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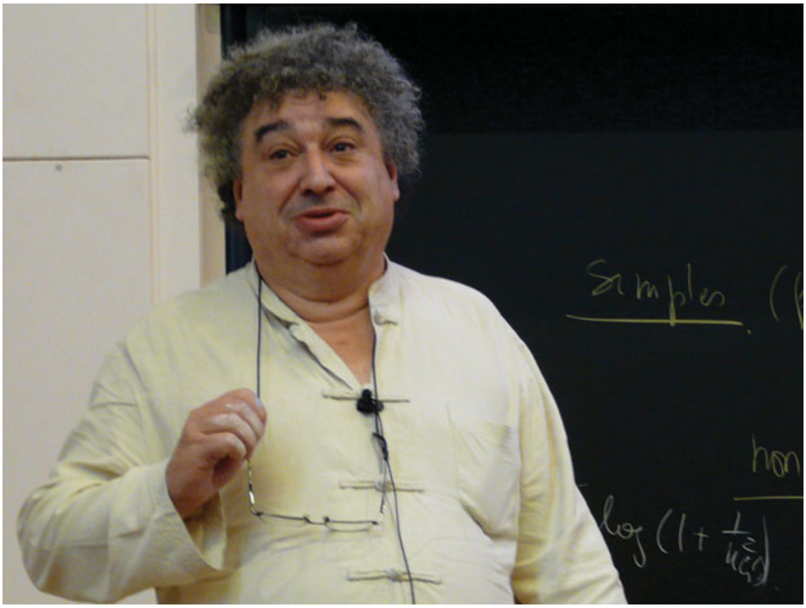
In Memory of Philippe Flajolet



Philippe Flajolet 1948–2011

In 2011, shortly after his untimely passing, several colleagues and I wrote an obituary for Philippe Flajolet [5] that includes the following:

He was the leading figure in the development of the international 'AofA' community that is devoted to research on probabilistic, combinatorial, and asymptotic methods in the analysis of algorithms. The colleagues and students who are devoted to carrying on his work form the core of his primary legacy.

This special issue is testimony to that legacy. Many of the dozens of authors who are represented here worked closely with Philippe; many others have been inspired by his work. All are devoted to carrying it on.

When Philippe saw an interesting piece of research, he would seek out the author at a conference or workshop. More often than not, an invitation to spend some time at INRIA would follow and a new paper would be born. To co-author a paper with Philippe always meant an intense exchange of ideas, punctuated by sharing a few beers and perhaps a few meals, developing into a learning experience, culminating in something one never expected to be able to accomplish, and leading to a host of problems to work on in the future. It does not stretch the truth to say that each co-authored paper marked a point in the development of a friendship.

Philippe worked hard and was a perfectionist, in mathematics, in science, and in writing and exposition. Every co-author will testify to the experience of sending to Philippe a 'final' draft of a paper or book chapter, only to have it returned covered with a sea of comments of all sorts, to the extent that the original manuscript was hardly visible. Personally, one of my great regrets is that I cleaned out my office in 2010 and discarded several boxes full of drafts of our books, all covered with handwritten comments by Philippe. I would treasure these now, and I am sure that many of the authors in this volume now treasure such artefacts, and strove to anticipate Philippe's now-missing comments when preparing their papers.

I think that the key to understanding Philippe's approach towards computer science and mathematics is to understand the dramatic changes in the world during the period when he (and I) came of age as we made the transition from students to teachers and researchers. During this period, computation changed the world. In the 1960s, when we entered school, every bit in a computer was implemented with a physical device, so computers only had thousands of bits; we communicated with our computers via punched cards; our papers were typed by secretaries; we learned mathematics as undergraduates; and little or no computer science was taught to undergraduates. By the 1970s, when we started in research and teaching, computer memories were implemented with integrated circuits, so computers had millions of bits; we communicated with our computers via CRT terminals, with no apparent physical restriction; we used word-processing and typed our own papers; and we were expected to teach computer science, not mathematics. On reflection, this change was more profound than the emergence of the personal computer or the internet. During this transition, everyone in our generation experienced the excitement of being able to not just experience, but work to influence the profound changes that were upon us. Most exciting were the research opportunities, in every direction. A description of this period would fill volumes.

For Philippe and me, and for many others in our generation, one particular realization was immediate: passing knowledge on to the next generation was going to be a significant challenge. We were going to have to develop the courses in computer science that we wanted our students to take, essentially from scratch. On reflection, this challenge was also a once-in-a-generation *opportunity* and a tremendous responsibility. The best of the textbooks that were developed in those years are still in use today. I believe that Philippe took this responsibility seriously and that it was a guiding force in much of his work.

At the beginning, the whole idea of 'computer science' was in question. In what sense is the study of computation a science? Philippe and I were fortunate to be grounded in the rich and voluminous work of Knuth [4], which argued convincingly for the development of a science where we could build mathematical models for performance characteristics of computer programs that we could validate through experimentation. Inspired by Knuth, our early careers were an exciting mosaic of mathematics, programming, and applications at universities and research labs, as the computational infrastructure that we enjoy today took shape, with efficient algorithms whose performance we understood playing a significant role. As Knuth said in his Foreword to our 1996 book *An Introduction to the Analysis of Algorithms* [2]:

> People who analyze algorithms have double happiness. First of all they experience the sheer beauty of elegant mathematical patterns that surround elegant computational procedures. Then they receive a practical payoff when their theories make it possible to get other jobs done more quickly and more economically.

Ironically, research in the analysis of algorithms in the theoretical computer science community drifted in the 1980s from the basis established by Knuth to a theoretical journey where algorithms are classified by asymptotic growth of their worst-case performance. This approach unleashed an 'age of design' that has attracted the attention of a generation of theoretical computer scientists, but has dubious relevance to the practice of computing, because the preponderance of the analyses in this literature give no way to predict performance or to compare algorithms on the basis of performance in the real world.

Philippe was a brilliant mathematician, but he was also a computer *scientist* extraordinaire. While he was fascinated by the tendency of mathematics to take us into an abstract world that leads to wondrous discoveries, he was also, like a typical classical mathematician, quite well-grounded in reality, always using his mathematics to formulate hypotheses that could be validated in the real world. Of course, the easiest way to do so nowadays is to write a program. Far too few people both prove theorems and write programs these days; Philippe found the opportunity irresistible. If there is one personal trait that I would be happy to see emulated by readers of this note, it is this one. Every one of his mathematical results would lead to the questions: 'What might this imply about the real world?' and 'What program could I write to validate and learn more about this phenomenon?'

Which brings us to Philippe's central accomplishment: the field of analytic combinatorics. Philippe had the basic outline of the research programme he would follow quite early on, as is evident in courses he taught in the 1980s (see, for example, [1]). Because of the research challenges and opportunities that intervened, it took nearly 30 years for Philippe (and his many co-authors) to systematize related research and develop the theory needed to fill in the significant gaps, and for us to lay out all the work in our book *Analytic Combinatorics* [3]. The key idea driving all the work was this: by taking us directly from a precise specification of a discrete structure to asymptotic results that quantify properties, analytic combinatorics holds the promise of supporting the scientific approach espoused by Knuth, but in a way that uses classical mathematics to uncover essential truths and avoid excessive detail. While he was an eternal optimist, I believe that Philippe was stunned by the extent to which his research programme was able to realize this dream.

Now we know that analytic combinatorics offers a wealth of opportunities for research in the future. Beyond applications in the analysis of algorithms, probability, and combinatorics, it provides insight into discrete structures that are studied in all fields of science, and it presents a foundation that researchers of the future can extend in many directions.

It is therefore quite gratifying to see a journal with so many papers devoted to so many aspects of analytic combinatorics. I know that Philippe would be delighted, and I hope to see many, many more papers and journals on the subject in the future.

Not long ago, my wife encouraged me to read a biography of Honoré de Balzac by Stephan Zweig [6]. While I do not want to suggest a direct comparison between two unique and disparate personalities, I was struck by the opening words of this book, which I think provide a perfect description of Philippe Flajolet:

> A man of ... genius, endowed with an exuberance of imagination which puts it in his power to establish and populate a universe of his own creation.

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