Mother Wode

(Preview, Chapters 1-10)

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http://www.tikalonpress.com

ISBN-10: 0985332506
ISBN-13: 978-0-9853325-0-1

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Author's Forward

Mother Wode is a novel set in the near future. The year is not explicitly stated, but the time period has many elements similar to the first decade of the twenty-first century, intermixed with an extrapolated future. Computers are much faster than today's computers, but computer scientists and computer programmers behave about the same. Also very similar to their present day counterparts are the corporate and academic cultures in which these people work. The human condition has not changed much through the years. Love, and the desire for a secure lifestyle, are still prime motivators. There may be people routinely working on the moon, but there are still bad guys back on Earth, and everyone would like more money.

A corporate computer scientist, a computer science graduate student and a computer hacker stumble upon evidence of a conspiracy to control worldwide financial transactions. Their curiosity fuels their attempt to discover the source and purpose of this conspiracy.

This book is dedicated to my wife Anne, who has had to live with a pastiche of some of the characters for many years; and to my son, Michael, and daughter, Marianne, who read the final draft and noted improvements.

This is a work of fiction. All characters appearing in this work are fictitious. Any resemblance to real persons, living or dead, is purely coincidental.

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1 Mother Wode

Michael Martelli was not the type of student who ran from place to place. His life's motto was that all things happened at their own rate, and speeding through one task would just make you arrive at the next task too early to do something useful. However, today was an exception to his life's rule. Today, Michael Martelli was running for his life. He must not be late for today's interview, since the entire future course of his career might depend on its outcome. This would be the first face-to-face meeting with a representative of his future employer, and folklore stressed that first impressions are crucial. In this case, Michael wasn't going to act contrary to tradition. As he walked past the familiar university buildings on his way to the distant student parking lot, he began to reminisce about his student career and the university in general.

The structure of universities started to change in the early part of the twenty-first century. Universities had become increasingly dependent on industrial support, and the successful research universities began to grow at the expense of the smaller private and public schools. Finally, all pretenses were dropped, and university programs became just another profit and loss center of large corporations. At first, the faculties were resistant to the change, and cries of lost academic freedom were widespread. But the most successful professors had been “on the take” for years, and they rather enjoyed the liberation from the bloated academic bureaucracy that had developed around the money sources. Finally, the authority to grant degrees was wrested from the universities themselves and given to Chartered Academic Guilds. The original argument for establishment of the Guilds was to reign in all the shady “distance learning” enterprises that had sprung up out from the original Internet, but the changes transcended mere accreditation. The professor-student relationship was shifted to a master-apprentice model, and all this had worked to the benefit of the large corporations.

East Wodenstumpf University had been on the fringe of this restructuring. It had been too small to be a real research university, but too large to be ignored completely. One thing that Mother Wode had was location. It was close to several powerful corporations. Not only that, but several top names in Computer Science had decided that the Atlantic beaches and friendly neighborhoods of East Wodenstumpf were preferable to the Pacific beaches and very highly priced neighborhoods of most West Coast universities.

The biggest enigma surrounding East Wodenstumpf University was its name. Yes, there was a city called East Wodenstumpf. It served as logistical support for the university and habitat for most of its employees. College students were still fueled by pizza and Chinese food and the occasional risqué cinema, and there was an abundance of purveyors of these in the many small establishments within walking distance of the campus. The enigma was that there was no Wodenstumpf; nor was there a North Wodenstumpf, South Wodenstumpf, or West Wodenstumpf. Most records of the city's founding were destroyed by a fire at about the time of the Civil War, but some explanation was pieced together from other sources. It seems there was a falling-out of bothers (Wodenstumpfs, of course) that led to an East-West split in the town. Over the years, East Wodenstumpf prospered and expanded. West Wodenstumpf faltered, and finally disincorporated. The records of the matter are hazy, but some fiscal malfeasance in the city administration appeared to be the root cause. When the West Wodenstumpf town hall caught fire, it didn't help that the fire department was ill equipped because its funding had been siphoned away over a number of years. There were reports that the town hall fire was arson, done to burn the records of some scandal. It was all downhill from that point. With the demise of their western rival, the citizens of East Wodenstumpf had the opportunity to shorten their name. However,

the expense of making new signs, or merely chopping away parts of signs, was voted down, so it's been East Wodenstumpf for more than two hundred years.

Michael Martelli was at Mother Wode because of the fearful combination of chance and the prepared mind. He had been a curious and precocious child. Since he liked taking apart his toys to see how they worked, his parents decided that he would enjoy the converse activity – putting things together – so they showered him with kits. These were at first models of automobiles, aircraft and rockets. Later, there were electronic kits for radios, door chimes, and finally simple robots. Robots were a turning point in his life, not merely because he could race them around the house to the occasional gasp of family and friends, but because they were programmable. This was liberating for a young boy who was always taking orders from others. Now, he was the master! He could give the orders!

After he had exhausted the limited instruction sets of his first programmable robots, Michael found network sites with instructions on how to "hack" his robots. He thought that the word "hack" was apropos, since the first step was to cut something open, typically with a hack saw. In reality, the earliest computer programmers coined the word, "hack," to refer to the quick fixes they sometimes did to existing programs to make them work in a different way. The word eventually became applied to the clever application of computer code to a specific problem, and later to the modification of consumer appliances to do odd things; like a coffee maker with a built in steam whistle to signal when the pot was ready. Hacking his robot kits allowed Michael to do things not usually seen in any household, such as dancing pairs of robots that responded to the beat of the music. By the time he had reached middle-school, his knowledge of programming was at a university level.

At the age when every other secondary school teenager was struggling to write acceptable computer programs, or at least programs of the type required to get a passing grade, Michael was spending most of his time on mathematics. He excelled in mathematics, and it's the ability to apply mathematical and logical reasoning to data structures that separates computer scientists from mere programmers. For one science fair project, he calculated pi to a million decimal places using the computing power of his computer's graphical processor chip and Machlin's arctangent series. Since the graphical processor couldn't do both its display tasks and his algorithm at the same time, Michael's computer chugged away for days with a blank screen. It was only when the computation was finished that he could check his results with another program that calculated just the few digits of pi around its millionth digit. He won that science fair not just because of his ability, but also for his showmanship. He printed the results on a ribbon of paper that he pasted around the high school gymnasium.

After secondary school, Michael Martelli became a willing participant of the University-Industrial complex. He enjoyed computing, so it was an easy decision to continue in computer science at a university. East Wodenstumpf University wasn't exactly a Mecca for the computer literate, but it was nearby, and he didn't like the "Distance Learning" concept. If he must be apprenticed, then it would be at a brick and mortar university. Besides, the social life would be better. A computer geek could only hope.

Although he was more prepared than most students, his university career was not a romp. There were other things required of him than his mathematical and computer skills. He was expected to be somewhat literate, an armchair historian, and a philosopher. Furthermore, because of the intimate link between computing and its primary application in the sciences and economics, he was forced to take introductory courses in many topic areas he would choose to ignore. At times he was tempted to leave without a degree and get a programming job, possibly with some startup company where his innovative talents would be appreciated. But the "A"s in his computer and math courses balanced the "C"s in his other courses, so he stayed at the Mother Wode. Michael's computer science skills did not go unnoticed among the Mother's faculty. When he had completed his undergraduate training, he was quickly apprenticed to one of the more eminent Master Professors of computer science. At that point,

his education accelerated, since it was all computer science with none of the cocktail-party-conversation subject areas he had detested as an undergraduate.

Michael reached his car, carefully parked in a student slot at about 6:00 AM that morning. He had gradually become an early riser when its advantages became apparent. Most of the undergraduates still tried to postpone their first class to as late in the morning as possible, and they struggled with traffic and parking as a result. Few cars were on the roads when he traveled to the university in the morning. Few students were apparent on campus at 6:00 AM, so he got his pick of parking slots. There were other perquisites, such as fresher coffee at the campus eatery, Wode's End, and time to think before the hubbub of civilization filled his campus building.

As usual, his windshield was festooned with leaflets about one event or another. Michael laughed that the “Save the Trees” people would doom so many trees to spread their word. He popped the door of his car's trunk, and tossed his mobile computer onto a pile of soft debris sitting there. “I've got to do something about this mess,” he thought, “But at least it serves as impact protection for the computer.” Settling into the driver's seat, he felt exhilarated as he started his engine.

2 Haematite

Michael had seen the industrial campus before, but it never ceased to impress him. Here was the corporate realization of the Robber Baron mansions of the last century. There were flowing fountains, manicured lawns, abstract sculpture, huge windowed facades, and plush carpets. There was even a human receptionist at the front desk and not just an automated help center. What impressed him the most was the parking. As a student at Mother Wode, he was required to park in lots at the distant perimeter of the campus and trek at least ten minutes to his office. Haematite, the corporation that had funded his education, had a parking lot right at the front of its building, and his walk to the front door was less than a minute. In the rain, he might not even need an umbrella.

The receptionist invited him to sit in a huge, overstuffed chair, while she buzzed the University Liaison Office. After a few moments of tapping his feet to the latest elevator music, an attractive young woman arrived to escort him into the offices of the inner sanctum. He was supplied with coffee and an exotic tropical flavor snack bar while waiting for the Director to finish a call. The snack bar was so good that he pocketed the wrapper in the hope of finding the brand at the food market at a reasonable price. He didn't discount the possibility that it was a custom foodstuff designed for this particular corporation.

Robert Moses, the Director of University Programs, was a somewhat plump man in his early fifties. He had a ready smile, firm handshake, and considerable people skills; in short, the perfect man for the job. Moses directed him to a chair across from a small round table and sat across the table from him.

“Michael, I've heard such wonderful things about you from Master Professor Sterba! He says that your progress has been superb, and he's about to recommend you to the Guild for certification as a Doctor Philosophiae. You know what that means!”

“That my sheepskin and thirty dollars can buy me a good cup of coffee?”

Moses laughed. It was a sincere laugh, although that ability could have been a prerequisite for his job.

“You must get out more often. It's more like fifty dollars, now, for a better cup. But that goes to the heart of what I meant. It's time for a real job! With a job, you can pay those outrageous coffee prices, hook-up with a nice girl, buy a house - all that normal living stuff!”

Michael knew before Moses' speech that this was the purpose of their meeting. His university days were ending and his indentured servitude was about to begin. It was time for Michael to settle down.

“Of course, you have the option of working anywhere,” Moses suppressed a chuckle, “But we would like you to work here.”

Michael could understand why Moses chuckled. Yes, he had options. They were required by law. He could repay the corporation for all the years of his training and move on. But another corporation would never pay for his freedom for the privilege of hiring him. Beyond all the unwritten rules of the game, there was no tax incentive in such a transaction, whereas Haematite Corporation had been getting a terrific tax break for funding his apprenticeship all these years. The only viable option for buying his freedom was paying the bill himself, which was not at all practical. As all the other apprentices before him, he would take the only viable route and sign on with Haematite.

Moses continued. “Haematite has some interesting ongoing research you could be a part of. I'm not a technical person, so I really can't explain it, but I've arranged for you to meet with Dr. Sandra Webb, one of our Computerati, so she can explain. I understand that you would be working for her.” He shuffled through some papers. “I see that your Non-Disclosure Agreement is in order, so you and she

can talk freely about what you can do for Haematite. Let me buzz her."

While Moses stroked his transceiver, trying to reach Webb, Michael had time to study the office. It was spacious by most standards, but sparsely furnished. He read once that an executive's importance was in inverse proportion to the number of items on his desk. By this standard, Moses was quite high in the corporate food chain, since his desk had only a transceiver and one other display. The display cycled through family photographs, and Michael speculated that this was the primary purpose of the display, if not its sole purpose. There was no keyboard, but most non-technical people used voice recognition almost exclusively. Keyboards were only needed when someone needed to scratch out some equations, or do programming. The wall hangings were photographs of early industrial settings. They were probably images of Haematite's early history.

"Dr. Webb will get you in a few minutes. She's finishing something... or starting something... whatever it is, she said it won't take long." Moses extended his hand, and while they were shaking hands, he steered Michael to a seat in the outer office. The pep talk and interview were over.

When Sandra Webb blanked the transceiver, she nearly launched into the usual string of expletives she reserved for times when management interrupted her work. In this case, she realized she had mixed feelings about the call, since this newbie might become a useful assistant. It was only two years ago when she herself had been the newbie, so she was able to muster some empathy for him. Her only concern was that he was just another average performer from East Wodenstumpf, Haematite's local nursery. She grabbed her dress whites - a lab coat rarely worn, but useful in hiding whatever crumpled mess she was wearing at the time - and walked down the corridor to the executive wing.

Sandra Webb, Ph.D., had apprenticed at Stanford with a Master Professor who would have won a Nobel Prize if the Alfred Nobel Foundation hadn't gone bankrupt and out of business several years prior. She certainly wasn't sponsored by Haematite. She was sponsored by a much more prestigious corporation, Tressor Systems. Unfortunately, the smaller Tressor was acquired by Haematite in a hostile takeover. Her management left en masse, but she was transferred like all other property to Haematite, and Haematite promptly relocated her here. Sandra was married to her work - no close family, no boyfriend, not even a cat - so the relocation didn't affect her lifestyle at all. At times she missed the temperate weather, but that was about all. She was actually starting to enjoy a real passing of seasons, but winter driving still made her nervous. Blizzards typically meant an overnight in her office, but she didn't mind. Sandra had come to the realization early in life that she was defined by her work.

At Tressor, she worked on autonomous agents that scanned local area networks for unusual traffic. This could be caused by hardware problems, or, more likely, malicious attacks by competitors. This was an outgrowth of her apprenticeship, and it was important enough to be funded now by Haematite after the Tressor takeover. At first, she resented the takeover as much as Tressor's management did, but she was doing the same sort of research, so a name change didn't seem to matter. As a benefit, Haematite seemed to have more financial resources than Tressor. Slow, but steady, really did seem to win the race.

Moses' secretary identified her on sight, and introductions were made. Sandra led Michael to her office, not by the same long corridor through which she had come, but by a more impressive "Scenic Route." There was, of course, the obligatory view of the clean room, a Class 1-50n facility in which only one particle larger than 50 nanometers per cubic meter of air was tolerated. It was a great place to work if you have allergies, but for a different reason than you would expect. All the workers breathed through air supply tubes, since one breath into the room would shut down the operation for days. The operators' white suits were specially coated so they would not shed particles or fibers when rubbed, and there was a near cyclone of filtered air flowing from ceiling to floor, sweeping any rouge particles out of the system. Electrostatic precipitators handled particles too small to be filtered.

The clean room personnel were working on standard electronic circuits with a few nano-mechanical twists. Many decades ago, quantum computation was touted as the holy grail of computation. Laboratory tests on small computation cells were impressive, but when people actually started building practical-sized circuits, they discovered fundamental problems they should have realized much earlier. First, quantum states cannot be maintained indefinitely. They tend to spontaneously disappear by a well known process called spontaneous symmetry breaking. Also, as useful functions were built from the standard cells, the physical size of the device necessarily increased. Through the fundamental properties of quantum mechanics, the electron wavefunctions spread out to encompass the entire device. This increase in spatial extent resulted in calculation errors. All this was related to the Heisenberg Uncertainty Principle, which states, in effect, that you can have peanut butter, or jelly, on your nano-sized slice of bread, but not both.

After the quantum roadblock, physicists had to devise physical shortcuts to achieve rapid computation of important functions. As usual, they were helped by some very old research. Ernest Chladni, a French physicist at the time of Napolean, had discovered the strange acoustical modes of vibration in irregular plates. He sprinkled sand on thin metal plates, and when they were excited by a violin bow, the sand would settle into a pattern in places where the amplitude of the vibration was small. After a while, the mathematicians got into the act, and they were able to analytically describe how these vibration modes related to the irregular boundaries of plates. In effect, you could simulate a mathematical function by a properly shaped plate. When nanotechnologists were able to make very small plates that would vibrate at high frequencies, Chladni Computation, the rebirth of analog computers, was born. It was most useful for signal analysis and filtering of data streams.

After the scenic tour, Sandra's office must have been a let-down, but Michael didn't seem to notice.

"Is this where you do your work? Nice place."

"Well, Haematite would probably like it that way - low overhead, and all that. As you know, we Computerati don't require much more than a display panel and keyboard. However, when I relocated here from Stanford, I insisted that as a scientist I needed a laboratory. I'll show it to you later. I keep up the scientist charade by wearing this coat."

They both laughed. Sandra was starting to warm to this character.

"So tell me about your work."

Michael started the elevator speech, but Sandra seemed genuinely interested, so the description dragged out into a half hour. There were dueling scribbles between Sandra and Michael on the white board, and Michael pulled-up some of his published papers on the panel. At one point, he forgot a link path to a publication, and he needed to search for it. Sandra was impressed when a keyword search on just his name yielded hundreds of page hits. This guy may just work out. When the conversation wound down, Sandra led him to her laboratory. The laboratory was small, but not cramped, and it had white boards filling three of the four walls. In one cozy corner was a desk with two large display panels and a keyboard.

"Watch this," said Sandra.

She poked at a wall switch, the lights dimmed to a restful illumination, and there was the sound of breaking surf off to one side.

"The sound can be changed. I sometimes use a setting called Forest Murmurs, but Surf Sounds is my favorite – probably imprinted on me during my California days. The sound is necessary to drown out the low level hum of the clean room machinery. Conducive to Deep Thought, wouldn't you say?"

Michael was awestruck. If this was servitude to Haematite, he could get used to it. Sandra took the chair at the desk and offered him another. Now that she was acquainted with Michael's work, it was her turn to present.

"Haematite's foremost and most successful business is electrical futures. As you must know, there

are nearly as many industrial generators of electricity as there are users. Everyone is doing co-generation from their waste heat sources, updraft turbines, solar converters... things like that. Along with the power transmission grid, there is a shadow communications grid where users bid for electrical power, and the generators set asking prices. It's like a specialized stock market, and it works like the stock market. Everyone wants to buy low and sell high, but there are many parameters involved, one of which is transmission cost."

"Although the superconducting backbone transmission lines are lossless, this efficiency comes at a cost; namely, amortization of the physical plant, maintenance of the cryogenics, vacuum systems, etc., so there's a per mile cost for transmission of electrical power. You would like to buy your power close to where it's generated, but sometimes that's not possible. However, there's a complex grid of other buyers and generators of electricity between you and some intended power sources. With appropriate calculation, you can offer a lower price to some of these buyers, a higher price to their generators, take your power off the top, and make some money on the deal. The problem, of course, is that these computations aren't easy to do, but you need to do them fast. The market moves in microseconds, and there are so many players that it's hard to find the lowest price, and find it before someone else does."

Michael interjected. "A perfect job for intelligent agents, but these autonomous programs can't be allowed on the same network. It would turn into a battlefield."

"Precisely. You need to follow the rules of the game. You can query individual suppliers for prices, or put out a bid, but you aren't allowed to host intelligent agents on the network to collect information on all the transactions. So, what you can't do in software, you do in hardware. That's where Haematite comes in. Haematite has its own shadow network of computational nodes that tap into the power network at various points. These nodes act like small users or generators of power, and they send out bids and offers just like everyone else. The trick is this – each of our nodes knows the existence of the other Haematite nodes and what they're doing, but no one else does. That way they can get the same data an intelligent agent would if it were allowed to roam the network, although not as efficiently. A little more expensive, yes, but the stakes are high in this game."

"It's a very interesting computational problem, but the whole thing sounds illegal."

"It isn't illegal. It's a fairly old game the economists call arbitrage. We play by the rules of the game, just like everyone else. We make money because we're smarter than everyone else. The problem is this: other companies may be attempting the same thing; we don't know. We need to somehow analyze the data to determine whether they are, where they are, and how to defeat them. We need to make constant improvements to our network and our algorithms."

"And this is what you would like me to do at Haematite?"

"One of the things. Our staff Computerati at a satellite location have most of the power thing fairly well covered, and it shouldn't take too much time to write some code to do some analysis of transactions to find whether we're getting any competition in this. Although this search for competing agents and improving the optimization algorithm are interesting problems, the rest of the power thing is rather mundane stuff. Ph.D.s shouldn't do the mundane. Haematite, of course, is a diversified corporation and does a lot of different things, like the clean room stuff, for example. In order to survive, Haematite is always looking for other things to do, typically variations on things it has done before. That's why I'm here, and that's why Haematite sponsored your apprenticeship at Mother Wode. We work on the research end of all this, here.

At this point, Sandra paused. Perhaps for emphasis, or maybe because it was one of those things you don't blurt outright.

"What Haematite wants is to do the same thing with the stock market. Actually, the commodity market at first, since it's a simpler case."

"Wow! That's either the best idea, or the worst idea, in the world! Playing the stock market has led

to the ruination of many a poor soul. And then you have to consider the fact that by trading stock you're changing the same system you're studying. You could get yourself into a non-linear area, things start to oscillate violently, and you wipe yourself out!"

Sandra smiled. Michael's last point was the first bullet point on her risk presentation to management. This guy really did know his stuff.

"Exactly right on all points. But there are a few things to remember. First, they pay our hefty wages because the things we do are not easy. Next, the testing phase will be extensive. We'll throw some neural networks at it to check for robustness... things like that. This will definitely not be launched before Haematite is thoroughly convinced that the risk/reward ratio is where it should be. At that point, Management will take the blame for failure, because it's their decision, not ours. How's your schedule for the next few months?"

Michael was excited to finally apply his knowledge to real problems, and he also understood his obligation to repay Haematite for his education. If he remembered right, built into his contract was a transition period between the time his dissertation was drafted and finally defended in which he was expected to start working for Haematite. His dissertation was essentially "in-the-cache," written, pretty-printed, and sent out for comments, but his Master, Professor Sterba, had a few more papers for him to write. Sterba was coauthor on all these, and he had an extreme vested interest in having these submitted before Michael was out of his grasp. In fact, Michael's dissertation defense would not happen until all were submitted for publication and Sterba could handle things from there. Sterba was a stickler for details, so all this would take time.

"Doctor Webb, have you ever met Professor Sterba?"

"Call me Sandra. No, I haven't, but I did hear him present something at a conference about two years ago. The paper was well crafted, but he seemed like the European Proper Professor type."

"You've got that right! You can understand that I have quite a few loose ends to handle before Sterba will schedule my defense."

"What about two days a week at the start, ramping to full time after your defense. When you start working full time, you'll be salaried at the appropriate level. Until that time, any work you'll do will be based on that salary, pro-rated on the number of hours you work. Just a little incentive to get the most out of you. Sounds fair?"

More than fair. From starving student to employed Computerati. He could buy that new display panel he had been lusting after for months and upgrade his wardrobe. Still not enough money for a girlfriend, but he didn't have time for that right now. You give up a lot for your craft.

"Yes, that's fair. Can I set my own days? You know, things will change from week to week."

Let's make Tuesdays a definite, with another floating day during the working week. I'm often here on Saturday, so you can consider that a working day, also."

"Doesn't your husband mind?"

"No husband or significant other. At this time, I'm married to my work...," Sandra thought she shouldn't give the wrong first impression, "...Not that I'm disinterested. No opportunities have presented themselves."

"Sounds like a copy of my life, but I'm still a student."

Bad choice of words! He didn't mean to offend. At least from her expression, she didn't seem to react, so he got off easy.

"Yeah, that's the Burden of the Computerati. Next Tuesday, then?"

"Sure."

A few minutes later he was exiting the manicured beauty of Haematite Corporation back to the granite buildings of Mother Wode. As he drove, Michael rehashed the visit in his mind. Haematite's physical plant was impressive, everything from the landscaping to the walnut paneling and original

artwork in the reception area. While in the reception area, Michael immediately recognized what must be a very expensive serigraph by Robert Rauschenberg. He realized that all this wasn't there just to give the employees a nice working environment. Such a show of conspicuous consumption was there to impress Haematite's customers. Only a corporation making a good profit could afford such amenities. And then there was Sandra.

First, Sandra as the computer scientist. There was certainly nothing unusual about a female computer scientist, since the genders were split fairly evenly in his field. In the last century, when women typically avoided mathematics, and computer science was decidedly a subset of mathematics, his field was dominated by men. When the sociologists decided to study this phenomenon, they discovered that math aversion in schoolgirls was more a product of subjective factors than a difference in brain function. After some government sponsored programs, a few girls actually surpassed the boys in their classrooms in math ability, and the visibility of these role models acted as a catalyst for the eventual equalization of the genders in all technical fields.

Then, there was Sandra, the woman. During their brief conversation, as Michael became more comfortable with her, he started to assess her possibility as a sex partner. He didn't feel at all guilty about this, since he had learned from the youngest age that this activity is hardwired into a man's brain. The locker room argument was that if men didn't behave this way, the human race would have gone extinct a long time ago, so men should feel guilty if they didn't think that way. The formal argument, which he learned later in a philosophy elective course he had taken, was called the Categorical Imperative. Sandra was rather attractive. Michael's question about her supposed husband's complaint about her work hours was the first step in a sequence of logical statements that would refine the probability of his success. At this point this probability had barely crept ahead of zero, but at least some progress was being made. As for now, though, it was best to concentrate more on his driving, since traffic was starting to pick up.

3 Towards the Prize

The rest of the week ran smoothly. Professor Sterba was out of town, at a meeting of the editorial board of a journal for which he was editor, so Michael could do a lot of work without interruption. While drafting one of the papers, Michael found a gap in the analysis that was too wide to ignore. He went back to the original data, and after some serious number-crunching on the Mother's central processor, he was able to produce a graph and summary table to support his conclusions. It was likely this type of attention to detail that encouraged Sterba to bring him on board in the first place.

This first paper was nearly finished, and he had taken some care in his writing. First, he tried to anticipate any objections the old professor might have and to flesh-out the text accordingly. Next, he scanned several of the current papers in the Journal of Autonomous and Intelligent Agents, the place where his paper would appear, to subsume the look and feel of the type of paper that was accepted for publication in that journal. Finally, he produced his final version of the draft to mimic exactly the format of that journal. Having a draft look exactly like a published paper sent a subliminal message to the editors and referees that this was publishable material. He was reminded of a story he had heard as an undergraduate about an astronomer who sent his friends copies of a paper on a controversial topic. The draft was prepared in a style that exactly mimicked that of a prestigious journal. This was long before desktop publishing – he actually had to have it typeset and run off by a print shop – so everyone believed it had been published in that journal. The end result was that there was serious talk about his controversial theory before the circumstances were revealed. This was exactly what he wanted, to get people thinking. Michael didn't know enough about astronomy, or the history of the matter, to know whether the theory was found to be true. It was a good story, nonetheless.

Rogue scientific papers had run rampant on the networks. There was a plethora of junk science out there that couldn't be published otherwise. A skilled scientist could usually sort the wheat from the chaff, but all this got the established journals very nervous early on. With the help of their own Computerati, they devised a digital signature system that not only identified a paper as a true scion of their journal, but verified that it had not been subtly changed. Each paper was associated with a lengthy number. When you fed the content of the paper and the code number of the journal into a certain algorithm, you would get the code number of the paper if the paper were genuine. Some cryptographic scheme made all this work. Michael had only a rudimentary knowledge of cryptography and had to take this on faith. He knew that there had been many attempts to break the algorithm, and all had failed.

His first day at Haematite was about what he expected. He spent a long time in an office filling out personal information forms. This was information that he had supplied earlier, during his internship, and he was amazed that they couldn't pull everything together from existing databases. But he was a Computerati, not a bureaucrat, so he just wasn't thinking straight. He was retinal-scanned, fingerprinted, voice-printed, and otherwise-printed. He was reminded of days past when young women would shed their underwear, hike up their skirts and scan their backsides on the primitive copy machines of their era. At least he wasn't required to do anything like that, but he was certain that several of his MRI full body scans resided on some Haematite computer, somewhere.

Michael was given a biometric ID badge, and he was issued several passwords. Sandra set him up in an office, and then ignored him most of the day. Apparently, Sandra's laboratory was her personal hideaway, and she wasn't about to cede space to a potentially annoying intruder. Michael passed the time by catching up on current papers and ordering his own lab coat. He chose a pale blue color to

offset Sandra's white, but he doubted he would use it much. Maybe Sandra would require it at meetings with the management as a way to separate the scientists from the bureaucrats. Sandra cut a fine figure in her coat, but he doubted he would turn any female heads wearing his.

Professor Sterba had returned to Mother Wode, jet lagged on the first day – he had scheduled his meeting for Vienna, of course – and didn't even say hello. However, his second day back was a different story. When Michael opened his calendar, he saw that he was five minutes late for a meeting Sterba had set up the night before. He raced to Sterba's office and found him engrossed in a call. He stood outside the office door for several minutes before Sterba logged off and invited him in.

"Mr. Martelli, sorry for the delay. I've been patching loose ends nonstop since I've arrived back from my trip. I've read a message that you've started the transition to Haematite."

"Yes. It's just two days a week at the start – not too taxing. I haven't really accomplished much."

Sterba continued, "You won't let your work schedule interfere with what is required of you at East Wodenstumpf, will you? After all, these last few weeks are the culmination of all your efforts here. It's no time to become too distracted."

Michael, of course, had anticipated this query. It was classic Sterba.

"My transition to Haematite hasn't really affected my final tasks here. If you check our file cache, you'll see a draft of the first publication, the one on stochastic network automatons."

"Excellent! Exactly what I had hoped to hear! You must remember that apprentice contracts work both ways. Haematite has an obligation to you, and secondarily to me, to facilitate your dissertation defense and these exit tasks. Although you have an obligation to work for Haematite for the next few years, there's the future to consider. Haematite may not be interested in publications, but it is important for you to publish and establish yourself in the field. Otherwise, your future options will be limited, and you may be stuck at Haematite." He paused for a second. "Not that Haematite is all that bad, of course. They've been very good to both of us over the years."

Money, especially big corporate money, has a way of cementing friendships.

"No, I have no complaints. I'll start work on the next paper. You should see something in a few weeks."

"Oh, don't drag things out that far. Let's see how it looks in two weeks. I'm sure that won't be a problem, will it, Mr. Martelli?"

A rhetorical question at its best. Once again, classic Sterba, with a dose of Frederick Winslow Taylor.

"No, I think I can pull things together by then, but it might be a little rough around the edges."

"That's expected, but as they say about that journey of a thousand miles, it's good to make that first step, but then keep things moving along."

As Michael exited Sterba's office, his mind was already spinning a schedule for the next two weeks.

The next day, Saturday, was his last chance to do his second working day of his first week at Haematite. That is, if you counted your week starting on Sunday, and not Monday. Calendars tended to go either way, since there was still no universal consensus on which day really started the week, although Michael was partial to Monday. After all, why were Saturdays and Sundays part of the weekend if they weren't both at the end of the week? He forced himself to bed by midnight the night before, so he wasn't too much of a zombie the next day. When he arrived at the Haematite gate house, he startled the guard out of a very deep reverie, or perhaps it was outright sleep. The guard seemed surprised to see anyone on Saturday, especially at such an early hour. Michael proffered his badge. When the guard saw his Computerati tag, he mumbled, "Oh, yeah," and let him through.

He hadn't really planned arriving on Saturday, but he thought a Saturday might be a good day to interface with Sandra. No one else would be around, and she might be more available. He needed to get some background and direction from her – at least pointers to some relevant documentation – or he

would be spinning his wheels. Michael did not like spending time uselessly. It was against his nature, and it was possibly another trait that Sterba admired about him.

Sandra was in neither her office, nor her laboratory. He had nearly written off the day until he spotted her in a corridor with a cup of coffee. The coffee aroma was wonderful.

"Michael, I wondered whether I would see you again this week."

"Hi, Sandra. Two things. First, good morning. Second, where can I get some of that coffee?"

"When I have the building to myself, I use the executive coffee station. Tastes much better. It must be a better blend, or maybe their assistants actually wash the pot once in a while."

On the way to the coffee, Michael explained that Sterba had him jumping, but not any more than usual. He was right about working Saturday. Sandra was much more relaxed and friendly. More importantly, she sat with him in his office, bookmarking several important documents for him, and giving him enough work for the next few weeks. She retreated to her laboratory after offering to take him to a local restaurant for lunch. Although she didn't say it, there was a tacit understanding that she needed to work undisturbed until lunch.

As he surveyed the documents, he realized the size and complexity of the operation. Haematite's shadow network had thousands of nodes, distributed among all the US states and the Canadian provinces. As he pulled data into graphs, he saw that the node distribution was in close proportion to population density, and, by implication, to power usage. Each node was a custom built computer with two wide bandwidth optical pipes - one to access the power marketplace network, and the other to connect to the Haematite hidden network. Because of the large number of nodes, the capital expense of the network ran into tens of millions of dollars. There was also the recurrent expense of the interconnecting network. The Computerati who did the initial installation had used a Traveling Salesman optimization on the network connections to both minimize cost and maximize speed. If a competitor decided to compete with Haematite in this game, it would take at least a hundred million dollars and more than a year. It proved both the adage that it takes money to make money; and, that time is money.

In the back of Michael's mind was his original idea that what they were doing was illegal, or should be illegal. It seemed as if Haematite was making a lot of money by tricking power generators into selling at an artificially low price, and then tricking the power users to buy at a higher price. He was reminded of a twentieth century scheme to corner the silver market. At one point, a small group held claim to half the world's silver, but the attempt failed with disastrous consequences to everyone involved with silver. Immersed in his work, Michael lost track of time until Sandra arrived at about 12:30.

"Sorry I'm a little late. I guess most people expect lunch to be at noon. Are you ready to roll?

"Sure. I'm really starting to understand things now. I'll have a few questions for you over lunch."

Michael blanked his display, and they exited to the parking lot. Sandra led him through a shortcut he hadn't learned. The building was cavernous, and he was certain it would be many months before he had toured every wing. When they arrived at the parking lot, he was surprised to see Sandra's vehicle. It was a late model, two seat, sports convertible, sans roll bar. Rapid-deploy carbon composite roll pivots, an innovation to replace the unsightly, but government mandated, roll bars, did not come cheaply. His general impression of Sandra as a lab rat with no social yearnings was starting to change.

Anticipating his question, Sandra said, "I got a great deal on the wheels. The car was previously owned, but in mint condition. I think the owner had one for every day of the week. Haematite pays its employees well, but usually not well enough to afford such luxuries."

The restaurant was only a few minutes from the site. It was quite large, but there were few cars in the lot, and few people inside. The place was designed for the Monday to Friday crowd. Sandra and Michael were seated in a window booth in a somewhat secluded area. Michael got the idea that the

hostess thought this was a romantic lunch for a couple that didn't want to be noticed.

Sandra started the conversation as they paged through the menus on the tabletop displays and keyed their selections.

"They get a lot more business during the usual work week. Not only the Haematite crowd, but there are quite a few other corporate sites in the area. So, what do you think about your first little project at Haematite?"

"After reading the docs, I can't say that this is a little project. This is serious stuff. I guess it's not unexpected that I had no idea what goes on in the real world. I knew Mother Wode was a sheltered environment, but I didn't realize how sheltered it was. There I was, running simulations on how Grandma's electronic messages are routed to her grandkids, and millions of dollars were zipping around underfoot! It's a whole different world."

"Yeah, it takes a while to get used to the scale of things, but at the code level, it's all the same."

"I'm still concerned with the underlying ethics of this venture. You said it's legal, and I'm sure the Haematite lawyers checked and double-checked things before it was implemented. There are likely teams of lobbyists out there steering the laws to ensure that the status quo holds. But the base idea is that we're using trickery to broker transactions. In economic parlance, it's not a level playing field. We've tilted it in our favor."

"Nowadays, almost all money is made that way, at least in brokerage. The smart trader is the one who wins, and we just use our technology to increase our smarts. As for social implications – stealing money from orphans, and stuff like that – what we do may even help society. The money Haematite makes isn't just thrown into a hole. We hire new employees, and we use it to buy goods and services from other companies who hire new employees. It's the same argument for increased government spending. That single government dollar changes hands so many times, the government gets back more in taxes than what it spent in the first place."

Michael thought for a moment.

"Hmmm... the dreaded second-order effects. The simple analysis does not apply. OK. I'll take it on faith at this point."

The waitress arrived with their orders. Michael steered the conversation to personal matters in an effort to understand this intelligent and attractive woman who was now his immediate supervisor and quite a change from Sterba!

"You said you were from Stanford. A rather impressive place. How did you end up in the area?"

Sandra recounted the acquisition of Tressor Systems, her initial misgivings about Haematite, and her acceptance of a new reality.

"I really enjoy my work. Sure, there are a few interruptions – calls from management, monthly progress reports, project reviews, stuff like that – but I'm usually happy when I'm in my laboratory. Everyone seems to understand, and they leave me alone. I can get away with it, because they know I produce, and dollar signs are what these guys understand. It doesn't hurt that we're highly-compensated employees. A Ph.D. is a professional employee, just like a corporate lawyer. Everyone else gets a cubicle, and we get an office. "

"Yeah, the perks are good. There's also what someone said once about physicists and baseball players – They both get paid a lot of money for doing something they enjoy. It applies to Computerati as well."

"Our game was so good that the physicists tried to capitalize on it in the late twentieth century with the rise of the 'Quants.' Sure, they made it seem like what they were doing was applying arcane statistical physics principles to the stock market, but in the end it was just data mining and algorithms, just like what we're doing now."

They were talking so much that they had ignored their food. Sandra had ordered a tuna sandwich

which was still in its pristine state, but Michael had ordered a hamburger and fries, which were now cold. He decided to eat just the meat part of his hamburger, and he only picked at the fries. Sandra and he finished their meals at the same time, and as the check arrived, Michael wondered about the payment protocol. Was it the peer-to-peer protocol in which they split the bill? He certainly didn't think it would be the male dominant protocol in which he paid the whole tab. Sandra diffused the problem by putting it on her company card.

"Every new employee deserves at least one welcome lunch, or what's a company for?"

On their return to Haematite, Michael spent the rest of the afternoon organizing his office, which principally meant customizing the look and feel of his display panel and loading some favorite applications. Most of his application programs were free. These were user-supported software packages built up over generations on the network. He had himself contributed a few snippets of code to some of these. This was something that made him proud, although his contribution was likely only a tenth of a percent of each application. The pride came because his code did something useful, and it was fully vetted by his programming peers. His name was there, somewhere in the source code, and perhaps it would remain for a century or more, becoming more hidden as programmers expanded the code. Haematite was automatically billed for the few applications that didn't interest a sufficiently large cadre of coders to have a free version or were bundled with a specific network database.

It was nearly six o'clock when he decided to end his first working day. As he drove home, he realized that his work at Haematite would possibly be enjoyable. No one bothered him, Sandra was pleasant to work with, and the hefty paycheck had its own appeal. Perhaps he could finally buy a new car, stop renting, have his own home and buy a few appliances. He could even support a non-working wife, but for that he would need to solve the girlfriend problem first. And then there's the mother problem - Mother Wode, that is. His new life depends on Mother's approval. Michael's mind snapped back to reality and all the tasks laid out for him by Professor Sterba. He needed to jump through a few final hoops before he could fully enter the next chapter of his life.

When he arrived back at his apartment, Michael did something that he rarely did. He wrote a task list. He generally maintained a task list in his head, shuffling priorities as the need arose. He didn't worry about forgotten tasks. As he had read in many articles about time management techniques, any task not important enough to be remembered should be dropped from even a written task list. His mind acted like the bookmarking agent on his computer – most accessed information was at the top of the list, and things not viewed in a long time were relegated to the archive. Now that he was being pulled in several directions at once, he needed a task list to give both Haematite and Sterba their due. Otherwise, one or another would be shortchanged, and Michael couldn't offend either.

His required work out of the way, he grabbed a quick sandwich for supper and decided to kick back and watch a video. After all, it was Saturday night.

4 Bad Stats

As Michael pulled into his usual space at Haematite, he started to realize that his life was becoming routine, but it wasn't a bad routine The routine of a regular, and hefty, paycheck was welcome. At the turn of the twentieth century, there was a saying, “Another day, another dollar.” Towards the end of the that century, because of inflation and currency devaluation, the expression was true for a hundred dollars. Now, “Another day, another thousand dollars,” was more like it, at least for a Computerati with a Ph.D. Ten dollars today purchased a loaf of bread which sold for about a penny in the early 1900s. Of course, it wasn't possible to buy a display screen in those days, so progress of some sort had been made in the quality of life.

There were those who thought that display screens, and Computerati in general, had been responsible for a decrease in the quality of life. These new Luddites, or Noviluds as they were formally called, yearned for a simpler yesteryear that probably never existed. The true irony was that they used the technology of the present age, like network postings, to protest technology. Several decades ago, there had been some violent demonstrations, and there had even been bombings of some computer fabrication plants. In one case, an obvious inside job, a smoke bomb had been placed at a strategic air intake, closing a plant for months while contaminating particles were scrubbed from a clean room. Such violence had scared away many followers, but a vocal core group still remained. Michael himself had been accosted on campus by a group of young Noviluds who saw him leaving the computer building. Fortunately, it was mid-day, and all he suffered were a few verbal barbs.

The environment at Haematite was quite different than Mother Wode's campus. Either Haematite's personnel were more tolerant towards each other, or they were indifferent. Michael thought it was the later. Everyone was immersed in their own projects, so there was no time to even think about others on a personal level. There was certainly no Novilud sentiment here – everyone was living high off the technology pig, and enjoying it. He imagined the Haematite father coming home to find his children wearing shirts embellished with Novilud slogans purchased with his money.

Michael's near-term data-mining task for his second project, applying Haematite's shadow network to financial transactions, was somewhat routine. While his computer was chugging away in the background, amassing a huge data set, Michael was programming filters in the foreground, trying to make sense out this data fire hose. A fire hose was a good description, since the number of financial transactions was huge. Most were brokered by autonomous agents, each looking to attain a few pennies advantage in arbitrage from currency fluctuation or some emerging newsworthy event. Then there was the undercurrent of corporations buying back their own stock in huge quantities, either for employee bonuses, or just to reduce the cost of their dividend. Way down the list was the individual investor who thought the banks were in business to rip-off the little guy, and he would get a higher return on his money than the banks offered by eliminating the middle man. These people were generally deluding themselves, since they were fighting a war against ultra-fast machines armed with mathematical models honed through many similar battles. Michael didn't understand most of this, nor did it matter. Numbers were just numbers. Temperatures in South American rain forests, or insurance mortality tables - they were all the same. Although the specific task at hand was unique (or, at least, Haematite thought it was unique; business intelligence was never perfect), he had done similar things repeatedly in his student career, so he wasn't over extended by any stretch.

As data were harvested over the course of days, an expected pattern emerged. Looking at all transactions in any given period, the dollar amount of the transaction plotted against the number of

transactions gave a power law distribution. This was a consequence of the simple fact that large transactions happened infrequently, and smaller transactions happened more often. Such behavior exists in many natural process, such as the number of species per genus in a given geological period, and the intensity of solar flares. A power law also describes many man-made processes, such as the frequency of words in novels, the number of followers of religions, and the number of deaths occurring in wars. It was as if we humans, despite all our culture and civilization, could not really distance ourselves from Nature. Large nuts go in this pile, and small nuts in the other. The existence of a power law distribution didn't tell Michael anything other than his dataset was accurate and complete.

This data harvesting exercise was getting boring, so Michael was spending more time at Mother Wode, polishing up his manuscripts. When he decided to check his data again, he noticed something odd. The distribution of transactions was still following the definite power law trend, but occasionally there would be a data point quite a bit out of place. Early in the analysis, Michael had noticed this, but there wasn't enough data to be concerned. One rule-of-thumb in statistics is that errors are in inverse proportion to the square-root of the number of data points. What this means in practice is that you need a lot of data to prove anything. In the case of a power law process, where you're looking at data over a large range of magnitudes, this proscription is that much more severe. But now, he had enough data to fit the power law and look at the residuals, the deviations from the fit. Some points stuck out like sore thumbs.

It's not as if such an occurrence was unusual to a computer programmer. It typically meant that he made an error in his code – Things like counting from one instead of from zero when accessing a data array, or a poorly constructed logical expression. Crap! Writing code is easy compared with debugging code! Michael had flirted in the past with some of the available error-checking programs, but the entire process still defaulted to the programmer scanning his own code, line by line, with a skeptical eye. Fortunately, his data harvesting programs were relatively simple. It would be a distasteful exercise, but it wouldn't take that long. Time for a cup of coffee.

As he went for coffee, he realized that the building was quite empty. A glance at a clock told him why. It was 6:30 PM, and his programming reverie had masked both the passage of time and the hunger pangs from his stomach. He passed Sandra's office and lab, hoping for a dinner companion, but she wasn't around. He decided to head home for a quick meal and tackle his debugging task the next day.

The next day started somewhat late. Sterba had sent him one of his infamous “need for speed” e-mails, the contents of which reminded him that they were working in a competitive field and asked for a copy of the most recent draft of a particular paper. Michael had been neglecting his writing duties while working on the Haematite data mining project, so he spent the evening actually doing a first draft of the paper, which he posted to Sterba at about 2:00 AM. He didn't awaken until late in the morning, and it was nearly noon when he arrived at Haematite. Fortunately, professional Computerati weren't on the clock. In any case, his after-hours effort the prior day easily erased any guilt he may have had.

The debugging effort went quickly, primarily because there weren't any bugs. The exercise did give Michael an opportunity to add some much needed comment lines in his code, something he often neglected to do in the heat of programming. Comments would prove invaluable if he needed to modify the program later, or reuse parts of his code. He thought that debugging would be a problem, but he was left now with a bigger, and more fundamental, problem; namely, why did these few transactions fall so far off the expected curve? Were the agents, whether human or machine, who posted these transactions making errors? The money involved was too great, at least from his starving student perspective, to allow such errors.

He did some searching to see whether this was a known feature in financial markets, perhaps attributed to the phase of the moon, or the times the Congress of European States adjourned for lunch.

He wasn't able to find any corroboration.

Most of the Haematite regulars were starting to leave. Although he felt guilty about arriving at noon and leaving at five, he was in a rut and needed time to think. That's what they paid him for, deep thought, twenty four hours a day, seven days a week. That's the lot of the professional. He's always on the clock because his mind is always active. This didn't apply to just waking hours. Analysis of a dream had often led to an important scientific discovery, such as the chemical structure of benzene.

Michael didn't drive directly home, since his cupboards were bare. They had become more barren than usual with his double shifts at Haematite and Mother Wode. There was simply no time to shop, and even if he did shop, there was no time to cook. The other home dining options, zipping ready-heat bagged meals or calling out for pizza, left much to be desired. He stopped at Miguel's, a Mexican restaurant near the campus, for a satisfying plate of burritos, corn chips and salsa. He ordered a Mexican beer as something to both relax and stimulate his mind. The restaurant was nearly empty, since the usual student clientèle dined much later in the day.

As he watched a boisterous group of all male students at another table, Michael remembered his first meal at Miguel's, when he was a freshman at Mother Wode. He had been part of a group of students that went on an impromptu field trip to attend a late night lecture by a Computerati superstar at another university. It was nearly midnight when they had returned to Mother Wode, and someone suggested a stop at Miguel's for food and beer. Michael wasn't yet of drinking age, but he had learned that if he was in the company of older students, no one bothered checking age when the drinks were served. It was a memorable night, not just for the alcohol, but also for the sage advice of the upperclassmen. He learned which professors were most respected in their disciplines, and which professors you should avoid when choosing a senior project; what computing fields were hot, and which were in decline and should be avoided. And, importantly for a poor student, where to get the best deals on the latest hardware. It was the information gleaned at this table that steered him towards working with Sterba.

That trip to Miguel's was one of his few group activities. He enjoyed them when they happened, but he was generally a loner. He had several friends, but he would see them infrequently. There were the occasional celebratory parties for graduation and the like, and he had even had his own graduation party with a dozen of his associates. It was just beer and snacks in his apartment, but that was their usual definition of a party. Some brought their wives, but there were no girlfriends. He wondered how there could be wives without there first being some girlfriends, but that was one of the mysteries of the universe best left to the physicists. He was never a gamer. He would see quite a few of his fellow students sleeping through their morning classes because they had been awake most of the night participating in multi-player games. These were computer students, so he could be fairly certain their stupor was from gaming, and not from wild partying.

Michael brought some printouts with him to Miguel's, and he spent some time examining his data analysis over the last few sips of beer. The sheer amount of data was enormous. Haematite had huge pipes to the network, and he was one of the few in the corporation who could take advantage of these. The one trouble he faced was that the tail was wagging the dog. Unlike physics, in which theory guides experiment, he was sorting through the experimental data looking for the theory. He had read once about the clash of cultures in physics that occurred while the Italian physicist, Enrico Fermi, was just starting his career. Italian physics at that time was divided into two camps. One of these advocated a shotgun approach for the experimental discovery of new phenomena, along the lines of switching the positive and negative battery terminals to see if there was any change. The other camp, the one to which Fermi subscribed, thought random experiments were a waste of time, and they allowed theory to guide them. In the end, Fermi's camp won, and their battle ribbon was Fermi's 1938 Nobel Prize.

Michael decided to call it a night. It was either the beer or the late hour, but he was having a hard

time concentrating. He would present his findings to Sandra and get her advice. It was her project also. Luckily, it was just a short drive from Miguel's to his apartment. He didn't think he was driving in an impaired state, but he was extra cautious on the short drive.

Michael arrived at his office the next morning earlier than usual. He collected his results into some easily understandable graphs and tables, and he went in search of Sandra.

It was mid-morning, so Sandra was in her laboratory. She smiled when Michael entered. He hadn't seen her in a few days. Was she genuinely happy to see him? He forced himself to subsume the student fantasy and concentrate on the work.

"Sandra, I've got some results here on the data mining. Something strange is going on."

Michael explained his results, emphasizing his code checking. After all, he was a professional now, wasn't he? There should be nothing left to chance.

"OK. I'm convinced, and I have no idea what's going on. Maybe it's time to call in an expert."

"An expert? You and I are the experts. What can someone tell us about computation that we don't know already?"

"No, not a computer consultant. Someone in finance and economics."

Sandra flitted along her display screen, accessing a company database.

"It looks like we've got an expert on retainer. Well, at least we're contracted with a knowledge company that has him on retainer. Malcolm Flory, Master Professor of Economics at Princeton University. Judging from his rate schedule, he's one of the best. The comments say he apprenticed under some Nobel Laureate. He might be our answer man. However, there's one bad thing about Professor Flory."

"Has the Old Man been shacking up with a graduate student?"

"No, nothing that bad. You could say he's eccentric - possibly Old School is the better term. He refuses to teleconference. He only communicates face-to-face. When you're as distinguished as he is, you can get away with it."

"He sounds almost like a Novilud. So, what do we do?

"You get to file your first expense report. You and I are traveling to Princeton."

5 Long Tail

Professor Flory's assistant set up an 8:00 AM meeting on Wednesday, just before Flory's first teaching responsibility. Sandra and Michael chose to travel by bullet train, the best option for any travel within the Eastern Locale. Even this efficient transport would require them to awaken at a uncomfortable early hour if they chose to travel on Wednesday. Instead, Sandra arranged for rooms in Princeton, and they left from work at mid-afternoon on Tuesday.

The train hugged the coastline through Connecticut, giving them a fine view of the Atlantic Ocean for the first few minutes of their trip. Then it was an endless urban landscape as they traveled just north of New York City, took a left turn somewhere north of the border with New Jersey, and then proceeded generally south in New Jersey in the general direction of Philadelphia. New Jersey still maintained the slogan, "The Garden State," and it still seemed to be true. The scenery was all trees, punctuated by an occasional outcropping of roadway. From his vantage, the state appeared to be unpopulated. Just short of Philadelphia, their rail car was automatically detached from the train, and shuttled up a slower branch route that finally terminated a little south of Princeton.

As they disembarked and waited for a cab, Sandra said, "We're very near an historic site. Just about a mile in that direction... " she pointed out into the distance, "... The Martians landed on Earth." Michael looked confused, so Sandra continued, "That's Grover's Mill, where the Martians landed in the Orson Well's version of War of the Worlds. There's even a plaque that marks the spot. Imagine if an archaeologist uncovers that in a few thousand years, and history has forgotten Orson Wells!" A cab came quite quickly, and soon they were within sight of the university.

Several decades earlier, the artificial distinction between Princeton, the town, and Princeton, the university, ended when Princeton University became manager of all its surroundings. Princeton had evolved from a minor whistle stop for trains out of New York into a major New Jersey suburb by riding the coat tails of university expansion. Through the end of the twentieth, and the beginning of the twenty-first century, Princeton University had become a research behemoth with new buildings being erected on an annual basis. The surrounding areas were enriched by spin-off companies established through university start-up funds. The municipal government had evolved into a rubber stamp for the university, and it was finally subsumed by the university through a ballot proposition.

Nassau Street had remained the historical main street in Princeton. Not surprisingly, the Nassau Inn had remained the preferred accommodation because it was within easy walking distance from the university. When Michael noted the room rate, overlaid with a hefty 30% tax, he was happy he was on an expense report. The view from his room was unremarkable. He could see nothing except for the office building across the street, a few stray pedestrians, and others on bicycle. The street was likely closed to vehicular traffic. The younger people all looked like students, and the older ones all looked like professors.

Sandra had suggested that they meet for dinner at about 7:30, so Michael spent his time showering and viewing the news on his room display. There was the usual – A hurricane off the coast of Florida; a workers' rebellion somewhere in South America; some religious leader ranting about declining morals in the world, but especially in the US; a vignette about scientific studies at the International Lunar Base; and dedication of a nuclear reactor in California, the third reactor that year.

Thankfully, Sandra knocked on his door a few minutes before 7:30. He was getting hungry. When he opened the door, he was surprised by what he saw. He had never seen Sandra in anything except pants, and here she was in a very flattering dress. Her breasts, usually hidden at work under a lab coat,

were half exposed by the spaghetti strap top. If he didn't know better, he could believe she was coming on to him. Then again, maybe she was. The age difference wasn't that much – she was likely only two or three years his senior - and they certainly had common interests. Michael started to imagine the possibilities, when Sandra snapped him out of his reverie by pointing to the clock and shuffling him out the door. She had inside information about a great Indian restaurant within walking distance. As they left the hotel, he wondered whether she had noticed his aroused gaze when she had first appeared at his door.

The restaurant was just a few blocks away, and it was a step above the Indian restaurants he frequented near Mother Wode. He was encouraged by Sandra, who said, "Don't worry, we're on expense report! We deserve a little combat pay for this trip." The restaurant was about half full, probably because of the late hour and the fact that Tuesday is not a typical restaurant day. They lingered a few minutes over the ice water, and then the waiter took their orders. Michael selected the Lamb Korma. Sandra, who was more adventuresome, ordered Chicken Vindaloo, which was a little too spicy for Michael's taste. They also ordered a Vegetable Pakora appetizer and Aloo Paratha as a bread accompaniment. Michael started the conversation.

"Do you travel much for Hamatite?"

"I try not to travel more than four times each year. Haematite has me visiting some of its other locations about twice each year. There are always some problems that demand some professional firefighting on location. Generally, I'm just someone from headquarters they pull in to demonstrate that their site is not isolated from corporate attention. The other two times are for professional conferences. I try to present a paper at one of these, at least. It gets a little difficult to do this, sometimes. The Haematite lawyers need to sign-off on my work, and they think we're giving away too many secrets, etc., so that's why I do some after hours stuff and work on Saturdays. I have to remind them that publication often works in the company's favor, since it prevents others from patenting the idea and forcing us to pay royalties for our own work."

"That's really different from my situation. I need to publish, and publish a lot, or Professor Sterba will be all over my case. There's an unwritten rule that you need three papers, either published or in-press, to get your Ph.D., no exceptions. It's probably a good rule, but don't ask my opinion just yet!"

"It was the same in my day. Professors need a hefty list of publications – publications in the right topic areas – to get corporate funding. It's like preventative maintenance for an old automobile."

The Pakoras arrived, and the conversation morphed from a philosophical discussion between Ph.D.s to sounds of gustatory delight. A Princeton Pakora apparently needed to live up to its name, and these did. The remaining dinner was just as good. When they arrived back at the hotel, Michael's after dinner fantasies were deflated when Sandra's only parting comment was "See you for breakfast in the morning, 7:00 AM sharp." Either she had passed beyond the college fantasy stage, or it was time for him to make the passage himself. One thing about hotel video displays, there's always some programming to aid in the release of male tension, so Michael slept well that night.

Sandra knocked promptly at 7:00 AM. Michael remembered how prompt Sandra had been the previous night, so he was ready a few minutes early. Sandra was familiar with much of Princeton, since she had attended a workshop there in her student days. Her choice for breakfast was an apparent throwback to that earlier time, since she zeroed in on an egg and bagel bar overrun with students attempting to get a quick breakfast before their early classes. He had eaten bagels before, or what were called bagels at Mother Wode, but they didn't resemble the bagel he bought, either in size or taste. These were true New York bagels, trucked in from the city in the early morning hours. The Princeton crowd would be satisfied by no others. Sandra and Michael ate breakfast out of bags while sitting on the window ledge in front of the store – a far cry from the elegant dinner the night before.

There was an enjoyable walk to Professor Flory's office at Fisher Hall, and they arrived right on

time. Flory, as befitted a professor of his stature, had an inner office fronted by an assistant's office. The assistant was not there, but Flory was, and he motioned them into his office. He was a cheerful older man, probably late eighties, with a ready smile.

"Sorry that my assistant wasn't here to greet you. Helen must be tending to her morning coffee. If I had the choice of a decaffeinated Helen, always at her desk, or a sometimes absent, but caffeinated, Helen, I would always choose the later. You must be the Haematite people. I'd better start my stopwatch to capture all those billable minutes!"

Flory laughed, and so did Michael and Sandra. It would be a billable hour, whether they stayed five minutes, or fifty minutes. After introductions, Sandra got down to business with a brief overview of the data mining Michael had undertaken. Although Flory must have been under a non-disclosure agreement, Sandra was careful not to state the purpose of the data collection. Then it was Michael's turn to speak. He pulled out printed copies of his analysis graphs. He had made printed copies, since he remembered Flory's aversion to teleconferencing, and this possible Novilud might object to all displays. Michael highlighted the discrepant data points, and Flory was quick to respond.

"So, you're hunting Black Swans."

"Black Swans?"

"Black Swans are the unexpected events that disagree with the simple probability distributions we've grown to love. Everyone knows that swans are white, but there's always a very slight probability that a black swan will appear. If our models expect white swans only, they may be unstable at the appearance of a black swan. A famous example is an equation that was used to price derivatives many years ago."

Sandra decided that Michael shouldn't take the full brunt of their ignorance, so she asked the question.

"What's a derivative? I assume we're not talking about the mathematical variety."

"A derivative is essentially a bet on the occurrence of certain conditions. It's gambling, pure and simple, so most types of derivative trading have been outlawed for years. As an example, an early winter in the US Midwest would be expected to lead to a poor wheat harvest, so the price of wheat is expected to increase. Householders need heat, so energy prices would be expected to rise under the same conditions. If you were a betting man, you would probably accept a bet from someone who says that the price of wheat will actually decrease when energy prices increase. Since it's such an outlandish position, you could be persuaded to give that man some rather high odds, say ten-to-one. You don't really care much, since in your mind it's easy money. But then the Black Swan appears, in the form of the cash-strapped European States dumping wheat on the market for one reason or another. The contrarian, the man who said that wheat would decrease in price makes a bundle of money. There were fancy formulas for calculating the odds, and everyone patted themselves on the back for discovering derivatives. The problem was that the odds equation was based on statistics that all too often ignored the Black Swan."

"Your transaction distribution, as you've noticed, is a power law distribution. It's also called a fat tail distribution, since it has more transactions at the extreme end than a bell curve would. A true power-law distribution is a straight line on this sort of graph, but people never have as much data as you have here to really show a good straight line. That's why your Black Swans are so evident. The overall power law happens because there's a continuum of big agents and small agents, all interconnected, and, on the average, they do the same things. Since they do the same things, no matter how large or small they are, the process is said to be scale-invariant, a physics term, or scale-free, a term used mostly by computer people."

"Economists thought that financial processes could be modeled on such natural systems, such as statistical mechanics and thermodynamics. They were making the incorrect assumption that people were like molecules of gas – not predictable individually, but quite predictable in the ensemble. They

soon found that humans transactions are not always as predictable as gas molecules. Human nature needs to be considered, like the rate that information diffuses and the idea that information might not be complete or accurate. There's also the widow who keeps her stock certificates under the mattress. The result of all this is that some of the smaller transactions don't happen in a timely fashion, and you get excess area under the tail of the curve. Your fit to the data is obviously not a pure polynomial, since the fat tail slopes upwards slightly, likely representing all those widows and all those mattresses. Whatever function you used seems to do this quite nicely."

Michael responded, "I can't take all the credit for that. I used an evolutionary algorithm. The computer picked the curve."

Flory smiled.

"Both of you did a nice job. Now, as for your particular Black Swans, there's no obvious reason why they're there. People have talked about them for quite a while, decades, in fact. In the past, there were too few examples to build up a pattern. I think people lost interest in this and moved on to other things. However, no one has had the resources or the interest to harvest as much data as you have. I'm as much in the dark as you are at this point, but you now have the advantage. My one observation is that, although you have a huge quantity of data, few of these data are the Swans. Collect as many Black Swans as you can, and do further analyses on just the Swans. Something might pop up. You might be able to get their DNA and clone your own Black Swans if you wanted to."

They had come here thinking their ignorance arose from their not being economists. Now, Flory was telling them that even eminent old school economists like he had no clue. It seemed that Haematite's money was well spent. It meant, also, that there was more work ahead. Without pinning down these Black Swans they had no hope of doing Haematite's planned market prediction.

Flory had a further warning.

"You seem to be following along the same tracks as the physicists of the last century. Physicists were at first confident that they could make big wins in the financial markets. It seemed all too obvious to them. First, financial transactions are uniquely specified by a set of numbers, and physicists love numbers. In the simplest case, where you're looking only at one specific item, these numbers are the cost of the transaction and the time of the transaction. The physicists were spurred on by several factors. First, you didn't need to be right a hundred percent of the time, you just needed to be mostly right. Second, you always worked with a mixture of financial instruments, so, by the law of large numbers, things should average out. You would never take too big a loss on one bad prediction. Finally, you just needed to be smarter than the next guy. With a phalanx of computing power behind you, it's easy to start to believe that this is true."

"What the physicists found in the end was that the financial markets were quite unlike the natural phenomena they were accustomed to study. Their models had some fatal axioms carried over from physical systems. One axiom that I described earlier was the idea that people were rational agents who always acted to maximize their financial worth. But markets do not act that efficiently. The most worrisome axion was that the market behaved like a thermodynamic system and things followed a normal distribution. In actuality, price trends are typically slow on the up-tick, and fast on the down-tick. There's no bell curve here, and the market knows that. There's a thing called the "volatility smile." The volatility smile is a graphical representation of the fact that bets on price decreases have lower odds than bets on price increases. You make money more easily on betting that the financial markets will go down in any time period."

Sanda interjected.

"So, in the end you have scale-free behavior of the kind Michael found. There will be more outliers than the bell curve predicts; that is, more billionaires than you would predict from the average income."

"Yes. So the physicists tried to work that into their models, as well. Soon, these models appeared to

be somewhat like the Ptolomeic model of the solar system - a patchwork of epicycles that made predictions but gave no knowledge of the underlying system. Of course, their models were found to be less and less predictive, and all this work was abandoned. The lofty idea that the financial markets could be expressed by a nice equation was abandoned. Don't fall into the same trap."

"Thanks for the warning," said Sandra. "Fortunately, Haematite's interests here are completely different."

Since their technical discussion was at a close, Michael saw the opportunity to ask another sort of question.

"Professor Flory, now that we are familiar with each other, can I ask you a somewhat personal question?"

"A man my age is hard to embarrass. Ask away!"

"Why do you dislike computers?"

"Yes, that must be a mystery to a Computerati like you, and the fact that computers seem indispensable to every field of intellectual endeavor, including my own field of Economics. Economics is very mathematical, and large data sets are de rigueur. I used computers extensively when I was a student, although what we called computers in those days are considered toys, today. I found, especially when transferring my handwritten notes into a publication quality piece for my dissertation, that I was no longer doing Economics. I was acting more as a secretary or an assembly line worker. I wasn't the master of the machine, I was its servant. I didn't like that at all, so I leave the servitude to others. I try to just think. After all, that's what a professor should do, isn't it?

Michael had heard it all before, although not from someone so advanced in his field, so he spun out his stock response.

"Things have changed from those days. The user interfaces are more developed. There's speech recognition, and computers that evolve their interfaces to match a user's style. I think computers are definitely the servant. You might want to give them another try."

Flory smiled.

"Old men have a habit of spouting aphorisms, so here's mine – You can't teach an old dog new tricks."

Helen was at her desk, sipping her morning coffee, as they were shuffled out of the office and into the mix of students and professors on the street. It was only 9:30 when they arrived back at the hotel, so they decided to check out, catch an early train and get lunch at home.

On the short train ride, Michael had one nagging question.

"Sandra, when we were talking with Flory and he warned us about the physicist's failed attempt to model the financial markets in the last century, you told him that Haematite wasn't trying to do the same thing. In my mind, it seems as if we're trying to do a variation on the same thing. Are all our efforts doomed to failure, even without the Black Swans?"

"No, what Haematite is attempting is arbitrage, not speculation. Just like in the energy futures markets we're in now, we're using speed to take advantage of small price differentials between different markets. If we're faster than the other guy – and in this case we're throwing a lot of hardware behind our need for speed – we'll always win. Sure, the net amount of any given trade will be small, but we're doing many trades, so the money should add up to a tidy profit. Our immediate goal is to verify that the profit does justify all this hardware expense, and that's why we need to understand these Black Swans, as Flory calls them."

It was just a little past 1:00 PM when Michael and Sandra arrived back at the East Wodenstumpf station, so they faced a decision. They were hungry, and they weren't expected back until late in the evening, which was effectively the next morning. Should they be loyal employees and head back to Haematite, or have a leisurely lunch and an afternoon holiday. Sandra's vehicle was at the station, so

she asked Michael if she could drive them to her place for lunch, and then take him back to Mother Wode. Her condominium was about ten minutes from the train station. Michael's stomach agreed, and he was also curious to see how she lived. After all, he was about to adapt a similar lifestyle in just a few weeks, and a tutorial would help him make the jump. Knowing Sandra, he didn't expect to find too many feminine touches about her place. Her place would likely be more masculine than even unisex.

Michael was suitably impressed when they arrived. It was a secluded community of condominiums with a pillared entrance drive, and Sandra's living accommodations were palatial compared to his student digs. Her place had a split-level floor plan. A marble tiled entry way lead to a spacious living room with fireplace on the right, and a spacious kitchen at the top of a short stairway. Stairs to the bedrooms continued off to the left, and the kitchen led to a small dining room that overlooked the living room. Sandra was not shy about colors. The living room was rose with canary accents, and the dining room was teal. The kitchen was wallpapered with a finely detailed floral print. The wallpaper, and possibly the choice of living room colors, were the only marginally feminine aspects of her interior decoration, but he hadn't seen the bedroom. Perhaps he would never see the bedroom, and that would be in keeping with Michael's history with women.

Sandra rifled through the freezer chest and came away with two food pouches.

"Well, it's either Beef with Broccoli, or General Tsao's Chicken."

"I'll take the chicken, but only if you don't have a preference."

Sandra pulled the rip cords that mixed chemicals in sealed pouch compartments so they would react and heat the food that surrounded them, a useful consumer spin-off of military technology. She plopped the pouches in plates before they got too hot to hold. In a minute, they had opened the food pouches and were having a Chinese dinner with White Zinfandel. Michael started the conversation.

"So, what do we do next?"

"I thought a light movie on my entertainment display, maybe a comedy. Want to join me?"

Finally, a slight movement in the direction of Michael's fantasy! He decided to play it cool, and not let his imagination run rampant.

"Sound's good to me, but my question was actually about the project. We need to completely understand these Black Swans. Flory convinced me that an uncertainty like that in our model can't be tolerated. Things would look good for a few days, then the whole thing would shatter. Haematite's margins on the stock transactions would be thin, at best, so even a small perturbation will lead to losses. Management would be upset. I think we need much more data."

Sandra sighed, "More data are not always useful. You need to look at the statistics, and see whether we might have enough data already. One thing I remember about Economics is this thing called Marginal Utility – you might be working too hard for too little gain. You might find that you do have enough data. Then again, maybe you need ten times as much data, in which case we need to rethink the whole model. We may need to convince Haematite to scrap the whole idea. At this point, we just don't know."

"Yeah, I see what you mean. No use spinning our wheels for nothing. I'll start the analysis tomorrow to see whether the data are sufficient. Now, as for your suggestions about the rest of the day..."

He purposely dropped his voice in a semi-seductive manner, waiting to see her reaction. There was none. OK. Perfect serve, but no follow-through. He could blow off the afternoon, so he decided to stay. In the end, he was glad he did.

6 Yes, You!

Sandra hadn't given much thought to men since moving from Tressor to Haematite. She was a solitary individual, as were most scientists. It wasn't as if she was married to her work, but they did have an exclusive relationship. Suddenly, Michael appeared, and she started to reassess her position. He was smart and reasonably good looking. Was he already in a relationship? Was she attractive to him? She would need to tread lightly, especially since they were coworkers.

Women scientists did not achieve parity with their male counterparts until the turn of the century. Women in science were a rarity a few hundred years ago. A few wives, daughters and sisters started as assistants to their scientist kin. When the Old Boy died, many of them continued their work, sometimes publishing still in the man's name, or finding another established scientist who would promote publication in the woman's own name. There were some outstanding exceptions. The work of Caroline, the sister of the astronomer William Herschel, was so essential to her brother's observations that she received a small salary from King George III. She was awarded a gold medal from the Royal Astronomical Society.

Towards the middle of the twentieth century, woman began to infiltrate the biological sciences and chemistry. Male scientists would joke that chemistry appealed to women because it was so much like cooking. Women were rare in mathematics, but after a while they quickly infiltrated computer science, which was considered a branch of mathematics at the time. Women in physics were extremely rare until the first part of the twenty-first century. Women at the top of their fields were rarer still, and the ones who did succeed seemed to have succeeded because they adopted a male persona and merged into the sea of their peers.

The outward signs of this persona was non-feminine dress and an aloofness that deflected any sexual overtures. There was a wall between male and female scientists that was hard to scale, and nearly impossible to break down. That was essentially a synopsis of Sandra's relationship with Michael up to that point. It was the same type of reception that Michael got from the girls at Mother Wode, and, fantasies aside, he didn't really expect anything different from Sandra. That's why he was so surprised when it happened.

The whole thing had started simply. Sandra excused herself to slip into her house clothes. Michael sat on the couch, sipping the remainder of the White Zinfandel, when she returned. Sandra's house clothes principally consisted of a lacy bra, fully shown, with some loose pajama bottoms. She snuggled alongside Michael so closely that his only option was to put his arm around her, and for a time they both feigned interest in the video. Michael finally turned to her and brushed his lips against her cheek. She responded by turning to touch her lips to his, and it was automatic pilot from that point forwards. They migrated to the bedroom, and Sandra chose the top. After a few minutes, she stopped and shuddered. This was was his cue to finish, which took only two additional slow strokes. They lay together, interlocked, for about half a minute, and then Sandra rolled off him. He was not familiar with any company rules about office relationships, but if there were, he and Sandra broke all of them in the span of fifteen minutes.

They lay together on the bed for a short time, side by side, but it was just mid-afternoon, so they returned to the living room and, this time, actually watched the video. They clung to each other on the sofa, rehashing the moment and contemplating how it would change their lives. After an initial intimacy, things sometimes become awkward. What to say? How to react? But they were genuinely comfortable with each other, and Sandra asked whether he could stay the night.

“I'm a man of very few needs. If you can find another food pouch in your freezer chest, that and your company will get me through the night.”

When morning arrived, Michael remembered that he had his travel bag from the Princeton trip, so he was showered and dressed at the time Sandra summoned him for breakfast. Sandra pecked him on the cheek.

“So, how's my favorite travel companion this morning?”

“Well rested, and feeling rather good about myself. Geeks like me don't usually score with such beautiful women.”

“Get used to it. I think we're committed. But there's the work thing...”

“What? There's a rule that I'm not allowed to bang the boss?”

Sandra slapped him with the dish towel.

“First, we're colleagues. I'm not your boss. Second, we're not just consenting adults, we're highly-educated consenting adults. Neither one of us is taking advantage of the other in any way. From where I sit, that would be impossible, actually laughable. However, the people we work for have a general one-size-fits-all policy that makes things difficult for us.”

Sandra paused for emphasis.

“Under no circumstance should anyone at Haematite have any suspicion that we have a relationship. It could mean our jobs.”

“OK. No necking in the laboratory, and no locker room bravado. It's all that much easier since Haematite doesn't have a locker room.”

“You're wrong. There is a locker room at Haematite, but it's where the clean room personnel change.”

After breakfast, Sandra drove him to his apartment so Michael could get his car and they could drive separately to work. He killed a few minutes in his apartment so there would be a decent interval between their arrivals. He cleaned his bedroom a bit, since there might be a time when Sandra would stay the night; but his was a student's apartment, and it seemed to him that he would be spending most of his time at Sandra's. He had heard that women were more comfortable having sex in their own bed.

After a few days, their relationship started to seem very natural. Because of their irregular work habits, it wasn't that hard to give the appearance that they were just distant coworkers. At times when they were both free, Michael found himself at Sandra's condominium.

Sterba was out of town more often than not, so Michael had a lot of time to continue his analysis of the transaction data set. Flory had convinced them that they should be hunting Black Swans, so he filtered the dataset to select just the Swans, and he set up a program to work in the background to harvest any new Swans as they appeared. As each new Swan was added to the dataset, his display would beep and flash up a statistical summary. Each time that would happen, he would look for an emerging pattern, but no pattern was emerging, and Michael was getting frustrated. Finally, he did what he should have done in the first place. He programmed a genetic algorithm to evolve to find a pattern. His program randomly generated thousands of potential pattern-finding algorithms. These were tested against the dataset, and the ones that were clearly the bad performers were eliminated from the gene pool. The best performers were allowed to “mate” to replace the algorithms eliminated from the population. This mating would tend to preserve the best properties of each parent and give an opportunity for a precocious offspring. There were some random mutations programmed as well, the Hand of God in the machine. Unfortunately, genetic programs take a while to run, so he left for a cup of coffee.

Michael's work routine had been fairly insular. He kept to his office, occasionally walking to Sandra's lab. He and Sandra avoided too much contact at work, for obvious reasons. Since he had time to kill, he wandered the hallways aimlessly, taking in the sights. One floor was populated with the

cubicle dwellers who tended to the financial operations of the corporation. It reminded him of a beehive, since everyone was active, and there was a background noise of transceiver rings and people talking that sounded like a buzz. The most interesting floor was the fabrication facility he had seen on his first tour of the building. Now, he was able to linger in front of the double-glazed windows to watch the workers making the specialized computing circuitry required for Haematite's operations. Michael noticed that in each area of the clean room, there was one guy doing the actual work, one guy who seemed to be looking over his shoulder, and another standing at a distance taking notes. This hierarchy seemed to be true for any factory, not just the Haematite clean room. It was like the old joke about the ten person row boat with one rower and nine managers.

When he arrived back at his office, his population of pattern-finding algorithms seemed to have converged on a solution. When he pulled up the summary, he had a hard time understanding it at first. Michael stroked Sandra's name on his transceiver shortlist.

"Webb, here. Oh, it's you, Michael."

"I think I found something you should look at."

"OK. I'll get a coffee and be at your office in a minute."

When Sandra arrived, he flashed his screen onto the wall display.

"At Flory's suggestion, I confined my analysis to the Black Swans. Since we're in a big money game, I figured that we needed to look just at Black Swan transactions above a certain monetary value, but what value should we use? Actually, that step was easy, since there appears to be a diploid distribution of transaction values; that is, there's a market for the big money traders, and then there's a market for everyone else. Then, I needed to decide at what place on the distribution I wanted to start looking. We want to look at the fat tail events, only, but where does the fat tail start? Once again, Flory was a help. Since the distribution should be scale-free, I just looked for the point at which the self-similarity breaks down."

Sandra stared intently at the graphs on the wall.

"OK. That makes sense, but how did you calculate where self-similarity breaks down? Would you do a curve fit and see where the data departs from the curve? That seems somewhat crude and open to interpretation."

"Exactly. That's why I normalized the data according to the scale-free model, and then did an autocorrelation. The breaking point is very apparent."

"OK, Mr. Math, I'll take your word for it. What did the analysis show, once you decided where to look in the distribution?"

"That's where I had a problem. I couldn't see any pattern, whatever, so I programmed a genetic algorithm. These Black Swan transactions are not out of place. They're out of time. They all make sense if the transactions happened an hour or two prior to the actual transaction time. Not only that, but if you plot the distribution of these errant transactions, they follow an almost perfect Gaussian distribution, a bell curve. If I were a betting man, I'd say that all this is the result of some sort of fixed process. It might be some subtle error in the network software, a periodic bug that shifts some bits left or right, or maybe someone is cooking the books. In any case, this is deterministic. It has a definite cause, and based on the distribution, it has one definite cause."

"It reminds me of the saying that anything that can go wrong will go wrong faster with computers. It could be a wrong line of code, but that line of code gives a predictable outcome. Sort of accidentally, on purpose. We need to know more about the internal workings of the network. Our model of the network as just something that moves data reliably from one place to another seems to be flawed. It's just as fallible as any other piece of computer code. Do we need to see another consultant?"

Michael thought for a moment, and then he had an answer.

"I think I know the perfect consultant for this, and he's local. He works at Mother Wode."

“A professor?”
No, probably better than a professor. Let me make an initial overture.”

7 Basil

It was time to call on Basil.

Basil had been a student at East Wodenstumpf many years ago, and then his sponsoring company went belly-up, leaving Basil out on a limb. He was from some Eastern European country – his accent gave him away – but he was always reticent about specifying exactly which country. You got the idea that Basil had done some unconventional things with computers in his homeland, and he wanted to keep a cold trail. Formal degree or not, Basil was a genius and a Computerati of the first rank. He was so useful that he had been kept on at a small salary by the university for all these years. Basil didn't complain about the money, and no one complained about Basil.

It was easy to find Basil's office, although it was often hard to find Basil in his office. First, Basil kept odd office hours, typically arriving as everyone was leaving, and leaving when everyone was arriving. Second, his office was so overloaded with junk and old beverage bottles, that Basil was well hidden. You could find him in his office anytime from late-afternoon through dawn – he freely admitted that he preferred night hours when no one else could disturb his concentration. There was an old joke about a Computerati who was asked to attend an 8:00 AM meeting. His response was that he didn't stay up that late. The joke could have been written about Basil.

Michael zipped down the basement stairs of the computer center and found Basil in his office. The only light was from the display, and it projected onto Basil's face in a way that reminded Michael of a villain from an old video. Basil didn't hear Michael's approach, and Michael was careful not to startle him. Michael retreated slightly outside the door and gave a gentle knock. No response. Another, louder knock. No response. Was he asleep? Michael knocked again, and between the first and second rap, Basil responded.

"OK! OK! Give Basil a second, here!"

Basil tapped out a few commands on a keyboard and swiveled around in his chair.

"That compile should take about fifteen minutes, so you caught Basil at a good time. You've got fifteen minutes, maybe more if you're entertaining!"

Basil pointed towards a chair, but thought better of the idea, since the chair was piled high with books. The paperless office, years in its coming, was still years into the future.

"It's Michael, right? You wouldn't mind standing, would you? Basil hears that you'll be leaving us in a few weeks. You do good work. Basil will be at your public defense."

"Basil, I'm honored. The reason I'm here is for some advice – about network routers."

"Ha! You came to the right man! Basil had some experience with these back in his home country during Gymnasium days – what you would call high school. Routers don't change much – standards and all that. They try to sell them on speed nowadays, not features. So, what about routers?"

"I think there must be some software bug in network router code that nobody knows about. They seem to unexpectedly drop packets here and there, then let them through at a later time. Sometimes the later time is an hour or two, which might indicate the limit of the store and forward capacity. I hear that the manufacturer will not release the code, for obvious reasons, and I won't even try to get them interested in this problem. The problem is too small, and they know that fixing it would likely cause a more serious problem somewhere else. As a Computerati, I understand their position, but I still need to know. By the way, there's some money in this for you. This is for Haematite."

Basil's face perked-up at the mention of money. He probably had a list of tech-toys posted somewhere in the office. Where exactly in the many piles of paper was anyone's guess.

“Good to hear about the money! Money makes risky things much more acceptable to Basil! So, you want to see the router code, maybe disassembled for easier reading. Not too hard to do. Speedy code must be short code, well written. Plus, there's the standard network protocols. The code almost writes itself. If anything is out of place, Basil will find it. But not here! Too easy to trace, but Basil knows a place. You come, too. No copies of this – we read it straight from the display and then erase the buffer! Easy in, easy out!”

Basil outlined a few scripts he would need to write to disassemble the code into a human readable form after he cracked into the system. The cracking part was all in his head, where it had resided since high school days. That part would not be committed to any script file – it would be Basil playing a symphony at his keyboard. Basil wrote Michael directions to an apartment on the outskirts of East Wodenstumpf and told him to arrive at about 2:00 AM the next day.

Michael had never been in that section of East Wodenstumpf before. It was a marginalized area that was bypassed years before by the major transport systems. As a consequence there were few merchants and the few residents who could stomach the tortuous commute to work in the more developed areas. Although he was out of his milieu, Michael wasn't concerned about his safety. Petty crime had ceased to be a problem after repeal of recreational drug criminalization. The monies saved on drug interdiction were funneled with great success into educational programs in primary and secondary schools. He remembered the addict videos he saw in elementary school, and these images still made him shudder.

He arrived a few minutes before two. The building looked strangely dark even for 2:00 AM, but he proceeded to walk up the front steps.

“Michael! Here!” Basil called to him as he exited his vehicle and walked up the steps to greet Michael. “No entry there. Come with Basil.”

Basil guided him around the side of the building, down another stairway, and into the cellar. The door was unlocked, and they entered. Basil had come prepared with a bright fuel cell lantern, another of his many tech-toys.

“One of Basil's pals left the door open for us. The building is abandoned, but it's being maintained for possible future renovation and occupation. They still pay their utility bills – a corporate oversight. We need to walk towards the front of the building. That's where we'll find the box.”

By box, Basil meant the communications junction box. When they arrived, Michael surmised that either Basil had been here before, or that it was a shared secret among some hacker brethren. There was a small table and several chairs. One chair was near a window – a lookout's perch? An optical fiber had been pulled out of the box and fitted with a small box. Basil proceeded to unpack a portable computer and plug it into a utility outlet on the fuel cell. He ran another cable from the computer to the improvised interface box. When it was all connected, Basil gave a running tutorial.

“Physical Layer,” he said, pointing to the interface box. Then he pointed to the portable computer. “Transport Layer - at least after Basil breaks into the network and gets the proper software running. The first step is to log onto a major computer, in this case Mother Wode's”

Michael was confused. “If we're on Mother Wode's computer, why do we need to be out here?”

“Michael and Basil are in this place, and not at the university, since this link is much harder to trace. It's slow speed out here, with antiquated hardware. No automatic traces are possible. Also, when Basil says log-on, he doesn't mean the usual log-on. We are going to spoof some data and get Mother Wode to think she's logging onto herself. An unusual protocol, but one that was accidentally allowed by the system administrator. Actually, he uses it for some important functions, just not what we're doing.”

After a few more keystrokes, “Basil is in! That was the easy part. Now Basil gets onto the global network with the proper permissions – somewhat harder, but not for Basil!” There was a flurry of keystrokes. A frown. Some chin rubbing. A few more keystrokes. Then a big smile.

“Give Basil a letter of the alphabet.”

“X.”

“No. No state names start with X. Give Basil another.”

“G.”

“OK. Guam... Georgia... Georgia must have a lot of hub routers.”

A list appeared on the display. There were about forty names.

“OK. Basil finds one about two-thirds down the list... Ah, Athens_01. Sounds as likely as any.”

Basil pecked away at the keyboard for a few more seconds then sat back.

“Basil will have the binary in a few seconds. Then we disconnect as fast as possible and do some analysis.”

There was a beep.

“Very short download. As Basil said, very small, very fast code.”

Basil did a few more keystrokes and unplugged from the interface box.

“Now Basil does some analysis. First Basil disassembles the binary into something Michael and Basil can read. Basil has incorporated the published network protocol commands into a shell script to make the disassembled codes much more readable.”

Basil punched a few more keys, and a progress bar appeared on the screen. When it reached a 100 percent, it went back to zero and started ramping again.

“It's a two-pass process – first pass for tokens, last pass for the labels.”

Michael knew in an abstract sense what was happening. He had learned about assemblers as an undergraduate. He and other Computerati wrote only in high level languages that were quite removed from the actual machine code. Sometimes, they were using languages that were written in other languages, and most of the time they didn't even know the type of machine that they were using – everything just worked. What Basil was doing wasn't magic, but as far as Michael was concerned, it was close to it. Another beep, and the display filled with columns of numbers and letters.

“OK. Here we have it, the magic code of the global network. It's actually pretty boring stuff. Most of it hasn't changed in about twenty years.” Basil pointed to the display. “Here they do some preliminary memory mapping, just so they don't step out of bounds. Then they get the data packet, save it in memory, find the header – the part with the addresses and command – then strip out the command.” Basil scrolled down a little. “Here they do a very long case statement to find out what command was sent. Obviously, the frequent commands are first, things like just send this data directly to the destination address without error checking. At the end of the list...” Basil scrolled much further “... are the last two statements, which are the administrator request for control – very password protected by a hardware key – and a jump to DAD.”

“What's DAD?”

“That's the case else condition where you should fall off the face of the earth because the command wasn't recognized. This jumps to an instruction that sends a message back to the sender – actually just a number – which is politely stated, Sorry, I didn't understand you. In actuality, the programmers call it DAD, for Dumb As Dirt. It's an exhortation from one programmer to another to learn how to write code. As you can imagine, these assembler guys think they're alpha dog. So, the DAD code is here, at 3C4A1.” Basil pointed to a statement that read JMP #03C4A1. He then highlighted the leftmost column and executed a find for 03C4A1. “So, here's Dear Old DAD.”

The display flashed, and 03C4A1 was highlighted in the leftmost column. Basil paused, tapped his fingers on the table, and made a frown.

“Basil must have typed the wrong number. Let's do that again.”

Basil typed a few more keystrokes and found himself at the same place in the code.

“OK, that's the place, but that's not DAD!”

Basil continued to scroll. He pointed to the display.

"Here's the routine that sends DAD. Basil doesn't quite understand what the rest of this code is for. DAD should send DAD, nothing more, nothing less. Someone's twiddled with this code."

"What does the code do?"

"That's going to take a little thought..." Basil looked around "... and a space more conductive to thought. Basil said everything we do stays here – no evidence – but this code is too deep for an instant analysis. Basil is happy he brought this along."

Basil reached into his pocket - God! Do they still sell pocket protectors? - and pulled out a pencil.

"You're going to take notes?" Michael said incredulously.

"Looks like a pencil, and writes like a pencil, but watch this!"

He unscrewed the eraser end to reveal a fiberoptic connector.

"Basil bought this last year. In fact Basil bought two, but the other one is presently non-functional. It's an encrypted memory device, with a twist. If you mistype your pass-phrase three times, it destroys itself with a high voltage pulse. Basil wasn't taking the manufacturer's word for it, so Basil did a test on the second unit. Still works as a pencil, though."

Basil plugged the pencil into a port on the portable computer, and typed a few more lines.

"Basil is done for now. Everything was done in volatile memory, and it's been erased. Only the pencil knows."

Basil screwed back the eraser and pushed the pencil into his overstuffed pocket protector.

"Basil will get back to you in a few days."

Michael and Basil left the room as they found it and went their separate ways. It was after 3:00 AM when Michael arrived at his apartment. Although 3:00 AM was well past his usual bed time, Michael's mind was racing. He was too stimulated by his hackfest with Basil to go directly to bed, so he switched on the entertainment display in his living room. His entertainment display was quite primitive compared to Sandra's, but he didn't mind. It was used mostly to view the occasional news summary, and it was good enough for that purpose. He was curious to see what was on at this late hour.

When Michael was a child, it seemed as if on demand would be the terminal trend for home entertainment. The studios loved the idea, since they had dollar signs in their eyes from projected profits on all those demanding eyeballs. The one thing they didn't consider was that people can be very selective about their demands, and there wouldn't be any demand for something completely unknown, no matter how much it was advertised. In the end, on demand became only a niche player, and the traditional deluge of thousands of random shows remained on the entertainment networks. The increased bandwidth of the networks allowed a greater number of specialty channels. The now global audience and instantaneous aural translation made even the most obscure hobby channel viable.

The problem for Michael, and for everyone else, was how to select a channel to watch. Artificial intelligence, in the form of computer programs built into entertainment displays, were able to sort the wheat from the chaff for any particular viewer by keying off his past viewing habits. In Michael's case, this now worked to his disadvantage, since his display started its session by bringing him the London Morning News and offering him choices of other news programs from most of Europe. After paging through a plethora of these news options, Michael retreated to the random button to see what surprises might await him. And random it was! First, there was crocheting, followed by the life-cycle of some unrecognizable insect, a replay of a soccer game, and an old movie about some little girl making all the adults around her behave foolishly. If he had to choose from among these, he would side with the little girl. Instead, Michael shut down the display and headed to bed.

8 Cracking the Code

Since the Haematite project was essentially on hold until Basil got back to him with his analysis of the mysterious router code, Michael spent the majority of his time at Mother Wode. He reminded Sandra that he was still in transition to Haematite, and his contract allowed him "reasonable time" away from work to complete his Ph.D. Of course, the unreasonable demands of Sterba expanded the definition of "reasonable time," but Sandra seemed to understand. She was busy working on other things, so it didn't matter at the moment, but management might come knocking in a few weeks for an interim report. Their project would not continue without an upbeat prognosis, and since it was good work, neither of them wanted the project canceled.

Sterba was away again on one of his many trips, this time to some government agency with another plea for funding. Perhaps he was using some of Michael's research as leverage. Whatever the case, Michael was left undisturbed as he finished the drafts of the few remaining manuscripts that Sterba required.

It was two days before Basil called him down to his office. When Michael arrived, Basil grabbed his portable computer and led him down the hall to another room. It was ostensibly a storeroom, but there was a desk and two chairs in one corner. The door locked behind them.

"This is Basil's private space. The added fireproofing has a side benefit of shielding us from electromagnetic eavesdropping. No network connection in here!"

Basil plopped the portable computer on the desk, plugged-in his magic pencil, and in a moment the display filled with color-coded text that was presumably a more readable representation of the router code.

"The usual code is all junk, at least as far as you're concerned, so Basil stripped it out of the file. These assembly coders are sharp. Basil did get a few pointers while studying the code."

Basil smiled, but the joke, if any, went right over Michael's head.

"Anyways, the code does call DAD in the usual way for all undocumented protocol commands, except three. If it receives these three commands, in sequence, in a span of less than about a millisecond, the router goes into an overriding administrative mode, locked to the network address of the command sender. Neat trick."

"But, what is this mode used for?"

"That's proving a little harder to find. Does Basil bill by the hour? Ha! Have you ever heard of obfuscated code?"

"Do you mean the kind I typically write?"

"Ha! Michael knows a little about what Basil means, but not the full story! This is purposefully obfuscated code, not just code that's difficult to understand, but code that's designed to be difficult to understand. Some of it is like a treasure hunt. You get a slip of paper that sends you to a box with a key that unlocks another box with another slip of paper that divulges the location of the treasure. You can do this in code, too, to hide the values of variables and the locations of subroutines. Worse yet, the code can be self-modifying. Look at it again, and it's different from the last time you looked. The amazing thing is that the code still does something useful. But Basil likes puzzles, so there's no problem. It will just take a little time. Maybe a few more days."

"OK. Let me know as soon as you have an answer. I've been shielding you from my management, but I can't do it for too much longer."

"Basil has a Guardian Angel! Basil always needed one of those!"

As Michael worked his way up the stairs from the storage room to his office, he wondered whether he would be happier if Basil wasn't able to make sense out of the router code. Things were getting too complicated. Michael was comfortable with numbers and programs that make sense out of number ensembles, but they were now moving one step back from the numbers to whatever generated them in the first place. This was unknown territory for him, but Basil didn't have a problem with it. Things were still relatively under control, and control is what computing is all about. Suddenly, Sterba's tasks seemed a lot easier in comparison.

Michael had anticipated spending a few hours the next day at Haematite, if only to see Sandra. By coincident circumstance, he was being pulled in too many directions at the same time, by Sterba, the Haematite project, and Sandra. The Haematite project was on a back burner again until Basil worked his magic, he was handling his Sterba tasks fairly well, but it almost seemed that he was avoiding Sandra. That was the last thing he wanted to do, especially since their relationship had just started to blossom, and he decided to spend some time with her. Unfortunately, opening his messages that morning changed his plans. Sterba, although out of town, must have been bored sitting in his hotel room, so he had time to pick through Michael's manuscripts line by line. Most of his corrections and comments were minor, but there was a graph in one paper that Sterba didn't like. To Michael's chagrin, it wasn't just the graph that was the problem, it was the underlying data that was graphed. Michael needed to run a few more trials and reanalyze the data. He thought about protesting this additional work, but he didn't want to antagonize his professor, and he had to admit that Sterba was probably right.

The research area of the particular paper was a new type of neural network architecture they had devised. Sterba had led him onto the right topic area, since neural network theory was gaining renewed interest after a considerable hiatus. Most of the reason for this was the inordinate amount of computing power available compared with the limited software resources. It was a typical Malthusian problem in which computing power was increasing exponentially, but software code was still written in a linear fashion by human programmers. The lure of neural networks was that each node required just a small amount of code, and you could fill the hardware space with as many nodes as it could handle. Of course, the software had to be self evolving, or it could never take advantage of the nearly infinite hardware space available. All that even the brightest Compterati could do for such a complex system was write a reasonable starting program, and then stand back as his machine evolved.

Sterba's idea was this. Since the neural network was evolving, we needed to help the evolution proceed. Of course, all the Darwinian stuff had been done to death, so it was difficult to do anything new in this area. Sterba had stumbled across an ancient, but discredited, idea of biological evolution called a morphogenic field. In this strange view of evolution, organisms were affected by a mystical field that shaped their development. It was as if a city-dwelling moth's distant cousins in the forest were sending out signals about what it means to be a moth. A consensus would develop in the species as to what the quality of “mothness” was, and this would amplify the field by a resonance effect. Scientists were quite upset about the whole idea of such a mystical field effect, and the idea had died within a decade.

Although the morphic field likely doesn't exist in real life, that doesn't mean that the idea wouldn't be useful in a neural network. A typical neural network is partitioned into layers, and connections are only made between nodes in adjacent layers. Adding a morphic field in a neural network would be like adding connections between all the nodes in the network, something that would be too hard to do, and the computations would take forever. Michael added fixed, random connections between some nodes and hoped for the best. His results showed some improvement, nothing really to write home about, but something Sterba could use to get further funding.

Michael's neural network needed a purpose, so they decided that language translation would be as

good a purpose as any. It had the benefit that many classic texts had translations into multiple languages, so the network training data were already in place. Since the computing power at their disposal at Mother Wode was enormous by most standards, their network could actually be trained using entire chapters of books at any one time. The only problem was how to measure how fast the neural network was learning how to translate from one language to another. The simple solution was to do a double translation; namely, Language A to Language B, then back to Language A. A program would compare the final Language A translation with the input Language A data and find the differences.

Michael had found that doing a simple, word by word, comparison wasn't possible. Sometimes contractions were spelled out, and sometimes they weren't. The original text might contain "aren't," and the translated text would come back "are not." After examining the translations, he was able to build in tables to eliminate these errors. One other problem was word order, since a sentence can still have the same meaning if the sequence of words is just changed. That was an easy fix, since you could just look for the occurrence of the same words in a sentence. In the end there were still a few sentences that were marked as incorrect by his scoring program that could be judged to be correct translations. Michael had decided to intervene and manually mark these as also correct.

Sterba had no problem with the scoring program's automatic corrections, but he did have a problem with the human intervention for some of the sentences. Since these were just a small percentage of the total number, Sterba decided it would be best to just use the program's judgment and eliminate Michael's hand scoring of the rogue sentences. This meant that Michael had to plow through his records, delete his "biased" scoring, and redo the graph with just the computer scoring. This was not intellectually challenging, but it would take quite a bit of time.

It was another three days before Basil called Michael back to his office. When Michael arrived, Basil was in a jubilant mood.

"Michael, the code could be a problem for most, but not for Basil! Come, look!"

Basil had not taken the precaution of dragging them into the storage room. Perhaps the new accumulation of littered boxes in his office now contained lead sheets.

"Oh, you must wonder why we aren't in the other room. Basil decided to work in the comfort of his office. This took some time."

Basil reached into a top drawer of his desk and pulled out a metal box, about the same size and shape as a half-pint milk carton. It appeared to have a spiral pattern etched onto its surface, along with a solitary switch and status light.

"This is Basil's latest acquisition. It's called a broadband jammer. Any radio signals within this office are effectively scrambled. No television, no radio, no wireless network, and no stray emissions from Basil's computer. Of course, to be safe, Basil has unplugged the transceiver and the wired network connections. Communications-wise, Basil and Michael are in the dark. Oh, Basil was sure to check the light bulbs, too!"

Michael didn't quite understand the last part, but knowing Basil's paranoia, he was sure that all the appropriate measures had been taken. He gazed at Basil's display screen.

"Basil, I was wondering, why did they choose to obfuscate the code, rather than encrypt it? If they didn't want it to be seen, encryption would be the best way."

"Well, there are two problems there. The first is that that code would need to be decrypted, which means it would need to be put into a writable memory space. The routers only have enough memory for a small stack. That's because the memory must be really fast, so there's not enough room. The other reason is that encrypted code would stand out like a pregnant mule."

Michael winced. He had never seen a mule, nor was he likely ever to see a mule, but Basil seemed to know his way around mules, so he took his word for this.

“If no one suspects anything, the obfuscated code just blends in, but Basil had reason to be curious.”

Basil pointed to some code on the display screen.

“As Basil found before, when the hub router receives three sequential commands in a very short time, it goes into an administrative mode controlled by the network address that sent the command. By unraveling the code, Basil found that this super-administrator can modify some look-up tables in hardware. What these tables do is a rapid routing of some addresses to others. There is no code, since it's all done in hardware, and it's really fast. In the old days, these were links to what were called Domain Name Servers, but now they're usually links to a super network – government and emergency stuff. These tables are updated regularly, but a normal administrator needs to physically access the router to do that. This is a security measure. Have you ever seen a hub location?”

Michael confessed, “No.”

“Well, there are concrete and steel doors; and guards with guns. Basil saw one once, during construction. No armed guards around then.”

Basil winked. Another insight into his past. He must have downloaded code right from a router when no one was around. Michael had made the right choice of a consultant.

“Very secure, at least on paper, but it seems that all that security has been bypassed. And another thing...”

Basil pointed to some code, as cryptic as the rest. Michael didn't understand any of it, but he tried to act interested.

“When these routers are shutdown or pulled out of service, the code erases the modified portions of the tables on the next power-up. Maintenance people would never know something is amiss, since there are just two rogue code bytes left after all that. Of course, these maintenance guys don't access the code on the fly like Basil did a few nights ago.”

“OK. Someone modified these tables. Where do we go from there?”

“Are you adventuresome, Michael?”

“What do you mean?”

“As Basil said, the tables are in a special cache in the router. The rogue code proves you can modify them remotely, although that really should have been prevented in the hardware. But as far as Basil can see, you can't use the code to read them remotely, an obvious security measure that still stands. If you want to see what's going on, you need to physically access the router.”

“So, to paraphrase what you just said, we need to visit an active router; and not just visit, but take it apart and examine it, all without anyone noticing. I suppose we just buy the armed guards some donuts!”

“Michael, it's not as bad as that! Yes, you need physical access to the machine, but Basil just needs a few seconds alone at its back panel. There's a port I can plug into. Zip, zip, we're done.”

As he left Basil's office, Michael started to wonder whether Haematite was paying him enough.

9 Ski Masks Optional

Basil did not advocate a full frontal assault on a hub router, just a little time at the back of the equipment racks. The scenario still pointed towards some risky business, and it was contingent on their getting access. From Basil's description, access was closely guarded, and he couldn't think of any excuse that would get them into such a place, let alone do what Basil had suggested. It was time to get Sandra involved, at least for a second opinion. He and Sandra would be together for the weekend, but Michael decided not to fill her in on the latest development until working hours, sometime next week.

Michael and Sandra's weekend plan was to spend Friday night at her place, and then take a tour of some antique shops in the vicinity of East Wodenstumpf on Saturday, probably taking a quiet dinner at some country restaurant before returning to her apartment. Michael had no interest whatever in antiques, but love can lead a man down many untrodden paths. He enjoyed new items, the latest technical gadgets, and didn't understand how old junk could command such high prices. He had noticed some old utilitarian furniture at Sandra's place, dresser drawers and the like, but he thought they had been in her family for years. He now realized that she had bought those items herself – another side of Sandra that made her unique, but a side that took getting accustomed to. Friday night in bed with Sandra made the whole adventure palatable.

Fortunately, Sandra was not an early riser on weekends, so they lingered in bed until about 9:00 AM, ate a hasty breakfast, and were on the road by ten. Sandra had mapped out a search radius of about thirty miles around East Wodenstumpf, and she had plotted an efficient path through several small towns with small antique shops. It was a beautiful, sunny day, so the ride was enjoyable. Sandra did a lot of looking, found a few small jewelry items to purchase, but no bulky items. Michael figured that any large purchases would need to be shipped, since they weren't equipped to transport anything like that. Some of the other customers came with vans or trailers. These were probably dealers from larger cities who routinely acquire stock at country shops, auctions and house sales, hauled them to their shops, and marked them up for a large profit.

It was 5:00 PM, and they were politely edged to the doorway at the fourth shop on Sandra's list. The shopkeeper wanted to close for the day, which was fine by Michael, whose mind had numbed to this whole antiquing concept midway into their visit to the second shop. Sandra was starting to look a little fatigued herself.

A few miles down the road, they found a modest little restaurant and decided to stop there for dinner. The restaurant was so small that it had a fixed dinner menu of traditional New England fare centered on the single entrée of pot roast and potatoes. The food choice appealed to both of them, quite possibly because they hadn't stopped for lunch and were famished, so they slumped into their chairs and ordered. Both were exhausted, and neither of them was up to much conversation until the biscuits and butter arrived and they had a chance to fuel their stomachs. Michael started.

"How is it that you're into antiques? It seems like a strange hobby for a girl from California."

"Actually, it all started in California. My mother, Helen, came from a family that traced its beginnings back to the Forty-Niners, or at least that's what she was told. There were a few memento items from what may have been that period in the house, an old chest and some items in it, that interested me when I was young. Mom would take us to flea markets – of course, there were rarely any genuine articles there, just reproductions – but I enjoyed the excitement of the quest. When I had a good income and found myself in New England, a place where real antiques passed frequently into the market from house sales of the last of the family line, the lure was irresistible. Unfortunately, I need to

temper my ambitions because of lack of space at my place. Come to think of it, you've been occupying as much space as a good-sized armoire. Oh, the difficult choices I have to make!"

The meal spanned almost two hours, mostly because of the carefree demeanor of the restaurant, which was quite unlike the hurried service they were accustomed to, but it was an enjoyable time. They were back at Sandra's place around midnight, but this wasn't a night for romance. They were both exhausted when they plopped into bed.

Sometime Sunday, Michael made it back to his office at Mother Wode. There were no new messages from Sterba, and the automated data analysis he had started to handle Sterba's last request had completed. With an additional half-hour's work, he revised the graph, but he didn't send it to Sterba. He decided to do that on Monday. A message from him to Sterba might only invite more work, and he needed a day's rest.

Michael spent most of Monday at Haematite. He wasn't purposely avoiding Sandra, but he wasn't actively hoping to run into her. He had to tell her about Basil's findings, which would mean he would need to tell her about Basil. Basil would be an acquired taste. Michael decided for the moment to shield her from Basil and talk only in general terms until he got a sense of Sandra's position. Maybe Sandra would enjoy wearing a black ski mask and raiding a hub router.

It was Tuesday morning before he got the courage to bring Sandra up to speed on the hub router problem. As usual, she wasn't in her office, but he found her in the lab. Michael paused in the doorway a moment to savor the gentle glow of the display light on her face. Direct lighting seemed to age most women – every little wrinkle and crease are exaggerated – but Sandra's face seemed to glow in a most beautiful way.

Finally, he knocked gently on the door, and Sandra looked up.

"Sandra, I've done a little more digging in the Black Swan problem, and I have a possible next step to resolve it."

"Wonderful! Details! Details!"

"With some help from a capable fellow at East Wodenstumpf, we did some investigating. It looks like the hub routers are sending packets off into deep space, and they are somehow retrieved a while later."

"So, we call the hub manufacturers and clue them in?"

"It's not as simple as that. This doesn't seem to be the fault of the hub manufacturer. There appears to be some outside agency responsible. We may need to tread lightly."

"The government? Oh! Maybe a foreign government!"

"Could be. I just don't know."

He paused, and Sandra interjected.

"You said you had a possible next step. What is it?"

Did Sandra see his face grow the slightest shade paler?

"Well, to discover who's responsible for the lost packets, which I think are our Black Swans, we need physical access to an active hub. It would just take a few seconds at the rear panel."

Michael decided not to mention that he didn't know anything about accessing the router information himself. He would need to bring Basil with them.

"My consultant at East Wodenstumpf says that that's the only way, so we're stuck. We can't just storm a hub with guns blazing. I guess the project's dead."

"Well, can't we just give the hub people our information, and let them sort it out? If they fix the dropped packet problem, that will fix our Black Swan problem, and I'm certain they would do this with utmost haste!"

An obvious point. Now Michael needed to put his cards on the table.

"The trouble is... they would wonder how we got our information. What my consultant did wasn't

exactly legal. And if the government is in cahoots with the manufacturer, then it's high level government trouble, and not something I would care to be mixed up in."

He had expected Sandra to look shocked. Her response was unexpected.

"Those government SOBs! I wouldn't be surprised if some government functionary was somehow lining his own pockets this way! Maybe he's redirecting financial transactions to work the market, or stealing industrial secrets, or blackmailing his government's own citizens! Things like this used to happen in the early century. Illegal government wiretaps, and all that. Tighter controls were put into place to stop such shenanigans, but that was a simpler time."

Sandra's face had turned an intense, but appealing shade of pink. She paused for a moment, collecting her thoughts.

"Perhaps the time was ripe for a second wave of such nonsense. Whatever, or whoever, it is, they should be stopped. I think we're obligated to look more deeply into this, as long as we can handle it discretely and anonymously. Access to an active hub might not be too much of a problem. Haematite is a big company. We must do business with router manufacturers on a regular basis. Our shadow network didn't just materialize out of thin air. I'm sure I could get a well placed introduction. If we're potential buyers, you'll be amazed a what some guys will do to make a sale." Sandra laughed. "Maybe I can keep the salesman busy while you do your dirty work behind the racks!"

10 Threesome

Michael knew that he wouldn't find Basil in his office anytime the next morning, so he spent some time at Haematite. He didn't really have much to do, so he did some deep dives into the network looking for tutorials on the types and mechanisms of securities trading. Most of the information he found presupposed some sort of financial background, and the texts were filled with all sorts of jargon. He imagined it was similar to what would happen if a finance student tried to figure out what Michael was doing for his Ph.D. He did find that computers mostly ran the show. In the rare instances when a human made a transaction, the human was playing a hunch, but he was relying on a display screen full of data from computer models.

Michael arrived at Mother Wode around noon, but Basil had still not arrived. He left a note on Basil's door that he would try again at about 1:00 PM, and he walked to Wode's End, the closest of the small campus eateries, for lunch. He tried not to eat there too often, since the greasy food was designed for younger stomachs than his; but he hadn't treated himself to a Wodeburger in quite a while, and he remembered that they tasted quite good when layered with a thick spread of sweet relish from the fixings bar. Since he was on a roll, he ordered the accompanying fries but promised himself he would eat only half the portion. Promises are too easily broken.

When Michael returned to Basil's office, he found him there.

"Michael! Basil got your message. Sorry about my lateness, but Basil had a very full night."

"You mean a full-figured woman?"

"Ha! Just some code, but Basil does prefer women!"

Michael informed Basil of Sandra's idea to pose as a potential customer to gain access to a hub router. Basil said he only needed about thirty seconds at a particular rear-mounted connector. The trick, said Basil, was that the optical connector was non-standard – another precaution to prevent accidental data leaks.

"Not to worry, Michael, Basil has a connector! Zip, zip – it is done!"

"OK, Basil, I'll take your word for it, but it's time for us to get together for a strategy session; and by "us," I mean you, me and Sandra. Sandra knows I'm working with someone at Mother Wode, but I haven't told her anything about you. She's probably expecting my associate to be some academic type, like me, so we'll need to ease her into things."

"Michael, don't worry! Basil cleans up nicely! Basil knows how to charm the women, too!"

"Clean is good, but forget the charm. She barely tolerates me. I'll set up a meeting."

Once again, the difficulties of his Sterba tasks paled in comparison with his real world problems. Michael needed to introduce Basil to Sandra and then get her comfortable with the idea of bringing Basil with them to a hub. It had surprised him that Sandra was so agreeable to Basil's idea of compromising hub security. He still had much to learn about her, or perhaps about all women in general.

Sandra had been playing transceiver tag with a few people, trying to line up a visit to an active hub. She found someone at Haematite who had bought a hub router – actually, almost a dozen – for the electrical futures shadow network. Dropping his name got an invitation to visit an active hub. A minor inconvenience was that the hub was near Hartford. Although they could rent a car in Hartford, public transportation to Hartford was not that convenient. They decided to drive the entire distance, and an appointment was set for early the next week. It was imperative that Sandra and Basil meet, and soon.

Basil's waking hours did not make this easy. Michael suggested to Basil that he would buy him a

late breakfast – at 6:00 PM – and he would bring Sandra with him. For Basil, breakfast was two burritos at Miguel's. Sandra had agreed to dinner that same night, and Mexican sounded good to her.

"I've invited my colleague from Mother Wode. Is it OK if he joins us? It would be good if you finally met, especially since you're paying the bills."

Since Sandra thought the only real romantic dinners were in the privacy of her home, Michael was fairly certain she would agree, and she did. Basil was never on time, so their arriving promptly at six meant they would precede him. Then he would have time to soften her up. A cocktail would help, if only for his own nerves, but when they arrived at the restaurant, Basil was already ensconced in a chair at the entrance, waiting for his table number to be called.

"Basil, you're right on time!"

Michael glanced sideways to see Sandra's reaction to this nearly spherically shaped human with whom she was to dine.

"Michael, you are a paying customer! Basil is always punctual in such cases! This charming young lady is the colleague Michael mentioned to Basil?"

"Sandra, this is Basil. He's the East Wodenstumpf consultant I brought onto the project."

Well, all the cats were out of the bag, now. Sandra's lips tensed as she turned to Michael.

"He signed all the proper non-disclosure agreements?"

"Don't worry, young lady. Basil discloses to no one! Too dangerous! In fact, Basil's mother doesn't even know Basil's birthday! But, let us eat and talk."

They were seated quickly and ordered. To Basil's credit, he didn't seem to imbibe at breakfast, although it was cocktail time in the real world. Michael ordered a Dos Equis and Sandra ordered a Corona. When the drinks arrived, Michael didn't know how to start the conversation. Fortunately, Sandra took the lead.

"So, Basil, you're our mystery consultant. Michael was keeping you a secret until now, but you've uncovered some interesting information that may advance our project. Did Michael outline what we're doing?"

Michael realized that Sandra was testing to see how much Basil really knew.

"Michael didn't say anything at all, except for the fact that Michael suspected a problem with the hub routers. That must be why Michael didn't think Basil needed to sign any non-disclosure forms. Michael didn't disclose any business information. Basil prefers things that way, so keep Basil in the dark as much as possible. Basil prefers computers to the harsh realities of the business world. Computers are much more predictable, at least for Basil!"

Sandra relaxed noticeably.

"OK, I'll accept that. What's your background? Are you a student like Michael? A post-doc, perhaps?"

Basil outlined his earlier funding problems, confessed he was a staff employee, and gave a resume of some interesting things he was doing at Mother Wode. He purposely refrained from divulging details of his supposed dark side, the side that made him a valued consultant. He refrained from this, possibly because Sandra had not yet won his trust. Basil continued.

"Sandra, do you code?"

Sandra looked a little surprised by the question.

"Yes, I'm a Computerati. I code a lot. Why do you ask?"

"In Basil's experience, there are two types of Computerati, those who know how to code, and those who produce elaborate schemes for others to code. As far as Basil is concerned, the non-coders are just philosophers who don't deserve to be called Computerati. Michael, here, codes a lot, and that's why Basil decided to help him. Michael understands the nature of the machine - sometimes you fight it, and sometimes it is your friend."

“I keep my machines friendly.”

Their meals arrived. Basil turned the plate around, carefully examining his breakfast, somewhat like a dog does with his bone.

“If you want to solve the hub router mystery, Basil is your man. As Michael must have told you, Basil would need physical access to a machine for about thirty seconds.”

Sanda turned pale.

“You're going to get the data, not Michael?”

“Basil knows his way around hub routers. Michael is a fast learner, but it's too tricky to try to teach someone else, especially when there is no router for practice.”

Sandra paused for a moment.

“I've been able to arrange a visit to an active hub near Hartford. I could add you to the guest list. What you plan to do is not quite illegal, is it?”

Michael choked on his beer.

“Basil will be discreet, and you have a good cover story. Besides, how important could a few bytes of information be?”

Michael could tell that Sandra was getting more and more uncomfortable with the hub venture. She was conflicted. On the one hand, she was curious and wanted to know what was happening. Also, as he had found, she had an anti-establishment bent that was somewhat exciting to him. But there was the added element of risk. He decided that the best way to manage her attitude towards the risk was by giving her more data.

Hoping that Basil would understand the purpose of his phrasing of the question this way, Michael said, “Basil, as I remember in our conversations, you mentioned that you had once helped in the construction of a hub router. Perhaps you could reassure Sandra that there would be no real danger of our being detected.”

“Ah, yes. Basil has direct, hands-on experience in this area. The first thing to understand is that all the security is at the perimeter, the front door, so to speak. If you are welcomed through the front door, no one is worried at all about you.”

Sandra interrupted.

“But there must some safeguards inside. The routers must be inside some cabinets. Won't the cabinets be locked?”

Yes, there are cabinets, but if they have locks, they are left unlocked. Technicians can't be bothered with locks. When they need access, they want it right away. Perhaps on days when some manager makes a call, they'll sweep the floors and lock the cabinets, but that's a rarity, not the norm. Besides, we're there to examine the routers, so the cabinet will be unlocked for us.”

Sandra started to look a little more relaxed, but she had another question.

“What about security cameras?”

Basil smiled.

“Yes, there will be security cameras, but they will be pointed at the doorways, just to see who enters and exits. Technicians are people, too, and everyone values his privacy. Remember, anyone inside has been authorized to be inside. Basil, Michael and Sandra will be authorized to be inside. No one will worry about us. Besides, if Michael acts as a shield, no one will see what Basil does in those thirty seconds.”

Sandra had no more questions, so she concentrated on her meal, as did Basil. For his part, Michael did more sipping of beer than eating, and he tried to fuel chit-chat so that Sandra would get to know Basil.

“Sandra, you'll be amazed at the number of programming languages that Basil knows. Most of them are only a name to me. Basil, why did you ever learn so many? Is it like a hobby?”

“Basil likes to code, but he doesn't like to work! There's always a best language for a particular application. If you write in that language, the application flows from your keyboard like a symphony. If you know only one or just a few languages, the whole venture is a chore. Sandra, have you heard of Fortran?”

Sandra paused to wipe her lips and then answered.

“Yes, it was a popular mathematical language last century. A lot of physical scientists wrote code in it, but it wasn't very user friendly and it's not used much except for some legacy applications. I think the For part of the name derived from the word formula.”

“Right. It was the programming language of choice among physicists. In fact, it was usually the only language they learned, although most were quite proficient in it. Well, there was a joke among the Computerati in those days that physicists would write a database in Fortran. Sure, you could do it, but it's the wrong language to use.”

“I guess it's like using the right screwdriver for a screw,” said Sandra.

Once the conversation got started, things mellowed a lot. They were a group of Computerati talking shop, with so many possible topics. Knowing that Sandra was driving, Michael ordered another beer.

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About the Author

Dev Gualtieri received his PhD in 1974 and had a thirty-five year research career in physics and materials science.

He is listed as an inventor on more than thirty US patents, and on numerous international patents. His eclectic research interests included superconductivity, chemical thermodynamics, magnetism, electronics and computer science. At one time, he was an internationally recognized expert in crystal growth.

Dr. Gualtieri is now retired, and he resides in Northern New Jersey with his wife Anne. They have a son and daughter who reside with their spouses in Pennsylvania.