

Extracting Conceptual Relationships from Specialized Documents

Bowen Hui

Dept of Computer Science
University of Toronto

Eric Yu

Fac of Information Studies
University of Toronto



Motivation

- much of human knowledge is expressed in free text (vs. structured data)
- conceptual modeling towards semi and unstructured data
- similar initiatives to structure or mark up text for processing
- issues: level of representation, complexity of processing technique
- we propose simple conceptual model that allows efficient extraction

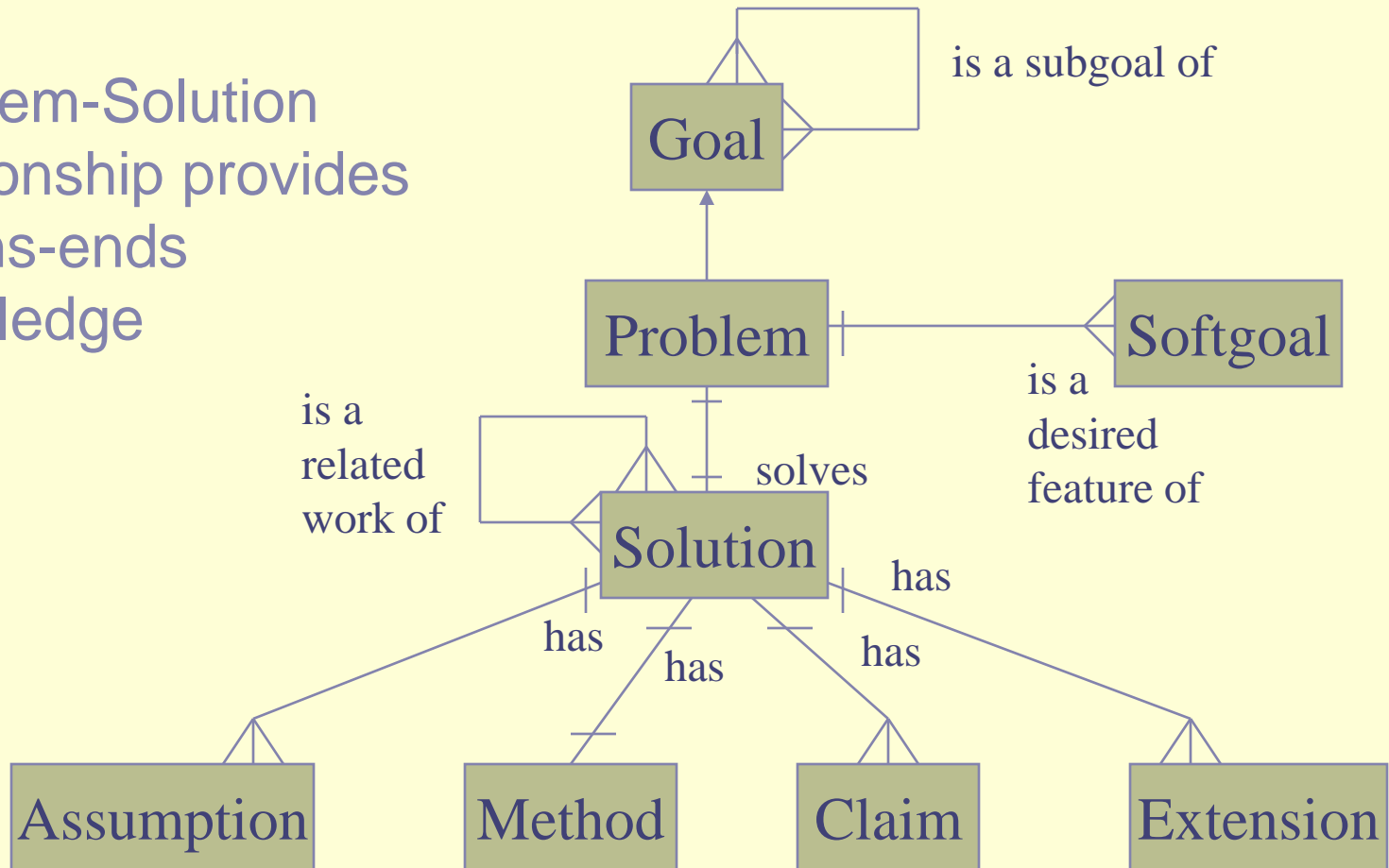


Outline

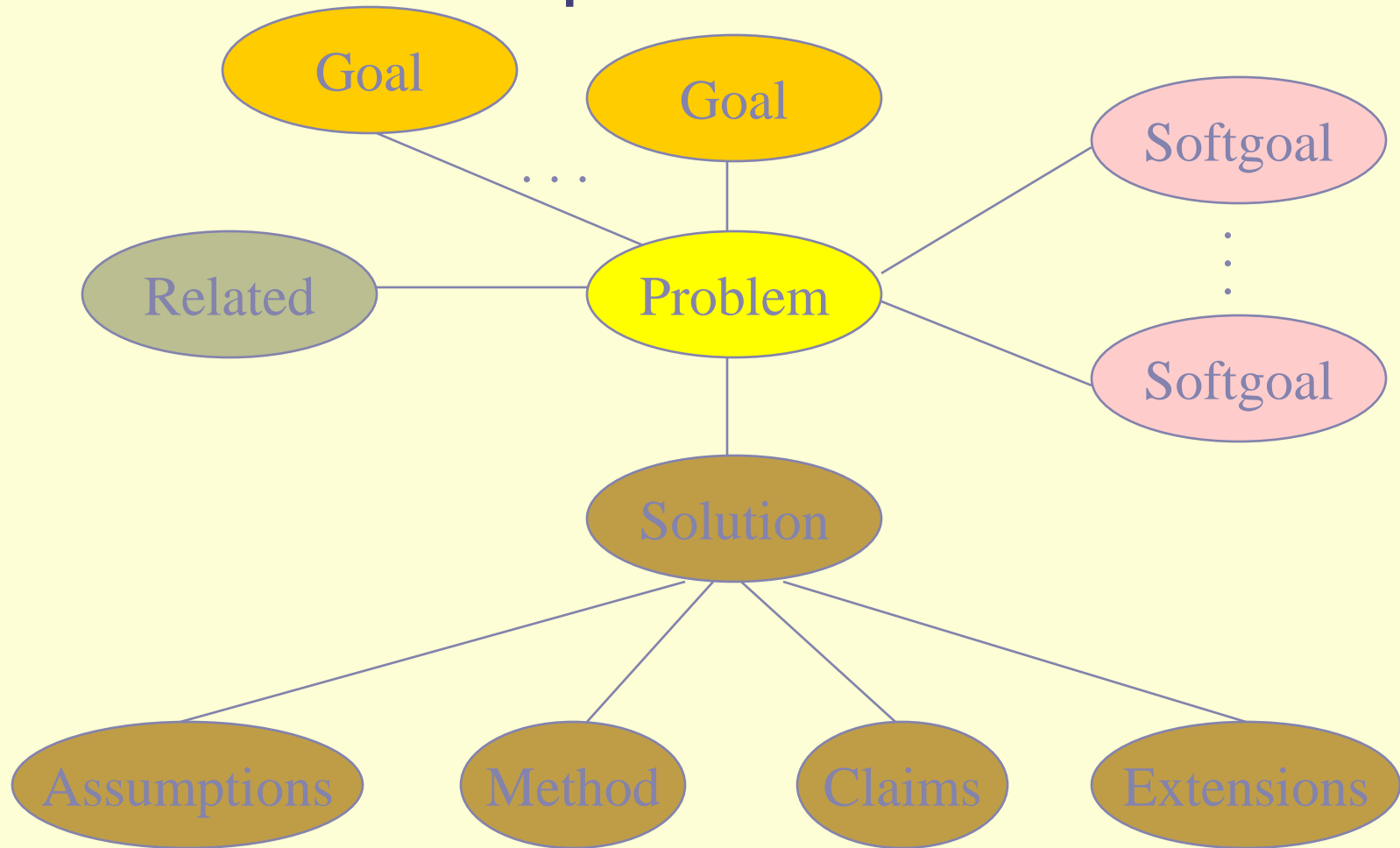
- proposed conceptual model for specialized documents
- graphical representation of model
- system implementation
- empirical evaluation
- summary and conclusions

Document Conceptual Model

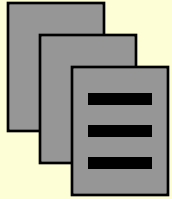
- Problem-Solution relationship provides means-ends knowledge



Graphical Model

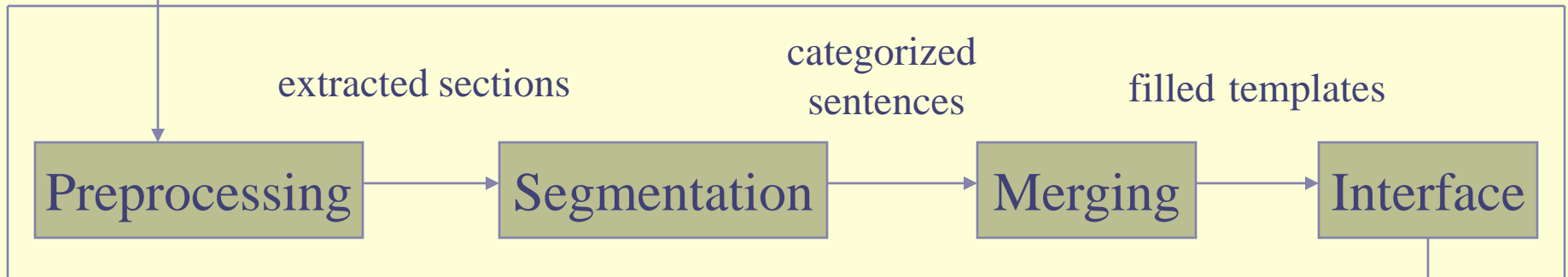


System Implementation



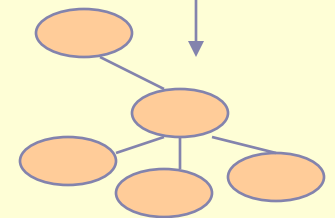
raw texts

- purpose: evaluate effectiveness of our model



● testbeds:

- scientific articles (*sci*)
- patents (*pat*)



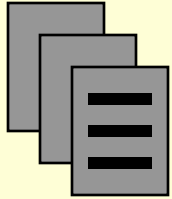
graphical layout

Template Slots and Patterns

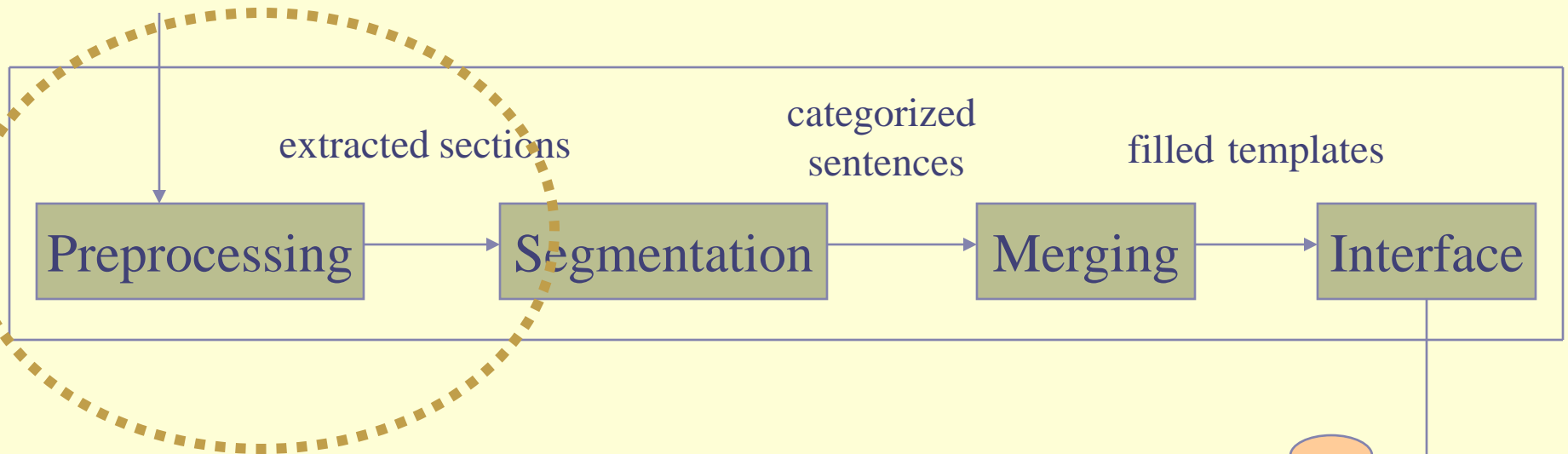
PROBLEM	“Our objective in ... is the study of”
RELATED	“Another successful approach”
SOLUTION	“We propose”
ASSUMPTIONS	“A long standing objection”
METHOD	“to achieve ... is used”
CLAIMS	“significant improvement”
EXTENSIONS	“yet to be investigated”
OTHER	“In this section, we”
GOAL	“technology in education”
SOFTGOAL	“immediate feedback”

● used 20 documents to develop 316 rules (Perl regex)

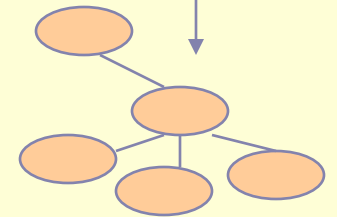
System Components



raw texts

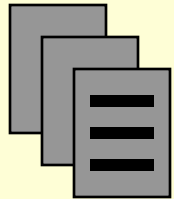


- pat: abstract + summary
- sci: abstract, introduction, conclusion



graphical layout

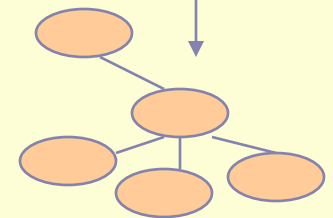
System Components



raw texts

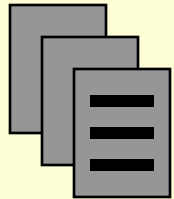


- categorize sentences
- inherit if no match
- categorize phrases (GOAL and SOFTGOAL)
- assign OTHER if unmatched

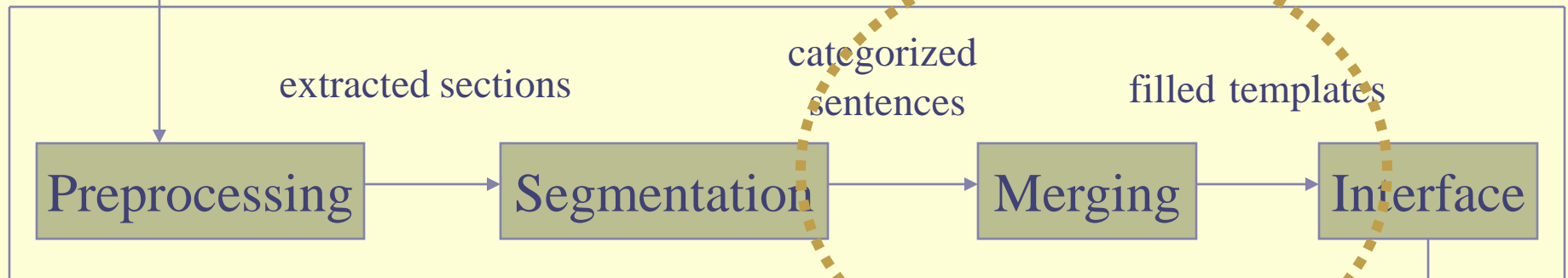


graphical layout

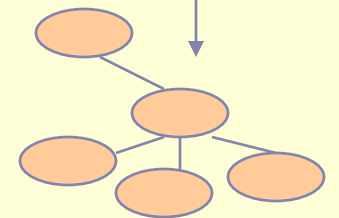
System Components



raw texts



- for each slot,
 - remove common/transition phrases
- for each stemmed sentence pair,
 - delete if similar

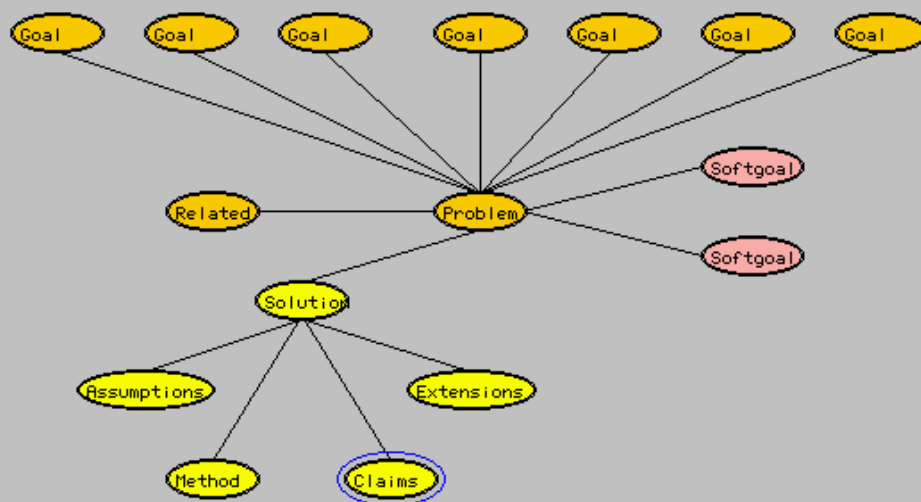


graphical layout

System Interface

Title: Children as Our Technology Design Partners

Graphical View



Claims and Results:

- we need to continue to refine the research process with children for children, because ultimately our goal is simple: to create exciting, meaningful new technologies for children.
- we need to establish new development methodologies that enable us to stop and listen, and learn to collaborate with children of all ages.
- in the chapter that follows, a discussion of new research methodologies will be presented.
- we believe that this has been the case because school activities lend themselves to the existing observation and participation methodologies.
- schools are generally places where children are asked to carry out directed, a dult-specified tasks.
- children are typically not in control of when they can have art or what they can write about, even when they can go home. Ultimately, we believe that researchers can only tell so much about what children want or need in technologies from environments such as these.
- we are trying to understand how we can bring our knowledge from the “real world” of children into the “design world” of technology development.



Empirical Study

- evaluate our conceptual model
- accuracy of extraction (segmentation)
 - intercoder reliability
 - full accuracy evaluation

$$\text{recall} = \frac{\text{items gathered}}{\text{items in standard}} \quad \text{precision} = \frac{\text{items correctly gathered}}{\text{items in standard}}$$

- usability of model/system (interface)
 - pilot study
 - full usability evaluation

Accuracy: Results

Domain	# Docs	# Sent	Precision	Recall
colour toy	11	324	73.98	72.84
education mathematics	12	430	81.35	81.16
design blouse	12	400	65.80	63.50
modern chair	12	311	67.18	70.42
Patents	47	366	72.08	71.98
women and language	10	527	37.83	38.33
children HCI	12	791	55.66	55.66
interface HCI	12	502	51.28	51.79
computational linguistics	12	640	49.37	49.06
Scientific Articles	46	615	48.53	48.71



Usability Evaluation

- **Heuristic evaluation** (Nielsen 1993)
- evaluator = potential user
- inspection method that walks through system by carrying out meaningful task in real-use scenario
- gives evaluator good sense of system capabilities
- evaluation centred around a set of principles
- resulting comments are a list of identified system problems
- benefits: easy set-up, low time demand, few evaluators (~5 to identify 75% system errors)



Usability: Principles

- cast as basic *summarization* system
- 1. **Conciseness**: not irrelevant, redundant
- 2. **Retention**: as compared to original document
- 3. **Coherence**: within sentence, overall summary
- 4. **Consistency**: words/concepts
- 5. **Informativeness**: useful, easily accessible
- 6. **Comprehensibility**: easy to understand
- 7. **Fit for Audience**: experts/novices
- 8. **Fit for Purpose**: fits intended task and purpose

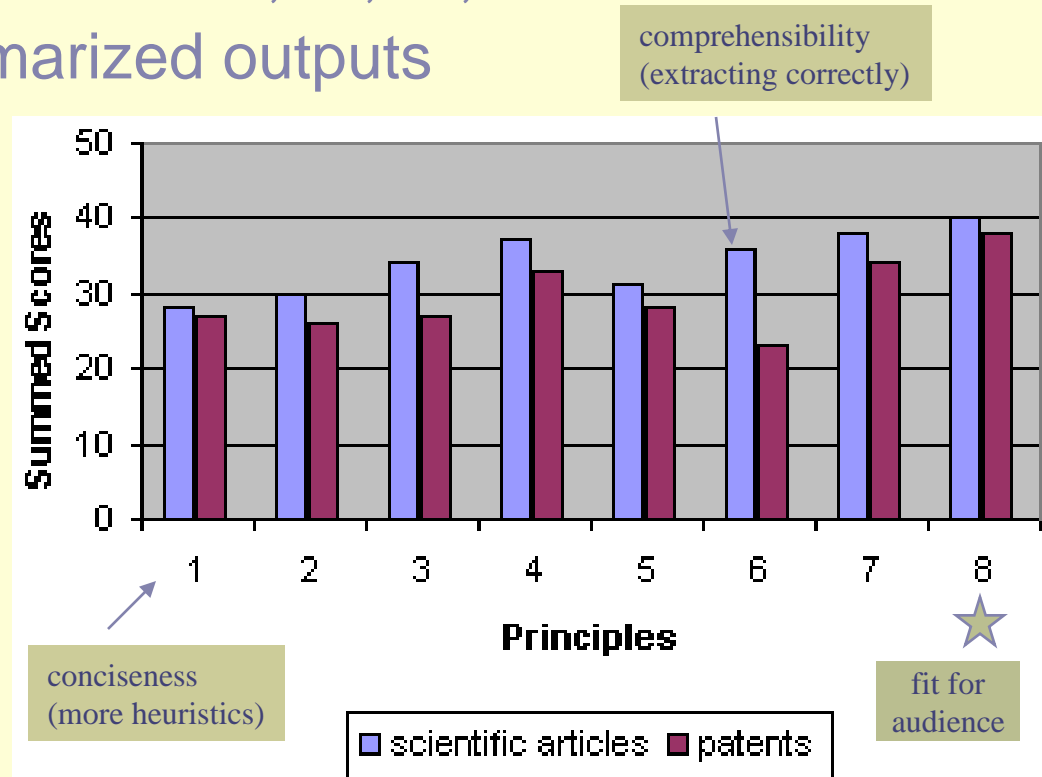


Usability: Task

- models a reviewer's question-answering task
 1. What is the problem addressed by this work? Does it describe why the problem is significant?
 2. Does the work present the approach taken to solve the problem targeted? Is the design or implementation of a system described in terms of key ideas of the approach?
 3. What are the contributions of this work? Are the benefits and limitations clear? Are the results positive or negative?

Experiment and Results

- pilot (3 participants) evaluated P1,S1
- full (4 participants) evaluated P2,P3,S2,S3
- complete task for summarized outputs
- for each output, rate each principle out of 5
- comments, access to original and summarized texts
- time spent between 1 hour – 2 hour





Summary

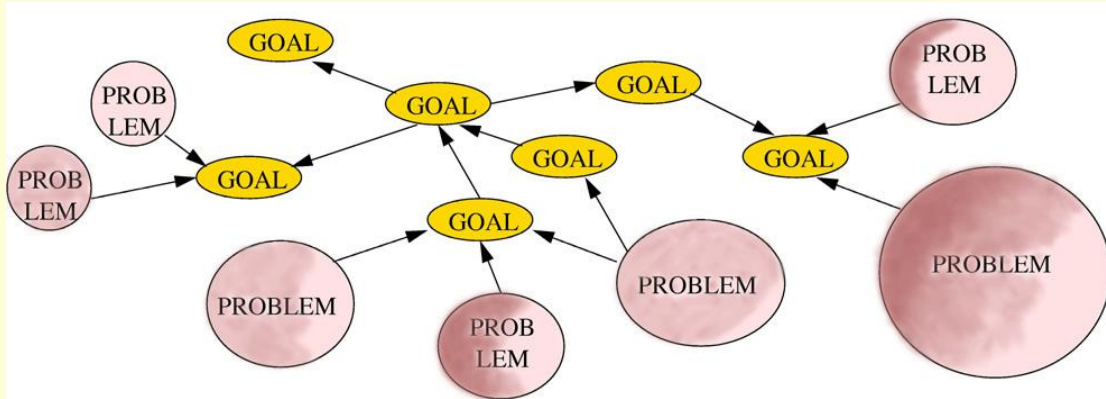
- we motivate a simple conceptual model for 2 kinds of specialized documents
- concepts based on user-centred goals
 - relations: problem-solution, benefits and drawbacks, assumptions, methods, claims, extensions
- capture high-level argumentative structure
- we evaluated our proposed model by implementing system prototype
- then conducted accuracy (traditional) and usability (novel) evaluations of system
- note: evaluation of conceptual model is embedded *within system implementation*



Conclusions

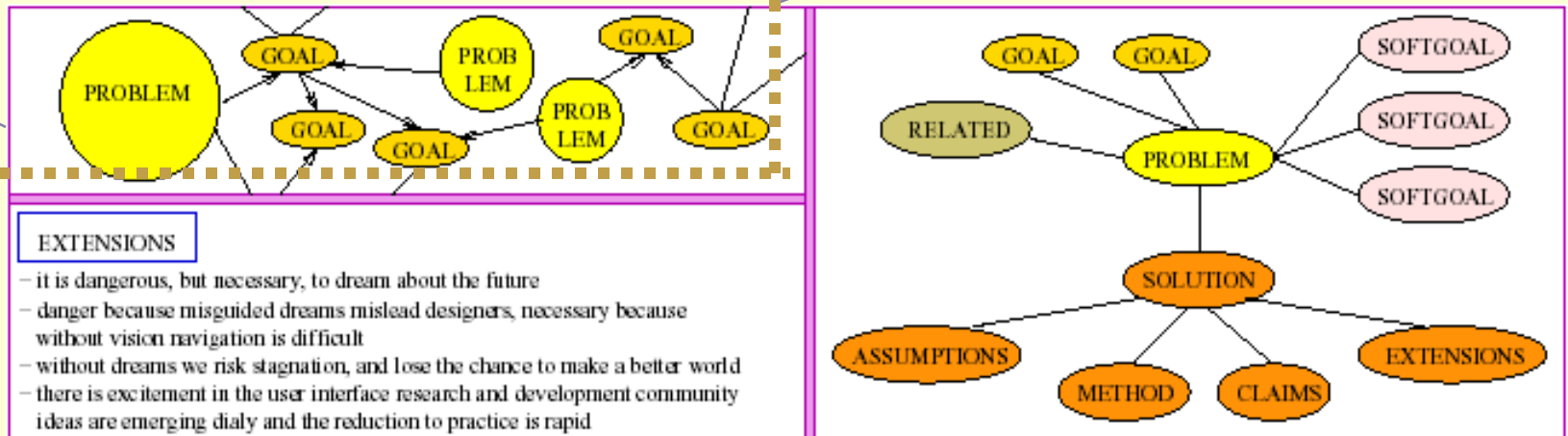
- achieved reasonable accuracy (pat >> sci)
 - “Is this supposed to mean something to me?”
 - generalize over document types by grouping patterns that suit the writing styles of each
- encouraging usability results (sci >> pat)
 - “I really liked the graphical representation ... [and] that a user can click and see the summarized data on the right”
 - users get value from simple modeling and processing of our approach
- we hypothesize stronger user acceptance if given better accuracy

Visionary System



network of goal and problem nodes

visionary system interface



EXTENSIONS

- it is dangerous, but necessary, to dream about the future
- danger because misguided dreams mislead designers, necessary because without vision navigation is difficult
- without dreams we risk stagnation, and lose the chance to make a better world
- there is excitement in the user interface research and development community ideas are emerging dialy and the reduction to practice is rapid