Decision Sciences Certificate

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Overview

The goal of this proposed certificate is to fill an open niche in undergraduate education given the enthusiasm of Duke students for topics in decision making. We believe that a new certificate in this area would attract considerable attention from students for several reasons:

- Decision-making research pervades frontier topics in the social and biological sciences, with particular growth in behavioral and experimental economics, consumer behavior and marketing research, medical decision making, neuroeconomics, and political psychology.
- Duke has a very strong (and interdisciplinary) research presence in these areas, especially with recent additions of high-profile faculty.
- A certificate program would draw interest from students with diverse career goals. Likely trajectories include law school, business careers (especially quantitatively oriented), policy careers, and graduate research in related areas.
- We anticipate that this would be a highly complementary credential; i.e., it would go well with popular majors in the social sciences (Economics, Political Science, Psychology, Public Policy) and the natural sciences (Biology, Neuroscience). We do not anticipate considerable intellectual overlap with existing certificate programs.

The proposed certificate will advance a number of the goals of undergraduate education at Duke. Core features of the liberal arts education for Trinity College students are (a) providing opportunities to participate in independent research, (b) facilitating students' intellectual growth as they consider new areas of inquiry, (c) developing citizens who are committed to high ethical standards and who fully participate as leaders in their communities, and (d) promoting a deep appreciation for the range of human difference and potential. This certificate will provide a novel and interdisciplinary means for students to reach these goals. It will not only introduce students to, but immerse them in, exploring and evaluating research on the cutting edge of the social, computational, and biological sciences. Its courses will consider the processes that shape our abilities to evaluate choices, to make ethical decisions, and to understand and influence those around us. It creates distinctive interdisciplinary opportunities for Trinity students to approach real-world problems from different fields of inquiry.

A certificate in Decision Science will be related to, but distinct from, existing curricular opportunities available to Trinity students.

- The *Psychology* major offers a few courses entirely complementary with our focus (e.g., Psych 425: The Psychology of Consumers), but these are a small portion of the curriculum. Neither the major nor the minor require a course focused on decision sciences.
- The *Economics* department has not historically had a strong presence in behavioral economics or neuroeconomics despite enormous student interest in this area.
- The *Political Science* major contains several courses on applications of decision models, but it has little consideration of underlying mechanisms nor on decision making in other domains

- The faculty teaching in *Neuroscience* have a strong research presence in the biological basis of decision making in both neuroscience and genetics, but the major offers minimal coursework with a decision-making focus. Its curriculum does not provide coursework training that could complement the research training its students can receive in a laboratory setting.
- *Computer Science* offers a number of courses that teach relevant techniques, but few of these courses focus on human decision-making and observational data.

Thus, the certificate we propose is a naturally complementary experience for these students and many others (e.g., those doing research on disorders of decision making like addiction). The proposed certificate will enhance their experiences considerably by linking their applied research experiences to a focused curricular background.

Curriculum[1]

The goal of the curriculum is to provide a shared methodological and substantive framework that will allow students to participate in the interdisciplinary study of decision making. Our expectation, though, is that students will arrive from and return to different departments and conduct research in their home departments. The cohorts produced by the certificate will provide these students with support and criticism from a variety of perspectives, however, and the hope is that this will result in stronger student research.

Prerequisites (the number of courses depends on AP credit / QS requirements)[@]:
Math foundations: Math 112L or 122L (Calculus)[^]
Stat 230 *or* Stat 111 *or* Stat 130 *or* Stat 101 (intro probability)[#]
[@] These courses count as general curriculum QS courses and thus are not an additional burden.
[^] Students may substitute AP credit for this course; see http://www.math.duke.edu/first_year/placement.html.
[#] If students wish to do more advanced coursework in the Statistics dept., they should take Stat 230 for probability.

Students should complete these prerequisites during their first year of study at Duke.

Gateway to the Certificate, Fundamentals of Decision Science (1 course): This will be a team-taught, question-driven introduction to the certificate. This will be a hands-on course and problem-focused course designed to connect students to research as early as possible. Because of this, the substantive topics will change from semester to semester due to changing faculty interests. This course will typically be taken in the Fall semester of the sophomore year.

Methods Foundations (4 courses): Students are expected to take each the following coursework in methods. The goal of this coursework is two-fold. First, students will be exposed to the core classes in applied modeling and neuroscience. Each of these courses has a high payoff without lengthy prerequisites. Second, by combining skills, students will be able to engage more readily in interdisciplinary work. Students should complete these courses during their first five semesters at Duke and in general, *more advanced classes may be used as substitutes for the classes listed here* (with advance permission of the certificate director).

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[1] Per existing rules, only two courses may count toward both the certificate and any other major, minor, or certificate.

- *Applied Statistics / Machine Learning*: Stat 210 (Applied Regression) or CS 290 (Intro to Machine Learning / Everything Data). Goal: exposure to regression and a statistical programming environment.
- *Computer Science*: CS 101L (Intro Programming) *or* CS 201 (Data Structures and Algorithms). Goal: to develop skill with a programming language and the analysis and use of data structures and algorithms).
- *Game Theory*: PS 631L (Intro to Game Theory)[2] *or* CS 173 (Computational Micro) *or* Econ 201 (Intermediate Micro) *or* STAT 340 (Decision Analysis). Goal: an understanding of utility, strategic behavior, and game theory.
- *Neuroscience*: Neurosci 101 (Biological Basis of Behavior). Goal: exposure to neuronal theories of brain function.

The prerequisites, gateway course, and methods foundations must be completed before proceeding further in the certificate. These courses may be taken concurrently and should be completed by the end of the first five semesters of study at Duke.

Integrated Modeling in the Decision Sciences (1 course): These courses are designed to integrate the methods the students have acquired in the previous section. The goal of the certificate is to model human choice in a variety of different contexts using mixed methods; as such, these courses will typically have an applied bent; e.g., creating / analyzing data, conducting experiments, considering extensions into the larger society, and/or modeling economic, political, and social actors with a variety of tools. Students must take one of these courses, though there will be some variance in which courses in this set are available in any given semester. We will require that future courses intended for this requirement must span several methodological traditions and we will keep the number of courses on this list small to help develop a cohort effect in the certificate.

Choose one of: CS 270 (Intro to Artificial Intelligence)^ *or* Econ 368 / 462 (Behavioral Econ)^ *or* Neurosci 258 (Decision Neuroscience) *or* PS 632 (Computational Political Economy).
^ Both of these courses have prerequisites that are not included in the certificate.

Research Capstone in Interdisciplinary Decision Sciences (1 course): Typically taken in the junior year, this capstone course will develop skills in modeling, data analysis, and ethical reasoning to improve students' readiness for related research (e.g., senior theses in their majors). The capstone may be taken concurrently with the integrated modeling elective. There are two goals for this course. The first is for students to form a cohort *across different majors* centered on a shared interest in human decision making; given differences in electives and majors, this will be an interdisciplinary group. The second is to help students develop research projects and to provide feedback throughout this process (from both faculty and students). This seminar is not meant to replace senior projects in the major; rather, it seeks to feed students into their disciplinary projects with the benefit of an interdisciplinary perspective on their research question.

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[2] Depending on demand, Political Science may add an undergraduate only version of this course. That said, there are no prerequisites for the existing course and undergraduates frequently succeed in it.