History and Philosophy of Mathematics
Histoire et philosophie des mathématiques

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Numerical instability and dynamical systems

In philosophical studies regarding mathematical models of dynamical systems, instability due to sensitive dependence on initial conditions, on the one side, and instability due to sensitive dependence on model structure, on the other, have by now been extensively discussed. Yet there is a third kind of instability, which by contrast has thus far been rather overlooked, that is also a challenge for model predictions about dynamical systems. This is the numerical instability due to the employment of numerical methods involving a discretization process, where discretization is required to solve the differential equations of dynamical systems on a computer. We argue that the criteria for numerical stability, as usually provided by numerical analysis textbooks, are insufficient, and, after mentioning the promising development of backward analysis, we discuss to what extent, in practice, numerical instability can be controlled or avoided.

BRENDA DAVISON, SFU

Stokes and the Pendulum

During the first half of the 19th century, the pendulum occupied an important place in experimental physics and in surveying. Precision pendulum measurements were used, for example, to determine accurate values of the gravitational constant and to determine the exact shape of the earth. The desire for exceedingly precise measurement meant that temperature, humidity, altitude, external vibrations, and the medium through which the pendulum swung had to be controlled or corrected for. Simultaneous measurements being made at a variety of locations around the world meant that assurance was needed that what was being compared from one location to the other was actually comparable. Further, theory was needed to support the various experimental results and to predict the effect of changing conditions on the pendulum period. In particular, the computation, from theory, of a vacuum to air correction factor for a given pendulum was important. Sir George Gabriel Stokes provided this theory in 1848 and he used divergent series to do so. This talk will use a portion of the fascinating history of the pendulum during the early 19th century to establish their importance and then will take a close look at the mathematics that Stokes developed in support of this effort.

DEBORAH KENT, University of St. Andrews

Experimentation and Mathematics: P.G. Tait at the Old Course

Nineteenth-century mathematician and physicist Peter Guthrie Tait (1831-1901) is widely known for his collaborations with Maxwell, Hamilton, and Thomson. Less familiar are his extensive aerodynamical studies. In the 1890s, Tait published over a dozen papers on the path of a rotating spherical projectile. Tait's classic work on the trajectory of golf balls was experimentally tested on the course at St. Andrews with the help of his son, celebrated amateur golfer Freddie Tait. P.G. Tait realized that the combination of a dimpled surface and backspin created lift that allowed the ball to exceed the maximum expected distance.

JEMMA LORENAT, Pitzer College

"I see the ellipsoid from inside" : responses from Galton's 1880 questionnaire on the faculty of visualising

Between November 1879 and April 1880, Francis Galton circulated a questionnaire on Mental Imagery to colleagues, schools, professional societies, and journal contributors. He received responses from 107 men, 180 women, and hundreds of schoolchildren. Galton restricted his statistical analysis and publications to the results from 100 men ("at least half of whom are distinguished in science or in other fields of intellectual work") and 172 boys from the Charterhouse School.

Among the women whose responses were consigned to the obscurity of a few vaguely qualitative remarks were Charlotte Angas Scott and Constance Herschel, fellow students at Girton College in Cambridge, who would both become resident lecturers there. Their responses and accompanying letters to Galton have been preserved and digitized by the University College London Digital Collections alongside all of Galton's surviving correspondence on Mental Imagery.

This talk will situate the responses from Scott and Herschel on the imagery of geometry and numerals with respect to their mathematical training and popular perceptions (including Galton's) of sex differences in imagery and abstract thought.

JABEL RAMIREZ, University of La Laguna

The philosophical heritage of Leibniz' mathesis universalis in modern computational mathematics

In the Regulae, Descartes writes that there must be a "general science that explains everything that is possible to explain concerning order and measure, without assigning any particular measure." This science was called mathesis universalis. Leibniz later picked up this idea and developed it in various essays between 1666 and 1704. Leibniz would have distinguished between a characteristica universalis or lingua characteristica and a calculus ratiocinator. The first would consist of a rational language of thought, whose mission would be to directly represent our concepts and their relationships, that is, the conceptual structure of the world; while the second would constitute a symbolic calculation whose aim would be the algorithmization of reasoning, of human thought. This distinction signified the emergence of two currents with opposing views on the nature of the mathesis universalis, or universal symbolic language. On the one hand, the "algebraic" school of Boole, Peirce and Schröder, and, on the other hand, mainly Frege, who in his Begriffsschrift opts for a characteristica universalis. These two visions affect, as Jean van Heijenoort points out, logic, which can be considered a language or a calculation, but it also transcends in linguistics with the works of Jakko Hintikka. They also gave rise to Carnap's proposal for a universal language of logical and physicalist science. In this work we propose to investigate the possible relationships between these concepts and the epistemological characterization of computational mathematics; In this sense, we will analyze whether they have calculus or language properties in the Leibnizian sense.

DAVIDE RIZZA, University of East Anglia

Salient phases of mathematical problem-solving

Recent philosophical discussions concerning the application of mathematics focus on the correspondence between empirical and mathematical structures (since Field (1980)) or on the issue of explanation (since Baker (2005)).

As a result, the analysis of applications has been persistently subjected to a counterproductive focus. In particular, the problem-solving character of applications has been concealed. Little attention has been paid to the fact that, in scientific enquiry, interrelated problems, rather than structured settings, present themselves first. Settings arise from after successful problem-solving techniques have been crystallised. Moreover, only after systematic work to bring problems under control has been carried out is it possible to consider certain facts as results of formal analysis, i.e. it is only after the construction of a problem-solving methodology by mathematical means that explanations arise as, possibly significant, byproducts.

My goal on this presentation is to refocus the study of applications around problem-solving and away from mirroring and explanation. I offer some reflections on what important phases of mathematised enquiry should be given prominence as a subject of closer analysis. In order to keep contact with mathematical practice, I develop my reflections in connection with the development of mathematical voting theory (especially Saari (1994)).

References: Baker, A. (2005) 'Are there genuine mathematical explanations of physical phenomena?', Mind 114, pp.223–238. Field, H. (1980) Science without numbers. Oxford: Clarendon Press. Saari, D.G. (1994) Geometry of Voting. New York: Springer.

NAFTALI WEINBERGER, Munich

Simpson's Paradox and Tests of Racial Discrimination

Simpson's paradox is a well known statistical phenomenon in which a probabilistic association in a population reverses, emerges, or disappears when the population is partitioned into subpopulations. Despite the existence of satisfactory probabilistic and causal analyses of the paradox, it continues to be a source of confusion among scientists and philosophers. In my talk, I illustrate the significance of the paradox for benchmark tests of racial discrimination. Neil and Winship (2019) correctly note that the paradox undermines the uncritical use of such tests, but their analysis is weakened by severe misconceptions about the paradox. I show how the causal analysis of the paradox avoids these errors and highlight the under-appreciated role of causal methodology for interpreting data.