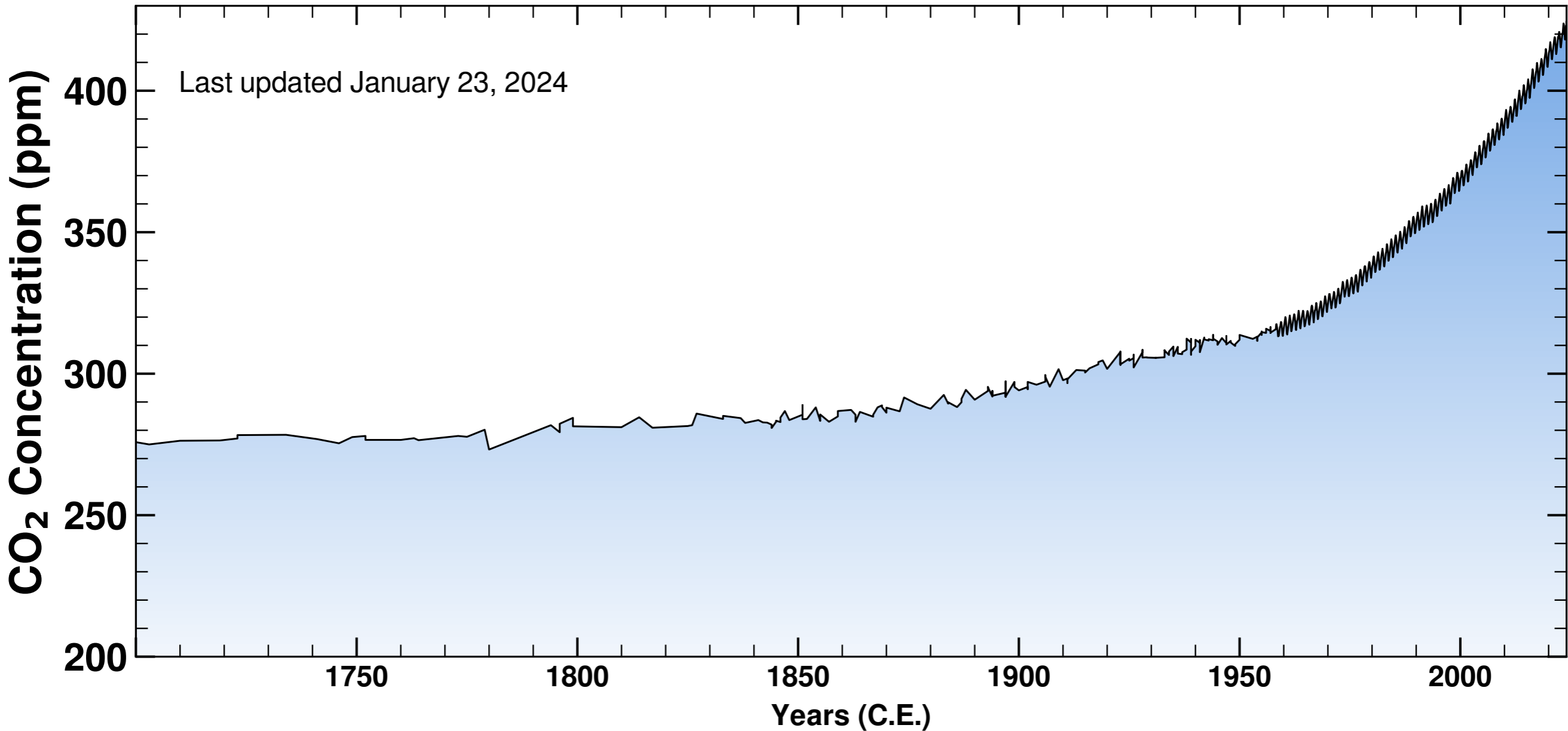


**Le Monde Bouleverse'**

In the eight months since Brian asked me to do this keynote a lot has happened that builds on longterm trends

Last updated January 23, 2024

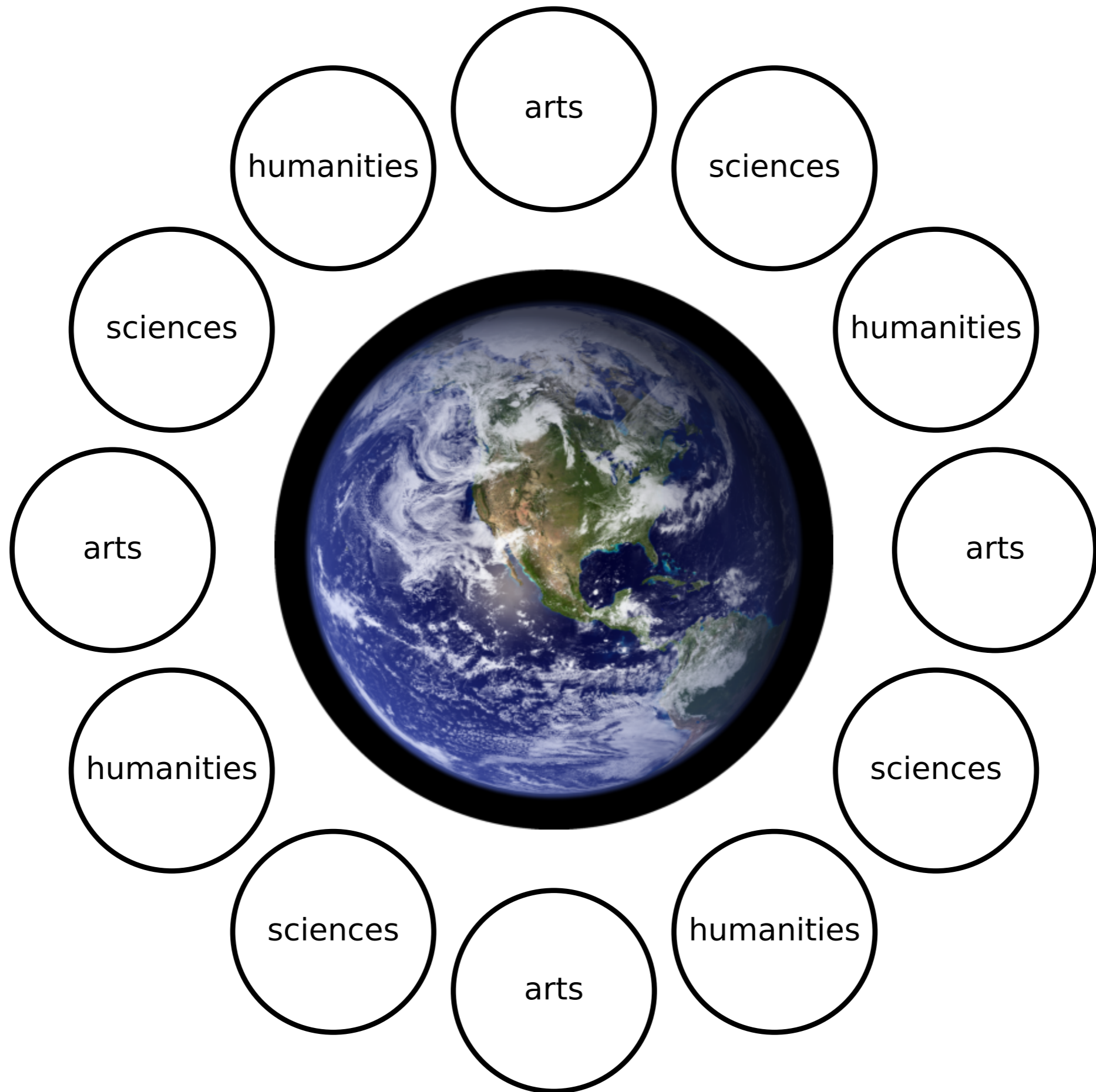


- Plagiarism
- Provenance
- Artistic Integrity
- Explainability

# We all know the events since June 2023

- Hamas' terrorist attack on October 7, 2023
- Carnage and destruction in Gaza
- Carnage and destruction in Ukraine
- The breakdown of the body politic in the United States and elsewhere
- The crescendo of mis- and dis-information, now powered by AI

**We need to understand AI and use it to  
better our world not make it worse.**



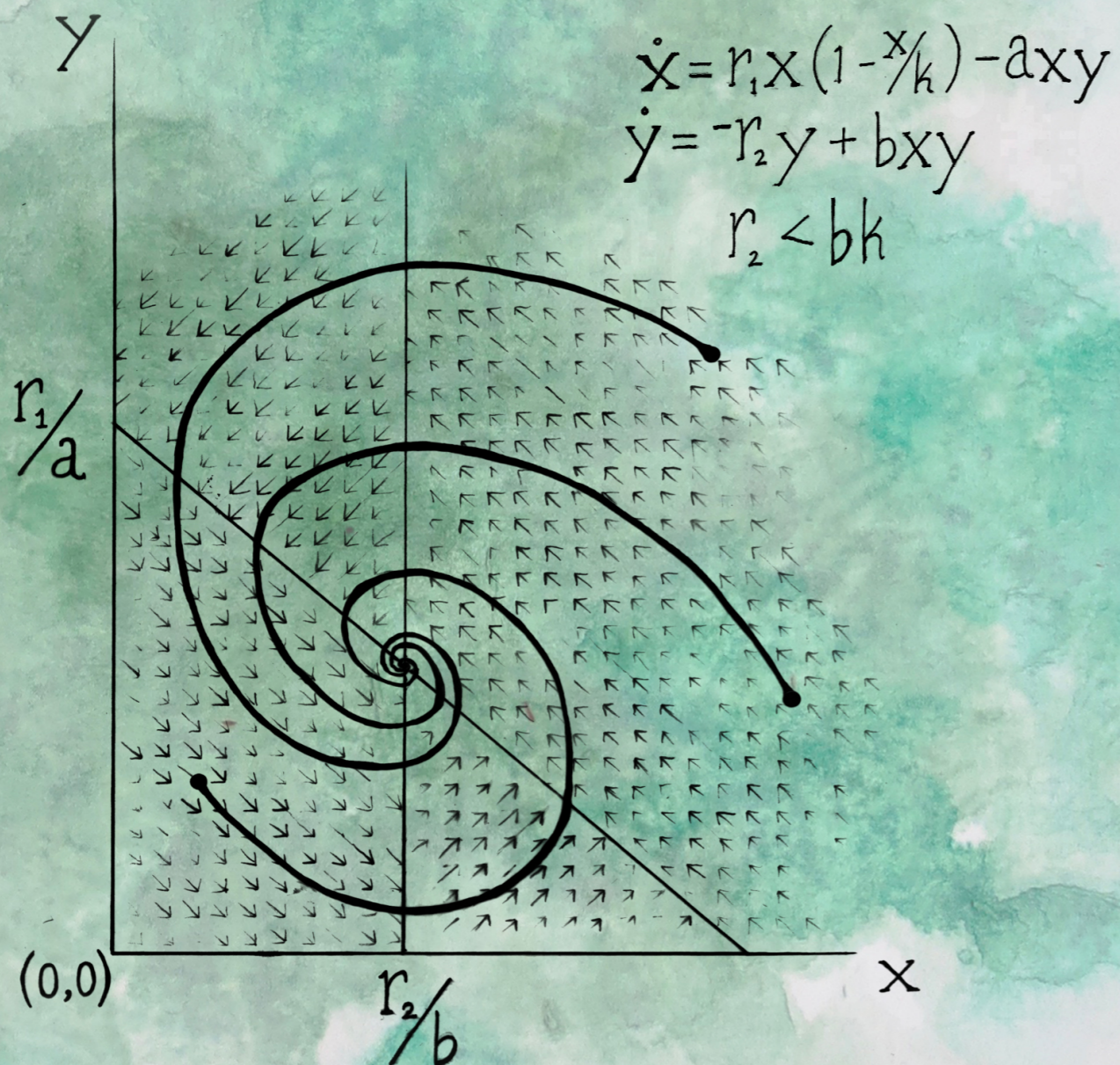


Large Language Models and George  
Santos Both Pass the Turing Test

# Differential Equations

A Toolbox for Modeling the World

Kurt Bryan



## A Great Start

But we need to change what and how we teach

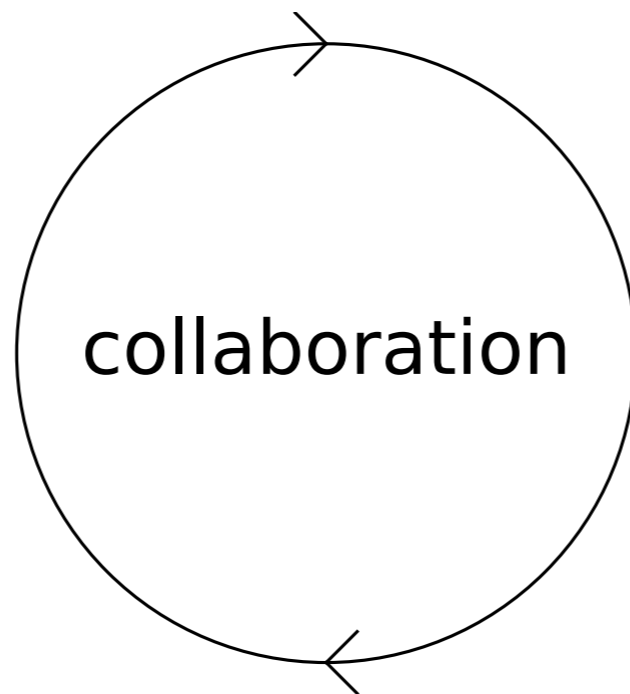
- The math underlying AI to better use AI and to engage students
- Modeling = **Understanding** far less algebra

# Machine Learning Intelligence and Intelligence by Design

## Daniel Kahneman: Thinking, Fast and Slow

Fast

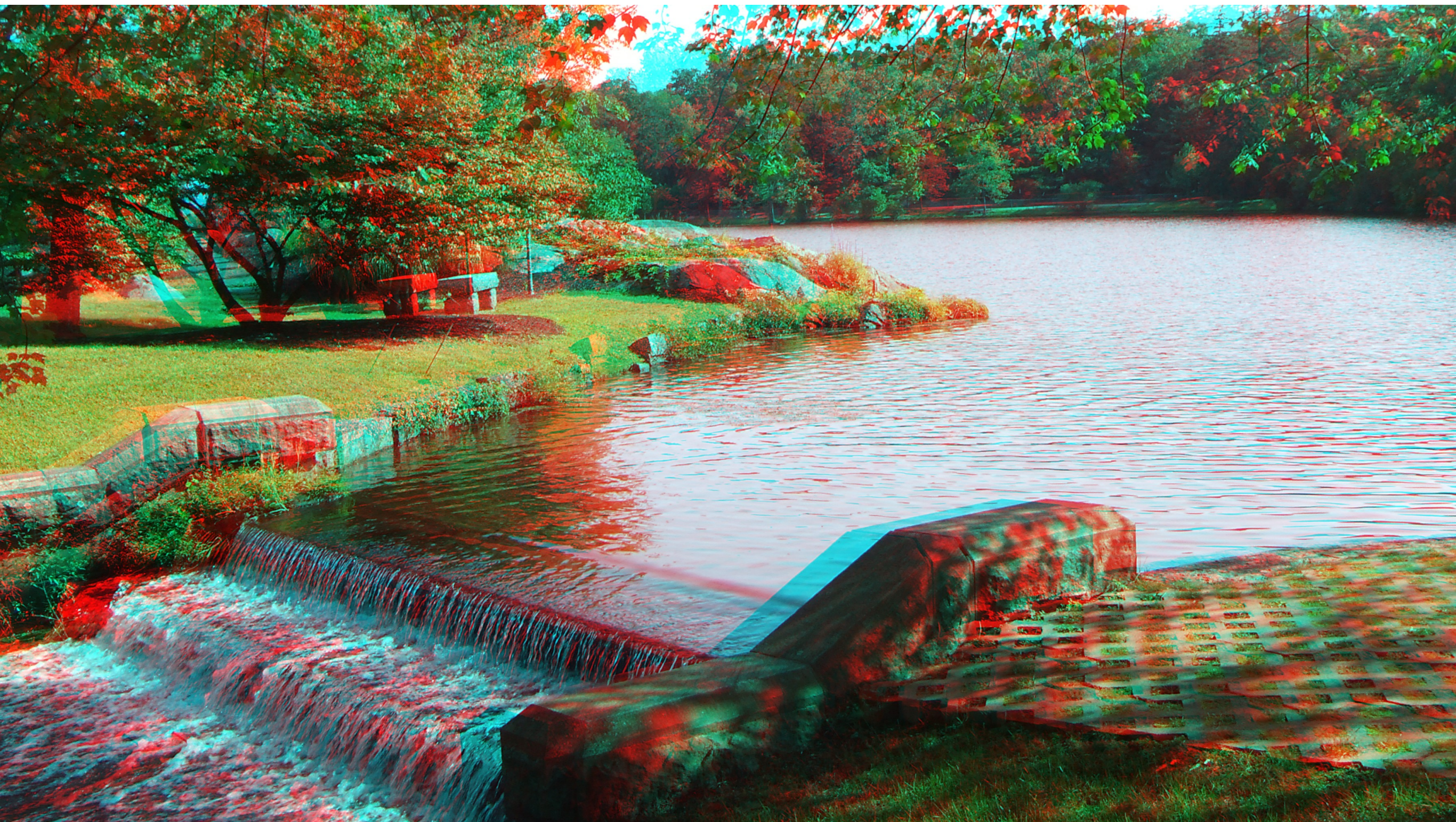
- Unconscious
- Highly Parallel
- Broadly-based
- Instinctive
- Informal
- Hard to Explain
- Learning



Slow

- Conscious
- Linear
- Focused
- Rational
- Often Mathematical
- Logical
- Design

# An Example of Fast Thinking — 3D Vision



# An Analogy - Artificial and Human Intelligence

This is a very controversial analogy - my take

- Inevitable
- As useful for understanding human intelligence as AI
- Can we use AI as a laboratory for learning about learning?
- Can we use AI as a laboratory for learning about communication?
- Can we use AI as a laboratory for learning about intelligence?

# A jargon-free explanation of how AI large language models work

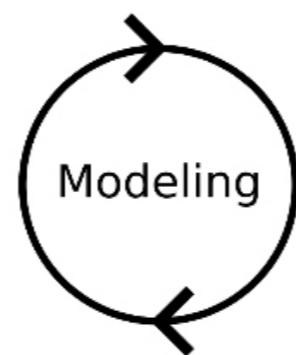
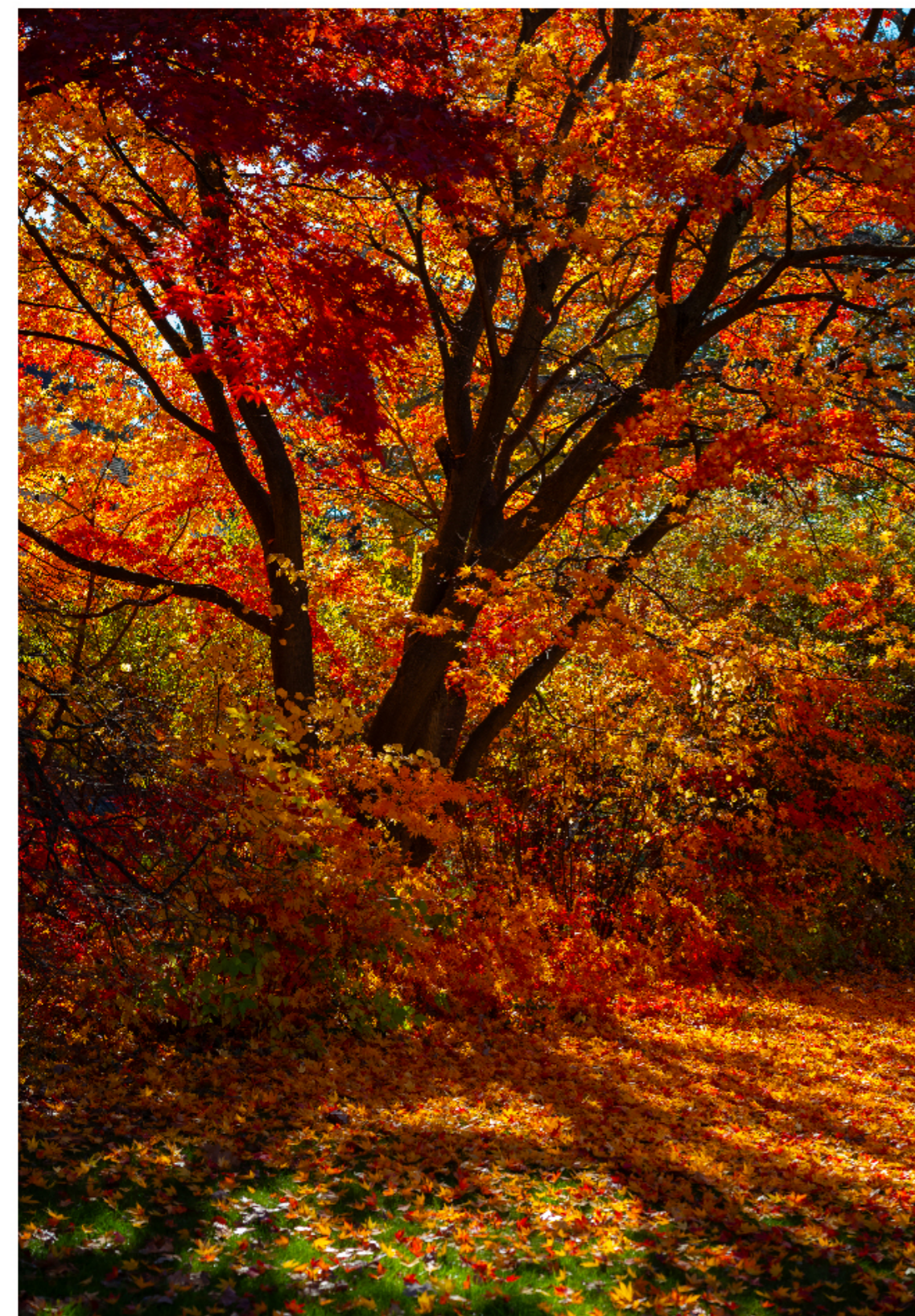
Want to really understand large language models? Here's a gentle primer.

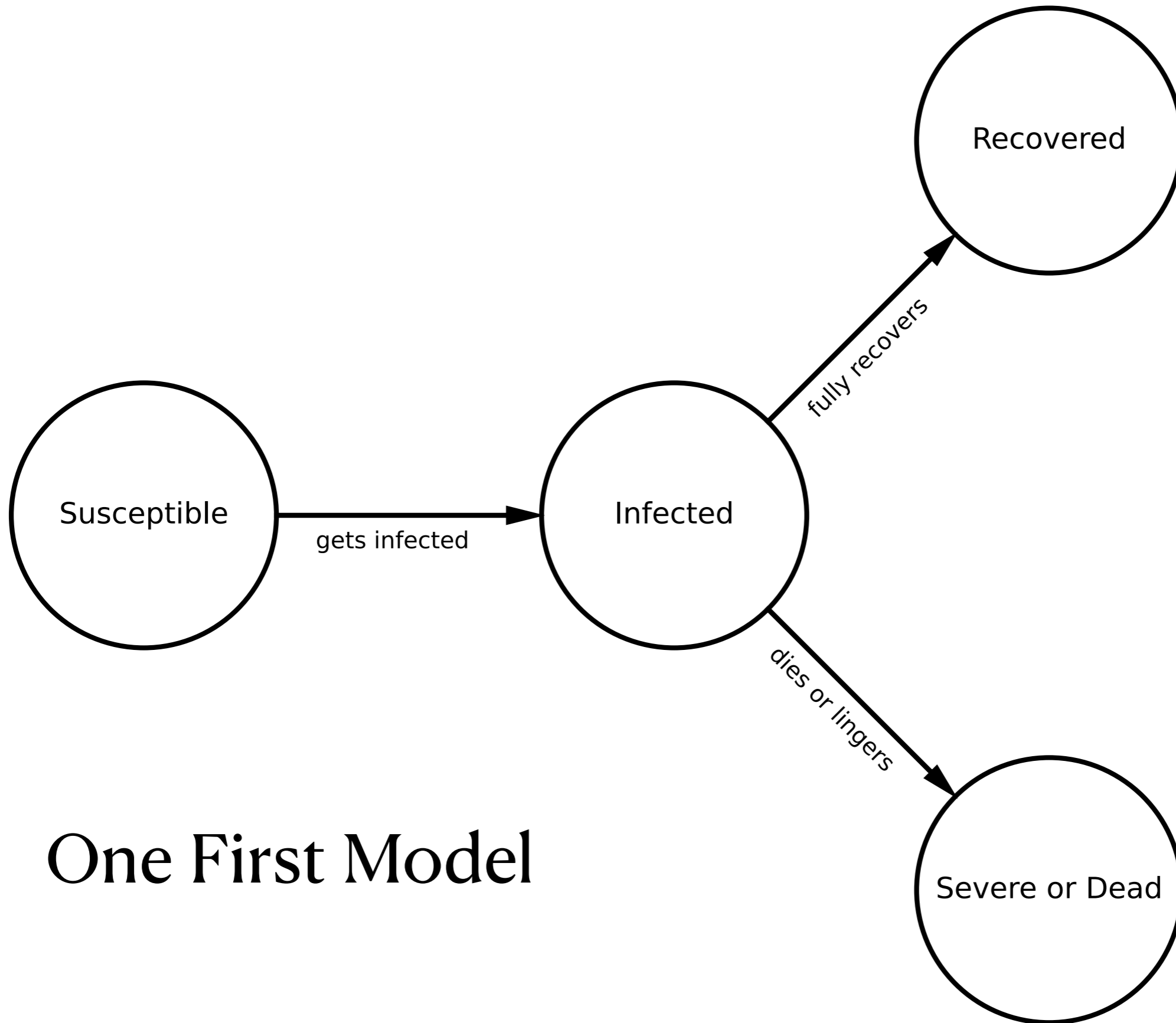
TIMOTHY B. LEE AND SEAN TROTT - 7/31/2023, 7:00 AM



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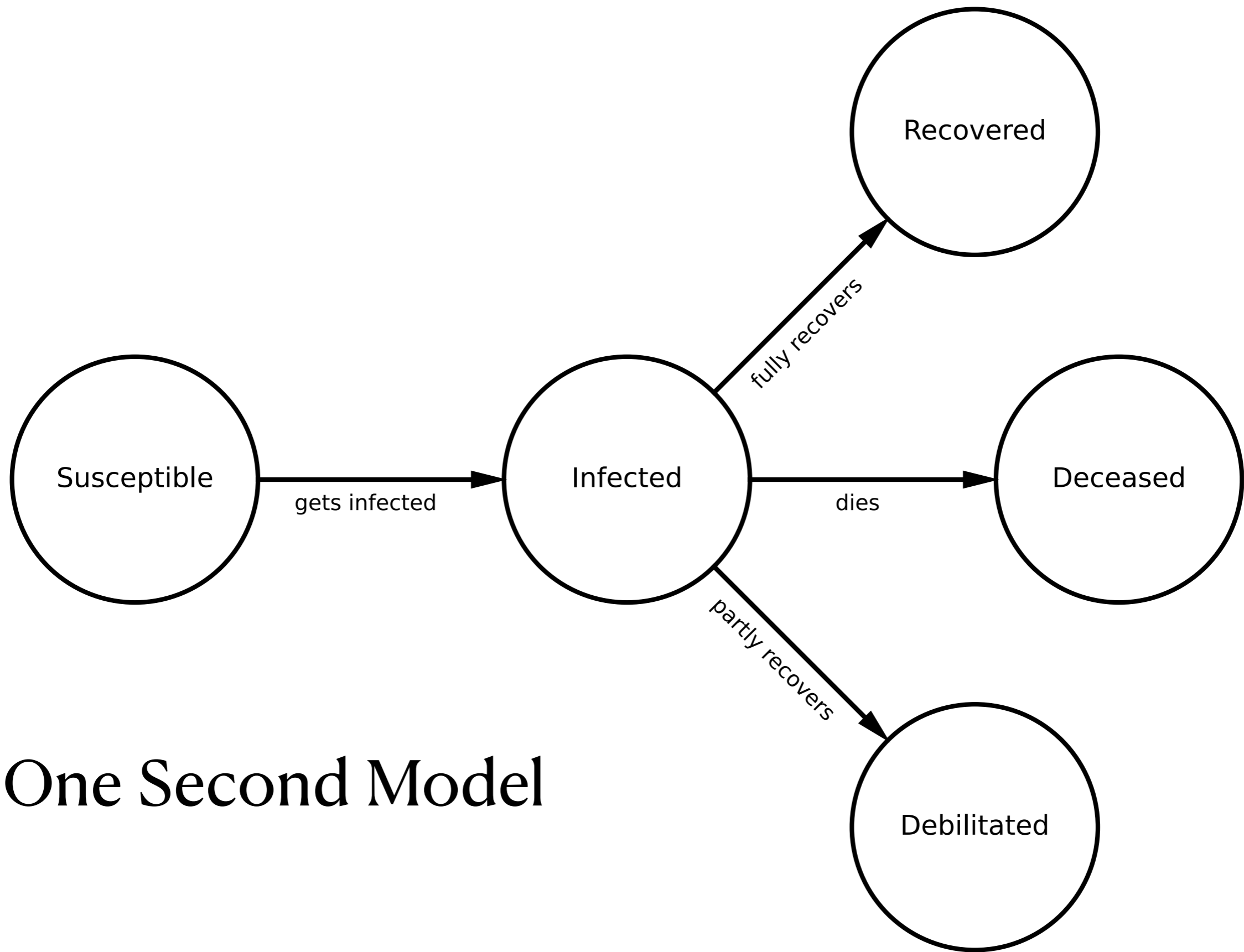
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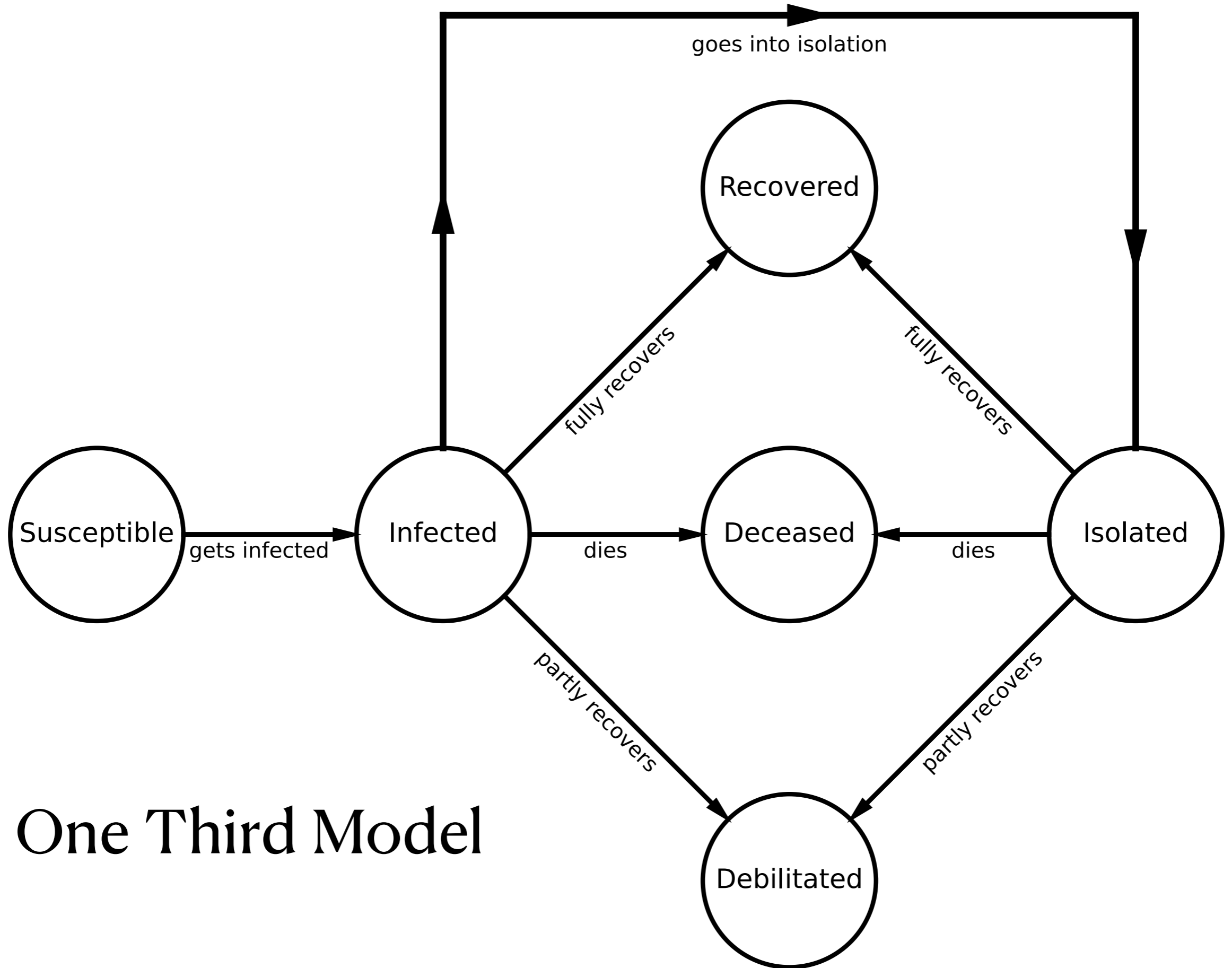


# One First Model





# One Second Model

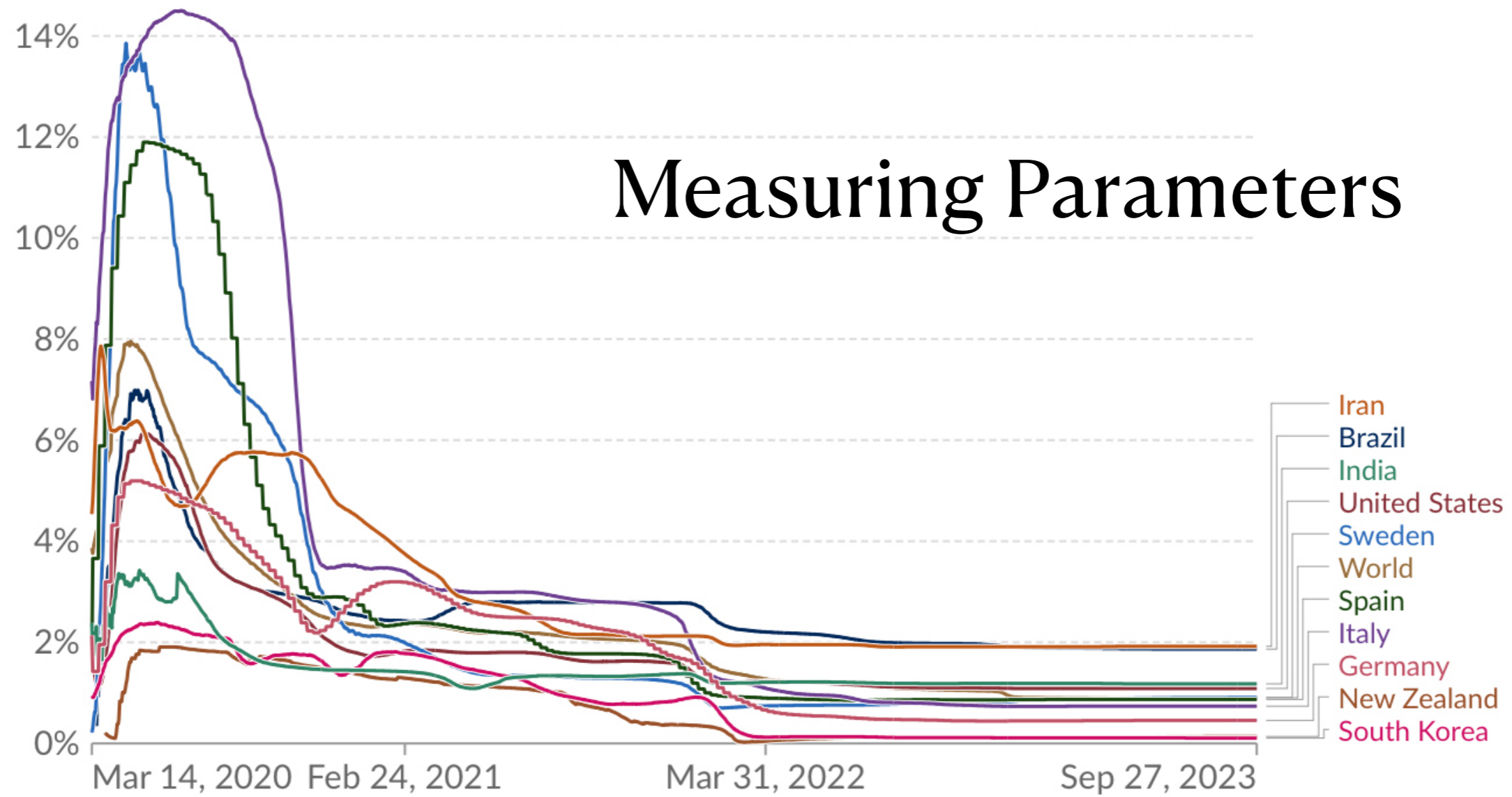


# One Third Model

# Case fatality rate of COVID-19

The case fatality rate (CFR) is the ratio between confirmed deaths and confirmed cases. The CFR can be a poor measure of the mortality risk of the disease. We explain this in detail at <https://OurWorldInData.org/mortality-risk-covid>

**LINEAR** LOG **+ Add country or region** All together **▼**



Source: WHO COVID-19 Dashboard

CC BY

▶ Jan 5, 2020 Sep 27, 2023

CHART

MAP

TABLE

SOURCES

📄 DOWNLOAD



Related: [Since 8 March, we rely on data from the WHO for confirmed cases and deaths](#)

# Less Algebra, More Understanding

## An Example that Resonates

FR

**You**

When I studied DEs we used the method of undetermined coefficients and introduced extra terms of the form  $t \sin(2\omega \pi t)$  but this "explanation" only works when the forcing term is a solution of the homogeneous DE. Is there a better and more general approach that produces better understanding?



**ChatGPT**

Certainly, the method of undetermined coefficients is a valuable technique for solving specific linear differential equations with forcing terms that are solutions of the homogeneous equation. However, when it comes to gaining a deeper and more general understanding of resonance, it's beneficial to explore other approaches that provide a broader perspective. Here's an alternative method that can help students grasp resonance more generally:

### 1. **Complex Amplitude Technique:**

- Start by expressing the solution  $x(t)$  in a complex form. For instance, if the external force is  $F(t) = F_0 \cos(\omega t)$ , you can express  $x(t)$  as  $X(\omega)e^{i\omega t}$ , where  $X(\omega)$  is a complex amplitude.
- Substitute this complex solution into the differential equation, which results in a complex equation.
- Separate the real and imaginary parts of the complex equation to obtain two real equations. These real equations describe the behavior of the amplitude and phase of the oscillation.

**A Far Better Analysis**

**Real Understanding and More General**

# First of Three Key Ideas

The general solution of the differential equation

$$y'' + \omega^2 y = 0$$

is

$$y = c_1 \cos \omega t + c_2 \sin \omega t$$

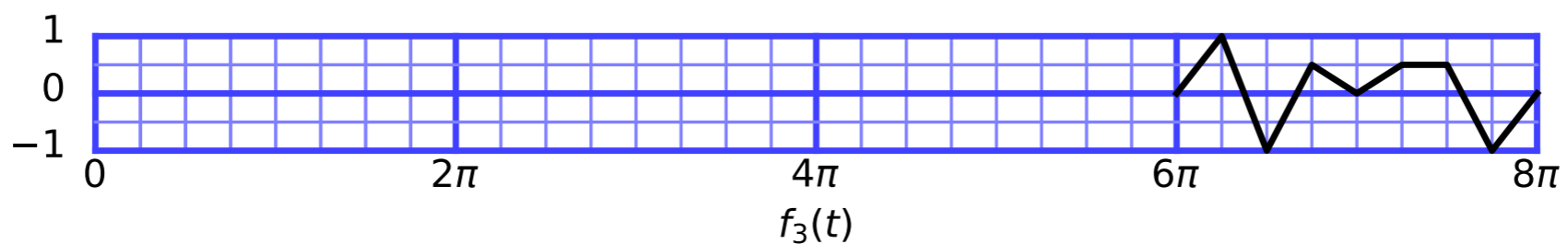
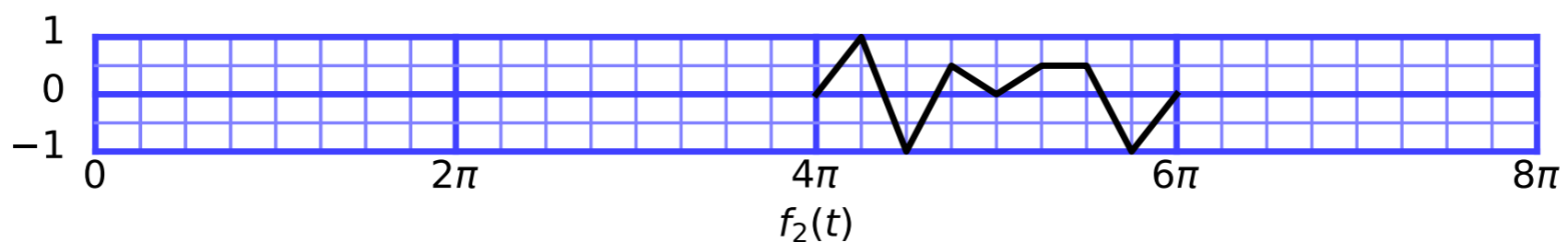
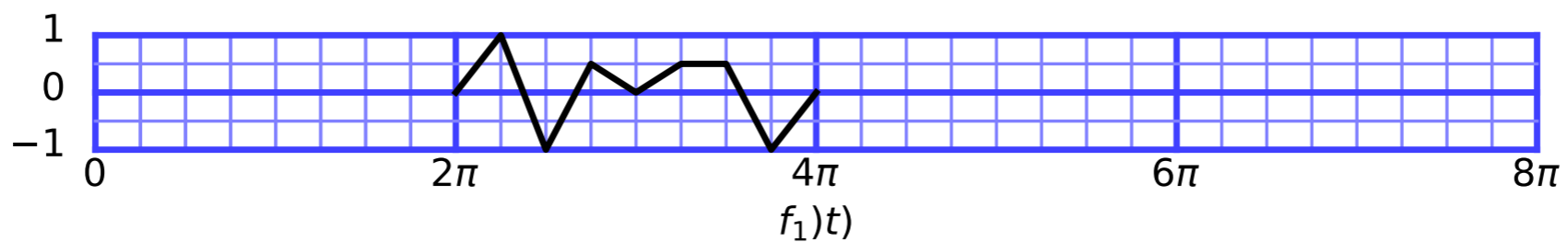
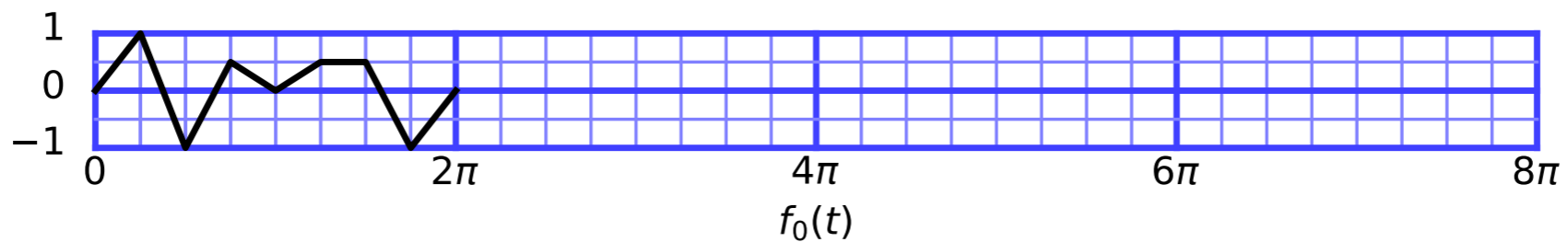
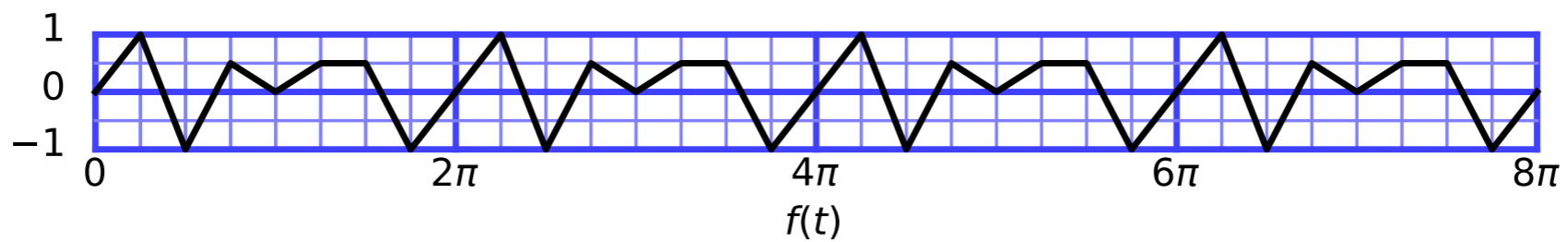
and the solution of the initial value problem

$$y'' + \omega^2 y = 0, \quad y(0) = y_0, y'(0) = v_0$$

is

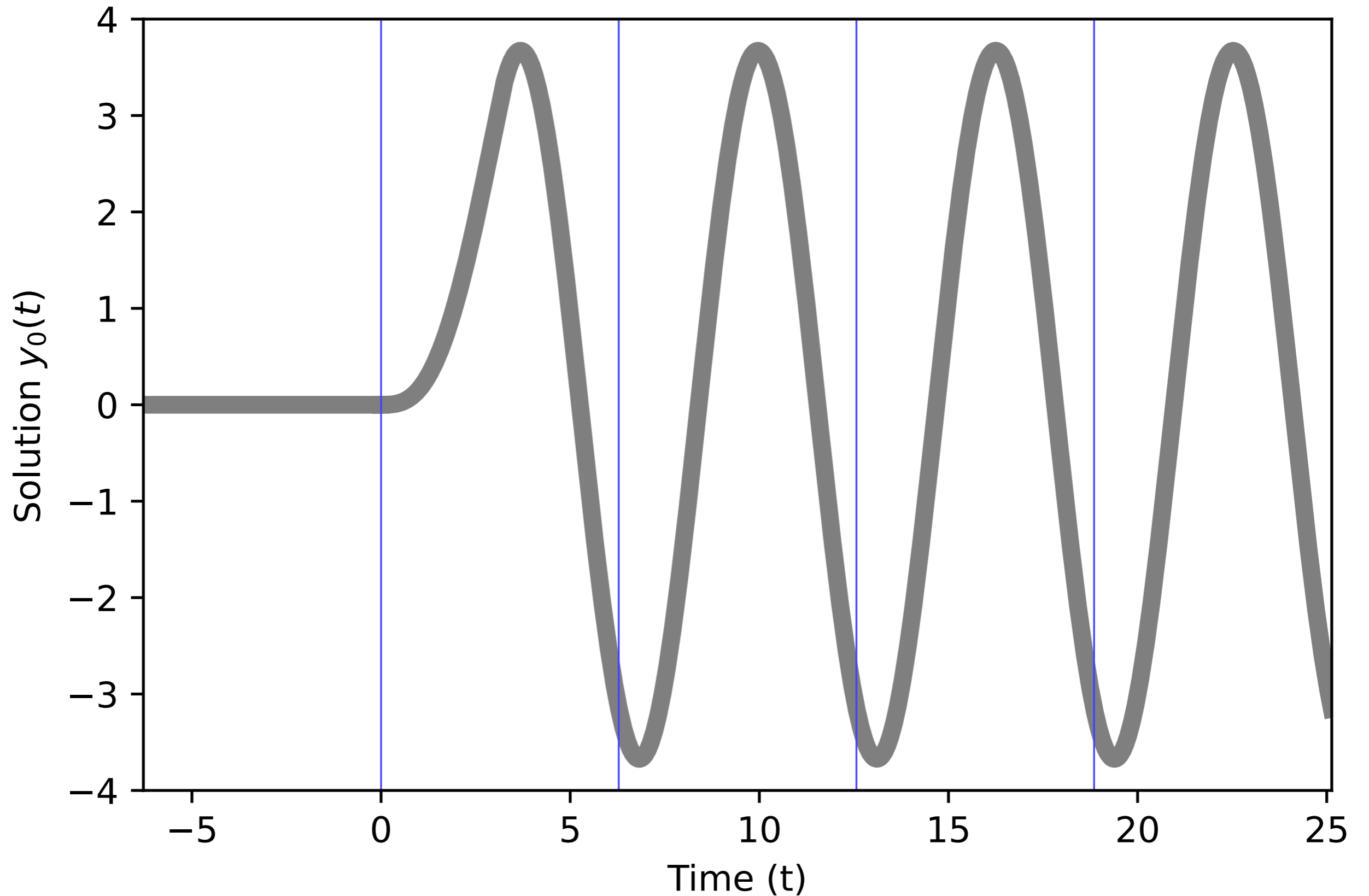
$$y = y_0 \cos \omega t + v_0 \sin \omega t$$

# Second Key Idea - Linearity and Superposition



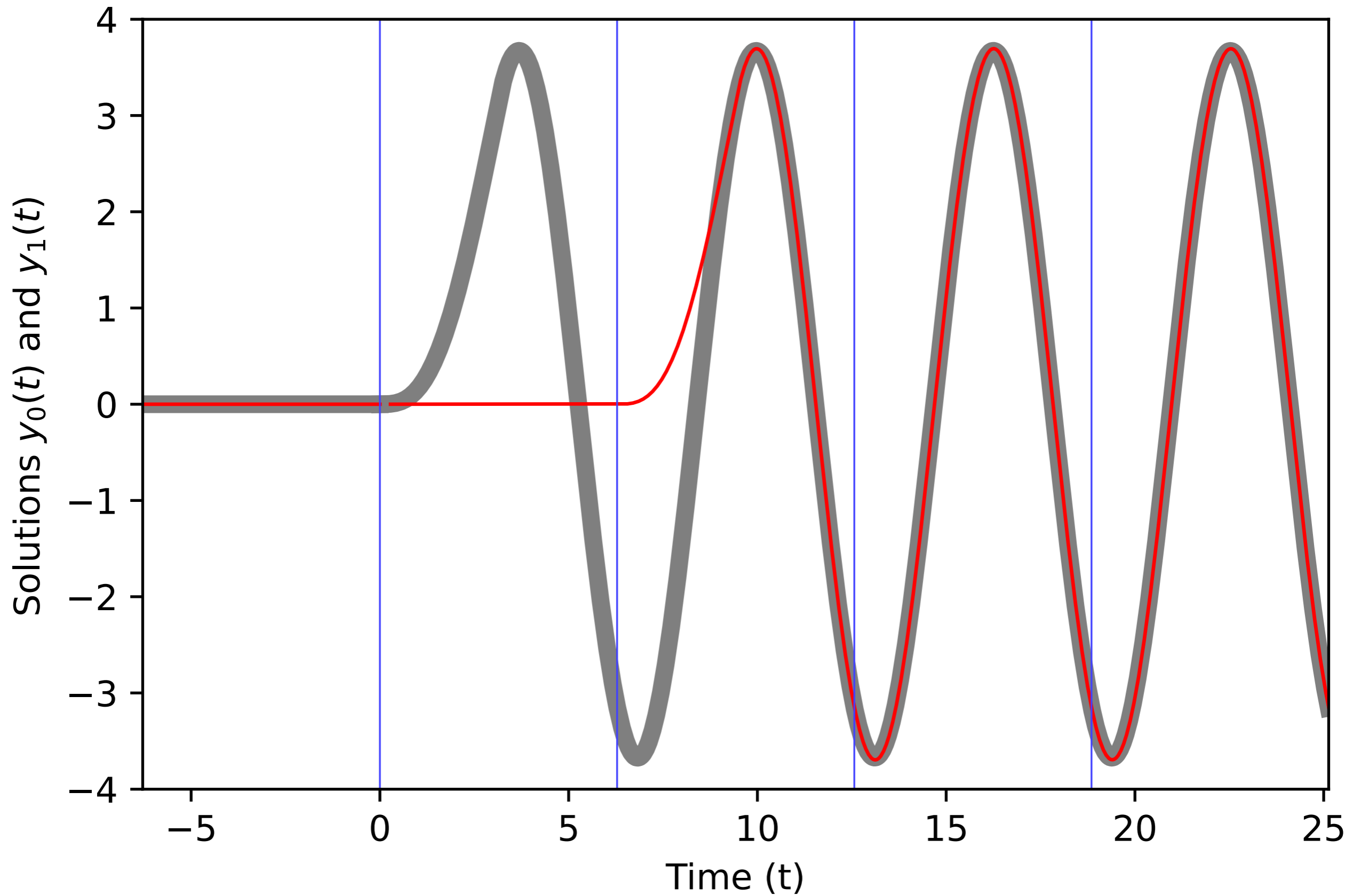
$$y''(t) + y(t) = f(t) = f_0(t) + f_1(t) + f_2(t) + f_3(t) + \dots, \quad y(0) = y'(0) = 0$$

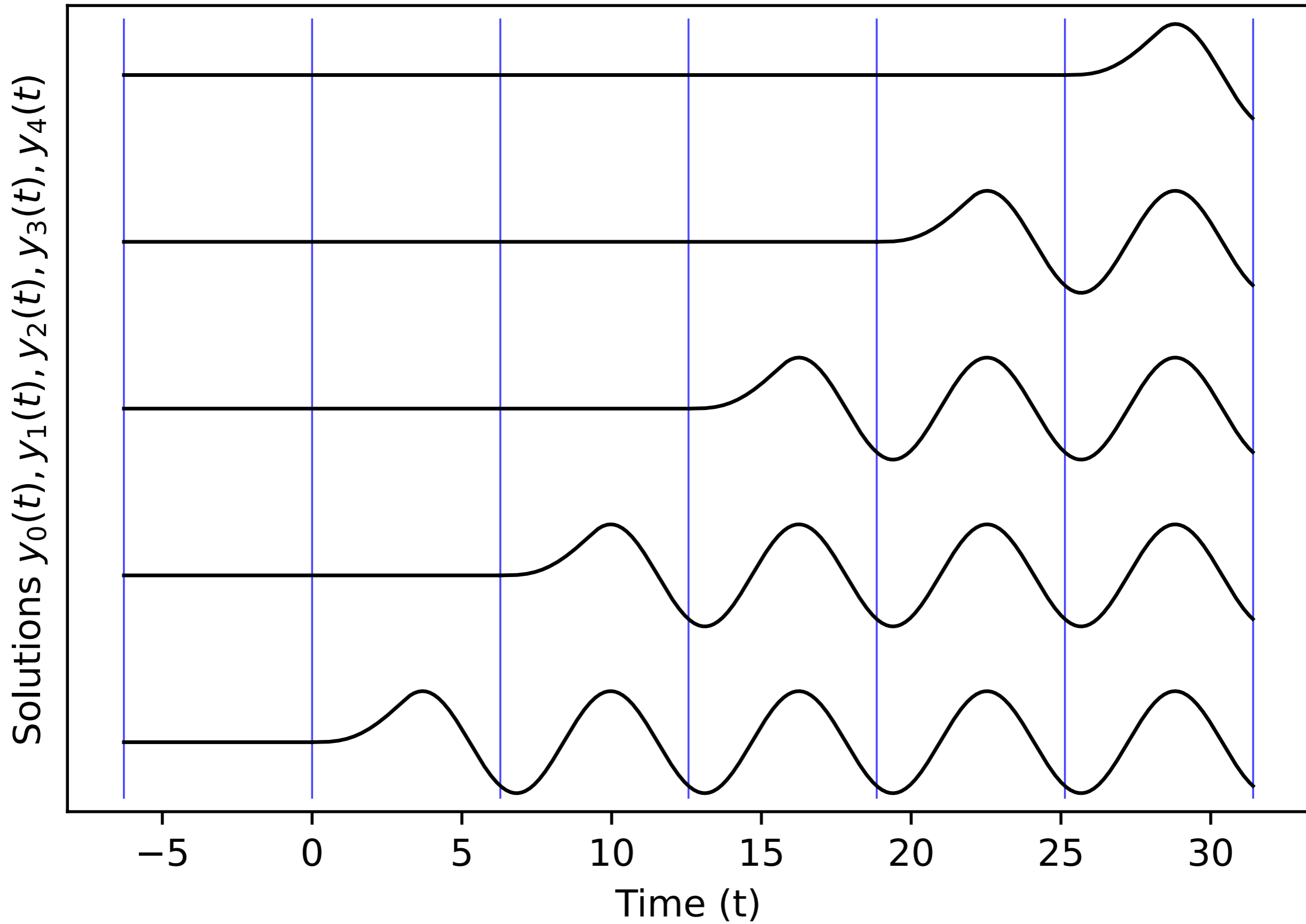
# Start with just first period of forcing





# Third Key Idea - Autonomous and Time Shift





# Focus on Two Mathematical Ideas Underlying LLMs

- Word Vectors — Also a good example of modeling
- Transformer architecture

## A jargon-free explanation of how AI large language models work

Want to really understand large language models? Here's a gentle primer.

TIMOTHY B. LEE AND SEAN TROTT - 7/31/2023, 7:00 AM



ARTIST: LAWSON / AFS TECHNICAL

Enlarge

How can we model or represent “words?”

The next five slides jump to the punchline

FR**You**

Please give me a list of five current football players and people who bear the same relationship to them as Tony Reginelli does to Peyton Manning. Please explain your reasoning.

**ChatGPT**

Tony Reginelli was Peyton Manning's high school football coach, a key figure in Manning's early development as a football player. To find similar relationships for current football players, we need to identify their respective high school football coaches who had a significant influence on their careers. Here's a list:

1. **Patrick Mahomes** - His high school coach was Adam Cook. Cook played a vital role in Mahomes' development at Whitehouse High School in Texas, where Mahomes showcased his talent that eventually led to his successful NFL career.



## You

That is perfect. I'd like to explore the same idea - noting persons who played similar formative roles in the development of Donald Trump and of Joe Biden. Please list some of the influential mentors in each of their lives.



## ChatGPT

Exploring the formative figures in the lives of Donald Trump and Joe Biden reveals mentors and influential individuals who played significant roles in their personal and professional development.

### Donald Trump:

1. **Fred Trump** - Donald Trump's father, Fred Trump, was a significant influence in his life. As a successful real estate developer, Fred provided Donald with a wealth of knowledge in the real estate business and an initial loan to start his own ventures, thus playing a pivotal role in shaping his business career.
2. **Roy Cohn** - An attorney known for his aggressive tactics, Cohn was a key legal advisor and mentor to Trump in the 1970s and 1980s. He significantly influenced Trump's approach to business and legal strategies.

## **Joe Biden:**

1. **Joseph R. Biden Sr.** - Joe Biden's father played a significant role in shaping his character and values. Despite facing financial difficulties, Biden Sr. instilled in his son the importance of resilience, hard work, and perseverance.
2. **Valerie Biden Owens** - Joe Biden's sister, Valerie, has been a lifelong advisor and confidante. She managed all of his Senate campaigns and his 1988 and 2008 presidential campaigns, playing a crucial role in his political strategy and success.
3. **Mike Mansfield** - The Senate Majority Leader when Biden first entered the Senate, Mansfield became a mentor to Biden. His advice and guidance were influential in Biden's early Senate career, shaping his legislative approach and political philosophy.



## You

Can you add people who each of Donald Trump and Joe Biden might not know personally but whose lives or writings served to help shape them.



## ChatGPT

Certainly, public figures often draw inspiration and guidance from historical figures, authors, and thought leaders, even without personal interactions. Here are individuals whose lives or writings likely influenced Donald Trump and Joe Biden:

### Donald Trump:

1. **Norman Vincent Peale** - The author of "The Power of Positive Thinking," Peale was a significant influence on Trump. Trump's family attended Peale's church, and his teachings on positivity and self-confidence likely had a substantial impact on Trump's approach to life and business.
2. **Sun Tzu** - While there is no direct link between Sun Tzu and Trump, the strategies outlined in "The Art of War," Sun Tzu's famous treatise on military strategy and tactics, seem to resonate in Trump's approach to business and politics, particularly in his emphasis on unpredictability and aggressive tactics.
3. **Ayn Rand** - Trump has expressed admiration for Rand's philosophy of objectivism, which emphasizes individualism and self-interest. Her works, especially "Atlas Shrugged," promote a worldview that aligns with Trump's business approach and libertarian leanings.



## **Joe Biden:**

1. **James Joyce** - Biden, known for his Irish heritage and literary interests, has often cited James Joyce as an influence. Joyce's exploration of the complexities of identity and the human condition in works like "Ulysses" may have influenced Biden's perspectives and speeches.
2. **Robert F. Kennedy** - Although Biden never met Kennedy personally, Kennedy's political career and tragic assassination profoundly impacted Biden. Kennedy's focus on social justice and civil rights likely influenced Biden's political views and his emphasis on empathy and social reforms.
3. **Dietrich Bonhoeffer** - A Lutheran pastor and anti-Nazi dissident, Bonhoeffer's writings on ethics, morality, and resistance against injustice could have impacted Biden, particularly in his views on moral leadership and foreign policy.

# Word Vectors

- As a first approximation think of a word as a text segment, which may be part of an (English) word or several English words. The English word “unbelievable” might yield three words un + believ(e) + able and the two English words “New” and “York” might yield the single word New York.

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- As intelligence, either human or machine, attempts to understand text, both the words and the vectors that represent them change.

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- Each occurrence of a word in a text is represented by its own word vector. Think of the text “New Year’s eve in New York City”
- As intelligence, either human or machine, attempts to understand text, both the words and the vectors that represent them change.
- Most dimensions are “hidden.” I would argue that this is true both for human and machine intelligence.



## You

How alike is the relationship between Tony Reginelli and Peyton Manning and the relationship between Mike Mansfield and Joe Biden? Please explain your answer and discuss how word vectors played a role in forming your answer.



## ChatGPT

The relationships between Tony Reginelli and Peyton Manning and between Mike Mansfield and Joe Biden are similar in terms of mentorship and influence but differ in their contexts and domains.

1. **Tony Reginelli and Peyton Manning:** Tony Reginelli was a high school football coach who mentored Peyton Manning, a renowned NFL quarterback. Reginelli played a crucial role in Manning's early development as an athlete, offering guidance and training that helped shape Manning's skills and approach to football.
2. **Mike Mansfield and Joe Biden:** Mike Mansfield, a long-time U.S. Senator and Majority Leader, served as a mentor to Joe Biden during Biden's early years in the Senate. Mansfield provided Biden with political wisdom and guidance, influencing his legislative style and approach to politics.

FR

**You**

Please discuss the role of the dot product in reasoning about the similarity between these two relationships.

**ChatGPT**

The dot product, a mathematical operation applied in the context of word vectors, plays a crucial role in reasoning about the similarity between the relationships of Tony Reginelli and Peyton Manning, and Mike Mansfield and Joe Biden. Here's how it's relevant:

1. **Word Vectors and Dot Product:** In natural language processing, words are often represented as vectors in a high-dimensional space. The dot product between two word vectors is a measure of their similarity. It calculates the cosine of the angle between the vectors, which reflects how closely related the words are in terms of their meaning and context.
2. **Application to Relationships:**
  - Each word (like "mentor", "coach", "politician", "athlete") in the context of these relationships can be represented as a vector.
  - The similarity in the relationships can be assessed by taking the dot product of vectors representing key concepts in each relationship. For example, comparing vectors for "sports mentorship" (related to Reginelli and Manning) and "political mentorship" (related to Mansfield and Biden).

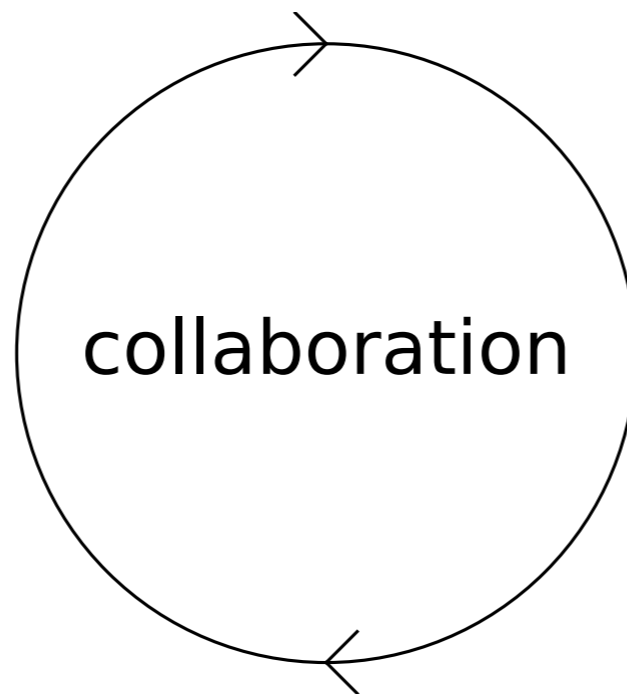


# Machine Learning Intelligence and Intelligence by Design

## Daniel Kahneman: Thinking, Fast and Slow

Fast

- Unconscious
- Highly Parallel
- Broadly-based
- Instinctive
- Informal
- Hard to Explain
- Learning



Slow

- Conscious
- Linear
- Focused
- Rational
- Often Mathematical
- Logical
- Design

If you've served recently in a civil or criminal trial the judge almost certainly gave you instructions about "unconscious bias" based in part on the work of Daniel Kahneman on fast thinking. The instructions I was given as a juror seemed somewhat contradictory.

- On the one hand we were cautioned to avoid judgements based on stereotypes.
- On the other hand we were told to make decisions about witnesses' credibility using our common sense in the same ways we do in everyday life.



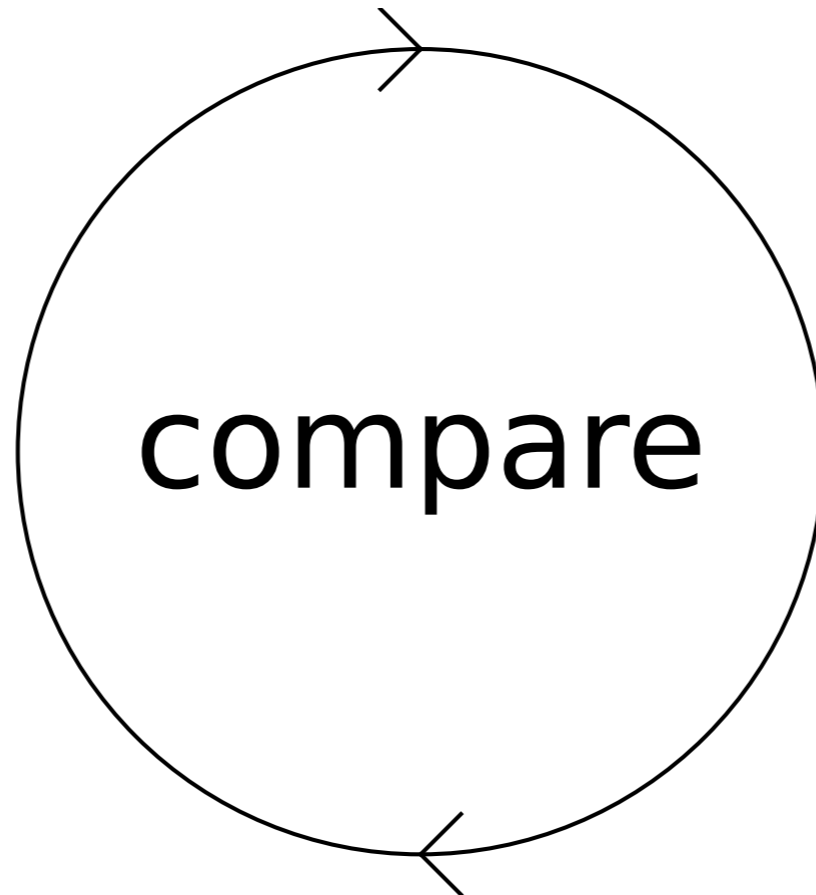
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# Nobel Prize Summit on Countering Misinformation and Building Trust in Science To Be Held May 24-26

**News Release** | February 2, 2023

WASHINGTON — The Nobel Prize Summit *Truth, Trust and Hope* will bring together Nobel Prize laureates and other world-renowned experts and leaders for a global dialogue on how to stop misinformation from eroding public trust in science, scientists, and the institutions they serve. Speakers will include Nobel Prize laureates such as journalist and author **Maria**

**Artificial  
Intelligence**



**Human  
Intelligence**

Perhaps we can learn more about the mistrust of science by studying how LLMs and people fast learn about the word “scientist” or “doctor.” Part of the urgency behind the NAS summit was mistrust related to COVID-19.

Google’s key word2vec project (2013) underlies the first step in the vector representation of words including words like “doctor.” We begin with a large text corpus (training data) and build vector representations of words by looking at things like how often different words appear in the same text and their proximity - that is, by looking at the context of each appearance.

For most people the training data for the word “doctor” includes their own formal and informal education, their own and their friends’ interactions with doctors, and appearances and portrayals of doctors in the media including advertisements.

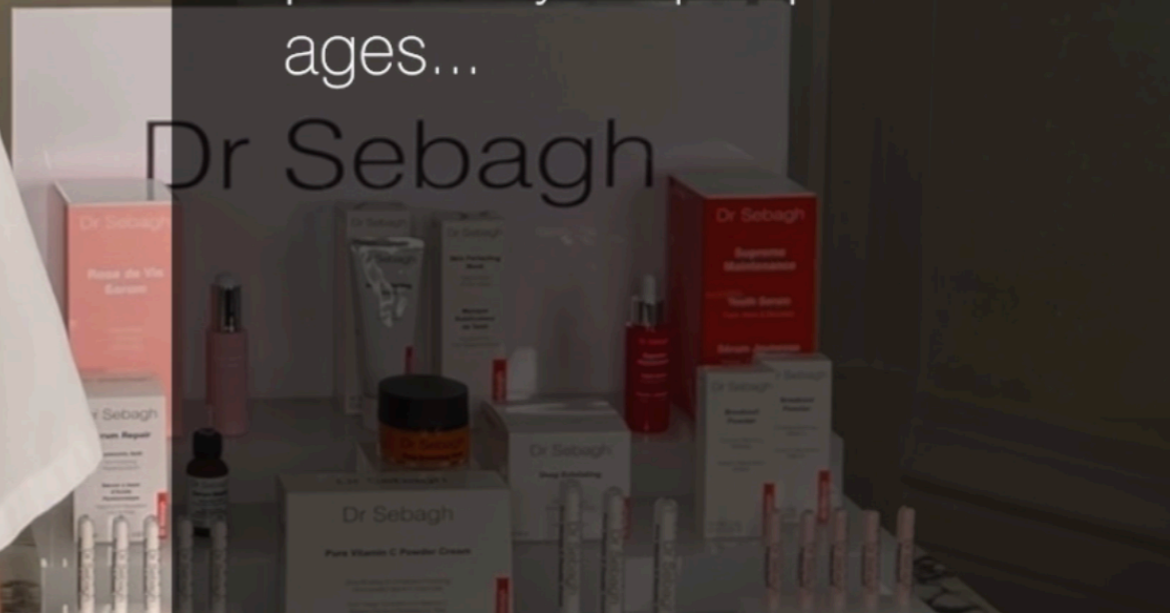
**CASCADE:** List some common contexts for “doctor” and describe how these contexts might lead to trust or distrust.





"When I started my career as a facial plastic surgeon 30 years ago, it was my dream to make 'Ageing-Maintenance' a possibility for people of all ages..."

Dr Sebagh




# Half of Dr. Oz's medical advice is baseless or wrong, study says



By [Terrence McCoy](#)

December 19, 2014 at 2:53 a.m. EST

 Share

 Save

It's not hard to understand what makes Dr. Oz so popular. Called "[America's doctor](#)," syndicated talk-show host Mehmet Oz speaks in a way anyone can understand. Medicine may be complex. But with Dr. Oz, clad in scrubs and crooning to millions of viewers about "miracles" and "revolutionary" breakthroughs, it's often not. He somehow makes it fun. And people can't get enough.

"I haven't seen a doctor in eight years," the New Yorker [quoted](#) one viewer telling Oz. "I'm scared. You're the only one I trust."





OPERATING PROFITS

## *They Lost Their Legs. Doctors and Health Care Giants Profited.*

Medical device makers have bankrolled a cottage industry of doctors and clinics that perform artery-clearing procedures that can lead to amputations.

# Sackler Embraced Plan to Conceal OxyContin's Strength From Doctors, Sealed Testimony Shows

As OxyContin addiction spurred a national nightmare, a member of the family that has reaped billions of dollars from the painkiller boasted that sales exceeded his “fondest dreams,” according to a secret court document obtained by ProPublica.

by David Armstrong, Feb. 21, 2019, 1:45 p.m. EST



**OPIOID BILLIONAIRES**  
The Deceptive Marketing  
of OxyContin

*This story is a collaboration between ProPublica and STAT.*

In May 1997, the year after Purdue Pharma launched OxyContin, its head of sales and marketing sought input on a key decision from Dr. Richard Sackler, a member of the billionaire family that founded and controls the company. Michael Friedman told Sackler that he didn't want to correct the false impression among doctors that OxyContin was weaker than morphine, because the myth

was boosting prescriptions — and sales.

# Nobel Prize Summit

## Truth, Trust and Hope

24-26 May 2023

Washington, DC

In-person and virtual

How can we build trust in truth, facts and scientific evidence so that we can create a hopeful future for all?

Misinformation is eroding our trust in science and runs the risk of becoming one of the greatest threats to our society today.

The Nobel Prize Summit 2023 brought together laureates, leading experts and the public in a conversation on how we can combat misinformation, restore trust in science and create a hopeful future.

The event was held in partnership with the National Academy of Sciences.

**Are Mis- and Dis-information really the problem?**

# Focus on Two Mathematical Ideas Underlying LLMs

- Word Vectors — Also a good example of modeling
- Transformer architecture

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Want to really understand large language models? Here's a gentle primer.

TIMOTHY B. LEE AND SEAN TROTT - 7/31/2023, 7:00 AM



ARTIST: LAWSON / AFS TECHNICAL

Enlarge

FR

**You**

dites-moi "Est-ce Napoleon Bonaparte un grand homme?" "Est-il un homme grand?"



**ChatGPT**

La question de savoir si Napoléon Bonaparte était un "grand homme" dépend de la perspective et du contexte dans lequel on l'évalue.

1. **Habile militaire et réformateur:** Napoléon est reconnu pour ses compétences militaires exceptionnelles et ses victoires dans de nombreuses batailles. Sous son règne, il a introduit des réformes administratives et juridiques importantes, dont le Code Napoléon, qui a eu un impact durable sur le système juridique français et européen.
2. **Expansionnisme et conséquences:** Napoléon a également mené des campagnes expansionnistes à travers l'Europe, apportant à la fois des réformes et des conflits. Ces guerres ont entraîné de nombreuses pertes humaines et ont bouleversé l'ordre politique européen.
3. **Controverse et héritage:** Son héritage est complexe et controversé. Pour certains, il est un symbole de leadership fort et de réforme, tandis que pour d'autres, il est un exemple d'ambition impérialiste et de la tyrannie.

Quant à la question "Est-il un homme grand?", si elle est prise littéralement pour se référer à sa stature physique, Napoléon était d'une taille moyenne pour son époque. Le mythe de sa petite taille vient probablement de la confusion entre les systèmes de mesure français et anglais, ainsi que de la propagande britannique de l'époque.



FR

**You**

Merci pour tous



**ChatGPT**

De rien ! Si vous avez d'autres questions, que ce soit sur l'histoire, la culture, ou tout autre sujet, n'hésitez pas à demander. Je suis là pour vous aider.

John wants his bank to cash the  
(verb) (John's) (financial institution) (verb)



Transformer

John wants his bank to cash the  
(verb) (verb)



Transformer

John wants his bank to cash the

# Learning about transformer architecture by probing



**You**

Please speculate on the meaning of the sentence "The brindles thunked the gurns gartly." With the exception of the word "the," which occurs twice in this sentence there other words are invented words with no known meaning. Nonetheless, I believe you might be able to speculate on possible, even probable, meanings of this sentence. Please try.

**CASCADE:** Respond as a human to the probe above.





**You**

Please speculate on the meaning of the sentence "The brindles thunked the gurns gartly." With the exception of the word "the," which occurs twice in this sentence there other words are invented words with no known meaning. Nonetheless, I believe you might be able to speculate on possible, even probable, meanings of this sentence. Please try.



**ChatGPT**

Speculating on the meaning of a sentence like "The brindles thunked the gurns gartly" is an exercise in creative interpretation since the words are invented and lack inherent meaning. However, we can attempt to infer possible meanings by considering how these words sound and the structure of the sentence:

1. **Brindles:** This could be a noun, given its placement in the sentence. It sounds similar to real-world words like "brindle" (a pattern of coloring) or "bindles" (bundles carried by hobos). Thus, "brindles" might represent a group of entities or objects, possibly characterized by a distinctive appearance or pattern.
2. **Thunked:** Resembling the past tense of a verb, this word sounds like "think," a real word that mimics a heavy, dull sound. It suggests an action that is forceful, possibly blunt or heavy-handed.
3. **Gurns:** As the direct object of the verb "thunked," "gurns" could be another noun. It's reminiscent of words like "urns" or "turns." This might imply that "gurns" are objects or entities that were acted upon, possibly in a physical or forceful way.
4. **Gartly:** This seems to be an adverb, modifying the verb "thunked," given its placement and the "ly" ending, common in English adverbs. It could imply the manner or quality of the action.

Putting these speculations together, a possible interpretation of "The brindles thunked the gurns gartly" might be: A group or collection of entities (brindles) performed a forceful, perhaps heavy or blunt action (thunked) upon another set of entities or objects (gurns) in a certain manner (gartly).

The exact nature of this action and the qualities of the entities involved are open to imagination, but the sentence structure implies a dynamic interaction between two groups, characterized by a physical or impactful action.

FR

**You**

Thank-you for indulging my odd query. What can we learn about your transformer architecture from your response?

**ChatGPT**

Your query about the invented sentence "The brindles thunked the gurns gartly" and my response to it can highlight several aspects of the transformer architecture and how it processes language:

1. **Contextual Understanding:** The transformer model doesn't understand words in isolation; it interprets them based on context. In your sentence, since the context is ambiguous (due to the invented words), the model relies on structural and phonetic similarities to known words to generate a plausible interpretation.
2. **Pattern Recognition:** Transformers are adept at recognizing and generating patterns in data. My response demonstrates how the model uses patterns in word formation (like the "-ly" suffix typically indicating an adverb) and sentence structure to speculate about possible meanings.
3. **Creative Inference:** While transformers don't 'create' in the human sense, they can generate novel combinations of ideas based on their training. In your query, I used the structure and sound of the words to infer meanings, showcasing the model's ability to combine existing linguistic knowledge in new ways.
4. **Handling Ambiguity:** The transformer architecture is designed to handle ambiguous and novel inputs. Your sentence is a prime example of this, as it contains words that the model has never seen. The response shows how the model navigates this ambiguity by relying on its understanding of language patterns and structures.
5. **Limitations in Understanding:** The response also highlights a limitation. Transformers, like the one used here, don't 'understand' language in the human sense. They can't assign meaning to words they haven't been trained on. They can only infer based on patterns and similarities to known words.
6. **Flexibility and Adaptability:** The ability to engage with and respond to a sentence composed entirely of fictional words underscores the model's flexibility and adaptability in linguistic tasks. It can adapt its responses to a wide range of queries, even highly unusual ones like yours.

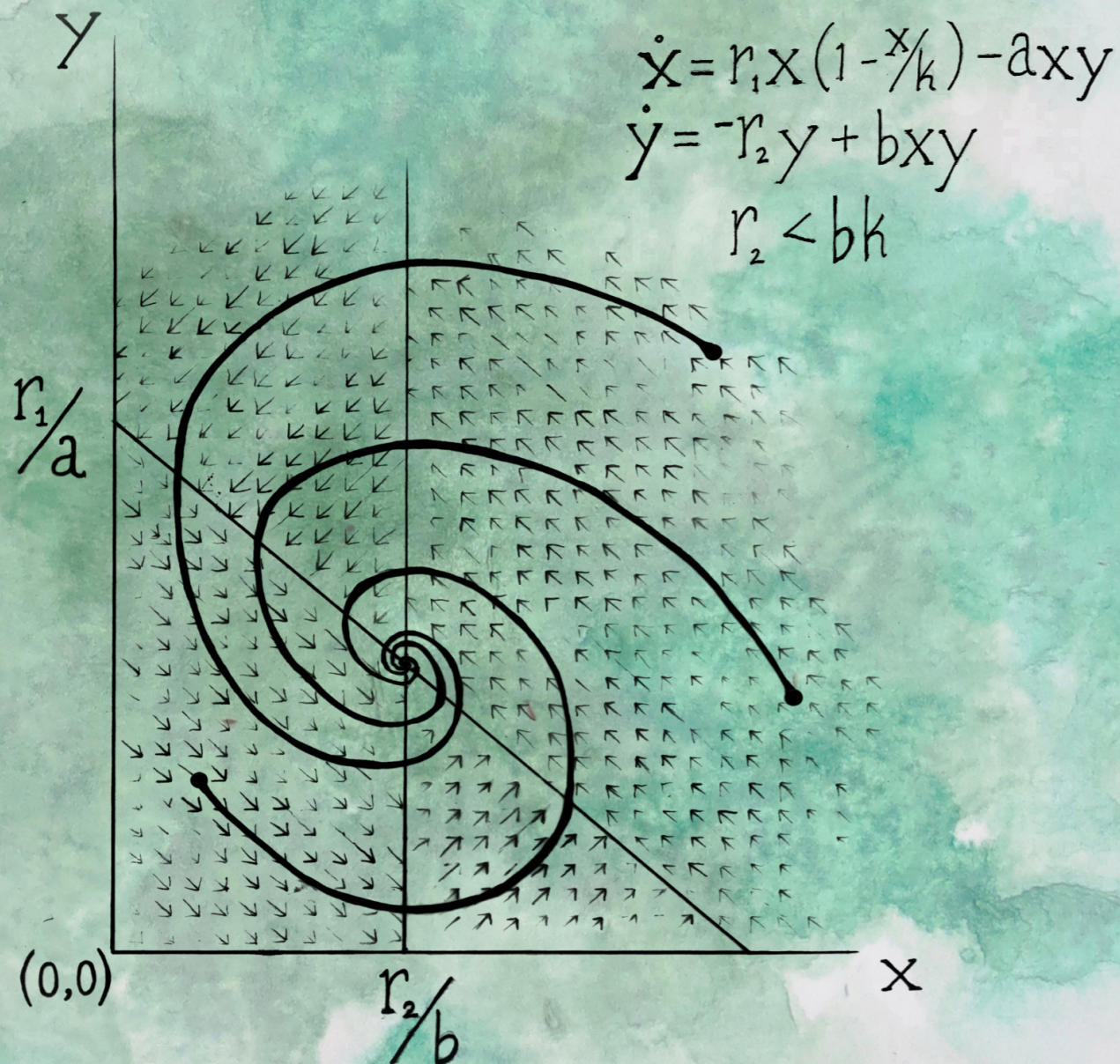
In essence, the response to your query showcases the transformer model's strengths in pattern recognition, inference based on linguistic structures, and adaptability, as well as its limitations in terms of genuine comprehension and the creation of new meanings.

Large Language Models and George  
Santos Both Pass the Turing Test

# Differential Equations

A Toolbox for Modeling the World

Kurt Bryan



## A Great Start

But we need to change what and how we teach

- The math underlying AI to better use AI and to engage students
- Modeling = **Understanding** far less algebra
- **“Learning” AI does not contribute to understanding BUT**
- **Learning about “Learning” AI does.**

