

TEACHING STATEMENT

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1 Introduction

Teaching Philosophy. Statistics students tend to enter the classroom with specific pre-conceived notions on how they can be successful. They rely heavily on memorization and tend to work through problems in a ‘cookbook’ fashion focusing on the mechanics instead of applications. While students become experts on memorizing and applying the formulas to well-defined problems, they fail to understand the rationale behind the methods and therefore, struggle to successfully navigate new, unforeseen situations. Over-memorization discourages critical thinking and leads to students’ knowledge quickly waning after graduation. While some professors view these habits as stumbling blocks, I view them as a personal challenge. My experience with teaching helped me to realize that this behavior can be transformed through effective communication between professors and students. I am motivated to learn how to listen and respect students, how to make a complex concept relatable to them, how to inspire students, and especially how to adapt to diverse attitudes and/or backgrounds. Therefore, my teaching philosophy is based on: classroom engagement, examples that spark curiosity, understanding of prior knowledge, homework reflections, enthusiasm and care for students’ success, and training.

Teaching Strategies. In order to achieve my teaching goals I employ several strategies, which I later reflect on to improve every semester.

1. **Classroom engagement plays a major role in pedagogy.** I always try to grasp my students’ interest from the beginning of class and keep it until the end. During the first week of the semester, I ask students to introduce themselves in a discussion forum, write few things we should know about them, and post a picture of anything they would like to share (pet, favorite activity or place, etc.). This creates a sense of community from the start and helps students create a friendly working environment. Moreover, I start every lecture with a fun *Poll Everywhere* question and then engage students by briefly reviewing what we did last time. This allows for a smooth transition between what has been taught and the new material. Throughout the class I continue with few more *Poll Everywhere* questions regarding examples covered in class. This technique has been positively received by students as one commented ‘*One thing I am very grateful for is her eagerness to check for understanding throughout her lectures. None of my other professors do this, but the PollEverywhere questions make me feel great about the class because when I would answer wrong it was great to have her explain and to know she could see what we didn’t understand before it came to homework time.*’ (STAT 4123/5123 - Fall 2021).
2. **Interesting examples spark curiosity.** I strongly believe that math is mastered with practice. During class time, I make sure to cover several examples that interest students. I use publicly available data sources to find interesting data sets for students to work with. Students commented on that by saying ‘*I enjoyed the class and I*

learned things that were not only interesting but with real-world applications as well.' (MATH/STAT 3123 - Fall 2020), *'I learned so much and I know it's only because of the teaching ability of the professor! Everything was clearly explained and she always provided plenty of examples in class.'* (MATH/STAT 3123 - Fall 2020), and *'I think the biggest thing that helped with your class was the amount of examples done during class, and your willingness to explain problems in further detail in office hours.'* (end of the semester discussion forum MATH/STAT 3123 - Fall 2020).

3. **I do not assume any prior knowledge.** I always review any material necessary for our classroom and do not assume that students remember or even have that prior knowledge. I avoid phrases such as 'it is clear that', 'trivially', and 'obviously', that may reduce students' confidence and reinforce their doubts. This is apparent to my students as they noted *'Instruction was provided in many different ways which is very helpful for different learning styles. Professor Christou has a wonderful teaching style and always make sure no student is left behind during the lectures.'* (STAT 3110 - Spring 2020), and *'She was really good at teaching this course in a way that made it accessible for learning. She is one of the best math/stats professors that I have had throughout my education.'* (MATH/STAT 3123 - Fall 2021).
4. **Homework Reflections.** Homework is one of the best avenues for students to practice their skills of solving practical problems. However, many students who submit their homework do not try to understand what they did wrong. I therefore use *Padlet* discussion forums and ask students to go over the homework solutions and reflect on their mistakes. This exercise is due few days after the homework is submitted and before they receive their graded homework back. This helps students to thoroughly go over the solutions. I started this technique on Fall 2020 and students received it very positively: *'I loved the lecture notes, the homework reflections, and all of the help given when it was a struggle.'* (end of the semester discussion forum MATH/STAT 3123 - Fall 2020).
5. **Be enthusiastic.** I truly believe there is nothing better, from a student's perspective, than to be seen as an enthusiastic professor teaching the material. When you teach from the heart, you teach with passion and that is something that motivates students to be more vigilant and have more desire to perform better. My passion for teaching is very apparent to students, who note *'You can also tell she loves what she teaches. I wish more professor were like her'* (MATH/STAT 3122 - Fall 2018), *'Some professors you see a lack of care / excitement for their students and with her, you can see how much passion she has for everyone!'* (MATH/STAT 3123 - Spring 2018), and *'You can tell she is passionate about teaching. She went above and beyond her job to make sure everyone understood the material. She really separates herself from her colleagues at this university with her dedication to excellence.'* (MATH/STAT 3123 - Spring 2022).
6. **Care for students' success.** I deeply care for all of my students' success. My role as an educator does not stop when I leave the classroom. I continuously strive to go above and beyond for my students - replying to their emails, offering extra office hours when I realize that students struggle, providing homework hints through videos, and

posting several sample exams before a test. This effort has not gone unnoticed to students as several of them noted *‘This is the first time in my three years at UNCC that I used a professor’s office hours. Professor Christou is extremely approachable and willing to help with any questions.’* (MATH/STAT 3122 - Fall 2018), *‘Ms. Christou is a wonderful professor. She cares about her students and wants to do her best to help them learn.’* (STAT 3110 - Spring 2019), *‘Professor Christou is an amazing teacher who cares deeply for her students. She provided excellent instruction in a well-organized manner that makes the material clear and intuitive.’* (MATH/STAT 3123 - Fall 2019), *‘None of my teachers have ever wanted their students to understand the materials like this one. She goes above and beyond. 10/10’* (STAT 3110 - Spring 2020), *‘By far my favorite stats teacher. She goes at a perfect pace, is always listening to her students, and puts so much effort into seeing them succeed.’* (MATH/STAT 3123 - Fall 2020), and *‘Dr. Eliana Christou is a truly remarkable professor at UNCC and genuinely cares about how her class is doing with regards to learning the material as well as overall grades (It is rare to see a professor who cares nowadays).’* (MATH/STAT 3123 - Fall 2021).

7. **Training.** I am humble enough to understand that learning how to be a successful educator never stops. My desire to improve my teaching skills has led me to attend 27 teaching workshops, complete two online courses, attend three teaching conferences, and complete two teaching certificates through the Center for Teaching and Learning at UNC Charlotte (see Appendix **B7-TeachingCertificates.pdf**).

2 Summary of teaching evaluations

The best way to improve my teaching skills is to hear students’ voices and take their suggestions into consideration. My primary assessment tool is the students’ course evaluations. These end-of-semester evaluations have a quantitative component which allows students to rate my skills and the class on a scale of 1 (lowest rating) to 5 (highest rating), and a qualitative component which allows students to provide written feedback to various questions about the class. Below, I provide a summary of the average ratings of several quantitative components and a selective sample of qualitative comments for the courses I have taught so far. Note that I had no teaching responsibilities during Spring 2021 as a result of the CLAS Junior Faculty Development Award and therefore, no average ratings are reported for that semester. Complete evaluation reports can be found in Appendix **B4-CourseEvaluations.pdf**.

Courses Taught. During my time at UNC Charlotte, I prepared and taught five courses; this list does not include the two independent studies I offered nor the courses taught during summer semesters.

Undergraduate level courses

1. STAT 3110: Applied Regression (Spring 2019, Spring 2020)
2. MATH/STAT 3122: Probability and Statistics I (Fall 2017, Fall 2018, Spring 2022)

3. MATH/STAT 3123: Probability and Statistics II (Spring 2017, Spring 2018, Spring 2019, Fall 2019, Spring 2020, Fall 2020, Fall 2021, Spring 2022)

Graduate level courses

1. STAT 4123/5123: Applied Statistics I (Fall 2016, Fall 2017, Fall 2018, Fall 2019, Fall 2020, Fall 2021)
2. STAT 4124/5124: Applied Statistics II (Spring 2018)

Survey questions. Surveys vary per semester, but overall, ratings for the following items were analyzed:

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- Q1: Overall, I learned a lot in this course.
 - Q2: Overall, this instructor was effective.
 - Q3: My instructor was prepared for class.
 - Q4: My instructor's teaching strategies helped me to understand the course content.
 - Q5: My instructor effectively challenged my thinking about the subject matter.
 - Q6: My instructor provided timely feedback on class performance and course assignments.
 - Q7: My instructor provided useful feedback on class performance and course assignments.
 - Q8: My instructor used grading methods that were fair.
 - Q9: My instructor treated all of the students in the class with respect.
 - Q10: My instructor was readily available for consultation (e.g. during office hours, by email, or otherwise).
 - Q11: Overall, I would rate this course.
 - Q12: Overall, I would rate this instructor as.
-

The average ratings for my performance are compared with the group and the department averages by using bar charts. The group refers to a collection of classes that are similar to each other. In summary, my evaluations are strong in all of my courses, with an overall average instructor rating of 4.9, well above the average department rating of 4.1. The qualitative comments from my students have all been positive with not one negative comment.

At the end of the semester evaluations, students highlight my commitment to demonstrating concepts and creating a positive environment by saying *'If I had to describe Professor Christou and her teaching this class in one word I would probably use 'Astounding'. I have never had a professor that has mastered their thoughts and teaching methods as professor Christou. The 'Astounding' aspect of this class is that she is ready for any question or concern and she cares for her students very much, she is always prepared and willing to go above and beyond for her students. I foresee Professor Christou receiving the BoA Professor of the Year award in the near future. She defines what students think of a 'GREAT' professor. 10/10 would recommend to any student. Students should consider themselves lucky if they get the chance to take a class she is offering.'* (MATH/STAT 3123 - Spring 2017)

2.1 STAT 3110: Applied Regression

STAT 3110 (Spring 2019, Spring 2020) covers the basics for linear regression, including parameter estimation, statistical inference, model diagnostics, multicollinearity, and variable selection. The class makes extensive use of the statistical software R. The average number of students enrolled for both semesters was 70.

Students' ratings were available for questions Q1 - Q12 for both semesters with an average response rate of 35.9%. However, the group average ratings were not available at the end of the semester evaluations and therefore, I only present the average ratings for my class and the department, given in Figure 1. My average ratings have been considerably higher than the department averages with the lowest rating at 4.59 and the highest rating at 4.92. It is worth mentioning that the highest rating for both semesters was given to Q3: 'My instructor was prepared for class.'

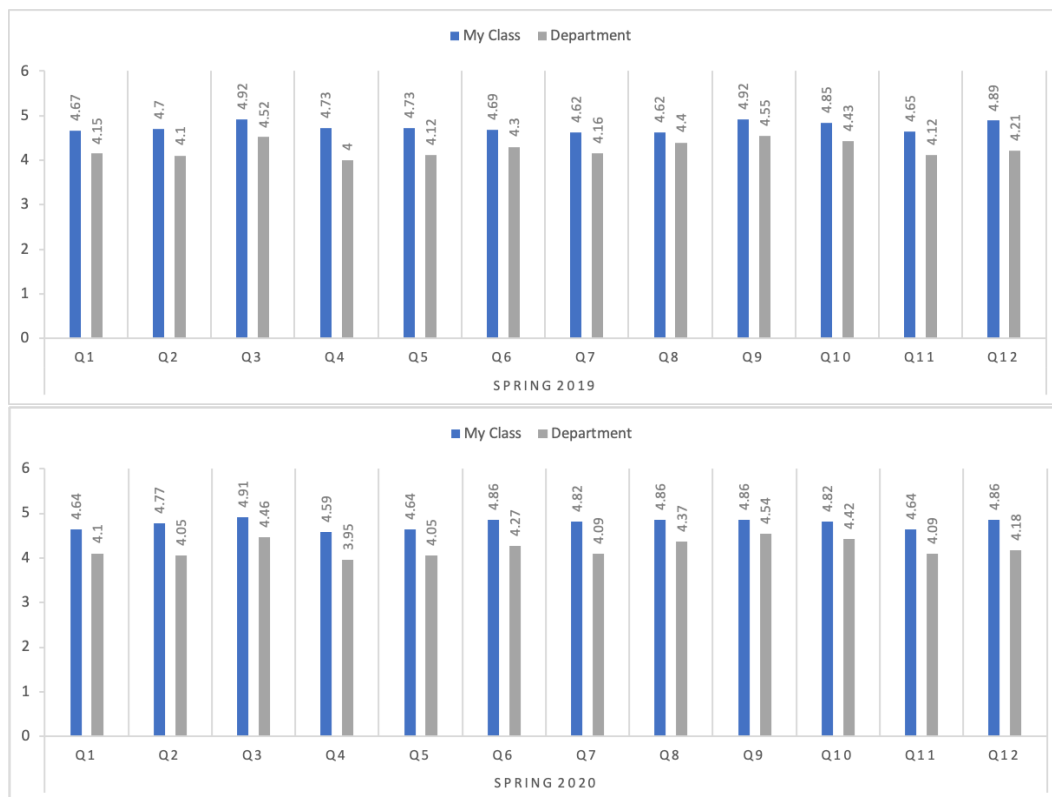


Figure 1: Average ratings for STAT 3110 during Spring 2019 and Spring 2020, respectively, for my class and the department.

In an effort to improve my students' experience in the class, suggestions provided during Spring 2019 were incorporated to Spring 2020. Although my ratings are consistently high, there are few questions that resulted in great improvement. Figure 2 compares my average ratings for questions Q2, Q6, Q7, and Q8 for both semesters, where the highest change resulted for Q8: 'My instructor used grading methods that were fair'. Note that during Spring 2020, the class had to quickly move online due to the COVID-19 restrictions and

several adjustments, including grading methods, had to be incorporated.

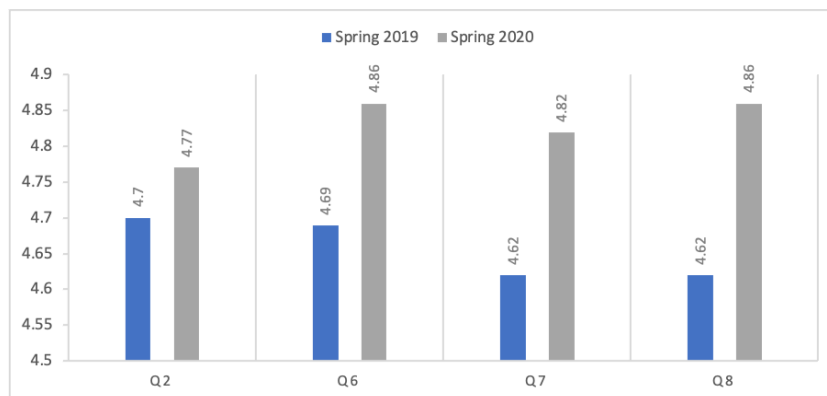


Figure 2: Average ratings for STAT 3110 for questions Q4, Q6, Q7, and Q8, during Spring 2019 and Spring 2020.

Selective Qualitative Comments:

- One of the best classes I've ever taken. Her teaching style is very detailed, comprehensive, theoretical, and inspiring. (Spring 2019)
- Dr. Christou was, by far, one of the best professors I've had. She always comes prepared to class and is very organized. She provides beneficial resources for students to enhance their learning on the concepts. She is always willing to help her students and is available in her office regularly. I would definitely recommend this course and Dr. Christou to future students. (Spring 2019)
- You are truly the best teacher I've ever had. I really appreciate how much effort you've put into this class. Your recorded lectures helped me so much with homework and test review. I wish you could teach all of my courses. (Spring 2020)
- Professor was always prepared and a wonderful teacher! Very pleasant learning experience. Was also one of the most kind and understanding professors I've ever had. (Spring 2020)
- Amazing! Dr. Christou explained things incredibly well. She made this 3000 level class feel like a breeze! (Spring 2020)
- Professor Christou is by far my favorite professor in my four years at UNC Charlotte. [...] Truly an outstanding professor who goes above and beyond and displays genuine care for her students. [...] Professor Christou will always be one of my role models and, frankly, three classes and a senior project wasn't enough to learn all that I could from her. (Spring 2020)
- It would be hard to find a professor who cares more about the way they teach and how their students are doing. She was a fantastic professor that was very open with

us and communicated everything we would need to know. [...] Being in this class with this professor was an absolute honor and I'm glad I took this class with this professor. Overall one of the best instructors I've ever had. (Spring 2020)

2.2 MATH/STAT 3122: Probability and Statistics I

MATH/STAT 3122 (Fall 2017, Fall 2018, Spring 2022) is a calculus-based course that covers the basics of probability, including random variables, counting techniques, and discrete and continuous distributions. The average number of students enrolled for all three semesters was 59 and the average response rate for the survey was 42.3%.

For brevity, Figure 3 presents the average ratings for the selective questions Q1: 'Overall, I learned a lot in this course', Q2: 'Overall, this instructor was effective', Q11: 'Overall, I would rate this course', and Q12: 'Overall, I would rate this instructor as'. Note that the group average ratings were not available for Fall 2017. Again, my average ratings were all above the group and department averages for each survey item and ranged from 4.52 to 5. The highest average rating for all semesters was again given for Q3: 'My instructor was prepared for class.'

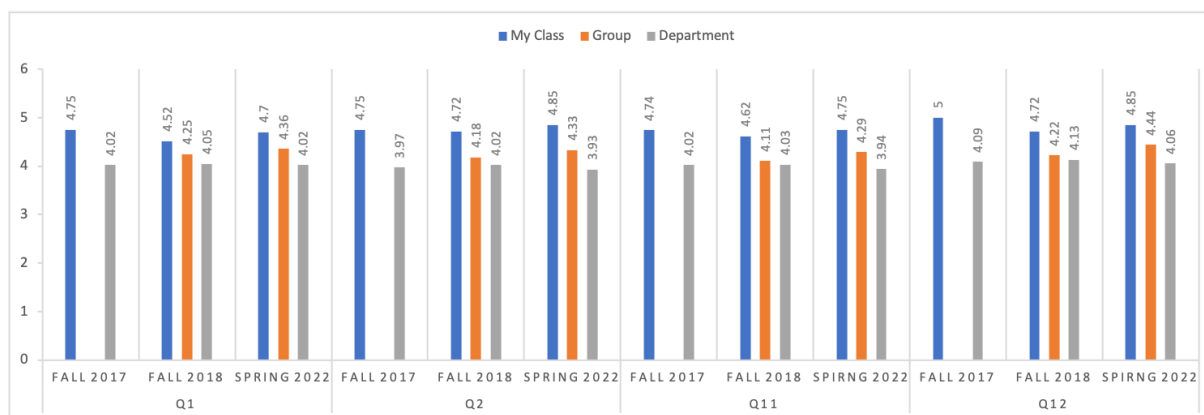


Figure 3: Average ratings for MATH/STAT 3122 for questions Q1, Q2, Q11, and Q12 for my class, group, and department, for all semesters taught the course.

Selective Qualitative Comments:

- Dr. Christou is a rare find in faculty. She is coherent, patient, and effectively communicates a complicated subject. Please UNCC, treat her well and do everything you can to keep her! (Fall 2017)
- Dr. Christou will help outside of the assigned office hours if needed. She also has an optional set time on Friday to help students preparing for the actuarial P exam. She has definitely gone above and beyond throughout the entire semester. (Fall 2018)
- The course is difficult but fair as it should be. The professor deserves to be awarded for her excellent ability to explain such difficult concepts and for truly caring about our

success in the course as well as our success in the future. She is obviously passionate about math and hopes the same for us. (Fall 2018)

- She is actually one of the best math professors that I have had at UNCC. I learned a lot the first time around and she put the most complicated lessons in simplest terms. (Fall 2018)
- Dr. Christou is such an amazing professor. Not only does she have a gift for teaching, but she goes out of her way for her students on many occasions. Her class notes and lectures were extremely clear and concise and she really does such a great job of teaching the intuition behind probability theory. (Spring 2022)

2.3 MATH/STAT 3123: Probability and Statistics II

MATH/STAT 3123 (Spring 2017, Spring 2018, Spring 2019, Fall 2019, Spring 2020, Fall 2020, Fall 2021, Spring 2022) is an introduction to statistical inference that covers topics on point estimation, confidence intervals, hypothesis testing, and the analysis of variance. The average number of students enrolled for all semesters was 28.

The average ratings for my class were based on an average response rate of 52.19%. For brevity, and since the patterns of the average ratings of my class compared with the group and department are the same, I decided to provide time trends for few questions. Specifically, Figure 4 presents the average ratings for questions Q3: ‘My instructor was prepared for class’ and Q4: ‘My instructor’s teaching strategies helped me to understand the course content’. Although my average ratings have been consistently high, Figure 4 demonstrates my commitment to improving my teaching skills and to testing innovative techniques.

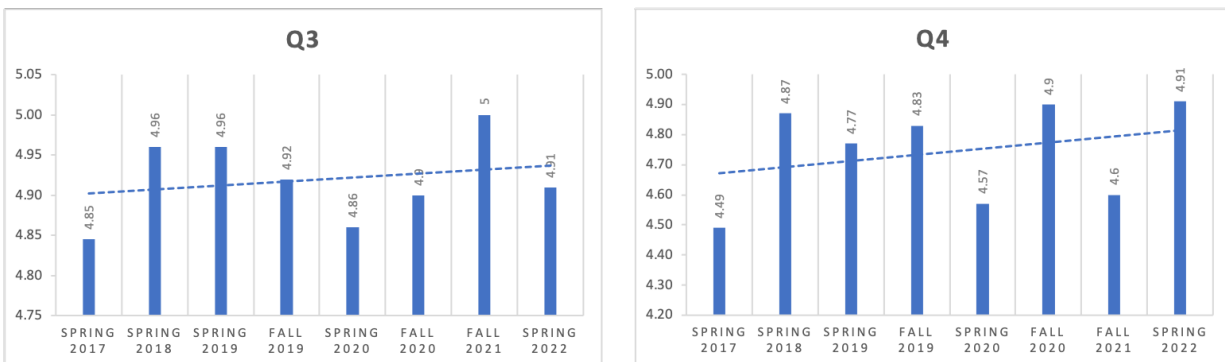


Figure 4: Average ratings for MATH/STAT 3123 for questions Q3 and Q4 for my class for all semesters taught the course. The dashed line indicates a linear trend.

Selective Qualitative Comments:

- Excellent instruction provided. It is easy to see that Prof Christou understands the material not only from an instructor’s point of view, but also from the point of view of a student new to the content. She is thorough in her instruction. (Spring 2017 - 001)

- The best professor I have ever had!!! I learned a lot in this class, and her method of teaching is very good, she explains everything and goes through a bunch of examples in class which helps the entire classroom to understand the material (not only the smart students leave with the knowledge). She also cares about her students and helps them in everything she can (even if is not for her class), she takes time of her own and gives it to us. We (her students) notice this and that makes the atmosphere in the classroom very enjoyable. She deserves a five stars evaluation from my perspective. (Spring 2017 - 001)
- This course was far superior to any other statistics course I have taken. The instructor explained things in a very efficient way. I learned more than I have in most other math courses. (Spring 2017 - 002)
- She has been holding extra study sessions for the Actuarial exams on Friday afternoons, that I assume she is not getting paid for, and I think that says a lot about her character and how much she cares for the success of her students. (Spring 2017 - 002)
- Dr. Christou is awesome! Hands down my favorite professor this far. She is always well prepared for class and has the best teaching methods I've seen yet. She is incredibly knowledgeable in statistics and was able to answer any question thrown at her. She is also fun and down to earth which I appreciate immensely. (Spring 2018)
- She has a heart for the students (as she once was one) and can relate to each of our problems. [...] When she sees students succeed, you can see a genuine smile in her face / heart. She is super kind and with her, you can 100% tell that she cares for her students. Some professors you see a lack of care / excitement for their students and with her, you can see how much passion she has for everyone! (Spring 2018)
- She is simply the best and cares a lot about her students. She makes the material easy, let's just say she has a gift of teaching. (Fall 2019)
- She was so caring and stayed professional at the same time! You can tell that this teacher loves teaching and is always ready to help her students out. (Fall 2020)
- By far one of the best professors I have ever had. Everything was set up perfectly on the canvas page, the professor was always available for questions, and I enjoyed going to class MWF. I learned so much and I know it's only because of the teaching ability of the professor! (Fall 2020)
- Dr. Christou was one of the top professors I have had over my course at UNCC. She made stats a class that I could actually learn and enjoy, despite my initial thoughts into this class. Stats is definitely not my favorite subject, but having her as the professor helped the class a lot. Over the course of the class I could tell how much she wanted all of us to succeed in her class, she made the material easy to understand and learn, and always provided help in a timely manor. I would gladly take another course with Dr. Christou if the opportunity arose. (Fall 2021)

- Professor Christou was not only my favorite math teacher, but favorite college Professor ever. She had the perfect balance of authority in the classroom while also showing that she cares and wants to truly help us out. There is nothing I would change about how Professor Christou taught this course. Thank you! (Spring 2022)

2.4 STAT 4123/5123: Applied Statistics I

STAT 4123/5123 (Fall 2016, Fall 2017, Fall 2018, Fall 2019, Fall 2020, Fall 2021) covers the theoretical aspects of regression analysis, including parameter estimation, statistical inference, and model diagnostics. The class makes extensive use of the statistical software R. The average number of students enrolled for all semesters was 20.

The average ratings for my class were based on an average response rate of 67%. They varied from 4.5 to 5, with an average rating across all questions of 4.8. For brevity, Figure 5 presents the average ratings for selective questions Q1: ‘Overall, I learned a lot in this course’ and Q2: ‘Overall, this instructor was effective’. Note that group average ratings were not available before Fall 2020. Again, my average ratings have been considerably higher than the group and department averages.

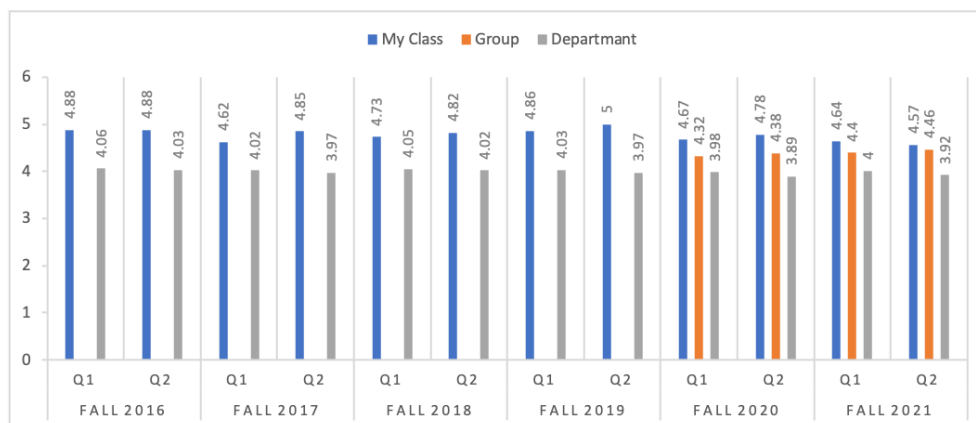


Figure 5: Average ratings for STAT 4123/5123 for questions Q1 and Q2 for my class, group, and department for all semesters taught the course.

Selective Qualitative Comments:

- The instructor was by far the most helpful and dedicated to making sure the students understood the material out of any instructor I have had during my time at UNC Charlotte. This course was appropriately challenging and I credit the instructor for designing the course in a way that pushed students while not holding them to unreasonable expectations. (Fall 2016)
- Professor Christou was organized in her materials and lectures and very responsive to questions. Overall she is one of the best professors I’ve ever had. I wish all of my professors had approached their subjects with such interest and clarity. (Fall 2017)

- Dr. Christou, is an excellent teacher. She makes the material easy to understand, and she is always prepared and wants the best for her students. She puts in 120% effort in to each class and has strong communication with her students and listens. There is no way you can leave her class without learning new information, and I thank her for her time and dedication. She has influenced me to work harder, and put my all into everything I do, from this point forward. (Fall 2018)
- Dr. Christou is an absolutely superb professor. She is clearly very well versed in her subject, yet can somehow understand how to deliver it in a way that is comprehensible to a beginner like myself. (Fall 2019)
- This course has given me the passion, and confidence in my abilities, to declare a second major in statistics. Having always hated math in high school, I never thought this would be the case. Dr. Christou's patience, compassion, intelligence, and concern for her students is like nothing I have ever seen before. And I have always felt my professors here at UNCC were great. Her door was always open. She was always available to discuss any issue, and she did so happily every time. Once she even allowed me and another student to interrupt her lunch to clarify something about a homework. [...] Not only have I been able to do well, it's turned out to actually have made a lasting positive impact in my life I will always be appreciate of. I truly don't believe that would have been the case if I'd had a different professor. Dr. Christou is the best I have ever had by leagues. (Fall 2019)
- She always wrote really thorough and helpful comments on our homework; it was really obvious she cared that we understood what the mistake was and how to fix it next time. She was also incredibly encouraging throughout the course and her grading. (Fall 2021)

2.5 STAT 4124/5124: Applied Statistics II

STAT 4124/5124 (Spring 2018) is a continuation of STAT 4123/5123 and covers the basics on how to design and analyze experiments. The class makes extensive use of the statistical software R. The number of students enrolled for that semester was 18.

Figure 6 presents the class average ratings and compares them with the group and department averages. The results are based on a response rate of 61.11% and demonstrate a consistent average rating of 4.91 to all questions - well above the group and department averages.

Selective Qualitative Comments:

- Ms. Christou did everything professionally since she is the only one teacher who posted the complete scheduled of this class at the beginning and updated it timely once some change happened! (Spring 2018)
- She has enthusiasm for teaching and she dedicates a lot to her work. We all love her both as a statistics professor and a friend in life. (Spring 2018)

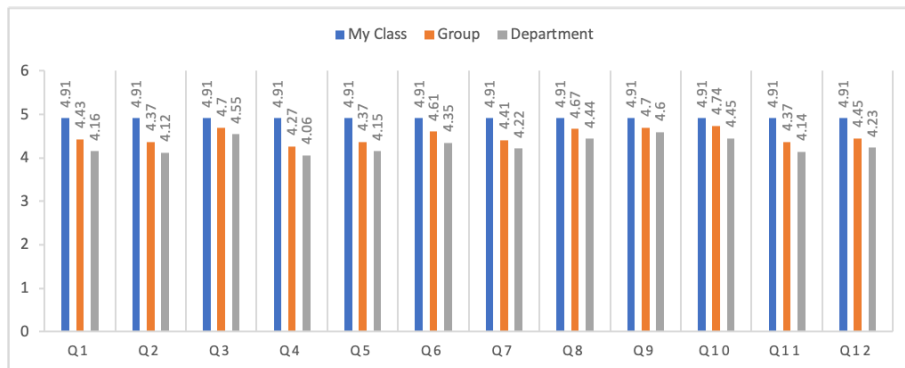


Figure 6: Average ratings for STAT 4124/5124 for my class, the group, and the department during Spring 2018.

3 Beyond the Classroom: Undergraduate and Graduate Research

Being an effective mentor is another important quality of an educator. I truly believe that a student's academic journey can be greatly influenced by his/her advisor and for that reason I want to make sure I develop effective mentoring skills. Therefore, I completed the 'Entering Mentoring' program through the UNC Charlotte Graduate school which offers mentor-training initiatives for faculty members and highlights ways to cultivate effective mentoring relationships with mentees (Spring 2021).

Since my arrival at UNC Charlotte I have advised 13 undergraduate students, including eight seniors projects, two honors projects, two independent studies, and one project through the Office of Undergraduate Research (OUR) Scholar Program. Moreover, I have advised five graduate students towards their master's theses and I am currently advising one PhD student and co-advising one master student.

It is important that my students disseminate their results and therefore, I always encourage them to participate in presentations. Some of their achievements include:

- Sierra Laine, undergraduate student, presented her honors thesis in a poster session at the 2019 Undergraduate Research Conference and published her work in an actuarial journal
- Rawan Al-shaer, undergraduate student, published our work in a top-tier conference, where she later presented it
- Annabel Settle, OUR Scholar, presented her work in a poster session at the 2020 October Math Symposium and co-authored our paper
- Kimberly Mays, graduate student, presented her work in a poster session at the 2021 October Math Symposium, where she placed first; see Figure 7 for her poster. We recently submitted our work in a peer-reviewed journal, which is currently under review

- Tanmay Kenjale, undergraduate student, presented his work in a poster session at the 2022 Undergraduate Research Conference
- Benjamin Dula, undergraduate student, presented his work in a poster session at the 2022 Undergraduate Research Conference

Refer to **B6a-Students'Publications.pdf** and **B6b-Students'PosterPresentations.pdf** for the students' publications and poster presentations, respectively.

PREDICTING MARCH MADNESS RESULTS USING A QUANTILE REGRESSION APPROACH

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University of North Carolina at Charlotte

Introduction

The NCAA Division I Men's Basketball Tournament presents a challenging opportunity to test predictive models:

- Tournament format mostly unchanged since 1985
- Inherent variability of amateur sports
- No perfect bracket to date
- 47 million U.S. bets on the tournament in 2021
- Bracket competitions such as Kaggle's Machine Learning Mania increase interest

Methodology

Let $Y^{(i)}$ be a binary response, denoting a team's win or loss in the i th round, $i = 1, \dots, 6$, where 0 represents a loss and 1 a win, and X a p -dimensional vector of predictors.

- **Goal:** Estimate the probability of winning, $P(Y^{(i)} = 1|X = x)$, for a specific round $i = 1, \dots, 6$.
- **Approach:** Estimate $P(Y^{(i)} = 1|X = x)$ by averaging over multiple conditional quantiles $Q_\tau(Y^{(i)}|X = x)$, $\tau \in (0, 1)$.
- **Model:** Assume $Q_\tau(Y^{(i)}|X = x) = g_\tau(B^T x)$, where B is a $d_i \times p$ matrix, $d_i \leq p$, resulting in new sufficient predictors.

Sample Level Algorithm

For each tournament round do the following:

1. Create a grid of quantile levels. For this work, we use equally spaced quantile levels $\frac{k}{m}$, $k = 1, \dots, m$.
2. Estimate $B^T x$ using dimension reduction and form the new sufficient predictors $\tilde{B}^T x$ following the approach of Christou (2020) [1].
3. Use a nonparametric technique to estimate the conditional quantile. In this work, we use the local linear conditional quantile regression. This gives $\hat{g}_\tau(\tilde{B}^T x)$.
4. Repeat steps 2 & 3 for the various quantile levels. Estimate $P(Y^{(i)} = 1|X = x)$ by averaging over quantile levels using the approach of Hashem et al. (2016) [2].

Once the probabilities are calculated, game pairings are considered. The team with the highest probability is selected as winner and advanced to the next round.

Data & Predictors


Except tournament seed, all predictors represent the season-wide averages:

1. region seed	8. defensive rebound percentage
2. 3 pointers per game	9. defensive rebounds per game
3. field goals per game	10. assists per game
4. free throw attempts per game	11. fouls per game
5. free throws per 100 possessions	12. scoring margin
6. offensive rebound percentage	13. assist to turnover ratio
7. offensive rebounds per game	14. offensive efficiency
	15. defensive efficiency

Tournament Bracket Design

64 teams divided into 4 regions of 16 teams with 6 single-elimination rounds.

Round 1 pairings based on team seeding with the game seed sum equal to 17 (1 vs. 16, 2 vs. 15, etc.).



Sample region bracket (West region, 2021)

Winning teams advance along the region bracket, with the region winners advancing to Round 5.

Model Comparisons

- Seed: Region seed
- Pomeroy: Pomeroy College Basketball Rankings (kenpom.com)
- Sagarin: Jeff Sagarin's College Basketball Ratings (sagarin.com)
- LRM-C: Logistic Regression/Markov Chain (gatech.edu/jskol/lrmc)
- Massey: Massey composite rank (masseyratings.com)
- RPI: Rating Percentage Index (collegerpi.com)

Results

Single Scoring						
Year	ACR	Seed	Pomeroy	Sagarin	LRMC	Massey
2015	42	44	42	45	41	41
2016	41	37	39	40	40	39
2017	45	44	44	46	44	43
2018	36	36	38	39	40	39
2019	42	41	44	43	42	41
Total	206	202	207	213	207	203
% of Points	65.4%	64.1%	65.7%	67.6%	65.7%	64.4%

Double Scoring						
Year	ACR	Seed	Pomeroy	Sagarin	LRMC	Massey
2015	94	89	81	92	73	79
2016	101	87	79	82	93	88
2017	140	82	110	113	88	90
2018	63	81	78	111	110	79
2019	81	92	127	94	93	88
Total	479	431	475	492	457	424
% of Points	49.9%	44.9%	49.5%	51.2%	47.6%	44.2%

Predictions were scored against actual tournament results in both single and double methods to follow standard March Madness bracket scoring:

1. Single scoring: 1 point for every correct game prediction (max = 63)
2. Double scoring: the value of correct predictions double for each round, giving greater weight to end-of-tournament predictions (max = 192)

*Note: RPI (Rating Percentage Index) was discontinued after the 2017-18 season but was a common benchmark metric for seasons prior to 2018-19.

Discussion

- Sagarin had the best performance overall for both single and double scoring; however, the ratings use proprietary metrics.
- Our method uses only freely-available game data and was the best 3 of the 5 years and 1 of the 5 in double and single scoring respectively.
- Of the remaining methods, Pomeroy was the top method 1 year in both scoring methods; Massey, RPI, and seed rankings never earned the highest score.
- 2018 was the only tournament to date where a #1 seed team lost in the first round.
- Algorithm easily adapts to other "successes": covering the spread, upsets by seed, etc.

References

[1] Christou, E. (2020). Central quantile subspace. *Statistics and Computing*, 30, 677-695.

[2] Hashem, H., Vinciotti, V., Alhamzawi, R., & Yu, K. (2016). Quantile regression with group lasso for classification. *Advanced in Data Analysis and Classification*, 10, 375-390.

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Figure 7: Kimberly Mays' poster for the 2021 October Math Symposium; placed first.