



# Sabiduría

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# Introduction

“No matter what people tell you, words and ideas can change the world.”  
Robin Williams playing John Keating  
in *Dead Poets Society* (Screenplay by Tom Schulman)

Dear Readers,

In honor of the astonishing talent of the Dr. Floyd F. Koch Honors College Students, the Sabiduría team is delighted to present to you the Sabiduria Spring 2021, Volume 11, Issue I, undergraduate academic journal. Under the guidance of Professor Robin Fiedler, as well as the assistance from Professor Allan Nosworthy and Professor Charles T. Cuthbertson, the Student Co-editors are proud to present this academic journal.

The Sabiduria academic journal is a collection of students' works from the 2020-2021 academic year. This would not have been possible without the Honors college students' hard work, and the collection of volunteer student editors whom under the Sabiduria team leaders, invested time from their busy schedules to read and assist in the selection process.

Due to COVID restrictions, we were unable to meet in person to work on this journal. However, we prevailed, and this would not have been possible if not for the dedication and determination of the students and professors. Now without further ado, the Sabiduría team presents the Spring 2021 edition.

Sincerely,

Erin Berish and Allison Ast, Co-Editors

## Acknowledgments

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**Cover Photography: Bamboo Beach by Tarruck Wheeler**

# The Alt-Right Solution: Fascism in America Today

by Bruna Amorim

## Abstract

The purpose of this literary review is to investigate the history of fascism in the United States and the apparent rise of it during recent years in the prevalence of fascist groups in American politics. Through the analysis of available data, historical sources confirm that fascism has never been unique to foreign countries and has been present on American soil ever since it was first described as a phenomenon. Data also shows that far-right and alt-right ideas are ever more present in the mainstream political sphere, especially through the rise in the use of social media as a preferred information dissemination method for the majority of Americans. Independent thought leaders online also exacerbate the spread of far-right ideas aligned to fascism, and social media corporations have not done enough to mitigate the situation. This is also congruent to the steady domination of far-right ideology as the inspiration of most terror attacks in America, according to available literature. Nevertheless, additional research is necessary to understand how to stop the dissemination of extremist ideas, as well as how to rehabilitate members of extremist groups.

Ever since the end of the Second World War, mainstream American political spheres have echoed a certain sentiment that permeated into the very core of many citizens' beliefs on the nature of American politics and government: "Fascism cannot happen in America." For decades, many chose or were led to believe that there was something in the American ethos that led the country to be immune to rises of authoritarianism, far-right ideology, and populism, and even Fascism. However, something seemed to shatter for many people when Donald Trump was elected president of the United States in 2016, which has been regarded both in and out of far-right spaces as a pivotal moment for the growth of authoritarian far-right ideology in the mainstream political conversation. Indeed, former President Trump is not necessarily the mind behind the rise of the popularity of these ideologies, but he does represent the moment the question was no longer whether these ideas could take hold on American soil, but rather, since when have they been on the rise? Although Democrat candidate Joe Biden has been elected President in the 2020 elections, it would be foolish to assume the energy created during the past four years would simply dissipate. Understanding the rise of this ideology, both historically at large and at home, is fundamental to mapping out where these groups and ideas are headed.

The initial issue for most has been understanding exactly what Fascism entails, as there are many misconceptions surrounding its definition. One of the most important voices in the process of defining Fascism was a school of critical theory dubbed as the Frankfurt School, which had the Institute for Social Research at Goethe University Frankfurt as its stage during its development over the early 1900s. In an analysis of critical theory and the Frankfurt School's role in studying the rise of Hitler and the politics associated with him, Abromeit (2018) expressed that the School understood Fascism as a form of right-wing authoritarian populism that was not in any way unique to Germany,

though the National Socialist Germany party furthered the ideology to unprecedented extremes leading up to and during the Second World War (Abromeit, 2018). A common misconception associated with fascism today is that it is something derived from socialism, an assumption that comes from the National Socialist Germany party's appropriation of socialist language. This aids in the idea that America could never be a fascist country, as capitalism has been the dominant national ideology to the point of antagonism toward socialists over the past decades. It is vital to clear this misconception, as fascism is further characterized as a result of powerful socio-historical and social psychological tendencies that were present in all advanced capitalist societies (Abromeit, 2018). That is, any country adept to capitalism might eventually find itself at the summit of a rise in fascistic ideology within its borders, as many before have. Rises in fascism are not unique to European countries, nor are they a uniquely modern phenomenon.

Indeed, the issue of such a stir in American politics is nothing new. In a Journal published by the American Political Science Association dated 1935, intellectuals were already signing sirens on the possibility of a fascist revolution in the United States (Steiner, 1935). The analysis of a uniquely American type of fascism at the time came after a few different groups manifested support for a departure from democracy in America, most of whom based their perceived necessity on a change of government on the grounds of race theory. Today, it is a popular philosophy among many to consider history to follow circular patterns – that is, not much is truly quite new in the broad processes of maintaining civilizations. Accordingly, it is no surprise that the issues faced today echo some of the same sentiments expressed almost a century ago. In fact, some of the same language was used as Steiner analyzed the dangers of using labels such as “liberal”, “conservative” and “reactionary” (Steiner, 1935) in times of social unrest, as they are likely to cause further division as each group seeks their own optimal solution to it. Furthermore, Steiner highlighted that an American fascism would likely take root aided by America's tendency of glorifying its past, going as far as citing those who seek to return to the political musings of the founding fathers in 1776 (Steiner, 1935). It is precisely those urges and tendencies to look upon an idealized past as an escape from the turmoil of the present that aids the rising aspects of the faltering fascist tendencies in America. Although the threat seems to always be lurking, there is not much discourse over the viability of an authoritarian regime taking over the United States government when there is not much of a social or economic turmoil.

Furthermore, during more stable periods, the mainstream political and social sphere is quick to paint a villain out of fascism, informed by vestiges and memories of past wars' propaganda, as well as an extent of knowledge of the effects of the ideology in other countries. Indeed, there are many ways, big and small, that antifascism became “common sense” in US culture (Vials, 2011). That is, rather than being part of the political conversation, or even a valid stop in the political compass one may adhere to, fascism is not even considered a viable political option to explore during periods of relative internal peace. Although this stance never achieved absolute hegemony, as the very nature of the discourse is one of highs and lows, it was pervasive enough to last a few recessions without

taking hold of real political space. Still, the figure of the fascist remains one of the primary villains in US discourse, even if its exact definition or form is never fully defined (Vials, 2011). Curiously, this almost mindless rejection of a poorly identifiable enemy has aided the rise of the thing it claimed to want to eradicate. Since fascism is so foreign and unreasonable, when public or private figures in one's life start putting forth points reminiscent of fascist ideology, most people are compelled to assume these are not signs of actual comradery with fascists, because that is simply not common sense; it is simply unthinkable.

Moreover, this culture of assessing how much a single individual is a fascist rather than investigating which of their ideas are fascistic in nature, combined with the denial that it is even possible for people to genuinely hold these values, has opened the door to embolden individuals who want to take their words steps further. The United States has become increasingly familiar with the far-right and their propensity to engage in Terrorism. Research has summarized some of the major components of the far-right as strident nationalism (usually racial or extrusive in some fashion), fascism, racism, anti-Semitism, anti-immigration, chauvinism, nativism, and xenophobia, and highlights that individual groups may adhere to one or more of these traits (Auger, 2020). Indeed, the list is quite lengthy and comprehensive, but the degree to which groups adhere to them is what placed them under the far-right umbrella. It is important to understand that the normalization of any of those beliefs in the political sphere has aided the legitimacy of far-right groups, and as such, their bigotry becomes normalized. Additionally, Auger expressed that far-right extremism covers the broad range of ideologies that essentially see violence as a legitimate tool to combat enemies, political or racial, that are seen as a threat to their own race or nation. The ideology of far-right extremism has often been linked to some kind of war that must be fought to secure a future for one's own race or nation. These groups have shown the tendency to perceive these fabricated threats as so fundamental to their existence that they are willing to engage in violent acts to mitigate the damage or win the war. Their violent actions are often seen by the broad public as terrorist attacks, although they may sometimes fail to be labeled as right-wing extremism.

Undoubtedly, one might question why such large sections of the public have felt reluctant labeling right-wing terrorism as what it is. According to research, right-wing groups evolved most dramatically in the streets, as groups realized that forces of law and order, such as the police, were unlikely to use their full force of repression against their "natural" allies on the Right (Wilson, 2020). That is, since the ideals of strict law and order might be better represented by those on the right of the political spectrum, law enforcement was shown to use lesser degrees of force against far-right agitators and terrorists. Furthermore, the contradiction between the treatment of terrorism from other groups versus the treatment of right-wing groups has, through history, allowed demagogues to make public space a central arena for the contestation of power (Wilson, 2020). The protection from a solid power such as the police has helped sections of the public to perceive right-wing terrorism not as it is, but as isolated cases of "lone wolf" extremists. Throughout history, the periods of rises in fascist ideology have shown that it

is necessary that these contestations of established power take place for the broader public to assimilate some of the far-right's aforementioned talking points, a process which has always had the induction of more members into far-right groups as a consequence.

Indeed, most of media attention has focused on very vaguely defined concepts of extremism, rather than naming the alt-right ideology that motivate a good portion of the attacks. With the prior establishment that Fascism rises from extremist ideas rooted in right-wing ideology, it is fundamental that acts of mass violence by far-right actors are referred to as terrorism so that accountability can be taken. In fact, between September 12<sup>th</sup>, 2001, and June 11<sup>th</sup>, 2016, violent attacks carried out within the United States were overwhelmingly linked to far-right terrorist groups (Jackson, 2019). The trend shown in this data was maintained through 2018, as murders committed by extremists during that year were overwhelmingly linked to the right-wing entities (Jackson, 2019). Failure to address this near homogeneity in the source of the majority of the terrorist attacks in American soil that have taken place over the past 20 years is extremely dangerous to this country's democracy. Terrorism and violence against citizens or the government was a fundamental aspect of the consolidation of fascism in the past, and only aids in the proliferation of fascistic ideology, especially as these instances of terrorism become more common.

Furthermore, it is extremely important to recognize the role that the internet has played in the rise of fascism in America and the proliferation of extremism in American politics. The consumption of print media and newspapers has declined over the past few decades, and sharply so over the past 20 years, as many people prefer to find their news online for free through social media and other cost-free platforms. Additionally, social media gave rise to what is known as a culture of digital hate, characterized not only by content consumers' speech in online platforms, but mainly by content creators seeking to change cultural norms or make a profit. Creators and consumers who have engaged with digital hate culture "write political blogs [...] that educate audiences with misleading narratives based on secondary sources, repeating extreme worldviews, and building on conspiracy theory and falsehoods" (Ganesh, 2018). Essentially, social media platforms have allowed the proliferation of different communities surrounding different public figures, be it of large or small scale, that not only negate reality within their circles, but actively try to expand their reach. This process has greatly aided in the progression of fascism in America directly as people get roped in by content creators, but also indirectly, as traditional media political pundits and journalists comment on the fallacies and tactics propagated by these groups, bringing further attention to their organizations (Ganesh, 2018). The scope of this problem is very large, and far-right fascists have been very successful in employing these tactics so far.

Particularly influential actors have often been found on Twitter, a social media platform popular among very diverse age groups. To most Twitter users who have engaged with politics in the platform, the prevalence of extreme right-wing political ideology has just been part of the experience. In fact, whenever Twitter updated their terms of service on acceptable speech on the website over the past few years, the company's own page was

often flooded with comments like “Just ban the Nazis” or “But what about the Nazis?” (Conway, Scrivens, & Macnair, 2019). Indeed, for many, it has become a mere nuisance to watch far-right groups spread misinformation online, and many have argued that social media platforms have not done enough to prevent or mitigate it. Though Twitter has rolled out several policies and acts to attempt that mitigation, a conservative estimation of the number of Twitter users associated with the alt-right set the number of unique addresses at around 100,000 (Conway, Scrivens, & Macnair, 2019). Other platforms also play a very important part in the dissemination of far-right ideology and fascistic alt-right ideas, and notable but less studied mainstream platforms include Facebook and YouTube, and fringe platforms like Reddit and 4Chan.

Moreover, the aforementioned “alt-right” has increasingly garnered space in mainstream political conversation following the white-supremacist “Unite the Right” rally in Charlottesville that took place in 2017. Several people that attended this rally identified themselves with an important group within the alt-right circle, the Proud Boys, who have once again made headlines during the 2020 election when former president Donald Trump failed to address them as the terrorist group that they are during a presidential debate. Taking a close look at the way the Proud Boys recruit as well as who they target is fundamental to understanding the rise of fascism as it stands today in the United States. Overwhelmingly comprised of young men, this brand of fascism has appealed to those who hold their identity as white, working-class American males, and fear that they are at risk of losing something they perceive belonged to them in some way and losing security as the United States’ demographics slightly shift (Kutner, 2020). That is, the Proud Boys and other alt-right groups have preyed on some young, conservative white men’s anxieties to further their fascistic ideology. Additionally, the initiation into these groups has focused especially on grievances against women, upon whom they project their insecurities. They may lash out against the idea of being seen as effeminate by “aggressively over-performing masculinity and adopting rigid gender roles” (Kutner, 2020). This habitual performance of aggression and rigidity has allowed members to become accustomed to – and even eager to participate in – acts of violence.

Undoubtedly, performances play a major role not only in the interactions between the members as a socialization tool, but also in recruitment and narrative-building. This propensity for performances and large stunts to gain recognition from the community is incredibly dangerous when applied to fascist alt-right groups, as they have shown themselves to be prone not only to commit acts of terrorism but actively attempt to leave “their mark” in their communities by inspiring copycats. In recent years, a great deal of terrorists who have been successful in their attacks and left some kind of manifesto clearly outline white supremacist ideas, Neo-Nazi ideas, anti-government sentiments, or frustration around sexual rejection from women in their works (Ware, 2020), all of which are hallmarks of alt-right circles online. Some do not fully write or record manifestos but may reference them before or after committing the attacks. What these manifestos have shown is an increasingly reactionary far-right wing, which not only believes their identities are in danger, but also that fascism is a viable solution to that peril.

Ultimately, history has shown us that fascistic ideology has existed for a long time, and research has pointed to the confirmation that it is not a philosophy limited by geography. Indeed, the American public has enjoyed a tendency for self-soothing by blindly believing that a rise in fascism could never happen here, although nothing could be further from the truth. Fascism rose in America before and appears to have risen into somewhat mainstream public discourse once more, albeit its extent is often covert. Groups that have been described as overtly fascistic or adjacent to those principles were mostly grounded on right wing ideology, some even described as far-right or alt-right. Common ideas spread among and between these groups included strong nationalism, racism, anti-Semitism, affinity to authoritarianism, anti-immigration sentiments as well as xenophobia and nativism, among other extreme ideas. Additionally, individuals who have been linked to the far and alt-right movements were often males who presented chauvinistic and misogynistic ideas, and who believed that there was some kind of threat against the social groups they saw themselves as part of, such as white, male, or working class. The spread of far-right groups in social media platforms has been pointed as one of the biggest causes for the rise of fascism in America, as members of far-right groups have been successful at recruiting using the social tools made available by websites such as Twitter, YouTube, Facebook, 4Chan, and more. Thus, as dissemination and membership rose, more cases of right-wing terrorism have been recorded over the past 20 years, making the right the overall biggest culprit of terrorism in American soil. Many terrorists have made it a tradition to leave behind manifestos, which is expected to inspire copycats. Future research must be conducted into the nature of relationships between members of far-right groups and social media platforms to inform the types of guidelines to be created by these platforms to mitigate the spread of fascistic ideology. Further research and analysis of the specific social groups as being at risk should be conducted, with great attention to how individuals can recover from being pulled into extremist groups before they commit violent acts, as well as general rehabilitation tactics. It is important that, though these people might feel left behind by society, they come to understand that they were not. Furthermore, it is fundamental for the well-being of democracy, both domestically and internationally, that the expansion of right-wing extremist groups is mitigated. Only through honestly facing the data acquired so far and understanding fascism as the threat that it truly is will prevent 2030 from looking like 1930.

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# Maya Angelou's *I Know Why the Caged Bird Sings*: Still Relevant Today by Angie Castellon

Maya Angelou has achieved what would usually take many people more than a lifetime to do. Angelou has garnered a reputation as a poet, performer, and activist as mentioned by Ruth Feldstein, an American historian. As an activist for civil rights and gender equality, Angelou was able to work alongside Dr. Martin Luther King Jr., James Baldwin, and Malcolm X, all activists in their own way (Chambers). Her activism was not confined to the U.S.; it was an international affair. Feldstein states that “black women were among the entertainers who became prominent in ... civil rights politics and entertainment in the 1950s.” Among them, Angelou wrote what would become her most recognized work, her autobiography, *I Know Why the Caged Bird Sings* after the encouragement of her friend and publishing company (Chambers). In this autobiography, which would go on and take on a life of its own, she recounts the highs and the lows of her life, not leaving out her recount of the sexual abuse she experienced at the hands of her mother's boyfriend and the silence that was to follow. *I Know Why the Caged Bird Sings* is still relevant when it comes to issues such as racism and women's struggles.

Angelou was far too familiar with the face of racism and prejudice. The racial discrimination she experienced was legally enforced (*Maya Angelou Academy of Achievement*). She recalls the comments her playmates would make regarding her skin tone; they would say that her skin was comparable to excrement. The children making these comments were not white. They were other young black children who had internalized racism. They were using the same racist comments made about them against their own, in an attempt to create distance between them and what they considered to be real black people. Angelou's uncensored recounting of the words spoken to her helps show the gravity of racism and discrimination even amongst each other. Racism is not pretty; it is not kind, and it does not take into consideration the harshness and power of words. As a young girl who was influenced by media and those around her, she often saw herself as less than those with a lighter complexion, an experience shared by many young black girls even today. The media propagates Eurocentric features as the standard of beauty, straight hair, and fair skin, the opposite of black features. In her autobiography, Angelou recounts her thoughts as a young girl where she would hope to wake up from her “black ugly dream” (4). This phenomenon is a result of colorism. Colorism is a form of prejudice or discrimination against individuals with a dark complexion, as stated by Adwoa Bagalini. Colorism does not only affect the self-esteem of women of color, but it also affects the job opportunities available to them, and even their wages, therefore changing into systemic racism.

Systemic racism is when policies and practices are in place that better support one race over another. Systemic racism takes on many different faces. It can be observed in employment opportunities, the wealth gap, housing opportunities, law enforcement, and even health care quality. As mentioned by Bagalini, research shows that as peoples' skin

tone darkens, the wage gap between them and those of a lighter skin tone widens as well, this is a form of systemic racism. Angelou's mother and grandmother benefited from colorism. Her mother was described as "light-skinned with straight hair" (Angelou 67). Because of this she was able to get better employment opportunities and was described as beautiful by those around her. Her grandmother was described as nearly being white, which allowed her to study nursing (Angelou). According to the article *What is Systemic Racism*, "black college graduates ... are almost twice as likely to be unemployed as white college graduates." This was the case for Angelou as well. She states that, among her graduating class, "only a small percentage would be continuing on to college" (165). This is a stark contrast with the graduates of white schools who could afford higher education.

Systemic racism in the law enforcement system has been in the public eye much more since people are now recording the happenings. Betty Wilson and Terry Wolfer, who studied sociology and criminal justice, state that "slave patrols... are considered the original institution of policing" (68). Because of its beginnings in a racist system, it is only reasonable that there would still be residual prejudices in law enforcement. The murders of unarmed black men and women such as "Michael Brown, Walter Scott, Sandra Bland, and Eric Garner" (Wilson and Wolfer 66) are only the tip of the iceberg to a much bigger problem, a problem that was almost usual in Angelou's life. As a black man, her uncle Willie feared being wrongly accused of angering or challenging white people, since the cost of even the smallest misunderstanding would be being publicly lynched. Angelou makes a profound statement in regard to this issue when she declares, "it was brutal to be young and already trained to sit quietly and listen to the charges brought against my color with no chance of defense" (176). The parallel between black men and women being publicly lynched back then and now being murdered publicly by police officers who are supposed to protect them is unsettling. Angelou's brother Bailey witnessed the dead swollen body of a black man being mocked by a white man. This left him stunned and forced him to contemplate why there was so much hate directed towards black people. He recounts feeling as if his soul had died (190-192). Wilson and Wolfer state that "repeated exposure to incidents of police brutality against unarmed African Americans can increase risks of psychological harm and traumatic stress" which is what Bailey experienced firsthand; the only difference was that this brutality was caused by white civilians.

Police officers are not the only ones disregarding the value of black lives. Healthcare facilities are also being found to be incompetent when it comes to ensuring the well-being of black mothers and their babies. Black babies are 2.5 times more likely to die before reaching their first birthday, and their mothers are 3 times more likely to die during childbirth because of the lack of proper prenatal care available to them (*What is Systemic Racism*). When Angelou had a severe cavity and sought medical attention from the nearest dentist who happened to be white, she was turned away because she was black. The dentist stated, "I'd rather stick my hand in a dog's mouth" (184). Although he was helped by her grandmother during the depression, all he saw was the color of her skin.

Angelou is no stranger to the struggles and abuse women around the world endure every day. As a victim of sexual abuse herself, she shares her story in hopes of helping

others overcome the trauma and the stigma that comes with being a victim of sexual abuse. In Angelou's case, the abuser was her mother's boyfriend. Angelou still being a young child did not understand what was going on; after the first incident she thought "what had we done?" (72). In response to his threat in which he said, "if you ever tell anybody what we did, I'll have to kill Bailey" (72), Angelou stops speaking. This is often the case for victims. They are threatened to keep quiet about the happenings or else their loved ones or themselves will be hurt or killed. Sexual abuse within families is not uncommon: "familial abuse accounts for some two-thirds of all child sex abuse..." (Unseen Evil). Angelou's hesitance to tell her family is a common reaction for children in her situation: "children are unlikely to tell someone that they are being sexually abused" (Unseen Evil), especially if they know the perpetrator. Sexual abuse has come into the public eye more now than ever before because of women stepping forward to call out and hold their abusers accountable for their actions. Movements that aim to empower and unify victims such as the MeToo movement have encouraged women to speak their truth about their experiences with sexual abuse. Tarana Burke, the founder of the MeToo movement states that the movement is built on the back of survivors such as Maya Angelou. By speaking out, survivors can help prevent it from happening to someone else. Burke also states when it comes to sexual violence, "dismantling the systems of power and privilege that allow sexual violence" is the ultimate goal. By making the victims and the effects of sexual abuse more public, it can change the stigma that comes with being a victim, encourage people to come forward about the abuse, and educate the abusers about subjects such as consent.

Gender inequality is still a problem today just as much as it was then. Throughout history, there has been a scrutinizing and demeaning eye over women's actions, attire, and position in society. This has translated to how women are treated in public places such as the workplace, and it has affected women financially as well. Seeing a black person owning a successful shop was rare during Angelou's youth but having a woman running it was even more surprising. This was the case for Angelou's grandmother; she was an anomaly during a time where women were perceived as just being able to cook, clean, and raise children. Her success in a market that was made for the prosperity of white men made this feat that much more praiseworthy. Currently, there is an obvious disparity between the wage of a woman and a man. Nicole Zelniker, a journalist for social justice issues, states that women make only 80% of what men make and this number decreases to 63% for black women. Women are even taxed on necessary menstrual products since they are considered a luxury. This has come to be known as the pink-tax; it is the added price women pay for products marketed towards them, as mentioned by Zelniker. For products such as razors, the price women pay is more than what men pay, although the only difference is its pink color. This emphasizes the constant struggle faced by women to get ahead and be on the same level as men, a struggle only made harder by being black. Angelou recounts her graduation in which the guest speakers insinuated that the highest level of success that her class of black children could achieve was that of a professional athlete. This comment did not include the girls, which Angelou took note of she stated

that as girls they were “maids, and farmers... anything higher ... was farcical and presumptuous” (176).

The pertinence of *I Know Why the Caged Bird Sings* by Maya Angelou is obvious when we look at her early life as a young girl in Stamps, Arkansas, where she faced racism and the struggles that come with being a woman, problems that many are currently facing 50 years later, such as colorism, systemic racism, sexual abuse, and gender inequality. Although Maya Angelou's experiences were less than favorable, she did not let them stop her from accomplishing her goals. When she would fall, she would get right back up again with an even stronger determination to become more than her circumstances. According to Veronica Chambers, she would go on to become the “first black female cable-car conductor in San Francisco, a successful calypso singer, a star of the New York theater,” just a few of her many accomplishments. Chambers states that the autobiography remains impactful because it reminds us of “all the possibility that lies on the other side of silence and suffering.” Angelou was recognized by various U.S Presidents, such as President Carter, Clinton, and Obama. Obama presented her with the Presidential Medal of Freedom, which is the nation's highest civilian honor, according to the Academy of Achievement (*Maya Angelou*). Activists such as Burke lead with the same hopefulness that Angelou once led with, though it seems like a never-ending struggle, the words of Burke's reverend give her and others strength, “We feel tired, but we press on”.

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# Development of a Therapeutic for Autoimmune Diseases from ShK by Alexander Lopez

The exploration of biodiversity and the search for chemical compounds that can be used as health remedies have been around for years. However, the approach that is now taken is recent and innovative. Scientists look for toxins produced by organisms to study its effects and mechanisms of action and employ them as potential medical treatments by exploiting these compounds' ability to target specific cells. This paper will focus on the use of the stichodactyla toxin (ShK), a peptide produced by the Caribbean Sea anemone *Stichodactyla helianthus*, for the development of a therapeutic for autoimmune diseases.

## Sea Anemones and Toxins in the Natural World

Sea anemones are anatomically simple animals that are among the most venomous organisms on Earth. Sea anemones belong to phylum Cnidaria and the Anthozoa class, which also includes soft corals, hard corals, sea fans, and sea pens. Their venom is essential for their survival, as they need it to immobilize the preys they feed on as well as for protection against potential predators. However, its biological role goes beyond protection against predators and includes digestion and spatial competition among individuals of the same species. The toxins produced by sea anemones consist mainly of peptides and proteins that can be neurotoxic or cytolytic and are efficient in targeting animals (Frazão et al., 2012). However, the composition of the venoms is not known in detail as there are many anemones toxins that have not been studied. According to Prentis et al. (2018), "there are only 236 peptide or protein toxins in the manually curated ToxProt database which have been isolated from just 45 sea anemone species" (p.3-4). There are more than 1100 species of sea anemones, which means that a very large percentage (more than 96%) of sea anemones venom peptides and proteins remain unknown (Prentis et al., 2018).

## Delivery of Toxins

Sea anemones, like other Cnidarians, contain numerous stinging cells (cnidocytes) located throughout the body, including the tentacles, acontia, and acrorhagi. Cnidocytes contain nematocyst, which are organelles used to inject the toxins/venoms in the target organism. After a chemical or mechanical stimulation, the toxins are injected into the prey or potential predator (Prentis et al., 2018).

## *Stichodactyla helianthus* and ShK

*Stichodactyla helianthus* is a species of sea anemone found in the Caribbean Sea. Like numerous other anemones, this species produces a venom that helps to immobilize prey once delivered via the nematocysts. This venom contains a cocktail of chemicals, including various ion channel blocking peptides and large cytolytic proteins (Pennington et al., 2015). However, a peptide in this venom, ShK, has the peculiarity of blocking

potassium ion channels, earning the interest of the scientific community. Voltage-gated ion channels play a major role in electrical excitability in cells. Voltage gated-ion channels, when opened (in response to changes in cell membrane potential), allow ions to enter a cell flowing down the electrochemical gradient across the cell membrane. This way, they form an ion-selective pore. Voltage-gated ion channels are crucial for the normal functioning and communication among cells (Frazão et al., 2012). Because of this, ShK is valuable for the understanding of the function and structure of potassium ion channels. Synthesis and characterization of this toxin have demonstrated that it is a potent blocker of Kv1.3 channels in Jurkat cells (T lymphocyte cells) (Pennington et al., 2015). This property makes it a promising candidate for the development of a therapeutic for autoimmune diseases.

### **Autoimmune Diseases**

More than 125 million people suffer from autoimmune diseases worldwide. Approximately 80 autoimmune disorders are known and affect every organ system, such as the central nervous system (multiple sclerosis [MS]), the integumentary system (psoriasis), and the endocrine system (type-1 diabetes mellitus [T1DM]). Autoreactive lymphocytes are responsible for tissue destruction. Autoreactive lymphocytes occur with the same frequency in patients suffering from autoimmune diseases as in healthy individuals. What causes the development of an autoimmune disease is the lack of regulation and suppression of autoreactive lymphocytes by regulatory T cells. In healthy individuals, autoreactive lymphocytes are suppressed by regulatory T cells, preventing them from proliferating. However, once an autoreactive lymphocyte escapes regulation and proliferates, the repeated stimulation caused by the presence of an autoantigen in the body causes the cell to terminally differentiate into effector memory T cells (TEM cells). Autoreactive B cells undergo a similar process and differentiate into class-switched memory B cells. TEM cells and class-switched memory B cells are responsible for tissue damage (Chi et al., 2012), leading to serious medical conditions.

### **Kv1.3 Channel and its Role in Autoimmune Diseases**

Out of the five types of ion channels that form a network in T lymphocyte (Kv1.3, KCa3.1, CRAC, TRPM7, and Clswell), the Kv1.3 channels have a vital function in TEM cells (Chi et al., 2012). The Kv1.3 channel was discovered in the 1980s at the University of California Irvine and at the University of Pennsylvania; continuous research two decades after its discovery helped to determine its relationship with the development of autoimmune diseases. In T lymphocytes, Kv1.3 is a voltage-gated membrane protein that controls the membrane potential when T lymphocytes are terminally differentiated into effector memory T cells. TEM cells in patients with chronic inflammatory diseases are responsive to antigens, which are implicated in various autoimmune diseases, including multiple sclerosis, rheumatoid arthritis, and type-1 diabetes. TEM cells in people with these conditions also have elevated numbers of Kv1.3 channels (Pennington et al., 2015). Also, medical reports of people suffering from autoimmune diseases show improvements

of symptoms after envenomation with scorpion peptides (Breland & Currier, 1983), which block Kv1.3 channels. This clearly indicates the existence of a relationship between Kv1.3 channels and autoimmune diseases.

### **Reason for Targeting K<sup>+</sup> Channels**

Lymphocytes depend on calcium signaling for them to activate, synthesize, and secrete antibodies, as well as to proliferate. In T cells, the binding of an antigen to the T-cell receptor causes the generation of IP<sub>3</sub>, which releases Ca<sup>2+</sup> from the endoplasmic reticulum store. Once the endoplasmic reticulum store is empty, a protein called STIM<sub>1</sub> is triggered, which then clusters under the plasma membrane and activates Ca<sup>2+</sup> influx. Ca<sup>2+</sup> influx is only possible because of the counterbalancing efflux of K<sup>+</sup> through potassium channels (Kv1.3 or KCa3.1) (Chi et al., 2012). Since K<sup>+</sup> channels promote the influx of Ca<sup>2+</sup>, by blocking these channels, the influx of Ca<sup>2+</sup> would be inhibited.

### **ShK and the Development of Therapeutic from ShK Analogs**

ShK was discovered in 1995 after a group of scientists administered *Stichodactyla helianthus* extracts to mice by intraperitoneal injection, realizing that the effects produced in the mice were similar to those produced by the snake toxin dendrotoxin, which was a K<sup>+</sup> channel blocker (Chi et al., 2012). Soon after it was discovered, ShK was isolated, being one of the first Kv channel blockers isolated from a marine source (Frazão et al., 2012). In that same year, Pennington et al. (2015) synthesized the ShK toxin and determined its three-dimensional structure. They also demonstrated that this toxin blocked Kv1.3 channels in T cells with low picomolar affinity. ShK was determined to be a 35-residue peptide that contained three disulfide bonds (Chi et al., 2012). According to Chi et al. (2012), "ShK blocks Kv1.3 with an IC<sub>50</sub> of ~10 pM but it also blocks two other channels with picomolar potency (Kv1.1, Kv1.6) and three others (Kv1.2, Kv3.2 and KCa3.1) with nanomolar potency" (Chi et al., 2012, p.533). For that reason, it was necessary to develop a peptide analog to the natural compound produced by the sea anemone with selectivity for the Kv1.3 channel over the other potassium ion channels. Scientists had to identify the ShK residues necessary for interaction with the Kv1.3 channel. Once this was accomplished, the ShK-binding site on Kv1.3 was characterized. With this knowledge, investigators were able to synthesize approximately 380 ShK analogs with the purpose of developing one that would specifically block Kv1.3 channels (Chi et al., 2012).

### **ShK-186**

Out of these ShK analogs, ShK-186 (dalazatide, the FDA approved name) is a promising treatment for various autoimmune diseases as it blocks the Kv1.3 channel with high selectivity over the other potassium ion channels. ShK-186 is currently being developed as a therapeutic for the treatment of autoimmune diseases. During the pre-clinical phase, it was manufactured under complete GMP regulations. The resulting pre-clinical manufactured formulations appeared to be resistant to ultraviolet light exposure and aggregation. Formulated ShK-186 also appeared to be stable under forced oxidation

conditions for several hours. It also showed stability as either a liquid or frozen formulation (Chi et al., 2012). Various studies showed that ShK-186 was safe at therapeutic levels. According to a study made by Chi et al. (2012) “ShK-186, at concentrations that are therapeutic in DTH, EAE and PIA, does not compromise the protective immune response against acute infectious agents” (Chi et al., 2012, p.542). The stability and safety of the manufactured pre-clinical formulations allowed scientists to proceed into the early clinical development of the drug. The stability of ShK-186 was further improved by various processes, and the early clinical development of the drug proceeded. In Phase 1 and 1b clinical trials, ShK-186 was well tolerated in healthy volunteers. After these positive results, the development phase of this drug has been advanced by Kineta Inc. into Phase 1- b-2a clinical trials, where the drug will be tested on patients (Pennington et al., 2015). According to Prentis et al. (2018), “Dalazatide is being advanced as a treatment for various autoimmune diseases, including inclusion body myositis, lupus, ANCA vasculitis, multiple sclerosis, psoriasis, psoriatic arthritis, rheumatoid arthritis, type 1 diabetes and inflammatory bowel diseases” (p.6).

### **Other ShK Analogs**

Other ShK analogs with higher Kv1.3 selectively ratios than ShK-186 have been developed. Some of these ShK analogs include ShK-223, ShK-224, ShK-234, and ShK-235, which demonstrated high selectively for Kv1.3 with little block of other important Kv subtypes (Pennington et al., 2015). The characteristics of these analogs make them attractive for the development of other therapeutics to treat autoimmune diseases.

### **Conclusion**

Nature offers a wide range of biochemical compounds that can be explored and used as therapeutics. This is the case for the toxin produced by the sea anemone *Stichodactyla helianthus*, ShK. ShK is a potent blocker of Kv1.3 channels, a channel that is essential for TEM cells proliferation. TEM cells are implicated in autoimmune diseases as they contribute to tissue damage. By blocking Kv1.3 channels, the necessary influx of Ca<sup>2+</sup> for TEM cells to activate and proliferate is inhibited, improving the health condition in patients with autoimmune diseases. Currently, a high Kv1.3 selective ShK analog, ShK-186, is being used to develop a drug (dalazatide), which as of now has already completed Phase 1a and 1b clinical trials. Other ShK analogs such as ShK-223 have even higher Kv1.3 selectively ratios than ShK-186, making them promising candidates for the development of similar drugs.

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# Comparing the Mosaic Law with The Law Code of Hammurabi by Enrico Oliveria

Ever since the first societal formations, some level of cooperation between people has always been necessary. As early tribes began to form, rules inevitably had to be created with the ultimate goal of maintaining order, peace and discipline. These early norms varied a lot between areas due to geographical, cultural, and spiritual reasons, but despite the drastic differences between them, these law codes were commonly associated with the religious beliefs of its people, as is the case with the Ten Commandments (also known as Mosaic Law), and the Law Code of Hammurabi. Both these ancient norms, in particular, generate interest and commotion within the scholar community, that draws parallels between our current legal practices and social morality to these two law codes. The goal of this essay, therefore, is to study and compare the Mosaic Law with the Law Code of Hammurabi, taking close inspection in their: Similarities; differences, and implications for their respective societies.

The origin to the Ten Commandments is inheritably religious. As is mentioned in the book “A Survey of the Old Testament”, God freed the Israelites and presented them with a “constitution”, which was meant to bind their people together and be the moral foundation of the new nation. (Stevenson, 2009, pp. 89). However, some controversy arises from the fact that the Mosaic Law is not mentioned in its entirety in any of the books in the Bible. Thus, as explained in the article “The Ten Commandments as Public Ritual”, the bodies of law that compose the Ten Commandments can be found in the books of Exodus, Leviticus and Deuteronomy. But, because of the non-linear appearance in the Bible, some religions may have slightly different interpretations of what constitutes the law of God. (Davis, 2002, pp. 224). Nonetheless, as explained in a different article by the name of “The Mosaic Code”, different societies have used the Mosaic Law as their primary body of law and morality guidelines, while obviously adding other norms as each of them progressed and encountered necessity. The interpretational differences did not affect the overall relevancy of the Mosaic Law in the shaping of the morality of ancient societies that were subsequently inspired by the Israelites. (Calisch, 1907, pp. 854).

As to the Commandments themselves, they can be divided into two categories: Commandments that exemplified the desired relationship between people and God (1-4); and Commandments that taught what not to do in the new Israelite nation (5-10). The description of each Commandment is as follows:

“You shall not have other gods beside me;  
You shall not make for yourself an idol or a likeness of anything in the heavens above or on the earth below or in the waters beneath the earth;  
You shall not invoke the name of the LORD, your God, in vain;  
Remember the sabbath day—keep it holy;

Honor your father and your mother;  
You shall not kill;  
You shall not commit adultery;  
You shall not steal;  
You shall not bear false witness against your neighbor;  
You shall not covet". (Exodus 20: 3 - 17. USCCB).

As is illustrated, the topic of religion and how to treat God is present from the first to the fourth Commandments. It is likely that in the Judaic religion's understanding, the presence of such Commandments illustrate that God set these rules as the condition for saving the Israelites from the tyrannical Egyptian empire and giving them the promised land to live in peace, procreate and spread the word of God. Such actions were therefore practiced tirelessly by those who had faith, and still carry on to today's religious societies. The fifth to tenth rules take a different approach. These were created to illustrate how the citizens of the new nation should behave. As the book "A Survey of The Old Testament" states, "The last six Commandments deal with principles of morality in man's relationship to other men. These are laws common to any society which recognizes basic establishment principles." (Stevenson, 2009, pp. 90).

A few centuries before the creation of the Mosaic Law, however, another legal system was detrimental for the success of an ancient society: The Law Code of Hammurabi. This legal system was found in 1901, in the city of Susa, ancient Persepolis. It consisted of a large block of diorite on which was carved the Babylonian laws. (Johns, 1904, pp.313). Created by Hammurabi, the sixth king of the Babylonian dynasty, the Law Code of Hammurabi is considered one of the first legal systems in the history of humankind. The code, which was formed by 282 separate rules has two main focuses: Rules that concern property, and rules that concern interpersonal relations. (Pfeiffer, 1920, pp. 310). The general norm among the 282 codes is the concept of retribution. Additionally, rulings would vary depending on the class of the citizens involved. Generally, there were three distinct social levels among the people of Babylon: High class, freedman and slaves. Frequently, crimes committed by higher classes received a more lenient fine than crimes committed by slaves. Gender was also differentiable in the eyes of the law, as men could have relationships outside of marriage (as long as it was with lower-class women) while the opposite was considered illegal.

The Law Code of Hammurabi did not shy away from the use of violence as a means of achieving retribution. Punishments were a common way of solving disputes, and these were extremely severe in some cases. In a translation of the entirety of the codes made by author L.W King, rules 229 to 232 provide a great example of harsh penalties and the concept of private property in the Babylonian's eyes:

229 If a builder build a house for some one, and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death.

230. If it kill the son of the owner the son of that builder shall be put to death.
231. If it kill a slave of the owner, then he shall pay slave for slave to the owner of the house.
232. If it ruin goods, he shall make compensation for all that has been ruined, and inasmuch as he did not construct properly this house which he built and it fell, he shall re-erect the house from his own means. (King, 2008).

As stated previously, the Babylonians praised their interpretation of justice and legal reinstatement. However, that concept could frequently be used in the most extreme circumstances, as seen in code 230 where the son of a constructor will pay with his life even though the son may have been completely absent from the process of building the faulty house. But perhaps the most famous phrase from the entire legal system can be seen in code 196: "If a man put out the eye of another man, his eye shall be put out." (L.W. King, 2008). This short code greatly summarizes the understanding of retribution among the Babylonian judges, which is that for every crime committed by an individual against another of equal class, often times the exact same crime will be conducted on the original offender, regardless of how harsh and evil such punishments may be.

Thus, it is clear that the Ten Commandments and the Law Codes of Hammurabi are extremely different when it comes to the use of violence. As stated in the translated codes from L.W. King, the Babylonian law does not shy away from capital punishments, mutilations, and even third-party executions in the event of grave occurrences. The Ten Commandments, however, simply lay a foundation as to how a healthy and faithful Israelite society should behave. This, obviously, did not include violence of any kind. Rather, it taught the Israelites how to act with good virtue, be respectful to others and to obey God. As a study conducted by the author Basil Cole concluded, a righteous society that believes in the words of God should always rely on good virtue and the Ten Commandments. Both concepts are meant to be intertwined, used in conjunction, but ultimately the Ten Commandments remain an irreplaceable set of moral values and societal guidelines. (Cole, 2010).

Furthermore, although both systems were believed to have been created by divine forces and passed down to trusted humans, the Israelites were monotheistic, while the Babylonians were polytheistic. Additionally, the legal system brought to use by Hammurabi was merely an amalgamation of civil concepts and customs of the people of his dynasty, which did not deal with the religious practices of the population. The Ten Commandments, on the other hand, were also perceived to have been a divine creation. As explained in "The Mosaic Code", the Commandments were given to Moses by God at the top of the Sinai Mountain, thus establishing a holy nature to the Mosaic Law. (Calisch, 1907). Where the two codes differ, however, is that the Ten Commandments explore the theme of religiousness and spirituality in multiple sects, such as in "you shall not have other gods beside me" (Exodus 20: 5. USCCB) while the Babylonian law does not cover that subject. Lastly, a merely esthetic difference between the two law systems is

that while the Ten Commandments were carved in two tablets of stone (the material used was either sapphire or lapis lazuli), the Law Codes of Hammurabi were carved in a large diorite block.

Despite all of their differences, the two legal systems share some fundamental similarities. First of all, some scholars have established a well-based theory that the Ten Commandments were inspired by the Hammurabi Codes. (Edward N. Calisch, 1907, pp. 864). That, in and of itself is a great indicative that both law codes share similar societal trends and customs. Additionally, the very nature of both Codes is religious, the Mosaic Law being given by God to the Israelites, whereas Hammurabi believed he was gifted the law codes from the Babylonian God of Justice. According to “The Law Code of Hammurabi”, even the name of the emperor had a religious connotation, as “Hammu” likely signifies “God”, and “Rabi” had the meaning “is great” in the ancient Babylonian language. (Urch, 1929, pp.437). In addition, the fundamental purpose behind both law codes for their respective societies is extremely similar. Each serve as norms, rules, customs, and practices that were developed specifically to aid the development of the nations, and both share strikingly similar characteristics to the current legal systems and societal trends of most countries in the world today, thousands of years after their creation.

The law Code of Hammurabi is closer to the legal system used in the present if compared to the Mosaic Law, since, in short, it showcases the concept of punishments being given to each violation, with severity of fines being influenced by the severity of the crime. The Ten Commandments, however, greatly align with what our current society considers moral, ethical, and virtuous. Despite being written thousands of years ago; “you shall not commit adultery” (Exodus 20: 14. USCCB) is an example of a Commandment that is as relevant today as it was the day of its creation. Furthermore, while the Law Code of Hammurabi established very important concepts which are used in today’s courtrooms, like the use of judges. The culture of retribution thorough physical punishments, however, is polar opposite to most legal systems used nowadays.

To conclude, both legal systems were greatly impactful for their respective societies. Although they may differ in important aspects, such as the use of violence and the establishment of required religious practices within the law code, both the Ten Commandments and the Law code of Hammurabi share striking similarities. Most notably, both are believed to have been passed down to selected humans by celestial beings, causing them to acquire a “holy” aspect. Ultimately, both law codes were simply detrimental for the establishment and evolution of their respective empires, and their repercussions can still be easily seen, thousands of years later, in our current society.

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# Python Programming Language: Definition and Significance by Jonathan Santos

## Abstract

The research explains the origin of the object-oriented programming language Python and the type of programming language Python is. Many different programming languages are used; therefore, this research highlights the difference between Python and those other languages by breaking down Python into several parts and detailly defining what each of them means. This study will show what makes Python popular and commonly chosen by people as their first programming language. Lastly, the scope describes what can be created with Python and how corporations use Python to create digital platforms for commercial or scientific purposes.

*Keywords:* Python, programming language, object-oriented programming

Programming is becoming more important as new technologies emerge. Programming aims to translate commands written in human language to machine language, thus making the commands easier to understand by the computer (Blackwell, 2002). Moreover, programming is used along with Operating Systems to facilitate the communication between humans and computers. To clarify, programming is essentially how people assign machines a set of orders, known as a program, and the machines execute those orders automatically without the need for human intervention (Blackwell, 2002). There are many programming languages, such as JavaScript, Python, C#, C, C++, etc. This study is focused on Python. The purpose of this study is to describe Python in a detailed manner, contrast the differences between Python and other different types of programming languages, and show how many corporations use Python to create digital platforms.

The events behind the creation of the Python programming language can be traced back to decades ago. Python was created in the late 1980s by Guido van Rossum (Shi, 2020). Before creating Python, Guido wished that there was a programming language "that could implement all computer functional interface[s] like C and be programmed easily like Shell" (Shi, 2020, p. 163). To clarify, Guido wanted a programming language that combined both efficiency and simplicity because some programming languages are especially difficult to learn and read. Guido participated in developing the ABC programming language when he worked at CWI (Centrum Wiskunde & Informatica) in the Netherlands (Shi, 2020). That language had a major influence on the design of Python. ABC was designed to be "easy to read, use, remember and learn" (Shi, 2020, pp. 162-196). Subsequently, Guido created Python, surpassing ABC. In 1989, Python was introduced as the successor to the ABC programming language (Tulchak & Marchuk, 2016). Furthermore, Python's logo is represented by the image of two snakes; however, in contrast to what many people think, Python's logo was not created after snakes. Python

was written after a "popular BBC comedy TV show" called "Monty Python's Flying Circus," which Van Rossum happened to be a big fan of back in the 1970s (Gowrishankar & Veena, 2018).

There are different types of programming languages. Python is a "very high-level, object-oriented, dynamic, general-purpose programming language that uses interpreter and can be used in a vast domain of applications;" moreover, Python also uses a "combination of reference counting and a cycle-detecting garbage collector for memory management (Srinath, 2017, p. 354; Tulchak & Marchuk, 2016). A programming language can be either high-level or low-level; Python was created with the intent of being as high-level as possible. High-level programming languages are more user-friendly, readable, and easier to understand; on the other hand, low-level programming languages are closer to machine language, making them less readable and difficult to understand (Schules, 2017). Being easier to learn makes Python a popular choice as people's first programming language. Python has a simple syntax making it easier to write and comprehend than several other programming languages, such as C++, Java, and C# (Srinath, 2017, p. 355). Python has become increasingly more popular over the last decade. According to a study conducted in 2018, Python holds the number one spot as the most popular programming language (Cass, 2018). Furthermore, many beginners choose to learn Python as their first programming language because, besides being easier to learn, a large amount of support is available on the internet. For instance, Python is the 5<sup>th</sup> largest Stack Overflow community, the 4<sup>th</sup> most used programming language on GitHub, and the 3<sup>rd</sup> largest Meetup community (Srinath, 2017, pp. 354). Therefore, many beginners can connect with groups of programmers and professionals who can guide them through the process of learning Python.

Programming paradigms exist to classify the different types of programming languages. Python is a "multi-paradigm programming language" that supports object-oriented, structured, imperative, functional, and procedural programming (Srinath, 2017, pp. 354-356). Each programming paradigm provides programmers with a distinct way of thinking aimed at solving complex problems by separating those problems into smaller parts. For instance, the notion behind the object-oriented paradigm consists of creating an abstract view of how a program works by visualizing the program as a set of objects that are made of "properties and functions" and have those objects interact with each other (Joque, 2016; Avacheva & Prutzkow, 2020, p.3). Examples of object-oriented languages are Python, C++, Java, and C#. Object-oriented programming comprises three core concepts that help reduce code duplication: inheritance, polymorphism, and encapsulation. Inheritance allows programmers to create a class based on the properties of another class (Avacheva & Prutzkow, 2020, p.4). Otherwise stated, a child class inherits the properties of a parent class. Encapsulation allows programmers to store data inside a class and prevent unauthorized parties from accessing that data (Lutowski, 2016, p. 9). Moreover, encapsulation is commonly used to hide values and data inside a class. Polymorphism allows programmers to modify a child class from its parent class by replacing their

inherited algorithms with new properties (Berger, 2016). Consequently, making the child class different from its parent class.

In a dynamically typed language such as Python, JavaScript, Ruby, and PHP, the interpreter running the code only checks the type of the codes during the runtime while the code is being executed (Bailey, n.d.). Besides dynamic languages, there are also static languages. In static languages such as C, C++, Java, and Pascal, the compiler checks the types of the codes during the compile-time, without executing the codes (Bailey, n.d.). Furthermore, in case a variable is assigned to a string, dynamic typing allows programmers to assign that variable to an integer or a floating-point number and vice versa. Simply put, dynamic languages allow programmers to change the type of a variable; on the other hand, static languages do not allow programmers to change the type of a variable (Bailey, n.d.). If these rules are not followed, a statically typed program would result in an error due to different types of data.

Both dynamic and static languages have their advantages and disadvantages. Static languages are more helpful at creating new sets of classes; moreover, an experiment conducted in a 2018 study concluded that static languages provide better error checking than dynamic languages as "errors [written by a static language] were caught before runtime and the compiler or IDE would inform the developer if there were an error and what had caused it;" on the other hand, error checking in dynamic languages does not occur until the program is executed (Kleinschmager et al., 2012, p. 163; Pang et al., 2018). That is to say, static languages work more efficiently than dynamic languages at specific tasks; however, the same is true the other way around. For instance, dynamic languages "provide more flexibility on code structure and are learned by having previous experience with a language, rather than relying on [the] theory;" plus, they can also be more convenient to use on a larger project than static languages because static languages can negatively impact the development of a project by slowing it down with all the time spent building and compiling the program (Pang et al., 2018). Nonetheless, dynamic languages also have a few drawbacks. For example, when a program made with Python grows larger and more complex, it becomes more difficult to track down and fix problems encountered in the program; thus, personal experience and precise judgment are necessary to keep the program running properly; besides that, being dynamic also makes Python performance slow as machines take a significant amount of time referencing to make sure that every code inside a program is being interpreted correctly (Srinath, 2017, p. 355). In the end, personal preference is what determines whether a programmer chooses to use a dynamic language or a static language.

A programming language can be categorized as a general-purpose language (GPL) or a domain-specific language (DSL). Python is a general-purpose programming language designed to be used in a variety of applications domains. For instance, Python is commonly used for designing a Graphical User Interface (GUI), system programming, network programming, database programming, components integration, game development, software development, business applications, scientific application, etc. (Srinath, 2017, p.356; Saabith et al., 2019). Thus, various corporations use Python due to its

universal applicability. On the other side, there are domain-specific programming languages such as HTML and CSS that are designed to focus on a particular application (Zucker & d'Leeuwen, 2020, p.421). Simply put, general-purpose languages have a wider range of use than domain-specific languages.

Python is compatible with a wide variety of Operating Systems, such as Windows, Linux, UNIX, Amigo, Mac OS, etc. (Srinath, 2017, p. 355). This compatibility allows Python to work on various platforms without the need to modify the program for each different platform. Furthermore, one of the main strengths of Python is its large standard library which provides programmers with everything from "modules that are as much a part of the Python language as the types and statements defined by the language specifications, to obscure modules that are probably useful only to a small number of programs" (Tulchak & Marchuk, 2016; Lundh, 2001, p. xiii). Simply put, the standard library is a collection of modules containing commonly used commands that help programmers to simplify the programming process. Moreover, Python is open-source, which means that it can be used and have everything made with it distributed freely, even for commercial use (Srinath, 2017, p.355).

Python is used by many corporations, such as Google, YouTube, and NASA, to create their digital platforms. For instance, Google's web search system, YouTube's video sharing service, and BitTorrent's file-sharing system all use Python in their structure; moreover, Python is also used for scientific purposes by corporations such as NASA, Los Alamos, Fermilab, JPL, and others (Srinath, 2017, p.356). Furthermore, as Python becomes more popular every year, more corporations will start using Python to develop their new projects.

In conclusion, this study described the origin of Python and what its creator, Guido Von Rossum, visualized when he created Python. Many types of programming languages allow a programming language to behave in a certain manner. Python has been increasingly becoming more popular due to its universal applicability and simple syntax, making it easier to read, write, and understand. Because of that, many people select Python as their first programming language, and many corporations use Python to create or improve their digital platforms.

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# The Rise and Fall of Marxism by Stephen Sims

## Abstract

The research examines Marxism through a historical, economic, and philosophical lens and explore the fundamental reasons why this revolutionary social and economic theory failed to deliver the utopian changes to society that the creators and original proponents promised. From a historical perspective I shall explore Marxism through the events of the 1917 Russian Revolution with the actions and motivations of Lenin, Trotsky, and Stalin will be explored in depth. From an economic perspective, Marxism will be examined through the theory of surplus value, property ownership, class antagonism that was expounded in *Capital* and Marx's other writings. Furthermore, Marxian economics are examined through the eyes of its adversaries, such as libertarian and classical liberal laissez faire schools of thought. The real-world effects of the dictatorship of the proletariat and the command economy will be compare-contrasted with its theoretical predictions.

*Keywords:* Marxism, dialectical materialism, dictatorship of the proletariat, Adam Smith, laissez-faire, Industrial Revolution, Russian Revolution

## Marxism: Origins

To understand Marx and Marxism, we must comprehend the epoch at which Marx lived, what he experienced and saw, and his intellectual and theoretical influences that were to be amalgamated into a new theory.

Karl Marx's ideas have their origin in Plato's Republic, the rule of society by Philosopher Kings, and G.W.F. Hegel's theory of history. Marx's doctoral dissertation entitled "The Difference Between the Democritean and Epicurean Philosophy of Nature" was on two Ancient Greek philosophers, Epicurus, and Democritus, who were proponents of materialism. Democritus would predict the existence of the atom 2,500 years before modern science proved its existence. Marx was also significantly influenced by Jean-Jacques Rousseau (1712-78), who more than any other man created the philosophical framework for the French Revolution, and Pierre-Joseph Proudhon (1809-65), the father of anarchism (Colleti, 1973, p. 185).

Marx lived through and saw the effects on society of the latter half of the Industrial Revolution. The Industrial Revolution began in 1760 and lasted until 1850; an epoch in European history would fundamentally transform the world. New processes in manufacturing technology, most significantly the creation of the steam engine led to a decline in the importance of animal power for work and changed the nature of work for the human population. Instead of working as serfs on the land of feudal landlords, or working as subsistence farmers for themselves, a significant portion of the population now

worked in crowded factories, with grueling hours, and no safety protections from the machinery. Children were forced to work in the factories so that their family had a better chance of surviving. In this new environment, the worker no longer created a commodity from the ground up and could call it his own. Instead, workers specialized in specific tasks on an assembly line. A worker would perform the exact same tasks hour after hour, thousands of times per day. Specialization would result in the major productivity increases that took place under Capitalism. On the other hand, this process and the working conditions imposed by the bourgeoisie caused alienation. The worker was alienated from not only the commodities he produced but from the mode of production and society itself. These radical changes to society under the Industrial Revolution would last until 1850. Marx was born on 14 March 1818, in Trier, in the Kingdom of Prussia, which later became Germany. Due to his revolutionary writings, he would be permanently exiled to London, England in 1849. Marx would see with his own eyes the exploitation of the working class by the owners of the means of production as a result of the new hierarchical stratification system known as Capitalism. England and Germany were the two primary countries in Europe that drove the Industrial Revolution.

In the words of Hobsbawm (1996), the 18<sup>th</sup> and 19<sup>th</sup> centuries were the “Age of Revolution.” The Industrial Revolution (1760-1850), the American Revolution (1776), the French Revolution (1789-99), and the upheavals throughout Europe in 1848 that became the most widespread wave of revolutionary action in European history and would weaken the monarchies in power. These revolutions would have lasting ramifications for the rest of European history.

### **Marxist Theory**

The beginning and ending of Marx and Engels (1848) Communist Manifesto are two of the most powerful and influential statements in modern human history:

The history of all hitherto existing society is the history of class struggles. Freeman and slave, patrician and plebeian, lord and serf, guild-master and journeyman, in a word, oppressor and oppressed, stood in constant opposition to one another, carried on an uninterrupted, now hidden, now open fight, a fight that each time ended, either in a revolutionary reconstitution of society at large, or in the common ruin of the contending classes.

The Communists disdain to conceal their views and aims. They openly declare that their ends can be attained only by the forcible overthrow of all existing social conditions. Let the ruling classes tremble at a Communistic revolution. “The proletarians have nothing to lose but their chains. They have a world to win. Working Men of All Countries, Unite!”

In the Communist Manifesto, Marx boldly states the beliefs of his movement: “In this sense, Communists may be summed up in the single sentence: Abolition of private property.” As we shall see, this fundamental statement of Communism is integral to its theoretical framework, but also defective in its practical applications to human society. Marx saw the Paris Commune, that existed during the French Revolution, as the embodiment of this theory put into practice (Marx, 1871). “For them, the commune had proved that the old state bureaucracy could be smashed, and all areas of government democratized” (Priestland, 2010, p. 37).

Marxian social theory is comprised of three parts: a materialist conception of history, known as dialectical materialism; the theory of class struggle, which includes alienation and false consciousness; and economic theory known as the labor theory of value (surplus value). Marx's theories became the foundation of Conflict theory, a framework in sociology whereby we understand the interaction between individuals and classes in our society is based on conflict over resources, the opposite of Structural Functionalism, which sees the different sectors of society working together towards a harmonious whole despite social problems that may exist.

Karl Marx is best known for predicting the downfall of Capitalism but in his writings, he expounded how Capitalism—the evolution from a feudal society to one of private individual ownership—is itself a revolutionary theory. In the Communist Manifesto Marx explains the power of Capitalism: it “has created more massive and colossal productive forces than have all preceding generations together” (Marx, 1848). Many thinkers in our epoch underestimate the power of Capitalism and human self-interest when free from government control. This dynamism is best shown by the rapid pace of economic growth and the changes to society during the Industrial Revolution, from the mid-18<sup>th</sup> century to the mid-19<sup>th</sup> century and of the technological revolution in the late 20<sup>th</sup> and early 21<sup>st</sup> centuries.

According to Erich Fromm (1961),

Marx's philosophy, like much of existentialist thinking, represents a protest against man's alienation, his loss of himself and his transformation into a thing; it is a movement against the dehumanization and automatization of man inherent in the development of Western industrialism.

Marxism was created as a direct response to these rapid changes. Society was no longer based on agriculture, nor on using human or animal labor to accomplish tasks. This was the beginning of the rise of machine technology, of mechanization, automation, and the specialization of labor. The population was no longer sparsely dispersed throughout the countryside to work on the land of feudal landowners, nor to struggle in desperation living as subsistence farmers. With the Industrial Revolution the great engine of economic growth was now the cities, and more specifically the largest factories. A substantial percentage of the population moved into the cities in a short span of time, leading to social problems such as pollution, disease, tension, the depletion of resources, and the straining of infrastructure. The factories, which ran entirely on coal, caused a massive increase in pollution. The externality of pollution, combined with overcrowding, disease, long hours, and no worker protections meant the life of a worker in the cities was a daily struggle, with no hope of a light at the end of the tunnel.

### **Why did Marxism fail?**

The failure of Marxism can be directly traced to its fundamental failure to understand human nature and to the rise of the brutal dictatorships who sought to create a “New Man” with the threat of imprisonment or death. Humans are inherently ‘selfish.’ This word has negative connotations but that is of no concern to the truth, it is merely

semantics. There is no inherent wrong in working hard, pushing yourself day in and day out to achieve a goal or aim for the purpose of advancing your positions in life, especially if you are providing for a family. The founding of Economics began with Adam Smith's *Wealth of Nations*, published in 1776, that introduced the revolutionary concept of the 'Invisible Hand,' which would impact all future social science. 'Selfish' motivations can and do cause greater good in society, as a byproduct.

Humans are a product of nature. In nature, humans are guaranteed nothing. Only the fittest survive—the physically fit or the most intelligent. Those who are only average in both are not guaranteed survival in the animal kingdom. In human society, we are no longer at the mercy of nature as during the hunter-gatherer phase of our development, but the lesson still holds. Humans, just as animals, are divided into leaders and followers, in a hierarchical structure. The system must be hierarchical in nature, so that the most intelligent, most capable are able to raise to the top and attain leadership positions. In this world, we must fight to survive by overcoming obstacles that are in the way of our survival and advancement. The fight takes place in attending a college or university for years, earning top grades, pulling countless all-nighters, and making major sacrifices all while working full-time. The fight takes place in being the best employee, so workers are the ones who is promoted and attain a higher status, higher income and the increased responsibility that comes along with that. The drive to survive is a fundamental aspect of the human condition that is a direct result of our origins.

We as humans would like to believe the myth that those of us who do great things are motivated solely by humanitarian and selfless aims and believe our achievements that we worked tirelessly, for years, or even a lifetime, warrant no more than good words from a fellow-citizens and not any financial or material compensation. This is simply not human nature and there is nothing inherently wrong with this. When asked what motivates us, what inspires us to achieve greatness we don't tell truth and portray ourselves as noble figures whose only concern is that of others, that our own happiness and standard of living takes a backseat to other considerations. One reason for this is to stay humble and humility is a virtue. The other reason is that if our 'selfish' motivations are exposed through our own admission, we are opening ourselves to disapproval from those who only want to praise selfless figures.

There does exist humans who are motivated entirely by the drive to acquire knowledge and have no earthly concerns for material possessions or financial gain. This cohort is comprised of many mathematicians, theoretical physicists, and philosophers. These driven individuals who are not under the control of self-interest comprise only a tiny fraction of the total human population. Of the 7.3 billion people on planet earth, the vast majority, including that of intellectuals, leaders, inventors, engineers, and entrepreneurs are primarily motivated by advancing their position in life and of their family.

The two fundamental lessons of economics are Adam Smith's Invisible Hand and the power of incentives. Along with the inherent drive for survival, humans instinctively respond to incentives. The ability to benefit materially and financially in a market system

creates the bedrock whereby human nature can be harnessed for the advancement of society. Incentives are the primary human motivator to produce, create, and innovate. This is the truth that underlies modern economic theory. The freedom to gain from one's efforts is the motivation that drives humans to attain a higher level of education, wealth, and power.

Dialectical (historical) materialism did not lead to Socialism and then Communism as Marx predicted. The Great Depression did not cause Capitalism to collapse. Instead, the consensus led to a synthesis of government intervention into the market system while keeping a balance of regulation and freedom, known as Keynesian economics. This was Hegel's theory of history in action: the thesis (unregulated laissez-faire Capitalism) met its antithesis (stock market collapse and unprecedented deflation and unemployment), resulting in a synthesis: Franklin Delano Roosevelt's New Deal, backed by the economic theory of John Maynard Keynes.

Using Hegel's theory of history, we can see the thesis of Marxism and its inherent contradiction, its antithesis, combine to form a synthesis whereby components of Socialism can combine and form a mixed-Capitalist system, that results in elements of both opposing systems: individualism, property rights, free enterprise; and universal healthcare, state support of education, social programs, progressive taxation. This mixed system can be seen as the synthesis of Capitalism and Socialism, or it can be seen as the synthesis of Marxism and its inherent contradiction canceling out its most radical properties. Hegel's theory of history holds true, Marx's interpretation thereof was not born out by history.

Communism, i.e., the complete abolition of all private property, is not possible on the large scale. It has existed only among small tribes in the pre-historic and ancient world. Marxism became an antithesis of itself with its failure to understand human nature. This self-negation in theory led the real-world results being diametrically opposite of what the original theorizers envisioned, with the real-world consequences of artificial famines, dictatorship, forced labor, secret police, abolition of freedom, and the complete subordination to the state. This state of society is fundamentally no different than feudalism and monarchy, what the revolutionaries fought against, but in fact much worse than what came before. The market system is the only economic system, and its power lies in that it can be modified without diminishing the underlying principles that allow it to work for the whole of society.

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## Calculus and Ebola by Tianhao Zhang

The word "calculus" comes from the word "rock" because people in ancient times work arithmetic with rocks (Davidson). However, in modern days, calculus often refers to the academic subject that focuses on the study of how things are changing. According to Jon Davidson, "The first half [of calculus] is concerned with learning and applying the techniques of differentiation, [called Differential Calculus, while the second half is about integration]" (Davidson).

Differential calculus is the study of how dependent variables change as the independent variable, which they depend on, change in different ways. Integral calculus, on the other hand, is a field of study that is the companion, complement, and inverse of differential calculus (Strang, 1991). Sir Isaac Newton from England and German mathematician Gottfried Wilhelm Leibnitz share the credit of creating calculus as early as around the 1670s. However, Leibnitz's calculus symbol was more widely adopted in the world (Jon Davidson). Calculus is the foundation of higher-level math and many other subjects, such as physics, higher-level chemistry, economics, and engineering, to name a few. After the invention of calculus, Sir Isaac Newton can better demonstrate many concepts in physics, taking the relationship between position, velocity, and acceleration for example.

An essential concept of calculus is limit, which means what will happen as the input value of an expression gets close to a point selected. Both Differential and Integral Calculus are based on this idea. In Differential Calculus, people use limits to estimate the slope of a curve at a point with a tangent line. Professor Leonard explained in the video, "as [number Q] get really, really, really close to [another number P], [then it is a great approximation to the slope of a curve at that small section of the graph.]" (Professor Leonard, 2012, 11:53). This is the process of estimating the slope of a secant line (line touches the graph twice) with a tangent line (line that touches the graph of function precisely one time). As point Q moves toward point P, the approximation becomes better, but no matter how close those two points move to each other, there is still a very, very small distance between them. The distance can be very obvious as we enlarge the graph infinitely. Each time we zoom in, there will be a better approximation we can make. When working with projects that require high accuracy like sending rockets into the galaxy, the error can be fatal. The limit allows us to make the distance between two points infinitely close to zero, but not quite zero. The reason why we approach to zero rather than get to zero is obvious, in order to draw a line, there have to have at least two points. The mathematical expression of a limit is often written as

$$\lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

It is also known as the formal definition of the derivative as a limit. To demonstrate how it works, we can plug a simple function,  $x^2$  into the expression above. After algebraic

manipulation and cancellation, the result would be  $\lim_{h \rightarrow 0} 2x + h$ . Since the variable  $h$  is getting infinitely close to zero by the limit, we can ignore the  $h$ , and we will get the derivative equal to  $2x$ . Differentiating simple functions such as  $x^2$  with the limit definition of derivative is not that complicated, but not all functions are simple like  $x^2$ .

When differentiating much more complex functions such as  $(\frac{5}{x^2})(5x^3 + 10x^2 + 30)^{\frac{1}{3}}$  using the limit definition of derivative would be a disaster. Thankfully, there are few rules that can make differentiating functions easier. Before showing the rules for differentiation, we should know that derivative can be denoted in many different ways, with the most common notations being the prime notation  $f'(x) = 2x$  and Leibnitz notation  $\frac{d}{dx}[x^2] = 2x$ .

A few of the rules are listed below:

Constant rule --  $\frac{d}{dx}[C] = 0$

Power rule --  $\frac{d}{dx}[x^a] = ax^{a-1}$

Product rule --  $\frac{d}{dx}[f(x) * g(x)] = \frac{d}{dx}[f(x)] * g(x) + \frac{d}{dx}[g(x)] * f(x)$

Quotient Rule --  $\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x) * \frac{d}{dx}[f(x)] - f(x) * \frac{d}{dx}[g(x)]}{(g(x))^2}$

Chain rule --  $\frac{d}{dx}[f(g(x))] = f'(g(x)) * g'(x)$

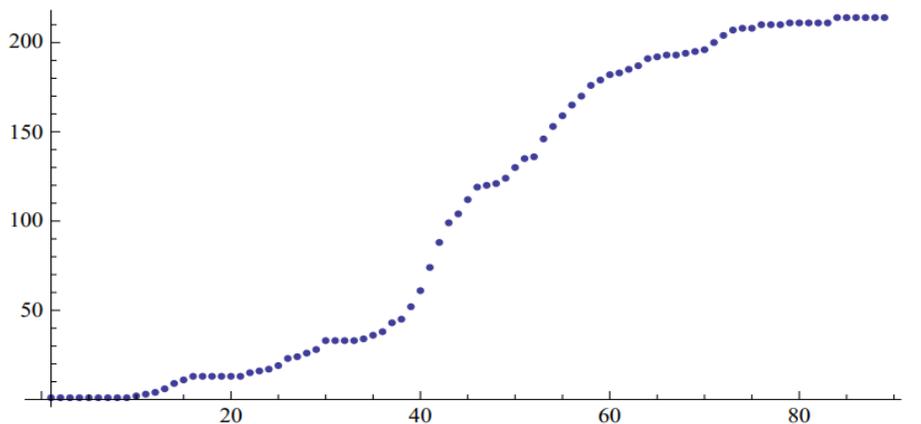
When differentiating some special functions like log and trigonometric functions, follow the own special rules and the rules above, e.g., taking a derivative of  $\ln(5x^4)$  will require a chain rule.

Derivatives have many real-life applications if there is a model can represent the actual data. Some of the easy applications are like find the marginal profit of commodities, finding the velocity when a ball is dropped from a cliff. Those applications will often have a negative quadratic function. When we try to use derivatives to find the marginal profit, we can also tell how many products to make to maximize/minimize the marginal profit. The ball dropped from the cliff case; it is also possible to find when the ball is falling quickest and how long it will take for the ball to hit the ground. We can also find how fast water surface is increase or decreasing in a conic cone tank, or how fast is the volume in that tank changing at the moment. One of the most important applications of derivative is to approximate the trend of diseases, such as Ebola.

CDC announced that "Ebola Virus Diseases (EVD) is a deadly disease with occasional outbreaks that occur primarily on the African continent. EVD most commonly affects people and no human primates [...] caused by an infection with a group of viruses within the genus *Ebolavirus*"(CDC, 2019). Ebola may develop symptoms 2 to 21 days after contact, with an average of 8 to 10 days. The symptoms develop from dry (fever, aches, fatigue, and pains) to wet (diarrhea, vomiting, unexplained hemorrhaging, bleeding). There is no specific treatment for EVD; The recovery mainly depends on supportive clinical care and the patient's immune system. With an average fatality rate of 50%, the

survivor from EVD will have antibodies that can be detected in the blood up to 10 years after recovery (CDC, 2019).

In this research paper, we will examine the model for deaths due to an Ebola outbreak in the Democratic Republic of Congo (DRC). We will study the case discover a connection between the value of the function, the area under the function, and its slope. There is a 90-day-long outbreak of EVD in DRC, 1995, which we will be modeling with inverse trigonometric function arctangent. The points below are a plot of a function  $N(t)$ , which represents the total number of deaths from the beginning of the outbreak to the end to day  $t$ .



This graph can be analyzed by answering a few questions proposed by Colorado University, which implement a better understanding of the EVD outbreak in 1995 in Congo.

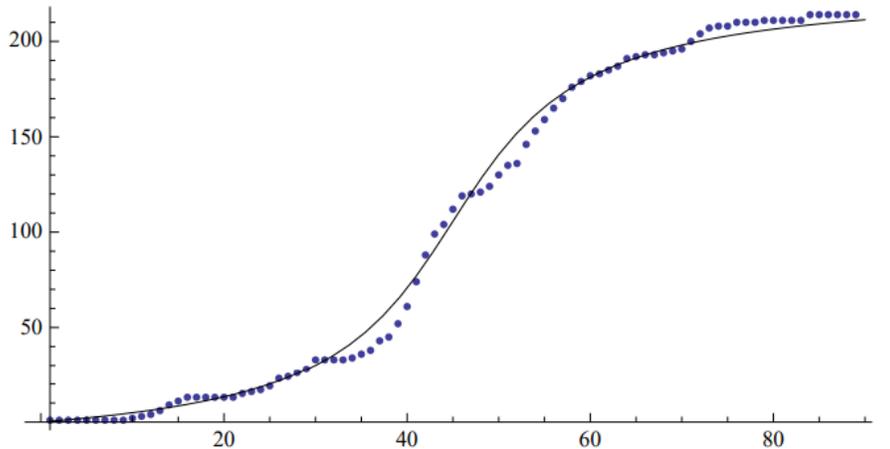
1. (a) Translate the equation  $N(22) = 15$  into an explanatory English sentence.  
 $N(22) = 15$ . This expression means there are 15 people died on the 22nd day of the outbreak.
- (b) The data shows that  $13 = N(16) = N(17) = N(18) = N(19) = N(20) = N(21)$  what does it mean?

The data have shown by day 16 of the outbreak of EVD in DRC, 13 people have died from EVD. There are no more deaths until the 21st days after the outbreak.

An essential way to analyze data is to find a function that models the data – the graph of the function closely fits the data points.

$$D(t) = \frac{1654}{21} \left( \arctan \left( \frac{2(t-45)}{21} \right) + \arctan \left( \frac{30}{7} \right) \right)$$

The function is a good model for the EVD data, as the below graph shows:



2. How well does the mathematical model  $D(t)$  for the number of deaths represent the actual cumulative death count  $N(t)$ ? When does the model least accurately reflect the data? When do we see the largest discrepancy between the rate of change of the model and the rate of change of the actual data?

As observed,  $D(t)$  is a good model representing the  $N(t)$ , the cumulative death counts, where

$$\begin{aligned} D(20) &= 13.263 \\ D(40) &= 70.661 \\ D(60) &= 181.281 \\ D(80) &= 206.427 \\ D(90) &= 211.328 \end{aligned}$$

There are only two sections where the data is seemingly different from  $D(t)$ , which is the domain where  $t = [30, 42] \cup [47, 57]$ . In other words, on day thirty to forty-two and forty-seven to fifty-seven days after the outbreak of EVD in DRC, the mathematical model  $D(t)$  is reflecting the data least accurately. The largest discrepancy between the actual data and the mathematical model is on day 38, where 48 people have died from EVD, while the mathematical model  $D(t)$  returned a value of 59.4.

3. From the mathematical Model  $D(t)$ , representing the cumulative death count, we can also find the instantaneous death rate  $R(t)$ , in death per day, by taking a derivative. We can start with the easier step, follow the multiply rule and constant rule to pull out the constant  $\frac{1654}{21}$  and differentiate  $\arctan\left(\frac{30}{7}\right)$ . The result would be

$$\frac{1654}{21} * \frac{d}{dx} \left[ \arctan\left(\frac{2(t-45)}{21}\right) \right] + 0$$

The derivative of  $\arctan(x)$  is  $\frac{1}{1+x^2} * \frac{d}{dx} [x]$ , we can plug in the function above to this general form, we will get

$$\frac{1654}{21} * \frac{1}{1 + \left(\frac{2(t-45)}{21}\right)^2} * \frac{d}{dt} \left[\frac{2(t-45)}{21}\right]$$

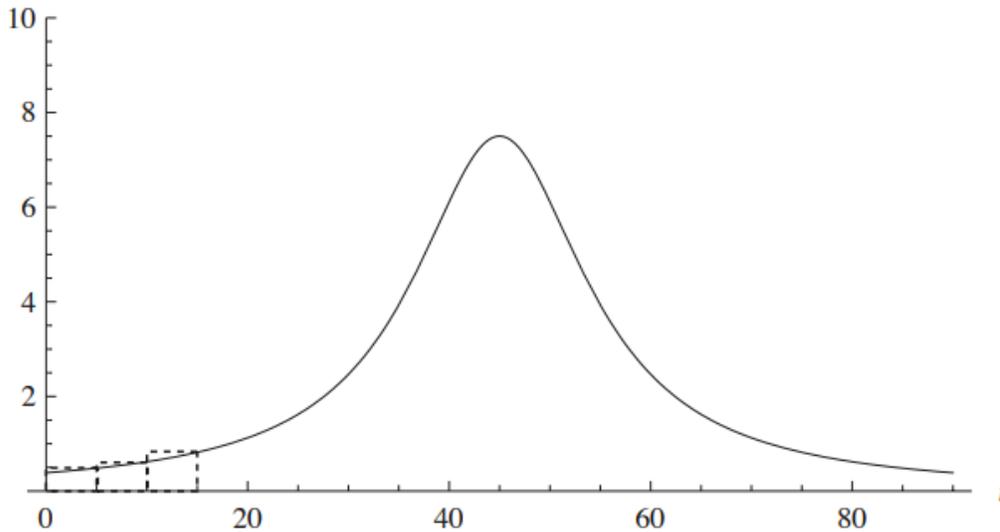
to simplify, solve  $\frac{d}{dt} \left[\frac{2(t-45)}{21}\right]$  with quotient rule to obtain  $\frac{2}{21}$  and then multiply it with  $\frac{1654}{21}$  to get

$$\frac{3308}{441} * \frac{1}{1 + \left(\frac{2(t-45)}{21}\right)^2}$$

the last step is distributing the exponent on the denominator and multiply; we found our derivative  $R(t)$  to be

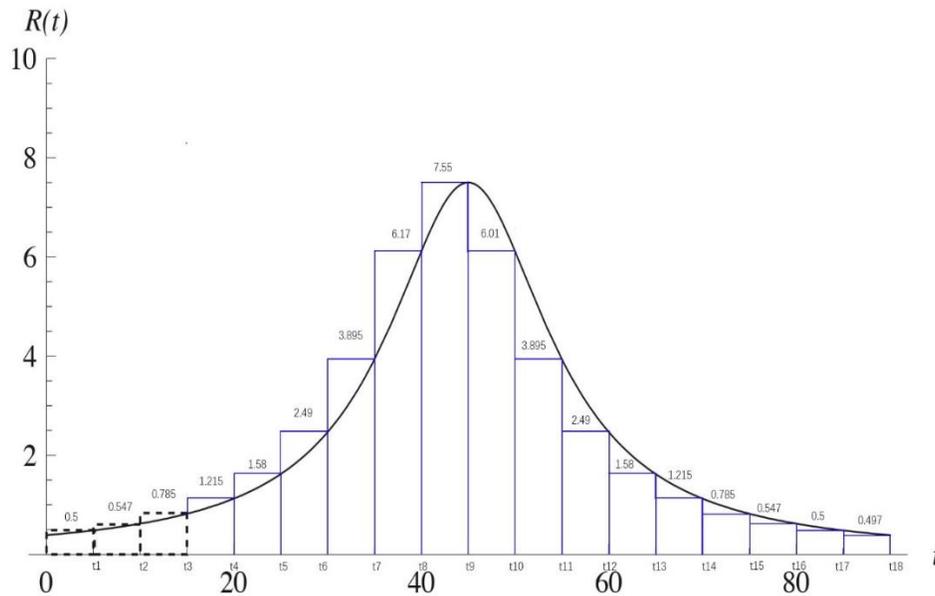
$$\frac{3308}{441 + 4(t-45)^2}$$

Below is the graph of function  $R(t)$



- Note that we have dashed in few rectangles over each of the first three intervals of length 5, on the above  $t$  axis, with the height of each rectangle bring the value of  $R(t)$  at the right endpoint of the interval in question. Those rectangles drawn are a method of approximating the area under the curve  $R(t)$ . This method will lead us to the second main branch of the calculus, the integral calculus. Integral calculus is entirely the opposite of the differential calculus; instead of focusing on the slope of the curve (one degree lower than the original function), integral calculus focuses on the area under the curve (one degree higher than the original function).

However, dashing rectangles is not the best way to approximate the area under the curve. The method of dashing in rectangles is called the "method of exhaustion." Indicated by its name, this method is exhausting. Rectangles have to be drawn for the entire graph to estimate the area. The accuracy of method of exhaustion mainly depends on the numbers of the rectangles and partially on where the rectangles touch the graph. The three points commonly picked are left endpoints, right endpoints, and midpoints. First, decide where the rectangles should touch the graph; typically, the midpoint will be a better approximation. However, at least three points mentioned before should be tested for accuracy. Then repeat the process of drawing rectangles, probably hundreds of rectangles if accuracy is the primary goal of the estimation. Since in this case, the length of the rectangles is five, and the length of  $t$  axis on the graph of function  $R(t)$  is ninety units long, we will draw the rectangles to explain method of exhaustion.



Now using the right endpoint approximation, the length of the first rectangle can be denoted as  $R(t_1)$  and the width will be 5 as indicated before. So, the area of first rectangle can be expressed as  $A_1 = R(t_1) * 5$ . In general, this formula can be written as  $A_i = 5R(t_i)$ . Adding up all the areas of the rectangles drawn above results in

$$T = \sum_{i=1}^{18} A_i$$

Adding up the area of eighteen rectangles will provide an approximation of the area under the curve  $R(t)$  can be called as  $T(t_0)$ . We can now compute  $T(20)$ ,  $T(40)$ ,  $T(60)$ ,  $T(80)$ , and  $T(90)$  using the area of the rectangles and add them up.

$$T(20) = A_1 + A_2 + A_3 + A_4 = ((0.5 * 5) + (0.547 * 5) + (0.785 * 5) + (1.215 * 5)) \\ = 15.235$$

$$T(40) = A_5 + A_6 + A_7 + A_8 + T(20) = ((1.58 * 5) + (2.49 * 5) + (3.895 * 5) + \\ (6.17 * 5) + 15.235) = 85.91$$

$$T(60) = ((7.55 * 5) + (6.01 * 5) + (3.895 * 5) + (2.49 * 5) + 85.91) = 185.635$$

$$T(80) = ((1.58 * 5) + (1.215 * 5) + (0.785 * 5) + (0.547 * 5) + 185.635) = 206.27$$

$$T(90) = ((0.5 * 5) + (0.497 * 5) + 206.27) = 211.255$$

Note the area approximated is 211.255-unit squares.

Trace back to the original graph  $D(t)$ ,

$$D(20) = 13.263$$

$$D(40) = 70.661$$

$$D(60) = 181.281$$

$$D(80) = 206.427$$

$$D(90) = 211.328$$

- As we can see from the data listed above,  $T(t)$  starts off higher than the corresponding value of  $D(t)$  because in the first half of the graph, we are overestimating the area. Later,  $D(t)$  catch up, because as soon as we hit day 45, the rectangles drawn afterward were estimated less than the actual areas under the curve. We found that right endpoint approximation provided an area of 211.255-unit squares from the method of exhaustion, which is 0.03 percent error from  $D(90)$ . This can be considered a very good approximation.

Instead of drawing finite rectangles and struggling with deciding where the rectangle should touch the graph and getting a rough approximation, method of exhaustion is formalized a German mathematician, Bernhard Riemann. He integrates the limit concept of calculus into the method of exhaustion.

$$\lim_{n \rightarrow \infty} \sum_{i=1}^n f(x_i) \Delta x$$

Where  $\Delta x = \frac{b-a}{n}$ . By taking a limit, the number of rectangles now is approaching the infinity. The point on rectangles that touch the graph is no longer important since the rectangles' length is approaching zero. From the part 2 of the Fundamental Theorem of

Calculus, we can convert  $\lim_{n \rightarrow \infty} \sum_{i=1}^n f(x_i)$  to a definite integral  $\int_a^b f(x)$ ,  $\Delta x$  will become  $dx$ , which is simply

$$\int_a^b f(x) dx$$

We can now take an integral to reverse the differentiation.

$$\int \frac{3308}{441 + 4(t - 45)^2} dt$$

Because the numbers of rectangles drawn are approaching infinity, integral will return a much better approximation than approximating with finite number of rectangles. Integral is considered as the exact area because when drawing infinity many rectangles, the error can be ignored. In our case, reverse the process differentiating function  $R(t)$ , we will get

$$\frac{1654}{21} \left( \arctan \left( \frac{2(t - 45)}{21} \right) \right) + C$$

where  $C = \arctan \left( \frac{30}{7} \right)$ . The result we found is exact to  $D(t)$  but represented different meanings. The function above represented area under the curve  $R(t)$ . Because the function obtained is exact to  $D(t)$ , to plug in 90 will return a value of 211.328. It means the exact area under the curve  $R(t)$  is equal to 211.328-unit squares, which is corresponding to value  $D(90)$ .

This example verified an important theorem in calculus known as the first part of the Fundamental Theorem of Calculus:  $F'(x) = f(x)$ . Stating that the derivative and integral are inverse of each other. Strang wrote, "[Fundamental Theorem of Calculus] establishes the relationship between differentiation and integration" (Strang et al., 1991) It bounded differential calculus and integral calculus as a whole. Without the Fundamental Theorem of Calculus, there will be no connection between differential calculus and integral calculus can be considered as two separate topics in mathematics. The second part of the Fundamental Theorem of Calculus also known as the evaluation theorem, made computing the area under the curve much easier by taking an integral rather than compute the Riemann Sum every time. From the Fundamental Theorem of Calculus, we can connect the mathematical module  $D(t)$  to  $R(t)$  and find the area underneath. It made analyzing the data more convincing and relative, so that can be understood better to estimate the trend of the diseases.

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## Sabiduría Staff

“The future belongs to those who believe in the beauty of their dreams.”

--Eleanor Roosevelt, First Lady of the United States (FLOTUS) 1933 – 1945

### ERIN BERISH



Erin Berish graduated from Dr. Floyd F. Koch Honors college at Palm Beach State College in spring of 2021 with her Associate Degree. Miss Berish is currently attending Florida International University, where she is an esteemed member of the Florida International University Honors College. She is continuing her passion of English Literature and is also pursuing a certificate in the Exile Studies program within the FIU English Department as well as a minor in history. During her academic career she has maintained a high GPA and has become a member of Phi Theta Kappa National Honor Society and The National Society of Collegiate Scholars. As she is approaching her senior year at FIU, Erin Berish plans to further her academic career by going to graduate school. There she plans to receive her master's degree in either Literature or History and is interested in the future to work as a historian and historical writer.

### ALLISON AST



Currently a sophomore at PBSC, Allison first started her academic journey in September of 2020 and is in progress of working towards an AA Degree in Biology focusing on the pre-med track. Ms. Ast is proud to be an active member of the Dr. Floyd F. Koch Honors College at Palm Beach State College pursuing the gold track diploma and the SSS Trio program. She loves to stay involved in campus culture and is a member of the following clubs, respectively; Phi Theta Kappa National Honor Society, Medical Professions Association Club, Students for International Understanding Club and holds the position of co-president of Rotaract Club. Allison intends to transfer to UMiami and go above and beyond academically to achieve her dream career as an oncologist surgeon.