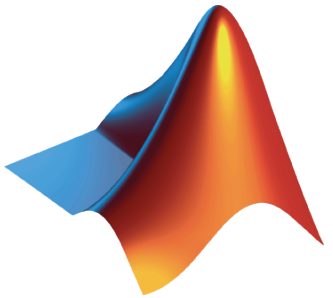
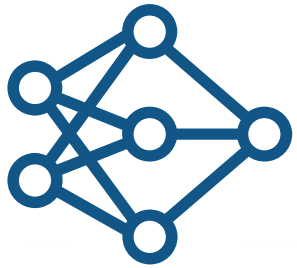
Building Neural Networks with MATLAB



Simon Thor
MATLAB Student Ambassador



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Poll

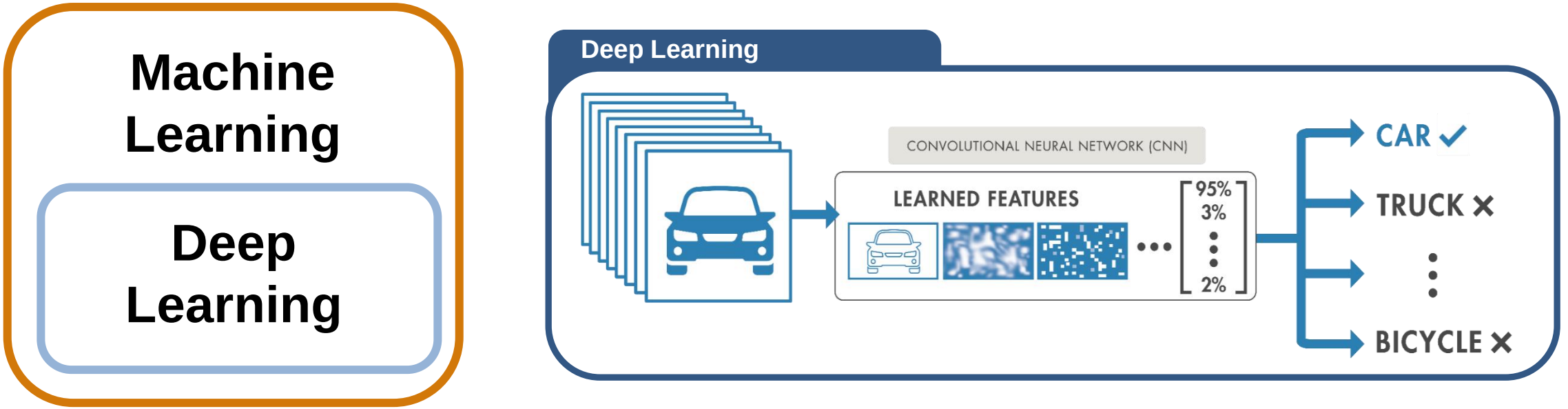
- How familiar are you with neural networks and MATLAB?

https://menti.com

Code: 7390 7670

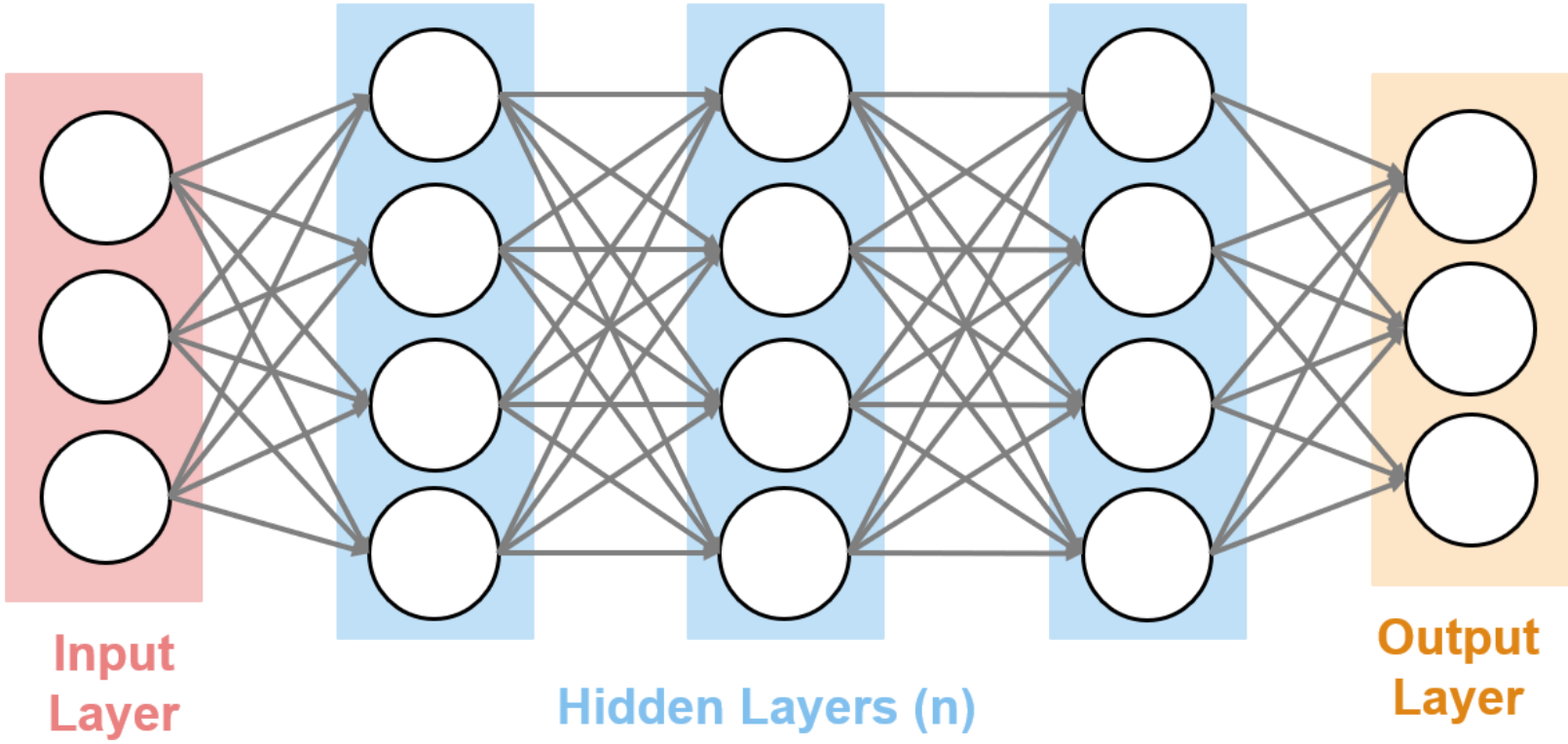
What is Deep Learning?

- Subset of machine learning with automatic feature extraction
  - Learns features and tasks directly from data
- Accuracy can surpass traditional machine learning algorithms
- Typically requires more data than other machine learning models



Deep Learning Models are Neural Networks

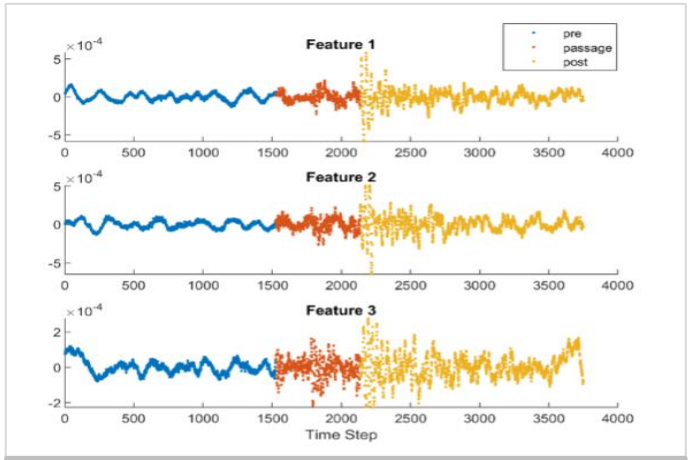
- Deep neural networks have many layers
- Data is passed through the network, and the layer parameters are updated (training)



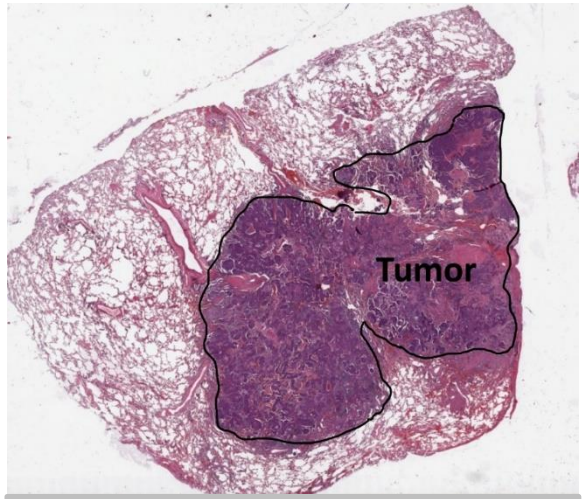
MATLAB Deep Learning examples

Automatic Defect Detection
Airbus

Particle/event identification
LHC, CERN



Seismic Event Detection
Shell



Predicting gastrointestinal cancer
Germany

5

Deep Learning Workflow

Data Preparation

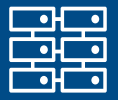
Data cleansing and preparation

Human insight

Simulation-generated data

AI Modeling

Model design and tuning



Hardware accelerated training

Interoperability

Deployment

Embedded devices

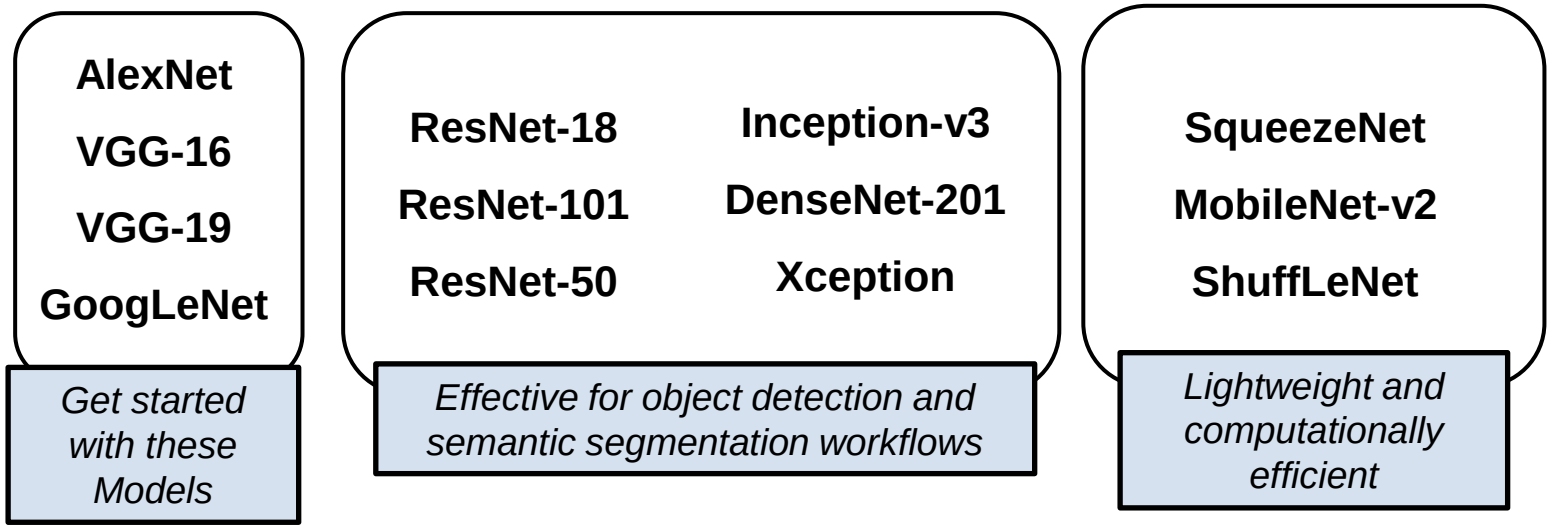
Enterprise systems

Edge, cloud, desktop

6

Pretrained Models

- Pretrained models have predefined layer orders and parameter values
- Can be used directly for inference (AlexNet Example)



Full list of models available HERE

What if pretrained models aren't enough?

Transfer learning

Take a pretrained model and modify it slightly

Pros

- Faster training
- Less data needed
- Most of the work already done

Cons

- Less customizable
- Must have a good pretrained model

Train from scratch

Make and train a neural network from scratch

Pros

- Fully customizable
- For specialized tasks
- You learn more about neural networks

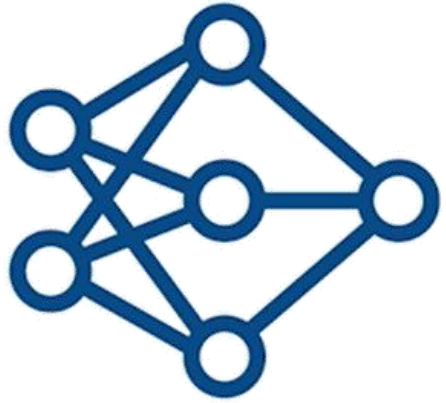
Cons

- More data needed
- Slower training time

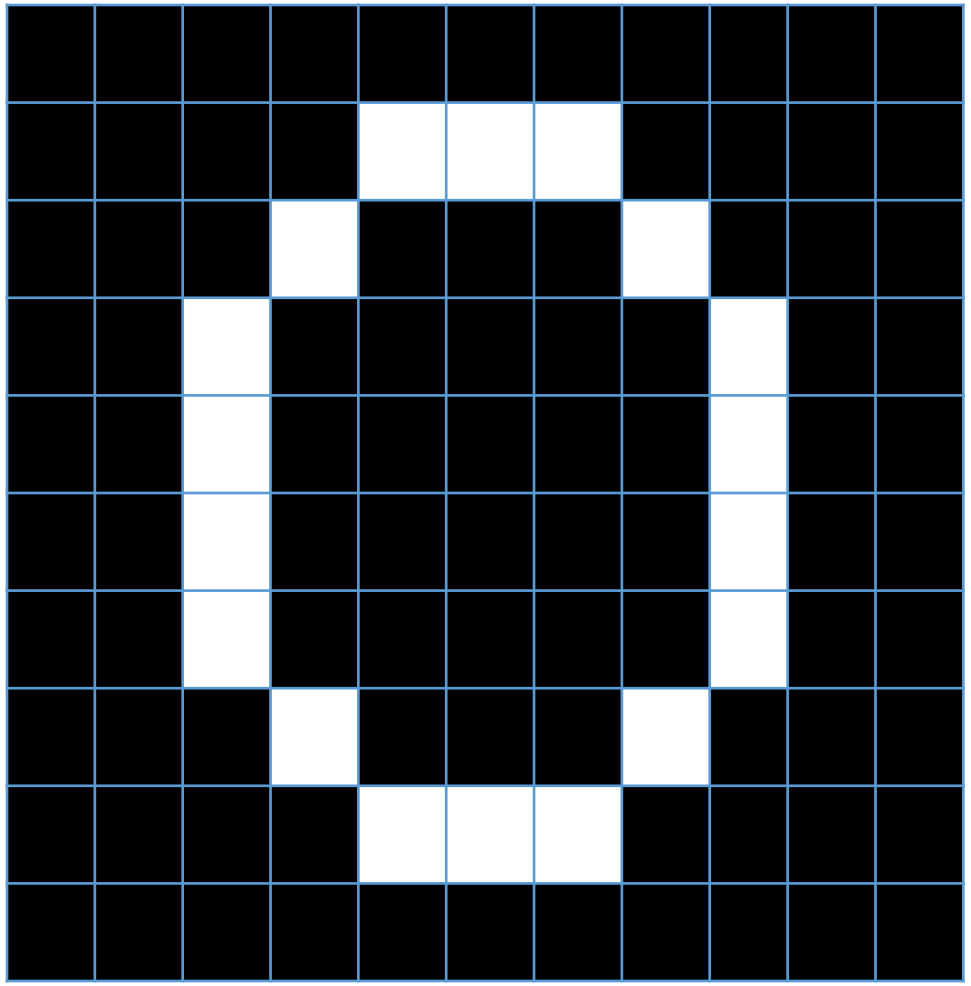
Creating Layer Architectures

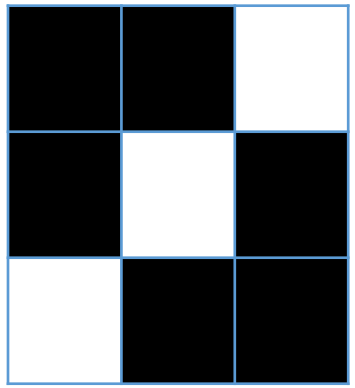
- Convolution Neural Networks – CNN
- Special layer combinations that make them adept at classifying images

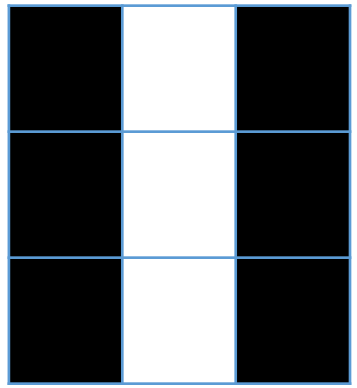
- Convolution Layer
- ReLU Layer
- Max Pooling Layer

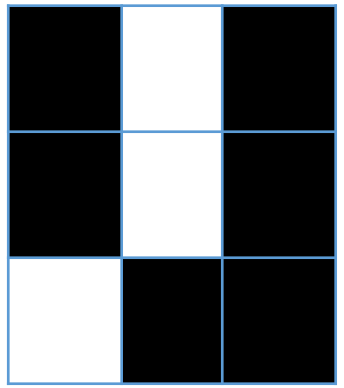


Convolution Layers Search for Patterns

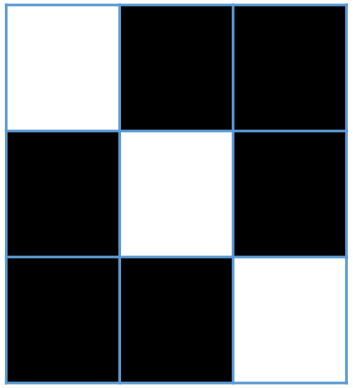


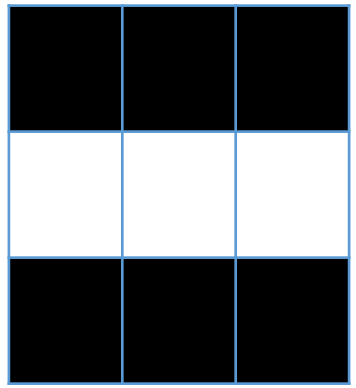


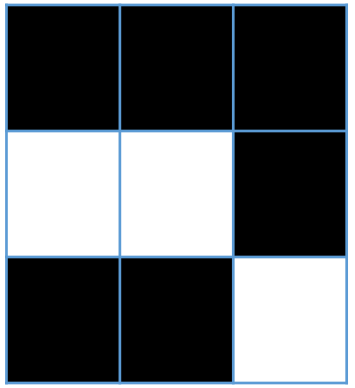




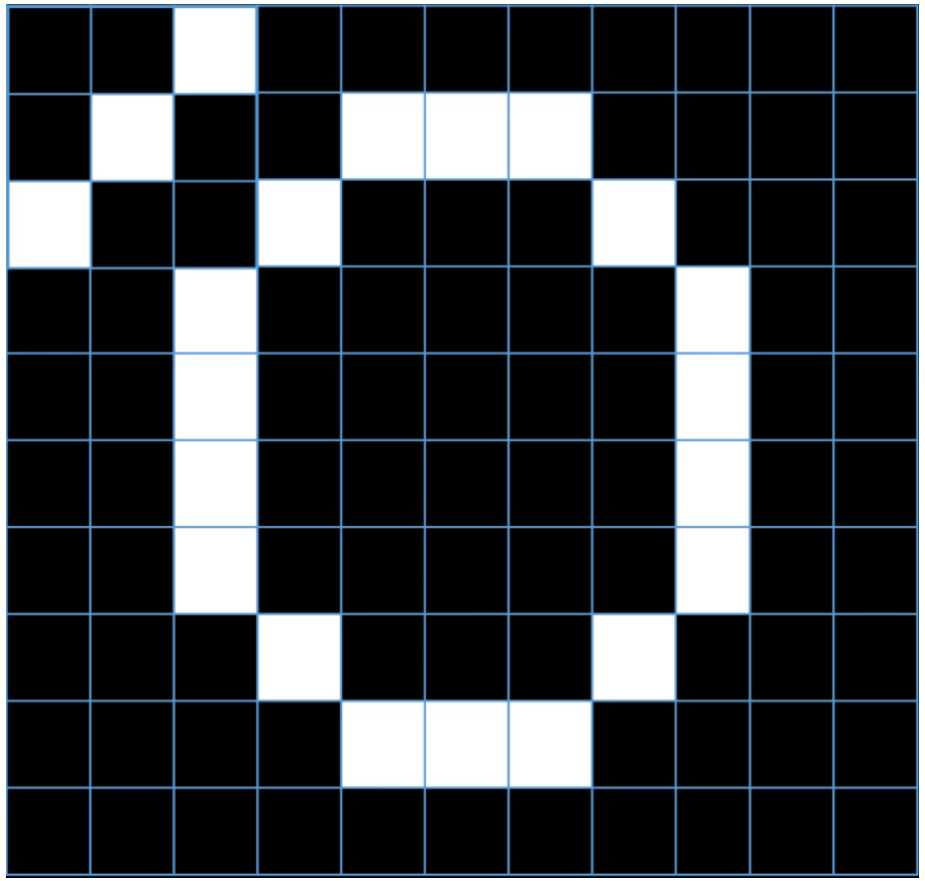
These patterns would be common in the number 0

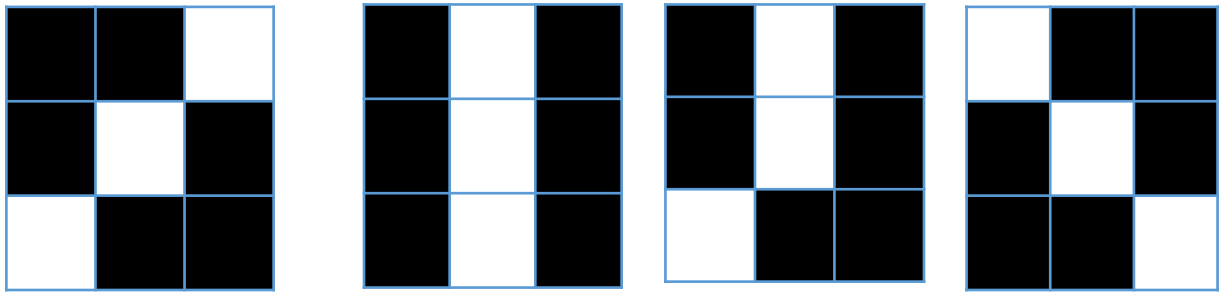






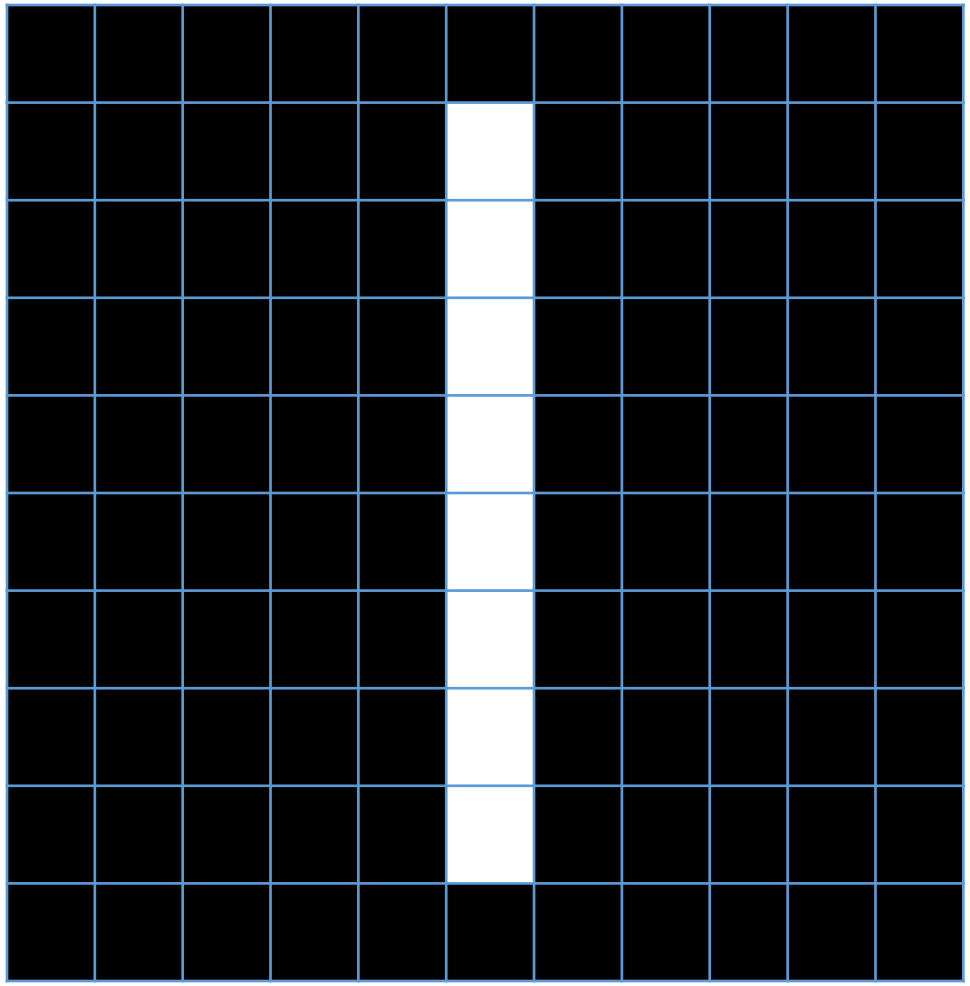
All patterns are compared to the patterns on a new image



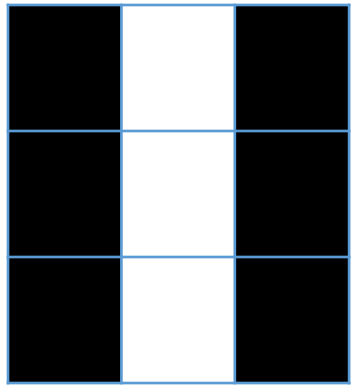


- Pattern starts at left corner
  - Perform comparison
  - Slide over one pixel
- Reach end of image
- Repeat for next pattern

Good pattern matching in convolution improves chances that object will classify properly

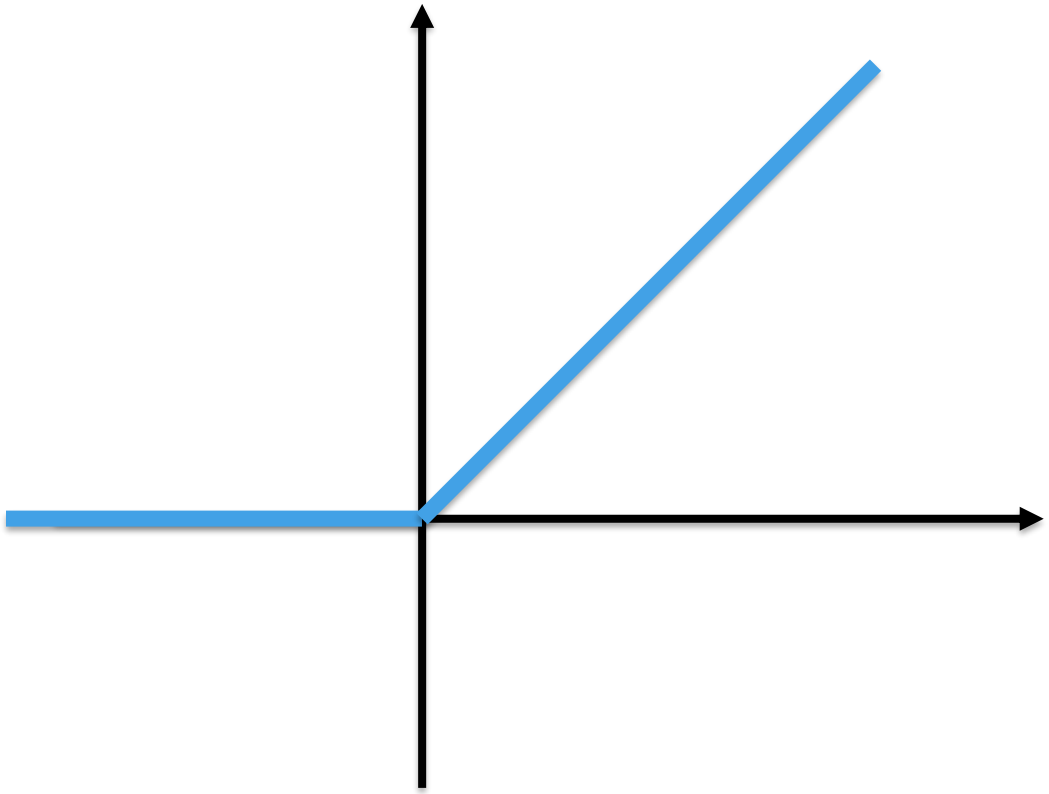


- This image would not match well against the patterns for the number zero
- It would only do very well against this pattern



Rectified Linear Units Layer (ReLU)

Converts negative numbers to zero

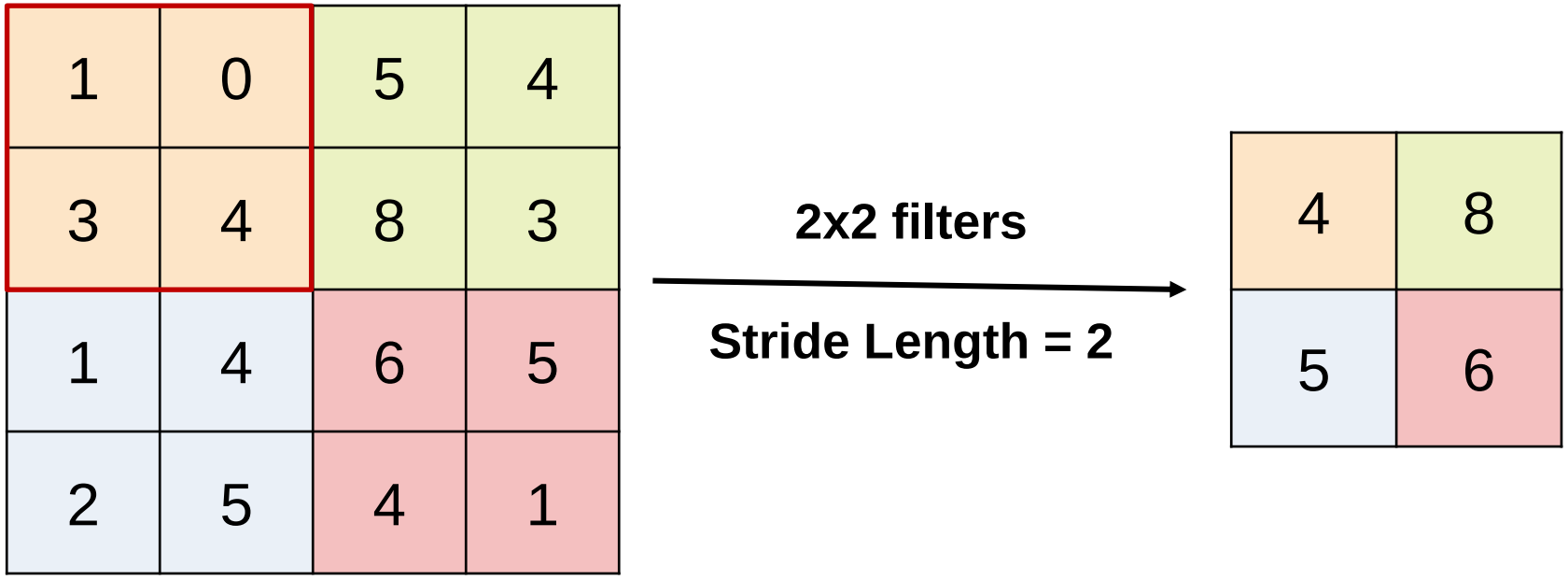


-1	0	5	4
3	-4	-8	3
1	4	6	-5
-2	-5	4	1

0	0	5	4
3	0	0	3
1	4	6	0
0	0	4	1

Max Pooling is a down-sampling operation

Shrink large images while preserving important information



How Do I know Which Layers to Use?

Feature Extraction - Images

- 2D and 3D convolution
- Transposed convolution
- Transformer

Activation Functions

- ReLU
- Tanh
- SeLU

Sequence Data

Signal, Text, Numeric

- LSTM
- Recurrent neural networks
- Word Embedding

Normalization

- Dropout
- Batch normalization
- Skip connections

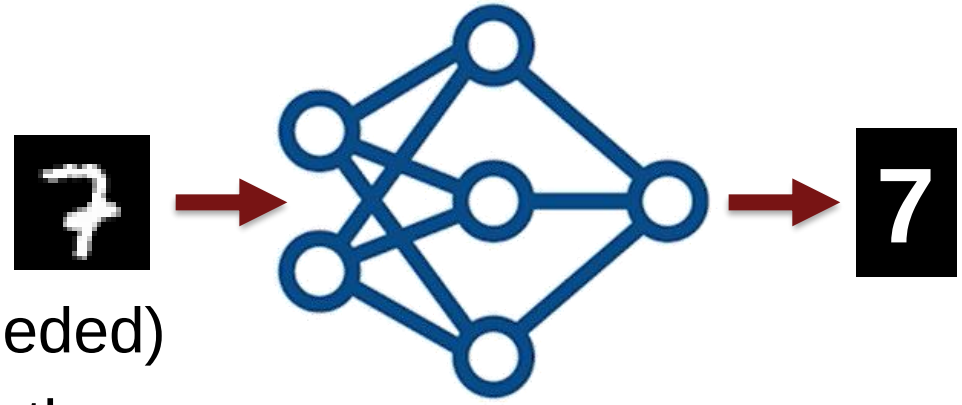
Research papers, doc examples, and documentation on network layers can provide guidelines for creating architecture

Demo - MNIST

Purpose:

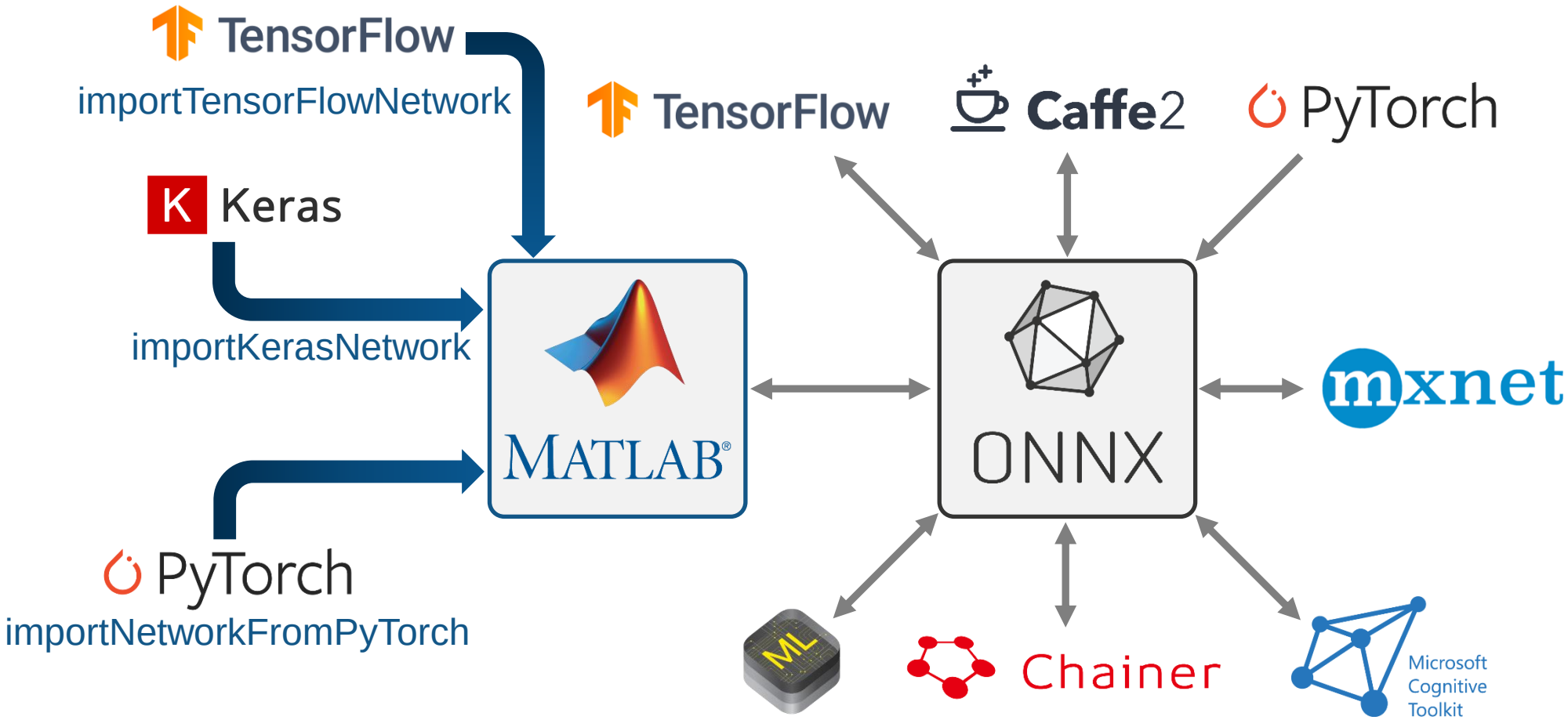
- Learn how to create and train deep neural network
- Deep learning toolbox
- Use MATLAB's Deep Network Designer
- Explore hyperparameters

Source: MNIST handwritten digit database



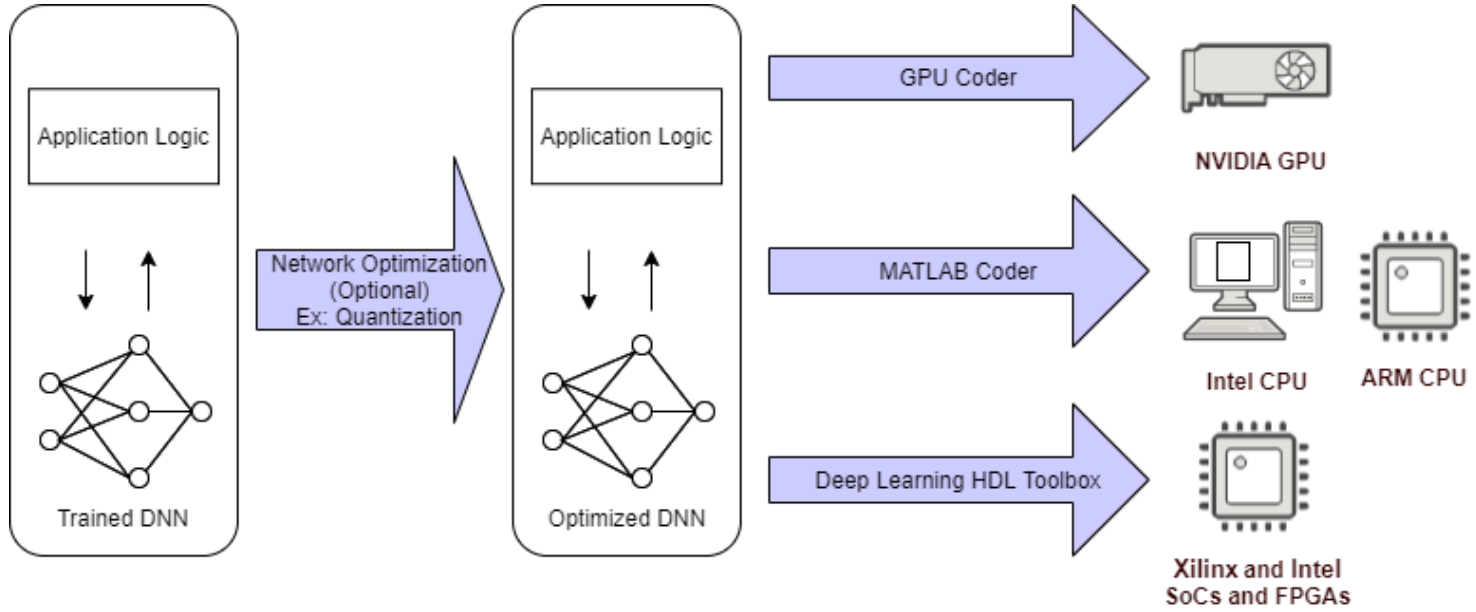
- Follow along in the demo!
- Run from MATLAB Online (no installation needed)
- Link available on the KTHAIS website and in the Facebook event page

Import and Export Models to/from other Frameworks



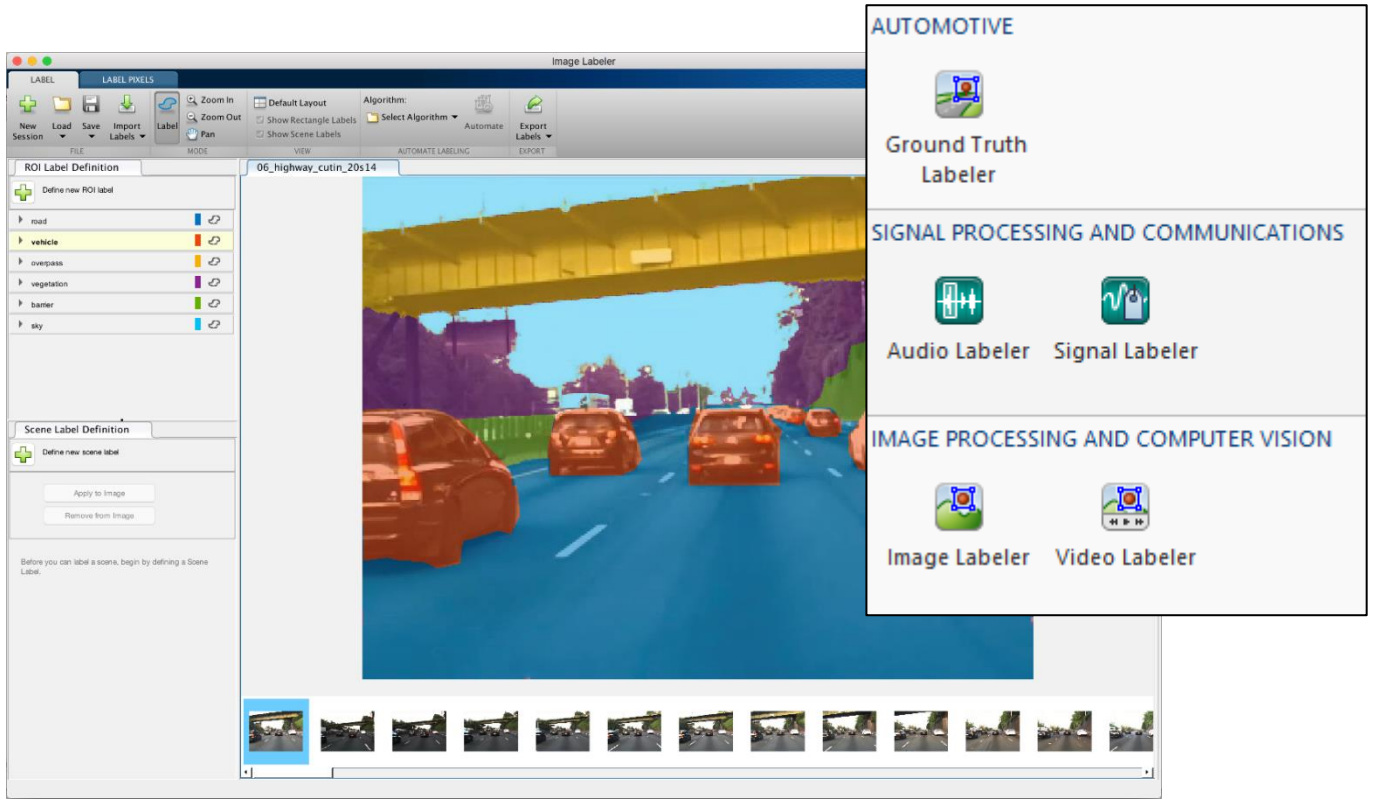
Code Generation for Deep Learning

- Generate CUDA, C/C++ code
- Compress model
  - Reduce precision of floats, ints
  - Approximate convolutions
- Deploy models on GPUs, CPUs, FPGAs

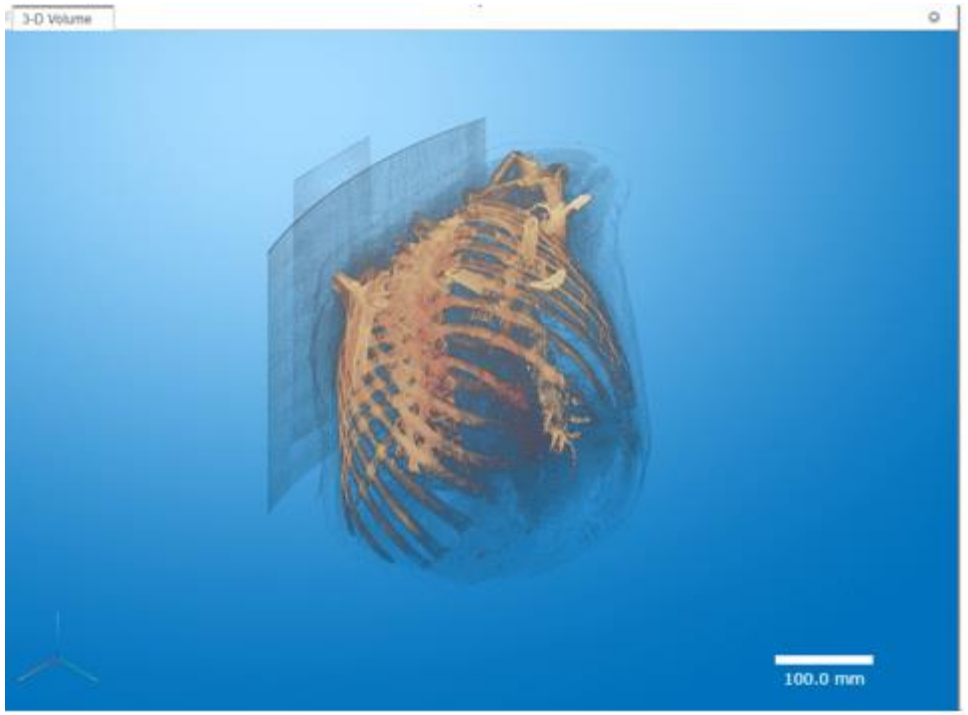


Spend less time preprocessing and labeling data

Synchronize disparate time series, filter noisy signals, automate labeling of video, and more.



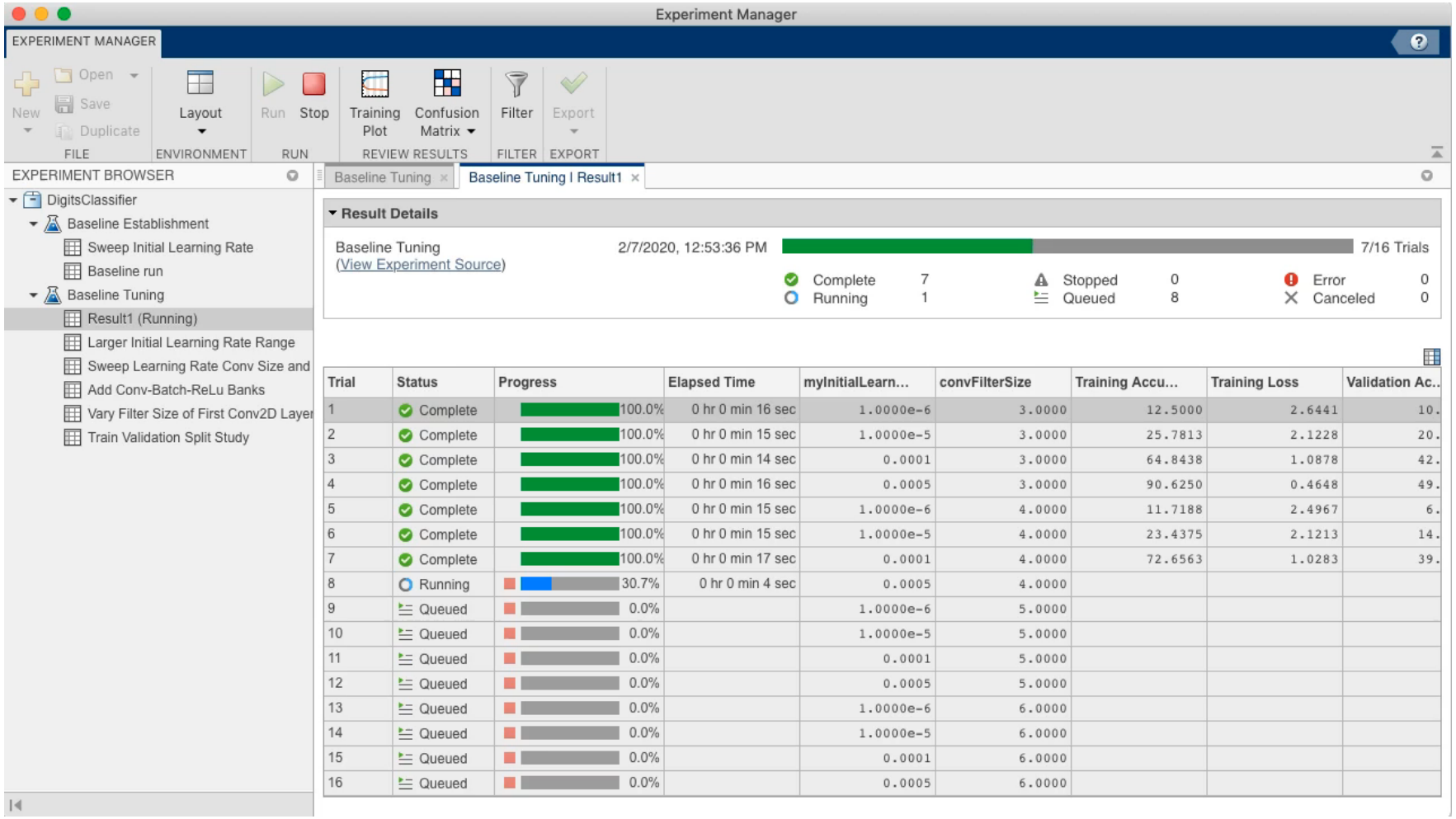
Use labeling apps for deep learning workflows like semantic segmentation



New! Medical imaging toolbox

19

Experiment Manager – Run, Track, and Analyze Multiple Deep Learning Experiments



Self-paced Online Courses

- Getting Started (12)
- MATLAB (4)
- Simulink (5)
- **AI, Machine Learning, and Deep Learning (5)**
- Math and Optimization (6)
- Image and Signal Processing (3)

Explore over 50 virtual and in-person **classroom courses**

AI, Machine Learning, and Deep Learning

Machine Learning Onramp

40%

6 modules | 2 hours | Languages

Learn the basics of practical machine learning methods for classification problems.

Machine Learning with MATLAB

7 modules | 12 hours | Languages

Explore data and build predictive models.

Deep Learning Onramp

5%

5 modules | 2 hours | Languages

Get started quickly using deep learning methods to perform image recognition.

Deep Learning with MATLAB

55%

13 modules | 8 hours | Languages

Learn the theory and practice of building deep neural networks with real-life image and sequence data.

Reinforcement Learning Onramp

36%

5 modules | 3 hours | Languages

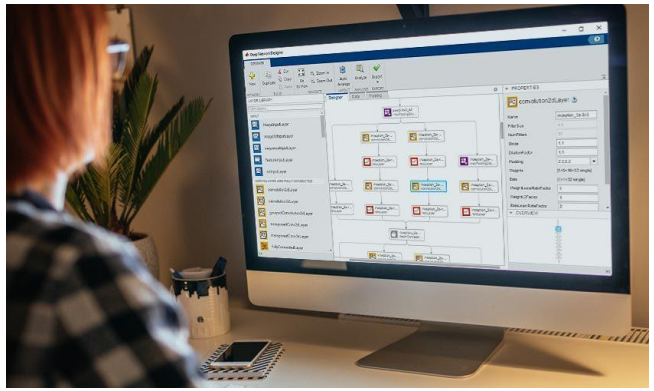
Master the basics of creating intelligent controllers that learn from experience.

https://matlabacademy.mathworks.com/

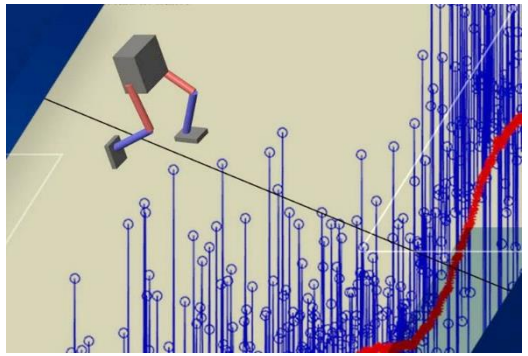
"The interactive MATLAB tutorials were perfect for engaging students and getting them up to speed quickly."

–Dr. Yu-li Wang, Carnegie Mellon University

More Deep Learning Resources from MathWorks



[Deep learning tutorials and examples with MATLAB]



[Reinforcement learning toolbox]

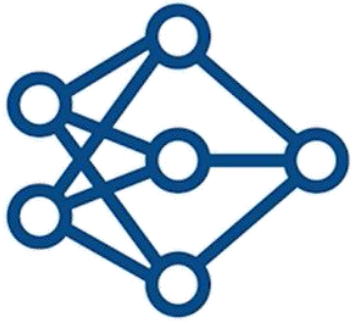
[Transfer learning tutorial]

[Deep learning toolbox]

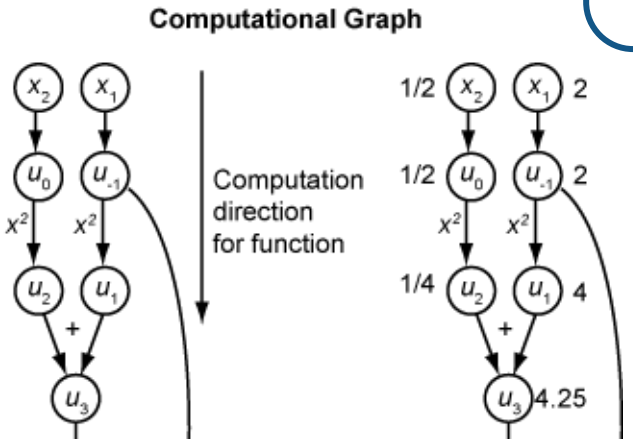
Advanced Deep Learning Resources from MathWorks

Deploy model to embedded hardware

Transformer models in MATLAB



Defining custom neural network layers

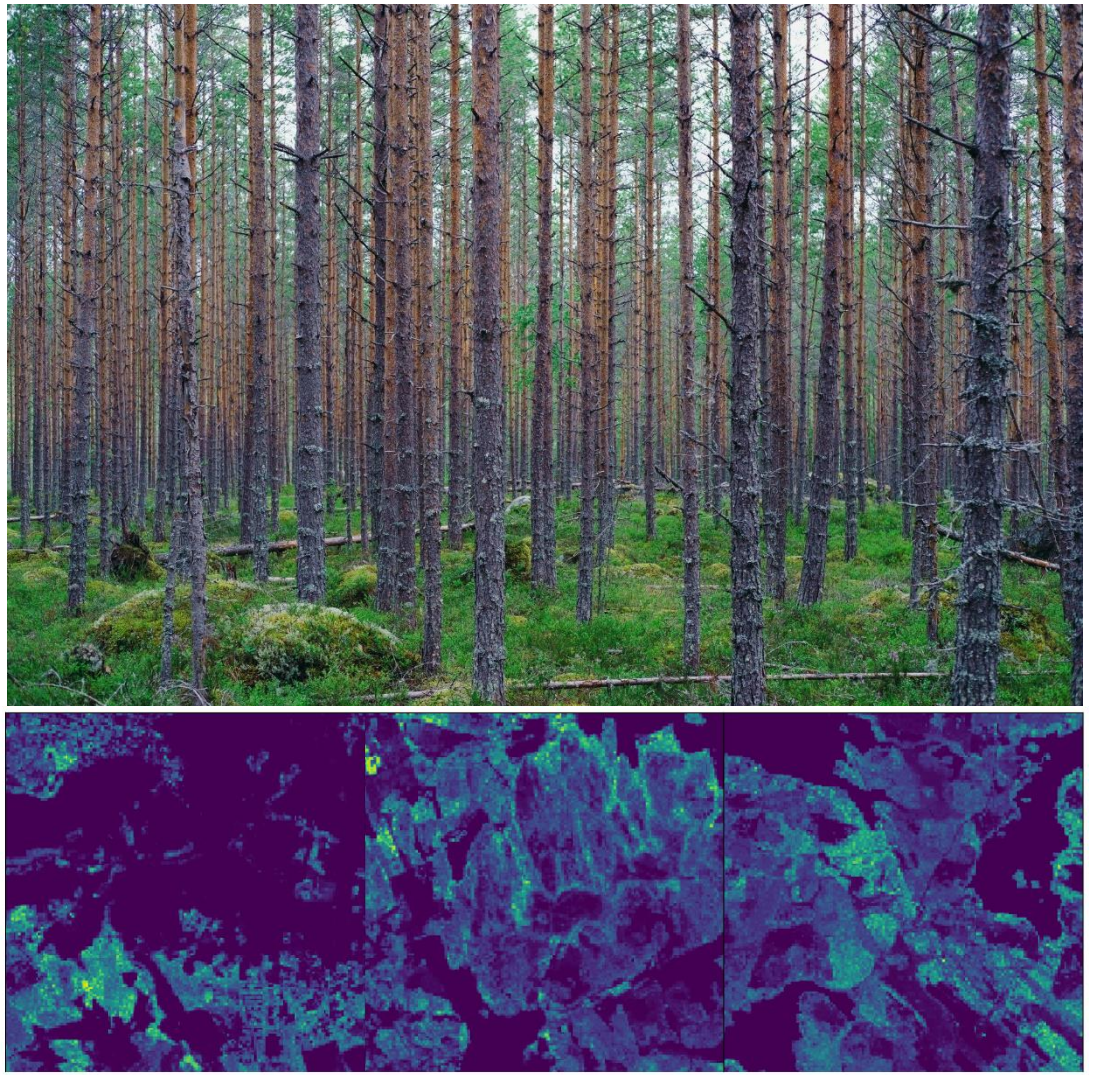


Automatic differentiation in MATLAB

The Biomassters Challenge

- Estimate the biomass using satellite images

Place	Prize Amount
1st	$5,000
2nd	$2,000
3rd	$1,000
Bonus	$2,000

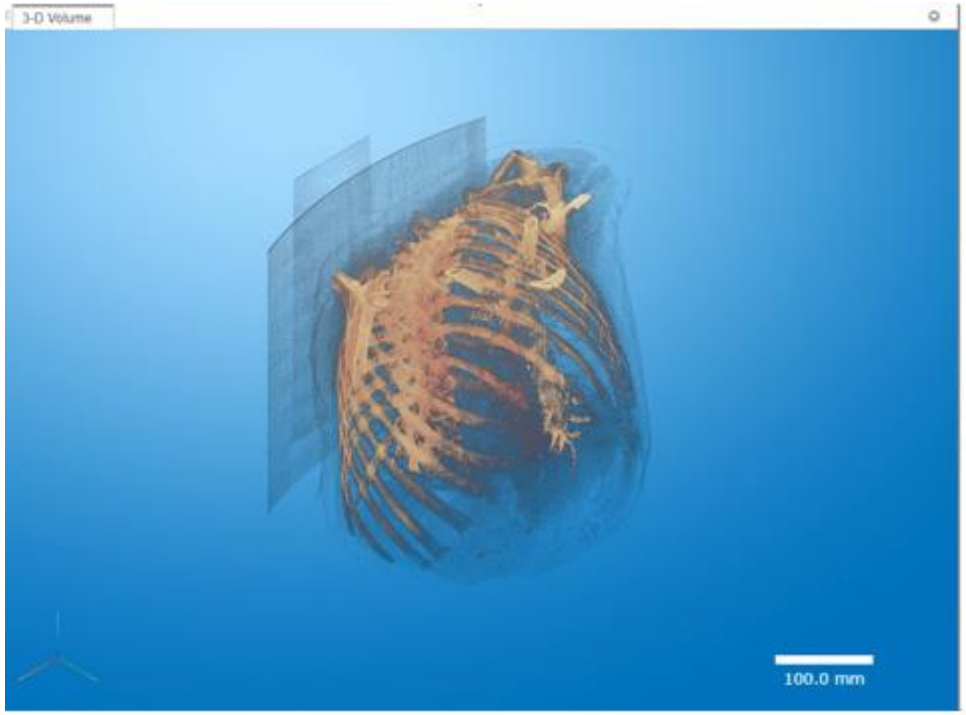


- Top user using MATLAB wins $2000 bonus!

- Join the competition
- Get MATLAB starter code

Student interest in AI within Healthcare/Life Sciences

- Survey in collaboration with Karolinska Institute
- https://forms.gle/TDHtbagAnmcvU3Pv9
- Potential future opportunities for working with machine learning and life science



Learn Deep Learning at KTH

- [DD2424 Deep learning in data science]
- [Masters program in machine learning]
- [KTH AI Society]

@matlab_kth

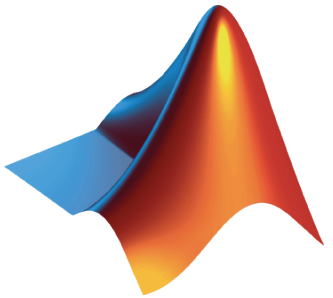
facebook.com/groups/MATLAB.KTH

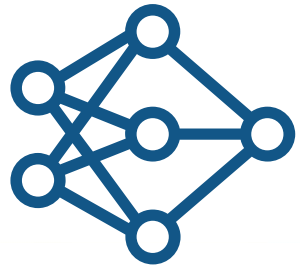
[https://kthais.com]

Thank you!

Questions?

Simon Thor
MATLAB Student Ambassador





Special thanks to Rohit Agrawal for providing the basis of this presentation

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