QUANTITATIVE AND MATHEMATICAL METHODS FOR THE SOCIAL SCIENCES

Euro-American Campus
Sciences Po Reims

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This course covers some of the **essential mathematics** used in the formalization of markets, populations and disease, as a means of introduction to the **quantitative research methods** used by social scientists to analyse human development, social surveys and economic activity.

Mathematics are used by social scientists to formalize generic problems and solutions in a given state of affairs. There is only a very finite supply of mathematicians, so to sort things out on our own, we can learn some elementary **calculus** and **probability** theory, as well as some **statistics** to produce quantitative descriptions, tests and models out of real-world data.

We intend this introduction to be as accessible as possible and assume no prior knowledge of the topics covered, but some curiosity in all of them. Laptops and calculators are never required or allowed during class: this is a strictly pen-and-paper course to build core skills at problem-solving, and you will be required to solve all problems by hand.

COURSE REQUIREMENTS

Students are expected to be regular and active participants in the course, and to complete the required readings and exercises prior to every class meeting. All course sessions start with a theoretical introduction, after which students will train themselves to work through routine examples, problems and solutions. The course sessions will introduce some applications based on the issues and methods covered in the social sciences.

Students will be assessed on the basis of **problem sets** and **class exams** that will be collectively revised in *review sessions* as well as *special office hours* (if time permits). Exam problems and questions will closely match the material covered in the handbook chapters that students are expected to read throughout the semester. Further expectations about coursework and exams will be outlined at the first meeting and further detailed at several points of the course.

Feel free to ask for additional guidance on what to read and how to structure your work, yet *do not wait for the last minute to do so, and read extensively from the course material first.* The grading policy for the course is 25 points for each of three exams and 25 points for overall class participation and progress. Attendance to all sessions is compulsory, and students will be asked to provide regular feedback on the course.

COURSE SUMMARY

Formalization · Calculus

1. Notation
2. Functions
3. Differentiation
4. Exponentiation
5. *Review · Exam to follow*

Randomization · Probability

6. Probability
7. Distributions
8. *Review · Exam to follow*

Modelling · Statistics

9. Sampling
10. Estimation
11. Association
12. *Review · Exam to follow*

HANDBOOKS

Almukkahal, R. *et al.* 2009. *Single Variable Calculus*. CK-12 Foundation.

Evans, A. *et al.* 2012. *Advanced Probability and Statistics Concepts*. CK-12 Foundation.

Gowers, T. 2002. *Mathematics: A Very Short Introduction*. Cambridge University Press.

> *Reading guide*: *You should read extensively from all books and train yourself on as many exercises as needed; additional practice sessions will be provided in class. Gowers' introduction is optional.*

ADDITIONAL READINGS

Gonick, L. and Smith, W. *The Cartoon Guide to Statistics*. HarperPerennial.

Tufte, E. 2001. *The Visual Display of Quantitative Information*. Graphics Press.

> *Reading guide*: *Gonick and Smith offer good eye candy to get harmlessly introduced to statistics; and Tufte is a beautiful treaty on visual design and data visualization. Both readings are optional.*
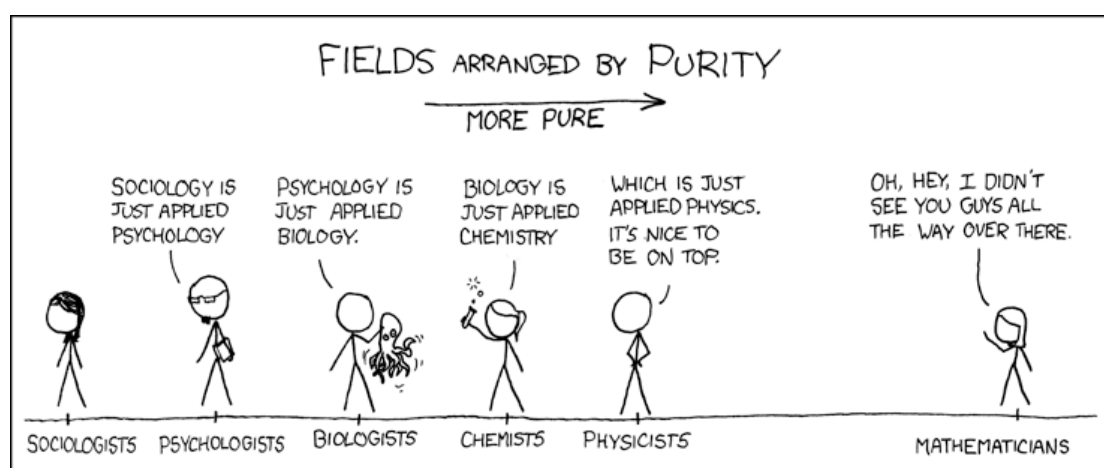
WEBSITES

CK–12 handbooks — *register online and download the material*
http://www.ck12.org/book/Calculus/
http://www.ck12.org/book/CK-12-Advanced-Probability-and-Statistics-Concepts/

QMM teaching material — *slides, syllabus and additional links*
http://f.briatte.org/teaching/math/

SESSION READINGS

Readings are taken from the CK–12 Calculus handbook (S. V. C.) for Sessions 1–5 and from the CK–12 Advanced Probability & Statistics handbook (A. P. & S.) for Sessions 6–12. All readings are compulsory for the 'Level 1' (Elementary) and optional for 'Level 2' (Advanced).

SESSION 1   NOTATION

☐   Gowers   ch. 1, 2 *& 7 (introductory points)*

SESSION 2   FUNCTIONS

☐   S. V. C.   ch. 1 *(mathematical notation)*

SESSION 3   DIFFERENTIATION

☐   S. V. C.   ch. 2 *(derivatives and marginal effects)*

SESSION 4   EXPONENTIATION

☐   S. V. C.   ch. 6 *(exponents and logarithms)*

SESSION 5   REVIEW

☐   S. V. C.   ch. 3 *(applications of derivatives)*

SESSION 6   PROBABILITY

☐   A. P. *&* S.   ch. 3 *(fundamental rules)*

SESSION 7   DISTRIBUTIONS

☐   A. P. *&* S.   ch. 4 *(mean and standard deviation)*

SESSION 8   REVIEW

☐   A. P. *&* S.   ch. 5 *(normal distribution)*

SESSION 9   SAMPLING

☐   A. P. *&* S.   ch. 6 *(survey design)*

SESSION 10   ESTIMATION

☐   A. P. *&* S.   ch. 7 *(confidence intervals)*

SESSION 11   ASSOCIATION

☐   A. P. *&* S.   ch. 8 *(hypothesis tests)*

SESSION 12   REVIEW

☐   A. P. *&* S.   ch. 9 *(linear regression)*