Health Spring Meeting
June 2009

Session # 88 PD: Data Mining and Patient Specific Information

Jim Del Vecchio
Chrysanne DiMarco, Ph.D.

Moderator:
Frank G. Reynolds, FSA, FCIA, EA, MAAA
Computer Generation of Personalized Health Persuasion Materials

Chrysanne DiMarco
University of Waterloo

Generating text with ‘personality’

- Computer-generated text tends to be bland and boring.
  - Generating any text ‘from scratch’ is still a hard AI problem.
- But in many situations, ‘computerspeak’ is a deterrent to people’s willingness to accept computer-generated text:
  - You should always use sunscreen. You should always wear a hat.
  - You should always wear sunscreen and it’s good to wear a hat as well.
- Our research: Assisting physicians to provide personalized information to patients about their health care.
Why we need personalized information

‘Generic’ health information either says too little or too much…

…and so isn’t useful: patients don’t get the advice they need.

A brochure with all information relevant to any reader…

– Complications of the surgery could include pain, scarring, swelling, infection, and discoloration. Numbness or neurologic problems may occur. The exact nature and duration of problems may not be determinable and may be irreversible. Other complications may involve inflammation of a vein, cardiovascular problems, injury to surrounding tissue, bone fractures, delayed healing, allergic reactions to drugs or medications, even death. In those cases where bone cement is used to secure implants in place, adverse reactions, including deep and surgical wound infection and a temporary lowering of blood pressure, may occur.

– Too much information won’t even be read!
Experiment:
Generating personalized anti-smoking letters

- Patients answered survey; later sent personalized letter.
  - Letters were produced by combining snippets of text:
    - You decided to quit smoking in order to make your clothes and breath smell better. By now everyone has probably noticed what a difference quitting has made. You should feel great about yourself now that your clothes and breath don’t smell like cigarette smoke and other people will enjoy being around you more. Smelling better is only one of many good things that will happen now that you have quit.
- Results: The recipients of personalized letters…
  - Read more of the document. And were three times more likely to quit smoking.

But mass personalization is hard for humans…

- All possible combinations of text snippets must make sense.
- All possible personalized brochures must sound well-written.
- This quickly becomes much too hard for humans to manage:
  - In experiment on anti-smoking, there were over 55,000 possible combinations of text snippets!
How AI can help:
‘Generation-by-selection-and-repair’

Our approach:
– Author a library ahead of time of reusable text.
– Contains all info needed for any patient.
– Info is marked up according to patient features.

Text snippets from library selected for a specific patient.
But combined text might sound repetitive or awkward.
So must ‘repair’ text to restore fluency.

What a “repair engine” might do

Suppose the following sentences are selected and turn up adjacent.
1) Non-insulin-dependent diabetes is the most common type of diabetes.
2) Non-insulin-dependent diabetes usually develops in adults over age forty, especially those who are overweight. The highlighted NPs have coreference links to the same object, so the second occurrence is marked for pronominalization.
3) Non-insulin-dependent diabetes is the most common type of diabetes. It usually develops in adults over age forty, especially those who are overweight.
Potentially many kinds of repairs…

Suppose the following sentences are selected:
1) The condition that you have is non-insulin-dependent diabetes.
2) Non-insulin-dependent diabetes is the most common type of diabetes.

The highlighted phrases indicate redundancies that can be repaired by combining—aggregating—the sentences:
3) The condition that you have is non-insulin-dependent diabetes, which is the most common type of diabetes.

But maybe the repair shouldn’t be made…

1) Smoking can lead to cancer.
2) Smoking can aggravate asthma.
3) Smoking can cost you financially.

A series of short repetitions might actually be more forceful than one long sentence:
4) Smoking can lead to cancer, aggravate asthma, and cost you financially.
But first we have to author the content (and this is hard)

Author must determine ‘workflow’ of the physician-patient encounter:
- In surgical intervention, physician must inform patient about each stage: pre-op, operation summary, post-op, complications, discharge plan, rehabilitation instruction, and more.
- Potentially many different patient “types” for each stage.

Author must consider purpose of information, what attitudes to convey to patient:
- In diabetes prevention intervention, health “coach” encourages, empathizes, but wants patient to be accountable for own wellness.
- Potentially thousands of combinations of rhetorical nuances.

Application: Diabetes prevention
A generic intervention model

First, determined ‘workflow’ of health coach-patient encounter.

In wellness advisory intervention, coach writes sequence of conversational ‘moves’, like acts in a play:
- Establish coach role.
- Establish community.
- Establish patient accountability.
- Address barriers and how to overcome.
- Remind goals.

Each move in sequence has a finely tailored piece of text.

Overall sequence forms personalized health persuasive model.
Application: Diabetes prevention
A rhetorical appraisal model

- Reviewed relevant literature in rhetorical theory and health behaviour models.
- Identified set of rhetorical dimensions describing different strategies coach may use:
  - **Social/situational**: Coach invokes sense of community to set expectations for patient.
  - **Agency**: Coach provides various tools (e.g., action plan) to help patient achieve goals.
  - **Accountability**: Coach role is to help patient assume responsibility for own health.
  - **Risk, Reward, Emotional Tone**, …

Application: Diabetes prevention
A promising start

- Team of rhetoricians analyzed manually written “coach” notes.
- Developed rhetoric models of personalized wellness advising.
- “Reverse-engineered” human notes into standardized repository.
- Used repository in our automated tailoring system to generate on-demand basic tailored wellness notes. Coach can now refine, add to basic note. Much less repetition!
Ongoing experiment:
Authoring and tailoring diabetes education

- Student rhetoricians simulate wellness coach-patient encounters.
- Write personalized persuasive notes about physical activity.
- Will use new “intelligent” authoring tool to enable reverse-engineering of human notes into standardized repository.

Outcomes—To evaluate various effects of tailoring:
- How behavioural factors map to rhetorical dimensions.
- Which factors matter for tailoring.
- Does finely tailored communication make a difference?
- Does the medium of delivery play a factor? (e.g. mobile devices)

Challenges in personalization of health persuasion

- How to say something to patients to convince them to do something? (take medication, have surgery, quit smoking)
- How to represent this linguistically rich knowledge in computer form?
- How to create computer ‘language experts’ capable of automatically detecting and revising text? (and multimedia?)
- How to get doctors and hospitals to use automated systems for patient education?
The HealthDoc Project
(1994–present)

- ‘Text-to-text’ generation by reuse of existing texts avoids hard problems of generation ‘from scratch’.
- But detailed personalization requires linguistically rich content embodying models of physician-patient communication.
- Fully automated solution will require solving open problems in intelligent authoring tools, automated text revision and ‘repair’.
- Many new and interesting research problems:
  - Health persuasion, personalization in e-health systems, mobile services as a conduit for personalized health info, patient self-access to electronic health record, ...

The HealthDoc Project: Academic and industrial partners

- Academic:
  - Computer Science (C. DiMarco, graduate students).
  - English (R. Harris, N. Randall, graduate students).
  - Waterloo Institute for Health Informatics Research (H.D. Covvey).
  - Princess Margaret Hospital (Dr. D. Wiljer).
  - Information Sciences Institute/USC (Dr. E. Hovy).

- Industrial:
  - DPS Health (tailored chronic disease management systems).
  - Nortel.