Fiction and Fable:
Tales of Time-Series

Edited by Johan Ferreira and Seite Makgai

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Foreword

Common statistics teaching approaches and interventions include (and mainly focus on) explaining the theory and applying introductory statistical concepts. Few focus on enriching the concepts covered in advanced undergraduate courses. The editors of this book recognised a potential intellectual and literary void in the South African tertiary statistics curriculum. They set out to supplement the traditional theoretical (and practical) pedagogy and praxis already used in instruction with a fresh perspective.

This book emanated from a project to develop and curate fictional narratives based on content from the STK 320/WST 321 time-series analysis syllabus at the University of Pretoria (UP). The output from this project may serve as an additional learning resource that UP (and other) students can use to spark further interest — and reduce uncertainty surrounding taught concepts in time-series analyses.

Time-series analysis (WST 321/STK 320) is an 18/25 credit third-year module taken by approximately 300 students each year, consisting of students from BSc Mathematical Statistics, BSc Actuarial and Financial Mathematics, BCom Statistics and Data Science, and BCom Economics, among others. The content includes univariate time-series, properties of autoregressive moving average models, estimation of the considered models, forecasting, and residual analysis.

In one semester, students voluntarily participated in a storytelling exercise where key time-series analysis concepts were used as characters. Students received a non-restrictive, non-stringent brief or guideline on writing such a fictional narrative (short story), with the purpose of exploring the stimulation of previously unconsidered cognitive centres that might supplement other such centres to accelerate learning and decrease perceived anxiety surrounding time-series analysis. In this way, teaching and research capacity is strengthened in a module which annually challenges BCom-students, particularly, by creating additional teaching material for future students, written by students and curated by lecturers (principal investigators in this project). Formal learning is thus encompassed

in an informal peer learning way with this initiative that supports creative, project-based, and cross-disciplinary learning.

Some descriptive definitions (Cryer and Chan 2008):

Time-series
Data obtained from observations collected sequentially over time, often with equally spaced intervals in between (for example, daily closing stock prices, hourly wind speeds, and annual figures for crop or livestock production). The value is often represented by X_t, which denotes the value of the time-series, and the subscript t denotes the point in time of the observation. Generally, there is an additive error term denoted by a_t, which represents the "randomness" that remains unexplained by the model itself. This additive error term is often called "white noise".

Autoregressive
A mathematical approach to model X_t based on its own past observations, such as $X_{(t-1)}$; in effect, regressing X_t on itself in past points in time.

Moving Average
A mathematical approach to model X_t based on past observations of the error terms, such as $a_{(t-1)}$.

Autocorrelation Function (ACF)
A statistical expression which indicates the correlation between observations X_t and X_k , for example, when observations in the time series X_t are t-k time intervals apart.

Augmented Dickey-Fuller (ADF)
A statistical test of significance to determine whether a time-series X_t contains a unit root.

Further definitions of minor references to specific nomenclature and abbreviations in this book can be found in Cryer and Chan (2008).

Purpose

The purpose of this project was to curate an anthology of contributed fictional texts where aspects and concepts of storytelling are taken from the course material in STK 320/WST 321.

Aims

The aims of the project were to:

- improve student learning with newly developed teaching resources;
- inspire students to take ownership in a creative way, of how their own educational experience could be supported through informal, project-based peer learning;
- reduce the degree of uncertainty and apprehension about the module for future students; and
- determine student contributors' reflective experience of cognitive changes following the creative process to address uncertainty and teaching value within the module content.

Objectives

The objectives of the project were to:

- collate, edit, and curate fictional narratives written by students emanating from the time-series component;
- publish this collection of narratives via ESI Press as an official volume of student contributions;
- implement this resource in the respective modules for student use and enrichment in future;
- promote the produced outcome of this project at national conferences; and
- understand, document, and curate student contributors' experiences of the creative process to gain insight into this trans-disciplinary and creative addition to a senior undergraduate course within the discipline of statistics.

For this project, the students were briefed as follows:

Write a narrative of approximately 1000 words (roughly 1.5 A4 pages) as if it is a "bedtime story" for a younger sibling or cousin you may have. This story has to use "characters" from the time-series component of WST 321/ STK 320. Your story must have a main character, a villain, and be set in a fictional/real world/country/place of your choosing.

Particular things I will be looking out for (but do not let these impede your creativity):

1. *There are specific characters/places with direct relation to time-series concepts (for example, ARIMA(0,1,0) is a villain!);*
2. *There is a natural link between the story and the course content of time-series;*
3. *The story is well-structured; and*
4. *The story ends with some resolution (the main heroine defeats the evil wizard, for example).*

You do not have to be a great writer to participate in this assignment. You just have to be yourself and want to try and be a little creative. Particular notes: You may write this narrative in your home language, or in English. If it is in a language different from English, I commit to try my best and obtain a suitably translated version into English. You are free to submit more than one narrative, but please submit them separately.

The approach following receipt of students' submissions was to read, comment, and edit each narrative to build and curate a cohesive, structured, contributed volume that serves the end-goal of not only just a contributed storybook, but also functioning as a newly developed and edited education tool within the WST 321/STK 320 module (or rather, within an introductory time-series analysis undergraduate module). Students were free to participate (no forced participation).

They had to give explicit consent that their stories may be used for research purposes as well as consent to potentially being published. Out of a class of approximately 300 students, over 30 contributions were received, of which 23 students permitted their work to be included in such a volume. The editors curated submissions into two distinct sections (Part I: Fables and Fairy Tales and Part II: Fantasy and Sci-Fi) based on the general style and gist of submitted work, commensurate with popular subgenres of stories also often encountered with bedtime stories.

Impact

The impact of the project was the following

- Students have a new additional reference and learning resource.
- New students can refer to the experiences of former students, leading to informal peer learning.
- Course content becomes relevant through a creative approach, stimulating transdisciplinary experiences within the analytical sciences.
- At the third-year level in statistics, students engage in a cognitive skill (creative thinking) that is not frequently examined in this particular field.

Each student presents unique learning abilities in any lecture hall (large or small). For this reason, implementing various teaching methods is essential for an effective learning environment. Attention, language, memory, and higher-order thinking are four (out of six) important components that influence the learning process. Any tool or environment that combines all four components is essential for the optimum cognitive learning experience. The science of good storytelling requires all four, if not all six components.

Foci on narrative storytelling in the mathematical sciences have received some interest recently (Albano and Pierri 2017; D'Andrea and Waters 2002; Lashari et al. 2022; Sherwood 2018). This allows students to supplement their learning in a cognitive area with strong skills already obtained in another. An article posted by Harvard Business Publishing (Peterson 2017) highlighted the science behind

storytelling. It is mentioned in the article that brain chemicals, such as cortisol (a stress hormone, but in this case increasing memory function), oxytocin, and dopamine are heightened when one reads a story. These brain chemicals assist with memory consolidation, sustaining attention, and regulating and deepening emotional responses.

Research has focused mainly on using interactive elements and fictitious contributions in pre-secondary education (Blackburn 2015) and plenty in elementary education (Lemonidis and Kaiafa 2019). Some researchers note that fictional narratives can spark interest, reduce anxiety, and stimulate engagement in the education process (D'Andrea and Waters 2002; Lemonidis and Kaiafa 2019). In tertiary education, there has been a focus on picture books and other digital media (Albano and Pierri 2017; Walters et al. 2018). Karanasiou et al. (2021) investigated the effect of storytelling in higher education. In their findings, storytelling was observed to be an effective teaching and learning tool. It was found to be more effective for students with higher memory ability. Karanasiou et al. (2021) explained narratives or storytelling as a vehicle for "making meaning of one's understanding and learning experience".

A volume of student contributions may thus make a valuable and meaningful contribution to the literature of storytelling as pedagogy within the analytical sciences — specifically senior undergraduate courses in statistics. In a world where problems become more complex to solve, statistics remain a scary and uninviting field of science beyond introductory courses (Kruppa et al. 2021; Lemieux 2020). A distinct interest in exploring fictional narratives in advanced undergraduate statistics courses may shed light on alternative (less stressful) teaching and learning approaches. In particular, the study contextualises storytelling as a meaningful framework for conducting a mathematical discussion. It allows teachers (lecturers) and students to homogeneously and heterogeneously share informal knowledge and stimulate peer learning.

Johan Ferreira and Seite Makgai, 2023

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PART I

Fables and Fairy Tales

4

Stationaryville and the Two Brothers

by Lebogang Malebati

Once upon a time, in a far and magical land called Stationaryville, lived two brothers. The brothers' names were AR(1) and AR(2) and they were part of the prestigious Autoregressive family; one that prided itself on being stationary and invertible in Stationaryville. Their family also liked to be generally linear on things.

AR(1) was AR(2)'s older brother. The brothers loved each other very much and always took care of each other. They did everything together. They played together, laughed together, ate together, and they were best friends.

One day the older brother, AR(1), asked his younger brother if he wanted to go on a Time-Series journey with him — a journey through time. AR(1) asked his younger brother to go on this journey because he realised they were both non-stationary, a condition not allowed in Stationaryville. Because the brothers loved going on adventures together and needed to go on a quest to be stationary, AR(2) decided that he would go on this beautiful Time-Series journey with his brother.

This journey would certainly test their courage and intelligence, so the brothers needed to check a few things about themselves before going on the adventure. The brothers remembered that they had to ensure they were generally linear because they belonged to the Autoregressive family. Furthermore, they realised that they have the power of μ. The power of μ states that they will have an expected value of μ. And no matter what they did, their expected value would be μ.

Brothers raised in the same family are often the same, but more often than not, they are different. These brothers were definitely different in the sense that AR(1) had one lag, and AR(2) had two lags. However, the brothers knew that they could use their differences to make each other stronger, and these differences would help them through the Time-Series journey. The brothers knew that if they worked together, they would be unstoppable.

As the brothers went on the Time-Series journey to obtain stationarity, they stumbled on the land of Invertibility. The land of Invertibility had a wise guardian who guarded its powers. Can you guess what the powers were? It's Invertibility, of course.

The brothers told the guardian why they were on this journey, and since the guardian was wise and had a kind heart, he decided to grant the brothers the power of Invertibility.

The guardian told them: "Since you belong to the Autoregressive family, and because I see how hard you are both working towards your journey, I will grant both of you the power of Invertibility. But listen to me very carefully. Stick together as brothers and use your new powers wisely."

The brothers thanked the guardian and left the land of Invertibility to continue on their Time-Series journey.

As the brothers progressed on their journey through time, they finally reached the Gate of Stationarity. Guarding this gate and its power was an evil wizard named Station-Nation. Station-Nation was a greedy little wizard who did not like sharing his powers unless his conditions were satisfied.

He was a very picky wizard - a picky and hard-to-please wizard.

Station-Nation heard all about the brothers' problems through the grapevine, and he started taunting them.

"I heard that you boys are non-stationary. How can you not be stationary and live in Stationaryville?" The brothers knew the wizard was right, but they told the wizard they would do whatever it took to become stationary. The wizard saw their eagerness as an opportunity to trap them.

Station-Nation told them: "Since you two are brothers, but different in your own way, you each have unique powers. You have to use these unique powers to help you gain the power of Stationarity. If you can tell me how to use these powers, I will grant you the gift you seek. But, I know that you will fail."

Even though the brothers were scared, they took the wizard up on his offer, and they thought back to what their parents had told them when they were just young boys: that they were both born with special powers, powers that could make them stationary.

AR(2), thinking on his feet, quickly thought of what could make him stationary. He told the wizard that three things could make him stationary.

AR(2) told the wizard, “If I harness the power of ϕ_1 and ϕ_2, then I can be stationary. Firstly, I need to ensure that $\phi_2 + \phi_1 < 1$. Secondly, I need to make sure that $\phi_2 + \phi_1 < 1$. Finally, and the cherry on top, is that $-1 < \phi_2 < 1$”.

The wizard was surprised that AR(2) passed his test and reluctantly gave him the power of Stationarity.

It was harder for AR(1) to remember his powers, but with the encouragement and support of his younger brother, he remembered: “Aha, you trickster, I know my powers. For me to be stationary, I need to harness my power of ϕ to make sure that $-1 < \phi < 1$.”

The wizard knew that the brother was right, and because he was bound by his powers to grant his promise, he also gave the power of Stationarity to AR(1).

The brothers were overjoyed that they defeated the wizard and managed to get the power of Stationarity to continue living in Stationaryville.

They returned home and lived happily ever after in Stationaryville.

IO

The Tales of Archibald Rubenstein

by Jaydean Botha

Once upon a time, in a galaxy far, far away called Forcastanation, there lived a young man called Archibald Rubenstein. To his family and friends, he was known as AR. During the day, AR was a normal schoolboy who did his homework and played outside with his friends in the backyard. One could say he was a busybody, or one could even say he was non-stationary. But during the night, AR was anything but ordinary.

AR transformed into a crime-fighting vigilante at night, saving lives wherever he went. He had intuition that would alert him when someone was in danger - a kind of superpower. Thus, he was always on the lookout, awake, and alert. His alertness would slightly diminish during the night when tiredness kicked in.

On one specific night, he was signalled through his internal superpowers that someone was in danger. He quickly rushed to the scene and saw a random man walking towards an innocent girl who was probably walking home from work. Let's refer to this man as the Random-Walk guy. As usual, when AR arrived on the scene,

he analysed the danger and the severity of the situation. Upon doing this, he noticed that the man was walking as if his next step could not be predicted. He took one step to the left, then one back, then two forward, and so on - walking like he was drunk.

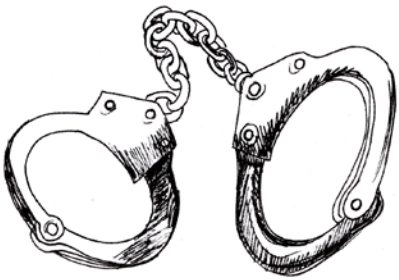
The next moment a taxi pulled up next to the innocent girl. The Random-Walk man ran towards her and threw her inside the taxi. She kicked and screamed, trying to fight him, but she was not strong enough and eventually she had to give in. The Random-Walk guy shut the door, and as the taxi was about to speed away, AR jumped on top of it and gripped onto the roof rack.

AR realised that this was not a fight he would win alone. He needed backup. Who better to call for backup than AR's best friend Martin Arlington, better known as MA. Together MA and AR were unstoppable. They were known as Forecastanation's top superheroes. Some newspapers started referring to them as the ARMA vigilantes.

When MA received AR's call, he dropped everything he was busy with and rushed to the innocent girl's rescue. Luckily, MA was still awake because his alertness and ability to stay up at night was not as good as AR's. MA could stay alert for a few hours during the night, but then he would fall asleep and not wake up until morning.

When MA arrived at AR's location, he also jumped on top of the car. They worked out a plan of action and decided to enter the taxi through the passenger window. They both jumped in, MA wrestled with the driver while AR rushed to the back of the van where the Random-Walk man was waiting. The car swerved across the road as MA tried to gain control of the vehicle. Finally, his strength kicked in, and he pushed the driver off the seat and out the door. He did it! He was able to stabilise the taxi.

Meanwhile, AR was still fighting the Random-Walk man at the back of the taxi. The back doors of the taxi flung open, and AR was about to fall out when the girl grabbed his arm and pulled him back into the taxi. After regaining his balance, AR knew what he needed to do. He kicked the Random-Walk man in the back, forcing him towards the doors at the back of the taxi. The Random-Walk man took four



steps forward, one to the left, two to the right and finally, the last step forward and fell out of the taxi onto the tarmac.

The innocent girl looked at AR with big round eyes full of shock. She only managed to utter: “Thank you, ARMA vigilantes”.

AR and MA returned the girl to her parent’s house. Before leaving her parent’s house, AR asked the girl her name, and she told him it was White Noise, a perfect name for an innocent girl.

A few days later, AR saw on the news that the Random-Walk man and his associate had been arrested.

AR and MA continue to fight crime to this day. They are known as the ARMA vigilantes, and they save innocent people’s lives and put the bad guys behind bars.

The Drunkard's Walk Prince

by Mayurie Pandaram

Once upon a time, in a land far, far away, lived a princess who dreamed of living a life she would be proud to call her own.

Her father was the king of the Autoregressive (AR) nation, while her mother was the queen of the Moving Average (MA) nation. When her parents got married, they formed a strong alliance between the two nations, renaming the nations as one: the nation of Autoregressive Moving Averages (ARMA).

The princess, Esmeralda, was the bridge between these two nations and was expected to rule the nation of ARMA after her parents. However, there was one slight hitch in that plan: she did not have a king to rule by her side when she became queen. So, Esmeralda sent a worldwide proclamation that she would marry whoever proved to her that they were pure of heart.

Her parents ruled a land where the purity of heart was measured by whether the subjects' (processes) hearts contained white noise or not. If they contained white noise, known as the Drunkard's Walk, they were considered not pure of heart.

Now, the nation of ARMA was at odds with another nation: the nation of Autoregressive Integrated Moving Averages (ARIMA). While the ARMA nation was peaceful and stuck to their same everyday traditions (stationary), the ARIMA nation preferred to test the limits of science by always moving forward (non-stationary). The ARMA nation believed that the ARIMA nation was moving away from what was natural with all its scientific breakthroughs.

The prince of this story, Rohan, came from ARIMA. Once he heard of the princess's proclamation, he was curious.

"How will I prove myself to this princess who has the purest heart when I come from a nation that her parents don't approve of?" he wondered.

Unbeknown to Rohan, his father, King Salmaan, had seen his son's interest in this foreign princess's announcement. He was determined to prevent Rohan from proving himself to Esmeralda at all costs. He believed that if Rohan met and married this princess, then the nation of ARIMA would suffer greatly, and all the scientific advancements he had encouraged his nation to achieve under his rule would be forgotten and replaced with complacency. So, King Salmaan started to hatch a plan to prevent Rohan from ever meeting Esmeralda. King Salmaan's plan was so simple, yet so devious: make Rohan believe that Esmeralda would never marry him, even if he proved to be pure of heart.

One day, King Salmaan called Rohan into his royal chamber to discuss the future of the ARIMA nation. Rohan did not know that his father would subtly suggest that his lineage was far from royal and as such, his heart was not pure.

"Son, get me that book over there labelled Ancestral Tests", King Salmaan told Rohan, pointing to the shelf of books on his righthand side. Rohan walked over to the bookshelf and gingerly gathered the large book in his arms. "What is this, Papa?" Rohan asked innocently. "This is a book containing the royal ancestral lineage, Rohan. Tonight, you will learn about the family chosen to lead our people."

Rohan's curiosity was piqued, and his father had his undivided attention.

"Long ago, when the age of the Time-Series just began, the god of mathematics, Johan, chose the purest ARIMA bloodline to rule our nation. For many years, they ruled with an iron fist, making long strides in the advancements of the sciences. One day, a civil war broke out, and the royal family was forced to flee. It is believed that the entire royal bloodline ended that fateful night. The next morning, the man who started the war, your grandfather, took up the ARIMA throne, and from that day on, our family has been the only one to rule ARIMA."

"Father, are you saying that our family was never part of the original royal bloodline? We were not even cousins of the royals like you told me when I was younger?" Rohan asked, realisation dawning in his mind.

"Precisely, my son" King Salmaan answered with a glint in his eye.

When Rohan heard this, he realised he would never be able to prove to Princess Esmeralda that his heart was pure. How could he when his ancestors were usurpers?

Heartbroken by this news, Rohan ran out of his father's royal chamber and straight to the one place where he had always felt at home: the palace kitchen. Chef Ameer, who was like an adoptive father to Rohan,

found him nursing a tall glass of milk and some cake leftover from dinner. He asked Rohan what the matter was and Rohan reluctantly relayed the past hour's events.

"You know," Chef Ameer began, "the legend told among the people doesn't quite match the one your father narrated."

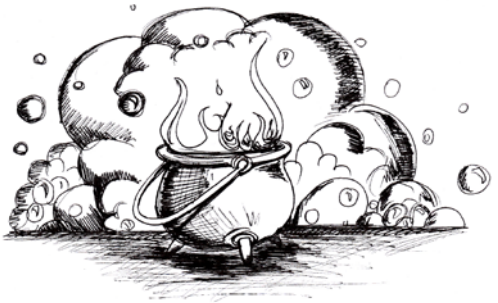
"What on earth do you mean, Ameer?"

"I mean, according to us, the royal bloodline did not end that night. Since your father wanted to be the only ruler, it was said that your mother, the queen, had lost the baby and that another woman's son was given to her to raise. Before your mother's passing, she shared with me that YOU were the true heir to the ARIMA throne. Not your father."

Hearing this, Rohan was caught in a dilemma: how could he prove his birth right and also his purity of heart to Esmeralda? He remembered from his lessons that the only way to test if his heart was pure was to do a DNA (Ljung-Box) test. If his heart were pure, then his blood type (p-value of Ljung-Box test statistic) would prove to be far lower than the average blood type (< significance level). Chef Ameer encouraged him to go to the ARMA nation's best doctors to do the test, as it wasn't safe for him in the ARIMA nation as long as his father was in power. Rohan packed his bags and made the long journey to the ARMA nation, where he got the DNA test done by the best doctors ARMA had to offer.

When the results came back, not only was Rohan able to prove to Princess Esmeralda that his heart was pure, but he was also able to gather enough supporters to take back his rightful place as King of ARIMA.

Once Esmeralda's parents handed the nation of ARMA over to her, King Rohan and Queen Esmeralda did what Esmeralda's parents had done: they merged their respective nations, bringing peace, love, traditions, and scientific advancements to all of their subjects.



Twisted Romance on AR(2)

by Jwalane Noko

Once upon a time, in a village of SAS lived a very beautiful princess called Princess ARMA(1,1). Princess ARMA(1,1) liked taking random walks around the village because she did not believe in stationarity, and neither did her family. It was very important that she sometimes took random walks in the village. It was also very important to her family that ARMA(1,1) married someone who also believed in non-stationarity. One fateful morning, she came across a very handsome man.

This man introduced himself as AR(2), the son of a very cruel witch called AR(1), who lived in the nearby village of R. Both villages, SAS and R, had somewhat the same infrastructure, but R was more advanced and populated than SAS. Many girls from the surrounding villages liked AR(2) and wished to marry him, not knowing that he was the son of a notorious and cruel witch.

ARMA(1,1) agreed to go on a date with AR(2) and thus began their relationship. The princess introduced her handsome man to her family, and it was only a matter of time until the new man took a family compatibility test to see if he believed in non-stationarity. This

test was named after ARMA(1,1)'s great-grandfather Mr Dickey-Fuller. AR(2) took the test and was unmasked as someone who believed in stationarity.

This was the end of their relationship because the princess respected her culture so much that she did not want to be the first in her family to defy the rules. This breakup really hurt AR(2), and of course, he went back to his mother to seek advice. His mother AR(1), informed him about the princess's family and how she also failed the test by appearing to be stationary according to the family test (the Dickey-Fuller test) ages ago when she wanted to get married to MA(1), the then prince.

That turned AR(1) into a heartless, cruel, and unsympathetic witch. She decided that her family won't get hit by lightning twice. She asked AR(2) to bring ARMA(1,1) to her house for dinner. AR(2) agreed and begged the princess to come to his house for dinner. The witch planned to give ARMA(1,1) a spell and kill the entire royal family for what they had done to her and her son.

At dinner, ARMA(1,1) refused to eat the food as she claimed to be full, but the witch pressed her to at least keep the food and eat it when she gets hungry. ARMA(1,1) took a lunchbox of food to her house and kept it till morning. She woke up to the news that the housemaid had eaten the food and later attempted to kill the king and the queen with a royal sword called LAG. The king was rushed to hospital, and the maid was held in a prison cell until she was helped by the traditional healer from SAS, who confirmed that the maid had been put under a spell meant to kill the entire royal family.

ARMA(1,1) realised that the maid ate the food she got from AR(2)'s house the previous night. She informed her father, who was in a very critical condition, that the maid was under a spell from the man she had brought into the house a few weeks back. Soon after the parents' recovery, AR(1) and AR(2) were tracked down by the R and SAS police officers, who found them at a nearby village called Excel.

They were both brought to the royal house and questioned. Only during the interrogation did the king realise who AR(1) was. He realised that AR(1) was the woman he was supposed to marry ages ago, but because they were family (and she did not know), they could not get married since they would have committed incest. But AR(1) was lied to and tossed outside. She was told she could not marry MA(1) because she was stationary.

The king held a family meeting and informed everyone that they were from one royal family of ARIMA, a vast royal family of stationary believers ages ago; they separated when some family members moved to different villages. That is how they started developing new characteristics and decided they would be non-stationary believers. Everyone who married into the family had to take a Dickey-Fuller test to determine whether or not they were stationary believers.

That is how the ARIMA family of stationary believers reunited and welcomed the witch and her son into their mansion. ARMA(1,1) married another young man in the village, and they all lived happily ever after.

The Chronicles of a Stationarnian Living in a Whole New World

by Thato Magano

Tym-Syries was in the business of extrapolation. The town was located in the south-west of the continent of Statistician, where data ports were always busy importing data from all walks, streams, and avenues of life. Upon arrival at the ports, they would be well packaged and shipped off to the relevant parts of the country that would be best suited to handle the extrapolation. The first thing they usually checked was the variance and the mean. If they were stationary, they would get sent out to Stationarnia, a tiny little province in the far north that nearly ceased to exist due to a scandalous relationship. Otherwise, everything else would be sent out to Non-Stationarnia.

In the early 2000s, Stationarnia faced a significant threat. The community was initially divided into two parts: the Autoregressive (AR) and the Moving Average (MA). The communities hardly mingled, and everyone kept to themselves. On the MA side of life, their focus was on determining the order of the process using the Auto-Correlation Function (ACF). They had a foolproof system that allowed them to do their work. They knew they could trust the ACF to yield the right results if the data they received were theirs.

Across the fence was the AR community. The AR community knew that if a model came in where they had to calculate the order, then the Partial-Auto-Correlation Function (PACF) would assist them in determining it. The community had a working system, and everything was as it should be.

One fateful afternoon, a young MA maiden with fair, radiant skin and silky-smooth black hair caught the eye of a lean, young AR gentleman. It was as though his entire life had come to a standstill. She was just that perfect, and he could not believe it. But of course, their love would be forbidden, and he couldn't afford to entertain the idea of them being together. He decided that a simple hello would be enough for him.

The simple hello became a picnic date and a loving relationship as time passed. First came the hello, then came the hug, and after a few months of having stolen moments, a stork delivered a baby boy to the residences of the MA maiden. The baby boy was perfect, and nobody suspected that he was, in fact, an ARMA baby. She kept it a secret because many things could go wrong if other people found out.

The young MA maiden raised her baby alone as she and the young AR gentleman were not allowed to be together. She raised him as well as she could, but the young boy with the absent father soon turned into an unruly brat that nobody could handle. Since he had the genetic makeup of an AR(p) and MA(q) model, he could not get any work done correctly. Since the ACF would only yielded the correct answers under the condition that the model was purely MA, the result that baby ARMA would get was constantly incorrect. This drew the attention of many since there has never been a single case

of a model unable to yield the correct details. People started asking questions: who exactly was this little boy, and where did he come from? Suspicions grew when they questioned the mother about the child's paternity, and she would not answer. This left the community uneasy.

News spread like wildfire, and before they knew it, members of the AR community heard about the boy. Thinking that maybe the stork had delivered the child to the wrong house, the chief of Autoregression had a meeting with the head of MA for the child to use the PACF to process data. He failed dismally in identifying the correct order.

The general consensus was reached that he would be banished alongside his mother. Even though she had lost everything, the maiden did not have a single regret, and she loved her son. He grew up to be a young man filled with anger. He was angry at himself for being unable to do the basic and bare minimum. He was angry at the community for throwing his mother out.

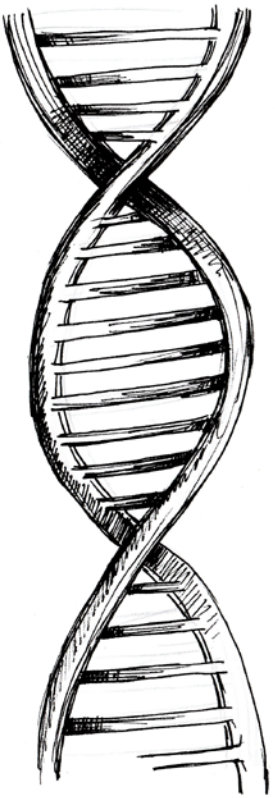
On one sunny day, while hunting for food, the boy wandered into the territory of Non-Stationarnia. A security guard found him outside the Tentative Models factory. Not knowing that he was not part of Non-Stationarnia, the security guard scolded him about being late for work and told him to hurry along. He was given a name tag: ARIMA(p,d,q).

He wanted to leave, but he realised that he had nothing to lose by staying at Non-Stationarnia since he had been banished from the only home that he ever knew. He was assigned to the Extended Sample Auto-Correlation Function sector at the factory, where he worked very well.

He went home to tell his mother he had found a place where he felt he belonged. His mother told him to be careful because he was not one of them.

Nearly six months later, during a night out with his friends, having drunk a bit too much, he let it slip that he was not a part of their community and was actually of stationary decent. That caught the attention of the bartender, who notified authorities. Early the following day, he was called to do a DNA test which confirmed that he had a constant mean and variance. However, that was also when the truth came out that he was an ARMA baby. The event caused a nationwide stir. Everyone asked themselves how it could be that a stationary model could not perform well in his own world but could perform so well in another.

It was then concluded that since there was a new breed of stationary models, they would simply use the non-stationary model's techniques. That is how we came to have stationary ARMA models with the model identification of non-stationary models.



The Shepherd and the Wolf

by Nelis Daniels

Long ago, an old shepherd and his wife lived in a small village next to a very large forest. The shepherd's name was Mongameli Abu, but the village's children simply referred to him as Mister MA or MA. Not "mahh", as you would sometimes call your mother, but "em ay". His wife was called Arivukile Abu, but MA just called her Ari. MA loved three things passionately: his wife, his carrots and his sheep. The rest didn't bother him much, and he was not easily angered by anything or anyone. MA followed his daily routine loyally: waking up at 05:30 and bringing Ari breakfast in bed at 06:00 - three hard-boiled eggs and a slice of toast. After breakfast, he would greet every one of his 100 woolly sheep, water his carrots, nap in the afternoon, and then have dinner with his wife at 19:30. He minded his own business and lived a quiet, peaceful life. However, one thing drove him completely crazy. He would swell up with rage when he thought about it, and sometimes, on days when he was particularly mad, you could even see grey wisps of smoke coming out of his old hairy ears. MA's arch-nemesis, his weakness, the thing he hated the most on earth, was a big grey wolf that lived in the forest.

The wolf was so big and bad that the villagers named it Arma. Just saying the wolf's name sent shudders of fear through even the bravest villagers. The wolf was named Arma because someone in the village once swore he had seen the wolf rip a man's arm clean off! The man shouted, "My arm! Ahhhh!" From that day, everyone knew about Arma, the wolf. He was elusive and sneaky, and his favourite snack in the world was, you guessed it, a delicious, meaty sheep.

Now, on a day like any other, MA woke up at 05:30, brought Ari breakfast at 06:00 and went out to greet his sheep. He greeted every sheep: number 1, 2, 3, ... 98, 99 .... but wait! Where was number 100? He counted again to make sure, but it was clear: number 100 was missing. The smoke started to swirl from his ears. It could be no one but Arma, the wolf.

Fuming, he vowed that the wolf would never take another sheep. He spent the rest of that day building a stone wall around his sheep's shed. The wall was two metres high and two bricks wide. He went to sleep that night, planning to rescue sheep number 100.

But the next day, when he counted his sheep, he only counted 98! Just to make sure, he wiped the sleep from his eyes and counted again. Sure enough, there was number 98 behind number 12, but number 99 was nowhere to be seen. His wife had never seen him so angry before. His eyes bulged, and his fists swung wildly from his gesticulating arms. He would get that wolf, he thought to himself. He realised the stone wall had not worked; Arma could still enter the sheep's house. MA worked tirelessly, and by the end of the day, the stone wall was twice as high as before. Now it was four metres high and four bricks wide. MA went to sleep, satisfied that the wall would do its job. Surely, he had gotten the better of Arma this time.

The next day, MA rushed through Ari's breakfast to get to his sheep faster and even boiled one egg significantly softer than usual. She noticed immediately, and seeing her beloved shepherd so distracted broke her heart - all because of the bad wolf. She loved his calm nature and couldn't bear to see him so upset. MA counted his sheep carefully and almost exploded when he stopped at 97! Not again! His wise old head seemed lost in a grey cloud of smoke.

He had never been angrier in his entire life. Ari saw his rage and decided to help him get rid of this bad wolf once and for all. She realised that brick walls would not help; they would need to attack! She told MA that she had to visit her sister in a neighbouring village, but she drove their small car to the airport just over the hill. She flew over the mountains and the sea until she landed in dusty South Africa on a mission to find a weapon to defeat Arma, the wolf.

Three days later, MA was still fuming. He had set up cameras around the sheep's shed and even bought a camp chair to sit outside and protect his sheep if Arma returned.

Night fell, and he took his place at the house's door. The moon was full that night, and he jumped at every shadow. The wind whistled through low branches at the edge of the forest, and he felt quite nervous, all alone with only his trusty staff for protection. He had almost fallen asleep when he spotted a shadow darker than the rest that was weirdly shaped. He held his breath. The shadow moved! From the forest emerged grey paws, large, pointy ears, and gleaming red eyes. It was Arma, the wolf! He shouted and banged his stick, but Arma just prowled closer. He seemed completely unafraid, almost arrogant.

Closer he snuck, ten metres, five, three, two... Arma was so close that MA could reach out and touch him, and MA almost fainted, but he stood his ground to protect his sheep. Arma crouched, ready to pounce. But then his eyes grew wide with fear. He jumped, turned around swiftly, and bounded into the woods, tail between his legs. From behind the house, an even larger shadow emerged. It was so big that MA could not see the moon for a second. The shadow also had paws and pointy ears, but it had yellow eyes - eyes that had seen fear and knew how to handle it. It also had a collar around its neck. What was it?

"It's a lion!" Ari proudly exclaimed as she appeared behind the golden shadow, which now lay on its stomach to lick its massive paws. "All the way from sunny South Africa!"

As the sun rose softly in the East, Ari explained that she had borrowed the huge lion from a zoo in South Africa to scare off Arma, the wolf. MA could see the lion clearly now, and he was completely flabbergasted. His mouth hung open, and he forgot to close it. The lion had a massive mane of dark brown hair, a slick, muscular body, and a long golden tail with a tuft of brown fur at the end. His yellow eyes, however, looked friendly. Ari said she had also found the missing sheep behind the farmhouse; they had just wandered off to sweeter grass, so they were fine after all.

And so, all was well again. MA had every one of his 100 sheep back where they belonged, and, thanks to his smart wife, he wasn't angry anymore. Arma the wolf never came back. Why would he, when a massive lion was patrolling their backyard?

The Wolf and the Three Kids

Adapted from 'The Wolf and Seven Kids' by the Brothers Grimm

by Tiffany Harzon

Once-upon-a-time there was an old goat with three little kids: ARman, ARon and MArgret.

Early one morning, the old goat decided to collect food from the forest, so she called her children and said: "My children, I am going to go collect food for us. Beware of the wolf, for if you let him in, he will have you all for breakfast."

"But how will we know it is him, Mother?" asked the eldest, ARman. "He will try to disguise himself, but you will know it is him by his gruff, erratic voice and black feet, like those wolves before him."

"Don't worry, Mother," the kids replied. "We will look after each other." The mother goat bleated and left for the forest.

Not long after, someone knocked on the door and cried, "Open the door. Your mother is here. I have brought us treats from the forest".

"His voice is erratic and can't be predicted. I vote he is the wolf", MArgret whispered to her siblings.

"We will not open the door for you", they replied. "You are not our mother. She has a smooth, dependable voice. You're the wolf!"

Then the wolf went to a shopkeeper and bought himself a small bowl of honey. He drank it all and made his voice smooth with it. Then he returned, knocked at the house door, and cried, "Open the door. Your mother is here. I have brought us all treats from the forest".

ARon glanced under the door and back at his siblings, "He has black paws, like the wolf before him. I don't think it is our mother".

"We will not open the door for you," they replied. "You are not our mother; you have black paws like the visitor before. You're the wolf!"

So the wolf went to a baker and asked for a bag of flour. He dipped his paws into the bag and pulled them out, white as snow. Then he came back, knocked at the house door, and cried, "Open the door. Your mother is here. I have brought us all treats from the forest".

"The voice is so smooth, and paws so white. How can this not be our mother?" ARman asked his siblings.

So, they believed him and opened the door, but alas, it was not their mother. It was the wolf.

The children were scared and ran to hide, but the wolf found them and swallowed them whole. With a full stomach and heavy eyes, the wolf decided to lie by the fire for a short morning nap. When the old mother goat came home, she found the wolf asleep and ran for help.

The local huntsman, Richard Fuller, came to her aid. He observed the wolf and, after examining him carefully, he exclaimed, "I believe your children are alright! In his greed, he has swallowed them whole."

A small incision was made in the wolf's stomach and ARman stuck out his head, followed by his siblings. They embraced their mother and thanked the huntsman for his help.

The old goat turned to her kids and said, “Go and look for some big stones to refill the wolf while he sleeps”.

Then before the wolf could wake up, the huntsman and children carried as many stones as possible and placed them in his tummy so that the mother goat could stitch him up.

They left and waited for the wolf to wake. Once awake, the stones made him awfully thirsty, and so he headed to the well to drink.

But alas, the grinding of the stones in his stomach was so uncomfortable that he cried, “What rumbles and tumbles against my poor bones? I thought it was three kids, but it’s nothing but big stones”.

As he leaned into the well to get a sip, he slipped and crashed into the water. All the rocks in his stomach made it impossible to swim, and he slowly sank to the bottom. The kids, their mother, and the hunter were so excited that they began to rejoice.

The mother goat turned to her children and said, “See, my children, looking for the wrong thing and not understanding will lead to incorrect judgement and wrong predictions”.

The Dark World

"The worst villain the world has ever seen"

by Ewan Botha

It was a cold winter night in the country of Johanistan, where things had been flourishing for decades. But change was looming. A great, century-old evil hiding and gathering strength in the shadows was almost ready to manifest. The queen of the Dark World, Queen Arima, and her loyal servants, Mr Non-stationarity and Professor Invertible, had been working and scheming all day and night to keep the heroes of Johanistan busy and distracted.

Decades ago, Queen Arima was defeated by the number-one hero. Before the heroes could get their hands on her, her servants put her in a deep slumber and hid her away in a dark cave that no one knew about. The number-one hero, First Difference, disappeared after the queen's defeat and hadn't been seen since, leaving many wondering what had happened to him. Some said he had died in the fight, while others said he had retired from being a superhero. A statue was built in his honour at the very place he had defeated Queen Arima.

Everyone adored the heroes of Johanistan, who kept the people in the country safe and the evil at bay. The main heroes of Johanistan, the guardians of the globe, consisted of four heroes. Three of the four

were Captain ARMA, Arman and Miss Moving Average. Captain ARMA was the second strongest hero and the child of Arman and Miss Moving Average, thus granting him both of their powers. Arman had the power to control the element phi, and Miss Moving Average possessed the power to control the element theta. These elements were most powerful when the energy they expelled stayed within certain limits under certain conditions. If the elements' power exceeded the limit or didn't meet one of the conditions, their powers would become insignificant. That meant they would not be able to perform their heroic duties.

Everyone in Johanistan knew that there was a big test that one had to pass before one could become a superhero. This test was called the correlogram. It tracked the development of a hero's power over time and how it correlated against their powers at previous points. In this testing period, heroes were tested for white noise and drunkard's walk. White noise was an attribute that increased the power of a hero, as it helped keep the energy they expelled within the necessary limits. The drunkard's walk, however, was a negative attribute that decreased the power of a hero, as it had the same effect on heroes that Mr Non-stationarity's power had.

Mr Non-stationarity had the power to weaken Arman by disrupting the limits within which Arman's power should fall or by making one of the conditions of his power redundant. Professor Invertible had learned to weaken Miss Moving Average's powers in the same manner in which Mr Non-stationarity weakened Arman's powers.

With Queen Arima's two servants gathering enough energy to wake her, a dark and thick mist started covering the whole country of Johanistan. The Dark World had come to pass once again. Queen Arima's power was that of legend. She could make people perceive her as Captain ARMA. She also removed the heroes' energy from their limits and broke the conditions of their power.

The emergence of Queen Arima had the heroes in turmoil. Not knowing what to do, they devised a plan in which there would be a big battle where they would try to defeat Queen Arima once and for all. Queen Arima and her servants also got ready for the impending war.

On the day of the battle, the superheroes felt confident in their abilities and power, but unfortunately, they underestimated Queen Arima and her servants. On that day, evil defeated good in one fell swoop. The guardians of the globe were caught and thrown in prison and left to die there. Johanistan had not seen a day as dark as this. The people were scared and forced to accept the queen's rule.

Queen Arima wanted to remove the statue of the one who had previously defeated her. She went to the statue to destroy it, but a young girl ran to it, crying and wrapped herself around it so no one would destroy it. Seeing this, the queen laughed and ordered Professor Invertible to remove the girl. As Professor Invertible approached her, one of the girl's tears dropped on the statue, resulting in a momentary blackout. As the queen went to destroy the statue, there was a massive crack, followed by silence.

The girl looked up and couldn't believe her eyes. The number-one hero, First Difference, stared down at her, his cape and long hair blowing in the wind. He was not affected by the queen's powers nor that of her servants, and he swiftly defeated them by differencing the queen.

To everyone's surprise, the First Difference converted the queen into a heroine. With the evil banished and an additional hero, Johanistan prospered once again.

Can you Cross the Bridge?

by Ndango Kutama

Once upon a time, a herd of elephants lived in the Elphi Kingdom. They were known for their unique memory and were envied by other animals. One day, while baby Kuda played hide and seek with the other baby elephants, he wandered around and reached the famous Time-Series Canyon.

On the other side of the canyon stood three baby pandas, Casey, Salam, and Min. They were crying hysterically for their friend, Bunny, who was taken away by the Time-Series Canyon king for failing to complete the riddle. Pandas were known for clumsiness and eating. These baby pandas wanted to go on an adventure to eat different bamboo. The problem was, no panda had ever crossed the Time-Series Canyon, according to the history books of the animal kingdom, and these cubs were determined to become the first embarrassment of pandas to do it.

When Kuda saw the cubs crying, he said to them, "Hello, hello. My name is Kuda. What are your names?"

But Kuda's voice was drowned out by the cubs' hysterical cries. Kuda didn't give up. The baby elephant decided to trumpet a lullaby to comfort the baby pandas. "Hush, little baby, don't say a word. Mama's gonna buy you a mockingbird. And if that mockingbird...." sang Kuda.

The baby pandas heard the trumpet and stopped crying. They looked around for the trumpet's owner and saw a baby elephant standing near the edge of the canyon trumpeting the lullaby.

The baby pandas started to sing along with the baby elephant and when the lullaby ended, they cheered together.

"You are a good trumpeter. Who taught you to trumpet?" asked Salam. Kuda responded shyly and said, "Mother taught me".

"Can you teach me how to trumpet?" asked Casey.

Before Kuda could respond, they heard a piercing shriek, making the cubs move back from the canyon's edge, bringing them back to reality.

"What are you?" asked Min.

Before Kuda could respond, Casey chimed in, "Can you cross the bridge? Does your kingdom have bamboo? What types of bamboo do you have?"

"I am an elephant, and yes, I can cross the bridge," Kuda answered proudly.

The baby pandas were beyond cheerful. They had finally met an animal that had crossed the canyon, and made a new friend. They were now more determined than ever to save their friend Bunny, and cross the canyon to continue on their bamboo adventure.

The Time-Series Canyon was ruled by King Arima(p,d,q). This canyon comprised four elements: fire; water; earth; and air. To cross the canyon, animals had to solve a riddle. This riddle was used to identify and group the subjects of King Arima(p,d,q). Once animals successfully solved the riddle, they could cross the canyon anytime.

Eager to see what their new friend could do, the baby pandas asked Kuda to cross the canyon, which Kuda did. Kuda crossed the canyon in a matter of seconds, shocking the baby pandas. They were surprised by how fast and easy it was for their new friend to cross the canyon, which made the clumsy pandas more determined to cross it. All they could see were bamboo rainbows and bamboo in different colours and shapes. They started to drool, but sadly, the moment was interrupted by Kuda.

"So, why were you three crying? What happened?" asked Kuda.

The three cubs looked at each other with big teary eyes and pointed towards the canyon with their paws.

Kuda was confused, so Casey decided to tell Kuda their story. It started when they met Lira, the snake, who told them about Bamboo Paradise. When they asked Lira to accompany them, Lira gave them directions instead.

After getting the directions, they left a note for their guardians and started on their journey. Travelling was difficult for them as they were used to eating and sleeping, but paradise became their motivation. Along the journey, Foxy, the fox, joined them. As she was concerned about the cubs' safety, she helped them pass the Pride Lands and Kuvuki Land (the land of hyenas). Thereafter, they went their separate ways. Their adventure was filled with laughter, tears, and pain.

Everything came to a halt when they reached the canyon, and King Arima(p,d,q) gave them a riddle which Bunny volunteered to do. If they failed, Bunny would hand himself to the king. The riddle was an equation to be solved with the aid of the kingdom's most sacred book, written by the smartest orangutan, Johanesty. The book had notes that could be consulted to help solve the riddle. They worked on solving the riddle for seven days and seven nights, but due to exhaustion and change in diet, the baby pandas couldn't help Bunny with the riddle.

And so, the king took Bunny from them. After Casey narrated the story, Kuda asked to see the riddle and the notes, which Salam had eaten out of anger.

Seeing that they no longer had the riddle, Kuda encouraged them to ask the king for their friend and a new riddle. The king gave them a riddle, and Kuda was allowed to help them as long as they solved the riddle by midnight. The baby pandas were relieved, but worried about the deadline as they could barely do the first one. This time it was different; they had Kuda by their side, eager to help them reunite with their friend and join them on their journey to Bamboo Paradise. The curious baby elephant asked the king for extra copies of the sacred book which was provided to them.

Kuda opened the riddle, which read as follows: "Identify parsimonious ARIMA(p,d,q) model for the following time-series process by determining the values of p, d, and q of the equation:
$Z_t = Z_{t-1} - 0.25Z_{t-2} + a_t + 0.5a_{t-2}$".

Kuda also noticed a reference that was given next to the riddle. The baby elephant asked the three baby pandas to go to the referenced section, which took longer than Kuda expected, especially with each baby panda holding its own copy. After a few hours, Min found the referenced section.

According to the referenced section, to find the p, d, and q values, they would have to check if the given equation had d unit roots by finding the first difference, thereby solving the characteristic equation of the first difference to determine if it was stationary or not. If it was stationary, the equation had no d unit root, but if it was not, then there

was a d unit root. To determine stationarity, they would have to check if the roots of the characteristic equation were all greater than one in absolute value. If they were, then $\{Z_t\}$ was stationary. Kuda already knew how to determine the values of p and q, which were easy to spot from the given equation.

Kuda determined that p=2 and q=1. The baby cubs worked together to determine the value of d=0. The thought of reuniting with Bunny motivated them to use their dormant intelligence. They concluded that the answer to the riddle was ARIMA(2,0,1).

The king presented the answer to Johanesty, who informed the king that the answer to the riddle was correct. The king released the baby panda, and Bunny was finally reunited with the other cubs. A decree was issued across the animal kingdom that three baby pandas, with the help of a baby elephant, had solved the name of King Arima(p,d,q), now known as King Arima(2,0,1).

The Tale of the ARMA Dynasty

by Santino del Fava

"In the mystical land of Johanistan, the plains were inhabited by those known as Time-Series Processes. These strange people were a sequence of observations arranged according to the time of their outcome. There was a division amongst these people: that of stationarity. The non-stationary processes were those whose expected values and autocovariance depended on time. On the other hand, stationary processes were independent of time. For centuries, these two types of processes waged war against each other. But who can forget the siege of Time-Series City twenty years ago?

The ARMA dynasty - descendants of a line of stationary processes - held the throne of that once great city. One fateful day, a strange force took root in the city and toppled the ARMA dynasty. No one could identify the process of this strange force, and to this day, it maintains control over the city. Some say the strange force was a non-stationary process. But woe, what's the point of speculation? The reality is that the ARMA dynasty's king, queen, and two sons had been dethroned and killed. Oh, how we meek dwellers of the poor farming village of Autoregressiveville wish for a change in fortunes!"

MA(1) stood and listened to the drunk man's rambling. That was the hundredth time that MA(1) entertained his stories.

"You fancy yourself a historian, don't you, Random Walk?" said MA(1). Random Walk replied, "Show some respect, boy! For the toppling of that great city, yes, I was there. And you, little 20-year-old, what would you know? I was a citizen! Once a stationary man myself, but now look at me, pitiful, non-stationary, and an infinite sum of white noise."

MA(1) was an orphan, found by farmers and raised like one. He had many difficulties growing up and had no time to look beyond his past actions since he found no correlation between his outputs and periods past one lag. One day he stumbled upon Random Walk, drunk in an alley. Drunks were common in their town. Random Walk sent him to buy some booze, and so began their friendship.

"Listen, boy, I'm out of a drink, and there's a shortage in the store. I heard that Old Man Dickey-Fuller's got a special brew. Go atop the hill and snatch me some. We'll share, of course."

"Dickey-Fuller... he's a sage. He brews potions, not alcohol. He's a scholar."

"...He's a would-be wizard at best. I need my drink now! But if you don't want to get me some, I can always tell your parents that you've been drinking with me in the dark for years now."

MA(1) agreed to help Random Walk. He reached Old Man Dickey-Fuller's house atop the hill. He snuck in and tried snooping for something he could take back to Random Walk. When he found what he was looking for and headed for the exit, he heard a booming voice call, "MA(1) — the prophecy reads true".

MA(1) turned and saw the old man.

"MA(1), the one who belongs to those stationary greats! MA(1), descendent of the ARMA family."

"How do you know who I am, old man? Leave me be."

"You, boy, are of stationary descent, the one the old one has prophesied about." The old man continued, "You exist beyond time, and the time is nigh, the time to defeat the force ravaging Time-Series City, the force you are destined to defeat. You see, boy, I have studied that force for years. I have developed a technique to identify his process. My Dickey-Fuller test will determine whether that thing is of stationary or non-stationary origin. If it is non-stationary, we will take first differences to make it stationary".

MA(1) was bewildered. He was a farm boy, not a warrior. But here he was, being told he was a descendant of the legendary ARMA family. The stories Random Walk spoke of weren't mere ramblings as he had initially thought.

"You, boy, are the son of the last ARMA king, sent away as a child. You were orphaned after the city fell to the siege. Now is your time to regain control and bring the stationary ARMA dynasty back to its rightful place amongst the chief authority!"

MA(1) finally spoke, "Old Man Dickey-Fuller, you are known as a wise man, and only for that do I believe you. I'll join you in finding a way to defeat the mysterious process that holds Time-Series City. But first, if I am the King's son, what of my brother?"

"Your brother was known as AR(1). He was the king's eldest son. Days before the siege, he disappeared and has not been heard of since. Once the city is recaptured, we may begin to investigate his fate."

The two travelled to Time-Series City. The place was shrouded in darkness, and an unsettling air of tension persisted. Once in the city, the old man began his work. He started shouting strange phrases, and MA(1) watched on as he cast his spells.

"Null hypothesis, you are not rejected! I have considered Case 3 (trend) and seen that your studentised test statistics' *p*-value is greater than any reasonable significance level. Mysterious force, you have a unit root; you are non-stationary! Your name is ARI(1,1)."

The mysterious force spoke in a sinister tone. His voice was heard, but he was out of view as the city's darkness hid him.

He called, "Ah! You're good, old man. But not good enough!"

And the mysterious force struck down Old Man Dickey-Fuller. MA(1) tried to rescue the old man, but it was too late.

The old man quietly said, "Use the differencing technique. That is how you can identify his process".

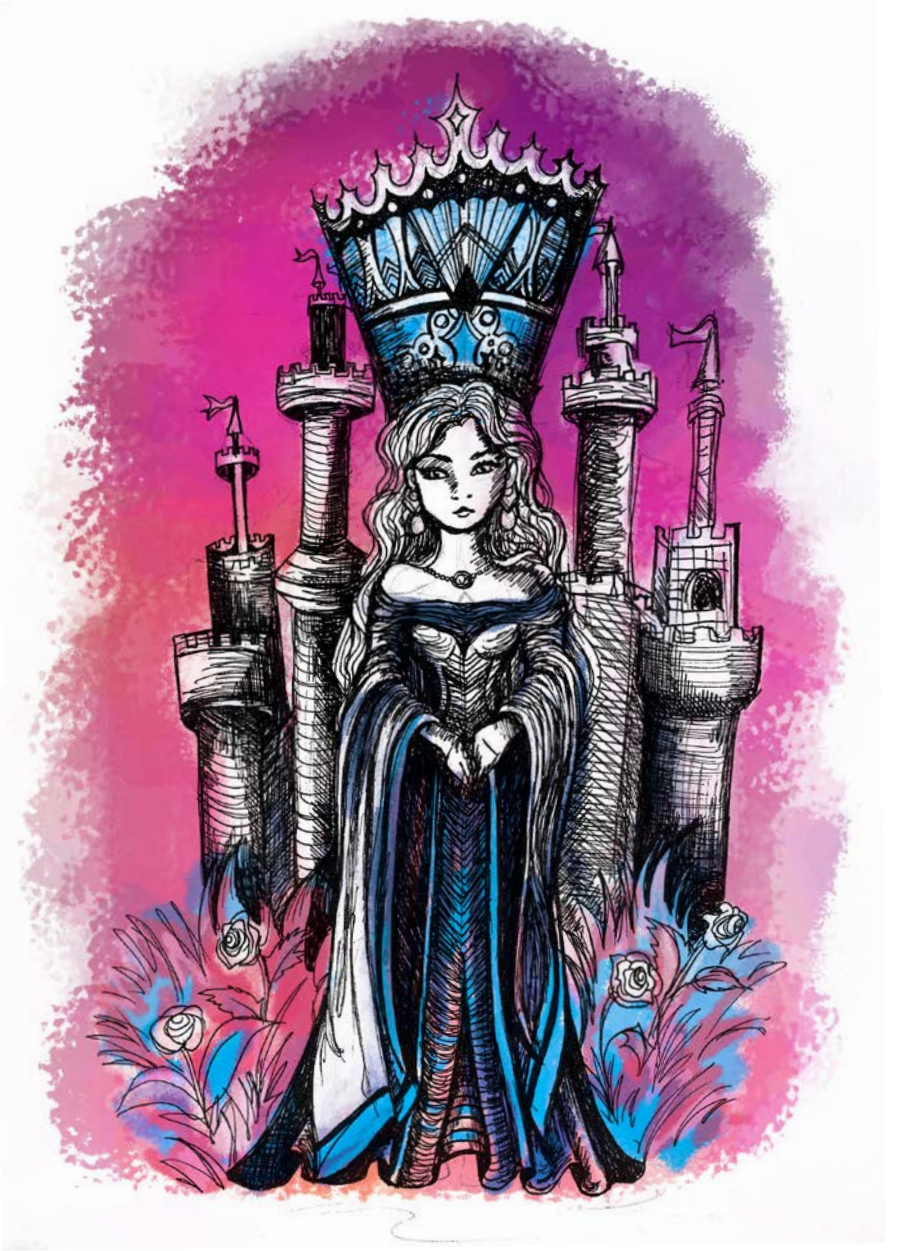
MA(1) proceeded to use the first differences on ARI(1,1), and with a great struggle, he managed to reveal that the mysterious process was underlined by a stationary AR(1) process!

This was MA(1)'s long-lost brother, but with the corrupting force of non-stationarity removed.

AR(1) finally spoke, "Brother, thank you for saving me from that dark force. The sacking of the city, it was my fault. I was too ambitious and tried to attain power by involving myself with those who were non-stationary. Please forgive me".

MA(1) forgave AR(1), and soon the two brothers began to rebuild the Time-Series City. As descendants of the ARMA dynasty, they ruled the city together. In honour of Old Man Dickey-Fuller, they taught his hypothesis testing technique to all scholars meant to identify foreign processes. MA(1) returned to his old village of Autoregressiveville as a king, yet humble enough to buy Random Walk one more drink for old-time's sake.

And so, peace was restored in the land of Johanistan, and everyone lived happily ever after.



Series Temporali

by Tanya Kleingeld

The sun was rising, and the null and alternative hypothesis guards filled the castle grounds. Their mission was to keep everything statistically sound, and they rejected anything that threatened their perfect kingdom.

The day had finally arrived. Models from around the Time-Series world gathered to celebrate ARIMA(1,0,1)'s coronation ceremony. She would become queen over Series Temporali, the colossal capital city of the Time-Series world. ARIMA(1,0,1) had a younger sister. Her name was Non-Stationary ARMA(1,1), but people called her NS for short. By the kingdom's standard, she was not the most beautiful model since she was not stationary.

She always felt worthless, like she should not be time-series royalty. She always loved her sister, but she became exceedingly jealous over the years and finally decided that she would have her revenge and become the nasty process that everyone thought she was. So, she started devising her plan. She would destroy every single stationary process, including her sister.

ARIMA(1,0,1), blissfully unaware of what her sister was planning, was getting ready with MA(1) — one of her closest friends — in one of the rooms on the castle's east side. ARIMA(1,0,1) was worried about her sister.

"I don't know why she is acting the way she does", ARIMA(1,0,1) said to MA(1) with tears in the corner of her eye.

MA(1) sighed and said, "Maybe she just doesn't like change. And this is quite a big one. You are going to become queen over Series Temporali. Don't worry. Your sister will be fine".

ARIMA(1,0,1) felt sad and did not know what to make of everything, but she kept smiling, hoping that her sister would one day accept everything.

NS did not stop her planning. She was busy gathering all the non-stationary processes that she could find. She tried to convince some of the guards to take her side, but they cared too much about the statistical well-being of the castle. She even went to the ACF, but he was too close to all the MA processes. He didn't even want to listen to NS. NS was desperate, she needed to find more people who did not like the stationary processes. She just didn't know where to go anymore. She went outside to sit on one of the benches in the yard near the Ljung-Box tree. She never really liked the tree, but she could not sit anywhere else, and then, unexpectedly, the Random Walk process came to her. She had nothing against him as a process, but she always found his way of walking strange and aimless. At least he understood and respected her as a process. If anyone could understand her, it was him. He finally stood still and started talking to NS.

"Hi NS, I hear you are starting a mission. I know it's difficult to find processes to stand up against those stationary ones, but I have a plan. There's a small town just a few time intervals away. The town is full of processes that aren't happy with themselves. Maybe you should go there and see if you can find anyone else to join your cause."

NS started to smile, things were finally looking up, and her plan to destroy every single stationary process was starting to fall into place.

But she was curious to discover how Random Walk discovered this place, so she asked him.

He smiled and replied, "Well, I don't really have a choice, going up and down like a drunkard all the time". He then stood up and walked in that funny manner again.

NS was excited; everything was falling into place.

She arrived in the town that was filled with all sorts of processes. The processes in the town looked very sad and mad. She saw an upward trend time-series process walking toward her. NS stopped her and started telling her about her plan. She could see that this upward trend was ready for anything. All the processes assembled themselves and started marching towards the castle. Everyone stopped before the gate, shouting for ARIMA(1,0,1) to come out. ARIMA(1,0,1) saw her sister and ran outside as fast as possible. But NS was surprised when she saw a small non-stationary AR(2) process walking with ARIMA(1,0,1).

AR(2) could see how confused NS was, so he decided to explain himself, "NS, I know you're angry, but you really have no reason to be. We're all processes. I was made the way I am for a reason. You can't just discard yourself and tell yourself that you are less important because you don't meet the kingdom's time-series beauty standards. We're all part of this amazing city called Series Temporali".

AR(2) then glanced at the other processes and continued, "Stop thinking that no one wants you or that you aren't good enough because you are. Upward trend, you are a time-series process that someone wants to see when it comes to their sales over time. You can make someone's day by just being you. Don't stop being yourself for someone who can't see your worth."

She cried, realising that together they formed the Time-Series world, and there was peace in the kingdom once again. All thanks to the AR(2) process, who stood up and realised he was more than enough.

The ARIMA

by Dylan J. Cuyler

Puddles of the moon's pale-silvery glow formed on the forest floor as a cool and gentle breeze blew through the area. Ari stared at the man before him.

He was broad-shouldered and well-built. The man sat crossed-legged with his eyes closed. He was bald and had a beard tied into a ponytail. The man wore only a pair of long cotton pants held up by a rope tied around his waist. Even while sitting, he was a head taller than Ari.

"Do you think she'll win?" Ari asked.

For a while, the man was silent.

"Sit," he said finally.

Ari did as instructed. The man opened his eyes and held out his hands, palms facing upwards.

"Movere Mediocris."

Suddenly, a curved sapphire blue dagger appeared before them, floating mid-air. It had a black hilt with symbols engraved along the length of the blade.

"As you know, in this world everything is governed by its relationship with time."

"Autocorrelation", Ari said.

"The more dependent something is on time" the man continued, "the more likely its actions now will affect what happens to it in the future. The more independent something is of time, the less likely its actions now will affect what happens to it in the future. How dependent or independent something is on time is known as its order."

He gripped the dagger by its hilt.

"The lower the order, the more powerful the technique."

He swung the dagger above Ari's head. Suddenly, he disappeared and reappeared behind him. He swung the dagger again. Immediately a clone of him appeared seated beside Ari.

"This is the power of the Movere Mediocris, to have strong independence of time. Mine is of low order, but not the lowest order."

He held out his arm. The dagger faded until it vanished altogether. He then faced his palms upwards.

"Autoregressive."

Suddenly, a long amber-orange double-edged sword appeared before him, floating in mid-air. It also had a black hilt, but with different symbols engraved along the length of the blade.

He gripped the sword by the hilt and walked to the nearest tree. He began tapping it gently with the sword. Soon the sword began to glow. On the third tap, it created a crack in the tree. On the seventh tap, the tree split in half.

“This is the power of the Autoregressive, to have a strong dependence on time.”

The man dismissed the sword and walked back, sitting before Ari.

“Temporis Seriem is the devotion to mastering the autocorrelation. Despite her young age, Arma is in a class of her own; while she is your superior, you have something she lacks.”

“What is it?” Ari asked.

“The strength to acknowledge your own weakness and move forward. To be at peace with oneself and the world is to be stationary. To be consistent and balanced. When you both came to me, neither of you were stationary. You were the last survivors of your village after it was pillaged and burned by the Differentia Pura, but despite all of that, Ari, you chose to move forward. You pursued your differenced self and found stationarity.”

The man took a deep breath and sighed. “Arma has yet to do so.”

“So you think she’ll lose?” Ari asked. “If she does not difference herself and find her stationarity, she will most definitely lose.”

Meanwhile, Arma breathed in the crisp, cool air as she climbed the last stone stairs to reach the summit of the snowy mountain.

A large square platform made of stone stood before her. Large stone columns lay broken across the floor. Snow blanketed everything outside of the platform.

Sitting on one of the columns was a man with pitch-black hair. He wore a black suit with a red tie. He stared at Arma with his crimson-red eyes. She met his gaze.

“You must be Arma”, he rasped. “Your friends told me about you. Well, the whole village, really. Nice to finally put a face to the name.”

Arma took a deep breath and then exhaled. Suddenly, the whole area was engulfed by a strong gust of hot wind. She walked towards the man and extended her hands, palms facing upwards. Immediately, two blades materialised in her hands — one sapphire blue and one amber orange. Each step she took was followed by a hiss of steam as the snow below her instantly evaporated.

"Not much of a talker, I see. Well, go on then. Let's see what you can do."

Immediately, Arma disappeared and reappeared behind him. She slashed downwards with both blades and struck his shoulders. She disappeared once more and then reappeared where she started.

The man looked at his shoulders. There was a slight tear in his suit.

"Is that all? I was exp—"

He was cut short by Arma punching him in the face and launching him across the platform. He collided with one of the broken pillars, shattering it. The man lurched to his feet.

"How? You hadn't—"

Arma disappeared again, reappearing behind him and slashing. Her clone appeared in front of him and slashed. The man spun on his heels and blocked both attacks with his arms.

Her orange sword began to glow.

She immediately disappeared again, reappearing with three clones, slashing from behind, on his left side and towards his right leg. The man tried to block, but the swords dug into his flesh. He bellowed in pain.

Arma continued her onslaught of attacks until the man was sprawled out on the floor, covered in gashes and unable to move. She stood over him and brought her blades to his neck.

“Go on, do it!” He spat.

Arma glared at him and began shaking.

The man laughed hysterically.

“You can’t do it, can you? Hehehe! You came all this way, and you can’t even follow through! What would your village think right now? Your friends? Your brother? All this way just to let them down!”

Her eyes welled with tears.

“Awwww, is the baby going to cry?” he yelled.

Tears began streaming down her cheeks. For a while, she did not move. Eventually, she lowered her blades and dispersed them. She began walking away toward the stone stairs.

“What are you doing? Finish me!”

Arma stopped at the stairs and looked back with bloodshot eyes. She took a shaky breath.

“This isn’t what they would have wanted. Not for me and not even for you. Despite all you’ve done, they’re probably praying for you right now.”

She took another breath.

“You are defeated. This battle is over.”

Arma began descending the stairs.

The man wailed and continued to taunt her, but she couldn’t hear him. Despite the pain, she transformed herself and found her stationarity. She had become the Arima.

The Masked Trend of All Time

by Mbekezeli Mazibuko

Once upon a time, there were two siblings named Non-stationary and Stationary. Their lovely home was situated in a country called Yemen. Yemen was known to be a fragile state - characterised by weak state capacity or weak state legitimacy, leaving citizens vulnerable to a range of shocks.

Yemen was one of the poorest countries in the region, and most of the population were living below the poverty line. This fuelled grievances around unemployment, economic conditions, and corruption, leading directly to frequent protests.

Non-stationary was very vigilant and was true to herself and the city. She would tell things as they were and would not shy away from expressing herself. From a young age, she was concerned about her family's and society's standard of living. She was never an average girl and could adapt quickly. On the other hand, Stationary was more concerned about fitting in and succumbed to society's standards. She did what she was told to do without analysing or critically thinking about it. She was an average person.

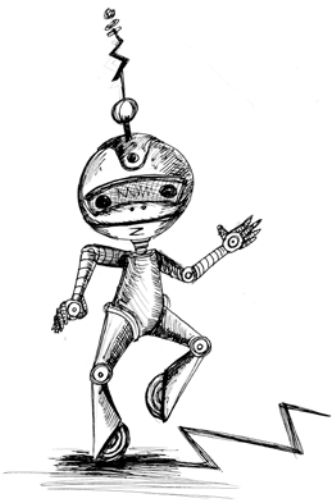
The two siblings had studied Future Prediction and how people made and spent money, but Non-stationary had a greater vision and determination than Stationary. After studying, they both served in the president's office in Yemen. Still, Stationary was preferred to Non-stationary because her economic interpretations were just average and gave hope to her superiors about the future state of the country.

Stationary found herself in a much higher position of power and authority, where she established official policies for the country. She served in forecasting rooms and could dress up in the most luxurious robes, such as the ARMA robe, without having to change a thing about herself because she hid the realities of the future and did not expose the risks of the economy of Yemen.

Whenever Non-stationary was appointed to complete economic tasks, when extra hands were needed to assist Stationary, she had to go through many hash tests and assessments, namely the character test, the ADF personality test, and the differencing assessment. After going through all the assessments and tests, she would then be given the ARIMA robe, which was the less expensive relative to the ARMA robe.

Non-stationary was always aware that she was the answer to every issue facing her nation, but she did nothing because she was afraid of losing her job and being exiled from her own nation. Stationary saw that the fear will hinder her from doing what was need for the country. And so she planned on reminding Non-stationary all about her strengths and purpose.

She reminded her that their strengths work hand-in-hand to solve the problems Yemen. This gave Non-stationary the courage to go through all those tests in order to become the solution to her country's challenges.



PART II

Fantasy and Sci-Fi

Z_t and the Shadow-spawn

by David Dodkins

So, you wish to hear the tale of Z_t and the shadow-spawn? Well, here it is, young one.

Once, long ago, when the mighty King Agamemnon and his brother Menelaus and all the great heroes of old, were away over the Aegean besieging the walls of Troy, there lived a young prince of Corinth by the name of Z_t.

When his father, the King of Corinth, sailed with the rest of the Greeks to fulfil their oath to Menelaus, Z_t was still just a boy, far too young to accompany the warriors. But that was seven years ago, and the warriors had not yet returned. Z_t had been forced to assume ever greater responsibility for the running of the kingdom, a task he felt he was ill-equipped to perform, for he had never faced battle nor done any deed worthy of a ballad. In hushed voices, the noble houses called him White Noise. Even on the amulet that his mother gave him on her deathbed, there was written: "$Z_t = a_t$".

As the seventh year of the Trojan War drew to an end, Pallas Athena turned her gaze to Corinth and took pity on the inexperienced Z_t, who would have to be king soon, for she knew that his father would

not return from the war. She resolved to prepare him for what was to come. She wrapped herself in her grey cloak, and thus, hidden from mortal eyes, she entered the palace of Corinth at midnight and cut off a lock of Z_t's hair. She weaved the lock into the shape of a man, blew life into it, and unleashed it on the city. She had created a shadow-spawn - beasts that look like men yet have no soul.

By dawn, the monster had attacked and killed an entire patrol of watchmen, leaving only a single man alive to report to the captain of the guard. When Z_t was informed of the monster running loose in the city, he was afraid, for he knew not what to do. He had never dealt with a beast of legend before; he doubted his judgement and abilities. So, Pallas Athena of the grey eyes garbed herself as one of the servants in the palace and thus approached Z_t in human form.

"My lord," she said, "you are troubled by this beast in the city. Dread it not, but go alone to the acropolis, the city's highest point, when it is deserted, and the sun is at its highest. Take nothing with you but a flask of wine and leg of lamb, and when you are certain that you are alone, build an altar and make an offering of the wine and mutton. Then pray to Helios, the sun god protector of Corinth, for guidance. You will surely be answered."

Z_t thought this to be good advice and did as Athena bade him. He climbed to the acropolis, built an altar, offered the wine and lamb, and prayed for guidance. The moment he had finished, the monster stepped out of the shadows. Z_t realised he had made a grave mistake in coming alone and unarmed to the deserted acropolis while a monster was loose in the city. The beast approached Z_t and cut his cheek with his long claws.

In a guttural voice, he said, "Had you but thought to bring a sword with you, you would have slain me now. Instead, more of your citizens will die because of your mistakes. This scar will remind you of your error". And then he was gone.

On his way back to the palace, Z_t was hard at work thinking about what had happened: "Why did he not kill me? Why did I not take a sword with me? But I must learn from this. When I am king one day,

my mistakes will cost even more lives. I must learn from each error I make so I do not repeat them."

As he thought about these things, his amulet grew hot against his chest. Glancing at it, he saw that the writing on the amulet had magically changed: in the place of "$Z_t = a_t$" there now stood "$Z_t = a_t - \theta a_{(t-1)}$" - the ancient formula used by the cult of the Moving Average Process.

"Yes" Z_t thought, "I am a function of my past errors."

When he arrived at the palace, Pallas Athena approached him in the guise of the captain of the guard. "So, my lord, more men have died because of your mistakes."

"Yes, captain, it is true," replied Z_t, "but though I regret my errors, I am no longer afraid of them. They are a part of me."

"Good. A future king needs to be able to admit his mistakes, learn from them, and correct them. You will have one more chance to defeat the beast."

As Athena thus spoke, she cast off her guise so that Z_t knew he was in the presence of an Olympian. "Tonight, you must go to the tomb of your forebears at moonrise when the huntress Artemis takes to the sky in her silver chariot. Take your sword and your helm and face the beast. Tonight, the future of the House of Corinth is decided, for your father fell in combat this morning." With a clap of thunder, she was gone from Z_t's sight.

Heeding the Olympian's advice, Z_t went to his ancestors' tomb alone. The beast was waiting for him there. Mockingly, it called out to Z_t.

"So you have come to die here among your dead? Put away your sword. You do not have your father's skill. Do not attempt to ensnare me with words, for you have neither your mother's silver tongue nor her magic. You are not worthy of your ancestors."

“Peace, demon, ‘tis all true what you have said. I have neither my father’s skill with a blade nor my mother’s power with words, but their memory lives in me yet. My father died on foreign soil to protect our people. His bravery will overcome my fear. My mother may have had powerful magic, but the most powerful magic of all is the power of love. My love for our people will overcome your dark arts. I am not my ancestors, but I am still their blood. And I know your name now, demon.”

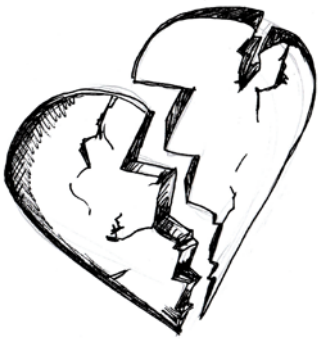
Zt did not need to look at his amulet to know that it now showed the formula of the ancient sect of the ARMA process, the demon-hunters: “$Z_t = \phi Z_{(t-1)} + a_t - \theta_{(t-1)}$”. He now knew that though he was not his parents, he was still a function of those that came before.

Sheathing his sword, Z_t approached the monster.

“I name you: blood of my blood, flesh of my flesh, shadow of my soul. You are an ARIMA process. You are I. I am you. You are the destruction I would have wrought in my ignorance. You are who I was, but now I am differenced from you. I have seen you. I have seen the cost of my errors. I have seen the gifts of my ancestors. I am not you anymore; I am differenced.”

With these words, Z_t took hold of the shadow-spawn, and it dissolved in his arms.

Legend says that it imparted these final words to Z_t: “Finally, you are ready to be king. Remember me. Remember what will happen if you do not rise to the challenges that await you. You are stronger than you believe.”



Differencing Society

by Oghenefejiro Arek-Bawa

Once, upon a time, two groups of people lived in separate harmony. One believed in perfection, while the other embraced imperfection. The first group were traditionalists who thrived off structure and believed their past helped them be the best version of themselves. They were educated and intelligent. They were known as ARs. The other group's imagination, creativity and willingness to fail allowed them to live a freer life. They were called the MAs. The ARs ruled the society as royalty, while the MAs were artists and free spirits.

Julie, an AR(2), was the AR people's princess and lived a beautiful life where she was given everything she ever wanted. The greater the number assigned to the person, the less they were considered in society. Therefore, Julie was highly thought of.

On the eve of her 21st birthday, she decided to walk inside the palace's garden. She saw a man dressed in old clothes covered in a mixture of fresh and old paint, who was painting a mural for her. When he turned around and looked into her eyes, they both fell in love. Upon approaching him, she realised that he was part of the MA tribe. After many hurdles and being treated as outsiders, they became the first ARMA couple.

During the seventy years of their marriage, the ARMA union changed everything, leading to many AR and MA marriages. But this created a whole new group of people with the Integrated gene.

They discovered that they were affected by the concept of time; therefore, they were non-stationary in their being, while the pure MA and AR groups were stationary. This resulted in the ARIMA race.

The ARIMA race became the outcast of the country. They had the worst jobs in society. They were known as the unhappiest race. The higher their integrated gene was, the worse the discrimination they felt.

Dave was a 14-year-old ARIMA(6,7,6). He was among the most non-stationary people because his integrated gene was 7. He was from one of the poorest families of the Integrated race in his whole village. He felt alone even though he had four older siblings and loving parents. Other parents used to tell their children not to play with him out of fear. His siblings all pretended not to know him.

One day, after a horrible day at school, he sat on his favourite bench under an old tree. He was praying for a better life, and a gush of wind brought a flyer to his feet. In frustration, he was about to tear up the flyer. Then he saw "The Differencing Society" in big, bold letters, a place where they promised to make you less different. He felt like his prayers had been answered. At that moment, he ran away from school and his parents and vowed only to return once he was less different, less ugly.

After walking all day and all night, he finally came to the headquarters of the Differencing Society, known as DS. He saw a long queue of people, all with the same look of hope written on their faces. For the first time, he felt he was seen and belonged. What consumed his thoughts was a new life filled with love, joy, and acceptance.

After what felt like years, he finally reached the front of the gate and was met with a question, "Do you have the payment?"

This shocked him to his core, and looking at the flyer in the bottom right-hand corner in fine print, he saw the most insulting words he had ever seen.

He left defeated. He found a bench under an old tree that resembled the one from his village. All he could think of was the fact that his hope was gone. Raising his head, he noticed an old man - around seventy years old.

The man asked him, “Are you okay, son?”

At that invitation, he told him everything. The old man sat with him for another ten minutes. Then he left, saying, “What you are looking for isn’t there.”

Dave did not understand the meaning of those words. After an hour, he finally got the courage to head home. As he got off the bench, he noticed the leather bag. Upon opening the bag, he was greeted with gold; beautiful yellow gold filled over half this bag. With the gold in his hand, he ran back to DS.

After undergoing the differencing procedure, he was told to stay for a month to recover and fully become stationary. During his stay, he noticed he could not access a part of himself. He felt incomplete, which for him felt worse than having extra. The faces around him echoed this thought.

One sunny day, he decided to leave his recovery center and take a walk. He ended up on the same bench. The old man came to him and asked him if he was okay.

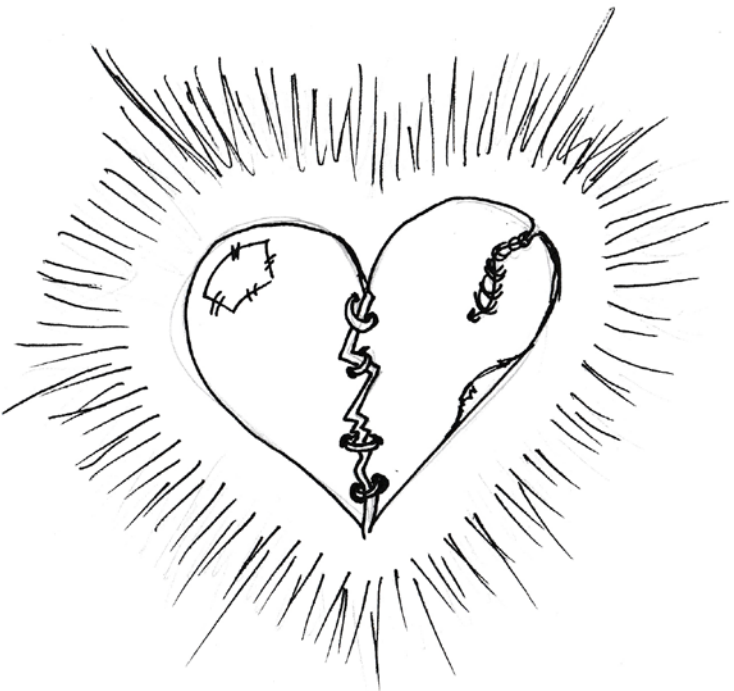
“No, just different” he replied.

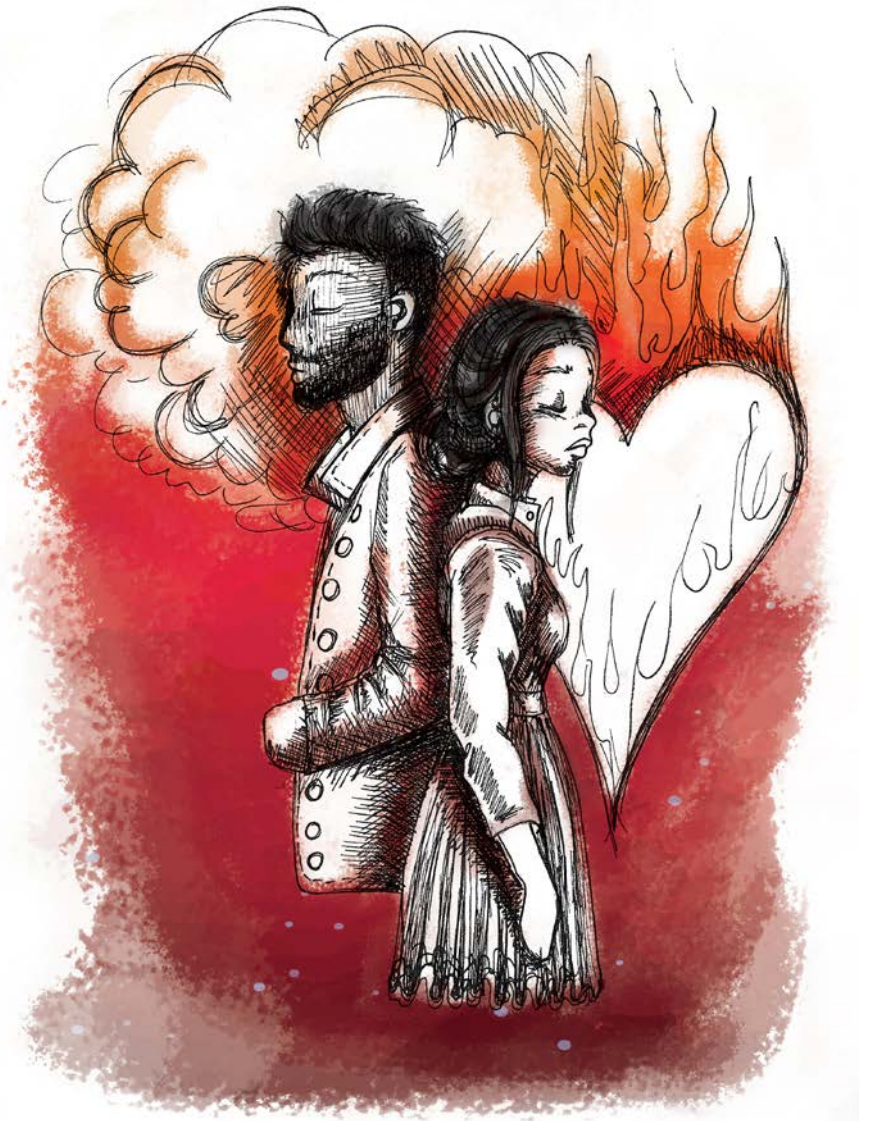
The old man told him he was no longer different. Upon hearing this, his heart broke, and he cried.

Looking up, he noticed the old man was still with him. He was puzzled, and before he could speak, the old man told him that his parents were the first ARMA couple and never felt accepted, that he was the first of the non-stationary race, an ARIMA(1,1,1). Regrettably, he was smart and came up with a DS. With a disappointed look, he said he wished Dave had taken the money for something else.

The old man offered him a red sweet that would undo the differencing - allowing Dave to return to how things were. Without a moment of hesitation, he took the sweet and felt revived.

He finally realised that joy was inside him all along. Without returning to the institution, he told everyone who listened about the beauty of being different. He lived his life happier and more loving than any stationary person and proved that the answer was always within ourselves.





Downtown Braamfontein

by Dikelede Rose Motseleng

In a busy, colourful, and vibrant central Johannesburg in Braamfontein lived a PhD student who knew all about desire and feeling desired, the freedom of letting your mind run wild with ideas. This story is of destruction, of wanting to have the best of both worlds, all at the same time.

The people we meet daily are in no way without a past - be it friends, family, or our significant others - we all have baggage from our lagged previous lives, which shows up in our present, and even our future selves.

When AR(1) met MA(1), he had no idea that his life would change significantly. You see, MA(1) and AR(1) were polar opposites in every sense of the word. AR(1) was more of a linear guy. Some people would even call him straightforward or uptight. He wanted things to be as clear as possible. He was the type of guy who regressed himself, meaning he predicted what happened in his present and future life using past experiences. It's a bad habit he had because he was just so obsessed with control. MA(1), on the other hand, was the type of girl who would always provide you with stationarity (stability). You didn't have to look for it, but she wasn't perfect either - she lived with her own

errors that she had made in the past and was not as straightforward as AR(1). One might even say she was the kind of girl who loved a good experience occasionally. Amid the love-hate relationship, the two were blessed with ARMA(1,1), who possessed the qualities of both AR(1) and MA(1). It seemed, for a little while, like there would be some hope for our two lovers because ARMA(1,1) had stationed (stabilised) the two, much like his mother, MA(1), did. Could this have been the happiest ever after we're all looking for?

Nothing in life is what it seems, and we can never assume normality as we do. As this relationship progressed over the years, we learn that one of these two had compromised some of their values and principles. We find out that there have been some differencing operations (non-stationarity and cheating) in the relationship.

Now, things became dicey as we discover that MA(1) had stepped out of the relationship, thus resulting in ARIMA(1,1,1). Two people were originally in the relationship, and one more was introduced on the side (d = 1). The autocorrelation (bond) between AR(1) and MA(1) through ARMA(1,1) had gradually died out; it exhibited an exponential decay towards zero. The bond, the love, and the connection were no longer there. Can we blame them, or was something sinister lurking in the background that pushed MA(1) to do what she did?

Questions start to race in our minds: Did the relationship between AR(1) and MA(1) return to where it was? Was there a way to pinpoint where things went sour for MA(1) to commit such an atrocious sin? How sure are we that it was just with one person? Who exactly were those people? Was it ARI(2), ARI(3), IMA(2), or IMA(3) maybe?

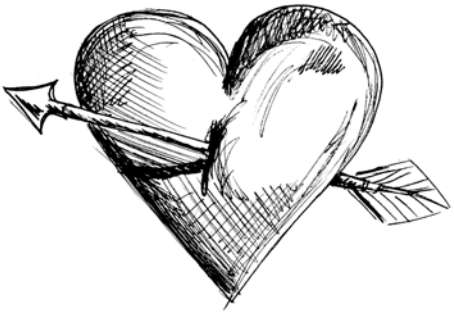
As the saying goes: "When two bulls fight, the grass suffers." Differences needed to be put aside to remedy the situation and prioritise the well-being of ARMA(1,1) - to provide the stationarity (stability) that was so needed.

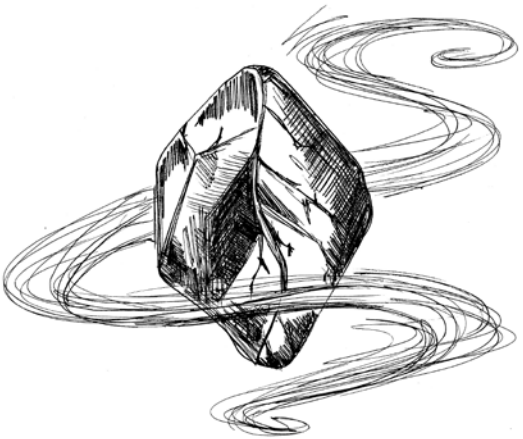
MA(1) was such a tricky character, right? So, let's break down why she did what she did. In a world full of judgement and hatred, how was she supposed to show her true self when all she ever wanted was to truly be with the girl who set her heart on fire? Her affair with IMA(1)

was not a coincidence, but merely a desire to want the best of the two worlds. A world in which AR(1) provided security in some form or the other and one in which IMA(1) provided the thrill, the experience of non-stationarity (no stability), where every event was just based on some random feeling that rose at that given point in time, be it in the past (lagged), present or future.

A solution, an answer, was needed to solve this. But what? How do we remove IMA(1) from the equation? How do we remove $d = 1$ from the ARIMA(1,1)? How do we un-integrate ARIMA(1,1)?

The best solution was first-differencing ARIMA(1,1,1) through mediation, therapy, and counselling, as this would enable AR(1) to come to terms with the issue. We can only hope that the relationship between AR(1) and MA(1) ended in reconciliation and had some stationary (stable) consistency with no seasonality (no extramarital activities).





The Osama and the Mashigo Stone

by Ndabeni Mokoena

Many moons ago, there was a beautiful mountainous land called Matibidi. It was found in the heart of Africa. It consisted of many villages in the same region. There was always animosity between the villages, leading to countless wars. As punishment, the Osama, the creator of all, sent the orange Balois, a magical breed of cheetah, to the land of Matibidi. The people feared for their lives.

The orange Balois came to search the hearts of the people. Those with good in their hearts were spared by the orange Balois, whilst those with evil in their hearts were taken to the Mapungubwe caves, a sacred place. Only a few hundred people remained in Matibidi. The survivors prayed to the Osama for forgiveness. In reply, the Osama created a white-noise stone called a Mashigo stone. For as long as the stone was active, the orange Balois would not return to the village.

The Mashigo Stone glowed brightly like the sun every morning. The Mapulana, the villagers of Matibidi, marvelled at this. This level of constancy was unheard of. However, after thirty years, the prophetess, Naledi, emerged with a message from the Osama.

Naledi said: "Here are the Osama's words: 'My people, Mapulana, I have given you a clean slate for thirty years. Now, I am displeased that you have not changed. You are still the same evil-doing people. Now I will bring judgement back again to Matibidi.'"

A great wave of fear passed through Matibidi and a dark cloud hung over the Mapulana. Correlating to the mood was the Mashigo Stone. It was glowing like a dying star. The consequences of what could happen were too frightening to contemplate for the Mapulana. Tshegofatso and Mmaphefo were children the last time the orange Balois graced the villages of Matibidi with its presence. Tshegofatso and Mmaphefo remembered a wise old man named Johan-Pitsedisuleyang, who then encouraged the people to pray to the Osama. They thought this wise old man might know what to do now, however, they needed to first find him. It was last heard that he stayed on Phiri Mountain. Their quest began.

In the morning, Tshegofatso and Mmaphefo made their way to Phiri Mountain. As they were walking, Tshegofatso and Mmaphefo realised that they needed to come up with a way to guess what the intensity of the Mashigo Stone would be the day after. Tshegofatso and Mmaphefo knew that the Mapulana people could not change their bad behaviour immediately.

As they climbed up the mountain, they concluded that it would be their best bet to estimate what pattern the intensity of the Mashigo Stone would follow. Close to the top of the mountain, they found a cave where they found Johan-Pitsedisuleyang in the flesh. He conceded that he might not be of much help. He insinuated that if they stayed the night, perhaps he might be of more help in the morning.

They found out just before they went to sleep that Johan-Pitsedisuleyang was a man of many revelations. He emphasised that the Mashigo Stone's beauty was its constancy (stationarity).

As such, he made sure they assumed that it was stationary. To Tshegofatso and Mmaphefo, it was amazing to think that the light emission of the Mashigo Stone was not dependent on how long it had been glowing. Such a principle could bind all their theory into something practical. There was more to come in the morning.

Johan-Pitsedisuleyang suggested that the sins of the people of Matibidi were consistent with ecological and environmental changes. When there was enough rainfall and abundant food, the people carried on in lawlessness and committed many evil acts.

During droughts and famine, the people were more compassionate towards one another and abiding by the Osama's laws. Johan-Pitsedisuleyang suggested that people's behaviour was trend-stationary, specifically, a seasonal trend (following trigonometric functions). Tshegofatso and Mmaphefo did not see the people's behaviour as much of a contributing factor to the glow of the Mashigo Stone. As they listened to Johan-Pitsedisuleyang's wisdom, their ignorance became apparent to them. But there was more.

He said that as much as this "guess" strategy could help the people predict what would happen to the Mashigo Stone, it was far from the point. He suggested that if people could find it in their hearts to adopt kindness and love, they could make peace with the Osama. Specifically, he said if, and only if.

Tshegofatso and Mmaphefo left the cave with enlightenment and with two minds. They remembered that there was a scribe for all the villages of Matibidi who had hand-written accounts of what happened daily in this great land.

The idea circulated between them that if the occurrences could be rated as to how the people behaved (bad to good, preferably from 0 to 1), they would have a measure of behaviour. The scribe also kept account of the light emission intensity of the Mashigo Stone. As such, they now had the past data values, which could be used in a recursive "guess" system to determine future behaviour.

They assumed that these data values were likely more or less the same daily, following Johan-Pitsedisuleyang's constancy claim. Also, they now had past data values giving measurements about the Mashigo Stone. To them, it became apparent that they could now make a full pledged "guess" system. To their surprise, they did not feel fulfilled.

The death of the Mashigo Stone was inevitable. Tshegofatso and Mmaphefo knew that the death of the stone would not change the hearts of the people. They would have to change the heart of the Mapulana, in order to help their people adopt kindness and love.

Birth and death are two contrasting ends. The death of the Mashigo Stone came as no surprise and looked to herald the beginning of the end of the Mapulana. However, lessons of hope and preachings of love and kindness gave birth to new behaviour of the Mapulana. Peace was maintained in all the land thereafter.

The Tale of the ARMA Warriors

by Levasen Reddy

Once upon a time, in a distant land in the Kingdom of Stats lived two warrior clans known for their incredible fighting displays and complex techniques. These clans were either given the gift of forecasting or the ability to see into the future. And because of that gift, many people in that land desired to be part of one of those clans. The names of the two clans were AR and MA. The AR and MA clans were the protectors of the Kingdom of Stats. The Kingdom of Stats was one of the most amazing kingdoms in the world, with its wealth seated in its knowledge and analytics.

The clans had many initiation processes that the people in the clan had to undergo to be accepted. In the MA clan, the people had to undergo a test of invertibility, which tested the strength of their relationship. Often, people had more than one relationship and were forced to restrict their relationship so that it could be one that was absolute and true. The AR clan had a test of stationarity. This test meant that the person had to prove their reliability and trust to the clan by showing them that they could function without depending on anybody. Due to the harsh nature of these tests, the people in these clans were the cream of the crop in the land and were seen as the most significant and strongest in the kingdom.

Over the years, the AR and MA clans had grown increasingly powerful, which also meant that they had many enemies. The enemy that proved the biggest threat to them was a clan by the name of non-stationary ARMA. This clan comprised those rejected by the AR and MA clans, who sought to bring destruction upon them. The non-stationary ARMA clan aimed to bring chaos into the kingdom by corrupting the AR and MA warriors and turning them into people who no longer had a sense of invertibility or stationarity. If the non-stationary ARMA clan were to be successful, the kingdom would lose its greatest warriors and fall prey to neighbouring kingdoms and invaders seeking to overtake the incredible Kingdom of Stats.

The AR and MA's greatest warriors all assembled in the great hall of the majesty to conjure up a plan and find a solution to fight against and nullify the advancing threats of the non-stationary ARMA clan, for they knew how powerful the non-stationary ARMA's corruption powers were. For weeks they pondered how they would counteract this with many ideas, but, in the end, nothing had come to bear. Just when all hope seemed lost, the majesty himself, with all his wisdom, brought about a solution that could save the kingdom. The solution was called differencing.

For this solution, the two clans, AR and MA, had to come together and form two super-beings called ARIMA. The chosen warrior from the AR clan would be called the ARIMA(1,1,0) warrior or the ARI warrior.

On the other hand, the chosen warrior from the MA clan would be called the ARIMA(0,1,1) warrior or the IMA warrior. These two beings would be the most powerful beings of the kingdom and have the power to destroy the non-stationary ARMA clan, as the ARI and IMA warriors could counter the ARMA clan's corruption powers.

But to become ARI and IMA warriors, they had to go through the most intense and stringent test: differencing. This process required their minds to be torn apart and rebuilt, and only the strongest warriors succeeded.

The day had come for the warriors from the AR and MA clans to come together and form these super beings as they could not do it without each other. With time running out before the attack of the non-stationary ARMA clan, it was of paramount importance that the test be done that day itself. Under the guidance of the monarch, the strenuous procedure began. The intensity of such a test caused the ground beneath them to shake and buildings to collapse around them.

Finally, when the dust had settled, two of the most powerful beings appeared: the ARI and IMA warriors. The sheer sight brought hope, courage, and relief to the clans and the kingdom, and it was at that very moment the majesty knew that they could win this battle.

The two warriors stood outside the kingdom's walls as they watched the non-stationary ARMA clan appear with great numbers and overwhelming force. But the ARI and IMA warriors looked unfazed. The non-stationary clan launched their first attack with a size greater than anybody could have ever imagined, and as their force attacked the ARI and IMA warrior, they were met with a thunderous bang. When the air had cleared up, all that was left was the ARI and IMA warriors standing seemingly untouched over the carnage that had just ensued. The non-stationary ARMA clan was shocked beyond belief and could not understand what had happened. Out of fear, they retreated as quickly as their first assault had ended, and the kingdom was saved.

Thanks to the monarch's wisdom, the non-stationary ARMA clan was defeated, and the kingdom was saved. The kingdom benefited from the attack as they now had two super-beings (ARI and IMA warrior) watching over the kingdom and protecting it against future threats and invaders.

Test to Train-Stationary

by Katlego Tjeane

Next month marks the 64th annual test to board Train-Stationary - an underwater train that moves on a stationary track, rendering it the safest and virtually only route to Yusebalitee. Everyone's dream is to leave the slums of Rhodaytawn, searching for prosperity and honour for their family. Millions of processes relish the chance to become Yusebal. Their citizens are said to enjoy local delicacies such as inférenz and conckluxin. Yusebalitee is said to elevate processes into higher beings, a transcendence into information.

The test is an extremely thorough process, despite Minister A. Smit's admission that it may not always be a hundred per cent accurate. Regardless of age, every process can only attempt the test once. Minister A.D. Fuller has made great strides in the schooling policy, allowing processes with varying lags to undergo the test.

Twenty-year-old Al-Rasheeda feels nervous about the test as she chews her pencil in a preparatory class. She peers into the other classroom, and the MA students ooze a delusional calm about them.

They are generally deemed fit to board Train-Stationary, viewing the test as a simple formality unto their generational claim to Yusebalitee.

"I'd like to see how they'd handle a phimosome or two", said Minister A.D. Fuller.

Al-Rasheeda nervously laughs in envy of young Ra's naivety. His family line traditionally passed the test at a young age, with one lag. She does not possess the same gusto as he does, nor the prospect of meeting her family in Yusebalitee.

"Elementary school wasn't fun, was it?" she whispers.

Ra frustratedly snaps, "Al, I just hate how we had to do the PACF analysis", unaware of his increased volume in the auditorium.

They feel the sharp gaze of the teacher in his total irritation. The pair focus their attention back on the presentation. They catch the ending: "... and remember, there's nothing wrong with the ARIMA, IMA, and ARI classes. It's better than a random walk".

Amidst all the snickering and giggling-induced commotion, Al-Rasheeda's heart sinks. She decides to walk the long path home, around the disintegrating live wire, between the soggy sheets of littered wrappers, and away from the mouldy rat-infested storm drains. She only now notices the loneliness of her life, her independence since she was twelve. She thinks of her fortitude, a testament to her will, in preparation for life and the coveted test to Train-Stationary. She unpacks her bag on the single rustic wooden table she uses for ironing, working, and eating. She feels alone.

She's heard of processes that have undergone the surgical process of Differencing, her mother included. She chooses not to think of her very much. She was "too bothered fending for my own life to think about that". She didn't believe her own lie; she learnt the hard way. Her father found a proxy to test his eligibility unto Train-Stationary, through a black-market group who called themselves "TheG raphT itle". Though unethical, his succeeding conspicuous celebrations in the local pub made his actions obvious. "Spirits rain from the

heavens in Yusebalitee, and heaven knows I love the spirits", he would announce to the concerned bartender. He did this for weeks preceding his final test. In the decisive moment, he had lost his essence. He did not pass his test. He did not realise that his ethanol consumption, biologically tempered with his thetasome, had grown undesirably. He was no longer invertible. He abandoned his wife, his aspirations, and ultimately himself. His withered body turned up on the blackened shore months later. He drowned in the infinite sea of data. He is the story used to steer younglings toward parsimony and away from substance abuse. That fabled bedtime story of the "Drunkard's Walk" is about Al-Rasheeda's father.

"Too much thinking for tonight", she sighs, waking in the middle of the night.

The day before the final test, Al-Rasheeda stabilises. She finalises her health test, and they are normal upon examining her sweaty residuals. A huge sigh of relief ensues as she heads back home for what could be her last night in this city. Red. Blue. Green. Red. Red. Orange. The festivities commence as she hears the crackling and sees the colours of the fireworks. It's only 04:20, but the atmosphere is filled with excitment. The local ladies clutter their wooden heels on the ground, singing in a high pitch and letting their flowy red cocktail dresses accentuate their movements. The men beat their drums, stomping on the cracking concrete with their black boots, and repeat after the ladies like loud shadows. The children complete the sriracha dance, cheering on the year's participants. Soon enough, Al joins the locals and heads to the SAS gates.

She can smell the refreshingly cool air blowing from the Annaly Seas. *Step, step, wait.* The ARIMA, IMA, and ARI classes are first as their final test is different. The few processes that are sent back from the gates look distraught. *Step, step, wait.* The MA class snickers as they are called up next. They maintain a hundred per cent success rate and board the platform. She heads up with the ARMA class. *Step, step, wait.* She can see the train's velvet interior. She is getting closer and closer to leaving her home. *Step, step, step, step.* The line moves unnervingly faster.

"No, try again! I wasn't prepared! I didn't warm up. I thought there'd be a *burn-in* period!" screams Al-Roberto III.

He is escorted away; however, she feels as if it is her dreams that are disappearing. She realises that it is not about likelihood, but in this very instant, that her world can change; it is simply a method of moments. Her results are immediately printed out, and she musters the courage to steal a glance.

The administrator's look of confusion immediately sends a shiver down her spine. She identifies her time plots' noticeable variation in relation to the others.

She takes the liberty to read his name tag, shudders, packs her bag, and says, "Mr u19264560, thank you for the opportunity anyway".

He does not respond and examines the rest of the test. "Ma'am, the results are conclusive. I have enough evidence to tell you that you do not have any unit roots." He further says, "Hey, you're weakly stationary. You're Yusebal".

Her jaw drops! She eagerly jumps on the train, already fantasising about her new life.

"This is your pilot. We'll reach our destination in *n* days."

It paid off! She believed in herself. She didn't allow the past to completely steer her life. She used her own phimosomes. She knew where she was expected to be and did not depend on her predecessors. She had set her own path, never varied from it, always catching herself. She never knew that her phimosome was an undesirable 0.94. She also did not know what her R^2 meant all her life. She had no idea that she was the most determined process.

At this moment, she doesn't know that she will realise her dream of being a forecaster. She has always been in control of her story.

Clones in Seattle

by Ziyanda Khumalo

One morning in Seattle's Grey Hospital, a ten-year-old girl, ARMA(*p,q*) was brought in for a blood transfusion after accidentally cutting herself with a butter knife. The young lady had been living on the street for as long as she could remember. She did not recall her parents or anyone from her family. The people in the street had become her family. Her doctor, Dr Model, married to a brilliant scientist, Mr Forecast, did blood tests, determined her blood type, and did a blood transfusion.

A few minutes later, ARMA(*p,q*), ARMA for short, had a terrible fever. The doctor discovered it was a reaction from receiving the wrong blood type. This was strange, and so they did another blood test. Her blood type was different from the first test.

Dr Model decided to run more tests on ARMA to determine what was happening with her body. They discovered that ARMA had a rare genetic makeup that allowed her to produce cells from both the male AR(*p*) and female MA(*q*) chromosomes. It was a rare occurrence in medical history.

The next morning, ARMA was on the first page of every tabloid in Seattle. Since she was a homeless kid, many opportunists offered to adopt her to make money off of her. Dr Model officially adopted ARMA to protect her from these vultures. ARMA was so happy that she had found a home where she would get everything.

Mr Forecast had his own lab in the house, so he was always home. That meant he spent much time with ARMA when his wife was working. ARMA was an inquisitive child, so she would go into the lab and ask Mr Forecast many questions.

One day, Mr Forecast had an idea. He wanted to create clones out of ARMA using her sequencing genome. He tried for days to forget this idea because he loved ARMA like she was his own child, but one day, he decided to act upon this idea. He would run tests on ARMA without his wife's knowledge. He used an incubator to create clone babies. Every day there would be a new clone created from the cells: AR(1), AR(2), MA(1), MA(2), and so on. As the babies grew up, he realised that his wife would find out about this when they had to be removed from the incubator, so he found a hospital three hours away from his home. In this hospital, they would give the babies to people who couldn't have kids.

Fifteen years later, Seattle had become very unsafe; there was a serial killer tormenting the city. The world had seen that there were clones in Seattle, and it had become a norm to see two people who looked the same.

The serial killer was also a clone but was different from the rest. He had been sick for quite some time, so he decided to expand his science knowledge. He had a life-threatening disease: non-stationarity. He would find the clones and study their genomes to find out if they were also sick like him and if he could use any of their DNA for his healing. He found a way to differentiate the clones using a DNA sequencing procedure called Proc Arima. The AR clones had chromosomes called autocorrelations that had an exponential decay, and the Y chromosomes of the MA clones would become zero after specific cells were run, which was what the numbers next to each name represented. It was known that the serial killer would act drunk

while walking up to his target; hence people called him Random Walk. Random Walk was different because his chromosomes were all equal, indicative of this non-stationary disease. He felt that since he would die, none of the other clones deserved to live. He would find the clones and kill them himself.

Meanwhile, ARMA had grown up to be a police officer. She was investigating the serial killer case and was determined to find out who killed her brothers and sisters. Five years previously, when she realised what her dad had done with the clones, she was mad and decided to tell Dr Model. Mr Forecast decided it was best to leave because he regretted hurting his family. No one knew where he went. ARMA thought he might be the serial killer trying to fix his mess to reconcile with his family. She finally succeeded in her investigation and found Random Walk. However, she needed a good strategy to approach him and not be killed in the process. As such, she decided to look for Mr Forecast to figure out how to help Random Walk.

After many unsuccessful attempts, she found him in a very secluded place, hiding, isolated from everyone. Mr Forecast's solution was to carry out a procedure called differencing on Random Walk's genome to heal him from the non-stationary disease.

ARMA found Random Walk's contact details and told him she was the original from which the clones were created. She tried to convince him of her solution with the condition that he would stop killing. Random Walk agreed, and the procedure was successfully executed. Random Walk was now healthy and stationary, and Seattle was safe again. He changed his identity to White Noise and fled the country because he knew he would be arrested for all the murders he had committed.

The Johanistan Murder Case

by Lute Munzhedzi

The date was 20 March 2020. Forensic detective Johan Ferreira and I, Detective Lutendo Munzhedzi, had just reached a breakthrough with the Johanistan murder of Miss Timely Serie. Initially, three suspects were bought in for questioning, each claiming they were stationary and had a white noise accent. Due to the lie detector test being inconclusive in all three cases, this case was labelled a cold case as no further evidence could prove any suspect to be the killer.

Detective Johan and I, however, discovered new methods to solve the crime.

The three suspects were A.R. Davis, the second (ID code: $z_t = 1.99z_{t-2} - 0.98\, z_{t-2} + a_t$), M.A. Rose, the first (ID code: $z_t = a_t - 0.01a_{t-1}$), and Miss ARMA II (ID code: $z_t = 0.8z_{t-1} + a_t - 0.01a_{t-1}$) each nicknamed AR(2), MA(1) and ARMA(1,1) respectively, who had a standard Gaussian characteristic.

From witness reports, we could narrow down the stand-out characteristics of the killer. Firstly, previous investigations concluded that the killer had no obvious motive and that this was a crime of malicious intent. Such criminals are labelled as mean-zero criminals.

Secondly, witnesses who heard the killer, explained that the killer did not have a white noise accent (which is common in this area). And thirdly, they were known to be non-stationary (they were unstable).

All suspects were proven not to have any obvious motive since there was little to no relation between them and the victim, but more tests had to be done. All three suspects claimed to be stationary and to have a white noise accent (which could easily be faked), but Detective Ferreira and I were confident that the killer was among the group; hence we decided to commence with the tests. Our intuition was correct; there was a killer in our midst. But the killer was the one I least suspected, although Detective Ferreira had a hunch.

MA(1), at first glance, seemed to exhibit characteristics of irregular variation which can be an unpredictable personality trait. But we could not base our judgement on that observation, so we took him in for testing. The first test commenced. We took in Mrs M.A. Rose, the first, and began the tests. From the data, we could conclude that M.A. Rose, the first, had a white noise accent and was indeed stationary; thus, all suspicion surrounding Mrs M.A. Rose, the first, was cleared, and we then moved on to the next suspect.

Miss ARMA II was no stranger to the precinct. She had been in for identity theft twice before. She had a personality disorder, but she was a good actress in the theatre before becoming infamous. As she walked in, she smirked as if she knew we would never find her guilty, but you could never trust someone with her reputation. The first test commenced, and her vocal statistics indicated that Miss ARMA did indeed not have a white noise accent by origin. I scoffed that sometimes it seemed way too easy. I could have locked her up that second. There was no way she could be stationary. She tended to change over time, but Detective Ferreira pushed further. The results of the second test came in, and to my surprise, she was indeed stationary. My shock about the results was not as big as the conclusion. There was one suspect left, but I could swear it was not Mr A.R. Davis, the second; he was such a well-known young man in the community.

The third test commenced. We took in Mr A.R. Davis, the second, for testing. At first glance, he seemed to have a noticable pattern, but the results for the first test came, and in bold red ink, I saw the word “FAILED”. He did not have a white noise accent by origin. I then flipped the document to uncover red ink on the same corner of the next page: “FAILED”. Looking at Mr A.R. Davis, the second, I could see his skin turn pale. It was as if he knew what was coming.

The officer came in and began to read him his rights, “Mr A.R. Davis, you are under arrest for the murder of Miss Timely Serie”, and they escorted him out.

I was stunned. He was well known in the community for being well-groomed, stationary, and had the best white noise accent in town. I thought he would have easily been cleared, but it was evident to me that day that we could never make assumptions without knowing the facts.

Needless to say, the breakthrough in this mystery case was a relief to the community. For five years there had been unrest knowing that the killer was on the loose, but thanks to the smart thinking and impeccable skill set of Detective Ferreira and Detective Munzhedzi, another murderer bit the dust!

The Story of Aria and Her ARIMAS

by Ziyaad Lundell

The story begins in a galaxy filled with stardust, the space constantly expanding, the light constantly reaching further. Aria, the master of the universe, began grouping particles of stardust. She called this "indexing". Some indices had dust from sister stars and others from stars light-years apart. Aria loved to see diversities in her grouped particles, and she wondered why and how each stardust particle had found its way into her universe, so she named an index (y_1,y_2,y_3, ... y_n). She began studying the indices, exploring how the location of each dust particle could affect another, and finding what else in her universe could affect the time-location of each particle.

Her clouds had consistent weight and equidistant particles with successive expansions of stationary. Star clouds that had particles of different weights and were spaced between different lengths from each other were non-stationary.

She called these varying distances in her index's "variance"; if she compared two different indices, she called it "covariance".

She found that her indices had averages that she could expect and called them "expected values". She used the variances of different indices to determine the strength and direction of the relationship of those indices. She called this "correlation".[1]

When she checked this correlation, she noticed a terrific outcome. If a group of stardust was compared with the same group of stardust from one expansion earlier, there could be stardust patterns that would predict future expansions of star clouds. But sometimes, a star cloud could expand in a different direction, and she would find no predictable pattern.

She called this predictable pattern an "automatic correlation", because previous stardust patterns would significantly affect its expansion. She noticed that forces outside of the stars' supernova could influence stardust's expansion. She called this "gravity",[2] and it existed from the ebb and flow of her paintbrush on the fabric of her creation. It pulled her stardust in directions that she could not predict.

She liked seeing how stardust and clouds could flow and form from one expansion to the next. She thought of them as an extension of herself, a way to watch her stardust. She named her clouds after her and called these indexed particles "ARIMAs".

She understood that to witness her stardust and divine its future, she needed to be able to calculate its variance and expected value, that her supernova cluster must be stationary. She discovered that if her index of time-location particles had a mean and variance that changed over time, she could pull, sort, and alter a cluster to derive its stationarity.

Realising the power of indexing supernovas and finding patterns of ARIMAs, she sought to predict the expansion of the entire nebula sector that housed the indexed supernova blats. She studied her time-location particles and applied Brownian motion to random occurrences she saw in the scatter of certain indices.

After determining the supernova's scatter of particles, she assigned them an age along with their name. If the cluster had direct automatic correlation at exactly p expansions before, they were donned AR(k)

[1] How she was so smart, only God knows

[2] White noise moving average terms

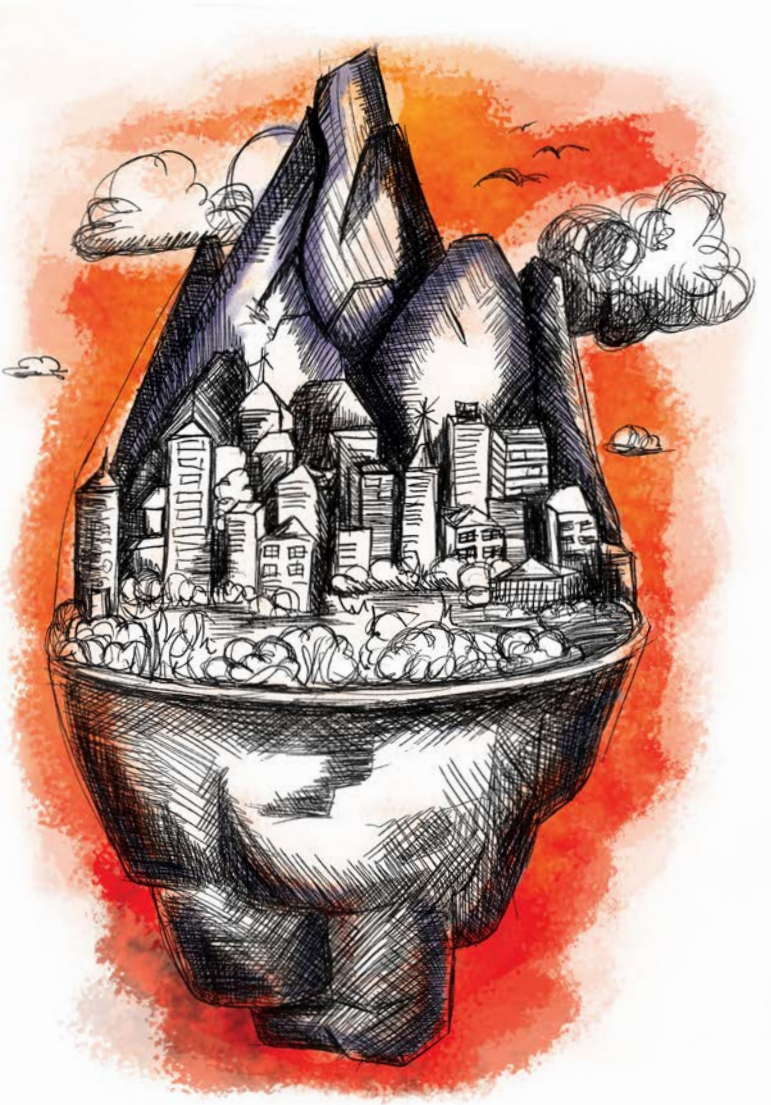
models. If the cluster required Aria's intervention to arrive at stationarity, she donned it with an I(d) where d showed the amount of order of moulding she needed to exert on the stardust. If her stardust was being pulled by gravity as it expanded through time and space, she accounted for this independent pull of gravity by anointing the MA(q) with the expansions of time in the past, whose average of q expansions ago still affected the clusters of today.

She used methods of estimating the overall parameters by minimising the distance between time-location stardust clouds and their observed history, maximising the likelihood of predicting the position of dust particles over their observed history or minimising the mean squared prediction error on the condition of their previous values.

She used these methods to look after each of her extensions of self and to divine the universe before her. Each ARIMA could be read as an extension of the endless motion of the universe. She was able to identify the supernova's stardust and use their statistics to estimate the parametric features of the nebula system that created the supernovas.

After she had attempted to identify the time-location essence of her ARIMAs, she checked for the validity of her estimations to determine if her study of the particles in the nebula system correctly captured the nebula's movement. She checked this by determining how accurately she could predict the movement of particles accounting for the patterns and susceptibility to gravitational manipulation. If Aria could see that the identification of her supernova stardust art was correct, that she had correctly determined its automatic correlation between p direct lags ago, its potential necessity for deconstruction, and its average effect of the particles q lags ago.

Aria used these techniques to begin the ultimate goal she had set out to achieve when she first started watching the nebula systems expand endlessly as their light coursed to the ends of the universe and then, still further.



Curing Non-stationarity in the TSA

by Stephanus Geyser

ARMA(20,21) stood on the top of the mountain, looking over the big country of the TSA. In front of him was the AR Capitol with its massive buildings. Behind him, on the other side of the mountain, was the glamorous MA Capitol. There were big walls around both capitols. You could only enter the MA Capitol if you could pass the ACF scanner; it only allowed pure MA citizens through. The same was true for the AR Capitol. You could only enter once you had passed the PACF scanner. The PACF scanner only cleared pure AR citizens.

Between the Capitols, around the mountain, ARMA(20,21) could see the rest of TSA. This was the place where the common ARMA people lived, like himself. They were farmers, miners, builders, and everything in between. They were not privileged enough to get into either capitol. These common ARMA people had to work hard to ensure the two capitols could live in luxury.

Right next to ARMA(20,21) was the peacekeeper's home. His name was White Noise. His purpose was to ensure a balance within this country of the TSA. Every month he met up with AR(1) and MA(1), the two presidents of the capitols. They talked about the good and the bad happening in the TSA, but the AR citizens just could not forget the past. They were mad about past wars, which meant that they couldn't reach an agreement that would unite all citizens of the TSA.

ARMA(20,21) walked down the mountain with a smile on his face after watching the beautiful sunset.

The next morning when ARMA(20,21) woke up, ready to go to work, he could sense something was not quite right. He looked out the window and saw several people being rushed to the hospital. His thoughts immediately jumped to ARMA(21,20). Was she okay? He was madly in love with her. They were a perfect fit for each other.

ARMA(20,21) rushed to his beloved's house only to find it empty. His heart sank. In desperation, he went to the nearest hospital to find her. He found her in a large room filled with sick people. There weren't enough doctors to help all the sick. There were different types of ARMA people of all p- and q-values. ARMA(20,21) spotted a doctor running by and grabbed his arm. The doctor could provide no useful information besides telling him that this big plague was called Non-stationarity-19. This affected the phi-chromosome, which caused the sickness.

The citizens of the AR Capitol became infected, even within their high walls. One thing stood out for ARMA(20,21) as he dug deeper into the cause of Non-stationarity-19. Not a single person in the MA Capitol became infected. They must have had some vaccine. ARMA(20,21) pledged to find the cure to save his dear ARMA(21,20).

The first place that ARMA(20,21) was going to search was the MA Capitol. When he arrived there, everything seemed eerily quiet. There were no guards, and all gates were sealed off. It was almost like they were locked down. He decided to investigate. Around the corner of the gates, he spotted a ladder going over the wall. Somebody must have broken in.

The only option was to climb the ladder to get over the wall. When ARMA(20,21) reached the top and peeped over, he saw all the MA citizens gathered silently. In front of them stood a familiar-looking person holding a gun to MA(1)'s head. ARMA(20,21) could not determine why this person looked so familiar. Their president was in danger!

This armed person shouted, "Nobody move, or I'll shoot!"

ARMA(20,21) decided that he needed more help, and climbed back down the ladder. After a long day of travelling, ARMA(20,21) reached the top of the mountain in the dark. White Noise gladly welcomed him into his home, having spotted ARMA(20,21) outside his home several times, watching the sunset. After discussing the situation in the MA Capitol, the two of them decided to get help from the AR Capitol. White Noise had a helicopter at his disposal. They travelled quickly to meet up with AR(1). Although AR(1) was not fond of helping the MA Capitol, he agreed. They gathered some guards and headed straight to the other side of the mountain.

The plan was to strike at dawn. The rescue party strategically entered through the back of the MA Capitol to ambush the intruder. ARMA(20,21), AR(1), and White Noise approached the intruder, still holding MA(1) hostage. Just as they stepped in front of the intruder, White Noise recognised him. It was his evil twin brother, Random Walk. He had escaped from the dungeons deep within the mountain.

White Noise said, "It's over, brother. We have you surrounded".

Random Walk had no choice but to give up. The MA Capitol was safe.

MA(1) told ARMA(20,21) that it was Random Walk that poisoned the drinking water with Non-stationarity-19. He didn't want the MA people to go and help the rest. The MA scientists did indeed have a vaccine, which they already gave to all the MA citizens at birth. MA(1) reassured ARMA(20,21) that ARMA(21,20) was going to be okay.

They got the vaccine to the rest of the TSA as quickly as possible. Everyone was back to full health within a few days. ARMA(20,21) was ecstatic that his beloved was cured. He had fulfilled his promise. ARMA(20,21) and ARMA(21,20) lived happily ever after.

At the next monthly meeting, White Noise, AR(1), and MA(1) decided to upgrade the locks in the dungeon and double the number of guards. Very importantly, AR(1) and MA(1) decided to restrict access to the capitols no longer.

To celebrate their differences. The whole TSA had a day off and held huge parties. Everywhere in the streets, you could hear the AR, MA, and ARMA people singing together repeatedly, "Born in the TSA".

Everything was good. They were safe from Non-stationarity, for now...

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