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The Teaching of Formalization in First Order Logic And its Problems (Abstract)

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The teaching of formalization, i.e. the translation from a non-formal or semi-formal language into the formal language of logic, is usually a part of college-level logic courses. Even though the teaching of formalization skills was not generally considered as one of the main goals of such courses the interaction of AI and logic, which has highlighted the important role of the language of first order logic as an instrument for knowledge representation, has led to a reevaluation of the relevance of those skills.

It is a common experience shared by most logic teachers that students find formalization tasks rather difficult, even more difficult than other tasks such as proof building. This difficulty poses two mutually related questions: the first one concerns the reason why formalization is so hard to learn for students and the second one, which can be more authoritatively responded after answering the first one, concerns the most adequate method to teach formalization.

It has been suggested that there are two loci of difficulty when we are translating a text from a source language into a target language: the first locus is comprehension of the text in the source language and the second locus is production of the text in the target language. The levels of this production difficulty will depend on the lexis and grammar of the target language.

Both sorts of translation difficulties are likely to be encountered by students of introductory logic courses. The interpretation of the meaning of the expressions *only if* and *something* in sentences like *He will come only if you call him* and *If something is missing, he will be blamed* are typical examples of comprehension difficulties that are dealt with in those courses.

But, I would like to argue here that the main cognitive obstacle that students must face when they try to translate an English or Spanish text into the language of first order logic is of the production kind. This cognitive obstacle has to do with the fact that the number and nature of the syntactic categories of the language of FOL is extremely different from the number and nature of the syntactic categories of English or Spanish. In order to translate a text into the language of FOL students must—after evaluating if the expressive limitations of the target language allow of such a translation—perform complex word class shifts and recast the meaning of the text in a completely different grammatical form.

Things are made worse for struggling translators by a fact which is ignored in most introductory texts: the rules that tell us how to translate syntactic categories in the source language into syntactic categories in the target language of FOL have puzzling exceptions that require quite a bit of a theoretical effort to be explained away. For example, consider the translation rule according to which adjectives and common nouns in English must be translated by predicates in FOL and the following two seemingly simple and parallel cases of application of this rule:

(E1) ABC is an equilateral triangle.

(E2) ABC is an equiangular polygon.

(E3) Hiroshi is a tall Japanese.

(E4) Hiroshi is a short basketball player.

(FOL1) Equilateral(ABC) & Triangle(ABC)

(FOL2) Equiangular(ABC) & Polygon(ABC)

(FOL3) Tall(Hiroshi) & Japanese (Hiroshi)

(FOL4) Short(Hiroshi) & Basketball-player(Hiroshi)

It is obvious that, while the formalization of E1-E2 seems to be perfectly correct, the formalization of E3-E4 is not the adequate one because it entails that Hiroshi is both tall and short, something that is not entailed by the English sentences E3-E4.

One of the pedagogical consequences of the thesis stated above is that we should not expect students to be able to perform translation tasks from a natural language into the language of FOL competently just because they are conversant with the grammar and semantics of FOL —and, of course, well acquainted with their native language. It is generally accepted that translation is a separate language skill, and this is specially true when one of the languages involved in the translation process is that of FOL. If teaching knowledge representation in FOL is taken as a serious goal of a logic course, the learning process cannot be limited to a few examples and a set of rules of thumb in the hope that students will conveniently generalize them and, in this way, become competent translators. Given the special difficulties of translation into the language of FOL, the provision of a theoretical framework within which both the students native language and that of FOL can be studied, compared and finally translated seems to be a *sine qua non* condition for a succesful teaching of formalization.