



* Designates a primarily student-authored paper

Technical Session 1- 4/1 1:00-2:15PM

Pedagogy

- **Comparison of Students' Learning and Engagement on an Online Course Before and After the Spread of COVID-19 Measured Through Emails Using Machine Learning and Deep Learning Algorithms**
 - Muhammad Abusaqer and Kenneth Magel
 - *Emails provide valuable information about students' learning and engagement in course activities. The contents of these emails can be examined using machine learning and deep learning algorithms. This research investigates students' learning and engagement before and after the spread of COVID-19. The data is collected from students' emails sent to the course instructor in an introductory computer course at a medium-sized US University in spring 2020. The course was already online, so it was interesting to see the impact of COVID-19. Therefore, we measured the sentiment of emails sent to the instructor using the BERT Neural Network and presented how sentiment has changed over time to compare it before and after the spread of COVID-19. Furthermore, we analyzed the emails using the Hugging Face Transformers deep learning algorithm to detect discussed subjects and frequently asked questions. Also, we provided exploratory data analysis numbers of emails sent before and after COVID-19. The contribution of this study is that it is the first to compare students' learning needs on an online course before and after the spread of COVID-19.*
- **Introducing programming literacy in a First-Year Seminar: An Experience Report**
 - Golam Mushih Tanimul Ahsan and Asm Iftekhar Anam
 - *First-Year Seminar (FYS) is recognized to be a High-Impact Practice (HIPs) since research demonstrated that it has positive outcomes on retention, persistence, and graduation rates (Kinzie, 2012). Hence, UW System has set a benchmark for all students to participate in two HIPs before graduating. First-Year Seminar is the first class of the two; the other is a Senior Capstone. There are different models of First-Year seminars. Of those, a 3-credit content-based course is what the University of Wisconsin at Green Bay (UWGB) chose to implement.*

There are three learning outcomes of the FYS. The first one is information literacy which focuses on identifying and using appropriate information sources. We partnered with a librarian to educate the students about formulating and executing search queries to collect pertinent information, analyzing the search results, and adopting relevant sources for different tasks. Interdisciplinarity is the second outcome where we integrated various topics of computing technology with varying perspectives of application. The last goal is communication. Through small-group discussions, reflections, and presentations, students have opportunities to develop their oral and written communication skills.

In this report, we share our experience of developing such a course where the focus of the content was the basics of computing. Starting college is an overwhelming experience for first-year students. Adding computer programming to the mix does not make it any easier. Over three semesters, we changed the modes of instruction due to the pandemic. The methodology for teaching also evolved based on student performance, reflections, and feedback. We introduced a high-level, general-purpose programming language (Python) in the first offering. In successive semesters, we used a block-based programming language before diving into a text-based programming language. We share how including the block-based programming language was helpful for the students to move to a high-level, general-purpose language. Based on the feedback, we also propose incorporating programmable robots to enhance in-class peer learning and engagement. Finally, we suggest assessment techniques gain more quantitative measures of student learning and engagement.

- **Literature Review of Assessment of High Impact Practices in General Education Courses Using Text Mining and Natural Language Processing***

- Shubham Chavan, Shlok Katare, Siddhesh Sutar and Vijayalakshmi Ramasamy
- *The teaching and learning process is quickly shifting to an online environment due to the impact that the Covid-19 pandemic has created on the education field. This transformation feeds its own unique set of challenges due to the high volume of students and the necessity to provide equal attention to each one of them. Kuh et al. introduced ten high-impact educational practices (HIP) in 2008 to bridge the gap between learning engagement and student success. The following are the ten components of undergraduate education: Learning communities (LC), writing-intensive courses, collaborative assignments & projects, undergraduate research, diversity & global learning, service-learning & community-based learning, internships, capstone courses & projects, first-year seminars & experiences., and common intellectual practices.*

Since they were identified, HIPs have been considered the chief strategies to increase student engagement, retention, performance, and completion rates in higher education institutions. Including a blend of these HIPs in a course makes it an effective General Education (Gen Ed) course since students from all majors can pursue it at the introductory level due to its general course structure. Gen Ed courses are essential to support a student's advanced lifelong learning since they can introduce students to many new ideas in a way that they can connect the different concepts that they learn. Gen ed courses help build a baseline knowledge and impart critical thinking skills.

Accommodating and providing equal representation to students from diverse ethnic, socio-economic, cultural backgrounds is key to their knowledge grasping and academic growth. Strategies to translate HIPs to online teaching mode, the possible challenges of implementing them, the impact of HIPs on learning amongst students of different backgrounds, and ways to overcome them have been well researched in the past. Similarly, other researchers studied different teaching approaches, including HIPs, one of the core pillars of IT education.

The current process of determining the High Impact Practices (HIP) components available in an undergraduate course to qualify for a general education course is manual and time-consuming. This research work attempts to automate the process based using Text Mining and Natural Language Processing to aid decision making and improve time efficiency. We first performed an extensive literature review to investigate the current status of HIPs and text mining along with Natural Language Processing (NLP). NLP is a core component of performing text mining operations on any text document. It allows us to convert the unstructured text data into a cohesive, structured format, which can then be

used to make sense of the text. This structured data helps perform other operations such as similarity analysis, topic modeling, and machine learning. Using the research work as a stepping stone and iterating on that, we propose a novel solution of automating the process of classifying an undergraduate course as a Gen Ed or Non-Gen Ed course using Machine Learning and NLP.

Emerging Technology

- **An Introduction to Blockchain Development***

- Joseph Weller
- *In today's interconnected world, there are few topics in computer science as far reaching and rapidly unfolding as the use of blockchain. However, as of recently, the public perception of this technology has been less than positive. From the ridiculousness of NFT digital art marketplaces to the detrimental effects of mining bitcoin, discussing the topic of blockchain has almost become taboo. With my experience in creating an undergraduate blockchain development curriculum at my university, as well as assisting a Fortune 500 company in researching blockchain integration, I will outline the value of using blockchain technology in modern software development. Through this discussion, one will gain an understanding of the importance of blockchain as a tool in every future developer's toolbox.*

I will begin by briefly providing a high-level overview of what blockchains are, how they work, and the advantages they provide to developers. I will then narrow into how developers can write smart contracts, which are code files that are capable of being deployed to and executed on blockchains. To demonstrate smart contracts, I will examine one that I created and deployed on a local instance of the Ethereum blockchain. Next, I will discuss the opportunities that blockchain opens up for entrepreneurially minded engineers, and how they can take advantage of these opportunities. I will end by reviewing the long-term trajectory of blockchain development, as well as its current use cases and applications, both in private and public sector. I will discuss both the effectiveness of ideas that have already been created and also examine ideas that are yet to be implemented. Going forward, the need for developers to traverse the unexplored idea space surrounding blockchain is crucial to solving the world's future uncharted problems.

- **Music Generation Using an LSTM***

- Kevin Adams, Michael Conner, Lucas Gral, David Hunger, Reagan Strelow and Alexander Neuwirth
- *Recent breakthroughs in deep learning have opened new frontiers in creative generative sequence modeling, particularly in natural language. These advancements have inspired renewed interest in other sequence-understanding applications, such as music generation. Music generation is a notoriously complex task, often requiring natural talent and years of compiled domain knowledge. A great composer generates music manually by applying music theory and well-studied musical techniques. Composing and learning these elements requires significant investment of practice and time. Algorithmic music generation promises to bring the ability to create music to a wider audience.*

Despite the many successes of deep learning in this domain, architecture design remains nontrivial, and many implementation details remain poorly understood. Issues of overfitting, structure, and ambiguity in how to most effectively model complex data features such as chords, slurs, and other complex musical features are prevalent. In this work, we propose a method of music generation using Recurrent Neural Networks (RNN). More specifically, a Long Short-Term Memory (LSTM) network. We provide a brief overview of the intuition and theory behind LSTMs and their application in music sequence modeling. We also describe how we adapted our music data format into a compatible shape for this structure.

The proposed techniques are based on a simple open-source model that generates quarter notes within a single octave. Using this open-source model as a starting point, we designed, executed, and documented experiments to incrementally improve our model results. We expand the problem space by exploring the addition of musical features including note durations and variable offsets in note start times. We trained the neural network on MIDI data of primarily single-track audio with consistent musical style. Our contributions include a comprehensive overview of how the network synthesizes MIDI data from existing music to compose novel MIDI sequences. We also describe the benefits and drawbacks of how we structured our network and training data, and we show the qualitative impact on the model output caused by these design choices. Finally, we explore what improvements could be made to our network in the future.

- **Applications of Block-Chain Technologies to Enhance the Security of Intrusion Detection/ Prevention Systems: A Review**

- Anna Ndri, Divya Bellamkonda and Akalanka Mailewa
- *Intrusions in the computing networking world have been a highly common unwanted malicious activity from the beginning of computing networks. For the past decade, variety of security measures have been implemented, but as technology has advanced, so have the security threats. With the entire world relying on computers, whether directly or indirectly, preventing unwanted activities and threats that can disrupt computing infrastructures is a critical concern. Intrusion Detection Systems (IDS) and Intrusion Prevention Systems (IPS) are common security techniques used to protect computing resources, which are mostly found in a network. As the threat of cyber-attacks increases, new security techniques are required. Blockchain has the potential to be used in the intrusion detection and prevention area since it can guarantee data integrity and maintain process transparency. This survey paper is presenting a review of the intersection between IDSs and IPSs and blockchains. We will discuss the history of intrusion detection and prevention and blockchain, describe how blockchain technologies might be applied into IDS and IPS, and identify open challenges in this area.*

Cyber-attacks have become increasingly more complex and sophisticated in recent years. With the digital revolution and the introduction of the Internet of Things, networks have become more difficult to protect and Intrusion Detection Systems and Intrusion Prevention Systems are widely used technologies to protect networks. Intrusion detection systems (IDS) and Intrusion prevention systems (IPS) are technologies that are used to strengthen the security of complex networks by capturing and monitoring activity. While IDS analyzes and monitors network traffic for signals that will indicate that there is a threat that is attempting to infiltrate the network, IPS will examine network traffic and proactively prevent vulnerability exploits. These detection systems have demonstrated their ability to safeguard the networks in which they are deployed from cyber threats. However, as the quantity and complexity of intrusions increase, a single or isolated IDS/IPS becomes ineffective in many cases, allowing advanced attacks to bypass it. Without prompt detection of cyber-attacks, the entire network is exposed to a variety of harms, including network paralysis. Cyber-attacks persist despite technological advancements, necessitating constant monitoring through the development of existing IDS/IPS systems and the introduction of new ways. Blockchain technology has gained popularity in recent years since it attracted a lot of attention from both academia and industry. A blockchain can be conceived of as a continuous series of records known as blocks that use a cryptographic hash to link each block. A peer-to-peer network typically manages blockchains, which provide transparent and integrity-protected data storage. Motivated by the versatility of blockchains technology, this paper intends to address the prospect of combining blockchain technology with intrusion detection and intrusion preventions systems.

Blockchains have been researched in a variety of fields, including healthcare and supply chain management, but there has been minimal research into their possible applicability in intrusion detection and intrusion prevention systems. Our research is primarily motivated by this fact, and it focuses on the use of blockchain technologies to address the issues of data sharing and trust computation in a collaborative detection context. On the one hand, as previously noted, blockchain technology can be used to improve the performance of an IDS/IPS, especially with collaborative IDS (CIDS), in terms of data transfer and trust computation. Intrusion detection, on the other hand, can assist in the discovery of anomalies during blockchain transactions. We also discovered that while blockchains have the potential to improve an IDS/IPS, not all IDS/IPS concerns could be solved with this technology.

In the first part of the paper, we will discuss the types and the uses of IDs and IPSs. Then we will introduce the concept of Blockchain technology and collaborative IDS/IPS. Next, we discuss the application of Blockchain technologies to Intrusion detection and intrusion prevention. Finally, we are going to examine open issues, challenges, and potential directions.

Job Preparation Panel

- **Discussion of trends in the software development industry, how to prepare for a career, as well as a Q & A**
 - Wade Krogwold- Campus Recruiting Manager, Direct Supply
 - Laura Schmidt- Chief Talent Development Officer, Milwaukee Tech Hub
 - Matt Wudy- VP IT Project Management, Kohl's
 - Austin Tadman- Software Engineer, Digi-Key Electronics

Technical Session 2- 4/1 4:00-4:50PM

Embedded Computing

- **A Low-Cost, Arduino-Based Platform for Emulating Energy Harvesting in Wireless Sensor Networks***

- Braden Miller, Ahmed Ammar and Heath LeBlanc

This work-in-progress paper describes an Arduino-based platform for emulating energy harvesting in Wireless Sensor Networks (WSNs), as a form of hardware-in-the-loop simulation. The platform utilizes a battery monitoring circuit and code implemented on the Arduino, as an alternative to using significantly more expensive, fully-equipped energy harvesting nodes. Using embedded code to emulate the energy harvesting process allows for various energy harvesting models and processes to be tested using the same platform.

Energy-lean WSN algorithms operating on energy harvesting nodes monitor the state of the battery in order to selectively transmit data only when the battery charge is adequate, and make use of sleep/wake cycles. Thus, it is important to determine the energy use characteristics of the embedded platform and implement a battery monitoring circuit for real-time monitoring of the battery state. The battery monitoring design will be fully described in the paper.

The network scenario under consideration for this work involves a shared-medium channel using a Time Division Multiple Access (TDMA) schedule, in a three-node relay network. The nodes are synchronized to the base station's clock using a logical clock approach. The implemented TDMA schedule is separated into two phases and two time slots. Two time slots make up each phase, and the initial time slot length has been selected to give ample time for each node to wake up, transmit or receive, and perform arithmetic calculations. Based on the transmission experiments that will be described in the full paper, the minimal time slot length has been determined to be 380ms. Determining the optimal time slot length from an energy consumption standpoint is ongoing work.

The energy use characterization involves nodes with an Elegoo Arduino Uno and a xBee S2C RF module. The energy use experiments involve measurements taken from the battery monitoring circuitry, which determine voltage, average current draw, and average energy consumption, across 50 phases, or 1000 seconds. The baseline values used to validate the operation of the battery monitoring circuit are obtained using an oscilloscope. These experiments and complete results will be described in the full paper. Some of the most pertinent results have validated the data sheets, showing a current draw of 45-50mA by the Arduino and 31mA by the xBee module, while not in low-power mode (overall average current draw in the range of 76-81mA). In the low power mode, the Arduino disables the ADC and IO ports while powered down and the xBee draws less than 1 μ A (overall average current draw down to 31mA). The energy consumption of the platform using the sleep/wake cycles, across 50 phases, is 5.59J. The energy consumption of each transmission is 2mJ, which is negligible compared to the energy used to idle the node.

The next steps in this work are to apply the energy harvesting emulation approach to test existing scheduling algorithms for a three-node network with Monte Carlo simulations of that scenario using the same scheduling algorithms. The primary metric will be Packet Delivery Ratio (PDR), the most common performance metric used for evaluating the WSN algorithm performance.

- **Remote-Controlled Electric Basic Utility Vehicle***

- Cesar Campos-Martinez, Adeel Sultan and Warren Vaz
- *University of Wisconsin-Oshkosh undergraduate students at the Fox Cities campus designed and built a radio control (RC) system, which allowed for remote operation of an electric basic utility vehicle (BUV) from a distance of up to 1 km. Students previously built the BUV as a research and teaching testbed. The vehicle was modeled after an all terrain golf cart, seating two passengers and having about 16 sq. ft. of pick-up bed space. It can be charged via a wall outlet and using solar panels on board. A brief summary of the vehicle design is provided, as well as some background on the motivation for carrying out the project at the Fox Cities campus. The mechanical and electrical hardware systems, and their design constraints are also explained. The RC system designed for the vehicle uses a 2.4 GHz transmitter and several stepper motors to actuate throttle, brake, and steering controls. The Arduino platform was used to receive signals from the RC transmitter and convert them into signals to specify stepper motor position. A special emphasis is placed on the development of this software, which was written in a variant of C/C++. Challenges involved minimizing signal write times in the program loop to maximize stepper motor torque output. The RC system hardware is a prerequisite to autonomous vehicle control, plans for which are discussed in the conclusion. Potential applications of the current iteration of the BUV include operation in hazardous environments, where a human driver would not be feasible, and operation by disabled persons, where people with limited physical ability can operate a vehicle or have a remote operator operate it for them. High level autonomous navigation capabilities could also be achieved with the addition of a visual input system, along with simple waypoint pathfinding, allowing for rover-like exploratory applications.*

Nifty Assignments

- **Nifty Assignment: Where is it? Exercises Locating Items in a File System**

- Erik Steinmetz
- *The target audience for this Nifty Assignment is student in the first year of programming courses - CS0 or CS1.*

Many students with little and even moderate experience using laptops or desktop computers have in recent years demonstrated a lack of knowledge about one of the most basic bookkeeping activities of a computer: storing and retrieving files of data. With the rise of smartphone and tablet operating systems which actively hide the file system from the user along with increased use of document storage in cloud systems such as Google Docs and its powerful search-to-find-it functionality, it is possible to extensively use a computer without ever needing to see or conceptualize the organization of data storage: the hierarchical file system.

This is not a healthy situation for programmers and computer science students who must know and use the file system in order to track their source files, keep them organized and up-to-date, and execute them. Simply searching for 'program_one.py', for example, often yields many results, and students often don't know 'where' the file is and so have no idea how to run code outside of the IDE that it was written in. Even when using an IDE students often find themselves puzzled when changing their code does not change the performance of the program: the IDE's editor is open to one file, but the big green 'run' button is invoking a different (perhaps original) version of the file. Lacking experience with the file system means that these students are unable to realize that this two-copies-of-the-source file problem is occurring. Another error that occurs is electronically submitting the incorrect document because the correct one can't be found.

This nifty assignment is meant to introduce students to the basic principles of a hierarchical file system, including

- * the typical way operating systems organize files,*
- * the path, including absolute and relative paths*
- * the GUI and command line views of a file system*
- * how the GUI views on Windows, macOS, and various flavors of Linux can obfuscate the locations of files*
- * how the file extension is used by the operating system*

Activities will include:

- * *drawing a hierarchical file system with the typical CS tree diagram*
- * *finding files and then locating them on the tree diagram*
- * *creating, moving, and deleting files*
- * *showing and modifying the (often hidden) file extension of files*

The goal of this assignment is give students a risk-free experience of using the file system on their computer so they can retain a usable mental model of 'where' the documents they create are located, and feel confident (not mystified) about writing and modifying source code files.

- **Nifty Assignment - An Adaptable Framework for Developing Students Written and Oral Communication Skills**

- Benjamin Fine
- *Written and oral communication of technical material to a general audience is a critical skill for Computer Science students to develop. Unfortunately, these skills are easily put aside as it is already challenging to fit in the technical content in a semester-long course without overburdening our students. To this end I have developed and refined an assignment framework over the past seven years, named the Compendium, that explicitly addresses these skills. The novelty here is not the basic assignment but in the lessons learned from adapting this assignment structure to all of the Computer Sciences courses that I have taught, including introductory courses, ethics courses, foundational courses (e.g., Algorithms, Software Engineering), and upper-level elective courses (e.g., Mobile Robotics, Artificial Intelligence).*

This assignment is in two simple parts; a written and an oral portion. While this is simple and unsurprising on the surface, this submission will discuss the nuances and variations to this basic framework that has been developed over 56 sections of 11 distinct Computer Science courses. This submission will cover how this framework can be easily applied to any course in the curriculum. It will support and discuss how this assignment assists students in developing these critical communication skills without distracting from the rigorous technical content delivered in any given course. Additionally, this work will support this assignment framework by connecting the skills students need to do well on the compendium and the skills needed to be competent software engineers and computer scientists.

Along with the discussion of the assignment and how it enhances the technical studies of the students as well as their communication skills, this submission will supply ample examples and adaptations of the compendium framework for all of the classes that this has been applied to: Introduction to Computer Science, Data Structures, Assembly Language Programming, Computers and Society, UNIX Programming, Object-Oriented Programming, Algorithms, Artificial Intelligence, Mobile Development, Mobile Robotics, and Software Engineering. The discussion of this assignment will also highlight the benefits of integrating this across the curriculum to, surprisingly, reduce the overall workload of both the faculty and the student.

Technical Session 3- 4/2 9:00-10:40AM

K12 Topics

- **Internet of Strings: Introducing Routing Concepts to Kids**

- Kyle Cronin, Michael Ham and Tom Halverson
 - *Introducing the concept of networking to students can be a challenging task. The costs associated with hardware, the interest level of students, and the ability to have age-appropriate engagement with the students can turn them off from a topic before they gain a core understanding of the materials. To alleviate these issues, we created: The Internet of Strings. In essence, we're able to teach the core concepts of how routers on the internet function while including: an introduction to Dijkstra's algorithm, experiencing key issues that exist on the internet (malformed packets, links that have gone offline, misconfigured routers), through a kinesthetic activity keeping the students on their feet with costs reduced to some strings and tubes.*
- The activity involves laying out a classroom with 12 stations, or routers. The routers are represented by pieces of paper with the number printed on them. As we see on the internet, each "router" is connected directly to other routers, forming a grid where all routers have interconnected partners. In the case of our activity, the connections are less complex than real world; we simply use twine and some tape. The map of this grid is available to the students, much like the global map of anonymous systems may be derived via the Border Gateway Protocol.*

To conduct the activity, students are then given a film canister with a destination number. This canister becomes their “packet”. The students, acting as routers, must then determine the most efficient path for their packet to make it to the destination, and deliver the packet to the next router on the link. Once the packet makes it to the destination, opening the canister reveals that “data” (in the form of some candy or a written message) has been encapsulated within the packet.

Much like the real-world internet, the Internet of Strings may be ripe with complications. Fiber optic links are cut every day causing links to go down; so can a string! Certain routers may be misconfigured, sending packets in the wrong direction; so can students! Some routers may become overwhelmed, unable to handle all of their traffic; so can our string routers.

The Internet of Strings has shown to be an activity that can be used to teach basic understanding of internet routing to introductory students without having to go through the expense or rote memorization typically undertaken to introduce the topic in a hands-on environment. The activity fits great with introductory students, non-technical learners, and makes a great outreach activity for K12 environments.

- **Applying Grading For Equity: An Experience Report**

- J. Philip East, Andrew Berns and J. Ben Schafer
- *Grading For Equity* posits that traditional grading processes are inaccurate, biased, and demotivating. Since encountering the book in 2019, we have been working to adapt our teaching to incorporate the tenets of *Grading For Equity* (GFE). The proposed paper will describe GFE and discuss our interpretation of its recommendations, describe how we have applied them in courses for computer science majors and for existing and prospective K12 teachers, and offer suggestions for those who might wish to try GFE. This abstract/proposal attempts to provide insight into the organization and content of the proposed paper.

Sources of inaccuracy suggested by Feldman seems to arise primarily from three sources. Traditional grading usually only considers what a student did on the initial assignment, quiz, or exam rather than what a student might know later in the course after additional work and learning. Use of percentage scoring and 90/80/70/60 percent grading scales can be inconsistent and substantially overemphasize failing grades (40 ways to pass, 60 ways to fail). Finally, averaging various grading elements can result in two students with the same scores but very different content understanding or the same scores earning different grades in different courses or semesters.

Unintended bias occurs in traditional grading occurs mostly through the grading of behavior instead of capability with respect to desired student outcomes. We grade behavior when we include attendance and participation, late penalties, cheating penalties, etc. in grades.

Traditional grading is motivational only for rote learning and for the more successful students, and is of limited duration. Otherwise, traditional grading discourages students as students know it measures actual learning in very limited ways. GFE has been shown to be more motivational and to aid the development of growth mindsets.

The paper will more fully describe GFE.

We worked with some GFE ideas prior to encountering Feldman in 2019 and beginning to more formally incorporate it into all our teaching. Dr. Schafer is applying GFE processes in all his CSEd courses:

- *Foundational Concepts of Computing*
- *Fundamentals of Programming*
- *Teaching and Learning Programming*
- *Data Structures and Algorithms*
- *Methods of Teaching Computer Science*

Dr. Berns has been using GFE to guide his work in his CS courses:

- *Theory of Computation*

- *Software Engineering*
- *Software Verification and Validation*

The paper will discuss efforts in this variety of courses to illustrate use of GFE.

We will close the paper with a discussion of how we think others might begin applying GFE in their instruction.

- **Developing a CS Teacher Prep Program**

- *J. Philip East and J. Ben Schafer*
- *The proposed paper will describe the effort at the University of Northern Iowa to develop and deliver a program leading an endorsement on K12 teacher certification. We will discuss the need for such teacher preparation; describe the context of teacher certification in Iowa; discuss our background and development goals, process, and resulting program; and provide suggestions for others who might wish to develop such programs. The rest of this abstract provides brief overviews of those topics.*

Computing has been taught in K12 schools since at least the 1970's but initial efforts did not require teacher certification and later efforts focused on computer literacy. Recently, there has been a substantial uptick in calls to include computer science in K12 schools with states often requiring its offering. However, few teachers have the necessary background to independently teach computer science, but many computer science departments are attempting to provide it.

Teacher certification rules are set by Departments of Education in individual states. Typically, certification is for one or more school “levels”— elementary, middle, and secondary— and at least one subject matter area of “endorsement”. Instructional responsibility is owned by or shared between education departments/schools and subject matter disciplines (e.g., math, language arts, science, etc.). State rules (as in the case of Iowa) often follow recommendations of professional organization such as CSTA (Computer Science Teachers Association) and NCTM (National Council of Teachers of Mathematics).

The teacher endorsement program at the University of Northern Iowa consists of five courses that were developed in light of recommendations concerning K12 computer science content and K12 teacher qualifications. The courses are:

- *Foundational Concepts of Computing*
- *Fundamentals of Programming*
- *Teaching and Learning Programming*
- *Data Structures and Algorithms*
- *Methods of Teaching Computer Science*

They have now been offered multiple times to both in-service (already teaching) and pre-service (prospective) teachers. We will describe the courses and course and program goals and have a variety of experiences to share.

We both were initially trained as middle/secondary teachers before our PhD work in computer science and computer science education. That background in both education and computer science enhanced the development and offering of our CS teacher-prep. We will share our experiences and offer suggestions we think important for others. They will relate to development process, course/program content, instructional strategy, and student and program assessment.

Security

- **Learning by Teaching: Creating an Educational Video on the “Muddiest” Topic**

- Saeed Al-Haj
- *Teaching is a challenging task; it requires delivering course concepts in a simple and easy way that students can understand. Since not all students are alike, instructors use several teaching methods and pedagogies to deliver their classes to make sure that students from different backgrounds and levels can learn the concepts being taught, and to keep students engaged in the learning process. In some cases, there is a blind teaching spot when instructors believe that material is clear while it is not.*

This paper discusses a case study in which students in advanced data structures and algorithms course, were assigned a group project to create an educational video. Students are required to select a topic that is confusing or unclear from their own perspective, i.e. one of the “muddiest” topics covered in the course. The objectives of this project are: 1) improving students’ understanding of these muddy topics; 2) increasing the motivation to learn; 3) enhancing teamwork and communication skills; and 4) identifying blind teaching spots. By working on their video projects, students have the opportunity to improve presentation and communication skills, teamwork and creativity.

The results show that playing the instructor role can lead to increased motivation to learn, since students will make a greater effort to learn for teaching others, than they do for themselves. Another notable benefit of this project, is when students learn the material with the teaching intention in mind, perform better when tested on that material than those who learn the material for themselves.

- **Security & Privacy Comparison of NextCloud vs Dropbox: A Survey***

- Ayodeji Olaosebikan and Akalanka Mailewa
- *In recent years cloud computing has moved from an idea phase to a necessity in the business and personal use world, it has gone from being a theory to being an easily accessible need for organizations and individuals. A few years ago, having a storage infrastructure was an expensive idea that had to come with the buying, storage, securing, and maintenance of the equipment used to develop the infrastructure. Cloud computing came with a lot of benefits such as cost-benefit, could be configured, accessed anywhere, being a reliable service, it also brought some negative aspects too which were centered on security and privacy concern. Cloud computing has brought about different types of cloud delivery services such as SaaS, PaaS. In this paper, we are going to focus on two cloud services NextCloud which is a private open-source cloud provider with an end-to-end solution Dropbox which is a public cloud provider we are going to compare the two services based on security, authentication, privacy of the systems we will have a detailed analysis of the benefits of one service over the other and their shortcoming or disadvantages. We concluded that each one of the services has their suited demographic which is for Dropbox it is for users that are not overly concerned about security and for NextCloud they need to have a little more expertise on computers that are needed to set up and maintain the private cloud and have concern for security and a sense of control. Both services deal with confidentiality, Integrity and Availability a little bit differently but they arrive at the same goal or close to the same goal.*

As the methodology, the authors are going to comparatively analyze major factors in cloud computing that can provide distinct differences between the two services NextCloud and Dropbox where we are going get data from articles on the web and verify their accuracy and compile that data to make sense and be understandable by everyone who reads the paper. The research is going to be more focused on the analysis of data gotten from the acceptable internet venues which will consist of articles, blogs, website pages, and prior research. It is going to be more focused on security, privacy, and portability due to the fact that the majority of the challenges fall into one of these categories.

In conclusion, when we compared the different cloud services, both services had their strength and weaknesses as for security NextCloud is the better service they allow you to host your service they give you multilayered security you have some security features not available to the other service mentioned above, Dropbox, on the other hand, has its strength on accessibility with less cost because the cloud provider maintained the server and takes the cost of the infrastructure you only have to focus on the cost of what you need. But for cost, Dropbox is better due to the

service model. Both services deal with confidentiality, Integrity and Availability a little bit differently but they arrive at the same goal or close to the same goal.

- **Cybersecurity Issues for Dairy Farms***

- Nick Tiede, Karland Kilian and Songqing Yue
- *Smart technologies are increasingly being adopted on dairy farms today to streamline the process of herd management, which also brings along new cybersecurity threats and risks to farmers across the world. A variety of cyberattacks targeting the dairy sector have been reported due to the vulnerabilities exposed by smart devices and communications. Such attacks have the potential to cause serious damage that may disrupt the normal operation of a farm, impair the health and welfare of herds, and hinder the growth of farm businesses. Cybersecurity concerns of dairy farmers are relatively new, as most agriculture security research comes from the past few years. The lack of awareness of research into this issue could leave dairy farms vulnerable. This paper will discuss the many IT and IoT systems employed by dairy farmers and their environmental, people, and cyber threats, followed by recommendations on countermeasures and best practices that can be implemented to help mitigate risks to dairy farms.*

- **Wireless Security: Learning by Hacking with Software Defined Radios**

- Michael Ham, Kyle Cronin and Tom Halverson
- *Wireless signals surround all of us each day, carrying messages from a sender to a receiver. Some wireless transmissions carry non-critical communication data such as commands to a remotely controlled lamp or fan. Others carry highly sensitive and vital transmissions belonging to critical infrastructure, real-time communication, and secure data transfer. Our reliance on wireless technology continues to grow. When coupled with the ever-expanding threat of cybersecurity attacks, wireless technologies are an important area for students to study and understand.*

We have developed a kinesthetic lab assignment that teaches students how to evaluate the security of a wireless transmission through the lens of a cybersecurity adversary. In the lab, students take control of a wireless device of their choosing such as a set of restaurant pagers, a wireless doorbell, a remote-control helicopter, wireless power outlets, garage door openers, or drones using a software defined radio (SDR). These target devices are low-cost, easy to obtain, and often rely upon wireless protocols that have poor security. While such devices may not be considered crucial, the skills students develop throughout the lab can be used to investigate critical wireless communications.

Students begin the lab with near-zero knowledge about a chosen wireless device. The lab begins by guiding learners through the process of discovering a wireless signal emitting from a transmitting device by using open-source intelligence (OSINT) and an SDR. Students will identify key aspects of the wireless transmission such as the wireless frequency, modulation technique, and protocol used. Armed with basic knowledge about the device's operations, students confirm their findings by capturing a transmission from the sending unit, often a remote control of some sort. Next, students examine this captured wireless signal and interpret the message that was originally sent. With sufficient understanding of the communication protocol used, students will be able to decipher the message and have the requisite information that they need to impersonate the sender. Students use the knowledge they've acquired to write scripts capable of transmitting from a SDR and can successfully take control of the receiving device.

Each of the steps in the process are adaptable for a varying range of skillsets and intended cognitive outcomes. The content and learning outcomes can be adjusted for beginners or advanced students. We have used this lab as a teaching tool for students ranging from high school to college seniors all of which made progress in their abilities to evaluate wireless security communications. Students greatly enjoy seeing their work result in tangible results; something that often inspires them to continue exploring. Applicable class content areas may include introductory cyber operations, computer science, cellular and mobile communications, reverse engineering, offensive network security, foundational binary math, protocol analysis and scripting.

Pedagogy, Nifty Assignments

- **Nifty Assignment: Programming Unplugged for CS1**

- Amy Larson
- *Students enroll in the CS1 course for a variety of reasons ranging from intending to be a CS major to being curious about computers. Students have varied programming experience (mostly none) and a broad range of math skills from algebra to calculus 2. Yet, it is important that all students acquire fundamental programming skills. At first, students struggle almost universally with the syntax and the abstract nature of programming, distracting them from the real objective of building their problem solving skills. For these reasons, a series of assignments called Programming Unplugged has been introduced in our Introduction to Programming (Python) course. Unplugged activities are a common technique employed to teach coding skills without the use of a computer. The assignments require students to conform to the syntax, but allowing for errors because humans are interpreting code. It transforms abstract concepts into physical ones, and it helps to level the playing field for those students with limited computer experience (not just programming, but computer literacy).*

Programming Unplugged is a series of assignments that build student's computational skills and acclimate them to rigid syntax. Students read and write simple code to create patterns on a grid with colored tiles – not in simulation, but with physical elements. In the first assignment, students read code to place tiles (e.g. `pink.place(2,3)`). The code uses variables whose value is written on a dry-erase card, functions, it makes use of random numbers generated from a die (e.g. `x=roll()`), random tile selection (e.g. `tile=random()`) and if-statements based on the value of the roll or color of tile. By reading code to create patterns, students learn the syntax and code structure. Once students are comfortable reading code, they choose from a stack of cards of tile pattern images and a stack of cards of relatively simple constraints (e.g. start the pattern at a random position, build the pattern from right to left, or use randomly colored tiles). The cards can be mixed and matched to create several programming problems from a relatively small set. Students share code with their peers to have it tested, giving them practice debugging code. In the second week of Programming Unplugged, the patterns and constraints increase in difficulty requiring more complex logic to solve. Students are introduced to while loops to meet constraints such as “place tiles in a row until the edge of the board is reached” or “place as many tiles as the number rolled.”

This Spring22 semester is the initial launch of Programming Unplugged with successful results thus far. Students are highly engaged and they have mostly (easily) grasped variables, if-statements and while loops within 3 weeks of starting to program. They are in the process of transferring these skills to Python. It is anticipated that the 3 weeks spent unplugged will translate to accelerated acquisition of Python programming skills in the subsequent weeks.

All materials can be downloaded from GitHub at <https://github.com/lars1050/ProgrammingUnplugged>

- **A Scrum Tool with Support for Cost Estimation***

- Xingzhang Feng and Kasi Periyasamy
- *Scrum is one of the most popular agile methods for software development. There are several artifacts developed when using scrum for a software project. These include user stories, sprint tasks and test cases. These artifacts are constantly updated throughout the project. In addition, the stakeholders (product owners, scrum master and developers) meet quite frequently; daily meetings are quite common in most scrum projects. It is therefore essential to track all documentation in timely manner for the successful completion of a scrum project. While there are a number of Scrum tools available, most of them are too complex to use. In particular, for students who are using Scrum for the first time, learning a Scrum tool is overwhelming. So, the authors of this paper decided to develop a customized Scrum tool that can be used in a software project management course.*

The tool provides role-based access to the three groups of users - product owners, scrum masters and developers. An administrative user (in this case, the instructor of the course) handles accounts management for the three types of users. Using the tool, the students will be able to create

new projects and new artifacts (user stories, sprint tasks and test cases) based on their roles assigned. Both the instructor and the students will be able to closely monitor the progress of the project at any time.

An important aspect of this tool is its support for cost estimation for a new project which uses the artifacts (user stories, sprint tasks and test cases) from previously completed projects. To do so, data from several previously completed projects have been uploaded and stored in the data repository of the tool. A previous version of this tool used the data from past projects and gave a rough estimation of the efforts required (in terms of story points) to implement each user story. Though it was useful, the users were expected to understand the notion of story points, another learning curve for the users. The tool was then modified to include additional features so that users will now be able to reuse some of the artifacts (user stories, sprint tasks and test cases) and/or to tailor them to suit new project requirements. The tool was developed as a capstone project by a graduate student and was enhanced by another graduate student. It has been tested using several academic graduate level software projects, and is currently used by the students in a Software Project Management course.

- **A Course on the Intersection of Deep Learning, Real Time Embedded Systems, and Robotics**

- Ziad Youssfi
- *This paper outlines a new senior-level course for an electrical and computer engineering curriculum that combines deep learning and embedded real-time systems in the context of robotics. The intersection of these three domains offers students an opportunity to innovate in the domain of autonomous systems. Current courses primarily focus on one of the three areas but do not leverage the value of their intersection. This new approach is enabled by new tools in AI and embedded systems.*

In the AI deep learning domain, developers can build and train models faster than ever before. Multiple factors drive this trend. One factor is that those deep learning frameworks, such as TensorFlow or PyTorch, are implementing more sophisticated optimization algorithms while becoming easier to use. Another factor is that annotated large data sets for training are becoming more accessible. Moreover, deep learning hardware accelerators such as GPUs (Graphical Processing Units) and TPUs (Tensor Processing Units) are cheaper to make and are often integrated into computing systems, even in mobile platforms such as the Nvidia Jetson platform line.

At the same time, in the embedded real-time systems domain, microcontrollers are now supporting more peripherals such as pulse-width modulation (PWM), fast analog to digital converters, multiple serial and parallel communications units, and sophisticated interrupt synchronization mechanisms. These features enable the execution of multiple threads to control motors, communicate with other devices, and respond to external events with very low latency while consuming very low power. To control this dazzling array of features and to create products faster, developers are often turning more often to embedded operating systems, such as the Real-Time Operating systems (RTOS), or libraries, such as the Robot Operating System (ROS).

The proposed course leverages the deep learning frameworks and the high-level embedded system development tools in a compact form. The topics are offered in the context of robotics and autonomy because of the many applications in this exciting area.

The course would be second in sequence to the embedded systems course. It can also be the first course in which students are exposed to deep learning models.

The course will cover the following topics.

Part 1: Computing and Robotic Platform

- *Introduction to Nvidia Jetson Nano (access, software, Linux basics, etc.)*
- *Introduction to Robotic platform (DC motors, motor drivers, power source, etc.)*

Part 2: Deep Learning Principles using high-level frameworks

- *Image classification*

- Object detections
- Semantic segmentation
- Transfer learning
- Real-time video analytics

Part 3: Basic Robotics

- Motor interfacing (DC, brushed, and brushless motors)
- Differential drive
- Servos
- Tachometer interfacing
- Odometry

Part 4: Advanced Embedded Real-Time Systems

- Finite state machines
- Thread synchronization
- Feedback control system
- Sensor integration
- System integration
- RTOS and ROS

Machine Learning

• Detecting and Predicting Classification of Cyber-bullying*

- Louise Dupont
- *Cyber-bullying has been around since the beginning of the internet and has become a major problem. Cyber-bullying is known for its harmful intent involving hurtful, derogatory, and embarrassing posts, messages or comments manifested through social media or electronic devices [2]. On April 15th, 2020, UNICEF issued a warning of an increase in cyber-bullying during the Covid-19 pandemic due to the increase of screen time and decline in face-to-face interaction [1]. There were an alarming 60% chance children ages 14-19 encountered cyber-bullying. Predators hide behind internet anonymous identity, making it hard for schools and law enforcement to apprehend the culprit. According to research, a victim of cyber-bullying is twice as likely to attempt suicide [4]. As stated by the Centers for Disease Control and Prevention (CDC), cyber-bullying is the 2nd leading cause of death between the ages of 10-34 years [5]. Studies show that approximately 454,046 derogatory public tweets have been sighted since the pandemic started [3]. Cyber-bullying is intended to attack certain groups based on ethnicity, age, gender, religion, etc. For this research, data were collected from 47,000 tweets which were labeled according to the personal characteristics of the intended recipient. This research will focus on training a machine learning model to predict harmful tweets based on these characteristics by using a random forest classifier and recursive feature elimination. NumPy, Pandas and Scikit-learn are some of the Python libraries that will be utilized to manipulate data and algorithms. Outcomes from this research could be utilized to counter cyber-bullying by flagging and removing potentially harmful tweets. Furthermore, this could reduce the impact of cyber-bullying on teen suicide.*

• Machine Learning Approach for Optimizing Healthcare Supply Chain*

- Anurag Rajput and Vijayalakshmi Ramasamy
- *SCM(Supply Chain Management) is a sequence of business activities from suppliers through customers, product decisions, services, and information to achieve customer satisfaction. SCM in healthcare (HSCM) involves the efficient movement of medicines, medical or surgical equipment, and other products. As per the Premier health survey, SCM costs consistently rank as some of the most significant healthcare and hospital systems expenses. The top priority of healthcare leaders is to estimate and reduce healthcare supply chain costs. The assessment of HSCM is essential to bridge the gaps using potential ML techniques and improve the modern healthcare system.*

A detailed systematic literature review (SLR) was performed to gain more insights into the technological innovations, which highlighted the vulnerabilities of HSCM and provided valuable measures to make it cost-effective. We followed a five-step process, which included a pilot search

in the first phase to obtain a better grasp of the present literature, develop criteria for literature selection, and formulate the research topic and subsequent steps. Based on the exploratory SLR results we consider the following primary research question for investigation is: How do ML techniques play a significant role in the HSCM system process by predicting the freight cost and thereby reducing the cost of the healthcare supply chain?

The essential contributions of this ongoing research paper include an Exploratory data analysis(EDA) of HSCM data and applying a Supervised ML approach to determine freight cost. The dataset used in this research study is obtained from the United States Agency for International Development. The dataset contains 33 features and 10325 observations, both numeric and categorical. We have used SLR by exploring multiple databases (IEEE, Science Direct, Mendeley, etc.) with specific keywords of predictive supervised ML (Linear and Non-Linear regression) algorithms to predict freight cost. The model is trained based on the United States Agency for International Development (USAID) data. Finally, the evaluation uses different performance measures and prediction of freight cost.

- **Car Accident Severity Prediction Modeling Using Machine Learning Techniques***

- Dhanashree Mehta, Shweta Avachat, Harshada Dhawade and Vijayalakshmi Ramasamy
- *Several studies imply that the growing number of accidents hampers the economic, societal, and business aspects. When rendered over statistics, the economic or societal impacts for most of the causes of traffic accidents cost the United States around hundreds of billion dollars every year. According to NHTSA 2021 reports, the fatality rate has increased by 16% between Jan and June 2021, which was more than the records observed in 2020 around the same period. The National Highway of Traffic Administration states that every 60 seconds, a car accident occurs, equivalent to 5.25 million accidents recorded across the nation yearly. According to the World Health Organization (WHO), crashes approximately amount to 1% of the total gross domestic product (GDP) for a particular country. For high-income countries like the USA, Germany, and Australia, it costs about 2% of the GDP, while for middle-income countries like Brazil, Russia, India, the cost is around 1.5% of the GDP. A significant contribution to this tremendous cost is due to a smaller number of serious accidents. It is observed that when it comes to fatality rate per capita and the number of vehicles traveling in miles, there is a way to examine and monitor vehicle deaths related to population and the amount of driving.*

However, to obtain accurate results, all the factors that can be held responsible for affecting these rates should be considered. These factors include the type of vehicle driven, the speed of travel, the rate of licensure, traffic laws for individual states, capabilities related to emergency care, weather, topography, and so on. However, this area of research is less in number, and the root causes for the increasing number of accidents are not fully addressed. These causes rely on factors related to geographical conditions like weather or location, mental conditions like stress, emotional anguish. Here, we studied and reported the critical attributes for an accident by identifying the patterns and trends. We performed an extensive analysis of the data that we collected and segregated based on various characteristics related to traffic, address, weather, time of the day, etc. Our research aims to investigate and build model-based predictive Machine Learning algorithms like Random Forest, Logistic Regression, and Decision Tree Classifiers.

The research study takes into consideration the following research questions. RQ1: When do most accidents happen (e.g., day vs. night, weekday vs. weekend, rush hour); RQ2: Where do most accidents happen (e.g., county, city, side of the street, location); and RQ3: What weather condition attribute to severe accidents (e.g., special weather conditions - snow, fog)? We aim to predict the severity of an accident based on several significant factors that collectively affect an accident to occur in the first place. With the help of this pervasive analysis, we can not only understand the factors responsible for accidents but also help avoid a few or more severe accidents in the future.

Computer Vision

- **Leaky ReLU on AlexNet with ImageNet***

- Nikhil Gajghate and Josiah Yoder
- *In this paper, we are exploring the effectiveness of LReLU on the large-scale dataset ImageNet, using AlexNet. Studies have shown that since ReLU is a non-saturating function, it solves the vanishing and exploding gradient problems. However, studies have also shown that ReLU has a*

caveat -- the dying ReLU problem. To address this problem, we take a look at Leaky ReLU (LReLU), an adaption of ReLU that solves the dying ReLU problem but also retains its advantages. Researchers have noted LReLU's higher performance on small scale datasets but its effectiveness on large scale datasets like ImageNet has not been fully explored. Hence, in our experiment, we make use of AlexNet on ImageNet, replacing ReLU with LReLU. We plan to train AlexNet on ImageNet twice -- first, using the former's default architecture, and again, replacing standard ReLU with LReLU. Comparing accuracies of the networks will help determine if LReLU consistently outperforms ReLU on large datasets.

- **Muscle Vision: Physical Pose Classification***

- Autumn Beyer, Bart Gebka, Joshua Goldshteyn, Nathan Johnson, Alex Moran and Alexander Neuwirth
- *Recent advances in machine learning technology have enabled highly portable and performant models for many common tasks, especially in image recognition. One emerging field, 3D human pose recognition extrapolated from video, has now advanced to the point of enabling real-time software applications with robust enough output to support downstream machine learning tasks. In this work we propose a new machine learning pipeline and web interface that performs human pose recognition on a live video feed to detect when common exercises are performed and classify them accordingly. This exercise pose classification pipeline experimentally determines, in a real-time mobile environment, the type of physical exercise being performed from a predefined set of examples. In contrast to existing models that use image recognition directly, our classification model strictly focuses on three dimensional coordinates for key landmarks on the human body, which requires a considerably smaller input size and parameter count for the model than a direct image-based approach. The reduced model size enables a highly performant model that can output live results, even when running in parallel to a landmark extraction model. We derive landmarks by leveraging an existing open-source model built for mobile GPU inference, MediaPipe BlazePose, allowing for our model to feed in landmark points and output real-time classifications. The classification model accepts a time series of keypoint positions, allowing our model to consider sequential position dependencies that constitute an exercise. Usage of time series data permits building towards possible future applications in automatic pose validation and correction with regards to the accuracy of individual keypoint movement across the time series. Our web-based interface is highly portable, allowing the model to run on many operating systems and device types, including mobile. The resulting model interface is capable of webcam input with live display of classification results. Our main contributions include a keypoint and time series based lightweight approach for classifying a selected set of fitness exercises and a web-based software application for obtaining and visualizing the results in real time.*

- **Lymphocyte Classification in Hyperspectral Images of Ovarian Cancer Tissue Biopsy Samples***

- Natalia Bukowski, John Cisler, Theodore Colwell, Andrew Crisler, Alexander Drobek, Benjamin Paulson, Joseph Weller and Alexander Neuwirth
- *Multiple types of cancer are diagnosed and monitored by utilizing several needle biopsies. This procedure makes use of a hollow needle to extract a narrow column of tissue from a suspected tumor, which is then sliced, chemically stained to reveal features of cell biology, paraffinized for preservation, and annotated under a microscope to identify signs of disease progression. This current process of analyzing tissue is time consuming, requires a trained pathologist, and is susceptible to human error during the Hematoxylin and Eosin (H&E) staining and deparaffinization stages. Recent works have explored the use of hyperspectral imaging: a technology for producing images of tissue by measuring light absorbance on precise wavelengths corresponding to specific chemical signals. Hyperspectral imaging of biopsy cores has shown potential as a faster, sample-preserving alternative to distinguish between tissue types without the need for H&E staining or deparaffinization. Inspired by "Deep Learning for FTIR Histology" (Berisha et al, 2018), which used Fourier Transform Infrared (FTIR) images of breast biopsy cores and a convolutional neural network (CNN) to classify disease-relevant tissue types, we propose a method for detecting lymphocytes within biopsy cores of ovarian samples based on FTIR image data. Labelled data was created by marking lymphocyte and non-lymphocyte regions within biopsy cores. Adjacent stained cores were annotated by a pathologist as ground truth. Previous work on this dataset performed histological tissue type segmentation but was limited by poor annotation quality due to the presence of numerous, tiny, unannotated lymphocytes embedded within other tissue types. We propose a method to overcome data-quality limitations from earlier models by comprehensively classifying lymphocyte annotations in a way that accurately assesses model performance. Lymphocytes within biopsy cores will be identified by a standalone model. This model could be incorporated as a preprocessing step in future machine learning pipelines to intelligently filter lymphocytes out of the annotated regions of other tissues prior to training. Our work compares various machine learning methods for lymphocyte detection. We evaluate both classical machine learning methods (including random forest, support vector machines, and naïve bayes) and modern deep learning techniques, including dense and convolutional neural networks.*

- **A Detection Tool for Traffic Objects***

- Jiashu Li, Wentai Peng, Song Chen and Mao Zheng
- *This manuscript describes the design and development of a software detection tool for traffic objects. It is a web-based system with a built-in machine learning model. The system allows users to upload images and videos and then detects traffic objects, such as cars, trucks, traffic lights, pedestrians, and bikers. Our machine learning model, using the YOLOv3 algorithm, will process images and videos and return results with the category and location of all detected objects. The results will be stored in the history, and users can then manage the information from there. Most of our data for training the YOLOv3 model came from Udacity Self Driving Car Dataset. We tried the YOLOv3 model with different backbones such as, Darknet, Mobilenet and Efficientnet. The best combination of both accuracy and speed was obtained using darknet-53, so this network was chosen as our backbone.*

The technologies used in this project are HTML, CSS and JavaScript on the frontend, and Python, TensorFlow and Django on the backend. We used MySQL as the database and deployed the project in a Linux Server.

To further improve our model's mAP, we could use a larger dataset scale. However, it will require a longer training process and higher computing power. This manuscript also describes future work on how to incorporate our model as part of a road monitoring and/or self-driving system.

Applications

- **Image Steganography Performance Analysis using Least Significant Bit***
 - Sagun Singh
 - *Steganography is the practice of concealing confidential information within another non-confidential medium whether it is digital or physical medium. Within the software field, steganography can be used to hide messages, files, images, audios or videos inside the previously mentioned mediums. Image steganography is a branch where confidential messages whether in the form of text or files are hidden in an image while maintaining the likeness of the original image. This is extremely useful in the digital world where security is a major concern as it allows users to add digital watermarks for copyright protection and reduces the risk of information leakage. But in a world where big data exists, the speed and time efficiency of storing large amounts of information inside large sized images that consume a high amount of storage space decreases as the size of data and images increases. This paper focuses on the parallelization of an image steganography algorithm using Graphics Processing Units to improve the speed of encoding and decoding images with information. In this paper, the implementation of image steganography using the Least Significant Bit (LSB) algorithm is analyzed when using a Central Processing Unit (CPU) versus when using a Graphics Processing Unit (GPU). The Least Significant Bit algorithm hides information within the least significant bit of the three channels - red, green and blue - of the pixels of an image. Each channel of a pixel is denoted by a numerical value which can be represented by 8-bit values and the least significant bits are replaced with the binary data of the secret message. The algorithm implemented uses text as the payload (secret data) and Portable Pixel Map (PPM) images as the carrier. The advantage of using this algorithm is that modifying a bit by "0" or "1" still preserves the likeness of the original image but storage can act as a limitation when storing large amount of information within images of smaller dimensions. The GPUs present in the supercomputer at Milwaukee School of Engineering were used to parallelize the algorithm and study the performance and speedup of encoding and decoding secret data of various sizes within images of various dimensions. This project intends to use the parallelized algorithm to reduce the time taken to encode/decode messages within an image as the size of the image or message increases. After parallelization, reading and writing of the message into the least significant bit occurs in parallel hence reducing the time taken for the process. In this paper, the main focus will be the implementation of the algorithm, its parallelization, and the analysis of the resulting speedup, performance and time taken for both implementations.*
- **Developing an Exploratory Study of Beginners' Interactions with Clojure***
 - Jeong Ha Seung
 - *Clojure and Racket are two similar programming languages that fall under the umbrella of Lisp programming languages. While Racket is considered to be more beginner-friendly due to its Beginner Student Language, Clojure can be potentially beneficial for beginners to learn since*

it is more widely used in real-life applications. A major barrier that challenges beginning programmers to use Clojure is its error messages. Dr. Elena Machkasova at the University of Minnesota, Morris is leading an ongoing project called Babel to improve such beginner-unfriendly error messages of Clojure.

The overall goal of this project was to develop tasks to evaluate Babel and provide the foundations for future research to improve error messages of Clojure. The target audience of these tasks are beginner-level, undergraduate programmers who took an introductory course of Racket. As a beginning programmer myself, I developed a theoretical framework to structure the tasks to let the future participants explore Clojure as much as possible in a limited amount of time.

The tasks were structured in a way that various pre-existing functions of Clojure and examples of using them are given to the participants. Then, the participant has to utilize the given information to complete a task. More importantly, the fundamental framework in this project is progressive learning. As the participant goes through each of the tasks, the difficulty, and complexity of the task increase. Some tasks are cumulative, which means that it requires knowledge from previous tasks. To design this structure and organize different components of Clojure accordingly, I categorized pre-existing functions or basic parts of the language into eight different levels and recorded different relationships or connections between them. This will enable future researchers to use various combinations of tasks from each level. Ultimately, such a variety of tasks will produce a wide variety of error messages.

The paper presents a framework and examples of a set of tasks developed based on the framework designed to evaluate the effectiveness of Babel on beginner-level programmers. Unlike a traditional usability study aimed at measuring the effectiveness of a system for a particular set of tasks, this framework provides a more open-ended perspective to researchers. Researchers will be able to observe the participants' programming process and gauge both what programming mistakes they are likely to make and how much the error messages help them fix those mistakes.

- **Raytracer and Scene Description Language in the Rust Programming Language***

- Zander Franks and Kenny Hunt
- *The field of graphics programming has developed significantly in the past two decades spurred largely by commodity GPU hardware providing access to highly parallelized rendering software techniques. This paper describes a raytracer and scene description method to render complex scenes at fast speeds, written in the Rust programming language. The raytracer uses modern rendering techniques such as bounded volume hierarchies as mesh acceleration structures, includes support for various lighting techniques, and is reasonably performant. The scene description method is a proprietary language and interpreter loosely based on the POV-Ray language that supports both declarative and imperative paradigms for scene definition. While this project doesn't currently exploit GPU acceleration, it is highly parallelized but running as such only on the CPU. We hope to extend the library to exploit GPU acceleration and briefly describe the work that such an effort will entail.*

Speed has been a critical component of the project since its conception, and runtime performance of the raytracer and scene description interpreter is carefully described. The interpreter has the express disadvantage of being a run-time scripting interpreter, so generally its inclusion will slow down rendering times quite significantly. Considering, however, the project's modular nature, the raytracer can be separated from the interpreter so that scenes can be generated without the encumbrance of the runtime interpreter.

The architecture of the raytracer is first described after which we describe the syntax and semantics of the scene description language along with high quality scenes generated by our system. The key element of the raytracer is the Scene structure such that a Scene is composed of a series of SceneObjects, any number of Lights, a Camera, a Skybox, and a few other rendering settings. These API data structures are described and illustrated with code samples. The scene description language is presented grammatically, and example scenes provided. This language supports vectors, functional constructs, loops, conditionals, and constructive geometric objects such as spheres and boxes.

- **An Android App for Detecting Sleep and Pausing Media***

- Carter Goodwin and Mao Zheng

- This purpose of this project is to develop an Android app that will detect when a user has fallen asleep and pause any media (music, podcast, video, etc.) that is playing. To do this, the phone must be placed near the user's head on their bed. Then using a combination of the phone's accelerometer, light sensor, proximity sensor, microphone and Android's Sleep API, our app will detect when the user has fallen asleep. Google's new Sleep API is part of the broader Android Activity Recognition API. It is available on Android 10 and higher and it provides a sleep confidence level, using an on-device machine learning model, developed by Google. Our app will use this Google's Sleep API to determine if the user is asleep or not. In addition, we also want to this app to work on older versions of Android. This project will involve collecting raw sensor data from an Android mobile device and training our own machine learning model to detect when the user is asleep. The model that we are currently training is a Random Decision Forest. We tested several machine learning models and found that this model gave the best results in terms of accuracy and speed. Once sleep is detected, Androids AudioManager is used to pause any media the user is playing. In the settings of the app, a user will be able to adjust the sensitivity if he/she feels the app is pausing the media too early or too soon. Customizing the setting will adjust how confident the app is that the user is asleep or not to pause the media. The app will also allow a user to look back at his/her past sleep data and see how much sleep he/she got on a given day and then set custom alarms for the morning.

The sleep data we collected through our app is stored in the cloud database Firebase. We used Python and Keras to train the machine learning model and we then added the trained model to the Android project.

The goal of this app is to help users sleep better and save time. A loud sound in the music or other media that you are listening or watching as you fall asleep can disrupt your sleep schedule. Losing your spot in the audiobook or podcast that a user is listening can also be very frustrating. The app will try to solve this issue while also allowing a user to track his/her sleep data, set alarms, and get sleep recommendations, all in one place.

Poster Session- 4/1 3:00-5:00PM

- **AI4K12**

- Christopher Botzoc, Bryan Morales, Cody Friso, Chet Witte, Jeomy Schultz, Sohumi Sohoni
- *Computer Science education in elementary, middle, and high school institutions is often not available in a student's curriculum. As a result, organizations like Milwaukee School of Engineering's (MSOE) STEM Center have introduced and organized various STEM programs to help educate young students about the STEM fields. Our team recognizes the need to promote STEM education to broaden young students' horizons and empower them with new knowledge about the ever-expanding fields within STEM, especially Computer Science (CS).*

The project we are working on, for our senior design course, consists of designing, developing, and deploying a website that contains interactive lessons to help high schoolers learn and explore the field of CS. The website will offer lessons constructed by us based on the fundamental topics we have learned throughout our own college education including Artificial Intelligence (AI) and Data Science (DS). More specifically, the lessons themselves will cover three major categories of CS: Data Science, Machine Learning (ML), and Deep Learning (DL).

The website itself will be constructed using a JavaScript frontend for servicing the end-users and a Python backend to serve up all of our data science, machine learning, and deep learning implementations. We will be using MSOE's supercomputer, ROSIE, to conduct any data analysis, model training, and neural network development to supplement the lessons we plan to teach.

As of now, we have distributed two surveys, one for students and one for teachers. For the student survey, we wanted to understand where student interest lies in varying topics and their knowledge in CS. Similarly, the teacher survey was to help us gain an idea of how much CS is taught at their institution and their role, if any, in CS education. The analysis of the survey results allowed us to narrow down on datasets that fit the interests of the students and to find the right balance between instructional yet simple lessons

At the end of the day, the main goal of our project is to provide young students with a resource that will help them develop an understanding of CS as well as inspire them to explore other STEM fields that are within their interests.

- **A Low-cost Design of Computer Vision Guided In-Row Weeding System**

- Baozhong Tian
- *In organic farming, weeds control relies largely on mechanical devices, which is quite labor intensive and not very effective for in-row weeds. This paper proposes a single-camera, computer vision guided, automated weeding system for in-row crops such as corn, soybean, etc.*

The software subsystem is based on previous works of crop stem segmentation algorithms. Despite the detection rate of around 80%, the trained network is still usable after adjusting the decision making process. The mechanical weeding head is not to be actuated unless a positive detection of stem is detected and transitioned to a designated position of action (POA) such as the center of view (COV).

The navigation subsystem includes a motorized carriage where the embedded system and cameras are located. A GPS unit is also need to define the region of the crop field where the carriage navigates back and forth between rows of crops. Low cost sonars or cameras can be used to detect and track the passage between rows.

The software subsystem also controls the movement of the carriage based on the detection of stems. Every effort is to be made to improve the image quality, thus improve the detection rate. In the case of a miss in stem detection, no action should be taken to avoid damaging the crop. However, a second round of weeding operation, or an alternative but probably less effective weeding technique may be applied to remedy the miss as best as it can.

The main difference between this proposed system and other systems is that this system detects crop stems only, where other systems also try to detect weeds. This system also uses a single camera for stem segmentation, instead of multiple-camera implementation as seen in other systems. The author argues that single camera detection system improves reliability, reduces cost, and yields faster detection speed. The view angles of the camera will also be discussed on how it may affect performance and what possible improvements can be made.

- **Evaluating Students' Blackboard performance and discussion using data mining approach and word cloud**

- Tamaike Brown and Muhammad Abusaqer
- *This paper aims to highlight the results of continuous application of association rule mining (ARM) in a 300-level software quality assurance (SQA) course throughout a semester. Previous application of ARM in lower-level CS is very useful in identifying order appropriateness in which information should be presented to students. However, continuous application of the technique has not been applied in higher level courses such as SQA courses. Many studies have been conducted which focus on the importance of teaching software quality techniques, metrics, and the benefits it has to improve the quality of designed software. Yet, there exists a knowledge gap between university graduates and industrial task force readiness. It has been noted that the software quality courses are either poorly structured, or the content does not reflect industry standards. In addition, the literature lacks study that highlights the importance of the order in which topics in the software quality curriculum should be taught in universities.*

This paper aims to address one issue at a time, that is, to continuously improve the course structure within the semester offered in senior software engineering (SE) courses using ARM. Additionally, students' online Blackboard discussion is used alongside the technique to provide more details on what specific area of a topic students are experiencing difficulty understanding. The course instructor gathers the discussion data and processes the information using word clouds to generate key words and their frequency. The Word clouds give unique insight into assignments from students' perspective and help visualize how students read and understand assignments when presented in an unfamiliar format. Images facilitate class discussions on various topics and assessments development, allowing instructor detailed insight into student understanding.

The data is collected from students' Blackboard Learning Management System (LMS) grade and discussion in a SQA course at a teaching US University. The students were evaluated on 7 team assignments, 4 project milestones, and 2 exams. The result shows strong rules e.g., assignment 4 and assignment 5 are highly correlated. The success in assignment 4 determines the success in assignment 5. The researcher reports higher students' success from the continuous application of ARM in the SQA course throughout the semester. Of the number of students enrolled in the course more than 80% received a final grade of B Average and above. As future work, further meta-analysis will be done by

extracting individual students' data, such as their grade data, discussion, to study correlation between questions asked and the student overall course performance.

- **Adversarial bandits for drawing generalizable conclusions in non-adversarial experiments: an empirical study**
 - Zhihan Yang, Shiyue Zhang and Anna Rafferty
 - *Online educational technologies can be used to investigate how to help students learn, but typical experimental designs assign a fixed proportion of students to each condition (i.e., an educational intervention), even if early results suggest some are ineffective. Experimental designs using multi-armed bandit (MAB) algorithms vary the probability of condition assignment for a new student based on prior results, and tend to place more students in more effective conditions. While stochastic MAB algorithms have been used for educational experiments, they typically collect data that decreases power and increases false positive rates in hypothesis testing, hindering the generalizability of conclusions made from such data to a broader population. We propose to use adversarial MAB algorithms instead, which are less exploitative of early results and thus may exhibit more robustness. Through simulations involving data from 20+ real-world educational experiments, we show that data collected using adversarial MAB algorithms does not have the statistical downsides of data collected via stochastic MAB algorithms. Further, we explore whether stochastic or adversarial MAB algorithms might be more effective than uniform random assignment in experiments where one condition is more variable, such as if performance gaps between students are narrowed by an educational intervention. Having conditions with differing variances affords an interesting opportunity to see whether the adversarial guarantees of adversarial MAB algorithms lead to behaviors similar to best arm identification, where the bandit assigns more participants to more variable conditions to ascertain their expected values and hence tend to improve power at the potential cost of participants when bad arms are more variable. This turns out to be not true: data from the adversarial MAB algorithms results in the same statistical power as uniform assignment. Surprisingly, data from stochastic MAB algorithms systematically reduces power when the better arm is less variable, while increasing it when the better arm is more variable. Overall, these results demonstrate that adversarial MAB algorithms are a viable "off-the-shelf" solution for researchers who want to preserve the statistical power of standard experimental designs while also benefiting student participants.*
- **Homologous Point Medical Image Registration**
 - Alexander Ruchti
 - *Prostate cancer is the second most common cause of cancer-related deaths among men in the United States. Biopsy is the gold standard for diagnosing the disease; however, it is extremely invasive. Non-invasive Magnetic Resonance Imaging (MRI) paired with state of the art machine learning approaches show promise for cancer diagnosis but require large amounts of data to train. In this study, we present a new deep learning pipeline for registration of prostate histology and MRI images for purposes of data generation. Previous approaches have used networks to predict the image transformation parameters required to align histology and MRI scans; our approach involves prediction of corresponding points (homologous points) on the histology and MRI scans. In our registration pipeline, a set of input points on the histology image is selected by a SIFT-based computational method. Then, a deep learning network predicts the homologous points on the MRI image. This enables the prioritization of specific regions of interest during registration through the modification of the input points. It also allows for a more accurate, memory-efficient network design than previous approaches.*
- **Gamification and Storytelling Principles for Mental Health Support.**
 - Shelley Feil
 - *Recent research has shown that most mental health applications, specifically, for depression and anxiety utilize extrinsic motivators like digital rewards and feedback to support users. This approach is not effective in the long term because these methods only temporarily gratify and motivate the user to continue the application. Without a personal or internal motivator, it is more difficult to pursue or complete treatments without relying on these extrinsic motivators. This research investigates better mental health support methods through the targeting of intrinsic motivators instead, and in the process creating a prototype from the accumulated information. In this meta-synthesis study, literature was compiled and analyzed about gamification principles, motivation, behavior intervention, and storytelling from different fields. Using the results from this research, a digital "Choose Your Own Adventure Story" was decided on and developed informing people of different mental health interventions, but not substituting as medical advice. The short story was developed partially based on an original account (with names changed for privacy) at a mental health institution. The user makes a variety of choices throughout the story that makes an impact on what type of intervention they are educated about at the end. Originally, the point of the research was to create a mobile app for mental health support, however, findings have shown that current methods are not as effective for sustained engagement, so a least common yet possibly effective*

method of support was explored: storytelling. The narrative immersion model, specifically “Outcome Stories” are proven to better persuade people when making decisions for their wellbeing, while conveying an experience of desirable behaviors. In conclusion, this research not only advances current knowledge about the impact of storytelling in mental health applications, but the prototype developed proposes another method for further research to create a meaningful and varied experience for the user’s education.



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