

EXCEL APPROACH TO SOLVING DAY 7'S CHALLENGE

By Wong Chee Hong

First, observe that this is an integer optimization problem. We are trying to find an **integer** point **d** such that the fuel cost to point **d** is minimum.

Thus, we can model the **total cost** of any given point **d** by this formula for part 1:

$$\sum_{i=1}^{1000} |x_i - d| \quad , \text{where } |x_i - d| \text{ is the individual cost}$$

And this formula for part 2:

$$\sum_{i=1}^{1000} (x_i - d)^2 + |x_i - d| \quad , \text{where } (x_i - d)^2 + |x_i - d| \text{ is the individual cost}$$

Thus, the mathematical model for this problem would be:

Minimize (depending on whether we are solving for part 1 or 2)

$$\sum_{i=1}^{1000} |x_i - d| \quad \text{or} \quad \sum_{i=1}^{1000} (x_i - d)^2 + |x_i - d|$$

subjected to the following constraints:

$$d \in \mathbb{Z}$$

In excel, we have the following construction:

B2		fx		=((A2-\$E\$1)^2 + ABS(A2-\$E\$1))/2	
	A	B	C	D	E
1	location	cost		d	466
2	1101	201930			
3	1	108345		total cost	92948968
4	29	95703			
5	67	79800			
6	1102	202566			
7	0	108811		mean	466.504
8	1	108345			
9	65	80601			
10	1008	147153			
11	65	80601			
12	25	82006			

In column A2:A1001, we have the input arguments for all the crabs, which represent their initial starting locations.

In column B2:B1001, we calculate the individual fuel cost for each crab to travel to point **d**. Point **d** is represented by Cell E1 in the image above, and the formula for the individual fuel cost, which is based on **d**, is highlighted in in green. In this case, this formula is for part 2.

=SUM(B2:B1001)	
D	E
d	466
total cost	92948968

Then, the total cost can be obtained by performing a summation across cells B2:B1001. This value is stored in cell E3.

Finally, under Data > Solver, we can set the solver's parameter like so:

Solver Parameters

Set Objective:

To: ☐ Max ☒ Min ☐ Value Of:

By Changing Variable Cells:

Subject to the Constraints:

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method:

Solving Method

Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Buttons: Add, Change, Delete, Reset All, Load/Save, Options, Help, Solve, Close

From topmost highlighted text to the bottom:

1. Set objective function (which is total cost stored in cell E3)
2. Select minimize (since the objective is to minimize total cost)
3. Changing variable cell \$E\$1 (which contains the value for **d**)
4. Constrain **d** to be an integer.
5. Set solver to use GRG Nonlinear, since the total costs are non-linear for part 2. It can be set to Simplex LP for part 1 since the total cost is a linear function.
6. Hit solve and excel will generate the correct value of **d** and the corresponding total cost.