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Master Thesis Proposal

How can generative AI help to build and transform optimization models? A study on assortment optimization.

Generative Artificial Intelligence (AI) is not only transforming various industries but also making its mark in the world of software development. With its ability to learn from existing codebases and generate new code, generative AI is becoming a valuable tool that supports developers in coding tasks. By automating certain aspects of coding and providing intelligent suggestions, generative AI streamlines the development process and enhances productivity.

Although many improvements have been made in the field of neural networks in recent years, it is the development of the transformer and its easy accessibility to the public through ChatGPT that has made it a topic in the news. Liu et al. (2023) and others have shown that generative AI geared towards code generation can support an increase in the development speed by taking over code generation tasks. Most studies investigate the capabilities of AI with respect to general programming tasks in popular languages like Python or Java. Little to no work has been done to investigate whether large language models can help build and improve optimization models. This thesis investigates their capabilities on the popular assortment optimization problem.

Assortment planning is one critical task to be successful as a retail company. It describes the retailer's choice of what mix of products to offer to maximize revenue or profit. Often companies can choose among a large variety of items but have only limited shelf space, limited budget, or other constraints. Summarized, they can pick only a subset of items to optimize their assortment. This problem type emerged roughly 45 years ago and, in many applications, is still difficult to solve today. The potential customer base can be split into different customer types to capture customer heterogeneity. The demand can be described by discrete choice models. If only one customer type is regarded, the multinominal logit (MNL) model can be applied. This model is well-known as it benefits through its nice mathematical properties. Unfortunately, this model suffers from the independence and irrelevance of alternatives (IIA) property (see red bus blue bus example) and assumes homogeneous customer preferences, which can be a strong assumption. The mixed multinominal logit model (MMNL) as a subsequent development is one of the most sophisticated models, as it can represent any arbitrary choice model and does not suffer from the IIA property. To solve this model, scholars transformed the original non-linear problem to linear or conic formulations (see e.g., Sen (2018)).

The objectives of this thesis are to:

- give an overview of the current state of large language model literature stream, discuss different approaches with their advantages and disadvantages,
- give an overview of the current state of the assortment optimization literature,
- to create an evaluation process to study large language models like ChatGPT, Codex or Tabine,

- to conduct the study on a well-known problem like knapsack or TSP, on a typical assortment optimization problem, and on an assortment problem, which is not in the training data of the AIs, in order to answer the fundamental research question: How can generative AI help to build and transform optimization models?
- And to provide open research gaps, limits and future trends.

Recommended basic literature:

Liu, Y., Han, T., Ma, S., Zhang, J., Yang, Y., Tian, J., ... & Ge, B. (2023). Summary of chatgpt/gpt-4 research and perspective towards the future of large language models*. arXiv preprint arXiv:2304.01852.*

Kök, A. G., Fisher, M. L., & Vaidyanathan, R. (2008). Assortment planning: Review of literature and industry practice. *In Retail supply chain management (pp. 99–153*). Springer.

Şen, Alper; Atamtürk, Alper; Kaminsky, Philip. (2018). Technical Note—A Conic Integer Optimization Approach to the Constrained Assortment Problem Under the Mixed Multinomial Logit Model. *In Operations Research* 66 (4), pp. 994–1003. DOI: 10.1287/opre.2017.1703.