

Uncertainty for uncertain times

*Adapting RNG to broaden appeal
and improve accessibility*



gcap



Prologue

*God is dead
and we have
video games*

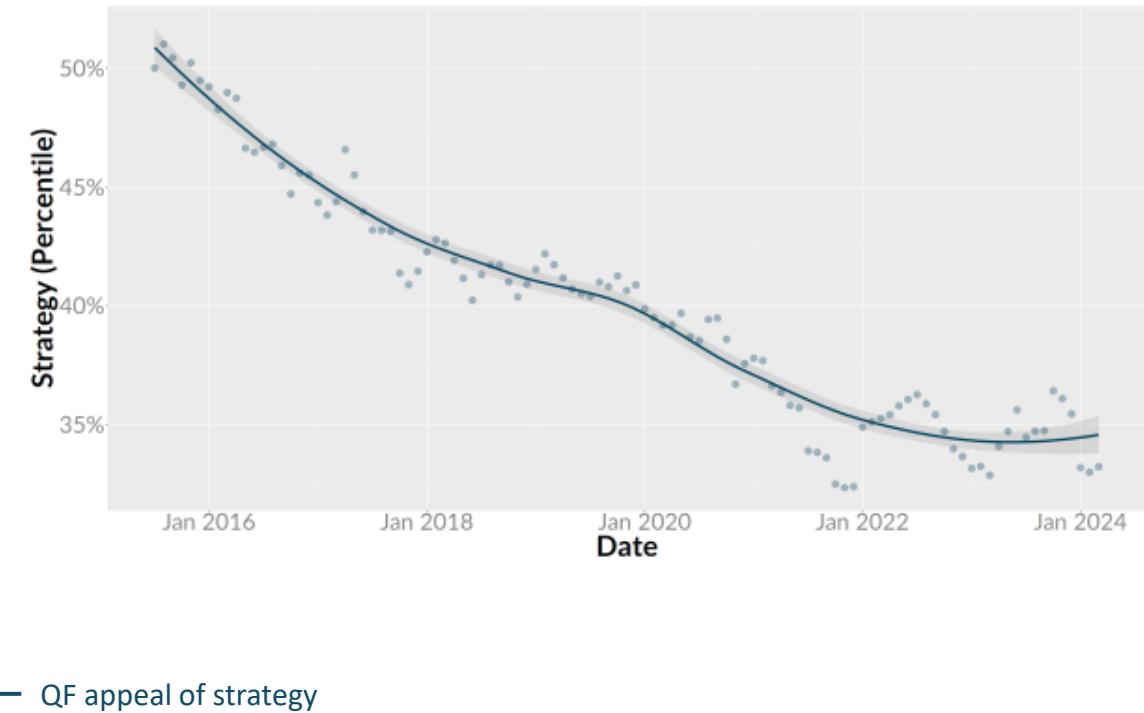
Who am I?

- I'm William ☺
- I've been working in games for 11 years, including 9 as an **AI & system designer** on titles like *Endless Legend*, *Endless Space 2*, *Humankind*...
- ... and *Solium Infernum*, OpenCritic's **top-rated Australian game of 2024** 🎉
- I'm now **working as a technical designer** on *Winnie's Hole*...
- ... and doing some **design consulting** for *Amplitude Studios* and *Studio Imugi*.



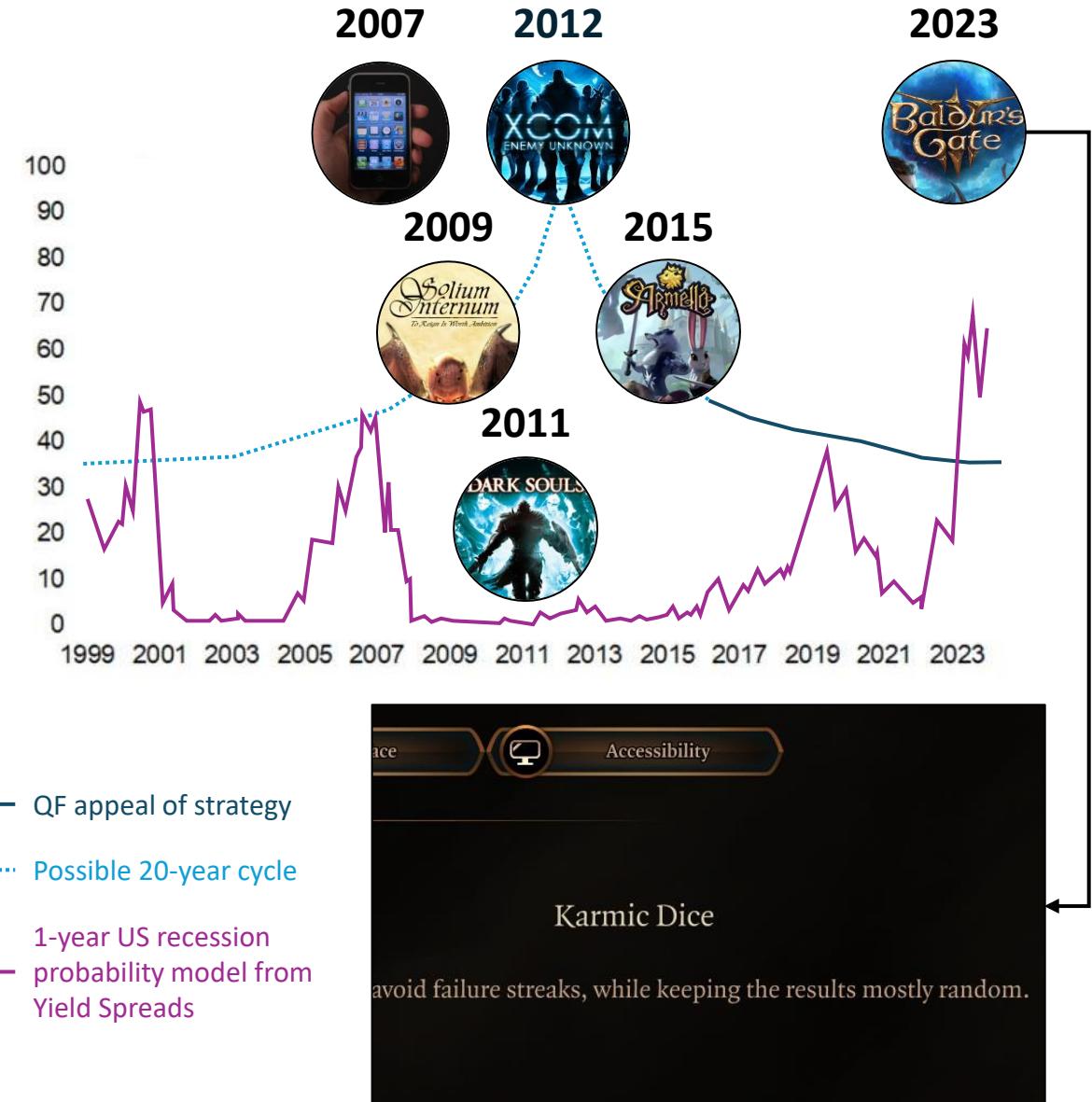
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- Interest in “strategy” has decreased for a decade, according to *Quantic Foundry*.
But is this...
 - ... presented in a misleading way?
 - ... just part of 20-year cycle?
 - ... the economy, stupid?
 - ... consistent with sales data?
 - ... a cause for moral panic?
- The original graph resonates because it taps into a foundational myth: *The Fall!*
- Games tap into it too: they promise an escape from alienation and a return to Eden in uncertain times like these.



This is finding Eden

- **Times are even harder** for players than for developers: it's more vital than ever to excise unnecessary friction from our games.
- Of particular interest today: how randomised systems can cause friction, and what to do about it.

E.g. every “shuffle” feature ever designed for a music app.
- **This isn't just a UX problem:** the best UX in the world can't fix an inherently frustrating system!



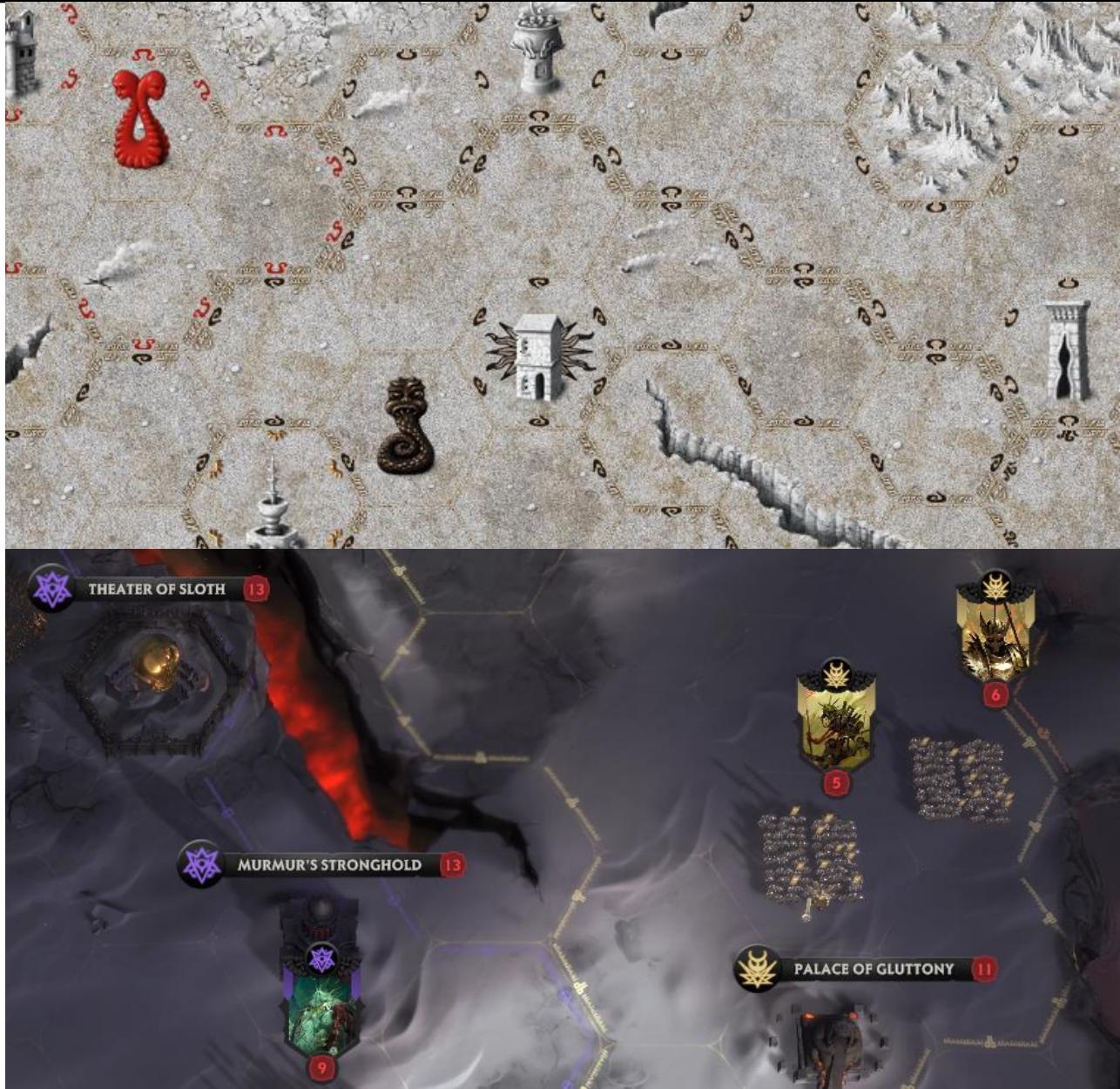


Chapter I

*The temptation
of RNJesus*

What is *Solium Infernum*?

- The original *Solium Infernum* (OSI), released in 2009, was a **beautiful but very niche** play-by-email strategy game.
- It was **infamous for the capriciousness of its randomised systems**: these helped sell its Kafkaesque vision of Hell.
- Our remake released in February 2024 to **universal critical acclaim**.
- Today I'll share the **situational approach to uncertainty** that we used to adapt OSI to a broader audience, without compromising its aesthetic.



Situational Game Design

- A game situation is a moment of agency →
- Game situations can be scripted by hand, but more often we design them only indirectly, by crafting the systems that will generate them on the fly.
- Not all situations were created equal.
Upton's book contains a list of heuristics to help weed out the bad ones:

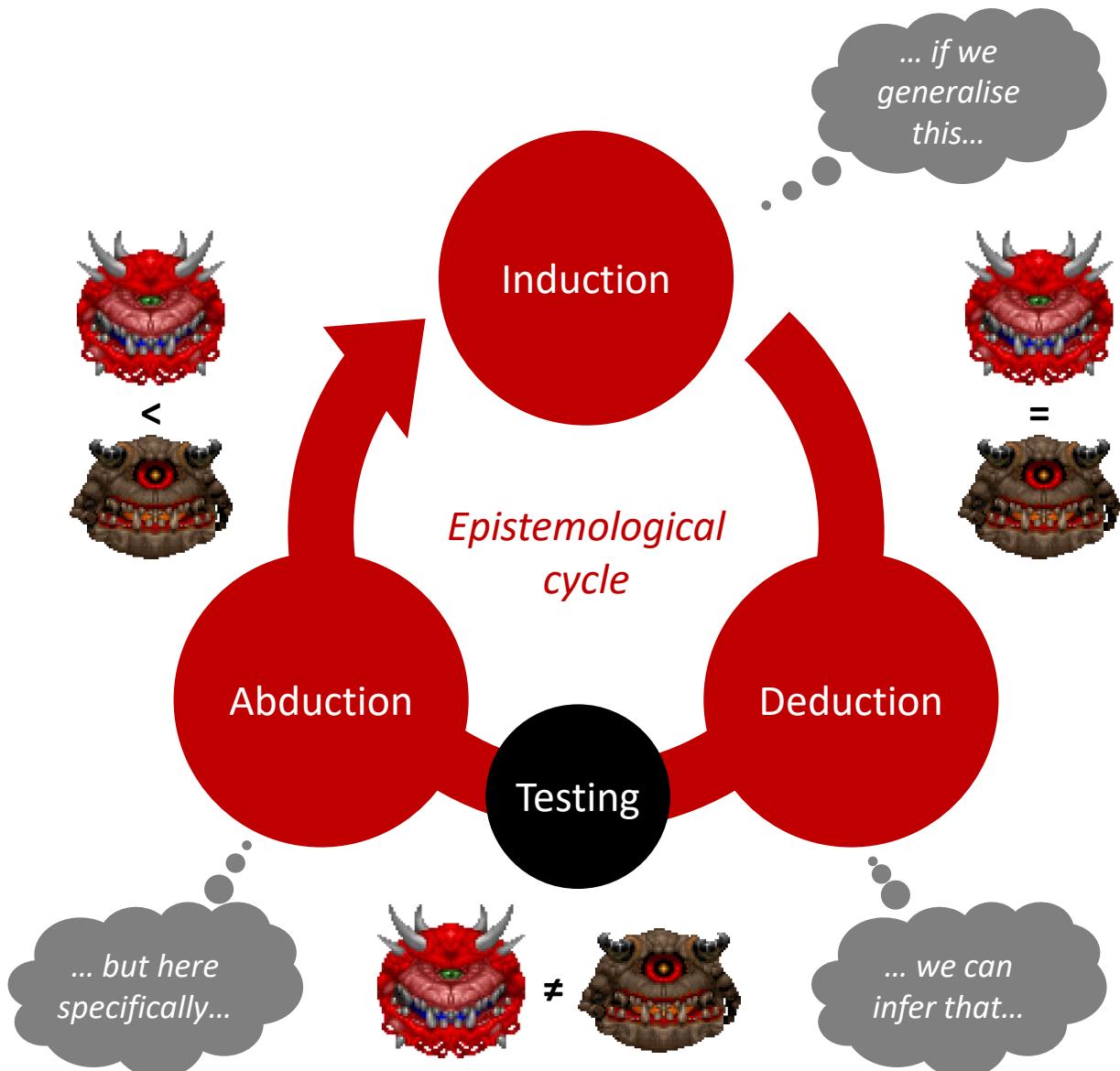
*Choice – Variety – Consequence –
Predictability – Uncertainty – Satisfaction*

- We'll be focusing on uncertainty today.



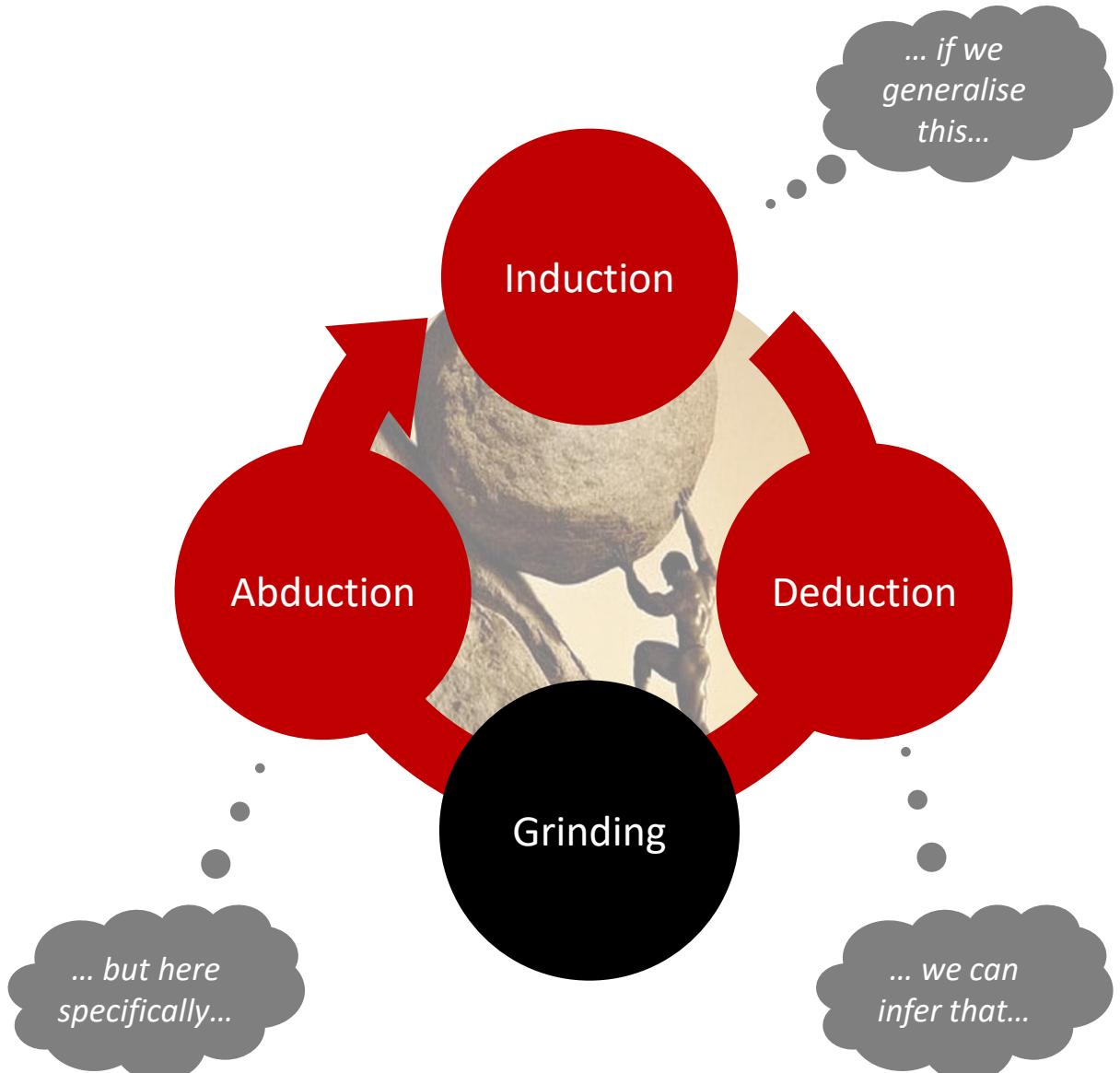
Uncertainty

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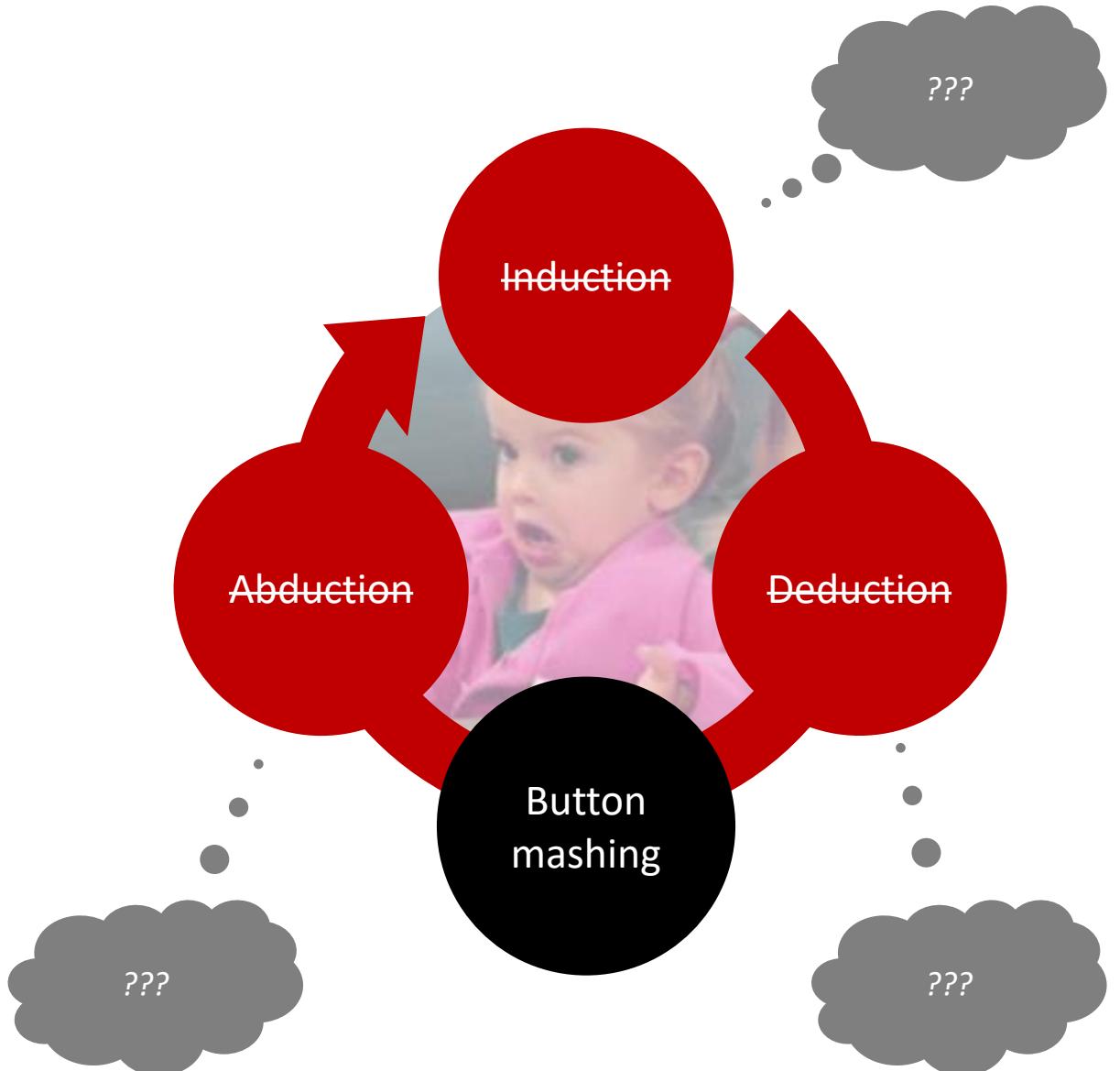
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 - And a perceived need to think too far ahead can lead to analysis paralysis.



Uncertainty

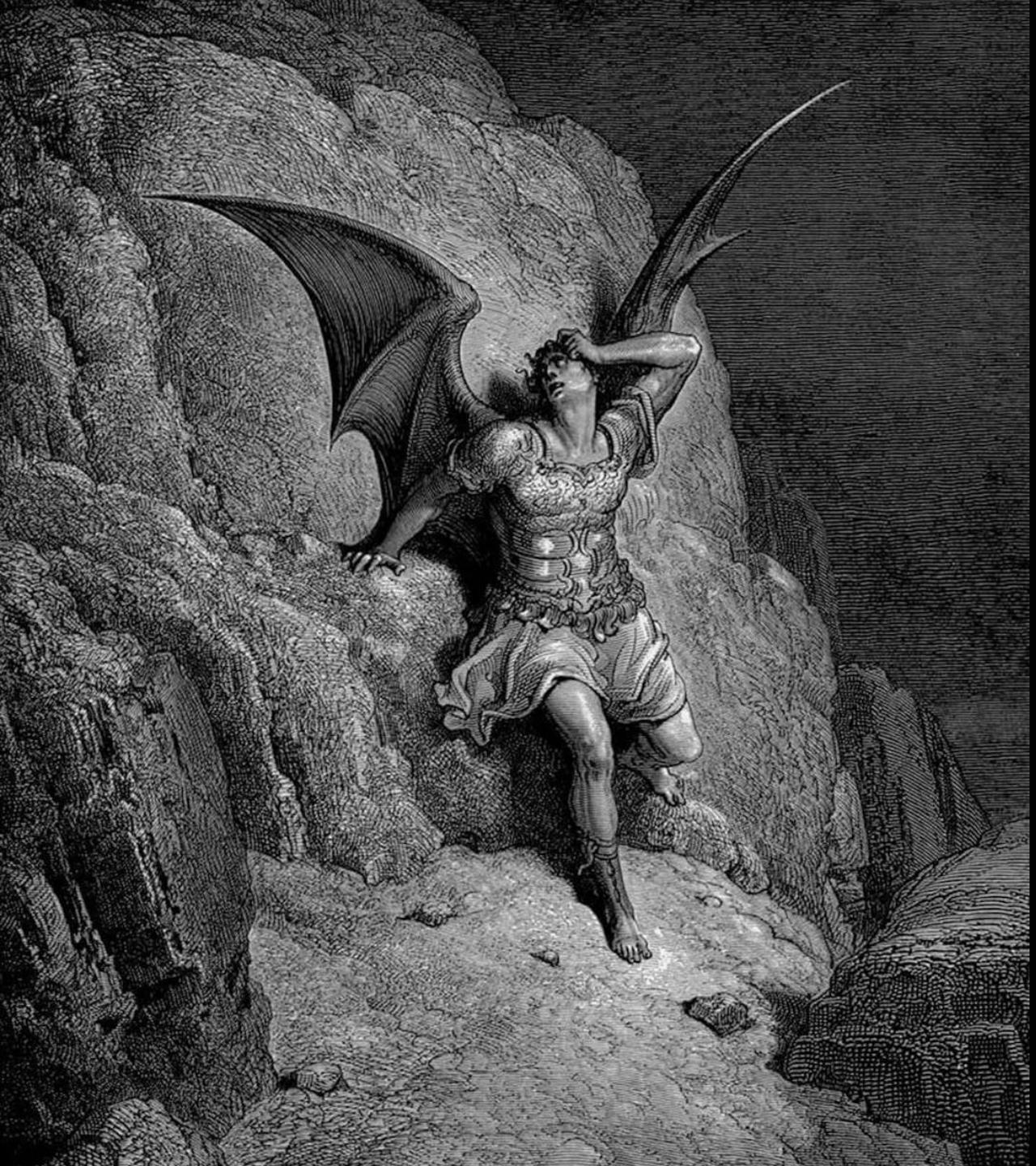
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 - Longer plans mean more labour before we find out if we were right.
 - And a perceived need to think too far ahead can lead to analysis paralysis.
- But too much uncertainty makes planning pointless.



Uncertainty – Legion combat / Duels

- In the original *Solium*, legion combat and duels both involved a lot of dice rolls...
- ... but the game is “We-Go”, like *Diplomacy*, so your actions can be interrupted in any number of ways!
- For the remake we extirpated the RNG from these systems, and others: we felt there was enough uncertainty already.
- Does your system *need* RNG? Before “*sprinkling it on top*”, it’s worth considering what forms of uncertainty are already present: is there enough?





Chapter II

*The Monty Hall
of mirrors*

Stochastic variables

- A “stochastic variable” is a quantity or object that depends on RNG.

E.g. the destination of *Lethal Company's* inverse teleporter →

- A variable has a “domain” of possible results that it can return when it is “sampled”.

E.g. a position on a moon, the moon itself, what's in the store, ... etc.

- Less-than-ideal situations can result from insufficiently constrained domains.



Mulligans

- The easiest way to constrain a stochastic variable's domain is to define failure conditions.

E.g. there must be a path from a teleport destination to an exit →

- Then, when we sample a result that “*fails*”, we simply try again.
- This is trivial to implement, but how many times should we sample before we accept a failed result? And what if this latest one is the worst yet?



Optimisation

- Rather than passing or failing results outright, we can **give them a score**.
- Then, after sampling a variable a set number of times, we simply **pick the best result we've seen so far**.
- We can also define rules for **locally tweaking samples** to improve scores.

E.g. *Endless Legend* modifies the terrain around player start locations to meet yield quotas →



Invariants

- Ideally, you want to avoid the need to reroll in the first place by imposing constraints from the beginning:

E.g. in *Winnie's Hole* we exclude mutations that you can't use at all before the drawing ones for you.

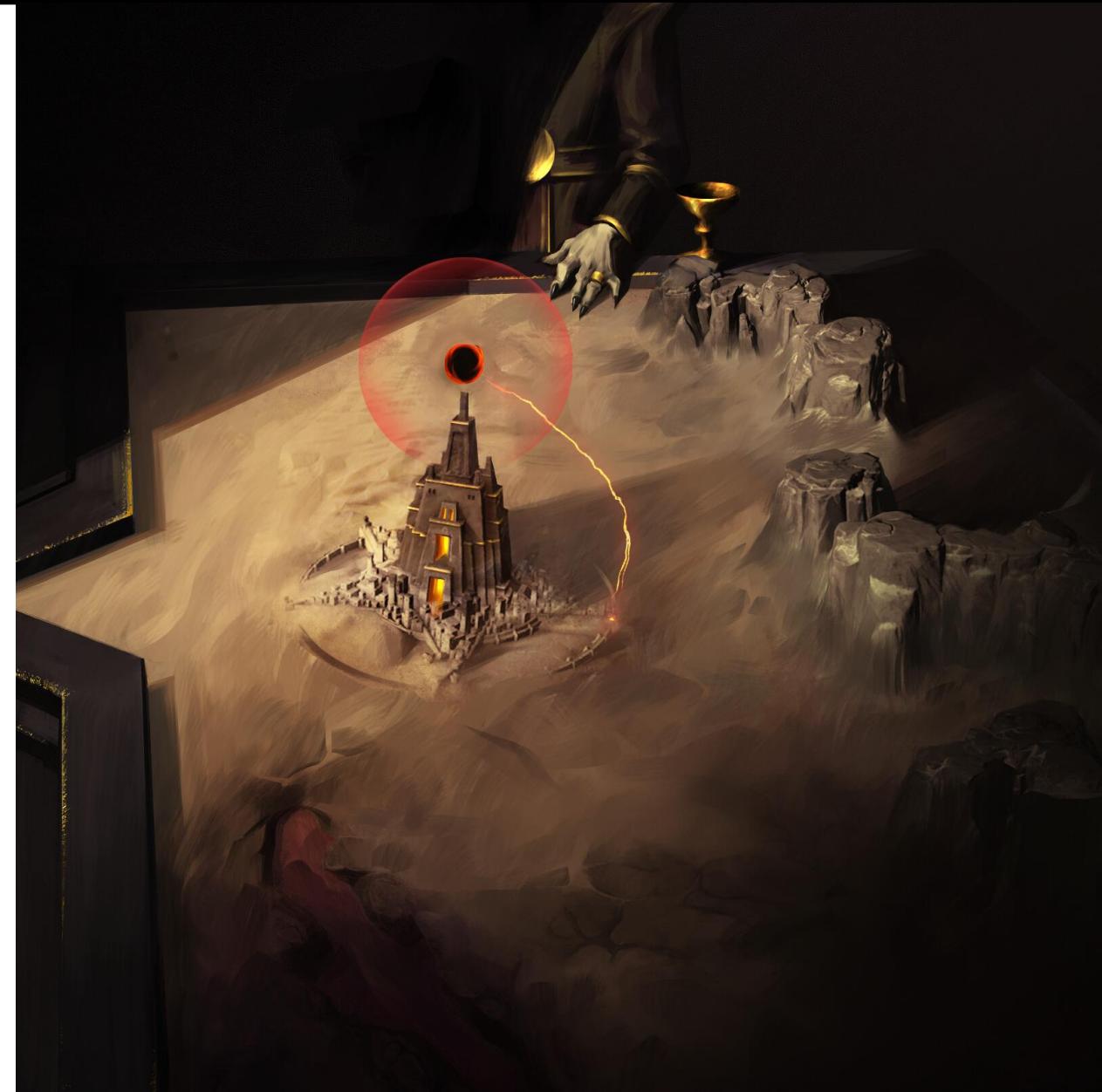
- Procedural generation 101: the initial state respects all your invariants, and every operation maintains them.

E.g. *Solum's* board generator will never expand a ravine or river into contact with a previous one.



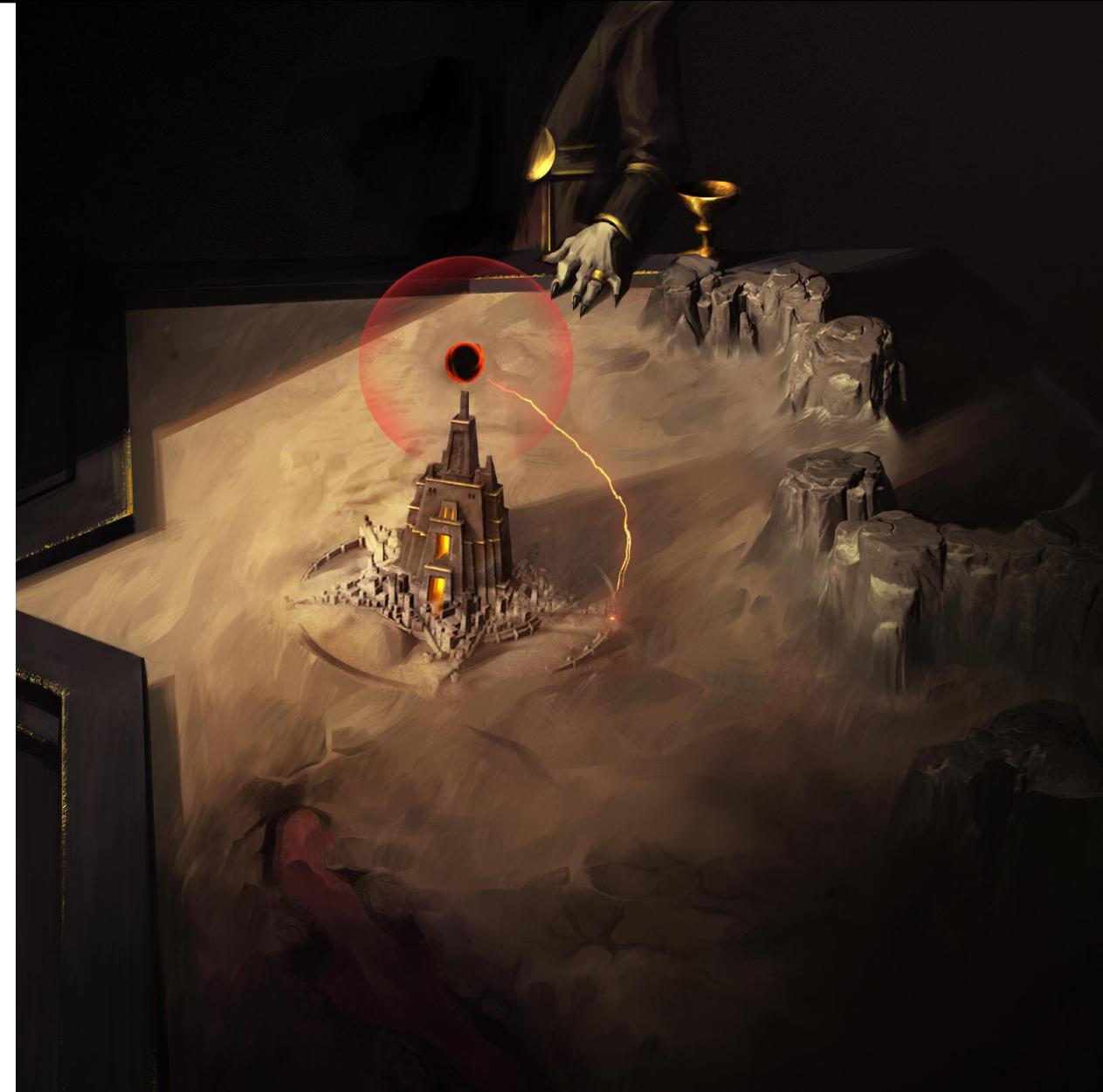
Invariants - Board generation

- The original *Solium* would sometimes spawn players in impossible situations:



Invariants - Board generation

- The original *Solium* would sometimes spawn players in impossible situations.
- The remake's invariants guarantee...
 - ... that the map is always navigable.
 - ... low-hanging fruit near each player's starting location.
 - ... an equal total count of weak and strong *Places of Power*.
 - ... a minimum number of access paths to each *Place of Power*.



Invariants - Event draw

- In *Solium Infernum* players are regularly given “events” to play at their discretion.
- As developers, we don't want...
 - ... the same event to come up too many times per match.
 - ... highly disruptive events to occur too early and stall the game.
- So we draw without replacement and hold back some events from the draw for the first few turns.



Invariants - Bazaar quotas

- Solium's military units come from the Bazaar, which is restocked by sampling a stochastic variable.
- At first the draw was *entirely* random, but this would invariably lead to a shop with nothing affordable in it.
- We solved this problem by reserving slots in each category for items matching very specific criteria.
- If bad draws are *possible*, some players will have a bad time: don't make it unlikely if it should be impossible!





Chapter III

*A mind made
for Eden*

Audience participation – Round 1

Let's say I'm flipping a coin 3 times. Which result is more likely to occur?

Heads, Heads, Heads (**HHH**)?



→ $1/8$
= 12.5%

– or Heads, Heads, Tails (**HHT**)?



→ $1/8$
= 12.5%



Audience participation – Round 2

Let's say I'm flipping a coin 3 times. Which result is more likely to occur at least once?

Heads, Heads (**HH**)?

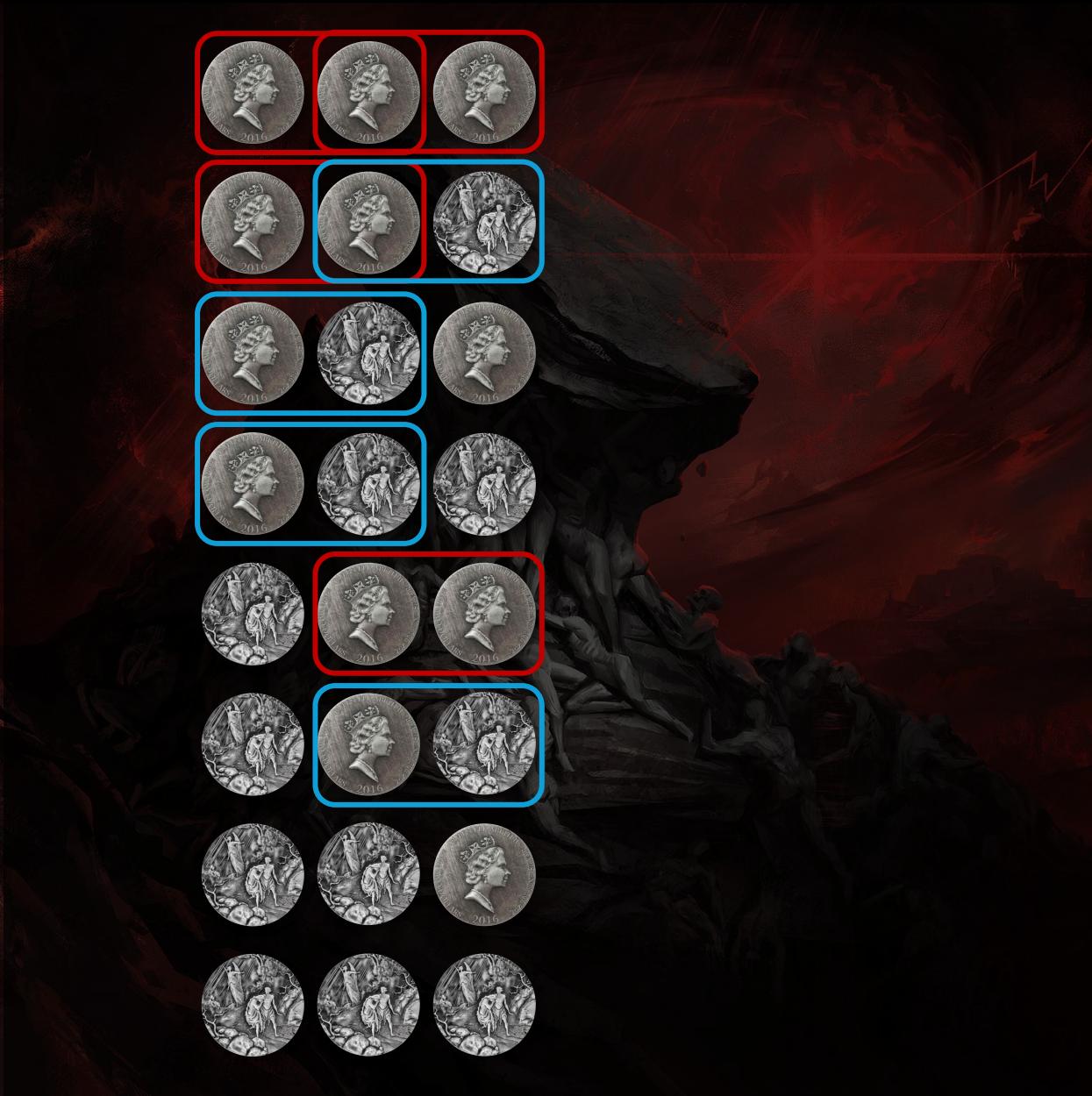


$$\rightarrow 3/8
= 37.5\%$$

– or Heads, Tails (**HT**)?

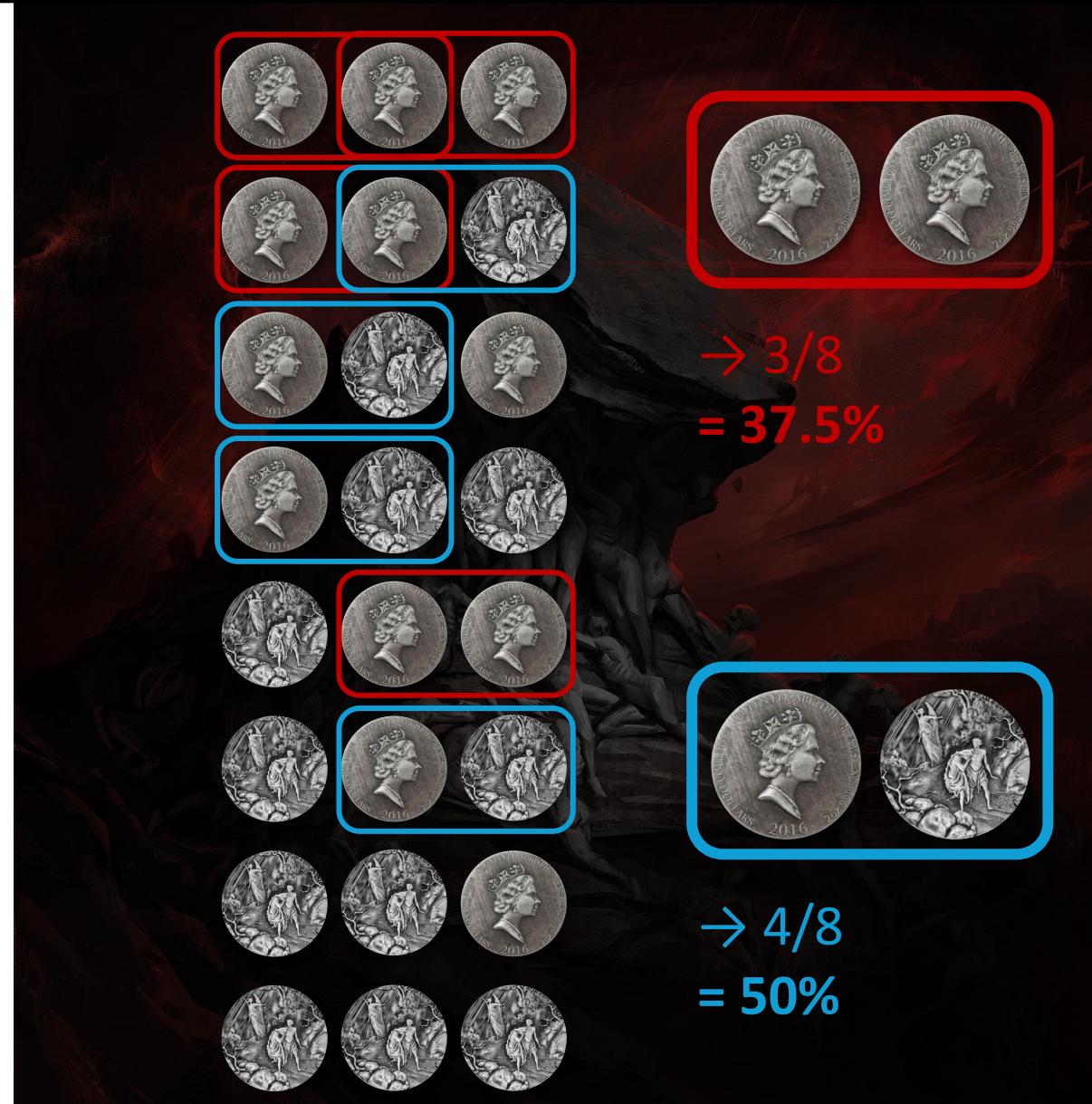


$$\rightarrow 4/8
= 50\%$$



Sequence-subsequence model

- Hahn & Warren 2009 suggests that our **cognitive bias towards alternation** is adaptive, given the finite nature of our memory, attention and lifespan.
- As they put it, given **finite sampling**
“(...) key aspects of laypeople's supposed misperceptions of randomness actually have probabilistic support”.
- **In game terms:** if DPS is the same in both cases, it is *rational* to choose **consistent damage** over a **high critical hit chance**, because you're only going to attack a finite number of times ☺



Without replacement

- Indeed, the *fewer* times you're sampling, the more similar the results of sampling with and without replacement become.
- Understanding stochastic variables as finite-sized “bags” of possible results is thus a fair approximation... for mortals.
- How finite? Well, most people can remember between 5 and 9 entirely unrelated “chunks” of information.
- This suggests that the finest unit of probability players will “grock” intuitively is well above 1% →



Without replacement – Ritual resistance

- To avoid disappointment, *Solium* hides the exact probabilities, and uses pessimistic wording for its predictions.
- We are also careful to frame a “miss” as a successful resistance, *not* a “failed attempt”, to empower both sides.
- Rituals are still a source of frustration for players though, given all the hidden information.
 - ... draw without replacement, or...
 - ... eliminate RNG entirely!



Without replacement – tribute generation

- There are 4 resource in *Solium*, drawn at random: testers would get frustrated waiting the type they needed.
- Drawing types without replacement had a huge impact, but nobody could identify what we'd changed.
- We don't expect players to hear ultrasounds or to see ultraviolet light, but there is a visible spectrum of entropy too.
- Lowering the entropy of your variables will improve accessibility.



Without replacement – Caveats

- We originally biased *Manuscript* draws **towards completing sets** the player had started to collect...
- ... which assumes the player *wants* to complete these partial sets: **they may want something new!**
- Storing decks or tribute and manuscript types **inflated the size of our saves**: this matters when you're paying to maintain the game's network infrastructure.



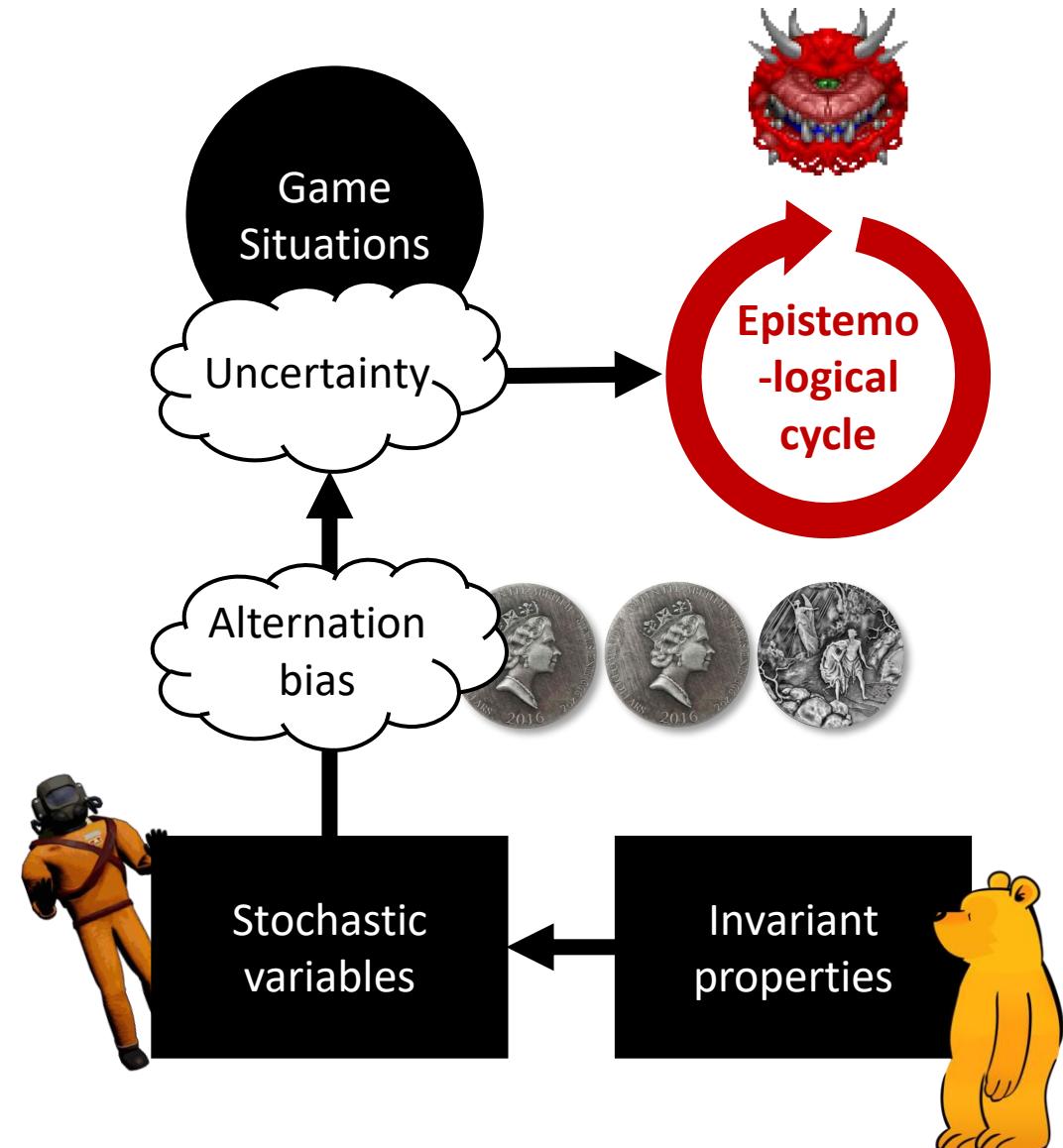


Epilogue

*Edenic game
design*

Take-aways

- In trying times, we must take particular care to banish inferior **game situations**.
- **Uncertainty** can lead to *grind* or *button-mashing* if dosed incorrectly.
- **Stochastic variables** are just one source of uncertainty among many.
- Designing **invariant properties** can help constrain your variables' **domains**.
- Humans tend to assume that all draws are **without replacement**.



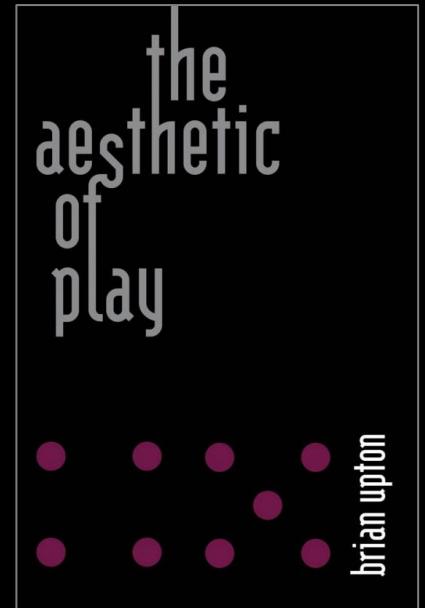
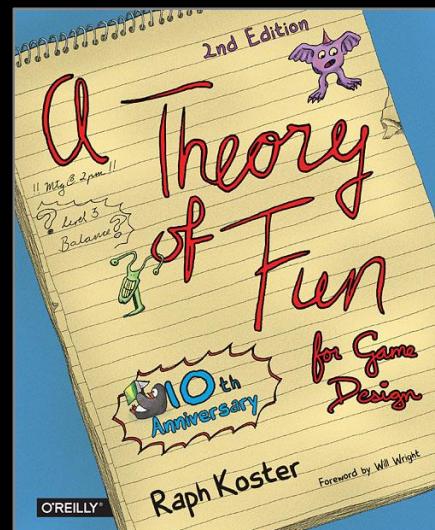
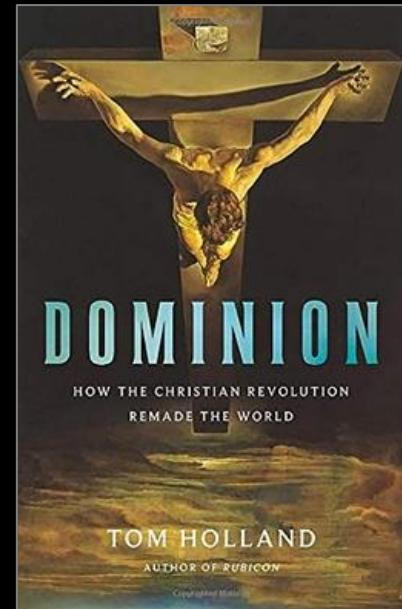
Recommended reading

Books:

- *Dominion* – Holland (2019)
- *The Aesthetic Of Play* – Upton (2021)
- *A theory of fun* – Koster (2005)

Papers:

- *The Magical Number Seven, Plus or Minus Two* (1956)
- *Perceptions of randomness: why three heads are better than four* (2009)
- *Who "believes" in the Gambler's Fallacy and why?* (2017)



Thank you for your time!

Questions?

**HAVE DICE
WILL DYCE**

