Introduction to Model Based Reasoning

In this activity we will use the *Mystery Box* software to gain some experience using a modeling approach to solve problems. Scientists use model based reasoning to explain natural events using rules, representations, or mathematical relationships to describe their observations and make predictions. This semester we will use a wide range of scientific models to understand biological concepts and to explore how biologists study the natural world.

The *Mystery Box* software provides a simple interface for doing model based reasoning. This activity is designed to give you some experience with the following features of scientific model based reasoning:

- 1. You can collect data about the behavior of the system by manipulating and observing it.
- 2. By organizing your data you can begin to see patterns in how the system behaves.
- 3. You can make hypotheses about things that you can't observe directly and think about how they cause the behaviors you observe.
- 4. You will have to develop ways to describe and share your data and hypotheses.
- 5. You can test your hypotheses by confirming that the observations match predictions that your model makes.
- 6. When you explore new systems (different "types of boxes" in this case) you may need to revise your models to account for new behaviors.

Most importantly, trying to understand the behaviors of the system involves making arguments based on data. The software is designed so that there is no way to see "inside the box" and there is no answer key with the "correct" answer. **This tool forces us to discuss what we know like scientists – by sharing our data and the evidence we have for our claims.**

Use the attached research report to study the behavior of Type 1 mystery boxes. The software can generate many individual boxes that follow the same basic set of rules. Each specific Type I box is identified by a "seed" number in the upper right corner of the box. Use the model proposed in the research report to explain the behavior of the mystery boxes you study and be prepared to share your findings, that is, the number and location of ARS within a box. Feel free to use the attached grid paper to develop a system for organizing your data and arguments.

http://www.pitt.edu/~epolinko/box/

I will put you into groups where you can explore some Type 1 boxes until you are confident applying the model presented in the attached research report. Practice using the available evidence to make claims and then make predictions that will help to confirm (or refute) your hypotheses. Were you able to place ARS into positions that explained all your observations?

When you are comfortable solving Type 1 boxes move on to another Type (2, 3, or 4). Be prepared - the rules may have changed and you will likely need to revise the model presented in the research report to explain your observations.

Recitation assignment

You will submit your recitation assignment on our Canvas course page. The assignment is due on Wednesday, January 27th at midnight Eastern time. There will be some flexibility on this deadline this week given that this is the first assignment.

Don't worry if you are not able to revise the model to account for all the data you collect from another box type, it is challenging. The goal is really to get you using data to work with a model and think about explaining things that cannot be directly observed. You may work with a group to complete the assignment but everyone is responsible for submitting your own work for the recitation write-up.

T]	he assignment	auestions	have been	reproduced	here for	your convenience	2
1	ic assignment	questions	Have been	i cpi oduccu	IICI C IOI	your convenience	

1.	Which type and	box did you stu	dy: Type #	_
----	----------------	-----------------	------------	---

- 2. Briefly describe a behavior that was inconsistent with the Type I ARS model (1 sentence).
- 3. Briefly describe a new proposed rule for the system you studied (1 sentence).
- 4. Do a little research on definitions and examples of scientific models. Write a 1-2 sentence definition of a scientific model in your own words. Include a citation (APA format) for a source you used to inform your definition. There is good information about citations here¹ and a link to the *citation machine* which is useful tool for generating citations.

¹ Elmer E. Rasmuson Library. (n.d.). Retrieved January 25, 2021, from https://library.uaf.edu/ls101-citing

Research Report

Title: Consistent behavior of blue mystery boxes' responses to light explained by the presence and properties of ARS.

Abstract: Our investigation into Type 1 (blue) mystery boxes has begun to identify consistent patterns of behavior associated with exposure to light. When shining light through the different sections the box behaves in one of 3 ways: the light passes straight through, it is completely absorbed, or it is reflected and exits the box somewhere other than directly across from the point of entry. While different Type 1 boxes have different patterns of response to light we believe that the pattern of behavior can be explained using hypothesized objects we call "absorbing and reflecting stuff" (ARS). We argue here that ARS interacts with light using the three following rules:

- 1. If they are struck directly an ARS will completely absorb the light (see Fig. 1);
- 2. If the light passes within one "lane" of the ARS is it reflected at 90 degrees and 10 units of energy are lost (Fig. 2);
- 3. If ARS is in an "edge lane" then light entering from an adjacent lane will be absorbed (Fig. 3).

We have observed individual boxes that appear to have as few as 3, and as many as 5 ARS within them. We believe that more complex outcomes can be explained through the interactions of several ARSs and a single light signal. This model has not been thoroughly tested on the Type II, III or IV mystery boxes.

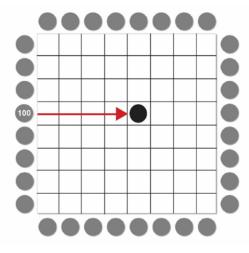


Figure 1. Complete absorption of light by an ARS.

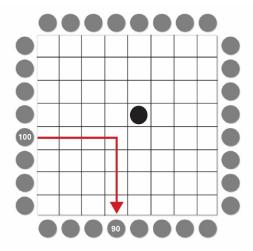


Figure 2. Partial absorption and 90 degree reflection of light by an ARS.

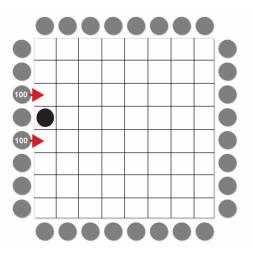
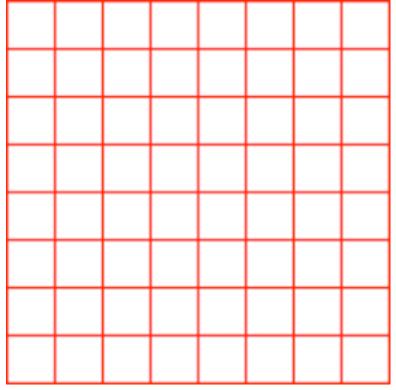
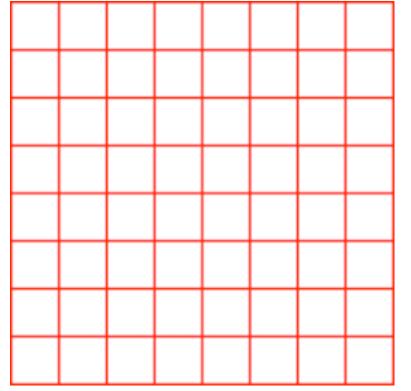


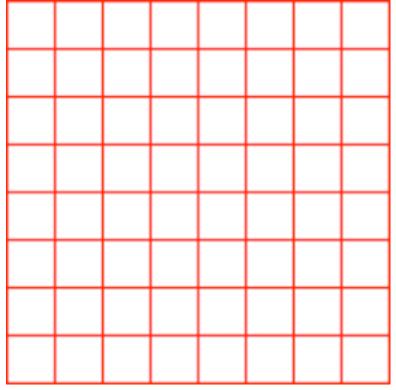
Figure 3. Complete absorbance of signals in adjacent lanes in an "edge" ARS.



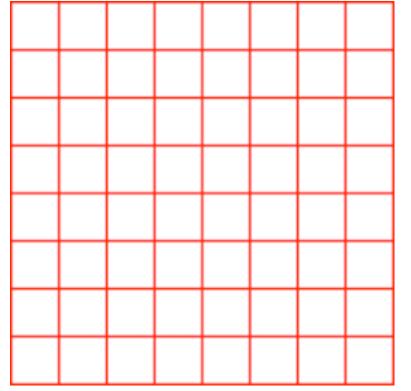
Individual # _____ Box Type ____



Individual # _____ Box Type ____



Individual # _____ Box Type ____



Individual # _____ Box Type ____