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FAAI:
The Future is in Applied Artificial Intelligence
Erasmus+ project 2022-1-PL01-KA220-HED-000088359

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A3.2: Main content and topics of the curriculum

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Summary: The Applied Artificial Intelligence (AAI) curriculum is a 120-hour, competency-based course focused on case-based study to provide practical, industry-relevant AI skills across fields like ecology, agriculture, healthcare, and industry. With a foundation in math and programming, students engage in 12 structured modules that blend theoretical lectures, interactive demonstrations, and hands-on projects using tools from IBM, Microsoft, and Google.

The curriculum's core objectives include developing critical skills in data management, machine learning, and ethical evaluation, with an emphasis on solving real-world problems. A learner-centered, flexible approach supports in-person and remote participation, with modules organized to reinforce practical skills in applying AI techniques. Through a competency matrix that maps skills to each module, students gain expertise in AI-driven decision-making and practical problem-solving essential for industry applications. This case-based, competency-focused approach prepares students to implement and evaluate AI solutions in diverse professional contexts.

Keywords: applied artificial intelligence, curriculum, FAAI

APPLIED ARTIFICIAL INTELLIGENCE (CURRICULUM)

Contents

I. COURSE DESCRIPTION

The Applied Artificial Intelligence (AAI) curriculum introduces students to AI principles and their practical applications across various fields, such as ecology, agriculture, healthcare, and industry. The course is designed to equip students with foundational skills for implementing AI solutions and critically evaluating data-driven decisions. Students will learn to leverage major AI tools from providers like IBM, Microsoft, Google, and AWS to address real-world challenges.

Prerequisite Knowledge and Skills

Students are expected to have a background in mathematics and basic programming, which will support the technical and analytical skills needed throughout the course.

Purpose of Course

This course aims to empower students to harness the potential of AI for data-driven decision-making and problem-solving. By applying AI models to diverse fields, students gain practical experience with tools and techniques for analyzing data and developing AI solutions in real-life contexts.

Course Objectives and Goals

Upon completion, students will be capable of conceptualizing AI applications, choosing and evaluating machine learning methods, and implementing AI solutions. They will be adept at managing data, evaluating ethical implications, and recommending effective improvements for AI-based projects.

Teaching Philosophy

AAI adopts a learner-centered approach, encouraging active engagement and hands-on learning to deepen understanding. Emphasizing self-directed learning, students are guided through interactive discussions, exercises, and projects.

Instructional Methods

Instruction includes lectures, demonstrations, team-based projects, and practical assignments to help students internalize core concepts and apply them in meaningful ways. Students work collaboratively and independently, with instructor support, to strengthen critical thinking and problem-solving skills.

Course Policies

The course offers flexible, hybrid attendance options, accommodating both in-person and remote learning. Students are encouraged to attend sessions, participate in discussions, and complete assignments punctually. All course recordings are accessible for students who may miss live sessions.

The course Applied Artificial Intelligence (AAI) enables students to learn what is the artificial intelligence, how to conduct research related to the practical AI applications and how to use to solve different problems using the embeddable modules from IBM, Microsoft, Google, AWS, etc. Using standard data sets will allow learners to understand and use data for identifying and determining cases and situations. We will discuss what means to use AI in Ecology, Agriculture, Healthcare, SmartCity, Industry, Robotics. What are the main problems as well as the effective and ineffective AI methods for solving them. The most frequently used tools for data analytics, machine learning, visualization will be introduced, and how to critique/ evaluate presented data. The students will learn how to apply their knowledge to new data sets to solve real cases.

1) Prerequisite Knowledge and Skills

Math and programming skills

2) Purpose of Course

AAI plays a crucial role in enabling researchers to effectively convey their ideas and discoveries to both their peers and the general public. By creating informative visual representations of data, students not only enhance their own understanding of plots created by others but also gain

the ability to discern between effective and ineffective methods of AAI. This course aims to explore the AAI embeddable modules, the objectives scientists should strive for, introduce available tools for presenting and researching related to the practical AI applications using *Python* and provide guidance on critiquing and evaluating presented data. Although this module is primarily intended for students in master's degree in regard to solving problem in different areas with applied artificial intelligence, it offers valuable insights that can benefit students in various science disciplines.

3) Course Objectives and Goals

After completing this module students will be empowered to:

- Conceptualize AI techniques with reference to Ecology, Agriculture, Healthcare, SmartCity, Industry, Robotics.
- Identify basic rules/guidelines to accurately convey data without misleading or distorting data.
- Utilize different tools and applications that can help to design efficient and useful data models.
- Have a sound grasp of data management strategies and increased comfort with data storage, accessibility and analysis.
- Be familiar with Python language, data modeling tools, data warehouses, applications for data manipulation.
- Evaluate AI techniques and recommend effective adjustments to peers, open projects and stakeholders.

- Recognize the breadth and utility of machine learning methods
- Compare and contrast machine learning methods
- Select appropriate (classes of) machine learning methods for specific problems.

- Use appropriate training and testing methodologies when deploying machine learning algorithms.
- Explain methods to mitigate the effects of overfitting and course of dimensionality in the context of machine learning algorithms.
- Identify an appropriate performance metric for evaluating machine learning algorithms/ tools for a given problem.

- Prepare a glossary of domain-specific terms to ensure shared understanding
- Evaluate the data to ensure that it meets ethical requirements (with help from domain experts and social scientists)
- Critical evaluation and assessment of the case studies
- AI Ecosystems
- Review explainability techniques for AI models
- Identify safety issues with AI models
- Identify the technical determinants of racial, gender and social biases in AI models
- Describe architectures for privacy-preserving AI deployments

4) Teaching Philosophy

This course will adopt a learner-centered approach to teaching, as the process of learning programming and data manipulation necessitates active engagement with computers.

5) Instructional Methods

The approach used for teaching is centered around the learner, placing the student at the heart of the educational experience and prioritizing their active involvement in the learning process. Our instructional methods revolve around actively engaging students in the learning process, fostering their critical thinking skills, and promoting independent exploration. Rather than relying solely on traditional lecture-style delivery, we create a dynamic learning environment that encourages students to take ownership of their education. We achieve this by incorporating interactive discussions, hands-on exercises, and collaborative projects that allow students to apply the concepts they have learned. Instructors must facilitate and guide the learning journey, providing support, feedback, and resources tailored to individual student needs. By embracing this learner-centered approach, the goal is to cultivate a deeper understanding of the subject matter, nurture a passion for learning, and empower students to become active participants in their own education.

6) Course Policies

Our goal is to help students learn, while recognizing the fast-changing environment and the limitations that people could have.

The training will be conducted in-person or in a hybrid approach. To provide maximum flexibility, but also effectiveness the course material can be engaged with in the following ways:

- In person: Attend class during the scheduled class periods. Follow each lesson, which combine video lectures and exercises, during the class periods and ask for help as you

run into questions. This is the closest approximation to how the course normally runs in-person.

- Hybrid: The training will be simultaneously run physically at the university and online allowing students to attend according to their preference. Learners come to class during the class periods and ask for help on challenges or do the same at the online meeting. Online participating students have the same direct student-instructor interaction to work through misunderstandings as the students at place. The hybrid approach gives equal rights to all learners regardless their physical limitations.

The course always has flexible deadline policies and will continue to do so to support students learning under these difficult circumstances.

Class Recording

In this course, the audio and visual components of the sessions may be recorded for the benefit of enrolled students who are unable to attend live, as well as for reference purposes for students in the class. By participating with camera turned on or using a profile image, students agree to have their video or image recorded. If they do not wish to consent to having their profile or video image recorded, they should make sure that their camera remains off and do not utilize a profile image. Similarly, students who choose to unmute their microphones and actively participate verbally are consenting to have their voices recorded. If they do not wish to consent to the recording of their voice during class, they should keep their microphone muted and use the "chat" feature exclusively for communication, allowing them to type questions and comments in real-time. As is the case in all courses, unauthorized recording and sharing of recorded materials are strictly prohibited.

Attendance Policy

Attendance would be taken and factor into the grades for this class. Experience suggests that students who regularly attend class are more successful in gaining knowledge and pass the exam.

Quiz/Exam Policy

Brief quiz on each module.

Make-up policy

Life happens and therefore there is an option for a grace period for the submission. However, it is highly recommended that you submit assignments on time when possible because assignments build on one another and it can be hard to catch up if you fall behind.

Assignment policy

The deadline for each assignment will be predetermined and announced to all learners.

Course Technology

Students are allowed to use their own laptops and to install free and open-source software. Support will be provided by the instructor in the installation of required software. Students could also use the technical equipment at the university.

Online Course Evaluation Process

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online.

Netiquette and Communication Courtesy

All members of the class are expected to follow rules of common courtesy in all email messages, threaded discussions and chats.

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams).

Software Use – good practice to follow

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

II. MAIN CONTENT

Course Duration and Structure:

- **Total Duration:** 120 hours.
- **Module Count:** 12 distinct modules.
- **Time Allocation per Module:** Each module encompasses 10 hours, divided into:
    - **Lecture Hours:** 4 hours focused on core theoretical content, delivered through traditional lecture format, interactive discussions, and multimedia presentations.
    - **Learning Activities:** 6 hours dedicated to hands-on tasks, practical exercises, and interactive engagements, designed to reinforce the lecture material and promote applied learning.

Module Design and Core Curriculum Components:

1. **Lectures (1 per Module):**
    - Each module contains a primary lecture that introduces the core concepts and foundational theories relevant to the module's focus area.
    - Lectures are complemented by a visual presentation, which includes infographics, case studies, and real-world examples to contextualize theoretical concepts.
2. **Demonstration and Practical Team Tasks:**
    - **Demonstration:** Following the lecture, the instructor leads a live demonstration, showcasing practical applications, software usage, or specific methodologies covered in the lecture.
    - **Team-Based Practical Tasks:** Students work collaboratively in small groups, applying lecture content to solve case-based problems or perform tasks mirroring industry scenarios. These activities promote teamwork, problem-solving, and critical thinking skills.
3. **Seminar Assignment (1 per Lecture):**
    - After each lecture, students receive a seminar assignment that challenges them to reflect on the material, analyze specific aspects in greater detail, and apply learned concepts to hypothetical or real-world cases.
    - These assignments serve as a bridge between theoretical knowledge and practical implementation, reinforcing learning objectives and allowing for individual exploration of course topics.
4. **Learning Scenarios (Minimum of 5 per Module):**
    - Each module provides at least five diverse learning scenarios, crafted to simulate real-world problems related to the module's theme.
    - Scenarios include case studies from various sectors, such as healthcare, smart cities, and robotics, allowing students to practice problem-solving within a context that reflects industry needs and challenges.
5. **Guides and Tasks (Minimum 1 per Module):**
    - Each module includes one or more comprehensive guides that outline key processes, workflows, or methodologies relevant to the module's content.
    - Accompanying tasks prompt students to apply the guide's contents in practical exercises, helping to deepen understanding and ensure mastery of essential skills.
6. **Resource Materials:**
    - A curated list of reading materials, toolkits, research articles, and industry reports is provided for each module to support independent learning and encourage deeper exploration of topics covered in the lectures and activities.
7. **Discussion Questions (Minimum of 5 per Module):**
    - Each module offers at least five thought-provoking questions, which stimulate discussion and critical analysis of the module's themes.
    - These questions are designed to encourage students to reflect on ethical considerations, societal impacts, and emerging trends within applied AI, promoting a comprehensive understanding of each topic.
8. **Quiz (1 per Module):**
    - Each module concludes with a quiz containing approximately 40-50 questions, each with four answer choices.

- Quizzes assess comprehension of lecture content, ability to apply theoretical knowledge to practical scenarios, and reinforce learning objectives across a range of difficulty levels.

9. **Presentations (Minimum of 1 per Module):**
   - Each module includes a 30-slide minimum presentation that visually summarizes key points from lectures and activities.
   - Presentations incorporate graphics, charts, and case examples, serving as a comprehensive review and study resource for students.
10. **Demonstrators (Minimum of 2 per Module):**
    - Modules contain at least two interactive demonstrators, which may include simulations, tutorials, or guided exercises.
    - These demonstrators are designed to give hands-on experience with software tools, coding environments, and other resources relevant to applied AI practices.
11. **Learning Videos (Minimum of 2 per Module):**
    - Each module offers a minimum of two instructional videos that explain complex concepts, demonstrate tools in action, or showcase industry case studies.
    - Videos supplement the lecture material and provide visual, step-by-step walkthroughs, enhancing understanding of practical applications in applied AI.
12. **Content (1 per Module):**
    - Each module presents a set of core content that encapsulates the primary themes, theories, and practices relevant to the topic.
    - This content is organized into a concise yet comprehensive format that serves as a foundational reference for students.
13. **External URLs (As Needed):**
    - Modules include external links to websites, databases, and online tools to support extended learning and encourage engagement with up-to-date resources from the field of AI.
    - These resources give students access to global repositories, research papers, and real-world AI applications to enhance learning and situate knowledge within a broader industry context.

III. COURSE MODULES

A. Part 1 - Introduction

- Module 1 - Basic principles of the application of Artificial Intelligence in science and in modern business solutions - Nis

B. Part 2 - Software implementation way

- Module 3 - Embeddable modules from IBM, Microsoft, Google, AWS, etc. - ULSIT
- Module 4 - Conducting research related to the practical application of artificial intelligence - UBB
- Module 5 - Building software applications using AI - UCM
- Module 6 - Implementation of external AI modules in software applications – UNI

C. Part 3 – Areas of Applied Artificial Intelligence

- Module 7 - AI-based solutions for Ecology - ULSIT
- Module 8 - AI-based solutions for Agriculture - UCGM
- Module 9 - AI-based solutions for HealthCare - UBB
- Module 10 - AI-based solutions for SmartCity - UCM
- Module 11 - AI-based solutions for Industry - UNI
- Module 12 - AI-based solutions in Robotics - UCGM

IV. COMPETENCE AND COMPETENCY-BASED EDUCATION

*A. **Competence***[1]

Competence is the person's knowledge, behavior, attitude, and skills that lead them to the ability to be successful in a job.

*B. **Competency-based education***

CBE is a system of instruction, assessment, feedback, self-reflection, and academic reporting that is based on students demonstrating that they have learned the knowledge, attitudes, motivations, self-perceptions, and skills expected of them as they progress through their education[2]**.**
CBE is a system[3] **in which:**

- Students:
  - advance based on their ability to master a skill or competency at their own pace regardless of environment;
  - are empowered daily to make important decisions about their learning experiences, how they will create and apply knowledge, and how they will demonstrate their learning;
  - receive timely, differentiated support based on their individual learning needs;
- Rigorous, common expectations for learning are explicit, transparent, measurable, and transferable.
- Students' progress based on evidence of mastery, not seat time;
- Assessment is a meaningful, positive, and empowering learning experience for students that yields timely, relevant, and actionable evidence;

Changing paradigm:

- Credit hour -> **content mastery**
- Focus on teaching -> **focus on learning (**Shifts the primary focus of education to the desired outcomes (for learners) rather than the structure and process of the educational system**)**
- Time is constant/learning is variable -> **time is variable/learning is constant**
- **Greater focus on employer input** regarding knowledge, skill, and aptitude (KSA) needs of future employees

Basic principles of CBE

- Students' centered education
- A set of expectations that demonstrate what learners can do with and know
- Clear expectations are made explicit to learners, employers, and the public.
- Visibly demonstrated and assessed over time by multiple methods and multiple assessors.

Learning experiences in CBE must be:

- integrative and experiential
- self-aware and reflective
- active and interactive
- developmental
- transferable

CBE is not:

- A checklist of tasks
- A one-and-done experience or demonstration.
- Isolated in one sphere of care or context;
- Demonstrated solely on an objective test.

C. Development of the AI Competency Framework

1) Existing Competency Frameworks

According to the ACM/IEEE Computing Competencies for Undergraduate Data Science Curricula (page 48), Artificial Intelligence (AI) includes the methodologies for modelling and simulating several human abilities that are widely accepted as representing intelligence. Perceiving, representing, learning, planning, and reasoning with knowledge and evidence are key themes.

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[1] Competence vs Competency
Competence is your ability to generally understand and perform anything at a basic level - knowledge and general state of being.
Competency refers to your ability to perform a specific task in which someone has trained you.
[2] https://www.aacnnursing.org/Essentials/Definition-of-Competency-Based-Education
[3] https://aurora-institute.org/our-work/competencyworks/competency-based-education/

Scope	Competencies
• Major subfields of AI • Representation and reasoning • Planning and problem solving • Ethical considerations	• Describe major areas of AI as well as contexts in which AI methods may be applied. • Represent information in a logic formalism and apply relevant reasoning methods. • Represent information in a probabilistic formalism and apply relevant reasoning methods. • Be aware of the wide range of ethical considerations around AI systems, as well as mechanisms to mitigate problems.
Sub-domains	
• AI-General • AI-Knowledge Representation and Reasoning (Logic-based models) • AI-Knowledge Representation and Reasoning (Probability-based models)	• AI-Planning and Search Strategies

From the other side the UNESCO Consultation on AI Competency Frameworks for Teachers includes:

- AI literacy,
- AI and pedagogy,
- ethics of AI,
- the use of AI for continuous professional development,
- the ability to foster AI competencies for students, etc.

According to Concordia University and Dawson College (2021) AI competence framework the **Competency Domains** could be structured in three main directions: Technical, Business and Human where the Ethical Competencies are horizontal and are integrated in each one of these three domains.

Technical	Business	Human
• Data • Mathematics and Statistics • Programming • Machine Learning • Deep Learning • Infrastructure • Libraries and Frameworks	• AI Initiative and Project Planning • AI Initiative and Project Scaling • AI Technologies	• Innovation • Teamwork • Professionalism • Ethics

2) FAAI Target Groups

To distinguish the main competences for the project is important to focus on direct target groups. They are:

- University students
- managers of SME
- researchers and experts

3) FAAI Competences Framework

The main twelve technical competencies selected are:

1. Recognize the breadth and utility of machine learning methods
2. Compare and contrast machine learning methods
3. Select appropriate (classes of) machine learning methods for specific problems.
4. Use appropriate training and testing methodologies when deploying machine learning algorithms.
5. Explain methods to mitigate the effects of overfitting and course of dimensionality in the context of machine learning algorithms.
6. Identify an appropriate performance metric for evaluating machine learning algorithms/ tools for a given problem.
7. Recognize problems related to algorithmic and data bias, as well as privacy and integrity of data.
8. Debate the possible effects -- both positive and negative -- of decisions arising from machine learning conclusions.
9. Describe major areas of AI as well as contexts in which AI methods may be applied.
10. Represent information in a logic formalism and apply relevant reasoning methods.

11. Represent information in a probabilistic formalism and apply relevant reasoning methods.
12. Be aware of the wide range of ethical considerations around AI systems, as well as mechanisms to mitigate problems.

In FAAI Competencies Framework the Ethics will be horizontal component.

V. MODULE-COMPETENCY CROSS-MATRIX

The **Module-Competency Cross-Matrix** in the curriculum is a structured tool that links each module to specific competencies, hard skills, and soft skills students are expected to develop. Competencies represent the ability to perform specific tasks or solve problems effectively, irrespective of the setting or context. This matrix acts as a roadmap, clarifying which skills and competencies each module builds, helping students track their progress, and guiding their learning focus throughout the course.

1. **Key Components of the Module-Competency Cross-Matrix**
2. **Competency Areas**:
    - **Core Competencies**: These are foundational abilities that students should acquire to proficiently apply AI techniques and problem-solving strategies across different situations. Competencies include analytical skills, adaptability, problem-solving, and ethical awareness in AI applications.
3. **Hard Skills**:
    - These are the technical, measurable abilities necessary for students to apply AI effectively. Hard skills mapped in the matrix include:
        - **Data Analysis**: Proficiency in analyzing, interpreting, and drawing insights from complex data sets.
        - **Machine Learning Algorithms**: Understanding, implementing, and adjusting machine learning models to specific problems.
        - **Programming Proficiency**: Coding skills in languages like Python, and the ability to use tools from providers such as IBM, Microsoft, and Google.
4. **Soft Skills**:
    - Soft skills in the matrix address dispositions that help students work well with others and adapt to different scenarios. These skills include:
        - **Critical Thinking**: The ability to assess AI model effectiveness, address biases, and make ethical decisions in data use.
        - **Communication**: Clearly conveying AI concepts, outcomes, and potential impacts to both technical and non-technical audiences.
        - **Team Collaboration**: Working effectively in diverse teams, especially in project-based tasks and case studies.
5. **How to Use the Module-Competency Cross-Matrix**

The matrix is a guide for students to:

- **Identify Learning Objectives**: By reviewing competencies and skills associated with each module, students understand the

purpose of their studies and set specific learning goals.

- **Monitor Development**: Students can use the matrix to track which competencies and skills they have gained after completing each module. This self-monitoring helps them recognize strengths and areas needing improvement.
- **Prepare for Practical Application**: By practicing both hard and soft skills mapped in the matrix, students ensure they are prepared for real-world applications of AI in professional settings, where technical proficiency and adaptability are equally important.

6. **Instructor and Institutional Benefits**

For instructors, the matrix offers a framework to evaluate student progress and make instructional adjustments. For institutions, it provides a cohesive structure, ensuring that each module contributes to the program's goal of developing well-rounded AI professionals who excel technically and adapt skillfully to various professional environments.

	Module 1 - Introduction	**Part 2 - Software implementation way**				**Part 3 – Areas of Applied Artificial Intelligence**						
	Introduction and Basic Principles of the AI application in Science and in Business Solutions	**Module 2 - Embeddabl e modules from IBM, Microsoft, Google, AWS, etc - ULSIT**	**Module 3 - Conducting research related to the practical application of artificial intelligence - UBB**	**Module 4 - Building software applications using AI - UCM**	**Module 5 - Implement ation of external AI modules in software applications – UNI**	**Module 6 - AI-based solutions for Ecology - ULSIT**	**Module 7 - AI-based solutions for Agricultu re - UCGM**	**Module 8 - AI-based solutions for HealthCa re - UBB**	**Module 9 - AI-based solutions for SmartCit y - UCM**	**Module 10 - AI-based solutions for Industry - UNI**	**Module 11 - AI-based solutions in Robotics - UCGM**	**Module 12 - Applicatio n of other AI modules**
Recognize the breadth and utility of machine learning methods		x	x	x	x							
Compare and contrast machine learning methods		x	x	x	x	x	x	x	x	x	x	

Select appropriate (classes of) machine learning methods for specific problems.		x	x	x	x							
Use appropriate training and testing methodologies when deploying machine learning algorithms.		x	x	x	x							
Explain methods to mitigate the effects of overfitting and course of dimensionality in the context of		x	x	x	x							
machine learning algorithms.												

Identify an appropriate performance metric for evaluating machine learning algorithms/ tools for a given problem.		x	x	x	x							
Prepare a glossary of domain-specific terms to ensure shared understanding	x											x
Evaluate the data to ensure that it meets ethical requirements (with help from domain experts and	x					x	x	x	x	x	x	x

social scientists)												
Critical evaluation and assessment of the case studies						x	x	x	x	x	x	x
AI Ecosystems												
Review explainability techniques for AI models						x	x	x	x	x	x	x
Identify safety issues with AI models	x					x	x	x	x	x	x	x
Identify the technical determinants of racial, gender and	x					x	x	x	x	x	x	x

social biases in AI models												
Describe architectures for privacy-preserving AI deployments						x	x	x	x	x	x	x

VI. Conclusions

The **Applied Artificial Intelligence curriculum** provides a comprehensive, competency-based approach to developing both technical and adaptive skills necessary for effective AI application across diverse fields. With its modular design and competency matrix, the course ensures students progress systematically through foundational AI concepts, technical hard skills, and essential soft skills, equipping them for real-world problem-solving and innovation.

The Module-Competency Cross-Matrix reinforces this development by mapping specific competencies, hard skills, and soft skills to each module. This approach allows students to track their learning journey, recognize their strengths, and address areas for improvement. Through hands-on projects, case-based studies, and practical applications of AI tools, the curriculum supports mastery of key technical skills in data analysis, machine learning, and programming while emphasizing soft skills like critical thinking, communication, and teamwork.

This curriculum empowers students with a robust skill set, combining technical expertise with the adaptability to meet diverse industry challenges. By bridging AI theory with practical applications and ethical considerations, the AAI curriculum prepares students to become skilled AI practitioners who are equipped to lead and innovate in today's rapidly evolving technological landscape.

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