

4.3.2. Elective Courses

CAI4106 Explainable AI (XAI)

COURSE INFORMATION							
Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.	
	Year	Semester	Lecture	Tutorial	Laboratory		
CAI3101	4	7/8	2	2	0	3	
COURSE AIM							
- To familiarize students with the concepts and advances in explainable artificial intelligence (XAI). - To explore different interpretable models and post hoc explanations in AI. - To understand the relationships between explainability, fairness, robustness, and privacy in AI systems. - To analyze and interpret the behavior of large generative models like GPT and DALLE 2.							
COURSE WEEKLY CONTENTS							
1 Introduction to Explainable AI (XAI): Overview and Importance							
2 Interpretable Models in AI: Rule-based and Prototype-based Models							
3 Feature Attributions and Counterfactual Explanations							
4 Mechanistic Interpretability: Understanding the Inner Workings							
5 The Connection Between Explainability, Fairness, and Privacy							
6 Robustness in AI Models: Analysis and Approaches							
7 Mid-term Review Session							
8 Understanding Large Language Models: Case Study on GPT							
9 Interpreting Behaviour of Generative Models: DALLE 2 and Others							
10 Challenges in Explainability of Complex Models							
11 Ethical Considerations in Explainable AI							
12 Student Project Presentations							
13 Case Studies in XAI: Real-world Applications							
14 Guest Lecture/Workshop on Advanced Topics in XAI							
15 Revision and Recap of Course Content							
STUDENT GRADING & ASSESSMENT							
Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40
REFERENCES							
Textbook	"Interpretable Machine Learning: A Guide for Making Black Box Models Explainable" by Christoph Molnar. This book is a comprehensive resource on the methods and importance of explainability in AI, making it highly suitable for this course.						

CAI4107 Reinforcement Learning and Decision Making

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3103	4	7/8	2	2	0	3

COURSE AIM

- Understand the concepts and principles of reinforcement learning and decision-making.
- Gain proficiency in applying reinforcement learning and decision-making algorithms to solve complex problems.
- Develop the ability to analyze decision problems and make optimal choices under uncertainty.
- Learn about advanced topics and recent research developments in reinforcement learning and decision-making.
- Understand the fundamental concepts and theories of decision-making.
- Gain proficiency in applying decision-making models and frameworks.
- Develop critical thinking and analytical skills for making optimal decisions.
- Learn about decision biases and heuristics that affect decision-making.

COURSE WEEKLY CONTENTS

- 1 Introduction to Reinforcement Learning
- 2 Markov Decision Processes (MDPs)
- 3 Dynamic Programming Methods
- 4 Monte Carlo Methods
- 5 Temporal Difference Learning
- 6 Deep Reinforcement Learning
- 7 7th Assessment and Introduction to Decision Making
- 8 Decision-Making and Data Analytics
- 9 Temporal Difference Learning for Decision Making
- 10 Decision Making under Uncertainty
- 11 Fuzzy Logic in Decision Support Systems
- 12 12th Assessment and The Most Popular Applications of Reinforcement Learning
- 13 Advanced Reinforcement Learning Algorithms
- 14 Reinforcement Learning and Decision-Making Integration
- 15 Revision

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		3 0	MARKS		→	30
8 to 12	←		2 0	MARKS		→	20
1 to 15	←		1 0	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

- Textbook** Szepesvári, C., "Algorithms for Reinforcement Learning", Morgan and Claypool Publishers, 2010
 Sutton, R. S., & Barto, A. G., "Reinforcement Learning: An Introduction" MIT Press, 2018
 Bertsekas, D. P., "Reinforcement Learning and Optimal Control.", Athena Scientific, 2020.

CAI4108 Generative Models and Adversarial Networks

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3103	4	7/8	2	2	0	3

COURSE AIM

- To introduce students to Generative Adversarial Networks (GANs) and their applications in various domains.
- To provide students with an understanding of the theoretical foundations, architectural complexities, and practical implementations of GANs.
- To explore the diverse applications of GANs in image synthesis, style transfer, data augmentation, and beyond.

COURSE WEEKLY CONTENTS

- 1 Introduction to Generative Models: Overview and Importance
- 2 Understanding Neural Networks: Basics and Architectural Considerations
- 3 Introduction to Generative Adversarial Networks (GANs)
- 4 Training GANs: Loss Functions and Optimization Techniques
- 5 Architectural Variants of GANs: DCGAN, WGAN, etc.
- 6 Applications of GANs in Image Synthesis and Data Augmentation
- 7 Mid-term Review Session
- 8 Style Transfer and Domain Adaptation using GANs
- 9 Adversarial Attacks and Defenses in Neural Networks
- 10 Ethical Considerations in the Use of Generative Models
- 11 Advanced Topics in GANs: Conditional GANs, Progressive GANs, etc.
- 12 Case Studies in Generative Models: Real-world Applications
- 13 Guest Lecture/Workshop on Cutting-edge Research in Generative Models
- 14 Challenges and Limitations of Generative Models
- 15 Revision and Recap of Course Content

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook Goodfellow, I., Bengio, Y., & Courville, A. "Deep Learning". MIT Press. (2016).

CAI4202 Natural Language Generation (NLG)

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI4201	4	7/8	2	2	0	3

COURSE AIM

To get students to:

- Define Natural Language Generation (NLG)
- Identify the key components of NLG systems
- Explain the role of syntax, semantics, and pragmatics in NLG
- Understand the importance of grammar in NLG
- Explore data sources for NLG
- Understand techniques for data pre-processing in NLG
- Differentiate between rule-based, machine learning, and deep learning NLG approaches
- Explore NLG algorithm applications in real-world scenarios
- Apply knowledge gained in previous modules to a real-world project

COURSE WEEKLY CONTENTS

- 1 Course Aim, Course outlines, understanding what is Natural Language Generation
- 2 NLG Components and Systems
- 3 Differences between NLG, NLP, and ML
- 4 NLG in comparison to NLU
- 5 Linguistic Elements in NLG
- 6 NLG Applications with Linguistic Principles
- 7 Data Sources for NLG
- 8 Evaluating the impact of different preprocessing techniques
- 9 NLG Algorithms
- 10 Comparing NLG algorithms
- 11 NLG algorithms in Chatbot and content generation
- 12 Ethical considerations in NLG
- 13 Analyzing NLG outputs for potential biases
- 14 Outlining the NLG algorithm and data preprocessing pipeline
- 15 Exploring posted studies papers related to NLG.

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	Ehud Reiter, Robert Dale "Building Natural Language Generation Systems (Studies in Natural Language Processing)", 1st edition, Cambridge University Press, 2000.
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CAI4406 Game Theory and AI

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI4406	4	7/8	2	2	0	3

COURSE AIM

- Understand the mathematical foundations of strategic decision-making in multi-player environments, including concepts such as Pareto optimality and Nash equilibrium.
- Apply advanced game-theoretic techniques, including mixed-strategy Nash equilibria and Bayesian games, to analyze complex strategic interactions.
- Demonstrate proficiency in modeling and analyzing strategic situations using mathematical tools and frameworks.
- Evaluate the role of artificial intelligence in optimizing strategies and decision-making processes in dynamic environments such as auctions, marketplaces, and social networks.
- Apply AI algorithms and techniques to solve strategic decision-making problems, including optimization, prediction, and learning.
- Critically assess the limitations and challenges of applying game theory and AI in real-world settings, considering factors such as incomplete information, uncertainty, and strategic behavior.
- Synthesize and communicate complex concepts related to strategic decision-making and AI through written reports, presentations, and discussions.
- Explore interdisciplinary connections between game theory, artificial intelligence, and other fields such as economics, computer science, and social sciences.

COURSE WEEKLY CONTENTS

- 1 Introduction to Strategic Decision Making
- 2 Pareto Optimality and Social Welfare
- 3 Nash Equilibrium and Multi-Player Games
- 4 Mixed-Strategy Nash Equilibria
- 5 Bayesian Games
- 6 Strategic Decision Making in Auctions
- 7 Strategic Decision Making in Marketplaces
- 8 Strategic Decision Making in Social Networks
- 9 Reinforcement Learning for Strategic Decision Making
- 10 Evolutionary Game Theory
- 11 Algorithmic Mechanism Design
- 12 Strategic Decision Making in Dynamic Environments
- 13 Ethical Considerations in Strategic Decision Making
- 14 Future Directions and Applications
- 15 Revision

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	Noam Nisan, Tim Roughgarden, Eva Tardos, and Vijay V. Vazirani, "Algorithmic Game Theory", Cambridge University Press, 2007
	Steven Tadelis, "Game Theory: An Introduction" Princeton University Press; First Edition, 2013

CAI4602 AI Ethics and society

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3101	4	7/8	2	2	0	3

COURSE AIM

- To get the students to:
 - Participate in deep discussions and analyses of AI's influence on privacy, employment, and cultural dynamics
 - Emerge with a holistic perspective on AI's place in society.
 - Understand the different AI/ML Techniques.

COURSE WEEKLY CONTENTS

1	How to think like an ethicist: introduction to critical thinking and ethical reasoning; why we shouldn't be ethical relativists.
2	Ethical issues in AI: privacy, transparency, explainability.
3	Ethical issues in AI: fairness, bias and regulation of AI technologies.
4	Introduction to Law and AI: application of general principles and emerging regulatory initiatives.
5	Data Collection
6	Descriptive Statistics
7	Inferential Statistics: Sampling Bias
8	Inferential Statistics: Causation vs. Correlation
9	Inferential Statistics: Confidence.
10	AI/ML Techniques: Word Embedding, Facial Recognition.
11	AI/ML Techniques: Predictive Algorithms, Crime-based Predictive Algorithms.
12	Bias in Predictive Algorithms.
13	AI/ML Techniques for Bias Mitigation.
14	AI, Society, and Ethics Wrap-up
15	Case study (TBC).

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	O'neil, Cathy, "Weapons of math destruction: How big data increases inequality and threatens democracy". Crown, 2017. Zerilli, John, et al. "Transparency in algorithmic and human decision-making: is there a double standard?" Philosophy & Technology 32 (2019): 661-683. Wong, Pak-Hang. "Democratizing algorithmic fairness." Philosophy & Technology 33 (2020): 225-244..
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CAI4501 Human-Robot Interaction

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3101 & CAI3401	4	7/8	2	2	0	3

COURSE AIM

- To explore the multidisciplinary field of Human-Robot Interaction (HRI).
- To understand the principles and techniques from engineering, computer science, robotics, psychology, sociology, and design that contribute to HRI.
- To provide students with the foundation to develop robot systems capable of natural and effective interaction with humans.

COURSE WEEKLY CONTENTS

1	Introduction to Human-Robot Interaction (HRI): Concepts and Importance
2	Multidisciplinary Perspectives in HRI: Engineering, Computer Science, Robotics, Psychology, Sociology, and Design
3	Understanding Human Behavior and Cognition in HRI
4	Design Principles for Human-Centric Robotics
5	Robot Perception and Sensing for Interaction
6	Robot Control and Behavior for Effective Communication
7	Mid-term Review Session
8	Socially Assistive Robotics: Applications and Challenges
9	Ethical Considerations in Human-Robot Interaction
10	User-Centered Design and Evaluation Methods in HRI
11	Human Factors and Ergonomics in Robot Design
12	Cultural and Contextual Adaptation in HRI
13	Collaborative and Cooperative Robotics
14	Case Studies and Real-world Applications of Human-Robot Interaction
15	Future Directions and Trends in HRI.

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	N. Correll, B. Hayes, and A. Tow, Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms. Publisher: CRC Press, Year: 2019.
	K. Dautenhahn and J. Saunders, Human-Robot Interaction: An Introduction. Publisher: Cambridge University Press, Year: 2016.

CAI4701 AI in Healthcare

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3101 & EBA2203	4	7/8	2	2	0	3

COURSE AIM

This course aims to:

- Introduce AI concepts relevant to healthcare applications
- Cover AI algorithms for medical imaging analysis
- Teach predictive analytics in healthcare
- Explore AI applications in drug discovery
- Address ethical and legal considerations in AI healthcare
- Present case studies and real-world applications of AI in healthcare

COURSE WEEKLY CONTENTS

- 1 Course Aim, Course outlines, understanding what is AI in Healthcare
- 2 How Artificial Intelligence Is Changing Health and Health Care
- 3 Machine Learning for Healthcare (Supervised and unsupervised learning)
- 4 Machine Learning for Healthcare (Reinforcement learning and other models)
- 5 Deep Learning for Healthcare (ANNs and CNNs)
- 6 Deep Learning for Healthcare (RNNs) and Autoencoders)
- 7 Medical Image Analysis (e.g., tumor detection, disease diagnosis)
- 8 Electronic Health Records (EHR) analysis (e.g., risk prediction, personalized medicine)
- 9 Drug Discovery and Development
- 10 Medical Robotics
- 11 Predictive Analytics in Healthcare
- 12 Potential Trade-Offs and Ethical Considerations of AI in Healthcare
- 13 The Future of AI in Healthcare
- 14 Case Study: AI in Healthcare part 1
- 15 Case Study: AI in Healthcare part 2

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	Adam Bohr and Kaveh Memarzadeh, "Artificial Intelligence in Healthcare", Academic Press, Elsevier, 2020.
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CAI4702 IoT and AI Integration

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3101 & CCS2201	4	7/8	2	2	0	3

COURSE AIM

- Understand the fundamental concepts of the Internet of Things (IoT) and the applications of the IoT and AI Integration (AIoT)
- Study the basic architecture and core modules of IoT including the protocols and platforms for sensing, networking and data analytics
- Explore potential scenarios where AI can be effectively applied in the context of IoT, and implement AIoT methods and techniques to address diverse and complex challenges in practical IoT applications.
- Learn how to deploy AI models and techniques for the enhancement of IoT operations such as efficiency improvement, cost reduction or event detection.
- Acquire the skills to implement Distributed Intelligence on the edge of IoT systems.

COURSE WEEKLY CONTENTS

- 1 Course Aim, Course outlines, understanding what is IoT and AI integration (AIoT)
- 2 IoT architecture, core modules and use cases.
- 3 IoT Protocols for sensing and networking
- 4 Big Data and IoT – Infusion of AI in IoT
- 5 Machine Learning for IoT
- 6 Machine Learning for IoT
- 7 Deep Learning for IoT
- 8 7th week Assessment
- 9 Deep Learning for IoT
- 10 Generative Models for IoT
- 11 Distributed AI for IoT
- 12 12th week Assessment
- 13 Security Challenges in AIoT- Implementing secure AI models for IoT
- 14 Emerging Technologies for AI in IoT
- 15 State of the art and Future trends in Industry and Market

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	Coulouris G., Jean Dollimore J., Kindberg T., and Blair G., Distributed Systems: Concepts and Design, Addison-Wesley.
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CAI4703 Evolutionary Algorithms and Swarm Intelligence

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3101	4	7/8	2	2	0	3

COURSE AIM

- Understand the fundamental principles and concepts of evolutionary computation
- Comprehend the principles and techniques of genetic programming
- Familiarize students with evolutionary strategies and evolutionary programming
- Understand the principles and mechanisms of particle swarm optimization
- Comprehend the principles and mechanisms of ant colony optimization
- Understand the principles and strategies of differential evolution
- Gain knowledge of multiobjective optimization concepts and techniques, apply evolutionary algorithms to solve multiobjective optimization problems
- Comprehend the principles and coordination strategies of swarm robotics
- Familiarize students with cultural algorithms and memetic computing
- Comprehend the principles and techniques of artificial bee colony optimization
- Understand the principles and mechanisms of coevolutionary algorithms
- Familiarize students with hybrid evolutionary algorithms

COURSE WEEKLY CONTENTS

- 1 Introduction to Evolutionary Computation
- 2 Genetic Programming
- 3 Evolutionary Strategies and Evolutionary Programming
- 4 Particle Swarm Optimization
- 5 Ant Colony Optimization
- 6 Differential Evolution
- 7 1st midterm assessment
- 8 Multiobjective optimization using evolutionary algorithms
- 9 Swarm Robotics
- 10 Cultural Algorithms and Memetic Computing
- 11 Optimization of artificial bee colonies
- 12 2nd midterm assessment
- 13 Coevolutionary Algorithms
- 14 Hybrid and Ensemble Approaches
- 15 Revision

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	YANG, Xin-She (ed.). Nature-inspired computation and swarm intelligence: Algorithms, theory and applications. 2020.
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CAI4109 Federated Learning

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3101	4	7/8	2	2	0	3

COURSE AIM

- Learn the concept of Federated Learning
- Understand decentralized federated optimization techniques
- Describe Federated Learning architectures
- Elaborate on Differential Privacy on Federated Learning
- Understand Federated Learning utilization in IoT, Autonomous, and Edge Computing Systems
- Develop Federated Learning programs for NLP and Computer Vision systems
- Implement Transfer Learning and Reinforcement Learning mechanisms for Federated Learning solutions
- Apply adaptive resource allocation approaches in Federated Learning framework
- Recognize the ethical considerations and challenges facing Federated Learning

COURSE WEEKLY CONTENTS

- 1 Introduction to Federated Learning
- 2 Decentralized Federated Optimization
- 3 Federated Learning Architectures
- 4 Systems Heterogeneity and Secure Aggregation
- 5 Differential Privacy
- 6 Communication and Synchronization
- 7 1st midterm assessment
- 8 Federated Learning in IoT, Autonomous, and Edge Computing Systems
- 9 Federated Learning in NLP and Computer Vision
- 10 Federated Transfer Learning
- 11 Federated Reinforcement Learning
- 12 2nd midterm assessment
- 13 Adaptive Resource Allocation in Federated Learning
- 14 Ethical Considerations and Challenges in Federated Learning
- 15 Revision

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	Heiko Ludwig and Nathalie Baracaldo, "Federated Learning: A Comprehensive Overview of Methods and Applications", Springer Nature, 2022, ISBN 9783030968960.
	Saravanan Krishnan, A. Jose Anand, R. Srinivasan, R. Kavitha, and S. Suresh, "Handbook on Federated Learning: Advances, Applications and Opportunities", CRC Press, 2023, ISBN 9781003837503.

CAI4704 AI in Bioinformatics

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3101 & EBA2203	4	7/8	2	2	0	3

COURSE AIM

This course aims to:

- Introduce the basic concepts and challenges in bioinformatics
- Cover machine learning algorithms and their applications in bioinformatics
- Discuss deep learning techniques and their use in genomics and proteomics
- Explore network analysis and systems biology in the context of bioinformatics
- Present practical applications and case studies of AI in bioinformatics
- Provide hands-on experience through assignments and projects

COURSE WEEKLY CONTENTS

- 1 Course Aim, Course outlines, understanding what is AI in Bioinformatics
- 2 Introduction to Bioinformatics
- 3 Machine Learning for Bioinformatics (Supervised and unsupervised learning)
- 4 Machine Learning for Bioinformatics (Reinforcement learning and other models)
- 5 Deep Learning for Bioinformatics (ANNs and CNNs)
- 6 Deep Learning for Bioinformatics (RNNs) and Autoencoders)
- 7 Sequence Analysis
- 8 Gene Expression Analysis
- 9 Gene Ontology and Enrichment Analysis
- 10 Protein Structure Prediction and Modeling
- 11 Protein Function Prediction
- 12 AI in Drug Discovery and Precision Medicine
- 13 Network Analysis in Bioinformatics
- 14 Multi-Omics Data Analysis
- 15 Ethical Considerations of AI in Bioinformatics

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	Mario Cannataro, Pietro Hiram Guzzi, Giuseppe Agapito, Chiara Zucco, Marianna Milano, "Artificial Intelligence in Bioinformatics: From Omics Analysis to DeepLearning and Network Mining", Academic Press, Elsevier, 2022.
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CCS4210 High Performance Computing

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CCS3203	4	7/8	2	2	0	3

COURSE AIM

To get the students to:

- Understand different parallel programming models
- Learn parallel program design techniques
- Understand high performance computing metrics
- Experiment with multicore programming
- Experiment with GPU programming
- Apply high performance computing in difference scenarios and case studies

COURSE WEEKLY CONTENTS

- 1 Course outline and syllabus discussion
- 2 High performance computing basics
- 3 Multicore and parallel program design (1/2)
- 4 Multicore and parallel program design (2/2)
- 5 Threads and Concurrency
- 6 Parallel Data Structures
- 7 Distributed Memory Programming (1/3)
- 8 Distributed Memory Programming (2/3)
- 9 Distributed Memory Programming (3/3)
- 10 GPU Programming (1/3)
- 11 GPU Programming (2/3)
- 12 GPU Programming (3/3)
- 13 Shared Memory Programming
- 14 HPC case studies
- 15 HPC case studies.

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	Gerassimos Barlas, "Multicore and GPU Programming: An Integrated Approach", 2 nd Edition, Elsevier, 2022. Robert Robey and Yuliana Zamora, "Parallel and High Performance Computing", Manning, 2021.
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CIS4103 Big data Analytics

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CAI3101 & EBA2203	4	7/8	2	2	0	3

COURSE AIM

1. Discovering Big Data's fundamental concepts and what makes it different from previous forms of data analysis and data science. Analyze typical decision situations to support them with computer technology.
2. Understanding the business motivations and drivers behind Big Data adoption, from operational improvements through innovation.
3. Planning strategic, business-driven Big Data initiatives.
4. Addressing considerations such as data management, governance, and security.
5. Recognizing the 5 "V" characteristics of datasets in Big Data environments: volume, velocity, variety, veracity, and value.
6. Clarifying Big Data's relationships with OLTP, OLAP, ETL, data warehouses, and data marts.
7. Working with Big Data in structured, unstructured, semi-structured, and metadata formats.
8. Increasing value by integrating Big Data resources with corporate performance monitoring.
9. Understanding how Big Data leverages distributed and parallel processing.
10. Using NoSQL and other technologies to meet Big Data's distinct data processing requirements.
11. Leveraging statistical approaches of quantitative and qualitative analysis.
12. Applying computational analysis methods, including machine learning.

COURSE WEEKLY CONTENTS

- 1 Big Data Concepts and Terminology
- 2 Big Data Characteristics
- 3 Different Types of Data
- 4 Business Motivations and Drivers for Big Data Adoption
- 5 Big Data Analytics Lifecycle
- 6 Big Data BI
- 7 Big Data BI (cont.)
- 8 Data Visualization for Big Data
- 9 Big Data Storage Concepts
- 10 Big Data Processing Concepts
- 11 Big Data Processing Concepts
- 12 Big Data Analysis Techniques
- 13 Big Data Analysis Techniques (cont.)
- 14 Projects Discussion
- 15 Revision

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook EMC Education Services, Data Science and Big Data Analytics, Wiley

CCY4303 AI in Cybersecurity

COURSE INFORMATION

Prerequisites	Academic Year & Level		Teaching Methods			Credit Hrs.
	Year	Semester	Lecture	Tutorial	Laboratory	
CCY2001 & CAI3101	4	7/8	2	2	0	3

COURSE AIM

To get the students to:

- Learn how to make use of AI in solving cybersecurity problems.
- Know the principles of AI and different neural network architectures
- Explore high-level security protocols
- Understand compliance and security assessment.
- How to secure websites by injecting AI techniques
- How to detect patterns and model behavior and identify anomalous behavior

COURSE WEEKLY CONTENTS

	Course Aim, Course outlines, and the principles of artificial intelligence, concentrating on
1	cybersecurity-related applications
2	Different cryptographic techniques and some major attacks
3	Neural network architectures such as ANN, CNN, and GAN
4	Detecting Spams with AI techniques
5	7 th week Assessment
6	Detecting Phishing with AI techniques.
7	Malware Threats detection
8	Network Anomalies detections
9	Machine Learning for fraud detection
10	12 th week Assessment
11	Evaluating AI algorithms.
12	Web application security, i.e. injection and broken authentication
13	Securing IOT infrastructure.

STUDENT GRADING & ASSESSMENT

Weeks	Exams	Assign.	Quizzes	Reports	Present.	Lab.	Total
1 to 7	←		30	MARKS		→	30
8 to 12	←		20	MARKS		→	20
1 to 15	←		10	MARKS		→	10
16 or 17	40	Final					40

REFERENCES

Textbook	Alessandro Parisi, " Hands-On Artificial Intelligence for Cybersecurity: Implement Smart AI Systems for Preventing Cyber Attacks and Detecting Threats and Network Anomalies ", 1 st ed., Packt Publishing, 2019.
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