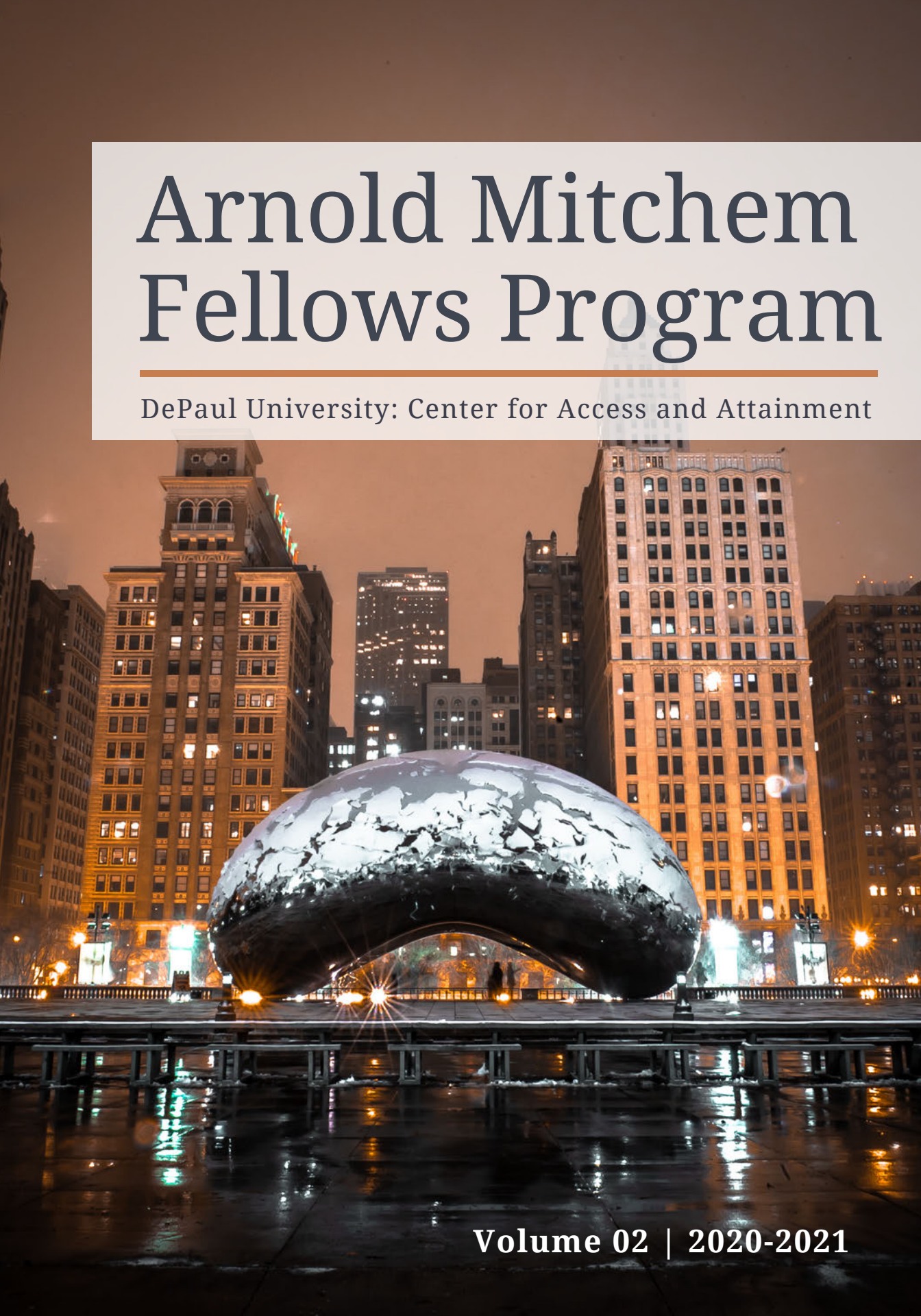
Arnold Mitchem Fellows Program

DePaul University: Center for Access and Attainment



Volume 02 | 2020-2021

2019-2020 AMF STAFF

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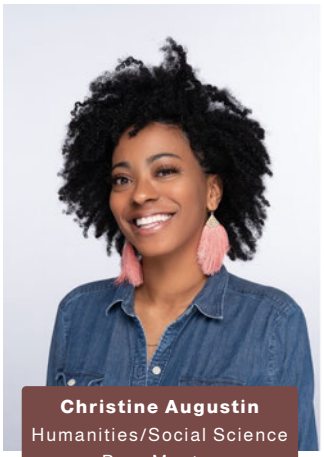

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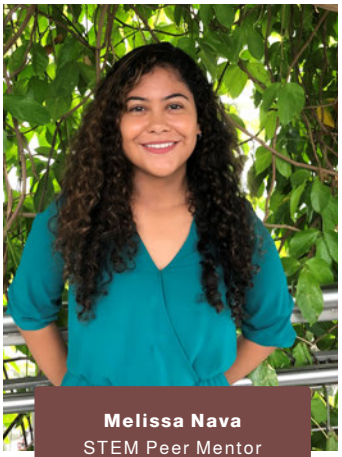
Peer Mentor
Graduated Spring 2020



Melissa Nava
STEM Peer Mentor
Graduated Spring 2020

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MISSION AND PURPOSE

The Arnold Mitchem Fellows Program serves first-generation, low-income, and underrepresented sophomores planning to attend graduate, law, or medical school and pursue a research-based career. Participation in the program is an academic, yearlong commitment.

The program is named after Arnold L. Mitchem, Ph.D., President Emeritus of the Council for Opportunity in Education. Dr. Mitchem has been a voice for low-income, first-generation students and individuals with disabilities his entire career.

DePaul is just one of several universities to offer fellowships named after Dr. Mitchem to encourage both opportunity and achievement in higher education.

NEW INITIATIVES

Humanities / Social Science and STEM Sections

Previously, the AMF program consisted of one section where students from all disciplines would learn and work within the same class. Starting Fall 2019, the AMF program now serves students through two class sections based on students' academic and professional interests – humanities/social science and STEM.

Moving forward, the program aims to add a third section to reflect a wider range of research-related academic and professional work – an Arts/Creative Works section.

AMF Peer Mentors

The AMF program created Peer Mentor positions for junior and seniors DePaul students who have completed the AMF program and wish to mentor current AMF Fellows. The first two AMF Peer Mentors, Christine Augustin and Melissa Nava, completed the AMF program during the 2017-2018 academic year. As seniors, they were excited to be in a position to guide current AMF Fellows.

(left to right) Peer mentors Melissa Nava and Christine Augustine promote the AMF program.

CONGRATS TO THE 2019-2020 COHORT!

AMF Social Sciences and Humanities

MAYA CHANCOSO
Major: Criminology
College of Liberal Arts & Sci.

CAMERON LEFLORE
Major: Secondary Education
College of Education

ARIANA MANSOUR
Major: Political Science
College of Liberal Arts & Sci.

GABRIELLE OGBEVIRE
Major: Management Information
College of Business

ISABELLA PETRI
Major: Actuarial Sciences
College of Business

DANIEL RAMIREZ
Major: Economics
College of Business

SARAH TOHME
Major: History
College of Liberal Arts & Sci.

NATALIA SEMANIUK
Major: Economics
College of Business

DHURVI SONI
Major: Economics and Secondary Education
College of Business and College of Liberal Arts & Sci.

ANA VALENZUELA
Major: Sociology
College of Liberal Arts & Sci.

AMF 2019 - 2020

AMF STEM

AMF STEM, visiting the Ghiradelli Ice Cream and Chocolate Shop.

NADIA ARTEAGA
Major: Health Sciences
College of Science & Health

SAGE AUSTIN
Major: Neuroscience
College of Science & Health

ALYSSA BYERS
Major: Psychology
College of Science & Health

MAAME KORLEY BAAH-ARHIN
Major: Psychology
College of Science & Health

HAWRAA FAISAL
Major: Neuroscience
College of Science & Health

BRENDA GAMON
Major: Biological Sciences
College of Science & Health

ALEXANDRA KUSNIERZ
Major: Psychology
Alexandra Kusnierz

KACPER PACHUT
Major: Psychology
College of Science & Health

R'ELLE ROBERTSON
Major: Psychology
College of Science & Health

SMRITI SINGH
Major: Physics
College of Science & Health

VALERIE TAFOYA
Major: Psychology
College of Science & Health

JOHN VALMONTE
Major: Psychology
College of Science & Health

LEANNE XU
Major: Neuroscience
and Psychology
College of Science & Health

LILLIAN MERRYMAN
Major: Biological Sciences
College of Science & Health

AMF 2019-2020 HIGHLIGHTS

Graduate Student Speakers

Thank you to Jocelyn Martinez (Left) & Donte Tanner (Right) for sharing their journey to graduate school with AMF students.

Social Science/ Humanities Faculty Guest Speaker

Thank you to Dr.Valerie Johnson from the Political Science Department (Left) for sharing her academic journey with the Social Science/ Humanities AMF class

STEM Faculty Guest Speaker

Thank you to Dr. Margaret Silliker from the Biological Sciences Department (Left) for sharing her academic journey with the STEM AMF class

AMF ALUMNI SPOTLIGHT

Alondra Venegas | AMF 2017 -2018

I joined the AMF program because, as a first-generation low-income student, I was completely oblivious to the opportunities around me. Oblivious to a whole new world of opportunity I'd never known. Moving from the farm to Chicago was already a bold decision, and I had no idea how I would go about achieving my goals – after all, I was the first one to do so. My story and my identity have been a rather intricate and complicated journey. I come from a line of immigrants, factory workers, and farmers where to dream outside that scope was misunderstood.

AMF gave me a voice, a voice to advocate for people of color. As a Native American woman living below the poverty line, I represent less than 2% of the U.S. population. Therefore, as an ethnic minority woman from a rural area, I knew that I could contribute by bringing a unique social and racial perspective to school environments that were predominately Caucasian. I have worked in two laboratories during my undergraduate career in the department of Neurosurgery at the University of Chicago and in the department of Psychology at DePaul University.

My desire is to continue becoming more educated in understanding key social, cultural, and environmental factors that contribute to overall health among pregnant women and infants across different ethnic minorities. I will be pursuing my master's in nursing upon graduation and hope to obtain my doctorate in nursing upon completion of my program.

Danya Soto | AMF 2017-2018

During my freshman year of college, I had the opportunity to get involved in Latinx research in the department of psychology at DePaul University. This opportunity ignited my passion for psychological research in Latinx communities, and I learned that the AMF program could help me further my research interests and guide me as a scholar. I decided to join the AMF because I wanted to receive more guidance on how to conduct culturally and academically relevant research and because I wanted to be part of a community that supports the dreams, needs, and passions of underrepresented voices.

I am eternally grateful to the AMF program for helping me become a more knowledgeable, compassionate, and confident researcher. I learned the significance of making meaningful connections with classmates and professors; the necessary process of questioning and challenging our personal biases; the importance of trusting your "gut;" and the ability to have an open mind and ask for help when necessary. I found my best friends in AMF – not only among my classmates but also my mentors. AMF is a family of research aficionados that help and support each other even after our time in the fellowship. I will always be indebted to AMF for providing me with unconditional scholarly, emotional, and financial support.

Since my participation in AMF, I completed a Summer Research Opportunity Program at Northwestern University, where I presented research about "Eating Disorders as a Form of Non-Suicidal Self-Injury," now pending publication. In addition, I obtained a research

Assistantship at the Department of Psychiatry and Behavioral Health at Northwestern University upon the completion of my Bachelor's degree. Last but not least, I will be starting the School Psychology PhD program at the University of Wisconsin-Madison in the fall of 2020.

In all honesty, without AMF, I would have been unable to navigate the U.S. education system as I did. AMF was true to their mission to help students like me who are the first in their families to attend an American university, and now thanks to their unconditional support I get to be the first person in my family to obtain a doctorate degree. A thousand thanks to AMF!

Iris Sanchez | AMF 2017 -2018

I joined AMF as a sophomore because I decided I wanted to go to graduate school. By joining the AMF program, I was able to learn more about grad school while also preparing for it. During my time in the program, I definitely accomplished those things. Along with that, I gained a lot of confidence in myself and my abilities as a researcher.

As a health sciences major, I was searching for not only a program that would enhance my research skills, but also one that would provide a community for students with similar backgrounds. Being a person of color in the STEM field, I appreciated meeting other POCs in similar fields and formed a strong community.

My peers within the AMF program have become my close friends who empower me throughout this journey. I want to thank AMF for giving me the opportunity to form these important relationships.

Melissa Nava | AMF 2017 -2018

As a health sciences major, I was searching for not only a program that would enhance my research skills, but also one that would provide a community for students with similar backgrounds. Being a person of color in the STEM field, I appreciated meeting other POCs in similar fields and formed a strong community.

My peers within the AMF program have become my close friends who empower me throughout this journey. I want to thank AMF for giving me the opportunity to form these important relationships.

We continue to support one another, and I am very proud of what my friends have accomplished during this program and afterward.

Since participating in AMF, I joined the McNair Scholars Program, which helped me gain acceptance into the University of Maryland's Summer Research Program. I have presented my research at multiple conferences, including SACNAS, and I am in the processing of publishing my research. I will be applying to MPH programs with a concentration in global health in the fall.

FEATURED AMF PAPERS

The Cumulative Effects of Race and Poverty on Mental Health

Danielle Ortiz
Political Science & Philosophy | College of Liberal Arts & Social Sciences
DePaul University

ABSTRACT

This paper examines the intersection between race, poverty, violence, and mental health issues.Examining the language used to discuss mental health in the inner city, Danielle Ortiz challenges preconceived notions of depression and PTSD as "hood disease." Instead of this blanket assessment, she looks at the social and systemic factors that lead to crime and violence and how these lead to health issues, both mental and physical. After discussing the cyclical relationship between PTSD, crime, and other mental health diagnoses—and lack thereof— she then argues for solutions that look at the root causes of violence and inequity instead of focusing on short-term change.

INTRODUCTION

Mental illness is, in many ways, drawn along the lines of race and class. This classification is not to say that a wealthy white person cannot be depressed or mentally ill, but that an impoverished black person is more likely to face trauma. Evidence shows an increase in suicide among black children under the age of 12 and a decrease in their white counterparts (Bridge et al., 2012). The issue of class is a factor, too. Over the past five decades, wages have failed to keep up with the rising cost of living with prices outpacing wages by an average of 36 cents per item (Hamm, 2014). As a result, many families struggle to make ends meet, facing financial stress on top of their everyday stressors. Many health professionals agree that increasing the minimum wage would be the most effective way to address the mental health crisis in America (Weir, 2016). Race and financial inequality intersect in the inner city, resulting in a crisis that is often overlooked.

In 2014, CBS San Francisco released an educational piece on post-traumatic stress disorder (PTSD) in the inner city and referred to the problem as "hood disease" (Cheney-Rice, 2014). The derogatory representation of a mental health crisis as "hood disease" demonstrates the double prejudice at play within discussions about mental health problems when coupled with specific populations, and illustrates the need for empathetic analysis of the crisis. By double prejudice, I mean that mentally unwell residents of impoverished areas, "the hood," face not just the stigma of mental illness, but the multiplicative effect of this stigma combined with

socioeconomic marginalization. This double prejudice is the unfortunate consequence of financial and racial inequity. There are other representations of the issue, however.

The National League of Cities published an article by Michael Karpman, now a senior research associate in the Health Policy Center at the Urban Institute, titled "Kids Living in Combat Zones ... in U.S. Cities," which makes the comparison between inner-city violence and war zones (Karpman, 2012). This comparison is particularly potent for those of us living in Chicago. As a result of the high levels of violence in Chicago, the city is sometimes referred to as "Chiraq," a term coined by local musician, King Louie, in his 2009 track "Chiraq Drillinois," in comparison to not only the violence seen by Iraq war veterans but also the resulting mental illness (Alderman & Caspersen, 2015; Daly, 2017). The mental health crisis in the inner city can be attributed to, and is magnified by, socioeconomic inequality and racism. These institutional disparities create problematic circumstances that stimulate violence, making inner-city residents—especially black children—more likely to develop mental health disorders such as PTSD. In response to the dismissal and prejudiced representation of the issue, we must reexamine how we talk about these neighborhoods and how we develop solutions.

This analysis must include how factors of racism and financial inequality intersect to create an environment that exposes inner-city youth to violence that causes symptoms of PTSD/mental illness, how these factors continue to influence the response to this health crisis, and how this response further perpetuates a cycle of violence. The crisis is embedded within a framework of racism and wealth disparity. Financial inequality and racism create circumstances that stimulate violence, which acts as a triggering factor for symptoms of PTSD. The resulting mental health complications have lasting effects on community members, particularly when they are exposed to violence as children. The permeation of racism and financial inequality in every facet of life perpetuates this cycle of violence. To understand this cycle, I will look at the relationship between impoverished neighborhoods and crime, the effects of crime on the residents of these neighborhoods, and the resulting changes in their quality of life. I conclude with recommendations for alleviating the root cause of the issue and an assessment of the validity of PTSD resulting from urban conditions as a legal defense.

IMPOVERISHED NEIGHBORHOODS AND CRIME

The linkage between poverty and crime is well documented. One particularly well-known component is known as “crimes of poverty,” which include crimes such as stealing food when hungry. Food theft is complicated by the existence of “food deserts,” which are areas where fresh food and produce is unavailable and unaffordable. Many food deserts are in predominately black neighborhoods (Morland et al., 2002, p. 23). Crimes like stealing to eat are committed to ensure one’s survival.

We can infer that communities lacking in business are, therefore, lacking in job opportunities, which leads some residents to turn to criminal activity as a last resort. In this way, some members of impoverished communities are inducted into a life of crime to survive. Moreover, there is a researched connection between poverty and gang-related activity. Gangs operate to provide protection, as well as financial and social support. The residents of these impoverished neighborhoods need support to survive and are often unable to meet their basic needs through accepted, legal channels. In many cases, gangs were created to cope with the tumultuous environment of their impoverished neighborhoods (Fleisher, 2009, p.11). In these neighborhoods, violence is often used to resolve issues and protect one’s ability to satisfy basic needs (Burnett, 1999). Normally, one might look to law enforcement to resolve or mediate conflicts; however, gang members do not have that option and must resolve conflict on their own, often leading to bloodshed. One could even consider violence and mental disorders like addiction, as the inevitable byproducts of economic stressors like poverty (Matto & Cleveland, 2016, p. 17).

This relationship with law enforcement is further complicated by racial profiling, the prison industrial complex, and the disproportionate number of African American men imprisoned. In addition to violence being related to the circumstances of poverty, impoverished communities (often communities of color), must also combat the psychological effects of racial stereotyping. The misconception that black and brown men are inherently dangerous further supports the need for such resistance. These misrepresentations can be internalized, allowing people to rationalize their violence. When a person grows up being told that they are automatically considered a criminal by the media, their teachers, and even their parents, it can be challenging to self-identify as anything else (Baker-Bell et al., 2017; Wald & Losen, 2003; Lopez, 2016). Though the relationship between poverty and crime is complicated, it has been well documented over the years and is generally uncontested.

CRIME AND PTSD

Studies on the relationship between impoverished communities and crime have explored some of the complexities. Research has shown family violence, community violence, and stigmas as contributing factors to PTSD (Kennedy et al., 2014). I want to pay particular attention, however, to how trauma responses are magnified by racism, which can be investigated through studies that examine PTSD symptoms among different racial groups. One study showed that there was a difference in the perception of stigma and its result on mental health for different racial groups, indicating that these issues are racialized (Kennedy et al., 2014).

Additionally, a study centered on the experiences of African American youth found a substantial correlation between being a victim of, or witness to, violence, and displaying symptoms of PTSD. (Bridge et al., 2015). This is also supported by the previously mentioned unfortunate and disproportionate rates of suicide among children under 12. The last few periods of the Bridge study (which ended in 2012) showed a decrease in suicide among white children but an increase among black children. This suggests a palpable difference in the quality of mental health among children of different racial groups.

Another study specifically examined children who have witnessed intimate partner violence and showed no substantial difference between the four identified ethnic-racial groups (Koolick et al., 2016). This suggests that the difference between racial groups is not their reaction to violence since the likelihood of developing PTSD symptoms after being exposed to violence is relatively equal across ethnic-racial groups. We can infer instead that certain groups are exposed more frequently to greater amounts of violence. This could be attributed to the link between impoverished neighborhoods and crime, as well as the historical institution of white supremacy and its effects on the socioeconomic status of African Americans. It is no accident that the poorest neighborhoods in Chicago are communities of color, predominately black, and the correlation between mental health imbalances must be confronted as the byproduct of historically oppressive practices.

PTSD AND QUALITY OF LIFE

How does the difference in violence exposure and resulting mental health translate to a difference in the quality of life? One study shows that across all the accessed domains of life (i.e., physical health, psychological health, social relationships, and environment), participants with PTSD symptoms rated their quality of life lower in all domains (Johansen et al., 2007). These

troubling but predictable results are compounded by evidence that the PTSD symptoms that impede quality of life most were anger, hypervigilance, and restricted affect (Forbes et al., 2019). Both studies suggest that quality of life might be related to PTSD and mental illness more broadly. The findings of these studies, combined with localization of PTSD within the inner-city neighborhoods, highlight the need to reexamine how we think about these neighborhoods and how we develop solutions.

IMPLICATIONS

Violence occurs in the inner city, in part, because of factors like economic inequality and institutional racism. Exposure to this violence leads to the development of PTSD and other mental illnesses, which impacts the residents' quality of life and is magnified in the case of children growing up in this environment. With this knowledge in mind, one must conclude that to improve the quality of life of inner-city children, we must address the issues of racism and financial inequality that are present at every stage of this sequence, from the inciting factors of violence to the multiplicative effect of interpersonal trauma.

Some people believe that interpersonal intervention is critical to confronting the violence and mental health issues that have arisen in the inner city. Conversely, one study conducted with young African American male participants, who are most likely to be a victim of or exposed to violence, concluded that social support did not effectively mediate the moderate psychological distress that resulted from exposure to violence (Paxton, 2004). This suggests that a multifaceted approach is necessary to combat this issue. I argue for pursuing a root cause approach that focuses on the causes of violent crime by infusing resources, such as business investment and educational opportunities, into impoverished communities to provide viable economic alternatives to crime for residents.

Mental illness is generally considered the result of genetic and environmental factors. Throughout my research, I have focused on environmental factors contributing to mental illness, specifically poverty and racism. If these factors are key components of the inner city mental health crisis, as my research demonstrates, then a structured approach aimed at alleviating these root causes is a necessary component of the problem-solving process. Without this root cause orientation that centers the historical reality of generational poverty and the targeted disenfranchisement of people of color – namely African Americans, individual intervention, while important, will only work to resolve the

and consequences of the problem without addressing the original trauma; namely, growing up poor and witnessing violence. While interpersonal support is important, it is a short term and individual solution for the long term and institutional problems.

Short term solutions are still of critical importance in filling the gap as we work to enact long term structural change through institutions to redress wealth inequality. In addition to the short term solution of personal intervention, we should also reconsider the legitimacy of PTSD affirmative defenses for inner-city offenders. An affirmative defense is a legal option wherein the accused admits guilt but argues that there are mitigating circumstances that require an alternative to prison time. The most notable affirmative defense is the insanity plea, in which the accused is portrayed as insane and, therefore, ought to go to a treatment facility instead of prison. PTSD is considered a viable basis for an affirmative defense in cases with combat veterans (Gansel, 2014).

Unfortunately, many still consider the affirmative defense to be less valid in cases of people living with inner-city PTSD and has been described as a legally illegitimate defense (Copp, 1995). Based on the strong evidence supporting the reality of PTSD in the inner city, we ought to reconsider the comparative similarities between veterans' PTSD and "urban survival syndrome," as inner-city PTSD has been termed by legal scholars, and treat them accordingly (Liggins, 1999). Of course, the comparison between veteran offenders and inner-city offenders is embedded in ideological considerations of value and debt in our society.

Many people are willing to accept affirmative defenses from veterans because we value their military service, and feel a social debt towards them. It is high time that we realize that we also owe a debt to the people still living in generational poverty as a result of slavery and other institutional practices of racism. Their social contributions have as much value, and it is time we act accordingly. For that reason, we should both work to address the root causes of violent crime in the inner city and, in the meantime, adjust our criminal punishments to reflect true justice.

Going forward, more research needs to expand on how currently incarcerated offenders respond to access to mental health treatment within prisons and how that treatment affects recidivism. Would we find that some convicted offenders have undiagnosed and untreated disorders? I would also like to know if untreated mental health issues are a factor for violent

offenders committing further acts of violence. On the root cause side, I would be interested to see research on the effects that business investment (or lack thereof) has on crime and how business investment in impoverished crime-ridden neighborhoods can be completed without gentrification. In conclusion, we should orient ourselves towards long term solutions that focus on mitigating the root cause, and promote short term solutions, like affirmative defense and interpersonal intervention, which help mediate the short term harms of this cycle.

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Company Paternalism: Comparing the Pullman Company to Modern Labor Politics

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History | College of Liberal Arts & Social Sciences
DePaul University

ABSTRACT

Drawing connections between Pullman company society and modern-day labor practices at Apple, Fae Robertson suggests that exploitation of workers is built into company paternalism for the sake of profit and control. Based on a literature review of both historic and modern first-hand accounts of practices in the Pullman Society and Apple's overseas dormitories, she highlights how little has changed when it comes to the plights of workers. Following the Pullman Strike and other organized labor movements, legislature that better protect individual workers and unions have formed; however, because the Apple dormitories discussed in this paper are located overseas, many of these protections do not extend to these workers. Robertson concludes with recommendations for further research and stronger international laws, labor practices, and protection for workers.

INTRODUCTION

The Pullman Strike of 1894 makes an inherently Marxist argument that exemplifies the deeply flawed system of company paternalism. This paper argues that labor and capital can never have the same interests for laborers since bosses (capital) are always looking for ways to exploit workers (labor) for profit. This lends itself to Marx's age-old class argument that capital continually reinvents itself with small meliorations that still exploit labor.

In the case of the Pullman Strike, the small "improvement" was on-site housing in a model town that was supposed to have comparable rent prices to Chicago. The workers of the Pullman factories, however, would later find out that life in the model town was set up by their boss to avoid paying them their due wages.

Prices of rent were doubled when business was not going well for the Pullman Company. At the same time, the worker's pay was being lowered. Company paternalism enabled bosses to revolutionize productivity while discouraging labor unionization by controlling the personal affairs of the workers — this system limited workers' agency. Laws aimed at protecting workers from labor contracts that lend themselves to paternalism were passed following the strike. A strong critique of these laws is that though

were meant to combat paternalistic labor practices, these laws seemingly imitated the principle of paternalism itself by not giving workers full agency over production from the company that was exploiting their labor.

This strike and the resulting legislation speak to the formation of modern labor relations as more businesses, such as Apple, find ways to sew production into the personal lives of their workers. My central research question then, was: Can labor and capital ever have the same goals? Through this research, I have concluded that it will always be impossible, as capital cannot create a perfect living/working condition for laborers as it will seek to exploit workers first before meeting their needs. In short, bosses are uninterested in the well-being of workers as their main priority is profit.

PATERNALIST UTOPIA

David Shapiro, of the Virginia Law Review, gives a working definition of paternalism that I will apply to the Pullman Rail Company. According to Shapiro (1988), company paternalism is when the boss, or the A party, acts in favor of the labor, or B party, while removing B's autonomy with either coercion or force. A party is responsible for giving B what they need, not want. If A is exploiting B in A's interest, that is not paternalism. In other words, company paternalism is when a boss claims to work in favor of their workers while at the same time taking away those workers' agency.

A modern example of company paternalism is the Apple dormitories for factory workers in Shanghai. At these factories, which Apple claims are devoted to creating a safe and fair work environment, 14 workers have committed suicide on the factory floor since 2010. These workers left behind suicide notes detailing the stress of the job (Merchant, 2017). Despite this evidence, companies like Apple and their partners like Foxconn, who supply them with workers, insist that they are furthering their technological innovations while fostering enjoyable conditions for their workers.

George Pullman similarly took the idea of company paternalism to an extreme through the creation of a live-in worker's community. Labor historian Jonathan Bassett suggests that this is because George Pullman had the idea of proving that labor and capital share the same goals and can both be appeased by taking the same measures (1997). To Pullman, the ideal for laborers is localism and comfort. In this ideal, workers have a secured home and a nice community close to work — essentially, making a worker's suburb before suburbs had been invented.

The Pullman community was stocked with apartments and amenities, such as libraries, cinemas, schools, shopping arcades, and media, which were all hand-picked by George Pullman. Workers who came to work for Pullman had the choice of opting to live on the company grounds; for many, this seemed too good to be true. The same goes for Apple factory workers who were lured into renting dorm rooms at the factory. They were promised free housing and forced to sign long term contracts agreeing to aggressive penalties if they missed a payment on their utilities. What workers were not made aware of was the exorbitant costs of utilities:

> 'They call Foxconn a fox trap,' he says. 'Because it tricks a lot of people.' He says Foxconn promised them free housing but then forced them to pay exorbitantly high bills for electricity and water. The current dorms sleep eight to a room and he says they used to be 12 to a room. But Foxconn would shirk social insurance and be late or fail to pay bonuses. And many workers sign contracts that subtract a hefty penalty from their pay if they quit before a three-month introductory period. (Merchant, 2017)

Similarly, when Pullman created the live-in worker's community, it first seemed like a revolutionary change in favor of capital. Workers seemed to be at ease with the current layout of the community and even eager to join. Additionally, workers would be readily available to Pullman if he so needed them. The pros of this living situation, however, ignore that there is a general power structure at play that incentivizes more labor productivity so that their landlord— and boss—would not evict them. This structure alone eerily rings back to feudalist societies.

Community amenities, such as access to libraries and theatres, were not included within the general charge for rent; workers would have to take extra money out of their paychecks in order to afford access. Though these are amenities and thereby not necessities, it speaks to the class inequality amongst workers, even within a worker community. Not every laborer is afforded the same standard of living in Pullman's community, yet the lack of equal accessibility served as an incentive to the workers to get full membership to their community.

Making amenities such as libraries something that must be earned by lower-level workers reinforces class division amongst the workforce. Pullman incentivized performing extra labor for amenities that workers would otherwise have access to if they did not live in the Pullman community. Low pay workers and high pay workers had starkly different experiences reflecting a class hierarchy while working in Pullman's paternalist setting.

Archeologist Jane Eva Baxter (2012) highlights the differences in the everyday life of these workers, stating,

> The town layout also reinforced class as the executives and skilled workers lived closest to the main buildings and parks (and the eyes of visitors) with unskilled workers living at the margins of the community furthest from the factory and the town's amenities" (p. 656).

Additionally, salaried workers (the minority) had the financial flexibility to eventually transition out of living within a paternalist system if they so choose because their wages were not docked. When asked by Labor Commissioner Kernan why he did not also lower the wages of salaried workers at the factory, George Pullman responded, as quoted in The Chicago Strike of 1894:

> It don't lie with me to go to him and say to him (a salaried worker) 'I am going to reduce you salary $1000' because he will say 'Very well; you will find somebody else to take my place'…It would be a matter of agreement whether they would take less and it is a matter then, whether a corporation could afford to dispense with their services. (Manning, 1964, p. 10)

George Pullman did not value his hourly pay workers, and he viewed them as dispensable.

To revolutionize production is to discourage labor unionism, which is an additional goal of paternalist labor, according to Basset. In the case of the Pullman Strike, it is most helpful to think of the workers as indebted to their bosses like sharecroppers of the south were at this time. When workers agree to a continual cycle of making wages to pay it back to their bosses in the form of rent, advocating for workers' rights becomes more difficult due to the power structure at play. Their agency was stripped from them.

The workers of Pullman had no choice in deciding how to run their lives without overstepping their boss. George Pullman dictated everything from where they lived to what media they could consume. Though the argument can be made that workers chose to live there, it negates the fact that Pullman was exploiting the insecurities of affordable housing that many of these immigrants and poor workers had. The same goes for poor factory workers in Shanghai. Apple and Foxconn are in a similar situation in which they have contractually bonded people to work 12-16 hour shifts daily while paying them a mere pittance—a pittance that Apple and Foxconn mostly keep due to workers paying housing fees.

CLASS CLASH

The paternalist system that Pullman created was not immune to strife caused by the economic turns of the time. When economic failure hit the entire railroad industry, George Pullman responded by gradually lowering the wages of the workers starting at 30% and ending at about 70% by the time of the strike (Manning, 1964). George Pullman claimed, however, that the numbers were grossly exaggerated by the workers when, in fact, they would have lost from 19–25% of their wages (Manning, 1964, p. 8)

Though the Labor Commissioner's report does show that 25% wage reduction was accurate, further investigations of the practices at the Pullman Company revealed that there were multiple reductions to the workers' wages that went generally undocumented. (Manning, 1964, p. 10) Manning referred to an example given by a worker who was a car builder. If he ever made a mistake such as using the wrong type of wood on a small part of the car, he would be forced by his superintendent to deconstruct the car and rebuild it completely:

> He (the general foreman) put inexperienced men in almost every department…as the cars had to be built for so much, the men had to do so much more work in order to pay for the destruction of the material. (Manning, p. 9)

The car builder's salary would be docked the amount of productivity lost and for the waste of materials. The Pullman Company seemed to thrive off systematically docking workers' salaries if the slightest misstep took place on the production line. The same concept applies to Apple workers in China as their low wages are generally ignored under the existing stereotype in the West that China has cheap labor. In the Foxconn factories, workers' pay is not reduced when they make a mistake, but they are individually punished in front of the rest of the factory and made to apologize publicly. On top of that, the work is grueling. Of Apple's factories:

> 'You have to have mental management,' says Xu, otherwise you can get scolded by bosses in front of your peers. Instead of discussing performance privately or face to face on the line, managers would stockpile complaints until later. 'When the boss comes down to inspect the work,' Xu's friend says, 'if they find any problems, they won't scold you then. They will scold you in front of everyone in a meeting later.'

> 'It's insulting and humiliating to people all the time,' his friend says. 'Punish someone to make an example for everyone else. It's systematic,'

> he adds. In certain cases, if a manager decides that a worker has made an especially costly mistake, the worker has to prepare a formal apology. 'They must read a promise letter aloud – 'I won't make this mistake again'– to everyone.' (Merchant, 2017).

To add insult to injury, the price of rent never once dropped to match the decrease in the Pullman factory workers' wages. Workers began to incur debt that they owed their bosses steadily, and there seemed there would be no forgiveness of this debt by their employer. Pullman raised the cost of rent as the economic recession worsened. This is shocking considering that the price of the housing in the Pullman community was nearly double the price of surrounding neighborhoods. A statement from the U.S. Strike Commission confirmed this to be accurate, which reads, "The rents there are from 20-25 percent higher than rents in Chicago or surrounding towns for similar accommodations. The aesthetic feathers are admired by visitors, but have little money value to employees, especially when they lack bread. (Manning, 1964, p. 21)

As their pay was continually reduced, the Pullman workers' boss and employer became more and more adamant about taking more money out of employees' paychecks to cover back rent. In his 1960 report on the Pullman Strike, Charles Manning (1964) pointed to an example from one of the Pullmans Rent Collector's testimonies who stated,

> Another I saw the other day was for seven cents...The man had worked as a skilled mechanic at ten hours a day for twelve days and earned $9.07. He keeps a widowed mother and pays the rent, the house being in his name. His half month's rent amounted to $9.00. The seven cents were his, but he never claimed it. (p. 22)

A similar situation at Foxconn and Apple factories is occurring where workers are penalized with more fees for not paying their high bills.

It is not surprising that the workers eventually began to radicalize based off their experiences politically. As tensions began to grow, the Pullman area became defined by two hostile camps with two hostile leaders: (1) The workers inspired by the likes of Eugene Debs, an American socialist and labor activist who would eventually run for president; and (2) capital headed by George Pullman and other rail owners who feared worker insurrection.

By the time of the Pullman Strike, rail workers nationwide were unionizing into the American Railway Union (ARU). There had been small victories for

newly unionized workers in other parts of the nation. These workers began to radicalize politically with the influence of Debs, who gave numerous speeches to Pullman workers calling them to act for better work conditions.

Workers started small with a petition to George Pullman stating their grievances and demands. Pullman responded to the letter by blaming the workers for their conditions, then mocked them by calling them all his "children." After this remark, a general strike day was planned and executed with reinforcements from rail workers all over the Midwest. The protest, however, ended with George Pullman and then President Cleveland calling in the military on the unarmed workers, sparking a riot. In modern-day China, the lethal turn that factory workers took was threatening to commit suicide end masse:

> In 2012, 150 workers gathered on a rooftop and threatened to jump. They were promised improvements and talked down by management; they had, essentially, wielded the threat of killing themselves as a bargaining tool. In 2016, a smaller group did it again. (Merchant, 2017)

Under company paternalism, we see workers push themselves to the extremes under the suppression of their bosses, who are supposedly acting in their favor. In the United States following the Pullman strike, the American government began to pass unconscionability laws that primarily protected workers from paternalism. These protections, however, do not extend to the Chinese workers at Foxconn and Apple because the companies are based in China. In the future, this could be subject to change; however, there is not much hope. The plight of poor Chinese workers has become accepted and incentivized. Until there is a strong enough Chinese labor movement, these atrocities will continue to happen.

CONCLUSION

Paternalism is the faulty system of labor-boss relationships that are meant to revolutionize productivity through bosses making decisions for their workers' personal lives that are supposedly in the workers' best interest. It is common for paternalism to manifest itself as on-site housing for industrial factories. It is important to note that these living arrangements often come with predatory fines and hidden agreements that undercut workers' autonomy and withhold their wages.

When that happened to the Pullman Company in 1894, workers led a general strike that resulted in the creation of unconscionability laws to protect them.

Now, American companies outsource their labor to nations were these laws will not apply to them.

I believe this information is important because no one should be forced to live and work under conditions that force them to consider ending their own lives, which often happens at the Apple and Foxconn factories in Shanghai, China. The only way I can see international laws changing is to create a campaign that is focused on inserting unconscionability laws into international business law. That would be a great feat considering that Apple is not the only company that outsources cheap labor. These remaining questions and tensions push me to further research regarding how globalization opened up the possibilities of outsourced labor. I want to understand better if there could ever be a process of reckoning shoddy labor practices internationally, and what it would take to launch a campaign aimed at changing how outsourcing is conducted.

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The Future of Our Cities Can Be Green: Evidence that the Incorporation of Urban Green Spaces Can Provide Benefits to Cities

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ABSTRACT

While urbanization continues to grow, incorporating green spaces into urban spaces can yield benefits for city residents, as well as displaced and dwindling plant and animal species. Ashlyn Royce looks at the benefits of green roofs and other green spaces in relation to heat and water absorption, biodiversity, and perceived and objective health. Because the implementation of green roofs can be costly and overwhelming, this discussion also includes ways to diffuse and minimize costs and to pursue practical installation. While much of this conversation focuses on the benefits to the local plant and animal species, Royce highlights the benefits of green spaces for city residents. Noting the impact of wealth disparity and systemic racism and poverty in many cities, she concludes with a call for more green space as a means for improving health and quality of living.

INTRODUCTION

Picture walking through a city, but instead of concrete and metal, your eyes are overwhelmed with an abundance of green coming from all around you. The crisp, fresh air and the slight hint of flowers convince you that you are no longer in a city limit. Roads are lined with trees, and the rooftops look like little jungles of their own. The hum of traffic has been muted, and in the distance, you hear birds chirping. The once concrete jungle we associate with cities has been reshaped into an almost perfect harmony of human invention and nature. This image crushes the view that human innovation has to be metallic and cold, and instead, a future of innovation using green methods can emerge. This could be the future of cities, where the very identity of a city has been changed.

But, how do we get there is the real question. One solution to look towards is the implementation of green infrastructure, or green space, into our cities instead of relying on grey infrastructure that traditionally involves the use of human-made materials such as concrete and steel. Green infrastructure can be added to cities as urban green space in the form of urban parks, gardens, green roofs, landscaping, and street trees; their addition can provide several benefits to the population and the city. Growing cities means that

more pollutants and waste will be concentrated in larger areas. Accordingly, accessibility to green space in cities is vital to maintaining the physical and mental health of city inhabitants and the environment.

Urbanization — the transition of persons from rural areas to cities — has been increasing over the past century to the point that about 55% of the global population now lives in urban areas, and the United Nations predicts that this percentage will rise to 68% by 2050 (United Nations, 2018). This growth is persistent, meaning that cities are going to continue to increase in area density, and population.

Urban sprawl, alongside urban development, guarantees that cities will grow in size (Johnson, 2001), and the sheer mass of population growth cities will see in the coming decades means that new plans to modernize current infrastructure and construct new infrastructure are needed. With growing cities, many factors need to be considered to maintain the health of the people who are moving into and living there, in addition to tending to the infrastructure and wellness of cities themselves. City planning is about keeping this core priority, and it is worth questioning what our future cities will look like.

Because growing cities mean that more pollutants and waste will be concentrated in larger areas, accessibility to green space in cities is vital to maintaining the physical and mental health of city inhabitants and the environment. Studies have shown that green space provides a multitude of health, environmental, economic, and social benefits that help to combat the adverse
effects that come with city living. If we want these benefits to be seen throughout our cities, it is imperative to incorporate green space into our current and future city planning as these cities increase in size and population. The addition of green space can be broken up into three main benefits: environmental, health, and economic. Together these benefits demonstrate the practicality of nature-based solutions over technology-based solutions and provide a persuasive argument for implementing more green space into city planning.

ENVIRONMENTAL BENEFITS OF IMPLEMENTING GREEN SPACE

Almost all types of green spaces provide some environmental benefits to their surroundings. It may seem evident that the addition of nature can be the solution to environmental problems, and the benefits of doing so could be the savior of our cities. Cities are often thought of as areas where nature

is nonexistent, but by urging city planners, architects, and policymakers to incorporate green infrastructure in various forms around the city, we can help combat this belief. Green space can take many forms in a city, from one tree to a park that takes up multiple city blocks. Urging for future city planning to incorporate as much green space as they can help cities see less of an impact of climate change over the next few decades.

Heat Absorption with Green Roofs.

One of the most significant environmental benefits of green roofs is heat absorption. Green roofs are a type of green space that is growing in popularity in many cities. They are characterized by the partial or full coverage of vegetation on the roof of a building, and soil depth can range from a few inches to a few feet deep. Their growing popularity is attributed to the aesthetic they provide to plain rooftops using a space that would otherwise serve no purpose.

Green roofs can also provide a multitude of environmental benefits. Cities encounter what is called the heat island effect, where the average temperature of a city is warmer than surrounding areas due to the heat absorption quality of cement and asphalt (Mohajerani et al., 2017). On warm days, this can cause cities to be as much as 14º F warmer than the surrounding rural land, which can quickly become a problem because of the harm it can have on the environment. More importantly, it can be deadly to humans.

One example of the detrimental results of the heat island effect was in 1995 when the city of Chicago experienced a heatwave so harsh that 739 people died, many of whom were elderly or poor residents (Semenza et al., 1996). The heatwave lasted multiple days, and temperatures reached a high of 110º F on the warmest day. After this incident, the city of Chicago took initiatives to incorporate more green roofs into their city plan. The biggest of the plans was the addition of a massive $2.5 million project to construct a rooftop garden on top of the Chicago City Hall building in downtown Chicago (Greenroofs Chicago, 2019).

This may seem like an extreme example, but as climate change continues to increase, and its effects continue to strengthen, conditions like the Chicago heat wave of 1995 are expected to happen more frequently (McKechnie and Blair, 2009). If we want to diminish the inevitable effects of climate change and the heat island effect, looking to green roofs and other types of green space that absorb heat can be a suitable solution.

Benefits of Green Roofs for Water Management.

Another problem that many cities face is the overflow of sewage systems from extreme rain events. Many current sewage system plans were not designed for such an increase in precipitation, which has caused problems in many cities. These extreme rain events are another consequence of climate change, where warming temperatures can result in the rising frequency and magnitude of rainfall, causing city sewage systems to overflow (Kunkel, 2003). This trend will depend on a city's location, but overall, the tendency of extreme global precipitation will increase over the next few decades (Fowler and Hennessy, 1995).

Because cities are mainly cement, asphalt, and metal, there is little space for water to be absorbed back into the ground. Water smoothly flows over these materials, and without any area to absorb into, recurrent flash flooding instances are more likely to occur in urban areas. To avoid this becoming a bigger issue and having to redesign water management systems in a majority of cities, green spaces in cities can help alleviate this water absorption problem by providing areas for water to be absorbed rather than continually flowing on the surface.

Due to the absorptive properties of soil, green spaces can absorb and retain the large increases of precipitation that some cities will see. One study calculated that green roofs absorb around 75% of the rainwater that falls onto them, which can reduce the work placed on an overloaded city draining systems (Hashemi et al., 2015). Of course, the effectiveness of green space absorption and retention depends on the density and depth of the soil, which is important to consider as green roofs are implemented into city plans. Regardless of the density and depth of the soil, their presence helps to absorb extra precipitation on cities and reduces the strain on city drainage systems.

Green Space as a Method to Increase Urban Biodiversity.

A big part of creating environmentally-friendly cities is to maintain and increase urban biodiversity. "Biodiversity" carries many different connotations depending on the habitat but ultimately comes down to the various types of life that may live in a particular habitat (Lovejoy, 1997). Regardless, biodiversity is vital to habitat and environmental health, and stress in any biological community will decrease the biodiversity in that area. Some species are more adaptable to living alongside humans in an urban setting (e.g., rats and the common pigeon), which are found in almost every American city. However, many other species struggle with adjusting to

urban lifestyle, and these are the ones whose populations suffer the most from urbanization. Since cities continue to grow outward and the land is consumed by this growth, more habitats and plant/animal species will suffer from the stress of urbanization.

The stress caused by the urban consumption of the landscape means that the wildlife that depends on that landscape will also suffer, and this loss of habitat is traced back to mainly anthropogenic causes. There are many reasons for increasing urban biodiversity, one being that it can improve human well-being alongside creating a space for nature to exist in cities. Supporting biodiversity can protect important species, as well as provide environmental education to those living in the city (Dearborn, 2010). The best way to incorporate hubs for increasing urban biodiversity is to include biodiversity considerations into green space planning intentionally. Green space in cities provides areas for wildlife to exist happily within city landscapes, from green roofs to city parks. Green roofs offer areas for microbe growth, from bacteria (McGuire et al., 2015), to fungi (McGuire et al., 2013), as well as a variety of plant life. Parks are natural hubs of biodiversity, and the various plants that make up an individual park can attract and provide a home for an array of diverse species.

Birds are a group of animals whose health and diversity has been shown to mirror the pattern of the quality of green space provided for them in an urban area, and they are just one example of a group that can thrive in an urban setting if given the right conditions (Strohbach et al., 2009). In Chicago, Montrose Point Bird Sanctuary on the Northside of the city was built to provide a hub for migratory birds to stop in the city along their migration route. The migration patterns of birds are unlikely to change, even if there is now a city where they have always stopped, which means migratory birds can become threatened from habitat loss even when the area is not their primary habitat. With time and the proper care, green spaces can become places of biodiversity within urban areas, benefiting local/migrating plants and animals, as well as the humans living there.

It will be a considerable challenge for humans to avoid damaging the loss of biodiversity through urbanization, but introducing sites into our cities dedicated to biodiversity would be a good start for combating this challenge in an urbanizing world.

ENVIRONMENTAL BENEFITS OF IMPLEMENTING GREEN SPACE

Mental and physical health play a massive role in the quality of life of an individual. We all want to live hahappier and healthier lives, but living in cities can take a toll on the quality of life and the human body itself. Pollution, combined with proximity to other people, can cause lower quality of life for city inhabitants, but that does not mean that there are not ways to create healthier cities (Galea et al., 2005). Based on the increasing urbanization trend, the effects city life has on health does not seem to deter people away from cities. Therefore, the health of city inhabitants must remain a priority for city planning. Access and proximity to green space have been proven to increase the overall health of city inhabitants, so the addition of green space throughout cities can alleviate the toll urbanization has on an individual's health.

Green Space and Perceived Health.

Being near green space in an urban setting has been proven to affect a person's perceived general health, and the closer people are to green spaces, the higher the perceived health was. One study showed that participants perceived general health, on a scale of very good to very poor across a series of categories, was more likely to be higher the closer people lived to urban green space (Maas et al., 2006). The general health was self-stated but proven to be a valid method for indicating health in other studies (Rütten et al., 2001). On top of surveying participants in urban areas, data from rural areas was collected too, noting the proximity to green space in both sample groups.

There is a significant relationship between how close a person is to a green space in an urban setting, and their perceived level of general health. These significant relationships further support the argument for pushing for green space to be a higher priority in city planning and policy.

Accessibility to Green Space and Objective Health.

Accessibility to different green spaces in cities can also improve objective health or the health of a person as determined by a health professional. According to the World Health Organization, cardiovascular diseases account for the most deaths from non-transmittable diseases worldwide, followed by cancers, respiratory diseases, and diabetes (World Health Organization, 2014). Exposure to high levels of air pollution, such as those shown in city environments, have been proven to increase the risk of cardiovascular diseases (Brook et al., 2004). Another environmental benefit of green spaces is that they help reduce air pollutants in cities and,

depending on the type of green space, can make a big difference in objective health as well (Zupancic et al., 2015).

ECONOMIC BENEFITS OF GREEN SPACES

Knowing the value of green spaces, the question often still becomes how we are going to make them more economical while continuing to work towards more sustainable cities. The trend for prioritizing sustainability in cities is expected to increase as the effects of climate change continue to escalate in severity. On top of wanting to combat the negative effects of climate change, there can be an economic incentive for increasing green building and the amount of urban green space. This will involve considering location and type of green space to maximize the economic benefits. It is no question that the addition of any new green space in a city will come with a price tag, but designing green spaces that mitigate costs and provide long term economic benefits will encourage the creation of more urban green space.

Alleviation of Cooling Systems with Green Roofs.

A type of urban green space that has been found to provide many economic benefits is green roofs. When installed correctly, they can drastically decrease the work of cooling systems. In a study performed in Singapore, a city with a rapidly growing population, the installation of green roofs was found to result in a range of savings between 1-15% in the annual energy consumption, 17-79% in the space cooling load, and 17-79% in the peak space load (Wong et al., 2003). By increasing the space cooling load, or increasing the amount of heat absorbed by the roof, the overall energy consumption of a building decreases while drastically decreasing the work of the cooling system.

This study also found that the type of green roof that helped achieve the most savings was a 300-millimeter thick soil rooftop garden with shrubs, but they found that all types of green roofs helped reduce the annual energy consumption of the buildings. For roofs with a soil thickness of 100-900 millimeters, the savings on the annual energy consumption went down to 1-3%, with the space cooling load ranging from 2-64%. It makes sense that green roofs with a thick soil layer, known as intensive green roofs, show the most savings in annual energy consumption because of the heat-absorbing properties of green roofs. As discussed earlier, green roofs can help alleviate the heat island effect in cities by absorbing the excess heat produced in cities, and the heat absorption actually can reduce the need for air conditioning, leading to overall savings in energy consumption.

Green Roofs on Commercial Buildings.

The biggest obstacle that will keep green roof installation from becoming more standard—especially intensive green roofs— is cost, which can deter people from choosing them over traditional bare roofs. Although they do provide more economic return than the traditional roof, the initial cost of installation is substantial. The key to allowing green roofs to provide the most economic benefit to a city could be encouraging their installation on commercial buildings, such as office buildings, warehouses, and retail buildings, where finding funding is more feasible.

Even though green roofs can be installed on residential buildings and provide annual energy consumption savings on residential buildings as they do for commercial buildings, the expenses for installation and management are more realistic for commercial buildings (Djordjecić et al., 2018). By using a life-cycle assessment approach to evaluate the effects a widespread installation of green roofs would have on an urban mixed-use neighborhood, one study concluded that green roofs were more active on commercial and multifamily buildings. The researches found that average electricity usage was higher, allowing for the energy consumption savings to be most serviceable (Blackhurst et al., 2010).

The U.S General Services Administration published a report in 2011 examining the use of green roofs on public and commercial buildings and found that the cost of green roof installation is high, with maintenance costs sometimes being higher than the initial installation cost, but the longevity of green roofs provides an average return on these costs within 6.2 years for commercial buildings (GSA, 2011). Since cities are combinations of neighborhoods, where commercial buildings are a large percentage, advocating for policies and funding commercial buildings to incorporate green space into their designs would be a considerable step towards using green building methods to re-nature and create more sustainable cities.

ECONOMIC BENEFIT OF WATER ABSORPTION BY GREEN SPACES

Other types of green spaces also provide an array of economic benefits, and their incorporation throughout growing cities will help almost every part of the city. Almost all urban green spaces, especially parks, gardens, green roofs, street trees, and even landscaping around buildings, play a decisive role in rainwater runoff reduction. A study done in Beijing found that Beijing's green spaces play such a key role in rainwater regulation and retention that the economic value of these spaces was equivalent to three-quarters of their maintenance cost, mainly because the rainwater stored

supplied almost all the water needed by the landscape plants (Zhang et al., 2012).

Because the maintenance of urban green space can be expensive compared to grey infrastructure, having some of the expenses being picked up naturally by the design of the green space will help reduce the maintenance cost for most types of green space. This can be a big incentive for city planners to incorporate more green space throughout their plans and can be a selling point for environmentalists to make when communicating with leaders considering funding the creation of new city (green) spaces.

CONCLUSION

There is much research that supports the value of adding urban green space in cities because of the environmental, health, and economic benefits to city inhabitants. Many people also argue that replacing grey infrastructure with green infrastructure can increase the longevity of infrastructures, such as a green roof versus a conventional roof (Kuppuswamy, 2009). Incorporating green space into city planning is challenging, but these challenges are confronted with the weight of the many benefits that come with these green spaces. When considering the options for city planners, as long as the outcome is a happier and healthier city, it is no surprise that the benefits that incorporate gray infrastructure are heavily outweighed by those that incorporate green infrastructure. Concerns about living in a city, such as the health of its people and the environment, can be simultaneously solved.

Creating these green spaces is also vital to sustainability and environmental justice within growing cities. Marginalized groups, especially in urban areas, are the ones that will be threatened the most from the implications of climate change; yet, they are most likely not to have access to green space. Further research can help these communities in combatting climate change and lift them economically. Because of the economic benefits that come with these green spaces, it would be great to see them explicitly implemented in marginalized communities.

One concern within many American cities is the economic disparity within the city borders (Lee, 2011). For example, Chicago neighborhoods vary drastically in economic and racial experiences. This has led to a significant issue of racial and economic inequalities, which can be tied together in some circumstances and put many communities at a disadvantage. Economic inequality can also lead to a disparity in the quality of life within different neighborhoods. The quality of life is already threatened by urban-

-ization alone, which leaves marginalized groups with much more of a disadvantage than the average city inhabitant.

Another disadvantage marginalized groups within cities are likely to encounter a lack of access to food. Many areas within major cities are considered food deserts, areas where access to food, particularly fresh and healthy options, is limited (Shaw, 2006). This can be seen in many Chicago neighborhoods, especially in the Southside, where stores that offer healthy options are scarce (Block, 2012). Access to food, especially fresh and healthy options, plays a large factor in a person's health, both physically and mentally, again, leaving neighborhoods of marginalized groups with another substantial disadvantage. Though this was not discussed within this literature review, green spaces have the capability of turning into areas for urban agriculture (Mougeot, 2000), which means that areas within the city can be dedicated to food production. Even green spaces such as green roofs can be designed for this purpose, making use of originally unused space to produce food within cities.

Urbanization can be seen as a good and bad reality and comes with a long list of environmental, economic, and health consequences. Because of the perseverance of urbanization, it will be vital to adapt our cities to help alleviate this list. We are now aware of the benefits of having green space in cities. The next step will be to take initiatives to incorporate these ideas into city planning. A push for green infrastructure will be vital to achieving cities that will not harm the environment and humans as much as they will if we continue to design while forgetting to consider the health of the environment. By changing the identity of our cities, we can have cities be where nature and humans live in harmony.

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Bioinformatics Pipelines: New Ways of Processing Data

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ABSTRACT

Bioinformatics analyses are composed of various components, and each has completely different performance characteristics that makes the analysis of big data difficult. Big data means that pipelines are used to run the data at scale with the aid of a cloud or cluster. This function directly ties to resource availability and the ability to make pipelines portable between different places with optimizations to reduce cost and run time. Efforts are maximized by the parallelization of scripts using Parsl, which is a parallel scripting library implemented and designed for expressing parallelism in Python through apps that define opportunities for parallelism and return futures; a proxy for a result that might not yet be available. This makes it so that apps can run concurrently while respecting data dependencies and helps to ease the needs and calculations of supercomputing.

INTRODUCTION

With the emergence of big data, the question of how to analyze data optimally becomes more relevant. Particularly in large-scale scientific computing fields such as machine learning or ensemble methods. Researchers often must choose between minimizing time and cost or maximizing accuracy. Understanding this tradeoff is crucial for researchers to make informed decisions about how to run their analyses, but these choices can become difficult as the analysis becomes increasingly complex.

In collaboration with colleagues from the Illinois Institute of Technology, I developed a generalized model for exploring these tradeoffs applied to variant calling tools used in genomics. The constant increase in data has required that there be an adaption of computationally intensive methodology for addressing and transforming the field of scientific computation. While this can be applied more broadly, in the scope of bioinformatics, our focus was be genomics. We explored the performance of four of the most well-known variant callers and develop predictive models that forecast their computation times and accuracy in ensemble models. We also outlined a strategy for selecting the set of variant callers to apply to a given sample. Our approach, which could be generalized to other problems,

allows researchers to select a strategy that optimizes cost, accuracy, or a mixture of both.

BACKGROUND

Scientists apply a range of computational processes to derive insights from next-generation sequencing data. Variant calling aims to identify single nucleotide variants within an individual genome relative to the population at large. This process is comprised of several steps, including reference sequence alignment and quality control before applying a probabilistic variant calling algorithm to identify genetic mutations.

Variant calling is the practice of using probabilistic methods to identify genetic variation within an individual genome relative to the population at large. For genome sequencing, variant calling can be used to compare a normal and a tumor genome sequence and find the variations. Four separate variant calling pipelines are implemented for Genomic Data Commons data harmonization. Unfortunately, as a result of innovation, there are now dozens of interchangeable variant callers, and there is currently no scientific consensus on the “best”' variant caller. Thus, individual researchers are responsible for selecting the most appropriate caller for their analysis. Increasingly, researchers and data repositories, such as the Genomic Data Commons (GDC), apply a range of variant callers to their data and publish results from each caller. To improve accuracy, researchers combine results from various callers using ensemble-based approaches. While this may increase the accuracy of their analysis, however, it can quickly become very costly to run multiple variant callers.

METHODOLOGY

In this study, GDC variant calling data is used, which consists of approximately 10,000 samples from 33 different types of cancers. Initial measurements, however, were made with gastric cancer data provided by the University of Singapore. This data was analyzed using the bioinformatics pipeline that I built, which implements four different variant callers (muse, mutect, somaticsniper, and varscan). The GDC DNA-Seq analysis pipeline was implemented in Parsl (Babuji et al., 2019) and computation time was measured using varying sample input sizes so that models, which predict the accuracy of the variant calling ensemble and predict the resulting cost-accuracy model could be created in an edge-weighted digraph.

The GDC DNA-Seq analysis pipeline identifies somatic variants within

whole exome sequencing and whole genome sequencing data (GDC, 2020). It then compares somatic variants identified in the comparison of allele frequencies in both tumor and normal sample alignments, while annotating mutations and aggregating them from multiple case files into a single project file.

The process is completed and aggregated across six primary procedures, which therein have sub steps for each of the different variant calling pipelines as they are separately implemented for the identification of somatic mutations before annotation. The primary procedures are genome alignment, alignment co-cleaning, somatic variant calling, variant annotation, mutation aggregation, and, depending on the dataset aggregated, mutation masking. The sub-processes for each procedure regarding the variant callers require specific files to be generated and specific tools to be used. This comes at a significant disadvantage for replication with the use of the GDC pipeline that does not use easily replicable methods.

The DNA sequence used for analysis was the Genome Reference Consortium Human Build 38 (GRCh38), which has a length of 3,099,734,149 and 999 contigs, which are overlapping DNA segments representing a region. The DNA sequence is composed of a genomics sequence of primarily finished clones that were sequenced as a part of the Human Genome Project. PCR products and WGS shotgun sequences have been added where necessary to fill in gaps or correct errors, those of which made were manual additions curated by the Genome Reference Consortium staff.

To compute data for some variant callers, the use of a PON or panel of normal is required to act as a resource for somatic variant analysis. In general, all PON have several commonalities primarily made from normal samples, which, in the context indicated, derived from healthy tissue that is believed to be without somatic alterations. Secondarily, their main purpose is to capture the recurrent technical artifacts to improve the results in variant calling analysis.

RESULTS

We combined these variant callers using an ensemble-based technique and show that the best-practice of running multiple callers is not always the most accurate approach. We developed a machine learning model where it was found that using an ensemble approach with three or four variant callers can sometimes be a waste of time/money because the accuracy

often does not increase when variant callers are added.

Starting with a preliminary random forest model, we can predict if a sample will benefit from additional variant callers using sequencing data from the variant callers that have already been run on the sample. We found that that a significant fraction of the samples had a zero or near zero percent increase in accuracy when adding a second, third, or fourth variant caller. Thus, when considering accuracy, it is important to predict which samples would benefit from additional processing. Predicting which variants would not benefit from adding variant callers would be highly beneficial and could lead to significant cost reductions. We see that we can achieve within 2% of perfect accuracy using only two callers.

Data at large scales, as in genomics, can be made up of billions of base pairs, which can take a lot of space, particularly when scientists want to run analysis on multiple genomes at a time. To minimize time and cost by parallelizing/parslizing the scripts has become our highest priority. Understanding the trade-off in this triad will affect analysis across research fields and will help us to understand (a) the way that resources are being used and (b) what we can do to use them more efficiently. As with the case of large-scale data, pipeline driven analysis is often used to help minimize the time and cost spent working on the data. Given the lens of high-performance computing, we refer to cost as a metric of time, unlike a cost that we may have when running on the cloud through something such as Amazon Web Services.

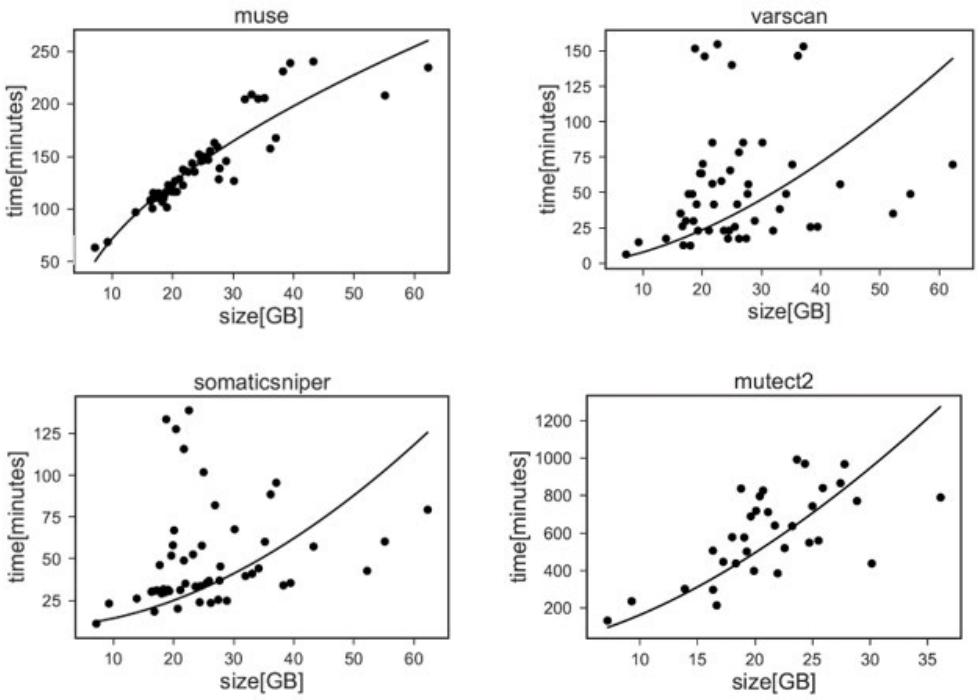
Cost-Accuracy Models

Variant caller models require cost quantification for which measurements are made of computation time with different data input sizes. We ran our experiments on ASPIRE1, a cluster with 1288 nodes (dual socket with 12 cores and 128 GB RAM per node).

Initial results indicated file system contention; as a result, we modified our experiments to make use of shared flash storage. Figure 1, on the next page, shows a least-squares fit, implemented using sci-py curve_fit, demonstrating the relationship between data size and execution duration for each caller. We use these fitted lines to predict run time as a function of input data size, demonstrating the relationship between data size and execution duration for each caller. We use these fitted lines to predict run time as a function of input data size.

Figure 1

Cost (Execution Time) as a Function of Input Data Size Plotted With a Least-Squares Fit for Four Variant Callers.



Furthermore, we can determine that there is also a slight influence in computation based on tenancy and use of a file system built for high performance computing such as an IME (Infinite Memory Engine). Applications of this model can be used to calculate a quantifiable cost (in execution time and resources) based on the use of more variant callers and the size of the input data, which applies to a model focusing on a combined analysis of cost and accuracy.

To determine accuracy, random forest models were created based on the number of variants identified by previously applied variant callers in the ensemble using scikit-learn which helped us to predict whether an additional variant caller would yield an accuracy increase based on the data features (e.g., type of cancer, allele substitution type, etc.). Table 1 shows the accuracy, precision, and recall of the models when applied to different combinations of variant callers. To aid in the data skew, random under-sampling was added as a part of the algorithm training set, which helped to improve predictions, particularly recall and will aid researchers by reducing costs without missing important variant data.

Table 1

Average Accuracy, Precision and Recall in Prediction of Variant Caller Accuracy Increase

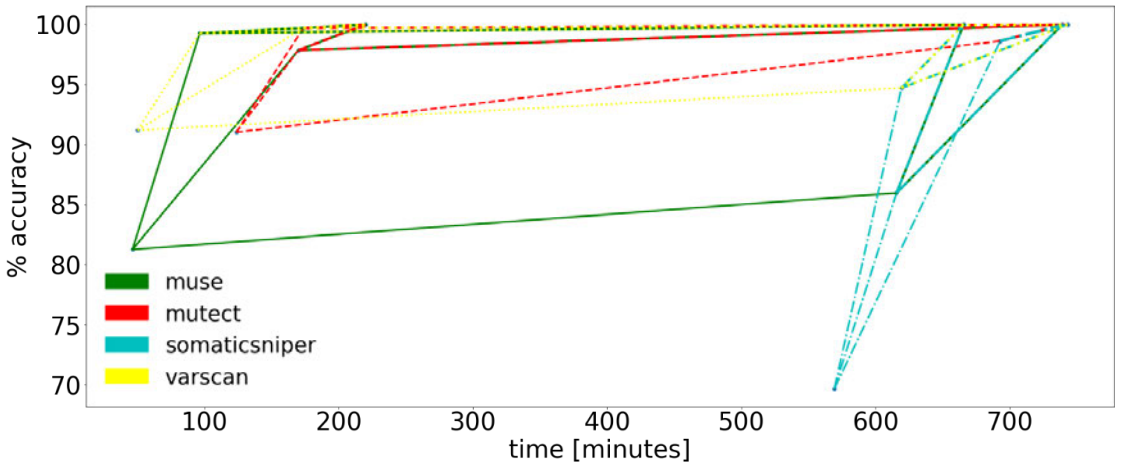
baseline variant callers(s)	accuracy	precision	recall
muse	0.67	0.69	0.81
mutect	0.68	0.55	0.68
somaticsniper	0.75	0.78	0.90
varscan	0.65	0.47	0.68
muse, mutect	0.65	0.21	0.66
muse, somaticsniper	0.63	0.63	0.66
muse, varscan	0.66	0.11	0.70
mutect, somaticsniper	0.71	0.24	0.67
mutect varscan	0.71	0.05	0.76
somatic sniper, varscan	0.70	0.49	0.68

Cost-Accuracy Trade-offs

The cost and accuracy models were visualized to measure the average accuracy across the samples and the cost of the given input size of the variant caller ensembles. Figure 2 indicates the increase of accuracy and cost or different variant caller pairings. This data is used to quantify the trade-off between cost and accuracy through ensemble optimization. On average, results indicate that 99% accuracy can be achieved with approximately half the cost with optimal selection.

Figure 2

Accuracy Vs. Runtime Visualization



DISCUSSION

The application of this model could be used to calculate a quantifiable cost (in execution time) based on the use of more variant callers and the size of the input data. Running multiple experiments would ensure that for each point we would be able to gauge the accuracy and distribution of the data better. Ultimately, this tool—as an extension of the reproduction of the GDC pipeline—is capable of being used to reflect and quantify the cost of using additional variant callers given the input size of a data set.

> *The development and analysis of this pipeline and its results entered the ACM undergraduate research competition at SC19 (Super Computing) in Denver, where the team placed second among 30+ teams of researchers across the country with the support of another undergraduate student from Princeton University and the faculty of the University of Chicago (Dongars, 2019).*

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