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.

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