Course Portfolio Of Final Exam Project

Learning Journey Course Portfolio Of Final Exam

https://github.com/joelleyarro03/Final-Exam-Course-Portfolio

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  - Houston Community College
  - ITAI 1378 Computer Vision
  - FALL 2024 - In Person Hybrid
  - Williane Yarro
  - December 11, 2024

- Title: *Learning Journey through ITAI1378*
  Subtitle: Foundations, Applications, and Reflections in Artificial Intelligence
- Introduction to the Course:
  This course provided an in-depth exploration of Artificial Intelligence, covering its fundamental concepts, applications, and ethical considerations. Through hands-on projects and reflective assignments, I developed technical skills and critical thinking abilities essential for AI development.
- Key Learning Objectives:
- Course Focus:
- Understanding the principles and applications of neural networks and computer vision.
- Exploring advanced architectures and their efficiency in image processing.
- Discovering the role of AI in video analysis and autonomous systems.
- Gaining insights into generative models and their innovative applications.

  Master foundational AI concepts.

  Build and evaluate machine learning and deep learning models.

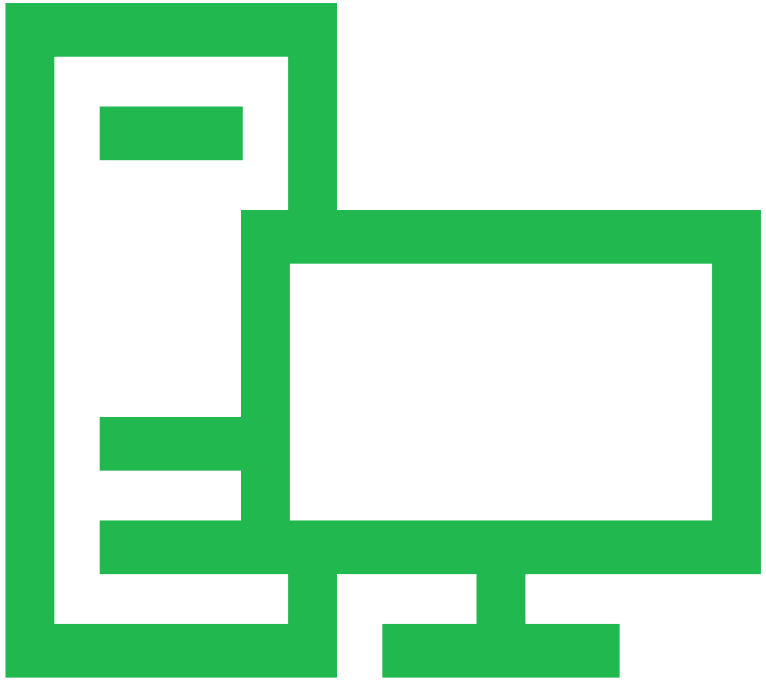
  Analyze the ethical and societal implications of AI.

  Visual: A diagram showcasing AI's core branches (NLP, CV, RL, etc.).

- Slide Title: Introduction
- Overview of the Course and Its Objectives
- The course aimed to provide foundational knowledge of artificial intelligence and its subfields,
- such as machine learning, natural language processing, and computer vision.
- Course Focus:
- Understanding key AI concepts.
- Exploring tools and frameworks for AI development.
- Learning about real-world applications.
- Key Areas Covered:
- Supervised and Unsupervised Learning.
- Deep Learning and Neural Networks.
- AI Ethics and Responsible AI Development.
- Personal Learning Objectives and Expectations:
- Gain hands-on experience with AI tools.
- Develop problem-solving skills using AI frameworks.
- Understand how to apply AI in real-world scenario

Module 03: Fundamentals of Neural Networks

- Module 03 served as the foundation for understanding the basics of neural networks, a crucial building block for artificial intelligence. It introduced the architecture of neural networks, including input, hidden, and output layers, and explored how neurons process data using weights, biases, and activation functions. These concepts were essential for grasping how neural networks learn patterns in data and make predictions.
- One of the module's highlights was the practical demonstration of Multi-Layer Perceptrons (MLPs), which use fully connected layers to process data. While MLPs are effective for simple tasks, their limitations became evident when applied to image data. The need to flatten 2D image matrices into 1D vectors results in a loss of spatial information, which is critical for recognizing patterns in images. For instance, MLPs fail to maintain the relationships between pixels, leading to suboptimal performance in image classification tasks.
- This module emphasized the need for more specialized architectures, paving the way for the study of Convolutional Neural Networks (CNNs) in subsequent modules. It was a pivotal step in understanding the evolution of AI models and highlighted the importance of designing networks tailored to specific data types.
- By the end of this module, I had a solid grasp of neural network fundamentals and an appreciation for the advancements that make modern AI systems more efficient and capable of handling complex tasks like computer vision



Module 07 - Introduction to Convolutional Neural Networks (CNNs)

- Overview of the Module and Its Objectives:
- This module introduced the foundational concepts of Convolutional Neural Networks (CNNs), a critical advancement in computer vision. It focused on how CNNs process and interpret image data, overcoming the limitations of traditional neural networks like Multi-Layer Perceptrons (MLPs).
- Module Focus:
- Understand the structure and components of CNNs, including convolutional, pooling, and fully connected layers.
- Explore how CNNs extract spatial features and preserve relationships within images.
- Learn about practical implementations for tasks like image classification and object detection.
- Key Areas Covered:
- Comparison of CNNs with MLPs and their advantages for image processing.
- Role of convolutional and pooling layers in feature extraction and dimensionality reduction.
- Applications of CNNs in tasks such as digit recognition, facial recognition, and more.
- Personal Learning Objectives and Expectations:
- Develop an understanding of how CNNs address the challenges of image data processing.
- Gain hands-on experience in implementing CNNs for real-world applications.
- Build a foundation for exploring advanced architectures in later modules.

Module 09 - Advanced Architectures in Deep Learning

- Overview of the Module and Its Objectives:
- This module explored advanced architectures in deep learning, focusing on their role in addressing the limitations of traditional models. It emphasized how these architectures improve performance and scalability for complex tasks in computer vision.

- Module Focus:
- Study the evolution of deep learning architectures, including ResNet, VGGNet, and Inception.
- Understand the importance of innovations like skip connections and multi-scale feature extraction.
- Learn how advanced architectures enhance the efficiency and accuracy of AI models.

- Key Areas Covered:
- Introduction to deeper networks and their role in overcoming challenges like vanishing gradients.
- Use of transfer learning with pre-trained models for faster training and improved performance.
- Practical applications of advanced architectures in areas like object detection and semantic segmentation.
- Personal Learning Objectives and Expectations:
- Develop an understanding of how advanced architectures solve limitations of basic CNNs.
- Learn to utilize pre-trained models and transfer learning to enhance efficiency.
- Explore real-world applications that benefit from these state-of-the-art architectures.

Module 11 - Generative Models for Computer Vision

- ## Overview of the Module and Its Objectives:

- This module delved into the world of generative models, focusing on their ability to create, enhance, and manipulate visual content. It introduced key concepts and explored how generative AI complements traditional computer vision approaches.

- ## Module Focus:

- Understand the principles behind Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs).
- Learn how generative models synthesize realistic images and enhance existing data.
- Explore the ethical implications of generative AI in computer vision.

- ## Key Areas Covered:

- Overview of GANs: The adversarial training process between generators and discriminators.
- Applications of VAEs in data reconstruction and image generation.
- Emerging techniques like Diffusion Models and their role in high-quality image generation.

- ## Personal Learning Objectives and Expectations:

- Gain hands-on experience implementing GANs and VAEs for creative and practical tasks.
- Understand the challenges and ethical considerations of generative AI, such as deepfakes.
- Explore the potential of generative models in enhancing AI applications like image synthesis and super-resolution.

Module 12 - Computer Vision for Autonomous Systems

- Overview of the Module and Its Objectives:
- This module explored the integration of computer vision with autonomous systems, focusing on how AI enables machines to perceive, analyze, and interact with their environments. It highlighted real-time decision-making and navigation in intelligent systems.
- Module Focus:
- Understand the role of computer vision in autonomous systems like self-driving cars and robotics.
- Learn how object detection, scene understanding, and motion tracking enable autonomous behavior.
- Explore reinforcement learning for training AI agents in dynamic environments.
- Key Areas Covered:
- The importance of object recognition and scene understanding in navigation and decision-making.
- Applications of reinforcement learning for real-time learning and adaptation.
- Challenges of real-world implementations, including variable lighting, occlusions, and computational demands.
- Personal Learning Objectives and Expectations:
- Develop an understanding of how computer vision empowers autonomous systems.
- Learn about the practical challenges and solutions in integrating AI into real-world scenarios.
- Explore innovative use cases for autonomous systems in industries such as transportation and robotics.

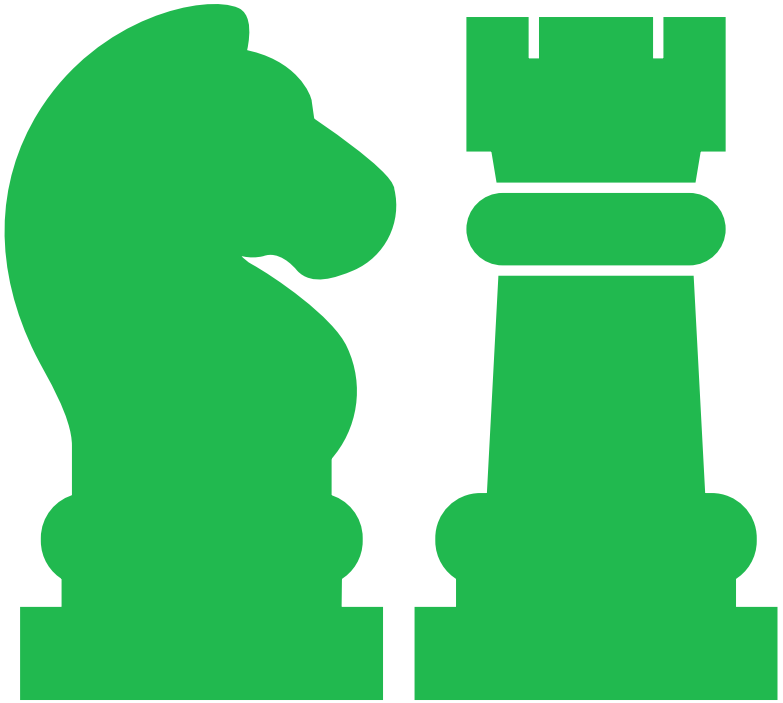
Module 3 - Games, Prelude to A.I.

- Overview: Understanding how games have influenced the development of AI systems.
- Key Learnings:

  The role of game theory and simulations in AI research.

  How AI has been used in games to create intelligent agents and strategies.

  Early AI applications in games and their impact on modern AI systems.



Module 5 - Machine Learning - The Data

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- Summary Slide:
- This module introduced machine learning concepts with a focus on data collection, preprocessing, and the importance of data quality. It highlighted the critical role data plays in training machine learning models.
- Key Points Slide:
- Data Types: Structured, unstructured, and semi-structured data.
- Data Preprocessing: Cleaning, transforming, and normalizing data before feeding it into models.
- Data Quality: The impact of data accuracy and completeness on model performance.
- Activities and Results Slide:
- Assignments: Data preprocessing for a predictive model using Python.
- Results: Improved data handling skills and model accuracy through better data practices.
- Reflection Slide:
- Challenges: Working with incomplete or noisy datasets.
- Solutions Implemented: Used data cleaning techniques like imputation and normalization.
- Key Takeaways: Data preprocessing is crucial for building effective machine learning models.

Module 6 - Machine Learning - The Pipeline

Overview: A deep dive into the machine learning pipeline, from data collection to model deployment.

Key Learnings:

The different stages in an ML pipeline: data collection, preprocessing, model training, and evaluation.

Tools and frameworks used in developing ML models.

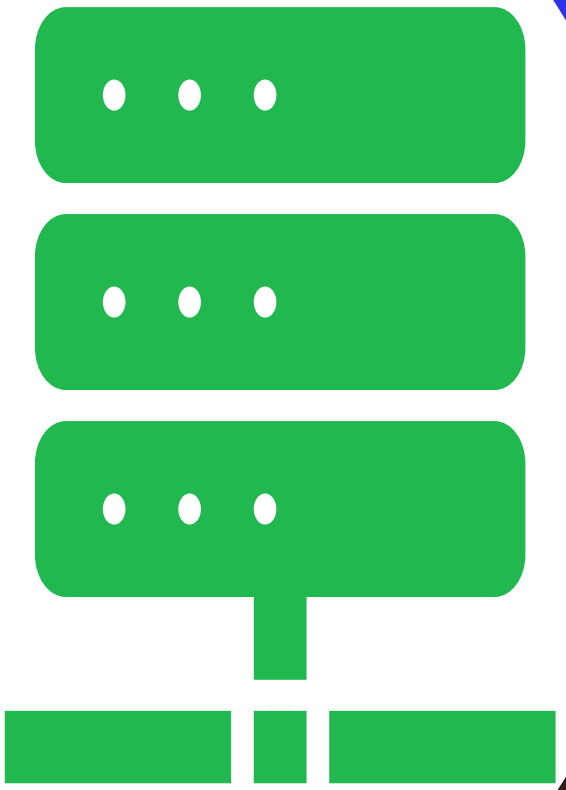
Real-world examples of ML model implementation.

Module 7 - Deep Learning - Neural Networks

- Overview: Introduction to deep learning and the structure of neural networks.
- Key Learnings:
- The architecture of artificial neural networks and how they mimic human brain function.
- The role of activation functions, weights, and biases in network training.
- Applications of neural networks in image recognition, speech recognition, and more.

Module 8 Deep Learning - Big Data and Architectures

- Module 8 - Deep Learning - Big Data and Architectures
- Title Slide:
- Module 8: Deep Learning - Big Data and Architectures
- Summary Slide:
- This module introduced the relationship between deep learning and big data, focusing on how deep learning models scale with vast datasets. It also covered various deep learning architectures, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs).
- Key Points Slide:
- Deep Learning and Big Data: Deep learning models require massive datasets to perform well.
- CNNs and RNNs: CNNs are used in image processing, while RNNs are ideal for sequential data like text.
- Architectural Challenges: Designing and training deep learning models that can scale with big data.
- Activities and Results Slide:
- Activities: Built a simple CNN for image classification using TensorFlow.
- Results: Gained hands-on experience with deep learning frameworks and architectures.
- Reflection Slide:
- Challenges: The complexity of building and tuning deep learning models.
- Solutions Implemented: Utilized pre-trained models and transfer learning to accelerate the process.
- Key Takeaways: Big data is essential for training deep learning models, and choosing the right architecture is crucial for optimal performance.



- Module 9: Computer Vision - Image Processing
- Summary Slide:
- This module focused on the fundamentals of computer vision and image processing, including techniques like edge detection, image segmentation, and feature extraction. It also discussed how AI algorithms can analyze visual data to recognize objects and patterns.
- Key Points Slide:
- Image Processing Techniques: Edge detection, filtering, and segmentation.
- Computer Vision Tasks: Object recognition, face detection, and scene understanding.
- Tools: OpenCV and other libraries for image processing.
- Activities and Results Slide:
- Assignments: Implemented image filtering and edge detection on sample images.
- Results: Gained practical experience in basic computer vision tasks.
- Reflection Slide:
- Challenges: Understanding the complexity of visual data and feature extraction.
- Solutions Implemented: Used pre-built functions in OpenCV to streamline the process.
- Key Takeaways: Image processing is a foundational skill in computer vision, enabling machines to interpret and analyze visual data.

Module 10 - Natural Language Processing - Basics

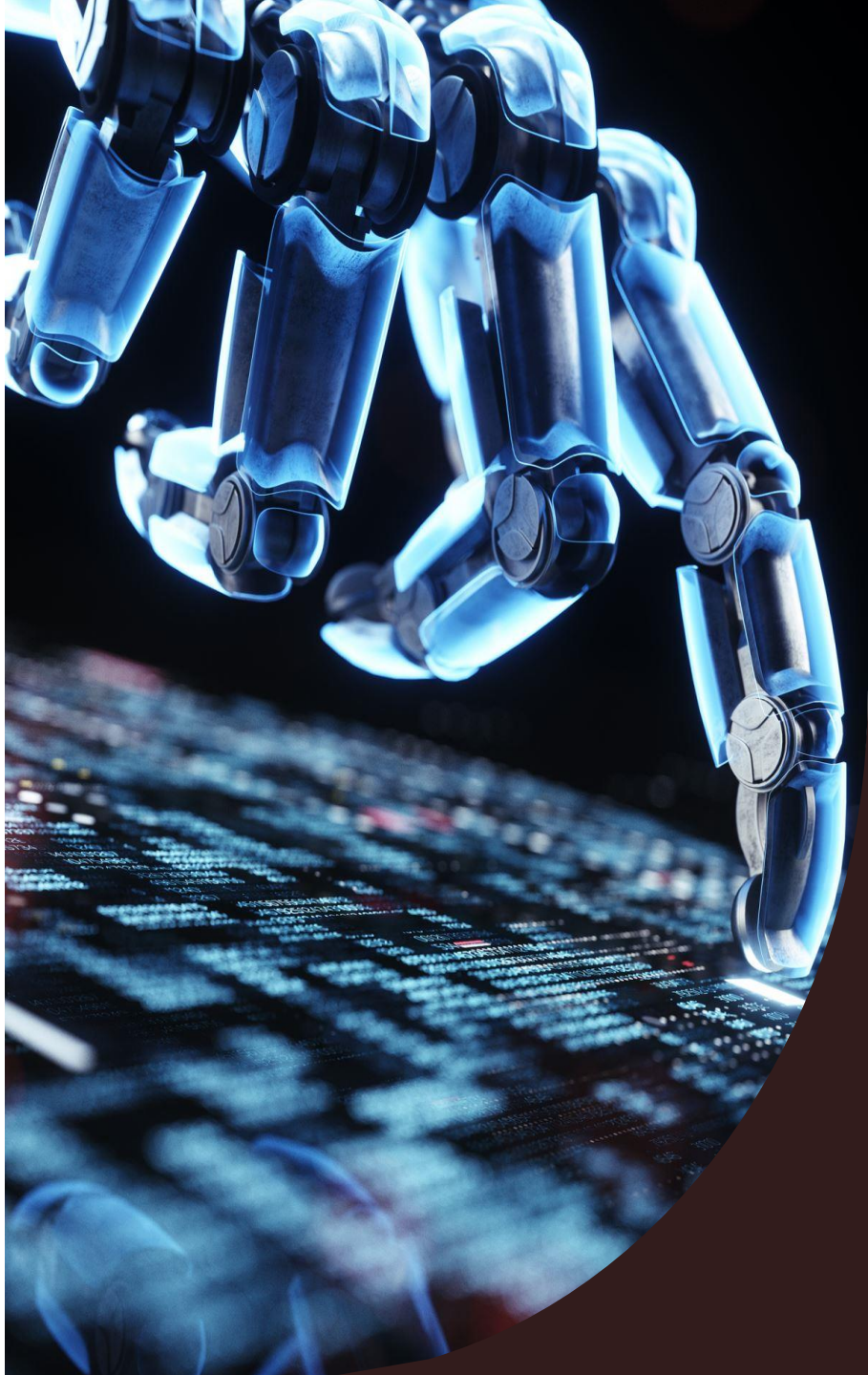
- Summary Slide:
- This module introduced the basics of natural language processing (NLP), covering key tasks like tokenization, part-of-speech tagging, and named entity recognition. It emphasized how NLP enables machines to understand and manipulate human language.
- Key Points Slide:
- NLP Tasks: Tokenization, POS tagging, and NER.
- Challenges: Ambiguity in language and context-dependent meanings.
- Applications: Text classification, sentiment analysis, and translation.
- Activities and Results Slide:
- Activities: Implemented a simple text classifier using NLP techniques.
- Results: Gained experience in handling text data and understanding language patterns.
- Reflection Slide:
- Challenges: Managing the complexity of natural language and its many nuances.
- Solutions Implemented: Focused on basic NLP tasks first to build a strong foundation.
- Key Takeaways: NLP is crucial for AI systems that interact with humans through text or speech.

Module 11 - Natural Language Processing - LLMs

- Module 11: Natural Language Processing - LLMs
- Summary Slide:
- This module delved into large language models (LLMs), such as GPT-3, and how they are trained on vast datasets to generate human-like text. It covered their applications in chatbots, text generation, and machine translation.
- Key Points Slide:
- LLM Architecture: Transformer-based models that use self-attention mechanisms.
- Training: LLMs are trained on massive text datasets to learn context and language patterns.
- Applications: Text generation, chatbots, and translation.
- Activities and Results Slide:
- Projects: Experimented with GPT-3 to generate text responses based on prompts.
- Results: Observed how LLMs generate coherent and contextually appropriate text.
- Reflection Slide:
- Challenges: Understanding the vast computational power required to train LLMs.
- Solutions Implemented: Focused on experimenting with pre-trained models to understand their capabilities.
- Key Takeaways: LLMs are powerful tools for text generation, but require large datasets and computational resources.

Module 12 - AI Agents

- Summary Slide:
- This module introduced AI agents as autonomous systems that perceive their environment, make decisions, and learn from experience. It explored their applications in virtual assistants, self-driving cars, and robotics.
- Key Points Slide:
- AI Agent Definition: An AI program that interacts autonomously with an environment to achieve specific goals.
- Reinforcement Learning: AI agents learn through trial, error, and rewards.
- Applications: Virtual assistants, recommendation systems, and self-driving cars.
- Activities and Results Slide:
- Assignments: Created a simple AI agent for a game using reinforcement learning.
- Results: Learned how agents can autonomously learn and adapt in dynamic environments.
- Reflection Slide:
- Challenges: Developing agents that can make decisions in unpredictable environments.
- Solutions Implemented: Used Q-learning algorithms to train agents effectively.
- Key Takeaways: AI agents are revolutionizing various industries by acting autonomously and learning from their environment.



Slide: Conclusion & Future Objectives

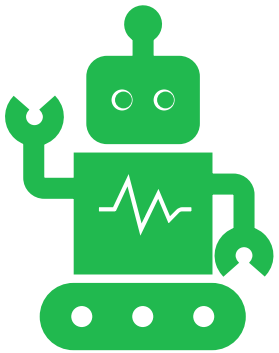
- Conclusion & Future Objectives
- Summary of My Learning Journey:
- Over the course of this AI program, I have gained a comprehensive understanding of the various facets of Artificial Intelligence, from its foundational principles to its real-world applications in machine learning, deep learning, computer vision, natural language processing (NLP), and robotics.
- I started by learning about the core concepts of AI and understanding its impact on society. As I moved through the modules, I delved into specialized fields such as deep learning and computer vision, exploring the power of AI in tasks like image recognition and natural language understanding.
- Through hands-on assignments and projects, I developed a practical understanding of how AI models are trained and deployed. This included working with data preprocessing, building machine learning pipelines, and exploring the integration of AI with robotics to create autonomous systems.
- I also explored AI agents, understanding their ability to learn from the environment and make decisions, as well as the ethical challenges they pose. Through case studies and practical applications, I gained insights into how AI is reshaping industries such as healthcare, entertainment, and autonomous transportation.

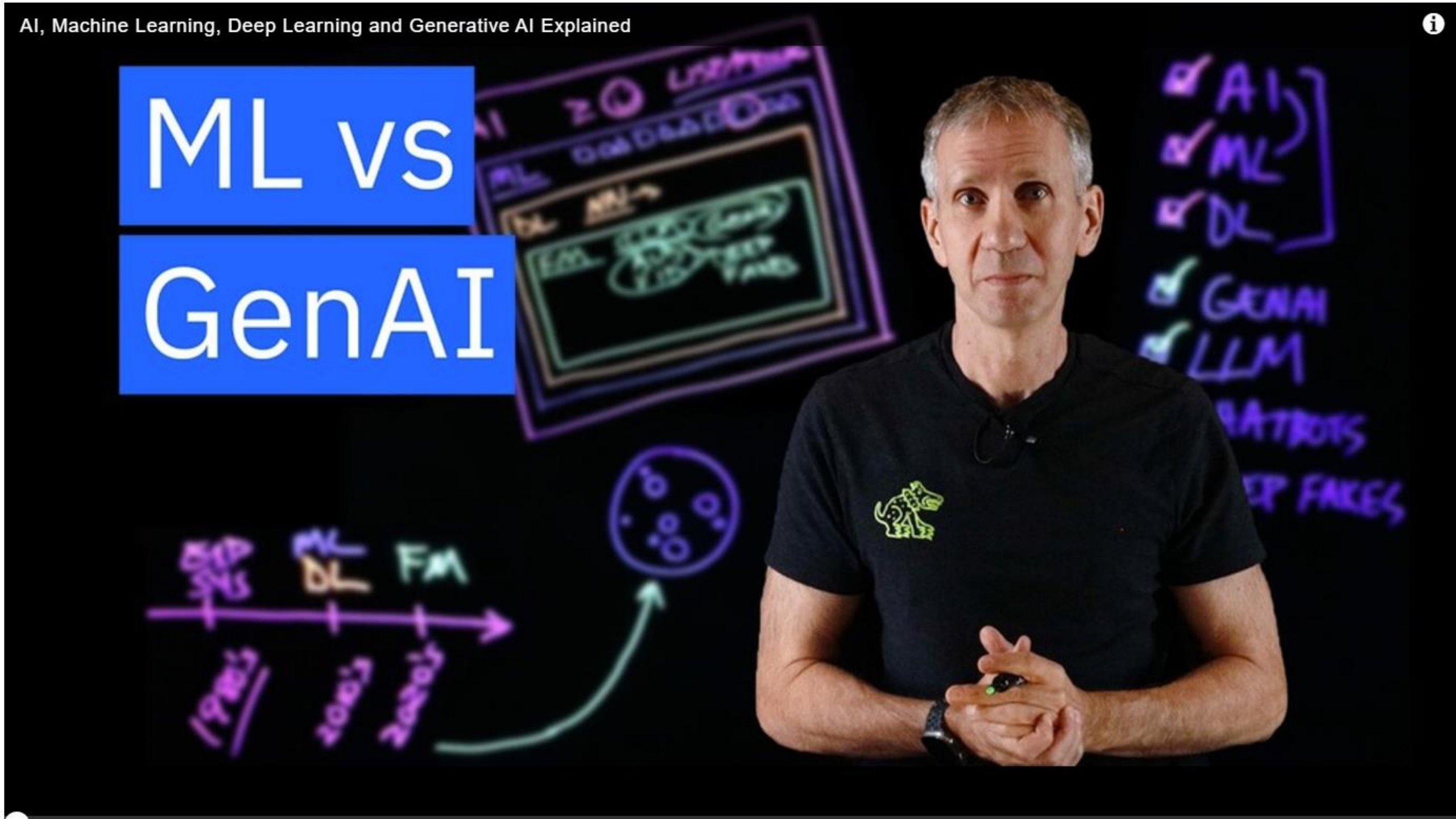
Key Takeaways:

- AI is a powerful tool: Its ability to solve complex problems across various domains, such as image recognition, language processing, and decision-making, makes it an invaluable asset.
- Ethics and responsibility are crucial: Understanding the ethical implications of AI, including biases in data, transparency in decision-making, and its impact on the job market, is necessary for responsible development.
- Continuous learning: The AI field is rapidly evolving, and staying updated with the latest advancements in deep learning, reinforcement learning, and robotics is essential to keeping pace.

Future Objectives

- **Deepen My Knowledge in Specialized AI Fields**: I plan to explore **Reinforcement Learning** in more depth, particularly how it can be applied to complex environments such as robotics and autonomous vehicles. Additionally, I aim to dive deeper into **Natural Language Processing (NLP)** and **Large Language Models (LLMs)** to further understand their capabilities in real-world applications.
- **Hands-On AI Development**: I look forward to working on more hands-on projects, particularly **AI in robotics** and **computer vision**, where I can build intelligent systems that can perceive and interact with the real world. I'm particularly interested in **autonomous robots** and **AI-driven creative applications** such as generative art and design.
- **Ethics and Policy**: As AI continues to grow, I want to focus on the **ethical and legal aspects** of AI development. Ensuring AI technologies are developed responsibly and ensuring they serve societal good without infringing on privacy or safety is a key area of interest for me.
- **AI for Social Good**: I want to explore how AI can be leveraged for **social good**, such as improving healthcare outcomes, advancing climate change solutions, and enhancing education and accessibility for all. I believe AI can be a powerful tool for solving global challenges and creating positive societal impact.




AI, Machine Learning, Deep Learning and Generative AI Explained
ML vs
GenAI
AI
ML
DL
GENAI
LLM
DL
FM

Google’s New AI Just Got Smarter and Can Fix Its Own Mistakes

Using Sigmoind

Epoch
000,258

Learning rate
0.03

Activation
Sigmoid

Regularization
None

Regularization rate
0

DATA

Which dataset do you want to use?

Ratio of training to test data: 50%

Noise: 0

Batch size: 10

REGENERATE

FEATURES

Which properties do you want to feed in?

X_1
X_2
X_1^2
X_2^2
X_1X_2
$\sin(X_1)$

2 HIDDEN LAYERS

4 neurons

2 neurons

*This is the output from one **neuron**. Hover to see it larger.*

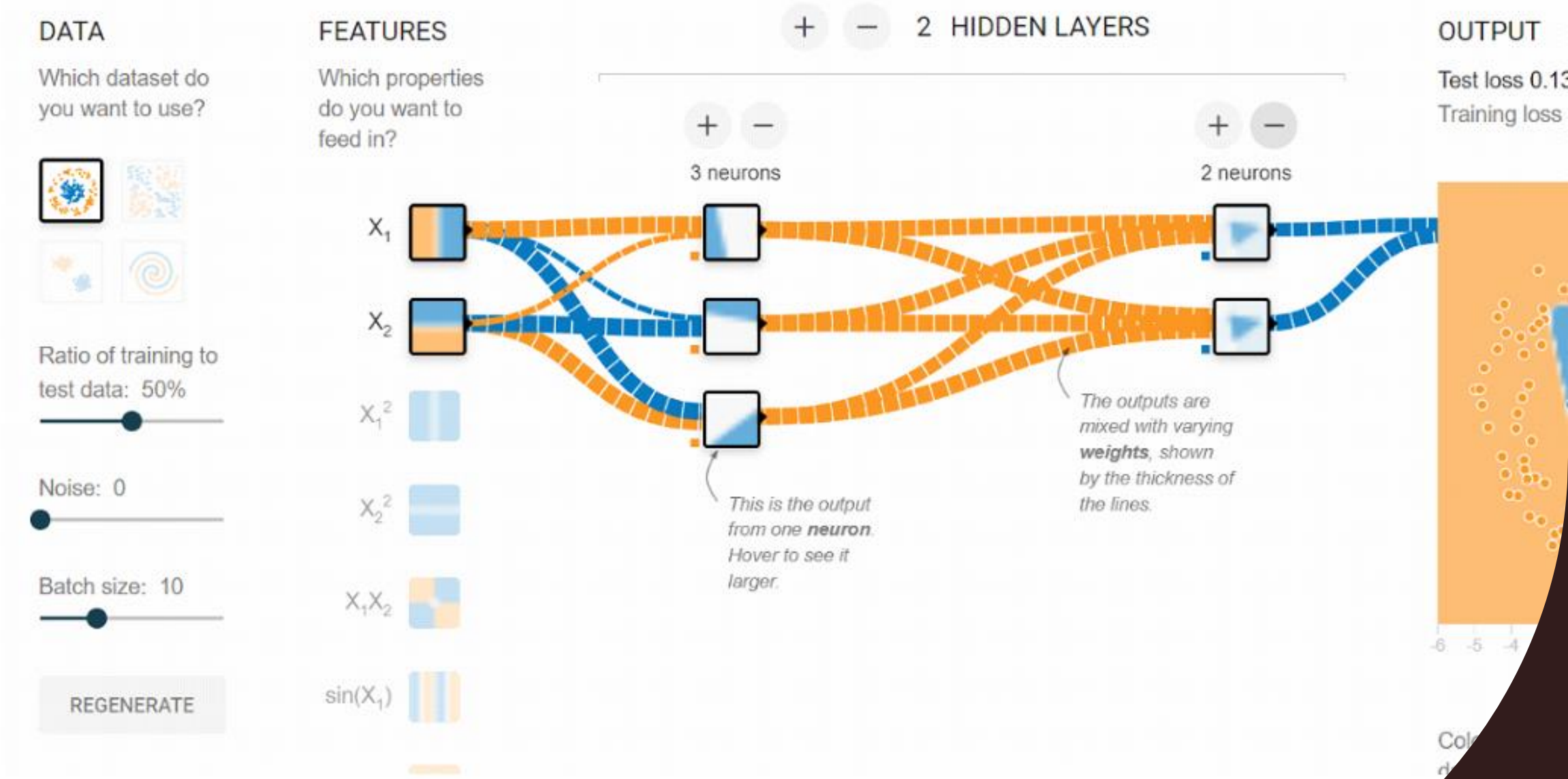
*The outputs are mixed with varying **weights**, shown by the thickness of the lines.*

OUTPUT

Test loss 0.50

Training loss

-6 -5 -4 -3



Task 4:

Low noise

- Overall Summary

- The ITAI 1378 course has been a transformative experience, providing a comprehensive understanding of artificial intelligence with a strong emphasis on computer vision. Spanning foundational concepts to advanced applications, the course enabled me to explore key AI technologies and their real-world implementations.
- Through a structured progression of modules, I gained insights into neural networks, advanced architectures, video analysis, generative models, and autonomous systems. Starting with the fundamentals of Convolutional Neural Networks (CNNs), I learned how these models revolutionized image processing by preserving spatial relationships and improving classification accuracy. Advanced architectures like ResNet and Inception further demonstrated the power of innovation in solving complex problems.
- The exploration of video fundamentals introduced me to temporal data analysis, motion estimation, and action recognition, showcasing the versatility of AI in dynamic environments. Generative models, including GANs and VAEs, revealed the creative and technical potential of AI, sparking my curiosity about ethical implications and innovative applications. Finally, integrating computer vision with autonomous systems highlighted the real-time decision-making capabilities of AI agents in areas like self-driving cars and robotics.
- This journey also enhanced my technical and soft skills. I developed expertise in implementing AI models, utilizing frameworks like PyTorch and OpenCV, and addressing challenges like computational demands and ethical concerns. Critical thinking, problem-solving, and a deeper understanding of responsible AI practices became integral to my learning.
- In conclusion, the ITAI 1378 course has equipped me with the knowledge and skills to contribute meaningfully to the AI field. It has inspired me to apply these insights in domains such as healthcare, autonomous systems, and creative industries while upholding ethical standards in AI development.

Bibliography

- Bibliography
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- ITAI 1378 Module 07. (2024). *Convolutional Neural Networks*. Lecture notes on CNN architecture, applications, and limitations of MLPs.
- ITAI 1378 Module 09. (2024). *Advanced Architectures in Deep Learning*. Lecture notes on ResNet, Inception, VGGNet, and transfer learning.
- ITAI 1378 Module 11. (2024). *Generative Models for Computer Vision*. Lecture notes on GANs, VAEs, diffusion models, and ethical considerations.
- ITAI 1378 Module 12. (2024). *Computer Vision for Autonomous Systems*. Lecture notes on object detection, scene understanding, and reinforcement learning applications in autonomous systems.

Citations

- **Module 01:** ITAI 1378. *Introduction to Artificial Intelligence*. Lecture notes, 2024.
- **Module 02:** ITAI 1378. *Machine Learning Basics*. Lecture notes, 2024.
- **Module 03:** ITAI 1378. *Deep Learning for Vision Systems*. Lecture notes, 2024.
- **Module 04:** ITAI 1378. *Supervised and Unsupervised Learning in AI*. Lecture notes, 2024.
- **Module 05:** ITAI 1378. *Optimization Techniques for AI*. Lecture notes, 2024.
- **Module 06:** ITAI 1378. *Neural Networks and Their Applications*. Lecture notes, 2024.
- **Module 07:** ITAI 1378. *Convolutional Neural Networks*. Lecture notes, 2024.
- **Module 08:** ITAI 1378. *Advanced Optimization Methods*. Lecture notes, 2024.
- **Module 09:** ITAI 1378. *Advanced Architectures in Deep Learning*. Lecture notes, 2024.
- **Module 10:** ITAI 1378. *Video Analysis Fundamentals*. Lecture notes, 2024.
- **Module 11:** ITAI 1378. *Generative Models for Computer Vision*. Lecture notes, 2024.
- **Module 12:** ITAI 1378. *Computer Vision for Autonomous Systems*. Lecture notes, 2024.