MASTER

MATHEMATICS

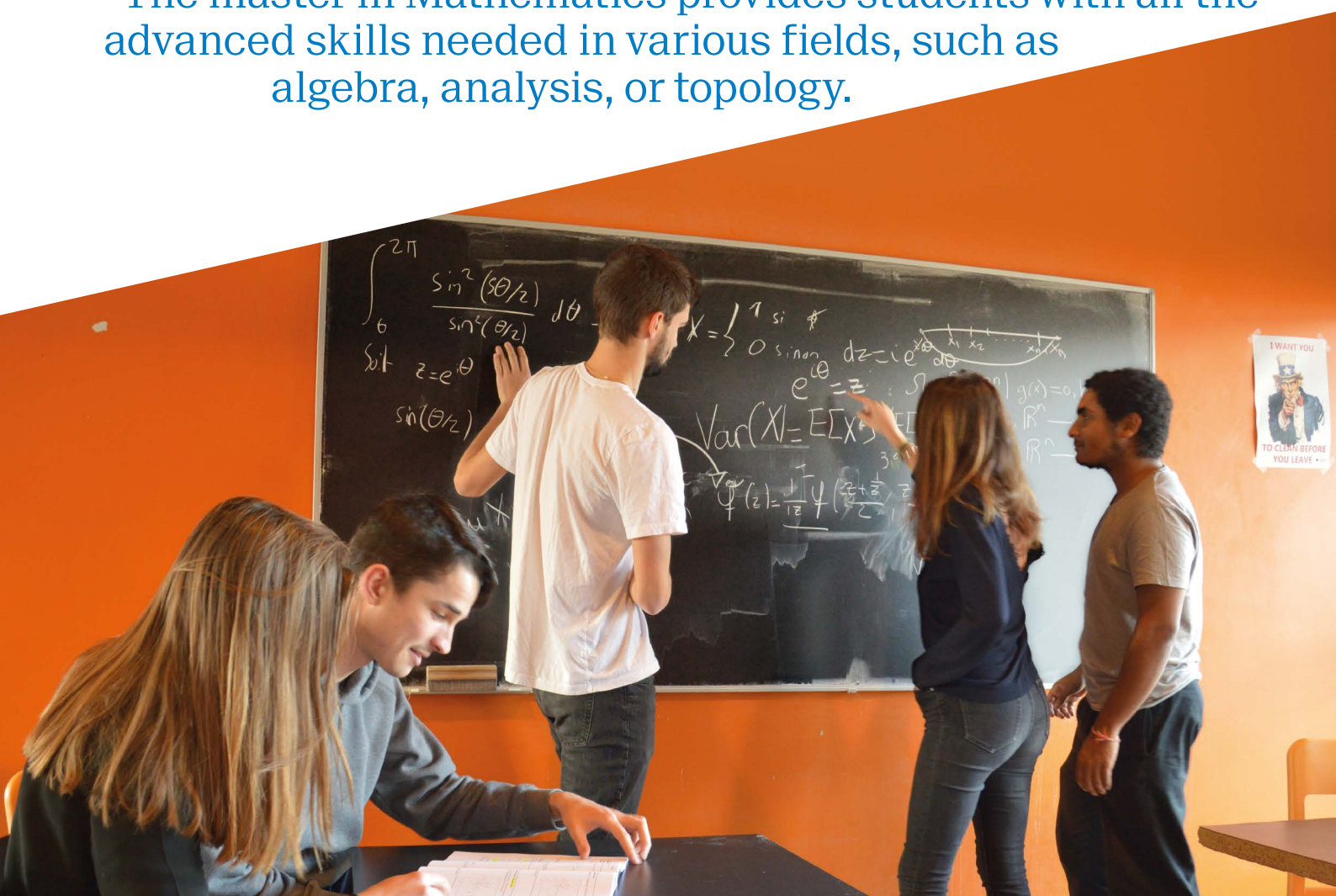
EPFL

The art of reasoning and the study of abstract concepts.

Mathematics is one of the oldest fields of human intellectual endeavor. In this era of new excitement and opportunities for pure mathematics, significant breakthroughs in the physical and biological sciences, as well as the data revolution, give rise to a wealth of mathematical challenges which invigorate the foundations of mathematics and encourage the development of practical applications. Research in mathematics is thus intimately connected to applied mathematics.

Mathematical tools have a varied use: Modelling DNA chains requires innovative differential equations; life science and neuroscience need algebraic topology; cryptography and coding require deep knowledge of modern algebra.

The master in Mathematics provides students with all the advanced skills needed in various fields, such as algebra, analysis, or topology.



The Calculation of Variations

Prof. Dacorogna

The Calculation of Variations is one of the classic subjects of mathematics. It deals with all kinds of optimization problems.

Here are some famous examples:

1 Find among all closed curves in the plane and having a given length, that which encloses the maximum area. The solution is a circle. In space, if we search among all closed surfaces of a given area, that which encloses the maximum volume, we find that the sphere has this property. One can think of a soap bubble, as painted by Manet in "Boy blowing bubbles".

2 On a given surface, find the shortest path between two points. If the surface is a plane, the solution is obviously a straight line. For a general surface, and by widening a little the problem, one speaks then of geodesics.

Maude Girardin:
"Analysis, algebra, statistics, geometry, topology and many more, mathematics are declined in a (nearly) infinity of domains. All have in common that they require a sheet, a pencil, rigor, concentration and obstinacy, but also creativity, imagination ... and a little madness!"

3 In space, find a surface of minimal area and whose boundary is a given closed curve.

4 In physics many problems, such as the Fermat principle in optics or the principle of least action or the problem of minimal resistance of Newton, are formulated as variational problems.

© Costa's minimal surface, Paul Nylander.
Website: bugman123.com

Yoan Golaz:
"I chose to study mathematics to keep as many doors as possible open. I appreciate to be able to personalize my academic program by choosing amongst a selection of diverse subjects. The ambiance and collaboration between students are excellent! We learn to develop critical thinking and to analyze problems from different angles, qualities that are useful for the future."

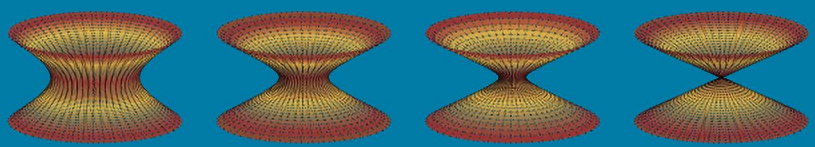
Algebraic geometry

Prof. Patakfalvi

Algebraic geometry is a classical subject of pure mathematics. Its main objects are algebraic varieties, which can be defined as common zero sets of finite collections of multivariable polynomials. The main goal of algebraic geometry is to understand different aspects of algebraic varieties using both algebraic and geometric ideas in an intertwining manner.

The illustration below shows the simplest example of a degeneration of smooth algebraic varieties to a singular one. The singular variety is the one on the far right, and is called a quadratic cone. We say it is singular because in the middle there is a point, called the cone point, around which this surface cannot be described by two local functions given by power series.

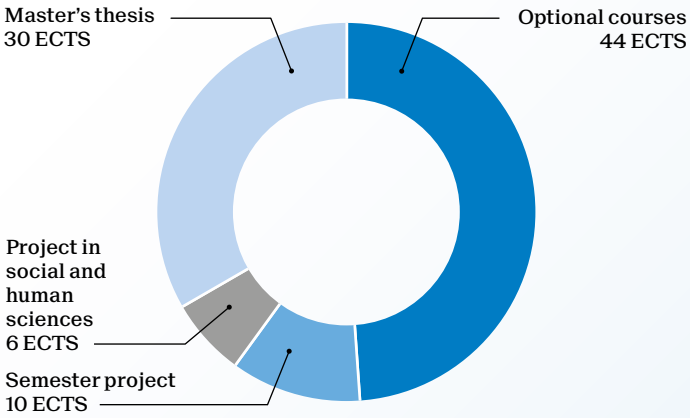
Large parts of other fields of pure mathematics rely on algebraic geometry, such as number theory or group theory. Furthermore, lately, it has been also extensively used in applications, such as cryptography, robotics, optimization or statistics.



Master of Science in

MATHEMATICS

1 1/2-year program - 90 ECTS



Optional courses are classified in the following tracks (included in the 44 ECTS is the possibility to choose courses in other EPFL programs):

- Algebra and geometry
- Algorithmic and discrete mathematics
- Analysis
- Numerical analysis
- Probability and interactions / Statistics

Students may choose an additional 30 ECTS minor or opt for a Teaching specialization (additional 30 ECTS at the *Haute école pédagogique du canton de Vaud*).

	Credits
Optional courses	**40**
Algebra and geometry	
Abstract analysis on groups	5
Advanced analytic number theory	5
Algebraic geometry II - Schemes and sheaves	10
Algebraic geometry III - Selected topics	5
Algebraic K-theory	5
Complex manifolds	5
Differential geometry IV - General relativity	5
Ergodic theory	5
Homotopical algebra	5
Homotopy theory	5
Introduction à la géométrie riemannienne	5
Lie groups	5
Linear algebraic groups	5
Number theory - Modular forms	5
Number theory - Selected topics	5
Number theory - Cryptography	5
Representation theory of semisimple lie algebras	5
Riemann surfaces	5
Spectral theory	5
Student seminar in pure mathematics	5
Topics in arithmetic geometry	5
Topology - Cohomology rings	5
Algorithmic and discrete mathematics	
Integer optimisation	5
Mathematical modeling of behavior	5
Metric embeddings	5
Analysis	
Calculus of variations	5
Dispersive PDEs	5
Distribution and interpolation spaces	5
Harmonic analysis	5
Lattice models	5
Nonlinear Schrödinger equations	5
Optimal transport	5
Topics in calculus of variations	5
Numerical analysis	
Computational linear algebra	5
Error control in scientific modeling	5
HPC for numerical methods and data analysis	5
Low-rank approximation techniques	5
Numerical integration of stochastic differential equations	5
Numerical methods for conservation laws	5
Numerics for fluids, structures and electromagnetics	5
Optimization on manifolds	5
Topics in machine learning	5
Probability and interactions / Statistics	
Applied biostatistics	5
Applied statistics	5
Biostatistics	5
Concentration of measures	5
Foundations of probabilistic proofs	6
Gaussian processes	5
Inference on graphs	5
Introduction to stochastic PDEs	5
Multivariate statistics	5
Regression methods	5
Risk, rare events and extremes	5
Statistical analysis of network data	5
Statistical computation and visualisation	5
Statistical genetics	5
Statistical inference	5
Statistical machine learning	5
Statistical mechanics and Gibbs measures	5
Statistical theory	5
Statistics for genomic data analysis	5
Stochastic epidemic models	5
Stochastic simulation	5
Theory of stochastic calculus	5
Topics in probability	5
Topics in stochastic analysis	6
Other courses	
Gödel and recursivity	5
Martingales in financial mathematics	5
Set theory	5

School of Basic Sciences
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