

PROGRAM APPROVAL PROCESS
(Revised January 28, 2015)

Highlights of the Program Approval Process:

- The Regent universities shall submit an annual program planning list to the Board Office in the spring of each year, which includes the name and educational level of proposed programs that have already undergone an initial institutional review, are currently undergoing an in-depth institutional review, and are likely to be submitted for program approval by the Board of Regents within the year. The proposed program must reside on the program planning list for at least six months prior to submitting a program proposal to allow sufficient time for discussion within the three Regent universities.
- The Board Office and the Council of Provosts shall review the annual program planning list at each Council of Provosts meeting.
- During the year, the universities shall complete their in-depth review of the proposed programs and submit their proposals to the Board Office using a program approval format developed by the Board Office (Form A). The form incorporates the key characteristics of a proposed program critical for Board decision-making – immediate and long-term need/demand for the program, cost to implement and operate the program, link to the institution’s and Board’s strategic plans, and potential for unnecessary duplication. Workforce data must include recent projections.
- Letters of support must be included with the program proposal. The staff member requesting the letters of support from the other two universities must send a copy of the request to the provosts at the other universities.
- A review by the Iowa Coordinating Council for Post-High School Education (ICCPHSE) shall also occur prior to being submitted for Board approval. A program with unresolved concerns by the ICCPHSE should be so noted.
- The program proposals shall be reviewed in-depth by the Council of Provosts and the Board Office.
- With the recommendation for approval by the Board Office and the Council of Provosts, the program proposal shall be submitted to the Board of Regents Education and Student Affairs Committee and Board of Regents for discussion and action.
- Substantial expenditures for the proposed program or advertising/marketing of the proposed program shall not occur until after the program is approved by the Board of Regents. This means that the institutions shall not hire any new faculty, secure facilities, develop curriculum, or advertise the program until it has been approved by the Board of Regents.

FORM A
Board of Regents, State of Iowa

**REQUEST TO IMPLEMENT A NEW BACCALAUREATE, MASTERS,
DOCTORAL, OR FIRST PROFESSIONAL DEGREE PROGRAM**
January 28, 2015

THE PURPOSE OF ACADEMIC PROGRAM PLANNING: Planning a new academic degree program provides an opportunity for a Regent university to demonstrate need and demand as well as the university's ability to offer a quality program that is not unnecessarily duplicative of other similar programs offered by colleges and universities in Iowa.

Institution: Iowa State University

CIP Discipline Specialty Title: AI Developer, AI Scientist, AI Architect

CIP Discipline Specialty Number (six digits): 11.0102

Level: B _____ M Master's D _____ FP _____

Title of Proposed Program: Artificial Intelligence

Degree Abbreviation (e.g., B.S., B.A., M.A., Ph.D.): M.S.

Approximate date to establish degree: Month August Year 2020

Contact person: (name, telephone, and e-mail) Jin Tian (jtian@iastate.edu),
Hridesh Rajan (hridesh@iastate.edu)

College that will administer new program: College of Liberal Arts and Sciences

Please provide the following information (use additional pages as needed). Do not use acronyms without defining them.

1. Describe the proposed new degree program, including the following:
 - a. A brief description of the program. If this is currently being offered as a track, provide justification for a standalone program.

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 Master of Science degree program in artificial intelligence is intended to enable students to compete for leading-edge positions with significant AI components. The target audience is graduate 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 M.S. in Artificial Intelligence consists of 9 credits hours of core AI courses, 9 credit hours of depth requirements, 6 credit hours of electives on AI related topics, 3 credits of advanced AI topics courses at the 600-level, 1 credit hour in a research colloquia course, and a Creative Component on which a final oral examination is required. A detailed curriculum including a two-year plan is provided in Appendix A.

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

- b. A statement of academic objectives;

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 majoring 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 when needed, design variants of existing algorithms, and
- E. an ability to communicate effectively about AI problems, algorithms, implementations, and their experimental evaluation to stakeholders.

Assessment

To assess, in part, that the learning outcomes for the M.S. in Artificial Intelligence are achieved, the proposed program will use the core AI courses and depth requirements as well as a Creative Component that requires a final oral examination, as shown in Table 1. Two new courses COM S 579x: Introduction to Natural Language Processing and COM S 536x: Introduction to Computer Vision will be created. Their descriptions are attached to this program proposal. The course proposals will be submitted in Spring 2020 for approval.

Outcome	Courses in which the outcome will be assessed
A	COM S 572: Principles of Artificial Intelligence COM S 573: Machine Learning COM S 574: Introduction to Machine Learning
B	COM S 573: Machine Learning COM S 574: Introduction to Machine Learning COM S 578: Optimization for Machine Learning
C	COM S 572: Principles of Artificial Intelligence COM S 573: Machine Learning COM S 574: Introduction to Machine Learning COM S 579x: Introduction to Natural Language Processing COM S 536x: Introduction to Computer Vision
D	COM S 572: Principles of Artificial Intelligence COM S 573: Machine Learning COM S 574: Introduction to Machine Learning
E	COM S 572: Principles of Artificial Intelligence COM S 573: Machine Learning COM S 574: Introduction to Machine Learning COM S 599: Creative Component

c. What the *need* for the program is and how the need for the program was determined;

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%¹. 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

¹ <https://www.cnbc.com/2019/12/11/linkedin-emerging-jobs-report-2020-fastest-growing-us-job-pays-136k.html>
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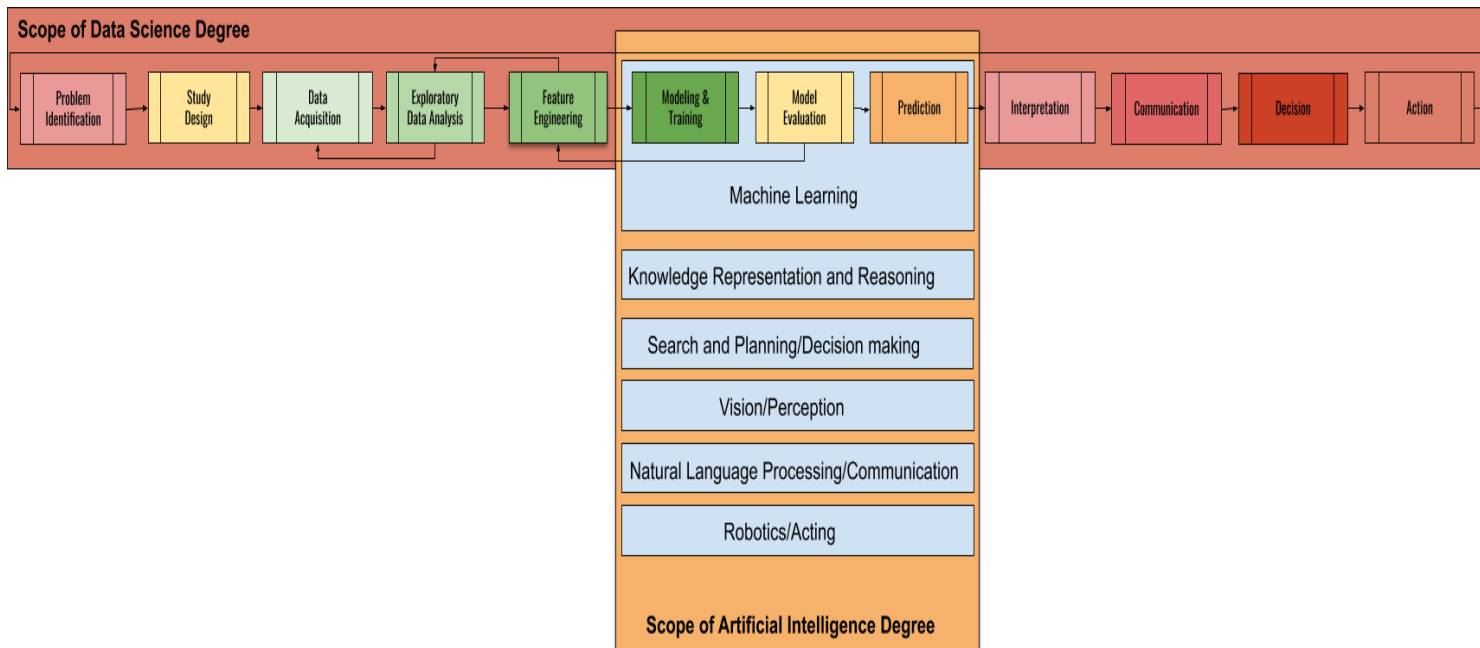
positions.

- d. The relationship of the proposed new program to the institutional mission and how the program fits into the institution's and college's strategic plan;

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 targets² in which AI will play an important role. Iowa State University's Presidential Initiative for Interdisciplinary Research has specifically targeted the Big Data area³. Artificial Intelligence is also linked to the strategic area of data science in the College of Liberal Arts & Sciences (LAS)⁴.

- e. The relationship of the proposed new program to other existing programs at the institution; describe how the proposed program will enhance other programs at the university. Will the proposed program duplicate existing programs at the university?

There are no other graduate programs at ISU that meet the overall objectives of the M.S. in Artificial Intelligence degree. AI is currently an area of emphasis within the existing M.S. in computer science; employer needs and student interest support the need for a specific graduate degree 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 established 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 graduate degree program.



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

² <http://www.destination2050.iastate.edu>

³ <https://www.news.iastate.edu/news/2016/09/07/presidentialresearch3>

⁴ <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/>
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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.

ISU has an interdisciplinary graduate degree program in Business Analytics housed in the Ivy College of Business. Compared to Business Analytics, which focuses on business applications of analytics techniques. The MS degree in Artificial Intelligence is a computer science degree that digs deeper into topics that enable computers to understand and make predictions and also considers broader applications e.g. AI for scientific discovery. Majors, minors and/or individual courses in various ISU colleges, e.g. Computer Science, 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.

We believe this proposed new program will attract new students into ISU. For instance, during a recent international university visit, we had several inquiries about whether we have an AI MS degree, which ultimately led to this proposal.

- f. The relationship of the proposed new program to existing programs at other colleges and universities in Iowa, including how the proposed program is different or has a different emphasis than the existing programs.

As of this writing, there are no such programs at the Regent's universities in Iowa. The University of Iowa (UoI) has a graduate program in business analytics, Compared to UoI Business Analytics, that focuses on business applications of analytics techniques, the MS degree in Artificial Intelligence digs deeper into topics that enable computers to understand and make predictions and also considers broader applications e.g. AI for scientific discovery. The University of Iowa also has an undergraduate degree in data science that consists of a carefully selected list of courses from the Statistics and Computer Science courses at the university. Data Science is different from AI as described in response to question 1.e.

The University of Northern Iowa doesn't currently have any related programs.

Luther College, a private liberal arts college in Iowa, also created a Data Science Major and a Minor degree in 2016. This Data Science Major's core consists of ten courses out of which six are computer science courses, two are statistics courses, and three are subject matter courses (equivalent to "application areas" in this proposal). As discussed above in 1.e. Data Science and Artificial Intelligence have emerged as separate and distinct disciplines. Also, this proposal is for a graduate degree in artificial intelligence

- g. Special features or conditions that make the institution a desirable, unique, or appropriate place to initiate such a degree program.

Iowa State University (ISU) has a longstanding history in data driven discovery and artificial intelligence is playing a major role to that end. In recent years, Iowa State University has placed great emphasis on developing expertise in artificial intelligence, e.g. AI meetings organized by the Office of ISU Vice President of Research. In addition to this focus from central administration, Artificial Intelligence is part of the constellation of research and study linked to Big Data, one of the strategic areas in several ISU colleges and academic units including the College of Liberal Arts and Sciences⁵. These activities have collectively prepared the university to develop educational programs in Artificial Intelligence over the last decade.

⁵ <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/M.S. in AI>

- h. Are the university's personnel, facilities, and equipment adequate to establish and maintain a high quality program?

Current facilities and equipment are adequate to establish and maintain a high-quality program. The Department of Computer Science has over 110 PhD students and 60 MS students. The department has well-established processes for graduate application evaluation, mentoring and advising for MS students, as well as career advising for MS students. The MS in AI program will leverage these resources. Additional hires (as discussed in items 11 and 13) would need to be made as well.

- i. How does student demand for the proposed program justify its development?

As stated in 1.c above, there is great demand for AI scientists in academia, industry, non-profit sectors, as well as government. For example, a report from job search site Indeed in March 2018 showed that employer demand for AI-related roles has more than doubled over the previous three years⁶. Also see item 2 in the following. This program can train students to fill this need. While student demand already exists as evidenced by creation of similar programs across the United States, further demand from incoming graduate students at Iowa State University will be developed by raising awareness about the program and about the job opportunities available to AI majors. By providing a program devised to meet the demand for AI scientists, and promoting the program, a derived demand for admission to the program will result.

2. Describe the state and/or national workforce need and/or demand for graduates of the proposed program currently and in the foreseeable future (provide documentation about the current sources of data used to estimate need and demand).

A report from job search site Indeed in March 2018 showed that employer demand for AI-related roles has more than doubled over the previous three years. AI job postings on Indeed from May 2018 to May 2019 increased by 29.1% over the same period a year earlier, and Machine learning engineer commands an average salary of \$142,858.57⁷. According to the Chief Data Officer of LinkedIn, "AI skills are among the fastest-growing skills on LinkedIn, and saw a 190% increase from 2015 to 2017", and AI skills are growing in every industry and are quickly spreading beyond the tech industry⁸. According to a Gartner report in December 2017⁹, "AI Will Create 2.3 Million Jobs in 2020, While Eliminating 1.8 Million", and "By 2022, one in five workers engaged in mostly nonroutine tasks will rely on AI to do a job".

3. List all other public and private institutions of higher education in Iowa currently operating programs similar to the proposed new degree program. (For comparison purposes, use a broad definitional framework, e.g., such identification should not be limited to programs with the same title, the same degree designation, having the same curriculum emphasis, or purporting to meet exactly the same needs as the proposed program.)

As mentioned previously, there are no similar programs at institutions of higher education in Iowa (see Items 1e and 1f for discussion of loosely related undergraduate programs at the University of Iowa and Luther College).

If the same or similar program exists at another public or private institution of higher education in Iowa, respond to the following questions:

⁶ <https://www.hiringlab.org/2018/03/01/demand-ai-talent-rise/>

⁷ <http://blog.indeed.com/2019/06/28/top-10-ai-jobs-salaries-cities/>

⁸ <https://www.weforum.org/agenda/2018/09/artificial-intelligence-shaking-up-job-market/>

⁹ <https://www.gartner.com/en/newsroom/press-releases/2017-12-13-gartner-says-by-2020-artificial-intelligence-will-create-more-jobs-than-it-eliminates>

- a. Could the other institution reasonably accommodate the need for the new program through expansion? Describe collaboration efforts with other institutions.

No similar programs exist at comparable quality and cost in the State of Iowa (see Items 1e and 1f).

- b. With what representatives of these programs has there been consultation in developing the program proposal? Provide a summary of the response of each institution consulted.

An informal e-mail describing our interest in creating an MS degree in Artificial Intelligence along with degree program requirements was sent to both the Computer Science faculty at the University of Iowa and the Computer Science faculty at the University of Northern Iowa for comments and suggestions on December 4, 2019. A positive letter of support from the University of Northern Iowa, Department of Computer Science was received on December 9, 2019. A response from the University of Iowa is expected soon and the department will notify the curriculum committee when these responses are received.

- c. Has the possibility of an inter-institutional program or other cooperative effort been explored? What are the results of this study? (Consider not only the possibility of a formally established inter-institutional program, but also how special resources at other institutions might be used on a cooperative basis in implementing the proposed program solely at the requesting institution.)

We have not explored the possibility of an inter-institutional program. Graduate students generally want to attend a particular institution and as a result, we do not believe there is anything to be gained from an inter-institutional program. However, if a student in our Artificial Intelligence program takes or has taken a class at either the University of Iowa or the University of Northern Iowa that is a direct substitute for one of the classes required for our program, we will allow that substitution if it meets our university and college policies for such substitutions.

- d. Do other colleges in Iowa offer programs similar to the proposed program at comparable quality and cost?

There are no similar programs at comparable quality and cost.

- e. Are letters of support included with the program proposal?

TODO: Letters of support are included from the Deans of the appropriate colleges at the University of Iowa and the University of Northern Iowa. Additional support letters are provided from within Iowa State University and from Industry.

4. Estimate the number of majors and non-majors students that are projected to be enrolled in the program during the first seven years of the program.

- a. Undergraduate

This is a graduate program.

- b. Graduate

The table below presents anticipated number of majors in the program.

Table 1: Anticipated Number of AI Majors

Graduate	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
Majors – Year 1	5	10	15	20	25	30	35

Majors – Year 2		5	10	15	20	25	30
Majors – Year 3			1	2	4	4	4
Total	5	15	26	37	49	59	69
Non-Majors	0	0	0	0	0	0	0

This projection assumes that the program will see an initial enrollment of 5 students, and the number of first year students would increase by five during years 2-6. Subsequently, a steady state enrollment of about 40 new students per year is anticipated.

We anticipate 2-3 students to transfer from other programs per year. We also estimate that about five students might take longer than two years to complete the program, which is a conservative estimate. Beyond year 8, a steady state enrollment of 80 graduate students is anticipated.

c. What are the anticipated sources of these students?

A majority of these students will be new students from the state of Iowa, neighboring states, and international students who are currently not considering Iowa State University as a destination because Iowa State University doesn't have an MS Degree in Artificial Intelligence. We believe this proposed new program will attract new students into ISU. For instance, during a recent international university visit, we had several inquiries about whether we have an AI MS degree. Some students will also transition from MS degree in various ISU colleges. There is a possibility that a small number of majors will transition from existing ISU graduate programs such as Computer Science.

5. If there are plans to offer the program away from the campus, briefly describe these plans, including potential sites and possible methods of delivery instruction. Will off-campus delivery require additional **HLC accreditation**?

At this point the program will be offered on campus only. The possibility of an online degree needs further investigation.

6. Has the proposed program been reviewed and approved by the appropriate campus committees and authorities?

The program is approved by the graduate committee in Department of Computer Science, and the faculty in the Department of Computer Science on December 4, 2019. The program was discussed at the Computer Curriculum Coordination Committee on December 3, 2019 and received favorable review. The program approval by the LAS Curriculum Committee, Graduate Council, Faculty Senate Curriculum Committees, the Faculty Senate, the Provost and the President is pending.

7. List date the program proposal was submitted to the Iowa Coordinating Council for Post High School Education (ICCPHSE) and results of listserv review.

Note: will be completed by the Provost Office.

8. Will the proposed program apply for programmatic accreditation? When?

At the time of this writing, accreditation bodies for Artificial Intelligence programs have not emerged. The MS degree in Artificial Intelligence will be included as part of Iowa State University Higher Learning Commission (HLC) accreditation in the next cycle. Once the Artificial Intelligence M.S. degree is well established, we will discuss with our industry partners and with members of our College of Liberal Arts and Sciences advisory councils whether the pursuit of additional accreditations would be worthwhile.

9. Will articulation agreements be developed for the proposed program? With whom?

We will continue to honor any course level articulation agreements with community colleges that are in place at Iowa State University. Program-level articulation agreements are not planned.

10. Will there be opportunities for student internships?

This is a graduate program that doesn't have any internship requirements; however, we do anticipate encouraging students to avail themselves of internship opportunities in their first summer. Given the demand for Artificial Intelligence Experts (see Item 1.c and Item 2), there should be ample opportunities for internships both within Iowa and outside Iowa. The program will leverage LAS career services, and well-established venues such as the LAS Career Fair and the Engineering Career Fair to connect students with potential employers. The existing alumni network of LAS established from such majors as Computer Science and Statistics will also be leveraged.

11. Describe the faculty, facilities, and equipment that will be required for the proposed program.

Faculty members

Faculty positions for teaching the existing courses listed in appendix will continue to be needed to sustain this degree program. As enrollment expands, new resources or reallocation of available resources will be necessary.

The College of Liberal Arts and Sciences (LAS) will work with the department to support the development and teaching of the two new Artificial Intelligence courses listed in Appendix A (see item 13).

Revenue generated from teaching the new Artificial Intelligence courses and increased enrollment in other courses is anticipated to offset the expended resources. Resources may come from new revenues or reallocation of existing funds within the relevant units.

To the extent that faculty members outside of LAS are involved in teaching the core courses and electives, other colleges will need to provide the resources to support those faculty members.

Computers, laboratories, and other facilities

Existing facilities associated with existing courses, e.g., AI electives will continue to be used. As the program expands there may be a need for new computer/statistics lab facilities. The Iowa State University Computation Advisory Committee (CAC) has the responsibility of overseeing the expenditure of the Student Technology fee. The program will apply for CAC/LASCAC funds to cover additional expenses associated with computers and undergraduate personnel.

Research facilities

No new research facilities are needed.

Library facilities (journals, documents, etc.) in the proposed area

No new resources needed.

Supplies, field work, student recruitment, etc.

While this program doesn't have significant supply needs at this time, a small supply budget will be required for various needs, such as printing information brochures to be used at college orientation events to recruit for the degree program.

12. From where will the financial resources for the proposed program come (list all that apply, e.g., department reallocation, college reallocation, grants, new to the university)?

Iowa State University utilizes a decentralized financial management model for the development of its annual operating budgets. The Resource Management Model (RMM), is a responsibility-centered and incentive-driven approach to financial planning and management. The model

supports departments and colleges in making budgetary decisions that enhance student success (e.g., retention), innovate by meeting market demands from students and employers for degree programs of the future, and discontinue legacy curricula which are either not aligned with industry/employer needs or for which student demand is low. Through the RMM, for graduate and professional students, net tuition revenue is allocated to academic colleges based on a student's enrollment. Tuition revenue will include both base tuition and applicable differential rates. The proposed degree program will be funded through this existing, proven financial model, and is expected to be fully self-sustaining over time. In addition to the budget model as described, financial resources may also come from internal reallocations made within the college during the program's startup phase. The level of reallocation will depend, in part, on the numbers of new students attracted to the proposed program, and the number of existing students who choose the proposed program over another program, based on standard and differential tuition rates. The proposed program will not be dependent on grants, contracts, gifts, central university resources, or reallocations between academic colleges.

13. Estimate the total costs/total new costs (incremental increases in expenditures) that will be necessary for the next seven years as a result of the new program. Be as specific as possible.

Table 2: Total Costs and Incremental Increases in Expenditures

	TOTAL COSTS	TOTAL NEW COSTS
Year 1	100,000	100,000
Year 2	253,750	153,750
Year 3	360,556	106,806
Year 4	365,965	5,408
Year 5	421,454	55,489
Year 6	427,776	6,322
Year 7	434,193	6,417

The estimates (under discussion with the College of the LAS) presented in the table above are based on the following assumptions. In Year 1 a new tenure track faculty member will be hired to teach artificial intelligence related courses such as COM S 572 and COM S 573 and develop COM S 536 and COM S 579. The total new costs reflect average LAS salary and benefits for a new tenure track faculty member. In Year 2 a dedicated graduate program coordinator for the AI program would be hired. The total new costs reflect average LAS salary and benefits for a graduate program coordinator as well as misc. cost such as supplies. In Year 2 and Year 3 one new tenure track faculty member will be hired each year to help teach core and depth artificial intelligence related courses such as COM S 536 and COM S 579 and to teach multiple sections of core courses. A 1.5% yearly inflation in costs is assumed. In Year 5 a lecturer for the AI program would be hired to offer additional sections of AI courses. The program is also expected to generate revenues, and a significant portion of these costs would be offset by the new revenue. The \$150,000 in Item 12 (see line "Year 7") is from reallocation of existing funds; the remaining \$284,193 is expected to come from increased enrollment.

14. Describe the marketing plan developed to communicate the new program and recruit students.

The Office of Admissions will incorporate this new program into the overall marketing strategy for student recruitment. The program will be included in print materials, websites, and other marketing strategies to attract students from within the state, from across the country and globally. The program will also be included in the appropriate college and departmental recruiting materials, websites, and outreach programs. This program will also be advertised by the LAS international advisers during the international recruiting visit conducted by the Office of Admissions.

15. Describe the program evaluation plan to determine if the program is meeting the intended objectives, if the expected student enrollment has occurred, funding for the program, and any other components that affect the effective operation of the program.

This program will be incorporated into the university's normal academic review process. That review process assesses whether the program is achieving its mission, providing high quality academic experiences, and fulfilling the enrollment and success metrics identified for the program. In addition to the academic program review, as a part of the college budgeting process the program will be monitored annually for achievement of enrollment goals.

16. Include any additional information that justifies the development of this program.

Appendix A: CURRICULUM

Core Courses

COM S / CPR E 511	Design and Analysis of Algorithms	3
COM S 572	Principles of Artificial Intelligence	3
COM S 573	Machine Learning	3
Total		9

Depth Requirements: at least 9 credits of courses from the following 9

COM S 574	Introduction to Machine Learning	3
COM S / CPR E / HCI 575	Computational Perception	3
COM S 579x	Introduction to Natural Language Processing	3
COM S 578	Optimization for Machine Learning	3
COM S 536x	Introduction to Computer Vision	3

Advanced Topics: At least 3 credits of courses from the following 3

COM S 612	Distributed Algorithms	3
COM S / CPR E 626	Parallel Algorithms for Scientific Applications	3
COM S 634	Theory of Games, Knowledge and Uncertainty	3
COM S 672	Advanced Topics in Computational Intelligence	3
COM S 673	Advanced Topics in Computational Models of Learning	3

ELECTIVES: at least 6 credits on AI related topics (some representative courses are listed below. This list will be periodically updated.) 6

CE 650C	C E 650C: Advanced Topics in Transportation: System Data Analytics	3
EE 526X	Deep Machine Learning: Theory and Practice	3
IE 583	Knowledge Discovery and Data Mining	3
CPRE 560	Data-Driven Security and Privacy	3
ME 592X	Data Analytics and Machine Learning for Cyber- Physical Systems Applications	3
COM S 535	Algorithms for Large Data Sets: Theory and Practice	3
STAT 502	Applied Modern Multivariate Statistical Learning	3
ENGL / HCI / LINQ 515	Statistical Natural Language Processing	3
MIS 546	Advanced Business Analytics	3
A B E 506	Applied Computational Intelligence	3

Research Colloquia: COM S 592: Research Colloquia. 1

Creative Component: COM S 599: Creative Component 3

TOTAL 31

M.S. Degree in Artificial Intelligence: A Sample Two-year Plan

Semester 1: 6 credits

COM S 511: Design and Analysis of Algorithms

COM S 572: Principles of Artificial Intelligence

Semester 2: 10 credits

COM S 573: Machine Learning

COM S 592: Research Colloquia

6 credits from the following:

COM S 575: Computational Perception

COM S 672: Advanced Topics in Computational Intelligence

COM S 673: Advanced Topics in Computational Models of Learning

Semester 3: 9 credits

6 credits from the following

COM S 579x: Introduction to Natural Language Processing

COM S 578: Optimization for Machine Learning

COM S 536x: Introduction to Computer Vision

3 credits from the following

A B E 506: Applied Computational Intelligence

MIS 546: Advanced Business Analytics

Semester 4: 6 credits

COM S 599: Creative Component

3 credits from the following

CPR E 560: Data-Driven Security and Privacy

IE 583 Knowledge Discovery and Data Mining

STAT 502: Applied Modern Multivariate Statistical Learning

Description of New Artificial Intelligence Courses

COM S 579x: Introduction to Natural Language Processing. Cr. 3-0. F.S.

Prerequisites: *COM S 311, COMS 573*

Description:

Introduction to concepts and techniques for automatically processing and understanding natural language with computers; language model; Part-of-Speech tagging; machine learning approaches to natural language processing; neural language models; selected applications in automatic speech recognition, information extraction, question answering and summarization, and machine translation; hands-on experience.

Course outcomes/objective:

After completing this course, students should be able to:

1. Understand various NLP tasks
2. Understand key concepts in NLP
3. Apply machine learning techniques to solve representative NLP tasks
4. Evaluate NLP models
5. Communicate effectively about NLP algorithms, implementations, and evaluation to stakeholders

Course content/major topics to be addressed:

Major topics include:

- Introduction – What is Natural Language Processing? Motivating case studies.
- N-gram language model
- Part-of-Speech tagging
- Machine learning for NLP
 - Hidden Markov Models
 - Deep Learning
 - Neural language models
 - Word embedding
 - Topic models
- Applications
 - automatic speech recognition
 - information extraction,
 - question answering and summarization
 - machine translation
- Hands-on experience

COM S 536x: Introduction to Computer Vision. Cr. 3-0. F.S.

Prerequisites: *COM S 311, COMS 573*

Description:

Introduction to basic concepts, techniques, and applications of computer vision, including image processing methods such as filtering and edge detection, image segmentation, 3D reconstruction, and image recognition tasks such as object recognition, face detection, category recognition, and scene understanding; hands-on experience in vision applications.

Course outcomes/objective:

After completing this course, students should be able to:

1. Understand key concepts in computer vision
2. Understand the basics of 2D and 3D Computer Vision
3. Understand the major technical approaches in computer vision
4. Apply computer vision techniques to solve vision tasks such as objection recognition and face detection
5. Communicate effectively about computer vision systems to stakeholders

Course content/major topics to be addressed:

Major topics include:

- Introduction – What is computer vision? Motivating case studies.
- Image processing
 - Filtering
 - Fourier transforms
 - edge detection
- Image segmentation
- 3D reconstruction
- Image recognition
 - object recognition
 - face detection
 - category recognition
 - scene understanding
- Hands-on experience in vision applications

Appendix B: Communication with Regents Institutions in Iowa



Department of Computer Science

305 Innovative Teaching &
Technology Center
Cedar Falls, Iowa 50614-0507

319-273-2618
Fax: 319-273-7123

Web: www.cs.uni.edu
E-mail: dept@cs.uni.edu

December 9, 2019

Dear Dr. Rajan,

I am pleased to write to you in support of the proposed M.S. program in Artificial Intelligence to be offered by the Department of Computer Science at Iowa State University.

There is a growing need in Iowa industries for knowledge workers with expertise in AI and its many applications, including machine learning, language processing, and reasoning in the face of uncertainty. The proposed curriculum includes both breadth and depth in AI and terminates in a creative project where students can demonstrate their knowledge and solve a problem of importance.

The Department of Computer Science at the University of Northern Iowa can certainly recommend this program to its graduates who seek more background in Artificial Intelligence before going into industry.

Sincerely,

A handwritten signature in cursive script that reads "Eugene Wallingford".

Eugene Wallingford, Head

Appendix C: Support Letter from Iowa Employers

400 Collins Rd. NE
MS: 133-101
Cedar Rapids, IA 52498
Phone: 319-295-3078
Email: joni.wallace@collins.com
www.collinsaerospace.com



Collins Aerospace
A United Technologies Company

Joni Wallace
Assoc. Director, Artificial Intelligence
Collins Aerospace, Inc.

December 6, 2019

Dr. Hriday Rajan
Kingland Professor and Interim Department Chair
Professor-In-Charge, ISU Data Science Program
Department of Computer Science
Iowa State University of Science and Technology

Dear Dr. Rajan,

I lead the Machine Learning (ML) and Artificial Intelligence (AI) Services for Collins Aerospace, a \$23B company with 70,000 employees. My company is making significant financial investment in ML and AI, from GPU compute hardware in our data centers processing algorithms such as deep hierarchical reinforcement learning models to an expanded staff running 24x7 automated AI workflows and associated AI dev-ops processes.

Your proposal to create a new Master's of Science in Artificial Intelligence has my enthusiastic support for many reasons. First, while we are a global company, our AI Lab and AI Engineering development staff are based in Cedar Rapids, Iowa. My team consists of 18 individuals, including full-time, part-time interns, co-ops, UTC Digital Technology Leadership Program rotates and offshore support teams. I am frequently looking for talent with formal education as I've recently expanded my team roles from ML/AI generalists to specialists focused on AI research, AI data processing, AI interfaces, AI center of excellence, AI production support and AI operations under five new managers. Second, along with my team focused on deep learning, there are hundreds of employees performing data analytics and basic machine learning at Collins Aerospace. Many of these employees are upskilling in the areas of data science, machine learning and just starting with deep learning. My strategy is to influence and expand the amount of citizen developers and augment my staff with a strong set of citizen machine learning analysts in our business units. This would be a population of hundreds of individuals who could take advantage of the generous Collins Aerospace tuition reimbursement program for upskilling in ML/AI. Finally, each day our company recognizes the value of applying algorithms to solve new business problems so my strategy and roadmaps are continually expanding. For example, we are augmenting our current internal use cases with externally-focused use cases selling AI-enabled data products. This requires a new way of thinking beyond our current norms.

I look forward to collaborating with you in the future and supporting your MS in AI program in any way I can. If you share an address that can accept packages, I'm happy to have my administrative assistant send you a Nvidia Jetson Nano Developer Kit for your students. My 2019 summer interns used the kit to build an autonomous jetbot and conducted a road race to end their internship in our AI lab. This extended skills in Python, deep CNN's, synthetic data, deployed AI at an edge device while sparking ideas of smart factories and industry 4.0.

Best Regards,
Joni Wallace

Appendix D: Support Letter from the Managing College