SIEMENS STEM DAY | Science Technology Engineering Math

GRADES 9–12

SIEMENS STEM DAY ACTIVITY

CAN MACHINES LEARN?

OBJECTIVES

Students will be able to:

- **Understand** that machine learning is a branch of artificial intelligence
- **Explain** how the artificial intelligence of machine learning has both advantages and disadvantages
- **Create** and support a claim that evaluates the effectiveness of machine learning in society

THIS LESSON FOCUSES ON

Engineering Design Cycle

- Communicating Results

21st Century Skills

- Communication
- Critical Thinking

OVERVIEW

Students will explore a variety of real-world applications of machine learning. Students will use this information to consider the potential advantages and disadvantages of machine learning. Students can then use evidence to support a claim that evaluates the effectiveness of machine learning in society.

STEM incorporates Science, Technology, Engineering, and Mathematics to focus on real-world issues and problems guided by the engineering design process. This type of instruction supports students in developing critical thinking, collaboration, reasoning, and creative skills to be competitive in the 21st-century workforce.

Each Siemens STEM Day classroom activity highlights one or more components of the engineering design cycle and an essential 21st century skill.

MATERIALS

- **Decision-Making Process Comparison** visual—*one copy*
- **Nine Essentials of Machine Learning** handout—*one per pair*
- **Support Your Thinking** handout—*one per person*
- computers with internet access

HAVE YOU EVER WONDERED . . .

How do machines learn and become smarter over time?

MAKE CONNECTIONS!

How does this connect to students?

In current society, artificial intelligence is all around us. From robotic vacuums to virtual assistants, people are engaging more with artificial intelligence. Understanding some of the risks and rewards of machine learning can help students to better understand the world they live in.

How does this connect to careers?

A **machine learning engineer** is an advanced programmer who is responsible for developing machines and systems that can learn and apply knowledge with very little direction. This role may involve working on customized news feeds, designing package picking robots or even developing self-driving cars. A machine learning engineer may work for any company that is looking to make AI advancements.

A **robotics programmer** is responsible for using programming code to bring the robots to life. A robotics programmer may find themselves working closely with engineers, as this role not only involves the development of computer software, but also includes assisting engineers in designing, assembling, testing, and repairing robots.

How does this connect to our world?

Machine learning is currently the most popular career choice with a 344% growth in 2019. Some credit cards are including biometric data and two-factor authentications.[1]

Artificial intelligence or AI collects large amounts of data with fast processing and intelligence algorithms to allow software to learn from patterns and features of the data. Learning about AI helps humans to better understand the ever advancing and changing society in which they live.

[1] https://www.winterstaffing.com/industry-specialties/robotics-programmer-job-info/

BLUEPRINT FOR DISCOVERY

1. To engage students in what they will be learning, display the **Decision-Making Process Comparison** visual. Ask the students to read the information and identify similarities and differences between human decision-making and machine design-making.

2. To begin understanding machine learning, explain to the students that machine learning (ML) is defined as the process of giving a computer a sample set of data and getting it to "learn" without the need to program explicit instructions.

   Provide the students with some background information on machine learning by showing them the following videos:

   - Machine Learning Explained in 5 Minutes
     https://www.youtube.com/watch?time_continue=6&v=3bJ7RChxMWQ
   - What is Artificial Intelligence (or Machine Learning)?
     https://www.youtube.com/watch?v=mJeNghZXtMo

3. Ask students to consider some of the real-world applications of machine learning that exist today. With a partner, ask the students to brainstorm and list as many examples of machine learning they can. Next, lead a conversation eliciting their responses. Some ideas that may be identified include but are not limited to:

   - virtual personal assistants
   - predictions while commuting
   - video surveillance using facial recognition
   - social media services
   - email spam and malware filtering
   - online customer support
   - search engine result refining
   - product recommendations
   - online fraud detection

   Note: Students may identify specific examples of these board categories. For example, they might say Siri or Alexa. Clarify for the students that these are examples of virtual personal assistants.

4. Explain that there are some essential aspects to machine learning. To help students better understand these basics, pass out the **Nine Essentials of Machine Learning** chart and instruct them to work with their partner to conduct some Internet research to learn about each topic. As students research, they should discuss the information with their partner and describe each aspect of machine learning and provide some examples.

5. To further enhance students' understanding of machine learning, create a T-chart on the board and label the left side "Advantages" and the right side "Disadvantages." Facilitate a discussion in which students list the potential advantages and disadvantages associated with machine learning. Examples might include:
    - advantages:
        - easily/quickly identifies trends and patterns to perform data analysis
        - continuous improvement
        - handles multidimensional data to solve problems
        - performs duties that humans cannot or choose not to complete for a variety of physical, functional, or safety reasons
        - does not need human interaction; therefore is not susceptible to:
            - term memory loss
            - information overload
            - sleep deprivation
            - distractions
    - disadvantages:
        - has high error susceptibility
    - is dependent upon humans for inputting data
    - needs time and resources for data acquisition
    - needs a huge knowledge base, as it is difficult for machine learning to respond well to situations outside of programmed expertise
6. To conclude this lesson, pass out the **Support Your Thinking** handout to each student. Students will write a claim, its evidence, and a reasoning explanation that addresses the students' personal thoughts on the effectiveness of machine learning in our society.

TAKE ACTION!

- Students can apply their Scratch coding skills by visiting: https://machinelearningforkids.co.uk/#!/ worksheets to complete a variety of machine learning projects using the step-by-step guides.

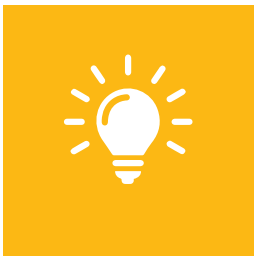
NATIONAL STANDARDS

Standards for Technology Literacy	Standard 6: Students will develop an understanding of Technology and Society. This includes learning about the role of society in the development and use of technology.
Next Generation Science Standards	SEP 7: Engaging in Argument from Evidence

DECISION-MAKING PROCESS COMPARISON

Human Decision-Making Process

Observe visible phenomena.



Interpret and make hypotheses.

Evaluate hypotheses.

Decide on the best option.

Machine Decision-Making Process

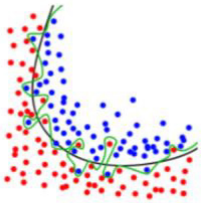
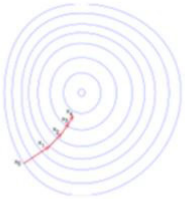
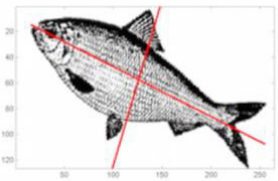
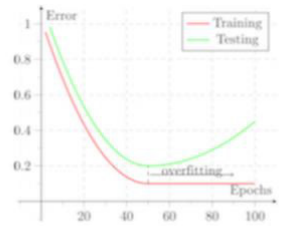
Analyzes question with diagram

Generates hypotheses from data

Scores hypotheses and evidence

Merges hypotheses for answer

NINE ESSENTIALS OF MACHINE LEARNING

Topic	Description	Example(s)
 **The Big Picture** Essential ML theory, such as the Bias-Variance tradeoff.		
 **Optimization** Algorithms for finding the best parameters for a model.		
 **Data Preprocessing** Dealing with missing data, skewed distributions, outliers, etc.		
 **Sampling & Splitting** How to split your datasets to tune parameters and avoid overfitting.		

NINE ESSENTIALS OF MACHINE LEARNING

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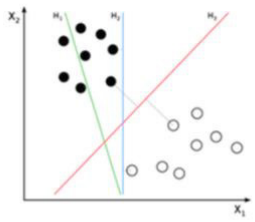
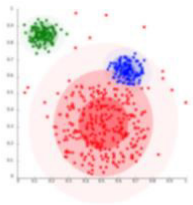
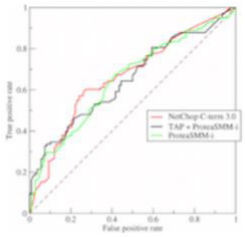
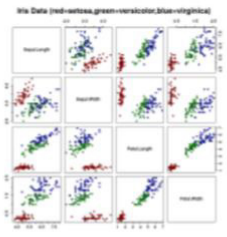
 **Supervised Learning** Learning from labeled data using classification and regression models.		
 **Unsupervised Learning** Learning from unlabeled data using factor and cluster analysis models.		
 **Model Evaluation** Making decisions based on various performance metrics.		
 **Ensemble Learning** Combining multiple models for better performance.		

NINE ESSENTIALS OF MACHINE LEARNING

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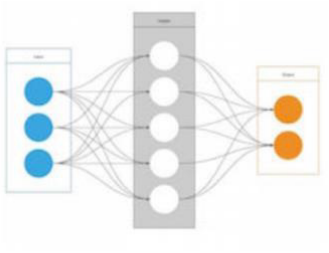 **Business Applications** How machine learning can help different types of businesses.		

SUPPORT YOUR THINKING

Consider the following quote that evaluates the effectiveness of machine learning in our society. Decide if you agree with the statement below and complete the claim, evidence, and reasoning chart below.

> "If designed properly, AI can help make decisions that are fairer because computers are purely logical, and, in theory, are not subject to conscious and unconscious biases that inevitably influence human decision-making."
>
> —Microsoft Authors, The Future Computed

Claim	
Evidence	Provide 2–3 pieces of evidence to support your claim. • • •
Reasoning	Use your own personal reasoning, interpretation and analysis to explain how your evidence supports the claim you made.

Works Cited

- https://elitedatascience.com/learn-machine-learning
- https://medium.com/app-affairs/9-applications-of-machine-learning-from-day-to-day-life-112a47a429d0
- https://data-flair.training/blogs/advantages-and-disadvantages-of-machine-learning/
- https://www.digitaltrends.com/cool-tech/ai-for-social-good-2018/
- https://machinelearningforkids.co.uk/#!/worksheets