6.976 Engineering Leadership in the Age of AI, Fall 2019
Monday and Wednesday, 12:30-2:00 p.m., Room: 4-231

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Overview

Artificial intelligence (AI) will continue to revolutionize many industries, for example, driverless cars, finance, national security, medicine, e-commerce, to name a few. President Rafael Reif stated in a recent article, “To prepare society for the demands of the future, institutions must equip tomorrow’s leaders to be ‘AI bilingual’. Students in every field will need to be fluent in AI strategies to advance their own work. And technologists will need equal fluency in the cultural values and ethical principles that should ground and govern the use of these tools.” ¹ This course will equip MIT graduate engineering students to lead, develop, and deploy AI systems in ways that augment human’s capabilities, while providing positive impact to society. It will teach at the intersection of engineering leadership and artificial intelligence, and deliver learning experiences in ways that are informed by research but applied to engineering products and/or services.

The course will begin with a brief AI history, including highlights of representative successes in the application of AI. The course will be project-based requiring the students to formulate a strategic roadmap of an innovative AI application. Several key engineering leadership principles will serve as the foundation for developing an AI application roadmap. These principles will include establishing a strategic vision, identifying candidate customers, project execution, and the building of teams with complementary strengths. The students will be required to present the strategic vision and roadmap proposal to a selected industry/academic panel with a broad range of expertise. The final presentation will require a balance between technical depth and breadth, as well as emphasis on strategic vision and uniqueness of the AI application. The course will also include invited speakers from industry that are practitioners in the development and deployment of AI applications. At the completion of this course, the students will have the necessary skills to lead AI teams. This course is offered through the Gordon-MIT Engineering Leadership Program.

Course Units: 12 credits, 3-0-9

Recommended Readings

¹ L. Rafael Reif, February 10, 2019, “Prepare students for a future of artificial intelligence,” Financial Times.
CRC Press, 2008, selected chapters.
6. Key papers on AI system subcomponents will be recommended throughout the course.
7. Key papers on Engineering Leadership will be recommended throughout the course.
8. Readings will also be posted to Stellar.

Learning Objectives

At the completion of this course, students will be able to lead AI teams based on four core competencies:

- Understanding an end-to-end AI architecture at the system engineering level
- Applying engineering leadership principles
- Creating a strategic vision and development plan focused on a product or service
- Developing an execution strategy staffed by a diverse and multidisciplinary team
Areas Covered in the Course are Based on the Following Framework:

Engineering Leadership in the Age of AI

- Areas Covered in 6.976 Course -

**Engineering Leadership Principles**
- Strategic vision
- External relationships
- Internal execution
- Recruiting / mentoring AI talent
- Technical depth and breadth
- Ethics in AI

**Human-Machine Augmentation**

Confidence Level vs. Consequence of Actions

- Best Matched to Machines
- Machines Augmenting Humans
- Best Matched to Humans

**AI Architecture**

- Data Conditioning
- Machine Learning
- Human-Machine Teaming
- Modern Computing
- Robust AI

**System Engineering Approach**

Invited Speakers and Panel Discussions

Project-based Conceptual Design

Additional Resources:
- [http://web.mit.edu/gordonelp](http://web.mit.edu/gordonelp)
- Twitter: @ELAAi16
The AI Canonical Architecture is Central to the Course Content:

AI Canonical Architecture

Data Conditioning

Machine Learning
- Supervised Learning
- Transfer Learning
- Reinforcement Learning
- Etc.

Information

Knowledge

Insight

Users (Missions)

Human-Machine Teaming (CoA)
- Human
- Human-Machine Complement
- Machine

Spectrum

Modern Computing
- CPUs
- GPUs
- TPU
- Neuromorphic
- Custom
- Quantum

Robust AI
- Explainable AI
- Metrics and Bias Assessment
- Verification & Validation
- Security (e.g., counter AI)
- Policy, Ethics, Safety and Training

GPU = Graph Processing Unit
TPU = Tensor Processing Unit
CoA = Courses of Action

http://web.mit.edu/gordonelp Twitter: @ELAAI16
Final Grading Breakdown:

<table>
<thead>
<tr>
<th>Contribution</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Individual contributions based</td>
<td>40%</td>
</tr>
<tr>
<td>on three exams</td>
<td></td>
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<tr>
<td>Class participation</td>
<td>20%</td>
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<tr>
<td>Final team project and presentations</td>
<td>40%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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Major Assignments, Exams, and Dates

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Weight</th>
<th>Dates</th>
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<tbody>
<tr>
<td>1st Exam focused on fundamentals of AI architecture</td>
<td>10%</td>
<td>September 23rd</td>
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<tr>
<td>2nd Exam focused on subcomponents of AI architecture and engineering</td>
<td>10%</td>
<td>October 16th</td>
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<tr>
<td>leadership principles</td>
<td></td>
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<tr>
<td>Class participation</td>
<td>20%</td>
<td>November 20th Peer presentation</td>
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<tr>
<td></td>
<td></td>
<td>of AI conceptual design and</td>
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<tr>
<td></td>
<td></td>
<td>development plan of a product</td>
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<td></td>
<td></td>
<td>or service</td>
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<tr>
<td>3rd Exam focused on bringing it all together: engineering leadership and</td>
<td>20%</td>
<td>November 25th</td>
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<tr>
<td>end-to-end AI architecture</td>
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<tr>
<td>Final presentation of AI project</td>
<td>40%</td>
<td>December 2nd and December 4th</td>
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<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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<tr>
<td>Lecture #</td>
<td>Class Date</td>
<td>Topic</td>
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<tr>
<td>1</td>
<td>4 Sept</td>
<td>Introduction and engineering principles</td>
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<td>2</td>
<td>9 Sept</td>
<td>AI canonical architecture</td>
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<tr>
<td>3</td>
<td>11 Sept</td>
<td>Data conditioning</td>
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<td>4</td>
<td>16 Sept</td>
<td>Machine learning algorithm taxonomy</td>
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<td>5</td>
<td>18 Sept</td>
<td>Modern computing as enabling technology</td>
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<tr>
<td>23 Sept</td>
<td>Exam focused on subsystem components of AI architecture</td>
<td>Exam addressing data conditioning, ML algorithm taxonomy and modern computing</td>
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<td>6</td>
<td>25 Sept</td>
<td>Robust AI</td>
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<td>7</td>
<td>30 Sept</td>
<td>Human-machine teaming</td>
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<td>8</td>
<td>2 Oct</td>
<td>Overview of engineering leadership principles</td>
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<td>9</td>
<td>7 Oct</td>
<td>Tools and techniques in formulating a strategic vision</td>
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<tr>
<td>10</td>
<td>9 Oct</td>
<td>External relationships</td>
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<tr>
<td>16 Oct</td>
<td>Exam focused on additional subsystem components of AI architecture and engineering leadership principles</td>
<td>Exam addressing AI architecture and material covered so far on engineering leadership principles</td>
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<tr>
<td>11</td>
<td>21 Oct</td>
<td>Internal execution and managing-by-results</td>
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<td>Date</td>
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<td>Topic</td>
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<tr>
<td>12</td>
<td>23 Oct</td>
<td>Effective recruiting and mentoring AI talent</td>
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<td>13</td>
<td>28 Oct</td>
<td>Leading from a position of strength in technical depth and breath</td>
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<tr>
<td>14</td>
<td>30 Oct</td>
<td>Tools and techniques in formulating a strategic development plan</td>
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<td>4 Nov</td>
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<td>Ethics in AI</td>
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<td>15</td>
<td>6 Nov</td>
<td>AI tools and techniques leveraging AI open ecosystem</td>
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<tr>
<td>13</td>
<td>13 Nov</td>
<td>Preliminary AI conceptual design for a product or service</td>
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<td>18</td>
<td>18 Nov</td>
<td>Refine AI conceptual design and development plan for a product or service</td>
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<td>20</td>
<td>20 Nov</td>
<td>Peer presentation of development plan for an AI conceptual design for a product or service</td>
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<td>25</td>
<td>25 Nov</td>
<td>Exam focused on bringing it all together</td>
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<td>16</td>
<td>27 Nov</td>
<td>Tools and techniques for quantifying AI system capabilities</td>
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<tr>
<td>2 Dec</td>
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<td>Final presentation of AI conceptual design (Group 1)</td>
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<tr>
<td>4 Dec</td>
<td></td>
<td>Final presentation of AI conceptual design (Group 2)</td>
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### Supplemental Readings on AI

**Canonical Architecture (required reading will be identified during class)**


**Supplemental Readings on Engineering Leadership (required reading will be identified during class)**

19. David Nadler and Mike Tushman, “A Model for Diagnosing Organizational Behavior,” Organizational...
Dynamics, Autumn 1980.