Natural Language Processing in support of Learning: Metrics, Feedback and Connectivity

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Making Use of Language Technologies to Provide Formative Feedback

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Outline
- Background & LTfLL
- Positioning of the learner in a domain
- Providing formative feedback on a learners Conceptual Development
  - Approach
  - Showcases
  - Future work
- Questions

Lifelong Learning

Arts et al.

Survey: ‘critical’ support activities
- Assessment of student work
  - Formative feedback (including plagiarism)
- Answering questions
  - Routing questions
  - Formulating personalised answer
- Monitoring progress
  - Drop out prevention; personal advice
- Supporting groups and communities
  - Selecting and creating groups
  - Providing overviews & feedback to activities

Van Rosmalen et al. (2008)
Inspired to LTfLL (www.ltfll-project.org):
- FP7-TEL: a 3 year project 2008-2011
- 11 partners (8 countries, 6 languages)

LTfLL Objective
To create a set of next-generation support and advice services that will enhance individual and collaborative building of competences and knowledge creation in educational as well as organizational settings.

The project makes extensive use of language technologies and cognitive models in the services.

LTfLL - Themes

Theme 1: Positioning
- Determine learner’s knowledge in a domain (given a specific context e.g. in support of Assessment of Prior Learning or with regard to a specific topic, competence or learning goal)

To determine in a (semi-) automatic way learner’s prior knowledge – by analyzing her Portfolio and the domain of study – to recommend learning materials or courses to follow

Locate best suitable learning materials or courses to follow

Positioning
To provide formative feedback with regard to the learner’s profile in the domain of study and recommend remedial actions to overcome conceptual gaps

- Provide formative feedback and recommend remedial actions

Formative feedback
- Services will offer semi-automatic measurement of conceptual development within a particular expertise area
- Diagnosing conceptual development
  - Person’s knowledge of a domain by looking on how s/he organizes the concepts of such domain
  - Novice vs. expert approach

EXPERTISE DEVELOPMENT: KNOWLEDGE PROCESSES
FORMATIVE FEEDBACK
The approach: Novice vs. Expert

Novices and experts differ in
• How they express the concepts underlying a domain
• How they discriminate relevant from non-relevant information
• And how they use and relate the concepts to one another

<table>
<thead>
<tr>
<th>Expertise Level</th>
<th>Knowledge Structure</th>
<th>Learning</th>
<th>Problem solving</th>
<th>Reasoning process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novice</td>
<td>Networks (incomplete and loosely linked)</td>
<td>Knowledge acquisition, integration and validation</td>
<td>Long chains of detailed reasoning steps through networks</td>
<td>Step by step process</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Networks (highly linked and integrated)</td>
<td>Encapsulation</td>
<td>Reasoning through encapsulated network, abbreviated</td>
<td>Big steps (but still one at the time)</td>
</tr>
<tr>
<td>Expert</td>
<td>Illness scripts</td>
<td>Illness script for formation</td>
<td>Illness script activation and instantiation</td>
<td>Groups of steps activated as a whole</td>
</tr>
<tr>
<td>Experienced expert</td>
<td>Memory traces of previous cases</td>
<td>Instantiated scripts</td>
<td>Automatic reminding</td>
<td></td>
</tr>
</tbody>
</table>

Boshuizen et al., 2004; Nievelstein, 2004

“Expert” Model

• Defines the expected set of concepts and relations that represent the domain of knowledge at a specific point in time of the development of a learner.
• It is not absolute
• → Derive it (semi-)automatically

Evidence from:
• Medicine – Networks, encapsulations, scripts
• Health sciences – Networks, scripts
• Business administration – Networks, scripts
• Law – Networks, encapsulation +/-, ...

Boshuizen et al., 2004; Nievelstein, 2004

“Expert” Model

1. ‘Archetypical expert’ model, state-of-the art information (e.g., scientific literature)
2. ‘Theoretical expert’ model, documents of a particular course or context (e.g., course material, tutor notes, presentations)
3. ‘Emerging expert’ model, concepts and the relations a group of people (co-workers, peers...) use to describe a domain
**Measuring conceptual development**

- **Knowledge elicitation**
  - measure the learner's understanding of the relationships among a set of concepts.
  - Methods: concept maps, think aloud, card sorting, word association.

- **Knowledge representation**
  - Define representations of the elicited knowledge that reflect underlying data organization.
  - Methods: cluster analysis, tree constructions, dimensional representations, pathfinder nets.

- **Evaluation of the representation**
  - Relative to some standard
  - Compare cognitive structures of experts and novices.

**Exploring the approach: Investigating the use of different 'expert' models**

1. **Theoretical expert model**
   - Formal education
   - Medical students, course and tutor materials
   - Leximancer and Pathfinder

2. **Emergent expert model**
   - Informal learning
   - Employees
   - Leximancer

**Theoretical Expert Model (Leximancer and Pathfinder)**

- Continuous or discontinuous?
  - Gaps and transitions
    - Arts et al
    - Prince
    - Boshuizen, Schmidt

- **Generation of expert and student concept maps**

**Leximancer**

**Initial findings**

Verification. Output discussed with an expert:

- The concept maps differ on the level of detail.
  - Student's concept map: detailed concepts (biology)
  - Model: encapsulated concepts, panoramic view of the knowledge (the disease)
Initial findings

Learning material
Explain the reasons and conditions of a problem “the why”

Students
Indicate procedural knowledge, mentioning how to solve a problem “the how”

Not ideal to generate an “expert” model

Theoretical Emergent Model (Leximancer)

Knowledge elicitation
- A think aloud protocol to elicit employee’s knowledge.
- The think aloud protocols were transcribed

Knowledge representation
- Leximancer was used to generate a single concept map of all (think alouds)

Evaluation representation
- Leximancer to compare cognitive structures novices & model, identify similarities and differences

Feedback Report

- These are the concepts you mentioned the most ……
- From your peers these are the most mentioned concepts ………
- The differences are: ….
- This means that you might find useful to
  - Read this material
  - Do this activity
  - Contact this person

Future work

- → emergent model (representation, number, quantitative metrics)
- Validation of the reliability and usability emerging expert map & report

- Design and develop service v.1
- Pilot with medical students (English)

Questions?

Feedback report photo by Leo Reynold. Licensed under Creative Commons.
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Project website: www.ltfll-project.org

Publications: DSpace dspace.ou.nl/simple-search?query=LTfLL

Comparison of expert and student map
Pathfinder

Language Technologies for Lifelong Learning