

# ANDREA NAPOLETANO

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I'm a junior research scientist at ISC CNR, Rome. My research focuses on the integration of machine learning technique with statistical tools to analyse economic data and build testable predictive models. I also actively carry out different tasks such as contributing in the writing of research projects for grant applications, managing the websites of the group, and tutoring master students working in our groups and first year bachelor students of classical mechanics.

## WORK EXPERIENCE

10/2017 – DATE

### JUNIOR RESEARCH SCIENTIST, ISC CNR

I'm currently working within the research group of Prof. Luciano Pietronero as a junior research scientist, conducting my own research and performing various tasks of different nature.

- **Scientific work.** My main scientific project is the study of technological innovations through network and machine learning techniques, deepening and broadening the results found during my PhD. This work is mostly grounded on PATSTAT, the official database for patents intelligence and statistic. The main software I use to carry on my research is Python, employing, in particular, statistical and machine learning libraries such as NumPy, Scikit-Learn, Pandas, TensorFlow, Keras, and PyTorch. Two scientific papers have been realized and are in preparation for publication in peer-reviewed journals, more are under preparation. Other scientific projects in collaboration with different colleagues are the analysis of databases of open access papers aimed to the creation of a numerical framework for scientometrics analysis, a collaboration with a Condensed Matter group to analyse simulated data through deep learning in search of potentially superconductive structures and a collaboration with the Italian State Archive and Prof. Vittorio Loreto to realize a platform for smart navigation, information retrieval and disambiguation of digitalized text data.
- **Other work.** In parallel with my scientific research, I have been tutoring two master students, helping them with their research, providing ideas and feedback on their work and reviewing their thesis. As a member of the research group, I have helped with the submission for national and international grants such as PRIN 2015 and ERC 2018, working together with my colleagues in a joint effort. I have also contributed to the organization of the Economic Fitness and Complexity workshop to be held at international conference CCS2018. During my first postdoc year (2017-2018), I have been in charge of various websites, realizing and managing them, or working together with the developers, providing feedbacks and carrying on negotiations during the development phase. While I still manage such websites, during my second year of postdoc (2018-date) I'm working as a teaching assistant for Prof. Pietronero tutoring first year bachelor students of Classical Mechanics covering one-third of the duration of the course.

## EDUCATION

2014-2017

**P.H.D. IN PHYSICS**, SAPIENZA, UNIVERSITY OF ROME

**Supervisor:** Professor Luciano Pietronero

**Title:** The Language of Innovation

**Keywords:** Innovation, Machine Learning and Natural Language Processing (NLP), Predictive Models, Complex Systems

**Abstract**

Predicting innovations is a peculiar problem in data science: an innovation is always a never-seen-before event, making the usual approach of learning patterns from the past a useless exercise. The Thesis propose a strategy to address the problem in the context of innovative patents: technological codes are considered as the vocabulary of the technological language and innovations are defined as the first occurrence in the same patent of couples of technological codes never associated before. This operative definition of innovations as neologisms of the technological languages overcomes the usual difficulties of predicting a new category. NLP can leverage this structure by embedding technologies in a high dimensional euclidean space where relative positions are representative of learned semantics. The Thesis demonstrate how quantitative measures in the technological vector space can be exploited to predict radical innovations events, forecast the nation most likely responsible for such innovation and study technological trends as rise and fall of patented innovations.

2012-2014

**MASTER DEGREE IN PHYSICS**, SAPIENZA, UNIVERSITY OF ROME

**Supervisor:** Professor Giovanni Amelino Camelia

**Title:** On the spherically symmetric compact solutions of Shape Dynamics

**Grade:** 110, summa cum laude

**Keywords:** Shape Dynamics, General Relativity, Constrained Hamiltonian Mechanics, Quantum Gravity

**Abstract:**

Shape Dynamics (SD) is a newly introduced field theory dual to General Relativity (GR) in the ADM formalism: it has as canonical variables a three-dimensional metric tensor and its conjugate momentum, and, therefore, it lives in the same phase space, although it possesses different constraints. Shape Dynamics in fact has been formulated to get rid of the Hamiltonian constraint of General Relativity, and more precisely to disentangle its double nature of generator of time evolution and of generator of gauge transformations in the hope that this will shed some light on the problem of quantizing gravity. The Thesis follows the results already achieved by other in an asymptotically flat space and investigates a compact manifold. In particular Shape Dynamics equations for a compact manifold are derived for the first time and than solved with the assumption of spherical symmetry. This allows to simultaneously study similarities and differences between GR and SD and the limitations of an asymptotically flat approximation of SD.

2009-2012

**BACHELOR DEGREE IN PHYSICS**, SAPIENZA, UNIVERSITY OF ROME

**Supervisor:** Professor Valeria Ferrari

**Title:** Fenomeni tipici nei pressi di un buco nero di Kerr (Typical phenomenons near a Kerr black hole)

**Grade:** 110, summa cum laude

**Keywords:** Black Holes, General Relativity

**Abstract:**

The Thesis follows the history of black holes in General Relativity, from the first time they were theorized to modern understanding. It starts from the description of the Schwarzschild metric and then focuses on Kerr black holes, describing in details all the peculiar phenomena that can

happen near a spinning black holes by deriving and commenting all the fundamental equations equations and properties of the Kerr metric.

## LANGUAGES AND SKILLS

### *Spoken Languages*

- **Italian** Mother Tongue
- **English** Fluent
- **Chinese** Basic-Intermediate
- **Japanese** Basic

### *Computer Skills*

- **Python** Advanced
- **Mathematica** Intermediate
- **C** Intermediate
- **Latex** Expert
- **Microsoft Office** Expert

## DETAILED ACADEMIC ACTIVITIES

- **PhD Second and Third Year**

My second and third year of PhD have been devoted to address the problem of building a predictive model to forecast incoming innovations in collaboration with Dr. Andrea Tacchella in the research group of Prof. Luciano Pietronero. The work is grounded on the PATSTAT technological database, which I have studied both with a classic network analysis and with more sophisticated machine learning techniques exploiting the parallel between technological language and natural language. The research has been conducted using Python programming language of which I acquired advanced knowledge and Mathematica software. Results have been presented in my PhD Thesis, which has been reviewed and approved by external experts and successfully defended on February 26 th, 2018 in front of an international commission. I have also presented my project in the Kreyon 2017 international conference (Rome, September 6-8 2017) in a 20 minutes long talk.

- **PhD Second Year**

I have conducted a preliminary analysis on the breast cancer genes expression data collected in the The Cancer Genome Atlas TCGA3 database as part of an interdisciplinary project coordinated by Prof. Stefano Zapperi and submitted to PRIN 2015 selection (Progetto di Ricerca di Interesse Nazionale) that aims to apply complex systems techniques to medical studies. Results have been submitted to research partners. In July 17-24 2016 I have attended the Lipari Summer School on Computational Life Science.

- **Master Degree and PhD First Year**

I have been multiple times at Perimeter Institute for Theoretical Physics as visiting graduate student under the supervision of Dr. Flavio Mercati first to write the thesis for the master degree and then to continue the work which resulted in a publication on the arXiv ( arXiv:1509.00833) and consequently in a paper in collaboration with Dr. Flavio Mercati, Dr. Henrique Gomes and Dr. Tim Koslowski published in Physical Review D (Phys. Rev. D95, 044013). I have also presented the results at the Conceptual and Technical Challenges for Quantum Gravity conference held at Sapienza University of Rome in 2014 (Rome, September 8-12) and at Shape Dynamics workshop which was part of the Convergence 2015 conference held at Perimeter Institute for theoretical Physics (Waterloo, Canada, June 20-27, 2015).

- **Master Degree**

Under the supervision of Prof. Valeria Ferrari, I made a research on the gravitational effects on the propagation of a light signal. On this topic, I gave a 2 hours seminary to the class during the master course Gravitational waves, Stars, Black Holes. The resulting paper has been included in the textbook materials of the course.

- **Bachelor Degree**

Due to high marks, I have been admitted to, and I regularly concluded, a 2 years program of excellence courses which contemplates additional courses on different topics with final evaluation decided with the tutors.

## **EXPERIENCES ABROAD**

- **Waterloo, Ontario, Canada 2014 ~ 2016**

I have lived several months abroad in Waterloo, Ontario, Canada. The longest stay consisted in 5 consecutive months from March 2014 to July 2014, while shorter ones consisted in two couples of months at the beginning and at the end of my PhD first year. During my time in Canada, I have visited and worked at Perimeter Institute of Theoretical Physics (PI). This experience allowed me to broaden my scientific knowledge by interacting with different scientists and attending various workshops periodically organized at PI. It was within the framework of this synergy that I could take part to international joint research groups at the Perimeter Institute, and publish in 2017 the related innovative results: "Gravitational collapse of thin shells of dust in asymptotically flat shape dynamics".

- **Changzhou, Jiangsu, China August 2007 ~ August 2008**

I have attended a one year home-stay program in a Chinese family and one year attendance at the Chinese High School "Changzhou No.2 Middle School" within the AFS School Program for High School Students. This experience allowed me to widen my cultural horizons by learning how people in such a different country conduct the daily life and gave me access to the Chinese written and spoken language. Together with the previous experience in Japan it also helped me to become comfortable in a multicultural environment.

- **Nakayama, Ichikawa, Japan June - September 2006**

I have lived 3 months in a Japanese family and attended to a 3 months course of Japanese language at Ichikawa Japanese Language Institute which reinforced my knowledge of the Japanese language that I had occasion to learn through pre-scholar experiences, during my four years long stay in Tokyo.

- **Edinburgh, Great Britain 2005**

3 weeks stay at College and attendance to 3 weeks summer school of English language.

## **AWARDS**

- Awarded within the program of the Italian Ministry of Instruction Valorizzazione delle Eccellenze for having achieved the grade 100 summa cum laude at High School.

## **SCOLARSHIPS**

- **P.h.D.** I have won the PhD scholarship of Sapienza University of Rome for the duration of my PhD from November 2014 to October 2017.
- **Visit to Perimeter Institute** All the expenses regarding my stay in Canada have been paid by Perimeter Institute.
- **Bachelor Degree** 3 years scholarship renewed each year granted by Sapienza University of Rome for high performance in exams. The scholarship covered the exact amount of the university fees for the 3 years.
- **Visit to China** Scholarship granted by AFS within the program AFS School Program for High School Students (one year in China).

## LIST OF PUBLICATIONS

- **Title:** A context similarity based analysis of countries' technological performance.  
**Authors:** Andrea Napolitano, Andrea Tacchella and Luciano Prietronero.  
**Status:** Published on Entropy, Economic Fitness Special Issue, <https://www.mdpi.com/1099-4300/20/11/833>
- **Title:** The Language of Innovation.  
**Authors:** Andrea Tacchella, Andrea Napolitano and Luciano Prietronero.  
**Status:** To be submitted to peer review journals.
- **Title:** Gravitational collapse of thin shells of dust in asymptotically flat shape dynamics.  
**Authors:** Flavio Mercati, Henrique Gomes, Tim Koslowski and Andrea Napolitano  
**Status:** Published in Physical Review D: Phys. Rev. D 95, 044013, Published 13 February 2017.

## LIST OF GIVEN TALKS

- **Title:** The Language of Innovation  
**Conference:** CCS 2018, Thessaloniki  
**Institution:** Complex Systems Society  
**Date:** September 23-29 2018
- **Title:** The Language of Innovation  
**Conference:** Kreyon Conference 2017 - Unfolding the Dynamics of Creativity and Innovation  
**Institution:** Sapienza University of Rome  
**Date:** September 6-9, 2017
- **Title:** Gravitational Collapse in Shape Dynamics  
**Conference:** SD@Convergence - A Shape Dynamics Workshop  
**Institution:** Perimeter Institute for Theoretical Physics  
**Date:** June 20-27, 2015
- **Title:** On compact, spherically symmetric solutions of Shape Dynamics  
**Conference:** Conceptual and Technical Challenges for Quantum Gravity  
**Institution:** Sapienza University of Rome  
**Date:** September 8-12, 2014

## OTHER EXPERIENCES

Private lessons in physics and math given to High School students and Bachelor students.