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Human and Machine Intelligence (MORS 950)

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Section 31 | Mondays and Thursdays | 10:30 am - 12:00 pm | Global Hub 1430, Evanston
Section 81 | Thursdays | 6:00 pm - 9:00 pm | Wieboldt Hall 250, Chicago

Office Hours: Schedule available on Canvas and by appointment

Contact info: Please add MORS950 to the subject of any email you send me

Course overview

Artificial intelligence (AI) is a transformative technology and a modern day equivalent to fire in the early stages of human civilization. It is a tool that can be used to solve complex problems, make predictions, automate tasks, and enhance productivity. But like fire, it has a dual nature and has potential for both good and bad outcomes. This course requires no prior technical knowledge and is designed for people who want to lead the deployment of AI systems in the real-world, manage data science and design teams, and build and invest in AI companies. The goal of the course is to build intuition for what AI can do, how machine learning works, where these tools tend to succeed and fail, and how to navigate their ethical implications. We will explore a wide range of business applications, examine tools including ChatGPT, Midjourney, DeepBlue, Watson, AlphaZero, the recommendation systems behind Twitter and TikTok, and many more, and discuss best practices for managing teams of humans assisted by these tools. This course is a lecture-based course with case-based discussions, individual assignments, a midterm, and a final group project. By the end, you should be an expert at identifying promising use-cases, evaluating current limitations, and recognizing potential pitfalls such that you are capable of applying human and machine thought partnerships to grow new businesses and disrupt Grand Masters in any field.

Attendance and Screen Policy

Students are expected to attend every class in-person unless they're feeling sick or have an approved absence. No laptops or cell phones are allowed to be used in class unless they're required for classwork.

Grading

Assignments (40%) Three individual assignments will give you first-hand experience in applying AI towards solving problems in business. The first assignment is worth 10% of your grade and the second and third are each worth 15% of your grade. **All assignments are due one hour before the start of class.**

Midterm (25%) A mid-term will give you feedback on your grasp of the course work.

Final Project (25%) A group project will offer experience identifying, thinking through, and artfully pitching an AI-based startup idea, product, business plan, or policy recommendation.

Participation (10%) You are expected to attend every class and actively engage in group discussions. Your participation grade is based on your attendance and participation in class. In addition, for the group project, we will collect peer evaluations to encourage all group members to make active contributions. These peer evaluations will be directly used to help determine an individual's participation grade.

Honor code

At the Kellogg School of Management, we are committed to the highest levels of integrity, professionalism, and respect for others, both inside and outside the classroom. We have a responsibility to behave ethically in all situations, to honestly represent our own contributions and those of others in all the work we perform, and to acknowledge and respect diversity in individuals and cultures. Any work that you submit should be entirely your own work. If you have any questions regarding how the honor code applies to this course, please ask.

AI Policy

I expect you to think critically and use AI as a tool for assignments in this class. Assignments will require using large language models (LLMs) like ChatGPT and image generation tools. Do not blindly trust AI outputs. LLMs are prone to making up facts, and it's your responsibility to think critically and double check purported facts with credible sources. You are responsible for errors and omissions in the assignments you submit. If you copy and paste a response from an LLM, then you must cite the response accordingly. Failure to do so is in violation of academic honesty policies.

Student safety and wellness

Students can find useful resources for safety and security, academic support, and mental and physical health and well-being on the NU help website. **If you are struggling, please know that you can reach out to me personally or the Office of Student Life. We will work to get you connected to the right resources.**

Students with disabilities

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities (and I personally share this commitment). Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university's established accommodation process (email: accessiblenu@northwestern.edu; phone: 847-467- 5530).

If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

Prohibition of recording of class sessions

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

Adapting in Real Time

Please note that the specifics of this course syllabus are subject to change in the case of developments in AI and unforeseen circumstances. I will notify students of any changes as soon as possible. Students will be responsible for abiding by the changes.

Required Books

Unmasking AI by Joy Buolamwini (2023)
The Alignment Problem by Brian Christian (2020)

Further Background Reading (Optional)

Computer Power and Human Reason by Joseph Weizenbaum (1976)
The Second Machine Age by Andrew McAfee and Eric Brynjolfsson (2014)
Artificial Intelligence, A Guide for Thinking Humans by Melanie Mitchell (2019)
Race After Technology by Ruha Benjamin (2019)
Rebooting AI: Building AI We Can Trust by Gary Marcus, Ernest Davis (2021)
Power and Prediction by Ajay Agrawal, Avi Goldfarb, Joshua Gans (2022)
Genius Makers by Cade Metz (2022)
The Worlds I See by Fei-Fei Li (2023)
The Coming Wave by Mustafa Suleyman (2023)

Background Coursework on AI (Optional)

Deeplearning.ai's short course on generative AI
Microsoft's Generative AI, AI, and ML for beginners courses
IBM's hands on short course on generative AI
Andrej Karpathy's Neural Networks: Zero to Hero
Udemy's courses on Midjourney and ChatGPT

Podcasts on Latest News in AI (Optional)

The AI Breakdown: Daily AI News and Discussions by Nathaniel Whittemore
Practical AI: Machine Learning, Data Science by Changelog Media
The AI in Business Podcast by Daniel Faggella

Reporters in AI to Follow (Optional)

Cade Metz at New York Times and Deepa Seetharaman at Wall Street Journal

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MORS 950 Winter 2024 Schedule (Jan 3 to Mar 7)

1. Artificial Intelligence: What, Why, and Where?

January 3rd in Evanston and January 4th in Chicago

What is artificial intelligence (AI)? What is AI capable of today? How have the capabilities changed over time? What is AI's relationship to machine learning, deep learning, algorithms, and analytics? When and where is AI well-suited and ill-suited for solving business problems?

Before Class Reading:

- Computing Machinery and Intelligence by Alan Turing (1950)
- Why AI is Harder than We Think by Melanie Mitchell (2021)

Additional Optional Reading:

- GPT-4 Technical Report by Open AI (2023)
- The Dawn of LMMs: Preliminary Explorations with GPT-4V(ision) by Zhengyuan Yang, Linjie Li, Kevin Lin, Jianfeng Wang, Chung-Ching Lin, Zicheng Liu, Lijuan Wang (2023)
- Gemini: A Family of Highly Capable Multimodal Models by Google's Gemini Team
- New Navy Device Learns by Doing in New York Times (1958)

2. Machine Learning: How?

January 4th in Evanston and January 4th in Chicago

How does a machine learn? How can machine learning be used to make predictions in business? How does the machine learning business flywheel work and where can it break down?

Before Class Reading:

- Algorithms need managers too by Michael Luca, Jon Kleinberg, and Sendhil Mullainathan (2017)
- The Definitive Guide to Machine Learning for Business Leaders by Hugo Bowne-Anderson (2020)
- "Introduction" (pages ix to xxi) in Unmasking AI by Joy Buolamwini

Additional Optional Reading:

- But, what is a neural network? | Chapter 1 Deep Learning by Grant Sanderson on the 3Blue1Brown Youtube channel (2017)
- Prediction and explanation in social systems by Jake Hofman, Amit Sharma, and Duncan Watts (2017)
- Computer Scientist Explains Machine Learning in 5 Levels of Difficulty by Hilary Mason (2021)

3. Computational Power and Deep Learning

January 8th in Evanston and January 11th in Chicago

What is compute and why does it matter? What is deep learning? What's a neural network in machine learning, and how related is it to a biological neural network in the human brain? How can computer vision and natural language processing be tools to address business problems?

Before Class Reading:

- Computational Power and AI by Jai Vipra and Sarah Myers West (2023)
- "A Parable of Three Entrepreneurs" (pages 3-24) in Power and Prediction: The Disruptive Economics of AI by Ajay Agrawal, Joshua Gans, and Avi Goldfarb (2022)
- "Representation" (pages 17 to 29) in The Alignment Problem by Brian Christian (2020)

Additional Optional Reading:

- What is Computer Vision and Why Does it Matter by NVIDIA (2022)
- How Computer Vision Works by Sara Robinson (2018)

4. Evaluating Algorithmic Performance: How and When?

Due: Please submit assignment 1 "Large Language Models for Solving Data Science Problems in Business"

January 11th in Evanston and January 11th in Chicago

How do you evaluate AI systems and ML models? When should we care about accuracy, precision, recall, area under the curve, and other metrics? What trade-offs emerge? When are AI systems likely to drift, err, or otherwise go awry? When can we compare machine predictions to human decisions?

Before Class Reading:

- "Shield Ready" (pages 28 to 38) in Unmasking AI by Joy Buolamwini
- "Representation" (pages 29 to 50) in The Alignment Problem by Brian Christian (2020)
- Reliance on Metrics is a Fundamental Challenge for AI by Rachel Thomas and David Uminsky (2020)

Additional Optional Reading:

- The Illustrated Word2Vec by Jay Alammar
- On the Folly of Rewarding A, While Hoping for B by Steven Kerr (1975)
- Performance vs. Competence in Human-Machine Comparisons by Chaz Firestone (2020)

5. Evaluating Algorithmic Performance is a Leadership Problem

January 17th in Evanston and January 18th in Chicago

What are the systematic yet surprising errors that crop up in business applications of AI systems and ML models? What is algorithmic bias? Why did Microsoft's chatbot Tay fail? Why can GPT-4 pass the bar exam and medical licensing exam but fail at other basic tasks? When is computer vision prone to errors?

Before Class Reading:

- **Case Study**: Challenges in Commercial Deployment of AI: Insights from the Rise and Fall of IBM Watson's AI Medical Program by Quy Huy, Timo Vuori, Tero Ojanpera, Lisa Simone Duke (2023)
- "Defaults Are Not Neutral and Facial Recognition Technologies" (pages 41 to 67) in Unmasking AI by Joy Buolamwini

Additional Optional Reading:

- The Mythos of Model Interpretability: In machine learning, the concept of interpretability is both important and slippery by Zachary Lipton (2018)
- Beware explanations from AI in health care by Boris Babic, Sara Gerke, Theodoros Evgeniou, and I. Glenn Cohen (2021)
- The Final 11 seconds of a fatal Tesla autopilot crash by Trisha Thadani, Rachel Lerman, Imogen Piper, Faiz Siddiqui, and Irfan Uraizee (2023)

6. Generative AI

Due: Please submit team, initial ideas, and AI-generated logos for final project

January 18th in Evanston and January 18th in Chicago

What is generative AI? How do text-to-image models work? How might generative AI transform the future of creativity, labor, law, and media? What business frameworks can help us harness this technology?

Before Class Reading:

- Art and Science of Generative AI by Ziv Epstein, Aaron Hertzman, Memo Atken, Hany Farid, Jessica Fjeld, Morgan Frank, Matthew Groh, Laura Herman, Neil Leach, Robert Mahari, Alex Pentland, Olga Russakovsky, Hope Schroeder, and Amy Smith (2023)

Additional Optional Reading:

- How to Capitalize on Generative AI by Andrew McAfee, Daniel Rock and Erik Brynjolfsson (2023)
- How Generative AI Can Augment Human Creativity (2023) by Tojin Eapen, Daniel Finkenstadt, Josh Folk, Lokesh Venkataswamy
- DAIR Prompt Engineering Guide by Elvis Saravia (2023)
- AI Prompt Engineering isn't the Future by Oguz Acar (2023)
- Fact Sheet: President Biden Issues Executive Order on Safe, Secure, and Trustworthy Artificial Intelligence (2023) US Government

7. Large Language Models

January 22nd in Evanston and January 25th in Chicago

What are LLMs and how can they transform business? How does the Eliza effect apply to LLMs? How should we address the dual-use dilemma of LLMs? Are LLMs stochastic parrots, conscious computers, or something else?

Before Class Reading:

- "Introduction" (pages 1-12) in Computer Power and Human Reason by Joseph Weizenbaum (1976)

- On the Dangers of Stochastic Parrots: Can Language Models Be Too Big by Emily Bender, Timnit Gebru, Angelina McMillan-Major, and Shmargeret Shmitchell (2021)
- Could a Large Language Model Be Conscious by David Chalmers (2022)

Additional Optional Reading:

- Introduction to LLMs by Andrej Karpathy (2023)
- What have language models learned? by Google's People and AI Research Team
- Faith and Fate: Limits of Transformers on Compositionality by Nouha Dziri, Ximing Lu, Melanie Sclar, Xiang Lorraine Li, Liwei Jiang, Bill Lin, Peter West, Chandra Bhagavatula, Ronan Le Bras, Jena Hwang, Soumya Sanyal, Sean Welleck, Xiang Ren, Allyson Ettinger, Zaid Hacchaoui, and Yejin Choi (2023)
- Human-like systematic generalization through a meta-learning neural network by Brenden Lake and Marco Baroni(2023)

8. Recommender Systems: Who Wants to See What When?

Due: Please submit assignment 2 "AI Generated Creative Campaign from Design to Marketing"

January 25nd in Evanston and January 25th in Chicago

How do large companies connect expansive product offerings with diverse customers? What is semi-supervised learning? What are the business decisions involved in designing and deploying recommender systems? What can go wrong with recommender systems?

Before Class Reading:

- The Netflix Recommender Systems: Algorithms, Business Value, and Innovations by Carlos Gomez-Uribe and Neil Hunt (2015)
- How the New York Times Recipe Team Makes Personalized Cooking Recommendations by Kyelee Fitts and Celia Eddy (2023)

Additional Optional Reading:

- Auditing YouTube's recommendation system for ideologically congenial, extreme, and problematic recommendations by Muhammad Haroon, Magdalena Wojcieszak, Anshuman Chhabra, Xin Liu, Prasant Mohapatra, and Zubair Shafiq (2023)
- Twitter's Recommendation Algorithm by Twitter (2023)
- How TikTok Reads Your Mind by Ben Smith (2021)
- Recommender Systems by Charu Aggarwal (2016)

9. Beating Human Grandmasters in Chess, Go, Poker, Diplomacy, and More

January 29th in Evanston and February 1st in Chicago

How are AI systems built such that they can beat human grandmasters complex games? What is reinforcement learning? When and why are AI systems' performance on games relevant to the real-world?

Before Class Reading:

- "Curiosity" (pages 181 to 210) in The Alignment Problem by Brian Christian
- How AI Conquered Poker by Keith Romer (2022)
- AI learns the art of Diplomacy by Matthew Hutson (2022)

Additional Optional Reading:

- Chess, a Drosophila of Reasoning by Garry Kasparov (2018)
- Acquisition of Chess Knowledge in AlphaZero by Thomas McGrath, Andrei Kapishnikov, Nenad Tomasey, Adam Pearce, Martin Wattenberg, Demis Hassabis, Been Kim, Ulrich Paquet, Vladimir Kramnik (2022)
- The Necessity of Awe (2020) by Helen De Cruz
- Chapter 9 "Game On" Artificial Intelligence A Guide for Thinking Humans by Melanie Mitchell

10. Midterm

February 1st in Evanston and February 1st in Chicago

Due: Please come prepared for the midterm

11. Identifying and Evaluating AI Opportunities

February 5th in Evanston and February 8th in Chicago

Before Class Reading:

- A Simple Tool to Start Making Decisions with the Help of AI by Ajay Agrawal, Joshua Gans, and Avi Goldfarb
- Opportunities in AI by Andrew Ng (2023)

Additional Optional Reading:

- What AI-Driven Decision Making Looks Like by Eric Colson
- How to Spot a Machine Learning Opportunity, Even if You Aren't a Data Scientist by Kathryn Hume (2017)

12. Red Teaming AI

February 8th in Evanston and February 8th in Chicago

Guest Lecture: Lama Ahmad, Policy Research at Open AI

Before Class Reading:

- DALL-E 2 Preview Risks and Limitations by Open AI
- GPT-4 System Card by Open AI

Additional Optional Reading:

- Evaluating the Social Impact of Generative AI Systems in Systems and Society by Irene Solaiman et al (2023)
- What is Red Team Thinking and The ROI of Ted Team Thinking by Bryce Hoffman

13. Fairness, Accountability, and Transparency in AI

Due: Please submit AI Canvas and Business/Policy Model Canvas for final project

February 12th in Evanston and February 15th in Chicago

Before Class Reading:

- "Guardians Assemble, Power Shadows, Gender Shades, and Deserted Desserts" (pages 68 to 85, 125 to 154) in Unmasking AI by Joy Buolamwini
- The AI Wars Have Three Factions, and They All Crave Power by Bruce Schneier and Nathan Sanders (2023)

Additional Optional Reading:

- The Alignment Problem from a Deep Learning Perspective by Ricard Ngo, Lawrence Chan, and Sören Mindermann
- Unsolved Problems in ML Safety by Dan Hendrycks, Nicholas Carlini, John Schulman, Jacob Steinhardt (2022)
- Engineering Knowledge: The Construction of Knowledge in Artificial Intelligence by Diana Forsythe (1993)

14. AI in the Music Industry

February 15th in Evanston and February 15th in Chicago

Guest Lecture: Jay Norman, Global Head of Marketing at Spotify

Before Class Reading:

- The Future of Music: How Generative AI is Transforming the Music Industry by Justine Moore and Anish Acharya (2023)
- Jukebox by OpenAI
- MusicLM: Generating Music from Text Andrea Agostinelli et al (2023)

Additional Optional Reading:

- How generative AI could disrupt creative work by David De Cremer, Nicola Morini Bianzino, and Ben Falk
- 5 ways AI has already changes the music industry by Elias Light and Kristin Robinson

15. Managing Data Science, Machine Learning, and AI

Due: Please submit assignment 3 "Interview with a Data Scientist"

February 19th in Evanston and February 22nd in Chicago

Before Class Reading:

- 4 Skills the Next Generation of Data Scientists Need to Develop by Joel Shapiro (2023)
- Biased Algorithms are Easier to Fix than Biased Humans by Sendhil Mullainathan (2019)
- Maker Manager Schedule by Paul Graham (2009)

Additional Optional Reading:

- What Data Scientists Really Do, According to 35 Data Scientists by Hugo Bowne-Anderson (2018)
- Please don't hire a Chief AI officer by Kristian Hammond (2017)
- Will A.I. Become the New McKinsey by Ted Chiang (2023)
- Do Algorithms Beat Us at Complex Decision Making by Shane Parrish

- MBA Students vs. ChatGPT on Generating Innovative Ideas by Christian Terwiesch and Karl Ulrich (2023)
- The Super Mario Effect by Mark Rober (2018)

16. Affective Computing

February 22nd in Evanston and February 22nd in Chicago

Before Class Reading:

- **Case Study:** Feeling Machines: Emotion AI at Affectiva by Shane Greenstein and John Masko (2019)
- Affective Computing by Rosalind Picard (1995)

Additional Optional Reading:

- Can AI Do Empathy Even Better Than Humans? Companies Are Trying It. by Lisa Bannon (2023)
- The Media Equation by Byron Reeves and Clifford Nass (1996)

17. Deepfakes and Synthetic Media

Due: Please submit story telling techniques for final presentation

February 26th in Evanston and February 29th in Chicago

Before Class Reading:

- Creating, Using, Misusing, and Detecting Deepfakes by Hany Farid (2022)

Additional Optional Reading:

- Deepfake Detection by Human Crowds, Machines, and Machine-Informed Crowds by Matt Groh, Ziv Epstein, Chaz Firestone, and Rosalind Picard (2022)

18. Being Human in the Age of AI

February 29th in Evanston and February 29th in Chicago

Before Class Reading:

- "Conclusion" (pages 310 to 334) in The Alignment Problem by Brian Christian
- "Seat at the Table" (pages 283 to 291) in Unmasking AI by Joy Buolamwini

Additional Optional Reading:

- Leading Thinkers on AI and What it Means to Be Human by Maria Popova (2015)
- Meaning in the Age of AI by Maria Popova (2023)
- Meaning in the Age of AI before ChatGPT by Maria Popova (2023)
- The Turing Trap: The Promise and Peril of Human-Like AI by Erik Brynjolfsson (2022)

19 and 20. Final Presentations

March 4th and 7th in Evanston and March 7th in Chicago

Due: Please submit materials for your final presentation