eLEARNIG INITIATIVE

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ONTOLOGY

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Executive summary

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Ontology

The PRAISE project was an ambitious project aiming to bring modern elearning and semantic analysis technologies and practice to an area that has often hitherto been neglected in terms of research and development in these spheres.

The process of eliciting domain practice from a soft science domain was challenging enough; taking the conceptual terms relating to a variety of frameworks and dimensions of social work and social work training and professional development, and harmonising them across a number of modern European languages and related cultures added another layer of complexity, and the final thread entailed the embedding of the developed ontology and case studies representing instantiations of the ontological elements into a new tool with which the users could interact within the learning platform.

As such, the process of pulling together the various practice and cultural concepts and allowing users from different European countries the ability and motivation to understand each other, and in so doing, to better analyse and understand themselves, represents one of the most crucial gains of the PRAISE project. This dimension of the project greatly enables the trans-European dimension that is fundamental for advancing social work aspects in a pan European regard.

This report will first give an overview defining ontologies and knowledge bases, how they represent knowledge and permit reasoning between related concepts. Then a brief account of the elicitation process will be given as undertaken in the PRAISE project, with some analysis of the challenges encountered. An account of the multilingual dimension will be given. Finally, a brief analysis of next steps for further developing the ontological and knowledge base support of the developed system will be given.

Ontology: Conception and Purpose

Ontology has its origins in philosophy, with the discipline dealing with the nature and organization of being; the first formal recognition of its existence and application being credited to Aristotle who, deviating from Plato's concern with the existence of knowledge (It is an interesting evolutionary line to follow. Socrates started off proving that we didn't know much, his student, Plato, then went out to prove what we did know, and his student, Aristotle, went about trying to relate all that was justifiable) and naming of things, became concerned with the categorization of knowledge and definition of things. To Aristotle, the name of a thing should explain both what a thing was and why, thus the emergence of taxonomy which related things to other things.

The philosophical aspects of ontology continued to be pursued by many important philosophers over the intervening centuries, including Kant, Hegel, Peirce, and Whitehead. Another important step in the evolution of ontologies was made by Gottlob Frege (1848-1925) who introduced a concept (Frege, 1922) today labelled as the meaning-triangle, which encompasses the ambiguities of language in implicit communication (Ogden and Richards, 1923).

When using a symbol for a thing, say a word, which stands for a thing, it evokes in the mind of the interpreter a concept, which may not be a one-to-one relationship between each pair in this triangle. These referential complexities lead to difficulties in communication, especially when terms are ambiguous or have imperfect cross-cultural definitions.
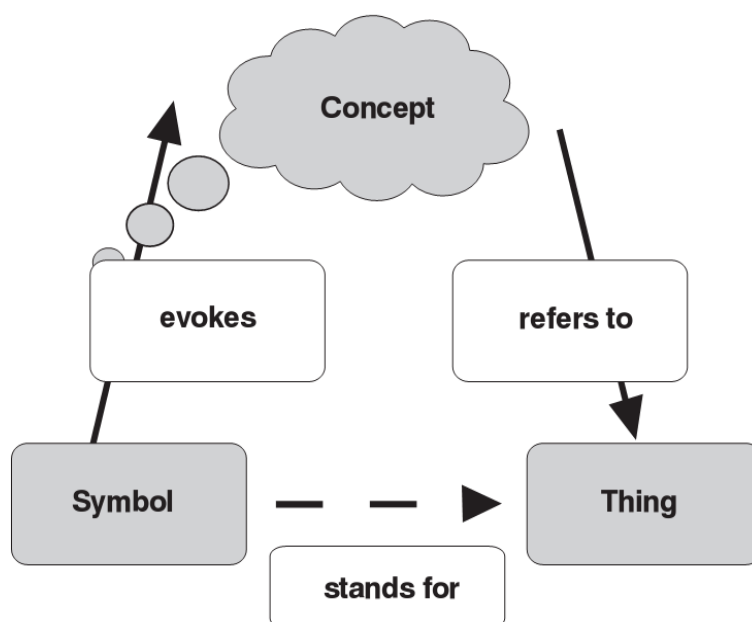
All of these attempts to determine the relationship between concepts, signs, definition and interpretation led to their natural inclusion in the study of representing human concepts and knowledge on machines.

As such, ontology moves from a philosophical abstraction into a systematic account of existence, representing a domain of discourse and allowing for the community shared, formal definitions of classes, relations, attributes, roles, types, etc (Gruber, 1993). Ontologies can cover very specific areas of discourse, termed domain ontologies, or can try to map all knowledge, upper level ontologies.

The PRAISE ontology and related knowledge base are domain specific to social work and related social work training.

The knowledge base [KB] is a set of specific instances of concepts contained in the ontology. As an simple example, one might have the concepts dog, cat, pet, child,

which can be made to relate together in that dogs and cats can be pets and children can have pets.

A KB can be made with the fact that Billy, a child, has two pets: Rover, a dog, and Whiskers, a cat. Given the KB and the ontology, we are able to start only with Rover and discover that he is a pet, he has an owner (inverse relationship of children have pets is that pets have owners), the owner's name is Billy, who has another pet, a cat, named Whiskers.

A formal mathematical definition is presented to add precision for those who may require it. We may consider the ontology, and its dependent structure, the knowledge base, to be structures with component objects.

The ontology is a 5-tuple containing two disjoint sets of elements called concepts C and relations R, a concept hierarchy, HC, which is a directed relation across the Cartesian product of the concept set, yielding super and sub concepts, a relation function f(R), that relates concepts non-taxonomically, with an associated domain dom(R), and a range range(R).

The dependent knowledge base takes the ontological structure that has defined the C and R and provides an additional set of instances or instantiations I which represent actual entities of the ontological elements. These instances are then related to the various C and R via two functions κ and p that provide a series of relationships between the abstract concepts and the more immediate instances.

Ontology 5-tuple	Knowledge Base 4-tuple
$O := \{C, R, H^c, f(R), A^o\}$	$KB := \{O, I, \kappa, p\}$
$H^c : H^c \sqsubseteq C \times C$	$O := \{C, R, H^c, f(R), A^o\}$
$f(R): R \rightarrow C \times C$	$\kappa : C \rightarrow 2^I$
$dom(R) := \prod_1(f(R))$	$p : R \rightarrow 2^{I \times I}$
$range(R) := \prod_2(f(R))$	

PRAISE Knowledge Elicitation and Ontological Representation

The domain experts were assisted with expert knowledge engineers [KE] supporting them throughout the project, yet they had three main stages of development to undertake in the iteration that was the project lifetime.

The first stage was one where each team member had to be empowered to reflect on what they thought were the key concepts and relationships in their own practice. This can be a very challenging and rewarding exercise for any domain expert as it will result in the reflected rationalization by the domain expert of how they internally describe what it is they do.

The process by which the domain experts were made to focus and determine what was important in their own practice began with workshops at the international level

where experts from each region were brought together with KE support to begin group reflection.

At the end of these exercises, which always resulted in a sense of frustration by the social work domain experts at the difficulties involved in trying to elicit a sensible representation of what was common sense knowledge, the lists of terms and relations would be modelled by a KE and the result sent around to each of the partners. At every stage example instantiations would always be sought in the form of brief anecdotes that instantiated the abstracted elements being discussed.

At this point, the partner would repeat the exercise with local representatives to gain a more generalized, representative view of that location's collective practice and conceptual terminology. A single representative (usually the same person who had been involved in the first, illustrative exercise) would feed the results of these sessions back into the group process where they would be folded into the larger process by a KE.

Once a sizeable set of terms had been collected, representing both nodes and relations, the KE guided partner representatives in group meetings at trans-national meetings to explore each other's term sets and to reach a negotiated meaning of what each of those terms meant and to measure how much divergence there was against a common term and their own particular interpretation of said term.

This was another illuminating process for the participants, where, through confrontation with different interpretations from other members, and with having to extend and enhance their own representations of particular concepts, they gained a much deeper, richer explicit understanding of their own practice. It should be noted that all members agreed at the end of this stage that their was important educational merit in this process, both within a particular language domain and when confronted with different cultural representations and interpretations.

At the next stage, the KE experts who were guiding and moderating the entire process worked with a subgroup of domain experts from several different partners in order to pull all of the agreed terms and to iterate the definitions further in order to resolve any semantic collisions or overlaps.

This final stage, the terms were taken from a list form and written into a semantic network graphical representation which lent itself directy to an ontological representation with directed edges in a full graph. This was coded into RDF and OWL respectively, with both representations offering expected advantages over one another.

The ensuing ontology was both presented back to the group and also linked to the learning application as available key terms with which to tag individual case studies generated by partners and allowing for subsequent semantic analysis and exploration by users as well as forming the basis for further domain modelling in the future. It was this tagging of the case studies by the domain experts that created the knowledge base, with the case study instances become instantiations of multiple concepts collected and allowing for a search from one instance to related instances via ontological analysis.

PRAISE Multilingual Dimension

The multilingual requirements of PRAISE were considerable, as there were domain workers targeted by the methodology and the application who spanned eight languages (Catalan, English, French, Icelandic, Italian, German, Romanian, Spanish).

The assessment of the domain workers revealed very wide expertise in a second language in technical terms, and no one single common second language that spanned the entire sufficient with sufficient cover and proficiency levels. Hence, the elearning application had to host content in the target language as well as allow for the ontological reasoning to occur in the target language.

The method chosen in PRAISE to encode the multilingual nature of the ontology was to have a slot at each node that referred to the term in the alternate languages. This slot method provided the hooks for the reasoner to be able to search across multiple languages. Another method would have been to make multiple ontologies in separate languages and to relate the similar nodes to one another.

One difference with the multiple trees approach would be to allow a greater degree of semantic dissonance between linguistic terms, whereas the PRAISE approach forced more conscious selection and alignment of terms.

The exercise was educational in its own right. For example, there were terms that were used in one cultural set that would not fully map onto other single terms in other languages.

The Italian word disagio was used by Italian domain workers to convey an illness in one's complete being, not simply physical or even mental, but extending into emotional and social aspects as well. This was a concept that many of the other culture's found illuminating and stimulating.

The process of exposing other domain workers to translations and the original terms was a fruitful exercise in virtuous circle discussions.

PRAISE Ontological Reasoning: Next Steps

There are now a number of avenues of development that can be pursued with the ontology and the knowledge base constructed during the PRAISE project.

The first aspect is to continue to grow the knowledge base itself by expanding the instance set through the collection of further case studies. Also, the richness of the relations can be increased by both increasing the number of connections between the KB instance case studies and the ontological concepts already represented, as well as an independent process of extending the ontology with further concepts,

relations, and increasing the coverage of both HC and f(R). This would require further exploitation from the actors interested in the target domain.

There is also the aspect of increasing and refining the multilingual representation in the ontology, which would help to foster greater use throughout Europe and the wider world, as well as helping to foster better understanding and standardization of social work and social work training in general.

An avenue that offers exciting prospects is the application of Peirce's trichotomy (1891) to the existing PRAISE domain ontology.

This trichotomy principle was a profound insight by Peirce into conceptual metalevel relationships first laid out by Kant in 1787. Briefly, there are three levels of perpective required when considering a conceptualization.

Firstness is determined by the inherent qualities of something, Secondness by the relation with the thing towards something else, and Thirdness by another thing which relates multiple items together (To be formally precise, firstness can be defined as a monadic predicate, $P(x)$. Secondness requires a dyadic relation $R(x,y)$. Thirdness requires an irreducible triadic $M(x,y,z)$, where x mediates y and z.)

An example which gives insight into the present domain would be woman, who can be recognized independent of any other facts. Secondness could be domestic abuse victim, where there is a necessity of involving some other actor into the definition. Thirdness could be Domestic Abuse, which involves the process of abuse in which the abuser and abused are involved.

The relations gifted by this treatment are very powerful and allow for powerful semantic analysis of the entities involved. The PRAISE ontology offers a rich field of concepts which could be tied together using this trichotomy categorization.

Another area of interest for engaging with social work, itself having a human dimension and often dealing with distraught social situations, would be the inclusion of emotional categories into the resultant ontology.

As remarked by Sowa (Sowa, 2000), Arieti (1978) developed an important three-way categorization for emotional classification that has strong similarities to Peirce's conceputalization. First-order emotions are triggered by the immediate experiences of the individual, including stress, fear, satisfaction, hunger, etc. Second-rder depend on cognitive processes that build upon first-order emotions, including anger, anxiety, wishing. These emotions may take place in the absence of any direct stimuli.

The third-order analogue is given by complex, conceptualized emotions that only work once past experience has established a reference, and lead to future expectations. Examples include joy, depression, discrimination, love, etc.

The inclusion of these emotional categories into an ontology dealing with narratives concerned with social work situations could greatly increase the value of the KB instances and the richness of their tags relating to social worker experience.

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Acronyms and Abbreviations

Acronym	Description