

REPORT

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All the simulation work is done on 2 Colab notebooks named as-

1. 203190021_and_203190022_IE630_TEAM_HOMEWORK_part_a_and_b.ipynb
2. 203190021_and_203190022_IE630_TEAM_HOMEWORK_comparing_alternative.ipynb

File 1 contains code for part a and b of Topic 2. File 2 contains code for comparing alternatives and simulation optimization for option B of Topic 2.

Results

(a) Make ten independent replications for the $(M, L) = (50, 30)$ policy, and estimate long-run mean monthly cost and profit with a 90% confidence interval.

1. mean of 90% CI for mean_monthly_cost 235.26

90% CI half width for mean_monthly_cost 5.14

2. mean of 90% CI for monthly_profit 12.7

90% CI half width for monthly_profit 4.35

These 2 CI's were build using 10 replications and 100 months simulation run. Warm up period was assumed to be zero as it was not mentioned in question.

(b) Using results of part(a), estimate the total number of replications needed to estimate mean monthly cost within \$5. Run the model the required number of replications and construct the CI.

Using $R_{\text{required}} =$

$$R \cdot (\text{current_half_width})^2 / (\text{required_half_width})^2$$

$\text{required_half_width} = 5$

$\text{current_half_width} = 5.14$

R_required = 11

After running simulation again for 11 replications-

NEW HALF WIDTH FOR 90% CI OF MONTHLY COST = 3.71

C). Comparing Alternatives

Option B Topic 2

Keep F1 fixed to level 1 and F5 to level 2.

Main and interaction effect of F2, F3, and F4 on mean_monthly_profit-

```
calculate_confidence_interval_for_effect(e2,e3,e4,e23,e24,e34)
```

```
-----Main_Effect-----
```

```
mean of 90%CI for effect of Factor 2 e2 is -8.18  
half width of 90%CI for effect of Factor 2 e2 is 2.5  
mean of 90%CI for effect of Factor 3 e3 is -78.6  
half width of 90%CI for effect of Factor 3 e3 is 4.57  
mean of 90%CI for effect of Factor 4 e4 is -5.0  
half width of 90%CI for effect of Factor 4 e4 is 3.09
```

```
-----Interaction_Effect-----
```

```
mean of 90%CI for effect of Factor 2and3 e23 is -12.16  
half width of 90%CI for effect of Factor 2and3 e23 is 5.26  
mean of 90%CI for effect of Factor 2and4 e24 is 1.16  
half width of 90%CI for effect of Factor 2and4 e24 is 4.63  
mean of 90%CI for effect of Factor 3and4 e34 is 3.43  
half width of 90%CI for effect of Factor 3and4 e34 is 5.28
```

▾ Observations

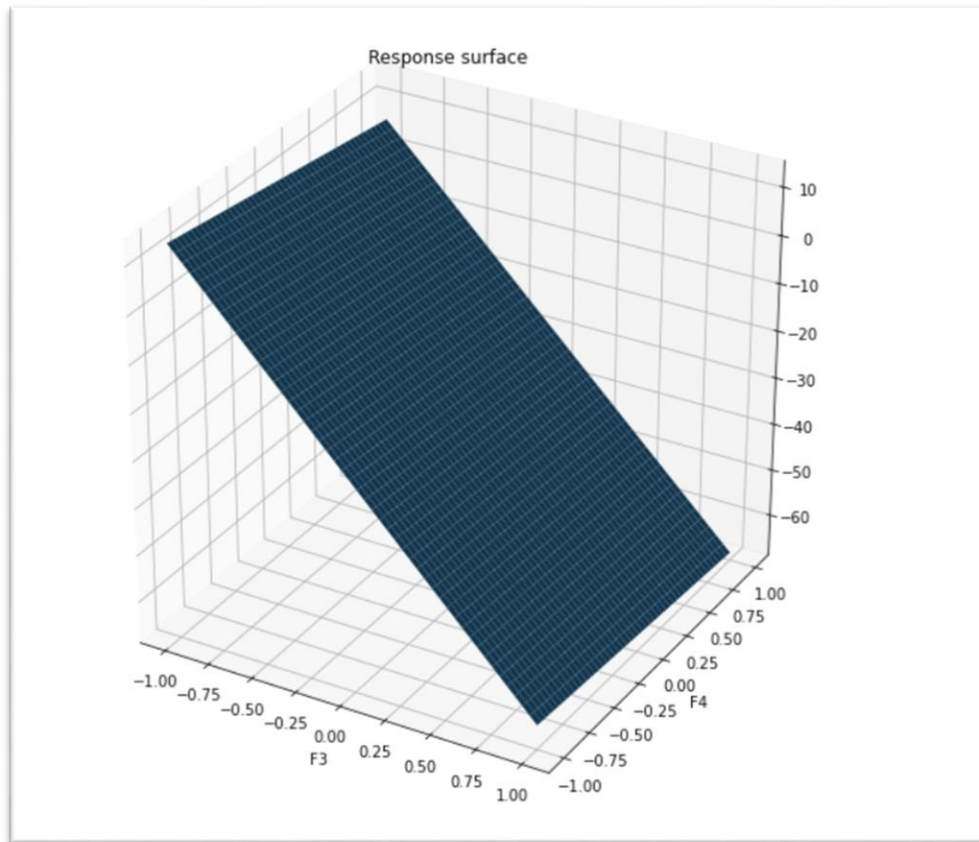
1. for 90%CI of e2 is on left side of zero completely. This indicates that the mean value of e2 is statistically different from zero. In other words switching F2 from low to high will decrease the mean_monthly_profit by 8.18 on average. This is in line with intuition 1.
2. For 90%CI of e3 is on the left side of zero with mean at -78.6 and high limit on *approx.* -74 . This shows that switching F3 from low to high will definitely reduce the mean_monthly_profit by -78.6 on average. This observation agrees with intuition 2.
3. For 90%CI of e4 contains the zero so the mean e4 is not statistically different from zero. So changing the F4 has more or less no. effect on mean_monthly_profit.

**Note intuitions are mentioned in Colab notebooks.

Simulation optimization

Find the maximum mean monthly profit combination of M and L such that CSL is $\geq 95\%$

For this first we build the response surface for monthly_profit with F3 and F4.



$$e3_bar = -66.32$$

$$e4_bar = -8.03$$

$$e34_bar = -0.35$$

$e3_bar = -66.32$ means that when M is switched from 50(low) to 100(high) on average profit is reduced by 66.32 So low value of M is preferred for good profit.

Similarly, $e4_bar = -8.03$ means that if L is switched from 30(low) to 40(high) then on average monthly profit is reduced by 8.03. So low value of L is preferred for good profit.

Low value of $e34_bar$ indicates that there combined effect on monthly_profit is negligible so the response surface is more or less a plane.

In the similar manner we also calculated effect on cycle service level (csl) by F3 and F4

```

C➔ -----Main_Effect_on_csl-----
mean of 90%CI for effect of Factor 3 e3 is 0.22
half width of 90%CI for effect of Factor 3 e3 is 0.04
mean of 90%CI for effect of Factor 4 e4 is 0.02
half width of 90%CI for effect of Factor 4 e4 is 0.05
-----Interaction_Effect_on_csl-----
mean of 90%CI for effect of Factor 3and4 e34 is -0.0
half width of 90%CI for effect of Factor 3and4 e34 is 0.06

```

Clearly switching F3 from 50 to 100 increases cls by 0.22 on average but F4 has no. effect as the CI contains zero.

So, there is a tradeoff between the mean_monthly_profit and CSL. If we decrease M and L then there is positive change in mean_monthly_profit and negative change in csl.

So according to *OptionB* we need to find minimum value of M and L so that profit is max. and csl ≥ 0.95

$$M^* = 108$$

$$L^* = 80$$

$$Csl^* = 0.953$$

$$\text{Mean_monthly_profit}^* = \text{-Rs. } 130.22$$

****Note** apart from the observations mentioned above we have also written some other observations in the Colab notebooks.