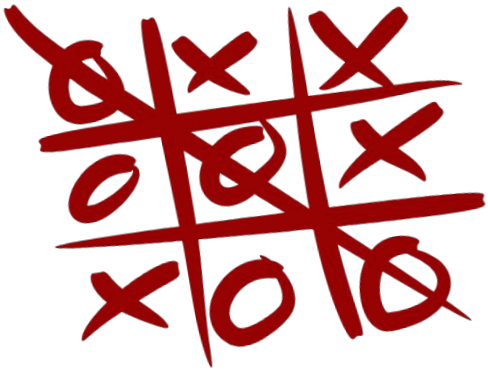
Why tic-tac-toe is NOT fun.

Chess is played by hundreds of millions into adulthood, but most stop playing tic-tac-toe once they enter middle school.

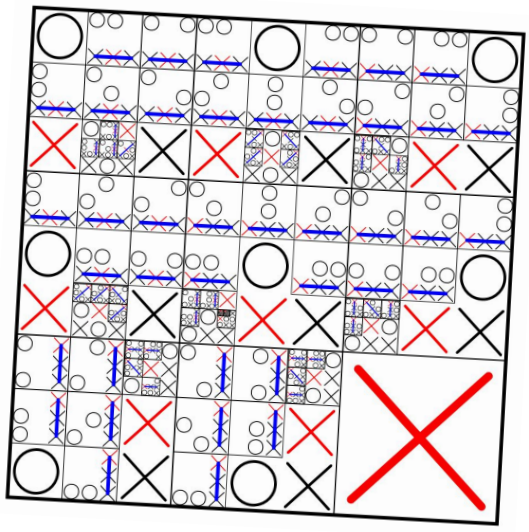


(not even accounting for symmetry)

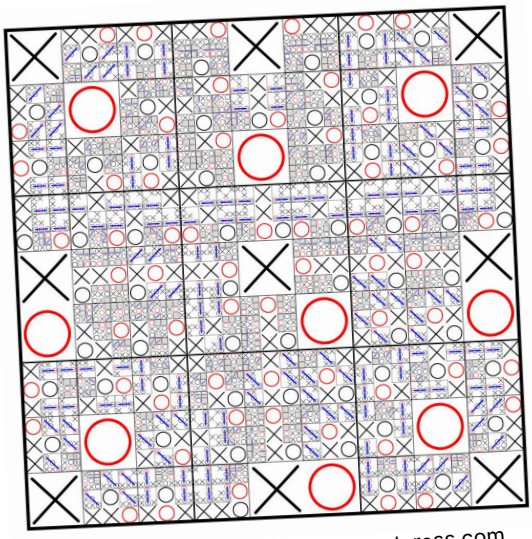
There are **255,168** distinct possible games of tic-tac-toe, while chess has been predicted to have a lower bound of 10^{120} possible games.

Shannon number (ask me about it)

Fact: There are 10^{80} atoms in the entire observable universe, which means there are 10^{40} times more chess games than atoms!



The **game tree** of tic-tac-toe visualized



Why does tic-tac-toe have so few possible games?

1) The board size
2) Only 2 types of pieces
3) A simple win condition

Tic-tac-toe is considered a **STRONGLY SOLVED system**, which means that we know the optimal move from any position to obtain the best possible result.
With perfect play on both sides, tic-tac-toe always ends in a DRAW!

byorgey.wordpress.com

Wait! What even is a SYSTEM?

And what does it mean to *SOLVE* a system?

The rules that govern a system's patterns are modelled through math.

A simple system:

x+5=y

x: input
y: output

A **system** is a collection of different parts that follow a common rule. It is anything that follows a pattern.

For tic-tac-toe:

- The input is your move
- The system is the state of the board
- The output is the new board with your move on it

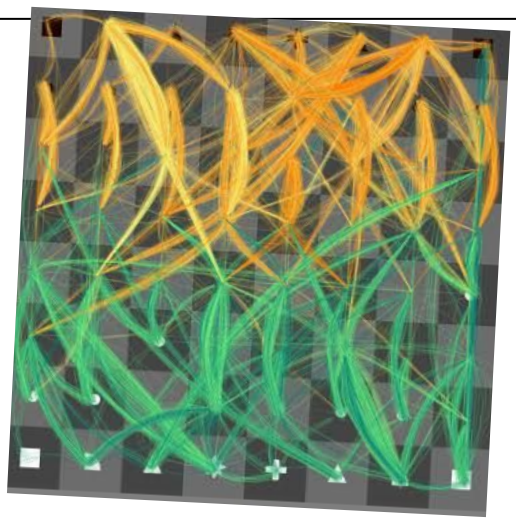
OR

- The input is a all of the sequential moves
- The system is the evolution of the board
- The output is the final state of the board

Solving a system means to find a strategy of inputs that results in a desired output 100% of the time.

Ex. "x+5=y" is solvable because if we desire y=9, we know we can make x=4

Now we know why tic-tac-toe is a **solved game**: because our desired output, getting a draw and if possible a win, is always possible when using a select set of inputs.



http://wordpress.mrreid.org/

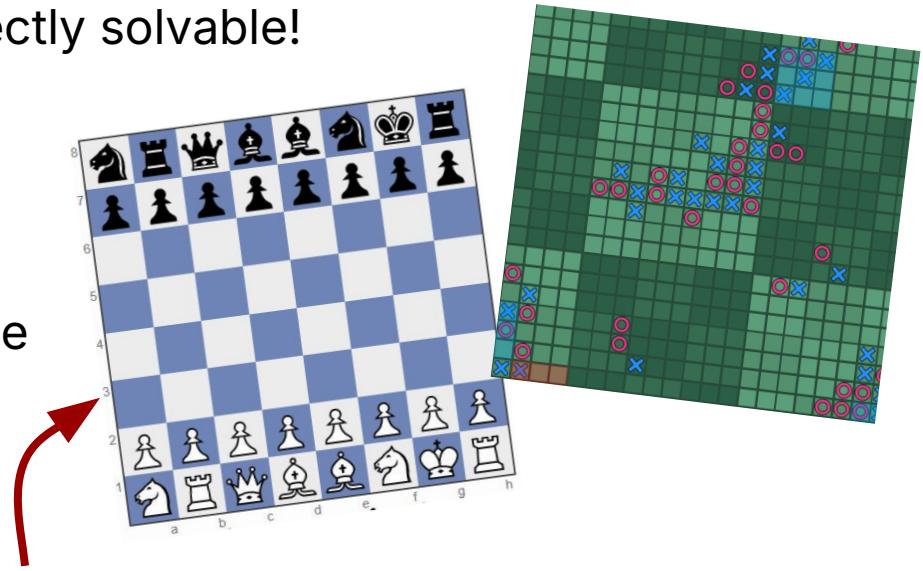
Are there UNSOLVED games?

Zermelo's Theorem

Every **2-player** finite game with no hidden information and no elements of chance is perfectly solvable!

This includes:

- Tic-tac-toe
- Chess
- 729×729 tic-tac-toe
- Mancala
- *Overcooked :D*



Then why does everyone say chess is unsolved!?

It has a massive **game tree** and the number of unique chess games *is greater than the number of atoms in this universe*.

While it is theoretically solvable, the constraints of our current computational hardware, as well as the physical limits of information travel, make it impossible for chess to be solved by ***us*** in ***this specific*** universe.

Fun fact: for chess to be *practically* solvable, Planck's constant would need to decrease or the speed of light would need to increase!

MAX information that can be stored in a spacetime region

$$S \leq \frac{2\pi k_B RE}{\hbar c}$$

Bekenstein Bound

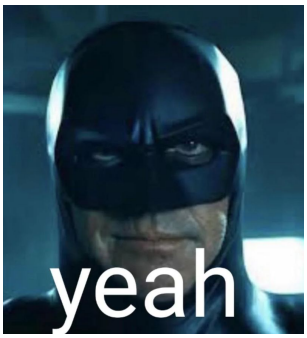
We made tic-tac-toe fun again.

The key to making a fun game is to make it *practically* unsolved, like chess!

When humans think they don't have a say in the outcome of a game, it makes a game not fun. *The fun factor of a system is directly correlated with our ability to change the output of a system.*

Fun fact: do not mention the word "free will" or "determinism" around me.

Even if a robot can solve a game, if *our* minds can't, we will still find it fun!



Fun Fact: This is the same reason there is push back on AI music. The combinatorial space of music is theoretically solved, but only by computers that can generate songs, not humans.

Step 1: Make it larger.

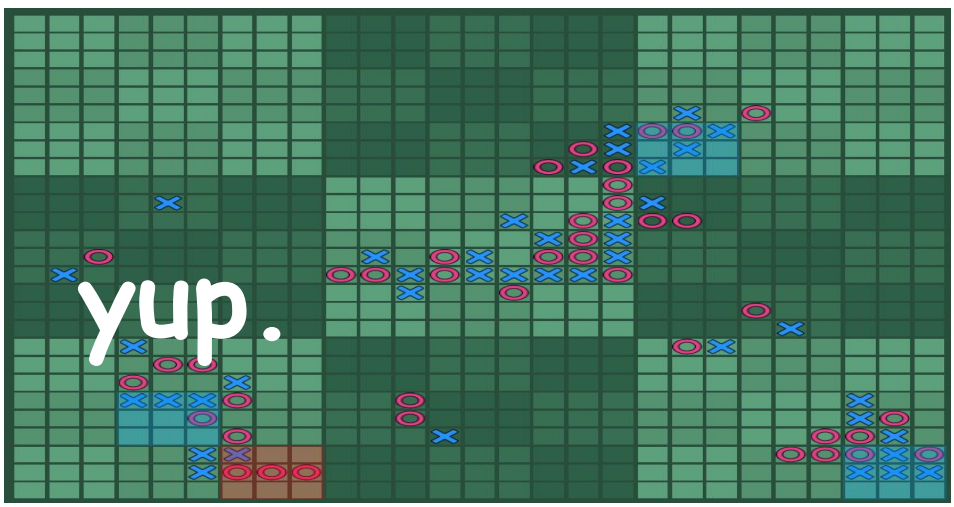
Tic-tac-toe is part of the family of **(m, n, k)-games**: an m x n board where k in a row is needed to win. This family has been studied highly due to its prevalence in history (dating back to **1300 BCE!**) and its relevance to computational limitations.

Gomoku is a more fun 15×15 tic-tac-toe. But let's make our version unreasonably bigger to see if that makes it even even even *mooorreeee* fun...

COMPLICATING THE GAME TREE EVEN *MORE*:

Step 2: Obstacles

Step 3: Points system adds choice to the win condition.

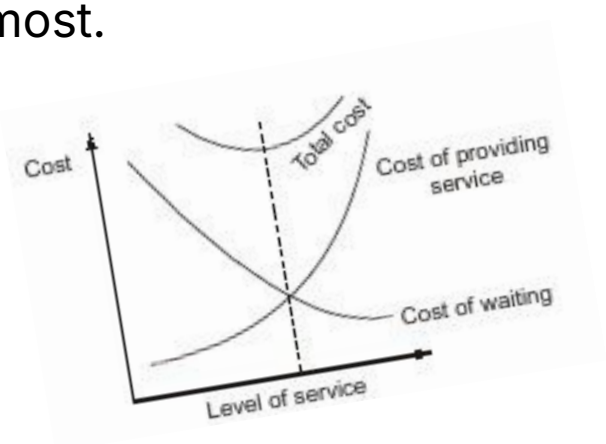


Why does our massively scaled up game of tic-tac-toe kind of suck?

Take a second to play the game. **Is it fun?**
(It won't hurt my feelings if the answer is no).

The fun factor is optimized around 9-27 size boards because they are the ones where you can ***visualize* and *feel*** your impact the most.

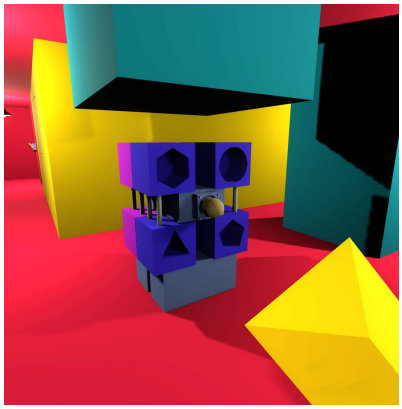
Out of all the people who have played so far, **80%** *preferred* **27×27** over 81×81 and 243×243.



"The larger games give your individual decisions less weight, which directly correlates with how fun the game seems."

THOUGHT EXPERIMENT:
*If you were an alien with a lifespan **10x** a human, would the **243×243** game then be fun?*

Ask me to see "the game made for aliens in another universe" if you are curious ;)



We can learn a lot from thinking about games, systems, and *life* this way. It leads to kindness for people who find different things fun, and mutual understanding.

Let's review what we've learnt so far:

1) Why the original tic-tac-toe was boring.
   (it had a small decision space)

2) Why the massively-scaled tic-tac-toe can also be boring.
   (difference in output from a single input was too low)

3) How to make games/systems fun.
   (optimize decision space)

What is YOUR favorite SYSTEM?

As a little experiment to get you thinking, write your favorite *finite* system on the giant sheet of paper. *It can be a video game, a task you accomplish each day, a job you clock in for in the morning, or whatever!*

My favorite systems:

- The yearly cycle.
  I love a complete year. It feels like it has everything. The week and decade are cool too, but the year is the most satisfying time period with a start and an end.

- Minecraft
- The galaxy (a classic tbh)
- World Cup format

Does TIC-TAC-TOE contain the rules for a Theory of Everything?

If you've taken a look at all the finite systems that people enjoy, you might start to see that almost everything we are a part of is a **finite system**.

(This is in contrast to a few popular ideas made by unscientific business geeks like *Simon Sinek*, who say that there are infinite games in our life).

Fun fact: There are no mathematically infinite games in life. *There are only finite games.*

But does this apply to the largest system, the *universe itself*?

Extrapolating simple rulesets and applying it to other places is called **universality.** We take this for granted, and it is actually quite incredible if you take a second to look around you.

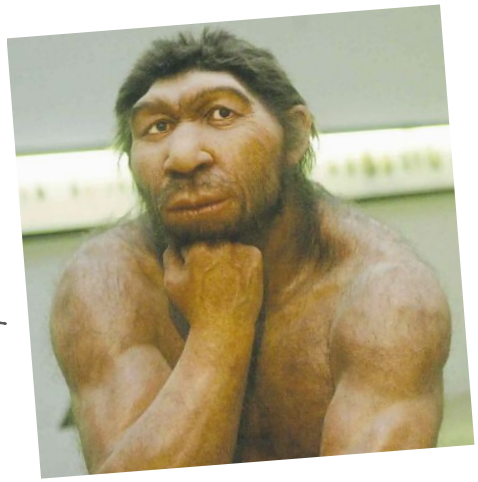
The "computational" form of universality is part of **digital physics**, which is a speculative idea that most people know nowadays as **simulation theory**.

Currently, most people clown on this idea because of the stupid and often cliche philosophical implications, but it was actually a credible topic, especially during its formation in 1978, when courses on digital philosophy were being taught at MIT. In academic circles, it is still fairly regarded, especially with the rise in information theory research due to quantum computing.

Are we playing a solved game?

Solvable game must be finite game.

We don't know if universe finite, but we have some evidence.



- According to the **Big Bang Model**: time had to start somewhere.

In the early 1900s, before this model was experimentally verified, most physicists actually believed the universe was cyclic or static. This was primarily because they couldn't grapple with the idea of *something coming from nothing*. After all, that would violate the **conservation of energy**.

- We were all born at some point.
- Yeah I mean there is probably other stuff but I'm too lazy to research it and put it here

Fun fact: Einstein didn't agree with the Big Bang theory at first and accidentally invented the basis for **dark energy** because of his resistance to the universe having a beginning 😐

If it is finite, there are still **2 main issues** preventing us from finding (AKA solving) a *systematic* theory of everything:

- **Gödel & Ashby:** An observer inside a system can never fully prove or understand its entire structure.
- **Quantum Mechanics:** Fundamental randomness and hidden variables cause uncertainty and unpredictability. 😕

Remember **Zermelo's Theorem?** This is in direct contrast with those rules. Uncertainty prevents predictability when modelling systems. Our model wouldn't allow us to find certain outputs when passing in the same inputs.

IN SUMMARY:

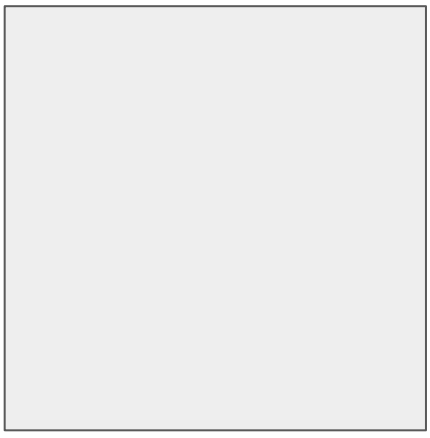
(thanks for stopping by 👋😁👍)

If the universe is a finite **system**, it could potentially be **solved** like a puzzle game.

A Theory of Everything would be considered the solution.

This consequently means a Theory of Everything is possible from the same systematic “rules” that govern tic-tac-toe.

But there are a *few* logical issues that stop this from being the prevailing attitude among physicists.



Read these posters online or save them for some retrospective inspiration :D

There isn't a section below this page.

There are no more problems to discuss, no more other issues with trying to solve the universe.

That's it.

There is nothing else to worry about.

Goodbye.

Another slight issue...

...which might prevent us from solving the universe...

Recently, the government announced the "**Genesis Mission**," which the White House describes as "a national effort to accelerate the application of AI for transformative scientific discovery focused on pressing national challenges."

From a glance, this seems like a big step up from the massive 60% cut in National Science Foundation (NSF) funding proposed by the government last year. It *looks* as if they have found some belief in science again. But with everything made by a businessman, there is a lot going on beneath the surface.

In order to fund the Genesis Mission, funding that use to be reserved for other scientific areas—specifically within the Department of Energy (DOE)—is being squeezed. In turn, those who previously received funding from alternate government programs are looking to the Genesis Mission for supplement. But the Genesis Mission mandates that in order to be eligible for grants from it, your research *must* have something to do with AI. *Some research simply doesn't need AI*. This consequently narrows what research is possible.

Along with this, it is possible that the Genesis Mission is implementing bias within scientific research, and possibly targeting specific industries to stop them from advancing. The current administration is known to have an adverse reaction to advances in medicine and physics. The DOE outlines 26 national science and technology challenges to be tackled by the Genesis Mission, and only 1 has to do with biology and 5 have to do with physics (that aren't purely there to ensure new weapons are being made).

And even worse, the Genesis Mission is putting further emphasis on pushing recently-graduated students into companies in order to increase the business value of America, rather than keeping them at universities where they have a greater ability to teach and *spread knowledge*. Part of the funding that was redirected to the Genesis Mission was from the education department, too. I should say that this is all speculation, but it's important to contemplate why a government might try to push resources away from educational institutions—it's possibly, just possibly, because *they're scared*. They're scared of what happens when the poor become educated, and when the educated become powerful.

As you relish how all these beautiful tidbits of science connect through something as simple as tic-tac-toe, it is important to understand that if the current administration gets their way, then tic-tac-toe will simply be plain-old tic-tac-toe. It won't be related to computers, to cosmology, or to vast existential principles. It will just be that regular, boring, already-solved game.