The University of Bristol
Faculty of Science and Engineering
School of Engineering Mathematics and Technology

COMSM0140: Internet Economics and Financial Technology (IEFT)

Academic Year 2023-24.

Main Coursework: this final summative coursework is for a maximum of 10 Credit Points.

Coursework specification release date: Friday 17th November 2023.
Coursework submission deadline: Thursday 7th December, 1pm (Blackboard)

Jupyter Notebook exploring automated trading in the BSE financial-market simulator.
Maximum length 2000 words.

Rather than write a static printed conference-paper, for this assessment you are required to create a fully functioning Jupyter notebook, with text, graphics, and executable code segments, all in one zip-compressed folder. It should be written as if the final intended use for the notebook is in future teaching on INFT: you don't need to explain the background history or write a literature review, but your notebook should have a definite narrative, explaining what is going on – as in the Jupyter notebook of the Vernon Smith demo experiments that is available on the BSE GitHub repository (Cliff, 2023). The maximum length of your notebook is 2000 words of Markdown. You are provided with a template notebook which contains a word count function. Do not edit this word count function.

You should submit a single zip-compressed folder containing:

- Your Jupyter notebook
- A printed PDF version of your notebook (to create a PDF, use either the "export" function of VSCode or the "Print" option in the "File" menu if using web browser or JupyterLab).

For this coursework submission you are required to work alone: you should not share code or data or text or images with any other student.

The coursework is in four parts:

Part A: This requires you to use BSE to perform a straightforward A/B comparison between two types of trader-agent. Assign appropriate values to parameters passed to BSE's `market_session` function to set up a market as follows:

- Set the supply/demand to be based on that used by Vernon Smith in Chart 4 of his landmark 1962 paper in the *Journal of Political Economy* (Smith, 1962): all sellers should have the same limit price of 310, giving a flat supply curve; buyer limit prices should range from a maximum of 490 at the high end of the demand curve, down to 250 at the low end, with equal-sized steps along the curve.
- Set the population of buyers, and also the population of sellers, to be R% traders of type SHVR and (100-R)% traders of type ZIC. Smith's Chart 4 shows 13 buyers and 13 sellers, but in your version of the experiment you should use 20 buyers and 20 sellers.

Then run n=50 independent and identically distributed (IID) repetitions of this market session with R=50 to gather a data-set of profitability figures for the two trader types. Select and apply an appropriate visualization of this data-set. Select and apply an appropriate statistical test, or sequence of tests, to determine whether, in the n=50 data-set you generated, traders of type SHVR are statistically more profitable than ZIC or statistically less profitable than ZIC, or whether the profitability of the two is, in your experiments, statistically indistinguishable. Then repeat this experiment again, but now using n=500. Write narrative text in the Jupyter notebook to explain your experiment set-up, the results, your visualization and analysis, and to state what conclusions you draw. **[10 marks]**

Part B: Generate more data sets as for Part A, but now for R=10, 20, 30, 40, 60, 70, 80, and 90, for n=50 and n=500. Select and apply appropriate visualization methods for this data set and select and apply an appropriate test or sequence of tests to determine at each R-value whether SHVR is statistically more profitable than ZIC, less profitable than ZIC, or indistinguishable from ZIC. Write narrative text in the notebook explaining what you did and what your findings are. **[15 marks]**

Part C: Add code to your notebook to run a new set of experiments, in which there are four different types of trader, SHVR/GVWY/ZIC/ZIP, and generate data from market sessions in which the ratios of these traders are (25:25:25:25), all four permutations of (40,20,20,20)[1], all four permutations of (10,30,30,30), and all four permutations of (70,10,10,10). Again, select and apply appropriate visualizations, and select and apply appropriate stats test(s) for each ratio's data, to determine whether there are any statistically significant differences in profitability between SHVR, GVWY, ZIC, and ZIP at any of the specified ratios. **[20 marks]**

Part D: A recent paper by Cliff (2023) describes the long-term co-evolutionary dynamics of markets populated by ZIP traders that are continually trying to improve their hyperparameter values, to trade more profitably. Edit the BSE code to re-create Cliff's results, and then introduce your own variations or extensions to explore the extent to which the results in Cliff's paper are affected by changes in the experiment set-up. For example, you might want to explore the effects of changes to the supply and demand curves, and/or changes in the number of traders in the markets, and/or changes in the type of evolutionary optimization that the ZIP traders use. For any such change, you will need to select and apply appropriate visualizations, and you will need to select and apply appropriate statistical tests to see whether the change you introduced does lead to a statistically significant alteration in profitability. **[55 marks]**

[1] When we say "…all four permutations of (N, M, M, M)…" we mean the following set of permutations: (N, M, M, M); (M, N, M, M); (M, M, N, M); and (M, M, M, N).

Appendix A: On plagiarism, use of AI, etc.

For this coursework submission you are required to work alone: you should not share code or data or text or images with any other student. You should also make sure that your notebook, cde, etc are not viewable or copyable by other students. Working collaboratively with other students, or not preventing other students from copying your work, would be viewed as *unauthorised group-work* which is an offence under the Univeristy's regulations on plagiarism and cheating,

Please be reminded that use of ChatGPT or any similar generative-AI system to create text which you submit for this coursework as if it was your own original work is a contravention of the University's regulations on cheating, and will be dealt with as plagiarism. If you are found to have committed plagiarism on this coursework, the most likely result is that your grade for INFT would be set to 0% for this assessment, resulting in a fail. You would then have to re-sit this unit over the summer of 2024, meaning you cannot start work on your individual project until September 2024, thereby delaying your completion of the MSc until December 2024, and the award of your final degree transcript etc would not take place until February or March 2025.

In academic writing, plagiarism is the inclusion of any idea or any language from someone else without giving due credit by citing and referencing that source in your work. This applies if the source is print or electronic, published or unpublished, another student's work, or any other person, or a machine like ChatGPT.

The University's Examination Regulations state that "Any thesis, dissertation, essay, or other course work must be the student's own work and must not contain plagiarised material. Any instance of plagiarism in such coursework will be treated as an offence under these regulations." (Section 3.1).

Section 4 of the University's Examination Regulations give information on the University's procedures for dealing with cases of plagiarism. More information about plagiarism, and how to avoid it is available from the Library website.

The University's guidance on use of generative AI tools such as ChatGPT is available here:
https://www.ole.bris.ac.uk/bbcswebdav/courses/Study_Skills/using-ai-at-university/index.html

Appendix B: Referencing

When you reference papers in your notebook text, you should reference them using a consistent referencing system, such as the APA referencing style, and you should normally cite sources in the text. As a general rule, you should avoid using footnotes to reference. If you include a quote, it should be in quotation marks, and a page number included in the in-text reference. Whilst you should normally avoid larger quotes, if you include them, you should also indent the text by increasing the left-hand margin width for the quoted passage of text. If you cite a paper, book, article, or any other source in your essay, you should also include a full reference to the paper in the reference list at the end of the notebook. Please **do not** list sources in your reference list that you have not cited in the notebook.

References

D. Cliff, (2023), *Recurrence-Plot Visualization and Quantitative Analysis of Long-Term Co-Evolutionary Dynamics in a Simulated Financial Market with ZIP Traders.* Available at SSRN: https://ssrn.com/abstract=4495631

D. Cliff, (2023), *Bristol Stock Exchange.* Open-source Python code repository available at https://github.com/davecliff/BristolStockExchange

V. Smith (1962), An Experimental Study of Competitive Market Behavior. *The Journal of Political Economy*, 70(2): 111-137. https://www.jstor.org/stable/1861810

University marking criteria (postgraduate)

	Fail (<50%)	Pass (50%-59%)	(60%-69%)	(70%+)
Attainment of Learning Outcomes	An inadequate level of knowledge and understanding of the basic concepts addressed by the question.	A reasonable knowledge and understanding of the topic, although more basic than at merit level, and at least of essential reading and material covered in lectures.	A good knowledge and understanding of the topic with clear indication of some reading beyond essential recommendations or material covered in lectures. A 'good' knowledge implies largely an absence of outright mistakes with clear evidence that you have understood the material and are not merely repeating it.	An authoritative knowledge and understanding of the topic gained from wide-ranging reading that goes beyond essential recommendations or material covered in lectures.
Application of Methods	Able to use a proportion of the basic methods and techniques taught.	Able to use most of the methods and techniques taught.	Able to use well a range of methods and techniques to come to conclusions.	Mastery of a wide range of methods and techniques.
Analysis, Comprehension and Synthesis	Inappropriate or irrelevant selection of content.	An ability to use relevant material which is directed to the question.	An ability to use relevant material which is directed to the question.	An ability to manipulate material intelligently and to direct it to the question set.
Technical Mastery	Limited technical competence with major shortcomings in significant areas of the subject.	Some technical competence but with shortcomings in significant areas of the subject.	A good general level of technical competence perhaps with some shortcomings.	A high level of technical competence with very few mistakes of any kind.
Evaluation/Critical Analysis	Little evidence of a critical perspective or of analysis so that the whole remains largely descriptive.	Some evidence of the ability to engage critically with content, although not fully developed.	A good ability to evaluate critically relevant theory and research.	A well-developed ability to engage critically with that material.
Quality of presentation	Poor presentation	Adequate presentation	Very good presentation	Excellent presentation

Note: Because the marking criteria consider a number of dimensions, it is unlikely that a single piece of work fits nicely into all of the descriptions above. For example, a piece of work may have excellent presentation, but due to significant errors, and major deficiencies, the piece of work may still be awarded a fail mark.