1110 S 67th St, Omaha, NE 68182
Omaha, NE 68182-0694
October 7, 2019

(Recipient Name)
(Recipient Address)
1110 S. 67th St.--PKI 172
Omaha, NE 68182-0694

To whom it may concern,

The attached report is intended for students, educators, or hobbyists interesting Artificial Intelligence. The main purpose of this report is to argue the value of implementing Artificial Intelligence into Computer Science Curriculum.

This report gives an overview of Artificial Intelligence, providing key term definitions and examples. Many real-world examples using Artificial Intelligence are given showing the usefulness of implementing and learning about Artificial Intelligence There are also resources provided that can help the target audience start learning more in depth on programming Artificial Intelligence that is not explicitly explained in this paper. This report also includes some visuals to help clarify and ease understandability of the topic.

Refer to the Executive Summary for a better overview of this report over the topic of Artificial Intelligence for Computer Science Curriculum.

Sincerely,

Parker Jensen
Please see attached report.

Artificial Intelligence in Computer Science

Advanced Composition for IS&T

University of Nebraska at Omaha

By: Parker Jensen

Image from: https://www.vpnsrus.com/

Artificial Intelligence in Computer Science

By Parker B. Jensen
December 2019

CIST 3000, Advanced Composition for IS&T
University of Nebraska, Omaha

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Executive Summary

Artificial Intelligence (AI) is used to form predictions and find trends from arbitrary data sets without explicitly programing the AI to do so. Many major companies such as Google, Facebook, or Amazon currently use AI and are investing more into implementing AI (Botha, 2019). Computer Scientists are in high demand, yet many computer science graduates aren't required to learn how to utilize or implement AI. This report provides a comprehensive look at what AI is, what it's used for, how to utilize AI, and why it's an important tool for many fields of research.

There are many key terms that help describe different components of AI neural network structures. It's important to know commonly used methods by their definition to help simplify the modular uses of AI neural networks. Having a strong understanding of the terminology helps build a foundation to make it easier to understand when implementing AI into its diverse focus fields of use. This report contains an overview or important key terms, helping describe AI.

AI has been used to construct and run a physics-based simulation that can assess and predict injury recovery and movement (Lee, 2019). It could also test different recovery techniques and exercises to see which methods could improve the healing process. This simulation used video references to mimic natural human movement with a simplified skeletal system. AI has also been used to predict emergency events to have faster response time, saving people where seconds can be the difference between life and death. In this case utilization of AI can literally save lives.

Knowing where to start is a main struggle for teaching one's self about anything new. AI is no exception. Despite this, teaching one's self can be manageable with the right resources to help simplify the learning process making it easier to understand. Resources are included to help find a starting point that explains the complexities of AI. Sometimes learning how to program an AI can be quite daunting, however there are also included resources for follow along tutorials that use the programming language Python.

AI is important for business, computer scientists, and educators as it can help bring innovation by bringing new unseen meaning to big complicated data sets. Learning about AI can help spread knowledge of AI and teach one's self with novice programming skills how to create an AI. AI can be used to solve many of today's problems.

Impact of Artificial Intelligence

Artificial Intelligence (AI) helps create predictions and find trends from big complex data sets. AI can also fine tune algorithms without explicitly programming them. Many major organizations utilize AI for many processes such as improving social media communication or to increase speeds of search engines (Botha, 2019). Computer Scientists are in high demand, yet many computer science graduates aren't required to learn how to utilize or implement AI. This report provides a comprehensive look at what AI is, what it's used for, how to utilize AI, and why it's an important tool for many fields of research.

AI is a useful tool that can be quite complex yet effective at solving complex tasks. Computer Science students should be required to learn the basic concepts of AI by implementing it as a course requirement. Many major businesses such as Google or Facebook have been implementing more AI to help sort big data to better their service for their customers (Botha, 2019). Lee (2019) along with a group of other researchers at Seoul University in South Korea have constructed a physics-based simulation using AI to help assess injury recovery and movement. Grekousis and Liu (2019) wrote about how they use artificial intelligence to improve the prediction of emergency events to better assist and save people in danger in a certain vicinity. In this case utilization of AI can literally save lives.

Students

Computer science students would benefit from learning the main concepts of AI mentioned throughout this paper. Basic knowledge of programming is required to understand the general points of AI and the many sub-categorical uses for AI. However, there are some resources included that point towards brief programming tutorials. Computer scientists or hobbyists will see the importance of AI implementation in many fields of their work. Throughout this paper, readers will gain a general understanding of AI and a basic idea of where to start when creating an AI.

Educators

Educators will also be able to understand the importance of implementing curriculum surrounding AI to help introduce their students to a useful problem-solving tool. They'll be able to see the many real-world examples that they could share with their students to drive the importance of learning AI programming. Educators will be able to use the resources mentioned in this paper to help structure their curriculum or jumpstart potential projects for students. learning and utilizing AI can be quite fun as it can include a wide variety of topics, ranging from data analysis, sound patterns, or to visual recognition.

Concepts of Artificial Intelligence

Artificial intelligence is the theory of computers that can perform tasks that usually require human intelligence such as speech or visual recognition. AI are crafted from a simplified structure inspired by the human brain. This structure is called a **neural network**. There are various common types of neural network structures also known as learning models. Each learning model is situated for different specific uses. To better understand these different structures, some vocabulary associated with AI terminology will be needed.

Key Terms for AI

There are many key terms that help describe different components of AI neural network structures. It's important to know commonly used methods by their definition to help simplify the modular uses of AI neural networks. Having a strong understanding of the terminology helps build a foundation to make it easier to understand when implementing AI into its diverse focus fields of use.

Machine learning is a subset of AI where computer systems utilize algorithms and statistical models to perform a specific task without explicit instructions. AI rely on patterns to construct an inference. A neural network consists of two or more layers containing neurons. A **Deep Neural Network** is used to describe neural networks with two or more hidden layers. A **Neuron** is a node or container that holds information which is represented by a circle in neural network diagrams.

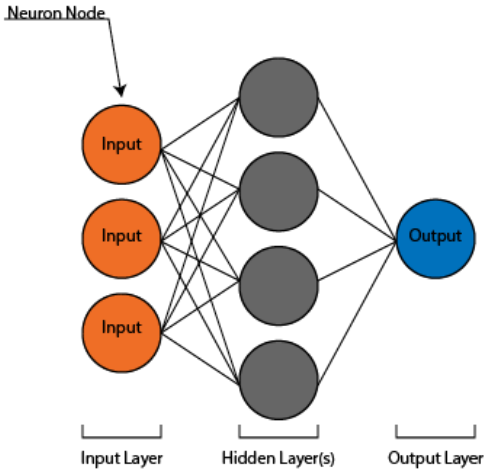

Fig. 1: Neural Network Diagram. Most Neural Networks are represented similarly to this diagram. (Loy, 2018)

The **input layer** of a neural network consists of a set of neurons that are connected to various inputs. Those inputs can be sensors, images, voice commands, etc. The **output layer** is the last layer of neurons that produce an output dependent on the previous layer. A **hidden layer** is any layer between the input and output layers consisting of neurons with certain weights and biases that take information from the previous layer, to give an output to the next layer. Each neuron's **weight** value is the sum of weighted outputs from all neurons in the previous layer. A **bias** for a node is the value needed to be activated. If a neuron is activated, then it will be used in the calculation of the next layer.

Feedforward is the process of sending information from the first layers to the next layers recursively or repeatedly until it reaches the output layer. The final output of the neural network compared to the expected value creates an error. **Backpropagation** is the processes of going back layer by layer and updating each weight and bias of the neurons based on the calculated error. **Deep Learning** is the iterative process of neural network that feedforwards and backpropagates for an arbitrary number of times.

Different Types of AI Machine Learning Methods

AI can behave in many different ways depending on the programmers intended use. Just like differing species on earth, AI have different intended tasks. Knowing popular AI machine learning models will help specialize the AI for certain intended tasks as each machine learning method have certain scenarios it works best with. There are three main types of AI machine learning methods. The three main methods are Supervised Learning, Unsupervised Learning, and Reinforcement Learning (Dwivedi, 2019).

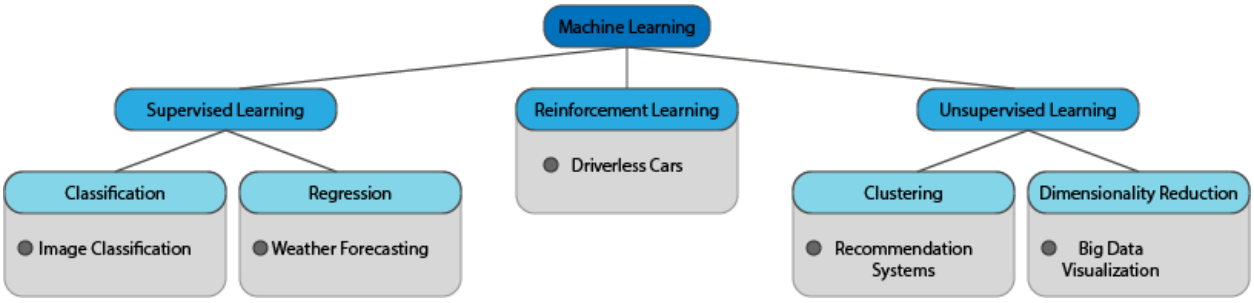

Fig. 2: Machine Learning Levels. This tree shows common sub-categories of Machine Learning Methods along with an example of when that specific learning method would be used. (Dwivedi, 2019)

Supervised Learning

Supervised Learning is task driven where the AI maps an input to an output based on labeled data. This labeled data contains the raw input data as well as the expected output. There are two types of supervised learning, Regression and Classification (Garbade, 2018).

Regression is one of the most common types of machine learning models where it approximates the relationship between different variables or data. An example of this is the input of temperature, wind speed, wind direction, and humidity to predict the weather forecast. Regression models estimate a mapping function from input variables to numerical or continuous output variables.

Classification is a systematic grouping of data into categories. From a given set of data, it will find similarities between this set of inputs and group them by similarity. Classification models estimate the mapping function rom input variables to discrete or categorical output variables. An example would be giving the AI picture sets of various animals. It would then group similar animals such as bird or lizards into their respective groups.

Both regression and classification models utilize known or labeled datasets. Supervised learning approximates the output based off of the input data by using what it is learning from the trained data. A main difference between the two is that regression puts out a numerical output while classification outputs categories.

Advantages of supervised learning is that these modes are a simpler, more common neural network AI model that is great for general purpose calculations. The downside to these models is

all of the data must be labeled correctly so that the AI neural network can learn the way one intends it to learn. It is very time consuming to label every piece of data, especially in larger data sets.

Unsupervised Learning

Unsupervised learning is data driven where the AI uses unlabeled data and searches for hidden trends or patterns. It draws inferences from data that hasn't had a verified expected output, trying to find some structure or similarities between groups. There are two main types of unsupervised learning, Clustering and Dimensionality Reduction (Dwivedi, 2019). Both types of unsupervised learning models help reduce big complex data sets to make them more readable for humans giving more implied meaning to the data set.

Clustering groups events, people, or data based on their proximity to each other. These clusters can develop insights about the given data. An example of this would be creating clusters in a plot graph.

Dimensionality Reduction is the process of reducing the dimension or size of the data set. For example, it can take an excel sheet with thousands of columns and reduce the size to a more manageable and readable size for humans to better understand the data.

Advantages of cluster and dimensionality reduction is that they are great for when the data is unknown. They are also very helpful for reducing the tedious task of labeling all of the given data as well as organizing and sifting through large datasets to make it human readable. Disadvantages are that these kind of learning models are not really useful for smaller data sets or labeled data sets.

Reinforcement Learning

Reinforcement learning is most commonly used when there is no data. It uses a trial and error approach where the AI tries to maximize reward in particular situations by taking suitable actions. This machine learning method is used commonly with automated robotics, simulations, or video games.

In reinforcement learning, there are three main components to understand. An **Agent** is considered the learner or decision maker. The **Environment** is everything the agent interacts with. **Actions** are what the agent can do. Movement is a common example of an agent's possible action.

Reinforcement learning is great for having the agents adapt accordingly to get the most reward. The behaviors of the AI change without being explicitly programmed. This is due to the reward function as the driving force for the AI's behavior.

Researchers from OpenAI, Baker (2019), designed a Multi-Agent Hide and Seek challenge utilizing the reinforcement learning model. A team of two seeker AI agents and a team of two Hider AI agents. Through the many tests, each team adapted to get the higher score respectively. Each team would learn to utilize their environment to create obstacles to block the opposing

team or to get to different areas.

Advantages of reinforcement learning is that this model is great for simulations or games where the environment is known or predictable. Reinforcement learning is also great when you want the AI to achieve a certain goal but aren't sure the behaviors that are explicitly needed. Disadvantages of this model is that it requires data from its environment which may be more complicated for real world applications as opposed to fully digital environments such as video games.

Uses of Artificial Intelligence

After knowing what AI is, it's easier to see the possible use cases. Many companies and businesses utilize such as Apple, IBM, or Google use AI to improve their missions and to help compensate areas of skill that humans lack due to natural human abilities (Botha, 2019). AI is great for big complex problems. Many AI implementations improve human safety through the field of medical research.

Using AI to Improve and Save Lives

AI has many useful uses especially when it comes to saving lives. Although AI is more complicated to implement when designing it to help save and protect people, there have been reported cases where AI have saved and improved lives of many humans and even animals. This further shows the importance of why it's important for computer scientists to learn more about AI.

Predicting Emergency Events

One of the main issues of emergency events is the time it takes to get a person in need of medical assistance. The difference of a few minutes could be life or death for someone. One way to improve this issue is the response time for medical services to send help to someone in need of medical attention earlier and faster.

Grekousis & Liu (2019) conducted research on the effectiveness of AI to help predict emergency events before they would happen. Utilizing AI compared to currently used formulas to predict Emergency events, AI was able to predict emergency events with an error of a few seconds. It was as effective as the currently used formulas and excelled further that the formulas could predict in a few scenarios.

AI is great for making inference from large amounts of data that could be complex for humans to makes sense of. In this case sifting through information about local crime rates, accidents, population density, etc. Even though the formulas were still useful, the AI can now be used with other cities and towns, allowing more adaptability. The current methods require a mathematician to use a combination of the formulas depending on the many factors of a city or town.

Safety isn't always monitored properly creating a slower response when needed. When monitoring of the safety of everyone, it requires more people to me employed to do so or a cheaper alternative is to have one person monitor several cameras through a vicinity. However, this comes with the ethical issue privacy.

With AI, Sandlin (2019, Feb) created an AI that would use surveillance cameras to detect when someone is holding a gun, allowing the AI to context enforcement. This helps reduce the response time. This also allows for the AI to give the most updated location of the suspect. AI can be used to respond to certain events without the need of endangering a person to be present in chaotic scenarios. It's these implementations that can help improve response time and the safety of everyone however it does come with the cost of reduced privacy.

Predicting Human Recovery Outcomes

For many people, recovery can be a long and painful journey. For many players and athletes that get injured during games or practice, the recovery time could stop someone from being involved in such activities for months. In some cases, peoples' careers can be changed because of serious injuries and recovery time.

Physics-based simulations utilizing AI (Lee, Lee, Park, & Lee 2019) could help predict injury recovery time. This was possible by applying different modifiers to a simplified skeletal system, such as replacing a leg for a peg leg. The AI would use supervised learning by mimicking reference motion clips. This AI could also test different recovery techniques and exercises to see which methods could improve the healing process.

Sports are one of the biggest industries making the players health an important priority. [I'll include a source for sports industry importance] The more time a player is out of the game due to recovery, the less they can help their team win. This is one example of why it's important to be able to implement AI as a possible tool to improve the health of an individual, where their careers depend on it.

Improving Safety

Humans have natural built in reactions to avoid harm to the body such as flinching or quickly removing a hand from a hot object. However, humans' reactions are sometimes too slow to avoid injury. Utilizing AI could help improve the safety for many applications.

Power tools are used to provide more power and control when working on projects such as woodworking, sculpting, or welding. Power tools can sometimes behave unexpectedly and can injury someone if they aren't prepared for such occasions. Sandlin (2019, Sept) and his friend created an AI to help stop a table saw kickback that could normally end up injuring the user. AI is important and needed in these types of scenarios to help protect people against unpredictable or quick reactions.

Using AI to Improve Education

In the United States, education is free all the way up until 12th grade and required for many to attend. This implies many students per teacher in the public education system making it difficult for each teacher to aid each student to their specific needs. It also makes it hard to know which students need more attention to increase their success of their education.

An AI created by Kučak, Juričić, & Đambić (2018) was used to calculate at risk students, retention rates, performance, and many other factors. It also predicted which students would drop out or fail. This information is useful for teachers so that they may adapt to their students to improve the students' learning experience. This also helps the teachers know which students need more educational assistance to ensure their success at school.

Although this may help the teacher know which students are more at risk of failing or dropping out, AI may not necessarily be able to detect what exactly may be causing the student to fall behind. Examples could include family or social issues. However, the use of AI would at least

give a heads up for teachers or other staff to turn their focus and adapt if needed.

Using AI to Improve Entertainment

Entertainment is a major driver of many technologies. AI is no exception as many people implement AI to highlight the many fun things you can do with it. Due to the recently new tool of AI and the increasingly utilization of AI, many show off the multiple ways it can be used for fun.

Former NASA Engineer Rober (2019) created an app that utilized machine learning to decipher baseball coaches' steal signals. This video was to show the use of AI but also to create awareness of the journey in creating an AI. Videos this this one appeal to hobbyist that want to learn a new skill. Humans curiosity is enough to drive the entertainment purposes of showing AI and its many examples of implementations.

AI is used in many areas of works as mentioned throughout this paper showing why it is a viable skill to learn how to program. This would add to the arsenal of a computer scientist's skillset.

Education of Artificial Intelligence

Learning how to construct, program, and utilize AI is a fairly complex mission. When teaching one's self, it's important to learn in simpler terms allowing a better grasp how one would program an AI. When teaching others, it is important to know the best medium of teaching and how to create assignments that improve the learning outcome for the students.

Resources for Artificial Intelligence

People are driven by their own curiosities in their free time to learn the skills that aren't necessarily taught in their education systems. Knowing where to start when learning something new is a common struggle, especially about AI. Despite this, teaching one's self can be manageable with the right resources to help simplify the learning process. Thus, making it easier to understand. I've gathered a few resources aimed to help find a starting point that is also explained in depth across the many complexities of AI. Parts of the process of learning about AI and how to program it can be quite ambiguous in regard to what other information is pertinent to utilize or know. Knowing how to program AI is also crucial.

Concepts

Youtube is a growing platform for educational videos allowing educators to share their knowledge for free. Sanderson (2017) a Khan Academy educator simplifies common models of AI neural networks through video presentations on Youtube, a popular video streaming platform. Sanderson has a four-part video playlist walking through each step with simple animations to help visualize what the neural network is doing *(See Table 1, Number 3).* This approach lets the user go back and re-watch any part that may be confusing. This also allows people to stop and research specific concepts mentioned in the video and then continue where they left off afterwards.

Programming

The concepts and background information over AI are important to know, however sometimes hands on learning works better for people. Tinkering with code to see how each line affects the outcome is a great way to understand how it all works together. Before looking into tutorials and sources providing code examples, it would be beneficial to know the programming languages used. Having a grasp of the languages helps the programmer what can be changed.

Most AI tutorials use Python, which is a popular programming language for AI with its simplified **syntax**, which is the grammar of how to write the language. Python also has a variety of useful libraries such as TensorFlow or OpenCV which both contain useful code for AI implementation. To get started, you need to install Python onto your computer via python.org *(See Table 1, Number 6).* PIP should be installed with Python which is useful for installing and utilizing other libraries.

There are a few free sources for learning how to program with Python. One example is codeAcademy *(See Table 1, Number 5)* which has free hands-on lessons. It starts with the basic syntax rules and continues on from there with example problems to practice. W3schools is also a great website to learn Python or other various programming languages *(See Table 1, Number 7).*

It gives you examples that you can test run and edit. They also have several subtopics going over specific functions or commands used in Python.

To edit Python offline, **integrated development environments** (IDEs) are commonly used as text editors to give feedback on correct syntax for programming languages. Microsoft Word with spellcheck is the equivalent to IDEs. Visual Studio Code and Spyder are some commonly used free IDEs to edit and write Python code (See Table 1, Number 8 & 9). IDEs help productivity and the understanding of Python.

Tutorials

Having a grasp of what's possible with Python is valuable for tutorials. A great tutorial with example code provided breaks down each line of code briefly explaining how it works *(See Table 1, Number 1)* (Loy, 2019). A more in-depth tutorial with more elaborate explanation of each line of code *(See Table 1, Number 2)* (Trask, 2015).

Resources and Tutorials:			
Number	**Title**	**Type**	**Description**
1	How to build your own Neural Network from scratch in Python	Neural Network Tutorial	Quick tutorial of creating a simple Neural Network AI with Python.
2	A Neural Network in 11 lines of Python (Part 1)	Neural Network Tutorial	First part of a more in-depth tutorial explaining each line of code used to create a simple Neural Network AI.
3	But what is a Neural Network? | Deep learning, chapter 1	Neural Network Tutorial	First part of four-part video tutorial by 3Blue1Brown explaining the concepts and steps for Deep Learning AI with engaging visuals
4	Coursera – Machine Learning offered by Stanford	Machine Learning Course	Online class requiring more time to learn even more in depth about AI and Machine Learning
5	Codeacademy – Learn Python 2	Python Course	Learn how to use the programming language Python
6	Download Python	Download	Download the programming language
7	W3schools – Python Tutorial	Python Tutorial	Free tutorials and examples of Python
8	Visual Studio Code IDE-Python	Download	IDE for Python
9	Spyder IDE - Python	Download	IDE for Python

Table 1: Self-Instructed Resources. This is a list of resources that I found helpful when learning more about AI and how to program AI.

Educational Implementation for Artificial Intelligence

The power of education comes from the process of passing on the knowledge. Such a task can be a challenge depending on the person. Knowing how to explain the curriculum to the learner in a way they can understand it is crucial. Explanations can be verbal, visual, or hands on.

With the gaming industry growing every year for the purpose of entertainment for others, some educators have gone lengths to teach through the medium of games. Wallace, McCartney, & Russell (2010) gamified their class curriculum on AI and compared test results and interest levels of traditional teaching methods. Students stated that they were interested in learning more about AI no matter the medium. Although gamifying curriculum is great for increasing interests for a topic, AI was already appealing to their students. This shows that AI is a fun and interesting skill to learn about.

Importance of Artificial Intelligence

AI is a viable tool for improving many systems and processes. Shapiro (2018) argues the importance of having AI integrated into computer science core classes. Utilizing AI aligns with the conceptual problem solving that computer scientist develop through their courses. Problem solvers knowledgeable about AI equip them with another tool to solve problems.

Major companies such as Amazon, Apple, Google, Microsoft, and Twitter are implementing more AI into their companies. Many of these companies are investing and buying AI startups to bring onboard such as Amazon or Google. These major companies have a demand for people knowledgeable about AI.

After seeing the different examples of real work uses of AI helps visualize what is possible with AI. The common conception of AI comes from movies, failing to show where it is actually used. AI can be used to improve the entertainment either behind the scenes or on the big screen as part of the story. Using AI as mentioned earlier can actually save lives or improve the safety for people showing why it is valuable to learn how to use.

Figuring out where to start learning a new topic can be the hardest part. With the given resources to help jump start the learning process for one's self makes it easier to jump in and start creating AI for simple applications. Educators can also utilize these resources to spread the knowledge to students or people simply wanting to learn more about AI. In some cases, AI in of itself is intriguing for learners (Wallace, McCartney, & Russell 2010).

Glossary

Actions: What the agent can do in a reinforcement learning model.
Agent: Considered the learner or decision maker of a reinforcement learning model.
Artificial intelligence: The theory of computers that can perform tasks that usually require human intelligence such as speech or visual recognition.
Backpropagation: The processes of going back layer by layer and updating each weight and bias of the neurons based on the calculated error.
Bias: Value needed to activate a node.
Classification: Machine Learning model that is a systematic grouping of data into categories, finding similarities between a given data set.
Clustering: Machine Learning model that groups events, people, or data based on their proximity to each other.
Deep Learning: The iterative process of neural network that feedforwards and backpropagates for an arbitrary number of times.
Deep Neural Network: Used to describe neural networks with two or more hidden layers.
Dimensionality Reduction: Machine Learning model that is the process of reducing the dimension or size of the data set.
Environment: Everything the agent interacts with in a reinforcement learning model.
Feedforward: The process of sending information from the first layers to the next layers recursively or repeatedly until it reaches the output layer.
Hidden layer: Any layer between the input and output layers of a neural network consisting of neurons with certain weights and biases that take information from the previous layer, to give an output to the next layer.
Input layer: A neural network layer that consists of a set of neurons connected to various inputs such as sensors, images, or voice commands.
Integrated development environments (IDEs): Used as text editors to give feedback on correct syntax for programming languages.
Machine learning: A subset of AI where computer systems utilize algorithms and statistical models to perform a specific task without explicit instructions.
Neural Network: programming data structure inspired by the human brain.
Neuron: A node or container that holds information which is represented by a circle in neural network diagrams.
Output layer: The last layer of neurons in a neural network that produce an output dependent on the previous layer.
Regression: Machine Learning model that approximates the relationship between different variables or data.
Reinforcement learning: Machine Learning model that is most commonly used when there is no data using a trial and error approach where the AI tries to maximize reward in particular situations by taking suitable actions.
Supervised Learning: Machine Learning model that is task driven where the AI maps an input to an output based on labeled data.
Syntax: The grammar of how to write a programming language.
Unsupervised learning: Machine Learning model that is data driven where the AI uses unlabeled data and searches for hidden trends or patterns.
Weight: A value that is the sum of weighted outputs from all neurons in the previous layer of a neural network.

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