Programme Manual

B.Sc. Data Science

1.0   THE MISSION OF THE BSC DATA SCIENCE PROGRAMME

The undergraduate programme in Data Science is aimed at developing competent, creative, innovative, entrepreneurial and ethically-minded persons, capable of creating value in the diverse fields of Data science.

2.0   THE PHILOSOPHY OF PROGRAMME

The fundamental aim of the program is tied to that of the University and it is to form competent and socially responsible data scientists who are committed to the promotion of the common good of society and the advancement of the Data Science profession. The programme is geared towards equipping the students with the foundations, methods, and implications of data science that extracts knowledge from data using techniques and theories from mathematics, statistics, computing, and information technology.

The programme is largely driven by the need to facilitate, through adequate theoretical and practical training, the emergence of competent professionals in the area of data science. The programme aims to build new generation of data scientists that can favourably compete with peers from any reputable institutions in the world. As a fundamental principle, the programme emphasizes interactions between the industry players, lecturers and students, with the goal of ensuring relevance to the industry as well as driving the innovation needs of the industry. Together with the technical skills and competencies, the programme also places emphasis on a holistic development of the positive character traits of the students. Hence, the curriculum will be suffused with courses that deal with human values, analytical and critical thinking. Such traits could be critical success factors in the team work required for professional success in the workplace.

3.0   GUIDING PRINCIPLES FOR THE PROGRAMME

The following basic points are the guiding principles for the programme:
   a) The programme will impart an education that is relevant to the needs of the nation and of international standard. The relevance of the programme's content will be ensured by fostering a strong relationship with the industry.
   b) The programme will give particular emphasis to teaching and research. The academic staff will be encouraged to engage in research and attend conferences of relevance across the world. This is expected to ensure a continuous improvement in their teaching and maintain its relevance to the needs of the nation.
   c) The programme will be concerned with the integral formation of the individual and will lay special emphasis on the development of values and ideals. Professional ethics will permeate all teaching activities in the programme.

4.0   GOALS OF THE PROGRAMME

The specific objectives of the Data Science programme for students are to:

a) provide students with the requisite skills needed to analyse real life problems that are computationally intensive and independently develop effective data-driven solutions for them;

b) imbibe students with the skills required to play significant roles in the four A's of data: architecture, acquisition, analysis and archiving; making them qualified for specialist Data Science jobs in the industry;

c) provide students with the necessary training and competency to dig out hidden information in the massive data of business, government, healthcare, schools, and other areas of data engineering, big data and data analytics;

d) train students on integrating data-driven Information Technology solutions and business processes to meet the information needs of businesses and other organisations, enabling them to achieve their objectives in an effective, efficient way;

e) provide the students with the necessary training to acquire deep knowledge of machine learning algorithm creation and application for data science.

5.0   ADMISSION AND GRADUATION REQUIREMENTS

5.1.   Admission and Matriculation Requirements

The entry requirements shall be at least credit level passes in five subjects including English Language, Mathematics, and Physics to form the core subjects with credit in any other two relevant science subjects, at the Senior Secondary School Certificate or its equivalent in not more than two sittings. In addition, an acceptable pass (currently 220) in the Unified Tertiary Matriculation Examination (UTME), with relevant subject combination is required for Admission into 100 Level.

Candidates with two A level passes (graded A-E) at the GCE Advanced Level in relevant subjects (Chemistry, Mathematics, Physics, Statistics) may be admitted into 200-level. This is in addition to fulfilling the requirement of a minimum of credit level passes in five relevant subjects at SSCE or WASCE/GCE 'O' Level as indicated above. Other tertiary level qualifications such as OND, HND may be considered for direct entry as well.

5.2.   The Semester Course System

The undergraduate programme in Data Science will be run on the semester course basis, and there will be two semesters in the academic year. Instruction in the programme shall be by courses, and it will be mandatory for students to take an approved combination of courses in any semester.

An evaluation of the courses will be carried out in terms of course units. For this purpose, one course unit is defined as one lecture/seminar/tutorial hour or three hours of practical class per week, for the duration of a semester. Ordinarily, students shall be expected to register for a prescribed number of units in each academic year. This number will be determined by Senate from time to time, based on the recommendation of the School Board.

There shall be four levels of courses in line with the years of study. The levels shall be numbered respectively as 101-199, 201-299, 301-399 and 401-499. Each of these numbers shall be prefixed by a two or three letter subject code.

Students will be required to complete their registration for the courses within the period stipulated by the school. Amendment of this registration will be allowed through the addition or deletion of courses but it must take place within three weeks of the commencement of lectures.

Direct entry and transfer students that enter into the second year of the programme will have to take some compulsory courses from the first year prior to their graduation from the University. However, if the Faculty Board assesses that a student has done any of the courses elsewhere, such a student will be exempted from taking the course.

5.3. Examinations and Grading System

At the end of each semester, students will be examined on all the courses they have registered for and been taught during that period. They shall subsequently be credited with the number of course units assigned to the courses that they pass.

The assessment of students will be based on a combination of continuous assessment (tests, assignments, etc.), class participation and examinations. To be eligible to sit for any examinations, students will be expected to attend a minimum of 80% of the lectures of any course registered for. All courses registered for will be taken into consideration during the computation of results. Students will not be credited for courses that they did not register for even if they are inadvertently allowed to take the examinations and pass them.

Failure to take the examination in a course for which one has registered will attract a score of 0.0, which will have the consequent effect of lowering the student's Grade Point Average.

Special examinations to enable a student graduate may in exceptional circumstances be held by order of Senate. Grades will be awarded based on the scores of the students as follows:

Percent Score	Grade point	Letter Grade
70 -100	5.0	A
60 – 69	4.0	B
50 – 59	3.0	C
45 - 49	2.0	D
0 – 44	0.0	F

For the purpose of description, a score below 2.0 Grade Point (from letter grade D) constitutes a failure. The following qualifications shall be applied to the grades:

A	Excellent
B	Good
C	Fair
D	Pass
F	Failed

To obtain the Cumulative Grade Point Average (CGPA) of the student, the grade point assigned to the mark obtained in each course is multiplied by the units of that course. The total from all the courses is added up to give the total weighted grade point. This total is then divided by the total number of units taken by the student to give the grade point average.

5.4.   Retention and Progression

To remain in the school, students will be required to ensure that their CGPA does not fall below 1.5. If a student's CGPA falls below 1.5, the student will be placed on probation. If the student fails to improve and, after one semester of probation, his/her CGPA remains below 1.5, that student will be asked to withdraw. A student on probation will not be permitted to register for more than 18 units.

5.5. Period of Study and Requirements for the Award of a Degree

The normal period of study for an honours degree shall be eight semesters for 100 level entrants and six semesters for direct level entrants. In order to be eligible for graduation, the student must pass all the compulsory courses, the minimum number of which is 75 credit units. Additional number of credit units required for graduation will be as stipulated by the Senate of the University. The determination of the class of degree shall be based on the weighted grade points of all the courses taken, including the courses that are repeated. The award of the degree with honours shall be dependent on the student having obtained a Cumulative Grade Point Average of at least 2.0 in addition to fulfilling other minimum requirements for an honours degree. The following classes of degree are approved for the CGPA indicated:

Class of Degree	Cumulative GPA
First Class	4.5 – 5.0
Second Class (Upper Division)	3.5 – 4.49
Second Class (Lower Division)	2.4 – 3.49
Third Class	1.5 – 2.39

The maximum number of semesters for the award of an honours degree shall be ten semesters. A student who spends more time than this to complete the degree programme will ordinarily not be eligible for an honours classification.

5.6. Curriculum for B.Sc. Degree in Data Science in agreement with the NUC CCMAS Standards

NOTE the following legend for the list of courses below:

C = Compulsory Course – A course which every student must compulsorily take and pass in any particular programme at a particular level of study.

E = Elective Course – A course that students take within or outside the faculty (school). Students may graduate without passing the course provided the minimum credit unit for the course had been attained.

LH   = Lecture Hours per semester
PH   = Practical Hours per semester

B.Sc. DATA SCIENCE PROGRAMME STRUCTURE

100 LEVEL

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	0
MTH 101	Elementary Mathematics I	2	C	30	0
MTH 102	Elementary Mathematics II	2	C	30	0
PHY 101	General Physics I	2	C	30	0
PHY 102	General Physics II	2	C	30	0
PHY 107	General Practical Physics I	1	C	0	45
PHY 108	General Practical Physics II	1	C	0	45
STA 111	Descriptive Statistics	3	C	45	0
COS 101	Introduction to Computing Sciences	3	C	30	45
COS 102	Problem Solving	3	C	30	45
PAU-DTS 111	Introduction to Software Packages	3	C	30	45
PAU-DTS 112	UI/UX Design Essentials	3	C	30	45
PAU-DTS 114	Introduction to Information Systems	2	C	30	
PAU-DTS 192	Introduction to Christian Theology	2	C	30	
	TOTAL	**33**			

200 LEVEL

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	0
ENT 211	Entrepreneurship and Innovation	2	C	30	0
MTH 201	Mathematical Methods I	2	C	30	0
MTH 203	Sets, Logic and Algebra I	2	C	30	0
MTH 209	Introduction to Numerical Analysis	2	C	30	0
COS 201	Computer Programming I	3	C	30	45
COS 202	Computer Programming II	3	C	30	45
DTS 201	Introduction to Data Science	2	C	15	45
DTS 204	Statistical Computing Inference and Modelling	3	C	45	0

DTS 211	Introduction to R Programming	2	C	15	45
DTS 299	SIWES I	3	C	0	135
CSC 203	Discrete Structures	2	C	30	0
PAU-DTS 216	Survey of Tools and Platforms for Data Science	3	C	30	45
PAU-DTS 212	Computer Graphics	3	C	30	45
PAU-DTS 214	Computer Security Fundamentals	2	C	30	
PAU-DTS 292	The Nature of Human Beings	2	C	30	
PAU-DTS 293	English for Business Purposes	2	C	30	
	TOTAL	**40**			

300 LEVEL

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolution	2	C	30	0
ENT 312	Venture Creation	2	C	15	45
DTS 302	Big Data Computing	2	C	15	45
DTS 304	Data Management I	3	C	15	45
DTS 308	Ethics and Legal Issues in Data Science	2	C	30	0
DTS 316	Probability for Data Science	3	C	45	0
DTS 322	Data Science Innovation and Entrepreneurship	2	C	15	45
DTS 399	SIWES II	3	C	0	135
CYB 201	Introduction to Cybersecurity and Strategy	2	C	30	0
PAU-DTS 311	Artificial Intelligence	2	C	15	45
PAU-DTS 312	Machine Learning	2	C	15	~~45~~
PAU-DTS 313	Formal Methods	2	C	30	
PAU-DTS 314	Deep Learning	2	C	15	45
PAU-DTS 392	Professional and Personal Skills	2	C	30	
	TOTAL	**31**			

400 LEVEL

Course Code	Course Title	Unit(s)	Status	LH	PH
COS 409	Research Methodology & Technical	3	C	45	0

	Report Writing				
DTS 403	Data Visualisation for Data-driven Decision Making	2	C	155	45
DTS 497	Final Year Project I	3	C	0	135
DTS 498	Final Year Project II	3	C	0	135
INS 401	Project Management	2	C	30	0
PAU-DTS 411	Survey of Informatics Disciplines	2	E	15	45
PAU-DTS 412	Survey of Programming Languages	3	E	30	45
PAU-DTS 413	Human-Computer Interaction	2	E	30	
PAU-DTS 414	Bioinformatics	2	E	15	45
PAU-DTS 415	Game Design and Development	2	E	15	45
PAU-DTS 416	Computer Vision and Image Processing	3	C	30	45
PAU-DTS 417	Business Cases and Analysis	2	C	15	45
PAU-DTS 418	IoT and Edge Computing	2	E	15	45
PAU-DTS 419	Advances in Web, Mobile and Blockchain Development	3	E	30	45
PAU-DTS 416	Computer Vision and Image Processing	3	C	30	45
	TOTAL	**36**			

COURSE DESCRIPTION

100 LEVEL

GST 111: Communication in English   **(2 Units C: LH 15; PH 45)**

Learning Outcomes

At the end of this course, students should be able to:

1. identify possible sound patterns in English Language;
2. list notable Language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

Sound patterns in English Language (vowels and consonants, phonetics and phonology). English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). Grammar and Usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and Critical Thinking and Reasoning Methods (Logic and Syllogism, Inductive and Deductive Argument and Reasoning Methods, Analogy, Generalisation and Explanations). Ethical considerations, Copyright Rules and Infringements. Writing Activities: (Pre-writing, Writing, Post writing, Editing and Proofreading; Brainstorming, outlining, Paragraphing, Types of writing, Summary, Essays, Letter, Curriculum Vitae, Report writing, Note making, etc. Mechanics of writing). Comprehension Strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern Language Learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening. Report writing.

GST 112: Nigerian Peoples and Culture   **(2 Units C: LH 30)**

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of Trade, Economic and Self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards Nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; Nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concept of trade and economics of selfreliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and self-reliance). Social justices and national development (law definition and classification). Judiciary and fundamental rights. Individual norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts. Cultism, kidnapping and other related social vices). Re-orientation, moral and national values: The 3Rs – Reconstruction, Rehabilitation and Re-orientation; Reorientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption (WAIC), Mass Mobilisation for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry) (2 Units C: LH 30)

Learning Outcomes

At the end of the course students should be able to:

1. understand the basic definition of Set, Subset, Union, Intersection, Complements and use of Venn diagrams;
2. solve quadratic equations;

3. solve trigonometric functions;
4. understand various types of numbers; and
5. solve some problems using the Binomial theorem.

Course Contents

Elementary set theory, subsets, union, intersection, complements, venn diagrams. Real numbers; integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand diagram. De-Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus)   (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. understand types of rules in Differentiation and Integration;
2. understand the meaning of Function of a real variable, graphs, limits and continuity; and
3. solve some applications of definite integrals in areas and volumes.

Course Contents

Function of a real variable, graphs, limits and idea of continuity. The derivative, as the limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

STA 111: Descriptive Statistics: (3 Units C: LH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. explain the basic concepts of descriptive statistics.
2. present data in graphs and charts.
3. differentiate between measures of location, dispersion and partition.

4. describe the basic concepts of Skewness and Kurtosis as well as their utility function in a given data set.
5. differentiate rates from ratio and how they are use.
6. compute the different types of index number from a given data set and interpret the output.

Course content

Statistical data. Types, sources and methods of collection. Presentation of data. Tables chart and graph. Errors and approximations. Frequency and cumulative distributions. Measures of location, partition, dispersion, skewness and Kurtosis. Rates, ratios and index numbers.

PHY 101: General Physics I (Mechanics)   **(2 Units C: LH 30)**

Learning Outcomes

At the end of the course students should be able to:

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum.
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents

Space and time; units and dimension, Vectors and Scalars, Differentiation of vectors: displacement, velocity and acceleration; kinematics; Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation); Relative motion; Application of Newtonian mechanics; Equations of motion; Conservation principles in physics, Conservative forces, conservation of linear momentum, Kinetic energy and work, Potential energy, System of particles, Centre of mass; Rotational

motion; Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates; conservation of angular momentum; Circular motion; Moments of inertia, gyroscopes and precession; Gravitation: Newton's Law of Gravitation, Kepler's Laws of Planetary Motion, Gravitational Potential Energy, Escape velocity, Satellites motion and orbits.

PHY 102: General physics II (Electricity & magnetism)   (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. describe the electric field and potential, and related concepts, for stationary charges;
2. calculate electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law, and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters;
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 107: General Practical Physics I   (1 Unit C: PH 45)

Learning Outcomes

At the end of the course, students should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data; 3. identify and evaluate some common experimental errors.
3. plot and analyse graphs; and
4. draw conclusions from numerical and graphical analysis of data.

Course Contents

This introductory course emphasises quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101 and PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II   **(1 Unit C: PH 45)**

Learning Outcomes

At the end of the course students should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyses graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

This is a continuation of the experiments designed for PHY 101 and PHY 102 some of which have been covered under PHY 107.

COS 101: Introduction to Computing Sciences   (3 Units C: LH 30; PH 45) Learning Outcomes

At the end of the course, students should be able to:

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

COS 102: Problem Solving   **(3 Units C: LH 30; PH 45)**

Learning Outcomes

At the end of this course, students should be able to:

1. explain problem solving processes;
2. demonstrate problem solving skills;
3. describe the concept of algorithms development and properties of algorithms;
4. discuss the solution techniques of solving problem;
5. solve computer problems using algorithms, flowcharts, pseudocode; etc.; and
6. solve problems using programming language using C, PYTHON, etc.

Course Contents

Introduction to the core concepts of computing. Problems and problem-solving. The identification of problems and types of problems (routine problems and non-routine problems). Method of solving computing problems (introduction to algorithms and heuristics). Solvable and unsolvable problems. Solution techniques of solving problems (abstraction, analogy, brainstorming, trial and error, hypothesis testing, reduction, literal thinking, meansend analysis, method of focal object, morphological analysis, research, root cause analysis, proof, divide and conquer). General Problem-solving process. Solution formulation and design: flowchart, pseudocode, decision table, decision tree. Implementation, evaluation and refinement. Programming in C, Python etc.

Lab Work: Use of simple tools for algorithms and flowcharts; writing pseudocode; writing assignment statements, input-output statements and condition statements; demonstrating simple programs using any programming language (Visual Basic, Python, C)

PAU-DTS 114 **Introduction to Information Systems** (2 Units Compulsory; LH=30)

Senate-approved relevance

Awareness of various forms of information systems (IS) helps to contextualize the quest for insights from data, as embodied in Data Science. In other words, exposure to multiple forms of information systems like Business Information Systems (e.g., Management Information Systems, Decision Support Systems, etc.), Health Information Systems, Government Information Systems, etc., can enrich the critical thinking ability of Data Scientists in fields relevant to business, public health, government, etc.

Overview

This course introduces the students to the concept of information, its relationship with data and also related fields like communication and knowledge. Subsequently, the students are exposed to information organization, processing and management that have evolved over time. Various information systems domains are introduced to contextualize the creativity of the students as they seek to apply data science principles to problems in IS domains. The course further introduces the concept of intelligent information systems which involves AI transformation of IS.

Objectives

The objectives of the course are to:

1. describe what information is and its relationship with data;
2. explain information systems principles and application in modern organisation;
3. explain system concepts and organisational processes;
4. explain networking and transmission standards for information;
5. explain information processing;
6. describe information security, policy and related ethical issues;

7. explain information organization and knowledge representation;
8. explain system development life cycle;
9. enumerate information systems domains;
10. explain the concept of intelligent information systems.

Learning outcomes

On completion of the course, the students should be able to:

1. describe what information is and its relationship with data;
2. explain information systems principles and application in modern organisation;
3. explain system concepts and organisational processes;
4. explain networking and transmission standards for information;
5. explain information processing;
6. describe information security, policy and related ethical issues;
7. explain information organization and knowledge representation;
8. explain system development life cycle;
9. enumerate information systems domains;
10. explain the concept of intelligent information systems.

Course content

Data and Information concepts. Roles and relevance of information systems in organisations to conduct business and solve problems. Information systems principles in modern organisations. Systems concepts; organisational processes; information processing; Networking and information transmission standards; Information security. Information policy. Ethical issues. Information organization and knowledge representation. Systems development life cycle. Information Systems Domains. Intelligent information systems.

PAU-DTS 192 **Introduction to Christian Theology** (2 Units Compulsory; LH=30)

Senate-approved relevance

Pan-Atlantic University has a strong Christian identity which is shown in its openness to people of all races and religions. Its mission is "to form competent and committed professionals and encourage them to serve with personal initiative and social responsibility the community in which they work, thereby helping to build a better society in Nigeria and Africa at large". One of the objectives of the university is to also give a well-rounded formation of the human person, which includes some courses in the humanities. The course intends to present the essentials of the Christian faith and morals that are related to contemporary issues that inform the identity of the school and will form the basis of other courses on humanities that the students will be taught. It will also help the students to learn to think deeply about contemporary societal issues.

Overview

Nigeria is a multicultural and multi-religious country. Christians make up roughly half of the population of the country. The purpose of the course is to provide essential background on key aspects of Christian faith and morals, related to contemporary issues, as a means of giving students basic criteria to analyze contemporary situations and form a basis for critical analysis from a Christian perspective.

The course will also help the non-Christians understand some aspects of the Christian faith which fosters societal integration of people of different religions. The purpose of the course is to aid the students to understand the human being in relation to God, the others and the world from a Christian perspective and apply that knowledge to modern-day issues.

Objectives

The objectives of the course are to:

1. state some basic philosophical concepts that are fundamental for theological discussion;
2. discuss some fundamental concepts and mysteries of the Christian faith;
3. explain the place of man in the modern world and correctly judge contemporary issues in the light of the Christian faith;
4. discuss the relationship between law and human conscience;
5. analyse human actions and determine their morality;
6. explain Christian morals and be able to judge situations with clear moral criteria;
7. discuss contemporary moral situations from a Christian perspective.

Learning outcomes

On completion of the course, the students should be able to:

1. discuss at least three philosophical arguments about the existence of God;
2. explain the relationship between science and faith using at least three concrete examples;
3. explain three modern theories about the relationship between creation and evolution;
4. analyse human actions to determine their morality based on the three criteria of action, circumstance, and intention;
5. list and explain the Ten Commandments and their implications;
6. explain at least five consequences of mishandling the truth, detraction and defamation;
7. explain five contemporary issues relating to human life and drug use.

Course content

The Existence of God. Divine Revelation. Creation and Evolution. Jesus Christ: both man and God. Eschatology. Human Freedom and Natural Law. Moral Conscience. Factors that determine the Morality of Human Acts. Personal Sin and Responsibility. Influence of the Passions in Human Actions. The Virtues. Introduction to the Ten Commandments. Contemporary human Life issues. Contemporary sexual issues. The morality of Gambling. Contemporary issues regarding handling the truth. Christian Prayer.

A classroom with a projector.

200 LEVEL

GST 212: Philosophy, Logic and Human Existence   **(2 Units C: LH 30)**

Learning Outcomes

At the end of this course, students should be able to

1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation   **(2 Units C: LH 15; PH 45)**

Learning Outcomes

At the end of this course, students should be able to:

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment, and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective Thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and joint ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

COS 201: Computer Programming I (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain the principles of good programming and structured programming concepts;
2. explain the programming constructs, syntax and semantics of a higher-level language;

3. describe the chosen programming language variables, types, expressions, statements and assignment; simple input and output;
4. describe the programme control structures, functions and parameter passing, and structured decomposition; and
5. develop simple programmes in the taught programming language as well as debug and test them.

Course Contents

Introduction to computer programming. Functional programming; Declarative programming; Logic programming; Scripting languages. Introduction to object-orientation as a technique for modelling computation. structured, and even some level of functional programming principles; Introduction of a typical object-oriented language, such as Java; Basic data types, variables, expressions, assignment statements and operators; Basic object-oriented concepts: abstraction; objects; classes; methods; parameter passing; encapsulation. Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Introduction to Strings and string processing; Simple I/O; control structures; Arrays; Simple recursive algorithms; inheritance; polymorphism.

Lab work: Programming assignments; design and implementation of simple algorithms e.g. average, standard deviation, searching and sorting; Developing and tracing simple recursive algorithms. Inheritance and polymorphism.

COS 202: Computer Programming II   **(3 Units C: LH 30; PH 45)**

Learning Outcomes

At the end of this course, students should be able to:

1. demonstrate the principles of good programming and structured programming concepts;
2. demonstrate string processing, internal searching, sorting, and recursion;
3. demonstrate the basic use of OOP concepts: classes, objects, inheritance, polymorphism, data abstraction;
4. apply the tools for developing, compiling, interpreting and debugging programmes; and

5. demonstrate the use of syntax and data objects, operators, central flow constructs, objects and classes programming, arrays, methods, exceptions, applets and the abstract, OLE, persistence, window toolkit.

Course Contents

Review and coverage of advanced object-oriented programming - polymorphism, abstract classes and interfaces; Class hierarchies and programme organisation using packages/namespaces; Use of API – use of iterators/enumerators, List, Stack, Queue from API; Searching; sorting; Recursive algorithms; Event-driven programming: event-handling methods; event propagation; exception handling. Applications in Graphical User Interface (GUI) programming.

Lab work: Programming assignments leading to extensive practice in problem solving and programme development with emphasis on object-orientation. Solving basic problems using static and dynamic data structures. Solving various searching and sorting algorithms using iterative and recursive approaches. GUI programming.

MTH 201: Mathematical Methods 1   **(2 Units C: LH 30)**

Learning Outcomes

At the end of the course students should be able to:

1. understand Real-valued functions of a real variable;
2. solve some problems using Mean value Theorem and Taylor Series expansion; and
3. evaluate Line Integral, Surface Integral and Volume Integrals.

Course Contents

Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line, integrals. Multiple integrals.

MTH 203: Sets, Logic and Algebra I   **(2 Units C: LH 30)**

Learning Outcomes

At the end of the course, students should be able to:

1. solve various problems using the concepts of set theory;
2. understand Algebraic structures; and
3. understand the meaning of logic in mathematics.

Course Contents

Introduction to the language and concepts of modern Mathematics. Topics include; Basic set theory: mappings, relations, equivalence and other relations, Cartesian products. Binary logic, methods of proof. Binary operations. Algebraic structures, semi-groups, rings, integral domains, fields. Homeomorphics. Number systems; properties of integers, rationals, real and complex numbers.

MTH 209: Introduction to Numerical Analysis   (2 Units C: LH 30)

Learning Outcomes

At the end of the course, students should be able to:

1. solve some numerical solutions of algebraic and transcendental equations;
2. describe curve fitting;
3. discuss error analysis;
4. calculate interpolation and approximation;
5. solve some numerical differentiation and numerical integration problems; and
6. solve some numerical problems in ordinary differential equations with initial value problems.

Course Contents

Solution of algebraic and transcendental equations. Curve fitting. Error analysis. Interpolation and approximation. Zeros of non- linear equations 'in one variable'. Systems of linear equations. Numerical differentiation and integration. Initial value problems in ordinary differential equations.

DTS 201: Introduction to Data Science   (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, the students should be able to:

1. demonstrate the principles of working with data across distributions, sizes and ranges;
2. explain from first principles the operations that power data-driven utilities that have transformed the modern computing industry; and
3. demonstrate foundational technological processes that enable various data functions.

Course Contents

Fundamentals of Data Science. Methodology of extracting knowledge from big datasets as well as various tools and platforms for Data Science. What is Data and why is it important? Basic classification of Data (Structured, semi-structured and unstructured data), Scope of Data Science, Steps of Data Science Process: Data collection, Pre-processing, training, and testing. Rudiments of data visualisations; Distributions, Probability, and Simulations; Predictions and Models. Use cases in various domains such Image, Natural Language, Audio and Video. Basic introduction to knowledge extraction: Data mining, Business Intelligence & Knowledge management, Introduction to Big Data integration and intelligence, Introduction to Data Analytics, Introduction to programming.

Lab work: Practical experiments on data science process steps in simulated models. Practical application of the methods and tools used in data science for prediction models with some simulated exerises. Practical experiments on how to extract knowledge; how to mine valuable data from large set of data sets using data mining process and methods. Learn how to integrate business intelligence in big data along with some data analytics pratical exercises. Simple exercises on R programming to enhance the coding knowledge acquired during theory class.

DTS 204: Statistical Computing II   **(3 Units C: LH 45)**

Learning Outcomes

At the end of the course, the students should be able to:

1. make conclusions based on statistical assumptions, models and results;
2. make inference on statistical outcomes, and real-world implications and how these outcomes are factored into decision-making processes;
3. demonstrate the various considerations that are applied both for communicating statistical solutions to real problems;

4. make conclusions based on statistical models and results by applying a broad range of statistical tools and packages; and
5. demonstrate logical, meaningful skills that bothers not just on the relevance of the data that informed the statistical outcomes, but also on the real-world implications of how these outcomes are factored into decision-making processes.

Course Contents

Population and samples. Asymptotics. Statistical models and methodologies. Random sampling distributions. Elementary time series analysis. Index numbers. Demographic measures. Estimation (point and interval) and tests of hypotheses concerning population mean and proportion (one and two sample cases). Regression and correlation. Programming in Python computer language. Computation of mean, variance and correlation. Sorting and ranking of data. Data Step Processing. Preparing Data for Analysis. Evaluating Quantitative Data. Sample Size Estimation. Basic statistical computing in regression analysis and the analysis of designed experiments. Introduction to Monte Carlo methods. Use of statistical packages like SPSS, SAS, Minitab, GENSTAT, EPI-INFO, SYSTAT.

Lab work: Practical experiments on statistical models and methodologies. Practical exercises on random sampling distribution methods. Practicals on test of hypothesis, population, mean, proportion, regression and correlation analysis. Exercise on how to sort and data from different data set. Use of SPSS for data analysis and computation.

DTS 211: Introduction to R Programming   (3 Units C: LH 30; PH 45)

Learning Outcomes

At the end of the course, the students should be able to:

1. utilise the R programming language for data-driven functions and utilities that have been lauded across the computing industry;
2. explain the structures, functions, and operations that power the utilities of this Language across various application domains;
3. explain the structures, functions, and operations of the language; and
4. apply the R programming language to various data-driven use-cases in practical problem domains in the real-world.

Course Contents

History and Overview of R, Installation, Introduction to R and RStudio, R interface, Cleaning and transforming data, Getting data in and out of R, Evaluation, R Objects, Numbers, Attributes, Vectors, Matrices/Arrays, Lists, Factors, Missing Values, Data Types, Structures and Frames, Names, , Displaying and plotting data, Reading lines of a Text File, Reading from a URL connection, Vectorised Operations, Dates and Times, Control Structures, Functions, Scoping Rules, Coding Standard for R, Looping, Debugging, Profiling R Code. Creating data products using R package.

Lab work: Installation of R programming language and learning the practical basics. Practical programming exercises on R programming language in getting data in and out, evaluation, computation, finding missing values and reading lines of text files. Practical exercises on R coding and debugging.

DTS 299: SIWES I   **(3 Units C: PH 135)**

Learning Outcomes

At the end of the course, the students should be able to:

1. explain how a typical Data Science firm operates;
2. expose students to the realities of the computing industry beyond the walls of the
3. University; through an attachment with an organisation in the computing industry; and
4. apply the skills and knowledge that they have acquired in class towards solving real problems in actual working environments.

Course Contents

Students are attached to private and public organisations for a period of three months during the second-year session long break with a view to making them acquire practical experience and to the extent possible, develop skills in all areas of Data Science. Students are supervised during the training period and shall be expected to keep records designed for the purpose of monitoring their performance. They are also expected to submit a report on the experience gained and defend their reports.

CSC 203: Discrete Structures I   **(3 Units C: LH 45)**

Learning Outcomes

At the end of this course, students should be able to:

1. convert logical statements from informal language to propositional and predicate logic expressions;
2. describe the strengths and limitations of propositional and predicate logic;
3. outline the basic structure of each proof technique (direct proof, proof by contradiction, and induction) described in this unit;
4. apply each of the proof techniques (direct proof, proof by contradiction, and induction) correctly in the construction of a sound argument;
5. apply the pigeonhole principle in the context of a formal proof;
6. compute permutations and combinations of a set, and interpret the meaning in the context of the particular application;
7. map real-world applications to appropriate counting formalisms, such as determining the number of ways to arrange people around a table, subject to constraints on the seating arrangement, or the number of ways to determine certain hands in cards (e.g., a full house); and
8. solve a variety of basic recurrence relations.

Course Contents

Propositional Logic, Predicate Logic, Sets, Functions, Sequences and Summation, Proof Techniques, Mathematical induction, Inclusion-exclusion and Pigeonhole principles, Permutations and Combinations (with and without repetitions), The Binomial Theorem, Discrete Probability, Recurrence Relations.

PAU-DTS 216 **Survey of Tools and Platforms for Data Science** (3 Units Compulsory; LH=30; PH=45)

Senate-approved relevance
As Data Science advances as a discipline, several tools have emerged. If not properly guided, students may end up being ineffective as solutions providers because of lack of optimal choice of tools. It is important to guide the students in the exploration of tools, highlighting their advantages and disadvantages, for various stages in data science workflow process.

Overview
This course introduces the students to a wide range of data science tools and platforms for solving problems. The course presents These include those for data capture, transformation, pipelining as well as modeling, analysis and visualization. The scope of this course includes handling of regular-sized data as big data requires further tooling expertise which will be

treated in a separate course. Comparison and contrasting of tools in this course covers development IDEs like Jupyter Notebook, PyCharm, VSCode; analytics tools like Excel, SAS, Stata; as well as programming libraries in python and R.

Objectives

The objectives of the course are to:

1. enumerate common tools for data science;
2. compare and contrast Integrated Development Environments (IDEs) for data science;
3. identify and use suitable tools for data capture, transformation and pipelining;
4. identity and use suitable tools for modeling and analysis;
5. identify and use suitable tools for presentation e.g., PowerBi and Tableau;
6. deploy models on the cloud;
7. deploy model visualisation on the Web.

Learning outcomes

On completion of the course, the students should be able to:

1. enumerate common tools for data science;
2. identify and use suitable Integrated Development Environments (IDEs) for data science projects;
3. identify and use suitable tools for data capture, transformation and pipelining;
4. identity and use suitable tools for modeling and analysis;
5. identify and use suitable tools for presentation e.g., PowerBi and Tableau;
6. deploy models on the cloud;
7. deploy model visualisation on the Web.

Course content

Overview of tools and platforms for data science. Integrated Development Environments. Data Capture tools. Data Transformation tools. Data Pipelining tools. Modelling tools. Analysis tools. Presentation tools. Deploying models to the cloud. Deploying model visualisation to the Web.

Minimum academic standards

Computer Laboratory.
Computers (1:2 students).
Internet connection.

PAU-DTS 212 **Computer Graphics** (3 Units Compulsory; LH=30; PH=45)

Senate-approved relevance

The need for computer graphic programming skills cannot be overemphasised. Computer graphics, which fundamentally refers to visual images produced by computer processing, is applied in a wide variety of systems. The need for it extends from basic graphical user interfaces to complex data visualisation, interaction and manipulation. Besides usage in business intelligence, marketing and entertainment industries, visualisations have become prevalent in science and engineering for modelling complex phenomena as well as in medical imaging. In fact, there is hardly any human computer interaction that does not incorporate some form of computer graphics. Besides, with the emergent spatial Web innovations comes the need for even more computer graphics expertise.

Overview

In this course, students are prepared to have foundational programming knowledge required to drive the development and maintenance of complex computer graphics frameworks like game engines, among others. This course builds on the knowledge of third generation programming language, acquired in previous semesters. The course begins with the creation and use of language in-built graphic primitives and extends to the use of external graphic libraries for more complex graphic systems developments. In addition to still images, motion graphic programming is treated as an animation core. The students are also introduced to the scientific foundation for image rendering along with the importance of GPU usage for higher efficiency.

Objectives

The objectives of the course are to:

1. explain what computer graphics means and the differences between vector and raster graphics;
2. list and describe graphic programming using primitives and libraries, in a third-generation programming language;
3. explain and guide the students on how to create and animate two dimensional (2D) and three dimensional (3D) images, programmatically;
4. explain what rendering is and guide the students on the art of rendering;
5. introduce the use of off-the-shelf software for modelling, rendering and animation of graphic images;
6. describe the various forms of image compression and how image compression is carried out programmatically;
7. describe various conventional image compression formats.

Learning outcomes

On completion of the course, the students should be able to:

1. explain what computer graphics means and distinguish between vector and raster graphics;
2. create graphic programs using a third-generation language (preferably C++ or Rust);
3. use graphic primitives available in the in-built graphic library, for coding;
4. program scaling, rotation and translation of graphic objects using in-built graphic library;
5. use external libraries like SDL (Simple DirectMedia Layer), OpenGL and Vulkan for graphic programming;
6. create 2D and 3D images programmatically;
7. animate 2D and 3D images;
8. render graphic objects using external graphic libraries;
9. use GPU (including WebGPU) for rendering;
10. use an industry standard software for a full modelling, rendering and animation workflow experience;
11. explain similarities and differences between lossy and lossless image compression;
12. explain conventional image compression formats;
13. create image compression formats programmatically.

Course content

Introduction to computer graphics concept and types. Language primitives for graphic programming. Still and motion graphics using language primitives. Introduction to external graphic libraries (e.g., SDL, OpenGL and Vulkan). Introduction to rendering. Use of external graphic libraries and GPU for rendering. Introduction to industry standard packages for computer graphics (e.g., blender, Maya). 2D and 3D modelling with industry standard packages. Rendering with industry standard packages. Image compression.

Minimum academic standards

2 Computer workstations per student for lab sessions.
Minimum configuration for computer is Intel core i5 processor with 16GB RAM and equipped with GPU.
Requisite compilers and industry standard packages should be installed in each system.

PAU-DTS 214 **Computer Security Fundamentals** (2 Units Compulsory; LH=30)

Senate-approved relevance

In its mission statement, Pan-Atlantic University seeks "to form competent and committed professionals and encourage them to serve with personal initiative and social responsibility the community in which they work, thereby helping to build a better society in Nigeria and Africa at large". As a means to promote the mission, this course aims to inculcate in students the capacity to understand and analyse security issues relating to the usage, deployment and maintenance of computer systems. Computer systems are the backbone of most organisations. Individuals also have their lives centred now around computers. The emergence of WEB 3.0 has ensured that society is more connected than ever before, through social media adoption and usage on mobile devices.

Overview

This course introduces the most relevant and up to date issues relating to computer security. It identifies the elements of security as related to computer systems and networks. An introduction to computer-based threats and players are explored, with the methodology of executing a risk assessment report also explored. This exploration of risk assessment methods and report writing gives the students an opportunity for practical experience with live production systems and case studies. Security in telecommunication networks, encryption methods and techniques, security models as well as government policies and laws relating to the security of computer systems and networks will also be explored in this course.

Objectives

The objectives of the course are to:

1. explain the concept of computer security;
2. explore the different attitudes to computer security;
3. explain the classes of threats, types of malware and the factors that can cause system breach in computer security;
4. explain cyber stalking, fraud and abuse;
5. explain the preventive measures against cyber fraud;
6. explain the concept of risk analysis;
7. list and describe security control frameworks and best practices;
8. explain the concept of distributed system and its characteristics;
9. describe cloud computing and IoT security;
10. define and classify SQL injection attacks;
11. explain the role of firewalls as part of a computer and network security strategy;
12. list, describe and illustrate the principles of secure coding.

Learning outcomes

On completion of the course, the students should be able to:

1. be aware of possible attack modes that can occur in a computer network;
2. execute a risk assessment of a computer system, what security models can be deployed to prevent an attack and what methods can be used to protect and prevent attacks on hardware, software and network systems;
3. identify all types of malwares and how there are deployed to computer systems and networks;
4. explain the unique need for database security, separate from ordinary computer security measures;
5. identify the attack modes and methods deployed by attackers to compromise a computer system;
6. develop a risk assessment report for any computer system and implemented process, while utilising the most current standardised method as defined;
7. explain the role of encryption in protecting user data, while in local storage and also while in transit;
8. explain the role government policies play in the security of computers nationally and globally;
9. describe the relative merits of various choices for firewall location and configurations;
10. distinguish between firewalls and intrusion prevention system;
11. recognize opportunities to apply secure coding principles.

Course content

Fundamental of Computer Security. Risk analysis in Computer Security. Hardware and Software Security Control. Virus. Encryption and Cryptography Techniques. Security models. Telecommunication Security. Distributed System Security. Firewalls. Database Security. Legal issues and current legislation. Government-based security standards. Secure software coding principles.

PAU-DTS 292 **The Nature of Human Beings** (2 Units Compulsory; LH=30)

The mission of Pan-Atlantic University is "to form competent and committed professionals and encourage them to serve with personal initiative and social responsibility the community in which they work, thereby helping to build a better society in Nigeria and Africa at large". Thus, Pan-Atlantic University is committed to ensuring that its students devote time to courses in humanities and liberal arts that ensure their all-around formation as persons and foster in them the highest regard for human dignity albeit inculcating in them a sense of service for humanity.

Overview

An anthropological crisis is at the root of most of the social and moral problems confronting contemporary society due to a resurgence of doubts as regards the true nature of human beings. This situation calls for intervention in the form of philosophical anthropology to the nagging existential questions such as; Who is a human being? What kind of difference exists between human beings and animals? What is the meaning of life? What is the foundation of human dignity? What is human fulfilment? Is death the end of life? etc.

This course is designed to introduce the students to the philosophical basis of considerations about the human person. It seeks to establish what/who the human person is to bring the students to a due appreciation of the human person and human dignity. The course exposes the students to human potencies and faculties, such as; rationality, understanding, imagination, freedom, Will, and emotions. The students will also be exposed to various conceptions of the human person across different epochs, the idea of death, immortality of the soul, and human destiny.

Objectives
The objectives of the course are to:

1. explain basic concepts in philosophical anthropology;
2. describe human beings as higher animals;
3. describe human rationality with a focus on the Intellect and Will;
4. discuss other aspects of human nature such as; relationality, freedom and responsibility, and human virtues;
5. stimulate conversation and guide the students to arrive at the knowledge of human existence, the meaning of life, and human fulfilment;
6. discuss human dignity and its practical consequences;
7. explore the idea of human death, arguments about the immortality of the human soul, and human destiny.

Learning outcomes
On completion of the course, students should be able to:

1. explain the basic concepts in philosophical anthropology;

2. compare the nature of human beings with the nature of lower animals;
3. explain the operations of the human Intellect and Will;
4. explain human dignity, its foundation, and its practical consequences of human dignity in socio-political, economic, and cultural practices as well as in technology development;
5. demonstrate knowledge of human virtues and their development in the human person;
6. discuss the phenomenon of human death, the immortality of the soul, and how the idea of death shapes one's sense of meaning and value of one's life and that of others.

Course content

Introduction and conceptual clarifications. Human beings as higher animals. Human emotions and emotional Intelligence. The rationality of human beings – intelligence and will. The unity of the human person. Human sexuality. The nature of Human Freedom. Freedom and truth. Freedom and Evil. Human beings as social beings. Expanded view of the social environment – virtual world and metaverse. Human beings as working beings – the objective and subjective dimensions of human work. Human development – the virtues. The dignity of human beings and its practical consequences. Human fulfilment. Existence and the meaning of Life. The phenomenon of Human death.

PAU-DTS 291 **English for Business Purposes** (2 Units Compulsory; LH=30)

Senate-approved relevance

One of the features of a competent professional is the capacity to communicate effectively. English is the most common language of communication in business and professional spheres in Nigeria. A good command of the language's use in professional work, is therefore important, especially in Nigeria, which has a rich variety of languages used in different regions. This course focuses on excellence in writing and business communication, an aspect of education in professional competence that the university aims to achieve among its students. It sets students at an advantage in the professional world as it empowers them to attain English language proficiency according to international standards of excellence.

Overview

English for Business Purposes (EBP) is a key aspect of practical business communicative processes. This course will help the students acquire the knowledge and skills required for their business and work life. This makes teaching them these skills relevant to enable them to perform effectively in their future endeavours.

Additionally, for many different reasons, difficult to engage in modern forms of writing. In this age of new media where business communication is digitally mediated, students need to be proficient in diverse forms of writing to succeed in their business endeavours.

Objectives

The objectives of the course are to:

1. state the importance of English for business purposes for effective communication in the workplace;
2. describe the techniques for writing different business documents;
3. explain how to use different media applications for effective business communication in the 21st century;
4. conduct practical exercises on writing different types of business documents;
5. identify students' communicative challenges for more practical demonstrations.

Learning outcomes

On completion of the course, the student should be able to:

1. state at least five importance of English for business purposes for effective communication in the workplace;
2. describe the techniques for writing at least five types of business documents;
3. use at least five different media applications for effective business communication in the 21st century;
4. write at least five different types of business documents for effective communication to a target audience;

5. demonstrate at least three competencies for writing business documents such as memos, business letters, communique, and executive summaries.

Course content

English as a language of global communication. Diversity in writing. Cross-cultural differences in writing. Writing for exporting. Writing reviews. Writing for the Internet. Writing to lead, inspire, and change. Commercial communication. Business documents. Business presentation skills. Giving feedback and performance reviews. Dialogue and protocol in business communication. Interviews and negotiation skills. Language and the new media. Content creation. Learning and memory skills. Effective time management for business executives. Goal setting for business management.

Minimum academic standard

Classroom with projector.

300 LEVEL

GST 312: Peace and Conflict Resolution　　　　　**(2 Units C: LH 30)**

Learning Outcomes

At the end of the course, students should be able to:

1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents

Concepts of Peace, Conflict and Security in a multi-ethnic nation. Types and Theories of Conflicts: Ethnic, Religious, Economic, Geopolitical Conflicts; Structural Conflict Theory, Realist Theory of Conflict, Frustration-Aggression Conflict Theory. Root causes of Conflict and Violence in Africa: Indigene and settlers Phenomenon; Boundaries/border disputes; Political disputes; Ethnic disputes and rivalries; Economic Inequalities; Social disputes;

Nationalist Movements and Agitations; Selected Conflict Case Studies – Tiv-Junkun; ZangoKartaf, Chieftaincy and Land disputes, etc. Peace Building, Management of Conflicts and Security: Peace & Human Development. Approaches to Peace & Conflict Management --- (Religious, Government, Community Leaders, etc.). Elements of Peace Studies and Conflict Resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and Terrorism. Peace Mediation and Peace Keeping. Peace & Security Council (International, National and Local levels) Agents of Conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution, ADR. Dialogue b). Arbitration, c). Negotiation d) Collaboration, etc. Roles of International Organisations in Conflict Resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peacekeeping. Media and Traditional Institutions in Peace Building. Managing Post-Conflict Situations/Crisis: Refugees. Internally Displaced Persons, IDPs. The role of NGOs in Post-Conflict Situations/Crisis

ENT 312: Venture Creation   **(2 Units C: LH 15; PH 45)**

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, Environmental scanning, Demand and supply gap/unmet needs/market gaps/market research, Unutilised resources, Social and climate conditions, and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture

capital, equity finance, microfinance, personal savings, small business investment organisations, and business plan competition). Entrepreneurial marketing and e-commerce (Principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, first mover advantage, e-commerce business models and successful e-commerce companies,). Small business management/family business: Leadership & Management, basic bookkeeping, nature of family business and family business growth model. Negotiation and business communication (Strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (the concept of market/customer solution, customer solution, and emerging technologies, business applications of new technologies- Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoT), Blockchain, Cloud Computing, renewable energy, etc. digital business and e-commerce strategies).

DTS 302: Big Data Computing   **(2 Units C: LH 15; PH 45)**

Learning Outcomes

At the end of the course the students should be able to:

1. identify Big Data;
2. identify some of the foundational tools, systems, and platforms that feature in working with Big Data across several domains;
3. install Big Data working tools on a computer; and
4. analyse Big Data contents.

Course Contents

Installation: Cloudera VM, Jupyter server. Big data retrieval and relational querying: Postgres databases, NoSQL data, MongoDB, Aerospike, and Pandas for data aggregation and working with data frames. Big Data Integration: Splunk and Datameer. Big Data Processing: Apache Spark, Hadoop, Spark Core (Spark MLlib and GraphX). Big Data Applications (Graph Processing). Big Data Streaming Platforms for Fast Data.

Lab Work: Analysing Twitter Data using Spark and MongoDB. Learn Big Data analytics skills. Practical procedure for the crafting of an enterprise-scale cost-efficient Big Data and machine learning solution to uncover insights and value from data. Use the practical exercises to bridge the gap between the theoretical world of technology with the practical ground reality of building corporate Big Data and data science platforms. Hands-on exposure to Hadoop and Spark (or any of the BD tools), build machine learning

dashboards using R and R Shiny, create web-based apps using NoSQL databases. Practical assignment of BD security.

DTS 304: Data Management I   **(3 Units C: LH 30; PH 45)**

Learning Outcomes

At the end of the course the students should be able to:

1. describe the components of a database system and give examples of their use;
2. describe the differences between relational and semi-structured data models;
3. explain and demonstrate the concepts of entity integrity constraint and referential integrity constraint;
4. apply queries, query optimisations and functional dependencies in relational databases;
5. describe properties of normal forms and explain the impact of normalisation on the efficiency of database operations;
6. describe database security and integrity issues and their importance in database design; and
7. explain the concepts of concurrency control and recovery mechanisms in databases.

Course Contents

Information Management Concepts. Information storage & retrieval. Information management applications. Information capture and representation. Analysis and indexing - search, retrieval, information privacy. Integrity and security. Scalability, Efficiency and Effectiveness. Introduction to database systems. Components of database systems. DBMS functions. Database architecture and data independence. Database query language. Conceptual models. Relational data models. Semi-structured data models. Relational theory and languages. Database Design. Database security and integrity. Introduction to query processing and optimisation. Introduction to concurrency and recovery.

Lab work: Practical exercise on information representation, capture, storage and retrieval. Learn how to analyse data and index for easy searching and indexing. Practical on creating database files and models. How to create and use various database designs. How to query the created database. Methods of concurrency and recovery in database. Learn how to secure the database.

DTS 308: Ethics and Legal Issues in Data Science   **(3 Units C: LH 45)**

Learning Outcomes

At the end of the course, the students should be able to:

1. identify ethical challenges and considerations when working with data of various sources, context, and compositions; and
2. contribute to global debates regarding best practices for handling sensitive data in a way that avoids harm to data subjects, while also not eroding the utilities that such data could present for various decision-making processes.

Course Contents

Legal and ethical consequences of applying Data Science. Current techniques such as Digital Data Repositories and Digital Object Identifiers as well as FAIR principles for Open Science, Open Data. Data ownership and transparency; privacy concerns and consent; and addressing unintended bias. Topics: Legal aspects of data ownership and privacy concerns, Data transparency, Ethical considerations for Data Science, Introduction to Data Repositories and Digital Object Identifiers, Introduction to Open Science, Open Data, and Introduction to FAIR data.

DTS 316: Probability for Data Science   **(3 Units C: LH 45)**

Learning Outcomes

At the end of the course the students should be able to:

1. analyse and interpret real-world statistical events;
2. utilise various principles and concepts from the broad theory of probability and adjoining statistical and mathematical fields;
3. apply statistical principles and concepts to analyse data; and
4. analyse and interpret real-world statistical events by applying various principles and concepts from the broad theory of probability and adjoining statistical and mathematical fields.

Course Contents

Experiments, sample spaces, outcomes and events. Generation of Statistical events from set theory (Venn diagrams). Concepts and principles of Probability (probability axioms). Random variables. The Law of Total Probability, Bayes' Theorem, Independence.

Permutation and Combination. Introduction to Probability and distribution functions. The probability density function. Basic distributions: Bernoulli Trials, Binomial, Hyper geometric, Poisson, and Normal. Exploratory data analysis. Combinatorial analysis. Probability models for the study of random phenomena in finite sample generating functions and its properties. Chebyshev's inequality and limit theorems in probability. Central limit theorem. Bivariate, marginal and conditional distributions. Variance and covariance. Probability mass function. Geometric distribution. Sampling with and without replacement. Hypergeometric distribution. Bounding probabilities, tail sum formula. Markov's inequality. The exponential distribution, moments, memoryless property, hazard function. Definition of a Markov chain and probability transition matrices. Equilibrium behaviour of Markov chains: computer demonstration and ergodic, limiting and stationary interpretations. Mean and variance of linear combination of two random variables. The joint Moment generating function (MGF) and MGF of the sum. Definition of absorbing Markov chains, structural results, hitting probabilities and expected hitting times.

DST 322: Data Science Innovation and Entrepreneurship   (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. explain business models;
2. identify some entrepreneurial opportunities available in IT;
3. describe business plan and business startup process;
4. explain business feasibility and strategy;
5. explain marketing strategies; and
6. discuss business ethics and legal issues.

Course Contents

Fundamental concepts of innovation, and business ideas in general. Product development. Business leadership. Digital marketing. Entrepreneurial opportunities in IT. Legal issues and Business ethics. New venture creation process. Business feasibility planning. Market research. Business strategy. Business models and Business plans. Technical presentations. Report on a successful entrepreneurial outfit.

DTS 399: SIWES II   (3 Units C: PH 135)

Learning Outcomes

At the end of the course, the students should be able to:

1. appreciate the realities of the computing industry beyond the walls of the University, through an attachment with an organisation in the computing industry; and
2. apply the skills and knowledge they acquired in class towards solving real problems in actual working environments.

Course Contents

Requires 3 months of Industrial Training after the completion of 300 Level. Students' experience will be documented and presented in a Seminar.

CYB 201: Introduction to Cybersecurity and Strategy   (2 Units C: LH 30)

Learning Outcomes

At the end of this course, students should be able to:

1. explain cybersecurity concepts, its methods, elements, and terminologies of cybersecurity, threat, attack, defence, and operations;
2. describe common cyber-attacks and threats, cybersecurity issues, challenges and proffered solutions, and build an enhanced view of main actors of cyberspace and cyber operations;
3. apply the techniques for identifying, detecting, and defending against cybersecurity threats, attacks and protecting information assets;
4. explain the impact of cybersecurity on civil and military institutions, privacy, business and government applications;
5. identify the methods and motives of cybersecurity incident perpetrators, and the countermeasures employed by organisations and agencies to prevent and detect those incidences and software application vulnerabilities; and
6. state the ethical obligations of security professionals, evaluate cybersecurity and national security strategies to the typologies of cyber-attacks that require policy tools and domestic response, and define the cybersecurity requirements and strategies evolving in the face of big risk.

Course Contents

Basic concepts: cyber, security, confidentiality, integrity, availability, authentication, access control, non-repudiation and fault-tolerant methodologies for implementing security, security policies, best current practices, testing security, and incident response, risk management, disaster recovery, access control, basic cryptography and software application vulnerabilities. Evolution of cyber-attacks. Operating system protection mechanisms, intrusion detection systems, basic formal models of security, cryptography, steganography, network and distributed system security, denial of service (and other) attack strategies, worms, viruses, transfer of funds/value across networks, electronic voting, secure applications, cybersecurity policy and guidelines. Government regulation of information technology. Main actors of cyberspace and cyber operations. Impact of cybersecurity on civil and military institutions, privacy, business and government applications; examination of the dimensions of networks, protocols, operating systems, and associated applications. Methods and motives of cybersecurity incident perpetrators, and the countermeasures employed by organisations and agencies to prevent and detect those incidences. Ethical obligations of security professionals. Trends and development in cybersecurity. Software application vulnerabilities. Evolution of cybersecurity and national security strategies, requirements to the typologies of cyber-attacks that require policy tools and domestic response. Cybersecurity strategies evolving in the face of big risk. Role of standards and frameworks.

PAU-DTS 311 **Artificial Intelligence** (2 Units Compulsory; LH=15; PH=45)

Senate-approved relevance
With the emergence of large language models like GPT, among others, Artificial Intelligence (AI) has taken the world by storm. More than ever, it is important to formally train budding data scientists on the rudiments of AI in order to help them better positioned to leverage on it for competitiveness in their development work. Besides, they need to be well-positioned to contribute to the future of AI itself.

Overview

This course on the one hand introduces the students to the history, fundamental concepts and techniques of Artificial intelligence, as a discipline. On the other hand, the course takes a practical approach to learning AI, by elucidating its application in a number of areas like intelligent agents, natural language processing, robotics, etc.

Objectives

The objectives of this course are to:

1. explain AI fundamentals, concepts, goals, types, techniques, branches, applications, AI technology and tools;

2. discuss intelligent agents, their performance, examples, faculties, environment and architectures, and determine the characteristics of a given problem that an intelligent system must solve;

3. describe the Turing test and the "Chinese Room" thought experiment, and differentiate between the concepts of optimal reasoning/behaviour and human-like reasoning/behaviour;

4. describe the role of heuristics and the trade-offs among completeness, optimality, time complexity, and space complexity;

5. analyse the types of search and their applications in AI and describe the problem of combinatorial explosion of search space and its consequences;

6. demonstrate knowledge representation, semantic network and frames along with their applicable uses;

7. practice Natural Language Processing, translate a natural language (e.g., English) sentence into a predicate logic statement, convert a logic statement into clause form, apply resolution to a set of logic statements to answer a query; and

8. analyse programming languages for AI and expert systems technology, and employ application domains of AI.

Learning outcomes

On completion of the course, students should be able to:

1. explain AI fundamentals, concepts, goals, types, techniques, branches, applications, AI technology and tools;

2. discuss intelligent agents, their performance, examples, faculties, environment and architectures, and determine the characteristics of a given problem that an intelligent system must solve;

3. describe the Turing test and the "Chinese Room" thought experiment, and differentiate between the concepts of optimal reasoning/behaviour and human-like reasoning/behaviour;

4. describe the role of heuristics and the trade-offs among completeness, optimality, time complexity, and space complexity;

5. analyse the types of search and their applications in AI and describe the problem of combinatorial explosion of search space and its consequences;

6. demonstrate knowledge representation, semantic network and frames along with their applicable uses;

7. practice Natural Language Processing, translate a natural language (e.g., English) sentence into a predicate logic statement, convert a logic statement into clause form, apply resolution to a set of logic statements to answer a query; and

8. analyse programming languages for AI and expert systems technology, and employ application domains of AI.

Course content

Overview of Artificial Intelligence. History of AI. Goals of AI. AI Technique. Types of AI. Branches and applications of AI. Advantages and Disadvantages. Introduction to Intelligent Agents. Agent Performance, Examples of Agents, Agent Faculties, Rationality, Agent Environment. Agent Architectures. Search. General Classes of AI Search Algorithm Problems. Problem Solving by Search. Types of AI Search Techniques and Strategies. Introduction to the types of problems and techniques in AI. Problem-Solving methods. Major structures used in AI programmes. Knowledge Representation. KR and Reasoning Challenges. KR Languages. Knowledge representation techniques such as predicate logic, non-monotonic logic, and probabilistic reasoning. Semantic Network - types of relationships, semantic network inheritance, types and components. Introduction to Frames. Natural Language Processing (NLP). Introduction to natural language understanding and various syntactic and semantic structures. Introduction to Expert Systems - characteristics, components, types, requirements, technology, development. Programming Languages for AI. Introduction to computer image recognition.

Minimum academic standards

Computer Laboratory.
Computers (1:2 students).
Lab with Robotics equipment.

PAN-ATLANTIC UNIVERSITY
B.SC. DATA SCIENCE PROGRAMME

PAU-DTS 312 **Machine Learning** (2 Units Compulsory; LH=15; PH=45)

Senate-approved relevance

In today's world, data is king, and machine learning is the key to unlocking its potential. From finance to healthcare, from e-commerce to autonomous vehicles, machine learning techniques are being applied in a wide range of industries to improve decision-making, automate tasks, and gain insights from large datasets. With the rise of big data and the need to process vast amounts of information, the demand for machine learning skills is only going to increase in the coming years.

Machine learning is also becoming increasingly important in emerging fields such as robotics, the Internet of Things (IoT), and augmented and virtual reality. As the boundaries between the digital and physical worlds continue to blur, the ability to design and implement intelligent systems will become a critical skill.

Overview

This course provides an introduction to the principles, algorithms, and applications of machine learning, which is a crucial skill for anyone interested in working with data. It is designed to teach students how to develop and evaluate machine learning models and apply them to real-world problems. By the end of the course, students will have a solid knowledge of the major machine learning techniques, including supervised learning, unsupervised learning, and reinforcement learning. The course also covers the essential concepts of feature engineering, model selection, evaluation, interpretation, and optimization.

In the course, students will work on practical assignments and projects that involve solving real-world problems using machine learning techniques.

Objectives
The objectives of the course are to:

1. explain the fundamental concepts of machine learning;
2. describe the historical background of machine learning;
3. state practical applications and potential limitations of machine learning;
4. show how to utilise machine learning techniques to address real-world problems by applying appropriate methods and tools for model development and evaluation;
5. help students develop critical thinking skills and apply them to machine learning problems effectively;
6. show students how to effectively communicate about machine learning concepts and techniques to others;

7. describe the challenges involved in deploying machine learning models in production environments, including working with real-world data, managing model performance, and ensuring reliability and robustness.

Learning outcomes

On completion of the course, students should be able to:

1. explain in details the core principles, algorithms, and techniques of machine learning
2. use machine learning principles, algorithms and techniques to solve real-world problems;
3. develop, implement, and evaluate machine learning models using appropriate tools and frameworks, and critically analyse their performance using relevant metrics;
4. use advanced problem-solving skills and critical thinking to identify and address complex machine learning challenges;
5. communicate about machine learning concepts and techniques, both verbally and in writing, to diverse audiences;
6. evaluate the ethical implications and limitations of machine learning, and be able to assess the potential impact of machine learning on society;
7. collaborate effectively in teams to design, develop, and deploy machine learning solutions to real-world problems, demonstrating strong project management and teamwork skills.

Course content

Introduction to machine learning and its history. Data pre-processing and feature engineering. Supervised learning: linear regression, logistic regression, decision trees, k-nearest neighbours, support vector machines, neural networks. Unsupervised learning: k-means clustering, hierarchical clustering, principal component analysis. Reinforcement learning. Model selection and evaluation: overfitting, underfitting, cross-validation, hyperparameter tuning. Interpretation and visualisation of machine learning models. Optimization techniques. Ethics and limitations of machine learning. Deploying machine learning models in production environments.

Minimum academic standards
Computers with at least 8GB of RAM.
A dedicated graphics processing unit (GPU) with at least 4GB of VRAM (optional, but highly recommended).
Sufficient hard drive space to store large datasets and model parameters.
Python 3.x, Numpy, Pandas, Jupyter Notebook or equivalent IDE.

PAN-ATLANTIC UNIVERSITY
B.SC. DATA SCIENCE PROGRAMME

PAU-DTS 313 **Formal Methods** (2 Units Compulsory; LH=30)

Senate-approved relevance

Formal Methods is highly relevant to the mission of Pan-Atlantic University, as it equips students with the necessary skills and knowledge to design, specify, and verify computer systems. By ensuring that computer systems are correct, reliable, and safe, graduates of this program can help build a better society in Nigeria and Africa at large.

Furthermore, this course encourages students to think critically, analyse problems, and develop innovative solutions using mathematical techniques. By promoting personal initiative and social responsibility, students will be able to apply their skills to real-world problems faced by organisations and communities, thereby contributing to the development of a better society.

Overview

This course covers the fundamental concepts and principles of Formal Methods. It involves a comprehensive study of mathematical techniques used in the design, specification, and verification of computer systems. Students will learn how to model computer systems using mathematical models, including temporal logic, model checking, and theorem proving.

Objectives

The objectives of this course are to:

1. explain the principles of formal methods;
2. list and describe different formal methods techniques and methods;
3. explain mathematical concepts and logic that underlie formal methods;
4. describe how to design computer systems;
5. describe how to specify computer systems;
6. describe how to verify computer systems;
7. illustrate model checking, theorem proving and program analysis.

Learning outcomes

On completion of the course, students should be able to:

1. explain principles of formal methods;
2. apply different formal methods techniques and methods in designing computer systems;

3. apply different formal methods techniques and methods in specifying computer systems;
4. apply different formal methods techniques and methods in verifying computer systems;
5. develop mathematical models of computer systems using temporal logic, model checking, and theorem proving;
6. analyse and evaluate computer systems using formal methods;
7. analyse and interpret formal models and specifications using mathematical reasoning.

Course content

Introduction to Formal Methods. Mathematical foundations of Formal Methods. Temporal logic and model checking. Theorem proving. Specification Languages. Program analysis. Program verification.

PAU-DTS 314 **Deep Learning** (2 Units Compulsory; LH=15; PH=45)

Senate-approved relevance

As technology continues to evolve, there is an ever-increasing demand for skilled professionals in the field of artificial intelligence. Deep learning, which involves the training of neural networks with large datasets to enable machines to learn and make decisions, is at the forefront of this technological revolution. The applications of deep learning are wide-ranging and include natural language processing, image and speech recognition, autonomous vehicles, and predictive analytics.

Overview

This course is designed to give students a solid understanding of the fundamentals of neural networks and deep learning, as well as the latest developments in the field. Throughout the course, students will explore the biological inspiration behind neural networks, learning about the way that the brain processes information and how that has influenced the development of artificial neural networks.

Students will also learn about the architecture of common network types, including feedforward networks, convolutional networks, and recurrent networks, and the specific applications for which they are best suited. They will gain practical experience in implementing these networks using popular deep learning frameworks such as TensorFlow and PyTorch.

Objectives

The objectives of the course are to:

1. explain the concept of neural networks and deep learning, including their applications, limitations, and underlying principles;
2. describe different network architectures and their applications, and evaluate the performance of different models for specific tasks;
3. illustrate the training of neural networks using popular tools and frameworks, such as TensorFlow and PyTorch, and introduce best practices for model selection, hyperparameter tuning, and optimization;
4. show recent advances and emerging trends in the field, such as generative adversarial networks, autoencoders, and capsule networks, and critically evaluate their potential impact and applications;
5. identify and analyse different network architectures and their specific applications, and develop the ability to choose the appropriate architecture for a given problem;
6. describe up-to-date advancements in neural networks and deep learning, and their implications for the broader field of artificial intelligence and society as a whole;
7. explain ethical considerations and potential biases in the use of deep learning.

Learning outcomes

On completion of the course, students should be able to:

1. explain the principles and concepts of neural networks and deep learning;
2. design and implement various types of neural network architectures for specific applications;
3. train neural networks using backpropagation and gradient descent, as well as apply regularisation and overtraining techniques to improve performance;
4. investigate and apply alternative training methods such as attention, feedback alignment, synthetic gradients, decoupled network interfaces, and transfer learning;
5. evaluate and implement various network architectures, including generative adversarial networks, autoencoders, restricted Boltzmann machines, capsule networks, and spiking networks;
6. apply critical thinking skills to analyse and evaluate the performance of neural network models in different scenarios;
7. recognize and address ethical considerations in the design and deployment of neural network models;
8. communicate effectively about neural networks and deep learning concepts and techniques both verbally and in writing.

Course content

Introduction to Neural Networks and Deep Learning. Biological Brain and Neural Networks. Perceptron and multi-layer perceptron. Network Architectures Overview. Feed-forward networks. Convolutional neural networks. Recurrent neural networks. Memory cells. LSTMs. Neural Network Training. Alternative Training Methods. Decoupled network interfaces. Transfer learning. Generative adversarial networks. Autoencoders. Restricted Boltzmann machines. Capsule networks. Spiking networks.

Minimum academic standards

Computers with at least 8GB of RAM, A dedicated graphics processing unit (GPU) with at least 4GB of VRAM (optional, but highly recommended).

Sufficient hard drive space to store large datasets and model parameters.

Python 3.x, TensorFlow, Keras, Jupyter Notebook or equivalent IDE.

PAU-DTS 392 **Professional and Personal Skills** (2 Units Compulsory; LH=30)

Senate-approved relevance

In order to appropriately resolve many challenges in Africa and the world, there is a need to have professionals who are not only competent but possess soft skills and other qualities which enrich interactions with their colleagues. The goal of our university education extends beyond obtaining technical skills and this course provides an opportunity for preparing students for personal and professional development and for service to the world. The course
equips the students with a variety of skills that they need in order to attain the mission of the
Pan-Atlantic university to provide holistic formation to students while preparing them for professional life.

Overview

Personal and professional skills contribute greatly to success. This course teaches the meaning of professionalism and its practical implications for the student's chosen career path
while exposing the student to ways in which they can be of service to humanity. It teaches skills that lead to personal effectiveness in the professional context and provides practical strategies for improving self-management and interpersonal relations. It will dwell on a range
of skills which are useful in managing ordinary situations and difficult ones in both personal and professional situations. It will teach how to maintain a sense of purpose and direction under pressure and develop the confidence to manage a variety of people and circumstances.

Through this course, the students will learn to make the most of all their capacities. They will
be taught to harness their personal talents, energy and time, relative to what is most important, and to channel their resources to achieve what is desirable.

Objectives

The objectives of the course are to:

1. describe the professional and personal skills needed to be effective in professional and personal relationships;
2. identify situations in which soft skills can be acquired for present and future employability;

3. evaluate the most effective practical ways to develop different personal and professional skills;
4. analyse real-life scenarios for applying professional and personal skills in today's world;
5. demonstrate the consequences of the absence or presence of certain skills in relation to personal budgeting and financial responsibility;
6. enumerate effective actions to take in different health emergencies;
7. illustrate what good leadership and team work entail.

Learning outcomes

On completion of the course, students should be able to:

1. describe at least five elements of professionalism and their manifestations within their chosen career path;
2. identify at least five ways in which their chosen career can be of service to communities;
3. identify at least three strengths and five weaknesses associated with each of the four classical types of temperaments;
4. describe five elements of good interpersonal communication differentiating between assertiveness and aggression;
5. describe at least five tips for financial responsibility and making good personal budgets;
6. describe appropriate actions and responses to at least four common medical emergencies;
7. describe two types of good leadership and describe at least five guidelines for good teamwork.

Course content

Professionalism. Job search: interviews, writing applications, CVs, resumes and professional profiles. Professional work as service to the community. Social responsibility. Self-knowledge. Self-esteem & assertiveness. Open-mindedness. Emotional intelligence. Temperaments, character development and personality. Interpersonal communications. Public speaking. Time management. Social etiquette. Cultivating optimal health: mental and physical. Personal budgets and financial responsibility. Leadership and Teamwork.

Minimum academic standards
A classroom with a projector.

400 Level

COS 409: Research Methodology and Technical Report Writing   (3 Units C: LH 45)

Learning Outcomes

At the end of this course, students should be able to:

1. describe research, types, approaches, significance of research, research methods, research process, criteria and strategy for good research;
2. discuss the principles of scientific research, scientific investigation, problem formulation, and technique of the research problem;
3. describe the various elicitation methods;
4. develop appropriate data collection instruments;
5. conduct the literature review process; and
6. prepare briefs as well as technical reports and know how to cite referenced works and prepare references and bibliography.

Course Contents

Foundations of Research. Types of Research. Research Approaches. Significance of Research. Research Methods versus Methodology. Research Process. Criteria and Strategy for Good Research. Principles of Scientific Research. Scientific investigation. Problem Formulation and Its Techniques. Developing Research Proposal and Research Plan. Formulation of Research Questions and Hypothesis Testing. Developing Research Proposal and Research Plan. Literature Review. Procedure for Reviewing Related Relevant Studies. Methods for Collection of Primary and Secondary Data. Elicitation Techniques - Questionnaires, Interviewing, Ethnography, etc. Guidelines for Constructing Data Instruments. Methods of Analysing Data in Computing and Related Disciplines. System Design: Architectural design, input design, process design, output design. Use case analysis, sequence diagram, activity diagram, deployment diagram, etc. Types of Reports. Technical Report Writing. Layout and Mechanics of Writing a Research Report. Standard Techniques for Research Documentation. Interpretation and Presentation of Results. How to Cite Referenced Works and Prepare References and Bibliography.

DTS 403: Data Visualisation for Data-Driven Decision Making (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of the course, the students should be able to:

1. utilise techniques that are applied in preparing and producing data into a form that meets the needs of particular and varied audiences; and
2. develop logical, meaningful skills that bothers not just on the relevance of the data that informed the particular outcomes, but also on the real-world implications of how these outcomes are factored into decision-making processes.

Course Contents

Various methods for presenting data for visualisation as well as how to choose between them. Fundamentals of data presentation using tables, graphs, images and video animations. Create engaging visualisations using graphs, images and video animations. Data summaries, working with tables, presenting data through graphs and plots, presenting data through video animation, creating interactive/augmented visualisation of data (ability to zoom into sections). **Lab work:** Practical experiments on different methods of presenting data for visualisation.

Practice on how to use graphs, tables, images, and video on animation for data presentation.

DTS 497: Final Year Project I   **(3 Units C: PH 135)**

Learning Outcomes

At the end of this course, students should be able to:

1. identify a researchable project topic in Data Science;
2. search and review literature pertinent to identified problem statements;
3. acknowledge and reference sources of information used in the research report;
4. conceptualise and design a research methodology to address an identified problem;
5. determine tools for analysing data collected based on research objectives; 6. write a coherent proposal on the research project to be conducted; and
6. orally present the written project proposal.

Course Contents

An independent or group investigation of appropriate software, hardware, communication and networks or IT related problems in Data Science carried out under the supervision of a lecturer. Before registering, the student must submit a written proposal to the supervisor to review. The proposal should give a brief outline of the project, estimated schedule of completion, and computer resources needed. A formal written report is essential and an oral presentation may also be required.

DTS 498: Final Year Project II   **(3 Units C: PH 135)**

Learning Outcomes

At the end of this course, students should be able to:

1. demonstrate technical skills in Data Science;
2. demonstrate generic transferable skills such as communication and team work;
3. produce a technical report in the chosen project;
4. defend the written project report; and
5. appreciate the art of carrying out full-fledged research.

Course Contents

This is a continuation of DTS 497. This contains the implementation and the evaluation of the project. A formal written report, chapters 4 - 5 has to be approved by the supervisor. A final report comprising chapters 1 - 5 will be submitted to the department for final grading. An oral presentation is required.

INS 401: Project Management   (2 Units C: LH 30)

Learning Outcomes

At the end of this course, students should be able to:

1. describe project management planning;
2. describe project scheduling;
3. explain management of project resources;
4. discuss project procurement, monitoring and execution; and
5. explain project communication and time management.

Course Contents

Introduction to Project Management; The Project Management Lifecycle: Project management and systems development or acquisition, The project management context, Technology and techniques to support the project management lifecycle, and Project management processes; Managing Project Teams: Project team planning, Motivating team members, Leadership, power and conflict in project teams, and Managing global project teams; Managing Project Communication and enhancing team communication; Project Initiation and Planning; Managing Project Scope: Project initiation, How organisations choose projects, Activities, and Developing the project charter; Managing Project Scheduling: Common problems in project scheduling, and Techniques for project scheduling; Managing Project Resources: Types of resources (human, capital, time), and Techniques for managing resources; Project quality and tools to manage project quality;

Managing project risk and tools for managing project risk; Managing Project Procurement: Alternatives to systems development, External acquisition, Outsourcing-domestic and offshore, Steps in the procurement process, and Managing the procurement process; Project Execution, Control and Closure: Managing project execution, Monitoring progress and managing change, Documentation and communication, and Common problems in project execution; Managing Project Control and Closure: Obtaining information, Cost control, Change control, Administrative closure, Personnel closure, Contractual closure and Project auditing.

Minimum Academic Standards

Equipment

A Data Science programme should have at least three categories of laboratories: software, hardware and data science laboratories. Best practice requires a staff to students' ratio of 1:20 for laboratory practical. Therefore, multiple small laboratories are preferable to a few large ones. Courses with large enrolments should have the students partitioned into groups to ensure each student has a computer/practice equipment to themselves during practical sessions. Laboratory sessions should be conducted by staff to ensure close monitoring and effective achievement of Learning Outcomes.

Software laboratory

Software laboratories support programming and other courses requiring use of software tools. Requirements for the software laboratory include:

1. Computer systems with capacity to run software systems for all lab-based courses (e.g., Desktop PC with minimum of 1,6 GHz or faster processor with at least 2 GB RAM and 500 GB hard disk space.) A maximum of 3 students to 1 computer system is recommended.
2. Programming environment and tools (e.g., Compilers/interpreters, debuggers, etc. for Java, Python, compiler compilers, e.g., flex, yacc, SableCC, etc,)
3. Operating systems environments and tools (e.g., Windows, LINUX, TempOS, Nachos, Xinu or MiniOS)
4. Tools for systems analysis and design (e.g., Unified Modelling Language (UML))
5. Computer maintenance tools like dust blowers and toolbox
6. Overhead projector
7. Power backup

Hardware laboratory

The hardware laboratory should provide facilities required for hardware-related practicals.

Requirements for the hardware laboratory include:

1. NAND, NOR, XOR, AND, OR gates
2. Multiplexers
3. Master-slave flip-flops
4. Digi-Designer Logic Board, etc
5. Dual–trace oscilloscope
6. Digital Proto-Board
7. Computer casing
8. Motherboard
9. ROMs/RAMs
10. Hard drives
11. CD ROMs
12. Display screens
13. Fans
1. Connectors/Jumpers, etc.

**Data Science
Laboratory**

It should have the
following:

a) medium- to high-end computing resources for running practicals in data analytics and visualisation.

b) A data bank / repository / warehouse which contains a variety of datasets collated from across various business and industry cases, to be used a testing and training resources for students enrolled to the degree programme.

Fully-licensed, multi-client data science tools and applications, including: E-views, Tableau, Hadoop, R Studio, JetBrains PyCharm, Jupiter Python Toolkit, amongst others.

PAU-DTS 411 **Survey of Informatics Disciplines** (2 Units Elective; LH=15; PH=45)

Senate-approved relevance
Informatics deals with the underlying techniques that shape Information systems. A major element among these underlying techniques is Data Science. In today's study of informatics, emphasis thus needs to be placed on the role of data science as a fundamental technique, in the various informatics domains.

Overview
This course focuses on Informatics as a discipline that is shaped by Data Science. In other words, in this course, students will learn how data science is applied to various information systems domains as fundamental technique for value creation. Emphasis is placed on informatics domains that may be considered common to societal lives. These include health, business, social, media as well as eGovernment.

Objectives
The objectives of the course are to:

1. explain informatics concept and its evolution;
2. enumerate common informatics disciplines;
3. describe and illustrate health informatics;
4. describe and illustrate business informatics;
5. describe and illustrate social informatics;
6. describe and illustrate media informatics;
7. describe and illustrate eGovernment informatics.

Learning outcomes

On completion of the course, students should be able to:

1. explain informatics concept and its evolution;
2. enumerate common informatics disciplines;
3. describe and implement health informatics solutions;
4. describe and implement business informatics solutions;
5. describe and implement social informatics;
6. describe and implement media informatics;
7. describe and implement eGovernment informatics.

Course content

Informatics concept and evolution. Informatic disciplines. Health Informatics. Business Informatics. Social Informatics. Media Informatics. eGovernment Informatics.

Minimum academic standards

Computer Laboratory.
Computers (1:2 students).
Internet connection.

PAU-DTS 412 **Survey of Programming Languages** (3 Units Elective; LH=30; PH=45)

Senate-approved relevance:

Survey of Programming Languages is highly relevant to the mission of Pan-Atlantic University, as it equips students with the necessary skills and knowledge to understand the evolution of computer programming languages, their traits and behaviour, several programming styles and paradigms and how to represent instructions in the major programming languages. By understanding the different structures of programming languages, graduates of this program can help write codes in one language and represent them in other languages thereby leading to more efficient programmers output in the Nigerian software market in particular and Africa at large.

Furthermore, this course encourages students to think logically, represent problems as algorithms and develop innovative solutions using the different programming styles or paradigms learnt. By enhancing good programming skills and attributes, students will be able to apply their skills to real-world problems faced by organisations and communities, thereby contributing to the development of a better society.

Overview

Several Programming Languages (PLs) have been developed and most of them are still in use while some are already obsolete. However, some of these PLs have similarity while some are entirely different from each other. The comparison between the PLs led to the categorization of programming languages into different classes, styles or paradigms. Survey of Programming Languages (SPL) is a course on the fundamental principles of programming languages, introduction to fundamental principles and techniques in programming languages design and implementation. It handles the programming paradigm and historical pattern of programming in addition to a broad comparison of the different programming paradigms. The course elaborates on language structure, syntax and semantics, data type and data structure.

Objectives

The objectives of the course are to:

1. explain good programming styles and ideas;
2. list and explain programming paradigms;
3. describe what makes one language different from another;
4. explain how to choosing appropriate languages;
5. describe how to master the learning of new languages;
6. explain the significance of programming implementation;
7. explain the core rudiments of code representation in several programming languages.

Learning outcomes

On completion of the course, students should be able to:

1. describe how the different types of programming languages evolved;
2. enumerate and explain programming paradigms in detail;
3. explain what makes each language different from the other;
4. describe the different ways of writing algorithms in each language;
5. recognize the different coding environments of each language;
6. compile or interpret codes in each language;
7. express the syntax of each language and its semantics;
8. select ideal programming languages for any given project.

Course content

Overview of programming languages. History of programming languages. Brief survey of programming paradigms (Procedural languages, Object-oriented languages, Functional languages, Declarative – non-algorithmic languages, Scripting languages). Effects of scale on programming methodology. Language Description: Syntactic Structure (Expression notations, abstract Syntax Tree, Lexical Syntax, Grammars for Expressions, Variants of Grammars), Language Semantics (Informal semantics, Overview of formal semantics, Denotation semantics, Axiomatic semantics, Operational semantics). Declarations and types: The concept of types, Declaration models (binding, visibility, scope, and lifetime), Overview of type-checking, Garbage collection. Abstraction mechanisms: Procedures, function, and iterations as abstraction mechanisms. Parameterization mechanisms (reference vs. value). Activation records and storage management. Type parameters and parameterized types. Modules in programming languages. Object oriented language paradigm. Functional and logic language paradigms.

Minimum academic standards

Computer Laboratory.
Computers (1:2 students).
Integrated Development Environment (IDE) e.g., VSCode.
Compilers for programming e.g. JDK, GCC, Jython.

PAU-DTS 413 **Human-Computer Interaction** (2 Units Elective; LH=30)

Senate-approved relevance

Human-Computer Interaction (HCI) is an interdisciplinary field that can prepare data science students for careers in a variety of fields where understanding user behaviour and designing effective interactive systems is essential. Teaching HCI to data science students will equip them with the skills and knowledge required to create effective, user-centred software. User-centred design is becoming increasingly important as technology becomes more integrated into our lives, and HCI principles are critical for creating usable and effective software. Understanding HCI can assist students in developing critical thinking and problem-solving skills that can be applied to a variety of software development challenges. Furthermore, as new technologies emerge, HCI knowledge will be required to design and develop effective interactive systems.

Overview

This course investigates the principles, theories, and practices that underpin interactive system design and evaluation. It covers fundamental human-computer interaction concepts like user-centred design, interaction design, and usability engineering, as well as advanced topics like natural language processing, machine learning, and virtual and augmented reality. Students will gain a critical understanding of the field and learn how to apply this knowledge to design, develop, and evaluate interactive systems that meet the needs and preferences of their users.

Objectives

The objectives of the course are to:

1. explain the foundational principles of HCI;
2. describe how to design and evaluate interactive systems;
3. illustrate how to use user research, prototyping, usability testing and heuristics for evaluation of interactive systems;
4. explain in detail the role of user experience (UX) design in software development;
5. impact critical thinking and problem-solving skills;
6. elucidate ethical and social issues in HCI, such as privacy, security, bias, and the impact of technology on society;
7. describe emerging trends and technologies in HCI, such as virtual and augmented reality, wearable computing, and natural language processing.

Learning outcomes
On completion of the course, students should be able to:

1. explain and apply fundamental human-computer interaction (HCI) concepts such as user-centred design, usability, and accessibility;

2. design and evaluate interactive systems using methods such as user research, prototyping, usability testing, and heuristic evaluation;
3. explain the importance of user experience (UX) design in software development and apply UX design principles to create successful and interesting software products;
4. recognize and resolve HCI-related problems in software development by applying critical thinking and problem-solving techniques;
5. identify and discuss HCI-related ethical and social issues such as privacy, security, bias, and the impact of technology on society;
6. express the ethical and social implications of interactive systems;
7. describe emerging trends and technologies in human-computer interaction (HCI), such as virtual and augmented reality, wearable computing, and natural language processing, and develop successful and interesting interactive systems.

Course content

Introduction to Human-Computer Interaction. Paradigms of Interaction. User-Centred Design. Interaction Design Basics. Usability Engineering. User Interface Design. Design Rules. Evaluation Techniques. Hierarchical Task Analysis. Adaptation of Human-Computer Interaction in Conventional Software Life Cycle. Collaborative and Distributed Systems. Natural Language Processing. Machine Learning in Human-Computer Interaction. Virtual and Augmented Reality. Ethical Issues in HCI. Emerging Technologies and Future Trends.

PAU-DTS 414 **Bioinformatics** (2 Units Elective; LH=15; PH=45)

Senate-approved relevance
Bioinformatics is a hot topic today in the context of the drive to better understand biological processes. The human genomic project in particular, has largely shaped recent advances in bioinformatics. Bioinformatics as a science largely counts on data science techniques. The need for skilled persons that can apply data science to present and future advances in bioinformatics cannot be over-emphasized.

Overview
This course begins by explaining the concept and evolution of Bioinformatics. Use cases of bioinformatics are enumerated and described. Use case examples include Gene therapy, Biotechnology, Alternative energy sources, Drug discovery, Plant modelling, etc. Students are exposed to data science related technology stack for bioinformatics projects. The course concludes with a mini project in bioinformatics.

Objectives
The objectives of the course are to:

1. explain the concept and evolution of bioinformatics;
2. enumerate and describe use cases of bioinformatics;
3. explain in detail the role of data science in bioinformatics;
4. identify tech stack for bioinformatics project;
5. identify and illustrate use of programming language (e.g., R) libraries for bioinformatics;
6. illustrate machine learning in bioinformatics project;
7. illustrate how to visualization tools in bioinformatics project;
8. illustrate a full data science project in bioinformatics.

Learning outcomes

On completion of the course, students should be able to:
9. explain the concept and evolution of bioinformatics;
10. enumerate and describe use cases of bioinformatics;
11. explain in detail the role of data science in bioinformatics;
12. identify tech stack for bioinformatics project;
13. use programming language (e.g., R) libraries for bioinformatics;
14. use machine learning in bioinformatics project;
15. use visualization tools in bioinformatics project;
16. design and implement a full data science project in bioinformatics.

Course content

Bioinformatics concept and evolution. Use cases of Bioinformatics. Data Science in Bioinformatics. Tech stack for Bioinformatics. R programming language libraries for Bioinformatics. Machine learning in Bioinformatics. Visualisation. Mini project.

Minimum academic standards

Computer Laboratory.
Computers (1:2 students).
Integrated Development Environment (IDE) e.g., RStudio
Internet.

PAU-DTS 415 **Game Design and Development** (2 Units Elective; LH=15; PH=45)

Senate-approved relevance

The global game industry is huge. The world of games is two pronged: game for gaming environment and game for gamification of non-gaming environments like learning. According to Statista.com, projected gaming market volume by 2027 amounts to US$482.30 billion. Gamification market size is also projected by globenewswire.com to be in billions of US Dollars ($58.8 billion) by 2028. These projections reflect the importance attached to games. Game developers are in high demand. So, there is a need to develop skilled persons that can competitively design and develop game systems in professionally and ethically sound ways.

Overview

In this course, students will leverage their existing programming skills to build games with particular emphasis on 3D. The course treats fundamentals of game development using game engines like Unity. In this course, students will learn how to create 3D game environments, characters, and interactions using the game engine's powerful and intuitive tools. Throughout the course, students will have the opportunity to work on their own game projects, applying the concepts and techniques they've learned in each lesson. By the end of the course, students will have a solid understanding of the game engines' capabilities and be able to create their own games from scratch.

Objectives

The objectives of the course are to:

1. explain the concept of game design;
2. explain the concept of gamification design;
3. describe the differences between game and gamification;
4. describe software development process for game development;
5. illustrate game design for game environment;
6. illustrate game design for gamification environment;
7. explain the Math for game development;
8. show how to develop games leveraging on game engines;

Learning outcomes

At the end of the course, the students should be able to:

1. explain the concept of game design;
2. explain the concept of and gamification;
3. design games for game environment;
4. design games for gamification environment;
5. describe software development process for game development;
6. apply Math in game development;
7. develop games using an industry standard game engine.

Course content

Game and gamification design concepts. Game genres. Introduction to Game design. Introduction to gamification design. Game audio. Software engineering methods for game design. Getting to know the game engine of choice (e.g., Unity, Unreal). Game engine installation. Programming review for game engine (e.g., C# for Unity, C++ for Unreal). Variables. Relational operators. Assessing Logic. Conditions. Branching. If and Switching branches. Looping. Iteration. Inheritance. Composition. Understanding 3D coordinate space. Object Transforms. Collision detection. Scripting. Parenting. Rotation. Arrays. List. Reference, and Value types. Coroutines. Trigonometry.

Minimum academic standards

1 Computer workstation per student for lab sessions.

Minimum configuration for computer is Intel core i5 processor with 16GB RAM and equipped with GPU.

Requisite compilers and industry standard packages should be installed in each system.

PAU-DTS 416 **Computer Vision and Image Processing** (3 Units Compulsory; LH=30; PH=45)

Senate-approved relevance

Computer vision and image processing are two closely related fields in data science that deal with the analysis and manipulation of digital images. Image processing is the manipulation of digital images using mathematical operations to extract useful information, enhance image features, or remove unwanted artefacts. Examples of image processing tasks include image filtering, edge detection, image segmentation, and image compression. Both image processing and computer vision rely on a combination of mathematical and computational techniques, including signal processing, machine learning, computer graphics, and artificial intelligence. These techniques enable computers to analyse and interpret images and video, providing valuable insights and applications in fields such as medicine, surveillance, robotics, and autonomous vehicles.

Overview

This course introduces the students to computer vision and image processing, which involves the development of algorithms and techniques that enable computers to interpret and understand the content of digital images and video. The course involves introducing students to a range of techniques and algorithms that can be used to process and analyse digital images. This can include tasks such as image enhancement, segmentation, feature extraction, object detection, and image recognition. Computer vision aims to replicate the human visual system's ability to recognize and interpret visual information, such as object detection, facial recognition, scene understanding, and image classification.

Objectives

The objectives of the course are to:

1. explain the fundamentals of digital images;
2. describe how to enhance and manipulate images;
3. explain image segmentation and feature extraction;
4. explain object detection and recognition;
5. describe relevant tools and software for computer vision and image processing;
6. apply deep learning algorithms to image processing;
7. describe how to implement efficient Convolutional Neural Networks (CNN).

Learning outcomes

On completion of the course, the students should be able to:

1. explain the properties of digital images, including resolution, colour models, and pixel values;
2. identify techniques for enhancing image quality, adjusting contrast and brightness, and removing noise or artefacts;
3. identify and extract meaningful features from images, such as edges, corners, and textures;

4. detect and recognize objects in images using techniques such as template matching, Haar cascades, and deep learning-based methods;
5. use tools and software commonly used in computer vision and image processing, such as OpenCV, Python libraries such as PIL, Scikit-image, and TensorFlow;
6. apply computer vision and image processing techniques to real-world problems and develop creative solutions;
7. implement efficient CNN.

Course content

Digital Image Fundamentals: Understanding the basics of digital image representation and the properties of images, including colour models, resolution, and pixel values. Image Enhancement: Techniques for improving the quality of digital images, including filters, histogram equalization, and contrast adjustment. Image Segmentation: Dividing an image into meaningful parts or regions, often using techniques such as thresholding, edge detection, and clustering. Feature Extraction: Identifying and extracting important features from images, such as edges, corners, and blobs. Object Detection: Techniques for identifying objects or regions of interest in an image, such as template matching, Haar cascades, and deep learning-based methods. Image Recognition: Using machine learning algorithms, such as convolutional neural networks (CNNs), to classify or recognize objects in images.

Minimum academic standards

Computer Laboratory.
Computers (1:2 students).
Software e.g. OpenCV, Python libraries: PIL, Scikit-image, and TensorFlow.

PAU-DTS 417 **Business Cases and Analysis** (2 Units Compulsory; LH=15; PH=45)

Doing Data Science without a sense of business is like playing chess without the kings on the board. For every business, making its products or services better is the ultimate goal of a data science project. This course introduces the students to a wide range of business problems.

Overview

The course takes a very flexible approach to exploring business cases that are data science related. The course leverages on the one hand on the vast amount of information available online (e.g., on Kaggle.com), as well as interaction with industry managers, for distilling business problems to be tackle with data science principles. The students are expected to produce a series of publishable writeups on the outcome of their case analyses.

Objectives

The objectives of the course are to:

1. analyse real-life business problems;
2. establish a data science related solution that addresses the problem;
3. identify suitable machine learning algorithm to address the problem;
4. carryout requisite data science project applying suitable workflow;
5. communicate project outcome;
6. apply outcome to real-life scenarios;
7. set improvement roadmap.

Learning outcomes

Upon completion of this course, students will be able to:

1. analyse real-life business problems;
2. establish a data science related solution that addresses the problem;
3. identify suitable machine learning algorithm to address the problem;
4. carryout requisite data science project applying suitable workflow;
5. communicate project outcome;
6. apply outcome to real-life scenarios;
7. set improvement roadmap.

Course content

Real-life business problem identification. Interaction with various industry sectors. Exploring online sources for problem distillation. Data science solutions design for business problems. Choosing algorithms that address business problems. Communicating project outcome. Applying outcome to real-life scenarios. Setting improvement roadmaps.

Minimum academic standards
Computer Laboratory with Internet connection.

PAU-DTS 418 **IoT and Edge Computing** (2 Units Elective; LH=15; PH=45)

Senate-approved relevance
According to statista.com, the number of IoT devices connected to the Internet was reported to have surpassed non-IoT devices in 2020. The install base of IoT has further been projected to reach 30.9 billion by 2025, which will imply a sharp rise from 13.8 billion estimated for 2021. These figures reflect the growing importance attached to IoT in different sectors of society as the implementation becomes increasingly more feasible with 5G network rollout. For a present-day computer scientist, a neglect of this subject matter could constitute a significant knowledge gap. Closely related to IoT growth is the growing perceived need to bring data processing and AI engines closer to the devices rather than centralise these engines in the cloud premises, a phenomenon that has become conventionally referred to as edge computing.

Overview
This course has been designed to help the students acquire working knowledge of three of the interrelated technology domains (IoT, cloud and edge computing) that are shaping the future of solutions, in a highly connected world. The course is approached primarily from the perspective of a computer scientist with emphasis on requisite programming skills. The course involves practical lab sections where the students will design, develop and deploy solutions in real devices as well as the cloud. They will also learn what it means in practice to provision infrastructure as service in the cloud and deploy scalable solutions using tools like Kubernetes.

Objectives
The objectives of the course are to:

1. explain the notions of Internet of Things (IoT), cloud computing and edge computing as well as the differences between them;
2. describe the evolution of IoT and edge computing;
3. explain the concept of embedded systems;
4. describe and illustrate how to implement embedded systems using microprocessor boards like Raspberry Pi and third generation programming language like Python, JavaScript, C/C++ and Rust;
5. describe and illustrate how to install and configure operating systems designed for IoT devices and edge computing;
6. describe and illustrate how to implement software solutions on edge devices;
7. describe the various forms of cloud computing and how to deploy scalable solutions to the cloud;

8. describe and illustrate how to orchestrate IoT related services using software tools like Node-Red, IFTTT (If This Then That).

Learning outcomes

On completion of the course, the student should be able to:

1. describe IoT, cloud computing and edge computing as well as how they are related;
2. describe the evolution of IoT;
3. explain why edge computing is gaining prominence even though IoT and cloud computing integration has long been established;
4. explain in detail what an embedded system is;
5. implement embedded systems using microprocessor board (e.g., Raspberry Pi) and a third-generation programming language like Python, JavaScript, C/C++ and Rust;
6. install and configure standard operating system (e.g., Ubuntu core, Windows 10 IoT Core, KataOs) on microprocessor boards (e.g., Raspberry Pi);
7. implement solutions (e.g., machine learning model) on edge devices (e.g., Raspberry Pi with relevant sensor);
8. explain cloud provisioning types e.g., IaaS, PaaS and SaaS;
9. deploy solutions to the cloud;
10. use cloud development operation tools like Kubernetes;
11. orchestrate IoT related services using software tools like Node-Red, IFTTT.

Course content

Comparative description of IoT, cloud computing and edge computing. Embedded systems concept. Embedded system implementation on microprocessor board. Using standard operating systems in embedded systems. Developing edge solutions. Notion of cloud computing. Provisioning of cloud infrastructure. Orchestrating IoT related services.

Minimum academic standards

1 Computer workstation per 5 students.
1 Raspberry Pi with in-built Wi-Fi per 5 students.
1 each of MicroSD memory card, keyboard, micro-USB power supply, HDMI cable, camera module, per Raspberry Pi.
Sensor devices for environmental input illustration.

PAU-DTS 419 **Advances in Web, Mobile and Blockchain Development** (3 Units Elective; LH=30; PH=45)

Senate-approved relevance

The Web which was invented decades ago continues to be relevant today and is solidly projected into the future as it transits through the hypothetical versions tagged Web1, Web2 and Web3. Closely associated with this transition to Web3 is the Blockchain as the underlying data structure. Complementary to the Web and Blockchain platforms are mobile devices (phones, AR/VR sets) which put solutions and access to platforms in the hands of the mobile user. We consider an atomic treatment of these three dimensions in a course, to be important for expertise in full-stack solutions development, needed now and in the future.

Overview

This course involves a deep dive into full-stack development embracing both Web2 and Web3. In order to inspire creativity, the students will be taken through the innovative history of the Web, from stage to stage. The course should equip them with the requisite skills required to become reputable solutions providers, at the service of global demands, while at the same time positioned to solve our local problems. The course should also expose the students to the academic questions in Web3 and blockchain evolution, with the potential to pursue post-graduate research in these areas.

Objectives

The objectives of the course are to:

1. describe in detail, the historical evolution of the Web from inception to Web3;
2. explain in scientific detail, what blockchain is and the benefits and drawbacks;
3. describe blockchain oracles and their importance in Web3 solutions stack;
4. illustrate the design, development and deployment of server-side software applications for Web2;
5. explain what it takes to build a blockchain;
6. describe and illustrate the development of blockchains;
7. illustrate the design, development and deployment of decentralised applications (dApps) for blockchains;
8. illustrate the design, development and deployment of mobile phone applications;
9. illustrate the design, development and deployment of progressive Web applications;
10. describe development for VR/AR devices.

Learning outcomes

On completion of the course, the student should be able to:

1. explain the historical evolution of the Web from inception to Web3;
2. explain in detail, blockchain and related blockchain oracles (e.g., IPFS);
3. identify the respective solutions stack for Web2 and Web3;
4. design, write and deploy simple to complex server-side software applications for Web2, in third-generation languages;
5. create blockchains using third-generation languages like Rust;
6. design, write and deploy decentralised applications for blockchains;
7. design and develop native mobile applications;
8. create simple to complex progressive Web applications;
9. create and deploy applications for selected AR/VR devices.

Course content

The evolution of the Web. Blockchain and related oracles. Web2 solutions stack. Web3 solutions stack. Server-side applications for Web2. Creating blockchains. Creating decentralised applications for blockchains. Mobile applications. Progressive Web applications. AR/VR applications.

Minimum academic standards

1 Computer workstation per two students for lab sessions.

Minimum configuration for computer is Intel core i5 processor with 16GB RAM.

Requisite compilers, mobile simulators and industry standard packages should be installed in each system, for development.

Networked systems for decentralised blockchain and oracles illustrations.

Mobile phones (personal phones recommended).

Two VR headsets.