

Physical Principles in Biology
Biology 3550
Fall 2016

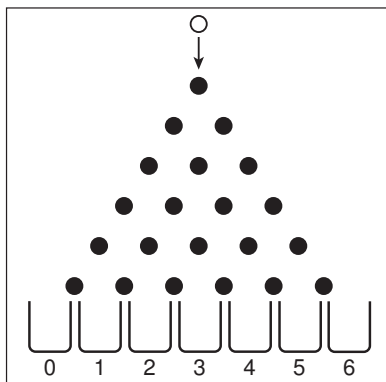
Lecture 6

Plinko Probabilities

Friday, 2 September

©David P. Goldenberg
University of Utah
goldenberg@biology.utah.edu

A Six-row Plinko

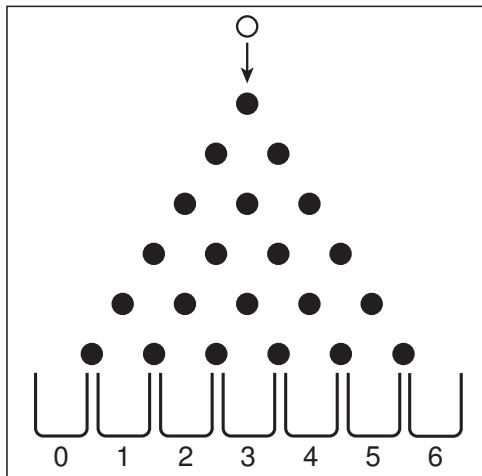


- For n plinko rows, there will be $n + 1$ buckets for balls to land in.
- For convenience, buckets are numbered from 0 to n .
- How shall we define the sample set?

Count The Paths to Reach a Given Bucket

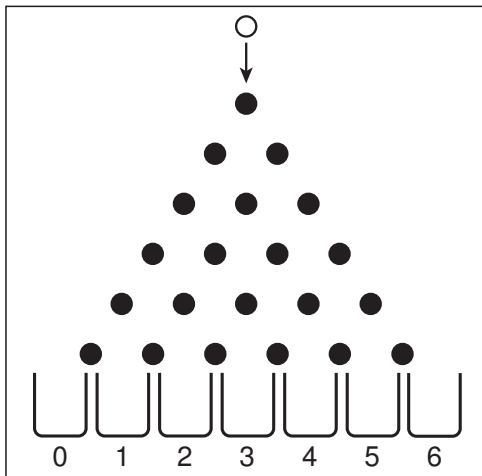
- Define outcomes as all of the possible paths.
- Define events as final positions of ball, *i.e.* bucket numbers.
- How many possible paths are there?
 - For a 6-row plinko, each path involves 6 places to change direction.
 - The number of different paths is: $2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^6 = 64$
 - Each path has an equal probability, equal to $1/64$
 - For an n -row plinko, the number of different paths is 2^n , and the probability of each is $1/2^n = 2^{-n}$.

Need to Count the Number of Paths to Each Final Position



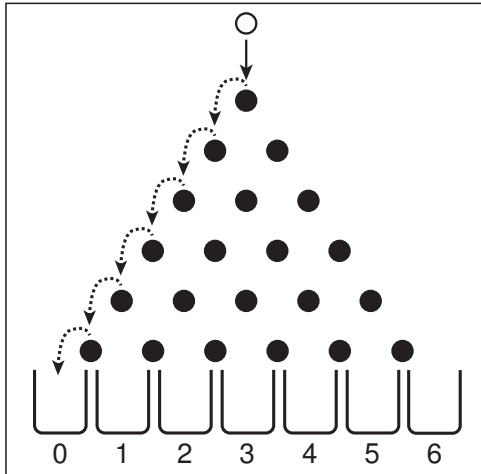
Bucket No.	Paths
0	
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 0?



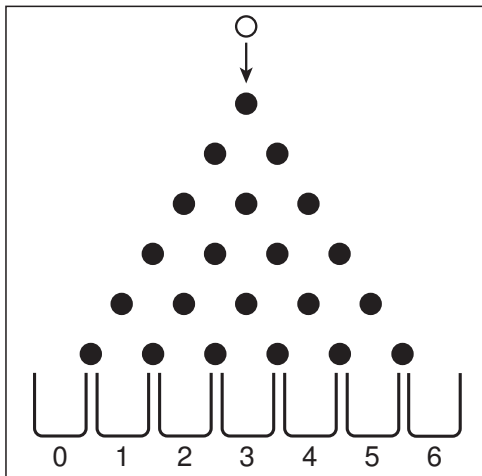
Bucket No.	Paths
0	
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 0?



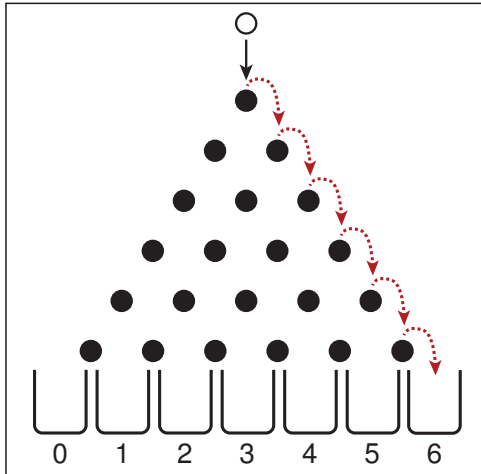
Bucket No.	Paths
0	1
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 6?



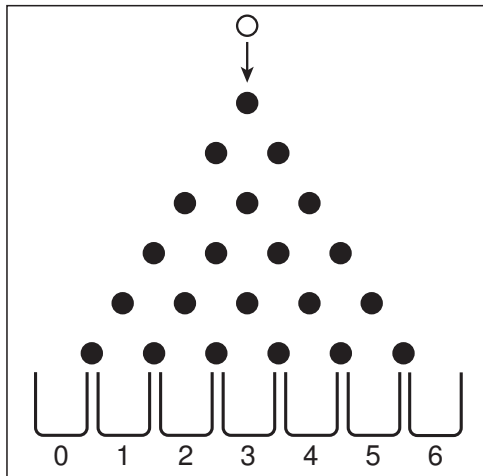
Bucket No.	Paths
0	1
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 6?



Bucket No.	Paths
0	1
1	
2	
3	
4	
5	
6	1

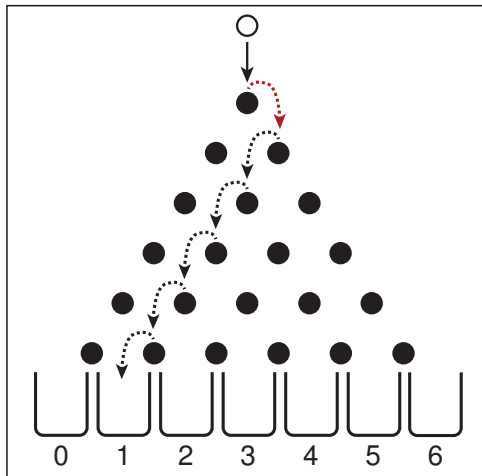
How Many Paths to Bucket 1?



Bucket No.	Paths
0	1
1	
2	
3	
4	
5	
6	1

- Each path to bucket 1 includes 1 turn to the right and 5 to the left.

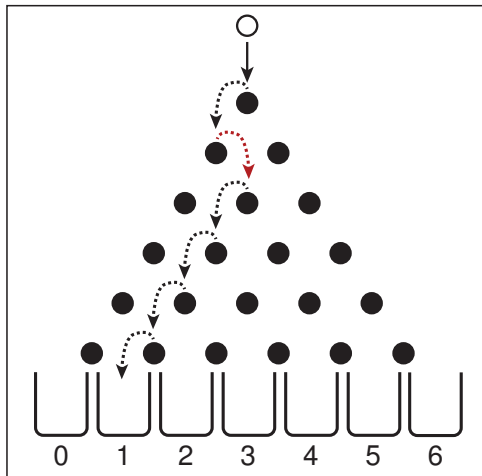
How Many Paths to Bucket 1?



Bucket No.	Paths
0	1
1	
2	
3	
4	
5	
6	1

- Each path to bucket 1 includes 1 turn to the right and 5 to the left.

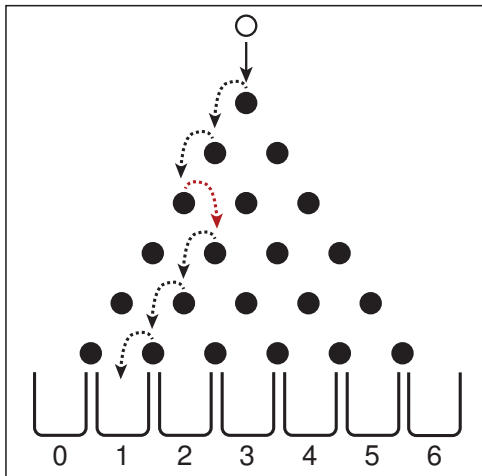
How Many Paths to Bucket 1?



Bucket No.	Paths
0	1
1	
2	
3	
4	
5	
6	1

- Each path to bucket 1 includes 1 turn to the right and 5 to the left.

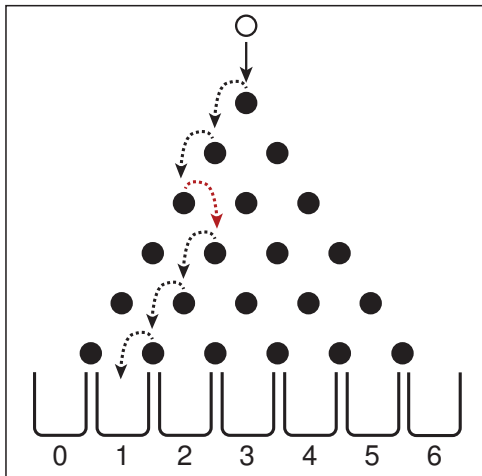
How Many Paths to Bucket 1?



Bucket No.	Paths
0	1
1	
2	
3	
4	
5	
6	1

- Each path to bucket 1 includes 1 turn to the right and 5 to the left.

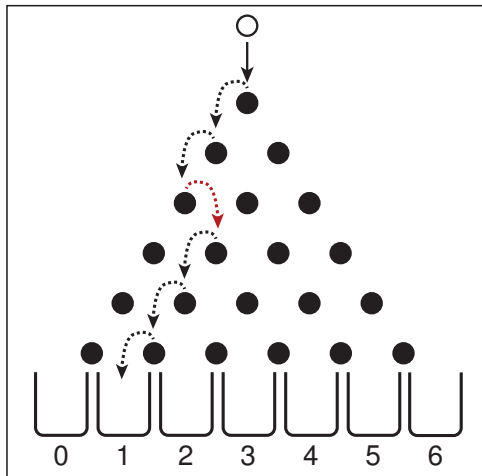
How Many Paths to Bucket 1?



Bucket No.	Paths
0	1
1	
2	
3	
4	
5	
6	1

- Each path to bucket 1 includes 1 turn to the right and 5 to the left.

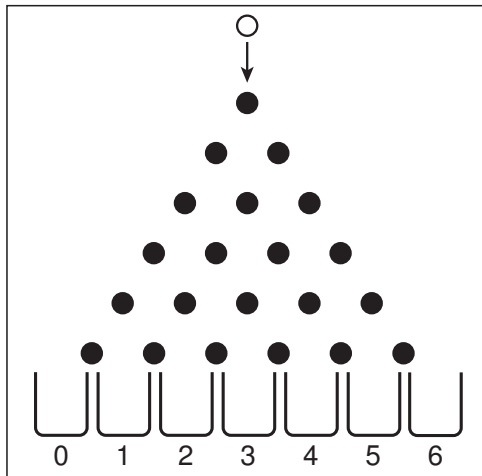
How Many Paths to Bucket 1?



Bucket No.	Paths
0	1
1	6
2	
3	
4	
5	
6	1

- Each path to bucket 1 includes 1 turn to the right and 5 to the left.

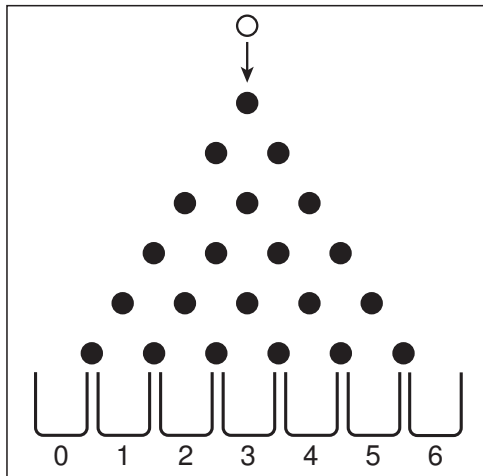
How Many Paths to Bucket 5?



Bucket No.	Paths
0	1
1	6
2	
3	
4	
5	6
6	1

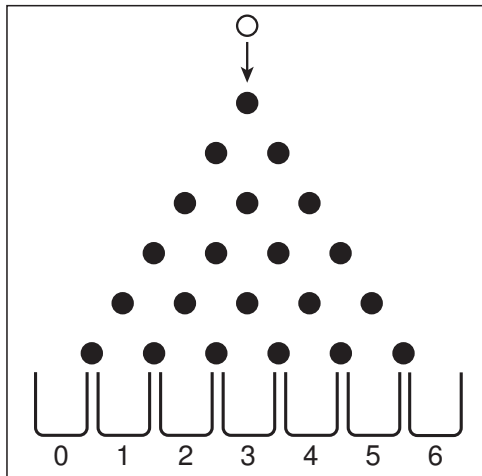
- Each path to bucket 5 includes 5 turns to the right and 1 to the left.

How Many Paths to Bucket 2?



Bucket No.	Paths
0	1
1	6
2	
3	
4	
5	6
6	1

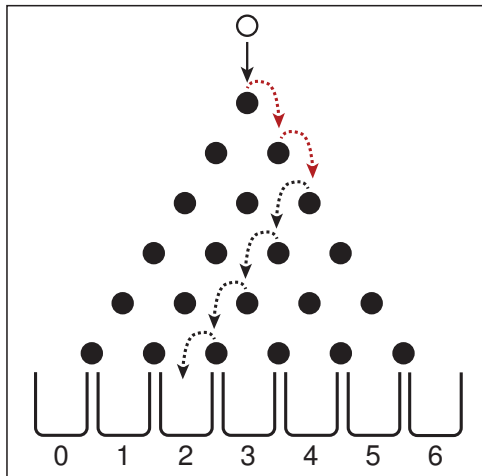
How Many Paths to Bucket 2?



Bucket No.	Paths
0	1
1	6
2	
3	
4	
5	6
6	1

- Each path to bucket 2 includes 2 turns to the right and 4 to the left.

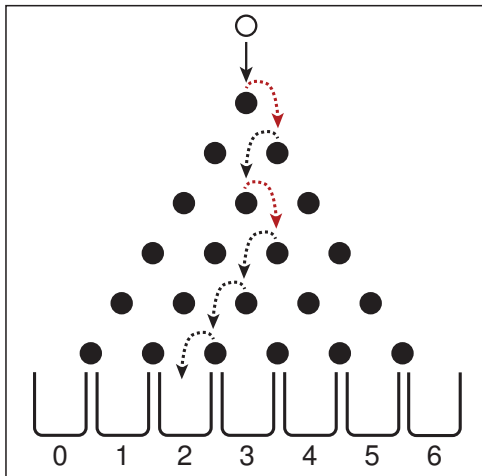
How Many Paths to Bucket 2?



Bucket No.	Paths
0	1
1	6
2	
3	
4	
5	6
6	1

- Each path to bucket 2 includes 2 turns to the right and 4 to the left.

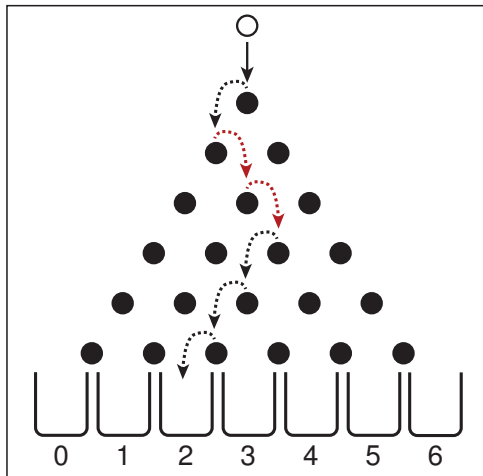
How Many Paths to Bucket 2?



Bucket No.	Paths
0	1
1	6
2	
3	
4	
5	6
6	1

- Each path to bucket 2 includes 2 turns to the right and 4 to the left.

How Many Paths to Bucket 2?

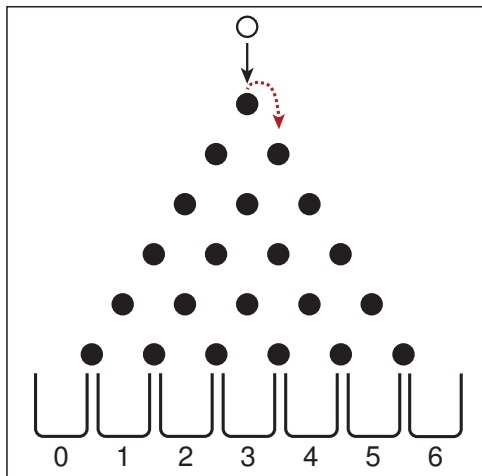


Bucket No.	Paths
0	1
1	6
2	
3	
4	
5	6
6	1

- Each path to bucket 2 includes 2 turns to the right and 4 to the left.

How Many Paths to Bucket 2?

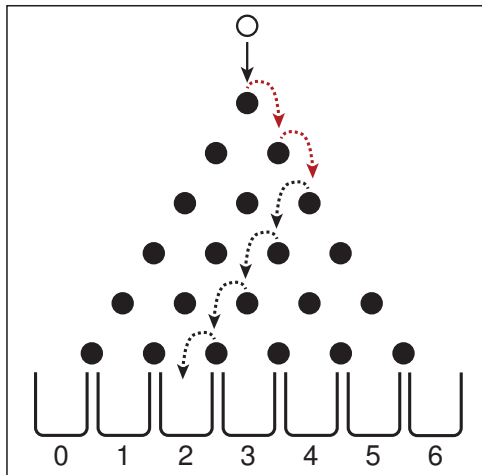
If the first turn is to the right, how many paths are there to bucket 2?



1 st right turn row	Paths
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

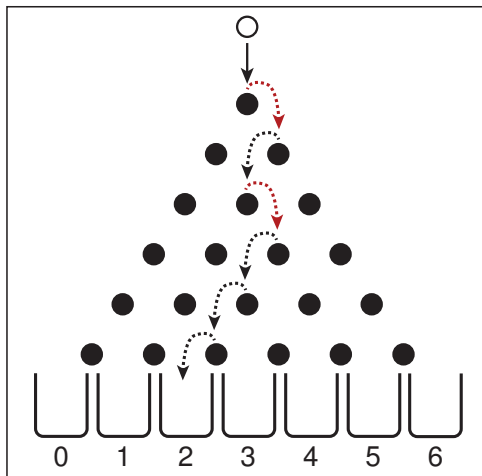
If the first turn is to the right, how many paths are there to bucket 2?



1 st right turn row	Paths
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

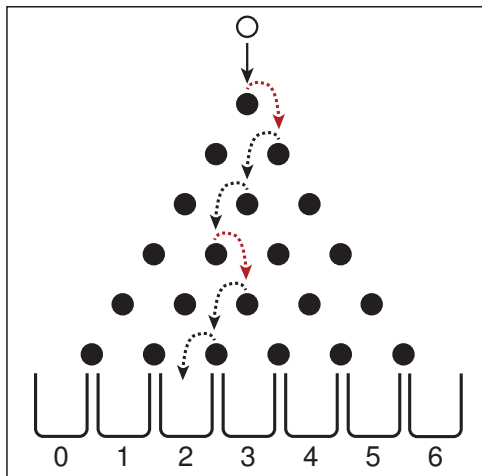
If the first turn is to the right, how many paths are there to bucket 2?



1 st right turn row	Paths
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

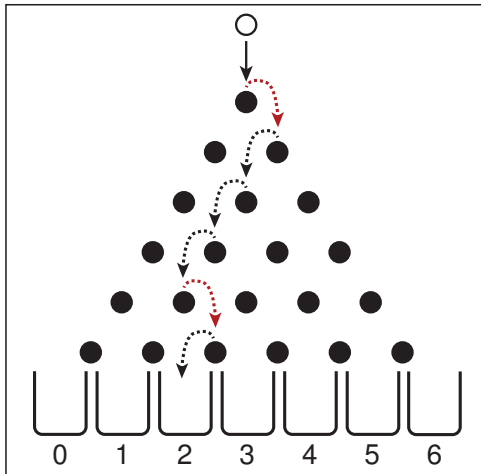
If the first turn is to the right, how many paths are there to bucket 2?



1 st right turn row	Paths
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

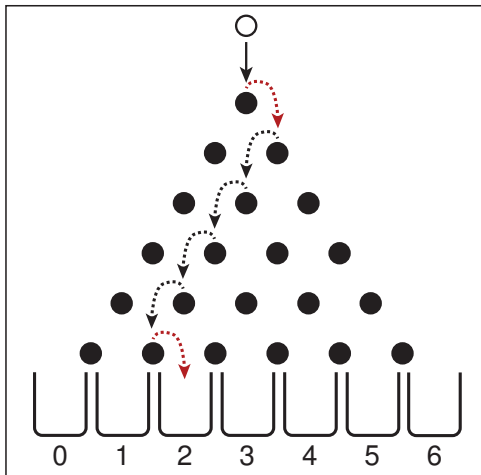
If the first turn is to the right, how many paths are there to bucket 2?



1 st right turn row	Paths
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

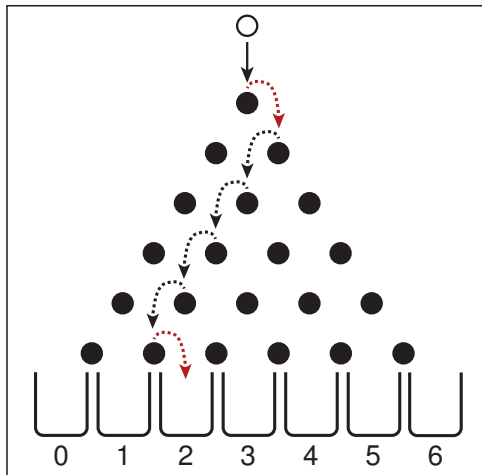
If the first turn is to the right, how many paths are there to bucket 2?



1 st right turn row	Paths
1	
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

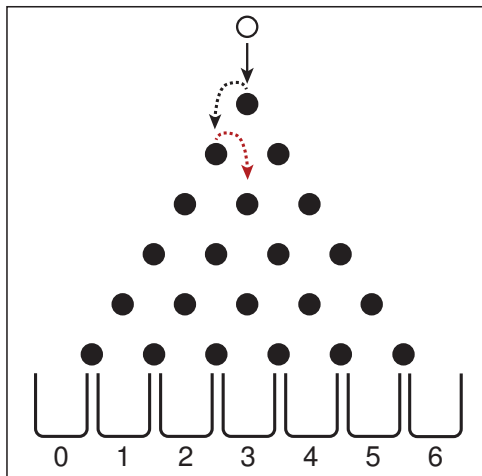
If the first turn is to the right, how many paths are there to bucket 2?



1 st right turn row	Paths
1	5
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

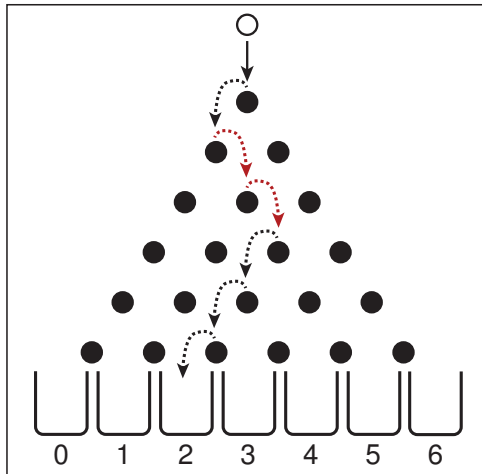
If the first turn to the right is at row 2, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

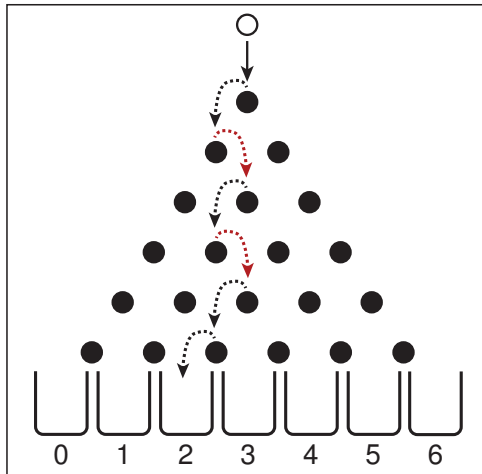
If the first turn to the right is at row 2, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

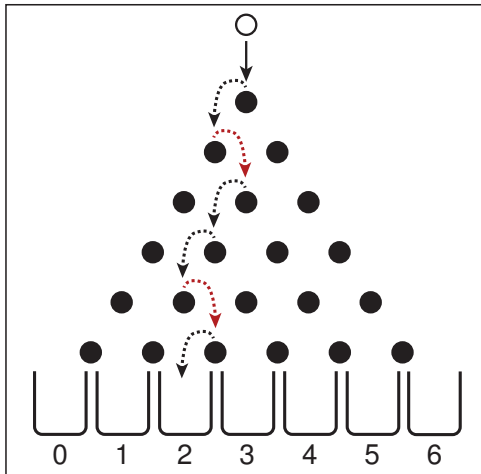
If the first turn to the right is at row 2, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

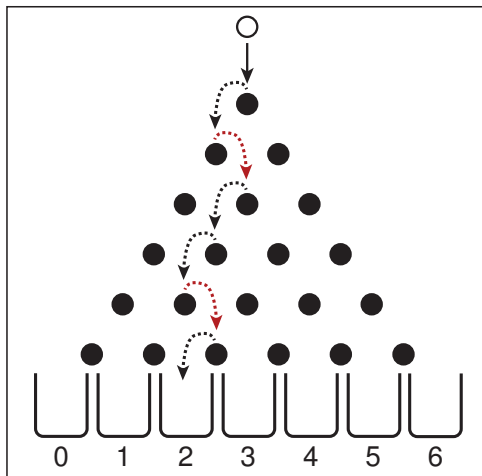
If the first turn to the right is at row 2, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

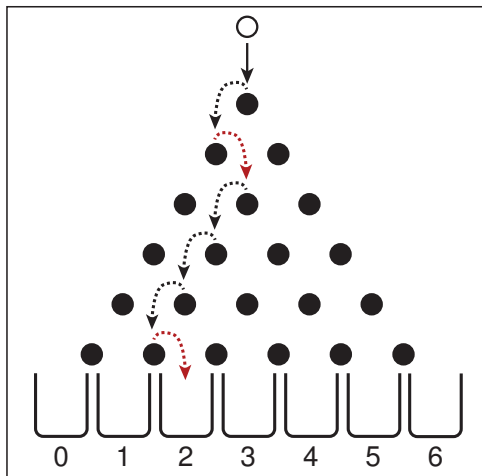
If the first turn to the right is at row 2, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

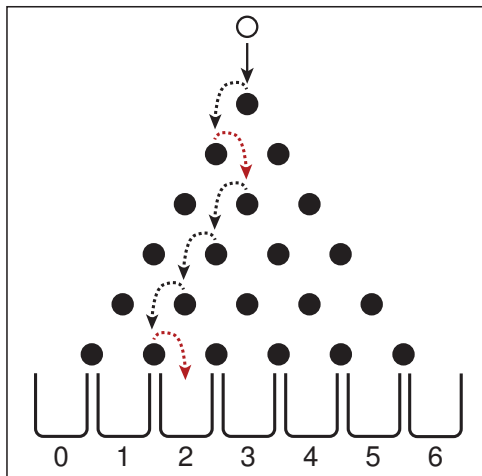
If the first turn to the right is at row 2, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	
3	
4	
5	
6	

How Many Paths to Bucket 2?

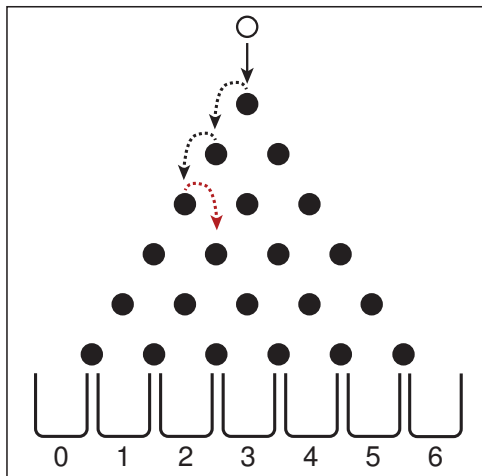
If the first turn to the right is at row 2, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	4
3	
4	
5	
6	

How Many Paths to Bucket 2?

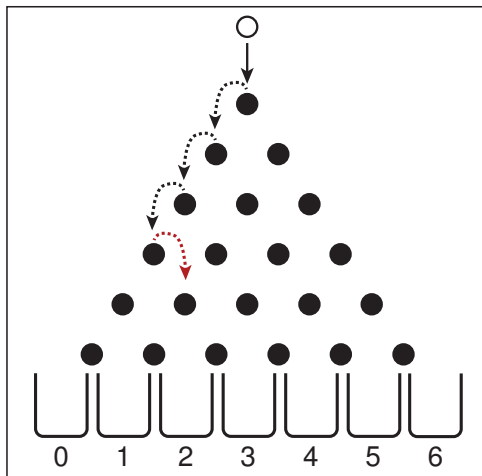
If the first turn to the right is at row 3, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	4
3	3
4	
5	
6	

How Many Paths to Bucket 2?

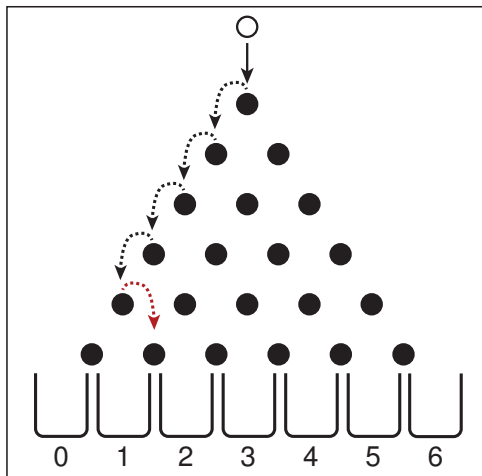
If the first turn to the right is at row 4, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	4
3	3
4	2
5	
6	

How Many Paths to Bucket 2?

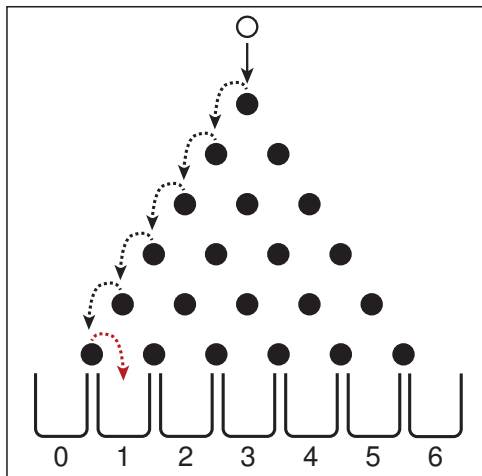
If the first turn to the right is at row 5, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	4
3	3
4	2
5	1
6	

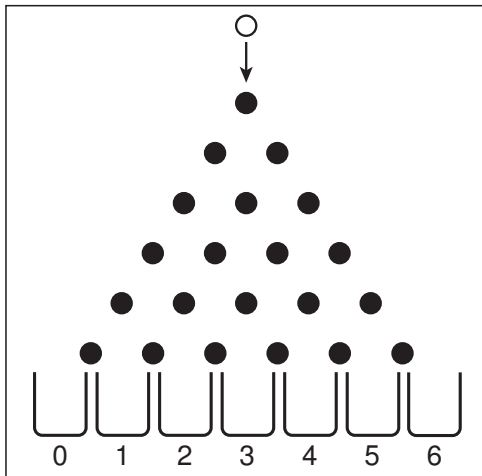
How Many Paths to Bucket 2?

If the first turn to the right is at row 6, how many paths to bucket 2?



1 st right turn row	Paths
1	5
2	4
3	3
4	2
5	1
6	0

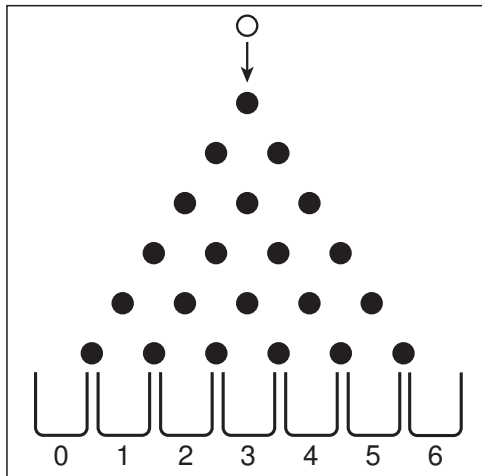
How Many Paths to Bucket 2?



Bucket No.	Paths
0	1
1	6
2	15
3	
4	
5	6
6	1

- Each path to bucket 2 includes 2 turns to the right and 4 to the left.

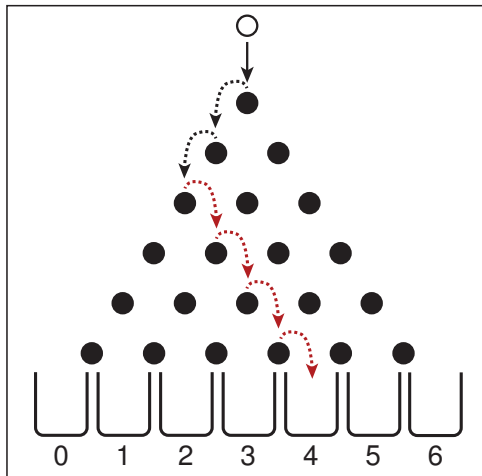
How Many Paths to Bucket 4?



Bucket No.	Paths
0	1
1	6
2	15
3	
4	
5	6
6	1

- Each path to bucket 4 includes 4 turns to the right and 2 to the left.

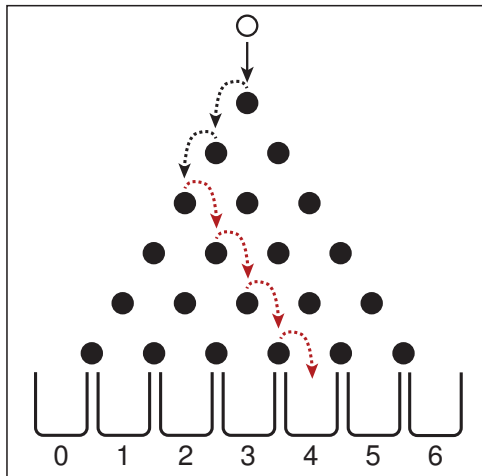
How Many Paths to Bucket 4?



Bucket No.	Paths
0	1
1	6
2	15
3	
4	
5	6
6	1

- Each path to bucket 4 includes 4 turns to the right and 2 to the left.

How Many Paths to Bucket 4?



Bucket No.	Paths
0	1
1	6
2	15
3	
4	15
5	6
6	1

- Each path to bucket 4 includes 4 turns to the right and 2 to the left.