UNIVERSITY OF TORONTO SCARBOROUGH

OFFICE OF THE CAMPUS COUNCIL

FOR APPROVAL **PUBLIC** **OPEN SESSION**

TO: UTSC Academic Affairs Committee

SPONSOR: Prof. William Gough, Vice-Principal Academic and Dean
CONTACT INFO: 416-208-7027, vpdean@utsc.utoronto.ca

PRESENTER: Prof. Mark Schmuckler, Vice-Dean Undergraduate
CONTACT INFO: 416-208-2978, vicedean@utsc.utoronto.ca

DATE: Wednesday, January 25, 2017

AGENDA ITEM: 4

ITEM IDENTIFICATION:

Major modification to introduce enrolment requirements for the first time to the Specialist in Statistics (BSc)

JURISDICTIONAL INFORMATION:

University of Toronto Scarborough Academic Affairs Committee (AAC) "is concerned with matters affecting the teaching, learning and research functions of the Campus" (*AAC Terms of Reference, Section 4*). Under section 5.6 of its terms of reference, the Committee is responsible for approval of "Major and minor modifications to existing degree programs." The AAC has responsibility for the approval of Major and Minor modifications to existing programs as defined by the University of Toronto Quality Assurance Process (*UTQAP, Section 3.1*).

GOVERNANCE PATH:

1. **UTSC Academic Affairs Committee [For Approval] (January 25, 2017)**

PREVIOUS ACTION TAKEN:

No previous action in governance has been taken on this item.

HIGHLIGHTS:

The Department of Computer and Mathematical Science (CMS) is proposing to add enrolment requirements for the first time to the Specialist in Statistics (BSc). The existing enrolment requirements for the analog Specialist (Co-operative) program in Statistics will not be changed as a result of this proposal.

The Specialist in Statistics (BSc) is a currently a program with two streams: (1) Quantitative Finance, and (2) Statistical Machine Learning and Data Mining. Enrolment into the program is unlimited, and the program has no enrolment requirements.

The Quantitative Finance non Co-op stream has grown steadily from 32 students in 2010-11 to 97 students in Fall 2016. The Statistical Machine Learning and Data Mining non Co-op stream, which was introduced in 2014-15, has grown from 17 students to 107 students in Fall 2016. Thus, in just six years, the non Co-op programs have effectively grown by over 500%.

Much of the recent growth in enrolments has been in the Statistical Machine Learning and Data Mining stream. Prior to the introduction of the Statistical Machine Learning and Data Mining stream, students enrolling in the Specialist in Statistics typically had a strong mathematical background, which is necessary in this demanding mathematical program. However, since the introduction of the Statistical Machine Learning and Data Mining stream, although the program continues to attract many excellent students, it has also started to attract a large number of students that lack the required mathematical aptitude to be successful in the program. This latter group of students regularly struggles with the program course requirements – especially upper-level C- and D-level courses, and consequently they are unable to fully achieve the program's learning outcomes.

To ensure that all students have the necessary background and aptitude to be successful in the non Co-op Specialist program, the Department proposes to shift the program from unlimited to limited enrolment, and to add enrolment requirements as follows:

1. Students may apply to enter the program after completing 4.0 credits, and must have passed all of the core A-level courses in the program (CSCA08H3, CSCA48H3, MATA23H3, MATA30H3/MATA31H3, and MATA36H3/MATA37H3).
2. Students with a CGPA of 2.5 or greater across the core A-level courses are guaranteed admission.
3. Admission for students with a CGPA of less than 2.5 will depend on their CGPA and the available space in the program.

Students who complete the core courses with a minimum 2.5 CGPA are guaranteed admission to the programs since these are the students who have proven to be successful in the past. Students with CGPAs below 2.5 will be considered based on CGPA and available space. Thus, students will CGPAs below 2.5 will still have the opportunity to enroll in the program.

The proposed enrolment requirements will ensure more consistency in the backgrounds and aptitudes of the students in the program. They mirror those already in place for the Specialist Co-op program in Statistics, the Specialist/Specialist Co-op and Major/Major Co-op programs in Computer Science, and they are also in line with the norms for other Specialist programs in Statistics offered at the wider University of Toronto.

The Department anticipates student demand for the Specialist program will remain robust, but acknowledges that, in the short term, there will be a drop in enrolments once the enrolment requirements are put into place. This decrease will help to alleviate some of the growing pressure on available teaching resources in the programs. In the longer term, the Department anticipates continued student interest in the programs will make up for the short-term reduction in enrolments.

Students with less aptitude, especially in mathematical areas, will be redirected to more appropriate alternatives, such as the Major in Statistics, which is an unlimited enrolment program without any admission requirements.

This proposal has been approved by the CMS Departmental Curriculum Committee. There has been extensive consultation within CMS, and with S. Soikie and D. Boyer, the Director and Manager – Operations, respectively, for Arts & Science Co-op (in person on Oct 28, 2015). The proposed changes were also presented to Prof. A. Gibbs, Associate Chair (Undergraduate) of Statistical Sciences on the St George campus (email communication on Oct 28, 2015). Finally, the proposal has been reviewed by the Dean's Office, the Decanal Undergraduate Curriculum Committee and the Provost's Office.

FINANCIAL IMPLICATIONS:

There are no net financial implications to the campus operating budget.

RECOMMENDATION:

Be It Resolved,

THAT the major modifications to the Specialist in Statistics (BSc), as described in the proposal dated November 23, 2016 and recommended by the Vice-Principal Academic and Dean, Professor William Gough, be approved effective April 1, 2017 for the academic year 2017-18.

DOCUMENTATION PROVIDED:

1. Major Modification to introduce enrolment requirements for the first time to the Specialist in Statistics (BSc) dated November 23, 2016.

UNIVERSITY OF TORONTO

University of Toronto
Major Modification Proposal: Significant Modifications to Existing Graduate and Undergraduate Programs

Program being modified:	Specialist Program in Statistics (BSc)
Proposed Major Modification:	Introduce CGPA enrolment requirements for the first time
Effective Date of Change:	April 1, 2017
Department / Unit where the program resides:	Department of Computer & Mathematical Sciences
Faculty / Academic Division:	University of Toronto Scarborough
Faculty / Academic Division contact:	Annette Knott, Academic Programs Officer aknott@utsc.utoronto.ca
Department / Unit contact:	Raymond Grinnell, Associate Chair, CMS grinnell@utsc.utoronto.ca
Date of this version of the proposal:	November 23, 2016

1 Summary

The Department of Computer and Mathematical Sciences (CMS) at the University of Toronto Scarborough (UTSC) is proposing to add enrolment requirements for the first time to the Specialist in Statistics (BSc). The existing enrolment requirements for the analog Specialist Co-operative program in Statistics (BSc) will not be changed as a result of this proposal. See Appendix A below for a complete description of both programs, showing applicable changes.

The Specialist in Statistics (BSc) is currently a program with two streams: (1) Quantitative Finance, and (2) Statistical Machine Learning and Data Mining. Enrolment into the program is unlimited, and the program has no enrolment requirements.

With the approval of this proposal, enrolment into the Specialist in Statistics (BSc) will be limited, and the following enrolment requirements will apply to both streams:

1. Students may apply to enter the program after completing 4.0 credits, and must have passed all of the core A-level courses in the program (CSCA08H3, CSCA48H3, MATA23H3, MATA30H3/MATA31H3, and MATA36H3/MATA37H3).
2. Students with a CGPA of 2.5 or greater across the core A-level courses are guaranteed admission.
3. Admission for students with a CGPA of less than 2.5 will depend on their CGPA and the available space in the program.

The proposed changes are within norms for the wider University of Toronto. Specifically, they will bring the Specialist in Statistics into alignment with the Specialist/ Specialist Co-op in Computer Science (BSc) offered by the Department of Computer and Mathematical Sciences, which have similar enrolment requirements, and the Specialist in Applied Statistics (BSc) offered at the University of Toronto Mississauga, which has enrolment requirements focused on a minimum GPA in particular courses, as well as a minimum CGPA. The Specialist in Statistical Sciences offered by the Faculty of Arts and Science does not currently have enrolment requirements, however, consultation with them revealed that the Department of Statistical Sciences will be submitting a proposal to introduce enrolment requirements for the first time, to be effective for 2017-18. They are looking at adding the following enrolment requirements:

1. After first year: 4.0 FCE plus a minimum grade of 70% in CSC108/120/121/148 and one of a minimum grade of 70% in MAT137Y or a minimum grade of 60% in MAT157;
2. After 2nd year (for transfer students or as a 2nd chance for students who didn't meet the 1st year requirements): a minimum grade of 70% in both STA257 and STA261.

No other changes to the program, including to program completion requirements, are being proposed at this time.

2 Academic Rationale

The Department of Computer and Mathematical Sciences (CMS) is proposing to add enrolment requirements for the first time to the Specialist in Statistics (BSc). The existing enrolment requirements for the analog Specialist Co-operative program in Statistics (BSc) will not be

changed as a result of this proposal. See Appendix A below for a complete description of both programs, showing applicable changes.

The Specialist in Statistics (BSc) is a currently a program with two streams: (1) Quantitative Finance, and (2) Statistical Machine Learning and Data Mining. Enrolment into the program is unlimited, and the program has no enrolment requirements.

As demonstrated in Table 1 below, the Quantitative Finance non Co-op stream has grown steadily from 32 students in 2010-11 to 97 students in Fall 2016. The Statistical Machine Learning and Data Mining non Co-op stream, which was introduced in 2014-15, has grown from 17 students to 107 students in Fall 2016. Thus, in just six years, the non Co-op programs have effectively grown by over 500%.

Table 1: FCE Enrolments

Program	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	Fall 2016
Quantitative Finance Stream, non Co-op	32	45	45	68	72	87	97
Quantitative Finance Stream, Co-op	3	4	7	11	13	17	13
Statistical Machine Learning & Data Mining Stream non Co-op					17	36	107
Statistical Machine Learning & Data Mining Stream Co-op						1	5
Totals	35	49	52	79	102	141	222

Much of the recent growth in enrolments has been in the Statistical Machine Learning and Data Mining stream. While some of this growth can be attributed to the recent surge of interest in Big Data, a substantial part comes from absorbing students that are primarily interested in Computer Science Specialist or Major programs, but who did not meet the enrolment requirements, and chose the Statistical Machine Learning and Data Mining stream of the Specialist in Statistics as the closest alternative.

Prior to the introduction of the Statistical Machine Learning and Data Mining stream, students enrolling in the Specialist in Statistics typically had a strong mathematical background, which is necessary in this demanding mathematical program. However, since the introduction of the Statistical Machine Learning and Data Mining stream, although the program continues to attract many excellent students, it has also started to attract a large number of students that lack the required mathematical aptitude to be successful in the program. This latter group of students regularly struggles with the program course requirements – especially upper-level C- and D-level courses, and consequently they are unable to fully achieve the program's learning outcomes.

To ensure that all students have the necessary background and aptitude to be successful in the non Co-op Specialist program, the Department proposes to shift the program from unlimited to limited enrolment, and to add enrolment requirements as follows:

1. Students may apply to enter the program after completing 4.0 credits, and must have

passed all of the core A-level courses in the program (CSCA08H3, CSCA48H3, MATA23H3, MATA30H3/MATA31H3, and MATA36H3/MATA37H3).
2. Students with a CGPA of 2.5 or greater across the core A-level courses are guaranteed admission.
3. Admission for students with a CGPA of less than 2.5 will depend on their CGPA and the available space in the program.

These enrolment requirements combine a requirement to complete specific core courses, with a minimum CGPA in these courses. This combination of requirements serves multiple purposes. First, it ensures students are on track with the program by forcing them to complete all first year core courses. This is important because the program has many upper level courses with long prerequisite chains, some going all the way back to first year. So, if students do not take these courses in their first year they risk delaying their graduation. Second, these core courses provide the necessary mathematical and computational foundation for the program. Moreover, these courses are good predictors of successful completion of the program. Lastly, we do not want to favor or disadvantage students in the admissions process based on the marks they received in courses that are not directly related to the Specialist program.

Students who complete the core courses with a minimum 2.5 CGPA are guaranteed admission to the programs since these are the students who have proven to be successful in the past. Students with CGPAs below 2.5 will be considered based on CGPA and available space. Thus, students will CGPAs below 2.5 will still have the opportunity to enroll in the program.

The proposed enrolment requirements will ensure more consistency in the backgrounds and aptitudes of the students in the program. They mirror those already in place for the Specialist Co-op program in Statistics, the Specialist/Specialist Co-op and Major/Major Co-op programs in Computer Science, and they are also in line with the norms for other Specialist programs in Statistics offered at the wider University of Toronto.

The Department anticipates student demand for the Specialist program will remain robust, but acknowledges that, in the short term, there will be a drop in enrolments once the enrolment requirements are put into place. This decrease will help to alleviate some of the growing pressure on available teaching resources in the programs. In the longer term, the Department anticipates continued student interest in the programs will make up for the short-term reduction in enrolments.

Students with less aptitude, especially in mathematical areas, will be redirected to more appropriate alternatives, such as the Major in Statistics, which is an unlimited enrolment program without any admission requirements.

3 Description of the Proposed Major Modification(s)

Description of Changes:

- The program will shift from unlimited to limited enrolment status

- Students may apply to enter the program after completing 4.0 credits, and must have passed all of the core A-level courses in the program (CSCA08H3, CSCA48H3, MATA23H3, MATA30H3/MATA31H3, and MATA36H3/MATA37H3).
- Students with a CGPA of 2.5 or greater across the core A-level courses are guaranteed admission.
- Admission for students with a CGPA of less than 2.5 will depend on their CGPA and the available space in the program.

No other changes to the program, including to program completion requirements, are being proposed at this time.

Impact on Learning Outcomes:
The proposed changes to the Specialist in Statistics will have no impact on the program's learning outcomes. Instead, they will help ensure that the existing program learning outcomes are met. This will be achieved by ensuring that students in the program have the right background and aptitude for tackling and making the most out of the advanced coursework in the program. For a more detailed description of the impact on learning outcomes, see Appendix B, below.

4 Impact of the Change on Students

Continuing Students:
Students who have already selected the Specialist in Statistics (BSc) as a Subject POSt will be grandfathered, and the proposed changes will have no impact on them. Moreover, there is essentially no change for Co-op students, since they already need a minimum CGPA of 2.5 in order to maintain good standing in the program.

New Students:
New students will be subject to the new enrolment requirements. Students will be made aware of the changes through the various Choose Your Program information sessions offered by the Department and by the UTSC Academic Affairs & Career Centre, and through the undergraduate Academic Calendar.

5 Consultation

There has been extensive consultation within CMS, and the proposed changes have been approved by the Departmental Curriculum Committee.

The proposed changes were presented to Prof. A. Gibbs, Associate Chair (Undergraduate) of Statistical Sciences on the St George campus (email communication on Oct 28, 2015).

Finally, we have consulted with S. Soikie and D. Boyer, the Director and Manager – Operations, respectively, for Arts & Science Co-op (in person on Oct 28, 2015). We have informed them of the changes and discussed ways to mitigate any potential effects on Co-op students.

6 Resources

Academic units should bear in mind that any additional resources needed must have been secured before the proposal can be moved into governance. The Vice-Dean will shepherd approval of these resources.

The Department is not requesting any additional resources to support this proposal. There are no resource implications.

7 Governance Process

Levels of Approval Required	Date
Academic Unit Curriculum Committee	June 30, 2016
Forwarded to PO for Review/Sign-Off	November 29, 2016 Sign off: December 9, 2016
Reviewed by DUCC (Undergraduate)	December 19, 2016
Decanal Sign-Off	Resources: September 8, 2016 Proposal: December 19, 2016
Approved by UTSC Academic Affairs Committee	
Submitted to Provost's Office	
AP&P – reported annually	
Ontario Quality Council – reported annually	

Appendix A: Calendar Copy [showing changes]

SPECIALIST PROGRAM IN STATISTICS (SCIENCE)

Supervisor of Studies: S. Damouras *Email:* sdamouras@utsc.utoronto.ca (416-208-4794)

Program Objectives
This program provides training in the discipline of Statistics. Students are given a thorough grounding in the theory underlying statistical reasoning and learn the methodologies associated with current applications. A full set of courses on the theory and methodology of the discipline represent the core of the program. In addition students select one of two streams, each of which provides immediately useful, job-related skills. The program also prepares students for further study in Statistics and related fields.

The Quantitative Finance Stream focuses on teaching the computational, mathematical and statistical techniques associated with modern day finance. Students acquire a thorough understanding of the mathematical models that underlie financial modeling and the ability to implement these models in practical settings. This stream prepares students to work as quantitative analysts in the financial industry, and for further study in Quantitative Finance.

The Statistical Machine Learning and Data Mining Stream focuses on applications of statistical theory and concepts to the discovery (or "learning") of patterns in massive data sets. This field is a recent development in statistics with wide applications in science and technology including computer vision, image understanding, natural language processing, medical diagnosis, and stock market analysis. This stream prepares students for direct employment in industry and government, and further study in Statistical Machine Learning.

Enrolment Requirements
Enrolment in the Specialist in Statistics (all streams) is limited.
Students may apply to enter the program after completing 4.0 credits, and must have passed all of the core A-level courses in the program. Students with a CGPA of 2.5 or greater across the core A-level courses (CSCA08H3, CSCA48H3, MATA23H3, MATA30H3/MATA31H3, and MATA36H3/MATA37H3) are guaranteed admission. Admission for students with a CGPA of less than 2.5 will depend on their CGPA and the available space in the program.

Program Requirements
To complete the program, a student must meet the course requirements described below. (One credit is equivalent to two courses.)

The first year requirements of the two streams are almost identical, except that the Quantitative Finance stream requires MGEA02H3/(ECMA04H3) while the Statistical Machine Learning and Data Mining stream requires CSCA67H; these courses need not be taken in the first year. In the second year the two streams have considerable overlap. This structure makes it relatively easy for students to switch between the two streams as their interests in Statistics become better defined.

Note: There are courses on the St. George campus that can be taken to satisfy some of the requirements of the program. STAB52H3, STAB57H3 and STAC67H3, however, must be taken at the University of Toronto Scarborough; no substitutes are permitted without permission of the program supervisor.

Core (7.5 credits)
1. Writing Requirement (0.5 credit) (*)
One of: ANTA01H3, ANTA02H3, (CLAA02H3), (CTLA19H3), CTLA01H3, ENGA10H3, ENGA11H3, ENGB06H3, ENGB07H3, ENGB08H3, ENGB09H3, ENGB17H3, ENGB19H3, ENGB50H3, (ENGB51H3), GGRA02H3, GGRA03H3, GGRB05H3, (GGRB06H3), (HISA01H3), (HLTA01H3), ACMA01H3, (HUMA01H3), (HUMA11H3), (HUMA17H3), (LGGA99H3), LINA01H3, PHLA10H3, PHLA11H3, WSTA01H3.
(*) It is recommended that this requirement be satisfied by the end of the second year.

2. A-level courses (2.5 credits)
CSCA08H3 Introduction to Computer Science I
CSCA48H3 Introduction to Computer Science II
MATA23H3 Linear Algebra I
One of:
MATA31H3* Calculus I for Mathematical Sciences
MATA30H3 Calculus I for Physical Sciences
One of:
MATA37H3* Calculus II for Mathematical Sciences
MATA36H3 Calculus II for Physical Sciences
(*) MATA31H3 and MATA37H3 are recommended; the latter requires the former.

3. B-level courses (2.5 credits)
MATB24H3 Linear Algebra II
MATB41H3 Techniques of the Calculus of Several Variables I
MATB61H3 Linear Programming and Optimization
STAB52H3 Introduction to Probability
STAB57H3 Introduction to Statistics

4. C-level courses (1.5 credits)
CSCC37H3 Introduction to Numerical Algorithms for Computational Mathematics
STAC62H3 Stochastic Processes
STAC67H3 Regression Analysis

5. D-level courses (0.5 credit)
STAD37H3 Multivariate Analysis

A. Quantitative Finance Stream
This stream requires a total of 26 courses (13.0 credits). In addition to the core requirements, 11 other courses (5.5 credits) must be taken satisfying all of the following requirements:

6. Additional A-level courses (0.5 credit)
MGEA02H3/(ECMA04H3) Introduction to Microeconomics: A Mathematical Approach

7. Additional B-level courses (2.0 credits)
ACTB40H3 Fundamentals of Investment and Credit
MATB42H3 Techniques of Calculus of Several Variables II
MATB44H3 Differential Equations I
STAB41H3 Financial Derivatives
8. Additional Upper Level courses (3.0 credits)
MATC46H3 Differential Equations II
STAC70H3 Statistics and Finance I
STAD57H3 Time Series Analysis
STAD70H3 Statistics and Finance II
Two of:
APM462H1 Nonlinear Optimization
CSCC11H3 Introduction to Machine Learning and Data Mining
MATC37H3 Introduction to Real Analysis
STAC51H3 Categorical Data Analysis
STAC58H3 Statistical Inference
STAC63H3 Probability Models
STAD68H3 Advanced Machine Learning and Data Mining
STAD94H3 Statistics Project

Note: Students enrolled in this stream should also consider taking complementary courses in economics and finance (e.g. MGEA06H3/(ECMA06H3), MGEB02H3/(ECMB02H3), MGEB06H3/(ECMB06H3), MGEC72H3/(ECMC49H3)), or a Minor in Economics for Management Studies.

B. Statistical Machine Learning and Data Mining Stream
This stream requires a total of 26 courses (13.0 credits). In addition to the core requirements, 11 other courses (5.5 credits) must be taken satisfying all of the following requirements:

6. Additional A-level courses (0.5 credit)
[CSCA67H3 or MATA67H3 Discrete Mathematics]

7. Additional B-level courses (1.0 credit)
Two of:
CSCB07H3 Software Design
CSCB20H3 Introduction to Databases and Web Applications
CSCB36H3 Introduction to the Theory of Computation
CSCB63H3 Design and Analysis of Data Structures

8. Additional Upper Level courses (4.0 credits)
CSCC11H3 Introduction to Machine Learning and Data Mining
STAC58H3 Statistical Inference
STAD68H3 Advanced Machine Learning and Data Mining

Five of: *

Any C or D-level CSC, MAT or STA courses (excluding STAD29H3), three of which must be STA courses.

(*) Some of the courses on this list have prerequisites that are not included in this program; in choosing courses to satisfy this requirement, check the prerequisites carefully and plan accordingly.

SPECIALIST (CO-OPERATIVE) PROGRAM IN STATISTICS (SCIENCE)

Supervisor of Studies: S. Damouras (416-208-4794) Email: sdamouras@utsc.utoronto.ca
Co-op Contact: askcoop@utsc.utoronto.ca

Program Objectives

This program combines the coursework of the Specialist Program in Statistics described above with paid work terms in public and private enterprises. It shares the goals and structure of the Specialist Program in Statistics, but complements study of the subject with considerable work experience.

Admission Requirements

Refer to the Program Admission requirements for the Specialist Program in Statistics described above and section 6B.5 (Co-operative Programs) in this *Calendar.* Students entering this program after first year must have a CGPA of at least 2.75.

Program Requirements

To remain in the program, a student must maintain a CGPA of 2.5 or higher throughout the program. To complete the program, a student must meet the work term and course requirements described below.

Work Term Requirements

Students must successfully complete three work terms, at most one of which can be during the summer. In addition, prior to their first work term, students must successfully complete the Arts & Science Co-op Work Term Preparation Activities. These include networking sessions, speaker panels and industry tours along with seminars covering resumes, cover letters, job interviews and work term expectations.

Course Requirements

The course requirements of the Co-operative Specialist Program in Statistics are identical to those of the Specialist Program in Statistics described above.

Appendix B: New Learning Outcomes, and Degree Level Expectations [Undergraduate Programs]

Address how the design, structure, requirements and delivery of the program support the program learning outcomes and degree level expectations

Degree Level Expectations	**Clearly describe the new Program Learning Outcomes.** • Program Learning Outcomes describe what students will know or be able to do at the completion of the program. • Program Learning Outcomes should support the Degree Level Expectations.	**Clearly describe how the revised program design/structure will support the program learning outcomes.**
1. Depth and Breadth of Knowledge Depth of Knowledge: is attained through a progression of introductory, core and specialized courses. Specialized courses will normally be at the C and D levels. Breadth of Knowledge: students will gain an appreciation of the variety of modes of thinking, methods of inquiry and analysis, and ways of understanding the world that underpin different intellectual fields.	The Specialist in Statistics (BSc) aims to equip students with core statistical knowledge combined with a theoretical and practical specialization on a chosen area of concentration. There are two streams in the program (Quantitative Finance, or Machine Learning and Data Mining): the former concerns financial applications of Statistics, such as Risk Management, whereas the latter focuses on the algorithmic analysis of data, like Predictive Modeling. For both streams, students are expected to have a solid foundation in mathematics (calculus and linear algebra), probability, and computer science. They are required to learn the basic statistical theories and models, and have experience applying a variety of statistical methods, assessing their appropriateness, and	The learning outcomes are supported through a common core of first and second year courses that also serve as prerequisites for upper-level courses. Differentiation between the two streams (Quantitative Finance, and Machine Learning and Data Mining) begins in the second year, and intensifies thereafter. Depth is attained through specialized courses designed specifically for each stream. Breadth is attained through required courses on basic statistical methodology, combined with a collection of electives that allow students to further explore their interests. The Quantitative Finance stream is served by a sequence of three specialized courses (STAB41H3, STAC70H3, STAD70H3) on financial instruments, quantitative modeling, and statistical applications in finance. The Machine Learning and Data Mining stream is served by two specialized courses (CSCC11H3 and STAD98H3) on the theory and methodology of algorithmic data analysis, together two Computer Science electives developing computing skills. Further upper-level courses (at least 5.0 credits in required and elective courses) ensure the necessary breadth and depth of knowledge. The introduction of enrolment requirements

	communicating their results. In particular, they should be able to design studies, explore data, use statistical models, employ a variety of inference procedures, and draw appropriate conclusions from the analysis. In terms of specific concentrations, the Quantitative Finance stream requires students to develop an understanding of modern financial products and markets. Moreover, students should able to build and asses Financial models, perform quantitative analyses, and assess the value and risk of different financial instruments and strategies. For the Machine Learning and Data Mining stream, students will develop an understanding of appropriate models and methods for the algorithmic analysis of data. In addition, students will develop programming skills for their efficiently implementation in an appropriate computing environment.	will support learning outcomes by ensuring that students posses the mathematical background and sophistication required for succeeding in the program. It will achieve this in several ways: • Students will have to complete all first year core courses before selecting the Specialist in Statistics as a Subject POSt, which will ensure a more complete preparation and a better progression through the program. • Most of the advanced coursework in the program requires a level of aptitude in foundational courses that goes beyond that which is required for just passing the course. A student getting consistently low marks through first year will most certainly be ill-equipped for the C- and D-level specialized courses required in this program. • Enrolment requirements will also ensure a more uniform student quality in the classroom, which will remove constraints in the content and delivery of advanced courses. We expect the combination of these effects to improve and enforce student learning outcomes.
2. Knowledge of Methodologies Students have a working knowledge of different methodologies and approaches relevant to their area of study. They are able to evaluate the efficacy of different methodologies in addressing questions that arise in their area of study.	Students in all streams of the Specialist in Statistics will develop a solid grasp the basic methodologies for analyzing data. They will understand the types of questions these methods answer, their theoretical basis, assumptions, limitations, and interpretation. Students in the Quantitative Finance stream will also develop an understanding of quantitative methods from Finance and Econometrics	The development of methodological knowledge is achieved through a combination of core and specialized courses. Basic statistical methodologies and their theoretical underpinnings are taught in the core courses STAB57H3, STAC67H3, and STAD37H3. For the Quantitative Finance stream, the specialized methodological courses are STAC70H3, STAD70H3, and STAD57H3. For the Machine Learning and Data Mining stream, the corresponding courses are CSCC11H3, STAC58H3, and STAD68H3. Student can also take a selection of elective courses to hone their methodological knowledge.

	for analyzing financial data. Students in the Machine Learning and Data Mining stream will develop an understanding of computational techniques for discovering patterns and making predictions based on data.	The introduction of enrolment requirements into the program will support methodological learning outcomes in a way similar to Depth and Breadth of Knowledge.
3. Application of Knowledge Students are able to frame relevant questions for further inquiry. They are familiar with, or will be able to seek the tools with which, they can address such questions effectively.	Students in all streams of the Specialist in Statistics will be able to properly apply statistical methodologies for analyzing data. In particular, they will be able to explore data to gain insights into their characteristics, select relevant approaches to address statistical questions, implement statistical techniques and draw appropriate conclusions.	Students are required to apply their knowledge in multiple ways. All methodological courses in the program have a strong practical component, where students have to use the techniques they learn to analyze real data with the help of a software package. This is done through a combination of assignments, course projects, and computerized tests. Students are given further opportunities to practice their knowledge through supervised project courses (STAD94H3), undergraduate research activities, and Co-op placements,. We expect the introduction of enrolment requirements will allow for more meaningful practical experiences for students. For example, group projects run more smoothly when group members have a more uniform level of ability.
4. Awareness of Limits of Knowledge Students gain an understanding of the limits of their own knowledge and an appreciation of the uncertainty, ambiguity, and limits to our collective knowledge and how these might influence analyses and interpretations.	Students in both streams of the Specialist in Statistics will be able to assess the assumptions and recognize the limitations of their modeling and methodological choices. This is particularly important when drawing conclusions from any data analysis.	Courses in the program place great emphasis on the assumptions, conditions and limitations of various models and methods. This is done through the examination of paradoxes, counterexamples, and extensions. Students also explore the limits of their knowledge through practice and experience. As described in part 3, the program affords students many opportunities to apply and test their knowledge on real data. The addition of enrolment requirements will not significantly impact these learning outcomes.
5. Communication Skills Students are able to communicate information, arguments, and analyses accurately and reliably, both orally	Students in both streams of the Specialist in Statistics will be able to clearly and effectively communicate statistical concepts, models and results to diverse audiences. They will be able	Both streams of the Specialist program include a writing requirement, fulfilled by one of a list of courses with a significant writing component. In addition, the program offers multiple opportunities to practice and refine these skills.

and in writing. They learn to read and to listen critically.	express statistical ideas both orally and in writing.	Several methodological courses (STAC67H3, STAD37H3, STAD57H3) require students to write reports and give presentation as part of data analysis course assignments. Co-op placements and project courses (STAD94H3) provide additional opportunities to improve these skills. The addition of enrolment requirements will not significantly impact these learning outcomes.
6. Autonomy and Professional Capacity The education students receive achieves the following broad goals: • It gives students the skills and knowledge they need to become informed, independent and creative thinkers • It instils the awareness that knowledge and its applications are influenced by, and contribute to, society • It lays the foundation for learning as a life-long endeavour	The Specialist in Statistics prepares students for further academic and professional development in areas with strong data-analytical demands. Students will gain a well-balanced education in Statistics, together with a more detailed examination of their respective field of specialization. Students will be prepared for employment, and also able to pursue further studies (MSc, PhD) or professional designations (FRM, CFA, SOA).	The Specialist in Statistics offers a curriculum that balances theory and practice. The foundational development is thorough, but students are also required to regularly apply their knowledge. Independent thinking is developed through practical experience, and course content is kept up to date with recent methodological and computational developments. In addition, the curriculum is flexible enough to allow student to pursue their own interests through electives and supervised project courses. Finally, the program requires students to demonstrate ethical practice in the conduct of data analysis and reporting. The addition of enrolment requirements will not significantly impact these learning outcomes.