Towards a Constitution Based Game for Fostering Fluency in "Semantic Web Writing"

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Abstract. The Semantic Web (SW) is still far from realising its full potential, partly because it is still lacking enough high quality SW representations of information. We argue that a step in the right direction is fostering people's capability to fluently create high quality SW representations of the information they generate during problem solving processes. To foster such a capability, we propose a game in which teams compete in creating the best translations of texts into SW representations. Although playing the game is in itself already a way to foster such a capability, we moreover pursue learning from the game which are the most successful translation strategies (embodied by "constitutions") so that they can also be used by people outside a game setting.

1 Introduction

The Semantic Web (SW), as envisioned by Berners-Lee, holds the promise of improving human collaboration, by increasing the transparency and reusability of representations of information, specifically in a computational sense [1]. The SW still may not be considered to be mature, in part due to a lack of the availability of high quality SW representations of information. We argue that the SW cannot come to full maturity without fostering the human capability of creating such representations, not only in specialists but also in information creators [2] [3].

This article focuses on fostering the capability of doing so *fluently* and *during the process of creating information for a specific purpose*. With fluency, or translating in real-time, we mean that thoughts are translated instantly, with minimum delay and duration, comparable with what many nowadays can approach with normal writing. An important scenario is people immediately sharing these representations of thoughts on the Web for others to reuse and extend, in this way approaching "collective thinking". An application area is improving scientific collaboration, within which much valuable information is not put to full use. Moreover, we assume that the capability of persons to translate their *own* information is beneficial because, among other things, there are not enough knowledge engineers to keep up with the rate at which information is produced.

For the purpose of fostering the mentioned capability we propose a *game* setting, because this stimulates people to participate and improve their strategies. In the basic form of the game, two or more competing teams translate the same text(s) into SW content in a fixed short time, after which teams challenge each others translations by posing questions that have a very specific answer based on the content of the text(s).

A question could for example be: give me the total number of inhabitants of all Asian countries mentioned in the text (imagine a geography text that mentions 25 countries from different continents). Each team then tries to construct an algorithm that derives the answer from their own translation. The final score is based on the complexity of the algorithms and the correctness of the answers.

From the game we hope to learn which strategies and conditions (in the game embodied by "constitutions") are most effective for transforming thoughts (embodied by the translation process) as quickly as possible into high quality SW representations (embodied by representations with high scores). Moreover, we believe that the game will provide strong direct and indirect incentives for people to participate in the construction of the SW, including: (1) Playing the game itself makes people create valuable SW content instantly. (2) Reaching fluency (implying low cognitive strain) and experiencing the benefits of high quality SW representations during the game is a great incentive to also apply the acquired capability outside the game. (3) Successful constitutions can be used by others – also outside the game – as an example, which makes it easier to also acquire the capability and apply it.

1.1 Related Work

Games with a purpose were introduced by von Ahn to seduce people to volunteer enriching the Web with new representations of information that cannot be created automatically, by wrapping this purpose in appealing online games [4]. Von Ahn metaphorically speaks of "human computation", and putting lost "human computer cycles" into use. In the *OntoGames* project, Siorpaes and Hepp have adopted the same approach for creating SW content, and achieved promising results [2]. A difference with our work is that the focus of OntoGames is mass participation, with the disadvantage that the game must not be too difficult to play and some SW content authoring tasks must be sacrificed to make the game attractive for many. We assume that this limits the games to the creation of fairly "lightweight" SW content. However, creating deeper SW content is also essential to the quality of the SW, and this is what we focus on. If you want to put more of the "lost cycles" of the collective human computer to use, we argue that it is best if the cycles on the human computers with certain gifts would be spend on playing (much) tougher games with higher benefits, even if such human computers would form a minority. Moreover, a capability that seems not likely to be acquired by a majority *at this stage*, can still become so in the future. Note that conventional literacy grew explosively in less than two centuries, for example in a modern Western country as France from around 30% of its population around 1800 to above 95% in 1910, amongst other things as a consequence of improved methods of dissemination of the art of writing [5,6]. Our games could contribute to accelerating such a process for "SW literacy".

In the area of Computer Supported Collaborative Work we see a strong relation with work of Buckingham Shum et al: *Compendium* [7] and related systems such as *Claimaker* [8]. Buckingham shum et al are also promoting a form of digital literacy during collective sensemaking which has many similarities with ours [3,9]. However, their literacy is different in that it is primarily used as a means for a community to grow in their understanding of the topics they are dealing with, instead of increasing algorithmic transparency.

1.2 Overview

In 2 we develop preliminary notions and explain how this work extends our previous work with Open Constitution Based Knowledge Communities. In 3 the game designs will be explained, including the motives behind the design decisions. The work is concluded in 4.

2 Preliminary Notions and Previous Work

Before presenting the game designs in the following section, we will first explain how it extends our previous work in 2.1 and sketch preliminary notions on symbolic representation and reasoning in 2.2.

2.1 Open Constitution Based Knowledge Communities and Experiments

The overarching research project of which the games are part is the OCBKC-approach (Open Constitution Based Knowledge Communities), applied to fostering the mentioned capability [10]. In OCBKCs the way of collaborating, including a specification of the technology used, is written down as explicitly as possible in a *constitution*, which all participants of the community agreed on following. The advantages of a constitution based approach are: (1) The constitution integrates the technological and the human dimension in one whole instead of isolating both dimensions from each other. (2) The constitution can be used descriptively to allow an active reflection on the way of collaborating, and therefore a way of improving it. (3) Vice versa, it can be used normatively to experiment with certain ways of collaborating.

The constitution is moreover *open* in two senses: (1) Participants are stimulated to participate in the construction of their own constitution. We believe users participating in the construction of their own environment, instead of being imposed an environment, to be a crucial factor in fostering collective intelligence, as has also been suggested by others [11,12,13,14,15]. (2) The constitution is open for reuse by other people, so that they can benefit from it, adapt it to suit their own purposes (diversification) and participate in its improvement (evolution).

In our case, we wanted to create a constitution to foster the capability that is central to this article, and developed an initial version, which we subjected to experimentation with volunteers who agreed on collaboratively solving a simple problem, while following this constitution. This constitution also included the development of a complete software environment which we coined *Constitution Based Subleme*. Although the experiment turned out to be quite successful and the results promising, it appeared that translating the own thoughts, although being the final goal, had as drawback that it is difficult to steer the process towards certain modelling problems, and with this shape and refine certain parts of the pursued capability [16]. Therefore, we decided to offer participants texts to translate instead of translating their own thoughts. Moreover, we wanted to incorporate a game element, for the reasons mentioned before.

2.2 Symbolic Representation and Reasoning

First we will provide our view on some key notions concerning the algorithmic aspect of the SW, which are important for explaining some design decisions of the game. The system of interpretation of any SW Knowledge Base (KB) can be divided in two parts, an "algorithmic part" and a "purely human part". The algorithmic part defines which information extracting algorithms ("reasoners") are valid, even if these algorithms have not been written yet. The definition has been inherited from symbolic logic, which defines validity in terms of truth preserving transformations on the expression of the language [17] [18].The human part consists of the way humans (should) interpret the expressions in the KB.

The current common practice on the SW is as follows. W3C publishes a range of different partial systems of interpretation, each of which predominantly include an algorithmic part, currently RDF, RDFS, OWL Lite, OWL DL and OWL full. A person who wants to express information can then adopt one of these partial systems, for example OWL Lite, in his system of interpretation, and extend the human part as suits him/her (by introducing new vocabulary), as long as (s)he does not violate the semantic conditions of the integrated partial system and as long as (s)he doesn't extend the algorithmic part. An advantage of this practice is that it is much easier to reuse algorithms: the person in the given example can just apply all algorithms written for OWL Lite with confidence. A disadvantage is that people cannot locally extend or modify the algorithmic part of the system of interpretation so that more information can be extracted by means of algorithms.

3 Game Designs

This section presents two games variants: the full game and the simplified game. The first, described in 3.1 and motivated in 3.2, is the ideal setting, which, however, is difficult to realise on short-term. The second, explained in 3.3, will be a simplified version, which we intend to realise on short-term.

3.1 Full Game

The full form of the game is as follows. From a pool of people who are logged into the game, the computer randomly composes two teams, each of which consist of *Translators* and *Answerers* (they do not overlap). Moreover, it randomly chooses a text from some large database of texts. The Translators first agree on a constitution to use for the translation (see 2.1). They then translate the text into a digitised form they think is as optimal as possible for applying algorithms to it to answer any question that can be answered *precisely* and *unambiguously* solely based on the information contained in the text. There is a maximum time available for making the translation which is set as short as possible, forcing the participants towards fluency. Each team (both Answerers and Translators) then challenges the other team with posing a fixed number of questions. Subsequently, the Answerers get access to the final translation of their team and the list of all questions. For each question they try to develop an algorithm, which, when

applied to the translation, extracts the answer from it. The final score is based on the quality of the answer and the simplicity of the algorithm.

Details about the game are as follows: (1) The text is divided into fragments that do not overlap and each fragment is assigned to exactly one Translator. (2) The Translators produce two things: a translation and a definition of (the system of interpretation of) the language they used (see 2.2). The language definition may not express any information that is expressed in the text. For example, it could be a combination of RDF, RDFS, OWL DL and a set of own language extensions, including extension of the algorithmic part as defined in 2.2 . (3) The quality of the algorithm is based on its length after some normalisation (among other things, counting labels as one sign). (4) The algorithms that are produced by the Answerers, may not contain the information needed to answer the question. The simplest way to cheat would for example be writing an algorithm which contains the answer in the form of a string. This is indeed an algorithm that yields the answer, but the information is contained in the algorithm and not extracted from the information base. All teams have to publish their algorithms so that they can be scrutinised by the other teams and anyone else. (5) The constitution may be one that already exists (defined by a previous team), a modification of such a constitution, or an own constitution. The constitution is open, for any other person to reuse or scrutinise. The latter prevents cheating, by for example using the rules to communicate. If the constitution is new, it is added to the pool of constitutions from which future players may choose. The constitutions also will be ranked, based on the success teams using it had with it.

3.2 Motivation, Strengths and Weaknesses

Motivations for the game design decisions include the following. Assigning a text fragment to a single person approaches the situation of a person working with a local purpose, for example designing an experiment. The questions being about the text *as a whole* will create the necessity for the team of Translators, in spite of their local purpose, to put everything to work to make the *aggregate* of their local individual translations an algorithmically transparent whole. The questions being invented to attack the other teams, creates a strong incentive to make the questions as difficult as possible, and thus, the test of quality as good as possible. Composing the teams randomly creates the necessity for the team to at least make their way of collaborating explicit in the constitution, because they have no other way to coordinate their collaboration. (If they would know each other they could meet and train together and develop the coordination strategy off-line.) In this way, successful constitutions can be harvested from the game, to be reused by other people, in the game and for serious purposes. Allowing the Translators to define their own language, including the algorithmic part of the system of interpretation (and not being tied down by for example only being allowed to use RDF+RDFS) potentially allows all text that can be made algorithmically transparent to be made so.

Weaker points of the design include: how to cope with texts with internal inconsistencies (possible solution: not allowing them); there is only a necessity to make coordinative activities explicit in the constitution, not individual strategies; computational complexity is completely disregarded (possible solution: also incorporate exe-

cution time and memory consumption of the algorithms in score); bad Answerers can still ruin the score even when the produced KB is of high quality (possible solutions: (1) continue the competition with a randomly chosen set of new Answerers who get offered the translation and repeat this process a number of times, so that the translation can earn a long-term score, or (2) instead of randomly composing the teams, the computer looks at the average scores to combine people (for example combining Translators who played in teams with high scores with Answerers who played in teams with high scores, as to make strong teams, or (3) the game providers can build in tests with good translations and predefined questions with solutions stored in the system to identify the less skilled Answerers, an approach similar to one mentioned by Siorpaes and Hepp [2].

3.3 Simplified Game

We will now present the simplified version we intend to realise on short-term. It is equal to the full game except for the following modifications: (1) *Fixed algorithmic part for all: RDF + RDFS*: the part of the system of interpretation of the language that may be assumed to write algorithms is fixed to be RDF + RDFS for all competing teams. In future variants of the simplified versions we are considering other fixed parts, for example OWL DL. An advantage is that there is already quite some algorithmic support for this language, which makes it much easier to construct algorithms. For example, in case the algorithmic support chosen is a reasoning engine, the final algorithm could be equal to a query in combination with that reasoning engine. Disadvantage is that only a fraction of all information that could be answered with the help of algorithms can be answered with algorithms under this condition. (2) *Fixed constitutions:* instead of allowing teams to create their own constitution, we will offer them to choose from a fixed set of constitutions we developed. We will partly explain one of them in the following paragraph. Advantage: we do not expect that players will develop their own high quality constitution anytime soon, while ours is the result of substantial research and development, providing the players a head start. (3) *Preselected texts:* instead of random texts from a large database, we will choose specific texts that confront the teams with certain translation problems, amongst others: a text in which many different names are used for the same entity, so that the capability of reaching a shared vocabulary will be tested. Advantage: the number of participants will probably be relatively low in the time to come, and thus so the number of texts covered, and so the probability that the constitution is subjected to a range of crucial modelling problems when randomly choosing texts.

All fixed constitutions will be extensions of an adapted version of the constitution we used during our experiments in collaborative problem solving, as well the tool as the human part (see 2.1). We suffice with briefly describing a part of one of them due to limited space. The shared terminology is reached in the following way. When a Translator introduces a new node, (s)he must define it in natural language, according to certain criteria described in our earlier work [16]. These criteria include: being unambiguous; being generic; defining a single entity and not defining a node that has been defined earlier. The other Translators have to judge the definition as soon as possible. When someone doesn't agree with the definition of the node, it has to be revised, or the node

has to be withdrawn completely and other nodes must be proposed to express the given information. Only after reaching a shared status, the node may be used to express information (build triples). Moreover it contains rules concerning best modelling practices, such as how to cope with representing properties of sets of individuals.

4 Conclusion and Future Work

The main goal of this article was presenting a way to foster the human capability of creating high quality SW representations of information with great fluency during problem solving. For this purpose, we proposed a constitution based game, integrating a game element in our previous work with Open Constitution Based Knowledge Communities as explained in 2.1. The advantage of a game setting is that it stimulates participation and self-improvement. In the design of the game we wanted to incorporate products and lessons learnt from this previous work, among other things parts of the constitution (such as Constitution Based Subleme) and that it has and advantage to choose for text translation instead of translation of thoughts during problem solving, because the text offers a solid frame of reference to compare the results of different teams, and allows steering the process towards certain modelling difficulties. Two variants were presented: a full and a simplified game. Based on the argumentation developed in 3, we conclude that both variants are likely to help us approaching the main goal, the full game more so than the simplified.

As for our future work, we conclude that the simplified game is easier to realise on short-term. It will therefore be the one that we intend to implement first. Among the first participators in the game will be experimental researchers of Top Institute Food and Nutrition based in the Netherlands with whom close collaborations exist. Due to the high rate at which the experimental research community creates new information, it has much to gain from the pursued capability. We will report on lessons learnt from the execution of the games, in particular the elements that optimise the constitution, in subsequent publications.

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