Sample Pac-Man Lesson Plan
Day 5 – 50 minutes
Scalable Game Design Summer Institute 2010

Note: Red links take you to portions of the tutorial. Blue links provide background information to aid in teaching.

1. **Learning Objectives:**
   In this unit, students will create a simple but complete version of Pac-Man game while expanding knowledge of the AgentSheets software program. Students will apply basic and advanced design process to identify objects “agents” and interactions “operations”. Throughout this unit, students will be introduced to **computational thinking** patterns and skills, including basic object interaction, creating object instances, rule based programming, and message sending. Over the course of the unit, the difficulty of the game with ghosts with random movement will be contrasted to the difficulty of the game with ghosts with artificial intelligence.

   In this lesson, we program our ghosts to start detecting Pac-Man’s smell and track down where he is based on where the smell is the strongest. We are working our way to creating a game which uses artificial intelligence. Today we will be mostly there – but how winnable is this game? We will soon find out…

2. **Standards:**
   ISTE (International Society for Technology in Education) NETS (National Educational Technology Standards)
   - #1a apply existing knowledge to generate new products
   - #4b plan and manage activities to develop a solution or complete a project.
   - #4d use multiple processes and diverse perspectives to explore alternative solutions.
   - #6c troubleshoot systems and applications.

   ISTE NETS are referred to by CDE Performance Standards for Teachers #7- Technology, which states, “The teacher will have demonstrated the ability to instruct students in basic technology skills. He/She will: … instruct students in basic technology skills by imbedding them in their standards-based, content instruction (7.5.3)”

   Please check with your district’s technology department to see if there are additional standards at the district or school level.

3. **Anticipatory Set / Modeling: 5-10 minutes**
   Show a portion of the video clip showing diffusion in another setting – dye in hot water
Optional activity: Place a glass of ice cold water on the table for each group and ask them to add a drop of food coloring to the water. Ask one group member to time how long it takes for the color to spread. Repeat the experiment with a glass of hot water. The temperature of the water changes the rate of diffusion of the dye.

Note: this activity is best done away from the computers if students are doing the experiment, or can be demonstrated by the teacher for whole group.

4. Teaching: 15 minutes

Input – Transition from mathematical thinking to computational thinking- Lead a discussion of how the mathematical equation from yesterday can be programmed in AgentSheets.

Making the Ghosts "Smarter": using AI to track the Pac-Man

To enter the diffusion equation into AgentSheets, we use the form:

\[ 0.25(s_{up} + s_{down} + s_{left} + s_{right}) \]

where \( s = \text{scent value} \)

The 0.25 can be changed to change the rate of the smell spreading. This would be like how strong the cologne is or the conditions of the room – temperature, ventilation, high or low ceilings, etc. The dye added to different temperatures of water showed this in a physical way for students.

We will be setting Pac-Man’s initial scent level to 1000. This represents how much cologne he put on, which can also be changed. Ask students what effect they think changing this value might have on the ghosts’ ability to find Pac-Man.

In real life, it is easier to find something with a stronger scent. However, in the computer simulated world, the initial value of the scent has very little effect on how quickly Pac-Man is found. This is because the computer calculates the very small percentages of scent and anything greater than zero, even if it is barely above zero, triggers the ghosts to move in that direction. This might be a little counter-intuitive to some at first.

Extend this conversation by asking students to consider what if there were multiple targets, such as in a Sims type activity. At different times, different things have a higher value. For example when the character is hungry, food is more important, while if the character is tired then sleep has a higher value. How would this be reflected when programming? Would there be different scent values?
5. **Guided Practice / Monitoring: 20-25 minutes**

Set Pac-Man’s initial scent to 1000**

Setting Pac-Man's scent

**It is important to note that we must erase and re-add Pac-Man in the worksheet so that the initial scent level is set (it only does this upon creation of a new agent). Students are reminded of this in the play test box:

Play_Test: ghosts_chase_pacman

Add the diffusion equation to both the background and the pellet agents. Ask students why one would not want to add the equation to the walls.

Background_and_Pellets_diffuse_Pac-Man's_scent

Note: demonstrate or remind students to type the diffusion equation in once and then duplicate the rule. This will tend to cut down on errors and typing time.

We can check the scent value in each agent on the worksheet by using tools > agent attributes to bring up a separate Attribute Window. Students can click on different locations to see the amount of scent. The agent attribute feature is further explained in the AgentSheets reference manual: [http://www.agentsheets.com/Documentation/windows/Reference/tm_agent_attributes.html](http://www.agentsheets.com/Documentation/windows/Reference/tm_agent_attributes.html)

Now we have a computer generated version of the activity done yesterday with the students where they calculated by hand the scent value in each box.

Students can then change the initial value of Pac-Man’s scent and see what this does to the scent value of the agents. Does this matter in a game setting? In a real life context outside of gaming? (see teaching section above)

Students can also be asked to change the coefficient value from 0.25. What happens to the scent values when the coefficient is smaller? larger? What does this mean for the game and the ability of the ghosts to track Pac-Man? What would a smaller (larger) coefficient represent in the context of cologne in the world outside of the computer?

A smaller coefficient could represent a large room, good ventilation, or cold air.
A larger coefficient could represent a smaller room, poor ventilation, or hot air.

Students should periodically save the worksheet (check save with the reset button) IMPORTANT: Saving the Worksheet and run the program to see what happens. Check understanding of each student.
6. **Closure: 5 minutes**
   Restate the scope of the project. Tomorrow we will be giving the ghosts their sense of smell and use that to track down Pac-Man. The hill climbing algorithm will be introduced and students will use this in the behavior of the ghost agents.

7. **Extension/Remediation**
   Students can edit the depictions of agents at any time. Encourage students to spend a short time on the initial creation and edit later as desired.
   Optional activity: Have students go to the *Scalable Game Design Arcade* to play other Pac-Man games to generate ideas for how they would like to design their games.