SOLVING PROBLEMS WITH COMPUTERS

Computer science is more than just the study of different programming languages or hardware parts. In most computer science careers, specialists use computer science thinking techniques to solve problems and puzzles and achieve specific goals.

In this activity, students are presented with a set of real-world problems and goals that computer programmers, computer animators, and more challenge themselves with each day. For each problem, the students are asked to discuss it, brainstorm ideas for addressing it, and then watch a video that presents one possible solution.

This activity can stand alone for approximately one day of class time, but it can be inserted at any point into the curriculum, or the individual discussions and videos can be interspersed throughout the curriculum however one sees fit.

PROBLEM A: ANIMATING RAPUNZEL'S HAIR

Although film animations were once hand-drawn, the entertainment industry has switched to using computers for drawing. While this works well for most objects, some challenges arose when animators were asked to create some more complicated structures. In Disney's *Tangled*, animators were asked to create the main character Rapunzel's unusually long, golden hair, which was much more complicated than any animated hair ever seen before.

*What techniques might be used to approach such a problem? If you were tasked with animating hair, where would you start?*

SOLUTION

Watch the video below about how one of Disney's software engineers used computer science and physics to model Rapunzel's hair.

* What steps did they use to approach the problem?
* Did they make any significant choices or compromises in animating the hair?
* Could similar approaches be used elsewhere?

VIDEO: UNTANGLING THE HAIRY PHYSICS OF RAPUNZEL

PROBLEM B: CAR SAFETY

Worldwide. about 1.2 million people die every year in car accidents and 50 million are injured. Over 90% of these accidents are caused by human error. To try and combat the problem of human error in transportation, the United States's Defense Advanced Research Projects Agency created a competition titled the DARPA Grand Challenge, where any group could win $2 million if they could create a self-driving vehicle that can drive across a desert by itself.

*How would someone make a self-driving car? What would such a car have to do, besides move?*

SOLUTION

In 2005, Stanford University took first place in the DARPA Grand Challenge. The same technology is now being developed in Google self-driving cars. Watch the video below about some of the programming and testing that goes into making these.

* What steps does Google use to better their technology?
* What different events would the car need to handle?
* What other tasks could you imagine automating?

VIDEO: GOOGLE'S SELF-DRIVING CAR ON CITY STREETS

PROBLEM C: JEOPARDY AND NATURAL LANGUAGE PROCESSING

Computers are already great at understanding instructions written in their own languages, but what about teaching them to understand the languages we speak in every day? The field of computer science called "Natural Language Processing" seeks to lessen the gap between human communication and computer understanding. IBM, a technology corporation, decided to put their language processing work to the test when they challenged some of the best players in a popular trivia game show called "Jeopardy" with a computer named Watson.

VIDEO: examples of Watson's interaction in Jeopardy

*How would you teach a computer to listen to or understand human speech? What other functionalities would IBM's Watson need?*

SOLUTION

Watch the video below about the specific methods IBM's scientists used to program Watson.

* Does Watson "understand" the questions and answers he gives?
	1. How is Watson's processing similar to ours?
	2. How is it different?
* Where else could Watson's technology be used?

VIDEO: WATSON'S JEOPARDY ALGORITHM

PROBLEM D: COMPUTER VISION AND INVISIBLE MOTION

Small and barely detectable motions such as breathing, heartbeat-caused skin color changes, or the swaying of unstable structures may be important but invisible to the human eye.

*How could you detect these small motions? What would the end result look like?*

SOLUTION

Watch the video below about MIT researchers who have developed software that emphasizes motion and color change in video.

* What other "little changes" could someone monitor, in areas beside film?
* Where else could you see applying this software?
* How might MIT develop this further? That is, what might a device do after it has sensed certain invisible motion?

VIDEO: INVISIBLE MOTION

PROBLEM E: POLLUTION & GRAFFITI

As population and population density increase, litter and graffiti are becoming more and more prevalent in urban areas. However, cleanup efforts have been only moderately successful in the past. Many green organizations have been reaching for alternative solutions, including technology and computer science.

*How could you use code to coordinate a community to help keep your neighborhood clean?*

SOLUTION

Watch this video to see how a team of girls in East Palo Alto worked together to make an app to help clean up their neighborhood.

* How could code be used to help community service projects you care about? If you were to design an app to help your community, what would it do?

VIDEO: EPA CHICA SQUAD

PROBLEM F: BIONIC LIMBS

There are a surprising amount of amputees (individuals missing at least one limb) worldwide; the US alone contains nearly 2 million amputees. The simple prosthetic limbs they currently use often lack some of the functionality that amputees need for their day-to-day lives.

*How might one approach the problem of making replacement limbs more effective? What would these limbs need to do, and how can coding or computer science provide these needs?*

SOLUTION

Watch the video below about MIT Professor Hugh Herr who is constructing and testing bionic limbs. These bionic limbs can let amputees walk, hike, and even dance with ease.

* We've now seen limbs and cars replaced by digital implementations. What other digital automations might be useful?
* This bionic limb is one of many technologies modeled after nature. What is another type of machine or technology that may benefit from being modeled after nature?

VIDEO: MIT BIONICS