Institute for Intelligent Systems

www.memphis.edu/iis/

-Available Resources-

IIS has a full suite of technologies that track emotions, eye movements, physiological responses, EEG, and behavioral sequences with data mining techniques

The IIS **Coh-Metrix** system (www.cohmetrix.com) automatically analyzes texts on multiple levels of language and discourse, serving nearly 10,000 users throughout the world It is the only website of this sophistication that is free to use.

SEMILAR, a semantic similarity toolkit, won two international competitions with objective evaluations of automated assessment of semantic similarity. IIS researchers partner with universities throughout the world on these automated assessments of meaning, semantics, and world knowledge. (www.cs.memphis.edu/~vrus/)

The **Institute for Intelligent Systems (IIS)** works to advance the science and capabilities of intelligent systems, including psychological, biological, and artificial systems. This highly interdisciplinary research center involves more than three dozen faculty from computer science, engineering, psychology, philosophy, linguistics, mathematics, education, English, physics, biology, and communication sciences. IIS research is supported by the National Science Foundation, multiple branches of the US Department of Defense, the Institute of Education Sciences, and the National Institutes of Health, with annual research expenses of $5 million. Its primary contributions are in artificial intelligence, adaptive learning environments, and language and discourse.

IIS serves as a central hub for advanced learning environments for the Department of Defense. We are the primary university partner of the Army Research Laboratory for the Generalized Intelligent Framework for Tutoring (www.gifttutoring.org), we are supported to develop custom STEM tutoring systems (ElectronixTutor) for the Office of Naval Research, and are the primary university partner with the Advanced Distributed Learning mission of the Office of the Secretary of Defense (http://www.adlnet.gov/collaboration). We are also partners in the only nationally funded research center for adult literacy, the Center for the Study of Adult Literacy (http://csal.gsu.edu/) in which we developed a version of our AutoTutor learning environment to help adults learn comprehension. And we are currently partnering with research centers throughout the world in building agent-based learning environments with a suite of authoring tools we have developed.

-Discoveries/Illustrative Projects-

IIS researchers were among the early developers and testers of latent semantic analysis (LSA), a statistical representation of word and world knowledge that could capture a text corpus of the size of Wikipedia into 300 dimensions (home.dsspp.com). We are also conducting dozens of projects in artificial intelligence, machine learning, computational linguistics, dynamical systems, and sensing technologies. These computational approaches are woven into the scientific theories, methods, and applications that help us understand human learning, emotions, problem solving, reasoning, memory, attention, language, discourse, personality, and other psychological phenomena. Two signature projects have received international attention:

Advanced learning environments with conversational agents. Individuals learn about difficult subject matters by holding a conversation in natural language. These systems integrate advances in computational linguistics, artificial intelligence, information retrieval, knowledge representation, and discourse analytics. AutoTutor (www.autotutor.org) was the first agent developed in 1997, and nearly two dozen agent-based learning environments have evolved since then, including DeepTutor (www.deeptutor.org) for physics and more recently ElectronixTutor for sailors learning about electronic circuits in the Navy. Learning gains from these systems are equivalent to expert human tutors and substantially higher than conventional educational settings. We developed the first intelligent tutoring system that showed learning gains through the tracking of emotions of the learner in addition to their knowledge states. The IIS established that the important emotions associated with deep learning are confusion, frustration, boredom, and flow/engagement. Confusion is a particularly important affective-cognitive state to promote deep learning, so we successfully orchestrated conversational agents to create cognitive disequilibrium and thereby cause deeper learning.

Representation of semantics and world knowledge. Meaning, semantics, and world knowledge have historically been difficult to represent computationally. IIS researchers have been pioneers in advancing computational linguistics, informational retrieval, statistical representations of semantic spaces, and machine learning to create breakthroughs in in this arena. For the first time ever, we have documented impressive assessments of the extent to which one text A is relevant to another text B, the novelty and relevance of contributions of participants in a conversation, the coherence of a politician in a speech, the quality of a student's summary of any arbitrary subject matter, and the quality of contributions in a tutorial conversation. Some of these advances have been in languages other than English, such as Chinese, Arabic, and Spanish.