Applied Data Science & Artificial Intelligence

Exchange Handbook



CREATING MEANINGFUL EXPERIENCES

Breda University
OF APPLIED SCIENCES

Introduction

Hello and welcome to Applied Data Science and Artificial Intelligence (ADS&AI)!

ADS&AI was first founded in 2021 with the aim to prepare students for careers in the international world of Data & Artificial Intelligence. In the projects and study units, our students explore various types of data and Artificial Intelligence applications, like Machine Learning, computer vision, robotics, natural language processing, etc. The programme, a project-based curriculum, has a practical orientation and offers collaborative learning in integrated multidisciplinary projects where students learn to continuously develop themselves as professionals. Highly qualified and international lecturers with years of experience in the industry deliver their expertise to the students. Approximately 60% of our students have an international background, while more than 75% of ADS & AI's lecturing staff have joined the academy from a number of places around the world.

In keeping with our international nature, and in order to ensure transparent communication within the academy, the language of both instruction and communication is English.

Students who would like to attend ADS & AI for an exchange programme of one or two semesters are welcome to join courses from either the second or third year in **either** the spring semester or autumn semester. Exchange students in ADS & AI get added to a regular class of our students which ensures greater integration and participation in student life outside of the classroom.

Key Dates:

31 August 2026	Start of first semester
19 - 23 October 2026	Autumn holiday
21 December 2026 - 3 January 2027	Christmas holiday
22 January 2027	End of first semester (end of block B)
1 February 2027	Start of second semester
8 - 14 February 2027	Spring holiday
26 April - 2 May 2027	May holiday
25 June 2027	End of second semester (end of block D)

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How ADS&AI is structured?

- In the second year, students work in blocks: autumn semester – Blocks A and B; spring semester – Blocks C and D.
- Year three consists of two semesters: autumn and spring.
- Attendance in classes is mandatory, so unfortunately it is not possible to travel during school weeks. However, there are several holiday weeks throughout the year that are suitable for travelling, ensuring that our exchange students have plenty of opportunities to explore Europe.
- The minimum passing grade in ADS & AI is 5.5 out of 10.
- Our programme is recognised for its special emphasis on *small-scale and intensive education*, a distinction awarded by the NVAO (Accreditation Organisation of the Netherlands and Flanders). As a result, you will receive close supervision and personal support from your mentor during your semester at BUas. This approach is closely connected to our exclusive in-house student training company, the DataLab.
- One study credit (1 ECTS) represents 28 hours of study. One block equals 15 ECTS credits. A student will therefore spend approximately 420 hours (15 × 28), which includes both class time (e.g., attending DataLabs) and independent study time (e.g., homework, project preparation, and self-study days).

What is the DataLab?

- In the DataLab, you will work on a wide variety of assignments, including data analysis, data collection, data visualisation, and model deployment.
- The DataLab takes place twice a week, and attendance is mandatory. During these sessions, you will have the opportunity to work on your project and receive feedback and support from your mentors. For the rest of the week, you will focus on self-study materials.

Whom ADS&AI is suitable for?

ADS & AI is most suitable for exchange students with a background in AI, computer science, big data, robotics, data science, digital transformation, or creative technologies, as the projects have a strong focus on these areas.
Please note that, depending on your educational background, you may be advised to follow a different study package. As our programme requires a strong technical background, this measure is intended to help ensure your academic success.

Additional ADS & AI information

- If you are joining ADS & AI in the autumn semester, classes are scheduled to begin in the week starting on 1 September. To ensure a smooth transition and to familiarise yourself with Breda and our university, we recommend arriving well in advance. An Introduction Week will be held during the week of 24 August, and further information will be provided to you.

- If you are joining ADS & AI in the spring semester, classes are scheduled to commence in the week beginning on 1 February. Please make sure to arrive before this date to allow sufficient time to settle in Breda before classes start.

- As an exchange student, you are welcome to choose one ADS & AI study package per semester. Each package consists of courses from either the second or third year. Unfortunately, it is not possible to select courses from different study years within the same semester, as this would result in scheduling conflicts.

- We warmly welcome our exchange students to join the *Dutch for Foreigners* course, which teaches the basics of the Dutch language. The beginner's level course is offered in both the autumn and spring semesters, runs throughout the entire semester, and is worth 3 ECTS.

- It is essential to bring your own laptop when studying in ADS & AI.

- For more information about our study, please visit our faculty page using this link.

Choosing ADS&AI study path

As an exchange student participating in the ADS & AI program for a semester, you are invited to choose from a selection of ADS & AI study packages.

Please be aware that we are undergoing a minor restructuring of our curriculum and there may be some minor changes between what is described and what runs in the 2026-2027 academic year.

1.1 Autumn Semester

In the autumn semester students are able to select one of the following study packages (see appendix A for full course information):

- **Year 2, First Semester:** In this package, students will initially (Block A) engage in a project focusing on Natural Language Processing (NLP), with a strong emphasis on practical applications across different domains. Students learn to process both written and spoken language using real-world data. Key tasks include emotion classification, speech-to-text transcription, machine translation, semantic representation, and feature extraction.

  In Block B (the second part of the first semester), the project will focus on Computer Vision, Robotics, and Reinforcement Learning. During the Computer Vision component, students will be introduced to core techniques such as image filtering, morphological operations, and deep learning-based object detection and segmentation. They will gain practical experience through structured, hands-on exercises that emphasize learning by doing.

  The Robotics and Reinforcement Learning component introduces the foundations and real-world applications of robotics and reinforcement learning (RL). Students learn how autonomous agents can perceive, decide, and act within complex environments using reward-driven learning strategies. The course emphasizes practical, hands-on development of control policies for simulated robotic systems, combining key robotics principles with modern RL techniques.

A total of 30 ECTS credits are available within this package. Additionally, students have the option to take *Dutch for Foreigners*, earning an extra 3 ECTS credits.

- **Year 3, First Semester:** In this package, students can specialize in a specific professional role of their choosing - such as data scientist, data engineer, or analytics translator - through a team-based, client-driven project. This project marks a transition toward professional autonomy, as students take ownership of a real-world challenge and work toward a deployable solution in collaboration with industry partners.

  This experience simulates working in an interdisciplinary data consultancy environment. Students are expected to define project goals, select appropriate tools and methods, and manage their own learning journey under the guidance of a mentor and subject-matter experts. It provides both technical and professional development - combining open-ended problem solving, client engagement, and domain specialization.

A total of 30 ECTS credits are available within this package. Additionally, students have the option to take *Dutch for Foreigners*, earning an extra 3 ECTS credits.

1.2 Spring Semester

During the spring semester, students have the opportunity to select one of the following study packages (see Appendix A for detailed course information).

- **Year 2, Second Semester:** In this package, students will participate in the Research Methodology and Statistics project (Block C). This course equips students with foundational skills in designing and conducting research. They learn to formulate research questions, collect and analyze data using both qualitative and quantitative approaches, and present their findings in a structured, ethical, and academically sound manner.

  In addition, students are introduced to the foundational concepts of statistics, including data collection, summarization, probability, and statistical inference. They learn to describe data, perform hypothesis testing, and interpret results using real datasets and statistical tools in Python. Emphasis is placed on understanding when and how to apply methods rather than memorizing formulas.

  In Block D, you will learn how to **Deploy Machine Learning Solutions**. This course introduces students to the principles and practices of deploying machine learning models in production environments. Students learn how to structure, automate, monitor, and manage ML systems at scale using modern MLOps tools and frameworks.

  Through practical deployment scenarios, students gain hands-on experience with containerization, cloud computing, model serving, and continuous integration/continuous deployment (CI/CD) pipelines. Emphasis is placed on reproducibility, scalability, and maintainability.

A total of 30 ECTS credits are available within this package. Additionally, students have the option to take *Dutch for Foreigners*, earning an extra 3 ECTS credits.

- **Year 3, Second Semester:** In this package, students can specialize in a specific professional role of their choosing - such as data scientist, data engineer, or analytics translator - through a team-based, client-driven project. This project marks a transition toward professional autonomy, as students take ownership of a real-world challenge and work toward a deployable solution in collaboration with industry partners.

  This experience simulates working in an interdisciplinary data consultancy environment. Students are expected to define project goals, select appropriate tools and methods, and manage their own learning journey under the guidance of a mentor and subject-matter experts. It provides both technical and professional development - combining open-ended problem solving, client engagement, and domain specialization.

A total of 30 ECTS credits are available within this package. Additionally, students have the option to take *Dutch for Foreigners*, earning an extra 3 ECTS credits.

The full details of all study packages and their course content are provided in Appendix A (Study Package Details). Please obtain approval from your home university before applying for a study package. Note that some packages may have prerequisites. If you have any questions about the content, please contact Zhanna Kozlova at kozlova.z@buas.nl

FAQ

I am an American student and need to leave before the spring semester starts in January at my home university. Can I participate in an exchange and take AI courses during the autumn semester instead?

It is important to double-check the start and end dates of each block. If you are an American student, please note that our autumn semester runs until the end of January. It is not possible to complete any courses before the Christmas holidays.

I would like to take a course package, but my exchange supervisor at my home university said that there is one course I do not need to take. Can I choose to skip that course within the package?

No. Due to the nature of the courses and their interconnection, it is not possible to skip a course within a package, as this would prevent you from being awarded the required ECTS credits.

I would like to do an exchange and take AI courses, but my home university does not have a partnership with Breda University of Applied Sciences. What should I do?

Please ask the International Office at your home university to contact Zhanna Kozlova (kozlova.z@buas.nl) to discuss the possibility of establishing a partnership for AI courses.

Appendix A: Study Package Details

In this section, you will find a full breakdown of the courses included in each AI study package. Please note that, due to constant improvements to our curriculum, there may be minor changes to the details published in this appendix. Keep in mind that attendance in all courses is essential, as they are closely interconnected.

Year 2, First Semester

Block 2A (15 ECTS credits): Natural Language Processing

Course Code: Y2A1
ECTS Credits: 15.0

Course Description
This course introduces students to core and advanced techniques in Natural Language Processing (NLP), with a strong emphasis on practical application across different domains. Students learn to process both written and spoken language using real-world data. Key tasks include emotion classification, speech-to-text transcription, machine translation, semantic representation, and feature extraction.
Students gain hands-on experience with both traditional models (e.g., Logistic Regression, Naive Bayes) and deep learning architectures (e.g., LSTM, RNN, Transformers). They apply widely-used NLP libraries and frameworks such as HuggingFace Transformers, SpaCy, NLTK, and Gensim. Feature engineering techniques include POS tagging, TF-IDF, sentiment scoring, and embedding-based representations. The course also covers model evaluation using F1-score, Word Error Rate (WER), and error analysis, as well as explainability methods like Gradient × Input and Layer-wise Relevance Propagation (LRP). Students explore prompt engineering strategies to fine-tune large language models for downstream tasks, and complete the course by designing end-to-end NLP pipelines.

Course Content

- Text Classification
  - Logistic Regression, Naive Bayes, LSTM, RNN, Transformers (e.g., BERT, DistilBERT)
- Speech-to-Text
  - Automatic transcription using Whisper and AssemblyAI
  - Evaluation with Word Error Rate (WER)
- Machine Translation
  - Neural machine translation using pretrained models (e.g., MarianMT)
  - Round-trip translation and quality assessment
- Feature Engineering
  - Part-of-Speech tagging, TF-IDF, sentiment analysis
  - Pretrained and custom-trained word embeddings (Word2Vec, GloVe)
- Prompt Engineering
  - Zero-shot and few-shot prompting for classification tasks
- Explainable AI for NLP
  - Gradient × Input
  - Layer-wise Relevance Propagation (LRP)
- Evaluation & Error Analysis
  - Precision, recall, F1-score, confusion matrices
  - Qualitative and quantitative assessment of model behavior
- End-to-End NLP Pipelines
  - Modular workflows combining transcription, translation, feature extraction, classification, and explainability

Recommended Reading

- Speech and Language Processing (3rd Ed.) by D. Jurafsky, J.H. Martin

- Natural Language Processing with Python by S. Bird, E. Klein, E. Loper

Course Coordinator(s)

- Myrthe Buckens

Block 2B (15 ECTS credits): Computer Vision & Robotics

Computer Vision

Course Code: Y2B1
ECTS Credits: 8.0

Course Description

This course introduces core techniques in computer vision, from image filtering and morphological operations to deep learning-based object detection and segmentation. Students gain practical experience through structured, hands-on exercises emphasizing learning by doing.
Rather than focusing on theory alone, the course is designed around applying concepts directly to real-world images. Students develop the skills to design, implement, and evaluate vision pipelines with both classical and modern approaches.

Course Content

- Introduction to Digital Images
- Thresholding and Filtering
- Morphological Operations
- Edge and Contour Detection
- Image Segmentation
- Object Detection with Deep Learning
- Image Segmentation with Deep Learning
- Multiclass Image Segmentation
- Skeleton Analysis
- Measuring Objects in Images

Recommended Reading

- Digital Image Processing by R. C. Gonzalez, R. E. Woods (4th Ed.)

Course Coordinator(s)

- Alican Noyan

Robotics and Reinforcement Learning

Course Code: Y2B2
ECTS Credits: 7.0

Course Description

This course introduces the foundations and real-world applications of robotics and reinforcement learning (RL). Students learn how autonomous agents can perceive, decide, and act within complex environments using reward-driven learning strategies. The course emphasizes practical, hands-on development of control policies for simulated robotic systems, blending key robotics principles with modern RL techniques.
Through guided self-study, coding exercises, and control tasks in a simulated digital twin of a robotic system, students explore how algorithms like PPO can be used to train agents to perform tasks such as grasping, navigation, and object interaction.

Course Content

- Introduction to Robotics and Autonomous Systems
- Components of Robotic Systems (Sensors, Actuators, Controllers)
- Coordinate Systems, Degrees of Freedom, and Kinematics
- Practical Applications of Robotics in Industry and Daily Life

- Introduction to Reinforcement Learning
- Key RL Concepts: Rewards, Policies, MDPs, Exploration vs. Exploitation
- Deep Reinforcement Learning with PPO and Stable Baselines 3
- Training Agents in Simulated Environments
- PID Control Fundamentals and Application
- Control System Tuning and Performance Evaluation
- Robotics and RL Integration for Real-World Tasks

Recommended Reading

- Reinforcement Learning: An Introduction by R. Sutton and A. Barto (2nd Ed.)

Course Coordinator(s)

- Dean van Aswegen
- Jason Harty

Year 3, First Semester (30 ECTS credits): Specialisation Project 1

Specialisation Project 1

Course Code: SPEC
ECTS Credits: 30.0

Course Description

The Specialisation Project is a pivotal part of the third year. It empowers students to deepen their expertise in a specific professional role of their choosing—such as data scientist, data engineer, or analytics translator—through a team-based, client-driven project. This project marks a transition toward professional autonomy, as students take ownership of a real-world challenge and work toward a deployable solution in collaboration with industry partners.

This experience simulates working in an interdisciplinary data consultancy environment. Students are expected to define project goals, select tools and methods, and manage their own learning journey under the guidance of a mentor and subject-matter experts. It is both a technical and professional growth experience—blending open-ended problem solving, client engagement, and domain specialization.

Course Content

- Problem analysis
- Project scoping
- Consultancy skills
- Project management
- Risk management
- Business understanding
- Role-specific application
- Stakeholder management
- Data visualization
- Presentation skills
- Ethical and human-centered design
- Team collaboration
- Professional reflection

Prerequisites

Completion of foundational and intermediate courses in data science and AI (120 ECTS).

Course Coordinator(s)

- Bram Heijligers
- Shival Indermun
- Mohsen Davarynejad

- Tsegaye Misikir Tashu

Example 1
Games Project: Enhancing Immersion in AAA Games using AI Tools

In the contemporary world of games, AAA titles are renowned for their high-quality graphics, storytelling, and gameplay. However, the quest for more immersive and engaging gaming experiences is an ongoing endeavour. As a third-year Applied Data Science and Artificial Intelligence student, you are given the challenge to explore, investigate, and implement AI tools that can enhance the immersion and engagement in AAA games. Over a six-month period, your task will be to devise a toolkit of AI solutions for games.

Project Scope:

The scope of the project involves research, investigation, and proof-of-concept development of various AI tools focusing on:

1. Large Language Models: Evaluate how narrative and NPC speech/actions can be driven using advanced language models to deliver more coherent and immersive narratives.

2. Speech to Text: Investigate possibilities to enhance player voice interaction and communication with in-game characters and systems.

3. Text to Speech: Explore the application of AI for character voice generation, aiming to create a more realistic and engaging dialogue system.

4. Facial Recognition: Investigate the possibilities of utilizing gaze detection, emotion recognition, and other aspects to enhance in-game character interactions.

5. Behaviour Recognition: Investigate the use of machine learning to identify player behaviours based on gameplay data, which can be used to dynamically adapt enemy behaviours, narrative, and gameplay elements.

6. Reinforcement Learning for Games: Explore how reinforcement learning can be used to improve NPC behaviour, enemy actions, and game difficulty scaling, making gameplay more responsive and challenging.

7. Diffusion Models for 2D and 3D Asset Generation: Explore how AI-driven generation can create a more visually engaging and adaptive game environment.

8. Vector Databases for Game Story and State: Develop an approach to use vector databases for managing game story and states for dynamic and reactive storytelling.

9. Transformer models to infer game state from audio-visual input: Investigate how transformer models can be used to infer game state from audio-visual input, allowing for more dynamic and adaptive gameplay.

10. Game analytics: Investigate the use game analytics techniques to analyse gameplay data and generate insights about player behaviours and business decisions.

The goal is to develop a toolkit consisting of APIs with simple front-ends as proofs of concept for a few of the above techniques. Integrating and aligning several of these techniques into high-level game features will increase the overall immersion in games. The APIs should be designed with integration in mind. The toolkit should be well documented and presented in a final presentation at the end of the project.

This is not an exhaustive list and you are free to include other techniques not listed here if they contribute towards the overall goal of the project (i.e., enhancing immersion in games).

Example 2
Logistics Project: Customer Journey Clothing Shopping

Before going shopping, people had a rough idea of what they needed and what their budget was. They went physically to a mall / town centre and visited multiple shops where they tried on their clothing. After evaluating the different options, they went back to the shops with their goods of interest and made the purchase.

FastForward to 2023 the customer in principle follows the same process, although he is not physically going to a shop, but is ordering his clothing online based on pictures and filters per shop. This results in approximately 20% of reverse flows (the new fitting process) and large volumes of traffic on distribution vehicles from a logistics point of view. However, most importantly, it is still product driven and not a customer-driven process.

Wouldn't it be great if we could have a solution in which we "chat" our way through the clothing selection process and are supported in making the decisions that matter most to us. We create a front-end solution based on an algorithm that supports customers (like you and me) to simplify and make the searching of clothing really fit for the customer.

Project Scope:

Below some examples are given to hopefully clarify: Minimum Viable Product "Configurator"

A (visual) chat function in which I can state the following prompt (or something better): I am looking for clothes, and I am on a tight budget for this month. As a teacher I want to be representative in front of class and do want to dress up. My favourite colour is black and I am wearing PME jeans size 32-34. One of my guiding principles is that I want to have a limited impact on the environment. However, I do not want to exceed a budget of €350 in purchasing two pairs of trousers, four shirts and two pairs of shoes, that, in the end, should match with each other. And oh yeah, I am not that fond of ironing. As a result of this prompt: it will give me the different options I have in different online shops, with maybe even the option to change / find alternatives.

The evolution of this way of shopping might expand in a cross-sectoral way (for other complex purchases) but can also go into depth in the decision-making process (including origin, CSR, logistic optimisations.

The aim of this business project is to increase customer satisfaction of the information collection and decision-making process for consumers and, on the other end, also improve the fulfilment of the selected clothing in relation to the sustainability, quality, speed and costs of the processes.

The project is supported by an entrepreneur who has successfully started and managed two companies. His name is Remko Been. The companies he has been involved in so far are ISTIA and StockSpots.

Project Outcomes:

The execution of this project is in close collaboration / co-creation between the Academy for Applied Data Science & Artificial Intelligence and Logistics. Three third-year students from Data Science will be joining three placement students of Logistics and we aim to reach a shared outcome. For the logistics part of this assignment, we see three professional products, which are described briefly below:

1) In this exploration of an innovative solution, where we are entering a greenfield situation we need to review and evaluate the possible business models behind a solution like this. There are multiple stakeholders in the customer journey and fulfilment and the assignment in this part is to recommend on the basis of research what possible business model is best and what the profitability of this model will be. In the research the elements of the business model canvas will be explored and the possible scenarios calculated. This part of the assignment

requires a person with a helicopter view and who can look at the concept from different perspectives and different angles to see what can be learned for innovations and disruptions in other segments. A desirable product can be an AI solution for a digitalised business model canvas to compare different customer journeys with calculated costs and profitability.

2) To see what possibilities there are in the customer journey the second professional product will deep dive into the different customer journeys per persona to see where an automated solution can support the decision-making process or maybe even take over. This will be a research where qualitative data needs to be translated into an "algorithm" and requires a person with good communication skills, and who loves to contact and interview professionals in relevant business and customers. A desirable product can be an AI solution that can recommend varied options in the clients' customer journeys for their decisions in the logistic chain.

3) The final part in this assignment is more hard-core logistics-related. To succeed we need to create insight into the different logistics and fulfilment activities triggered by current customer processes. We need to see what waste is created in the chain and for fulfilment and returns to quantify the current state in costs, time, sustainability and customer satisfaction. To understand the current state, we need someone who is keen on details and figures and not afraid to ask triggering questions. A desirable product can be an AI solution to automatically collect the data and to visualise the waste, cost, time and satisfaction of the above-mentioned options for all the current activities in the logistic chain.

All assignments will be coached by one lecturer of logistics with support of different Subject Matter Experts in the logistics field, and one lecturer from the Data Science team will be appointed. The assignment will be executed as a team whereby everybody has their own focus point to contribute to the shared success of this discovery journey.

These assignments will offer students a unique and challenging opportunity to learn and work with professionals and students of logistics and in other very relevant industries, like data science, AI and consumer products. It offers an opportunity to do applied research and contribute to an innovative solution for logistics and supply chain.

Year 2, Second Semester

Block 2C (15 ECTS credits): Research Methodology & Statistics

Research Methodology
Course Code: Y2C1
ECTS Credits: 10.0

Course Description
This course equips students with foundational skills in designing and conducting research. Students learn to formulate research questions, collect and analyze data using both qualitative and quantitative approaches, and present their findings in a structured, ethical, and academically sound manner.
Through applied research based on their earlier work in computer vision or natural language processing, students gain experience in writing a research paper that meets academic standards and contributes to their field of study.

Course Content
- Understanding the Research Process
- Literature Search and Review Techniques
- Reading and Critically Evaluating Scientific Papers
- Research Ethics and Academic Integrity
- Research Design: Quantitative and Qualitative Methods
- Writing Research Papers: Structure, Argumentation, Clarity
- Survey Design and Analysis
- Citation Standards and Referencing Tools (APA/IEEE)

- Connecting Research Questions to Data and Models

Recommended Reading

- How to write a good paper by William T. Freeman
- Purdue Online Writing Lab (OWL)

Course Coordinator(s)

- Shival Indermun

Introduction to Statistics

Course Code: Y2C2
ECTS Credits: 5.0

Course Description

This course introduces the foundational concepts of statistics, including data collection, summarization, probability, and statistical inference. Students will learn to describe data, perform hypothesis tests, and interpret results using real datasets and statistical tools in Python. Emphasis is placed on understanding when and how to apply methods rather than memorizing formulas.
Through practical exercises and Jupyter notebooks, students will develop the ability to think statistically and make data-driven decisions. The course provides a solid foundation for further study in data science and machine learning.

Course Content

- Introduction to Data
- Summarizing Data
- Probability
- Distribution of Random Variables
- Foundations for Inference
- Inference for Categorical Data
- Inference for Numerical Data

Recommended Reading

- OpenIntro Statistics by David Diez, Mine Çetinkaya-Rundel, Christopher D. Barr (4th Ed.)

Course Coordinator(s)

- Alican Noyan

Block 2D (15 ECTS credits): Deploying Machine Learning Solutions

MLOps and Cloud Engineering

Course Code: Y2D1
ECTS Credits: 5.0

Course Description

This course introduces students to the principles and practices of deploying machine learning solutions in production environments. Students learn how to structure, automate, monitor, and manage ML systems at scale using modern MLOps tools and frameworks.
By working through deployment scenarios, students gain hands-on experience with containerization, cloud computing, model serving, and continuous integration/continuous deployment (CI/CD) pipelines. Emphasis is placed on reproducibility, scalability, and maintainability.

Course Content

- MLOps Concepts and Lifecycle
- Reproducible Experiments with MLflow and Azure ML

- Continuous Integration / Deployment (CI/CD) with GitHub Actions
- Model Deployment Options: Real-Time vs Batch
- Containerization with Docker
- Using Azure Machine Learning Services
- Monitoring, Logging, and Retraining Strategies
- Version Control of Code, Data, and Models

Recommended Reading

- Introducing MLOps by Mark Treveil and Alok Shukla
- Microsoft Learn: Introduction to Azure Machine Learning

Course Coordinator(s)

- Dean van Aswegen

Data Engineering II

Course Code: Y2D2
ECTS Credits: 5.0

Course Description

In this course, students deepen their understanding of data pipelines and infrastructure for deploying machine learning solutions. The focus is on scalable data ingestion, transformation, and storage techniques that support robust, production-grade ML workflows.
Students implement pipelines using cloud services and build modular, maintainable systems that enable automated retraining and seamless integration with ML models.

Course Content

- Data Ingestion and Preprocessing Pipelines
- Storing and Versioning Datasets in the Cloud
- Azure ML Pipelines and Job Scheduling
- Automated Model Training Workflows
- Secure Access and Environment Management
- Data Handling for Real-Time and Batch Scenarios

Recommended Reading

- Designing Data-Intensive Applications by Martin Kleppmann

Course Coordinator(s)

- Jason Harty

Advanced Programming Concepts II

Course Code: Y2D3
ECTS Credits: 5.0

Course Description

This course equips students with advanced programming practices essential for deploying and maintaining machine learning applications. Emphasis is placed on writing modular, testable, and well-documented code in collaborative development environments.
Students transition from exploratory notebooks to production-ready Python packages and APIs, applying best practices in software engineering.

Course Content

- Writing Modular and Maintainable Python Code
- Developing and Publishing Python Packages
- CLI Tools and Interfaces

- API Development with FastAPI
- Code Documentation and Docstring Standards
- Unit Testing and Continuous Integration
- Version Control and Branching Strategies in Git

Recommended Reading
- FastAPI Documentation
- GitHub Documentation

Course Coordinator(s)
- Dean van Aswegen

Year 3, Second Semester (30 ECTS credits): Specialisation Project 2

Specialisation Project 2
Course Code: SPEC
ECTS Credits: 30.0

Course Description
The Specialisation Project is a pivotal part of the third year. It empowers students to deepen their expertise in a specific professional role of their choosing—such as data scientist, data engineer, or analytics translator—through a team-based, client-driven project. This project marks a transition toward professional autonomy, as students take ownership of a real-world challenge and work toward a deployable solution in collaboration with industry partners.
This experience simulates working in an interdisciplinary data consultancy environment. Students are expected to define project goals, select tools and methods, and manage their own learning journey under the guidance of a mentor and subject-matter experts. It is both a technical and professional growth experience—blending open-ended problem solving, client engagement, and domain specialization.

Course Content
- Problem analysis
- Project scoping
- Consultancy skills
- Project management
- Risk management
- Business understanding
- Role-specific application
- Stakeholder management
- Data visualization
- Presentation skills
- Ethical and human-centered design
- Team collaboration
- Professional reflection

Prerequisites
Completion of foundational and intermediate courses in data science and AI (120 ECTS).

Course Coordinator(s)
- Bram Heijligers
- Shival Indermun
- Mohsen Davarynejad
- Tsegaye Misikir Tashu

Example 1
Games Project: Enhancing Immersion in AAA Games using AI Tools

In the contemporary world of games, AAA titles are renowned for their high-quality graphics, storytelling, and gameplay. However, the quest for more immersive and engaging gaming experiences is an ongoing endeavour. As a third-year Applied Data Science and Artificial Intelligence student, you are given the challenge to explore, investigate, and implement AI tools that can enhance the immersion and engagement in AAA games. Over a six-month period, your task will be to devise a toolkit of AI solutions for games.

Project Scope:

The scope of the project involves research, investigation, and proof-of-concept development of various AI tools focusing on:

11. Large Language Models: Evaluate how narrative and NPC speech/actions can be driven using advanced language models to deliver more coherent and immersive narratives.

12. Speech to Text: Investigate possibilities to enhance player voice interaction and communication with in-game characters and systems.

13. Text to Speech: Explore the application of AI for character voice generation, aiming to create a more realistic and engaging dialogue system.

14. Facial Recognition: Investigate the possibilities of utilizing gaze detection, emotion recognition, and other aspects to enhance in-game character interactions.

15. Behaviour Recognition: Investigate the use of machine learning to identify player behaviours based on gameplay data, which can be used to dynamically adapt enemy behaviours, narrative, and gameplay elements.

16. Reinforcement Learning for Games: Explore how reinforcement learning can be used to improve NPC behaviour, enemy actions, and game difficulty scaling, making gameplay more responsive and challenging.

17. Diffusion Models for 2D and 3D Asset Generation: Explore how AI-driven generation can create a more visually engaging and adaptive game environment.

18. Vector Databases for Game Story and State: Develop an approach to use vector databases for managing game story and states for dynamic and reactive storytelling.

19. Transformer models to infer game state from audio-visual input: Investigate how transformer models can be used to infer game state from audio-visual input, allowing for more dynamic and adaptive gameplay.

20. Game analytics: Investigate the use game analytics techniques to analyse gameplay data and generate insights about player behaviours and business decisions.

The goal is to develop a toolkit consisting of APIs with simple front-ends as proofs of concept for a few of the above techniques. Integrating and aligning several of these techniques into high-level game features will increase the overall immersion in games. The APIs should be designed with integration in mind. The toolkit should be well documented and presented in a final presentation at the end of the project.

This is not an exhaustive list and you are free to include other techniques not listed here if they contribute towards the overall goal of the project (i.e., enhancing immersion in games).

Example 2
Logistics Project: Customer Journey Clothing Shopping

Before going shopping, people had a rough idea of what they needed and what their budget was. They went physically to a mall / town centre and visited multiple shops where they tried on their clothing. After evaluating the different options, they went back to the shops with their goods of interest and made the purchase.

FastForward to 2023 the customer in principle follows the same process, although he is not physically going to a shop, but is ordering his clothing online based on pictures and filters per shop. This results in approximately 20% of reverse flows (the new fitting process) and large volumes of traffic on distribution vehicles from a logistics point of view. However, most importantly, it is still product driven and not a customer-driven process.

Wouldn't it be great if we could have a solution in which we "chat" our way through the clothing selection process and are supported in making the decisions that matter most to us. We create a front-end solution based on an algorithm that supports customers (like you and me) to simplify and make the searching of clothing really fit for the customer.

Project Scope:

Below some examples are given to hopefully clarify: Minimum Viable Product "Configurator"

A (visual) chat function in which I can state the following prompt (or something better): I am looking for clothes, and I am on a tight budget for this month. As a teacher I want to be representative in front of class and do want to dress up. My favourite colour is black and I am wearing PME jeans size 32-34. One of my guiding principles is that I want to have a limited impact on the environment. However, I do not want to exceed a budget of €350 in purchasing two pairs of trousers, four shirts and two pairs of shoes, that, in the end, should match with each other. And oh yeah, I am not that fond of ironing. As a result of this prompt: it will give me the different options I have in different online shops, with maybe even the option to change / find alternatives.

The evolution of this way of shopping might expand in a cross-sectoral way (for other complex purchases) but can also go into depth in the decision-making process (including origin, CSR, logistic optimisations.

The aim of this business project is to increase customer satisfaction of the information collection and decision-making process for consumers and, on the other end, also improve the fulfilment of the selected clothing in relation to the sustainability, quality, speed and costs of the processes.

The project is supported by an entrepreneur who has successfully started and managed two companies. His name is Remko Been. The companies he has been involved in so far are ISTIA and StockSpots.

Project Outcomes:

The execution of this project is in close collaboration / co-creation between the Academy for Applied Data Science & Artificial Intelligence and Logistics. Three third-year students from Data Science will be joining three placement students of Logistics and we aim to reach a shared outcome. For the logistics part of this assignment, we see three professional products, which are described briefly below:

1) In this exploration of an innovative solution, where we are entering a greenfield situation we need to review and evaluate the possible business models behind a solution like this. There are multiple stakeholders in the customer journey and fulfilment and the assignment in this part is to recommend on the basis of research what possible business model is best and what the profitability of this model will be. In the research the elements of the business model canvas will be explored and the possible scenarios calculated. This part of the assignment requires a person with a helicopter view and who can look at the concept from different perspectives and different angles to see what can be learned for innovations and disruptions in other segments. A desirable product can be an AI solution for a digitalised business model canvas to compare different customer journeys with

calculated costs and profitability.

2) To see what possibilities there are in the customer journey the second professional product will deep dive into the different customer journeys per persona to see where an automated solution can support the decision-making process or maybe even take over. This will be a research where qualitative data needs to be translated into an "algorithm" and requires a person with good communication skills, and who loves to contact and interview professionals in relevant business and customers. A desirable product can be an AI solution that can recommend varied options in the clients' customer journeys for their decisions in the logistic chain.

3) The final part in this assignment is more hard-core logistics-related. To succeed we need to create insight into the different logistics and fulfilment activities triggered by current customer processes. We need to see what waste is created in the chain and for fulfilment and returns to quantify the current state in costs, time, sustainability and customer satisfaction. To understand the current state, we need someone who is keen on details and figures and not afraid to ask triggering questions. A desirable product can be an AI solution to automatically collect the data and to visualise the waste, cost, time and satisfaction of the above-mentioned options for all the current activities in the logistic chain.

All assignments will be coached by one lecturer of logistics with support of different Subject Matter Experts in the logistics field, and one lecturer from the Data Science team will be appointed. The assignment will be executed as a team whereby everybody has their own focus point to contribute to the shared success of this discovery journey.

These assignments will offer students a unique and challenging opportunity to learn and work with professionals and students of logistics and in other very relevant industries, like data science, AI and consumer products. It offers an opportunity to do applied research and contribute to an innovative solution for logistics and supply chain.



Games



Leisure & Events



Tourism



Media



Data Science & AI



Hotel



Logistics



Built Environment



Facility

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