TEACHING STATEMENT
Christopher J. Bishop

If you are a professor, then teaching is your job; the cake to research's icing. You should strive to do to it well, which means to inspire, as well as educate, your students. A year or two ago, I covered an analysis class for one of my colleagues who was away; I discussed the definition of uniform convergence and proof that uniform limits of continuous functions are continuous. It did not seem like anything special to me, but after the class one of the students came up and thanked me for the lecture; he said that it reminded him why he became a math major in the first place. This what we want to do for every student in every class: make them feel that studying mathematics is a worthwhile endeavor, and for some of them, worth devoting their lives to. What follows are a few random thought about what I think are important aspects of teaching.

Smile: There was a study some years ago that showed students a 30 second video of a professor (without audio) and asked them to rate the instructor based on this video. It turns out the rating was almost identical to those given by students who had that instructor for a whole semester and filled out the course evaluation forms. I don't find this particular surprising, except that they used a full 30 seconds of video; a few photographs would probably be enough to show whether the instructor was smiling or not, and that one fact probably has more to do with evaluations than anything else: if the teacher doesn't enjoy being in class, why should anyone else? The teacher, at least, is fulfilling their life's ambition by walking into the classroom and getting an hour to discuss their favorite subject with a captive audience. If this opportunity doesn't make you giddy, then at least fake it until you find employment more suited to your natural disposition.

Be prepared: When I was a graduate student at the University of Chicago, I took a course from Alberto Calderon. He showed up for each class in a jacket and tie (which showed us that this was serious material) and gave an impeccable lecture from memory. On very rare occasions, he would pause for a moment, pull a bundle of carefully written notes from his jacket pocket, refer to them briefly and then carry on. He was well prepared and it showed. You should always show up for class prepared to present the material clearly. In lower level classes the clarity should be even greater, although it is natural to skip preparing "easy stuff" but then get stuck in a computation or explanation. On an advanced level, there is a possible point in favor of letting the students see you dig yourself into a hole and then get out out of it, but this should only happen accidentally in upper division classes and never the lower division.

Answer questions: In one of my favorite math anecdotes, G.H. Hardy claims during a class that a certain claim is trivial. When challenged on this point, he thinks about it a while, paces up-and-down, leaves the room, and returns a half hour later, announcing "I was right. It is trivial.". This is a great story, but a poor policy to actually implement in class. For most students, it takes significant courage to ask a question in class and dismissing it as trivial neither answers the question at hand, nor encourages the formation of any in the future. I love getting questions and I try to respond in a way that encourages more of

them. First of all, the more questions I get, the less I have to wonder what the students are "getting"; they are simply telling me where their gap are. Second, the question indicates that someone actually cares enough about what I am saying to make sure they understand it; that's pretty nice too. I am shocked when I hear (and I have heard) from students that questions are sometimes dismissed in other class as being too easy, off-topic or something that is better discussed after class. Any of these might be true, but I would never this in front of a class: after a few such instances, I would end up having to do all the talking during my lectures. Let the students pull their own weight too, and they do this through questions. If you don't address questions seriously the students will mark you down as either mean, incompetent or afraid, and none of these help the learning process.

Technology: Several years ago I was part of an effort to teach calculus using technology in the form of graphing calculators. This was not a success; using the calculators made simple concepts seem more complicated. On the other hand, one of my favorite courses is MAT 331, "Problem Solving with Computers", where we draw ideas from all over the undergraduate curriculum to write `MATLAB` scripts to solve problems that are too big or too hard for theory alone. In this course I have discussed topics like numerical integration, optimization, root finding, Newton's method, Julia sets, the Mandelbrot set, fractal dimension, image compressions, wavelets, simple substitution codes, letter frequencies, language models, one time pads, random walks, harmonic measure, percolation, and random growth models (this course could be taught for years without ever repeating a topic). Of course, computation can illustrate theory; but the real power and purpose of mathematics is for theory to facilitate computation. While I am not a fan of adding technology to elementary courses, I think it is critical that our majors and graduate students have some familiarity with programming and computation; only a minority will end up as academic mathematicians and machine computation will be a major career component for the rest. Our MAT 331 class at Stony Brook has no programming perquisite and forms just a introduction to what is possible. I would also like to see a more advanced sequel to this course, and something of a similar flavor in the graduate program (perhaps replace a foreign language requirement with a computational competency one).

Testing: Why do we give tests? To filter out the weak students? I prefer to think that tests are a way to encourage students to study, and a way to focus their attention on the most important points. For undergraduate classes, I generally hand out a nearly perfect copy of the actual exam for students to review ahead of time; the actual exam has different instances of the questions, but the structure and difficulty is the same. In my mind, the purpose of giving the in-class exam is simply to provide a powerful motivation for doing the practice exam. Furthermore, because there are no secrets about what the exam will cover, I can ask more and tougher questions that I could otherwise and I rarely (in fact, never) get a complaint about an exam being unfair. In some classes, I feel I have sufficient information from midterms and homework and give a tentative grade in the last week of classes; a student can accept this grade or take an optional final to try to raise it (I promise not to give a lower grade as a result of taking the final).

Listed below are my teaching assignments for the last 15 years.

Spring 2019:
- MAT 495 Honors thesis,
- MAT 555 Introduction to Dynamical Systems,
- MAT 699 Dissertation research,

Fall 2018:
- MAT 331 Computer assisted problem solving in mathematics,
- MAT 459 Write Effectively,
- MAT 487 Independent Study,
- MAT 495 Honors thesis,
- MAT 532 Real analysis I,
- MAT 699 Dissertation research,

Spring 2018
- MAT 487 Independent Study,
- MAT 627 Topics in complex analysis,
- MAT 699 Dissertation research,

Fall 2017
- MAT 331 Computer assisted problem solving in mathematics,
- MAT 459 Write Effectively,
- MAT 487 Independent Study,
- MAT 495 Honors thesis,
- MAT 532 Real analysis I,
- MAT 699 Dissertation research,

Spring 2017
- MAT 402 Seminar in Mathematics,
- MAT 698 Independent Study,
- MAT 699 Dissertation research,

Fall 2016
- MAT 342 Applied Complex Analysis,
- MAT 487 Independent Study,
- MAT 551 Real Analysis III,
- MAT 699 Dissertation research,

Spring 2016
- MAT 487 Independent Study,
- MAT 627 Topics in dynamical systems,
- MAT 699 Dissertation research,

Fall 2015
- MAT 324 Real Analysis ,
- MAT 495 Honors Thesis,
- MAT 543 Complex Analysis II,
- MAT 699 Dissertation research,

Spring 2015
- HON 496 Honors College Senior Project,

MAT 656 Topics in Dynamical Systems,
MAT 699 Dissertation research,
Fall 2014
HON 496 Honors College Senior Project,
MAT 122 Overview of Calculus,
MAT 544 Real Analysis,
MAT 699 Dissertation research,
Spring 2014
MAT 487 Independent Study,
MAT 656 Topics in Dynamical Systems,
Fall 2013
MAT 118 Mathematical Thinking,
MAT 487 Independent Study,
MAT 551 Real Analysis III,
Spring 2013
HON 496 Honors College Senior Project,
MAT 627 Topics in Complex Analysis,
Fall 2012
HON 495 Honors College Senior Project,
MAT 401 Seminar in Mathematics,
MAT 551 Real Analysis III,
Spring 2012
MAT 495, Independent Study,
MAT 559 Real Analysis II,
Fall 2011
MAT 324, Real Analysis,
MAT 638, Topics in Real Analysis,
MAT 699, Dissertation Research,
Spring 2011
MAT 542, Complex Analysis I,
MAT 699, Dissertation Research,
Fall 2010
MAT 118, Mathematical Thinking,
MAT 487 Independent Study,
MAT 543, Complex Analysis III,
MAT 699, Dissertation Research,
Spring 2010
MAT 542, Complex Analysis I,
MAT 698, Independent Study,
Fall 2009
MAT 401, Seminar in Mathematics,
Spring 2009
MAT 542, Complex Analysis I,

Fall 2008
MAT 171, Accelerated Calculus,
MAT 626, Topics in Complex Analysis,
Spring 2008
MAT 542, Complex Analysis I,
Fall 2007
MAT 171, Accelerated Calculus,
MAT 324, Real Analysis,
Spring 2007
MAT 402, Seminar in Mathematics,
Fall 2006
MAT 324, Real Analysis,
MAT 543, Complex Analysis II,
MAT 699, Dissertation Research,
Spring 2006
MAT 627, Topics in Complex Analysis,
MAT 698, Independent Study
Fall 2005
MAT 142, Honors Calculus,
MAT 698, Independent Study,
MAT 699, Dissertation Research,
Spring 2005
MAT 125, Calculus A,
MAT 495, Honors Thesis,
MAT 639, Topics in Real Analysis,
MAT 698, Independent Study,
MAT 699, Dissertation Research,
Fall 2004
MAT 122, Overview of Calculus,
MAT 401, Seminar in Mathematics,
MAT 698, Independent Study,
MAT 699, Dissertation Research,
Spring 2004
MAT 125 Introduction to Calculus,
MAT 627, Topics in Complex Analysis,
MAT 698, Independent Study,
MAT 699, Dissertation Research,
Fall 2003
MAT 122, Overview of Calculus,
MAT 626, Topics in Complex Analysis,
MAT 699, Dissertation Research,

To Whom It May Concern,

The first time I met Professor Bishop in my freshman year, he was the endpoint of a long series of math professors passing the buck. Me and three other freshmen were convinced that we wanted to dive into a book far beyond our level (Walter Rudin's Real and Complex Analysis), and members of the analysis faculty were taking turns dissuading us at great length and passing us on to somebody else. In his turn, Professor Bishop also offered us a series of other options, but when we didn't budge he agreed to mentor us. He approached it with characteristic humor, "if they want to, let them try." He worked closely with us throughout the semester, even writing us a personal midterm and final exam. This became the first in a long line of instances in which Professor Bishop went significantly out of his way to help us, and a good example of why he is so warmly regarded by the undergraduates he comes in contact with.

We didn't get through much of the book. We only had about four chapters to show for ourselves at the end of the semester I remember as my sink-or-swim introduction to not only graduate-level analysis, but also the rigor of formal proofs, the impenetrable density of concise mathematical text, and higher mathematical thinking as a whole. With another professor, it could have easily become the semester I turned away from mathematics. I remember the sense of wonder that I often felt during discussions with Professor Bishop. It felt like no matter what kind of question I came up with, he had not just an answer, but an entire lecture already prepared to present the material in the clearest and most engaging way. Often we came into our weekly meetings frustrated with our progress on homework problems we found very challenging, but we always left with our curiosity and passion rekindled by Professor Bishop's guidance and positive example.

The next semester, the first of my sophomore year, we ended up taking our first graduate-level course, Real Analysis 1 with Professor Bishop. The textbook (Gerald Folland's Real Analysis) was very concise, but his lectures brought the material to life, interpreting the text and clarifying the intuitive ideas behind it with great care and expertise. The course was somewhat beyond my abilities at the time, and I often felt challenged, but I never felt lost or unsupported. Professor Bishop prolonged my enchanted mathematical youth, delaying the inevitable realization that not all professors are actually good teachers, or even care all that much about the teaching components of their positions.

I went on to explore other areas of mathematics in my undergraduate career, as well as some computer science, and the solid foundations of measure theory and analysis I received in those early days proved invaluable for my development. I also took a seminar course with Professor Bishop in my last semester that introduced me to some of the foundations for his own fascinating work with probability and fractals. After taking two years off from school to work as a data scientist in a biotechnology startup, I will be returning to mathematics as a PhD student at the CUNY Graduate Center this fall. A mathematician's personality often engages me more than his or her work on its own, and I will be looking for an advisor who is not only knowledgeable, but also inspiring and supportive. Doubtless, the mental model I will be comparing against is in large part Professor Bishop.

Sincerely,
Matvey Genkin

Mathematics Department

Stony Brook University

To whom it may concern,

I would like to take this time to express my appreciation and gratitude toward Professor Christopher Bishop and for the experience of having him as my teacher while studying toward my undergraduate degree at Stony Brook University. Professor Bishop taught my section of MAT 331 – Computer Assisted Problem Solving in the fall semester of 2017.

I was glad to be asked to be used as an example to testify to Professor Bishop's skill as a teacher and to highlight traits and abilities that made my time in his class such a joy and valuable experience.

There were many things I found valuable about Professor Bishop's class including his desire to make using MATLab and difficult areas of mathematics more accessible to his students and the passion that he backed each of his lessons with. He drew to my attention the immense practicality of using MATLab in such a technologically driven time, and his instruction in the language gave me an advantage over other new graduates while job searching after graduation. I am happy to say that this practical element, in partnership with my mathematics degree, helped me secure the position as an analyst at an insurance brokerage company.

Learning to model mathematical events on a computer was a brand new experience, but one that should not be overlooked, in such a technologically driven time. This was applied in each of his projects and lessons throughout the semester which focused on specific areas of math and used experiments to achieve a result that could be reported on. What the projects also showed me is that it is one thing to be able to perform a mathematical process, but another to be able to write about it. This was my first taste of mathematical writing and the skills that came with being able to clearly explain a process and the ideas backing it.

Besides the computer and writing skills I developed in Professor Bishop's class, I was also reminded of why I chose to study mathematics in the first place. My first day in class, I glanced at the syllabus and saw topics that I had never heard of, which initially terrified me. One cannot underestimate the impact of a passionate and prepared teacher, and in no time the fear was gone, and was replaced by excitement when I realized that Professor Bishop knew how to teach these subjects to give students context with respect to their prior mathematical studies. The end of his semester was dedicated to cryptography, which was a topic I had always wanted to know more about, and I was very excited to be given the opportunity to learn from a professor who had a distinct ability to teach in an accessible way. By the end of the semester, I found great

interest in real life applications of math, and began to apply to graduate programs for Actuarial Sciences, and to study for the first exam.

I can say with confidence that Professor Bishop was one of my favorite professors from my time at Stony Brook, and also brought me fresh motivation toward pursuing a career in mathematics. I found that his passion and knowledge for his subject made me excited to attend class every week, and his instruction made me well rounded as a student, and as a new graduate joining the workforce. I am very glad to have been lucky enough to be given the opportunity to have taken class with Professor Bishop at Stony Brook University.

Thank you for your time,

Sincerely,

Gillian Armstrong

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Work Email: Gillian.Armstrong@marsh.com

To whom it may concern,

Dr. Chris Bishop was one of the most engaging, enthusiastic, and helpful professors that I ever had. His extraordinary way of teaching and communicating mathematics had a significant impact on my academic and career choices, and taught me how to communicate math to others. I am forever grateful for having the opportunity to be his student.

I took an Analysis course with Professor Bishop over two years ago, and I still vividly remember his captivating lectures and enthusiastic exposition of measure theory. Professor Bishop's course involved more than just theorems and proofs. He eloquently pointed out subtleties and counter examples, guided us through the proofs, and encouraged us to think and ask questions. Notwithstanding his expertise in the area, the proofs and definitions never seemed pre-packaged and memorized in advance. Rather, Professor Bishop motivated the definitions and showed how they arose naturally; discussed the proofs in a conversational manner, emphasizing the difference between clever tricks and deep insight. We were therefore able to pick up how he understands and learns things, and gain from it. The homework assignments were also very well selected. The questions were challenging but doable, and deepened our understanding of the subject. I always felt comfortable to ask questions in his lectures, and know that I will not be answered with "its trivial to show that", or "clearly".

This was one of my first advanced math courses, and for the very first time I could see the beauty and elegance of math. It was during that semester that I decided to pursue math, and Professor Bishop's lectures had everything to do with it. I am currently a graduate student at Columbia, and as I prepare for my own teaching assignments, I remember the impact Professor Bishop's lectures had on me and I hope to be able to do the same for others.

Sincerely,

Lea Kenigsberg.

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Jessica Loehr
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September 3, 2018
Re: Christopher Bishop

To Whom It May Concern:

I am writing to recommend Professor Christopher Bishop for teaching the subject of Complex Analysis. During the Fall of 2016 I took MAT 342 (Applied Complex Analysis) with Professor Bishop.

Through my experience working with Professor Bishop during that semester, I learned what a compassionate and dedicated mathematician he is. He was easily accessible to his students, willing to accommodate to the entire class and their academic needs, and able to present the very dense material in a clear and concise way. Although analysis has always been a hard subject for me to grasp, the way he taught led me to be very successful that semester.

I was especially impressed with the way Professor Bishop was able to break down complicated theorems in a way that made it easy for everyone to understand, all the while using high level mathematical vocabulary.

Based on my personal experience, I can confidently recommend Christopher Bishop as a professor for any Complex Analysis course. I can be reached through the contact information above should you wish to speak about this further.

Sincerely,

Jessica Loehr

Dear Sir or Madam,

As a second-year PhD student in mathematics at Columbia university, I am writing in support of Professor Christopher Bishop, who has made a tremendously positive impact on my mathematical career.

Professor Bishop was my senior thesis adviser, and he was also the one who motivated me to specialize in probability theory and stochastic analysis. I first asked him about open problems in mathematical analysis during my second-to-last semester of undergraduate studies at Stony Brook University. He suggested a very interesting probabilistic problem related to the geometric properties underlying the paths traced out by two-dimensional random walks and Brownian motion. Throughout the ensuing year-long project, Professor Bishop was very helpful in guiding me through various numerical experiments while also suggesting references to increase my knowledge of general probability theory. In the process, I became enamored with the subject and Professor Bishop strongly encouraged me to pursue further master studies related to conformally invariant planar interfaces appearing in statistical mechanical models. Thanks to his encouragement and recommendation, I was able to go to Switzerland the following year in order to pursue such studies with the leading experts in the world.

Furthermore, Professor Bishop was also the lecturer for my first seminar class in Fourier analysis during my second year of undergraduate studies. During this class, it was clear that he was very passionate and knowledgeable about analysis, and highly enthusiastic about teaching it. I was greatly motivated to write my own work, and I very excitedly composed a piece describing some relations of Riemannian geometry to harmonic analysis.

In summary, Professor Bishop has encouraged me to express my creative abilities more so than any other professor, and has opened up many career opportunities I would not have otherwise had.

Sincerely,
Shalin Parekh

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Kevin Sackel
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Somerville, MA 02143

To whom it may concern,

I am joyed to write on behalf of Professor Christopher Bishop's skills as a teacher and mentor. During my time as an undergraduate student at Stony Brook University, from 2009 to 2013, I attended two courses taught by Professor Bishop, in addition to writing an Honors College Thesis under his supervision. Over these mathematically formative years, he was a tremendous influence on me, and his clear and effective tutelage helped very much to convince me that I would continue down the route of mathematics for years to come.

My second semester, in Spring 2010, I was convinced by a friend to take MAT 542, which was a graduate-level "core curriculum" course on complex analysis taught by Professor Bishop. It was a daunting experience for me. I had missed the first week of class, so I had to play catch up on material of which I only knew disconnected morsels. For hours and hours, I struggled to understand the material and complete the problem sets. The one thing which drew me in, and which ultimately convinced me to stay in the class, was Professor Bishop's clear and engaging style. I was attending lectures which were magical, in that they promoted a clear appreciation for the power of the mathematics described. It was one of the first times I felt like I understood what real mathematics looked like, and how interconnected and elegant it could be. Over time, more and more of Professor Bishop's words seemed less foreign. I began to understand how there was a whole world of mathematics behind the curriculum as well, since he would often bring up mathematical tidbits that were jumping-off points for the class, notably including a proof of the famous Prime Number Theorem at the end of the course. Scattered through my notes are helpful pointers which were indicated by Professor Bishop, including when a statement was more useful than it seemed at first glance, or when a proof was so slick that it might obscure the main idea. These pointers were not only helpful in digesting the information, but in providing a perspective that is often difficult to glean from other lecturers.

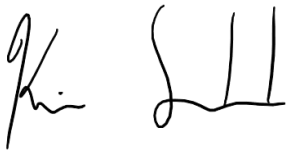
The next course I took with Professor Bishop was MAT 401 in Fall 2012, an undergraduate mathematics seminar with topics which vary each term with the instructor. The way he chose to run the class was to let the students give lectures after the first week, providing constructive feedback along the way. There was also a final project, which was an essay on a related topic. Even in this style of course, after lectures by students, Professor Bishop might say a few words that were eye-opening for anyone interested in material beyond the curriculum, and meshed well with the casual and historically-minded nature of the textbook we were following (Thomas Körner's *Fourier Analysis*). His choice to flip the classroom made the class a true seminar for mathematicians, and forced me to think about how a lecture should be given. Furthermore, the final project at the end was a fantastic introduction to the world of writing mathematics, which is often not emphasized enough. This style should be a gold standard for how an undergraduate seminar should be run – a student-centric course with useful and thorough feedback.

Finally, Professor Bishop was my mentor for my Honors College Thesis (HON 495) through my final year, Fall 2012 to Spring 2013. It was no accident that I asked him to be my mentor – he was always very open and friendly about research opportunities. In his MAT 542 class, he had mentioned that if any students were interested in certain aspects of the material, for example numerical analysis of Schwarz-

Christoffel maps, he would be open to talk about research. At the beginning of the fall, he offered a variety of possible topics to work on, including some I had started reading about over the summer, which gave me a chance to really invest myself in the research world. He was always happy to chat, providing many helpful resources along the way, and I always felt comfortable asking questions. I always appreciated his willingness to treat me as a true researcher. At the same time, I recall his patience one particular time when I felt as though I was hitting a brick wall with one project. He was calming, reminding me it was still early, and offering plenty of ideas about how to proceed. Overall, I was proud of the work I produced, and I owe a lot of it to Professor Bishop's mentorship.

Since graduating, I have continued down the long mathematical road, first as a Churchill Scholar, obtaining a Masters of Advanced Study after completing Part III of the Mathematical Tripos at the University of Cambridge, and currently as a Ph.D. student at MIT, now entering my fifth year. Along this road, the effects of Professor Bishop's encouragement still linger, and I am grateful to have had such a friendly and effective mentor.

Sincerely,



Kevin Sackel

I was a doctoral student of Professor Bishop's until my graduation from Stony Brook in 2011 and had the opportunity to have him as a lecturer prior to my thesis work. As a teacher I found Professor Bishop to be engaging, thorough, and more than helpful to aid in his student's understanding of the material whether through classroom discussions or office hours.

It was through one of his classes that I came to consider the possibility of working with him for my research. At the time I had just decided against pursuing an area that I had put in a lot of time and effort and was feeling a little lost and worried about my future in the program. When I mentioned this to Professor Bishop he said that he might have some problems in his research program that I might find interesting and we should talk about them. After a few discussions it was clear to me that he was passionate about the problems he wanted to see solved (whether it was by him or his students) and I thought he might be a supportive mentor and adviser.

This turned out to be the case. His door was always open to talk through difficulties I might be having and his positivity helped me through times of self-doubt. I knew through conversations with my peers that this was not always the case with their advisers and I'm certainly lucky to have had Chris as mine.

Kind Regards,
Chris Green

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June 29, 2018

Professor Christopher J. Bishop as a teacher and mentor.

To whom it may concern:

It is with immense pleasure and honor that I write this letter on behalf of Professor Christopher J. Bishop. I have know Professor Bishop since 2001, first as a teacher and later as a PhD adviser, and a co-author. It is in this capacity of a former mentee that I will comment on Chris's effectiveness as a teacher and adviser.

Before I delve into details about Bishop's influence on me as a mentor and a scholar, I would like to mention that his helpfulness extended far beyond the direct supervision of my dissertation. Chris has always been very helpful whenever I traveled to conferences, he arranged for me to have teaching free periods during my studies, nominated me to several departmental and outside awards, and would take me with him if he was giving a talk at a nearby university. Chris was also extremely helpful when I was facing problems with the military service in my country. On two occasions he even wrote letters to the Supreme Certifying Committee of Armenia on my behalf. In the first letter he stated how my work would benefit from me staying one more year in Stony Brook, and in the second letter he commented on the quality of my work in my PhD thesis. His letters allowed me to first get a deferment and then an exemption from the military service. He was always asking me if he could be of any help in this matter. To me this was a testament to how caring Chris was towards his graduate students. To this day, every time I tell Chris about a new result I prove or a paper I write I have a feeling that

he is even more excited about it than I am. He is an excellent example of a true "academic father".

My first encounter with Chris as a mentor was in the second year of my studies in Stony Brook. I asked several professors about the possibility of working with them. What drew me to Bishop was the nonstandard way he approached the task of getting me interested. Already for the very first meeting he had an outline/proposal for my thesis project written up on 5 - 6 pages. Somehow he was able to gauge my knowledge in the right way and the problems he suggested were easy for me to understand. Now the problems turned out to be quite difficult and I ended up working on other but related topics, but being a beginning PhD student Chris's hands-on approach gave me confidence and certainty. Already after the first meeting I felt that thesis was not going to be something ephemeral and unobtainable, and only required time, hard work and patience.

It is hard to overestimate Chris Bishop's influence on my own research both during and after graduate school. Some of the qualities that I appreciated being his PhD student included his generosity with his time and ideas, his encyclopedic knowledge of mathematics and his patience. I was also lucky to have an open minded adviser - he did not force a problem on me to solve, but rather encouraged me to think for myself and look for problems and topics that I found to be closer to my liking.

The first project in my thesis was a solution of a problem that Chris and Jeremy Tyson formulated in a paper they wrote some time before. It was about existence of sets of zero Lebesgue measure and conformal dimension 1. Chris didn't direct me toward that problem. In fact, he didn't even remember that he formulated such a problem. Nevertheless, he was happy to see that I was finding problems on my own. He helped and encouraged me to write down a detailed solution and on numerous occasions provided the crucial ideas which helped me to come to the final solution.

The second part of my thesis was about defining and investigating a concept which I was quite excited about at the time. I had a gut feeling what I wanted but didn't know how to formalize the concept. The interaction with Chris on this topic was extremely influential. It seemed like every week I was coming up with a new definition and Chris was giving examples showing that the definition was not the one I was aiming for (it would either be trivial for some examples or not satisfy a property I wanted to). Eventually I came up with a definition and a theory which was satisfying, but I think the main outcome was that this very stimulating interaction with Chris helped

me understand the classical theory of modulus for curve families on a much deeper level than I could have by taking a course or reading a book. This understanding turned out to be very important in my subsequent work, since a large part of it was related to the notion of modulus. I think all of that would have been impossible if it wasn't for Chris's extraordinary amount of knowledge and his ability to instantly penetrate to the root of any problem I was thinking about. It seemed magical at the time, and I had a lot of fun.

The last part of my thesis was actually suggested by Bishop. I remember vividly how Chris called me once to his office and said that while reading a paper he encountered a problem that I might have liked. Turned out not only he found an interesting open problem but also he had the solution. It was about constructing an example of a fractal set with some surprising properties. It took me some time to figure out the details outlined by Chris, but he was very patient and encouraging all the way until the publication. This was a great example of how generous he was with his ideas.

Yet another example of Chris's mathematical generosity came up a few years after my graduation. After attending a workshop in American Institute of Mathematics, I mentioned to Chris some of the problems suggested during the workshop. A couple of weeks later he came up with a beautiful example solving one of these problems. His example was also showing the sharpness of a result I had proved but not published before. Chris suggested that we combine these results into one paper. I thought that it was extremely generous on his part, since I felt that his result was much more interesting and harder to prove than mine. Working with Chris on this project was yet another fun experience. I was in Armenia at the time, so I would work on the paper during the day (night in the US) send the results to Chris in the evening, and by the next morning he already sent me his remarks. He was very efficient. We kept polishing the paper for a while and eventually a postdoc of mine, Marshall Williams, joined the paper and it was finally published in GAFA in 2016. I consider this to be my most important paper to date and it would not have been possible without Chris's ingenuity, efficiency and generosity.

This letter would not have been complete without mentioning Chris's influence on me as a lecturer. I took many courses with Chris on topics ranging from quasiconformal mappings, Kleinian groups and dynamics to computational geometry and conformally invariance processes. His beautiful lectures were always extremely clear, perfectly paced and structured. Most of the courses he teaches start from the basics and end with topics of current re-

search. He somehow is able to distill the complex concepts and ideas and present them in a very understandable way. Looking back, I can say that those were some of the best classes that I have ever attended, delivered by a world class expert. The only way I can describe Chris's seminar presentations is as works of art. I have never seen a talk he gave which hasn't impressed me by its clarity, beauty and novelty of ideas.

To summarize, I would like to say that Professor Christopher J. Bishop is an outstanding adviser, who is able to cultivate the mathematical talent in his students by stimulating and challenging them with interesting and relevant open problems. Bishop is undoubtedly a leading authority in Analysis who is completely taken by this beautiful subject. His excitement with Mathematics transfers to everyone who is lucky enough to have him as a mentor.

Sincerely Yours,

Hrant Hakobyan
Associate Professor of Mathematics

Caltech **Dr. Kirill Lazebnik, PhD**

Dr. Kirill Lazebnik
Harry Bateman Research Instructor
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This is a recommendation letter on behalf of Professor Christopher J. Bishop. I have known Chris in two capacities: (1) as my scientific advisor in the doctoral program in the Stony Brook University math department (from January 2014 through May 2017), and (2) as a lecturer at Stony Brook for the courses MAT655 (*Introduction to Transcendental Dynamics*, Spring 2016), MAT543 (*Geometric Function Theory*, Fall 2015), and MAT551 (*Functional Analysis*, Fall 2013).

(1) I decided to work with Chris because of an interest in the mathematics he was doing, and also because I could comfortably ask him questions ranging anywhere from nitpicking details about a technical proof to vaguer questions such as 'Why is this result important?' While studying for my oral exam with Chris, we met weekly (and indeed we met weekly during semesters for the remainder of my Ph.D at Stony Brook). These meetings would usually consist of me asking about some step in a proof of Ahlfors' *Lectures on Quasiconformal Mappings* which I did not understand, and Chris puzzling out the full line of argument. This was tremendously helpful to see as a student; not only the solution, but the process of seeing Chris start out with an intuitive reason why a thing should be true, and then putting a line of reasoning together to outline a proof.

This continued past the oral exam. The first paper Chris had me read was *Dimension of Quasicircles* (Smirnov, 2009). There are many statements in the paper which are clear to people who work in the field, but are perhaps unclear to a student starting out. I emailed Chris a list of questions about the paper (eight of them), and received a prompt response. Here is one example:

(Question from me, dated Sep. 2014): In his proof of Theorem 1, he defines quantities Iv - 'entropy', $\Lambda v(\lambda)$ -'Lyapunov exponent' and a 'probability distribution'. Are these words defining important concepts? I can follow the proof just fine without knowing what the general definitions of 'entropy', 'Lyapunov exponent' of a 'probability distribution' are, but should I learn the general concepts?

(Answer from Chris): Yes, it is worth learning more about these, although the connections with conformal maps are somewhat formal. Entropy is generally a measure of the 'randomness' of a probability distribution (= a measure of total mass 1). For example, the probability measure of maximum entropy on $[0, 1]$ is the uniform distribution and the measures of maximum entropy on the real line are the Gaussians. Thus entropy is a measure of how 'evenly distributed' a measure is and plays an important role in statistics and physics (very often in these fields one wants to consider distributions that satisfy some known constraints, but is otherwise as random as possible; these are the measures of maximal entropy). Since entropy measures how 'spread out' or 'concentrated' a measure is, it is not surprising that it would have some connection to the dimension of the support of the measure. The Lyapunov exponent measures the exponential rate of expansion in a dynamical system. In simple systems, such as self-similar expanders, this is closely related to the idea of Hausdorff dimension. *[continued…]*

Other questions Chris answered from this list were more technical, such as 'how do we know that this quantity is $o(1)$?'.

My thesis was a refinement of a construction of Chris's contained in his paper *Constructing entire functions by quasiconformal folding* (Bishop, 2015). There was a later paper *On the set where the iterates of an entire function are neither escaping nor bounded* (Osborne and Sixsmith, 2015) that asked several questions Chris was confident could be answered using techniques from his work. This resulted in the paper *Several Constructions in the Eremenko-Lyubich Class* (Lazebnik, 2017) which essentially comprised my thesis. Again, as was the case when I was preparing my oral exam, I met weekly with Chris where he gave me invaluable technical and non-technical advice during this project. As he mentioned, getting me a thesis was a top priority of his.

From the perspective of professional development Chris has also been very helpful. He funded (in part or in their entirety) my trips to about 10 conferences/workshops during my Ph.D including: *Parameter Problems in Analytic Dynamics* (Imperial College London, June 2016), *Topics in Complex Dynamics School in Barcelona* (October 2015), *Summer school on SLE, conformal welding, and random planar maps* (UCLA, 2013). It was in the complex dynamics summer school in 2015 where Chris put me in touch with Nuria Fagella and Xavier Jarque, who are now my coauthors. During my visit to the U.K. in October 2016, Chris put me in touch with several mathematicians who then invited me to give talks at their institutions, including Phil Rippon and Gwyneth Stallard at the Open University.

As I have hopefully convinced you, Chris is an excellent scientific advisor who does all in his power to help his students succeed.

(2) As a lecturer, Chris has the ability to transition between giving intuition behind a result/concept and explaining its proof. This was evident for instance in MAT543 (*Geometric Function Theory*) - a course on harmonic measure following the textbook of Garnett and Marshall. The Hayman-Wu Theorem is a statement which, roughly speaking, gives a non-obvious upper bound on the length of the conformal image of a line segment in a certain setting. This bound would be obvious if the conformal map had bounded derivative, and Chris told us that a lot of results in geometric function theory can be vaguely interpreted as saying conformal maps almost have bounded derivative. This led into a careful explanation of the proof of the theorem. I think it is difficult to maintain the balance, especially in an advanced course, between trying to communicate intuition and giving proofs, and Chris certainly achieves this.

The other two courses, MAT655 (*Introduction to Transcendental Dynamics*) and MAT551 (*Functional Analysis*) were also well taught, with Chris's expertise livening up the material. For instance MAT551 followed Lax's *Functional Analysis*. When we reached material about Banach algebras, Chris told us about the history of the Corona theorem (conjectured by Kakutani in 1941 and proven by Carleson in 1962) - a statement about the spectrum of bounded holomorphic functions on the unit disc. This led to a brief discussion of Carleson measures and gave a concrete example of the theory in Lax's textbook.

Chris is an engaging lecturer who can communicate proof and liven up a lecture with his intuition and experience in the subject.

Sincerely,

Kirill Lazebnik