Integrated Masters Thesis • Examples for Feedback   (JAB, 2023)

Why these examples?

Question 7 and 8 in the online marking form ask you to provide feedback to students when you mark their Integrated Masters project. Following some justified complaints, we aim to harmonise the degree of informativeness and length of markers' feedback across the student cohort.

What is the point of written feedback instead of giving only a numerical grade?

- This is an opportunity for us to demonstrate that we not only teach communicating about mathematical work in full sentences, but we can even excel in that activity ourselves.
- Your feedback is likely read by parents due to the close temporal proximity to graduation.
- After working on a project for nearly a whole academic year a couple of paragraphs addressing the multidimensional nature of achievement (or lack of it) are well deserved.

I don't have any idea what to write. Where can I get help?

These challenges have been considered in the design of this process. You may copy phrases from the marking guideline grid (i.e., the Excel document you uploaded for justifying your mark) or let yourself be inspired by the examples below.

Are these examples not confidential?

This is a very important question. While they are based on synthetic students and imaginary content, not sharing these is an opportunity for you to practice handling confidential documents. (You may list this as an achievement on your professional training records.)

Example 1: Georgina Kirrin (George), "Stochastic Models for Amoebae Movement"

- **Best aspects of the project.** You found a well documented dataset of microscopic amoebae videos and optimally exploited the scientific context of the experiments that generated these data to inform your models choices. Your decision to involve stochastic Navier-Stokes equations with multiplicative Lévy noise in your models is well justified, but it places you at the frontier of a fast evolving field. You not only mastered the established theory, but you even fine tuned a recently derived theorem about uniqueness. Your introduction of suitable assumptions on the cost functional demonstrates your deep level of insight. Your dissertation is original, rigorous, and addresses relevant real-world problems both from the obvious context (ecology) and less obvious applications such as criminology.
- **Possible improvements.** While your dissertation is at such high standard that no improvements could be suggested on the level of what is expected for a Masters project, you may consider a publication in an Undergraduate Research magazine or even a peer reviewed journal. For the latter you would need to expand your literature review and rewrite the discussion and introduction sections to follow the style used in the applied spatial statistics community more closely. In particular, the results and implications of your findings need to be compared with those in recent related publications.

Example 2: Julian, "Closed Form Solutions for the Fair Price of Fruit Salad Options"

- **Best aspects of the project.** This is a very conscientious piece of work on pricing pure fruit salad options from the perspective of investment banks (as traditionally adopted in mathematical finance). Covering different alternative recipes through the use of mixture models for the payoff matrix process allows an elegant martingale representation, which you combine with sophisticated integration techniques to find a closed solution. You rightly point out a necessary stability condition phrased in terms of the relationship of the mixture coefficients and the stock's implied volatility. While not a novel result, it has not been written up before at this level of detail.
- **Possible improvements.** The literature review is shallow and references are simply listed rather than explained. While your work is very solid it only uses a plain vanilla 1970s Black-Scholes framework. Developments since then include, for example, work on transaction costs, incompleteness, liquidity, price manipulation (regularity issues), incentive effects or risk perception gaps, and it would be desirable to develop this work in light of some of these aspects. Testing your methodology on real data would further enhance this research.

Example 3: Dick, "Building a Digital Twin Alethiometer using Bayesian Forecasting"

- **Best aspects of the project.** You spotted very well that the study of the mechanics of the alethiometer has been underserved by statistical research. The dynamic linear model set-up you selected fits the context described in *His Dark Materials* very well from a conceptual point of view. Your simulation study includes a comprehensive selection of scenarios covering a variety of spatial models for landscapes across several altitudes as well as indoor locations. The R markdown files are well structured and documented making your research easy to reproduce, verify, and expand.
- **Possible improvements.** The models could be extended to include the daemons along with every subject using Bayesian mixtures. The extensive body of literature on stochastic dust modeling could be reviewed carefully to link different point process models (e.g. log-gaussian Cox processes and spatio-temporal extentions) to different types of altitude, humidity, and temperature, and thereby a variety of real landscapes. The data collection in the observational study section was not properly described, raising questions about the validity of the findings beyond simulations. The dissertation would also benefit from better proofreading.

Example 4: Anne, "Optimal Dynamic Allocation under Scarcity"

- **Best aspects of the project.** Inspired by PPE shortages during the recent COVID-19 pandemic this work uses North American data to test and extend resource allocation algorithms based on stochastic control on networks in conjunction with a non-parametric Bayesian model. A composite likelihood approach is applied to a carefully selected simplification of the real-world situation, but taking into account multi-model situations. The results are compared against several performance metrics taking into account a variety of loss functions. While the fit to the data is of mixed quality, your work convinces from a methodological point of view and is well written up.
- **Possible improvements.** Important issues in real-time applications such as PPE allocation in a pandemic are data quality problems such as missing and noisy data. This work could be improved by including a sensitivity analysis and, if necessary, modify the control conditions to robustify the optimisation under real-world conditions. Readability of this work could be improved by creating charts to visualise the algorithm.

Example 5: Timothy (Timmy), "Kirrin Fixed Points in George RDS"

- **Best aspects of the project.** The introductory sections provide a lot of motivation for the relevance of this research. You make a good case for the need to deepen the theoretical understanding of random dynamical systems and for opening up pathways to impact on a range of real-world applications. Narrowing the scope to the study to George systems is well justified. The simulations carried out in the last section contain a range of interesting scenarios and the associated graphs support the reader in grasping the character of these types of systems.
- **Possible improvements.** The theoretical sections require modifications. The methods section lacks rigor; common notation and layout for writing up mathematics (as seen in lecture notes and textbooks) should be adopted more closely. The main result concerning Kirrin fixed points is not correct as presented in this dissertation: counterexamples involving non-convex functions show that the solution does not have to be unique. You could, however, modify the assumptions and close some gaps in the proof to correct this. Reading more of the existing body of literature including at least three of the relevant fixed point papers would support this process.