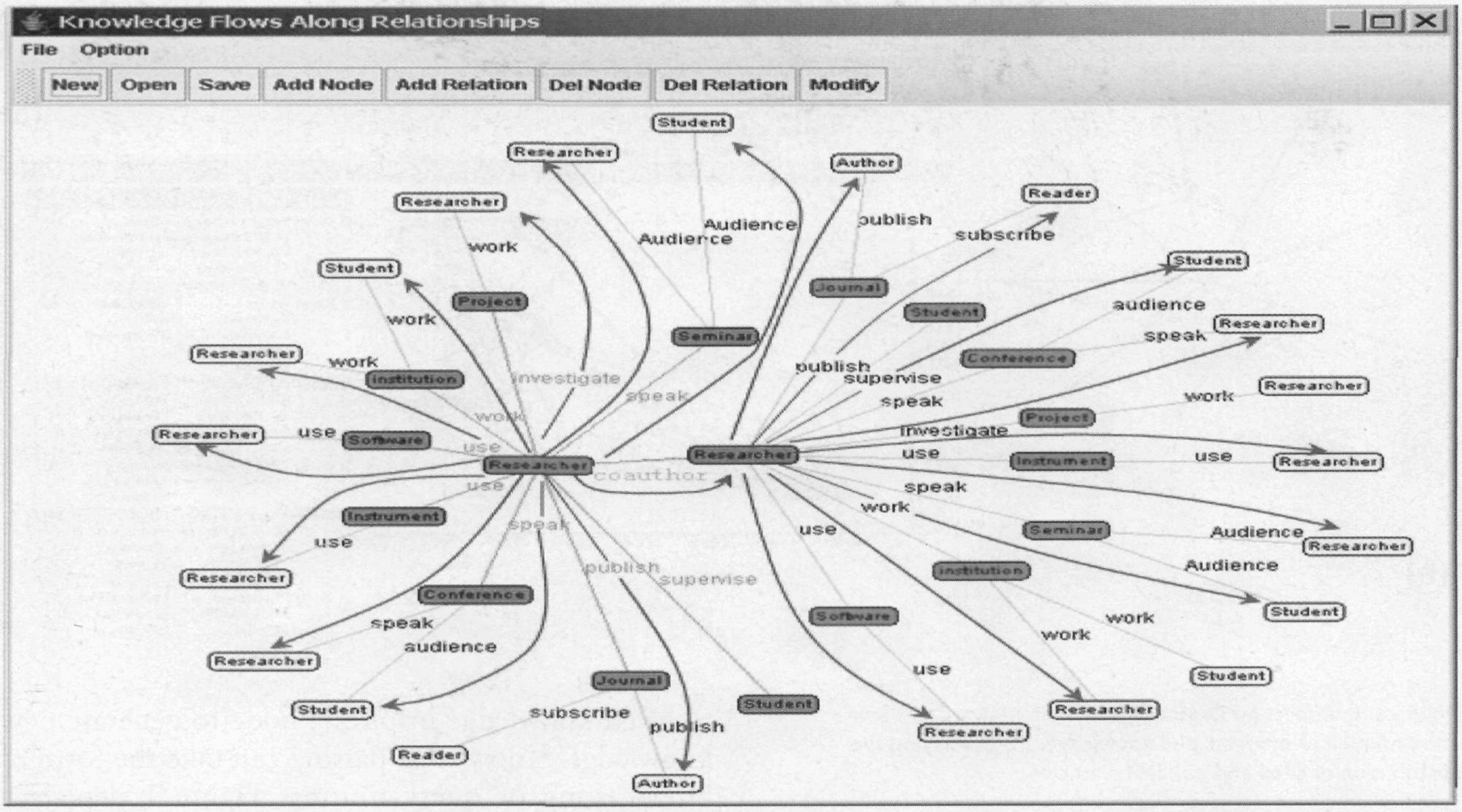

Figure 3. A visual semantic map organized according to interest. The red arcs denote knowledge flowing along the semantic links between scientists and scientific activities.

knowledge. An effective knowledge flow network enables a research team to be very powerful in generating new knowledge if every node can innovate and output new knowledge to appropriate members.

Recording the evolution of knowledge flows among authors needs a semantic space of three dimensions: *article*, *author*, and *time* as shown in Figure 1. An orthogonal classification semantic space called the Resource Space Model can ensure the correctness of operations on the space [10]. Storing knowledge requires a semantic space with three dimensions: *knowledge level*, *area*, and *location*. *Concept*, *axiom*, *rule*, *method*, and *theory* are coordinates of the knowledge level. Invisible knowledge flow networks self-organize and evolve continuously and interact with each other through flows to form an autonomous knowledge space for providing advanced knowledge services.

Knowledge energy and strategy of cooperation. Like energy in the physical world, knowledge energy reflects knowledge differences between nodes. A high-energy knowledge node in science has many articles being cited by peers, that is, it emits more knowledge and contributes more to an area. Reflecting the development of a discipline, the distribution of knowledge energy in a network changes as its citation network evolves. Maintaining knowledge energy differences between knowledge nodes and ensuring that only needed knowledge is passed between nodes are critical to realizing an effective knowledge flow spiral. Maintaining openness is a strategy for the sustainable development of knowledge flow within a research community.

The hyperlink network evolves under the "rich get richer" rule [6]—higher-ranking nodes have more energy to attract new links. For the same reason, highly cited articles attract more citations as the citation network evolves. However, the knowledge flow network evolves in a more complex and dynamic way. A high-energy knowledge node puts out more knowledge than low-energy nodes. However, the release of knowledge does not lead to the loss of energy: knowledge energy does not obey the physical world's law of the conservation of energy.

Knowledge energy can differentiate the capability of intelligent agents in large autonomous networks. Enhancing inflow, that is, selecting the appropriate higher-energy nodes to cooperate, is a strategy to increase the efficiency of knowledge flow networking. Our experiment shows that knowledge routing in a peer-to-peer autonomous network can attain higher efficiency if higher energy nodes are more likely to be selected at each hop.

Trusted team members ensure the effectiveness of knowledge sharing. In a trusted community, high-energy nodes that keep helping others will obtain