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Halifax Meeting Abstracts, June 2026

Title: What Counts as a Proof? Criteria and Value Judgments in Mathematics

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Mathematicians rely on shared criteria when determining whether something counts as a mathematical proof. In earlier work, I argued that these criteria do not function as rigid rules but as shared values whose interpretation and relative weight vary among mathematicians. I identified five such criteria: truth, validity, understanding, elegance, and generality. This talk builds on that account by examining how these criteria are applied in practice. I discuss three different proofs of a theorem in number theory—diagrammatic, algebraic, and formal—as well as a proof of a classical theorem together with a Brouwerian counterexample to it. These examples show how the same criteria can be interpreted and weighed differently, and how disagreements about what counts as a proof are therefore not purely mathematical, but involve philosophical commitments and value judgments.

A Case for the Extrinsic Theory of Surfaces

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Through the development of curvature in differential geometry, much fruitful attention has been paid to intrinsic surface theory. From Carl Gauss' *Disquisitiones Superficies* of 1827 to Bernhard Riemann's 1854 habilitation address and Albert Einstein's 1915 announcement of general relativity, the intrinsic perspective has brought out a kinship between surfaces and higher-dimensional manifolds.

However, Leonhard Euler's original 1760 investigations extended the notion of curvature to surfaces via an *extrinsic* analogy with lines. The extrinsic character of this comparison is essential; all one-dimensional notions of curvature must rely on relations with some object outside the line itself (a reference axis, a circle, etc.).

In this paper, I offer an account of how the extrinsic perspective can still be a valid source of insight for the study of surfaces. Beyond a philosophical interpretation of existing results, I also offer as evidence a new extrinsic object, answering a 260-year-old question of Euler's in this area.

Rigor and Significance

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In recent years, the topic of mathematical rigor has received a thorough examination. Tanswell (2024) argued for a pluralistic approach to mathematical rigor – invoking different models of rigor to understand different normative and descriptive components of mathematical practice. But less attention has been paid to how rigor functions outside the inferences of mathematical proof. In particular, there seems to be some level of rigor in applied mathematical practices. This talk focuses on hypothesis testing using statistical significance.

The talk examines three loci of rigor in significance testing – the mathematical definition of a p-value, the procedure itself, and real-world use of the procedure. I'll argue that these three loci are often evaluated by mathematicians, statisticians, and scientists for their rigor. I'll argue that none of the extant views of rigor can make sense of all three aspects. The standard view of rigor fails to make sense of the norms required for real-world rigorous applications of the procedure. Virtue theoretic and dialogical accounts struggle to make sense of rigorous definitions. And the procedure itself falls squarely within typical discussions of rigor. This, I'll argue, is some evidence for adopting a pluralistic approach to mathematical rigor.

History-Driven Storytelling and the Mathematical Pedagogy

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For the first several millennia of human existence a large component of any education consisted of stories told and heard around a campfire. As a result storytelling as a pedagogical tool is deeply embedded in the human psyche. But it is difficult to convey mathematics via stories so we -- or at least our textbooks -- have for the most part simply dispensed with this essential pedagogical tool, opting instead for the highly efficient seeming theorem/proof/example approach. Most teachers recognize, at least intuitively, the poverty of this. But how does one embed a given topic, say calculus, into a story while simultaneously maintaining focus on the mathematics to be learned?

It sounds impossible, but it is not.

There are a multitude of interesting and beguiling stories in mathematics. Taken together they make up what Ivor Grattan-Guiness has called our mathematical heritage. They explain why modern mathematics has taken its current form, conceptually, notationally, and culturally and they provide context for the subtle and often non-intuitive ideas and methods our students must master. We have written two textbooks (and we're working on a third) where we have explicitly used our mathematical heritage as a frame for the topics being taught. In the course of writing these books we found that we could also present the progression of mathematical ideas itself as a story with a beginning, middle, and end. We will discuss our efforts to use story-telling techniques as an effective teaching mode in our textbooks and classrooms without sacrificing the mathematics.

Servois' Anticipation of Hyperbolic Geometry

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François-Joseph Servois (1767-1847) was a French mathematician; mostly remembered for his contributions to the foundational problem of the differential calculus. He taught at military colleges and published frequently in the *Annales des mathématiques pures et appliquées*. His final mathematical publication was an 1826 article in the *Annales*, titled "Sur la théorie des parallèles" (On the Theory of Parallels). Influenced by the *Éléments de Géométrie* of Legendre (1752-1833), he offered two purported proofs of the parallel postulate in neutral geometry. Although one of these is flawed, he added an additional assumption in the other proof, which provided a correct result that prefigures certain aspects of hyperbolic geometry. We present an analysis of this paper, which sheds light on the transitional period in Geometry prior to the birth of Non-Euclidean Geometry.

Title: Remembering the Forgotten – John Lodge Cowley FRS

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If any mathematician, to quote Trotsky, has been unfairly consigned to the dustbin of history, it is the 18th century geometer John Lodge Cowley (1719 – 1797). Almost nothing has been written about Cowley, despite a busy professional life worth further study. He was noted for his geometry texts, map-making (he was Cartographer Royal for George II), his engravings, and his teaching. He wrote a variety of books for broad audiences. For example, A Discourse on Comets from 1757 written in anticipation of the return of Halley's Comet. Also, Geometry Made Easy from 1752, with fold-up figures! It is interesting to note that books with titles along the lines of "Such and Such Made Easy" were almost nonexistent in the 17th century but have thousands of examples in the 18th century. In this talk we will discuss Cowley's work as a textbook publisher, a mapmaker, and his work as a mathematics instructor at the Royal Military Academy at Woolwich and at the Saint Martin's Lane Academy founded by the artist William Hogarth.

Signicism and the Foundations of Geometry in late 19th-Century Italy

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Formalism in the philosophy of mathematics is typically associated with Hilbert, or with Heine and Thomae, who Frege criticizes in his Grundgesetze. There was, however, an alternative 'formalist' movement in Italy, explicitly motivated by questions about the foundations and interpretation of geometry.

Centred around Giuseppe Peano and his Formulaire de mathématiques, The Italian School conceived mathematics as a purely logical and syntactic activity. Peano's formulations of arithmetic and geometry recast propositions as symbolic expressions akin to algebraic equations, extending Lambert's analogy between reasoning and formal manipulation. Veronese calls this method signicismo ('signicism'), which frees the axioms of geometry from empirical considerations and instead allows the idea to be "a slave to the sign."

Mario Pieri formulated the most mature expression of this formalist program in his 1900 description of geometry as a purely logical (hypothetico-deductive) system. For Pieri, primitive terms are implicitly defined by axioms understood as 'logical equations' whose satisfaction by different interpretations marks geometry as a science independent of spatial intuition. Pieri's conception thus completes the shift from empirically grounded geometry to a formalist epistemology, in which mathematics is grounded by the logical interplay of uninterpreted symbols rather than perceptual intuition.

The talk traces this alternative and underappreciated genealogy of formalism along with its philosophical presuppositions and mathematical motivations.

Euclidean diagrams as evidence for historical continuities and discontinuities

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Abū al-Qāsim `Alī ibn Ismā`īl al-Nīsābūrī (active during 3rd-4th / 10th-11th centuries), is credited with a condensed Arabic edition of Euclid's Elements. His edition, although extant in two complete but undated manuscripts, has not yet been subjected to critical or historical evaluation. One of the most distinctive features of this Taḥrīr is the consistent pattern of (re)labeling the Euclidean diagrams that were inherited from the Greek Euclidean tradition. This distinctive pattern of diagram labelling is also evident in the Taḥrīr of the Elements authored by Muḥyi al-Dīn al-Maghribī (died about 690 / 1290-1), suggesting a genetic connection between the two Taḥrīr, although in the introduction to his Taḥrīr al-Maghribī had criticized al-Nīsābūrī for removing Euclid's abstract enunciation statements during his condensing of the Euclidean text. The discontinuities between al-Nīsābūrī's Taḥrīr and the Greek tradition suggest that his edition can offer important insights into the process of assimilating Euclid's treatise following its translation into Arabic in the 2nd / 8th century. At the same time, the continuities between the Taḥrīr of al-Nīsābūrī and the Taḥrīr of al-Maghribī suggest that al-Nīsābūrī's influence as a mathematical thinker was more pervasive and long-lasting than has previously been recognized.

The Inductive Argument for the Consistency of Classical Mathematics

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I discuss the “inductivist” argument that, because no contradiction has been found in ZFC set theory, the theory is probably consistent. Critics of this argument will reply that an inductive argument requires an unbiased sample, and it is unclear whether our sample of ZFC theorems is unbiased. This objection raises two questions. First, who has the burden of proof in these discussions? Does the inductivist need to show that the sample is unbiased? Or is it enough that critics have not shown that the sample is biased? Second, what is a “biased” sample, anyway? In answer to the first question, I will use a simple thought experiment to suggest that, roughly speaking, it is the inductivist who has the burden of proof. In answer to the second question, I will offer a pragmatic account, emphasizing the variety of methods used by researchers when investigating bias.

What God Left to Aristotle

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One of the most famous passages in Locke’s Essay Concerning Human Understanding comes in Chapter 17 of Book 4: ‘But God has not been so sparing to men to make them barely two-legged creatures and left it to Aristotle to make them rational.’ He goes on to say, ‘He has given them a mind that can reason, without being instructed in methods of syllogizing.’ Nevertheless, if one looks at the Kneales’ The Development of Logic, one finds 20 pages devoted to logic before Aristotle and 75 pages devoted to Aristotle. This does not do justice to Plato or a number of other contributors to philosophy who did not feel the need to formulate a syllogism. This talk will try to identify the features of Aristotle’s logical writings that led to his recognition as the ‘founder’ of the discipline while suggesting that what he had to offer did not bring about a crucial improvement in the ability of the mind to reason, as Locke has it.

Simplicity and Equipoise: Criteria for Ancient Greek Astronomical Models

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In ancient Greek astronomy, mathematicians faced a decision. They aimed to construct models that corresponded to the true configurations of bodies in the heavens—that is, the realm from the Moon outward to the spherical circumference of the cosmos—but two models equally accounted for the Sun’s apparent motion: the eccentric model and the epicyclic model. In this talk, I will examine two criteria that mathematicians used to choose between these models: simplicity and equipoise. In the Almagest, Ptolemy appeals to simplicity as grounds for preferring the eccentric model for the Sun’s motion, whereas Theon of Smyrna, a second-century Platonist, ascribed to Hipparchus the use of equipoise as a criterion for preferring the epicyclic model. I will analyze what Ptolemy and Theon meant by ‘simplicity’ and ‘equipoise’, how they used these criteria to adjudicate between competing astronomical models, and why, philosophically, they were concerned with simplicity and equipoise, respectively.

Isaac Todhunter: Historian and Researcher of the Calculus of Variations

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Isaac Todhunter (1820-1884) was a Cambridge mathematician who wrote three books on the history of mathematics. These books were not histories in the modern sense but rather systematic and annotated reports on work in the subject. As such they are a valuable resource for the historian today. They are also of interest in providing a well-documented picture of how the subject was understood by a researcher of the period.

The first history that Todhunter wrote was his 1861 *A History of the Progress of the Calculus of Variations during the Nineteenth Century*. The calculus of variations was a prominent mathematical subject and attracted the interest of British mathematicians. A notable textbook in English was John H. Jellett's 1850 *An elementary treatise on the calculus of variations* (translated into German in 1860). Todhunter himself published a research monograph on the subject in 1871.

Todhunter's 1861 history was cited by a range of researchers, from amateur mathematicians such as social theoretician Francis Y. Edgeworth, to leading authorities in the mathematical field such as Adolph Mayer. Our paper examines various aspects of the reception of Todhunter's book in the decades following its publication.

What Proofs Leave Out: Should Mathematicians Publish their Proof Discovery Processes?
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This paper explores norms related to the discovery, planning, and presentation of proofs in contemporary mathematics. Mathematicians and philosophers of mathematics emphasize the role that planning plays in developing a proof (see, e. g., Schoenfeld 1992; Gowers 2002; Hamami and Morris 2021 and 2024). However, despite the seeming importance of planning, mathematicians often don't reveal elements of their planning processes, such as the examples, conjectures, counterexamples, generalizations, or other insights that led to a proof. Typically, proofs are presented as concisely as possible. We consider potential reasons for norms excluding discovery processes from communications of results and we ask what benefits might emerge from norms of communicating processes of discovery and planning. We suggest that existing norms function well for an expert audience focused on efficient verification and less well for a wider audience of learners seeking understanding. We argue that adopting a norm of communicating proof discovery and planning more broadly may 1) render mathematical practices more accessible to new researchers, 2) foster cross-disciplinary work by making people in one field aware of techniques in another, 3) improve understanding of a given proof itself, and 4) help decenter perceptions of the necessity of "genius" for mathematical discovery.

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From Tags to Totals: A Photographic Survey of Ancient Egyptian Numeration
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Mathematics and writing appear to have developed in a symbiotic partnership, driven by the practicalities of counting and quantitative recordkeeping. Some of the earliest known Egyptian hieroglyphs, such as Predynastic inventory tags discovered in a tomb at Abydos, offer important evidence for the origins of numerical notation. From these primitive tallies, the Egyptian system evolved into a sophisticated additive decimal framework including notation for parts of a whole, i.e. unit fractions. This presentation brings ancient Egyptian hieroglyphic numerals to life by exploring these symbols within their primary material and historical settings through photographic examples documented by the speaker in field sites in Egypt and in museum collections worldwide.

Feminist Critiques of Logic and the Elusiveness of Logical Form

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Feminist philosophers have critiqued formal logic, alleging that it is gendered and functions as a tool of exclusion or oppression. While feminist philosophy of empirical science has received substantial attention, comparatively little work has been devoted to a feminist philosophy of logic. This relative neglect may stem from the tendency to direct critiques of logic and rationality toward other domains within feminist philosophy.

This paper examines feminist critiques of formal logic by focusing on the notion of logical form. I argue that formality admits multiple distinct senses, several of which have been the target of feminist criticism. I identify these senses and show that they are less secure than critics often assume: like other human-made concepts, they are contested, historically contingent, and actively debated within the literature on formality. I further argue that even when a particular sense of "formal" is fixed, logical form itself remains variable. What counts as the "correct" formalization depends on one's explanatory or practical aims, and because such aims can legitimately differ, logical form is not unique. By analyzing both the ambiguity of formality and the purpose-relative nature of logical form, I argue that logic differs significantly from how it is often portrayed in feminist critiques.

Title: "Coordinating" Mathematical Criteria: Why did Huygens and Sluse Solve Alhazen's Problem Again (and Again)?

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This paper offers a historical and philosophical analysis of the exchange between Christiaan Huygens and René de Sluse from 1669 to 1672 concerning their solutions to "Alhazen's problem," the determination of the point of reflection on a spherical mirror given the positions of the eye and the object. Huygens first provided a general solution using analytic geometry, to which Sluse responded, through Henry Oldenburg, with an alternative general solution that he considered superior. This initiated a polite but sustained debate in which both mathematicians produced additional solutions to the problem, based on their different choices of coordinates and the geometric constructions derived from them. While the technical aspects have received scholarly attention, the motivations for repeatedly providing solutions to an already-solved problem remain unexplored. I argue that the repeated formulation of different general solutions, beyond showcasing their mathematical expertise, also reflects their competing views on the proper application of Cartesian mathematics to concrete problems, as well as their interpretations of epistemic criteria such as elegance and simplicity in mathematics. Their correspondence thus serves as an arena where such criteria within the emerging discipline of analytic geometry were articulated and negotiated through actual problem-solving practices.

The Jolly Square Root of Minus One: Tracing the Mathematical Poetics of Khlebnikov in Malevich's Suprematism

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Kazimir Malevich's early twentieth-century artistic movement and philosophy termed Suprematism explicates a view of the known world as finite, calling to break through its shell to arrive at the "realm beyond zero"—the infinite space of nothing. In previous scholarship, I established the critical but overlooked connection between Malevich's "beyond zero" philosophy and Pavel Florensky's analysis of geometry of $\sqrt{-1}$ in *Imaginaries in Geometry* (1922). This paper extends that investigation by identifying a third, catalytic figure in Malevich's milieu: the avant-garde poet Velimir Khlebnikov.

I argue that Khlebnikov is the missing link who sustained the importance of Florensky's ideas on imaginaries for Malevich. A close friend and collaborator, Khlebnikov worked with Malevich on the 1913 opera *Victory Over the Sun*, whose decorations designed by the artist contain elements of Suprematist visual language officially announced in 1915. Furthermore, Khlebnikov's poetry is imbued with mathematical

symbolism, often referencing√-1—he even christened himself “a jolly square root of minus one.” By analyzing these literary and biographical intersections, this paper demonstrates how Khlebnikov provided the poetic and conceptual reinforcement necessary for Malevich to integrate Florensky’s mathematical abstraction into his Suprematist artistic philosophy.

All units are unequal, but some are more unequal than others

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In a gaggle of geese, each goose is spatiotemporally distinct from all the other ones. However, since numbers are supposed to be abstract entities, we can't tell them apart via physical properties. And yet, virtually every definition of numbers since ancient Greece frames these as being a multiplicity of units. This begs the question of how we can tell the units that make up numbers apart. As Lavers (2020) convincingly argues, this question was first raised in Zeno's paradox of the one and the many and occupies a central part of Frege's (1884) Grundlagen.

Unfortunately, Frege's answer relies on Platonism, which struggles with Benacerraf's (1973) challenge.

In this talk, I propose to explore how psychology can answer this puzzle via the notion of chunking (Gobet et al. 2015; 2016). I argue that the units we label with numerals are chunks, and that seeing chunks as subjectively meaningful units (Baddeley et al. 2017) allows us to reconcile the abstract character of numbers with there being differences in the units that compose them. The idea is that our mental individuation of counting units via culturally-developed conventions that regulate numeral systems is what sets them apart, rather than anything in the units themselves.

Stefan Banach (1892-1945) and the Lwów Mathematical School

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Stefan Banach (1892-1945) was a highly influential Polish mathematician known in particular for popularizing the notion of a Banach Space, or an “espace du type B” as he called it. This presentation will celebrate Banach's remarkable life, his work, and especially his place in the vibrant Lwów (Polish) Mathematical School of the interwar period. At the legendary Scottish Café in Lwów, Banach and his colleagues would scribble ideas on marble tabletops, giving rise to the famous “Scottish Book” of problems. Stanisław Ulam contributed the greatest number of problems (55) to the Scottish Book, translated the Book to English and later worked on the Manhattan Project. Stanisław Mazur contributed 43 problems to the Book. One of these was Problem 153 (1936) for which he offered a prize of a live goose for a solution. This famous goose was awarded to the solver Per Enflo 36 years later. Hugo Steinhaus famously "discovered" Banach randomly in a public park in 1916, contributed the last problem to the Scottish book in 1941, and helped to establish the Banach-Steinhaus theorem, also known as the Uniform Boundedness Principle. We will consider the lives and works of Banach, Ulam, Mazur, Steinhaus and others.

Applying Mathematics By Fitting Descriptions: The Case of Borsuk-Ulam and the Necklace-Splitting Problem

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Literature on the "puzzle" of applied mathematics, particularly following Eugene P. Wigner's 1960 paper "On the Unreasonable Effectiveness of Mathematics in the Natural Sciences," has often focused on mathematics applied to "the world." I argue that this focus is based in a basic, distorting "difference framing" whereby the "puzzle" of applied mathematics arises from a supposed general ontological difference between mathematics and the world. In this paper, I advocate a different approach to applied mathematics, one which focuses on the many "gaps" which exist between a piece of mathematics and that to which it is applied, in particular how practitioners cross such "gaps." My central case is one where one piece of mathematics is applied to another piece of mathematics, Noga Alon and Douglas West's 1986 paper where

they use of the Borsuk-Ulam Theorem (from topology) to provide a solution to the Necklace-Splitting Problem (from combinatorics). I draw several lessons from this case. First, I argue that this case demonstrates a variety of strategies the authors use for crossing "gaps" between the theorem they apply and the problem they solve. Second, I argue that this case shows the fertility of studying math-math in addition to math-world applications.

Geometry in Jerusalem Prior to the Fall: Findings from Jerusalem's Absalom Pillar
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The fall of Jerusalem to the Romans in 70 CE resulted in mass devastation, including the destruction of the Second Temple, significantly diminishing the number of its first century CE monuments available for direct geometric analysis. However, the Absalom Pillar is a notable exception. The approximately 20 metre tomb is situated in Jerusalem's Kidron Valley adjacent to the Temple Mount. My preliminary geometric analysis of the tomb's exterior in 2013 yielded a complex geometry showing its designer's familiarity with Archimedes' works *Measurement of a Circle* and *On the Sphere and Cylinder*. However, the analysis was tentative awaiting translation of Nahman Avigad's definitive work on the Pillar from 1954 (written in Hebrew) that gives precise measurements. With translations now available, the 2013 tentative findings from the tomb's exterior are revisited. While much of this earlier analysis is confirmed, a more involved mathematics is employed in the near cubes, rectangular blocks, and cylinder comprising the monument. A geometric analysis of the tomb's *interior* is then presented for the first time. This reveals an elaborate geometry in the tomb's inner chamber (including its ceiling image and arcosolia), staircase, and landing. These additional findings provide an important window on first century mathematics in Jerusalem.

L'intuitionnisme brouwérien face au problème de l'existence en mathématiques .
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S'il y a bien un temps où le dialogue philosophie-science est appelé à être des plus fructueux, c'est certainement lorsque l'histoire en vient à imposer à une discipline scientifique l'interrogation épistémique de ses propres fondations. En mathématiques, cette opportunité d'une rencontre féconde entre philosophie et science a été occasionnée, entre la fin du XIXe s. et le début des années 1930, par le grand débat fondationnel qu'a suscité la Grundlagenkrise. Ce qu'a révélé cette crise des fondements, c'est qu'à la question épistémologique « quels raisonnements peuvent légitimement mener à des connaissances en mathématiques ? » aucune réponse ne pourrait être donnée si préalablement aucune conception philosophique n'est à même de résoudre, avec satisfaction, le problème de l'existence mathématique. Or, face à ce problème ontologique, deux solutions antagonistes, aujourd'hui devenues classiques, ont fait écoles aux XXe et XXIe s. Il s'agit de celle logico-formelle, défendue par Hilbert et Poincaré, ainsi que de celle intuitionniste, imputable à Brouwer. Cependant, le criterium brouwérien d'existence, qui définit la vérité en mathématiques par sa constructivité, est-il seulement ontologiquement justifiable ? À en croire l'ontologie aristotélico-thomiste, non ! Cet impair commis par l'intuitionnisme reposerait sur une confusion entre deux types de questions bien distinctes (la quæstio an sit vs la quæstio quid sit) et mettrait ultimement à mal le programme brouwérien.

Integer Sums in Hebrew Mathematics (12th-16th Century): Methods, Proofs, and Cross-Cultural Connections
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The calculation of integer sums—including arithmetic and geometric series, as well as sums of squares, cubes, and higher powers—has fascinated mathematicians across cultures and centuries. While early approaches relied on figurate-number representations and trial-and-error methods, the development of rigorous proofs of sum formulas marked an important advance.
This talk examines how Jewish mathematicians from the 12th to the 16th centuries contributed to this tradition through their Hebrew arithmetic texts. First, a general survey of how sums of integers are

calculated in the extant Hebrew manuscripts from this period will be presented. Then we will focus in depth on two important figures—Gersonides (14th century) and Elijah Mizrahi (16th century)—whose proof techniques offer new insights into medieval mathematical reasoning. Their works include pre-inductive reasoning methods that anticipate modern mathematical induction, pre-algebraic language developed in the absence of symbolic notation, and, in Gersonides' case, the use of diagrams as an explanatory tool.

The presentation also identifies connections between these Hebrew texts and contemporary Islamic mathematical traditions, suggesting promising directions for future comparative research that could reveal how mathematical knowledge was disseminated across cultures.

Title: The Practical Approach to Motion Theory: Tartaglia's Imperfect Ballistics

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Niccolò Tartaglia was a mathematician in Renaissance Italy. His 1537 *Nova scientia* started a theory of ballistics for the first time in history, trying to solve the farthest-shot problem, and came up with a mathematical science of projectile motion. Despite the popularity of this theory, it is problematic in many ways, the most striking being the obviously wrong trajectory curve and the self-contradicting physical explanation. However, Tartaglia was well aware of the imperfection of his theory. For the specific ballistic problem he was facing, an instructive theory for practice was much more useful than a precise mathematical theory or a rigorous physical explanation. In comparison, Galileo's physico-mathematical theory could describe motion in an accurate and elegant manner, resulting from years of effort and special training; Tartaglia didn't care about metaphysical limits and accuracy, aiming only for usefulness and simplicity. As a "superior artisan", Tartaglia's approach represents a practical, bottom-up solution to solve newly emerging problems in the Renaissance period. This ultimate pragmatism and unjustified use of mathematics in physics are the key points to read his achievements, and also the results of his background of practical knowledge and the general milieu of the practical scope of Renaissance sciences.

Writing the History of Pre-Modern Geometry and Trigonometry

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Much of the movement toward current historiography of mathematics was galvanized by an incendiary critique by Sabetei Unguru in 1975, questioning portrayals of Euclidean geometry by leading figures at the time such as Neugebauer and van der Waerden. Since then, historians have gradually adjusted their methods and presentations to capture the historical actors' categories, rather than our own. Trigonometry, emerging from geometry to serve astronomy, is especially sensitive to these issues: it bridged these two mathematical disciplines and allowed numerical computations to interact with geometry. The challenges intensify when the subject is taken up in medieval India and Islam, the former approaching geometry very differently, and the latter developing classifications of magnitudes distinct from Euclid. The fact that the word "trigonometry" itself was not even coined until the Renaissance, after all these developments occurred, highlights the challenge of writing about a subject that, in a sense, did not yet exist

Mathematical Explanation in Henkin's Proof of Completeness

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This paper examines Baldwin's insightful study of proofs of completeness, in which he argues that Steiner's account of mathematical explanation can be modified by expanding the idea of a characterizing property to count Henkin's proof of the completeness theorem as explanatory. I endorse both Baldwin's assessment of the significance of Henkin's proof in the development of model theory and the idea that the proof may be said to be explanatory. However, it is not so clear that the reasons that it is explanatory are captured by extending Steiner's notion of a characterizing property of an object to the characterizing property of a proof. Moreover, the sort of depth Baldwin locates in the proof does not fit neatly into the most natural way of interpreting Steiner's ideas about explanation.

I observe that various concepts of explanation in the literature seem to be conflated in Baldwin's discussion and draw upon work on scientific explanation to identify some distinctions between different types of explanation in mathematics. I then make use of this to argue that Henkin's proof of completeness contributes to our understanding at least in part via its organizational features, rather than by referencing a characterizing property.

The Evolution of College Algebra: An Analysis of Textbooks and Curricula of the Early 20th Century
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Do courses create the textbooks with the material they require, or do textbooks dictate what is taught in the course? This presentation will report on the first half of a larger project analyzing the contents of most College Algebra textbooks used in the United States from 1888 to 1930, in order to understand reform efforts and the environment in which mathematics teaching existed. The critics of mathematical education of the early 20th century (inside and outside of the mathematical community) and the uninvited intervention of the College Entrance Examination Board (ca.1901) will be considered, with an examination of changes in textbook topics and a reduction of textbook size throughout the era. Did textbook authors respond to the criticisms and recommendations of the time and make thoughtful edits, or simply chop away material not explicitly covered on the exam? Are the curricular changes we see an early example of "teaching to the test"? And how did these changes influence the future of College Algebra courses in the U.S.?

Sri Lankan Brahmi Numerals as Precursor to Place-Value Notation and as a Multiplicative and Additive System
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In the 3rd century BCE, Sri Lankan scribes used Brahmi numerals alongside the Brahmi script. These numerals, ancestors of modern decimal sets such as the Hindu-Arabic and East Hindu-Arabic numerals, included symbols for 1–9, 10, 20, 30 ... 90, 100, and 1000, but lacked a symbol for zero. Neither Sri Lankan nor Indian Brahmi had positional notation, though the later invention of zero in India officially during the 3rd–6th centuries CE marked a turning point in mathematics. While Indian and Sri Lankan Brahmi numerals were broadly similar, distinct differences existed, particularly in the symbols for seventy, hundred, and thousand.

Indian Brahmi, attested in the Nanaghat cave inscriptions (c. 250 BCE), used an additive system. Large values were expressed through ligatures combining signs for hundred or thousand with smaller values. By contrast, Sri Lankan Brahmi evolved beyond this additive method. Inscriptions reveal a gradual shift toward multiplicative and additive practices. For instance, the Sithulpauva inscription (1st century CE) still used ligatures, but by the 1st century CE, scribes wrote four thousand with four separate thousand signs. A clearer innovation appears in the Bakki alla inscription, where seven hundred is expressed as "seven × hundred," written both in numerals and words, showing deliberate use of multiplication. Alongside this, the Karisa sign, denoting an area unit, functioned as a separator, helping distinguish numeral columns—an early step toward place-value representation. Indian Brahmi inscriptions, in contrast, merely left spaces between ligatures.

After 400 CE, numerals largely disappear from Sri Lankan rock inscriptions, but the tradition continued in later scripts. Sinhala Illakkam, in use during the Kotte and Kandy periods, retained the multiplicative-additive principle. It appears in official contexts, notably in the 1815 Kandyan Convention, where its numerals numbered the Sinhala paragraphs of the treaty ceding rule to the British. Like earlier Brahmi forms, Sinhala Illakkam lacked zero. A parallel development, Lith Illakkam (Astrological digits), also derived from Brahmi, was used in horoscopes and calculations. Several palm-leaf manuscripts preserved in the Kandy Museum attest to its use between 1600 and 1750. Unlike Sinhala Illakkam, Lith Illakkam introduced a symbol for zero—*Halant or Halantha*—integrating a positional element into the system.

The evidence suggests that Sri Lankan Brahmi numerals were not a static borrowing from India but an evolving system experimenting with multiplicative notation and separators. This trajectory set the groundwork for later Sinhala numerical traditions and anticipated elements of positional notation and zero. They produced a complete place-value system as Lith Illakkam, the Sri Lankan innovations—especially the explicit use of multiplication and the Karisa sign as a column marker—represent a significant step toward that development.

This paper compares Sri Lankan and Indian Brahmi numerals, outlining their similarities and differences, and traces the evolution of Sinhala and Lith Illakkam between 300 and 800 CE. It argues that Sri Lankan Brahmi was gradually advancing toward a positional notation, bridging the additive system of Indian Brahmi and later numerical innovations in South Asia.

Using the Past to Visualize the Present
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The use of primary source projects (PSP) – either in class or as individual work outside of class – give students in introductory statistics or data science courses the opportunity to think about the meticulous mathematics need in previous centuries to make sense of data. Conversation about the drift from tables of data to pictures lead to connections between statistics and social trends long before quantitative information was readily available to non-mathematicians and scientists.

How did Florence Nightingale create the polar area diagram from the British Army's Hospital Data without a computer? Where did William Playfair get the economic data for his use in bar charts, histograms, and time series plots? Even the 20th century brought some amazing, noncomputerized examples that are still standard fare in textbooks and the media. Nightingale's creation has not survived the century and a half, but Playfair's have shown no signs of falling out of favor after two centuries.

The influence of these pioneers in data visualization can be seen in many of the most modern graphics created today. Recognizing the past in the present is a real-world connection that engages many of my students. Maybe yours too.

Torricelli's Puzzling Proof of the Quadrature of the Cycloid
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This talk will consider the computations on the quadrature of the cycloid done by Evangelista Torricelli (1608-1647). His computations were completed sometime before April 1643 when Bonaventura Cavalieri sent a letter to Torricelli congratulating him on his findings. Torricelli's results were published in an appendix in his *Opera Geometrica* (1644). He provides three different computations for the area under the cycloid and consistent with the mathematical practice of the period, all three proofs rely heavily on geometry. The Latin describing one of the proofs is vague and raises some interesting questions about the details of Torricelli's logic. This talk will explore more than one way to understand how Torricelli completes with proof.