Artificial Intelligence

Course Overview

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SCIS 432
Spelman College

Course Structure

This course is divided into three main parts:

1. **Uninformed Search & Classical AI** (Weeks 1-5)
   - Search algorithms and problem-solving
   - Graph search methods

2. **Mathematical Foundations** (Week 6)
   - Linear algebra review
   - Calculus essentials

3. **Machine Learning** (Weeks 7-15)
   - Supervised learning
   - Neural networks and deep learning
   - Modern AI and generative models

Part 1: Uninformed Search & Classical AI

Weeks 1-5

Week 1: Introduction to AI & Problem Solving

- What is AI? History and applications
- Problem-solving agents
- State space representation

Week 2: Uninformed Search Strategies

- Breadth-First Search (BFS)
- Depth-First Search (DFS)
- Uniform-Cost Search (UCS)
- Complexity analysis

Part 1: Uninformed Search & Classical AI

Week 3: Informed Search

- Heuristic functions
- Greedy Best-First Search
- A* Search algorithm
- Admissibility and consistency

Week 4: Advanced Search Topics

- Iterative deepening
- Bidirectional search
- Search in continuous spaces

Week 5: Game Playing & Adversarial Search

- Minimax algorithm
- Alpha-beta pruning
- Monte Carlo Tree Search

Part 2: Mathematical Foundations

Week 6

Linear Algebra Review

- Vectors and matrices
- Matrix operations (multiplication, transpose, inverse)
- Eigenvalues and eigenvectors
- Norms and distance metrics

Calculus Review

- Derivatives and partial derivatives
- Gradient and Jacobian
- Chain rule
- Optimization basics

This mathematical foundation is essential for understanding machine learning!

Part 3: Machine Learning

Weeks 7-15

Weeks 7-8: Supervised Learning Foundations

- Introduction to machine learning
- Linear regression and least squares
- Loss functions and optimization
- Gradient descent

Week 9: Classification

- Logistic regression
- Decision boundaries
- Multi-class classification

Part 3: Machine Learning (continued)

Weeks 10-11: Neural Networks

- Perceptrons and activation functions
- Feedforward neural networks
- Backpropagation algorithm
- Training neural networks

Week 12: Deep Learning with PyTorch

- Introduction to PyTorch
- Building and training models
- Convolutional Neural Networks (CNNs)
- Transfer learning

Part 3: Machine Learning (continued)

Week 13: Advanced Neural Network Architectures

- Recurrent Neural Networks (RNNs)
- Long Short-Term Memory (LSTM)
- Attention mechanisms
- Transformers

Weeks 14-15: Generative AI

- Autoencoders and VAEs
- Generative Adversarial Networks (GANs)
- Large Language Models (LLMs)
- Diffusion models
- Ethical considerations in AI

Weekly Topic Overview

Week	Topic
1	Introduction to AI & Problem Solving
2	Uninformed Search (BFS, DFS, UCS)
3	Informed Search (A*, Heuristics)
4	Advanced Search
5	Game Playing & Adversarial Search
6	**Math Review: Linear Algebra & Calculus**
7-8	Linear Regression & Gradient Descent
9	Logistic Regression & Classification
10-11	Neural Networks & Backpropagation
12	Deep Learning with PyTorch
13	Advanced Architectures (RNNs, Transformers)
14-15	Generative AI & Ethics

Grading Breakdown

- **Weekly Homework (25%):** Problem sets with theory + coding
- **Two Tests (50%):** Midterm (25%) + Final (25%)
- **Project (25%):** Implement and evaluate ML model

Course Learning Objectives

By the end of this course, you will be able to:

1. Implement classical search algorithms for problem-solving
2. Apply mathematical foundations to machine learning problems
3. Build and train supervised learning models from scratch
4. Design and implement neural networks
5. Use modern deep learning frameworks (PyTorch)
6. Understand and work with state-of-the-art AI models
7. Critically evaluate AI systems and their societal impact

This course prepares you for careers in AI/ML and graduate studies

Prerequisites & Course Materials

Prerequisites:

- Data Structures and Algorithms
- Programming proficiency (Python)
- Basic probability and statistics
- Comfort with mathematical reasoning

Course Materials:

- Textbook: *Artificial Intelligence: A Modern Approach* (Russell & Norvig)
- Online resources: PyTorch tutorials, papers, lecture notes
- Computing: Python, Jupyter notebooks, Google Colab

Course Website: Canvas