The Mathematical Imagination

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Humanists are learning mathematics—again. Amidst a renewed sense of crisis in literary, cultural, and language studies, many humanists have turned to mathematics and digital technologies based on mathematical processes in hopes of modernizing and reinvigorating humanistic inquiry. Literary, cultural studies, and media studies scholars as well as historians are using algorithms to read novels, making digital maps to plot the geographies of films, using online tools to annotate and publish texts collaboratively, and applying other computational technologies to explore historical and literary records. According to proponents of such new methods, the so-called digital humanities promise to bring the analytic power of computation to bear on the study of culture and the arts, lending the humanities a more public face and, thus, renewed relevance in the early twenty-first century.

Of course, not everyone shares the digital humanists’ enthusiasm and optimism. One recent op-ed in The Atlantic alleges that the digital turn in the
humanities simply reacts to economic worries about funding increases in and administrative emphasis on STEM fields (science, technology, engineering, and mathematics). The proposed digital rejuvenation of the humanities threatens to forfeit precisely what the critical study of art, literature, and history offer our advanced scientific society: access to concepts such as understanding and empathy that, by their very nature, resist quantification. Indeed, other critics of the digital humanities worry that, beyond not bringing anything essentially new to humanistic inquiry, the climate around the digital, in fact, eschews the rigorous historical research and critical discourse central to the humanities. If the digital humanities embrace the tech industry, do the humanities not also acquiesce to the merger of technology and industry, whose mechanisms of manipulation and control critical theory seeks to expose and oppose?

What often goes unacknowledged in these contemporary debates is the long history of similar disagreements over epistemology that date back to the very inception of critical theory. As Max Horkheimer (1895–1973) and Theodor W. Adorno (1903–1969) first conceived of it in the 1930s, critical theory steadfastly opposed the mathematization and quantification of thought. For them, the equation of mathematics with thinking, embraced by their intellectual rivals, the logical positivists, provided the epistemological conditions leading reason back into the barbarism and violence that culminated in World War II and the Holocaust. However, the fact that Horkheimer and Adorno interwove mathematics with the dialectics and downfall of enlightenment obscures how mathematics provided some of their intellectual forerunners and friends—Gershom Scholem (1897–1982), Franz Rosenzweig (1886–1929), and Siegfried Kracauer (1889–1966)—with concepts, metaphors, and tools that helped negotiate the crises of modernity. Although Scholem, Rosenzweig, and Kracauer are not often counted as critical theorists, we can find in their work the potential for theory that is at once mathematical and critical. In particular, their theories of aesthetics, messianism, and cultural critique borrow ideas from mathematical logic, infinitesimal calculus, and geometry to theorize art and culture in ways that strive to reveal and, potentially, counter the contradictions of modern society. By revisiting and rethinking the origins of critical theory, this book seeks to recapture the potential contribution that mathematics holds
for the critical project. To understand the influence of mathematics on Scholem, Rosenzweig, and Kracauer is to uncover a more capacious vision of critical theory, one with tools that can help us confront and intervene in our digital and increasingly mathematical present.

The Eclipse of Mathematics in Critical Theory

In 1935, Edmund Husserl saw the world of reason that he had helped construct crumbling before him. A founder of the philosophical school of phenomenology earlier in the century, Husserl held a series of lectures that year in Prague recounting how, over time, the positivistic special sciences had eliminated all the genuine problems of reason—the question of rational knowledge, the ethics of truly good action, and the notion of values as values of reason. At some point, Europeans had traded a mode of thinking genuinely concerned with reason, ethics, and values—the basic questions of humanity and their meaning in life—for the facts of science and the formulae of mathematics. First published in Belgrade as “Die Krisis der europäischen Wissenschaften und die transzendentale Phänomenologie” (“The Crisis of the European Sciences and Transcendental Phenomenology,” 1936), these lectures took on a very different tone than Husserl’s other introductions to phenomenology, not least because they could not be delivered or published in Nazi Germany (Husserl was of Jewish descent). Instead of the “Age of Enlightenment” producing the great philosophers to whom Husserl had turned in Cartesian Meditations (1931), it now appeared as if the advent of the mathematical natural sciences in the Enlightenment had been the progenitor of a radical turn away from reason in philosophy, manifest in a new type of thought that threatened to “succumb to skepticism, irrationalism, and mysticism.” For Husserl, stripped of his German citizenship and removed from the roster at the University of Freiburg, the ramifications of the situation were undeniable. This was not merely a crisis in the natural sciences or philosophy but a fundamental problem with knowledge and reason as such, as implied by the broader German term Wissenschaft (literally, body or collection of knowledge). And yet Husserl thought crisis could still be avoided and Europe could still be saved, but only if, as he put it in the
preface to the 1936 publication, the heirs of the Enlightenment embraced “the unavoidable necessity of a transcendental-phenomenological re-orientation of philosophy.”\textsuperscript{7} Husserl died in April 1938; a year later, Germany invaded Prague on its way to total war.

Europe and its sciences had, of course, been in crisis for decades. A “crisis of language” (\textit{Sprachkrise}) had plagued the intellectual life of fin-de-siècle Vienna, inspiring the work of poets such as Hugo von Hofmannsthal, cultural critics such as Fritz Mauthner, and philosophers such as Ludwig Wittgenstein. For these thinkers, language no longer offered a reliable means of capturing and communicating experience and thought, the more problematic aspects of which Wittgenstein famously recommended that we pass over in silence.\textsuperscript{8} In 1922, the idea that history called into question the state, morals, and religion, instead of providing their justification, signaled to Ernst Troeltsch a “crisis of historicism” (\textit{Krise des Historismus}).\textsuperscript{9} For Troeltsch and others, the idea that there might be no moral position that transcends its historical context implied that the writing of history drew instead on values relative to cultures and individuals. In mathematics, the publication of the paradoxes in set theory earlier in the century unleashed a debate, a “foundations crisis” (\textit{Grundlagenkrise}) over the philosophical foundations of mathematics, which by the late 1920s had already entered philosophical parlance with no sign of resolution.\textsuperscript{10} And in 1933, amidst the growing catastrophe of Nazism in neighboring Germany, Hans Hahn, an Austrian mathematician of Jewish descent, diagnosed a “crisis of intuition” (\textit{Krise der Anschauung}) in mathematics as well, as mathematicians produced results that contradicted the hegemony of visual intuition.\textsuperscript{11} Just a few years later, by the time Husserl delivered his lectures in Paris and Prague, the implications and potential consequences of this latest crisis in Enlightenment thought—in terms of politics, reason, and the relationship between the two—had become much more severe.

For Husserl, the crisis in the European sciences was no less than a crisis in reasonable society as a whole. At stake was “civilization” based on human values and thoughts, “a rational civilization, that is, one with a latent orientation to reason.”\textsuperscript{12} The creation of such a rational civilization had been the initial, utopian hope of a universal, mathematical science—the dream of a means to calculate all thought as if it were mathematics in Gottfried Wil-
helm Leibniz’s *characteristica universalis* and of a unified science of nature and culture in Francis Bacon’s *scientia universalis*. Indeed, as Husserl notes, such hopes manifested themselves in the eighteenth century as the Enlightenment sought to reform education, society, and political life. But in 1935, a time far removed from the Enlightenment, Husserl’s alarm pointed to a shift in what the sciences meant in Western European society: due to the prosperity that they had produced, the mathematical natural sciences had become the “total world-view of modern man,” culminating in an “indifferent turning-away from the questions which are decisive for a genuine humanity.”

Husserl asserted that, instead of fostering reflection on the value and meaning of human existence, a pressing matter in 1930s Germany, the “fact-minded sciences [made] merely fact-minded people.” In 1917, the German sociologist Max Weber resigned himself to the idea that science no longer offered insight into the general conditions of modern life. Two decades later, the ever-worsening political situation meant, for Husserl, that the task of philosophy now lay in locating and correcting the moment at which this totalized, scientific worldview had gone astray.

In Husserl’s eyes, this crisis represented not a sudden change in how people understood humanity as ushered in by the rise of authoritarianism in Germany, but rather a change that had taken root centuries before, in the work of Galileo. What was decisively new with Galileo was the idea that the limited application of geometry to astronomy could be extended to the world as the “mathematization of nature,” in which “nature itself is idealized under the guidance of the new mathematics; nature itself becomes—to express it in a modern way—a mathematical manifold.” Galileo’s transformation of nature into mathematics thus became the success story of the modern sciences. What worried Husserl, however, was the epistemological and methodological transformation implied by the mathematization of nature, a change driving the crisis of knowledge in the 1930s: “We must note something of the highest importance that occurred even as early as Galileo: the surreptitious substitution of the mathematically substructured world of ideals for the only real world, the one that is actually given through perception, that is ever experienced and experienceable—our everyday lifeworld. This substitution was promptly passed on to his successors, the physicists of all the succeeding centuries.” One feels the urgency in Husserl’s
tone—the only real world; the text continues: “What was lacking, and what is still lacking, is the actual self-evidence through which he who knows and accomplishes can give himself an account, not only of what he does that is new and what he works with, but also the implications of meaning which are closed off through sedimentation or traditionalization, i.e. of the constant presuppositions of his own constructions, concepts, propositions, theories.”¹⁸ A number of elements in these two passages resonate with contemporary readers, especially with critical theorists. We register not only a deep ambivalence toward the total mathematization of “our everyday life world” but also how this foundational shift exchanges knowledge as the comprehension of meaning in “the only real world” for inquiry into mathematized nature. Moreover, as this change passes from physicist to physicist we recognize the reification of this unspoken shift, the transformation of historical choices into the way we interpret nature itself. For Husserl, this link between the mathematization of nature and the ever-worsening situation in Germany and across Europe was not explicitly causal. Instead, it provided the conditions to understand and, potentially, return to and correct the point at which we began to foreclose the investigation of our everyday life world and the consequences of that for humanity.

For Horkheimer and Adorno, however, the connection between the mathematization of nature and the crises in Europe in the twentieth century was causal. By the time Husserl died in 1938, Horkheimer and Adorno were already living in the British and American exile from which they wrote texts foundational to the canon of critical theory: “Traditional and Critical Theory” (“Traditionelle und Kritische Theorie,” 1937), *Dialectic of Enlightenment* (*Dialektik der Auflärung*, 1947), and *Minima Moralia* (1951). For these two exiled German-Jewish philosophers and social theorists, the mounting catastrophe in their former homeland was not the result of a deviation from the core questions of reason but the product of reason, of so-called enlightened society itself.¹⁹ As Galileo symbolized this transformation for Husserl, Francis Bacon personified in *Dialectic of Enlightenment* the duality of reason. He exemplified “the scientific temper that followed him. The happy marriage between human understanding and the nature of things that he had in mind is patriarchal: the understanding, which conquers superstition, is to rule over demystified nature.”²⁰ This linkage was the troublesome promise
of enlightenment—taken to mean reason (Vernunft) as well as the Enlightenment as a historical period; both forms of enlightenment supplant mythological explanations of the world, but do so in a way that violently subordinates nature in order to control it. For the first generation of critical theorists, the technology of cinema embodied this ambiguous potential of modernity and enlightenment.\textsuperscript{21} Mathematics did too, offering the cognitive tools that expanded not only knowledge but also domination from the historical Enlightenment to the present day: “Before and after quantum theory, nature is what can be grasped mathematically; even what cannot be assimilated, insoluble and irrational, is fenced in by mathematical theorems.”\textsuperscript{22} Like the compass, the cannon, and the printing press, mathematics became an instrument with which reason could formulate, calculate, and, hence, control the world and all that exists in it.

The emergence of critical theory in the works of Horkheimer and Adorno thus shifted how theoreticians of culture and art thought about mathematics. For Horkheimer and Adorno, the proposed equation of mathematics with thought by the logical positivists in the 1920s represented the most recent example of the return of enlightenment to barbarism and violence, exemplified by Odysseus’s self-restraint to hear the Sirens’ song, Bacon’s equation of knowledge with power, and the culture industry’s manipulation of the masses. In the period of Horkheimer and Adorno’s self-staging of critical theory in the 1930s and 1940s, an intellectual narrative emerged that saw in mathematics not the emancipation, knowledge, and freedom once promised by enlightenment, but rather its relapse into restriction, coercion, and subjugation. This is how mathematics appears in Horkheimer and Adorno’s collaborative work: “With the forfeiture of thought, which in its reified form as mathematics, machine, and organization exacts revenge on humans forgetful of it, enlightenment renounced its own realization. By subjugating all particulars to its discipline, it [enlightenment] granted the uncomprehended whole the freedom to fight back as mastery over things against the being and consciousness of humans.”\textsuperscript{23} By 1935, mathematics pointed Husserl to the aborted realization of the Enlightenment evident in a crisis of reason that materialized for Horkheimer and Adorno in their forced exile. By the end of World War II, the mathematization of thought and nature had become a central factor in answering the question of why “humanity, instead
of entering a truly human state” was “sinking into a new kind of barbarism,” which the destruction of Europe and the attempted annihilation of the European Jews only confirmed. Indeed, Horkheimer and Adorno’s association of mathematics with a regressive vision of thought became an enduring mode of presentation for critical theorists such as Herbert Marcuse and Jürgen Habermas, for whom mathematics symbolized naïve positivism and a mode of social and economic conformity. In the earliest phase of critical theory’s development and deployment, the choice facing modern thought seemed clear: either it could expose and resist societal mechanisms of control and domination, an assignment called critical theory, or it could continue to mimic the expedient symbols and operations of mathematics, seemingly indifferent to the fate of humanity.

And yet even the briefest look back into critical theory’s intellectual origins, let alone the ideas and letters of the broader German-speaking world in the early twentieth century, challenges the narrative that mathematics must work in opposition to the concerns of humanity. For instance, whereas for Husserl the mathematization of nature vanquished reason from reality, for Siegfried Kracauer the mathematical study of space—geometry—bridged the void between materiality and pure reason. In Kracauer’s essays written during the Weimar Republic, the material logic of mathematics informed his readings of mass culture, which sought to advance, rather than oppose, the project of the Enlightenment. For him, geometry enabled a literary approach to cultural critique in which the work of the critic helped confront the contradictions of modernity and, through such confrontation, potentially resolve them. Whereas for Horkheimer and Adorno the mathematization of thought typified the return of enlightenment to barbarism, for Gershom Scholem the philosophy of mathematics dealt with the problem of language at a moment of cultural crisis by omitting representation. This exclusion revealed, at least to Scholem, configurations of language that captured historical and religious experiences whose extremity exceeded language’s limits. Following mathematics’ lead, restricting representation in poetic language symbolized, as a negative aesthetics, the inexpressibility of the privations of life in exile. And, for Franz Rosenzweig, infinitesimal calculus circumvented the enigma of the infinite, revealing a messianism that brought the messianic moment into the here and now. “Mathematics,”
Rosenzweig writes in *The Star of Redemption (Der Stern der Erlösung, 1921)*, “is the language of that world before the world.” Where empire and war had dissolved the relationships among God, the human, and the world, the austere symbols and mute signs of mathematics offered Rosenzweig a means to reformulate their interconnections. Rosenzweig’s messianism and messianic theory of knowledge made human action, belief, and critical thought the motors of achieving emancipation in the real world, restoring to them the same epistemological significance as mathematics.

By tracing this as yet unacknowledged lineage of critical theory, this book explores the underdeveloped possibilities that mathematics held—and still holds—for theories of culture and art. Thanks to contemporary scholars such as Martin Jay, Andrew Feenberg, and Susan Buck-Morss, we know that the intellectual origins of critical theory lie in Sigmund Freud and psychoanalysis, in George Lukács’s adaptation of the concept of reification from Karl Marx, and in Walter Benjamin’s theorizations of language. I wish to build on these histories of critical theory by returning to the origins of the critical project and recovering a critically productive vision of mathematics in the work of Scholem, Rosenzweig, and Kracauer. This is about more than thinking of the intersections of mathematics, culture, and art in terms of the apparent aesthetic beauty and elegance of a mathematical proof, for example, or of the historical moments at which artists have drawn inspiration from the abstractness of mathematics. In the works of these German-Jewish thinkers, two much more complicated intellectual visions of the relationships among mathematics, culture, and art emerge: one vision—in Horkheimer and Adorno’s early vision of critical theory—that sees in mathematics the destructive force of reason and another vision that, about two decades earlier, finds in mathematics methods of navigating the modern crises of the Enlightenment. One of the primary claims of this book is that revisiting these intellectual narratives enables us as critical theorists to rethink how we approach mathematics—not as an antithesis to humanistic inquiry, but instead as a powerful and timely mode of intervening in the worlds of culture and aesthetics.
Introduction

Defining a Program of Negative Mathematics

For Scholem, Rosenzweig, and Kracauer, the very austerity and muteness of mathematics revealed pathways through apparent philosophical impasse, a chance to realize the Enlightenment’s promise of inclusion and emancipation as it seemed to disappear in early-twentieth century Germany. Building on the thought of these three lesser-known German-Jewish intellectuals of the interwar period, I propose an understanding of mathematics that can help move past today’s debates that pit the humanities against the sciences. By locating in mathematics a style of reasoning that deals productively with that which cannot be fully represented by language, history, and capital—what I call negative mathematics—the work of these three German-Jewish intellectuals illuminates a path forward for critical theory in the field we know today as the digital humanities. Here negative mathematics refers neither to the concept of negative numbers nor to the infamous image of Adorno and other members of the Frankfurt School as unremittent naysayers. Instead, it offers a complement to the type of productive negativity that Adorno in particular located in the Hegelian dialectic. We can think of negative mathematics as negative in terms of mathematical approaches to issues of absence, lack, privation, division, and discontinuity. One example of such negativity that we will repeatedly encounter in this book is how mathematics develops concepts and symbols to address ideas that, in some accounts, human cognition and language cannot properly grasp or represent in full, such as the concept of the infinite or even the nature of mathematical objects themselves. For Scholem, Rosenzweig, and Kracauer, these mathematical approaches to negativity provided the generative spark for theorizing culture and art anew, where inherited modes of philosophical and theological thought no longer applied to modern life. Negative mathematics thus expands Horkheimer and Adorno’s critical project in spite of themselves, introducing avenues for critical thought that treat mathematics as a crucial cultural and aesthetic medium.

In the work of Rosenzweig, Kracauer, and Scholem, negative mathematics provided a progressive yet critical approach to cultural crises as the secularization of the Enlightenment threatened the particularity of religious life and the rationalization of capitalism exchanged aesthetic experience and po-
litical action for mass entertainment. It was a shared discourse that saw in mathematics’ approach to negativity modes of cultural analysis and intervention. While never a cohesive school or doctrine, we can think of negative mathematics, in the words of Anson Rabinbach, as “an ethos in the Greek sense of a characteristic spirit or attitude (*Haltung*).” As an intellectual ethos, negative mathematics was critical, in the Kantian sense of the term, in that it sought to address and correct the shortcomings and contradictions of reason manifest in language, religion, and mass culture. But negative mathematics was also critical in the sense in which Horkheimer redefined the term in the 1930s: For Scholem, Rosenzweig, and Kracauer, negative mathematics meant “not just the proliferation of knowledge, but rather the emancipation of humans from enslavement.” By examining concepts such as language and redemption, negative mathematics allowed these thinkers to refashion them in order to take account of experiences, beliefs, and perspectives otherwise marginalized by mainstream society. Negative mathematics emerged in the brief yet profound window of cultural activity between the World Wars in Germany, at a point when the prospect of realizing an inclusive, self-reflective society—the goal of the Enlightenment—still seemed to exist. The approach faded to the margins of critical theory as mathematics became, in the work of Horkheimer and Adorno, a key accomplice in the return to superstition and violence that was the catastrophe of the twentieth century. In passing over Horkheimer and Adorno’s equation of mathematics with barbarism, critical theory continues to forfeit mathematics as a tool not only to understand but also to act in contemporary society. In the age of quantification and big data, negative mathematics thus helps us confront what remains a priority for critical thought: the critique of and intervention in a digital world through critical analysis that succumbs neither to the naïveté of scientific positivism nor the rejectionism of critique.

Mathematical approaches to negativity have a long history in German-Jewish intellectual life and letters that dates back to the Enlightenment itself and sets the stage for the interventions of Scholem, Rosenzweig, and Kracauer in the interwar period. This prehistory begins with the Enlightenment philosopher Moses Mendelssohn for whom mathematics offered a justification for metaphysics. His essay “On Evidence in the Metaphysical
Sciences” (“Abhandlung über die Evidenz in metaphysischen Wissenschaften,” 1764) argues that mathematics shares with philosophy its mode of analysis, which makes “obscure and unnoticed” parts of concepts “distinct and recognizable” by unpacking and expounding them through chains of inference. Yet whereas mathematics finds impartiality, in that one easily “grasps” (as in the German fassen) its deductions, the truths of philosophy are muddled by the prejudices of the human mind. The essay concludes that “metaphysical truths are capable, to be sure, of the same certainty as mathematics,” even if they are not capable “of the same perspicuity [Faßlichkeit] as geometric truths.” Mathematics thus helped Mendelssohn show that metaphysics rested on stable footing, even if some still refused to accept the validity of its claims. The eloquence of this argument won Mendelssohn the Prussian Academy of the Sciences essay prize in 1763, which helped him gain permission to reside permanently in Berlin—“an unprecedented triumph,” writes Alexander Altmann, “for the son of the ghetto who had arrived in Berlin only twenty years earlier.” For Mendelssohn, and for a number of German-Jewish intellectuals that followed him, mathematics was a point of entry into debates about metaphysics and reason that signified not only a powerful philosophical tool but also a means of inclusion, allowing those of Jewish heritage to participate in the society and culture of the Enlightenment.

For Salomon Maimon, another Jewish philosopher of the German Enlightenment, the latest developments in mathematics intervened in a central debate of the times: the nature of pure reason. As a commentary on Kant’s critical philosophy, Maimon’s Essay on Transcendental Philosophy (Versuch über die Transcendentalphilosophie, 1790) agreed with Kant that the mind plays an active role in constituting the contents of thought, but Maimon claimed that pure reason must originate in thought itself and not draw on the world of experience, as Kant had suggested. According to Maimon, we can think of the pure generation of thought as following not from experience but rather from the intellectual tools employed in infinitesimal calculus that Leibniz and Newton had developed in the previous century to calculate motion in the new mechanics. Their calculi hinged on the idea of infinitely small increments that Leibniz had called differentials; these infinitesimal quantities allowed Leibniz to calculate the rate of change of a
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curve. For Maimon, the differential provided the origin of pure cognition as a medium between experience and thought. “Sensibility,” he writes, “provides the differentials to a determined consciousness; out of them, the imagination produces a finite (determined) object of intuition; out of the relations of these different differentials, which are its objects, the understanding produces the relation of the sensible objects arising from them.” Reason appeals not to experience, but rather to how the differentials present experience to the mind as a set of relations, out of which thought can construct pure knowledge. For Maimon, mathematics bridged the seeming impasse between experience and transcendental philosophy but signified more than just an interjection into an ongoing philosophical debate. Alongside the natural sciences, mathematics had played a key role in Maimon’s decision to move from a life governed by Jewish orthodoxy in the provinces of Polish Lithuania to an “emancipated” life in cosmopolitan Berlin. Indeed, mathematics allowed him not only to sustain himself in Berlin as a tutor but also to participate in the city’s enlightened circles through his Essay on Transcendental Philosophy.

Almost a century later, mathematics again provided the keys to pure thought for the German-Jewish philosopher Hermann Cohen. The embodiment of the post-Enlightenment spirit of a Jewish synthesis with German culture and the hope for a truly egalitarian Germany, Cohen was the first Jew to hold a full professorship in Germany. Philosophy, he advocated, must be saved from Hegelian speculation via a return to the Kantian tradition of idealism, taking mathematics as the basis for a scientifically grounded metaphysics. As it had for Maimon, infinitesimal calculus offered a method of generating the objects of pure thought without recourse to intuition and experience. In The Principle of the Infinitesimal Method and its History (Das Prinzip der Infinitesimal-Methode und seine Geschichte, 1883), Cohen asserts that pure thought creates the continuous fabric of metaphysical reality (Realität) in the same fashion that, in mathematics, infinitesimal tangent lines can be thought of as producing a curve. The mathematical genesis of the contents of cognition became, in the logic of Cohen’s System of Philosophy, the foundation of the Neo-Kantianism that shaped the German philosophical academy around 1900: “The analysis of the infinitesimal is the legitimate instrument of the mathematical natural sciences. . . . This mathematical
generation [Erzeugung] of movement and, thereby, nature is the triumph of pure thought.” To Cohen, mathematics—and in particular the watershed mathematical developments of the Enlightenment that made the Newtonian cosmos knowable through calculation and prediction—provided the conditions of possibility for pure thought.

In Cohen’s work with mathematics, I recognize something new that would be pivotal for Scholem, Rosenzweig, and Kracauer: a link among mathematics, negativity, and theories of culture and religion. For Cohen, mathematics represented the possibility of pure knowledge that underpinned his concept of a religion of reason, as derived in his posthumously published work Religion of Reason Out of the Sources of Judaism (Religion der Vernunft aus den Quellen des Judentums, 1919). Here Cohen drew on his earlier work, The Logic of Pure Knowledge (Die Logik der reinen Erkenntnis, 1902), in which infinitesimal calculus rendered legible and scientifically operative the pure genesis of thought, “the judgment of origin.” Accordingly, thought originates not in the negation of something (“A” is not “nothing”) but rather in the determination of the positive, infinite possibility for what something (“A”) is not (“nothing”), exemplified by the concept of the infinitely small in mathematics. In Religion of Reason, this mathematical origin of pure thought provided the terms for the pure cognition of God’s attributes. Drawing on the medieval Jewish philosopher Maimonides, Cohen’s final work argues that we have positive knowledge about God through the judgment: “God is not inert [träge].” In the same fashion that the finite line originates in the infinitesimal point in mathematics, we can think of God as the infinite totality of activity, all that which is not inert and inactive (“träge”). Along with Mendelssohn’s and Maimon’s arguments, Cohen’s usage of mathematics here is remarkable. Not just metaphysics but also cultural discourse on religion, if they are to draw on reason, require a method that is both logically certain and self-evident, apodictic and exemplary, and only mathematics fulfills the duality of this task.

Here, I do not devote separate chapters to Mendelssohn, Maimon, or Cohen. Instead, I take their mergers of mathematics with metaphysics and of mathematics with religious and cultural thought, as well as the intellectual possibilities that these mergers opened up for German Jews, as points of departure for negative mathematics in the interwar period.
**Mathematics, Metaphor, and the Experience of Modernity**

This book argues that the contributions that Scholem, Rosenzweig, and Kra-cauer made to the project of critical theory become legible in the thinkers’ deployment of specific sets of metaphors that they drew from mathematics and mathematical approaches to negativity. These sets of metaphors depended on and reflected the diverse branches of mathematics from which they were drawn—a diversity often obscured by the singular and seemingly monolithic abbreviation, *math*. For Scholem, the philosophy of mathematics signified purity, privation, and structures of language lacking representation. For Rosenzweig, infinitesimal calculus implied motion over rest (the absence of motion) and a form of subjectivity that dynamically grasped the otherwise unknown elements of the physical world. And, for Kraeauer, geometry pointed to the concept of space as a bridge across the void separating experience and cognition. Although these metaphors may not all directly embody negativity, their common link to negativity lies in the fact that they were derived from mathematical strategies for dealing with issues of lack, absence, and privation. Signifying mathematical approaches to negativity made these metaphors applicable when issues of negativity became manifest in the cultural and aesthetic sphere. For Scholem, Rosenzweig, and Kraeauer, the metaphors of negative mathematics uncovered the deeper dimensions and illuminated the dark corners of language, redemption and eternity, and the tenuous link between materiality and cognition that, in their work, translated into strategies to confront the intellectual impasses presented by the early twentieth century.

These metaphors represent the critical potential of negative mathematics, but their status as metaphor has also conditioned the exclusion of mathematics from critical and scholarly discourse. As a more delicate interaction between cultural and mathematical thought, the function of mathematical metaphors has been overshadowed, in part, by the polemic equation of mathematics with a restrictive and limited mode of thought by Horkheimer and Adorno’s inception of critical theory and by their subsumption of mathematics into a narrative of enlightenment’s dialectical return to myth and barbarism. But we as scholars have also missed the significance of these mathematical metaphors, because we have viewed them in the pejorative sense as just that—as metaphors, analogies, the remnants of inauthentic
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speech. To grasp the critical potential of negative mathematics, we must think of mathematics less as a simple and limited analogy for a formal methodology and more as a conscious and consequential rhetorical strategy. For Scholem, Rosenzweig, and Kracauer, negative mathematics was not insight provided by some mathematical theorem nor did it function in terms of the figurative power of a lone metaphor. Instead, negative mathematics operated in terms of the conceptual implications that interconnected and governed cohesive sets of metaphors, “metaphorics” to adopt the German term (Metaphorik), drawn from different branches of mathematics. As a metaphorics, the modes of mathematical thinking unique to the philosophy of mathematics, infinitesimal calculus, and geometry corresponded to the distinct influence that each branch of mathematics had on Scholem, Rosenzweig, and Kracauer, resulting in, respectively, an aesthetics of privation, a dynamic messianism, and a materialist form of cultural criticism. As systematic sets of metaphors and not as simply analogies for formalized thought, these metaphorics served as the medium in which ideas could transfer between mathematics and theories of culture and aesthetics.

Paying closer attention to these metaphorics, then, enables us to recover the specific contribution that negative mathematics made for these German-Jewish intellectuals. In taking this approach, I draw on Hans Blumenberg’s study of metaphor, Paradigms for a Metaphorology (Paradigmen zu einer Metaphorologie, 1960), which views metaphor in philosophical discourse as more than just the “leftover elements” of the process of creating philosophy’s clear and distinct concepts. For Blumenberg, philosophical metaphor and, in particular, our study of them, “brings to light the metakinetics of the historical horizons of meaning and ways of seeing within which concepts undergo their modification.” Blumenberg discusses, for example, how a metaphorical shift in the concept of truth precipitated the rise of the modern experimental sciences: the medieval notion of the “mighty” truth required truth to overpower the passive knowing subject, whereas the “hidden” truth of the modern period necessitated the labor of the active intellect to discover, experiment, and know it. Likewise, in my readings of Scholem, Rosenzweig, and Kracauer, it was through the metaphorics that arose around mathematical approaches to absence, lack, and discontinuity that mathematics impacted and shaped cultural and aesthetic discourse. This book
charts the systematic construction and theoretical consequences of metaphors of purity and privation in the philosophy of mathematics, metaphors of motion and subjectivity in infinitesimal calculus, and metaphors of space in geometry. Tracing the implications of mathematical metaphors in the work of these German-Jewish thinkers reveals the moments where mathematics’ approach to negativity expanded the horizons of cultural and aesthetic thought to include minoritarian perspectives, such as ideas that evade representation and the histories of marginalized groups.

For Scholem, Rosenzweig, and Kracauer, negative mathematics intervened at a particularly precarious moment in Jewish intellectual existence in Germany during the early twentieth century. Indeed, the emergence of the metaphorics of negative mathematics in their thought coincided with the end of World War I and the collapse of Imperial Germany, experienced as a world-historical destabilization of philosophical and political authority accompanied by the crises and freedoms that such destabilization afforded. These crises and the sense in the early twentieth century that Jews, despite their legal emancipation in 1812, had never become full members of German society called into question the theological and philosophical modes of social and cultural engagement inherited from the generations of Mendelssohn and Cohen. Amid the growing unease of cultural crisis, negative mathematics showed Scholem, Rosenzweig, and Kracauer paths through these modern crises by offering ways of reconfiguring language, history, messianism, and cultural criticism that worked to realize the emancipatory promise of the Enlightenment. The story of negative mathematics and critical theory is, in other words, a German-Jewish story, not only because the majority of the protagonists were born in Germany of Jewish descent and worked primarily in the German language. It is also a German-Jewish story because the mathematical metaphors developed by these authors addressed concerns of reason, inclusion, and, ultimately, exile and extermination tied to the historical experiences of Jews living in Germany. At stake in investigating negative mathematics, the origins of critical theory, and German-Jewish intellectual life are ways of not only pulling apart inherited philosophical, theological, and cultural categories but also redefining more inclusive visions of them, which Horkheimer and Adorno’s opposition of mathematics and critical theory has tended to eschew.
One of the primary critical categories further illuminated by the metaphors of negative mathematics is the persistent theological dimension of critique, which interlinks the critical project with an insistence on redemption—or, at least, an insistence on the need for redemption. For Scholem, Rosenzweig, and Kracauer, critique was bound up with a refusal that this world, as broken as it appears and is, is all that there is. Since the first histories of the critical project, scholars have emphasized and built upon the “weak messianic” element in critical theory, operative most notably in the work of Adorno and Benjamin.\textsuperscript{51} Even after Auschwitz, critique held hope for the possibility of radical change in the historical process that, especially for the first generation of critical theorists, was located in aesthetics.\textsuperscript{52} The metaphors of negative mathematics, however, reveal the presence of mathematics in this theological register and suggest that mathematics’ differing approaches to negativity can help excavate the deeper layers of critique’s theological impulse. Mathematical logic, for instance, allowed Scholem to rescue marginalized, precarious, and often unspeakable experiences and traditions, such as Judaism, from erasure and oblivion. While scholars have started to pay closer notice of theological concerns of Adorno’s materialism, infinitesimal calculus already served Rosenzweig as a way of attending to and refusing to give up on even the infinitesimal and seemingly insignificant aspects of life, history, and the world.\textsuperscript{53} Finally, the synthesis of materiality and logic in geometry pinpointed perhaps the most tireless theological aspect of the critical project: the idea that the practice of critique is itself a fundamentally redemptive enterprise, centered on the possibility of reason’s intervention into the material conditions of life. As the following chapters explore the development and deployment of negative mathematics in Scholem, Rosenzweig, and Kracauer’s work, readers will recognize these mathematical imprints on the theological dimension of critical thought—not as attempts to expand knowledge for knowledge’s sake, but rather as a means of articulating the emancipatory potential of critique.

Ultimately, the fact that mathematics enabled these German Jews to theorize critical yet also inclusive visions of culture and art points to the relevance of negative mathematics for critical theory in the digital age. For Scholem, Rosenzweig, and Kracauer, negative mathematics was able to re-integrate into theory Jewish perspectives on history, redemption, and cul-
tural critique because it was—and still is—concerned with and essential to a core set of cultural questions and anxieties over the fate of language, the viability of critique, the nature of reason, and the path toward societal emancipation and recognition. Negative mathematics thus helps us in the present conceive of theory that takes advantage of what mathematics (and technologies based on mathematics and quantification) offer analytically, while remaining committed to the critical project. The fact that negative mathematics helped these German-Jewish intellectuals to push past cultural impasses of the 1920s suggests that the potential of digital technologies also lies in allowing underrepresented and marginalized communities, those living in exile, or peoples with more oblique relationships to power to break up and redefine social and cultural categories. Negative mathematics implies that the critical potential of digital humanities lies, as practitioners such as Lauren Klein have shown, in exposing and giving voice to the silences, discontinuities, and modes of exclusion that remain, in part because of digital technologies, in contemporary society. To be sure: recovering negative mathematics is not a return to a once happy marriage between mathematics and cultural and aesthetic theory. Reinstating the productive tensions between mathematics and critical theory—as often competing but not necessarily opposed ways of approaching the cultural problems of the present—is the goal of this book.

Overview of the Book

The following four chapters examine the emergence of the intellectual tensions between mathematics and critical theory and explore negative mathematics as an alternative paradigm for thinking about mathematics in cultural and aesthetic thought. Chapter 1 investigates the construction of a seeming opposition between mathematics and critical theory as first framed by Horkheimer and Adorno in conversation with Benjamin and Lukács. This opposition emerged out of an acrimonious philosophical confrontation with members of the Vienna Circle and their vision of a scientific philosophy, logical positivism. Mathematics served as the grounds on which this disagreement played out, as the logical positivists’ reliance on mathematics
linked them for the critical theorists to a form of political quietism and the acceptance of authoritarian government. At stake were, at least for Horkheimer and Adorno, not only the concepts of subjectivity, experience, and language but also the course and political imperative of modern philosophy. The critical theorists’ side of the debate cast mathematics as instrumental reason, reification, and a restricted form of thought that perpetuated the status quo amidst the increasingly troublesome political situation of the late 1930s. What is striking—and what has been pervasive about the image of mathematics set into motion by Horkheimer and Adorno—is how it transformed a historical intellectual conflict into a history of thinking that associated mathematics with the breakdown of reason that brought about Hitler and Auschwitz. Even after the war, the image of mathematics established in this brief but decisive phase of critical theory’s inception persisted as a symbol of positivistic thinking and a tool of societal control.

Subsequent chapters return to the origins of the critical project before Horkheimer and Adorno’s confrontation with logical positivism to reconstruct the creative possibilities for critical thinking revealed by negative mathematics, the intellectual project shared by Scholem, Rosenzweig, and Kracauer. Chapter 2 investigates the first formulation of this project in the work of Scholem. For Scholem, the debates surrounding the philosophical foundations of mathematics revealed the aesthetic and historical potential of privation: mathematics, in particular mathematical logic, produces novel results by abandoning the conventional representational and meaning-making functions of language. The philosophy of mathematics provided Scholem with metaphors of structure lacking the representational functions of language. These metaphors enabled him to counter not only the previously mentioned crisis and skepticism that surrounded language but also his growing sense of the unviability of Jewish emancipation and equality in Germany. In his work on mathematical logic, these metaphors of privation opened up for Scholem unlikely avenues of aesthetic and linguistic expression, showing how language as silence can serve as a symbol of its own limitations. How mathematics deals with the shortcomings of language showed Scholem the expressive potential of the poetic genre of lament and informed his translations of biblical lamentations, laying the groundwork for a philosophy of history that underpinned his Major Trends
in Jewish Mysticism (1941). Like mathematics, lament and history mobilized for Scholem the idea of privation—the experience of deprivation—to symbolize that which remains unsayable in language and untransmissible in history. Scholem’s negative mathematics thus bears the possibility for theories of culture and history that could account for the experience of exile and diaspora, finding historical transmission and continuity in moments of silence, rupture, and catastrophe.

Rosenzweig’s mathematics-inflected intellectual program materialized around the same time as Scholem’s poetics of negation, but the former focused on embedding messianism into the everyday work of thought. In chapter 3, I revisit the debates surrounding Leibniz and Newton’s calculi in the philosophy of Cohen and trace how the concept of the infinitesimal quantity (the differential) signaled to Rosenzweig not only the source of pure cognition but also metaphors of motion, rest, and the primacy of the former over the latter. Benjamin Pollock has shown that Rosenzweig drew on German Idealism and Cohen’s use of the differential to rebuild thought in response to crises unleashed in 1914. But practical, contemporary pedagogical debates and popular intellectual histories emphasizing the significance of infinitesimal calculus and the concept of the differential influenced Rosenzweig and his Star of Redemption as well. Infinitesimal calculus revealed the ways in which thought could account for the actuality of motion as it is experienced in the world by synthesizing finitude in reference to infinitude in a single concept, the differential. The Star of Redemption hinges on this approach as it transforms the finite, thinking subject into the agent of revelation and an active participant in the creation of the eternal Kingdom of God on earth. This is the messianic role that the individual assumes in Rosenzweig’s theory of knowledge, the “New Thinking,” which makes room, alongside the truths proved by mathematics, for the truths verified by the beliefs of individuals in the course of history—including historically marginalized groups, such as the Jews in Germany. It is also a messianism and an epistemology that informs critical theory, where the cultural critic works in the dim light of messianic reconciliation.

With aims equally as grand as Rosenzweig’s messianism, the style of cultural critique cultivated by the journalist and philosopher Siegfried Kracauer employed negative mathematics as a means of working toward a society
based on reason through the aesthetic composition of his analyses. Chapter 4 deals with the metaphorics of space and the method of projection that Kracauer found in geometry. In his early theoretical texts and feuilletons for the Frankfurter Zeitung, mathematics fulfilled an impossible yet pressing assignment: in a world vanquished of authority, geometry and the metaphorics of space bridged the divide between the raw contingency of materiality and the necessity of a priori laws. Drawn from his training as an architect, geometry also provided Kracauer with the analytic method of projection, which read in the material products of mass culture the metaphysical trajectory of history and the modern crisis point represented by capitalism. These rationalized products of capitalism (detective novels, dance revues, etc.) embodied this troubling stagnation of Enlightenment reason into mere rationality, and yet, according to Kracauer, if we confront rather than ignore the petrification of reason we may still realize the true progressive force of the Enlightenment. As a “natural geometry,” the metaphorics of space and method of projection became a literary strategy for Kracauer, an aesthetic styling of his texts, which, in my account, served as a programmatic attempt to stage publically a confrontation of Enlightenment reason with capitalist rationality. For Kracauer, this was the unique task of the marginal figure of the societal observer, the Jew, the cultural critic, who thus played a salient role in correcting the historical trajectory of reason. Even as mathematics came under scrutiny with the rise of Fascism, Kracauer’s claim that the aesthetics of theory work toward a societal confrontation with rationalization suggests that the critical project ought to take seriously the material and performative dimension of criticism as a mode of cultural intervention in a still hyper-rationalized and, now, digitized present.

Around the end of the 1920s, mathematics appeared to lose its critical appeal, transforming, through the work of Horkheimer and Adorno, into an instrument of oppression and totalitarianism. And yet mathematics has by no means disappeared from our philosophical and cultural horizons. The conclusion considers the persistence of the intellectual positions and antagonisms of the past century in contemporary debates over the place of mathematics, quantity, and computation in the humanities. Based on mathematical processes, computational approaches to the humanities—known as the digital humanities—offer broader access to cultural and aesthetic
products and new insights into their composition, circulation, and interrelation. However, those skeptical of the incursions of quantitative and computational methods into humanistic inquiry recognize that proponents of such mathematically inflected methods all too often reiterate a scientific optimism and rejection of the humanistic tradition akin to that of the logical positivists. Like Horkheimer and Adorno, contemporary critics of the digital humanities claim that digital humanists focus too narrowly on technology and code at the cost of politics and language, history and critique. Negative mathematics offers a third way for the digital humanities to maneuver between an uncritical positivism and the rejectionist impulse of critical theory. Drawing on the ideas offered by Scholem, Rosenzweig, and Kracauer’s project of negative mathematics, the conclusion maps out this third way, which sees in mathematical and computational approaches to negativity ways to capture and express otherwise marginalized experiences, histories, and cultures. Understanding how negative mathematics once helped shape critical theories of culture and art opens avenues for theorizing a more reasonable and inclusive society, avenues that enable the humanities to draw on the analytic benefits of mathematics while, at the same time, reconfiguring the limits of representing minoritarian ideas and peoples in the digital age.