Introduction to Machine Learning

Topic: Introduction to Machine Learning		Student(s) Presenting Matthew Paver
Age of Pupils 13 to 14 (Year 9)	**Expected Number in Class** 30	**Length of Session** 45 minutes

Links to the National Curriculum in Computing
- **Understand how data of various types can be represented and manipulated digitally.**
  - Explored through the hands-on activity with Google Cloud Vision (Slides 24–25).
- **Design, use, and evaluate computational abstractions that model the state and behaviour of real-world problems.**
  - Case study on predicting construction delays using ML algorithms (Slides 14–20).
- **Understand the ethical, legal, and environmental impacts of digital technology on society.**
  - Discussion on bias, privacy, and accountability in ML (Slide 35).
- **Use logical reasoning to compare the utility of alternative algorithms for the same problem.**
  - Comparison of ML algorithms (e.g., logistic regression, SVM) in the case study (Slide 18).
- **Undertake creative projects that involve selecting, using, and combining multiple applications.**
  - Hands-on exercise with Google Cloud Vision encourages critical evaluation of AI outputs (Slides 24–25).

Summary

Introduction to Machine Learning (ML) is a hands-on and engaging session introducing Year 9 students to the exciting world of Artificial Intelligence (AI). The lesson includes real-life examples, a case study in the construction industry, and a practical exercise in image recognition. Students will explore how Machine Learning works, its applications, and its challenges. This lesson will delve into AI's potential and pitfalls, and students will learn how this technology can be applied in their lives.

Learning Outcomes

By the end of this lesson, students will be able to:
- Using examples, define and differentiate between Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning.
- Identify and explain practical applications of ML in real-world contexts such as healthcare, wildlife conservation, and language learning.
- Apply ML concepts by using Google Cloud Vision to analyse and interpret image data in a hands-on activity.
- Evaluate and discuss the ethical implications of ML, including issues like bias, accountability, and the societal impact of AI decisions.

Assumed Prior Knowledge, Skills and Experience

Students are expected to:
- Students are familiar with using computers for basic tasks, such as browsing the internet and typing.
- Students have seen or used technology in everyday life, like virtual assistants (e.g., Siri, Alexa) or mobile apps.
- Students are interested in exploring how technology solves real-world problems, such as detecting spam emails or recommending videos.

Lesson Overview

Time	Type	Activity	Summary
5 min	Introduction	Use Slido to gauge prior knowledge and introduce the lesson.	Word cloud: "What is Machine Learning?".
10 min	Lecture	Introduction to AI, ML, and Deep Learning with relatable examples.	Use Slides 7–13 to explain terms and examples.
10 min	Guided Activity	Case study on predicting construction delays using ML algorithms.	Cover Slides 14–20 to break down the ML process.
10 min	Practical	Hands-on image recognition exercise using Google Cloud Vision.	Cover Slides 24–25; students analyse images and results. The Solution slides are 28-32.
5 min	Reflection	Discuss ethical challenges, including data biases and accountability in AI.	Cover Slides 31–35.
5 min	Q&A	Open discussion to address questions and explore student curiosities. There is also a Reading list for students to view if they are interested in learning more about machine learning and how it can be applied to data analytics.	Use Slide 37 as a prompt and students can interact using slido.

Preparation

Tools and Materials:

- Lab PCs with Internet Access: Students will need access to lab computers for using Google Cloud Vision during the practical activity.
- Teacher PC: The teacher's computer must have Slido integrated into PowerPoint to ensure live polls and quizzes function smoothly.
- Folder of Images: A shared folder containing sample images (e.g., landmarks, animals) for students to use during the hands-on activity. This has been attached in the PowerPoint as a zipped folder on the exercise slide 25.
- Students will also need access to the solutions once the task has been completed. One of the solution slides will be shown but for brevity this is just an example of what type of answers were expected.
- Slido Account:
  - A free Slido account is required for setting up quizzes and polls. The account must be pre-registered, and the session setup shared or recreated before the lesson.
  - Collaboration Link for Slido Setup: Collaboration Link – This can be used to either collaborate on the same Slido or to copy the Slido into the teacher's account.
  - Participant Join Link: Participant Link – This is for all attendees so they can answer any of the polls. In the PowerPoint itself, there are join codes and links to navigate the participants to the polls, too, for each time they are asked to answer a question.

Slides and Activities:

- **Slides 1–37:** Include all lesson content covering key concepts, definitions, case studies, and activities.

- **Interactive Word Cloud (Slide 6):** Use Slido to collect student responses to the question: *"What is Machine Learning?"*

- **Interactive Word Cloud (Slide 22):** Engage students by asking: *"Can you think of any other examples where machine learning could be used?"*

- **Interactive Q&A (Slide 37):** Provide an opportunity for students to ask questions about the lesson content.

Detailed lesson plan

Title of section	Type	Description
Introduction 5 minutes	Lecture	**Activity:** Begin by displaying a Slido code on the screen (Slide 5). Guide students to join the session and participate in a word cloud activity answering the question: "What is Machine Learning?" (Slide 6). **Purpose:** The word cloud provides insights into students' prior knowledge, highlights common misconceptions (e.g., "computers think like humans"), and sets the stage for the lesson.

		• **Teacher Actions:** Facilitate the activity by addressing common misconceptions visible in the word cloud and briefly introducing ML as "teaching computers to learn patterns from data." • **Supporting Materials:** Slides 1–6. The slide surrounding the Activity is to provide the topics and timeline of the lesson to highlight what will be covered. • **Assessment:** Review the word cloud responses to evaluate baseline understanding and identify areas requiring clarification. • **Pitfalls:** Ensure all students can access Slido (provide an alternative, such as verbal responses, for those without access).
Introduction to Artificial Intelligence and Machine Learning 10 minutes	Lecture	• **Activity:** Deliver a structured explanation of key terms: - AI: Machines mimicking human intelligence to perform tasks. - ML: A subset of AI focused on learning patterns from data. - Deep Learning: A further subset of ML using neural networks. • Relate concepts to real-world examples (Slide 13): - **Wildlife Conservation:** Identifying animal species with AI cameras. - **Healthcare:** Detecting tumours with ML models. - **Language Learning:** Generating exercises with AI tools like Duolingo. • **Purpose:** provide foundational understanding of ML, emphasise real-world relevance, and demystify exaggerated media portrayals (Slide 9). • **Teacher Actions:** Encourage student engagement by asking questions like: *"Where have you encountered AI in your life?"* • **Supporting Materials:** Slides 7–13. • **Assessment:** Observe responses to open-ended questions to gauge understanding of concepts. • **Pitfalls:** Avoid overloading students with technical jargon; prioritise simplified explanations.
ML Case Study 10 Minutes	Guided Activity	• Activity: Introduce a real-world scenario of predicting construction delays using ML (Slide 14): - Step 1: Collect historical annotated data (e.g., images of construction sites with labeled completion times). - Step 2: Select an ML algorithm (e.g., logistic regression, SVM). Explain briefly how each works and when to use them (Slide 18). - Step 3: Train the model using labeled data. Highlight patterns the model learns (e.g., "presence of four walls correlates with near completion"). - Step 4: Test the model on new, unseen data. Evaluate accuracy (Slide 20). • Purpose: Demonstrate how ML models are built, tested, and refined in real-world applications. • Teacher Actions: Prompt students to brainstorm other use cases for ML (e.g., retail, weather prediction). Facilitate small group discussions. • Supporting Materials: Slides 14–20. • Assessment: Evaluate student participation in brainstorming and group discussions.

		• Pitfalls: Clarify algorithm choices without diving into unnecessary technical details.

Hands-On ML Exercise
 	
10 Minutes
	Practical	• **Activity:** Guide students in using Google Cloud Vision to explore image recognition (Slide 25):
		  - Step 1: Upload images (e.g., landmarks, animals).
		  - Step 2: Review labels generated by the AI and assess their accuracy.
		  - Step 3: Explore SafeSearch categorization for sensitive content (e.g., marking images as "safe" or "violent").
		  - Step 4: Discuss any surprising or inaccurate results (e.g., mislabeling the River Thames as a "lake").
		• **Purpose:** Provide hands-on experience with ML tools and demonstrate real-world limitations of AI systems.
		• **Teacher Actions:** Walk round the groups/individuals to offer support, answer questions, and guide discussions on biases.
		• **Supporting Materials:** Slides 24–25, sample images, Google Cloud Vision API.
		• **Assessment:** Observe student ability to interpret and critique AI-generated outputs.
		• **Pitfalls:** Ensure all students have functioning access to Google Cloud Vision. Provide sample outputs if technical issues arise.

Reflection and Ethics Discussion
 	
5 Minutes
	Reflection	• **Activity:** Facilitate a class discussion on the ethical challenges of ML (Slides 35):
		  - Data quality: Poor data leads to inaccurate results.
		  - Bias in models: Examples of discrimination or misclassification due to biased training data.
		  - Accountability: Who is responsible for AI decisions in fields like hiring or healthcare?
		• **Purpose:** Encourage critical thinking about the societal implications of AI and ML.
		• **Teacher Actions:** Pose reflective questions like: *"What could happen if AI decisions are biased?". This would be an extension if there was more time in the lesson.*
		• **Supporting Materials:** Slides 31–35.
		• **Assessment:** Gauge the depth of student responses to ethical questions.
		• **Pitfalls:** Ensure discussion remains focused and inclusive.

Q&A 5 Minutes	Interactive Discussion	• **Activity:** Open the floor for questions. Use Slide 37 to prompt discussion if needed (e.g., "What surprised you most about ML?"). • **Purpose:** Clarify misconceptions, encourage curiosity, and address any questions. • **Teacher Actions:** Ensure all students feel comfortable participating. Summarise key points to reinforce learning outcomes. • **Supporting Materials:** Slide 37. • **Assessment:** Monitor questions to identify gaps in understanding. • **Pitfalls:** Manage time effectively to ensure all questions are addressed.

Assessment opportunities

Interactive Quiz Results (Slide 6):
- Collect responses from the Slido word cloud activity *("What is Machine Learning?").*
- This can be used to assess baseline understanding and identify common misconceptions of machine learning, especially in the context of Artificial Intelligence. One example of this is the belief that AI can think like humans.

Case Study Contributions (Slides 14–20):
- Assess their suggestions for additional ML use cases, ensuring they connect concepts to real-world applications. The suggestions should stem from the case study to highlight what is possible.

Hands-On Exercise Outputs (Slides 24–25):
- Evaluate students' ability to interpret Google Cloud Vision outputs, including:
    - Accuracy of assigned labels for images.
    - Identification and discussion of any surprising or inaccurate labels.
- Assess their ability to critically analyse AI performance biases (e.g., why certain images were misclassified).

Reflection Responses (Slide 35):
- Discuss ethical challenges such as bias, accountability, and data privacy.
- Gauge student engagement's depth and ability to connect these issues to real-world contexts.
- Look for thoughtful responses, such as suggestions for mitigating bias or ensuring AI accountability.

Interactive Q&A (Slide 37):
- Provide students the opportunity to ask questions about the lesson content.
- Use their questions to identify areas of confusion or topics that sparked interest, offering insights into their level of understanding and engagement.

Additional sources

What is Artificial Intelligence – BBC

- Provides a simple, student-friendly explanation of AI for Year 9 pupils. This resource can provide further knowledge and depth to the introduction to help students understand AI in an accessible way.

What is Machine Learning – IBM

- A supplementary explanation to introduce ML concepts. It offers clear definitions and real-world applications to extend class discussions.

Google Cloud Vision Documentation - Google

- This resource provides detailed instructions for using the API for the Exercise and can act as a troubleshooting or reference guide.

10 Detailed Artificial Intelligence Case Studies 2024 - Medium

- To provide detailed AI case studies that can be used if the construction industry example does not resonate effectively with students or aligns less with their interests. It allows

for flexibility in tailoring examples to engage the class better.

AI Ethics – IBM

- To extend the knowledge base for the reflection and ethics discussion. It further explores ethical considerations such as bias and accountability, supporting critical thinking in class discussions.