# Proposal for a tutorial at the GALA 2016 conference

*Title:*

**Learn how to construct student models for personalized feedback using MEBN/Pr-OWL2 (lessons from the WATCHME project)**

*Duration:* **half day (3 hours)**

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*Bio:* Jeroen Donkers currently is assistant professor in the department of educational development and research (EDUC) and the School of Health Professions Education (SHE) of the Faculty of Health, Medicine and Life sciences (FHML) at Maastricht University in the Netherlands. He received his Ph.D. degree in artificial intelligence on the topic of Opponent Modelling in 2003. At the department of Computer Science of Maastricht University he has been mainly interested since 1995 in uncertainty in AI and in games. In 2007 he moved to his current, more on education oriented environment. Here he is interested in applying AI and smart IT-solutions to support learning, with a focus on learning analytics. He has been co-author of and participant in the EU-founded WATCHME[1] project.

*Intended audience:* The tutorial is going to be more practical than theoretical. It is aimed at game designers and developers who are interested in providing personalized feedback through student modelling in serious games.

*Pre-requisite:* No strict pre-requisites are needed, but a basic knowledge of probability theory, OWL-ontology and Java will help, as does basic pedagogical knowledge in your own application domain.

*Theme:* Student models for personalized feedback using MEBN/Pr-OWL2

*Goals:* To share the knowledge we developed in the WATCHME project[1] on developing and using student models using this technology; to provide hands-on experience with using this technology; to stimulate to use this technology in serious games and other learning environments.

*Level of the tutorial:* beginner (we do not expect any experience in using MEBN/Pr-OWL2 or other probabilistic methods)

## Description of the tutorial

*Background – the WATCHME project:*

During workplace based learning, e.g. clinical or during an internship, supervisors' quality of feedback and assessment are crucial for students' professional development. Electronic portfolios (EPs) containing selected evidence of a student's performances and reflections are often used to assess workplace-based learning (Van der Schaaf et al., 2008; Van

[1] WATCHME (*Workplace-based e-assessment technology for competency-based higher multi-professional education*), EU-FP7 grant no. 619349. www.project-watchme.eu.

Tartwijk & Driessen, 2009). For the learner an EP can serve as a (1) reflective 'log' of the learner, demonstrating their progress through the curriculum and (2) a repository of evidence regarding his or her performance. Although the use of EPs may have a positive impact on learning, this largely depends on how they are implemented in an educational setting. Research shows that there is indeed a problem with the implementation of EPs, hence learning opportunities are often missed (Van Schaik, Plant, & O'Sullivan, 2013). Most EPs contain rich longitudinal datasets that remain often unexploited and opportunities for feedback to students' learning processes are missed. We postulate that EPs enhanced with student models may serve as means to improve the quality of feedback and assessment. We applied this approach in the EU-FP7 funded WATCHME project[1], which started in 2014 and will end in 2017.

The tutorial aims to share the experiences we had building student models in the WATCHME project[1]. We believe that the approach we followed is promising and could be of use for anyone who wants to provide personalized feedback to students, but is confronted with an uncertain and varying context such as in workplace based learning.

*Student modelling using Bayesian networks*

A Bayesian network (BN, also called belief network, probabilistic network, or causal belief network) is used to reason in situations where uncertainty plays a large role (Pearl, 1988). It is grounded in classical probability theory and therefore a mathematically sound approach. BN's can be used for prediction, given a set of observed indications, as well as for finding possible causes of an observed outcome. BN's can do this efficiently by the use of a specific structural representation and by using specific reasoning algorithms.

In Millán, Loboda, and Pérez-de-la-Cruz (2010), an overview is provided of the use of BNs for student modelling, most predominately in intelligent tutoring systems. In classical student models, the variables included in the network can be divided as follows:

- Features of the student (knowledge state, cognitive features, affective features)
- Evidence (e.g. answers to questions, measurable behaviour, eye movements, physiological data)

In a BN, all variables and their relations need to be specified, including all probability tables before the network can be used. In complex situations, however, this information might not be available beforehand, since the context of learning differs per student (especially in workplace-based learning).

*Multi-entity Bayesian Networks (MEBN)*

An extension of the classical Bayesian network paradigm that can overcome these problems is called MEBN (Costa, Laskey & Laskey, 2008; Laskey, 2008). It uses a probabilistic version of first-order logic as the basis of the paradigm (Pr-OWL2), but offers a graphical language to design networks in a more user friendly way.

The basic concept of MEBNs is the MFrag (or knowledge fragment). An MFrag defines a piece of (probabilistic) knowledge about an entity type, for instance, an assessment, a school, a student, in general. Context and input variables then specify the particularities of a specific assessment, student or school. Given a specific context, MFrags are instantiated and combined into a classical BN that can be queried in the traditional way.

MEBN / Pr-OWL2 is supported by the java framework UnBBayes, developed at University of Brazil and George Mason University (unbbayes.sourceforge.net).

In this workshop you will learn how to create and use MEBNs for student modelling.

*Program (3 hours):*

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| 15 minutes: | lecture | The WATCHME project[1] |
| 30 minutes: | lecture | MEBNs for student models |
| 15 minutes: | brainstorm | designing your own student model |
| | | |
| 40 minutes: | hands-on | create an MEBN using UnBBayes |
| 20 minutes: | discussion | design decisions |
| | | |
| 30 minutes: | hands-on | feeding evidence to and querying your model |
| 30 minutes: | discussion | practical implementation issues |

*Needed facilities, material*: Participants can use their own laptop. A good internet connection (Wifi) is needed. A beamer and screen for the presentation is also needed.

Participants should preferably pre-install the following on their laptops (no costs):

- Java JRE and JDK (recent version)
- Some Java IDE (e.g. Eclipse)
- Protégé ontology editor 5.0 (http://protege.stanford.edu)
- UnBBayes (http://sourceforge.net/projects/unbbayes)
    - GUI and plugins unbbayes.prs.mebn, unbbayes.gui.mebn.ontology.protege
    - Versions: Gui: 4.21.15, plugins 1.13.11 and 1.1.4, *or*
      Gui: 4.21.18, plugins 1.14.13 and 1.2.5.

*Knowledge and skills:* Participants will learn:
- what MEBN/Pr-OWL2 is, how you can construct knowledge fragments and query networks using the interactive environment UnBBayes.
- how to design a student model
- what is needed to feed, use, and update the student model
- how to feed evidence into your model and query the output using Java
- how this was done in the WATCHME project, and what problems we encountered

*References:*


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