problema_PFCM

February 15, 2025

1 Problema de Fluxo de Custo Mínimo (PFCM)

[29]:
```
import cplex
import networkx as nx
import matplotlib.pyplot as plt
```

1.1 Leitura e pré-processamento dos dados

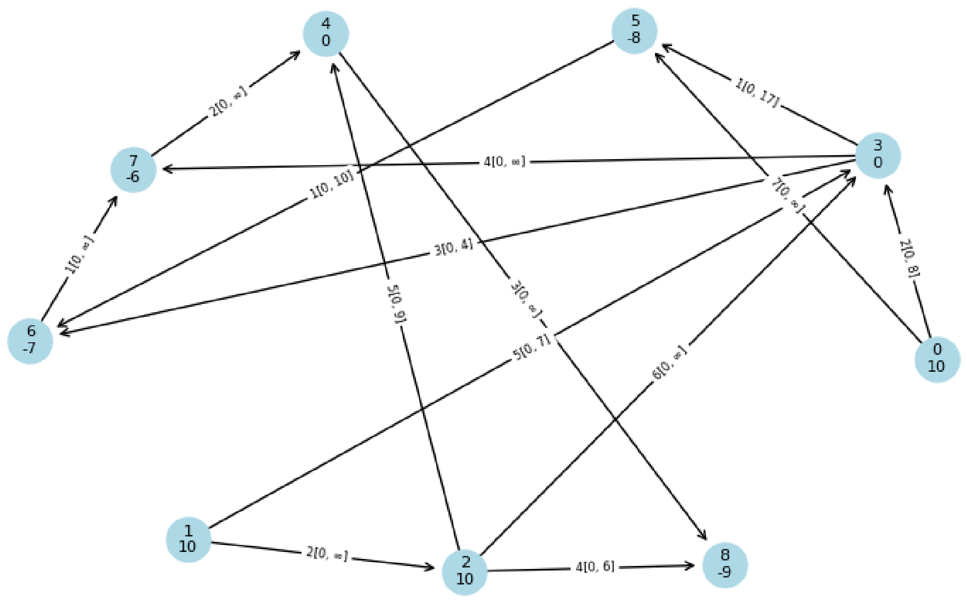
[30]:
```
file = "in_pfcm.txt"

supply_demand = []
infinito = 1e20

with open(file, 'r') as f:
    lines = f.readlines()
    lines = [line.strip() for line in lines]
    lines = list(filter(None, lines))

num_nodes, num_edges = map(int, lines[0].strip().split())

for line in lines[1:num_nodes + 1]:
    node_id, value = map(int, line.strip().split())
    supply_demand.append(value)

arcs = {}
for line in lines[num_nodes + 1:]:
    parts = line.strip().split()
    node1, node2, cost, min = map(int, parts[:4])
    max = int(parts[4]) if len(parts) > 4 else infinito
    arcs[(node1, node2)] = (cost, min, max)

arcs
```

[30]:
```
{(0, 5): (7, 0, 1e+20),
 (0, 3): (2, 0, 8),
 (1, 3): (5, 0, 7),
 (1, 2): (2, 0, 1e+20),
 (2, 3): (6, 0, 1e+20),
 (2, 4): (5, 0, 9),
 (2, 8): (4, 0, 6),
 (3, 5): (1, 0, 17),
 (3, 6): (3, 0, 4),
 (3, 7): (4, 0, 1e+20),
 (4, 8): (3, 0, 1e+20),
 (5, 6): (1, 0, 10),
 (6, 7): (1, 0, 1e+20),
 (7, 4): (2, 0, 1e+20)}
```

1.2 Visualização do problema

[31]:

```
G = nx.DiGraph()

for i, oferta_demanda in enumerate(supply_demand):
    G.add_node(i, oferta_demanda=oferta_demanda)

for (u, v), (cost, min, max) in arcs.items():
    G.add_edge(u, v, cost=cost, min=min, max=max)

pos = nx.spring_layout(G, k=5.0, iterations=50)

node_labels = {i: f'{i}\n{G.nodes[i]["oferta_demanda"]}' for i in G.nodes}
edge_labels = {
    (u, v): f'{G[u][v]["cost"]}[{G[u][v]["min"]}, {G[u][v]["max"]}]' if␣
 ↪G[u][v]["max"] != infinito
    else f'{G[u][v]["cost"]}[{G[u][v]["min"]}, ∞]' for u, v in G.edges
    }

plt.figure(figsize=(10, 6))
nx.draw_networkx_nodes(G, pos, node_color='lightblue', node_size=500)
nx.draw_networkx_labels(G, pos, labels=node_labels, font_size=8)
nx.draw_networkx_edges(G, pos, arrowstyle='->', arrowsize=10, min_target_margin␣
 ↪= 15)
nx.draw_networkx_edge_labels(G, pos, edge_labels=edge_labels, font_size=6)

plt.axis('off')
plt.show()
```



1.3 Modelagem e solução

```
[32]: infinito = 1e20
      nodes = list(range(num_nodes))

      model = cplex.Cplex()
      model.set_problem_type(cplex.Cplex.problem_type.LP)
      model.objective.set_sense(model.objective.sense.minimize)

      # Variáveis de decisão
      variaveis = []
      objetivo = []
      fluxo_minimo = []
      fluxo_maximo = []

      for (i, j), (cost, min, max) in arcs.items():
          variaveis.append(f"x{i}{j}")
          objetivo.append(cost)
          fluxo_minimo.append(min)
          fluxo_maximo.append(max)

      model.variables.add(names=variaveis, obj=objetivo, lb=fluxo_minimo,␣
       ↪ub=fluxo_maximo)

      # Restrições de balanço de fluxo
```

```
for node in nodes:
    inflow = [f"x{i}{node}" for (i, j) in arcs.keys() if j == node]
    outflow = [f"x{node}{j}" for (i, j) in arcs.keys() if i == node]
    flow_vars = inflow + outflow
    coefficients = [-1] * len(inflow) + [1] * len(outflow)
    model.linear_constraints.add(
        lin_expr=[cplex.SparsePair(ind=flow_vars, val=coefficients)],
        senses=["E"], # Igualdade
        rhs=[supply_demand[node]]
    )

%time model.solve()
```

```
Version identifier: 22.1.0.0 | 2022-03-25 | 54982fbec
CPXPARAM_Read_DataCheck                          1
Tried aggregator 1 time.
LP Presolve eliminated 0 rows and 1 columns.
CPXPARAM_Read_DataCheck                          1
Tried aggregator 1 time.
LP Presolve eliminated 0 rows and 1 columns.
Aggregator did 3 substitutions.
Reduced LP has 6 rows, 10 columns, and 20 nonzeros.
Presolve time = 0.01 sec. (0.01 ticks)

Iteration log . . .
Iteration:     1   Dual objective     =           139.000000
CPU times: user 20.9 ms, sys: 5.12 ms, total: 26 ms
Wall time: 25.1 ms
```

1.4 Sumário dos resultados

[33]:

```
status = model.solution.get_status()
if status == model.solution.status.optimal:
    print("Status da solução:", model.solution.get_status_string())
    print(f"Custo total: {model.solution.get_objective_value()}")

    for var in variaveis:
        value = model.solution.get_values(var)
        if value > 0:
            print(f"{var}: {value}")

    model.write("./output/model_pfcm.lp")
    model.solution.write("./output/solution_pfcm.sol")
else:
    print("No Solution.")
```

```
Default row names c1, c2 … being created.
```

```
Status da solução: optimal
```

```
Custo total: 184.0
x05: 2.0
x03: 8.0
x13: 7.0
x12: 3.0
x23: 4.0
x24: 3.0
x28: 6.0
x35: 16.0
x36: 3.0
x48: 3.0
x56: 10.0
x67: 6.0
```