Logic for Computer science in Distance Education
The logic courses of the Open University of the Netherlands

Introduction
The Dutch Open University (abbreviated OUNL) is a nation-wide institution that caters for several tens of thousands of students. (The OUNL is roughly comparable to the better known British OU.) Several hundreds of those are engaged in a computer science programme, five-year on a fulltime basis, leading to something comparable to a Master Degree in Computer Science. Two courses in logic form part of this programme: Logic and Computerscience 1 and 2. These two courses have been developed jointly in an altogether four-year project: 1989 - 1993 and they are recently slightly revised. Apart from these courses the introductory course Discrete Mathematics contains an extensive section on logic. Altogether several hundreds of students have followed one or both of the logic courses. Talking of bulk and numbers: over one thousand pages of theory, exercises and explanations have been developed.

Course content

The course Logic and Computer science 1 contains: propositional, predicate and many-valued logic with applications. This includes systematic validity checking with semantic tableaus, some treatment of Hilbert-style axiomatic proofs, logic programming and Hoare calculus. Lots of attention for formal semantics. The course Logic and computer science 2 contains: natural deduction, some fundamental and prooftheoretic topics from classical logic, second-order logic, equational logic (not extensively), lambda-calculus, modal logic (the major part of the course, including epistemic logic, dynamic logic), temporal interval networks, non-monotonic reasoning. Several case-studies in the use of the learnt techniques form a part of the courses: notably the treatment of many-valued logic in a specific KBS shell manual, use of interval networks in production planning, relation Prolog - logic programming, relation Pascal - Hoare calculus.

In the rest of this paper we discuss some distinctive points in the didactics used in both courses:

-adherence to standard Dutch Open university format
-three levels of explanation and exercises corresponding to three different study paths
-explicitly describing strategies for building proofs
-case studies
-treatment of models for predicate logic
-web-support

1 OUNL style

The educational department of the OUNL has developed a didactic model to stimulate self-study. The components proposed by this model can be found in almost every OUNL-course. As a result all OUNL courses look more or less alike. One aspect of this OUNL-style is the two-column page layout, with the first column used for structural information in roman (such as 'Exercise' and 'Example') and other infomation in italic (such as keywords like 'functional complete', truth table', etc). Each unit starts with a short introduction followed by an explicit list of the knowledge and abilities to be aquiered. The unit is concluded by a test which enables the student to check if he or she has mastered the unit. The last unit contains a sample exam. Other aspects include study-instructions (e.g. references to other units), exercises inserted in the text to activate the student, and rehearsel units.

Since all OUNL courses are presented according to this standard format, students will easily recognize the structure of the course material. Students are supported by these didactic components, and even those who prefer to structure their study themselves don't think the components are disturbing . Notable are the different ways in which the didactic components are used by the students. For instance when asked for the most important function of the keywords 23 percent of the students mention ' making the subject-matter accessible', 25 percent mentions 'remembering the subject-matter and 15 percent mentions structuring of the study-material. (A van Staa, C van Meurs, Didactische

hulpmiddelen in OUNL-cursussen, Rapport JOO / 1992-III)

2 Three levels

The material is presented in roughly three levels, called extra (from `extra support'), standard and `star'. The motivation for this treatment is, that distance education material tends to be lengthy and therefore tedious to the overaverage student. This is because a lot of explanation is naturally needed for distance teaching. The explanation given should, in absence of teachers, always be up to the level of underaverage students. This dilemma has been solved by the three level presentation: the standard level is rather shortish and business-like. Labels are attached to standard exercises that link to more extensive explanations and more elementary exercises; the `extra' stuff. The student that doesn't have any problems with the standard training will not come across extra training, as he / she does not need to follow up links. The `star' exercises are just there if you want them; no links provided.

Much care has been paid to the extra support. Roughly speaking, extra support can be divided into five (not necessarily disjunct) categories, according to the kind of support that is given.

- Learning the student how to read the textbook
- Extra explanation of concepts and notation
- Simple exercises
- Prevention of common mistakes
- Development of intuition and understanding

The effects of this presentation have been more or less informally tested by interviewing some 50 examination candidates, with the result that it is indeed a useful feature [v Ditmarsch & vd Vrie 1994]. Students do use the three levels according to their needs, and they also appreciate the extra support.

Some course excerpts will be given and explained.

3 Explicitly describing strategies for building proofs

Given a purely formal system of proof, proofs have to be found according to a strategy. Naturally of prime importance for theorem provers, also for human agents good strategy pays of. This is true for natural deduction, axiomatic proofs, semantic tableau building (and less so for resolution proofs, where a strategy always seems to be one in vue of an algorithm anyway). The way strategy is taught in a classroom situation is more or less the following: while writing the proof on the blackboard, the lecturer comments on the steps he / she makes. From this local strategy the student should deduce his / her own global strategy. Since most of our students don't see any lecturer (unlike the British Ou, the OUNL provides no television lessons) we had to write the local strategy down, mostly in the solutions to the exercises. Apart from that we also tried to give some global stategy-rules. We give some (by no means a complete) strategy for natural deduction and for semantic tableaus. In our experience for a topic like natural deduction this made all the difference between seeing it as a bag of tricks or as a systematic procedure. And also: a bag of tricks is never fun, whereas a game (systematic procedure i.e.) is.

A full example from the course will be given.

4 Case studies

As mentioned above, the courses contain several case studies. One of the functions of these studies is to learn the student to how to apply logic to computerscience problems. A second goal is to motivate the students. It is not easy to find good cases, since a case should not be too complicated, and at the same time it should be as 'real' as possible. Therefore, the case based on the KBS-shell doesn't use a real expert system, since it would cost too much time to understand what is going on. Instead a small system is used, which clearly not belongs to real life (in fact it is based on a well known fairy tale). However, it is clear that the problems that arise in this system are the same problems as in a real life case. Most students highly appreciate these case-studies.

5 Treatment of models for predicate logic

One of the shortcomings of the course Logic and Computer science 1 is the absence of a more or less informal treatment of semantics for predicate logic. Hardly any attention is paid to the formalizing of expressions in natural language. With the development of the section on predicate logic in the course Discrete Mathematics we tried to fill this gap. In this course students are trained in translating simple sentences into predicate logic before a formal definition of the language is given. In the section on models, students learn to interpret formulas on (mostly) finite models. The concept of an assignment is only treated informally.

6 Web-support

In the next years the OUNL will be changed into an "Internet"-university. At the moment most of the courses consist of books containing written material. But there is also support by way of the internet. On the site corresponding to the course students will find information on exams and lessons, but also links to other interesting sites, FAQ, an ftp-site with errata, old exams, etc and last but not least a discussion group where a student can pose questions and correspond with other students. Since our students seldom meet their collegues the discussion group helps in making studying a less lonely business. Students who actively participate in the discussion group also have a more active attitude in their study and consequently get better marks. A prerequisite for a succesful discussion group is that the number of students for the particalur course is large enough.

References

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