



course

# ARTIFICIAL INTELLIGENCE FOR SUSTAINABILITY

## **Course Info**

### **Artificial intelligence for sustainability**

#### **Teacher**

Prof. Filippo Chiarello

#### **Credits**

6 ECTS

#### **Course delivery mode:**

Hybrid (asynchronous online activities and in-person sessions)

**Course period:** I Semester

**Language:** English

**Teaching Platform:** Moodle

**Prerequisites:** None

**Exam type:** Project work

**Course Website:** <https://www.detaills.eu/>

#### **Contacts Information:**

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**Registration is open until October 10, 2025.**

**To register, fill out the form at the following link:**

<https://www.detaills.eu/ai-for-sustainability/>



# Description

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The course *Artificial Intelligence for Sustainability* offers training on the principles and uses of artificial intelligence to support creativity, critical thinking, and communication with the goal of bringing sustainable innovation in organisations. It integrates the principles of environmental, social, and economic sustainability with advanced AI technologies, in particular Large Language Models. The course is interdisciplinary and is designed for students from different backgrounds. No prior knowledge in AI or Sustainability is required.

It emphasizes ethical responsibility, innovation, and the practical application of AI in design and innovation. The course promotes critical thinking about the role of AI in responsible and inclusive innovation. At the end of the course, students will collaborate with organisations to address real challenges related to AI and sustainability. Partner organizations propose real-world challenges that student teams will tackle collaboratively. The resolution of these challenges will represent the final exam project: an applied project that combines technical skills, critical thinking, and innovative solutions.

The course is developed by DETAILLS (DEsign Tools of Artificial Intelligence in Sustainability Living LabS) (<https://www.details.eu/>), a European Erasmus+ project (ID KA220-HED-1785D7F1).



# Course structure

# Course Structure

The course has a total duration of 60 hours, divided into 30 hours of lectures (6 hours in-person) and 30 hours of practical application (3 hours in-person). The lectures are delivered in an asynchronous online format via the Moodle platform, with the 9 in-person hour, divided in 3 meetings.

The course is structured in 4 modules:

**Module 1 - *Foundations of generative AI in sustainable design***: introduces AI fundamentals and explores their ethical and sustainable applications.

**Module 2 - *Advanced AI-driven design methods***: focuses on advanced AI tools for data analysis, modelling, and design optimization.

**Module 3 - *Application of AI-driven sustainable design methods***: emphasizes practical AI applications for eco-innovation and resource efficiency.

**Module 4 - *Project management and real-world applications***: guides students in managing real-world AI-driven design projects through a capstone experience.

Participants are required to complete the first two modules before the second in-person meeting, and the third and fourth modules before the third meeting.

The in-person meetings are scheduled as follows:

**October 15, 2:00 PM–5:00 PM** – Course introduction, first introductory lecture, and formation of work groups.

**November 19, 2:00 PM–5:00 PM** – Presentation of materials for tackling the challenges: this session will explain the steps and workflow to follow in order to address the challenge, i.e., how to structure and develop the final exam project. Presentation of challenges by partner organisations, including a Q&A session and confirmation of work groups.

**December 18, 3:00 PM–6:00 PM** – Final plenary session: students will present their final exam projects to partner companies and faculty members. Those who haven't completed their projects yet are still encouraged to attend, as they can receive valuable feedback from companies and professors, and gain inspiration by watching their peers' presentations.

## Credits and Exam

The course is worth 6 ECTS credits. Recognition of the credits as curricular is subject to the regulations of each student's degree program and must be approved by their program.

The final exam consists of a group project based on a challenge proposed by partner companies. The project represents the exam paper and must demonstrate the students' ability to apply the knowledge acquired during the course to develop an innovative, sustainable solution supported by Artificial Intelligence. The assessment of the project will be expressed in thirtieths and will refer to the group project, but with the possibility of an oral exam for personal assessment (if required by the student).



# Learning outcomes

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The learning outcomes of the Artificial Intelligence for Sustainability course are listed below, organized module by module.

## Module 1

### Foundations of generative AI in sustainable design

- Understand the basics of Artificial Intelligence and generative models (GANs, VAEs, transformers)
- Learn the principles of sustainable design and how to apply them synergistically with AI technologies
- Recognize ethical issues and social impacts associated with the use of AI
- Evaluate the potential of AI tools to enhance sustainable design practices
- Understand the main regulatory frameworks and standards governing the use of AI

## Module 2

### Advanced AI-driven design methods

- Apply advanced data analysis techniques to sustainability-focused datasets
- Use generative data synthesis methods to address data scarcity and foster creativity in sustainable design processes
- Employ pattern recognition and predictive modelling to support informed decision-making in industrial and architectural design projects
- Integrate AI-based tools for prototyping, simulation, and visualization of complex systems
- Evaluate the environmental impact of design choices using AI tools for material selection and resource optimization

- Demonstrate ethical awareness in the use of AI, with a particular focus on data management, privacy, regulatory compliance, and adherence to social standards

### **Module 3**

#### **Application of AI-driven sustainable design methods**

- Apply AI-driven methodologies to optimize sustainable design practices
- Use AI-based simulation and modelling tools to assess sustainability metrics
- Integrate generative AI techniques into the development of sustainable products
- Critically analyse AI-generated designs to evaluate their ethical soundness and functional efficiency
- Develop AI-assisted solutions aimed at reducing environmental impact and resource consumption
- Understand and apply interdisciplinary approaches in AI-driven sustainable design projects

### **Module 4**

#### **Project management and real-world applications**

- Apply project management principles to plan, execute, and evaluate AI-driven sustainable design projects
- Adapt AI strategies to address a variety of design challenges while maintaining a strong focus on sustainability
- Effectively engage stakeholders and implement co-design approaches in AI-driven projects
- Manage risks, allocate resources, and coordinate interdisciplinary teams within design projects
- Assess the ethical and social implications of AI use and propose responsible solutions
- Develop and present an AI-driven sustainable design solution through a final capstone project





# Course program

## Module 1

# Foundations of generative AI in sustainable design

### 1.1 Introduction to the course: the synergies of AI, design and sustainability

In presence, 15.10.2025

Introduces the key concepts of AI, design, and sustainability—defining what each term means and identifying the design stages involved. It explores why these topics are important today and highlights how they intersect, showing the benefits of combining them.

### 1.2 Principles of generative AI models

Online

Covers the basics of generative AI, including key models like GANs, VAEs, and transformers. It explains how Large Language Models (LLMs) like GPT work, and introduces tools for using LLMs effectively with prompts to generate creative content.

### 1.3 Ethics and responsibility in AI

Online

Explores ethical concerns in AI, including privacy risks, biased algorithms, and societal impacts. It also examines legal frameworks governing AI and its potential misuse, with case studies illustrating ethical regulations and responsibilities.

### 1.4 Basics of sustainable design

Online

Covers the fundamentals of sustainable design, including its definitions, history, and frameworks. Students will explore its environmental, social, and economic

impacts, and learn how to apply sustainability principles in the design process, with AI as a tool to enhance these practices.

## 1.5 **The role of AI in sustainable design**

Online

Introduces AI technologies for responsible design, exploring how AI addresses sustainability challenges and creates efficient, sustainable solutions. Real-world examples will show how AI optimizes resources and supports sustainability goals.

## 1.6 **Driving eco-friendly innovation with generative models**

Online

Examines the ethical implications of AI in sustainable design, covering issues like data bias, transparency, and accountability. Students will explore AI tools such as generative design and machine learning, learning how they address environmental challenges and support sustainability goals.

## 1.7 **Social sustainability of AI in design and innovation**

Online

Explores social sustainability in AI, highlighting its role in creating inclusive solutions while addressing issues like bias and privacy. Students will examine case studies of AI's impact on communities and learn how human-centered design can ensure fairness, inclusion, and alignment with community values. Economic sustainability of AI in design

## 1.8 **Economic sustainability of AI in design and innovation and innovation**

Online

Covers economic sustainability in AI-driven design, focusing on the upfront costs and long-term benefits, such as improved efficiency and cost reduction for businesses. Case studies will show how AI optimizes resources and promotes eco-friendly solutions, while students will explore strategies to maximize the return on investment and foster innovation while ensuring ethical practices.

## 1.9 **Future trends in AI and sustainable design**

Online

Explores AI's role in shaping sustainable design, focusing on energy efficiency, circular economies, and predictive analysis to reduce waste. Students will examine challenges and opportunities in AI-driven sustainable design, considering future trends and ethical concerns.

## Module 2

# Advanced AI-driven design methods

### 2.1 **Advanced data analysis techniques in AI**

Online

Teaches advanced data analysis methods, including clustering, dimensionality reduction, and advanced regression techniques, with a focus on sustainability data. Tools to be used: Python libraries (Scikit-learn, pandas).

### 2.2 **Generative data synthesis and its applications**

Online

Explores techniques for generating synthetic data and their applications in design and sustainability, addressing issues of data scarcity and enhancing creativity. Tools to be used: TensorFlow and PyTorch.

### 2.3 **Pattern recognition and predictive modelling in sustainability**

Online

Introduces predictive modelling and pattern recognition techniques to identify trends and make informed design decisions in sustainability projects. Tools to be used: Orange and Weka.

### 2.4 **AI-Driven Design Methods for Creativity**

Online

Introduces design methods that boost creativity and examines how AI can support and transform the creative process. Through hands-on challenges, students apply AI tools to generate innovative ideas and enhance creative outcomes.

## 2.5 **AI-Driven Design Methods for Measuring**

Online

Focuses on design methods that improve the measuring process, highlighting how AI can enhance accuracy and efficiency. Students engage in practical challenges to apply AI tools for better measurement and data-driven insights.

## 2.6 **AI-Driven Design Methods for Communication**

Online

Explores how design elements like charts, layout, and color influence effective communication. It shows how AI can improve visualization and speed up early design stages, especially in complex or sustainable contexts. Students also learn to use tools like Figma to apply AI-driven enhancements in interface design.

## 2.7 **Ethics and Responsibility in AI Data**

Online

Covers the fundamentals of ethical data management in design, focusing on principles like consent, fairness, and transparency. It also addresses data privacy, security, and regulations such as GDPR, while exploring how to detect and explain social bias in AI systems.

## 2.8 **Real-World Challenges: Presentations, Q&A, and Team Formation**

In presence, 19.11.2025

Presentation of challenges by partner organizations, including a Q&A session and confirmation of work groups.

## Module 3

# Application of AI-driven sustainable design methods

### 3.1 Deep dive into generative AI technologies

Online

Explores advanced features and techniques in generative AI, emphasizing their application in sustainable design.

### 3.2 Overview AI frameworks for design

Online

Provides hands-on training with AI frameworks tailored for design applications.

### 3.3 AI-driven simulation tools for sustainable design

Online

Teaches learners how to use simulation tools to evaluate sustainability metrics and improve design efficiency.

### 3.4 Creative problem-solving with AI in design

Online

Encourages innovative thinking by leveraging AI to solve complex design challenges creatively and sustainably.

### 3.5 Integrating AI with traditional design methods

Online

Explores how AI can complement and enhance traditional design methods, fostering a hybrid approach to innovation.

### 3.6 **AI in design optimization and decision-making**

Online

Focuses on AI techniques for optimizing designs and supporting decision-making processes in sustainable projects.

### 3.7 **Interdisciplinary approaches to AI-driven design**

Online

Encourages collaboration across disciplines, integrating technical, environmental, and social perspectives.

### 3.8 **AI-assisted design prototyping**

Online

Explores tools and techniques for rapid prototyping using AI, enabling efficient iteration and testing.

### 3.9 **Critiquing AI-driven designs**

Online

Develops critical evaluation skills to assess AI-driven designs for effectiveness, sustainability, and ethical considerations.

### 3.10 **The future of design: AI and beyond**

Online

Examines emerging trends in AI-driven design, inspiring learners to envision innovative futures.

## Module 4

# Project management and real-world applications

### 4.1 Fundamentals of project management in AI-driven design

Online

Introduces project management principles tailored to AI-driven sustainable design, covering planning, execution, and evaluation with a focus on AI-specific challenges.

### 4.2 Real-world AI project lifecycle

Online

Examines the end-to-end lifecycle of AI projects, highlighting best practices for managing sustainable design initiatives.

### 4.3 Stakeholder engagement and co-design in AI projects

Online

Focuses on engaging stakeholders and applying co-design in AI-driven projects, addressing diverse needs and ethical concerns.

### 4.4 Risk management and mitigation in AI design

Online

Explores risk management in AI-driven design, identifying and mitigating AI-specific risks like data bias and privacy issues.

### 4.5 Resource allocation and budgeting for AI projects

Online

Teaches resource allocation and budgeting for AI-driven projects, focusing on AI-specific needs like data and compute resources.

## 4.6 Collaborative work in AI and design teams

Online

Explores teamwork in AI-driven design, managing interdisciplinary teams.

## 4.7 Case study analysis of successful AI design projects

Online

Analyses successful AI-driven design projects, identifying best practices and lessons.

## 4.8 Ethics and social responsibility in AI design projects

Online

Explores ethical principles and concerns specific to AI-driven design projects. It shows strategies to ensure ethical practices in the design process.

## 4.9 Adapting AI strategies to different design challenges

Online

Explores various types of design challenges across different fields and how AI can address them. Real-world case studies illustrate how AI is effectively tailored to support sustainable design solutions.

## 4.10 Case Study: developing an AI-driven design solution

In presence, 18.12.2025

Presents a realistic case study showcasing AI-driven sustainable solutions. It outlines a practical workflow for tackling real-world challenges through sustainable design with AI and provides guidance on preparing the final exam project based on these methods.



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