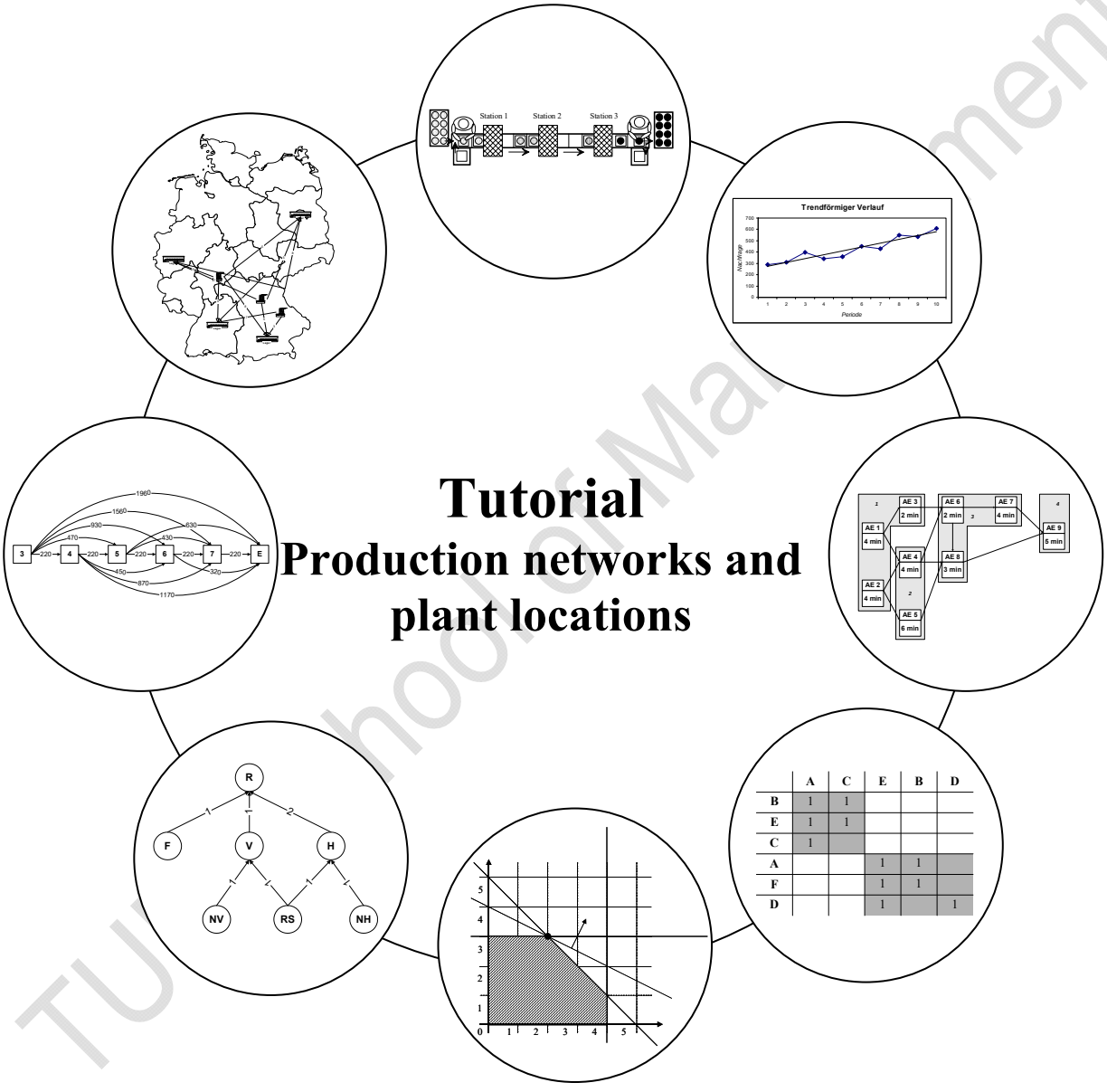


Tutorial

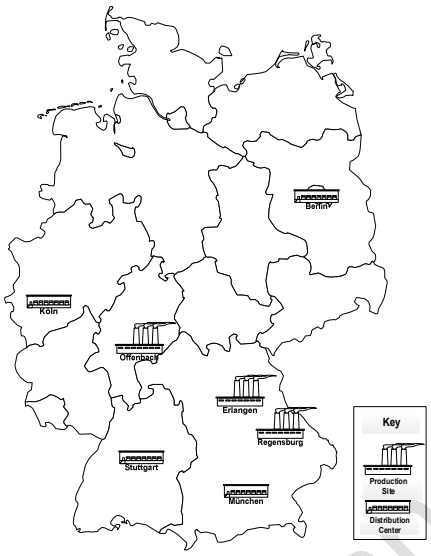
Production networks and plant locations

Production networks und plant locations

	True	False
1. In classic transportation planning, transport and production quantities are estimated over multiple periods.		
2. The classic transportation model assumes that only production and transportation costs need to be considered.		
3. Production costs are identical for each plant.		
4. Not only the objective function, but also the constraints of the classic transportation model are linear functions.		
5. Another assumption of the classic transportation model is unlimited transportation capacities.		
6. In the classic transportation model, only one product and one period, but several production locations are considered.		
7. The classic transportation model aims at minimizing the total amount of transports.		
8. In Vogel`s approximation method you choose the transport path whose non-realization would cause the biggest additional costs.		
9. In Vogel's approximation method you first satisfy those demands which can be satisfied with the lowest costs.		
10. Since Vogel's approximation method considers production and transportation costs, the optimal solution is always found.		
11. The assumptions of the classic transportation model are also valid for the plant location model.		
12. In comparison to the classic transportation model, the additional binary variables of the plant location model require a more complicated solving process.		

Exercise 1

A company in Germany runs three production sites serving four different distribution centers. The structure of the production-distribution system is depicted below.



Available supply quantities as well as demand and per unit transportation costs are given in the following table.

Production site	Distribution centre				Capacity
	Cologne	Munich	Stuttgart	Berlin	
Offenbach	6	8	4	5	**10**
Erlangen	7	5	8	5	**8**
Regensburg	8	3	7	8	**12**
Demand	**6**	**10**	**8**	**6**	

Solve the transportation problem given in the table above using Vogel's approximation method and determine the total costs.

Transportation costs =

Exercise 2

The distribution system of the production company TRADE AG is organized in a single stage. The 4 sales regions are supplied by 5 production locations. In the following table, production and transportation costs per quantity unit between the locations and sales regions are given, as well as capacity and demand values:

Production location	Sales region 1	2	3	4	Capacity
1	2	5	2	6	14
2	4	2	5	4	8
3	2	5	6	5	10
4	5	7	4	2	12
5	6	1	4	2	8
Demand	10	8	12	20	

1.) Name at least three assumptions of the classic transportation model.

2.) Formulate the constraints of the classic transportation model in general and define the used symbols! (Note: Non-negativity constraints may be omitted.)

3.) How many constraints are considered in the described case?

4.) Perform Vogel's approximation method.

Exercise 3

The following exercise is adopted from Chopra and Meindl (2007). p. 144-145.

DryIce Inc. is a manufacturer of air conditioners that has seen its demand grow significantly. The company anticipates nationwide demand for the year 2006 to be 180,000 units in the South; 120,000 units in the Midwest; 110,000 units in the East; and 100,000 units in the West. Managers at DryIce are designing the manufacturing network and have selected four potential sites – New York; Atlanta; Chicago; and San Diego. However, each site only allows for either a small or a big plant. Small and big plants have a capacity of 200,000 units and 400,000 units, respectively. The annual fixed costs at the four locations are shown in the following table along with the costs of producing and shipping an air conditioner to each of the four markets.

Annual fixed costs for running a plant and production and transportation costs per unit

	New York	Atlanta	Chicago	San Diego	Demand
Fixed costs of a small plant	6,000,000	5,500,000	5,600,000	6,100,000	
Fixed costs of a big plant	10,000,000	9,200,000	9,300,000	10,200,00	
Transportation costs per unit					
East	211	232	238	299	110,000
South	232	212	230	280	180,000
Midwest	240	230	215	270	120,000
West	300	280	270	225	100,000

Develop an optimization model, which helps DryIce to decide where to build its factories and how large they should be.

Model formulation

Indices and sets

Parameters

Minimizesubject to