

# BISV:

# The Scope

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## *A Letter from the Editorial Team*

Welcome to the Fourth Edition of the BISV Research Journal, now known as the Scope! After a highly successful edition last fall, we are extremely excited to announce the second publication in the 2023-24 school year. This will also be our third edition since transitioning to an interdisciplinary research journal, and the second edition with articles written by our own editorial board about important and fascinating recent advances in STEM. We've also changed our name from this edition in order to better reflect the community of students and the work we represent.

We wanted to give special thanks to the array of capstone projects we have been able to accept this edition. We'd like to extend special thanks to Mr. Meyerowitz and his students from the Existentialism and Absurdism class for allowing us to publish their work. Congratulations to the seniors on their fantastic work; the editorial team wishes them luck in all their future endeavors! Our current co-editors-in-chief will also be graduating this year, and we wanted to take this moment to acknowledge their hard work in taking this journal to new heights.

As for the rising high school students, we're excited to be a part of your journey in exploring your potential and applying your learning to further our world. We've seen so much growth in the paper this year, and can't wait to see what happens next year. We aim to continue our mission of showcasing the amazing talent at our school while inspiring others to take part. We hope to lead the way and encourage our Bobcats to eagerly share and contribute their research in order to help benefit and introduce others to the possibilities beyond just what we learn in class. Leaving you with these wishes, the editorial team will see you again in the 2024-2025 school year!

Always looking forward,

Dr. Karen Allendoerfer - *Scope* Advisor

Jeonghyun An - Co-Editor-in-Chief

Ellie Xi - Co-Editor-in-Chief

Aanya Gupta - Senior Editor

Iris Li - Senior Editor

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Joy Zhu - Senior Editor

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# *Science In The News*

## *Astonishing New Discoveries To Revolutionize Today's Cancer Treatments*

Aanya Gupta

Scientists have made yet another amazing advancement in the field of oncology. The discovery promises to set a precedent for future treatments and bring the world one step closer to a developed cure for cancer. Fibrolamellar hepatocellular carcinoma (FLC) is a rare liver cancer, characterized by a chromosomal rearrangement resulting in the fusion of the DNAJB1 and PRKACA genes, which leads to the expression of a fused protein with abnormal kinase activity. This means the protein doesn't properly execute its cell function. Kinase dependent signaling pathways help cells communicate and normally prevent deregulated cell proliferation, and so are often altered in cancer cells. There are currently no effective treatments for FLC, and patients often face poor outcomes due to the lack of targeted therapies and the limited efficacy of conventional treatments such as chemotherapy, radiation, and surgery. Interestingly, only recently in 2014, researchers in a lab run by Dr. Sanford Simon at Rockefeller University discovered that this fusion was the cause of FLC, a few years after Simon's own teenage daughter, Elana, was diagnosed with the deadly liver disease (she later worked at the lab after having the tumor removed, thanks to them being able to catch it very early on). FLC tumors are completely dependent on the fusion kinase DNAJB1::PRKACA mentioned earlier, making this protein an ideal drug target.

In recent years, mRNA degrading modalities such as antisense oligonucleotides or small interfering RNAs (siRNAs), which attack mRNA before it can be translated into dysfunctional proteins, have become more prevalent. They have emerged as a promising therapeutic strategy for various diseases, including cancer. However, the clinical application of RNAi (the more general term) has been hindered due to two main reasons. Firstly, these conventional small-molecule inhibitors have yet to demonstrate specific targeting. For example, they can inhibit the kinase activity of fusion DNAJB1::PRKACA but show no specificity to it, and so also tend to inhibit the normal kinase and rapidly distribute throughout the body, resulting in side effects and limited efficacy. The other big issue is the difficulty in delivering small interfering RNAs (siRNAs) to target cells and tissues, because siRNAs are unable to cross the cell membrane.

To address these challenges, various siRNA delivery systems, including nanoparticles, liposomes, and conjugates have been developed. Among these, conjugates of siRNAs with ligands that specifically bind to receptors on target cells have shown promise for the targeted delivery of siRNAs. Because FLC is a liver tumor, scientists in the Simon's lab hypothesized that siRNAs conjugated to the ligand N-acetylgalactosamine (GalNAc) will go and bind to their specific receptor, the asialoglycoprotein receptor (ASGR), which is highly expressed on liver cells. GalNAc-siRNA have already been used for other ailments, such as hereditary transthyretin mediated amyloidosis and atherosclerotic cardiovascular disease. This approach using GalNAc-conjugated siRNA limits distribution to only the siRNA to the liver and tumor tissue, thereby efficiently concentrating the siRNA in the target tissue to achieve robust knockdown of DNAJB1-PRKACA (50% decrease in mRNA and protein levels in mice experiments) with no apparent toxicity. Translating these experimental results to clinical efficacy basically meant that tumor growth was inhibited though not killed completely.

While future research hopes to improve on this efficacy to reach 100% inhibition (completely killed), even at its current level this strategy offers a lot of hope. It clearly shows how chemical modifications of RNA in conjunction with efficient delivery systems such as GalNAc conjugation have transformed siRNAs from a powerful laboratory tool to a promising field of therapy, especially for cancer.

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## *Genetic Sequencing with the Assistance of AI*

By Cindy Liu and Joy Zhu

Genomic sequencing, a technique used for determining the sequence of an individual's genome has been a subject of interest in genetic studies and clinical hereditary disorders for decades. For rare or complex genetic disorders, sequencing is often used to determine the mutation, typically one that is not well known or well researched because of its rareness. From this emerges the opportunity for the use of precision medicine, personalized medication specifically modified for the best treatment for individuals or groups, especially those with rare disorders. It is here that we can enlist the aid of artificial intelligence (AI), algorithms that mimic how neurons in a human brain would function, used for detecting patterns in data and outputting the ones requested by the user. The implementation of AI into genetic sequencing is a relatively new idea—AI plays a role in assisting the mapping of DNA fragments using deep learning; facilitating the process of genome sequencing by using convolutional neural network models, which recognizes patterns in the DNA reads; and thus making it easier to identify which spot the DNA fragment belongs in.

Next-gen sequencing (NGS) is a method commonly used for genome sequencing. First, DNA strands are cut into smaller fragments, with additional nucleotides called adaptors attached onto each end. Next, fragment adaptors are attached to flow cells by forming hydrogen bonds with the complementary adaptor on the flow cell. Adaptors on both ends of the fragment bind to the complementary primers, which are RNA sequences that initiate DNA replication, that are located on the flow cell and initiate a polymerase chain reaction (PCR), elongating the DNA fragment. PCR is used with labeled fluorescent nucleotides, with each type of nucleotide emitting a different color light when stimulated by a laser. The elongated fragment sequences are then copied numerous times via bridge amplification, where one end of the fragment attaches to a primer and the other end to another primer. These fragments are inputted into a machine, which uses mass parallel processing to detect each individual fluorescent nucleotide for each fragment and subsequently create forward and backward reads, inferred sequences based on the DNA fragments in the direction DNA strands may run in—5' to 3' or vice versa. Finally, reads would be mapped onto a reference sequence, a pre-existing sequence that is the most common genomic sequence and normal genotypes.

Next-gen sequencing without using AI would be much more tedious, due to the millions of short sequences of DNA fragments produced from NGS sequencing. Typically, reads will be aligned based on overlapping sequences with the reference sequence by mapping the reads on a software,

which biotech companies like Illumina can provide. However, AI can simplify this process. In NGS, AI plays a role in automating the process of data analysis by finding the best matching sequences and screening for errors in sequencing with more precision, as well as finding mutated sequences in genes that cause disease phenotypes. In addition, AI can search for variants in genes, which helps with identifying the most relevant and common mutations, as well as new mutations. Some AI models can also detect specific mutations such as splicing defects, which is useful due to the vast number of disorders related to problems with mRNA splicing. Many AI models already exist for each of these purposes, such as DeepVariant and Fabric GEM, and they will only be further optimized in the future for better accuracy and efficiency.

The AI that is used in NGS is a deep-learning algorithm known as a convolutional neural network (CNN). Through dividing a DNA sequence into smaller subsamples to which various filters are applied, patterns in the subsample data are uncovered and subsequently used to create feature maps. Feature maps depicting patterns in subsamples of a DNA sequence are used to train the AI, through algorithms such as logistic regression, to correctly classify DNA. As the CNN is trained using large amounts of data, it creates many feature maps through which the algorithm learns how to identify patterns and to differentiate or categorize objects, and is then tested on new data to verify the model's accuracy. This algorithm is commonly used in computer vision for object recognition, and in genome sequencing it is used to distinguish and classify nucleotides in the DNA reads. Genes are broken down into subsamples, which are then filtered and analyzed for specific sequences by pattern recognition. The classifier then decides what label to classify the sequence under, such as whether the sequence is a binding site or not.

With the help of AI, the process of genetic sequencing has simplified yet also become more efficient. As technology continues to advance, we hope to continue decreasing the cost and time required for genetic sequencing, while bringing more benefits to society. But for our hopes to become a reality, AI models would need to be more optimized and give more accurate results, improving the process of sequencing to have lower error rates.

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## Measuring the Eye-Body-Brain connection with Video Games

Iris Li

Ophthalmologists are those who treat and diagnose problems with the eye. Recently, it has been discovered that video games could be used as an easier method to evaluate eye health and the eye-brain-body connection. This allows ophthalmologists to add something fun in the process of evaluating one's vision health.

The team started the development of the VPI eight years ago. The index was like the IQ test, in which the average VPI was 100, and the higher it was, the better one's eye-brain-body connection and performance were. It was developed based on a willing participant's performance in the games. Participants played two games, Balloon Pop and Picture Perfect. Balloon Pop's goal was to pop balloons with a certain pattern, while Picture Perfect was to adjust photos to match their original color saturation. Each game was played two times by participants. Through each game, the team measured five domains of vision to find signs of diseases.

In a recent Stanford Medicine study, researchers used video games to evaluate participants' field of vision and visual stamina, along with other factors. The researchers acknowledge the weaknesses of the visual acuity test, which is not 100% accurate. They wanted to find another measurement that could get rid of the possible errors. This is when they developed a different approach to assessing vision health called the "Vision Performance Index(VPI)". It was based on five domains of vision. Researcher Khizer Khaderi claims that VPI is important because it captures every domain that could be influenced by disease, and it's accessible because it can be done through interactive media.

Khaderi hopes that VPI will become more widespread, helping doctors and researchers to improve their understanding of the eye-brain-body connection.

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## *Neuralink: Unraveling the Ethical and Technological Frontiers of Neural Interfaces*

Linda Wang and April Li

During the 21st century, the rise of artificial intelligence has added more potential and innovation in terms of developing technology in modern industries. The neurotechnology segment has been one of these areas that has experienced several market expansions and rising consumer expectations. According to Precedence Research, "the global neurotechnology market size was projected to hit around USD 38.17 billion by 2032, growing at a CAGR of 11.53% during the forecast period 2023 to 2032." Brain-computer interface (BCI) is a segment within the neurotech market that focuses on building a direct connection between external devices and human's cognitive or sensory-motor function. Remarkably, the global brain computer interface market is expected to "reach \$5340.38 million [5.3 billion] by 2030" (Strategic Market Research), and the BCI segment will occupy around 14% of the neurotechnology market shares.

One neurotechnology company working on brain-computer interfaces is Neuralink. Neuralink is a United States-based neurotechnology company, founded by Elon Musk and a team of

scientists and engineers, aiming to provide generalized implantable BCIs to aid people with quadriplegia. On January 29, 2024, Elon Musk announced, on X, Neuralink's first brain chip implant in a human patient. Recently on February 19, Musk updated that the patient was able to move a mouse with their mind. The testing is part of the company's goal to manufacture a product that can enable people to control devices like phones and computers "just by thinking."

The brain chip itself is around the size of a coin and it works by registering brain activity and converting it to digital signals to communicate with other devices. It contains 1024 electrodes distributed across 64 extremely fine threads. The chip is designed to be embedded under the skull and a surgical robot was developed to insert its threads into the brain's cerebral cortex, the portion of the brain involved in information processing. Prior to the human trial, Neuralink tested the chip on several animals including pigs and monkeys.

Neuralink isn't the first to implant a device in a human brain though. BCIs have been tested in humans and animals for several decades already. In 1998, Philip Kennedy was able to implant a BCI in his patient, Johnny Ray, who suffered from Locked-in syndrome, which allowed Ray to type words out using his mind. Neuralink's technology can potentially help those suffering from conditions like paralysis or neurological disorders. Additionally, it poses potential when it comes to human "enhancement" and enhancement in cognitive abilities like memory and learning.

Despite the various potential benefits, Neuralink's brain chip and experimental procedures are not without criticism. Overall, critics predominantly focus on potential ethical, health, and security concerns regarding the chip.

Several of these concerns center around Neuralink's status as a private company. Many scientists expressed that "When scientific research is funded by government agencies or philanthropic groups, it aims to promote the public good. Neuralink, on the other hand, embodies a private equity model [...] [private investor] may strive to do good, but they also strive to maximize profits, which can conflict with patients' best interests" (FastCompany).

Experts were also concerned about the "lack of transparency" of Neuralink's scientific experiments and clinical trials. Marcello Ienca, a professor of ethics of AI and neuroscience at the Technical University of Munich, criticized Neuralink's utilization of social media as the primary medium for illustrating and publicizing experimental procedures and results "rather than traditional outlets for science like peer-reviewed publications, public repositories or even simple pre-prints." Some experts note that it is unethical and dangerous to show the experimental process directly to the public while skimming the process of discussion and critique by other professionals in the field. "A tweet is not exactly a peer-reviewed scientific report," said L. Syd M Johnson, an ethicist at SUNY Upstate Medical University" (Forbes).

Additionally, many critics were concerned with potential data security risks, such as patients being "brain hacked" and information and privacy violations. In a recent interview with The U.S. Sun, Roger Grimes, a cybersecurity expert of 35 years, said that "currently, the chips are not clearly advertised as Internet-connected, which reduces cybersecurity risks, but cybercriminals would still need to overcome several obstacles. These include understanding the chip's unique operating system, which is likely not common software, making it harder to hack." In this case, it can be inferred that

Neuralink can take comprehensive measures to prevent potential hacking and cyber-attacks by establishing reliable security protection systems on its BCI chips.

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## *Crypto Economic Impact Only Grows*

Vedh Reddy

Crypto is a decentralized, anonymous, and powerful currency, taking over transactions all over the world. As it's a new system of trading and bartering, it is bound to have large scale effects on the economy. Crypto Technology - Impact on Global Economy, by Arunkumar Pillai analyzes these effects.

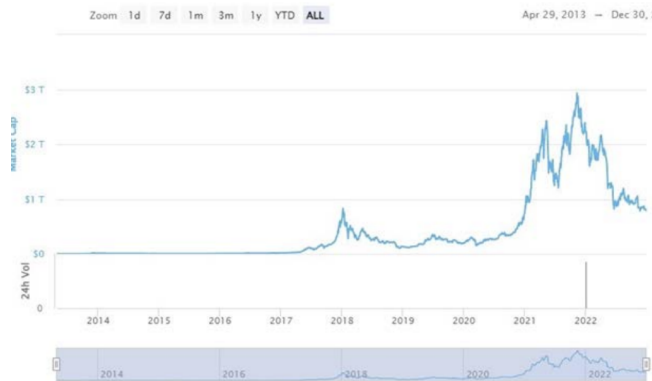
As an introduction and background to the paper, Pillai discusses how crypto came on the rise. It was a fascinating new technology, eliminating an intercessor between the people and money. The impact this has had on the internet and human life is coined Web3.0. He also continues to explain that no one has actually analyzed the large scale effects on the economy. Blockchain technology is and will continue to have significant effects, and we need to fully understand the core of the tech.

After this introduction, he provides some statistics and analysis on the effects on the globalized economy specifically. He shows, crypto related jobs grew 1500% from 2015 to 2019 and the crypto industry severely outpaced the regular tech industry. These statistics are really important to his analysis because we now have to analyze an entirely new form of economics, not one of fundamental principles but one of leaders and the social institutions enforcing order on the flow of money. This combination of decentralization and individuality provides extensive uses for crypto, the most powerful yet to be found.

Next up, he takes a look into some possible uses of blockchain and web3. In his words, "From financial services to retail and e-commerce, media and entertainment, healthcare, IT, government, and energy: Almost every sector is expected to adopt Web3.0 blockchain" (Pillai 2). This is really

important because using these ideas we can dive deeper into how exactly the effects will be made evident. Industries all the way from aircraft industrialization to food security will adopt Web3 technologies, growing at a rate of 44.7% CAGR in the next 6 years. This leads the reader to a specific type of Web3 application, “DAO”’s. DAO’s are groups of people that work together in a decentralized environment towards a common interest.

With these initial observations in mind, the author finally delves into the meat of the paper. What the growth of the crypto economy will look like. Starting off with a chart, the crypto currency market cap comparison:

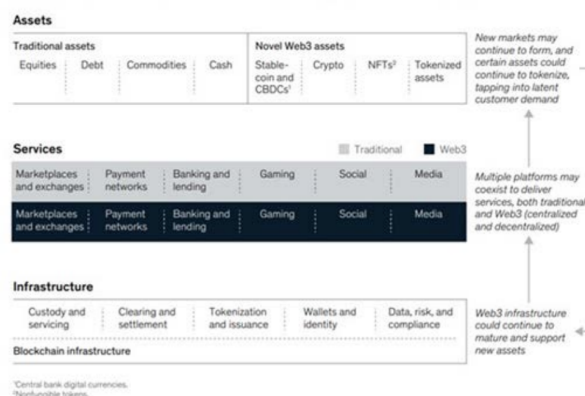


It shows that the digital assets industry grew a lot, but it fell due to high tech rising. Even so, it is poised for another phase of extreme growth.

One example provided was Ripple Labs, a US based blockchain company. They deal with cross border transactions in a carbon neutral way, costing about 0.0002 dollars. These will reach 156 Trillion dollars in 2022, making the economy about 35 Trillion dollars. There were many advantages to this software, faster settlements, cost effectiveness, enhanced security, and improved transparency (the crux of all web3 security).

Investment into this tech has risen significantly as well, rising over 20 Billion dollars in one year. Even with dampeners like the war in Europe, the crypto raised an additional 15 Billion. The industry continues to withstand these factors that should cripple it. A graph of the future in the financial industry is given.

Looking ahead, Web3 could affect financial services in far-reaching ways.



Utilizing decentralized systems and tokens give way for different types of trading like NFTs and tokenized real estate.

In conclusion, this paper talked about the large-scale macroeconomic effects of crypto, ranging from the effects on the economy, crypto, to financial services and even food security. There was also detailed analysis of the industries past and projected growth, allowing us to understand what may come in the future in big tech.

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# Analyzing Two Approaches to Treating Cancer: Chemotherapy Versus Targeted Therapy

Isha Tripathi

## Abstract

Targeted therapy, a form of cancer treatment, has significantly advanced the field of oncology and improved the outcomes of several cancer patients in recent years. However, many hurdles remain in replacing the more toxic chemotherapy that is still in use. These two therapeutic approaches differ in multiple aspects, namely the way they're synthesized or produced, the mechanism of action, the delivery mechanism into cells, and the efficacy or results of these treatments in cancer patients. Unlike chemotherapy, which targets all cells, targeted therapy only targets cancer cells. Beyond the biology that each therapy targets, several factors, including socioeconomic factors, determine the need and availability of these treatments. These socioeconomic factors are cost, availability, scope, and speed. This review article investigates these factors and their differing impacts on types of cancers and patients in the United States. Moreover, we share our perspectives and insights on essential changes on the medical and social fronts that can enhance the reach of targeted therapy to patients worldwide.

## 1. Introduction

### 1.1 Chemotherapy

Cancer is a disease involving abnormal cell growth in a specific body part and can spread to other parts. The standard care for many cancers is chemotherapy, which are drugs that are used to kill cancerous cells or prevent them from growing. Some of the most common chemotherapy types are classified as alkylating agents, plant alkaloids, and antimetabolites. An alkylating agent is a form of chemotherapy that attaches an alkyl group to the guanine base of DNA.<sup>1</sup> Before being used in chemotherapy, alkylating agents were used as sulfur mustards ("mustard gas") in chemical weapons during World War I. Nitrogen mustards were the first alkylating agents used medically and the first modern form of chemotherapy.<sup>2</sup> Today, five types of alkylating agents exist: nitrogen mustards, nitrosoureas, alkyl sulfonates, triazines, and ethylenimines. Some types of nitrogen mustards include bendamustine, chlorambucil, and cyclophosphamide; some nitrosoureas are carmustine, lomustine, and streptozocin; one alkyl sulfonate is busulfan; some triazines are dacarbazine and temozolomide; and some ethylenimines include altretamine and thiotepa.<sup>3</sup> A study about nitrogen mustards found that when nitrogen mustards are combined with small-molecule targeted agents and monoclonal antibodies, the overall response in breast cancer and melanoma, a form of skin cancer, is 100% and 85%, respectively.<sup>14</sup>

Plant alkaloids are small organic molecules that contain nitrogen, usually in a ring.<sup>6</sup> Alkaloid-containing plants have been used as early as 2000 BC in Mesopotamia, and today, they're categorized into five primary types: alkaloids, protoalkaloids, polyamine alkaloids, peptide and cyclopeptide alkaloids, and pseudoalkaloids. Some polyamine alkaloids include coniine and caffeine; some peptide and cyclopeptide alkaloids are ergotamine and amatoxin; and some pseudoalkaloids include colchicine and quinine.<sup>7</sup> A study on tetrandrine found that in breast cancer xenograft mouse models, tetrandrine significantly reduces tumor volume and weight (Figure 1).<sup>15</sup>

An antimetabolite is a substance that inhibits the use of a metabolite.<sup>10</sup> Some types of antimetabolites include 5-fluorouracil (5-FU), 6-mercaptopurine (6-MP), and capecitabine (Xeloda®).<sup>11</sup>

There are several aspects to chemotherapy: how it's synthesized or produced, the mechanism of action, the delivery mechanism into cells, and the efficacy or results of this treatment in cancer patients (Figure 1). Alkylating agents are produced through amino acid nitrosation. This involves the reactions of alpha-, beta-, and gamma-amino acids. These reactions produce amino acids with an -NH(2) group, namely alpha-lactones, beta-lactones, and gamma-lactones, which serve as alkylating agents against cancer.<sup>4</sup> Alkylating agents stop tumor growth by crosslinking guanine nucleobases in DNA double-helix strands, directly attacking DNA. This prevents the strands from uncoiling and separating, halting cell division.<sup>5</sup>

Many alkaloids are present in raw plants as salts or organic acids. They're extracted by processing the raw material with an alkaline solution and removing the alkaloid bases with organic solvents such as 1,2-dichloroethane, chloroform, diethyl ether, or benzene. Then, the impurities are dissolved by weak acids, which convert the alkaloid bases into salts that are washed away with water. The process is repeated until the desired purity is achieved.<sup>8</sup> Plant alkaloids act as a defense system in living organisms and play a vital role in cancer patients.<sup>9</sup>

Antimetabolites impair DNA by incorporating chemically altered nucleotides or depleting the supply of deoxynucleotides needed for DNA replication and cell proliferation. They're considered the first generation of chemotherapy and work by inhibiting the action of an enzyme crucial to an organism's metabolic processes.<sup>12</sup> They're often used as treatments for leukemia, breast, and intestinal cancer because they interfere with DNA production, cell division, and tumor growth.<sup>13</sup>

## 1.2 Targeted Therapy

Targeted therapy is a form of cancer treatment that blocks the proliferation of cancer cells by interfering with specific molecules that cause abnormal cell growth, which is one of the hallmark characteristics of cancer (Figure 1). There are four major types of targeted therapy: angiogenesis inhibitors, monoclonal antibodies, proteasome inhibitors, and signal transduction inhibitors. Angiogenesis inhibitors inhibit angiogenesis, the growth of new blood vessels. Certain types of angiogenesis are shown to be linked to the formation of malignant tumors and the expression of several pro-angiogenic factors, such as vascular endothelial growth factor (VEGF) and fibroblast growth factor (FGF), which these inhibitors aim to stop.<sup>16</sup> Angiogenesis inhibitors are classified as either endogenous or exogenous. Endogenous angiogenesis inhibitors are naturally present inside an organism, and exogenous angiogenesis inhibitors are external sources such as pharmaceutical drugs.<sup>17</sup>

Monoclonal antibodies (termed mAb) are produced by cloning a unique type of white blood cell and creating a cell line. The first use of mAbs to treat cancer was documented in the early 1900s by an immunologist named Paul Ehrlich. More recently, in 2018, James P. Allison and Tasuku Honjo received the Nobel Peace Prize in Physiology or Medicine for discovering cancer therapy by inhibiting negative immune regulation using mAbs that prevent inhibitory linkages.<sup>20</sup> Examples of mAbs approved by the FDA for cancer are Alectinib, Bevacizumab, and Cetuximab.<sup>21</sup>

Proteasome inhibitors are drugs that block proteasomes' actions, which are cellular complexes that break down proteins.<sup>24</sup> Only three have been approved for treating multiple myeloma-affecting plasma cells: Bortezomib, Carfilzomib, and Ixazomib. Bortezomib, or Velcade, was approved by the FDA in 2003, and it was the first proteasome inhibitor approved in the United States. Its boron atom binds to the catalytic site of the 26S proteasome. Carfilzomib, or Kyprolis, was approved for relapsed and refractory multiple myeloma in 2012, and it attaches to and inhibits the chymotrypsin-like activity of the 20S proteasome. Ixazomib, or Ninlaro, was approved in 2015 for use in combination with lenalidomide and dexamethasone for the treatment of multiple myeloma, and it's the first orally available proteasome inhibitor.<sup>25</sup>

Signal transduction inhibitors are drugs that block signals passed inside a cell from one molecule to another. Blocking these signals can affect many cellular functions, such as mitosis and apoptosis.<sup>27</sup> Some types of signal transduction inhibitors include Imatinib, Cetuximab, and Tacrolimus.<sup>28</sup>

There are several aspects to targeted therapy: the way it's synthesized or produced, the mechanism of action, the delivery mechanism into cells, and the efficacy or results of this treatment in cancer patients. (Figure 1) Angiogenesis inhibitors block the formation of new blood vessels that feed and nourish cancer cells.<sup>18</sup> This can be done through drugs that either reduce the production of anti-angiogenic factors, prevent them from binding to their receptors, or completely block their actions.<sup>19</sup> Because about 60% of malignant tumors express high concentrations of VEGF, inhibiting the VEGF pathway has become a potential way to inhibit angiogenesis. Some ways to inhibit the VEGF pathway include antibodies directed against VEGF or VEGFR, soluble VEGFR/VEGFR hybrids, and tyrosine kinase inhibitors.<sup>16</sup> The most used VEGF inhibitor on the market today is Bevacizumab, or its brand name, Avastin. The article "Bevacizumab (Avastin)" states that using Bevacizumab significantly increases overall survival in patients with metastatic breast cancer.<sup>30</sup> (Figure 1)

Most of the production of monoclonal antibodies relies on generating hybridomas, which involves identifying plasma cells that produce antibodies to a specific antigen and fusing these cells with myeloma cells. Then, this mixture of cells is diluted, and clones of these cells are grown from single-parent cells. The most productive and stable clones are selected for future use. The hybridomas are grown in a cell culture medium enriched to maximize hybridoma growth. After this, the desired antibodies are extracted. First, the sample is conditioned or prepared for extraction. Cells, cell debris, and clotted material are removed by centrifugation, and larger particles are removed by filtration. If the concentration of the product in the sample isn't sufficient, either ultrafiltration or dialysis is performed.<sup>22</sup> MABs directly bind to cancer cells and typically inhibit them, which leads to the death of these cancer cells.<sup>23</sup> Proteasome inhibitors disrupt normal cell functions so that cancer cells die. They prevent the deterioration of pro-apoptotic factors, such as the p53 protein, activating programmed cell death in neoplastic cells.<sup>26</sup> Signal transduction inhibitors disrupt cell signals, changing the actions of cancer cells and preventing them from proliferating.<sup>2</sup>

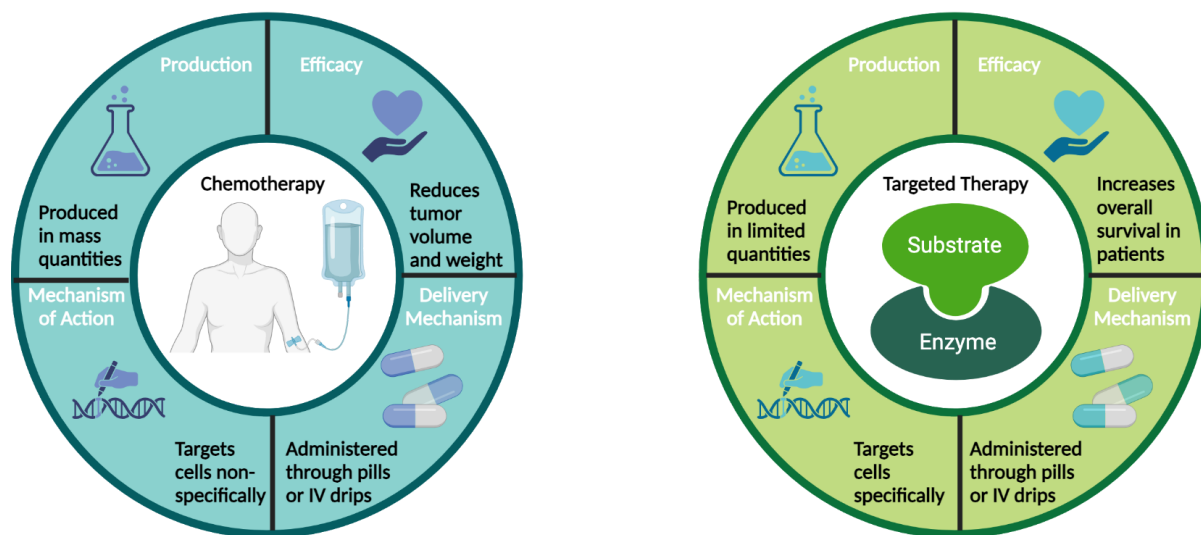


Figure 1. This figure illustrates the various aspects of chemotherapy and targeted therapy, namely how they're synthesized, the mechanism of action, the delivery mechanism into cells, and the results of these treatments in cancer patients.

## 2. Discussion

The socioeconomic factors that affect chemotherapy and targeted therapy are cost, availability, scope, and speed. The cost that a patient pays for chemotherapy depends on the type of chemotherapy, the frequency and duration of the treatment, the drug doses administered, the institution where the procedure is performed, and the patient's residence. Because of this, there's no standard annual cost of chemotherapy, but it usually ranges from \$10,000 to \$200,000 (Table 1). Melanoma has one of the lowest costs for treatment in the United States, with an average of \$5,000 for women and \$5,400 for men, while brain cancer has one of the highest costs for treatment, with an average of \$108,000 for women and \$115,000 for men. Because chemotherapy is one of the most expensive treatments in the world, health insurance covers about 10-15% of the cost, depending on whether the treatment is in the form of pills, administered through intravenous infusion (IV), or other methods. There are also charitable organizations that sponsor cancer patients who don't have enough money to pay for their treatment.<sup>15</sup> Targeted therapy also depends on whether the treatment is in the form of pills, administered through IV, or other methods. They cost a monthly average of around \$5,000-10,000 and a yearly average of about \$100,000. Orphan drugs, used to treat rare cancers, can cost \$300,000 or more annually (Table 1). One of the most expensive therapies is CAR-T cell therapy, which costs up to \$500,000 annually.<sup>33</sup>

Both chemotherapy and targeted therapy have availability problems, but because there is chemotherapy for all types of cancer, there's less of a shortage of it (Table 1). By 2022, around 40 states had at least one chemotherapy drug in shortage, one of the most important being carboplatin. Carboplatin, an alkylating agent, is used to treat several cancers, including breast, lung, and ovarian. Not only is carboplatin an effective drug, but it's also less toxic and causes fewer side effects than other available chemotherapy drugs. This shortage led to doctors rationing the treatment by decreasing dosage sizes by 10 percent, and some patients weren't even able to get their second round of chemotherapy.<sup>35</sup> Although chemotherapy is available for all types of cancers, this isn't the case for targeted therapy. Despite the limited list of approved targeted therapies, significant shortages remain. CAR-T cell therapy is most commonly used to treat leukemias, lymphomas, and myelomas. However, only 70 cancer centers in the US can prescribe CAR-T therapy for their patients. Although many patients need this therapeutic, a shortage of raw materials and supply chain restraints have made it harder to manufacture in specialized labs. Patients tend to get around 1 to 2 slots a month, and others don't get any. (Table 1) Several patients spend months on the waiting list, and about 20% die before they can even receive treatment.<sup>34</sup>

In terms of scope of use, there is chemotherapy available for all types of cancers, while targeted therapy is only available for a small percentage of cancer patients (Table 1). Additionally, chemotherapy and targeted therapy are different in their approaches to treating cancer. Traditional chemotherapy is cytotoxic, and it targets cells non-specifically, causing severe side effects such as nausea, fatigue, and, most commonly, hair loss. (Table 1) In contrast, targeted therapy, as its name suggests, specifically targets anomalies associated with a patient's cancer. Because targeted therapy only targets cancer cells, there's a high chance they don't target hair cells, so unlike chemotherapy, patients who undergo targeted therapy may not experience hair loss as one of their symptoms. (Table 1) For example, Pembrolizumab, or Keytruda, is an anti-PD1 antibody that's used to treat melanoma, lung cancer, and certain forms of breast cancer. It blocks the protective mechanism of cancer cells and allows the immune system to destroy them by specifically targeting the programmed cell death protein (PD-1) receptor of lymphocytes.<sup>31</sup> The side effects of Keytruda are similar to chemotherapy in that they include nausea and fatigue but exclude hair loss.<sup>32</sup>

For speed, chemotherapy treatment is much faster than targeted therapy treatment. This is because chemotherapy is already available for all cancers, so doctors can provide the patient with the

correct pill or put them on an IV drip as soon as they walk in (Table 1). However, for targeted therapy, doctors need to first find out which genetic alterations are present in a patient's cancer. First, to sequence the cancer, a biopsy needs to be performed to isolate a section of the tumor for sample processing. Then, this sample must be sent to a sequencing facility, which often isn't a part of a medical center. This not only adds significant time to the sequence of treatments but also adds cost since these sequencing services are often offered through private companies. Following the sequencing of the tumor sample, the data needs to be analyzed by bioinformaticians and, finally, interpreted by a doctor. This procedure takes several weeks and is heavily affected by the quality of the biopsy. For example, there are many instances where solid biopsies aren't feasible, depending on a patient's condition. This would require sequencing circular tumor DNA (ctDNA) from the patient's blood, significantly limiting the sequencing depth (Table 1).

Table 1. This table summarizes the socioeconomic factors that affect chemotherapy and targeted therapy. Targeted therapy is significantly more expensive than chemotherapy and less available to cancer patients, unlike chemotherapy, which is available for all types of cancers. However, targeted therapy results in fewer and less severe side effects than chemotherapy because chemotherapy targets both cancerous and noncancerous cells, while targeted therapy only targets cancerous cells.

|              | Chemotherapy                                                                                                                                 | Targeted Therapy                                                                                                                                                    |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Annual Cost  | 10,000 - 200,000 USD                                                                                                                         | 100,000 - 500,000 USD                                                                                                                                               |
| Availability | Available for all types of cancers, so there isn't as much of a shortage of it.                                                              | Available for a limited amount of cancers, so there's a significant shortage of it; many patients die before they can even receive treatment.                       |
| Scope        | Usable by all cancer patients because it targets cells non-specific; causes more severe side effects such as nausea, fatigue, and hair loss. | Usable by a small number of cancer patients because it targets cells specifically; causes fewer and less severe side effects.                                       |
| Speed        | Quick, because doctors can immediately provide the patient with the correct pill or put the patient on an IV drip as soon as they walk in.   | Slow, because finding the specific anomaly in the patient, creating a new targeted therapy, and getting it FDA-approved is not only time-consuming but also costly. |

## 2.2 Solutions

Creating targeted therapy is difficult because it involves a lot of time and money. Whenever there's too much of a specific protein on a cancer cell, a protein on a cancer cell that isn't on normal cells, a protein that's mutated in some way on a cancer cell, or gene changes that aren't in a normal cell, targeted therapy aims to either block or turn off chemical signals that tell the cancer cell to grow and divide, change proteins within the cancer cells so the cells die, stop making new blood vessels to feed the cancer cells, trigger the immune system to kill the cancer cells, or carry toxins to the cancer

cells to kill them, respectively.

To produce a targeted therapy, we must know the protein on the cancer cell's surface very well. More specifically, we need to know its properties, such as size, shape, stability, abundance, and chemical composition. After this, we need to know how to make a compound that chemically binds to and targets this. This involves not only biology but also chemistry. Drug delivery is an essential part of ensuring the success of a targeted therapy. We must ensure our body uses the compound, which is much more complicated than it sounds. To verify this, we need to conduct several clinical trials, which are both costly and time-consuming.

Even after the targeted therapy is created and FDA-approved, matching the correct one to the patient is a long, slow process. This process includes a biopsy or sample collection, molecular investigation such as sequencing, data analysis, and matching the analysis to an available drug, which can take several weeks to months. For CAR-T cell therapy specifically, the vein-to-vein time between T cell collection and infusion takes around three weeks but can go up to five to eight weeks if there's a delay. During this time, patients can die from lack of treatment, which takes up slots and wastes viable cells.<sup>33</sup> Many companies that produce CAR-T products, such as Novartis, Bristol Myers Squibb, and Janssen, are trying to increase their capacity to manufacture CAR-T cells and shorten the vein-to-vein time for patients. Many facilities manufacture CAR-T products by hand, but they plan to use technology to automate some steps of the process to help expedite it. Some companies have already built digital platforms for CAR-T manufacturing and are working on integrating these into other facilities. These digital systems will reduce the risk of errors, allow medical records to be shared electronically, and make the manufacturing process of targeted therapy 40% faster.<sup>34</sup>

### **3. Conclusion**

In this paper, we compared and contrasted chemotherapy and targeted therapy by describing their different aspects: cost, availability, scope, and speed. Although the aim was to deduce why targeted therapy isn't more popular and if it'll replace chemotherapy altogether, there isn't a clear answer to this question. Not only are there strengths and weaknesses to both treatment approaches, but this topic also doesn't simply encompass the purely biological features of cancer; it also delves into the more nuanced facets of the medical world that deal with socioeconomic factors, which play a crucial role in the success of chemotherapy and targeted therapy.

Although chemotherapy isn't necessarily better than targeted therapy and vice versa, chemotherapy is more suitable for patients in the short run. In contrast, targeted therapy is more suitable for patients in the long run. This is because chemotherapy is readily available for all cancers, so doctors can provide patients with the correct treatment as soon as they walk in. However, for targeted therapy, the mutation in a patient's cancer informs the doctor whether or not a targeted therapy already exists. If a targeted therapy doesn't exist, the process of creating one can take a long time, which can result in the patient dying before they can even receive treatment.

On the other hand, targeted therapy causes fewer side effects than chemotherapy. This is because chemotherapy targets cells non-specifically, meaning that it targets both cancerous and noncancerous cells, while targeted therapy only targets cancerous cells. This is preferable for patients in the long run since targeted therapy leaves healthy cells untouched, thus allowing patients to experience fewer health issues than they would if they underwent chemotherapy. Having said all this, there isn't a clear answer as to whether chemotherapy is superior to targeted therapy for cancer patients at this current stage of medicine.

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# Stochastic Volatility Modeling of Implied Volatility Smile Curve in Options

Ethan Xu

## Abstract

A smile curve in the implied volatility of options derivatives has been realized ever since the stock market crash of 1987. The implied volatility increases the further away from near the money the option is. Stochastic volatility models such as the Heston model can give the effect found in implied volatilities. This study will compare the difference between empirical methods such as Monte Carlo simulation to compare with asymptotic analysis.

## 1. Introduction

Options are a type of derivative, meaning that they get their value from an underlying asset which in this case is a stock. There are two types of options: calls and puts. In calls, the option writer or seller gives the holder or buyer the right but not the obligation to purchase a stock at its exercise time T in exchange for a premium. On the other hand, puts give the holder the right but not the obligation to sell a stock at T. In an efficient market without arbitrage, the premium will equal to the discounted expected payoff. The Black-Scholes model was a predominant continuous time option pricing model that assumed a constant volatility. However, the implied volatility from the Black-Scholes model was shown to be in a smile curve with strike prices after the Black Monday

stock market crash of October 19, 1987. At the money options tended to have a lower implied volatility than in the money or out of the money options. Stock prices follow a leptokurtic distribution characterized by heavy tails and high peaks rather than a Gaussian distribution. There exists a volatility risk premium that is higher the further away from the money because they are exposed to more risk.

## 2. Literature Review

### 2.1. Black-Scholes Equation

The Black-Scholes model (Black & Scholes, 1973) is one of the most influential in options pricing. Created by Fischer Black, Myron Scholes, and independently Robert Merton, the method was awarded the 1997 Nobel Prize in economics. It gave a closed form continuous time solution to option valuation. The stock price is given as a stochastic differential equation that follows geometric Brownian Motion:

(1)

$$dS = \mu S dt + \sigma S dW$$

$W$  is a variable that follows the Wiener process. As a function of  $S$  and  $t$ , the option price  $C$  can be described by Itô's lemma:

(2)

$$dC = \left( \mu S \frac{\partial C}{\partial S} + \frac{\partial C}{\partial t} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 C}{\partial S^2} \right) dt + \sigma S \frac{\partial C}{\partial S} dW$$

A delta-hedged portfolio will return the risk-free rate to eliminate arbitrage:

(3)

$$\begin{aligned} \Pi &= -C + \frac{\partial C}{\partial S} S \\ d\Pi &= r\Pi dt \\ d\Pi &= \left( -\frac{\partial C}{\partial t} - \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 C}{\partial S^2} \right) dt \end{aligned}$$

Combining the equations creates the Black-Scholes partial differential equation:

(4)

$$\frac{\partial C}{\partial t} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 C}{\partial S^2} + rS \frac{\partial C}{\partial S} - rC = 0$$

It can be solved and simplified in the form of the heat equation with the boundary conditions of the payoff, giving a closed form solution.

### 2.2. Stochastic Volatility

One of the weaknesses of the Black-Scholes is that it assumes a constant volatility  $\sigma$ . In models for volatility such as the Heston model (Heston, 1993), volatility follows a stochastic process. Volatility has the characteristics of mean reversion to its long-term volatility and the leverage effect which is the negative correlation between stock returns and volatility. The Heston model replicates the Cox–Ingersoll–Ross model for interest rates given by:

(5)

$$dS = \mu S dt + \sqrt{v} S dW_1$$

$$dv = \kappa(\theta - v)dt + \sigma\sqrt{v}dW_2$$

Where  $S$ ,  $v$ ,  $\kappa$ ,  $\theta$ , and  $\sigma$  are the stock price, variance, long term average variance, the rate of mean reversion, and volatility of volatility respectively. The covariance between  $W_1$  and  $W_2$  is where  $\rho < 0$  for the leverage effect. The Black-Scholes PDE now becomes:

$$(6) \quad \frac{1}{2}TvS^2 \frac{\partial^2 C}{\partial S^2} + \rho\sigma vS \frac{\partial^2 C}{\partial S \partial v} + \frac{1}{2}\sigma^2 v \frac{\partial^2 C}{\partial v^2} + rS \frac{\partial C}{\partial S} + [\kappa(\theta - v) - \lambda] \frac{\partial C}{\partial v} - rC + \frac{\partial C}{\partial t} = 0$$

Where  $\lambda$  is the volatility risk premium.

### 2.3. Asymptotic Analysis

As shown in (Sircar & Papanicolaou, 1998) an asymptotic solution describing the smile curve can be created where volatility is characterized by a stochastic process similar to the Heston model:

$$(7) \quad dv = \varepsilon \alpha dt + \sqrt{\varepsilon} \beta dW$$

Where  $\varepsilon$  is a small number. It satisfies the PDE:

$$(8) \quad \frac{\partial C^\varepsilon}{\partial t} + \frac{1}{2}vS^2 \frac{\partial^2 C^\varepsilon}{\partial S^2} + \sqrt{\varepsilon}\rho S \sqrt{v}\beta \frac{\partial C^\varepsilon}{\partial S \partial v} + \frac{1}{2}\varepsilon\beta^2 \frac{\partial^2 C^\varepsilon}{\partial v^2} + (\varepsilon\alpha + \sqrt{\varepsilon}\beta\lambda) \frac{\partial C^\varepsilon}{\partial v} + r(S \frac{\partial C^\varepsilon}{\partial S} - C^\varepsilon) = 0$$

When  $\varepsilon = 0$  the PDE is equivalent to the Black-Scholes PDE of  $C^{BS}(\sqrt{v})$ . Therefore, a asymptotic solution can be constructed:

$$(9) \quad C^\varepsilon = C^{BS}(\sqrt{v}) + \sqrt{\varepsilon}C^1 + \varepsilon C^2 + \dots$$

The solution to  $C^1$  can be expressed as:

$$(10) \quad C^1 = A(\sqrt{v}, t)S \frac{\partial C^{BS}(\sqrt{v})}{\partial S \partial \sigma} + B(\sqrt{v}, t) \frac{\partial C^{BS}(\sqrt{v})}{\partial \sigma}$$

Where:

$$A(\sigma, t) = - \frac{\rho\sigma\beta(T-t)}{2(\sigma+1)}$$

$$B(\sigma, t) = - [\frac{\rho\beta(\sigma^2)}{4} (1 + \frac{\sigma}{\sigma+1}) + \frac{\beta}{2\sigma}](T-t) - \frac{\rho\beta\sigma(\frac{3}{2}\sigma-2)}{2(\sigma+1)}(T-t)^2$$

An asymptotic solution can also be made for the implied volatility of the call since:

$$(11) \quad I^\varepsilon = \sqrt{v} + \sqrt{\varepsilon}I^1 + \varepsilon I^2 + \dots$$

Where the solution to  $I^1$  is given by:

$$(12) \quad I^1 = B(\sqrt{v}, t) + A(\sqrt{v}, t)(\frac{1}{2} - \frac{\tilde{L}}{v(T-t)})$$

$\tilde{L}$  is the log moneyness which is the log ratio of the ratio of the future stock price to the strike price. It can be shown that the implied volatility is at a minimum at  $\tilde{L} = 0$  so that the strike price is equal to  $Se^{rt}$  and the curve becomes steeper the closer to expiration the option is when  $\rho$  is equal to zero and stock price and volatility are uncorrelated. When  $\rho \neq 0$  in the correlated case, there is no apparent minimum. When  $\rho < 0$ ,  $I^\varepsilon$  will increase slowly as  $K$  increases within the region  $\tilde{L} = O(1)$ .

### 3. Methods

The Heston model can be numerically calculated using Monte Carlo simulation. Many different stock price paths will be generated with many discrete time steps. The call option price can be calculated by the mean value of the discounted payoffs of each of the paths. The implied volatility can then be solved using the option price. The stock price and volatility at each step can be calculated using the discretization of the Heston model in equation (5) using the Euler–Maruyama method:

(13)

$$S_{t+\Delta t} = S_t e^{(r - \frac{1}{2}v_t)\Delta t + \sqrt{v_t}\Delta t\Delta W_{1,t}}$$

$$v_{t+\Delta t} = [v_t + \kappa(\theta - v_t)\Delta t + \sigma\sqrt{v_t}\Delta t\Delta W_{2,t}]^+$$

The volatility is taken the maximum with zero to avoid negative volatilities.  $\Delta W$  can be calculated as a normal random variable. The implementation for this paper was done in python and was plotted using the matplotlib library.

#### 4. Results

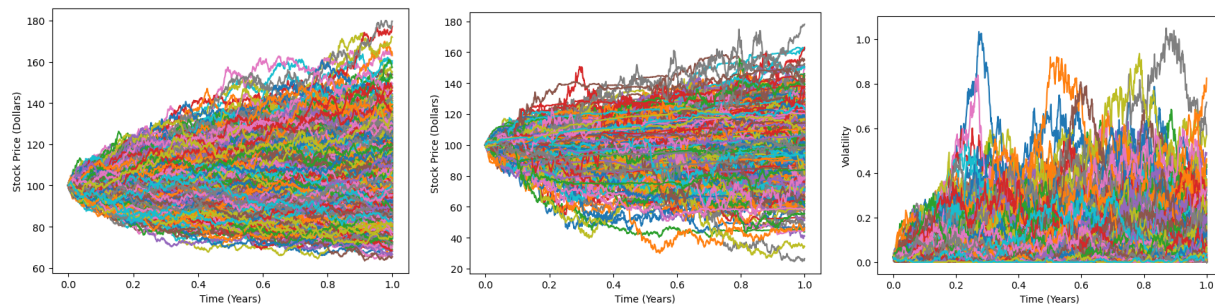


Figure 1. Constant volatility price paths with  $S_0 = 100, r = 0.04, \sigma = 0.15$ .

Figure 2. Stochastic volatility price paths with  $S_0 = 100, r = 0.04, \kappa = 3, \theta = 0.004, v_0 = 0.0225, \rho = -0.1, \sigma = 1$ .

Figure 3. Stochastic volatility variance paths with  $S_0 = 100, r = 0.04, \kappa = 3, \theta = 0.004, v_0 = 0.0225, \rho = -0.1, \sigma = 1$ .

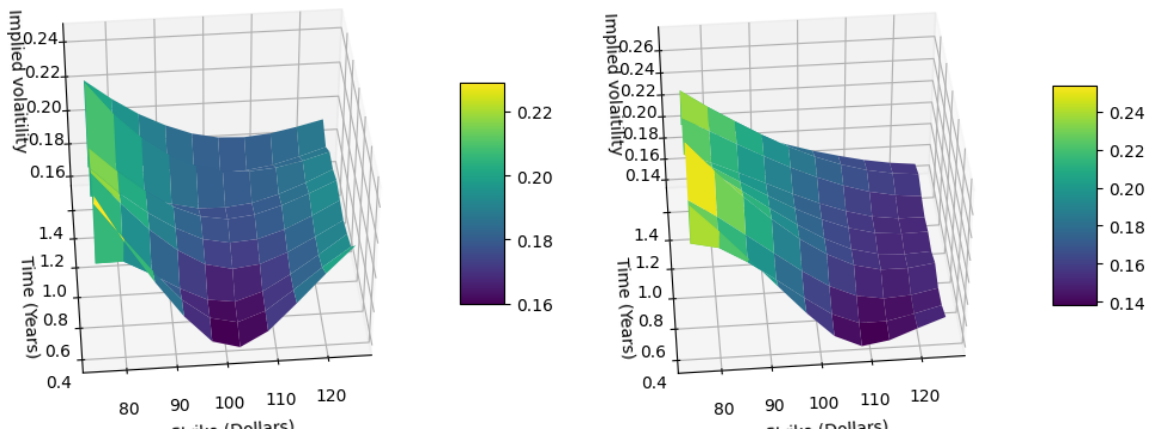


Figure 4. Volatility surface with  $S_0 = 100, r = 0.04, \kappa = 3, \theta = 0.004, v_0 = 0.0225, \rho = 0, \sigma = 1$

Figure 5. Volatility surface with  $S_0 = 100, r = 0.04, \kappa = 3, \theta = 0.004, v_0 = 0.0225,$   
 $\rho = -0.7, \sigma = 1.$

## 5. Discussion

The results in figure 2 shows the leptokurtic properties of stochastic volatility stock paths compared to paths with constant volatility in figure 1. Figure 3 shows the mean reverting property of the Heston model. Figure 4 affirms the asymptotic solution when stock returns and volatility are uncorrelated. The minimum is close to the initial stock price and when log moneyness is zero. It also displays the flattening of the curve as time to expiration increases. It also supports the asymptotic solution when stock returns and volatility are negatively correlated since there is no apparent local minimum. The parameters can be calibrated to market data in order to simulate volatility in the real world. Results can be used to trade and hedge volatility using options.

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# *‘Capstone: Existentialism and the Absurd’ Papers*

## *Shadows Behind the Glamor: Dubai*

Alex Chen

The concepts and ideas associated with the term “slavery”, especially from the point of view of the Western World, are traditionally seen as part of a generation long gone; a time in history defined by imperialistic motives, capitalistic greed, and racial prejudice. Slavery, though, has been prevalent in many forms throughout the past two centuries, and manifests itself all across the world. From the Jewish concentration camps in Nazi Germany, to the descent-based slavery in Mauritania, to the discriminatory sharecropping practices in Jim Crow-era America, modern slavery always seems to encapsulate one trait – the entrapment of the individual in a hopeless cycle of meaninglessness and powerlessness, dooming them to a fate in which they serve as pawns of the institution. It is here that I would like to shed light on this issue of modern slavery within the context of the United Arab Emirates, specifically within one of its biggest cities and fastest-growing emirates – Dubai. Advertised to the rest of the world as an urban metropolis with luxury resorts, lavish hotels, and grandiose megaprojects, the “City of Gold” has quickly become a favorite among tourists and travelers from all across the world, attracting numerous high-end brands, big-name social media influencers, and Hollywood actors, among many other influential companies and people. Behind this allure of prosperity, wealth, and influence, though, the City of Gold reveals itself to be a gilded city; a city not made of gold but rather a gold-covered city that is, in reality, built upon the inhumane exploitation of cheap migrant workers in the construction and sex trafficking industries. As these individuals grapple with the absurdity of their own situation, they are now confronted by an existential crisis in which they are squeezed by both top-down and bottom-up pressures.

Beginning the conversation specifically in regards to the migrant workers that work under Dubai’s construction agencies, the adoption and popularity of the kafala system has created a hyper-restrictive environment in which migrant workers (mainly originating from Southeast Asian countries like India, Pakistan, etc.) have become socially and financially bound to their employers (Walk Free Foundation 2023). These migrant workers, who initially come in pursuit of a better life, or even just a sustainable wage to provide for their families back at home, are often tricked into the construction agency scheme, where they are fed the same Western propaganda that depicts Dubai to be a flourishing city with exponential growth, and that working there would guarantee an individual a secure financial future (Human Rights Research 2022). Despite the fact that these construction agencies cover the cost of flying these workers all the way to the United Arab Emirates, the construction agencies’ scheme only unfolds when these migrant workers are immediately stripped of their VISAs when they land, downright preventing any worker from ever leaving Dubai once they are flown in. The article further details how migrant workers are often far from their families and support networks, and therefore find themselves at the mercy of their employers’ whims, unable to voice grievances or seek redress for their mistreatment. Furthermore, the Guardian reveals in an article from 2022 how the promise of fair wages, which initially drew them to the UAE, is cruelly betrayed as

these migrant workers not only discover that they will not be compensated for the first three to six months of labor, but also that when they are finally paid, they often receive a drastically reduced value compared to what they were initially told. An interesting parallel can be drawn between the paradox of Catch-22 in Joseph Heller's novel "Catch-22" and how migrant workers in Dubai are ultimately forced to stay after they are tricked into a job in the city. The initial Catch-22 presented by Doc Daneeka to Yossarian entraps the individual in an ironic dilemma where no matter the decision Yossarian makes, he is still stuck in the endless cycle of flying missions. Want to be grounded and stop flying missions? Report yourself as crazy. Simple right? No. If you report yourself as crazy in order to stop flying missions, then you clearly aren't crazy, and your request will be denied. It is conducive to an environment whereby the individual (like Yossarian) feels both helpless and trapped; stuck in a situation in which they are damned if they do, but also damned if they don't. By the same token, these corrupt construction agencies in Dubai entrap migrant workers in a manner that is very Catch-22-esque. From stripping away their VISAs to prevent them from fleeing the country to reducing, delaying, and denying their salary, it leaves these migrant workers in a state of constant dependence on the employer for any semblance of wellbeing, thereby dooming them to continue laboring under the construction agencies in Dubai for as long as they are deemed "useful", or in other words, able to contribute manual labor.

Shifting the focus towards Dubai's robust domestic labor and sex trafficking industries, we can immediately see how Southeast Asian women are confronted with the same issues that Southeast Asian men face in the aforementioned construction industry – powerlessness and entrapment within an institution. A 2014 study published by the Journal of Strategic Security confirms and highlights these specific issues, emphasizing how domestic female workers are usually hired to work in their master's house doing housework, and often live in their home as well. As such, these women face a unique problem; their employers have control over them every waking hour of the day. Domestic workers are often denied freedom of movement, and are either locked inside or forbidden to leave the home without permission. They are forced to work excessive hours with little or no pay, and have no way to escape. In regards to sexual slavery, the author further details how there are two main forms: the complex sex trafficking system which brings women from many parts of the world to work as sex slaves in Dubai, and the exploitation of young women out of work in the city by pimps. Both of these are an emblem of the human rights violations that are prevalent throughout the rest of the city, and only serve to add an additional layer of corruption to the existing institutions in Dubai. A personal recount of a Pakistani woman's experience as a sex slave in Dubai only further highlights the atrocities and human rights violations that are prevalent throughout the supposed "City of Gold", detailing how she was forcefully detained without an arrest warrant, stripped of all modes of communication, and denied any consular or counsel access. By the same token, Kafka's *The Trial* poses a similar comparison in the fact that the UAE government acts very akin to how the government in Kafka's novel acts - nonsensical, absurd, and arbitrary. Especially with the personal recount from the Pakistani woman, we have proof of how the local governments in Dubai and even the greater government in the UAE offer no help to individuals that are adversely affected by their corruption, and how their individual livelihoods are completely disregarded. In *The Trial*, this duality of the individual versus the institution manifests itself through the character of Joseph K, whereby his

unnecessarily complex and arduous trial serves as an emblem of the corrupt legal institution, ultimately dooming Joseph K. to meet his tragic fate by the end of the novel.

Pivoting the discussion to focus on how Dubai's international relations has affected the livelihood of these migrant laborers, it is immediately obvious how tourism (especially from Western nations) plays a critical role in the exponential growth that Dubai is reporting. Over the past two decades in particular, Dubai has seen its tourism industry grow to new heights, with data from 2022 reflecting a consistent 97% year over year growth and a shattering 14.36 million overnight visitors. To put that into perspective, that is more than the population of the entire state of Pennsylvania according to 2022 census records (which is only about 12 million). One major reason for this unprecedented growth in the past two decades can be narrowed down to the actions of Sheikh Mohammed, and how ever since he got into office in the early 2000s, has emphasized the rapid modernization of Dubai's infrastructure and economy, as well as the expansion of Dubai's aviation industry. Youtuber "Moon" highlights this very fact in his video essay titled Dubai Is Everything Wrong With Society, whereby he goes on to expand on how Sheikh Mohammad's executive decision to expand Dubai's aviation industry, enact the 2002 Housing Reform, and also turn Dubai into a Free Trading Zone has laid the foundation for the huge tourism industry we know today. Expanding Dubai's aviation industry may be the most straightforward of them all, as taking the name "Emirates Airlines" and making it synonymous with wealth and luxury positioned Dubai to take on a new portrayal from the rest of the world – one that embodied money, influence, and power. Furthermore, the enactment of the 2002 Housing Reform and the decision to turn Dubai into a Free Trading Zone made it much much easier to buy and sell property within the Emirate, and thus meant that many wealthy individuals, businesses, and foreign countries were enticed to invest and join in on the emerging commercial hub. This cemented the interests of foreign businesses within Dubai, and importantly provided Dubai the revenue possible to experience such a boom in the tourism industry, and by extension, the growth of the entire city. Its precedent of exponential growth laid the foundation for Dubai's growing demand for new, big, luxury megaprojects, and therefore indirectly led to Dubai's implementation of the kafala system to satisfy this sudden demand for laborers.

In regards to the solution to this issue, it is unfortunately multifaceted and therefore no one medium of reform will act as a silver bullet here. Despite this, the most effective type of reform has always involved policy reform from within. Specifically for policy reform, the recent amendment of Article 54 of the United Arab Emirates (UAE) Labor Law (dealing with employment disputes) in December of 2023 has not only made it illegal to establish unlimited work contracts (companies are now limited to issue only contracts that are 1 to 3 years), but also comes with a lieu of other improvements for the migrant worker. From the Authority to Issue a Decision, to the Right to File the Claim Before the Court of Appeal, to the Failure to Amicably Settle a Large Dispute Clause, all of these have demonstrated the ability that policy reform has for change, and though providing these benefits is definitely a long time coming, it is undeniably a big step towards ending modern slavery in the UAE.

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## *Data-opolies: The Pernicious Consequences of Weak Antitrust Regulation*

Emily Clark

People have been at the mercy of institutions for millennia since social pressure has always been the fundamental motivation for human action. Governments, aware of this emotional propensity, enforce order through creating an "Us vs Them" mentality. In *Catch-22*, military leaders are rampant users of this strategy. During the Loyalty Oath Crusade, Captain Black explains the reasoning behind the excessive pledges. He states, "The important thing is to keep them pledging... it doesn't matter whether they believe it or not" (Heller). Captain Black is aware that signing loyalty oaths is not for the individual's comfort but to perpetuate the power of the military. The officers are thus being forced to disregard any commonalities they may have had with the enemy, in order to become part of the community. Aside from quasi-tribalistic propaganda, institutions can also physically strongarm individuals into accepting their authority. For example, laissez-faire markets legalize anti-competitive practices that can result in the formation of trusts/monopolies- large economic institutions that often harm customers. My work will investigate the history of trusts and how the novelty of the internet has allowed for the proliferation of new tech monopolies- "data-opolies"- and the subsequent degradation of personal privacy.

With the advent of new industries, especially in tech, the antiquated antitrust laws of the Gilded Age have become more irrelevant in curbing contemporary monopolies. The most infamous of these early monopolies was Standard Oil, a master of vertical and horizontal integration, and known to "late nineteenth-century Americans, [as] a monster that corrupted politicians and laid waste its competitors" (Lamoreaux). This was because Standard Oil grew to dominate the American petroleum market by absorbing its competitors and undercutting prices as opposed to the more honest method of "innovation". They also raised prices and degraded the quality of their oil once they had taken the market (Lamoreaux); This outraged Americans, inducing the government to create the first "antitrust legislation": the Sherman Antitrust Act. Citing the federal government's power to

regulate interstate commerce, it declared that, “[any company] in the form of trust or otherwise that was in restraint of trade or commerce among the several states” was illegal. Under Presidents Roosevelt and Taft, the Act was used to bust the Northern Security Company and American Tobacco (Lamoreaux, Sherman Antitrust Act). However, because trusts were so new, politicians were hesitant to be too harsh on trusts and failed to define terms such as “monopoly” or “conspiracy”. This hindered the Act’s efficacy even in its own time at the turn of the century. American Sugar Refining, who owned 98% of the sugar industry, was declared as not violating the law because the court did not have a strict definition of “monopoly” and “conspiracy” (Lamoreaux, Sherman Antitrust Act). The Sherman Antitrust Act is still the main legislation cited against monopolies in the current day- it was cited in a case against Microsoft in the 1990s- yet its language has become increasingly irrelevant. I reference this turbulent history of trusts in my project by drawing my personification of the big tech monopolies- Google, Apple, Facebook, Amazon- in the sketchy, caricaturist style of Gilded Age political cartoonists. Additionally, he will be carrying a briefcase overflowing with data, in lieu of cash, like the satirized robber barons of the past, another nod to how the antitrust legislation has affected the monopolies of today.

Trusts in the Gilded Age were difficult to regulate, but modern monopolies have proven even harder since their negative effects are often related to consumer privacy instead of providing expensive products. The four current tech monopolies are Google, Apple, Facebook, and Amazon- commonly abbreviated as GAFA. Because they have hegemonic control, GAFA is able to reduce privacy. According to ZDNet, an online tech magazine, “Facebook says it can take up to 90 days for posts to be permanently deleted from its servers”. Users’ data, therefore, can be used even after an individual has clicked “delete” on their phone. These opaque privacy terms have also caused anger among parents, as Amazon was charged by the Department of Justice (DOJ) for violating child privacy laws because they kept “voice recordings of children and [ignored] parental requests to delete them” (ZDnet). Apple, because it has complete control over the AppStore, was able to suppress an app called Beeper Mini that provided end-to-end encryption on iMessages between OS’s that Apple had not yet implemented. Beeper Mini was removed from the store soon after its release because its existence threatened the captured market of users they had curated. (EFF). Unlike the trusts of the Gilded Age, modern monopolies trade with data instead of goods, thus they have earned the moniker “Data-opolies” by economists. Not only can personal data be sold to ad agencies or phishing sites, but it can also be used by federal governments for surveillance. China for example uses data-opolies to monitor its people, and the fewer data-opolies in a country the easier it is for a government to “capture” these firms for federal use (HBR). Existing antitrust law is centered around identifying what is a “good” and “bad” trust wherein bad trusts provide inferior or expensive products to consumers (Lamoreaux). Data-opolies fall outside of this definition as their negative effects on customers are not about the services they provide, but the privacy that they take away.

America, as opposed to the European Union, has been disinterested in breaking up data-opolies because they value the free market over consumer protection. The European Commission, for instance, took Facebook to court for providing “incorrect or misleading information during the Commission’s 2014 investigation... of Facebook’s acquisition of WhatsApp” (Stucke). This is a facsimile of the accusation ZDnet made against Facebook: data-opolies provide inferior services

because consumers have nowhere to go. The European Commission has also fined Google for biased search results, which cost the data-opoly 2.42 billion euros (Stucke). The DOJ and Federal Trade Commission (FTC) in America however, do not view GAFA's anti-competitive practices or opaque privacy conditions as illegal. The head of the DOJ has stated that data-opolies do not display "demonstrable harm to competition and consumers" and implied that if more severe antitrust laws were to be put in place it would stifle the innovation-rewarding market that had allowed for GAFA to create the vital devices and search engines we use today (Stucke). It is true that stricter data privacy regulations would have some negative effects on the market if put into place. The EU's GDPR, a law that makes data privacy a fundamental right, has restricted the transatlantic data trade, stifling the previous US\$7.1 trillion that had come from it (Dekker, Maaïke). Small, European tech companies have also struggled to compete with international ones after the establishment of the GDPR, as they do not have access to grand databases (Dekker, Maaïke). In my cartoon, the central figure, a man adorned in American cowboy attire, is shown leaping across the Atlantic Ocean from the data-strict EU to the data-loose US. This is because, while laws protecting an individual's digital privacy are important, I wanted to acknowledge the weighty decisions governments have to make regarding data-opoly regulation.

Data-opolies are far from being the benign versions of the infamous trusts of Standard Oil and American Tobacco in the late 19th century; GAFA holds significant power over what consumers purchase, view, and learn from online, and the American government is likely to keep it that way. The "survival of the fittest" mentality is a common ideology taken by American politicians regarding the market. If a company survives and becomes a monopoly then they're a winner- a "good trust". An optic that is similar to Friedrich Nietzsche's claim on the origin of goodness: "the aristocratic, the powerful, the high-stationed, the high-minded, who have felt that they themselves were good and that their actions were good". Unlike in the past, individuals can take significant action to protect their information even without their government's help. Many companies, such as the EFF, have created AdBlockers and VPNs that stop sites from accessing personal data. It is important for people to be educated about the drawbacks of tech monopolies so they can make active decisions to protect their private information.

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## *John Deere, Right to Repair, and the Existential Struggle for Autonomy*

Caiden Ho

With the ever-evolving nature of technology, the right to repair movement is a response to this changing landscape of consumer electronics, tools, and other appliances where manufacturers have increasingly restricted access to repair information and spare parts. The movement seeks to push back against companies by advocating for legislation that promotes access to repair documentation and tools, to combat planned obsolescence, and to reduce electronic waste. This movement has not only expanded beyond consumer electronics but also expanded to other sectors such as agriculture, where companies like John Deere have faced scrutiny for their restrictive stance on repair of their farm equipment. In this article I aim to prove that John Deere has overexerted their control of the agricultural machinery market to the point of oppression and has infringed on the individual rights of farmers in doing so.

John Deere and other corporations like Apple are frighteningly like the institutions we condemn within works like *Catch-22*. Within the novel, the main character Yossarian states "When I look up, I see people cashing in. I don't see heaven or saints or angels. I see people cashing in on every decent impulse and every human tragedy." In this statement, we see constant criticism of the absurd bureaucracy of the military, and their focus on the war only and not the people who have to fight the war. For companies, like John Deere, they act in a similar fashion where they are only focused on turning a profit and in turn their customers, those who depend on them must suffer. Much like the character in *Catch-22*, John Deere as a company is focused on "cashing in on every decent impulse and every human tragedy." However, in the case of John Deere, they use their size and monopoly to make their farm equipment unrepairable unless one goes directly to them for repair. The absurdity of this situation has driven a change in society and thus, from situations like this, the Right to Repair movement was born. In *The Rebel*, Camus states, "Up to this point he has at least remained silent and has abandoned himself to the form of despair in which a condition is accepted even though it is considered unjust." Movements like these are not born out of nothing, and as Camus has stated, there is a point up to which people are able to tolerate injustice, but only up until a certain point before they rebel. For the Right to Repair movement, these people have gotten to the point where they feel as though they no longer own the product they have purchased. Does one truly own a tractor that they cannot fix? These are the sort of questions that drive the Right to Repair movement and are questions we should ask when facing institutions like John Deere. To what point are we willing to

fold in the face of the institution. This refusal to accept the inability to repair electronic devices symbolizes a defiant assertion of agency against corporate interests prioritizing profit over environmental sustainability and consumer rights, and is very much in line with the idea that Camus discusses within *The Rebel*.

Because of their market dominance, John Deere can fight against a change in policy and retain their current policies that disincentivize repair. They do this through various methods like fighting people in court or even making hidden stipends with agreements that allow them to maintain their control while giving the appearance of cooperation. In an NPR article, Joe Hernandez talks about the skepticism surrounding the MOU (memorandum of understanding) that John Deere has signed with the American Farm Bureau Federation. Within the article it even states that there is a provision “that allows the company to pull out of the memorandum if any right-to-repair legislation is enacted.” Even when the Right to Repair has seemingly achieved a win in the Right to Repair there are always caveats like this provision that will hinder the progress of the movement. In another article, Monica Miller's highlights John Deere's conditional commitment within this MOU and the precarious nature of corporate concessions and the constant threat of regression. All of this is to say that John Deere has overexercised their monopoly and entrenched the rights of individuals, including the Right to Repair the farm equipment that they theoretically should own. We can also see further evidence of this infringement on the rights of individuals in some of the lawsuits that have been filed against them. One such lawsuit filed in North Dakota by Forest River Farms states that, “Deere has deliberately monopolized the market for repair and maintenance services of its agricultural equipment with ECUs (“Deere Repair Services”) by making crucial software and repair tools inaccessible to farmers and independent repair shops.” This quote from this class action lawsuit gives us a view of a direct infringement on the rights of Forest River Farms. Because John Deere knows they have a complete monopoly over this sector, they have created monopolistic policies that make it completely impossible to repair and maintain agricultural equipment without going directly back to Deere for repair services. The most outlandish part of this situation is the fact that you could have a completely functional tractor but be completely unable to use it because of the “ECU” (Electronic Control Unit) which is designed to lock you out of using their equipment unless brought to a Deere certified repair shop. This struggle is further shown in a Reuters article where it is stated that “John Deere has the ultimate control of the repair services market.” This statement is further evidence that John Deere as a company has overexerted their control and has gone past the point of being simply a monopoly. John Deere has moved to the point where even if someone has bought their product, they do not truly own that product because John Deere has essentially sold them a subscription disguised as a product with a one-time payment. This exact trickery is an infringement on the rights of the individual as they should be able to do whatever they want with a product they own and not be locked out of repair solely because John Deere wants to make even more money from these farmers. Despite all of this, however, there are still those who take up the Sisyphean struggle of fighting against the very corporation who holds power over their very livelihood, and it is only with farmers and people like this that they will truly be able to take something back from institutions like John Deere.

Despite all this, the future of the Right to Repair is bright. For example, Takara Small outlines how Grassroots groups like the Repair Association are pairing up with hobbyists, law groups and more to recruit members and motivate everyday consumers and how dozens of U.S. States have been starting to consider Right to Repair bills. Especially with increasing concerns and general advocacy about the environment and e-waste, planned obsolescence, and greater concern for sustainability, the right to repair has been increasingly pushed into the limelight with President Biden even issuing an executive order on Right to Repair. Another article from the VICE outlines how there are many consumer rights organizations and that many states like New Jersey, Delaware, or New York are considering introducing new right to repair laws.

The Right to Repair movement is one that is existentialist at heart. It is a movement against institutions like John Deere or Apple that create products that are meant to be unrepairable. It is also a movement to protect the environment from excessive e-waste and a movement against the current consumer culture of use and forget whereas Right to Repair aims to get people to repair and continue to use these products and promote reusable products. In the *Myth of Sisyphus*, Camus outlines how despite the punishment Sisyphus must endure, he can be happy because he is able to find fulfillment in rolling the boulder up the hill, and this fulfillment is an act of rebellion against the gods who condemned him to endlessly roll this boulder up a hill. Camus states that, “The struggle itself toward the heights is enough to fill a man’s heart. One must imagine Sisyphus happy.” Much like Sisyphus, the Right to Repair movement may not go anywhere or even succeed because like the gods, companies hold so much power, however there are still those who continue to push for change and those that have found success in pushing for more repairability. As such, the act of repair itself can be considered a Sisyphean or existentialist act because of the very nature of these products and their planned obsolescence in which they are designed to fail.

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## Reshaping Reality: Capitalist Control vs. Visitor Autonomy at Disney Parks

Manasvi Pinnaka

From their thrilling attractions to their character-inspired performances, Disney parks push the limits of kids' fantastical creations while enabling adults to shamelessly unleash their inner child. They are more than just an everyday source of entertainment as every memory at these parks is uniquely connected emotionally to nostalgic experiences or a sense of familial bonding. At the same time, however, it is important to realize how every detail of this hyperreal space has been carefully curated to serve a higher motive. In *Simulacra and Simulations*, Baudrillard argues that this motive is “to hide that it is the ‘real’ country, all of ‘real’ America that is Disneyland (a bit like prisons are there to hide that it is the social in its entirety, in its banal omnipresence, that is carceral).” By blurring the lines between what is imaginary and what is reality, Disneyland hooks its visitors into a trance of never-ending happiness that blinds them by way of a “simulation” to the struggles of the real world. While Disney parks are portrayed by their creators as places where the unimaginable is truly tangible and within reach, every aspect of their existence from their layouts to their attractions is specifically designed to confine visitor autonomy according to the desires of those in power while feeding them with the false perception of free choice.

Our entrapment into this seemingly endless cycle of happiness that Disney parks are able to provide its visitors is driven by the comfort they provide in efforts of escapism. The contrast of the vibrant park displays from the barren lands beyond the gates of Disney parks gives visitors the illusion that they can “live as colorfully as that” if not for the restrictions of the “gods and the reality managers” (O’Hagan). As this optimism for attaining the most fulfilling level of livelihood is spread from parent to child, the appeal of Disney parks starts to transcend generational lines while strengthening familial bonds. O’Hagan continues to support the emotional resonance of these parks by describing visits as allowing adults to revitalize “a part of [their] belief system that experience has failed to dull” and “hope that the same thing will happen for [their children].” Both the desire to achieve the sense of fulfillment that Disney parks project and the hope to experience this desire for themselves and the loved ones around them keep visitors engaged in this new reality. While at least slightly increased emotions of happiness are automatically a consequence of these ideas, Casey Clark adopts this perspective more seriously with regard to her mental health journey. After moving next to Walt Disney World, her presence in the park itself boosted her willingness to connect with others and socialize, overcoming even her persistent struggles with anxiety. Her ease at the park was rooted in her excitement to “have conversations about an imaginary world,” releasing her of “mundane small talk that drains the life out of [her] in regular conversations” (Clark). Without the comfort of the idea that Disney World can support her need for escapism, Clark would not have experienced the same positive benefits from her visits. These different narratives thereby emphasize the capacity of Disney parks to foster a sense of well-being and community like no other. Joe Rhode adds a psychological explanation to the phenomenon of this Disney parks addiction, particularly in response to the fact that Todd Martents, a self-identifying addict in this manner, would rather visit Disneyland several times a month than save all that money for a new trip. He explains that Disney parks have “all the super cohesiveness that your brain is looking for,” comparing this idea to “surfing on a wave” rather than “surfing out to sea against [the wave]” (Martents). It is both thrilling and terrifying to realize that Disney parks are so curated in such a way that they perfectly satisfy our deep-rooted psychological needs for order and a sense of belonging.

The attractions at Disney parks play a pivotal role in creating immersive experiences that display elements of hyperreality, drawing visitors into a world purposefully constructed to mirror their deepest desires. Ana Calvete expands upon Baudrillard's example of Disneyland as a supreme hyperreal environment by demonstrating that the castle or the pirate robots, for example, either represent physical manifestations of a fictional idea or draw upon an idealized and imagined reality. With the incorporation of these aspects throughout the parks, there is this idea that the hyperreal improves upon rather than just resembles reality. Calvete further critiques Disneyland as "a place of total passivity" with visitors essentially forced "to behave like its robots." Not only is there a figurative sense of entrapment as visitors can only interact with the park environment according to how the hyperreal space has been constructed by its creators, but there is a literal sense of this as well with the lines and metal gates that restrict visitor access to the various attractions. Through this perspective, attractions at Disney parks are not simply sources of entertainment but rather purposeful creations that reshape our understanding of what is fantasy and what is reality. This complex dynamic between attraction design, perception, and interpretation based on visitor interaction with the environment is a major factor in determining how and why visitors are drawn into the control of Disney parks. Matt Hills further explores the relationship between creator-driven narratives and visitor-based physical experiences, particularly examining engagement with Star Wars attractions. Some particularly immersive opportunities he notes include rides like Star Tours at Star Wars Land or even the opportunity to 'fly' in a life-size Millennium Falcon, taking fan interaction with this artificial world beyond just traditional media consumption (Hills). This focus on the narrative world of Star Wars demonstrates how Disney park attractions leverage the power of storytelling to construct the hyperreal. Through it all, while Disney parks offer the benefits of escapism, they also demand an abandonment of our critical thinking, leading us to accept a pre-packaged version of reality.

The practice of Disneybounding represents a creative fan initiative that acts as a prime example of how visitors can rebel against or at least better navigate the regulatory controls set by the creators of the Disney parks. Disney's installation of a no-costume policy at its theme parks prohibited guests over the age of 14 from wearing character costumes to prevent any confusion between the visitors of the park and the employees of the corporation. With Disneybounding, fans have essentially found a form of a loophole to this policy as they still aim to resemble their favorite characters at the parks but in their everyday clothes instead (i.e. by matching the colors of their outfits with those representative of the respective characters). The success of this practice can be seen from all the traction it has gained on social media platforms: "On TikTok, the #disneybounding hashtag has nearly 770 million views; 1.8 million posts on Instagram use the tag" (Sampson). The ability of this practice to strengthen individual autonomy over the institution, however, has been limited by Disney's own endorsement of this practice through the production of "official dresses and accessories designed to be utilized as part of the practice" (Williams). The essence of Disneybounding is rooted in a form of resistance, where visitors are provided with the opportunity to assert their own identity and creativity within a space defined by corporate interests. The commercialization of this entire practice only highlights how unbalanced the power dynamics between park creators and visitors are as even these simpler acts of autonomy are being redefined by

corporate interests. The initial purpose of the practice was to improve visitor self-expression through everyday costumes, even challenging societal norms or customs like the idea of the binary gender. For instance, Uriel Diaz explains how they would not have discovered their comfort with the idea of being nonbinary without the chance they took bounding in a Daisy Duck dress one day (Sampson). The role of Disneybounding in fostering a sense of community belonging and connection at this point is undeniable. Another significant limitation of this practice, however, arises from the idea that “the architectural spaces of theme parks (which are often influenced by ‘colonialism or ‘Victorianism’) mean that fans can never truly be resistant since they continue to be framed (and constrained) by the physical settings around them” (Williams). With the time periods of influence themselves being strictly adherent to the ideals of strict cultural and gender norms, it is important to realize how every aspect of the park from the portrayal of characters to their interactions with visitors will be impacted by these viewpoints. Thus, any attempts at true and meaningful self-expression are only expressive as long as they do not conflict with the narrative that is imposed by the parks’ creators. While Disney parks have the potential to act as canvases for personal expression and connection, they still remain spaces of corporate control above anything else.

The juxtaposition of utopian-like Disney parks with the dystopian critique presented by Dismaland, the work of the anti-institutionalist artist Banksy, serves to deter consumer culture in favor of awareness of many dangerous societal problems. In her senior thesis, Lina Wang emphasizes Banksy’s beliefs in the idea that “theme parks should have bigger themes,” and so the resultant wasteland that is Dismaland while a depressing collection of attractions is perfectly reflective of our reality and the ignored problems of our generations. For instance, instead of Turtle Talk with Crush at Disney parks, why not highlight how our littering and accumulation of plastic in the oceans is endangering the lives of real turtles daily? Instead of the Expedition Everest ride, why not shed some light on the global climate change crisis and the consequently melting ice glaciers all around us? As a solution to the ignorance towards these ideas that Disney parks perpetuate, Banksy set up attractions like that of a dead princess in a crashed carriage surrounded by paparazzi to highlight the tragic and ignorant trend of sensationalization that the media tends to follow (Wang). Even if we have as much hope as possible for humanity, a significant limitation with this exhibit arises from the fact that these attractions will be seen as exactly that — as attractions (rather than highlights of the world around us). They will be perceived as something different to explore as the hyperreal environments around us have made us forget what the original reality actually consists of. At the end of the day, the reduction of Dismaland to a simple sensationalized selfie post on a social media platform can render the entire message of the exhibit meaningless to the average visitor.

The expansiveness of the hyperreal landscapes of Disney parks serves to blur the lines between fantasy and reality, influencing how the balance of power between spaces of individual autonomy and corporate control is set. With their immersive attractions and narrative-based environments, Disney parks offer an escape from the mundane by utilizing magical ideals of storytelling and a tangible form of imagination. This world of happiness, however, operates within the boundaries of carefully curated experiences designed to reflect the wishes of its creators to the extent that grassroots attempts at self-expression by visitors are still framed according to their constructions. This struggle between individual autonomy and institutional control is best framed in

Catch-22 by Joseph Heller, but the difference lies in how explicit this control truly is in both situations. In the novel, at least for characters like Yossarian and Orr, there is much self-awareness with regard to entrapment within the military institutions as evident paradoxes like “Catch-22” keep soldiers flying missions despite the fulfillment of their duty. In the case of the control of visitors to Disney parks, the indirect nature of this power exertion for the same end goal is all the more terrifying as visitors cannot act against the problem without knowing about the existence of the problem. In finding a more effective manner of communicating societal problems and creating spaces where visitors can regain autonomy over the profit-seeking creators, both approaches must be combined. Increased transparency efforts from the corporation through workshops on behind-the-scenes economics and storytelling motives can make visitors more aware of their sense of control at the parks. They are more likely at this point to take in the genuine message of social critique-based attractions if the trust of the creators is gained in this manner. As always, the balance between the two is a tough battle as the allure of Disney parks in the first place is their secretly magical nature.

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## *Social Media: The Endless Circus Starring Users’ Draining Mental Health*

Brandon Tsai

Since the introduction of social media in the late 20th century, the modern world and the way we approach our daily interactions have been irrevocably changed. From 1997 with the release of

SixDegrees.com, one of the earliest social networking websites, to present day with a wide variety of platforms including Facebook, Instagram, Snapchat, Twitter, and more, these sites have notably combined the ability to personalize and create “a public or semi-public profile within a bounded system, articulate a list of other users with whom they share a connection, and view and traverse their list of connections and those made by others within the system” (Lee, 2). However, as with any new development, this new technology has introduced new problems into our daily lives through constant stimuli such as “likes, notifications, comments, etc.” entrapping users in social media’s content and presenting curated feeds to vulnerable individuals with “frequent and extreme upward social comparison,” creating an “erosion of self-esteem, depressed mood, and decreased life satisfaction” and lashing out on others or “cyberbullying” (Qiu). Despite these issues to mental health, these apps still maintain consistent, self-servicing followings, aided by intentional tactics to increase engagement and incentivize more “relatability” in videos, while creators struggle to find ways to fortify their own willpower to push others and themselves beyond the addictive qualities of the service.

In particular, the problem with the institution of social media spans generational lines with efforts by companies to keep individuals in check under their “scrolling system,” echoing historical strategies of keeping populaces in order. From a theoretical lens, these internet platforms follow many other political, religious, and economic organizations as “Repressive” and “Ideological State Apparatuses,” bodies aimed at “correcting” the populace’s actions using violence, censorship, and routine desensitization (Althusser). By existing as the primary means of communication for many individuals worldwide and reinforcing advertiser-friendly content through algorithmic promotion and censorship, these services appear to serve a mixture of private and individual interests while achieving broader agendas like portraying companies in a better light and hooking users into echo chambers or fanbases. Undoubtedly, not every individual will be affected, but even attracting one member of a group results in returns in terms of profits and effects of the infectious “Fear of Missing Out” on peers, incentivizing an arms race for addictiveness. This competition for attention results in minimal ways from escaping the Internet and eventual “conversion” by interacting with these websites at least to some extent. The effectiveness of this campaign is evident today with at least 4.7 billion people using the Internet as of 2020 and billions using various social media platforms, where the younger generations tend to be more involved and time spent online only increases every year, especially on mobile devices (Ortiz-Ospina). With such an integral position over a large portion of the populace, fears for sites like TikTok controlling the minds of the masses are not completely unfounded. However, the reality is not as politically motivated as is often discussed as the issues with these services’ business models revolve around using as much of users’ time as possible. Whether this increased engagement is done by controversial rhetoric or cute cat videos, these institutions with people’s attention caught in their “Inter-webs” often do not have the mental and sometimes physical health of the consumer as their main priority.

While blaming corporations may be easy scapegoats, users of these applications pose as great a danger to themselves as they do to others by existing in a system that bases itself on virtual validation and a “necessity” to always remain online. The Panopticon as described in Discipline and Punish perfectly aligns with the self-regulating factors weighing especially on teenagers and young adults as “the major effect of the Panopticon [is to] induce in the inmate a state of conscious and permanent visibility that assures the automatic functioning of power” (Foucault). By interacting with these platforms, individuals agree to a one-sided relationship where they are always “performing” to the masses and are heavily encouraged to conform to the trends of the day to remain relevant. However, even when posting or abstaining from posting, as is often suggested, to close friends, one’s actions may constantly be watched and judged. Ignoring is possible, but commonly, this pressure leads to a near endless effort to appeal to one’s peers by consistently liking, creating, and mimicking

content, thereby feeding into the library these platforms can recommend and the expectations users place upon themselves. The unhealthy nature of social media stems, ironically, from its signature ability to share anything with anyone, creating a paradox where platforms give “off the illusion of acceptance and validation, while detrimentally affecting one’s self-esteem” through “likes” and idealized realities (“The Paradox of Social Media and Self-Esteem”). Although championed as a space for free expression, societal norms and pop culture add a factor to this online “self-expression” all while virtual updates engrain themselves as vital parts of daily communication. This subservience to platforms is only further reiterated by the dopamine received, no matter how small, from gaining “likes” on posts of oneself, reaffirming biases that one holds or awakening new doubts from public responses. Ultimately, users distance themselves from the physical world, overvaluing the easily available and readily understandable affirmations social media offers and frequently promotes.

Designed to prey on the natural tendencies of its audience, these online services’ algorithms utilized youths’ dependence on external confirmation or their self-awareness to this dependence by serving content that worsens the addictive “rabbit hole” or hypocritically claims to help in breaking the cycle with additional instructional media. *Catch-22* describes the paradox soldiers and users, especially creators, face when given the option to escape the trap of the military or social media: “Orr was crazy and could be grounded. All he had to do was ask; and as soon as he did, he would no longer be crazy and would have to fly more missions” (Heller, 46). As the novel showcases, “Catch-22’s” exist in many more ways beyond just bombing missions, and frequently for influencers, producing content often comes at a great amount of stress and burnout encouraging a retirement from the spotlight, but simultaneously, those who are able to end their addiction are encouraged to use their position to help others. Incentivized by monetary gain and popularity, the consumers of the media create a system that sustains itself through niche content to pander to individual interests and advisory content asking individuals to leave the platform. While generally well intentioned, these viewers can gain a sense of satisfaction in passively watching remedial videos without actually acting on their original dependencies. These websites continue this seemingly altruistic façade through intentional algorithmic designs like Pinterest’s “compassionate search” where users who searched for topics such as stress or work anxiety would be suggested activities to improve their mood (Ifeyanyi). Through efforts to appease the problem of unhealthy relationships with online personas instead of solving it, addiction to these sites’ media is an uphill battle. By curating and adjusting recommendations to viewers, these services refine a customized list that maximizes retention, no matter the cost to one’s time or mental health. Mixed in the praise for those combating algorithmic addiction is the grim reality that getting the most eyes on one’s message requires submitting to the status quo implemented by those tuning these apps’ formulae.

Competing in this sea of 1’s and 0’s, producers seek to use historical strategies and modern preferences to get their voice heard, or at least passively acknowledged, through more attractive content, often following the latest trends to attract and maintain a following. In addition to social media’s growing role as source of information and misinformation, it has proved extremely useful for understanding best practices to appeal to a virtual public: well- tailoring content, utilizing technology and psychology, and cultivating consistent branding (Bialy, 19). By gearing content towards specific parts of the population, content creators can guarantee a baseline level of success, and themes of identity like politics, generations, and nostalgic experiences have been extremely successful throughout time. Consequently, the young base of these online networking sites are both original and unoriginal at the same time. Extremely welcoming of recent developments, Millennials and Generation Z have pushed artificial intelligence to its limits through written, audio, and visual manipulation, but in the end, they still follow time-proven marketing techniques by providing and

reminiscing over reliable routines and formats to familiarize consumers and childhood memories to tug on the heartstrings of the occasional “scroller.” The Postmodern results of these implicit tendencies can be seen in the “-core” trend, specifically “Corecore,” on TikTok where an assortment of “nostalgic, nihilistic, or poignant” video and music clips are used to “[hint] at meaning, but may not be anything more than a feeling” in favor of environmental or socioeconomic change (Townsend). Even without a direct call to action, the popularity of this type of short video demonstrates the emotional impact these platforms can have on their audiences. The individualized relatability of the broader app as uniquely compiled by the user base creates a bond that is not easily replicable or always available in day-to-day interactions. Social media provides an interesting look at our internal values from a surface level. Although societal issues may be brought up, fundamentally, this institution serves as an escape from reality and its responsibilities, allowing the maker and observer to skirt past important problems while overlooking or agreeing on their general sentiments.

Standing against such an entrenched establishment and deliberately considering engagement-based techniques can be extremely difficult especially when relaxing and listening to “trusted” sources, but similar to how one should approach any institution, reclaiming one’s independence simply relies on oneself and a commitment to changing. In a study analyzing numerous experiments combating “digital addiction,” four notable categories of solutions emerged: psycho-social countermeasures (based on Cognitive Behavioral Therapy where participants, and possibly their relatives, were taught, reinforced, or otherwise notified about the implications of social media, the time they spend on it, etc.), software interventions (through education on potential dangers or time limits), pharmacological supplements (to decrease the dopamine received from watching, playing, and “discovering” new content), and combinations of methods (Deniz, 4). Essential to all these solutions is changing the behaviors of the affected individual and understanding the limits social media’s influence has. Adhering to Existentialist philosophy, setting one’s boundaries, being properly informed on the institutions’ methods of control, and mitigating the effects of these influences are necessary to break one’s overdependence on these online services. Additionally, a pivotal component of this process is the treatment of this issue not as a “habit” but as an “addiction,” not trivializing the “endless scroll” but destigmatizing it through support groups and better education on its signs and consequences.

From an individual’s experiments on herself over two years to determine productivity with social media, she noted how initially starting to reduce time spent on these apps was harder than committing to the change, and throughout her various methods, the biggest contributor to lessening temptations came from replacing one attention-grabbing activity with another and playing into natural tendencies rather than against them (Peck). Of course, these are subjective solutions reliant on personal obligations, but the base principles still apply where self-regulation can be accomplished by exploiting the same human instincts platforms use to increase user retention. Deliberate, healthier distractions like mere walks and daily routines instated for the purpose of limiting screen time can be extremely helpful in restricting the hold social media has over one’s life by adding greater purpose to an Internet dive beyond a neutral pastime. Carving out one’s own meaning from the virtual world may sound cliché especially when talking about an action as plain as clicking a new video, but grappling with the end goal of anything one spends time on is crucial to ensuring one doesn’t get trapped in the “default” psychological pitfalls these services and its creators expect.

Social networking has been a vital part of human society since its inception, and social media as we know it today is only its shiniest, modern derivation. However, with the many ways technology has to advance our way of life, it has also opened as many new avenues to corrupt it. With mounting stress to perform and escalating expectations of beauty and insight into private lives, these websites

continue to keep large swaths of the population engaging with and creating content that appeals to human nature's need for excitement and inclusion and shallowly resonates with our ideals. Even though these basic desires are difficult to overcome, research and anecdotal evidence surrounding methods of mitigating "digital addiction" have revolved around controlling one's own tendencies and confronting the manipulative tactics utilized by these platforms' algorithms and creators. The failure or success of current generations to overcome the jaws of the online world will be critical for the direction future advancements take: leaning more into quick, emotion-filled grabs for our attention or reversing recent trends towards genuine reporting and longer-form productions. Though there are always deviants to current trends, history and the actions we take now will shape broader pop culture for "better" or for "worse" according to our current or future standards, leaving an unforgettable mark on humanity's communication.

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# *Synopsys Science Fair 2024*

## *Building A Classification Model For Detection Of Diabetic Retinopathy Using Deep Learning*

Aanya Gupta

Diabetic retinopathy is a disease where diabetes eventually causes symptoms that impair the retina, causing gradual blindness. It usually doesn't show symptoms until a severe stage where treatment is both intensive and expensive. In many rural and impoverished areas, this sort of medical treatment is rare, and often dire problems are found too late due to the "invisibility" of the disease and the hospital visit's high prices and long commute. The goal for my project is to make diagnosis for diabetic retinopathy more available by creating a deep learning model with the primary objective of classifying retina images as diseased that can easily be loaded onto any device. In order to achieve this goal, I obtained a wide variety of retina image samples from a leading eye research institute and used transfer learning on four existing convolutional neural networks for image classification. I added different image normalizations, such as min-max scaling and perchannel, and I used data augmentation on my small dataset to make up for the data insufficiency, going from 236 to 1,180 images. After that, I tried two different types of validation, k-fold and leave-one-out, in order to try and maximize the accuracy and F1 score. Overall, my best model achieved a validation accuracy of around 81%. In conclusion, my deep learning model for detecting diabetic retinopathy works towards a future of at-home diagnosis so that individuals can test early and prevent loss of vision due to diabetes.

 Diabetic Retinopathy Poster 2024

## *TractX: A Density Aware Streamline Exclusion System for Accurate White Matter Reconstruction*

Krishna Bhatt

White matter tractography is a non-invasive diffusion-imaging tool essential to analyzing brain connectivity; it is the most prevalent system for pre-operative and research-based analysis. However, it faces challenges from erroneous methodologies ignoring bottleneck regions where multiple white matter bundles converge before diverging. This results in false-positive paths in around ~70% of voxels (3D MRI pixels) and an exceedingly low precision of ~23%. TractX aims to resolve bottlenecks through a three-part pipeline of systematic identification and alteration utilizing a novel nerve-density-analysis architecture. The prototype initially conducts Constrained Spherical Deconvolution (CSD) on 1mm dMRI images to produce a field orientation distribution (FOD) of individual voxels. The FOD is then parsed to a bottleneck identification system in which fiber-vectors assigned to multiple bundles are extracted alongside relevant data, including fiber-density and

associated voxels. Next, the data is transformed into a feature vector representing selectively weighted characteristics of the bottleneck through a linear regression model trained with gradient descent. An Approximate Nearest Neighbors procedure deconstructs the vector into a low-dimensional space before streamlines are associated by distance in the vector space. Finally, TractX regenerates bottlenecks through CSD, connecting in and out fibers. After comparison against HCP-based ground truth datasets, the TractX pipeline produced a recall of 94.52% and a precision of 72.83%. The novel architecture demonstrated an unprecedented and phenomenal gain in precision score, 216.15% higher than current state-of-the-art pipelines. Accessed through command-line interface, TractX has great promise for improving tractography results and reliability by over two-hundred-fold across innumerable applications.

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