Joint Technology Enhanced Learning Summer School (2010)

Acquiring Conceptual Knowledge on how Systems behave using Qualitative Reasoning technology

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Contact information and short CV

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Dr. B. Bredeweg is as an associate professor at the University of Amsterdam (Faculty of Science). His research is driven by fundamental questions about computational intelligence and includes themes such as: knowledge capture, qualitative reasoning, learning by modelling, cognitive diagnose, and human-computer interaction. Bredeweg has published more than 35 articles, 10 book chapters, 49 conference papers, 10 edited collections (including 3 special issues of leading journals[1]), and a series of technical reports. For details visit: http://www.science.uva.nl/~bredeweg. Bredeweg is coordinator of the DynaLearn project (STREP, EU, FP7, no.: 231526).

Main contribution

From the DynaLearn consortium we can contribute with lectures addressing the theoretical issues underpinning the DynaLearn approach (http://www.DynaLearn.eu). The main focus will be on learning to understand and explain system behaviour by interacting with tools for constructing conceptual knowledge. In addition, we can provide hands-on practical sessions in which JTEL learners work with such tools. There is enough material to cover a full day, but shorter contributions can also be provided. The contribution could include:

- An overview of the theory and background on Qualitative Reasoning.
- Practical sessions with the DynaLearn workbench: building and simulating Conceptual models.
- An overview of Qualitative Reasoning applications (with focus on Education, Ecology, and Sustainable Development).
- Ideas and challenges for future research on Artificial Intelligence and Education using Qualitative Reasoning technology.

[1] Most recent: Bredeweg, B. and Salles P. (editors) (2009) *Ecological Informatics* (special issue), 4(5-6), 261-412.

Addition contributions

If we included more people from the DynaLearn project as lectures during JTEL, further topics could be addressed, notably the use of Semantic Web Technology (e.g. Asunción Gómez-Pérez[2], full professor) and use of Virtual characters (e.g. Elisabeth André[3], full professor), both the context of learning conceptual knowledge.

DynaLearn background

There is a need for software that supports learners in actively dealing with theoretical concepts by having them create models and perform concept prediction and explanation (e.g. [3,4,5]). DynaLearn seeks to address this by developing a domain independent Interactive Learning Environment (ILE) based on Qualitative Reasoning (QR) [1] (see also Figure 1). The QR vocabulary fits the nature of conceptual knowledge, and the explicit representation of these notions in the software provides the handles to support an automated communicative interaction that actually discusses and provides feedback at the conceptual level.

DynaLearn seeks to provide an instrument for studying the characteristics under which learners develop conceptual knowledge, particularly for ill-defined domains. The DynaLearn ILE offers a suite of technical advances for educational research. The following features can be manipulated (see [2] for design specifications). (*i*) Use-levels adapt the interface and tool interaction to tailor for groups of a specific age or experience. (*ii*) Different types of knowledge-based feedback, such as recommending terminology, model quality feedback, and suggestions for model improvements. (*iii*) Learner interaction through virtual characters with roles such as student, peer, teacher, critic and quizmaster.

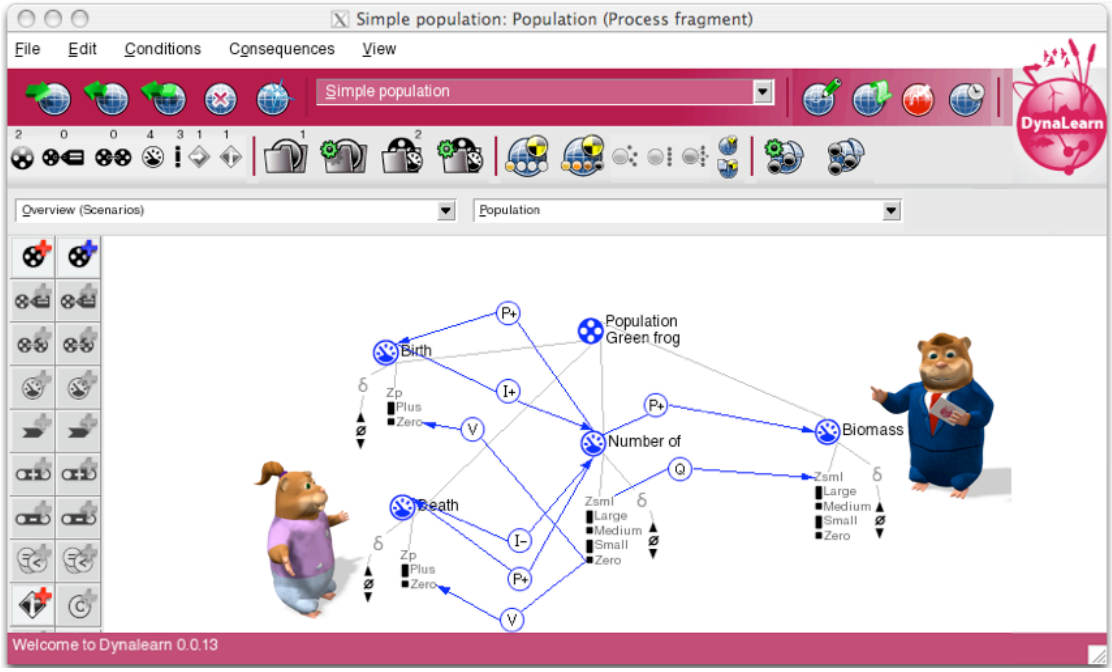

Figure 1. DynaLearn workspace with a diagrammatic expression and two interacting virtual characters, the Student / Learning companion (LHS) and the Quizmaster (RHS).

[2] http://webode.dia.fi.upm.es/Asun/Asun.html
[3] http://mm-werkstatt.informatik.uni-augsburg.de/Elisabeth-Andre.html

References

[1] Bredeweg, B., Linnebank, F., Bouwer, A., Liem, J. (2009). Garp3 — Workbench for Qualitative Modelling and Simulation. *Ecological Informatics* 4(5-6), 263–281.

[2] Bredeweg, B. (ed.), André, E., Bee, N., Bühling, R., Gómez-Pérez, J.M., Häring, M., Liem, J., Linnebank, F., Thanh Tu Nguyen, B., Trna, M. and Wißner, M. (2009). Technical design and architecture. DynaLearn, EC FP7 STREP project 231526, Deliverable D2.1.

[3] Hucke, L. and Fischer, H.E. (2002). The link of theory and practice in traditional and in computer-based university laboratory experiments. In D. Psillos and H. Niedderer (Eds.), Teaching and learning in the science laboratory, pp. 205-218. Kluwer, Dordrecht.

[4] Otero, V., Johnson, A. and Goldberg, F. (1999). How Does the Computer Facilitate the Development of Physics Knowledge Among Prospective Elementary Teachers? *Journal of Education* 181(2), 57-89.

[5] Osborne, J., Simon, S. and Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *Int. Journal of Science Education* 25(9), 1049-1079.

Intended audience

This tutorial can be useful and inspiring for the audiences with the following goals:

- Learning about Qualitative Reasoning: Ph.D. students and researchers who want to learn more about Artificial Intelligence, particularly Qualitative Reasoning.
- Using educational software: Educators, trainers, and domain experts who want to use software in their educational and/or professional setting as a way of mediating knowledge.
- Research on education: Researchers in general (including Ph.D. students) who are looking for opportunities to use available educational software to perform research on theories of learning and teaching involving conceptual knowledge.
- Research and development on knowledge communication: Researchers (including Ph.D. students) who want to implement ideas on educational dialogues may use the DynaLearn software and augment it with components that address issues, such as: Question generation, Cognitive diagnosis, Explanation generation, and Automated curriculum planning.