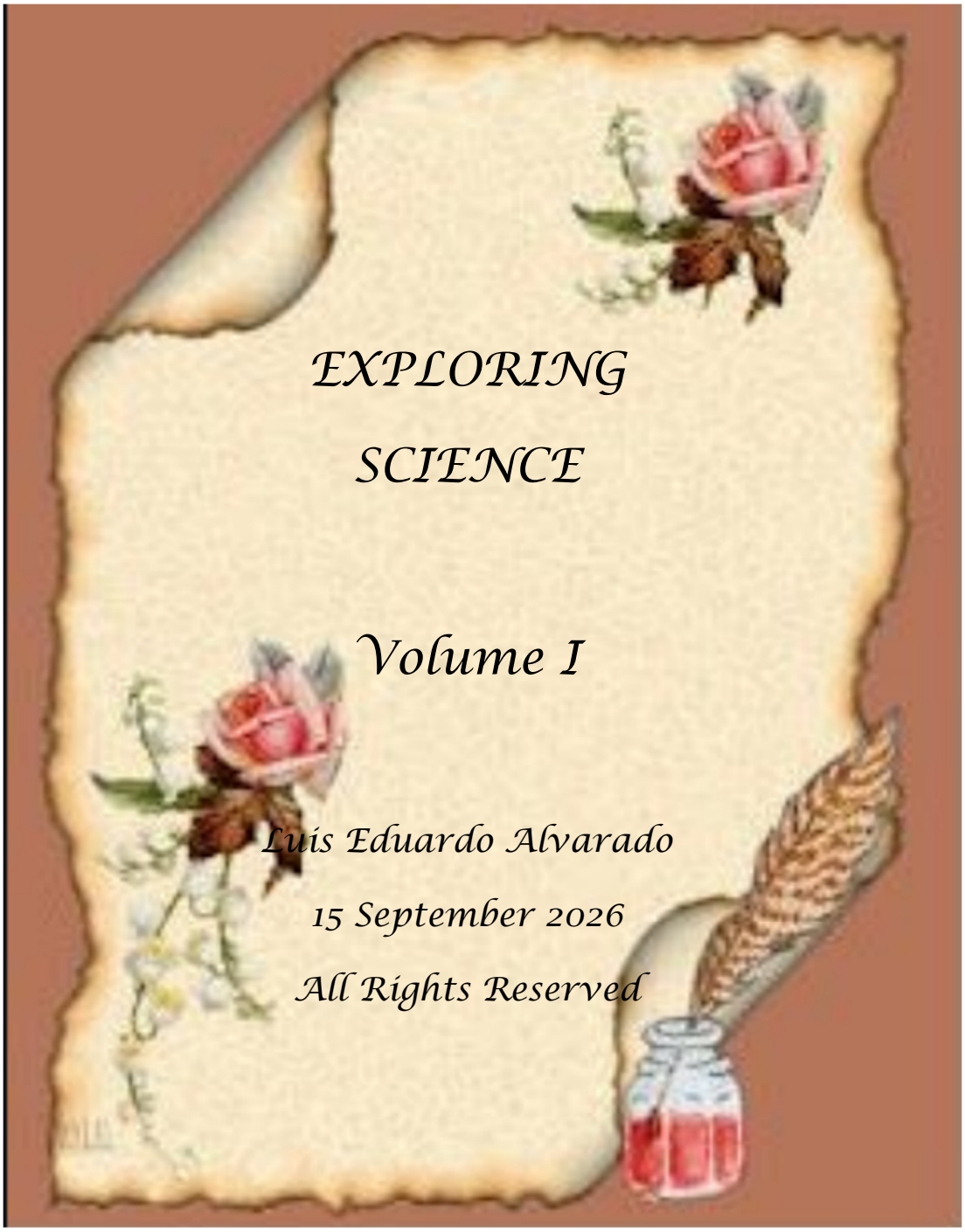

EXPLORING
SCIENCE
Volume I
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Prologue

This is Volume I of my science articles, which I have published in various internet groups and shared with my family and friends. Some of these writings were originally drafted in English and later translated into Spanish using the portal "www.poe.com." The same portal was also used as support in editing this document.

I cordially invite the reader to visit my website: www.luiseduardoalvarado.net, where you can find other works and publications of mine.

This book has been prepared with the purpose of offering a clear and structured overview of various scientific topics that have deeply sparked my curiosity—and which I hope will spark yours as well. Throughout these pages, I attempt to provide the best possible answers to questions that humanity has long asked, such as: What is the origin of the Universe and how large is it? How does the quantum world work? How does the evolution of species operate? In what direction is the Universe expanding? Is time an illusion? How can something arise from nothing? What is artificial intelligence and where is it leading us? Have extraterrestrials visited our planet? Could the universe be a simulation? These are among the many questions that have motivated my reflection and study.

This document is intended for the general public, with the aim of strengthening their knowledge and encouraging critical thinking regarding these great scientific topics. In several sections, the document provides simple numerical examples to facilitate the reader's understanding. Most of these questions cannot be answered without bringing together two fields of study that sometimes oppose each other and sometimes help each other; I am referring to science and philosophy.

Finally, I sincerely thank all the people who made this work possible, whether through their guidance, support, or valuable criticism during the writing process.

I invite the reader to explore the following pages with an open and analytical mindset, in the hope that the content presented here will be both useful and enriching.

The Concept of Time

If you ask me what time means to me, I would answer that it is, quite simply, one more dimension of the universe, integrated, together with the three spatial dimensions, into the structure of spacetime. Each object follows a trajectory through that spacetime, called a worldline, and along it experiences its own time. Not all clocks advance at the same rate when compared with one another.

Unlike the three spatial dimensions, time seems to have a privileged direction: it always moves toward the future. This orientation is related to the second law of thermodynamics, according to which, in an isolated system, entropy tends to increase.

1. The Relativity of Time

On a trajectory close to an object of great mass, such as the Sun, time passes more slowly compared with that of an observer located in a region where the gravitational field is weaker. This is due to the curvature of spacetime produced by mass and energy. This effect is called gravitational time dilation. In regions where the gravitational field is weaker, clocks run faster in that same comparison.

There is no absolute “now”: simultaneity depends on the observer’s state of motion, as established by the theory of special relativity.

Motion also affects the measurement of time and space. An object moving at high-speed relative to you experiences a contraction of its length in the direction of its motion, according to your reference frame. The closer it gets to the speed of light, the greater this effect becomes. In addition, its clock will run more slowly than yours according to your measurement; this phenomenon is called relativistic time dilation. However, in its own reference frame, its clock runs normally.

Einstein’s theory of relativity teaches us that past, present, and future are not absolute concepts in the classical sense; rather, some temporal relationships, such as simultaneity, depend on the observer.

When we look at the stars, we see the light they emitted thousands or millions of years ago. If I turn on a lamp today, an observer located thousands of light-years away will be able to see it thousands of years from now, according to the time it takes for the light to reach them. It is not that they see “my future,” but simply that information takes time to travel.

Similarly, if a civilization located 65 million light-years away observed Earth today with a telescope of sufficient resolution, it would be receiving the light that left Earth approximately 65 million years ago, when dinosaurs still existed.

A classic example is the twin paradox. If one of the twins traveled at a speed close to the speed of light and then returned, when reunited with his brother he would have aged less than the twin who remained on Earth.

During the trip, each one may consider the other's clock to be advancing more slowly while they are in uniform relative motion. The final difference appears because the traveling twin changes reference frames by accelerating, changing direction, and returning, breaking the symmetry of the situation.

While the spacecraft moves away from Earth at constant speed, the situation may seem symmetrical: from Earth, the traveler's clock runs more slowly; from the spacecraft, Earth's clock also appears to run more slowly. However, this symmetry is not maintained throughout the entire trip.

The crucial point is that the traveler must change direction in order to return. To do so, he must accelerate and modify his trajectory, while the twin who remains on Earth follows, approximately, an inertial trajectory. It is precisely this difference between their trajectories through spacetime that produces the final difference in the time elapsed for each one.

Time dilation in special relativity is expressed by the relationship:

$$DT = \frac{T0}{\sqrt[2]{1 - \left(\frac{v}{c}\right)^2}}$$

where c is the speed of light, **T0** is the proper time — measured by the observer moving together with the phenomenon — **v** is the relative velocity, and **DT** represents the dilated time measured by an external observer. As **v** approaches **c**, the denominator decreases and time dilation increases exponentially.

A simple example would be:

Two twins: Andrés stays on Earth. Luis travels in a spaceship to a distant star and returns.

Constant speed of the spacecraft:

v = 0.8*c

where **c** is the speed of light.

Distance to the star from Earth's point of view:

d=8 light-years

Time measured from Earth:

Time = $\frac{d}{v}$ **=** $\frac{8c}{0.8c}$ **= 10 years**

Therefore, the round trip lasts 2*10 = 20 years for Andrés.

Time dilation factor for Luis:

$$DT = \frac{10}{\sqrt[2]{1 - \left(\frac{0.8c}{c}\right) \text{^} 2}} = 0.6$$

Therefore, the trip lasts for Luis:

Trip Time for Luis = 20 * 0.6 = 12 = 12 years

Luis ages only 12 years, while Andrés ages 20 years.

General relativity introduces an additional and fundamental element: mass and energy curve spacetime and modify the rate at which clocks run. In intense gravitational fields, clocks run more slowly; in regions where gravity is weaker, they advance more quickly.

For this reason, GPS satellites must correct for both the effects of their orbital speed and the effects of Earth's gravity in order to provide precise measurements of time and position.

When the curvature of spacetime reaches extreme conditions, gravity can become so intense that, within the event horizon of a black hole, not even light can escape. Near it, and especially within the event horizon, our usual notions of space and time cease to be applicable in the everyday sense.

2. Origin of the Universe

Regarding the origin of the universe, the Big Bang should not be imagined as an explosion within preexisting space, but rather as the expansion of spacetime itself from an extremely hot and dense state.

During the earliest stages of the universe, space may have expanded in such a way that very distant regions separated from one another at a recession speed greater than the speed of light, without contradicting relativity. It was not matter traveling locally faster than light, but the expansion of space between distant regions.

Driven by dark energy, the universe could continue expanding for extraordinarily long periods of time, possibly for trillions of years, while its average temperature progressively decreases.

Some proposals, such as Roger Penrose's Conformal Cyclic Cosmology — CCC — suggest that when the universe reaches an extremely diluted state, its geometry could be described through a mathematical transformation that would allow that state to be interpreted as the beginning of a new cosmological eon, related to a new Big Bang. Perhaps this process has repeated indefinitely, although this hypothesis remains speculative and is not an established cosmological theory.

Perhaps questions such as "what existed before the Big Bang?" or "who created the universe?" arise, in part, from our own cognitive limitations. We are accustomed to thinking in terms of beginning and end, but modern physics suggests that, if time itself has a boundary or loses its physical meaning under certain conditions, some of those questions might cease to have physical meaning.

3. The Arrow of Time

Entropy, a fundamental quantity in thermodynamics, is related to the so-called arrow of time. According to the second law of thermodynamics, in an isolated system entropy tends to increase, and this direction distinguishes, in our physical experience, the past from the future.

That increase in entropy is related to the irreversibility of many natural processes. If I break a cup into a thousand pieces, you will never spontaneously observe those pieces come back together and reconstruct the original cup. This phenomenon illustrates what we call the "arrow of time."

For this reason, we can relate our experience of time to an irreversible trajectory through spacetime, marked by physical processes that have a temporal direction. What human beings experience as "the arrow of time" is closely related to the evolution of entropy and to our particular trajectory through spacetime.

That is why we speak of a temporal arrow: we remember the past, but not the future; we see objects break, age, or disperse, but we do not spontaneously observe the reverse process.

In that sense, time is not simply one more coordinate of spacetime, but a dimension whose experience is deeply related to the irreversibility of certain physical processes.

Your path through spacetime can never be traveled again in exactly the same way, nor crossed freely as if it were a place in space. We move forward through it, but we cannot retrace it identically.

However, an interesting question arises: if we could return to the past, would we really return to the same spacetime, or would we enter a new one, into a line of reality where we had never been before?

In that case, we would not travel the same path, but a different one. Your past would no longer be exactly the same: it would be another route, another possibility, perhaps even another universe. It would be a new experience of yourself.

It would be a new journey through spacetime in which, at least hypothetically, one would have to explain how causality and the laws of thermodynamics would be preserved.

This thought could be related to the idea of a “block universe,” according to which past, present, and future form part of a complete structure of spacetime. However, the block-universe interpretation is a philosophical interpretation of certain features of the theory of relativity and does not, by itself, imply that it is possible to travel freely into the past.

The secret also lies in how we imagine the geometry of spacetime when a photon travels from a star, through space, to Earth and is finally detected by the retina of your eye.

For the trajectory of a photon, proper time is zero. However, it is not correct to speak of the “photon’s point of view,” because in relativity there is no valid inertial reference frame associated with an object traveling at the speed of light.

For us, as observers, that photon may have traveled a distance of millions of light-years and may have taken millions of years to reach Earth.

Similarly, we can imagine how matter and energy modify the geometry of spacetime. Light follows the trajectories determined by that geometry. Near very massive objects, the curvature of spacetime can modify the path of light and also the time that a distant observer assigns to its journey. This effect appears, among other phenomena, as gravitational lensing and as the gravitational delay of light.

Therefore, the distances and time intervals that we measure are not independent of the geometry of spacetime. In a universe with curved geometry, light may follow paths that differ from those it would follow in flat spacetime.

4. Time Inside a Black Hole

A black hole is such an extreme and deep curvature of spacetime that no electromagnetic radiation, including light, can escape from it.

If you fall into a black hole, you would experience your own time — proper time — advancing at the usual rate of one second per second. However, an outside observer would see you approach the black hole's horizon more and more slowly until your image appeared to freeze in time right at the edge of the black hole. The observer would not see you fall into the black hole; your image would simply disappear.

Once the event horizon — the boundary of no return — is crossed, the physical laws undergo a radical inversion. The extreme gravity of the singularity alters the geometry of spacetime to the point of reversing their physical roles.

Time is no longer a temporal direction; it becomes a spatial dimension pointing directly toward the center of the black hole. The singularity is no longer a coordinate in space that you can choose to go to or not; it becomes an inevitable moment in your chronological future. You cannot go backward or remain still, because that would be equivalent to traveling into the past. The mathematical demonstration of this concept is beyond the scope of this article.

This phenomenon was cleverly illustrated in Christopher Nolan's film **Interstellar**, where time appears transformed into a navigable dimension. Cooper can see his daughter Murph's room at many different moments and can move through them as if they were shelves in a store. Cooper, inside the tesseract, temporarily gains access to a higher perspective where time unfolds as a dimension that can be traversed. The tesseract is the four-spatial-dimensional equivalent of a cube.

Imagine a two-dimensional being living on a sheet of paper. It knows only the xxx-yyy plane. We, three-dimensional beings, can see the entire sheet from above. We can touch different points in its world without moving within its plane. For them, our third dimension would seem almost magical. In **Interstellar**, Cooper was able to see our spacetime in a similar way.

5. Summary

Time can be understood as a dimension of the universe, inseparable from the three spatial dimensions. Together they form spacetime, within which all events occur. Time is the temporal dimension through which we can order and measure events. Time is not absolute; rather, it depends on the observer's state of motion and gravitational field.

Our Digital Universe

The more I read about the universe, the more I am inclined to think that we may be living in a digital reality.

Scientists maintain that elementary particles are not solid objects in the classical sense, but rather disturbances in the fabric of the universe, as described by quantum field theory and quantum electrodynamics. In this view, what we call a “particle” is simply a localized excitation of a fundamental field.

The double-slit experiment is one of the most famous and puzzling experiments in quantum physics. It demonstrates that light and matter can behave both as waves and as particles.

The setup is simple: a source emits particles—photons or electrons—toward a barrier with two tiny slits. Behind it is a screen that records the impacts.

When no observation is made to determine which slit each particle passes through, the pattern that appears on the screen is an interference pattern, characteristic of a wave—as if each particle had passed through both slits at the same time. However, if detectors are placed to identify the path taken, the pattern changes drastically. Instead of interference, two defined bands appear, as if the particles were small solid spheres passing through one slit or the other. The mere act of observation alters the result. Most strikingly, this behavior remains the same even if you fire one particle at a time. The particle behaves like a wave when it is not observed and like a solid object when it is observed.

This phenomenon can be imagined from a computational perspective. In programming—for example, in C++—a class defines properties and behaviors, but the object itself does not exist until the class is instantiated.

Suppose there is a class called “Particle,” with attributes such as size, linear momentum, and state of observation. The class describes all possible characteristics, but the specific particle only “exists” when an instance is created. Before that, it is merely a potential definition.

From this analogy, the wave function would be like the set of abstract properties of the class. Only when it is instantiated—when it is “measured”—do those properties acquire specific values and manifest as a concrete particle. Wave-particle duality would then correspond to the transition from definition to instance.

Within this conceptual framework, the structure of the universe would act as a base class. Its subclasses, functions, and internal variables would determine the properties

of all known particles—electrons, protons, and others. As long as they are not observed, they would remain mere perturbations of spacetime: defined possibilities, but not yet actualized.

Quantum entanglement could also be interpreted through this digital metaphor. Two electrons that once formed part of the same atom may retain correlations in properties such as spin, even when separated by enormous distances. It is as if they share a "common memory."

In programming terms, we might imagine a function Particle.entangle() that links two instances. When the spin of one is measured, the other instantly updates its state to preserve the coherence of the system. To the observer, they appear to be the same original particles; from the program's perspective, they could be new instances generated under consistent system rules.

If we extend the analogy even further, the universe might not have an absolute beginning or end, but could operate like an infinite loop—an endless cosmic "while loop"—where each Big Bang represents a new iteration.

Many physical phenomena appear to occur in discrete steps: the Planck length, quantized energy levels, radiation emitted in defined packets. This discrete structure resembles digital logic.

Time, for its part, can be understood as a set of lines within the geometry of spacetime. Each worldline is like a clock advancing at a different rate. A function of the "universal program" could assign trajectories according to the curvature of spacetime, determined by mass and gravity. In the same way, the program would calculate the observed time for each object according to its relative velocity.

Perhaps we live in an imperfect digital simulation—imperfect because it is difficult to imagine that the "programmers" would allow so many inconsistencies, such as creating human beings capable of behaving like a virus that ultimately damages the system itself.

And it would be ironically amusing if our lives were nothing more than sequences of bytes—perhaps simple 8-bit blocks—in a program written, who knows, as a beginner's exercise.

A Brief Instant in a Universe of Many

Do not feel alone: even if you are only an instant in one universe, perhaps one among many, your presence leaves an unrepeatable mark.

1. We Are a Brief Instant in the Universe

It does not matter who you are or how much money you have. We live in a universe governed by processes that, on many levels, are fundamentally probabilistic and ruled by unbreakable laws: from the quantum mechanics of Niels Bohr and Werner Heisenberg, where particles do not have a definite position until they are observed, to the cosmic vision offered by Einstein's general relativity, where space and time curve under the weight of matter and energy.

Imagine a vast cosmos populated by brilliant stars and distant galaxies, where even the smallest events can influence the course of existence. Your probability of dying is written into your biology and into the way you live; you cannot deceive it or avoid it indefinitely. Every cell in your body follows chemical and physical processes that, sooner or later, will reach their limit. You are part of the rules of the cosmic game.

But that should not sadden you. On the contrary: feel deeply proud for the simple fact of having been born. You were born human, a member of a fragile and relatively recent species in the history of the universe. On this small blue planet, surrounded by immense oceans and majestic mountains, you emerged among millions of biological possibilities. Among countless possible combinations, you are the one who came into existence. Imagine that you were the unique combination of millions of sperm cells from your father and thousands of eggs from your mother. Also remember that we are all simply stardust. Imagine that an enormous number of atoms — approximately 7×10^{27} — had to come together in one place for you to be born.

To die is, in a sense, a privilege: it means that, for a brief cosmic instant, you were alive. Do not waste that fact by complaining endlessly or by attributing your existence to imaginary entities. Recognize your own fortune: you had the infinitesimal and extraordinary opportunity to experience this beautiful and chaotic world. And perhaps also the opportunity to pass life on to your children and grandchildren, who, like you, will have the privilege of existing and, eventually, of dying.

Because what is truly extraordinary is not death, but that for an instant in the immensity of the cosmos you were here. And that instant — your instant — is all the cosmos will ever need in order to have been conscious of itself.

2. A Universe of Many Universes That Have Existed

Our brains lead us to think that everything, including the universe, must have a beginning and an end. However, not everything in geometry follows that logic. A circle or a sphere, for example, has no starting point or ending point. In the same way, it may be that the universe is not an isolated event, but part of a broader reality: a set of multiple universes that have existed or will exist.

It is worth remembering that our perception of reality is mediated by our senses and by the structure of our brain. Mathematics and physics allow us to model the universe with extraordinary precision, but a model is not reality itself: it is a mathematical representation. We can formally describe quantum phenomena, but that does not mean we fully understand them.

Numerous studies analyze, for example, the behavior of electrons when an atom is excited by high-energy radiation. It is said that electrons "jump" from an energy level close to the nucleus to another farther away, acquiring greater potential energy. However, this "jump" is not a continuous displacement through space. In the quantum formalism, the electron stops occupying one state and moves to another without passing through defined intermediate positions. Sometimes this is called a "quantum leap," but we do not know how to describe what happens in classical terms between one state and the other.

In fact, modern physics no longer conceives of electrons as tiny material spheres, but as excitations of quantum fields. Within this framework, matter is not something solid and fundamental, but rather a quantized manifestation of fields, just as light is an excitation of the electromagnetic field.

Some theories have proposed the existence of additional dimensions. To illustrate this, let us imagine that we are two-dimensional beings living in a flat world. If a three-dimensional sphere passed through our universe, we would perceive only a point appearing out of nowhere, then a circle gradually growing, reaching a maximum size, and then shrinking until it disappeared. We would never understand that we had witnessed the passage of a three-dimensional object through our two-dimensional world. In an analogous way, certain phenomena could correspond to realities that exceed our perceptible dimensions.

Another mystery is the duality of light. It can behave as a wave in some experiments and as particles — photons — in others. Today we know that its most precise description is provided by quantum electrodynamics, or QED, where light is understood as a quantized excitation of the electromagnetic field. It is not that it "is" a wave or a particle in the classical sense; those are approximations we use according to the experimental context.

There are also interpretations that suggest parallel universes. According to some versions, if in your universe you observe an electron with “spin up,” in another universe it would have been observed with “spin down.” These hypotheses attempt to give mathematical coherence to the probabilistic results of quantum mechanics, although they are still far from having direct empirical confirmation.

The question of how something can arise from nothing remains open. Perhaps its answer must wait until we better understand current phenomena such as quantum entanglement, the measurement problem, or the nature of dark matter and dark energy.

Even so, we are fortunate. Although we occupy a tiny place in the cosmos, we can understand that Earth is merely a small planet orbiting an ordinary star in a galaxy with approximately 200 billion stars. And our galaxy is only one among more than two trillion observable galaxies in the visible universe. “Visible” means precisely that: limited by the speed of light. There could be countless galaxies whose light has not yet had time to reach us.

Our ignorance and our cognitive limitations should not push us to accept easy explanations. Throughout history, humanity has created hundreds of gods to explain the unknown. But if it is argued that a god has always existed, one could also propose that the universe itself, or reality as a whole, has always existed.

Ignorance is not a defeat; it is an invitation. It drives us to study more, to encourage in new generations an interest in science and technology. Perhaps, in the not-too-distant future, we will come to understand our universe better and recognize that life is not a phenomenon separate from nature, but one more expression of energy organized into increasingly complex forms.

The Immensity of the Universe and Its Expansion

We live in an immensely large universe that may continue expanding for many trillions of years. Its expansion may eventually continue to the point where matter becomes so dispersed that the conditions necessary for life become impossible.

1. The Immensity of the Universe

We live on a planet called Earth.
Our star is called the Sun, and our solar system is part of our galaxy, the Milky Way.

The Milky Way is approximately 100,000 light-years in diameter. It is a relatively flat spiral galaxy, with a thickness of approximately 1,000 to 2,000 light-years. It contains between 100 and 200 billion stars, many of them much larger than our Sun.

To compare sizes: if the Sun could be represented by the dot above the letter “i,” approximately one million Earths could fit inside that tiny dot. On that same scale, our galaxy would be unimaginably larger than the planet Earth.

Our observable universe contains approximately 2 trillion galaxies. It has an estimated age of 13.8 billion years. We call it the “observable universe” because the oldest light we can observe originated approximately 13.8 billion years ago. If the universe is older, its light has not yet reached our telescopes.

We should remember that when we look at the starry sky at night, we are seeing light that was generated millions, and even billions, of years ago. It is very likely that some of those stars no longer exist.

Conversely, if you could observe the surface of Earth from a star located 65 million light-years away, you would see dinosaurs inhabiting our planet, and human beings would not yet exist.

To visualize the immense age of the universe—13.8 billion years—on a human scale, imagine compressing its entire history into a single “cosmic year” of 365 days. According to this calendar, popularized by Carl Sagan, human history is incredibly recent. The appearance of our species, *Homo sapiens*, would occur on December 31 at approximately 11:52 p.m. In other words, modern humans would have emerged only about eight minutes before midnight on the last day of the year.

The average lifespan of a woman is approximately 80 years (yes, my friends, men live about five years less, which means they will very likely be the ones to bury us!). On this same scale, 80 years would represent approximately 0.81 seconds of that cosmic year—less time than it takes to blink an eye.

2. The Expansion of the Universe

Some people have asked me: If the universe is expanding, **what is it expanding into?**

Below is an answer based on readings of works by prominent physicists:

The question assumes the existence of an external dimension into which the universe is expanding. My answer is that there is no "something" outside the universe. This is a difficult idea to grasp intuitively.

A useful visualization—although it is only a simple analogy—is to imagine the universe as a continuously expanding sphere, with the observable universe located on the surface of that sphere. Time can be conceived as a vector perpendicular to the surface. To contemplate what the universe was like in remote epochs, we simply "look" toward the interior of the sphere. On the surface, galaxies move farther apart from one another as the "bubble" expands.

According to this image and analogy, at the initial moment—the Big Bang—the sphere was extremely small and, within a very brief fraction of time, underwent expansion at a rate much faster than the speed of light. In other words, the Big Bang was not an explosion of matter and energy into preexisting empty space, like a bomb exploding at the center of something. It was the expansion of spacetime itself from an extremely dense and hot state.

This accelerated expansion helps explain why we cannot directly observe the birth of the universe: the speed of light, limited to approximately 299,792.458 km/s, does not allow light to reach us from regions whose separation from us increases sufficiently rapidly because of the expansion of space.

In the long term, expansion may continue to the point where matter becomes so dispersed that the conditions necessary for life become impossible. This scenario is known as the **"Big Rip."**

Nevertheless, energy would persist and, according to some proposals—for example, ideas associated with Roger Penrose—that energy might eventually give rise to the formation of a new universe. In such a case, the process could repeat indefinitely.

It is worth remembering that the concepts of "beginning" and "end" are often human mental constructs. We tend to think in terms of origins and endpoints; however, these categories do not necessarily describe the fundamental structure of reality.

If, speculatively, spacetime is conceived as a discrete system—a "digital model" in which space and time are quantized—it might provide a possible framework for

understanding the quantization of energy as well as the discreteness of space and time. Within such a framework, the principle of quantum superposition could be interpreted as the coexistence of different configurations of a particle over extremely brief time intervals, on the order of the Planck time, which might appear as simultaneity to macroscopic observers. It should be emphasized, however, that there is currently **no experimental confirmation of this hypothesis**.

The Quantum Measurement Problem

The measurement problem in quantum theory reminds me of a very popular decorative object in the 1980s and 1990s known as a **magic sphere**. It was also known as a **plasma lamp**. It was a transparent glass sphere containing a low-pressure gas and a central electrode. When turned on, colored electrical rays—purple, pink, or bluish—could be seen extending from the center toward the glass surface. What was most striking was that when you placed your finger on the glass, the rays seemed to "follow" your touch and concentrate at the point where you were touching, glowing more intensely there. This happens because your body conducts electricity and alters the electric field inside the sphere. I remember it because, to me, it was a magical sphere, just as quantum mechanics still is for me. This object awakened in me a desire to understand the physics behind these effects.

Now I imagine an analogous phenomenon for quantum particles. When I touched the magic sphere, what I observed inside the sphere changed. Something similar happens when you observe a quantum particle. It behaves like a wave when you do not observe it and like a particle when you do observe it. But as some physicists say, it is neither a wave nor a particle, but something entirely different.

1. The Double-Slit Experiment

The double-slit experiment is one of the most famous and perplexing experiments in quantum physics. It demonstrates that light and matter can exhibit both wave-like and particle-like behavior.

The setup is simple: a source emits particles—photons or electrons—toward a barrier containing two tiny slits. Behind the barrier is a screen that records the impacts.

When we do not observe which slit each particle passes through, the pattern that appears on the screen is an **interference pattern**, characteristic of waves—as if each particle passed through both slits simultaneously. However, if detectors are placed to identify which path the particle takes, the pattern changes dramatically. Instead of interference, two distinct bands appear, as if the particles were tiny solid objects passing through one slit or the other. The act of measurement changes the result.

What is most curious is that this behavior remains the same even if you send only one particle at a time. The particle produces a wave-like interference pattern when its path is not measured, but behaves in a particle-like manner when its path is measured.

This wave-particle duality can be described mathematically as follows:

Classical Probability

P1 — Probability that the particles pass through slit #1.

P2 — Probability that the particles pass through slit #2.

P-total — The total probability of the system would be the sum of both:

P-total = P1 + P2

Quantum Probability

For electrons, photons, and other quantum particles, we do not add the probabilities directly. Instead, we add the **probability amplitudes**.

In the double-slit experiment, there are two possible paths:

- Passing through slit #1.
- Passing through slit #2.

Each path is associated with an amplitude:

A1 — Probability amplitude for passing through slit #1.

A2 — Probability amplitude for passing through slit #2.

If we do not measure which slit the particle passes through, the amplitudes are added, producing the wave-like behavior associated with interference:

A-total = A1 + A2

Therefore, the total probability would be:

(Equation 1)
P-total = $|A1 + A2|^2 = A1^2 + 2A1A2 + A2^2$

For example, suppose:

A1 is the amplitude of wave 1 and is equal to 1/2.

A2 is the amplitude of wave 2 and is equal to 1/2.

If the waves reinforce each other through constructive interference, the maximum total probability would be:

P-total = $(1/2)^2 + 2 \times (1/2) \times (1/2) + (1/2)^2 = 1$

If the waves cancel each other through destructive interference, the minimum total probability would be:

A1 is the amplitude of wave 1 and is equal to 1/2.

A2 is the amplitude of wave 2 and is equal to −1/2.

Therefore:

P-total = $(1/2)^2 - 2 \times (1/2) \times (1/2) + (1/2)^2 = 0$

Notice that the term responsible for the interference effect is:

$2 \times A1 \times A2$

and this term produces the interference pattern.

Now suppose that we place a detector at each of the two slits.

If **A1 > 0, A2 = 0**

or

If **A2 > 0, A1 = 0**

It is impossible for both amplitudes to contribute simultaneously because the detector tells us which slit the particle passed through. Therefore, the probabilities behave like classical probabilities, and the interference term disappears.

Notice that the interference term in Equation #1,

$2 \times A1 \times A2$

is always equal to zero. Therefore, the total probability becomes simply:

P-total = P1 + P2

Two bands would then form behind the slits, and the interference pattern would disappear.

2. A Conjecture About Quantum Time

Every time you measure a quantum system, you incorporate it into your spacetime reality. Following an idea sometimes associated with Roger Penrose, suppose that quantum systems are, in some sense, insensitive to gravity and therefore do not experience time in the same way we do. They might exist as delocalized wave states within an “atemporal” quantum domain.

Measurement would then be the process by which a quantum system becomes embedded in our spacetime, producing a definite result—for example, a specific position or spin—consistent with the probability amplitudes described by the Schrödinger equation.

This picture is difficult to grasp, but it may help illustrate the wave-particle duality. Light, as well as other quantum systems, behaves like a wave when it is not measured; when a measurement is performed, the system manifests particle-like properties.

From this perspective, the observer projects the quantum system into their own spacetime: at a specific moment and at a specific location determined by the measurement. Because time is relative and is linked to a particular trajectory—a worldline—in spacetime, the result of the measurement must be recorded relative to the observer's clock and coordinates.

If quantum systems truly do not "experience" time in the same way macroscopic systems do, then what we observe at the moment of measurement would simply be the probability distribution, described by the Schrödinger equation, evaluated at the observer's time.

This perspective might help us understand why unifying quantum mechanics with general relativity is so difficult. One theory describes evolution as unitary dynamics in Hilbert space, while the other treats time as a coordinate of a dynamic spacetime geometry. A theory that successfully combines them may need to explain how spacetime—and time itself—emerges from, or relates to, quantum degrees of freedom.

Part of the difficulty is conceptual: our brains evolved to understand a classical world with a well-defined flow of time, not a quantum domain that might be "atemporal," or in which time could be an emergent property.

Bridging this conceptual gap is one of the central challenges in research into **quantum gravity** and the foundations of quantum mechanics.

Science and Human Responsibility

I deeply admire the supervisors of the Artemis II mission, the crewed mission to the Moon. On their shoulders rests the responsibility for the lives of four astronauts, who could die if a wrong decision is made. The pressure they face is immense, and only someone who has experienced something similar can truly understand it.

I retired from my job as a supervisor of drones and supersonic combat aircraft after a decision of mine nearly cost a pilot his life.

During testing, we operated drones such as the QF-4 and the QF-16, unmanned versions of the F-4 Phantom and F-16 aircraft. They could fly automatically using onboard computers, be manually controlled from a remote console, or, in specific exercises, be piloted by an aviator on board. We launched them from Holloman Air Force Base and, if they were not destroyed during surface-to-air missile tests, we brought them back to land there. In theory, many maneuvers could be executed simply by pressing a button on the console.

For safety reasons, when a pilot was on board, he always kept one hand near the joystick: any movement would automatically disconnect remote control and restore full control of the aircraft to him.

One day, due to my own lack of attention, I failed to verify that the correct software had been loaded. The wrong program was installed—one that lacked protection against sending an erroneous signal capable of commanding an extremely dangerous maneuver: a full pitch downward toward the ground.

The aircraft executed that maneuver while flying at 500 feet and approximately 500 miles per hour. At that instant, the pilot took control. As he felt the nose of the aircraft point toward the ground, he experienced a negative acceleration of –1 g. The squadron commander, Colonel Heinlein, reacted immediately and pulled back on the joystick with all his strength to raise the aircraft. He did so so abruptly that the plane endured nearly 9 g—that is, his body experienced a force equivalent to nine times his weight.

From the control room, we began asking if he was all right. Those seconds felt eternal to me. Finally, he responded:

“I’m fine. I think it would be best to end the test and return to Holloman.”

There were clear signs of structural damage: the turbine mounts had broken, and the aircraft was vibrating in a severe and dangerous manner. Even so, he managed to land successfully.

He was taken to the hospital and recovered from neck pain caused by the sudden shift from –1 g to 9 g. The next day, his photograph appeared in the Alamogordo newspaper alongside the accelerometer, whose needle had frozen at 9 g after being damaged by the extreme force.

The Air Force conducted a thorough investigation. I confessed that the error had been mine for failing to properly supervise the software loading. During my statement, I was asked to swear on the Bible; although I am not a believer, I promised to tell the truth. And as the supervisor, I never mentioned the name of the person who had loaded the incorrect program.

Years later, in another contract, that same person helped me obtain a job. That was when I understood how life can take unexpected turns. Colonel Heinlein thanked me for telling the truth, and over time, we became friends.

In later jobs, I learned a fundamental lesson: always verify the checksum of all software before any mission and confirm the serial numbers of every hardware component to be used.

Since that incident, I have understood the almost infinite pressure faced by supervisors of space missions, whose decisions can directly affect the lives of several astronauts. What is most striking is that almost no one knows their names. We do not know how many sleepless nights they spend asking themselves, “Where did I make a mistake?” We only learn their names when an accident occurs.

That is why I was deeply pleased when the Artemis II mission was a success. Believe me: it is very easy to find someone to blame after the fact. Too often, some leaders shift the blame onto others to cover up their own incompetence.

Signal, Noise, and Truth

About 38 years ago, one of my mentors told me that one of the secrets of life is learning to distinguish noise from truth. I wrote the following words in his honor: Mr. Marvin Hake, a brilliant IBM engineer.

Your worst enemy in any endeavor is learning to live in a world full of noisy signals.

How do you distinguish the real signal from the noise?

As an engineer who designed navigation systems for satellites, drones, and missiles for 45 years, noise was always my greatest adversary. The challenge was clear: how do you eliminate the noise without eliminating the signal you actually want to process?

Experience taught me that the best approach is first to observe and analyze the noisy environment.

If you work with cameras, you point them at the target and monitor the average pixel intensity levels. From there, you determine threshold values; anything below them can be treated as noise and filtered out. A similar scheme can be applied to eliminate extremely high- or low-frequency noise.

If you work with radar, the principle is the same, but instead of processing visible light, you are handling invisible electromagnetic frequencies.

If you analyze the stock market, you learn to ignore normal fluctuations. For example, with an investment of two million dollars, the average daily “noise” might be ten thousand dollars. Understanding that volatility helps prevent disproportionate emotional reactions.

If you are determining the position and velocity of an object, such as a missile, you rely on multiple sensors to reduce uncertainty. These may include GPS, inertial measurement units (IMUs), trilateration systems, infrared sensors, and others. By combining signals, you reduce noise and improve accuracy.

Our brains evolved to filter noise. They suppress echoes, adapt to changes in lighting, compensate for blind spots, and regulate emotional responses. Yet they remain sensitive to urgent signals—loud sounds or bright lights—that demand immediate attention.

The real secret is learning to survive in a world saturated with noise. How do we distinguish truth among the countless signals that can consume our lives if we are not careful?

Various substances such as alcohol, marijuana, opioids, and others have been used to dampen the noise reaching our brains. They may temporarily silence the overload of signals, but they are rarely the proper solution.

Perhaps dedicating a few minutes each day to consciously separating noise from truth can help us live with less anxiety and greater clarity.

Conformal Cyclic Cosmology

Conformal Cyclic Cosmology (CCC), proposed by Roger Penrose, offers a different way of imagining the universe. This theory suggests that the universe goes through infinite cycles called *eons*.

Each cycle begins with an extremely hot and dense state—the Big Bang—and continues with the expansion of the universe (including the accelerated expansion we observe today due to dark energy). It culminates in an extremely diluted and cold future in which matter as we know it ceases to exist and only massless particles, such as photons, remain. That state would then give rise to a new Big Bang and the beginning of the next cycle.

When the universe loses all its matter due to expansion, the geometry of space becomes "conformal"; that is, scale—size, time, and entropy—ceases to matter. At that point, the universe can "reset" and become the Big Bang of the next aeon. Sections 1 through 7 describe this process in greater detail. Section 8 includes a list of references.

1. Spacetime and Expansion

To explain the expansion of the universe, we accept that its geometry has four dimensions: three spatial (X, Y, Z) and one temporal dimension. Astronomers and physicists refer to this as spacetime.

To help us conceive of four-dimensional space from our three-dimensional perspective, we can imagine that the universe is like the surface of a sphere that continuously expands over time, and that we are two-dimensional beings living on that surface. From our point of view, all stars and galaxies move away from us. In this model, the universe would have no edge or physical boundary. See Figure 1, where we could observe the past of our universe by looking with a telescope toward the center of the sphere.

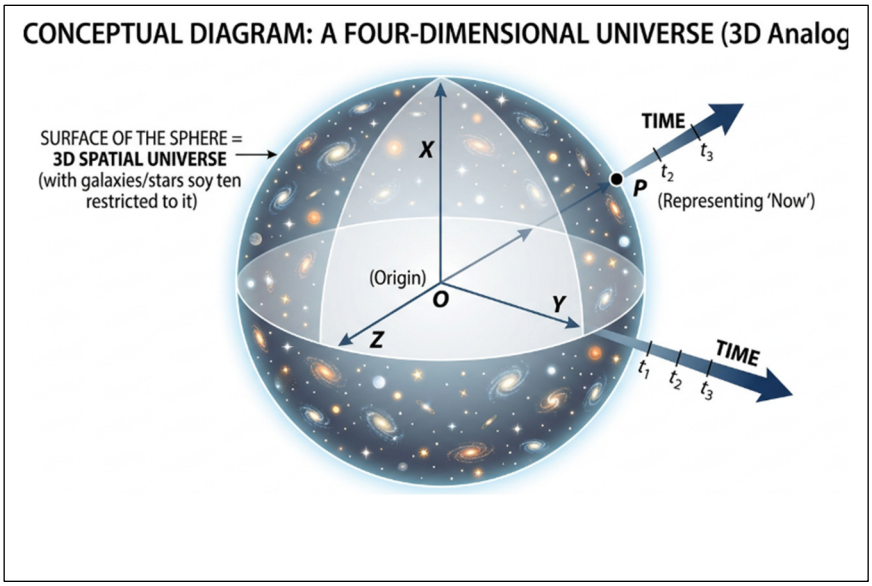


Figure 1

Galaxies separate at such high speeds that, due to the expansion of space, some can effectively recede faster than light. This does not contradict relativity, since it is not the galaxies moving through space, but space itself that is expanding.

Penrose also explains that we should not imagine the universe expanding "into" another dimension. Spacetime is everything; there is no "beyond" outside it.

2. Total Energy and Gravity

Penrose also argues that the total energy of the universe may be equal to zero. Gravity would represent negative energy, while mass and other forms of energy would represent positive energy. This could offer an explanation of how the universe might have arisen without violating the first law of thermodynamics, which states that energy is neither created nor destroyed, only transformed.

In other words, the curvature of space caused by mass would correspond to that negative energy associated with gravity.

3. Time, Mass, and Massless Particles

Einstein's theory of relativity proposes that absolute time does not exist; it is a property of spacetime geometry. The experience of time arises only for objects with mass.

Photons, which have no mass, do not experience time or distance between two points. They may have been created in a star billions of years ago, but for them that interval represents neither a second nor a journey. In that sense, the geometry of space loses meaning for a massless body traveling at the speed of light: for it, the vastness of space shrinks to something infinitesimal.

In summary, the geometry of space only has meaning for objects that, like us, possess mass.

4. The Distant Future of the Universe

In CCC, the expansion of the universe is not merely the result of dark energy, but an inherent property of spacetime itself. Edwin Hubble demonstrated that the universe is expanding, which led to the abandonment of the idea of a static universe that Einstein had tried to maintain by introducing a cosmological constant.

Penrose suggests that this expansion will continue for extremely long times, until the distance between galaxies, stars, planets, particles, and atoms becomes so vast that all matter disappears and only radiation composed of massless particles remains.

In that scenario, the concepts of entropy, time, and distance would lose physical meaning. Mathematically, an extremely cold and diluted universe could be described as equivalent to an incredibly small and hot universe once mass no longer exists. The equations of physics, in the absence of mass, do not distinguish between an infinitely large universe and an infinitely small one. Thus, infinite expansion can be "rescaled" into a compact and dense state corresponding to the conditions of a new Big Bang and the beginning of another cycle.

This final step of the theory raises doubts. Although the mathematical equations may allow such an equivalence, mathematics is not reality itself, but a model that attempts to describe it.

5. The Role of Black Holes

During the expansion of the universe, black holes would be the last massive objects to remain. However, according to Stephen Hawking, black holes are not eternal: they emit quantum radiation and slowly lose mass until they completely evaporate. Eventually, all their matter would disappear, leaving only radiation composed of massless particles.

Penrose argues that black holes play a fundamental role by absorbing complex structures such as stars and planets, progressively simplifying the universe. In this way, they help the cosmos transition from an extremely structured and cold state to one in which mass disappears entirely.

Penrose also proposes that the energy released by collisions of supermassive black holes in the previous eon could be visible in our current universe.

6. Anomalous Circles in the CMB

According to CCC, such signals might be observed as anomalous circles in the Cosmic Microwave Background (CMB), the residual radiation emitted about 380,000 years after the Big Bang.

The CMB is extremely uniform, although it shows small temperature variations. For Penrose, the anomalous circles would be nearly concentric circles (that is, sharing the same center) with different radii, showing lower-than-expected temperature variations and distributed in a way that is not entirely random.

However, this part of the theory remains debated within the scientific community. Many researchers argue that those variations in the CMB can be explained as normal statistical fluctuations and do not constitute evidence of "fossils" of black holes from a previous eon.

7. Final Reflection

Even so, CCC is fascinating because it attempts to close the cosmic cycle and suggests that beginning and end, as well as distances between worlds, may be concepts tied to our condition as beings with mass and consciousness.

The theory proposes that the universe in which we live is just one cycle within an infinite process, and that it will eventually disappear to give rise to another. In this view, the Big Bang would not be an absolute beginning, but a transition from a previous eon.

However, the philosophical conclusions that may be drawn from this theory belong to the realm of personal interpretation. As Kurt Gödel reminded us with his incompleteness theorem, no system can prove all truths from within itself. Perhaps our cosmological theories, including CCC, are human attempts to approach a reality that will always surpass our conceptual tools.

8. References

a. *Cycles of Time: An Extraordinary New View of the Universe*
Author: Roger Penrose (2010).

b. Various internet podcasts.

Probability of an Alien Visit to Earth

1. Introduction

In May 2026, the United States Government began releasing to the public hundreds of images and videos showing Unidentified Anomalous Phenomena (UAP) observed over various countries. Some of these objects appeared to be near the ocean's surface, others were flying in formation, and still others seemed to move at very high speeds or make sharp turns of nearly 90 degrees.

However, most of the published videos are of such low quality that it is difficult to determine what is actually being observed. In some cases, it is evident that the object is nothing more than a balloon with its string still visible. Based on my experience as an engineer in the design and operation of drones and integrated sensor systems—including radar, GPS, optical systems, and laser tracking—I believe that many of these observations can be attributed to sensor malfunctions, misinterpretations of data, or foreign drone activity. Formation flying, supersonic speeds, and high-acceleration (high-g) maneuvers have been possible with advanced remote or autonomous aerial systems (drones) since at least the 1990s.

These observations motivated me to analyze why I do not believe that intelligent extraterrestrial life has visited Earth in the past 100 years, despite having reviewed numerous UAP videos. To support my reasoning, I used the well-known Drake Equation to mathematically estimate the probability that an extraterrestrial civilization exists close enough to interact with Earth. The Drake Equation was developed in 1961 by astronomer Dr. Frank Drake while preparing for the first scientific meeting on the Search for Extraterrestrial Intelligence (SETI). Its purpose was to stimulate scientific discussion rather than to provide a precise numerical prediction.

The Drake Equation is a probabilistic formula used to estimate the number of technologically advanced civilizations in the Milky Way that might be capable of communication.

My methodology was as follows:

1. Use the Drake Equation (Section 2) to estimate the number N of communicative civilizations in the Milky Way.
2. Estimate how long humanity has been unintentionally broadcasting detectable electromagnetic radiation into space ($\mathbf{N_{years}}$), discussed in Section 3.
3. Compute the volume of space reached by our electromagnetic "radiation bubble" ($\mathbf{V_{bubble}}$).
4. Estimate the volume of the Milky Way galaxy ($\mathbf{V_{galaxy}}$).

5. Compute the average density of civilizations in the galaxy ($\mathbf{D_{civilization}}$) per cubit unit of volume.
6. Multiply the density by the volume of our radiation bubble to estimate the expected number of civilizations within 100 light-years of Earth.

2. Probability of an Extraterrestrial Civilization Within 100 Light-Years

2.1- Drake Equation

The Drake Equation depicted below is a product of a sequence of factors and probabilities defined to estimate the number of civilizations "N" in our Milky Way galaxy.

$$\mathbf{N} = R * FP * Np * FL * FI * FC * L$$

Below are the definitions for each one of the parameters. The numbers in parameters in parenthesis are the most recent values for the Drake Equation parameters.

N is the number of civilizations in our galaxy with which communication might be possible.

R is the average rate of star formation per year in the Milky Way. Astronomers measure the mass of the Milky Way, calculate the rate at which gas clouds collapse, and observe how often stars are born. Furthermore, not all stars are suitable for life (massive stars burn out quickly) while smaller, stable stars, like our sun, are often considered better candidates.

(Assumed R = 2 stars/year)

FP is the probability of those stars that have planetary systems. Derived from observational data (like the Kepler Space Telescope) by looking for the periodic dimming of a star as a planet crosses in front of it. Most stars have planets, no planets no life.

(Assumed FP=1)

Np is the average number of planets per star that could potentially support life. Based on the percentage of planets located in the "Goldilocks zone" (the orbital distance where liquid water can exist). Furthermore, they need to have:

An atmosphere that will maintain the temperature of the planet somewhat stable by trapping infra-red radiation from the sun and also allowing the presence of liquid water.

A magnetic field is required to protect life against high energy particles coming from space. The magnetic field is generated by the earth's core; moving liquid iron caused by earth's rotation crates currents which in turn creates a magnetic field.

Plate tectonics, through friction between the rocks generate energy which liquifies the rocks creating the earth's lava which in turn feeds volcanos. The volcanos explode generating huge amounts of CO_2 which is released to the atmosphere. The CO_2 cycle is used to maintain the earth's temperature more stable. The CO_2 generates rain which in turn cools down the earth which in turn stops the rain and CO_2 accumulates causing the earth to heat up one more time (Thermic cycle).

(Assumed Np=0.2)

FL is the fraction of habitable planets where life actually appears. This is entirely speculative, as we only have Earth as a data point. Biologists estimate this by studying how quickly life emerged on Earth after its formation. Earths age is approximately 4.5 billion years. Early life appeared on earth 3.5 to 4 billion years ago. So simple life must be common since only took 500 million years for life to appear.

(Assumed FL=0.3)

FI is the fraction of planets with life that eventually develops intelligent life. Astrobiologists look at the evolutionary history of Earth to determine the odds of simple organisms eventually evolving into tool-using, intelligent beings. Again, we only have a sample of 1 the earth to calculate this parameter. Earth simple life appeared about 3.4 to 4 billion years ago. Intelligent life (Humans) has been around for 200 million years which is about .05 of earths biological history (200,000,000 / 4,000,000,000 = .05).

(Assumed FI=.01)

FC Fraction of intelligent civilizations that develop detectable communication technology**.** Estimated by assessing the percentage of intelligent species that figure out how to transmit signals into space (e.g., radio, TV, or lasers). Electromagnetism is a fundamental force in our Universe. Humans have been on earth for about 200 million years ago so it did not take too long for an intelligent civilization to develop electromagnetic communication. Therefore, any civilization that understands electromagnetism can, in principle, generate radio waves. So, from a physics standpoint, it's achievable.

(Assume FC=0.2)

L is the length of time such civilizations release detectable signals into space. This is the most unknown variable. It is the average number of years a civilization broadcasts

detectable signals before either destroying itself (e.g., climate, war) or naturally going silent. This is a critical parameter because if its number doubles it practically doubles the number of civilizations. It should be noted that L may not be the age of civilization it could mean that the civilization does not want to be found and starts using low power EM signals to avoid detection and consume less energy.

(Assume L=10,000 years)

Solving for **N** will give us about **2.4** detectable civilizations in the Milky Way right now. I should point out that the values of these parameters are continuously being refined by scientists based on new data.

2.2- Intelligent civilizations within 100-light years from us.

To calculate this first we calculate the volume of space that the light will travel in 100 light years.

The speed of light is used as the reference speed because it is the maximum speed in the universe, approximately 300,000 kilometers per second. It is the speed of any electromagnetic signal in the vacuum.

I used 100 years because the Earth has been releasing detectable radio energy into space for roughly 125 years as described below:

Years	**Events**
1895-1901	Early radio experiments (Marconi's first transatlantic signal in December 1901).
1920's	The beginning of regular commercial radio transmissions.
1930s-1940s	High-power television broadcasts and military radar (especially during World War II) significantly increased the emission of radio signals into space.

Let's do the calculation for 100 years of radio leakage ($\mathbf{N_{years}}$).

We'll use the same moderate Drake estimate (N≈2.4 civilizations currently in the Milky Way).

2.2.1 Size of Earth's 100-Year Radio Bubble

Radio signals travel at light speed, so:

R=100 light-years

Volume of a sphere V_{bubble}:

$$V_{bubble} = \frac{4 * \pi * R^3}{3} = \frac{4 * \pi * 100^3}{3}$$ = 4.188 * 10^6 cubic light-years

2.2.2 Volume of the Milky Way

Approximate galactic disk:

Radius ≈ 50,000 light-years

Thickness ≈ 1,000 light-years

Volume of Galaxy V_{galaxy}

$V_{galaxy} = \pi * (50000)^2 * 1000 = 7.853 * 10^{12}$ cubic light-years

2.2.3 Percentage of the Galaxy Reached

$V_{percentage} = \frac{V_{bubble} * 100}{V_{galaxy}}$ $\frac{4.188 * 10^6}{7.853 * 10^{12}}$ * 100 = 5.33 * 10^{-4}

or .000533 %

2.2.4 Number of civilizations inside bubble volume

If N≈2.4:

Civilization density:

$D_{civilizations} = \frac{2.4}{7.583 * 10^{12}}$ $= 3.05 * 10^{-13}$ civilizations/cubic-light-years

Number of Civilizations in our 100-light year sphere:

$N_{civilizations} = (3.05 * 10^{-13}) * V_{bubble}$ $= 1.28 * 10^{-6}$

2.2.5 Probability of finding one civilization in our 100-light-year volume

Prob = $N_{civilizations}$* 100 = 0.000128 %

That corresponds to a probability of roughly:

About 1 chance in 781,000

4. MATLAB Program

A MATLAB script was developed to allow readers to vary the Drake Equation parameters and the size of the radiation bubble (in years) to explore different scenarios.

Figure 1 shows the probability of finding another civilization within 100 years.

Figures 2 shows the probability of finding another civilization within 2000 years. Figure 2 represents the case where the SETI program is listening to planets and stars located within 2000 light-years from earth. As you can see the probability only increased up to 1%.

SETI focuses on detecting technological signals from alien civilizations, rather than searching for simple microbial life. Scientists look for radio signals, laser pulses, repeating signals, on and off patterns and any other signal that could be generated by intelligent alien life. The SETI program has been operating since 1960. To date, SETI has not confirmed any extraterrestrial intelligent signal, which is consistent with the low probabilities estimated in this analysis.

```
clear all
%************************************************
NLightYears = 200;  % Number of Space Bubble Light Years
% Drake Equation
R = 2.0;     % Average rate of star formation per year in the Milky Way
FP= 1.0;    % Fraction of those stars that have planetary systems
Ne= 0.2;    % Average number of planets per star that could support life
FL= 0.3;     % Fraction of habitable planets where life actually appears
FI= 0.01;   % Fraction of planets with life that develop intelligent life
FC =0.2;    % Fraction of intelligent civilizations that develop communication technology
L = 10000; % Length of time such civilizations release detectable signals into space
%************************************************
N = R * FP * Ne * FL *FI * FC * L;
k=0;
for i=1:NLightYears
Rs=i; % Radius of sphere of 100 light-years
Rg = 50000; % Radius of Milky Way Galaxy in light-years
Tg = 1000;  % Thickness of Galaxy in light-years
Vbubble = (4/3)* pi * Rs^3; % Volume of 100 light-years sphere
Vgalaxy = pi * Rg^2 * Tg; % Volume of galaxy in cubic light-years
Fv = Vbubble / Vgalaxy ; % Ratio (fraction) between V and Vg
Vpercentage = Fv * 100 ; % Percentage of galaxy reached
% If number of civilizations in our galaxy is N therefore the
% civilization density per volume
Dcivilization = N / Vgalaxy ;
% Therefore the number of civilizations in 100 light-year volume is
Ncivilizations = Vbubble * Dcivilization;
% Final Percentage Probability
Prob = Ncivilizations * 100;
% Chances 1 in Ratio
Ratio = floor(1/Ncivilizations);
disp(Ratio)
k=k+1;
Ratio_save(k)=Ratio;
Prob_save(k)=Prob;
Rs_save(k)=Rs;
end
plot(Rs_save,Prob_save),xlabel('Number of Light-Years'),  ylabel('Probability
%'),title('Probability vs Light-Years'),grid minor
```

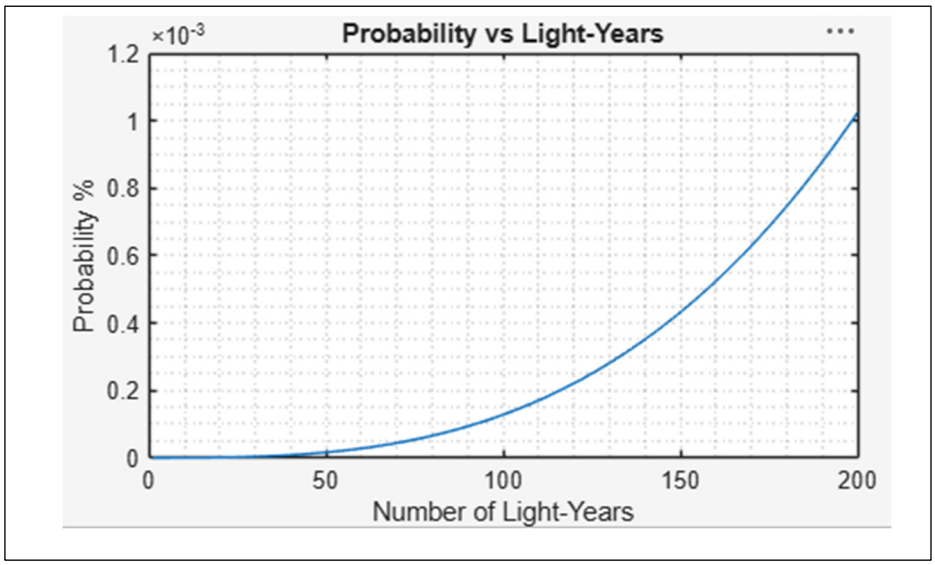


Figure 1 Probability within 100 light-years from earth

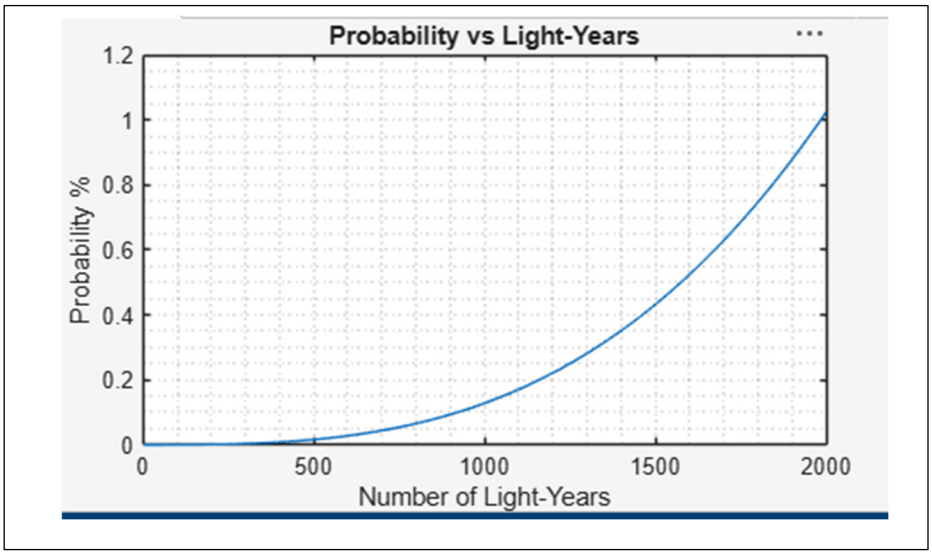


Figure 2 Probability within 2000 light years from earth

5. Conclusion

The mathematical results show that, using moderate assumptions in the Drake Equation, it is extremely unlikely that any alien civilization has detected Earth's radio signals within the past 100 years. The primary reason is simple: our signals have reached only a tiny fraction of the galaxy.

The dominant limitation is not necessarily whether extraterrestrial civilizations exist elsewhere in the universe, but rather the finite speed of light. Although light travels at approximately 300,000 kilometers per second, this speed is extremely slow when compared to the vast scale of the Milky Way, let alone the observable universe. Even if other civilizations do exist, our expanding radio sphere remains minuscule relative to the size of our galaxy.

I personally believe that microbial life may be abundant throughout the Milky Way. However, the evolution of intelligent life is likely a much rarer event. Intelligence is not a requirement of evolutionary theory for survival; natural selection favors traits that enhance reproduction and adaptation, not necessarily advanced cognition or technological capability. On Earth, millions of species have existed over billions of years, yet only one has developed the ability to generate and transmit radio signals into space.

Alien civilizations may very well exist somewhere in the universe. However, there is no credible evidence that they have visited Earth in the last 100 years, or at any time in recorded history. And perhaps, in a broader cosmic sense, we ourselves are the "alien" civilization, emerging in a vast and largely unknown universe.

Imperfect Human Evolution

1. Prologue

This essay discusses aspects of human biology that do not fit a perfect design conceived by a creator, but instead align better with a Darwinian evolutionary process. Evolution by natural selection is far from perfect. Evolution does not care whether you are perfect; it cares whether your species survives. Our human imperfections are consequences of our evolutionary history.

Section 2 was included to thoroughly explain evolution by natural selection, given the rejection by many readers who maintain that the creation of humanity and life was the work of a designer, rather than attempting to understand evolutionary theory. Its purpose is to demonstrate that evolution is considered a scientifically established fact, strongly supported by overwhelming evidence. It also attempts to counter arguments against evolution, such as the infinitely small probability that evolution could have given rise to life, and the claim that life reflects the perfection of a creator.

Section 3 describes additional factors that influence evolution and make it imperfect.

Finally, **Section 4** lists biological human imperfections and describes their evolutionary origins.

Note: This Essay was translated from Spanish to English with the help of the website www.poe.com. I should point out that every effort was made to not change the contents of the original essay titled “La Evolución Humana Imperfecta”. Also, the figures in this essay are not original all of them were copied from different internet websites. No AI was used to write any of the contents of this document.

2. Evolution by Natural Selection

The theory of evolution by natural selection is one of the most studied sciences in modern biology. The central concept of this theory is that all species that exist on Earth descend from a common ancestor. This evolutionary process occurred because small genetic changes gave rise to new cells, organisms, animals, and plants, which had to adapt to their environment in order to survive and reproduce (**References 2 and 3**).

It should be noted that most genetic mutations are defective and do not give rise to another organism; they simply disappear. However, an extremely small number of them survive and become a new starting point for future genetic mutations. In other words, evolution by natural selection is a selective and iterative process of random genetic mutations.

Studies indicate that the first organic molecules appeared in water as a result of the combination of hydrogen, carbon, oxygen, and nitrogen atoms generated by electrical discharges. These new molecules competed with one another for access to atoms, and only the most stable molecular combinations survived (**Reference 1**). In turn, these organic molecules combined to form the first DNA (deoxyribonucleic acid) molecules. I must emphasize that the formation of DNA was also an evolutionary process driven by natural selection. Only the "strongest" DNA survived.

DNA is a long polymer that contains the genetic information necessary for the development and functioning of all living organisms. A polymer is a substance formed by smaller units called monomers that join together to form longer molecules. Science suggests that RNA (ribonucleic acid) developed first, as it is a simpler molecular structure than DNA. RNA is a molecule that the human organism uses as a "messenger," since it contains the genetic material used for protein synthesis. RNA is produced from DNA; it is a copy of the DNA information necessary to manufacture proteins. Proteins are large molecules that our body uses for the repair and construction of tissues that eventually form our organs.

Some hypotheses suggest that "non-living" entities that we now call "viruses" may have preceded the formation of the first prokaryotic cells (simple cells without a nucleus), especially viruses composed exclusively of RNA, whose genetic structure is highly unstable and constantly mutating.

It is important for the reader to understand that the creation of new life forms is not simply the product of random mutations in and of themselves. The genetic mutations within the system called "life" are random; however, the results of these mutations are not. For example, if you inject white noise into an electronic system, you will observe that the result is not completely random. The output signal becomes a noisy sinusoidal wave, but with well-defined primary and secondary frequencies. In other words, the result of mutation is not purely random because the environment (natural selection) eliminates outcomes that do not survive.

The diagram in **Figure 1** provides an example: when dark-skinned individuals reproduce, there may be a small mutation affecting melanin production, and their skin becomes slightly lighter (gray). Eventually, this mutation survives; however, after two generations, another mutation may produce an individual whose skin is too light to survive in an area where sunlight is intense and significantly affects health (for example, skin cancer). That individual dies before being able to reproduce. In other words, that mutation disappears.

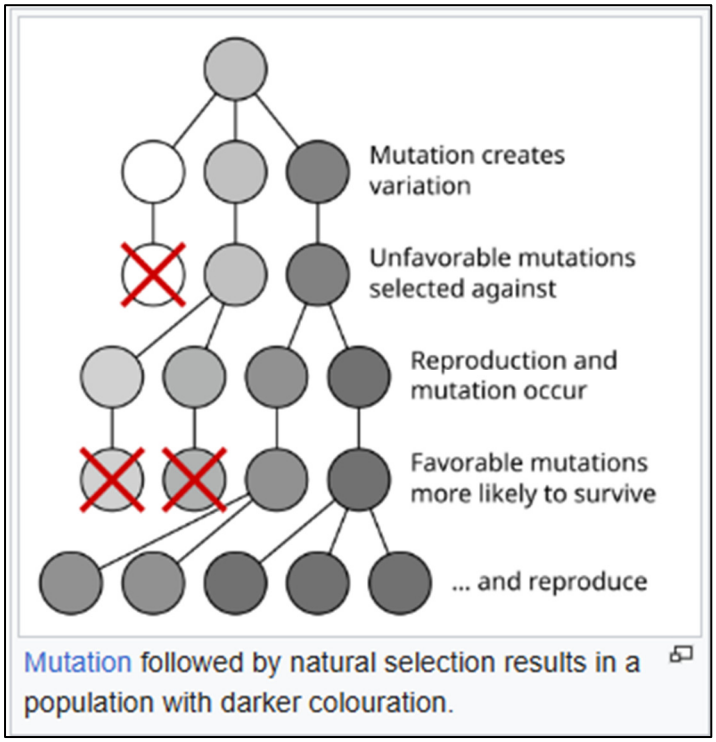


Figure 1 – Genetic Mutations

It is also important to understand the "Impossibility Theorem," in order to recognize that although some people argue that certain events are impossible because of their low probability, they can occur if the problem is analyzed correctly.

For example, a reader may believe that the probability of organizing a DNA structure like ours is impossible; and indeed, it would be if one assumes that everything must occur all at once. However, when other factors are added—such as the probability that our DNA is not the only structure capable of creating life, and that the formation of DNA was an iterative process—the situation changes.

For instance, if we calculate the probability of obtaining the following sequence of 10 digits:
0132456789, it would be approximately 101010^{10}1010, that is, 1 in 10 billion.

However, in an iterative process, the probability of selecting the first number (0) would be 1 in 10. If the natural selection process indicates that it is stable, 0 is selected. For the second digit (1), the probability would again be 1 in 10, and so on. Thus, the probability is reduced to a magnitude associated with the total sum of probabilities, approximately 1 in 100. Notice how the probability was reduced from 1 in 10 billion to 1 in 100.

Moreover, the probability could increase further if we assume that the 10-digit sequence 0132456789 is not the only combination that leads to the desired result. Please refer to Reference 4 in the bibliography for more details.

Modern science indicates that this common ancestor gave rise to the enormous diversity of living beings that exist. It is believed that about 3.5 billion years ago, the first prokaryotic bacteria appeared—cells that do not have a cellular nucleus and whose DNA is distributed within the cytoplasm. Bacteria are the simplest example of prokaryotic cells, such as *E. coli*, staphylococci, and salmonella. These bacteria emerged as a result of mutations in their DNA that allowed them to survive as new entities capable of reproducing and possessing their own metabolism.

Science also suggests that approximately 2 billion years ago, the first eukaryotic cells developed. Eukaryotic cells are cells that possess a defined nucleus containing their DNA, as well as a cell membrane and specific organelles such as mitochondria and ribosomes. Examples include our nerve cells, skin cells, and, in general, the cells of the human body.

Science further suggests that the evolution from prokaryotic to eukaryotic cells was the result of fusion between prokaryotic cells that survived the process of adaptation and evolutionary competition in the environment where they developed. An example would be the mitochondrion in eukaryotic cells, which contains DNA different from that of the host cell, indicating that it may have originated as a distinct organism that fused with another cell.

Science also explains that, due to a genetic variation in these cells, when they reproduce through mitosis, in some cases they do not separate from one another, remaining together and giving rise to multicellular organisms. This same evolutionary process gave rise to life on this planet as we know it today. **Figure 2** describes the tree of evolution, from very simple organisms to more complex forms. Everything begins from a common trunk (common ancestor) and branches into different lineages: plants, animals, fungi, and so on.

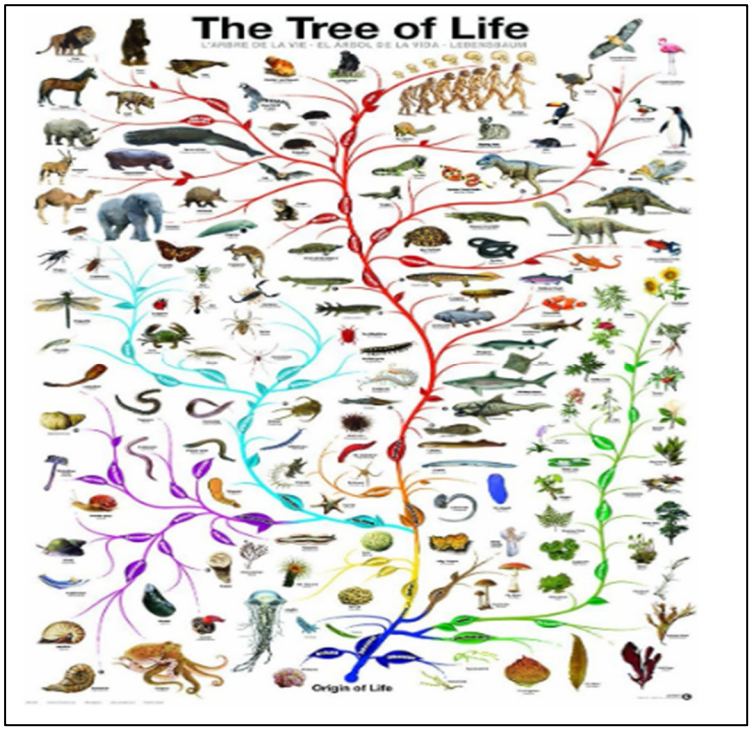


Figure 2 – Evolution Tree

It should be noted that perhaps the word “evolution” is incorrect; perhaps the word “adaptation” would be more accurate. Evolution does not care whether you are intelligent or whether you understand the universe. It only cares about survival. If a species is resistant to the current environment, it will evolve very little because it is already well adapted. If the environment changes, it is very likely that species that previously survived will no longer be able to do so.

For example, if the environment changes rapidly, insects may witness the disappearance of the human species from the Earth, just as happened 65 million years ago with the dinosaurs (i.e., birds are the last surviving dinosaurs). Another example is how human intelligence appears to be declining, partly thanks to technology: on average, people no longer know how to calculate without a calculator; they cannot write without a word processor; moreover, many people no longer solve basic arithmetic operations or simple algebra problems. Nor do we know how to survive in an environment hostile to our bodies. Leave us alone in the desert with some animals, and we would be the first to die.

I would like to offer a very simple example that demonstrates that the evolutionary process is real and represents a fact. To do so, I will present organic similarities between humans and other animals.

For example, **Figure 3** shows the evolution of the forelimbs of different species: birds, crocodiles, whales, horses, bats, and humans. Notice the extraordinary similarity of their bones: the ulna and radius in birds, crocodiles, and humans; the presence of the humerus in all species; and the structure of the fingers. A striking similarity.

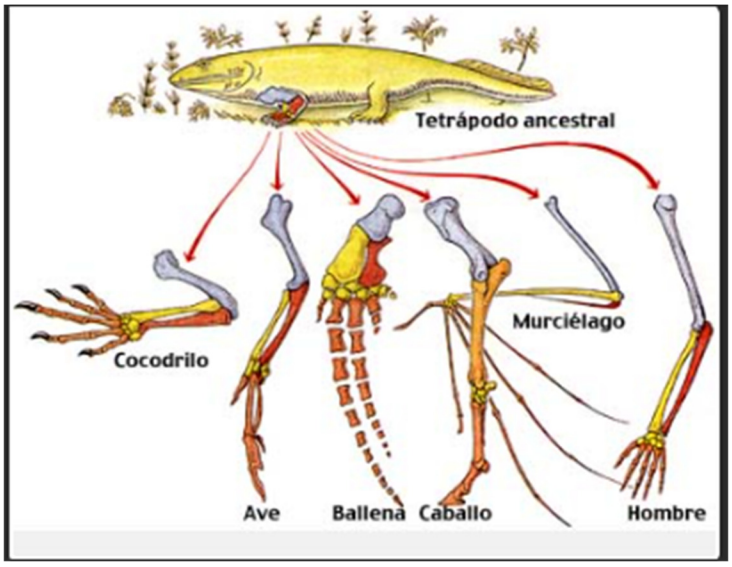


Figure 3 – Evolution of Animal Forelimbs

Another example is the neural connection of the human laryngeal nerve. **Figures 4, 5 & 6** show how this nerve evolved from the fish in the giraffe and in the human being. It should be noted that in the fish, the recurrent Laryngeal nerve also went around its hearth as depicted **Figure 4**

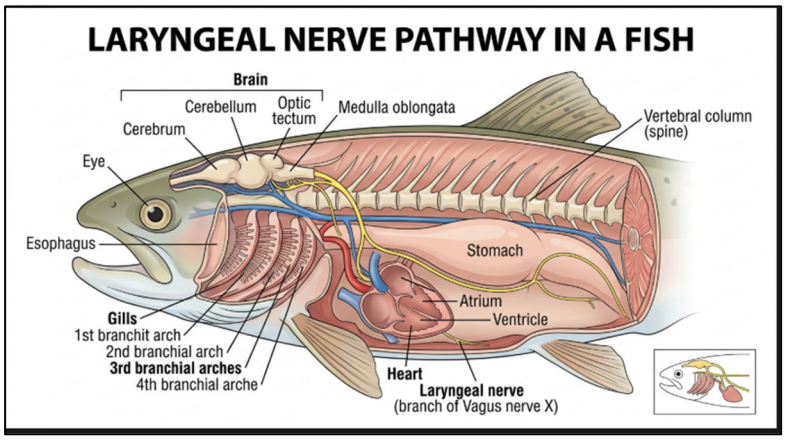


Figure 4 Laryngeal Nerve in Fish

Figure 5 shows that this nerve leaves the brain, travels almost down to the heart, and then returns to the throat. **Figure 6** shows that this same nerve in the giraffe does something similar: it reaches down to the heart and then returns to the throat. It travels approximately 13 meters to return to the same place.

This demonstrates four evolutionary concepts:

1. The nerve connection in the fish was logical.
2. It indicates that this nerve evolved imperfectly in the giraffe and in humans.
3. In humans there is a second nerve connection that evolution added, allowing better control of the larynx and the vocal cords.
4. Evolution is not perfect: it does not correct evolutionary "errors" if they are not necessary for the survival of the species.

This last point is the main purpose of this essay: to demonstrate that evolution is imperfect by nature and that living beings are not a perfect design; we are simply a design that has evolved over 3.5 billion years to reach the current state of animals, including human beings.

There are hundreds of books that explain the evolution of life and of humans much better and in greater detail than this description. Please consult **References 2 and 3** in the essay's bibliography.

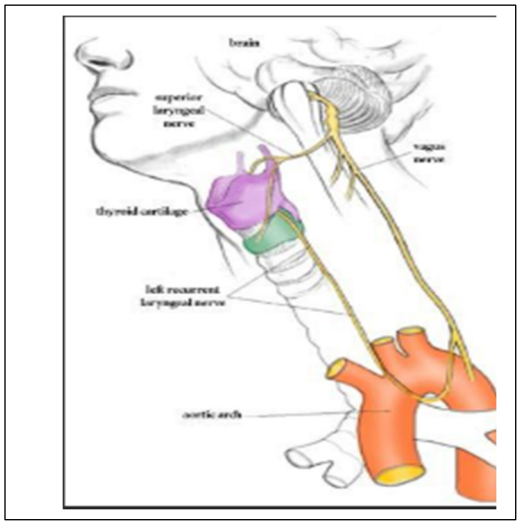


Figure 5 – Human Laryngeal Nerve

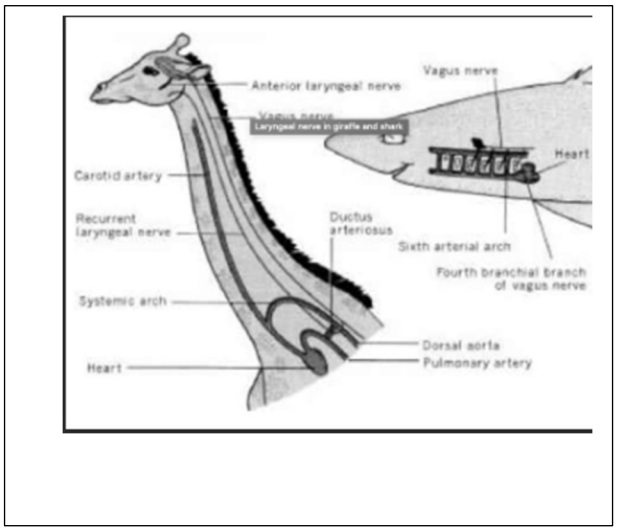


Figure 6 – Giraffe Laryngeal Nerve

3. Imperfect Evolution

- The human imperfections described in the following section are the result of imperfect evolution, for the following reasons:
- Evolution is a slow process that adapts organisms by modifying structures inherited from ancestors. This limits the changes it can make in an organism. As they say: “Evolution operates more like a tinkering cobbler than like an engineer.”
- Evolution is an open system: it requires solar energy to operate within the second law of thermodynamics and to counteract the entropy of the system. In other words, it consumes energy from the system to adapt organisms. Therefore, if there is an organ that is no longer used but does not interfere, evolution preserves it because it is more costly to eliminate it than to keep it.
- Evolution attempts to maintain a balance between modifications that may be advantageous for one function but harmful for another. For this reason, it is a “compromise,” not an optimal solution.
- Evolution adapts to the current environment, but when climate changes occur faster than evolution can respond, disadvantages arise.
- A limited population of a species limits its diversification and, in turn, reduces the appearance of new random genetic changes. The efficiency of evolution lies in the diversification of the species.

Note: *The “purity” of a species limits the effectiveness of evolution, putting the species at risk. This could allow a virus to wipe out all of humanity. It is never too late to diversify the species.*

Technology has also contributed to the fact that human imperfections are not corrected through evolution. One example is the skin color of humans who currently live in low latitudes. Due to air travel, these individuals migrated from the north to the south. They are now exposed to greater amounts of ultraviolet radiation. Normally, these individuals would develop skin cancer and would not have time to reproduce, causing the genes responsible for insufficient melanin production to disappear. However, thanks to modern medicine, these individuals live long enough to reproduce and thus pass on offspring who are not adapted to low latitudes.

Another example includes various genetic imperfections, such as mutations in the VCP gene, fragile X syndrome, cystic fibrosis, hemophilia, Huntington’s disease, and many others. These conditions continue to be inherited from parents to children. This occurs because modern medicine allows affected individuals the opportunity to

reproduce; in this way, these genetic mutations are not eliminated by natural selection.

Of course, I am not proposing eugenics. I am simply describing how technology is allowing evolution not to eliminate harmful genetic mutations.

Note: *I am familiar with the mutation in the VCP gene ("Valosin-Containing Protein") because a longtime friend of mine has it. This condition can cause terrible diseases such as amyotrophic lateral sclerosis (ALS) and frontotemporal dementia (FTD). I am also very familiar with fragile X syndrome because many of my cousins on my father's side in California (USA) inherited it. It can cause dementia and, in some cases, hyperactivity and behaviors associated with autism.*

4. Human Imperfections

Humans are a product of evolution; we do not come from monkeys. Rather, monkeys and humans share a common ancestor that lived 6–7 million years ago. We do not descend directly from modern monkeys; we are evolutionary cousins, as shown in **Figure 7**.



Figure 7 – Humans and Primates Common Ancestor

Human imperfections are anatomical remnants from our ancestors. They are caused by the fact that at some point they had a function, and evolution has not been able to eliminate them. The following sections describe some of them:

4.1 Blind Spot of the Human Eye

Hundreds of nerve fibers from the optic nerve converge at a point in the retina, creating a blind spot in the human eye (optic disc), where there are no photoreceptors. The "wires" of the photoreceptors are positioned in front of the

receptors rather than behind them. **Figure 8** compares the human eye with that of an octopus. The octopus's eyes are "well designed," whereas the human eye clearly is not.

Evolution prioritized rapid brain processing and binocular vision to "fill in" that gap rather than redesigning the physical structure of the eye—similar to how, in industry, software is often used to compensate for hardware errors.

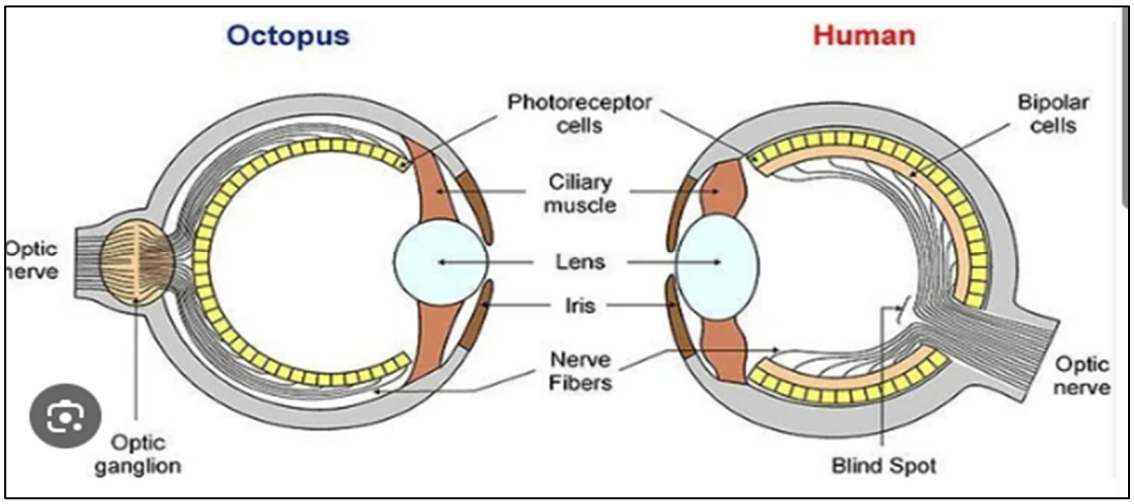


Figure 8 – Octopus and Human's Eye Blind Spot

4.2 Bipedalism

Human bipedalism originated in Africa approximately 7 million years ago (for example, "Lucy"). It was an evolutionary adaptation that allowed early hominids to use their hands freely to build tools and weapons, facilitating the hunting of animals.

Although the spine developed an "S"-shaped curvature to balance weight, its basic structure remains similar to that of primates. In primates, all four limbs support the body's weight, which is distributed more evenly along the spine. In bipedalism, the weight of the upper body rests vertically on the lower vertebrae (the lumbar region), causing compression, wear of the intervertebral discs, and pain. **Figure 8** shows the skeleton of a primate compared with the human skeleton. It clearly demonstrates that the weight of the upper body is supported by the lumbar vertebrae. It also shows that the pelvis became narrower, making natural childbirth more difficult.

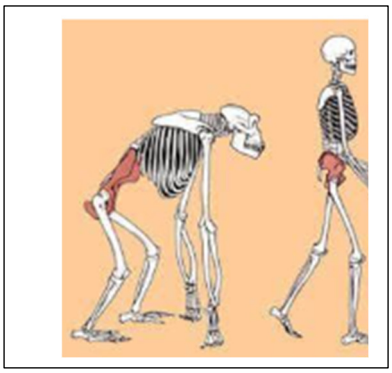


Figure 9 – Primate and Human Skeletons

4.3 Male Reproductive System

In the human body, the testicles are located outside the body cavity, which makes them more vulnerable. Evolution likely placed them there as a "quick" solution so that sperm would not be affected by the body's internal temperature and could survive longer, thereby facilitating human reproduction.

4.4 The Appendix

In our hominid ancestors, the appendix was probably a larger structure that helped digest fibrous vegetation such as leaves and cellulose. This structure likely functioned in a manner similar to the cecum of modern herbivorous animals, such as the horse. See **Figures 10 and 11**.

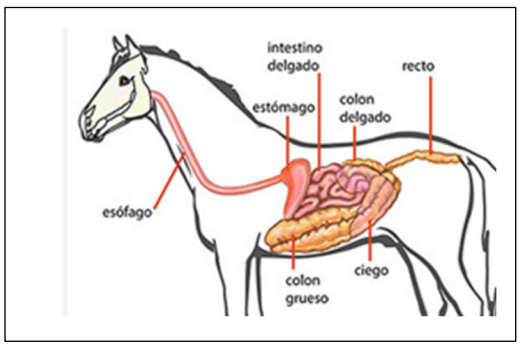


Figure 10 – Horse Large Intestine

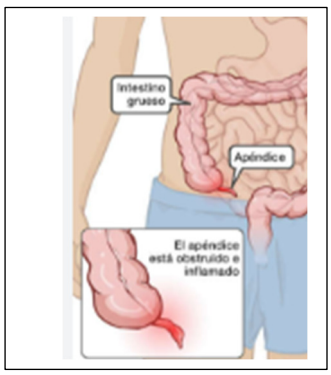


Figure 11 – Mans Large Intestine

4.5 Wisdom Teeth

Wisdom teeth are the last molars to emerge, generally between the ages of 17 and 25. They commonly cause complications when erupting due to insufficient space in the jaw. Dentists usually recommend the extraction of all four wisdom teeth. Wisdom teeth are evolutionary remnants from our ancestors, who needed to chew tough and raw foods.

4.6 Throat

We use the same passageway to carry food to the stomach as we use for breathing. This increases the risk of choking while eating. Instead of creating two separate passages—one for breathing and another for eating—evolution opted for a valve that opens and closes, called the epiglottis, which prevents water and food from entering the lungs. **See Figure 12**.

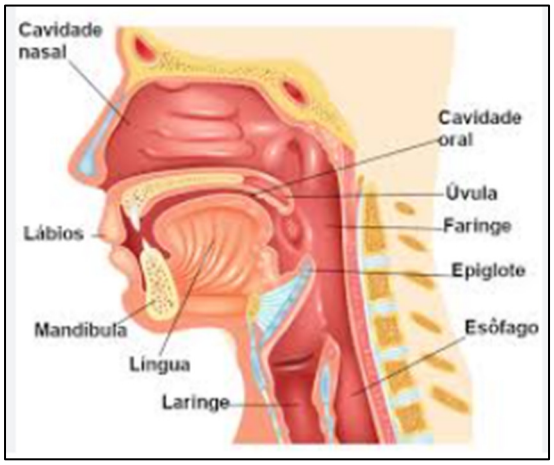


Figure 12 Human Pharynx and Larynx

4.7 Modern Diseases

Many modern diseases, such as diabetes, hemochromatosis, and cystic fibrosis, may have offered evolutionary advantages to our ancestors in order to survive climate changes and plagues. These diseases persist today because, at some point, they helped our ancestors survive. See **Reference 6**.

4.7.1 Diabetes

Type 2 diabetes is characterized by the body's resistance to insulin. It is believed that insulin resistance evolved as a way to protect the brain during periods of famine: by maintaining high levels of sugar in the blood, the body ensured sufficient energy for the brain to continue functioning, which increased the probability of survival and reproduction.

It is worth remembering that, from an evolutionary perspective, it does not matter whether an individual lives or dies once they have passed their reproductive stage. In modern times, when famine is no longer common, this excess sugar tends to be converted into fat, promoting obesity, insulin resistance, and eventually type 2 diabetes.

4.7.2 Hemochromatosis

Hemochromatosis is a genetic disease that causes the body to absorb excessive amounts of iron. When accumulated, this iron can damage organs such as the liver, heart, and pancreas.

When humans shifted their diet from red meat—typical of hunter-gatherers and rich in iron—to a grain-based diet associated with agriculture, they faced new diseases related to iron deficiency in the blood, such as iron-deficiency anemia, kidney disease, and developmental problems during childhood.

In that context, this defective gene may have favored survival.

4.7.3 Narrowing of the Birth Canal

From an evolutionary perspective, human bipedalism (walking upright) caused the narrowing of the female pelvis, as illustrated in Section 2, Figure 8. This evolutionary phenomenon, combined with the increase in fetal brain and skull size, resulted in many women no longer being able to give birth naturally, requiring surgical intervention in order to have a baby.

4.7.4 Cancer

Cancer is a disease caused by genetic replication errors in our cells. This process creates "immortal" cells that reproduce rapidly, forming tumors and invading nearby organs and tissues. These cells have the ability to evade recognition as malignant by our immune system. They can metastasize and invade different organs, such as the lungs, bones, and brain.

Cancer cells are also subject to evolution by natural selection, which eventually makes them resistant to treatments such as chemotherapy and radiation. This is why it is common to observe that many cancer patients initially improve during treatment but eventually succumb to the disease. It only takes a single cell that, due to a genetic

mutation, is able to survive cancer treatment; that cell can then reproduce and give rise to other cancer cells that are immune to treatment. That is why I have always said that cancer is like a weed—it never truly dies.

4.8 Paranasal Sinuses

The paranasal sinuses are four pairs of air-filled bony cavities located in the skull around the nose (frontal, maxillary, ethmoidal, and sphenoidal). **Figure 13** shows the human paranasal sinuses.

During human evolution, from our primate ancestors to modern humans, the human skull changed radically in size and shape. As a result of these changes, the paranasal sinuses also changed in shape and size, particularly the maxillary sinus, causing them not to drain easily and leading to very common illnesses such as sinusitis.

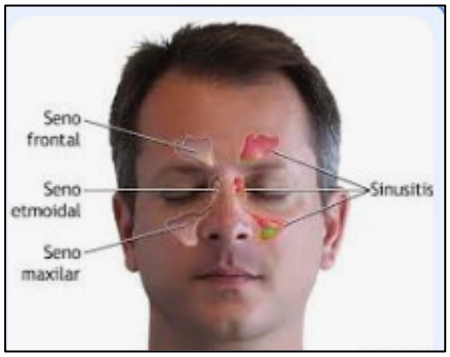


Figure 13 Human Paranasal Sinuses

4.9 Impact of Technology on Evolution

Technology has also contributed to the fact that human imperfections are not corrected through evolution. One example is the skin color of humans who currently live in low latitudes. Due to air travel, these individuals migrated from the north to the south. They are now exposed to greater amounts of ultraviolet radiation. Normally, these individuals would develop skin cancer and would not have time to reproduce, causing the genes responsible for insufficient melanin production to disappear. However, thanks to modern medicine, these individuals live long enough to reproduce and thus pass on offspring who are not adapted to low latitudes.

Another example, as mentioned in Section 3, is the various genetic imperfections, such as mutations in the VCP gene, fragile X syndrome, cystic fibrosis, hemophilia, Huntington's disease, and many others that continue to be inherited from parents to children. This occurs because modern medicine allows affected individuals the opportunity to reproduce, so these genetic mutations are not eliminated by natural selection.

5. Conclusion

Human beings are imperfect simply because we are the product of imperfect evolution by natural selection. Evolution does not seek perfection; it seeks the easiest path to ensure the survival of our species. Human technology impacts our natural evolution. To what extent, we will not know for thousands of years—if the human species does not destroy itself first. We are an imperfect, destructive, and foolish species, and sometimes I think the planet might be better off without humans.

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Artificial Intelligence

1. Prologue

Artificial Intelligence (AI) is a branch of computer science dedicated to the design of systems and algorithms capable of simulating human cognitive processes, such as learning, logical reasoning, language understanding, and decision-making. Section 2 presents a more detailed description of what AI represents.

The purpose of this article is to explain, in a clear and accessible way, how AI algorithms work for people who are not familiar with this field. It also aims to show that AI is not a recent phenomenon: although it has gained greater visibility in recent years, its foundations and developments have existed for several decades. Section 2.1 provides a brief historical overview of what we now know as Artificial Intelligence.

Throughout prehistory and history, inventions and technological advances—such as the discovery of fire, the invention of the wheel, the development of tools, agriculture, livestock farming, electric power, engines, transformers, and computers—have profoundly transformed society and influenced human evolution. These aspects are described in greater detail in Section 3.

Similarly, Artificial Intelligence promises to generate significant repercussions in society and possibly in the future evolution of human beings. Unlike other technological advances, AI not only expands human physical capacity but also cognitive capacity, by developing systems capable of learning from data, recognizing images, making predictions, making decisions, understanding and generating language, and solving complex problems.

Rarely in history has humanity created a tool as powerful and, at the same time, with such considerable risk potential as AI. Section 4 analyzes in detail its positive and negative impacts on society and on human evolution.

Section 5 concisely summarizes the basic functioning of AI and the possible risks that may arise if its development and use are not managed responsibly.

Finally, Section 6 presents the list of books and sources used in preparing this article.

This article is intended to be a general discussion of the topic and does not follow the structure of a formal scientific research paper. This article was translated from English into Spanish and edited using the poe.com portal.

2. Artificial Intelligence Explained

Artificial Intelligence (AI) is a branch of computer science that develops systems capable of simulating certain aspects of human intelligence, such as solving logical problems, performing tasks without direct supervision, and analyzing information to facilitate decision-making.

It is worth noting that the term Artificial Intelligence can be ambiguous. For some people, the word "intelligence" is associated with "consciousness." However, AI systems do not possess consciousness or self-awareness; they simply process data and apply mathematical models to generate results. In this sense, some authors consider that a term such as "Artificial Cleverness" might more accurately describe how these systems function, although the official and widely accepted term remains Artificial Intelligence.

2.1 History of AI

Below is a brief chronological overview of AI:

1936 – Alan Turing and the Turing Machine

In 1936, Alan Turing proposed the Turing Machine, a mathematical model that constitutes the theoretical foundation of modern computing. It is not a real physical machine, but rather an abstraction that explains how any computer works.

This model introduces fundamental concepts such as: program, memory, state, logic, repetition, and process termination.

The Turing Machine consists of three main components:

Infinite tape: Divided into cells, each containing a symbol (for example, "1", "0", or blank). It represents a computer's memory.

Read/write head: Can read the symbol in each cell, write a new one, and move left or right.

Rule table: Determines which action to execute based on the symbol read and the current state (for example, writing a symbol, changing state, or moving along the tape).

A simple example of how it works would be:
It reads a "1," replaces it with "0," moves to the right, and repeats the process until completion.

1950 – Turing Test

In 1950, Turing published the article *"Computing Machinery and Intelligence"*, in which he proposed the Turing Test. This test evaluates whether a machine can exhibit intelligent behavior indistinguishable from that of a human being during a conversation.

1956 – Dartmouth Conference

In 1956, the Dartmouth Conference was held, organized by John McCarthy, Marvin Minsky, Claude Shannon, and other researchers.

At this event, the term "Artificial Intelligence" was officially coined. At the time, there was great optimism, and it was believed that within a few decades machines would reach a level of intelligence comparable to that of humans.

1957 – Rosenblatt's Perceptron

In 1957, Frank Rosenblatt developed the Perceptron, one of the first artificial neural network algorithms, designed for pattern recognition.

The perceptron works as follows:

It receives multiple inputs.

Each input is multiplied by a weight.

The results are summed.

An activation function is applied to determine the output.

Mathematically, it can be expressed as:

$$Z = \sum_{k=1}^{n} W_k * I_k + B_k$$

- **Wk**: The weights
- **Ik**: The inputs
- **Bk**: The biases
- The activation function could be 1 if Z > 10, and 0 otherwise.

1959 – “Machine Learning”

Arthur Samuel coins the term “Machine Learning” and creates a computer program to play checkers that learns from its mistakes.

1969–1980 – The First AI Winter

Marvin Minsky and Seymour Papert mathematically demonstrate that the Perceptron cannot solve simple logical problems such as the XOR (“Exclusive OR”) function.

XOR represents the binary function:



A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

It cannot be used with the perceptron because the inputs 0 and 0 or 1 and 1 produce the same result, Z=0Z = 0Z=0.
Computers were also still very slow at the time. That period is called the “AI Winter.” Research funding was frozen.

1980–1990 – Expert Systems

Systems that simulate decisions made by human experts. Examples include medical diagnostic systems and financial systems for calculating loan interest. They were expensive and difficult to maintain.

In 1986, the “Backpropagation” algorithm: Rumelhart, Hinton, and Williams popularized backpropagation. This mathematical algorithm made it possible to train multi-layer neural networks, finally overcoming the perceptron’s 1969 limitation.

1990–2010 – The Renaissance of “Machine Learning”

For the first time, data and statistics were used to train AI systems. There were advances in neural network algorithms and decision trees. Success was due to the availability of powerful computer hardware, the collection of massive datasets, and the application of solid mathematical methods.

In 1997, the computer “IBM Deep Blue” defeated the world’s top chess player at the time, Garry Kasparov.

2010–2017 – Deep Learning

In 2012, AlexNet and Big Data: Geoffrey Hinton and his team won the ImageNet competition using Convolutional Neural Networks (CNNs) and Graphics Processing Units (GPUs). Deep Learning demonstrated overwhelming superiority.

Convolutional neural networks are a type of deep learning network highly specialized in processing data with grid-like structure, such as images. They revolutionized computer vision by analyzing data pixel by pixel without losing the spatial relationships between them. The invention and widespread use of GPUs (Graphics Processing Units) also facilitated advances in digital image processing.

AlphaGo: DeepMind used Reinforcement Learning (algorithms that learn through reward and punishment) to defeat the world champion of the complex board game Go in 2017.

2017–Present – The Revolution of the "Transformer" Architecture

Google scientists published the paper *"Attention Is All You Need."* They introduced the self-attention mechanism, an algorithm that processes data in parallel and understands the broader context of words. Self-attention allows the model to directly connect words, even if they are far apart in a sentence.

Transformers are neural networks that analyze an entire sentence at once rather than word by word. For example, in the sentence "the dog on the street barked," the neural network can analyze the tokens "dog" and "barked" simultaneously, even though other words appear between them.

Present

Foundation Models: Transformers enable the creation of Large Language Models (LLMs) such as GPT, Claude, and Gemini, transforming generative AI into a global, everyday tool.

2.2 Areas of AI

The different AI structures can be divided according to their approach, techniques, and applications. Here they are described in a clear and structured way:

2.2.1 Machine Learning

These are algorithms that analyze data and are used to identify patterns and make predictions. They improve their performance over time by learning from their successes and mistakes.

2.2.2 Neural Networks and Deep Learning

Neural networks are digital mathematical models inspired by the functioning of the human brain. They are composed of neurons, weights, inputs, outputs, and functions.

Deep learning consists of multiple neural networks organized in sequence. The outputs of one neural network become the inputs of the next. These are commonly used for processing and identifying digital images.

Let us imagine a neural network used to detect whether an email is SPAM. The inputs would be:

X1 = Does it use the word "free"? Yes = 1, No = 0
X2 = Does it ask you to respond to the email quickly? Yes = 1, No = 0
X3 = Does it use many exclamation marks? Yes = 1, No = 0
X4 = Does it have an unknown sender? Yes = 1, No = 0

Each of these inputs has an initial weight:
W1 = 0.2 for X1, W2 = 0.3 for X2, W3 = 0.2 for X3, W4 = 0.4 for X4.

The AI performs the following weighted sum:

$Y = X1 \times W1 + X2 \times W2 + X3 \times W3 + X4 \times W4$

$Y = 1 \times (0.2) + 1 \times (0.3) + 0 \times (0.2) + 1 \times (0.4) = 0.9$

Then it asks the question: Is $Y \geq 1$?
It is not, so the email is not classified as SPAM.

It should be noted that the training of this process is an iterative operation. The weights **W1, W2, W3, and W4** are recalculated during each iteration.

For example, suppose we know that this email **is** spam. If that is the case, all the inputs would have a value of **1**, and the weighted sum **Y** would be:

$Y = 1 \times (0.2) + 1 \times (0.3) + 1 \times (0.2) + 1 \times (0.4) = 1.1$

Since **$Y > 1$**, the email is classified as **SPAM**.

The next step is to verify that the inputs and their corresponding weights are appropriate for determining whether an email is spam. The model is tested with emails that are **not** spam, and it is verified that **Y** is **not greater than 1**. If the model makes an incorrect prediction, the weights **W1, W2, W3, and W4** are adjusted. This process is repeated iteratively until the model achieves satisfactory performance.

The term **"deep learning"** refers to neural networks that contain more than one neuron (or, more precisely, multiple layers of neurons). In these networks, the inputs to one neuron are the outputs of one or more neurons from the previous layer, and

this process continues through successive layers, as shown in **Figure 1**. The figure illustrates image data that has already been processed by an earlier neural network, which identifies the locations of objects in the image. These processed outputs are then used as inputs to a second neural network, which classifies the detected objects—in this example, a **person**, a **car**, and a **bicycle**.

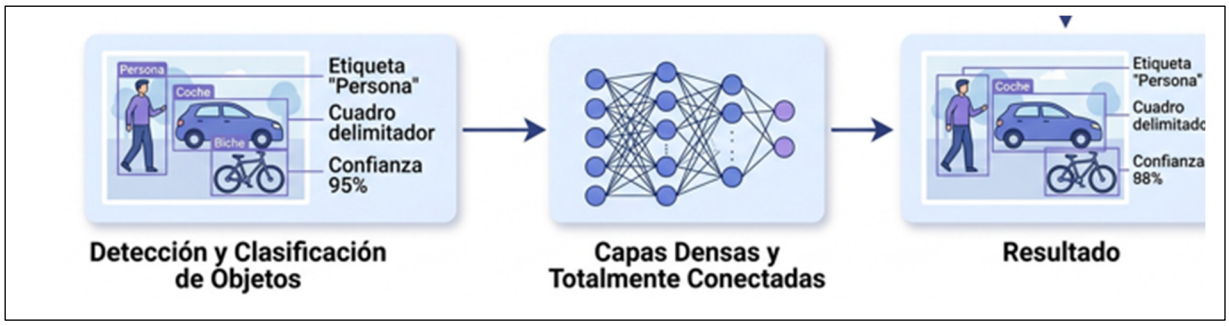


Figure 1 Neural Network

> **Author's Note**: I would like to mention that in 2007, 19 years ago, my friend Manuel Soto and I developed an algorithm that was conceptually similar to the one described above. The algorithm automatically generated an aircraft's flight path ("flight pattern") so that, while maintaining a constant altitude above the terrain, the aircraft would select the shortest route between two cardinal points.
>
> Although the algorithm relied on a weighted-sum approach similar to the previous example, it would not be considered an artificial intelligence system because it lacked the ability to learn and adapt its behavior. In particular, it could not learn to control the aircraft's altitude using AI techniques.
>
> I would encourage a graduate student in computer science or engineering to build upon this algorithm and enhance it by incorporating artificial intelligence to control the aircraft autonomously.

A simple example is the use of a neural network with a single artificial neuron. This illustrates the process of recognizing a digital "image" composed of only three pixels. Naturally, a real image would contain thousands or even millions of pixels, but for simplicity, we will limit the example to three.

Another interesting point is that the primary mathematical relationship used in artificial intelligence is very similar to the matrix equations previously employed in linear regression. However, there are important differences. In classical methods, it was necessary to know in advance the structure of the **Laplace transform** that

modeled the system—that is, the number of zeros and poles in the numerator and denominator, respectively.

The objective was to use linear regression on the available data to determine the coefficients of the numerator and denominator of the Laplace transform. This approach was necessary because computers at the time did not have sufficient processing power and therefore required additional information about the system being modeled. See **Reference 6.4**.

Today, artificial intelligence does not require prior knowledge of the system in order to make predictions.

The fundamental relationship can be expressed as:

$$Y=Ax+B$$

where:

- **A** is the weight matrix,
- **x** represents the algorithm's input variables,
- **B** is the bias vector (or bias matrix),
- **Y** is the predicted output.

Although this equation represents a linear system, updating the weights through their time derivatives enables the network to approximate nonlinear systems. In other words, the system can be treated as approximately linear over sufficiently small-time intervals.

The derivatives of the weights can also be used to regulate the damping characteristics of the system's response during the learning process.

The implementation of the algorithm using MATLAB will be as follows:

```
% Initialize parameters manually
% Weights and biases are the “knowledge” of your AI. They are typically
started with % small random numbers.

weights = [0.1; -0.2; 0.3]; % initial values for all 3 pixels
bias = 0.05; % Assumes the same bias for each pixel

% Define number of iterations and learning step rate
nLoop = 10000; % Total number of iterations.
learning_rate = 0.1

%  '1' indicates detection value
y_true = 1.0;

%  Initialize matlab vectors
y_true_v = zeros(1,nLoop);
y_pred_v=zeros(1,nLoop);
weights_v=zeros(3,nLoop);
bias_v = zeros(1,nLoop);

%*********************************************************
%  Start of Learning Loop
%*********************************************************
for k=1:nLoop
% 1. Entrada de imagen (Imagen de 3-pixeles blanco y negro)
% Se asume que la imagen permanece constante durante las 10,000
iteraciones
X = [0.5; 0.8; 0.2]; % Valor de pixeles, 0= blanco 1= negro, 0 < x <
1=gris

% Calculate Predicted value y_pred
% Weighted sum: z = (w1*x1 + w2*x2 + w3*x3) + bias
% Determine how far are you from the truth
z = sum(X .* weights) + bias;

% Forward pass: funcion Sigmoid to squish probability value between 0 y 1
y_pred = 1 / (1 + exp(-z));

% Backward Pass: Calculate Error y Gradient values
%
error = y_pred - y_true;

% Gradient of the Sigmoid activation; First Derivative of y_pred is
                y_pred * (1 - y_pred)
% Total gradient for the update
```

```
% Update Weights and Bias (Gradient Descent Step)
% Weight_new = Weight_old - (LearningRate * Gradient * Input)
% Determine how much weight contributed to the error.
% You subtract the gradient from the current weights. The learning_rate
controls how large of a "step" you take toward the correct answer.

weights = weights - (learning_rate * gradient * X);
bias = bias - (learning_rate * gradient);

% Display partial results
fprintf('Original Prediction: %.4f\n', y_pred);
disp('Updated Weights:'); disp(weights);
disp('Updated Bias:'); disp(bias);

y_true_v(k)=y_true;
y_pred_v(k)=y_pred;
weights_v(1:3,k)=weights;
bias_v(k)=bias;

end
%************************************************************
%  End of Learning Loop
%************************************************************

% Plot Matlab Data
figure(1);
plot(y_pred_v), xlabel('Iterations'), ylabel("Prediction")
title("Prediction vs True Value"),grid minor
figure(2);
plot(bias_v), xlabel("Iterations"), ylabel("Predicted Bias")
title("Predicted Bias"), grid minor
figure(3);
plot(1:nLoop,weights_v(1:3,1:nLoop)),xlabel("Iterations");
ylabel('Weights'),title("Weight Values"),grid minor
legend('Weight1',"Weight2",'Weight3')
```

MATLAB (Matrix Laboratory) is a programming language and development environment designed primarily for:

- Numerical computation
- Data analysis
- Matrix algebra
- Graphing and visualization
- Simulation and modeling

Developed by **MathWorks**, MATLAB is widely used in:

- Engineering (electrical, mechanical, civil, and others)
- Mathematics
- Data science
- Signal processing
- Artificial intelligence
- Automatic control

Figure 2 shows how the prediction produced by our AI model converges asymptotically toward the value **1**, representing a positive detection, after more than **10,000 iterations**. The object can be considered successfully detected when the error between the AI's prediction and the target value of **1** is less than **0.05**.

Figure 3 illustrates how the bias converges asymptotically to an approximate value of **2.2** after more than **10,000 iterations**.

Finally, **Figure 4** shows how the weights also converge asymptotically to stable values after **10,000 iterations**.

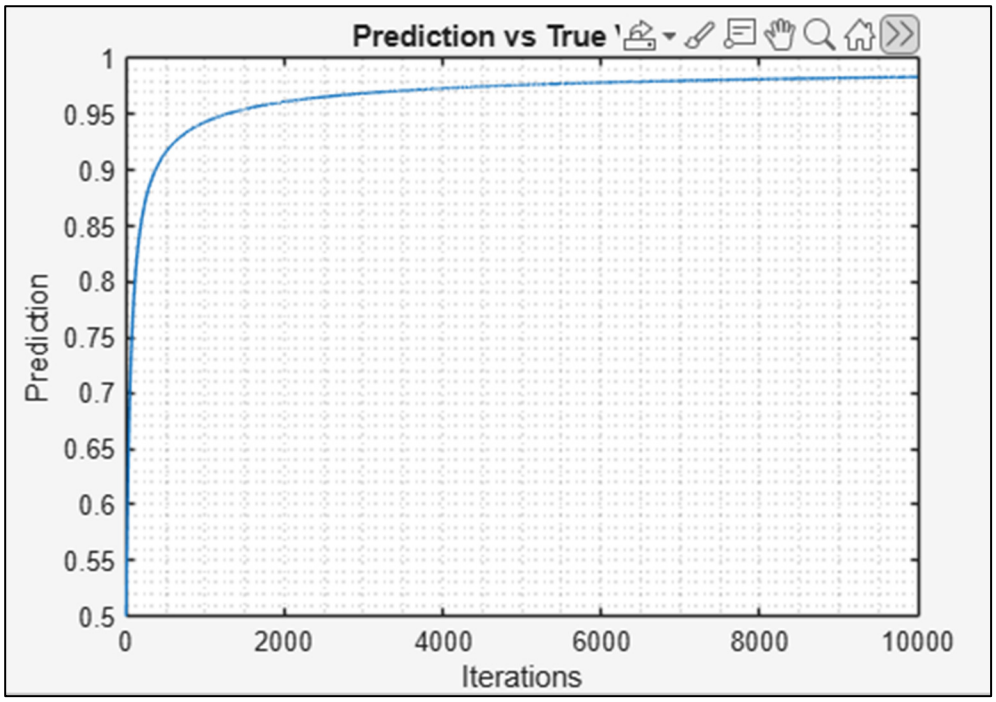


Figure 2 Prediction vs Iterations

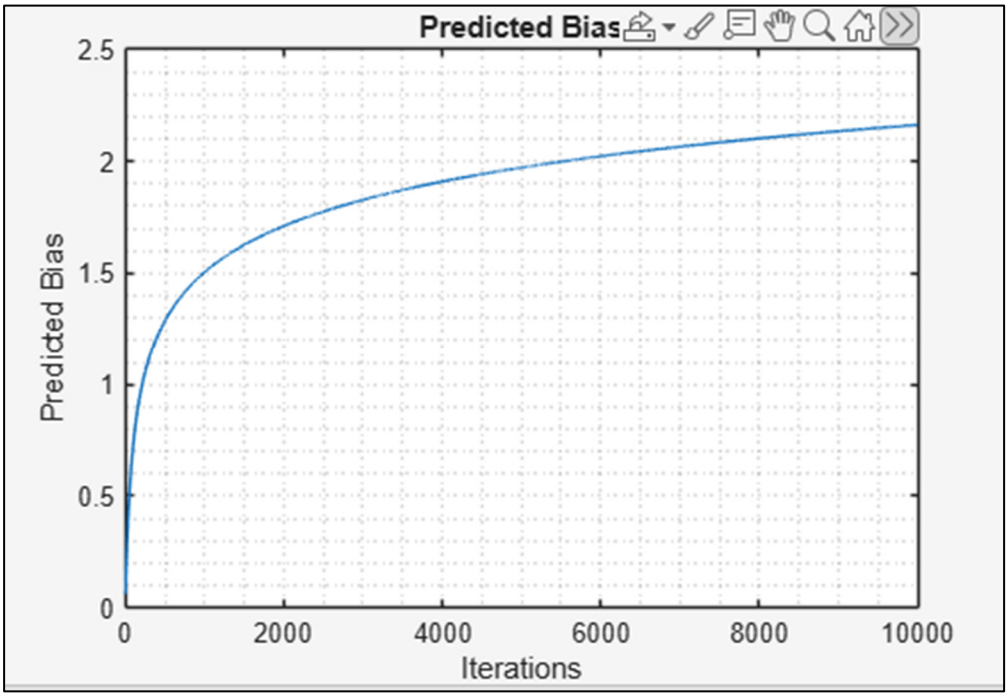


Figure 3 Biases vs Iterations

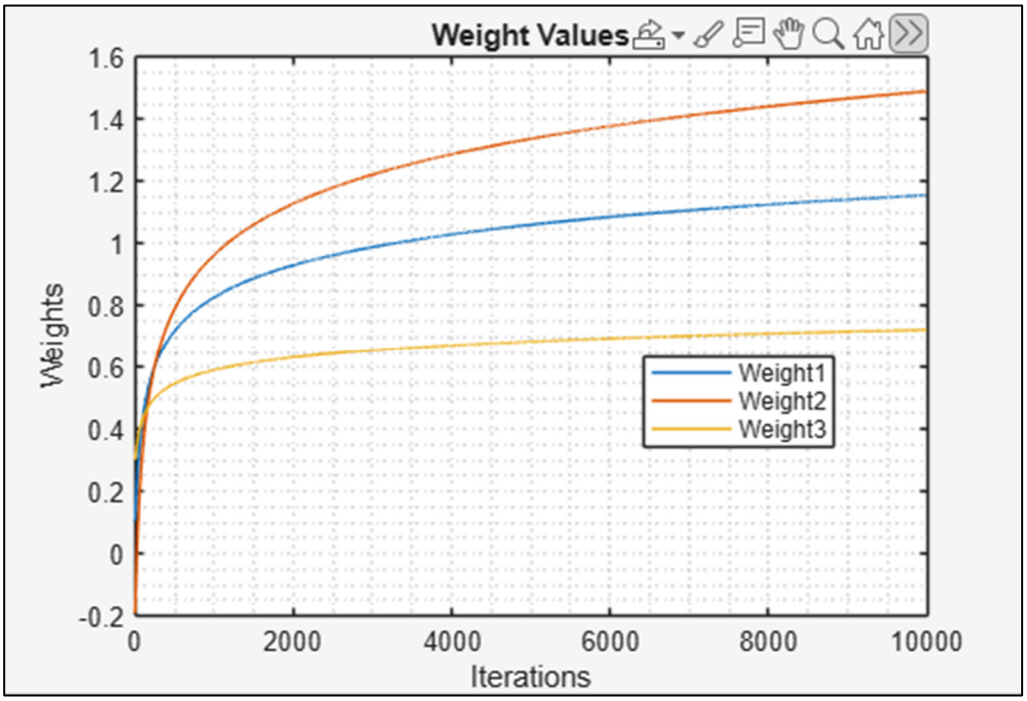


Figure 4 Weights vs Iterations

2.2.3 Large Language Models

Large Language Models (LLMs) are artificial intelligence systems trained on enormous amounts of text to understand and generate human language. They are used to understand context, translate between languages, generate creative content, answer questions, and summarize text.

These systems, known as **Large Language Models (LLMs)**, are capable of analyzing an entire sentence and understanding its meaning. They first identify key words and then use prior knowledge obtained from billions of text documents available on the Internet to recognize language patterns and predict the most likely word to continue the sentence.

For example, consider the sentence:

"The hare is faster than the _____."

An LLM would most likely complete the sentence with the word **"tortoise,"** because of the well-known fable *The Hare and the Tortoise*. In countless texts, the word *tortoise* frequently follows the phrase *"faster than the."*

It should be noted that LLMs also use neural networks, such as those described in **Section 2.2**, to determine the most probable next word.

LLMs do not process words such as *car*, *stone*, or *cat* directly. Instead, they use numerical representations (codes) for each word in the vocabulary. For example, if the Spanish language contains 100,000 words, the model uses 100,000 different numerical identifiers to represent them.

The architecture of the artificial neurons used in LLMs is different—it is based on the **Transformer architecture**. Each word is analyzed in relation to the preceding words to determine the context and predict the next word. Mathematically, this can be expressed as:

$$P(\text{next word} \mid \text{previous words})$$

The objective of the neural network is to determine which words have the highest probability of appearing after the input sequence. These probabilities, computed internally from the network's learned weights, are obtained by training on millions of text documents available on the Internet.

For example, during training, the neural network may learn that the word **"France"** is frequently associated with words such as **"Paris," "Belgium," "Italy," "the Netherlands," "Switzerland," "Sweden," "Germany,"** and **"Russia,"** among many others.

LLMs use vector representations of words, commonly referred to as **Word2Vec embeddings**, to represent these relationships mathematically.

Consider the following example:

"The capital of France is ___."

First, the model converts the sentence into **tokens**:

["The", "capital", "of", "France", "is"]

Next, it encodes these tokens as numerical values (internal identifiers):

[10740, 10, 200, 5000, 1]

Based on training with massive amounts of text, the model estimates the following probability distribution:

$$P(\text{next word} \mid \text{"The capital of France is"})$$

For example:

- Probability of **"Paris"** = 0.90
- Probability of **"Lyon"** = 0.01
- Probability of **"Madrid"** = 0.01
- Probability of **"London"** = 0.02
- Probability of **"Sweden"** = 0.001

Since the probability of **"Paris"** is significantly higher than that of the other candidates, the model selects:

"The capital of France is Paris."

2.2.4 Diverse Applications

Applications of artificial intelligence include chatbots, autonomous vehicle driving, data processing, medical diagnosis, digital assistants, robotics, and many other fields.

3. Impacts of Technology on Society and Human Evolution

Technology and human inventions have significantly affected our society, as explained in Sections 3.1, 3.2, 3.3, and 3.4. They have also created evolutionary pressures that have biologically influenced human evolution, as described in greater detail in Section 3.5.

3.1 Communication

The invention of the telephone, the Internet, and smartphones has enabled instant communication. Social media platforms connect millions of people around the world.

3.2 Health

The development of more effective vaccines and medications, along with new medical equipment and surgical techniques, has significantly improved medical diagnosis and treatment. As a result, human life expectancy has increased.

Two centuries ago, the average life expectancy was probably between 30 and 40 years, compared with the current global average of approximately 75 years. It is important to note that infant mortality was very high during that period, which significantly reduced the average life expectancy compared with today.

3.3 Economy

The automation of industrial processes has enabled the economy to grow more rapidly. It has also created more specialized and better-paying jobs.

3.4 Education

In the past, knowledge depended primarily on printed books and libraries.

Today, thanks to the Internet, students have access to:

- Digital libraries
- Online courses
- Educational videos
- Up-to-date scientific articles
- Technology also facilitates:
- International projects
- Communication among students from different countries
- Collaborative work through platforms such as Zoom and Skype
- Data analysis

In summary, technology has made education more accessible, flexible, and interactive, although it also requires responsible use.

3.5 Human Evolution

Technology has profoundly influenced human evolution by changing the evolutionary pressures necessary for survival. These pressures shifted from primarily favoring physical strength to promoting adaptations related to brain development and learning ability.

The following sections summarize some evolutionary changes associated with technological development.

3.5.1 Reduction in Jaw and Tooth Size

The discovery of fire made it possible to cook food instead of consuming it raw and tough. This reduced the need for large, powerful jaws and teeth, improved digestion, and enhanced nutrient absorption, thereby contributing to the development and expansion of the human brain.

3.5.2 Reduction in Physical Strength

The development of tools and hunting weapons made it easier to capture animals as well as process and transport food. As a result, exceptional muscular and skeletal strength became less essential for survival.

3.5.3 Increased Learning Capacity

The invention of writing and reading enabled people to access the accumulated knowledge of previous generations more easily. This promoted a greater capacity of the brain to store and process information.

3.5.4 Increased Mobility and Adaptation to Different Climates

The development of agriculture and animal husbandry allowed humans to establish settlements in regions with diverse climates. Over time, this favored adaptations such as variations in skin color to protect against ultraviolet radiation, changes in body fat composition, and differences in body hair to conserve heat in colder climates.

3.5.5 Increase in Hereditary Diseases and Genetic Disorders

Advances in medical technology have enabled individuals who previously would have died before reproducing to survive because of modern medicine. For example, cesarean section has allowed babies who could not have been delivered naturally to survive and develop normally. Some researchers have argued that this may influence the transmission of certain hereditary traits associated with the size of the birth canal.

Likewise, these medical advances have contributed to improved infant survival and healthier development of newborns.

The development of Artificial Intelligence, described in Section 2, will have an even greater impact on our lives and on biological evolution, as discussed in Section 4.

4. Impact of Artificial Intelligence on Society and Human Evolution

Artificial Intelligence (AI) will affect many aspects of human life. It will transform the way people live on a daily basis and will have both positive and negative effects, as described in the following sections.

The solution I propose for controlling AI and preventing its negative effects is that every AI system should include a **structural supervisory program**. In other words, a system that does **not** use AI to program itself. This supervisory program would monitor the inputs and outputs of the AI system. For example, input data containing racist or discriminatory biases would be filtered out. Likewise, the supervisory program would ensure that the AI's outputs comply with rules established by humans and that this information is not used to retrain or provide feedback to the AI system without human oversight.

4.1 Increased Productivity

AI will free people from repetitive and tedious tasks, allowing them to devote more time to creative activities.

One example is computer programming: the programmer simply specifies the inputs, outputs, user interface, and programming language, while the AI generates the software. Another example is the use of intelligent robots in industrial manufacturing.

4.2 Scientific Advances

AI has demonstrated capabilities that can significantly assist scientific research by addressing problems that have previously been difficult or impossible to solve.

Its applications include:

- Predicting weather events such as hurricanes and tornadoes.
- Developing more accurate climate models.
- Automatically analyzing millions of images of space.
- Detecting exoplanets and distant galaxies.
- Identifying unusual signals, such as gravitational waves.
- Designing stronger and lighter materials.
- Processing electromagnetic signals in the search for possible intelligent extraterrestrial civilizations.
- Simulating complex neural networks of the human brain.

4.3 Education and Entertainment

AI is already transforming the music, film, and publishing industries.

Examples include:

- AI-generated music videos on platforms such as YouTube. In some cases, songs are incorrectly attributed to artists who are not their original creators. The following link provides an example of videos that claim to feature songs by Kany García when they do not.
- Movies featuring digitally de-aged actors. For example, in *The Irishman* (2019), Robert De Niro, Al Pacino, and Joe Pesci were digitally rejuvenated to portray different stages of their lives.
- Educational videos in which a person's voice is digitally cloned and their lip movements synchronized as if they were actually speaking. The following link

shows Roger Penrose, the 2020 Nobel Prize laureate in Physics, discussing the origin of the universe.

- Automatic generation of movie scenes and visual effects.

4.4 Medicine

AI has an enormous capacity to process large amounts of data rapidly, making it possible to:

- Diagnose diseases such as cancer, leukemia, amyotrophic lateral sclerosis (ALS), immune disorders, and heart disease at earlier stages.
- Analyze medical images, including X-rays, magnetic resonance imaging (MRI), CT scans, and electrocardiograms.
- Perform real-time blood analysis.
- Provide personalized medicine based on genetic information and medical history.
- Analyze DNA to identify genes associated with diseases such as Alzheimer's disease, Hutchinson disease, diabetes, lupus, and others.
- Develop vaccines, antibiotics, and synthetic organic molecules for designing drugs that target complex diseases.

4.5 Changes in the Workforce

AI will replace many jobs, particularly those involving repetitive or easily automated tasks, including:

- Call center and customer service representatives, who will be replaced by chatbots and virtual assistants.
- Workers on automated assembly lines using industrial robots.
- Taxi and truck drivers, accountants, financial analysts, translators, graphic designers, and many others.

This could have a significant economic impact due to increased unemployment.

One possible solution is to encourage young people to pursue professions that are less likely to be replaced by AI in the near future, such as teachers, nurses, psychologists, therapists, engineers, and AI specialists. Nevertheless, these professionals will also use AI to improve the efficiency of their work.

4.6 Ethics

AI also presents ethical and security challenges, including:

- **Discrimination:** Systems trained on biased data may reject job applicants based on race, age, or gender. AI reflects the data on which it is trained; if those data contain biases, the system may reproduce them unless appropriate oversight mechanisms are in place.
- **Privacy:** Training AI with information available on the Internet may pose risks to privacy and the security of personal data.
- **Authorship:** The authorship of texts, songs, and works of art created with AI assistance may become ambiguous.

4.7 Cognitive Impact

Artificial Intelligence can become a powerful tool for enhancing learning, supporting decision-making, increasing creativity, and improving education in general.

Its main contributions include:

- **Memory:** Facilitating rapid access to information through search engines, digital assistants, and automatic summarization tools.
- **Learning:** Providing personalized education with immediate feedback that accelerates learning and reinforces material according to each student's pace.
- **Decision-making:** Supporting complex processes such as medical diagnosis, financial analysis, and, in some cases, the evaluation of legal scenarios.
- **Creativity:** Helping generate new ideas, suggest alternative approaches, and serve as a starting point for artistic or innovative projects.

However, excessive or inappropriate use of AI could negatively affect certain cognitive abilities:

- **Reduced critical thinking:** Accepting AI-generated answers without questioning them may diminish independent analysis and evaluation.
- **Excessive dependence:** Skills such as memorization, mental arithmetic, and handwriting may weaken (for example, no longer remembering important telephone numbers).
- **Reduced personal creativity:** Artistic creation may decline if it is delegated entirely to automated systems, such as composing music exclusively with AI.

- **Difficulty functioning without technological assistance:** People may lose the ability to perform basic tasks independently, such as solving mathematical problems mentally.

From an evolutionary perspective, some researchers have suggested that if humans were to rely entirely on AI for problem-solving and substantially reduce the use of their own cognitive abilities, this could have long-term effects on intellectual development. However, this remains a speculative hypothesis, and there is currently no conclusive scientific evidence to support this scenario.

4.8 Security and Privacy

Artificial Intelligence can have significant positive impacts in cybersecurity and data protection. Its principal applications include:

- **Real-time cyberattack detection:** AI systems can monitor network traffic and detect anomalous patterns, such as multiple requests originating from the same Internet Protocol (IP) address, which may indicate an attempted cyberattack.
- **Detection of suspicious behavior:** AI can identify unusual activities, such as repeated password-guessing attempts (brute-force attacks) or logins from unknown devices.
- **Financial fraud prevention:** AI algorithms can detect unusual transactions, such as cash withdrawals made from a country different from the user's usual location.
- **Large-scale data analysis:** By processing massive volumes of information in real time, AI can identify fraudulent transactions, unauthorized access, and behavioral patterns that indicate security risks.

Together, these capabilities enable faster and more accurate responses to digital threats, reducing the impact of cyberattacks and strengthening security systems.

However, Artificial Intelligence can also have negative consequences if it is misused or deployed without adequate regulation. Major risks include:

- **Intrusive surveillance and social media monitoring:** AI systems can track people's locations, analyze their interests, opinions, shopping habits, musical preferences, and browsing behavior. This large-scale collection of data may result in a significant loss of privacy.
- **Creation of deepfakes:** AI-generated videos, images, or audio recordings that appear authentic. This technology can be used to create false content involving public figures, such as artists or politicians, leading to misinformation, reputational harm, or even extortion.

- **Automated cyberattacks:** Software and scripts can launch millions of cyberattacks worldwide automatically, increasing both the speed and scale of digital threats.
- **More sophisticated phishing attacks:** AI can enable more convincing impersonation of legitimate organizations, such as banks, companies, or social media platforms, to obtain confidential information including passwords, personal identification numbers, birth dates, or banking information.
- **Intelligent malware:** Malicious software capable of adapting to its environment, evading detection systems, and scanning for vulnerabilities to maximize its effectiveness.
- **Unfair decisions resulting from biased data:** AI systems trained on incomplete or biased datasets may produce discriminatory decisions in areas such as employment, lending, or judicial proceedings.
- **Autonomous military systems:** The development of autonomous weapons raises serious ethical and geopolitical concerns. Delegating critical decisions to automated systems could have severe consequences without strict human oversight.

4.9 Human Physical Integration with AI

Human-AI physical integration refers to the direct connection between the human body and intelligent systems, allowing technology to interact with biological functions.

For example, **Neuralink** is developing brain-computer interfaces. Potential applications include:

- Allowing individuals with paralysis to control an exoskeleton using only their thoughts.
- Smart pacemakers that automatically adjust heart rate.
- Body sensors that help control balance disorders (vertigo) or involuntary movements caused by Parkinson's disease.
- Continuous monitoring of diseases such as diabetes or cardiac arrhythmias.
- Advanced brain integration to enhance cognitive abilities, such as faster mental calculations or direct access to digital information.

4.10 Biological Evolutionary Risks

The biological evolutionary risks of Artificial Intelligence arise when artificial systems directly modify the genome, health, or evolutionary trajectory of humans and other living organisms. The primary risk scenarios include:

- **Digital eugenics:** AI is used to select embryos based on their genetic characteristics. This could reduce the genetic diversity of the human species, making it more vulnerable to biological attacks.
- **Evolutionary dependence:** AI is used to modify genes through software rather than relying on the natural process of evolution by natural selection.
- **Biological attacks:** AI may be used to design and create more lethal and infectious viruses.
- **Neural implants:** The human brain could evolve to function more efficiently with neural implants, to the point that it might no longer function properly without them. This could eventually give rise to two distinct human populations: enhanced or hybrid humans (the wealthy) and unenhanced humans (the poor).

5. Conclusions

After studying and understanding the fundamental AI algorithms, such as **deep learning**, **neural networks**, **machine learning**, and **large language models (LLMs)**, I have reached the conclusion that there is no reason to fear AI, provided that its developers act responsibly and surround it with a supervisory software architecture written using human logic (rather than AI-generated logic) that monitors the inputs and outputs of the algorithms.

AI algorithms are not new; many of them were invented 30 to 40 years ago. The difference today is that sufficient computational power now exists to execute them efficiently. These algorithms rely on brute-force computation to produce conclusions that appear intelligent but are not truly intelligent. They simply process information that has been generated and stored by millions of people on the Internet. We cannot compete with them unless we make use of our own imagination. As Albert Einstein once said, **"Imagination is more important than knowledge."**

I believe AI may eventually contribute to the emergence of two distinct groups of people: those who become completely dependent on it and those who continue to rely primarily on their own cognitive abilities. The first group might say, *"Why think if AI can do it better?"* The second might respond, *"Let's compete with it, because our brains are still superior and we do not need to depend entirely on AI."* Over time, the

brains of these two groups could evolve differently. The number of neural connections might decrease in the first group while increasing in the second. The question is: **Which group would you choose to belong to?**

During infancy, the human brain forms approximately **250,000 neural connections per minute**. I believe we possess enormous biological potential that we should not lose now that AI has become widely available.

Today, individuals with limited training may appear highly knowledgeable simply because they use AI. Likewise, average students may suddenly rank among the best performers.

But what would happen if, during a nuclear war, the infrastructure required to operate AI systems were destroyed? We could find ourselves living in a world full of people who have lost the ability to think independently.

Let us observe one minute of silence to reflect.

6. References

This article was edited with the assistance of Artificial Intelligence using the **Poe** platform to improve clarity and correct spelling and grammar. In addition, **MATLAB**, developed by **MathWorks Inc.**, was used to implement the coding examples presented in this article.

The article was originally written in Spanish and later translated into English using the **Poe** platform. I should emphasize that it would probably have been easier to write it in English first and then translate it into Spanish because there are Spanish technical terms that I am not accustomed to using, such as *biases* ("sesgos"), *Amyotrophic Lateral Sclerosis (ALS)* ("Esclerosis Lateral Amiotrófica"), and many others.

The following references were also consulted:

6.1 Mitchell, M. (2025). *Artificial Intelligence: A Guide for Thinking Humans.*

6.2 Kahn, J. (2024). *Mastering AI: A Survival Guide to Our Superpowered Future.*

6.3 Kanan, M. (2025). *T-Minus AI: Humanity's Countdown to Artificial Intelligence and the New Pursuit of Global Power.*

6.4 Alvarado, L. E., & Nemir, D. (1990). *Adaptive Autopilot Design for the F-106 Supersonic Aircraft. Memoria Electro 90*, Instituto Tecnológico de Chihuahua.

6.5 Soto, M., Nava, P., & Alvarado, L. E. (2007). *Drone Formation Control System Real-Time Path Planning.* AIAA Paper 2007-2770.

Abiogenesis and the Principle of Improbability

Abiogenesis is the natural process by which life arose from nonliving matter, such as simple organic chemical compounds. This concept attempts to explain the origin of the first life on the early Earth, billions of years ago.

The principle of improbability is a statistical concept developed by mathematician David J. Hand. It states that extremely improbable events are, in fact, inevitable and occur frequently; therefore, great coincidences or so-called “miracles” may be mathematically normal. Many events are modeled incorrectly, which leads to their probability also being calculated incorrectly.

Human beings have a tendency to dismiss events that we consider impossible. For example, we tend to think that it is virtually impossible for lightning to strike the same tree twice, or we are surprised to learn that only 23 people are needed for the probability that two of them share the same birthday to be approximately 50%.

In the same way, many people find it impossible to believe that life could have arisen from inorganic matter. Some even attempt to mislead the reader by claiming that it is impossible for a DNA macromolecule to have formed through a random process from inorganic matter. Some scientists have even gone so far as to calculate that the probability of such an event would be **1 in 10^40,000.**

DNA, or deoxyribonucleic acid, is the molecule that contains the genetic instructions necessary for the development, functioning, and reproduction of all living organisms, as well as some viruses. In a sense, it is the biological instruction manual of life.

For example, a reader might argue that the probability of randomly organizing a DNA structure like ours is virtually zero. And, indeed, it would be if we assumed that everything had to occur simultaneously and in exactly the correct configuration. However, when other factors are taken into account—such as the possibility that our DNA is not the only molecular structure capable of supporting life, or that the development of complex molecules could have occurred through an iterative process—the situation changes considerably.

The development of organic molecules and, subsequently, amino acids may have been an iterative process driven by variation, selection, and adaptation. If we calculate the probability while taking this iterative process into account, the result may be very different. Therefore, the problem should be approached from the perspective of the actual process rather than treating it as a single random event in which everything must occur simultaneously.

Consider, for example, the probability of obtaining the following specific sequence of ten digits:

0132456789

If each digit had to be selected independently and appear in exactly the correct position, the probability of obtaining this specific sequence purely by chance would be approximately **1 in 10 billion, that is, 1/10^10.**

However, an iterative process is fundamentally different from a single random event. Suppose the first step consists of selecting one digit. The probability of selecting 0 is 1 in 10. If that choice produces a stable or advantageous result, it can be retained. The process then continues by evaluating subsequent steps and retaining or discarding them according to their stability or usefulness. In that case, the probability would be reduced to **1 in 100 rather than 1 in 10 billion.**

In this type of process, each successful step does not have to be recreated from the beginning. Instead, the successful outcome of one step becomes the starting point for the next. This fundamentally changes the way the probability of the final outcome should be analyzed.

Furthermore, the probability of obtaining a functional biological system could be even greater if we recognize that **0132456789** is not necessarily the only sequence capable of producing the desired outcome. There may be many different molecular configurations capable of performing the same function or leading to a similar result.

Therefore, calculating the probability of one specific final configuration and then concluding from that calculation that the entire process is impossible can be misleading. The correct analysis should consider the pathway by which the outcome is produced, including iteration, selection, the preservation of successful intermediate states, and the possibility that multiple solutions may exist.

Prostate Exams Cause More Problems Than Benefits

Disclaimer: *"This article was written solely for informational and educational purposes and does not replace the evaluation, diagnosis, treatment, or recommendations of a healthcare professional. The information contained herein should not be interpreted as personalized medical advice. The author or person responsible for this document assumes no responsibility for damages, harm, complications, or consequences that may arise from the use, interpretation, or application of the information presented here."*

Author's Notes: *The purpose of this article is to inform my friends, in a simple and concise way, that many of the treatments and medical practices recommended by some doctors may be mistaken, may have side effects, and, at times, may cause more harm than benefit. I have suffered from benign prostatic hyperplasia (BPH) since the age of 50 and have undergone several prostate biopsies, none of which were positive.*

Prostate cancer is one of the most common cancers among men in the United States. It ranks second after lung cancer. According to the most recent data from the CDC, or Centers for Disease Control and Prevention, in 2023, 33,881 men died from prostate cancer. The mortality rate was approximately 19 deaths per 100,000 men.

The most commonly used test for detecting prostate cancer is the blood measurement of PSA, or prostate-specific antigen. PSA is a protein produced mainly by the prostate. One of its functions is to help thin semen, which facilitates sperm movement and helps sperm travel toward the egg.

However, PSA is not a cancer-specific test. In other words, an elevated PSA level does not necessarily mean that a man has prostate cancer. Likewise, some men with prostate cancer may have relatively low PSA levels.

Researcher Richard Ablin, who participated in the discovery of PSA, has criticized its use as a routine screening test, pointing out that PSA is prostate-specific but not cancer-specific. According to Richard Ablin, its main usefulness was to monitor men who had already been diagnosed and treated, not necessarily to use it as a general screening test for the entire male population.

There are several reasons why PSA can be difficult to interpret:

- Some men with prostate cancer may have low PSA levels.
- Some men with elevated PSA levels may not have cancer.
- Infection or inflammation of the prostate, called prostatitis, can raise PSA.
- Benign prostatic hyperplasia, or BPH, can also increase PSA.

- In some men, cycling or recent ejaculation can temporarily raise PSA.

In medical practice, an elevated PSA may lead to further evaluations. Traditionally, a PSA greater than 4.0 ng/mL — nanograms per milliliter — was considered abnormal, but today the decision to perform a biopsy does not depend solely on that number. Urologists also consider the patient's age, family history, rectal exam, the rate at which PSA is rising, the percentage of free PSA, PSA density, prostate MRI, and other risk factors. Doctors might possibly use the percentage of free PSA and PSA density for a better diagnosis of prostate cancer.

Free PSA is the PSA that is not bound to other blood proteins.

The percentage of free PSA is calculated as:

(free PSA/total PSA) * 100

PSA density is calculated as:

(total PSA/ prostate Volumen)

A higher percentage of free PSA is usually associated with a greater probability of a benign cause, such as prostatic hyperplasia.

A lower percentage of free PSA may be associated with a greater probability of prostate cancer, although it does not constitute a diagnosis by itself.

The idea behind the PSA density factor is to better distinguish between an elevated PSA caused simply by a large prostate and a PSA that may be disproportionately high for the size of the prostate.

If a biopsy is recommended and the result is negative, the doctor may suggest follow-up with new PSA tests, MRI, or other evaluations, depending on the patient's individual risk. If the biopsy is positive and cancer cells are detected, the options may include active surveillance, surgery, radiation therapy, hormone therapy, or other treatments, depending on the aggressiveness and extent of the cancer.

It is important to clarify that prostate biopsies are highly invasive procedures. In a transrectal biopsy, the doctor inserts an ultrasound probe through the rectum to visualize the prostate and guide a needle that takes tissue samples. In a transperineal biopsy, the needle is inserted through the skin located between the scrotum and the anus, through an area called the perineum. These procedures can cause pain, bleeding, fever, infection, and blood in the urine or semen.

Most prostate cancers are adenocarcinomas, meaning types of cancers that originate in glandular cells. Because glandular cells are involved, part of the treatment is to reduce testosterone levels in the body. Many of these cancers grow very slowly; therefore, some men can live many years with prostate cancer without it causing serious symptoms or threatening their lives. In those cases, immediate treatment may not be necessary. However, other prostate cancers are more aggressive and may progress, metastasize, and cause death if they are not detected and treated in time.

Prostate cancer screening can cause significant problems for several reasons:

- It may detect slow-growing cancers that might never have caused harm during the patient's lifetime.
- It may lead to unnecessary biopsies.
- It may cause anxiety, overdiagnosis, and overtreatment.
- Treatments such as surgery and radiation therapy can produce significant side effects.

Surgery to remove the prostate, called prostatectomy, can cause urinary incontinence and erectile dysfunction. Some men need to use diapers after the operation, and others experience persistent erection problems. Radiation therapy can also cause side effects, such as urinary, intestinal, and sexual problems.

An important study called **ProtecT** evaluated 82,429 men between the ages of 50 and 69 who underwent PSA testing. Of these, 2,664 were diagnosed with localized prostate cancer. Then, 1,643 agreed to participate in a randomized comparison between two strategies: **(1) radical prostatectomy** and **(2) radiation therapy**. The third group, composed of 1,041 men — 2,664 minus 1,643 — chose only **(3) active monitoring** of the cancer.

After 10 years of follow-up, there were 17 deaths from prostate cancer in total, with no statistically significant differences among the three groups. Prostate-cancer-specific survival rates were very high: 98.8% in the active monitoring group, 99.0% in the surgery group, and 99.6% in the radiation therapy group.

At the 15-year follow-up, 45 men died from prostate cancer: 17 in the active monitoring group, 12 in the prostatectomy group, and 16 in the radiation therapy group. Again, there was no statistically significant difference in prostate cancer mortality among the three groups. Surgery and radiation therapy did not reduce mortality compared with active monitoring — 17 deaths versus 38 deaths.

These results suggest that, for many men with localized prostate cancer detected by PSA, the risk of dying from the disease may be low for many years, regardless of the

initial strategy. However, they also show that some treatments may slightly reduce the risk of progression or metastasis, although at the cost of possible side effects.

In summary, current methods for detecting prostate cancer are very imprecise. PSA can help identify some important cancers, but it can also lead to unnecessary biopsies, diagnoses, and treatments. One of the main difficulties is accurately distinguishing which cancers will be aggressive and which will grow slowly without causing harm.

For this reason, the decision to undergo a PSA test, a biopsy, or treatment should be made individually, after discussing the benefits and risks with a doctor. Factors such as age, general health, family history, PSA level, MRI results, and the patient's personal preferences are essential for making an informed decision.

Famous Paradoxes

A paradox is an idea, situation, or statement that seems contradictory or impossible, but that, upon analysis, may have a logical explanation, reveal a hidden error, or show something surprising.

Put more simply: a paradox is something that seems not to make sense, but makes you think.

There are several ways to classify paradoxes; this is one of them.

1. **Probabilistic paradoxes:** The probability of an event occurring challenges our intuition. This is when someone says, "That can't be possible."
2. **Algebraic paradoxes:** An incorrect use of mathematics can lead to absurd results.
3. **Physical paradoxes:** Physical theories produce strange or difficult-to-understand results.
4. **Logical paradoxes:** These arise from problems of reasoning and language.
5. **Temporal paradoxes:** These are logical contradictions that arise when we consider the possibility of traveling to the past and altering the timeline.

The following sections provide an example of each of these paradoxes.

1.0 The Birthday Paradox

An example of a probabilistic paradox is the fact that, in a group of only **23 people**, the probability that at least two of them share the same birthday is greater than **50%**.

This statement is known as the **birthday paradox**. It is not a logical paradox in the strict sense, but rather a mathematical result that conflicts with our intuition. We tend to think that a very large group is needed—such as half of the 365 days of the year—to find a match, but the mathematics works differently.

Figure 1 represents the probability that two people share the same birthday in a group of various sizes. The **y-axis** represents probability from 0 to 100%, while the **x-axis** shows the number of people in the group. Notice that if the group has more than 60 people, the probability that one of them shares your birthday is 100% or more.

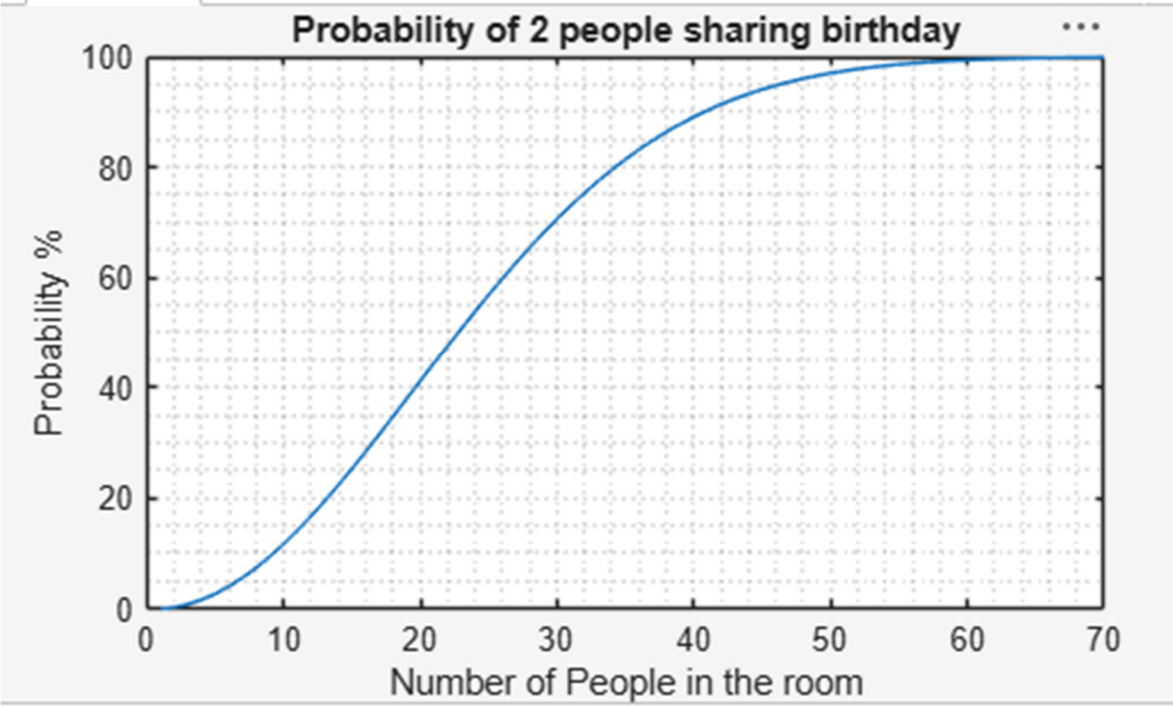


Figure 1

Figure 2 includes a copy of the MATLAB program that was used to generate Figure 1.

```
%**********************************************************************
% Paradox about N people in a room sharing the same birthday
%**********************************************************************
%  Probability of no two people sharing a birthday
%  PNot = (365/365) * (364/365) * (363/365) * .. (365-N+1)/365
%----------------------------------------------------------------------
%  Therefore:
%  PNot = NDY!/( (NDY^N)*(NDY-N)! )
%----------------------------------------------------------------------
%  Probability of 2 people sharing a birthday:
%  PYes = 1 - PNot;
%----------------------------------------------------------
% Inputs and Definitions;
%----------------------------------------------------------
Ntotal=70;    % Total number of people
Probability=zeros(1,Ntotal);
Npeople=zeros(1,Ntotal);
%----------------------------------------------------------
% For Loop: increment the number of people in the room
%----------------------------------------------------------
for k=1:Ntotal
Np = double(k); % Number of people in the room
NDY = double(365); % Number  of days in a year
NDYn = double (NDY-Np)+1;
Fact1=prod(NDYn:NDY);
Pow1 = NDY^Np;
PNot = Fact1/Pow1;
PYes = (1-PNot)*100;
% Plotting variables
Npeople(k)=k;
Probability(k)=PYes;
End
%-----------------------------------------------------------
% Plots
%----------------------------------------------------------

figure(1)

plot(Npeople,Probability),xlabel("Number of People in the room"),

ylabel("Probability %"), grid minor

title("Probability of 2 people sharing birthday")
```

Figure 2

2.0 The Algebraic Paradox of 2=1

Through an apparently valid procedure, it is possible to “prove” that the number 2 is equal to 1.

(1) Mathematical Argument

Let: $a = b$.

(2) Multiply both sides of the equation by a:

$a^2 = ab$.

(3) Subtract b^2 from both sides of the equation:

$a^2 - b^2 = ab - b^2$.

(4) Factor both sides:

$(a - b) * (a + b) = b * (a - b)$.

(5) Divide both sides by the factor $(a-b)$:

$a + b = b$.

(6) Since a=b, substitute a with b:

b +b =b then 2b=b

(7) Divide both sides by b:

Then 2=1

Mathematical Error

In step 4, both sides are divided by $(a-b)$. Since we stated at the beginning that a=b then:

$a-b=0$

Dividing by zero is not allowed in mathematics and breaks the logic, producing the absurd result.

3. The Twin Paradox

A classic example of a physical/temporal paradox is the **twin paradox**. If one twin traveled at a speed close to the speed of light and then returned, upon reuniting with his brother, he would have aged less than the twin who remained on Earth.

During the trip, each twin may consider the other's clock to be running more slowly while they are in uniform relative motion. The final difference appears because the traveling twin changes reference frames when accelerating, changing direction, and returning, breaking the symmetry of the situation.

While the spaceship moves away from Earth at a constant speed, the situation may seem symmetrical: from Earth, the traveler's clock runs more slowly; from the spaceship, Earth's clock also appears to run more slowly. However, this symmetry does not hold throughout the entire trip.

The crucial point is that the traveler has to change direction in order to return. To do so, he must accelerate and modify his trajectory, while the twin who remains on Earth follows, approximately, an inertial trajectory. It is precisely this difference between their trajectories in spacetime that produces the final difference in the elapsed time for each one.

Time dilation in special relativity is expressed by the relationship:

$$DT = \frac{T0}{\sqrt[2]{1 - \left(\frac{v}{c}\right)^2}}$$

where c is the speed of light, **T0** is the proper time — measured by the observer moving together with the phenomenon — **v** is the relative velocity, and **DT** represents the dilated time measured by an external observer. As **v** approaches **c**, the denominator decreases and time dilation increases exponentially.

A simple example would be:

Two twins: Andrés stays on Earth. Luis travels in a spaceship to a distant star and returns.

Constant speed of the spacecraft:

v = 0.8*c

where **c** is the speed of light.

Distance to the star from Earth's point of view:

d=8 light-years

Time measured from Earth:

$$\text{Time} = \frac{d}{v} = \frac{8c}{0.8c} = \mathbf{10\ years}$$

Therefore, the round trip lasts 2*10 = 20 years for Andrés.

Time dilation factor for Luis:

$$DT = \frac{10}{\sqrt[2]{1 - \left(\frac{0.8c}{c}\right)\text{^}2}} = 0.6$$

Therefore, the trip lasts for Luis:

Trip Time for Luis = 20 * 0.6 = 12 = 12 years

Luis ages only 12 years, while Andrés ages 20 years.

4. Achilles and the Tortoise Paradox

Achilles gives a tortoise a head start in a race. Although Achilles is faster, he must first reach the point where the tortoise was. But by then, the tortoise has already moved a little farther ahead. It seems that Achilles will never catch the tortoise, even though in reality he does. A numerical example would be:

Suppose the tortoise starts 10 meters ahead of Achilles.

(1) The race begins. Achilles runs at 10 m/s, and the tortoise walks at 1 m/s. Achilles reaches the point where the tortoise started, 10 meters ahead, in one second.

Achilles's time to travel 10 meters = (10 m) / (10 m/s) = 1 second

During that time, 1 second, the tortoise travels 1 meter. Now the tortoise is only 1 meter ahead of Achilles.

(2) Achilles covers the distance of 1 meter in 0.1 seconds.

Achilles's time to travel 1 meter = (1 m) / (10 m/s) = 0.1 second

During that time, 0.1 seconds, the tortoise gets only 0.1 meters ahead of Achilles.

It would seem that Achilles could never catch the tortoise, because by the time Achilles reaches the place where the tortoise used to be, the tortoise has already moved a little farther during that time, but remains ahead of Achilles.

(3) And so on, the time intervals would be:

$t = 1 + 0.1 + 0.01 + 0.001 + 0.0001 + 0.00001 + \ldots\ldots$ seconds.

This is an infinite geometric series of time intervals.

An infinite geometric series has this form:

$A + A \times R + A \times R^2 + A \times R^3 + A \times R^4 + \ldots$

Where $A = 1$ y $R = 0.1$

(4) The series is infinite, but its sum is finite, as shown by the following equation:

Sum of "n" terms would be $= A / (1 - R) = 1/ (1-0.1) = 1/0.9 = 1.111\ldots$ seconds

This indicates that Achilles will overtake the tortoise in approximately 1.111 seconds.

In conclusion, although there are infinitely many terms, their sum is not infinite. The sum approaches a finite value. Therefore, infinitely many steps that become smaller and smaller can be completed in a finite amount of time. That is the mathematical key to the paradox.

4. The Fermi Paradox

Another classic example of a physical paradox is the Fermi paradox. "If the universe is full of billions of planets capable of hosting intelligent life, why haven't we found any proof or signal of extraterrestrial civilizations? Where is everybody?"

The Drake equation mathematically demonstrates that the probability of an extraterrestrial civilization existing close enough to interact with Earth is infinitely small.

The Drake equation was developed in 1961 by astronomer Dr. Frank Drake while he was preparing for the first scientific meeting on the Search for Extraterrestrial Intelligence (SETI). Its purpose was to stimulate scientific discussion rather than to offer a precise numerical prediction.

The Drake Equation depicted below is a product of a sequence of factors and probabilities defined to estimate the number of civilizations “N” in our Milky Way galaxy.

$$\mathbf{N} = R * FP * Np * FL * FI * FC * L$$

Below are the definitions for each one of the parameters. The numbers in parameters in parenthesis are the most recent values for the Drake Equation parameters.

N is the number of civilizations in our galaxy with which communication might be possible.

R is the average rate of star formation per year in the Milky Way. Astronomers measure the mass of the Milky Way, calculate the rate at which gas clouds collapse, and observe how often stars are born. Furthermore, not all stars are suitable for life (massive stars burn out quickly) while smaller, stable stars, like our sun, are often considered better candidates.

(Assumed R = 2 stars/year)

FP is the probability of those stars that have planetary systems. Derived from observational data (like the Kepler Space Telescope) by looking for the periodic dimming of a star as a planet crosses in front of it. Most stars have planets, no planets no life.

(Assumed FP=1)

Np is the average number of planets per star that could potentially support life. Based on the percentage of planets located in the "Goldilocks zone" (the orbital distance where liquid water can exist). Furthermore, they need to have:

An atmosphere that will maintain the temperature of the planet somewhat stable by trapping infra-red radiation from the sun and also allowing the presence of liquid water.

A magnetic field is required to protect life against high energy particles coming from space. The magnetic field is generated by the earth’s core; moving liquid iron caused by earth’s rotation crates currents which in turn creates a magnetic field.

Plate tectonics, through friction between the rocks generate energy which liquifies the rocks creating the earth’s lava which in turn feeds volcanos. The volcanos explode generating huge amounts of CO_2 which is released to the atmosphere. The CO_2 cycle is used to maintain the earth’s temperature more stable. The CO_2 generates rain

which in turn cools down the earth which in turn stops the rain and CO_2 accumulates causing the earth to heat up one more time (Thermic cycle).

(Assumed Np=0.2)

FL is the fraction of habitable planets where life actually appears. This is entirely speculative, as we only have Earth as a data point. Biologists estimate this by studying how quickly life emerged on Earth after its formation. Earths age is approximately 4.5 billion years. Early life appeared on earth 3.5 to 4 billion years ago. So simple life must be common since only took 500 million years for life to appear.

(Assumed FL=0.3)

FI is the fraction of planets with life that eventually develops intelligent life. Astrobiologists look at the evolutionary history of Earth to determine the odds of simple organisms eventually evolving into tool-using, intelligent beings. Again, we only have a sample of 1 the earth to calculate this parameter. Earth simple life appeared about 3.4 to 4 billion years ago. Intelligent life (Humans) has been around for 200 million years which is about .05 of earths biological history (200,000,000 / 4,000,000,000 = .05).

(Assumed FI=.01)

FC Fraction of intelligent civilizations that develop detectable communication technology**.** Estimated by assessing the percentage of intelligent species that figure out how to transmit signals into space (e.g., radio, TV, or lasers). Electromagnetism is a fundamental force in our Universe. Humans have been on earth for about 200 million years ago so it did not take too long for an intelligent civilization to develop electromagnetic communication. Therefore, any civilization that understands electromagnetism can, in principle, generate radio waves. So, from a physics standpoint, it's achievable.

(Assume FC=0.2)

L is the length of time such civilizations release detectable signals into space. This is the most unknown variable. It is the average number of years a civilization broadcasts detectable signals before either destroying itself (e.g., climate, war) or naturally going silent. This is a critical parameter because if its number doubles it practically doubles the number of civilizations. It should be noted that L may not be the age of civilization it could mean that the civilization does not want to be found and starts using low power EM signals to avoid detection and consume less energy.

(Assume L=10,000 years)

Solving for **N** will give us about **2.4** detectable civilizations in the Milky Way right now. I should point out that the values of these parameters are continuously being refined by scientists based on new data.

This demonstrates that the reason we have not detected an intelligent civilization is caused mainly by the facts that the speed of light is extremely slow compared to the size of our Milky Way and our universe.

5. The Epimenides Paradox

A classic example of a logical paradox is the Epimenides paradox, also known as the liar paradox. A man says, "I am lying." If the statement is true, then the man is lying, which means that the sentence is false. But if the sentence is false, then he is not lying, which means that the sentence is true. This creates an infinite closed loop in which nothing can be either true or false.

6. Schrödinger's Cat Paradox

Erwin Schrödinger presented this paradox in 1935 to show the world how absurd quantum physics can seem. Quantum physics explains that a quantum particle, such as an electron, can be in two different states at the same time. For example, an electron can have spin up and spin down as long as it is not observed. This phenomenon is called **superposition**, and its correct state can only be known once the electron is observed.

Faced with this phenomenon, which seems so absurd in the real world, Erwin decided to present the following thought experiment to the scientific community:

Imagine that we place a cat inside a completely sealed steel box, together with the following elements:

- A radioactive atom that has a 50% chance of decaying within one hour.
- A radiation detector, or Geiger counter.
- A small vial of poison connected to the detector.

If the atom decays, the detector notices it, releases the poison, and the cat dies. If the atom does not decay, nothing happens and the cat lives.

According to quantum physics, subatomic particles can be in two states at once. Until someone measures or observes the atom, it is both decayed and not decayed at the same time.

Since the fate of the cat depends directly on that atom, quantum logic dictates that before opening the box, the cat is both alive and dead at the same time. Both states coexist in a superposition. The mystery is resolved when we open the box. At that precise moment, the superposition breaks down, or collapses, and reality is decided by only one option: we see the cat either completely alive or completely dead.

Schrödinger used this example to criticize an interpretation of quantum physics, pointing out that it was ridiculous to think that a cat could be in a state of both life and death simply because a human was not looking at it. The theoretical explanations of this phenomenon are:

The Copenhagen Interpretation

This is the classical explanation proposed by Niels Bohr and Werner Heisenberg.

- **What it says:** Things in the quantum world can exist in multiple states at the same time, or in superposition, as long as no one observes them.
- **Applied to the cat:** The cat is truly in a superposition of "alive and dead." When the box is opened, the act of looking, or measurement, forces nature to choose a single reality. This is known as the **collapse of the wave function**.

The Many-Worlds Theory

Proposed by Hugh Everett in 1957, this theory eliminates the idea that reality "chooses" a single option.

- **What it says:** There is no such collapse. Instead, the universe splits into different independent branches every time a quantum event occurs.
- **Applied to the cat:** At the moment the hour is completed, the universe splits into two parallel realities. In one universe, you open the box and find the cat alive; in another parallel universe, you open the box and the cat is dead. Both universes are equally real, but they cannot communicate with each other.

Quantum Decoherence

This is the theory most accepted today by physicists to explain why we do not see cats that are "alive and dead" in our everyday lives.

- In order for an object to maintain its quantum properties, such as superposition, it must be completely isolated. The macroscopic world, including air, heat, and the walls of the box, constantly interacts with particles.
- **Applied to the cat:** It is impossible to perfectly isolate the cat and the mechanisms from the environment. The air inside the box and the cat's own molecules collides with one another immediately. This interaction with the "real world" destroys the superposition almost instantly, a process known as

decoherence, forcing the system to behave classically, as either alive or dead, long before a human opens the box.

7. The Grandfather Paradox

This time-travel paradox is very easy to explain. Imagine that you have a time machine, travel to the past, and kill your grandfather before he has children.

If your grandfather dies before having descendants, your father or mother is never born, and therefore you are never born either.

If you never existed, you could never have traveled through time to kill your grandfather. But if you did not kill him, he lives, you are born, you travel to the past, and you kill him. Figure 3 explains it in detail.



Figure 3

Control and Safety in AI Development

Artificial intelligence should be made available to users together with external control software, not based on AI and created by the developer. This control program should monitor both input and output data. It should also ensure that AI-generated content does not contaminate the data available on the internet.

This control software should not, in any way, hinder the development of AI. It makes no sense for the United States to slow its progress in artificial intelligence while China continues advancing. Companies could test their AI tools on local networks to avoid unwanted data contamination or the hacking of other networks. Access to internet data should be strictly one-way.

I do not believe that the worst and most dangerous programmer of all—the government—should have any control over AI. For example, why should someone like DJT have any kind of control over artificial intelligence?

AI developers and companies should be subject to substantial lawsuits if their systems cause harm to third parties or other entities.

Another important measure would be to require external audits before releasing advanced AI models to the public. These audits should evaluate the system's safety, its resistance to manipulation, its tendency to generate dangerous information, and its ability to refuse malicious requests. Likewise, periodic testing should be conducted after release, since an AI may behave differently when interacting with millions of real users.

A disclaimer should also be added for all AI users, stating that if they ask incomplete questions or fail to establish clear limits and parameters, the answers they receive may be unexpected.

For example, when I ask AI to translate this document from English into Spanish, I must specify that the context of my document must not be changed. If I do not, the AI may begin to hallucinate or alter the original meaning of the text.

I would recommend using non-AI software as an intermediary between users and AI, in order to ensure that users do not ask unclear or poorly formulated questions.

Likewise, it would be useful to implement automatic limits based on the risk level of each query. Simple, educational, or creative questions could be processed freely. By contrast, requests related to dangerous, illegal, or high-impact activities should go through stricter filters. This system would allow freedom of use to be preserved without leaving the door completely open to abuse.

Finally, there should be a shutdown button or emergency disconnection mechanism, designed securely and accessible only to authorized personnel. This mechanism would make it possible to stop an AI system if it begins to behave dangerously, if it is hacked, or if it produces unforeseen consequences.

So far, AI is limited to knowledge of the world found on the internet. However, it is capable of generating new knowledge from existing data, in a way very similar to how Albert Einstein did when he proposed the theory of relativity. This new knowledge should be treated as top-secret information, to ensure that malicious individuals or governments do not misuse it.

AI is a new technological advance that, if used intelligently, could benefit humanity. However, if used recklessly, it may become yet another factor contributing to the end of our civilization long before the expected 10,000-year lifespan of an intelligent civilization.

Epilogue

As these pages come to a close, I hope to have planted in the reader not only answers, but also new questions. Science, like life itself, is not a final destination, but a path constantly under construction.

The topics addressed here—such as the origin of the universe, the nature of time, the evolution of species, and the advancement of artificial intelligence—do not represent absolute and immutable truths, but rather human approximations to the great mysteries that surround us. Each generation expands the knowledge it inherits and challenges what once seemed unquestionable.

We live in an extraordinary era, where scientific discoveries transform the way, we understand the cosmos and our place within it. Yet beyond data and theories, what is truly valuable is keeping curiosity alive—that inner force that drives progress and creativity.

If this book has succeeded in awakening in you the desire to learn more, to question more, and to observe the world more deeply, then its purpose has been fulfilled. I invite the reader to generate new ideas that may offer a better answer to the questions analyzed in this book.

Knowledge has no end; there will always be new horizons to explore.