Optimize, Design, and Minimize

Mathematics

(Worksheet V1.0)

# Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| Note |
| * Anaconda (Python version 3.7 or above) and PuLP library are required for this practice. If they have not been installed, please refer to Installation and Troubleshooting Guide. * Download and Extract the ‘Working Files’ folder for this hands-on practice. * If you encounter any difficulties along the way, please refer to Installation and Troubleshooting Guide. |

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| **Step 1: Simplifying with Assumptions** | |
| **Instructions** | **Screenshot** |
| Notice that the dimensions of a 13" laptop box on the right side are actually larger than the actual size of the laptop it contains. What factors contribute to this extra size in the packaging for laptops in general? | *Image: Dieline for a 13” laptop box* |
| Laptop boxes are generally larger in size to account for factors like cushioning and protection. The dieline for such a box can be approximated as a rectangle that needs to be cut from the cardboard sheet. This rectangle is then folded and assembled to form the final box.  Therefore, the dimensions can be approximated as:   * *For a 13" laptop box: 23.315 inches by 25.685 inches* * *For a 15" laptop box: 25.315 inches by 27.685 inches*   For a charger we can approximate the dimensions to be *11.5 inches by 7.25 inches* | *Image: Dieline for a 15” laptop box* |

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| **Step 2: Setup Notebook** | |
| **Instructions** | **Screenshot** |
| 1. Run the Jupyter Notebook program (included in Anaconda). This will automatically open your default web browser and display the Jupyter Notebook web application.   *You can also use the Windows search bar. Just type 'Jupyter Notebook' and launch it.* | A screenshot of a computer  Description automatically generated  *Image: Jupyter Notebook Program* |
| 1. In the web application, navigate to the ‘Files’ tab at the top left corner besides running. 2. At the ‘Files’ tab, click on the ‘Upload’ button at the top right corner. 3. Select the file Optimize\_Design\_Minimize.ipynb\_Problem\_1from the ‘Working Files’ folder and upload it. 4. Once uploaded double click on the file to open it.   *Note: There are three problems, each split into separate notebooks. You need to repeat the process for every problem.* | *Image: Navigating Jupyter Notebook* |

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| **Step 3: Setup LP using Jupyter Notebook** | |
| **Instructions** | **Screenshot** |
| 1. This notebook contains comprehensive details about the code used and the underlying logic behind it. It is structured to guide you through each step of the process. To fully understand and execute the examples, please follow these steps: 2. Review the code and explanations provided before each cell to grasp the methodology and logic. 3. Run each cell sequentially by pressing Shift + Enter to execute the code 4. Begin by executing the first code cell. |  |
| In LP, we either minimize or maximize. For our problem, where we cut boxes from a cardboard sheet, what should we minimize?  We should aim to minimize the remaining area. This objective ensures that you maximize the utilization of the cardboard by reducing the amount of unused space. |  |

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| **Questions** |
| 1. How can optimization techniques be applied in real-world situations outside of packaging? 2. Supply Chain Management: Optimization techniques help in efficiently managing inventory levels, transportation routes, and production schedules to minimize costs and meet demand. 3. Healthcare Scheduling: Optimizing staff schedules and patient appointments improves resource allocation and reduces waiting times in hospitals and clinics. 4. Financial Portfolio Management: Techniques are used to balance risk and return in investment portfolios, helping investors maximize returns while managing risk. |
| 1. Reflect on the role of constraints in optimization problems. How do they affect the possible solutions?   Constraints define the feasible region of solutions in optimization problems by:   * Defining Feasibility: Solutions must satisfy all constraints to be considered viable. * Limiting Solution Space: Constraints narrow down the range of possible solutions. * Impacting Objective Function: Constraints can affect the maximum or minimum values of the objective function. * Ensuring Practicality: They ensure solutions are realistic and applicable in real-world scenarios. |
| 1. What ways can optimization contribute to sustainability in various industries?   Optimization can contribute to sustainability in various industries by:   1. Reducing Waste: By optimizing processes, industries can minimize material waste. For example, in manufacturing, optimization n help in precise cutting and production techniques that reduce scrap and by-products. This not only lowers costs but also reduces the environmental impact of waste disposal. 2. Enhancing Efficiency: Streamlining operations through optimization improves the efficiency of energy and resource use. For instance, optimizing heating, ventilation, and air conditioning (HVAC) systems in buildings can significantly reduce energy consumption and operational costs while maintaining comfort. 3. Lowering Emissions: Efficient designs and processes can lead to a reduction in greenhouse gas emissions. For example, optimizing the logistics of transportation can reduce fuel consumption and emissions by improving route planning and load management. Similarly, optimizing industrial processes can lead to cleaner production methods with fewer pollutants. |