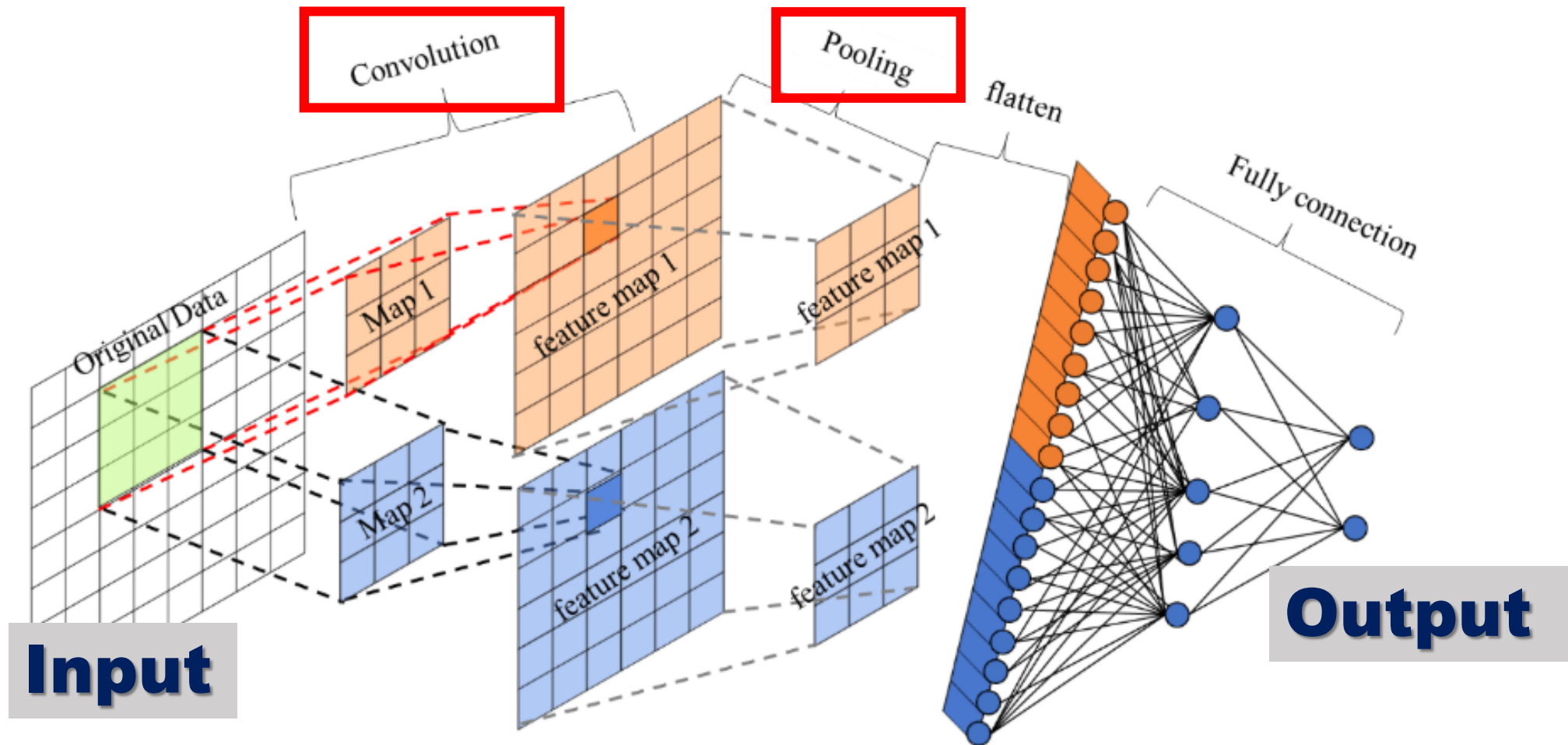
- Why do we need to tune the parameters?
- How do we prepare the data and validate the model performance?

```
opts = struct('Optimizer','bayesopt','kfold',10,'useparallel',true,...  
             'AcquisitionFunctionName','expected-improvement-plus');  
svmmodel = fitcsvm(dataTrain,grpTrain,...  
                  'KernelFunction','rbf','Standardize',true,...  
                  'OptimizeHyperparameters','auto',...  
                  'HyperparameterOptimizationOptions',opts);  
[grpPredict,scores]=predict(svmmodel,dataTrain);  
[X,Y,T,AUC,optcutpt] = perfcurve(grpTrain,scores,'G1');  
cm = confusionmat(grpTrain,grpPredict);
```



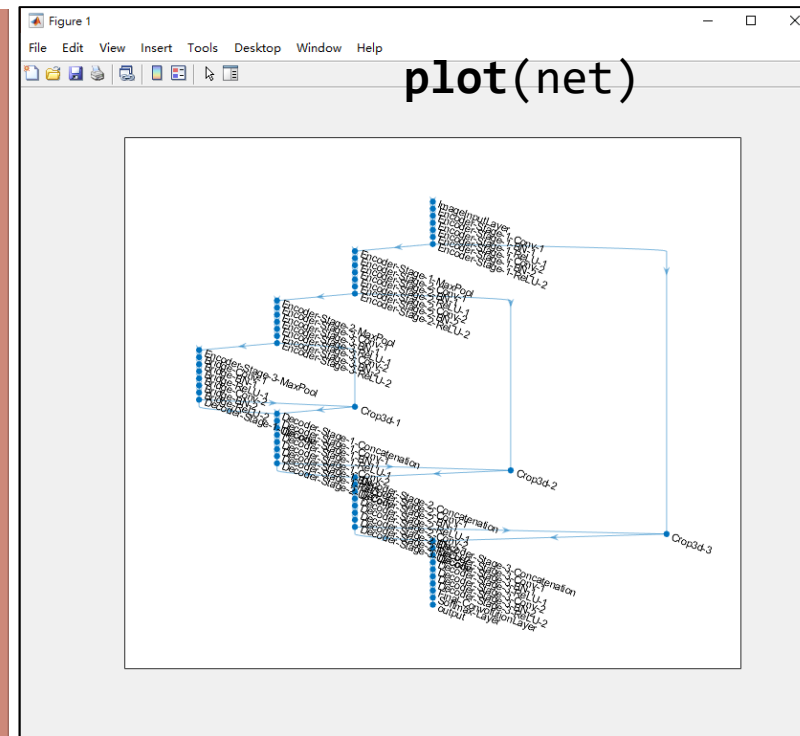
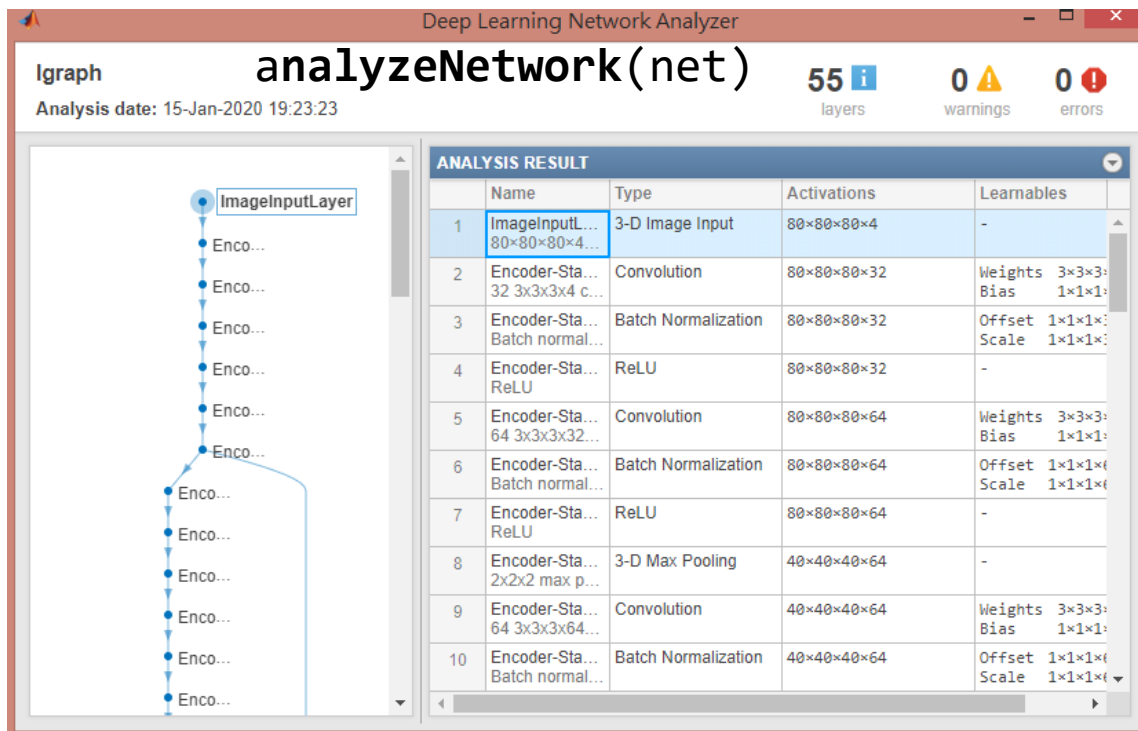


# Fundamental Architecture of DL



# MATLAB Deep Learning

- `inputL = image3dInputLayer(inputPatchSize, 'Name', 'input');`
- `conv1 = convolution3dLayer(NumChannels, NumFilters, 'Name', 'conv1');`
- `relu1 = reluLayer('Name', 'relu1');`
- `layers = [inputL; conv1; relu1];`



# MATLAB Layer Functions

<b>Layer</b> imageInputLayer image3dInputLayer sequenceInputLayer roiInputLayer (Computer Vision Toolbox™)	clippedReluLayer eluLayer tanhLayer preluLayer (Custom layer example)	dependentConcatenationLayer concatenationLayer weightedAdditionLayer (Custom layer example)
<b>Convolution and Fully Connected Layers</b> <b>Layer</b> convolution2dLayer convolution3dLayer groupedConvolution2dLayer transposedConv2dLayer transposedConv3dLayer fullyConnectedLayer	<b>Normalization, Dropout, and Cropping Layers</b> <b>Layer</b> batchNormalizationLayer crossChannelNormalizationLayer dropoutLayer crop2dLayer crop3dLayer	<b>Object Detection Layers</b> <b>Layer</b> roiInputLayer (Computer Vision Toolbox) roiMaxPooling2dLayer (Computer Vision Toolbox) regionProposalLayer (Computer Vision Toolbox) rpnSoftmaxLayer (Computer Vision Toolbox) rpnClassificationLayer (Computer Vision Toolbox) rcnnBoxRegressionLayer (Computer Vision Toolbox)
<b>Sequence Layers</b> <b>Layer</b> sequenceInputLayer lstmLayer biLstmLayer sequenceFoldingLayer sequenceUnfoldingLayer flattenLayer wordEmbeddingLayer (Text Analytics Toolbox™)	<b>Pooling and Unpooling Layers</b> <b>Layer</b> averagePooling2dLayer averagePooling3dLayer globalAveragePooling2dLayer	<b>Output Layers</b> <b>Layer</b> softmaxLayer classificationLayer regressionLayer pixelClassificationLayer (Computer Vision Toolbox)

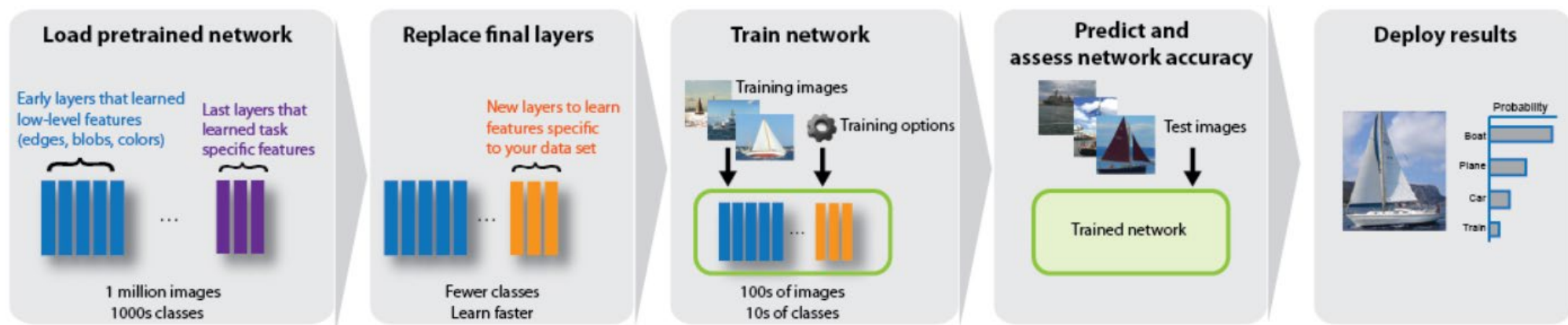
<https://www.mathworks.com/help/deeplearning/ug/list-of-deep-learning-layers.html>

# MATLAB Deep Learning

Model	Size	Top-1 Accuracy	Top-5 Accuracy	Parameters	Depth
Xception	88 MB	0.790	0.945	22,910,480	126
VGG16	528 MB	0.715	0.901	138,357,544	23
VGG19	549 MB	0.727	0.910	143,667,240	26
ResNet50	99 MB	0.759	0.929	25,636,712	168
InceptionV3	92 MB	0.788	0.944	23,851,784	159
InceptionResNetV2	215 MB	0.804	0.953	55,873,736	572
MobileNet	17 MB	0.665	0.871	4,253,864	88

Import and use the pre-trained networks

## Reuse Pretrained Network

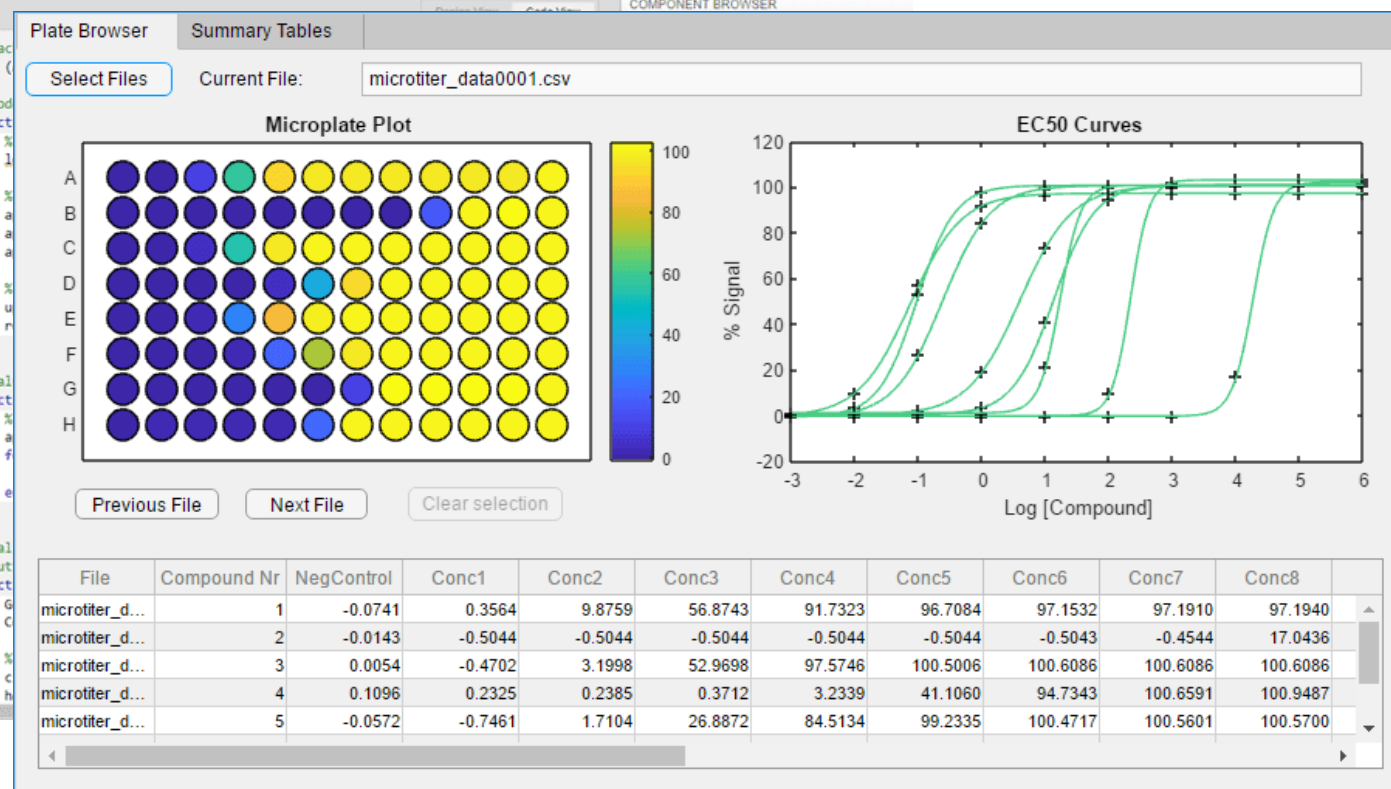
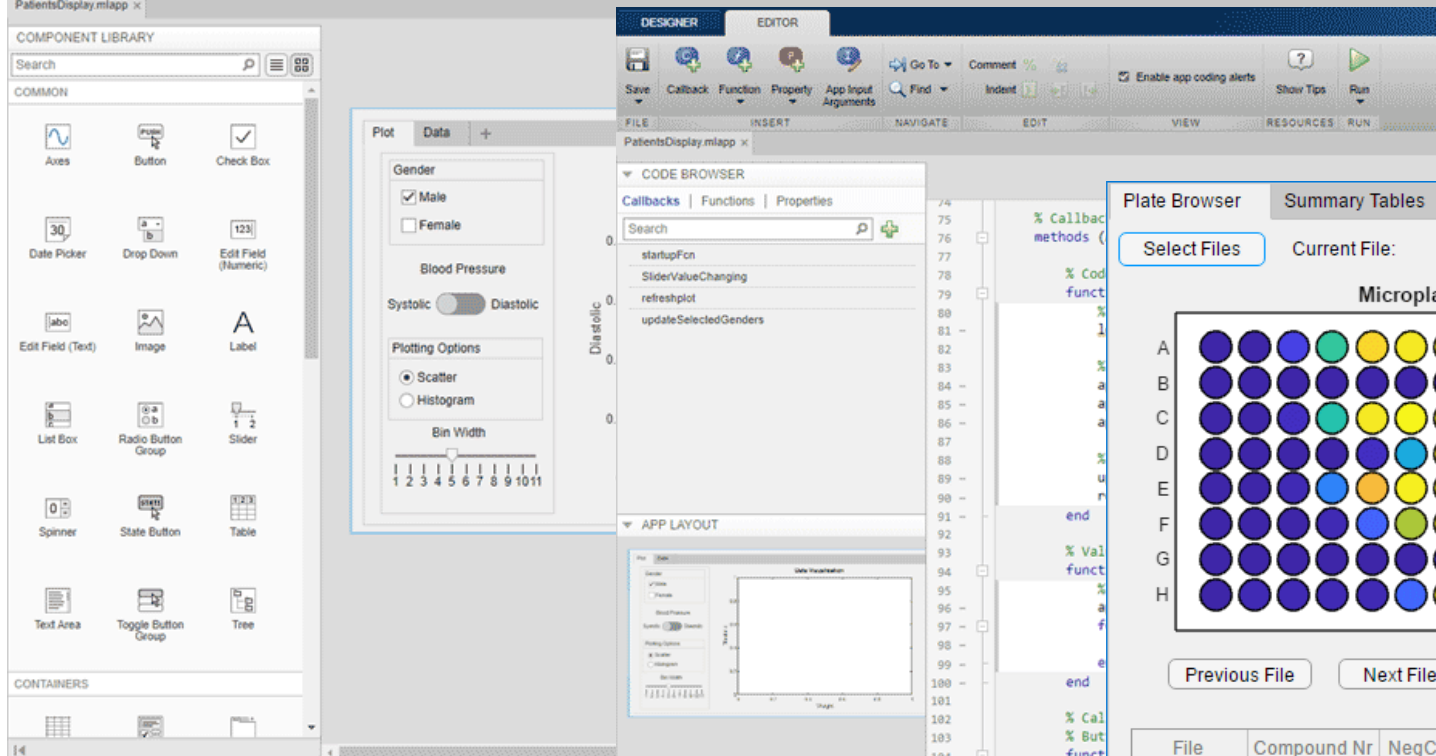
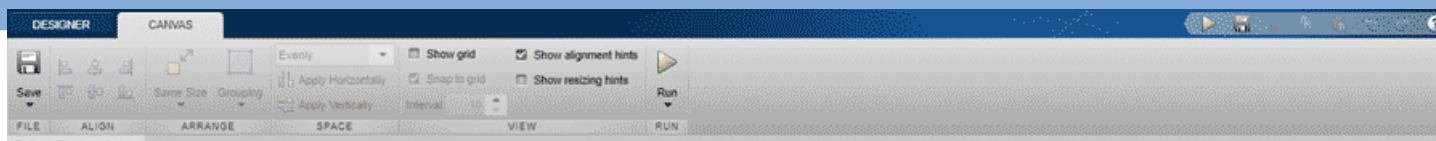


<https://www.mathworks.com/videos/interactively-modify-a-deep-learning-network-for-transfer-learning-1547157074175.html>

Improve network

# MATLAB App Designer (GUI)

App packages or Web Apps for sharing.



<https://www.mathworks.com/products/matlab/app-designer.html>



# Basic Requirements for DL

- **MATLAB 2021b** or later
  - Statistics and Machine Learning Toolbox
  - Deep Learning Toolbox
  - Computer Vision Toolbox
- **GPU computation**
  - Graphic Card (compute capability 3.0 or better)
    - <https://developer.nvidia.com/cuda-gpus#compute>
  - CUDA Toolkit 10.1 or later
    - <https://developer.nvidia.com/cuda-toolkit>

GeForce RTX 3090	8.6
GeForce RTX 2060	7.5
GeForce GTX 1080	6.1
GeForce GTX 960M	5.0
GeForce GTX 650	3.0
GeForce GT 730M	3.0

# Goals of this Course

- **Being familiar with ML/DL and the usage of MATLAB functions**
  - Data formats (datastore, table arrays, ...)
  - Data preparation (labeling and cross-validation partition)
  - Clustering, regression and classification functions
  - Tuning parameters and validating model performance
  - Deep Learning Usages and design
  - Using and creating MATLAB apps (GUI)
  - Project-oriented/team-based learning
- **Having primary hands-on experience of machine learning**



THE END

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