#7 Bertrand's Box

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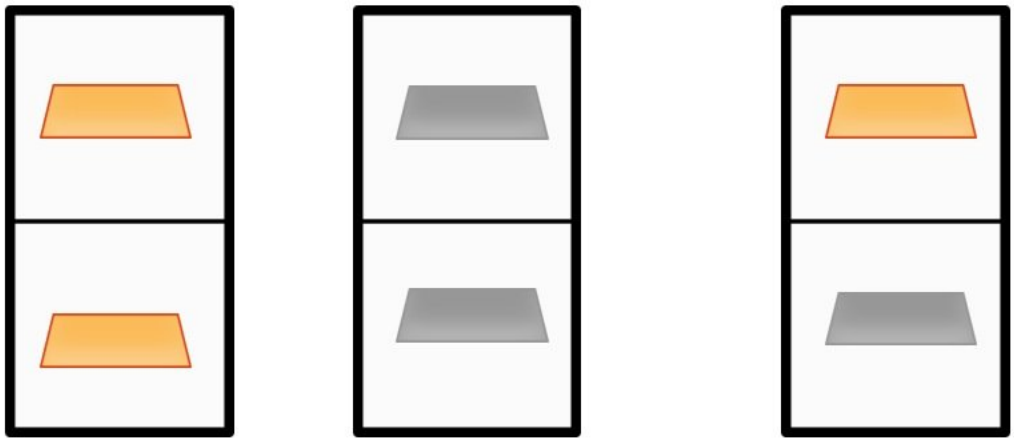
Bertrand's Box Paradox

- I have three boxes, each with two compartments.
  - One has two gold bars
  - One has two silver bars
  - One has one gold and one silver bar



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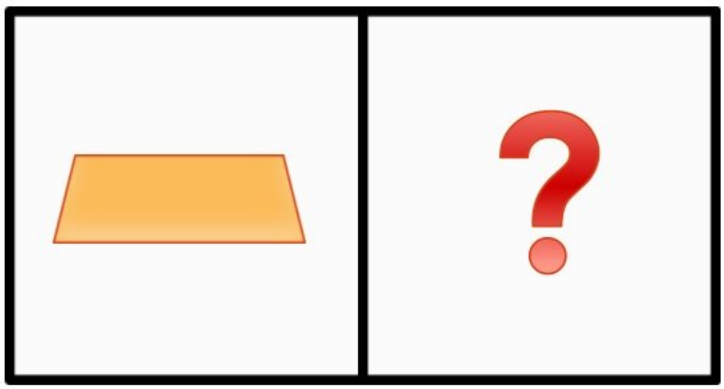
Bertrand's Box Paradox

- You choose a box at random, then open a compartment at random.
- If that bar is gold, what is the probability that the other bar in the box is also gold?



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Your first thought: 1 in 2 chance

- Since there are only two boxes with a gold bar in it, you reason, I must have picked one of those.
- Since one has a gold bar and the other has a silver bar on the other side, the probability that I have another gold bar is ½.
- **Right?**

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WRONG.

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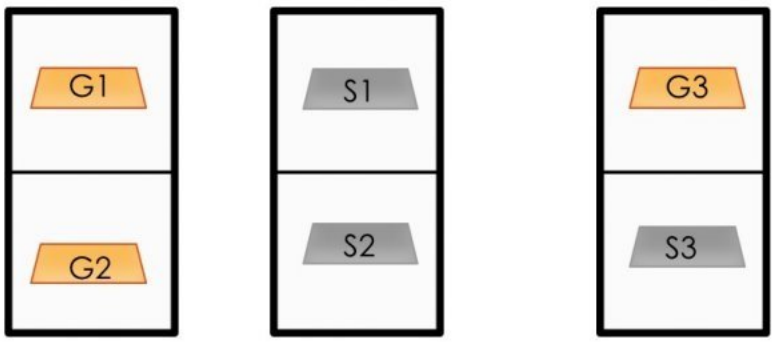
It's actually more complicated than that. To figure out why it's not a 1 in 2 chance, let's label the bars like so:



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Then, let's enumerate all of the possible draws:

You first draw:	The other side:
G1	G2
G2	G1
S1	S2
S2	S1
G3	S3
S3	G3

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Next let's only focus on draws where the first was gold:

You first draw:	The other side:
G1	G2
G2	G1
S1	S2
S2	S1
G3	S3
S3	G3

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So, there's a 2/3 chance that the other side contains a gold bar given that you drew a gold bar on the first try.

- 2 out of 3 times you draw another gold bar, because two out of three times when you picked a gold bar it was either bar #1 or # 2.
- 1 out of 3 times you draw a silver bar, because one out of three times when you pick a gold bar you pick bar #3
- This problem is closely tied to the Monty Hall problem.

You first draw:	The other side:
G1	G2
G2	G1
G3	S3

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