Before we begin:

1) Log in to your PCs using the below details:

Login: XXXXXXXXX
Password: XXXXXXXXX

2) Sign up for an account then log in at:

https://rstudio.cloud/

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How to Outsmart Nobel Physicists

(& Be On Par With Pigeons)

Amy Li & Dr. Elma Akand

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BUT HANG ON...

What even *is* data science?
And why are we here?

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BUT HANG ON...

What even *is* data science?
And why are we here?

> The Monty Hall Problem

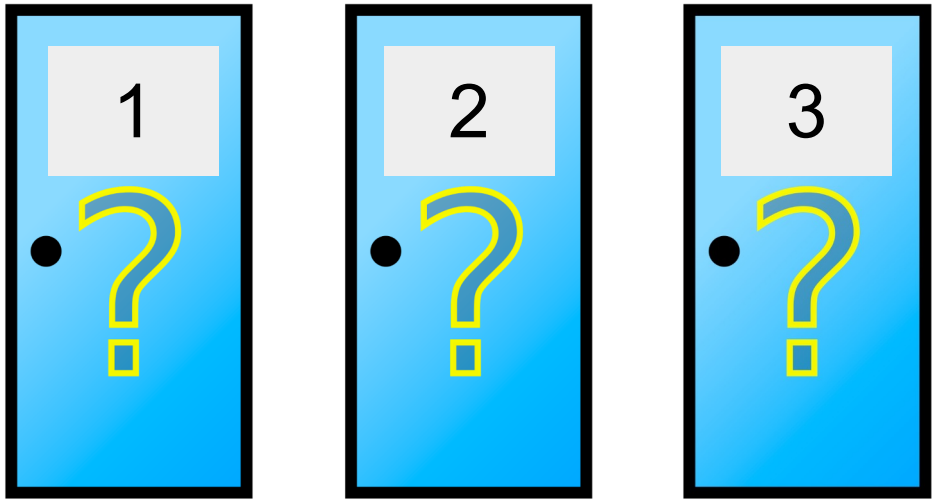
> What simulation is & how to implement it in R

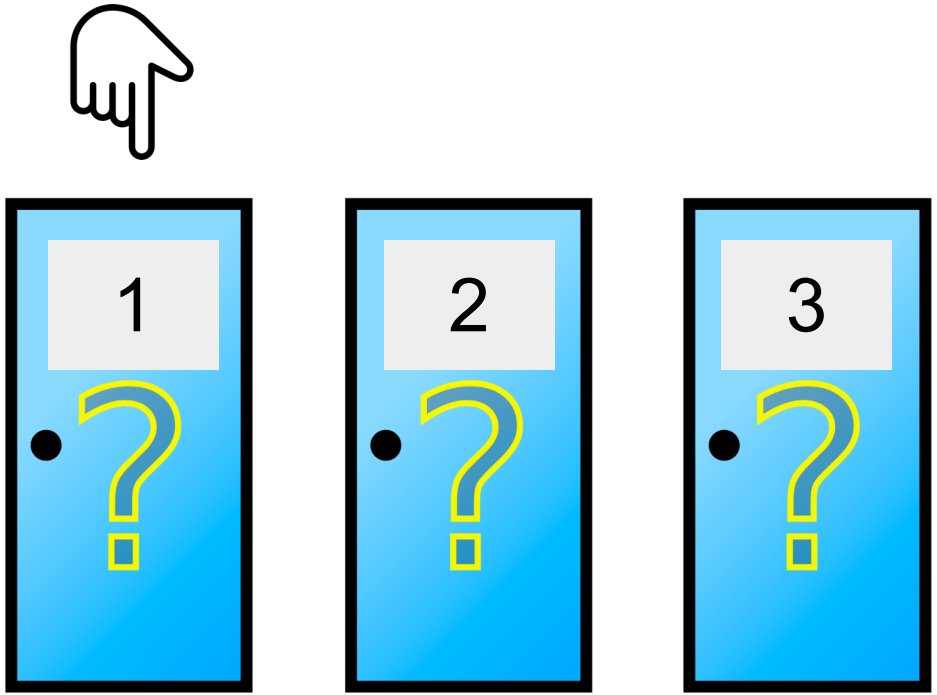
> Verifying your solution using maths

> Challenge: Extending the problem

> What we've learned today, &
what's it all good for?


LET'S
MAKE
A
DEAL


1
?
2
?
3
?


1
2
3
?
?
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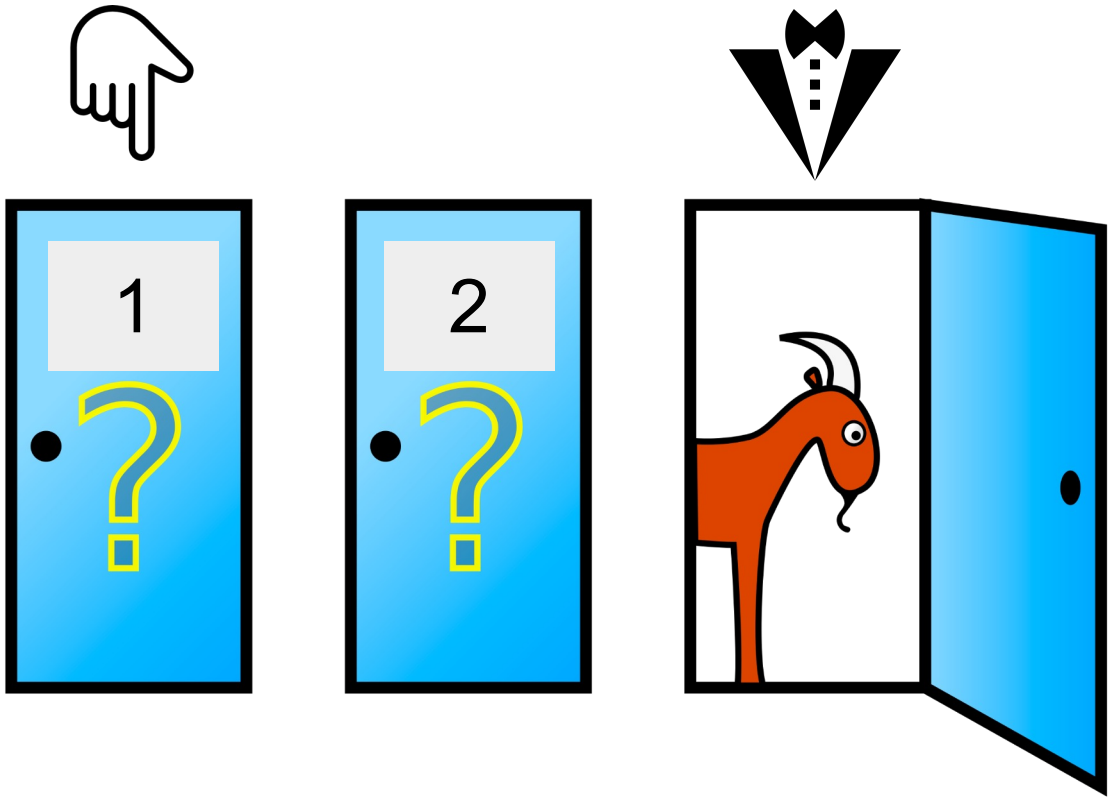
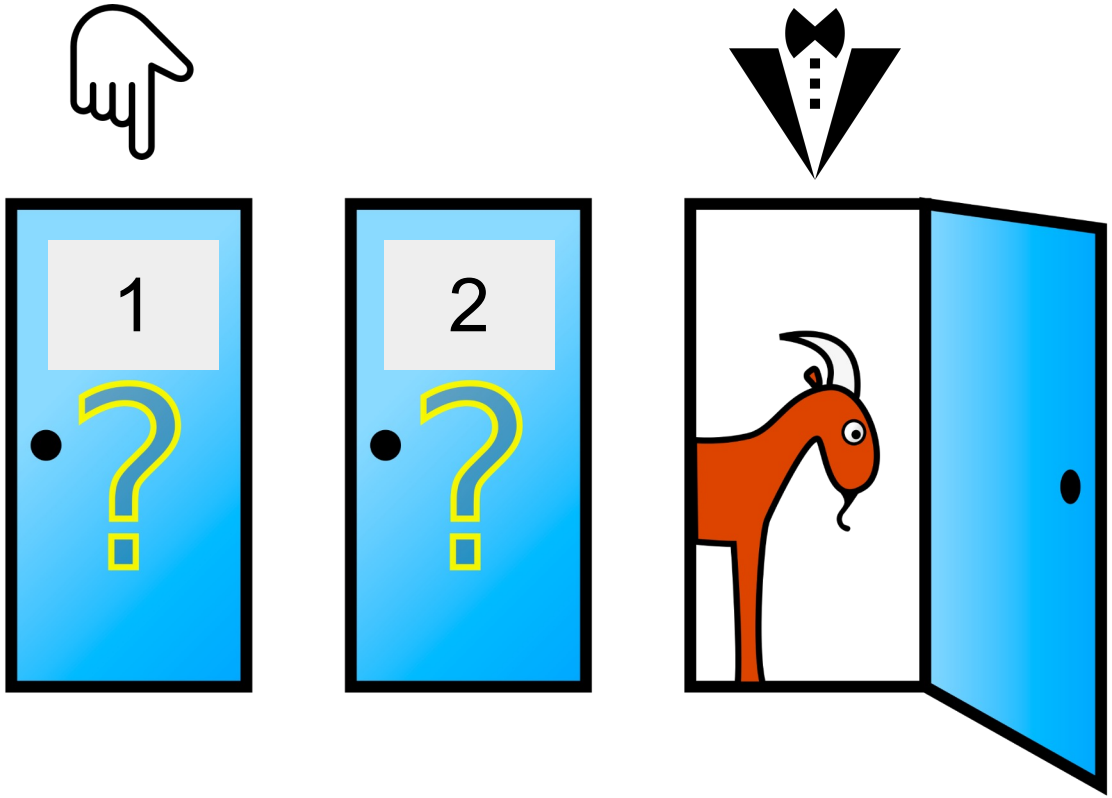
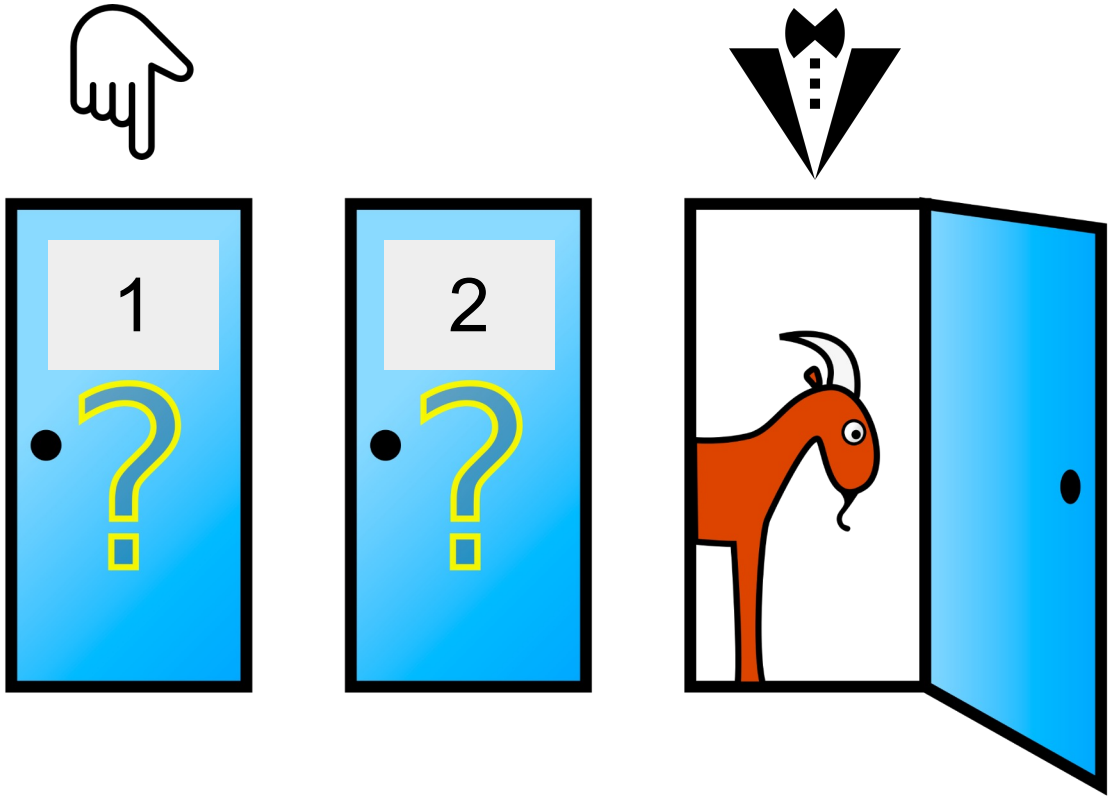

1
2
?
?

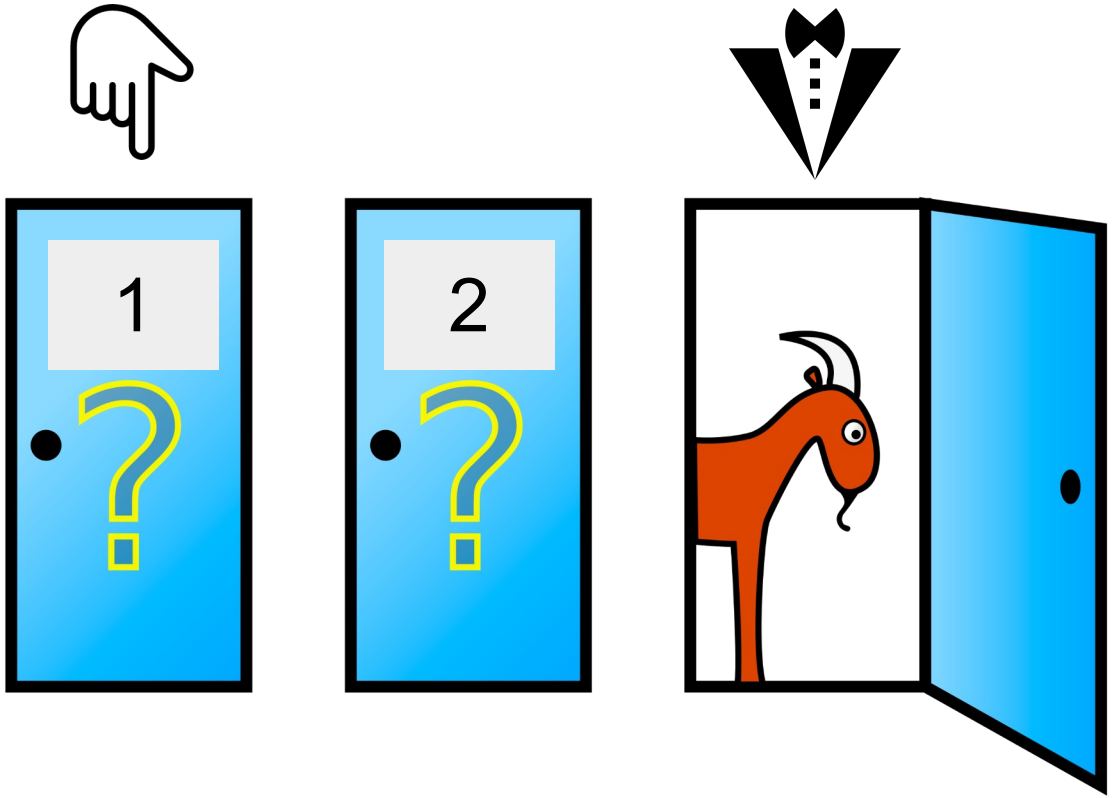


Stay with your door, or switch to the other door?



Stay with your door, or switch to the other door?

VOTING TIME



Answer: Switch??

May I suggest that you obtain and refer to a standard textbook on probability before you try to answer a question of this type again?
Charles Reid, Ph.D.
University of Florida

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REAL-LIFE SIMULATION TIME!

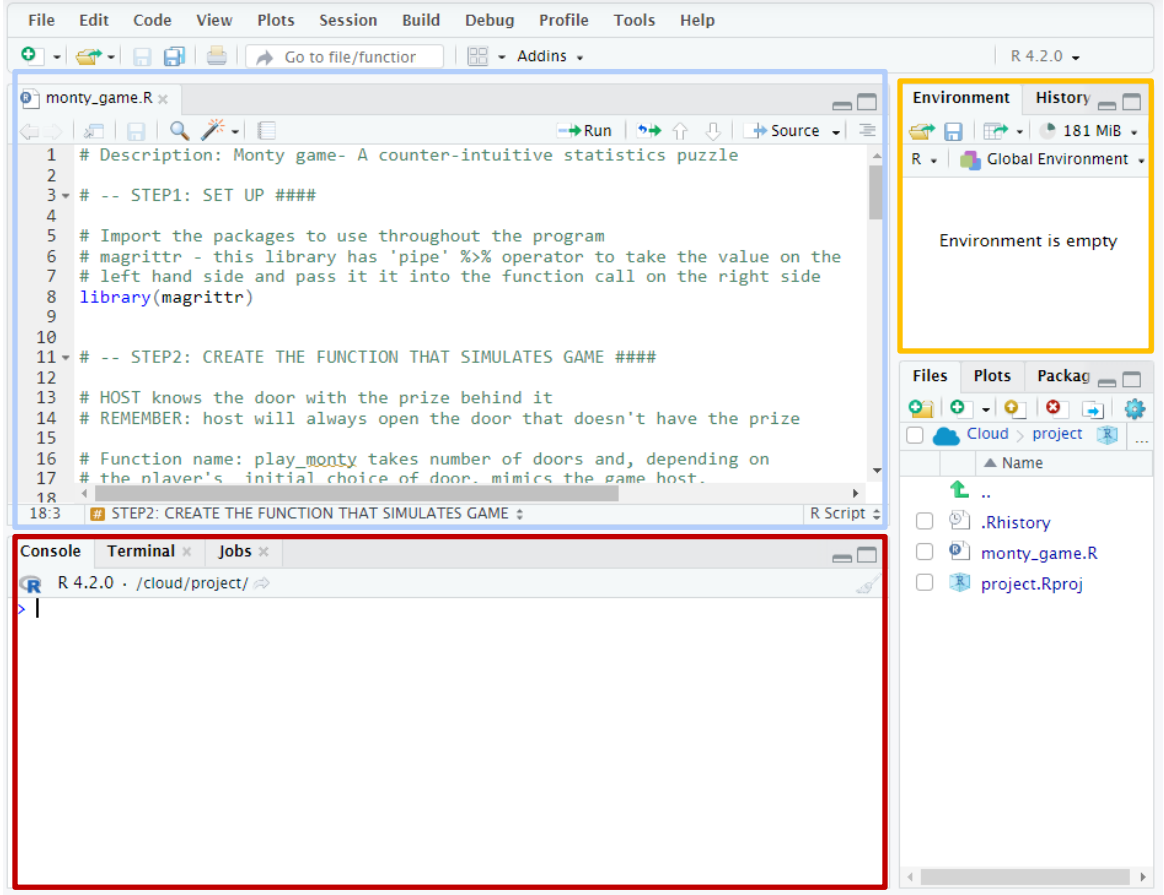
Simulating more repetitions using R

https://rstudio.cloud/project/4209621

In-built script editor

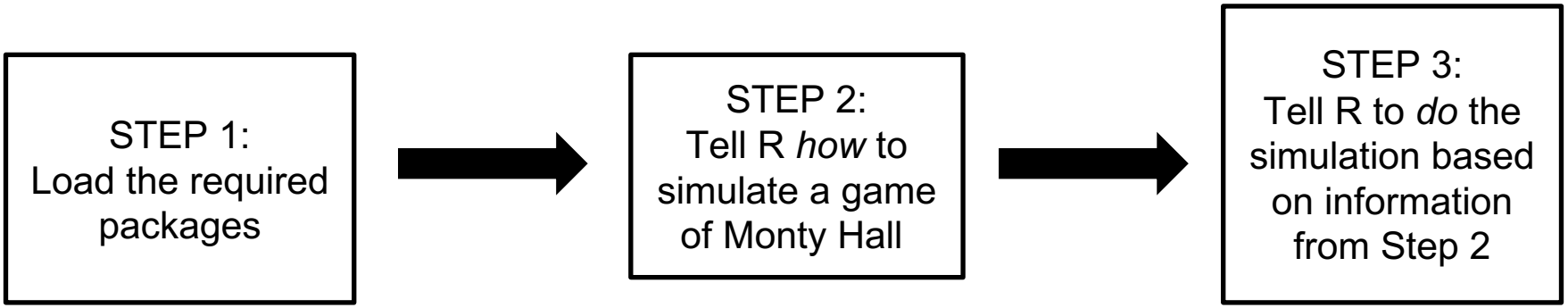
(ctrl+enter to execute a given line)

What code R has executed

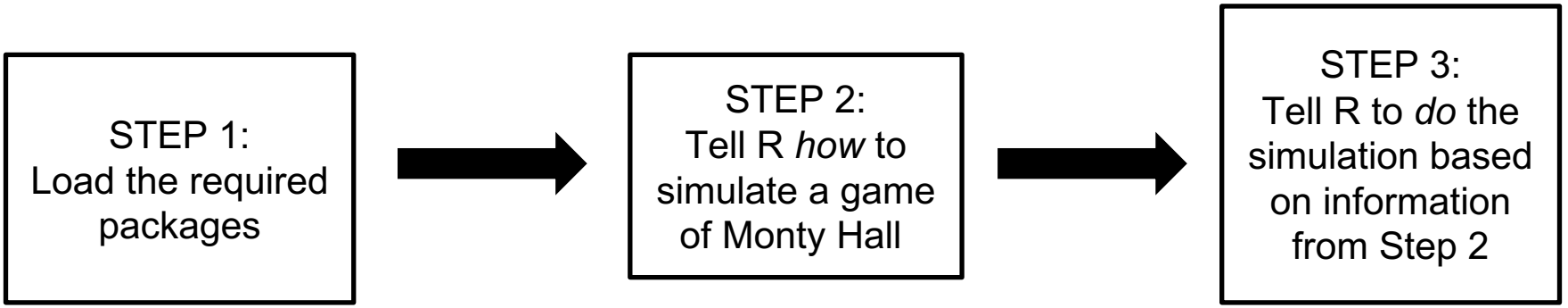


What R has in short-term memory

The Program!


STEP 1:
Load the required packages
STEP 2:
Tell R *how* to simulate a game of Monty Hall
STEP 3:
Tell R to *do* the simulation based on information from Step 2
install.packages("…")
library(…)
play_monty <- …
replicate(…)

The Program!




```
install.packages("…")
library(…)
```

```
play_monty <- …
```

```
replicate(…)
```

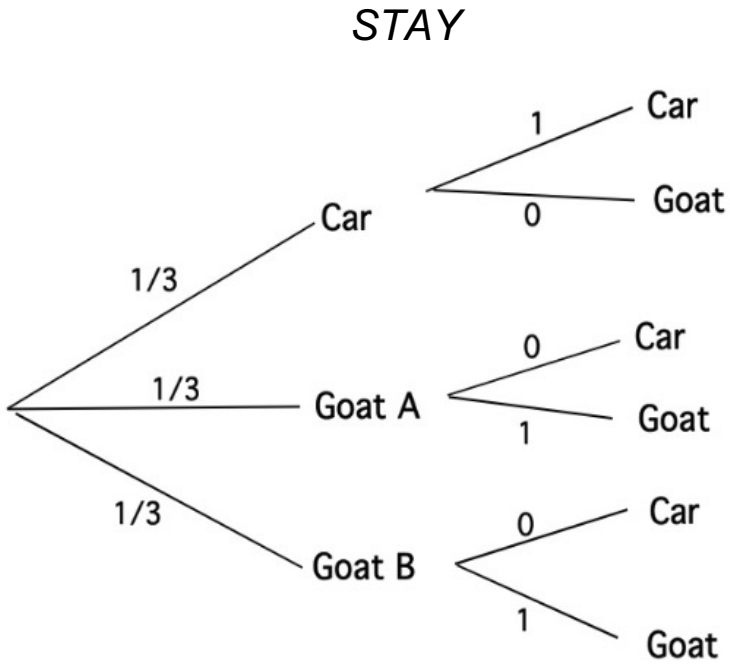
Now verify using maths...

Solution: Probability Tree Diagram

Solution: Probability Tree Diagram

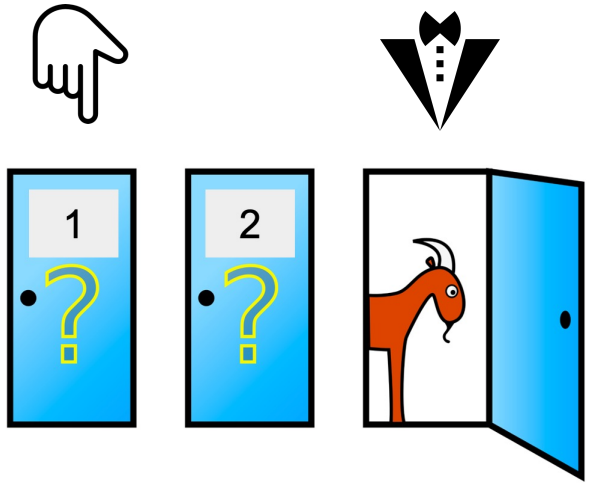
Probability of prize if STAY is

?

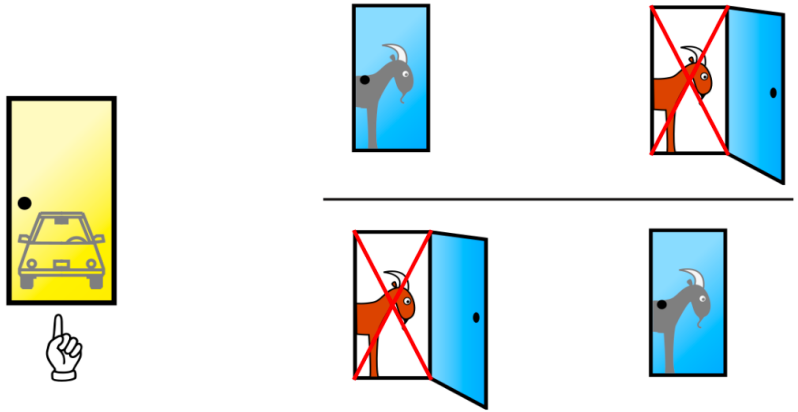


Probability of prize if SWITCH is

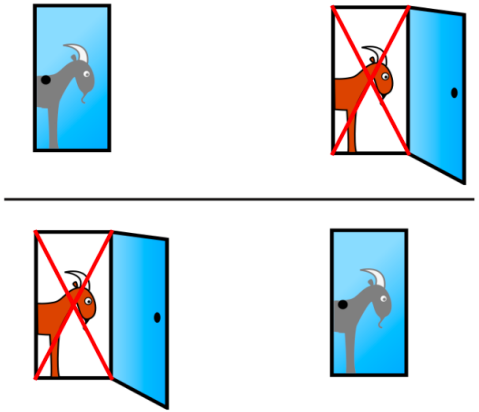
?



Case #1



Case #1

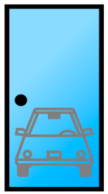


SWITCH

1/3 → Car → 0 → Car

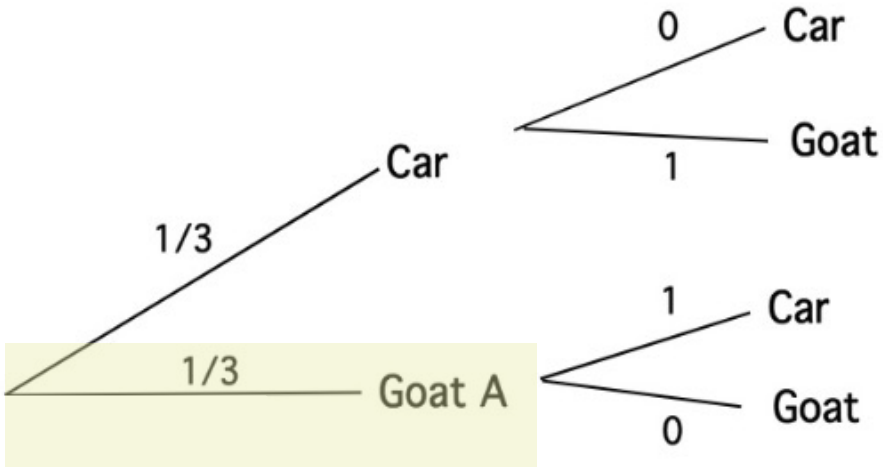
1/3 → Car → 1 → Goat

Case #2



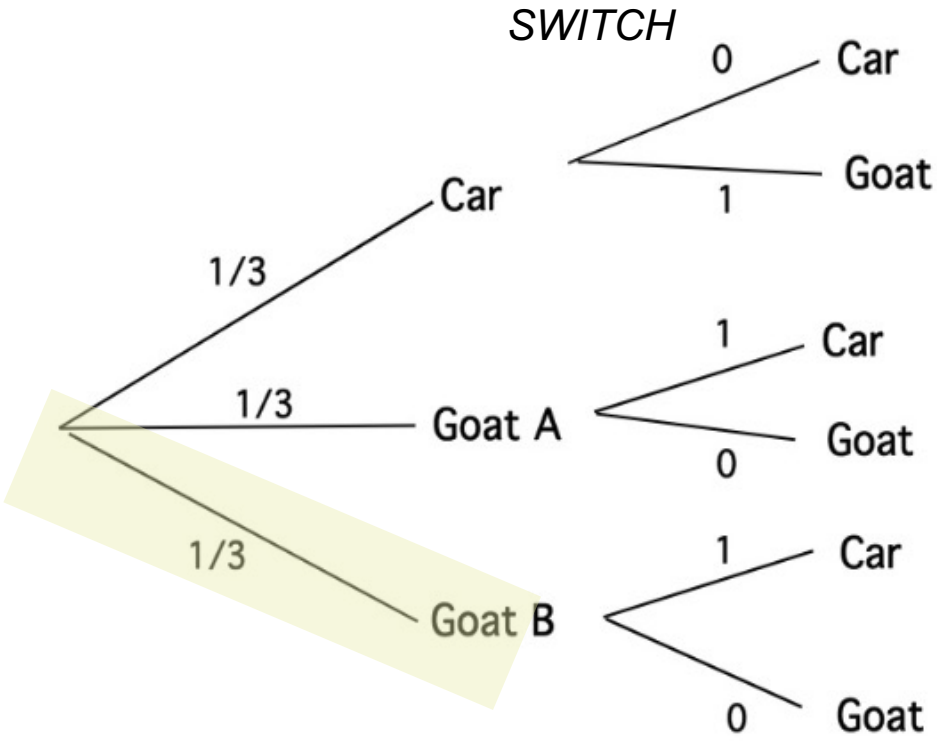
Case #2

SWITCH



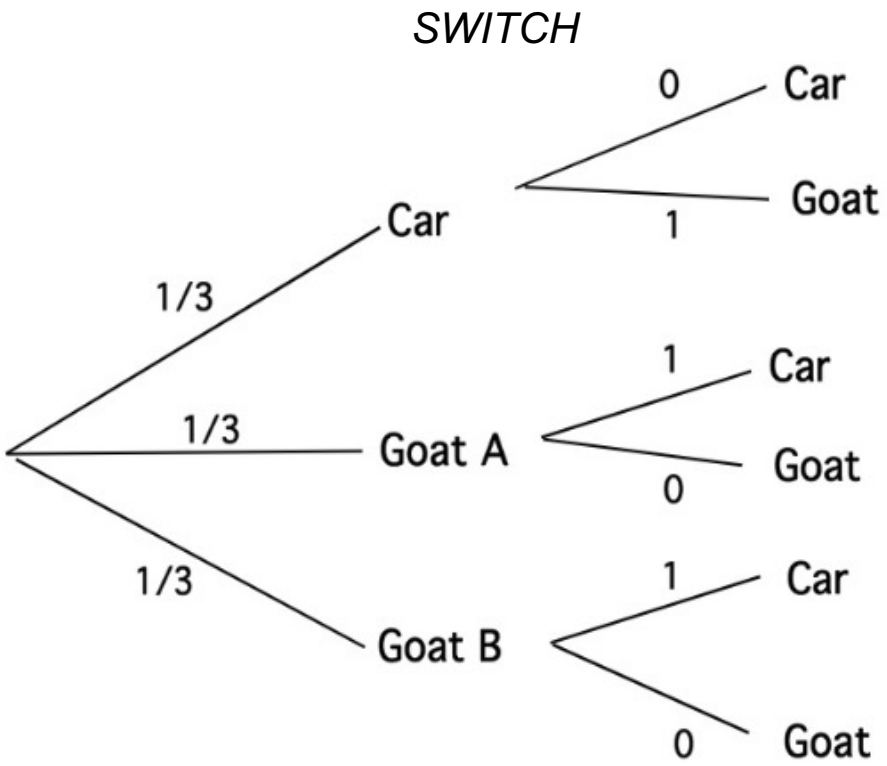
Case #3

Case #3

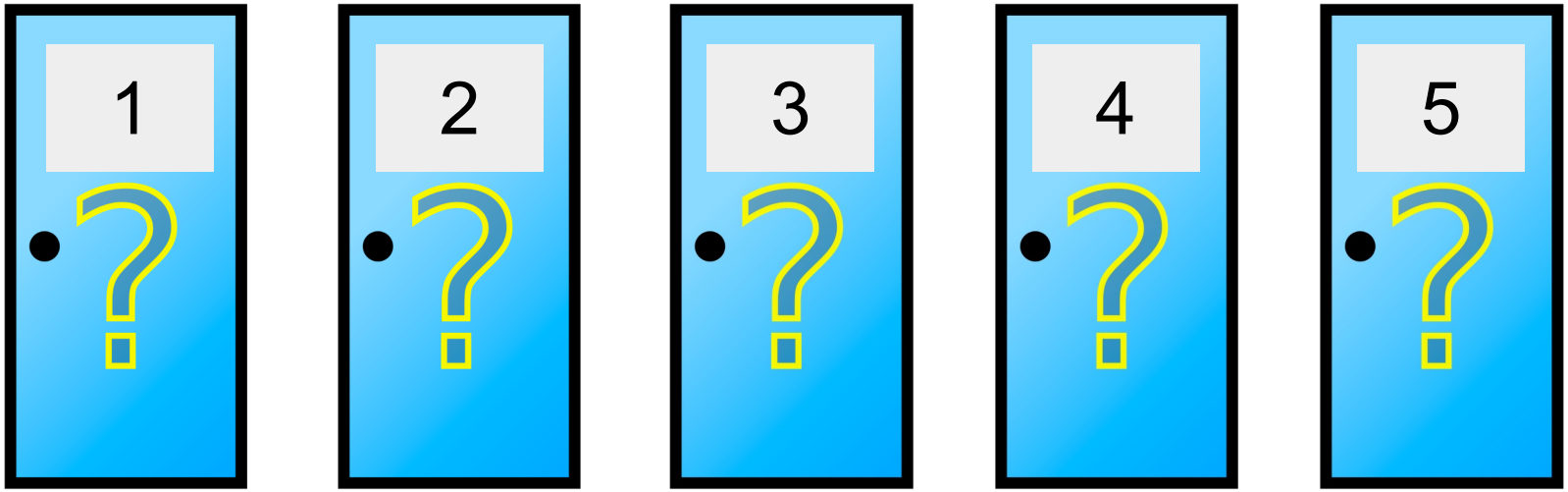

SWITCH
0
Car
Goat
1
Car
1/3
1/3
1
Car
Goat A
Goat
0
1/3
1
Car
Goat B
0
Goat

Probability of prize if SWITCH is

$$\frac{2}{3}$$

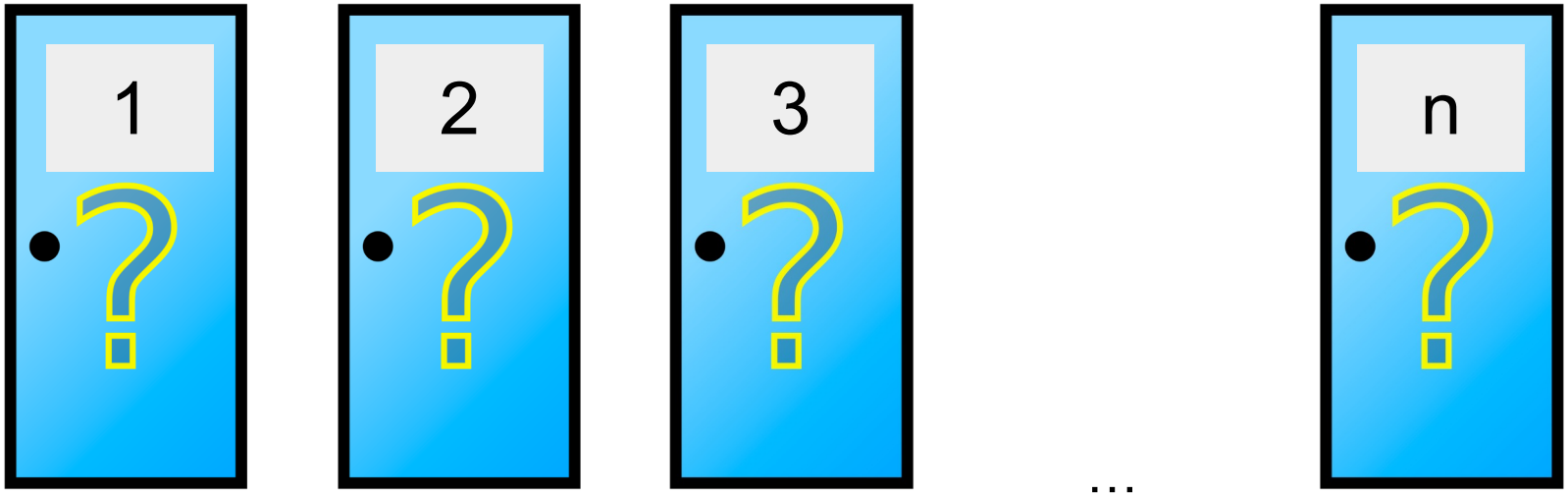


Challenge: What if there are *5 doors*?



Try STEP 4: EXTENSION in R

Challenge: Can you generalise a solution to *n* doors?

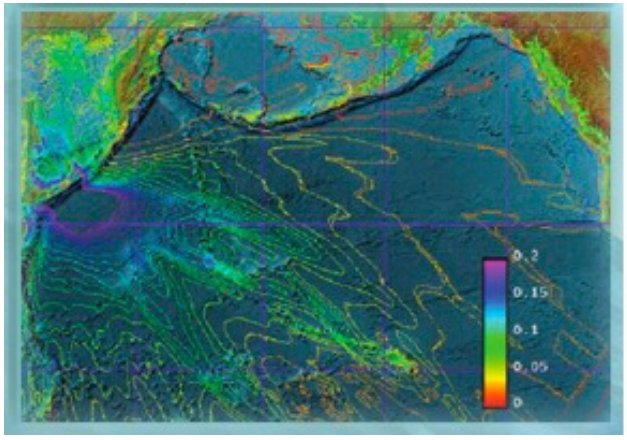


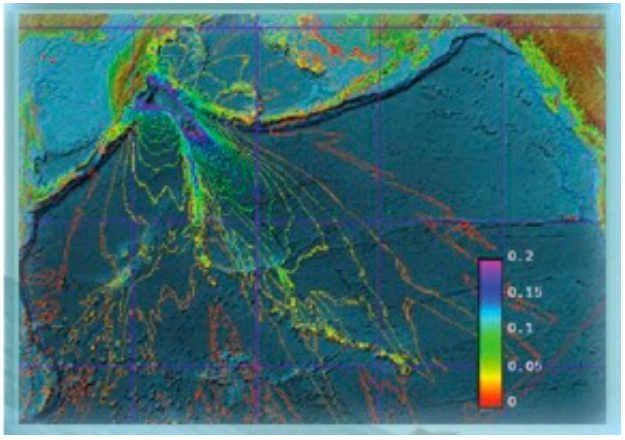
What happens with probability of prize when staying vs. switching as $n \to \infty$?

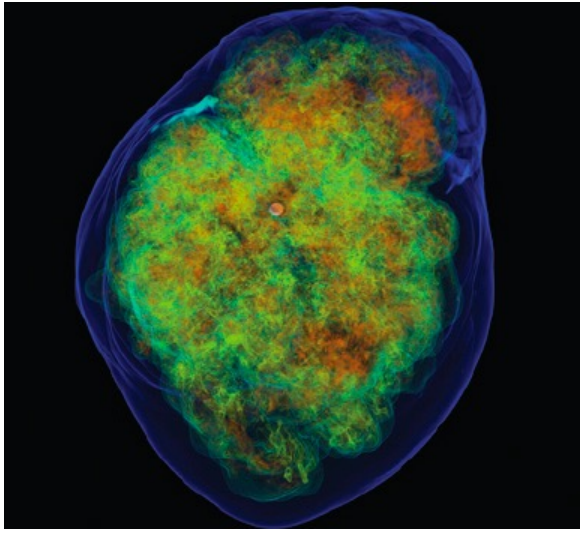
> **Data** helps verify our intuitions

> **Simulations** help us when our data & the lab just isn't enough

> This is a taster of how scientists solve a range of critical, real-life challenges.


0.2
0.15
0.1
0.05
0


0.2
0.15
0.1
0.05
0



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And that's it... for now.

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And that's it... for now.

But adventures lie ahead!

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And that's it... for now.

But adventures lie ahead!

B Sc

B Adv Sc (Hons)

B Adv Maths (Hons)

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Q & A

Proof Using Bayes Theorem

$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)}$$

Let *C* be which door the prize is behind (*C* = 1, 2, 3),
and *H* be which door Monty opens (*H* = 3).

$P(H = 3 \mid C = 1) = 0.5$

$P(H = 3 \mid C = 3) = 0$

$P(H = 3 \mid C = 2) = 1$

$P(C = 1 \mid H = 3) = ?$ $P(C = 2 \mid H = 3) = ?$

$$P(C = 2 \mid H = 3)$$

$$= \frac{P(H = 3 \mid C = 2)\, P(C = 2)}{\sum_{c=1}^{3} P(H = 3 \mid C = c)\, P\,(C = c)}$$

$$= \frac{1 \times \frac{1}{3}}{\frac{1}{2} \times \frac{1}{3} + 1 \times \frac{1}{3} + 0 \times \frac{1}{3}}$$

$$= \frac{2}{3}$$