## Matrix Games

## What you need: Hands.

How to play: Two players (let's call them Rose and Colin) each hide one hand behind their back. On the count of three, each player reveals either a closed or an open hand.

This is a lot like Rock-Paper-Scissors, except there's no scissors. But here's the catch: who wins or loses — and how much — is determined as follows.

- If both players play rock, then Rose pays Colin \$10.
- If both players play paper, then Rose pays Colin \$30.
- If one player plays rock and one plays paper (it doesn't matter which), then Colin pays Rose \$20.

The players keep playing the game until someone eventually runs out of money. Who wins?

This is called a <u>matrix game</u>, because the amounts of wins and losses are determined by a matrix — a rectangular array of numbers. In this case, the matrix is as follows:

		Colin:	
		Rock	Paper
Rose:	Rock	-10	20
	Paper	20	-30

- The numbers are from Rose's point of view, so a positive number means that Colin pays Rose; a negative number means that Rose has to pay Colin. (If we wanted to work from Colin's point of ciew, we'd flip all the minus signs.)
- The rows of the matrix correspond to Rose's possible choices, and the columns correspond to Colin's choices.

## **Research Questions**

- Is this game fair? (Again, what does "fair" mean?) If not, how can it be made fair?
- What happens if each player flips a coin (privately) on each turn to decide whether to play Rock or Paper?
- What happens if one player flips a coin and the other doesn't?
- What happens if the coins are loaded?
- Is it a disadvantage if your opponent knows what you are about to do on this turn?
- Is it a disadvantage if your opponent knows your overall strategy?
- Why are these two questions not the same?
- How does Rose calculate her best strategy from the payoff matrix?
- What does "best strategy" mean in the first place?
- How are Rose's best strategy and Colin's best strategy related?
- What if we change the payoff matrix? For instance, if both players play Paper, then Rose has to pay Colin \$3000 instead of \$10.
- What if the players have more than two choices on each turn? (Like classic Rock-Paper-Scissors, where each player has three choices.)
- What if Rose's profit or loss is not always equal to Colin's loss or profit? (For example, if both players play rock, the bank pays them each \$20, but if they both play scissors, then they each have to pay the bank \$15.)