

Lecture on 1-14 SA305 Spring 2013

1 Resource Allocation Models

A very standard problem to model with a linear program is the allocation of resources to optimize some function. In lecture 1-9 we were optimizing a profit function and allocating aluminum and steel.

Example 1.1. In Afghanistan a battalion of Marines has decided they will beef up the armor on some of their vehicles doors. There are three different levels of armor doors they can make: standard, thick, and maximum. Each type of door uses two different types of machines to install them and uses a certain number of labor hours. Also, each type of door produces a certain number of lives saved. This data is all put into the following table:

Door type	Machine 1	Machine 1 labor hrs	Machine 2	Machine 2 labor hrs	lives saved
Standard	2	1	3	1	5
Thick	3	1	3	2	7
Maximum	4	2	4	3	11

Suppose that for combat reasons you are restricted to having 30 labor hours per week. Also suppose that you are restricted to 110 hours on machine 1 and 130 hours on machine 2 before they brake per week. Note that each door must go through machine 1 and 2 and that each worker works at both machines. Also the general has mandated that the number of maximum doors made be greater than the total of standard and thick made.

How many of each door should we make so that the number of lives saved is maximized?

The model is

$$\begin{array}{ll}\max & 5S + 7T + 11M \\ \text{s.t.} & 2S + 3T + 4M \leq 110 \\ & 3S + 3T + 4T \leq 130 \\ & 2S + 3T + 5M \leq 30 \\ & M \geq S + T \\ & S, T, M \geq 0\end{array}$$

Putting these into GUSEK we see that the optimum solution is $S = 4.2$, $T = 0$ and $M = 4.2$.

Now machine 1 is used $2 * 4 + 3 * 0 + 4 * 4 = 24$. This means that machine 1 has $110 - 24 = 86$ hours of “slack” time; that is time on the machine that is not utilized. Such a quantity is called **slack**. Now if the inequality were flipped as in the case $M \geq S + T$ and we had a strict inequality (not like in this particular solution) then we would call it **surplus**. We will see these concepts arise again in the future. But for now just note that if we had more troops we could eliminate the slack time on the machines and save more lives.

Key Vocab:

slack

surplus

Key Ideas:

creation of the model and sensitivity analysis on the constraints