INTRODUCTION TO GAME DESIGN

CSD2511 – Week 02

Lecturer . Jonathan Kwek

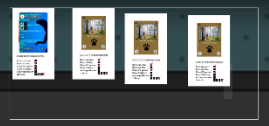
Before we begin

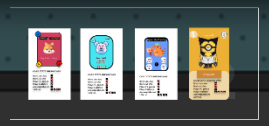
- Use the first 15 minutes to settle in
  - Sign your attendance
  - Log into your workstation
  - Log into Moodle, specifically CSD2511 module
  - Log out from your game, application, communication, chats
  - Prime yourself physically for the next hour, ie. Finish your food, fill up your water, visit the restroom, get comfy
  - Prime yourself mentally for the next hour, ie. Recall what happened during last week's session, put a save point on any ongoing conundrums, meditate on what to do this morning

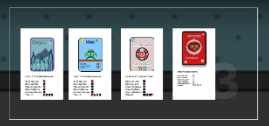
Module Matters

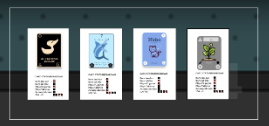
- Team Formation
  - Teams will be finalised by Sunday
  - Get into one early, start discussing asap
- Fluxx

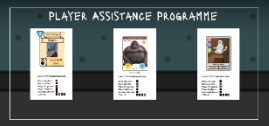
Module Matters

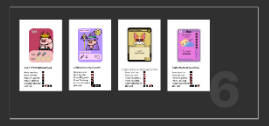


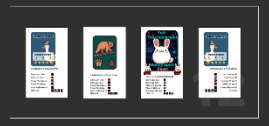


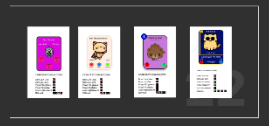


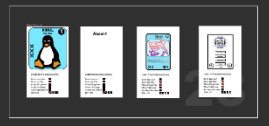


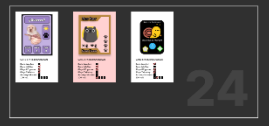












Recap

Tools:

- Paper Prototyping equipment:

Recap

Digital Tools:

- FIGMA - https://www.figma.com/
- Tabletopia account: https://tabletopia.com/
- Boardgame Arena account: https://boardgamearena.com/join

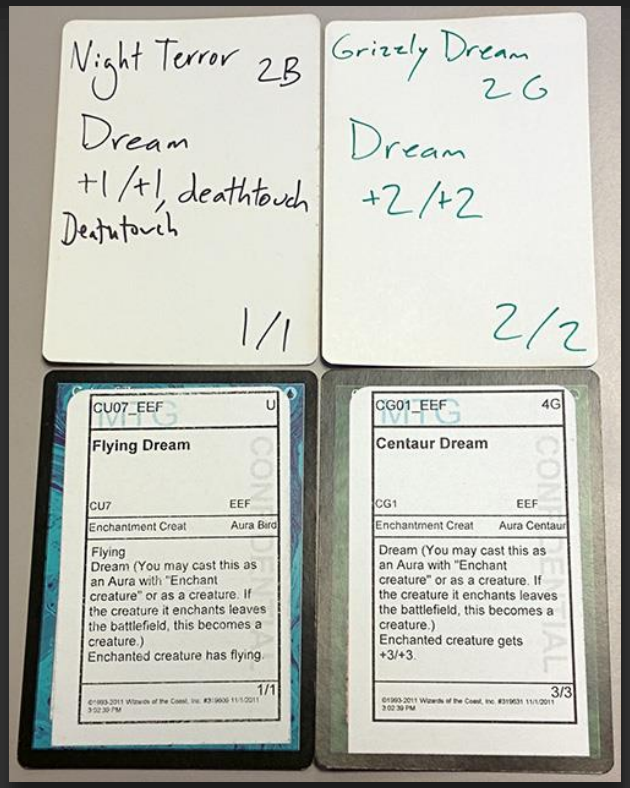
Other tools:

- Screentop : https://screentop.gg/
- Tabletop Simulator (SGD$20, 50% during sales)
- OBS Studio: https://obsproject.com/

Recap

Tabletop games help you understand pure design

- Not hidden by art or programming
- Bad gameplay mechanics reveal themselves very quickly



Recap

Tabletop games enforce 3 core principles of game design:

What is the Player's **OBJECTIVE**?

- It should be clear, quantifiable and easy-to-understand

What are the **MECHANICS** for the players to gain their objective?

- The fewer mechanics the better, and they must be clearly linked to the player's objective

What is the **GAME LOOP**?

- Games progress through update loops, where the mechanic can be used, executed and evaluated for results

Assignments

Prototype A – AN ADVENTURE IN 40 CARDS

- Group Work – 4 team members (*assemble by beginning of Week 2*)
- Pitch and prototype a solo(*1 player*) card game that takes place within a modern(*2023*) context(*please define*)
  - 1x 4 panel narrative pitch
  - 1x A4 page rules and setup
  - 40x card deck
  - Dice and tokens allowed, no more than 20 in total
  - No maps/board allowed; game is designed around mechanics and choices
  - Individual - 2x card DLC per team member (total 8)
  - More details in separate doc
- Submit by end of Week 5 (FIGMA/MOODLE)
- Live presentation and recording in Week 6

RANDOMNESS IN GAMES

Recap

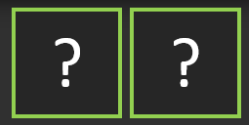
Let's Play – EVEN MINUS ODDS

- Each player has six 6-sided dice. There are ten counters in the middle.
- Player with the most counters at the end of the game wins
- During their turn, each player will roll all the dice
- The total sum of the ODD dice values is deducted *from* the total sum of the EVEN dice values
- If you have a positive result, take that many counters from the middle
- If you have a negative result, return that many counters to the middle
- The game ends when no more counters remain in the middle

Let's Play – SHIP CAPTAIN CREW

- Five 6-sided dice (5d6) for each player
- Player with the most points at the end of 3 rounds wins
- Player gets to roll dice at least once, and up to 3 times per round
- For the first roll, player must roll ALL the dice
- After which, player decides which dice to roll, and which to "freeze", or whether to end the round
- The numbers "6", "5" and "4" must appear and be "frozen", before points can be tabulated
- Once "6,5,4" have been assembled, the remaining two dice values are added for points
- The round ends after 3 rolls, or when the player ends the round

Must have



Sum of these two = points

Luck? Skill? Illusion of Control?

How old is Nintendo?

1889, hanafuda card company

“Nintendo” assumed to mean “leave luck to heaven”

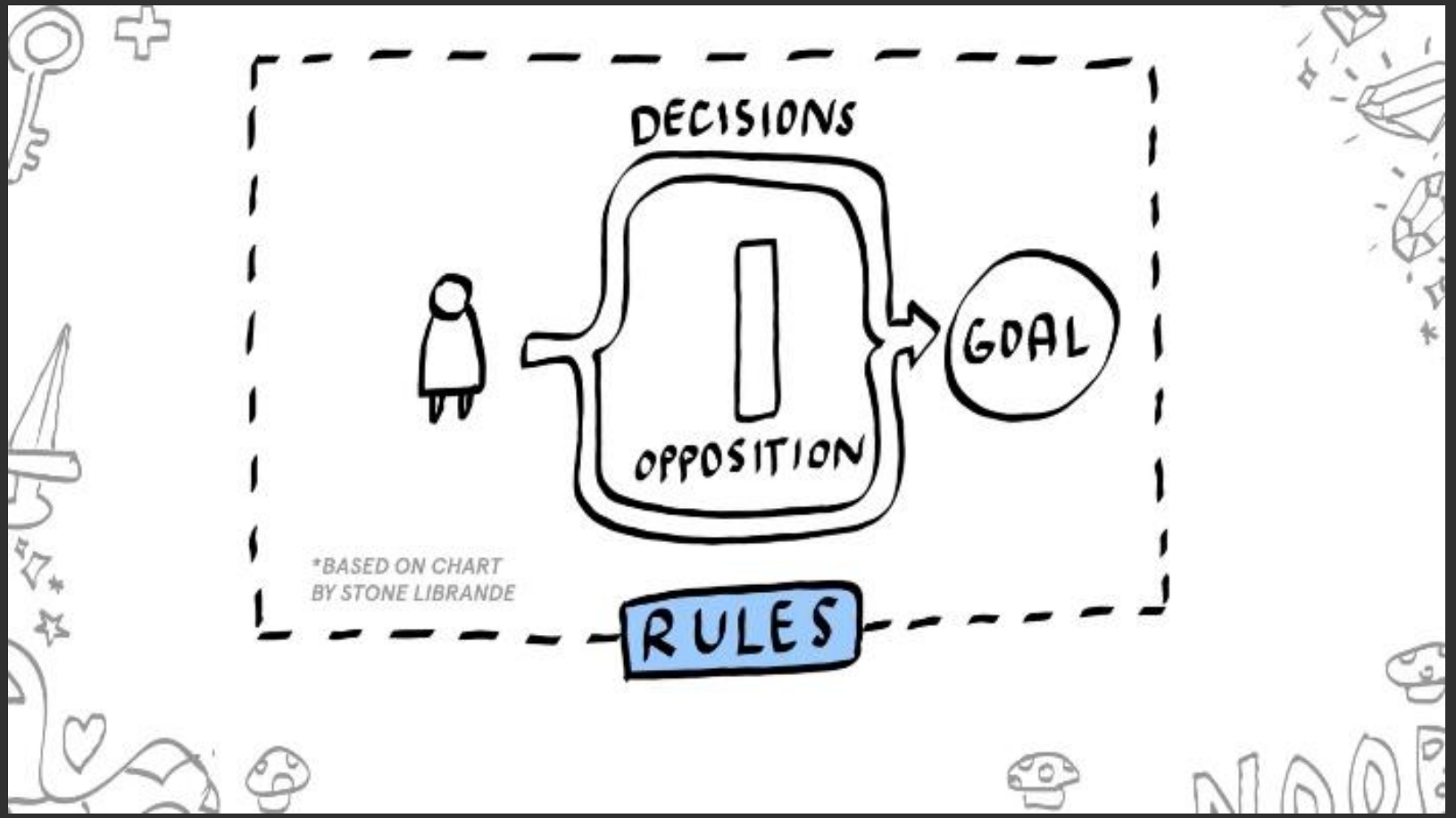
What does having “luck” mean?

What does having “luck” mean?

What does having “luck” mean?

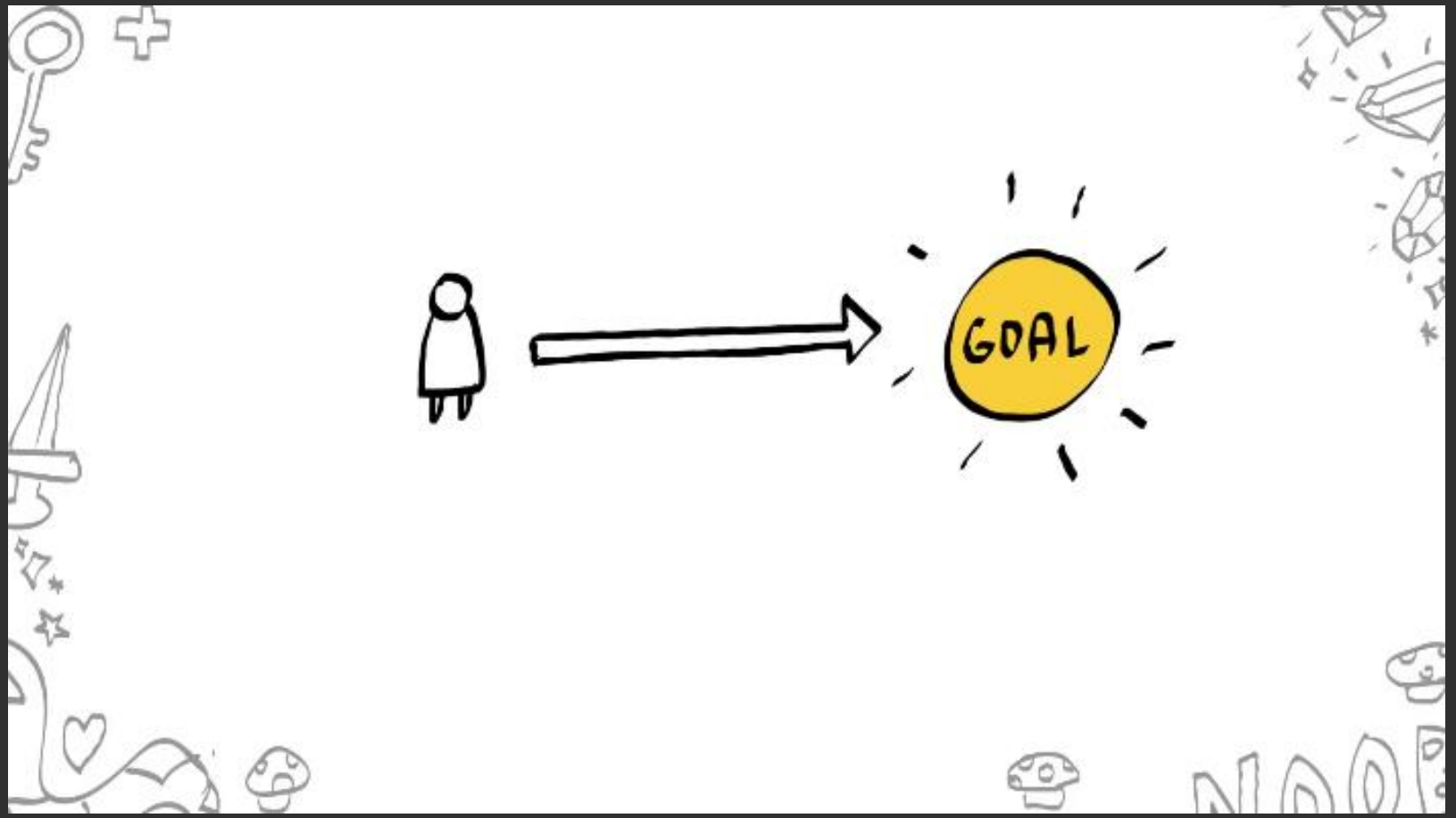
What does having “luck” mean?

What is a “Game”?



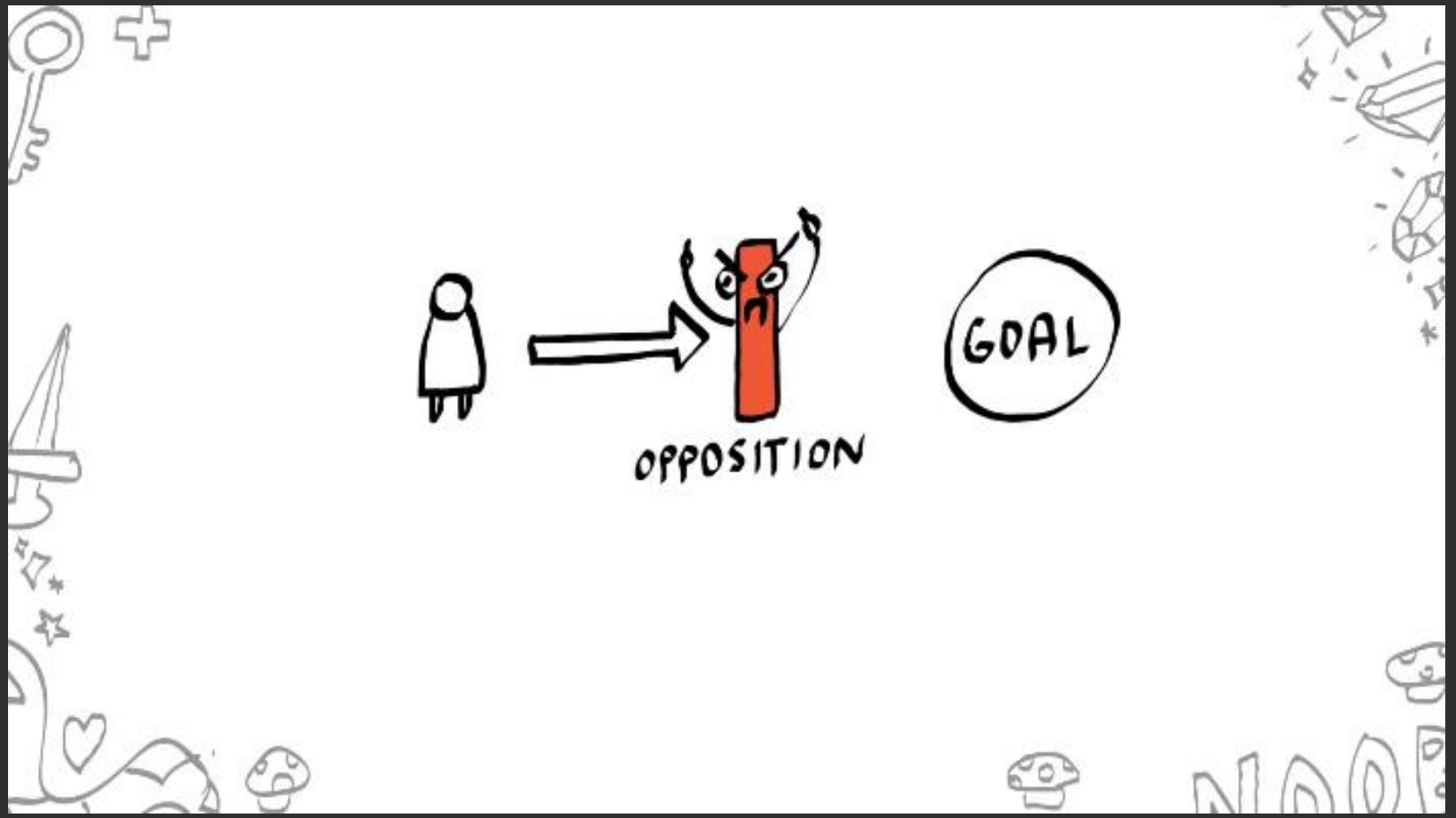
- Stone Librande, https://en.wikipedia.org/wiki/Stone_Librande
- So you wanna make games?? https://youtu.be/yYYtBFSxoCg

What is a “Game”?



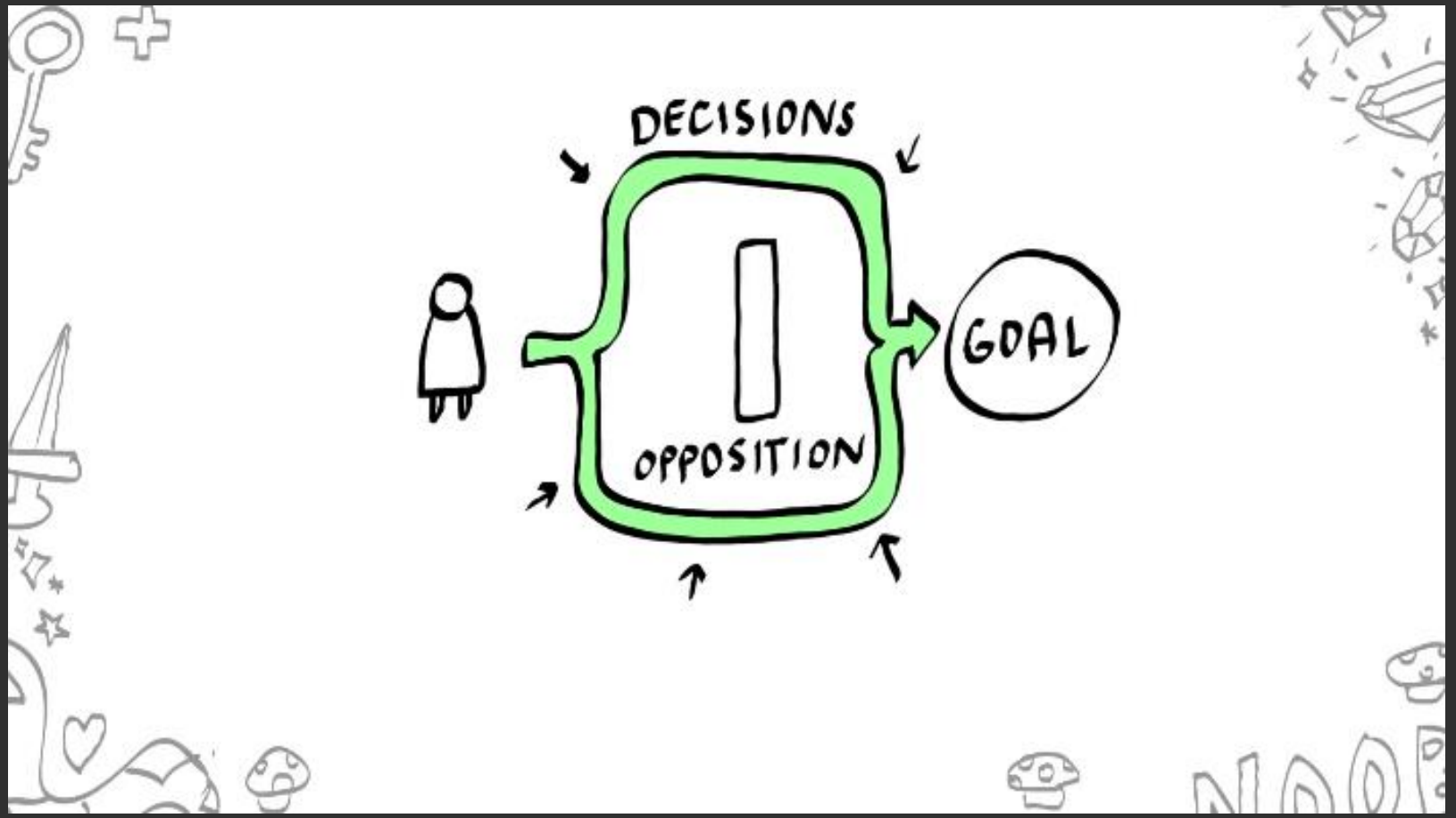
In a game, there is often a simple, clear goal for the player to achieve

What is a “Game”?



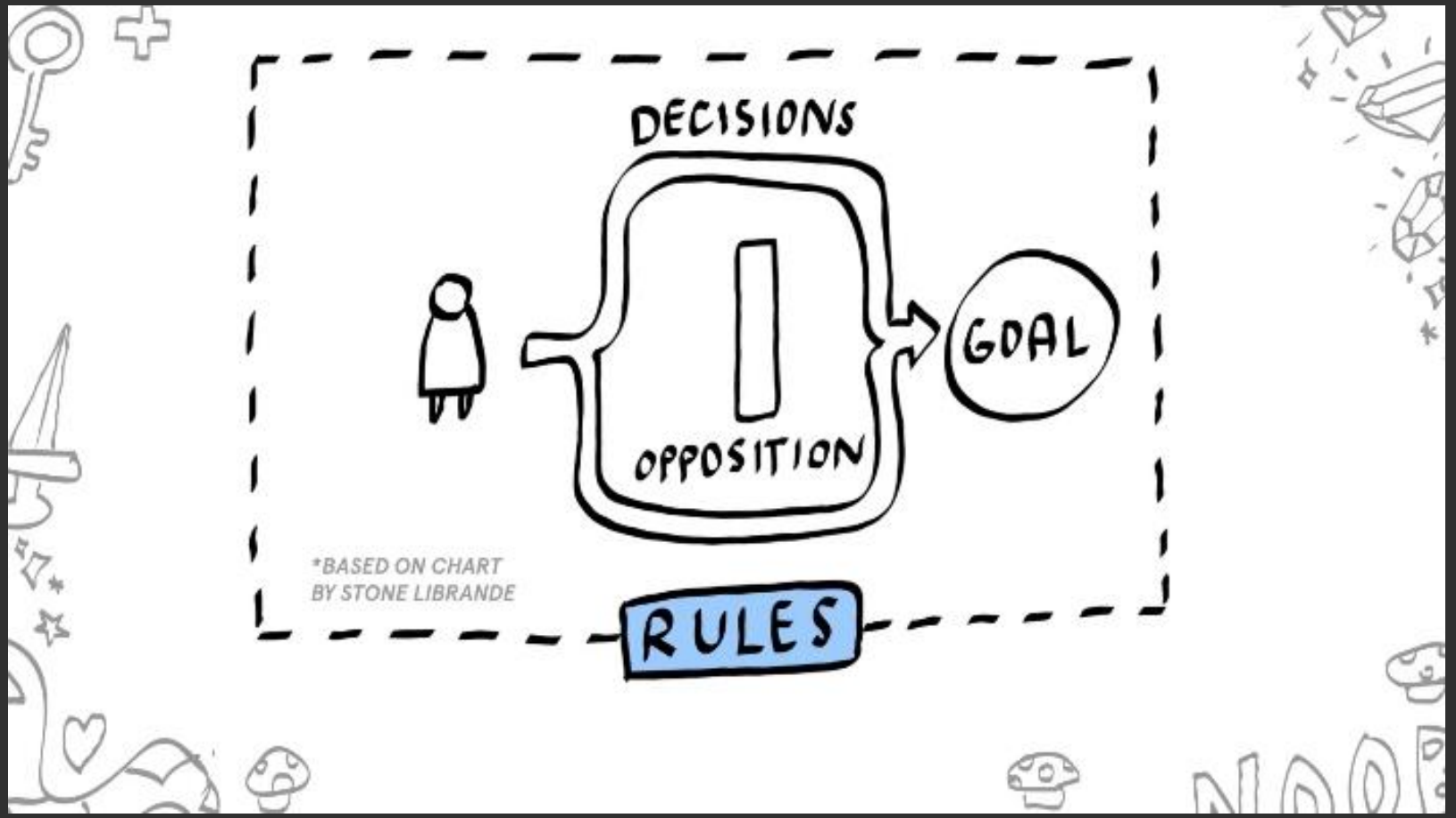
However, there must be some form of opposition to achieving that goal, or the experience will be over quickly.

What is a “Game”?



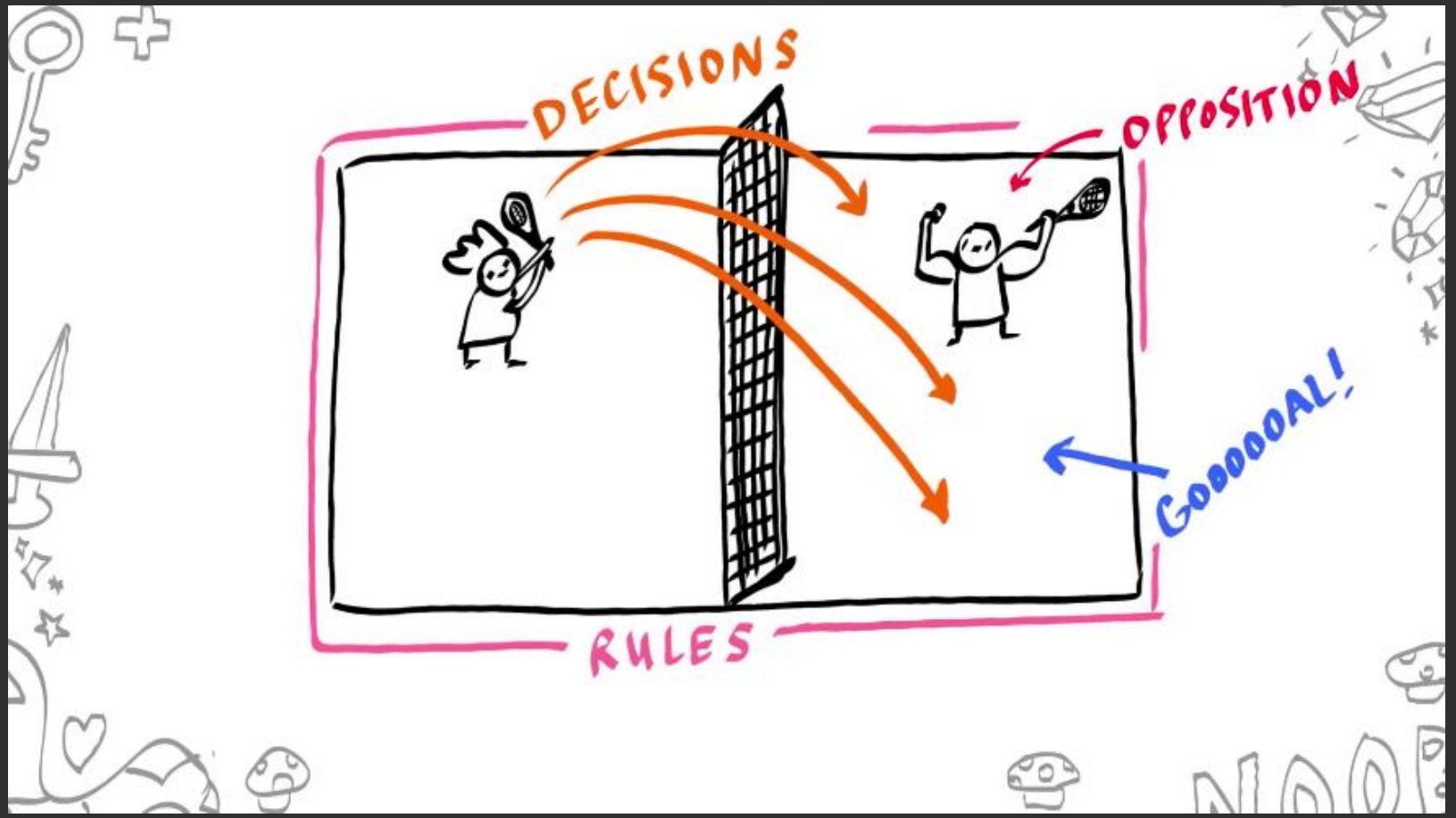
Decisions must now be made by the player on what actions to take, in order to overcome or bypass the opposition.

What is a “Game”?



All of this takes place within a framework of rules that govern what is possible and otherwise.

What is a “Game”?



One example of this could be a game of tennis!

What is a “Game”?

Another example of this could be a game of chess!

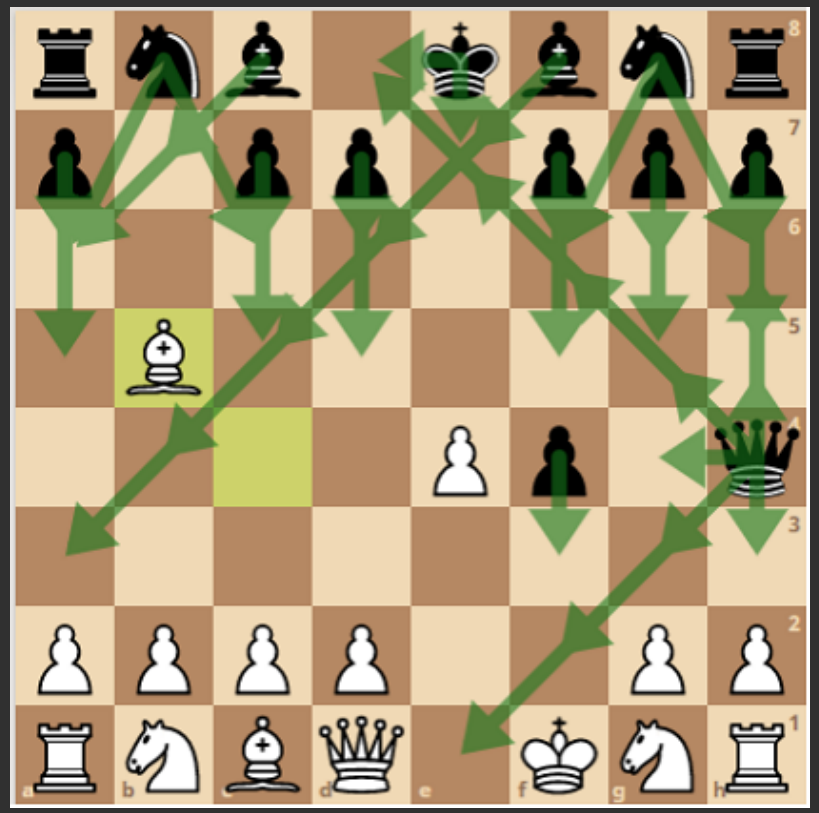
Randomness in Games

- Deterministic
- Stochastic

Randomness in Games

Symmetrical, Equal, Perfect information

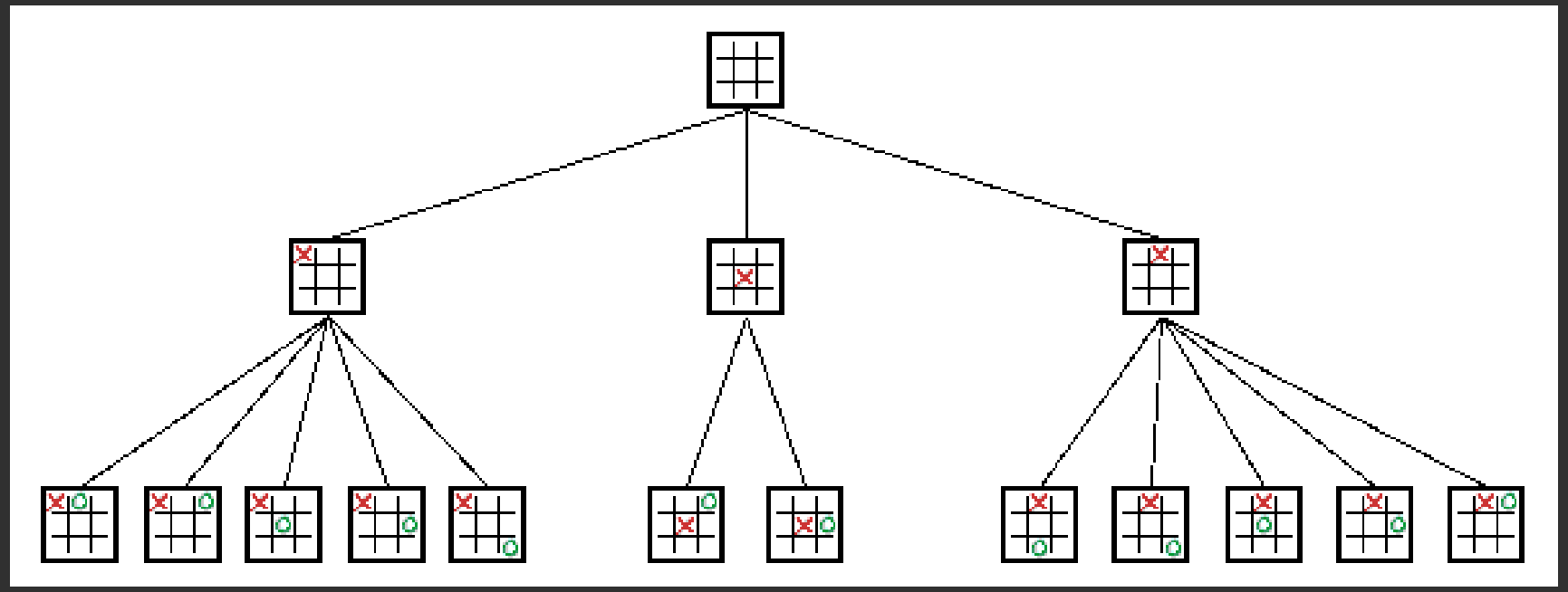
Randomness in Games



However large, there will be a fixed number of possible moves that your opponent can make. It is possible to predict 5, 10 moves ahead if the board state is simple enough

Randomness in Games

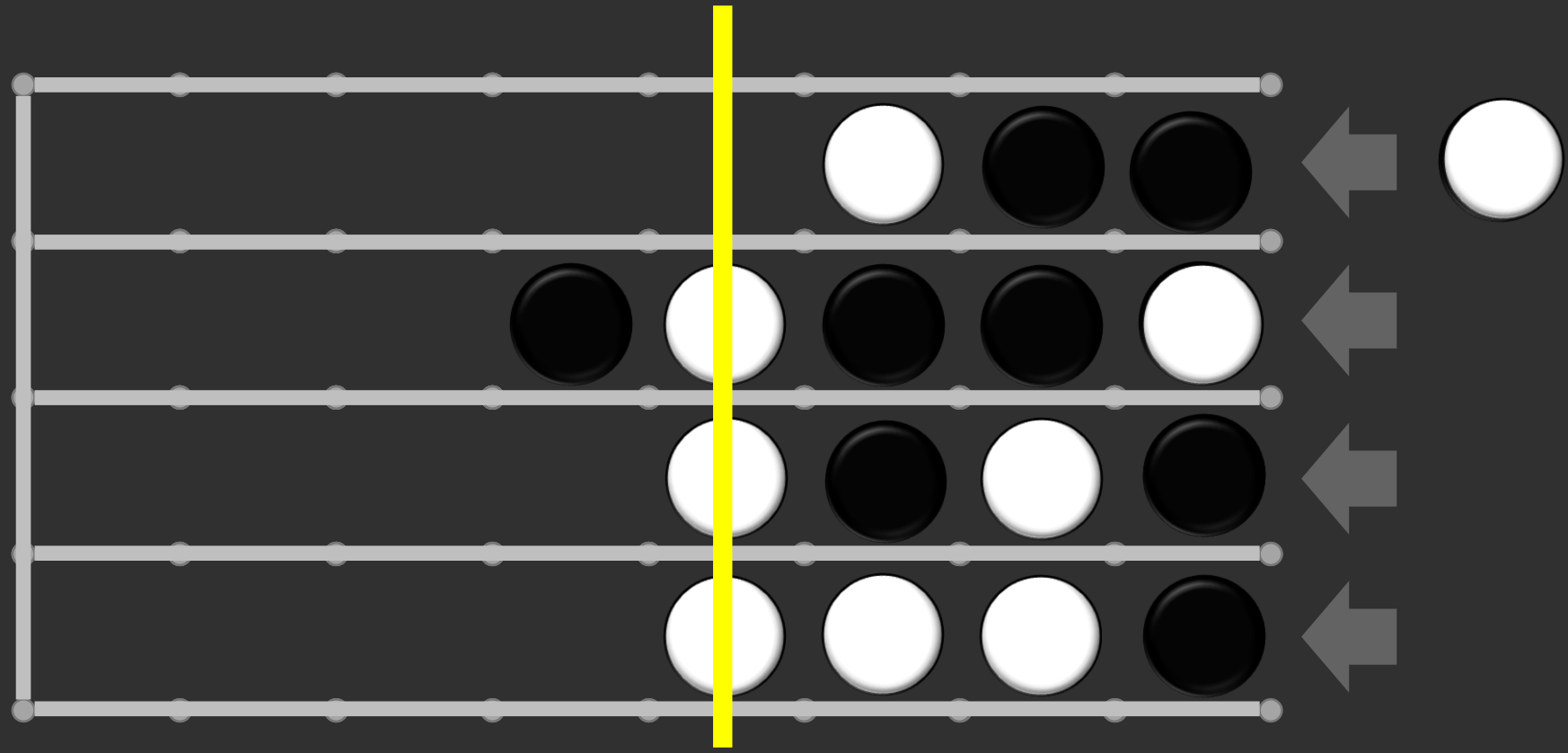
- Deterministic Games
  - No randomness
  - When played with the same choices/actions, the outcome will be entirely identical, eg. Chess, Tic Tac Toe



Randomness in Games

- Deterministic Games
  - No randomness
  - When played with the same choices/actions, the outcome will be entirely identical, eg. Chess, Tic Tac Toe
  - Favours strategy, competitive play and logical thinking
    - *Done badly, the game may be bland, boring, predictable, even exploitable*

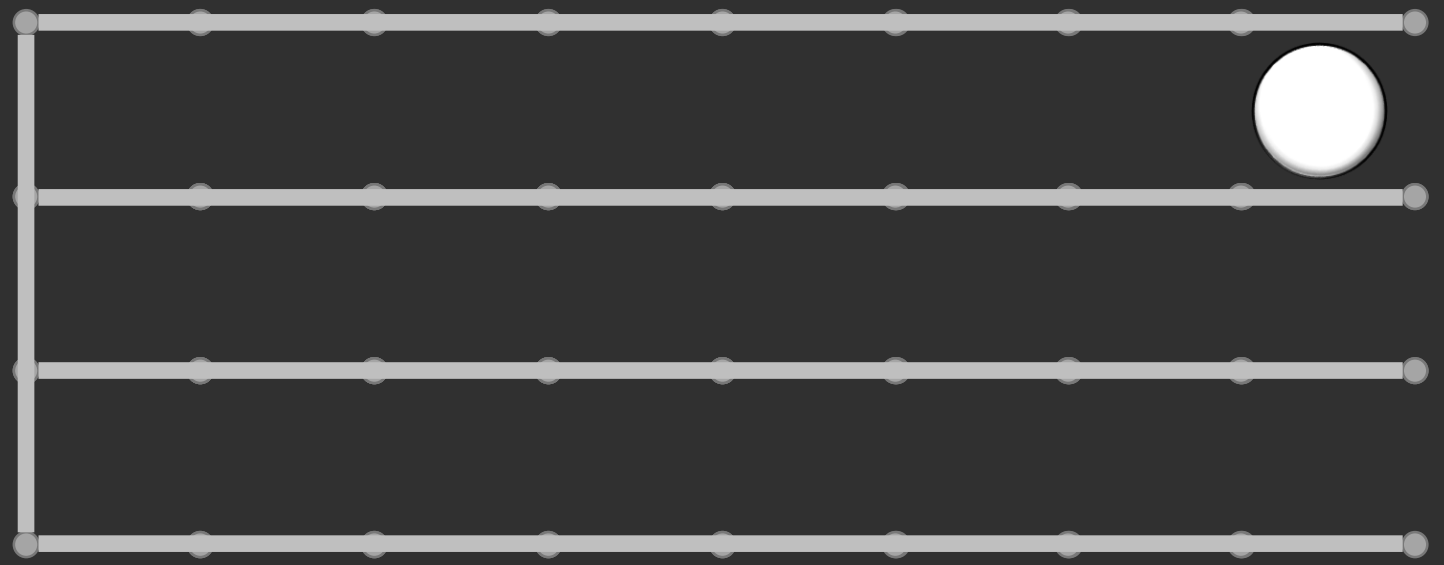
Randomness in Games



Complica

New Tactical Games with Dice and Cards, Reiner Knizia

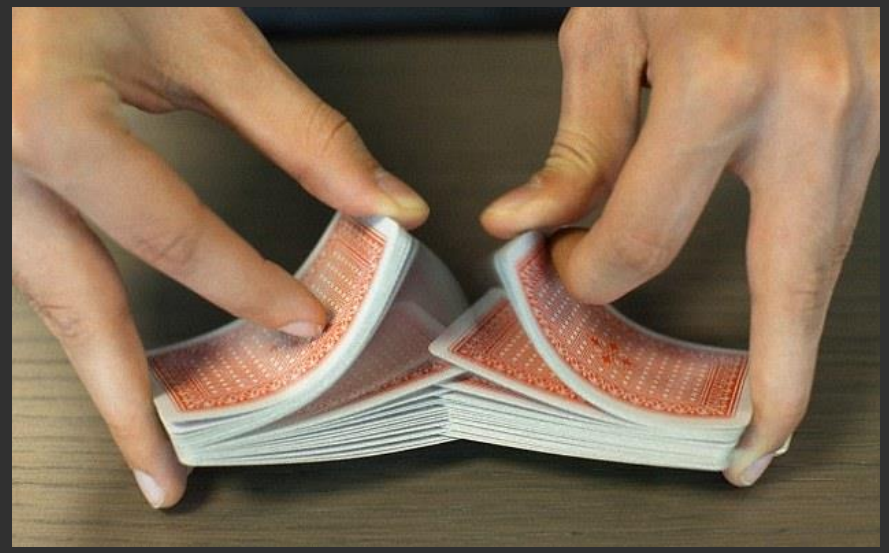
Randomness in Games



Do not play with someone who suggests Complica with 3 rows

Randomness in Games

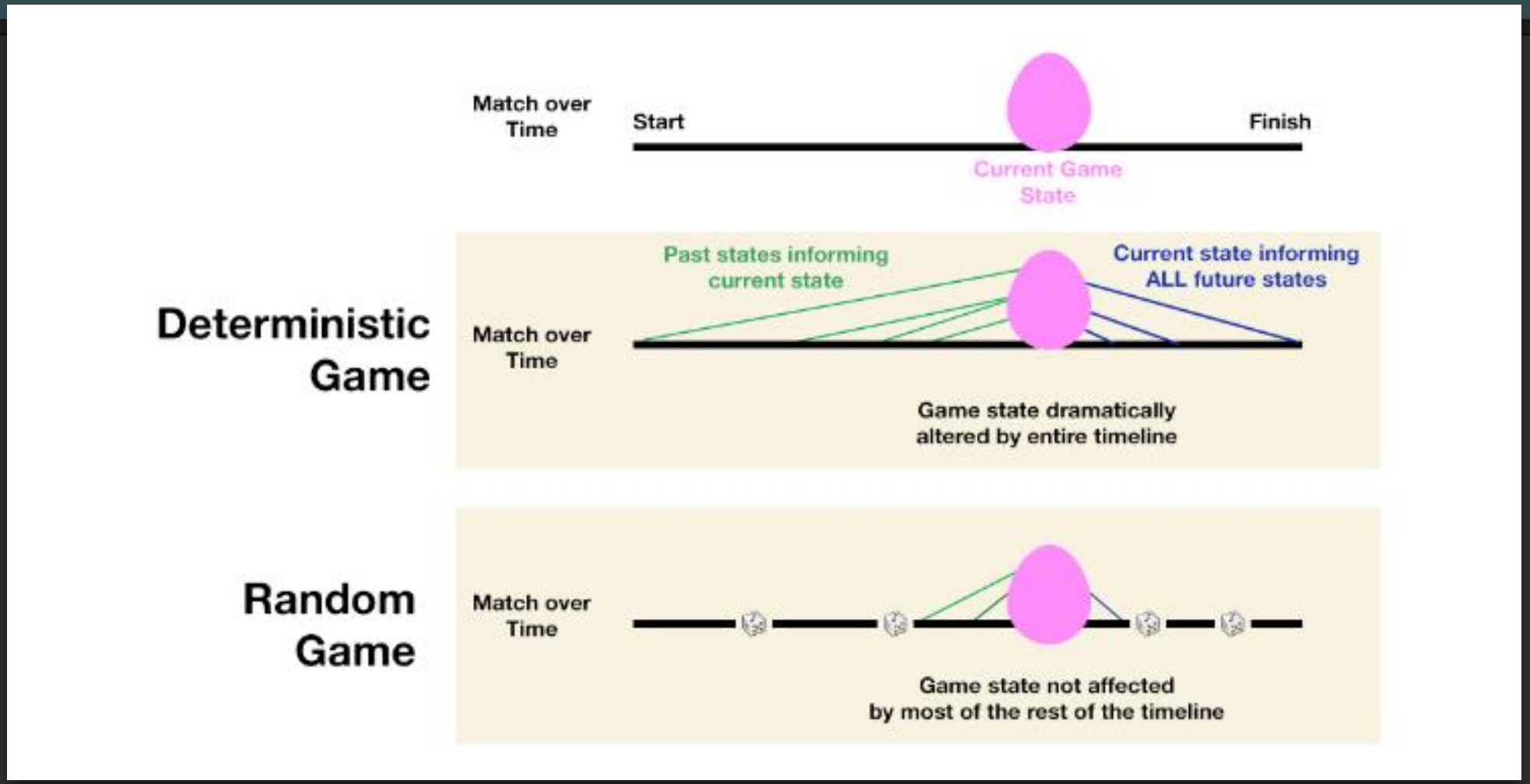
- Non-Deterministic or Stochastic Games
  - Incorporates some form of randomness, eg. Shuffled Deck, Dice Roll



Randomness in Games

- Non-Deterministic or Stochastic Games
  - Incorporates some form of randomness, eg. Shuffled Deck, Dice Roll
  - Favours risk management and reacting quickly to unexpected situations
    - *Done badly, the player will find the rules confusing when their actions have erratic, non-consistent outcomes*

Randomness in Games



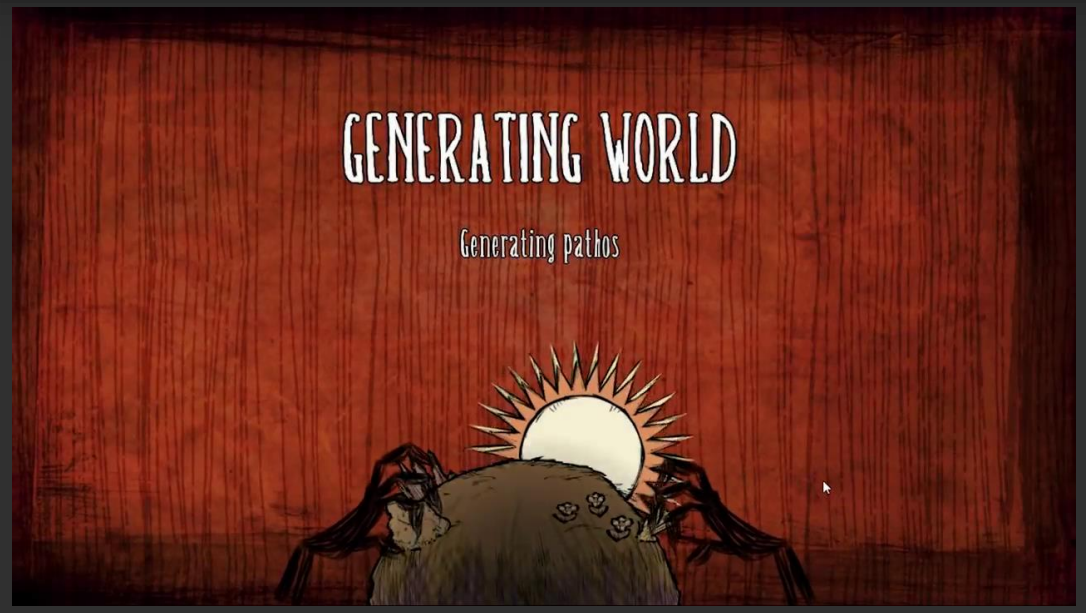
Keith Burgen, Randomness and Game Design

Randomness in Games

- Input Randomness
- Output Randomness

Randomness in Games

- Input Randomness
  - Occurs **prior** to Player making a move
  - Informs the decision, eg. procedural map generation
  - Deterministic mechanics will allow players to gain control after the initial randomisation



Randomness in Games

- Output Randomness
  - Occurs **after** the Player makes his move
  - Decides the outcome, eg. dice-roll combat
  - Require understanding of probability and information to help players commit to their decisions

Methods of Randomisation

Before we start wielding Randomness as game design tools…

- Humans are bad at randomness

Choose a number from

1 to 10

7

22.5% likely to choose

3

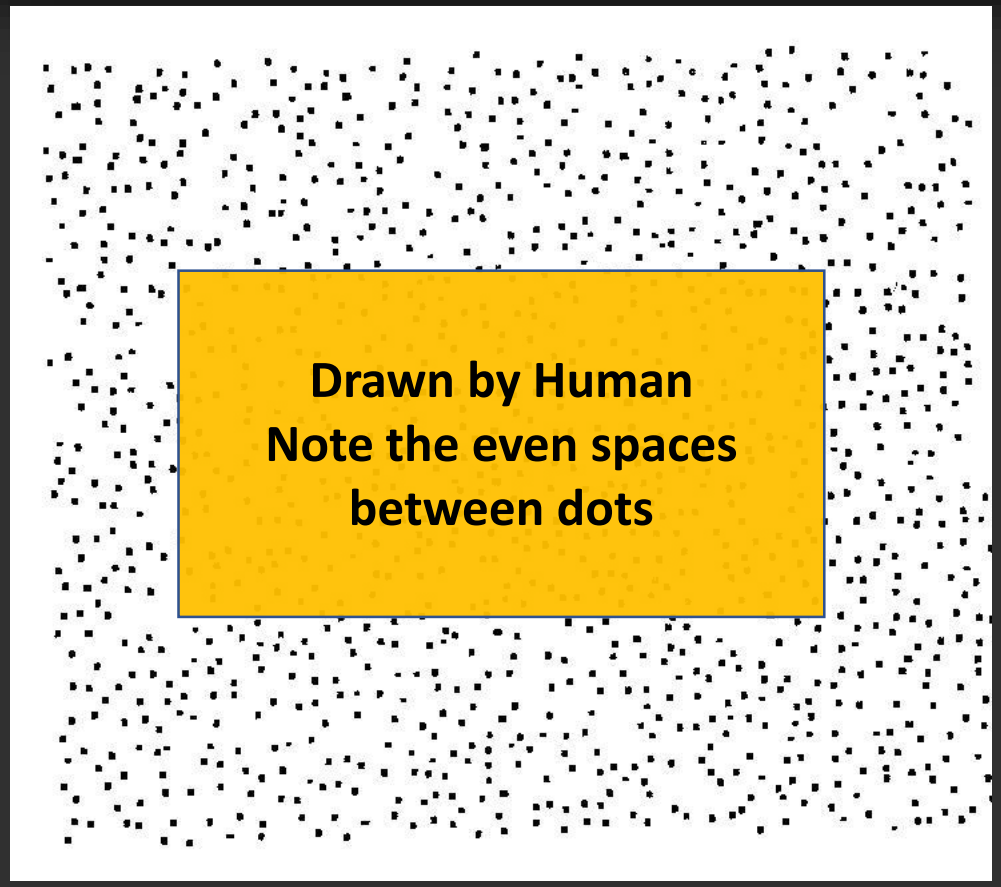
16.24% likely to choose

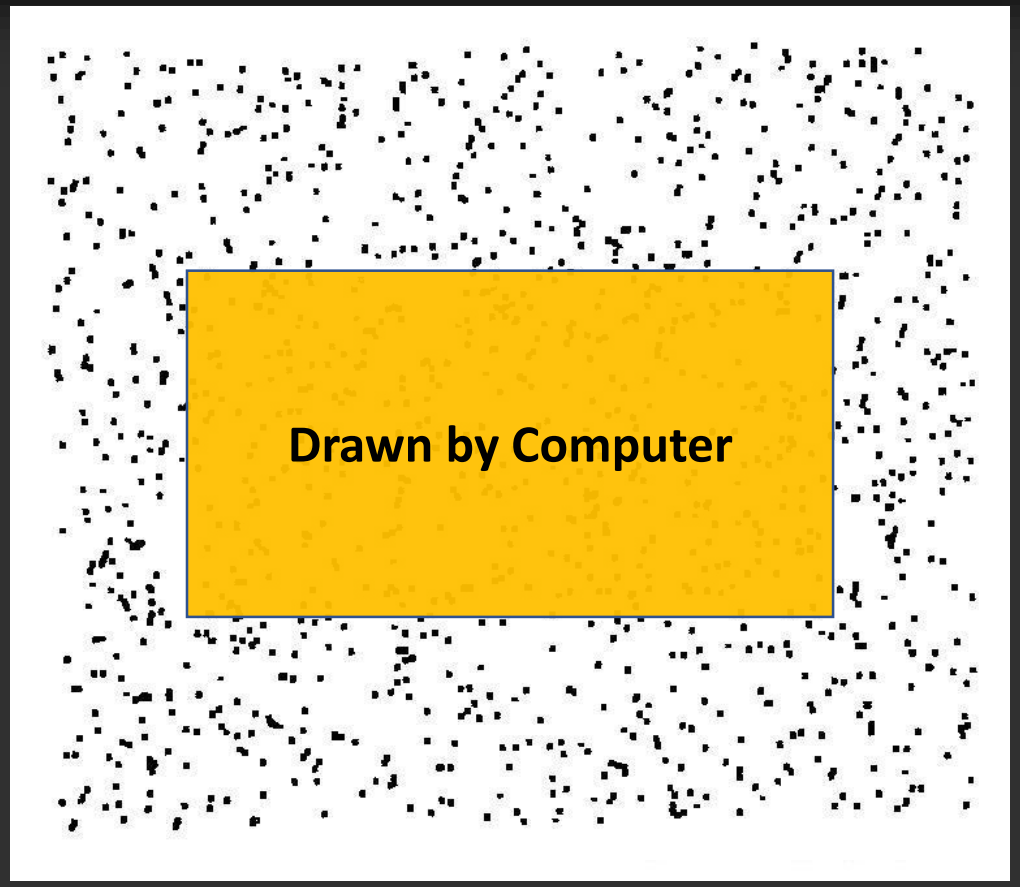
Odd

68.35% likely to choose

Methods of Randomisation

- Humans are bad at randomness





Methods of Randomisation

- Computers are bad at randomness too

PSEUDO

RNG

Random Number Generator

Seed + **Algorithm**

Methods of Randomisation

- Spinning the RNG
  - Moving index sequentially through a list of pre-generated numbers
  - Call the RNG every 2 frames simply to advance the index

The current state lets you predict future outcomes

https://youtu.be/NexyGZCZ9KM?t=1177

Methods of Randomisation

- Linear Congruential RNG
  - Seed number is passed through algorithm, and the result becomes the seed for subsequent generation
  - Pokémon Stadium:
    - result = 0x41C64E6D * seed + 0x0000303B

- Diverging State using Player Input
  - Pokemon GenIV uses Nintendo DS's date, time, delay between starting the game and pressing "Continue" to generate seed
  - Commodore64 uses the output of the noise oscillator on the sound chip

Methods of Randomisation

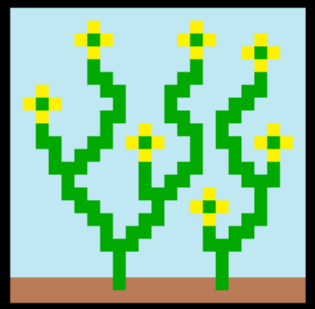
- Cellular Automata
  - Each “cell” in a grid checks all 8 of its neighbours, then decides if the cell “lives” or “dies” in the next frame based on predetermined rules

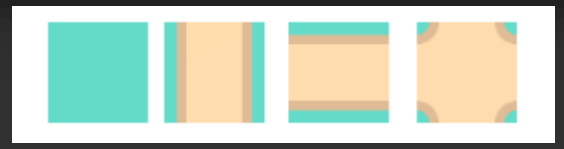
In Life, eight cells surround a given cell. All eight of these cells are checked to see if they are on. *On* cells are counted, and this count is used to determine what will happen to the current cell. Based on the count, the rules defining Life are as follows:

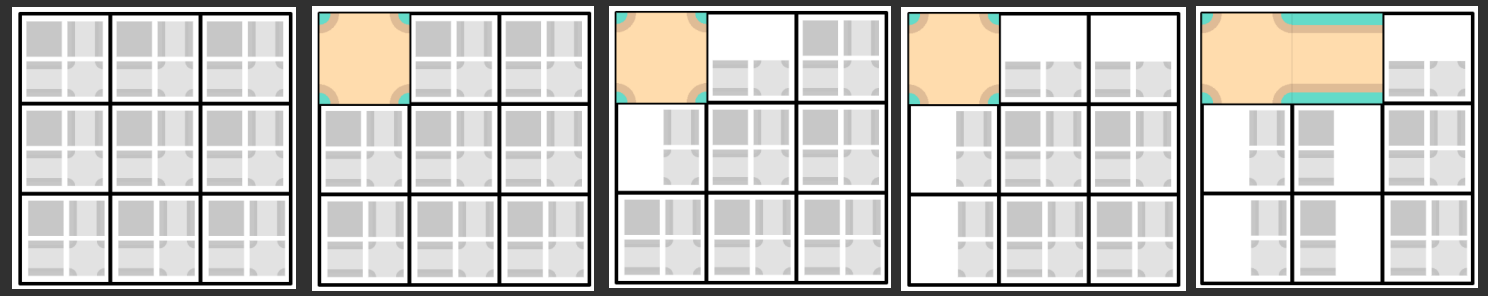
- Death: If the count is < 2 or > 3, the current cell is switched off.
- Survival: If the count = 2 or the count = 3 and the current cell is on, it is left unchanged.
- Birth: If the current cell is off and the count = 3, it is switched on.

Methods of Randomisation

- Wave Function Collapse
  - After deciding on the value of a cell from a predefined range of values, propagate constraints and rules to neighbouring cells before deciding the next cell's value

Sample =  , N = 3





There are 4 possible values for each cell.

Once a value is chosen for the first cell, it eliminates the possibility of certain values in the neighbouring cells and beyond.

Methods of Randomisation

- Computers are bad at randomness too

PSEUDO

RNG

Random Number Generator

Seed + **Algorithm**

Methods of Randomisation

- Physical Methods

10,000 times

7 times

1 minute

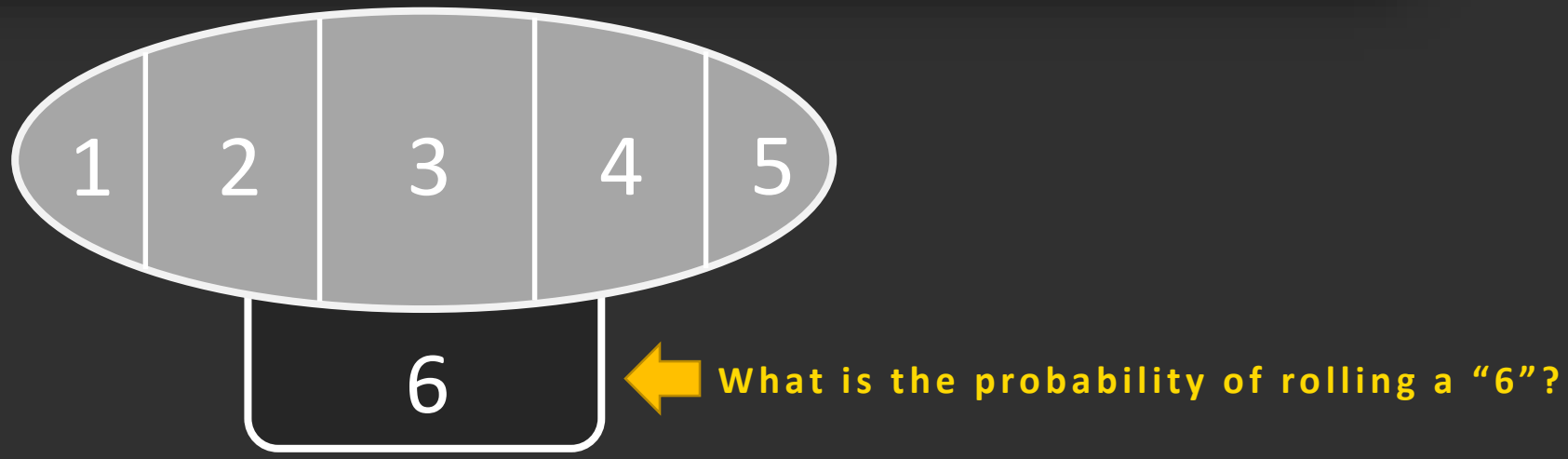
Randomness in Games

- Output Randomness
  - Occurs **after** the Player makes his move
  - Decides the outcome, eg. dice-roll combat
  - Require understanding of probability and information to help players commit to their decisions

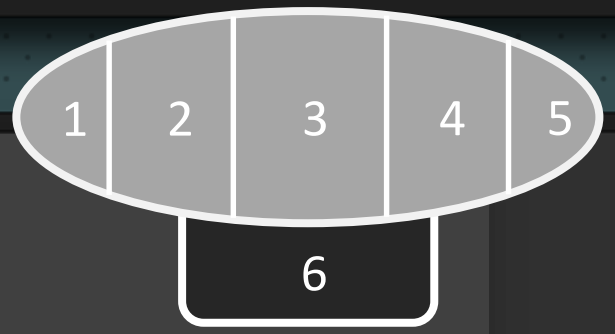
Dice Theory & Probability

Let’s Play – ZEPPELIN

- Each player starts with 6 counters and 1d6
- The goal is to be the last man standing (*last player with tokens*)
- If you roll 1/2/3/4/5, and the corresponding space is empty, give one counter; otherwise, take all counters on the space
- If you roll a 6, give one counter. The counter is lost forever
- If a player has no counter, the player is out of the game

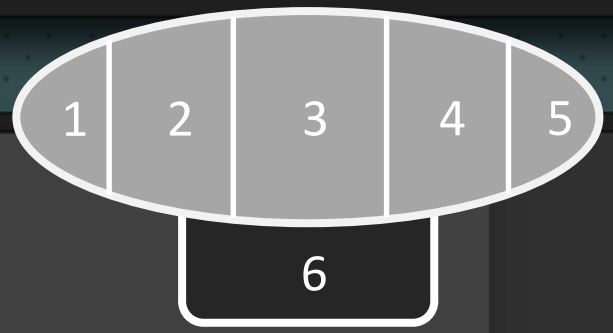


Probability Theory - Basics



- Possible outcomes of 1d6 → 1,2,3,4,5,6
  - All are equally possible
- Probability of each outcome → 1 divided by total number of possible outcomes (6)
  - 16.67% (*0.1667*)
- Probability of even numbers → 3 (*2, 4 and 6*) divided by total number of possible outcomes (6)
  - 3/6 = 0.5 or 50%
  - 16.67% + 16.67% + 16.67% = 50%

Probability Theory - Basics



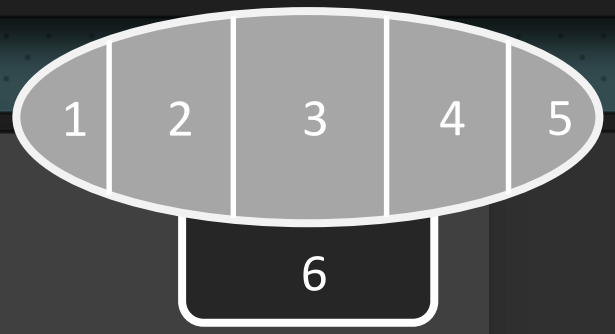
- Probability of getting “3”
  - 16.67%

- Probability of **NOT** getting “3” → One Minus, or 100% Minus
  - 100% - 16.67% = 83.33%

Note:

- No such thing as 101%

Probability Theory - Basics



- Probability of getting “3” **OR** “6”
  - 2/6 = 0.33
  - 16.67% + 16.67% = 33.33%

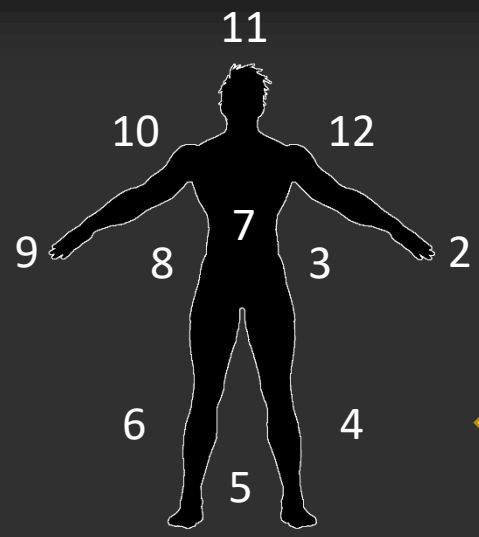
“6” **AND** “6”

- Probability of getting “6” **TWICE IN TWO ROLLS**
- → **Multiply the probabilities**
  - 16.67% * 16.67% = 2.78%

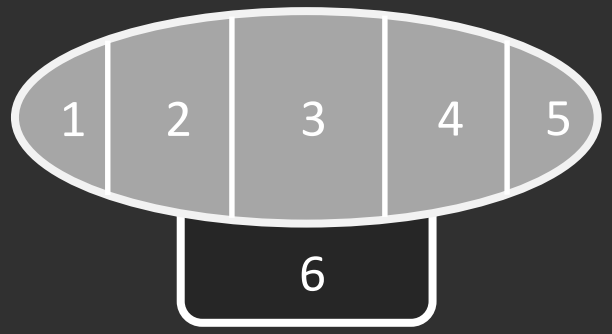
- Probability of **NOT** getting “6” twice in two rolls
- → One Minus, or 100% Minus
  - 100% - 2.78% = 97.22%

Let’s Play – HUNGRY JACK

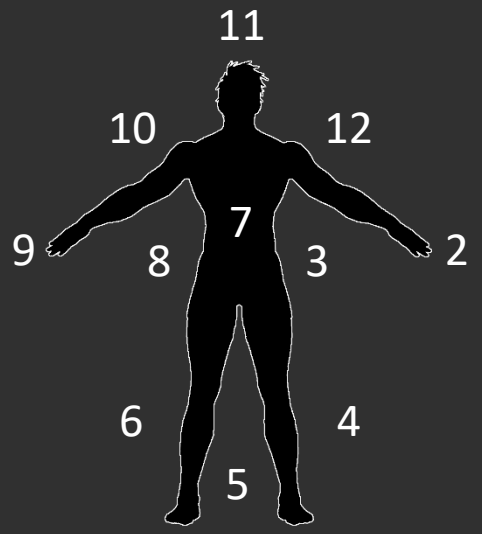
- Each player starts with 6 counters and 2d6
- The goal is to be the last man standing
- Roll 2d6 and add up the result; if the corresponding space is empty, give one counter; otherwise, take all counters on the space
- If you roll a 7, give one counter. The counter is lost forever
- If a player has no counter, the player is out of the game



What is the probability of rolling a “7”?



1D6



2D6

Dice Theory – One die

- Linear distribution
  - Random, you could get any value on the spread

Coin Toss / Yut dice

Front	Back
0.5	0.5

1D4

1	2	3	4
0.25	0.25	0.25	0.25

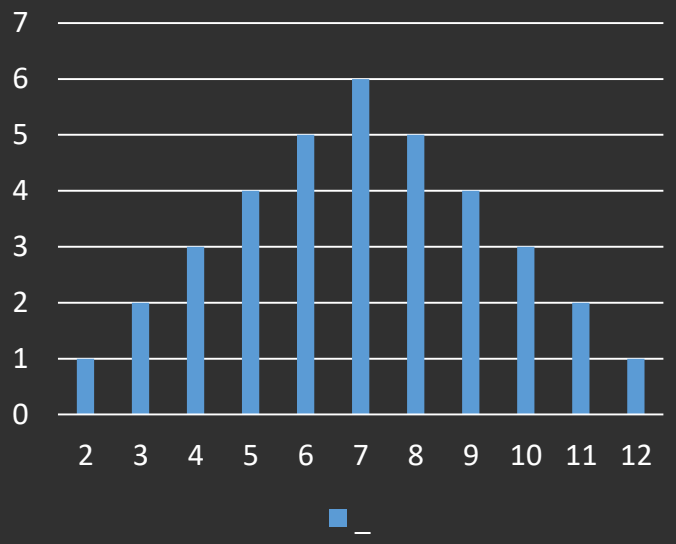
1D6

1	2	3	4	5	6
0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Dice Theory – Two die

- Binomial distribution (bell curve)
  - Bias, you will tend to get values closer to the mid value

SUM	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12



Dice Theory – Two die

- Probability of basic outcomes using 2 die
  - (Probability of basic outcome of specific value)*(Probability of basic outcome of specific value)
  - (16.67%)*(16.67%) or (1/6)*(1/6)
  - 2.78% or 1/36

2.78%

2.78%

2.78%

2.78%

2.78%

2.78%

Dice Theory – Two die

- Probability of getting a sum value of “7”
  - 2.78% + 2.78% + 2.78% + 2.78% + 2.78% + 2.78%
  - 16.67%

SUM	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

Possible die combinations that add up to 7

1	6	2	5	3	4	4	3	5	2	6	1
2.78%		2.78%		2.78%		2.78%		2.78%		2.78%	

Dice Theory – Multiple die

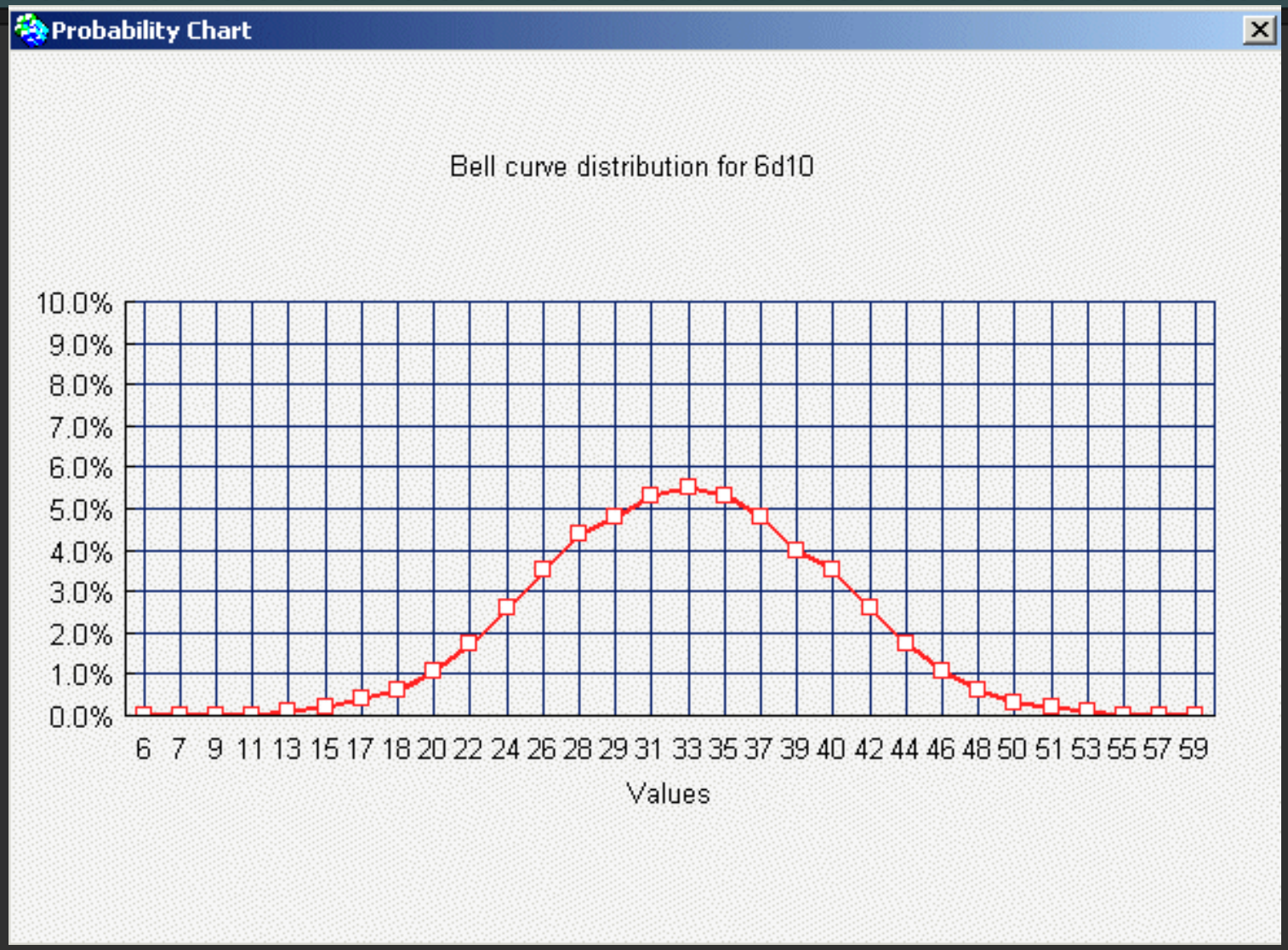
Find the most probable sum value of a 6d10 roll

- **6D10**

1. Multiply Number of Die by Number of Die Faces
   - 6 x 10 = 60
2. Add the Number of Die to the Result
   - 6 + 60 = 66
3. Divide the Result by 2
   - 66 / 2 = 33

Easy formula!

Dice Theory – Multiple die



Dice Theory – Multiple die

ACTIVITY

- What is the most probable sum value of 3D8?

Dice Theory – Multiple die

ACTIVITY

- Let's roll for stats!
- Which method yielded more balanced/satisfactory results?

STAT	3D6	1D20
STRENGTH		
DEXTERITY		
CONSTITUTION		
INTELLIGENCE		
WISDOM		
CHARISMA		

*Let's talk money**

Disclaimer: The following slides' focus is not gambling, nor does it condone the act of it. Rather, it seeks to highlight the importance of understanding probability theory and the concept of risk/reward both from the perspective of players as well as designers

Know Your Odds

- Betting Odds
  - Two different kinds of expressions to describe payouts
    - 1-*TO*-1 … 3-*TO*-1 … 5-*TO*-2 … etc.
    - 2-*FOR*-1 … 3-*FOR*-1 … 5-*FOR*-2 … etc.

- 3 *TO* 1
  - If you win, banker pays the quoted ratio in addition to returning your stake, *ie. $1(you) + $3(banker)*
- 3 *FOR* 1
  - If you win, banker pays the quoted ratio for your bet, *ie. $3(banker)*. The stake is not returned

Know Your Odds

- True Odds
  - A “fair” payout
  - Probability Theory

The probability of rolling a number using 1d6 is 1/6.

The true odds are 6 for 1.

On average, you win one in six bets. The payout evens out the stakes you lost.

Neither side is advantaged.

Let’s Play – Under and Over Seven

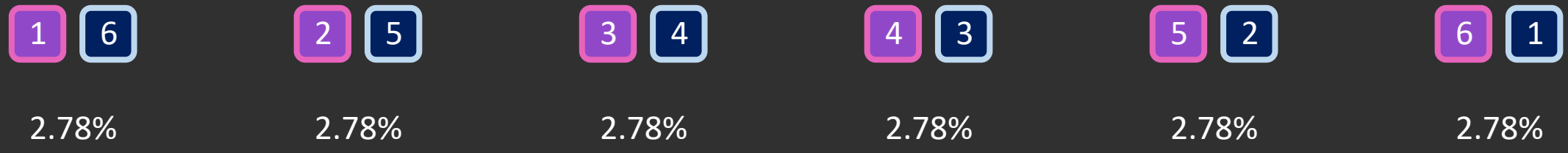
- Win by betting successfully on the next throw
- Banker will roll 2d6

Under 7	7	Over 7
2 for 1	5 for 1	2 for 1

Dice Theory – Two die

- Probability of getting a sum value of “7”
  - 2.78% + 2.78% + 2.78% + 2.78% + 2.78% + 2.78%
  - 16.67%

Possible die combinations that add up to 7



2.78% 2.78% 2.78% 2.78% 2.78% 2.78%

Know Your Odds

- Probability of getting a sum value of “7” is 16.67% or 1/6
- True odds is { 6 for 1 }
- What does it mean when the payout is { 5 for 1 } then?
- If you bet on “Under 7”, what is the probability you lose the bet?

Under 7	7	Over 7
2 for 1	5 for 1	2 for 1

Know Your Odds

- Understanding and balancing Risk/Reward considerations as a Designer
- Both from the Player's perspective, as well as the Banker's

Under 7	7	Over 7
2 for 1	5 for 1	2 for 1

Randomness in Games

- Deterministic vs Non-deterministic(Stochastic)
- Randomness
  - Replayability
    - Each time you play, the game is different, not replicable
  - Surprise
    - Key aspect of “play”
- Risk/Reward
  - Probability Theory
  - Single/Multiple Dice Theory

Randomness in Games

- Players enjoy RNG, but also want to abuse it
- Designers do it too!
- Luck Mitigation

End

Homework

- ZOMBIE DICE
  - https://tabletopia.com/games/d115-2020-w4iqky/play-now
  - https://youtu.be/NMtlQxJeWvc?t=624
- MARTIAN DICE
  - https://en.boardgamearena.com/gamepanel?game=martiandice

Next Tuesday

- Sit in your teams and start working on your game!
- Bring your own tabletop games, or borrow from library

Additional Reading

- https://www.gamedeveloper.com/programming/how-classic-games-make-smart-use-of-random-number-generation
- https://bulbapedia.bulbagarden.net/wiki/Pseudorandom_number_generation_in_Pok%C3%A9mon?_sp=557cae00-6148-40ae-96a0-e8400b00aa52.1662307763730
- https://www.random.org/
- https://keithburgun.net/randomness-and-game-design/