14/05/2025

Course Outline

IT-Center School of Technology Module

Name: ARTIFICIAL INTELLIGENCE

Artificial Intelligence Instructor
Mr. Phooko PM

IT Center

Course Description

This course provides an in-depth introduction to Artificial Intelligence (AI), covering both theoretical foundations and practical applications. Students will explore the evolution of AI, problem-solving using search and logic-based methods, machine learning with Python, natural language processing, computer vision with OpenCV, and the ethical and societal dimensions of AI deployment. The course integrates hands-on programming using modern AI libraries like scikit-learn and OpenCV, giving learners the tools to build intelligent systems capable of learning, reasoning, and interacting with the world. The course also considers regulatory and ethical frameworks for AI use in real-world contexts.

Prerequisites: Must have Knowledge in either Python, and/or C++ Programming.

Recommended Textbooks: 1. Artificial Intelligence A Modern Approach_Third Edition-Stuart J. Russell and Peter Norvig
2. Howse-Joshi-Beyeler Opencv_computer_vision_projects_with_python
3. Introduction to Machine Learning with Python-Andreas C. Müller and Sarah Guido

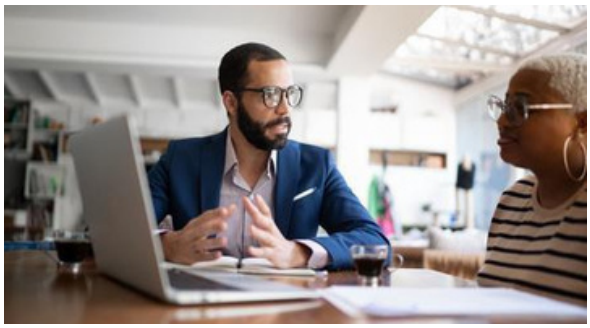
Course Objectives

By the end of this course, student-teachers should be able to:

1. Understand the fundamental concepts and definitions of AI including its history, core philosophies, and approaches to intelligence.
2. Apply search algorithms and logic-based reasoning to solve complex AI problems.
3. Use propositional and first-order logic to represent and infer knowledge in intelligent systems.
4. Develop classical AI planning solutions and analyze planning algorithms.
5. Build and evaluate supervised and unsupervised machine learning models using Python and scikit-learn.
6. Understand and apply preprocessing, scaling, clustering, and uncertainty estimation techniques in data analysis tasks.
7. Apply natural language processing concepts, including grammar parsing, semantic interpretation, and machine translation.
8. Use OpenCV for computer vision tasks, such as image filtering, gesture recognition, facial emotion analysis, and real-time tracking.
9. Critically evaluate the ethical, societal, and regulatory impacts of AI, including data privacy, fairness, bias, and policy implications.

Career Opportunities

Upon successful completion of the course, students will be equipped for entry-level and intermediate roles in the field of AI, including:



- **AI/ML Engineer**
- **Data Scientist**
- **Computer Vision Engineer**
- **NLP Specialist**
- **AI Research Assistant**
- **Robotics Developer**
- **Software Developer (AI-focused applications)**
- **AI Ethics and Policy Analyst**
- **Automation Engineer**
- **Academic/Researcher in AI**

This course is ideal for students willing to pursue computer science, engineering, data science, and related fields seeking foundational and practical knowledge to thrive in the fast-growing field of Artificial Intelligence.

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COURSE CONTENT

WEEK 1 - 2

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

1.What Is AI?

- Acting humanly: The Turing Test approach
- Thinking humanly: Cognitive modeling approach
- Thinking rationally: The "laws of thought" approach
- Acting rationally: The rational agent approach

2. The Foundations of Artificial Intelligence

3. The History of Artificial Intelligence

- Early work & foundational concepts
- The birth of AI (1950s)
- Knowledge-based systems
- Machine learning and statistical approaches (1990s–2000s)

4. The State of the Art

5. Agents and Environments

6. Good Behavior: The Concept of Rationality

7. The Nature of Environments

8.The Structure of Agents

- Agent functions and programs

WEEK 3 - 4

KNOWLEDGE, REASONING, AND PLANNING

1. Search Problems and Knowledge-Based Agents .

2. Logic

3. Propositional Logic: A Very Simple Logic .

- Propositional Theorem Proving

4. **First-Order Logic Representation**

- Syntax and Semantics of First-Order Logic
- Using First-Order Logic
- Inference in First-Order Logic
- Propositional vs First-Order Inference

5. Forward Chaining

6. Backward Chaining

7. Resolution

8. Classical Planning

- Definition of Classical Planning
- Algorithms for Planning; State-Space Search
- Planning Graphs

9. Uncertain knowledge and reasoning

- Quantifying Uncertainty
- Acting under Uncertainty

10. Basic Probability Notation

11. Inference Using Full Joint Distributions

12. Independence

13. Bayes' Rule and Its Use

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COURSE CONTENT

WEEK 5 - 6

MACHINE LEARNING WITH PYTHON

1. Introduction to Machine Learning with Python.

- Problems Machine Learning Can Solve
- Knowing Tasks & Knowing Your Data

2. Why Python?

3. scikit-learn

- Installing scikit-learn

4. Essential Libraries and Tools

- Jupyter Notebook ,NumPy, SciPy; etc

5. **Python 2 Versus Python 3** (Versions)

6. A First Application: Classifying Iris Species

- Meet the Data,Measuring Success: Training and Testing Data

7. Supervised Learning

- Classification and Regression

8. Supervised Machine Learning Algorithms

- Some Sample Datasets,k-Nearest Neighbors, Linear Models, Naive Bayes Classifiers

WEEK 5 -6

MACHINE LEARNING WITH PYTHON

9. Uncertainty Estimates from Classifiers

- The Decision Function, Predicting Probabilities
- Uncertainty in Multiclass Classification

10. Unsupervised Learning and Preprocessing

- Types of Unsupervised Learning
- Challenges in Unsupervised Learning

11. Preprocessing and Scaling

- Different Kinds of Preprocessing
- Applying Data Transformations
- Scaling Training and Test Data the Same Way
- The Effect of Preprocessing on Supervised Learnin

12. Dimensionality Reduction, Feature Extraction, and Manifold Learning

- Principal Component Analysis (PCA)
- Non-Negative Matrix Factorization (NMF)
- Manifold Learning with t-SNE

13. Clustering

- k-Means Clustering

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COURSE CONTENT

WEEK 7 - 8

NATURAL LANGUAGE PROCESSING

1. Phrase Structure Grammars

- Formal grammars
- Constituents and rules
- Tree structures
- Ambiguity and complxity

2. Syntactic Analysis (Parsing)

- Top-down and bottom-up parsing
- Parsing algorithms (e.g., Earley parser, CYK parser)
- Parsing efficiency and ambiguity resolution

3. Augmented Grammars and Semantic Interpretation

- Feature structures and unification
- Semantic attachments
- Syntax-driven semantic analysis

4. Machine Translation

- Direct translation
- Transfer-based translation

5. Speech Recognition

- Language models
- Challenges in speech recognition (e.g., noise, accents, real-time processing)

WEEK 9 - 10

OPENCV, COMPUTER VISION WITH PYTHON

1. Setting up OpenCV

- Choosing and using the right setup tools
- Running samples
- Finding documentation, help, and updates

2. Handling Files, Cameras, and GUIs

- Basic I/O scripts
- Project concept
- An object-oriented design

3. Filtering Images

- Creating modules
- Channel mixing – seeing in Technicolor
- Curves – bending color space
- Highlighting edges
- Custom kernels – getting convoluted
- Modifying the application

4. Detecting and Tracking Different Body Parts

5. OpenCV with Python Blueprints

- Hand Gesture Recognition Using a Kinect
- i. Depth Sensor.
  - Planning & Setting up the app

6. Learning to Recognize Emotions on Faces

- Planning the app, Face detection & Facial expression recognition

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COURSE CONTENT

WEEK 11 -12

ROBOTICS AND AUTOMATION

1. Introduction
- Definition of robotics
- Historical overview & Relationship between robotics and AI

2. Robot Hardware
- Sensors, Actuators, Effectors & Power systems and controllers

3. Robotic Perception
- Mapping from sensory input to knowledge
- Vision and object recognition, Localization

4. Planning to Move
- Path planning algorithms (e.g., A*, D*), Obstacle avoidance, & Map representation
- Workspace vs. configuration space

5. Planning Uncertain Movements
- Probabilistic motion models
- Partially Observable MDPs (POMDPs)

6. Moving
- Feedback control, PID controllers, Trajectory tracking & Kinematics and dynamics

7. Robotic Software Architectures
- Deliberative architectures, Reactive architectures, etc

8. Application Domains
- Industrial robotics (manufacturing, assembly)
- Service robots (healthcare, cleaning)
- Autonomous vehicles
- Search and rescue
- Space and underwater exploration

WEEK 13 - 14

AI ETHICS AND SOCIETAL IMPLICATIONS

1. Ethical Impact
- Bias and Discrimination
- Privacy Concerns
- Accountability and Transparency
- Autonomy and Consent
- Security Risks

2. Societal Impact
- Employment and Workforce Displacement
- Economic Inequality
- Social Interaction and Behavior
- Education and Skill Development
- Cultural and Ethical Norms

3. Regulatory Standpoint
- Existing Legal Frameworks
- Need for AI-Specific Regulations
- International Collaboration
- Ethical Guidelines and Standards
- Public Awareness and Engagement

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COURSE CONTENT

WEEK 15

CAPSTONE PROJECTS AND PRACTICAL EXPERIENCE & RECAP

1.Logical Agents & Knowledge Representation

- Mini Project: Propositional Logic-Based Inference Engine
  - Build a rule-based system that uses propositional logic to infer new facts from known data (e.g., a medical diagnosis assistant).
- Mini Project: First-Order Logic Family Tree Solver
  - Create a program that uses FOL to infer family relationships (e.g., "Who is John's grandfather? ").

2. Inference in First-Order Logic

- Mini Project: Backward Chaining Chatbot
  - Implement a chatbot that uses backward chaining to answer queries from a knowledge base.
- Mini Project: Automated Theorem Prover
  - Develop a simple theorem prover using resolution and unification for logic-based queries.

3. Classical Planning

- Mini Project: AI Puzzle Solver (e.g., 8-puzzle)
  - Design an agent that solves a classical planning problem using A*, BFS or DFS.

WEEK 15

CAPSTONE PROJECTS AND PRACTICAL EXPERIENCE & RECAP

- Mini Project: Task Planner for a Robot
  - Simulate a robot planning task sequences like picking up and dropping off items in a grid world.

4. Planning and Acting in the Real World

- Mini Project: Schedule Optimizer using Planning Graphs
  - Build a simple application to optimize class or work schedules using constraint based planning.
- Mini Project: Hierarchical Task Planner
  - Create a planner for decomposing complex tasks (e.g., planning a trip) into sub tasks.

5. Uncertain Knowledge and Reasoning

- Mini Project: Bayes' Rule Medical Diagnosis System
  - Create a system that uses Bayes' theorem to estimate the likelihood of diseases based on symptoms.
- Mini Project: Weather Predictor using Joint Distributions
  - Use conditional probability and independence to predict weather outcomes.

COURSE CONTENT

WEEK 15
CAPSTONE PROJECTS, PRACTICAL EXPERIENCE & RECAP

6. Learning from Examples

- Mini Project: Email Spam Classifier
  - Implement a naive Bayes or decision tree model to classify emails as spam or not.
- Mini Project: Student Performance Predictor
  - Use supervised learning to predict students' grades based on historical data.

7. Natural Language for Communication

- Mini Project: Phrase Structure Parser
  - Build a parser that breaks down sentences into grammatical structures using a CFG.
- Mini Project: English-to-French Machine Translator (Rule-Based or Statistical)
  - Build a basic translation system using word-to-word or phrase-level rules.
- Mini Project: Speech-to-Text Using Prebuilt Libraries (e.g., CMU Sphinx, Google Speech API)
  - Implement basic speech recognition functionality to convert spoken input into text.

8. Robotics

- Mini Project: Robot Path Planning in a Maze (Simulated)
  - Simulate a robot navigating a maze using A* or RRT algorithms in Python.
- Mini Project: Obstacle-Avoiding Robot (with Arduino or V-Rep/CoppeliaSim)
  - Build or simulate a robot that uses sensors to navigate without collisions.
- Mini Project: SLAM in 2D Environment
  - Implement a basic version of Simultaneous Localization and Mapping using LIDAR data or simulations.
- Mini Project: Delivery Robot Simulation
  - Simulate a robot that plans, navigates, and executes delivery tasks in a virtual environment.

COURSE ASSESSMENT METHODS

Assessment Method	Description	Weight	Aligned Course Learning Outcomes
Course work	**The Internal Assessments overall mark**	**40%**	The Foundations of Artificial Intelligence • The History of Artificial Intelligence • Logic • Propositional Logic: A Very Simple Logic . • First-Order Logic Representation • Forward Chaining,Backward Chaining • Resolution • Classical Planning • Introduction to Machine Learning with Python. • Why Python? • Classifying Iris Species • Supervised Learning ◦ Supervised Machine Learning Algorithms • Uncertainty Estimates from Classifiers • Unsupervised Learning and Pre-processing
Examination	**Examination Mark**	**60%**	• Introduction to AI • Knowledge, Reasoning, and Planning • Machine Learning 2 • Natural Language • Processing(NLP) • Computer Vision • Robotics and Automation 1 • AI Ethics and Societal Implications • Capstone Projects and Practical Experience
The Final Assessment Mark	**40% Course Work + 60% Exam**	**100%**	**Get Certified**

Approvals

"Come learn with us at IT-Center School of Technology"

Signature:	**S. Kala**
Name:	Sebolele Kala
Tittle:	Manager

Signature:	**Phooko PM**
Name:	Makhotla Phooko
Tittle:	**Instructor**

Signature:	**K. Sole**
Name:	Kefuoe Sole
Tittle:	Instructor