Augmented Intelligence

University of Chicago Booth

Business 39100 Spring 2017
Wednesday 1:30–4:30 PM (Harper C10)

Professor James Evans
jevans@uchicago.edu
Office Hours: Saieh 252, Thur. 3-5pm
Teaching Assistant: Pete Aceves
paceves@uchicago.edu
Developer: Reid McIlroy
reidmcy@uchicago.edu

An executive's most prized advisor may no longer be a consultant or member of the C-suite, but a machine. Enhanced with big behavioral, operational and financial data, machines now augment rational decision-making, estimation, prediction, perception, pattern recognition, and combinatorial search. Executives, on the other hand, excel in creativity, intuition, and cognitive flexibility. Together they have the potential to assemble teams, networks and crowds endowed with powerful collective intelligence. Using hands-on cases and applications—including IBM's Deep Blue and Google's AlphaGo, computers that beat Chess and Go's Grand Masters—this course shows how to use critical machine learning tools to transform numbers, text, images and arbitrary data streams into promising new strategies, unbiased decisions, creative product designs and convincing stories, and to lead augmented data science, decision-making and design teams by understanding the limits and potential of machine intelligence. The overarching goal is for you to develop the imagination and experience to incorporate machines strategically to augment your cognitive skills, grow collectively intelligent businesses and disrupt Grand Masters in any field.

This course seeks to help students design, configure and evaluate human-machine intelligence systems that support their decisions as managers. Each week is organized around a distinct opportunity: first we lay out the possibilities (and perils) of *augmented intelligence* in general and the dominance of human-machine ensembles; second, we explore *augmented perception* through big data-producing digital sensors; third, we evaluate approaches to *augmented judgment* through machine learning on data streams; fourth, we consider *augmented organization* through approaches to intelligent crowd-sourcing and rewiring the firm; and fifth, we evaluate successful attempts to cultivate *augmented imagination* through algorithms and networked crowds that generate new ideas and designs for the 21st Century business.

In this course, we will cover material that speaks to central tensions faced by a general manager in the digital economy, and cultivates an ability to manage and pioneer intelligent systems to serve your strategic purposes and improve the value proposition of your business. We will specifically identify and evaluate opportunities through which computation and data can augment the collective foresight, flexibility and imagination of your enterprise. The course is constructed around an action framework in which students

identify business problems or opportunities, assemble computationally augmented solutions, and design the evidence or demonstration required to persuade oneself and others—bosses, funders, advisors—that the approaches will yield positive change.

Computers: Bring a laptop computer, connected to the Internet (over Booth internet) for in-class course demonstrations and to follow along with coding demonstrations.

Readings: Readings for each week consist of a case, business and popular press articles, and selections from recent books. Optional readings include scholarly journal articles and chapters. All readings are available in electronic format on Canvas and I expect them to be read prior to class. Supplemental readings are optional, and may be read following class.

Case Responses: I have posted study questions for each case to help you prepare for class discussion under each week's page in Canvas. These are study aids. Each week students will individually write short responses to case questions posed, drawing on the readings and their unique business experiences. These will be due at 10am on Wednesday, prior to class discussion.

Group Profiles & Pitches: After week 1, students will form groups of approximately five students (4 to 6). Each week thereafter, student groups will be asked to construct blog posts that profile and critically evaluate a form of augmented intelligence recently pioneered within a company, collective or community; or pitch their own augmented intelligence opportunity with a designed demonstration.

For **solution profiles**, students will (a) outline the problem or opportunity to which the company, collective or community's ensemble of machines and people was directed; (b) summarize the nature of their solution; (c) evaluate its effectiveness and commercial promise from available performance information, by analogy to comparable efforts, and analysis of anticipated competition; and (d) propose alterations—additions or subtractions—that might increase its potential and appropriable value. Each student group will perform one of these analyses over the course of the half-quarter, posted to the UChicago Voices blog as a clearly sign-posted 500-700 word discussion. Pictures and related media can be embedded as they assist your examination and argument. Information for profiles must be drawn from three or more sources, which could include attention in the business press (e.g., Wired, Fast Company, Wall Street Journal, Crain's Chicago Business), the technical press , analyst reports, patents, research articles, site visits, or interviews with company members, suppliers or customers. Select your cases based on the novelty and promise of the problem or opportunity, not the success or ultimate promise of the company's solution. As such, these should not all be glowing reports, but provide appropriate criticism and the opportunity to pose constructive changes that might increase their value.

For **solution pitches**, student groups will (a) identify a *new* problem or opportunity, (b) propose a *novel* augmented intelligence solution, (c) detail the design of an empirical demonstration that persuades others of their solution's commercial value and promise, oriented toward potential investors, bosses, colleagues, and critics of the proposal, and (d) pilot that demonstration to reveal its plausibility, promise, and appropriable value. Students should assume an intelligent, critical audience moved not only by narrow modeling and parameter estimation, but also scope and possibility. Consider IBM's 2011

staging of the *Jeopardy* game show competition between Watson and the two highest scoring champions in the game's history. Students will produce two of these over the course of the half-quarter, posted to the UChicago Voices blog as a clearly sign-posted 500-700 word discussion. Diagrams, images of prototype mock-ups, and group-produced video can be embedded as they amplify your proposal and detailed demonstration. Pilots could illustrate an actual deployment of a crowd-sourced or machine learning solution on an exemplary task or simulated data (e.g., drawing on algorithms and models from the Python Jupyter notebooks described below or others learned through prior experience or classes at Booth), or interviews with potential suppliers or customers that demonstrate the efficacy of a solution if achieved.

Student groups will briefly share one profile or pitch over the course of the quarter for interactive evaluation by the class in Ignite Talk format—5 minutes, 20 PDF slides, auto-advancing every 15 second (see a description here). These will be due at 10am the day of class in the relevant week. For those not presenting, they will be due the Friday following class at 5pm.

Final Project: This project will involve expansion on the most promising of your solution pitches or radical alteration to an existing company solution from a solution profile into a **final pitch**, of the same form described immediately above, but written in longer format (1000-1400 words), with a more substantial pilot. These will also be performed for an audience of your peers and outside experts in an Ignite Talk format. Students will collectively evaluate these pitches through a securities market, and be ultimately scored not only on expert evaluations of their own presentations, but also their estimation of the value of others' projects combined with the expert evaluations of those projects (see below for more details).

Examples: Each week, I will produce a new Python Jupyter notebook with one or more working examples of machine intelligence relevant to our course subject. I will briefly mention and illustrate these in class and/or through online resources. Students may follow along with their own sandboxed version of this code, and groups may choose to repurpose code for their solution pitches. There is no requirement to use these notebooks.

Course Schedule

Week 1 (5/3): Augmented Intelligence

How can we maximize collective intelligence by designing ensembles of machines, crowds and data?

Case: Netflix, Designing the Netflix Prize (A & B)

Readings:

- Kasparov, Garry. "The chess master and the computer." *The New York Review of Books* 57.2 (2010): 16-19.
- Brynjolfsson, Erik, and Andrew McAfee. "Winning the Race with Ever Smarter Machines" *Sloan Management Review* (2012).

- Iansiti, Marco, and Karim R. Lakhani. "Digital Ubiquity: how connections, sensors, and data are revolutionizing business." *Harvard Business Review* 92.11 (2014): 91-99.
- Ohlheiser. "Three days after removing human editors, Facebook is already trending fake news." (August 29, 2016).

Optional:
- Fogg, Andrew. "Anthony Goldbloom gives you the secret to winning Kaggle competititions" import.io (2016)
- Bock, Robert, Marco Iansiti and Karim R. Lakhani. "What Companies on the Right Side of the Digital Business Divide Have in Common" *Harvard Business Review* (2017)
- Brynjolfsson, Erik, and Lorin M. Hitt. "Beyond the productivity paradox." *Communications of the ACM* 41.8 (1998): 49-55.
- Tamuz, Omer, et al. "Adaptively learning the crowd kernel." *arXiv preprint arXiv: 1105.1033* (2011).

Week 2 (5/10): Augmented Perception

How can we augment our perception by distributing (or drawing on already distributed) sensors across people, places and devices, and analyzing the data streams they emit?

Case: GE and the Industrial Internet

Readings:
- Brynholffson, Erik and Andrew McAffee. "The Digitization of Just about Everything." Fall 2015. *Rotman Magazine*. Rot 275
- Lazer, David, et al. "The parable of Google Flu: traps in big data analysis." *Science* 343.6176 (2014): 1203-1205.
- Daugherty, Paul, Prith Banergee, and Allan Alter. 2014. "5 Ways Product Design Needs to Evolve for the Internet of Things" Harvard Business Review.
- Court, David and Dominic Barton. "Making Advanced Analytics Work For You: A practical guide to capitalizing on big data." *Harvard Business Review*.

Optional:
- Hanna, Rema, Sendhil Mullainathan, and Joshua Schwartzstein. "Learning through noticing: Theory and evidence from a field experiment." *The Quarterly Journal of Economics* 129.3 (2014): 1311-1353.

Week 3 (5/17): Augmented Judgment

How can we augment collective judgment by constructing machine learning models that increase the speed or accuracy of organizational decision-making?

Case: Aspiring Minds

Readings:
- Domingos, Pedro. *The Master Algorithm*. Penguin Books, 2016. Chapter 2, "the Master Algorithm": 23-55.

- Silver, Nate. *The signal and the noise: Why so many predictions fail-but some don't.* Penguin, 2012. Chapter 6, "How to drown in three feet of water."
- McElheran, Kristina and Erik Brynholffson. "The Rise of Data driven Decision Making is Real but Uneven." *Harvard Business Review* (2015).

Optional:
- Kleinberg, Jon, et al. "Prediction policy problems." *The American economic review* 105.5 (2015): 491-495.
- Brynjolfsson, Erik, Lorin M. Hitt, and Heekyung Hellen Kim. "Strength in numbers: How does data-driven decisionmaking affect firm performance?" (2011).
- O'Neil, Cathy. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. Crown, 2016. Introduction, Bomb Parts, and Ineligable to Serve.
- Brynjolfsson, Erik and Kristina McElheran. "The Rapid Adoption of Data-Driven Decision-Making" *The American economic review* (2016) 106(5): 133–139. *http://dx.doi.org/10.1257/aer.p20161016*

Week 4 (5/24): Augmented Organization

How can we augment an organization's collective intelligence by networking (or drawing on existing) crowds and communities beyond them.

Case: Innocentive A

Readings:
- Iansiti, Marco and Karim Lakhani. "The Truth About Block Chain." *Harvard Business Review* January-February 2017:HBR R1701J
- King, Andrew and Karim Lakhani. "Using Open Innovation to Identify the Best Ideas." *Sloan Management Review* 55(1):SMR 466.
- Boudeau, Kevin J. and Karim R. Lakhani. "Using the Crowd as an Innovation Partner." *Harvard Business Review* April 2013 R3104C.
- Parise, Salvatore, Eoin Whelan, and Steve Todd. "How Twitter users can generate better ideas." *MIT Sloan Management Review* 56.4 (2015): 21.
- Schlack, Julie Wittes. "Ask Your Customers for Predictions, Not Preferences" *Harvard Business Review* January, 2015.

Optional:
- Nielsen, Michael. *Reinventing discovery: the new era of networked science*. Princeton University Press, 2012, chapter 4, "Patterns of Online Collaboration", 44-68.
- Page, Scott E. *The Difference: How the power of diversity creates better groups, firms, schools, and societies*. Princeton University Press, 2008., chapter 1, "On Diversity and Complexity", 16-53.

Week 5 (5/31): Augmented Imagination

How can we augment imagination by deploying algorithms and networking crowds and communities to generate and filter novel solutions?

Case: A Menagerie of Examples

1. Blue Chef (later "Chef Watson")
   - The Vision: Varshney, Lav R., et al. "A big data approach to computational creativity." *arXiv preprint arXiv:1311.1213* (2013).
   - Popular evaluation as Blue Chef in the press.
   - The Chef Watson website.
2. Narrative Science
   - Popular evaluation of Narrative Science in the press.
   - The Narrative Science website.
3. Computational Visual Art by Jason Salavon
   - 100,000 abstract paintings.
   - Herotown(s).
   - Still Life (Morandi's Infinite Shelf).
4. Movie Trailer for Morgan by IBM's Watson
   - Popular press.
   - Watch it here.
5. Movie Script for Sunspring:
   - Popular press.
   - Watch it here.

Readings:

- Brynjolfsson, Erik, and Andrew McAfee. *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. WW Norton & Company, 2014. Chapter 5. Innovation: Declining or Recombining, 71-88.
- Domingos, Pedro. *The Master Algorithm*. Penguin Books, 2016. Chapter 5, "Evolution: Nature's Algorithm", pp. 121-142.
- Boudreau, Kevin J., and Karim R. Lakhani. "Using the crowd as an innovation partner." *Harvard business review* 91.4 (2013): 60-69.
- Hulme, Tom, Matt R. Tucker, Colin Maclay, Karim R. Lakhani, "Can you crowdsource a big idea?" *Harvard Business Review*
- Parise, Salvatore, Eoin Whelan, and Steve Todd. 2016. "How Twitter Users can Generate Better Ideas," *Sloan Business Review*.

Optional:

- Johnson, Steven. *Where Good Ideas Come From*. Penguin, 2010. Chapter 1: "The Adjacent Possible".
- Schmidt, Michael, and Hod Lipson. "Distilling free-form natural laws from experimental data." *science* 324.5923 (2009): 81-85.
- Itti, Laurent, and Pierre Baldi. "Bayesian surprise attracts human attention." *Vision research* 49.10 (2009): 1295-1306.
- Domingos, Pedro. *The Master Algorithm*. Penguin Books, 2016. Chapter 6, "In the Church of the Reverend Bayes", pp. 143-175.

Course Requirements

There are four graded requirements for the course:

- Case write-ups (15%)
- Class discussion (20%)
- Weekly Profiles/Pitches (35%)
- Final group project (30%)

This class **cannot** be taken **pass/fail**.

Case Write-ups:

You are required to submit a write-up each week.

Your write-up grade will be pass/fail. Write-ups are graded on a ✓, no ✓ scale. You must receive a ✓ on at least three write-ups to receive a passing grade.

All write-ups are due before class. If you attend a different section for the week, your write-up is due before the section you attend or before your assigned section, whichever comes first. You may not submit a write-up after having attended class. Submit write-ups to Canvas.

Class Participation:

This course depends heavily on case discussions. Cases expose the ambiguities that are part and parcel of any decision. Case discussions develop the skills of persuasion, analysis, and listening that are key to the success of any general manager.

You are expected to be an active participant throughout the quarter. Please note that the frequency (i.e., the quantity) of your contributions in class is not the only criterion for effective class participation. The quality of your participation is more important. Criteria that are useful in measuring effective class participation include:

- Is the participant a good listener? Does s/he respond to other comments, and not simply repeat what has already been said?
- Are the points that are made relevant to the discussion? Are they linked to the comments of others? Is there willingness to test new ideas or are all comments "safe" (for example, repetition of case facts without analysis and conclusions)?
- Do the comments show evidence of analysis of the case and an understanding of the assigned reading?
- Do comments lead to a clearer statement of the concepts being covered and the problems being addressed?

It is also important to remember:

- Well-posed questions are not only a legitimate way to interact, but should be an important part of the discussions.
- In most of the cases we discuss, there will be many different actions and plans that could be undertaken. Enlightened debate about the best plan to implement adds significantly to understanding of the issues.

- Because of the varied backgrounds in the class, many of you will have important contributions to make based on your personal experience. You are encouraged to bring these experiences to bear on the analysis of the cases.

I expect you to be prepared for class each week. I will cold call on people. If you are not adequately prepared for class and do not wish to be called on, please tell me prior to the beginning of class. I will drop your lowest participation grade for the quarter. Repeated absences will negatively affect your overall participation grade.

Weekly Profiles/Pitches:

Group solution profiles and pitches, as described above, will be graded on a 3-level scale: ✓+ (the emoticon: '=)') for a compelling profile or pitch that generates new insight and would enable a potential investor to make a reasoned (and in the case of a pitch, favorable) decision about the promise and appropriable value of the approach for backing; ✓ (the emoticon: '8|') for an interesting profile or pitch that clearly describes the problem, opportunity, and solution, but nevertheless fails to perform an insightful analysis or convincing demonstration of their solution or proposed alteration's promise and its appropriable value, required to make a reasoned decision; ✓−(the emoticon: '-_-') for a profile or pitch that fails to clearly articulate the problem and profiled or proposed solution, necessarily rendering the analysis or proposed demonstration inconclusive.

For solution profiles, imagine the memo a venture capitalist might internally generate to critically evaluate its own company assets, and how to maximize their value through recombination.

For solution pitches, consider the criteria for U.S. patents: – novelty, utility, non-obviousness, and sufficient detail to enable replication. To "utility" add the value proposition for a potential investor—what value could be appropriated from the solution. For example, while Google creates information search efficiencies for many who use it, the company primarily appropriates value from the eyeballs this attracts and its use of user data to feed them targeted advertising, paid by advertiser.

Final Project: Final pitches will be accompanied with a short, 5 minute Ignite Style oral presentation presented by one or more group members to an audience of peers and experts. Based on reading pitches and watching presentations, students will engage in a collective valuation procedure involving trading randomly valued securities based on the perceived valuation of these pitches, where final grades will be awarded based on both expert evaluation of your group's presentation *and* a quantity determined by your ultimate portfolio of securities, multiplied by the expert evaluation for each securitized project.

Team evaluation: I will provide a form that allows you to assign relative credit to the members of your project group. If you receive discernibly lower or higher standardized within-group scores, this will affect your final project grade. If you do not evaluate your team members, I will assume you rate each equally.

Accommodations:

If you require any accommodations for this course, as soon as possible please provide me with a copy of your Accommodation Determination Letter (provided to you by the

Student Disability Services office) so that we may discuss how your accommodations may be implemented. The University of Chicago is committed to ensuring the full participation of all students in its programs. If you have a documented disability (or think you may have a disability) and, as a result, need a reasonable accommodation to participate in class, complete course requirements, or benefit from the University's programs or services, you are encouraged to contact Student Disability Services as soon as possible. To receive reasonable accommodation, you must be appropriately registered with Student Disability Services.

Grading Policies

- Chicago Booth policy mandates a maximum average grade of 3.33.
- I provide provisional grades for graduating students.
- Case write-up, class participation, and group profiles/pitches cannot be contested.
- Any request for re-grading for the final written pitch must be submitted in writing within one week of receipt of the grade. Grades cannot be contested in person. The request must include an explanation of why you believe the grade to be in error. Grades may go up or down after a re-grade.
- Absences (excused or unexcused) result in a zero participation grade for that day.
- In computing the class participation score, I will drop each person's and each group's lowest score over the course of the half-session.

Honor Code

Students in the class are required to adhere to the standards of conduct in the Chicago Booth Honor Code and the Chicago Booth Standards of Scholarship.