# The Mathematics of Game Shows

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# Overview

Game shows are filled with math problems…

- Contestants
  - How do I play best?
  - How much is enough?
- Producers
  - How do I build a fun game to watch?
  - How will contestants behave?
  - How much money are we giving out?

# *PRIZES!*

Want to win?

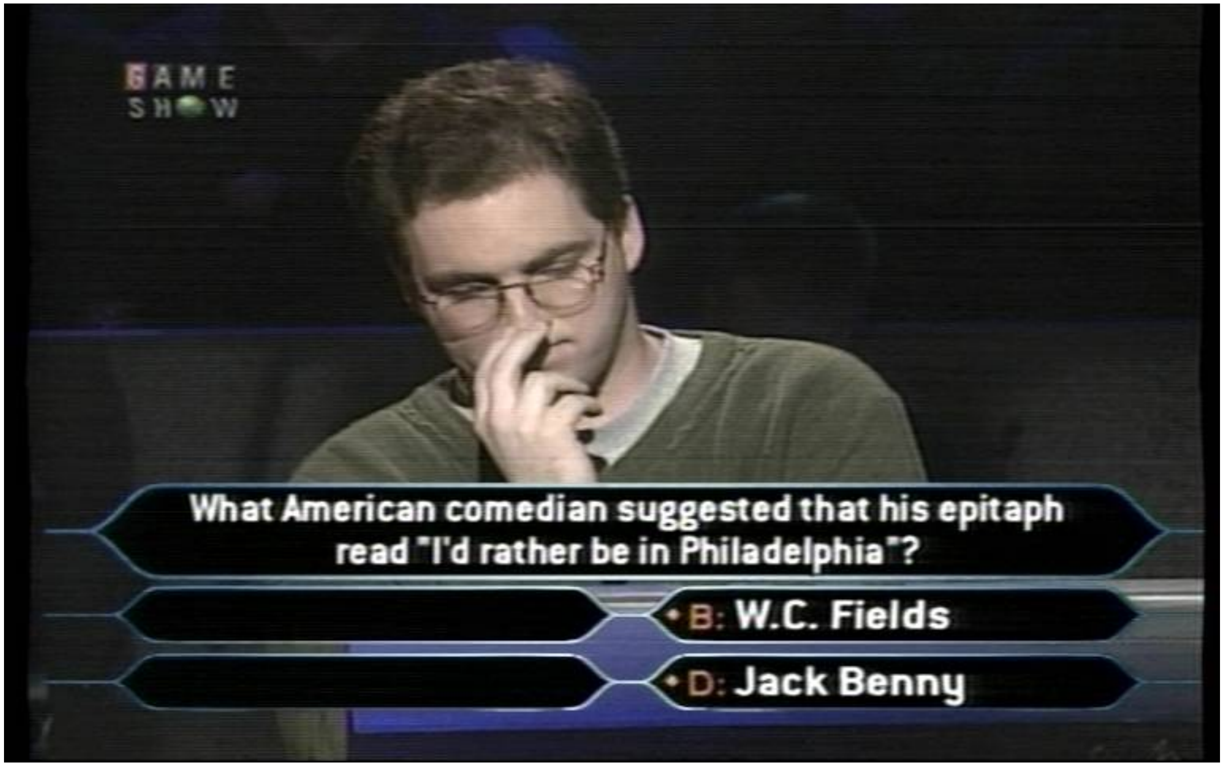
We'll need some volunteers for games.

You may leave here with *fabulous prizes*!

(Warning: definition of fabulous may vary.)

# Personal Encounters

February 2000: *Millionaire* (episode #49)




(for $1000: How many degrees in a right angle?)

# Personal Encounters

February 2000: *Millionaire* (episode #49)


(I got the next question wrong.)

# Personal Encounters

April 2004: *The Price Is Right*


(Double overbid on the showcase! Bummer.)

# Personal Encounters

July 2007: *National Bingo Night*


(I also worked on “Show Me The Money” and “The Singing Bee”… which, four years later, is still on the air.)

# Personal Encounters

## Since Then…

Recent work: “in-development” shows for Endemol, Gurinco, and Ryan Seacrest Productions.  (He’s older than me.)

# Expected Value Hour

| | | |
|---|---|---|
| $.01 | | $1,000 |
| $1 | | $5,000 |
| $5 | | $10,000 |
| $10 | | $25,000 |
| $25 | Better known as | $50,000 |
| $50 | | $75,000 |
| $75 | *Deal or No Deal* | $100,000 |
| $100 | | $200,000 |
| $200 | | $300,000 |
| $300 | | $400,000 |
| $400 | | $500,000 |
| $500 | | $750,000 |
| $750 | | $1,000,000 |

# Expected Value Hour

$.01
$1
$5
***$10***
$25
$50
$75
$100
***$200***
$300
$400
$500
$750

The "fair deal":

Multiply each outcome by its probability…

Total: $410,210

Fair deal: ~$102,500

$1,000
$5,000
***$10,000***
$25,000
$50,000
$75,000
$100,000
$200,000
$300,000
***$400,000***
$500,000
$750,000
$1,000,000

# Expected Value Hour

| | | |
|---|---|---|
| $.01 | The "bank offer": | $1,000 |
| $1 | | $5,000 |
| $5 | | ***$10,000*** |
| ***$10*** | Guarantee, almost always less than fair value | $25,000 |
| $25 | | $50,000 |
| $50 | | $75,000 |
| $75 | | $100,000 |
| $100 | | $200,000 |
| ***$200*** | | $300,000 |
| $300 | Fair deal: ~$102,500 | ***$400,000*** |
| $400 | Offer: $82,000 | $500,000 |
| $500 | | $750,000 |
| $750 | *Deal* or *No Deal*? | $1,000,000 |

# Expected Value Hour

$.01
$1
$5
$10
$25
$50
$75
$100
$200
$300
$400
$500
$750

*What's the expected value of the initial board?*

*How does it compare to the first offer?*

*How does it compare to how much money players actually win?*

$1,000
$5,000
$10,000
$25,000
$50,000
$75,000
$100,000
$200,000
$300,000
$400,000
$500,000
$750,000
$1,000,000

# Expected Value Hour

| | | |
|---|---|---|
| $.01 | Initial board… | $1,000 |
| $1 | Fair deal: $131,477 | $5,000 |
| $5 | | $10,000 |
| $10 | | $25,000 |
| $25 | | $50,000 |
| $50 | First offer: | $75,000 |
| $75 | ~$8,000-$20,000 | $100,000 |
| $100 | | $200,000 |
| $200 | | $300,000 |
| $300 | | $400,000 |
| $400 | The first offers are *terrible!* Why? | $500,000 |
| $500 | | $750,000 |
| $750 | | $1,000,000 |

# Expected Value Hour

| | |
|---|---|
| $.01 | $1,000 |
| $1 | $5,000 |
| $5 | $10,000 |
| $10 | $25,000 |
| $25 | $50,000 |
| $50 | $75,000 |
| $75 | $100,000 |
| $100 | $200,000 |
| $200 | $300,000 |
| $300 | $400,000 |
| $400 | $500,000 |
| $500 | $750,000 |
| $750 | $1,000,000 |

Actual average winnings per player:

$122,500

Initial board's expected value:

$131,477

(Close! Why the difference?)

# Expected Value Hour

| | | |
|---|---|---|
| $.01 | Offer percentages (compared to fair value, by round): | $1,000 |
| $1 | 11%, 21%, 36%, 50%, 62%, 73%, 88%, 92%, 98% | $5,000 |
| $5 | | $10,000 |
| $10 | | $25,000 |
| $25 | | $50,000 |
| $50 | | $75,000 |
| $75 | | $100,000 |
| $100 | | $200,000 |
| $200 | | $300,000 |
| $300 | | $400,000 |
| $400 | | $500,000 |
| $500 | (Commercial break…) | $750,000 |
| $750 | | $1,000,000 |

# *Sponsored by… CME Project*

- Four-year, NSF-funded curriculum written by EDC
- Published in 2008 by Pearson Education
- 25,000+ students use it nationally: Boston, Chicago, Pittsburgh, Des Moines… *and more*

## Fundamental Organizing Principle

The widespread utility and effectiveness of mathematics come not just from mastering specific skills, topics, and techniques, but more importantly, from developing the ways of thinking—the *habits of mind*—used to create the results.

# *CME Project* Overview

By focusing on *habits of mind*…

- Coherent curriculum, fewer chapters
- Closely aligned to Common Core's Standards of Mathematical Practice (several ideas come from CME)
- Closely aligned to NCTM's Reasoning and Sense-Making goals (several examples come from CME)
- General-purpose tools help students get the big ideas

## *Summer sessions in New England!*

June 27-29, July 18-20, August 1-5

(we also do house calls… but now, back to the show)

## *The Price Is Right*

- Now in its 39th year
- Lots of good math problems!
- Also a huge sample size of repeatedly-played games (for agonizing detail, visit http://tpirsummaries.8m.com)

*Who wants to play??*

# Four Price Tags

Place a price next to each item. If it's the right price, you win the prize!

Slumdog Millionaire

Glee: The Game

Word Wear

Jenga

# Four Price Tags

Place a price next to each item. If it's the right price, you win the prize!

| | |
|---|---|
| Slumdog Millionaire | Good luck… you'll need it. |
| Glee: The Game | $9.99 |
| Word Wear | $10.00 |
| Jenga | $10.09 |
| | $10.59 |

Audience, any advice?

# Four Price Tags

So, how did you do…?

| | |
|---|---|
| Slumdog Millionaire | $10.00 |
| Glee: The Game | $10.59 |
| Word Wear | $9.99 |
| Jenga | $10.09 |

# The Producers' Question

If I keep offering this game repeatedly, how many prizes will I give away, on average?

Answer by calculating the expected value for the number of prizes per game.

There are 24 different ways the player can place the price tags. (Why?)

# 24 Ain't That Many

Here are the 24 ways to place the price tags:

| | | | |
|---|---|---|---|
| ABCD | BACD | CABD | DABC |
| ABDC | BADC | CADB | DACB |
| ACBD | BCAD | CBAD | DBAC |
| ACDB | BCDA | CBDA | DBCA |
| ADBC | BDAC | CDAB | DCAB |
| ADCB | BDCA | CDBA | DCBA |

# Gotta Score ‘Em All

For each of the 24 ways, count the number of price tags placed correctly.

| | | | |
|---|---|---|---|
| ABCD **4** | BACD **2** | CABD **1** | DABC **0** |
| ABDC **2** | BADC **0** | CADB **0** | DACB **1** |
| ACBD **2** | BCAD **1** | CBAD **2** | DBAC **1** |
| ACDB **1** | BCDA **0** | CBDA **1** | DBCA **2** |
| ADBC **1** | BDAC **0** | CDAB **0** | DCAB **0** |
| ADCB **2** | BDCA **1** | CDBA **0** | DCBA **0** |

# The expected value is…

This frequency chart shows the number of ways to get each result.

| # prizes | # ways |
|---|---|
| 4 | 1 |
| 2 | 6 |
| 1 | 8 |
| 0 | 9 |
| TOTAL | 24 |

# The expected value is…

This frequency chart shows the number of ways to get each result.

| # prizes | # ways |
|---|---|
| 4 | 1 |
| 2 | 6 |
| 1 | 8 |
| 0 | 9 |
| TOTAL | 24 |

The total number of prizes is

$4 \times 1 + 2 \times 6 + 1 \times 8$

… 24 prizes and 24 ways. Divide to find…

Hey, it's 1!

# A Second Opinion

Reconsider the problem from how Sue sees it. (Sue Sylvester, from Glee.)

| | | | |
|---|---|---|---|
| ABCD | BACD | CABD | DABC |
| ABDC | BADC | CADB | DACB |
| ACBD | BCAD | CBAD | DBAC |
| ACDB | BCDA | CBDA | DBCA |
| ADBC | BDAC | CDAB | DCAB |
| ADCB | BDCA | CDBA | DCBA |

# A Second Opinion

Light up all the places where B (the Glee game) is correctly placed.

| | | | |
|---|---|---|---|
| A**B**CD | BACD | CABD | DABC |
| A**B**DC | BADC | CADB | DACB |
| ACBD | BCAD | C**B**AD | D**B**AC |
| ACDB | BCDA | C**B**DA | D**B**CA |
| ADBC | BDAC | CDAB | DCAB |
| ADCB | BDCA | CDBA | DCBA |

# A Second Opinion

Glee is won one-fourth (6 out of 24) of the time… and all the prizes are like that.

| | | | |
|---|---|---|---|
| A**B**CD | BACD | CABD | DABC |
| A**B**DC | BADC | CADB | DACB |
| ACBD | BCAD | C**B**AD | D**B**AC |
| ACDB | BCDA | C**B**DA | D**B**CA |
| ADBC | BDAC | CDAB | DCAB |
| ADCB | BDCA | CDBA | DCBA |

# It's *always* 1!

With four prizes, each is won 1/4 of the time.

$$4 \times (1/4) = 1$$

With five prizes, each is won 1/5 of the time.

With *n* prizes, each is won 1/*n* of the time.

$$n \times (1/n) = 1$$

*Clever methods can "beat" enumeration.*

# Two Extensions

1. As the number of prizes grows, what happens to the probability of winning *nothing at all*?

2. The mean (average) number of prizes given away is always 1. What happens to the *standard deviation*?

These two problems have great conclusions, which this slide is too small to contain…

(We'll be right back.)

# *Sponsored by… Rice-A-Roni*

- It's "The San Francisco Treat"!
- A favorite since 1958
- 25,000+ people eat it nationally: Boston, Chicago, Pittsburgh, Des Moines… *and more*


(And we're back.)

# The #1 Game on TPIR is…

*PLINKO!*

# The #1 Game on TPIR is…

## *PLINKO!*

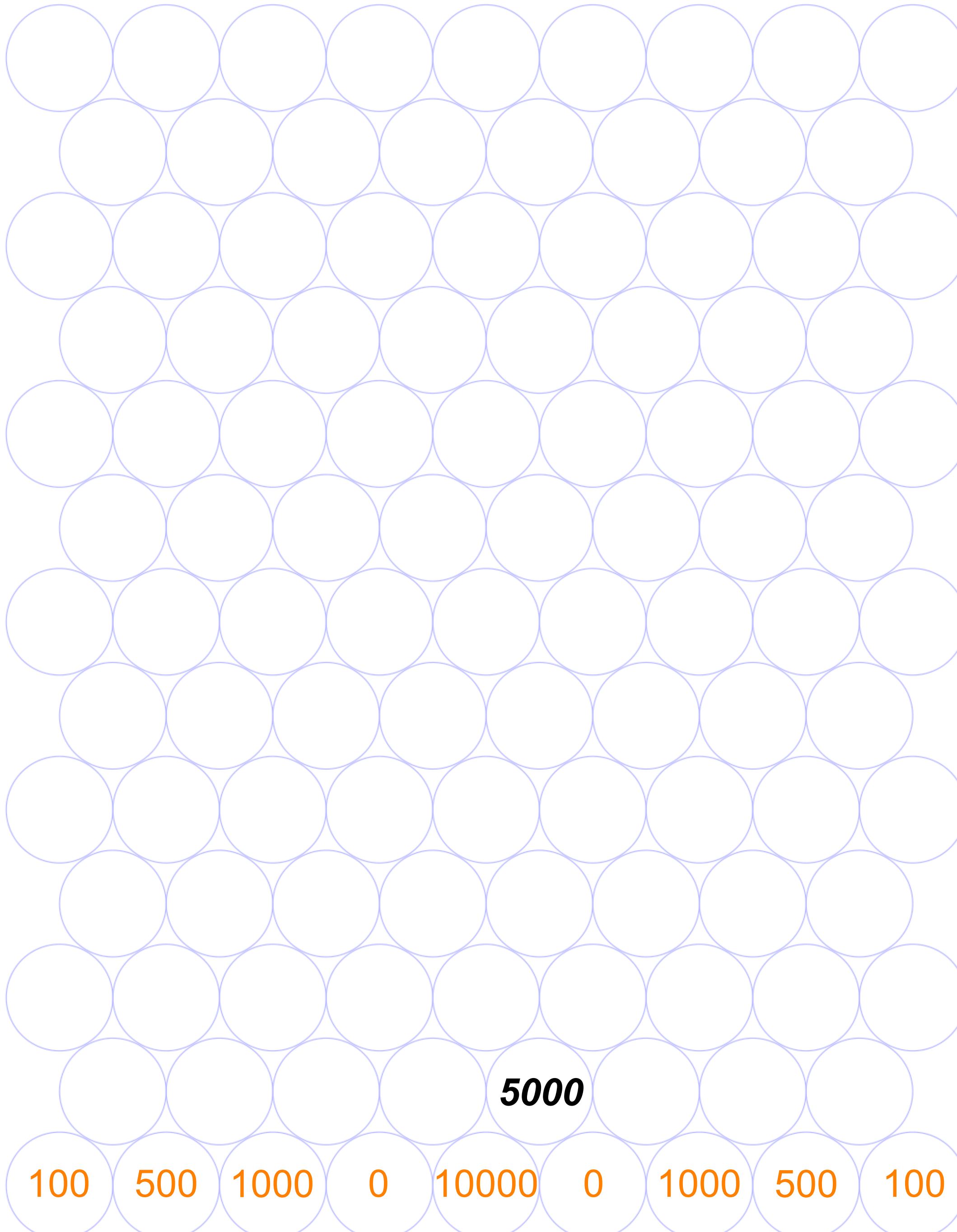
Plinko is played so often that great data is available:

2000-2011: played 308 times!
Total chips: 1,227
Total chips in $10,000 space: 176 (14.3%)
Total winnings: $2,214,600 ($1,805 per chip)
Average winnings *per play*: $7,190

# Backtracking Plinko

*How much is this Plinko chip worth right now?*

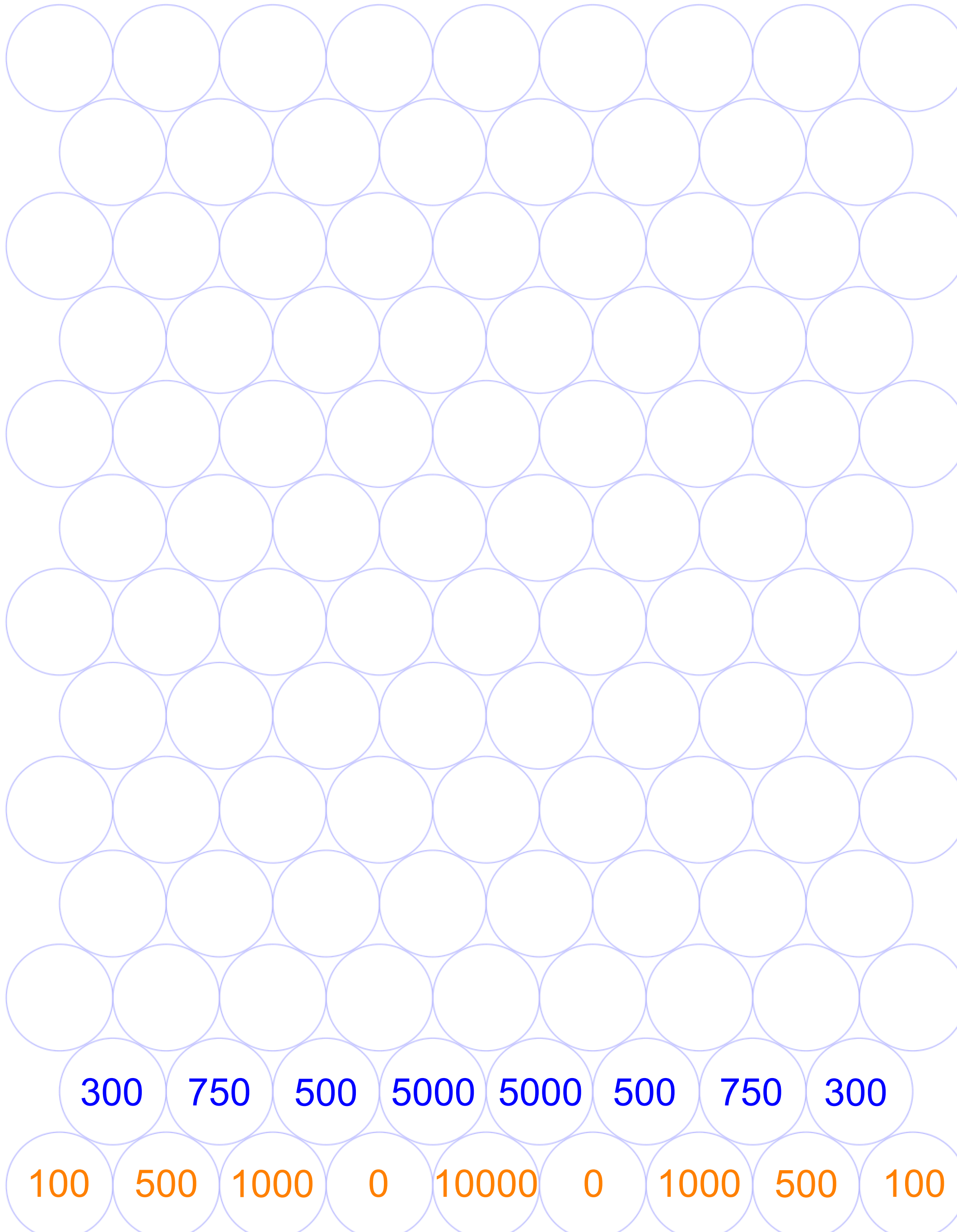
# Backtracking Plinko




*Each entry is the value of a chip at that spot.*

*We know the last row…*

# Backtracking Plinko




*Work from the bottom up… each number is the mean of the two below it!*

# Backtracking Plinko

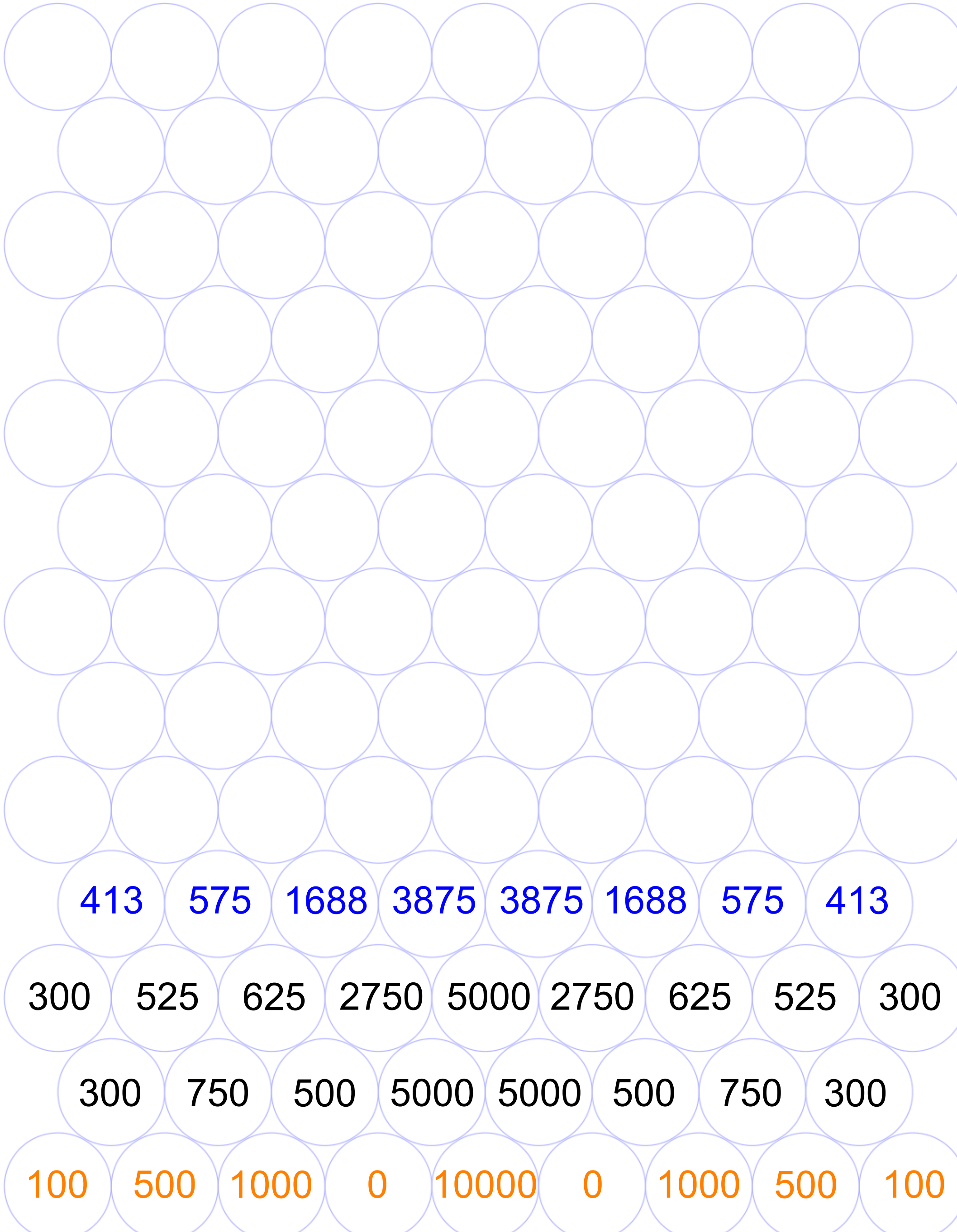
300 525 625 2750 5000 2750 625 525 300

300 750 500 5000 5000 500 750 300

100 500 1000 0 10000 0 1000 500 100

*Work from the bottom up… each number is the mean of the two below it!*

# Backtracking Plinko



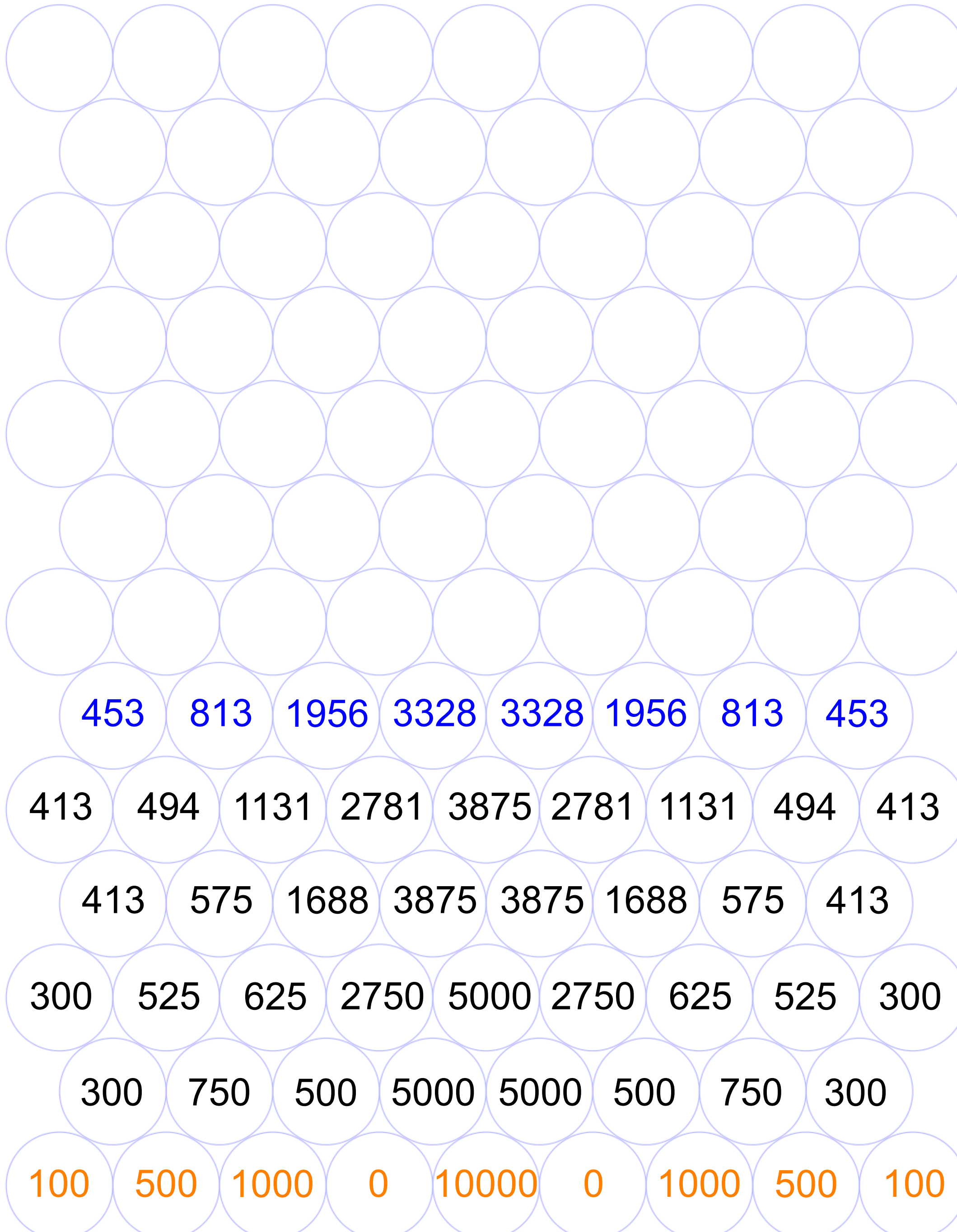

*Work from the bottom up… each number is the mean of the two below it!*

# Backtracking Plinko

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| 413 | 494 | 1131 | 2781 | 3875 | 2781 | 1131 | 494 | 413 |
| 413 | 575 | 1688 | 3875 | 3875 | 1688 | 575 | 413 | |
| 300 | 525 | 625 | 2750 | 5000 | 2750 | 625 | 525 | 300 |
| 300 | 750 | 500 | 5000 | 5000 | 500 | 750 | 300 | |
| 100 | 500 | 1000 | 0 | 10000 | 0 | 1000 | 500 | 100 |

*Work from the bottom up… each number is the mean of the two below it!*

# Backtracking Plinko

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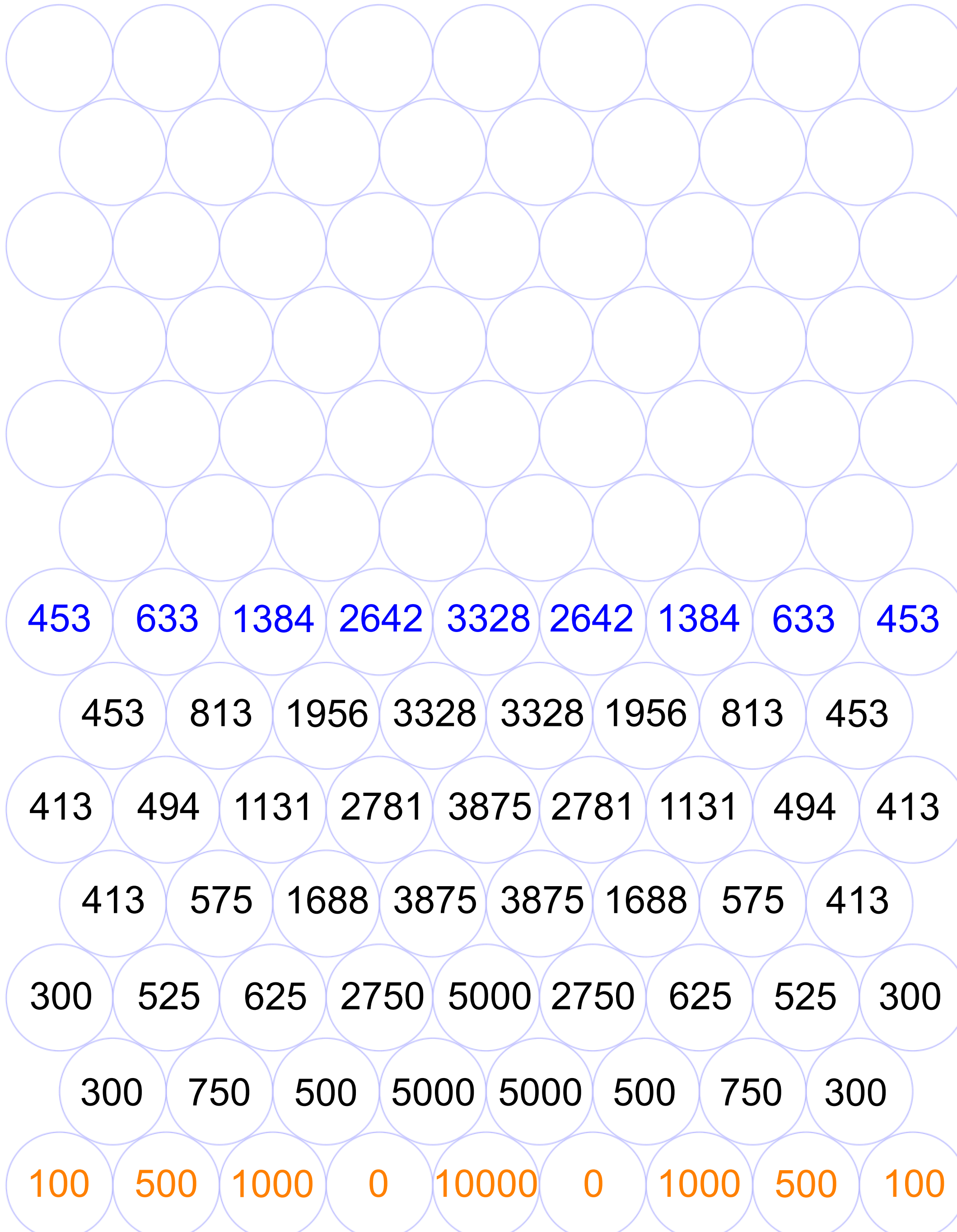
# Backtracking Plinko




*In the long run, it all evens out.*

*But this isn't a long run…*

# Backtracking Plinko

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 543 | 1009 | 2013 | 2985 | 2985 | 2013 | 1009 | 543 | |
| 453 | 633 | 1384 | 2642 | 3328 | 2642 | 1384 | 633 | 453 |
| 453 | 813 | 1956 | 3328 | 3328 | 1956 | 813 | 453 | |
| 413 | 494 | 1131 | 2781 | 3875 | 2781 | 1131 | 494 | 413 |
| 413 | 575 | 1688 | 3875 | 3875 | 1688 | 575 | 413 | |
| 300 | 525 | 625 | 2750 | 5000 | 2750 | 625 | 525 | 300 |
| 300 | 750 | 500 | 5000 | 5000 | 500 | 750 | 300 | |
| 100 | 500 | 1000 | 0 | 10000 | 0 | 1000 | 500 | 100 |

*In the long run, it all evens out.*

*But this isn't a long run…*

# Backtracking Plinko

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 543 | 776 | 1511 | 2499 | 2985 | 2499 | 1511 | 776 | 543 |
| 543 | 1009 | 2013 | 2985 | 2985 | 2013 | 1009 | 543 | |
| 453 | 633 | 1384 | 2642 | 3328 | 2642 | 1384 | 633 | 453 |
| 453 | 813 | 1956 | 3328 | 3328 | 1956 | 813 | 453 | |
| 413 | 494 | 1131 | 2781 | 3875 | 2781 | 1131 | 494 | 413 |
| 413 | 575 | 1688 | 3875 | 3875 | 1688 | 575 | 413 | |
| 300 | 525 | 625 | 2750 | 5000 | 2750 | 625 | 525 | 300 |
| 300 | 750 | 500 | 5000 | 5000 | 500 | 750 | 300 | |
| 100 | 500 | 1000 | 0 | 10000 | 0 | 1000 | 500 | 100 |

*In the long run, it all evens out.*

*But this isn't a long run…*

# Backtracking Plinko

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 659 | 1143 | 2005 | 2742 | 2742 | 2005 | 1143 | 659 | |
| 543 | 776 | 1511 | 2499 | 2985 | 2499 | 1511 | 776 | 543 |
| 543 | 1009 | 2013 | 2985 | 2985 | 2013 | 1009 | 543 | |
| 453 | 633 | 1384 | 2642 | 3328 | 2642 | 1384 | 633 | 453 |
| 453 | 813 | 1956 | 3328 | 3328 | 1956 | 813 | 453 | |
| 413 | 494 | 1131 | 2781 | 3875 | 2781 | 1131 | 494 | 413 |
| 413 | 575 | 1688 | 3875 | 3875 | 1688 | 575 | 413 | |
| 300 | 525 | 625 | 2750 | 5000 | 2750 | 625 | 525 | 300 |
| 300 | 750 | 500 | 5000 | 5000 | 500 | 750 | 300 | |
| 100 | 500 | 1000 | 0 | 10000 | 0 | 1000 | 500 | 100 |

*In the long run, it all evens out.*

*But this isn't a long run…*

# Backtracking Plinko

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| 659 | 901 | 1574 | 2374 | 2742 | 2374 | 1574 | 901 | 659 |
| 659 | 1143 | 2005 | 2742 | 2742 | 2005 | 1143 | 659 | |
| 543 | 776 | 1511 | 2499 | 2985 | 2499 | 1511 | 776 | 543 |
| 543 | 1009 | 2013 | 2985 | 2985 | 2013 | 1009 | 543 | |
| 453 | 633 | 1384 | 2642 | 3328 | 2642 | 1384 | 633 | 453 |
| 453 | 813 | 1956 | 3328 | 3328 | 1956 | 813 | 453 | |
| 413 | 494 | 1131 | 2781 | 3875 | 2781 | 1131 | 494 | 413 |
| 413 | 575 | 1688 | 3875 | 3875 | 1688 | 575 | 413 | |
| 300 | 525 | 625 | 2750 | 5000 | 2750 | 625 | 525 | 300 |
| 300 | 750 | 500 | 5000 | 5000 | 500 | 750 | 300 | |
| 100 | 500 | 1000 | 0 | 10000 | 0 | 1000 | 500 | 100 |

*In the long run, it all evens out.*

*But this isn't a long run…*

# Backtracking Plinko

780 1238 1974 2558 2558 1974 1238 780

659 901 1574 2374 2742 2374 1574 901 659

659 1143 2005 2742 2742 2005 1143 659

543 776 1511 2499 2985 2499 1511 776 543

543 1009 2013 2985 2985 2013 1009 543

453 633 1384 2642 3328 2642 1384 633 453

453 813 1956 3328 3328 1956 813 453

413 494 1131 2781 3875 2781 1131 494 413

413 575 1688 3875 3875 1688 575 413

300 525 625 2750 5000 2750 625 525 300

300 750 500 5000 5000 500 750 300

100 500 1000 0 10000 0 1000 500 100

*At the top we find the expected value for dropping a chip from each slot!*

# Backtracking Plinko

**780 1009 1606 2266 2558 2266 1606 1009 780**

780 1238 1974 2558 2558 1974 1238 780

659 901 1574 2374 2742 2374 1574 901 659

659 1143 2005 2742 2742 2005 1143 659

543 776 1511 2499 2985 2499 1511 776 543

543 1009 2013 2985 2985 2013 1009 543

453 633 1384 2642 3328 2642 1384 633 453

453 813 1956 3328 3328 1956 813 453

413 494 1131 2781 3875 2781 1131 494 413

413 575 1688 3875 3875 1688 575 413

300 525 625 2750 5000 2750 625 525 300

300 750 500 5000 5000 500 750 300

100 500 1000 0 10000 0 1000 500 100

*At the top we find the expected value for dropping a chip from each slot!*

# Good Plinko Advice

Where you drop Plinko chips matters a lot!

| Drop Above | Chip EV |
|---|---|
| $10,000 | |
| $0 | |
| $1,000 | |
| $500 | |
| $100 | |

# Good Plinko Advice

Where you drop Plinko chips matters a lot!

| Drop Above | Chip EV |
|---|---|
| $10,000 | $2,558 |
| $0 | $2,266 |
| $1,000 | $1,606 |
| $500 | $1,009 |
| $100 | $780 |

# Good Plinko Advice

Where you drop Plinko chips matters a lot!

| Drop Above | Chip EV |
|---|---|
| $10,000 | $2,558 |
| $0 | $2,266 |
| $1,000 | $1,606 |
| $500 | $1,009 |
| $100 | $780 |

(Did they build the board this way on purpose?)

# Good Plinko Advice

Where you drop Plinko chips matters a lot!

| Drop Above | Chip EV |
|---|---|
| $10,000 | $2,558 |
| $0 | $2,266 |
| $1,000 | $1,606 |
| $500 | $1,009 |
| $100 | $780 |

If you ever get on…

DROP IT IN

THE MIDDLE!!!

Actual average winnings:

$1,805 per chip

($753 lost per chip… 1,227 times)

# *Sponsored by… Gold Bond Medicated Powder*

- Developed in 1882 by pharmacists in Rhode Island
- Gold Bond: Does what it says.
- It's got triple action, whatever *that* means!

(Let's get back to the games already…)

# The #2 Game on TPIR is…

## *ANY NUMBER!*

We don't need a Plinko board to play this one.

*Who wants to play??*

| | |
|---|---|
| CHEESE | 32.07 |
| BUS | 6.95 |
| PIGGY BANK | 1.84 |

# Any Number

Assuming the player is just picking randomly (which seems about right), what is the probability that they win the big prize?

*This is a hard question!*

# Any Number

Assuming the player is just picking randomly, what is the probability that they win the big prize?

This question would be a lot easier if the big prize had 3 digits instead of 4…

*The probability of winning the big prize must be less than 1/3.*

# Solving by Simulation

There are 10! = 3,628,800 different ways the player can pick numbers.

10! is a much bigger number than 24, so enumerating by hand is impractical.

One option is to simulate running the game a large number of times.  Here's 10,000 trials:

Cheese: 2,605 (26.05%)

Bus: 3,682

Piggy Bank: 3,713

# Solving by Tree Diagram

*Solve a simpler version!* If there's one number in each prize left, there is a 1/3 chance of winning the big prize.

If there's two numbers left in the big prize and one in each of the small prizes, there is a

$$2/4 \times 1/3 = 1/6$$

chance of winning the big prize. This is like a coordinate system: $P(2,1,1) = 1/6$.

Continue and "build out" until you find the answer at $P(4,3,3)$. (Build a 3-D model!)

# Solving by Enumeration

For computers, 3.6 million isn't that big, it's around the number of 5-card poker hands.

A computer can try all 10! ways the game could be played:

Cheese: 933,120 (25.71% = 9/35)

Bus: 1,347,840 (37.14% = 13/35)

Piggy Bank: 1,347,840 (37.14% = 13/35)

This is different from what the simulation found; its probability is an estimate.

# Solving by Being Clever

Let's play a different game called Any Number But That One.

You pick a number; if it's in a prize, that prize explodes. You win the last prize standing.

Say you pick 3… cheese explodes! (Oops.)

*What's the probability of the cheese standing alone?*

# Solving by Being Clever

*This game doesn't last nearly as long…*

On the first pick, 6 of the 10 numbers explode one of the two small prizes. (Which is good.)

After you blow up one small prize, the next pick is decisive: 3 of the 7 numbers explode the other small prize, and then it's all cheese.

$$6/10 \times 3/7 = 9/35 \ (25.71\%)$$

*Hey, it's the same probability…*

# Solving by Being Clever

Imagine being forced, before playing Any Number, to write down all 10 digits in the order you plan to call them. Here's how it matches up with Any Number But That One:

• The first exploding number you pick is the final digit that you never plan to pick.

• The second exploding number is the last one in the other prize you didn't complete.

In long games, it is often easier to look at what *doesn't* happen instead of what *does*.

# Historical Data

Players win Any Number more often than predicted by chance.

2000-2011

257 plays

Big prize (*A New Car!*): 92 (35.80%)

Small prize: 91

Piggy Bank: 74

Players often guess the first digit of the car. Also, 0 and 5 are more likely to appear there.

*(Our last commercial break…)*

# Classroom Interlude

In my teaching, I found some game shows worked better than others. Mostly I used games for test review, but also for openers or wrap-ups.

| Good | Bad |
|---|---|
| ***Press Your Luck*** | Jeopardy! *(yes, bad)* |
| Card Sharks | Deal or No Deal |
| Millionaire | Twenty-One |
| High Rollers | Newlywed Game |

# *Sponsored by… the Mathematical Practices Institute*

- EDC's new professional development program
- Curriculum-neutral, focused on Common Core's eight Standards for Mathematical Practice
- One-day and one-week seminars available

Visit the MPI website and blog:

*www.edc.org/cme/mpi*

That website again is:

*www.edc.org/cme/mpi*

# A Quick Game…

*Who's got a #2 pencil? Stand up.*

Now roll this ~~die~~ number cube, but before you do, pick one:

- Try to roll a 1 through 5 to win $2, or
- Try to roll a 6 to win $20.

*You must pick in advance!*

*What's it gonna be???*

# The Same Game…?

*Let's raise the stakes… hypothetically.*

Now roll this ~~die~~ number cube, but before you do, pick one:

- Try to roll a 1 through 5 to win $25,000, or
- Try to roll a 6 to win $250,000.

*Why is this so different?*

*How do players behave?*

# It's *National Bingo Night*!

*NBN* was *The Price is Right* with bingo instead of shopping.

(It only lasted six episodes. Wonder why…)

Its games were interesting probability problems, but usually no strategy. *Except for Bingo 365…*

*Who wants to play?*

# Get Out Your Bingo Cards…

The final game of the show is Bingo 365.

If you complete a bingo before the contestant wins, *you win* all remaining prizes!

(Ties will be broken by a math problem.)

Important: if you are one number away from a bingo, *STAND UP* so we can tell you are one away.

# Bingo 365

For each bingo ball, the contestant guesses whether the next ball will be *higher* or *lower* than the one that just came out.

If they are right, the *ball number* is added to their score. 75 is better than 23.

The first ball doesn’t score any points.

# Bingo 365

The contestant wins if they get a total of 365 points or more *before* anyone in the audience completes a bingo.

TV Show audience: 200 players, one card each.
This audience: 100 players, two cards each.

I swear this was actually on network TV.

# Bingo 365

42

Bingo balls go from 1 to 75.

Is the next ball *higher* or *lower* than 42?

# Bingo 365

42 60

Is the next ball *higher* or *lower* than 60?

# Bingo 365

42 60 5

Is the next ball *higher* or *lower* than 5?

# Bingo 365

42 60 5 30

Remember: if you are one away, STAND UP.

Is the next ball *higher* or *lower* than 30?

# Bingo 365

42 60 5 30

46

Is the next ball *higher* or *lower* than 46?

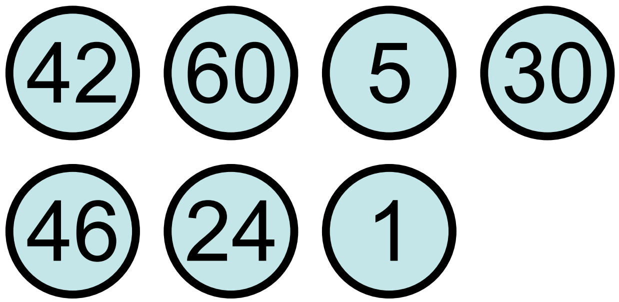
# Bingo 365

42 60 5 30

46 24

Is the next ball *higher* or *lower* than 24?

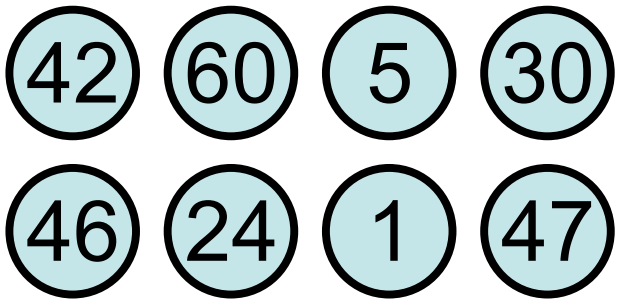
# Bingo 365




Is the next ball *higher* or *lower* than 1?

(Don’t think too hard about this one.)

# Bingo 365




Remember: if you are one away, STAND UP.

Is the next ball *higher* or *lower* than 47?

# Bingo 365

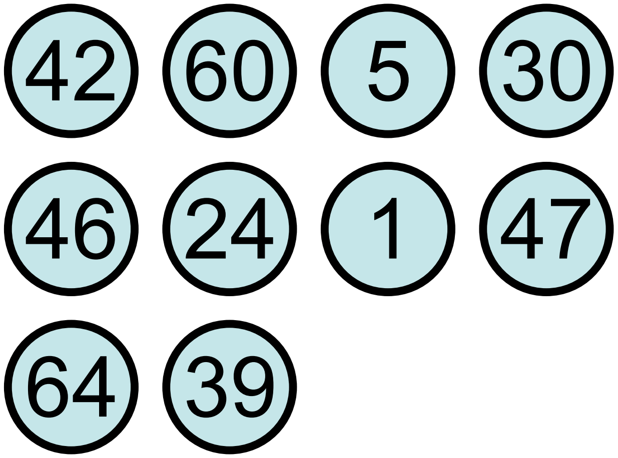
42 60 5 30

46 24 1 47

64

Is the next ball *higher* or *lower* than 64?

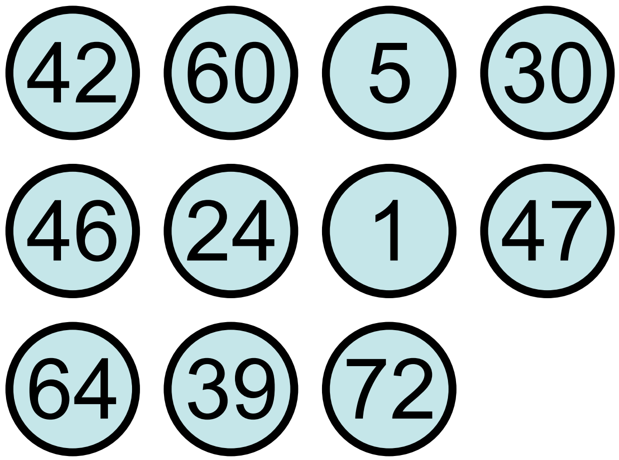
# Bingo 365




Is the next ball *higher* or *lower* than 39?

(What would you do here? This one is kind of in the middle.)

# Bingo 365




Is the next ball *higher* or *lower* than 72?

# Bingo 365

| | | | |
|---|---|---|---|
| 42 | 60 | 5 | 30 |
| 46 | 24 | 1 | 47 |
| 64 | 39 | 72 | 56 |

Getting closer…?

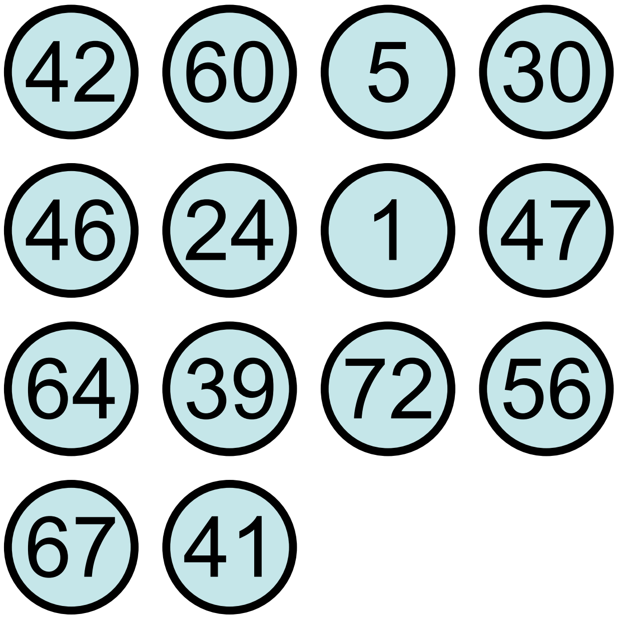
Is the next ball *higher* or *lower* than 56?

# Bingo 365

| | | | |
|---|---|---|---|
| 42 | 60 | 5 | 30 |
| 46 | 24 | 1 | 47 |
| 64 | 39 | 72 | 56 |
| 67 | | | |

Is the next ball *higher* or *lower* than 67?

# Bingo 365




Is the next ball *higher* or *lower* than 41?

# Bingo 365

| | | | |
|---|---|---|---|
| 42 | 60 | 5 | 30 |
| 46 | 24 | 1 | 47 |
| 64 | 39 | 72 | 56 |
| 67 | 41 | 18 | |

Is the next ball *higher* or *lower* than 18?

# Bingo 365

| | | | |
|---|---|---|---|
| 42 | 60 | 5 | 30 |
| 46 | 24 | 1 | 47 |
| 64 | 39 | 72 | 56 |
| 67 | 41 | 18 | 3 |

Bad time for such a low number!

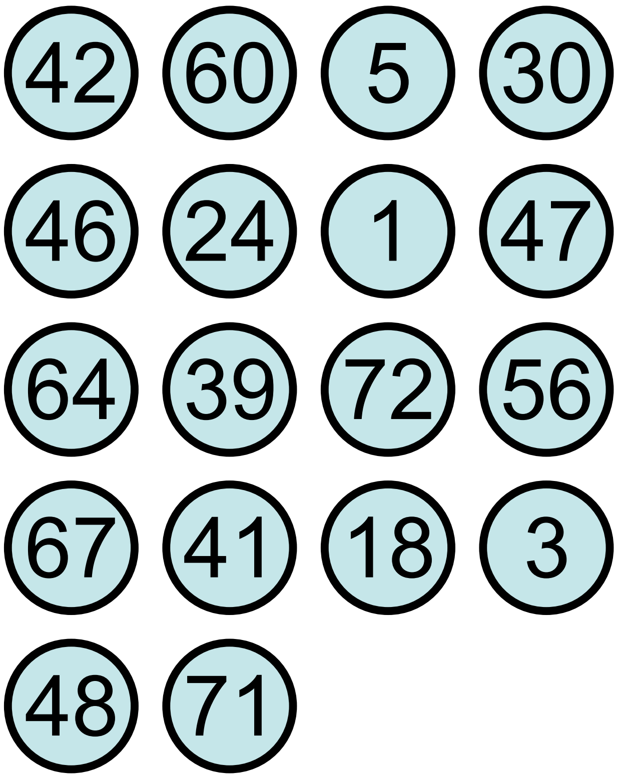
Is the next ball *higher* or *lower* than 3?

# Bingo 365

| | | | |
|---|---|---|---|
| 42 | 60 | 5 | 30 |
| 46 | 24 | 1 | 47 |
| 64 | 39 | 72 | 56 |
| 67 | 41 | 18 | 3 |
| 48 | | | |

Is the next ball *higher* or *lower* than 48?

# Bingo 365




Is the next ball *higher* or *lower* than 71?

# Bingo 365

| | | | |
|---|---|---|---|
| 42 | 60 | 5 | 30 |
| 46 | 24 | 1 | 47 |
| 64 | 39 | 72 | 56 |
| 67 | 41 | 18 | 3 |
| 48 | 71 | 26 | |

(At NCTM 2011, the contestant won with this ball.)

# Bingo 365 Strategy

Did strategy change as the game went on?

One strategy is to go higher if in the bottom half, otherwise lower. Is this the best strategy? Or what?

What's this got to do with summations? Balance? Similar triangles??

Players did not follow good strategy on the actual show: the first contestant to play Bingo 365 picked "lower" on a 30. (He lost.)

# More to Explore

Many related topics are asked about in *CME Project* Precalculus, and in the Park City Math Institute materials at

*www.mathforum.org/pcmi/hstp/sum2007/morning*

- How can spinners or dice be represented by polynomials?
- How would expected value change if the Plinko board were really, really tall?
- Would it be reasonable for 30 of 100 people to win Any Number by chance? 35? 40?

# Thanks and good luck!
# Any questions?

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