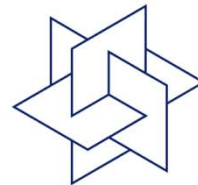


# Combinatorial auctioning of transportation contracts

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Mathematics for key technologies



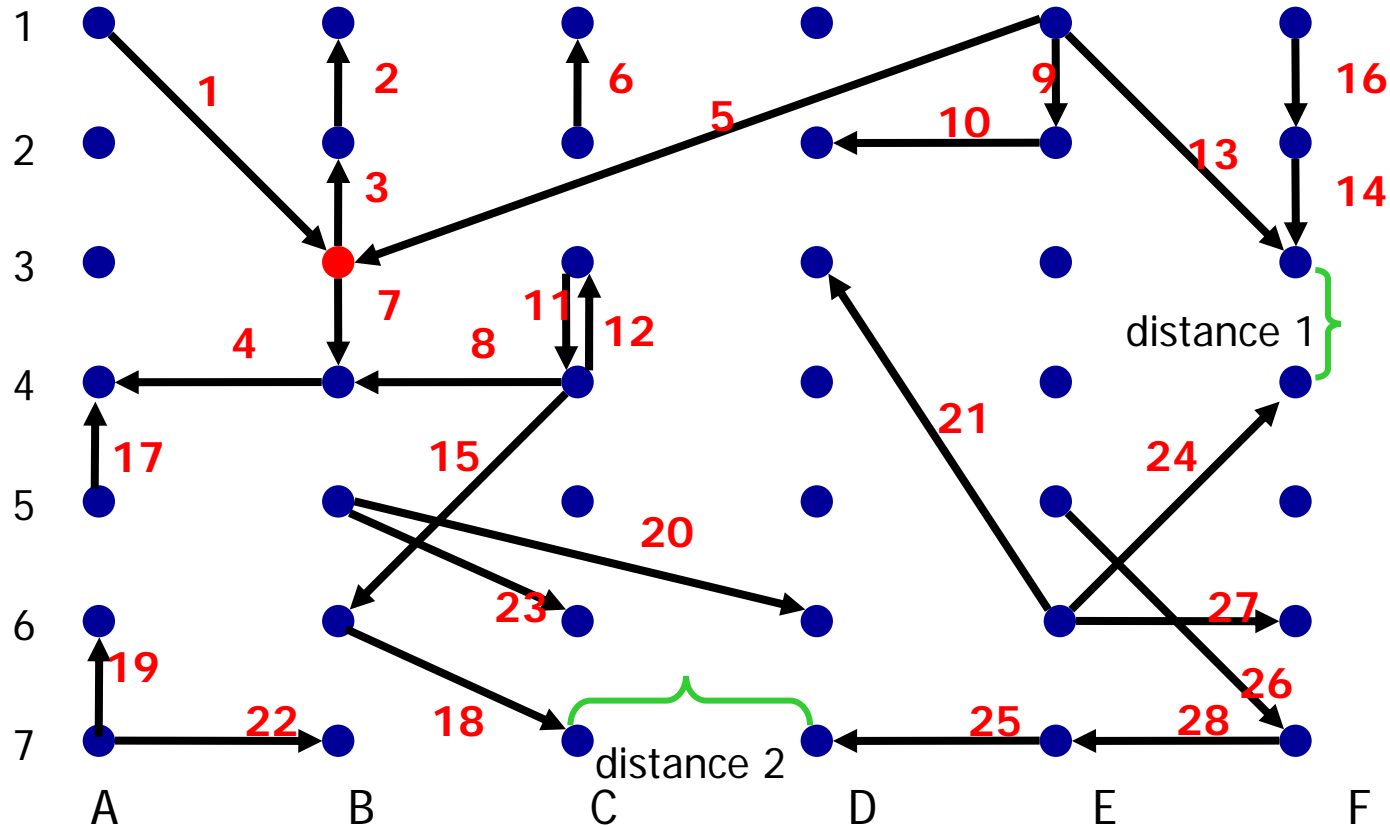
# The Auction

- ▶ The Zuse Institute needs (cheap) transportation service.
- ▶ The participants of this course are eager to provide it.
- ▶ The audience in this room will have to form several bidder-teams, in other words, you have to get organized.
- ▶ Each bidder-team consists of (maximal) 6 persons.
- ▶ Each team represents a haulage company (carrier), which wants to bid for transportation contracts and thereby obtain its profit (earnings minus expenses)
  - ▶ In your bids you have to offer how much you want to charge for executing the contracts (your earnings). The currency is Euro and the bidding-unit is 1 cent, e.g., it is allowed to charge for instance 10.01 Euro.
  - ▶ The expenses arise when you execute the contracts.

# Description of the transportation services needed

- ▶ ZIB will show a map from which the requested transportation services (called **contracts**) can be inferred. For each contract, a load has to be picked up at a starting point that has to be delivered to a terminal point.
- ▶ Each arrow indicates a contract and has a **red id number**.
- ▶ There are only “horizontal” and “vertical” streets. Horizontal street segments have length 2, vertical ones have length 1.
- ▶ All trucks have to be rented from a central truck service company.
- ▶ There is one common starting point for all trips of all trucks.
- ▶ ZIB has its own fleet of very costly small trucks. These will take care of the contracts not assigned to the bidders.

# The Contracts



- ▶ The distance between 2 nodes is the sum of the horizontal and vertical distances (Manhattan distance), e.g., the distance between A6 and C5 is 5.
- ▶ The red numbers are the contract's id numbers. The arrows show the directions.
- ▶ The red point B3 is the start point of all trucks.

# The Expense

- ▶ Trucks must be rented. Each truck costs 10 Euro. This “fixed cost” is independent from the distance travelled.
- ▶ Each truck is, however, allowed to travel only at most 30 distance-units.
- ▶ “Variable costs”: Each running-distance-unit costs 1 Euro.
- ▶ The expense is the sum of the rental fee (fixed cost) and the operating-cost (variable cost) of each truck.
- ▶ Each truck may serve several contracts consecutively, but can carry the load of only one contract at any point in time.
- ▶ Each truck has to start and end at B3.

# The Auction Rules

- ▶ There are several auctioning rounds, at least 3.
- ▶ In each round, each team can give one bid. Each bid consists of at most 6 contracts, e.g., team 1 may offer to fulfil contracts 1, 4, 8, and 11 for 25 Euro (this is the amount ZIB will have to pay to team 1 if it wins).
- ▶ Once all bids are submitted, the principal (ZIB) will determine the least cost combination of all bids serving all its requests (the **allocation**) and disclose which bids win at the current round. However, he will only tell which team receives which contract and the total price ZIB will pay for all contracts (but not the price for any single winning contract), e.g.,
  - ▶ Team 1 gets contracts 1, 4, 8, 11; team 2 gets contract 5, etc...
  - ▶ The total price is 150 Euro.
- ▶ The next round starts afterwards. Again each team can give a bid. **BUT the bids of previous rounds remain.** In other words, after 3 rounds each team may have 3 different bids in the auctioning process.
- ▶ The auction stops when the principal is satisfied with the outcome, or when there are no further bids.

# The End

- ▶ When the auction stops, the allocation of the last round is final. Each team obtains the prices of its winning bids as the earnings.
- ▶ Each team has to calculate its expenses to execute its winning bids.
- ▶ The team with the largest profit is the winner.
- ▶ The bidding process is run electronically via the Internet.