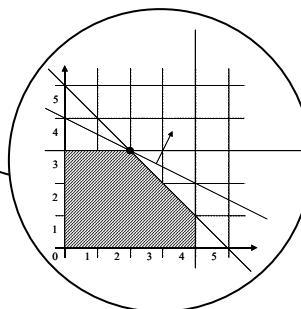
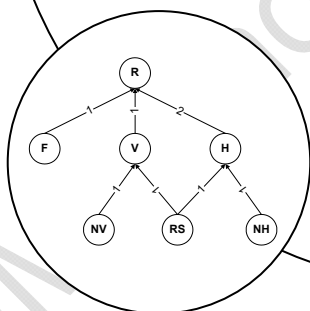
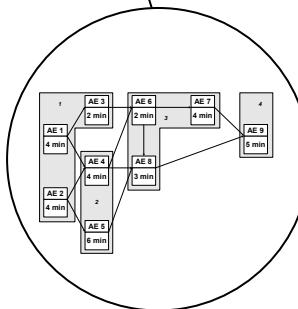
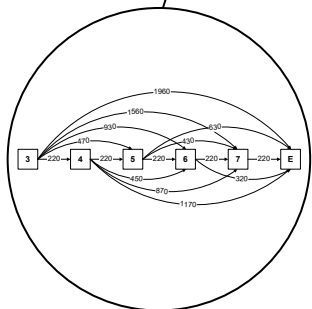
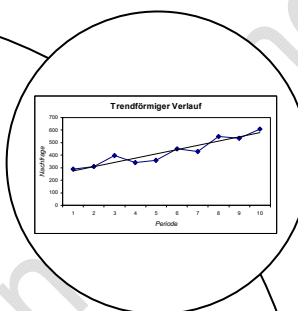
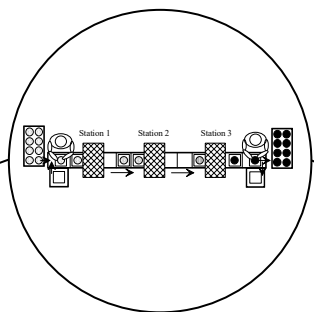
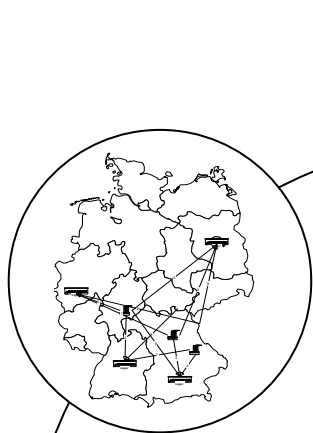


# Tutorial

## Job shops and flow lines



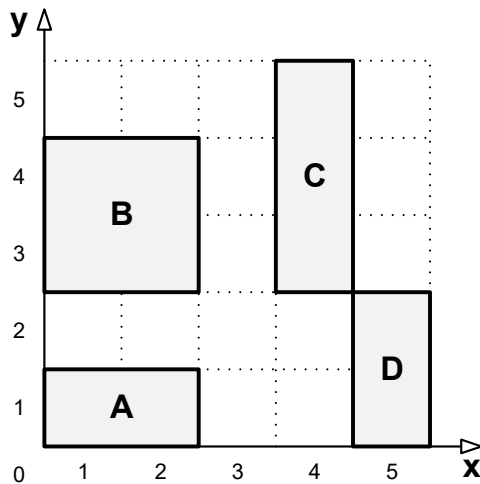
	A	C	E	B	D
B	1	1			
E	1	1			
C	1				
A			1	1	
F			1	1	
D			1		1

### Layout planning of job shops

	True	False
1. Facility layout planning is of particularly great importance for job shop production.		
2. The distance is always measured rectangularly in layout planning.		
3. An assumption of layout planning is that the floor space is a square.		
4. In layout planning, the entire floor space is divided into equally-sized grid squares.		
5. The standard greedy method assumes that every object has the same size.		
6. The greedy method assumes that the value of the proxy criterion is given from the start.		
7. In the greedy method, the first object is assigned to any grid square.		
8. After the first object is placed, the following objects are always assigned to a grid square closest to an already assigned object.		

### Exercise 1: Greedy method

In a distribution center a picking area is used to store buffer quantities of products. Manual pickers retrieve individual items from the respective storage location and assign them to shipping units according to the specific customer orders. Storage locations are to be determined such that total travel distances of the pickers are minimized. The picking area is divided into 5x5 grid squares (see the figure below). Some locations are already occupied with product groups A, B, C and D.



Three additional product groups are to be arranged on the not yet occupied areas. Space requirements are as follows.

- Product group X: three adjacent grid squares either in x- or y-orientation,
- Product group Y: 2x2 adjacent grid squares (quadratic layout),
- Product group Z: three arbitrary adjacent grid squares.

Traffic lanes are already included in the grid squares. Items are retrieved at the grid which is closest to the 0-location of the layout. All distances are rectangular.

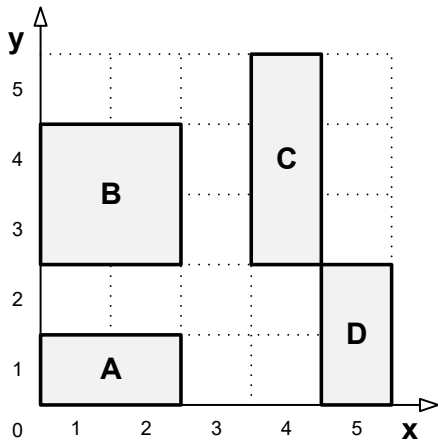
Product groups are to be assigned to locations such that the proxy criterion is minimized. The table below indicates how often items from the same product group are contained in one customer order, i.e. how often the picker has to move between the respective storage locations.

	A	B	C	D	X	Y	Z
A	--	3	5	1	4	6	5
B		--	3	2	8	10	1
C			--	1	5	12	8
D				--	2	4	6
X					--	5	1
Y						--	2
Z							--

Assign product groups X, Y and Z according to the greedy method.

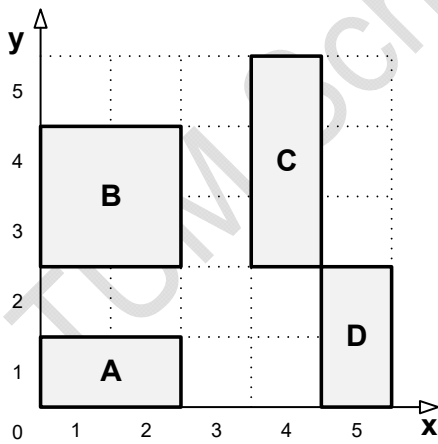
**Product group:**

**Location:**



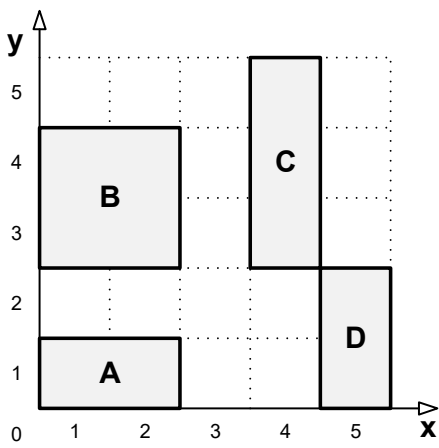
**Product group:**

**Location:**



Product group:

Location:



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### Exercise 2: layout planning

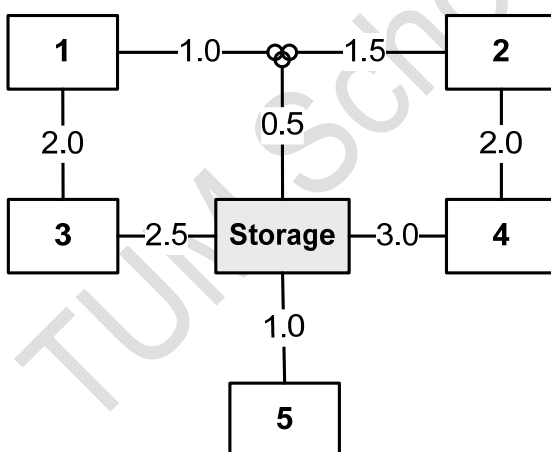
In a job shop system four different product types are produced which differ by daily production volume, machine sequences and required unit loads (see the following table).

Product	Daily production volume (units)	Pallets per unit	Machine sequence
1	10	2	A→B→C→E
2	15	1	A→C→D→E
3	5	2	B→C→D→E
4	30	1	A→D→E

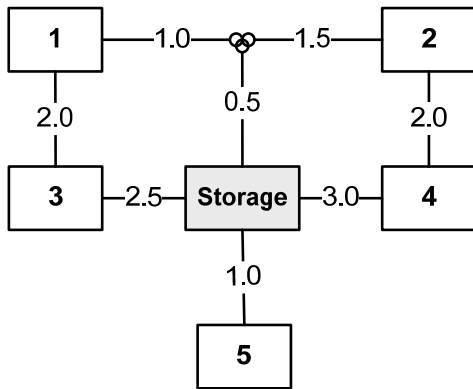
Determine the material flows between the machines (in pallets).

From/To	A	B	C	D	E
A					
B					
C					
D					
E					

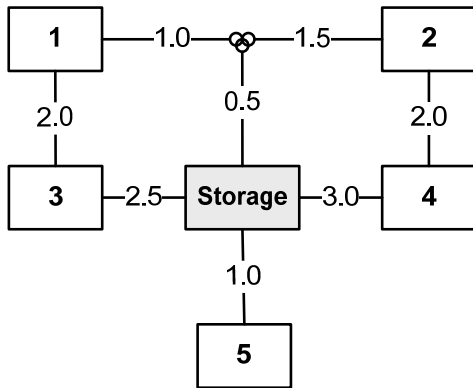
In addition the following layout of the plant is given. Figures indicate distances between locations. Raw work pieces (before they visit the first machine) and final products (after completion of the last manufacturing task) are stored in a central storage area whose location is given. All other material flows are performed directly between the individual machines.



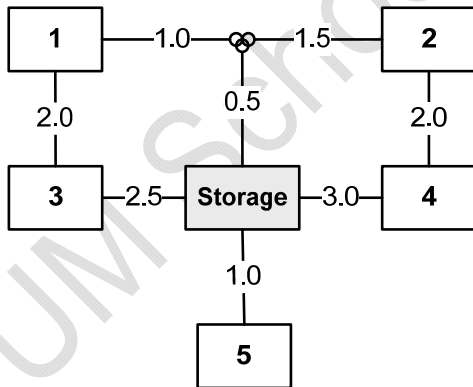
- a) The machine showing the highest material flow to and from the storage area has to be assigned as close as possible to the storage location. The machine showing the second highest material flow to and from the storage area has to be assigned to one of the vacant locations as close as possible to the storage location.



b) Assign the third machine according to the greedy method.



c) Assign the remaining machines according to the greedy method.



### Configuration of flow lines

	True	False
9. Binary sorting is a common method for the configuration of flow lines.		
10. For flow shops and cellular manufacturing the work systems are assigned according to object layout.		
11. The cycle time of a paced assembly line (assembly process) is the lower time limit for assigned tasks considering each work station.		
12. To determine the lower time limit of the cycle time in flow lines, the planning period and the production volume must be known.		
13. The objective of assembly line balancing is to minimize the number of work stations and to ensure a balanced workload.		
14. In assembly line balancing, the task with the highest priority weight is the next to be assigned to a work station.		
15. To determine the minimal number of work stations in assembly line balancing, the sum of all task times is divided by the cycle time. If it is not an integer, the number is rounded up to the next whole number.		
16. In assembly line balancing, the number of work stations that need to be set up is given.		

**Exercise 3: Configuration of flow lines**

An assembly process consists of eight tasks, which have to be assigned to stations (in a line) such that an average output of five product units per hour is achieved. Details are given below.

Tasks	Duration [min]	Direct predecessor
1	5	-
2	7	1
3	6	1
4	8	2
5	6	3
6	4	3
7	3	4,5
8	7	6,7

- Draw the precedence graph.
- Determine the cycle time which is required to achieve 5 product units per hour.
- Determine the theoretical minimal number of work stations.
- Carry out the line balancing according to the maximum total number of successors rule.

