MATH3205 Project Final Presentation

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| Slide # | Goals/Topics | Presenter |
| 1 | * Introduction to the topic, briefly * What, why, * Applications |  |
| 2 | * Summarise Fabio’s findings |  |
| 3 | * How we matched Fabio’s results * Show our results |  |
| 4 | * Issues we came up after Fabio’s work |  |
| 5 | * What approaches did we attempt/implement to further the work? |  |
|  | * Introduce new approach formulation/modelling * Any assumptions? |  |
| 6 | * Did the approach work? Why/why not? * Benders * SA * Others? Generating our own data |  |
| 7 | * Benders * Initial approach * Reformulation, why? * Did it work? Was it an improvement * Limitations |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |
| 11 | * Summarise our end results + recommendations, future work |  |
| 12 | * End, acknowledgements |  |

Presentation Script

* SA

In addition to the Benders decomposition, we applied a simulated annealing heuristic to the problem such that we could compare the results to those of the MIP and the aforementioned Benders implementation. An example of the solution process is demonstrated in this figure. The heuristic was run at 1000 iterations to provide a baseline solution within a timeframe comparable to the existing MIP. By comparing these results to those seen for the alternative frameworks, we note that most cases in SA differ in terms of optimality when compared to the results of the MIP. Run-times are more or less equivalent across most examples, though there is a marked improvement in performance for network 6 at P = 0.6. It is currently assumed to be a result of the generalised nature of the heuristic compared to the restrictions of the actual MIP, though this result would appear to be an outlier compared to the increased complexity of R7.

Similarly, comparing the SA data to that of the Benders decomposition, there is significant deviation from optimality. This is to be expected given that the Benders framework also achieved optimality, as well as similar results to those found in the MIP. The only major difference as mentioned previously by Clancy, is the difference in computation time between the Benders and MIP solutions, though again, Benders exceeds the performance of the SA heuristic in all cases.

* Graphs/Visualisations

Here, we show some visualisations comparing the current P value to the computation time required to optimise under a given network design. We note that for all networks, P = 0.2 generates the greatest computation time, presumably due to the reduction in model flexibility. Interestingly, the pattern of the relationship between these parameters is not completely consistent across each network design. While increasing the value of P tends to immediately improve the time outcomes for each network design, the behaviour of each network computation is less predictable.

* Limitations/Future Work

Given the similarities in outputs between the current models, consideration may be given to alternative heuristic approaches, stochastic optimisation approaches, or a combination of multiple frameworks to either improve computation efficiency, or find potential improvements to the optimal solution. Exploring a wider range of parameters, such as increasing the number of P values used to compare network designs, or generating new network designs could also provide new avenues with which to further optimise the solution.

Looking forward, further inquiry could be directed at investigating other strategies by which to minimise the impact of interruptions to power within the network. These could include maintenance of existing infrastructure, making changes to the proximity and availability of response teams, and/or investing in localised energy storage devices. By comparing these approaches, as well as exploring combinations of them, costs and interruptions could be further reduced within the scope of the problem.

* Concluding statements

To summarise the findings of the investigation, we note that previous efforts by Dr. Uzberti et al achieved close to optimality, evidenced by comparison to the models developed by our team. Current data suggests that the implementations employed by our team show that the MIP framework is the fastest in terms of computational runtime, whilst all models remain close to each other in terms of solution optimality and accuracy. Integrating these models into a pipeline may yield further optimisation, though it remains to be seen at present.

Further work at this stage would involve the consideration of alternative heuristics and optimisation methods. Additionally, investigating other approaches to mitigating network interruptions to provide another point of comparison for making decisions regarding the ‘best’ decision in terms of timeliness and cost reduction.

The second graph shows curves describing the relationship between switch proportion, P, and various costing measures. In particular, using basic cost parameters obtained from the source paper, we recreated a plot of the cost of switch investment capital, ENS cost savings, and the overall returns. Returns in this context are described as the difference of the ENS cost savings and the investment capital for switch installation.