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Review Article

TOWARD DEVELOPMENT OF HUMAN-COMPUTER INTERACTION USING NATURAL LANGUAGE PROCESSING

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ABSTRACT
This paper presents the field of natural language processing as it relates to human- computer interaction. "One of the goals of HCI is the development of systems which match (and possibly augment) the physical, perceptual, and cognitive capabilities of users (Manaris, 1998). "NLP could be defined as the discipline that studies the linguistic aspects of human-human and human-machine communication, develops models of linguistic competence and performance (Manaris, 1998). It also presents Motivations and research areas of Natural Language Processing.

Keywords: *Natural Language Processing, Human-Computer Interaction, Development of Human-computer Interaction*

INTRODUCTION
The idea of giving computers the ability to process human language is as old as the idea of computers themselves (Jurafsky and Martin, 2008). According to Jurafsky and Martin (2008), Data processing systems require knowledge about what it means to be a word and thus becomes a language processing systems. Although the unrestricted NLP is still a very complex problem (and according to some, an AI-complete problem) (Manaris, 1998).

Manaris (1998)

Numerous successful systems exist for restricted domains of discourse. In the context of HCI, NLP applications range from various speeches recognition systems, to natural language interfaces to database, expert, and operating systems, to a multitude of machine translation systems. Currently, interactive applications may be classified along the following categories (Manaris and Slator, 1996; Obermeier, 1988):

- Speech Recognition/Understanding and Synthesis/Generation
- Natural Language Interfaces
- Discourse Management, Story Understanding, and Text Generation
- Interactive Machine Translation
- Intelligent Writing Assistants (pp. 2-3)

Jurafsky and Martin (2008) found "The goal of this new field (Natural Language Processing) is to get computers to perform useful tasks involving human language, tasks like enabling human-machine communication, improving human-human communication, or simply doing useful processing of text or speech."(p. 1)

The Scientific Motivation

Manaris (1998)

The scientific motivation is to understand the nature of language. Other traditional disciplines, such as linguistics, psycholinguistics, and philosophy, do not have tools to evaluate extensive theories and models of language comprehension and production. It is only through the tools provided by computer science that one may construct implementations of such theories and models. These implementations are

indispensable in exploring the significance and improving the accuracy (through iterative refinement) of the original theories and models (p. 5).

The Technological Motivation

Manaris (1998)

The technological motivation is to improve communication between humans and machines. Computers equipped with effective natural language models and processes could access all human knowledge recorded in linguistic form; considering the revolution in information dissemination and communication infrastructure that has been introduced by the World-Wide-Web, one could easily see the importance and potential of such systems. User interfaces with natural language modalities (either input or output, spoken or typewritten) would enhance human-computer interaction by facilitating access to computers by unsophisticated computer users, users in hands-busy/eyes-busy situations (such as car driving, space walking, and air traffic control tasks), and users with disabilities. Actually, the development of this technology for the latter group is motivated by federal legislation and guidelines, such as (a) the US Public Laws 99-506 and 100-542 which mandate the establishment of accessible environments to citizens with disabilities, (b) the 1989 US General Services Administration's guide, Managing End User Computing for Users with Disabilities, which describes accommodations for disabled computer users (Shneiderman, 1993), and (c) the 1996 Telecommunication Act. In this context, it does not matter how closely the model captures the complexity of natural language communication; it only matters that the resultant tool performs satisfactorily in a given domain of discourse, or complements/outperforms any alternative solutions. This article adheres to this perspective in presenting and discussing various NLP theories, models, and application (p. 5).

Research Areas of Natural Language Processing

Manaris (1998)

In this context, and given the state-of-the-art, NLP could be defined as the discipline that studies the linguistic aspects of human-human and human-machine communication, develops models of linguistic competence and performance (Chomsky (1965) defines competence as the linguistic knowledge of fluent speakers of a language, and performance as the actual production and comprehension of language by such speakers (Akmajian *et al.*, 1990), employs computational frameworks to implement processes incorporating such models, identifies methodologies for iterative refinement of such processes/models, and investigates techniques for evaluating the resultant systems (p. 5).

Manaris (1998)

NLP is an interdisciplinary area based on many fields of study. These fields include computer science, which provides techniques for model representation, and algorithm design and implementation; linguistics, which identifies linguistic models and processes; mathematics, which contributes formal models and methods; psychology, which studies models and theories of human behavior; philosophy, which provides theories and questions regarding the underlying principles of thought, linguistic knowledge, and phenomena; statistics, which provides techniques for predicting events based on sample data; electrical engineering, which contributes information theory and techniques for signal processing; and biology, which explores the underlying architecture of linguistic processes in the brain. (p. 5)

Web Based Question Answering Systems

This is a generalization of simple Web-search, where instead of just typing keywords, a user might ask complete questions (Jurafsky and Martin, 2008).

Jurafsky and Martin (2008)

Definition questions, or simple factoid questions like dates and locations, can already be answered by search engines. But answering more complicated questions might require extracting information that is embedded in other text on a Web page, doing inference (drawing conclusions based on known facts), or synthesizing and summarizing information from multiple sources or Web pages (p. 2).

There are questions we all face during the day and we all need **intelligence question answering systems**. According to Jurafsky and Martin (2008), "robust question-answering systems require much broader and deeper **knowledge of language**".

User Inerfaces

(Manaris, 1998)

As the use of computers is expanding throughout society and affecting various aspects of human life, the number and heterogeneity of computer users is dramatically increasing. Many of these users are not computer experts; they are experts in other fields who view the computer as a necessary tool for accomplishing their tasks (Day and Boyce, 1993). Consequently, the user-friendliness and robustness of interactive computer systems is becoming increasingly more essential to user acceptability and overall system performance. (p. 3)

Manaris (1998)

When examining the evolution of software systems, we observe a definite transition from the languages understood by the underlying hardware, i.e., languages based on binary alphabets, to the natural languages of humans (Feigenbaum, 1996; Firebaugh, 1988). In terms of programming languages, this transition is manifested as a shift from machine languages to assembly languages, to high-level languages, up to non-procedural languages (also known as fourth generation languages). The goal of natural language interfaces is to bridge the gap between the linguistic performance of the user and the linguistic "competence" of the underlying computer system. These systems deal with typewritten as opposed to spoken language. They usually perform much deeper linguistic analysis than traditional speech recognizers (pp. 10-11).

Manaris (1994) & Manaris and Slator (1996) found "Applications have been built for various domains including operating systems, databases, text editors, spreadsheets, and Internet navigation and resource location." (As cited in Manaris, 1998, p. 11)

According to Church and Rau (1995) & Obermeier (1988) "Examples of natural language interfaces that have been marketed include Battelle's Natural Language Query, BBN's Parlance, EasyTalk, English Query Language, INTELLECT, Intelligent Query, Language Craft, Natural Language, Symantec's Q+A Intelligent Assistant, and Texas Instrument's Natural Access" (As cited in Manaris, 1998, p. 11).

NLP Tools and Human-Computer Interaction

Manaris (1998)

One of the goals of HCI is the development of systems which match (and possibly augment) the physical, perceptual, and cognitive capabilities of users. The field of NLP offers mechanisms for incorporating natural language knowledge and modalities into user interfaces. As NLP tools are becoming more powerful in terms of functionality and communicative capabilities, their contribution to HCI is becoming more significant (p. 3).

Manaris (1998)

As the relationship between NLP tools and HCI matures, more sophisticated systems are emerging– systems which combine intelligent components with various communicative modalities, such as speech input and output, non-speech audio, graphics, video, virtual environments, and telepresence. As the two fields become more integrated, new developments will make it possible for humans to communicate with machines which emulate many aspects of human-to-human interaction. These new interfaces will transform computers from machines which are visible, and attention-grabbing, to tools that are transparent and embedded; these tools will be so natural to use that they may become part of the context, in such a way that the user may be able focus on the task and not the actual tool (Weiser, 1994; Winogard and Flores, 1986, p. 164) (p. 4).

Brief History of User-Centerd Phase

Manaris (1998)

In the late 1980s, NLP entered the current empirical, evaluative, "user-centered" phase. Major advances and tangible results from the last fifty years of NLP research are being reinvestigated and applied to a wide spectrum of tasks where NLP can be applied. These tasks require "real-life" models of linguistic knowledge, as opposed to the models incorporated in earlier "toy" systems. Consequently, many successful NLP applications are emerging including spelling checkers, grammar checkers, and limited-

domain, speaker-independent, continuous-speech recognizers for various computer and telephony applications (p. 9).

Manaris and Slator (1996) found "During this phase, the field of human-computer interaction enters the mainstream of computer science. This is a result of the major advances in graphical user interfaces during the 1980s and early 1990s, the proliferation of computers, and the World-Wide-Web (As cited in Manaris, 1998, p. 9).

Manaris (1998)

According to Chinchor and Sundheim (1993), Hirschman and Cuomo (1994), Moore (1994), Pallett *et al.*, (1994) and Spark Jones (1994) "Due to the "user-centeredness" of this phase, theories as well as applications are being judged ability by their ability to successfully compete in structured evaluations or in the marketplace" (As cited in Manaris, 1998, p. 9).

CONCLUSION

Jurafsky and Martin (1998)

Understanding human language processing is an important scientific goal in its own right and is part of the general field of cognitive science. However, an understanding of human language processing can often be helpful in building better machine models of language (p. 14).

"Currently, the field of Natural language processing includes a wide variety of linguistic theories, cognitive models, and engineering approaches (Manaris, 1998). "Since an important application of speech and language processing systems is for human-computer interaction, it makes sense to copy a solution that behaves the way people are accustomed to (Jurafsky and Martin, 2008).

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