COMPUTATIONAL MODELING AND DATA ANALYTICS
VIRGINIA TECH

CAPSTONE PROJECT PROPOSAL GUIDELINES

Virginia Tech's Computational Modeling and Data Analytics (CMDA) Program invites proposals for its Capstone projects course (CMDA 4864), a required senior-level class for CMDA majors.

In the Capstone projects course, teams of three to five students spend the semester tackling an open-ended, *client-driven* project. Each team works on a different problem, so the class benefits from seeing the particular challenges that arise in a variety of projects. In addition to the technical aspects of the project, students are mentored in teamwork, project management, professional conduct, and technical leadership. Through the lens of their particular projects, the teams also consider the ethical aspects of data science and mathematical modeling.

The CMDA Program seeks partners from business, government, and academia to serve as sponsors for our capstone projects. These projects should *not* be theoretical research projects within statistics or applied mathematics, but could be inspired by research questions from other disciplines (e.g., using data science to illuminate research questions in engineering, finance, the humanities, or public health).

A sponsorship donation of $5000 per project is requested. The resources will contribute toward team needs (e.g., software, supplies) and class expenses, and support the CMDA major. Donations will be solicited after the sponsor's project has been assigned to a team.

Proposals for Fall 2025 projects, including multi-semester projects to begin during Fall 2025, should be submitted by **Monday, July 28, 2025**. Project proposals for the Spring 2026 semester may be submitted anytime up to **Monday, January 12, 2026**. To propose a project, please complete this short form:

https://virginiatech.questionpro.com/CMDA-Capstone-Project-Proposal

If you have questions or would like to discuss potential project ideas, please contact Dr. Alan Lattimer (alattime@vt.edu) or Dr. Angela Patterson (apatterson@vt.edu), co-Directors of the CMDA Capstone Program.

PROPOSAL ELEMENTS (COLLECTED BY THE FORM LINKED ABOVE)

1. **Project Sponsor.** List the sponsoring organization and the individual point of contact.
2. **Contact Details.** List email and phone contact information for the primary client.
3. **Project Summary.** Give a concise (1–2 sentence) summary of the project (i.e., the "question" or "challenge" referred to below).
4. **Project Description.** Provide additional details about the project via Word or PDF upload. This description (200–300 words is ideal) should address the following elements. (a) Elaborate on the question or challenge. Provide an initial estimate of scope. (b) Why is the project important to your organization? (c) What data sets or existing models, if any, can you provide to the team? (d) What prior work has been done on this subject?
5. **Expectations.** Describe what you expect from a successful project. Beyond the final project report and presentation, do you seek any other outcomes or deliverables?
6. **Special Requirements or Constraints.** Do the students require special skills (e.g., facility with a specific programming language or software platform; background in biology, economics, etc.)? Will students need to sign a Non-Disclosure Agreement, conform to HIPAA restrictions, meet citizenship requirements, or have restricted access to your data?

BACKGROUND ON THE CAPSTONE COURSE

When developing project proposals, the following background might be helpful.

- **A Question or Challenge.** Many of the best projects start with a concise question. "How should we best deploy medical workers to reach the population of Malawi?" "How many Americans died from the Russian flu epidemic in 1889 – 1890?" "Can we identify a tuberculosis bacterium in an image of a sputum sample?" "What is the economic impact of open-source software?" Others start with an open-ended challenge. "Develop an algorithm to advise students how to choose among campus dining options according to personal food preferences and daily dietary targets." (**Projects should not be prescriptive about methodology.** For example, the instruction to "Use support vector machines to classify this brain tumor data set" would not give the team sufficient freedom to identify, assess, and select a solution strategy.)
- **Scale.** The projects should be scaled to a level where a team of 3–5 students can make significant progress over a one semester (3 credit-hour) class with good likelihood of arriving at some definitive result. Successful projects might well spin off into new projects for subsequent semesters. Multi-semester project sequences might explore different facets of a problem or issue, or build upon a prior semester team's work.
- **Scope.** The projects should lend themselves to several different potential solution strategies. Each team will (a) develop project requirements, in consultation with the client; (b) brainstorm modeling/analysis solutions; (c) score how the solutions meet requirements; (d) select the most suitable solution; (e) implement the solution; (f) present their solution to the client. The teams' formal assignments due throughout the semester will follow these planning/decision points.
- **Background and Data.** The client should provide the team with background knowledge about the problem, and guide them toward accessing representative data. Data might be incomplete and messy; the teams anticipate some nontrivial data cleaning. The data may be acquired by the team from publicly available sources, or provided by the client. In the latter case, the client might wish to anonymize data before distributing it to the team or require the team to sign a nondisclosure agreement to handle proprietary data.
- **Client Meetings.** The client should be available to meet with the team at least once every two weeks (typically virtually). Scheduling weekly meetings is preferred, on the understanding that such meetings might sometimes be unnecessary and therefore deferred. Should the team drift off track or fail to produce timely results, the client should point this out to the team and notify the course instructors.
- **CMDA Mentor Meetings.** In addition to the client, each team will be assigned a coach from among the course instructional staff. The teams may also identify a mentor within the community of CMDA faculty and graduate students as circumstances warrant. In such cases, the team may seek out this mentor periodically for technical insight to support the solution strategy. While the team's coach and mentor can point the team toward techniques, algorithms, or software, they should not participate in the project at a deeper level.
- **Final Presentation.** At the end of the semester, each team will summarize their findings in a 15-minute class presentation. Clients are invited to attend these presentations and/or ask the team to repeat the presentation for the client's organization.
- **Final Report.** Each team will also develop a final report that summarizes their problem-solving process and presents their final results in detail. The team should send the client a copy of this report.
- **Evaluation.** In addition to their written assignments and oral presentations, the teams will also evaluate their teammates' contributions via the CATME peer-evaluation system. Clients will have an opportunity to provide feedback on team performance to the instructors.

Our Charge to the Students Presented on the First Day of Class

CMDA 4864 • CAPSTONE PROJECT COURSE

CLASS SUMMARY AND SYLLABUS • SPRING 2025

The best work in CMDA does not typically begin as beautiful theory developed in vague hope of eventual application: rather, some problem (rooted in engineering, physics, biology, economics, social science, healthcare, finance, business, government, or beyond) needs solving, and the computational scientist selects – or invents – those analytical and computational tools best suited to the challenge at hand.

CMDA 4864 puts an applied problem front-and-center. You will devote the entire semester in pursuit of its solution. You will draw on the breadth of your CMDA education (and other background skills) to find the proper tools, learning new techniques as the challenge demands. Your problem will be neither clean nor simple; there is no answer in the back of some book. Yet you will not be alone in this process: you will work in a team, ideally with students possessing complementary strengths. The client for your project will help your team understand the essential goals, just as a wide range of Virginia Tech faculty experts can provide valuable insight as you pursue a solution.

In this course, you will obtain hands-on experience in structured problem solving and project management. We organize our work around a methodical project management paradigm, a procedure for identifying requirements, brainstorming solutions, rationally selecting best strategies among those solutions, and developing viable prototypes. This approach is a classic problem solving paradigm; other strategies exist, of course, but learning this framework – *some framework* – is helpful.

The clients for our projects come from corporations, non-profits, government agencies, and diverse corners of Virginia Tech. They have high expectations of you. In many cases, this is their first experience working with a CMDA Capstone team: your success will build relationships that will help future CMDA students. A number of our past clients have hired members of the teams they mentored. Sometimes CMDA alumni serve as clients.

You should find this class to be a rich experience that draws together many aspects of your CMDA education, but *everything depends on the effort you devote to the project and your generosity as a team member*.

The class is taught in person and regular attendance is expected for all students. We will conduct some events virtually, to assure familiarity with various modes of communication. We believe that the mix of in person and online communications will maximize your learning experience, as you prepare to launch careers in leading organizations whose operations will, most likely, mirror these very same modalities in the workplace.

Virginia Tech's motto is Ut Prosim, which we translate as That I May Serve. More than most courses, Capstone gives you a chance to put our university's ethos to work in the classroom. Please keep that mentality of service in mind as you collaborate with your team.

Any student with special needs or circumstances requiring accommodation in this course is encouraged to contact the instructors during the first week of class, as well as Virginia Tech's SSD Office. We will ensure that these needs are appropriately addressed.

We urge any student who is experiencing food or housing insecurity, or who has a disability that may affect their success in this course, to speak with us at their first opportunity, or to contact the Dean of Students office for support at 540-231-3787.

External Capstone Partners for the Past Two Academic Years