SRO: Student Showcase

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About the SRO: Student Showcase

The *SRO: Student Showcase* presents research papers and literature reviews as well as graphic representations, data analysis, and abstracts.

It is hoped that by presenting this special issue the scholarship on display will reach a wider specialist and non-specialist audience and generate feedback and a scholarly profile for the authors. Every paper in this collection has gone through a rigorous internal review process.

SCHOLARLY REVIEW ONLINE

TABLE OF CONTENTS

How Angel Investors Identify Startups with Potential for Success

By George Jamieson

AUTHOR BIO

George Jamieson is a student at Glynn Academy High School in Brunswick Georgia. A native of nearby St. Simons Island, Jamieson attended his local Catholic middle school, and is active at his home church of St. Williams. His interests include: politics, business, finance, architecture, and music. Outside of school, Jamieson plays the violin in the local youth Philharmonic Orchestra as well as the Chamber Ensemble. He is also active in Model UN, Boy Scouts of America, and the United Community Bank Jr. Board of Directors. In his spare time, Jamieson enjoys reading, following politics, taking piano lessons, and playing golf with friends or family.

ABSTRACT

This paper serves as a reference to prospective angel investors looking to find a way to get started in investing in their first start-ups. Identifying start-ups with greater potential for growth than others is the focus and identifying factors that allow companies to grow and survive are articulated in this paper. Since a large percentage of companies fail within the first several years, being able to select companies with greater chances than others to succeed is crucial to potential investors.

Keywords: Angel Investing, Startups, Business, Business Competitiveness.

INTRODUCTION

Within the first five years of starting, 45% of companies will fail (Deane, 2022, as cited from the Bureau of Labor Statistics, 2022). Given these high rates of non-success, identifying companies with higher potential than others for growth is crucial to success in investing during the due diligence phase. This is especially true when such companies are in seed-stage development and before they become well-known to the market and competing investors. In the following essay, identifying start-ups that are less likely to fail is the focus, as well as how to learn the early signs and infrastructure for success. Market compatibility, a well-constructed business and financial plan, and a functional and expertly assembled team are all factors that are to be considered when future angel investors are looking to support start-ups.

Correct Product-Market Fit

The ability of a product or service that a company is selling to match what is in demand in the market is absolutely essential to company growth. When considering investing in a company, one needs to be sure the product is compatible with the market. Selling anything that the market has no need for, is already oversaturated with, or is indifferent to is not a winning business strategy.

Need, or demand for a product is of utmost importance when deciding whether or not the company that produces this product will stay afloat. For it to succeed, the product must fill a gap that is not effectively covered by any other product. The market must have need for it in certain applications to the point where buying it makes their life easier, or more luxurious depending on what the product is. According to the International Trade Administration, per capita income of the market will determine its

ability to pay for the product being sold; however, this can be overcome in certain circumstances of exceptionally high demand such as in specific status or luxury goods that elevate the perceived rank of individuals (Export Pricing Strategy, n.d.). This means that unless the product elevates the customer's status, it should be priced according to his or her economic situation, which should be calculated during the evaluation of that individual market's average income.

Oversaturation of a product in a market mostly guarantees that a new rendition of a similar product that is put into the market will fail. The companies that any given business is competing with have already established deep roots and allowed their product to develop a reputation and certain recognition. Competing with established companies is very difficult, as the product in question must stand out to the point where it is set apart and given separate attention by advertisers and other later investors who will get the company moving. As stated earlier, the product must fill a gap in the market, and not serve the same function as too many others of its kind. Unless the product is really truly excellent for its price, and the company heads are very competent and well-versed in competing with other companies, steering clear of investing in companies that are vying to compete with other more established ones from the beginning is advised to prospective investors.

Identifying the correct market at which to advertise is equally important, as different products will have differing levels of appeal on different demographics. For example, one should not advertise lawnmowers in cities, as the people who live there will have no need for them, but the people in suburbs will, as will those living in exurbs outside the city. Furthermore, engagement rings should not be marketed towards retirees, as they are past the stage of marriage in their lives. Selecting a

market, or a niche within a larger market is necessary for the company to effectively advertise and further cultivate its product. One way to identify the market to which the product will appeal is to see to whom similar competitors are advertising. Alternatively, researchers have said that testing the product on focus groups is a good way to discover what kinds of people are interested in the product, and even going as far as to tweak it to their needs (Stewart, 2014).

A Well-constructed Business and Financial Plan

Financial responsibility coupled with a solid outline of the business plan will lead to a higher chance of success for companies. Together, they are essential factors for investors to consider when looking to support start-ups. When companies are starting out, having both a long term financial plan and set but malleable business goals and pivots are vital components of early companies to analyze when looking to invest as an angel investor.

The creation of a budgeted, cash management plan opens the window for the company to establish future goals with relation to new products or improvements to existing ones. The process of business budgeting is the preparing and overseeing of a financial document that estimates income and expenses for a period, and "at its core, budgeting's primary function is to ensure an organization has enough resources to meet its goals" (Cote, 2022). Once money has been allocated to a certain area of the business, the future profit margins can be estimated with varying accuracy, and new extensions of the business plan can be cultivated. A good investor must look for this kind of planning in advance if he or she is looking to potentially devote resources to the growth of this company.

Having long term business goals in place allows the company to survive in the ever-changing economy where no product lasts forever. Planning into the future ensures that the company has something to pivot on when its leading products start to reach the end of their life-cycle. This also allows the business to know where to allocate resources for future projects that will need substantial funding. However, companies should leave room for unexpected market occurrences in which they will need to adapt and veer off-plan. According to Harvard Business Review, becoming "future ready" means "scaling up capabilities relevant to future competition." Additionally, "a company must make regular shifts in its know-how in order to stay ahead of competitors over the long run" (Yu et al., 2022). This means that successful companies, while having future plans, also are able to adapt to changing business environments.

A Functional and Expertly Assembled Team

For angel investors undergoing due diligence, analyzing the capabilities of those within the company is a process that should not be neglected. Competent leadership coupled with quality intra-company cooperation and domain expertise are key elements that future investors must consider before undergoing the process of angel investing.

Knowledge in the area in which the company is operating must be abundant amongst the key members of the team. Domain expertise, as this is called, is critical for the survival of a start-up. The members of a business team must have a " thorough understanding of a particular field of study" (Wallin & Baltaxe, 2020, p. 45). Thorough comprehension of the field within which the company is operating is something that must be held by functioning members of a business. This is acquired through experience in operating in the area that company seeks to cement itself.

Intra-company communication and cooperation are equally essential to an effective business team, as it allows good relations to foster among them, but also with stakeholders, employees, and advertisers. According to Wallin and Baltaxe (2020), when looking to invest in a company, seeing if any of the members of the team have worked together before, or have prior business or personal relationships with one another is a factor that should be considered, as people who work well together within a company hugely increases the chances of success (p. 52).

Conclusion

Angel investing is a timely process requiring copious due diligence and research. In spite of this, most will fail. Prospective angel investors are usually unaware of the sheer amount of work that goes into deciding which companies to invest in. When selecting a company to financially support, investors have quite a lot of due diligence to delve into. Furthermore, product-market compatibility, a well constructed business and financial plan, and a functional and expertly assembled team are chief considerations when looking to invest in potential companies.

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The Effect on Athletes' Performance of Selecting Lanes in the 200m Dash

By Youyi Ding

AUTHOR BIO

ABSTRACT

During the 200 meter dash in the sport of track and field, the first 100 meters of the race are run on a curve and the second half in a straight line. Since each athlete has to stay in their own lane throughout the race, athletes in higher lanes will start ahead in a staggered pattern, so each athlete runs the same distance. A common myth in the world of track and field is that the middle lanes are the best because biomechanics tells us that there is a physical disadvantage to an inside lane because the curve is run at a tighter angle and many believe there is a disadvantage to the outside lane because you are unable able to see the other competitors race and gauge yourself. However, this study found that contrary to common belief, the outside lanes are the best and provide a notable advantage when compared to other lanes in the 200 meters. Future studies should examine why the outside lanes provide an advantage compared to other lanes, including both mental and physical factors.

Keywords: Athletics, data, race angle, advantage.

INTRODUCTION

In the sport of track and field, during sprinting events, the 100 meter dash, the 200 meter dash, and the 400 meter dash, and even the 800 meter race for the first 100 meters, an athlete is assigned a lane at the start of the race. Other than the 100 meter dash, all the other races start on a curve. In order to make sure all the athletes are running the same distance, athletes on the outer lanes will start a little bit in front in a staggered formation.

However, because the athletes are running the curve at different degrees, the question of whether the angle of the curve impacts an athlete's performance in the 200 meter dash rises. In this paper, an athlete's best time during the season (SB) will be compared to how fast they ran at the World Championships and what lane they ran in.

Background

In track and field, the 100 meters is run in a straight line for the entire race, where each athlete remains in their own lane. However, in the 200 meters, the first 100 meters of the race are run on a curve. Then, the second 100 meters of the race are run on a straightaway. In order to guarantee athletes actually runs the same distance, as an athlete in lane 8 would be running more than an athlete in lane 1, the athletes in the outside lanes would start further up ahead of the inside lanes in a staggered pattern. Thus, athletes in higher lanes would run the curve at a less sharp angle than other athletes, but would not be able to see any athletes unless they are getting passed. (Chadwick, 2009)

In the world of track and field, it is a common held belief that the middle lanes are the best lanes to race in. This is because researchers studying biomechanics found that running on an inside lane can slow the athlete down because the curve is much tighter compared to an outside lane. (Churchill et al, 2019). Many believe the outside lanes are a disadvantage to athletes because the athlete won't be able to see anyone throughout the entire race to gauge their own speed unless the athlete is getting passed.

The sport of track and field is competed by countries around the world. When the athletes compete in the World Championships each year, and the Olympics every four years, the athletes are representing not only themselves, but also the people who are supporting them, and the country they are running and representing for. If lane numbers or other factors provide an unfair advantage to certain athletes, then the rules, regulations, and standards need to be changed in the spirit of fair competition for all athletes.

Methods

The data being used are the results of the World Championships from 2000 to 2019 and collected by David Munro, "Are there lane advantages in track and field?". The data being used is only from the first round of the 100 meter and 200 meter dash because athletes in later rounds will be assigned lanes based on their time instead of at random. Thus, to eliminate the possibility of an athlete running faster because the athlete is more talented, the study will only be using the data from the first round when lane assignments are assigned at random.

Once the data is opened, an excel file was created to store the lane number the athlete ran in, the athlete's SB in that season, what the athlete's racetime was, and what the difference was between the athlete's SB and what the athlete ran (DIFF). In order to delete any outliers, athletes that were in the dataset, but disqualified from the actual race were removed as their difference would be around 20 seconds

and skew the data. This procedure was done for both the 200 meter dash and the 100 meter dash.

Using the R programming language and RStudio, Analysis of Variance (ANOVA) models were generated to compare the DIFF with the lanes in the 200 meter dash. Then, the same ANOVA model was used on the 100 meter dash. The lane numbers will be represented using letters instead of numbers because of the way the ANOVA model takes in numbers as the independent variable. Hence, A will be lane 1, B will be lane 2, and so on.

Results

Table 1. Summary of the 100 Meter Dash Generated by *ggplot2()*

	Df	Sum Sq	Mean Sq	F value
Lanes	8	0.34	0.04216	0.801
Residuals	1608	84.61	0.05262	

Table 2. Multiple Comparisons of Means with 95% Family-wise Confidence Level Generated by *TukeyHSD()* of the 100 Meter Dash

	DIFF	Lwr	Upr	
B-A	0.0046431322	-0.07859722	0.08788348	
C-A	0.0236750458	-0.05986078	0.10721087	
D-A	0.0318952429	-0.05113031	0.11492079	
E-A	0.0158129479	-0.06686688	0.09849278	0.9996384
F-A	-0.0007058534	-0.08331831	0.08190660	1.0000000
G-A	-0.0034688995	-0.08642410	0.07948630	1.0000000
H-A	0.0299176788	-0.05408196	0.11391732	0.9734023
I-A	-0.0173139746	-0.13222607	0.09759812	0.9999403
C-B	0.0190319136	-0.05169032	0.08975415	0.9957729
D-B	0.0272521107	-0.04286667	0.09737089	0.9550843
E-B	0.0111698156	-0.05853926	0.08087889	0.9999045
F-B	-0.0053489856	-0.07497814	0.06428017	0.9999997
G-B	-0.0081120317	-0.07814750	0.06192343	0.9999922
H-B	0.0252745466	-0.04599495	0.09654404	0.9740992
I-B	-0.0219571068	-0.12792026	0.08400605	0.9993462
D-C	0.0082201971	-0.06224909	0.07868949	0.9999917
E-C	-0.0078620980	-0.07792373	0.06219954	0.9999939
F-C	-0.0243808992	-0.09436301	0.04560122	0.9768011
G-C	-0.0271439453	-0.09753033	0.04324244	0.9570860
H-C	0.0062426330	-0.06537174	0.07785700	0.9999992

I-C	-0.0409890204	-0.14718444	0.06520640
E-D	-0.0160822951	-0.08553473	0.05337014
F-D	-0.0326010963	-0.10197332	0.03677112
G-D	-0.0353641424	-0.10514417	0.03441589
H-D	-0.0019775641	-0.07299906	0.06904093
I-D	-0.0492092175	-0.15500371	0.05658528
F-E	-0.0165188013	-0.08547688	0.05243928
G-E	-0.0192818474	-0.08865017	0.05008648
H-E	0.0141047309	-0.05650928	0.08471875
I-E	-0.0331269225	-0.13865032	0.07239648
G-F	-0.0027630461	-0.07205105	0.06652496
H-F	0.0306235322	-0.03991158	0.10115865
I-F	-0.0166081212	-0.12207874	0.08886250
H-G	0.0333865783	-0.03754966	0.10432282
I-G	-0.0138450751	-0.11958437	0.09189422
I-H	-0.0472316534	-0.15379231	0.05932900

Table 3. Summary of the 200 Meter Dash Generated by *ggplot2()*

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Lanes	8	3.25	0.4067	2.138	0.0296 *
Residuals	1635	310.97	0.1902		

Table 4. Multiple Comparisons of Means with 95% Family-wise Confidence Level Generated by *TukeyHSD()* of the 200 Meter Dash

	DIFF	Lwr	Upr	p adj
B-A	0.027909408	-0.1531386	0.208957419	0.9999289
C-A	-0.009005340	-0.1890108	0.171000147	1.0000000
D-A	-0.019973788	-0.1995418	0.159594192	0.9999943
E-A	-0.024058442	-0.2034132	0.155296365	0.9999755
F-A	-0.058843854	-0.2387385	0.121050831	0.9844364
G-A	-0.066441678	-0.2460097	0.113126303	0.9664552
H-A	-0.108818425	-0.2888239	0.071187063	0.6294199
I-A	-0.137142857	-0.3672552	0.092969467	0.6477208
C-B	-0.036914748	-0.1692924	0.095462910	0.9946031
D-B	-0.047883195	-0.1796653	0.083898929	0.9699479
E-B	-0.051967849	-0.1834594	0.079523655	0.9505066

F-B	-0.086753261	-0.2189802	0.045473689
G-B	-0.094351085	-0.2261332	0.037431039
H-B	-0.136727832	-0.2691055	-0.004350174
I-B	-0.165052265	-0.3601767	0.030072185
D-C	-0.010968447	-0.1413146	0.119377712
E-C	-0.015053101	-0.1451054	0.114999229
F-C	-0.049838513	-0.1806344	0.080957356
G-C	-0.057436337	-0.1877825	0.072909822
H-C	-0.099813084	-0.2307613	0.031135139
I-C	-0.128137517	-0.3222950	0.066020006
E-D	-0.004084654	-0.1335308	0.125361445
F-D	-0.038870066	-0.1690632	0.091323035
G-D	-0.046467890	-0.1762092	0.083273411
H-D	-0.088844637	-0.2191908	0.041501522
I-D	-0.117169069	-0.3109210	0.076582905
F-E	-0.034785412	-0.1646843	0.095113513
G-E	-0.042383236	-0.1718293	0.087062863

H-E	-0.084759983	-0.2148123	0.045292347	0.5264721
I-E	-0.113084416	-0.3066388	0.080470008	0.6724937
G-F	-0.007597824	-0.1377909	0.122595277	1.0000000
H-F	-0.049974571	-0.1807704	0.080821298	0.9593746
I-F	-0.078299003	-0.2723538	0.115755798	0.9442671
H-G	-0.042376747	-0.1727229	0.087969412	0.9850362
I-G	-0.070701180	-0.2644532	0.123050795	0.9691577
I-H	-0.028324433	-0.2224820	0.165833090	0.9999534

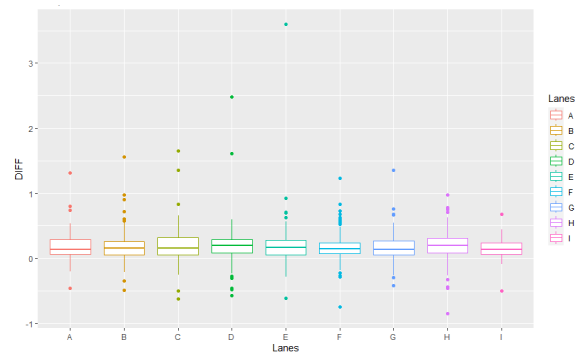Figure 1. Boxplot of DIFF vs Lanes in the 100 Meter Dash

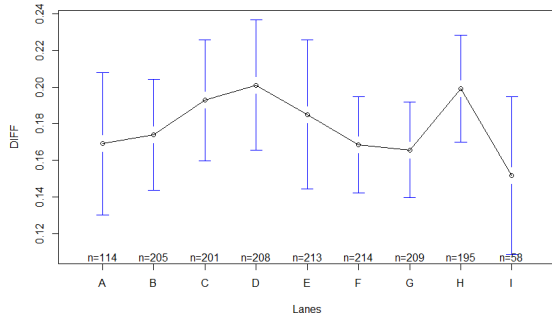Figure 2. Mean Plot with 95% Confidence Interval in 100 Meter Dash

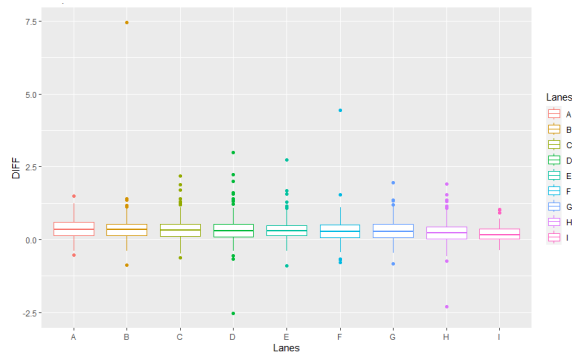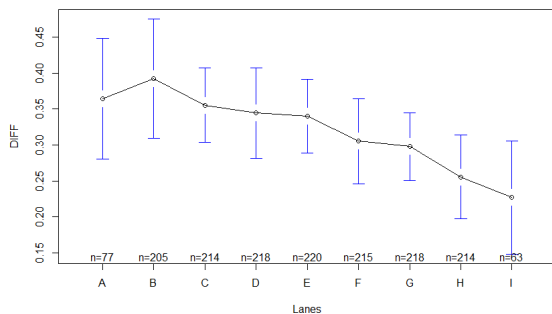Figure 3. Boxplot of DIFF vs Lanes in the 200 Meter Dash

Figure 4. Mean Plot with 95% Confidence Interval in 100 Meter Dash

Definitions

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

DF: Degrees of freedom in the source.

Sum Sq: Sum of squares due to the source.
Mean Sq: Mean sum of squares due to the source.
F value: the *F* Statistic
Pr(>F): the *p* value.
SB: Athlete's fastest race time before World Championships meet.
DIFF: Athlete's SB subtracted from World Championships race time.
Lwr: Lower end point of the interval.
Upr: Upper end point of the interval.
p adj: *p* value after adjustment for multiple comparisons.
n: Number of datapoints.
Signif: Significant
ANOVA: Analysis of Variance

Discussion

Examining the results, there is no significant correlation between the lane number and the athlete's performance in the 100 meter dash. Looking at the summary generated by *ggplot2()* in Table 1, there is no significance in the 100 meter dash as the *p* value generated is 0.601, which is much greater than 0.05. Thus, there is no strong correlation between the lane number and the athlete's performance in the 100 meter dash. This can be further proven in Figure 1 and Figure 2 as there is no apparent correlation between the lane number and the DIFF.

Looking at the 200 meter dash, we can observe a correlation between the lane number and the athlete's performance. Using *ggplot2()*, Table 3 shows the *p* value is 0.0296, which is indeed less than 0.05 and is significant. Then, using *TukeyHSD()*, the *p* value is 0.0367078 at H-B in Table 4, which means there is a significant difference between lane 2 and lane 8 as the *p* value is less than 0.5. It is however interesting to note that H-B is the only significant difference out of all the possible comparisons. However, a clear negative correlation between lanes and DIFF is shown in

Figure 4, where lane 1 has the greatest DIFF and lane 9 has the smallest DIFF.

The results of this study supports the work done by Munro, Chadwick, Churchill et al. The data shows that the lane number does not affect the 100 meter dash because there is no significant correlation as the athletes are all running in a straight line. However, there is a significant correlation in the 200 meter dash as there is a strong correlation where the outer lanes give athletes an advantage compared to the inside lanes.

Conclusion

This study is the first time an ANOVA model has been used to compare the difference between an athlete's SB and their racetime against the lane number they ran in for that race. It is noteworthy to note that the athlete's lane number for their SB before the World Championships were not considered in this study.

Future studies should be done to examine how lane numbers affect athlete's performance whether there is an advantage for athletes physically or mentally in some lanes compared to others. If future studies continue to prove lane assignments give some athletes an unfair advantage compared to other athletes, then in the spirit of fair competition, the rules and standards of track and field need to be adjusted in order to give every athlete a fair opportunity.

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SCHOLARLY REVIEW ONLINE

Gentrification and the Displacement of Minorities: Urban Citizenship

By Inchara Hosanagar

AUTHOR BIO

Inchara Hosanagar is a student at Newark Academy in Livingston, New Jersey. She is currently Captain of the Women's Varsity Fencing Team, and she is the president of the Pop-Up Book Club, vice president of the Cancer Awareness Club, and she is the grade appointed member of the Equity & Inclusion Team as well as the Community Service Council at Newark Academy. Apart from school, Inchara has a deep passion and interest in the STEM field where she spends time on ongoing research projects and internships. Inchara, while being a full-time high school student, attempts to gain more insight and depth of understanding in the STEM fields.

ABSTRACT

This paper explores gentrification and questions of inequality. While minority communities have long been segregated and treated unfairly, gentrification has brought these inequalities to the forefront. The disparity between minority groups and their wealthier, white counterparts grows as gentrification continues to displace them into neglected areas. Rising housing costs reduce the supply of affordable housing, preventing them from benefiting from the economic growth and increased availability of services that come with increased investment. Communities attempting to achieve economic revitalization without the disruption that displacement brings face a challenge from gentrification.

Keywords: Gentrification, Displacement, Minorities, Economic Revitalization.

INTRODUCTION

Historically, cultural differences have divided American society, allowing minorities to be denied resources due to their geographic location. While minority communities have long been segregated and treated unfairly, gentrification has brought these inequalities to the forefront. The disparity between minority groups and their wealthier, white counterparts grows as gentrification continues to displace them into neglected areas. Existing residents, many of whom are minorities, are displaced as rising housing costs reduce the supply of affordable housing, preventing them from benefiting from the economic growth and increased availability of services that come with increased investment. Communities attempting to achieve economic revitalization without the disruption that displacement brings face a challenge from gentrification.

Gentrification

Gentrification has a long history in the U.S. because it excludes many minority groups and maintains the traditional social hierarchy along urban-rural lines. However, as racial categories have come to take on new meanings under new economic conditions, the perception of gentrification has shifted over time. Redlining and racial covenants have prevented Black families from renting or purchasing homes in certain neighborhoods for decades, particularly during the Jim Crow era. This contributed to the formation of densely populated, impoverished communities of color across the U.S. Gentrification has evolved since then, and minority communities have become prime targets for property speculators, though it has taken on a more subtle form as a result of laws prohibiting explicit segregation. As a result, gentrification calls into question the concept of urban citizenship, which can be defined as a citizen's relationship with urban spaces and their

individual or collective engagement within them. Although some may argue that the positive effects of gentrification outweigh the negative, its use in urban policy to displace minority communities culturally and physically undermines the fundamental basis of citizenship—specifically urban citizenship—to a greater extent.

Many of the contributing factors to gentrification stem from the complexity of different social standings, as exemplified by racial redlining, which allows for the further displacement of minorities, highlighting the history of urban revitalization. As the importance of cities grew in the 1900s, banks and the stock market began to fail, resulting in the Great Depression. Franklin D. Roosevelt created a series of emergency relief programs in response to the Great Depression, one of which was the Home Owners' Loan Corporation (HOLC). Many people of color were offended by the HOLC's decision to map most of the neighborhoods and label many of them as "hazardous" in red ink: racial redlining.[1] It's no coincidence that many of these communities were mostly made up of people of color. The HOLC would assist homeowners with mortgages by lending low-interest money to refinance existing mortgages and by originating new mortgages. Many people of color were denied access to federal emergency funds because of maps labeling communities of color as "hazardous," although they were just as affected as white people by the Great Depression. This prompted gentrification because it resulted in higher living costs and amenities that weren't equally available to all residents. Historically redlined areas frequently have a "rent gap," or the difference between the property's potential value and current housing

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[1] Neilson Voyne Smith, *The New Urban Frontier: Gentrification and the Revanchist City* (London, New York: Routledge, 2005). 15.

prices.[2] Urban housing's prime location, combined with historical underinvestment and low rent prices, makes it appealing to young professionals, developers, and investors looking to profit from the gap in property values. In San Francisco, 87% of gentrifying neighborhoods were previously designated as "hazardous."[3] The HOLC's discussion of racial redlining relates to urban citizenship because many minorities have been denied equal resources in comparison to other groups of people solely because of where they live.

While Ruth Glass, a British sociologist, coined the term "gentrification" in 1964, gentrification patterns can be traced back to urbanization and the development of suburbs during the Great Migration in the U.S.[4] Due to a decrease in the demand for agricultural labor, urbanization resulted in a population shift from rural to urban areas, primarily farmers moving to cities.[5] Similar aspects of urbanization can be applied to gentrification, such as pollution, poor public health, and limited access to resources that were only available to wealthy white men. As a result of their social status, many minority communities lacked adequate resources. Minorities gathered in ethnic clusters in the early 1900s, but their resources were often insufficient in comparison to their white counterparts.[6] As a result of the sudden increase in population in urban areas, gentrification emerged as a concept in which systemic racism allowed minority communities to have fewer opportunities than new farmers, eventually leading to their forced displacement. Because white farmers would be given more opportunities than people of color, urbanization justified the disparity between white and minority communities. The physical displacement of the lower, working-class during urbanization is linked to the concept of urban citizenship because it acted as an accelerator for the shift in community diversity, allowing ethnic groups to be forced out. The Great Migration was the movement of six million African Americans from rural Southern America to urban areas in the Northeast, Midwest, and West between 1916 and 1970.[7] In response, there was a sudden exodus of white people from urban areas to suburban areas, motivated by economic and racist ideologies. [8]The growing popularity of suburbs, which were off-limits to most minority homebuyers due to many racist obstacles such as racial redlining, was due to newly developed transportation systems and a booming postwar economy.[9] The Great Migration resulted in gentrification as a result of racial hierarchy, allowing white people to flee cities as they became more integrated, allowing suburbia to become safer and more resourced. Ethnic groups didn't have "unalienable rights," as their right to life and the pursuit of happiness was severely limited as a result of historically racist ideologies and subsequent displacement.[10] Urbanization, racial redlining, and the Great Migration are some of the causes of

[2] Ph.D. Hannah De los Santos, "From Redlining to Gentrification: The Policy of the Past That Affects Health Outcomes Today," Primary Care Review, May 26, 2021, http://info.primarycare.hms.harvard.edu/review/redlining-gentrification-health-outcomes.

[3] Francis Pearman, "Gentrification and Academic Achievement: A Review of Recent Research," Review of Educational Research, October 13, 2018, https://journals.sagepub.com/doi/10.3102/0034654318805924.

[4] Smith, *"The New Urban Frontier: Gentrification and the Revanchist City"*, 22.

[5] Francis Pearman, "Gentrification and Academic Achievement: A Review of Recent Research".

[6] Francis Pearman, "Gentrification and Academic Achievement: A Review of Recent Research".

[7] Smith, *"The New Urban Frontier: Gentrification and the Revanchist City"*, 126.

[8] De los Santos, "From Redlining to Gentrification: The Policy of the Past That Affects Health Outcomes Today".

[9] Smith, *"The New Urban Frontier: Gentrification and the Revanchist City"*, 126.

[10] Smith, *"The New Urban Frontier: Gentrification and the Revanchist City"*, 126

gentrification because they allowed for the forced displacement of people through the use of racial hierarchy and racist ideologies.

During gentrification, poorer minority neighborhoods are frequently converted to high-end communities with expensive housing options such as high-rises, causing physical displacement of minorities and challenging minorities' basic rights. As property values rise, the neighborhood's original residents are pushed out in a variety of ways. First, as building prices rise, the gap between the price of the building and the income the landlord receives from renting the building widens, resulting in higher rent prices and the physical displacement of low-income minority residents.[11] Ordinary living spaces are converted to luxury buildings due to the potential for large profits, which means that landlords purposefully displace minority residents to convert these areas into areas that are perceived to be nicer. Developers also attract new residents with higher incomes because of the improved services and amenities that many minority communities lack. The influx of these new, wealthier residents puts pressure on the housing market, resulting in inflated rents and prices, effectively displacing low-income residents. For example, a corporation in New York's Chinatown applied for a special zoning permit to build an apartment on a plot with rent-control housing, and the developer had already evicted many Chinese tenants before the city decided whether to issue the permit.[12] Residents claimed that the corporation forced them out of the building by depriving them of services, harassing them, intimidating them with gangs, and setting fire to it.[13] This is related to citizenship because low-income people of color are disproportionately affected by displacement.

Many minorities are being forced out of their neighborhoods due to rising costs, resulting in fewer community networks, which encourages these citizens to move elsewhere. Citizens have the right to equal access to community resources; however, many high-income groups now have the power to shape city policy to protect themselves from further gentrification as a result of forced displacement.

People with higher economic status have more power and resources than low-income minority residents because they deny them their fundamental rights to equal access to opportunities and to live freely. For example, according to a newspaper article written by M.P. McQueen in New York Newsday, the protesters featured in the article are members of the Association of Community Organizations for Reform Now, a network of community-based organizations that advocates for low- and moderate-income families led by minorities.[14] The city believed that a variety of projects, such as residential neighborhood renovations and the development of major commercial strips, would reduce crime, increase job opportunities, and improve overall neighborhood safety.[15] Instead, gentrification forced many lower-income residents to relocate due to rising housing costs. The article demonstrates how cities promote gentrification by implementing public projects to 'clean' up the city, resulting in the creation of even larger, stronger gentrified areas because of cultural displacement. While the protest was largely unsuccessful, it did create movement, nuance, and conversation between the two groups–the wealthy whites and the poorer minorities–as gentrification would be viewed in two very different ways as poorer communities were forced to relocate due to rising housing costs. As a result of certain social and economic

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[11] Loretta Lees, Tom Slater, and Elvin K. Wyly, *Gentrification* (London; New York: Routledge, 2011). 15.
[12] Lees, Slater, and Wyly, "*Gentrification*", 48.
[13] Lees, Slater, and Wyly, "*Gentrification*", 48.

[14] M.P. McQueen, "Housing's Income Scale Draws Protestors," *New York Newsday*, October 29, 1989.
[15] McQueen, "Housing's Income Scale Draws Protestors," *New York Newsday*.

standings, higher-income residents would physically evict low-income minority residents from neighborhoods and deny them their basic rights as urban citizens, posing a challenge to urban citizenship as many minority communities would be forced out, lowering their engagement in urban spaces.

In addition to physical displacement caused by rising property values and coercive tactics, gentrification can also result in cultural displacement, as low-income people of color are excluded from newly planned spaces in gentrified areas. The urban planning shift from "fostering community formation" to "investing the city with money and consumption-oriented spaces that resemble suburban shopping malls that exclude low-income people of color" is common in gentrification efforts.[16] Rather than community integration, there is selective development and enforcement of boundaries between different areas.[17] Furthermore, when developers construct houses, they do so for high-income white families rather than diverse groups.[18] These spaces call into question the concept of citizenship because they disproportionately exclude people of color by forming communities for wealthy white people. A complex array of private and public actions at the local, regional, state, and federal levels shape the development patterns that lead to gentrification. Minorities' citizenship is challenged as gentrification dismantles and destroys minority communities by forcing them out of their neighborhoods, culturally displacing an ethnic group by specifically building houses for their white counterparts, and discouraging

integration within communities.[19] In this housing market, minorities frequently face severe discrimination, which poses a challenge to urban citizenship as gentrification reconfigures the urban landscape by shrinking residential options for disadvantaged residents while expanding them for more advantaged residents.[20] While rising home values put pressure on low-income minorities, racist ideologies were prevalent, allowing for the cultural displacement of minority groups by excluding people of color and creating spaces designed to push people of color out, ultimately challenging the notion of urban citizenship as racist ideologies were used to perpetuate the belief that gentrified neighborhoods were better.

Many argue that gentrification's benefits outweigh its drawbacks because it promotes development, rapid economic investment, and consumer and entertainment-related projects. An increase in resource allocation to schools, stores, and other developments is directly related to the influx of more affluent residents and people of privilege. For example, a newspaper article titled "New Shopping Hub: Convenience, Quality, and Safety" describes how a new shopping center in New York was opened, and while it was very convenient, it also managed to raise the taxes and rent of the surrounding areas as it attracted many people to the center.[21] Many smaller businesses were forced to close as a result of the shopping mall's construction and their inability to compete with the larger clothing. Many were outraged because it forced poorer families to seek housing elsewhere due to rising costs. Long-term effects of the shopping center led to

[16] Lees, Slater, and Wyly, "*Gentrification*", 272.
[17] Lees, Slater, and Wyly, "*Gentrification*", 272.
[18] Lance M Freeman, "Commentary: 21st Century Gentrification - JSTOR," 2016, https://www.jstor.org/stable/26328278.

[19] Maureen Kennedy and Paul Leonard, "Dealing with Neighborhood Change a Primer on Gentrification- Brookings," 35. https://www.brookings.edu/wp-content/uploads/2016/06/gentrification.pdf.
[20] Smith, *"The New Urban Frontier: Gentrification and the Revanchist City"*, 35.
[21] Bryant Mason, "New Shopping Hub: Convenience, Quality, Safety," *Daily News*, August 11, 1975.

the city developing more gentrified areas by creating more expensive residential neighborhoods, which eventually attracted more people to the urban neighborhood as the borough's overall wealth grew as poorer communities were forced to relocate due to rising costs.[22] The negative effects of gentrification outweigh the positives in terms of urban citizenship, physically and culturally displacing residents through exponentially rising property prices, coercion, or buyouts.[23] Gentrification can be seen as beneficial if the changes are carefully planned with community input and participation and result in greater socioeconomic and racial integration.[24] However, this is rarely the case because higher home values attract affluent families, effectively pushing minorities out. Gentrification's positive effects contribute significantly to the further gentrification of minorities. Furthermore, because of the ramifications of forced displacement of minorities due to increased home values, the negative effects outweigh the positive. As a result, in addition to increased economic investment and home values, there is a growing gap between gentrified and non-gentrified neighborhoods, reflecting systemic inequalities between ethnic groups and their white counterparts.

While some may argue that increased home values and economic investment have had a greater impact on the fundamental basis of citizenship than the forced physical and cultural displacement of minority communities, However, inequities and disparities in gentrified neighborhoods between minorities and their white counterparts directly reflect inequities and disparities in how society views and values white people and people of color, implying that people of color have a moderated citizenship in comparison to white people.[25] While gentrified neighborhoods provide minorities with unequal access to resources, the implications and ramifications of gentrification furthering the cultural and physical displacement of minority communities exemplify how people of color are undervalued and not viewed as equal citizens by society. For example, a study of Census and American Community Survey data in 380 metropolitan areas found that 25% of the neighborhoods were "ascending," meaning their median incomes had doubled, their share of residents with a college degree had increased by 14%, their share of residents working white-collar jobs had increased by 15% and housing costs had doubled.[26] This example demonstrates how gentrification and residential selection are governed by a long-term racial hierarchy. These findings help to explain how neighborhood racial inequality is reproduced during urban transformations and accurately determine how often a neighborhood's rise in economic status corresponded to a drastic change in its racial and ethnic composition.[27] While inequalities between people of color and white people are often abstract and intangible, gentrification, its causes, and its consequences are qualitative measures that convey and evaluate how society views minorities as second-class citizens with limited access to

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[22]Smith, *"The New Urban Frontier: Gentrification and the Revanchist City"*, 158.

[23]Smith, *"The New Urban Frontier: Gentrification and the Revanchist City"*, 158.

[24]Conor Wilson, "Book Review: Capital City: Gentrification and the Real Estate State by Samuel Stein," LSE Review of Books, July 15, 2021, https://blogs.lse.ac.uk/lsereviewofbooks/2019/09/27/book-review-capital-city-gentrification-and-the-real-estate-state-by-samuel-stein.

[25]Wilson, "Book Review: Capital City: Gentrification and the Real Estate State by Samuel Stein".

[26] Sandra Feder, "Gentrification Disproportionately Affects Minorities," Stanford News, February 5, 2021, https://news.stanford.edu/2020/12/01/gentrification-disproportionately-affects-minorities/.

[27]Feder, "Gentrification Disproportionately Affects Minorities," Stanford News.

resources and opportunities compared to white people.

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AI Art Will Never Reach the Level of Human Art

By Olivia Zhao

AUTHOR BIO

Olivia Zhao is a student at Belmont High School who plans to study art and technology in college. She is passionate about painting and computer science and has received multiple scholastic awards for her art. Through her art, she strives to express herself and her beliefs and to advocate for societal issues.

ABSTRACT

This paper discusses Artificial Intelligence (AI) in art and compares its artistic ability to that of a human. In the past few years, the increased usage of AI based tools in art has led to a concern that it will replace human artists. However, this article argues that AI cannot possibly surpass human artists due to many adverse factors: Most people prefer human artworks; AI artwork developments are based on human creativity, not original; Therefore AI art is not real art. It is important to have a definition of art; so we can compare aspects of both artificial intelligence and humans and determine which is more capable of creating real art. If art is defined as the channel for emotional transfer from the art creator to the viewer, AI-created arts are far less likely to be considered as real arts as they lack original emotion and cannot express its inner meaning for the viewers effectively. While artworks created by human artists can convey the deepest metaphysical truth by sensory/perceptual means much more effectively.

Keywords: AI, Art, Creativity, Emotional Transfer, Creator.

INTRODUCTION

In recent years, the involvement of AI in our lives has increased drastically. Artificial Intelligence can now accomplish many tasks in place of humans in artistic rendering or creation (Please check Fig. 1 for a list of popular AI art platforms). As an example, 3D illumination/rendering in computer generated videos have been effectively automated by tools such as Mid-Journey(or others) that only minimum human interventions are needed. They even pose a threat to replace human artists as many positions are no longer needed.

While AI may work more efficiently(up to several orders of magnitudes) in these repetitive use cases than humans, it still cannot match human artists in other aspects. For instance, most people prefer their art to be made by humans, as they are more likely to build a personal connection to it; They are less inclined to consider AI art real "art". As a result, AI art is commonly devalued in comparison to human art and has lower monetary value. Although some pieces were sold for high prices, the general opinion of these occurrences has been negative. As most of the AI generated art works, although proficient in certain techniques, lack the resonance in human reception in conveying underlying meanings. Since AI art is a reflection of human capabilities, it will never be able to further its abilities unless humans develop related concepts first. It cannot create art that it has not already seen, while many humans consider this their main purpose in their work. Furthermore, "art" is a term commonly associated with the emotions put into the work and the emotions it evokes in a viewer. AI, which has no experience and real emotion, at least in the foreseeable future, is unable to convey the same emotion as a human artist can and is therefore incapable of creating real art. It has also been proven that humans sympathize more easily with other humans, so the knowledge of a piece having a human creator can affect the piece's impact on a view as well.
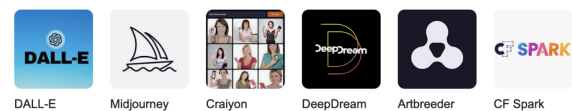

Figure 1. A short list of popular AI tools for artistic rendering

AI in Art

To determine whether or not AI art will be on the same level as human art, we must first establish a set of criteria for what defines "real" art. This topic, as well as the discussion of whether or not AI can create real art, has been a source of debate for many years. "Art" is a very difficult word to define, as there is no single property that can apply to every piece. However, I believe that the significance of true art lies in two groups: the creator and the viewer. The transference of intention from the artist to the piece and then from the piece to the viewer is what creates the art. Without these two aspects, I do not believe a piece of work should be considered true art.

Most People Prefer Their Art to be Made by Humans

The University of Waterloo Research Ethics Board conducted a study in which participants were shown 60 paintings, half of which were created by AI, and the other half created by humans. The test participants did not know which art piece was created by AI or human artists. Partakers were given four criteria to rate each piece: Liking, beauty, profundity, and worth. Across 4470 trials, the researchers found an anti-AI bias across all four categories, in which participants favored the work labeled as "human-made" more than the ones labeled as "AI-made" (Bellaiche et al., 2023).This experiments verifies that general people would perceive the differences between AI arts and human arts using these very general/vague ratings.
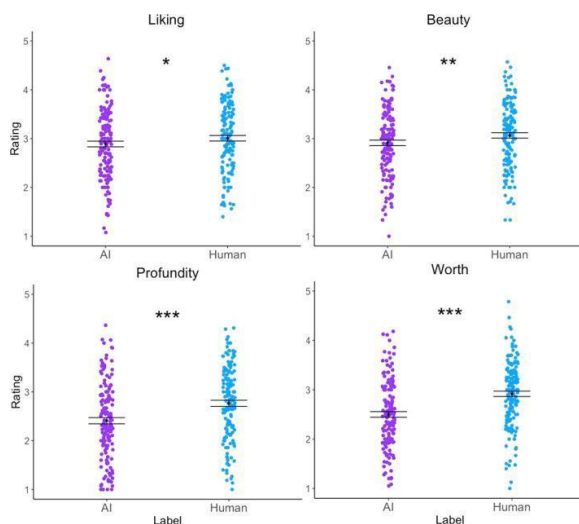
Distribution of values on artworks associated with AI and Humans for each criterion (Liking, Beauty, Profundity, Worth). Error bars represent the standard error of the mean. Following multiple-comparison corrections, *p < 0.05, **p < 0.01, ***p < 0.001
Figure 2. Statistics of Preference between Human Arts and AI Arts

In another study with 254 people from the USA, participants were asked if an abstract painting was considered art. The experiment had two scenarios: one being an accidental creation with the paint having been knocked over, and the second being an intentional painting.

For both experiments, participants were more willing to judge the human-made piece as art, and the paintings that resulted from intentional action were considered to be art much more than the ones that resulted from an accident.

The consensus that arose from these two experiments was that people are more likely to consider human-made artworks than AI ones as real art, even in the form of abstract arts. However, in both scenarios, there were still people who judged AI art to be legitimate. However as shown in Fig. 2, the statistical analysis reveals a significant difference in participant's opinions between human arts and AI arts.

People tend to devalue AI art

When buying art, people typically prefer human-made pieces over AI ones. In comparison to human art, AI art is consistently devalued and considered to be of less monetary value. "This is true even when the art itself is held constant

(i.e., labeling the same piece as "AI-made") and regardless of participants' overall feelings towards AI. Echoing historical examples of automation in other industries, this devaluation is more pronounced on evaluations of skill and monetary value and is less pronounced on artistic dimensions (e.g., evaluations of complexity or emotional intensity). Moreover, devaluation effects weaken substantively when participants are not directly comparing human and AI-made art." (Bellaiche et al., 2023)

"Although collaborative art (humans interacting with AI art generating softwares) is perceived to be less valuable than work made only by humans, perceptions of the human artist's status as the primary creative agent depend largely upon whether the collaboration is being compared to human or AI-made references. That is, an evaluative bias against AI-made artwork persists even in circumstances where the AI functions as a human aid but these detrimental effects on value can be moderated by anchoring the evaluator on the efforts of AI art produced without the help of humans." (Bellaiche et al., 2023)

Even if a piece is only assisted by AI and the majority of the work is done by a human, the piece is still devalued. The bias is not about the quality of the piece but about the AI itself. These results were demonstrated in (Bellaiche et al., 2023) where experiments are designed and statistical results are collected.
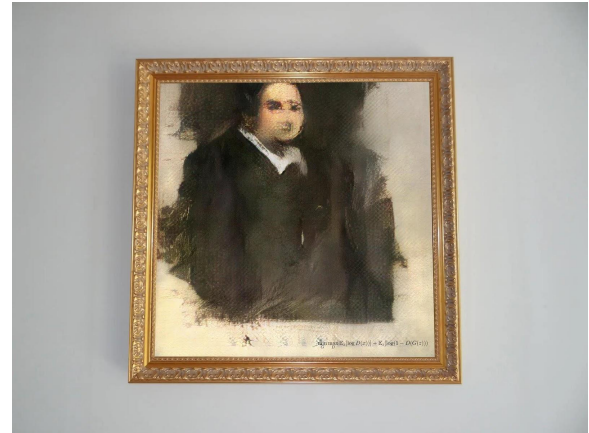

Figure 3. The AI art "Portrait of Edmond Belamy"

AI can only replicate that which has already been made by human artists

AI software is trained through the algorithm known as reinforcement learning on images and art that has been created by human artists, which means its development is dependent on human progress. Therefore, AI art is also dependent on human creativity. Over time, the images AI software churns out start to become repetitive, as it cannot create anything that it has not already seen. It can only repeat what it sees, meaning that it cannot surpass human creativity, which can form that which does not currently exist. If AI is to create anything worthwhile, it must be able to have its own insight and senses (Demmer, 2023). These attributes are not demonstrated in the generative AI systems so far. Therefore, we consider AI arts more of imitations/mixing of human artists that they learned from in the recursive ML process.

AI art is an imitation, eliminating its ability to be creative

Although AI's efficiency and capability may seem to far surpass humans, its systems "remain a reflection of their training data -- and do not have the same capacity for originality and critical thinking as humans do…Human creativity draws not only on past data but also on experimentation and the full range of human experience." (Demmer, 2023) It can only imitate what it can see, meaning it lacks the essential form of creativity.

The efficient generation of AI-based artistic rendering or even the creation of artworks of different styles is incredible in the speed of volume of the outcome. But we still argue that we are yet to see that AI arts are truly capable of refreshing the boundary between existing techniques and truly original creativity.

AI cannot create "real" art

A key difference between AI and human artists is that humans can incorporate their emotions and past experiences into their work, giving their pieces depth and allowing them to evoke feelings in others as well. Artificial Intelligence, developed to create 'art' after being given a prompt, possesses neither of the two and is therefore unable to incorporate them into its pieces. Through machine learning, AI learned to make inferences between different language based inputs to the vast majority of existing artworks. But AI could not understand the true

human emotion and apply these feelings in the composition and techniques.

A handful of professors from the University of Vienna wrote that "A core aspect of making art seems to be the ability to record and then impart some aspects of a creator's reality, their views, and their feelings to an audience. This latter aspect, often in the form of specific emotions, is suggested to be a main aspect of such connections and a core element—as a human communicative act—of art's definition itself." Tolstoy put it this way: 'to evoke in oneself a feeling one has once experienced, and … then, using movements, lines, colors, sounds, or forms … to transmit that feeling that others may experience the same feeling—this is the activity of art.' It appears to be very problematic to ascribe such intentions to an AI or any computer. Thus it is extremely hard to analyze how artificial intelligence can actively transmit emotions to viewers. Even when the emotions are hard to define with regards to AI. Therefore, in this definition, art generated by AI may, in the critics' view, not be qualified as true art. As the main communicative channels are instructions, software code or data-feed; without an artist to even initiate the communication of emotions, the entire interaction becomes an empty gesture—an 'illusion of art'." (Demmer, 2023)

The transfer of feeling from the artist into their work, and then from the piece to the viewer(Tolstoy, 1995) is such a vital part of what true art is and is something AI is unable to

replicate. AI's inability to incorporate emotion into its art results in a piece that contains nothing and is essentially hollow.

The impact of having a human creator

The knowledge of a human creator affects a person's perception of a piece as well. In an experiment conducted by Kwak et al, he asked children (10–12 years) to engage with a robot, resembling a head with eyes, designed to communicate emotions via colored lights. The engagements, in which the child and robot played a collaborative game, were framed by two conditions in which participants were told that the robot was expressing its feelings (e.g., sadness when making a mistake) versus expressing another's feelings, framed by showing a picture of a person suggested to be controlling the robot. Children showed stronger empathic responses (operationalized as a propensity to take a penalty in the place of the robot) when they believed that the feelings were from the human operator and not from the robot, which, the authors suggested, indicated that the quality of an emotional interaction is crucially tied to the presumed level of agency behind, but not necessarily embodied by, an object.

Even if AI attempts to spark emotion through its work, knowing that the intention behind a piece comes from a human self-consciousness but not a machine makes it more genuine to the viewer. As proved in the experiment, people are more willing to resonate with a piece created by other humans. AI can imitate a human, but it can never become human, at least in the foreseeable future, as it lacks the sensual/philosophical aspects of artistic creation. What AI relies on is merely maximizing a mathematical measure in the maximum likelihood algorithm and the training dataset it relied on. With different training dataset or with separately fine-tuned machine learning algorithms, AI artists might create totally different or even opposing results. AI art also sufferers from the instability of the underlying algorithm/computing platform; while the emotional/philosophical values are relatively stable in our human society.

Conclusion

AI will never be on the same level as human artists, as the transfer of self-consciousness between AI and the artwork and a human being is almost impossible. It is also hard for AI to have a breakthrough in creativity. Although AI makes the rendering of certain forms of art more efficient, many are unwilling to consider it real art.

Although among the general population, most prefer human-made art, there have been cases in which AI art has sold for astronomical prices. The most expensive of these was a painting titled 'Portrait of Edmond Belamy', which sold for $432,500 in 2018. (Figure 3) Instead of being sold to a large institution or community, it was bought by an anonymous individual. Since only one person was willing to value the piece

that high, they do not reflect the general opinion of AI art, and can be marked as an outlier. Unsurprisingly, this incident sparked many controversies, and most reactions were negative. Jerry Saltz, a well-known American art critic, stated, "An artwork made by Artificial Intelligence just sold … I am shocked, confused, appalled" (Demmer, 2023).

In time, AI will replace humans more prevalently in certain repetitive and time-consuming jobs. It is natural for us to take the route of least effort for our work. Take ChatGPT for example, which can pump out an AI-generated essay in seconds. Many are already using it as a reference for their writing, eliminating the need to find those ideas themselves. If we continue to rely on the development of our technology, our abilities will begin to degrade. With ever-accelerating technological advancements, we need to accept that we must preserve certain critical developments and applications of creative skills for us as a society. (Bran, et al, 2023)

To stop the growing prevalence of AI technology before it becomes detrimental to humans as a race, I believe it is urgent to form an international committee to be a watchdog for the AI industry, and for setting up unified policies as the boundaries for AI. The committee will also discuss current prevalent issues, such as the topic of ownership in AI art and copyright.

The creation of art is incredibly important to our society and is a way for people to express themselves and communicate with others. Leaving this task to AI takes away a key component of our society. Overly relying on generative AI would not be a viable strategy. In the long run, this could be detrimental to our value system, creativity and humanity as a whole piece.

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Are There New Types of Compact Stars?

By Yihong Zhou

AUTHOR BIO

Yihong Zhou is a student at the International Department of Affiliated High School of South China Normal University. Spending his childhood in a small village with no light pollution, he is particularly fond of astronomy, astrophysics, cosmology, and metaphysics. While being China's highest scorer in the 2023 International Astronomy & Astrophysics Competition, he won a global silver in the British Astronomy and Astrophysics Olympiad. He also does volunteer work translating astronomy articles into Chinese, exposing more people to a greater world. This research was motivated by his curiosity about matter's behavior under extreme situations and his ceaseless pursuit of the objective truth. My research was largely inspired by Prof. Glendenning's masterpiece *Compact Stars-Nuclear Physics, Particle Physics, and General Relativity*, and I hereby express my utmost gratitude to him.

ABSTRACT

This research examines two hypotheses about the inner structure of neutron stars: the hybrid star theory, which presents neutron stars with different layers, and the strange star theory, which presents neutron stars as an almost homogeneous sphere. Each reveals the possible existence of a new type of compact star. Moreover, possible future discovery of sub millisecond pulsars is vital to justify the strange star hypothesis.

Keywords: Neutron stars, Hybrid star theory, Strange star theory, Compact star.

INTRODUCTION

Compact stars are the densest objects in our universe, possessing an interior structure with extreme similarity to a newborn universe. Human beings cannot create a piece of the early universe on Earth due to technological limitations. Still, space is a perfect laboratory—compact bodies are right there, thousands of light-years away, awaiting our analysis. By researching these exotic objects, humans may better understand the universe's fate and that of themselves, rendering mankind closer to objective reality.

Compact Stars

Before delving into the most intriguing part, some basic concepts should be examined in the first place. Compact stars are ashes of stars—when stars reach the end stage of stellar evolution and stop nuclear fusion, compact stars form. As their name implies, compact stars are extremely tight objects whose density can exceed hundreds of trillions of that of the Earth.

Generally, compact stars are classified into three categories: white dwarfs, neutron stars, and black holes. If the progenitor star has a mass less than the Chandrasekhar limit, around 1.38 solar masses, it will become a white dwarf at the end of its life. (Mazzali et al., 2007) For instance, our Sun will eventually become a white dwarf around 6 billion years later. (Frazier, 2019) An Earth-sized white dwarf will be about two hundred thousand times denser than the Earth, implying extreme gravity on its surface. Such monstrous gravity is counteracted by electron degeneracy pressure, explained by Pauli Exclusion Principle, which renders it stable. (*White Dwarfs,* 2010)

Once gravity overcomes electron degeneracy pressure, another type of compact star forms—a neutron star. The actual mechanism requires a deep understanding of particle physics; for simplicity, electrons are forced to merge with protons, and neutrons are created. Due to the abundance of neutrons, neutron degeneracy pressure will take place to cope with gravity because neutrons, like electrons, are fermions and follows the same Pauli Exclusion Principle stated previously. (Glendenning, 2012) Inside the star, the gaps inside atoms are eliminated, so its radius is much smaller compared to a white dwarf—around 10km. Using Oppenheimer-Volkoff equations, the upper mass limit for such a neutron star was calculated to be about three solar masses, exceeding twice the Chandrasekhar limit. (Glendenning, 2012) Considering its relatively minute volume and enormous mass, the density and surface gravity of a neutron star will be significantly higher than those of a white dwarf.

Once neutron degeneracy pressure is overpowered by gravity, in a more traditional view, a black hole is formed. (Tillman, 2018) It is a debatable topic, and several more aspects of this question will be examined later in this research; in what follows, black holes are briefly discussed. When a star's surface gravity becomes so enormous that even electromagnetic waves cannot escape, it becomes a black hole. For a non-rotating star, once its radius falls inside Schwarzschild radius (solved by Schwarzschild using Einstein's general relativity equations), it becomes a black hole. (Glendenning, 2012) It is "black" not only because no electromagnetic waves can leave its surface but because people obtain no information from the insides of the event horizon as well. Although black holes are exotic and worth studying, they are not the focus of this research.

Great Mysteries of Neutron Stars

It is a common misunderstanding that

neutron stars are bound by nuclear force—the same force that holds nucleons together—since they predominantly contain neutrons. The fact is, nucleons inside a neutron star do not attract each other but repulse (neutron degeneracy pressure). (Glendenning, 2012) Therefore, neutron stars are gravitationally bound and behave differently than gigantic nuclei.

Another common misunderstanding is that neutron stars are made entirely of neutrons. But a gigantic pure neutron sphere is untenable—the pressure varies dramatically across the interior of a neutron star, implying different phases inside.

Due to neutron stars' extreme gravity mentioned in the previous section, the composition of the core and the pressure inside go beyond human understanding of particle physics. Therefore, different hypotheses are proposed regarding the structure of neutron stars, especially their cores. For the rest of this research, two premises will be presented—the hybrid star hypothesis and the strange star hypothesis. Methods to recognize strange stars will be examined later. However, for hybrid stars, distinguishing them from pure neutron stars has been almost impossible hitherto.

Quark Stars

Before the hypotheses are introduced, a fundamental understanding of particle physics is needed.

Nucleons are comprised of even smaller particles called quarks. There are six types, or flavors, of them—down quark (d), up quark (u), strange quark (s), charm quark (c), bottom quark (b), and top quark (t). A proton comprises two up quarks and one down quark; a neutron comprises two down quarks and one up quark. Gluons, a type of boson, deliver the strong force binding two quarks together. (Augustyn, 2019)

Quark stars are compact stars that contain quark matter. In this hypothesis, the neutron

star's core is said to be composed of deconfined quarks that are asymptotically free. (Glendenning, 2012) The term "asymptotically free" is a fundamental concept of quantum chromodynamics (QCD)—within a distance of 10^{-15}m, quarks behave as though they were nearly free, and this condition is called asymptotically free. As the distance increases, the force between quarks will increase as more gluons are produced. (Augustyn, 2019) In this sense, if the core of a neutron star can provide enough pressure to diminish the distance between particles, the quarks will no longer be confined.

Two hypotheses, namely the hybrid star hypothesis, and the strange star hypothesis, will be addressed in this research. These hypotheses rely on the MIT bag model, a simplified representation of quark matter, where the "asymptotically free" theory holds significance. (Glendenning, 2012)

Hybrid Star

Recent studies suggest that applying simplifications, such as the constant-pressure phase transition, to the stellar model may result in the inner regions of more massive neutron stars being occupied by quark matter. (Glendenning, 2012)

It is unlikely that quark matter will solely exist in the core—there might be mixed phases where quark matter and confined hadronic matter are in equilibrium with one another. When a neutron star has a composition of pure quark matter or mixed phases in its interior, it is classified as a hybrid star.

Two graphs from the book *Compact Stars-Nuclear Physics, Particle Physics, and General Relativity*, authored by venerable particle astrophysicist Norman K. Glendenning, are used for a more intuitive interpretation of hybrid stars.
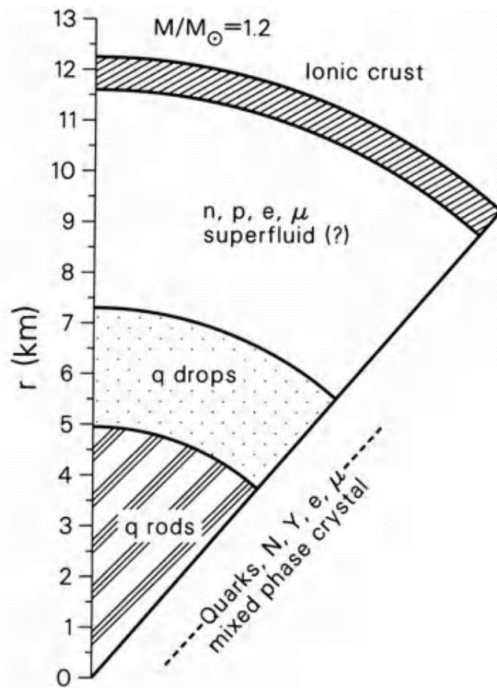
FIGURE 1   Structure of a hybrid star with 1.2 solar masses, where n, p, e, μ, and q represent neutron, proton, electron, muon, and quark, respectively.

    (Credits: Glendenning, 2012, p. 304)

This graph appears that quark matter occurs inside a hybrid star with 1.2 solar masses at a radius of about 7.3km. At first, they take the form of tiny drops. As the pressure increases (i.e. the radius decreases), the drops connect and form quark rods. This phase of quark rods and the confined hadronic matter will persist through the core of this star.
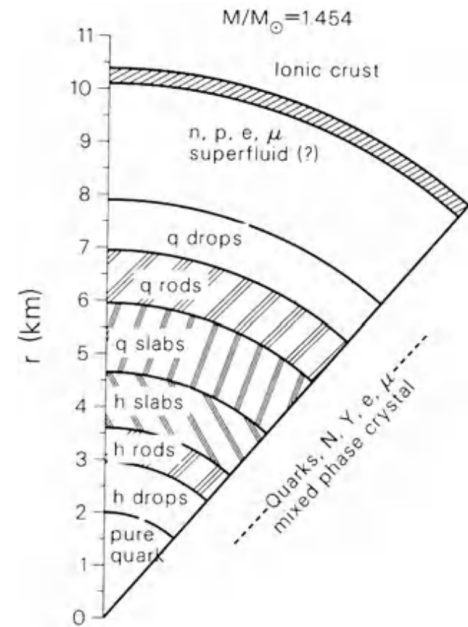

FIGURE 2   Structure of a hybrid star with 1.454 solar masses, where n, p, e, μ, q, and h represent neutron, proton, electron, muon, quark, and hadronic matter, respectively.
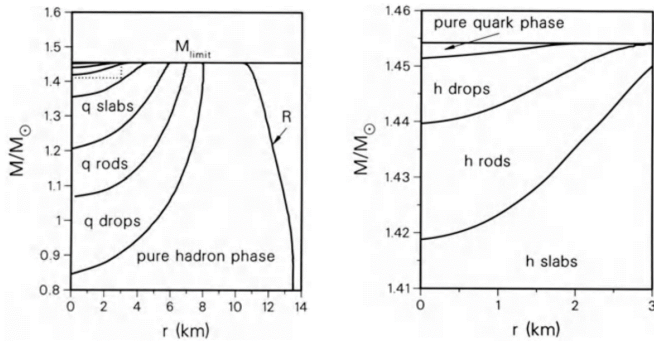
    (Credits: Glendenning, 2012, p. 4)

If the hybrid star possesses a greater mass (1.454 solar masses in this graph), more phases are predicted using the same simplified stellar model (MIT bag model). As the pressure increases, quark rods will combine and form quark slabs. As quark slabs grow thicker, the hadronic matter will lose its dominance gradually, and that is why the h-slabs phase is right inside the q-slabs phase—quark slabs are now thicker than hadronic slabs. Inside the h-slabs phase, similar phase transitions described previously will repeat inversely for hadronic matter: h-slabs become h-rods and then h-drops; ultimately, the hadronic matter will completely deconfine, leading into a pure quark core.

    It is worth noting that such a hybrid star's radius decreases as the mass increases. For detailed mass-radius relation and exact radius for phase transitions, Glendenning provides

another paired graph.

FIGURE 3   The left panel shows phase transition radii for hybrid stars heavier than 0.8 solar masses. The right panel shows the details for the dotted box of the left panel. (Credits:

Glendenning, 2012, p. 326)

It is evident that the radius of a hybrid star decreases gradually as the mass increases (starting from 0.8 solar masses). Based on the data presented in this graph, it appears that the maximum weight for a hybrid star slightly exceeds 1.45 solar masses, and its radius measures approximately 10.5 km.

Strange Star

Strange star is strange—its structure is unique and almost perfect. Before the examination of its structure, some background should be introduced first.

It is conventionally assumed that the ground state of hadronic matter is the state in which quarks are confined in individual hadrons. (Glendenning, 2012) This seems evident because most matter humans have observed is made of confined hadronic matter, even deep in space (i.e. when the universe is much younger). However, just as the concept of vacuum decay (Mack, 2015) challenges the existence of the true ground state of vacuum, Bodmer and Witten both independently proposed the strange matter hypothesis to question the actual ground state of

hadronic matter. (Glendenning, 2012)

Quarks are fermions, which means they follow the Pauli exclusion principle: "The probability to find two identical particles of half-integral spin (fermions) in the same quantum state must always vanish." (Krane &
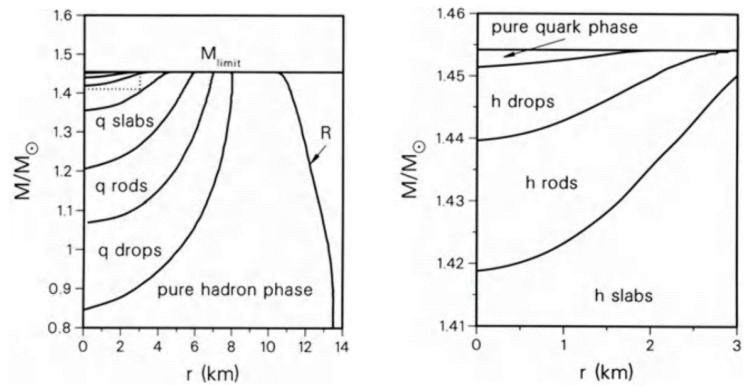
Halliday, 1988) According to the principle, every quantum state in a system can be occupied by only one quark with a specific combination of quantum numbers, including flavor. In this sense, quarks of different flavors can be treated as a different combination of quantum numbers. This allows them to occupy a lower energy state together, rendering the matter more stable (i.e. with lower energy) overall. In this strange matter hypothesis, the absolute ground state of matter is called strange quark matter, which is in a deconfined state where an equal number of up quarks (u), down quarks (d), and strange quarks (s) co-exist. With the introduction of this extra quark flavor, a greater number of quarks can now exist at a lower energy level. This idea is essential for this study because under intense pressure, like in a core-collapse supernova, 2-flavored ordinary matter (e.g. protons and neutrons) can restore 3-flavor symmetry (up, down, and strange) to occupy lower energy states. (Lai et al., 2023) Glendenning's book shows the exact energy comparison: "Three-flavor quark matter has an energy per baryon of approximately 0.9 times that of 2-flavor, or about 100 MeV lower." (Credits: Glendenning, 2012, p. 339)

It was hypothesized that once the core of a neutron star deconfines, a third of down quarks will spontaneously convert into strange quarks since strange quark matter is more energetically favorable. The conversion of the remaining part of the star will happen relatively quickly. (Glendenning, 2012) That is why the strange star is so strange—it is made almost entirely of strange quark matter.

strange stars have an uncommonly abrupt edge (indicating an incredibly smooth surface) for its unique structure. (Glendenning, 2012) Relatively, neutron stars have a more natural transition toward the surface. Additionally, the graph also exhibits that the average density for strange stars increases rapidly as their mass increases. In fact, a strange star follows a mass-radius relationship similar to a hybrid star. Then why has no strange quark matter been observed? Didn't the extreme pressure near the universe's beginning create strange quark matter? Both of these questions are worth considering. Some assert that the strange quark matter is almost impossible to observe and can even be the candidate for dark matter. However, a more reliable explanation rebuts by suggesting strange matter would have evaporated in the early universe into ordinary hadronic matter. The conversion from normal matter to strange matter can occur over a long period of time (much longer than the universe's age). (Glendenning, 2012)

Charm Stars? Bottom Stars? Top Stars?

As stated in the section Quark Star, there are six flavors of quarks. Since strange matter is said to be more energetically favorable than ordinary matter, could the "charm matter," "bottom matter," or "top matter" be even more stable than strange matter?

This idea seems natural since more flavors allow more particles to stay at a lower energy state (see section Strange Star), rendering the

matter more stable. However, charm quark is absent in strange stars due to their requirement for a much higher density than the core of a strange star can provide. (Glendenning, 2012) Therefore, there will be no charm, bottom, or top stars.

Recognizing Strange Stars

Neutron stars are gravitationally bound stars, but strange stars are not. This difference is vital in the method I will introduce—a self-bound star can spin faster than a gravitationally bound star.

Before getting into the method, one basic concept should be explained: Kepler frequency is the maximum rotational frequency at which a star can rotate. (De-Hua et al., 2007) If a neutron star spins faster than its Kepler frequency, it cannot be a neutron star, but it could be a self-bound star such as a strange star. A gravitationally bound star's Kepler period ($P_k = \frac{2\pi}{f_k}$) is calculated to be:

$$P_k \approx 10.1\left(\frac{R^3}{M}\right)^{\frac{1}{2}} = 0.0276\left(\frac{\left(\frac{R}{km}\right)^3}{\left(\frac{M}{M_\odot}\right)}\right)^{\frac{1}{2}} \text{ ms}$$

(Credits: Glendenning, 2012, p. 280)

when the mass is low, gravitationally bound stars possess much larger radii than self-bound stars. Additionally, self-bound stars have a higher upper limit for spinning frequency.

However, the limit calculated by this method is conservative, because the structure of stars is usually not optimized to minimize their rotational period. Glendenning used another more complicated approach, which will not be addressed in this research, to give a less stringent constraint. The conclusion is that a pulsar that rotates at a frequency faster than 1 ms is probably not bound by gravity (i.e. not a neutron star) (2012).

Aside from detecting sub millisecond

pulsars, there were other approaches for distinguishing strange stars. For instance, some suggested that a strange star will cool faster than an ordinary neutron star since the conversion from a down quark to a strange quark will absorb some heat. (Zapata et al., 2022) However, they are not the focus of this study.

Conclusion:

In this research, the structure of hybrid stars and strange stars are examined. A possible approach to recognizing strange stars is discussed as well. Though all information is from reputable sources, it strongly relies on simplified models for stellar structure (e.g. MIT bag model) and certain fields without definite conclusions (e.g. quantum chromodynamics); therefore, the hypothetical nature of this research should not be ignored. Human beings still have a long way to go on the road to reality; more studies should be done to unveil the truth.

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SCHOLARLY REVIEW ONLINE

DDoS Attacks: Detection Techniques

By Alice Lin

AUTHOR BIO

Alice is a student at Nobles and Greenough school, in Dedham, Massachusetts. Her primary academic interest is computer science, and she is also interested in mathematics and physics. She appreciates the practical applications of computer science, and has completed research in the past on the usage of machine learning in different areas of healthcare. She hopes that with research she is able to explore different areas of computer science and gain more experience and knowledge about what she would like to pursue as a career. Outside of academics, she enjoys spending her time reading, running, and baking.

ABSTRACT

As we become more reliant on technology, we also become more vulnerable to cyberattacks. One of the most common types of cyberattacks is DDoS attacks, or Distributed Denial of Service attacks. These attacks are carried out to make certain servers or web pages unavailable, or very slow to update. One of the reasons DDoS attacks are very effective is that it is very hard to catch the attacker while the DDoS attack is occurring. Therefore, one of the crucial steps to protecting oneself against DDoS attacks is to develop a way to distinguish between DDoS traffic and normal traffic, so that the normal traffic is not affected when the DDoS traffic is being dealt with. This paper provides an overview of what DDoS attacks are, as well as some of the methods people have researched to detect DDoS attacks and distinguish between the different types of traffic.

Keywords: Distributed Denial of Service, DDoS, Cybersecurity.

INTRODUCTION

Distributed denial of services attacks, or DDoS attacks, occur when an attacker overwhelms a target so that it is not able to address legitimate traffic, rendering it unavailable to users. DDoS attacks are carried out through multiple devices, making them harder to detect. They are almost always carried out using bots, or zombies, which are devices with malware which allows the attacker to control them. A group of these bots are referred to as a botnet.

DDoS attacks have become more and more of an issue in our digital world. From 2021 to 2022, the number of DDoS attacks worldwide increased by 150% (Radware). There can be many motivations for an attack to launch a DDoS attack, ranging from financial, to political, to personal. Financial motives can have an attacker who demands the victim pay a fee before they stop the attack, or could be an attack between rival businesses. Political motives could be launched at oppressive governments or protestors, it could also be used to cause confusion in military troops or civilians when there is political unrest. These attacks can target large companies, small companies, or even personal web pages – no one is exempt. Following is a couple of major DDoS attacks in history:

On April 27, 2007, there was political conflict in Estonia between the Russian-speaking Estonians and ethnic Estonians. There was a surge in cyberattacks, most of them being DDoS. People were using ping floods and botnets to attack financial institutions, government departments, and media outlets.

On July 20, 2008, the government of the Republic of Georgia experienced a DDoS attack right before being invaded by Russia. This attack highlights how cyberattacks have and can be used alongside physical attacks.

On March 18, 2013, the Spamhaus incident occurred, sometimes also called "Attack that Almost Broke the Internet." Spamhaus added a group called Cyberbunk to their blacklist, and the group responded with a DDoS cyberattack. The attack even managed to take down Cloudflare, which was an internet security company which was designed to combat DDoS attacks.

On February 28, 2018, there was a DDoS attack on GitHub, which was viewed as the most prominent developer platform. The attackers spoofed GitHub's IP address in order to send huge traffic towards them. However, it only took GitHub 10 minutes to get back online, as they routed the traffic through scrubbing centers.

In February, 2020, Amazon Web Services were attacked with a DDoS attack. It took Amazon Web Services three days to get back online and running. This attack was the largest to its date, 2.3 Tbps, while previously these attacks had only reached 1.7 Tbps. (CompTIA)

As DDoS attacks become more common and damaging, it becomes more important for people to be aware of these attacks, as well as how to protect themselves from them. One of the first steps someone can take to protect themselves from DDoS attacks is being able to detect when one is occurring, and when it is occurring knowing what traffic to ban and what traffic to let through. This paper attempts to highlight some of the methods people have researched to detect and separate DDoS traffic and normal traffic.

Types of DDos Attacks

DDoS attacks take advantage of the natural connection that occurs between devices and networks. These connections can

be modeled by the OSI model, which divides the network connection into 7 layers: Physical, Data Link, Network, Transport, Session, Presentation, and Application.

1. The first or bottom layer is the Physical Layer. This layer refers to the physical or electrical components, and is where raw data bits are transmitted. Examples of what is encompassed in this layer include cable types, pin layouts, voltages, network adapters, etc.

2. The second layer is the Data Link Layer. This layer is where data is packaged into frames, as well as where error correction for the physical layer occurs. It then transmits the data through node-to-node connections.

3. The third layer is the Network Layer. This is the layer where the routers are. It determines the route the data will take to get to the correct IP address as its destination.

4. The fourth layer is the Transport Layer. This layer regulates the data transfer, meaning it determines how much data is being sent, how fast, the destination, etc. There are a number of different methods that can be used, the most common being Transmission Control Protocol (TCP) which is built on top of the Internet Protocol (IP).

5. The fifth layer is the Session Layer. This is the layer that maintains sessions between computers or other devices. The sessions are set up, managed, and terminated at this layer.

6. The sixth layer is the Presentation Layer. This layer makes sure that the data is in the correct format for the next step. Most of the time it is switching the data from application format to network format, or vice versa. Data encryption also occurs at this step.

7. The seventh, and final, layer is the Application Layer. This layer receives information from the users and also displays data to the user. This is where the human and the computer interact directly.

There are three main types of DDoS attacks: Application Layer, Protocol, and Volumetric attacks.

Application Layer attacks, also sometimes called Layer 7 attacks, are the most common type of DDoS attack. The attack targets the Application Layer of the network connection, where web pages are generated from HTTP requests. The attacker can initiate an HTTP flood, overwhelming the server with HTTP requests so that legitimate traffic cannot get through. There are multiple types of HTTP Flood attacks, one being GET attacks. During GET attacks, attackers utilize a botnet to send a large number of GET requests for large files to overwhelm the victim. Another type of HTTP flood is a Single Session or Single Request attack, where attackers will use only one HTTP packet, but include a large number of requests.

Protocol attacks target the third and fourth layer (Network and Transport Layers) of the OSI model, and is the second most common type of DDoS attack. One type of Protocol attack is the IP Null attack. All packets are expected to specify what transport protocol to use for the packet (ex: TCP, IMCP, etc.), but attackers can set the value to "null," causing the server to consume resources to try to determine how it should deliver the packages. Another type of Protocol attack is the SYN Flood, where the

attacker sends many SYN request packets, but the final acknowledgement (ACK) never comes, leaving the server waiting. Slowloris is another type of Protocol attack which sends a large number of partial HTTP requests to a web server, in order to hold open many sessions to consume the server's resources.

Volumetric attacks create a ton of network traffic to overwhelm the server. The attack is usually carried out using amplification or a botnet. One type of Volumetric attack is a UDP flood attack, which is when a two-way session is not established, but instead the UDP sends data packets to the server without waiting for a reply. Another type of Volumetric attack is an ICMP (Ping) Flood. The Echo Request and Echo Reply commands are used to test network connectivity, and together the two of them form the "ping" command. The attacker will send a large number of Ping packets without waiting for the response from the server, which will consume the incoming and outgoing bandwidth of the server.

A common trick that attacks will use to carry out their attacks more effectively is spoofing. This is when they disguise their address as something else, making it easy for them to trick devices into sending packets to a victim that never requested them.

Detection

One of the most challenging parts to protecting against DDoS attacks is differentiating between legitimate and attack traffic. There have been multiple studies on the detection of DDoS, and this paper will go over some proposals.

Doshi et al. (2018) used multiple machine learning techniques to test the accuracy of each in distinguishing between normal and DoS attack packets. They used the K-nearest neighbors (KN), support vector machine with linear kernel (LSVM), decision tree using Gini impurity scores (DT), random forest using Gini impurity scores (RF), and a neural network (NN). The results showed that the LSVM performed the worst, and the decision tree and K-nearest neighbors both performed the best with an accuracy of 0.99. They also noted that the neural network was expected to do better if there had been more training data available. They also noted that in their feature importance testing, stateless features performed much better than stateful features.

Lee et al. (2008) used cluster analysis on a selection of parameters in order to recognise and classify each phase of a DDoS attack. The parameters they selected for detection were: the entropy of source IP address and port number, entropy of destination IP address and port number, entropy of packet type, occurrence rate of packet type, and number of packets. The cluster method used was hierarchical clustering. They divided the data set into five groups: normal, phase 1, phase 2, attack, and post-attack. They were able to detect three of the five phases.

Idhammad et al. (2018) used a semi-supervised machine learning approach. There were five steps to their proposal: dataset preprocessing, estimation of network traffic Entropy, online co-clustering, information gain ratio computation, and network traffic classification. To estimate the entropy they used the flow size distribution (FSD) features, source and destination packets count, and the source and destination bytes count. They also used a co-clustering technique to eliminate some of the normal traffic to avoid the noise it provides. They tested their method on three different datasets, and obtained accuracies of 99.88%, 98.323%, and 93.74%.

Saied et al. (2016) used an artificial neural network (ANN) for detecting DDoS attacks. They compared their neural network

approach to a couple of previous approaches, and found that their accuracy of 98% was the highest among them. They also compared the results of their network trained on old datasets compared to new ones, and found that the new datasets (with an accuracy of 98%) surpassed the old datasets (with an accuracy of 92%).

Singh & De (2017) also used an artificial neural network, and decided to train theirs with genetic algorithms instead of gradient descent. The features they used were the number of HTTP count, the number of the IP addresses, the constant mapping function, and the fixed frame length. After testing, their method had an accuracy rate of 98.04%, when detecting an application layer DDoS attack.

Discussion

While the methods presented in this paper all seem to be effective at detecting and categorizing DDoS attacks, they are all research methods that have not yet been applied to real life. It is also important to note that detecting DDoS attacks and differentiating between traffic is an important step to take in protecting against DDoS attacks, but it is not the end. Once the DDoS traffic is detected, there needs to be an implemented way to route that traffic into a sinkhole to prevent it from using up resources.

There are some methods available online to use for protection against DDoS attacks. One such method is cloud scrubbing devices, which are inserted between the DDoS traffic and your network. THey take the traffic and route it to a different location to isolate the damage from the target. Akamai, Radware, and Cloudflare all provide cloud scrubbing devices. Some businesses will protect against DDoS attacks by using multiple internet service connections. If the business feels that they are

being overwhelmed by traffic, it is possible for them to switch from one to another to avoid the negative consequences of being overwhelmed by traffic. Content delivery networks (CDN) are networks that are separated to help mitigate the effects of DDoS attacks. Since they are separated, if one gets overwhelmed by traffic, they can distribute it to the other connected networks. Web application firewalls (WAF) are usually used in conjunction with other protection techniques. WAFs filter traffic coming towards a specific web server or application.

Conclusion

As DDoS attacks become more and more prevalent and effective, the need for detecting and preventing them also becomes more pressing. This paper highlights a couple of attempts at developing detection methods for DDoS attacks, a critical step in being able to prevent them. Further research could discuss ways to make this accessible to the public, as well as combining it with mitigation techniques once the DDoS attack is detected.

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Monkeys, Machines, and MPTP: Discovery for the Parkinsonian Brain

By Daniel Joshi

AUTHOR BIO

This paper was written by Daniel Joshi, a student at Sage Hill High School in Newport Beach who found a passion for neuroscience after participating as a research assistant in a Parkinson's Longitudinal Study. He enjoys leading his school team as a captain of varsity cross country and track and field, and he also relishes the competition he faces as a starter for the varsity soccer team. Outside of physical activity, Daniel loves hanging out with friends, watching TV, and eating delicious foods. In the future, Daniel hopes to major in neuroscience or biomedical engineering, and he plans to research Parkinson's specifically.

ABSTRACT

Parkinson's Disease (PD) is a brain disorder characterized by tremors, bradykinesia, and dyskinesia. Although discovered in the early 20th Century, to this day there remains no cure. This research paper highlights the neural identifiers in people diagnosed with PD, the history of artificial intelligence (AI), and several existing methods to improve the lifestyles of PD patients. Also reviewing the history of PD, the paper ventures through some history, discoveries, and breakthroughs surrounding the condition. The goal of this paper is to explain several Parkinsonian experiments and review the capabilities of AI in PD treatment. Finally, the present paper will discuss the limitations of AI in this field and hypothetical treatments to the neurological disorder.

Keywords: Parkinson's disease, Neurological disorder, AI, Treatments.

INTRODUCTION

With nearly one million people diagnosed with Parkinson's disease (PD) in the United States, the disease is quite prevalent and widespread in today's society. Patients living with PD suffer from gradually worsening symptoms. The condition typically makes it harder for people to walk and talk, as balance and coordination deteriorates with time. Additionally, those with PD are prone to gastrointestinal and psychiatric symptoms along with sleeping issues during the long term progression of the disease. As their lifestyle declines, the dopamine medications patients are prescribed also slowly lose effect. Most patients only live for 10 to 20 years after their PD diagnosis.

History of PD

In 1817, James Parkinson first described the symptoms of the disease in an essay about his patients. Although the namesake of the disease, Parkinson never found a cure or had the disease. Although PD became well-known, treatments were essentially non-existent until the mid-20th Century. In the 1950s, a treatment known as a pallidotomy saw some success, in which the globus pallidus internus (GPi) of the brain was removed to relieve some PD symptoms. However, the addition of L-dopa effectively put pallidotomies out of use (Vitek & Johnson, 2019). Currently the United States spends 52 billion dollars annually on PD treatment (Parkinson's Foundation, 2023). In this research paper, I will summarize our understanding of PD, review current treatments, and look into potential future treatments to Parkinsons' with AI.

The Monkey Experiments

In 1971, a study run by Mahlon DeLong conducted a seminal study for the role of the pallidum in movement with monkeys. After years of studying monkey anatomy and electrophysiology, scientists were able to describe the basal ganglia, a part of the brain responsible for motor control, in terms of functionality in the year 1986. By this time, scientists had already gained an understanding of the motor, oculomotor, limbic, and associative circuits of the brain. Based on the studies, scientists developed accurate models of the basal ganglia. Also during the 1980s, scientists discovered MPTP, which proved to be critical in analyzing the changes in dopamine state in PD patients. Researchers experimented with MPTP to develop a monkey model of a subthalamic nucleus (a part of the basal ganglia responsible for circuitry; STN) comparable to a Parkinsonian brain. With this developed model of the STN, researchers observed the levels of dopamine activity in the globus pallidus externus (GPe) an d GPi (Vitek & Johnson, 2019).

MPTP and the Rate Model

Through the monkey experiments and models, scientists found that the exposure to the neurotoxin MPTP tended to decrease the brain activity utilized in motor control and increased the likelihood of an individual getting PD. Certain occupations increased risk of exposure to this PD-correlated chemical. When human basal ganglia were used, the results mirrored those of the monkey brains. A rate model hypothesis was developed based on the monkey model. This reflected how scientists found that the basal ganglia with PD produced dopamine in a different quantity and rate. This in turn caused the direct dopamine pathway (thalamocortical) to decrease flow and the indirect dopamine pathway (GPi) to have an

excessive amount of dopamine which caused the dopamine levels sent throughout the body to change. However, compared to the PD brain, a brain with an ibotenic acid lesion of the STN showed a removal of the imbalance of dopamine in a PD patient (Vitek, Johnson, 2019).

The History of Related AI

With the advancement in understanding of the brain, researchers looked for ways to apply the knowledge. However, long before the development of the PD brain rate model, scientists had been developing brain-related AI that possessed the ability to analyze the human brain. In 1943 Warren S. McCulloch wrote a paper titled "A logical calculus of the ideas immanent in nervous activity". He described a mathematical model known as MP neuron created to perform computation with binary commands. In 1949, Donald Hebb discovered that when two nerve cells fire simultaneously, connection is stronger, and that neural pathways strengthen with use. Following this, in 1954 Farley and Clark created the first randomly connected reverberatory network. In 1960, Roserberg introduces MADALINE (Multiple Adaptive Linear Elements), which is the first learning machine capable of identifying optical patterns. This paved the way for diagnosis of PD with the help of AI (Chandrabhatla, 2022).

Current Treatment

Currently, AI is mainly used to diagnose or monitor PD in patients. Because doctors are not as accurate as machines in determining the stage or progression of PD, AI has taken prominence in the initial diagnosis. Computer-based algorithms are used to measure the symptoms and stage of the condition. Magnetometers are used to quantify the tremors of PD patients to classify the extent of the disease and track gait freezing as well. Monitors on the body, which include biosensors, are used to track vitals and activity of the patient for the caregiver to see and to help provide feedback for healthcare professionals to limit the degradation of the body. Additionally, an autoreminder AI has been developed to take care of schedules for PD patients. They use reinforcement learning to produce an efficient schedule that tracks habits, includes exercise for maintaining health, and to help keep the patient independent.

Deep Brain Stimulation Machine Learning

As a current PD treatment, deep brain stimulation (DBS) is a risky surgery that yields different levels of benefit from patient to patient (Mayo Clinic 2021). It involves implanting a neurostimulator that sends electrical signals throughout the brain to reduce symptoms of PD. However, DBS is quite inconsistent among individuals and is far from perfect. Perhaps in the future researchers could launch experiments with a brain model, whether from a monkey or human, to test the use of AI in the development of DBS. Using reinforcement learning to help adjust electric signals based on the reaction of the brain could prove to be monumental in the development of PD treatment. With AI, patients could improve their lifestyles just with the addition of AI inside their head. Perhaps with the knowledge of the brain, AI could learn to target electrical signals at parts of the brain such as the GPi to remove excess dopamine activity. However, with the vast complexities of the brain, AI would not have many examples to learn from. Additionally, this poses moral problems as having AI in an individual's head would effectively make them a cyborg. After the addition of AI for medical purposes, researchers would not know where to stop the line at. This

could lead to the addition of AI to someone for non-therapeutic purposes, which would emerge as a difficult ethical controversy to deal with.

Conclusion

Since its discovery in 1817, PD has been a prominent enigma that scientists have struggled to find a cure for. Through the studying of monkey brains, the neuroscience community discovered the difference in brain activity that PD causes. However, with a greater understanding of the brain, the causes, and the symptoms of PD, researchers have been able to develop different treatments to the brain with varying success. However, with the advancement of AI, there have been ways to improve the lifestyles of patients. In the future, AI has great potential to change the entire field of neuroscience, but researchers must be careful in their use of their treatments. Focusing on AI will prove crucial for revolutionary progress in the foreseeable future.

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Robinhood's Retail Investing App: Investor Psychology and Financial Markets

By Zheyu (Jasper) Li

AUTHOR BIO

Zheyu Li is a student at Saint Margaret's Episcopal High School in San Juan Capistrano, California who is interested in the fields of economics and finance. Recently, psychology has also triggered their interest. The growth in retail investing during the pandemic made this student very passionate to explore the psychological aspects behind it. Professor Sujata Bhatia mentored Zheyu throughout the process of writing this paper, for which Zheyu is extremely grateful.

ABSTRACT

The pandemic has seen a dramatic rise in retail investing, with millions of individuals worldwide downloading trading apps such as Robinhood. Such trading apps have provided unprecedented access to commission-free investing for all, regardless of investing experience and financial literacy. This creates an ethical dilemma: while a moral society should provide universal access to opportunities for wealth accumulation, easy access to investing has the potential to do great harm to novice investors. The GameStop frenzy of 2021 is a prime example of the damaging effects of risky investing decisions, both on individual novice investors and on financial markets overall. In its November 2021 Financial Stability Report, the U.S. Federal Reserve specifically called out the dangers of social media-driven investing and speculation by retail investors, citing the hazards of market volatility for financial stability. This research will examine the history of retail investing, the societal factors and existing inequities that have led to the rise of retail investing, and the impact of retail investing on investor psychology and decision-making. The research finds that retail investing encourages herd behavior and impulsive decision-making, and leads to more attention-induced trading and negative returns. Retail investing also amplifies both positive and negative market movements. This research will then describe possible solutions to these challenges, to ensure stable and secure financial markets, wise financial decision-making on the part of individual investors, socially responsible and responsive trading apps, and ethical access to trading for all investors.

Keywords: Financial stability, meme stocks, retail investing, trading, volatility.

INTRODUCTION

Robinhood is a newly emerged retail trading platform and a study conducted by the University of Groningen showed that in the post-pandemic era, the aggregate absolute change in holders of securities on Robinhood was more than five times higher than the pre-pandemic period. This is a shocking change and leads us to wonder why there is such a dramatic difference. The rise of retail trading played a role here as people got more time to trade during the pandemic. In addition to that, the ease of trading on the Robinhood problem makes the platform more prevalent.

One interesting fact is that when you compare Robinhood to Vanguard, a very large and reputable trading platform, Robinhood has about $80 billion in assets under management while Vanguard has $7.2 trillion in assets under management. This is a symbol that the users of both platforms have distinct ways of trading. Both platforms offer a zero commission fee, but Vanguard charges 1 dollar per contract for option trades. Furthermore, in terms of active users Robinhood has 16 million active users, with 21 million active users at its peak during the GameStop frenzy; in contrast, Vanguard has 30 million investors. All these data shows that Vanguard is a more stable and robust company.

The Rise of the Retail Investor

The Robinhood platform argues that they are democratizing investing. This has already been done years ago by Vanguard and Jack Bogle, who tried to make investing less expensive and safer. Their goal is to offer low-cost investing and to build wealth for their clients. Robinhood is not democratizing investing, Robinhood is making it easy to trade. Robinhood mainly focuses on short-term investments, which helps traders to have a

dopamine surge in their mind. While long term trading will not offer such things. In addition, Robinhood added features to make investing more like a game. New members were given a free share of stock, but only after they scratched off images that looked like a lottery ticket which, in some perspectives, may be viewed as gambling, attention-induced trading is the term scholars use to describe this behavior.

In addition to that, Robinhood is also offering extended hour trading, which is a way of trading by going through electronic communication networks. It is quite different from traditional ways of trading. Apart from the fact that they also have a Top Movers and a Most Popular lists. A study from UCSC states that the top 0.5% of stocks bought each day lose 4.7% over the subsequent month. It is reasonable to wonder whether Robinhood can move market prices, given the relatively small amount of assets under management. (Robinhood $81 billion, Charles Schwab $3.8 trillion). However, it is important to remember that trades, not passive positions, move prices. While Charles Schwab may have a larger number of assets under management, Robinhood has more users (13 million Robinhood users vs. 12.7 million Charles Schwab customers). Robinhood users account for 30% of the daily trades from the largest brokerage firms catering to retail investors, so Robinhood users can absolutely move the market.

Robinhood herding events result in negative returns, which can lead to trading losses for many investors. Robinhood's business model relies on user data and payment for order flow. SEC considering rules to prevent payment for order flow, which will significantly affect Robinhood's business model and their profit structure. Payment for order flow means that Robinhood is incentivized to encourage investors to trade as much as possible. Robert Battalio and Tim Loughran suggest that "Finally,

the examples suggest that market makers and other liquidity providers on the NYSE may have been making monopolistic profits before the requirement to provide real-time trade and quote information"(Battlio, Longhorn). However, this contradicts the basic idea of trading brokers, which is to offer their consumers the best price possible to their clients. There is a very cliche ethical dilemma existing here. Robinhood's stock price tumbled when the SEC announced that it was considering a ban on payment for order flow which shows the investor's confidence in Robinhood when it comes to making profit without payment for order flow. Today, payments for order flow barely survive based on the fact that people are trying to prevent trading with inside traders, which could potentially cause them to lose more. Payment for order flow originated with infamous Ponzi schemer Bernie Madoff, who lost billions of dollars of investors' money. Madoff developed payment for order flow in 1991. Another problem with payment for order flow is the types of securities being traded. Two-thirds of all payment for order flow comes from options trades, which are the most risky trades. Since payment for order flow means that Robinhood wants you to trade more, and trading more means that you will lose money, then ultimately Robinhood wants you to lose money by trading constantly. Trading Volume is an indicator of the likelihood of people losing money by making risky trades.

The trading volume on Robinhood platform is also way larger than other platforms, as statistics show: in the first quarter of 2020, Robinhood users "traded nine times as many shares as E-Trade customers, and 40 times as many shares as Charles Schwab customers, per dollar in the average customer account in the most recent quarter." More trades means more risks and more profit Robinhood could collect. Many users on Robinhood are doing day trades, which is considered to be a very risky way of

trading. A study of day traders showed that only 3 percent of day traders actually make money, and less than 1 percent of day traders make above minimum wage; the longer an individual traded, the more money they lost. Furthermore, research has consistently shown that people who are very active in trading tend to underperform against the market as a whole.

Risk-taking behavior on Robinhood; Investor Psychology

Peer observation encourages risk-taking behavior and attention cues on the Robinhood platform drive investing decisions. The Robinhood platform offers a special form of stock which is "fractional share" buying encourages risk-taking behavior. Fractional shares are illiquid outside of Robinhood. This financial innovation allows the users to invest in securities that would normally be outside of their price range and will make the barriers to invest in these securities much lower. In addition, a mention of a security in the Top Movers list is associated with it being traded 36 times more than the amount that it is traded on average, even when controlled for overall market trading activity in the security. It is plausible to say that Robinhood is indirectly involved with stock manipulation. The closing price of a stock on Robinhood is significantly associated with herding behavior. A higher price signals higher market value of a firm which in turn boosts the investor base of that security, thereby driving up the price. Positive feedback loops on Robinhood can contribute to financial bubbles. The price of a stock moves upward, which stimulates herding behavior and more stock purchases, which further drives the price of the security upwards, which induces more herding behavior. The result is a positive feedback loop and a vicious cycle. Fractional shares also contribute to bubbles by lowering the barriers to investing, and driving more herd behavior. These types of feedback loops are also present in the cryptocurrency market.

Trade volume and prices are significant contributors to herding behavior. An increase or decrease in stock price may be followed by a rush or flee of investors, respectively. Stock investments are driven by popularity over profitability; this warps capital allocation. Research suggests "Paranoid Style in American Investing", "Identity Investing" "It's the financial equivalent of buying lottery tickets." This caused Stock prices to be completely detached from fundamental value. The theoretical underpinning of Wall Street, that markets will act efficiently, has been disrupted. Robinhood and other retail investing platforms can make ordinary people feel powerful; Robinhood rose in popularity during a pandemic when many felt desperate. Memes, in-group language foster a feeling of identity among risk-taking investors; there is a slippery slope between group identification and peer pressure. 2.5% of investors exhibit addictive gambling behavior; this is consistent with prior research showing that 2.6% of the U.S. population suffers from gambling addiction

Herd behavior on Robinhood

When individuals rely on internet searches to find financial information, they can fall prey to confirmation bias, meaning that they will not get the other side of the story. Information flows in social media-type platforms contain significant noise, and attention to a stock does not necessarily correlate with returns. There is a significant correlation between tweets and stock volatility and trading volume. Herd behavior is troubling because it means that a market can be manipulated just by messaging alone. As research indicates, "A few hundred bot (human) tweets posted at the right moment could potentially spark an increase of several percentage points in trading volume." A bot working in concert with a platform like Robinhood could readily manipulate the market. Herd behavior can be difficult to predict, and depends on a combination of stock characteristics and trade outcomes for individual investors. Because investing on Robinhood is attention-driven, a social media and PR campaign could be devised to encourage investment in a company. Research has shown that social media participation are correlated with stocks performance (Fan, Talavera, Tran). It will affect a stock in many different areas, such as stock returns, volatility, and trading volume. These are favorable factors for the platform to take advantage of. Robinhood users are tech-oriented and would be especially susceptible to such a strategy. "Companies could get a severe misvaluation, which over time could cause investors' money to evaporate." Hardcore AMC shareholders are obsessed with the idea that the mother of all short-squeezes (MOASS) will propel the stock to new, incredible heights. The stock has fallen more than 50% since the June peak. In addition, Investors in Hertz, Kodak, and Nikola lost more than half of their investment. The more scarce the information about the company, the more likely it is that herding behavior will take place. This is troubling because it means that companies are incentivized to share little about their operations and performance. Because herding behavior means that investor behavior can be easily manipulated, in the same way that social media propagates self-enforcing algorithms. "The attraction of the herd's capital could be a legitimate method for upcoming companies to fund their operations or for third parties to profit from trading." This is why herding behavior is so dangerous. Herding behavior is non-linear, which can also threaten stability of the financial system. "Fortune Favors the Brave" is the phrase crypto.com uses, while it is difficult for ordinary retail investors to spot predators; many crypto schemes are pump-and-dump and take advantage of naive and desperate investors. This is a recent issue associated with herding behavior. Potential threats to financial stability and volatility

Moreover, today's most speculative assets are often interconnected — people who own Tesla also own Bitcoin; indeed Tesla owns Bitcoin — amplifying potential volatility. Across all adults in the United States, 16% have invested in cryptocurrency. Bank of America reports the number of its customers using cryptocurrency tumbled more than 50% to fewer than 500,000 since the market's highs in November. Robinhood is also transforming to expand their cryptocurrency business. According to statistics, 43% of men ages 18-29 have invested in cryptocurrency; 22% of women in the same age range have invested in cryptocurrency. Robinhood's involvement in cryptocurrency trading was initially lucrative and promising. Crypto transaction based revenue for the second quarter of 2021 was $233 million, up from just $5 million in the second quarter of 2020. However by the third quarter of 2021, crypto revenue at Robinhood was $51 million. Crypto revenue for Robinhood has remained in the range of $50 million per quarter since then.

Robinhood competitors and alternatives

The number of users of the commission-free trading app Robinhood grew steadily since 2014, even though the app did not officially launch until mid-2015. The number of users grew from half a million in 2014 up to 22.8 million as of March 2022. The app's net revenue did also grow steadily since its official launch, reaching 91 million U.S. dollars as of second quarter 2021. The number of users is dropping, and the average revenue per user is also dropping. Market capitalization has plummeted from a peak of 46 billion in August 2021 to 7.76 billion in May 2022. "From a sheer stock market valuation perspective Robinhood's 15.9 million active accounts are now valued at less than $500 per customer versus $3,600 per customer for Charles Schwab.

When Morgan Stanley acquired E-Trade in 2020, the price was $13 billion which meant a value of about $2,500 per customer." Robinhood canceled plans to expand into the UK and Australia. The UK does not allow payment for order flow. Robinhood defines a monthly active user as a "unique user who makes a debit card transaction, or who transitions between two different screens on a mobile device or loads a page in a web browser while logged into their account, at any point during the relevant month. A user need not satisfy these conditions on a recurring monthly basis or have a Funded Account to be included in MAU (Monthly Active Users)." Privately investors have suggested that Robinhood should bring in a more seasoned executive; the founder CEO Vlad Tenev may be viewed as a liability. Tenev cannot be forced out since he holds a controlling stake in the company. In June 2022, Robinhood stock price plummeted to the point that the company was worth less than its cash on hand. Stock analysts forecast that Robinhood will not become profitable within the next three years. Insiders including the chief legal and chief operating officer have already reported sales of shares to the SEC. If the SEC bans payment for order flow, Robinhood will no longer be a viable business model. Competition for Robinhood is on the rise. Lightyear is a trading app that provides multi currency accounts, a feature that Robinhood does not have. Lightyear makes its money from foreign exchange fees, not payment for order flow. FTX is emerging as a competitor for Robinhood. FTX began as a cryptocurrency trading platform, but announced in July 2022 that it would begin offering no-fee stock trades. FTX will not engage in payment for order flow. FTX was founded by Sam Bankman-Fried, an early cryptocurrency trader, and has already acquired a 7.6% stake in Robinhood. FTX may partner with Robinhood in the future. Robinhood was too slow to diversify its revenue streams. It recently began offering a debit card, and is now

planning to offer tax-advantaged retirement accounts but it may be too late.

Conclusions and recommendations

Eliminate payment for order flow, remove Top Movers list to reduce attention driven investing and herd behavior, provide more background on fundamentals to investors to enable wise investment decisions. These are the ways for Robinhood to become a more socially responsible company. Robinhood demonstrates that there is indeed a demand for commission free, convenient stock trading and investing. However, Robinhood also illustrates the dangers of a system that incentivizes trading through payment for order flow. Robinhood benefits whether its traders make money or lose money. Robinhood also illustrates the dangers of herd behavior and attention-driven investing, which threaten to destabilize the financial system and untether value from stock prices. We can learn that trading and investing can be democratized but it must be done in a responsible manner, in which investors are given an appropriate education to achieve financial literacy. Robinhood has tried to save its business using cryptocurrency, however, interest in cryptocurrency can lead to more herding behavior which can further destabilize the financial system. Therefore, the future of the company remains unclear, the user base is declining and the total assets invested are declining. Robinhood may have a future, but it may be as part of another company.

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SCHOLARLY REVIEW ONLINE

Large Language Processing Model ChatGPT and its Impact

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Qiaochu (Echo) He is a student at Skyline High School in Washington, United States. She was born and raised in China and moved to the United States in 2021. She became interested in business, specifically entrepreneurship after participating in a Washington state-based business education camp called Washington Business Week, where her team won first place. She also worked on a research project with Professor Howard Geltzer at New York University Stern School of Business. Because her dream is to become a young female entrepreneur, she wanted to learn more about the rise of AI technology and its applications and future impact, which is why she wrote this research paper. Outside of school hours, she loves to sing, draw, and read books. She also loves to write blogs and produce videos to record her life.

ABSTRACT

This research paper explores the transformative impact of ChatGPT, a Large Language Processing Model developed by OpenAI, on various facets of contemporary society. Through an extensive examination of academic literature and empirical research, the study delves into the capabilities, applications, limitations, and ethical considerations surrounding ChatGPT in the realms of education, healthcare, and business.

In the current world, Artificial Intelligence is playing an increasingly important role in different aspects of human society due to its rapid advancements. One of the classifications for AI is the Large Language Processing Models (LLMs), which are trained to have a massive dataset of text for dialogue with users through chatbots. ChatGPT, developed by the OpenAI company, has demonstrated impressive capabilities as an LLM. Through an analysis of data and research conducted about ChatGPT, we can see that the development of ChatGPT by OpenAI has already created significant impact and controversy in different aspects of human society. This is important because AI is likely to be the most influential technology of our time and will fundamentally change people's way of life. This paper aims to systematically review literature related to the impacts, and controversies, and discuss areas of future research.

Keywords: ChatGPT, Large language processing models, AI chatbots, Ethical AI, ChatGPT capabilities, ChatGPT controversies, ChatGPT impact on education, ChatGPT's applications and impact on healthcare, ChatGPT's applications and impact on Business, Limitations of ChatGPT, Future of AI technology.

INTRODUCTION

Artificial intelligence (AI) is the science and engineering of making intelligent machines to mimic human intelligence. AI research began after World War II when a number of independent researchers started to work on experiments to develop these intelligent machines. By the end of the 1950s, there were multiple research projects on AI carried out based on programming computers. As time progresses, nowadays, AI research and development has been divided into different areas of focus. Some common branches of evaluating AI program performance include logical AI, search, pattern recognition, inference, common sense knowledge, and reasoning (McCarthy, 2007).

As AI programs continue to advance, they have been actively injected into different aspects of human society; the high precision and low computation time make AI a cutting-edge technology that can be applied to almost all human activities. For example, one of the most common applications of AI is its use in the gaming industry, where its strong algorithms to scan positions every second have made it a strong opponent for chess. Additionally, AI robots are employed in jobs that are usually considered dangerous for humans such as the ones in heavy industries, where they have been shown to be more efficient and work without break. AI is also applied in weather forecasting, expert systems, data mining or knowledge extraction, and many other aspects of human society (Strong, 2016).

In recent years, the technology industry has made progress in the development of AI into chatbots, as a way to utilize the advantage of AI's natural language processing ability. One example is ChatGPT, an AI chatbot launched in late 2022 by the Company OpenAI. As a large learning processing model technology. ChatGPT is designed to be highly intelligent and user-friendly. It utilizes natural language processing and machine learning functions to enable users to have conversational interactions with the chatbot, which has the ability to understand and respond to complex input from the users and respond in a way that is natural and human-like (King, 2023). Unlike the existing AI chatbots, what is unique about ChatGPT's functionality is that it has the ability to understand the given prompt with specific requirements and generate appropriate answers that fit the user's request. In many instances, the output is hardly different from the human authors. With a large corpus of text data in a dynamic manner including books, articles, and online conversations at its disposal, ChatGPT can generate answers with accurate information for difficult academic questions that are not easily found through web searchers. The unique utility of ChatGPT is also why it had over one million users within two months after its initial launch (Wang, 2023). The success of ChatGPT has created a debate about the future of AI technologies and content-based platforms overall (Naumova, 2023); ChatGPT's success has contributed to a nearly 200% increase in the searches for AI writing and a 139% rise in interest for AI content as people flock to see what is the functionalities and capabilities of current AI technologies (Cuming, 2023).

Therefore, this serves as a literature review of ChatGPT that summarizes the major research, and academic studies on the testing of ChatGPT's capabilities, including its strengths and limitations. Based on those capabilities, this paper will then critically examine how it affects different fields and areas of human society, from education to healthcare to multimodal cultural, and ethical concerns such as academic integrity and replacement of human job opportunities. Lastly, I'll conclude the literary review with the future implications of ChatGPT and similar language processing models.

ChatGPT and Education– Capabilities and applications

Soon after ChatGPT was launched, there were several studies that provided a first analysis of the capabilities of ChatGPT including its reliability and ethical concerns of its being massively applied. For example, a study published by Massey University in New Zealand on December 20, 2022, ChatGPT: *The End of Online Exam Integrity* evaluated ChatGPT's ability to perform high-level cognitive tasks and produce human-like answers. With the aim of examining the complexity of ChatGPT's reasoning and ability to answer university-level questions across different disciplines, researchers conducted an experiment by asking ChatGPT four university-level academic questions and evaluated the response. Some key factors in evaluating ChatGPT's level of critical thinking and quality of its logical reasoning in its responses are determined by the following criteria: "Relevance to the topic, clarity of the text, accuracy of the idea, precision, depth, breadth, logic, persuasiveness, and originality". In all the generated responses, ChatGPT demonstrated a strong clarity of language, it is straightforward and easy to understand for the intended audience. Subject experts from all the above four disciplines confirmed the accuracy of each response, and they have agreed upon a high precision of the responses as they are both specific and detailed. All answers demonstrated relevance to the prompts and were on target with both the subject matter concerning each discipline and the intent of the requests. The results also found that all the responses had a logical flow and consistent reasoning that showed breadth and persuasiveness. However, one aspect that ChatGPT's capability that was not mature enough was originality: ChatGPT is trained to store a vast amount of accumulated knowledge that is designed to generate human-like responses based on the patterns and data found in its system, therefore, the responses

contained the perspectives based on the established knowledge and practices in that specific field.

Overall, this study provided experimental evidence of ChatGPT's strong capabilities. It has developed an ability to produce responses with critical thinking, just as humans, rather than merely retrieve information l. This ability far exceeds the current capabilities of search engines. Therefore, aiming to investigate the effect of ChatGPT on online exam integrity, the researchers proposed the risk that students could cheat on their online exams using ChatGPT without being noticed as the responses produced are nearly indistinguishable from human writing. This study raises a serious concern for every educator: How should online exams go forward with ChatGPT's strong capability in generating human-like responses? ChatGPT is particularly robust in doing human examinations– it already has the capability to pass the U.S. Medical Licensing Exam (USMLE) without special training or reinforcement (DePeau-Wilson, 2023). Kung (2022) found that ChatGPT's performance on USMLE scored a 50% accuracy across all the exams and achieved more than 60% in its analyses, researchers concluded them to have "demonstrates a high level of concordance and insights in its explanations", which suggests that the large language models like ChatGPT may have applications on medical education and potentially clinical decision-making process (Kung, 2022).

Meanwhile, ChatGPT is not solely used for the purpose of generating responses for exam questions in education. In the academic world, researchers began to use ChatGPT for their research papers and even listed ChatGPT as a co-author in a new research paper focused on testing the technology's usefulness in medicine (DePeau-Wilson, 2023). One study published by van Dis (2023) explores how using a large language model like ChatGPT for highly

specialized research is likely to add inaccurate, biased information to the paper, therefore putting the validity and professionalism of the research project at risk (van Dis, 2023). Susnjak (2020) holistically evaluated ChatGPT's capabilities in producing human-like texts with critical thinking and logical reasoning; his research tested its ability to summarize a systematic review and found its responses to have several severe issues, including factual errors, misinterpretations, and wrong data. In asking ChatGPT to summarize a study on the effectiveness of cognitive behavioral therapy published in JAMA Psychiatry, it wrongly stated the number of studies to be 69 when it was actually 46 studies. ChatGPT also exaggerated the effectiveness of CBT (Van Dis, 2020). The researchers concluded that such errors that existed in ChatGPT are highly relevant to the absence of relevant articles in ChatGPT's training system, resulting in the inability to distill relevant information or distinguish between credible and unreliable sources.

ChatGPT and its application in medical and the healthcare field

Large Language Processing Models, such as ChatGPT, can be huge factors of change in the medical field. ChatGPT has the ability to offer information on public health concerns encompassing infectious diseases, chronic illnesses, and environmental health hazards. This capacity enables it to address inquiries concerning health promotion and disease prevention strategies, providing practical examples such as guidance and information regarding healthy lifestyle choices, vaccinations, screenings, early detection methods, risk factor reduction, and environmental health measures (Biswas, 2023). Cascella and their colleagues undertook a study to assess the viability of incorporating ChatGPT into healthcare, particularly within clinical settings. The researchers tasked ChatGPT with composing a

medical report for a patient who was admitted to the intensive care unit (ICU), while providing details on "ongoing treatments, laboratory samples, blood gas analysis parameters, as well as respiratory and hemodynamic measurements". When asked to produce a structured note, ChatGPT demonstrated the ability to accurately classify the majority of these parameters into their respective sections, even when they were presented solely with abbreviations without accompanying information about their significance. Furthermore, ChatGPT exhibited a remarkable aptitude for self-correction, effectively rectifying the misplacement of parameters by simply inquiring about the appropriateness of their respective sections, without requiring additional prompts. Impressively, it demonstrated the capacity to offer insightful recommendations for subsequent treatments, drawing from the available information. ChatGPT's most notable performance manifested in its ability to summarize information succinctly, employing technical terminology for seamless inter-clinic communication, while seamlessly transitioning to plain language for effective communication with patients and their families (Cascella, 2023).

AI also has the potential to analyze medical images, detect diseases, and generate personalized treatment plans for patients. It is also predicted that Large Processing Models such as ChatGPT will be largely used in alleviating mundane responsibilities such as data entry and appointment scheduling, something that would need human employment to do (George, 2023). The integration of AI into healthcare systems is expected to witness a progressive surge in its implementation within medical care on a daily basis

ChatGPT's application in business– Capabilities, Impact, Concerns

The arrival of ChatGPT marks an AI revolution in the job market. Research has

shown that ChatGPT can serve as an adequate replacement for most jobs that exist in the market. Muhammad (2023) shows that 43% of employers are thinking of using ChatGPT to replace some workers because its product is comparable at a much lower cost. Looking at the big picture, more employers envision using AI to replace most human jobs is ultimately becoming an inevitable trend (Muhammad, 2023). As evidence shows, ChatGPT has very robust systematic functions for business purposes. A study published in Finance Research Letters, *ChatGPT for (Finance) Research: The Bananarama Conjecture* shows that ChatGPT has significantly assisted with finance research because of its capabilities in idea generation and data identification. With the focus on cryptocurrencies as the finance research topic, Dowling and Lucey, as cited in Cargill and O'Connor, 2021, started the empirical approach through the main four stages– "idea generation, prior literature synthesis, data identification and preparation, and testing framework determination and implementation" (Cargill and O'Connor, 2021). The empirical research findings demonstrate that ChatGPT has the ability to produce fundamental research studies suitable for prestigious journals, particularly enhanced through the utilization of private data and iterative refinements by experienced researchers. Dowling and Lucey also concluded that the results would be even stronger with the introduction of GPT-4 as the underlying generative model launching in 2023, which was said to be a "truly revolutionary language model due to advances in algorithms and over 600 times greater testing parameters" (Dowling, 2023). Similarly to its role in education and academics, ChatGPT has already influenced the future of business operations and it is predicted that AI will begin to reduce employment for college-educated workers in the next five years. Generative AI, such as ChatGPT, has the capability to harness user inputs and prompts, as well as the knowledge acquired through interactions with users, to produce content that is perceived as a product of human creativity. This ability allows it to generate entirely novel content by incorporating learned information and creative insights. Even though generative AIs are still in their early days of scaling, businesses have already started utilizing ChatGPT as a tool across different functions in marketing and sales, operations, and HR to IT/Engineering, risk and legal, etc (Chui, 2022). For instance, ChatGPT can be a powerful tool to revolutionize digital marketing and e-commerce by using its natural language processing and machine algorithms. ChatGPT is also capable of efficiently and effectively utilizing analytic tools to develop digital marketing campaigns; it has been trained on extensive datasets from various industries and organizations, providing valuable insights that the company might not have otherwise invested in obtaining. For customers, ChatGPT will assist them by swiftly addressing their inquiries regarding products and services, eliminating the need to wait for a human representative or navigate convoluted menus to find the desired information. Moreover, its improved translation feature allows ChatGPT to understand user requests in various languages worldwide, granting companies enhanced access to new markets. This capability can potentially result in increased sales from previously inaccessible regions due to language barriers with potential buyers or customers abroad (George, 2023). Below in Figure 1 lists the use of ChatGPT in different categories of business functions.

There are many possible generative AI use cases across the business that could create early impact.

Example use cases[1] (not exhaustive)

Marketing and sales	Operations	IT/engineering	Risk and legal	HR	Utility/employee optimization
Write marketing and sales copy including text, images, and videos (eg, to create social media content or technical sales content)	**Create or improve customer support chatbots** to resolve questions about products, including generating relevant cross-sell leads	**Write code and documentation** to accelerate and scale developments (eg, convert simple JavaScript expressions into Python)	**Draft and review legal documents,** including contracts and patent applications	**Assist in creating interview questions for candidate assessment** (eg, targeted to function, company philosophy, and industry)	**Optimize communication of employees** (eg, automate email responses and text translation or change tone or wording of text)
Create product user guides of industry-dependent offerings (eg, medicines or consumer products)	**Identify production errors, anomalies, and defects** from images to provide rationale for issues	**Automatically generate or auto-complete data tables** while providing contextual information	**Summarize and highlight changes** in large bodies of regulatory documents	**Provide self-serve HR functions** (eg, automate first-line interactions such as employee onboarding or automate Q&A or strategic advice on employment conditions, law, regulations, etc)	**Create business presentations** based on text prompts, including visualizations from text
Analyze customer feedback by summarizing and extracting important themes from online text and images	**Streamline customer service** by automating processes and increasing agent productivity	**Generate synthetic data** to improve training accuracy of machine learning models with limited unstructured input	**Answer questions from large amounts of legal documents,** including public and private company information		**Synthesize a summary** (eg, from text, slide decks, or online video meetings)
Improve sales force by, for example, flagging risks, recommending next interactions such as additional product offerings, or identifying optimal customer interaction that leads to growth and retention	**Identify clauses of interest,** such as penalties or value owed through leveraging comparative document analysis				**Enable search and question answering** on companies' private knowledge data (eg, intranet and learning content)
Create or improve sales support chatbots to help potential clients understand, including technical product understanding, and choose products					**Automated accounting by sorting and extracting documents** using automated email openers, high-speed scanners, machine learning, and intelligent document recognition

[1] Given that generative AI is in the early stages of maturity, organizations will want to consider use cases and their implications carefully and determine the appropriate level of human oversight.

McKinsey & Company

Figure 1, ChatTGPT's application in different categories of business functions (George, 2023).

As Figure I shows, ChatGPT has strong capabilities and wide application to many areas of business. Because of that, it also gives an opportunity for companies looking to cut costs by automating processes as ChatGPT can perform tasks that were previously thought to require a high level of education and professional knowledge. Figure 2, demonstrates that more than 32 percent of employers in the software and tech industry are willing to pay over $250 for ChatGPT as it can possibly lower the cost of hiring technical engineers.

Top 5 industries willing to pay >€250 per month for ChatGPT

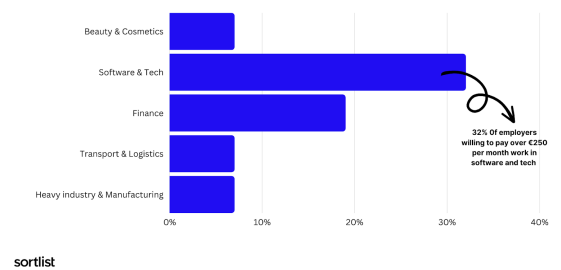32% Of employers willing to pay over €250 per month work in software and tech

sortlist

Figure 2, Top 5 industries that are willing to pay more than $250 per month for ChatGPT (Muhhamad, 2023).

The rise of ChatGPT and AI in general could lead to a significant displacement of workers and alter the employment environment permanently: an Oxford study estimates 47% of US jobs will be at risk (Lowrey, 2023).

ChatGPT's limitations and areas of improvements

Even though ChatGPT has been proven to be a powerful tool and has affected different areas of human life such as the academic, healthcare, and business world, the relatively new technology still has a few functional limitations. Several researchers conducted experiments and discovered several capabilities that are still limited and contain errors. In Jiao (2023), Jiao and his colleagues conducted an experiment and reported on ChatGPT's ability to translate multilingual texts. Researchers compared the translation product with commercial translators already available in the market, namely Google Translate, Deep L translate, and Tencent TranSmart. The results have shown that ChatGPT performs competitively with commercial translation products on high-source European Languages, but lags significantly on low-source languages (Jiao, 2023). Moreover, ChatGPT's current maximum input is 5000 tokens. Although ChatGPT provides good responses in most circumstances, it is still limited in tasks such as text summarization that is over its maximum

capacity. Another limitation is that ChatGPT does not support uploading files, images, and audio, and it also can't produce the same responses when generating responses for the same input question (Bang, 2023). Moreover, ChatGPT's database can only fetch information about events and incidents prior to September 2021. It shows that the preprogramming is limited in accessing all sources of information needed to provide the latest news as they usually require a human touch to ensure accuracy and relevance (Geroge, 2023).

The limitations described above are some examples that show ChatGPT is not fully capable of applying to all three of the main fields of human society: the academy, healthcare, and business. ChatGPT's current level of sophistication lags significantly behind that of a real human being, who possesses the ability to think critically and creatively. Similarly, AI systems in general do not yet have any form of emotional intelligence which can make this technology inapplicable in areas where they need to understand subtle social situations and work with human beings outside of highly controlled environments like customer service chatbots. Within the realm of medicine, ChatGPT exhibits a notable constraint in addressing causal relationships among conditions (George, 2023). This limitation potentially stems from the incompleteness or lack of currency in its information sources, which hinders the establishment of precise causal connections. Furthermore, since ChatGPT is not tailored explicitly for medical applications or adept at addressing medical inquiries, it lacks the requisite medical expertise and contextual comprehension necessary to fully grasp the intricate interplay between various conditions and treatments (Cascella, 2023).

Future concerns, ethical considerations with ChatGPT and other Language Processing Models

The rise of ChatGPT and other language processing models is a significant transformation of human daily life, therefore, it is advised to use all AI tools and models with caution and further verification of their capabilities and limitations. Ethical considerations play a significant role in determining the boundaries of the technology used. Ray, (2023) points out several ethical considerations surrounding the use of ChatGPT in scientific research in the areas of data privacy and security, the misuse and abuse of the technology for malicious purposes, and potential bias and discrimination associated with the trained datasets. There were several cases associated with ChatGPT that raised further debate and deep controversies. One example from February 2023, a Colombian judge, Juan Manuel Padilla made headlines after he used ChatGPT in a legal ruling of a health insurance coverage related case. In another, a tech startup, Koko, used ChatGPT to generate content to facilitate mental-health-related conversations among users. Finally, the Sci-Fi magazine Clarkeswrold was inundated with AI-generated story submissions (Ray, 2023). The production of scientific research with the assistance of ChatGPT also raises concerns over plagiarism, especially if ChatGPT is listed as a co-author of the paper. Organizations such as the influential Committee on Publication Ethics (COPE) and the World Association of Medical Editors (WAME) called for banning AI authorship, which has led to influential journals including *Nature* banning AI authorship. Ultimately, the researchers at *Nature* suggest staying away from "a futile arms race between AI chatbots and AI chatbot detectors", and that researchers and the academic community should treat the use of LLMs like ChatGPT with "integrity, transparency and honesty." The expert-driven fact-checking and verification processes," are accountable for scientific practices (Van Dis, 2023).

Conclusion

ChatGPT has shown enormous impact and played a significant role in different aspects of human society, namely the education, health care, and business fields. As one of the cutting-edge developments that signifies the advancement of AI technology, ChatGPT exhibits remarkable capabilities, such as critical thinking, logical reasoning, and natural language understanding. In the education segment, academic integrity is at risk because of its high performance in human exams and its ability to produce responses that are highly indistinguishable from human writing. ChatGPT has significantly affected the medical field by working on clinical inquiries and offering insightful recommendations for patient treatments, even having the potential to analyze medical images and detect disease. Companies and businesses are increasingly applying the ChatGPT technology across multiple areas, namely finance, IT, and operations. They also seek out the opportunity to embrace technological advancement to lower people costs and replace limited jobs in the job markets with AI.

However, the journey with ChatGPT also brings to light its limitations and ethical considerations. While ChatGPT demonstrates impressive performance, it still lacks the depth of understanding and emotional intelligence inherent in human thinking. Its limitations include language and knowledge boundaries, an inability to process certain types of content, and potential biases embedded in its training data. These constraints underscore the importance of cautious and responsible use of such technology. The ethical concerns surrounding ChatGPT are significant. The potential for misuse, the blurring of lines between human and AI authorship, and the risk of generating biased or inaccurate information raise critical questions about its impact on scientific integrity, privacy, and security. Addressing these ethical dilemmas and establishing clear guidelines for the use of AI tools in research, communication, and decision-making will be essential for navigating the evolving landscape of AI-powered technologies.

As we move forward, it is clear that ChatGPT and similar language processing models will continue to shape our interactions with technology and each other. Their deployment requires a balanced approach that combines human expertise with AI capabilities to ensure accurate, reliable, and ethical outcomes. Its strengths and limitations, its potential benefits and risks, underscore the need for ongoing research, collaboration, and ethical discourse. As society navigates the ever-expanding realm of artificial intelligence, it is imperative to harness the potential of ChatGPT while carefully considering its implications, thereby shaping a future where AI and human intelligence coexist in harmony and mutual benefit.

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Is Safety More of a Priority Than Fun?

By Peichen (Payson) Dong

AUTHOR BIO

Payson Dong was born in Hong Kong, raised in Shenzhen, and is now attending a boarding school. He found his voice through writing stories filled with fantastical experiences, and to date has built a portfolio with poems, essays, short stories, and a novel. Art has also become a voice for his emotions. He enjoys experimenting with colors and forms to create artworks, and merging art with technology such as Python and Midjourney. His interests are diverse including squash, coding, math, and Latin. These activities have shaped him into an individual full of love and inspiration.

ABSTRACT

The human desire for security has deep evolutionary roots, prioritizing safety over enjoyment. Early humans faced various threats and developed vigilance to survive. This tendency to prioritize security is evident in the negativity bias, where negative stimuli receive more attention than positive ones. Understanding this desire for safety helps us appreciate its importance in modern enjoyment. Safety is paramount when seeking pleasure. Neglecting safety protocols can turn enjoyable experiences into tragedies, as seen in drowning statistics. Ensuring safety in recreational activities enhances enjoyment and minimizes risks. Fear, stemming from the absence of security, hinders enjoyment. Crime rates and neighborhood safety affect individuals' well-being. Addressing safety concerns fosters relaxation and enjoyable experiences. Prioritizing safety fosters trust and security in communities, improving mental health and overall satisfaction. Safe environments enable social connections, fulfilling higher-level needs. Balancing thrill-seeking with safety is essential. While thrill-seekers report higher happiness levels, they engage in riskier behaviors. Finding a balance between excitement and safety is crucial.

Keywords: Maslow's Hierarchy of Needs, security, enjoyment, risk, crime rates,mental health, social connections, higher-level needs.

INTRODUCTION

Safety and fun are two essential components of the universal human experience. According to Maslow's Hierarchy of Needs, both aspects are significant contributors to fulfillment. Security, defined as a state of being free from danger, risk, or injury, is closely tied to the second tier of the hierarchy, representing our need for physical, emotional, and financial stability. Fun, on the other hand, encompasses the enjoyment and amusement we derive from various activities and experiences. As an individual progresses through the levels of Maslow's pyramid, the pursuit of enjoyable experiences can lead to a greater sense of belonging, self-esteem, and even self-actualization. When making decisions in our careers, hobbies, and lifestyle choices, however, it is vital to prioritize security over fun. A secure environment lays the foundation for pleasurable experiences, further enabling us to effectively satisfy our higher-level needs and achieve personal fulfillment.

The Origin of Safety

The desire for a secure environment has been ingrained in human beings long before their desire for enjoyable experiences. Evolutionary psychologists suggest that our ancestors prioritized security when navigating the dangers of their environment, as it was a crucial factor in our survival as a species (Buss, 2015). According to Maslow's Hierarchy of Needs, safety is a fundamental human need that must be met before anyone can pursue higher-level needs such as social connections or self-actualization, which often involve seeking some form of enjoyment.

Early humans faced numerous threats, such as predators and natural disasters. In response to dangers, they developed a heightened sense of vigilance, allowing them to

better detect and avoid risks (Öhman & Mineka, 2001). This tendency to prioritize security over enjoyment is still evident today. Humans are more likely to respond excessively to negative or threatening stimuli than to positive or neutral ones, a tendency called the negativity bias (Rozin & Royzman, 2001). By understanding the evolutionary roots of our innate desire for safety, we can now better appreciate the importance of prioritizing security in humans' modern pursuit of enjoyment.

The Importance of a Secure Environment for Fun

When it comes to seeking pleasure, maintaining a secure environment should always be a priority. Pleasurable experiences can quickly turn into a tragedy when people do not follow basic safety protocols. According to the World Health Organization, drowning accounts for over 320,000 deaths every year, and the majority of these cases could be prevented with the enforcement of proper safety measures (WHO, 2021). Ensuring safety in recreational activities, such as swimming, can greatly reduce the risk of accidents and enhance overall enjoyment for all participants.

Here is another example: during my birthday party last year, I organized a boxing class for my friends and me. The boxing coaches prioritized our group's safety by providing us with adequate safety equipment and giving us clear instructions on how to avoid injuries during the class. Their attention to safety and overall care allowed us to fully enjoy the experience and create lasting memories without worrying about potential risks.

The Absence of Security Brings Fear and Hinders Fun

Fear is a powerful emotion that can prevent us from enjoying life to its fullest. When

a secure environment is absent, feelings of fear take over, making it impossible to have pleasurable experiences. The relationship between fear and the absence of safety is seen in crime rates and their impact on individuals' well-being. A study published in the Journal of Health and Social Behavior found that people who perceived their neighborhoods as unsafe, due to social disorder, reported higher levels of subjective alienation and distress (Ross & Mirowsky, 2009). Therefore, it is not an extreme claim to say that addressing safety concerns and creating secure environments would allow individuals to relax and engage in enjoyable experiences without fear.

Consider the following: during a trip with friends last October, we stayed at a camp on a mountain. One night, my friend asked me to venture outside the camp. However, I believed that we should not explore unfamiliar places without parental consent. Recognizing the potential risks associated with wandering off in an unknown area, especially at night, I erred on the side of caution. This decision kept us safe and reinforced the importance of considering safety first when seeking enjoyment or adventure.

Prioritizing Security Can Foster a Sense of Trust and Security

Prioritizing safety can foster a sense of trust and security within a community, contributing to overall well-being and allowing for more meaningful and fulfilling enjoyment. Safe environments provide a strong foundation for individuals to form social connections, which are essential for meeting higher-level needs in Maslow's Hierarchy, such as love and belonging. A study published in the American Journal of Public Health found that communities with higher levels of trust and social cohesion reported better mental health outcomes and overall life satisfaction (Ehsan et al., 2019). By

implementing safety precautions and fostering a secure environment, community members can feel at ease participating in different types of events and activities, allowing them to build stronger connections and experience greater enjoyment.

During a family vacation to the Maldives, we went snorkeling. The snorkeling center sent us detailed instructions on how to prevent dangers in the sea, including wearing life jackets, staying within designated areas, and following the buddy system. Their emphasis on safety fostered trust, allowing my family to fully enjoy the breathtaking underwater scenery without any fear or apprehension.

Thrills, Spills, and the Quest for Balance

Some people might argue that one should prioritize enjoyment instead of safety. One reason is that taking risks can be thrilling and exciting. Engaging in risky activities like bungee jumping, skydiving, or fast driving may lead to unnecessary casualties, but thrill-seekers may value the enjoyment above their potential dangers. While a study by the National Center for Biotechnology Information (NCBI) found that thrill-seekers had higher levels of happiness and life satisfaction, it also revealed that they were more likely to engage in risky behaviors that could lead to severe injuries or death (Zuckerman & Kuhlman, 2000). Therefore, it is crucial to find a balance between seeking excitement and ensuring a secure environment.

Conclusion

In conclusion, prioritizing safety over enjoyment is a crucial aspect of fulfilling human needs outlined in Maslow's Hierarchy. By focusing on creating a secure environment, we ensure that individuals can freely engage in enjoyable activities without worrying about potential hazards. Addressing safety protocols as

a priority not only eliminates the fear that inhibits our capacity for enjoyment but also emphasizes its foundational role in fostering well-being and personal growth. Moreover, prioritizing safety promotes trust within communities, laying the groundwork for higher levels of the hierarchy, such as love and belonging, esteem, and self-actualization to be satisfied. Ultimately, placing safety at the forefront of decision-making enables us to maximize the pleasure and enrichment that enjoyable activities bring to our daily lives while also contributing to the overall quality of our shared experiences and human evolution.

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