



Dudo: Exploring the Incan Bluffing Dice Game

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Dudo

- “According to legend, King Atahualpa of the Incas taught this to the Spanish conquistador Pizarro more than 400 years ago...” (Mohr, 1997)
- Origin generally believed to be 15th c. Inca
- Variants long popular in many Latin American countries

Beyond Latin America

- Many variants/names (Liar's Dice, Perudo, Bluff, Call My Bluff, Cacho, Cachito)
- Internationally popular
 - BoardGameGeek.com rank 173/4268 w/ 30+ ratings, 30K+ games (top 4% of 14% most rated), 2/4/08

Dudo Overview

- Bluffing dice game for 2+ players
 - Each player rolls 5 dice concealed under cup
 - Players make successively bolder claims about *all* dice rolled until player challenges
 - Loser of challenge loses dice
 - Last player with dice wins

Rock, Paper, Scissors

- Players each simultaneously reveal rock, paper, or scissors
 - Rock beats scissors
 - Scissors beats paper
 - Paper beats rock

Mixed Strategy

- Optimal play for rock, paper, scissors is a *mixed strategy*:
 - A strategy which chooses proportionally between actions at random

Optimal Play in Rock, Paper, Scissors

- Choosing one action consistently
 - Predictable
- Optimal Play:
 - Throw rock $\frac{1}{3}$ of the time
 - Throw paper $\frac{1}{3}$ of the time
 - Throw scissors $\frac{1}{3}$ of the time

Systems of Equations

$$5x + y = 13$$

$$3x - y = 3$$

- Solution: $x = 2, y = 3$

Linear Programs

- Used this summer to find optimal play
- Maximizing a value subject to constraints (equations / inequalities) of unknowns

Rock, Paper, Scissors Linear Program

$$\max_{x, q} -q_2$$

$$-q_1 + q_2 \leq 0$$

$$-x_3 + x_4 - q_1 + q_2 \leq 0$$

$$+x_2 - x_4 - q_1 + q_2 \leq 0$$

$$-x_2 + x_3 - q_1 + q_2 \leq 0$$

$$+x_1 - q_1 + q_2 = 0$$

$$-x_1 + x_2 + x_3 + x_4 - q_1 + q_2 = 1$$













$$x_1, x_2, x_3, x_4 \geq 0$$

Linear Program for Dudo

- Rock, paper, scissors
 - 6 relations and 6 unknowns to solve optimal play for both player 1 and player 2
- Endgame Dudo: 2 players, 1 die each
 - 36,866 relations and 36,872 unknowns to solve optimal play for player 1
 - 36,872 relations and 36,866 unknowns to solve optimal play for player 2
 - Matrices with 1,359,323,152 entries each.

Endgame Dudo Claims

- 1's are wild (counted as any # incl. 1)
- Claims are ordered left-to-right, top-to-bottom (reading order)
- 1x2 is least claim; 2x1's is greatest claim

	1 	1 	1 	1 	1 
1 	2 	2 	2 	2 	2 
2 					

Endgame Dudo Rules

- 2 players each roll and privately view 1 die concealed under a cup. 1's are wild.
- Players make successively greater claims until one challenges the previous claim with “Dudo!” (Sp. “I doubt it!”), both reveal dice, and:
 - Less than claimed? Challenger wins!
 - More/equal? Claimant wins!

Endgame Dudo Claims





- Let's play!

	1	1	1	1	1	1
1	2	2	2	2	2	2
2						







































Sharing vs. Concealing Information

- Making a true claim too consistently shares information to other players about which dice you are holding giving them an advantage
- If you *bluff* too often, others will *call your bluff* often, causing you to *lose* often
- Mixed strategy

An Example of Optimal Play

- First player rolls a 
 - Claim 1  18/43rds of the time
 - Claim 1  16/43rds of the time
 - Claim 1  9/43rds of the time
- This is just one initial possible situation
- We computed optimal responses to all of the many possible rolls and claim sequences

Dudo Claims

	1		1		1		1		1		
1		2		2		2		2		2	
	3		3		3		3		3		
2		4		4		4		4		4	
	5		5		5		5		5		
3		6		6		6		6		6	
	7		7		7		7		7		

Dudo Rules

- Players each roll and privately view 5 dice concealed under a cup. 1's are wild.
- Players make successively greater claims until one challenges the previous claim with “Dudo!” (Sp. “I doubt it!”), all reveal dice, and:
 - More/less than claimed? Challenger/claimant loses dice according to difference.
 - Claim exactly correct? Each player loses 1 die.
- The next round begins with challenge winner.
- The last player with dice wins.

References

- Reiner Knizia. ***Dice Games Properly Explained***. Elliot Right-Way Books, Brighton Road, Lower Kingswood, Tadworth, Surrey, KT20 6TD UK, 1999
- Marilyn Simonds Mohr. ***The New Games Treasury – More Than 500 Indoor and Outdoor Favorites with Strategies, Rules and Traditions***, Houghton Mifflin Co., Boston, 1997
- Dudo rules online:
<http://cs.gettysburg.edu/~tneller/games/rules/dudo.doc>