Project Ariadne – Use Case 1 / 3

RapidMiner Research

21 to 22 October 2020

Presentation Layout

- List of Use Cases
- Use Case 1 : Outdoor backhaul/fronthaul networks of fixed topology
  - Story Line
  - Functional and Non-Functional Requirements / Challenges
- Conventional AI (constraint solving optimizations)
  - Why do we need to frame optimization simulations
  - How do they work?
- Transferring optimization results into ML model
- Transferring Ariadne Experience to RapidMiner Product
- Stay in touch

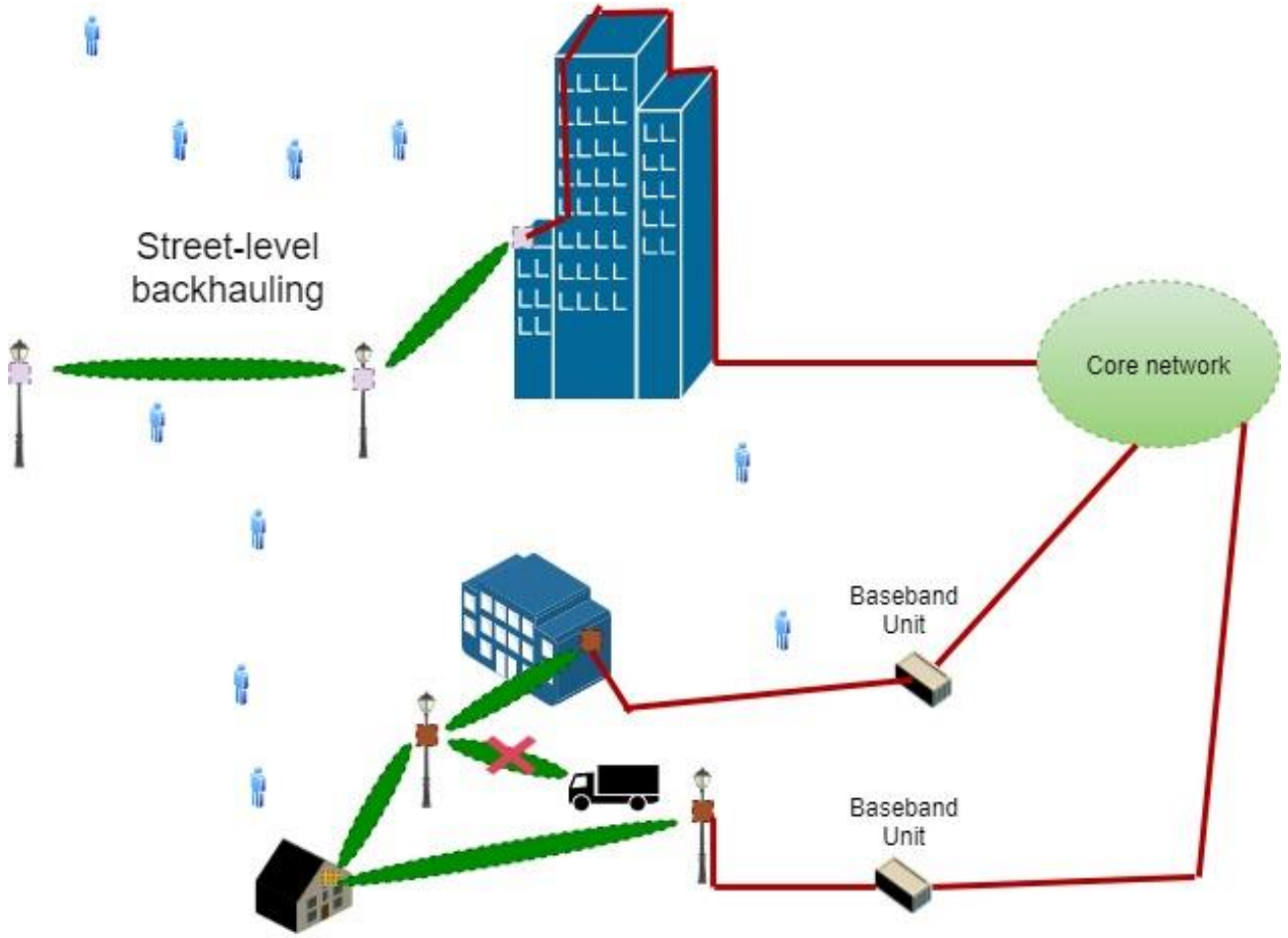
List of Use Cases

- **Use case 1**: **Outdoor backhaul/fronthaul networks of fixed topology**
  - Scenario 1: Long-range Line of Sight (LOS) rooftop point-to-point backhauling.
  - Scenario 2: Street-level point-to-point and point-to-multipoint backhauling/fronthauling.

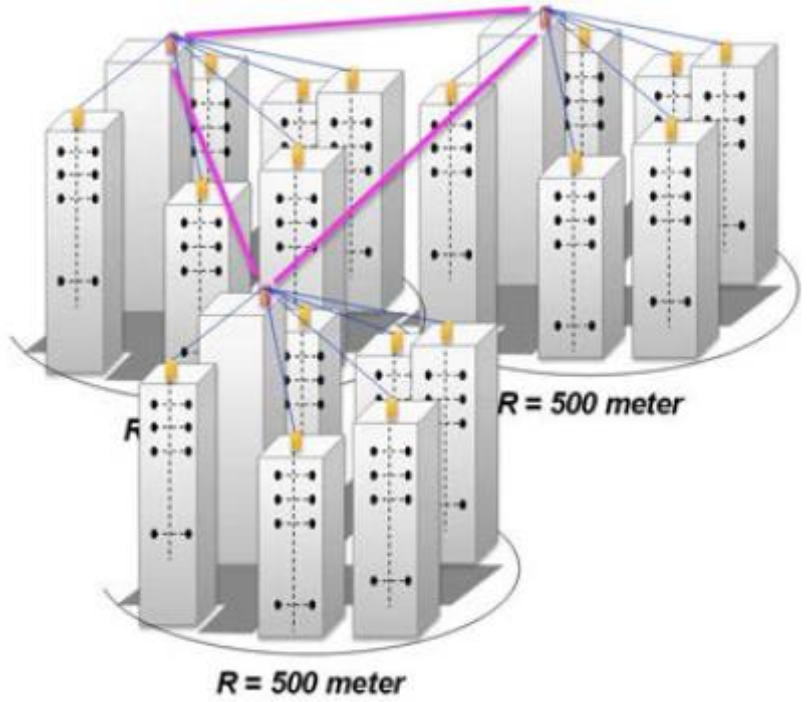
- **Use case 2**: Advanced NLOS connectivity based on metasurfaces
  - Scenario 1: Indoor advanced Non-Line of Sight (NLOS) connectivity based on metasurfaces
  - Scenario 2: Data kiosk

- **Use case 3**: Adhoc connectivity in moving network topology
  - Scenario 1: Dynamic front/backhaul connectivity for mobile 5G access nodes and repeaters
  - Scenario 2: V2V and V2X connectivity

Use Case 1: Outdoor backhaul/fronthaul networks of fixed topology



Street-level fronthauling with and without metasurfaces



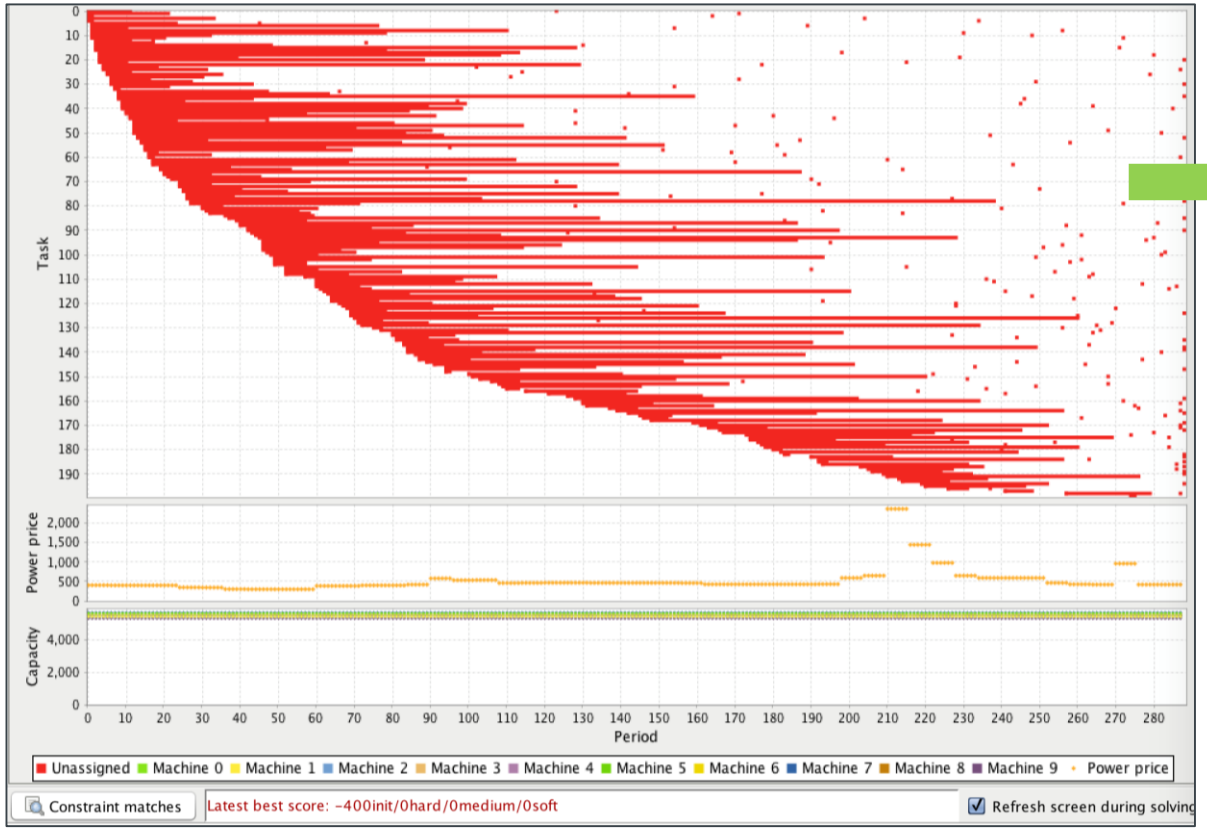
Long range rooftop point-to-point backhauling

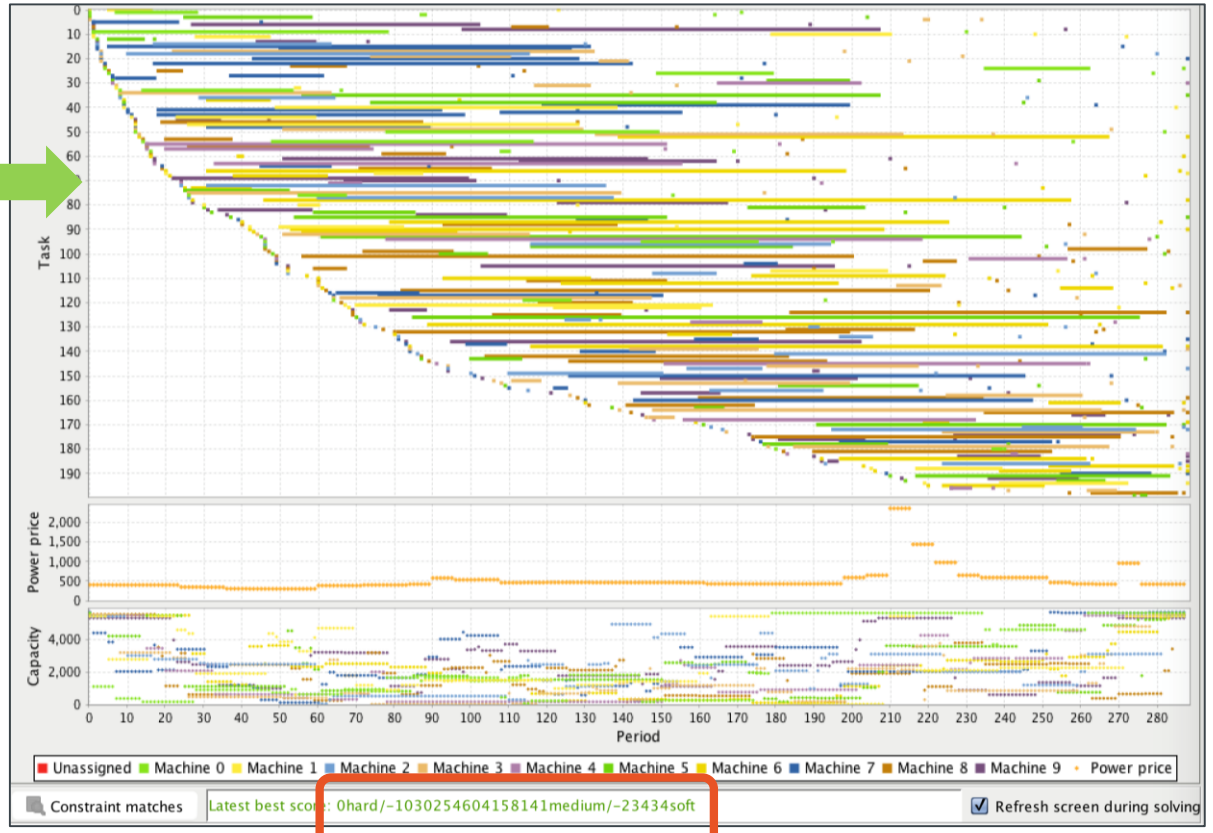
Use Case 1: Outdoor backhaul/fronthaul networks of fixed topology

- **Functional Requirements**
  - High gain and very directive antennas are to be deployed in rooftop cases
  - Avoid attenuation
    - D-band spectrum has mm sized wavelengths, which are highly susceptible to attenuation from adverse weather conditions (rain, fog, gases)
  - In street-level links, establish reliable communication in dense urban settings with obstructions
    - Deal with 1) Full blockades, 2) Static blockades, and 3) Partial blockades
    - Convert environment into a dynamic network using a model of RIS objects stuck on walls, buildings, pathways, etc.
  - Network design: network placement (where to place base stations to maximize coverage)
- **Non Functional Requirements**
  - Keep *link-setup latency* and *adaptation latency* between 1 to 10 milli-seconds for following
    - Allocating resources in real-time to new arriving mobile nodes (user equipments) that maximizes data-rates
    - If primary frequencies get overloaded, switch to secondary frequency ranges in real-time
    - Redirect traffic towards RIS-based NLOS links (in real-time) if LOS links get obstructed

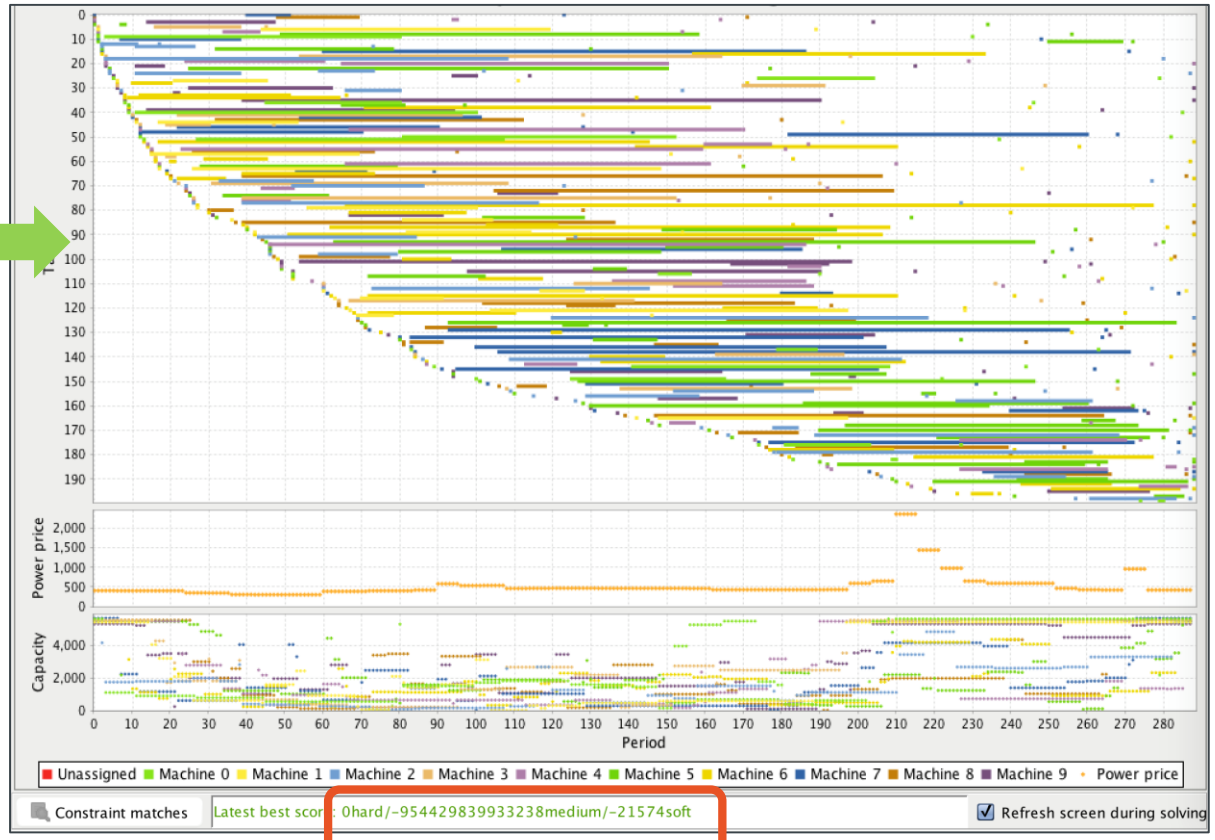
Conventional AI (constraint solving optimization)

- In the absence of data, write optimization simulations
- Allocate tasks (e.g. mobile phones) to machines (e.g. base stations) for a given time to maximize & reduce power costs
- Explore State Space using Metaheuristics & collect data (snapshot of the network with corresponding best allocations)

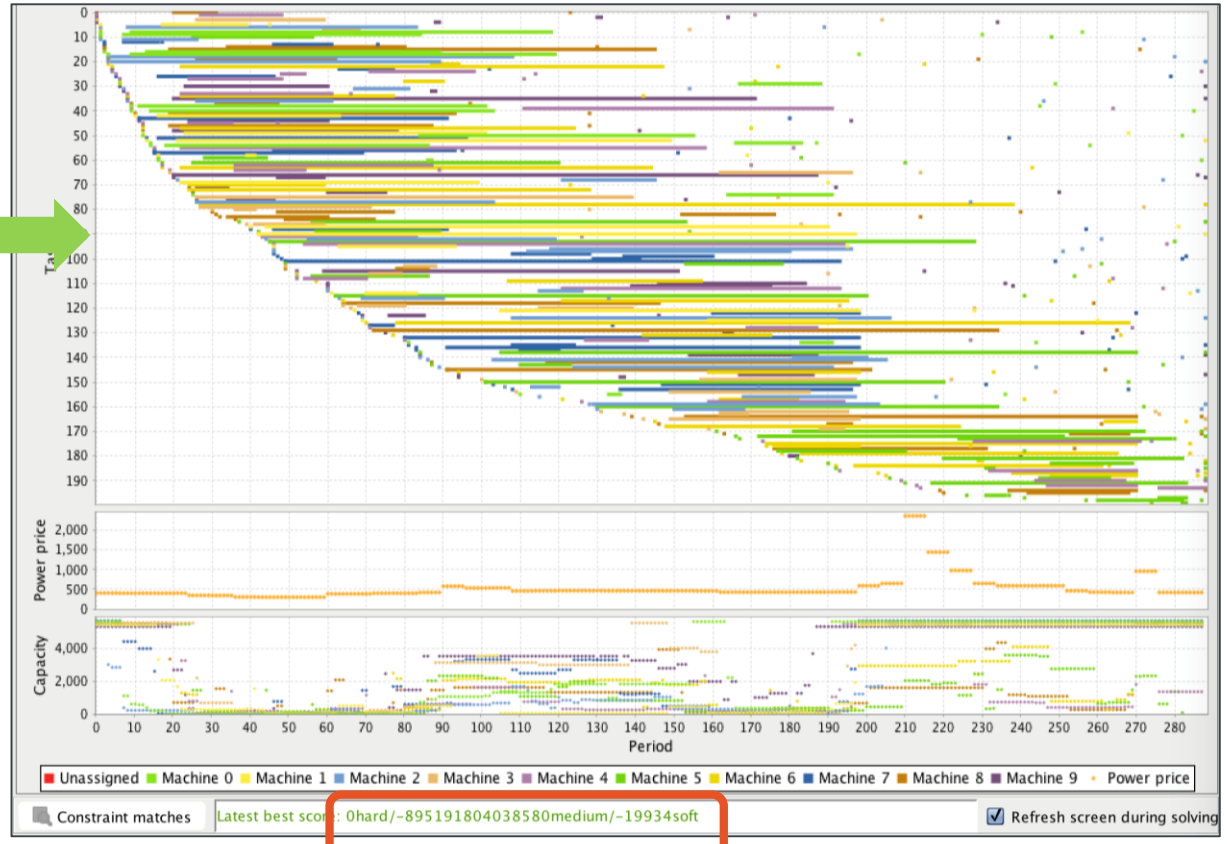




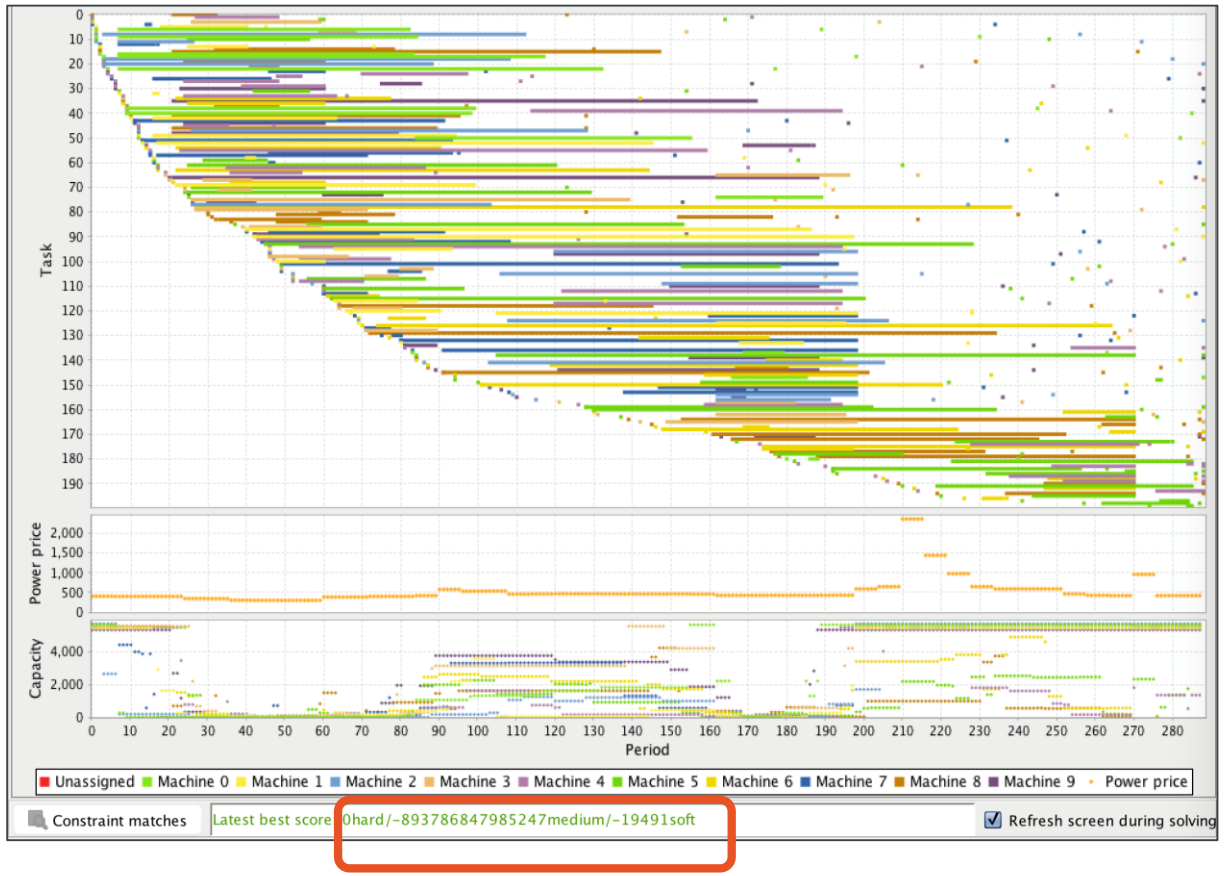
Conventional AI (constraint solving optimization)



Conventional AI (constraint solving optimization)



Transferring optimization results into ML model



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Historical Problem Scenarios and their Best Solutions

Train ML model to efficiently find scheduled resource allocation for newly arriving mobile nodes by learning from different snapshots of the network explored during online optimization simulations

Transferring optimization results into ML model

- Collect data (network snapshot, solutions) with variation
- Map it to train ML model i.e. we *map* LHS to RHS

Left Hand Side (LHS)	Right Hand Side (RHS)
Snapshot of network: situation 1	Resource allocation solution 1.1
Snapshot of network: situation 1	Resource allocation solution 1.2
Snapshot of network: situation 2	Resource allocation solution 2.1
⋮	⋮
Snapshot of network: situation n	Resource allocation solution n

Transferring Ariadne Experience to RapidMiner Product

- **Generating and Preparing Simulation Data**
  - For various use case scenarios

- **Future Work / Work in Progress**
  - Library
    - Of customizable Optimization Problems and Solutions
  - RapidMiner Extension
    - Constraint solving optimization - being developed in Ariadne for Telco (5G, Beyond5G, 6G) domains
    - Predictive and Prescriptive analytics functions
  - Web Demonstrator
    - To showcase offline and online optimization scenarios and solutions

Stay in touch

- If our work appeals to you, you may stay in touch by following us online

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THANK YOU VERY MUCH

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