**Applicable Application of Applied Linear Algebra**

(*Daffy Duck-Inspired Title*)

As you probably know, linear algebra can be applied to a multitude of different fields. When attempting to narrow down the options to a specific topic, I wanted to pick something that had broad implications and could be beneficial in a variety of different applications. After considering things like search-engine ranking, signal analysis, graphics, machine learning, and quantum computing, I finally landed on linear optimization (programming) which uses linear equations to determine how to arrive at the optimal solution (maximum or minimum), assuming the quantifiable nature of the end optimization goal (BasuMallick, 2022). In Linear Programming (LP), linear equalities and inequalities are used to determine the optimal value under those constraints.

Using two variables (for example) and graphing these constraints on an - space, the boundaries of this polytope (“feasibility region”) produced by the intersection (vertices) of the different pairs of lines can be evaluated in the optimization equation to get the function for the maximum or minimum value, based on a level set (points with the same cost function value) and the direction of optimization. The standard form of a maximum linear function for two variables may be , with constraints on the variables and is usually expressed in matrix form, as well as mathematically as something like (Wikipedia, n.d.). The simplex algorithm is commonly used, in which the vertices of the polytope are iterated over in the direction of increasing (or decreasing) values of the objective function and tested for optimality.

A specific real-world example of linear algebra for optimization is in the user-based personalization of the content-feed of commonly used social media and similar type apps like Tik Tok. Tik Tok has over 1 billion monthly active users (Zauderer, 2023), and a big part of its success is the algorithm used to determine what a user should be fed. Linear algebra, using linear optimization/programming techniques, can help optimize the mix of content and maximize engagement , based on things such as “likes” (), shares (), and time spent on a post (). Then weights can be assigned to each of these metrics to define their importance: , where is the frequency of each type of content to show and is the maximum value of the combined frequencies. Then each of these metrics could be defined as , along with other constraints such as . Ideally, this (or something similar) would provide optimized values for the frequencies of the different types of content for each individual user.

As we move into the future, linear optimization/programming can be used to optimize resource distribution in neural networks, including machine learning and artificial intelligence models, and could help automize decision-making for the content-delivery example provided earlier. Logistics for traffic management and energy utilization for smart cities and other supply chains can also be optimized using these techniques. These are the types of things that I may come across in my professional life that linear optimization may prove extremely beneficial.

**References**:

BasuMallick, C. (2022). *What is Linear Programming? Meaning, Methods, and Examples*. Spiceworks. <https://www.spiceworks.com/tech/it-strategy/articles/linear-programming/#:~:text=Linear%20programming%20is%20a%20technique,of%20the%20end%20optimization%20goal>.

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Zauderer, S. (2023). *89 TikTok Statistics, Facts & User Demographics*. Cross River Therapy. <https://www.crossrivertherapy.com/research/tiktok-statistics#:~:text=TikTok%20has%201%20billion%20monthly,January%20to%20June%202021%20alone>.