How a Middle School Teacher Can Use Artificial Intelligence to Teach Evolution

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This curriculum unit is recommended for:
Life Sciences/Middle School/6-8 Grades

Keywords: evolution, machine learning, artificial intelligence, genetic algorithms, art.

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This curriculum unit (CU) parallels the concepts of Evolution and Artificial Intelligence (AI) for the purpose of making the Theory of Evolution easier to grasp for the middle school student. This analogy and background information is supplied for the teacher who has no experience in AI and its related fields. The concepts of Machine Learning, Evolutionary Robotics, and Universal Darwinism are all subsets of AI. Terms such as adaptation, natural selection, fitness, random, mutations, variation, and evolutionary algorithms are commonly used with both evolution and subfields of AI. By providing activities, the middle school teacher can provide hands on, higher order thinking along with inquiry-based learning. The activities in the last section of this CU serve to reinforce the principles shown in the body of this work. In the Teaching Strategies section, I give ideas and strategies on how to parallel AI with evolution. There are ideas and background for both struggling students with below-grade reading levels as well as gifted students. For gifted and higher order thinkers, algorithms can be integrated into this CU for interdisciplinary lessons with math. In one activity, there are ideas to combine evolution with art.

I plan to teach this unit during the coming year in to 150 students in ***8th Grade Integrated Science.***

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Phil H. Carver

Introduction of AI and Evolution Parallels

In a recent *Wall Street Journal* article, Artificial Intelligence (AI) has been labeled the Third Industrial Revolution.[1] The culmination of the work of the United States Department of Defense, in creating the internet or world-wide-web and Silicon Valley, where *Apple, Microsoft, Cisco,* and others revolutionized information technology, created the third industrial revolution in the form of computers, networks and faster and more powerful systems. Electronic miniaturizations, and greater computing power with increased speeds, and algorithmic advances have helped usher in a new technological age. However, more powerful computers, high speed networks, fiber optic cable, and sophisticated algorithms have not led to the creation of machines and computers which can think like humans. Just because *Google* can create an automobile that can drive itself doesn't mean mankind is on the brink of robots and computers being able to think for themselves. Humans create algorithms and software that scientists hope one day will lead to a higher level of AI. This CU seeks to explore the connections between AI and evolution.

Just what exactly is Artificial Intelligence? And how does evolution parallel AI? In this unit I will give some background information about AI, how it can relate to evolution, how it can be taught to 8th graders, and how a teacher can use AI to demonstrate some of the processes in evolution. AI is the theory and development of computer systems able to perform tasks that normally require human intelligence.. When I discuss and brainstorm AI, I think about how a machine can think, reason, or learn. Just like a human brain, a machine (maybe a computer, maybe a robot, maybe a genetically modified bacterium) that can self-direct it's actions and behaviors without human intervention (that is my definition after researching machine learning and AI and later in this unit I will explore a more formal meaning and definition of AI)). To achieve artificial intelligence, machines, like students, need to know how to solve problems, make decisions based on facts and reasoning, and be flexible in a stressful situation; in other words, how can machines learn how to solve problems and how they can adapt to a situation instead of simply memorizing or responding to a command. AI encompasses several areas such as machine learning, knowledge representation, natural language processing/understanding, planning, and robotics.

Elon Musk, founder of PayPal, Tesla and Space X, stated recently that Artificial Intelligence could be more dangerous than nuclear bombs. Could machines rule our world one day? Could machines evolve on their own and become autonomous? Could all the science fiction movies come true? As a fan of the *Terminator* trilogy, and other

robotic movies such as *I Robot*, I believe Hollywood has skewed our perceptions of machine learning and artificial intelligence. For example, Data, a robot and realistic looking human on *Star Trek: The Next Generation,* the long running TV series, explored many issues relating to the complexities of robots attempting to become human. As of right now, computers and programming cannot create a version of AI that's is depicted in movies, video games and on television. But, AI is an interesting and engaging topic with parallels to the abstract concepts contained in the theory of evolution. This is why I believe I can use AI to teach evolution to students who have a great interest in technology but no interest in evolution.

Evolution and AI

Evolution parallels AI in many areas. Evolution really is a random designer.[2] Nature designs randomly through trial and error, and man designs until he creates what he needs and his design may never be perfect. After all, the development of corn through the centuries is really man-made evolution; random attempts (some successful and some unsuccessful) to improve the texture, color, taste, production, disease resistance, water usage, and general performance of the plant in terms of human consumption and desirability. As we know, evolution is change over time and is possible through random mutations and pressured adaptations over extended periods of time. One big reason, I believe, why students and human beings in general, have difficulties comprehending evolution is the extremely long periods of time that organisms need to evolve. The human mind just cannot embrace the concept or time frame of one billion years or even one million years. When scientists genetically modify a bacterium, the very same vocabulary words can be used such as adaptation, mutation, natural selection, generations, evolve, and heredity. The short period of time used in "evolution" in a machine that learns in comparison to the massive amount of time needs for "evolution in nature" to occur is beneficial for students to comprehend the elements of evolution. We can use an analogy of AI and evolution to help students understand evolution, algorithms, and machine learning. As I will discuss below, Genetic Algorithms provide an interesting connection between AI and Evolution. All living things have a set of rules, a blueprint, that tell us how that organism is built from the tiny building blocks of life. Life on earth has happened through the processes of natural selection, re-combination and mutation. Genetic Algorithms are a way of solving problems by playing copy-cat using the same processes nature uses. They use the same processes of selection, re-combination and mutation to discover a solution to a problem.

Rationale

The purpose and intent of this curriculum unit (CU) is to introduce the concept and theories behind AI. The audience for this paper is the teacher teaching middle school in a low-income, high-needs Title One school. The paper is not intended to be a textbook on

AI. Instead it is intended to be easy to read, easy to digest, and provides background research and information for a middle school teacher in order to create a lesson plan related to evolution and AI. AI is a very complex subject and can involve writing detailed code and mathematical algorithms which is above the education level and area of the average middle school educator, such as myself. So I will limit this CU to what is needed to parallel evolution with machine learning and AI. I will also touch briefly on Universal Darwinism.

The school in which I teach is a high needs, low performing middle school in a large inner city metropolitan area. The students struggle with any learning outside of their cell phones and iPads. They have no relationship with the outdoors and the physical world around them. They don't know how much money their parents pay for utilities. This CU addresses 8th grade integrated science at a middle school in Charlotte, North Carolina. With 1200 or so students, the school is located in an affluent area of Charlotte, located near The University of North Carolina at Charlotte in the prestigious Research Park area of North Charlotte. The demographic makeup is approximately 90% African-American and the rest mostly Hispanic students. 80% of the student population receive free or reduced lunches. Charlotte and this school system see a large transient population, with some students living in hotels. Most students (60 %+) read below grade level and are seldom seen reading books. While these students own tablets and smart phones, however, reading comprehension is weak in all subject areas. Reading and writing effectively about observations, science activities, and experiments are difficult for them. This situation requires scaffolding and differentiation strategies while staying true to the Common Core Standards and New Science Essential Standards that are required for students to pass the North Carolina 8th grade science End of Grade Test and transition into high school. North Carolina End of Grade Tests are packed with higher order questions, not just memorization questions, and for this reason it is imperative that students effectively analyze, write, and describe concepts and demonstrations performed and discussed in the classroom.

The Different Levels of AI: Weak AI verses Strong AI

In the strictest sense, *Merriam-Webster's Dictionary* states that AI is a branch of computer science dealing with the simulation of intelligent behavior in computers.[3] This is a very broad definition of the subject and this CU deals only the subsets of AI that help connect AI and evolution. AI researchers and philosophers discuss two notions of AI: weak and strong. Weak AI is purely a simulation of "true intelligence" – such a system may perform useful and seemingly intelligent tasks, but has no real intelligence, self-awareness, or understanding."

Strong AI would be a robot, machine, or computer that could actually considered to be thinking – one that could learn, reason, evolve, execute ethical decisions, show emotions, and exhibit rational actions. The machines that are strong in AI are generally fantasized

about in books, movies and on the drawing boards of companies like *Google*, *Apple*, and *Microsoft.* If the human mind could be manufactured and utilized for robotics, we could say this is the highest, strongest example of AI. So, most machines and computers today are weak AI. But there's a catch – how could we ever know that a machine was truly thinking? British mathematician Alan Turing proposed a game to address this very question. This test is today called the Turing Test in his honor.

The Turing Test

The Turing test is a test of a machine's ability to show intelligent behavior equivalent to a human. The test does not check the ability to give the correct answer to questions; it checks how closely the answer resembles human answers. The conversation is limited to a text-only channel such as a computer keyboard and monitor so the result is not dependent on the machine's ability to convert words into sound. The test was introduced by Alan Turing in his 1950 paper *Computing Machinery and Intelligence,* which opens with the words: "I propose to consider the question, 'Can machines think?"[4]

Thinking is difficult to define, so Turing's new question might be; are there any digital computers or machines which would do well in the Imitation Game? In the remainder of the paper, he argued against all the major objections to the proposition that machines can think. Since 1950, the test has proven to be both very well thought of and criticized as the test got older and new technology came along, and it is an important concept in the philosophy of artificial intelligence. Earlier this year, an artificially intelligent persona of a teenager became the first computer to pass the test by successfully convincing enough judges into believing they were conversing with a real human, according to the University of Reading, which organizes the yearly event.[5] This event, called the Loebner Prize has been held for 24 years and receives wide media attention.

Artificial Intelligence, Machine Learning, and Evolution

Machine learning is one of many areas in artificial intelligence. Machine learning (ML) is the science of getting computers to act without being directly programmed. Machine Learning is a subset of AI. Machine Learning can be used to parallel the random processes found in the Theory of Evolution. The concept of machine learning is the closest part of AI that is related to Evolution.

Society needs machine learning to perform tasks that are too complex for humans to perform and for tasks that require adaptation and flexibility. And most machine and computer programming are too rigid and not flexible enough for today's technology driven world.[6] Machine learning deals with designing and developing algorithms to evolve behaviors based on historical data, so they can learn from errors and experiences. So how can a machine learn? One way to demonstrate how evolution takes place is to

build a machine that learns. This machine can learn through random mutations, errors, and accidents.

Learning is inherently human. We learn new behaviors, concepts, theories, and actions every day, just by being human. We learn stuff that other animals cannot learn. We learn difficult abstract concepts through reasoning. A machine can only learn if a human programs it to learn and its limited by how it is programmed to learn. What is learning? I really had a difficult time trying to come up with an answer off the top of my head. Learning is (according to the Merriam-Webster's online dictionary) is the activity or process of gaining knowledge or skill by studying, practicing, being taught, or experiencing something: the activity of someone who learns.[7] But, can a machine learn? Is a bacterium that evolves considered to be learning? So we say that humans learn from their experiences. You get burned on a hot stove and you learn not to touch it again or to feel closely if it is hot first. Can a machine learn through experiences? But is this a learned behavior that the machine can use to protect itself from further damage? Just like evolution, machines learn knowledge acquired through experience, study, or being taught (programmed). Then you have ethics. Can a machine learn ethics, religion, right from wrong, and punishment? If you have seen *Terminator 2 T2 Judgment Day*. The machine/robot/actor Arnold Schwarzenegger asks the boy, "Why do you cry?" He learns some handshakes and learns to say, "no problemo." To learn to think and learn without human intervention; that to me is true AI.

Universal Darwinism

Evolution is related to AI and machine learning through an interesting theory called Universal Darwinism. The Universal Darwinism Theory can be applied to other disciplines as well as evolution. In laymen's language, everything evolves in the universe. In this curriculum unit I intend to parallel Artificial intelligence with the concepts in evolution. Universal Darwinism refers to many of the same concepts that the original theory of evolution contains. It is Darwinism beyond the original theory of biological evolution on Earth. The idea is to picture a theory of evolution which can be used in areas outside of the biological world. It includes the concepts of variation, selection and heredity as theorized by Charles Darwin, so that they can be used to explain evolution in many other areas, including psychology, economics, culture, medicine, computer science and physics. In this CU we are only exploring the computer science and machine learning areas. At its most elementary definition, Charles Darwin's theory of evolution states that organisms evolve and adapt to their environment by a random process. The process has three parts:

Variation is small changes in the pattern and happens usually by mutation or recombination.

Selection is the retention of the fittest variations with priority to those that are best suited to survive and reproduce in their environment. The unfit variations are eliminated.

Heredity means the variations must be kept or passed on in offspring.

The premise of Universal Darwinism is to replace an organism by any pattern or system. The first rule is that the pattern can survive (maintain, be kept alive or maintained) long enough to reproduce (replicate, be copied) rapidly so as not to disappear immediately. This is the heredity part: the information in the pattern must be kept or passed on. The second rule is that during survival and reproduction, variation (small changes in the pattern) can occur. The final rule is that there is a selected adaptation, so that certain variations may survive or reproduce better than others. If these rules are met, then, by the process of natural selection, the pattern will evolve towards more adapted forms. Examples of patterns that have been known to generate variation and selection, and adapt, are genes, ideas (memes), neurons (in the brain) and their connections, words, computer programs, firms, antibodies, institutions, quantum states and even whole universes.

Genetic and Evolutionary Algorithms

Genetic Algorithms are a fascinating piece of AI and Evolution. All living things have a set of rules that we can call a blueprint. They tell us how that living thing is built from the tiny building blocks of life. These rules are contained in the genes of an organism, which in turn are connected together into long strings called chromosomes. Each gene represents a trait of the organism, like the color of our hair or eyes. For example, the types of a hair color gene may be blonde, black or red. These genes and their colors are usually referred to as an organism's genotype. The physical component of the genotype (the living thing itself) is called the phenotype. When two living things breed they share their genes. The offspring that result may end up having half the genes from one parent and half from the other. This process is called recombination. Sometimes a gene may be mutated (changed). Normally this changed or mutated gene will not affect the growth of the phenotype, but sometimes it will be demonstrated in the organism as a new trait. Life on earth has evolved to be as it is through the processes of natural selection, recombination and mutation. Genetic Algorithms are a way of solving problems by playing copy-cat using the same processes nature uses. They use the same processes of selection, re-combination and mutation to evolve a solution to a problem.

According Merriam-Webster’s Dictionary, algorithms are a set of steps that are followed in order to solve a mathematical problem or to complete a computer process.[8] An algorithm is abstract; it’s a set of instructions that can be followed by a living thing or non-living thing: a person, a child, a machine, etc. A computer program, i.e. code, is a specific implementation of an algorithm. It is an algorithm that has been written in a

language meant for computers. In other words, algorithms are just a set of instructions such as: fold the paper this way. For example if we fold a paper airplane (which of course is a fairly simple task for the human motor skills) one must create a set of detailed instructions to complete the same process. For example; The paper size shall be 8.5" X 11". The thickness of the paper shall be 20 mils. The paper must be oriented in a landscape manner. The folds should be at a 90 degree angle. There shall be 8 folds per side. The folds shall be oriented to the top and bottom of the paper. You get the picture. We must use very detailed instructions to accomplish this task.

We must remember that algorithms are completely mechanical. The entire evolutionary process is an algorithm, i.e. a mindless procedure that produces an outcome.[9] An evolutionary algorithm (EA) should include parts of natural selection or survival of the fittest. An evolutionary algorithm states that a population of structures (randomly generated), evolves according to rules of selection, recombination, mutation and survival. A common environment determines the fitness or performance of each individual in the population. The most fit (the capacity of a living thing or machine to survive and transfer its genotype to offspring as compared to competing living things or machines) individuals are most likely to be selected for reproduction, while re-combination and mutation change those individuals, creating better ones; just as evolution does. This is for the high school math teacher perhaps who wants to teach an interdisciplinary lesson about evolution with a science teacher. There is an excellent link in the resource section relating to this topic.

Teaching Strategies: How to Teach Artificial Intelligence and Evolution

Evolution is not just a theory from the past. It happens in real time also. Bacteria mutate and resist antibiotics. Viruses reinvent themselves and escape new medicines. Animals adapt their behavior in response to a changing planet. The only difference is the time factor. Historically researchers have studied evolution by looking back, often using fossils and other evidence to understand how organisms have changed over time in order to survive. It is a traditional and valuable approach to research. However, it is not the only way to research evolution. Thanks to new computer technology, scientists now mix field observations with digital evolution software, allowing them to answer important biological questions, as well as solve non-biological problems using evolutionary theory. Computer software allows the researchers to create digital organisms, similar in some ways to real bacteria and viruses, for example that can copy themselves, make mistakes and cause mutations--essentially behaving like real life organisms. The difference, however, is that the digital creatures can do it in a small amount of time. Engineers also can use engineering simulation software to create an environment where new product designs can evolve. With each generation, the computer makes random mutations in existing designs in order to produce new ones. The simulation software then tests each new line and allows the better ones to survive, much like evolution in nature. Computers

also can evolve into new robot programs, making use of natural selection and enabling the machines to respond to human or animal interaction.

The purpose of this CU is to teach the concepts of evolution by paralleling and using analogies with the theory of evolution and the concept of Universal Darwinism. When teaching and paralleling AI with evolution, vocabulary knowledge is key to the foundation of this unit. The teacher of this CU must relate vocabulary terms to both AI and evolution.

Let's discuss the vocabulary words commonly used to support the analogy between The Theory of Evolution and AI. The definition of the word *adaptation* can be a confusing term because of the many ways it is used. For example, adaptation can refer to both processes and products:

> A repeating change such as that of a sensory organ (a sensor in machine) that make it less responsive to that particular stimulus, or
>
> An evolutionary change such as those caused by selection pressure on some trait (heredity) that helps the organism with changing environments over the generations, or
>
> A biological trait that happens because it is linked to a trait that now (or in the past) has passed on an advantage helping an organism's fitness.

Natural selection is typically a difficult phrase to understand relating to evolution, but here is one definition:

> Differential survival and reproduction of organisms as a consequence of the characteristics of the environment.

Variation has many different connotations:

> A difference or deviation (in structure, form, function) from the recognized model.
> A modification in structure, form or function in an organism, changing from other organisms of the same species or group.
> Mutant; an organism possessing characteristics as a result of mutation (I like to use the word change).

As I mentioned earlier, I believe I can engage the students more effectively with a CU that relates to the adolescent students' lives. I intend to make this unit project-based, along with integration of literacy, such as writing and analyzing texts for comprehension

and knowledge in order to enhance the comprehension of the subject matter. Any activities or experiments designed will demand writing at least a paragraph or more about the student's observation and interpretation of what they witnessed. Students must be encouraged and allowed to construct their own learning, using prior knowledge and creativity to learn the standards and eventually pass standardized tests which are stressed heavily in public schools today. Again, my intended audience for this curriculum unit is 7th and 8th grade inner city middle school students in a large metropolitan area. These particular students today face a myriad of learning challenges including attention deficit problems due to excessive exposure to video games, excessive TV viewing, and internet usage. Books, newspapers or e-readers are looked upon with disdain. Low reading levels and transient living conditions are the norm at this school. These children face many challenges to become prepared to contribute to the world of science, technology, engineering, and mathematics. As a teacher, I find it very difficult to explain the abstract concepts such as microbial interaction in seawater to an audience who is fixated on smartphones and hip hop music. Teachers need a connection that will motivate students to prepare for high-tech jobs that have not been created yet.

Teaching Reading and Literacy in this Curriculum Unit

Another focus and intention of this curriculum unit is to enhance reading comprehension and increase implementation of higher order reasoning while providing a more effective written analysis of science demonstrations and activities. Text in the science reading can include more than just textbooks and articles. I have listed some examples of "text" in the science classroom below.

Charts, tables, graphs
Video files, audio files
Works of art
Pictures & diagrams
Models
Maps
Smells, odors, textures
Patterns that require knowledge to interpret; i.e. patterns seen in waves, spectra (light & sound), test results (gels, karyotypes, microscopic slides, x-rays, Punnett squares, etc.), land and rock formations, seismic charts
Articles from science journals or textbook readings

Thus, resources and methods have been included to assist science content teachers in the preparation and motivation for struggling middle grades readers and writers. This unit was developed to target the specific needs of this middle school; below level readers in transient living conditions. This unit encompasses higher order thinking, rigorous activities, and teaching methods to utilize Gardner's Multiple Intelligences as well as some common reading and writing strategies.

Technology is so important in our daily lives. I, along with my students, must learn to incorporate smartphones, tablets, and laptops into our daily lessons to engage our imaginations. In order for today's educator to effectively reach most students, we must effectively integrate technology into our students' daily classroom time through *YouTube* video creation, writing eBooks, creating video lessons and through Power Point lessons created by the students themselves. I have included the Essential Questions students are required to know and be able to answer within the 8th Grade Curricula during the school year related to evolution. Some of these questions include:

1. How can changes in environmental conditions affect the survival of individual organisms and species of life on Earth?
2. How does the Geologic Time Scale help scientists to learn about Earth's past life forms, land forms and climate?
3. How have climate, geography and sea level changes affected the evolution of life on Earth?
4. How is life on Earth classified?
5. Explain how genetic diversity affects the likelihood that a species will be able to adapt to environmental changes.
6. How does an organism's phenotype and genotype affect its ability to adapt?
7. How do environmental, behavioral and genetic factors affect a species chance of survival?
8. How does natural selection play a role in evolution?

Additional I Can Statements and Essential Questions

1. I can compare the anatomy of several different species and explain why they adapted and evolved in a certain manner.
2. I can explain how natural selection affects the process of evolution.
3. I can differentiate random processes in evolution and machine learning.
4. How does evolutionary robots compare to the evolution of man?
5. How can a machine learn?
6. How can I adapt a robot to a given environment?
7. How does climate affect my design of a robot?
8. How does geography affect my design of a robot?
9. How does adaptation and natural selection come into play with artificial selection.
10. I can design an animal that can survive in a given environment.
11. I can create a species which that has evolved through changing climates.
12. Relate artificial selection with machine learning.

Students need to be able to answer these questions eloquently with strong writing skills and be able to analyze text and observations. And the best way to learn to write is to write and write often, perhaps every day, and receive feedback from a teacher. Just writing a sentence or two is important. It is important to note that writing about science is

a little different from language arts writing. I have included the Common Core Writing Standards for 8th grade science in the appendix and will be referring to them in the activities. My warm up usually contains writing one or two sentences to be read back to the class and teacher. Just write!

Graphic organizers, KWL charts, and *read write think*, are all commonly used techniques to enhance student learning. In today's technology driven world students must know how to research a topic and make sure the data is factual and authentic. This can be challenging for the student, and they must be trained in making judgments about the validity of texts and images.

Activities

Building the Ideal Animal Species

Teachers know that students struggle with the ideas presented that are related to the Theory of Evolution. Since the evolutionary process takes such a long period of time (often much longer than a human life span and longer than a class period), the idea of evolution is sometimes too abstract for students to really wrap their head around. Many students learn a concept better by performing hands on activities. However, sometimes a topic just does not click right away with students in a science classroom and a short activity to illustrate an idea may be needed to supplement a lecture, discussion, or even a longer lab activity. By keeping some quick ideas on hand at all times, with minimal planning, a teacher can help show many evolution concepts without taking up too much class time.

The following activity described in this CU can be used in the classroom in many ways. They can be used as stationed lab activities, or as a quick illustration of a topic as needed. They could also be used as a group of activities together in one or more class periods as a sort of rotation or station activity.

Each individual environment on Earth has a set of adaptations that are the most favorable for survival in those conditions. Understanding how these adaptations occur and add up to drive the evolution of species is an important concept for evolution education. If it is possible, having all of those ideal traits in one species could greatly increase that species' chances to survive a very long time in that environment and throughout time. In this activity, students are assigned certain environmental conditions and then they must figure out which adaptations would be the best for those areas to create their own ideal species.

How this activity connects to evolution:

Natural Selection works when individual organisms in a species with adaptations live long enough to pass down the genes with certain traits to their offspring. Individuals with unfit adaptations will not live long enough to reproduce and those traits will gradually disappear from the gene pool. By creating their own creatures with the most advantaged adaptations, students can demonstrate an understanding of which adaptations would be beneficial in their chosen environment to make sure their species would continue to thrive.

Evolutionary Robotics Creation

We can apply the theory of evolution and Universal Darwinism in creating robots. I have created an activity to parallel evolution and artificial intelligence. How can a student create a robot to demonstrate the concepts of evolution? Let's think about the vocabulary words.

> Adaptation: How can a robot evolve for a set of environmental conditions? For example: On the planet Mercury how can a robot evolve to adapt to such high temperatures? Or if a robot is created under the Pacific Ocean what sets of adaptations would be needed? Why do you build the robot that way?
>
> Mutation: How can a robot change (mutate) to adapt to rapidly changing conditions?

Natural Selection: Select pressures which cause adaptations to occur. Allow students to draw pictures of the adaptations and label them. You get the picture. The students can work in groups or alone to create the ultimate super-robot using vocabulary words in the evolution unit.

Art and Artificial Intelligence

While reading *The New Yorker,* I came upon an article about James Prosek and his new book, *Real and Imagined* and exhibition. This book has unusual creatures involving animals combined with machines today and relates to evolution. Mr. Prosek is a naturalist who writes about evolution and nature and also creates and paints strange animals such as beavers with chainsaw tails. He blends machines with animals to demonstrate evolution and machine evolution as well. These machine creatures are labeled *Industrial Evolution.*

This is a perfect opportunity for an interdisciplinary lesson combining art, science, the theory of evolution and the notion of androids – beings that are part-biological, part-machine. These lessons will drive home the concepts in the theory of evolution as well as *Universal Darwinism* that are discussed above in the previous background information. A lesson related to this concept could be created using these imaginary animals to engage students in the theory of evolution. The link to his book is:

http://www.nytimes.com/2014/04/06/nyregion/creatures-great-small-and-imagined.html?_r=0

This activity is an excellent use of the multiple intelligence principles written about in *Gardner's Multiple Intelligences* book.

The Intelligent Piece of Paper and The Jellybean Machine Learning Activities

These two activities, especially the jellybean machine learning activity, demonstrate how machines can learn through random trial and error. The sweet computer activity is a simple demonstration that shows how a machine can make mistakes and learn from them. The purpose of this activity in this CU is to prove that a computer, in this case non-digital, can learn and adapt through random errors, just as evolution does. This demonstration, based on the principles of the theory of evolution, concretely illustrates how seemingly intelligent behavior can emerge from blindly following a set of mechanical rules. Here are the links to these activities:
http://www.cs4fn.org/teachers/activities/sweetcomputer/ and
http://www.cs4fn.org/teachers/activities/intelligentpaper/intelligentpaper.pdf

Eating jelly beans and playing the Machine Learning Game

Appendix 1: Implementing Teaching Standards

8.L.4.2: Explain the relationship between genetic variation and an organism's ability to adapt to its environment.

I use the similar concepts and vocabulary of Artificial Intelligence to create an analogy to compare to the Theory of Evolution. Vocabulary such as natural selection, adaptation, random, mutations, variation, and fitness can be applied to both AI and evolution to help scaffold the student in the understanding and comparison of both topics.

Unpacking: What does this standard mean a student will know and be able to do?

8.L.4.1: Students know that biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment. Students know that most species that have lived on the earth are now extinct. Extinction of species occurs when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment.

8.L.4.2: Students know that individual organisms with certain traits are more likely than others to survive and have offspring. Students know that changes in environmental conditions can affect the survival of individual organisms and entire species. Students know that living organisms have morphological, biochemical, and behavioral features that make them well adapted for life in the environments in which they are usually found.

Resources

http://www.ai-junkie.com/ga/intro/gat1.html
Very detailed explanation of genetic algorithms

http://aeon.co/magazine/technology/emily-monosson-robot-evolution/
Article on robotic evolution

http://youtu.be/xS1xOXerBM0
An excellent video about genetic algorithms

http://youtu.be/3PMlDidyG_I
A video about The Turing Test

http://www.conceptschools.org/alive-evolutionarly-robotics-kids-yes-can/
An article about creating evolutionary robots

http://mashable.com/2013/12/09/facebook-artificial-intelligence-lab/

How face book uses AI

http://www.theatlantic.com/magazine/archive/2011/03/mind-vs-machine/308386/
An article about the human mind versus computers

http://www.boston.com/business/technology/articles/2011/01/31/artificial_intelligence_based_on_darwins_idea/
An article based upon Universal Darwinism

http://research.google.com/pubs/ArtificialIntelligenceandMachineLearning.html
Resources regarding machine learning and AI

http://egtheory.wordpress.com/2014/02/14/evolution-is-machine-learning/
Article relates machine learning to evolution

http://www.universaldarwinism.com/
Readings about Universal Darwinism

http://mashable.com/2014/08/03/elon-musk-artificial-intelligence/
Elon Musk discusses the dangers of AI

http://usatoday30.usatoday.com/tech/techreviews/2004-07-15-i-robot-ai_x.htm
Review of Robots and AI

http://youtu.be/_m97_kL4ox0
Using evolution to build AI

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