Exploring student approaches to model construction in a simulation-based inference curriculum
USCOTS 2019

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Goals of the Breakout Session

- How can probability modeling play a role in a simulation based inference course?
- What are the affordances and challenges that emerge when allowing students to create their own models?
- How do we as teachers assess student models and their modeling strategies?
- Share pedagogical strategies we learned through our work that might help teachers better support student modeling.

NFL Task

The National (American) Football League (NFL) uses an overtime period to determine a winner for games that are tied at the end of regulation time. Between 1974 and 2009, the overtime period started with a coin flip to determine which team gets the ball first in overtime, and then the team that scores first wins. Rules were changed after 2009 because fans and players both believed that these rules were unfair for the team that lost the coin flip. Between 1974 and 2009, there were 428 games that went to overtime, and 240 of them went to the coin-flip winner.

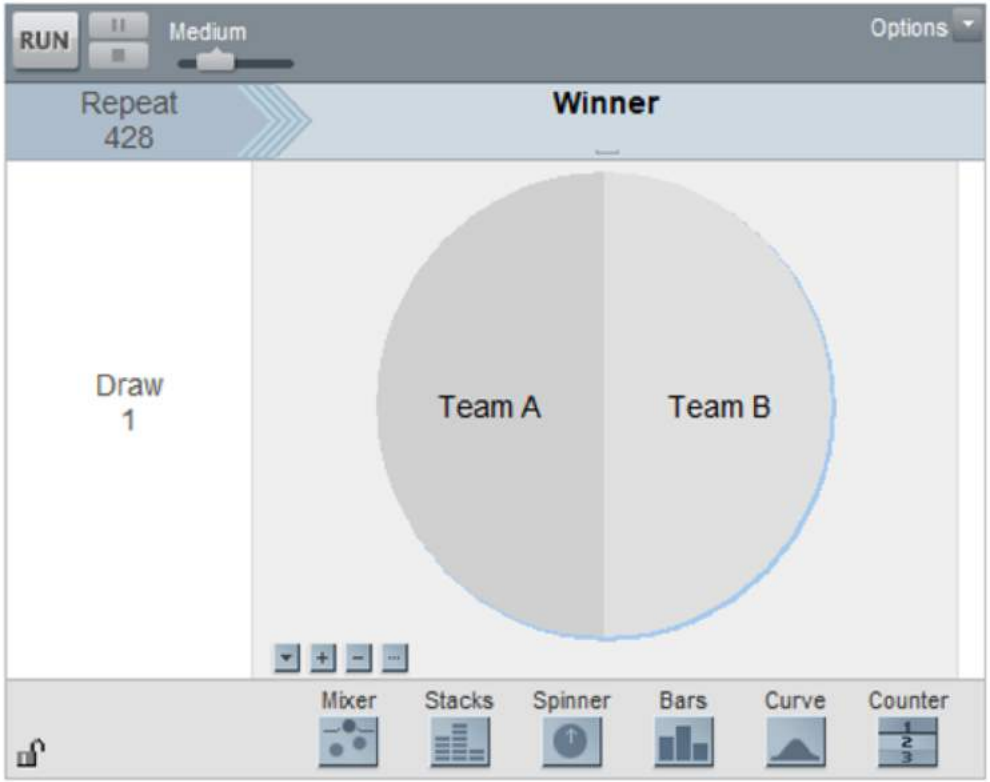
Based on this data, how can we conclude if there is an advantage to the team that won the coin flip?

Creating a Model to Simulate the NFL Task

- Take a minute to think about how you would create a simulation to model the NFL Task in order to answer the research question.
- Share your simulation with people sitting next to you and discuss any similarities of differences between the simulations of your peers. Try and list those differences that you are seeing.
- What are important features or characteristics that should be included in a simulation for the NFL Task?

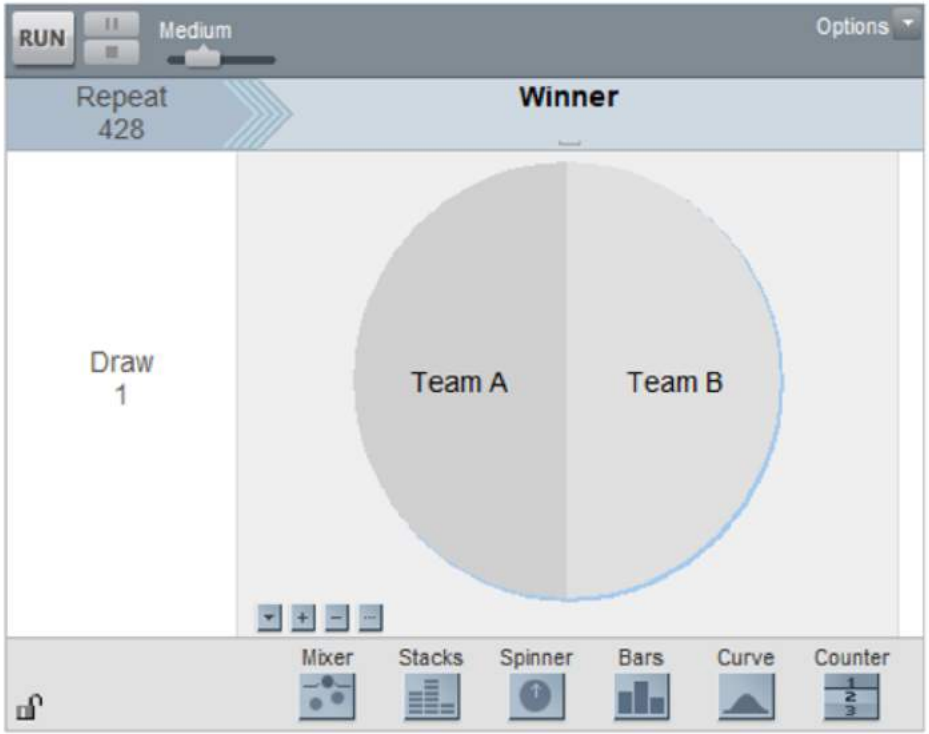
Demo in TinkerPlots

Analyzing a Student Generated Model



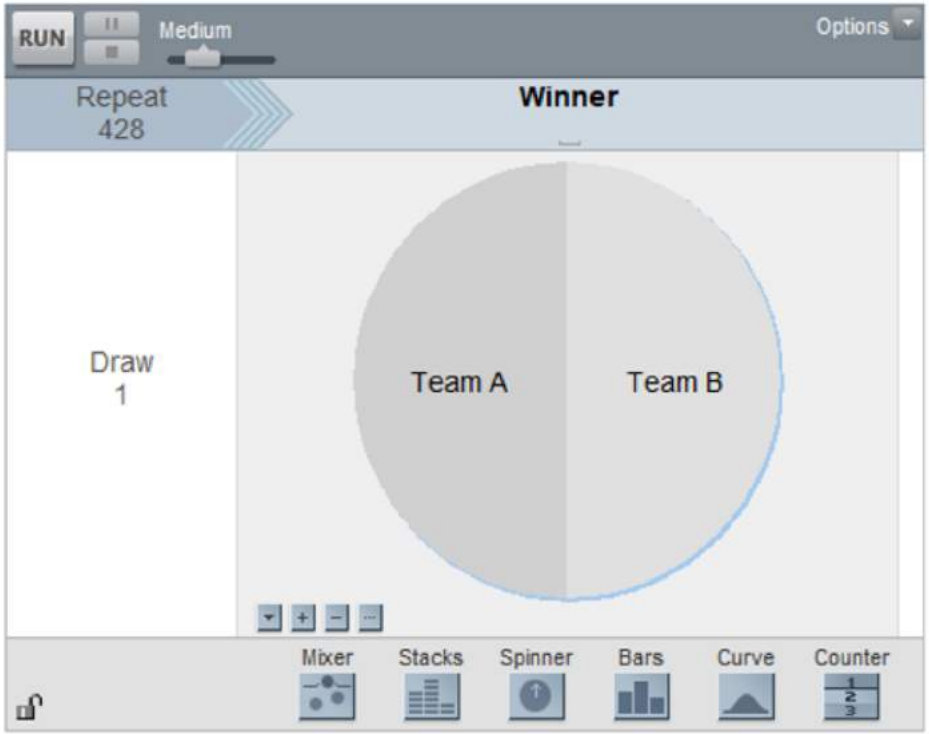
Analyzing a Student Generated Model

Take 5 minutes to think about the types of ways we can evaluate the quality of a student's model. Write these down and discuss with the people sitting next to you.

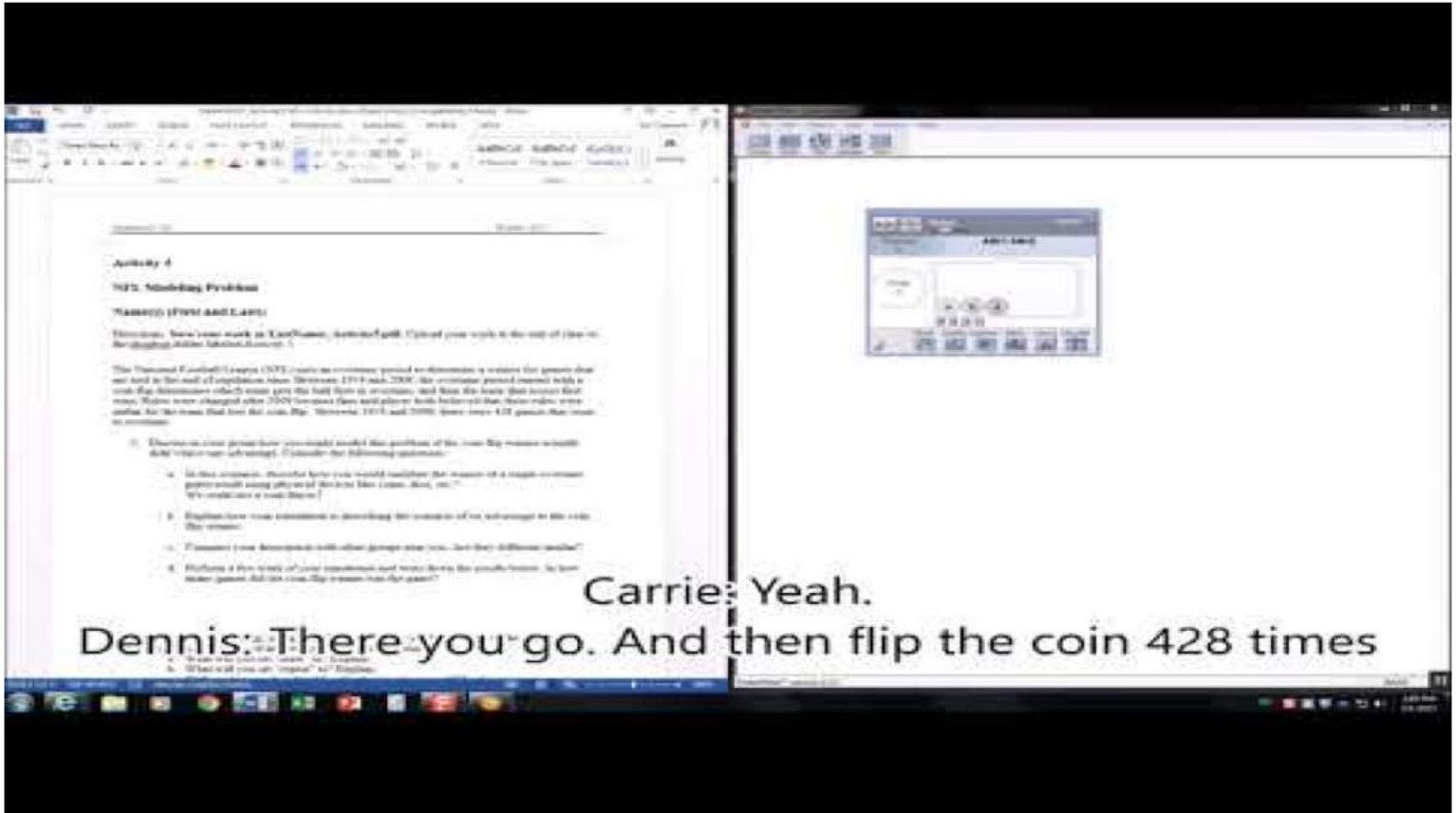


Analyzing a Student Generated Model

- What do you imagine might be a student's thought process for creating the model shown?
- What do you think the student is assuming when they created the model?
- What question(s) would you ask the student to explicate understanding of their model construction?



Analyzing Student Approaches

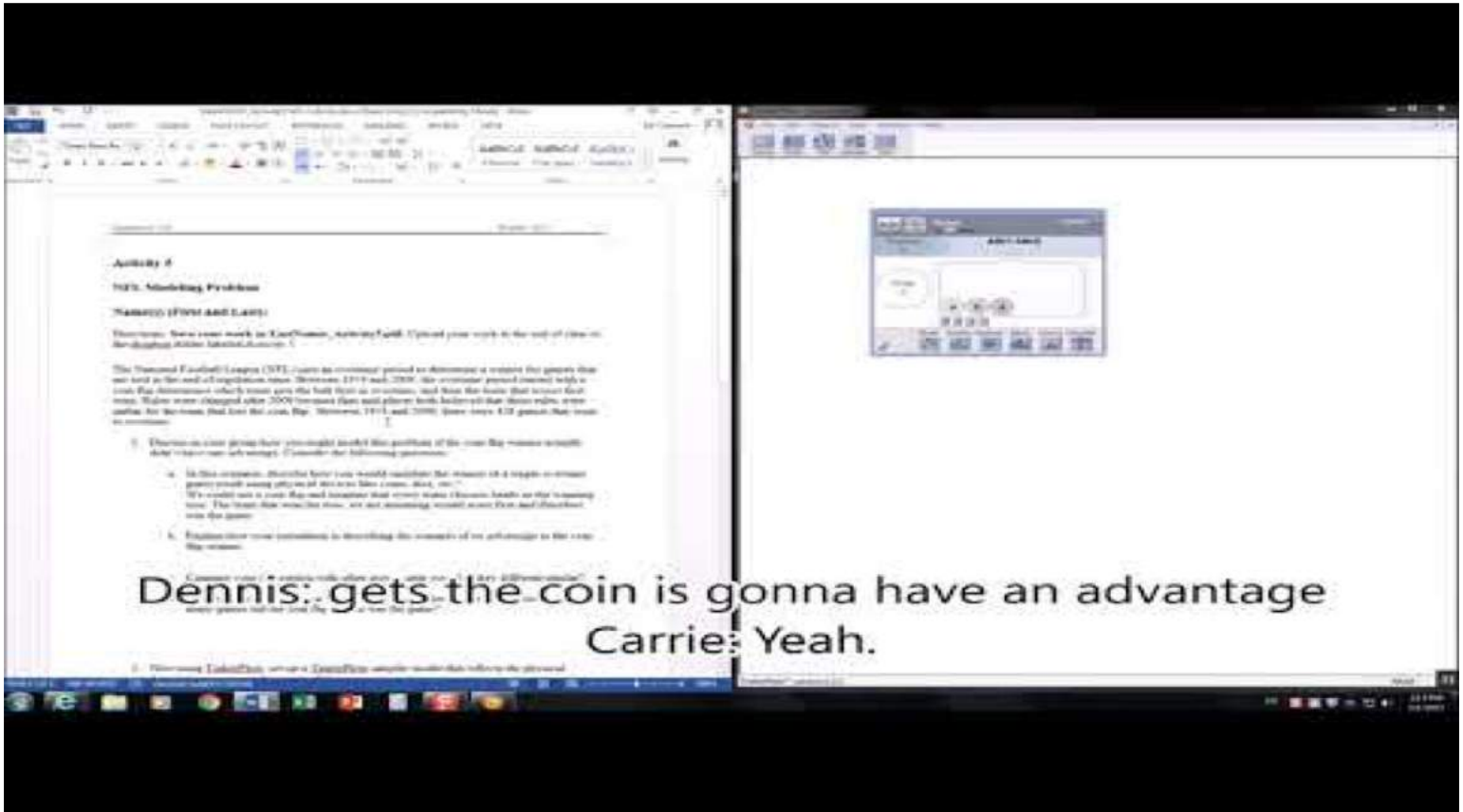


Analyzing Student Approaches

This group's perspective:

- They recognize they want to determine the winner of each game
- Dennis doesn't know how to recognize a game winner, so assumes that the coin-flip winner will win the game too.
- Carrie also assumes that getting the ball first means you will score first: "A coin flip determines which team gets the ball first in overtime, and then the team that scores first wins, so obviously the team that wins the coin flip will win."
- While their envisioned sampler device is functionally correct, their thinking is not in-line with how this situation should be modeled.

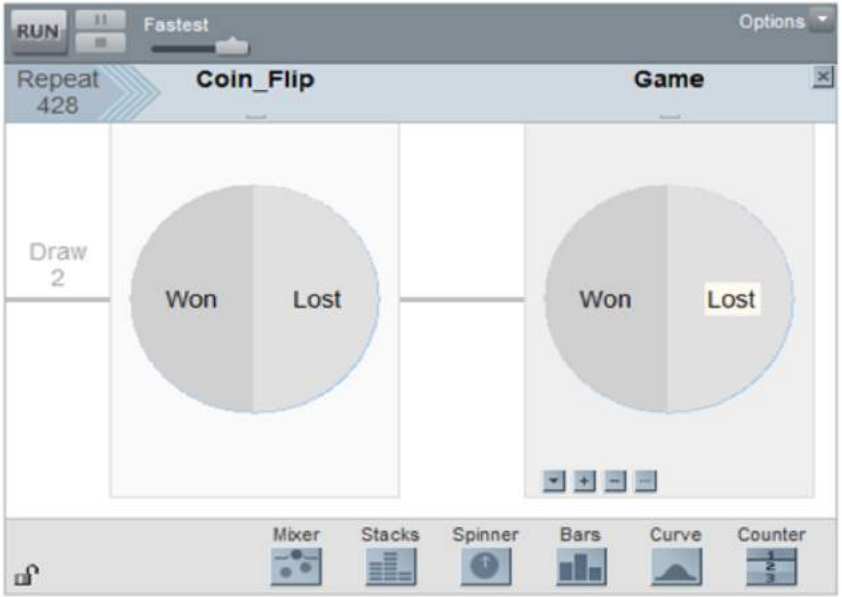
Analyzing Student Approaches

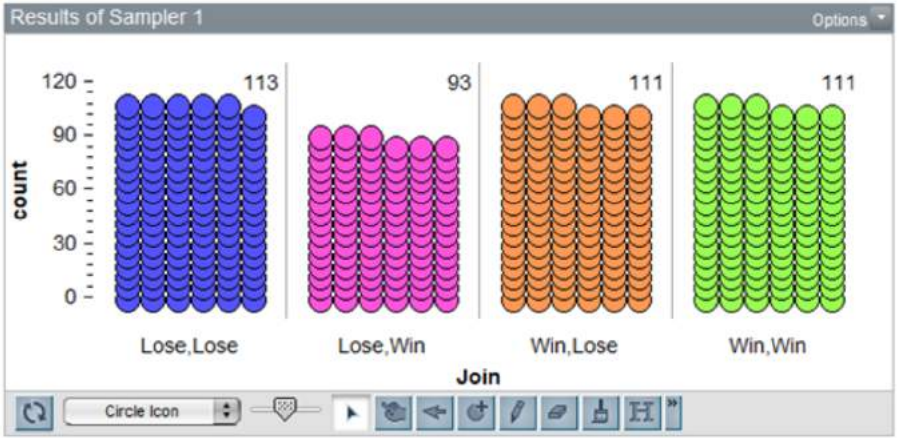


Analyzing Student Approaches

- Dennis is evaluating how their model provides no advantage to the coin-flip winners.
- Carrie claims there is no advantage since the winner is determined by a coin flip.
- Hope provides a different perspective here by assuming that regardless of which team wins the coin flip, there is no advantage to either team.
- This assumption leads to the proper “conditioning” on the coin flip outcome to determine the game winner.
- In general, groups who often take the approach of a single spinner do not make it clear what their assumptions are or if the device is simulating the game outcome or the coin flip outcome.

Other Student Sampler Models





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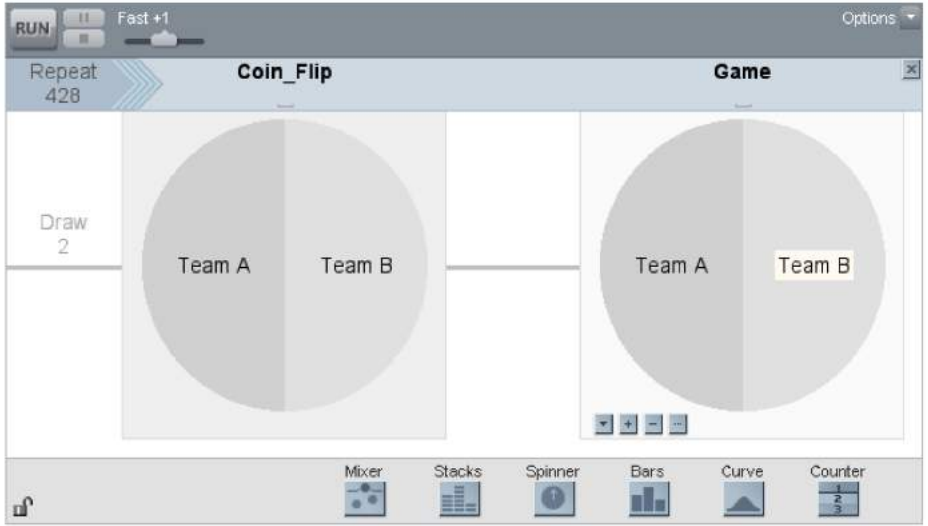

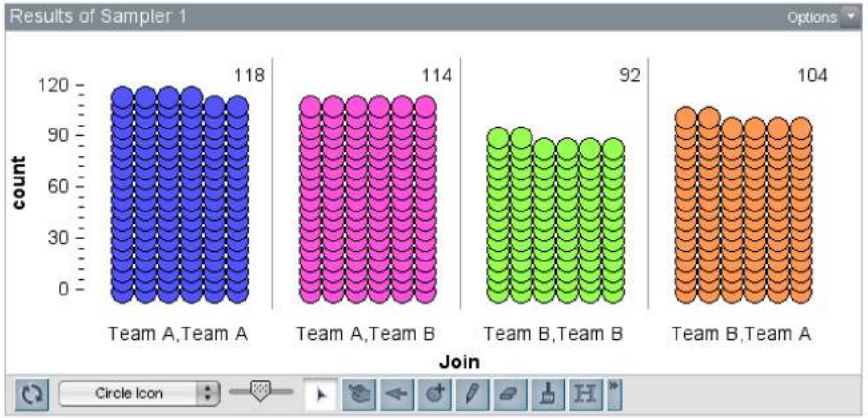

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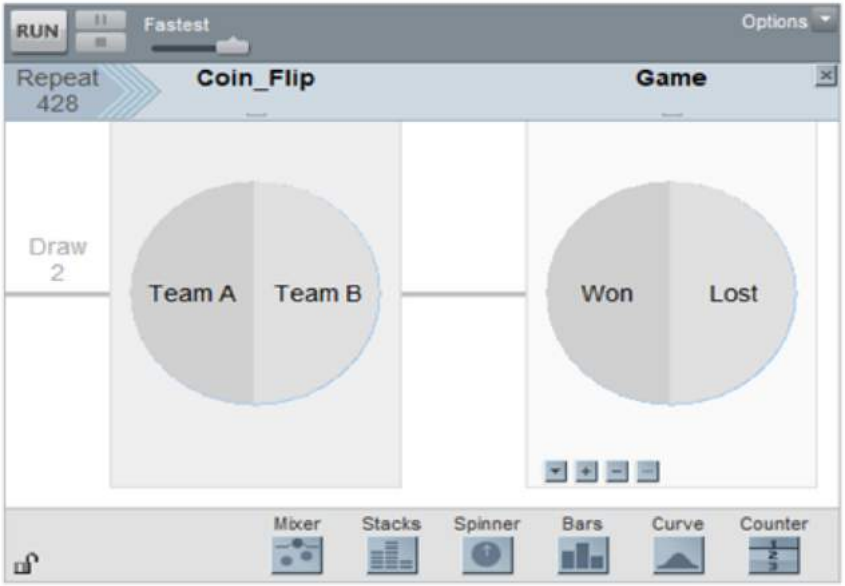

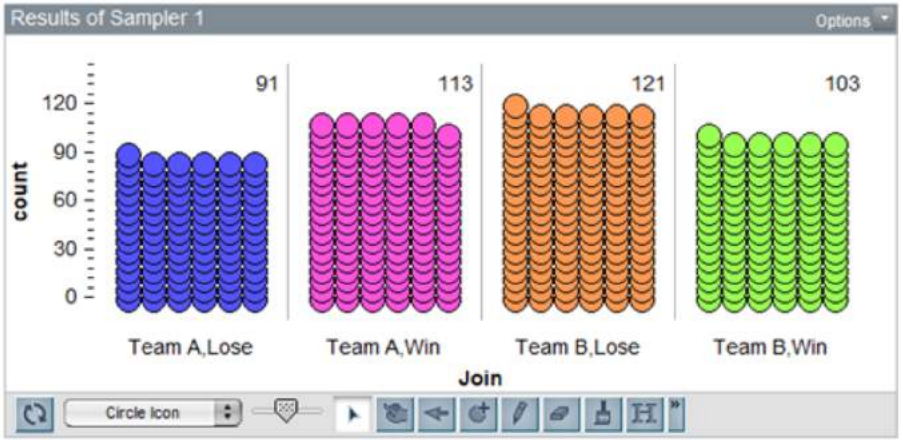

Assessing Student Models

- How do we as teachers assess the quality of a student model?
  - What are the kinds of criteria teachers should consider to be important parts of a student model?
  - When students start evaluating models themselves, what potential questions can we as teachers ask students to assess their understanding?

Main Lesson Learned

Simulation is not enough!

The NFL Task shows that how students envision a simulation process under a null hypothesis may not align with a statistician's perspective.

Advantages of Modeling

- Simulation-based intro statistics courses have been gaining popularity.
- Research literature has shown that they have benefits on students learning, especially with regard to p-values and inference.
- Simulation tools often leave out the simulation process, assuming that students know how the data was generated. Through modeling, students will be able to understand how data is generated because they will have personal ownership of the sampler they created.
- TinkerPlots is a powerful tool to allow students to construct their own simulations with no coding knowledge. It also allows students to “Tinker” with various models which opens the door to tasks involving like model evaluation.

About TinkerPlots

- Originally designed by Cliff Konold and Craig Miller
- An educational tool for data visualization and simulation
- “Sampler” feature most unique aspect of TinkerPlots
  - Allows students to create a method of simulating data with no code
  - Provides visual representations of simulation processes that students can use to verify its validity.

Thank you!

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