A Computational Analysis Framework and Tools for Studying Transformation of Social Networks

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Teams and organizations often need to be transformed in order to work more efficiently or to achieve certain goals. In this paper, we propose a computational analysis framework, inspired by image morphing, to study the transformation of an organization so that the cost for the transformation is minimized. We also present a visualization tool to illustrate the transformation process.

There are three types of entities in an organization: agents, resources, and tasks. The relationship between these entities can be represented by the following meta-matrix:

Table 1 Relations between different entities

	Agents	Resources	Tasks
Agents	Relation Network	Capabilities	Assignments
Resources	-	Substitutability	Commitment
Tasks	-	-	Precedence

Each element in the above matrix can be represented by a binary matrix. For example, the Agents-Agents element in the meta-matrix is itself a matrix with element N_{ij}. If $N_{ij} = 1$, the corresponding Agent i has certain relationship with Agent j. If $N_{ij} = 0$, they do not have such relationship.

The meta-matrix in Table 1 describes the current status of the whole organization. When the organization transforms, it *morphs* from a beginning state to an end state that is the desired goal. The transformation of a social network can be studying using the image morphing. During the transformation, or morphing, the number of each type of entities may change. A matrix at the end state may be larger or smaller than the corresponding matrix at the beginning state. In some cases, the number of each type of entities may remain the same, but the beginning and end states can have different matrices.

Our goal is to find an optimal path to morph an organization from the beginning state to a desired end state. If the optimal path is too difficult to find, we would like to find a sub-optimal solution. By "optimal path," we mean that morphing along this path will cost the least, based on a pre-defined cost function. To derive a close-form formula for the cost function is difficult in general. We propose to compose the cost function from a set of rules, or a set of constraints on morphing, such as:

- Minimize increases in perception of relative advantage
- Minimize increases in perception of relative disadvantage
- Prefer to give individual resources than take them away
- Prefer to decrease than increase the number of tasks assigned to an individual
- Keep cognitive effort within a certain range
- Minimize effort (physical, communicative, cognitive, emotional)
- Conserve power
- Abide by constraints (there may be one or more of these constraints –
- Maximum/minimum number of personnel
- Maximum cost
- No change in personnel
- Cannot bring on new personnel
- Cannot get rid of personnel
- Cannot acquire new resources
- Must use existing resources
- Must do certain tasks
- Must maintain strategic advantage

At the conference, we will report our results in applying optimization methods such as simulated annealing, decision tree, genetic algorithm, etc, to the morphing problem and test the performance of these methods.

To visualize the morphing procedure, we have been developing a software application with a graphical user interface (GUI). It is a Java-based application that can read and write files describing the social network in a specific file format. With GUI, the application also allows the user to edit the network with click-and-drag.

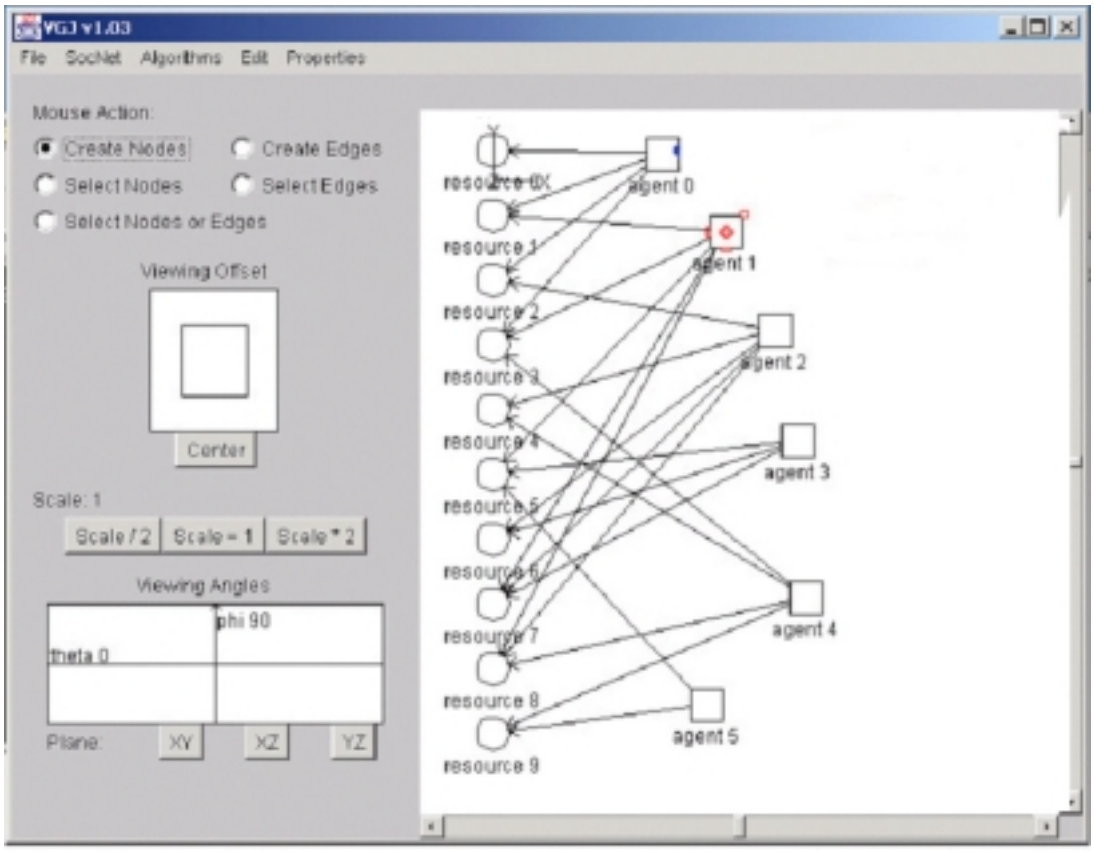

Figure 1. Snapshot of the software application

Such a software application will provide us more insight into organization transformations. Currently we are working on providing different types of icons for different types of entities to enhance the visualization of a network. At the conference, we will report our results in integrating the morphing algorithm into this software application, to visualize the transformation of the organization from the beginning state to the end state along the optimal path found by the optimization algorithm.

Reference

[1]. "Organizations and Constraint Based Adaptation," Kathleen Carley, *Chaos, Complexity and Sociology: Myths, Models and Theories*, 1997.

[2]. "On the Evolution of Social and Organizational Networks," Kathleen Carley, *Networks In and Around Organizations*, 1999.