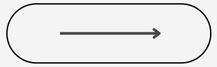
MONTE CARLO SIMULATION
Ramel Cary Jamen

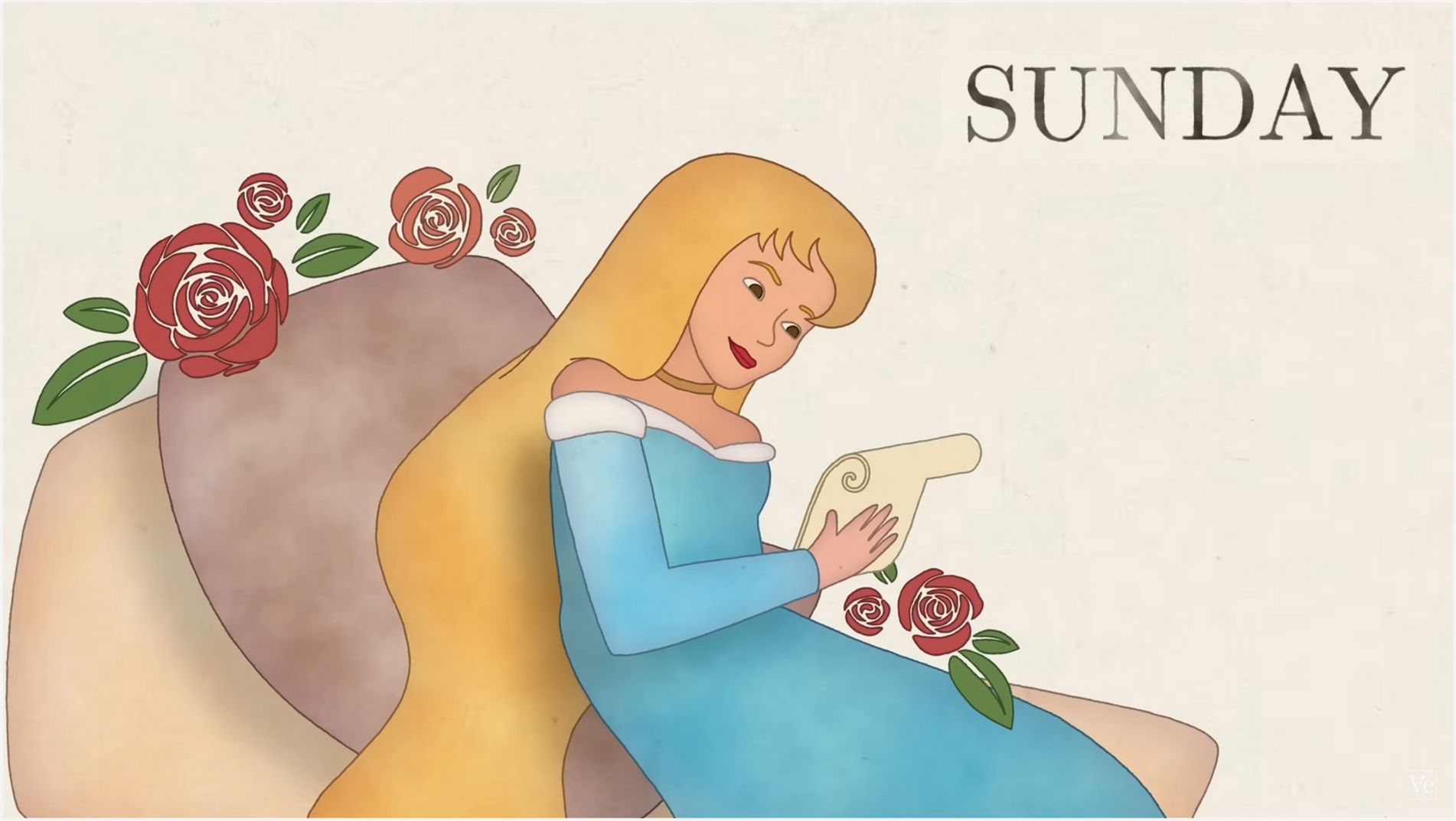
THE SLEEPING BEAUTY PROBLEM

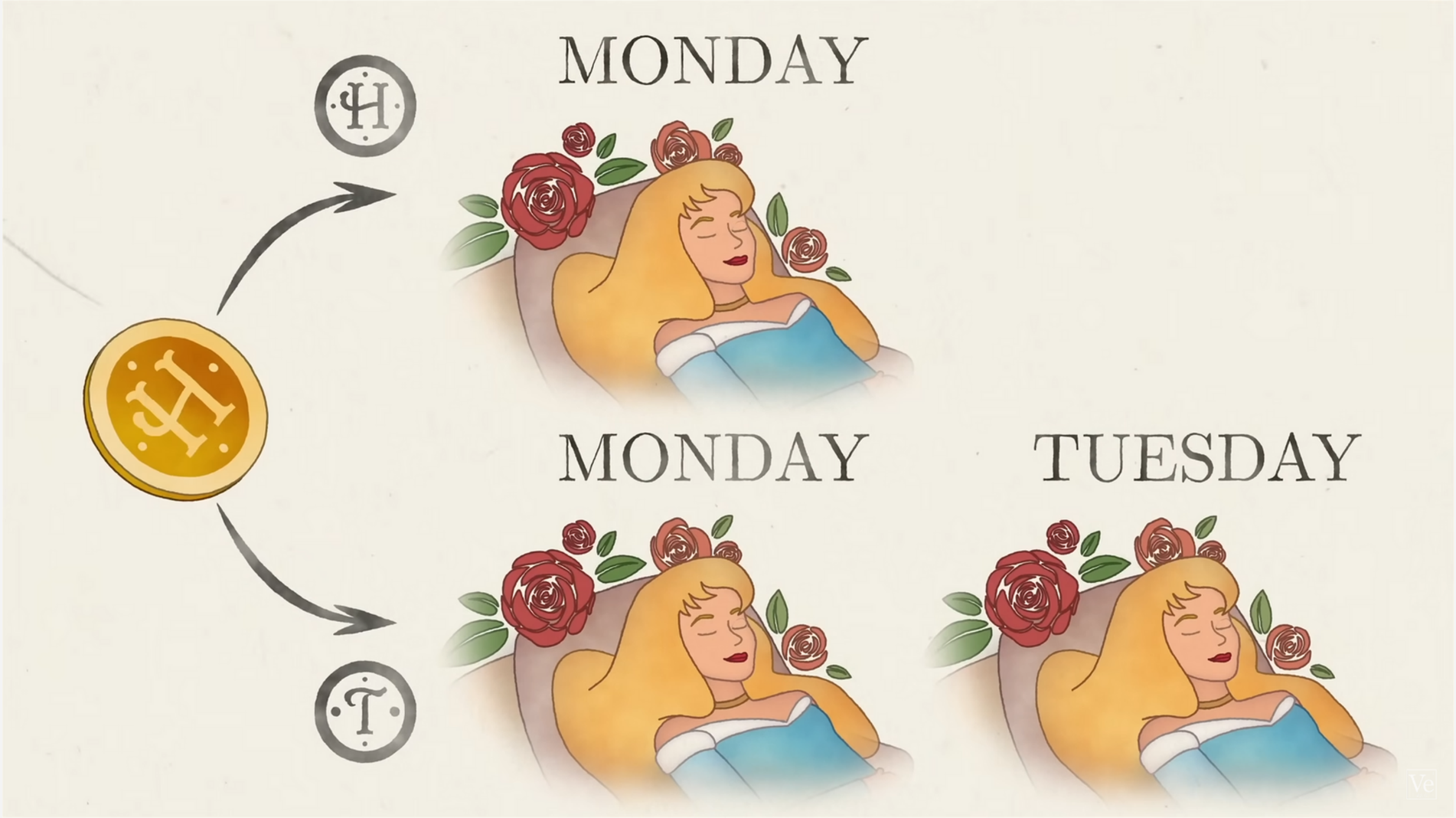
by: Adam Elga

INTRODUCTION

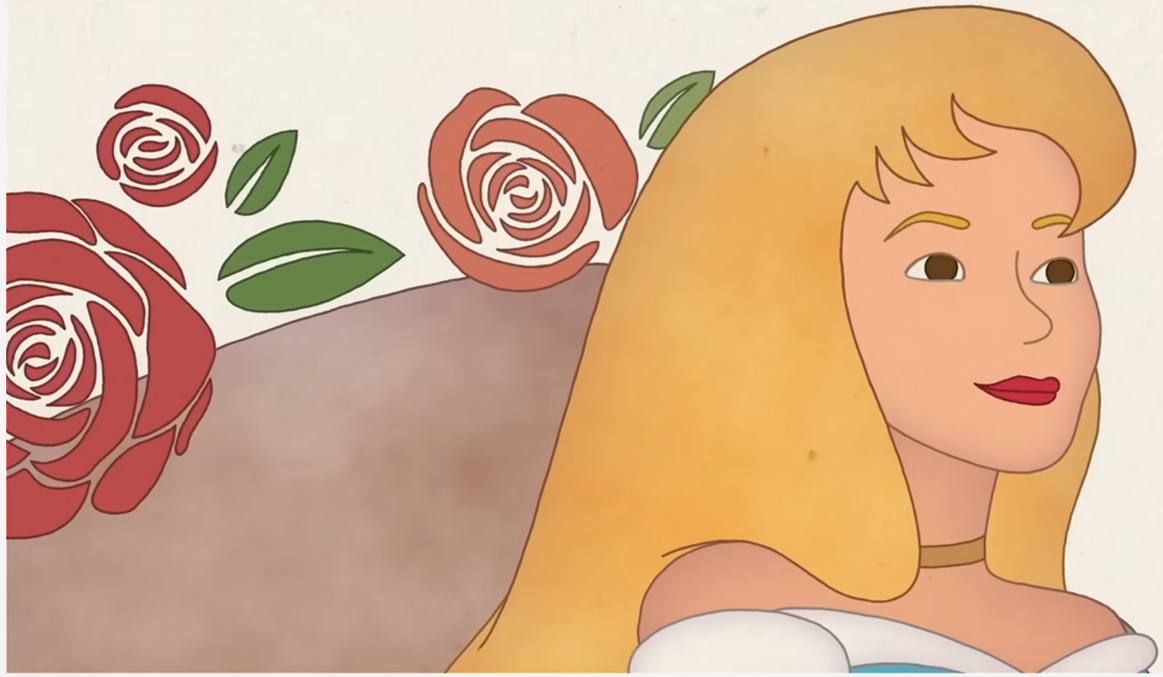
The Sleeping Beauty problem is a puzzle in decision theory in which whenever an ideally rational agent is awoken from sleep, they have no memory of whether they have been awoken before. Upon being told that they have been woken once or twice according to the **toss of a coin**, once if heads and twice if tails, they are asked their **degree of belief** for the coin having come up heads.




SUNDAY


MONDAY
MONDAY
TUESDAY

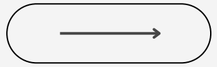
What do you believe is the probability that the coin came up heads?



HALFER POSITION

Sleeping Beauty should assign a credence of 1/2 to the coin landing heads.

The probability of the coin landing on heads or tails, regardless of the rest of the experiment, is always 50 percent.



THIRDER POSITION

Sleeping Beauty should assign a credence of 1/3 to the coin landing heads.

This position asserts that there are three equally likely possibilities:

She wakes up Monday, and heads was thrown.
She wakes up Monday, and tails was thrown.
She wakes up Tuesday, and tails was thrown.

Monday	Monday	Tuesday
Heads	Tails	Tails
48	52	52

MONTE CARLO SIMULATION

Thirder Experimentation of Sleeping Beauty Problem (100,000 runs)

- ₱2000 Money
- Sleeping Beauty bets ₱2 on Sunday at the start of each run
- Each awakening is asked whether the coin came up heads or tails
- Paid ₱3 every time she answers correctly
- Differentiate gains between Halfer and Thirder Positions

PS: Changes may apply to the simulation setup to adapt the rules of the Sleeping Beauty Problem

REFERENCE

Veritasium (2023). https://www.youtube.com/watch?v=XeSu9fBJ2sI&t=345s

Bischoff (2023). https://www.scientificamerican.com/article/why-the-sleeping-beauty-problem-is-keeping-mathematicians-awake/

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THE SLEEPING BEAUTY PROBLEM: A MONTE CARLO SIMULATION

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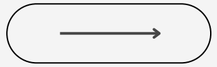
INTRODUCTION

The Sleeping Beauty problem is a puzzle in decision theory in which whenever an ideally rational agent is awoken from sleep, they have no memory of whether they have been awoken before. Upon being told that they have been woken once or twice according to the **toss of a coin**, once if heads and 5-times if tails, they are asked their **degree of belief** for the coin having come up heads.



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METHODOLOGY

Monte Carlo Simulation

- N – Runs (300,000 / 600,000 / 1,000,000)
- Pocket Money – ₱1,000,000
- Sleeping Beauty bets ₱2 on Sunday at the start of each run
- Each awakening is asked whether the coin came up heads or tails
- Paid ₱3 every time she answers correctly
- Differentiate gains between All Heads, Random, All Tails

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FINDINGS

Table 1. Simulation Setup

N - Attempts	Toss Results (H/T) %			
	On Sunday		On Wakeup	
300,000	49.82	50.18	16.70	83.30
600,000	50.02	49.98	16.68	83.32
1,000,000	49,94	50.06	16.63	83.37

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FINDINGS

Table 2. Money Gains at 300,000 attempts

Approach (H/T)%	Number Count in Thousands(K) and Million (M)			
	Bet Win	Bet Lose	Wakeups	Gains
Halfers (16/83)	≈150K	≈748K	≈898K	≈ -148K
Random(49/50)	≈449K	≈448K	≈898K	≈748K
Thirders(83/16)	≈749K	≈150K	≈899K	≈1.6M

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FINDINGS

Table 3. Money Gains at 600,000 attempts

Approach (H/T)%	Number Count in Thousands(K) and Million (M)			
	Bet Win	Bet Lose	Wakeups	Gains
Halfers (16/83)	≈300K	≈1.5M	≈1.8M	≈ -297K
Random(49/50)	≈896K	≈902K	≈1.7M	≈1.4M
Thirders(83/16)	≈1.5M	≈300K	≈1.8M	≈3.3M

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FINDINGS

Table 4. Money Gains at 1,000,000 attempts

Approach (H/T)%	Number Count in Thousands(K) and Million (M)			
	Bet Win	Bet Lose	Wakeups	Gains
Halfers (16/83)	≈500K	≈2.5M	≈2.9M	≈ -499K
Random(49/50)	≈1.5M	≈1.4M	≈3M	≈2.5M
Thirders(83/16)	≈2.4M	≈500K	≈2.9M	≈5.4M

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FINDINGS

- The halfers gain results show an inverse relationship with the number of wakeups, as the number of attempts increases shows undesirable decrease in gains for all simulation.
- A negative gain shows a loss from the simulation from the halfers
- Random choice of guessing from SB upon waking up shows promising results with gains.
- The thirders money gains peaked at ≈5.4M from 1Minitial money, from the 1,000,000 reruns of the simulation.

CONCLUSION

By providing empirical evidence, we contribute to the ongoing discourse surrounding rationality and decision theory.

Thorough assessment to the ideal approach of Sleeping Beauty Problem in terms of gambling

REFERENCE

Elga, A. (2000). Self-locating belief and the Sleeping Beauty problem. Analysis, 60(2), 143–147. https://doi.org/10.1093/analys/60.2.143