Lesson 3: KIBO Rover
(1 hour)

Overview: Students will create a "rover" robot that uses its sensors and programming to explore a new environment. KIBO will illustrate the "sense, think, act" cycle that is fundamental to both robotics and AI.

Powerful Ideas of AI:
Perception (computers and robots perceive the world using sensors)
Processing (sensor data is used to make decisions about what to do in a program)

Learning Goals:
- Understand that AI and robot behavior can be understood as "sense – think – act."
- Understand that robots can use AI programming to act on their own.
- Be able to create a program for KIBO that uses sensor data to act independently.

Materials/Resources:
- One KIBO 18 kit or higher per group of 2 – 4 students.
- Optionally, one Advanced Coding Extension Set per KIBO.
- Craft supplies for decorating KIBO rovers.

Lesson Plan

Introduce the Concepts and the Task: "Today we will create KIBO Rovers to explore a new environment. We'll use what we know about KIBO's **sensors** and **programming** to make KIBO operate on its own."

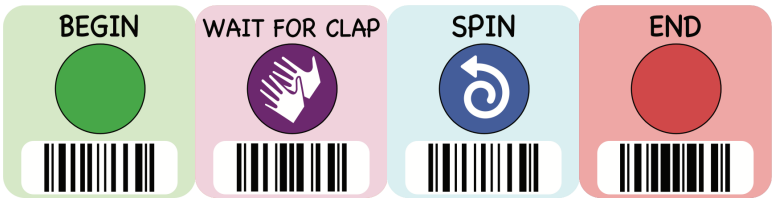
"Rovers and explorers are real-world robots that sometimes have to operate far away from people, so they need to be able to act on their own." Ask students to share ideas for places that would be interesting to explore but difficult for humans to go to. This could include other planets like Mars or Venus, difficult to reach places like dark caves, or environments like the deep sea where humans can't survive. What about these places make robots more suited for exploration?

"Sometimes scientists can remote-control these explorer machines, like they were driving a car. But other times they use artificial intelligence to let these explorer robots make decisions themselves about what to do next. Robots can use their sensors and their programs to decide what to do. We call this the "**sense – think – act**" cycle."

Talk to the students about each of these steps:

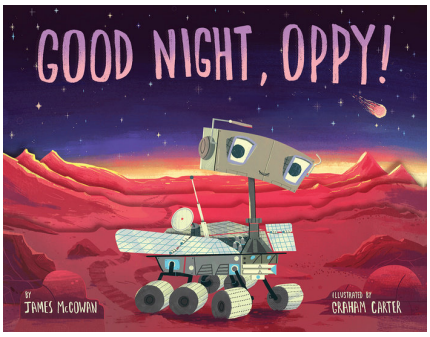
- **Sense**: robots use their sensors to gather information. Ask the students to recall examples of KIBO's sensors and what they can detect.
- **Think**: robots use their programs to make decisions based on what their sensors tell them. Ask the students to recall examples of KIBO's conditional programming blocks (WAIT FOR CLAP, IF/END-IF) and how they represent decision-making.
- **Act**: robots act (such as by moving) based on their decision. The actions they can take are also determined by their program.

With a KIBO equipped with the **sound sensor** (ear), demonstrate this program:



Discuss with the students how KIBO's sensors and program illustrate each element of **sense – think – act**. Ask students to share ideas for more complicated programs that use this cycle. We will explore their ideas in the group activity.

Warm-Up / Connect: Read *Good Night, Oppy!* by James McGowan and Graham Carter*. This book follows the NASA Opportunity rover on its mission to Mars. Several AI and robotics related themes are included, such as what sensors Opportunity used to explore its environment and how the Earth team communicated with the rover across long distances. For older students, the book includes optional side passages with additional material about space exploration.



Afterward, reflect with the students on the way the author represented the communication between Opportunity and the NASA team on Earth. What decisions was Opportunity making using the sense – think – act cycle?

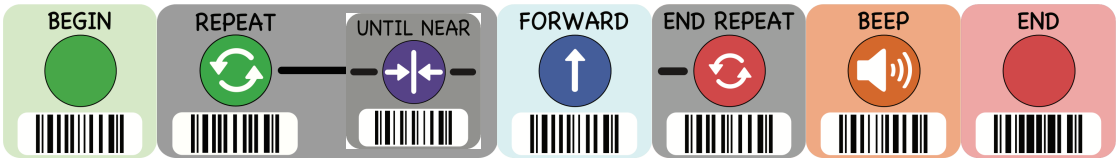
* If you don't have access to the book, a teacher created read-aloud video is linked from KinderLab's curriculum website at kinderlabrobotics.com/curriculum.

Small-Group Work: Now it's time to create our own robotic rovers! Each group will design a KIBO program to explore an environment using the sense – think – act structure. Allow students to design their own programs but they should include the following elements:

- Wheels and motors to allow KIBO to explore the environment.
- At least one sensor.
- Conditional program elements such as REPEAT (UNTIL), IF/END-IF or WAIT FOR CLAP driven by the sensor.
- An action to take based on the sensor input.

Here are examples of a program the students might create, drawing on prior work they've done with sensor programming. Share these examples if students need guidance:

KIBO will travel forward once, then check if the environment is dark. If so, it will turn on its light to make the environment safer for human explorers later.



KIBO will keep rolling forward, checking to see if an obstacle is near. When it reaches an obstacle, it will beep to let the scientists know it found something!

Optionally, students use of the IF NOT block from the Advanced Coding Extension Set to create more sophisticated "**think**" behavior.

Students can use art and craft materials to decorate their rovers. Students can take inspiration from thinking of what features might be useful in navigating the environment they're exploring: fins and tanks for an undersea robot, or big wheels and solar panels for a Mars explorer.

Technology Circle: Allow each group to demonstrate their rover robot. They should explain how their robot engages in the sense – think – act cycle. They should also describe the environment their robot is exploring, and how the independent action of the AI program allows the robot to perform its task.

Discuss with the students: compared to humans exploring dangerous or challenging environments, what are the advantages AI-driven robotic explorers? What are the problems or limitations? What if a robot encountered something completely unexpected?