Obituary for Luca Trevisan

The Theoretical Computer Science Community is heartbroken by the untimely loss of Luca Trevisan, who passed away on June 19, 2024 in Milan at the age of 52. His husband, Junce Zhang, was at his side along with a few other dear friends and colleagues. Luca leaves behind a rich and diverse legacy of influential results and a profound impact on our community.

Life & Career Trajectory

An only child, Luca was born and raised in Rome, where as an adolescent he spent many long afternoons reading books about mathematics. He loved to cycle to Villa Ada or along the river Tiber, and was passionate about film—in particular Mel Brooks's *Young Frankenstein*, and films by Monty Python and Woody Allen. In school, Luca earned the highest marks, but he was particularly precocious in mathematics. Luca's lifelong friend, Flavio Marchetti, says "I've often spoken about Luca with our high school mathematics teacher Daniela Crosti...and we joke about Luca's questions, which frequently turned into extemporaneous original demonstrations in which he arrived at the answers by reasoning together with the class, without any advance preparation."

As an undergraduate at Sapienza University in Rome, he became the first student to graduate from the department of information science. An article about the event in the Roman newspaper *Il messaggero* from 1993 [31] sheds some light on

Luca's youthful personality. Luca's mother, Giuseppina, described him as calm, disorganized, and not very well equipped to deal with practical matters. Friends remarked that he drove like a madman and was a danger to public safety, but had a great sense of humor.

In his third year of university, he took a class on computational complexity taught by Daniel Pierre Bovet. That semester's announcement of the FGLSS breakthrough on hardness of approximation [17] caught Luca's imagination, and he began to do research on the topic with Pierluigi Crescenzi, continuing on to receive his doctorate from Sapienza in 1997. "Luca was the perfect PhD student," Pierluigi recalls. "Clearly, he was exceptionally intelligent. But he was also always so kind and thoughtful that he patiently and clearly explained his ideas, making you feel comfortable with them and never embarrassed for not immediately understanding them."

During his PhD, Luca did an internship with Madhu Sudan at IBM Research, who also hosted Luca for a postdoc at MIT, where Luca obtained his landmark result on randomness extractors [41]. Of meeting Luca, Madhu recounts "It was one of most striking first encounters. In fifteen minutes while I was driving on crowded streets of Manhattan, Luca explained elements of my own paper (with Bellare and Goldreich) to me, and explained why one idea in the paper led to a solution to what we thought was a completely different problem from a different part of the same paper. This led eventually to Luca's first FOCS(/STOC) paper with me and Sorkin and Williamson and helped launch a storied career. It was a privilege to have met Luca so early on!."

Subsequently, Luca did a second postdoc at DIMACS before joining the faculty of Columbia University. He then served on the faculty of Berkeley and Stanford before returning to Berkeley in 2014 to be the Senior Scientist at the Simons Institute for the Theory of Computing. "There is no question that Luca significantly elevated the intellectual climate in the theory group at Berkeley," remarks Simons Institute Founding Associate Director Alistair Sinclair, "and did so moreover with great humility and a disarming sense of humor. His ability to distill the essence of a huge range of mathematical ideas, and generously share his insights with others, through his blog and elsewhere, was a truly rare gift. It was a major coup for Berkeley to bring him back from Stanford as senior scientist at Simons. His advice and words of wisdom were invaluable during the endless rounds of decisions we faced in the early years of the Institute."

In 2019, Luca proudly returned to Italy to help launch the new Department of Computing Sciences at Bocconi University in Milan. His intellectual and personal charm were instrumental in attracting world-class scientists to Italy, catalyzing a period of remarkable and unexpected growth for the department. At Bocconi, he held the Invernizzi Foundation Chair in Computer Science and co-founded and directed the two-year Master of Science in Artificial Intelligence program, which

was launched in the fall of 2023 and is now undergoing significant expansion. Shortly after his return, Luca was awarded the prestigious Advanced Grant from the European Research Council, and in 2021 he became the first computer scientist to be elected to the Italian National Academy of Sciences. The Bocconi department continues to thrive on the momentum he created and remains committed to realizing the visionary legacy he shared during his final days.

Figure 1: Luca at a Bocconi University workshop, 22 May 2024

Research Contributions

In the course of his career, Luca made beautiful contributions across the theory of computing, spanning pseudorandomness, approximate optimization and PCPs, distributed computing, property testing, cryptography, and spectral algorithms. We survey just some of these below.

Approximability & PCPs. Luca's PhD research in the mid-1990s focused on approximability and included two very elegant non-approximability results: one showing that the doubly exponential dependence on the dimension of the approximation schemes for Euclidean TSP was inherent [40], for which he received the STOC 1997 Best Student Paper Award, and another that provided a systematic LP-based framework to discover gap-preserving gadget reductions and argue their optimality [49]. By the time he received his PhD, Luca had become an expert on the rapidly evolving PCP literature, crediting the thorough exposition of Bellare, Goldreich, and Sudan [11] as his entry point.

Among Luca's varied contributions to PCPs is a line of work that culminated with PCPs with the best bang for the buck for queries made, asymptotically yielding an almost factor-two gain in soundness for each additional bit queried [36, 34, 35]. The final paper in this series [35] brought tools from additive combinatorics like the Gowers norms [21, 22] into the purview of TCS. Luca had a real knack for identifying directions in pure mathematics with fruitful connections to complexity theory (and vice versa). Similarly, in [32, 50] he found deep connections between the Dense Model Theorem that plays a central role in the Green-Tao Theorem [23] on arbitrarily long arithmetic progressions in the prime numbers and fundamental concepts in average-case complexity and pseudorandomness, such as Impagliazzo's Hardcore Lemma [25].

Pseudorandomness. Luca made many important contributions to the theory of pseudorandomness, including the aforementioned Dense Model Theorem and related results. The standout of these was Luca's mind-blowing discovery [41], as a postdoc, that the Impagliazzo-Wigderson construction of pseudorandom generators from (conjectured) functions of high circuit complexity [26] is also an (unconditional) construction of randomness extractors. (See Figure 2.) Thus, Luca demonstrated that two major lines of work on randomness in computation were really studying the same problem in disguise. The connection established by Luca was very non-obvious and creative; it came as a surprise even to the leaders in the field who had been involved in both lines of work. This sudden shake-up gave many other young researchers around the world a perfect opportunity to enter what was previously a well-established and intimidating area.

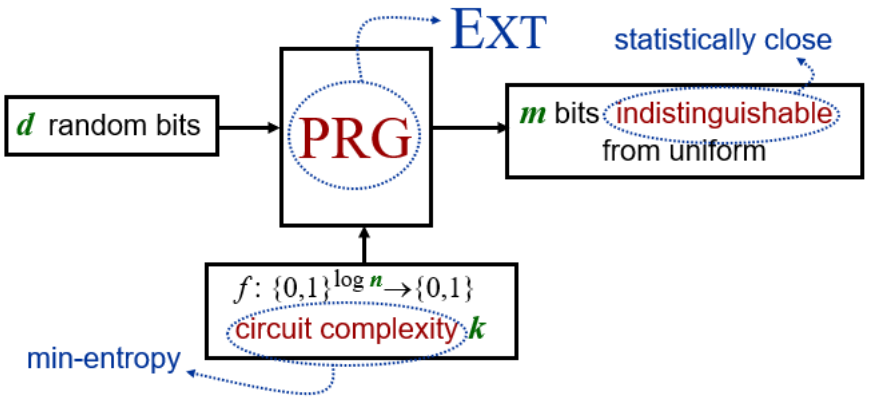

Figure 2: Luca's way of turning a pseudorandom generator (PRG) construction into a randomness extractor [41]. If instead of running the construction with a fixed function of high circuit complexity (as was always imagined), we feed it a random function drawn from a distribution of sufficient min-entropy, it turns out that output will not only be computationally indistinguishable from uniform but statistically close to uniform.

Spectral Graph Theory. In the latter half of his career, Luca's journey in approximation algorithms led him to work on algorithmic spectral graph theory. His several extensions of Cheeger's Inequality, relating the smallest eigenvalue of graph's Laplacian to nearly bipartite components [43], and relating the k'th eigenvalue to k-way graph partitioning [28] are already part of the canon of this area of research and also had striking consequences in pure mathematics [29, 30]. Reading their beautiful proofs, there is an inevitability about them that makes them hard to unsee.

Distributed Algorithms. Starting from 2012, Luca was attracted by the world of distributed computing and, in particular, by the self-organizing behaviour yielded by simple, fully-decentralized processes known as *dynamics* [7]. As part of a close-knit group of Roman collaborators (some shown in Figure 3), he proposed new techniques and models to study information-spreading and network-formation dynamics in evolving graphs that led to several significant advances in understanding the complex behaviour of such dynamical systems [9]. Luca achieved further important contributions in the study of majority and averaging dynamics and their ability to perform fundamental distributed tasks such as self-stabilizing consensus [8, 9] and community detection [6, 10].

Figure 3: Luca with friends and collaborators in Rome. From left to right: Stefano Leucci, Guido Proietti, Pierluigi Crescenzi, Luca Trevisan, Luca Becchetti, Riccardo Silvestri, and Luciano Gualà. Photo by Andrea Clementi.

Other Contributions. In cryptography, Luca had several influential papers on understanding the limitations of "black-box" constructions and reductions in constructing cryptographic primitives [19, 13, 33]. In coding theory, Luca gave the first lower bounds for locally decodable codes [27, 20], a research direction that has seen a resurgence of activity and progress two decades later. In property testing, he proved the first linear lower bound for testing a natural graph property (namely, 3-colorability) in the bounded-degree model [12].

Luca had an uncanny ability to quickly identify the significance and potential of a new direction when he saw one. He would comprehend the essence of the first paper on a topic at great depth, write a beautiful follow-up filled with insights that clarified and improved matters, and in turn inspire further follow-ups and progress. He did this repeatedly, on diverse topics, ranging from hardness amplification to Unique Games algorithms. This is best articulated in Luca's own words in his blog post "On being second" [42].

Human Impact

Beyond his research prowess, Luca was a leader in another (more subtle) way, which is no less important. As a teacher and expositor, Luca awakened curiosity in others. In his many survey articles [39] and lecture notes [38], he gave us the crispest expositions of many canonical results in theoretical computer science. His way of explaining was generous, making full use of his intellect but keeping it

in the background. He was passionate about making theoretical computer science approachable to newcomers, and his writings did so wonderfully. Many of us regularly benefited from Luca's notes for our teaching—he had a gift for distilling advanced material in an engaging style perfectly tuned and packaged for lectures; in fact, we sometimes picked topics to lecture on *because* Luca had notes on them!

On his blog, *in theory* [37], in addition to his lecture notes, Luca also shared with us what he was learning. This included topics such as zeta functions [46], manifolds [44], and other objects not so familiar to the TCS audience. It was an invitation to expand our imagination, and a reminder that it's okay to just learn something for its own sake. In person, Luca had a way of asking simple questions and then exploring them with clarity, devoid of any hint of competition or rush. Talking with him was a gentle invitation to wonder. He shared his questions and insights generously, and repeatedly went out of his way to collaborate with junior people, not even necessarily his students, including us. We doubt that our journey with Luca is unique. He represents what is best about our field: its openness and the generosity of its leaders. We hope that Luca's way will forever remain alive in our community.

As a faculty member for over 25 years, Luca was a beloved mentor to many students. He both collaborated with them on influential results and inspired them to grow as fearless researchers with their own ambitious agendas. His former students are now faculty or researchers at the University of Ottawa, NTT Research, TTI-Chicago, the University of Michigan, the Institute for Research in Fundamental Sciences, the University of Memphis, the University of Pennsylvania, and Google. "As graduate students we were awed and a bit intimidated by Luca's brilliance and prowess," recalls his first PhD student, Andrej Bogdanov. "His gentle personality and humorous manner quickly put us at ease. Luca had his share of fun solving hard problems, but what he truly enjoyed was talking, joking, or just sitting there over a cup of coffee. I signed up for an advisor. I ended up with a friend for life."

On a personal level, Luca was one of the early out, gay theoretical computer scientists who have helped make this community a welcoming one for LGBTQIA+ researchers and students. He recounted his coming-out in 2000 in a characteristically humorous (and now legendary) blog post [47], which was part of Luca's effort to "put the gay back in the Turing Centennial." In addition to his own post, he hosted a series of 8 guest blog posts [45, 15], where LGBTQIA+ colleagues from TCS and Math wrote about their experiences in the field, an initiative that had a huge impact on the inclusiveness of our field. These kinds of contributions meant so much to Luca that, even while hospitalized in his final weeks, he heroically prepared an Inspirational Talk that he was invited to give at the TCS4All workshop at STOC, which was delivered posthumously on his behalf [48]. The community's love of and respect for Luca is reflected in the numer-

Figure 4: Luca with his first three PhD students. From left to right: Kenji Obata, Luca Trevisan, Andrej Bogdanov, and Hoeteck Wee.

ous tributes that have been paid to him since his passing, including well-attended tribute workshops or sessions at RANDOM 2024 [2], the Simons Institute [3], and Bocconi University [1]; blog posts by numerous colleagues [4, 5, 14, 18, 24]; an Open Problems Column in SIGACT News [16]; and the TCC Conference naming its Young Researcher Paper Award after him.

Conclusion

Luca Trevisan was an ACM Fellow and was the first computer scientist elected to the Italian National Academy of Science. Earlier in his career, he received the Oberwolfach Prize and a Sloan Research Fellowship, and was an Invited Speaker at the International Congress of Mathematicians. He served on the Turing Award Selection Committee, the Scientific Board of the Institute for Pure and Applied Math, and the editorial boards of JACM, the ACM Transactions on Computation Theory, the SIAM Journal on Computing, and the EATCS Bulletin. He was Program Chair for RANDOM 2001, RANDOM 2005, CCC 2005, FOCS 2010, and TAMC 2013.

Luca was a brilliant scientist and expositor, and unfailingly funny friend and colleague. His clarity and insight deepened our understanding, and advanced the frontiers of research in the theory of computing. Luca leaves behind an enduring

scientific legacy. He will be sorely missed.

Andrea Clementi, Venkatesan Guruswami, Kristin Kane, Alon Rosen, Nikhil Srivastava, Salil Vadhan, and Riccardo Zecchina.

The starting point for this piece was the blog post [24].

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