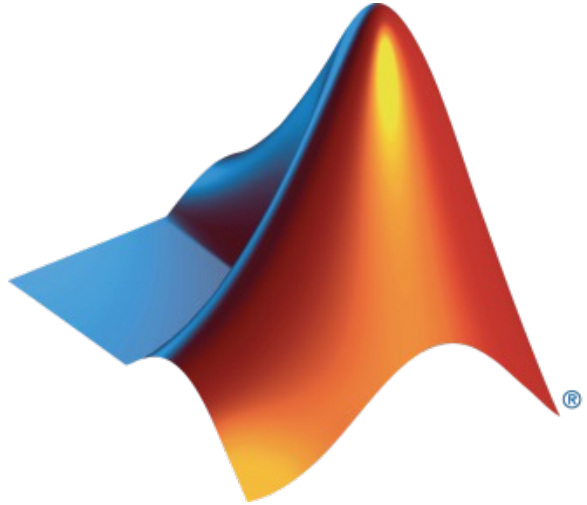
Intro to Deep Learning



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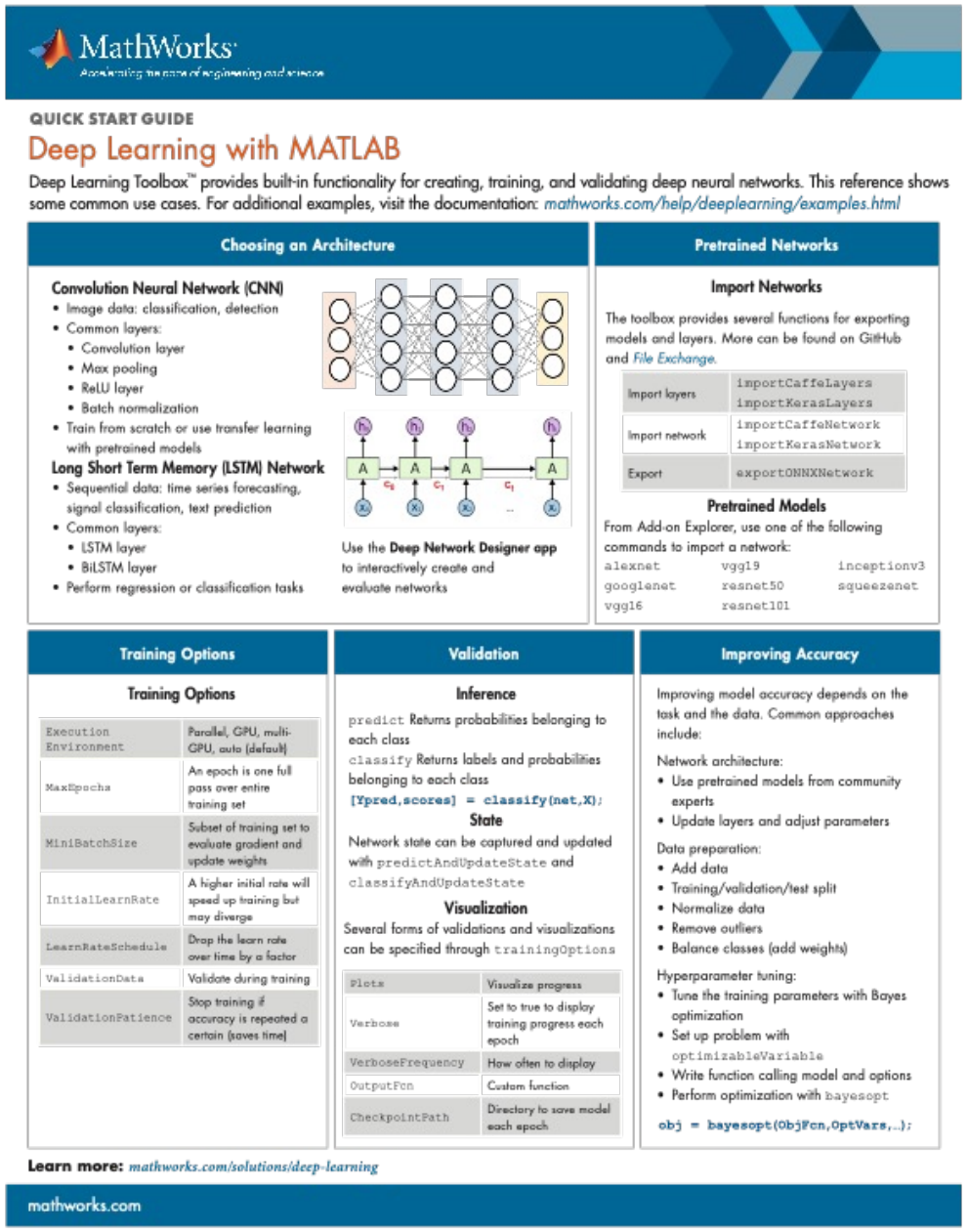
Agenda

- Presentation
  - Intro to Deep Learning
- Deep Learning Onramp
  - Complete 60% for a prize
- Additional resources
  - Machine Learning Tutorial



MathWorks

QUICK START GUIDE

Deep Learning with MATLAB

Deep Learning Toolbox™ provides built-in functionality for creating, training, and validating deep neural networks. This reference shows some common use cases. For additional examples, visit the documentation: *mathworks.com/help/deeplearning/examples.html*

Choosing an Architecture

Convolution Neural Network (CNN)
- Image data: classification, detection
- Common layers:
  - Convolution layer
  - Max pooling
  - ReLU layer
  - Batch normalization
- Train from scratch or use transfer learning with pretrained models

Long Short Term Memory (LSTM) Network
- Sequential data: time series forecasting, signal classification, text prediction
- Common layers:
  - LSTM layer
  - BiLSTM layer
- Perform regression or classification tasks

Use the **Deep Network Designer app** to interactively create and evaluate networks

Pretrained Networks

Import Networks

The toolbox provides several functions for exporting models and layers. More can be found on GitHub and *File Exchange*.

Import layers	`importCaffeLayers` `importKerasLayers`
Import network	`importCaffeNetwork` `importKerasNetwork`
Export	`exportONNXNetwork`

Pretrained Models

From Add-on Explorer, use one of the following commands to import a network:

`alexnet` `vgg19` `inceptionv3` `googlenet` `resnet50` `squeezenet` `vgg16` `resnet101`

Training Options

Training Options

`ExecutionEnvironment`	Parallel, GPU, multi-GPU, auto (default)
`MaxEpochs`	An epoch is one full pass over entire training set
`MiniBatchSize`	Subset of training set to evaluate gradient and update weights
`InitialLearnRate`	A higher initial rate will speed up training but may diverge
`LearnRateSchedule`	Drop the learn rate over time by a factor
`ValidationData`	Validate during training
`ValidationPatience`	Stop training if accuracy is repeated a certain (saves time)

Validation

Inference

`predict` Returns probabilities belonging to each class

`classify` Returns labels and probabilities belonging to each class

```
[Ypred,scores] = classify(net,X);
```

State

Network state can be captured and updated with `predictAndUpdateState` and `classifyAndUpdateState`

Visualization

Several forms of validations and visualizations can be specified through `trainingOptions`

`Plots`	Visualize progress
`Verbose`	Set to true to display training progress each epoch
`VerboseFrequency`	How often to display
`OutputFcn`	Custom function
`CheckpointPath`	Directory to save model each epoch

Improving Accuracy

Improving model accuracy depends on the task and the data. Common approaches include:

Network architecture:
- Use pretrained models from community experts
- Update layers and adjust parameters

Data preparation:
- Add data
- Training/validation/test split
- Normalize data
- Remove outliers
- Balance classes (add weights)

Hyperparameter tuning:
- Tune the training parameters with Bayes optimization
- Set up problem with `optimizableVariable`
- Write function calling model and options
- Perform optimization with `bayesopt`

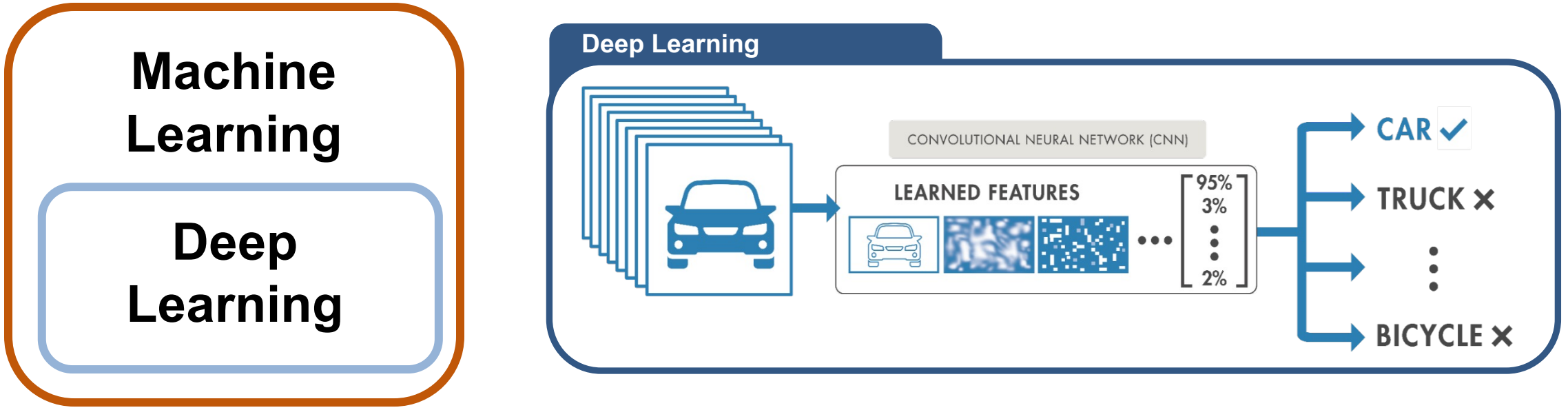
```
obj = bayesopt(ObjFcn,OptVars,...);
```

Learn more: *mathworks.com/solutions/deep-learning*

mathworks.com

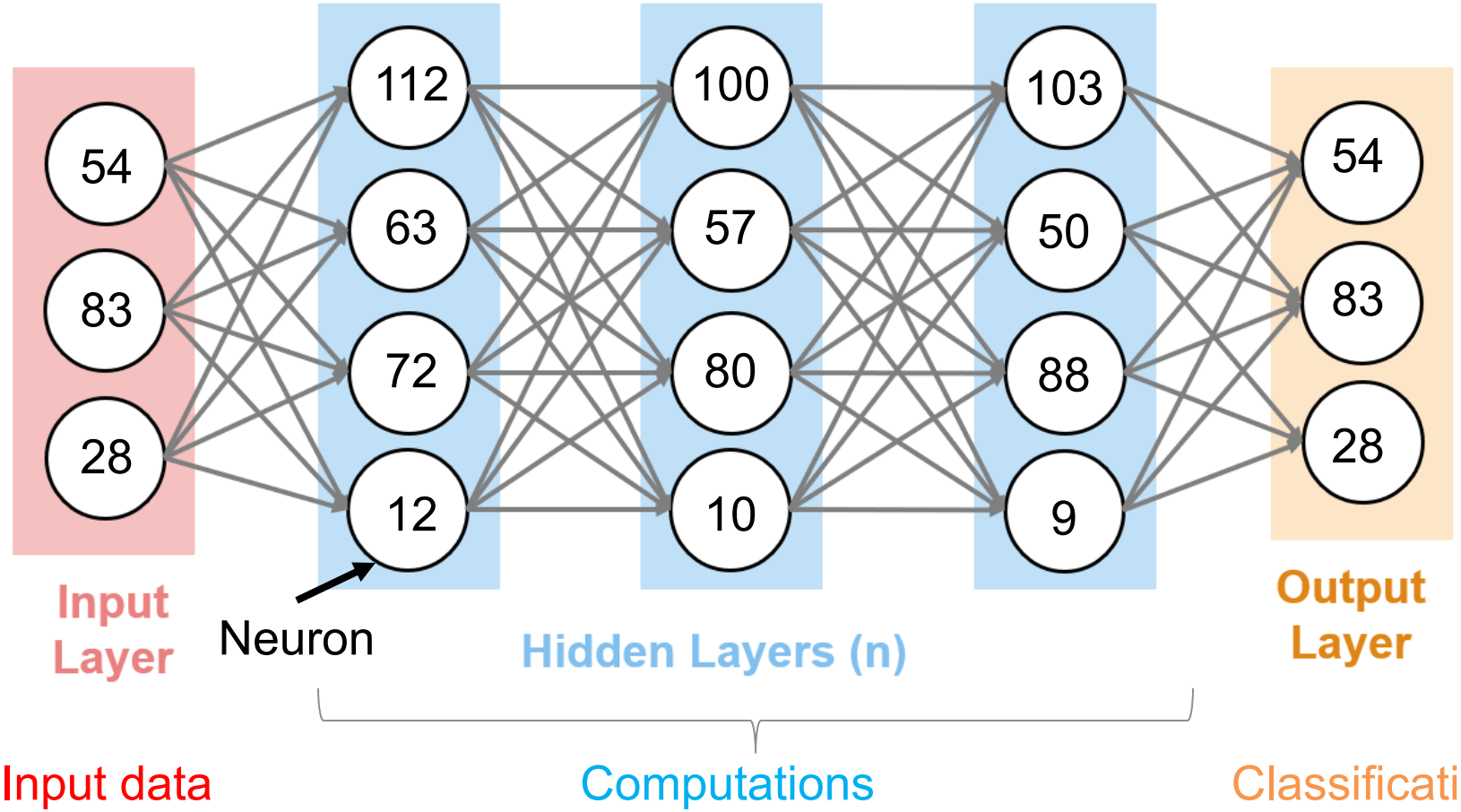
What is Deep Learning?

- Subset of machine learning (ML) with automatic feature extraction
  - Learns features and tasks directly from data
- Implemented using a neural network architecture
  - Deep refers to the numerous number of layers in the network
- Accuracy can surpass traditional ML Algorithms



Deep Learning Models are Neural networks

- Neural networks are a set of neurons that perform computations on input data to predict what the input object is

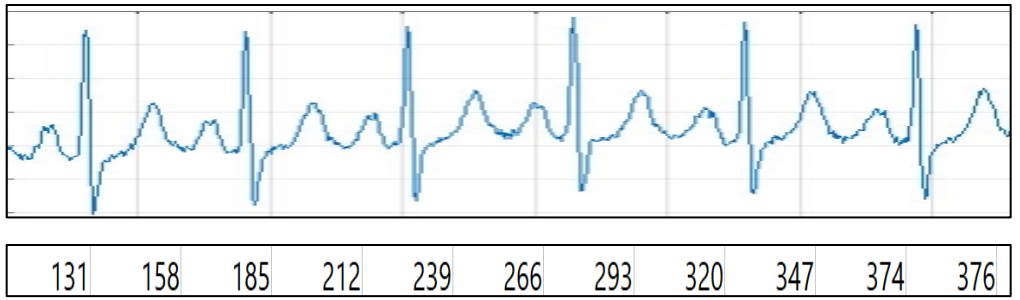


How can a neural network perform computations on an image or audio file?

Deep Learning Networks Take in Numeric Data

199	206	208	201	188	178	165	164	180
202	205	202	188	176	169	178	186	183
203	206	189	178	181	183	182	154	87
203	192	184	186	177	167	153	181	192
191	182	176	166	153	141	136	180	227
166	165	154	154	138	137	169	170	211
158	150	145	183	144	156	158	154	179
143	51	98	144	129	130	143	178	123
107	50	33	95	152	173	192	159	87
104	100	84	120	132	172	131	64	94
119	101	97	81	90	109	87	106	111
127	122	110	97	108	120	133	131	134
111	117	108	119	131	143	146	141	156
126	122	113	119	139	142	155	161	151
129	126	130	111	103	130	149	149	156
138	128	136	144	136	129	134	122	145
154	133	134	141	168	150	126	127	151

Images are a numeric matrix



Signals are numeric vectors

The Bird Flies = [0 13 5 6]

The Leaf Is Brown = [13 3 11 2]

Text is processed as numeric vectors

Deep Learning Workflow

PREPARE DATA

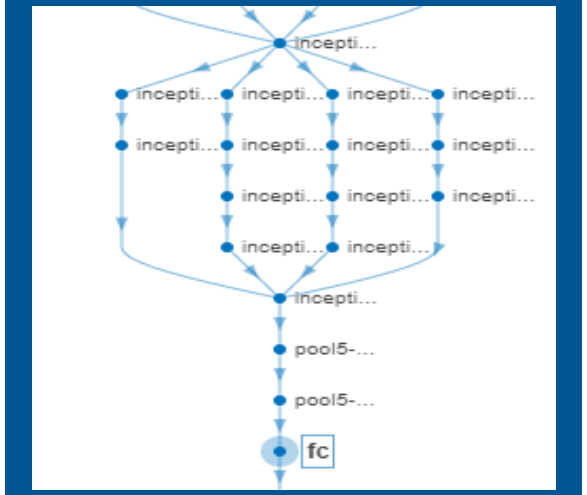
Label: Dog
Size: 524x640

Label: Lion
Size: 444x205

Label: Cat
Size: 3338x2592

The data must be labeled and preprocessed to give accurate results

BUILD & TRAIN MODEL



Build a neural network that learns from your dataset

DEPLOY SYSTEM

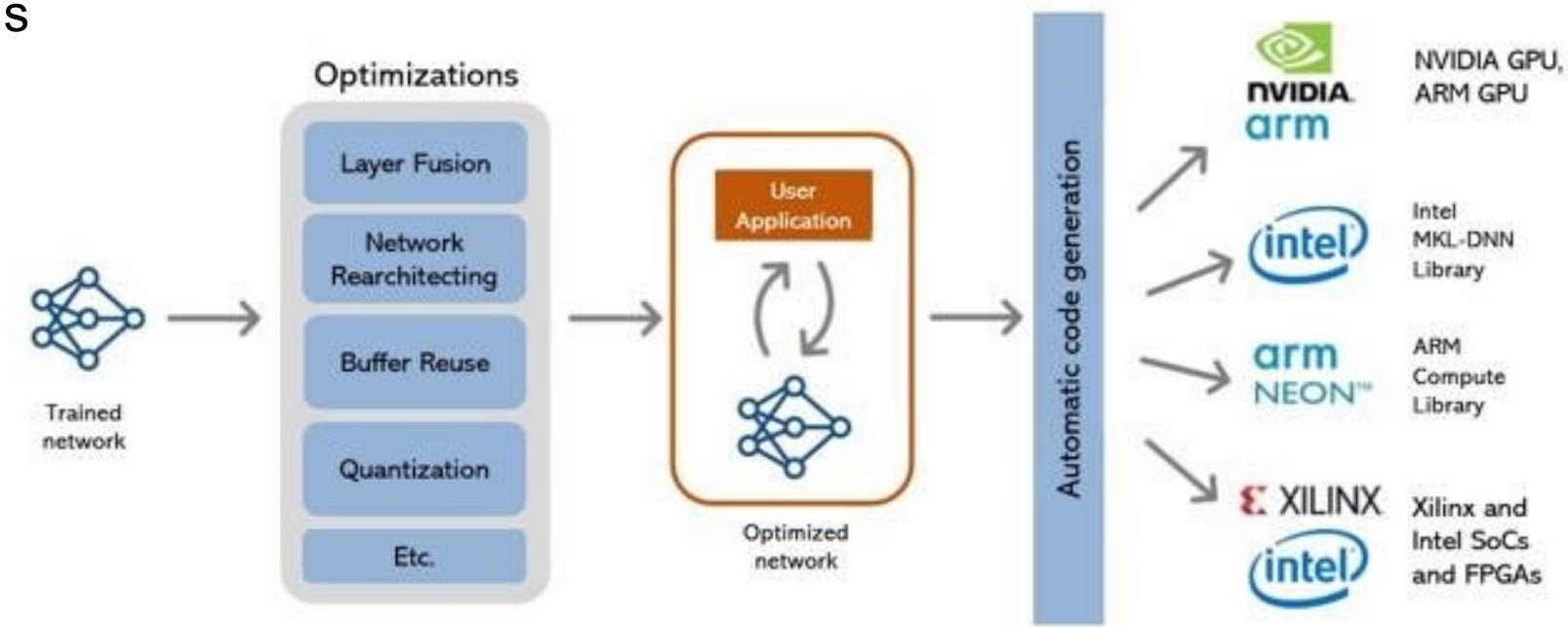
Integrate your trained model onto embedded hardware or cloud

Pretrained Neural Networks

- Pretrained neural networks are networks that have been designed and trained
- These networks can be used to classify data just by loading it
- GoogLeNet for example can be used to classify 1000 object categories, such as keyboard, mouse, pencil, and many animals
- Using these networks can save time and leverage the accuracy achieved in these models

Deploying neural networks

- Use MATLAB to deploy the trained model to:
  - GPUs and CPUs
  - Embedded devices (e.g. NVIDIA or Raspberry Pi)
  - Standalone applications
  - Web Apps



Resources to get started on your own

- Free Deep learning onramp course
  - What we are doing today!
- Free Machine learning onramp course
  - Next time!

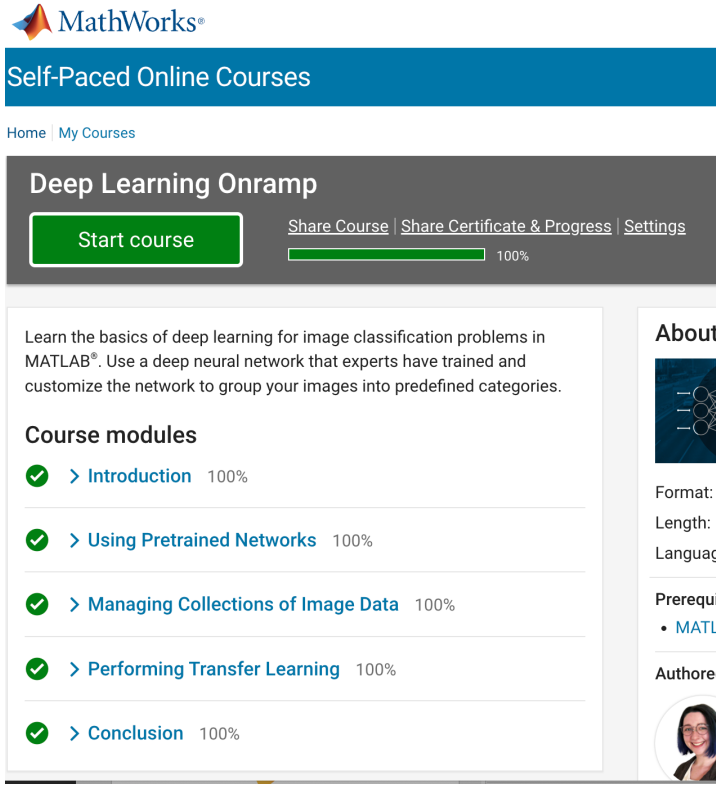
TO DO

- Create your UWO - MathWorks Account

  https://www.mathworks.com/academia/tah-portal/western-university-964054.html

- Go to Deep Learning Onramp
- (Within the AI, Machine Learning, and Deep Learning Tab)
- https://matlabacademy.mathworks.com/

- Launch Deep Learning Onramp



MATLAB Prizes

- Complete at least 60% of the Deep Learning Onramp to be eligible for any prize
  - Bring your laptop when you come to collect the prize

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