$\sqrt{-1}$ and Other Irrational Symbols

Quinn Ray Keck

We inherit our symbolic reality from the moment we first learn to name something. Performers in a play passed down to us that we did not write, yet with every thought we transform the script's symbols. Someday the symbol's original forms may no longer be recognizable. Spinning new ontologies with each new idea and new worlds with each symbol, we create the world within our skulls – yet whose world are we creating?
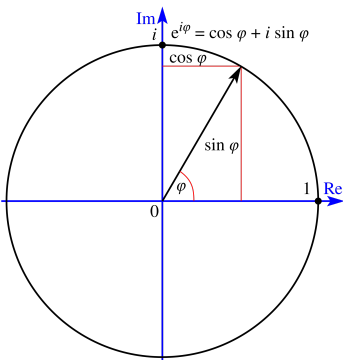
From the moment we first learn to speak, we inherit a script we did not choose with its words, symbols and equations so deeply embedded in our worldview we might not even see them. Freud and Jung's psychoanalytic theories are foundational to how the human mind is seen from European and American perspectives: both men were inspired by the recent advancements in quantum mechanics to develop their theories. If you have had the privilege of seeing a therapist in the United States, Freud and Jung's work shapes how that therapist has been taught to see your mind by the institutions that credentialed them.
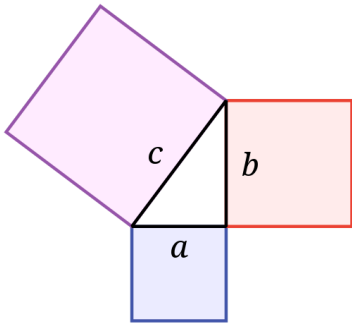
It can be tempting to imagine our skulls to be like the walls of the gallery – blank canvases to house our autonomous creations. Like the gallery wall and Plato's cave, our minds have a circumstance that determines possible interpretations of shadows on the wall, obscuring the questions we do not ask. Are we discovering an ideal world of forms or a product of our times incapable of conceiving a world existing outside of dualism? All models are wrong, some are useful. The most dangerous model is imaging that you do not have one, for what is default was never neutral. How can you amend a model you refuse to see?

Equations and Symbols Used

chosen irrationally, but certainly not randomly

$i = \sqrt{-1}$	*i*, the square root of -1 is the unit of imaginary time, which was popularized by Steven Hawking. When a friend died, thinking of imaginary time brought more than comfort, but new horizons for remembering her life. "One might think this means that imaginary numbers are just a mathematical game having nothing to do with the real world. From the viewpoint of positivist philosophy, however, one cannot determine what is real. All one can do is find which mathematical models describe the universe we live in. It turns out that a mathematical model involving imaginary time predicts not only effects we have already observed but also effects we have not been able to measure yet nevertheless believe in for other reasons. So what is real and what is imaginary? Is the distinction just in our minds?" — Stephen Hawking, *The Universe in a Nutshell.*
π	March 14th is the birthday of the friend who died and pi day.
$G_{\mu\nu} = 8\pi T_{\mu\nu}$	In *The Disordered Cosmos - A Journey into Dark Matter, Spacetime, and Dreams Deferred* Chanda Prescod-Weinstein discusses quarks, the sociology of science, and her experiences as the 54th Black American woman* to earn a Ph.D. from a department of physics. Einstein's equation is the only equation she includes in her book explaining that it "describes the relationship between spacetime's curvature and spacetime's matter-energy contents. We call this a dynamical relationship because both the curvature and matter-energy create change in each other." *Chanda Prescod-Weinstein cites this statistic on her website. When explaining her gender, she says "I'm agender so I don't have an internal sense of gender but I do [...] present as femme, and I'm okay with my body, so I consider myself to be an agender cis-sex woman, so I'm not quite trans in the way that people

	normally envision what is a trans person."
$$E = \sum mvs$$	Action as conceived of by Pierre Louis de Maupertuis, defined as mass times velocity times distance. He claimed everything always follows the path that minimizes the action (the path of least action). Sir William R. Hamilton later proved action was equivalent to the integral over time of kinetic energy minus potential energy: $$S = \int (T - V)dt$$ Action was key to the work of Max Planck, Albert Einstein, and the birth of quantum mechanics.
$$max(0.1x, x)$$	Neural Nets are many, sometimes billions, linear equations with activation functions. Inputs $x_1 - x_n$ are multiplied by their corresponding weights, the bias is added, and then an activation function is applied to the result. The inputs, weights and bias are just numbers combined in a linear way. Which activation function you use is a choice, two popular ones in recent years have been ReLu and Leaky ReLu. ReLu is simply if the output number is negative, change it to zero otherwise it remains unchanged which can be written as $max(0, x)$. Leaky ReLu just multiplies negative inputs by 0.1 and keeps positive outputs unchanged, which can be written as $max(0.1x, x)$. The neural nets you interact with today are billions* of these equations whose parameters are fine tuned with massive amounts of training data, the calculations done with distributed computing and data centers. Google states its data centers used approximately 6 billion gallons of water in 2024. *depending on the model, the number varies, but nonetheless very large
$$1729 = 1^3 + 12^3 = 9^3 + 10^3$$	Srinivasa Ramanujan is regarded as one of the greatest mathematicians of all time and called the "man who knew infinity." He did not graduate college and sent British mathematicians his formulas resulting in him spending 5 years at Cambridge collaborating with G. H. Hardy and John Edensor Littlewood. Due to a variety of factors, from a lack of vegetarian food and racism he faced in England, he was arrested for attempting suicide by the Scottland Yard and suffered from numerous illness. In a famous hospital visit, Hardy told Srinivasa that the taxi he rode in was number CE1729, an unremarkable number. Srinivasa replied that it is not dull at all, 1,729 the smallest number that can be written as the sum of two cubes in two different ways. At age 31, Ramanujan was one of the youngest Fellows in the Royal Society's history and the second Indian ever admitted. He died a year later at age 32. The almost 3,900 equations he wrote in his notebooks are still puzzling mathematicians to this day.
$$e^{ix}$$	Euler's formula states that, for any real number x this equation holds true: $e^{ix} = cos(x) + i\,sin(x)$ where e is the base of the natural logarithm, i is the imaginary unit (square root of negative one), and cos and sin are the trigonometric functions cosine and sine respectively. The formula is still valid if x is a complex number, i.e. a combination of a real number and imaginary numbers such as $3 + 3i$.
ז	In the Kabbalah, zayin teaches that "times cannot be destroyed as a basic facet of human existence, but it can be sanctified." Zayin is one half of chet, which represents physical health, linking our relationships with other people (vov) and our inner relationship with time (zayin). Judaism is not Zionism. No kind of thinking justifies a genocide and a world where people starve while we have a surplus. Free Palestine.

	When non-European people make advancements and discoveries, the people who create those theories are largely unnamed, a tradition dating back to antiquity. The theorem now known as the Pythagorean theorem existed thousands of years before Pythagoras was born, and according to NASA it is believed he learned it from the Egyptians. Pythagroras believed the world could be understood through measurement and that he was a demi-god. Followers of Pythagoreanism practiced his rituals and teachings until the 4th century BC.	
$a^2 + b^2 = c^2$		

Works Cited

Babs, Temi. "The Mathematics of Neural Networks." *Medium*, 16 Aug. 2020,
    medium.com/coinmonks/the-mathematics-of-neural-network-60a112dd3e05.

Becker, Dans. "Rectified Linear Units (ReLU) in Deep Learning." *Kaggle.com*, 2018,
    www.kaggle.com/code/dansbecker/rectified-linear-units-relu-in-deep-learning.

Benson, Tom. "Pythagorean Theorem." *National Aeronautics and Space Administration*, 13 May 2021,
    www.grc.nasa.gov/WWW/K-12/rocket/pythag.html.

Britannica. "Pythagorean Theorem | Definition & History." *Encyclopædia Britannica*, 1 Mar. 2018, www.britannica.com/science/Pythagorean-theorem.

Clark, Carol. "Mathematicians Find "Magic Key" to Drive Ramanujan's Taxi-Cab Number | Emory University | Atlanta GA." *Emory.edu*, 2015,
    news.emory.edu/stories/2015/10/esc_taxi_cab_numbers/campus.html. Accessed 30 May 2025.

Durbin, Sean. ""I Will Bless Those Who Bless You": Christian Zionism, Fetishism, and Unleashing the Blessings of God." *Journal of Contemporary Religion*, vol. 28, no. 3, Oct. 2013, pp. 507–521, https://doi.org/10.1080/13537903.2013.831659. Accessed 16 Oct. 2019.

GuntherDerivative. "Euler's Formula." *Wikipedia*, Wikimedia Foundation, 16 Apr. 2025,
    en.wikipedia.org/wiki/Euler%27s_formula#/media/File:Euler's_formula.svg.

Hawking, Stephen. *The Universe in a Nutshell*. London, Bantam, 2001.

Hayes, Brian. "Never a Dull Number." *American Scientist*, 6 Feb. 2017, www.americanscientist.org/article/never-a-dull-number.

Hoffman, Edward. *The Kabbalah Deck*. Chronicle Books, 1 July 2010.

Muller, Derek . "How Imaginary Numbers Were Invented." *Youtu.be*, 2025, youtu.be/cUzklzVXJwo?si=uhXLRvdiPlGQClwM. Accessed 30 May 2025.

Oliver, Mark. "10 Strange Facts about Pythagoras: Mathematician and Cult Leader." *Listverse*, 7 Feb. 2019,
    listverse.com/2017/04/26/10-strange-facts-about-pythagoras-mathematician-and-cult-leader/.

"Pierre-Louis Moreau de Maupertuis - Biography." *Maths History*, 2025, mathshistory.st-andrews.ac.uk/Biographies/Maupertuis/.

Prescod-Weinstein, Chanda. "Professor Chanda Prescod-Weinstein." *Professor Chanda Prescod-Weinstein*, chanda.science/.

---. *The Disordered Cosmos : A Journey into Dark Matter, Spacetime, and Dreams Deferred*. New York, PublicAffairs, 2021.

Sattiraju, Nikitha. "The Secret Cost of Google's Data Centers: Billions of Gallons of Water." *Time*, 2 Apr. 2020,
    time.com/5814276/google-data-centers-water/.

The Editors of Encyclopedia Britannica. "Pythagoras | Biography, Philosophy, & Facts." *Encyclopædia Britannica*, 6 Dec. 2018,
    www.britannica.com/biography/Pythagoras.

Veritasium. "The Strange Physics Principle That Shapes Reality." *YouTube*, 29 Oct. 2024, www.youtube.com/watch?v=Q10_srZ-pbs.

Wikipedia Contributors. "Srinivasa Ramanujan." *Wikipedia*, Wikimedia Foundation, 30 Dec. 2019, en.wikipedia.org/wiki/Srinivasa_Ramanujan.

Wilkins, David. "Sir William Rowan Hamilton | Irish Mathematician and Astronomer." *Encyclopedia Britannica*,
    www.britannica.com/biography/William-Rowan-Hamilton.