UNIVERSITY OF ZAGREB
Faculty of Electrical Engineering and Computing

Project:
Capacitated Vehicle Routing Problem with Time Windows

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Academic year 2020/2021

Masters program

Information and communication technologies

Outline

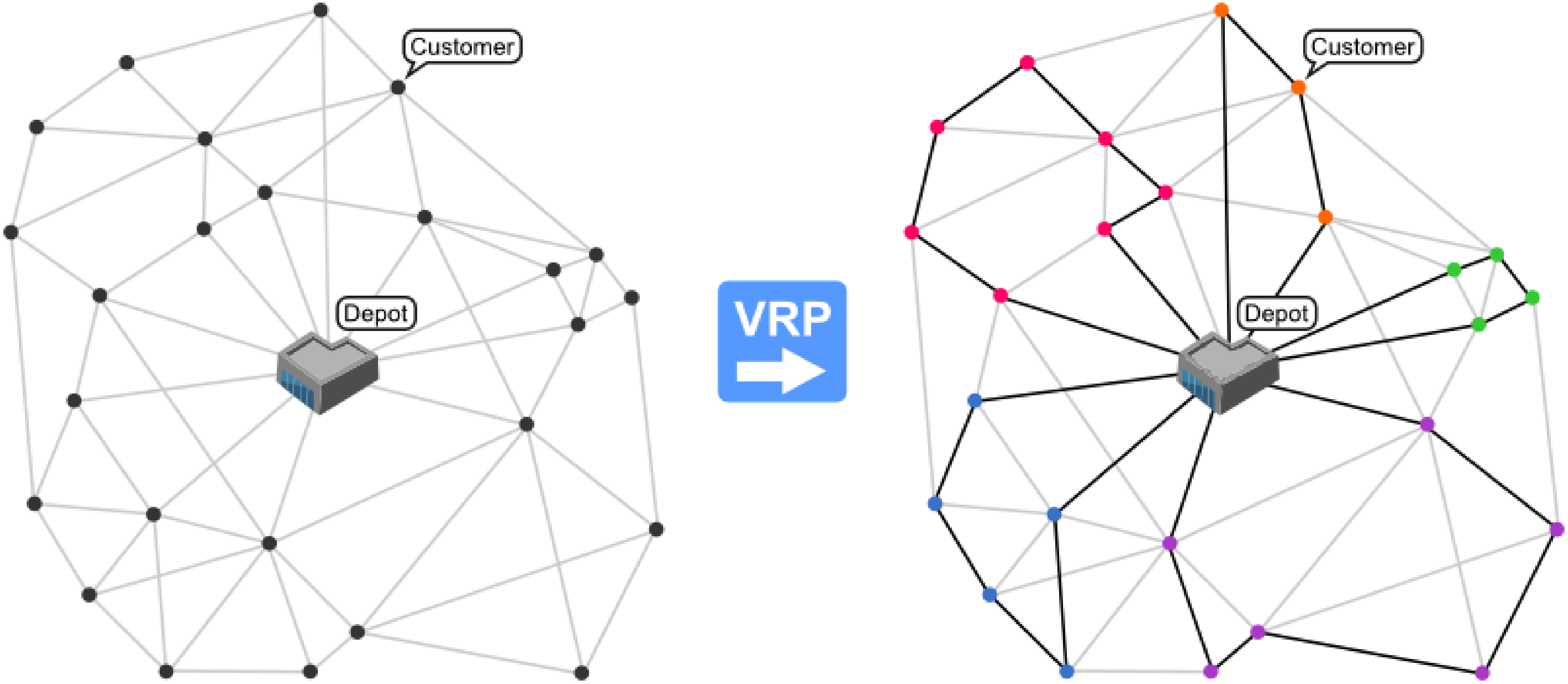
- Problem description
- Problem instances
- Problem formulation
- Your project task

Problem description

- Vehicle Routing Problem, VRP
- **Objective**: find a set of routes for a fleet of vehicles supplying customers from a depot
- Specific constraints define the **problem „flavor”**:
  - Vehicle capacity, CVRP
  - Time intervals in which customers must be supplied, VRPTW

    → CVRPTW

Problem description



Problem instances

- 6 instances are given:
  - i1: 100 customers, 25 vehicles
  - i2: 200 customers, 50 vehicles
  - i3: 400 customers, 100 vehicles
  - i4: 600 customers, 150 vehicles
  - i5: 800 customers, 200 vehicles
  - i6: 1000 customers, 250 vehicles

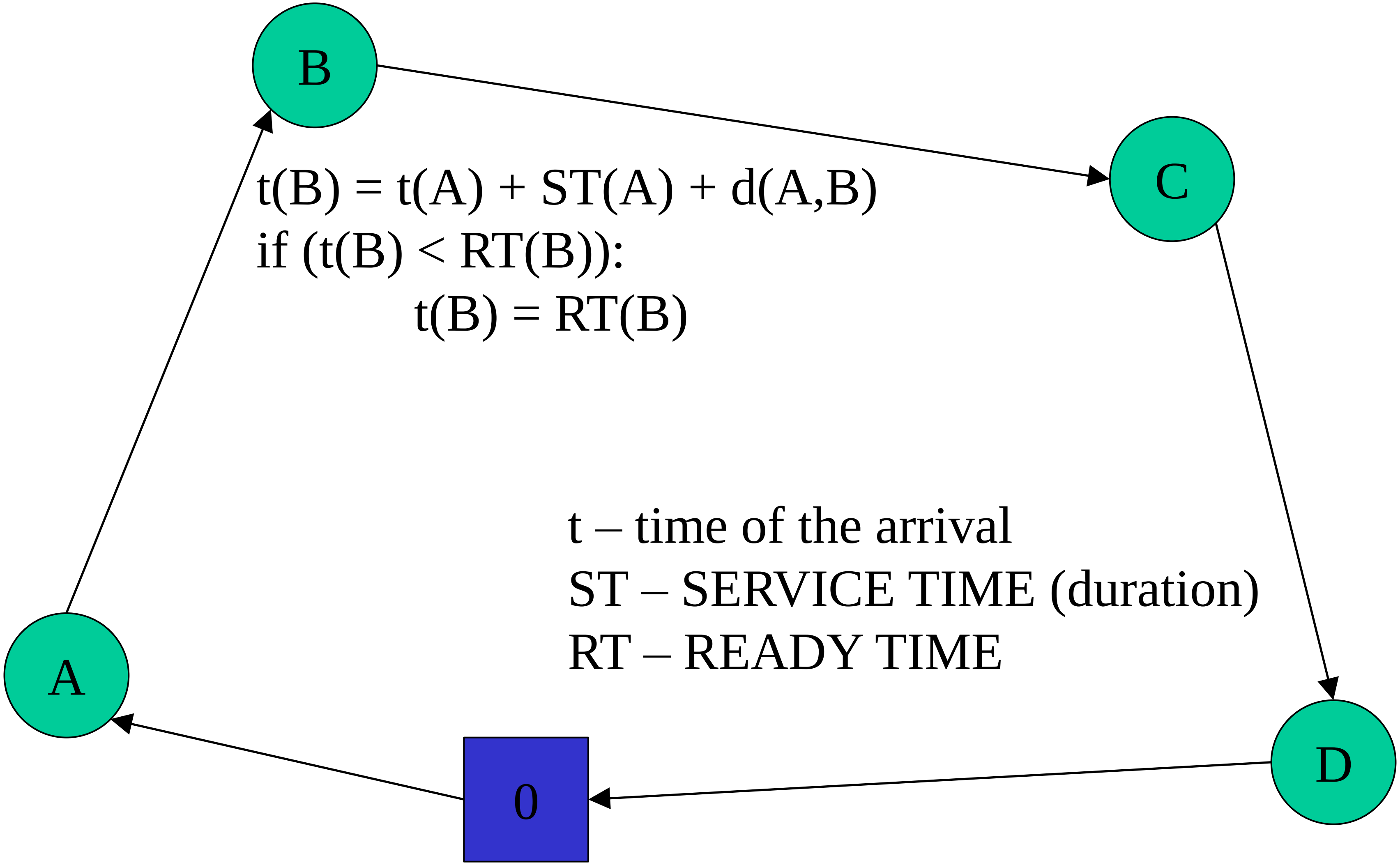
Problem instances

```
VEHICLE
NUMBER     CAPACITY
  25         200

CUSTOMER
CUST NO.   XCOORD.   YCOORD.   DEMAND  READY TIME  DUE DATE  SERVICE TIME

    0      35         35          0          0        230          0
    1      41         49         10          0        204         10
    2      35         17          7          0        202         10
    3      55         45         13          0        197         10
    4      55         20         19        139        169         10
    5      15         30         26          0        199         10
    6      25         30          3         89        119         10
    7      20         50          5          0        198         10
    8      10         43          9         85        115         10
    9      55         60         16         87        117         10
   10      30         60         16        114        144         10
   ...
```

Problem formulation

- Constraints:
  - Each customer is served by exactly one vehicle/route, with the resource amounts that equal their **demands**.
  - The demand on each route must not exceed the **capacity** of the vehicle.
  - The vehicle servicing a certain customer must arrive at the customer location within the **interval** given for that customer. The duration of the service can exceed the interval.
  - Each vehicle **starts and finishes** its route in node 0 (depot), within the time interval given for customer 0.

Problem formulation



t(B) = t(A) + ST(A) + d(A,B)

```
if (t(B) < RT(B)):
        t(B) = RT(B)
```

t – time of the arrival

ST – SERVICE TIME (duration)

RT – READY TIME

Problem formulation

- Objectives:
  1. minimize the number of vehicles by which all the customers can be serviced – **primary**!
  2. minimize the sum of distances on all routes

$$d(c_0,c_1) = \sqrt{(41-35)^2+(49-35)^2}$$

- Distance is considered in solution comparison only in solutions using the same number of vehicles.

Project task

- **Design and implement** a heuristic algorithm to solve the given problem.
- **Execute** your algorithm for given instances.
- Save 3 **solutions** for each instance:
  - solution obtained after 1 minute of alg. execution,
  - 5 minutes of algorithm execution, and
  - without time constraints.
- Save the value of both objective functions, and the number of iterations in which you evaluated the objective function until obtaining saved solutions.

Project task

- Create a **report** that describes your implemented heuristic algorithm.
- **Submit by January 15, 2021 at 12:00 noon**:
  - The report,
  - Source code,
  - Solutions.

```
21
1: 0(0)->53(85)->58(180)->2(200)->0(228)
2: 0(0)->27(27)->28(44)->12(81)->80(168)->77(185)->50(203)->0(230)
...
19: 0(0)->44(59)->38(80)->0(133)
20: 0(0)->39(34)->23(58)->67(80)->0(134)
21: 0(0)->65(50)->0(110)
1836,87
```