

Machine Learning PhD Handbook

Revised: March 2021

I. Introduction

The Machine Learning (ML) Ph.D. program is a collaborative venture between Georgia Tech's colleges of Computing, Engineering, and Sciences. The central goal of the PhD program is to train students to perform original, independent research. The most important part of the curriculum is the successful defense of a PhD Dissertation, which demonstrates this research ability. The academic requirements are designed in service of this goal.

The curriculum for the PhD in Machine Learning is truly multidisciplinary, containing courses taught in eight associated schools across three colleges at Georgia Tech:

- Computational Science and Engineering (Computing)
- Computer Science (Computing)
- Interactive Computing (Computing)
- Aerospace Engineering (Engineering)
- Biomedical Engineering (Engineering)
- Electrical and Computer Engineering (Engineering)
- Industrial and Systems Engineering (Engineering)
- Mathematics (Sciences)

[ML PhD Program Faculty](#) from these eight associated schools also supervise students in the program.

The program is administered by the Director, the Faculty Advisory Committee (FAC), the Director of Graduate Program Services, and the ML Academic Advisor. The roles of these entities are detailed below. The lifeblood of the program are the ML PhD students, and the ML PhD Program Faculty who advise, mentor, and conduct research with these students.

This handbook is meant to detail the inner workings of the ML PhD program for students, faculty, and administrators. The sections below describe the processes in the most important parts of the program, including admissions, coursework requirements, the qualifying exam, the PhD proposal, the dissertation, and final defense, as well as the mechanisms for administration. A list of Current Personnel, Core and Elective Course Listings, Doctoral Minor information, and Health and Wellness Resources are included at the end of this guide.

II. Admissions

External applications are only accepted for the Fall semester each year. Students apply to the ML PhD program through one of the eight participating home schools. The application deadline and requirements may vary by home school.

The ML PhD admissions process works bottom-up through the home schools. The FAC representative coordinates the process in their respective units, working with the associate chair for graduate studies and other faculty associated with the ML PhD program. Admissions decisions are made by the home school, and then submitted to the ML FAC for final approval.

Support for incoming students (including guarantees of teaching and research assistantships and/or fellowships) is determined by the home schools.

After the admissions have been approved by the FAC, the home school will communicate the acceptance to the prospective student. The home school will also communicate all rejections.

Transfer Admissions

Students may also transfer into the ML PhD if they are currently enrolled in another PhD program at Georgia Tech. Transfers are accepted at the ML PhD Director's discretion. A guideline for transfer admission is that the student must have a commitment for a research assistantship (GRA) for at least one year with a [ML Ph.D. Program Faculty](#), who will be their thesis advisor.

Transfer applications are submitted via email to the Program Director. The application should include a statement of purpose by the student, unofficial transcripts for all graduate work done at Georgia Tech and other institutions, and a letter or email from their advisor guaranteeing their support for the student through a research assistantship.

If approved by the Program Director and proposed academic home school, the student will then be instructed on how to finalize the change with their current program and the ML Academic Advisor, including obtaining signatures required for the Graduate Change of Major form.

Recruiting visits

Recruiting visits are organized in the Spring by the home schools along with their other degree programs.

New Student Orientation

There will be a new student orientation for all new ML PhD students the week before classes start in August. It will consist of a short presentation by the director on the degree requirements, an open discussion, and then a mixer with current PhD students and faculty. This will be in addition to the orientation the incoming students have with their home schools.

III. Coursework Requirements

The coursework for the ML PhD consists of the following, per the current 2020-21 GT Catalog year:

1. Core curriculum, 4 courses, 12 hours. The courses that can be used to fulfill this requirement are discussed in detail in Appendix A.
2. Area electives, 5 courses, 15 hours. The electives must be chosen from the list in Appendix B.
3. Doctoral minor, 9 hours. These courses must form a cohesive course of study and must come from outside the area of machine learning; no ML courses (core or elective) can be used to fulfill this requirement. A minimum GPA of 3.0 must be achieved in courses used for the minor. Please see Appendix C for more details.
4. Responsible Conduct of Research, 1 course, 1 hour (pass/fail). Georgia Tech requires that all PhD students complete an RCR requirement that consists of an online component and in-person training. The online component is completed during the student's first semester enrolled at Georgia Tech. The in-person training is satisfied by taking PHIL 6000 or their associated academic program's in-house RCR course.
5. ML PhD Qualifying exam, 1 course, 3 hours (pass/fail). As described in the Qualifying Exam section, the qualifying exam consists of a one semester literature study. To take the exam, students enroll in CS 7999 (Prep-Doctoral Qual Exams).

All coursework must be completed before the PhD proposal. An overall GPA of 3.0 is required for the PhD coursework.

The coursework requirements are subject to change. Students can satisfy any version of them that are in effect from the date of matriculation into the program to the date of the PhD Proposal.

More information about the Institute-level requirements for the PhD degree can be found here: <http://www.catalog.gatech.edu/academics/graduate/doctoral-degree-info/>

Special Problems

Special problem courses (e.g. ECE 8901,8902,8903) offer students the opportunity to be involved in research while earning course credit. Up to six special problem hours (two courses) can be used towards the ML PhD Area Elective Credits. Courses must be taken for a letter grade and student performance for special problems courses must be certified by the faculty instructor. A short (5 page) report detailing the student's activities during the semester should be submitted to the supervising faculty during the last week of class. Faculty must also certify that the work done for a special problem course is not simultaneously being done for pay (as a GRA).

Only special problems courses taken in the first two years in the program will be counted as credit towards the ML PhD.

Course transfer credit/Course Waivers

If a student has completed graduate work at another institution, they can petition to receive credit or course waivers. Students should request the class evaluation during their second term or later. The classes must be at the graduate level and no classes that were used to satisfy an undergraduate degree can be used toward the ML PhD degree. Up to 30 hours of credits earned toward a graduate degree with a grade of B and above at a different institution can be used towards the PhD degree. The approved classes will count toward the PhD degree course requirements, but will not be shown as transferred on the Georgia Tech transcript or appear in Degreeworks.

The course waiver process is coordinated by the ML Academic Advisor. The student should submit to a short letter of petition describing which courses they believe they should receive credit for along with justification. Along with this letter, an unofficial transcript from the institute where the classes were taken and syllabi for each of the courses in question should be included. The ML Academic Advisors will work with faculty in the home units to determine waivers. The FAC will have final approval.

Teaching Apprenticeship and Extra-curricular Requirements

ML Ph.D. students are subject to their home unit's teaching apprenticeship requirements (e.g., a certain number of semesters serving as a TA) and other the extra-curricular requirements. Students are responsible for ensuring that they understand and satisfy any home school requirements in addition to the ML program and Institute requirements.

Academic Advising

For advice on which courses, including doctoral thesis hours, to take and when to take them, students should refer to the home school representative to the ML FAC (see the Program Personnel section), and/or their thesis advisor.

Advising on non-academic issues, including Institute policies and procedures regarding program requirements such as qualifying exam, proposal, defense, course waivers, etc, will be provided by the ML PhD Academic Advisor (see Program Personnel section) and through the resources available in the student's home school.

IV. Qualifying Exam

The purpose of the Qualifying Examination is to judge the candidate's potential as an independent researcher. The ML PhD qualifying exam consists of a focused literature review that will take place over the course of one semester. In the semester in which they take the qualifying exam, the student registers for CS 7999 (Prep-Doctoral Qual Exam, section ML with Prof. Romberg). This is a permit only course; please email the ML Academic Advisor for approval. All assignments and forms related to the quals will be provided on the course Canvas site. Before taking the exam, it is expected that the student has either taken or is currently enrolled in all four core required courses and has completed their RCR requirement. As a guideline, students should plan to take the exam in the second semester of their second year in the ML PhD program.

At the beginning of the semester in which they are taking the qualifying exam, the student forms an exam committee consisting of three members of the [ML Ph.D. Program Faculty](#). If a student has a co-advisor, then the committee should consist of four faculty members. The committee, in consultation with the student, will approve a course of study consisting of influential papers, books, or other intellectual artifacts relevant to the student's research field.

The student should ask one of the committee members to be the chair. The chair is in charge of managing the qualifying exam, making sure that time of the presentation is appropriate, and that questions are asked and responded to in a reasonable manner. Although the student's thesis advisor can be on the committee, the advisor cannot be the chair.

Near the end of the semester, the student will submit to the committee a written summary of each artifact which highlights their understanding of the importance (and weaknesses) of the work in question. Subsequently, the student will have a closed oral exam with the faculty members of the committee. The exam will start with a short presentation by the student that summarizes their report. The exam will be interactive, with the student and the committee discussing and criticizing each work and posing questions related to the student's research field to determine the breadth of student's knowledge in that specific area.

The oral exam should be scheduled on or before the last week of class in the semester; the written report should be submitted to the committee at least one week prior.

The success of the examination will be determined by the committee's qualitative assessment of the student's understanding of the theory, methods, and ultimate impact of the assigned syllabus.

The evaluation for qualifying exam will be completed by the committee members online after their presentation. The ML Academic Advisor will provide the online evaluation form, which the student will be responsible for sending it to their committee members immediately after their presentation, and it should be encouraged that the faculty complete the form immediately.

The student will be given a passing grade for meeting the requirements of the committee in both the written and the oral part. Unsatisfactory performance on either part will require the student to redo the entire qualifying exam in the following semester. Each student will be allowed only two attempts at the exam.

Student Guidelines:

- Complete Qualifying Committee Exam form at the beginning of the semester. Details will be provided on the Canvas site after week one of class.
- The written report should be presented to the committee at least one week before the oral exam.
- Ninety (90) minutes should be allocated for the exam. The talk should be no longer than 25 minutes; the rest of the time is meant for question and answer.
- Submit the written report and slides via Canvas after the oral exam.
- Provide committee members with the required post-presentation survey link

Faculty committee guidelines:

- Each faculty member should make their expectations about the content of both the written report and the oral exam clear at the beginning of the semester.
- Each committee member should come to the oral exam prepared with at least one technical question that tests the student's depth of knowledge about the artifacts on the syllabus.
- The evaluation forms should be filled out independently, and away from the site of the exam. Private discussion amongst committee members is acceptable, but the evaluation form should be completed and returned to the ML Academic Advisor (via online survey provided by the student). This allows each faculty member to provide an independent evaluation.
- If a student receives a 'fail' from any committee member, their case will be discussed at a year-end FAC meeting along with the faculty on the qualifying exam committee.

V. Admission to PhD Candidacy and PhD Proposal

To qualify for PhD candidacy, a student must have completed the following:

1. Complete the requirements for training in [Responsible Conduct for Research \(RCR\)](#).
2. Complete all course requirements.
3. Achieve a satisfactory scholastic record.
4. Pass the qualifying exam.
5. Submit a formal proposal naming the dissertation reading committee and delineating the research topic for approval to the school chair and Graduate Students

Upon satisfactory completion of these requirements and the processes as outlined below, the Office of Graduate Studies will formally admit the applicant to PhD candidacy for the degree on behalf of the Vice Provost for Graduate Education and Faculty Development.

PhD Proposal

The final requirement to admission to candidacy is the PhD proposal, which consists of a short document describing the student's thesis, and a presentation to a proposal committee chosen by the student and approved by the ML FAC. The proposal must be at least six months before the PhD defense.

All coursework must be completed before the proposal can be scheduled. Students should contact the ML Academic Advisor at least one month prior to express the intent of submitting their thesis proposal, review coursework and committee requirements, and clarify details of the process as outlined below to ensure everything is in order for admission to PhD candidacy.

At this time, students should submit the following for review to the ML Academic Advisor:

- A letter describing the composition of the committee
- ML Coursework Completion form
- Doctoral Minor forms (both ML internal form and Institute-required forms) should also be turned in at this time if they have not already been submitted. See Appendix C for more details on the minor course of study requirements.

Students should check with their home units for additional requirements (ie, all CoC schools requires a gap semester between the proposal and defense, effective fall 2021).

The proposal document should be solely authored by the student and should be no longer than 30 pages. The proposal should describe the context of the research, including relevant references to the literature, the work that has been completed, and the research left to be done. It should be made clear throughout what the original research contributions of the thesis will be.

When the document is prepared, the student forms a Proposal Committee consisting of three [ML Ph.D. Program Faculty](#), one of which is the thesis advisor. If a student has a co-advisor, then the committee should consist of four faculty members. The student submits their written proposal to their committee for review.

After the committee approves the written proposal, the student should submit the following documents to the ML Academic Advisor:

- Proposal (pdf)
- ML PhD Proposal Committee Memo (confirming approval of the proposal)

All aforementioned thesis proposal forms can be found [here](#).

After all the above requirements are satisfied, the student schedules the proposal presentation. The student is responsible for providing the ML Academic Advisor with their proposal announcement. A template including email recipients for the announcement will be provided. This announcement must be made at least one week prior to the proposal presentation, so it may be added to the ML website and sent to their home school and other constituents through the usual official and unofficial channels.

The proposal presentation consists of a short talk by the student (less than one hour) and questioning from the committee. Both the proposal document and the presentation are evaluated by the committee. The committee members provide feedback on the proposed research directions, comments on the strength of writing and oral presentation skills and might suggest further courses to solidify the student's background.

The student will be responsible for sending all committee members the following forms immediately after the presentation:

- 1). A link to a brief online "Proposal Exam Report" survey (provided by ML Academic Advisor)
- 2). Grad Studies form "Request for Admission to PhD Candidacy" via [DocuSign](#). In the form, the Grad Coordinator should be the name and email of the ML Academic Advisor, while students should list the School Chair of their home school and all committee members. Note under "School," please list as "Machine Learning - ECE, Machine Learning- IC, etc" so both major and home school are recorded.

Once all paperwork has been approved, the student is unofficially admitted as a PhD candidate in the ML program.

VI. PhD Dissertation and Final Defense

The primary requirement of the PhD student is to create original and substantial research. This research is reported for review in the PhD dissertation, and presented at the final defense.

The Following steps are taken to fulfill the PhD thesis requirement:

1. Students should contact the ML Academic Advisor at least one month prior to express the intent of submitting their dissertation and preparing their final defense, review committee requirements, and clarify all details of the process.

2. The student writes a complete draft of their thesis. It is expected that the thesis advisor will read and provide feedback during the process. Institute guidelines and requirements for the formatting the document can be found in the [Georgia Institute of Technology Graduate Studies Thesis and Dissertation Manual](#).
3. The student forms their PhD thesis committee. The PhD thesis committee consists of five faculty members:
 - a. Three [ML Ph.D. Program Faculty](#) who served on the student's thesis proposal committee, including the student's advisor. These faculty are the reading committee.
 - b. One faculty member external to the ML PhD Program and who is not in the student's home school. This faculty member may be from the [ML@GT faculty](#) list or from another university. External non-academic faculty who are active in research may also serve as the external members; in this case, a CV must be provided for approval by the ML FAC.
 - c. One additional Georgia Tech faculty member. This additional member can come from inside or outside the ML PhD Program.
4. The student submits the thesis to the reading committee, giving them a review period of at least 14 days.
5. After the review period, the reading committee can either recommend the thesis for defense or send it back to the student for revisions. To recommend for defense, the reading committee signs the Reading Committee Report along with the thesis advisor.
6. The student, in conjunction with the thesis committee, schedules a time and location for the oral defense. This is communicated officially through the Final Defense Memo. The thesis advisor submits the Reading Committee Report and the Final Defense Memo to the ML Academic Advisor, which will be shared with the ML FAC and student's home unit.
7. The Reading Committee Report and the Final Defense Memo must be signed and submitted to academic staff at least 14 days in advance of the defense. The aforementioned forms can be found [here](#).
8. The student is responsible for providing the ML Academic Advisor with their oral defense announcement, which will be shared with their home school and other constitutes through the usual official and unofficial channels, including the ML website.

9. The student defends their dissertation at the oral defense. The defense is open to the public and consists of four segments: a presentation by the student, questions from the audience at large, questions from the thesis committee, and a private deliberation and discussion period by the committee. After a successful defense, each committee member fills out a Dissertation Evaluation Form and signs the Institute Certificate of Thesis Approval.
10. The student will be responsible for sending all committee members immediately after the presentation:
 - a). A link to a brief online "Final Dissertation Evaluation Form" survey (provided by ML Academic Advisor)
 - b). Grad Studies form "Certificate of Thesis Approval" via [DocuSign](#). In the form, the Grad Coordinator should be the name and email of the ML Academic Advisor, while students should list the School Chair of their home school and all committee members. Note under "School," please list as "Machine Learning-ECE, Machine Learning-IC, etc" so both major and home school are recorded.
11. The student submits their thesis electronically to the Georgia Tech Graduate Studies - VPR office. Information can be found in the [Georgia Institute of Technology Graduate Studies Thesis and Dissertation Manual](#).
12. The student completes a short online ML PhD Graduate Student Exit Survey: https://gatech.co1.qualtrics.com/jfe/form/SV_2sfKQH90eSeZ7Om

Online Application for Graduation (OAG)

Students should refer to the Registrar's [Online Application for Graduation \(OAG\)](#) and submit a petition to graduate the semester before they plan to graduate. (eg. if planning to graduate in Spring 2021, then the OAG is due in Fall 2020). This allows time to correct any unfulfilled requirements identified by the Office of Graduate Studies. See the GT academic calendar for OAG deadlines: <https://registrar.gatech.edu/calendar>. If a student has previously applied but did not graduate, they must repeat the same process to graduate.

To view graduation status, login to [DegreeWorks](#). Near the top of the audit, under a section titled *Student View*, there will be a field for *Graduation Information*. The text that appears in that field is the current graduation application status. To review missing requirements, see the section *Degree Requirements*.

NOTE: The status "lacks thesis" may appear on OSCAR for several weeks after the thesis or dissertation has been accepted by the Graduate Thesis Office as both the Graduate Thesis Office and the Registrar must do some processing of records. Acceptance by the Graduate Thesis Office, documented either by an approval e-mail for the ETD or a copy of the signed Certificate of Thesis Approval, is assurance that everything is all right.

Last semester Registration Options

Students who are completing their Ph.D. may find that the timing of their defense, graduation, and start of their subsequent employment leads to uncertainty in how to register for their final semester at Georgia Tech. There are three options (see the above Thesis Manual for more details and rules).

- 1). Register as full-time as in a typical semester (i.e., 9000 doctoral thesis hours). This works best if the final version of the thesis is submitted in time for graduation in the last semester (see the [deadlines](#)), and there are no funding limitations.
- 2). 1-credit hour option. Students in their graduating semester may register for only 1 hour of doctoral thesis hours. Such students are not full-time and will therefore not receive a tuition waiver or be paid as a GTA or GRA. These students must pay the 1-hr of tuition and fees (~\$950/in-state and ~\$2400/out-of-state). Students may be hired as a Graduate Assistant (GA) by their advisor and paid hourly, pending advisors and their department's approval.

Note: Students who are US citizens are ineligible for student health insurance if they are registered for less than 4 credit hours. Such students should contact STAMPS Health Services and consider their options before registering for 1-credit hour. Students can use the 1-credit hour option only once while at Georgia Tech.

- 3). Enrollment Waiver. This is for students who missed the final submission deadline for their target graduating semester, but have successfully defended, submitted their thesis, and are ready to start their job. They must stay 'on the books' at Georgia Tech in order to graduate the following semester, even though they may not be on campus during the semester. The Enrollment Waiver allows a student to stay 'on the books' and not register for any hours or pay any fees. To use the Enrollment Waiver, complete the form via Grad Studies [DocuSign](#). Note that all thesis-related forms must be completed and submitted for the Enrollment Waiver to be approved. Students can use the enrollment waiver only once while at Georgia Tech.

Note: International students should contact [OIE](#) via istart if registering for less than full-time to request an academic reduced course load.

If none of these seem to fit, students should discuss their case with the Registrar's Office.

VII. Administration and Governance

Program Director

The Director oversees the overall administration and policy directions for the program. They also chair the Faculty Advisory Committee, and approve transfers into the ML PhD program from students enrolled in other PhD programs at Georgia Tech.

Faculty Advisory Committee

The FAC consists of one faculty member from each school involved with the program and is chaired by the Program Director. Duties of the FAC include:

- Admissions. Each FAC member will coordinate with their school on admissions offers into the ML PhD program. The FAC member coordinates the review of applications within the school with the relevant faculty and corresponding associate chair within the school, then supplies a list of candidates for the FAC to approve.
- Committee approval. The FAC will have ultimate approval over ML PhD student thesis proposal and thesis defense committees.
- Course waivers. The FAC will have ultimate approval over course waivers from other universities. (The process is coordinated by the ML Academic Advisor, as detailed above).
- Curriculum revisions. The FAC will periodically review the curriculum. Revisions to the requirements will be submitted to the Director of Graduate Program Services, who will shepherd them through approval by the Institute Graduate Curriculum Committee.

ML PhD Program Faculty

Faculty members of the ML PhD Program may serve as the thesis advisor for any student in the program, no matter their academic unit. ML Faculty must have an appointment in one of the participating home schools at Georgia Tech.

ML PhD Program Faculty members are also expected to serve on ML PhD qualifying exam, proposal, and PhD defense committees.

To become a faculty member of the ML PhD program, email the Program Director. Members will be approved by the FAC.

The current list of ML PhD Program Faculty can be found at:

<http://ml.gatech.edu/people/faculty/phdprogramfaculty>

VIII. Current Personnel

Director

Justin Romberg, jrom@ece.gatech.edu

Director of Graduate Program Services - Atlanta Campus

Rebecca Wilson, rebecca.wilson@cc.gatech.edu

ML PhD Academic Advisor (Graduate Coordinator)

Stephanie Niebuhr, stephanie.niebuhr@cc.gatech.edu

Operations and Support

Kyla Hanson, khanson@cc.gatech.edu

Faculty Advisory Committee

Each school affiliated with the ML PhD program has a member on the FAC.

Aerospace Engineering (AE): Evangelos Theodorou, evangelos.theodorou@gatech.edu

Biomedical Engineering (BME): May Wang, maywang@gatech.edu

Computational Science and Engineering (CSE): Polo Chau, polo@gatech.edu

Computer Science (CS): Jacob Abernethy, prof@gatech.edu

Electrical and Computer Engineering (ECE): David Anderson, dva@ece.gatech.edu

Industrial Systems Engineering (ISyE): Yao Xie, yao.xie@isye.gatech.edu

Interactive Computing (IC): Zsolt Kira, zkira@gatech.edu

Mathematics (MATH): Vladimir Koltchinskii, vlad@math.gatech.edu

Chair (Program Director): Justin Romberg, jrom@ece.gatech.edu

Appendix A: Core Courses

Machine Learning PhD students are required to complete courses in four different areas: Mathematical Foundations, Probabilistic and Statistical Methods in Machine Learning, Machine Learning Theory and Methods, and Optimization. With the exception of the Foundations course, each of these area requirements can be satisfied using existing courses from the College of Computing or Schools of ECE, ISyE, and Mathematics.

Mathematical Foundations of Machine Learning. This required course is the gateway into the program and will cover the key subjects from applied mathematics needed for a rigorous graduate program in ML. Particular emphasis will be put on advanced concepts in linear algebra and probabilistic modeling.

ECE/ISYE/CS/BMED 7750, Mathematical Foundations of Machine Learning

Probabilistic and Statistical Methods in Machine Learning.

ISYE 6412, Theoretical Statistics

ECE 7751/ISYE 7751/CS 7751/CSE 7751 Probabilistic Graphical Models

MATH 7251, High Dimension Probability

MATH 7252, High Dimension Statistics

Machine Learning: Theory and Methods. This course serves as an introduction to the foundational problems, algorithms, and modeling techniques in machine learning. Each of the courses listed below treats roughly the same material using a mix of applied mathematics and computer science, and each has a different balance between the two.

CS 7545, Machine Learning Theory and Methods

CS 7616, Pattern Recognition

CSE/ISYE 6740, Computational Data Analysis

ECE 6254, Statistical Machine Learning

ECE 6273, Methods of Pattern Recognition with Applications to Voice

Optimization. Optimization plays a crucial role in both developing new machine learning algorithms and analyzing their performance. The three courses below all provide a rigorous introduction to this topic; each emphasizes different material and provides a unique balance of mathematics and algorithms.

ECE 6270, Convex Optimization: Theory, Algorithms, and Applications

ISYE 6661, Linear Optimization

ISYE 6663, Nonlinear Optimization

ISYE 7683, Advanced Nonlinear Programming

Appendix B: Elective Courses

In addition to meeting the four core area requirements, students are required to complete five elective courses. These courses are required for getting a complete breadth in ML. These courses must be chosen from at least two of the five subject areas listed below.

Up to two elective courses can be Special Problems courses (e.g. ECE 8901,8902,8903) as described in the Coursework Requirements section III above.

After core requirements are satisfied, all courses listed in the core not already taken can be used as (appropriately classified) electives.

Statistics and Applied Probability:

To build breadth and depth in the areas of statistics and probability as applied to ML.

AE 6505, Kalman Filtering

BMED 6700, Biostatistics

ECE 6558, Stochastic Systems

ECE 6601, Random Processes

ECE 6605, Information Theory

ISYE 6404, Nonparametric Data Analysis

ISYE 6413, Design and Analysis of Experiments

ISYE 6414, Regression Analysis

ISYE 6416, Computational Statistics

ISYE 6420, Bayesian Statistics

ISYE 6761, Stochastic Processes I

ISYE 6762, Stochastic Processes II

ISYE 7400, Adv Design-Experiments

ISYE 7401, Adv Statistical Modeling

ISYE 7405, Multivariate Data Analysis

ISYE 8803, Statistical and Probabilistic Methods for Data Science

ISYE 8813, Special Topics in Data Science

MATH 6263, Testing Statistical Hypotheses

MATH 6266, Statistical Linear Modeling

MATH 6267, Multivariate Statistical Analysis

MATH 7244, Stochastic Processes and Stochastic Calculus I

MATH 7245, Stochastic Processes and Stochastic Calculus II

Advanced Theory:

To build a deeper understanding of foundations of ML.

CS 7280, Network Science

CS 7510, Graph Algorithms

CS 7520, Approximation Algorithms

CS 7530, Randomized Algorithms

CS 7535, Markov Chain Monte Carlo Algorithms

CS 7540, Spectral Algorithms

CS 8803 CA, Continuous Algorithms

ECE 6283, Harmonic Analysis and Signal Processing

ECE 6555, Optimal Estimation

ISYE 7682, Convexity

MATH 6112, Advanced Linear Algebra

MATH 6221, Advanced Classical Probability Theory

MATH 6241, Probability

MATH 6580, Introduction to Hilbert Space

MATH 7338, Functional Analysis

MATH 7586, Tensor Analysis

MATH 88XX, Special Topics: Mathematical Foundations of Learning Theory

Applications:

To develop a breadth and depth in variety of applications domains impacted by/with ML.

AE 6373, Advanced Design Methods

AE 8803, Machine Learning for Control Systems

AE 8803, Nonlinear Stochastic Optimal Control

BMED 6780, Medical Image Processing

BMED 8813BHI, Biomedical and Health Informatics

BMED 8813MHI, mHealth Informatics

BMED 8813MLB, Machine Learning in Biomedicine

BMED 8823ALG, OMICS Data and Bioinformatics Algorithm

CS 6440, Introduction to Health Informatics

CS 6465, Computational Journalism

CS 6474, Social Computing

CS 6475, Computational Photography

CS 6476, Computer Vision

CS 6601, Artificial Intelligence

CS 7450, Information Visualization

CS 7476, Advanced Computer Vision

CS 7630, Autonomous Robots

CS 7636, Computational Perception

CS 7643, Deep Learning

CS 7646, Machine Learning for Trading

CS 7650, Natural Language Processing

Computing and Optimization:

To provide more breadth and foundation in areas of math, optimization and computation for ML.

CS 6505, Computability and Algorithms

CS 6550, Design and Analysis of Algorithms

CSE 6140, Computational Science and Engineering Algorithms

CSE 6141, Massive Graph Analysis

CSE 6240, Web Search and Text Mining

CSE 6242, Data and Visual Analytics

CSE 6301, Algorithms in Bioinformatics and Computational Biology

ECE 4580, Computational Computer Vision

ECE 6255, Digital Processing of Speech Signals

ECE 6258, Digital Image Processing

ECE 6260, Data Compression and Modeling

ECE 6550, Linear Systems and Controls

ECE 8813, Network Security

ISYE 6421, Biostatistics

ISYE 6810, Systems Monitoring and Prognosis

ISYE 7201, Production Systems

ISYE 7204 Info Prod & Ser Sys

ISYE 7203, Logistics Systems

ISYE 8813, Supply Chain Inventory Theory

HS 6000, Healthcare Delivery

MATH 6759, Stochastic Processes in Finance

MATH 6783, Financial Data Analysis

CSE 6643, Numerical Linear Algebra

CSE 6644, Iterative Methods for Systems of Equations

CSE 6710, Numerical Methods I

CSE 6711, Numerical Methods II

ISYE 6644, Simulation

ISYE 6645, Monte Carlo Methods

ISYE 6662, Discrete Optimization

ISYE 6664, Stochastic Optimization

ISYE 6679, Computational methods for optimization

ISYE 7686, Advanced Combinatorial Optimization

ISYE 7687, Advanced Integer Programming

Platforms:

To provide breadth and depth in computing platforms that support ML and Computation.

CS 6421, Temporal, Spatial, and Active Databases

CS 6430, Parallel and Distributed Databases

CS 6290, High-Performance Computer Architecture

CSE 6220, High Performance Computing

CSE 6230, High Performance Parallel Computing

Appendix C: Doctoral minor, 3 courses, 9 hours

Per the Institute's requirements, in addition to an adequate knowledge of the major field of intended research, all PhD students must demonstrate mastery of another smaller body of knowledge—the minor field—preferably outside the student's school. The purpose of the minor is to encourage a wider interest on the part of the student and to provide a broader basis for the evaluation of the student's capabilities.

The minor will consist of at least nine semester hours of work in related courses, selected by the student in consultation with their thesis advisor. These courses should be at the 6000 level or above. The student must receive a letter grade within the minor comprising an overall GPA of a 3.0 (B) or higher. (Courses that are taken as pass/fail are not eligible to count toward the doctoral minor). Courses taken at other institutions may be included in the minor and do not need to be transferred into Georgia Tech.

The minor courses must form a cohesive course of study and must come from outside the area of machine learning; no ML courses (core or elective) can be used to fulfill this requirement. Examples of minor field of study are Math, Psychology, Business Analytics, Cognitive Science, Control Theory, or Fluid Mechanics.

The minor course of study is approved first by the student's thesis advisor and ML Academic Advisor with two separate required forms:

- 1). The internal "Machine Learning PhD: Request for Approval for Doctoral Minor," which is available [here](#).
- 2). The Office of Grad Studies "Doctoral Minor Form" available via [Docusign](#) is signed by both the thesis advisor and the ML Academic Advisor. Students should plan to officially declare their minor to the Institute when submitting their ML Coursework Completion Form due at the time of the thesis proposal.

The minor coursework and the associated forms must be completed at time of the thesis proposal, but students may submit it after their quals have been passed and they have formulated their minor with their thesis advisor.

Health and Wellness Resources

Questions about Student Health Insurance should be directed to Jennifer White at STAMPS at: jennifer.white@health.gatech.edu.

Graduate school can be a stressful time for students. The [Georgia Tech Counseling Center](#) and STAMPS health services offer a wide range of programs and services that can help students who may need assistance. The Georgia Tech Health Initiatives site includes information on many stress-management services available on campus (e.g., yoga, mindfulness), as well as diet and lifestyle resources.

If you just need to talk to another graduate student who knows what you are going through, the [Peer Coaching Program](#) provides students with another way to receive support with their academic, social, and other concerns. Students are matched with a fellow Tech student who has been extensively trained to navigate mental health conversations and who is knowledgeable about campus resources.

Additional resources on campus that are there to assist graduate students include the [Women's Resource Center](#), the [LGBTQIA Resource Center](#) and the [Veteran's Resource Center](#).

Put the Georgia Tech Police number in your phone (404-894-2500) to call for any safety concerns. Call 911 for emergencies.

All these links (and more!) are collect at one site:[GT United](#). Please bookmark this site.

