CFT Day 1: Introduction to Data Analysis

Keywords: Python, Colab, Big Data, optional

Learning Outcomes

Introduction to Python in the Colab environment

- Learn to use Jupyter notebooks
- Learn to use the Colab environment

Introduction to Data Analysis Workflows

- Learn how to construct a workflow to ingest, analyze, and visualize large data

Exercises

Working with data in Python Colab environment		
Working with big datasets and visualization		

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CFT Day 2: Python for Data Analysis

Keywords: Pandas, Numpy, Timing, Profiling, Colab, optional

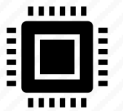
Learning Outcomes

Introduction to Numpy
- Gain familiarity with Numpy for data analysis

Introduction to Pandas
- Practice using the Pandas package tools for datasets

Introduction to Timing & Profiling
- Work with introductory examples of timing code execution

Exercises

Numpy basics		
Pandas basics		
Code Timing & Profiling		

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CFT Day 3: Use Cases in Data Science

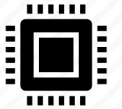
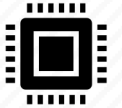
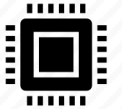
Keywords: Data Science workflows, unstructured text, image data, GeoPandas

Learning Outcomes

Highlight workflows for different kinds of data

- Understand how workflows are modified with different data types: text, images, maps
- Gain experience implementing the workflow examples

Exercises

Workflows with Image data		
Workflows with Unstructured text		
Working with Maps		

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CFT Day 4: Fundamentals of Machine Learning

Keywords: OnDemand Jupyter, Supervised ML, Unsupervised ML, Reinforcement learning

Learning Outcomes

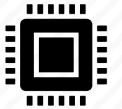
Machine Learning Basics

- Gain familiarity with the types of machine learning: supervised, unsupervised, reinforcement

Optimization strategies

- Practice with Linear regression with gradient descent
- Work with unsupervised clustering methods

Exercises

Linear Regression		
Clustering examples: Mixture of Gaussians, K-means		

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CFT Day 5: Probabilistic Modeling / Bayesian Networks

Keywords: Probabilistic Modeling, Bayesian Networks, Sentiment Analysis

Learning Outcomes

Probabilistic Modeling

- Become familiar with basic concepts in probabilistic machine learning
- Either try out coding up, or explore code for, the Naive Bayes algorithm to understand probability modeling

Bayesian Networks

- Explore the results of probabilistic cluster induction through the Latent Dirichlet Allocation algorithm

Exercises

Naïve Bayes classifier for sentiment analysis		
Latent Dirichlet Allocation		

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CFT Day 6 : Neural Networks

Keywords: Neural Networks

Learning Outcomes

Basics of Neural Networks

- Understanding the "model zoo" of current neural network approaches
- Build a first neural network in Pytorch
- Gain familiarity with Multilayer Perceptrons (MLPs)

Convolutional Neural Networks (CNNs)

- Become familiar with convolutional networks for image processing
- Compare Multilayer Perceptrons (MLPs) to Convolutional Neural Networks (CNNs)

Exercises

Building a 4-2-4 autoencoder in Pytorch		
Explore multi-layer perceptrons vs convolutional networks		

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CFT Day 7 : Exploiting HPC for ML, DL and Data Science

Keywords: MPI, NCCL

Learning Outcomes

Overview of NCCL and MPI Libraries

- Become familiar with Hardware Architectures like Interconnects and Processors
- Gain familiarity with Communication Middleware including: Message Passing Interface (MPI), CUDA-Aware MPI and NVIDIA NCCL

Benchmarking with MPI and NCCL

- Gain familiarity with OSU Micro Benchmarks for MPI, PGAS, CUDA and OPENACC
- Try out or explore the results from running the benchmarks

Exercises

Running OMB-based MPI Benchmarks		
Running OMB-based NCCL Benchmarks		

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CFT Day 8: Introduction to Data Parallel DNN Training

Keywords: Horovod, tensorflow, pytorch, data-parallel training

Learning Outcomes

Deep Learning Frameworks

- Review Deep Learning Frameworks
- Gain familiarity with DL Execution Environments
- Learn about the steps in Deep Learning training

Distributed DNN Training

- Learn about approaches to parallel DDN training
- Understand data-parallel training and trade-offs Learn about the evolution of Data-Parallel Training
- Compare training time for serial and parallel DNN training

Exercises

Setting up Distributed DNN Training using Horovod		
Evaluate the performance of Data-Parallel training for MLP and ResNet-50		

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CFT Day 9: ML and DL Frameworks for Analysis of Large Data Sets

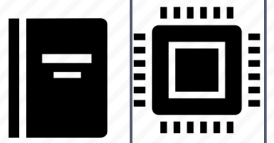
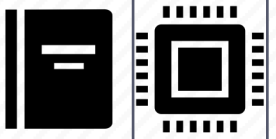
Keywords: Image classification, Naïve Bayes, SVM, Logistic regression

Learning Outcomes

Practical ML and DL workflows for text and images

- Create workflows to analyze text and images
- Realize workflows for texts and pictures on commonly used platforms
- Gain a practical understanding of widely used machine learning and deep learning methods on real data
- Learn to measure the effectiveness of machine learning methods
- Learn methods of working with hyperparameters

Exercises

Unsupervised Classification w/ Image Data	
Workflows for images and with multi-layer perceptrons and convolutional neural networks	

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SDFT Day 10: Data Science using Dask

Keywords: spark, hadoop, dask

Learning Outcomes

Software for Data Science on HPC Systems

- Gain familiarity with data growth
- Become familiar with the Apache Spark Project
- Become familiar with DASK and task graphs
- Learn about Parallel and Distributed Data Science using MPI4Dask

Exercises

Run parallel and distributed data science applications using Dask on HPC systems		
How to use multi-node GPUs for Dask-based applications		

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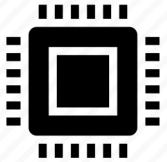
Key to Icons for exercises

Command Line

Notebook



CPU

GPU