Master of Science in Artificial Intelligence

Dec. 6, 2023
Why and Why Now?

• Although “Artificial Intelligence” has a long history dating back to 1956, it has recently been democratized and broadly adopted.

• AI is pivotal in transforming existing disciplines, empowering new industries, and reimaging jobs:
  • Breakthroughs in science and engineering, augmenting human capabilities from medicine to learning, automation for increased efficiency and productivity, new innovations & markets

• Job Market Opportunities:
  • 2 million unfilled AI jobs (Bureau of Labor Statistics)
  • $111,118 average base pay for AI job (Glassdoor Economic)
  • 83% of businesses say AI is their strategic priority (Forbes)
  • $15.7 trillion contribution to global economy by 2030 (PWC)

• With looming “Enrollment Cliff”, degree offerings that could attract new students are important for WPI.
Why WPI?

• With WPI being a technological institution, “preparing young people for emerging careers” is central to our mission and future [John Boynton].

• WPI is uniquely poised to contribute due to our tremendous investments and successes in AI faculty, curriculum, research and disciplines.

• WPI leadership selected AI as strategic direction.
What?

- Train students in the understanding, development, deployment and innovation of AI techniques and systems in a responsible fashion for economic growth & betterment of society
What?

- Train students in the understanding, development, deployment and innovation of **AI techniques and systems** in a **responsible fashion** for economic growth & betterment of society.

- This degree proposal is a **nimble start** for WPI to quickly offer a (**technical**) **AI degree**, but it is the **very beginning only** . . .
What?

- Train students in the understanding, development, deployment and innovation of **AI techniques and systems** in a **responsible fashion** for economic growth & betterment of society

- This degree proposal is a **nimble start** for WPI to quickly offer a **(technical) AI degree**, but it is the **very beginning only . . .**
What?

• Train students in the understanding, development, deployment and innovation of AI techniques and systems in a responsible fashion for economic growth & betterment of society

• This degree proposal is a nimble start for WPI to quickly offer a (technical) AI degree, but it is the very beginning only . . .
• Train students in the understanding, development, deployment and innovation of AI techniques and systems in a responsible fashion for economic growth & betterment of society.

• This degree proposal is a nimble start for WPI to quickly offer a (technical) AI degree, but it is the very beginning only as we move towards “AI-for-all”.

What?
CIP Code 11.0102
Title: Artificial Intelligence.
Definition: A program that focuses on the symbolic inference, representation, and simulation by computers and software of human learning and reasoning processes and capabilities, and the computer modeling of human motor control and motion. It includes instruction in computing theory, cybernetics, human factors, natural language processing, and applicable aspects of engineering, technology, and specific end-use applications.
CIP Code 11.0102

Title: Artificial Intelligence.

Definition: A program that focuses on the symbolic inference, representation, and simulation by computers and software of human learning and reasoning processes and capabilities, and the computer modeling of human motor control and motion. It includes instruction in computing theory, cybernetics, human factors, natural language processing, and applicable aspects of engineering, technology, and specific end-use applications.
Structure of Proposed MS in Artificial Intelligence

Total: 30 credits

• Five core AI bins required (15 credits)
  • Artificial Intelligence Bin (at least 3 credits)
  • Ethics & AI Bin (at least 3 credits)
  • Machine Learning Bin (at least 3 credits)
  • Knowledge & Reasoning Bin (at least 3 credits)
  • Interaction & Action Bin (at least 3 credits)

• Capstone experience required (3 or 9 credits)
  • Graduate Qualifying Project in AI (3 credits), or
  • Master's Thesis in AI (9 credits)

• Remaining credits:
  • Additional core AI bin courses (any # of credits),
  • AI-related special topics, ISP, and DR (any # of credits)
  • AI-related preparatory courses (at most 6 credits), and/or
  • Thematically-related courses in any discipline at WPI* (at most 6 credits)
Structure of Proposed MS in Artificial Intelligence

Total: 30 credits

• Five core AI bins required (15 credits)
  • Artificial Intelligence Bin (at least 3 credits)
  • Ethics & AI Bin (at least 3 credits)
  • Machine Learning Bin (at least 3 credits)
  • Knowledge & Reasoning Bin (at least 3 credits)
  • Interaction & Action Bin (at least 3 credits)

• Capstone experience required (3 or 9 credits)
  • Graduate Qualifying Project in AI (3 credits), or
  • Master's Thesis in AI (9 credits)

• Remaining credits:
  • Additional core AI bin courses (any # of credits),
  • AI-related special topics, ISP, and DR (any # of credits)
  • AI-related preparatory courses (at most 6 credits), and/or
  • Thematically-related courses in any discipline at WPI* (at most 6 credits)
Structure of Proposed MS in Artificial Intelligence

Total: 30 credits

• Five core AI bins required (15 credits)
  • Artificial Intelligence Bin (at least 3 credits)
  • Ethics & AI Bin (at least 3 credits)
  • Machine Learning Bin (at least 3 credits)
  • Knowledge & Reasoning Bin (at least 3 credits)
  • Interaction & Action Bin (at least 3 credits)

• Capstone experience required (3 or 9 credits)
  • Graduate Qualifying Project in AI (3 credits), or
  • Master's Thesis in AI (9 credits)

• Remaining credits:
  • Additional core AI bin courses (any # of credits),
  • AI-related special topics, ISP, and DR (any # of credits)
  • AI-related preparatory courses (at most 6 credits), and/or
  • Thematically-related courses in any discipline at WPI* (at most 6 credits)
Structure of Proposed MS in Artificial Intelligence

Total: 30 credits

• Five core AI bins required (15 credits)
  • Artificial Intelligence Bin (at least 3 credits)
  • Ethics & AI Bin (at least 3 credits)
  • Machine Learning Bin (at least 3 credits)
  • Knowledge & Reasoning Bin (at least 3 credits)
  • Interaction & Action Bin (at least 3 credits)

• Capstone experience required (3 or 9 credits)
  • Graduate Qualifying Project in AI (3 credits), or
  • Master's Thesis in AI (9 credits)

• Remaining credits:
  • Additional core AI bin courses (any # of credits),
  • AI-related special topics, ISP, and DR (any # of credits)
  • AI-related preparatory courses (at most 6 credits), and/or
  • Thematically-related courses in any discipline at WPI* (at most 6 credits)
Structure of Proposed MS in Artificial Intelligence

- **Five core AI bins required** (15 credits)
  - Artificial Intelligence Bin (at least 3 credits)
  - Ethics & AI Bin (at least 3 credits)
  - Machine Learning Bin (at least 3 credits)
  - Knowledge & Reasoning Bin (at least 3 credits)
  - Interaction & Action Bin (at least 3 credits)

- **Capstone experience required** (3 or 9 credits)
  - Graduate Qualifying Project in AI (3 credits), or
  - Master's Thesis in AI (9 credits)

- **Remaining credits**:
  - Additional core AI bin courses (any # of credits),
  - AI-related special topics, ISP, and DR (any # of credits)
  - AI-related preparatory courses (at most 6 credits), and/or
  - Thematically-related courses in any discipline at WPI* (at most 6 credits)
Five AI Core Bins

**BIN: Artificial Intelligence At least 1 course**
- **CS 534**: Intro to Artificial Intelligence

**BIN: Ethics & AI**
- **WR 513**: Ethical Impact & Comm in Robotics & AI Research
- **MIS 520**: AI and its Ethical Application in Business
- **SS 560**: AI: Exploring Technology, Ethics & Policy
- **DS 555**: Responsible Artificial Intelligence

**BIN: Machine Learning At least 1 course**
- **CS 548**: Knowledge Discovery and Data Mining
- **CS 559**: Machine Learning
- **DS 541**: Deep Learning
- **DS 551**: Reinforcement Learning
- **DS 502**: Statistical Methods for DS

**BIN: Knowledge & Reasoning At least 1 course**
- **ECE 571**: ML for Engineering Applications
- **CS 557**: ML in Cybersecurity
- **ECE 556**: On Device Deep Learning
- **CS 553**: Machine Learning Development & Operations
- **CS 553**: Database Management Systems
- **DS 553**: Big Data Management
- **CS 509**: Design of Software Systems
- **MIS 502**: Data Management for Analytics

**BIN: Interaction & Action At least 1 course**
- **DS 554**: Natural Language Processing
- **DS 552**: Generative AI
- **CS 549**: Computer Vision
- **CS 547**: Information Retrieval
- **ECE 545**: Digital Image Processing
- **CS 526**: Human-Robot Interaction
AI+X Specialization in Thematically-related Courses in Any Discipline

6 credits | approved by AI advisor | meeting rules & approved by discipline

Some examples are listed here:

**AI & Business:** ML for Business, Project Management, Supply-Chain Optimization.
**AI & Engineered Systems:** Digital Signal Processing, Medical Signal Analysis, Sensor Eng.
**AI & Foundations:** Mathematical Optimization, Multi-variate Data Analysis, Advanced Statistics.
**AI & Game Development:** Serious & Applied Games, Design of Interactive Experiences, Virtual Worlds.
**AI & Global Development:** Sustainability, Climate Change, Social Justice, Global Health.
**AI & Health:** BioInformatics, Health Sciences, Neuroscience, Biology.
**AI & Humans:** Human-Computer Interaction, Visualization, Virtual Reality, Human-Robot Interaction.
**AI & Learning Sciences:** Foundations of Learning Sciences, Learning Environments in Education.
**AI & Material Sciences:** Smart Materials, Nanomaterials, Manufacturing Processes.
**AI & Neuroscience:** Computational Neuroscience, Brain-Computer Interaction, Advanced Psychophysiology.
**AI & Security:** Software Security Design and Analysis, Machine Learning in Cybersecurity, Cryptography.
AI BS/MS Path & AI Graduate Certificate

AI BS/MS Path

• Double-count up to 12 graduate credits in BS/MS.
• Included are all approved MS-AI core graduate courses and 4000-level undergraduate courses if the later is acceptable in place of a graduate course by the unit offering the course and that graduate course is an MS-AI approved course.

AI Graduate Certificate (12 credits)

• Introduction to AI Course (core bin)
• Two courses from 2 distinct core bins of MS-AI, besides Intro-to-AI bin
• Any fourth MS-AI approved course
Comparison to Existing MS Degrees at WPI

Programs Compared: Computer Science, Data Science, Electrical Eng. and Robotics Engineering

**Similarities:**
30 credits; Core Bin Requirements; Capstone Experience and/or MS thesis; plus 3 to 9 credits of flexibility.

**Differences:**

**MS in CS:** 12 CS credits in CS Theory, Algos, Systems, Networks, & Compiler, Graphics, etc, -- *one Bin is AI*. Allows 6 credits outside CS. Courses or MS thesis. (*M of CS* – no MS thesis)

**MS in DS:** 15 credits in 5 Bins: Intro DS, Math Analytics, Data Access, Data Mining, Bus Intelligence. Preapproved electives in DS, CS, Math and Business courses. GQP or MS thesis.

**MS in ECE:** 21 credits in ECE courses; Smart Connected Sys, Integrated Sys, Cybersecurity, Power Systems. Allows 9 credits in CS, math, physics or eng. Capstone or MS thesis. (*M Eng in ECE*, add Bus, no MS thesis)

**MS in RBE:** 15 RBE credits must include Fct Robotics, Robot Dynamics, Robot Control; Bus. Entrepreneur; Allows 3-9 credits in any Science, Engineering or Business.

**MS in AI:** 15 credits in core AI bins: Intro to AI, Ethics AI, Machine Learning, Knowledge+, Interactions+. Allows 6 credits in disciplines outside AI as target applications.
<table>
<thead>
<tr>
<th></th>
<th>Northeastern Univ.</th>
<th>Boston Univ.</th>
<th>CMU</th>
<th>CMU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree</strong></td>
<td>MS in AI</td>
<td>MS in AI</td>
<td>MS AI &amp; Innovation</td>
<td>MS AI-Engineering</td>
</tr>
<tr>
<td><strong>Originating Unit</strong></td>
<td>Computing</td>
<td>CS department</td>
<td>School of Computer Science</td>
<td>College of Eng.; within eng. dept.</td>
</tr>
<tr>
<td><strong>Required credits</strong></td>
<td>Data science, machine learning, human-computer interaction</td>
<td>AI, algos, programming, machine learning,</td>
<td>Knowledge in AI: Coding Bootcamp: ML; Machine Learning, NLP, DL, ML on Large Datasets; ML+.</td>
<td>AI+Eng: fundamentals of AI/ML + domain knowledge in eng</td>
</tr>
<tr>
<td><strong>Ethics</strong></td>
<td>required</td>
<td>optional</td>
<td>No mention</td>
<td>Required</td>
</tr>
<tr>
<td><strong>Target careers</strong></td>
<td>ML engineer, AI/Data Scientist, Robotic engineer</td>
<td>ML engineer, AI scientist, Data Scientist</td>
<td>Entrepreneurs, ML engineer, Innovators.</td>
<td>Battery/Process engineer, quality engineer, DL engineer</td>
</tr>
<tr>
<td><strong>Other notes</strong></td>
<td>Other: Prof studies applied ML for finance, healthcare, etc.</td>
<td>Starts in 2023-24. MS in health info, AI +healthcare</td>
<td>Costs &gt;= 100k</td>
<td></td>
</tr>
</tbody>
</table>
Endorsements by participating departments & schools for MS-AI programs and their courses

School of Arts and Sciences
School of Engineering
School of Business
Computer Science Department*
Data Science Program*
Robotics Engineering Department*
Electrical and Computer Engineering Department
Mathematical Sciences Department
Social Science and Policy Studies Department
Humanities & Arts
Management & Support

MANAGEMENT:
• Program Head for MS-AI
• MS-AI Graduate Committee: One faculty from RBE & One from CS & One from DS.
• Faculty Advisory Committee for MS-AI
  • Advisory capacity for above leadership and commit to periodic meetings and to serve on subcommittees as needed based on size of student cohort and growth of program.
• Collaborative Faculty for MS-AI
  • Supervise MS thesis, ISP, and DR to students in this MS-AI degree.

RESOURCES:
• Faculty positions in AI authorized in affiliated & other departments across WPI (Fall 2024)
• Advisor staff position approved for MS-AI program
• Funding for marketing for initial launch approved
• Funding for actual operation to be established (soon) based on cohort size & operation needs