ccWSSN-GraphML: An Extended Graph Markup Language for Visualizing Closeness-centrality Measurements of Workflow-supported Org-social Networks

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Abstract

There is a hot-issued research topic in the workflow intelligence arena, which is dubbed "the workflow-supported social network" that represents a work-sharing and collaborating network of workflow-actors performing workflow-related operations in an organization. We can discover the org-social network from a workflow model and visualize its analysis results as organizational knowledge. In this paper[1], we are particularly interested in how to visualize the degrees of closenesses among workflow-performers forming a workflow-supported org-social network. That is, this paper is about proposing a graph markup language, which is named to ccWSSN-GraphML, for graphically visualizing the measurements of the analyzed closeness centralities in a workflow-supported social network. Conclusively, the proposed graph markup language is extended from the conventional graph markup language, GraphML.

Keywords*:* workflow-supported org-social networking knowledge, graph markup language, close-*ness centrality analysis, workflow intelligence, organizational knowledge*

1. Introduction

The research group of the authors has introduced the basic concept of workflow-supported org-social network[5], at first, and its related formalisms have also been defined through the frameworks[4][5][6] providing organizational knowledge discovery methodologies. However, those frameworks cope only with a bare couple of formalisms, like a degree-centrality analysis technique, in terms of analyzing the workflow-supported org-social networking knowledge and its representative models. So, we have been trying to intentionally expand on these frame-works with more sophisticated and diversified analysis techniques, such as closeness-centrality, betweenness-centrality, eigenvalue-centrality, correspondence analysis, and so on, in order to be practically applied into a real organizational world. As one of these efforts, the authors[11] tried to conceive an algorithmic formalism of closeness-centrality measurements to quantitatively analyze workflow-supported org-social networking knowledge and models. The eventual goals of the formalism was to numerically measure and calculate the degree of work-intimacy among employees involved in a workflow model or a workflow package (a group of inter-relevant workflow models) on a

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workflow-driven organizational environment. In this paper, we particularly focus on a visualizing approach of the closeness centrality measurements using the so-called GraphML (Graph Markup Language). That is, we suggest a new graph markup language for graphically visualize the closeness centrality measurements and devise its XML schema extended from the WSSN-GraphML[12].

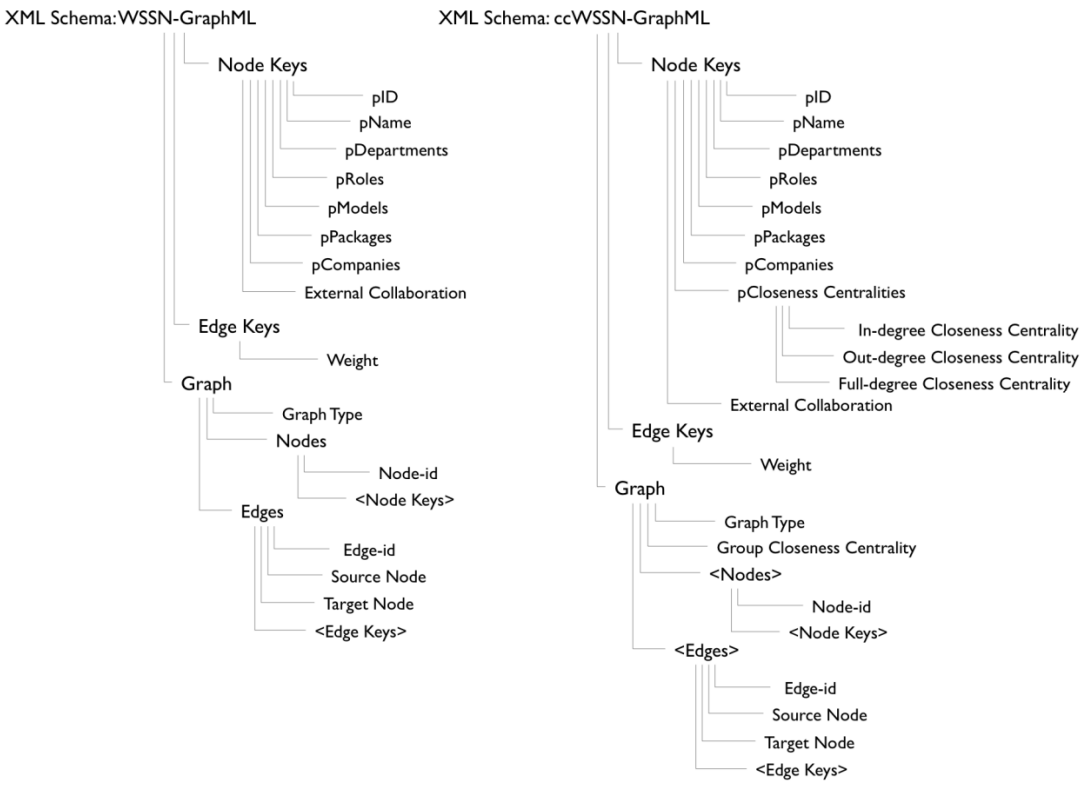

Fig. 1. The WSSN's Schema and Its Extended Schema with Closeness Centrality

2. ccWSSN-GraphML

There exist several social network analysis techniques and algorithms for measuring the centralities. Particularly among them, the most widely used centrality measures are degree, closeness, eigenvalue, and betweenness, and these measures not only vary in their applicability to non-directed and directed relations, but also differ at the individual actor and the group or complete network levels. As stated in the introductory section, we are particularly interested in visualizing the degree of closeness centrality of each workflow performer associated with a specific workflow-supported org-social network by borrowing the well-known technique, GraphML. In this section, we devise an XML schema of the ccWSSN-GraphML, which is extended from the WSSN-GraphML[12], and formally describe the mathematical equations for calculating the closeness centralities of individual performers and group as well, as the additional key attributes of the closeness centralities in the devised schema.

As depicted in Fig. 1, the XML schema of the proposed ccWSSN-GraphML is basically extended from the GraphML-based workflow-supported org-social network, WSSN-GraphML[12] by appending three types (in-degree, out-degree, and full-degree) of closeness centralities on each workflow-performer as well as one type of group closeness centrality for the corresponding workflow-supported org-

social network.

Basically, the graph markup language, GraphML, is an XML-based graph definition language comprising nodes and edges. The nodes and edges are represented by the key attributes defined in the tags of <Node Keys> and <Edge Keys>, respectively. Each node is identified by node-id, whereas edges distinguish each other t99hrough three attributes of edge-id, source-node, and target-node. Also, the graph itself can be characterized by graph-type attribute as either non-directed graph or directed graph. In order to sophisticatedly describe the workflow-supported org-social network by using GraphML, WSSN-GraphML supplemented the domain-specific attributes to <Node Keys> and <Edge Keys> as shown in the left-hand side of Fig. 1. Especially, to graphically reflect the strengths of the relationships (or work-intimacies) between workflow performers, we adopt the attribute of Weight as <Edge Keys>.

As an extended XML schema of the WSSN-GraphML, we newly define ccWSSN-GraphML schema as shown in the right-hand side of Fig.1 in order to graphically reflect the measurements of closeness centralities of workflow performers. That is, we supplement the attribute of pCloseness Centralities with three types of measurements like in-degree, out-degree, and fulldegree -closeness centrality measurements to the WSSN-GraphML schema, and name it ccWSSN-GraphML. By additionally adding the attribute of Group Closeness Centrality as a graph-level key attribute, we can represent the group closeness centrality measurement of the corresponding workflow-supported org-social network.

Conclusively, the proposed ccWSSN-GraphML can be used for graphically rep-resenting not only the closeness centralities of individual performers but also the degree of group closeness centrality of specific workflow-supported org-social networks. Especially, the rationale of the ccWSSN-GraphML is the fact that it is able to provide the independence between the closeness centrality measuring component and the closeness centrality visualizing component of the workflow-supported org-social networking knowledge discovery and analysis system to be implemented by the authors' research group in the near future. In other words, it is possibly done for the visualizing component to visualize a variety of graphical shapes and colors in representing the closeness centralities of workflow performers without the interferences or revisions of the internal measuring component of the system, and *Vice versa*.

3. Conclusions

In this paper, we described one of the efforts that the authors' research group has been done in order to develop an effective way of measuring and visualizing the knowledge and collaborative behaviors among workflow performers. At this moment, it is important to emphasize again that the measuring component and the visualizing component in developing a workflow knowledge discovery and analysis system can be assured of the independence, each other, through the proposed ccWSSN-GraphML. Therefore, the knowledge visualizing component developers need not to be concerned about changing and revising the graphical shapes and colors to effectively visualize the measurements of the closeness centralities of workflow performers. At the same time, the knowledge analyzing component developers won't be worried about how the volumes and scales of the measured and calculated closeness centralities may cause to change the shapes or colors of the corresponding graphical components and representations of the workflow-supported org-social network and its analysis results. Likewise, as a future work, we need to develop graph markup languages to be applied to the remainder centrality analysis techniques, like betweenness and eigenvalue centralities of workflow-supported org-social networks.

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