1.11.23

Module III

TRANSPORTATION PROBLEM

Transportation problem is a special class of allocation problem in which the objective is to transport various quantities of a single homogenous commodity that are kept at different origins to a number of destinations such as shops, markets etc.

Let c_{ij} be the cost of transporting 1 unit of commodity from m origins $O_1, O_2, O_3, \ldots, O_m$ to the different shops / destinations $d_1, d_2, \ldots d_n$. Then the cost matrix of a TP can be expressed as a table.

	D_1	D_2	D_3	$\ldots$	D_n	Available
O_1	c_{11}	c_{12}	c_{13}	$\ldots$	c_{1n}	a_1
O_2	c_{21}	c_{22}	c_{23}	$\ldots$	c_{2n}	a_2
$\vdots$	$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
O_m	c_{m1}	c_{m2}	c_{m3}	$\ldots$	c_{mn}	a_m

~~to~~

where ~~ai's~~ a_i's are the quantity of resource available in each of the origins $O_i = 1, 2, 3, \ldots, m$.

and b_j's are the requirement, demand of the shops.

Let x_{ij} be the no. of unit of ~~comm~~ commodity transported from the i^{th} origin to j^{th} ~~origin~~ destination. Then the mathematical form~~ula~~ of TP may be expressed as

$$\min \ z = \sum_i \sum_j c_{ij} x_{ij}$$

st

$$\sum_{j=1}^{n} x_{ij} = a_i \ , \quad i = 1, 2, 3, \ldots, n$$

$$\sum_{i=1}^{m} x_{ij} = b_j \ , \quad j = 1, 2, 3, \ldots, n$$

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j, x_j \geq 0 \qquad x_{ij} \geq 0$$

2.11.23

→ Balanced and Unbalanced Transportation problem

A TP is said to be balanced if the demand of the shops = sum of the resources.

A feasible solution of a Tp is a set of non-ve individual allocation which satisfy the row & column sum restrictions.

- Basic feasible solutions :-

A feasible solution of an $m \times n$ TP is said to be basic feasible soln if the total no. of non-ve allocation $= m+n-1$.

- Optimal solution of a TP :-

A feasible soln of an $m \times n$ TP is said to be optimal if it minimizes the total transportation cost.

- Non degenerate basic feasible solution :-

A feasible solution of an $m \times n$ TP is said to be non-degenerate basic feasible solution if

- The no. of non-zero allocations is exactly equal to $m+n-1$.
- These allocations are at independent positions:

- A set of allocations of a TP are said to be at independent positions if it is not possible to form a polygon joining occupied cells.

— Methods of finding IBFS :-

3 methods :-

i) North-West ~~control~~ corner rule
ii) Matrix minimum / minimum cost method
iii) VAM (Vogel's approximation method)

Q Find an initial feasible soln to the following TP using

a) north-west corner rule
b) matrix - ~~multiplication~~ minimum
c) Vogel's approximation method.

A) a) North-West Corner Rule :-

	D_1	D_2	D_3	Availability
O_1	$\boxed{5}$ 2	2	4	~~5~~ 0
O_2	$\boxed{2}$ 3	$\boxed{6}$ 3	1	~~8~~ ~~6~~ 0
O_3	5	$\boxed{3}$ 4	$\boxed{4}$ 7	~~7~~ ~~4~~ 0
O_4	1	6	$\boxed{14}$ 2	14
	~~7~~ ~~2~~ 0	~~9~~ 3	~~18~~ 14	

no. of allocations $m+n-1$ $\begin{bmatrix} \text{no. of} \\ \text{row +} \\ \text{col} - 1 \end{bmatrix}$ $= 4+3-1$ $= 6$ allocations

North-west corner rule :-

Allocate the min of 5 and 7 to the (1, 1) cell at the north-west corner of the table. Then, the resource of ~~polygon~~ origin O_1 is fully utilized. Then strike of the 1st row. Then allocate the min of (8, 7-5) to the cell (2, 1) which is at the n-w corner position of D_1 is fully satisfied. Strike of the first column. Continue this procedure until all demands are satisfied ... all ... fully utilized.

b) Matrix – ~~mult~~ minimum method :-

	D1	D2	D3	availability
O1	2	$\boxed{5}$ 2	4	~~5~~ 0
O2	3	3	$\boxed{8}$ 1	~~8~~ 0
O3	5	$\boxed{4}$ 4	$\boxed{3}$ 7	~~7~~ ~~3~~ 0
O4	$\boxed{7}$ 1	6	$\boxed{7}$ 2	~~14~~ ~~7~~ 0
demand	~~7~~ 0	~~9~~ ~~4~~ 0	~~18~~ 10	

cost $= 5\times7 + 8\times1 + 4\times4 + 3\times7 + 7\times1 + 7\times2$
$= \underline{\underline{76}}$

c) VAM method :-

highest diff
lowest cost
→ min(demand & availability)
strike

difference of min. of lowest & next lowest

	D1	D2	D3					
O1	2	$\boxed{5}$ 2	4	5(0)	5(0)	–		
O2	3	3	$\boxed{8}$ 1	~~8(2)~~ 8(2)	–	–		
O3	$\boxed{3}$ 5	$\boxed{4}$ 4	7	7(1)	7(1)	7(1)	7(1)	3
O4	$\boxed{4}$ 1	6	$\boxed{10}$ 2	14(1)	14(1)	14(1)	4(5)	
	7(1)	9(1)	18(1)					
	7(1)	9(2)	10(2)					
	7(4)	4(2)	10(5)					
	7(4)	4(2)						

$\Rightarrow 5\times2 + 8\times1 + 3\times5 + 1\times1 + 4\times1 + 10\times2$
$= \underline{\underline{73}}$

2.11.23

Q. Find an initial feasible soln for the following TP using north-west corner rule & then use ~~moder~~ modified - distribution method to find the optimal solution, which will minimize the total cost ~~no~~ of transportation.

warehouse

factory	W1	W2	W3	W4	W5	Available res.
F1	$\boxed{20}$ 2	4	6	8	9	20
F2	$\boxed{20}$ 2	$\boxed{6}$ 10	$\boxed{4}$ 1	5	8	~~30~~ ~~10~~ ~~4~~ 0
F3	4	11	$\boxed{4}$ 20	$\boxed{11}$ 40	3	~~15~~ ~~11~~ 0
F4	2	1	9	$\boxed{7}$ 14	$\boxed{6}$ 16	~~13~~ ~~13~~ 6
demand	~~40~~ ~~20~~ 0	~~6~~ 0	~~8~~ ~~4~~	~~18~~ ~~7~~ 0	6	

1st check : total demand = total availability

$40+6+8+18+6 = 20+30+15+13$

$78 = 78$

(If shortage, add row or column)

check
→ no. of non-zero allocation is $m+n-1$
$8 \Rightarrow = 4+5-1$
$= 8$

~~or~~ ∴ no. of non zero allocation ~~is~~ $= m+n-1$

MODI ~~method~~ :-
~~The no of~~

MODI method :-

	$V_1=2$	$V_2=10$	$V_3=1$	$V_4=21$	$V_5=23$
$u_1=0$	$\boxed{20}$ 2	(-6) 4	(5) 6	(-13) 8	(-14) 9
$u_2=0$	$\boxed{20}$ 2	$\boxed{6}$ 10	$\boxed{4}$ 1	(-16) 5	(-15) 8
$u_3=19$	(-14) 7	(-18) 11	$\boxed{4}$ 20	$\boxed{11}$ 40	(-39) 3
$u_4=-7$	(7) 2	(-2) 1	(15) 9	$\boxed{7}$ 14	$\boxed{6}$ 16

→ $m+n$ variables are introduced

then ;

→ $u_i + v_j = c_{ij}$

→ $m+n-1$ no. of equations

→ $u_i+v_j = c_{ij}$

$u_1 + v_1 = 2$

$u_2 + v_1 = 2$

$u_2 + v_2 = 10$

$u_2 + v_3 = 1$

$u_3 + v_3 = 20$

$u_3 + v_4 = 40$

$u_4 + v_4 = 14$

$u_4 + v_5 = 16$

- assign values to u_i's & v_j's.
  (~~assume~~ 1st putting $u_1 = 0$)

- cell evaluation / net evaluation
  corresponding to each ~~unoc~~ unoccupied cell
  calculate - $d_{ij} = c_{ij} - (u_i + v_j)$
  - $(\cancel{c_{1}}\ 1,2) \Rightarrow 4 \Rightarrow -6$ $[c_{ij} - (u_i + v_j) = 4 - (0+10) = -6]$

- highest ~~neg~~ -ve in d_{ij}, give max. allocation
  - construct polygon starting from high -ve d_{ij} ~~with~~ whose corners are on the basic/~~oc~~ occupied cell.
  - (occupied cell) alternate cell's allocation along the polygon & skip other allocations.

- find min. ~~of~~ $\{6, 11\} = 6$

- allocate that min. ~~of~~ to the cell that have the highest negative d_{ij} value.

	$V_1=2$	$V_2=10$	$V_3=1$	$V_4=21$	$V_5=-16$
$u_1=0$	$\boxed{20}$ 2	(-6) 4	(5) 6	(-13) 8	(25) 9
$u_2=0$	$\boxed{20}$ 2	$\boxed{6}$ 10	$\boxed{4}$ 1	(-16) 5	(24) 8
$u_3=19$	(-14) 7	(-18) 11	$\boxed{4}$ 20	$\boxed{5}$ 40	$\boxed{6}$ 3
$u_4=-7$	(7) 2	(-2) 1	(15) 9	$\boxed{13}$ 14	(39) 16

→ $11 - 6 = 5$

→ $6 - 6 = 0$

$7 + 6 = 13$

in polygon
- skip = add min value
- alternate cell
  ↳ sub. min value

min $\{4, 6\} = 4$

	$V_1=2$	$V_2=10$	$V_3=1$	$V_4=39$	$V_5=2$
$u_1=0$	$\boxed{20}$ 2	(-6) 4	(5) 6	(-31) 8	(7) 9
$u_2=0$	$\boxed{20}$ 2	$\boxed{2}$ 10	$\boxed{8}$ 1	(-34) 5	(6) 8
$u_3=1$	(5) 7	$\boxed{4}$ 11	(18) 20	$\boxed{5}$ 40	$\boxed{6}$ 3
$u_4=-25$	(25) 2	(14) 1	(-17) 9	$\boxed{13}$ 14	(39) 16

min $\{5, 2\} = 2$

corners only

~~215~~
267

8/11/2023

Q. Solve the following transportation problem with the following post - matrix

	w_1	w_2	w_3	w_4	availability
P_1	190	300	500	100	70
P_2	700	300	400	600	90
P_3	400	100	600	200	180
demand	50	80	70	140	

Using Vogan's method to find initial feasible soln.

→ A

	w_1	w_2	w_3	w_4						
P_1	[50] 190	300	500	[20] 100	~~70~~ (90)	20 (200)	20 (100)	–	–	
P_2	700	300	[70] 400	[20] 600	90 (100)	90 (100)	90 (200)	90 (200)	90 (200)	70 (400)
P_3	400	[80] 100	600	[100] 200	180 (100)	180 (100)	100 (400)	100 (400)	–	
	50 (210)	80 (200)	70 (100)	140 (100)						
	–	80 (200)	70 (100)	140 (100)						
		–	70 (100)	140 (100)						
		–	70 (200)	120 (400)						
		–	70 (400)	20 (600)						
		–	70 (400)	–						

= highest diff.
= lowest cost
↳ (availability & demand) min
= strike

$$cost = \underbrace{90 \times 190}_{9500} + 2000 + 28000 + 12000 + 8000 + 20000$$

~~= 43,500~~ = 79,500

Now, we use ~~moderned~~ modified distribution method to find the optimum solution.

$V_1 = 190$ $V_2 = 0$ $V_3 = -100$ $V_4 = 100$

$u_1 = 0$	[50] 190	(300) 300	(600) 500	[20] 100	70
$u_2 = 600$	700 (10)	(-200) 300	[70] 400	[20] 600	90
$u_3 = 100$	400 (110)	[80] 100	600 (600)	[100] 200	180
	50	80	70	140	

100

⇒ Unoccupied cells

~~$d_{12} = 300 - 0 = 300$~~

Some $d_{ij} < 0$, so the current soln is not optimum.

$\min(80, 20) = 20$

Allocate a ~~co~~ quantity which is equal to the min. of those allocations in the alternate occupied cell connected by the polygon.

$V_1 = 190$ $V_2 = 0$ $V_3 = 100$ $V_4 = 100$

$u_1 = 0$	[50] 190	(300) 300	(400) 500	[20] 100	70
$u_2 = 300$	(210) 700	[20] 300	[70] 400	(200) 600	90
$u_3 = 100$	(110) 400	[40] 100	(400) 600	[120] 200	180
	50	80	70	190	

~~This is optimum~~.

$d_{ij} = c_{ij} - (u_i + v_j) \geq 0$

since d_{ij} is greater than 0, it gives the optimum solution.

The min. cost of transportation =

$= 50 \times 190 + 20 \times 100 + 20 \times 300 + 70 \times 400 + 60 \times 100 + 120 \times 200$

$= 775500$

Q. Solve the following TP to max. profit

				availability
15	51	42	33	25
80	42	26	81	45
90	40	66	60	35
demand 23	31	16	30	$\boxed{100}$ $\boxed{105}$

The following table giving profit when 1 unit of commodity is transported from origin to destination.

A) Here there is excess resource of 5 units, so we introduce a dummy shop label $\left[\begin{array}{l}\Sigma \text{ availability} = 105 \\ \Sigma \text{ demand} = 100\end{array}\right]$

$\Rightarrow$

while adding column or row. $\left\{\begin{array}{l}\text{min cost} \to 0 \\ \text{max. profit}\end{array}\right.$

9.11.23

~~Since all dij are non-negative, this given table~~

min cost → assign 0 in dummy col/row

max → max. profit

~~70 min to w_3, from~~

The min cost of transportation ~~20×~~ $= 50 \times 190 + 20 \times 100 + 20 \times 300 + 70 \times 400 + 60 \times 100 + 120 \times 200$

$= 75500$

15	51	42	33	90	25
80	42	26	81	90	45
90	40	66	60	90	35
23	31	16	30	5	

max. → profit

~~Remove~~ Replace each cell by highest profit minus ~~by~~ each cell value.

$\Rightarrow$

75	39	48	57	0
10	48	64	9	0
0	50	24	30	0

When we are given an unbalanced TP, to make it balanced, we will be giving ~~an~~ a dummy row when demand is higher than availability. ~~(dum~~ or a dummy col. (demand is lesser than availability) with 0 cost is each cell if the given problem is of minimising the cost.

If the given TP is of maxing profit, we will give the max. profit to ~~the~~ each cell of the adding dummy row or col.

MODI method is used to minimize the total cost, so when we are given a ~~#~~ TP in which our aim is to maximise the profit, we will convert the given TP into 1 in which our aim is to min. the cost, for this we will replace the each cell entry by the highest profit minus the corresponding cell entry.

To solve the following problem, Vogan's method used to find the initial solution.

⟹

20(9)	16(39)	75	$\boxed{16}$ 39	$\boxed{4}$ 48	57	$\boxed{5}$ 0	25(39)	20(9)	20(9)	20(9)
15(16)	15(16)	10	$\boxed{15}$ 48	64	$\boxed{30}$ 9	0	45(9)	45(1)	45(39)	15(16)
–	–	$\boxed{23}$ 0	50	$\boxed{12}$ 24	30	0	35(0)	35(24)	12(6)	12(26)
		23(10)	31(9)	16(24)	30(21)	5(0)				
		23(10)	31(9)	16(24)	30(21)	–				
		–	31(9)	16(24)	30(21)					
		–	31(9)	16(24)	–	–				
		–	31(9)	4(24)	–	–				
		–	31(9)	–	–	–				

→

15	$\boxed{16}$ 51	$\boxed{4}$ 42	33	$\boxed{5}$ 90	25
80	$\boxed{15}$ 42	26	$\boxed{30}$ 81	90	45
$\boxed{23}$ 90	40	$\boxed{12}$ 66	60	90	35
23	31	16	30	5	

- Assignment problem :-

It is a special case of TP in which the objective is to assign a no. of origins (person, machines etc) to an equal no. of jobs/ tasks in such a way that the total cost of assignment is min (total profit is max).

eg : suppose there are ~~4~~ 4 persons in a dept available for doing 4 different jobs, Now ~~a~~ our objective is to assign 4 jobs to 4 persons in such a way that total cost / time is min. Let c_{ij} be the cost if the i^{th} person is assign to j^{th} job. Then the cost matrix can be represented as

	J_1	J_2	. . .	. . .	
P_1	c_{11}	c_{12}	. .	. . .	1
P_2	c_{21}	c_{22}	. . .	. . .	1
⋮	⋮	⋮	c_{ij}		1
	1	1	1 . . . 1		

~~Mathematical formulation of assignment problem :-~~

~~min z =~~

Let x_{ij} ~~b~~ represents the no. of persons assigned from i^{th} origin to j^{th} destination. Then the mathematical formulation of given problem is

$$\min \quad z = \sum_{j=1}^{n} \sum_{i=1}^{n} c_{ij} x_{ij}$$

$$\text{st} \quad \sum_{j=1}^{n} x_{ij} = 1, \quad i = 1, 2, 3 \ldots n$$

$$\sum_{i=1}^{n} x_{ij} = 1, \quad j = 1, 2, 3 \ldots n$$

$$\text{with} \quad x_{ij} = 0 \text{ or } 1$$

→ Method ~~for~~ solving AP :- Hungarian method

Q: Solve the following minimal AP

	J_1	J_2	J_3	J_4
P_1	12	30	21	15
P_2	18	33	9	31
P_3	44	25	21	21
P_4	14	30	28	14

A→

- Find the min. of each row & subtract it with ~~from the cell~~ value in each row.

0	18	9	3
4	24	0	22
23	4	0	0
0	16	14	0

Find the min. of each col & subtract this ~~quantity~~ min. from the cell of the respective ~~cells~~ cols.

$\boxed{0}$	14	9	3
9	20	$\boxed{0}$	22
23	$\boxed{0}$	$\cancel{0}$	$\cancel{0}$
$\cancel{0}$	12	14	$\boxed{0}$

(Start with top row)

- Identify the row ~~mapped~~ having exactly one 0. Then mark a square (~~assign~~ to that cell, we give an assignment ~~Next, each col~~ & strike the 0's of that column)

- ~~Subtract row min with each cell value~~.

∴ The optimum assignment is ~~assign~~

$P_1 \to J_1$, $P_2 \to J_2$; $P_3 \to J_3$, $P_4 \to J_4$

Minimum cost of assignment $= 12 + 9 + 25 + 14 = 60$

Q: Solve the following AP involving 5 jobs & 5 persons

	J_1	J_2	J_3	J_4	J_5
P_1	1	3	2	8	6
P_2	2	4	3	1	5
P_3	5	6	3	4	6
P_4	3	1	4	2	2
P_5	1	6	6	5	4

~~Form a table, by replacing each~~

Find the min. of each row & subtract ~~with~~ this min ~~with~~ from the cells of respective rows.

0	2	1	2	5
1	3	2	0	4
2	3	0	1	3
2	0	3.	7	1
0	4	5	4 ~~4~~	3

$\Downarrow$

$\boxed{0}$	2	1	2	4
1	3	2	$\boxed{0}$	3
2	3	$\boxed{0}$	1	2
2	$\boxed{0}$	3	1	$\cancel{0}$
$\cancel{0}$	4	5	4 ~~4~~	2

Using minimal no. of horizontal & vertical lines, cover all 0's

no. of lines = no. of ~~colu~~ rows $\Rightarrow$ optimum soln.

~~Find the min. of those entries of ~~over~~ which no lines passes. Subtract this min from ~~these~~ entries & add it to the ~~this min~~ to ~~those~~ cells where 2 lines ~~to~~ ~~tes~~ crosses & leave the remaining ~~enters~~ entries as such~~

Find the min. ~~o~~ those entries over which no lines passes. Subtract this min from these entries. & add it to the entries which have cross intersection ~~of~~ of lines & leave the remaining entries as such.

min = 1

$\cancel{0}$	1	$\cancel{0}$	1	3
2	3	2	$\boxed{0}$	3
3	3	$\boxed{0}$	1	2
3	$\boxed{0}$	3	1	$\cancel{0}$
$\boxed{0}$	3	5	4	2

Using min. no. of horizontal & vertical lines, cover all zeroes. If the no. of lines = no. of ~~tot~~ rows, then soln is optimum. Hence, the above table is not optimum.

* find the min. of those entries over which no line passes.
* subtract this min. from those entries.
* add this min. to those cells where 2 lines crosses and leave the remaining entries as such.

no line → sub (min)
line passing cells → no change
intersection → add (min)

$\cancel{0}$	1	$\cancel{0}$	1	3	✓ ①
2	3	2	$\boxed{0}$	3	④
3	3	$\boxed{0}$	1	2	✓ ③
3	$\boxed{0}$	3	1	$\cancel{0}$	⑤
$\boxed{0}$	3	4	3	1	✓ ⑥
✓ ②		✓ ⑧			

using minimal no of lines, cover all zeros

14/11/23 Rule to find the ~~a~~ min. no. of lines
1) mark all rows for which there is no assignment.
2) Mark cols which has zero's ~~assignments~~ in marked rows.
3) mark the rows which has assignment in marked ~~rows~~ cols.
4) Draw lines through unmarked rows and marked cols.

randomly chosen because nothing to choose

$\boxed{0}$	$\cancel{0}$	$\cancel{0}$	$\cancel{0}$	2
3	3	3	$\boxed{0}$	3
3	2	$\boxed{0}$	$\cancel{0}$	1
4	$\boxed{0}$	4	1	$\cancel{0}$
$\cancel{0}$	2	4	2	$\boxed{0}$

5 zeros = 5 rows ⇒ ∴ optimum

min. cost of assignment = 1 + 1 + 3 + 1 + 4
= 9

Q: The following table gives profits for different jobs done by diff. machines. Find the max. profit of assignment.

	M_1	M_2	M_3	M_4	M_5
J_1	30	37	40	28	40
J_2	40	24	27	21	36
J_3	40	32	33	30	35
J_4	25	38	40	36	36
J_5	29	62	41	34	39

The given problem is to max. the profit. we replace each cell ~~entrie~~ entry by 62 − the respective cell entry (60 ie the max. of all entries).

32	25	22	34	22
22	38	35	41	26
22	30	29	32	~~27~~
37	24	22	26	26
33	0	21	28	23

Find the row ~~matrix~~ minima, for each row - subtract this ~~col~~ min. from the elements of respective rows. Form the new table.

10	3	0	12	0
0	16	13	19	4
0	8	7	10	5
15	2	0	4	4
33	0	21	28	23

Find col minima.
Subtract this minimum from the elements of respective col. Form the new table.

10	3	$\boxed{0}$	8	~~0~~	
$\boxed{0}$	16	13	15	4	✓②
~~0~~	8	7	6	5	✓①
15	2	~~0~~	$\boxed{0}$	4	
33	$\boxed{0}$	21	24	23	
✓③					

Cover all zeros by min. no. of horizontal & vertical lines.

Mark rows without assignment.
Draw lines through unmarked rows & marked cols.

- subtract min. of uncovered elements to this elements

Ⓐ

14	3	$\boxed{0}$	8	~~0~~
~~0~~	12	9	11	$\boxed{0}$
$\boxed{0}$	4	3	2	1
19	2	~~0~~	$\boxed{0}$	4
37	$\boxed{0}$	21	24	23

16. 11. 2023

HW Q: A company has 4 machines to do 3 jobs. Each job can be assigned to one & only one machine. The following table gives the cost of each job on each machine. Determine an optimal assignment which will minimise the cost.

	1	2	3	4
A	18	24	28	32
B	8	13	17	19
C.	10	15	19	22

A> This AP is unbalanced. We introduce 1 dummy job ~~machine~~ D with 0 cost ~~on~~ in the respective cells.

	1	2	3	4
A	18	24	28	32
B	8	13	17	18
C	10	15	19	22
D	0	0	0	0

16.11.2023

MODULE 4

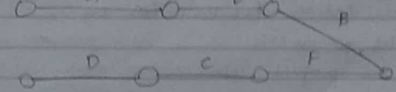
Network Analysis

A project is a composed of a no. of jobs and activities or tasks that are related to each other. And all of these should be completed in order to finish the project. There are 2 prominant methods to do this
1) ~~Criterial~~ Critical path method (CPM)
2) ~~Pret~~ PERT (Project Evaluation Review Technique)

Q: Assume that a statue is to be erected in a village square on a stone base which is to be build ~~in~~ on a cement concrete foundation. The statue is to be made on another place, ~~ma~~ move to the base and install. The various operations of the entire project are below in a random order.

A - make statue,
B - lift the statue into place,
C - construct concrete foundation,
D - compact & level the site
E - move statue to village square,
F - construct stone base.

Construct network ~~dat~~ diagram of the project

A> 

Rough sketch