Team Formation with Social-Technical Constraints

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0.1 Problem Definition

We consider a group of people that have certain skills, between a set of S possible skills, together with a relation $d : V^2 \to \mathbb{R}^+$ that represents the "disharmony" degree between pairs of persons. Hence, the higher the value $d(u, v)$, the worst is the capacity of u and v to work together. This is naturally represented by a complete graph G with a weight function d on its edges, and where each vertex has a subset of "skills". Also, we consider a set of team models, where a model consists of demands for each skill (number of people with each skill is desired in such a model). Finally, the problem consists of dividing the group of people into a certain number of teams, each being of a certain type of team model. More formally.

TEAM FORMATION WITH SOCIAL-TECHNICAL CONSTRAINTS (**TFSTC**)
Instance:

- *Complete graph G with a weight function d on its edges*
- *S possible skills*
- *0-1 function $r_{u,j}$ which says wether u possess skill j*
- *T team models, each consisting of a demand function $w_{j,s}$ which tells how many vertices with skill s are necessary in teams of type j*
- *demand function e_j which says how many teams of type j are desired.*

Task: *Find a partition of the vertices of G into the demanded teams that minimizes the maximum value of a team, where the value of a team is given by the sum of the weights of the edges within the team. Each vertex can apply only one of its skills.*

We first define the sets, data and variables used in the model

- Sets :
  - U set of workers
  - J set of type of teams to cover
  - E_j set of indices of teams of type j
  - S set of possible skills in teams
- Data
  - e_j the number of team required in type j
  - $r_{us} = 1$ if worker $w \in W$ has the skill $s \in S$.
  - t_{js} number of workers with the skill $s \in S$ in the team of type $j \in J$
  - $d_{uv} = \{v_0, ..., v_d\}$ level of "disharmony" , "dislikeness"
    v_0 u or v say : "Yeaar, I love working with v".
    v_D u or v say : "Grrrr, I refuse to work with this bip.",
- Variables

– $x_{uij} = 1$ if worker u is involved in the team i of type j, O otherwise.

– y_{ij} cost variable of a team i of type j

$$
\begin{array}{lll}
\text{Min} & \sum_{j \in J, i \in E_j} y_{ij} & \\
\text{s.t.} & y_{ij} = \sum_{u \in U} \sum_{v \in U} d_{uv} x_{uij} x_{vij} & \forall j \in J, i \in E_j \\
& x_{uij} + x_{ui'j'} \leq 1 & \forall u \in U,\ i \in E_j, i' \in E_{j'}, j, j' \in J \\
& \sum_{u \in U} r_{us} x_{uij} \geq t_{js} & \forall i \in E_j,\ \forall j \in J,\ s \in S \\
& \sum_{s \in S} r_{us} x_{uij} \leq 1 & \forall w \in W, i \in E_j, j \in J \\
& \sum_{s \in S} \sum_{u \in U} r_{us} x_{uij} = \sum_{s \in S} t_{js}, & \forall i \in E_j, j \in J \\
& x_{uij} \in \{0, 1\} & \forall u \in U, j \in J, i \in E_j \\
& y_{ij} \in N & \forall j \in J, \forall i \in E_j
\end{array}
$$

0.2 Plan of action

Brazilian group will work on a branch an cut approach of the problem, while Betrand, Rosa and Lorena (maybe others) will work on a column generation approach.

0.3 Input File Format

Below, n represents the number of vertices of graph G.

¡number of vertices¿

¡$n \times n$ matrix giving edge weight function d¿

¡$n \times S$ matrix that describes which skills each vertex possess¿

¡$T \times (1 + S)$ matrix. For a given row i, the first column tells the number of teams of each type, and the $(j + 1)$-th columns tells how many persons with skill j are needed.¿

As for instances, Tatiane has a webpage (that has to be translated to english) where companies can enter with their data to generate our entries. Also, we may try to use clustering existing instances (any known benchmarks?).