

# Deep Learning Adventures

## TensorFlow In Practice -

## Presentation 3

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A quick overview of Coursera's Tensorflow in Practice specialization course

Robert Kraig, David Patton, George Zoto

<https://www.meetup.com/Deep-Learning-Adventures>

# In the beginning...

Meetup

The screenshot shows the homepage of the Deep Learning Adventures Meetup group. At the top, there's a photo of two men sitting on a blue couch. Below the photo, the group's name "Deep Learning Adventures" is displayed in large, bold letters. To the right of the name are links for "Start a new group", "Log in", and "Sign up". Under the group name, it says "Washington, DC", "377 members · Public group", and "Organized by George Z. and 2 others". There are sharing options for Facebook, Twitter, and LinkedIn. A red "Join this group" button is prominent. Below the main header, there are sections for "What we're about", "Upcoming events (2)", and "Members (377)". The "What we're about" section contains a detailed paragraph about the group's mission and history. The "Upcoming events" section lists an event with Laurence Moroney on July 3rd at 7:30 PM EDT. The "Members" section shows a grid of member profiles.

**Deep Learning Adventures**

Washington, DC · 377 members · Public group · Organized by George Z. and 2 others

Share: [Facebook](#) [Twitter](#) [LinkedIn](#)

[Join this group](#)

**What we're about**

Deep Learning Adventures is a welcoming group for anyone interested in learning more about deep learning, its foundations, its strengths and weaknesses and ever growing applications that best serve humanity and help those in need throughout the world. After participating in hundreds of meetups in the area, we have taken many lessons learned and incorporated them into this group. This group is also startup oriented in the sense that we are open minded and ready to pivot to new directions as our community and needs around the world guide us....

[Read more](#)

**Upcoming events (2)**

**FRI, JUL 3, 7:30 PM EDT**

**A chat with Laurence Moroney, AI Lead at Google**

Online event

Join us for a fun conversation with Laurence Moroney, AI Lead at Google (<https://www.linkedin.com/in/laurence-moroney/>) and developer of our TensorFlow in Practice and TensorFlow: Data and Deployment Specializations! We plan to...

**Members (377)**

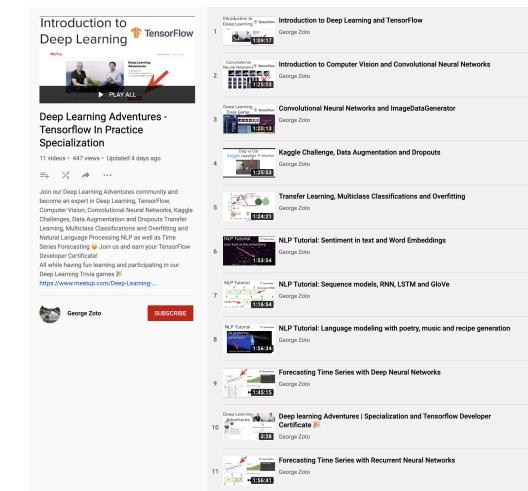
**Organizers**

George Z. and 2 others

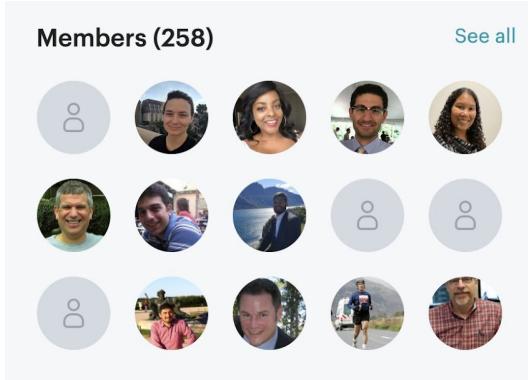
[Message](#)

[See all](#)

- **Meetup Link**  
<https://www.meetup.com/Deep-Learning-Adventures>
- **GitHub repository**  
<https://github.com/georgezoto/Deep-Learning-Adventures>  
<https://github.com/georgezoto/TensorFlow-in-Practice>
- **Join us on Slack**  
[https://join.slack.com/t/deeplearninga-nmk8930/shared\\_invite/zt-d52h9mm9-h~Q0ZXw5PXsTDzPIINivoq](https://join.slack.com/t/deeplearninga-nmk8930/shared_invite/zt-d52h9mm9-h~Q0ZXw5PXsTDzPIINivoq)
- **Need a refresher or new to Deep Learning?**
- **YouTube recordings of all our Meetups 😊**  
<https://bit.ly/deep-learning-tf>



# Get to know our community



Hello, my name is \_\_\_\_ and this is my \_\_\_\_ meetup.

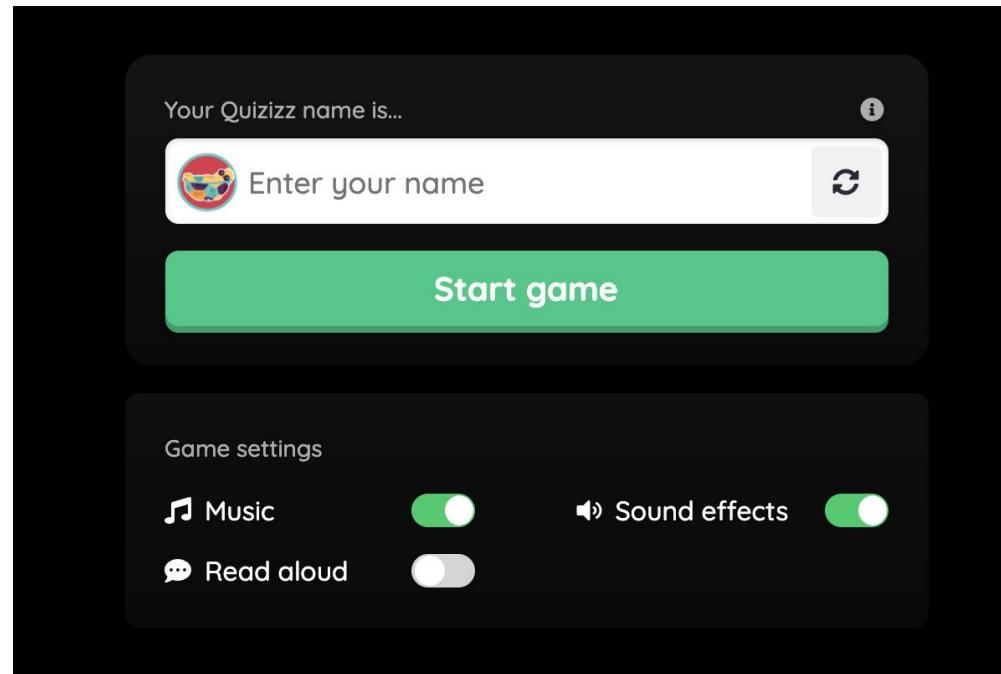
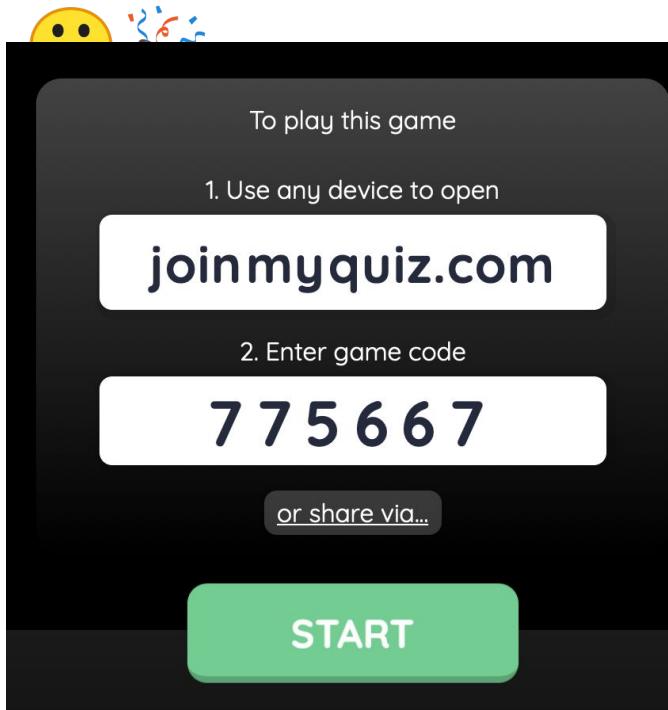
I enjoy \_\_\_\_ and I am interested in learning more about \_\_\_\_

Training set 😊

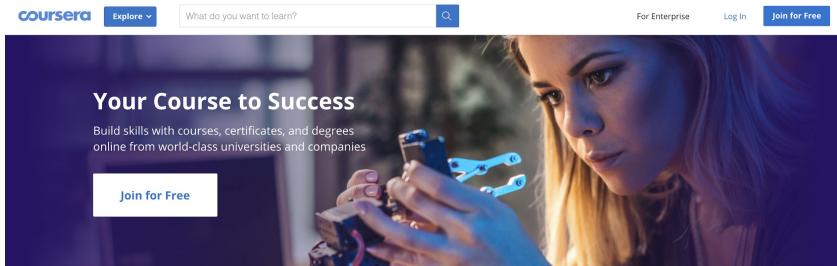
Hello, my name is **George** and this is my **4th** meetup.

I enjoy **applying deep learning to solve interesting problems** and I am interested in learning more about **data augmentation, transfer learning and NLP**.

# Not a typical Meetup... Get ready for a fun game



# Attribution to Coursera and deeplearning.ai



A screenshot of the deeplearning.ai website homepage. The header features the deeplearning.ai logo and a navigation menu with links for "Courses", "Workers", "The Batch", "Events", "Forums", "Blog", and "Company". The main section has a dark background with the title "Break Into AI" in large white letters. Below the title, a paragraph reads: "Whether you want to build algorithms or build a company, deeplearning.ai's courses will teach you key concepts and applications of AI." A red button at the bottom says "Take the Deep Learning Specialization". To the right, there's a graphic of a laptop screen showing two images: a "Content Image" of the Golden Gate Bridge and a "Generated Image" of the same bridge in a painterly style, labeled "Art Generation with Deep Learning".

Source:

<https://www.coursera.org/about/terms>  
<https://www.coursera.org/>  
<https://www.deeplearning.ai/>

# Chapter 1 - TensorFlow in Practice Specialization

## About this Specialization

199,621 recent views

Discover the tools software developers use to build scalable AI-powered algorithms in TensorFlow, a popular open-source machine learning framework.

In this four-course Specialization, you'll explore exciting opportunities for AI applications. Begin by developing an understanding of how to build and train neural networks. Improve a network's performance using convolutions as you train it to identify real-world images. You'll teach machines to understand, analyze, and respond to human speech with natural language processing systems. Learn to process text, represent sentences as vectors, and input data to a neural network. You'll even train an AI to create original poetry!

AI is already transforming industries across the world. After finishing this Specialization, you'll be able to apply your new TensorFlow skills to a wide range of problems and projects.

Looking for more advanced TensorFlow content? Check out the new [TensorFlow: Data and Deployment Specialization](#).

# Chapter 1 - TensorFlow in Practice Specialization

There are 4 Courses in this Specialization

COURSE

1

## Introduction to TensorFlow for Artificial Intelligence, Machine Learning, and Deep Learning

★★★★★ 4.7 6,196 ratings • 1,282 reviews

If you are a software developer who wants to build scalable AI-powered algorithms, you need to understand how to use the tools to build them. This course is part of the upcoming Machine Learning in Tensorflow Specialization and will teach you best practices for using TensorFlow, a popular open-source framework for machine learning.

[SHOW ALL](#)



6 hours to complete

### A New Programming Paradigm

Welcome to this course on going from Basics to Mastery of TensorFlow. We're excited you're here! In week 1 you'll get a soft introduction to what Machine Learning and Deep Learning are, and how they offer you a new programming paradigm, giving you a new set of tools to open previously unexplored scenarios. All you need to know is some very basic SHOW ALL



4 videos (Total 16 min), 5 readings, 3 quizzes [SEE ALL](#)

COURSE

2

## Convolutional Neural Networks in TensorFlow

★★★★★ 4.7 2,751 ratings • 410 reviews

If you are a software developer who wants to build scalable AI-powered algorithms, you need to understand how to use the tools to build them. This course is part of the upcoming Machine Learning in Tensorflow Specialization and will teach you best practices for using TensorFlow, a popular open-source framework for machine learning.

[SHOW ALL](#)



7 hours to complete

### Introduction to Computer Vision

Welcome to week 2 of the course! In week 1 you learned all about how Machine Learning and Deep Learning is a new programming paradigm. This week you're going to take that to the next level by beginning to solve problems of computer vision with just a few lines of code! SHOW ALL



7 videos (Total 15 min), 6 readings, 3 quizzes [SEE ALL](#)

COURSE

3

## Natural Language Processing in TensorFlow

★★★★★ 4.6 2,037 ratings • 277 reviews

If you are a software developer who wants to build scalable AI-powered algorithms, you need to understand how to use the tools to build them. This Specialization will teach you best practices for using TensorFlow, a popular open-source framework for machine learning.

[SHOW ALL](#)



8 hours to complete

### Enhancing Vision with Convolutional Neural Networks

Welcome to week 3! In week 2 you saw a basic Neural Network for Computer Vision. It did the job nicely, but it was a little naive in its approach. This week we'll see how to make it better, as discussed by Laurence and Andrew here. SHOW ALL



6 videos (Total 19 min), 6 readings, 3 quizzes [SEE ALL](#)

COURSE

4

## Sequences, Time Series and Prediction

★★★★★ 4.6 1,374 ratings • 223 reviews

If you are a software developer who wants to build scalable AI-powered algorithms, you need to understand how to use the tools to build them. This Specialization will teach you best practices for using TensorFlow, a popular open-source framework for machine learning.

[SHOW ALL](#)



9 hours to complete

### Using Real-world Images

Last week you saw how to improve the results from your deep neural network using convolutions. It was a good start, but the data you used was very basic. What happens when your images are larger, or if the features aren't always in the same place? Andrew and Laurence discuss this to prepare you for what you'll learn this week: handling complex images! SHOW ALL

Source: <https://www.coursera.org/specializations/tensorflow-in-practice>

# Setup



Colaboratory is a free Jupyter notebook environment that requires no setup and runs entirely in the cloud. You can write and execute code, save and share your analyses, and access powerful computing resources, all for free from your browser.

<https://colab.research.google.com>

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# **Course 2: Convolutional Neural Networks in TensorFlow**

**Week 1:** Exploring a Larger Dataset

**Week 2:** Augmentation: A technique to avoid overfitting

**Week 3:** Transfer Learning

**Week 4:** Multiclass Classifications

# Exploring a Larger Dataset



## Dogs vs. Cats

Create an algorithm to distinguish dogs from cats  
215 teams · 6 years ago

[Overview](#) [Data](#) [Notebooks](#) [Discussion](#) [Leaderboard](#) [Rules](#) [Team](#)

[Overview](#)

**Description**  
In this competition, you'll write an algorithm to classify whether images contain either a dog or a cat. It is easy for humans, dogs, and cats. Your computer will find it a bit more difficult.

**Prizes**

**Evaluation**

**Winners**



Deep Blue beat Kasparov at chess in 1997.  
Watson beat the brightest trivia minds at Jeopardy in 2011.  
Can you tell Fido from Mittens in 2013?



$$\text{Human-Interactive Proof: } P(\text{breach}) = p^n$$

## Kaggle Competition: Dogs vs Cats

<https://www.kaggle.com/c/dogs-vs-cats/>

Metric: Binary Classification Accuracy (i.e. no partial credit)

Winner: Pierre Sermanet ---> Overfeat

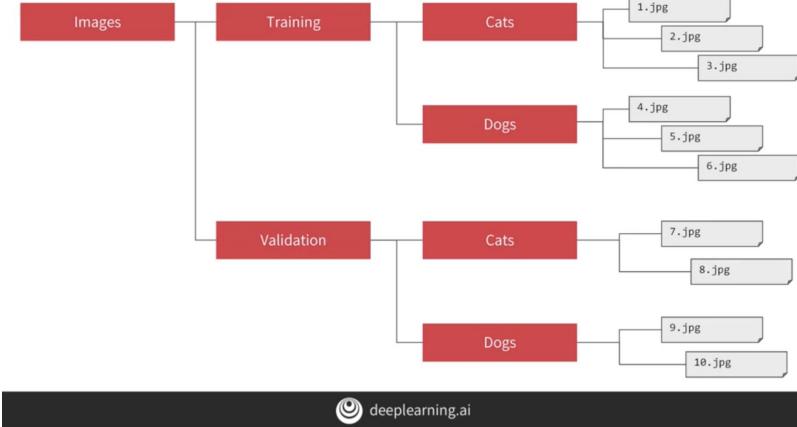
<https://cilvr.nyu.edu/doku.php?id=software:overfeat:start>

<https://arxiv.org/abs/1312.6229>

<https://www.youtube.com/watch?v=3U-bZqKFS7g>

#	△pub	Team Name	Notebook	Team Members	Score	Entries	Last
1	—	Pierre Sermanet			0.98914	5	6y
2	▲ 4	orchid			0.98308	17	6y
3	—	Owen			0.98171	15	6y
4	—	Paul Covington			0.98171	3	6y
5	▼ 3	Maxim Milakov			0.98137	24	6y
6	▼ 1	we've been in KAIST			0.98102	8	6y
7	▲ 1	Doug Koch			0.98057	6	6y
8	▲ 2	fastml.com/cats-and-dogs			0.98000	6	6y

# Exploring a Larger Dataset



```
from tensorflow.keras.preprocessing.image import ImageDataGenerator  
  
# All images will be rescaled by 1./255.  
train_datagen = ImageDataGenerator( rescale = 1.0/255. )  
test_datagen = ImageDataGenerator( rescale = 1.0/255. )  
  
# -----  
# Flow training images in batches of 20 using train_datagen generator  
# -----  
train_generator = train_datagen.flow_from_directory(train_dir,  
                                                 batch_size=20,  
                                                 class_mode='binary',  
                                                 target_size=(150, 150))  
  
# -----  
# Flow validation images in batches of 20 using test_datagen generator  
# -----  
validation_generator = test_datagen.flow_from_directory(validation_dir,  
                                                       batch_size=20,  
                                                       class_mode = 'binary',  
                                                       target_size = (150, 150))
```

Found 2000 images belonging to 2 classes.  
Found 1000 images belonging to 2 classes.



# Exploring a Larger Dataset

```
model = tf.keras.models.Sequential([
    # Note the input shape is the desired size of the image 150x150 with 3 bytes color
    tf.keras.layers.Conv2D(16, (3,3), activation='relu', input_shape=(150, 150, 3)),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(32, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    # Flatten the results to feed into a DNN
    tf.keras.layers.Flatten(),
    # 512 neuron hidden layer
    tf.keras.layers.Dense(512, activation='relu'),
    # Only 1 output neuron. It will contain a value from 0-1,
    # where 0 for 1 class ('cats') and 1 for the other ('dogs')
    tf.keras.layers.Dense(1, activation='sigmoid')
])
```

```
from tensorflow.keras.optimizers import RMSprop

model.compile(optimizer=RMSprop(lr=0.001),
              loss='binary_crossentropy',
              metrics = ['accuracy'])
```

```
model.summary()
```

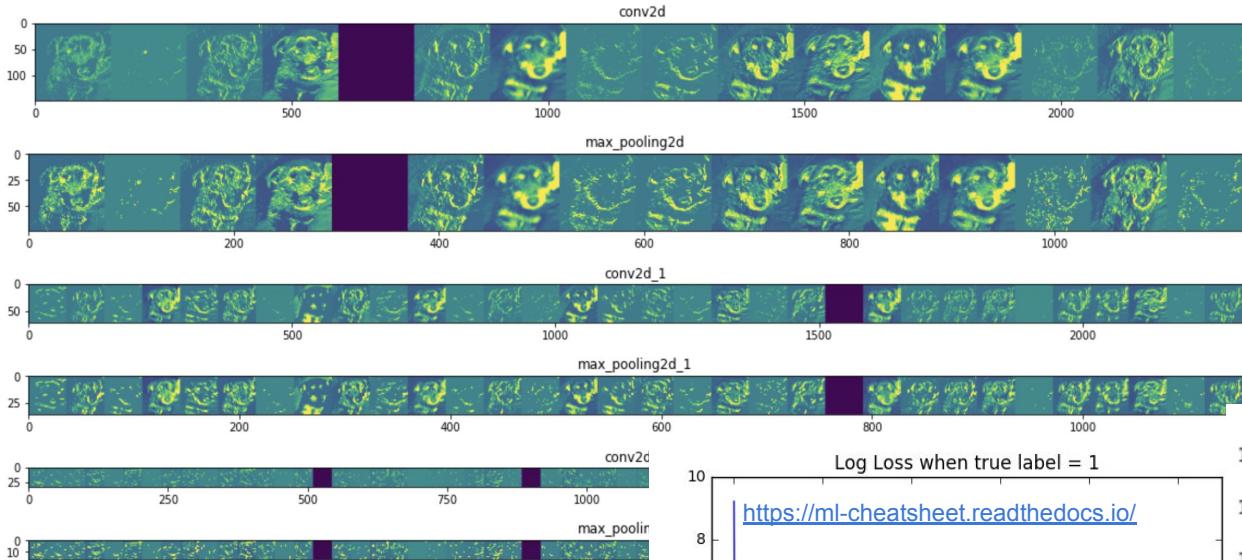
```
Model: "sequential"
```

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 148, 148, 16)	448
max_pooling2d (MaxPooling2D)	(None, 74, 74, 16)	0
conv2d_1 (Conv2D)	(None, 72, 72, 32)	4640
max_pooling2d_1 (MaxPooling2D)	(None, 36, 36, 32)	0
conv2d_2 (Conv2D)	(None, 34, 34, 64)	18496
max_pooling2d_2 (MaxPooling2D)	(None, 17, 17, 64)	0
flatten (Flatten)	(None, 18496)	0
dense (Dense)	(None, 512)	9470464
dense_1 (Dense)	(None, 1)	513

Total params: 9,494,561  
Trainable params: 9,494,561  
Non-trainable params: 0

```
history = model.fit(train_generator,
                     validation_data=validation_generator,
                     steps_per_epoch=100,
                     epochs=15,
                     validation_steps=50,
                     verbose=2)
```

# Exploring a Larger Dataset

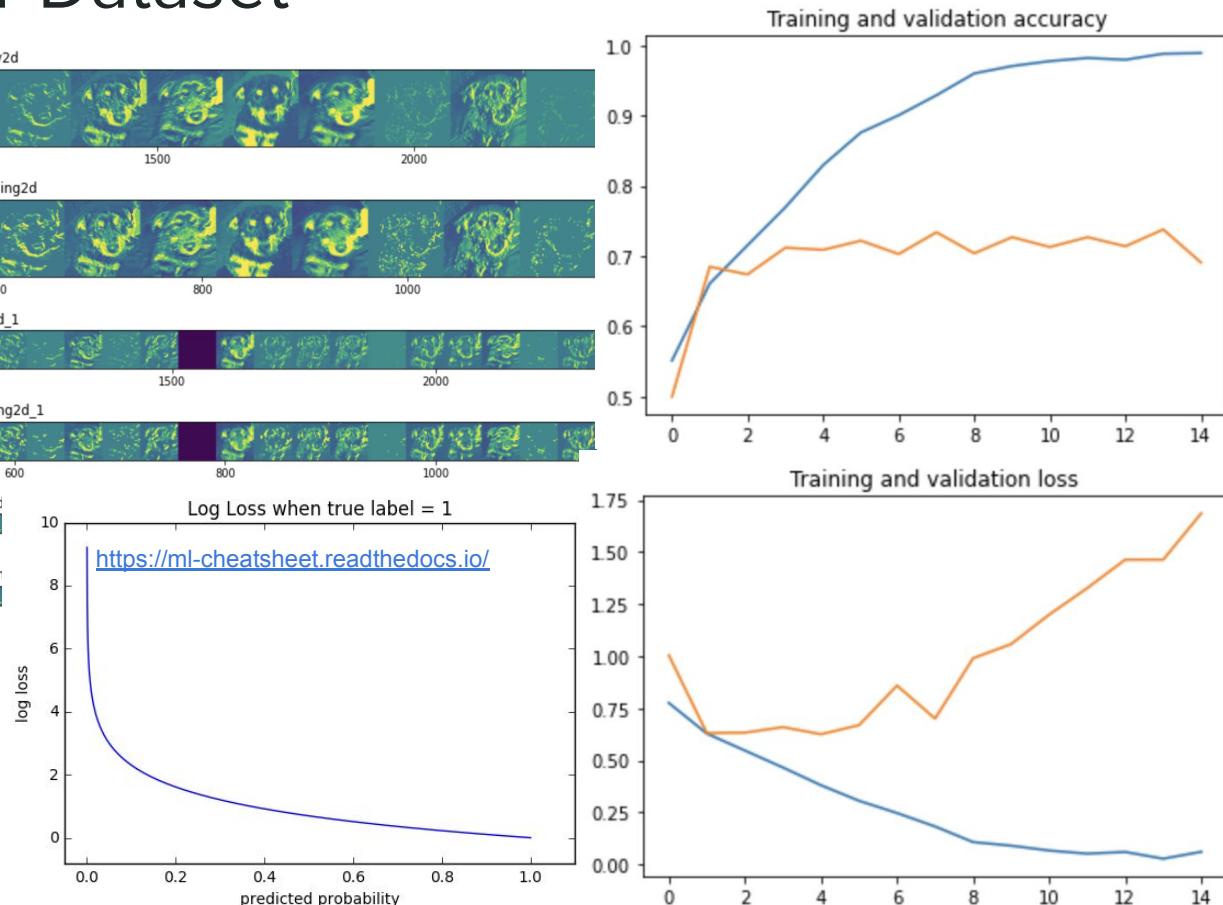


Bug fix: [layer.output for layer in model.layers[1:]] X

Model is badly overfitting!

Training Loss Decreasing

Validation Loss Increasing



# **Course 2: Convolutional Neural Networks in TensorFlow**

**Week 1:** Exploring a Larger Dataset

**Week 2:** Augmentation: A technique to avoid overfitting

**Week 3:** Transfer Learning

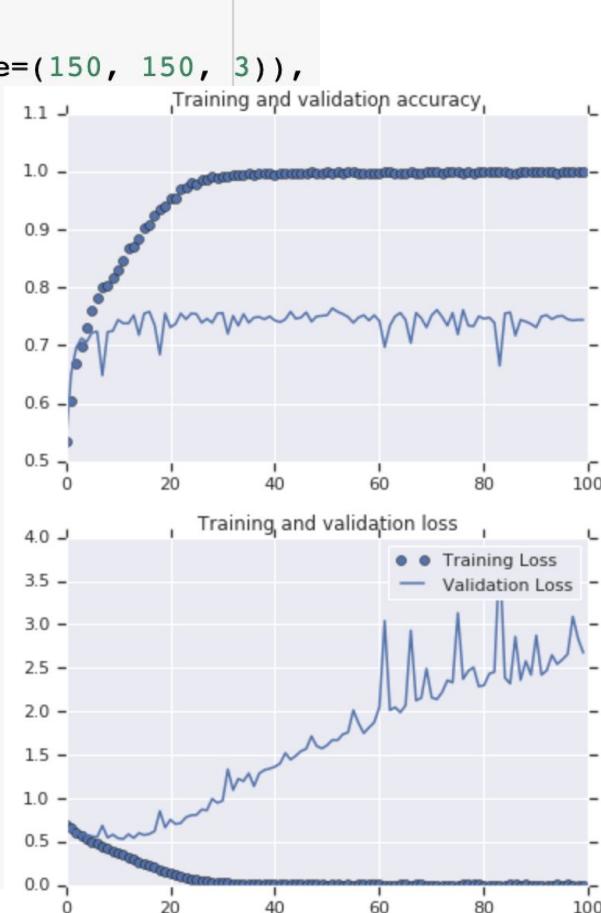
**Week 4:** Multiclass Classifications

# Augmentation: A technique to avoid overfitting

```
model = tf.keras.models.Sequential([
    tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(150, 150, 3)),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(512, activation='relu'),
    tf.keras.layers.Dense(1, activation='sigmoid')
])

model.compile(loss='binary_crossentropy',
              optimizer=RMSprop(lr=1e-4),
              metrics=[ 'accuracy'])

# All images will be rescaled by 1./255
train_datagen = ImageDataGenerator(rescale=1./255)
test_datagen = ImageDataGenerator(rescale=1./255)
```



# Augmentation: A technique to avoid overfitting

```
# Updated to do image augmentation
train_datagen = ImageDataGenerator(
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    fill_mode='nearest')
```

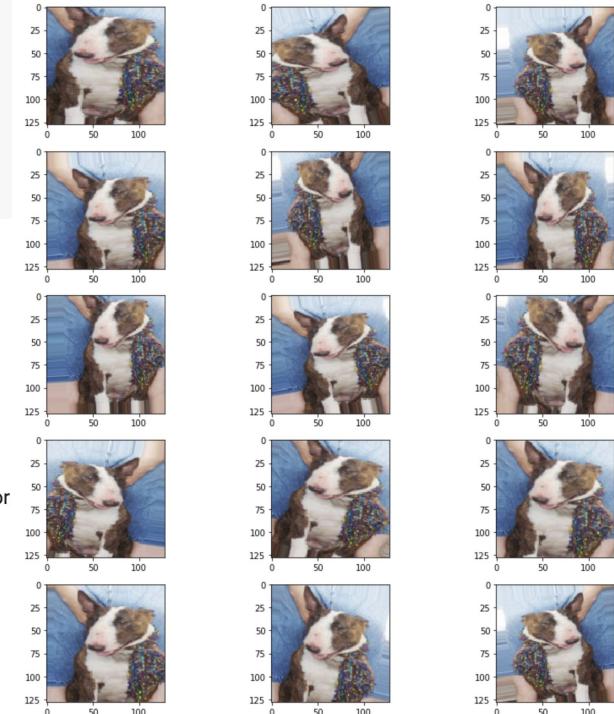
```
train_datagen = ImageDataGenerator(
    rotation_range=15,
    rescale=1./255,
    shear_range=0.1,
    zoom_range=0.2,
    horizontal_flip=True,
    width_shift_range=0.1,
    height_shift_range=0.1
)
```

These are just a few of the options available (for more, see the Keras documentation. Let's quickly go over what we just wrote:

- `rotation_range` is a value in degrees (0–180), a range within which to randomly rotate pictures.
- `width_shift` and `height_shift` are ranges (as a fraction of total width or height) within which to randomly translate pictures vertically or horizontally.
- `shear_range` is for randomly applying shearing transformations.
- `zoom_range` is for randomly zooming inside pictures.
- `horizontal_flip` is for randomly flipping half of the images horizontally. This is relevant when there are no assumptions of horizontal assymmetry (e.g. real-world pictures).
- `fill_mode` is the strategy used for filling in newly created pixels, which can appear after a rotation or a width/height shift.

Source:

<https://www.kaggle.com/uysimty/keras-cnn-dog-or-cat-classification>



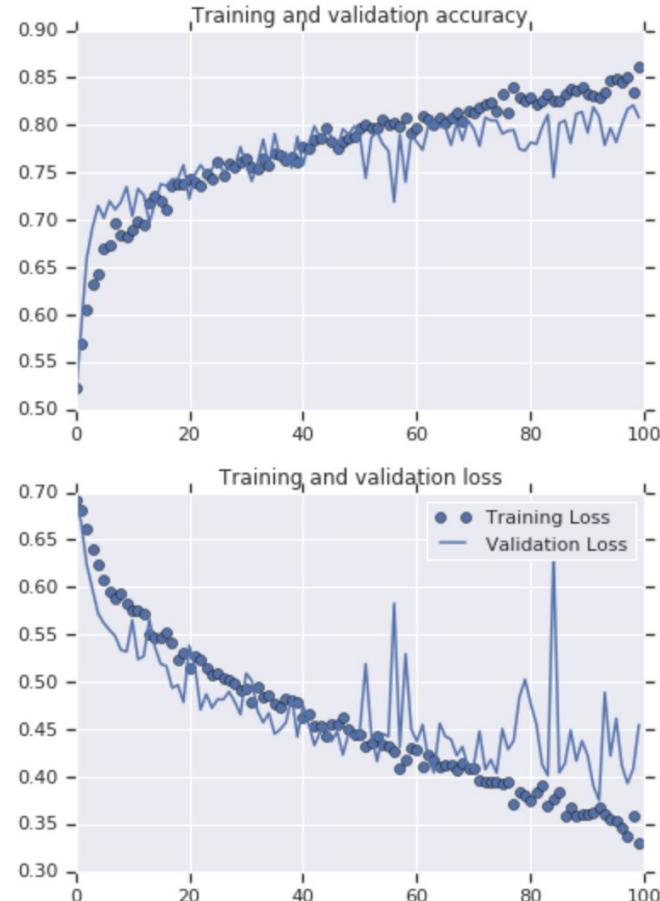
# Augmentation: A technique to avoid overfitting

```
model = tf.keras.models.Sequential([
    tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(150, 150, 3)),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(512, activation='relu'),
    tf.keras.layers.Dense(1, activation='sigmoid')
])

model.compile(loss='binary_crossentropy',
              optimizer=RMSprop(lr=1e-4),
              metrics=['accuracy'])

# This code has changed. Now instead of the ImageGenerator just rescaling
# the image, we also rotate and do other operations
# Updated to do image augmentation
train_datagen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    fill_mode='nearest')

test_datagen = ImageDataGenerator(rescale=1./255)
```



# tf.keras.preprocessing.image.ImageDataGenerator

`zoom_range`: Float or [lower, upper]. Range for random zoom. If a float, `[lower, upper] = [1-zoom_range, 1+zoom_range]`.

`fill_mode`: One of {"constant", "nearest", "reflect" or "wrap"}. Default is 'nearest'. Points outside the boundaries of the input are filled according to the given mode:

- 'constant': kkkkkkkk|abcd|kkkkkkkk (cval=k)
- 'nearest': aaaaaaaaa|abcd|ddddddddd
- 'reflect': abcdcdcba|abcd|dcbaabcd
- 'wrap': abcdabcd|abcd|abcdabcd

`cval`: Float or Int. Value used for points outside the boundaries when `fill_mode = "constant"`.

`preprocessing_function`: function that will be applied on each input. The function will run after the image is resized and augmented.

original



constant (cval=0)



constant (cval=100)



nearest



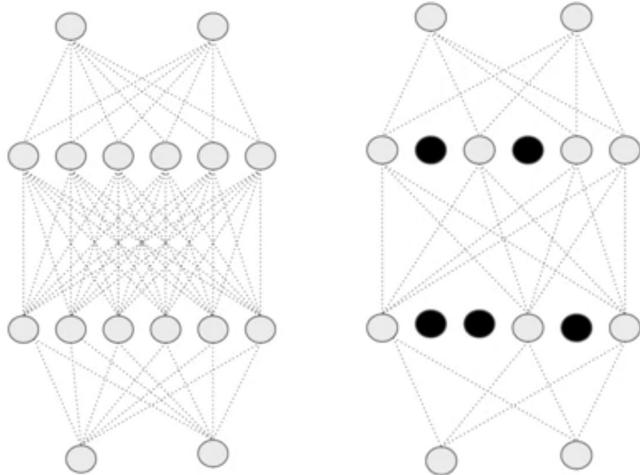
reflect



wrap



# Augmentation: A technique to avoid overfitting



 deeplearning.ai

 deeplearning.ai

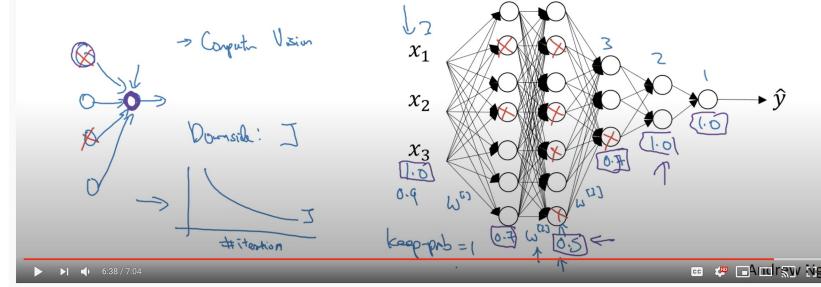
Another useful tool to explore at this point is the Dropout.

The idea behind Dropouts is that they remove a random number of neurons in your neural network. This works very well for two reasons: The first is that neighboring neurons often end up with similar weights, which can lead to overfitting, so dropping some out at random can remove this. The second is that often a neuron can over-weigh the input from a neuron in the previous layer, and can over specialize as a result. Thus, dropping out can break the neural network out of this potential bad habit!

Check out Andrew's terrific video explaining dropouts here: <https://www.youtube.com/watch?v=ARq74QuavAo>

## Why does drop-out work?

Intuition: Can't rely on any one feature, so have to spread out weights. ↗ Shrink weights.



Source: <https://www.youtube.com/watch?v=ARq74QuavAo>

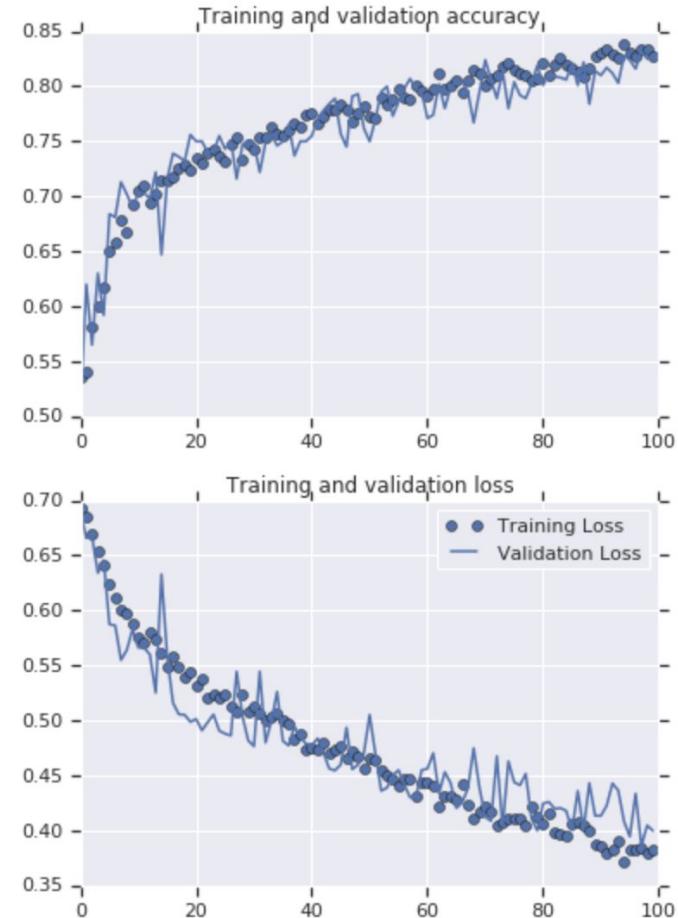
# Augmentation: A technique to avoid overfitting

```
model = tf.keras.models.Sequential([
    tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(150, 150, 3)),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Dropout(0.5), #NEW here
    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(512, activation='relu'),
    tf.keras.layers.Dense(1, activation='sigmoid')
])

model.compile(loss='binary_crossentropy',
              optimizer=RMSprop(lr=1e-4),
              metrics=['accuracy'])

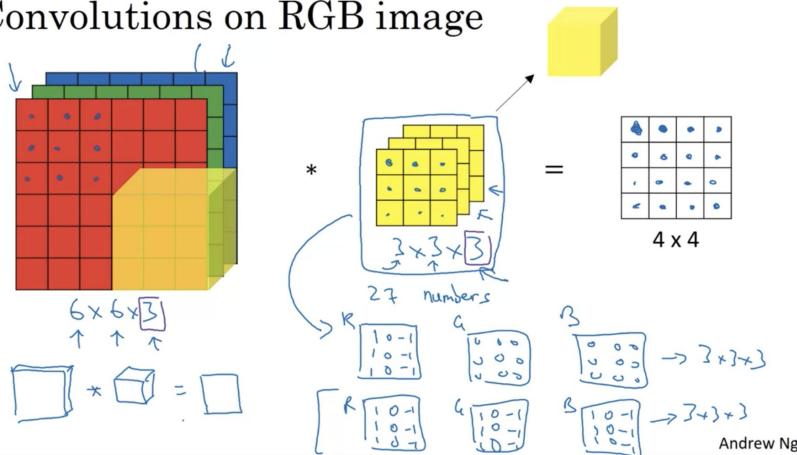
# This code has changed. Now instead of the ImageGenerator just rescaling
# the image, we also rotate and do other operations
# Updated to do image augmentation
train_datagen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    fill_mode='nearest')

test_datagen = ImageDataGenerator(rescale=1./255)
```

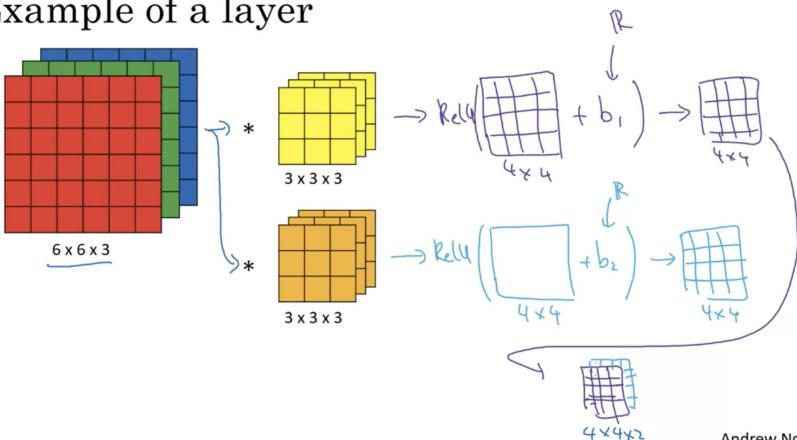


# Content added after Week 1 and 2, based on group feedback

## Convolutions on RGB image



## Example of a layer



Input Volume (+pad 1) (7x7x3)	Filter W0 (3x3x3)	Filter W1 (3x3x3)	Output Volume (3x3x2)
$x[:, :, 0]$	$w0[:, :, 0]$	$w1[:, :, 0]$	$o[:, :, 0]$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 1 & -1 & 1 \end{matrix}$	$\begin{matrix} 0 & 1 & -1 \\ 0 & -1 & 0 \\ 0 & -1 & 1 \end{matrix}$	$\begin{matrix} 2 & 3 & 3 \\ 3 & 7 & 3 \\ 8 & 10 & -3 \end{matrix}$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 1 \\ 0 & 0 & 1 \\ 1 & -1 & 1 \end{matrix}$	$\begin{matrix} -1 & 0 & 1 \\ -1 & 0 & 0 \\ 1 & -1 & 0 \end{matrix}$	$\begin{matrix} o[:, :, 1] \\ -8 & -8 & -3 \\ -3 & 1 & 0 \end{matrix}$
$\begin{matrix} 0 & 1 & 0 \\ 0 & 2 & 0 \\ 0 & 2 & 1 \end{matrix}$	$\begin{matrix} 1 & -1 & 1 \\ 1 & -1 & 1 \\ 0 & 1 & 0 \end{matrix}$	$\begin{matrix} 1 & -1 & 0 \\ -1 & 0 & 0 \\ 1 & -1 & 0 \end{matrix}$	$\begin{matrix} -3 & -8 & -5 \\ 0 & 0 & 0 \end{matrix}$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & -1 & 0 \end{matrix}$	$\begin{matrix} -1 & 1 & -1 \\ 0 & -1 & -1 \\ 1 & 0 & 0 \end{matrix}$	$\begin{matrix} \text{Bias } b1 (1x1x1) \\ b1[:, :, 0] \\ 0 \end{matrix}$

$x[:, :, 1]$	$w0[:, :, 1]$	$w1[:, :, 1]$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 2 & 1 \\ 0 & 2 & 1 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 2 & 1 & 1 \\ 2 & 0 & 1 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 0 \end{matrix}$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$

$x[:, :, 2]$	$w0[:, :, 2]$	$w1[:, :, 2]$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 2 & 1 \\ 0 & 2 & 1 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 2 & 1 & 1 \\ 2 & 0 & 1 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 1 & 1 & -1 \\ 0 & -1 & 0 \end{matrix}$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$
$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$	$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{matrix}$

Source: <https://www.coursera.org/learn/convolutional-neural-networks>  
<https://images.app.goo.gl/Z4xDvji3Gcerpm27>

# **Course 2: Convolutional Neural Networks in TensorFlow**

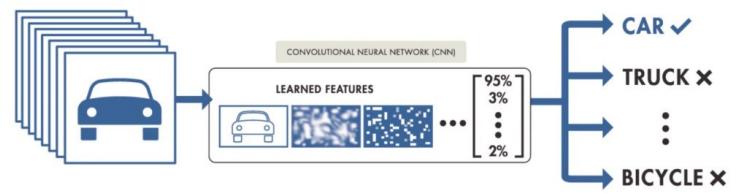
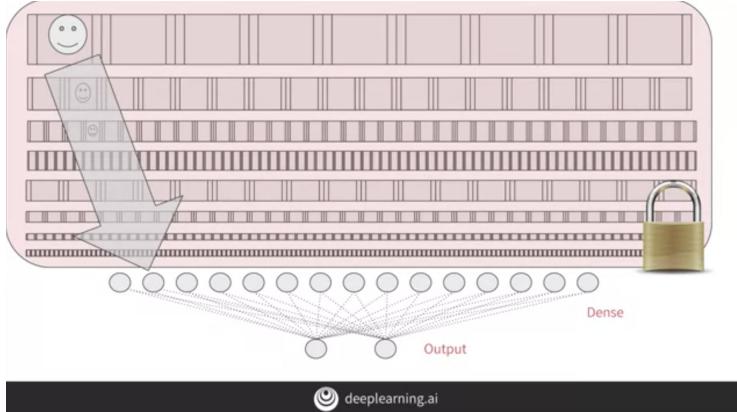
**Week 1:** Exploring a Larger Dataset

**Week 2:** Augmentation: A technique to avoid overfitting

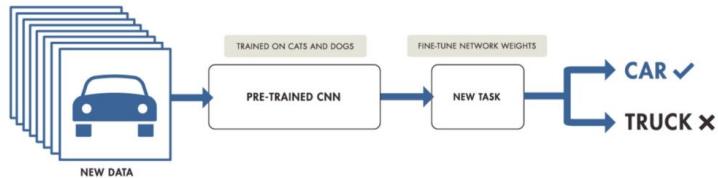
**Week 3:** Transfer Learning

**Week 4:** Multiclass Classifications

# Transfer Learning



## TRANSFER LEARNING



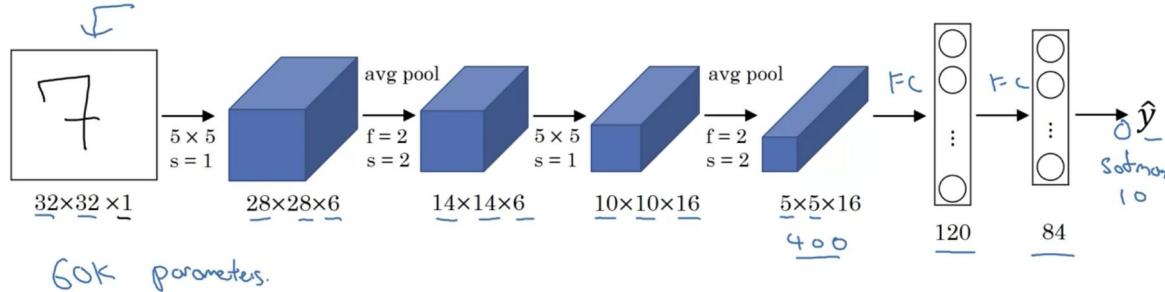
Source:

- [https://www.tensorflow.org/api\\_docs/python/tf/keras/applications/InceptionV3](https://www.tensorflow.org/api_docs/python/tf/keras/applications/InceptionV3)
- <https://mc.ai/introducing-transfer-learning-as-your-next-engine-to-drive-future-innovations-2/>
- [https://www.researchgate.net/figure/Ensemble-transfer-learning-using-pretrained-CNN-model-initialized-with-weights-trained-on\\_fig4\\_333619654](https://www.researchgate.net/figure/Ensemble-transfer-learning-using-pretrained-CNN-model-initialized-with-weights-trained-on_fig4_333619654)

# Extra Content - Classic Networks

Gradient-Based Learning Applied to Document Recognition

LeNet - 5 1998



60K parameters.

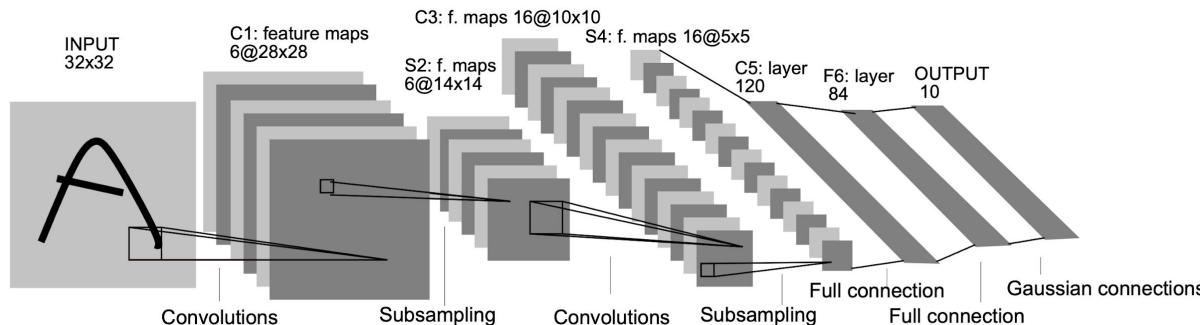


Fig. 2. Architecture of LeNet-5, a Convolutional Neural Network, here for digits recognition. Each plane is a feature map, i.e. a set of units whose weights are constrained to be identical.

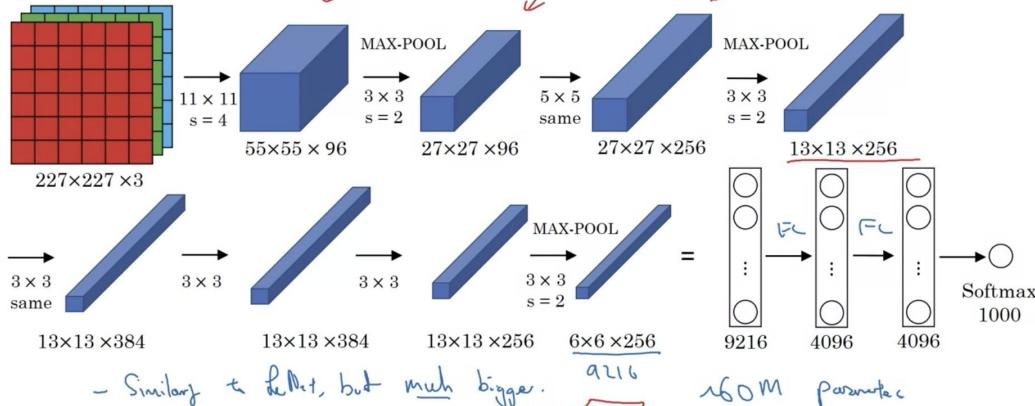
Source:

<https://www.coursera.org/learn/convolutional-neural-networks/lecture/MmYe2/classic-networks>

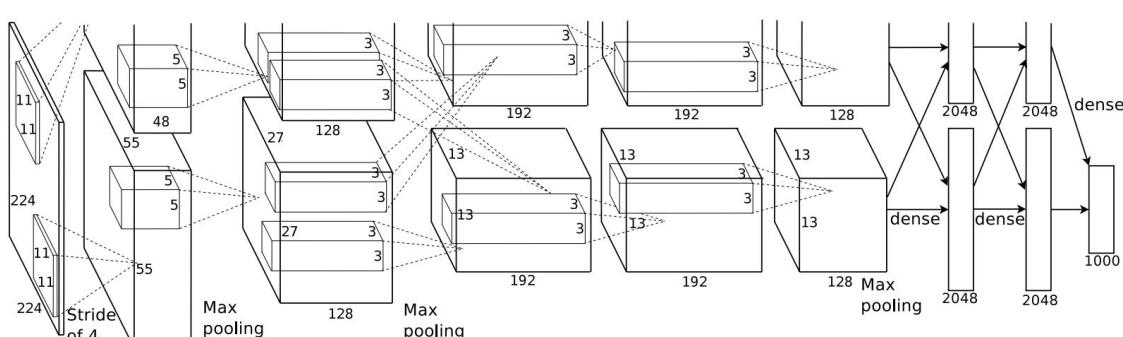
<http://yann.lecun.com/exdb/publis/pdf/lecun-01a.pdf>

# Extra Content - Classic Networks

## AlexNet 2012



[Krizhevsky et al., 2012. ImageNet classification with deep convolutional neural networks]



Source:

<https://www.coursera.org/learn/convolutional-neural-networks/lecture/MmYe2/classic-networks>

<https://papers.nips.cc/paper/4824-imagenet-classification-with-deep-convolutional-neural-networks.pdf>

Alex Krizhevsky  
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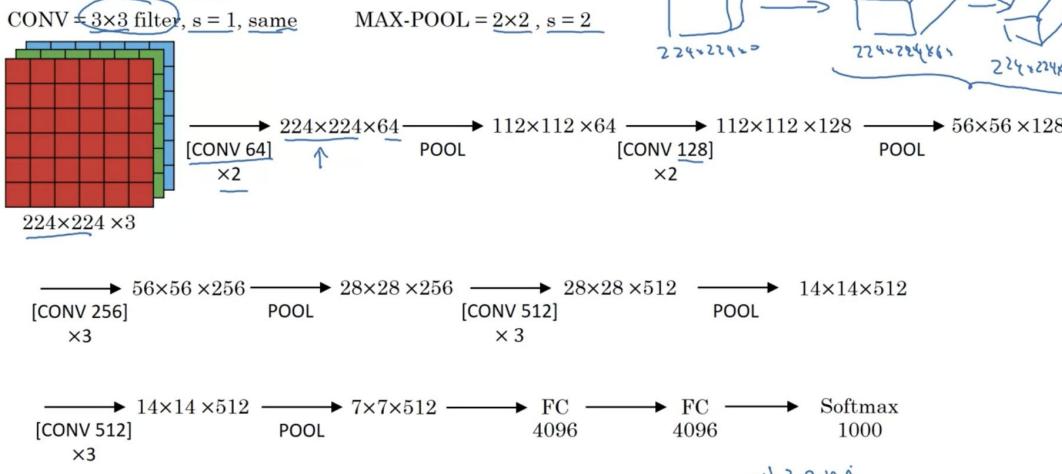
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# Extra Content - Classic Networks

## VERY DEEP CONVOLUTIONAL NETWORKS FOR LARGE-SCALE IMAGE RECOGNITION

VGG - 16 2014



[Simonyan & Zisserman 2015. Very deep convolutional networks for large-scale image recognition]

Andrew Ng

Table 2: Number of parameters (in millions).

Network	A,A-LRN	B	C	D	E
Number of parameters	133	133	134	138	144

Source:

<https://www.coursera.org/learn/convolutional-neural-networks/lecture/MmYe2/classic-networks>

<https://arxiv.org/pdf/1409.1556.pdf>

Karen Simonyan\* & Andrew Zisserman<sup>+</sup>

Visual Geometry Group, Department of Engineering Science, University of Oxford  
`{karen, az}@robots.ox.ac.uk`

ConvNet Configuration					
A	A-LRN	B	C	D	E
11 weight layers	11 weight layers	13 weight layers	16 weight layers	16 weight layers	19 weight layers
input ( $224 \times 224$ RGB image)					
conv3-64	conv3-64 LRN	conv3-64 <b>conv3-64</b>	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 <b>conv3-128</b>	conv3-128 conv3-128	conv3-128 conv3-128	conv3-128 conv3-128
maxpool					
conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256 <b>conv1-256</b>	conv3-256 conv3-256 <b>conv3-256</b>	conv3-256 conv3-256 conv3-256 <b>conv3-256</b>
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 <b>conv1-512</b>	conv3-512 conv3-512 <b>conv3-512</b>	conv3-512 conv3-512 conv3-512 <b>conv3-512</b>
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 <b>conv1-512</b>	conv3-512 conv3-512 <b>conv3-512</b>	conv3-512 conv3-512 conv3-512 <b>conv3-512</b>
maxpool					
FC-4096	FC-4096	FC-4096	FC-4096	FC-1000	soft-max

# Extra Content - Classic Networks

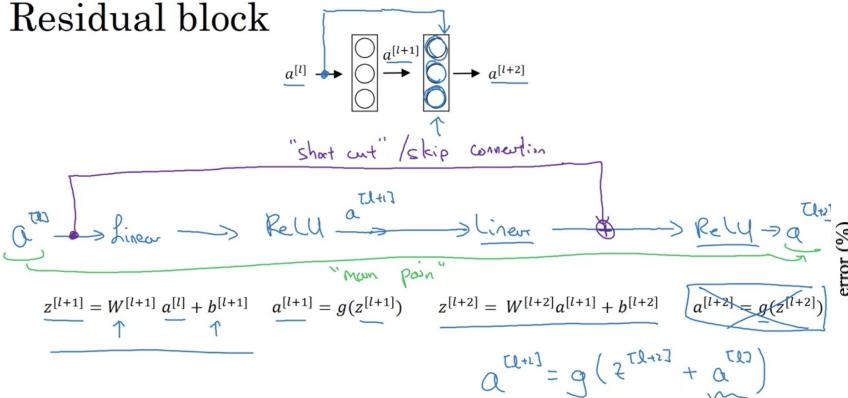
Deep Residual Learning for Image Recognition 2015

Kaiming He Xiangyu Zhang Shaoqing Ren Jian Sun

Microsoft Research

{kahe, v-xiangz, v-shren, jiansun}@microsoft.com

Residual block

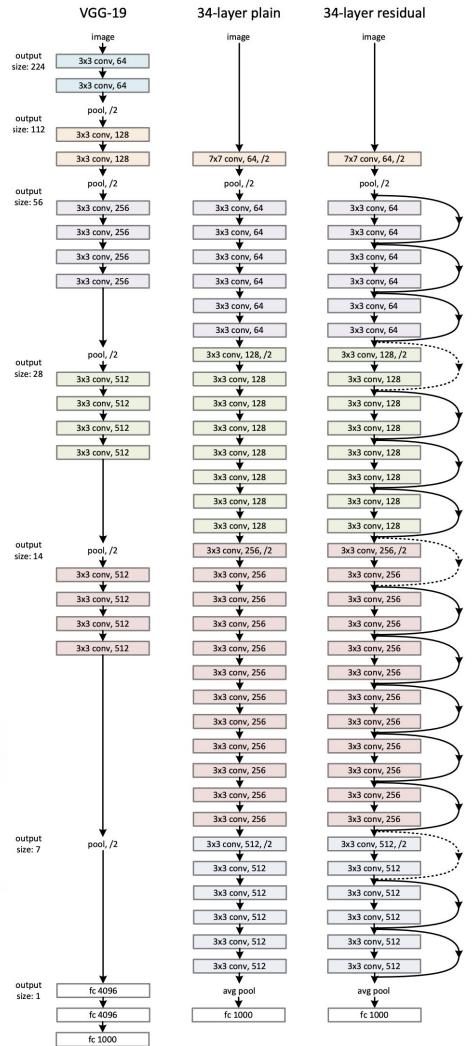
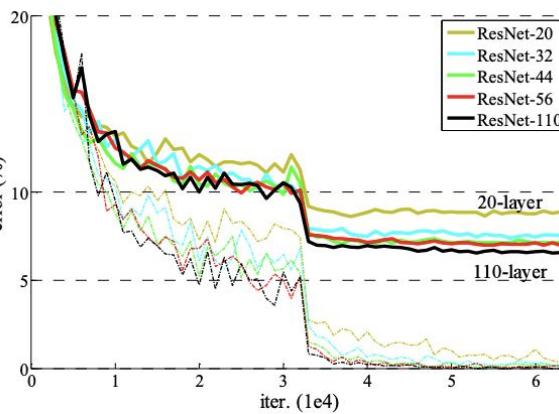
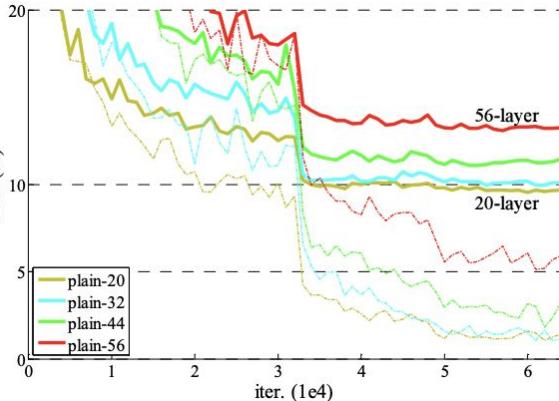


[He et al., 2015. Deep residual networks for image recognition]

Source:

<https://www.coursera.org/learn/convolutional-neural-networks/lecture/MmYe2/classic-networks>

<https://arxiv.org/pdf/1512.03385.pdf>



# Extra Content - Classic Networks

Going deeper with convolutions 2014



Christian Szegedy  
Google Inc.

Wei Liu  
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Yangqing Jia  
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Pierre Sermanet  
Google Inc.

Scott Reed  
University of Michigan

Dragomir Anguelov  
Google Inc.  
Dumitru Erhan  
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Vincent Vanhoucke  
Google Inc.

Andrew Rabinovich  
Google Inc.

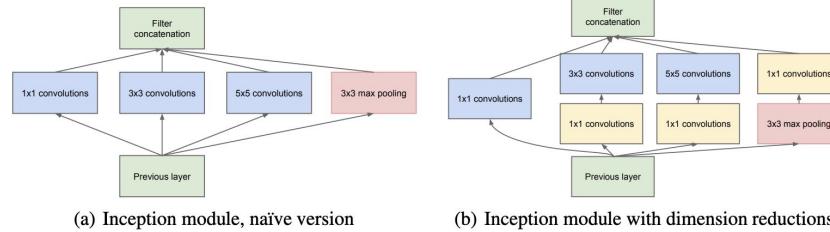
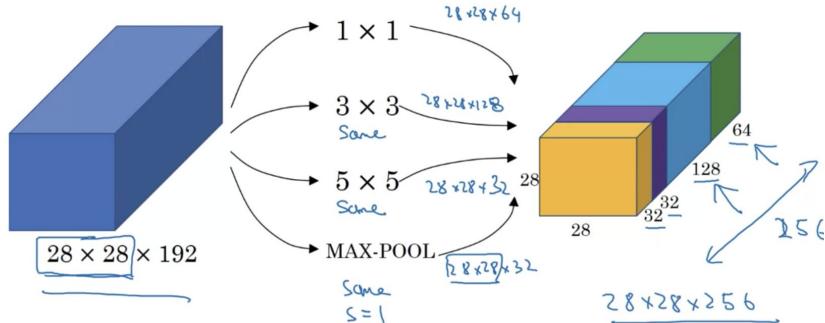


Figure 2: Inception module

## Motivation for inception network



[Szegedy et al. 2014. Going deeper with convolutions]

Source:

<https://www.coursera.org/learn/convolutional-neural-networks/lecture/5WIZm/inception-network-motivation>

<https://arxiv.org/pdf/1409.4842.pdf>

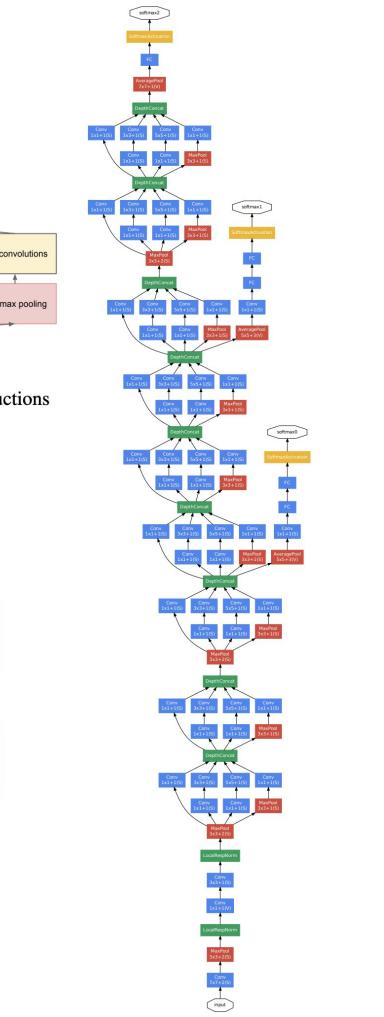
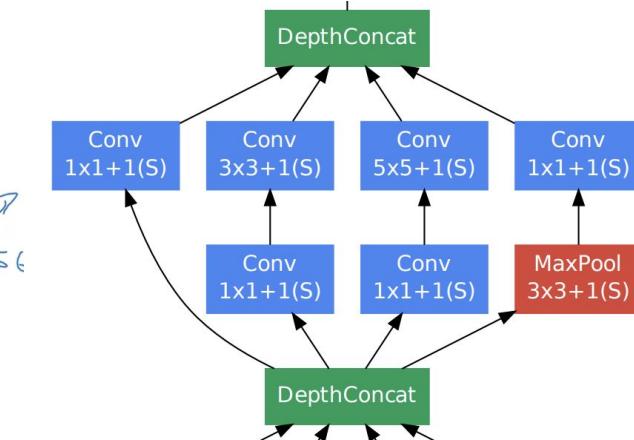
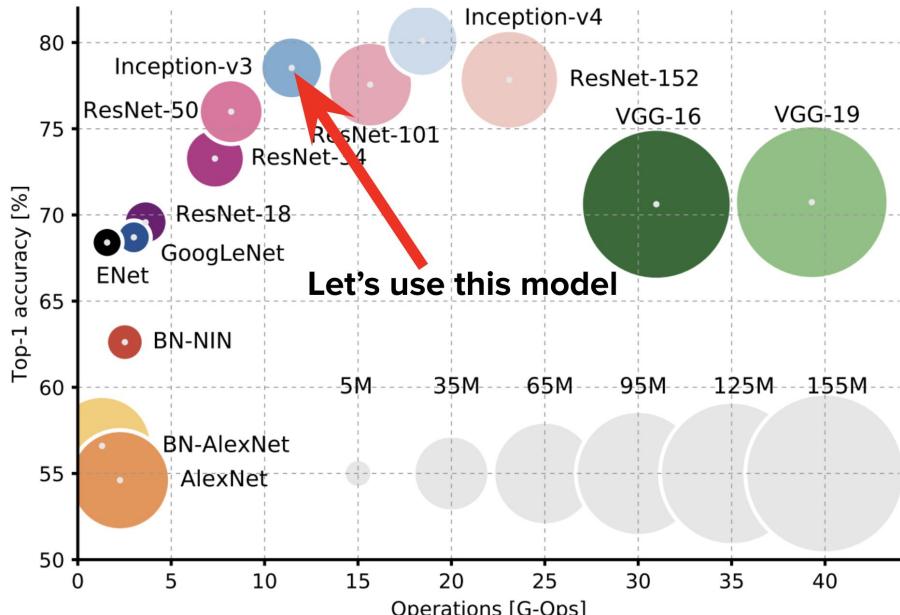
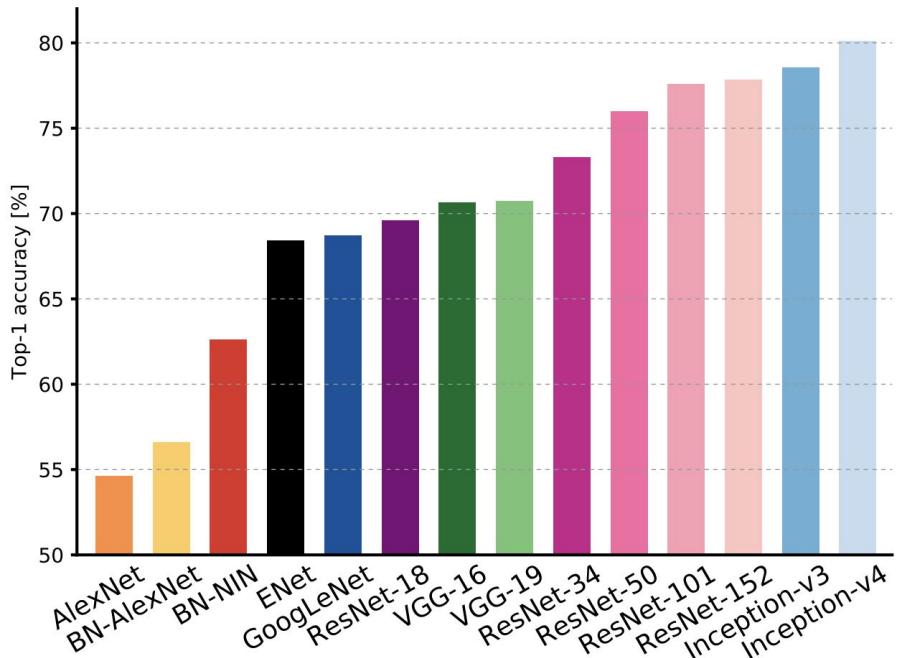


Figure 3: GoogLeNet network with all the bells and whistles

# Extra Content - Classic Networks



# Transfer Learning



14,197,122 images, 21841 synsets indexed  
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ImageNet is an image database organized according to the [WordNet](#) hierarchy (currently only the nouns), in which each node of the hierarchy is depicted by hundreds and thousands of images. Currently we have an average of over five hundred images per node. We hope ImageNet will become a useful resource for researchers, educators, students and all of you who share our passion for pictures.  
[Click here](#) to learn more about ImageNet. [Click here](#) to join the ImageNet mailing list.



Start exploring here

Numbers in brackets: (the number of synsets in the subtree ).

ImageNet 2011 Fall Release (32326)

plant, flora, plant life (4486)

geological formation, formation (175)

natural object (1112)

sport, athletics (176)

artifact, artefact (10504)

fungus (308)

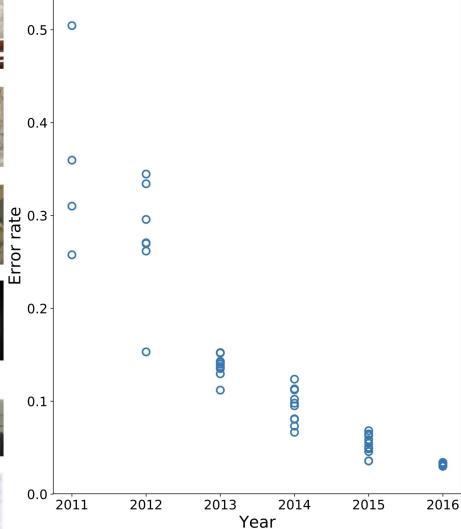
person, individual, someone, somebody, mortal, soul (6978)

animal, animate being, beast, brute, creature, fauna (3998)

Misc (20400)



ImageNet competition results



Synset: Newfoundland, Newfoundland dog

Definition: a breed of very large heavy dogs with a vigorous swimmers; developed in Newfoundland.

Popularity\_percentile: 70%

Depth in WordNet: 8

Synset: dalmatian, coach dog, carriage dog

Definition: a large breed having a smooth white coat

Popularity\_percentile: 65%

Depth in WordNet: 8

Synset: Eskimo dog, husky

Definition: breed of heavy-coated Arctic sled dog.

Popularity\_percentile: 62%

Depth in WordNet: 9

Synset: German shepherd, German shepherd dog.

Definition: breed of large shepherd dogs used in pc

Popularity\_percentile: 61%

Depth in WordNet: 10

Synset: African hunting dog, hyena dog, Cape hunt

Definition: a powerful doglike mammal of southern area.

Popularity\_percentile: 58%

Source: <http://www.image-net.org>

The **ILSVRC 2014 classification challenge** involves the task of classifying the image into one of **1000** leaf-node categories in the **Imagenet** hierarchy. There are about **1.2 million images for training, 50,000 for validation** and **100,000 images for testing**. Each image is associated with one ground truth category, and performance is measured based on the highest scoring classifier predictions.

**top-1 accuracy rate** compares the ground truth against the **first** predicted class

**top-5 error rate** compares the ground truth against the **first 5** predicted classes. An image is deemed correctly classified if the ground truth is among the top-5, regardless of its rank in them. The challenge uses the top-5 error rate for ranking purposes.

```

from tensorflow.keras import layers
from tensorflow.keras import Model
!wget --no-check-certificate \
    https://storage.googleapis.com/mledu-datasets/inception_v3_weights_tf_dim_ordering_tf_kernels_notop.h5 \
    -O /tmp/inception_v3_weights_tf_dim_ordering_tf_kernels_notop.h5

from tensorflow.keras.applications.inception_v3 import InceptionV3

local_weights_file = '/tmp/inception_v3_weights_tf_dim_ordering_tf_kernels_notop.h5'

pre_trained_model = InceptionV3(input_shape = (150, 150, 3),
                                 include_top = False,
                                 weights = None)

pre_trained_model.load_weights(local_weights_file)

for layer in pre_trained_model.layers:
    layer.trainable = False

#pre_trained_model.summary()

last_layer = pre_trained_model.get_layer('mixed7')
print('last layer output shape: ', last_layer.output_shape)
last_output = last_layer.output
from tensorflow.keras.optimizers import RMSprop

# Flatten the output layer to 1 dimension
x = layers.Flatten()(last_output)
# Add a fully connected layer with 1,024
# hidden units and ReLU activation
x = layers.Dense(1024, activation='relu')(x)
# Add a dropout rate of 0.2
x = layers.Dropout(0.2)(x)
# Add a final sigmoid layer for classification
x = layers.Dense  (1, activation='sigmoid')(x)

model = Model( pre_trained_model.input, x)

model.compile(optimizer = RMSprop(lr=0.0001),
              loss = 'binary_crossentropy',
              metrics = ['accuracy'])


```

last layer output shape:  
 (None, 7, 7, 768)

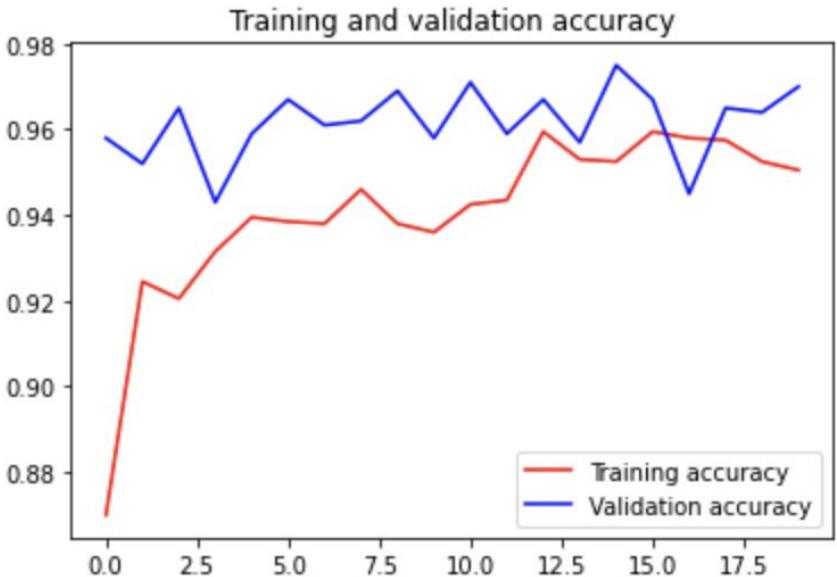
# Transfer Learning

pre\_trained\_model.summary()

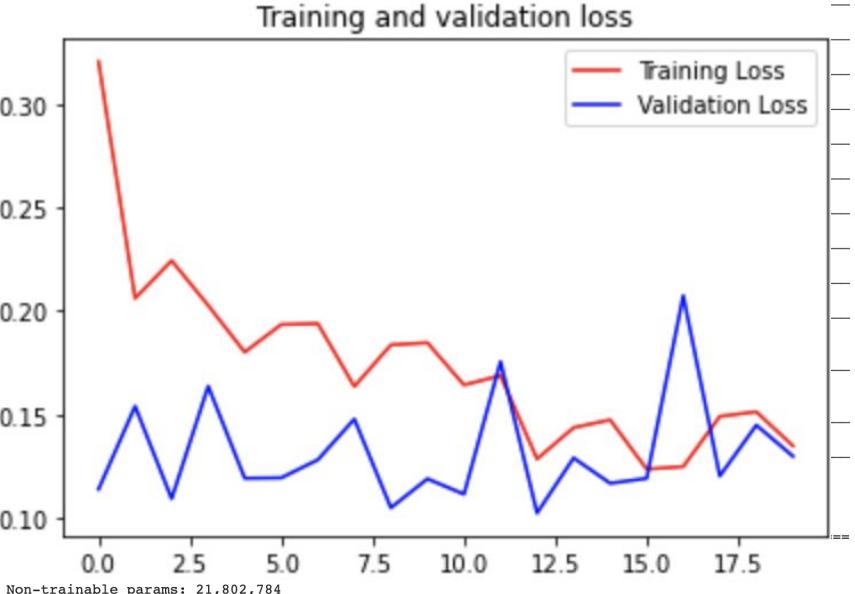
mixed7 (Concatenate)	(None, 7, 7, 768)	0	activation_60[0][0] activation_63[0][0] activation_68[0][0] activation_69[0][0]
conv2d_72 (Conv2D)	(None, 7, 7, 192)	147456	mixed7[0][0]
batch_normalization_72 (BatchNo)	(None, 7, 7, 192)	576	conv2d_72[0][0]
activation_72 (Activation)	(None, 7, 7, 192)	0	batch_normalization_72[0][0]
conv2d_73 (Conv2D)	(None, 7, 7, 192)	258048	activation_72[0][0]
batch_normalization_73 (BatchNo)	(None, 7, 7, 192)	576	conv2d_73[0][0]
activation_73 (Activation)	(None, 7, 7, 192)	0	batch_normalization_73[0][0]
conv2d_70 (Conv2D)	(None, 7, 7, 192)	147456	mixed7[0][0]
conv2d_74 (Conv2D)	(None, 7, 7, 192)	258048	activation_73[0][0]
batch_normalization_70 (BatchNo)	(None, 7, 7, 192)	576	conv2d_70[0][0]
batch_normalization_74 (BatchNo)	(None, 7, 7, 192)	576	conv2d_74[0][0]
activation_70 (Activation)	(None, 7, 7, 192)	0	batch_normalization_70[0][0]
activation_74 (Activation)	(None, 7, 7, 192)	0	batch_normalization_74[0][0]
conv2d_71 (Conv2D)	(None, 3, 3, 320)	552960	activation_70[0][0]
conv2d_75 (Conv2D)	(None, 3, 3, 192)	331776	activation_74[0][0]
batch_normalization_71 (BatchNo)	(None, 3, 3, 320)	960	conv2d_71[0][0]
batch_normalization_75 (BatchNo)	(None, 3, 3, 192)	576	conv2d_75[0][0]
activation_71 (Activation)	(None, 3, 3, 320)	0	batch_normalization_71[0][0]
activation_75 (Activation)	(None, 3, 3, 192)	0	batch_normalization_75[0][0]
max_pooling2d_3 (MaxPooling2D)	(None, 3, 3, 768)	0	mixed7[0][0]
mixed8 (Concatenate)	(None, 3, 3, 1280)	0	activation_71[0][0] activation_75[0][0] max_pooling2d_3[0][0]

# Transfer Learning

```
history = model.fit(  
    train_generator,  
    validation_data = validation_generator,  
    steps_per_epoch = 100,  
    epochs = 20,  
    validation_steps = 50,  
    verbose = 2)
```



pre_trained_model.summary()				
activation_86 (Activation)	(None, 3, 3, 384)	0	batch_normalization_86[0][0]	
activation_90 (Activation)	(None, 3, 3, 384)	0	batch_normalization_90[0][0]	
conv2d_87 (Conv2D)	(None, 3, 3, 384)	442368	activation_86[0][0]	
conv2d_88 (Conv2D)	(None, 3, 3, 384)	442368	activation_86[0][0]	
conv2d_91 (Conv2D)	(None, 3, 3, 384)	442368	activation_90[0][0]	
conv2d_92 (Conv2D)	(None, 3, 3, 384)	442368	activation_90[0][0]	
average_pooling2d_8 (AveragePooling2D)	(None, 3, 3, 2048)	0	mixed9[0][0]	
conv2d_85 (Conv2D)	(None, 3, 3, 320)	655360	mixed9[0][0]	
batch_normalization_87 (BatchNormalization)	(None, 3, 3, 384)	1152	conv2d_87[0][0]	
batch_normalization_88 (BatchNormalization)	(None, 3, 3, 384)	1152	conv2d_88[0][0]	
batch_normalization_91 (BatchNormalization)	(None, 3, 3, 384)	1152	conv2d_91[0][0]	



# **Course 2: Convolutional Neural Networks in TensorFlow**

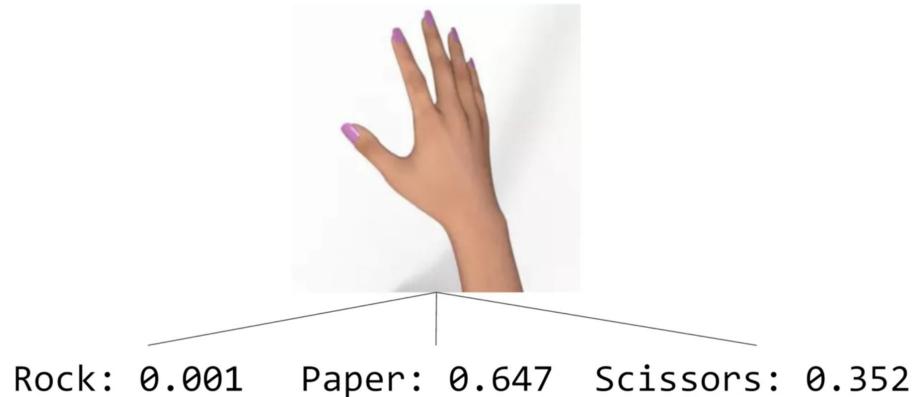
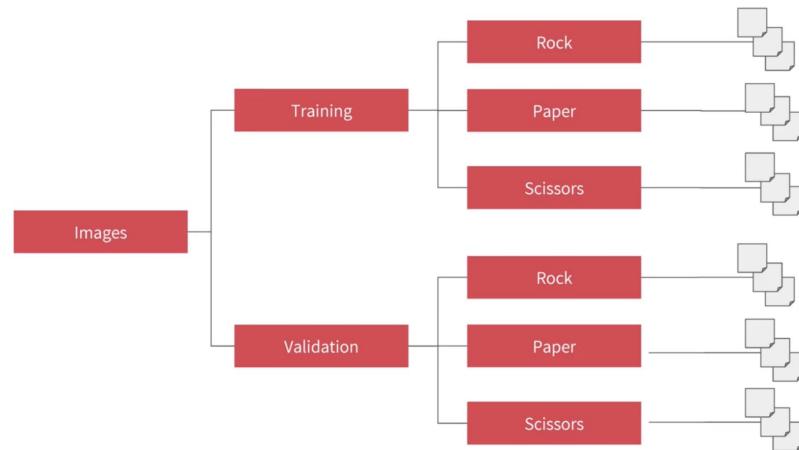
**Week 1:** Exploring a Larger Dataset

**Week 2:** Augmentation: A technique to avoid overfitting

**Week 3:** Transfer Learning

**Week 4:** Multiclass Classifications

# Multiclass Classifications



 deeplearning.ai

 deeplearning.ai

## Rock Paper Scissors Dataset

**Introducing Rock Paper Scissors – A multi class learning dataset**

### Abstract

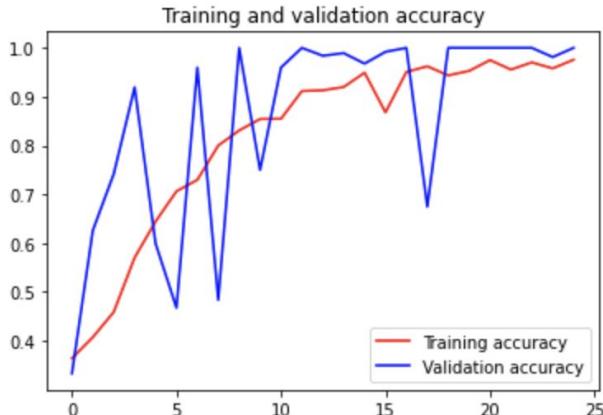
Rock Paper Scissors is a dataset containing 2,892 images of diverse hands in Rock/Paper/Scissors poses.



Source: <http://www.laurencemoroney.com/rock-paper-scissors-dataset>

# Multiclass Classifications

```
train_generator = training_datagen.flow_from_directory(  
    TRAINING_DIR,  
    batch_size = 20,  
    target_size=(150,150),  
    class_mode='categorical'  
)  
  
validation_generator = validation_datagen.flow_from_directory(  
    VALIDATION_DIR,  
    batch_size = 20,  
    target_size=(150,150),  
    class_mode='categorical'  
)
```



```
model = tf.keras.models.Sequential([  
    # Note the input shape is the desired size of the image 150x150 with 3 bytes color  
    # This is the first convolution  
    tf.keras.layers.Conv2D(64, (3,3), activation='relu', input_shape=(150, 150, 3)),  
    tf.keras.layers.MaxPooling2D(2, 2),  
    # The second convolution  
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),  
    tf.keras.layers.MaxPooling2D(2,2),  
    # The third convolution  
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),  
    tf.keras.layers.MaxPooling2D(2,2),  
    # The fourth convolution  
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),  
    tf.keras.layers.MaxPooling2D(2,2),  
    # Flatten the results to feed into a DNN  
    tf.keras.layers.Flatten(),  
    tf.keras.layers.Dropout(0.5),  
    # 512 neuron hidden layer  
    tf.keras.layers.Dense(512, activation='relu'),  
    tf.keras.layers.Dense(3, activation='softmax')  
)
```

## Loss Functions for Multi-Class:

One-Hot Encoding: categorical\_crossentropy

Integer Representation: sparse\_categorical\_crossentropy

```
model.compile(loss = 'categorical_crossentropy', optimizer='rmsprop', metrics=[ 'accuracy' ])
```

# Multiclass Classifications

Dataset

## Sign Language MNIST

Drop-In Replacement for MNIST for Hand Gesture Recognition Tasks

tecperson • updated 3 years ago (Version 1)

Data Tasks (1) Kernels (130) Discussion (8) Activity Metadata Download (101 MB) New Notebook



The American Sign Language letter database of hand gestures represent a multi-class problem with 24 classes of letters (excluding J and Z which require motion).

Source: <https://www.kaggle.com/datamunge/sign-language-mnist>

# **Course 2: Convolutional Neural Networks in TensorFlow**

**Week 1:** Exploring a Larger Dataset

**Week 2:** Augmentation: A technique to avoid overfitting

**Week 3:** Transfer Learning

**Week 4:** Multiclass Classifications

# Extra Content - Regularization

## Logistic regression

$$\min_{w,b} J(w,b) \quad w \in \mathbb{R}^n, b \in \mathbb{R}$$

$$J(w,b) = \frac{1}{m} \sum_{i=1}^m L(\hat{y}_i, y_i) + \frac{\lambda}{2m} \|w\|_2^2$$

L<sub>2</sub> regularization  $\|w\|_2^2 = \sum_{j=1}^n w_j^2 = w^T w \leftarrow$

L<sub>1</sub> regularization  $\frac{\lambda}{2m} \sum_{j=1}^n |w_j| = \frac{\lambda}{2m} \|w\|_1$

$\lambda$  = regularization parameter  
 lambda  
 lambd  
 onit

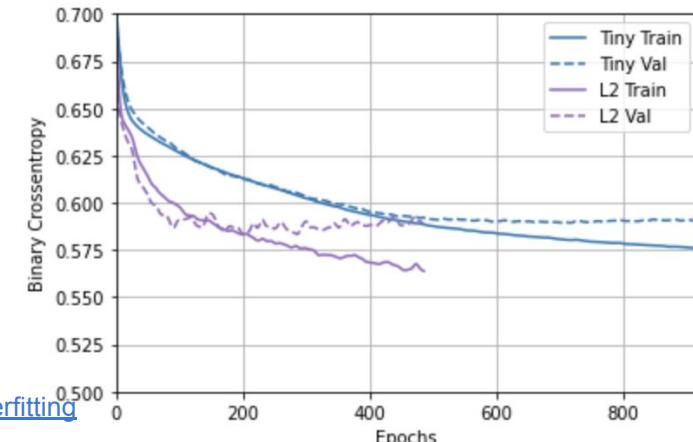
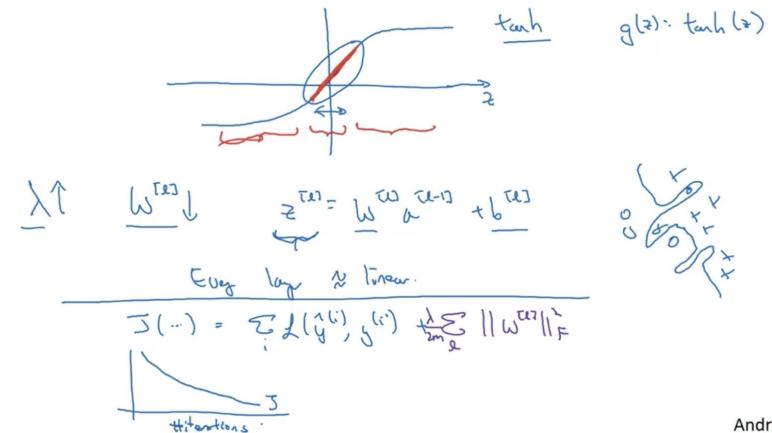
w will be sparse

Andrew Ng

```
from tensorflow.keras import regularizers
```

```
l2_model = tf.keras.Sequential([
    layers.Dense(512, activation='elu',
                kernel_regularizer=regularizers.l2(0.001),
                input_shape=(FEATURES,)),
    layers.Dense(512, activation='elu',
                kernel_regularizer=regularizers.l2(0.001)),
    layers.Dense(512, activation='elu',
                kernel_regularizer=regularizers.l2(0.001)),
    layers.Dense(512, activation='elu',
                kernel_regularizer=regularizers.l2(0.001)),
    layers.Dense(1)
])
```

## How does regularization prevent overfitting?



Source: <https://www.coursera.org/learn/deep-neural-network/lecture/Srsrc/regularization>

<https://www.coursera.org/learn/deep-neural-network/lecture/T6OJj/why-regularization-reduces-overfitting>

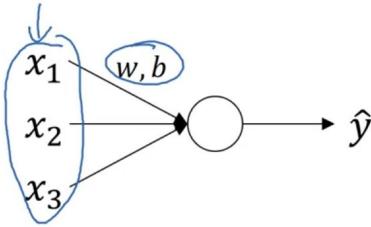
[https://www.tensorflow.org/tutorials/keras/overfit\\_and\\_underfit](https://www.tensorflow.org/tutorials/keras/overfit_and_underfit)

# Extra Content - Batch Normalization

## Normalizing inputs to speed up learning

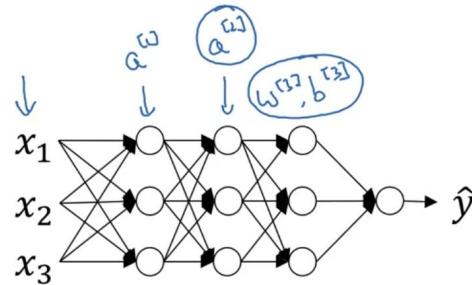
TensorFlow > API > TensorFlow Core v2.1.0 > Python

`tf.keras.layers.BatchNormalization`



$$\begin{aligned}\mu &= \frac{1}{m} \sum_i x^{(i)} \\ X &= X - \mu \\ \sigma^2 &= \frac{1}{m} \sum_i (x^{(i)} - \mu)^2 \quad \leftarrow \text{element-wise} \\ Z &= X / \sigma^2\end{aligned}$$

```
graph LR; X((X)) --> Z((Z))
```



Can we normalize  $a^{[2]}$  so  
as to train  $w^{[2]}, b^{[2]}$  faster  
Normalize  $\underline{z}^{[2]}$ .

Andrew Ng

Normalize the activations of the previous layer at each batch, i.e. applies a transformation that maintains the mean activation close to 0 and the activation standard deviation close to 1.

Batch normalization differs from other layers in several key aspects:

Source:

<https://www.coursera.org/learn/deep-neural-network/lecture/4ptp2/normalizing-activations-in-a-network>

[https://www.tensorflow.org/api\\_docs/python/tf/keras/layers/BatchNormalization](https://www.tensorflow.org/api_docs/python/tf/keras/layers/BatchNormalization)

# Extra Content - Overfitting in Neural Networks

To recap: here are the most common ways to prevent overfitting in neural networks:

- Get more training data.
- Reduce the capacity of the network.
- Add weight regularization.
- Add dropout.

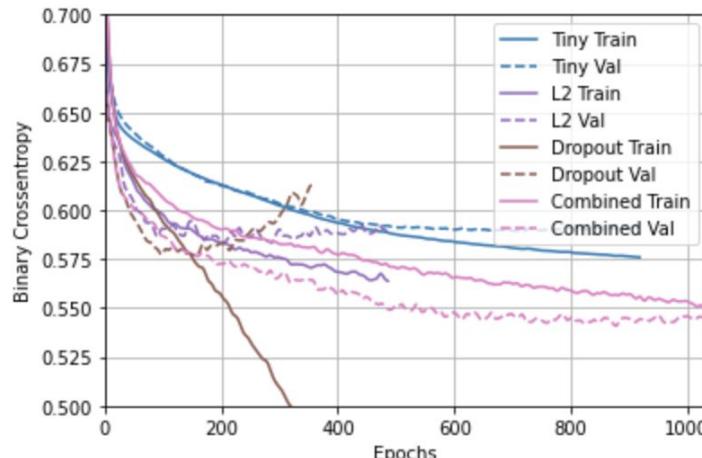
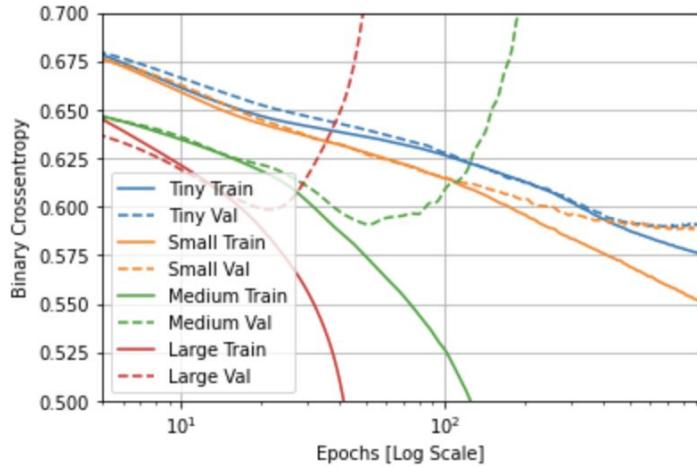
Two important approaches not covered in this guide are:

- data-augmentation
- batch normalization

Remember that each method can help on its own, but often combining them can be even more effective.

- Data Augmentation
- Dropout
- Early Stopping
- Ensembling
- Injecting Noise
- L1 Regularization
- L2 Regularization

Source: [https://www.tensorflow.org/tutorials/keras/overfit\\_and\\_underfit](https://www.tensorflow.org/tutorials/keras/overfit_and_underfit)  
<https://ml-cheatsheet.readthedocs.io/en/latest/regularization.html>



# Content added after Week 3 and 4, based on group feedback



**Image**

Here you'll find models that enable:

- Image Augmentation
- Image Classification
- Feature Vector Extraction

...and more.



**Text**

Here you'll find models that enable:

- Text Embedding Generation
- Text Classification

...and more.



**Video**

Here you'll find models that enable:

- Video Classification

...and more.

# **Course 2: Convolutional Neural Networks in TensorFlow - Questions**

1. ...
2. ...
3. ...

Images  
Convolutional Neural Network  
Image classification  
Transfer learning with TF Hub  
Transfer learning with pretrained CNN  
Data Augmentation  
Image segmentation  
Object detection with TF Hub   
Object detection API 

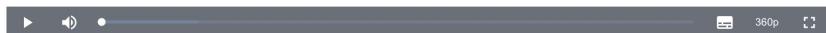
# Check out these resources

## Classic Networks



## Case Studies

## Classic networks



 **Convolutional Neural Networks**  
deeplearning.ai



4.9 (30,192 ratings) | 230K Students Enrolled

Course 4 of 5 in the [Deep Learning Specialization](#)

Enroll for Free

 TensorFlow [Install](#) [Learn](#) [API](#) [Resources](#) [Community](#) [Why TensorFlow](#)

TensorFlow Core

Overview Tutorials Guide TF 1

**TensorFlow tutorials**

- Quickstart for beginners
- Quickstart for experts

**BEGINNER**

- ML basics with Keras
- Load and preprocess data
- Estimator

**ADVANCED**

- Customization
- Distributed training
- Images
- Text
- Structured data
- Generative

The TensorFlow tutorials are written as Jupyter notebooks and run directly in Google Colab—a hosted notebook environment that requires no setup. Click the [Run in Google Colab](#) button.

**For beginners**

The best place to start is with the user-friendly Keras sequential API. Build models by plugging together building blocks. After these tutorials, read the [Keras guide](#).

**Beginner quickstart**  
This "Hello, World!" notebook shows the Keras Sequential API and `model.fit`.

**Keras basics**  
This notebook collection demonstrates basic machine learning tasks using Keras.

**Load data**  
These tutorials use `tf.data` to load various data formats and build input pipelines.

**For experts**

The Keras functional and subclassing APIs provide a define-by-run interface for customization and advanced research. Build your model, then write the forward and backward pass. Create custom layers, activations, and training loops.

**Advanced quickstart**  
This "Hello, World!" notebook uses the Keras subclassing API and a custom training loop.

**Customization**  
This notebook collection shows how to build custom layers and training loops in TensorFlow.

**Distributed training**  
Distribute your model training across multiple GPUs, multiple machines or TPUs.

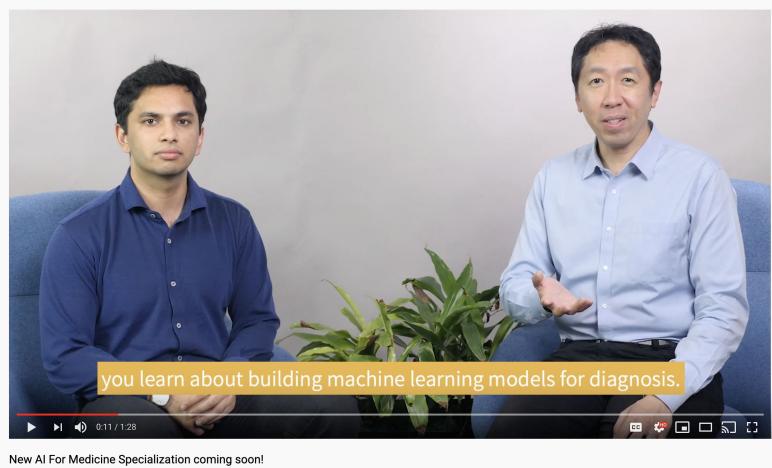
The Advanced section has many instructive notebooks examples, including [Neural machine translation](#), [Transformers](#), and [CycleGAN](#).

Source:

<https://www.coursera.org/lecture/convolutional-neural-networks/classic-networks-MmYe2>

<https://www.tensorflow.org/tutorials/>

# Check out these events and Meetups



New AI For Medicine Specialization coming soon!

Source:

- [https://www.youtube.com/watch?v=zGFKSQlef\\_0](https://www.youtube.com/watch?v=zGFKSQlef_0)
- <https://www.meetup.com/Bethesda-Artificial-Intelligence-Meetup/events/268561559/>
- <https://www.meetup.com/DC-NLP/events/270026712/>
- <https://www.meetup.com/Washington-Quantum-Computing-Meetup/events/269752061/>
- <https://pennylane.ai/qml/demonstrations.html>
- <https://www.meetup.com/QuantUniversity-Meetup-Washington-DC/events/270322193>
- <https://www.dropbox.com/s/ncm4qfc0dkbl2bg/ML%20Master%20Class%20Final%20-%20Part%201-%20CFA%20Institute%202020.pdf?dl=0>
- <https://www.meetup.com/ArtificialIntelligenceAndMachineLearning/events/268478285/>
- <https://www.meetup.com/Machine-Learning-Paper-Club/events/270046053>

Saturday, April 25, 2020

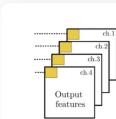
## AI Meet & Greet



Hosted by  
viraf and 2 others



Quantum transfer  
learning



Quanvolutional Neural  
Networks

Monday, April 27, 2020

## Online: The COVID-19 Open Research Dataset



Hosted by  
Seth Grimes

Monday, April 27, 2020

## An introduction to Quantum Machine Learning



Hosted by  
Debabrata Ghoshal

## Machine Learning and AI: An Intuitive Introduction master class



Hosted by  
Sri Krishnamurthy

Monday, April 27, 2020

## AI-ML April 2020 Meeting : Overview of Microsoft AI Platform

Thursday, April 30, 2020

## Remote Session: Neural Nets + Trees



Hosted by  
Elsa Schaefer



**TensorFlow Core**

## Introducing the TensorFlow Developer Certificate!

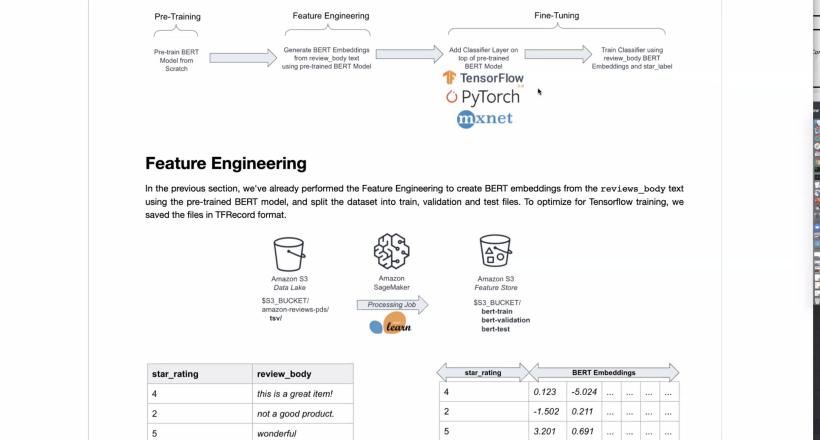
March 12, 2020 

Posted by Alina Shinkarsky, on behalf of the TensorFlow Team

In the AI world today, more and more companies are looking to hire machine learning talent, and simultaneously, an increasing number of students and developers are looking for ways to gain and showcase their ML knowledge with formal recognition. In addition to the courses and learning resources available online, we want to help developers showcase their ML proficiency and help companies hire ML developers to solve challenging problems.

**Feature Engineering**

In the previous section, we've already performed the Feature Engineering to create BERT embeddings from the `zreviews_body` text using the pre-trained BERT model, and split the dataset into train, validation and test files. To optimize for Tensorflow training, we saved the files in TFRecord format.



## Data Science on Amazon Web Services

O'Reilly Book · Early 2021

Hands-on Learning with KubeFlow + GPU + Keras/TensorFlow 2.0 + TF Extended (TFX) + Kubernetes + SageMaker + PyTorch + XGBoost + Airflow + MLflow + Spark + Jupyter

Source:

<https://blog.tensorflow.org/2020/03/introducing-tensorflow-developer-certificate.html?m=1>

<https://www.meetup.com/AWS-Washington-DC-Meet-Up/events/270065827/>

<https://www.eventbrite.com/e/full-day-workshop-kubeflow-gpu-kerastensorflow-20-tf-extended-tfx-kubernetes-pytorch-xgboost-tickets-63362929227>

<https://github.com/data-science-on-aws/workshop>



# Let's keep it up and continue our TensorFlow journey 😊

FRI, MAY 1, 7:30 PM EDT

## TensorFlow in Practice - Course 2 - Week 1,2 - Kaggle Challenge and...

Online event

Join us for our 4th adventure in Deep Learning! Just bring your curiosity and be ready to meet our growing community 😊 We are taking Course 2 of TensorFlow in Practice Specialization available at:...



 39 attendees

[Manage](#) 

FRI, MAY 8, 7:30 PM EDT

## TensorFlow in Practice-C2 Week 3,4- Transfer Learning & Multiclass...

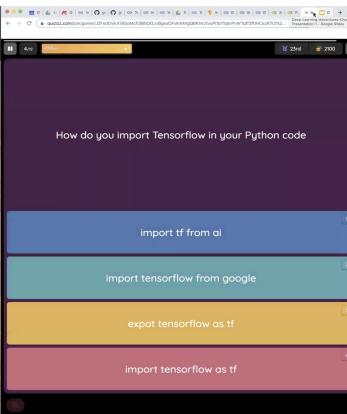
Online event

Join us for our 5th adventure in Deep Learning! Just bring your curiosity and be ready to meet our growing community 😊 We are taking Course 2 of TensorFlow in Practice Specialization available at:...



 42 attendees

 2 [Manage](#) 



Source: <https://www.meetup.com/Deep-Learning-Adventures>

FRI, MAY 15, 7:30 PM EDT

## Deep Learning Adventures - Happy Hour+Trivia Night 🍹🍸🎉



Online event

Join us for a fun conversation 🍹🍸🎉 No slides or recording this time, just getting to know each other better and forge a stronger community 😊 We are taking a break from our TensorFlow in Practice Specialization available at:...

 18 attendees

[Manage](#) 

# Time for a fun game



To play this game

1. Use any device to open  
**joinmyquiz.com**
2. Enter game code  
**775667**

or share via...

**START**

Your Quizizz name is... i

**Enter your name**

**Start game**

Game settings

**Music**

**Sound effects**

**Read aloud**

Practice here or use Flashcards:

<https://quizizz.com/join/quiz/5eae10a807df73001b0c59a4/start?from=soloLinkShare&referrer=5d921444d0fa99001a135336>



Deep Learning Adventures - Quiz 3

Professional Development 1 times

Other

# Time for a fun game



Practice here or use Flashcards:

<https://quizizz.com/join/quiz/5eae10a807df73001b0c59a4/start?from=soloLinkShare&referrer=5d921444d0fa99001a135336>

The image shows two side-by-side screenshots. On the left is the Quizizz game dashboard for a game with code 432 236. It lists 22 players with their names, profile icons, scores, and a 'leave' button. On the right is a slide from a presentation titled 'Deep-Learning-Adventures-Chapter-1-Presentation-1 - Google Slides'. The slide has a purple header with the question 'How do you import Tensorflow in your Python code'. Below the question are four numbered options: 1. 'import tf from ai', 2. 'import tensorflow from google', 3. 'expot tensorflow as tf', and 4. 'import tensorflow as tf'. The first option is highlighted in blue.

Rank	Name	Score
6	Anil	8630
6	rek	8630
7	Charles Stockman	7450
8	Martin	7290
9	Angel	7230
10	Chuba	7050
11	Peter	6880
12	Dean	6840
13	Melissa	6505
14	Sanjay	5710
15	Hasson	4750
16	AH	4470
16	Kottie	4470
17	v	4010
18	KL	3910
19	Tony	3240
20	SS	2130
21	George	2100
22	Thomas	0

# Questions

# Discussion

## 2 Deep Learning representations

For representations:

- nodes represent inputs, activations or outputs
- edges represent weights or biases

Here are several examples of Standard deep learning representations

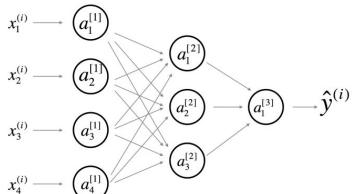


Figure 1: Comprehensive Network: representation commonly used for Neural Networks. For better aesthetic, we omitted the details on the parameters ( $w_{ij}^{[l]}$  and  $b_i^{[l]}$  etc...) that should appear on the edges

## Standard notations for Deep Learning

This document has the purpose of discussing a new standard for deep learning mathematical notations.

### 1 Neural Networks Notations.

General comments:

- superscript (i) will denote the  $i^{th}$  training example while superscript [l] will denote the  $l^{th}$  layer

Sizes:

$\cdot m$  : number of examples in the dataset

$\cdot n_x$  : input size

$\cdot n_y$  : output size (or number of classes)

$\cdot n_h^{[l]}$  : number of hidden units of the  $l^{th}$  layer

In a for loop, it is possible to denote  $n_x = n_h^{[0]}$  and  $n_y = n_h^{[\text{number of layers} + 1]}$ .

$\cdot L$  : number of layers in the network.

Objects:

$\cdot X \in \mathbb{R}^{n_x \times m}$  is the input matrix

$\cdot x^{(i)} \in \mathbb{R}^{n_x}$  is the  $i^{th}$  example represented as a column vector

$\cdot Y \in \mathbb{R}^{n_y \times m}$  is the label matrix

$\cdot y^{(i)} \in \mathbb{R}^{n_y}$  is the output label for the  $i^{th}$  example

$\cdot W^{[l]} \in \mathbb{R}^{\text{number of units in next layer} \times \text{number of units in the previous layer}}$  is the weight matrix, superscript [l] indicates the layer

$\cdot b^{[l]} \in \mathbb{R}^{\text{number of units in next layer}}$  is the bias vector in the  $l^{th}$  layer

$\cdot \hat{y} \in \mathbb{R}^{n_y}$  is the predicted output vector. It can also be denoted  $a^{[L]}$  where  $L$  is the number of layers in the network.

Common forward propagation equation examples:

$a = g^{[l]}(W_x x^{(i)} + b_1) = g^{[l]}(z_1)$  where  $g^{[l]}$  denotes the  $l^{th}$  layer activation function

$\hat{y}^{(i)} = \text{softmax}(W_h h + b_2)$

· General Activation Formula:  $a_j^{[l]} = g^{[l]}(\sum_k w_{jk}^{[l]} a_k^{[l-1]} + b_j^{[l]}) = g^{[l]}(z_j^{[l]})$

·  $J(x, W, b, y)$  or  $J(\hat{y}, y)$  denote the cost function.

Examples of cost function:

$\cdot J_{CE}(\hat{y}, y) = -\sum_{i=0}^m y^{(i)} \log \hat{y}^{(i)}$

$\cdot J_1(\hat{y}, y) = \sum_{i=0}^m |y^{(i)} - \hat{y}^{(i)}|$

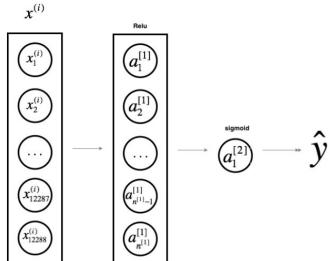


Figure 2: Simplified Network: a simpler representation of a two layer neural network, both are equivalent.