ment of a wide range of organismal characteristics (phenotypes) from the same set of genes. Chapter 8 describes gene duplication and horizontal gene transfer, whereby genomes can be enriched and enlarged. For example, horizontal gene transfer between bacteria has been shown to account for the spread of resistance to drug treatments. Chapter 9 explores the evolution of eukaryotic cells (ones with a nucleus, such as those in the human body) as a merger of an archaebacterium and a eubacterium.

The final chapter describes genetic "freeloaders," genes that seem to serve no useful purpose except to ensure their own survival. Occasionally these genes do take up a new function (exaptation in Stephen J. Gould's terminology). In the human genome, the freeloaders hugely outnumber useful genes. Yanai and Lercher link this to the beginning of life on Earth around hydrothermal vents at the bottom of the ocean, where RNA freeloaders could have been abundant.

The book concludes with a paraphrase: "it is the society of genes that has brought us this far, but it is our humanity that must now bring us home." I do not share Yanai and Lercher's faith in humanity and prefer the original: "'Tis grace hath brought me safe thus far, and grace will lead me home" (from the hymn "Amazing Grace"). God's grace is a surer foundation for humanity's future than a purported society of selfish genes.

Overall, the book is a good introduction to modern genetics from a Dawkins-like perspective. A key message of the book is that many aspects of human biology are controlled by a number of genes acting together, rather than by a single gene. This exposes the lie of popular misconceptions such as our having a "god gene," a "gay gene," or an "alcoholism gene." Yanai and Lercher see their book as Darwin saw his *On the Origin of Species*, as "one long argument" (p. 258).

In the tradition of one long argument, they conclude that "this book exhibits the explanatory power that comes from viewing the genetic makeup of a species as a society of genes" (p. 258). I would dispute that conclusion, not only because their argument does not seem to be sustained chapter by chapter, but also because I find the metaphor itself to be questionable.

Nevertheless, this is a generally readable book, giving an updated view of developments in genetics since Dawkins wrote his popularizing book on the same topic. The book's major limitation is its gene-centric view of genetics. Other perspectives exist, such as the systems biology approach of Denis Noble (a colleague of Dawkins at Oxford), as exemplified in his book *The Music of Life: Biology beyond Genes.* Likewise, Jablonka & Lamb's book *Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral and Symbolic Variation in the History of Life* provides a broader perspective. That Yanai and Lercher do not go beyond their gene-centric view might be due to a space constraint, but it might also be due to the constraint of their choice of metaphor.

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Mathematics

REDEEMING MATHEMATICS: A God-Centered Approach by Vern S. Poythress. Wheaton, IL: Crossway, 2015. 200 pages, bibliography, index. Paperback; $21.99. ISBN: 9781433541100.

Challenged by Kuyper's declaration that faith affects all of life, Poythress begins his book with a keen interest in exploring how faith applies to mathematics. There are other books on the subject, but in this short book, Vern Poythress adds his own view to the mix. He introduces some of the theological and philosophical work of the Reformed theologian John M. Frame, for example, *The Doctrine of the Knowledge of God*, and he acknowledges the influence of the Reformed philosopher Dirk Vollenhoven. He challenges the notion that mathematics is merely secular; instead, to cite one argument, arithmetic laws are "in essence personal" and imply a lawgiver. Poythress observes that the rules and order of mathematics demonstrate the biblical principle that God upholds the world. He attributes mathematics to God's law, a divine command, for the universe. Poythress tries to develop a philosophical position that steers away from both Christian Platonism and Christian empiricism.

While available in hardcover, *Redeeming Mathematics* is one of 20 free ebooks that Poythress has written. The list includes *Chance and the Sovereignty of God, Logic, Redeeming Science, Redeeming Sociology,* and *Symphonic Theology*. Many of his books share a variation of the subtitle "A God-Centered Approach" with the book under review. In this mathematics edition, Poythress leans heavily on his other work, such as *Redeeming Science*. In fact, some paragraphs are borrowed verbatim, and some of these words also appeared in his 2003 article "Why Scientists Must Believe in God: Divine Attributes of Scientific Law." In other places he encourages the reader to consult his other works to get the full details of his argument. In the end, I would have preferred that the book

were self-contained and did not lean so much on his other works. His brief supplemental chapter on other resources could have been more robust and included, for example, brief commentary on the edited books by Bradley and Howell, *Mathematics in a Postmodern Age: A Christian Perspective* and *Mathematics through the Eyes of Faith*, or Byl's *The Divine Challenge: On Matter, Mind, Math and Meaning*, which are listed in the bibliography.

This book is not specifically written as an apologetic argument; rather, it is meant to help Christians consider Kuyper's clarion call in the context of mathematics. In a world that views mathematics as purely secular, Poythress aims to recover "a robust doctrine of God's involvement in daily caring for his world." Poythress leans heavily on the Reformed Christian apologist Cornelius Van Til, often via the work of John Frame. In particular, he draws on the concept of the Trinity to bolster his ontology of mathematics and he uses Van Til's analogical approach with an oft-repeated refrain that we are "thinking God's thoughts after him."

In chapter 1, Poythress ties arithmetic statements such as 2+2=4 to some attributes of God, such as being immutable, omnipresent, and omnipotent. He develops the idea that arithmetical rules are part of the Law of God for creation, part of God's Word. He then describes the personal character of Law, the goodness of Law, the beauty of Law, the righteousness of Law, and the Trinitarian nature of Law, declaring that arithmetic participates in all these attributes. Through these, Poythress recognizes a nonsecular approach to mathematics. He observes that "people working with mathematics rely on God's Word in order to carry out their work" and exposes the nonbiblical notion that God acts in creation, but only in supernatural ways via miracles. After all, as noted in Psalm 104, God "causes the grass to grow." Poythress notes that laws reflect God's character, but in my mind, he takes the analogy too far. Instead of simply saying that mathematics captures part of God's regular working in the world, he equates the laws directly with part of his character.

In chapter 2, Poythress briefly addresses the philosophical problem of the one and the many, tying it to one's understanding of mathematics. He uses the concept of the Trinity to make sense of the unity and diversity of the created world, describing how the expression of unity and diversity in number concepts reflects God's character.

In chapter 3, he describes the limitations of a materialist worldview to answer the philosophical problem of the one and the many. He argues that materialism does not adequately explain the origins of mathematics. In chapter 4, Poythress reflects on the nature of numbers. He attributes mathematical equations to God's speech, associating them with the divine characteristics of omnipresence, eternality, and omnipotence. In this chapter, he develops an analogical tie to the Trinity using Frame's three perspectives: normative, situational, and existential. He develops these perspectives to further connect arithmetic with God's character.

In chapter 5, Poythress describes Frame's square diagram for understanding transcendence and immanence in Christian perspective. He connects the square to different interpretations of arithmetic statements such as 2+2=4. In chapter 6, Poythress covers the concepts of necessity and contingency with respect to God and mathematics, elaborating on the relevance of Frame's square for transcendence and immanence. He notes that numbers exist eternally, "not as Platonic abstractions, but as an aspect of God's knowledge." In a later chapter, he argues, based on the character of God, that numbers could be no different in any alternate universe.

In chapters 7–10, Poythress explores addition, the idea of succession, and multiplication. He develops curious links to the Tabernacle, the Trinity, and breeding animals. For example, Poythress argues that since God uses numbers to describe proportions for the earthly temple, this illustrates that numbers derive from God, instead of allowing for the fact that God may be communicating a broader principle using human-accessible terms. In chapters 11 and 12, he links symmetries and sets to the character of God. In chapters 13–16, Poythress links fractions, irrationals, and imaginary numbers to God via his three perspectives. In chapters 17–19, he touches on infinity, geometry, and higher mathematics before ending with a very brief conclusion. In the appendices, Poythress helpfully describes other philosophies of mathematics as well as other Christian approaches to the philosophy of mathematics. He describes Christian Platonism as well as a Christianized empiricism, giving critiques from his perspective.

There are a few places where Poythress could have taken more care in his writing. Some chapters start with stunted introductory paragraphs that deserve to be developed. He makes a speculative conjecture about the etymological roots of the word "irrational," tying it to later decimal representations instead of to the ambiguity of the Greek word for ratio within the context of the Greek worldview. He incorrectly states that imaginary numbers were introduced historically to be solutions to equations, rather than a means to a real solution. When reflecting on unexpected

applications of imaginary numbers, he provides the unsatisfactory statements that "God in his wisdom made it so," and that such numbers "are known by God," making them "real." Finally, on occasion in an argument, he has inserted the word "clearly" unnecessarily. For example, he brushes off a common inference as "clearly invalid" (p. 20); the adverb is either redundant or dismissive.

But these issues are minor and perhaps picky concerns. The bigger concern is with the overall argument itself. While I appreciate his anti-reductionist approach, allowing for the complexity and diversity of the created world, I do not find the analogical approach particularly convincing. In my opinion, it is applied too literally. And his oft-repeated refrain of thinking God's thoughts muddles the distinction between God's character and the specific way God upholds the creation, not to mention the particular ways that humans observe God's handiwork. In the end, despite his intention, I find it hard to distinguish his position significantly from a Christianized Platonist approach. Nevertheless, Poythress provides food for thought for those exploring the relationship of faith and mathematics.

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WEAPONS OF MATH DESTRUCTION: How Big Data Increases Inequality and Threatens Democracy by Cathy O'Neil. New York: Crown, 2016. 218 pages, notes, index. Hardcover; $26.00. ISBN: 9780553418811.

If you are looking for a dispassionate analysis of ethical issues in the use of big data, this book is not it. "Weapons of math destruction" (WMDs) are algorithms whose analyses of human data are used to make decisions that affect people's lives in nefarious ways. O'Neil's last chapter opens with the words, "As you know by now, I am outraged by all sorts of WMDs." So why does O'Neil call some algorithms weapons of math destruction? And why is she so outraged by them?

Here is one of her examples. In 2009, Michelle Rhee was chancellor of Washington, DC's public schools. She was appointed by a new mayor, Adrian Fenty, who wanted to improve the quality of DC's schools. His plan was straightforward: "Evaluate the teachers. Get rid of the worst ones, and place the best ones where they can do the most good." Rhee implemented a teacher assessment tool called IMPACT developed by a consultancy, Mathematics Policy Research, based in Princeton, NJ. It was a value-added model, measuring the educational progress of students and calculating how much of that could be attributed to the teacher. In 2011, based on its results, 206 teachers were fired, an action which O'Neil regards as unjust. The algorithm was very complex—it took into account not only test scores but other factors as well, such as the presence or absence of learning disabilities and socio-economic background—but the algorithm was not available for review or critique. There were neither independent means to assess the accuracy or effectiveness of the tool nor any means of feedback by which it could be improved. The resulting assessment was based on a small sample, only the 25 or so students in a teacher's class. And it was vulnerable to cheating. In the case of one fifth grade teacher who was fired, subsequent review of her students' fourth grade assessment tests suggested that they might have been altered to make the fourth grade teachers look better.

So what makes algorithms WMDs? O'Neil focuses on several characteristics: they define their own reality and use it to justify their results; the underlying models are often opaque or even invisible to those affected by them; they tend to punish the poor; they may use sloppy statistics and biased models that create their own feedback loops; and they are unfair in that they may damage or destroy lives.

Here are two more examples: (1) Crime prediction software such as PredPol and CompStat, and (2) E-scores. These programs illustrate the feedback loop issue: more patrolling in a neighborhood creates more data fingering that neighborhood. They also illustrate the uneven treatment of the poor, as much of the data is for "nuisance crimes" included as relevant because of a purported link between antisocial behavior and crime; yet, the data exclude "white collar" crimes. Thus, the assessments contribute to a system of discrimination against the poor. In the second example, E-scores are scores rapidly computed online to evaluate potential customers. They take into account information such as web browsing history, purchasing patterns, and location of the visitor's computer. Thus, for instance, at call centers e-scores are used to identify potentially more profitable prospects and funnel them to a human operator. But again there is a nasty feedback loop: people from poor neighborhoods get lower scores, and hence less personal attention, less credit, and higher interest rates. Predatory advertising is also generated through these scores.

Some further examples O'Neil addresses include recidivism models, risk models such as those used by hedge funds, the *US News* college rankings, personality tests sometimes in job application processes, automated resume reviews, use of behavioral data