THE GAME THAT ISN'T A GAME

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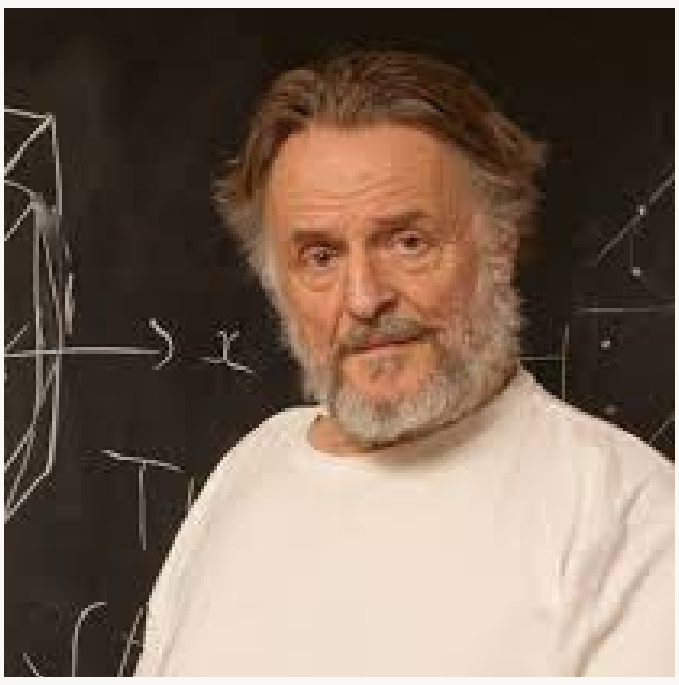
MATH 1700

John Horton Conway claims to have never worked a day in his life but carries one of the most impactful mathematical legacies. Among his contributions, he created a game that isn't a game at all in 1970, Conway's Game of Life, which has significantly impacted the field of math. Beyond being immortalized in the math community, Conway's Game of Life has provided a basis for scientific and digital development that marks the convergence of different areas of mathematics.



WHO IS JOHN HORTON CONWAY? ✦

John Horton Conway (1937-2020) became a mathematics professor at Princeton University in 1987 and was a John Von Neumann Professor in Applied and Computational Mathematics. In 2013, Conway was transferred to emeritus status. He was largely known for his childlike curiosity and passion for thinking that informed many of his major contributions from Surreal Numbers to Knot Theory

Known for his love for games and magic tricks, Conway was known to carry ropes, pennies, cards, dice, and models as a means to entertain those around him. Many of his colleagues often referred to Conway with several nicknames and titles such as the "most charismatic mathematician," a "magical genius," and "The Prof" (a name given by one of his math professors in youth)

Despite his strong affinity for games, Conway is responsible for several mathematical discoveries in the fields of number theory, geometric topology, theoretical physics, combinatorial game theory, and geometry - all of which have served as a foundation for advanced mathematics as we know it today.

CONWAY'S GAME OF LIFE ✦

In 1970, Conway's Game of Life was introduced to the public. The game betrays its namesake by not being a game at all. In fact, Conway's Game of Life is a mathematical model that simulates the evolution of cellular autonomation, which means beyond its inception, the game doesn't need human interaction, hence why Conway called it a "no-player never-ending game".

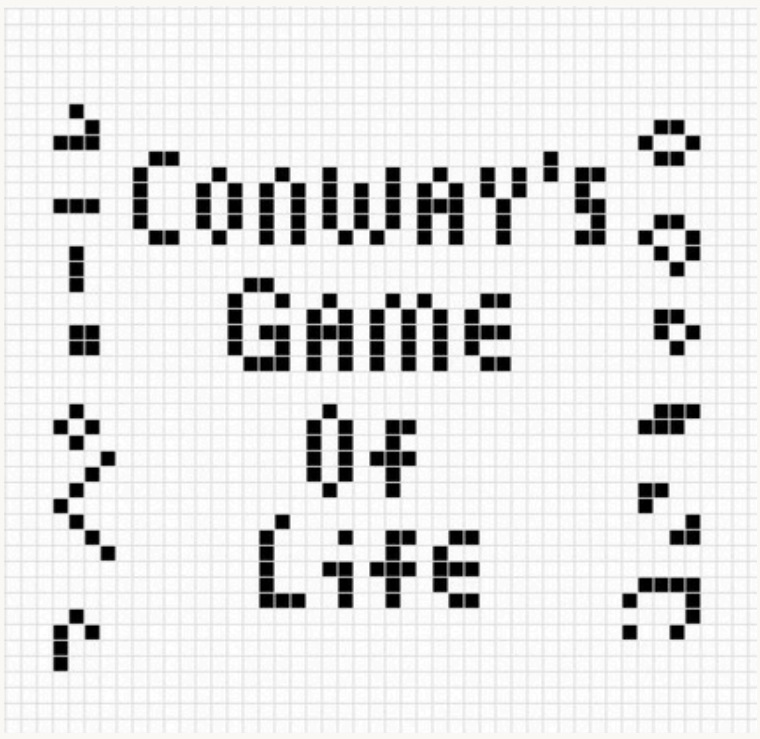
HOW DO YOU “PLAY”? ✦

What is this so-called “game” and how do you “play” it? Conway’s Game of Life is best summarized as being a model existing on a two-dimensional rectangular grid of cells. Before enabling a round of the game, these cells can be assigned by an individual to have a particular status, either “on” when they’re full or “off” when empty, which determines their movement once the simulation is initiated. One application of the game is its parallel to the billions of cells in the human brain. There are three basic rules governing the game’s progression:

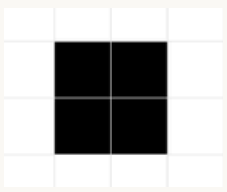
1. The Life Rule: If at time t, a cell is off and surrounded by three on cells in any direction, it is alive at time t + 1

2. The Death Rule: If the cell has less than one or over four on cells surrounding it, the cell will dies

3. The Survival Rule: If a cell has two or three living neighboring cells, the cell will stay alive at t + 1



Game of Life in Java via Google

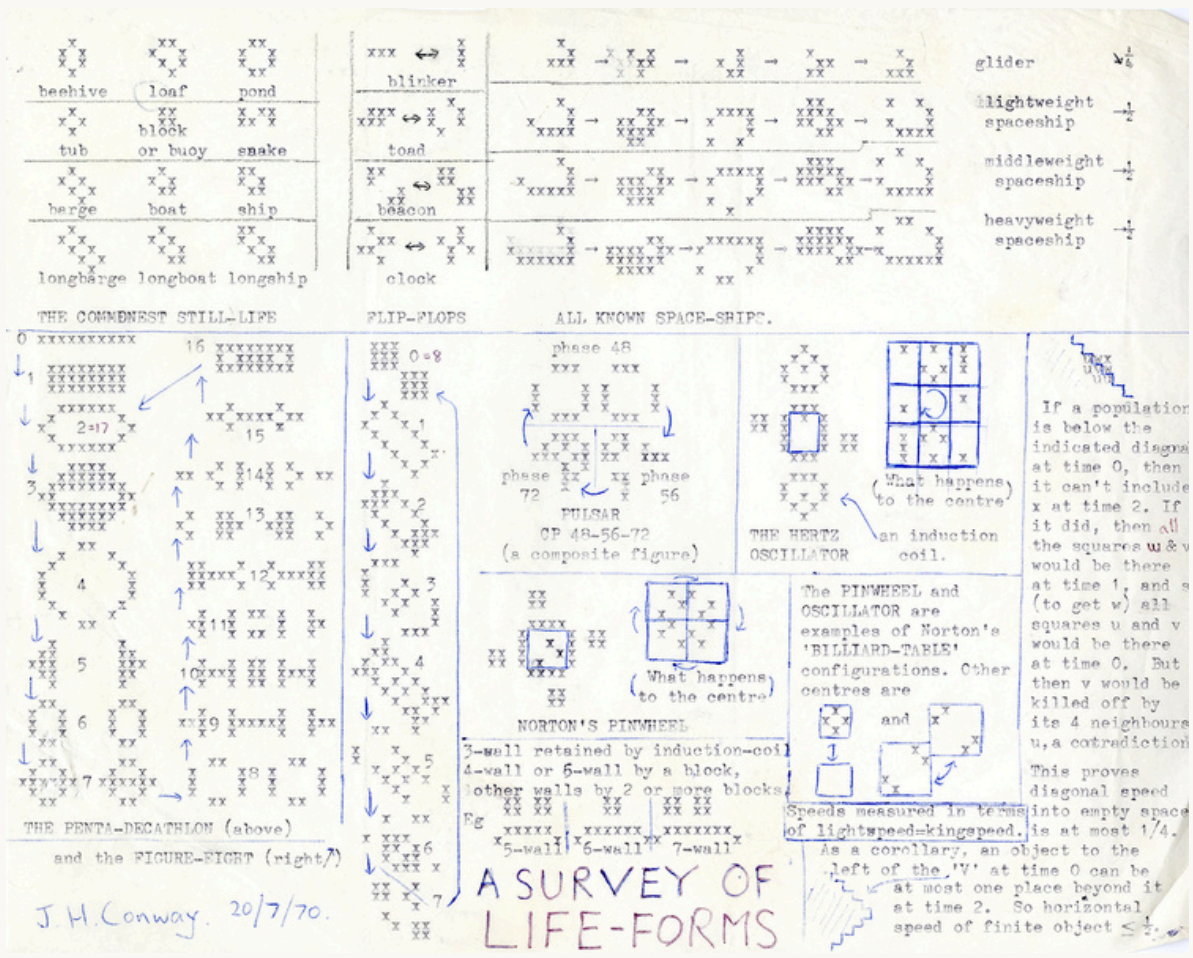


Blocks (“eaters”): 2x2 structures that maintain shape when interacting with other patterns

PATTERNS IN CONWAY’S GAME OF LIFE ✦

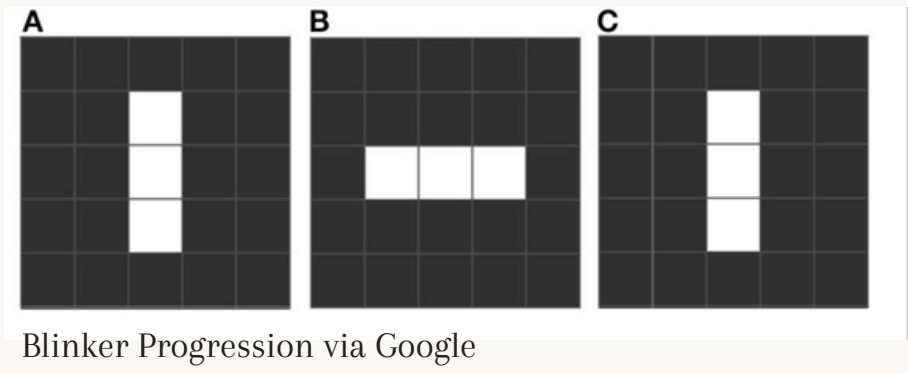
Each iteration builds upon the previous iteration to forward the game’s progression. Despite the apparent simplicity of these rules, Conway’s Game of Life is far from easy to predict. Several patterns arise from simulations, having been discovered since its creation to today, where new patterns are being discovered and named each year. Some characteristics of the game are distinct pattern formations, perpetual game movement, and impermanent structures.

Conway created a survey of noticeable life forms from early explorations of his game. One of the most common forms exhibited in the game are still-lifes, structures that once created, never change due to the unique orientation of on and offcells. These include blocks, boats, loaves, and beehives



John Conway’s Survey of Life-Forms via Princeton University archives

Oscillators are another pattern with the characteristic of repeating periodically, yet never shifting on the grid. The two categories of oscillators are “blinkers,” which oscillate between two states, and “pulsars,” which oscillate between three states. Some common blinkers are the Toad and Beacon.

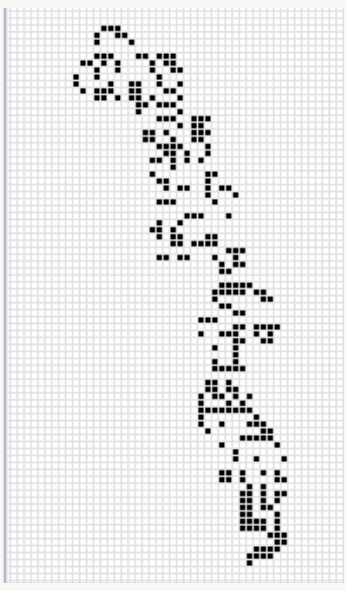


Blinker Progression via Google

DISCOVERIES: SPACESHIPS ✦

Discoveries in the game of life have vastly increased the knowledge of different spaceship forms, structures that can induce their own movement across the rectangular plane without dissipating. The glider is the most fundamental example of a spaceship but is also known to be the first discovered, due to its commonality and small size.

A discovery as recent as in 2018 was made to discover the first knightship, known as Sir Robin by Adam P. Groucher, a British algorithmist, Other spaceship forms such as the Speed Demonoid and Doo-Dah have similarly been discovered.



Sir Robin via LifeWiki

WHAT IS THE IMPACT OF CONWAY'S GAME OF LIFE? ✦

There has been an immeasurable impact on the field of mathematics but also several other fields that indicate the convergence of math with new opportunities for research and development, including biology and computer science. Conway's Game of Life belongs to the growing class of what are called "simulation games," which has been brought upon by the popularization of cellular automata. This has led to the modeling of everything from ants to traffic. These aspects indicate that the game is Turing complete and can simulate any computation process with the right initial configuration.

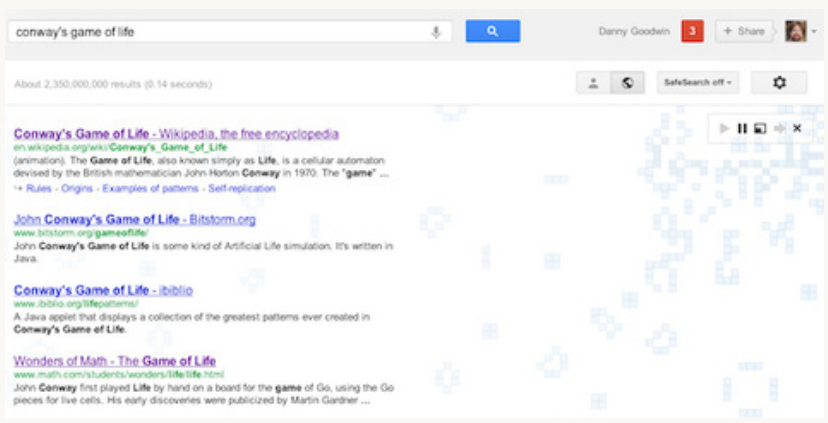
Beyond yearly discoveries adding to the complexity of Conway's, several takeaways can be gleaned from Conway's invention.

The **complexity** of the game exhibits that simple systems are capable of showing computable behavior and indicates universality, the existence of a universal system that can solve any computable process and handle prevailing problems. The **pattern-driven nature** of the game indicates that the game is omni-periodic, defined by having oscillators of all periods, even those that haven't been discovered by humans. **Non-linearity** is exhibited in the ability for small changes in the initial conditions of the game to have large and unexpected effects on a system's behavior, where complex patterns can arise from simple rules. Lastly, the game exhibits **self-organization** through having a simple system that can organize itself into complex patterns and structures.

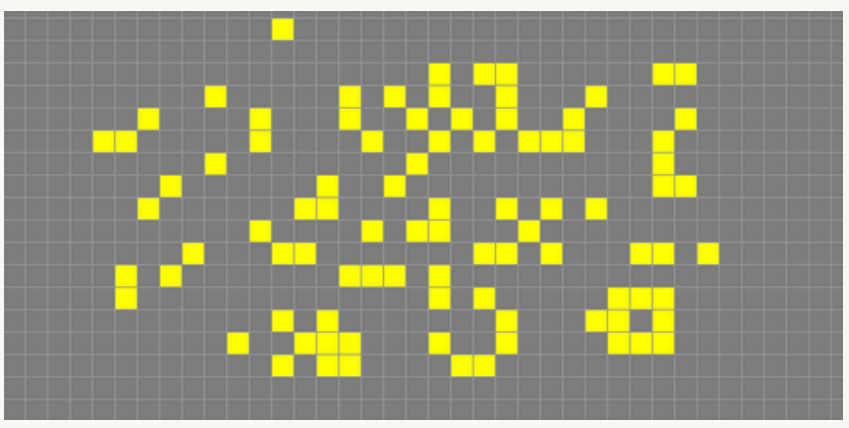
DIGITAL IMPACTS OF CONWAY'S GAME OF LIFE ✦

It is becoming increasingly easier to find modes to play Conway's Game of Life, from open-source implementations using Experiments with Google to online programs. This is one of the many impacts Conway's Game of Life has had on our lives, especially in the online world.

The first interactive program was written by Michael J. T. Guy and Stephen R. Bourne, which sparked the many Game of Life programs that exist online such as Golly, Mirek's Cellebration, Xlife, Dr.Blob's Organism, and ConwayLife.com. One of Google's many "Easter eggs" can be found by searching for "Conway's Game of Life," resulting in search results being slowly covered by a growth of blue cells.



Google Easter Egg: Search Conway's Game of Life via SearchEngineWatch



Conway's Game of Life vis playgameoflife.com

For a while, Conway would often say "I hate Life," but through seeing the impact of the game and the popularity of being referred to as 'John Conway, Creator of Life,' he rediscovered a love for the mathematical legacy he created.