THE BALTIMORE
STOCKBROKER AND
THE BIBLE CODE

People use mathematics to get a handle on problems ranging from the everyday ("How long should I expect to wait for the next bus?") to the cosmic ("What did the universe look like three trillionths of a second after the Big Bang?").

But there's a realm of questions out beyond cosmic, questions about The Meaning and Origin of It All, questions you might think mathematics could have no purchase on.

Never underestimate the territorial ambitions of mathematics! You want to know about God? There are mathematicians on the case.

The idea that earthly humans can learn about the divine world by rational observation is a very old one, as old, according to the twelfth-century Jewish scholar Maimonides, as monotheism itself. Maimonides's central work, the *Mishneh Torah*, gives this account of Abraham's revelation:

After Abraham was weaned, while still an infant, his mind began to reflect. By day and by night he was thinking and wondering: "How is it possible that this [celestial] sphere should continuously be guiding the world and have no one to guide it and cause it to turn round;

for it cannot be that it turns round of itself?" . . . His mind was busily working and reflecting until he had attained the way of truth, apprehended the correct line of thought, and knew that there is one God, that He guides the celestial sphere and created everything, and that among all that exist, there is no god besides Him. . . . He then began to proclaim to the whole world with great power and to instruct the people that the entire universe had but one Creator and that Him it was right to worship. . . . When the people flocked to him and questioned him regarding his assertions, he would instruct each one according to his capacity till he had brought him to the way of truth, and thus thousands and tens of thousands joined him.

This vision of religious belief is extremely congenial to the mathematical mind. You believe in God not because you were touched by an angel, not because your heart opened up one day and let the sunshine in, and certainly not because of something your parents told you, but because God is a thing that *must be*, as surely as 8 times 6 must be the same as 6 times 8.

Nowadays, the Abrahamic argument—just *look* at everything, how could it all be so awesome if there weren't a designer behind it?—has been judged wanting, at least in most scientific circles. But then again, now we have microscopes and telescopes and computers. We are not restricted to gaping at the moon from our cribs. We have data, lots of data, and we have the tools to mess with it.

The favorite data set of the rabbinical scholar is the Torah, which is, after all, a sequentially arranged string of characters drawn from a finite alphabet, which we attempt faithfully to transmit without error from synagogue to synagogue. Despite being written on parchment, it's the original digital signal.

And when a group of researchers at the Hebrew University in Jerusalem started analyzing that signal, in the mid-1990s, they found something very strange; or, depending on your theological perspective, not strange at all. The researchers came from different disciplines: Eliyahu Rips was a senior professor of mathematics, a well-known group theorist; Yoav Rosenberg a graduate student in computer science; and Doron Wit-

ztum a former student with a master's degree in physics. But all shared a taste for the strand of Torah study that searches for esoteric texts hidden beneath the stories, genealogies, and admonitions that make up the Torah's surface. Their tool of choice was the "equidistant letter sequence," henceforth ELS, a string of text obtained by plucking characters from the Torah at regular intervals. For example, in the phrase

DON YOUR BRACES ASKEW

you can read every fifth letter, starting from the first, to get

DON **Y**OUR **B**RA**C**ES **A**SKEW

so the ELS would be **DUCK**, whether as warning or waterfowl identification to be determined from context.

Most ELSs don't spell words; if I make an ELS out of every third letter in the sentence you're reading, I get gibberish like **MTSOSLO** . . . , which is more typical. Still, the Torah is a long document, and if you look for patterns, you'll find them.

As a mode of religious inquiry, this seems strange at first. Is the God of the Old Testament really the kind of deity who signals his presence by showing up in a word search? In the Torah, when God wants you to know he's there, you *know*—ninety-year-old women get pregnant, bushes catch fire and talk, dinner falls from the sky.

Still, Rips, Witztum, and Rosenberg were not the first to look for messages concealed in the ELSs of the Torah. There's some sporadic precedent among the classical rabbis, but the method was really pioneered in the twentieth century by Michael Dov Weissmandl, a rabbi in Slovakia who spent World War II trying, largely in vain, to raise enough money from the West to buy respite for Slovakia's Jews from bribable German officials. Weissmandl found several interesting ELSs in the Torah. Most famously, he observed that starting from a certain "mem" (the Hebrew letter that sounds like "m") in the Torah, and counting forward in steps of 50 letters, you found the sequence *"mem shin nun hay,"* which spells out the Hebrew word *Mishneh*, the first word of the title of

Maimonides's Torah commentary. Now you skip forward 613 letters (why 613? because that's the exact number of commandments in the Torah, please try to keep up) and start counting every 50th letter again. You find that the letters spell out *Torah*—in other words, that the title of Maimonides's book is recorded in ELS form in the Torah, a document set down more than a thousand years before his birth.

Like I said, the Torah is a long document—by one count, it has 304,805 letters in all. So it's not clear what to make, if anything, from patterns like the one Weissmandl found—there are lots of ways to slice and dice the Torah, and inevitably some of them are going to spell out words.

Witztum, Rips, and Rosenberg, mathematically as well as religiously trained, set themselves a more systematic task. They chose thirty-two notable rabbis from the whole span of modern Jewish history, from Avraham HaMalach to The Yaabez. In Hebrew, numbers can be recorded in alphabetic characters, so the birth and death dates of the rabbis provided more letter sequences to play with. So the question is: Do the names of the rabbis appear in equidistant letter sequences unusually close to their birth and death dates?

Or, more provocatively: did the Torah know the future?

Witztum and his colleagues tested this hypothesis in a clever way. First they searched the book of Genesis for ELSs spelling out the rabbis' names and dates, and computed how close in the text the sequences yielding the names were to the ones yielding the corresponding dates. Then they shuffled the thirty-two dates, so that each one was now matched with a random rabbi, and they ran the test again. Then they did the same thing a million times.* If there were no relation in the Torah's text between the names of the rabbis and the corresponding dates, you'd expect the true matching between rabbis and dates to do about as well as one of the random shuffles. That's not what they found. The correct association ended up very near the top of the rankings, notching the 453rd highest score among the 1 million contenders.

* Which is only a tiny fraction of the possible *permutations* of thirty-two dates, of which there are 263,130,836,933,693,530,167,218,012,160,000,000.

They tried the same thing with other texts: *War and Peace*, the book of Isaiah (part of Scripture, but not the part that God is understood to have written), and a version of Genesis with the letters scrambled up at random. In all these cases, the real rabbinical birthdays stayed in the middle of the pack.

The authors' conclusion, written with characteristic mathematical sobriety: "We conclude that the proximity of ELSs with related meanings in the Book of Genesis is not due to chance."

Despite the quiet language, this was understood to be a startling finding, made more so by the mathematical credentials of the authors, especially Rips. The paper was refereed and published in 1994 in the journal *Statistical Science*, accompanied by an unusual preface by editor Robert E. Kass, who wrote:

> Our referees were baffled: their prior beliefs made them think the Book of Genesis could not possibly contain meaningful references to modern-day individuals, yet when the authors carried out additional analyses and checks the effect persisted. The paper is thus offered to *Statistical Science* readers as a challenging puzzle.

Despite its startling findings, the Witztum paper didn't immediately draw a lot of public attention. All that changed when the American journalist Michael Drosnin got wind of the paper. Drosnin went hunting for ELSs of his own, jettisoning scientific restraint and counting every cluster of sequences he could find as a divine foretelling of future events. In 1997, he published a book, *The Bible Code*, whose cover features a faded, ancient-looking Torah scroll, with circled sequences of letters spelling out the Hebrew words for "Yitzhak Rabin" and "assassin who will assassinate." Drosnin's claims to have warned Rabin of his 1995 assassination a year in advance were a potent advertisement for his book, which also features Torah-certified predictions of the Gulf War and the 1994 collision of Comet Shoemaker-Levy 9 with Jupiter. Witztum, Rips, and Rosenberg denounced Drosnin's ad hoc method, but death and prophecy move units: *The Bible Code* was a best seller. Drosnin appeared on *The Oprah Winfrey Show* and CNN, and had personal audiences with Yasser

Arafat, Shimon Peres, and Clinton chief of staff John Podesta during which he shared his theories about the upcoming End of Days.* Millions saw what looked like mathematical proof that the Bible was the word of God; modern people with a scientific worldview were presented with an unexpected avenue toward accepting religious faith, and many took it. I have it on good assurance that one new father from a secular Jewish family waited until the *Statistical Science* paper was officially accepted before deciding to circumcise his son. (For the kid's sake, I hope the refereeing process was on the speedy side.)

But just as the codes were drawing wide acceptance in public, their foundations were coming under attack in the mathematical world. The controversy was especially bitter among the large community of Orthodox Jewish mathematicians. The Harvard math department, where I was a PhD student at the time, had on the faculty both David Kazhdan, who had expressed a modest openness to the codes, and Shlomo Sternberg, a vocal opponent who thought promotion of the codes made the Orthodox look like dupes and fools. Sternberg launched a broadside in the *Notices of the American Mathematical Society* in which he called the Witztum-Rips-Rosenberg paper "a hoax" and said that Kazhdan and others with similar views "have not only brought shame on themselves, they have disgraced mathematics."

The math department afternoon tea was kind of awkward the day Sternberg's article came out, let me tell you.

Religious scholars, too, were resistant to the lure of the codes. Some, like the leaders of the yeshiva Aish HaTorah, embraced the codes as a means of drawing unobservant Jews back into a more rigorous version of the faith. Others were suspicious of a mechanism that represented a sharp break from conventional Torah study. I heard of one distinguished rabbi who, at the end of a long and traditionally boozy Purim dinner, asked one of his guests, a code adherent, "So tell me, what would you do if you found a code in the Torah that said the Sabbath was supposed to be on Sunday?"

There wouldn't be such a code, the colleague said, because God commanded that the Sabbath is on Saturday.

* Which was supposed to happen in 2006, so, whew, I guess?

The old rabbi didn't give up. "Okay," he said, "but what if there were?"

The young colleague was silent for a time, and finally said, "Then I guess I'd have to think about it."

At this point, the rabbi determined that the codes were to be rejected; for while there is indeed a Jewish tradition, particularly among rabbis with mystical leanings, of carrying out numerical analysis of the letters of the Torah, the process is meant only to aid in understanding and appreciating the holy book. If the method could be used, even in principle, to induce doubt as to the basic laws of the faith, it was about as authentically Jewish as a bacon cheeseburger.

Why did mathematicians reject what seemed plain evidence of the Torah's divine inspiration? To explain, we need to introduce a new character: the Baltimore stockbroker.

THE BALTIMORE STOCKBROKER

Here's a parable. One day, you receive an unsolicited newsletter from a stockbroker in Baltimore, containing a tip that a certain stock is due for a big rise. A week passes, and just as the Baltimore stockbroker predicted, the stock goes up. The next week, you get a new edition of the newsletter, and this time, the tip is about a stock whose price the broker thinks is going to fall. And indeed, the stock craters. Ten weeks go by, each one bringing a new issue of the mysterious newsletter with a new prediction, and each time, the prediction comes true.

On the eleventh week, you get a solicitation to invest money with the Baltimore stockbroker, naturally with a hefty commission to cover the keen view of the market so amply demonstrated by the newsletter's ten-week run of golden picks.

Sounds like a pretty good deal, right? Surely the Baltimore stockbroker is onto something—it seems incredibly unlikely that a complete duffer, with no special knowledge about the market, would get ten up-or-down predictions in a row correct. In fact, you can compute the odds on the nose: if the duffer has a 50% chance of getting each prediction right, then the chance of his getting the first *two* predictions right is half of half, or a quarter, his chance of getting the first three right is half of

that quarter, or an eighth, and so on. Continuing this computation, his chance of hitting the mark ten times in a row[*] is

$$(1/2) \times (1/2) \times (1/2) \times (1/2) \times (1/2) \times (1/2) \times (1/2) \times (1/2)$$
$$\times (1/2) \times (1/2) = (1/1024).$$

In other words, the chance that a duffer would do so well is next to nil.

But things look different when you retell the story from the Baltimore stockbroker's point of view. Here's what you didn't see the first time. That first week, you weren't the only person who got the broker's newsletter; he sent out 10,240.[†] But the newsletters weren't all the same. Half of them were like yours, predicting a rise in the stock. The others predicted exactly the opposite. The 5,120 people who got a dud prediction from the stockbroker never heard from him again. But you, and the 5,119 other people who got your version of the newsletter, get another tip next week. Of those 5,120 newsletters, half say what yours said and half say the opposite. And after that week, there are still 2,560 people who've received two correct predictions in a row.

And so on.

After the tenth week, there are going to be ten lucky (?) people who've gotten ten straight winning picks from the Baltimore stockbroker—*no matter what* the stock market does. The broker might be an eagle-eyed observer of the market, or he might pick stocks by slapping chicken guts against the wall and reading the stains—either way, there are ten newsletter recipients out there to whom he looks like a genius. Ten people from whom he can expect to collect substantial fees. Ten people for whom past performance is going to be no guarantee of future results.

I've often heard the Baltimore stockbroker parable told as a true story, but I couldn't locate any evidence that it's ever really happened.

The closest thing I found was a 2008 reality TV show—reality TV being where we go for parables nowadays—in which British magician Derren Brown pulled off a similar stunt, mailing various horse-racing picks to thousands of Britons with the result of eventually convincing a single person that he'd devised a foolproof prediction system. (Brown, who likes dispelling mystical claims more than he does promoting them, exposed the mechanism of the trick at the end of the show, probably doing more for math education in the UK than a dozen sober BBC specials.)

But if you tweak the game, making it less clearly fraudulent but leaving unchanged the potential to mislead, you find the Baltimore stockbroker is alive and well in the financial industry. When a company launches a mutual fund, they often maintain the fund in-house for some time before opening it to the public, a practice called *incubation*. The life of an incubated fund is not as warm and safe as the name might suggest. Typically, companies incubate lots of funds at once, experimenting with numerous investment strategies and allocations. The funds jostle and compete in the womb. Some show handsome returns, and are quickly made available to the public, with extensive documentation of their earnings so far. But the runts of the litter are mercy-killed, often without any public notice that they ever existed.

Now it might be that the mutual funds that make it out of the incubator did so because they actually represented smarter investments. The companies selling the mutual funds may even believe that. Who doesn't, when a gamble goes right, think their own smarts and know-how are in some way due the credit? But the data suggests the opposite: the incubator funds, once the public gets their hands on them, don't maintain their excellent prenatal performance, instead offering roughly the same returns as the median fund.

What does this mean for you, if you're fortunate enough to have some money to invest? It means you're best off resisting the lure of the hot new fund that made 10% over the last twelve months. Better to follow the deeply unsexy advice you're probably sick of hearing, the "eat your vegetables and take the stairs" of financial planning: instead of hunting for a magic system or an advisor with a golden touch, put your money in a big dull low-fee index fund and forget about it. When you sink your savings into the incubated fund with the eye-popping returns,

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[*] There's a useful principle, the *product rule*, hiding in this computation. If the chance of foo happening is p, and the chance of bar happening is q, and if foo and bar are independent—that is, foo happening doesn't make bar any more or less likely—then the chance of both foo *and* bar happening is p × q.

[†] This story certainly dates back to the days when this process would have involved reproducing and stapling ten thousand physical documents, but is even more realistic now that this kind of mass mailing can be carried out electronically at essentially zero expense.

you're like the newsletter getter who invests his life savings with the Baltimore stockbroker; you've been swayed by the impressive results, but you don't know *how many chances* the broker had to get those results.

It's a lot like playing Scrabble with my eight-year-old son. If he's unsatisfied with the letters he pulls from the bag, he dumps them back in and draws again, repeating this process until he gets letters he likes. In his view this is perfectly fair; after all, he's closing his eyes, so he has no way of knowing what letters he's going to draw! But if you give yourself enough chances, you'll eventually come across that Z you're waiting for. And it's not because you're lucky; it's because you're cheating.

The Baltimore stockbroker con works because, like all good magic tricks, it doesn't try to fool you outright. That is, it doesn't try to tell you something false—rather, it tells you something true from which you're likely to draw incorrect conclusions. It really *is* improbable that ten stock picks in a row would come out the right way, or that a magician who bet on six horse races would get the winner right every time, or that a mutual fund would beat the market by 10%. The mistake is in being surprised by this encounter with the improbable. The universe is big, and if you're sufficiently attuned to amazingly improbable occurrences, you'll find them. *Improbable things happen a lot.*

It's massively improbable to get hit by a lightning bolt, or to win the lottery; but these things happen to people all the time, because there are a lot of people in the world, and a lot of them buy lottery tickets, or go golfing in a thunderstorm, or both. Most coincidences lose their snap when viewed from the appropriate distance. On July 9, 2007, the North Carolina Cash 5 lottery numbers came up 4, 21, 23, 34, 39. Two days later, the same five numbers came up again. That seems highly unlikely, and it seems that way because it is. The chance of those two lottery draws matching by pure chance was tiny, less than two in a million. But that's not the relevant question, if you're deciding how impressed to be. After all, the Cash 5 game had already been going on for almost a year, offering many opportunities for coincidence; it turns out the chance *some* three-day period would have seen two identical Cash 5 draws was a much less miraculous one in a thousand. And Cash 5 isn't the only game in town. There are hundreds of five-number lottery games running all over the country, and have been for years; when you put them all together, it's not at all surprising that you get a coincidence like two identical draws in three days. That doesn't make each individual coincidence any less improbable. But here comes the chorus again: *improbable things happen a lot.*

Aristotle, as usual, was here first: despite lacking any formal notion of probability, he was able to understand that "it is probable that improbable things will happen. Granted this, one might argue that *what is improbable is probable.*"

Once you've truly absorbed this fundamental truth, the Baltimore stockbroker has no power over you. That the stockbroker handed you ten straight good stock picks is very unlikely; that he handed *somebody* such a good run of picks, given ten thousand chances, is not even remotely surprising. In the British statistician R. A. Fisher's famous formulation, "the 'one chance in a million' will undoubtedly occur, with no less and no more than its appropriate frequency, however surprised we may be that it should occur to *us.*"

WIGGLE ROOM AND THE NAMES OF THE RABBIS

The Bible decoders didn't write ten thousand versions of their paper and send them to ten thousand statistical journals. So it's hard to see, at first, how their story resembles the Baltimore stockbroker con.

But when mathematicians took up the "challenge" Kass had posed in his journal preface, looking for some explanation other than "God did it" for the Bible code results, they found the matter wasn't as simple as Witztum and company had made it seem. The pace was set by Brendan McKay, an Australian computer scientist, and Dror Bar-Natan, an Israeli mathematician then at Hebrew University. They made the critical point that medieval rabbis didn't have passports or birth certificates granting them official names. They were referred to by appellations, and different authors might denote the same rabbi in different ways. If Dwayne "The Rock" Johnson were a famous rabbi, for example, would you look for a prediction of his birth in the Torah under Dwayne Johnson, The Rock, Dwayne "The Rock" Johnson, D.T.R. Johnson, or all of these?

This ambiguity creates some wiggle room for code hunters. Consider

Rabbi Avraham ben Dov Ber Friedman, an eighteenth-century Hasidic mystic who lived and worked in the shtetl of Fastov, in the Ukraine. Witztum, Rips, and Rosenberg use "Rabbi Avraham" and "HaMalach" ("the angel") as appellations. But why, McKay and Bar-Natan ask, do they use "HaMalach" alone but not "Rabbi Avraham HaMalach," a name by which the rebbe was also often known?

McKay and Bar-Natan found that wiggle room in the choices of names led to drastic changes in the quality of the results. They made a different set of choices about the appellations of the rabbis; their choices, according to biblical scholars, make just as much sense as the ones picked by Witztum (one rabbi called the two lists of names "equally appalling.") And they found that with the new list of names, something quite amazing transpired. The Torah no longer seemed to detect the birth and death dates of the rabbinic notables. But the Hebrew edition of *War and Peace* nailed it, identifying the rabbis with their correct dates about as well as the book of Genesis did in the Witztum paper.

What can this mean? Not, I hurry to say, that Leo Tolstoy composed his novel with the names of rabbis concealed therein, designed to be uncovered only once modern Hebrew was developed and classic works of world literature translated into it. Rather, McKay and Bar-Natan are making a potent point about the power of wiggle room. Wiggle room is what the Baltimore stockbroker has when he gives himself plenty of chances to win; wiggle room is what the mutual fund company has when it decides which of its secretly incubating funds are winners and which are trash. Wiggle room is what McKay and Bar-Natan used to work up a list of rabbinical names that jibed well with *War and Peace*. When you're trying to draw reliable inferences from improbable events, wiggle room is the enemy.

In a later paper, McKay and Bar-Natan asked Simcha Emanuel, a Talmud professor then at the University of Tel Aviv, to draw up another list of appellations, this one not designed for compatibility with either the Torah or *War and Peace*. On this list, the Torah did only a little better than chance. (How Tolstoy did is left unreported.)

It is very unlikely that any given set of rabbinic appellations is well matched to birth and death dates in the book of Genesis. But with so many ways of choosing the names, it's not at all improbable that among all the choices there would be *one* that made the Torah look uncannily prescient. Given enough chances, finding codes is a cinch. It's especially easy if you use Michael Drosnin's less scientific approach to code-finding. Drosnin said of code skeptics, "When my critics find a message about the assassination of a prime minister encrypted in *Moby Dick*, I'll believe them." McKay quickly found equidistant letter sequences in Moby Dick referring to the assassination of John F. Kennedy, Indira Gandhi, Leon Trotsky, and, for good measure, Drosnin himself. As I write this, Drosnin remains alive and well despite the prophecy. He is on his third Bible code book, the last of which he advertised by taking out a full-page ad in a December 2010 edition of the *New York Times*, warning President Obama that, according to letter sequences hidden in Scripture, Osama bin Laden might already have a nuclear weapon.

Witztum, Rips, and Rosenberg insist they weren't like the masters of the incubator funds, displaying to the public only the experiments that gave the best possible results; their precise list of names was chosen in advance, they say, before running any tests. And that may well be true. But even if it is, it casts the miraculous success of the Bible codes in a very different light. That the Torah, like *War and Peace*, can successfully be mined for *some* version of the rabbis' names is not surprising. The miracle, if there is one, is that Witztum and his colleagues were moved to choose precisely those versions of the names on which the Torah scores best.

There's one loose end that should trouble you, though. McKay and Bar-Natan made a compelling case that the wiggle room in the design of Witztum's experiment was enough to explain the Bible codes. But the Witztum paper was carried out using standard statistical tests, the same ones scientists use to judge claims about everything from medicines to economic policies. It wouldn't have been accepted in *Statistical Science* otherwise. If the paper passed that test, shouldn't we have accepted its conclusions, however otherworldly they may have seemed? Or, to put it another way: if we now feel comfortable rejecting the conclusions of the Witztum study, what does that say about the reliability of our standard statistical tests?

It says you ought to be a little worried about them. And it turns out that, without any input from the Torah, scientists and statisticians have already been worrying about them for quite some time.