LP Optimising Spend on Campaign

Code

`library(linprog)` — #install.packages("linprog")

`Max_ROI <- c(0.07, 0.03, 0.15, 0.12, 0.05)` — #Objective Function

`Contraint_Vector <- c(5000, -500, 0, -200, 0, 0, -300, 900, -100, 2500)` — RHS of constraints

```
Decision_Var <- rbind(
  c(1,1,1,1,1),
  c(-1, 0, 0, 0, 0),
  c(-0.05, 0.95, -0.05, -0.05, -0.05),
  c(-0, -1, 0, 0, 0),
  c(0.5, 0.5, -0.5, -0.5, 0.5),
  c(0, 0, 1, -2.5, 0),
  c(0, 0, -1, 0),
  c(0, 0, 0, 1, 0),
  c(0, 0, 0, 0, -1),
  c(2, 0.3, 1.8, 0.9, 2)
)
```
— #Decision variables under constraints

`solveLP(MaxROI, ContraintVector, Decision_Var, TRUE)`

Output

Solution	
opt	
1	500.0000
2	92.4638
3	256.8116
4	900.0000
5	100.0000

Results of Linear Programming / Linear Optimization
Objective function (Maximum): 189.296
Iterations in phase 1: 7
Iterations in phase 2: 0

Budget for TV = x1 — 500
Budget for Print media = x2 — 92
Budget for Mobile = x3 — 256
Budget for SEO + AdWords = x4 — 900
Budget for Facebook Mkt = x5 — 100

Conclusion

The Maximum ROI from the marketing effort is expected to be 189K. This is just an example. Real market numbers can be different! All this adds up to 1,848. Though we might have a budget of $5 million, the simplex has optimized it demonstrating that the maximum ROI of 189K is achieved over $1.848 Million spend; anything north of it might result in increasing the ROI only marginally and will not result in a linear growth in ROI. This also advises us to not invest less in print media

Links 🌐

https://www.linkedin.com/pulse/optimizing-marketing-portfolio-through-linear-neelima-gaddam/

Case

Let us suppose that we are tasked by the CMO to recommend allocation of budgets across TV, Print (catalogue, bill boards, Airports etc.), SEO, AdWords, Facebook and Mobile. These allocations are assuming that the CMO office has done due diligence in setting up universal analytics and is measuring conversions through path length reports while performing Multi Channel Funnel Analysis. Let's say we find that ROI from each campaign as below:

7% from TV, 3% from Print, 15% from Mobile Advertising, 12% from SEO + Adwords, and 5% from Facebook.

Per Multi Channel Funnel Analysis and past experience, CMO's office has come up with the following as a part of their marketing strategy.

1. Production and airing the TV advertisements cost at least $500K.
2. Print media should not account for more than 5% of the budget.
3. Minimum Ad agency costs for content creation and placement for Billboards, game place promotions, airport promotion cost $200K.
4. Mobile and SEO + AdWords together should account for at least 50% and that SEO+Adwords should be no more than 2.5 times the mobile marketing costs.
5. Mobile content and advertising cost anywhere between $300K and $900K.
6. Facebook advertising should not exceed 15 % of the marketing spend.
7. Agency costs for Facebook advertising cost at least $100K.

It has been learnt that a $1 spent on each channel has customer reach as: Channel (# customers reached), TV (2), Print (0.3), Mobile (1.8), SEO+Adwords (0.9), Facebook (2).

The directive is that the marketing budget should not exceed $5 million and there are about 2.5 million customers in the target market segment.

Solution

Decision Variables:
- Budget for TV = x1
- Budget for Print media = x2
- Budget for Mobile = x3
- Budget for SEO + AdWords = x4
- Budget for Facebook Mkt = x5

Constraints:
Mathematically representing the 7 constraints as equations so that the right hand side of the equation is always greater than the left hand side we have:

Total Budget — Total budget should not exceed $5 Million —>
x1 + x2 + x3 + x4 + x5 <= 5000K

TV — TV adcosts at least $500K
-x1 <= -500K
x1 >= 500K

Print Media
3. Print media not greater than 5% of the budget —>
x2 <= 0.05(x1 + x2 + x3 + x4 + x5)
-0.05x1 + 0.95x2 – 0.05x3 – 0.05x4 – 0.05x5 <= 0

4. Print media costs at least $200K
-x2 <= -200K
x2 >= 200K

Mobile & SEO
5. Mobile and SEO + AdWords to account for at least 50% of budget
x3 + x4 >= 0.5(x1 + x2 + x3 + x4 + x5)
0.5x1 + 0.5x2 – 0.5x3 – 0.5x4 + 0.5x5 <= 0

6. SEO + AdWords to be not more than 2.5 times of Mobile
– 2.5x3 + x4 <= 0
x4 <= 2.5x3

Mobile Marketing — Mobile marketing budget between $300K and $900K
-x4 <= -300K
x4 >= 300K
x4 <= 900K

Facebook — Facebook advertising costs at least $100K
-x5 <= -100K
x5 >= 100K

Reach Customers
10. Reaching 2.5 million customers —>
2x1 + 0.3x2 + 1.8x3 + 0.9x4 + 2x5 <= 2500K

Now formulating these into respective matrices, we obtain

Objective Function:
We have set out to maximize our ROI on the Marketing spend.
Max (0.07x1 +0.03x2 + 0.15x3 + 0.12x4+ 0.05x5)

LP

There are three components in the mathematical representation of Linear Programming.

Decision Variables: Let us represent them as x1, x2,… xi where i represents number of products, or number of projects in a portfolio or number of stocks in investment portfolio. x represents the number of each products to be produced, or number of stocks to be bought, or expenditure on each project.

Constraints: These are some functions of decision variables that must be either greater than or less than or equal to some specific value. Remember that we operate under constraints of time, money, resources, etc. These can be mathematically represented as: f(x1, x2,… xi) <= b, f(x1, x2 … xi) >= b, f(x1, x2 … xi) =b

These set of constraints can be encoded into a matrix.

MAX(f (k1 x1 + k2 x2 +…. + ki xi)) where we solve for x to x subject to
f(x1, x2, … xi) <= b1
f(x1, x2 … xi) <= b2
f(x1, x2 … xi) <= bm

Objective Function: The function comprising of decision variables that the decision maker want to either maximize or minimize given the constraints.

While MAX function applies to problems where outcome can be ROI, Revenue, or other upward metrics, the function can be MIN(f (k1 x1 + k2 x2 +…. + ki xi)) for problems with costs or other similar metrics as possible outcome to measure.