

Planning a Computational Exploration of Candy Sharing

Introduction

The Candy Sharing math circle activity lends itself to a number of different entry points for computational exploration, depending on the students' (and the instructor's) experience level in mathematics, spreadsheet use, general programming, and agent-based programming.

This document outlines some of these entry points, with suggested selection criteria, and references to corresponding handouts that can be used for each.

All of the alternatives outlined below assume that the instructor and students have already explored the hands-on candy sharing activity, as outlined in “Candy Sharing Game: Lesson Plan” and “Candy Sharing Game Rules / Candy Sharing Game Challenges” [1], [2].

Spreadsheet activity

Summary

In this activity, students construct a spreadsheet that performs several “turns” of the candy sharing game, starting from an initial distribution of candy.

Criteria

This activity is suitable for students who already have some experience with spreadsheets, or where the time for the activity is sufficient to include key general concepts and techniques of spreadsheets. Specifically, students must be able to write formulas in spreadsheet cells, using combinations of relative and absolute addresses, and copy and paste those formulas to other cells in the spreadsheet.

Objectives

The spreadsheet constructed in this activity will enable a student to address many of the challenges in [2] – in particular, those asking the student to find an initial distribution that results in a specified final outcome.

Infrastructure

To our knowledge, none of the formulas or operations used in this activity include functions which are highly specialized or specific to any given spreadsheet product. Thus, virtually any relatively current spreadsheet software package can be used, including Microsoft Excel, Google Sheets, Apple Numbers, LibreOffice Calc, and OpenOffice Calc. Given that, this activity is generally well-suited to most computing environments, as long as some spreadsheet package is either installed locally or accessible online (in the case of Google Sheets, for example).

NetLogo model activity

Summary

In this activity, students construct a NetLogo model that distributes the candy among player “agents”, and then plays any number of turns of the candy sharing game, displaying the current state (i.e. the current distribution of candy) after every turn. The model includes user interface controls for setting the number of players and the total amount of candy, and for displaying the current distribution of candy.

Criteria

This activity is suitable for students who are learning NetLogo, and have already constructed at least 1 or 2 models.

Objectives

The NetLogo model constructed in this activity is well-suited to students’ explorations of some of the challenges in [2], and especially those that include the condition “... no matter how the leader distributes the candy.” (NetLogo makes it straightforward to implement several different types of random distributions of candy at the start of the game.)

Infrastructure

It is highly recommended that students have NetLogo 6.0 or higher installed locally (it is also possible to run NetLogo of a USB flash or hard drive, though this requires special preparation); it is not well-suited for NetLogo Web.

NetLogo model extension activity

Summary

This activity starts with an existing NetLogo model (the one described in “NetLogo model activity”, above). Students are then allowed to choose from of a small set of possible extensions that they will then make to the model.

Potential extensions include

- time-series plotting within NetLogo;
- user-selectable random distributions for the initial distribution of candy;
- user-editable explicit specification of the initial distribution of candy;

- alternative sharing rules and conditions (e.g. thresholds other than 2 pieces for sharing, individual sharing turns vs. simultaneous sharing);
- definition of BehaviorSpace experiments, with supporting reporter procedures.

Criteria

This activity is suitable for students who are either learning NetLogo, or have some other (at least minimal) programming experience. It is not assumed that a student will know how to build a NetLogo model from scratch – even while guided by the instructor. However, it is assumed that the student has some experience with the basic concepts (such as variables and procedures) and user interface controls (such as sliders), or that instruction in these elements will be part of the activity.

Objectives

Aside from the time-series plot, all of the extensions listed above amplify the capability of the model produced in “NetLogo model activity” (above) to serve as an aid to students’ exploration of the challenges and questions in [2].

Infrastructure

Due to its incremental nature, this activity is better suited to NetLogo Web than an activity requiring model construction from scratch. It can also be performed with NetLogo 6.0 or higher installed locally, or running from a specially-prepared USB flash or hard drive.

NetLogo BehaviorSpace activity

Summary

In this activity, students work with an already developed NetLogo model (e.g. matching the one produced in “NetLogo model activity” or incorporating multiple extensions described in “NetLogo model extension activity”) that has been configured to run BehaviorSpace experiments. Students are encouraged to explore the use of BehaviorSpace, including designing and running variations on the pre-configured experiments. After running experiments, students import and analyze the data in a spreadsheet program.

Criteria

This activity is suitable for students who have little (if any) NetLogo programming experience – though it also provides the opportunity (time and other resources permitting) for students with such experience to investigate more advanced features of the NetLogo language. Also, students with some NetLogo experience will be better prepared to modify the experimental specifications

to design new experiments. (BehaviorSpace specifications use a limited form of the NetLogo programming syntax.)

Students should have some spreadsheet experience – specifically, with importing text files into spreadsheets, and with sorting and plotting data – though teaching these concepts and techniques that can be included in the activity, with sufficient time and planning.

Objectives

Through the use of BehaviorSpace and follow-up analysis, students will be able to broaden their exploration of the questions and challenges in [2] (e.g. sweeping through several combinations of the input parameters, repeated experiments with specified combination of input parameters to increase their confidence in their conclusions), and even to ask and answer (at least in part) new questions.

Infrastructure

BehaviorSpace is not supported by NetLogo Web; thus, NetLogo 6.0 or higher should be run locally (installed on the system or running from a specially prepared flash drive) for this activity. Similarly, though none of the spreadsheet techniques required are unavailable in Google Sheets, the amount of data produced by BehaviorSpace experiments can make it impractical to use that approach; in any event, use of a locally installed spreadsheet package is highly recommended. (Note that like NetLogo, LibreOffice Calc and OpenOffice Calc can both be set up to run from a specially prepared flash drive.)

For some groups of students, it's possible to combine this activity with the previous one ("NetLogo model extension activity", above). For example, students could conduct experiments with the model prepared for this activity; then, they could design and conduct new experiments that would involve them making one of the enhancements from the previous activity.

References

- [1] A. K. Serenevy, "Candy Sharing Game: Lesson Plan," Riverbend Community Math Center [Online]. Available: https://riverbendmath.org/modules/Candy_Sharing_Game/Lesson_Plan/Candy_Sharing_Lesson_Plan.pdf
- [2] A. K. Serenevy, "Candy Sharing Game Rules / Candy Sharing Game Challenges," Riverbend Community Math Center [Online]. Available: https://riverbendmath.org/modules/Candy_Sharing_Game/Activity_Directions/Candy_Sharing_Directions.pdf