University Vice-Presidency

College of Computing and Informatics

STUDY PLAN PROJECT

BACHELOR OF SCIENCE IN DATA SCIENCE

October 2021

Introduction

The College of Computing and Informatics offers Bachelor of Science in Data Science program that aims to enhances and contributes to the National strategic plans for the data scientists needs in order to localizing job market demands. The program focuses on combining the cognitive and applied aspects in the field of data science, machine learning and artificial intelligence. The program aims to enable the students to practically apply these technologies in problem solving.

The Importance and Reasons for Creating the Program

- Data science is considered one of the most exciting specialty in the twenty-first century. With an enhanced focus and application in areas of Internet technologies, social networking applications and the Internet of things, we now have huge amounts of data that are difficult to handle and analyze by the traditional statistical methods. Thus, the specialty of data science has become what is today termed as the oil of the twenty-first century.
- The labor market is still suffering from a severe shortage of qualified data scientists. Thus, this program is introduced to fill in the gap by graduating highly qualified data scientists, who can make use of the latest artificial intelligence techniques to analyze data and extract knowledge.
- Therefore, the College of Computing and Informatics in the Saudi Electronic University presenting an integrated program for the Bachelor of Data Science, that was implemented based on international standards and conform with the latest techniques and methods.

Program Objectives

1. Development of a technically proficient workforce comprising of Saudi citizens capable of carrying out software development projects to the best of international standards.
2. Developing both academic and professional skills in the domain of data science and AI.
3. Enhancing students' experience by enabling them to solve academic and practical problems in their areas of specialization.
4. Implementing best practices to develop comprehensive data analysis projects plans.
5. Preparing students to meet the labor market requirements in data science domains.
6. Integrating the academic programs by bridging the gap between theoretical advances and practical applications.

Duration of Study in the Program

8 semesters.

Program Learning Outcomes

1. Recognize the concepts of computing and mathematics related to the discipline.
2. Master the current techniques, skills, and tools necessary for the computing practice.
3. Demonstrate algorithmic, computational, and statistical models in data science.
4. Comprehend the local and global impact of computing on individuals, organizations, and the society.
5. Analyze a problem, identify and define the computing requirements appropriate to its solution.
6. Apply mathematical foundations, algorithmic principles, and Data science theories in modeling.
7. Implement theories and principles using cutting edge technologies in the analysis, design, implementation and testing of computer-based systems.
8. Construct machine learning and AI optimization models using problem-solving strategies for data analytics.
9. Function effectively on teamwork activities to accomplish a common goal.
10. Identify the needs for continuous development of professional skills with the ability to engage all group members.
11. Develop projects to visualize data for exploration, analysis, and communication.
12. Communicate effectively with a range of audiences, both orally and in a written form, using appropriate media.

Career Opportunities for Graduates of the Program

1. Data Administrator.
2. Computer Systems Analyst.
3. Data Scientist.
4. Software Developer.
5. Data Analyst.
6. Big Data Analyst.
7. Financial Data Analyst.
8. Machine Learning Engineer.
9. Business Intelligence Analyst.
10. Big Data Administrator.
11. Data Mining Analyst.
12. Big Data Architect.
13. Data Visualization Developer.

Vision

The Bachelor of Data Science program utilizes the latest technologies and trends in data science domains, to improve students' skills in implementing and developing data science projects, collaborate with industry, and provide advanced tools and technologies in artificial intelligence, machine learning, and data science.

Mission

Offer the highest quality education in the field of data science. It also intent to provide equal opportunities for those whose work conditions and geographical borders prevent them from continuing their educational path without the student having to travel abroad to study courses in foreign universities, also the method of blended learning focuses on merging students and faculty members with a professional and international level. The program targets to qualify students with expert skills in data analysis and data science, that will impact the industry and society.

Program Study Plan

The Bachelor of Data Science program contains 43 courses, distributed over eight semesters.
The program is only offered in English.

University Requirements: (34 Credits)

1. **CS001**: Computer Essentials
2. **ENG001**: English Language Skills
3. **CI001**: Academic Skills
4. **MATH001**: Fundamentals of Mathematics
5. **ENG002**: English Language Skills 2
6. **COMM001**: Communication Skills
7. **ISLM101**: Islamic Course 1
8. **ISLM102**: Islamic Course 2
9. **ISLM103**: Islamic Course 3
10. **ISLM104**: Islamic Course 4

College of Computing and Informatics (CCI) Requirements: (24 Credits)

1. **ENG103**: Technical Writing
2. **MATH150**: Discrete Mathematics
3. **MATH151**: Linear Algebra
4. **DS230**: Object Oriented Programming
5. **DS240**: Data Structure

6. **DS350**: Introduction to Database
7. **DS351**: Operating Systems
8. **DS360**: Computer Networks
9. **DS499**: Practical Training

Specialization Requirements: (72 Credits)

1. **SCI 101**: General Physics 1
2. **SCI 201**: General Physics 2
3. **DS241**: Calculus
4. **STAT202**: Introduction to Statistics and Probabilities
5. **DS231**: Introduction to Data Science Programming
6. **DS242**: Advanced Data Science Programming
7. **DS243**: Computer Architecture and Organization
8. **DS352**: Design and Analysis of Algorithms
9. **DS353**: Project Management in Computing
10. **DS361**: System Analysis and Design
11. **DS362**: Web Programming
12. **DS363**: Artificial Intelligence
13. **DS364**: Data Curation (Management and Organization)
14. **DS470**: Data Security and Privacy
15. **DS471**: Machine Learning
16. **DS472**: Data Mining
17. **DS480**: Data Visualization
18. **DS481**: Professional Ethics in Data Science
19. **DS479**: Senior Project 1
20. **DS489**: Senior Project 2
21. **DS4xx**: Elective 1
22. **DS4xx**: Elective 2
23. **DS4xx**: Elective 3
24. **DS4xx**: Elective 4

Electives:

- *Artificial Intelligence:*
    - **DS473**: Computer Vision
    - **DS474**: Decision Support Systems
    - **DS482**: Deep Learning
    - **DS483**: Natural Language Processing
- *Big Data Analytics:*
    - **DS475**: Big Data Modeling

- **DS476**: Big Data Integration and Processing
- **DS484**: Big Data Optimization
- **DS485**: Business Intelligence

Program Structure

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	CS001	Computer Essentials	3	
2	ENG001	English Language Skills	8	
3	CI001	Academic Skills	2	
4	MATH001	Fundamentals of Mathematics	3	
5	ENG002	English Language Skills 2	8	
6	COMM001	Communication Skills	2	
7	SCI 101	General Physics 1	3	Passing the First Year
8	DS230	Object Oriented Programming	3	
9	ENG103	Technical Writing	3	
10	MATH150	Discrete Mathematics	3	
11	DS231	Introduction to Data Science Programming	3	
12	ISLM101	ISLM101	2	
13	MATH151	Linear Algebra	3	MATH150
14	DS240	Data Structure	3	DS230
15	DS241	Calculus	3	MATH150
16	DS242	Advanced Data Science Programming	3	DS231
17	DS243	Computer Architecture and Organization	3	
18	ISLM102	ISLM102	2	
19	SCI 201	General Physics 2	3	SCI 101
20	DS350	Introduction to Database	3	DS240
21	DS351	Operating Systems	3	DS243
22	STAT202	Introduction to Statistics and Probabilities	3	MATH150
23	DS352	Design and Analysis of Algorithms	3	DS240
24	DS353	Project Management in Computing	3	
25	DS360	Computer Networks	3	DS243
26	DS361	System Analysis and Design	3	DS240
27	DS362	Web Programming	3	DS350
28	DS363	Artificial Intelligence	3	DS352
29	DS364	Data Curation (Management and Organization)	3	DS350

30	ISLM103	ISLM103	2	
31	DS499	Practical Training	Pass/Fail	Passing 86 Credit Hours
32	DS470	Data Security and Privacy	3	DS364
33	DS471	Machine Learning	3	DS363
34	DS472	Data Mining	3	DS364
35	DS479	Senior Project 1	3	DS361, DS362
36	DS4xx	Elective 1	3	
37	DS4xx	Elective 2	3	
38	ISLM104	ISLM104	2	
39	DS480	Data Visualization	3	DS472
40	DS481	Professional Ethics in Data Science	3	
41	DS489	Senior Project 2	3	DS479
42	DS4xx	Elective 3	3	
43	DS4xx	Elective 4	3	
Total Credits			**130**	

	Concentration	**Course Code**	**Course Title**	**Credit Hours**	**Pre-Requisites**
Electives	**Artificial Intelligence**	DS473	Computer Vision	3	DS363
		DS474	Decision Support Systems	3	DS363
		DS482	Deep Learning	3	DS471
		DS483	Natural Language Processing	3	DS471
	Big Data Analytics	DS475	Big Data Modelling	3	DS363
		DS476	Big Data Integration and Processing	3	DS363
		DS484	Big Data Optimization	3	DS475
		DS485	Business Intelligence	3	DS475

Program Structure by Levels

Level One

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	CS001	Computer Essentials	3	
2	ENG001	English Language Skills	8	
3	CI001	Academic Skills	2	

Level Two

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	MATH001	Fundamentals of Mathematics	3	
2	ENG002	English Language Skills 2	8	
3	COMM001	Communication Skills	2	

Level Three

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	SCI 101	General Physics 1	3	Passing the First Year
2	DS230	Object Oriented Programming	3	
3	ENG103	Technical Writing	3	
4	MATH150	Discrete Mathematics	3	
5	DS231	Introduction to Data Science Programming	3	
6	ISLM101	ISLM101	2	

Level Four

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	MATH151	Linear Algebra	3	MATH150
2	DS240	Data Structure	3	DS140
3	DS241	Calculus	3	MATH150
4	DS242	Advanced Data Science Programming	3	DS240
5	DS243	Computer Architecture and Organization	3	
6	ISLM102	ISLM102	2	

Level Five

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	SCI 201	General Physics 2	3	
2	DS350	Introduction to Database	3	DS240
3	DS351	Operating Systems	3	DS243

4	STAT202	Introduction to Statistics and Probabilities	3	MATH150
5	DS352	Design and Analysis of Algorithms	3	DS240
6	DS353	Project Management in Computing	3	

Level Six

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	DS360	Computer Networks	3	DS243
2	DS361	System Analysis and Design	3	DS240
3	DS362	Web Programming	3	DS350
4	DS363	Artificial Intelligence	3	DS352
5	DS364	Data Curation (Management and Organization)	3	DS350
6	ISLM103	ISLM103	2	

Summer

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	DS499	Practical Training	Pass/Fail	Passing 86 Credit Hours

Level Seven

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	DS470	Data Security and Privacy	3	DS364
2	DS471	Machine Learning	3	DS363
3	DS472	Data Mining	3	DS364
4	DS479	Senior Project 1	3	DS361, DS362
5	DS4xx	Elective 1	3	
6	DS4xx	Elective 2	3	

Level Eight

#	Course Code	Course Title	Credit Hours	Pre-Requisites
1	ISLM104	ISLM104	2	
2	DS480	Data Visualization	3	DS472
3	DS481	Professional Ethics in Data Science	3	
4	DS489	Senior Project 2	3	DS479
5	DS4xx	Elective 3	3	
6	DS4xx	Elective 4	3	

Program Courses Descriptions

Object Oriented Programming:

This course is to introduce the students to the principles of computer analysis of problems, design of algorithms, programming, and testing using the Java programming language. Topics include problem analysis basics of programming, data types, control structures, functions, arrays, object-oriented programming, inheritance, recursion and the mechanics of running, testing, and debugging.

Data Structure:

In this course, students will be taught to work on complex data structures and algorithms. It includes key data structures including stacks, queues, linked lists, binary trees, recursion and examples using some fundamental algorithms of computer science. Java programming languages will be used. Course is designed keeping in mind the need to make students understand concepts related to data representation and organization in development of software products and services. The students are taught advanced algorithmic concepts such as time and space complexity, searching algorithms and sorting algorithms etc.

Introduction to Data Science Programming:

This course provides a basics introduction to Data Science. The goal is to provide students with a solid foundation in data science cycle from data collection, to Exploratory Data Analysis (EDA), data interpretation, data analytics and visualization. Students will learn how to explore, visualize and pose questions about data using high level language.

Advanced Data Science Programming:

This course covers in-depth knowledge of data science concepts and techniques. Topics includes modeling, both deterministic and stochastic, data collection methods and statistical inference as well as emerging applications and trends in data science. Also, students will become familiar with essential data science tools such as Python programming language. In this course students will learn through real-world examples.

Calculus:

Differentiation of algebraic and transcendental functions, applications of the derivative, differentials, indefinite integrals, definite integrals. Partially fulfills Core Mathematics requirement. The goal here is developing the student's geometric insight into the concepts of differentiation and integration, and applying these concepts to problem solving and "real world application". Also, topics include integration of elementary functions; techniques of integration; integrals with infinite limits of integration; integrals of discontinuous integrands; applications of the definite integral; an introduction to differential equations; infinite series; analytical geometry; and other applications.

Introduction to Statistics and Probabilities:

In this course, students will learn about applications of probability and statistics in the data science field and how it is used in the analysis of algorithms. Also, learn about the impact of probability theory in many powerful computing tools and how the current trends are causing a higher need for probabilistic analysis. Learn about optimization, inference, testing, and other methods for analyzing patterns in data and using them to predict, understand, and improve results. Lastly, understanding how randomness influence computing decisions that are made nowadays.

Computer Architecture and Organization:

Computer architecture is the science and art of selecting and interconnecting hardware components to create a computer that meets functional, performance and cost goals. In this course, the students will learn how to completely design a correct single processor computer, including processor data path, processor control, pipelining optimization and instruction level parallelism, cache and memory systems, and I/O systems. The students will also learn how to quantitatively measure and evaluate the performance of the designs. The students will also learn how to construct an assembly language programs.

Operating Systems:

This is an introductory and core course in the program which familiarizes students with the principles and underlying concepts of operating systems. The focus of this course is to understand the underlying technologies that make contemporary operating systems work efficiently. System Architecture, Processes, threads, synchronization, I/O, file systems, memory and storage management, Protection and Security techniques will be explored in depth.

Introduction to Database:

In this course, students will be introduced to the following topics: basic concepts of database systems and architectures including Database Management Systems (DBMS) Types (Relational, Hierarchical, NoSQL Databases, Object-Based, Object Oriented and Distributed), Entity-Relationship model, Data models (Relational model & SQL), Database design (Database dependencies and normalization), Database implementation, and Database Security Models. Students will learn about Database implementation using modern Database Management System tools. This course will provide knowledge, skills and abilities to manage, use and protect database systems.

Design and Analysis of Algorithms:

This course introduces formal techniques to support the design and analysis of algorithms, focusing on both the underlying mathematical theory and practical considerations of efficiency. Topics include asymptotic complexity bounds, techniques of analysis, and algorithmic strategies.

Computer Networks:

This course explores fundamental concepts in the design and implementation of computer communication networks and their protocols. This includes layered network architectures, applications, transport, congestion, routing, data link protocols, local area networks. An emphasis will be placed on the protocols used in the Internet. Furthermore, the concepts and structure of IPv4 addressing and subnetting, its application, operation and implementation to networks are discussed. Lastly, Cloud computing will be introduced in this course.

Project Management in Computing:

This course is developed to provide the students with the needed knowledge, and skills for perform as project managers in the field of computing.

This course covers detailed topics of the basic concepts of project management in computing, including initiating, planning, controlling, executing, and closing projects. The course also shows how that type of projects should be managed, from inception to post implementation review. This course will help improve management skills and abilities to define the project scope, create a workable project plan, and manage within the budget and schedule.

System Analysis and Design:

This course introduces the modelling techniques and the fundamental principles of problem analysis and software design as core concepts in software engineering discipline. The course concentrates on object-oriented approaches for modelling software requirements and leading to software design. The course is designed to integrate theoretical concepts of system analysis and design with practical examples and case studies. Students will be enabled to understand the practical techniques of software analysis, design, implementation, and maintenance. The course also elaborates different related concepts such as requirements determination, database design, characteristics of analyze and design internet-based systems, and factors affecting maintenance process.

Web Programming:

This course is an overview of the modern Web technologies used for the Web development. The topics include: HTML5, CSS3, JavaScript, DOM, XML, Rich Internet Applications (RIAs) with AJAX, server-side programming using PHP, and designing and manipulating web databases.
Upon completion, students should be able to:

1. Describe methods and tools in web development.
2. Create web pages using HTML5 and CSS3.
3. Develop dynamic web pages using JavaScript.
4. Design XML Schemas and documents.
5. Create Rich Internet Applications.
6. Build web applications using PHP and MySQL.

Artificial Intelligence:

The course is designed to educate students with broad range of artificial intelligence (AI) topics. It provides sufficient understanding about central concepts pf Artificial intelligence such AI applications, predicate calculus, and state space search. Topics also include but are not limited to heuristic strategies, problem solving, knowledge representation, expert systems, and machine learning. The learning of various Artificial Intelligence techniques is supplemented with algorithms development and real-world problem-solving examples.

Data Curation (Management and Organization):

This course educates students on how to curate (select, organize, present) data to improve performance of Decision-Making process. This course provides instruction on data curation approaches, metadata, data valuation, and decision engineering. Also, it will help students understand the diversity of data and their management needs across the research data lifecycle as gaining the ability to identify the components of good data management plans and to perform best practices for working with data including the organization, documentation, and storage and security of data.

Data Security and Privacy:

This course intends to provide students with an understanding of personal data and information, the background and principles of data security and privacy, the consequences of not adhering to applicable laws and regulations, and students' responsibilities with respect to data protection. The course also studies the legal rules on data protection.

Machine Learning:

Machine Learning is an active and growing field of study and research. It is the study of building computer systems, which can learn from experience, by developing learning models. These models automatically learn from data - for example, a model, which learns through data files of facial images to recognize faces. Other examples of real-life machine learning applications are speech recognition, machine translation, natural language processing, medical diagnosis and intelligent robots. This course introduces the concepts behind several Machine Learning techniques including how they work. In addition, it will use existing software packages to illustrate how the machine learning algorithms are applied on data, thus students are going to gain practical experience in applying them. This course covers supervised learning (parametric/non-parametric algorithms such as regression, decision trees and ensemble methods, support vector machines, kernels, neural networks) and unsupervised learning (clustering, dimensionality reduction, recommender systems).

Data Mining:

The course of data mining is designed to educate the students with algorithms and techniques designed to enable computers in finding hidden patterns and models within database, These algorithms and techniques have immense applications ranging from prediction and analysis to forecasting and optimization enabling organizations to reach strategic goals with the help of computer systems. Knowledge discovery is the main aim of techniques taught in this course by extracting relevant information from big volumes of raw data. The students will be familiarized with techniques such as data selection, cleaning, coding, using different statistical and machine learning techniques, and visualization of the generated structures. The course will equip students with knowledge of relevant Machine Learning methods data warehousing techniques and on-line analytical processing (OLAP).

Data Visualization:

This course covers the basics of data visualization and exploratory data analysis. We will many motivating examples and Matplotlib Library, a data visualization package for the programming language Python. Students will learn how to visualize data in various numbers of dimensions and how to use latest technology to do so. Also, learn about interactive visualization techniques.

Professional Ethics in Data Science:

Professional Ethics in Data Science is the basic course to understand the moral values in practical life activities. This course will be helpful to understand the ethics of data science, computing, licensing, and certification. This course covers the impact of intellectual property on data engineering related technology. Government and network communication privacy is also covered by this course.

Senior Project 1:

This course will equip undergraduate data science students with the basic skills to conduct researches in the field of Data Science. The course aims to introduce the required techniques for conducting a research, implementing systems, writing technical reports and the skills for presenting the work for audiences. This course will particularly focus on topics which are related to the field of Data Science. The course will also provide guidance to the students in selecting their projects, understanding the research process as well as the tools needed to build analytical system and writing its documentation. The course discusses other issues including research methods that are normally used in researches such as experiments, survey, interview and simulations, understanding the importance of literature review, preparing visual presentations and other ethical issues such as plagiarism.

Senior Project 2:

This course is a continuation of the graduation project started in DS 490. The focus will be in this part on low-level design, implementation, testing and quality assurance as well as management of the project. The outcome of this project must be a significant information system, employing knowledge gained from courses through the curriculum. Students must deliver the code, a final report and must do a presentation of their work as well as a demo.

Electives: Artificial intelligence

Computer Vision:

Computer Vision is one the most leading areas of research and application in the discipline of data science with applications ranging from medical imaging to security and public safety. Innovations in this field are enabling researchers to develop more accurate mechanisms to help mankind cope with challenges of 21st century. In this course, the students will be taught the methods and techniques applied in the field of computer vision such as (but not limited to) fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification and scene understanding. After completion of this course, the students will have ability to develop applications and methods that can discover known models in images, perform depth recovery from images, achieve image stabilization, automated alignment, tracking, boundary detection, and recognition.

Decision Support Systems:

Decision support systems are playing key role in today's organizations in taking effective and useful decisions while insulating organizations from effects of wrong decisions. The course is devoted to introduce decision support systems; show their relationship to other computer-based information systems, demonstrate DSS development approaches, and show students how to utilize DSS capacities to support different types of decisions. The topics covered in the course include but not limited to, Introduction to decision support systems; DSS components; developing DSS; DSS models, emerging technologies in DSS in including business intelligence, data analytics, data visualization big data, deep learning and AI-based DSS.

Deep Learning:

This course provides students with a solid foundation in deep learning concepts. Students will gain foundational knowledge of deep learning techniques and algorithms. The course will cover different Neural network architectures as well as selected topics discussing recent learning models. In this course, students will apply deep learning techniques to real-world problems through practical experiences using TensorFlow framework.

Natural Language Processing:

This course covers the basics of Natural Language Processing. The goal is to provide students with skills and tools to apply and develop Natural Language Processing systems. The course will cover the following topics: NLP workflow, feature engineering, POS, name entity recognition, text mining and classification techniques, as well as recent advances in language modeling. In this course students will apply NLP techniques to real-world problems through practical experiences.

Electives: Big Data Analytics

Big Data Modelling:

This course will present various data genres and management tools and teach student how to appropriately handle each. Also, learn how to describe the reasons behind using any big data platforms from the perspective of big data management systems and analytical tools. Students will become familiar with techniques using real-time and semi-structured data examples. By the end of this course student should be able to recognize different data elements in his/her own work and in everyday life problems.

Big Data Integration and Processing:

In this course, student will learn how to use distributed system in effort to process Big Data. Tools students will be familiar with upon ending this course include MapReduce, Hadoop and Spark.

Big Data Optimization:

In this course, student will learn how to create an efficient environment and what steps can he/she take to deal with big data efficiently. Tools students will be familiar with upon ending this course include MapReduce, Hadoop and Spark.

Business Intelligence:

This course includes several topic ranging from Introduction to Data and Data Science, Statistics and Excel, Database theory, SQL, Tableau, SQL + Tableau. Students will be familiar with using various tools for business reporting and how to utilize data for business advancements.