EM384: Analytical Methods for Engineering Management

Lesson 13: Resource Allocation Problem

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Lesson Objectives

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- Understand and recognize resource allocation problems.
- Formulate resource allocation problems algebraically.
- Solve linear resource allocation problems using Excel Solver.

Excel Solver

Installing Excel Solver

Instructions for enabling Excel Solver in Excel:
https://www.youtube.com/watch?v=LKV6fT8xApAt=2s

Resource Allocation Problems

Resource Allocation Problems

Linear programming problems involving the allocation of resources to activities.

Identifying feature: Resource constraint!

- Amount of resources used $\leq$ amount of resources available.
- Objective: Maximize

Example Exercise

Cake *A* requires 200g of flour and 25g of sugar. There's a total of 5000g of flour and 1000g of sugar available. Cake *A* is sold for $10 and cake *B* for $8. How many of each cake should be made to maximize profit?

1. Formulate your linear program algebraically.
2. Design an Excel model to solve your linear program. Using Excel Solver, confirm the answer you got above.

Problem Formulation

Decision variables:

x_1: Number of cakes of type A that are made

x_2: Number of cakes of type B that are made

Objective function:

Maximize $Z = 10x_1 + 8x_2$ (profit)

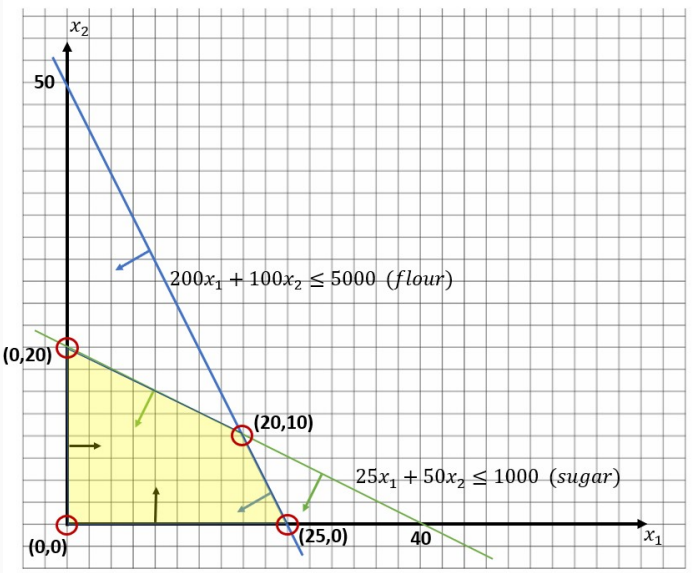
Constraints:

$200x_1 + 100x_2 \leq 5000$ (flour)

$25x_1 + 50x_2 \leq 1000$ (sugar)

$x_1, x_2 \geq 0$ (non-negativity)

Graphical Solution Review



Graphical Solution Review

Enumeration of extreme points:
$Z(20, 10) = 10(20) + 8(10) = 280$
$Z(0, 20) = 10(0) + 8(20) = 160$
$Z(25, 0) = 10(25) + 8(0) = 250$
$Z(0, 0) = 10(0) + 8(0) = 0$

Therefore, $x_1 = 20$ and $x_2 = 10$ maximizes the profit, which is \$280. The optimal number of cakes is 20 cakes of type A and 10 cakes of type B.

Excel Solution

	A	B	C	D	E	F
1	**Parameters**					
2						
3	Cake	Flour	Sugar	Resource Available		
4	A	200	100	5000		
5	B	25	50	1000		
6	Profit	10	8			
7						
8	**Decision Variables**					
9						
10		Cake A	Cake B			
11	Amount	20	10			
12						
13	**Objective Function**					
14						
15	Total Profit	280				
16						
17	**Constraints**					
18		Cake A	Cake B	LHS		RHS
19	Flour	200	100	5000	<=	5000
20	Sugar	25	50	1000	<=	1000
21						

Practical Exercise

You are the S3 Air of a battalion deploying to the Joint Readiness Training Center. Your battalion commander wants to deploy as many soldiers as possible.

- There are twelve C130 and ten C17 aircraft available from the Air Force at a cost of $4K and $5K per aircraft, respectively.
- $80K is budgeted for airlift. • For this type mission, the maximum pax load is 3 dozen for a C130 and 4 dozen for a C17.
- Only 36 hours of ground support are available to support your missions at the arrival airfield. A C130 requires 2 hours for service and a C17 requires 3 hours.

The S3 wants your recommendation for an airlift plan to support the deployment.

REQUIREMENT: Formulate the LP (Objective Function, Decision Variables, and Constraints) and solve using Excel Solver.

Algebraic Formulation

Decision variables:

x_1: Number of C130s used

x_2: Number of C17s used

Objective function:

Maximize $Z = 3x_1 + 4x_2$ (Soldiers deployed, in dozens)

Constraints:

$x_1 \leq 12$ (C130s available)

$x_2 \leq 10$ (C17s available)

$2x_1 + 3x_2 \leq 36$ (Ground support)

$4x_1 + 5x_2 \leq 80$ (Budget, in \$1000's)

$x_1, x_2 \geq 0$ (non-negativity)

Excel Solution

	A	B	C	D	E	F	G	H
1	**Parameters**							
2								
3			**C-130**	**C-17**				
4		Personnel	3	4	dozen			
5		Ground Support	2	3	hours			
6		Cost	4	5	$k			
7								
8	**Decision Variables**							
9								
10			**C-130**	**C-17**				
11		Number of Aircraft	12	4	# AC			
12								
13	**Objective Function**							
14								
15		# of Personnel	**52**	dozen				
16								
17	**Constraints**							
18								
19					**LHS**		**RHS**	
20		C-130s Available	1	0	12	<=	12	# AC
21		C-17s Available	0	1	4	<=	10	# AC
22		Ground Support	2	3	36	<=	36	hours
23		Cost Constraint	4	5	68	<=	80	$k

Conclusion

Next Class

Homework:

- Finish Homework Set 4
- Read Chapter 3.4 (Stop at Distribution Unlimited on page 59

Next Lesson:

- Understand and recognize cost-benefit trade-off problems.
- Formulate cost-benefit trade-off problems algebraically.
- Solve cost-benefit trade-off problems using Excel Solve