Introduction to AI/ML Concepts

A bicycle for the mind

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Feb 18, 2023 @ 9am - 3pm EST

9:00 am - 9:20 am  Intro to AI/ML/Deep Learning
9:20 am - 9:30 am  Intro to PyTorch
9:30 am - 10:00 am Workshop Introduction
10:00 am - 11:00 am Workshop: Torch Vision
11:00 am - 11:10 am Generative AI Part 1
11:10 am - 11:30 am Workshop Introduction
11:30 am - 12:30 pm Workshop: Summarizer
12:30 pm - 1:00 pm Lunch Break
1:00 pm - 1:05 pm Generative AI Part 2
1:05 pm - 1:30 pm Workshop Introduction
1:30 pm - 1:45 pm Workshop: Virtual Assistant Part 1
1:45 pm - 2:00 pm Workshop: Introduction
2:00 pm - 2:45 pm Workshop: Virtual Assistant Part 2
2:45 pm - 3:00 pm Wrap up/Q&A
What is AI?
Artificial Intelligence
Artificial Intelligence

Refers to the simulation of human intelligence

Mimicking the intelligence or behavioral pattern of humans or any other living entity.
What is ML?
Machine Learning
Machine Learning

Enables computers to learn from data

A technique by which a computer can “learn” from data without using a complex set of rules. Mainly based on training a model from datasets.
Innovations
ImageNet

Largest dataset of annotated images

• Created in 2009 @ Stanford University

• Creators: Fei-Fei Li & Jia Deng

• 14 million images

• 22 thousand categories of images
Large Scale Visual Recognition Challenge

ImageNet’s Yearly AI Challenge to inspire and reward innovation

• Competition to achieve highest accuracy on the task

• Driven rapid advances
  • Computer vision
  • Deep learning
  • Many more
AlexNet

Winner, winner chicken dinner

- Convolutional Neural Network
- Demonstrated feasibility deep CNNs end-to-end
- 15.3% top-5 error rate!
- Enabled further innovation! (VGGNet, GoogLENet, ResNet, etc.)
AlexNet

AlexNet Block Diagram
What is Deep Learning?
Deep Learning

Pattern Recognition & Feature extraction w/ multi-layer neural networks

A technique to perform machine learning inspired by our brain’s own network of neurons.
Deep Neural Networks

Inspired by the human brain

Input Layer → Hidden layer 1 → Hidden layer 2 → Hidden layer 3 → Output Layer
AI/ML and Deep Learning

Understanding how each subset fits into the overall picture

- Mimicking the intelligence or behavioral pattern of humans or any other living entity.
- A technique by which a computer can “learn” from data without using a complex set of rules. Mainly based on training a model from datasets.
- A technique to perform machine learning inspired by our brain’s own network of neurons.
Deep Learning @ Meta

If you use Meta Products, DL is in your life

- News Feed Personalization
- Image and Video Recognition
- Language Translation
- Spam and Fake News Detection
- Predictive Analytics
How Deep Learning is used at Meta

Instagram’s Explore recommender system

https://ai.facebook.com/blog/powered-by-ai-instagram-s-explore-recommender-system/
Case Study: Disney

Animated face detection

https://medium.com/pytorch/how-disney-uses-pytorch-for-animated-character-recognition-a1722a182627
Case Study: Disney

Non-human facial detection presents new challenges

https://medium.com/pytorch/how-disney-uses-pytorch-for-animated-character-recognition-a1722a182627
Case Study: Blue River Tech

Self-driving automated weed eliminating tractors!

https://medium.com/pytorch/ai-for-ag-production-machine-learning-for-agriculture-e8cfdb9849a1
Case Study: Blue River Tech

Weed detection models

https://medium.com/pytorch/ai-for-ag-production-machine-learning-for-agriculture-e8cfdb9849a1
Case Studies

Red = Weed; Green != Weed

https://medium.com/pytorch/ai-for-ag-production-machine-learning-for-agriculture-e8cfdb9849a1
Check out more case studies

Gain inspiration for your AI/ML projects

- Advertising & Marketing
- Agriculture
- Autonomous Driving
- Education
- Finance
- Healthcare
- Insurance
- Media & Entertainment
- Medical
- Mining
- Retail
- Technology
- Travel

https://pytorch.org/community-stories
PyTorch

Open-source library to build and train models

• Based on the Torch Library

• Developed by Facebook’s AI Research Lab

• Released in 2016

• Programming interface for building and training Neural Networks
PyTorch

Well-known domain-specific libraries

- TorchText
- TorchVision
- TorchAudio
Typical ML Pipeline with PyTorch

Understanding the process
Getting started with PyTorch

Useful resources

Learn the basics:

https://pytorch.org/tutorials/beginner/basics/intro.html

Quickstart:

https://pytorch.org/tutorials/beginner/basics/quickstart_tutorial.html
Workshop: Identify Objects with TorchVision
Identify objects with TorchVision

Is there a traffic light in this image?
Identify objects with TorchVision

Is there a traffic light in this image?
Typical pipeline for object detection

Identifying objects in images with TorchVision

1. Input Image
2. Image Tensor
3. Batch of input tensors
4. Object detection model
5. Detected objects
6. Model output report
How do computers see images?

Do Androids Dream of Electric Sheep?
How do computers see images?

Ever open an image in a text editor?
Workshop key concepts

Tensors: Multi-dimensional data structures

Scalar

<p>| |</p>
<table>
<thead>
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<tr>
<td>1</td>
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Vector

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Matrix

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Tensor

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</table>
Workshop key concepts

Tensors: Multi-dimensional data structures

Scalar
Rank 0 Tensor

1

Vector
Rank 1 Tensor

[1
2]

Matrix
Rank 2 Tensor

[1 2
3 4]

Tensor
Rank 3 Tensor

[1 2
3 4]
Workshop key concepts

Tensors: Multi-dimensional data structures

Scalar
Rank 0 Tensor

Vector
Rank 1 Tensor

Matrix
Rank 2 Tensor

Tensor
Rank 3 Tensor

Rank 4 Tensor

https://pytorch.org/tutorials/beginner/basics/tensorqs_tutorial.html
https://pytorch.org/tutorials/beginner/introyt/tensors_deeper_tutorial.html
Workshop key concepts

Image Tensors

- Image tensors are typically rank 3 tensors
  - dim0: number of channels (3 for an RGB image)
  - dim1: height of the image
  - dim2: width of the image

https://pytorch.org/tutorials/beginner/basics/tensorqs_tutorial.html
Workshop key concepts

Torchvision


- Library for Image and Video:
  - datasets
  - models (pretrained and untrained)
  - transformations
Workshop key concepts

Batching
Workshop key concepts

Batching

CPU QUEUE

Image 1

Image 2

Image 3

Image 4

Image 5

Image 6

GPU
Workshop key concepts

Batching

CPU QUEUE

Image 1
Image 3
Image 5

GPU

Image 2
Image 4
Image 6

Image 7
Image 8
Image 9
Image 10
Image 11
Workshop key concepts

Batching

Batch of 6 images

Introduction  Deep Learning  Intro to PyTorch  Generative AI
Workshop key concepts

Batching

- Image 1
- Image 3
- Image 5

- Image 2
- Image 4
- Image 6

CPU QUEUE

- Image 12
- Image 18
- Image 24
- Image 30
- Image 36

Introduction  Deep Learning  Intro to PyTorch  Generative AI
Workshop key concepts

Pretrained Models

- You will use fasterrcnn_resnet50_fpn for the lab
- The name refers to the neural architectures used in the model.
  - Resnet50 is a popular model that extracts useful information from an image tensor
  - Faster RCNN is an object-detection architecture that uses Resnet’s extracted features to identify objects in an image
- The model has been trained on the COCO academic dataset
- Torchvision contains several more pretrained models for different use cases
Workshop key concepts

Fast R-CNN

Workshop key concepts

COCO dataset

- COCO dataset contains many common objects.
- Models trained on COCO predict the class of the object as an integer.
- We then look up the integer to find out the object it represents.

```json
{
"0": "__background__",
"1": "person",
"2": "bicycle",
"3": "car",
...
"88": "teddy bear",
"89": "hair drier",
"90": "toothbrush"
}
```
Workshop key concepts

Model Inference

- Process of generating a prediction from inputs
- In PyTorch, as simple as
  \[ \text{prediction} = \text{model}(\text{input}) \]
- If input is a batch of \( N \) samples, output is a batch of \( N \) predictions
- Each prediction is a list of the objects detected in the image, and how confident the model is about the detected object
Workshop key concepts

Post processing

Output

0: [Pizza, 1]
1: [Pepperoni, 16]
2: [Cheese, 1]
...
Use TorchVision to identify objects

Follow the steps at your own pace

45 MIN
11:15AM

https://github.com/fbsamples/mit-dl-workshop

https://discord.gg/uNRcgFVW
Workshop wrap-up

We learnt

- Image loading and manipulation in Python and PyTorch
- Loading pretrained models with Torchvision
- Batch processing in deep learning models
- Inference and post-processing with object detection models
Generative AI
What is Generative AI?
What is a modality?
Input vs Output Modalities

Generative AI can be segmented by modality

**Input modalities**

- Text
- Audio
- Images - 2D
- Videos – 2D
- 3D assets – static
- 3D assets - movement

**Output modalities**

- Text
  - Lines of code
  - Essays, chatbots, conversation
- Audio
  - Cleaned up audio
  - Songs / instrumental pieces
  - Voice Renderings
- Images - 2D
- Videos – 2D
- 3D assets – static
- 3D assets - movement
Notable Players

Innovators in the generative AI space

DALL-E2

Stable Diffusion
Refik Anadol Studios

Using data as pigments to generate a new artform
Refik Anadol Studios

Check out the interview

https://www.youtube.com/watch?v=yjPv2ltMt-E
Workshop: Video Synopsis Generator
Create a text summary of a video

Easily create cliff’s notes for videos!

Art & AI/ML collaborate in creative ways, like how the Refik Anadol Studio is powered by PyTorch. Watch Refik and Christian B. talk with Developer Advocates Suraj Subramanian and Justin Jeffress about how the Studio uses PyTorch to turn data into pigments...
Anatomy of the video summarizer

From video to text summary
Workshop key concepts

Extract audio from video

- FFMPEG is a suite of libraries and programs for handling video, audio, other multimedia files, and streams.

- It is a command-line tool, but can also be called from python notebooks by prefixing an exclamation mark (!)

  !ffmpeg -i input.mp4 output.avi
Workshop key concepts

Automatic Speech Recognition

Building models with PyTorch is fun!
Workshop key concepts

Text Summarization

- Produce a concise and accurate summary of the input text

- Earlier NLP architectures used recurrent neural networks (RNNs). Modern NLP models are transformer-based

- Summarization models are general language models that have been fine-tuned for summary generation using datasets like CNN Dailymail, Amazon reviews etc.

- Typically, models have limits on the input length i.e. the number of tokens constituting the input fed to the model
Workshop key concepts

Tokenization

- Splitting a large body of text into smaller pieces (*tokens*)
- Tokens can be words, phrases or even whole sentences
- Tokenization helps to make the text more manageable and easier to process.

"Building models with PyTorch"
Build your video synopsis generator

Follow the steps at your own pace

60 MIN

Workshop wrap-up

We learnt

- FFMPEG for audio extraction
- Automatic speech recognition
- NLP concepts (tokenization, summarization)
- Whisper and Huggingface APIs
- Pandas DataFrames
How might you use the summarizer?

We used it on the recording of this workshop!
How might you use the summarizer?

We used it on the recording of this workshop!

When dealing with generative AI, you have different modalities. An input modality could be text, it could be audio. It could be images, videos, 3D assets. Generative AI is a type of artificial intelligence that is being made available to third parties to be able to play with. Rafik Anadol Studios is using generative AI to create art from people's brainwaves. We're going to go through a workshop on how to create a video synopsis generator with AI. We're going to be using two different AI ML models to achieve this task. And so you'll learn some more details as we go along. Once you've done this, you'll actually have the necessary components to be able to do whatever video you want to. Python is a programming language. It can be used to generate video summaries and other types of data.
Feedback

It helps us improve our content

https://forms.gle/fYp6LdCcdufTRczc7
Generative AI (cont.)
OpenAI

Text completion, image and code generation; Oh my!

Explore the OpenAI API

Start with the basics

Build an application

Text completion

Image generation

Code compilation

Fine-tuning

Embeddings

Introduction  Deep Learning  Intro to PyTorch  Generative AI
Welcome our generative AI workshop guests.

Welcome, everyone, to the generative AI workshop! I'm excited to be a part of this learning experience with all of you. Let's dive into the world of generative AI and explore the possibilities it has to offer. Get ready to engage in hands-on activities and create amazing AI models. Let's get started!
Welcome our generative AI workshop guests in the spirit of a pirate.

Ahoy mateys! Ye be heartily welcomed to this here generative AI workshop. I be a pirate of the seven neural nets and I'll be yer guide on this voyage. So hoist the black flag, grab yer laptops and let's set sail to the high seas of artificial intelligence. Arrr!
Not trained on anything post 2021

Don’t worry you can fill in the gaps

Please write an abstract for a talk at an open-source summit. The topic is about PyTorch 2.0 and will highlight PyTorch 2.0 is fully backwards compatible, speeds up model training speedup of approximately 43 percent, and will provide an overview of the technology stack that powers the new torch compile API.
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In this talk, we will delve into the exciting world of PyTorch 2.0, the latest version of the widely-used open-source deep learning framework. Attendees will learn about the key features of PyTorch 2.0, including its full backwards compatibility and the speedup of model training by 43%. Additionally, we will provide a comprehensive overview of the technology stack that powers the new torch compile API, showcasing how it helps streamline the model development process and make it easier for users to take advantage of PyTorch's capabilities. Whether you are a seasoned PyTorch user or new to the framework, this talk will provide valuable insights into the future of PyTorch and how it is shaping the deep learning landscape.

Title: "PyTorch 2.0: Unlocking the Power of Deep Learning with Backwards Compatibility and the Torch Compile API"
Need help coding?

Should I go to Stack Overflow or chatGPT?

Write some python code to reverse a string

```python
string = "hello world"
reversed_string = string[::-1]
print(reversed_string)
```

This will output:
```
dlrow olleh
```
Need help coding?

Do it manually using recursion

```python
def reverse_string(string):
    # Base case: return empty string or string of length 1
    if len(string) == 0 or len(string) == 1:
        return string

    # Recursive case: concatenate the last character with the reversed substring
    return string[-1] + reverse_string(string[:-1])

# Example usage
string = "hello world"
reversed_string = reverse_string(string)
print(reversed_string)
```
Other things to try

Poetry

write a haiku about cats in the style of a jimi hendrix song

Alright, here's a haiku about cats in the style of a Jimi Hendrix song:

Feline eyes aglow,
Purring riffs of love and soul,
Jazz cats, hear them roll.
Workshop: Generative AI as a creative partner
Get your OpenAI API Key

How do I get one?

Welcome to OpenAI

Start with the basics

Quickstart tutorial
Learn to building a simple sample app

Examples
Explore some example tasks

Build an application

Text completion
Generate and edit text

Image generation
Generate and edit images

Embeddings
Search, classify, and compare text

Code-completion
Understand, edit, and explain to code

Fine-tuning
Tweak a model for your use case
Get your OpenAI API Key

How do I get one?
Get your OpenAI API Key

How do I get one?
Get your OpenAI API Key

How do I get one?

Save this in a file somewhere.
Part 1: Create your Open AI Key

Create an account, save your API key, and write a story

5 MIN

https://openai.com/api/
https://discord.gg/uNRcgFVW
Part 2: Personal Assistant with openAI

? What do you want to do? (Use arrow keys)
  freetext
  rewrite
  write_passage
  write_essay
  write_segue
  » advertise
  mixologist
  pytorch_help
  chef
Part 2: Personal Assistant with openAI

? What do you want to do? advertise

Prompt template: Create a campaign to promote {product}. You will choose a target audience, develop key messages and slogans, select the media channels for promotion, and decide on any additional activities needed to reach your goals.

? product:   
Part 2: Personal Assistant with openAI

What do you want to do? advertise

Prompt template: Create a campaign to promote {product}. You will choose a target audience, develop key messages and slogans, select the media channels for promotion, and decide on any additional activities needed to reach your goals.

Product: a device that translates dog barks to English

Generating response....
Additional Activities:
1. Host a virtual launch party for the device and invite influencers, pet owners, and pet industry professionals.
2. Create a series of videos with owners using the device and sharing their experiences.
3. Offer discounts to pet owners who purchase the product.
4. Create a user-generated content campaign to encourage pet owners to share how the device helps them understand their pets.

Media Channels:
1. Social Media Ads: Facebook, Instagram, and Twitter
2. Digital Video Ads
3. Online Pet Communities
4. Influencer Marketing
5. Blogs, Websites, and Forums

Target Audience: Dog owners, age 25-45

Key Messages:
1. Know what your dog is saying with [Product Name].
2. Unlock the secret conversations between you and your dog with [Product Name].
3. Nurture a deeper understanding of your dog with [Product Name].

Slogans:
1. A New Way to Talk to Your Dog.
2. Unlock the Barkcode.
3. Don't Miss the Bark.
Workshop key concepts

Calling GPT from Python

```python
import openai

openai.api_key_path = 'apikey'

my_prompt = "Write python code... "
response = openai.Completion.create(
    model="text-davinci-003",
    temperature=0.75,
    max_tokens=650,
    top_p=1,
    frequency_penalty=0,
    presence_penalty=0,
    prompt=my_prompt
)

gpt_answer = response['choices'][0]['text']
```
Workshop key concepts

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Workshop key concepts

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gpt_answer = response['choices'][0]['text']
```
Workshop key concepts

Prompt dictionary

- YAML file containing tasks and their prompt templates
- Prompt templates contain placeholders for user inputs

advertise: "Create a campaign to promote {product}. You will choose a target audience, develop key messages and slogans, select the media channels for promotion, and decide on any additional activities needed to reach your goals."

mixologist: "Create 2 imaginative and inspiring cocktails using the following ingredients: {ingredients}. Include as many different ingredients as necessary, The cocktails must be delicious."

pytorch_help: "Write pytorch code to {task}" 

chef: "Create a michelin starred dish that I can cook in 20 minutes using the following ingredients: {ingredients}. Include as many different or exotic ingredients as you can."
Call OpenAPI from your own code
Follow the steps at your own pace

30 MIN

https://replit.com/@sus118/AskGPT-CLI-Tool#INSTRUCTIONS-README.MD
https://discord.gg/uNRcgFVW
Workshop wrap-up

We learnt

- How to create your own personal customizable tool to interact with GPT
- Calling the GPT API from Python
- Building pretty command-line tools with questionary
- Running Python on the cloud
Follow PyTorch!

For news, tutorials, and sample code

Social Networks
• @PyTorch
• www.linkedin.com/company/pytorch/
• www.facebook.com/pytorch/

GitHub
• http://github.com/pytorch

Check the events page!
• http://pytorch.org/events
Follow Meta Open Source

For news about all Meta’s other open source projects

Social Networks
• @MetaOpenSource
• www.facebook.com/pytorch/
• Instagram
Feedback

It helps us improve our content

https://forms.gle/fYp6LdCcdufTRczc7
Thank You!

Introduction to AI/ML Concepts

Justin Jeffress
Developer Advocate
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