Project Descriptions (if available)

Dr. Abusitta: Location-based reminder Mobile App
Description: It occurs a lot many times that we visit the shop or market and forget to buy some items, especially when visiting many places on the same day. This GPS-powered mobile app will enable a user to fill in all the items she/he wants to buy when visiting a particular area. We can add more features to make the app more intelligent, useful, and interesting.

Dr. Abusitta: Mobile App for Car Washing Service
Description: This mobile app will allow a user to order car wash service anywhere (e.g., home) and any time. The application will show nearby car washer persons and the price that they want for their services. We can add more features to make the app more useful, intelligent, and interesting.

Dr. Abusitta: Mobile App for Snow Removal Service
Description: Winter is coming! This mobile app will enable a user to order the snow removal from the driveway, simply by putting their home address on the application. The application will search for the best deal for both the customer and the service provider. More features can be added to make the app more intelligent and interesting.

Dr. Abusitta: Mobile App for Grass Cutting Service
Description: This mobile app will allow a user to order grass cutting service from a user-friendly mobile application. The price of service and the waiting time will be shown on the application so that both the user and the service provider can get the best deal. We can add more features to make the app more useful, intelligent, and interesting.

Dr. Ahmad: Database System for Stocks/Portfolio Management
Description: To create a database for management of selected stocks and stock portfolios and maintain information (past and current) using MySQL. The database should be able to update information using data from the US stock exchanges (DOW & NASDAQ) and TSX via appropriate APIs. The application needs to have visualization capabilities for individual stocks as well as portfolios.
Pre-requisites: COMP-3150

Dr. Ahmad: Excel based Stock Data Compilation & Visualization
Description: Based on the required information about a stock portfolio (or multiple portfolios) to update desired information (prices and related information) from the Internet on daily basis or whenever desired. There should be a capability of visualization of different set of information.

Dr. Ahmad: Interactive JPEG Encoding
Description: JPEG is a very popular and commonly used image file format. It is a lossy compression scheme such the size of compressed image is inversely proportional to the desired quality of image. JPEG is not a single compression algorithm but involves a suite of algorithms, most important among them is the discrete cosine transform (DCT). A perceptual model based loosely on the human psycho-visual system discards high-frequency information. Another important step in JPEG compression scheme is called quantization which is primarily a method for optimally reducing a large number scale into a smaller one.
This project has following objectives:
• Study and learn JPEG compression / decompression algorithm.
• Implement JPEG compression engine on all or a selectable portion of image.
• Visually convey the information on a small selectable portion of image as it is
being processed through an interface
Prerequisite: COMP-2120, COMP-2540 and motivation to learn a different type of information

Dr. Alhadidi: Analyzing the Verify app
Description: Students will analyze the Verify app by the Government of Ontario from a security and privacy perspectives. https://github.com/ongov/OpenVerify

Dr. Al Mamoori: Text to HTML Generator App using Django

Description: In this project, the team can build a website with an interface from where the user can specify the text as an input. The website should generate or convert the text to an HTML web page with suitable stylings. This website is useful for creating rapid online HTML documents used in many applications, supported by all kinds of browsers, and can be easily integrated with any programming languages.
Prerequisites: the students should have knowledge and understand the HTML language with its mark-up tags, styling, formatting, forms, etc.

Dr. Biniaz: Guarding cities with cameras
Description: Project Description: Video cameras are common equipment to guard cities/streets. The goal is to find upper bound and lower bounds on the number of cameras that are needed to guard a city. While the nature of this project is theory (algorithms and combinatorics), the interested applicant may also perform some implementation. See this paper for more information
https://vga.usask.ca/cccg2020/papers/City%20Guarding%20with%20Limited%20Field%20of.pdf

Dr. Biniaz: Biplanar drawing of the complete graph with 12 vertices
Description: The complete graph with 12 vertices (K12) can be drawn in two planes with at most 12 crossings. It is known that any such drawing of K12 has at least 6 crossings. So, the minimum number of crossings for K12 is between 6 and 12. The goal of this project is to shrink this gap either by drawing the graph with fewer than 12 crossings or by showing that any drawing requires more than 6 crossings. Students with strong background in discrete mathematics or algorithms are welcome for this project.

Dr. Boufama: Vision-Based Obstacle Detection
Description: This project concerns the use of one or more cameras for detecting obstacles on a moving robot path. A smart phone can be used to capture the images that will be processed in a computer for detecting any object on the way. Two possible methods can be explored and compared: (1) similarity measure between observed scene and saved obstacle-free scene and (2) flatness test is carried on the observed scene to detect whether the path is completely flat or not.
This project requires strong programming skills and descent knowledge of mathematics.

Dr. Chen: Working with big graphs
Description: The students will choose to implement various solutions to a well-known graph-related algorithm and use publicly available large datasets to compare the performance of these solutions.

Dr. Gras: R-Drop regularization for Tabular Data
Description: Deep Learning techniques have proven their superiority over all other machine learning techniques for vision and natural language processing tasks. However, few deep learning approaches has been shown to be as performant as Gradient Boosting methods for tabular data classification and regression tasks. Moreover, deep learning models require large amount of data and important computational resources both for learning and for prediction.
R-Drop is a variant of the classic dropout regularization techniques based on each sample going 2 times through the model with 2 different random dropout masks. An additional loss term is added to force the 2 outputs to be similar. It has shown significant improvements compared to dropout when applied to machine translation task using transformer architecture. The paper is available here: https://arxiv.org/pdf/2106.14448.pdf. See also https://medium.com/codex/r-drop-a-simple-trick-to-improve-dropout-d6f0bb64f302.
The purpose of this project is to develop a deep learning Fast.ai Python code for tabular data and to apply R-Drop regularization to see if similar result can be obtained with tabular data. Multiple configurations of R_Drop will be tested and evaluated by comparing the resulting accuracy with the one obtained with traditional dropout techniques.
Prerequisite: strong Python programming skills, some experience with Machine Learning and Deep Learning solution implementation..

Dr. Jaekel: Secure Communication for connected/autonomous vehicles
Description The emergence of Vehicular Ad Hoc Networks (VANETs) is expected to be an important step toward achieving safety and efficiency in intelligent transportation systems (ITS). One important requirement of safety applications is that vehicles are able to communicate with neighboring vehicles, securely with low latency and

packet loss. This project will implement and evaluate different communication strategies for VANET, where the goal is reliable delivery of safety messages and automatic detection of 'malicious' packets. Performance evaluations will be done through simulations using SUMO traffic simulator and OMNet++ network simulator.

Dr. Jiang: Signature Database Updating for Antivirus Engine ClamAV
Description: ClamAV is an open source of antivirus engine for detecting Trojans, viruses, malwares and more malicious threats. However, ClamAV has a very high false positive detection rate. That is, it has a high rate of claiming a non-harmful program as a malicious one. How to reduce the false positive rate of ClamAV is our research focus of this project. You will be guided to get familiar with ClamAV development environment. Then, you will learn how ClamAV is working. Next, you will learn how to add virus signature into database which is essential for detecting virus. You will write program to update signature database automatically. You will also use an assembly tool to analyze if a program is a virus.
Requirements: C/C++, Linux programming

Dr. Jiang: Containers network security
Description : Docker is a technology to help creating multi-containers. It is widely used in the academy and industries. However, the security of containers created by docker is not widely considered. In the life cycle of containers, frequent destruction and generation bring great challenges to network access control between containers. Traditional firewalls don't work at all. To fill this gap, we need a tool to secure network access between application workloads such as image, application containers, CIDR or processes. This includes the access control for image-to-image, image-to-ip, image-to-DNS and more. In this project, you will be guided to implement such a tool. You will first get familiar with docker environment and docker commands. Then, you will learn a tool to manage containers. Next, you will learn a tool Istio to manage network traffic flows. Then, you will use an open source Cilium to implement docker access control.
Requirements: C/C++, Linux programming, Linux kernel development

Dr. Kobti: Social Network Analytic and Information Retrieval for Intelligent Decision Systems
Description: This project is in Information Retrieval and Intelligent Decision Making. The aim is to identify various methods to scrape the web for various data sets and build an ontology in real time. The idea is to use a set of advanced data retrieval and scraping tools and APIs to retrieve and manage data into ontologies that can be assessed for their information content and use in decision making. A variety of languages including visualization tools are to be used.

Dr. Kobti: Virtual Reality Cave Emulator
Description: Please read about the VR cave in the link provided (https://www.wavin.ca/vr-cave.html). We have created a mini version of this cave in our laboratory to enable development. The purpose of our project is to create innovative applications for this environment. The previous team used Unity and Kinect, while other potential software packages may be used as well. What can one do in such environment? What tools can be used? how can we develop on the test environment and deploy on the production environment? All these challenges we face require a creative team with strong aptitude for Virtual Reality (and Augmented Reality) application development in the VR Cave. If you like to see the actual environment in our lab ask Dr. Kobti.

Dr. Kobti: Tackling Child Poverty using Social Network Analysis and Multi-Agent Simulations
Description: Child poverty is a combination of multiple factors that is a complex system. How do we model such complex systems and dynamic environment? we use Multi-Agent Simulations. There are languages for this such as Repast J (Java based) or Repast HPC (C++). We like to be able to work with the United Way to model the reasons and factors that trigger child poverty and try to create a decision support tool, simulating what-if scenarios, to help decision makers to solve this problem with least cost on the community.

Dr. Kobti: PicoCluster, a super computer in a box
Description: We have a super computer made up of Raspberry PI's. Learn how to create parallel applications for this super machine. Potentially use MPI in C++ or C, and/or Python, and/or Java threads to create strong scientific applications for this super computer. If you like to see the actual machine, ask Dr. Kobti.

Dr. Kobti: Mobile App platform for non-profit organizations
Description: Create a full comprehensive and customizable solution for non-profit groups trying to reach out to their benefactors and clients during covid-19.

Dr. Lu: Vectorization of Online Social Networks for Deep Machine Learning
Description: Project description is available at   https://jlu.myweb.cs.uwindsor.ca/w2v/

Dr. Lu: Capture Word Semantics in Natural Language using Neural Network Algorithms
Description: Project description is available at   https://jlu.myweb.cs.uwindsor.ca/w2v/

Dr. Moradian Zadeh: 4 projects
> **a) Web application to store and retrieve profile data in/from database**
> **b) Data visualization tool**
> **c) Messaging, file transfer and VOIP service**
> **d) Develop a mobile app for personal safety**

Description: Develop a web-based framework to collect, store, retrieve, analyze and visualize data. for the partner organization - The Windsor-Essex Compassion Care Community (WECCC).
The student will:
* Develop and implement new software application;
* Maintain and improve the performance of existing software;
* Design and update software database;
* Clearly and regularly communicate with advisor and WECCC team;
* Test and maintain software products to ensure strong functionality and optimization;
* Recommend improvements to existing software programs as necessary;
* Analyze data, and produce reports;
* Participate in technical discussions;
* Present, demonstrate and document the project.

Technical skills:
* Strong motivation to learn new techniques
* Familiarity with the software development lifecycle including analysis, design, development, testing, implementation and support.
* Knowledge of Agile development methodologies;
* Basic knowledge in programming languages and databases such as C#, Python, Java, ASP, PHP, and SQL;
* Basic knowledge of web and mobile technologies, such as HTML, CSS and Javascript;
* Ability to learn new technologies quickly and take on challenging research opportunities;
* Ability to prioritize and organize effectively;
* Ability to work independently and multi-task effectively;

Dr. Mukhopadhyay: Interactive web interface for graph generation algorithms
Description: We have an ongoing research project with the goal of designing efficient algorithms for generating graphs belonging to different graph classes. The usefulness of such algorithms stems from the fact that we often need to generate test-instances of graphs, belonging to a particular class.
An important part of this project is to be able to visualize the generated graphs in order to better understand their structural characteristics. Additionally, it enables us to make useful and often significant conjectures about these graphs, besides serving the original goal of their use as inputs to other algorithms. A fourth need that this serves is that visual snapshots of the intermediate steps are a huge aid in the debugging of these algorithms which are often very complicated.
In a previous 499 project, two students have created a first version of such an interface. The details of their implementation can be found in an attached report. Currently, the web interface supports only the generation and visualization of chordal graphs. We would like to extend this to the generation of weakly chordal graphs, strongly chordal graphs as well dynamic maintenance of strongly chordal graphs. Often, we have faced the need to test specific graphs. So this web interface should also support the capability of creating and recognizing the graph as belonging to one of the above classes.

Knowledge of JavaScript, HTML5, CSS, Python are necessary, as is a sound understanding of the principles of algorithm design. Knowledge of graph algorithms would be helpful.

Dr. Ranga: Frequent Itemset Mining in a Hadoop cluster using MapReduce
Description: Frequent itemset mining is a popular technique used for Market Basket Analysis. It aims at discovering consistencies and regularities in customer/consumer shopping behavior. In simple terms, it aims at finding things that are frequently bought together by consumers. This project aims at mining frequent item sets from historical transactions that are stored in a distributed manner across a Hadoop cluster.

Dr. Rueda: Contextual Online Advertisement using Reinforcement Learning
Description: Comparative tool for visualization, analysis, and interpretation of high-dimensional data
This project consists of implementing a tool that will learn how to optimize number of clicks of an online advertisement system. The system will use techniques from reinforcement learning (RL) to learn the best strategy for advertisement, namely type of ads, time of day, etc., depending on the context, which is modeled in terms of users' variables like age, preferences, profession, and other data. The RL techniques do not have to be implemented but deployed from existing APIs already written in Python. The system will initially work with synthetic data in the first phase of the experiments. A second phase will involve online advertisement with real users who will interact with the system.
The participants of this project are expected to work in the following tasks (depending on the depth required and the number of participants). One of the main tasks of this project is to deploy the RL tools and use them to simulate and learn from the users. Another task is to generate synthetic data and experiment with it. A third task is to deploy the system by doing online advertisement on real users.
Skills required or willingness to learn: Python, HTML, PhP, Javascript. Basics of reinforcement learning. Jupyter notebook, Tensorflow, Ray, RLlib, and additional platforms may be used.

Dr. Saad: TBD
Description:

Dr. Selvarajah: Full Stack Dev AI
Description: This is an AI project which involves deep learning, computer vision and rule-based inference engine. The objective is to create an AI which can understand the hand-drawn forms and creates full-fledged application with front-end and back-end. The AI will identify the data model from the drawn form and generates front-end and back-end code. The back-end will be in REST API format for the CRUD operations. The front-end will be in HTML code and connected to the AI generated API end points. The AI will generate and store the required code form the application in a structured way. It is recommended to define rules for the AI to follow the MVC pattern. The REST APIs can be in Python/Java/C#. Microsoft released a project called Sketch2Code which transform hand-drawn images to HTML code. It is recommended to check the following link to get better understanding of the front-end design. Further information will be discussed in the project meeting. https://www.microsoft.com/en-us/ai/ai-labsketch2code

Dr. Tsin: Implementation and empirical study of certifying algorithms I & II
Description: A major problem in software engineering is correctness of software. Even after an algorithm is proven correct by its designer, its implementation as a program may still contain bugs (implementation errors). This is particularly true for complex algorithms as their implementations tend to be error-prone. Consequently, it is difficult to tell if an output generated by a program is correct or has been compromised by a bug.
A certifying algorithm is an algorithm that generates a certificate along with its output for each input. The certificate is an evidence that can be used by an authentication algorithm to verify the correctness of the output. An authentication algorithm is a separate algorithm that takes the input, the output, and the certificate to verify (independently of the algorithm) whether the output is correct. Certifying algorithms are of great value in practice as the user can verify the correctness of the output they received for each input regardless of whether the program is bug-free. Certifying algorithms have been extensively used in the software library LEDA after a user discovered an error in a program for testing graph planarity. The inclusion of programs based on certifying algorithms greatly improved the reliability of the library.
Tasks

This is an ongoing project. The tasks are:
• implement a new certifying algorithm for testing if a graph is generalized series-parallel, and if it is, whether it is series-parallel and/or outerplanar using the programming language C++.
• carry out an empirical study of the performance of the algorithm by running the resulting program on graphs with multi-million vertices and edges.

Learning outcomes
1. understand certifying algorithm;
2. gain experience in reading theoretical research paper on algorithms and implementing the algorithms correctly (a skill required for those who wish to work in the Research and Development Department of a high-tech company such as google);
3. gain experience in program testing with large input data sets.
4. know how to create a repository in GitHub and manage it

Required background At least a B grade (or 70%) in COMP-2310 (60-231) and experiment in writing C++ programs

Dr. Wu: Applying Machine Learning/deep learning to Astronomy
Description: Investigate, explore, and implement machine learning/deep learning algorithms for astronomy projects (no background in astronomy required)

Dr. Wu: Developing a learning Tool for AI course (web/app development)
Description: Develop a website/webapp to showcase important algorithms in AI and its relevant information.

Dr. Yacoub: Virtual Communication Stack – Development of DEVS-based MANET Simulation
Description: Verification and validation of Mobile Adhoc Network in the context of emergency response is a challenge. Indeed, when a disaster overcome, lives are at stake, and communication network are not available. Coordinate rescues teams and civilians is critical in these conditions. MANETs represent the best solution in literature, because they don't need any pre-existing infrastructure to be deployed. What you need is only two nodes (two smartphones, two computers, two drones…). However, this aspect increases the importance of the reliability of this kind of networks. Furthermore, it's like impossible to guarantee the efficiency of MANET in case of emergency because it's obvious we cannot test them in extreme conditions before that these conditions appear. That's why simulation is often used as test technique.

Literature recently highlighted the lack of accuracy of these simulators because of unrealistic simulation scenarios (especially the lack of models of real software using MANETs). Different approaches have been proposed to solve this problem. The Virtual Communication Stack is one of these solutions : the VCS acts as a transparent VPN for the end-user application, and it routes a real traffic to a simulator or to the OS kernel. As a result, any software can be used in simulation environment without abstraction. A possible application is the communication between a real drone and a simulator for instance (hardware-in-the-loop). This project proposes to the student to explore and implement a VCS design based on DEVS (Discrete-Event System Specification) and see how to use such an infrastructure in a co-simulation environment.
Requirement : Good level in C++. Basic knowledge in telecommunication, IoT. Interests in theory of simulation. Interests in kernel and drivers development.
Outcome : Learn development of cosimulation and communication protocols.

Dr. Yacoub: INDUSTRY 4.0 – Simulation of smart manufacture
Description: The Fourth Industrial Revolution (or Industry 4.0) is the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology. Large-scale machine-to-machine communication (M2M) and the internet of things (IoT) are integrated for increased automation, improved communication and self-monitoring, and production of smart machines that can analyze and diagnose issues without the need for human intervention.
This revolution leads to the development of numerous tools and proofs of concept, in the domain of system control, prognosis, and diagnosis. This project consists on maintaining an existing integrated simulation environment developed as part of an international research collaboration, and in which virtual robots and real robots can coexist

and operate as if they were in the same industrial environment. According to your experience, you will be proposed to participate in the development of features related to the user interface, user experience, robot diagnosis and control in the simulation tool/real robots. Other tasks related to cognitive science and implementation of AI algorithms (especially RL algorithms) may be also considered according to the interests of the student.

Example of smart factory : https://www.youtube.com/watch?v=SHNyByL6JXE

Requirements : Good level in C++17 programming and algorithms. Interested in multidisciplinary approaches.

Outcome : develop skills in software architecture, develop skills in C++20/Qt, low-level and embedded development, learn some approaches in systems science, automation science/automatics, cognitive science. Learn how to work with and integrate existing tools (Gazebo, ROS, KUKA OS). Learn about interoperability and language wrapping (C++/Python, C++/FORTRAN, C++/Matlab). Learn development in the context of a research project and an iterative lifecycle.

Dr. Yacoub: Sentence-To-Music encoder/decoder

Description: This goal of this project is to evaluate the possibility to encode natural sentences in a music sheet and melodious sound. With the help of a cognitive scientist, the student will be proposed to develop a little program which translates french or english sentences in a music sheet and produces the corresponding music following a predefined coding table. The student will also be invited to think about the choice of the appropriate technology and participate in the improvement of the coding table. Other tasks related to computer vision (export the music sheet in an JPEG format, analyze and convert a picture containing a music sheet to a computerized representation) may also be possible (depending on the level and interests of the students). Depending on progress, other tasks may include compression, encryption and steganography.

Requirements : no specific requirements, except an interest in music and information coding, compression, encryption and steganography.

Outcome : develop in software development and programming.

Dr. Yacoub: Integrated Verification and Validation Environment – DEv-PROMELA

Description: System and software become increasingly complex every day. Especially in complex systems with many interconnected components such as network-on-chip, finding the exact issue may be a challenge, especially when undefined behaviours come from incomplete specifications. Literature proposes two independent techniques to solve this problem : simulation on the one hand, and formal checking in the other hand. However, since few years, another approach combining both techniques have been developed. Especially, Integrated Verification and Validation Environment has been proposed as a solution. In these environments, designers write their specifications in a formalism which allows the automatic generation of a formal model (which is used for the formal verification), and the corresponding simulation model (which is used for the validation and as a base of the final software). In this project, the students are proposed to redevelop an IVVE for the design of network-on-chips. The main tasks consist on :

- Implement an user interface in which the designer can design a NoC
- Implement the automatic generation of the DEv-PROMELA specifications corresponding to this NoC
- Rewrite (using Lex/Yacc) /Reuse the existing DEv-PROMELA compiler to generate the formal and simulation model corresponding to the NoC

Requirements : Good level in C++ programming ; the students should have interest in software engineering, formal calculus, theory of computation, compiler construction, embedded systems, system-on-chip.

Outcome : develop skills in software development and programming, learn about formal transformation.

Dr. Yuan: SmartCampus -- Better Students' Life on Campus

Description: SmartCampus was started as a project that brings convenience to students' life on campus. Along with the need of virtual learning(https://www.ecampusontario.ca/), it now extends to include educational technologies for online learning. This is one of the subprojects of SmartCampus that extends the existing system by creating a virtual environment of the campus (Reference at http://xyuan.myweb.cs.uwindsor.ca/smartcampus.mp4).

Dr. Yuan: SmartCampus -- Talking Software Avatar for Online Learning

Description: SmartCampus was started as a project that brings convenience to students' life on campus. Along with the need of virtual learning(https://www.ecampusontario.ca/), it now extends to include educational technologies for online learning. This is one of the subprojects of SmartCampus that extends the existing system by creating a virtual environment of the campus (Reference at https://scholar.uwindsor.ca/cgi/viewcontent.cgi?article=8732&context=etd).

Dr. Yuan: SmartCampus -- Construction of Virtual Campus

Description: SmartCampus was started as a project that brings convenience to students' life on campus. Along with the need of virtual learning(https://www.ecampusontario.ca/), it now extends to include educational technologies for online learning. This is one of the subprojects of SmartCampus that extends the existing system by creating a virtual environment of the campus (Reference at https://scholar.uwindsor.ca/cgi/viewcontent.cgi?article=8961&context=etd).

Dr. Yuan: SmartCampus -- Technique of Virtual Learning

Description: SmartCampus was started as a project that brings convenience to students' life on campus. Along with the need of virtual learning(https://www.ecampusontario.ca/), it now extends to include educational technologies for online learning. This is one of the subprojects of SmartCampus that extends the existing system by creating a virtual environment of the campus (Reference at https://accessdl.state.al.us/sites/default/files/VIRTUAL%20LEARNING%20STRATEGIES%20AND%20TIPS.pdf) .