Marketing Budget allocation

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Abstract

What split ratio of a one million Euro advertising budget on two products - a Paul's Secrets shirt for 30 Euro and a Calvin Smart shirt for 20 Euro - is best to maximise (1) the expected profit and (2) the ratio of expected profit to profit standard deviation based on the past sales figures (PSFs) for 10,000 stores given in [1]?

Results

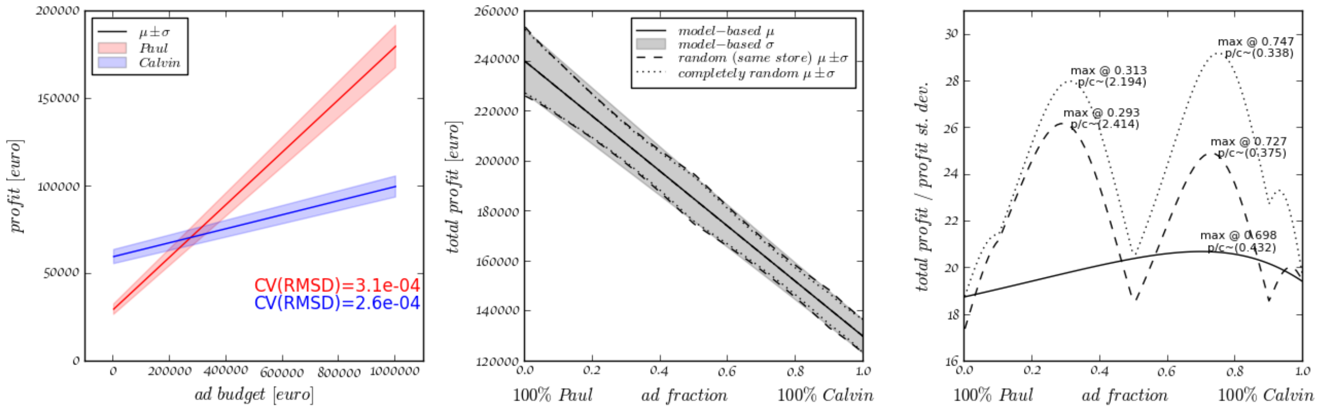

Fig. 1: (Left) Profit mean μ (solid line) and standard deviation σ (shaded area) at discrete values for the advertising budget 0, 100000, 500000 and 1000000 Euro. Red (blue) marks revenue of product "Paul's Secrets shirt" ("Calvin Smart shirt"). (Middle) Total profit versus advertising fraction of advertising budget (1 is equivalent to 100% of the ad budget goes to the Calvin Smart product campaign, 0 means 100% of the ad budget goes to Paul Secret's). Mean (solid line) and 1σ uncertainty (grey area) are based on linear fits to the data in the left hand panel. The dashed and the dotted line indicate bootstrapping results for 10^6 realisations. The dashed line indicates a randomised selection of a store (equivalent to one line in the given table). The dotted line indicates a completely random selection of PSFs. (Right) As in the middle panel but for μ/σ. The details of the peaks of respective distributions are given.

❶ Maximising Profit

The PSFs of the two products seem to indicate a linear relation between revenue and spent ad budget. But we can't assume generality for these trends. Saturation effects for the curves should be seen at a certain point, meaning despite increased advertising expenses sales figures increase with a shallower slope or stagnate. The inverse trend of decreasing sales figures due to an over-exposure to advertisement is also not unheard of. Introducing too strong assumptions on underlying regularities might hence lead to false predictions. Because of this I implement three different methods. First a model-based one assuming a linear relation between profit and spent ad budget. The goodness of the linear model is shown by means of the root mean square difference over mean profit (CV) in Fig. 1 (left). The task requires using the whole marketing budget for the two products. As a consequence the total profit can be written as

$$total\ profit = (c_1 f \times 10^6 + c_2) + (p_1(1-f) \times 10^6 + p_2), \qquad (1)$$

where f is the ad budget splitting ratio and (c_1, c_2) and (p_1, p_2) are the slopes and intercepts of the linear PSF models for the Calvin Smart and Paul Secret's shirt, respectively. As the gain and the slope of the linear model of the Paul's Secrets shirt outweighs the relatively small additional revenue of the Calvin Smart shirt, one might just spend the whole ad budget on the former (see Fig.1, middle panel).

If we want to assess the variance of the PSFs in a less model-dependent way, a random sampling technique with replacement (bootstrapping) is helpful. We choose two modes: (i) by picking a random store (row in the table) and using it's PSFs to do the analysis (while using piecewise linear interpolation between given values). Reasons for this mode could be the location or another property of the store producing systematically different PSFs. And (ii) by picking completely randomised PSFs, which means that information specific to the shop will get lost.

❷ Profit / Standard Deviation

The merit of this method is not readily accessible from the results shown in the middle panel but will become clear in this section. When we try to minimise the extent of variability in relation to the mean (coefficient of variation) or to maximise it's inverse we get different answers for different model assumptions. In the middle panel we could already see a slight difference in the standard deviations for the bootstrapping methods, which become more pronounced in the second part of the task.

A **linear model** assumption for the profit-ad-budget relations yields a peak at an ad budget ratio (Paul Secret's/Calvin Smart) of 0.432, i.e. $\sim$ 70% goes to Calvin Smart.

The two **bootstrapping** methods give multiple peaks. The maximum μ/σ for mode (i) is at an ad budget ratio of 2.414, i.e. e. $\sim$ 71% goes to Pauls Secret's. Mode (ii) has it's second highest peak at about the same value, however, the primary peak is at 0.338, i.e. $\sim$ 75% for the Calvin Smart shirt.

❸ Program

The program code can be found on github [2]. The python program libraries used for the above plot are available here [3]. It is optimised to cope with different input tables of same dimension. If started from terminal the program takes two input parameters: the filename (e.g. teaser1.csv) and the number of realisations used for the above bootstrapping methods. If required the product prices can be changed easily in the `main()` function.

References

[1] PSFs table: `tinyurl.com/pqtzv7m`
[2] GitHub: `github.com/leier/o_py`
[3] Matplotlib v1.3.X: `matplotlib.org`