

The Mathematics of Game Shows

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June 16, 2025

1 Deal or No Deal

<https://www.youtube.com/watch?v=JFQvVe0FreY>

1. At the beginning. what is the *expected value* of the contestant's suitcase?
2. After the first round, what is the expected value?
3. What about the second?
4. Do you agree with the contestant's choices?
5. How do you think the banker is deciding what to offer?

2 The Price Is Right – Contestants' Row

<https://www.youtube.com/watch?v=kcfmRgahBss>

What do you see?

The **Coin Stealing Game**:

1. For two to five players. Determine the order in advance.
2. Start with a pile of coins. The first player takes some or all of the coins.
3. Each successive player, in turn, takes all or part of (a) the remaining coins, or (b) any one other player's coins.
4. Each player's objective is to get as many coins as possible. You're *not* trying to get more coins than the other players – you don't care one way or the other how much they get, only how much *you* get.

Questions:

1. Would you rather go first, last, or in the middle?
2. In a two-player game, what is each player's optimal strategy? If every player plays optimally, how many coins do they get?
3. What about a three-player game? Four? Five? n , for any positive integer n ?
4. What does this have to do with The Price Is Right?

3 The Price Is Right – Plinko

<https://www.youtube.com/watch?v=GnIEc4sl2x8>

We will discuss a simplified model for the game.

1. How realistic is the model?
2. According to the model, how do you compute the probability of landing in each slot?
3. Where should the contestant drop the chip?
4. If the contestant wins every chip, what is the expected value of the game?
5. If the contestant guesses the prices of the small prizes at random, what is the expected value of the game?

Now try this Plinko Simulator:

https://phet.colorado.edu/sims/html/plinko-probability/latest/plinko-probability_en.html

1. Describe the distribution that is taking place.
2. (Challenge!) Let n be the number of rows. As $n \rightarrow \infty$, can you find (with proof!) the limiting distribution of the balls?

4 Press Your Luck

Watch the following video, from 14:30 to 20:20.

<https://www.youtube.com/watch?v=WltjaxiowW4>

1. Describe what you see.
2. According to your description, compute the approximate probability of this happening by chance.

5 Golden Balls – Split or Steal

<https://www.youtube.com/watch?v=yM38mRHY150>

1. What is each player's optimal strategy?
2. If both players played their optimal strategy, then why did ... *that* happen?

You can compare with the classical *Prisoner's Dilemma*:

Two prisoners, A and B, suspected of committing a robbery together, are isolated and urged to confess. Each is concerned only with getting the shortest possible prison sentence for himself; each must decide whether to confess without knowing his partner's decision. Both prisoners, however, know the consequences of their decisions: (1) if both confess, both go to jail for five years; (2) if neither confesses, both go to jail for one year (for carrying concealed weapons); and (3) if one confesses while the other does not, the confessor goes free (for turning state's evidence) and the silent one goes to jail for 20 years.

6 Jeopardy

<https://www.youtube.com/watch?v=eeFdPALpSgk>

1. What do you think of the contestants' choices?
2. Consider a simplified model – two players, each with \$10,000, and they flip a coin to see whether they win or lose their wager. How much should they wager?
3. Now consider the same model, where one player has \$10,000 and another player has \$12,000. What should the players do?
4. What about the game of *rock, paper, scissors*? What is the optimal strategy in that game?

7 The Price Is Right – Bonkers

<https://www.youtube.com/watch?v=mjGEV8s0Dc4>

1. What should a good strategy optimize for?
2. Can you find the best strategy? (Try starting with two or three digits.)
3. How many moves are required in an optimal strategy?
4. What other famous math problem has exactly the same solution?

8 The Price Is Right – Spelling Bee

<https://www.youtube.com/watch?v=Pm-bfQmMROA>

1. After the contestant has revealed three cards, what is her probability of winning?
2. After the contestant has revealed two cards, what is her probability of winning?
3. A YouTube comment says:

She should had [sic] gone for the \$4,000 because the chance of winning a car is slim since there are only 11 Cs, 11 As, 6 Rs, and 2 Car Signs.

Another YouTube comment says

Would of [sic] taken the money very hard to get the word car

The price of the car is \$22,975. Explain why, if the contestant's odds of winning are greater than $\frac{160}{919}$, she should go for the car.

4. Prove that the probability she wins is greater than $\frac{160}{919}$. (Try to look for an easy solution!)
5. (Challenge!) Compute the exact probability she wins the car.

9 (Challenge) The Price Is Right – Three Strikes

<https://www.youtube.com/watch?v=AAIU6knD7BA>

Come up with a strategy, and estimate the contestant's odds of winning following that strategy.