RepEng Project: Functional Replication of Spreadsheet Solver

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PVLDB Artifact Availability:
The source code, data, and other artifacts w.r.t. the reproduction package have been made available at https://github.com/iTsluku/RepEng-SpeadsheetSolver-ReproductionPackage. The equivalent for the report is available at https://github.com/iTsluku/RepEng-SpeadsheetSolver-Report.

1 INTRODUCTION

According to Baker[1], based on a nature survey of 1, 576 scientists, more than 70% of those researchers have failed to reproduce another scientist's experiment. The consequence is a loss of trust and credibility, as reconfirmation by other scientists is fundamental in the computer science domain, which is largely based on inductive reasoning. To tackle this issue, Mauerer et al.[2] suggest that the necessary skills should be taught as part of software engineering education.

This paper begins with the initial task of reproducing an experiment described in the Head First Data Analysis[3] book in chapter three. Therefore, the following introduction refers to Milton[3].

The essence of the described experiment is to solve a linear optimization problem. Specifically, the goal is to determine the optimal number of fish and duck bath toys that will yield the highest profit for the company. The number of products to be manufactured are decision variables, as these can be controlled. Decision variables are limited by constraints. Milton[3] introduces production time and rubber supply limitations as constraints. Furthermore, it is also described how much profit a duck or a fish yields so that the total profit can be calculated based on an objective function.

The task is therefore very simple: Again, decision variables are limited by constraints. Therefore, there is a range of possible values for each decision variable. According to the three scenarios described, these only contain discrete values. Depending on the scenario, additional constraints now act on the decision variables, causing the range of possible values to be potentially smaller. All this data is saved in an excel spreadsheet. To solve the linear optimization problem, i.e. determining the optimal number of duck and fish bath toys to be produced, the spreadsheet solver package introduces the excel solver function. Here, decision variable cells, the objective function and constraints must be entered manually using the solver GUI. The excel solver determines the optimal values of the decision variables and updates the corresponding cells in the excel spreadsheet.

Milton[3] also visualizes some charts such as representations of feasible region in a 2D plot with or without marking the optimal solution. Based on a data set with historical sales, demand is also predicted by an analyst. Accordingly, the time series of sales per product and sales in total are visualized in a chart. Depending on the analyst's observations, a new constraint per product is subsequently added, which in turn can affect the feasible region.

2 REPRODUCIBILITY

To achieve reproducibility, one would need to achieve the same results with the artifacts of Milton[3]. The calculation would have to take place in the same environment, i.e. under the same conditions, and run in exactly the same sequential order. By manually going through the described steps for the individual scenarios based on the excel spreadsheet, which was made publicly available using gitlab, I was able to generate the same new decision variable values using the spreadsheet solver. However, this did not take place under the exact same experimental setup, which is why this partial success only corresponds to a partial replication. Moreover, it was impossible to generate identical charts, as the necessary scripts are not publicly available as artifacts. Furthermore, not even the charts themselves are published. Therefore, the image comparison is not possible at all, even though the historical sales data has been published. But even with this data it is impossible to generate the exact identical chart, since information regarding color values, font size, limitation of axes etc. is missing. Hence, not only the reproduction, but also the replication of the entire project is impossible.

3 FUNCTIONAL REPLICATION

The reproduction package of this work is limited to a partial scope and aims to replicate the functionality of the spreadsheet solver in order to achieve identical output values for all three scenarios defined by [3].

The criteria for successful confirmation of the solver output values are determined by an equality comparison and visualized in Table1.

Scenario	Duck Count	Fish Count	Total Profit
Sce_1_Paper	400	300	3200
Sce_1_F_Rep	400	300	3200
Sce_2_Paper	400	80	2320
Sce_2_F_Rep	400	80	2320
Sce_3_Paper	150	50	950
Sce_3_F_Rep	150	50	950

Table 1: Comparison of the solver outputs of the functional replication with the values from Milton[3].

REFERENCES

[1] Monya Baker. 2016. 1,500 scientists lift the lid on reproducibility. *Nature* 533, 7604 (May 2016), 452–454.

[2] Wolfgang Mauerer, Stefan Klessinger, and Stefanie Scherzinger. 2023. Beyond the Badge: Reproducibility Engineering as a Lifetime Skill. In *Proceedings of the 4th International Workshop on Software Engineering Education for the Next Generation* (Pittsburgh, Pennsylvania) *(SEENG '22)*. Association for Computing Machinery, New York, NY, USA, 1–4. https://doi.org/10.1145/3528231.3528359

[3] Michael Milton. 2009. *Head First Data Analysis*. O'Reilly Media, Inc.