MA in Computational Social Science

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- Zhao Wang (MACSS)

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General Information

The Master of Arts in Computational Social Science (http://macss.uchicago.edu/) is a two-year program of graduate study. It has a structured curriculum, with a total of 18 required and elective courses tailored to the disciplinary track a student follows. Students submit an article-length MA thesis in their second year, modeled on a professional journal article.

The program aims to produce leading social scientists in each of the core social science fields—economics, sociology, political science, psychology, history, and anthropology—producing competitive PhD applicants, well-trained in computational approaches, who have mastered the research and analytical skills necessary to make important contributions. MACSS also offers a concentration in economics which is operated jointly with the Department of Economics. Students receive close mentorship from the program's Faculty Directors, academic staff, and members of our Executive and Affiliated Faculty to design a customized curriculum, define an area of scholarly research, and write a MA Thesis.
They receive full professional support from the director of career services, with biweekly workshops, career planning, and employer recruitment.
Finally, all MA students may participate in an optional summer practicum between their first and second years, with internships drawn from academic and professional organizations. International students have three years of STEM work eligibility after they graduate.

Program Requirements and Course Work

General MACSS curriculum

In their first year, all MA students will complete:

- The Computational Math camp or the Econ Math camp and the Computing Fundamentals Boot Camp, which run for three weeks in August / September.
- A Computational Statistics placement exam and a Computing Fundamentals exam offered at the end of the Boot Camps.
- A three-course core in Perspectives (Perspectives on Computational Analysis, Perspectives on Computational Modeling, and Perspectives on Computational Research).
- A three-course computing sequence. This computing sequence provides our students with all the necessary computing skills to write their own programs, collect, process and scale their computational research workflows to run in on-premise computing clusters, as well as the Cloud.
- Three graduate social science electives that will vary, depending on the student's prior training and intended disciplinary path.
- Minor exceptions: (1) students who do not place out on our statistics exam will take an introductory course in computational statistics instead of a social science elective in the Fall quarter; (2) students who need additional math for computational economics will take those courses before attempting graduate level electives in economics; (3) students may take more advanced programming courses instead of the first two courses in our computing sequences, if they place out on a computer science placement exam administered in the September before the start of the Fall quarter.

In their second year, all MA students will complete:

- Three advanced courses in computational methods, drawn from any graduate department or professional school of the University.
- Three graduate social science electives.
- Three graduate courses that the student may select, from any UChicago department or professional school, where the student meets the minimum prerequisites.
- Students may register for the MA Research Commitment once during the second year. This option allows students to allocate more time to their MA thesis. The course grade will be the one the faculty reader assigns on the final draft of the MA thesis, no matter when that paper is submitted. If students want additional course credit for working on their thesis project, they may register for independent study with a faculty advisor. The faculty advisor and student will form an agreement at the beginning of the quarter outlining the requirements for the student and what work the student must produce in order to earn a letter grade for the independent study.

Outside of their coursework, all MA students are expected to attend our weekly Computation Workshop, where advanced scholars and invited guests present drafts of their research for critique and discussion.

MACSS-Econ curriculum

In their first year, all MACSS-Econ students will complete:

- Computational Math Camp (MACS 33000), which will run for three weeks in September.
- Computing Fundamentals Boot Camp (MACS 30120), which will also run for three weeks in September.
- A Computational Statistics placement exam and Computing Fundamentals exam, offered at the end of the Boot Camps.
- A Computer Science placement exam, offered during orientation week.
- A two-course core in Perspectives on Computational Analysis and Computational Modeling, the first of which must be taken autumn quarter.
- A three-course core in Foundations of Quantitative Analysis. (Up to 2 courses may be waived via statistics placement exam)

In their second AND/OR first year, all MACSS-Econ students will complete:

- Econ Math Camp (ECON 30400) which will run for three weeks in September.
- A three-course core in Computer Science with Social Science Applications OR a three-course core in Principles of Computing. (Up to 2 courses may be waived via computer science placement exam)
- Two courses to satisfy the Foundations in Economic Theory requirement.
- Two courses to satisfy the Foundations in Empirical Analysis/Computational Methods requirement.
- Six graduate economics/computational method electives that will vary, depending on the student's prior training and intended disciplinary path. (This number may increase if student earns placement on CS or stats exams)
- Students may register for the MA Research Commitment once during the second year. This option allows students to allocate more time to their MA thesis. The course grade will be the one the faculty reader assigns on the final draft of the MA thesis, no matter when that paper is submitted. If students want additional course credit for working on their thesis project, they may register for independent study with a faculty advisor. The faculty advisor and student will form an agreement at the beginning of the quarter outlining the requirements for the student and what work the student must produce in order to earn a letter grade for the independent study.

Outside of their coursework, all MA students are expected to attend our weekly Computation Workshop, where advanced scholars and invited guests present drafts of their research for critique and discussion.

Admission

MACSS applicants must meet the formal requirements of the Graduate Social Sciences Division which are listed here (https://socialsciences.uchicago.edu/admissions/application-materials/).

MACSS offers tuition scholarships at the time of admission. Some financial need-based tuition scholarships may be available through an application process after prospective students are admitted.

Applicants to the Division of the Social Sciences and the University of Chicago who do not meet waiver criteria must submit proof of English language proficiency. Please contact our Dean of Students Office with any questions: ssd-admissions@uchicago.edu

How to Apply

The application with instructions and deadlines, is available online at: https://socialsciences.uchicago.edu/admissions/how-to-apply (https://socialsciences.uchicago.edu/admissions/how-to-apply/). Current students in the University of Chicago College may be eligible to apply through UChicago Advanced Scholars (https://careeradvancement.uchicago.edu/student-opportunities/uchicago-advanced-scholars-program/) instead.

Any questions about MACSS can be directed to Sabrina Biggus our Student Affairs Administrator, at 773-702-8304 or sbiggus@uchicago.edu.

Please also visit our website: https://macss.uchicago.edu (https://macss.uchicago.edu/)

Computational Social Science Courses

MACS 30000. Perspectives on Computational Analysis. 100 Units.
Massive digital traces of human behavior and ubiquitous computation have both extended and altered classical social science inquiry. This course surveys successful social science applications of computational approaches to the representation of complex data, information visualization, and model construction and estimation. We will reexamine the scientific method in the social sciences in context of both theory development and testing, exploring how computation and digital data enables new answers to classic investigations, the posing of novel questions, and new ethical challenges and opportunities. Students will review fundamental research designs such as observational studies and experiments, statistical summaries, visualization of data, and how computational opportunities can enhance them. The focus of the course is on exploring the wide range of contemporary approaches to computational social science.
Instructor(s): Ali Sanaei, Henry Dambanemuya, David Peterson, Fabricio Vasselai Terms Offered: Autumn Winter

Note(s): This course cannot be dropped without instructor consent.
Equivalent Course(s): MACS 10000

MACS 30005. Graduate Practicum in the Social Sciences. 100 Units.
Students interested in gaining additional applied experience or writing an alternative or public facing thesis should consider taking the Graduate Practicum in the Social Sciences course. The practicum is a hands-on experiential course designed to enable students to apply and expand their knowledge in a career pathway based on their unique interests and improve their technical and applied writing skills, all while providing a useful service to a Chicago-based community partner. During the course, students work individually or in small teams to research a career pathway and identify and address issues/needs faced by a local community partner of their choice. Each student or team receives guidance from their instructor and community partner throughout the project. The experience culminates in a final project (report and formal presentation to the community partner and/or class).
Instructor(s): Shelly Robinson Terms Offered: Winter
Equivalent Course(s): MAPS 30005, INRE 30005

MACS 30100. Perspectives on Computational Modeling. 100 Units.
This is a core-course for the MACSS program and it requires Python programming experience (for non-MACSS students, please email the instructor for consultation). This course will teach fundamental skills of applying statistical machine learning models in computational social science tasks. It will focus on understanding the strengths and weaknesses of modern machine learning algorithms as well as their applications in real-world tasks. Topics will include the key techniques in standard machine learning pipelines: data processing (e.g., data representation, feature selection), classification models (e.g., decision trees, logistic regression, naive bayes), regression models (e.g., linear regression), model evaluation (e.g., cross-validation, confusion matrix, precision, recall, and f1 for classification models; RMSE and Pearson correlation for regression models), and error analysis (e.g., data imbalance, bias-variance tradeoff, interpret model performance).
Instructor(s): Zhao Wang, Ali Sanaei Terms Offered: Winter
Note(s): Consent required for all Undergraduate and Non MACSS students
Equivalent Course(s): MACS 10100

MACS 30111. Principles of Computing 1: Computational Thinking for Social Scientists. 100 Units.
This course is the first in a three-quarter sequence that teaches fundamentals of computational thinking to students in the social sciences. Lectures in the class will cover topics such as functions, data structures, as well as classes and objects. Assignments will give students the opportunity to practice these basic computing concepts using the Python programming language and get familiar with computational logic in real-world tasks.
Instructor(s): Clipperton, Jean Terms Offered: Autumn Winter
Prerequisite(s): This course is intended for those who placed into it via MACS 30120 "Computing Fundamentals Boot Camp" or for those who are not otherwise prepared to independently and fluently write code using any programming language (e.g., R, Python, C, C++, Java). Note that this is the introductory version of MACS 30121. We will provide several test questions to help students better identify the suitability of this course at the beginning of the quarter.
Equivalent Course(s): MACS 10111

MACS 30112. Principles of Computing 2: Data Management for Social Scientists. 100 Units.
This course is the second in a three-quarter sequence that teaches computational thinking and programming skills to students in the social sciences. Specifically, this course equips students with a fundamental toolkit for working with social science data. Students will learn the basics of web-scraping, relational databases, record linkage, data cleaning, modeling, visualization, and data structures. The programming language of the course is Python.
Instructor(s): Nardin, Sabrina Terms Offered: Winter
Prerequisite(s): MACS 30111 or instructor consent. Note that this is the introductory version of MACS 30122. Instructor consent required for all non-MACS students.
Equivalent Course(s): MACS 10112

MACS 30113. Principles of Computing 3: Big Data and High Performance Computing for Social Scientists. 100 Units.
Computational social scientists increasingly need to grapple with data that is too big and code that is too resource intensive to run on a local machine. Using Python, students in this course will learn how to effectively scale their computational methods beyond their local machines --optimizing and parallelizing their code across clusters of CPUs and GPUs, both on-premises and in the cloud. The focus of the course will be on social scientific applications, such as: accelerating social simulations by several orders of magnitude, processing large amounts of social media data in real-time, and training machine learning models on economic datasets that are too large for an average laptop to handle.
Instructor(s): TBD Terms Offered: Spring
Prerequisite(s): MACS 30111 and MACS 30112, or equivalent
Equivalent Course(s): MACS 10113

MACS 30120. Computing Fundamentals Boot Camp. 000 Units.
This boot camp focuses on introducing fundamental open-source tools for producing reproducible, computational research. Topics include the basics of Python programming, working on the Linux command line,

as well as using Git/GitHub for version control. The course assumes no prior exposure to these topics and serves as preparation for MACS 30121 "Computer Science with Social Science Applications 1."
Instructor(s): Jon Clindaniel Terms Offered: Summer

MACS 30121. Computer Science with Social Science Applications 1. 100 Units.
This course is the first in a three-quarter sequence that teaches computational thinking and essential skills to students in the social sciences. Lectures in the class will cover topics such as functions, data structures, classes and objects, as well as recursion. Assignments will give students the opportunity to practice these computing concepts using the Python programming language and apply the computational logic in a wide variety of social science applications. Previous example assignments include modeling epidemics, modeling language shifts, analyzing candidate tweets from presidential debates, determining the number of machines needed at a polling place, predicting housing price with linear regression models
Instructor(s): Zhao Wang Terms Offered: Autumn
Prerequisite(s): At least one completed programming course and the ability to fluently and independently write code using any programming language (e.g., R, Python, C, C++, Java). Note that this is the accelerated version of MACS 30111. We will provide several test questions to help students better identify the suitability at the beginning of the quarter.

MACS 30124. Computational Analysis of Social Processes. 100 Units.
How does the human social and cultural world develop and change? The focus of this course is on introducing computational methods for studying the evolution of phenomena over time, alongside relevant theories for interpreting these processes from fields such as History, Anthropology, and Sociology. Students will gain hands-on experience using the Python programming language to harness a diverse set of digital data sources, ranging from satellite images to social media posts. Additionally, they will learn to employ computational approaches, such as simulation and dynamic topic modeling, to study social processes over a variety of different time scales: from the short term (changes in social media network structures over the course of the past week), to longer term (the evolution of English language discourse over the past 100 years), to deep time scales (long-term settlement pattern dynamics over the past 10,000 years).
Instructor(s): Jon Clindaniel Terms Offered: Autumn
Equivalent Course(s): MAPS 30124

MACS 30135. Interpretable and Explainable Machine Learning - from Prediction to Knowledge. 100 Units.
ML is already ubiquitous, revolutionizing our lives in all domains. Precisely because of this, its new frontier is occupied with finding ways to ensure that we truly understand and exert control over how our techniques predict what they predict, and generate the results that they generate. This movement beyond being satisfied with just the accuracy of results is critical for a couple of reasons. First, as the wise say, with great power comes great responsibility - since our revolutionary ML techniques only learn from what we feed them, they reproduce (and even exacerbate) biases present in our data. To counter this, we need to be able to interpret and then intervene in how Machine Learning learners are learning what they learn. Second, by being able to interpret, explain and modify how algorithms learn what they learn from our datasets (not merely how algorithms mechanically work), we can uncover relevant latent knowledge hidden in such data. In this course, we start by discussing what Interpretable or Explainable ML even means to different audiences. Next, students will be introduced to several types of state-of-the-art techniques that have been proposed to increase the interpretability/explainability of ML models. Along the way, students will be presented to the discussion on how interpretable or explainable models can help fight biases, improve the fairness, trustworthiness or reliability of predictions, and ensure the ethical use of ML as it continues to change our lives.
Instructor(s): Fabricio Vasselai Terms Offered: Winter
Prerequisite(s): prior exposure to linear algebra and probability; to have taken a graduate-level class specific on Machine Learning and which covered Supervised Machine Learning (that is, a class that covers only Unsupervised Machine Learning, or a class on general AI methods, will not suffice); experience programming in Python.
Note(s): Enrollment is only open to graduate students

MACS 30150. Perspectives on Computational Modeling for Economics. 100 Units.
In this course students will learn several computational methodologies and tools to solve, simulate, and analyze models that are the backbone of current macroeconomic analysis. While learning the relevant computational methods is the main objective, the theoretical economic aspects of the model will be stressed and the students will be required to apply their economic knowledge and skills to interpret and analyze the results. We will examine non-stochastic and stochastic general equilibrium models, both under local and global approximations. The main part of the course will deal with representative agent models, but a significant part will be devoted to introducing students to the solution of heterogeneous agent models as well.
Instructor(s): Sergio Salas Terms Offered: Winter
Prerequisite(s): PQ for undergraduates: Econ 20200/20210 and MATH 19620/Stat 24300/Math 20250 and Stat 23400/Stat 24400/Stat 24410.
Note(s): MACSS students have priority.
Equivalent Course(s): ECMA 31140, MACS 10150

MACS 30200. Perspectives on Computational Research. 100 Units.
This course focuses on applying computational methods to conducting social scientific research and the development of a strong research proposal. Students will identify a research question of their own interest that involves a direct reference to social scientific theory, the use of data, and a significant computational component. The students will review existing literature, identify an appropriate data source and conduct exploratory analysis, or develop a method (e.g. survey, experiment) through which they plan on collecting data, and generate a complete and well-motivated research proposal. The course will include modules on theoretical and practical considerations, including topics such as epistemological questions about research design, conducting literature reviews, data visualization and interpretation, reproducible research, writing and rhetoric, as well as presenting work to an audience.
Instructor(s): Pedro Arroyo, Shilin Jia, Ali Sanaei Terms Offered: Spring
Prerequisite(s): MACSS students have priority. Others admitted with instructor consent.
Equivalent Course(s): MACS 10200

MACS 30205. Public Opinion Research in Practice. 100 Units.
This seminar provides an introduction to the evolving landscape of public opinion research in the digital age. It combines foundational theories and methods with an emphasis on how computational techniques have transformed the field. The goal is to equip students with a robust understanding of public opinion research, along with practical skills in data gathering, analysis, and interpretation, and insight into recent developments in data collection methodologies. We will focus on experimental methods, especially survey experiments, and on utilizing social media as a source of data and as a medium for recruiting respondents. Throughout the course, students will have the opportunity to produce an original public opinion research project, applying the techniques and methods discussed.
Instructor(s): Sanaei, Ali Terms Offered: Spring
Equivalent Course(s): MAPS 30205

MACS 30250. Perspectives on Computational Research for Economics. 100 Units.
This course focuses on scaling up computational approaches to social science analysis and modeling with big data in context of opportunities afforded by high performance and cloud computing. We will begin by exploring various data structures encountered in social science research, how to deal with large or complex data storage and streaming data, and how to factor considerations of computational complexity into their analyses. We will also study social science applications of parallel computing, both on stand-alone machines and in supercomputing environments, to carry out complex computations. Students will learn to carry out parallel I/O and parallel computation on their own machines and on a cluster. We will also address API construction and access, and explore cloud configurations for social science research designs. We will also help students construct web-based outward facing data, analysis and visualization portals. Students will efficiently gather, structure, perform and present analysis on large-scale social science data. This course will be specifically tailored to students concentrating in Economics.
Instructor(s): R. Evans Terms Offered: Spring
Prerequisite(s): MACSS students have priority.

MACS 30267. Thinking like a Computational Social Scientist. 100 Units.
The movement of much of our social lives online has created exciting new opportunities for social science research. This course provides a broad survey of computational methods used to make sense of this data. Students will learn how to collect online data and analyze this data using contemporary techniques from natural language processing, supervised/unsupervised machine learning, and generative AI. Students will also cultivate analytical skills through formal paper presentations, oral exams, and an original research project. The course will be taught in Python. This is an intuitive introduction without prerequisites, although previous experience with probability, statistics, and/or programming will be helpful.
Equivalent Course(s): MACS 20267, SOCI 20602, PSYC 28520, SOCI 40267, PSYC 38520, DATA 20602, HIST 49307

MACS 30300. Data Science Clinic I. 100 Units.
In order to enroll in this class, students must first submit an application and be matched with a project. Visit the Data Science Clinic site for application deadlines, how to apply, and information session details: https://github.com/dsi-clinic/the-clinic. The Data Science Clinic partners with public interest organizations to leverage data science research and technology to address pressing social and environmental challenges. The Clinic also provides students with exposure to real-world projects and problems that transcend the conventional classroom experience including: working with imperfect datasets, applying models and algorithms to real-world data, navigating security and privacy issues, communicating results to a diverse set of stakeholders (e.g., industry, public interest, government agencies), and translating information into actionable insights, policy briefs and software prototypes. The Clinic is an experiential project-based course where students work in teams as data scientists with real-world clients under the supervision of instructors. Students will be tasked with producing key deliverables, such as data analysis, open source software, as well as final client presentations, and reports.
Instructor(s): N. Ross Terms Offered: Autumn Spring Winter
Prerequisite(s): DATA 12000, DATA 13600, DATA 21100, DATA 21200, DATA 23100 (or equivalent) and by permission of instructor
Equivalent Course(s): CAPP 30300, MPCS 57300, DATA 27100, PPHA 30581

MACS 30455. Collective Intelligence. 100 Units.
An impactful discovery in human decision-making has been "crowd wisdom,'" or the ability of crowds to make better decisions than individuals. Classic wisdom of crowds theory is based on evidence gathered from studying large groups of diverse and independent decision-makers. Yet, most human decisions are reached in online settings of interconnected, like-minded people who challenge these criteria. In this course, students will engage with general science literature drawn from diverse disciplines (e.g., computer science, business, psychology, behavioral economics, political science, etc) to gain a better understanding of collective intelligence and how it emerges (i.e., principles and mechanisms) in diverse contexts, both online and offline. For instance, students will learn the theoretical background underpinning the wisdom of crowds, aggregation methods & techniques for pooling individual estimates in collective settings, network dynamics of collective intelligence, and applications of collective intelligence in society, business, and teams. Most class time will be spent discussing the assigned readings. In most weeks, students will write a short response memo to the assigned readings. By the end of the course, students will synthesize their knowledge to develop a term paper or research proposal that aims to advance some theoretical, methodological, or computational aspects of collective intelligence.
Instructor(s): Henry Dambanemuya Terms Offered: Winter
Note(s): Open to graduate students only

MACS 30500. Computing for the Social Sciences. 100 Units.
This is an applied course for social scientists with little-to-no programming experience who wish to harness growing digital and computational resources. The focus of the course is on learning the basics of programming and on generating reproducible research. Topics include coding concepts (e.g., data structures, control structures, functions, etc.), data visualization, data wrangling and cleaning, version control software, exploratory data analysis, etc. Students will leave the course with basic programming skills for the social sciences and will gain the knowledge of how to adapt and expand these skills as they are presented with new questions, methods, and data. The course is taught in R. Requirements: At least one prior course that made use of a programming language (e.g., Python, R, Stata, SPSS, etc.) in some capacity. If you are unsure or had some informal exposure, email the instructor to see if the course is a good fit.
Instructor(s): Jean Clipperton Terms Offered: Autumn Spring Winter
Note(s): MACS students have priority.
Equivalent Course(s): PSYC 30510, ENST 20550, PLSC 30235, SOCI 40176, SOSC 26032, CHDV 30511, MACS 20500, SOCI 20278, MAPS 30500

MACS 30519. Spatial Cluster Analysis. 100 Units.
This course provides an overview of methods to identify interesting patterns in geographic data, so-called spatial clusters. Cluster concepts come in many different forms and can generally be differentiated between the search for interesting locations and the grouping of similar locations. The first category consists of the identification of extreme concentrations of locations (events), such as hot spots of crime events, and the location of geographical concentrations of observations with similar values for one or more variables, such as areas with elevated disease incidence. The second group consists of the combination of spatial observations into larger (aggregate) areas such that internal similarity is maximized (regionalization). The methods covered come from the fields of spatial statistics as well as machine learning (unsupervised learning) and operations research. Topics include point pattern analysis, spatial scan statistics, local spatial autocorrelation, dimension reduction, as well as spatially explicit hierarchical, agglomerative and density-based clustering. Applications range from criminology and public health to politics and marketing. An important aspect of the course is the analysis of actual data sets by means of open source software, such as GeoDa, R or Python.
Instructor(s): L. Anselin and P. Amaral Terms Offered: Winter
Prerequisite(s): STAT 22000 or equivalent; SOCI 20253/30253 (or equivalent) Introduction to Spatial Data Science required.
Equivalent Course(s): GISC 30519, SOCI 20519, GISC 20519, SOCI 30519, MACS 20519, DATA 20519, ENST 20519

MACS 30755. Digital Experiments. 100 Units.
This course takes a hands-on approach to help students develop a deep understanding of the theoretical underpinnings, principles, and methodologies of digital experimentation. Students learn how to design robust and ethical digital experiments in various domains (e.g., online behavior, A/B testing, product design, etc.) while mastering tools and platforms for running digital experiments, such as survey platforms, online experiment frameworks, and analytics tools. Key concepts taught in this course include causal inference, experiment types and validity, factorial designs, sampling, blocking, random assignment, stimuli, mediators, moderators, and effect sizes. Class sessions alternate between lectures & workshops and the culmination of the course requires students to apply their newly acquired knowledge of digital experimental design to solve real-world research problems, e.g., in marketing, behavioral economics, and the social sciences more broadly.
Instructor(s): Henry Dambanemuya Terms Offered: Spring
Prerequisite(s): Statistics or research methods coursework

MACS 31300. AI Applications in the Social Sciences. 100 Units.
Artificial Intelligence (AI) describes algorithms constructed to reason in uncertain environments. This course provides an introduction to AI applications in the social sciences. Driven by the rapid increase in accessible big data documenting social behavior, AI has been applied to: increase effective diagnosis and prediction under different conditions, improve our understanding of human interaction, and increase the effectiveness of data management in different social and human services. Random forests and neural networks are among the most

frequent AI methods used for prediction, while natural language processing and computer vision contribute to understanding decision-making and improving service provision. We begin with careful consideration for what AI can achieve and where current limitations exist by looking at a variety of real-world applications. We will focus on three core sections: search, representation, and uncertainty. In each section, we will explore major approaches, representational techniques and core algorithms. We will examine the trade-offs between model structure and the algorithmic constraints that this structure implies. The course is driven by hands-on exercises with AI algorithms written in Python. At the end of the term, you should be able to apply and tweak these algorithms to accommodate your own data and research interests.
Instructor(s): Brooke Luetgert Terms Offered: Spring
Prerequisite(s): One course in introductory data science as well as basic familiarity with Python are prerequisites for the course.

MACS 33000. Computational Math Camp. 000 Units.
This course surveys mathematical and statistical tools that are foundational to computational social science. Topics to be reviewed include mathematical notation and linear equations, calculus, linear algebra, probability theory, and statistical inference. Students are assumed to have encountered most of these topics previously, so that the camp serves as a refresher rather than teaching entirely new topics. Class sessions will emphasize problem solving and in-class exercises applying these techniques. Students who successfully complete the camp are situated to pass the MACSS math and statistics placement exam and enroll in computationally-enhanced course offerings at the University of Chicago without prior introductory coursework.

MACS 33002. Introduction to Machine Learning. 100 Units.
This course requires Python programming experience. The course will train students to gain the fundamental skills of machine learning. It will cover knowledge and skills of of running with computational research projects from a machine learning perspective, including the key techniques used in standard machine learning pipelines: data processing (e.g., data cleaning, feature selection, feature engineering), classification models (e.g., logistic regression, decision trees, naive bayes), regression models (e.g., linear regression, polynomial regression), parameter tuning(e.g., grid-search), model evaluation (e.g., cross-validation, confusion matrix, precision, recall, and f1 for classification models; RMSE and Pearson correlation for regression models), and error analysis (e.g., data imbalance, bias-variance tradeoff). Students will learn simple and efficient machine learning algorithms for predictive data analysis as well as gain hands-on experience by applying machine learning algorithms in social science tasks. The ultimate goal of this course is to prepare students with essential machine learning skills that are in demand both in research and industry.
Instructor(s): Wang, Zhao Terms Offered: Winter
Prerequisite(s): Python programming experience required.
Equivalent Course(s): PLSC 43505, MAPS 33002, MACS 23002

MACS 33050. Artificial Intelligence, Innovation, and Growth. 100 Units.
Social and cultural innovation, alongside economic growth, are among the most compelling, critical and challenging phenomena in modern social science. Innovation has always been associated with unleashing transformative growth in art, science, and the economy, and in this class we explore these issues in the context of the contemporary emergence of Artificial Intelligence (AI). AI represents a novel source of innovation in economy and society, but also a powerful tool for understanding, modeling, and steering innovation in new ways. The primary purpose of this course is to enable students to understand innovation and growth in the age of AI, and with tools from AI alongside theoretical frameworks and methods from economics, sociology, evolution, and complex systems necessary for study them. The course strives to provide students with a background in dynamic analysis, data analysis, and modern AI requisite for studying innovation in the modern age. We will also consider a number of compelling theoretical and empirical challenges, ranging from the paradox of institutionalizing innovation to inequalities that emerging AI capacities could create or remove to advances it could unleash in science and technology to the spread of misinformation to consequences of AI tools and "agents" in all domains of modern life to existential risks associated with AI. We will cover theories and models at an abstract and advanced level.
Instructor(s): Akcigit, U. and Evans, J. Terms Offered: Winter
Prerequisite(s): [MATH 13200 or MATH 15200 or MATH 16200 or MATH 15910 or MATH 20250 or MATH 20300] and [STAT 22000 or STAT 23400 or STAT 24400 or SOCI 20004 or SOCI 20602 or SOCI 20596]
Note(s): You must have the degree of mathematical maturity associated with calculus (e.g., differentials, integrals), optimization (e.g., function fitting), matrix algebra (e.g., multiplication, decomposition), basic statistics (e.g., regression), and basic programming (e.g., Python). The course will involve a technical mid-term and a final group project involving theoretical and data analysis that explores innovation and growth in the age of AI.
Equivalent Course(s): SOCI 20620, SOCI 30620, ECMA 33050, ECON 23050

MACS 35000. MA Research Commitment. 100 Units.
Student Initiated research and writing for the MA research component.
Instructor(s): James Evans, Marc Berman Terms Offered: Autumn Spring Winter

MACS 35001. Structured MA Research Commitment. 100 Units.
Student initiated research and writing for the MA research component.
Instructor(s): James Evans Terms Offered: Autumn

MACS 36000. Computational Methods Using Online Social Media Data. 100 Units.
This course will discuss a broad range of computational social science topics that leverage large-scale data from online communication platforms to gain insights into social issues. We will start from collecting and processing data from social media platforms (e.g., Twitter, IMDB, Airbnb, Yelp), and then introduce computational research topics that include but are not limited to: sentiment analysis, deceptive marketing, recommendation system, fake news detection, spam detection, bot detection, demographic inference, public health, political attitude analysis, personality and behavior analysis, and cyberbullying. We will use version control techniques (e.g., git, Github) to keep track of the class projects. The ultimate goal of this course is to provide a broad introduction of computational social science research areas and train students to be familiar with the pipelines of doing computational research.
Instructor(s): Wang, Zhao Terms Offered: Winter
Equivalent Course(s): MAPS 36001, MACS 26000

MACS 36043. The Aesthetics of Artificial Intelligence. 100 Units.
With the emergence of generative AI tools such as ChatGPT, DALL-E, and Midjourney, the production of computer-generated content has become accessible to a wide range of users and use cases. Knowledge institutions are particularly challenged to find adequate responses to changing notions of authorship as the mainstreaming of 'artificial' texts, audio-visual artifacts, and code is transforming our paradigms of communication in real-time. This course offers a survey of scholarship from the nascent field of critical AI studies to investigate the impact of AI, machine learning, and big data on knowledge production, representation, and consumption. In addition to theoretical discussions, we will conduct research-creation experiments aimed at documenting and evaluating emerging methods of AI-augmented content creation across text, image, and sound. Prospective students should demonstrate a substantial interest in media art and design and its connections to digital humanities, critical theory, and pedagogy. Experience with artistic and/or engineering practice is a plus. Please submit a 300 word max statement of interest to uhl@uchicago.edu by12/22 in order to be considered for enrollment.
Instructor(s): Andre Uhl Terms Offered: Winter
Equivalent Course(s): CMST 26043, CHSS 36043, HIPS 26043, CMST 36043, MADD 12043, KNOW 36043, KNOW 26043, ANTH 26043, ANTH 36043

MACS 37000. Thinking with Deep Learning for Complex Social & Cultural Data Analysis. 100 Units.
A deluge of digital content is generated daily by web-based platforms and sensors that capture digital traces of human communication and connection, and complex states of society, culture, economy, and the world. Emerging deep learning methods enable the integration of these complex data into unified social and cultural "spaces" that enable new answers to classic social and cultural questions, and also pose novel questions. From the perspective of deep learning, everything can be viewed as data-novels, field notes, photographs, lists of transactions, networks of interaction, theories, epistemic styles-and our treatment examines how to configure deep learning architectures and multi-modal data pipelines to improve the capacity of representations, the accuracy of complex predictions, and the relevance of insights to substantial social and cultural questions. This class is for anyone wishing to analyse textual, network, image or arbitrary structured and unstructured data, especially in concert with one another to solve complex social and cultural analysis problems (e.g., characterize a culture; predict next year's ideology).
Instructor(s): James Evans Terms Offered: Spring Winter
Prerequisite(s): The course uses Python and the widely popular PyData ecosystem to demonstrate all motivating examples and includes working code, accompanying exercises, relevant datasets and additional analytics and visualization that facilitate social and cultural interpretation and communication. Familiarity with Python is required.
Equivalent Course(s): MACS 27000, DATA 30332, SOCI 30332

MACS 39999. Reading/Research: Computational Social Science. 100 Units.
Consent only. This is a full-credit independent study course, offered at the discretion of the instructional professor. Interested students should seek a petition from the MACSS Student Affairs Administrator and email the instructor with an intended reading list and a method of evaluation. Required meetings, academic work, and course expectations will be set by the instructor before the quarter begins.

MACS 40100. Big Data and Society. 100 Units.
The massive explosion of information produced by computers and sophisticated computational methods capable of harnessing this data to generate inferences has led to an increasingly data-driven society. Businesses, governments, and individuals seek to leverage this data to develop and market products, formulate policy, and improve the human condition. Computational approaches to decision making have become increasingly prevalent in domains such as criminal justice, education, employment, finance, and politics. While decision making based on data mining and algorithms has the capacity to improve society, critics argue that these approaches strengthen socioeconomic class divisions, constitute an invasion of privacy, or violate the civil rights of minority groups. This course will survey some of the major uses of big data in society and assess the potential ethical, moral, and legal implications of these models.
Instructor(s): B. Soltoff Terms Offered: Autumn

MACS 40101. Social Network Analysis. 100 Units.
This course introduces students to Social Network Analysis (SNA) as a theoretical and methodological approach to studying the structure of relationships among entities (people, organizations, etc.). By the end of the course, students will be able to apply and interpret the most important measures and methods to study social networks from a social science perspective. Topics of this course include fundamental network measures (density, paths, centrality, etc.) and fundamental concepts (structural holes, homophily, etc.); research design; cohesive subgroups; ego networks; affiliation networks; and statistical models. The course is taught in R. Requirements: At least one prior introductory programming or statistics course in Python or R. If you are unsure, please check with the instructor to see if the course is a good fit.
Instructor(s): Sabrina Nardin Terms Offered: Autumn
Equivalent Course(s): SOCI 40248, MACS 20101

MACS 40123. Large-Scale Data Mining for Social and Cultural Knowledge Discovery. 100 Units.
Are you prepared to deepen your knowledge of large-scale computational modeling and pioneer new frontiers in social scientific research? This course will introduce fundamental data mining techniques for extracting insights from massive datasets, as well as the practical and theoretical implications of using these approaches to produce new knowledge about the social and cultural world. For instance, students will learn strategies for deciphering cultural logics at scale (e.g. association rule and frequent itemsets mining), revealing patterns in complex social networks (e.g. link analysis and graph neural networks), and discovering large-scale processes that shape our social and cultural world (e.g. recommender systems and causal rule mining). Through in-class discussions, as well as hands-on exercises using Python and large-scale computing frameworks like Spark, students will develop the mastery necessary to conduct large-scale data mining research. By the course's conclusion, students will synthesize their knowledge and skills into an original research project, geared toward publication in a relevant Computational Social Science journal or conference.
Instructor(s): Clindaniel, Jon; Wang, Zhao Terms Offered: Autumn
Prerequisite(s): Instructor Consent Required. Must complete first-year CSS Computing Sequence (through MACS 10113/30113/30123) and at least one course in Machine Learning (e.g. MACS 10100/30100 or 23002/33002) in order to enroll.
Equivalent Course(s): MACS 20123

MACS 40400. Computation and the Identification of Cultural Patterns. 100 Units.
Culture is increasingly becoming digital, making it more and more necessary for those in both academia and industry to use computational strategies to effectively identify, understand, and (in the case of industry) capitalize on emerging cultural patterns. In this course, students will explore interdisciplinary approaches for defining and mobilizing the concept of "culture" in their computational analyses, drawing on relevant literature from the fields of Anthropology, Psychology and Sociology. Additionally, they will receive hands-on experience applying computational approaches to identify and analyze a wide range of cultural patterns using the Python programming language. For instance, students will learn to identify emerging social movements using social media data, predict the next fashion trends, and even decipher ancient symbols using archaeological databases.
Instructor(s): Clindaniel, Jon Terms Offered: Autumn Winter
Prerequisite(s): No previous coding experience required. A Python boot camp will be held at the beginning of the quarter to teach the coding skills necessary to succeed in the course. Open to Advanced Undergraduates with Instructor Permission.
Equivalent Course(s): MACS 20400, PSYC 40460, MAPS 40401, CHDV 40404

MACS 40550. Agent-Based Modeling. 100 Units.
Social science problems often have so many details and moving parts that it can be difficult for researchers to gain traction without models. In this course, we explore agent-based modeling approaches to understand these social science problems including cooperation and the development of culture. Agent-based models enable us to build an understanding from the bottom up, starting with simple assumptions and analyzing how patterns emerge at a larger scale. Through the term, we'll cover the fundamentals of modeling, including basic principles of model design, data extraction, and canonical examples like Conway's Game of Life, Schelling's segregation model, and Boids/flocking. The course is balanced between social science readings and applications and hands-on coding. It cumulates in a final project consisting of an agent-based model designed by students to apply to a social science phenomenon.
Instructor(s): Clipperton, Jean Terms Offered: Winter
Prerequisite(s): Background in Python at the level of MACS 30111 or equivalent. Consent required for all undergrads not meeting prerequisite and all non MACSS students.
Equivalent Course(s): MACS 20550

MACS 40700. Data Visualization. 100 Units.
Social scientists frequently wish to convey information to a broader audience in a cohesive and interpretable manner. Visualizations are an excellent method to summarize information and report analysis and conclusions in a compelling format. This course introduces the theory and applications of data visualization. Students will learn techniques and methods for developing rich, informative and interactive, web-facing visualizations based on principles from graphic design and perceptual psychology. Students will practice these techniques on many types of social science data, including multivariate, temporal, geospatial, text, hierarchical, and network data. All graphics are designed using R, and students will gain exposure to plotly within R and build a Shiny app.
Instructor(s): Jean Clipperton Terms Offered: Winter

Equivalent Course(s): PLSC 40700, PLSC 20700, MACS 20700

MACS 49800. Research Experience: Psychology Lab. 000 Units.
All MAPSS and MACSS students with a confirmed Psychology lab placement will be pre-registered. This course does not count as one of the three for-credit courses you must take each quarter to maintain full-time status in your MA program.
Instructor(s): Jon Rogowski Terms Offered: Autumn Spring Winter
Equivalent Course(s): MAPS 49800

MACS 51000. Introduction to Causal Inference. 100 Units.
This course is designed for graduate students and advanced undergraduate students from the social sciences, education, public health science, public policy, social service administration, and statistics who are involved in quantitative research and are interested in studying causality. The goal of this course is to equip students with basic knowledge of and analytic skills in causal inference. Topics for the course will include the potential outcomes framework for causal inference; experimental and observational studies; identification assumptions for causal parameters; potential pitfalls of using ANCOVA to estimate a causal effect; propensity score based methods including matching, stratification, inverse-probability-of-treatment-weighting (IPTW), marginal mean weighting through stratification (MMWS), and doubly robust estimation; the instrumental variable (IV) method; regression discontinuity design (RDD) including sharp RDD and fuzzy RDD; difference in difference (DID) and generalized DID methods for cross-section and panel data, and fixed effects model. Intermediate Statistics or equivalent such as STAT 224/PBHS 324, PP 31301, BUS 41100, or SOC 30005 is a prerequisite. This course is a prerequisite for "Advanced Topics in Causal Inference" and "Mediation, moderation, and spillover effects."
Instructor(s): G. Hong Terms Offered: Winter
Prerequisite(s): Intermediate Statistics or equivalent such as STAT 224, PBHS 324, PBPL 31301, BUS 41100, or SOCI 30005
Note(s): CHDV Distribution: M; M
Equivalent Course(s): STAT 31900, SOCI 30315, PLSC 30102, PBHS 43201, CHDV 30102, CHDV 20102, MACS 21000

MACS 51100. Computational Social Science Skills Workshop. 000 Units.
Modern social scientific research designs often require individuals to have advanced computational skills and the ability to write programs that implement the research tasks. This workshop teaches participants a range of computational tools and methods within open-source programming languages (e.g. R, Python, Julia). Workshop topics will vary throughout the quarter and have differing prerequisites (purely introductory, intermediate, advanced training, etc.).
Instructor(s): Soltoff, Benjamin Terms Offered: Autumn Spring Winter

MACS 54000. Introduction to Spatial Data Science. 100 Units.
Spatial data science consists of a collection of concepts and methods drawn from both statistics and computer science that deal with accessing, manipulating, visualizing, exploring and reasoning about geographical data. The course introduces the types of spatial data relevant in social science inquiry and reviews a range of methods to explore these data. Topics covered include formal spatial data structures, geovisualization and visual analytics, rate smoothing, spatial autocorrelation, cluster detection and spatial data mining. An important aspect of the course is to learn and apply open source GeoDa software.
Instructor(s): Y. Lin Terms Offered: Autumn
Prerequisite(s): STAT 22000 (or equivalent), familiarity with GIS is helpful, but not necessary
Equivalent Course(s): GISC 20500, SOCI 20253, GISC 30500, SOCI 30253, ENST 20253, CEGU 20253

MACS 95000. Computation MA Internship. 000 Units.
All MACSS students who have completed three academic quarters of full-time course work in our MA program are eligible to participate in the Computational Social Science Internship Program. Any interested persons must speak with Career Services, have an approved external employer, complete a petition from our Student Affairs Administrator, and enroll in this non-credit field research course. The course will appear on your transcript, and will be evaluated on a pass/fail basis, in consultation with the employer. Note that MACS 95000 does not count against your other curricular requirements.
Instructor(s): James Evans, Marc Berman Terms Offered: Autumn Spring Summer Winter