COURS GALOIS

ATELIER DE MATHÉMATIQUES

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Some history

In 1830, Évariste Galois created a course called *algèbre supérieure*, because he disagreed with the methods of teaching mathematics. More than a century later, the *Nicolas Bourbaki* group developed a new approach to mathematics and its teaching, which caused the emergence of many renowned mathematicians, so much so that even today, being French is often synonymous with "being good at maths". In both cases, these eminent mathematicians offered an approach and a methodology that parted with the teachings of their time, which they considered, in particular, to lack rigor and consistency.

What did I notice?

During my years of teaching mathematics at university, I was able to observe the way in which students approached mathematics, and noted their lack of knowledge and mastery of the fundamentals, generating a misunderstanding of the subject. Some learning techniques, especially those based on memorization, have been neglected in favor of longer explanations, misrepresented as more intuitive and generally so convoluted that they end up being even more complicated. This approach completely undermines what math education is all about, and produces sloppy and rather poorly educated students.

What consequences can this have?

In many fields such as computer science or finance, mastery of mathematics is necessary, even essential. During a recruitment interview, it is indeed common for the candidate to be tested to check their level of knowledge. Intensified competition due to the increase in the number of students, in addition to the system which encourages more and more lax notations, means that obtaining a higher education degree, such as a Bachelor's or even Masters, no longer guarantees a remunerated job commensurate with the achievements. The selection being done sooner or later, it is essential to guarantee to have a solid training especially if it is accompanied by a significant student debt.

What motivated me to develop this training?

I talked a lot with people from the teaching staff, and most were in agreement with my observations, analyzes and conclusions. On the strength of these observations, and being concerned, even worried, about the methods of teaching mathematics, used in the United States, but also in France, I decided, following the example and in the spirit of Galois and of the Bourbaki group, to develop appropriate training, which would allow students to acquire the fundamentals, efficiently and quickly. The concepts are studied in more detail with application exercises in physics,

finance or economics. In addition to an adequate education in mathematics, it is also a work methodology that will extend beyond school, the goal being also to maximize the chances of success in higher education as well as the best chances for the most selective establishments.

What are the necessary prerequisites?

In addition to motivation, only the ability to read, write and count is necessary.

Who is the target audience?

Training can be started from the age of 11 or 12 depending on the profile, but is also aimed at older students to prepare for higher education, as well as adults returning to their studies in order to obtain an MBA or Masters' degree which would require a refresher in mathematics.

What is the material needed?

Upon registration, geometry instruments, two notebooks, a *Mathematica* license and the textbook will be provided. The rest will be the responsibility of the student and the use of a computer will be necessary for learning computer coding.

What are the benefits of training?

With considerable economies of scale resulting from consistent instruction that minimizes redundancy, training would equate to the entire curriculum covered in middle school, high school, and 1-2 years of higher education as well as some physics, economics and finance. All in much less time (44 weeks at the rate of one session of 2h30min per week in the best case), and the level attained will certainly culminate in high marks in school, at the *Brevet des Collèges, French Baccalaureate*, standardized tests such as the *SAT*, as well as a significant advance on higher education studies.

• Can be started at any time during the year in small groups of 10 students maximum.

• The training can be chosen in English or in French.

• Every week, 1 hour of office hours online.

• Training in coding with Mathematica and Python, as well as LaTeX for writing papers (useful in all subjects), CV, cover letter, etc...

• Importance will be given to certain aspects of mathematics which are too often neglected such as presentation, the correct use of notation and calculator.

• Development of a good work methodology through, for example, the use of scratch paper or the creation of formula sheets.

• Several types of grading will be provided for each assignment, in order to be able to follow the progress of several aspects:

  ◦ A score out of 100, with points awarded only when the answer is completely correct.
  ◦ A score out of 100, with partial points but high standards.
  ◦ A grade supposed to reflect what would be obtained at the university.
  ◦ A presentation grade.

• At the end of the training, a personalized recommendation as well as contacts and assistance will be provided in the application process for American, British or French universities, as well as for *classes préparatoires aux grandes écoles.*

Program of the training

• Several times are available depending on the frequency of classes chosen (one to two sessions per week is recommended). Sessions last 2h30min.

Monday and Tuesday	Wednesday	Thursday and Friday	Saturday and Sunday
6pm – 8:30pm	2pm – 4:30pm and 4:45pm – 7:15pm	6pm – 8:30pm	10am – 12:30pm and 1:30pm – 4pm

Table 1: *Schedule*

• Although everyone starts at level $1a$, each student can complete the levels at their own pace, with all 4 levels taking an average of 1 to 3 years.

• Validation tests for each level will be offered regularly. Students will also be offered, if they so wish, the opportunity to take *khôlles* (oral exercises), the mathematics examination for the *Brevet National des Colleges* or the *Baccalaureate* under the same conditions in order to measure progress.

Levels		Topics
1	1a 1b 1c 1d	Algebra and Set Theory Geometry 1 General Mathematics Geometry 2
2		Calculus
3		Probability and Statistics
4		Logic

Table 2: *Curriculum*

• During school holidays, intensive courses with daily classes are available.

• Trips between Paris, Boston and London can be organized, combining courses with visits to university campuses, the city and meetings with professors from local universities.

End of training

• What will have been learned, not counting optional courses, covers the program of university courses listed below (non-exhaustive list). Those with * are not totally covered, but mostly. University credits can, perhaps, be obtained by equivalence for certain institutions.

MIT

18.01: Calculus, 18.02*: Calculus, 18.05: Introduction to Probability and Statistics, 18.06*: Linear Algebra, 18.090*: Introduction to Mathematical Reasoning

Harvard University
Mathematics MA: Introduction to functions and calculus I, Mathematics MB^*: Introduction to functions and calculus II, Mathematics $1A$: Introduction to calculus, Mathematics $1B^*$: Integration, series and differential equations, Mathematics $18B/19B^*$: Linear algebra, probability and statistics, PhySci 3^*: Electromagnetism, Circuits, Waves, Optics, and Imaging, Stat 110: Introduction to probability

Boston University
MA 111: Mathematical Exploration, MA 113: Elementary Statistics, MA 115: Statistics I, MA 116^*: Statistics II, MA 119^*: Applied Mathematics for Personal Finance, MA 120: Applied Mathematics for Social and Management Sciences, MA 121: Calculus for the Life and Social Sciences I, MA 122^*: Calculus for the Life and Social Sciences II, MA 123: Calculus I, MA 124^*: Calculus II, MA 193: Discrete Mathematics for Engineering, MA 213: Basic Statistics and Probability, MA 214^*: Applied Statistics, MA 225^*: Multivariate Calculus, MA 242^*: Linear Algebra, MA 293^*: Discrete Mathematics, MA 531^*: Mathematical Logic, PY 106^*: Physics 2, PY 212^*: General Physics 2, PY 252^*: Principles of Physics 2

• Subjects usually studied in higher education may also be requested.

Option 1: Math 1	Linear Algebra Calculus 2 Calculus 3	Option 6: Math 2	Stochastic Calculus Real Analysis Complex Analysis
Option 2: Classical Physics	Classical Mechanics Optics Electromagnetism Thermodynamics	Option 7: Math 3	Abstract Algebra Number Theory
Option 3: Chemistry	Atomistic Inorganic Chemistry Organic Chemistry	Option 8: Math 4	Differential Equations Differential Geometry
Option 4: Economics 1	Microeconomics Game Theory	Option 9: Relativistic Physics	Special Relativity General Relativity
Option 5: Economics 2	Macroeconomics Finance Financial economics	Option 10: Quantum Physics	Quantum Mechanics Quantum Computing Quantum Field Theory

Table 3: *Optional Courses*

Calendar

The following schedule, based on 1 session per week, is provided as an indication, to get an idea of the minimum duration of the training as a whole.

Week	Topics	Week	Topics
1	*Algebra*, chapter 1 Exercises	2	*Set Theory*, chapter 2 Exercises
3	Exercises level 1a	4	Exam level 1a
5	*Geometry 1*, chapters 8 et 9 Exercises	6	*Geometry 1*, chapter 10 Exercises
7	Exercises level 1b	8	Exam level 1b
9	Beginning of *LaTeX* training *General Mathematics*, chapter 3	10	*General Mathematics*, chapter 3 Exercises
11	Beginning of *Mathematica* training *General Mathematics*, chapter 3 Exercises	12	*General Mathematics*, chapter 3 Exercises
13	*General Mathematics*, chapters 4, 5 Exercises	14	Beginning of *Python* training *General Mathematics*, chapter 6 Exercises
15	*General Mathematics*, chapter 7 Exercises	16	Exercises level 1c
17	Exam level 1c	18	*Geometry 2*, chapters 11, 12, 13 Exercises
19	*Geometry 2*, chapters 11, 12, 13 Exercises	20	Exercises level 1d
21	Exam level 1d	22	*Calculus*, chapters 14, 15, 16 Exercises

Week	Topics	Week	Topics
23	*Calculus*, chapters 14, 15, 16 Exercises	24	*Calculus*, chapters 14, 15, 16 Exercises
25	*Calculus*, chapters 14, 15, 16 Exercises	26	*Calculus*, chapters 14, 15, 16 Exercises
27	Exercises level 2	28	Exam level 2
29	*Mathematica*	30	*Python*
31	*Probability and statistics*, chapters 17, 18 Exercises	32	*Probability and statistics*, chapters 18, 19 Exercises
33	*Probability and statistics*, chapters 18, 19 Exercises	34	*Probability and statistics*, chapters 18, 19 Exercises
35	Exercises level 3	36	Exam level 3
37	*Mathematica*	38	*Python*
39	*Logic*, chapters 20, 21 Exercises	40	*Logic*, chapters 22, 23, 24 Exercises
41	Exercises level 4	42	Exam level 4
43	Exercises Final Exam	44	Final Exam all levels

About me

I did my undergraduate studies in France at *University Paris VI* before moving to London where, after spending 6 months in the mathematics department of *Queen Mary University* conducting research in general relativity, I went to *Imperial College London* where I specialized in string theory. Concluding a third year in London studying finance and economics at the *London School of Economics*, I moved to Boston where I concluded my studies with a doctorate in mathematics from *Tufts University*. Finally, I taught mathematics, physics, economics and finance for many years in academic institutions such as *Harvard University* and *Boston University*.