

Batch: B - 1

Roll No.: 16014022050

Experiment No.: 1

Title: Study of Artificial Intelligence and Machine Learning based projects.

Course Outcome:

CO1: Define and explain the fundamental concepts, scope, and types of Artificial Intelligence and Machine learning.

Books/ Journals/ Websites referred:

1. http://en.wikipedia.org/wiki/List_of_artificial_intelligence_projects
2. http://www.cs.cornell.edu/courses/cs478/2002sp/mllinks/interesting_ai_demos_and_project.htm
3. <http://homepages.inf.ed.ac.uk/rbf/AIMOVIES/AImovai.htm>
4. “Artificial Intelligence: a Modern Approach” by Russell and Norving, Pearson education Publications
5. “Artificial Intelligence” By Rich and knight, Tata McGraw Hill Publications

Pre Lab/ Prior Concepts:

History and evolution of AI, Artificial intelligence: definitions and theories.

Historical Profile:

AI research is highly technical and specialized and is also divided by several multidisciplinary technical issues. So far there are many projects those have been developed and are in progress to work on those issues. Students must learn the applications of intelligent robots by studying various such projects to know the depth and complexity of the course.

New Concepts to be learned: Applications of AI, Current research and future research potential in the field

Project 1: ChatGPT by OpenAI

Project Description:

ChatGPT is an AI-based conversational agent built on the GPT (Generative Pre-trained Transformer) architecture. It understands and generates human-like text using deep learning techniques and is used in customer service, education, coding help, and creative writing.

Project category/field:

NLP (Natural Language Processing)

Agent architecture:

Transformer-based (Large Language Model)

Programming language:

Primarily Python (PyTorch framework)

Awards/Strengths/Weaknesses:

- **Strengths:** Human-like conversation, multilingual, adaptable to various domains.
- **Weaknesses:** May hallucinate facts, context-limited to input length.
- **Highlights:** Used by millions; integrated into Microsoft products (Word, Excel), GitHub Copilot.

Nature of the project:

Deployed by OpenAI and integrated with Microsoft Office, used globally in education, coding, and customer support.

Applications:

- Chatbots
- Code generation
- Language tutoring
- Writing and summarization
- Personal assistants

Project 2: Tesla Autopilot

Project Description:

Tesla Autopilot is an advanced driver-assistance system (ADAS) that uses neural networks, computer vision, and real-time decision-making to enable lane keeping, adaptive cruise control, and limited self-driving capabilities.

Project category/field:

Autonomous Vehicles / Computer Vision

Agent architecture:

Deep Reinforcement Learning Agent

Programming language:

C++, Python, custom neural net stack (Dojo)

Awards/Strengths/Weaknesses:

- **Strengths:** Real-world deployment, large data feedback loop

- Weaknesses: Regulatory scrutiny, edge case failures
- Highlights: Millions of vehicles using it; real-world feedback collection

Nature of the project:

Enabled in Tesla cars across multiple countries.

Applications:

- Lane keeping
- Auto parking
- Smart summon
- Full Self-Driving (FSD beta)

Project 3: GNoME by Google DeepMind

Project Description:

GNoME uses AI to discover new **crystalline materials** with potential applications in clean energy, semiconductors, and batteries. It leverages **graph neural networks (GNNs)** to simulate and predict stable material structures.

Project category/field:

Materials Science / Clean Energy / Deep Learning for Scientific Discovery

Agent architecture:

Graph Neural Network + Reinforcement Learning

(GNNs treat atoms as nodes and bonds as edges in a graph structure)

Programming language:

Python, TensorFlow, PyTorch

Awards/Strengths/Weaknesses:

- **Strengths:**
 - Identified over **2.2 million stable crystals**, 380,000 of which are entirely novel.
 - Enables accelerated material discovery without expensive lab tests.
- **Weaknesses:**
 - Requires huge computational power and curated datasets.
 - Predictions still need lab validation for real-world deployment.
- **Highlights:**
 - Considered a major breakthrough in computational materials science.
 - Partnered with the Materials Project and publicly released findings.

Nature of the project:

Actively deployed in research labs **and used to guide experimental material synthesis.**

Applications:

- Designing next-gen batteries
- Developing superconductors

- Clean energy applications (solar, hydrogen)
- Drug discovery (future extension)

Project 4: DALL·E 3 by OpenAI (Text-to-Image Generation)

Project Description:

DALL·E 3 is a text-to-image generation model that creates stunning, coherent, and imaginative images from natural language prompts. It's capable of understanding detailed instructions, relationships, emotions, and even artistic styles.

Project category/field:

Generative AI / Computer Vision / Multimodal Learning

Agent architecture:

Transformer-based model trained on paired image-text datasets, using **diffusion models** for generation.

Programming language:

Python (PyTorch, OpenAI infrastructure)

Awards/Strengths/Weaknesses:

- **Strengths:**
 - Can generate high-resolution, artistically styled images.
 - Understands **complex prompts and context**.
 - Used in design, advertising, education, and prototyping.
- **Weaknesses:**
 - Sometimes overfits common visual tropes.
 - May hallucinate details or struggle with fine text.
- **Highlights:**
 - Integrated into Microsoft Copilot (via Azure).
 - Has filters to reduce harmful or biased outputs.

Nature of the project:

Deployed in production via ChatGPT Pro (with image generation), Microsoft Designer, Bing Create.

Applications:

- AI-assisted art & concept design
- Marketing visuals, game assets
- Educational illustrations
- Creative storytelling, comics

Project 5: Stockfish + NNUE (Neural Network-powered Chess Engine)

Project Description:

Stockfish + NNUE is a powerful open-source chess engine combining traditional **alpha-beta pruning** with a **neural evaluation function** (Efficiently Updatable Neural Network - NNUE), making it much stronger at positional play.

Project category/field:

Game-playing AI / Classical AI + Modern ML Hybrid / Decision Making

Agent architecture:

- Classical search (minimax with alpha-beta pruning)
- Neural network evaluation (NNUE in C++ and AVX2)
- Optimized for CPUs (no GPU required)

Programming language:

C++, NNUE neural networks trained in Python/Torch but run in C++

Awards/Strengths/Weaknesses:

- **Strengths:**
 - Combines brute-force search with **machine-learned intuition**.
 - Beats top grandmasters and AI-only models like Leela in many settings.
 - Efficient — runs on commodity hardware.
- **Weaknesses:**
 - Still handcrafted in parts (e.g., move ordering).
 - Does not learn during play.
- **Highlights:**
 - Used in online tournaments, chess.com, Lichess analysis.
 - Beats older engines like Stockfish Classic and Komodo.

Nature of the project:

Open-source, community-maintained and actively used worldwide.

Applications:

- Chess coaching and analysis
- Game engines for training players
- Algorithmic game theory testing
- Hybrid AI research (classical + neural)

Chat session with any chatbot

User: What is AI?

Chatbot: AI stands for Artificial Intelligence. It refers to systems that mimic human intelligence to perform tasks.

User: Can you explain reinforcement learning?

Chatbot: Reinforcement learning is a type of machine learning where agents learn by interacting with their environment, receiving rewards or penalties.

User: What is the Turing test?

Chatbot: It is a test to determine if a machine can exhibit human-like intelligence.

User: What's the difference between supervised and unsupervised learning?

Chatbot: Supervised learning uses labeled data, while unsupervised learning finds patterns in unlabeled data.

User: Which AI is used in self-driving cars?

Chatbot: Computer vision, deep learning, and sensor fusion algorithms.

User: Can AI replace doctors?

Chatbot: AI can assist doctors but not replace their judgment or empathy.

User: What's the best language for AI development?

Chatbot: Python, due to its vast ecosystem and libraries.

Post Lab MCQ Questions:

1. Which of the following best describes Artificial Intelligence?

A. A branch of biology that studies neural networks.
B. The simulation of human intelligence by machines.
C. The study of physical processes in computers.
D. Programming games to run on computers.

Answer: B

2. What does the term "machine learning" mean in AI?

A. The use of machines to replace humans in industries.
B. Training machines to perform tasks without explicit programming.
C. Writing programs with fixed rules.
D. None of the above.

Answer: B

3. Which of the following is NOT an example of AI?

A. Self-driving cars.
B. Smart virtual assistants like Alexa or Siri.
C. A simple calculator.
D. Facial recognition systems.

Answer: C

Post Lab Descriptive Questions:

1. Define Artificial Intelligence in terms of human performance.

Artificial Intelligence refers to the ability of a machine to perform tasks that typically require human intelligence like learning, reasoning, and problem-solving.

2. What is a Turing test?

Turing Test is a method of inquiry in AI to determine whether a machine can exhibit intelligent behavior indistinguishable from that of a human.

3. Define an Omniscient agent. Are intelligent agents Omniscient?

Omniscient Agent knows the actual outcome of all actions — practically impossible. Intelligent agents are not omniscient, they make rational decisions with limited knowledge.

4. What can today's AI systems do?

Today's AI systems can: classify images, translate languages, chat, generate text/code, drive cars (partially), recommend content.

5. What can today's AI systems not do?

Today's AI systems cannot: understand context deeply, have true reasoning, emotions, or consciousness, or adapt across unrelated tasks (general intelligence).

6. Design ten questions to pose to a man or a machine that is taking a Turing test.

- What's your favorite book and why?
- Tell me a joke.
- What do you do when you're sad?
- What is 543×21 ?
- Describe the feeling of being in love.
- Do you believe in free will?
- Can you draw something?
- What would you do if you won a million dollars?
- How do you make tea?
- Do you get tired?

7. How is machine learning useful for healthcare applications?

ML in Healthcare: Predict diseases, analyze medical images, personalize treatments, and monitor patients.

8. What is the future scope of ML?

Future scope of ML: Autonomous systems, advanced drug discovery, climate modeling, personalized education, general AI.