How to find your best Engineers?

Ence 360
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Malaclemy's Solution Incorporated

- Scenario Based
  - Listed as one of the Top 100 Best Engineering Firms in the US
  - 5 Locations:
    1. St. Louis
    2. San Diego
    3. Washington D.C.
    4. New York
    5. Orlando

Project Objective

- Malaclemy’s Solution wants to hire the most qualified engineers for the new year
  - Applicants from all over the US applied
  - A preliminary selection process has been applied
    - The top 25 applicants are to be analyzed for selection
    - 15 males and 10 females

Description of Project

- We want to pick the 10 most qualified applicants
- Subject to 5 males and 5 females
- Each applicant is unique:
  - Based on
    - GPA
    - Previous Experience
    - Original Location

Coefficient for Each Variable in the Value Objective

- Value Coefficient
  - Amount of Experience
    - Assign a value for each applicant's yr's of experience
      - 0 yrs = 10,000 pts.
      - 5 yrs = 45,000 pts
      - Exponential Curve to approximate points between the 0 and 5 years experience
        - $Y = Y_o e^{kt}$ ← t = yr's experience
      - Our rate coefficient K = .30
  - GPA
    - Assign a value for each applicant's experience
      - Same concept as above
      - Our rate coefficient K = .922

Coefficient for Each Variable in the Cost Objective

x		y		location	Destination	Distance (mi)	Cost for relocation ($)
1	1			*New York*	*St. Louis*	1000	2000
1	2			*New York*	*San Diego*	2800	5600
1	3			*New York*	*Washington, DC*	250	500
1	4			*New York*	*New York*	0	0
1	5			*New York*	*Orlando*	1050	2100
2	1			*San Francisco*	*St. Louis*	1850	3700
2	2			*San Francisco*	*San Diego*	500	1000
2	3			*San Francisco*	*Washington, DC*	2850	5700
2	4			*San Francisco*	*New York*	3000	6000
2	5			*San Francisco*	*Orlando*	2900	5800

This example data shows applicant 1 from New York and the actual distances from New York to our 5 main branches and the approximate cost for relocating the applicant. Same data show for applicant 2 who is from San Francisco.

Coefficient for Each Variable in the Cost Objective (cont.)

- Cost Coefficient (for Training)

# years of experience	Time of training	Approx. cost
0	12 months	$31,200
1	10 months	$25,800
2	8 months	$19,200
3	4 months	$9,600
4	2 months	$4,800
5	2 weeks	N/A

These approximate costs are equal to point values given to applicants.

Multi-Objective Functions

- Maximize Z1 (value)

$$\sum_{i=1}^{n} \boldsymbol{V}\mathbf{i}\ \mathbf{Xij} + \sum_{i=1}^{n} \boldsymbol{V}\mathbf{i}\ \mathbf{Yij}$$

  - Xij = male applicant i to location j
  - Yij = female applicant i to location j
  - i=1,2…25 (individual applicants)
  - j=1,2…5 (each location)

Multi-Objective Functions

- Minimize Z2 (cost)

$$\sum_{i=1}^{n} \boldsymbol{C}\mathbf{i}\ \mathbf{Xij} + \sum_{i=1}^{n} \boldsymbol{C}\mathbf{i}\ \mathbf{Yij}$$

  - Xij = male applicant i to location j
  - Yij = female applicant i to location j
  - i=1,2…25 (individual applicants)
  - j=1,2…5 (each location)

Constraints

$$\sum_{i,j}^{n} X_{ij} = 5$$

$$\sum_{i,j}^{n} Y_{ij} = 5$$

$$\sum_{i=1}^{n} X_{ij} \leq 1 \qquad j=1,2\ldots5$$

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$$\sum_{i=15}^{n} X_{ij} \leq 1$$

$$\sum_{i=16}^{n} Y_{ij} \leq 1 \qquad j=1,2\ldots5$$

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$$\sum_{i=25}^{n} Y_{ij} \leq 1$$

Binary Integer Programs

- The optimal solution calls for 0 and 1 values for x and y
- 125 total variables
  - inte x11

    inte x12

    .

    .

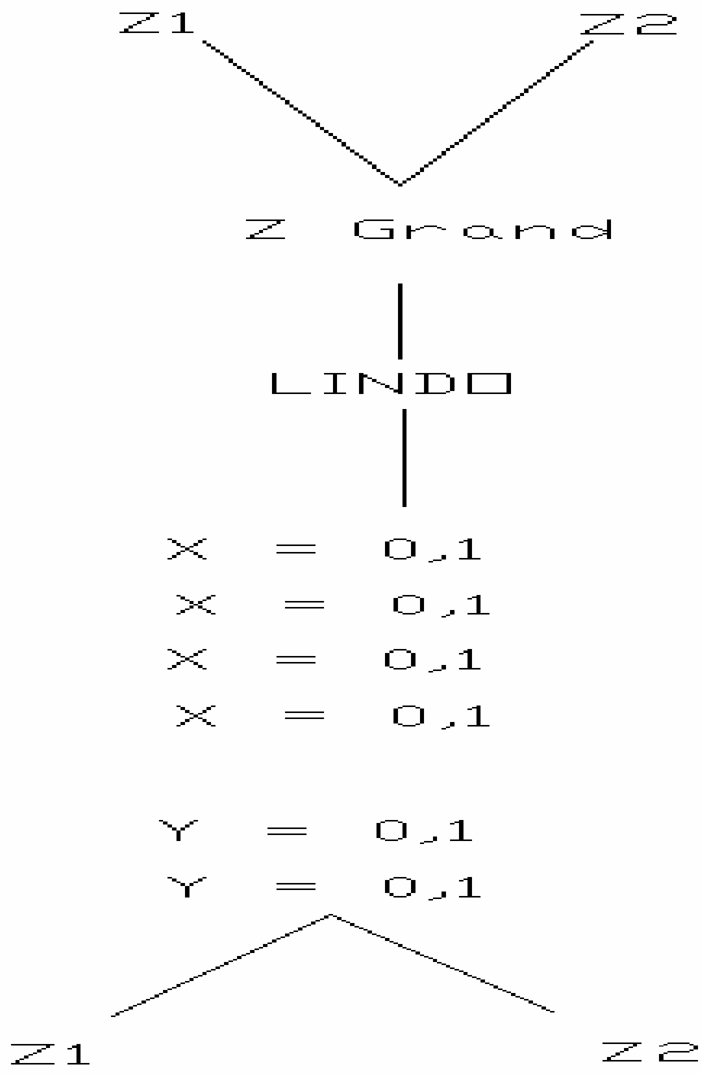
    inte y255

Weighting Method

w1	w2	Min Z Grand
0	1	-1(w=0.0) Z1 - (1-w) Z2
0.1	0.9	-1(w=0.1) Z1 - (1-w) Z2
0.2	0.8	-1(w=0.2) Z1 - (1-w) Z2
0.3	0.7	-1(w=0.3) Z1 - (1-w) Z2
0.4	0.6	-1(w=0.4) Z1 - (1-w) Z2
0.5	0.5	-1(w=0.5) Z1 - (1-w) Z2
0.6	0.4	-1(w=0.6) Z1 - (1-w) Z2
0.7	0.3	-1(w=0.7) Z1 - (1-w) Z2
0.8	0.2	-1(w=0.8) Z1 - (1-w) Z2
0.9	0.1	-1(w=0.9) Z1 - (1-w) Z2
1	0	-1(W=1.0) Z1 - (1-w) Z2

By applying this method, we calculated a set of values for our objective functions which tell us the non-inferior set of solutions we wanted.

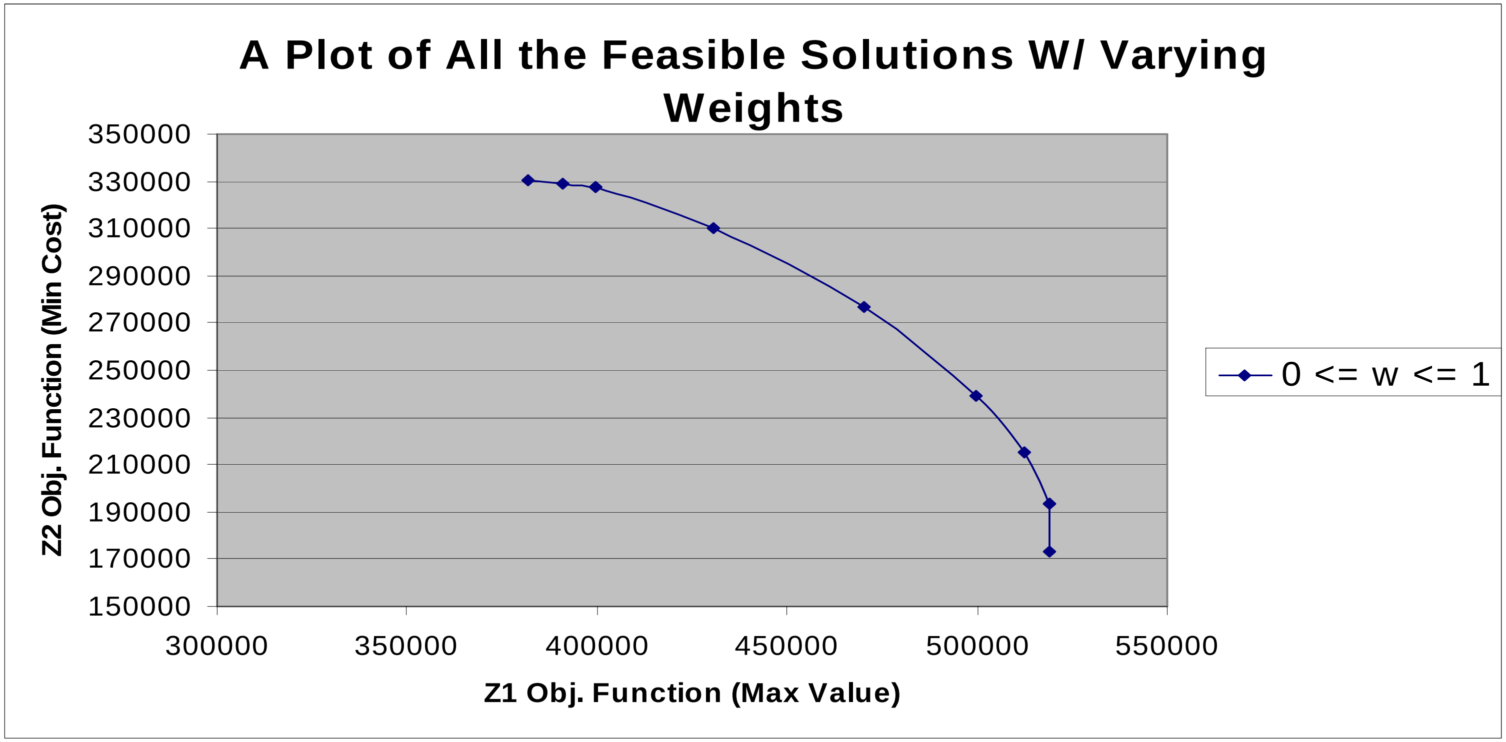
Weighting Concept to Obtain Optimal Solutions for Z1 and Z2



Z1 and Z2 Values

w-values	Z1 (max)	Z2 (min)
0	381698.3056	330200
0.1	391016.23	329200
0.2	399513.3	327500
0.3	399513.3	327500
0.4	430622.91	310300
0.5	470102.8784	277000
0.6	499903.8329	239000
0.7	512550.9	215000
0.8	518934.1857	193700
0.9	518934.19	193700
1	518934.19	177600

Paretto Curve



Top Two Best Solutions

w1	*w2*	**Values**	**Cost**
0.9	**0.1**	518934.19	193700
1	**0**	518934.19	177600

Between these two, the best solution for our objective functions is w1=1 , w2=0 with total point Values=518,934 and total Cost = 177,600.

Names and Locations Most Optimized Applicants

	Last	First	Origin	Location
x44	JONES	Nicholas	Phoenix	New York
x62	DAVIS	Joshua	Pittsburgh	San Diego
x75	MILLER	Austin	Boston	Orlando
x83	WILSON	Tyler	Denver	Washington, DC
x111	ANDERSON	Andrew	Nassau	St. Louis
y161	PRICE	Emily	Atlanta	St. Louis
y172	BENNETT	Sarah	Cincinnati	San Diego
y185	WOOD	Brianna	San Diego	Orlando
y224	COLEMAN	Kaitlyn	Tampa	New York
y233	JENKINS	Madison	Washington, D.C.	Washington, DC

X's are male applicants and Y's are female applicants. As shown, there are 10 applicants picked, and two (1 man, 1 woman) were assigned to one of our five branches.

Dynamic Programming

- What if we pick more number of men than women, or more women than men, will this change the optimum solutions?
- We change this constraint and analyze the solution results for (0M,10F) (1M,9F) (2M,8F) (3M,7F) (4M,6F) (6M,4F) (7M,3F) (8M,2F) (9M,1F) (10M,0F)

Surprisingly, the best optimal solution is when we pick 2 males and 8 females as our 10 final applicants. The total Values and Cost result are:

w1	*w2*	**Values**	**Cost**
1	**0**	519747	147700

_This yield the best solution in all solutions we obtained before. The applicants and locations of branches they assigned to are:

	Last	**First**	**Origin**	**Location**
x63	DAVIS	Joshua	Pittsburgh	Washington, DC
x113	ANDERSON	Andrew	Nassau	Washington, DC
y153	WASHINGTON	Kisha	Cleveland	Washington, DC
y164	PRICE	Emily	Atlanta	New York
y172	BENNETT	Sarah	Cincinnati	San Diego
y183	WOOD	Brianna	San Diego	Washington, DC
y201	ROSS	Hailey	St. Louis	St. Louis
y213	HENDERSON	Ashley	Philadelphia	Washington, DC
y224	COLEMAN	Kaitlyn	Tampa	New York
y233	JENKINS	Madison	Washington, D.C.	Washington, DC

Conclusion

- All the presented solutions are based on arbitrary values assigned by what we think a company could value quantitatively and qualitatively potential employees.
- That is some kind of scoring method that is always subject to change depending on what it is more important for a particular company at a certain point.
- If the scoring method change, we can arrive to completely different solutions.

Questions?