Application of Paraconsistent Logic in an Intelligent Tutoring System

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Abstract. Experience shows that testing students' understanding of new concepts immediately after they have been introduced considerably improves the learning process. In this work understanding of a concept is assumed to take place if a student can provide reasonably correct answers to questions requiring application this concept. A possible solution to the problem of how to determine whether students actually understand a concept is to give them tests. Such tests, being a part of an intelligent system, provide inconsistent information to intelligent agents, facilitating the tests evaluation process. This happens because the degree of a student's understanding varies a lot depending on factors like time and the way questions are formulated. Since classical logic fails to draw conclusions in the presence of inconsistencies we propose application of paraconsistent logic.

Keywords: intelligent infrastructures and automated methods, logic.

1 Introduction

Many philosophers have been questioning the "ex contradictione quodlibet" rule in classical logic. The rule states that in the presence of inconsistency, anything, and thus nothing useful at all, can be inferred as an answer to any given problem. However, the majority of today's information systems produce quite meaningful answers despite receivel of inconsistent information.

Russell and Whitehead's logicism, Hilbert's formalism and Brouwer's intuitionism [9] represent different approaches of building contradiction-free logic foundation of mathematics. The first two are based on classical logic while the third one is questioning the law of excluded middle (tertium non datur), which states that a statement is either true or false. Brouwer's intuitionism was first presented by axioms in [10].

In this paper we propose use of paraconsistent logic for assessing learner's understanding of a concept employing an intelligent tutoring system. An important advantage of using such a system is that problems with inconsistent and/or incomplete input can be resolved. In addition, using automated tests reduces

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the problem of evaluating learner's understanding to that of making a decision based on a limited number of alternatives. The applied system logic is very useful if incorporated in a multiple user system. This approach can facilitate both cooperative learning and cooperation of tutors.

The rest of the paper is organized as follows. Related work and supporting theory may be found in Section 2. The model of the proposed system is presented in Section 3. The system architecture is described in Section 4. The paper ends with a conclusion in Section 5.

2 Related Work

Paraconsistency is considered to be a way to reason in the presence of inconsistency [7]. Paraconsistent logic suggests a solution by disregarding the law of double negation and the law of contradiction [4].

The field of paraconsistent logic was independently established by Jaskowski [8] and da Costa [2]. Paraconsistency, many-valued logic, query answering systems and higher order logic are discussed in [15].

Lukasiewicz has devised a three-valued calculus whose third value, $\frac{1}{2}$, is attached to propositions referring to future contingencies [11]. The third truth value can be construed as 'intermediate' or 'neutral' or 'indeterminate' [14].

Let P be a non-empty ordered set. If $sup\{x, y\}$ and $inf\{x, y\}$ exist for all $x, y \in P$, then P is called a *lattice* [3].

The epistemic value of formula when it is known that the formula may take on the truth value true is denoted by $\mathsf{unknown}_t$ and by $\mathsf{unknown}_f$ when it is known that the formula may take on the truth value false, [5].

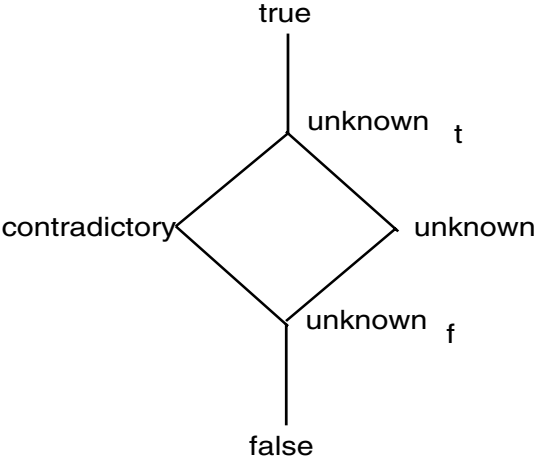

Fig. 1. Degree of truth