Canadian Statistics Undergraduate Program Outcomes (DRAFT)

1. **Statistical Methodology:** Upon graduation, Statistics Majors should be able to appropriately apply and compare methods of analyzing data. In particular, they should be able to:
   - 1.1. Explore the data to gain insights into their behavior and characteristics.
   - 1.2. Select appropriate models and techniques (including computational techniques) to address statistical questions.
   - 1.3. Implement various statistical methods and draw conclusions from their results.
   - 1.4. Assess assumptions and recognize limitations of their data analyses choices.
2. **Computing with Data:** Upon graduation, Statistics Majors should be able to implement a substantial statistical analysis project in a programming environment of their choice. In particular, they should be able to:
   - 2.1. Store and retrieve data of various types and formats, and manipulate them efficiently.
   - 2.2. Explore and effectively visualize and summarize data, and perform statistical modeling, inference and/or prediction.
   - 2.3. Write efficient and well-documented code that supports reproducible research, including writing algorithms and conducting simulations.
   - 2.4. Scale up computation for handling big data.
3. **Statistical Practice:** Upon graduation, Statistics Majors should be able to translate real-world problems into statistical questions, and communicate their answers in an accessible manner. In particular, they should be able to:
   - 3.1. Distill statistical questions from the contextual information of the problem at hand.
   - 3.2. Recommend appropriate designs of statistical studies to address real-world problems.
   - 3.3. Clearly and effectively visualize and communicate concepts, methods and results to diverse audiences, both in writing and orally.
   - 3.4. Function effectively in a collaborative and/or interdisciplinary environment.
   - 3.5. Demonstrate ethical practice in the conduct of data collection, handling, statistical analysis and reporting[1].
4. **Theoretical Foundations:** Upon graduation, Statistics Majors should posses the necessary theoretical sophistication required to analyze and interpret statistical models and methods. In particular, they should be able to:
   - 4.1. Apply fundamental results from calculus and linear algebra.
   - 4.2. Use probability theory to describe and analyze random phenomena.
   - 4.3. Identify important issues in the modeling and analysis of data (e.g. randomness, sources of variation, association vs. causation) and understand the foundations and implications of different approaches to analyzing data.

[1] In accordance with the Statistical Society of Canada (SSC) Code of Ethical Statistical Practice and the ethics requirements described in the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS) and the Canadian Council on Animal Care in Science (CCAC) standards.

Suggested Topics and Skills (DRAFT)

1. **Statistical Methodology:** Methods for descriptive, inferential, and predictive data analyses.
   - 1.1. **Descriptive Statistics:** Graphical and numerical summaries of data for exploring different types of variables and their relationships.
   - 1.2. **Modelling:** Modeling relationships of response and explanatory variables (simple & generalized linear regression), models for multivariate and time-series data, simulation-based methods, nonparametric and machine learning methods for classification and prediction (decision trees, nonparametric regression, neural networks, support vector machines).
   - 1.3. **Inferential Statistics:** Estimation and hypothesis testing for statistical model parameters.
   - 1.4. **Data Collection:** Experimental vs observational data, methods for collecting experimental, survey and observational data**.**
2. **Computing with Data:** Necessary computational tools for performing data analysis with big and/or complex real-world data.
   - 2.1. **Data Processing:** Tools for accessing and manipulating large structured (SQL) and semi-structured (XML, text, web-pages) data.
   - 2.2. **Statistical Software:** Develop proficiency in more than one language or environment for data analysis (R, SAS, Python, etc).
   - 2.3. **Programming:** Basic programming concepts (e.g., control structures, recursion, elementary data structures algorithms, run-time analysis) and computationally intensive methods.
   - 2.4. **Big Data:** Open source tools for distributed data storage and processing (e.g., Hadoop, Spark)
3. **Statistical Practice:** Provide regular and frequent opportunities for students to practice their statistical knowledge and skills, with a focus on experiential learning.
   - 3.1. **Practical experience**: Analyzing large, messy, real world data through capstone projects, internships, consulting opportunities, or interdisciplinary research projects.
   - 3.2. **Communication:** Technical writing and oral presentation skills, opportunities for collaboration and team-work with those who have statistics backgrounds and also across disciplines.
   - 3.3. **Statistical Literacy**: Critically review statistical reports: assess assumptions, identify strengths/weaknesses, and evaluate the conclusions and impact.
   - 3.4. **Best Practices:** Develop and promote professional and ethical standards in statistical practice.
4. **Theoretical Foundations:** Necessary mathematical background for developing and analyzing statistical models and their properties.
   - 4.1. **Calculus:** Differentiation and integration in one or more variables & **Linear algebra:** Matrix operations, linear systems, Euclidean spaces and matrix decompositions.
   - 4.2. **Probability:** Discrete & continuous probability distributions in one or more variables, (in)dependence and conditioning, stochastic processes.
   - 4.3. **Theory of Statistical Inference:** Scientific method, causal vs descriptive inference, predictive modelling, likelihood concepts, frequentist and Bayesian perspectives, and parametric and nonparametric approaches.