

## 1 Overview

I got my PhD in Algebraic Topology from the University of Florida Mathematics, Department under the supervision of A. Dranishnikov. I find the interplay between algebra and topology fascinating but even more so when it is applied to real world problems. Thus, during my last years of PhD and for the 2 years of my post-doc I explored the field of Topological Data Analysis, an interesting application of Algebraic Topology in point-clouds and data analytics in general. During my years at North Carolina State University, I became a part of the Lab of Analytical Sciences, a collaboration between NCSU and NSA. During those years I was introduced to ideas like machine learning, image recognition and data mining in general and I have geared my research towards these areas. As a member of Florida Polytechnic University I worked mostly on Big Data and Health Informatics problems using, among other tools, Neural Networks and Support Vector Machines. As a member of the Experimental Statistics Department at LSU I am applying those machine learning techniques to Precision Agriculture and Price analysis.

I have a total of 8 papers published in peer reviewed journals and conferences and at least 8 more in various stages of preparation. I am a co-creator in 2 patents issued with the help of NCSU and have successfully acquired 2 internal grants at Florida Polytechnic university of \$40,000 and \$25,000 respectively. I have had my second year of my post-doc being self funded from a grant I wrote, while I was at NC state.

I am not the person to stay rooted in one field but I like to explore different problems and different methods of solving them. My interests are very broad as are the backgrounds of my collaborators which is something I really enjoy.

## 2 Research through the years

### 2.1 Geometric Group Theory

During my masters in Greece, when I started seriously considering mathematics as a career, I was working mainly in Analysis and Algebra, with a specific interest in Group Theory. My adviser at the time, Dr. Panos Papasoglu, introduced me to Geometric Group Theory a subject I immediately liked. I was also interested in Mathematics Education but mostly as a means of improving pedagogy and not a field of active research at the time.

My first paper was created then, titled “[Asymptotic Dimension of Finitely Presented groups](#)” [7] but it wasn’t until 2008 that it was finally published. In it there is an interesting result connecting a geometric property of an infinite group (asymptotic dimension 1) to an algebraic property of it (virtually free). That paper has 12 citations to date.

## 2.2 Algebraic Topology, Asymptotic Dimension

When I moved to the United States I was very fortunate to have Dr. Alexander Dranishnikov as my adviser at the University of Florida. Under him, I continued working on Geometric Group Theory but slowly opened up to Algebraic Topology in general, a field that combined all my knowledge up until then and offered something new at the same time. My results and papers at the time were in the area of pure mathematics, yet I was always fascinated by applications and “real world” problems.

With my adviser we published the paper, “[On cohomology of the Higson compactification of hyperbolic spaces](#)” [1] which was part of my thesis, “[Properties of Groups at Infinity](#)”. The main drive of the thesis was again the idea of asymptotic dimension, which can be thought of as a large scale analogue of the classic dimension theory. Also, the main focus was on endowing infinite groups with a metric structure and use them as our object of interest, instead of working with “wild” topological spaces.

Another original paper came out of that thesis titled: “[On limit aperiodic G-sets](#)” [8]. All the definitions and theorems were peer reviewed and deemed correct. Unfortunately when the paper was about to be published by the journal “Mathematical Complutence”, I discovered another paper recently published which, after the appropriate translations, could prove a much stronger result than mine, so I had to retract my publication.

Although in academia the number of papers matters I believe content and originality is also important and thus I only submit for publication papers that are scientifically sound, novel and generally ready. Still, I intend to use some of the content of that paper for future work especially the open problems posed at the end, which could be good papers for graduate students.

## 2.3 Computational Topology and Applications

During my last years as a PhD student I was introduced to the idea of Persistent Homology, a branch of Computational Topology, and started working on social graphs and collaboration networks. I immediately picked up the various software packages used for it, R and Matlab mostly and even got a functional knowledge of two programming languages, C++ and Python. The emerging field of Topological Data Analysis seemed like the best fit for me.

With my collaborator, Dr. Maria Bampasidou we wrote an exploratory paper titled: “[Modeling Collaborations with Persistent Homology](#)” [15]. That paper, although unpublished officially (no specific target audience), has 1 citation already and lots of reads on researchgate. In it, we coined the term “socioplex”, created to describe more than two way connections in a network and showed how that may be a natural extension to the classic ideas of two way connections in various collaborative networks.

I decided to continue my work on that field and thus accepted a Post-Doctoral position as a research assistant at the Electrical and Computer Engineering department at NC State

University working under the supervision of Dr. Hamid Krim. My research rapidly branched out into various fields including Signal Processing, Coverage Networks, Social Networks and Big Data.

Our first success at the time was the paper “[Persistent Homology of Delay Embeddings and its Application to Wheeze Detection](#)” [5] which I co-wrote with Saba Emrani, a graduate student I supervised, and Dr. Hamid Krim. In that paper we created a method to detect almost periodicity in signals using the classic idea of Delay Embeddings due to Takens and the new approach of hole detection in Persistent Homology. We concluded the paper with a very interesting application, namely the detection of wheezes in breathing, which was an excellent development for me. That method was later patented with the help of the university and used at a prototype wearable device.

With two other graduate students, Scott Clouse and Xiao Bian, we started looking into Computer Vision from both an applied and theoretical point our view. Our paper, “[Multi-Level Scene Understanding via Hierarchical Classification](#)” [3] led to another patent, again with the help of NCSU, which provides the code and the mathematical analysis of stitching a high resolution global picture from various snapshots of a certain area taken by micro-cameras.

During my time at NC State I was also trying to understand the mathematical underpinnings of the theory of Topological Data Analysis. With my collaborator, Dr. Greg Bell we wrote a paper on “Directed Filtrations” [6] an idea that will extend the Persistent Homology Computations to include directional features. The paper has been ready and awaiting the newly journal of Topological Data Analysis to be formed so we can submit it there.

With Dr. Rocio Gonzalez Diaz, Dr. Harish Chintacunta, Dr. Maria J. Jimenez and Dr Hamid Krim we wrote a paper on the analysis of the persistent barcodes using information theoretic tools. The paper was titled “[An entropy based Persistent Barcode](#)” [2] and contained purely theoretical results on the nature of the output of the Persistent Homology algorithm on various point-clouds.

Finally, I was invited with my collaborators Dr. Harish Chintakunta and Dr. Hamid Krim to write an introductory paper on Topological Data Analysis for the Signal processing magazine. The output “[Discovering the Whole By the course: A Topological Paradigm for Data Analysis](#)” [14] has already gathered 300+ full read text views on researchgate in a very short time span.

## 2.4 Analytics

In North Carolina I was fortunate to work for the lab of Analytical Sciences, a collaboration between NC State and NSA. It was then that I realized that I should expand to other fields besides Algebraic Topology. To be able to work with them I wrote a successful proposal for internal grant funding with the help of Dr. Krim, which was used to support me for the second year there.

I started with text analytics, incorporating tools from Bayesian Analysis, Support Vector machines and Neural Networks. My main focus was on text based data and specifically twitter data. I also applied my knowledge of collaboration networks to other networks of interest. I co-wrote a paper called “[First Study on Data Readiness Levels](#)” [12] that introduced the idea of Data Readiness and presented some preliminary results on how that can be applied to twitter data with Hui Guan, a graduate student I supervised then and Dr. James Keiser the Research Director of the LAS.

During my year and a half at the lab I was introduced to Big Data Analytics, through the VTC system, and especially machine learning techniques. I learned SQL and continued working on matlab and python. I updated my knowledge on experimental statistics and started investing in coding with R.

## 2.5 Health Informatics, Mathematics Education, Networks

In January 2015 I moved to Florida Polytechnic University as an Assistant professor and became a member of the newly formed Health Informatics Program. I also became the head of the corresponding Big Data and Health Informatics lab and started branching out in that field. I found the transition relatively easy especially with the knowledge of experimental statistics and computer science that I got during my stay at NCSU.

During the spring of 2016 I wrote a successful internal grant proposal and over the summer of 2016 together with my collaborator Dr. Harish Chintakunta we created a team of 4 undergraduate and 2 graduate students. We worked on text mining in Electronic Health Records and created the foundations for the lab.

Since the University is rather small, everybody needs to pick up many roles. Thus, I became the course coordinator for Calculus I which gave me the opportunity to implement and test two new teaching methodologies. Two papers came out of this endeavor both of which will be hopefully published in PRIMUS.

The first of those called: “Florida Poly Primers: Calculus” [13], which I co-wrote with Jennifer Kindle, my graduate student, is part of her master’s thesis which she defended successfully in Spring 2016.

In it we examine the effects of a preparatory pre-calculus online course which we created, on the Calculus I performance of students, especially those with a weaker math background. This paper won the [2016 Florida Academy of Sciences Student award](#) and is now accepted to be published by the journal PRIMUS.

The second paper, titled “Modified Calculus Class” [16], which I co-wrote with Langley Payton, another graduate student, examines a different methodology of teaching using a hybrid approach with a strong technology component. A statistical analysis was carried over for 3 semesters with the unmodified Calculus classes as control and the very positive results were presented to the Board of Trustees here at Florida Poly and are now adopted as the Calculus I coordinated standard starting this semester. This paper was also submitted

to PRIMUS and we are awaiting their decision, but the initial results are encouraging with the strongest point being a significant reduction in the drop rate and retention in Calculus II.

Another paper that is under preparation is named “Corrupted Blood: An analysis” [4] analyzing infectious diseases using Poisson Point Processes. The paper started as an end semester project for my Differential Equations class and together with my undergraduate student Cyle Cook, we extended it to an original result about the average distance and speed of the infection. The paper was presented successfully at the [Annual SIAM meeting](#) and it will be published at the journal of undergraduate research maintained by SIAM.

During that time I was also working on an application of Topology in information flows on networks. A conference paper titled: “[Influence of topology on Information flow in social networks](#)” [11] was published at the 50th Asilomar Conference on Signals, Systems and Computers. With my collaborator, Harish Chintakunta, we intend to extend it into a journal publication.

Finally, our Health Informatics group published a paper on the [IEEE DataCom 2017](#) conference in Orlando, titled “Predicting Hospital Length Of Stay using Neural Networks on MIMIC III Data” [9] which will appear November 2017. In it we use machine learning on the MIMIC III database of EHR’s for patients with severe symptoms to predict long vs short length of stay at the hospital after they leave the ICU. The corresponding codes are available on our gitlab repository upon request and a subsequent journal publication is now being created.

## 2.6 Agricultural Economics

Since August 2017 when I joined the department of Experimental Statistics at LSU in a joint appointment with the LSU Agribusiness Center. My role here is to support the Ag. Center in their newest effort of incorporating data analytics into precision agriculture. I was recruited to apply machine learning techniques, mainly Neural Networks and Support Vector Machines, to the multitude of datasets the center has been collecting over the years. Parallel to that I am working on a trend analysis paper for lumber prices [10]. With my collaborators Maria Bampasidou and Shawn Targer we have completed an analysis and created a strategy for purchasing based on historical lumber prices using forecasting ideas on time series. Our paper “Predicting Lumber Prices: An Analysis” will be presented at the [Southern Agricultural Economics Association](#) and is almost complete and ready for submission.

Finally I am a co-PI in an Agriculture and Food Research Initiative (AFRI) grant proposal spearheaded by Jeffrey Englin and Ashok Mishra from ASU, to analyze attendance at national parks using Satellite Imagery and Neural Networks. The results on that are pending.

### 3 Conclusions

As it can be seen from my research career thus far I favor collaborations and I intend to continue doing so in the future. I find working with others more productive and rewarding. I will also try to keep integrating my teaching methods with research and actively pursue any interesting ideas. I like equally graduate and undergraduate research and I welcome any problem that seems interesting.

[Here is a link to my arxiv page where some mentioned papers can be found.](#)

[A link to my research gate account can be found here.](#)

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