Programming Exercise 1
Construction Heuristic

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Approach

1. Preprocessing
    a. Battery constraints
    b. Time constraints
    c. Capacity constraints
2. Parallel Savings
    a. Initial route creation
    b. Calculate the savings
        i. customer - customer
        ii. charger - customer
    c. Delete charger only routes
    d. Combine routes
3. Verify/Visualize

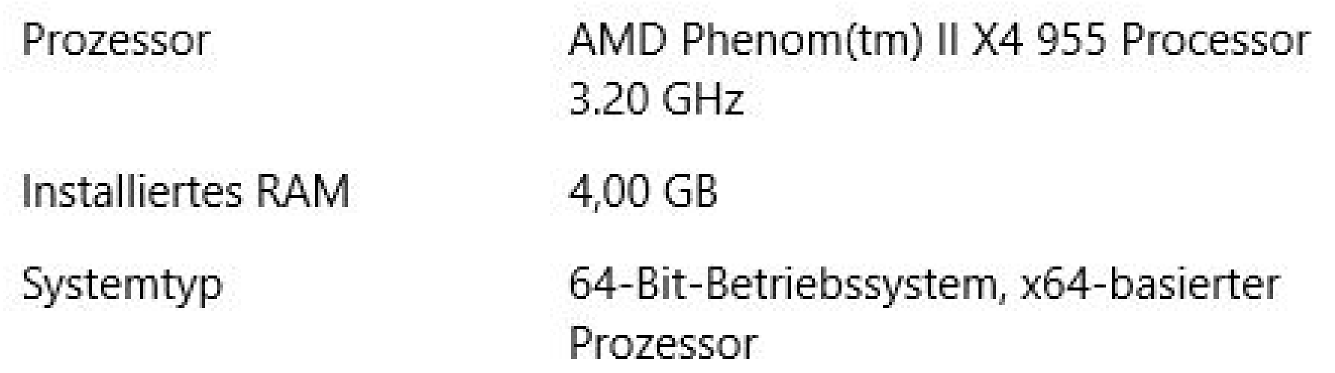
Used Ressources

- Provided paper (The Electric Vehicle-Routing Problem with Time Windows and Recharging Stations; Schneider, Stenger, Goeke) and slides
- Python 3.x
- Provided Verifier
- Graphviz/Dot for visualization

Results

- Total Runtime: 206.125036 seconds
- Average Cost over all Instances: 1065.25
- Worst Cost: instance: ../data/instances/rc101_21.txt
  cost: 3115.0410853411863
  time: 3.442202091217041
- Worst Runtime: instance: ../data/instances/r112_21.txt
  cost: 1344.055276592745
  time: 9.748563051223755

Computer



Prozessor	AMD Phenom(tm) II X4 955 Processor 3.20 GHz
Installiertes RAM	4,00 GB
Systemtyp	64-Bit-Betriebssystem, x64-basierter Prozessor

Preprocessing

q_i - demand of vertex *i*
C - vehicle load capacity
e_i - beginning of a time window at vertex i
l_i - end of a time window at vertex *i*
Q - vehicle battery capacity

Arc (*v,w)* is blacklisted if:

$v,w \in V: q_v + q_w > C$

$v \in V_d , w \in V_d: e_v + s_v + t_{vw} > l_w$

$v \in V_d, w \in V_d: e_v + s_v + t_{vw} + s_w + t_{wd} > l_d$

$v,w \in V, \forall j \in F_d, i \in F_d: h^*(d_{jv} + d_{vw} + d_{wi}) > Q$

Parallel Savings

Initial Routes:

- initial routes are created for every node
- customer might not be reachable without charger
- insert charger after customer and, if needed, before customer

Parallel Savings

Calculate Savings:

- Calculate savings between:
  a. Customer - Customer
  b. Charger - Customer
  c. Both not on Blacklist

Parallel Savings

Delete Charger only Routes

- delete routes that only contain charger
- adding chargers is not done by savings
- add instead nearest charger by necessity

Parallel Savings

Combine Routes

- Create new combined Route
- Check if and where charge is exceeded
    - iterate from there backwards and insert nearest charger if possible
    - if no previous insertion makes combined routes feasible then insert the closest charger between two farthest nodes
    - since we insert chargers until we make our route feasible, we have to decline routes that have more than some number of chargers, because we can create an infinite loop
- Check capacity, time-windows and charge capacity
- If newly created Route is feasible, add it and remove the old ones
- At the end, check for one edge case

Result Examples

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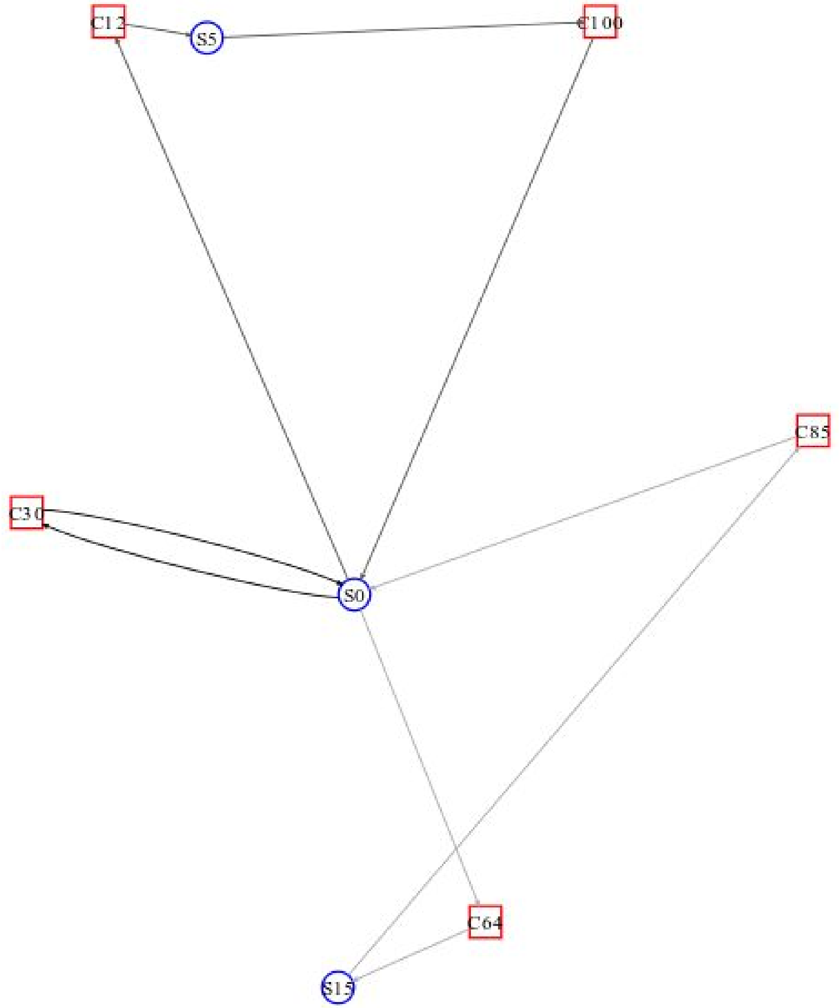

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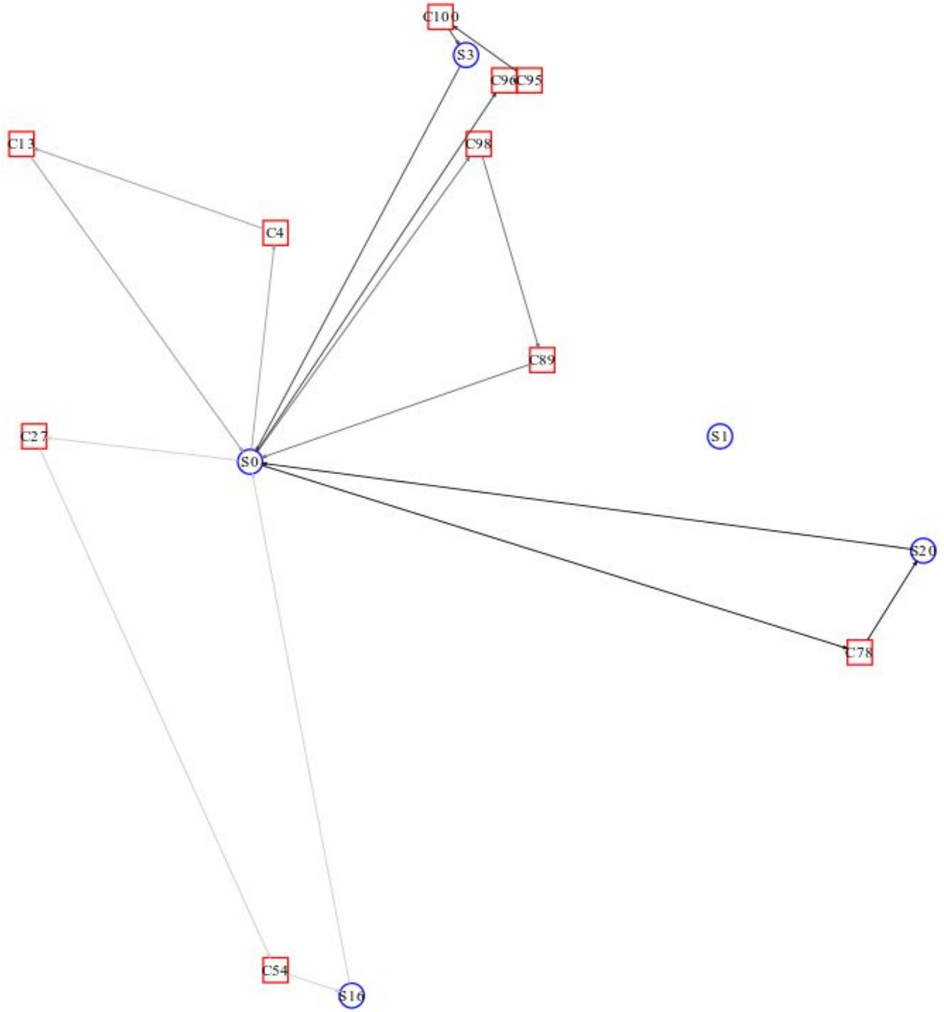

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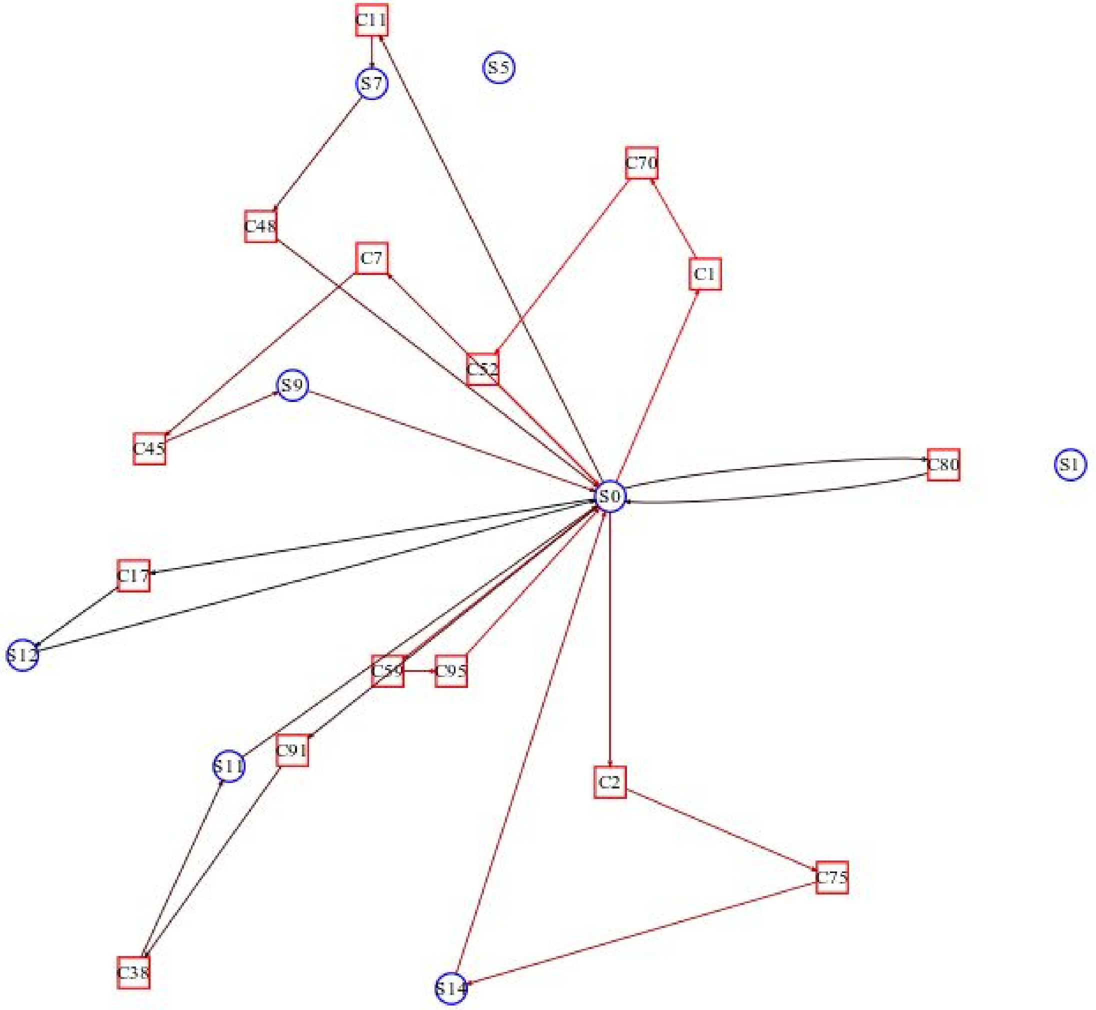
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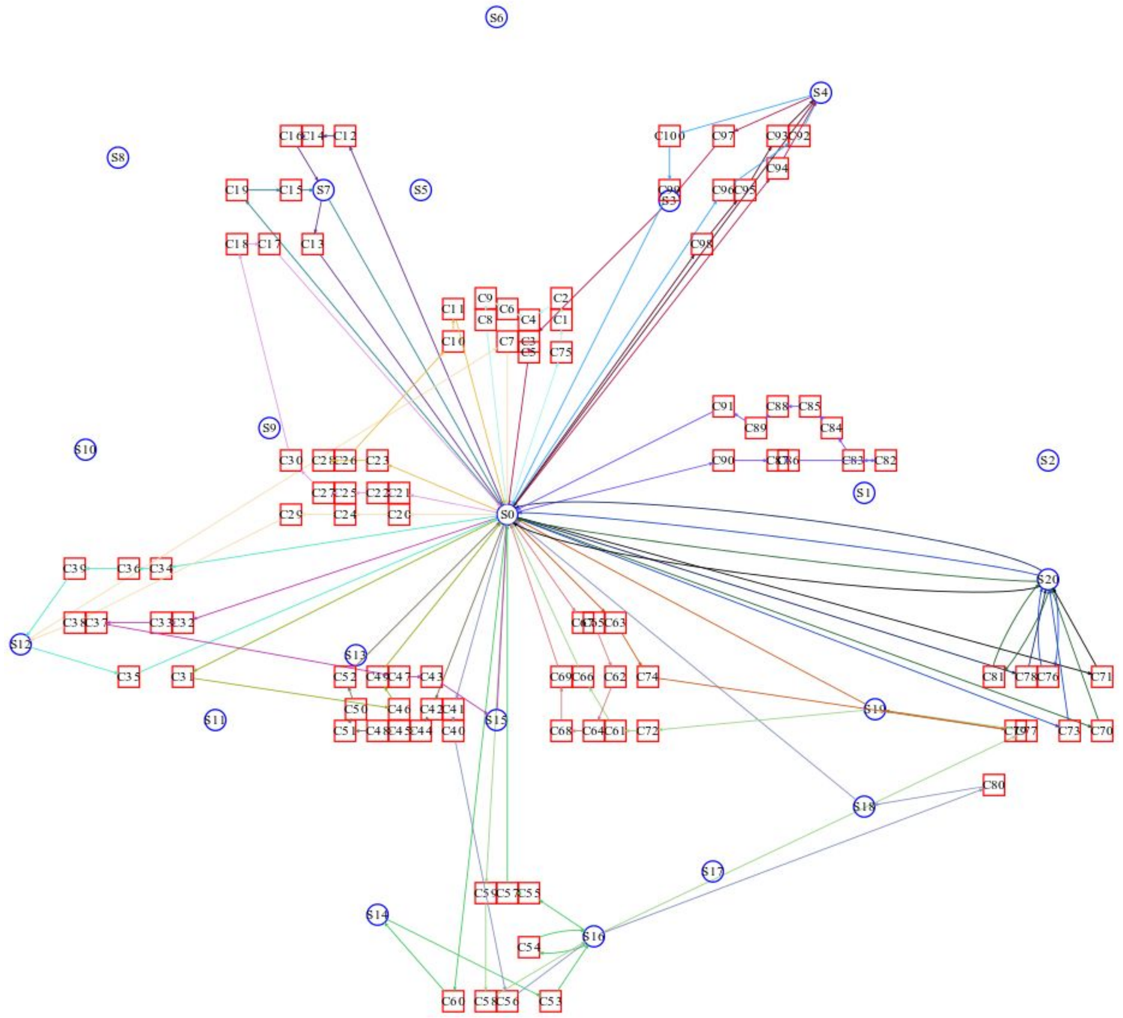
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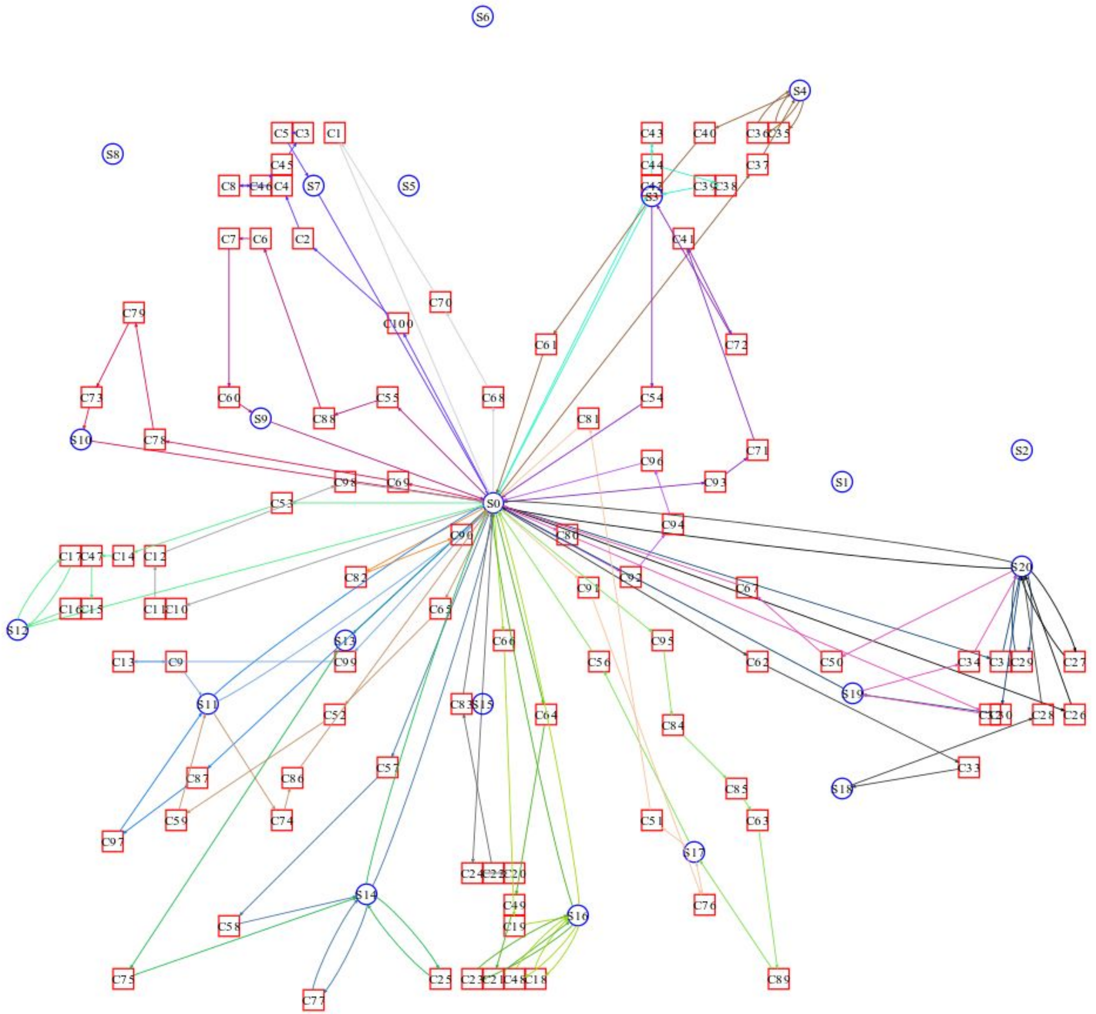
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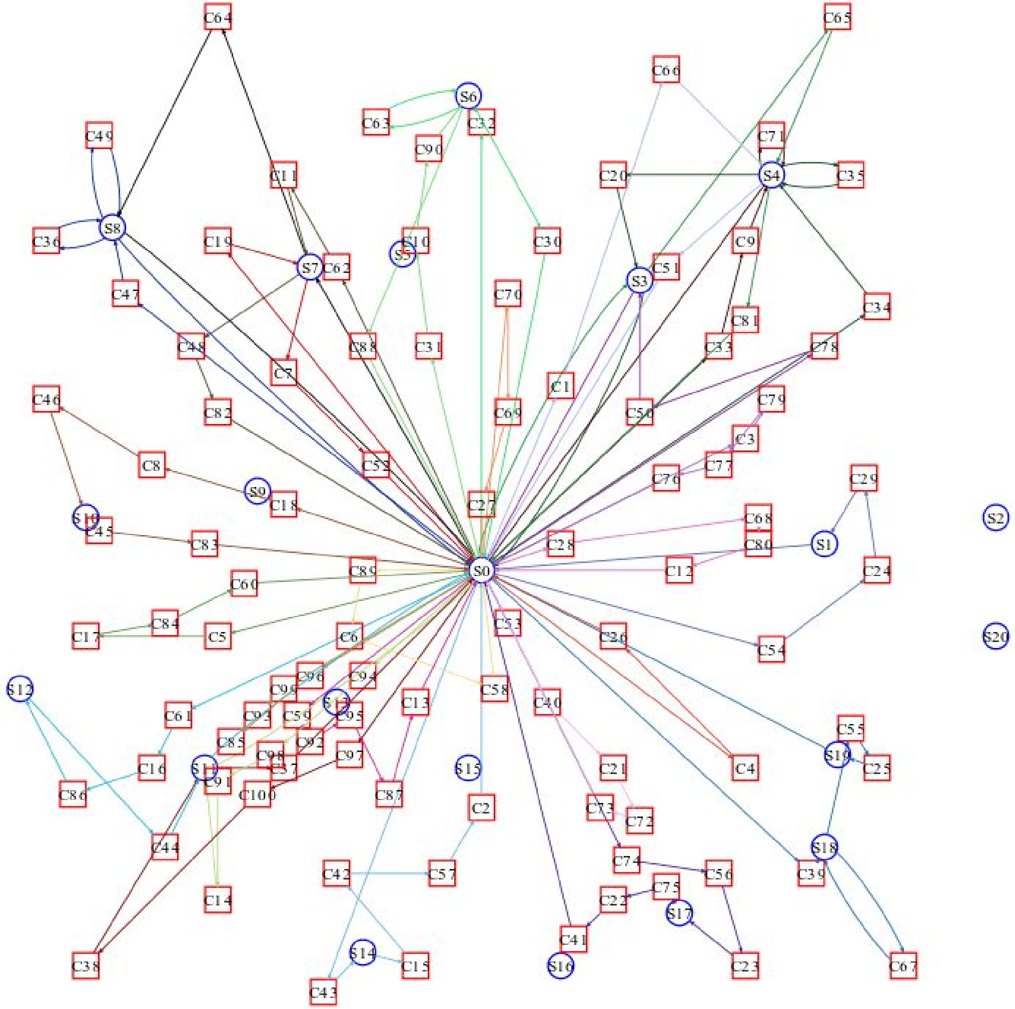
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