MATH 441: Discrete Optimization
University of British Columbia
Vancouver, BC Canada

April 14, 2024

RE: Learning Portfolio – Artifacts Presentation

Dear Professor Patrick Walls,

MATH 441 proved to be a fun, challenging, and above all, the most uniquely structured class I have taken at UBC. Students were responsible for transforming their learning into a portfolio of seven artifacts, accompanied by a group project. This applied way of learning not only gave me the opportunity to reinforce my learning, but to also think strategically and creatively to formulate a learning portfolio of high quality. To summarize my work, I have developed a series of artifacts that demonstrate a progressive mastery of discrete optimization and network analysis using Python and NetworkX. Starting with basic graph manipulations in "Networkx Basics," I advanced to more complex mathematical problems and optimization techniques in subsequent artifacts. These included solving the Shortest Path Problem, comprehensive discrete allocation analyses in portfolio optimization theory, and tackling the computationally intensive Traveling Salesman Problem using cvxpy (convex optimization). My final challenge was the Multiple Traveling Salesman Problem, where I innovated on traditional models to manage increased complexity and multiple agents. Each artifact not only underscores my technical skills but also illustrates my ability to apply theoretical concepts to solve real-world problems effectively.

Funnily enough, one of the most important things that I learned in this course was to not rely on Large Language Model's (LLM). This sounds counterintuitive, especially when I have referenced OpenAI's ChatGPT in all my artifacts. But to expand on my thought, this course made me understand how LLM's are knowledge aids, and not thinking aids. Their potential is best suited to aid you bridge your knowledge gap when fixing any bugs or ideating, rather than aiding your strategic thinking. This is particularly revelatory, since most students at university seem to have a skewed idea of it. This course fostered an environment of unjudged ideation, where no idea was deemed too unconventional, ambitious, or irrelevant. This approach was particularly encouraging for students like me, who might hesitate before pursuing an innovative idea. Consequently, the second most important lesson I learned in this course was to act without overthinking—to simply pursue an idea and follow it through to its fruition.

In this class, I tackled two broad topics through my artifacts—Routing Problems and Portfolio Optimization. I have always been fascinated by routing problems but had never had the opportunity to develop foundational knowledge in this area. Dissecting the Shortest Path problem and the Traveling Salesman Problem allowed me to satisfy my curiosity. As a Mathematics and Economics student aiming to explore the realm of Venture Capital investments, gaining knowledge in Portfolio Optimization was like acquiring a life skill. My goal through these artifacts was to achieve progressive mastery and to experiment and learn about different concepts within the expansive horizons of Routing Problems and Portfolio Optimization. Consequently, I mastered quadratic formulation, convex optimization, and combinatorial problems (through the Traveling Salesman Problems). While my last artifact on the "Multiple Traveling Salesman Problem" encapsulates a mix of all the knowledge I have learned—from problem formulation and convex optimization to utilizing networks—my artifacts on "Discrete Allocation Analysis" involved algorithm testing through comparative analysis, sensitivity analysis, and back-testing of portfolio returns. This was a new endeavor for me and showcases my experimental approach to creating my artifacts.

In reflecting on the artifacts I created, I am most proud of my work on "Discrete Allocation Analysis" and its sequel. These projects were particularly fulfilling as they pushed me to engage deeply with advanced analytical methods. Crafting an algorithm testing framework required analytical prowess and quantitative skill proficiency. I found

myself delving into algorithm testing through comparative analysis, sensitivity analysis, and back-testing of portfolio returns. This work was not just about applying what I learned; it was a test of my ability to innovate and apply those theories in more dynamic and complex contexts. Documenting every step and challenge helped me improve how I communicate complex ideas—making the intricate details accessible and understandable. This experience was both challenging and rewarding, and in fact most enjoyable too. It gave me a profound sense of accomplishment and a clearer view of my capabilities and potential in my field.

My biggest challenge while creating my artifacts was staying on course with the goals and objectives I initially set. I often found myself straying off-course, caught up in exploring multiple ideas or dimensions that I wanted to add to my artifacts. Considering this is an optimization class, one might assume that I would optimize my time, effort, and the deliverables for each artifact. Therefore, learning when to stop was crucial, which I gradually mastered over the course of creating my artifacts. A clear indicator for me to stop was when I noticed myself spending more than 10 hours on a single artifact. This can also be a key takeaway for anyone who plans on starting with their own portfolio.

For my artifacts, I submit the following grade proposal:

- Effort: 85/100

  I believe I have spent considerable amount of time generating original artifacts, and formulating and solving problems with creative solutions. I have interacted with my fellow classmates to learn from their respective portfolio's. I haven't been able to attend and receive feedback sessions at earlier times due to my own personal priorities. I have also not attended as many lectures as I would ideally want to for the same reason. But nonetheless, I have deducted grades to reflect my absence.

- Growth: 95/100

  My growth in mathematical maturity, and discovering new mathematical concepts is evident through my progressive learning from setting up a scipy.optimize.linprog formulation to tackle shortest path problem, to a more complex Miller-Tucker-Zemlin formulation of the Multiple Traveling Salesman Problem on the same routes network of Vancouver. Be it a progressive deep dive into how Networks work, or testing and analyzing how greedy algorithms function in portfolio optimization, I have consistently demonstrated growth. But I do believe, that I can do more and there is always more to learn.

- Quality: 95/100

  I take pride in showing creative and informative visuals (through graphs, networks, simulations), and communicating novel ideas in clear, precise and robust manner. I have always thrived to make sure that the reader can understand precisely what I attempt to communicate through my presentations. And I believe I have demonstrated considerable creativity in all my artifacts.

This brings my overall grade to a 91.67/100. I have no reference point of evaluating myself. Hence, I look forward to receiving your feedback on our one-on-one meeting. Besides, I am grateful for this unique and enriching learning opportunity. And I couldn't thank you enough for it!

Sincerely,
Divyadarshan Punjabi.