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The Development of a Natural Language Generation System For Personalized e-Health Information

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Abstract

Personalization—adaptivity to the individual—is becoming an essential component of any computer-based system. In e-health systems, personalization of health information is emerging as a key factor in the trend to patient-centric care. Patient-centric healthcare aims to engage patients in their treatment to promote greater compliance and satisfaction with their therapeutic regimens, resulting in both better patient outcomes and reduced healthcare costs. We have developed a prototype Web-based Natural Language Generation system for the authoring and subsequent personalization of patient education materials. Our initial domain of application is reconstructive breast surgery, but our Natural Language software tools and authoring methodologies are generally applicable to all medical interventions.

Keywords:

patient education; personalized e-Health; natural language generation; artificial intelligence

Introduction

E-health services are playing an increasingly important role in health-care management by providing relevant and timely information to patients about their medical care. An important factor in the rapid growth of online health services is the trend in health management to *patient-centric* health care: patient-centric care aims to involve the patient directly in the medical decision-making process by providing better access to the relevant information that patients need to understand their medical condition and to enable them to make more-informed decisions about their prescribed treatment.

An important new approach in patient-centric care is through 'Information Therapy': prescribing the right information to the right person at the right time. Ideally, Information Therapy promises to deliver specific medical information to individual patients at just the right time to assist with decision-making or behaviour changes [5]. So far, however, the kinds of information delivered through specific patient portals or other individualized 'information prescriptions' is still quite generic (Claudette DeLenardo, Program Director, My CARE Source Patient Portal, Grand River Hospital, personal communication).

An effective means of providing patient-centric healthcare would be through the personalization of health information: with individually tailored information, the patient would be both better-educated about their specific condition and better able to make informed decisions. As a key element in e-health services, personalized health education has great potential to provide relevant, patient-specific information that would integrate the clinical process with 'anywhere, anytime' healthcare delivery to produce both better-informed patients and enhanced patient outcomes. Some improvements in patient outcomes we may hope to see: greater compliance and satisfaction with therapeutic regimens, fewer complications, shorter hospital stays, and fewer return visits.

Natural Language Generation System for personalized health information

The fundamental problem in personalization of patient education is that the process involves much more than just producing each brochure or leaflet in half a dozen different versions for different audiences. Rather, the number of different combinations of factors can easily be in the tens or hundreds of thousands. It is impossible to produce and distribute, in advance of need, the large number of different editions of each publication that is entailed by individual tailoring of health information. Recently, researchers in Natural Language Generation have begun to apply methods from Artificial Intelligence and Computational Linguistics to develop automated systems for tailoring health information to individual patients (e.g., [1][4][6]).

The key components in our health information tailoring system are:

- Creation of corpora of content variants written in language that will engage the patient and address individual concerns.
- A *Physician's Authoring Tool* that assists the physician in mapping from the various options at each stage of a medical intervention to corresponding content variations.
- *A Natural Language Generation Tailoring Engine* that will automatically select, assemble, and revise content from a library of reusable text to produce a customized version for an individual patient [2].

Project team roles and competencies

The HealthDoc Project (1994-present) [3] involves team members from the University of Waterloo, the Waterloo Institute for Health Informatics Research, the University Health Network of the University of Toronto, and the University of Southern California. Our project team includes a wide variety of academic, clinical, and health IT professionals fulfilling the following roles:

Health IT Leader: A professional who provides strategic leadership regarding all aspects of IT/IM for health organizations.

Healthcare Providers: Clinicians who provide specifications for design of our technology based on their day-to-day practices and who evaluate our systems and software tools.

Patient Education Providers: Experts in patient education are available to our project as advisors and evaluators through the University Health Network (University of Toronto) and Grand River Hospital (Kitchener-Waterloo).

Health Portal Developers: Experts in development of health portal systems and software tools.

Computational Linguists: Researchers in theory and design of Natural Language Generation systems.

Linguists: Researchers in rhetoric of medical language, physician/patient communication, and communication design.

Software Manager: Professional software developer who oversees all aspects of system design and development.

A pilot tailoring system

The initial stage of our project focused on the creation of a corpus of patient-specific educational content by our surgeon team members covering a selected subprocedure of reconstructive breast surgery. We developed an initial Web-based authoring environment that allows the medical domain expert to interact directly with the system from any provider location.

To demonstrate the results of our research so far, we implemented a pilot Web-based delivery system for generating tailored health information materials. The pilot system integrates the main components of our project—the corpus of content variants, the Authoring Tool, and the Natural Language Generation Tailoring Engine—with a Web-based framework for delivery of tailored health education, i.e., a 'personal patient portal'. Several sample domains for tailored health information (e.g., smoking cessation, reconstructive surgery) have been tested with the pilot system.

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