Collision Detection - Distance and Inequality

Students use function composition and the distance formula to detect when characters in their games collide.

Lesson Goals	Students will be able to: • Explain how the distance formula is related to the Pythagorean theorem. • Write a function for the distance formula.
Student-Facing Lesson Goals	• I can explain how the distance formula is connected to the Pythagorean theorem. • I can write a function that takes in 2 points and returns the distance between them.
Materials	• Lesson slides • Sample game file - no distance lines • Sample game file - with distance lines • Top Down / Bottom Up (Page 5) • Word Problem: is-collide (Page 6) • *Optional: the Flag of Trinidad and Tobago Starter Code (Pyret)*
Preparation	• Make sure all materials have been gathered • Decide how students will be grouped in pairs
Key Points for the Facilitator	• The distance formula is an excellent review of ***Circles of Evaluation***. Have students work out the expression in small groups to foster discussion.
Language Table	Students have not seen any primitives yet!

Click here to see the prior unit-based version

Glossary

circle of evaluation :: a 'sentence diagram' of the structure of a mathematical expression

pixel :: the smallest unit that makes up a digital image. The more pixels, the more detailed an image or video can appear.

Problem Decomposition Returns! 20 minutes

Overview

Students revisit the problem decomposition concept from earlier lessons.

Launch

Students should have their workbook, pencil, and be logged into code.pyret.org on their computer.
Problem Decomposition is a powerful tool, which lets us break apart complex problems into simpler ones that we can solve, test, and then glue together into a complex solution.
Students may remember that there are two strategies for doing this:

1. **Top-Down:** Describe the problem at a high level, then fill in the details later
2. **Bottom-Up:** Focus on the smaller parts that you're sure of, then build them together to get the big picture

Problem Decomposition is the focus of an entire Bootstrap lesson, is used to solve "onscreen?", and build up the 2-dimensional distance function.

Investigate

For the following complex word problem, have students **first** decide which strategy they want to use, and then apply the Design Recipe to build the functions they need.

A retractable flag pole starts out 24 inches tall, and can grow at a rate of 0.6in/sec. An elastic is tied to the top of the pole and anchored 200 inches from the base, forming a right triangle. Define functions that compute the height of the pole and the area of the triangle after a given number of seconds.

Have students complete the Top Down / Bottom Up worksheet, using Problem Decomposition and the Design Recipe to solve this problem!

Synthesize

- Which strategy did students use?
- Did they start out with one, and then switch to another?

Collision Detection

20 minutes

Overview

Students once again see function composition at work, as they compose a simple inequality with the `distance` function they've created.

Launch

Knowing how far apart our characters are is the first step. We still need the computer to be asking: "True or False: is there a collision?"

Investigate

Using Word Problem: is-collide, have students write a function that takes in two coordinate pairs (four numbers) of the `PLAYER` and a character (`(px, py)` and `(cx, cy)`), and and returns `true` if they are within 50 ***pixels*** of each other.

Synthesize

- You started by writing the `distance` function first, and then `collide?` Is this **Top-Down** or **Bottom-Up** decomposition?
- Explicitly point out that this function is easy to write because we can *re-use* the distance function.
- Connect this back to `profit` , `revenue` , `cost` and `onscreen` from previous lessons. Problem Decomposition is powerful!

Additional Exercises:

- For teachers who've already introduced your class to flags, the Flag of Trinidad and Tobago Starter Code (Pyret) makes use of Pythagorean Theorem and could make for an interesting connection to this lesson.