

Research Statement

My general area of research is Artificial Intelligence (AI) and Multi-Agent Systems (MAS). My long-term research goal is to understand intelligence and to build human knowledge into software agents to support decision making, to improve the productivity and adaptability of autonomous systems, and to support individual/team learning in complex and dynamic environments.

Philosophy. I see AI and MAS as an interdisciplinary science, both theoretical and applied. As a theoretical science, AI and MAS benefits from research carried out in cognitive science, psychology, sociology, economics and other fields. As an applied science, AI and MAS can provide intelligent tools for use in other areas and learn from the application of established methods to unique domains. Collaboration is an integral part of doing such interdisciplinary research. I am willing and able to work with researchers from other fields. Such collaboration is useful both to create joint projects and to serve as a mechanism for cross-fertilization between areas.

Distributed Intelligent Agent System (DIAS) Laboratory. I am leading the DIAS Laboratory which is funded by NSF, ACS (Association of College in South), CUR (Council on Undergraduate Research) and Trinity University. Our interdisciplinary research team consists of faculty from Computer Science, Sociology, Economics and Psychology in Trinity. Our team also collaborates with the computer scientists and sociologists in Oklahoma State University, Mississippi State University and George Mason University. We have also developed a partnership with Bexar County and City of San Antonio to utilize our system as a tool for understanding the urban dynamics of the City of San Antonio. We are among the first few multidisciplinary research groups in using multi-agent systems to study social problems in Southwest. The multidisciplinary background of our team is a guarantee for us to explore wide-spectrum applications and will foster further collaboration beyond the current disciplines we have.

Current Projects. We currently have four on-going projects: (1) *Cognitive Agents for Social Environments (CASE)*. CASE is a MAS architecture that captures the force that makes society and agent evolves as well as the highly cognitive decision-making process for an individual agent that sometimes follows intuition and bounded rationality. (2) *A Service-Oriented Architecture Approach to Multi-Agent Simulation*. We developed a MAS simulation which provides various services including representing large sets of data of varying types and visualize them. (3) *Advanced Data Structures and Algorithms for High Performance Parallel and Distributed Multi-Agent Systems*. We designed various load balancing schemes to efficiently spread work between multiple computers, processes and hard disks. (4) *Enabling Multidisciplinary Applications*. We explored multidisciplinary applications, including urban dynamics, GIS, multi-scale interactions, emergent behaviors, pattern formation, self-organization, etc. Our system is innovative. It is among the first few agent architectures to systematically study the multi-dimensional agent-to-agent interactions and has been implemented in multidisciplinary applications. This will contribute markedly to the multi-agent community in studying human social behaviors.

Future Directions. In the future, my research will continue the current work and apply the results to a wider range of applications. One direction my research could take is multi-agent games including learning agents and game design that supports learning and optimization from interaction with open-ended, dynamic environments that include multiple, autonomous data and knowledge sources. Examples of such domains include negotiations, auctions, social dilemma games, and market games. The learning-gaming combination forms a growing field of interdisciplinary research crossing multi-agent systems (design of really-learning agents in games) and socio-economic sciences (simulation of learning agents). It would include design of algorithms for learning from heterogeneous data sources, distributed in time and space, and simulation of market games in multi-agent systems (for e-business applications or socio-economic simulations). Multi-agent games are applicable in e.g. e-business, transportation logistics, health care planning, distributed recommendation, and economics.