Winograd Schemas and Machine Translation

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Abstract

A Winograd schema is a pair of sentences that differ in a single word and that contain an ambiguous pronoun whose referent is different in the two sentences and requires the use of commonsense knowledge or world knowledge to disambiguate. This paper discusses how Winograd schemas and other sentence pairs could be used as challenges for machine translation using distinctions between pronouns, such as gender, that appear in the target language but not in the source.

1 Winograd Schemas

A Winograd schema (Levesque, Davis, and Morgenstern 2012) is a pair of sentences, or of short texts, called the elements of the schema, that satisfy the following constraints:

1. The two elements are identical, except for a single word or two or three consecutive words.
2. Each element contains a pronoun. There are at least two noun phrases in the element that, grammatically, could be the antecedents of this pronoun. However, a human reader will reliably choose one of these as plausible and reject the rest as implausible. Thus, for a human reader, the resolution of the pronoun in each element is unambiguous.
3. The correct resolution of the pronoun is different in the two sentences.
4. Computationally simple strategies, such as those based on single word associations in text corpora or selectional restrictions, will not suffice to disambiguate either element. Rather, both disambiguation require some amount of world knowledge and of commonsense reasoning.

The following is an example of a Winograd schema:

A. The trophy doesn’t fit in the brown suitcase because it’s too large.
B. The trophy doesn’t fit in the brown suitcase because it’s too small.
Here, the two sentences differ only in the last word: ‘large’ vs. ‘small’. The ambiguous pronoun is ‘it’. The two antecedents are ‘trophy’ and ‘brown suitcase’. A human reader will naturally interpret ‘it’ as referring to the trophy in the first sentence and to the suitcase in the second sentence, using the world knowledge that a small object can fit in a large container, but a large object cannot fit in a small container (Davis 2013). Condition 4 is satisfied because either a trophy or a suitcase can be either large or small, and there is no reason to suppose that there would be a meaningful correlation of ‘small’ or ‘large’ with ‘trophy’ or ‘suitcase’ in a typical corpus.

We will say that an element of a Winograd schema is “solved” if the referent of the pronoun is identified.

An example of a pair of sentences satisfying conditions 1-3 but not 4 would be

A. The women stopped taking the pills because they were pregnant.
B. The women stopped taking the pills because they were carcinogenic.

Since women cannot be carcinogenic and pills cannot be pregnant, the pronoun ‘they’ in these sentences is easily disambiguated using selectional restrictions. This pair is therefore not a valid Winograd schema.

The Winograd Schema Challenge (WSC) is a challenge for AI programs. The program is presented with a collection of sentences, each of which is one element of a Winograd schema, and is required to find the correct referent for the ambiguous pronoun. An AI program passes the challenge if its success rate is comparable to a human reader. The challenge is administered by commonsensereasoning.org and sponsored by Nuance Inc. It was offered for the first time at IJCAI-2016 (Morgenstern, Davis, and Ortiz, in preparation); the organizers plan to continue to offer it roughly once a year.

2 Winograd schemas as the basis for challenges for machine translation programs

In many cases, the identification of the referent of the pronoun in a Winograd schema is critical for finding the correct translation of that pronoun in a different language. Therefore, Winograd schemas can be used as a very difficult challenge for the depth of understanding achieved by a machine translation program.

The third person plural pronoun ‘they’ has no gender in English and most other languages (unlike the third person singular pronouns ‘he’, ‘she’, and ‘it’). However Romance languages such as French, Italian, and Spanish, and Semitic languages such as Hebrew and Arabic distinguish between the masculine and the feminine third-person plural pronouns, at least in some grammatical cases. For instance in French, the masculine pronoun is ‘ils’; the feminine pronoun is ‘elles’. In all of these cases, the masculine pronoun is standardly used for groups of mixed or unknown gender.

In order to correctly translate a sentence in English containing the word ‘they’ into one of these languages, it is necessary to determine whether or not the referent is a group of females. If it is, then the translation must be the feminine pronoun; otherwise, it must be the masculine pronoun. Therefore, if one can create a Winograd schema in English where the ambiguous pronoun is ‘they’ and the correct referent for one element is a collection of men and for the
other is a collection of women, then to translate both elements correctly requires solving the Winograd schema.

As an example, consider the Winograd schema:

A. Fred and George knocked on the door of Jane and Susan’s apartment, but they did not answer.

B. Fred and George knocked on the door of Jane and Susan’s apartment, but they did not get an answer.

If these sentences are translated into French, then ‘they’ in the first sentence should be translated ‘elles’, as referring to Jane and Susan, and ‘they’ in the second sentence should be translated ‘ils’, as referring to Fred and George.

A number of the Winograd schemas already published can be “converted” quite easily to this form. Indeed, the above example was constructed in this way; the original form was “Jane knocked on Susan’s door, but she did not [answer/get an answer].” Of the 144 schemas in the collection at http://www.cs.nyu.edu/faculty/davise/papers/WinogradSchemas/WSCollection.html there are 33 that can plausibly be translated this way. (#’s 3, 4, 12, 15, 17, 18, 23, 25, 26, 27, 42, 43, 44, 45, 46, 57, 58, 60, 69, 70, 71, 77, 78, 79, 86, 97, 98, 106, 111, 114, 127, 132, 144) — essentially any schema that involves two people as possible referents where the content of the sentences makes sense as applied to groups of people rather than individuals.

A similar device, in the opposite direction, relies on the fact that French does not distinguish between the possessive pronouns ‘his’ and ‘her’. The pronouns ‘son’ and ‘sa’ are gendered, but the gender agrees with the possession, not the possessor. Therefore a Winograd schema that relies on finding a referent for a possessive pronoun can be turned into a hard pair of French-to-English translation problems by making one possible referent male and the other one female. For example, schema #124 in the online collection reads “The man lifted the boy onto his [bunk bed/shoulders].” Changing the boy to a girl and translating into French gives “L’homme leva la fille sur [ses épaules/son lit superposé]”. In the first sentence “ses” is translated “his”, in the second “son” is translated “her”. The eleven Winograd schemas #’s 112, 117, 118, 119, 124, 125, 127, 129, 130, 131, and 143 can be converted this way.

Care must be taken to avoid relying on, or seeming to rely on, objectionable stereotypes about men and women. One mechanism that can sometimes be used is to include a potentially problematic sentence in both directions. For instance, schema 23 from the WSC collection can be translated into both “The girls were bullying the boys so we [punished/rescued] them” and “The boys were bullying the girls, so we [punished/rescued] them,” thus avoiding any presupposition of whether girls are more likely to bully boys or vice versa.

A historical note: Winograd schemas were named after Terry Winograd because of a well-known example in his doctoral thesis (Winograd 1970). In his thesis, this example followed the above form, and the importance of the example was justified in terms of machine translation. Winograd’s original schema was: “The city councilmen refused to give the women a permit for a demonstration because they [feared/advocated] violence”, and Winograd explained that, in the sentence with ‘feared’, ‘they’ would refer to the councilmen and would be translated as ‘ils’ in French, whereas in the sentence with ‘advocated’, ‘they’ would refer to the women and would be translated as ‘elles’. In the later versions of the thesis, published as (Winograd 1972), he changed ‘women’ to ‘demonstrators’; this made the disambiguation clearer, but lost the point about translation.
3  Current state of the art

No one familiar with the state of the art in machine translation technology or the state of the art of artificial intelligence generally will be surprised to learn that currently machine translation programs are unable to solve these Winograd schema challenge problems.

What may be more surprising is that currently (July 2016), machine translation programs are unable to choose the feminine plural pronoun even when the only possible antecedent is a group of women. For instance, the sentence “The girls sang a song and they danced” is translated into French as “Les filles ont chanté une chanson et ils ont dansé” by Google Translate (GT), Bing Translate, and Yandex. In fact, I have been unable to construct any sentence in English that is translated into any language using the feminine plural pronoun. Note that, since the masculine plural pronoun is used for groups of mixed gender in all these languages, it is almost certainly more common in text than the feminine plural; hence this strategy is reasonable faute de mieux. (It also seems likely that the erroneous use of a feminine plural for a masculine antecedent sounds even more jarring than the reverse.)

The same thing sometimes occurs in translating the feminine plural pronoun between languages that have it. GT translates the French word ‘elles’ into Spanish as ‘ellos’ (the masculine form). Curiously, in the opposite direction, it gets the right answer; the Spanish ‘ellas’ (fem.) is translated into French as ‘elles’.

4  Language-specific issues

The masculine and feminine plural pronouns are distinguished in the Romance languages (French, Spanish, Italian, Portuguese etc.) and in Semitic languages (Arabic, Hebrew, etc.) I have consulted with native speakers and experts in these languages about the degree to which the gender distinction is observed in practice. The experts say that in French, Spanish, Italian, and Portuguese, the distinction is very strictly observed; the use of a masculine pronoun for a feminine antecedent is jarringly wrong to a native or fluent speaker. “Les filles ont chanté une chanson et ils ont dansé” sounds as wrong to a French speaker as “The girl sang a song and he danced” sounds to an English speaker; in both cases, the hearer will interpret the pronoun as referring to some other persons or person, who is male. In Hebrew and Arabic, this is much less true; in speech, and even, increasingly, in writing, the masculine pronoun is often used for a feminine antecedent.

Looking further ahead, it is certainly possible that gender distinctions will be abandoned in the Romance languages, or even that English will have driven all other languages out of existence, sooner than AI systems will be able to do pronoun resolution in Winograd schemas; at that point, this test will no longer be useful.

In some cases, a translation program can side-step the issue by omitting the pronoun altogether. For example, GT translates the above sentence “The girls sang a song and they danced” into Spanish as “Las chicas cantaron una canción y bailaban” and into Italian as “Le ragazze hanno cantato una canzone e ballavano.” However, with the more complex sentences of the Winograd Schemas, this strategy will rarely give a plausible translation for both elements of the schema.

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1 I have heard the claim made that GT always uses English as an interlingua; that is, when GT translates from language $S$ to $T$, it always translates from $S$ to English and then from English to $T$. However, this example of translating ‘ellas’ shows that that claim cannot be entirely true, since the English intermediary could only be ‘they’, losing the gender.
5 Other languages, other ambiguities

Broadly speaking, whenever a target language $T$ requires some distinction that is optional or non-existent in source language $S$, it is possible to create a sentence $U$ in $S$ where the missing information is not explicit but can be inferred from background knowledge. Translating $U$ from $S$ to $T$ thus requires using the background knowledge to resolve the ambiguity, and will therefore be challenging for automatic machine translation.

A couple of examples: The word ‘sie’ in German serves as both the formal second person pronoun (always capitalized), the third person feminine singular, and the third person plural. Therefore, it can be translated into English as either “you”, “she”, “it”, or “they”; and into French as either ‘vous’, ‘il’, ‘elle’, ‘ils’, or ‘elles’. (The feminine third-person singular German ‘sie’ can be translated as neuter in English and as masculine in French because the three languages do not slice up the worlds into genders in the same way.) Likewise, the possessive pronoun ‘ihr’ in all its declensions can mean either ‘her’ or ‘their’. In some cases, the disambiguation can be carried out on purely syntactic ground; e.g. if ‘sie’ is the subject of a third-person singular verb, it must mean ‘she’. However, in many case, the disambiguation requires a deeper level of understanding. Thus, it should be possible to construct German Winograd schemas based on the words ‘sie’ or ‘ihr’ that have to be solved in order to translate them into English. For example,

Marie fand fünf verlassene Kätzchen im Keller. Ihre Mutter war gestorben.
(Marie found five abandoned kittens in the cellar. Their mother was dead.)

vs.

Marie fand fünf verlassene Kätzchen im Keller. Ihre Mutter war unzufrieden.
(Marie found five abandoned kittens in the cellar. Her mother was displeased.)

Another example: French distinguishes between a male friend ‘ami’ and a female friend ‘amie’. Therefore, in translating the word “friend” into French, it is necessary, if possible, to determine the sex of the friend; and the clue for that can involve an inference that, as far as AI programs are concerned, is quite remote. Human readers are awfully good at picking up on those, of course. In general, with this kind of thing, if you want to break GT or another translation program, the trick is to place a large separation between the evidence and the word being disambiguated. In this case, at the present time, the separation can be pretty small. GT correctly translates “my friend Pierre” and “my friend Marie” as “mon ami Pierre” and “mon amie Marie” and it translates “She is my friend” as “Elle est mon amie,” but rather surprisingly it breaks down at “Marie is my friend,” which it translates “Marie est mon ami.” As for something like “Jacques said to Marie, ‘You have always been a true friend,’” that is quite hopeless. GT can surprise one, though, in both directions; sometimes it misses a very close clue, as in “Marie is my friend”, but other times it can carry a clue further than one would have guessed.

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2The masculine pronoun ‘mon’ is standardly used in this phrase rather than the feminine ‘ma’, purely for reasons of euphony.
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