

HUMANS VS COMPUTERS

by Gojko Adzic



Humans vs Computers

Wrong assumptions, computer bugs, and people caught in between

Gojko Adzic

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LeanPub Sample

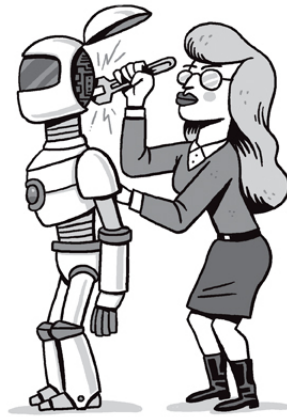
Dear Reader,

Thank you very much for downloading the sample of *Humans vs Computers*. This sample contains some nice stories from the full book, and a list of resources and references for further research. The full book contains many more stories, and a summary of heuristics, collected from all the stories, that you can use to make your software less error prone.

Gojko

Introduction

There's no doubt that computers are running our world, having the final say on everything from the price of your morning cup of coffee to global foreign exchange rates. Governments around the world are quickly becoming digital. Jobs are getting replaced with algorithms. Ubiquitous automation, along with some clever marketing, tricks us into believing that phones, TV sets and even cars are somehow smart. Yet all those computer systems were created by people – people who are well-meaning but fallible and biased, clever but forgetful, and who have grand plans but are pressed for time. Digitising a piece of work doesn't mean there will be no mistakes, but instead guarantees that when mistakes happen, they'll run at a massive scale.



This book is about ordinary people caught between bad assumptions and binary logic. You'll read about humans who are invisible to computers, how a default password once caused a zombie apocalypse and why airlines sometimes give away free tickets. This is also a book on how to prevent, avoid and reduce the impact of such problems.

As a professional software developer, I'm much more guilty than

the average person of driving civilisation towards a digital apocalypse. At the same time, I've been on the wrong end of a computer bug frequently enough to appreciate the pain that such a thing can create. This book is my attempt to raise awareness about some common and dangerous, but perfectly preventable, types of software blunders. I also want to help ordinary people fight back against digital monsters.

Knowing how software developers think, and what kind of mistakes they're likely to make, helped me open a bank account against the better judgement of a robotic workflow, resolve extortionate utility bills and even recover my debit card after it was kidnapped by an angry ATM. The next time you bang your head against a digital wall, the stories in this book will help you understand better what's going on and show you where to look for problems. If nothing else, when it seems as if you're under a black-magic spell, these stories will at least allow you to see the lighter side of the binary chaos.

For my colleagues involved in software delivery, I hope this book helps you find more empathy for people suffering from our mistakes, as it's always people who pay the price in the end. My intention with this book is to illustrate some typical, common mistakes with memorable stories, not to create a comprehensive guide for software quality. However, the final part of the book contains some nice tips and tricks, combined from all the stories, that you can use to make your software less error prone.

For the impatient

The [Inverse Monkey Rule](#) part contains checklists and heuristics that you can use during analysis, development or testing.

610,000 JPY

When Dentsu Inc started trading on the Tokyo Stock Exchange in December 2001, financial analysts watched the stock price with great expectations. Dentsu was one of Japan's largest advertising companies, and the event was one of the biggest initial public offerings that year. In the early hours of trading, the stock value surprised everyone



by falling through the floor. A single trader in Tokyo, working for UBS, caused the crash by mistake. Instead of offering to sell 16 Dentsu shares at 610,000 yen (roughly US\$5000 at that moment), the trader offered 610,000 Dentsu shares at 16 yen each. The Wall Street Journal reported that, upon noticing the error, 'UBS's trading floor in central Tokyo went into a panic, with a cacophony of yelling and screaming.' The mistake was rolled back after just two minutes, but ended up costing UBS almost US\$100 million.

Not to be outdone, a trader at Mizuho Securities caused even bigger chaos in 2005 with a touch of, as the financial news broadcasters all over the world named it, a 'fat finger'. Instead of offering to sell one share of the recruitment company J-Com at the price of – imagine the coincidence – 610,000 yen, the trader offered 610,000 shares to the market at a price of 1 yen each. Needless to say, the bargain was quickly picked up by anyone with a pair of eyes. Other investment banks made a killing, but the biggest individual winner that day was Takashi Kotegawa, 27 and unemployed. He

made a profit of 2 billion yen, roughly US\$15 million at the time. Mizuho Securities tried to recall the offer after spotting the error, but a bug in the Tokyo Stock Exchange systems prevented that from happening. Takuo Tsurushima, president of the Exchange, resigned over the issue. Mizuho ended up picking up the bill for the whole episode, to the total of 40 billion yen.

Fat-finger errors are a human mistake and happen all the time, all over the world. But the ones that make news all, as a rule, happen in Japan. In 2009, UBS placed an order for bonds issued by the game-maker Capcom worth 3 trillion yen (US\$31 billion), 100,000 times more than it intended. Luckily, the order was placed through an off-hours trading system, and UBS was able to reverse it before it caused an impact on the market. In 2014, a tsunami of 67.78 trillion yen (US\$617 billion) of fat-finger orders hit the Tokyo Stock Exchange, but this time they were cancelled in time. Bloomberg reported that the value of the error was greater than that of Sweden's economy.

Fair enough, people in the Land of the Rising Sun wake up before everyone else, so sleepiness might be causing fat-finger more errors than in other places. But there's actually a good reason why it's always Japanese trades that are so error prone. ISO standard 4217, controlling the

display of currency information, requires that amounts in yen use just integers without decimal places. This makes it easy to confuse currency amounts and other numbers, such as how many bonds you want to sell. My UK bank, for example, tries to prevent careless fat-finger errors by requiring that all currency amounts have two digits. If I want to pay £50 to someone, the bank will only let me enter it as 50.00. That's how it prevents people entering the payment reference



into the amount field, or the other way around. With Japanese yen, that kind of validation just isn't possible. Even worse, third-party software might mysteriously complain if you do try to supply decimals with yen amounts. That's why the popular Q&A site Stack Overflow is full of questions relating to incorrectly formatted item errors when using yen with PayPal.

The humble yen is a lovely edge case, even for developers not working in Japan. In fact, it's the people in the West who are most at risk of making daft mistakes. Floating-point numbers aren't precise, so they aren't suitable for financial calculations. That means that financial amounts often get represented by integers or special-purpose database types that record numbers to a fixed number of decimal points. Because most developers live in countries where two-digit amounts are taken for granted, it's quite common to see code where amounts are multiplied by 100 before saving. In fact, to prevent rounding errors, many payment APIs require amounts as integers. That works the same for euro, British pounds or most other popular currencies. But not for yen. A payment request for 2000 using a popular payment gateway Stripe might only ask for US\$20, but it will ask for 2000 yen. That's why there's a special warning about yen amounts in the Stripe payment documentation. For an even weirder edge case, consider Kuwaiti dinar (ISO code KWD), which should use exactly three decimal places.

In plain English, the correct way to record financial amounts is to use an integer in the smallest currency-amount units. A US dollar consists of 100 cents, so the smallest unit is a cent. But the smallest currency unit in Japan is 1 yen, so all kinds of wrong assumptions about always multiplying by 100 or adding two decimal places cause weird and wonderful bugs. Yen is not the only zero-digit currency in use, but it's by far the most popular one. Very few developers ever had to deal with payments in Rwandan francs, but Japan is a huge market so it's quite likely that people working even for mid-size US or European companies need to deal with yen payments at some point.

Mr Test

An ominous preview of Knight Capital's meltdown happened a whole year earlier, illustrating another key risk for automated decision systems. One of Knight's primary sources of revenue was market making for many smaller electronically traded funds. Market makers play a crucial role in financial exchanges by guaranteeing to buy or sell at a certain price, effectively ensuring that someone



is always interested in matching an offer for less popular financial instruments. Knight Capital was a key player in one of the biggest stock exchanges in the world, so it had to ensure that its systems could continue working even in the event of data centre problems. In October 2011, Knight decided to test its disaster recovery plans. The test happened over a weekend, outside normal working hours, and was a success. What followed was everything but.

Market making is a high-volume business, mostly automated, so the engineers used a large set of test data to simulate a relevant flow of trading requests. Everything worked well, and people went home knowing that their recovery procedures could survive even a small disaster. Inadvertently, however, a disaster had been triggered for the next day. Someone had forgotten to remove the test data after the experiment. When trading resumed on Monday morning, Knight's computers continued to use the test data to match offers from the exchange. As a result, Knight lost more than US\$7 million

before someone spotted what was going on.

Although leaving test data in the real system for Knight was a mistake, software is often built to support running tests alongside real work. The more complex a system, the more likely it is to break at the seams. Having some way to place a test order or book a test trade is a cheap and effective way to check that everything is working, effectively putting some much needed automated oversight around algorithmic decision making. To make that idea work, however, it's critical to actually recognise the test cases.

Computers at Hartsfield–Jackson International Airport in Atlanta failed to spot the test on 19 April 2006, causing travel chaos around the world. In order to prove that the security systems and staff are not asleep, the luggage X-ray machine at the airport occasionally shows images of suspicious devices. Normally, the computer identifies the suspect device and, a few moments later, warns that the alarm is part of a test. However, that Wednesday, a computer failed to identify a test case. The Transportation Security Administration agent screening luggage noticed something that looked like a bomb, but couldn't find a bag that matched the image. He alerted a supervisor, and the two of them went through all the luggage on the conveyor belt again. The test bag invented by a computer wasn't there, of course. This was too strange to ignore, so the two of them escalated the problem to the security director, who decided to call the Atlanta police bomb squad. Passengers had to evacuate the terminal, and all flights were grounded for two hours. Hartsfield–Jackson International is the busiest airport in the world, so the delayed flights caused a knock-on effect and disrupted travel around the world.

Test data problems can stay under the radar for a long time. The US Securities and Exchange Commission fined Citigroup more than \$7 million in 2016 because of a software glitch that caused the Global Markets division of the bank to incorrectly report regulatory data for 15 years. Citigroup Global Markets assigned test trades

to special bank branch codes, ranging from 089 to 100. In 1999, the bank changed from purely numeric to alphanumeric branch codes. Some real branches had codes starting with the number 10 and followed by a letter, but the regulatory reporting software incorrectly assumed they were just tests and decided not to include any related trades in ‘blue-sheet’ reports.

People sometimes make up special cases for testing that couldn’t possibly happen in real life, but make wrong assumptions about the world. James Bach got a parking ticket from the city of Everett on 16 December 2010, although he’d never parked in Everett. A county clerk confirmed that the ticket was in the system, but was confused by the case number. All tickets in Everett start with the number 10, but this one was 11111111. It turned out that the city of Everett had started using a new automated ticketing system just a few days before the alleged violation. Someone had obviously tried it out by issuing a made-up ticket that was easy to type in. That’s why the case number was all 1s. To ensure the ticket was clearly flagged as a test case, the tester issued it for the licence plate TESTER. Bach, a well-known software testing consultant and author, actually has a custom licence plate matching exactly that name. Luckily the clerk quickly recognised the error, and a judge dismissed the case.

The way to avoid such tunnel vision caused by idealistic data is to test software upgrades using real-world examples. However, this can create huge problems if test cases are not clearly identified. On 16 March 2010, New York police raided a house in Marine Park in Brooklyn. The house had been raided more than 50 times in the previous eight years, so New York Police Department officers were



prepared for heavy resistance. Instead, they found only Rose and Walter Martin, both over 80 years old.

The Martins had got used to the police banging on their doors, sometimes up to three times a week. On paper, the address looked like a hotbed of crime, but in fact this was all caused by a software test gone wild. In 2002, the police had used the Martins' address as part of a random data sample to test a new software system, but forgot to remove the test records afterwards. As a result, officers from all over New York started showing up in Marine Park looking for suspects.

In 2007, Rose wrote about the harassment to the Police Commissioner, Ray Kelly, warning that her husband's blood pressure problems could lead to a heart attack if the house was raided again. Commissioner Kelly ordered investigators to remove the Martins' address from their systems, but this turned out to be more difficult than expected. By that time, records had already been exchanged with many other police systems and copied into lots of different places. After the raid in 2010, Commissioner Kelly visited the Martins personally to apologise. When NBC TV picked up the story, even the New York City Mayor, Michael Bloomberg, publicly acknowledged the problem. Instead of trying to clean up test data further, police officials flagged the address with an alert, so that officers have to double-check any future visit with their superiors. It turns out that it was easier to change the police process than to fix a software test data problem.

The problem with test cases co-existing with real data gets even weirder when several systems need to talk to each other, because tests in one system are not recognised in another. This was the case of James Test, whose flight booking with American Airlines kept disappearing into a void. 'The booking would last only long enough to process my credit card, then fade to just a test', complained Mr Test to The Wall Street Journal. Jeff Sample ran into a similar problem caused by disagreements between the computer systems

of his travel agent, an airline in Argentina, and a bank. The airline processed his flight booking from Buenos Aires to Patagonia, and took the payment from his credit card, but another system then falsely flagged it as a test case and deleted the ticket. Even worse, the flight booking system no longer recognised the card charge, so Sample had problems getting a refund.

Sometimes, the only way to inspect a complex set of computer systems is to allow special test cases to exist alongside real data. But this approach can backfire badly if the tests end up matching any real-world usage. This problem is particularly problematic if test data can also be used for authentication, as the next story shows.

Appendix: References and bibliography

This appendix contains a list of all the reference material, news reports, articles and papers used in the research for this book. If you're reading this in an electronic version, just click the links to open online resources. If you're reading this on paper, go to humansvscomputers.com to find an online, clickable version of this appendix.

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