Advance Statistics

The course will cover the following topics: • Introduction to the R statistical software • Multivariate linear regression • Analysis of categorical data: multi-way tables, the generalized linear model. Logistic regression. Poisson regression. • Analysis of clustered and panel data: mixed models • Principal component analysis • Modern use cases: text mining, image processing

**Agile Software Development**

Objectives of course: • To understand the principles and values of Agile Software Development. • To learn the various Agile methodologies and frameworks used in the industry. • To develop proficiency in implementing Agile practices and techniques. • To cultivate effective teamwork, communication, and collaboration skills in an Agile environment. • To acquire practical experience in Agile project management and iterative development. • To embrace adaptability and responsiveness to changing requirements and customer feedback. • To foster a culture of continuous improvement and learning within Agile teams. • To address challenges and best practices in Agile software development. Course outline: Introduction to Agile Software Development Overview of the Agile Manifesto and its core values and principles. Evolution of Agile methodologies and their impact on modern software development. Comparison of Agile with traditional waterfall approaches. Agile Methodologies and Frameworks Scrum: Roles, ceremonies, and artifacts in Scrum. Kanban: Visualizing workflow and continuous delivery principles. Extreme Programming (XP): Pair programming, test-driven development (TDD), and continuous integration. Lean Software Development: Reducing waste and optimizing flow. Agile Requirements and User Stories Techniques for gathering, refining, and managing Agile requirements. Writing effective user stories and acceptance criteria. Prioritizing and managing the product backlog. Agile Planning and Estimation Iterative planning and release planning in Agile projects. Agile estimation techniques, including story points and planning poker. Tracking progress and adapting plans in response to changing circumstances. Agile Requirements and User Stories Techniques for gathering, refining, and managing Agile requirements. Writing effective user stories and acceptance criteria. Prioritizing and managing the product backlog. Agile Planning and Estimation Iterative planning and release planning in Agile projects. Agile estimation techniques, including story points and planning poker. Tracking progress and adapting plans in response to changing circumstances. Agile Development Practices Test-driven development (TDD) and behavior-driven development (BDD). Continuous integration and automated testing. Pair programming and code reviews for improved code quality. Agile Project Management and Metrics Setting up and managing Agile projects with Agile project management tools. Measuring and tracking team performance with Agile metrics. Addressing project risks and challenges in Agile projects. Agile Team Collaboration and Communication Facilitating effective Agile team meetings and stand-ups. Enhancing collaboration and communication within cross-functional Agile teams. Adopting Agile project management tools for seamless collaboration. Agile Delivery and Continuous Improvement Incremental delivery and continuous deployment in Agile projects. The role of retrospectives in fostering continuous improvement. Identifying and implementing improvements in Agile processes. Scaling Agile for Large Projects and Organizations Strategies for scaling Agile practices in large and distributed teams. Agile frameworks for enterprise-level projects (e.g., SAFe, LeSS). Managing dependencies and aligning multiple Agile teams. Agile Adoption and Transformation Strategies for successfully adopting Agile within organizations. Overcoming resistance to Agile transformation and driving cultural change. Evaluating the impact of Agile adoption on software development.

Data Mining :

Course Orientation; Course Part 1 Pattern Discovery Overview; Pattern Discovery Basic Concepts; Efficient Pattern Mining Methods; Pattern Discovery Programming Assignment 1 2 Pattern Evaluation; Mining Diverse Frequent Patterns 3 Sequential Pattern Mining; Pattern Mining Applications: Mining Spatiotemporal and Trajectory Patterns 4 Constraint-Based Mining 5 Graph Pattern Mining 6 Pattern-Based Classification 7 Pattern Mining Applications: Mining Quality Phrases from Text Data; Advanced Topics on Pattern Discovery 8 Pattern Discovery Programming Assignment 2; Preparation for Part 1 Exam 9 Course Part 1 Exam on Pattern Discovery 10 Spring break 11 Course Part 2 Cluster Analysis Overview; Cluster Analysis Introduction; Similarity Measures for Cluster Analysis 12 Partitioning-Based Clustering Methods; Hierarchical Clustering Methods 13 Hierarchical Clustering Methods (continued); DensityBased and Grid-Based Clustering Methods; Cluster Analysis Programming Assignment 1 14 Methods for Clustering Validation; Cluster Analysis Programming Assignment 2 15 Preparation for Part 2 Exam 16 Course Part 2 Exam on Cluster Analysis

Data-driven Decision Making

WHAT IS DDDM? Course Week 1 Intro Ayers: Read Introduction KPI: Read Introduction Marr Videos - What is KPI? http://www.youtube.com/watch?v=wnOgRO2 zpDE and What is Business Intelligence? http://www.youtube.com/watch?v=KpYw0x HancY Weekly Reflection Paper Weekly Discussions 1. Longevity Game at: http://www.northwesternmu tual.com/learningcenter/the-longevitygame.aspx 2. Prediction Tools at: http://islandia.law.yale.edu/ ayers/predictionTools.htm Weekly Quiz Week 2 ALGORITHMS Course Week 2 Intro Ayers: Chapter 1 Slavin Video: How algorithms shape our world: http://www.ted.com/talks/kevin\_slavin\_how\_ algorithms\_shape\_our\_world Weekly Reflection Paper Weekly Discussion Who’s doing your thinking for you? Weekly Quiz Week 3 REGRESSION AND RANDOMIZED Course Week 3 Intro Ayers: Chapters 2 and 3 McCandless video: The beauty of data Weekly Reflection Paper Weekly Discussion Creating your own data TRIALS visualization: http://www.ted.com/talks/david\_mccandless\_ the\_beauty\_of\_data\_visualization with the flip of a coin. Government by chance? Weekly Quiz Week 4 DATA IDENTIFICATION AND APPLICATION Course Week 4 Intro KPI: Parts One and Two Video: Discovering math primary statistics and data analysis: http://www.youtube.com/watch?v=L69WqL MJceU Weekly Reflection Paper Weekly Discussion The financial perspective The customer perspective Weekly Quiz Week 5 DATA IDENTIFICATION AND APPLICATION Course Week 5 Intro KPI: Parts Three and Four Video: Introduction to Excel for stats http://www.youtube.com/watch?v=4AZ8G\_ MqyiM Video: Introduction to Excel for visuals http://www.youtube.com/watch?v=-btUxQi76qI Weekly Reflection Paper Weekly Discussion Marketing and sales perspective Operational processes and supply chain perspective Weekly Quiz Week 6 DATA IDENTIFICATION AND APPLICATION Course Week 6 Intro KPI: Parts Five and Six Google Video: How Google is using data analytics to improve decision making? http://www.youtube.com/watch?v=l6ISTjupi5 g Weekly Reflection Paper Weekly Discussion Employee perspective Corporate and social responsibility perspective Weekly Quiz Week 7 CULMINATING PROJECT Course Week 7 Intro/Summary KPI questions – white paper KPI design – white paper DDDM WORKBOOK Complete the entire DDDM Workbook Are you using the right data

Edge AI

We will cover the following concepts with the given learning objectives:

1. [What is edge computing?](https://docs.edgeimpulse.com/docs/concepts/edge-ai-fundamentals/what-is-edge-computing)
   * Understand the differences between cloud and edge computing
   * Advantages and disadvantages of processing data on edge devices
   * What is the Internet of Things (IoT)
2. [What is machine learning (ML)?](https://docs.edgeimpulse.com/docs/concepts/edge-ai-fundamentals/what-is-machine-learning)
   * What are the differences between artificial intelligence, machine learning, and deep learning
   * Understand the history of AI
   * What are the different categories of machine learning, and what problems do they tackle
3. [What is edge AI?](https://docs.edgeimpulse.com/docs/concepts/edge-ai-fundamentals/what-is-edge-ai)
   * Articulate the difference between training and inference
   * How does traditional cloud-based AI inference work
   * What are the benefits of running AI algorithms on edge devices
   * Examples of edge AI systems
   * What are the business implications for future edge AI growth
4. [How to choose an edge AI device](https://docs.edgeimpulse.com/docs/concepts/edge-ai-fundamentals/how-to-choose-an-edge-ai-device)
   * Define and provide examples for the different edge computing devices
   * How to choose a particular edge computing device for your edge AI application
5. [Edge AI lifecycle](https://docs.edgeimpulse.com/docs/concepts/edge-ai-fundamentals/edge-ai-lifecycle)
   * How to identify a use case where edge AI can uniquely solve a problem
   * Identify constraints to edge AI implementations
   * Understand the edge AI pipeline of collecting data, analyzing the data, feature engineering, training a model, testing the model, deploying the model, and monitoring the model's performance
6. [What is edge MLOPs?](https://docs.edgeimpulse.com/docs/concepts/edge-ai-fundamentals/what-is-edge-mlops)
   * Identify the three principles of MLOps: version control, automation, governance
   * Describe the benefits of automating various parts of the edge AI lifecycle
   * Define operations and maintenance (O&M)
   * How does edge MLOps differ from cloud-based MLOps
   * Define the causes of model drift: data drift and concept drift
7. [What is Edge Impulse?](https://docs.edgeimpulse.com/docs/concepts/edge-ai-fundamentals/what-is-edge-impulse)
   * How does a short learning curve lead to faster go-to-market times
   * Articulate the advantages and disadvantages of using an edge AI platform versus building one from scratch
8. [Case study: Izoelectro](https://docs.edgeimpulse.com/docs/concepts/edge-ai-fundamentals/case-study-izoelektro)
   * How is edge AI used to detect anomalies on power lines
   * How anomaly detection on edge devices saves power over cloud-based approaches

Expert Systems

**Programming in Expert Systems**

* [CLIPS Overview](https://www.csie.ntu.edu.tw/~sylee/courses/clips/overview.htm)
* [Introduction to CLIPS](https://www.csie.ntu.edu.tw/~sylee/courses/clips/intro.htm) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter07.ppt))
* [Pattern Matching](https://www.csie.ntu.edu.tw/~sylee/courses/clips/pattern.htm) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter08.ppt))
* [Advanced Pattern Matching](https://www.csie.ntu.edu.tw/~sylee/courses/clips/advpattern.htm)
* [Modular Design and Execution Control](https://www.csie.ntu.edu.tw/~sylee/courses/clips/module.htm) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter09.ppt))
* [Efficiency in Rule-based Languages](https://www.csie.ntu.edu.tw/~sylee/courses/clips/efficiency.htm)
* [Procedural Programming](https://www.csie.ntu.edu.tw/~sylee/courses/clips/procedural.htm) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter10.ppt))
* [COOL Class and Inheritance](https://www.csie.ntu.edu.tw/~sylee/courses/clips/class.htm) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter11.ppt))
* [COOL Message Handling](https://www.csie.ntu.edu.tw/~sylee/courses/clips/message.htm)
* [Design Examples](https://www.csie.ntu.edu.tw/~sylee/courses/clips/design.htm) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter12.ppt))
  + [Clipsjni: Clips Java Native Interface](https://www.csie.ntu.edu.tw/~sylee/courses/clips/clipsjni.htm)
* [JESS : Java Expert System Shell](https://www.csie.ntu.edu.tw/~sylee/courses/jess/intro.htm)
* [JESS Object Support](https://www.csie.ntu.edu.tw/~sylee/courses/jess/object.htm)
  + [JESS Web Interface](https://www.csie.ntu.edu.tw/~sylee/courses/jess/web.htm)
  + [JESS Examples](https://www.csie.ntu.edu.tw/~sylee/jess/)
* [Introduction to Fuzzy Jess Toolkit](https://www.csie.ntu.edu.tw/~sylee/courses/FuzzyJ/FuzzyJess.htm)
* [JADE : Java Agent Development Framework](https://www.csie.ntu.edu.tw/~sylee/courses/jade/jade.htm)
* [Protege -- A Graphical Ontology Editor](https://www.csie.ntu.edu.tw/~sylee/courses/protege/protege.html)

**Part II -- Expert Systems Theory**

* [Knowledge Representation](https://www.csie.ntu.edu.tw/~sylee/courses/expert/kr.htm) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter02.ppt))
* [Knowledge Engineering](http://www.comp.dit.ie/dlawless/Downloads/Ft2284/Lectures/L17%20-%20Knowledge%20Engineering.pps) ([local](https://www.csie.ntu.edu.tw/~sylee/courses/ai/kbdss/L17%20-%20Knowledge%20Engineering.pps))
* [Methods of Inference](https://www.csie.ntu.edu.tw/~sylee/courses/expert/logic.ppt)

([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter02.ppt))

* [Reasoning Under Uncertainty](https://www.csie.ntu.edu.tw/~sylee/courses/ai/Lectures/Lecture03.pdf) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter04.ppt))  
  [Bayesian Reasoning](http://www.comp.dit.ie/dlawless/Downloads/Ft2284/Lectures/L06%20-%20Rule%20Based%20Expert%20Systems%20-%20uncertainty.pps)

([local](https://www.csie.ntu.edu.tw/~sylee/courses/ai/kbdss/L06%20-%20Rule%20Based%20Expert%20Systems%20-%20uncertainty.pps))

* [Inexact Reasoning: Certainty Factors](http://www.comp.dit.ie/dlawless/Downloads/Ft2284/Lectures/L08%20-%20Certainty%20Factors.pps)

([local](https://www.csie.ntu.edu.tw/~sylee/courses/ai/kbdss/L08%20-%20Certainty%20Factors.pps)) ([PowerPoint](https://www.csie.ntu.edu.tw/~sylee/courses/clips/PowerPoint/chapter05.ppt))

* [Fuzzy Sets](https://www.csie.ntu.edu.tw/~sylee/courses/ai/Lectures/ch02.ppt)
* [Fuzzy Rules and Fuzzy Reasoning](https://www.csie.ntu.edu.tw/~sylee/courses/ai/Lectures/ch03.ppt)
* [Fuzzy Inference Systems](https://www.csie.ntu.edu.tw/~sylee/courses/ai/Lectures/Lecture05.pdf)

Fundamental of Data Science

Foundations of Data Science (Preparatory material) • Introduction to Big Data, Data Science, and Predictive Analytics • Introduction to Azure ML Studio • Fundamentals of Data Mining • Introduction to R Programming Fundamentals of Data Science • Data Exploration, Visualization, and Feature Engineering • Hands-On Labs: Data Exploration, Visualization, and Feature Engineering • Machine Learning Fundamentals Classification Algorithms • Introduction to Predictive Modeling • Decision Tree Learning • Logistic Regression • Naïve Bayes • Hands-On Lab: Building a Classifier • Hands-On Activity: Determining the best split for Classification Models, Evaluation and Cross Validation Regression Algorithms • Linear Regression • Regularized Regression Models • Hands-On Lab: Building a Regression Model • Hands-On Activity: Evaluating Performance, Finding Maxima and Minima, Gradient Descent, Visualizing Features and Parameters Unsupervised Learning • K-Means Clustering • Hands-On Lab: Using K-Means Clustering • Text Analytics • Content-Based and Collaborative Filtering • Evaluation of Recommendation Systems. DCG, nDCG • Hands-On Lab: Analyzing a Document Collection • Hands-On Activity: Using TF-IDF and Cosine Similarity to Query a Document Collection Recommender Systems • Bootstrapping, Bagging, and Boosting • AdaBoost • Random Forests • Hands-On Lab: Building a Random Forest Classifier • Hands-On Activity: Calculating Probabilities with Binomial Distribution, Sampling with and without Replacement Ensemble Methods Operationalizing Machine Learning Models • Metrics and Methods for Evaluating Classification and Regression Models • Tuning Machine Learning Algorithm Parameters • Hands-On Lab: Building a Classification Model in Azure ML Studio • Hands-On Lab: Deploying a Predictive Model as a Service Fundamentals of Big Data Engineering • Introduction to Large-Scale Online Systems • Hive Tutorial • Hands-On Labs: Creating a Hadoop Cluster and Writing Hive Queries Handling Real-Time and Streaming Data\* • Message Queues and Real-time Analytics • Hands-On Lab: Creating a Streaming Analytics Pipeline Data Science Essentials\* • Introduction to Online Experimentation and A/B Testing • Hands-On Activity: Performing a t-Test.

Fuzzy Systems

The basic concepts of type-1, 2 fuzzy sets (membership, cardinality, normality), set operations (union, intersection, complementation), distances between fuzzy sets (Hamming distance, normalized Hamming distance, Euclidean distance, normalized Euclidean distance), similarity measures, fuzzy relation and composition, fuzzy number, fuzzy function, probability and possibility, fuzzy logic, linguistic variable, fuzzy inference, defuzzification, fuzzy control and fuzzy expert systems. Intuitionistic fuzzy sets (IFSs), distances between IFSs, similarity measures between IFSs, level cut sets, IF relation and composition, IF fuzzy number, Triangular norms, soft sets and set operations, Applications of fuzzy systems in semigroups, groups, semirings, graphs and differential equations.

Game Development

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| --- |
|  |
| 2 | Introduction to the game development life-cycle, the game loop, a brief history of how games have been developed. Basic components of a game  Sprites, animations, coordinate systems and handling input for 2D games. Introduction to Unity. Introduction to game physics, Introduction to 3D game systems and coordinates. Objects and their transformations that is rotation, scaling, translation and combinations. 3D and 2D vectors and their use. Scenes and cameras, perspective and different type of games with respect to angles. Running games, birds eye view games, racing games and more. |
| 3 | Object Collusion, Environments and Drawing the world, Particle Systems. Developing first full game, making the game run on PC and mobile phones. |
| 4 | Handling lights, particle systems, fire, smoke, water and more. Using Terrains, mountains and landscapes, placing objects like trees, stones and texturing them to create custom worlds. |
| 5 | Acquiring assets from online sources, websites, unity store and more. Importing such assets into the unity project and making a sample game. |
| 6 | Introduction to game physics, velocity, acceleration, collusion, momentum and how Unity handles it, how can we use game engines to make stunning effects in games. Materials, bounciness, elasticity, chains, ropes and hinges etc. |
| 7 | Game optimization and making sure it runs on the target platform. Ways to improve game efficiency without sacrificing a lot of quality. |
| 8 | Publishing games on different stores. Monetization models for games.  Using advertisements, in app purchases and more |
| 9 | Building humanoids for 3d games, 2 legged character design, texturing, optimization and rigging. |
| 10 | Creating animations and using the humanoids in 3D/ 2D games |
|  |  |

Game Engine Development

This is a suggested a list of topics and we will likely cover a subset based on the interests of the class and time constraints. Topics will not necessarily be presented in the order listed here. • History of Game Development • Programming for the Nintendo DS console. • Game Engine Development - Common Systems & Pitfalls • Unity 3D - A Game Engine • Real-time Rendering – The scene-graph model – Indoor real-time rendering: BSP, portal rendering – Outdoor real-time rendering: ROAM, Geomipmapping, Geoclipmaps, GPU raycasting – Character Animation: Explicit and Implicit Shading: Lighting models, NPR, Shadows, Full-screen effects, HDR, Spherical Harmonic Lighting – Physically based rendering • Physics – Basic physical concepts. – Basic properties of bodies: mass, centre of mass, moment of inertia. – Newton’s laws. – Kinematics for particles and rigid bodies. – Kinetics for particles and rigid bodies. – Collision and conservation of momentum. – Pulling it all together in an engine. – Current Physics Engines

Generative AI

Introduction to Generative AI • Introduction to generative models • Scenarios that are challenging and require Generative AI • Probability theory and generative modeling • Deep learning foundations for generative AI 2 3 • Normalizing Flow Models 4 Autoencoders and Variational Autoencoders (VAEs) • Autoregressive Models • Variational autoencoders Assignment 1 5 7 Generative Adversarial Networks (GANs) • Introduction to GANs and their components • Training GANs and improving stability • Conditional and progressive GANs Quiz 1 8 9 Transformers and Language Models • Transformers • Text generation and language modeling • Large Language Models Quiz 2 10 11 Assignment 2 12 MSE 13 • Optimization methods for generative models • Evaluation Metrics for Generative Models 14 • Data augmentation using generative models • Prompt programming and neural text decoding Assignment 3 16 Ethical Considerations in Generative AI • Bias and fairness in generative models • Privacy implications and considerations • Addressing ethical challenges in generative AI Quiz 3 17 Advances in Generative AI • Review of recent research papers and breakthroughs • Exploring cutting-edge architectures and techniques • Emerging trends and future directions in generative AI

HCI & Computer Graphics

Introduction to Human-Computer Interaction Week-2 Basic principles and guidelines of HCI Week-3 User-centered design and usability testing Week-4 Designing Effective User Interfaces Week-5 User interface design principles and guidelines Week-6 User interface prototyping Week-7 Prototyping through Wireframes Week-8 Designing for accessibility and mobile devices Week-9 Visual Design Principles for User Interfaces Week-10 Introduction to Computer Graphics 2D and 3D graphics and rendering Week-12 Animation techniques, Virtual Reality, Augmented Reality Week-13 Lighting and shading techniques Week-14 Rendering algorithms and techniques Week-15 Usability testing and evaluation Week-16 User feedback and user experience metrics

High Performance Computing

* Fundamental concepts in High Performance Computing.
* Shared memory programming (OpenMP).
* Message passing programming (MPI).
* GPU programming.
* Parallel decomposition.
* Performance measurement and analysis.
* High performance I/O.
* High performance networking.
* High Performance Computing systems.
* Typical scientific applications.

Large Langyage Model:

**Week 1**

1. Course Introduction
2. Introduction to NLP (NLP Pipeline, Applications of NLP)

**Week 2**

1. Introduction to Statistical Language Models
2. Statistical Language Models: Advanced Smoothing and Evaluation

**Week 3**

1. Introduction to Deep Learning (Perceptron, ANN, Backpropagation, CNN)
2. Introduction to PyTorch

**Week 4**

1. Word Representation

a. Word2Vec, fastText  
b. GloVe

1. Tokenization Strategies

**Week 5**

1. Neural Language Models

a. CNN, RNN  
b. LSTM, GRU

1. Sequence-to-Sequence Models, Greedy Decoding, Beam search
2. Other Decoding Strategies: Nucleus Sampling, Temperature Sampling, Top-k Sampling
3. Attention in Sequence-to-Sequence Models

**Week 6**

1. Introduction to Transformers

a. Self and Multi-Head Attention  
b. Positional Encoding and Layer Normalization

1. Implementation of Transformers using PyTorch

**Week 7**

1. Pre-Training Strategies: ELMo, BERT (Encoder-only Model)
2. Pre-Training Strategies: Encoder-decoder and Decoder-only Models
3. Introduction to HuggingFace

**Week 8**

1. Instruction Tuning
2. Prompt-based Learning
3. Advanced Prompting Techniques and Prompt Sensitivity
4. Alignment of Language Models with Human Feedback (RLHF)

**Week 9**

1. Open-book question answering: The case for retrieving from structured and unstructured sources;retrieval-augmented inference and generation
2. Retrieval augmentation techniques  
   a. Key-value memory networks in QA for simple paths in KGs  
   b. Early HotPotQA solvers, pointer networks, reading comprehension  
   c. REALM, RAG, FiD, Unlimiformer  
   d. KGQA (e.g., EmbedKGQA, GrailQA)

**Week 10**

1. Knowledge graphs (KGs)  
   a. Representation, completion  
   b. Tasks: Alignment and isomorphism  
   c. Distinction between graph neural networks and neural KG inference

**Week 11**

1. Parameter-efficient Adaptation (Prompt Tuning, Prefix Tuning, LoRA)
2. An Alternate Formulation of Transformers: Residual Stream Perspective
3. Interpretability Techniques

**Week 12**

1. Overview of recently popular models such as GPT-4, Llama-3, Claude-3,Mistral, and Gemini
2. Ethical NLP – Bias and Toxicity
3. Conclusion

**Introduction to Information Retrieval**.

Inverted indices and Boolean queries

Optimization

The term vocabulary and postings lists and Text encoding.

Optimizing indices with skip lists. Proximity and phrase queries. Positional indices.

Index construction.

Index compression, Dictionaries and tolerant retrieval. Wild-card queries, permuterm indices, n-gram indices.

Spelling correction and synonyms:

Scoring, term weighting, and the vector space model. Parametric or fielded search. Document zones.

The vector space retrieval model.

Computing scores in a complete search system

K Nearest Neighbors, Decision boundaries, Vector space classification using centroids. Comparative results

Latent semantic indexing (LSI). Applications to clustering and to information retrieval.

MLOps

Introduction to Web Scraping Introduction to web langages Web Scraping with Beautiful Soup library Web Scraping of Google searches, Linux System and Bash Script , Presentation of Linux System Handling and use of a terminal Implementation of Bash scripts, Setting up unit tests with Pytest Introduction to integration tests and their functions Presentation of the benefits of testing : Discovering collaborative work on Git and Github Management of Git projects with the repository system File and project sharing with the push function Updating your local repository with the pull Participation in the improvement of public projects Introduction to workflows and their automation with Github Actions Web Scraping Linux System and Bash Script Git and Github Unit Testing Master the Linux operating system Learn to use a terminal Create and manage Bash executables Master the versioning tools Cooperate and save projects with Git and Github Automate workflows with Github Actions Understand how workflows work in general and CI/CD in particular Be able to manage unit tests Verify the functioning of independent code units during development Master the Beautiful Soup library for Web Scraping Setting of a Git account Discovery of the branch principle and the systems that result from it Time saving Legibility Quality Code improvement

**Swarm Intelligence**

Course topics: There are four main topics:

1. Agent-based modeling: Bottom-up modeling method. individual agents. System theory and complex systems. Multi-agent systems.
2. Behavioral swarm intelligence: Modeling flocking behavior. Boids model. Flocking behavior applications, such as agents queuing and homing.

3. Computational swarm intelligence (CSI): Optimization theory and multi-objective optimization. Particle swarm optimization (PSO) Ant colony optimization (ACO). Bees colony algorithm (BCO). Bats algorithm

4. Selected applications: Different selected application where the students can apply the swarm intelligence algorithms to solve real problems, such as:

* Multi-robot path planning
* Task scheduling.
* Etc.

**Vulnerability Assessment &  Reverse Engineering**

* Intro to Intel Assembly
* Disassembly Process and Algorithms
* Integer Errors
* Source Code Analysis
* Binary Analysis
* Stripped Binary Analysis
* Debugging Demystified
* ASLR/DEP/CFG
* ROP/SEH
* OS Internals
* Malware
* Advanced Malware Analysis
* Fuzzing
* Advanced RE Topics

Recommender Systems

* Content-based Filtering
* Collaborative Filtering
* Exploration vs. Exploitation
* Evaluation Methodology and Metrics Personalization
* Context-awareness
* Natural Language Processing
* Ethical Considerations
* Generative AI
* Multi-objective Recommendation