

INTERACTION-ORIENTED PROGRAMMING FOR THE WEB  
A Position Statement for the  
CoopIS-97 Panel on  
Cooperative Multi-Agent Systems for the Web

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Everyone agrees that the Web is a Good Thing, assuming we can get a handle on it; some think agents are a Good Thing as well, assuming we can use them to get a handle on something. It stands to reason the two should come together. And indeed they have. However, the agents of today are for the most part simple programs by a fancy name. Don't get me wrong: simplicity is a great thing. However, buzzwords aren't.

Agents are a metaphor for computations when the computations are persistent, autonomous, able to perceive, reason, and act, and to communicate with other such computations. The last is important: to all reasonable ends, the agent metaphor comes into its own only when the agents are communicative—social, if you will—and not autistic.

The Web is a natural home for social agents. The Web has many sources, the agents can project them; the Web has many users, the agents can represent them; the Web has many contexts, the agents can customize them. There are many aspects to personalizing the Web - you need techniques to find the information, retrieve it, filter it, fuse it, and present it. There is much to these techniques, and several people are studying their nuances. However, most current work focuses on the algorithmic or indexing aspects local to an agent or resource, and not on the interactional aspects involving multiple agents and resources.

It is these aspects that I focus on. I have been proposing a framework for developing multiagent systems, which I dub *interaction-oriented programming (IOP)*. IOP studiously emphasizes what is between, rather than within agents. In this manner, it seeks to maximize design autonomy in the construction of agents. IOP has three chief components:

- *coordination*, which enables the agents to operate in a shared environment
- *commitment*, which reflects the agents' obligations to one another, capturing the social structure of multiagent systems and the norms governing their behavior
- *collaboration*, which deals with knowledge-level constraints on communications.

Informal concepts may be classified into different layers. For example, cooperation can involve commitments or collaboration. Similarly, competition can reside in all three layers: bidding in an auction requires no more than coordination, whereas commerce involves commitments, and negotiation involves sophisticated protocols.

Pieces of the above have been studied, albeit fragmentarily, in areas as diverse as distributed computing (DC), databases (DB), and distributed artificial intelligence (DAI). The DB and DC work focuses on narrower problems of synchronization, and eschews high-level concepts such as social commitments. Thus it is less flexible, but more robust, than the DAI work. The challenge is to enhance and synthesize the above ideas into a framework that is rigorous yet flexible.

The approach we are developing includes *services* corresponding to the above three layers. Each service is customizable in that it takes explicit specifications of its desired behavior in a given class of applications. The presentation will have examples. I close with some citations [1, 2, 3, 4], which have additional technical details.

## References

- [1] Michael N. Huhns and Munindar P. Singh. Conversational agents. *IEEE Internet Computing*, 1(2):73–75, April 1997. Instance of column *Agents on the Web*.
- [2] Munindar P. Singh. *Multiagent Systems: A Theoretical Framework for Intentions, Know-How, and Communications*. Springer Verlag, Heidelberg, Germany, 1994.
- [3] Munindar P. Singh. Commitments among autonomous agents in information-rich environments. In *Proceedings of the 8th European Workshop on Modelling Autonomous Agents in a Multi-Agent World (MAAMAW)*, May 1997.
- [4] Munindar P. Singh. A customizable coordination service for autonomous agents. <http://www.csc.ncsu.edu/faculty/mpsingh/papers/mas/coord.ps>, April 1997.