Web Intelligence, World Knowledge and Fuzzy Logic -- The Concept of Web IQ (WIQ)

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Fuzzy Conceptual Matching: Tool for Intelligent Knowledge Management and Discovery in the Internet

Given the ambiguity and imprecision of the "concept" in the Internet, which may be described with both textual and image information, the use of *Fuzzy Conceptual Matching* (*FCM*) is a necessity for search engines. In the *FCM* approach, the "concept" is defined by a series of keywords with different weights depending on the importance of each keyword. Ambiguity in concepts can be defined by a set of imprecise concepts. Each imprecise concept, in fact, can be defined by a set of fuzzy concepts. The fuzzy concepts can then be related to a set of imprecise words given the context. Imprecise words can then be translated into precise words given the ontology and ambiguity resolution through a clarification dialog. By constructing the ontology and fine-tuning the strength of links (weights), we could construct a fuzzy set to integrate piecewise the imprecise concepts and precise words to define the ambiguous concept.

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From Search Engines to Question-Answering Systems - The Need for New Tools

Search engines, with Google at the top, have many remarkable capabilities. But what is not among them is the deduction capability--the capability to synthesize an answer to a query by drawing on bodies of information which are resident in various areas of the knowledge base. It is this capability that differentiates a *q*uestion-*a*nswering *s*ystem (*Q/A*-system) from a search engine.

Question-answering systems have a long history. Search engines as we know them today owe their existence and capabilities to the web. Upgrading a search engine to a *Q/A* system is a complex, effort-intensive and open-ended problem. Semantic web and related systems may be viewed as steps in this direction. However, the thrust of the following is that substantial progress is unattainable through the use of existing tools, which are based on bivalent logic and probability theory. The principal obstacle is the nature of world knowledge. Reflecting the bounded ability of sensory organs, and ultimately the brain, to resolve detail and store information, perceptions are intrinsically imprecise. The imprecision of perceptions puts them well beyond the reach of existing methods of meaning-representation based on predicate logic and probability theory. What this implies is that new tools are needed to deal with world knowledge in the context of search, deduction and decision analysis.

The principal new tool is based on the recently developed methodology of *c*omputing with *w*ords and *p*erceptions (*CWP*). The point of departure in *CWP* is the assumption that perceptions are described in a natural language. In this way, computing with perceptions is reduced to computing with propositions drawn from a natural language, e.g., "If *A*/person works in *B*/city then it is likely that *A* lives in or near *B*." A concept which plays a key role in *CWP* is that of *p*recisiated *n*atural *l*anguage (*PNL*). A proposition, *p*, in *NL* is precisiable if it is translatable into a precisiation language. In the case of *PNL*, the precisiation language is the *g*eneralized *c*onstraint *l*anguage (*GCL*). By construction, *GCL* is maximally expressive. One of the principal functions of *PNL* is that of serving as a knowledge-description language and, more particularly, as a world-knowledge-description language. In this context, *PNL* is employed to construct what is referred to as *e*pistemic (knowledge-directed) *l*exicon (*EL*).

The BISC Initiative: Fuzzy Logic and the Internet (FLINT); Perception based Information Processing and Analysis

This project is focused on the need for an initiative to design an intelligent search engine based on two main motivations:

The web environment is, for the most part, unstructured and imprecise. To deal with information in the web environment, we need a logic that supports modes of reasoning that are approximate rather than exact. While searches may retrieve thousands of hits, finding decision-relevant and query-relevant information in an imprecise environment is a challenging problem, which has to be addressed. Another

less obvious issue is deduction in an unstructured and imprecise environment given the huge stream of complex information.

As a result, intelligent search engines with growing complexity and technological challenges are currently being developed. This requires new technology in terms of understanding, development, engineering design, and visualization. While the technological expertise of each component becomes increasingly complex, there is a need for better integration of each component into a global model adequately capturing the imprecision and deduction capabilities.

The objective of this initiative is to develop an intelligent computer system with deductive capabilities to conceptually match and rank pages based on predefined linguistic formulations and rules defined by experts or based on a set of known homepages. The *C*onceptual *F*uzzy *S*et (*CFS*) model will be used for intelligent information and knowledge retrieval through conceptual matching of both text and images (here defined as "Concept"). The selected query doesn't need to match the decision criteria exactly, which gives the system a more human-like behavior. The *CFS* can also be used for constructing fuzzy ontology or terms related to the context of search or query to resolve the ambiguity. Also the expert knowledge with soft computing tools of Berkeley groups will be combined.

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Biography

Lotfi A. Zadeh is a Professor in the Graduate School, Computer Science Division, Department of EECS, University of California, Berkeley. In addition, he is serving as the Director of *BISC* (*B*erkeley *I*nitiative in *S*oft *C*omputing).

Prof. Lotfi A. Zadeh is an alumnus of the University of Teheran, MIT and Columbia University. He held visiting appointments at the Institute for Advanced Study, Princeton, NJ; MIT; IBM Research Laboratory, San Jose, CA; SRI International, Menlo Park, CA; and the Center for the Study of Language and Information, Stanford University. His earlier work was concerned in the main with systems analysis, decision analysis and information systems. His current research is

focused on fuzzy logic, computing with words and soft computing, which is a coalition of fuzzy logic, neurocomputing, evolutionary computing, probabilistic computing and parts of machine learning. The guiding principle of soft computing is that, in general, better solutions can be obtained by employing the constituent methodologies of soft computing in combination rather than in stand-alone mode.

Prof. Zadeh is a fellow of the IEEE, AAAS, ACM and AAAI, and a member of the National Academy of Engineering. He held NSF Senior Postdoctoral Fellowships in 1956-57 and 1962-63, and was a Guggenheim Foundation Fellow in 1968. **Prof. Zadeh** was the recipient of the IEEE Education Medal in 1973 and a recipient of the IEEE Centennial Medal in 1984. In 1989, **Prof. Zadeh** was awarded the Honda Prize by the Honda Foundation, and in 1991 received the Berkeley Citation, University of California.

In 1992, **Prof. Zadeh** was awarded the IEEE Richard W. Hamming Medal "For seminal contributions to information science and systems, including the conceptualization of fuzzy sets." He became a Foreign Member of the Russian Academy of Natural Sciences (Computer Sciences and Cybernetics Section) in 1992 and received the Certificate of Commendation for AI Special Contributions Award from the International Foundation for Artificial Intelligence. Also in 1992, he was awarded the Kampe de Feriet Prize and became an Honorary Member of the Austrian Society of Cybernetic Studies.

In 1993, **Prof. Zadeh** received the Rufus Oldenburger Medal from the American Society of Mechanical Engineers "For seminal contributions in system theory, decision analysis, and theory of fuzzy sets and its applications to AI, linguistics, logic, expert systems and neural networks." He was also awarded the Grigore Moisil Prize for Fundamental Researches, and the Premier Best Paper Award by the Second International Conference on Fuzzy Theory and Technology. In 1995, **Prof. Zadeh** was awarded the IEEE Medal of Honor "For pioneering development of fuzzy logic and its many diverse applications." In 1996, **Prof. Zadeh** was awarded the Okawa Prize "For outstanding contribution to information science through the development of fuzzy logic and its applications."

In 1997, **Prof. Zadeh** was awarded the B. Bolzano Medal by the Academy of Sciences of the Czech Republic "For outstanding achievements in fuzzy mathematics." He also received the J.P. Wohl Career Achievement Award of the IEEE Systems, Science and Cybernetics Society. He served as a Lee Kuan Yew Distinguished Visitor, lecturing at the National University of Singapore and the Nanyang Technological University in Singapore, and as the Gulbenkian Foundation Visiting Professor at the New University of Lisbon in Portugal. In 1998, **Prof. Zadeh** was awarded the Edward Feigenbaum Medal by the International Society for Intelligent Systems, and the Richard E. Bellman Control Heritage Award by the American Council on Automatic Control. In addition, he received the Information Science Award from the Association for Intelligent Machinery and the SOFT Scientific Contribution Memorial Award from the Society for Fuzzy Theory in Japan. In 1999, he was elected to membership in Berkeley Fellows and received the Certificate of Merit from IFSA (International Fuzzy Systems Association). In 2000, he received the IEEE Millennium Medal; the IEEE Pioneer Award in Fuzzy Systems; the ASPIH 2000 Lifetime Distinguished Achievement Award; and the ACIDCA 2000 Award fot the paper, "From Computing with Numbers to Computing with Words --

From Manipulation of Measurements to Manipulation of Perceptions." In 2001, he received the ACM 2000 Allen Newell Award for seminal contributions to AI through his development of fuzzy logic.

Prof. Zadeh holds honorary doctorates from Paul-Sabatier University, Toulouse, France; State University of New York, Binghamton, NY; University of Dortmund, Dortmund, Germany; University of Oviedo, Oviedo, Spain; University of Granada, Granada, Spain; Lakehead University, Canada; University of Louisville, KY; Baku State University, Azerbaijan; the Silesian Technical University, Gliwice, Poland; the University of Toronto, Toronto, Canada; the University of Ostrava, Ostrava, the Czech Republic; the University of Central Florida, Orlando, FL; and the University of Hamburg, Hamburg, Germany; and the University of Paris(6), Paris, France. **Prof. Zadeh** has authored close to two hundred papers and serves on the editorial boards of over fifty journals. He is a member of the Advisory Board, Fuzzy Initiative, North Rhine-Westfalia, Germany; Advisory Board, Fuzzy Logic Research Center, Texas A&M University, College Station, Texas; Advisory Committee, Center for Education and Research in Fuzzy Systems and Artificial Intelligence, Iasi, Romania; Senior Advisory Board, International Institute for General Systems Studies; the Board of Governors, International Neural Networks Society; and is the Honorary President of the Biomedical Fuzzy Systems Association of Japan and the Spanish Association for Fuzzy Logic and Technologies. In addition, he is a member of the International Steering Committee, Hebrew University School of Engineering; a member of the Advisory Board of the National Institute of Informatics, Tokyo; a member of the Governing Board, Knowledge Systems Institute, Skokie, IL; and an honorary member of the Academic Council of NAISO-IAAC.