Yann Ollivier

Researcher in mathematics and computer science

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Born May 26th, 1978
French citizenship

Curriculum

2010 – ...	Research scientist, CNRS, Computer Science department, Paris-Saclay University.
2004 – 2010	Research scientist, CNRS, Math department, École Normale Supérieure de Lyon.
2009	"Habilitation à diriger des recherches" (accreditation to supervise research)
2000 – 2003	PhD in Mathematics, under the supervision of M. Gromov and P. Pansu.
1997 – 2001	Student at the École Normale Supérieure (ENS Ulm) in Paris.

Research topics & achievements

My research focuses on the interplay between geometry and probabilistic models, on various application domains, from machine learning to Markov chains on metric spaces or group theory.

Geometry of learning. I am developing geometric and probabilistic tools well suited to the problems arising in machine learning, such as learning good models of text in natural languages or of musical tunes... The tools come from Riemannian geometry and information theory in spaces of probability distributions. Applications include new, principled and more effective algorithms for neural networks and for black-box optimization.

Discrete curvature and its applications. I have been able to develop a notion of (Ricci) curvature that is valid on discrete spaces. The main tools come from optimal transport and Markov chains. Several results about smooth manifolds with positive curvature are extended to discrete spaces: spectral gap, concentration of measure, functional inequalities, etc. Geometric properties can thus be transferred to non-geometric settings, allowing for new results such as statistics of MCMC (Monte Carlo Markov chain) simulations. Even in the original setting of smooth manifolds, this point of view yields previously unknown results (spectral gap, ergodic-like properties).

Probabilistic general relativity. Since general relativity is non-linear, statistical fluctuations in the content of space-time do not cancel out on average. The net effect on space-time geometry is an emerging "apparent matter". For instance, we have shown that small gravitational waves could generate large amounts of apparent matter in the Universe.

Random groups. What does a "typical" group look like? Gromov suggested ways to pick a group at random among all possible finitely presented groups; he showed that typically a random group is hyperbolic. In my PhD thesis and the following years, I identified a number of properties of random groups. I have subsequently written a short book on the topic.

Selected works – Full list at http://www.yann-ollivier.org/rech/

Y. Ollivier, L. Arnold, A. Auger, N. Hansen, *Information-geometric optimization: A unifying picture via invariance principles*, J. Machine Learning Research, to appear.

Y. Ollivier, *Riemannian metrics for neural networks I & II*, Information and Inference (2015).

A. Joulin, Y. Ollivier, *Curvature, concentration, and error estimates for Markov chain Monte Carlo*, Ann. Probab. (2010).

Y. Ollivier, *Ricci curvature of Markov chains on metric spaces*, J. Funct. Anal. (2009).

C. Chevalier, F. Debbasch, Y. Ollivier, *Multiscale cosmological dynamics*, Physica A (2009).

Y. Ollivier, *Sharp phase transition theorems for hyperbolicity of random groups*, GAFA, Geom. Funct. Anal. (2004).

Popular science

I am currently (2012–present) serving for EUCYS, the European Union Contest of Young Scientists, a science fair for high school students from 30+ countries organized by the European Commission.

I took part (2011–2013) in launching *Mathematic Park* (initiated by X. Caruso), a bi-monthly math seminar for undergrad students on Saturdays at Institut Henri Poincaré (50–150 participants).

I have been (1998–2004) a member of the board of *Animath*, a French association promoting the diffusion of mathematics. I participated in coaching the French team to the International Mathematical Olympiad, delivered talks for high school students about contemporary mathematics, and was involved in the day-to-day life of the association.

In 2016 I am coordinating various events around Shannon's 100th birthday.

I have taken part in other initiatives such as the *Marathon des sciences*, *Fête de la science*, editing of the brochure *Mathématiques : l'explosion continue* by French mathematical societies, and so on. I have written several mathematical texts for the general public.

Thus, I have developed communication skills with the media (TV, press: *Le Monde*, *La Recherche*...), with the general public, and with students from middle school to college levels.

Scientific management & teaching

Students. I am currently supervising two PhD students, two Masters students, and one engineer. Another PhD student defended in 2012.

Project management. I was project leader for an ANR grant "Robust geometry and fluctuating space-times" (2005–2008), and am strongly involved in the academic part of a project with Bull and other companies funded by the ministry of economy (2015–2017).

Contacts and contracts with the industry. Thalès, SYSTRAN (the leading machine translation company), Bull.

Teaching. Lab sessions of C++ programming in Orsay (2001–2004); mandatory course on exposition technique and scientific English at the Master's level at the ENS Lyon (2004–2008). Occasional contributions to machine learning courses (2014–2016).

Services to the community as usual in academia: referee reports for scientific journals, reports for theses and habilitations, participation in hiring committees, etc.

International conferences I organized: *Glimpses of geometry* (ENS Lyon, May 2008) and the summer school *Optimal transportation, Theory and applications* (Grenoble, June and July 2009). I also organized various working seminars.

Computer skills. I wrote several small mathematical programs, some of which have hundreds of downloads, mostly in C++. I was Webmaster for my research group (2004–2009).

Other interests. Philosophy, piano, choir singing, paleontology, economics, linguistics, etc.

Awards and honors

Bronze medal of the CNRS (2011).
First prize at the European Union Contest for Young Scientists (Helsinki, 1996).
Junior Fermat Prize (1995).
Second place in Mathematics at the "Concours général" (French general competition of high school students).
Second place in Physics at the "Concours général".
First prize at the "Dictée de l'École normale supérieure" (1999).
International Mathematical Olympiad (Toronto, 1995).