BAX 358 - Project 1 Report

Part 1 - ROI Overview

	Platform	Print	TV	SEO	AdWords	Facebook	LinkedIn	Instagram	Snapchat	Twitter	Email
0	ROI	0.031	0.049	0.024	0.039	0.016	0.024	0.046	0.026	0.033	0.044
1	Second Firms ROI Estimate	0.049	0.023	0.024	0.039	0.044	0.046	0.026	0.019	0.037	0.026

We are data scientists in the marketing department who have been given the ROI Data above. Using the data set, we utilized Gurobi in Python to find the optimal budget allocation for each of our 10 different marketing mediums as our CMO has asked.

Part 2 - Constraints

Our constraints are as follows:

1. $print + TV \leq Facebook + Email$
2. $Facebook + LinkedIn + Instagram + Snapchat + Twitter \geq 2 \times (SEO + AdWords)$
3. $Each\ investment\ \leq 3,000,000$
4. $Budget\ =\ 10,000,000$

Part 3 - Optimal Solution for ROI #1

Using the first row of data that shows estimated ROI figures for each marketing medium, we came to the following allocation:

```
===============================================================================
Print                   0.0
TV                      3000000.0
SEO                     0.0
AdWords                 1000000.0
Facebook                0.0
LinkedIn                0.0
Instagram               3000000.0
Snapchat                0.0
Twitter                 0.0
Email                   3000000.0
```

The objective value from this allocation is $456,000, so the return we got from a $10 Million Budget was 456,000.

Part 4 - Optimal Solution for ROI #2

Using the second row of data that shows a different ROI estimate for the different marketing mediums, we came to the following allocation:

```
======================================================================================

Print                      3000000.0
TV                         0.0
SEO                        0.0
AdWords                    1000000.0
Facebook                   3000000.0
LinkedIn                   3000000.0
Instagram                  0.0
Snapchat                   0.0
Twitter                    0.0
Email                      0.0
```

The objective value from this allocation is once again $456,000, so the return we got from a $10 Million Budget was 456,000, the same as above, although our allocations are clearly different using the different sets of data.

Part 5 - Differences in Allocation

From our code, we determined that if the second allocations were used on the first ROI data the objective value would be $204,000 lower.

Additionally, if the first allocations were used on the second ROI data the objective value would be $192,000 lower.

Based on the results, our constraint that makes it so that the amount invested in each platform should be no more than $3M is not useful for us as it is limiting the amount of return we are getting from our investments, and in a real-world context having a lack of diversification amongst investments is risky.

Part 6 - Change in Optimal Allocation based on ROI Changes

Next, we explored how much could each advertising medium's ROI increase or decrease and still result in the same optimal allocation we found above, and the results are as follows:

The first row of ROI data results below:

```
================================================================================
    Variable                        Allowable Increase        Allowable Decrease
    Print                           1.049                     -inf
    TV                              1.062                     1.039
    SEO                             1.039                     -inf
    AdWords                         1.046                     1.033
    Facebook                        1.029                     -inf
    LinkedIn                        1.039                     -inf
    Instagram                       inf                       1.039
    Snapchat                        1.039                     -inf
    Twitter                         1.039                     -inf
    Email                           inf                       1.029
```

The second row of ROI data results below:

```
================================================================================
    Variable                        Allowable Increase        Allowable Decrease
    Print                           1.052                     1.039
    TV                              1.049                     -inf
    SEO                             1.039                     -inf
    AdWords                         1.046                     1.038
    Facebook                        inf                       1.029
    LinkedIn                        inf                       1.039
    Instagram                       1.039                     -inf
    Snapchat                        1.039                     -inf
    Twitter                         1.039                     -inf
    Email                           1.029                     -inf
```

Lastly, we want to look at the maximum ROI we could get after an entire year where we can reinvest half of the monthly returns from the previous month with the same constraints in place.

Part 7 - Optimal Allocation for Each Month

Our data set for ROI returns across each medium for each month for a one-year time span is below:

	Print	TV	SEO	AdWords	Facebook	LinkedIn	Instagram	Snapchat	Twitter	Email
0	0.040	0.036	0.024	0.039	0.030	0.035	0.036	0.0225	0.035	0.035
1	0.040	0.039	0.027	0.038	0.043	0.032	0.027	0.0180	0.037	0.035
2	0.035	0.029	0.031	0.038	0.024	0.041	0.037	0.0260	0.042	0.025
3	0.038	0.031	0.024	0.044	0.024	0.038	0.037	0.0250	0.036	0.029
4	0.035	0.032	0.019	0.034	0.027	0.027	0.039	0.0220	0.045	0.039
5	0.040	0.032	0.027	0.034	0.034	0.030	0.045	0.0210	0.038	0.041
6	0.039	0.036	0.020	0.044	0.039	0.037	0.043	0.0180	0.040	0.038
7	0.042	0.033	0.028	0.042	0.020	0.037	0.036	0.0150	0.044	0.043
8	0.041	0.028	0.025	0.042	0.029	0.037	0.028	0.0250	0.040	0.034
9	0.030	0.030	0.031	0.046	0.031	0.033	0.032	0.0230	0.025	0.032
10	0.048	0.033	0.027	0.041	0.029	0.036	0.042	0.0300	0.031	0.041
11	0.048	0.040	0.019	0.037	0.042	0.036	0.026	0.0290	0.036	0.037

Our results for the optimal allocation for each month across the 10 different marketing mediums are as follows:

	Print	TV	SEO	AdWords	Facebook	LinkedIn	Instagram	Snapchat	Twitter	Email
January	3,000,000.00	0.00	0.00	1,333,333.33	0.00	0.00	2,666,666.67	0.00	0.00	3,000,000.00
February	3,000,000.00	0.00	0.00	2,395,500.00	3,000,000.00	0.00	0.00	0.00	1,791,000.00	0.00
March	0.00	0.00	0.00	3,000,000.00	0.00	3,000,000.00	1,389,648.00	0.00	3,000,000.00	0.00
April	0.00	0.00	0.00	3,000,000.00	0.00	3,000,000.00	3,000,000.00	0.00	1,596,856.49	0.00
May	1,804,099.90	0.00	0.00	0.00	0.00	0.00	3,000,000.00	0.00	3,000,000.00	3,000,000.00
June	3,000,000.00	0.00	0.00	0.00	0.00	0.00	3,000,000.00	0.00	2,020,171.65	3,000,000.00
July	0.00	0.00	0.00	3,000,000.00	2,247,554.91	0.00	3,000,000.00	0.00	3,000,000.00	0.00
August	3,000,000.00	0.00	0.00	1,827,294.08	0.00	654,588.16	0.00	0.00	3,000,000.00	3,000,000.00
September	1,362,932.65	0.00	0.00	3,000,000.00	0.00	3,000,000.00	0.00	0.00	3,000,000.00	1,362,932.65
October	0.00	0.00	0.00	3,000,000.00	0.00	3,000,000.00	3,000,000.00	0.00	0.00	2,955,475.27
November	3,000,000.00	0.00	0.00	2,056,420.96	0.00	1,112,841.91	3,000,000.00	0.00	0.00	3,000,000.00
December	3,000,000.00	3,000,000.00	0.00	427,950.65	3,000,000.00	0.00	0.00	0.00	0.00	3,000,000.00

A stable budget is defined as a monthly allocation such that for each platform the monthly change in spending is no more than $1M. The allocation that we found is not stable, as spending drastically changes between months, such as between February and March for Print, spending goes from $3,000,000 to $0 (we can also see standard deviations greater than 1,000,000 in the table below). To create a new model with a stable budget, you can add a constraint to the model that specifies that the change from month to month for each of our marketing mediums cannot be greater than $1 Million.

Summary Statistics of Optimal Allocations:

	Print	TV	SEO	AdWords	Facebook	LinkedIn	Instagram	Snapchat	Twitter	Email
count	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
mean	1,763,919.38	250,000.00	0.00	1,920,041.59	687,296.24	1,147,285.84	1,838,026.22	0.00	1,700,669.01	1,859,867.33
std	1,406,976.87	866,025.40	0.00	1,207,118.82	1,257,088.61	1,410,084.63	1,430,262.15	0.00	1,352,822.78	1,448,608.79
min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25%	0.00	0.00	0.00	1,106,987.66	0.00	0.00	0.00	0.00	0.00	0.00
50%	2,402,049.95	0.00	0.00	2,225,960.48	0.00	327,294.08	2,833,333.33	0.00	1,905,585.83	2,977,737.63
75%	3,000,000.00	0.00	0.00	3,000,000.00	561,888.73	3,000,000.00	3,000,000.00	0.00	3,000,000.00	3,000,000.00
max	3,000,000.00	3,000,000.00	0.00	3,000,000.00	3,000,000.00	3,000,000.00	3,000,000.00	0.00	3,000,000.00	3,000,000.00