UPark

2019-2020 Honors Praxis Lab - Automation

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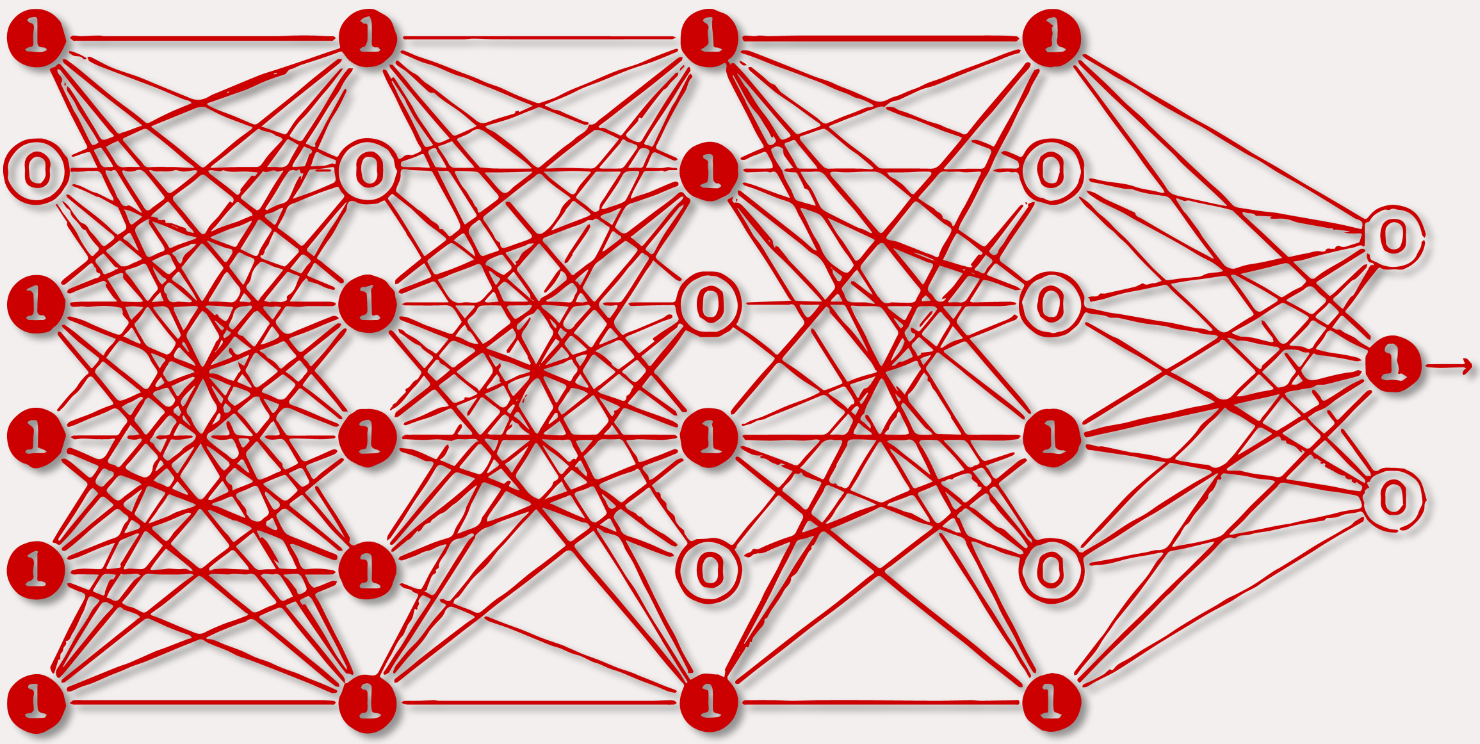
AUTOMATION



BACKGROUND

One of the national fast-food chains in the U.S. recently announced the replacement of cashiers in 2500 locations with digital ordering kiosks. This "Experience the Future" initiative will also deploy mobile ordering at 14,000 locations. AI experts predict that by 2027 truck drivers will be redundant, AI will surpass human capabilities in retail by 2031, best-sellers will be written by AI in 2049, and surgeons will be replaced by 2053. In the next 100 years, all human jobs will be replaced by automation.

These predictions are in contrast to today's realities of automation: While low-level automation found wide adoption (see history of elevators, home thermostats), more complex systems used in professional contexts (e.g., flight management systems, mining) or in consumer products (e.g., home automation systems) either require extensive training for their operation, or are taken up only by small groups of early adopters.

High complexity automation systems that are currently available, are even more challenging in terms of the parameters of their use, user training requirements and user adherence to the conditions of safe operation (e.g., Tesla's autopilot that has likely caused a number of fatalities, or adaptive cruise control systems that have a level of complexity that makes them unpredictable for the driver). Many systems that are available today are at the edge of what is technologically possible, but often engineers do not consider what is socially desirable. Thus, while automation will reshape and restructure society, it is today that we will need to understand how to develop human-centered automation.

The Praxis Labs are a set of courses hosted by the University of Utah Honors College where students learn about a topic in-depth, and then decide on a problem to tackle with a collaborative, community-oriented project. Students spend the first semester together analyzing a topic under the guidance of leaders and experts in that field through guest lectures and readings. Throughout the first semester students aim to identify a problem related to the topic. During the second semester, the class works together on a project aimed at solving that identified real-world issue. Praxis Lab Projects can take many different forms depending on the topic of focus. Previous projects have included think-tanks, public awareness campaigns, legislative-frameworks, and many other works.

MEET THE ADVISORS

DR. FRANK DREWS

My research is on human-technology interaction, which by definition includes humans as part of the system. Full automation aims at eliminating the human from system input and/or control. What surprised me as part of this course is how little consideration automation researchers and technologists are giving to the broader issues related to automation. These groups are working in isolated silos without any consideration of the broader impact on the individual and society. While this was reasonable with previous technologies, automation has too broad an impact on society that these issues can be ignored. Not everything that is possible is desirable.

DR. PRATT ROGERS

I am genuinely interested in how automation changes the methods of doing business and human connection with their work. My research and professional work have focused on developing a better understanding of how technology improves the extraction of natural resources. Automated processes and advanced technology have drastically changed mining systems. The introduction of technology disrupts the workforce and the engineering required for the new operation. Institutions of higher learning should be preparing the next generation for these potential changes. This class has improved my understanding of the current state of automation and how other disciplines are approaching the subject.

MEET THE TEAM

Coming from a family of heavy-equipment owners, I was most intrigued when Drew Larson from ASI Robots came and talked about how they implement automated systems into heavy-equipment. Doing so, they enable entire mining sites to be ran by machines in order to be cost-efficient and keep workers out of dangerous working environments. This made me most interested in watching how technology will continue to transform our world and, as a computer science major, how I will play a role in this transformation myself.

JASON GIBSON

The ethical discussion around automation is something that we rarely consider in our day-to-day interactions with automata that holds a surprising amount of depth and complexity. In our class, the various approaches to those ethical problems caught my interest, especially the ways in which modern engineers deal with the ethical consequences of their choices . The discussions we've had have helped me to learn that I ought to consider the ramifications of my work particularly in regards to how they impact the well-being of the people they were made for, especially in ways that may not be originally expected.

JOSEPH WANG

Taking this class made me realize the topic of artificial intelligence is more intricate than I thought. I particularly enjoyed learning about the liability involved in AI-related accidents. We discussed lots of interesting questions, such as how machines should be legally classified, who's legally liable when machines cause harm, and what institutions are fit to resolve liability issues. These concepts broadened my mind about how AI doesn't just affect the technical aspect of society. It's way more complicated than that, and the complexity is enthralling.

SEVIN PARK

Growing up around increasingly complicated technology, I have been interested in automation in one form or another my entire life. Much of my chosen major and coursework has been shaped by this interest, but only from a technical perspective. This course was an opportunity to correct my lack of knowledge about the domain of automation outside of that limited scope. Learning about topics like algorithmic bias and how automation impacts work has been incredibly interesting, and has given me a new perspective on the potential dangers of automation that I will be taking forward to my future work.

TAJEN FREEMAN

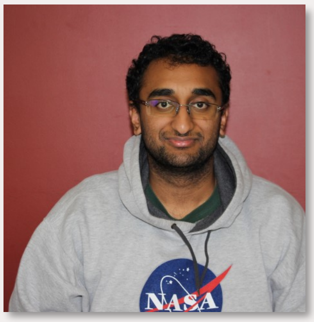
MEET THE TEAM

What caught my interest the most about automation were the AI biases that occur. In a case where a clinic implemented AI software to help physicians schedule time with their patients, researchers found that the AI was scheduling physicians less time with black patients than with white patients. The software didn't start making this decision alone, it had recognized this pattern from the physicians' already existing behaviors. There are many other ways that AI biases occur that I didn't realize that before taking this class.

MICHELLE SANCHEZ

In today's climate our lives are so deeply integrated with technology that the automation that surrounds us usually goes unnoticed. Typically, until the technology fails, we recognize we're interacting with automation. What caught my interest in particular is learning that automated systems meant to interact with humans may carry a bias. These biases can range from the sink not turning on because the color of your skin is absorbing too many light waves to receiving a longer criminal punishment due to the zip you live in. If developers aren't cautious their automation may unintentionally ruin lives.

RUBEN OCHOA



I have spent a lot of time learning about automation in aviation, because this is one of the topics motivating my career choices. The main topic I found most interesting was the interaction between automation and humans, and how this interaction manifests itself in aviation, as well as multiple other situations. The different types and levels of automation involved interested me, as well as the subsequent psychological effects on the humans who are using it. Examining the psychology behind automation was perhaps one of the most interesting and engaging aspects which I hadn't been previously exposed to.

SIDDHANT DEVARU

Within our lifetimes, automation has the potential to completely change the way the economy works. There are nearly no tasks that are completely safe from being automated away. Artificial intelligence can be used for almost any job, from truck drivers all the way to doctors and lawyers. Hopefully this momentous change in the course of humanity will create new jobs we have not even thought of at this point. Nevertheless, many people will be left unemployed through this process. Over the course of this class I have learned about the potential for change automation holds and the consequences involved.

VARUN GARG

MEET THE TEAM

Automation interests me because of the intense juxtaposition of its unlimited possibilities to vastly improve our world and its real potential to disrupt the fundamental principles of our society. Part of me says, "Go for it! Let's see what we can do!!" And another part questions, "Should we do that? It can't be undone..." Automation has and will continue to revolutionize our lives, nation, and world. It’s up to us to decide how.

BROOKE YARDLEY

My eyes have been opened to how intricate and impactful automation is and will grow to be in every person’s future. As automation advances, human jobs will be replaced by a more skillful and qualified machine, with programmed biases and problems of its own. I have found it interesting how unaware we, as a society, are of these upcoming shifts. Our government, businesses and society's education on the subject will play an essential roll in navigating, implementing and regulating automation for our future success.

GRACE LARSEN

Automation sits at the table of future world powers. However, how deep can it go? Can everything be broken down to a computation? Automation shows promise of societal growth not wrought by humans. Every leap of human civilization has been built on the back of a disposable work force. Automation is the solution to human servitude but at the cost of how much ethic? As we gain automated efficiency we loose the independence of identity. What I have learned about automation is that in order for it to work, one must forfeit control of it, or what is machine learning. We must be careful with intelligence we don't understand.

NORMAN OLSEN

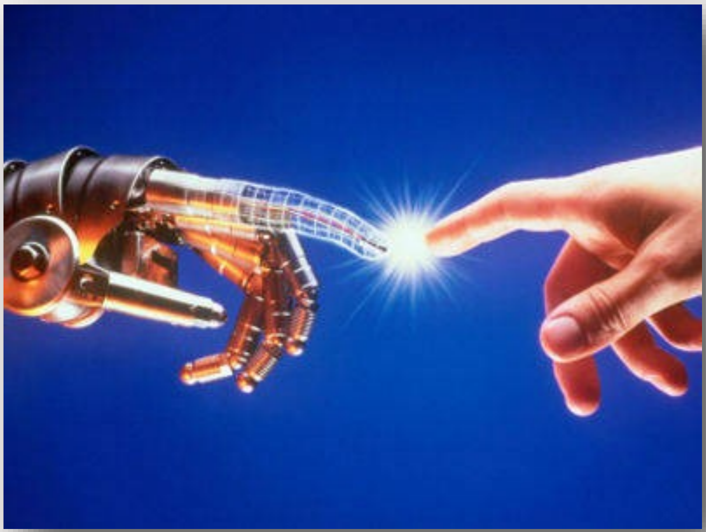
FIRST SEMESTER

COURSE OVERVIEW

As a new decade begins we look back and see how much our world has changed over the last ten years. Looking towards the future, this pattern shows no sign of stopping. One of the major catalysts for this change will be the advent and implementation of automation. We are already seeing automation in our daily lives, whether it be artificial intelligent assistant on our phone or a self-driving technology that enables our cars to operate themselves. The industry has also already seen a major change regarding intelligent manufacturing systems and mining operations that utilize driverless vehicles and machinery. The rise of automated systems and artificial intelligence rises many questions. Especially regarding the entity that will hold responsibility when automation goes wrong. During our first semester we focused on learning these types of issues.

In learning about automation we covered many different aspects and issues involved with this technological evolution. The aspects we covered included history, ethics, economics, law, psychology, and the impact on fields such as mining, aviation, and civil engineering. Each class we were fortunate enough to hear from experts dealing with these aspects of automation and artificial intelligence. We heard from professors, specialists in the industry, and innovators working to bring this technology into our daily lives. Throughout the semester we kept track of different issues involved with the adoption of automation into our world and thought about potential projects that could work towards solving these issues. As a class, one of our goals for the project was to create something that could impact our local university community in a meaningful way. We wanted to create something that we found engaging and useful.

As a largely commuter school, many students drive to and from campus daily. One of the most significant problems that has arisen from this is parking. Parking on campus is challenging as lots fill up quickly in the morning. On any day, you can find people driving around and between parking lots in an attempt to find an open parking spot. The tools of automation can help us solve this problem through an app that uses image recognition from cameras around campus to count cars in a lot, find open stalls, and relay that information to commuters.



TOPIC TIMELINE

8/27
Natalia Washington
Automation and Agency/Ethics

9/3
Lisa Swanstrom
Automation in Literature and Film

9/10
Tom Maloney
Economics of Automation

9/17
Mark Minor
Robotics

9/24
Drew Larsen
Automation in Mining

10/1
Frank Drews
Psychology of Automation

10/15
David Cleveland
Automation in Aviation

10/22
Kody Powell
Process Control

10/29
Randy Dryer
Automation and the Law

11/5
Dan Reed
Computer Science and Automation

11/12
Cathy Liu
Infrastructure for Automation

GUEST SPEAKERS

NATALIA WASHINGTON

Natalia Washington is an Assistant Professor of Philosophy at the University of Utah. She specializes in the philosophy of psychiatry, cognitive science, and mental health. Natalia is from Chicago's south side and completed her B.A. in Philosophy with honors from the University of Wisconsin. She completed her Ph.D. in philosophy at Purdue University. As a McDonnell Postdoctoral fellow, she pursed the philosophy-neuroscience-psychology program at Washington University. She then spent a year working with an artificial intelligence platform Cyc. Natalia Washington's expertise in philosophy made it a great fit for our ethics in automation lecture where we discussed the trolley problem in the context of an artificially intelligent robot. The trolley problem is a philosophical thought experiment: a runaway streetcar is moving towards five unsuspecting people. Do you pull the switch and divert the streetcar onto another track where there is only one unsuspecting person, or do you do nothing?

LISA SWANSTROM

Lisa Swanstrom is an Associate Professor of English at the University of Utah. She completed her B.A in Classics at New College of Florida. In the following years, she completed her Master's in Professional Writing at the University of Southern California and then her Ph.D. in Comparative Literature at the University of California, Santa Barbara. She became a postdoctoral research fellow at Umeå University's HUMlab in northern Sweden. Then, she became a Florence Levy Kay Fellow in Digital Humanities in the English Department at Brandeis University. Lisa was also an Assistant Professor of English at Florida Atlantic University. Recently, Lisa participated as a Visiting Scholar/Fellow in the Greenhouse Project in Norway at the University of Stavanger's. Her interest in science fiction and the digital humanities made her a perfect fit for our Literature and Film in Automation. With Lisa, the class discussed Asimov's three laws of robotics and how these laws play a role in current culture.

GUEST SPEAKERS

TOM MALONEY

Tom Maloney in an economics professor at the University of Utah. He received his B.A. in Economics from the University of Dayton. Then, he received his M.A. and Ph.D. in Economics from the University of Michigan. He finished his post-doctoral fellowship in the Center for the Study of Urban Inequality at the University of Chicago. Tom Maloney is an economist with expertise in the areas of US economic history, demography, and labor. With his vast knowledge in economics, we were able to learn about future changes the US economy may undergo by implementing artificial intelligence into the US workforce.

MARK MINOR

Mark Minor is an adjunct Associate Professor of Computing and an Associate Professor of Mechanical Engineering at the University of Utah. He received his B.S. in Mechanical Engineering from the University of Michigan. He completed his M.S., and Ph.D., in Mechanical Engineering from Michigan State University. His research lab has extensive expertise with design and control of underactuated nonholonomic systems, kinematic motion control, dynamic motion control, state estimation, sensor development, and data fusion. The lab is currently developing "smart" shoes for those living with Parkinson's Disease. The goal of the project is to allow the person to feel the surface of the ground as they should without the disease. Before working on this research, Mark spent his time working on a driverless car competition known as the DARPA Grand Challenge. The course consists of a 60-mile area course that needed to be completed in under six hours. Some of the rules included following traffic regulations while encountering obstacles and merging traffic. A big part of this challenge was creating a vehicle software that was intelligent enough to make decisions in real-time based on the actions of nearby vehicles.

GUEST SPEAKERS

DREW LARSEN

Drew Larsen is an experienced leader in business development and operations management. He received his B.S. from Utah State University in Computer Science and completed his MBA at Pepperdine University. Drew currently works in transitioning heavy machinery to an automated form. He provides these autonomous vehicle solutions to the global mining industry through the company Autonomous Solutions, Inc (ASI). ASI is a world leader in vendor-independent vehicle automation systems. Aside from mining, they serve the agriculture, automotive, government, and manufacturing industries. Drew's co-workers refer to him as "an entrepreneur of the highest caliber and work ethic." With Drew, the class was able to learn about the growth of automation in other fields.

FRANK DREWS

Frank Drews is an adjunct professor for the department of educational psychology, mining engineering, internal medicine, anesthesiology, and biomedical informatics. He is also a professor for the psychology department. Frank's research lies within cognition, medical decision making, human error in medicine, human factors, and visualization. His extensive history in psychology was a perfect fit for our lecture on the psychology of automation. The class learned about autonomy in the context of freedom of choice and the psychological effects that people may encounter due to automation taking over the workforce. For example, the psychological effects that people may feel due to unemployment

GUEST SPEAKERS

DAVID CLEVELAND

David Cleveland is a airline captain that was formally trained at the University of North Dakota in 1981. During his time at UND, David earned his commercial pilot, airline transport pilot, multiengine and instructor certificates. From 1981-1985 he has served as an airport manager, flight instructor, ground instructor and charter pilot. Since then, David has flown both national and international passenger operations with machines varying from the Boeing B737 – 777, McDonnell Douglass MD88, and Airbus A330.

KODY POWELL

Kody Powell is an assistant professor of chemical engineering and an adjunct assistant professor of mechanical engineering at the University of Utah. Koby received his bachelor's degree in chemical engineering at the University of Utah, where he later earned his Ph.D. in chemical engineering at the University of Texas at Austin. During this time, he conducted research in dynamic optimization of energy systems with thermal energy storage. He is currently conducting research on dynamic simulation, optimization, and control of complex, integrated systems.

GUEST SPEAKERS

RANDY DRYER

Randy Dryer is a professor of law at the University of Utah. He earned his bachelor's degree in communications / journalism from the University of Utah, where he later earned his Juris Doctorate in Law. Randy is also nationally recognized as an expert in media who has represented most major news organizations in Utah. He has also been listed in Best Lawyers in America every year since 1993 and was named a 'Utah Top Lawyer' by Utah Business Magazine and a Rocky Mountain 'Super Lawyer'.

DAN REED

Daniel Reed is a professor at the school of computing at the University of Utah. He received his bachelor's from Missouri University of Science and Technology in computer science and he later earned his master and Ph.D. from Purdue University. Daniel is also the senior vice president for Academic Affairs. He was previously the university chair in computational science and bioinformatics, professor of computer science, electrical and computer engineering, and medicine at the University of Iowa. Prior to this, he served as the Corporate Vice President for Technology Policy and Extreme Computing at Microsoft.

GUEST SPEAKERS

CATHY LIU

Cathy Liu is an associate professor of civil and environmental engineering at the University of Utah. She received a Ph.D. in transport engineering, civil and environmental engineering at the University of Washington. She also earned a master's degree in transportation palling and management from Texas Southern University. Her research is geared toward sustainable transportation with a focus on shared mobility, public transit, managed lanes, large-scale transportation modeling and simulation, and intelligent transportation systems.

RYAN MORAN

Ryan Moran is an assistant professor of history at the University of Utah. He received his bachelor's degree in history at Reed College and later earned a Ph.D. in history at UC San Diego. His research consists of examining how scientific practices function within capitalism to transform life into a commodity and object of governance.

SECOND SEMESTER

OUR SOLUTION

As a large commuter school, parking on campus is a persistent issue. Parking lots fill up quickly in the morning, forcing others to drive around campus in hopes of finding a spot. Many people do not know more than a limited number of lots so, finding alternative parking becomes difficult. In turn, drivers roaming around campus pose other concerns. From a safety aspect, student pedestrians on campus are at a higher risk of incurring an accident with many cars driving around and between parking lots. These drivers tend to be focused on competing for a spot, causing an elevated safety risk. There is also an environmental aspect to be considered. A method to reduce the amount of idling time for vehicles will help the air quality in the valley and lower the greenhouse effect. Students need a solution to solve these issues with the campus parking system. Our praxis lab proposes a mobile application that uses principles of automation and computer vision to scan lots around campus in live-time and relay that information to drivers.

The goal of the app will be to list all the lots on campus available for student parking and the number of spots available. Included is map compatibility so drivers can navigate to whichever lot has availability. A parking app like this will be able to solve many of the aforementioned problems. We aim to help students find available parking spots in other parking lots quickly if their preferred lot is full. Knowing what parking spots are open, can greatly cut down on the number of cars driving around and between lots. This helps with the safety and environmental issues. Another potential impact of such an app will be novel data collection on the way parking lots fill up and at which times of day and days of the week. This information could be useful in better informing commuter services in building/removing parking spaces, changing permit zones, or other parking-related changes.

DEVELOPMENT AND RESULTS

For the technical portion of the project, we decided to split the work into three parts: image analysis on vehicles, an Android app to display information, and networking with data storage. We would take live camera feed from security cameras around campus and send it to the system that is running image preprocessing and analysis. After the image analysis, we would send the information about the number of cars in each parking lot being analyzed to the database. From the database, new information would be sent to the app at regular intervals to update users about available space.

The original plan for the flow of information was something like the below image:

Image Processing

In order to detect cars, we decided to use Python code because most major machine learning libraries were written in that language. The car detection program we used depended on four different Python libraries:

TensorFlow

- Google-created library for setting up neural networks. It is a framework that operates through setting up a set of nodes, which each represent some kind of mathematical operation on a given input.

Keras

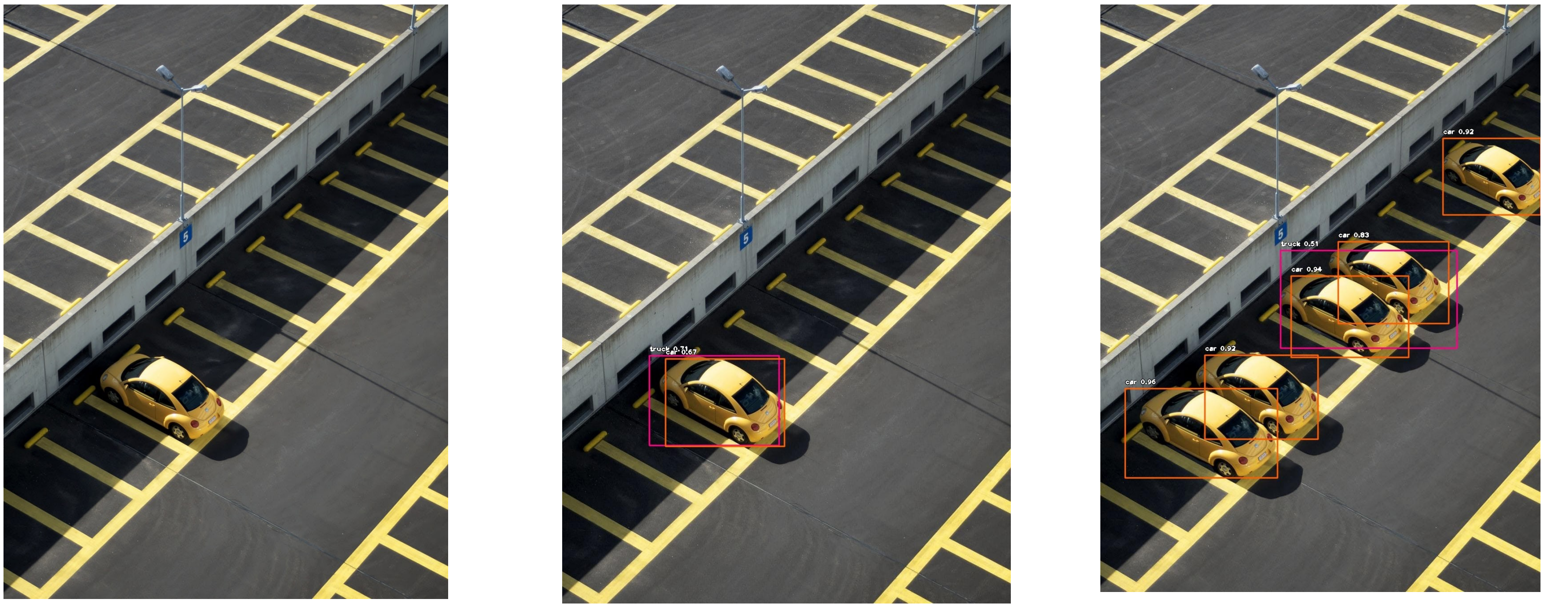
- An open source library that is used alongside TensorFlow as a set of abstractions or simplifications that make TensorFlow provided tools easier to use.

Open CV

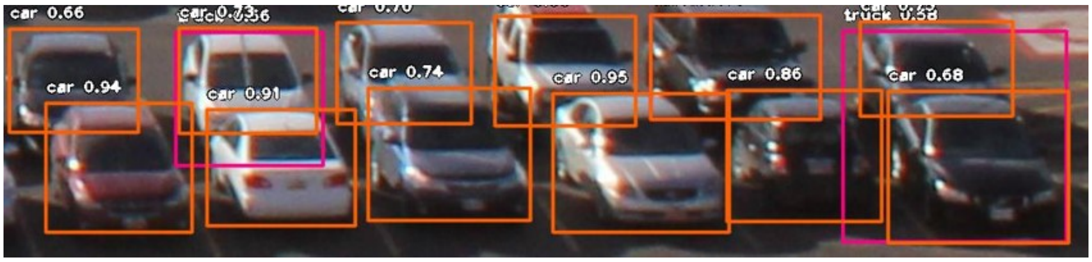
- Short for Open Source Computer Vision Library, provides the infrastructure needed to manipulate images or perform image recognition tasks with a computer.

ImageAI

- Another library that helps to perform image recognition. It also depends on code from Keras and OpenCV to run. Our code mainly used ImageAI in order to detect cars.



The above pictures show an example of the sliding window approach which uses a rectangle that slides across the image and attempts to recognize objects within said rectangle



The pictures above are our own images that demonstrate an example of the sliding window approach describes previously.

ImageAI requires a trained model in order to work. We decided to use the YOLOv3 model ("You Only Look Once") as it was a pre-trained model that also matched our requirements for accuracy. We compared this model to the TinyYOLOv3 model (which is a lightweight version of the YOLOv3 model that runs faster while losing some accuracy) and found that the YOLOv3 model was more reliable. Initially, we were only using the TinyYOLOv3 model instead of the full YOLOv3 model, which made it seem like our algorithm wasn't capable of picking up cars in each picture. However, once we switched to the full model, we were able to more accurately detect cars in our image.

We learned how images were transferred between devices and could use Python's functionalities in order to encode and decode our images in base 64 so that they could be transferred over the internet. We also learned how to set up a simple web server with Amazon Web Services that could run our image detection program on stored images.

While using our pre-trained model, we found that there were some advantages and disadvantages to the way the model worked in terms of detecting cars. While the model was fast at counting the number of cars in an image, it struggled with larger images (as it would attempt to declare groups of cars as a singular car) and would need to be fed cropped images in order to work correctly. Similarly, we did not perform any pre-processing on our images, so obstructions like glare or the wrong camera angle could cause our model to miscount the number of cars in the image.

Database

The majority of the work that needed to be done on this project was designing a database that is capable of holding long term information about the number of cars parked in any given parking lot, regularly populating that database with information from the image analysis, and sending the processed information to the app interface to be used by the university community.

Due to the change of scope we had, focusing more on showcasing the feasibility of our idea rather than a full scale deployment, the first portion of this networking setup was cut pretty much completely in favor of setting up a few images to showcase how it would work if connected to regularly updated camera feed. The database was designed to be fairly simple as a result of this shift as well. Rather than designing for scalability, it is set up to showcase a few key entries being sent to the app.

A large portion of the work that would need to be done to further this project into a campus wide deployment would be in the sector of networking and data management. The infrastructure that was set up was fairly temporary and integrating into the existing systems of the University in a way that isn't disruptive and allows regular updates of our database is a difficult technical challenge that has not yet been addressed.

App Design

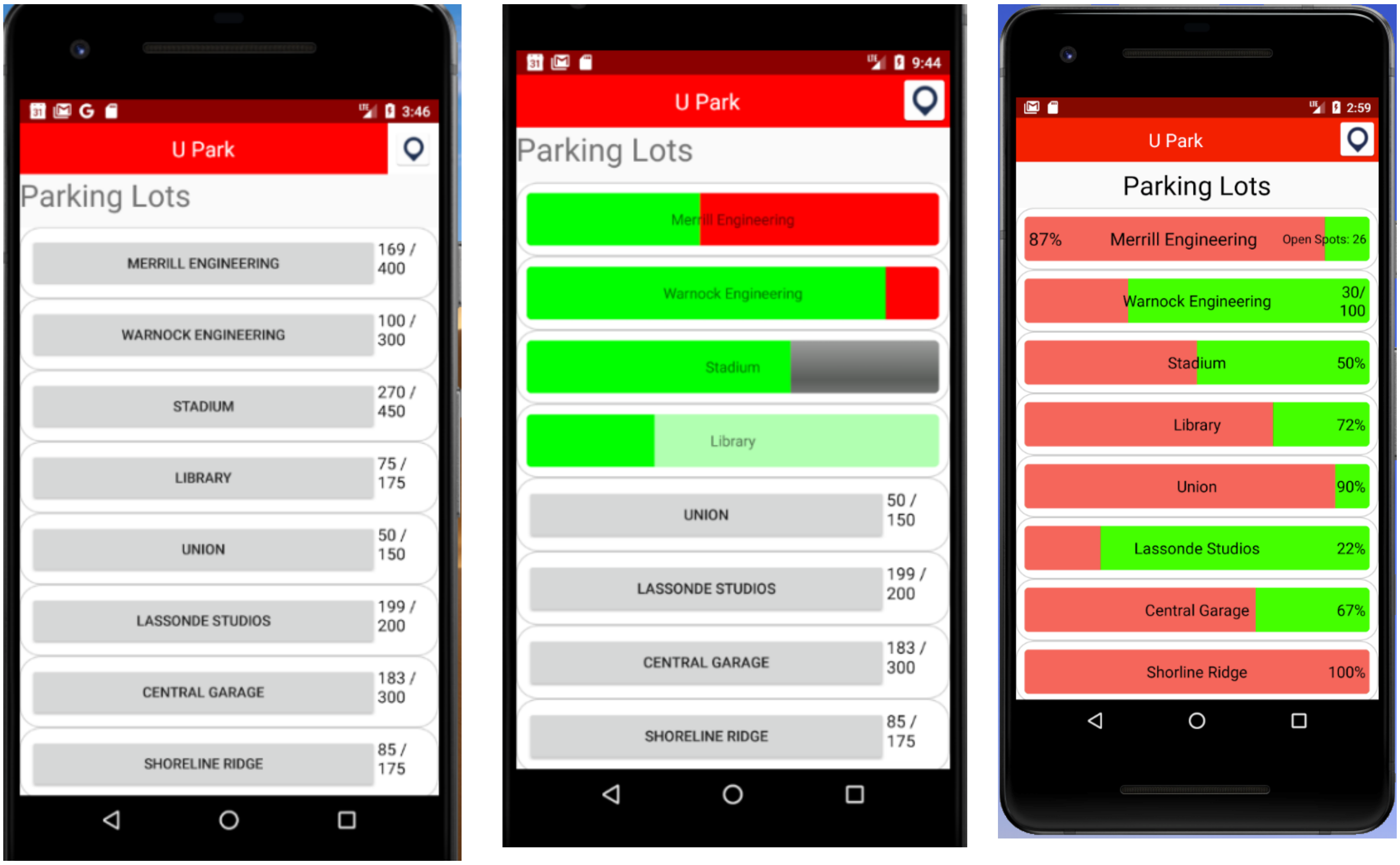
Before we started building the actual app, we sketched designs for the team, first by hand then on an electronic document. The visual outline was helpful for planning out what frames the app needed, what each frame would contain, and what various functionalities the app would have. The first frame was originally planned to be a welcome page, the first frame the user would see when opening the app. However, the functionalities of the app took priority. Implementing the functionalities proved to be more difficult as we started developing the app, so we decided to focus on the main and map frames instead of the welcome frame.

The main frame would be the app's main page, where the necessary information would be displayed: the list of parking lots, the number of available spots, and percentages of how full each parking lot was. The map frame would show the locations of the parking lots and allow navigation to the desired parking lot.

Designing the user interface for the application was a big part of our project. We wanted to ensure that our design was simple, easily navigated, and the user is able to get the information they need quickly in order to minimize the time they had to spend on the app. This was the criteria around our design process and led to a two-screen application where all of the information about the parking lots is on the home screen. The screen is color coordinated to help the user interpret the data quickly, and if the user desires to get directions to the parking lot it only takes two clicks. Other features that we found would be necessary for a full deployment of this application involve geo-fencing, and text-to-speech information presented to the user. This will would make nearly on functionality of the app "hands-free" for user that are using it while driving.

As a development team, the process we followed of mocking up designs, building a prototype, and constantly getting feedback from the rest of the team is very similar to real industry practice of developers working with the product team to meet a common goal. In most undergraduate classes, you don't get this experience of going through an entire development process that isn't on a pre-planned course. This ensured every challenge we faced was new and required adversity and critical-thinking to find the best solution.

One of the most challenging aspects of the app development was learning how to use unfamiliar software. Before building the app, we did not have much experience with using Android Studio, the software application we used to make the app. A lot of research was devoted toward figuring out how to use the application, what syntax it used, how to implement a certain functionality, and many other components.



The above pictures show the progression of the home page of the app from beginning to end

Privacy Concerns

In a society surrounded by technology, concerns over privacy often rise. China's victory to 5G technology led to a ban on Huawei from United States communication networks due to privacy concerns. Memes also scour the internet about FBI agents watching our actions on our smartphones. Google and Amazon are constantly in the public's eye for "spying" on private conversations rather than just reacting when these devices hear their wake word. These varying examples tell us that privacy and security is an issue that crosses the mind of most Americans. So, our team knew that there would also be concerns over a machine-learning application that tracked parking on campus. Two of the biggest concerns our team thought of was the issue of tracking a person's movements and identifying license plates. Our group understands that privacy is an enormous risk and it is continually addressed. In a fully functioning app, the software would blur license plates and faces.

Project Management

Our primary goal for this project was to create a fully-functioning app for university students, Faculty, and Visitors to use. We called this “Plan A,” We wanted to have an app that:

- Included all of the parking lots on campus
- Provided real-time parking space availability
- Informed the user on how many spaces were available per parking lot
- Contained a model that tracked and predicted trends through a deep learning algorithm
- Was able to split the parking lot up by parking permit type
- Provide the user with alternative options to parking lots depending on the number of available spaces
- Convey the availability of the user’s preferred parking lot in an audio format rather than on-screen through geofencing

If the first goal was not achievable, we had an alternative plan to Plan A. Plan B would also involve an app however it would be more simplistic. We wanted this version to have the following:

- The most popular parking lots: Merrill Engineering and the Stadium
- Provide close to real-time parking space availability, maybe a 2-5 minute delay
- Inform the user of the number of available spaces in the two parking lots.

Finally, if all else failed our goal was to create a proof of concept for Plan A. The proof of concept (Plan C) would involve us going out to collect our own parking lot footage as opposed to receiving camera access from the university. Rather than having a fully functioning app, we would include an app with the features we desired such as

- Settings screen
- Home screen
- Favorites function
- Map of the parking lots

However, the features of this app would not be connected to the image analysis which would be essential to a fully functioning app. The image analysis would also not be fully refined but would function enough to show that this method is viable.

We started the semester very optimistically that we were going to be able to conquer Plan A. However, as the first month flew by, we still did not have access to the security cameras. As February rolled around, our software team was working on their individual parts without any footage. Then, the internal administration team decided to set out to collect footage of the Stadium parking lot with our teammate's camera. Essentially, after the first month and a half, we were sitting at a mixture between Plan A and the proof of concept. For the remaining month before spring break, the software team worked hard on perfecting the image analysis and functionality of the app while the internal administration team worked on the written report for this project. Spring break rolled around and our outreach team was finally able to give the Software team some footage. Unfortunately, we were unable to use any of the footage and with that, we left for spring break. After spring break, the coronavirus pandemic shut down the campus, forcing us into a decision to switch to our proof of concept, Plan C.

While our focus was now on the proof of concept, it allowed us to provide a higher emphasis on the foundation of this project, and lay the initial steps towards a future where this develops into Plan A.

THE FUTURE

Ultimately at the end of this year, we were able to research and present a proof of concept about this idea, but we believe that this project's potential lies in the future. In the development section, we have shown the various steps needed to create a fully integrated app, which includes the ability for the app to pull information from the image analysis, which in turn can pull real time data from the security camera feed. This fully functioning app would need to be integrated with the current infrastructure of the university, which throughout the course of the year we found to be a difficult task to do. Another important step would be to add several important features such as audio cues to prevent drivers from getting distracted while driving to campus among other things and an integrated Maps ability to allow the user to use just one app for travel purposes, among others.

While improving the app itself would allow for a better user experience, perhaps the biggest hurdle to clear which we learned throughout the year. This would be the capability of the app to use real time data from the security cameras, and as we found out, this would likely require some processing of the raw footage into usable pictures or photos that can be fed through the image analysis model. Similarly, the model itself would have to be refined to handle processing regardless of what time/weather the photos were taken, to provide accurate data regardless of the circumstances.

We believe that this project is not far away from what we envisioned as our Plan A. With more time, (and without the effects of the COVID-19 pandemic) we believe that we have simultaneously outlined the necessary steps that need to be taken.

AWKNOWLEDGEMENTS

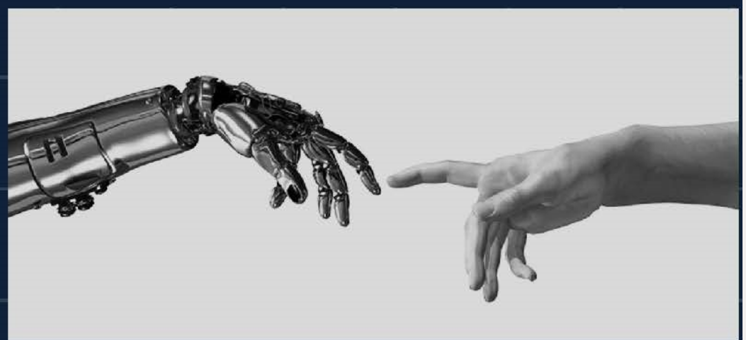
Our class would like to acknowledge our amazing advisors, Frank Drews and Pratt Rogers, who able to handle our unprecedented transition in a coordinated manner.

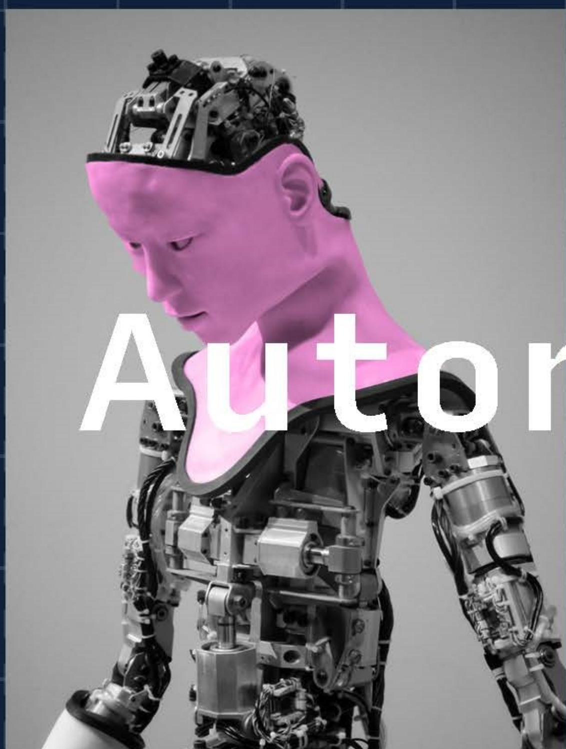
We would like to acknowledge all of our guest speakers that took the time to come inform and discuss, with us, important issues/topics involving automation.

Last but not least, we would like to acknowledge the Honors College for providing us with such a unique experience.

Thank You!

PRAXIS
THEORY + ACTION





Automation

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