Proposal for New Undergraduate or Graduate Minor

CREATION OF:

1. x Undergraduate Minor   Graduate Minor

2. Name of the proposed minor: __Artificial Intelligence (AI)_____

3. Primary College: __LAS_____   Secondary College: _____

4. Involved Department(s): ___Computer Science_____

5. Name and email address of Administrator, Academic Unit or group originating the proposal:

   Name: J. Tian, S. Chaudhuri, P. Aduri, and H. Rajan

   email address: _ jtian@iastate.edu, chaudhur@iastate.edu, pavan@iastate.edu, hridesh@iastate.edu_____

6. **General description of the minor:**

   In recent years artificial intelligence (AI) has become a very active field with many commercial and scientific applications. As stated in the National Artificial Intelligence Research and Development Strategic Plan: 2019 Update: "Artificial intelligence presents tremendous opportunities that are leading to breakthroughs in improved healthcare, safer and more efficient transportation, personalized education, significant scientific discoveries, improved manufacturing, increased agricultural crop yields, better weather forecasting, and much more."

   This Undergraduate Minor in artificial intelligence is intended to enable students to compete for leading-edge positions with significant AI components. The target audience is undergraduate students with strong quantitative backgrounds who are interested in learning basic AI and machine learning techniques and applying AI methods to solve practical problems. The courses are designed to provide students with the knowledge and core skills needed to apply AI and machine learning techniques to address a wide range of practical problems.

   The Undergraduate Minor consists of 9 credit hours of core AI courses and 6 credit hours of elective AI-related courses. A detailed curriculum is provided in Appendix A.

   At this point, the program will be offered on campus only. The possibility of a fully online minor needs further investigation.

7. **Rationale for creation of this minor:**

There is a great demand for artificial intelligence scientists today both in Iowa and nationally, and the market is quickly growing. LinkedIn's 2020 Emerging Jobs Report names AI specialist as the job that saw the most growth in the past five years with average annual growth rate since 2015 to be 74% . Recognizing the importance of artificial intelligence, on February 11, 2019, the President signed Executive Order 13859 on Maintaining American Leadership in Artificial Intelligence, which established the American Artificial Intelligence Initiative - a whole-of-government approach for maintaining American leadership in AI.

Iowa State University is well positioned to fill the need due to its long history in data-driven sciences. Iowa State University's significant recent investments in the data science areas have further served to strengthen the university's capacity in AI and machine learning. This program is designed to prepare students with the knowledge and core skills needed to compete for leading-edge AI scientist positions.

8. **Objectives of the proposed minor including the student learning outcomes and how the learning outcomes will be assessed:**

The program will prepare students with the knowledge and core skills to enter the workforce as artificial intelligence scientists. These positions are in high demand today in industry, nonprofit sectors, and government.

Learning Outcomes
After successfully completing the program, students minoring in Artificial Intelligence will demonstrate

A. an understanding of the basic concepts, techniques, and applications of artificial intelligence,

B. an understanding of machine learning algorithms and their use in knowledge discovery,

C. an ability to design, implement, and evaluate intelligent agents for representative AI problems in problem-solving, planning, decision-making, and learning,

D. an understanding of the strengths and weaknesses of different AI algorithms (relative to the characteristics of the application domain), and

E. an ability to communicate effectively about AI problems, algorithms, implementations, and their experimental evaluation to stakeholders.
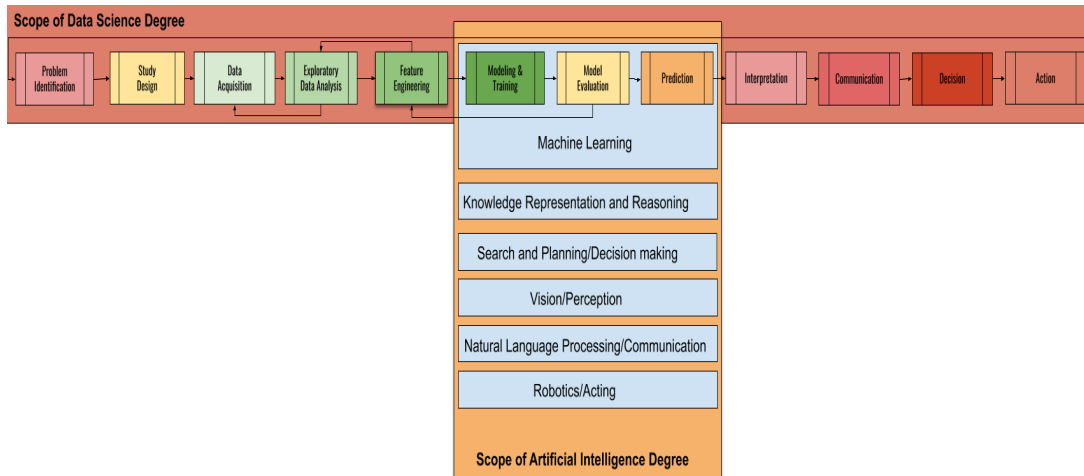
Assessment

The program will use the core AI courses and electives to assess that the learning outcomes are achieved as shown in the following table.

Outcome	Courses in which the outcome will be assessed
A	COM S 472: Principles of Artificial Intelligence COM S 474: Introduction to Machine Learning
B	COM S 474: Introduction to Machine Learning
C	COM S 472: Principles of Artificial Intelligence COM S 474: Introduction to Machine Learning COM S 477: Foundations of Robotics and Computer Vision
D	COM S 472: Principles of Artificial Intelligence COM S 474: Introduction to Machine Learning COM S 477: Foundations of Robotics and Computer Vision COM S 435: Algorithms for Large Data Sets: Theory and Practice
E	COMS 471: Responsible AI COM S 472: Principles of Artificial Intelligence COM S 474: Introduction to Machine Learning

9. **Relationship of the minor to other programs at Iowa State University:**

Iowa State University recently established an interdisciplinary minor in Applied Artificial Intelligence that focused on foundational knowledge for users of AI applications using low-code or no-code tools. This minor seeks to prepare students with strong quantitative backgrounds to use AI and machine learning techniques and applying AI methods to solve practical problems. As suggested in the Applied AI minor proposal, the goal of that minor was to prepare a student to drive a car; the goal of this Artificial Intelligence minor aims to prepare students to produce the car or perform work under the hood. There are no other programs at ISU that meet the overall objectives of the Undergraduate Minor in Artificial Intelligence. Employer needs and student interest support the need for a specific undergraduate minor program to provide a curriculum that will prepare students to work in this area of expertise. Iowa State established an undergraduate certificate, minor, and major in Data Science programs in 2016. The chart below helps illustrate the ways that the broad area of Data Science intersects with the depth area of Artificial Intelligence that is the focus of this undergraduate minor program.

Scope of Data Science Degree

Problem Identification · Study Design · Data Acquisition · Exploratory Data Analysis · Feature Engineering · Modeling & Training · Model Evaluation · Prediction · Interpretation · Communication · Decision · Action

Machine Learning

Knowledge Representation and Reasoning

Search and Planning/Decision making

Vision/Perception

Natural Language Processing/Communication

Robotics/Acting

Scope of Artificial Intelligence Degree

While Data Science focuses on topics ranging from study design to modeling to interpretation; artificial intelligence digs deeper into topics that enable computers or automated systems to perform tasks that historically have required human abilities. Data science and Artificial Intelligence have one commonality: machine learning, which focuses on methods of modeling and predictive data analysis – part of the Data Science pipeline. But AI also includes knowledge representation and reasoning, search and planning, vision, natural language processing, and robotics – methods that enable intelligent systems to perceive, reason, plan, learn, and act in complex environments.

Majors, minors, and/or individual courses in various ISU colleges, e.g. Computer Science, Electrical and Computer Engineering, Mechanical Engineering, Statistics, Business Analytics, Bioinformatics, etc., provide materials relevant and useful for those pursuing careers in AI but none provides the depth of coverage open to a wide range of students as does this proposed program.

10. **Relationship of the minor to the strategic plans of the university, of the college, and of department or program:**

Artificial Intelligence and its role in data-driven discovery is a priority area for Iowa State University. For example, ISU President's Destination 2050 initiative features Big Data as one of the six targets[1] in which AI will play an important role. Iowa State University's Presidential Initiative for Interdisciplinary Research has specifically targeted the Big Data area[2]. Artificial Intelligence is also linked to the strategic area of data science in the College of Liberal Arts & Sciences (LAS)[3].

11. **Comparison of the proposed minor with similar programs at other Regent's institutions:**

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[1] http://www.destination2050.iastate.edu
[2] https://www.news.iastate.edu/news/2016/09/07/presidentialresearch3
[3] https://news.las.iastate.edu/2017/01/11/college-of-liberal-arts-and-sciences-designated-as-recipient-of-one-of-iowa-state-universitys-largest-gifts/

University of Iowa offers BS in data science. This program consists of selected courses from the computer science statistics and mathematics. Data science focuses on a broad range of topics such as design, exploratory and descriptive data analysis, statistical methods, predictive data analysis and interpretation. AI digs deeper into topics that enable computers to perform tasks that historically required human abilities. In addition, AI covers topics such as knowledge representation, reasoning, robotics, NLP and big data algorithms.

University of Northern Iowa does not offer any similar degrees/minors.

12. Program requirements and procedures, including:

    a.   prerequisites for prospective students;

    b.   application and selection process;

    c.   language requirements (if applicable)

    d.   courses presently available for credit toward the program;

    e.   proposed new courses or modifications of existing courses;

    f.   advising of students;

An undergraduate student with a major in any discipline is eligible to obtain the undergraduate minor in AI. Students in the undergraduate computing majors, specifically, computer science, computer engineering, software engineering and data science, will find that their primary coursework matches well with the prerequisites and courses required for the minor. However, any undergraduate student with prerequisite knowledge is eligible. To take the courses in the minor, students would need Com S 311: Introduction to the Design and Analysis of Algorithms (or its equivalent) as prerequisite knowledge, a course required by all computing majors.

There is no formal application or selection process. To pursue the minor, the student must receive approvals from their academic advisor. All the proposed courses for the minor are currently available and no new courses are proposed.

Interested students who would like more information and advice about the minor should reach out to the computer science advisors.

13. General description of the resources currently available and future resource needs, in terms of:

    a.   faculty members;

    b.   computers, laboratories, and other facilities;

    c.   library facilities (journals, documents, etc.) in the proposed area;

    d.   supplies, field work, student recruitment, etc.

All the faculty in the computer science department are associated with the AI program and will teach the courses. Current computing facilities offered by the department of the computer science will suffice for students pursuing the minor.

14. **Describe the needs for new resources and/or reallocated resources.** Attach to the program proposal memos from the department chair(s), the college dean(s), and other appropriate persons, agreeing to the allocation of new resources and/or the reallocation of resources.

   This minor is built on existing courses so that no new resources are required to launch. Should the core courses become oversubscribed by students from computing-related majors who want to add the distinct learning outcomes of this minor to their program of study, the department and LAS College will navigate the need through existing course availability processes.

15. **Attach to the program proposal letters of support**, recommendations, and statements, when appropriate, from programs and departments at ISU which are associated with the proposed program or have an interest in the proposed program. Letters of support from external stakeholders may also be included.

   See attached letter from Associate Dean Arne Hallam, the convener of the Computer Curriculum Coordination Committee with representation from stakeholders from computational disciplines across campus.

16. If the new program is interdisciplinary, a governance document should be created and submitted to the Associate Provost for Academic Programs. Indicate here that it has been completed. N/A

APPENDIX A

Proposed Curriculum for Undergraduate Minor in AI

Department of Computer Science, Iowa State University

May 3, 2023

The minor is intended for students in the computing majors, specifically, computer science, computer engineering, software engineering and data science. To take the courses in the minor, students would need Com S 311 as a prerequisite, a course required by all computing majors.

Core courses: 9 credits

- PHIL 343: Philosophy of Technology
- COM S 472: Principles of Artificial Intelligence
- COM S 474: Introduction to Machine Learning

Electives: 6 credits of AI-related courses (tentative list, more courses to be added as appropriate)

- CPR E 419: Software Tools for Large Scale Data Analysis
- EE 424: Introduction to Digital Signal Processing
- EE 425: Machine Learning: A Signal Processing Perspective
- M E 425: Optimization Methods for Complex Designs
- M E 456: Machine Vision
- M E 475: Modeling and Simulation
- COM S 435: Algorithms for Large Data Sets: Theory and Practice
- COM S 476: Motion Planning for Robotics and Autonomous Systems
- COM S 477: Foundations of Robotics and Computer Vision
- STAT 474: Intro to Bayesian Data Analysis

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Dear Colleagues,

The Computer Curriculum Coordination Committee (CCCC) considered the Minor in Artificial Intelligence and the Minor in Applied Artificial Intelligence at the September and October 2023 meetings. The minors are designed for different audiences. The Minor in Applied Artificial Intelligence is intended for all students at ISU and how no prerequisites for the two core courses. Elective classes have few prerequisites or prerequisites consistent with majors in declared by students to also declare the minor. The Minor in Artificial Intelligence is intended for students with significant coursework and background in computer science. The two core courses COMS 4720: Principles of Artificial Intelligence and COMS 4740: Introduction to Machine Learning have cumulative prerequisites of

COMS 3110
STAT 3300 or STAT 3050 or STAT 3410 or STAT 3470 (all have MATH 1650 as prereq)
COMS 2300 or CPRE 3100
MATH 1660
COMS 2280
COMS 2270

Students majoring in COMS, SE and CprE meet these requirements. Other technical majors in Engineering and Business may also satisfy these requirements without taking courses not already part of their program.

The CCCC strongly supports both majors.

Arne Hallam
Associate Dean, College of Liberal Arts and Sciences
Convener of the CCCC

Academic Program Approval Voting Record

This document is to be appended as the last page of the proposal for any new or revised academic program to record the successive votes of approval as the proposal moves through its required review and approval steps. Consult Faculty Handbook Section 10.8 or the Faculty Senate Curriculum Committee website for information regarding Committee review and voting requirements for each action.

Curricular Action: (check appropriate boxes below)

1. x New Program □ Name Change □ Discontinuation □ Concurrent Degree for:

2. □ Undergraduate Major □ Graduate Major x Undergraduate Minor □ Graduate Minor

   □ Undergraduate Certificate □ Graduate Certificate □ Other: _____

3. Name of Proposed Change: Undergrad Minor in Artificial Intelligence

4. Name of Contact Person: _J. Tian_____ e-mail address: jtian@iastate.edu

5. Primary College: _LAS_____ Secondary College: _____

6. Involved Department(s): _Computer Science_____

Voting record for this curricular action:

Voting Body	Votes For	Against	Abstain	Date of Vote
Computer Science Dept	31	0	1	5/4/2023
LAS College Curriculum Committee	8	0	0	March 1, 2024
College Approval Vote:				
--Faculty Representative Assembly	24	0	0	March 26, 2024
Graduate Council				
Faculty Senate Curriculum Committee	6	0	0	April 4, 2024
Faculty Senate Academic Affairs Council	9	0	0	April 22, 2024
Faculty Senate				

[FSCC – November 2013]