Doctoral Thesis

Deep Learning, Artificial Intelligence, and Genomics

Course Information

- Instructor: Manoj K. Bhasin, Ph.D.
- Course Prefix and Number: BMED 9000
- Term: Fall 2026
- Research Focus: Deep Learning, Artificial Intelligence, Bioinformatics, and Genomics

Course Description

This course provides academic credit for independent doctoral thesis research conducted under the supervision of a Georgia Tech faculty advisor. The thesis research will emphasize computational and data-driven biomedical research, with particular opportunities in deep learning, artificial intelligence (AI), bioinformatics, genomics, single-cell and spatial omics, and integrative multi-omics analysis. The course does not involve regular class meetings, assignments, or examinations. The scope and direction of the research are determined by the student in consultation with the thesis advisor and Thesis Advisory Committee, consistent with the requirements of the degree program.

Course Learning Outcomes

1. Formulate significant and testable biomedical research questions that can be addressed using computational, genomic, or multi-omic data.
2. Design and conduct independent research using appropriate bioinformatics, statistical learning, machine learning, and/or deep-learning approaches.
3. Develop reproducible workflows for preprocessing, integration, modeling, interpretation, and visualization of high-dimensional biomedical datasets.
4. Critically evaluate AI and deep-learning models using appropriate training, validation, calibration, robustness, and generalizability criteria.
5. Integrate genomic, transcriptomic, single-cell, spatial, imaging, clinical, or other multimodal data when appropriate to the thesis question.
6. Interpret computational findings in their biological and clinical context and distinguish association, prediction, and potential mechanism.
7. Communicate research progress, methods, results, limitations, and next steps effectively to the thesis advisor and, as applicable, the Thesis Advisory Committee.
8. Conduct computational and genomic research in an ethical, reproducible, and responsible manner.

Research Scope and Methods

Depending on the student's thesis project, research may include:

- Deep learning and machine learning for prediction, classification, representation learning, or multimodal data integration.
- Genomic and transcriptomic analysis, including bulk RNA-seq, whole-genome/exome sequencing, and variant or pathway-level analyses.
- Single-cell and spatial genomics, including cell-state discovery, cell-cell interaction analysis, spatial neighborhoods, and integration across modalities.
- AI-enabled biomarker discovery, patient stratification, outcome modeling, and development of biologically interpretable predictive models.
- Model explainability, feature attribution, uncertainty estimation, external validation, and assessment of bias and generalizability.

- Reproducible computational research using version-controlled code, documented analytical workflows, and appropriate data-governance practices.

Required Course Materials

No specific textbook is required. Research articles, software documentation, public or approved research datasets, computational resources, and other materials will be selected in consultation with the thesis advisor based on the project.

Research Progress and Expectations

- Maintain regular communication with the thesis advisor and provide research updates at a frequency agreed upon by the student and advisor.
- Maintain organized and reproducible records of code, analyses, model versions, datasets, parameters, and major research decisions.
- Demonstrate progress appropriate to the number of thesis credit hours and the student's stage in the doctoral program.
- Present work to the thesis advisor and/or Thesis Advisory Committee when requested and incorporate feedback into subsequent research.
- Work toward thesis-quality outputs such as validated analytical methods, figures, manuscripts, conference abstracts, software, or other scholarly products, as appropriate.

Grading Policy

This course is graded on a Satisfactory (S) / Unsatisfactory (U) basis.

- Satisfactory (S): The student demonstrates acceptable research progress toward degree completion, appropriate to the number of thesis credit hours, including evidence of rigorous and reproducible research activity.
- Unsatisfactory (U): The student does not meet agreed expectations for research progress, scholarly engagement, research integrity, or communication during the term.

Attendance Policy

This course does not include scheduled class meetings. Students conduct independent research under faculty supervision. The frequency and format of student-advisor interactions are determined by mutual agreement and may include individual meetings, research-group meetings, computational review sessions, and Thesis Advisory Committee meetings.

Academic and Research Honesty/Integrity Statement

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards and to comply with the Student Code of Conduct, the Academic Honor Code, and applicable graduate research requirements. Students are expected to perform research in an ethical and responsible manner and to complete required Responsible Conduct of Research training.

For AI- and genomics-focused research, students must also follow applicable requirements for data privacy, human-subject protections, secure handling of genomic and clinical data, appropriate attribution of software and datasets, transparent reporting of AI-assisted work, and rigorous documentation sufficient to support reproducibility. Fabrication, falsification, plagiarism, inappropriate data use, or misrepresentation of computational results is unacceptable.

Core IMPACTS

Not applicable.

Accommodations for Students with Disabilities

Students with learning needs that require accommodation should contact the Georgia Tech Office of Disability Services as early as possible to discuss their needs and obtain appropriate documentation. Students are also encouraged to communicate approved accommodations to the instructor so that appropriate arrangements can be made.

Expectations of Advisors and Advisees

The advisor-advisee relationship should be based on mutual respect, clear communication, intellectual rigor, responsible research conduct, and shared commitment to the student's scholarly development. Students are expected to take ownership of their research, prepare for meetings, respond constructively to feedback, and communicate challenges promptly. The advisor will provide scientific guidance, feedback on research strategy and interpretation, and mentorship toward successful completion of the doctoral thesis.