

The Improbability Audits

Yavad Naddaf

Note from the author

This is a work of fiction, meaning the events described in this book did not, in fact, happen. You may be tempted to extrapolate and generalize this story to the day-to-day matters of your life. That would be a mistake, as everything in this book is made up.

As you progress through the story, you may find yourself wondering about the unlikely events that have happened in your own life, questioning how plausible they were. As the author of this work, I assure you that all improbable events in your life have been perfectly within the bounds of the probability laws. Most likely.

Chapter 1

*** 1 ***

Chris Mount did not consider himself an asshole. Assertive on occasion, perhaps, but not an asshole. He certainly hadn't planned to hurt anyone on that dark, gloomy February morning. All he wanted to do was to make a left turn from Cardero St. onto Georgia and make it to the office before his 9 a.m. meeting. He sat in his new BMW X5, peering through the windshield at the Vancouver rain pouring down, making it almost impossible to see the car in front of him.

A month ago, when contemplating buying a new X5, he pitched it to his wife as a "family car." Something with enough space for Sophie, his two-year-old, and the new baby on the way. Privately, he'd also relished the idea of a more comfortable and prestigious commute. Why the hell not? He already had to sit in traffic for an hour every day. Why not make it a little fun? But now, sitting in the new car, bleary-eyed, exhausted, and stressed, watching the traffic light

switch to red yet again without a single car moving, he couldn't help but feel slightly disappointed. He had already missed his alarm, his breakfast, his coffee, and the last three goddamn green lights.

During the next green light, suddenly, a small gap appeared in the lane he was trying to merge into. He put his foot on the accelerator. Through the rain-soaked windshield, he noticed a small figure starting to cross Georgia Street.

"Goddamn it," he thought to himself. "They're going to stop."

He went for it, but the figure did not stop. He slammed on the brakes as the front grill of the X5 screeched to a halt an inch from the torso of the pedestrian. Chris saw her clearly through the windshield - a girl, maybe ten or eleven, carrying a large red backpack. Even through the pelting rain, he could see the fury on her face. He felt a chill creep down his spine, then saw her lips move as if in slow motion, swearing: "You stupid idiot!"

Chris waved his hand apologetically and completed his left turn.

Sixteen seconds later, he was dead.

*** 2 ***

"Unlucky man," said Ed, taking a large gulp from his wine glass. Leaning back on the L-section of his sofa, he balanced the laptop on his chest and began to read aloud.

"A construction worker's routine task turned fatal in Downtown Vancouver early Monday morning. While working on the thirty-ninth floor of a high-rise condo under construction, the worker accidentally dropped his tape measure. The one-pound tool ricocheted off a metal beam, plummeting over four hundred feet before piercing through the windshield of a BMW X5 on Georgia Street. The driver, identified as Chris Mount, 52, was struck in the head and tragically killed instantly due to severe injuries. The incident has sparked an investigation into the circumstances surrounding the accident."

Ed took another sip of wine and glanced at Zi, wondering if she was listening. She wasn't. She sat cross-legged on the opposite end of the sofa with a glass of Scotch in her hand, apparently engrossed in some superhero action movie playing on mute. On the large projected screen, an armored truck silently exploded in slow motion. Ed felt a bit hurt. It was one thing to be ignored because someone is watching a great movie with the sound on, but it sucked when you couldn't compete for attention with a muted rewatch of Rhino Man 3.

Ed turned back to his laptop and loaded "The Model." The Model was the reason Shield Star Financial, the insurance corporation that Ed worked for, could proudly display the phrase "pioneers in Artificial Intelligence" under the innovation section of their website. The Model was also why Ed could work only seven hours per week from home and pay his bills. The Model consisted of 117 lines of Python code. Ed had written it in an afternoon four years ago and hadn't changed it much since. Why mess with a good thing?

What The Model actually did, beyond keeping the investors of Shield Star Financial appeased and paying Ed's bills, was to determine if the various types of accidents happening in a geographical region were too improbable to be random. This might sound fancy, but it is not actually very complicated. Anyone who plays poker understands that their opponent pulling out

a royal flush is extremely rare. If the same guy lays down another royal flush in the following round, most people will cry foul. If yet another royal flush turns up in the next hand, someone's poker career might end due to a few broken fingers. The Model worked similarly, but rather than protecting poker buddies from cheaters, it was supposed to warn Shield Star Financial about insurance fraud.

The Model was built on sophisticated statistical methodologies founded on beautiful theoretical guarantees. If you were to feed it infinite samples of infinitely accurate inputs, in theory, The Model could generate infinitely accurate results. In the real world, as is the tradition in most applications of statistical tools, Ed fed The Model a few rough estimates that he mostly made up out of thin air. Consequently, in the real world, what The Model generated was not much better than Ed making an educated guess himself. Ed was not embarrassed about this shortcoming of The Model, much in the same way your doctor would not blush if the headache they'd attributed to stress turned out to be symptomatic of a baseball-sized brain tumor. There's nothing to be ashamed of. They're simply cases of professionals following the best practices in their trade.

Ed stared at the projected screen, attempting to conjure some plausible numbers to feed The Model. On the wall, Rhino Man was grappling with a nightmare about his childhood, sweating profusely and preventing Ed from concentrating.

"Hey, Dr. Zi!" Ed called out. "What would you say is the likelihood of someone accidentally dropping a tape measure from the fortieth floor, hitting a driver on the street, and breaking his skull?"

The blissful look disappeared from Zi's face as if she had been yanked from the delightful universe of Rhino Man and pulled down into the mundane world of regular men. She took a sip from her glass.

"Dude, if you are going to call me doctor and give me a bullshit work assignment, you better expense my bottle of Scotch. It was \$105."

"You know I can't expense liquor. I've already gotten in trouble a few times for that shit. I can buy you dinner?" Ed suggested.

"Sure, I'll order some Ramen."

"Ramen is awful when delivered in foam containers. Bleh. Can you get Korean fried chicken instead? Also, get enough side dishes to push the total over \$100. Anything under that is more likely to get flagged."

This was factually true. For the previous two years, Shield Star Financial had partnered with a tech startup called "expanse.ai". This was another self-proclaimed "pioneer in Artificial Intelligence," using machine learning models to audit business expenses. Buried deep within their models, a decision tree had concluded that people were less likely to file fraudulent claims for items over \$87.98. This was not an unreasonable conclusion. It was, in fact, a statistically sound one. Most people tend to tell small lies. However, this statistical rule had an unforeseen and somewhat ironic consequence. Once the employees of Shield Star Financial got wind of this flagging policy, they started padding their bills until they exceeded \$100. As a result, the annual business expenses claimed at Shield Star Financial nearly doubled. The Silicon Valley-based startup expanse.ai, however, measured and reported the effectiveness of its

product based on the estimated amount of fraudulent expenses that went undetected. This was pretty much a made-up number, curiously always hovering near zero. Hence, the partnership flourished, and the employees of Shield Star Financial enjoyed ordering extra side dishes.

Zi got busy on her phone.

"So?" Ed probed after a few minutes.

Zi kept tapping on her phone, ignoring him.

"Dr. Zi?" Ed pressed again impatiently.

"Don't rush me, dude," Zi snapped, her thumb scrolling up and down her screen. "I'm still deciding."

"I'm not talking about the dinner. I'm talking about the probability of a tape measure dropping on someone's head."

Zi sighed, glancing up from her phone. "You always overthink these things. It's just a simple chain rule. What is the probability of a construction worker dropping a small tool? You must have a table for that at work," Diving back into her phone, she tapped tentatively. "What do you think? Should we order some Tteokbokki again? We didn't finish it last time."

Ed shrugged.

"Fuck it. Let's get Gunmandu instead," she decided, swiping down on the screen. "Anyway, once you know the probability of the guy dropping the tool, multiply it by the probability of it hitting the dude's head, given that some asshole dropped it. You could overcomplicate it and deal with the part that it ricocheted off something else, but I'd keep it simple. Just assume a uniform distribution over the area immediately around the construction site. It's still going to be a minuscule number. Then keep going. What is the probability of the guy dying, given that a fucking tape measure hit him in the head from the 40th floor? Probably damn near one. You can use 0.5 as a lower bound."

Ed grinned, sitting up and pouring a new glass of wine. "It's good to have smart friends." Zi set her phone on the coffee table and picked up her glass. "It's better to have wise friends," she raised her glass, "neither of us is that fortunate."

Two hours later, as the remnants of the Korean fried chicken and the six side dishes cooled on the coffee table, Ed finished calculating the required estimates and started running The Model on his laptop. Zi lounged on the sofa with her feet resting on the coffee table amongst the takeout containers, happily polishing off a box of Hodugwaja cookies. A screening of Rhino Man 4 soundlessly played on the wall.

"Hey, Zi?" Ed called, wiping a smudge of grease from his laptop screen to double-check the group of numbers spit out by The Model.

"Hmm?" Zi murmured absently.

Ed glanced at Zi and then at the screen. Rhino Man silently landed a punch on the face of a burly guy with a rocket launcher.

"How can you keep watching this crap?" asked Ed with a hint of annoyance. "It's fucking unwatchable the first time around, and I am pretty sure this is the third time you are rewatching it."

Zi ignored him.

"Every superhero movie follows the same damn plot," Ed continued. "It starts with a handsome protagonist struggling with everyday life. Maybe he gets bullied at school or has a mean boss at work. This is the first twenty minutes of the movie. Then the hero gets some random superpower. During the next twenty minutes, the hero uses his superpower to take revenge on his adversaries, with a side of some goofy action for humor. This is also about the timestamp when he begins to act arrogantly and disappoints the story's love interest. Then the main villain shows up, who just so happens to have a slightly modified version of the exact same superpower. The two fight. First round, the hero eats shit. This is approximately at the one-hour mark of the movie."

Ed drained his wine glass and began pouring another. Zi was still absorbed in the screen.

"Now humbled," Ed continued his rant, "the hero goes back to his roots, realizing what gives him strength is not his powers, but his kindness, or friends, or whatever fucking cliché the writers have picked. He also reconnects with the romantic interest. We are at the eighty-minute mark now. For the next twenty minutes, the hero and the villain fight, reducing half of a modern city to rubble. Around the hundred-minute mark, the hero finally defeats the villain, who is usually

destroyed by an unintended consequence of his own power. The hero then kisses or fucks the main love interest, depending on the movie rating," he paused, fishing the last Gunmandu out of the take-out box. He continued as he bit into the crispy, pan-fried dumpling—"There. I summarized every fucking superhero movie ever made. Now, you tell me how you can rewatch this crap over and over?"

Zi did not take her eyes off the screen. "You just don't know how to enjoy them," she said.

"Why don't you enlighten me, please?"

"The predictability is the point. You watch a superhero movie because you know it will end well. Someone is not going to randomly shoot Peter Parker and then the credits roll. The good guys are going to win. It's mindless entertainment that you can enjoy with peace of mind."

"I'd pay good money," Ed responded, "for a new Spider-Man movie in which Peter Parker gets shot in the head by some random bad guy at the thirty-minute mark and then dies on the spot. The rest of the movie should be about how society can function properly without random acts of vigilante justice. They should show it in schools."

Zi chuckled, "Yeah, I'll watch it too."

"By the way," continued Ed, taking advantage of the brief window of Zi's attention, "after that cruise ship that crashed into the harbor a couple of days ago, the East Hastings hostel incident, and now this guy getting his skull cracked by a tape measure, The Model says that Vancouver is now over the improbability threshold."

"Really?" Zi mocked. "A statistical model is given made-up numbers, then predicts a value over a made-up threshold. Statisticians are in turmoil!"

"Hey, a man gotta eat," Ed shrugged, finishing his drink.

*** 3 ***

The girl was happy. She had made it to the train station without anyone bothering her—no asshole had cut her off, no creepy guy had started yelling at her. She walked with her phone in one hand, casually watching a Twitch stream of Fortnite, holding a McDonald's soft serve in the other. Pushing open the heavy station door with her foot, she walked in and found a spot on a wooden bench in the main hall. She carefully positioned the remains of her ice cream cone beside her, wiped her sticky hands on her pants, and began purchasing a train ticket on her phone.

When she tapped the purchase button, a red message box popped up on her screen.

"Insufficient funds (Code 51): You don't have enough money in the accounts associated with your card. Please try again."

The girl frowned, annoyed at how unfair everything was. "Why the fuck can't I have a few minutes of peace without something going wrong?" she seethed inside, the anger growing.

"Why is something always fucking broken?"

Almost every bit of data processed by a computer, at some point in its journey, needs to be stored on a memory chip. A memory chip is where computers read and write short-term data for immediate processing. The computer can write a piece of data, let's say the available balance of a credit card account, to the chip. Later, the computer can access that data for processing, for instance, when a program checks if the available balance is sufficient for a purchase value. This works perfectly, nearly always. In extremely rare cases, a single bit stored on the chip can switch from 0 to 1 or vice versa. This is called a bit flip, and it is bad news for a credit-card server because a single bit flip can turn a balance of \$14 (000000000000000000001110) into \$1,048,590 (001000000000000000001110).

Background radiation, partly due to neutrons from secondary cosmic rays, is believed to be one of the main causes of bit flips. Fortunately, ingenious engineers have implemented a sophisticated Error Correction Code that stores additional bits on the memory chip and makes such undetected bit flips astronomically improbable.

The girl tapped the retry button, and this time the transaction went through without any issues. She smiled, picked up her ice cream, switched her screen back to the Twitch stream, and started walking towards the platform. A middle-aged woman in a light blue uniform stood by the doorway. The girl nonchalantly flashed the QR code on her phone screen. The woman studied her, then the electronic ticket.

“Elizabeth? Dear, you cannot board the train alone. Where are your parents?”

“Oh, my mom is already on board. I just stepped out to get ice cream,” the girl waved the remainder of the cone. “My mom is inside waiting for me,” she tried to give the woman a cute, innocent look.

“Your mother let you wander outside by yourself? In this neighborhood?” the woman chided disapprovingly. “We should go talk to her.”

“Oh, it’s ok. I’ll tell my mom she shouldn’t have allowed it.”

“No, dear. Your mom’s actions are inappropriate. I must have a word with her.” The woman then reached for her radio and pressed a button. “Can anyone cover my post on platform two? I need to escort a minor.”

The girl frowned, violent rage bubbling inside her. She stared at the stupid, fat woman, furious thoughts thundering in her head, “Stupid, dumb, bitch! Why can’t you leave me the fuck alone? You fat nosy nanny!” She closed her eyes.

The woman’s phone started ringing. She gave it an irritated glance before answering.

“Hi, Dad! I’m at work.”

The girl could hear an old man coughing on the other end.

“Dad?? Are you ok?” the woman cried frantically. “Jesus! Dad?? Are you choking?” More coughing could be heard from the other end. “Listen, Dad, I want you to hang up now and call 911. I’ll call them too.”

As the annoying woman dashed towards the exit, the girl smiled, put her headphones back on, and stepped onto the train. When she located her seats in the business-class car, she draped a pink, old-fashioned coat over the extra aisle seat she had purchased. This generally was enough to discourage nosy women and creepy men. Settling into the window seat, she finished off the ice cream in one satisfying bite and unpaused the Twitch stream on her phone.

Seventeen minutes later the train pulled out of the station. The girl was gazing out the window as the gritty back alleys around Pacific Central Station turned into the drab suburbs of Surrey and then the green flatlands of Delta. She loved trains. She enjoyed the steady rumble, the shifting landscape, and the calming feeling of always being in motion. Just as she was about to walk to the café car to order a burger and a coke, an announcement interrupted her plans. The train was about to stop for a US passport inspection. She didn't have a passport.