NAIRR Pilot

National Artificial Intelligence Research Resource Pilot

Machine Learning vs. Deep Learning

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Director, AI and Big Data, PSC
April 3rd, 2025/ Track 2 – Intermediate or Advanced Participant
AI Workshop Denver, CO April 2-3, 2025

Machine Learning vs. Deep Learning

Track 2 – Intermediate or Advanced Participant

Welcome!

About this training!

- 1.5 hour of presentations + hands-on training.
- Assumes some background in Machine Learning.
- Assumes you are familiar with Jupyter notebooks, PyTorch, and OOD.
- Requires you to have set up your ACCESS ID.
- Requires access to DeltaAI and Expanse.
- Slack channel

Instructors and Support Staff

- Paola A. Buitrago, instructor

- Dana O'Connor
- Juliana Duncan
- Andrew Pasquale
- Vikram Gazula
- Devin Bayly (online)

Hands-On Segment of the Session

- How to ask for help?
    - Sticky notes on your laptop to signal that you need help!

Outline

This session provides a comparative overview of deep learning and machine learning, focusing on their distinct characteristics, applications, and requirements.

Key topics include:

1. Overview of Deep Learning vs. Machine Learning
2. Applications of Each Model
3. What You Need to Know Before Using These Models

By the end of the session, participants will understand when to use deep learning versus machine learning and the knowledge necessary to implement each effectively.

Outline

This session provides a comparative overview of deep learning and machine learning, focusing on their distinct characteristics, applications, and requirements.

Key topics include:

1. **Overview of Deep Learning vs. Machine Learning:**
   Explanation of the differences between deep learning and traditional machine learning.

2. Applications of Each Model:

3. What You Need to Know Before Using These Models:

By the end of the session, participants will understand when to use deep learning versus machine learning and the knowledge necessary to implement each effectively.

Outline

This session provides a comparative overview of deep learning and machine learning, focusing on their distinct characteristics, applications, and requirements.

Key topics include:

1. Overview of Deep Learning vs. Machine Learning:

2. **Applications of Each Model:**
   - Deep learning applications in image recognition, natural language processing, and speech recognition.
   - Machine learning applications in predictive analytics, classification, and clustering.

3. What You Need to Know Before Using These Models:

By the end of the session, participants will understand when to use deep learning versus machine learning and the knowledge necessary to implement each effectively.

Outline

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Key topics include:

1. Overview of Deep Learning vs. Machine Learning:

2. Applications of Each Model:

3. **What You Need to Know Before Using These Models:**
   - Prerequisites for using DL and ML, such as data quality, computational power, and algorithm selection.
   - Considerations for choosing the right approach based on project requirements and available resources.

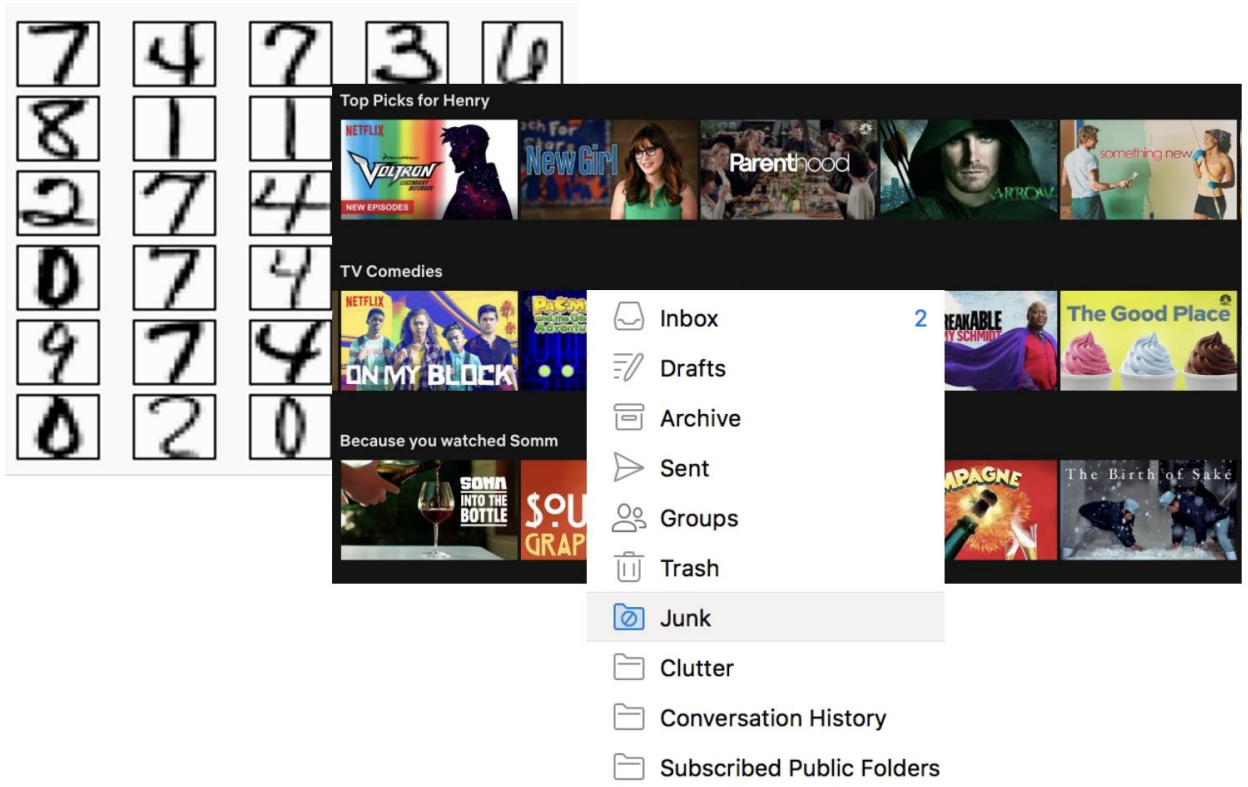
By the end of the session, participants will understand when to use deep learning versus machine learning and the knowledge necessary to implement each effectively.

Outline

1. **Overview of Deep Learning vs. Machine Learning**
2. Applications of Each Model
3. What You Need to Know Before Using These Models

What's is Machine Learning

Machine Learning a long time ago...



What's is Machine Learning

Machine Learning not so long ago...

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What's is Machine Learning

Machine learning definition:

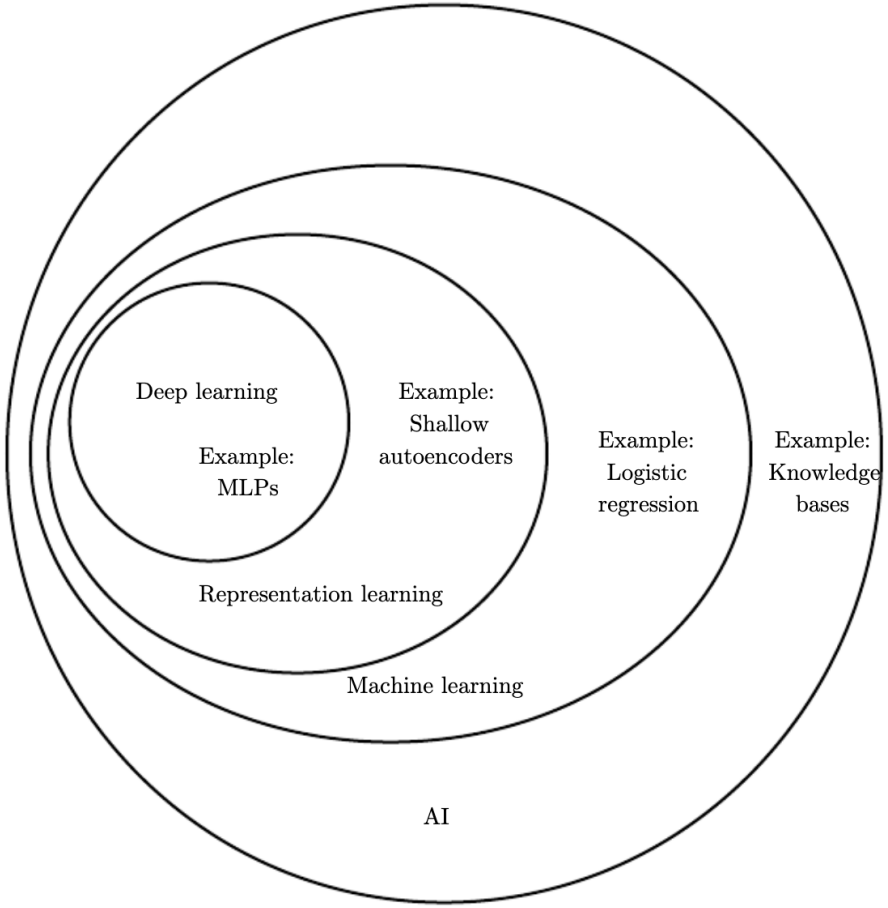
Machine Learning (ML) is a subset of artificial intelligence (AI) that enables computers to learn from data and make predictions or decisions without being explicitly programmed. Instead of following a fixed set of rules, ML models identify patterns in data and improve their performance as they are exposed to more information.

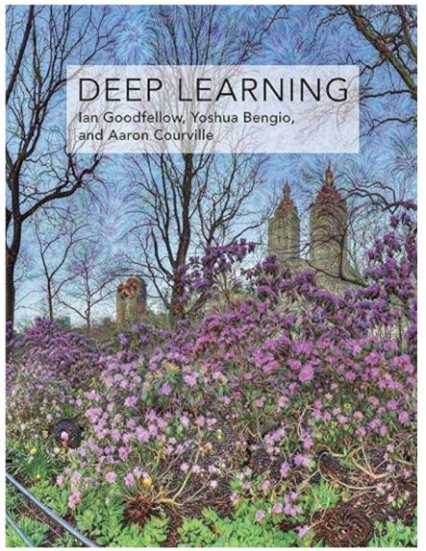
What's is Machine Learning

Machine learning definition:

- A computer program is said to **learn** if its *performance*, P, as some *task*, T, improves with *experience* E.
- Three components:

Machine Learning vs. Deep Learning



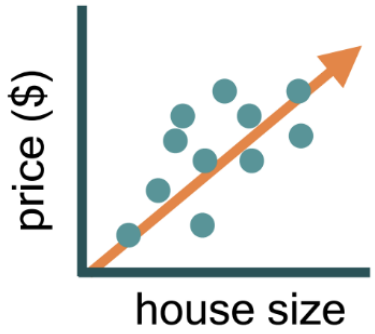


A Venn diagram showing how deep learning is a kind of representation learning, which is in turn a kind of machine learning, which is used for many but not all approaches to AI. Each section of the Venn diagram includes an example of an AI technology. Source: https://www.deeplearningbook.org/contents/intro.html

Machine Learning Pipeline

Task 1 - Regression

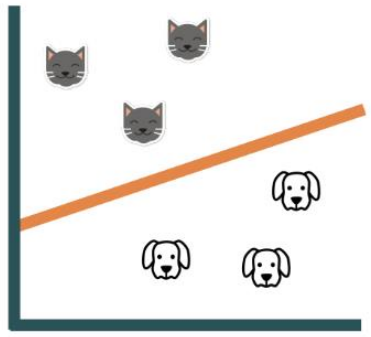
How much should you sell your house for?



input: houses & features **learn**: $x \rightarrow y$ relationship **predict**: y (*continuous*)

Task 2 - Classification

Cat or dog?



= ??

input: cats and dogs

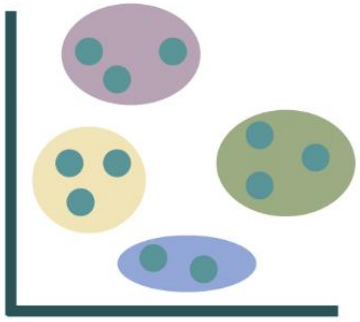
learn: $x \rightarrow y$ relationship

predict: y (*categorical*)

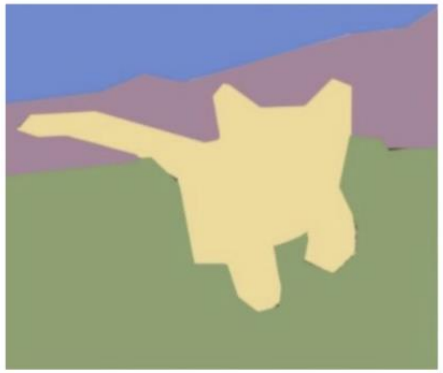
Task 3 - Clustering

How to segment an image?

input: raw pixels $\{x\}$



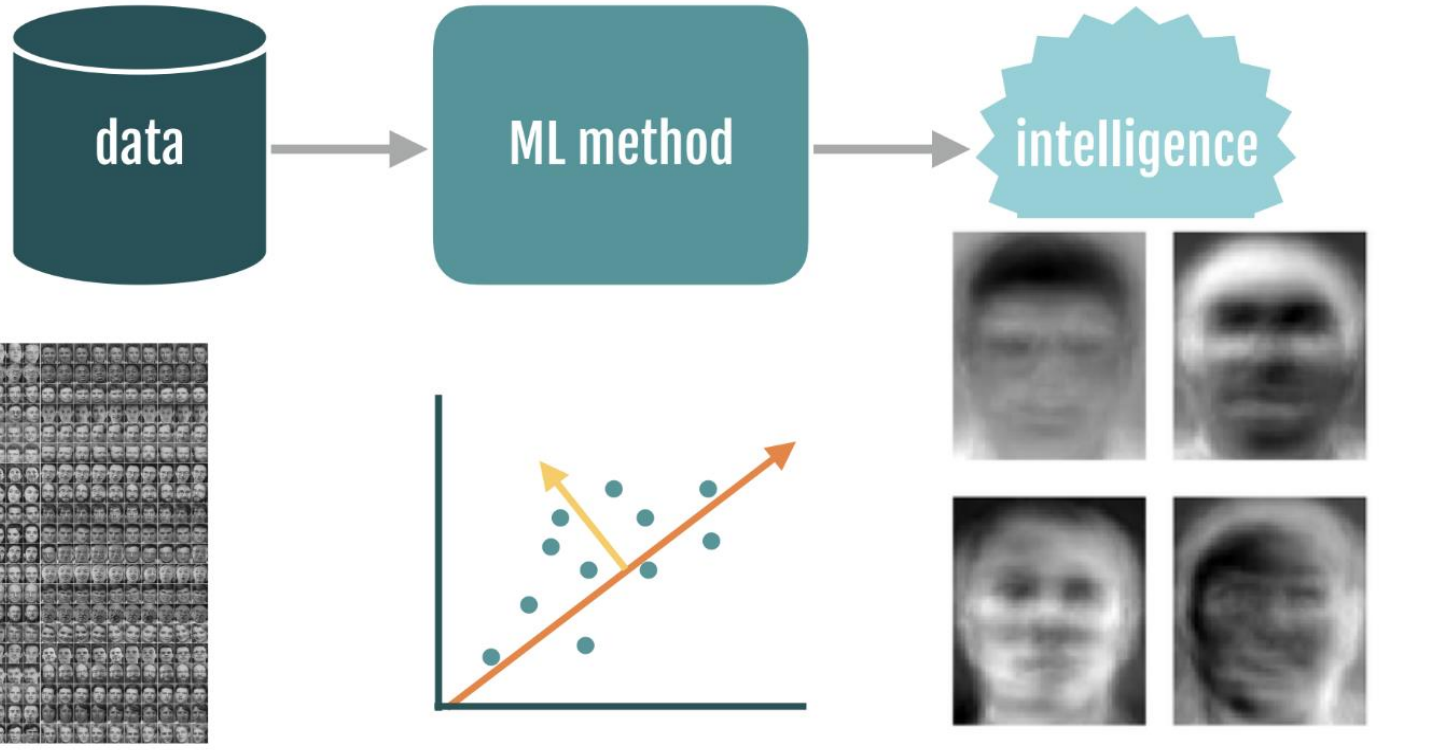
separate: $\{x\}$ into sets



output: cluster labels $\{z\}$

Task 4 - Embedding

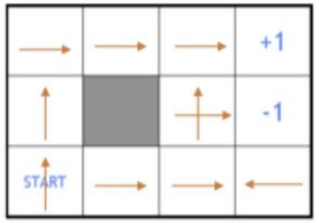
How to efficiently represent data?



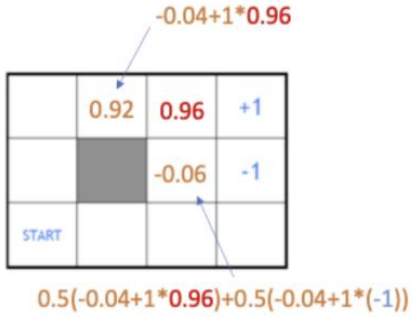
input: large dataset $\{x\}$ **find**: sources of variation **return**: representation $\{z\}$

Task 5 - Reinforcement Learning

How to take the actions that maximize reward?



input:
state-action-reward trajectories



find: Value function or Q function

actions: UP, DOWN, LEFT, RIGHT

UP

80% move UP
10% move LEFT
10% move RIGHT

return: Optimal Policy π

Other Tasks

Computer Vision

- Depth Estimation
- Image Classification
- Object Detection
- Image Segmentation
- Text-to-Image
- Image-to-Text
- Image-to-Image
- Image-to-Video
- Unconditional Image Generation
- Video Classification
- Text-to-Video
- Zero-Shot Image Classification
- Mask Generation
- Zero-Shot Object Detection
- Text-to-3D
- Image-to-3D
- Image Feature Extraction
- Keypoint Detection

Natural Language Processing

- Text Classification
- Token Classification
- Table Question Answering
- Question Answering
- Zero-Shot Classification
- Translation
- Summarization
- Feature Extraction
- Text Generation
- Text2Text Generation
- Fill-Mask
- Sentence Similarity

Audio

- Text-to-Speech
- Text-to-Audio
- Automatic Speech Recognition
- Audio-to-Audio
- Audio Classification
- Voice Activity Detection

Other Tasks

Multimodal

- Audio-Text-to-Text
- Image-Text-to-Text
- Visual Question Answering
- Document Question Answering
- Video-Text-to-Text
- Visual Document Retrieval
- Any-to-Any

Tabular

- Tabular Classification
- Tabular Regression
- Time Series Forecasting

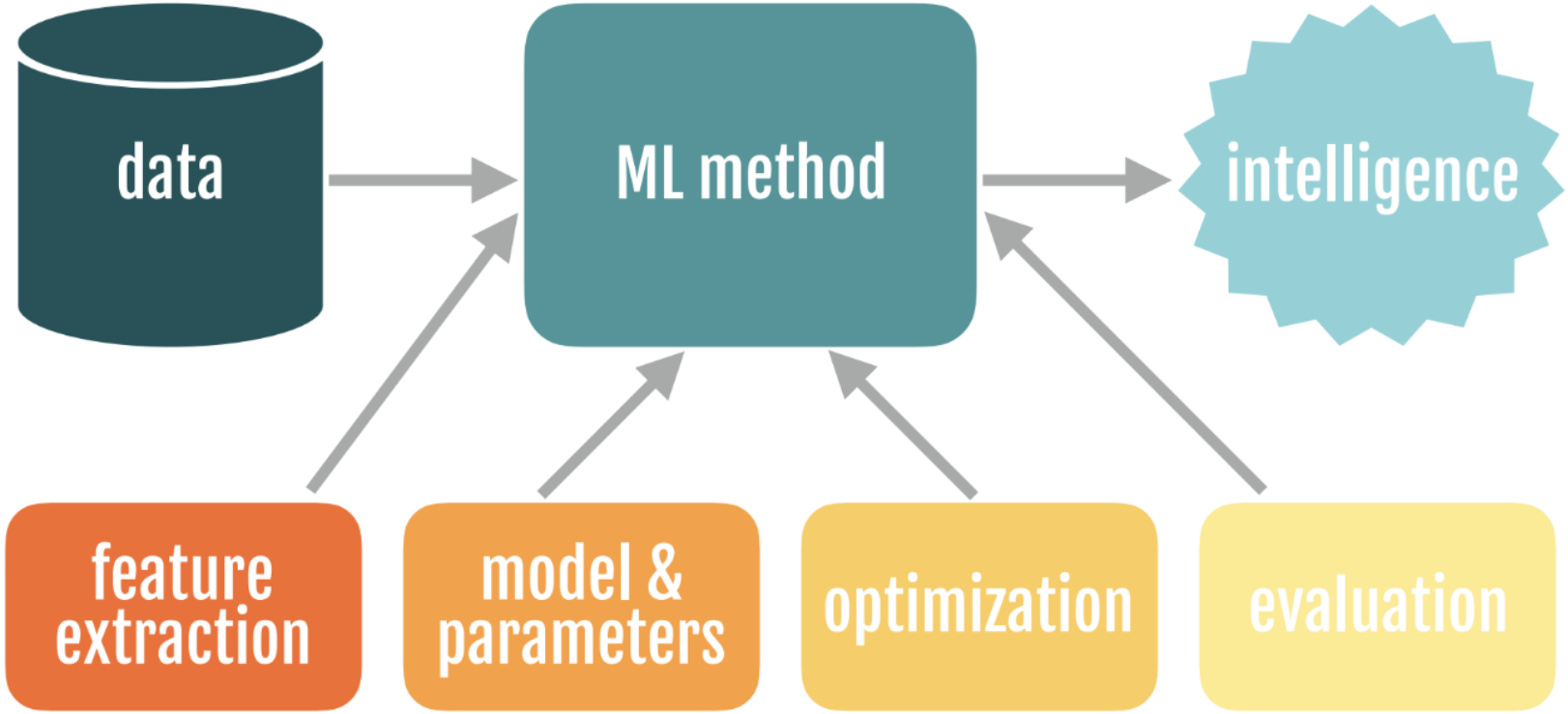
Reinforcement Learning

- Reinforcement Learning
- Robotics

Other

- Graph Machine Learning

Machine Learning Pipeline



Outline

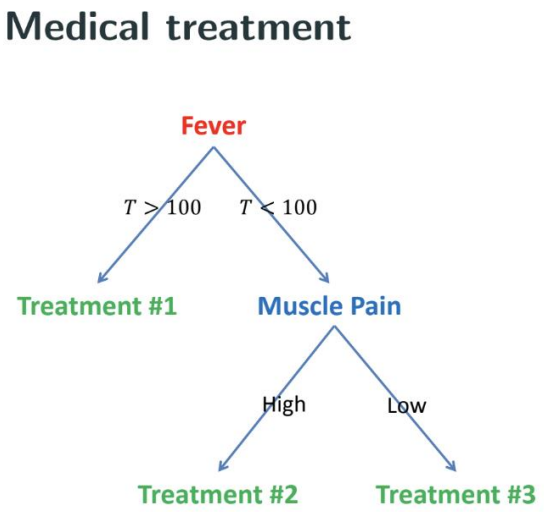
1. Overview of Deep Learning vs. Machine Learning
2. **Applications of Some Models**
3. What You Need to Know Before Using These Models

Decision Trees

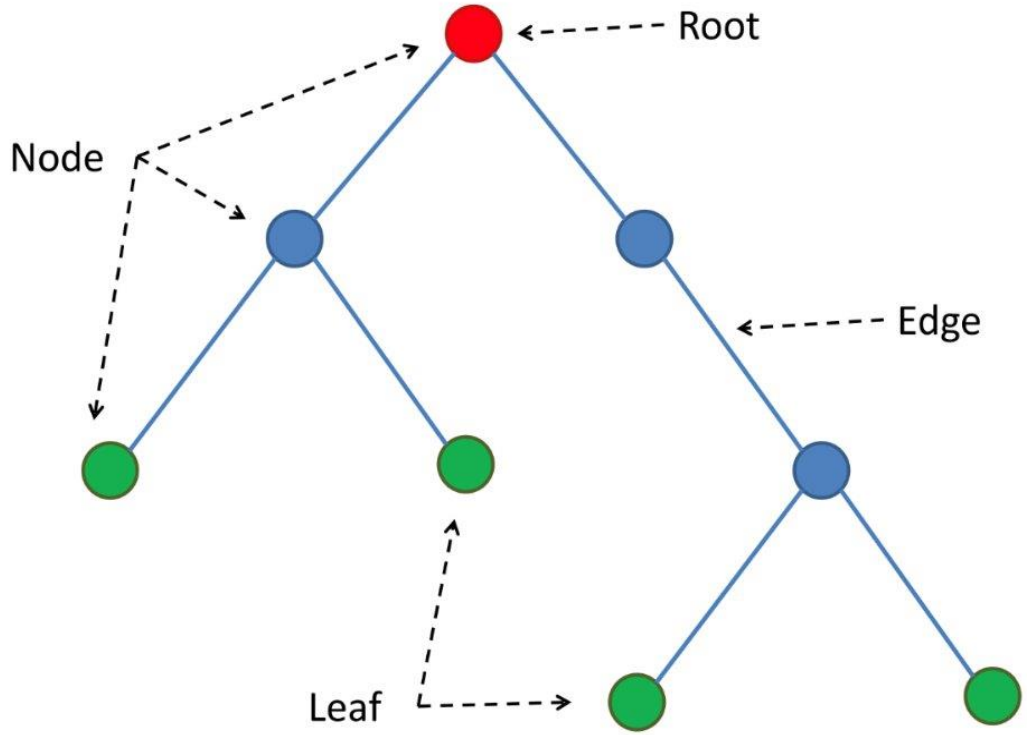
Task: Multiclass Classification

Advantages:

- Explain the reasoning in clear terms.

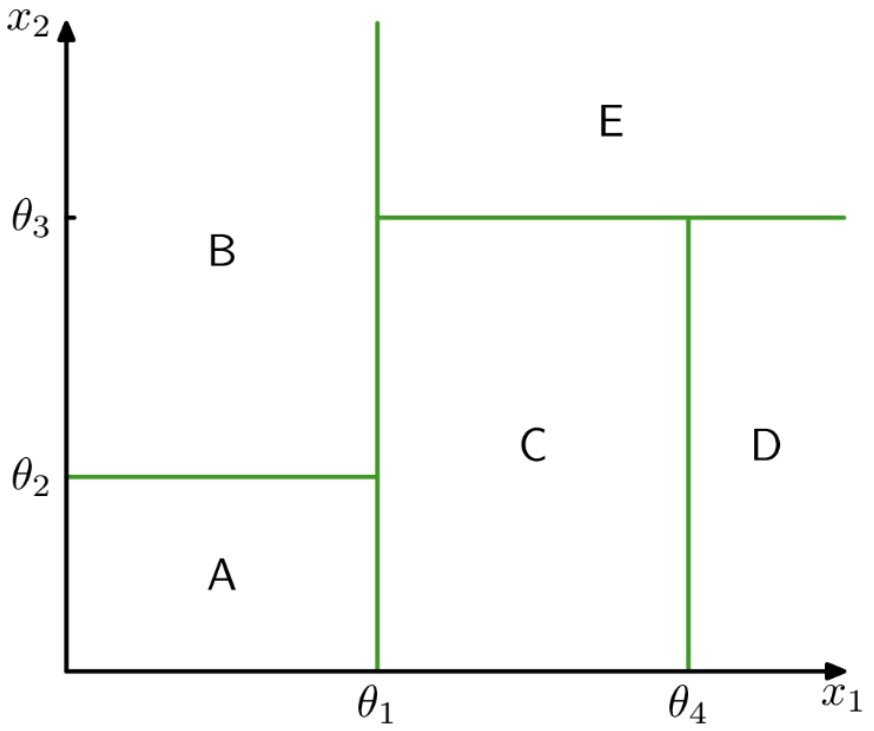


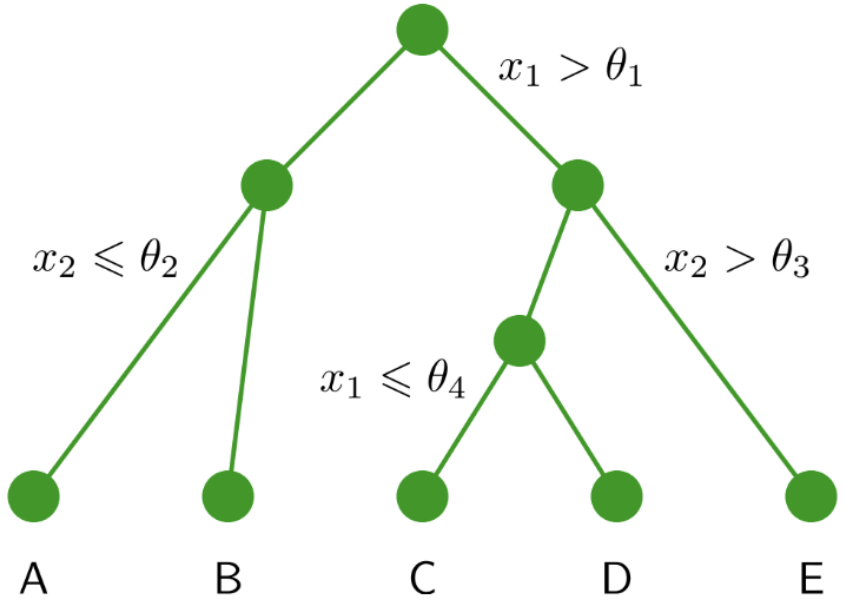
Model structure:



Decision Trees

Feature space partitioning





Decision Trees

Data example

Attributes										Target
Alt	*Bar*	*Fri*	*Hun*	*Pat*	*Price*	*Rain*	*Res*	*Type*	*Est*	*WillWait*
T	*F*	*F*	*T*	*Some*	*$$$*	*F*	*T*	*French*	*0–10*	*T*
T	*F*	*F*	*T*	*Full*	*$*	*F*	*F*	*Thai*	*30–60*	*F*
F	*T*	*F*	*F*	*Some*	*$*	*F*	*F*	*Burger*	*0–10*	*T*
T	*F*	*T*	*T*	*Full*	*$*	*F*	*F*	*Thai*	*10–30*	*T*
T	*F*	*T*	*F*	*Full*	*$$$*	*F*	*T*	*French*	*>60*	*F*
F	*T*	*F*	*T*	*Some*	*$$*	*T*	*T*	*Italian*	*0–10*	*T*
F	*T*	*F*	*F*	*None*	*$*	*T*	*F*	*Burger*	*0–10*	*F*
F	*F*	*F*	*T*	*Some*	*$$*	*T*	*T*	*Thai*	*0–10*	*T*
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F	*F*	*F*	*F*	*None*	*$*	*F*	*F*	*Thai*	*0–10*	*F*
T	*T*	*T*	*T*	*Full*	*$*	*F*	*F*	*Burger*	*30–60*	*T*

Task

- Decide whether to wait or not to wait for a service (e.g. in a restaurant).

Decision Trees

Advantages

- Can be interpreted by humans (as long as the tree is not too big)
- Computationally efficient (for shallow trees)
- Handles both numerical and categorical features.
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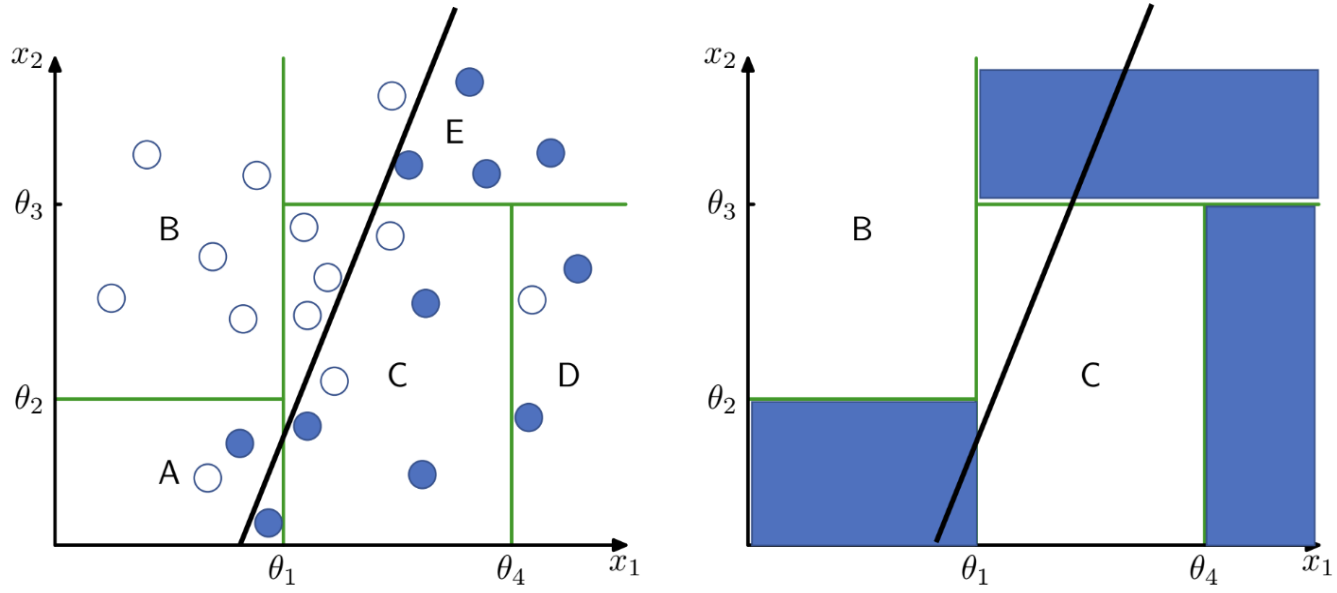

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- Grow full tree, then post-prune.
- **Use tree ensembles**

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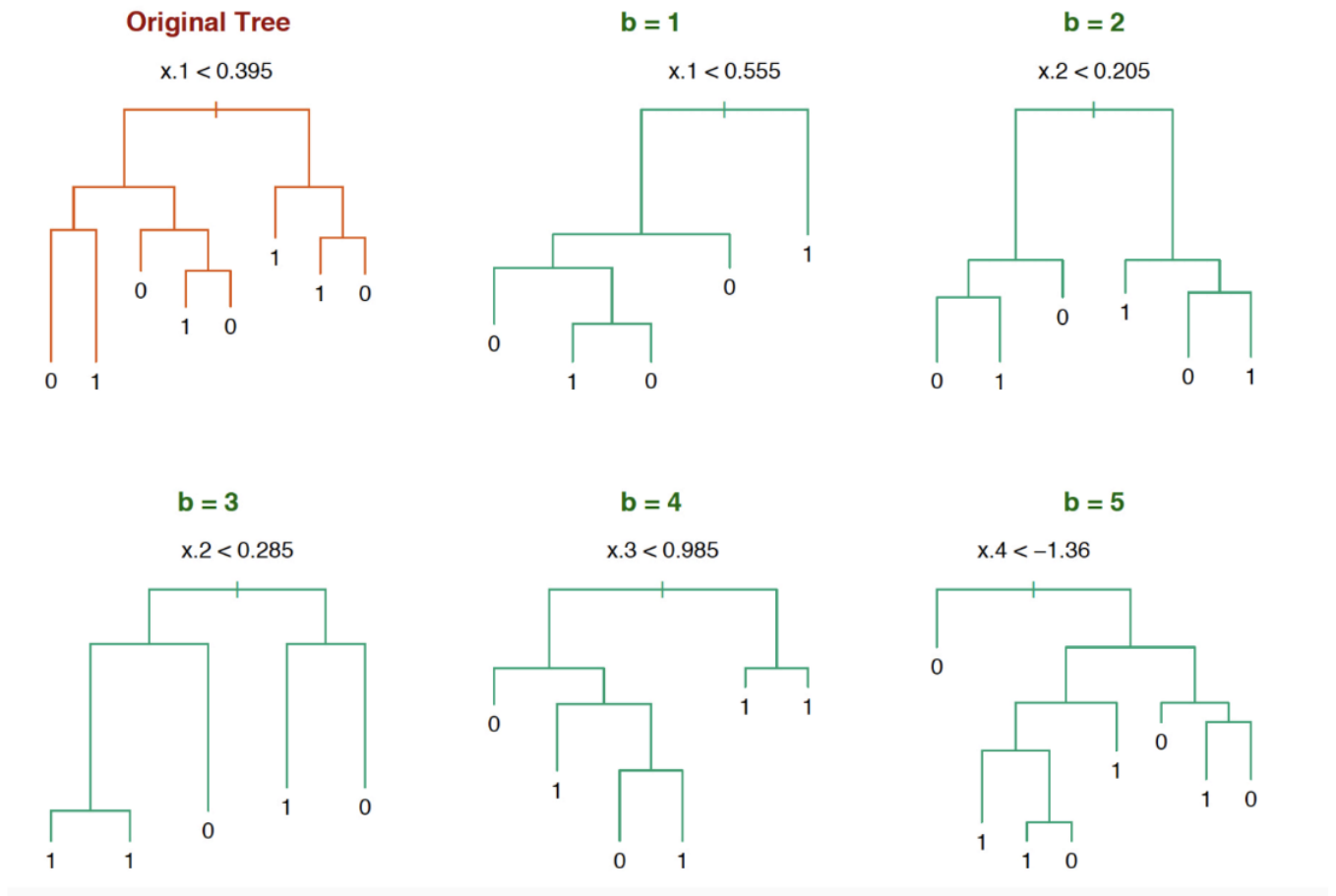
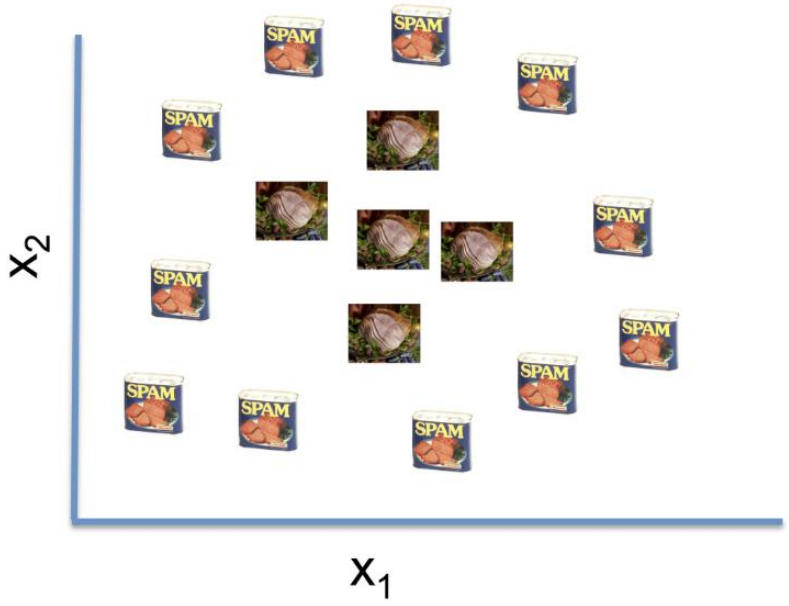
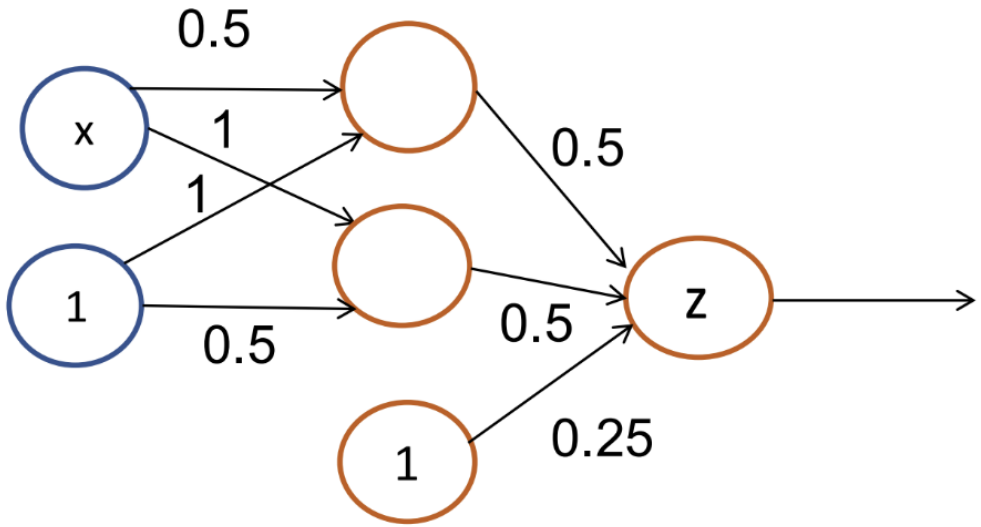
Random Forest



Neural Networks



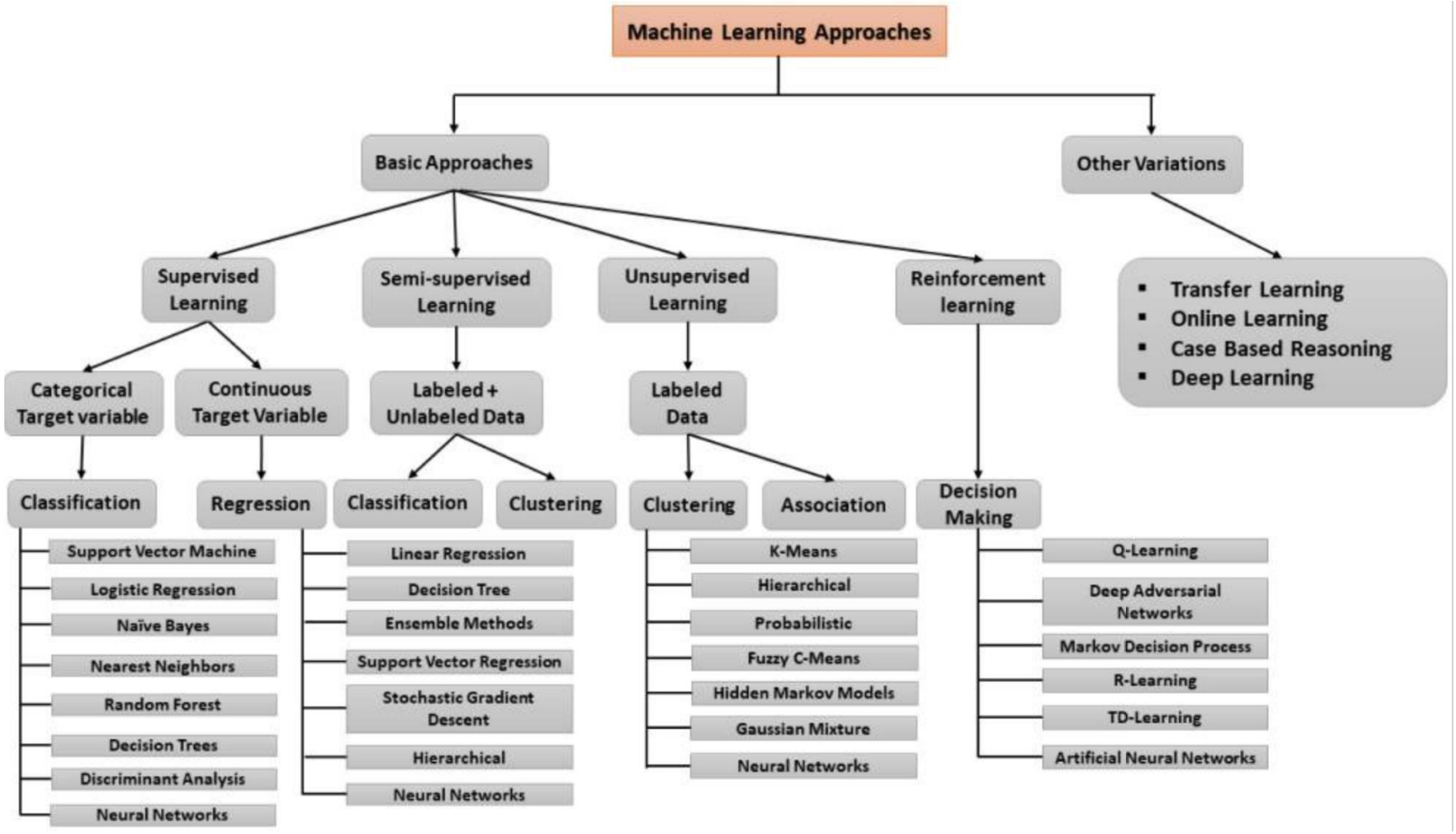


Hands-On ML and DL

Outline

1. Overview of Deep Learning vs. Machine Learning
2. Applications of Each Model
3. **What You Need to Know Before Using These Models**

What You Need to Know Before Using These Models



What You Need to Know Before Using These Models

1. Identify your task
2. Characterize the type of data available (supervised vs. unsupervised)
3. **Identify approaches that are ideally suited for your task and your data.**
    - **Aim to use the simplest approach first.**

Q&A

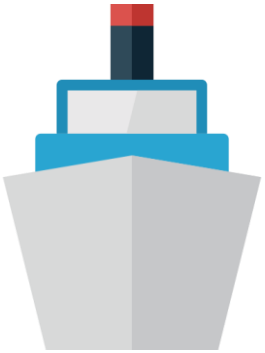
Hands-on Portion

Hands-on Portion

- Supervised Binary classification and Multiclass classification
- Jupyter notebook

Datasets:

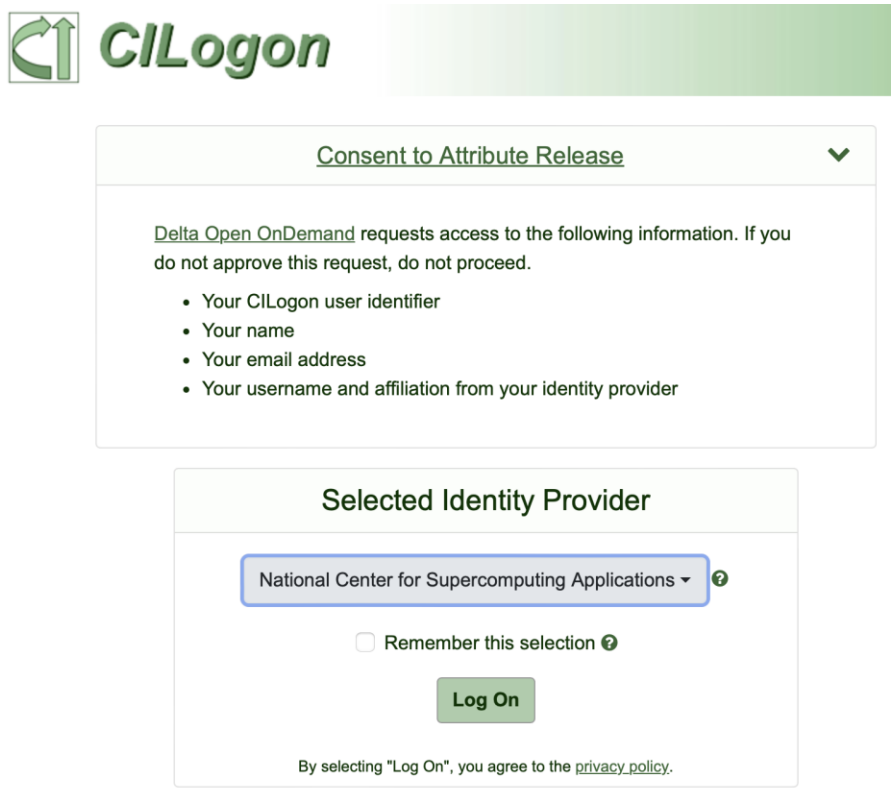





Hands-on Portion

NCSA Delta

Go to: https://openondemand.delta.ncsa.illinois.edu/



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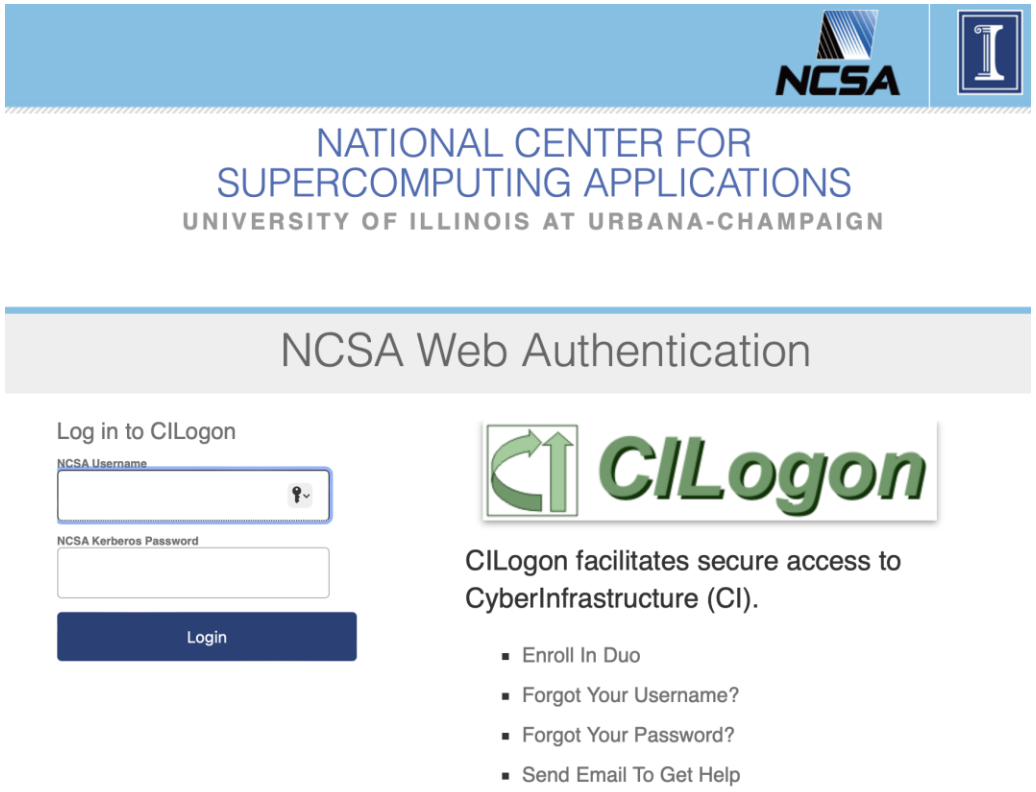

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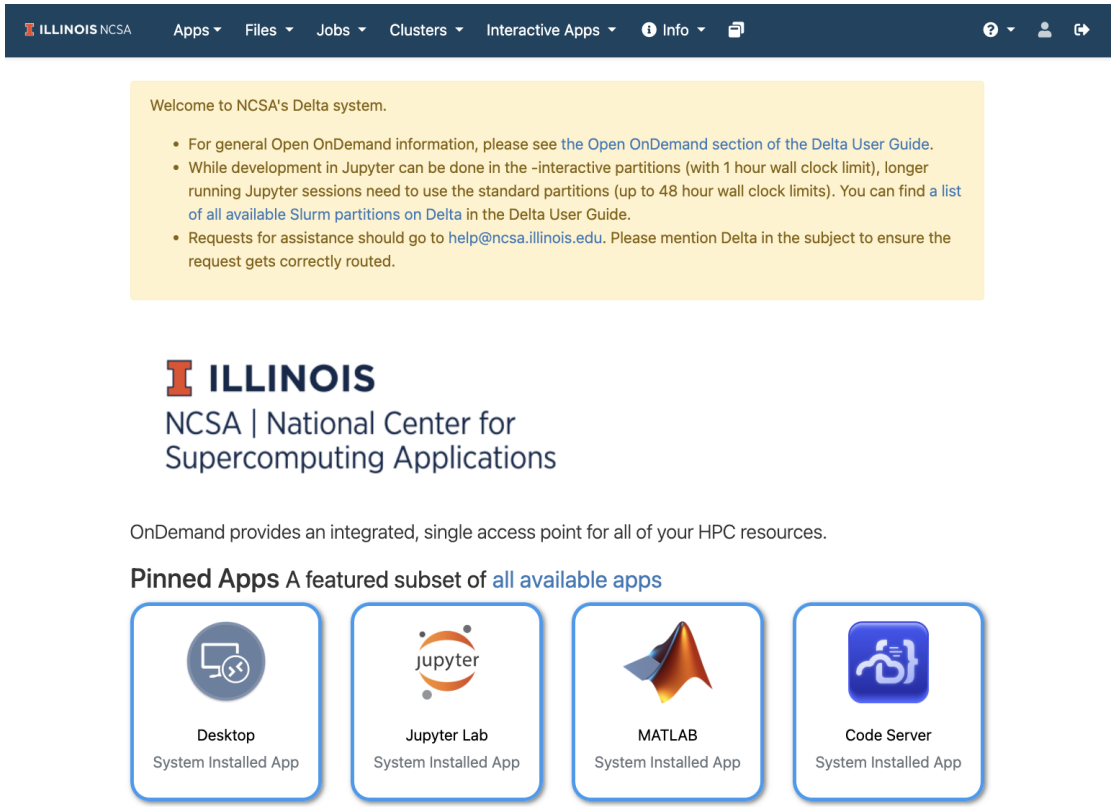

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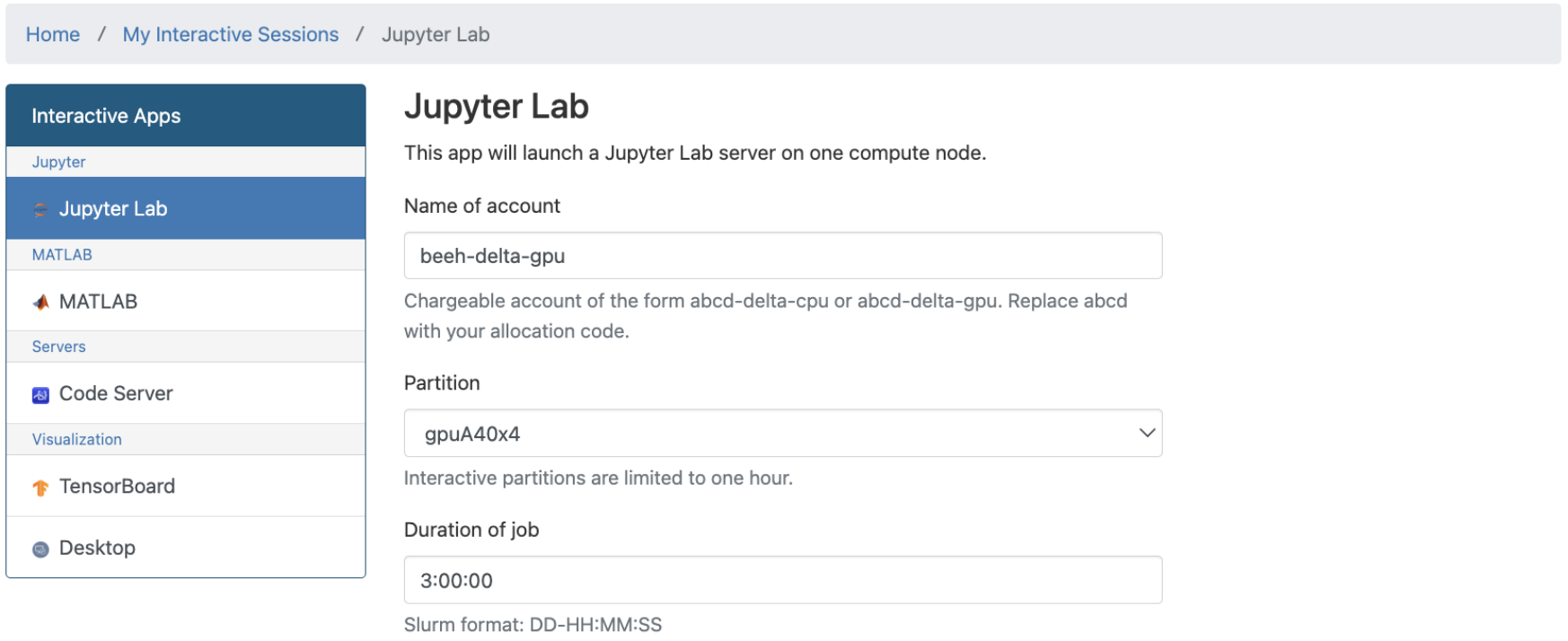

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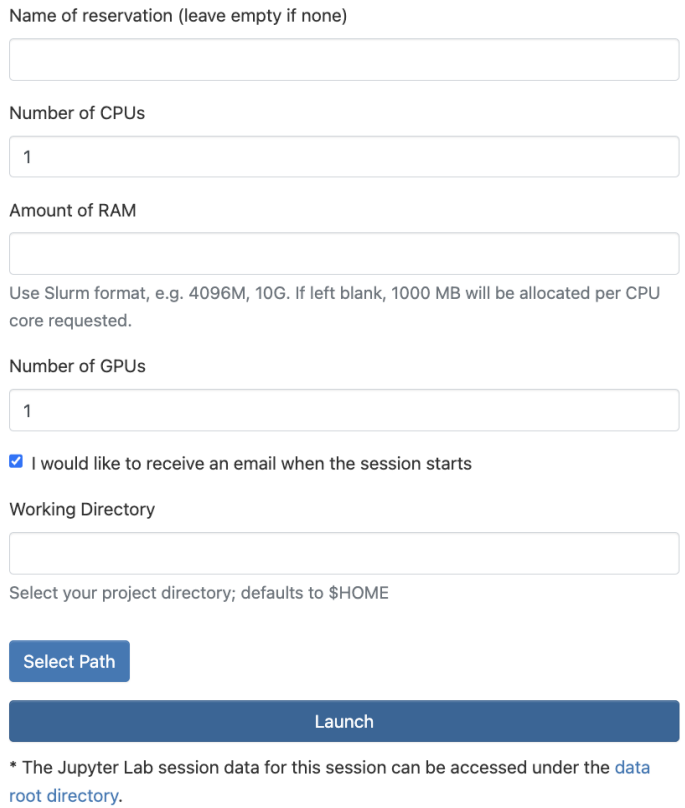

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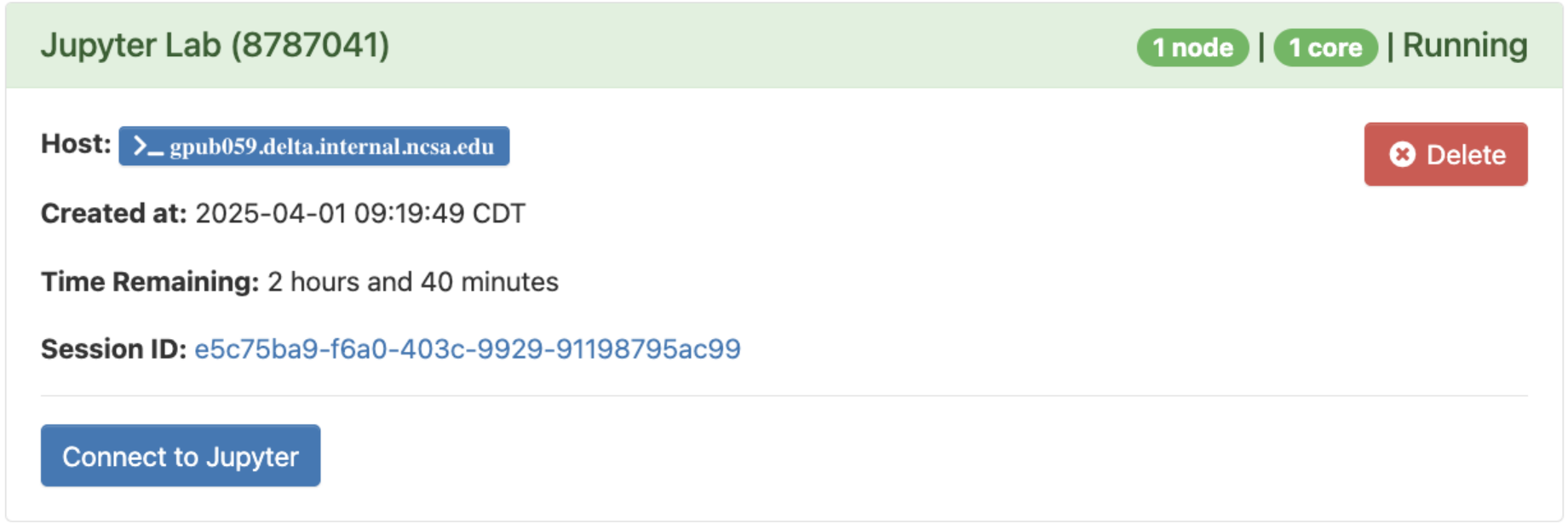

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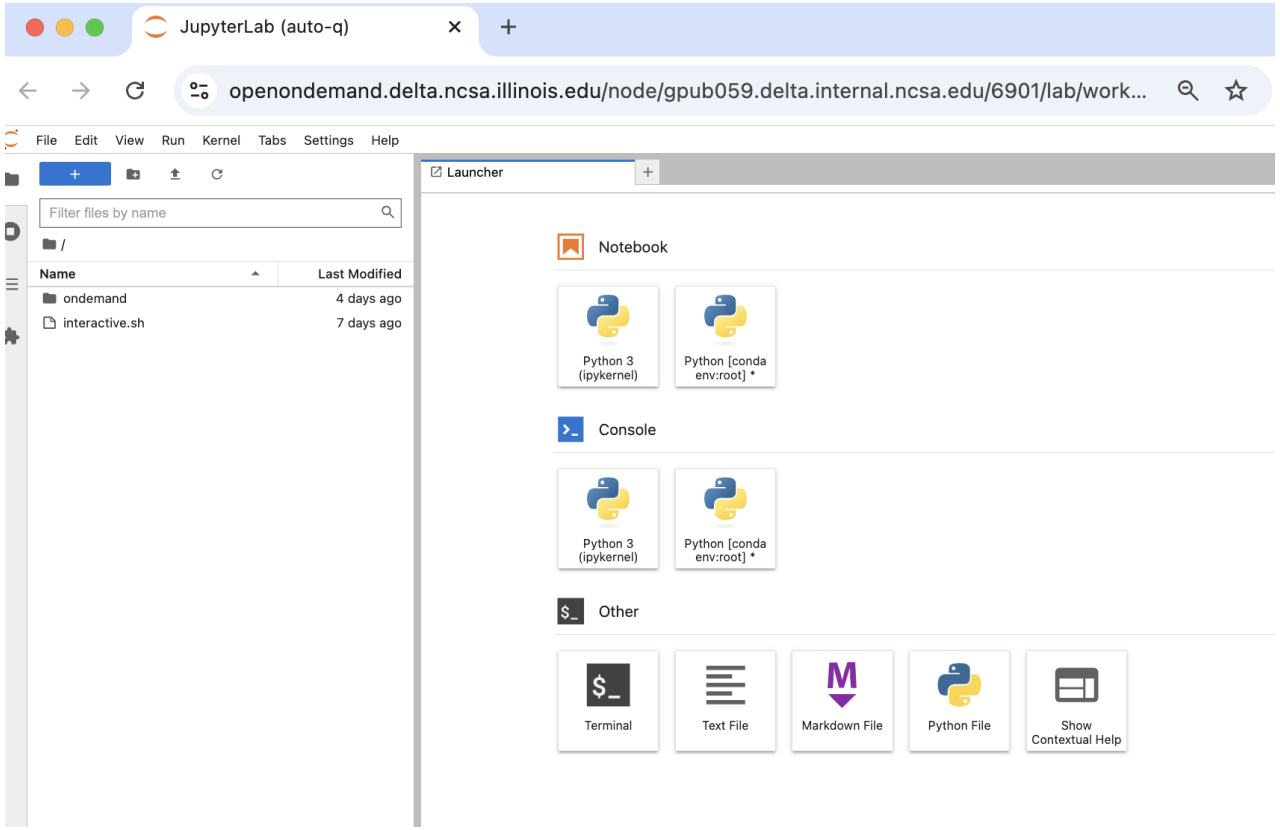

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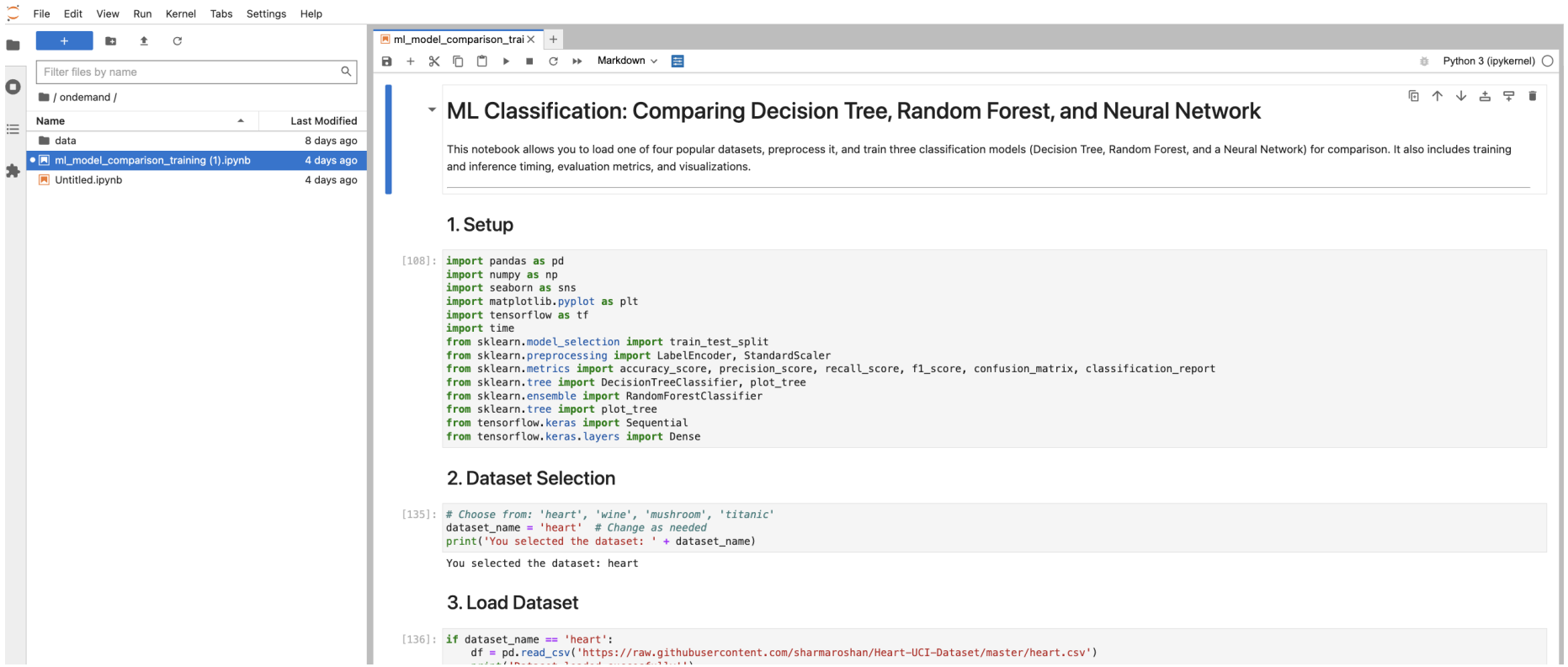

Let's work with the Jupyter notebook!

Considerations

- Target Expanse and DeltaAI

- Prepare materials so they can run on their machine
  - Environment
  - Download in advance.
    - Jupyter notebooks with solutions.
      - PDF.

- Share in the Slack channel.
  - TODO: Who is sending this message?

- Hands on exercises – even after the workshop the attendees can leverage the material.
  - Allocation will be active for 1 year.

- **Are we prepopulating the accounts with the material?**

- Resource available: ACCESS github.

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Next steps:

- DONE: Create Slack channel for the session.
- Use ACCESS account to get access to Expanse (direct login on OOD).
- Ask Laurie to help us find a time to go through the hands-on portion.

Timeline

- Intro portion of the talk (30 mins)
- Hands on portion (50 mins)
  - 5 mins to show how to get the jupyter notebook up and running
  - Classification trees (10 mins)
  - 5 mins to look at results of classification
  - Random forest (10 mins)
  - 5 mins to look at results of Random forest
  - Neural networks (10 mins)
  - 5 mins to look at results of Neural networks
- Wrap up and some considerations & Q&A (10 mins)

Aptos or Arial 28 pt black - Heading

Aptos or Arial 18 pt black Text Body

Use black, blue and white color palette