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

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Preoperative Education

The Problem:

Patients only retain approximately 15% of information discussed prior to surgery

Preoperative Education

Possible solutions:

- "Take-away" information
- Brochures, booklets, etc
- Online information

How to take care of your wound from the operation

- Keep the bandage clean and dry at all times.
- Leave the bandage on until you return for your follow-up appointment.
- If your surgeon has told you to remove the bandage, do so as instructed.
- If you have Steri-strips® under the bandage (small white tapes), leave them in place. When they start to peel off, remove them and throw them away. Keep your arm or foot covered until the wound heals or the stitches have been removed (usually 7 to 10 days after the surgery).
- If you have stitches, they will be removed at your next follow-up appointment.

Preoperative Education

Potential benefits of improved information:

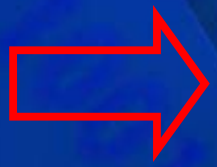
- Reduced anxiety
- Higher patient satisfaction
- Improved outcomes, therapy compliance

Our solution: Tailored information:

- Previous studies on tailoring:
  - Nutrition
  - Smoking cessation
  - Diagnostic testing (mammography)
- However, surgical literature sparse

The HealthDoc Approach:
'Generation-by-selection-and-repair'

Pre-author 'Master Document'



Selection

'Repair'

– Contains all text snippets needed for any patient

– Specific choices for individual patient

– Automatic restoration of good style

Authoring of the Master Document

Three levels of authoring:

- Knowledge level
  - Knowledge engineer
- Content level
  - Domain expert = Physician
- Deep-linguistic level (for repairs)
  - Computational linguist

Authoring: Knowledge level

- Knowledge engineer defines high-level structure of the master document.
- Goal: Map patient and physician concerns, components of surgical procedure, to organization of master document.
- Ideal: Authoring tool should maintain cognitive model to guide mapping of complementary, sometimes conflicting, concerns.

Authoring: Content level

A new model of composition

- Surgeon fills in raw ‘medicalese’ blocks of content in spreadsheet-like format.
- Rhetorician shapes content using models of argumentation:
  - Physician wants to *engage* patient, ensure *compliance*.
  - Patient wants *adaptivity* to preferred style of learning.
- Creation of stylistic variations:
  - By the physician.
  - By the rhetorician.
  - Automated?
- On-going: Modification by individual surgeon.

An Authoring Tool for Creating Tailorable Content

The Basic Tool: Specifications

- Domain expert directly enters textual variations, accompanied by Boolean selection conditions.
- Gradual editing at any re-entry point, by multiple authors.
- Automated checking of conditions for consistency and completeness.
- Displaying sets of text variations for validation.
- Many regular text-processing features:
  - cut-and-paste, spell-checking, thesaurus.

An Authoring Environment for Physicians: What would it look like?

- Both *push* and *pull* content authoring:
  - Physician directly enters procedure-specific text components (*push*).
  - Wizard-like query engine prompts author for details (*pull*).
- Reuse of discourse structure, text passages from similar surgical procedures.
- Natural Language Generation text-repair engines
  - Relieve physician of worrying how selected text will go together.
  - Need for both stylistic and semantic repair.

A Web-based Delivery System

- Automated transformation creates customization form from Master Document: Fill in form, press a button, display customized document.
- Can progressively update Master Document as add/refine surgical procedure, re-invoke transformation, view results.
- Using “Web Informatics Development Environment” (WIDE): wizard-like development of Web-based system that supports databases, shared virtual spaces, rich multimedia content.

References

- Bental DS, Cawsey AJ, and Jones R. Patient information systems that tailor to the individual. *Patient Education and Counselling*, 36, 1999.
- DiMarco C, Hirst G, and Hovy E. Generation by selection and repair as a method for adapting text for the individual reader. Flexible Hypertext Workshop, ACM Hypertext Conf, 1997.
- DiMarco C, Hirst G, Wanner L, Wilkinson J. HealthDoc: Customizing patient information and health education by medical condition and personal characteristics. Workshop on Artificial Intelligence in Patient Education, 1995.
- Green N. Generation of biomedical arguments for lay readers. Intl Nat Lang Gen Conf, 2006.
- Mettler M and Kemper DW. Information Therapy: Health education one person at a time. *Health Prom. Prac.* 4(3), 214-217, 2003.
- Reiter E, Robertson R, and Osman LM. Lessons from a failure: Generating tailored smoking cessation letters. *Artificial Intelligence*, 144, 41–58, 2003.

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