First year courses

BA Data Science & KE Year 1 Core Courses

Data Science & Knowledge Engineering

Introduction to Data Science and Knowledge Engineering

Full course description

The course Introduction to Data Science & Knowledge Engineering offers a comprehensive overview of the core topics in Data Science and Knowledge Engineering (DKE), both from a mathematical and from an Artificial Intelligence perspective. Particular emphasis will be put on: the basic classes of techniques and methods, the theoretical underpinnings of data science and computational intelligence, and the main application domains of knowledge engineering. As such the course will provide an overview of many topics that are addressed in much more detail in the Bachelor's programme.

Prerequisites

None

Recommended reading

S. Russell and P. Norvig (2010): Artificial Intelligence, A Modern Approach. Third edition, Pearson Education, ISBN 978-0-13-207148-2

KEN1110

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
P. Bonizzi
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Introduction to Computer Science 1

Full course description

Introduction to Computer Science 1 introduces students to the world of programming. Programming is a core tool of the Knowledge Engineer, as it allows translating theoretical ideas into practical applications. After a brief introduction about the inner workings of a computer, students learn about the principles of programming and basic programming tools. The lectures are accompanied by computer labs in which the student has to translate simple tasks into computer programs and feedback is provided to the student about their progress. Throughout the bachelor programme, Java is used as the main programming language. After completing this course the student is familiar with the core elements of programming and can implement simple programs in Java.

Prerequisites

None

Recommended reading

Cay Horstmann (2012. Big Java Late Objects. John Wiley & Sons, New York, ISBN 978-1-1180-8788-6 (Chapter 1-6,13)

KEN1120

Print course description

ECTS credits:

4.0

Instruction language:

English

Coordinator:

K. Driessens

Teaching methods:

Project-Centered Learning

Assessment methods:

Written exam

Data Science & Knowledge Engineering

Discrete Mathematics

Full course description

Discrete Mathematics introduces students to mathematical logic and reasoning. Students learn to recognise whether an argument is sound and if not, why certain steps go wrong. The basics of logic and mathematical proofs will be studied and used to discuss, among other things, concepts such as sets, relations, infinity, functions, permutations and combinations. This course builds upon common sense reasoning and abstract thinking, and no previous knowledge about mathematics is required. Lectures are accompanied with practical assignments to help the students apply the material that was learned. After completing this course the student will know how to use mathematical concepts correctly and apply several types of mathematical proofs.

Prerequisites

None

Recommended reading

None

KEN1130

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
S.M. Kelk
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Computational and Cognitive Neuroscience

Full course description

Computational and Cognitive Neuroscience presents an overview of the core topics in cognitive and biological psychology. These topics include, among others, (human) perception, learning, memory, planning and problem solving and do not require a background in psychology or biology. The course relates concepts in artificial intelligence (AI) to concepts in psychology. Students are introduced to algorithms used in AI that are based on biological and psychological concepts such as evolution and neural models. After completing this course the student has become aware of the main findings that relate psychology and biology to artificial intelligence. Additionally the student has identified the limitations of theories and interpretations of psychological and neuro-scientific experimental findings.

Prerequisites

none

Recommended reading

Sternberg, R.J. (1999). Cognitive psychology (latest edition). Fort Worth: Harcourt Brace. Eysenck, M.W. and Keane, M.T. (1995). Cognitive psychology: A student's handbook (3rd ed.). Hove: Psychology Press. Kalat, J.W. (2007) 9th edition Biological psychology. Pacific Grove, California; London: Brooks Cole. Gazzaniga, M. (2009). Cognitive Neuroscience (third edition).

KEN1210

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinators:
A.F. Roebroeck
M. Capalbo
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Introduction to Computer Science 2

Full course description

Introduction to Computer Science 2 is the second programming course in the curriculum. The course continues where Introduction to Computer Science 1 left off, and students are expected to possess the basic level of programming that was previously taught. The central topic of this course is the interaction between the program and the user. An example of such an interaction is a graphical user interface that visualizes the working of a program. The lectures in this course are accompanied by computer labs, in which the student has to program a set of assignments. After completing this course the student will be able to write more advanced programs that can interact with its user. Additionally the student will be able to graphically display the state of their program.

Prerequisites

Introduction to Computer Science 1

Recommended reading

H. Deitel and P. Deitel (2007). Java How to Program, 7/E, Pearson, ISBN- 10: 0132222205

KEN1220

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
E.N. Smirnov
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Linear Algebra

Full course description

Linear Algebra introduces students to the concepts of linear algebra from an algebraic and geometric point of view. Linear algebra is essential for most calculations in mathematics, engineering and computer science. This makes it a broad topic in which students are taught concepts ranging from solving systems of linear equations to linear transformations and characteristics of linear systems. The lectures in this course are accompanied by computer labs, in which the student has to program a set of assignments. The software package used in this course is Matlab, which is one of the industry standards for calculations and computations that involve linear algebra. After completing this course the student will be able to use the fundamental concepts of linear algebra to implement and perform mathematical computations. Additionally the student will obtain valuable experience in using and writing code for Matlab.

Prerequisites

None

Recommended reading

None

KEN1410

Period 2
28 Oct 2019
20 Dec 2019

Print course description

ECTS credits:

4.0

Instruction language:

English

Coordinator:

P. Bonizzi

Teaching methods:

Project-Centered Learning

Assessment methods:

Written exam

Data Science & Knowledge Engineering

Project 1-1

Full course description

The project will be carried out by small groups of students, and will be guided by the teachers of the courses from the first period. The project will strongly relate to the content of the subjects from the first period. Project 1-1 is split up into two sub-projects.

The first project will be held during period 1.1 and will span a week. In this project the students will work in groups together to complete a small assignment related to the courses in period 1.1. No courses are held during this project week, such that the students can maximally focus on the project assignment. The second project starts in period 1.2 and consists of a larger assignment, to be completed at the end of period 1.3. During period 1.2 the student will work, in groups, on their project next to the courses, and during period 1.3 the students will work with their group for three weeks full-time on the project.

Both projects require the student to apply the material that was learned in the first period to the problem assignment. Additionally the students have to work together in groups of maximally 6 persons. The combination of both of these factors offers a challenging task for the students whereby besides theoretical knowledge also more practical skills such as teamwork and communication are further developed.

Prerequisites

This project has no prerequisites. This project occurs as part of the prerequisites of project 2-1.

KEN1300

Semester 1

2 Sep 2019

31 Jan 2020

Print course description

ECTS credits:

6.0
Instruction language:
English
Coordinators:
K. Driessens
J.P. Paredis
J.M.H. Karel
P. Bonizzi
E.N. Smirnov
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Data Structures and Algorithms

Full course description

Data Structures and Algorithms introduces the students to the design and application of data structures and algorithms. Abstract datatypes will be used as a central topic in this course. As part of the basic abstract data types, such as trees, lists, and graphs, the associated algorithms and their complexity will be treated. Besides abstract datatypes the course will focus on design principles for algorithms such as recursion, divide-and-conquer, and dynamic programming. The lectures in this course are accompanied by computer labs, and students are expected to have obtained an understanding of the basic concepts in java via earlier courses. After completing this course students will be able to determine the appropriate data structures and algorithms for a given problem.

Prerequisites

Introduction to Computer Science 1 and 2.

Recommended reading

None.

KEN1420

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
4.0
Instruction language:
English

Coordinator:
M.H.M. Winands
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

ICT and Knowledge Management

Full course description

Knowledge is a fundamental prerequisite in the ability of a person to execute a task. This ability consists of explicit knowledge or information, implicit knowledge or experiences, skills and attitudes. We will analyze knowledge from different perspectives, depending on which element in the definition the emphasis is placed. In knowledge management, basically three dominant approaches exist:

– The ICT approach, with focus on expliciting and structuring the knowledge. The knowledge can be objectively shared.
– The Human-talent approach, also known as competence management.
– The Knowledge-friendly organization approach, with focus on providing means to stimulate the sharing of knowledge.

Prerequisites

None.

Recommended reading

Lecture material.

KEN1430

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
P.W.L. Bollen
Teaching methods:
Project-Centered Learning

Assessment methods:
Written exam

Data Science & Knowledge Engineering
Calculus

Full course description

Calculus introduces the students to a theoretical notion of the basic concepts in applied mathematics. The topics discussed in calculus are fundamental for the mathematical aspect of knowledge engineering and, among others, include limits, continuity, differential equations, series and multivariable calculus. Both the intuition behind the concepts and their formal definitions will be presented along with simple examples of formal mathematical proofs. For this reason it is required that the student has completed discrete mathematics in period 1.1. After completing this course the student has obtained a theoretical notion of the basic topics in applied mathematics, and is able to validate all kinds of mathematical arguments.

Prerequisites

None.

Recommended reading

None.

KEN1440

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinators:
K. Stankova
Z.I.T.A. Soons
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Software Engineering

Full course description

Software Engineering introduces the student to the software engineering process. The course addresses the way in which large and complex software projects have to be conceived and managed. Topics in this course include, among others, requirement analysis, design methodologies, implementation strategies and test procedures. These topics are essential for software development, and are essential if the student wishes to pursue a career in software development. The students will use the knowledge acquired in this course during the semester projects of the curriculum. After completing this course the student will be able to judge the viability of a selected software development methodology. Additionally the student is aware of the standard design patterns for programming which are essential in software development.

Prerequisites

Introduction to Computer Science 1 and 2.

Recommended reading

None.

KEN1520

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
C.B. Browne
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Logic

Full course description

Logic introduces the student to three core logical systems, namely propositional logic, first-order predicate logic and epistemic logic. Understanding these logical systems will improve the ability of the student to think in a structural way about, among others, problem solving and program design. Besides logical systems the course will focus on proving and reasoning techniques. These techniques are relevant to various kinds of logics and include, among others, semantic tableaux, deduction, and proof systems. After completing this course the student has obtained a solid basis in the three core logical systems. Additionally the ability of the student to reason and communicate about problems has been improved.

Prerequisites

Introduction to Computer Science 1 and 2

Recommended reading

None

KEN1530

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
J.W.H.M. Uiterwijk
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Numerical Mathematics

Full course description

Numerical Mathematics introduces the students to the concept of solving mathematical problems using a digital computer. The course covers the fundamental concepts of numerical mathematics, including the floating-point representation of real numbers, truncation and round off errors, iterative methods and convergence. The most fundamental algorithms to solve numerical problems, such as obtaining solutions of algebraic equations and numerically estimating derivatives and integrals, will be studied. The lectures in this course are accompanied by computer labs in which the student has to implement its own numerical code and test the performance on various problems. After completing this course the student will have knowledge of the fundamental problems of numerical mathematics, and the basic techniques to solve them.

Prerequisites

Calculus.

Recommended reading

None.

KEN1540

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
P.J. Collins
Teaching methods:
Project-Centered Learning

Data Science & Knowledge Engineering
Project 1-2

Full course description

The project will be carried out by small groups of students, and will be guided by the teachers of the courses from the first period. The project will strongly relate to the content of the subjects from the first period. The project is split up into three phases:

In the first phase students will become familiar with the project assignment, and lay a foundation for the next phases. This often involves the implementation of a basic environment and research regarding the project assignment. The first phase will be concluded with a presentation.

In the second phase the student will have obtained a basic platform to work with. In this phase more advanced concepts will be implemented, and a planning will be made for phase three. The second phase will be concluded with a presentation.

Phase three consist of three full-time weeks in which the students work together with their project group on the core of the assignment. Before starting this phase it is expected that students have previously implemented an environment to work with, and have obtained a planning for this phase. The third phase will be concluded with a presentation. Additionally in the third phase a scientific paper needs to be written about the project results.

The project will be accompanied by so-called skills classes. These classes help the student develop competences that are useful when working on a project assignment with a group. These skill classes vary in topics from technical concepts such as working with LaTeX, to more social concepts such as leadership, presentation skills, and scientific writing.

Prerequisites

In order to participate in this project the student has to have passed at least 2 out of the following 4 courses:
Introduction to Computer Science 1 / Introduction to Computer Science 2 / Discrete Mathematics / Linear Algebra
This project occurs as part of the prerequisites of project 2-2.

Recommended reading

None

KEN1600

Semester 2
3 Feb 2020
3 Jul 2020

Print course description
ECTS credits:
6.0
Instruction language:
English
Coordinators:
J.P. Paredis
P.J. Collins
R. Möckel
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Second year courses

BA Data Science & KE Year 2 Core Courses

Data Science & Knowledge Engineering

Databases

Full course description

Databases introduces the students to data modelling, and data handling. Databases store data and are therefore fundamental for any type of project. This course covers the concepts and theory of the relational data model, and the widely used language SQL. Additionally the course discusses principles and methods for database design, and query languages. The concepts that are learned will be applied in case studies, which requires the student to have previously completed the courses Computer Science 1 and Computer Science 2. After completing this course the student will be able to design, build and query databases. Additionally the student will be able to communicate with a database from within a programming language.

Prerequisites

None

Recommended reading

Study material: to be announced.

KEN2110

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
D. Rafailidis
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Philosophy & Artificial Intelligence

Full course description

One of the characteristics of scientific knowledge is the translation of natural phenomena into quantitative or mathematical data – the book of nature, Galileo wrote, is written in the language of mathematics. Over the course of the twentieth and twenty-first century, this desire to understand the world through the logic of mathematics has been extended beyond the natural world to include such things as human consciousness, learning, and intelligence. Indeed, the foundation of what is called ‘artificial intelligence’ is the pursuit of replicating human consciousness and intelligence through mathematical models and formulas. In this course we will examine these issues from a philosophical perspective, beginning with a basic overview of the philosophy of science with an emphasis on quantification and then moving on to study philosophical issues that have developed out of the pursuit of artificial intelligence.

Prerequisites

None.

Recommended reading

None

KEN2120

Print course description

ECTS credits:

4.0

Instruction language:

English

Coordinator:

D.M. Cressman

Teaching methods:

Project-Centered Learning

Assessment methods:

Written exam

Data Science & Knowledge Engineering

Probability and Statistics

Full course description

Probability and Statistics introduces the student to the main concepts of probability theory and statistics. Probability theory is the mathematical branch that focuses on experiments where the outcome is determined by chance. Here students learn how to make use of random variables to extract the probability distribution of an experiment. Additionally topics such as, expectation, standard deviation, and independence will be examined. The statistics part of the course discusses basic statistical topics such as the central limit theorem, verification of hypotheses, and confidence intervals. After completing this course students will have obtained an overview of commonly seen probability distributions, as well as several statistical procedures. Additionally the student will be able to deal with problems that involve probabilities, and measure their outcome.

Prerequisites

None.

Recommended reading

None.

KEN2130

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
G. Stamoulis
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering
Graph Theory

Full course description

Graph theory introduces the student to the world of graphs. Many real-world problems can be modelled into graph-problems. Several classic examples include the problem of finding the shortest route between two cities, of maximizing flow in a network of pipelines, or of finding an optimal pairing between producers and consumers. Once a problem is modelled as a graph it can be solved at more abstract level. The course covers both the applied side of graph theory, and its more abstract mathematical foundations. The student will gain insight into modelling and analysing problems with the use of graphs. After completing this course the student will be able to quickly understand when a problem can be modelled with graphs. Additionally the student will be able to solve such problems using standard graph-theoretic algorithms.

Prerequisites

Discrete Mathematics.

Recommended reading

None.

KEN2220

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:

4.0

Coordinator:

M. Mihalak

Teaching methods:

Project-Centered Learning

Assessment methods:

Written exam

Data Science & Knowledge Engineering

Reasoning Techniques

Full course description

Reasoning Techniques introduces the student to reasoning techniques that can be used to acquire more knowledge and information from given data. Often the student will encounter a situation in which a limited set of data is available to solve a rather complex problem. In this course formal techniques will be discussed to acquire new knowledge and information based on the given data. Four techniques can be distinguished in this course: problem solving using search, reasoning using logic, planning, and reasoning with uncertainty. Each technique covers a different problem setting which the student may encounter. After completing this course the student has gained knowledge and insights that enable the student to find solutions to complex problems. Additionally the student have learned the skills to necessary for building complex expert or decision-support systems.

Prerequisites

Introduction to Knowledge Engineering

Recommended reading

Luger, G.F. and Stubblefield, W.A., Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 3rd edition. Addison-Wesley Longman, Inc., Reading, 1998. ISBN 0-805-31196-3.

KEN2230

Period 2

28 Oct 2019

20 Dec 2019

Print course description

ECTS credits:

4.0

Instruction language:

English

Coordinator:

J.W.H.M. Uiterwijk

Teaching methods:

Project-Centered Learning

Assessment methods:
Written exam

Data Science & Knowledge Engineering

Machine Learning

Full course description

Machine learning introduces the student to a broad area of artificial intelligence that aims at developing computer systems that automatically improve their performance with experience. Machine learning algorithms are widely employed and are encountered daily. Examples are automatic recommendations when buying a product or voice recognition software that adapts to your voice. The course will present both the basic, and the state-of-the-art techniques of machine learning. The practical use of the presented techniques and the problems of developing real machine-learning applications will be emphasized. The course is accompanied by practical labs that help the student understand the working of machine learning algorithms. After completing this course students will be able to use machine learning algorithms when encountered with a learning problem. Additionally students will be able to judge the quality of the model that is learned.

Prerequisites

Students entering the course should have a working knowledge of probability theory/statistics, logic and algorithms (including programming).

Recommended reading

I.H. Witten and E. Frank (2005). Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, June 2005, ISBN 0-12-088407-0 T. Mitchell (1997). Machine Learning, McGraw-Hill, ISBN 0-07-042807-7.

KEN2240

Period 2
28 Oct 2019
20 Dec 2019

Print course description

ECTS credits:
4.0

Instruction language:
English

Coordinators:
E.N. Smirnov
R. Möckel

Teaching methods:
Project-Centered Learning

Assessment methods:
Written exam

Data Science & Knowledge Engineering

Project 2-1

Full course description

The project will be carried out by small groups of students, and will be guided by the teachers of the courses from the first period. The project will strongly relate to the content of the subjects from the first period. The project is split up into three phases:

In the first phase students will become familiar with the project assignment, and lay a foundation for the next phases. This often involves the implementation of a basic environment and research regarding the project assignment. The first phase will be concluded with a presentation.

In the second phase the student will have obtained a basic platform to work with. In this phase more advanced concepts will be implemented, and a planning will be made for phase three. The second phase will be concluded with a presentation.

Phase three consist of three full-time weeks in which the students work together with their project group on the core of the assignment. Before starting this phase it is expected that students have previously implemented an environment to work with, and have obtained a planning for this phase. The third phase will be concluded with a presentation. Additionally in the third phase a scientific paper needs to be written about the project results.

The project will be accompanied by so-called skills classes. These classes help the student develop competences that are useful when working on a project assignment with a group. These skill classes vary in topics from technical concepts such as working with LaTeX, to more social concepts such as leadership, presentation skills, and scientific writing.

Prerequisites

A pass for project 1-1. Furthermore a pass for at least 2 out of following 3 courses:
Introduction to Computer Science 1 / Introduction to Computer Science 2 / Data Structures and Algorithms.
This project is a prerequisite to project 3-1.

Recommended reading

None.

KEN2300

Semester 1
2 Sep 2019
31 Jan 2020

Print course description
ECTS credits:

6.0
Instruction language:
English
Coordinators:
[S.M. Kelk]
[J.P. Paredis]
[R. Möckel]
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Human Computer Interaction & Affective Computing

Full course description

Human Computer Interaction and Social Media is the study of interaction between people (users) and computers. It can often be seen as the intersection between computer science, behavioural sciences, design, and other fields of study. The course gives an introduction to interface design. Students are taught about the different stages of successful user interface design, and the problems that may occur at each stage in the design process. Additionally students are taught techniques and methodologies for successful user interface design, and how and which information should be visualized. After completing this course the student will be able to judge whether a user interface meets certain design criteria. Additionally the students will be able to design and evaluate user interfaces from a user perspective.

Prerequisites

None.

Recommended reading

None.

KEN2410

Period 4
3 Feb 2020
3 Apr 2020

[Print course description]
ECTS credits:
4.0
Instruction language:
English

Coordinators:
J.P. Paredis
S. Asteriadis
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Theoretical Computer Science

Full course description

Theoretical Computer Science introduces the students to the theoretical foundation of computing. The course investigates the working of algorithms and programs in the form of language recognition problems. A broad spectrum of subjects will be discussed, including, mathematical foundations, alphabets and languages, finite automata, regular and context-free languages, and complexity. Although most of these concepts are theoretical they still influence modern hardware and software system design today. After completing this course students will be able to judge whether a problem is solvable or not. In the case a problem is solvable the student will be able to determine the computational complexity of a problem. The student will also be able to judge the computational complexity of a problem, and classify this problem within a hierarchy.

Prerequisites

Discrete Mathematics, Linear Algebra, Elementary Calculus, Data structures and Algorithms.

Recommended reading

None.

KEN2420

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
J.W.H.M. Uiterwijk
Teaching methods:
Project-Centered Learning
Assessment methods:

Written exam

Data Science & Knowledge Engineering

Mathematical Modelling

Full course description

Mathematical Modelling is of great importance for solving practical problems by casting them into a form suitable for the use of mathematical techniques. The course introduction consist of a general methodology by means of the modelling cycle. After that the course will focus on the most widely used model classes in engineering. In particular the class of linear time-invariant dynamical models will be discussed. Models will be described based on their governing difference/differential equations. Alternative model descriptions that will be used include transfer functions, and state space models. This course is accompanied by practical labs in which the students analyse linear dynamic models using Matlab. After completing this course students will be able to set up an elementary mathematical model for solving practical problems. The students will be able to perform an elementary model analysis and switch between various model descriptions.

Prerequisites

Linear Algebra, Calculus.

Recommended reading

Richard J. Vaccaro, Digital Control: A State-Space Approach, McGraw- Hill, 1995, ISBN 0-07-066781-0.

KEN2430

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinators:
J.M.H. Karel
R.L.M. Peeters
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Linear Programming

Full course description

Linear programming introduces the student to a specific mathematical model: the linear programming model. This model has a wide range of applications, and is of interest to practitioners in operations research, statistics, economics management and psychology. This, and the fact that good algorithms can solve huge linear programs, is the reason for the success of this model. The theory of the course treats the simplex algorithm, duality theory, and sensitivity analysis. The theory is accompanied by practical examples that illustrate the power of the model, and teach the student the skill of modelling. After completing this course student will have obtained knowledge of the existing algorithms for linear programming. Students will be able to detect when a problem be solved via linear programming, and model it accordingly. Furthermore student will be able to perform sensitivity analysis.

Prerequisites

Linear Algebra

Recommended reading

None.

KEN2520

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
S.M. Kelk
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Mathematical Simulation

Full course description

Mathematical Simulation is concerned with the study of processes and systems. When modelling a process or system there is often an uncertainty factor present. Such uncertainty is often caused by the random nature of certain factors that affect the process/system. In order to properly analyse a model it is important to correctly model any uncertainty that is present. Once the right model is in place various scenarios can be simulated, using Monte Carlo simulation, to gain insight. The results of such analyses need to be properly interpreted and uncertainty has to be reduced. The modelling, implementation, analysis and technical aspects will all be discussed in this course. The emphasis will be on discrete even simulation. After completing this course the students will be familiar with the essentials of simulation, such as the model cycle, discrete event simulation, output analysis and experimental design. Students will be able to employ simulation as a tool for evaluation.

Prerequisites

Probability & Statistics

Recommended reading

Object-Oriented Computer Simulation of discrete-event systems – Jerzy Tyszer, Design and Analysis of Experiments – Douglas C. Montgomery, Introduction to Probability Models – Sheldon M. Ross.

KEN2530

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
J.M.H. Karel
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Project 2-2

Full course description

The project will be carried out by small groups of students, and will be guided by the teachers of the courses from the first period. The project will strongly relate to the content of the subjects from the first period. The project is split up into three phases:

In the first phase students will become familiar with the project assignment, and lay a foundation for the next phases. This often involves the implementation of a basic environment and research regarding the project assignment. The first phase will be concluded with a presentation.

In the second phase the student will have obtained a basic platform to work with. In this phase more advanced concepts will be implemented, and a planning will be made for phase three. The second phase will be concluded with a presentation.

Phase three consist of three full-time weeks in which the students work together with their project group on the core of the assignment. Before starting this phase it is expected that students have previously implemented an environment to work with, and have obtained a planning for this phase. The third phase will be concluded with a presentation. Additionally in the third phase a scientific paper needs to be written about the project results.

The project will be accompanied by so-called skills classes. These classes help the student develop competences that are useful when working on a project assignment with a group. These skill classes vary in topics from technical concepts such as working with LaTeX, to more social concepts such as leadership, presentation skills, and scientific writing.

Prerequisites

A pass for project 1-2. Furthermore a pass for at least 2 out of following 3 courses:
Introduction to Computer Science 1 / Introduction to Computer Science 2 / Data Structures and Algorithms.
This project is not a prerequisite for another project / course.

Recommended reading

None.

KEN2600

Print course description

ECTS credits:
6.0
Instruction language:
English
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

BA Data Science & KE Year 2 Electives

Data Science & Knowledge Engineering

Natural Language Processing

Full course description

Watson won Jeopardy. Siri can tell me when I need an umbrella. But how do they work? Over the past decade, Natural Language Processing (NLP) has been revolutionized by statistical, probabilistic and machine learning methods. NLP addresses fundamental questions at the intersection of human language and machine learning. How can computers acquire, understand and produce language? How can computational methods give us insight into observed human language phenomena? How to make sense of the vast amounts of information available online in free, unstructured form? In this course students will learn how computers can learn useful text/language representations and how different tasks (language modeling, text classification, information extraction, sequence labeling, etc.) can be used for solving different complex problems (spelling correction, spam detection, search engine design, opinion analysis, summarization, question-answering, etc.). Open NLP problems (such as evaluation or interactive dialogue systems) and the effect of deep learning on NLP will be discussed.

KEN2570

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
4.0
Coordinator:
G. Spanakis
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Introduction to Image & Video Processing

Full course description

Image and video processing is everywhere around us, in smartphones, robotics, medicine, security systems, microscopy, remote sensing, video games, travel, shopping, environmental management and many other applications. Image and video processing is based on principles of signal processing, extended to multiple dimensions. In this class students will have a short introduction to basic 2D signals and systems, sampling, image filtering. Color domain processing in different spaces (RGB, CiE, Lab) and its relevance to our visual perception system will be presented. We will learn about linear and non-linear filtering in the spatial domain, for segmentation, noise reduction, smoothing among others. Frequency domain transforms will be presented (Fourier, DCT), along with their use in filtering for image enhancement, denoising, restoration, and the understanding of standards like JPEG. Video analysis will be introduced, with focus on motion estimation and its relevance to compression standards like MPEG.

KEN3238

Print course description
ECTS credits:

0.0
Coordinator:
A. Briassouli
Teaching methods:
Project-Centered Learning

Data Science & Knowledge Engineering
DKE Honours Programme - KE@Work (2-1)

KEN2310

Semester 1
2 Sep 2019
31 Jan 2020

Print course description
ECTS credits:
6.0
Coordinator:
F. Thuijsman

Data Science & Knowledge Engineering
DKE Honours Programme - KE@Work (2-2)

KEN2610

Semester 2
3 Feb 2020
3 Jul 2020

Print course description
ECTS credits:
6.0
Coordinator:
F. Thuijsman

Data Science & Knowledge Engineering
DKE Honours Programme - MaRBLe 2.0 (2-1)

Full course description

DKE Honours Programme - Research Track 1

KEN2320

Semester 1
2 Sep 2019
31 Jan 2020

Print course description
ECTS credits:
6.0
Coordinator:
R. Möckel

Data Science & Knowledge Engineering

DKE Honours Programme - MaRBLe 2.0 (2-2)

Full course description

DKE Honours Programme - Research Track 2

KEN2620

Semester 2
3 Feb 2020
3 Jul 2020

Print course description
ECTS credits:
6.0
Coordinator:
R. Möckel

Third year courses

BA Data Science & KE Year 3 Electives

Data Science & Knowledge Engineering

Semantic Web

Full course description

Semantic Web introduces the students to the standards of the semantic web. The World Wide Web has changed the way people communicate with each other. Over the years the web has developed into a medium for sharing all kinds of information. Most of the information on the web is designed for human-readability. This makes it difficult for computer programs to interpret the information that is present on webpages. The semantic web should eliminate these difficulties and thereby increasing the functionality of a computer program on the web. By separating the content of what is presented on a web-page from the way it is presented, and by annotating the content it becomes possible to provide semantics for the content. In this course the students will become familiar with the developments and standards of the semantic web, such as RDF, RDFa, SPARQL, and OWL2. After completing this course students will be able to build web applications using semantic web standards. Furthermore students will be able to judge whether and how semantic web standards can be applied in web-applications.

Prerequisites

Knowledge of Propositional and Predicate Logic.

Recommended reading

None.

KEN3140

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
N. Roos
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering
Game Theory

Full course description

Game theory introduces the students to the field of game theory. Game theory is the mathematical study of problems that involve two or more decision makes, called players, which each have their own individual preferences over the possible outcomes. As the outcome of the problem (game) is determined by multiple decision makers it is often non-trivial to find the action that maximizes the reward of a player. Classic examples of game theoretic problems are the prisoner’s dilemma, and the hawk-dove game. In this course both strategic and non-strategic game theoretical models and their solutions will be discussed. Furthermore issues like value, fairness, manipulations, threats, optimality and rationality will be addressed. After completing this course students have gained insight into the basic notions and solutions of mathematical models of multi-person decision problems.

Prerequisites

None.

- Discrete Mathematics

Recommended reading

None.

KEN3130

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
F. Thuijsman
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Prolog

Full course description

Prolog introduces the students to the field of Artificial Intelligence (AI) based on one of the most important non-procedural programming languages: PROLOG. Programming in a non-procedural programming language is very different from a procedural programming language. In PROLOG the programmer specifies what the program should do, rather than specifying a sequence of steps indicating how the program should perform its task. The course will provide the student with a detailed introduction into PROLOG. It will be shown how standard AI techniques can be applied in PROLOG and how expert systems can be realized with it. This course is accompanied by practical labs in which the student is taught how the acquired techniques can be put into practice. After completion of this course the student has obtained experience in PROLOG. The student gained insight into fundamental techniques that are essential to AI and knowledge Engineering.

Prerequisites

Logic

- Introduction to Computer Science 1
- Logic

Recommended reading

Sterling, L. and Shapiro, E. (1986). The Art of Prolog. MIT Press, Cambridge, MA. ISBN 0-262-69105-1.

KEN3234

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
J.W.H.M. Uiterwijk
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering
Robotics and Embedded Systems

Full course description

Robotics introduces the students to the programming of embedded systems in the real-world. Nowadays embedded systems control a lot of the common devices, such as watches, DVD players, mobile phones or medical instruments. The embedded systems used in this course will be small autonomous robots. The embedded software for these robots will be developed in Java. Several software patterns and mathematical concepts will be discussed to control engines and sensors of the robot. The course is accompanied by practical labs in which the students will program and test the autonomous robots with real-time computing. After completing this course the student will have obtained practical experience in programming embedded software. The student is able to implement basic control an autonomous robot using sensor-input and real-time computing.

Prerequisites

Programming experience in Java and the object oriented system

Recommended reading

None.

KEN3236

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
R. Möckel
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Computer Security

Full course description

Computer security is the process of detecting and preventing unauthorized and illicit access to a computer. As information systems have become mandatory in the commercial world, coupled with the increased frequency of security incidents, organizations now recognize the need for a comprehensive security strategy. The course will introduce a wide range of topics in computer security and online privacy. The main objective of the course is to cultivate a security mindset by discussing various attack techniques and defenses. Some of the topics we will explore include: computer security technology and principles, software security and trusted systems, management issues, and Internet security.

Recommended reading

- Goodrich & Tamassia. Introduction to Computer Security. Pearson. - Tanenbaum & Bos. Modern Operating Systems (4th edition). Pearson.

KEN2560

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
4.0

Teaching methods:
Project-Centered Learning

Data Science & Knowledge Engineering

Logic for Artificial Intelligence

Full course description

Logic for Artificial Intelligence introduces the students to the semantics of logics for knowledge representation and reasoning. Logics form the formal foundation of knowledge representation and reasoning, which is a fundamental topic in Artificial Intelligence. The semantics of logics enable us to evaluate the intended meaning of knowledge representation formalisms, and the correctness and completeness of reasoning processes. Assumptions play an important role in practical applications such as model-based diagnosis, legal argumentation, and so on. In this course it will be investigated which properties a knowledge representation formalism that uses assumptions should possess and what the intended meaning of an assumption should be. The emphasis will be on applications of classical logics and on non-monotonic logics. After completing this course student will be able to analyse important properties of practical formalisms for knowledge representations and reasoning. The student will be able to judge for several knowledge representation formalisms whether it is able to represent the intended meaning of the knowledge to be represented and whether the derived conclusions are correct and complete.

Prerequisites

Knowledge of Propositional and Predicate Logic

Recommended reading

None.

KEN3231

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
N. Roos
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Parallel Programming

Full course description

Parallel programming introduces the students to the paradigm of parallel computing on a computer. Nowadays almost all computer systems include so-called multi-core chips. Hence in order to exploit the full performance of such systems one needs to employ parallel programming. This course covers shared-memory parallelization with OpenMP and java-Threads as well as parallelization with message passing on distributed-memory architectures with MPI. The course starts with a recap of the programming language C followed by a brief theoretical introduction to parallel computing. Next the course treats theoretical aspects like MPI communication, race conditions, deadlocks, efficiency as well as the problem of serialization. This course is accompanied by practical labs in which the students have the opportunity to apply the newly acquired concepts. After completing this course students will be able to write parallel programs with MPI and OpenMP on a basic level, and deal with any difficulties they may encounter.

Prerequisites

Programming experience. The examples and exercises will be given in C, however any C/C++ or Java programmer will be able to solve these.

Recommended reading

Parallel programming with MPI; Peter Pacheco; Morgan Kaufmann (1996); www.cs.usfca.edu/mpi/ (a very early revision is available online)

KEN3235

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
M.H.M. Winands
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Introduction to Bio-Informatics

Full course description

Introduction to Bio-Informatics introduces the student to the fundamental methods and techniques of bioinformatics in biomedical and biological research. The main objective of the course is that the student acquires a general understanding of bioinformatics methods at the algorithmic level. This will enable the student to read and understand publications in this field, and apply their knowledge in concrete biological problems. The major areas and problems in bioinformatics will be discussed, such as sequence alignment, phylogenetic analysis, gene finding and gene expression analysis. The lectures and computer lectures in this course will be based on relevant real case-studies that highlight the main topics in the course. After completing this course the student has obtained a general understanding of bioinformatics methods at the algorithmic level. The student will be able to understand the major problems in bioinformatics and how their knowledge can be applied to such problems.

Prerequisites

None.

Recommended reading

Introduction to Computational Genomics, A Case Studies Approach, Nello Cristianini, Matthew W. Hahn, Cambridge University Press, 2006, Hardback and Paperback (ISBN-13: 9780521856034 | ISBN-10: 0521856035).

KEN3440

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
R. Cavill
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Web Applications

Full course description

The course gives an introduction into modern web development. First, the server-side programming is taught using the languages PHP and MySQL. After that, the development on the client-side is explained. That includes basic knowledge of the programming language JavaScript as well as the usage of the framework jQuery. Further topics are AJAX, DOM manipulation and event handling. The common vulnerabilities of web applications are discussed as well as the protection of servers and their data. The course is accompanied by practical labs in which the students build own web applications. In addition, the students use a test tool to reenact web security problems from an attacker's point of view.

Prerequisites

Computer Science I and II, Data Structures & Algorithms

KEN3237

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
4.0
Coordinator:
T. Dondorf
Teaching methods:
Project-Centered Learning

Data Science & Knowledge Engineering

Software and Systems Verification

Full course description

Have you ever written a program with a bug in it? Then this course is for you! Software verification tools can check whether your program works by showing that it correctly satisfies its specification, or finds a case in which it can go wrong. Unlike unit testing and other software validation methods, verification tools use formal methods to rigorously prove correctness. Similar techniques can be used to show that (mathematical models of) cyber-physical systems work as designed.
In the course, we will start by looking at formal models of software and systems as labelled transition systems (automata) and at formal temporal logics for specification, and consider the fundamental algorithms for verification. We shall then apply these algorithms to simple discrete verification problems, such as vending machines and communications systems, and use tools for the verification of Java programs. Finally, we will look at simple continuous systems, such as robots and electronic systems, and show how to verify these using rigorous numerical methods based on interval arithmetic.

KEN3150

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
4.0
Coordinator:
P.J. Collins
Teaching methods:
Project-Centered Learning

Data Science & Knowledge Engineering
Study Abroad

KEN3600

Semester 1
2 Sep 2019
31 Jan 2020
Semester 2
3 Feb 2020
3 Jul 2020

Print course description
ECTS credits:
30.0
Coordinator:
N. Roos

Data Science & Knowledge Engineering
Project 3-1

Full course description

The project will be carried out by small groups of students, and will be guided by the teachers of the courses from the first period. The project will strongly relate to the content of the subjects from the first period. The project is split up into three phases:

In the first phase students will become familiar with the project assignment, and lay a foundation for the next phases. This often involves the implementation of a basic environment and research regarding the project assignment. The first phase will be concluded with a presentation.

In the second phase the student will have obtained a basic platform to work with. In this phase more advanced concepts will be implemented, and a planning will be made for phase three. The second phase will be concluded with a presentation.

Phase three consist of three full-time weeks in which the students work together with their project group on the core of the assignment. Before starting this phase it is expected that students have previously implemented an environment to work with, and have obtained a planning for this phase. The third phase will be concluded with a presentation. Additionally in the third phase a scientific paper needs to be written about the project results.

The project will be accompanied by so-called skills classes. These classes help the student develop competences that are useful when working on a project assignment with a group. These skill classes vary in topics from technical concepts such as working with LaTeX, to more social concepts such as leadership, presentation skills, and scientific writing.

Prerequisites

A pass for Project 2-1.

Recommended reading

None.

KEN3300

Semester 1
2 Sep 2019
31 Jan 2020

Print course description
ECTS credits:
6.0
Instruction language:
English
Coordinators:
N. Roos
J.P. Paredis
J.W.H.M. Uiterwijk
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

DKE Honours Programme - KE@Work (3-1)

KEN3310

Semester 1
2 Sep 2019
31 Jan 2020

Print course description
ECTS credits:
6.0
Coordinator:
F. Thuijsman

Data Science & Knowledge Engineering

DKE Honours Programme - MaRBLe 2.0 (3-1)

Full course description

DKE Honours Programme - MaRBLe 2.0 (3-1)

Course objectives

DKE Honours Programme - MaRBLe 2.0 (3-1)

KEN3320

Semester 1
2 Sep 2019
31 Jan 2020

Print course description
ECTS credits:
6.0
Coordinator:
R. Möckel

BA Data Science & KE Year 3 Core Courses

Data Science & Knowledge Engineering

Data Analysis

Full course description

This course aims at preparing students on how to be a successful “data scientist”. The crucial processes of inspecting, cleaning, transforming, restoring and preparing data for modelling are tacked. Types of data include numeric, categorical, image, text and they are explored through case-studies that a modern “data scientist” has to deal with. Furthermore, several techniques from machine learning and mathematical modelling (multiple regression, dimensionality reduction, etc.) are presented from the data analysis perspective and you will learn how to apply these techniques to different types of data (time series, signals, images, etc.). Finally, the cornerstone of data analysis is presented: correct communication of your outcome (storytelling, visualization, etc.).

Prerequisites

None

Recommended reading

None

KEN3450

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
G. Spanakis
Teaching methods:
Project-Centered Learning

Data Science & Knowledge Engineering

Operations Research Case Studies

Full course description

Operations Research (OR) is concerned with the best way to assign scarce resource to competing activities. OR is widely used in industry to support economically efficient decision-making, but also other application areas where discrete optimization has a central role. It is for this reason an important branch of mathematics. In this course the student will be introduced to a number of themes both from within deterministic OR and stochastic OR. Themes within deterministic OR include the network simplex method, integer linear programming, non-linear programming and approximation algorithms. Stochastic themes include queuing systems, Markov chains and Markov decision problems. After completing this course the student will have obtained an overview of available models and techniques in the field of OR and their mathematical foundations. The student will be able to formulate and solve a mathematical model for real-life OR problems.

Prerequisites

None.

Recommended reading

None.

KEN3410

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinators:
F. Thuijsman
S.M. Kelk
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam

Data Science & Knowledge Engineering

Intelligent Systems

Full course description

Intelligent systems introduces the student to computational agents, which act and interact flexibly and autonomously in order to achieve some goal. This course discusses the basic concepts and methods from agent technology. Topics that are covered include: characteristics of an agent, agent architectures, cooperation and competition among agents, and agent communication. This course contains a practical part where the students work in teams on a concrete application and implementation of an agent system. After completing this course the student will be able to judge whether it is beneficial to use agent technology over other approaches. The student will have a basic understanding of agent technology, which allows the student to apply agent technology to practical problems.

Prerequisites

None.

Recommended reading

• Mike Wooldridge (2009, 2nd edition): An Introduction to Multi Agent Systems, Michael Wooldridge, John Wiley & Sons Ltd, ISBN-13: 978- 0470519462 • Stuart Russell and Peter Norvig (2010, 3rd edition), Artificial Intelligence, A Modern Approach, Prentice-Hall, ISBN-13: 9780136042594.

KEN3430

Print course description

ECTS credits:

4.0

Instruction language:

English

Coordinator:

K. Driessens

Teaching methods:

Project-Centered Learning

Assessment methods:

Written exam

Data Science & Knowledge Engineering

Bachelor's Thesis

Full course description

At the end of the Bachelor study Data Science & Knowledge Engineering each individual student has to write a thesis. This thesis has to be designed as a scientific paper of 8 to 10 pages using a standard (LaTeX) design. The thesis has to be accompanied by any relevant attachments and software. Students will present the thesis in a conference. Students are free to choose any related research question to investigate. The student will be guided throughout the entire period by a thesis supervisor.

Prerequisites

None.

Recommended reading

None.

KEN3500

Semester 2

3 Feb 2020

3 Jul 2020

Print course description

ECTS credits:
18.0
Instruction language:
English
Coordinator:
M.H.M. Winands
Teaching methods:
Project-Centered Learning
Assessment methods:
Written exam