PROGRAM ACTIVITIES GUIDE

A roadshow program typically has two parts, a slide presentation that helps presenters introduce themselves and the field of computing, and a hands-on activity (or two) that drives the learning home. You will find the “introducing” presentations, one each for grades K-6 and 7-12, in the Training folder at **www.ncwit.org/roadshow**.

The activities below show what you do after the introductory slideshow. These interactive learning experiences anchor the content of the talk and make the entire experience memorable. This *Program Activities Guide* includes six activities, a sampling of the kinds of experiences student presenters might incorporate into their roadshow program.

Please note! Activity 1 requires the purchase of a small robotic car, available from a variety of online vendors. Be sure to order the car a week or more in advance of your scheduled event. See Activity 1: Line Chaserz Robotic Car, on the following page, for more information.

Here is a summary of the activities in this section:

Activity 1: Line Chaserz Robotic Car

Objective: Students learn that a robotic car is a mechanical computing device that employs sensors. Students recognize how sensors are used in a variety of applications in their everyday world.

Activity 2: Sorting Networks

Objective: This activity shows how computers sort random numbers into order using sorting algorithms or a “sorting network.”

Activity 3: Sudoku

Objective: Students understand that computers are problem-solving (and creating) devices that use logic based on algorithms.

Activity 4: University of Washington Careers Video

Objective: Students see people working and talking about their work in Computer Science and Information Technology and recognize they are regular people who enjoy rewarding careers.

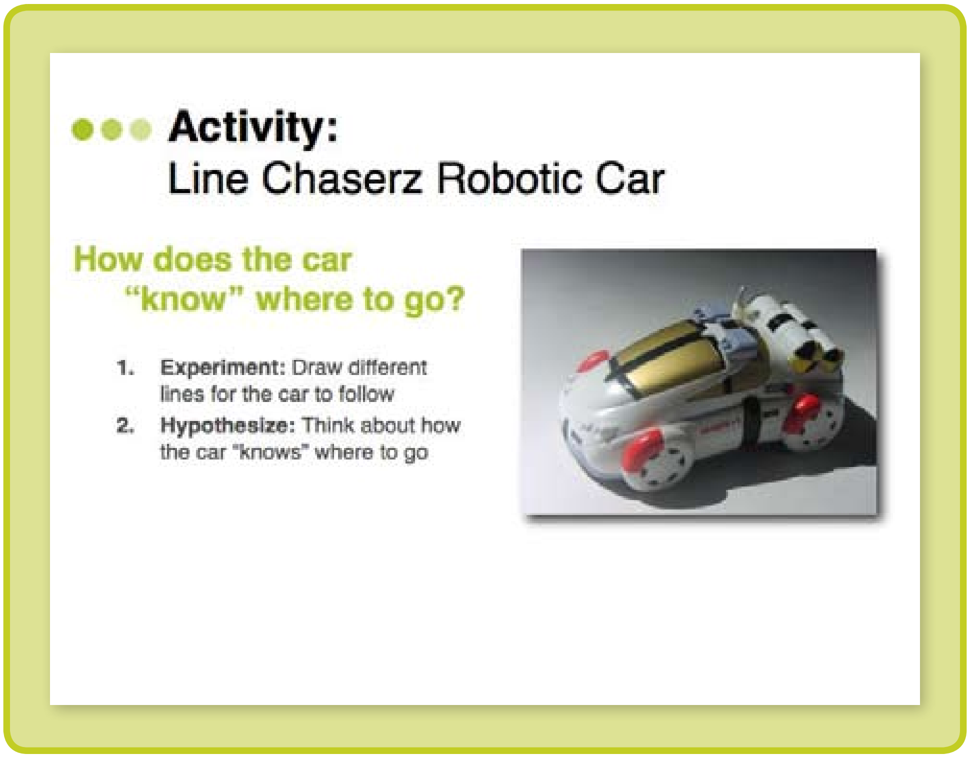
Activity 5: Cheetos and Candy Bars

Objective: In this logic activity students approach a problem that involves employing a set of rules known to be true. Such rules, or algorithms, dictate how computers solve problems.

Activity 6: Teach a “Robot” to Draw

Objective: Students understand that computing devices function by acting on precise and sequenced instructions, and these instructions are delivered through computer program languages that devices “understand” and execute.

Activity 1: Line Chaserz Robotic Car



Robot Car Activity – 35 minutes (Can be easily modified for shorter or longer time frames and age groups.)

Description: This inquiry activity will get students thinking about how computers work. Discuss the activity with the hosting teacher. He or she will have ideas for overall management of the activity.

Objective: Students learn that a robotic car is a mechanical computing device that employs sensors and circuitry. Students recognize that sensors are used in a variety of applications in their everyday world.

ACTIVITY 1 — (CONTINUED)

Materials:

a. Line Chaserz Kit (at least one) Each kit is $16.00 and can be purchased at Amazon.com and other online retailers. Be sure to order in advance!
b. Downloaded *Roadshow Activity Slides* (use the first slide showing the image on the previous page.)
c. Downloaded *Roadshow Activity 1 Supplemental Slides* for magnified view of robotic car (optional, shown below).
d. Document camera for magnified view of robotic car (optional, but these are becoming standard classroom equipment replacing the overhead projector, so ask your host school)
e. Blank white paper
f. 8.5”x11” scratch paper for planning
g. 2’x3’ butcher paper or chart pack paper, one for each pair (half the number of students in class)
h. Black markers – thick chisel point similar to that in the kit - one for each pair (half the number of students in class)

Room/Setting: Situate students in chairs in a semi-circle around open, uncarpeted floor space so they can see the car in action.

Directions:

1. ***Show.*** Demonstrate how the car follows a black line on a 2’x3’ piece of paper. Keep the line fairly simple and run the car several times. Ask students how they think it operates. Don’t go into great explanation here. Just encourage many possibilities and then say, “Let’s find out.”

2. ***Involve Students.*** Follow these steps:
    a. Invite student pairs to draw their own line with a thick-tipped black pen on a 2’ x 3’ sheet of paper. (You may want students to pencil sketch their idea on small paper before drawing their path on the large sheet.)
    b. Collect the large sheets and randomly select eight sheets, keeping them face down.
    c. Pull a sheet, find the pair who drew it, and let this pair run the trial. Before each pair runs the car on their sheet, ask the class to predict how the car will respond to the design.
    d. After trying all eight, ask and discuss: What seems to give the car trouble? Success? Which drawings worked? Which ones didn’t?

3. ***Inquire.*** Ask students how they think the car might be working. You can pass the car around for students to look at, if you’d like. Tell them not to take it apart, but guess “what’s under the hood?” Ask them to describe what they see on the car.

ACTIVITY 1 — (CONTINUED)

4. ***Discuss what's going on.*** Show the slides with photos of car details. Talk about how the car follows the line.
   a. On the bottom of the car are two red LEDs (light emitting diodes) and two pairs of IR (infrared) emitter/detector pairs. Explain: When the car is turned on, the red LEDs are illuminated and cast light under the car, changing the color on the paper. Notice the LEDs are on the outside of the IR pairs.
   b. The IR emitter sends out a beam of infrared light (which you can't see), which detects the reflected light sent out by the LEDs. The color of the reflected light tells the sensor if it's over a black line or not. (More detailed description: When the LED casts a beam on black (the line) it is absorbed and shows nothing for the IR pair to sense. When it casts a beam on white (plain paper) it is reflected, and it is this reflected light that the IR pairs sense. So LED beam over black is like "off," LED beam over white is like "on.")
   c. Ask: Why are there two pairs? (Get students to think about this.) What would happen with only one set? Could we still follow a line? Would it work as well? Why or why not?
   d. Pop the cover off the chassis and expose the circuitry. (Run any additional trials with the cover off.) Explain that this is circuitry like in any computing device. It responds to electric signal based on programmed computer code. Give more detail if students show interest.
   e. Write pseudocode for line-following on the board or show the slide with this "code" on it. Explain that the circuitry "reads" the code and relays instructions to the car. Read the code aloud:

      if left-ir sees black, steer to left, otherwise steer to right

      if right-ir sees black, steer to right, otherwise steer to left

      - ***Ask:*** What's happening in this code? What happens when neither line sees black? (Car should go straight – verify this with your car.) The students can also experiment with the car held in the air, using paper to block one of the pairs of sensors
      - ***Ask:*** Why not the following? Are we really using both sides to follow the line with the code below?
      - ***Ask:*** What happens if a line forks? Does the car tend to take one branch rather than the other? Test.
      - ***Ask:*** What does this tell us about the car's programming?
      - Discuss precision in instrumentation, that a toy car doesn't require the fine-tuned precision of a surgical instrument for instance.
   f. ***Discuss Sensors.*** Explain that the IR pairs are sensors that read information about the environment; the car acts on the information from these sensors to change its behavior, based upon the program (above). Explain that not all sensors are light sensors. There are motion sensors, tilt sensors, touch sensors, and more. All sensors give feedback to circuits that instruct a machine to do work, like steering the robot car.
      Ask: Where else do you see sensors? Have the students brainstorm, and write examples on the board.

ACTIVITY 1 — (CONTINUED)

Here are ideas:

- Faucets in bathrooms that turn on automatically (use a distance sensor)
- Automatic doors at stores (might use a distance sensor or a motion sensor)
- Alarm systems (might have motion sensors, contact sensors on windows and doors, or audio sensors)
- Toys (Furby and Sony Wii have a tilt sensor and touch sensor; Mindstorms has sensors in the kit)
- Roomba vacuum cleaner (touch sensors in bump skirt, IR emitter/detector pairs to prevent going off stairs)
- Television (IR detector to read signal from IR emitter in remote control)
- Thermostat (temperature detector to turn on heat or air conditioning)
- Rain gauge in a sprinkler system (contact sensor)
- Cars (speed readings, thermometer for engine heat, sensing problems with engine)
- Automatic lights that come on when it gets dark (if not on timer, otherwise controlled by a light sensor)
- Bar code scanner at stores (light sensor)

g. ***Ask:*** Why do we use sensors so much? This gets at the heart of robotics — computers plus mechanics produce automated work. A machine is, by definition, a laborsaving device; the computer sensors make machines even more independent and laborsaving. Encourage kids to brainstorm: How might more sensors be put to work in the world? If time allows, encourage student pairs to draw diagrams of their ideas to share now or continue with later.

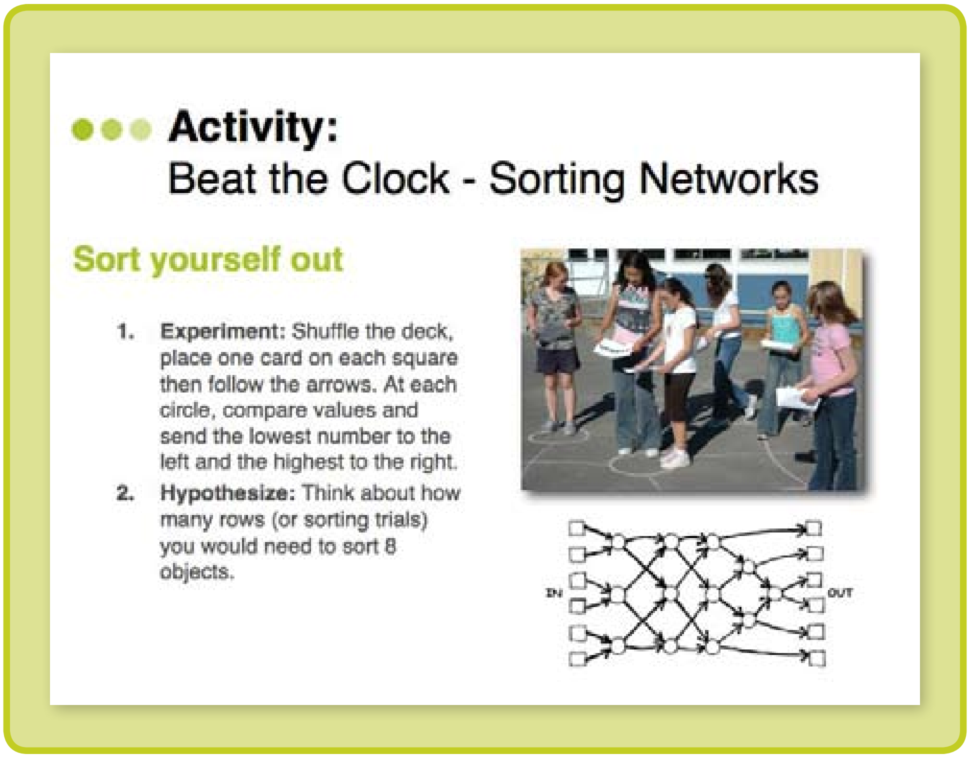
h. If time allows and students show interest in coding, explore: How could this car run differently? One example: A car could be programmed to stay between two parallel lines instead of following a single line. The "programming" would look like:

if left-ir sees black, steer to right, otherwise steer to left

if right-ir sees black, steer to left, otherwise steer to right

Ask: How might it respond to different colored lines?

Activity 2: Beat the Clock — Sorting Networks



This activity is used with permission from *Computer Science Unplugged* by Tim Bell, Ian H. Witten, and Mike Fellows, with illustrations by Matt Powell. You can download additional Unplugged activities at **http://csunplugged.org/home**.

Description: Even though computers are fast, there is a limit to how quickly they can solve problems. One way to speed things up is to use several computers to solve different parts of a problem. In this activity we use sorting networks, which do several sorting comparisons at the same time.

Objective: This activity shows how computers sort random numbers into order using sorting algorithms or a sorting network.

Skills: Comparing, ordering, developing algorithms, cooperative problem solving

ACTIVITY 2 — (CONTINUED)

Materials:

a. Downloaded *Roadshow Activity Slides* (use the second slide showing the image on the previous page.)

FOR INDOOR GROUP ACTIVITY	FOR OUTDOOR GROUP ACTIVITY
b. Sorting networks board	b. Sidewalk chalk (to draw sorting networks)
c. Two sets of six sorting networks cards (included)	c. Two sets of six sorting networks cards (included)
d. Stopwatch/timer	d. Stopwatch/timer

Room/Setting: Indoor activity with a sorting networks board; Outdoor activity with sidewalk chalk. Gather group around sorting board or chalk sorting network.

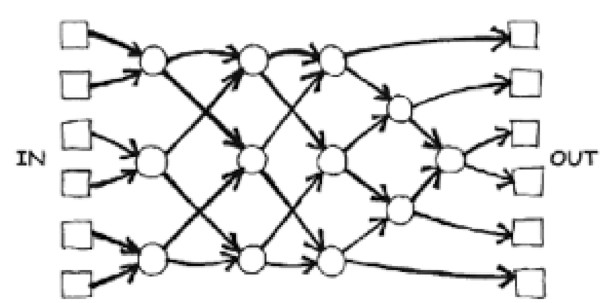
Directions:

Prior to activity:

1. Print age appropriate sorting networks cards (included at end of this document) and cut out individual cards.
2. For indoor version, use Sorting Networks board or create the following network on a large piece of poster board. For outdoor version, prior to the activity use chalk to mark out this network on a court.

Activity:

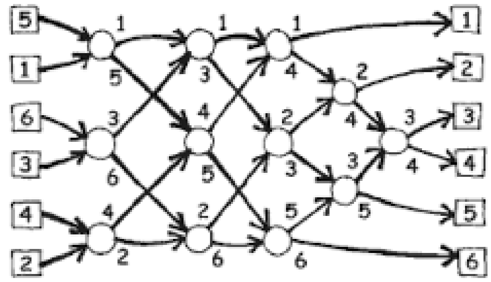
1. Organize class into groups of six. Only one team uses the network at a time.
2. Give each team member a numbered card.
3. Each member stands in a square on the left hand (IN) side of the court. Your numbers should be in jumbled order.



4. You move along the lines marked, and when you reach a circle you must wait for someone else to arrive.
5. When another team member arrives in your circle compare your cards. The person with the smaller number takes the exit to their left. If you have the higher number on your card take the exit on the right.
6. Are you in the right order when you get to the other end of the court?

ACTIVITY 2 — (CONTINUED)

If a team makes an error they must start again. Check that they have understood the operation of a node (circle) in the network, where the smaller value goes left and the other goes right. *See numbered example to the right.*



Variations:

1. When the students are familiar with the activity use a stopwatch to time how long each team takes to get through the network.

2. Use cards with larger numbers.

3. Make up cards with even larger numbers, fractions, decimals, etc. that will take some effort to compare, or use words and compare them alphabetically.

Extension Activities:

1. ***Ask:*** What happens if the smaller one goes right instead of left and vice versa?

   Answer: The numbers will be sorted in reverse order.

2. ***Ask:*** Does it work if the network is used backwards?

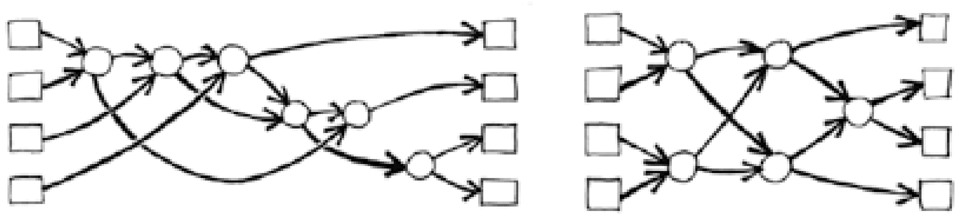
   Answer: It will not necessarily work, and the children should be able to find an example of an input that comes out in the wrong order.

3. Try to design smaller or larger networks. For example, below is a network that sorts just three numbers. The students should try to come up with this on their own.

ACTIVITY 2 — (CONTINUED)

4. ***Ask:*** Below are two different networks that will sort four inputs. Which is the faster?

   Answer: The second one is. Whereas the first requires all comparisons to be done serially, one after the other, the second has some being performed at the same time. The first network is an example of serial processing, whereas the second uses parallel processing to run faster.



5. Try to make a larger sorting network.

6. Networks can also be used to find the minimum or maximum value of the inputs. For example, here is a network with eight inputs, and the single output will contain the minimum of the inputs (the other values will be left at the dead ends in the network).

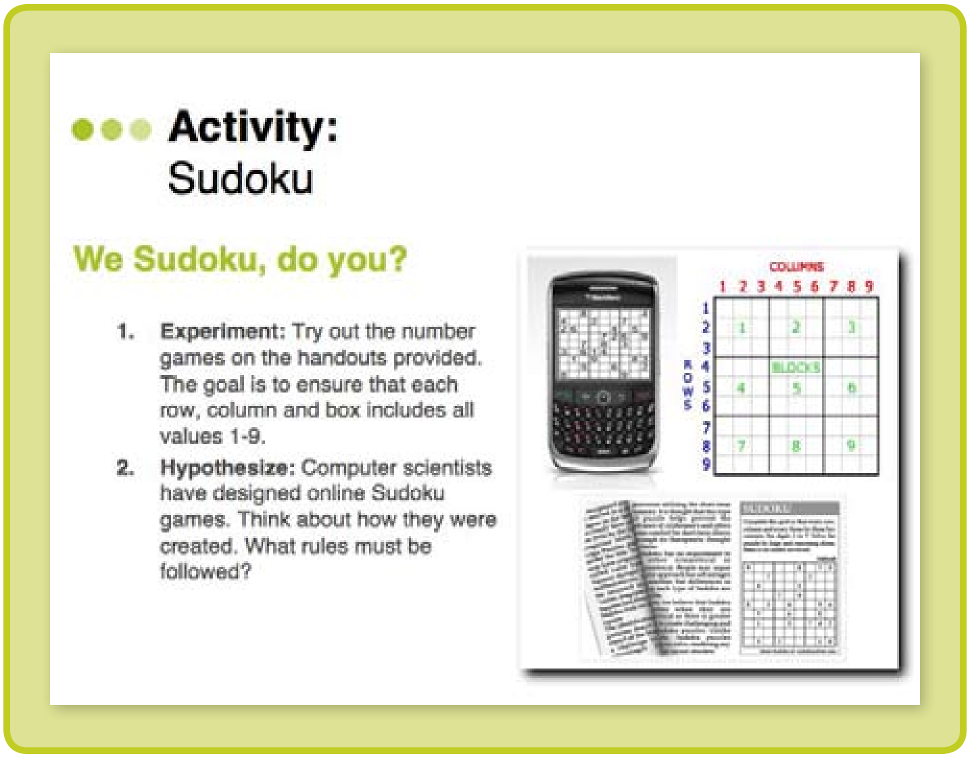
7. What processes from everyday life can or can't be accelerated using parallelism? For example, cooking a meal would be a lot slower using only one cooking element, because the items would have to be cooked one after another. What jobs can be completed faster by employing more people? What jobs can't?

What's it all about?

As we use computers more and more we want them to process information as quickly as possible. One way to increase the speed of a computer is to write programs that use fewer computational steps. Another way to solve problems faster is to have several computers work on different parts of the same task at the same time. For example, in the six-number sorting network, although a total of 12 comparisons are used to sort the numbers, up to three comparisons are performed simultaneously. This means that the time required will be that needed for just 5 comparison steps. This parallel network sorts the list more than twice as quickly as a system that can only perform one comparison at a time.

Not all tasks can be completed faster by using parallel computation. As an analogy, imagine one person digging a ditch ten meters long. If ten people each dug one meter of the ditch the task would be completed much faster. However, the same strategy could not be applied to a ditch ten meters deep — the second meter is not accessible until the first meter has been dug. Computer Scientists are still actively trying to find the best ways to break problems up so that they can be solved by computers working in parallel.

Activity 3: Sudoku



Description: In this activity students explore Sudoku, a logic-based number placement puzzle. This problem-solving game requires the player to fill a grid so that each column, each row, and each of the smaller boxes that make up the puzzle contain one of each possible number from 1 to 9.

Objective: Students understand that computers are problem-solving (and creating) devices that use logic based on algorithms.

Materials:

a. Sudoku puzzle handouts (included)

b. Pencil

c. Downloaded *Roadshow Activity Slides* (use the third slide showing the image above)

Room/Setting: Depending on the size of the class, have students work in small groups or in pairs using the included handouts. For younger age groups, have the students work together as a class.

ACTIVITY 3 — (CONTINUED)

Directions:

1. Introduce the activity. You may wish to say:
   Sudoku is a very popular puzzle or logic based game that requires problem solving skills. Sudoku can be found in newspapers, magazines, and on the internet. It is similar to a crossword puzzle with numbers. In front of you is a [4x4 or 9x9] Sudoku puzzle. The puzzle is comprised of rows, columns, and smaller boxes or regions that make up the larger grid.

   For younger audiences, say:
   Can someone point out the rows? How about the columns? Where are the regions or smaller boxes within the larger box? How many smaller boxes or regions make up the larger box?

   Make sure everyone in the class understands what a row, column, and region is.

2. ***Ask:*** Has anyone in here ever played Sudoku? If so, have her/him explain the rules. If not, tell the class about the purpose of the game. You could say:
   The main rule of Sudoku is to have only one of each number (either 1-4 or 1-9) in each row, column, and region. You will see that some of the numbers in the puzzle have been provided for you. These numbers will help you to solve the puzzle.

3. Depending on the age of the audience and past Sudoku experience, ask if the group would like to fill in a few blanks together or break into groups. If the group elects to start working together, make sure they figure out the solutions by talking aloud. Don't give them the correct answer or tell them if the answer is incorrect. Let the group decide whether the number in that particular box adheres to the rules.

4. Once the group(s) has/have completed the puzzle, compare answers to see if everyone came up with the same solution.

5. Tell students that they could make their own Sudoku puzzles and puzzle solvers using a computer. You might say, "Using a computer you can create your own Sudoku puzzles and create programs that will solve Sudoku puzzles for you. Does this sound like a fun job? Would anyone be interested in doing something like this? By exploring computer science and information technology you can create Sudoku puzzles and other fun games!"

Sudoku Handout

4x4 Sudoku (easy)

	2		4
	3	2	
	1	4	
3		1	

4x4 Sudoku (medium)

2	4		
			2
3			
		1	3

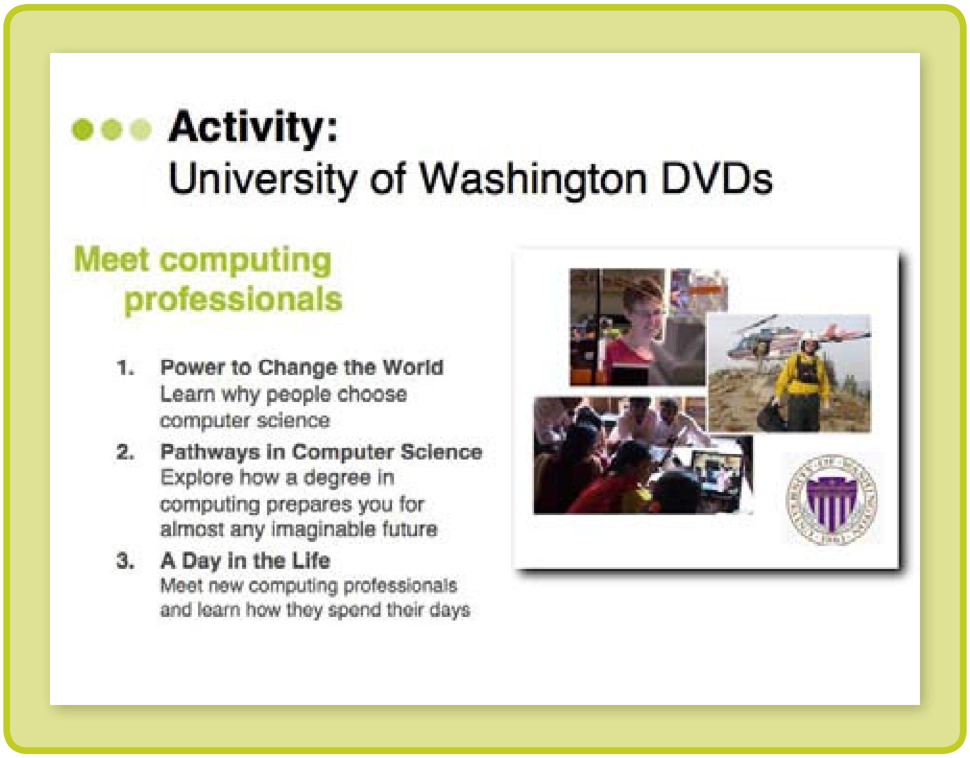
4x4 Sudoku (hard)

2	1		
4			
			4
		1	

9x9 Sudoku (hard)

	8			2	7		3	1
		7	9	1	4		6	
1				3	8			5
7	6	8	2	4	7		9	3
			3	5	6	7		
4	3	5	8		9	2	1	6
6		3	4		2	1		
	7	2	1		5		4	
5								

Activity 4: University of Washington DVDs



Show one or more of the videos described below.

Description: Videos from the University of Washington's School of Computer Science & Engineering: "Why Choose CSE?"

Objective: Students see people working and talking about their work in Computer Science and Information Technology and recognize they are regular people who enjoy great careers.

Materials:

Downloaded *Roadshow Activity Slides* (use the fourth slide showing the image above.)

All videos from "Why Choose CSE?" can be downloaded or streamed. You will also find instructions for obtaining a free copy on DVD. These videos can be found at: **www.cs.washington.edu/WhyCSE**.

ACTIVITY 4 — (CONTINUED)

Power to Change the World – First-person accounts of computer science and engineering students, alumni, and faculty explaining why they chose computer science. Use the video to introduce computing as an exciting field full of opportunities.

Pathways in Computer Science – Illustrates the diverse professional pathways students can pursue after receiving a degree in computer science or computer engineering. Use the video to explore how a degree in computing prepares students for almost any imaginable future.

A Day in the Life – Six brief profiles of recent computer science and engineering graduates. Meet bright young women engaged in secure, highly collaborative, creative, diverse, challenging, and well-compensated work. These role models will resonate with young people who might not otherwise consider a career in computing.

Following the videos, use these steps:

1. Have students write a reflection on this prompt: *Use your imagination - If you could change the world and use technology to do it, what would you do? What would you invent or improve?* Encourage students to be imaginative and have fun, and tell them there are no right or wrong answers.

2. Have students share their reflections and discuss how their ideas might tie back to fields of Computer Science and Information Technology.

3. Encourage students to keep their eyes open, talk to people who do what interests them, and to follow their passion!

Activity 5: Cheetos and Candy Bars

Description: The purpose of this activity is to discover what objects are inside a set of mislabeled boxes. The audience is told that each box has either Cheetos, candy bars, or Cheetos and candy bars. The problem? The boxes are mislabeled. Students can only sample from one box and then relabel the boxes correctly.

Objective: In this logic activity students approach a problem that involves employing a set of rules known to be true. Such rules, or algorithms, dictate how computers solve problems.

Materials and preparation:

Downloaded *Roadshow Activity Slides* (use the fifth slide showing the image above)

ACTIVITY 5 — (CONTINUED)

To complete this activity, you will need Cheetos, candy bars, and three boxes with holes that allow students to pick out objects without seeing inside the box. Before beginning the outreach presentation, label the boxes with "Cheetos," "candy bars," and "Cheetos and candy bars." Fill the boxes with objects with mismatched objects (e.g., put only candy bars in the "Cheetos and candy bars" box). If you are able to bring enough for every student, and you obtain permission, bring another container with extra Cheetos and candy bars for students to receive as a reward.

Room/Setting:

Have students work in small groups or in pairs. They may need paper and pencil to work out the problem.

Directions:

1. Introduce the activity. Say:

   I have three boxes here, and they are full of snacks. I have candy bars, Cheetos, and one box with both Cheetos and candy bars in it. Unfortunately they are all mislabeled. None of the labels are correct. I don't want to destroy the boxes, but I need to know what is inside them. I can peak into ONE box, then I should be able to figure out what is in each one.

2. Show students the boxes. Some might want to shake them to guess which objects are in each one. If the box is sturdy, allow them to do so. One way to "trick" them is to add rocks to all of the boxes to simulate candy bars, along with crumpled paper, to simulate Cheetos wrappers. They may guess without working it out first. Ask them, "How can you be sure?"

3. Now encourage them to figure out the answer to the problem. "Which box will give you the most information about the contents of the other boxes?"

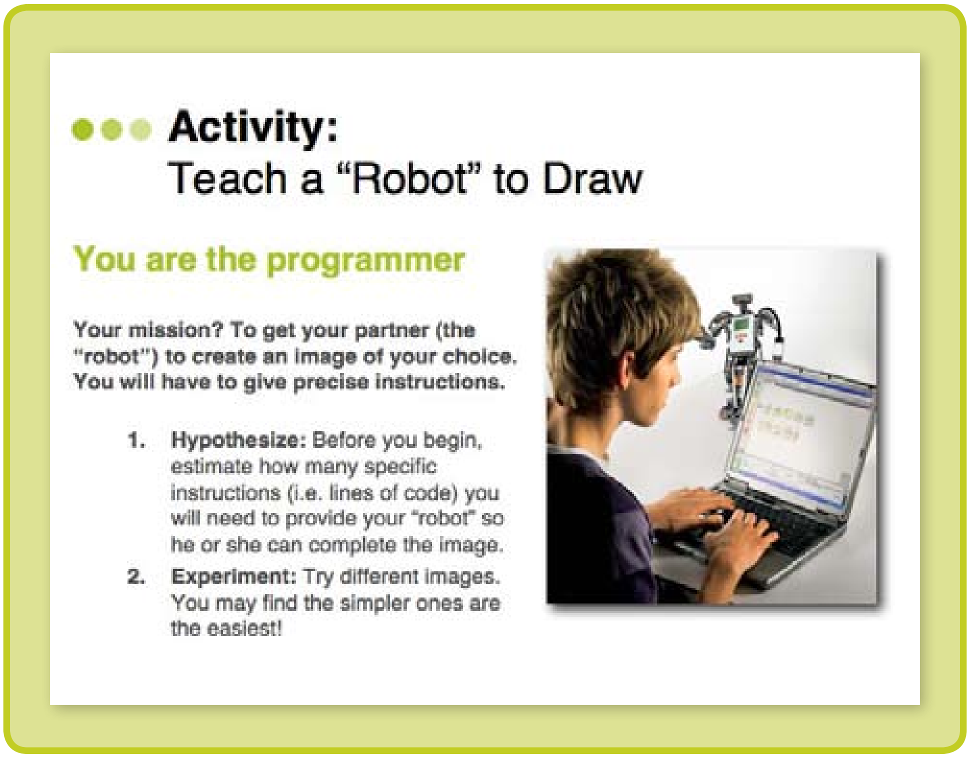
4. Some students may need prompts or assistance in answering this logic problem. You might say:

   Let's think about this. What if I stick my hand in this Cheetos box, and I pull out a candy bar? What does that tell me?

<u>SPOILER ALERT! HERE IS THE ANSWER!</u>

By choosing from the box labeled "Cheetos and candy bars," you will know exactly what is in the box. If you pull out a candy bar you know that ONLY candy bars are inside the box. Thus, Cheetos must be in the box labeled "candy bars," and Cheetos and candy bars must be in the box labeled Cheetos. This will only be true if **<u>each box</u>** is mislabeled, so double-check this before you introduce the activity.

Activity 6: Teach a “Robot” to Draw



This is a Kinesthetic Learning Activity (KLA) meant to physically engage students in the learning process. KLAs fill an important niche; they energize students, employ underutilized learning styles, and achieve especially challenging learning goals. Discuss this activity with the teacher and plan how students will pair, arrange themselves, and use their materials.

Description: A student “programmer” thinks about transmitting information so a fellow student “computer” acts on it, moving his or her pencil to draw a line drawing that only the “programmer” sees. Students may describe using some terms that express scale and position, but they will find it takes precise instructions for the drawing to come close to matching the original picture.

Objective: Students understand that computing devices function by acting on precise and sequenced instructions, and these instructions are delivered through computer program languages that devices “understand” and execute.

ACTIVITY 6 — (CONTINUED)

Materials:

a. Enough photocopies of several different line drawings so each pair has one sheet (samples included)
b. 8.5” x 11” sheets of blank paper
c. pencils or pens
d. Downloaded Roadshow Activity Slides (use the sixth slide showing the image on the previous page)

Room/Setting:

Have students sit back to back on the floor or at tables or desks with a divider between them (could use a propped up 3-ring binder) so they cannot see each other’s paper/drawing.

Directions:

1. Introduce the activity. You may wish to say:
   In order to think about how you could program a robot or other computing device to draw a picture, we’re going to do a drawing activity in pairs. One of you will be the ‘programmer’ giving instructions and the other will be the computing ‘device’ acting on those instructions and drawing. You should sit such that neither of you will be able to see the other’s paper. You can do this by sitting back to back or by propping a 3-ring binder or large book on the table between you.
   (You may wish to ask the teacher in advance which method is best.)

2. Give one member of each pair a line drawing. It is important that students sitting near each other have different drawings, otherwise they can listen to descriptions given by describers on other teams. Say:
   I’ll start by giving a line drawing to each programmer. If you are the “programmer,” don’t tell the “device” what the picture is. Instead, try to tell your partner how to draw the object in simpler terms, describing pieces of the drawing one at a time. The “device” cannot ask any questions, but may ask for a command to be repeated if it can’t act on it. After the picture has been described and drawn, wait for my cue and then you can show your pages to one another. This activity should only take five minutes or so.

3. After drawing is complete, ask pairs to raise their hands if their two pictures (the original and the drawing) ended up different from one another. Call on pairs to describe how the drawings differed (e.g., item placement, shape, scale)

   Ask pairs: *What terms did you use to describe the task? Ask if other groups used other terms.*

4. Discuss how computers need to have precise language. For example, it would not be enough to say, “Draw a square.” The size of the square would need to be specified. Computers (think: “compute”) use mathematical terms to express position, shape, size, and relationships.

ACTIVITY 6 — (CONTINUED)

5. Select one original and hold up all its renderings so students can compare.

   Ask: *Which picture most closely matches the original?* Ask that pair of students what kinds of terms they used. Ask the students if they could think of other ways to describe drawings to a computer. If no one has thought about describing line segments in terms of end points, ask if that might be a good way to describe drawings.

   Other alternatives to suggest:

   - Pen up, pen down, north for ‹distance›, south for ‹distance›, west for ‹distance›, and east for ‹distance›. Ask the students if any of them have drawings that could not have been done (easily) with this method (anyone with a circle or diagonal line should show their drawing).

   - Drawing a grid, then moving left to right across each row, saying if a grid square should be colored in or not. (Can lead to a discussion of pixels on a computer screen.) ***Ask:*** *Do you think it would have helped you to know what the object was that you were trying to draw? Do you think it would help a computer?*

6. If time allows, switch roles of programmer and device and repeat the activity with different pictures.

7. At the conclusion, ask students if they did anything differently this second time. Did they change their terms after the discussion about different approaches? How? If so, did they have a better result?

8. Close the discussion with a suggestion that students try their hand at programming and programmable devices like robots.

Pictures for Teach a Robot to Draw