

# MSCS Capstone Conference Schedule - Spring 2022

## THURSDAY (3/3)

	OLRI 254	OLRI 256	OLRI 258	OLRI 241	OLRI 245
9:00	Elizabeth Schnaubelt How Fourier Transforms Can Help Save Dolphins	Juthi Dewan NYC Transit Access and Inequity	Ethan Deutsch How to Master the Madness: Predicting the NCAA Tournament	Jacob Bulling Is it game over?- Midgame predictions in the NFL.	
9:40	Amy Xu That's Not Fair: Exploring Algorithmic Biases	Sam Ding Not All Stations are Created Equal - Exploring Transit Deserts in NYC	Betsy Foy Tainted Waters: Looking at Environmental Racism and Access to Clean Drinking Water in Texas	Carrie Shao Spectra of Pancake Graphs	Katherine Liberko Should you buy that fertilizer? An overview of Bayes Factor
10:10	Geven Liu Your Average is Normal: Central Limit Theorem	Yunyang Zhong sleep tight & love life: Does more sleep = higher life satisfaction?	Benjamin Blomquist What's in your water? : Texas Water Violations	Zully Maya Procedurally Generated Clouds for Your Aesthetic Purposes	Saby Cortez Solving Sudoku Using Graph Coloring
10:40	San Sieng Good Vibrations: Finding the Normal Modes of Molecular Vibration with Representation Theory	Jinghan Zhou "I Will Survive" the Billboard Top 100 Weekly Chart	Spencer McNall Social Media For The Outdoors	Carrie Shao Notebuddy: A Website to Share Your Notes with Your Classmates	Radu Lungu What car is that? Using Artificial Intelligence to recognize a car's make and model.
11:30	Henry Bell Analog-Inspired Digital Differential Equation Solver	Zixuan Zheng Can we predict a movie's box office revenue? A Bayesian Network approach	Xinyi Wang A duration analysis in entrepreneurship: What are the most important factors in determining business formation time?	Alyssa Pham Fidget-Widget: Your Mindless Tool For Focused Productivity	Freddy Barragan Statistical Genetics for Pediatric Leukemia: Characterizing racial disparities in pediatric B-cell acute lymphoblastic leukemia
12:00	Emily Harper The Great Equalizer? Visualizing Locale-Based High School Achievement Gaps	Frederick Kerr Drawn Together: Implementing an Online Multiplayer Pictionary Game	Zhaoheng Li Using Machine Learning to Analyze Partially Observed Survival Data	Becka Geleto Jobs Galore! You won't have to search for jobs from more than one place again.	Xuechen Yu Step by step intro to build a shiny app: a US health disparity overview
1:20	Roman Bactol Let's go outside! Connecting people to the outdoors	Sivhuo Prak Using AI to colorize black-and-white photos	Jianyang Li What kind of dog are you?	Duc Ngo Can you predict the stock market using machine learning?	Michael Steele Painting with the Easel of Access
1:50	Will Moscato Predicting the FIFA Team of the Season	Hayley Hedges Help Wanted! How to Retain your Employees	Aidan Alls What's for Dinner? Exploring Food Insecurity in Minnesota	Daniel Beidelschies The Draw of Game Design	Yifan Wu Upset the Directors, with AI!
2:20	Jacqueline Shao Yi Ong How to Shade Your Dragon	Nadav Skloot A Better Way To Find a Job	Jianyang Li Random Survival Forest and its Application	Paul Heo Starcraft AIs: Can AIs Strategize Wars?	Alexander Shevchenko Can a computer identify landscapes? - Using Convolutional Neural Networking to categorize a set of images
3:00	Ivy Contreras Motion of the Sotion: Web UI Design & Development	Connor Bass Crystal Graphs for the Symmetric Group	Ryan Kinnucan EasyEmployment	Alejandro Aguilar Rodriguez TrackMan: An Educational Game about Cyber Security	Daniel Lim Redlining: The Unequal Burden of Hot Summers

<b>3:30</b>	<b>Adam Bass</b> Bijections Between Subfamilies of Gog and Magog Triangles	<b>Christopher Beckwith</b> The Barcode of a Seizure: Can Topology Differentiate Normal and Abnormal EEGs?	<b>Preston Locke</b> That's a Hot GPU: Using Parallelism to Simulate Forest Fires	<b>Michael Helton</b> Predicting the EA Sports FIFA Team of the Season	<b>Anjali Moorthy</b> Red Lines on Green Spaces: How Racist Housing Policies of the Past Affect The Health of St. Paul Residents Today
<b>4:00</b>	<b>Yuchen Dou</b> Texas Hold'em Game Agent	<b>Lena Underwood</b> Does your major determine your career?	<b>Leen Diab</b> Virtual Journal: A calming website for evidence-based reflection practices	<b>Elisabeth Landgren</b> Big Data Big Problems: Opportunities for Optimizing RNA Data Sets	<b>Claire Wilson</b> Learn to Speak Dolphin!

## FRIDAY (3/4)

	<b>OLRI 254</b>	<b>OLRI 256</b>	<b>OLRI 258</b>	<b>OLRI 241</b>	<b>OLRI 245</b>
<b>9:40</b>	<b>Christina Kiehl</b> An invasive story: Modeling the spiny water flea in MN lakes	<b>Jeongyeob Hong</b> From Speech to Text, Text to Emotion	<b>Lena Underwood</b> The Shapes of Languages - A Topological Analysis	<b>Will Orser</b> Promotion-Relegation: Predicting the Most Cutthroat System in English Football	<b>Vichearith Meas</b> Discovering NYC Hidden Deserts
<b>10:10</b>	<b>Yutong Wu</b> Twin Cities Airbnb Data Analysis: How to choose a suitable house?	<b>Qingru Zhang</b> NoteBuddy: Share your class notes with your friends!	<b>Christopher Beckwith</b> EEG Artifact Removal: Separating Brain Waves from Non-Brain Waves	<b>Raymond Gu</b> Will It Ever End? Predicting COVID-19 Case Rate	<b>Franco Salinas Meza</b> Predicting the Severity of Car Accidents from environmental factors
<b>10:50</b>	<b>Izzy Valdivia</b> "So-tion Sickness!" Social Media & Backend Web Development	<b>Yuchen Dou</b> Network Analysis in European Football Transfer Market	<b>Alpha Ma</b> Representation theory in Physicists' perspectives: Hilbert Space and the spin representations of $su(2)$	<b>Leonardo Bucello</b> Using Survival Analysis to Compare Common Breast Cancer Treatments	<b>Paige Robertson</b> Packing Triangles: Using Logic Games to Approach Combinatorial Questions
<b>11:20</b>	<b>Yutong Wu</b> Algorithm of Characterization of Rectifiable Measures that are Carried by Lipschitz Graphs on Discrete Space	<b>Qingru Zhang</b> Image Inpainting: Removing unwanted objects from an image	<b>Arthur DressenWall</b> Inequalities in Functional Analysis: A Mathematical Journey of Norms, X-Rays, and the Proof that Refused to be Generalized	<b>Raymond Gu</b> Speechless? How Computers Recognize Human Speech	<b>Vichearith Meas</b> Hey AI, What type of car is that?
<b>12:00</b>	<b>Shouayee Vue</b> movJdej: A Hmong Recipe Website Because AllRecipes Excludes Us In "All"	<b>Howard Cai</b> I Heard You: Speech Recognition Using AI	<b>Aron Smith-Donovan</b> How to steal data without getting caught	<b>Henry Basu</b> Simulating a Predator-Prey Environment with Artificial Life	<b>Ty Bruckner</b> NFL Win Probability Predictor
<b>12:30</b>	<b>Daniel Chechelnitsky</b> AirCanvas: Making Art with Movement	<b>Kyaw Za Zaw</b> What \$VENMO\$ reveals about you	<b>Jiashu Liu</b> A shiny app for health insurance coverage	<b>Jonathan Neve</b> ADAPT OR DIE: How generational changes to an organism's genetic string alters their chances of living in a simulated environment.	<b>Kaden Maloney Bieger</b> Risk & Protective Factors for Serious Mental Illness among People Receiving Public Mental Health Services
<b>1:40</b>	<b>Nathan Ngo</b> AI: Colorizing black and white images with one click	<b>Vaja Kldiashvili</b> What's for Dinner? Investigating Food Insecurity in Minnesota	<b>Katherine Liberko</b> Virtual Journal: The bits and pieces of self-organization in one place	<b>Heeth Surana</b> The Dollar can talk, but can we listen? An engineer's guide to financial trading	

### **How Fourier Transforms Can Help Save Dolphins**

**Elizabeth Schnaubelt** (AMS)

OLRI 254

Dolphins are the bats of the ocean, and they are smarter than us. If we could imitate their echolocation, it would vastly improve our sonar technology and help us protect ocean mammals as they face the trials of climate change. We test two new methods of analyzing dolphin whistles, contrasting them against the standard spectrogram, and highlight the potential for improved denoising and categorizing of dolphin sounds.

### **NYC Transit Access and Inequity**

**Juthi Dewan** (AMS)

OLRI 256

Chances are that if you've been to NYC, you rode through one of its 36 subway lines. Known for having the best public transit system in the United States, NYC was a place of great personal interest. This project explores the city's transit accessibility from a Bayesian statistics perspective. What neighborhoods can be classified as subway deserts? Who is best served by the system and who is left behind? If you're interested in transportation access and urban geography, this might be something of interest to you!

### **How to Master the Madness: Predicting the NCAA Tournament**

**Ethan Deutsch** (AMS)

OLRI 258

Have you been struggling with your NCAA Tournament bracket in recent years like I have? Maybe it's time to turn to analytics and statistics so you can finally beat your friends in your pool. In my project, I use past tournament data in order to predict the 2022 NCAA Tournament starting on March 19th. Using predictions and data from past tournaments, I will present statistically based strategies for how to predict the results of March Madness.

### **Is it game over?- Midgame predictions in the NFL.**

**Jacob Bulling** (AMS)

OLRI 241

ESPN has win probability charts for all of our favorite NFL football teams, where it gives us a line graph showing win probability after every play of every game. In this project, we will use Bayesian methods to recreate ESPN's model, using variables including score differential and home field advantage to come up with a midgame win probability prediction similar to that of the ESPN Football Power Index model.

**That's Not Fair: Exploring Algorithmic Biases**

Amy Xu (CS)

OLRI 254

Algorithms have the potential to revolutionize the decision-making process. While using algorithms to make more efficient and accurate choices, have you thought about the downsides such algorithms bring about? Historic training data and missing information in electronic health records are the main culprits for disparities in healthcare and medicine. In the workforce, the algorithms trained to help select qualified candidates may reduce equality in hiring by disproportionately focusing on some qualities over others. This project examined several such algorithms, analyzed underlying biases, and discussed improvements and future directions to create an equitable process.

**Not All Stations are Created Equal - Exploring Transit Deserts in NYC**

Sam Ding (STAT)

OLRI 256

New York City's subway has been in operation for well over 100 years. Yet, not all corners of the City are reached by its expansive transit system. Those areas that are not well-connected to quality public transit are called 'transit deserts', which create concerns for urban development and inequalities. Could this be explained by the differences between neighborhoods? In this project, my teammates and I delve into the nitty-gritty of NYC's demographics and its relationship to transportation accessibility using Bayesian statistics. If you are interested in areas of transportation, urban geography, or statistics, don't hesitate to come in!

**Tainted Waters: Looking at Environmental Racism and Access to Clean Drinking Water in Texas**

Betsy Foy (CS)

OLRI 258

Do you know what's in your water? This project explores the topic of environmental justice by comparing water violations per county to percentages of different demographic groups in Texas. Thirsty for more? Stop on by!

**Spectra of Pancake Graphs**

Carrie Shao (MATH)

OLRI 241

Are you curious about how many ways you can permute a stack of pancakes? Or just interested in learning what spectra of a pancake graph is, and how it can be calculated and represented by matrices? Come see how we combined representation theory and graph theory concepts to calculate spectra of pancake graphs and build fascinating representations of these spectra

**Should you buy that fertilizer? An overview of Bayes Factor**

Katherine Liberko (AMS)

OLRI 245

Have you ever wondered if it's worth it to buy fertilizer, even if your plants are doing fine without it? Bayes Factor is a tool we can use to help us make this decision. A Bayes Factor ratio is used to evaluate data and compare a null hypothesis against an alternative hypothesis (e.g. the null = fertilizer has no effect on your plants' health vs. the alternative = the new fertilizer has a positive effect on your plants' health). We will explore Bayes Factor and its power in interpreting data.

**Your Average is Normal: Central Limit Theorem**

Geven Liu (AMS)

OLRI 254

This project explores possibly the most important and exciting theorem in statistics—the central limit theorem. We all enjoy the elegance and simplicity of estimating confidence intervals by adding and subtracting two standard deviations. The simplicity comes from the central limit theorem, which suggests that no matter how weirdly shaped the distribution we are dealing with is, their sample mean would still be approximately normally distributed. We will investigate why this theorem holds and potentially explore around its applications.

**sleep tight & love life: Does more sleep = higher life satisfaction?**

Yunyang Zhong (AMS)

OLRI 256

Is sleeping time related to life satisfaction? Does sleeping time determine life satisfaction? Correlation DOES NOT imply causation! This project examined whether there is a causal relationship between sleep and life satisfaction, while controlling for several relevant variables, such as weight, marital status, well-being, and family income, including unmeasured ones. I will talk about the causal diagram based on our domain knowledge and also the technique of causal discovery to investigate what our data tells us.

**What's in your water? : Texas Water Violations**

Benjamin Blomquist (CS)

OLRI 258

Should you be filtering your tap water? If you live in Lubbock or Harris County, Texas, you probably should. This presentation will represent access to safe drinking water based on Race and Counties in Texas. Seen with the continuation of environmental racism, especially with water, with examples like Flint, Michigan and the Line 3 pipeline, Texas stuck out with striking data. A cluttered group of datasets pulled together to bring us all on a journey through visual representation.

**Procedurally Generated Clouds for Your Aesthetic Purposes**

Zully Maya (CS)

OLRI 241

How is it possible to create graphically randomized clouds whilst keeping them looking picturesque? What make clouds so special is that each one is uniquely shaped, but they also just look like slight variations of each other. In this talk we explore the shortcut to generate clouds using the Perlin Noise algorithm. Instead of spending hours and hours manually coding your clouds, this algorithm will let you spend those hours admiring them.

**Solving Sudoku Using Graph Coloring**

Saby Cortez (CS)

OLRI 245

Sudoku is a game that is easy for humans to solve since we can see which numbers are near each other and which numbers are missing visually—computers however don't have this same understanding. In this project my teammates and I created an accurate sudoku solver which bridges the gap between what we know and what a computer can understand regarding how the numbers in a game of sudoku are connected using concepts from graph coloring.

**Good Vibrations: Finding the Normal Modes of Molecular Vibration with Representation Theory**

San Sieng (MATH)

OLRI 254

Atoms in a molecule constantly vibrate. Their motions can be described by systems of differential equations, which are hard to write down and even harder to solve. I'll show how to use symmetries and representation theory to "solve" some of these equations without even needing to write them down in the first place.

**"I Will Survive" the Billboard Top 100 Weekly Chart**

Jinghan Zhou (AMS)

OLRI 256

Have you ever wondered what makes a hit song? What is the trend of the music genre? How do people's taste in music change over time? This presentation will use survival analysis methods to show you the types of music that are most likely to be popular.

**Social Media For The Outdoors**

Spencer McNall (CS)

OLRI 258

Do you want to go for a hike? Use TrailBlazer to find trails near you, and see what others have to say about them! The goal of this project was to create a social media website that connects people with the outdoors. Users can explore a variety of information about popular outdoor locations near them, and see what others have to say. This project uses Mapbox API and location data to build an interactive map of the United States that helps users find and explore nature near them.

**Notebuddy: A Website to Share Your Notes with Your Classmates**

Carrie Shao (CS)

OLRI 241

Forgot to write down what your professors said? See how a note sharing website can help you take everything down by looking at notes that your classmates share. In this project, I will talk about how we used Javascript, HTML5, CSS, Flask and Python to build a website that makes spaces for you to share your notes with others.

**What car is that? Using Artificial Intelligence to recognize a car's make and model.**

Radu Lungu (CS)

OLRI 245

Hundreds of cars pass by us daily and most of the time they go unnoticed, however, sometimes we see an unusual or really nice car and wonder about its make and model. Come see how we solved this problem with the help of convolutional neural networks and supervised learning.

### **Analog-Inspired Digital Differential Equation Solver**

Henry Bell (MATH)

OLRI 254

Differential equations are how we model the world around us: from the motion of a pendulum to the orbit of the planets. But, in almost all cases, we cannot solve them with pen and paper and we must use computers. With inspiration from analog computers, I use the Fourier transform and Picard's method to solve interesting differential equations on a digital computer.

### **Can we predict a movie's box office revenue? A Bayesian Network approach**

Zixuan Zheng (STAT)

OLRI 256

What makes some movies more popular than others? To understand how the movie industry operates, and the specific factors that might impact the preference for movies, we analyze the US box office and study what factors are most related to box office performance. We utilized Bayesian Belief Networks, a graphical probabilistic tool, to investigate the causal relationship between variables that might influence a movie's performance.

### **A duration analysis in entrepreneurship: What are the most important factors in determining business formation time?**

Xinyi Wang (AMS)

OLRI 258

Young people always talk about big tech companies, like TikTok and Instagram, which seemed to grow from an idea to an integral part of their daily lives very quickly. We may be wondering, how long does it take for a brilliant idea to be turned into a true business and what affects such business formation time. In my capstone project, I use survival analysis, building both parametric and non-parametric models to simulate business formation in the real world. By interpreting those models, we will be able to get a sense of what matters the most in determining the business formation time.

### **Fidget-Widget: Your Mindless Tool For Focused Productivity**

Alyssa Pham (CS)

OLRI 241

Fidget Cube... Fidget Spinner... you may have heard of these at some point in your life. While they may seem like simple toys on the surface, they are actually great tools for individuals of all ages who experience ADHD or deficiencies in sensory processing. Targeting the auditory, tactile, and visual senses, Fidget Widget consolidates many of these very same tools into one convenient web application that is sure to boost individual productivity!

### **Statistical Genetics for Pediatric Leukemia: Characterizing racial disparities in pediatric B-cell acute lymphoblastic leukemia**

Freddy Barragan (STAT)

OLRI 245

There are documented differences in B-cell acute lymphoblastic leukemia (B-ALL) outcomes by race/ethnicity that cannot be wholly explained by socioeconomic status or other social determinants of health. Black children typically present with more aggressive cancer characteristics and face worse survival outcomes than their White and Latinx counterparts, even after the adjustment for socioeconomic status and treatment adherence. In my honors thesis, I aim to integrate methods from genetic epidemiology, statistical genetics, and survival analysis to characterize the impact of genetic ancestry on gene expression and cancer prognosis in an effort to explain the observed disparities in pediatric B-ALL.

**The Great Equalizer? Visualizing Locale-Based High School Achievement Gaps**

Emily Harper (CS)

OLRI 254

How does high school achievement in rural school districts compare to suburban school districts? How does the size of a city or the remoteness of a town influence test performance or dropout rates of high schoolers? In my project, I created web-based data visualizations to communicate this connection between place and educational achievement, focusing predominantly on public high schools in Minnesota. Accessibility concerns, data limitations, and data visualization best-practices shaped my process of transforming real-life data into visual, easily-discernible patterns and trends.

**Drawn Together: Implementing an Online Multiplayer Pictionary Game**

Frederick Kerr (CS)

OLRI 256

Free-to-play, minimalist, multiplayer games, like Agar.io, are popular online. This project, Drawn Together (a team-based Pictionary game), falls into this genre. These games rely on rapid communication between computers for an enjoyable user experience. Learn how WebSockets and Flask make real-time networking possible.

**Using Machine Learning to Analyze Partially Observed Survival Data**

Zhaoheng Li (MATH)

OLRI 258

Many study designs are used for convenience, but they may lead to data that is not from the target population of interest. For example, in some studies, we only partially observe survival data since an individual may enter our study already partway through their survival time. In my project, I investigated three machine learning methods to combine non-parametric and parametric estimators from different families to take the strengths of both in order to produce more accurate and robust predictions for survival distributions based on partially observed data.

**Jobs Galore! You won't have to search for jobs from more than one place again.**

Becka Geleto (CS)

OLRI 241

If you've ever had to hunt for jobs or internships online, you've probably had to use multiple job board sites like LinkedIn, Glassdoor, and Indeed simultaneously. Constantly having to switch between these sites can eventually turn into a huge hassle. What if there was a single location you could go to that can consolidate information from multiple job boards into one place? I have built a website called 'Better Job Finder' that does just that.

**Step by step intro to build a shiny app: a US health disparity overview**

Xuechen Yu (AMS)

OLRI 245

Have you ever wondered how patterns of insurance varies across United States? Do you want to see how health disparities can be reflected by data visualization? Plus, we will talk about how to impress your classmate on your stats project using a shiny Shiny app. This project aims to give a simple step by step intro to build a shiny app using county level health data. We will talk about how to put cool interactive graphs, regression analysis in Shiny. Most excitingly, we will see how to use Leaflet to show a map reflecting factors showing health disparities in the United States.



## Let's go outside! Connecting people to the outdoors

Roman Bactol (CS)

OLRI 254

With the COVID-19 pandemic that has been happening for almost two years, there has been a big emphasis on going outside. Maybe you're social distancing or just want to take a breath of fresh air, there has never been a better time to go outside. My capstone is centered around helping people find locations to go outside (trails, neighborhood parks, national parks, etc.) and then helping them connect through that.

## Using AI to colorize black-and-white photos

Sivhuo Prak (CS)

OLRI 256

Do you have black-and-white photos and want to see what they would look like if they were colorful? What if I told you that an AI model could colorize these photos for you in one click? Come see how we can use convolutional neural networks to colorize black-and-white photos.

## What kind of dog are you?

Jiayang Li (CS)

OLRI 258

How could you tell the difference between an Alaskan Malamute and a Siberian Husky? How can you detect a Dalmatian camouflaged in a dotted sheet? These tasks are already difficult for humans. However, we can actually train a computer to do so. A natural subsequent question might be: what is happening in our brain when we see an adorable dog, and how can machines imitate our recognition process with ruthless and cold GPUs and CPUs? This project examines a machine learning algorithm to detect and distinguish dog breeds using Faster RCNN, an object-detection algorithm based on Convolution Neural Network.

## Can you predict the stock market using machine learning?

Duc Ngo (DS)

OLRI 241

Many people have attempted to answer the billion dollar question: how do the best investors pick their stocks? While about 90% of investors lose money over time, some exceptional individuals - such as Warren Buffett, Ray Dalio, and Charlie Munger - have made billions of dollars. In this capstone, we develop machine learning models using data from the S&P 500 to predict the profitability of stock prices. Our goal is to come up with an effective method to achieve a stable and positive investment return.

## Painting with the Easel of Access

Michael Steele (CS)

OLRI 245

Our five-year global flight from the COVID-19 pandemic has skewed our world of work heavily toward the realm of computers and technology. Though this drastic switch to the digital platform has improved quality of life for some, the tech industry's growing neglect for accessible interfaces in the computerized world has spurred us to rethink traditional human-computer interfacing (HCI) media, with the ultimate goal of streamlining digital interaction for users with disabilities. I showcase with my project a Python-based, AI-powered, contactless digital art canvas, and demonstrate how gesture recognition through artificial intelligence could set a new precedent for accessibility in the digital world.

## Predicting the FIFA Team of the Season

Will Moscato (AMS)

OLRI 254

Each year EA Sports FIFA comes out with its Team of the Season for each of the major leagues in world soccer. Have you ever wondered if there was a method to their madness? We will predict these teams for each of Europe's top five leagues using machine learning algorithms based upon real world soccer statistics in order to see what statistics EA values over others. Come see well how good the predictions were!

## Help Wanted! How to Retain your Employees

Hayley Hedges (STAT)

OLRI 256

As employee attrition soars to all time highs, the Great Resignation has brought turmoil to companies across the US. Retaining employees has become both more challenging and more urgent. So how can companies keep their employees happy and minimize attrition? In this talk, I will use Bayesian classification models to predict employee attrition and make data driven recommendations for lowering resignations.

## What's for Dinner? Exploring Food Insecurity in Minnesota

Aidan Alls (CS)

OLRI 258

Where does your food come from? How far do you need to drive to get there? As it turns out, not everyone has the same access to food. In this presentation I will discuss the factors that impact food insecurity in Minnesota. I'll walk through the process my group took to turn a cluttered table of data into an accessible and understandable interactive visualisation. Who struggles the most? Where do they live? With the power of data visualization, even you will be able to answer these questions.

## The Draw of Game Design

Daniel Beidelschies (CS)

OLRI 241

Drawn Together is a fast-paced, team-based Pictionary game where two teams compete head-to-head against each other by drawing and guessing the prompt given. The two teams race against each other each round to guess the same word. In this talk, I will go over the design aspects and a little about the engine of the game and as well as the process behind working on this online multiplayer experience.

## Upset the Directors, with AI!

Yifan Wu (CS)

OLRI 245

Hitchcock, Chaplin, Tarkovsky, and many other directors intentionally shot black and white images when colored pictures were heavily used already, but we are going to upset them by doing the opposite: turning black and white images into colored images. What if we could see historical pictures closer to how they appeared in real life? This talk presents image colorization using convolutional neural networks.

## How to Shade Your Dragon

Jacqueline Shao Yi Ong (CS)

OLRI 254

You've seen a dragon, but have you ever seen THROUGH a dragon? What does it take to make something transparent in computer graphics? What even makes glass look like glass?! Come to my talk about shader programs to learn how I made a 3D dragon model look like glass, metal, plastic and gummy candy!

## A Better Way To Find a Job

Nadav Skloot (CS)

OLRI 256

Have you ever spent hours sifting through various job boards only to find that you don't fit the requirements for half of the postings? We created an app that scrapes several job posting sites for relevant jobs and scores them based on user search criteria such as your years of experience, education level, and skills. Come learn about web scraping and see if our app can help you with your job or internship search.

## Random Survival Forest and its Application

Jiayang Li (AMS)

OLRI 258

Random forests is an ensemble learning method that is most widely used for classification and regression tasks due to their accuracy by reducing overfitting, interpretability and the ability to handle missing data. Random forests can also be applied to survival analysis, making it an efficient algorithm for analysis of right-censored time-to-event data. This project introduces the Random Survival Forest algorithm and gives an example of its application on the IBM HR Analytics Employee Attrition & Performance data.

## Starcraft AIs: Can AIs Strategize Wars?

Paul Heo (CS)

OLRI 241

Ever seen the movie Ender's Game? Independence Day? Or even Star Trek? If you have, then you have at least once imagined yourself fighting against a foreign entity. Because someday, we really might. Starcraft is a real-time science-fiction strategy game that allows players to choose one of three alien races and survive by gathering resources, building armies, and constructing facilities. This talk will show how and why specific AIs out-strategize others and how they can hopefully

## Can a computer identify landscapes? - Using Convolutional Neural Networking to categorize a set of images

Alexander Shevchenko (CS)

OLRI 245

Is it possible to teach a computer to tell the difference between a street and a building photo? Using Convolutional Neural Networking (CNN), we can train a computer to classify different landscapes ranging from buildings to glaciers. Come to my talk to learn more about CNNs and to see how smart a computer can get in identifying images.

## Motion of the Sotion: Web UI Design & Development

Ivy Contreras (CS)

OLRI 254

Don't you wish that you could make your profile page on social media platforms fit your aesthetic? Sotion is the new social media platform that makes your page as unique as you are! Dive into the UI design that makes this possible, and see how we implemented it with Python, Flask, and CSS.

## Crystal Graphs for the Symmetric Group

Connor Bass (MATH)

OLRI 256

What is a crystal graph? What is the symmetric group? If these questions sound just as fun to you as they do to me, you've come to the right place! This project explores a seemingly natural intersection of combinatorics and abstract algebra, where we will introduce the Symmetric group, crystal graphs, and the combinatorial objects called "Standard Young tableaux". We will connect all of these ideas by demonstrating an algorithm that allows us to embed these objects into the familiar integer lattice. And of course, plenty of colorful pictures will be included.

## EasyEmployment

Ryan Kinnucan (CS)

OLRI 258

Are you a tired, stressed, overworked college student looking for a job so you can finally feed yourself instead of begging underclassmen for meal swipes? Are you worried you picked a useless major? Are you curious how many Snake Milker jobs there are in San Francisco? Then look no further than EasyEmployment, the job search engine that will help you find your dream job! Come see how we take your search criteria and scour the web, gathering together copious job listings and filtering them based on your specifications before displaying them for you in a list conveniently ranked by relevance to your resume.

## TrackMan: An Educational Game about Cyber Security

Alejandro Aguilar Rodriguez (CS)

OLRI 241

Do you want to learn more about cybersecurity, how cookies work and what websites do with your information? Do you want to browse the Internet without fear of trackers? Come play TrackMan for fun and education!

## Redlining: The Unequal Burden of Hot Summers

Daniel Lim (CS)

OLRI 245

You may experience much hotter summers than usual based on what neighborhood you live in St. Paul, and this isn't just a coincidence. This is the result of the racist housing policies of redlining that separated white and colored neighborhoods. Come explore who lives in these neighborhoods, what it is like living in them, and the consequences that come with it.

### **Bijections Between Subfamilies of Gog and Magog Triangles**

Adam Bass (MATH)

OLRI 254

The Gog and Magog Triangle families (being in bijection with the Totally Symmetric Self-Complementary Plane Partitions and the Alternating Sign Matrices, respectively) are both indexed by the Robbins numbers and yet no known bijection exists between them. We explore the use of Step-Function Summations in an attempt to bridge the gap.

### **The Barcode of a Seizure: Can Topology Differentiate Normal and Abnormal EEGs?**

Christopher Beckwith (MATH)

OLRI 256

An electroencephalogram, or EEG, is a recording of a patient's brain waves that is primarily used to diagnose seizure-related disorders. A previous study has shown evidence that a topological measure called Persistent Entropy tends to be significantly different in normal vs. abnormal EEGs. In this project, I put that to the test by showing how to calculate persistent entropy and plotting the distribution of this value for various types of EEG recordings.

### **That's a Hot GPU: Using Parallelism to Simulate Forest Fires**

Preston Locke (CS)

OLRI 258

Modern GPUs have thousands of cores that can run in parallel to speed up complex computations, like simulating the spread of a fire through a forest with hundreds of thousands of trees. This talk will document one approach to running such a simulation, while explaining the options available to programmers when running code on a GPU. Also look out for a quick tutorial on how to avoid doing the actual work for your capstone project by writing a "debugging" library to output bitmap image files :)

### **Predicting the EA Sports FIFA Team of the Season**

Michael Helton (AMS)

OLRI 241

FIFA, the EA Sports video game, allows players to create and compete with their dream squad of professional athletes from around the world. Each year, EA creates a "Team of the Season" for each major FIFA-partnered league, consisting of the best players from that league. We develop a machine learning model for each of Europe's top five leagues: England's Premier League, Germany's Bundesliga, Spain's La Liga, Italy's Serie A, and France's Ligue 1. Using these models with the players' real stats, we predict who EA Sports will select for their 2020-2021 teams.

### **Red Lines on Green Spaces: How Racist Housing Policies of the Past Affect The Health of St. Paul Residents Today**

Anjali Moorthy (CS)

OLRI 245

The Twin Cities rank among the best in overall quality of life, yet among the very worst in racial disparities in the country. Redlining, a racist housing policy from the 1930s, effectively segregated St. Paul, turning green spaces in predominantly Black neighborhoods into highways, warehouses, and parking lots. Now, 50 years after the practice ended, these neighborhoods show worse air quality and warmer temperatures than their white counterparts; hospitalization rates for asthma and heart disease are higher too. Through data visualizations I will reveal how these outcomes emerged, the health consequences they pose, and why we should all be concerned.

## Texas Hold'em Game Agent

Yuchen Dou (CS)

OLRI 254

Motivated by the widespread popularity of Texas Hold'em, many researchers keep trying to find the optimal algorithm for a game agent of Texas Hold'em. However, as there are millions of possibilities in each turn of a Texas Hold'em game, it is nearly impossible for researchers to predict all of the possibilities and make an ideal algorithm that is as competitive as Alpha Go is. Armed with a python-based platform for Texas hold'em, I apply three algorithms to different game agents and compare the effectiveness of those agents.

## Does your major determine your career?

Lena Underwood (CS)

OLRI 256

Which majors lead to work in a specific industry? Which companies hire discriminatingly from one or two majors, and which hire students across the board? Which majors have the most overlap? These questions and more will be answered through a network analysis of the connections between Macalester students' majors and the companies that hire them. Colorful network visualizations included.

## Virtual Journal: A calming website for evidence-based reflection practices

Leen Diab (CS)

OLRI 258

In this strange post-pandemic world, we can all use more sustainable self care practices to ground us in the present moment and help us make sense of the passage of time. We built Virtual Journal using the latest web technologies for you to enjoy the benefits of bullet journaling from a computer, anywhere, without having to carry around the only physical representation of your past wanderings everywhere you go. This talk will go into the process of building a full stack web application from conception to completion, with an emphasis on front end development.

## Big Data Big Problems: Opportunities for Optimizing RNA Data Sets

Elisabeth Landgren (CS)

OLRI 241

Big data is usually lauded as being a great thing that we can utilize to get maximum insights, but is more data always better? In genetics, researchers often aim to have deeply sequenced genomes and transcriptomes to make sure they get all the information they need. This may seem like the best choice, but collecting more data is expensive, consumes more time and resources, and takes longer to analyze. This presentation will look at deeply sequenced RNA data sets from prostate cancer samples and investigate if less sequencing could yield similar results, providing opportunities for optimization.

## Learn to Speak Dolphin!

Claire Wilson (AMS)

OLRI 245

Did you know that dolphins can use sound to not only detect objects, but also gain information about their size, structure, and material? By studying dolphins' use of echolocation, humans can gain insight into how to better protect dolphins from noise pollution, and also how to improve our own sonar capabilities. So come wade with me into the world of a dolphin! We will listen to dolphin clicks and whistles, examine visual representations of dolphin sounds, and explore Fourier methods used to denoise, isolate and reconstruct dolphin signals. You may even become dolphin fluent!

**An invasive story: Modeling the spiny water flea in MN lakes**

Christina Kiehl (MATH)

OLRI 254

Aquatic invasive species have the potential to decimate ecosystems, with serious implications for biodiversity, clean water, and ecosystem stability. We created a simple model of the populations in a Minnesota lake under invasion by the spiny water flea, a non-native zooplankton, using skills from Math432. While this is an extreme example, it illustrates the potential trophic cascades that the spiny water flea could instigate, and explicitly demonstrates the complexities of ecosystem dynamics in ecological modeling.

**From Speech to Text, Text to Emotion**

Jeongyeob Hong (CS)

OLRI 256

Not everything on the internet is true. Especially when it comes to the Covid-Vaccine, trust me, Twitter goes wild. Let's see whether computer can listen anti-vaccine tweets and figure out why humans go crazy. Are they distrusting a government? Are they worried about side effects? This talk will cover state of the art techniques such as CNN, BERT and Multimodal Learning

**The Shapes of Languages - A Topological Analysis**

Lena Underwood (MATH)

OLRI 258

What would a text look like if each sentence were a point in space and the distance between points were determined by the similarity between sentences? How can we determine the shape of those points altogether? How would that shape change if we plotted the sentences of a translated version of the same text instead? This talk will find and compare the topological shape of six translations of "The Little Prince," as well as explain how topological analysis works.

**Promotion-Relegation: Predicting the Most Cutthroat System in English Football**

Will Orser (AMS)

OLRI 241

Each year, three teams make the jump to the Premier League, widely-regarded as the best league in the world, while three teams drop down into the Championship, the second tier of English football. The financial implications and the pride involved in these moves are enormous. Using survival analysis, I examine how a team's squad value, transfer market expenditure, and style of play impact their ability to stay afloat in the Premier League, with a special interest on newly-promoted teams.

**Discovering NYC Hidden Deserts**

Vichearith Meas (AMS)

OLRI 245

In the middle of the world metropolitan New York City hides an unusual underground desert. My teammates and I set out to unveil the truth about this desert using the power of Bayesian statistics. If you are interested in urban development, public transportation, statistics or simply curious what type of desert we discover, please drop by.

**Twin Cities Airbnb Data Analysis: How to choose a suitable house?**

Yutong Wu (CS)

OLRI 254

As a traveler, the distance between our homes to the destination is considerably further than that of the domestic students. Therefore, finding a place to stay during breaks and vacations could be a problem. Since the expenditure of renting a house in a foreign country could be costly and the contract might require a longer period of time than needed, Airbnb houses become a suitable choice for us. Pick our city as an example, in this project, we conduct an exploratory study on the Twin-cities Airbnb dataset.

**NoteBuddy: Share your class notes with your friends!**

Qingru Zhang (CS)

OLRI 256

We all know that Moodle is a great place to get resources from the professors. However, have you ever tried to use some help from your classmates by looking at their notes? Have you ever tried to help your friends by sharing your great notes with them? Using Notebuddy, my note sharing platform, you can build a better study environment with your own class notes!

**EEG Artifact Removal: Separating Brain Waves from Non-Brain Waves**

Christopher Beckwith (CS)

OLRI 258

An electroencephalogram, or EEG, is a recording of a patient's "brain waves" that is used in hospitals to diagnose various disorders. However, if the patient moves or blinks during a recording, the EEG data becomes contaminated with artifacts that make it more difficult to read. In this project, I explore two blind-source separation techniques that can be used for automatic EEG artifact removal, and train an artificial neural network to recognize eye movement artifacts.

**Will It Ever End? Predicting COVID-19 Case Rate**

Raymond Gu (AMS)

OLRI 241

Omicron has prompted concern among scientists and public health officials because it is more transmissible and less susceptible to existing vaccines. In this talk, we aim to investigate how factors such as state and time can help us predict future outbreaks using a Bayesian approach: Markov chain Monte Carlo simulations. We'll also show how vaccines and new variants play a role in this model.

**Predicting the Severity of Car Accidents from environmental factors**

Franco Salinas Meza (STAT)

OLRI 245

According to the U.S. Department of Transportation's National Highway Traffic Safety Administration, around 20,000 people died in motor vehicle crashes in the first half of 2021. This represents an 18.4% increase relative to the 2020 estimate. This analysis is intended to bring light to the main environmental conditions that are associated with the severity of a car accident such as starting longitude, month, and wind chill. For this study, we defined severity as the accident's impact on traffic. We utilized different methodologies to predict accident severity, including LASSO, random forests, and classification trees.



**“So-tion Sickness!” Social Media & Backend Web Development**

Izzy Valdivia (CS)

OLRI 254

Social media plays a huge role in people’s daily lives, and most people do not know how these applications store and transmit data. How does a website remember and display user data? What is a database? How do you create a login form? Come learn about how \*SICK\* So-tion is, and what the development process involved.

**Network Analysis in European Football Transfer Market**

Yuchen Dou (MATH)

OLRI 256

European football is one of the largest sports industries in the world. In this project, we present data in different networks and analysis with mathematical methods.

**Representation theory in Physicists’ perspectives: Hilbert Space and the spin representations of  $su(2)$**

Alpha Ma (MATH)

OLRI 258

Do you want to learn some cool algebra concepts that can apply to Physics? Do you want to understand how representation theory helps physicists understand angular momentum operators? The connection between Physics and Algebra lies within the representations of  $su(2)$  Lie algebra. Using a method called “Highest Weight Decomposition”, we find out how the Hermitian operators - which represents measurable quantities in Quantum Mechanics, of the  $su(2)$  Lie algebra acts on basis of finite-dimensional Hilbert Spaces. The spin- $j$  representations of  $su(2)$  obtained by HWD gives us a scope of representation theory in Physicists’ perspectives.

**Using Survival Analysis to Compare Common Breast Cancer Treatments**

Leonardo Bucello (AMS)

OLRI 241

Has someone close to you ever been diagnosed with breast cancer? Have you ever wondered what the best method of treatment might be for them? Just under 300,000 new cases of breast cancer are discovered each year in the United States alone, and 1 in 8 women will develop breast cancer over the course of their lifetime. In this presentation, we will use various Survival Analysis techniques to explore the efficacy of three treatment methods in an attempt to determine if there is a method that is the most effective.

**Packing Triangles: Using Logic Games to Approach Combinatorial Questions**

Paige Robertson (MATH)

OLRI 245

Counting isn’t always as easy as it sounds. However, using games to contextualize counting problems can make questions more accessible and easy to visualize. For example, while following a specific rule set, how many boxes can fit in a triangular grid? How many ways are there to accomplish that task? Is the pattern predictable? And if so, what is the pattern? These are all questions I will seek to answer as we explore in this triangle packing game.

### **Algorithm of Characterization of Rectifiable Measures that are Carried by Lipschitz Graphs on Discrete Space**

**Yutong Wu** (AMS)

OLRI 254

One direction for further study Analysts' Traveling Salesman Problem is to find a characterization of measures carried by Lipschitz graphs. Additionally, people define "measure" as a tool to express our perception of the world. Mathematically, measure is the tool that assigns sizes of different kinds of sets. Latest results provide a characterization of measures carried by Lipschitz graphs that are more discrete in nature. In this project, we generate the algorithm and program it utilizing its discrete nature and test it through different samples of figures containing singles and sets of Lipschitz and non-Lipschitz graphs.

### **Image Inpainting: Removing unwanted objects from an image**

**Qingru Zhang** (MATH)

OLRI 256

You travelled to a beautiful park with your friends and took a great selfie of yourselves. However, there was a passer-by showing up in the background. Isn't it kinda annoying? With image inpainting algorithms, you can remove the passer-by from the image while keeping everything else reasonable. Come to learn how image inpainting helps us remove unwanted objects from an image!

### **Inequalities in Functional Analysis: A Mathematical Journey of Norms, X-Rays, and the Proof that Refused to be Generalized**

**Arthur DressenWall** (MATH)

OLRI 258

In this talk, I will describe my endeavors in studying a question that has challenged analysts for decades: "What function maximizes the ratio between the norm of its X-ray transform and its own norm?" Along the way, we will probe into the very nature of functions as we learn how to measure their size and take X-rays of them, while also giving a narrative account of the work that mathematicians actually do: the gradual unraveling of open problems, the exciting highs and illuminating lows of research, and what happens when a powerful proof decides to be just a bit stubborn.

### **Speechless? How Computers Recognize Human Speech**

**Raymond Gu** (CS)

OLRI 241

"Hey Siri. What's the weather like today?" This might sound familiar to us. But have you ever wondered how machines process audio and turn the audio signal into actual words? In this talk, we'll go through a simple and interactive speech recognition program that uses a one dimensional convolutional neural network model to recognize 30 short words.

### **Hey AI, What type of car is that?**

**Vichearith Meas** (CS)

OLRI 245

Even for car enthusiasts, it is sometimes simply hard to tell what type a car is just from looking. Is it a coupe, a sedan, or hatchback? Can an AI do better than us, humans, in classifying cars? In this presentation, I will be talking about my project in training a convolutional neural network to tell the difference between car body types.

**movJdej: A Hmong Recipe Website Because AllRecipes Excludes Us In "All"**

Shouayee Vue (CS)

OLRI 254

To call a website "All Recipes", yet ignore ethnic cuisines from very American citizens, exemplifies the lacking scope and focus of technology solutions for diverse groups. Try typing in my ethnic group, "Hmong", into their search bar and see for yourself what the results are. Join me with my Senior Capstone, movJdej, a Hmong recipe website. Although it is a common solution, it is unique as a Hmong-made solution with support from the local community for Hmong users. At the very least, it also doesn't hold a pretentious name.

**I Heard You: Speech Recognition Using AI**

Howard Cai (CS)

OLRI 256

Have you ever wondered how Siri converts your speech into words accurately and quickly? Or in general how does a computer make sense of human language? This talk will go through how we built a simple and interactive speech recognition program using Convolutional Neural Network that can recognize 30 short words.

**How to steal data without getting caught**

Aron Smith-Donovan (CS)

OLRI 258

What if you could hide a message so that nobody can tell it exists at all? Then you'd be able to smuggle digital information for malicious purposes, posing a major security risk often called data exfiltration. For my project, I investigate the possibility of such an exploit in a time synchronization protocol called PTP. Research questions include: how can PTP hide a payload? how hard would this be to detect? and, what are the potential consequences of my findings? This talk will discuss network security, vulnerability testing, and steganography.

**Simulating a Predator-Prey Environment with Artificial Life**

Henry Basu (CS)

OLRI 241

Can an organisms' behavior be encoded in a 16-digit string? This project uses Artificial Life, an emerging field of AI, to simulate organisms and natural selection. In it, agents have attributes and behaviors determined by a 16-digit string. The agents compete to survive and pass on their beneficial traits while contending with obstacles like hunger and disease. Eventually a dominant species emerges as the best adapted to the environment.

**NFL Win Probability Predictor**

Ty Bruckner (AMS)

OLRI 245

What were the chances that the Bengals came back to beat the Chiefs after being down 11 at halftime? Our project looks at how changes in scores at the end of each quarter affect the chance of winning a game in the NFL. We used Bayesian statistical methods to recreate a version of the ESPN in-game probability predictor graphs. This interactive tool allows you to track the progress of your favorite team's chances of winning in real-time throughout the game.

**AirCanvas: Making Art with Movement**

Daniel Chechelnitsky (CS)

OLRI 254

Wanna make art happen simply waving your hands in the air? Look no further than the AirCanvas, which uses your hand motions to plop ink onto a virtual canvas with the help of convolutional neural networks and user client interaction.

**What \$VENMO\$ reveals about you**

Kyaw Za Zaw (CS)

OLRI 256

Venmo is a crucial element of college life and we utilize it for splitting restaurant bills and paying rent. Social technologies are an accessible and convenient part of our lives and are installed on almost all of our smartphones. However, the utilization of these ubiquitous technologies may bring unintended privacy concerns and consequences of having too much information on you broadcasted to the wider world. In this talk, we will discuss what we can learn about you using public information from Venmo and highlight why and how you might want to keep it personal.

**A shiny app for health insurance coverage**

Jiashu Liu (AMS)

OLRI 258

Data visualization helps to tell stories by curating data into a form easier to understand, and highlighting the trends and outliers. In my Advanced Data Science in R class, I created a shiny app to visualize various factors that might be correlated with the proportion of uninsured individuals, and the potential impact of lacking health insurance coverage on people's health condition. The project can be separated into two parts: data visualization and regression analysis. Our audience can directly manipulate the graphs and regressions based on their interests.

**ADAPT OR DIE: How generational changes to an organism's genetic string alters their chances of living in a simulated environment.**

Jonathan Neve (CS)

OLRI 241

Have you ever wondered how a creature changes based on the environment it lives in? Wonder no more, as we explore the genetic mutations that can drive a species to extinction or expansion. Watch as organisms run around in changing and differing environments, all with the same goal: survival. Will the prey find shelter amongst the trees? Will the predators find the prey that is marooned in the middle of an ocean? How can a deadly virus rampage through a once dominating population? All of these questions will be answered, and all you have to do is show up.

**Risk & Protective Factors for Serious Mental Illness among People Receiving Public Mental Health Services**

Kaden Maloney Bieger (MATH)

OLRI 245

What are the demographics of those receiving public mental health services? Among them, what factors predict decreased chance of having serious mental illness? Answers to these questions could point to important places for public health intervention. Using data from the New York office of mental health, we used Bayesian statistical methods to evaluate these questions, and found some unexpected results.

**AI: Colorizing black and white images with one click**

**Nathan Ngo** (CS)

OLRI 254

We all have black and white images of our grandparents and relatives. To bring these photos to life, adding colors manually using Photoshop could take months. Can an AI colorize these images with just one click (and a lot of learning)? Come and find out how I train and test the AI models for this specific task and how they differ from normal classification AI.

**What's for Dinner? Investigating Food Insecurity in Minnesota**

**Vaja Kldiashvili** (CS)

OLRI 256

1 in 13 people and 1 in 9 children face hunger in the US - with millions of people living in food deserts. These are locations in urban areas where there is low access to quality food. Unfortunately, food insecurity is not unfamiliar to communities we live in - did you know that 44% of Minnesotans live more than a mile away from the nearest grocery store? I will be using interactive visualizations to show which counties in Minnesota have limited access to food and who is most likely to be suffering from food insecurity issues.

**Virtual Journal: The bits and pieces of self-organization in one place**

**Katherine Liberko** (CS)

OLRI 258

Creating an app for organization. In today's world, people use bullet journals to help organize and prioritize life tasks, as well as their thoughts and feelings. We wanted to virtualize this process to cater to our busy and scrambled lives. Our creation of Virtual Journal aims to provide an easy platform for logging daily moods, tracking habits, writing journal entries, and keeping a thorough to-do list all in the same place!

**The Dollar can talk, but can we listen? An engineer's guide to financial trading**

**Heeth Surana** (AMS)

OLRI 241

Do engineering textbooks hold the secret to the mysteries of the financial market? Are electrical engineers the next superstar wall street traders? Welcome to a bizarre world of audio processing, where a set of Harmen Kardons may just teach you the secret to financial trading success. Digital signal processing techniques can allow us to reduce random looking spikes on a price chart into more intuitive cyclic patterns. Join me to see how we can put this into action when trading US Dollars against the Euro.