MATLAB의 새로운 딥러닝 기술 : 객체 인식부터 GAN까지

송완빈, MathWorks

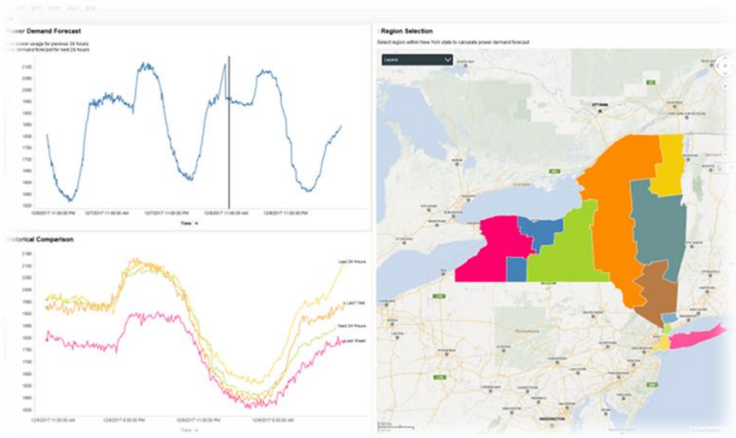
Artificial Intelligence is Transforming Engineering

Robotics & Autonomous

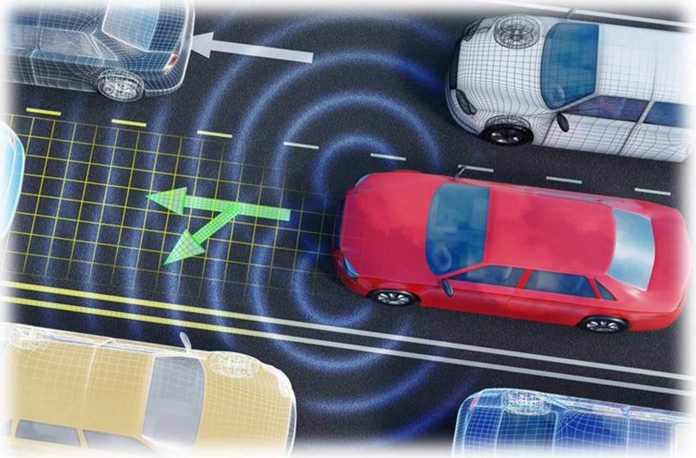
Industrial Automation

Predictive Maintenance

Patient Monitoring



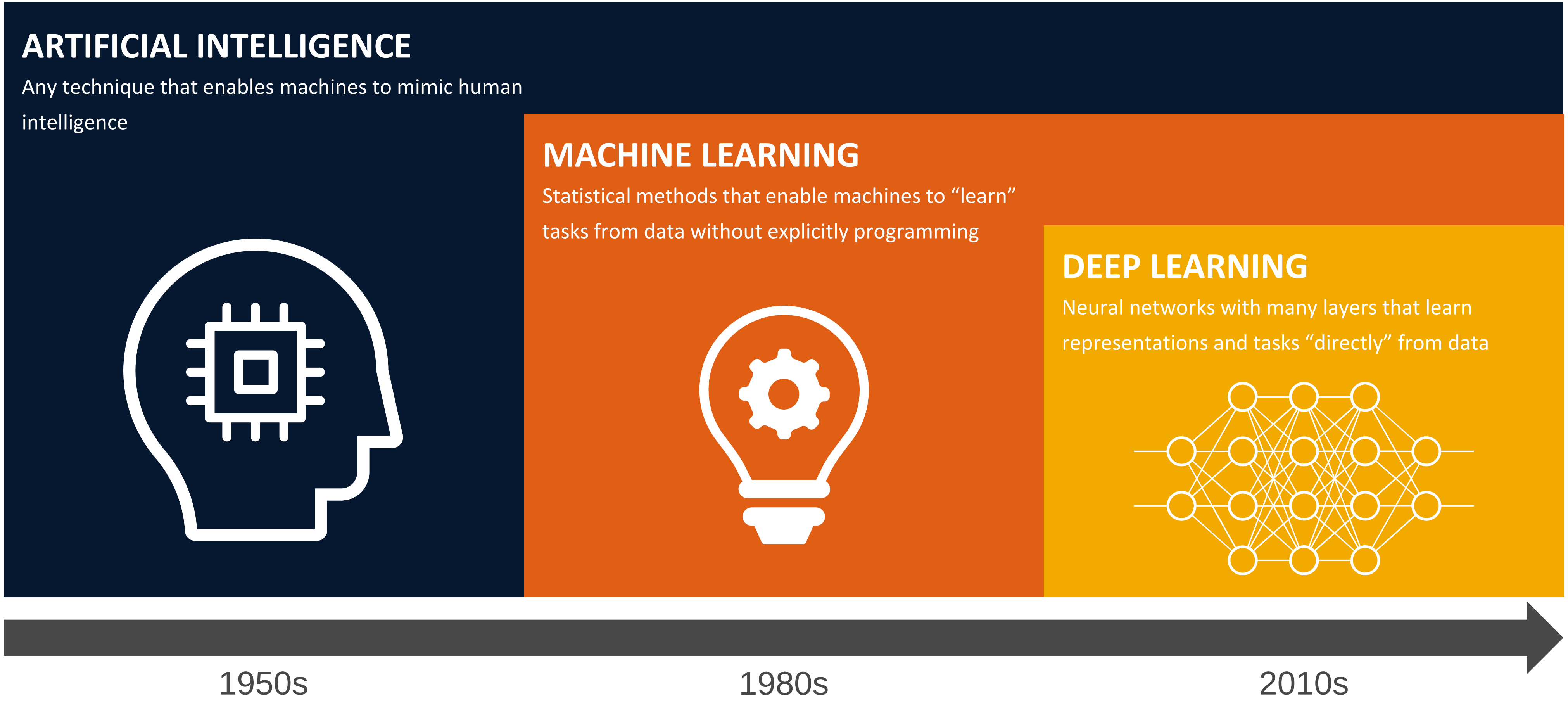
Electricity Use Forecasting



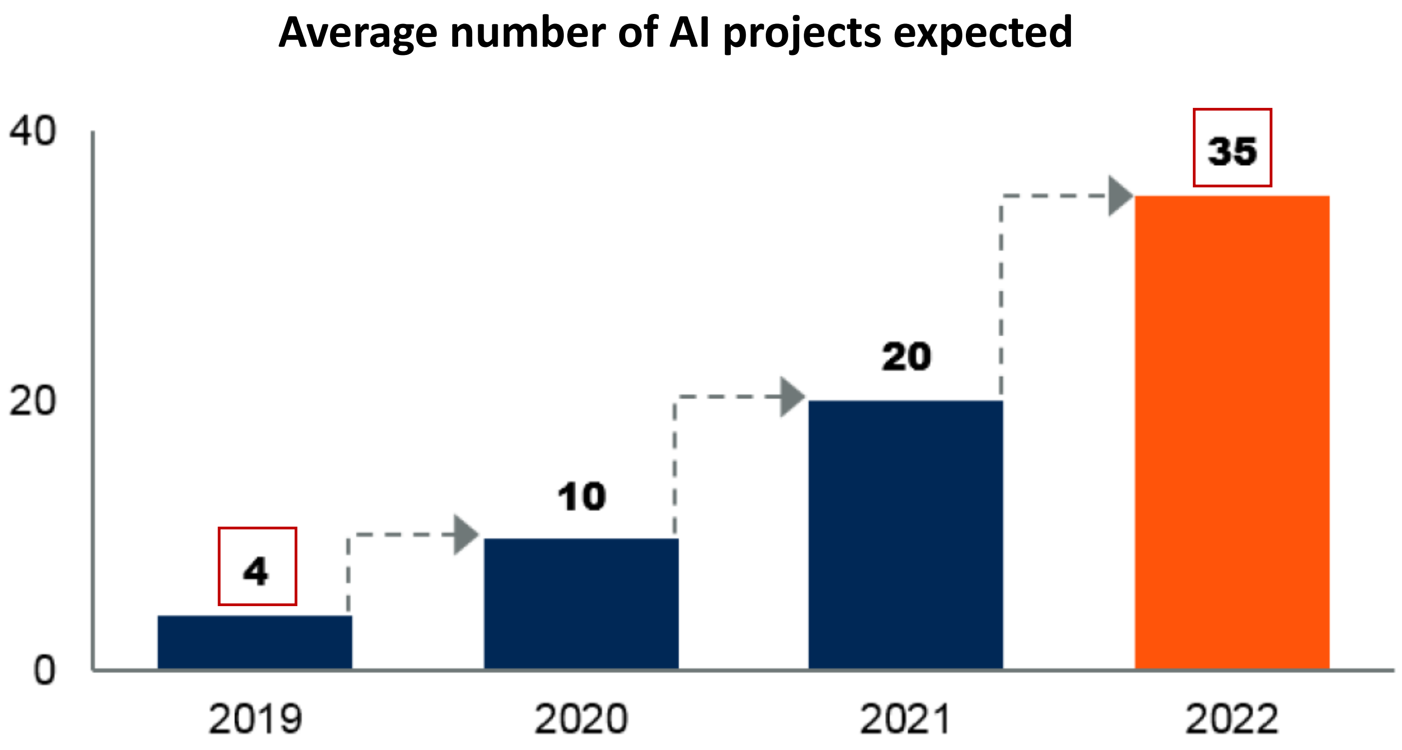
Automated Driving

Artificial Intelligence

- In computer science, artificial intelligence (AI), sometimes called *machine intelligence*, is ***intelligence demonstrated by machines***



Integrating AI is a priority for companies today



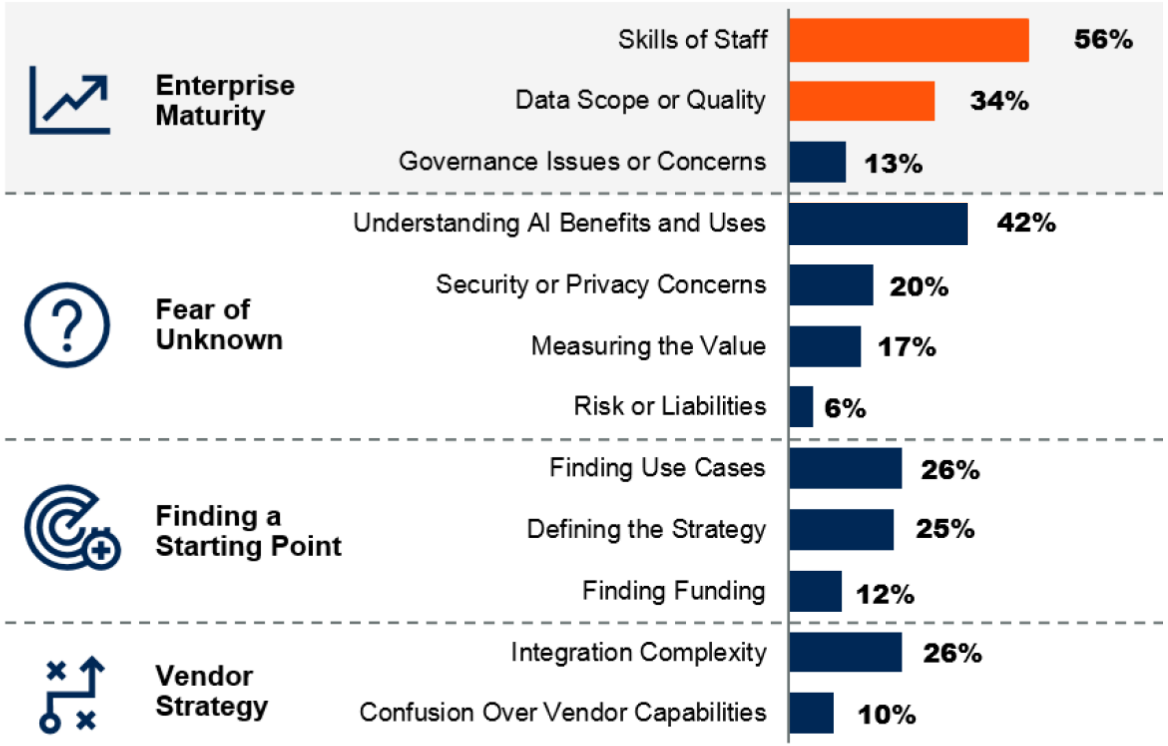
10x increase in AI projects in three years!

* *Source: "AI and ML Development Strategies, Motivators and Adoption Challenges," Gartner Research Note, published 19 June 2019*

n = 57 to 63
Gartner Research Circle members with AI/ML projects deployed/in use today, excluding "unsure"
Source: Gartner AI and ML Development Strategies Survey
Q. How many projects are deployed/in use today? How many projects do you estimate in zero to 12 months, 12 to 24 months, and 24 to 36 months?
ID: 390794

AI skills and data quality are major concerns

Top Three Challenges to AI and ML Adoption



n = 106
Gartner Research Circle members, excluding “unsure”
Source: Gartner AI and ML Development Strategies Survey
Q: What are the top three challenges or barriers to the adoption of AI and ML within your organization?
Rank up to three.
ID: 390794

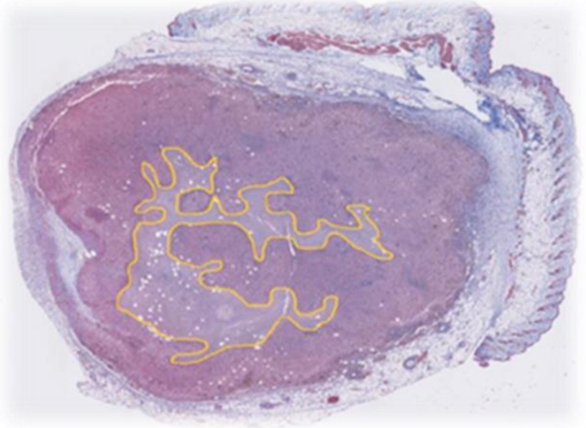
Top barriers to successful adoption of AI

1. Skills of your team
2. Data quality

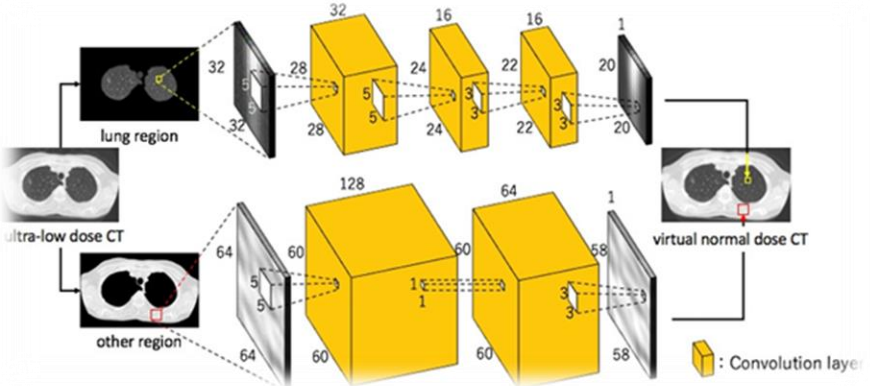
* *Source: “AI and ML Development Strategies, Motivators and Adoption Challenges,” Gartner Research Note, published 19 June 2019*

But, Deep Learning with MATLAB is Growing Rapidly

Shell:
Machinery Identification

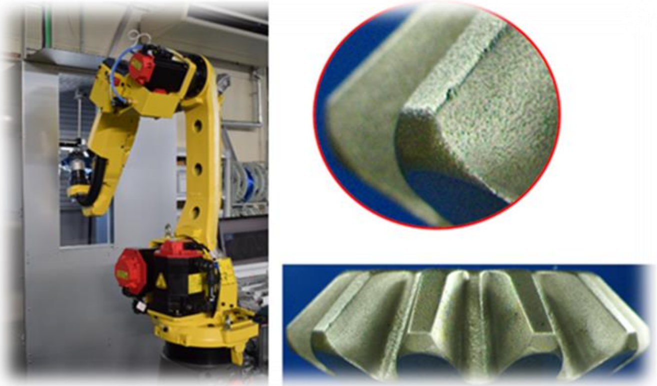


Genentech:
Pathology Analysis

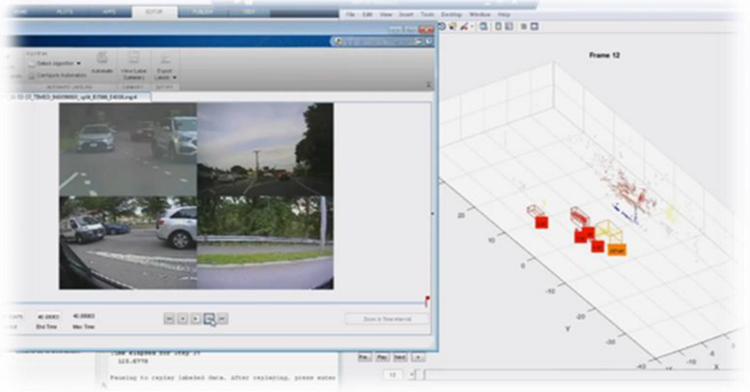


Ritsumeikan University:
Reduce Exposure in CT Imaging

Airbus:
Aircraft inspection



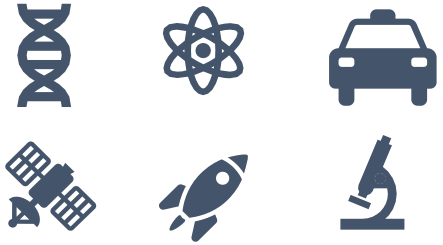
Musashi Seimitsu Industry Co:
Detect Abnormalities in Auto Parts



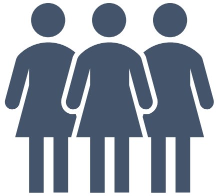
Veoneer:
Lidar Object Detection

Why MATLAB & MathWorks for Deep Learning?

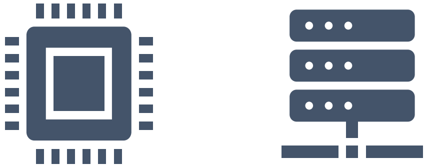
Domain-specialized workflows for **engineering and science**



People

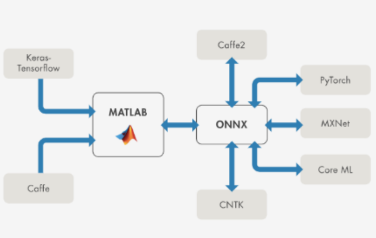


Multi-platform **deployment of full applications and systems**



Platform productivity

Interoperability with TensorFlow and PyTorch



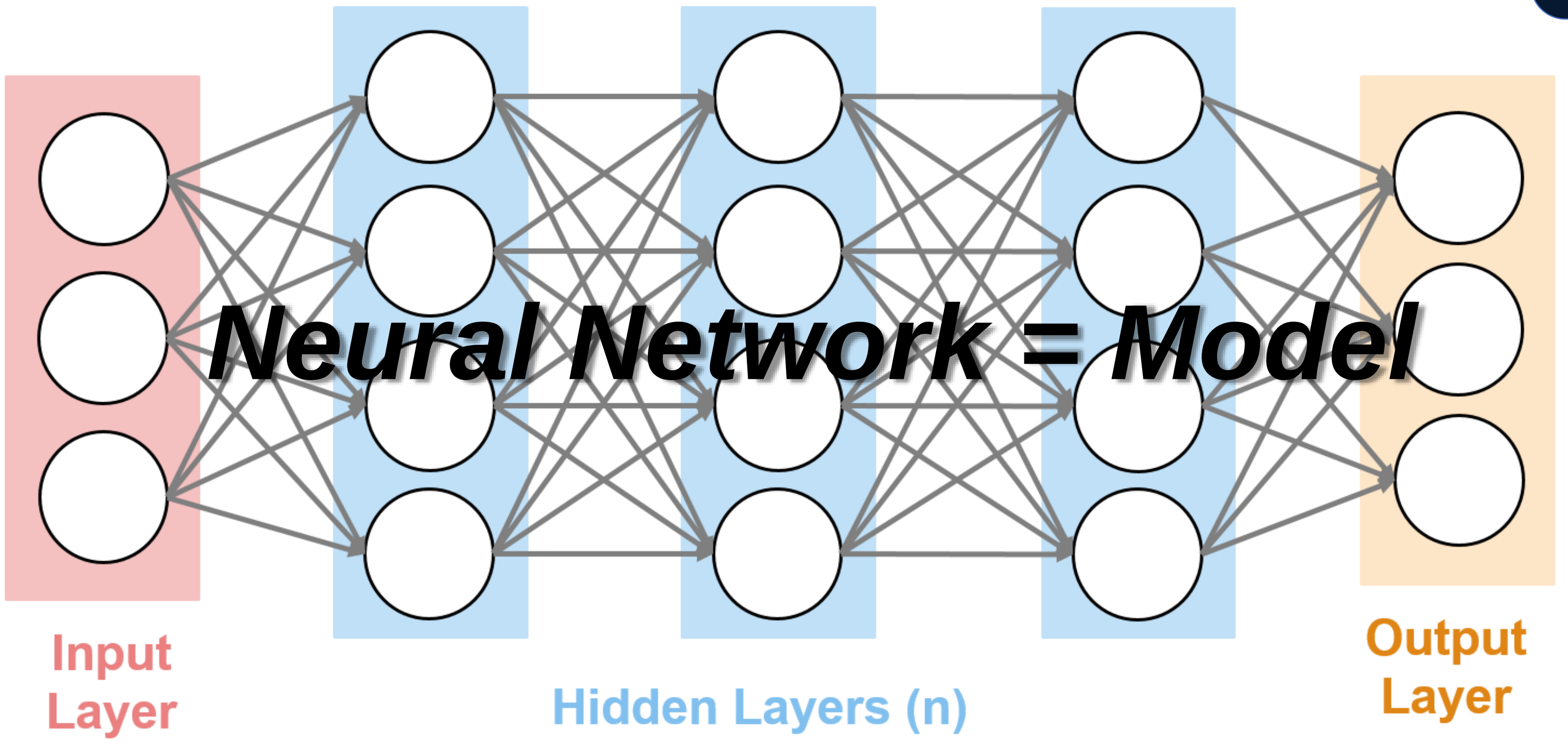
AI-driven system design workflow

You Should Consider the Entire Process for AI Project

Data Preparation → AI Modeling → Simulation and Test → Deployment

What is AI Modeling?

AI Modeling



- Designing the Neural Network topology
- Training and validating the model with dataset
- Experimenting with and tuning different parameters

Apps for AI Modeling

R2018b

Deep Network Designer

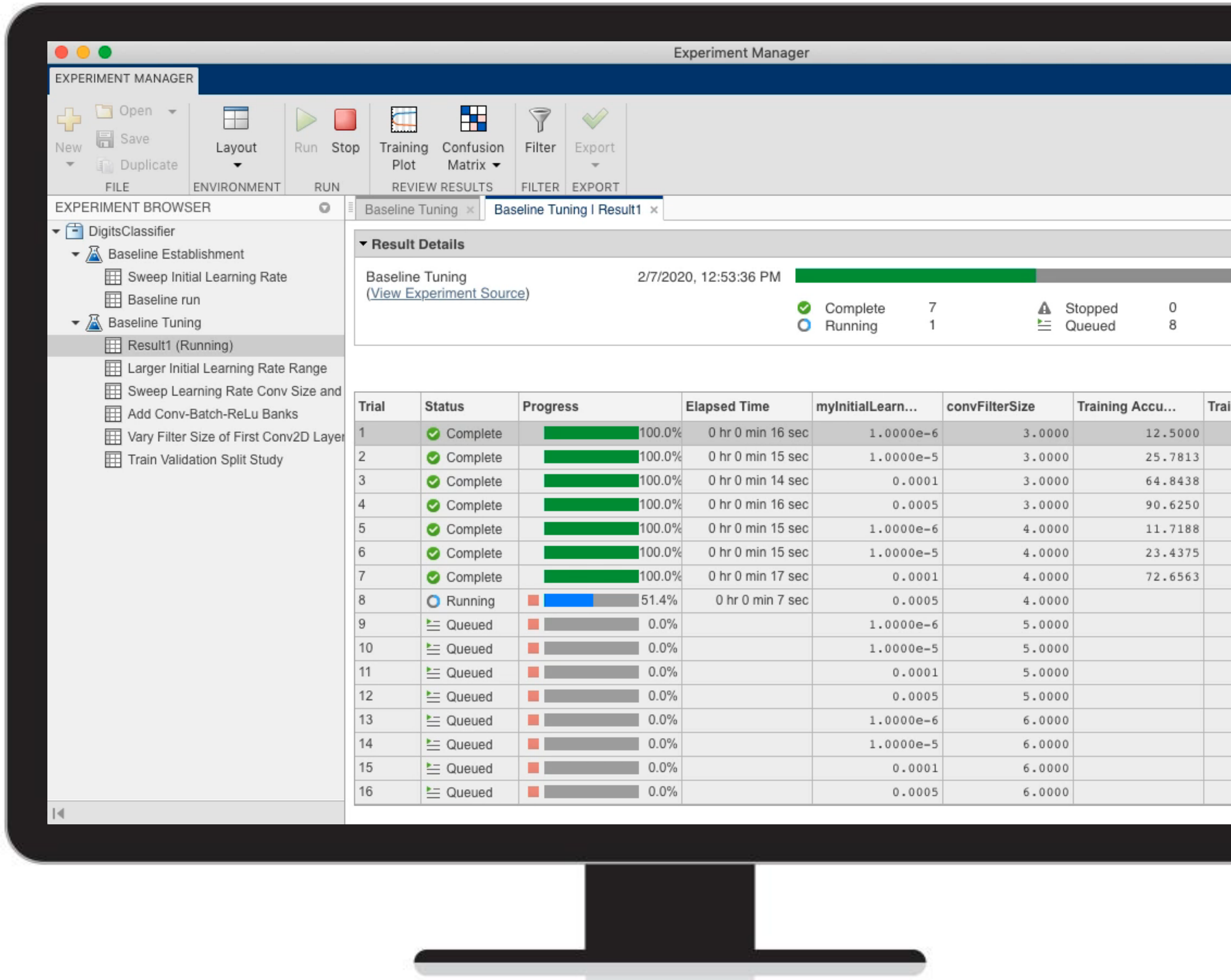
- Choose from a comprehensive library of pre-trained models
- Easily design, analyze, and train networks graphically
- Monitor training with plots of accuracy, loss, and validation metrics.
- Generate equivalent MATLAB code to recreate design

R2020a

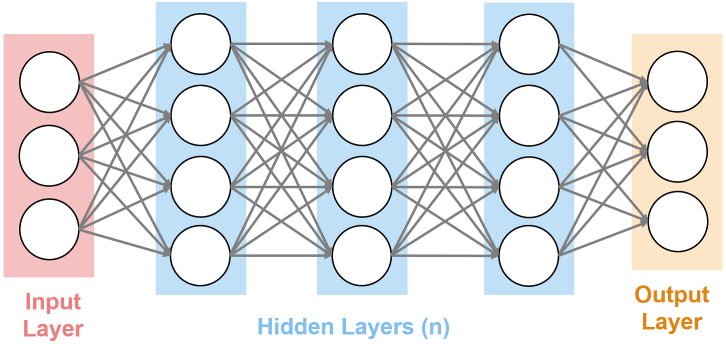
Apps for AI Modeling

Experiment Manager

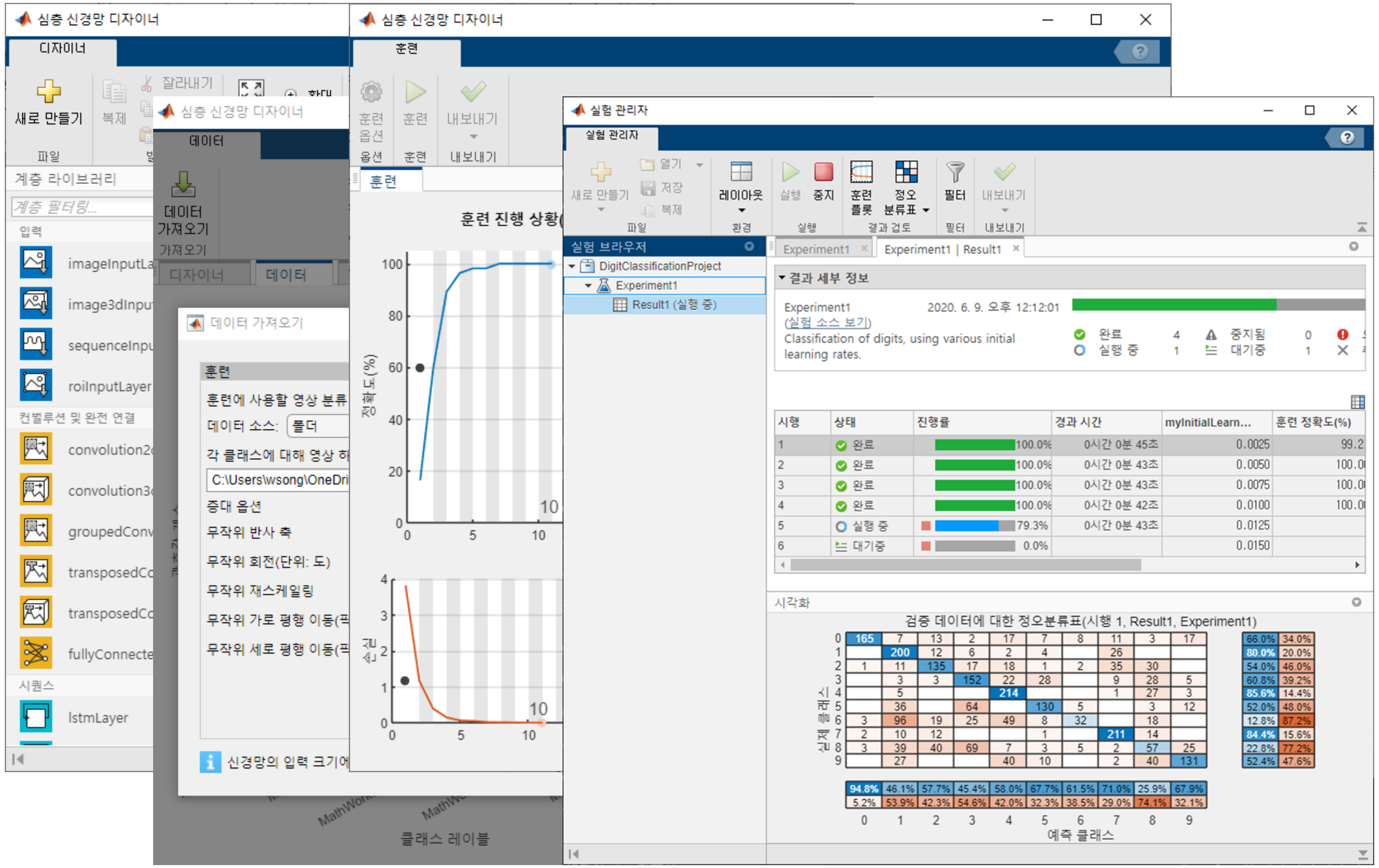
- Saves time during trial-and-error model selection
- Sweep over hyperparameter combinations
- Sort, filter, monitor training plot, confusion matrix
- Allows you to replicate research and track results



Get benefits from Apps

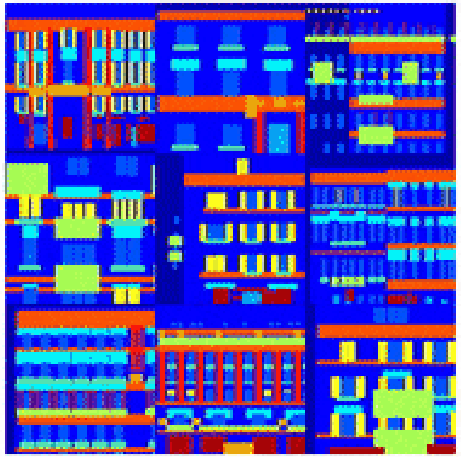


- Designing the Neural Network topology
- Training and validating the model with dataset
- Experimenting with and tuning different parameters

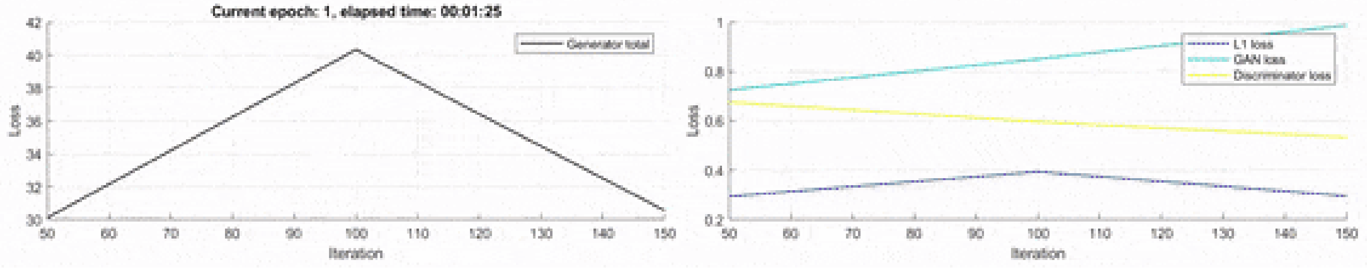


How about advanced deep learning model training?

Input



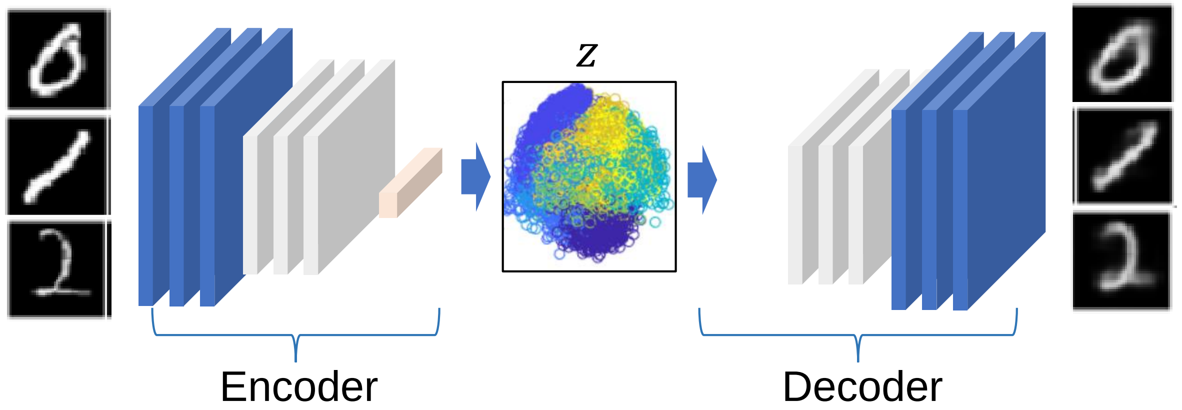
Output



- Generate an image similar to real images
- Image to Image Translation Using GAN

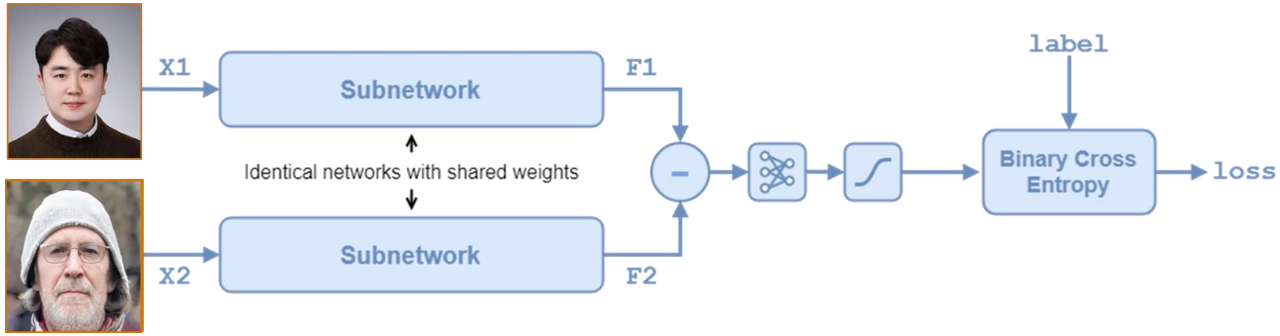
Answer is “You can now train advanced models with MATLAB”

- Variational Autoencoder (VAE)

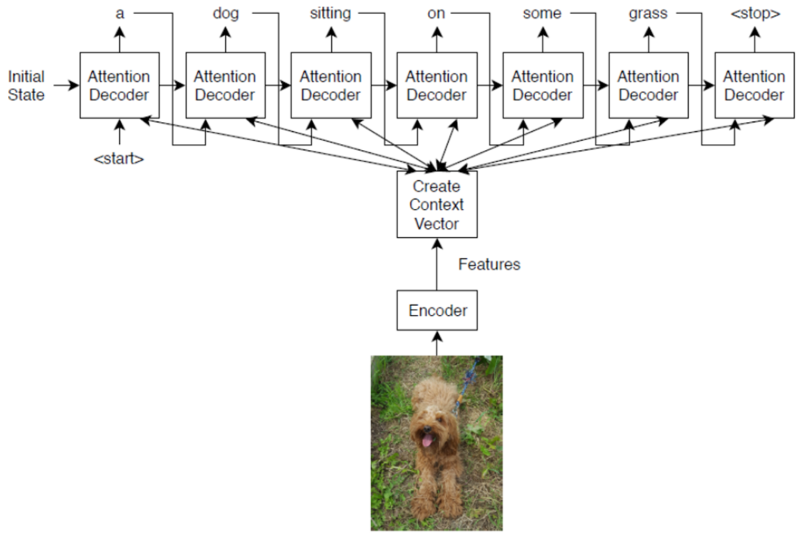


- Neural Style Transfer

- One shot learning Using Siamese Networks



- Image Captioning using Attention

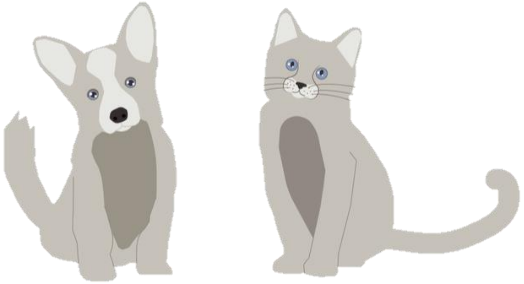


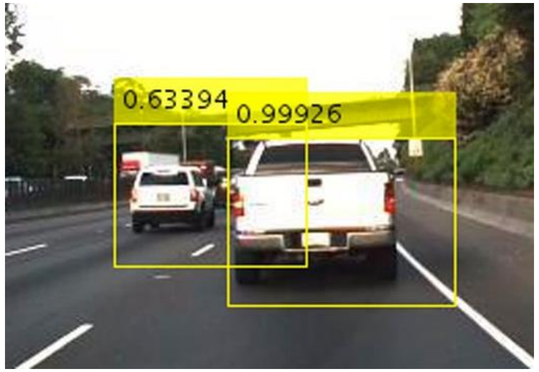
You now have 2 options to train Deep Learning model

R2019b

- For a Simple Deep Learning model
  - Use Apps or High-Level API

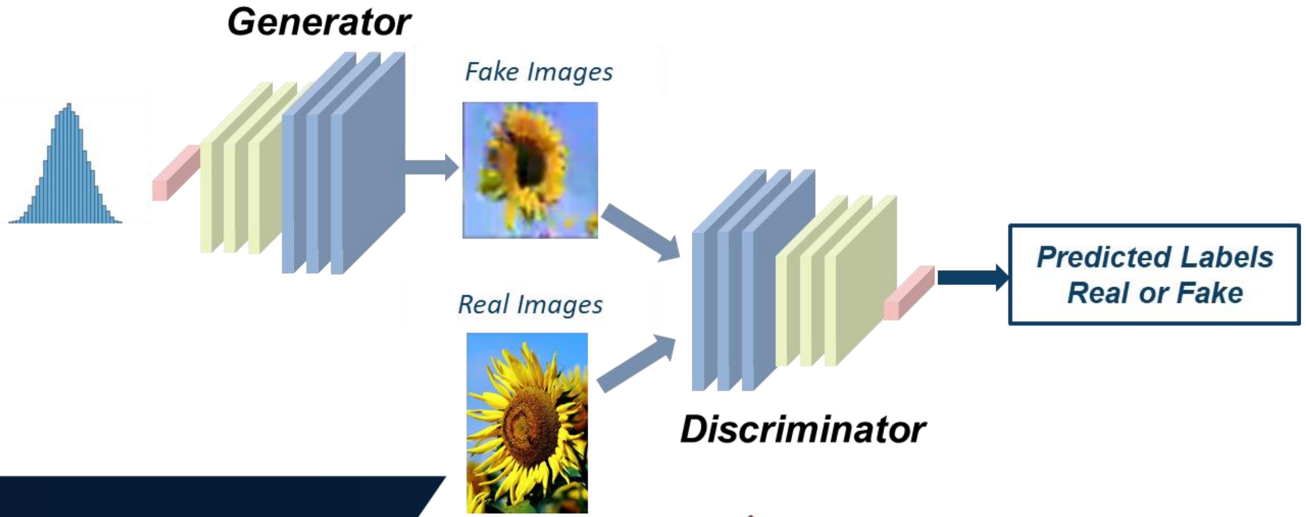
```
net = trainNetwork()
```





- For a Advanced Deep Learning model
  - Use Low-Level API

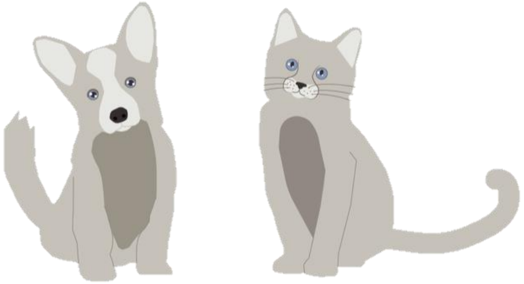
```
for i = 1:epoch
    [loss, Grad] = dlfeval(@iLoss, ...
        images, labels, net);
    [net.Learnables, ~] = adamupdate(...
        net.Learnables, grads);
end
```

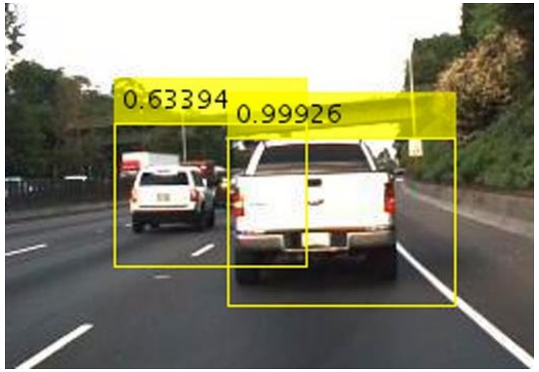


You now have 2 options to train Deep Learning model R2019b

- For a Simple Deep Learning model
  - Use Apps or High-Level API

```
net = trainNetwork()
```





- When to Use?
  - Relatively Simple Deep Learning model
    - Object Recognition / Detection
    - Semantic Segmentation
    - Sequence Classification
    - Time Series Forecasting
  - Single Command to train Network
  - Leverage Apps for training, validating and tuning parameters

You now have 2 options to train Deep Learning model

- When to Use?
  - Advanced Deep Learning model training
    - Generative Models
    - Networks needs custom loss function, custom training rules
    - Multiple Network training
  - Low-level coding required for network training
  - Automatic differentiation for compute gradients

- For a Advanced Deep Learning model
  - Use Low-Level API

```
for i = 1:epoch
    [loss, Grad] = dlfeval(@iLoss, ...
        images, labels, net);
    [net.Learnables, ~] = adamupdate(...
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```
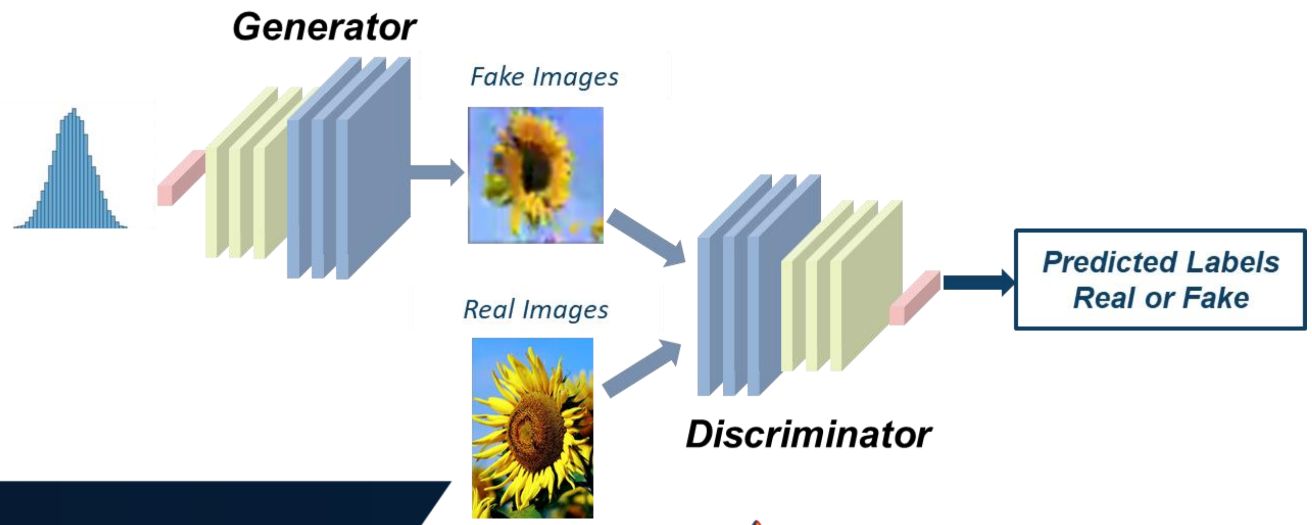



Structure of a Low-Level API - Custom training loop

Convert network and data

```
net = dlnetwork(lgraph)
data = dlarray(data)
```

Manual Training loop

```
for i = 1 : epoch

    [loss, Gradient ] = dlfeval(@myfunction, data,net, ... )

    [net.Learnables, ~ ] = adamupdate(net.learnables , Gradient, ... )

end
```

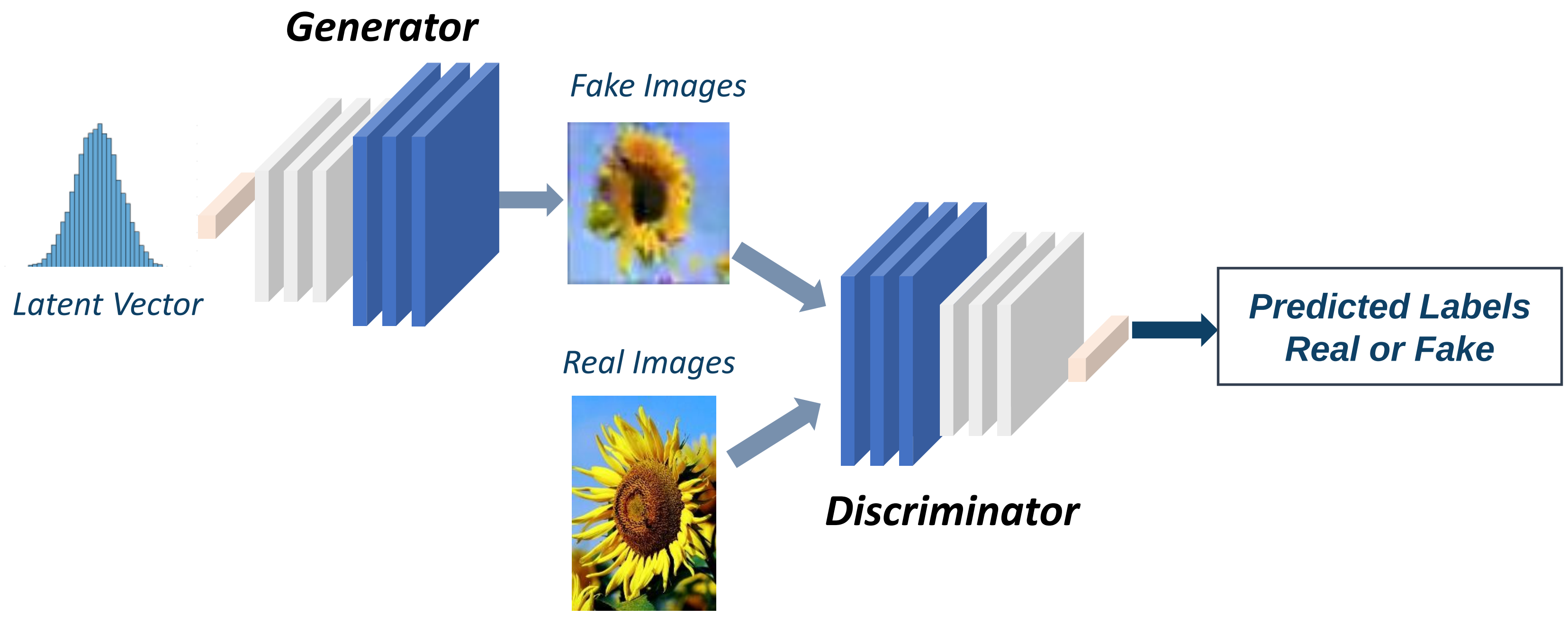
Calculate forward processing, loss and gradient

```
function [loss, Gradient ] = myfunction(data,net,...)

loss = xxxxxxx
Gradient = dlgradient(loss, net.Learnables)
```

- Custom training loop for the network training
- Can define custom loss function for gradient calculation
- Compute gradients using Automatic Differentiation

Let’s briefly work through with GAN!
Generative Adversarial Network

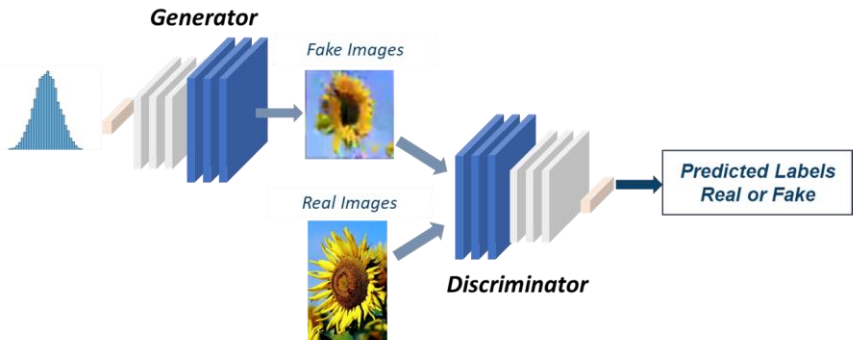
Train to trick the Discriminator

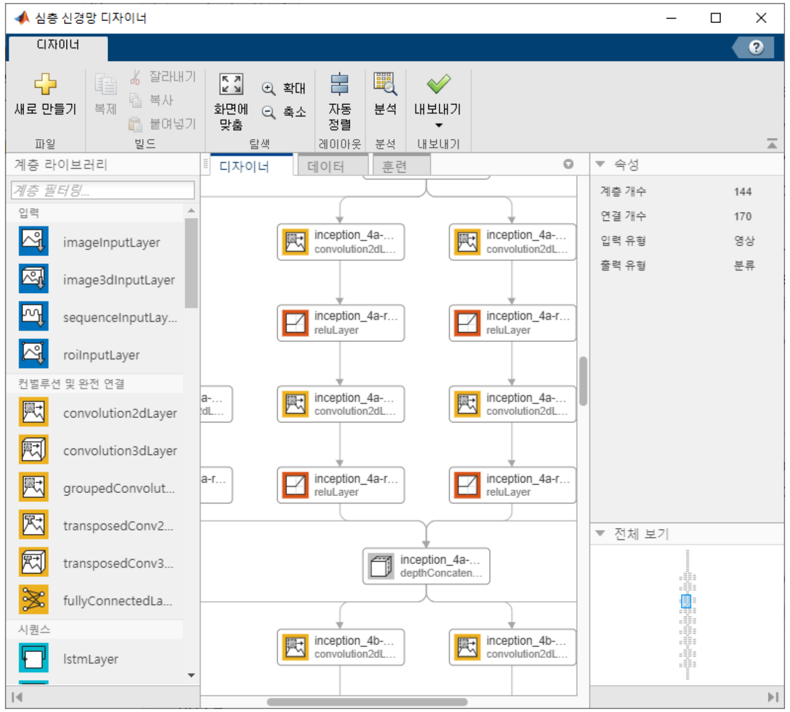


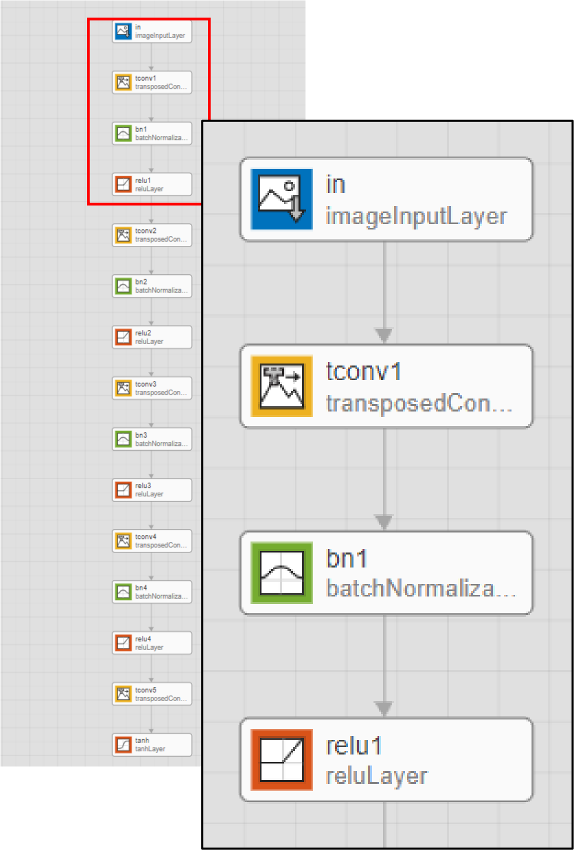
Train to judge real / fake correctly

Generate an image similar to real images

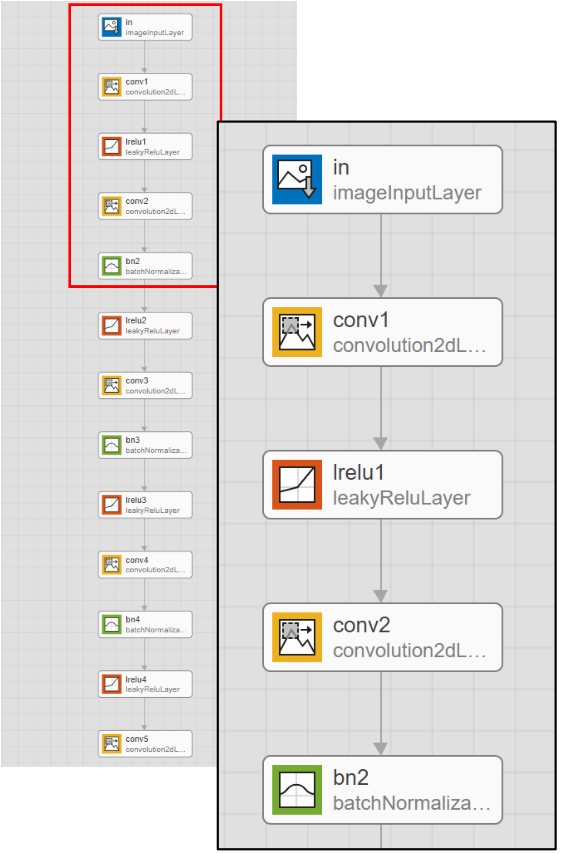
Generative Adversarial Network in Action – Networks





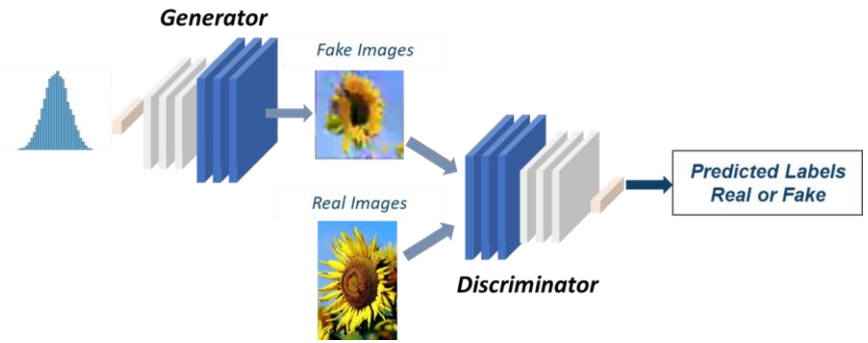


✓ Generate an image from random numbers using transposed Convolution.



✓ Common Network for classification

Generative Adversarial Network in Action – Loss Function




```
function [lossGenerator, lossDiscriminator] = ganLoss(probReal,probGenerated)

% Calculate the loss for the discriminator network.
lossDiscriminator = -mean(log(probReal)) -mean(log(1-probGenerated));

% Calculate the loss for the generator network.
lossGenerator = -mean(log(probGenerated));

end
```

Generator loss function = *To generate data that the discriminator classifies as "real"*

Discriminator loss function = *To judge the Real image as Real* + *To judge the Fake image as Fake*

Convert network and data

```
net = dlnetwork(lgraph)
data = dlarray(data)
```

Manual Training loop

```
for i = 1 : epoch

    [loss, Gradient ] = dlfeval(@myfunction, data,net, ... )

    [net.Learnables, ~ ] = adamupdate(net.learnables , Gradient, ... )

end
```

Calculate forward processing, loss and gradient

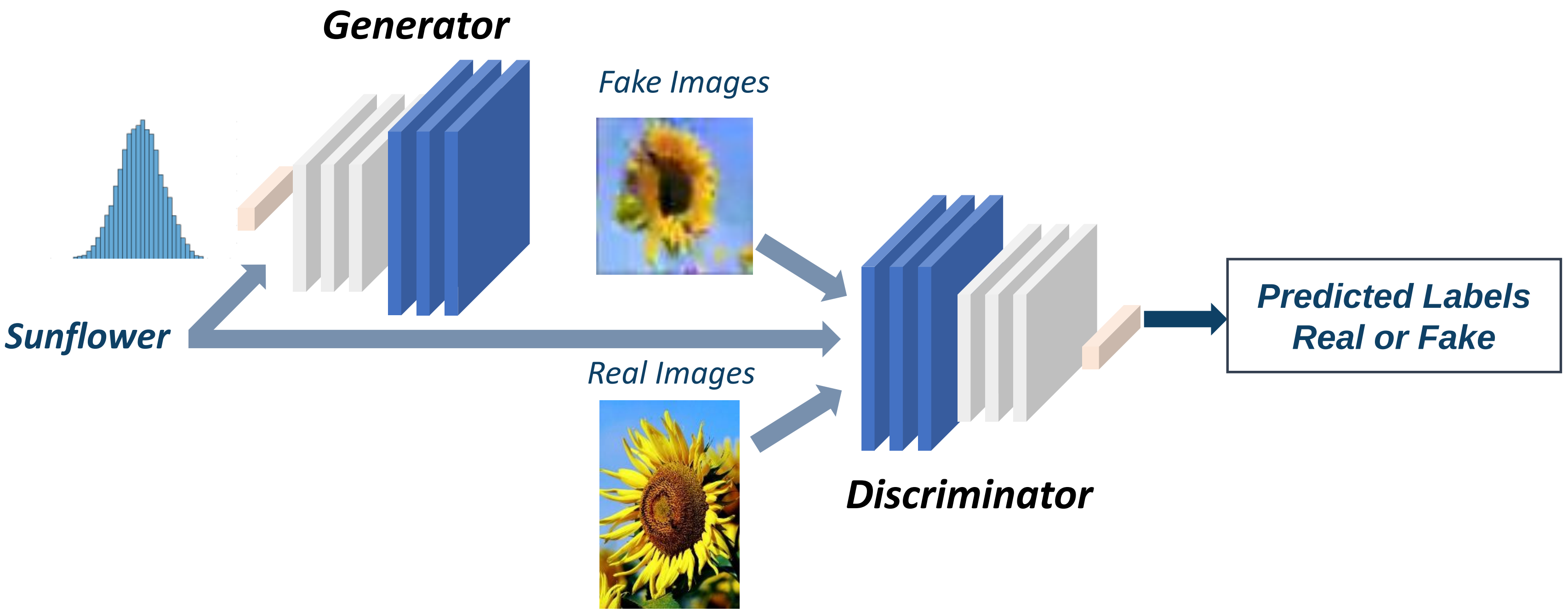
```
function [loss, Gradient ] = myfunction(data,net,...)

loss = xxxxxxx
Gradient = dlgradient(loss, net.Learnables)
```

Follow the structure, then you can get GAN model!

Full code available

Extensions of GANs

- cGAN
  - A *conditional* generative adversarial network is a type of GAN that also takes advantage of labels during the training process.

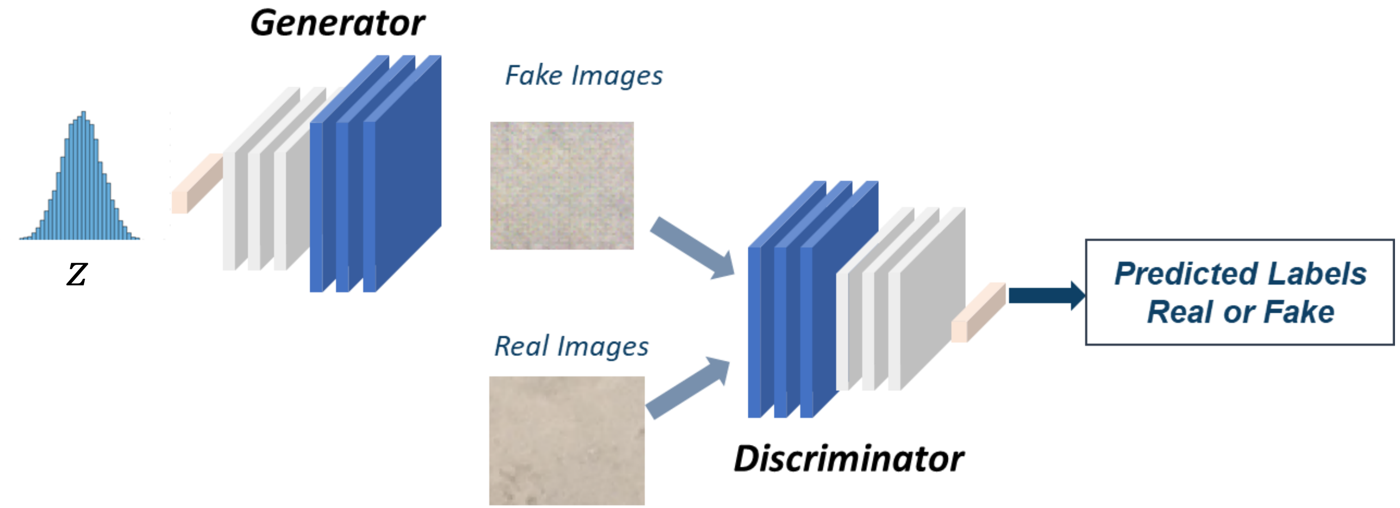


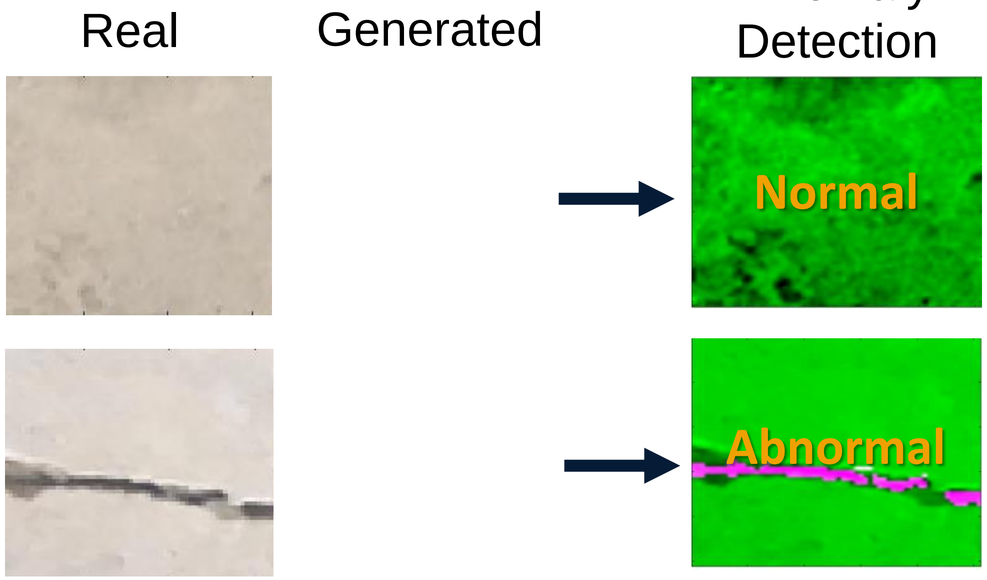
Generate Daisy flower!

Full code available

Extensions of GANs

- AnoGAN
  - Anomaly detection using GAN, Unsupervised Learning
  - Train GAN with only Normal data (No Abnormal data needed)
  - Adjust latent vector z that can generates similar images with real data

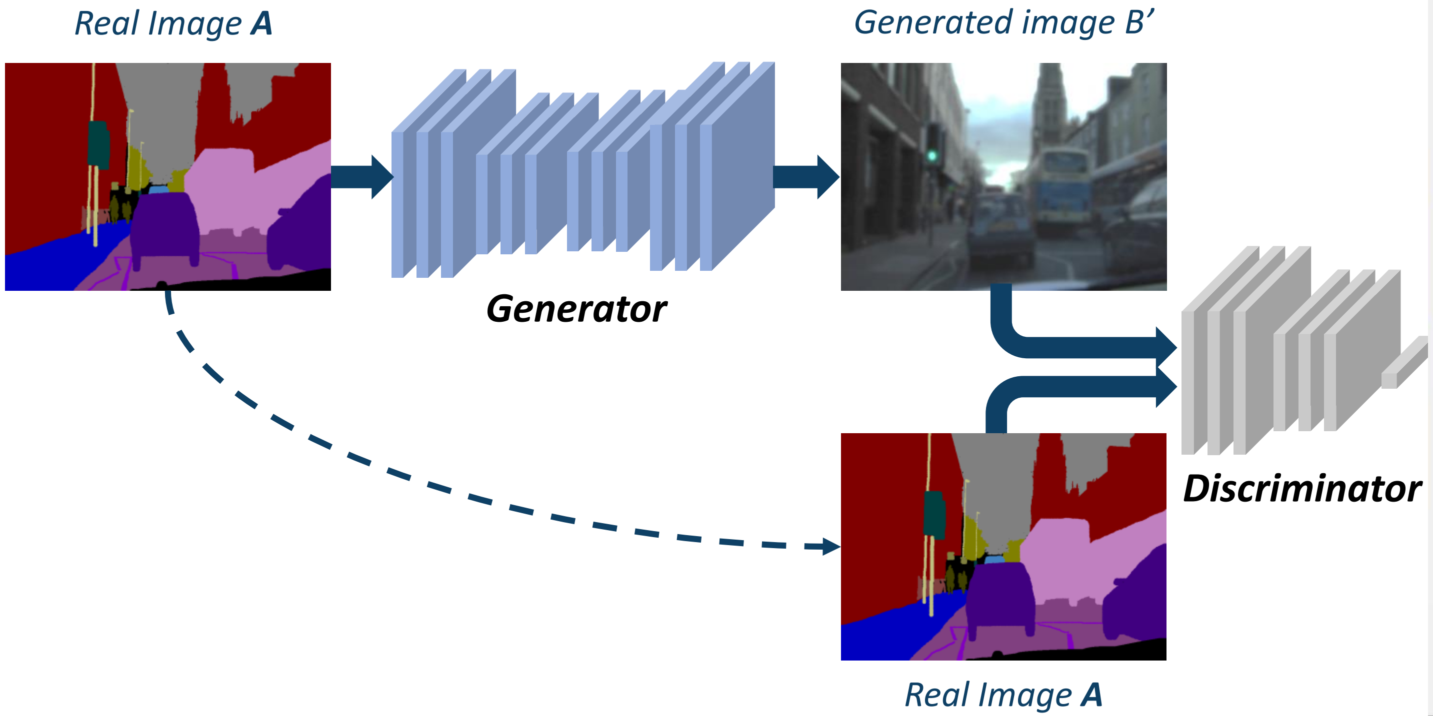


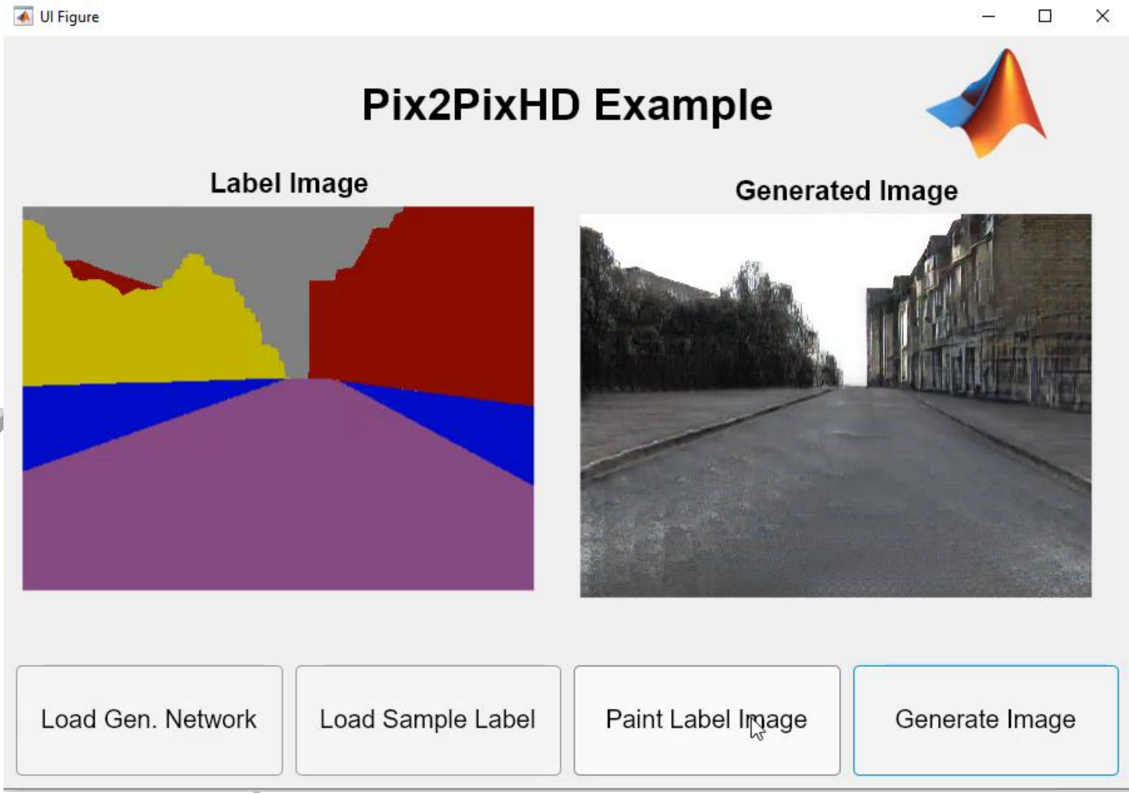


Images are from [Concrete Crack Images for Classification]

Extensions of GANs

- Pix2Pix
  - Image to Image Translation using GAN (Conditional GAN Model)
  - Using **pairs** of images of "before" and "after", generate “after” using “before” Full code available

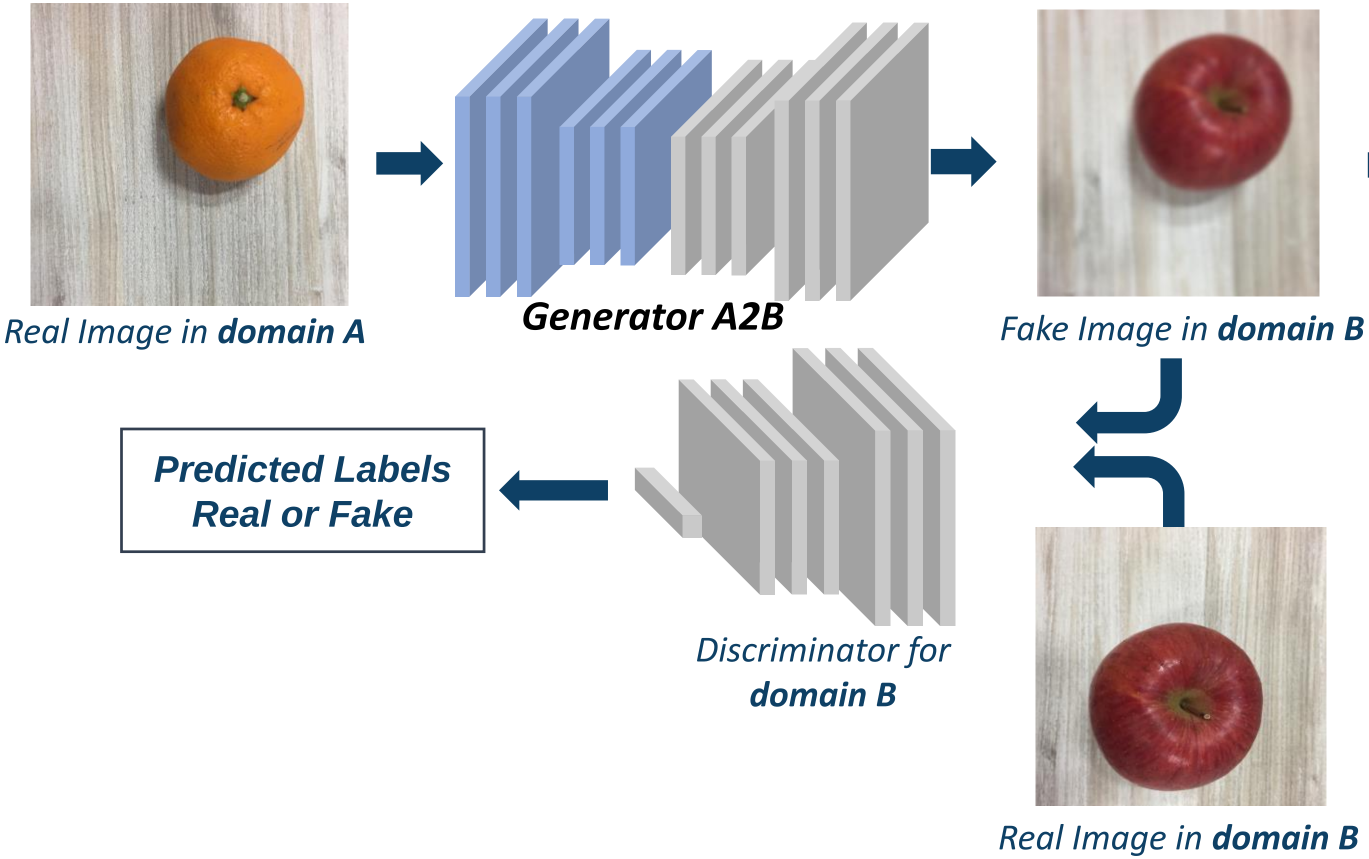


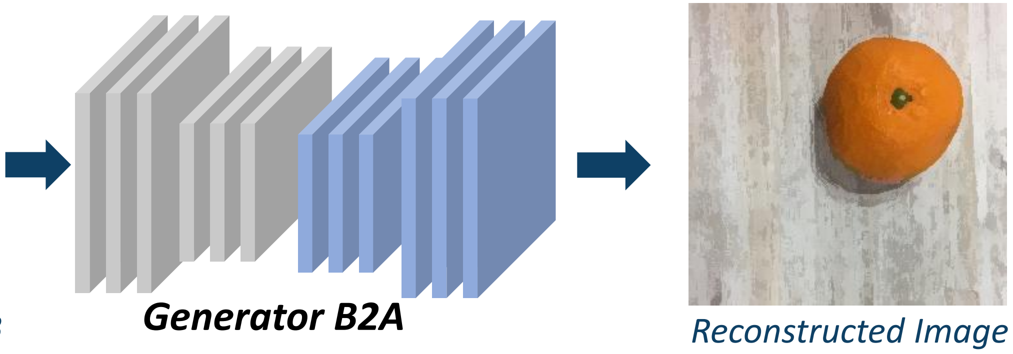


Extensions of GANs

- CycleGAN
  - **Unpaired** Image to Image Translation using GAN

Full code available





Domain transfer

Siamese Network for One-shot Learning

- Siamese Network

[Full code available]

  - Neural networks containing two or more identical subnetwork components with shared weights

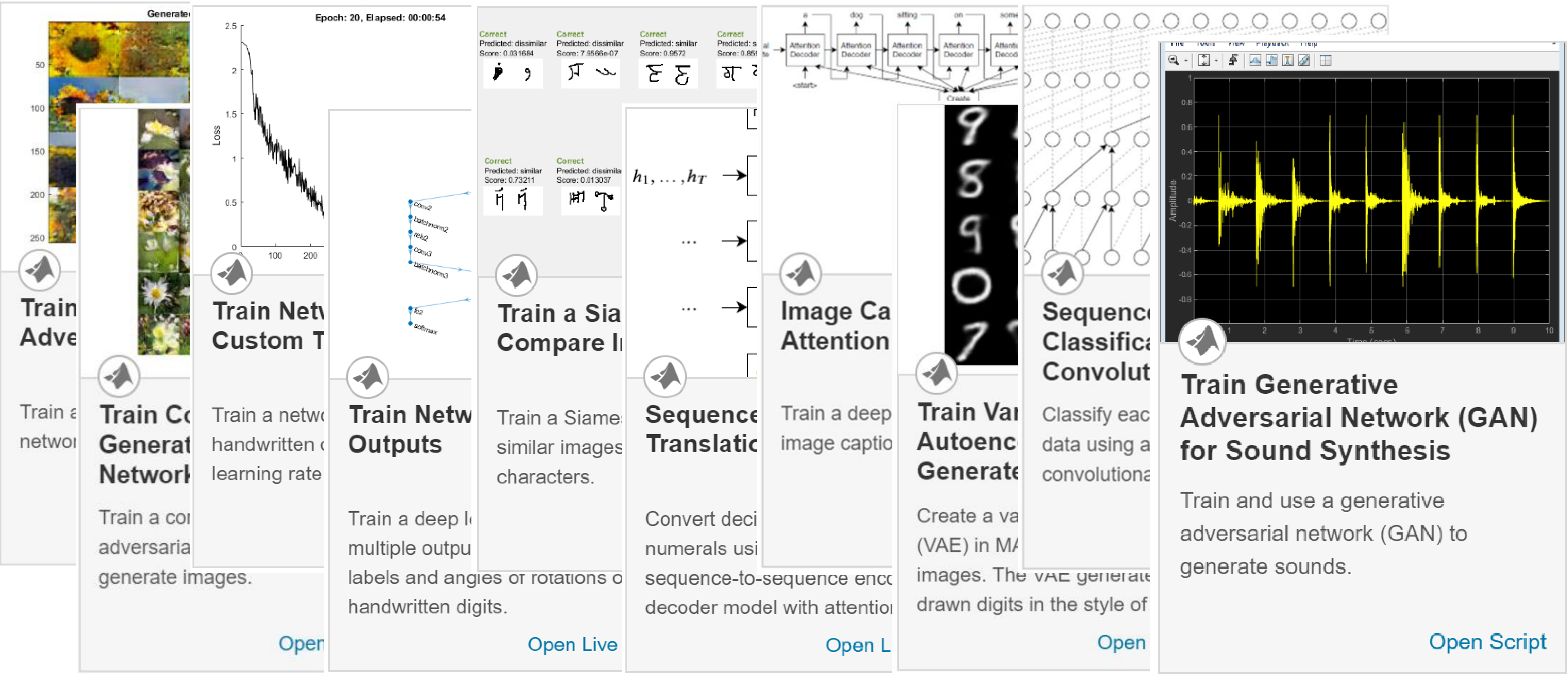
And Many More!

We'd Like to track this vehicle

  - If two inputs are similar, $||F1 - F2||^2$ is small.
  - If two inputs are dissimilar, $||F1 - F2||^2$ is large.

Getting started with rich examples

Documentation



MATLAB makes it easy to learn and automate workflow steps

Access Data → **Preprocess** → **Access Models** → **Train** → **Deploy**

Preprocess	Access Models	Train
MUNGING/LABELING	BUILD	FROM SCRATCH
FUSION	BORROW	TRANSFER
DENOISING		

Datastores

fo

- D
- C
  da
- Image, video, audio, and other datatypes

Preparing Data

Finding va

- Apps for la
  images, vid
  and ground
- State-of-the-art signal and image processing functions

Pretrained Models

Frameworks

TensorFlow

VGG-19
ResNet-50
ResNet-101
… and more

Caffe Model Zoo

ONNX

Interactive Apps

nalysis

er Ap

Experiment Manager App

Advanced Deep Learning Model

Training Hardware

Speed and Scale

NVIDIA
intel
amazon web services

Deployment

sy

CUDA

TensorRT

ONNX

Data Preparation → AI Modeling → Simulation and Test → Deployment

MATLAB EXPO

Thank You

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