QBS 185: Health Data Science Capstone Experience
3 Units

The goal of the capstone is to enable students to refine their data science skills as they work on a real-world, applied data science project. The capstone also provides training in critical professional skills including scientific writing, presentation skills, and translating a data science project to key stakeholders who may not be data scientists. Preparation for the capstone project begins in August of the first year and culminates in a written white paper and oral presentation at the end of the summer term, and a poster presentation of their completed capstone work at the Celebration of Biomedical Research at Dartmouth (CBRaD) held in the fall of the second year. Students are required to attend seminars, workshops, and small group meetings and are accountable for deliverables throughout the year-long course. Students may select from three tracks for their summer project: a project-based external experience (e.g., an internship), an individual project with a Dartmouth researcher, or a self-led individual project. Students are expected to finalize their track selection in April. Credit for the capstone (3 units) is applied during the summer term. Tuition & Fees apply.

Course Directors

- Todd A. MacKenzie, PhD
  Professor of Biomedical Data Science
  Professor of Medicine
  Professor of The Dartmouth Institute
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- Jennifer A. Emond, PhD, MSc
  Assistant Professor of Biomedical Data Science & Pediatrics
  Norris Cotton Cancer Center
  Jennifer.A.Emond@Dartmouth.edu

Career Development

- Shaniqua Jones
  Program Administrator
  Quantitative Biomedical Sciences
  Shaniqua.A.Jones@dartmouth.edu

- Other TBD

Administrative Assistance

- Shaniqua Jones
  Program Administrator
  Quantitative Biomedical Sciences
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Teaching Assistants

- TBD

Canvas Site

This course will utilize Canvas (canvas.dartmouth.edu) for announcements, document posting, and assignment submission.

Capstone Experience Tracks

Students may select from three tracks for their capstone. Tracks differ based on the summer term project. The pre-capstone work is required for all tracks. Students are expected to finalize their track selection in April.

- Project-Based External Experience

  Students in this track will complete an external internship. Internships may be with a for-profit company, governmental agency, non-profit organization, or another academic institution. For this option, residency at Dartmouth is not required.

- Individual Project with Dartmouth PI

  Students in this track will match with an investigator at Dartmouth and will work on a data science project under the PI’s mentorship; the project may be supervised by a postdoctoral research fellow or doctoral candidate in the PI’s lab. For this option, residency at Dartmouth is required. Students are encouraged to submit a conference abstract in the fall on their capstone project.

- Individual Project, Self-Led

  Students in this track will work on an independent project of their own choosing. Students will develop their own data science research project that uses available data. QBS faculty will assist students in defining feasible projects. For this option, residency at Dartmouth is required. Students are encouraged to submit a conference abstract in the fall on their capstone project.

Capstone Competencies

Competencies address traditional data analytic knowledge and skill areas and attributes needed to pursue a career in data science. Given that students will work on a variety of data science projects, there is no formal criteria regarding which core competencies each proposal must address. Instead, each capstone proposal will be reviewed by QBS faculty before the agreement is formalized to ensure the project adequately reflects a culminating project representative of the QBS MS in Health Data Science.

Competencies:
Formulate a problem statement and justification for the proposed approach
Create or evaluate a conceptual model detailing the workflow for a data analytics plan
Create or evaluate a data analytic plan for data wrangling
Develop and test programming code to manage relational databases
Apply data wrangling skills (e.g., extraction, merging, and/or construction of analytical data set)
Apply and/or interpret appropriate statistical analysis/machine learning
Visually and numerically summarize data
Evaluate and/or validate a data analytics approach
Communicate the results of a data analytics approach to address a problem statement, in writing and orally
Work effectively as part of an multidisciplinary team to address a data analytics problem
Identify and address the ethical concerns related to the analysis of data

**Capstone Components and Final Grading**

All students must complete the following capstone components. Activities begin in the fall of the first year. The purpose of the pre-capstone activities is to provide students with training within the course competencies, and to position students to be highly competitive for job placement upon graduation.

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<th>Component</th>
<th>% of Final grade</th>
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<td>(1) QBS seminar series</td>
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<td>(2) Career development activities</td>
<td>10%</td>
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<tr>
<td>(3) HDS pre-capstone meetings</td>
<td>10%</td>
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<tr>
<td>(4) Capstone proposal</td>
<td>20%</td>
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<tr>
<td>(5) Capstone progress report</td>
<td>10%</td>
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<tr>
<td>(6) Final capstone white paper</td>
<td>20%</td>
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<tr>
<td>(7) Oral presentation</td>
<td>10%</td>
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<tr>
<td>(8) Poster presentation</td>
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(1) **QBS seminar series**

The QBS seminar series is held during each quarter. The series primarily features invited speakers from industry and provides students the opportunity to learn about data science careers, as well as an opportunity to network. Students who expect to miss a seminar must notify Ms. Jones in advance.

(2) **Career development activities**

All students are required to complete a series of career development activities. The overarching goal of these activities is to maximize students’ competitiveness on the job market and to increase students’ awareness of data science careers across various industries.
Fall Term

- QBS/TDI workshops: August
  - How to market your strengths
  - Resume/Cover Letter
- Center for Professional Development workshops (https://sites.dartmouth.edu/cpd/)
  - Attend two workshops of your choice per term, and submit a brief (200 words or less) summary of the workshops attended.
- Market research write-ups
  - Choose 10 companies/institutions/PIs of interest and complete a Market Research Write-Up for each.
- Weekly internship applications
  - Submit proof that you have applied to one summer internship position per week (10 total). Include the job posting and the submitted cover letter and resume. Students must also have their application material reviewed by the QBS Career Development team before applying to the posting. For students who do not want to pursue the internship option, cover letters and resumes only need to be submitted as a capstone assignment and do not need to be submitted to the companies.
- General interview series
  - Students must complete four practice interviews (~15 minutes each) with the QBS Career Development team.
- Technical interview series
  - Weekly series to practice technical interview skills. Led by Christian Darabos, Assistant Director or Research Informatics with the Research Information, Technology & Consulting (RITC) at Dartmouth College. Students are encouraged to attend these meetings each quarter.

Winter Term

- Center for Professional Development (https://sites.dartmouth.edu/cpd/)
  - Attend two workshops of your choice per term and submit a brief (200 words or less) summary of the workshops attended.
- Market research write-ups
  - Choose 10 companies/institutions/PIs of interest and complete a Market Research Write-Up for each.
- Weekly internship applications
  - Submit proof that you have applied to one summer internship position per week (10 total). Include the job posting and the submitted cover letter and resume. Students must also have their application material reviewed by the QBS Career Development team before applying to the posting. For students who do not want to pursue the internship option, cover letters and resumes only need to be submitted as a capstone assignment and do not need to be submitted to the companies.
- Technical interview series
2019-2020

- Weekly series to practice technical interview skills. Led by Christian Darabos, Assistant Director or Research Informatics with the Research Information, Technology & Consulting (RITC) at Dartmouth College. Students are encouraged to attend these meetings each quarter.

**Spring Term**

- Center for Professional Development ([https://sites.dartmouth.edu/cpd/](https://sites.dartmouth.edu/cpd/))
  - Attend two workshops of your choice per term, and submit a brief (200 words or less) summary of the workshops attended.
- Technical interview series
  - Weekly series to practice technical interview skills. Led by Christian Darabos, Assistant Director or Research Informatics with the Research Information, Technology & Consulting (RITC) at Dartmouth College. Students are encouraged to attend these meetings each quarter.

**Health Data Science (HDS) Pre-Capstone Meetings**

There will be an introductory meeting in August and monthly pre-capstone meetings in the fall, winter and spring quarters preceding the summer capstone. Students will be assigned to a small group and will meet with that same group throughout the year. Students are required to complete assignments for each meeting. Details for each meeting, including pre-meeting readings and deliverables, will be available on Canvas. Meetings will be 90 minutes.

**Pre-Fall**

- Meeting 1: Introduction and expectations
  - Outline expectations for the year
  - Marketing yourself as a data scientist

**Fall**

- Meeting 2: Updates and progress
- Meeting 3: Updates and progress

There will not be deliverables for the fall quarter meetings because the career development activities are intensive in the fall. Instead, the fall meetings will provide students an opportunity to meet with QBS faculty and discuss their progress in the program to date.

**Winter**

- Meeting 4: Development of a novel data science research project; identifying data sources
  - Students will identify publically available datasets and outline a data science-related project or research question that would be feasible during the summer term.
Meeting 5: Development of a novel data science research project; outlining the proposal
  o Students will outline their research project using the format of an NIH Specific Aims page.
Meeting 6: Development of a novel data science research project; peer-review part 1
  o Students will peer review the initial research proposals.

Spring

Meeting 7: Development of a novel data science research project; peer-review part 2
  o Students will complete peer review of the revised research proposals.
Meeting 8: Development of a novel data science research project; pitching the proposal
  o 10 minute presentation outlining the proposal for your research project followed by 5 minutes of discussion.
  o Half of the small-group will present at this meeting.
Meeting 9: Development of a novel data science research project; pitching the proposal
  o 10 minute presentation outlining the proposal for your research project followed by 5 minutes of discussion.
  o Half of the small-group will present at this meeting.

(4) Capstone Proposal & Agreement (CPA)

Students must submit a written proposal for their capstone project. Proposals will serve as the contract between the student and QBS faculty. Details on the capstone proposal content and student, faculty and supervisor/PI expectations (as needed) are in the document, QBS Health Data Science Capstone Proposal and Agreement (CPA).

Deadlines:
  • May: CPA due
  • July: Progress report and amended CPA as needed

(5) Capstone progress report

The progress report is due mid-way during the summer capstone project. The report will outline the progress of the project to date and any deviations from the initial CPA. An amended CPA is also required with the progress report.

(6) Final Capstone White Paper

The final written capstone white paper must include 1) an executive summary of the project, which includes a brief summary of the project and a full report which includes the 2) background of the problem and a justification for the analytic approach; 3) methods of the analytic approach; 3) key findings of the project; 4) study strengths and limitations, and 5) study implications. A bibliography of cited work is also required. The white paper is limited to 10,000 words and a combined total of 10 tables and figures. Text must be Arial or Times New Roman font, size 11 point or larger, and page margins must be 1”
(6) Oral Presentation

All students must present their Capstone Experience orally at the end of the summer term. Presentations will be 20-25 minutes in length and there will be discussion afterwards. Students must frame their presentation to a target audience of non-data scientists, such as key stakeholders. QBS faculty will attend the presentation.

(8) Poster Presentation

All students will present a poster on their capstone work at the Celebration of Biomedical Research at Dartmouth (CBRaD) held in the fall.

<table>
<thead>
<tr>
<th>Expectations of Students During the Capstone</th>
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<tbody>
<tr>
<td>• Attend all capstone meetings; show up on time and plan to attend for the full session. Notify the course director ahead of time regarding expected absences. A written summary of the meeting topic(s) must be submitted for any missed meeting.</td>
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<tr>
<td>• Be prepared for class discussions: read assigned publications and complete assigned work before capstone meetings.</td>
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<tr>
<td>• Be courteous to and respectful of your peers and any speakers in capstone meetings.</td>
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<tr>
<td>• <strong>Do not use cell phones in capstone meetings.</strong> Only use laptops for reviewing publications or other course-related material.</td>
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<tr>
<td>• Act in a professional manner when interacting with Dartmouth faculty, students and invited speakers and industry representatives throughout the capstone.</td>
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<td>• Abide by the Dartmouth College Academic Honor Principle, listed below.</td>
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<tr>
<th>Expectations of Course Directors During the Capstone</th>
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<tr>
<td>• Respond to any student questions or concerns in a timely manner.</td>
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<tr>
<td>• Be prepared for capstone meetings. Provide and foster a collaborative environment at capstone meetings for students.</td>
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<td>• Assist students in time management for capstone activities.</td>
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<td>• Provide timely, constructive feedback to each student to foster professional development.</td>
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<td>• Act as a liaison between the student and the preceptor.</td>
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<tr>
<th>Honor Code</th>
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<tr>
<td>Academic Honor Principle: <a href="https://students.dartmouth.edu/judicial-affairs/policy/academic-honor-principle">https://students.dartmouth.edu/judicial-affairs/policy/academic-honor-principle</a></td>
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Honesty is the foundation of the academic pursuit of knowledge. In recognition of this, the faculty will not overlook any violations of the Academic Honor Principle. Indeed, the Faculty of Dartmouth College and the Geisel School of Medicine at Dartmouth are obligated to report potential violations of the Academic Honor Principle. All Dartmouth students are required to read the Academic Honor Principle.
Here we highlight one common violation of the policy, Plagiarism. Any form of plagiarism violates the Academic Honor Principle. Plagiarism is defined as the submission or presentation of work, in any form, that is not a student's own, without acknowledgment of the source. With specific regard to papers, a simple rule dictates when it is necessary to acknowledge sources. If a student obtains information or ideas from an outside source, that source must be acknowledged. Another rule to follow is that any direct quotation must be placed in quotation marks, and the source immediately cited. Students are responsible for the information concerning plagiarism found in Sources and Citation at Dartmouth College, available in the Deans' Offices or at Sources and Citations.

**Sexual Respect Policy**

At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all have equal access to the educational and employment opportunities Dartmouth offers. We strive to promote an environment of sexual respect, safety, and well-being. In its policies and standards, Dartmouth demonstrates unequivocally that sexual assault, gender-based harassment, domestic violence, dating violence, and stalking are not tolerated in our community. These principles are also enumerated in the Professionalism Policy for the Undergraduate Medical Education Program at Geisel.

The Sexual Respect Website (sexual-respect.dartmouth.edu) at Dartmouth provides a wealth of information on your right with regard to sexual respect and resources that are available to all in our community. Please note that, as a faculty member, I am obligated to share disclosures regarding conduct under Title IX with Dartmouth’s Title IX Coordinator.

Should you have any questions, please feel free to contact Dartmouth’s Title IX Coordinator (Kristi.Clemens@Dartmouth.edu) or the Deputy Title IX Coordinator for Geisel (Leslie.Henderson@Dartmouth.edu) or for Guarini (Gary.Hutchins@Dartmouth.edu).
## Course Summary and Deliverables

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<tr>
<th>Track selection</th>
<th>Prep</th>
<th>Fall Quarter</th>
<th>Winter Quarter</th>
<th>Spring Quarter</th>
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### Additional Activities
- Dartmouth Career Fair