PyTorch for Beginners

Joe Papa
Author, PyTorch Pocket Reference

Welcome!

We’re in the middle of an AI boom!

*How will **YOU** be a part of it?*

Business Opportunities in AI

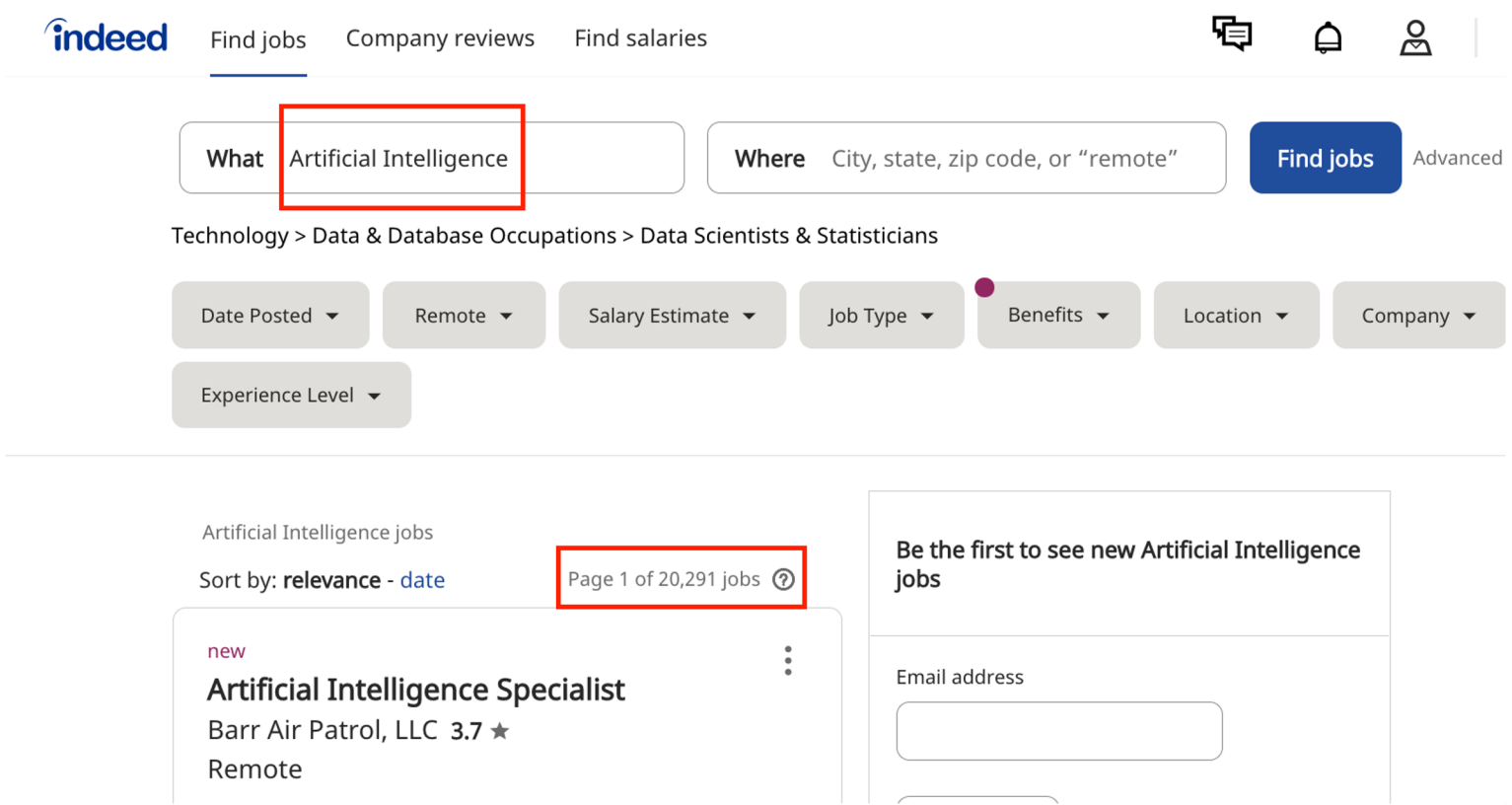
"It is difficult to think of a major industry that AI will not transform. This includes healthcare, education, transportation, retail, communications, and agriculture. There are surprisingly clear paths for AI to make a big difference in ***all of these industries****."*- **Andrew Ng**, Computer Scientist and Global Leader in AI

"What all of us have to do is to make sure we are using AI in a way that is for the ***benefit of humanity****, not to the detriment of humanity."* - **Tim Cook**, CEO of Apple

What industry are you in?

Careers in AI

Indeed Search June 6, 2021



What to Expect

My Promise: **Maximize your R.O.A.**

You should walk away good understanding of what PyTorch is, how it works, and how to use it

- Q&A Window - questions at end of section
- Attendee Chat Window - problems and feedback
- Breaks
- Surprise Bonuses
- Coding Exercises
- Beginners Level - Python, ML/DL
    - Part I - Getting Started
    - Part II - Tensors & Data
    - Part III - Deep Learning Model Training

About your instructor

LinkedIn: @MrJoePapa
Email: jpapa@joepapa.ai

Joe Papa

- **Chief AI Engineer**, Mobile Insights
- **Author**, O'Reilly, PyTorch Pocket Reference
- **Master Trainer**, PyTorchAcademy.com
- MSEE, BSEE Rutgers University
- 25 Years in R&D: Verizon Wireless, Bell Labs, Booz Allen
- Led AI Teams, Career Manager
- 6000+ students on Udemy
- AI Edge Deployment & Signal Processing

"Tell me about yourself."

Poll - What is your primary role?

Multiple-choice, Single Answer

- Researcher
- Developer
- Analyst
- Leader

Getting Started

What is PyTorch?

"PyTorch is an open source **machine learning framework** that accelerates the path from research prototyping to production deployment." - pytorch.org

About PyTorch

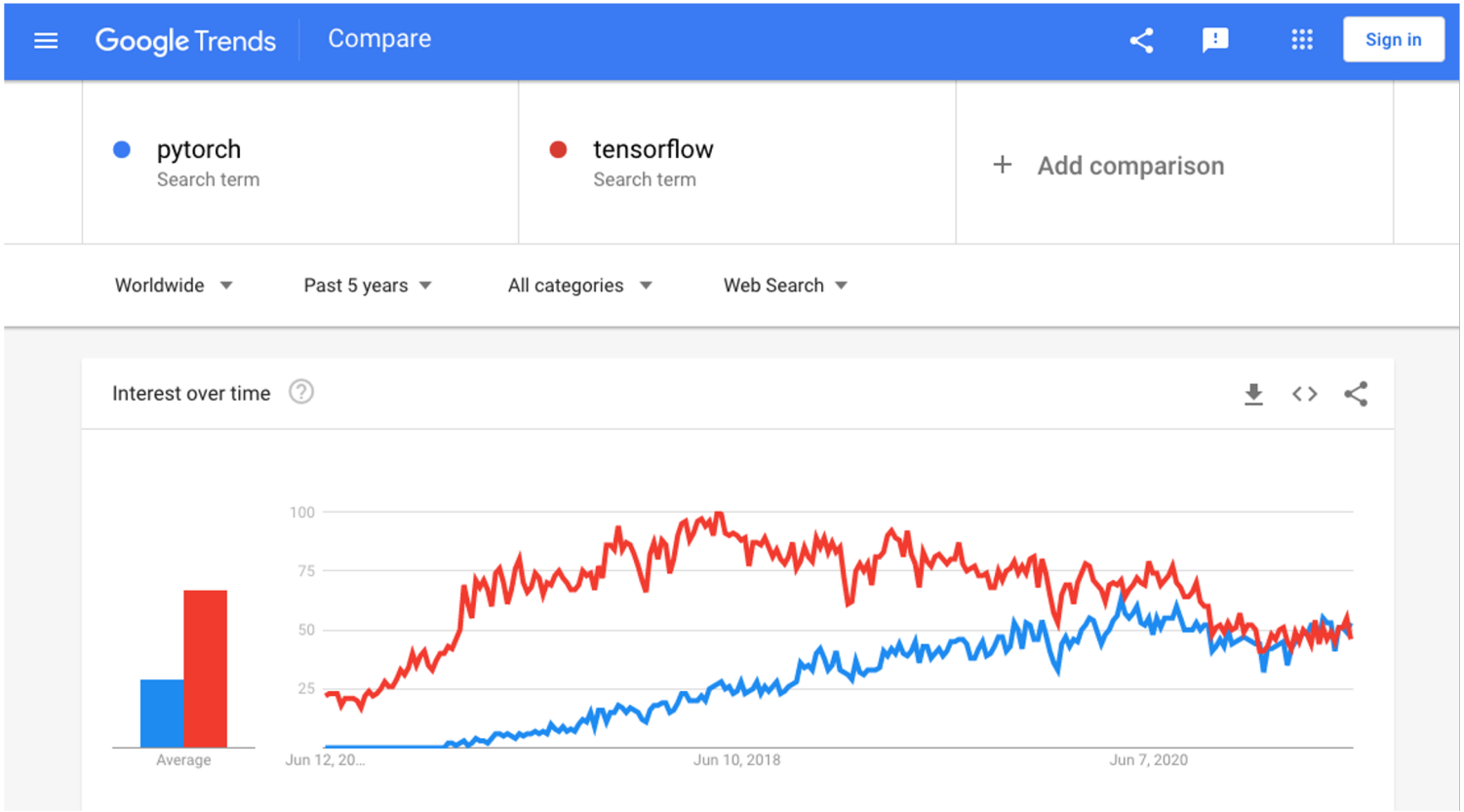
- Top Deep Learning Framework
- Open sourced in 2018
- Primarily developed by Facebook AI Research (FAIR) w/ 1,870 Contributors
- Python API
- Popular: 60,000+ repos on Github, 55% PwC, 50-75% papers at Top Conferences

PyTorch Key Benefits

- Mature & stable (v1.8.1)
- Supported natively by cloud providers (AWS, GCP, Azure), Colab, & Kaggle
- Simple to use (Python API)
- Easy to install
- Customizable, pythonic
- Strong GPU support
- Flexibility through dynamic graphs
- Supports Parallel Processing & Distributed Training
- Supports Deployment to Production
- Beginning to support Mobile & Edge Deployment
- C++ Front End available
- Large User Community Forum
- Vast Ecosystem & Many Open Source Libraries

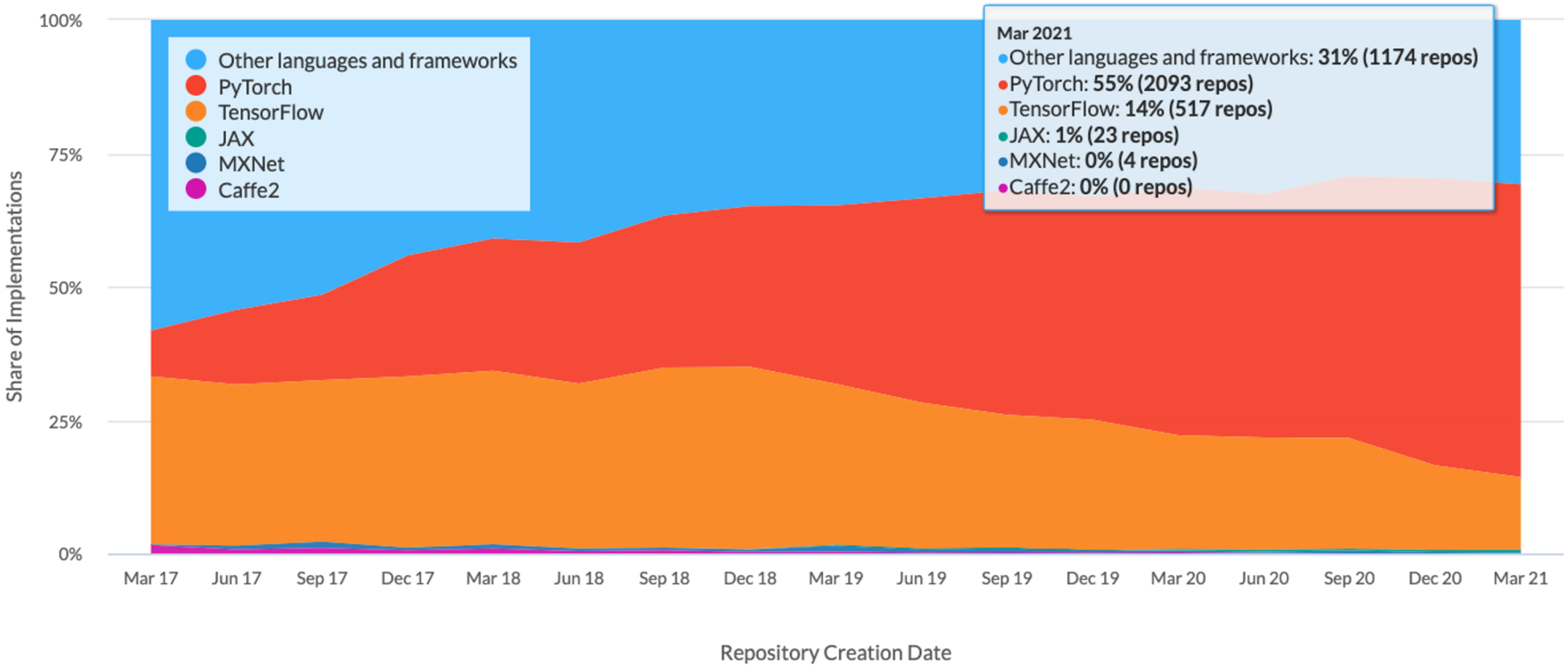
PyTorch vs Tensorflow

Google Trends - June 2016 - June 2021



PyTorch vs Tensorflow

Papers with Code 3/2017-4/2021



Why Learn PyTorch?

PyTorch can be used to ...

- Study Machine Learning
- Conduct DL research experiments
- Create, process, and analyze datasets
- Design & train NN models
- Create AI applications & tools
- Deploy AI to cloud platforms, mobile & edge devices

"How might you use PyTorch?"

Poll - How do you plan to use PyTorch?

Multiple-choice, Multiple Answer

- Study Machine Learning
- Conduct DL research experiments
- Create, process, and analyze datasets
- Design & train NN models
- Create AI applications & tools
- Deploy AI to cloud platforms,
- Deploy AI to mobile & edge devices

Q&A

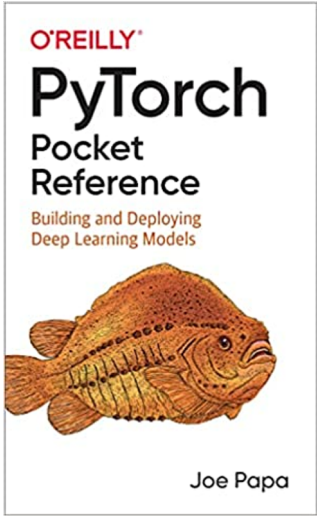
[Q & A]

Surprise Bonus # 1

Free PyTorch Book (just pay S&H)

PyTorch Pocket Reference (May 2021)

1. Introduction to PyTorch
2. Tensors
3. Deep Learning with PyTorch
4. NN Development Reference
5. Customizing PyTorch
6. PyTorch Acceleration & Optimization
7. Deploying PyTorch to Production
8. PyTorch Ecosystem & Additional Resources



https://pytorch.tips/free-book

Free Signed Copy

(just pay $7 for S&H)

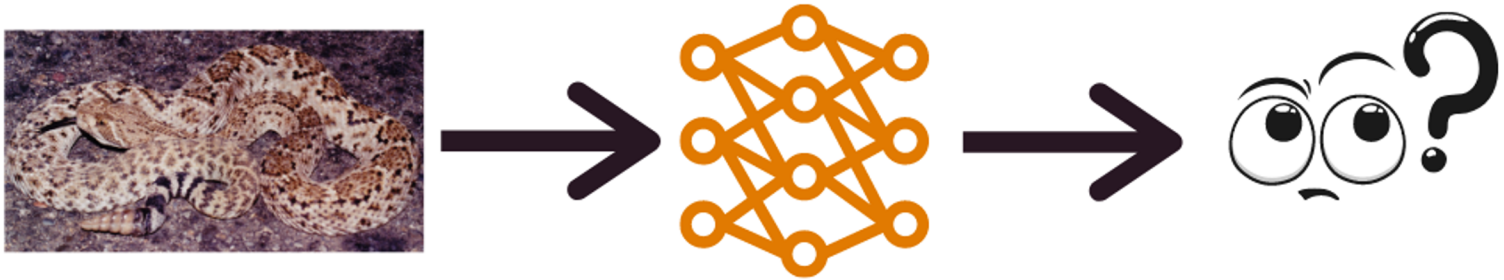
After Break: Building an Image Classifier

Break

Next: Building an Image Classifier

Let’s Build an Image Classifier

What is this?

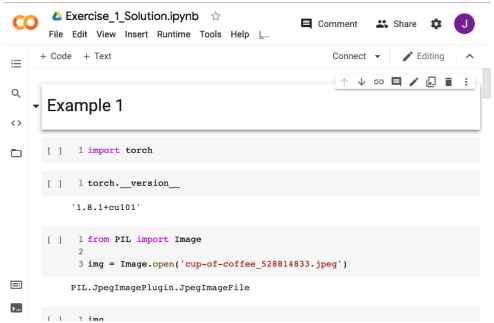


Model: ***AlexNet*** model (10 layers) pre-trained
Dataset: ***ImageNet*** Large Scale Visual Recognition Challenge (ILSVRC) dataset (14 Million images, 1000 classes)

Installing PyTorch

3 Options

Google Colab



Local Machine

Cloud

aws

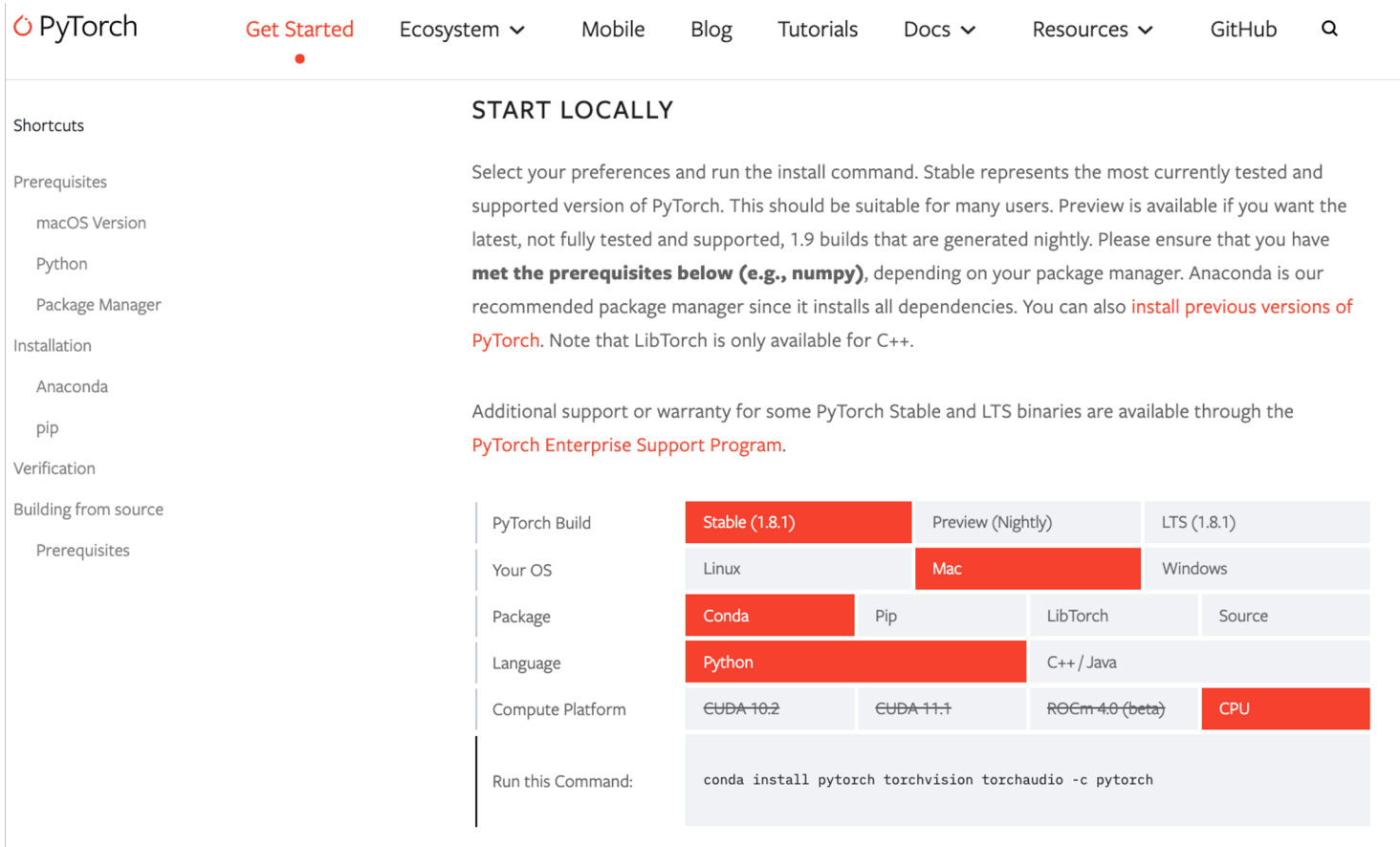
Azure

Lambda

Paperspace

Local Machine

pytorch.org



Google Colab

Setting up your development environment

https://colab.research.google.com

Exercise 1: Image Classifier

Google Colab Walk-thru

pytorch.tips/olt-ex-1

Q&A

[Q & A]

Tensors & Data

What is a Tensor?

Fundamental building block of PyTorch

- Multi-dimensional Array
- Contains numbers
- GPU support
- Gradient support (good for computing derivatives of computational graphs)

```
[1]  1 import torch
```

```
     1 x = torch.rand((2,3,4))
     2 x
```

```
tensor([[[0.4192, 0.8142, 0.4676, 0.4339],
         [0.4914, 0.7444, 0.1403, 0.9538],
         [0.5356, 0.6300, 0.8804, 0.0405]],

        [[0.9440, 0.9334, 0.8104, 0.8546],
         [0.2348, 0.4871, 0.0631, 0.1839],
         [0.2344, 0.2144, 0.7371, 0.0665]]])
```

Tensor Attributes & Operations

A robust data type

- Attributes
  - `.dtype, .device, .shape, .ndim`
- Conversion
  - `to(), numpy()`
  - `x.detach().to('cpu').numpy()`
- Creating Tensors
  - `tensor()`
  - `empty(), zeros(), ones()`
  - `empty_like() ...`
  - `rand(), randn(), randint()`
  - `arange(), linspace(), logspace(),`
  - `eye(), full()`
  - `load(), save()`
- Indexing, Slicing, Combining , & Splitting
  - `x[5], y[:5,1], x[x<5]`
  - `item(),t(), view()`
  - `stack(), unbind()`
  - `squeeze(), unsqueeze()`
  - `permute()`
- Math Operation
  - `+ - * / **`
  - `ceil(), floor(), round()`
  - `abs(),angle(), conj()`
  - `cos(), sin(), tan(), acos(), asin()`
  - `exp(), log(), log10()`
  - `logical_and(), logical_not()`
  - `bitwise_and() bitwise_not()`
- Reduction Operations
  - `mean(), median(), mode(), std(), var()`
  - `argmax(), argmin(), dist(), norm()`
  - `sum(), prod(), unique()`
- Comparison Operations
  - `== < <= > >= !=`
  - `isclose(), allclose()`
  - `max(), min(), sort(), topk()`
- Linear Alg. Operations
  - `matmul(), addmm(), eig(), det(), inverse(), dot(), svd(), solve()`
- Other
  - `fft(), ifft()`
  - `histc(), flatten()`

Data - Loading, Preprocessing & Batching

PyTorch Built-in Classes

- `torch.utils.data.Dataset`
- `torch.utils.data.DataLoader`
- Torchvision Datasets

"What types of DATA do you or could you process?"

TORCHVISION.DATASETS

All datasets are subclasses of `torch.utils.data.Dataset` i.e, they have `__getitem__` and `__len__` methods implemented. Hence, they can all be passed to a `torch.utils.data.DataLoader` which can load multiple samples in parallel using `torch.multiprocessing` workers. For example:

```
imagenet_data = torchvision.datasets.ImageNet('path/to/imagenet_root/')
data_loader = torch.utils.data.DataLoader(imagenet_data,
                                          batch_size=4,
                                          shuffle=True,
                                          num_workers=args.nThreads)
```

The following datasets are available:

Datasets

- CelebA
- CIFAR
- Cityscapes
- COCO
  - Captions

torchvision.datasets
CelebA
CIFAR
Cityscapes
+ COCO
DatasetFolder
EMNIST
FakeData
Fashion-MNIST
Flickr
HMDB51
ImageFolder
ImageNet
Kinetics-400
KMNIST
LSUN
MNIST
Omniglot
PhotoTour
Places365
QMNIST
SBD

Surprise Bonus # 2

Private Zoom Training

Private PyTorch Training (August 2021)

1. Tips & Tricks
2. Examples
3. LIVE Q&A
4. Limited attendance

https://pytorch.tips/zoom

Register for
Private Session

After Break: Data Walk-Thru & DL Training

Break
Next: Data Walk-thru & Training a Deep Learning Model

Exercise 2: Tensors & Data

Google Colab Walk-thru

`pytorch.tips/olt-ex-2`

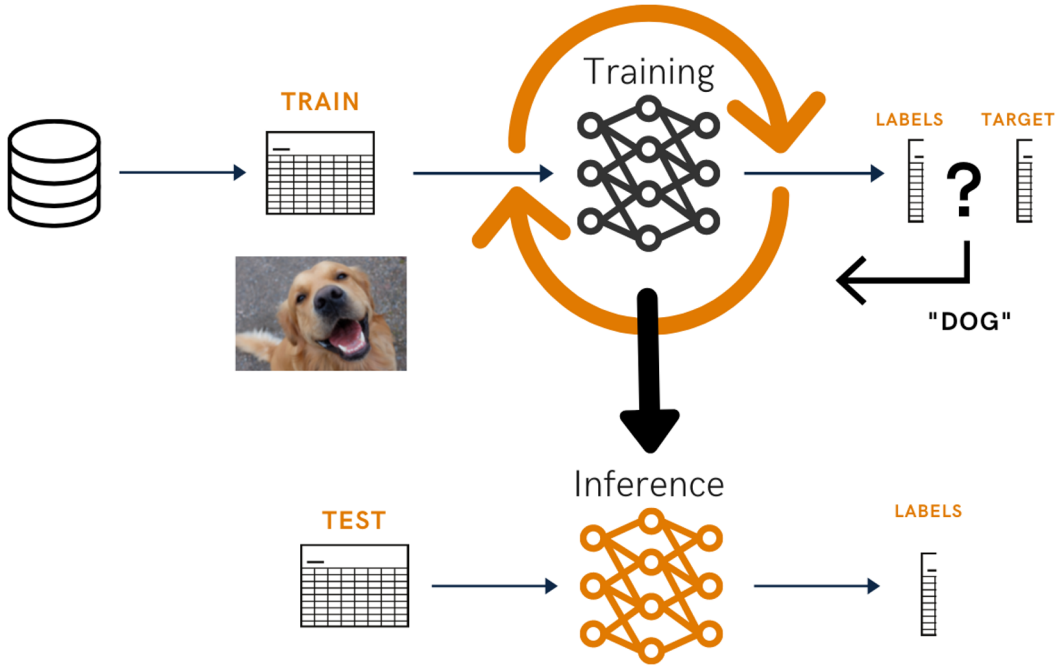
Q&A

Brief Intro to Machine Learning

Supervised Learning - Classification

Types of Machine Learning

- **Supervised Learning**
  - Classification
  - Regression
- Unsupervised Learning
- Semi-supervised Learning
- Transfer Learning
- Reinforcement Learning
- Generative Learning
- What is Deep Learning?



Exercise 3: Training a Model

Google Colab Walk-thru

`pytorch.tips/olt-ex-3`

GPU Acceleration

Supervised Learning - Classification

```
1 device = "cuda" if torch.cuda.is_available() else "cpu"
2 device
```

```
'cuda'
```

```
1 x = torch.rand((2,3,4))
2 x.device
```

```
device(type='cpu')
```

```
1 x = x.to(device)
2 x.device
```

```
device(type='cuda', index=0)
```

Exercise 4: Training a Model (GPU)

Google Colab Walk-thru

`pytorch.tips/olt-ex-4`

Q&A

Recap

PyTorch for Beginners

Way to go! You learned a lot.

- What PyTorch is
- Why use PyTorch
- PyTorch Use Cases
- Setup & Installation
- Colab Development Environment
- Image Classifier
- Tensors
- Data Loading, Preprocessing & Batching
- Training a Deep Learning Model
- GPU Acceleration
- Next Steps

What's Next?

Your journey into PyTorch has just begun …

Next steps:

- **Questions?** - email (jpapa@joepapa.ai) or linkedin (https://linkedin.com/in/MrJoePapa)
- **Free Signed Book** - (https://pytorch.tips/free-book)
- **Private Zoom Training** (https://pytorch.tips/zoom)
- Pytorch.org **Tutorials** (https://pytorch.tips/tutorials)
- Pytorch **Ecosystem** (https://pytorch.tips/ecosystem)
- **Papers with Code** (https://paperswithcode.com)
- Recommended **Books** -
  - A. Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow
  - I. Pointer, Programming PyTorch for Deep Learning
  - J.Howard, Deep Learning for Coders with Fastai and PyTorch

Thanks for attending …

Go build something cool!

PyTorch


O'REILLY®