

ViSiCAST Milestone M5-1: Semantic Def Rep

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Author(s):	I Marshall, E Safar (UEA)

Abstract:

The report for this milestone is a provisional definition of the DRS interface between NLP work at UEA and Sign Languages Synthesis lead by IDGS.

Originally scheduled for month 3, it was produced by month 7 due to delays in recruitment at UEA and IDGS which rendered its earlier production premature. As this milestone feeds Deliverable 5.1 due month 12, and as progress since has compensated for later recruitment, this delay has not hindered progress.

Postscript:

Initial discussion highlighted the need for treating the DRS as an ordered collection of predicates and for maintaining indication of sentence boundaries of the original text within the propositions of the DRS.

An initial prototype is being developed which constructs DRSs from the output of the CMU parser. This has highlighted some further inadequacies in the original DRS interface formulation, specifically this reformulation will include propositions for carrying forward information about sentence type (imperative, declarative, interrogative) and indication of topic comment structure.

These revisions will be incorporated in the Deliverable 5.1 *Interface Definitions* for month 12.

Semantic Representation Definition

Ian Marshall (UEA)

Preliminaries

At the meeting in Hamburg on 8/5/00 I said I would prepare an initial draft of a proposal for the interface between Language Processing work at UEA and later work on construction of sign synthesis at Hamburg/IvD/UEA for each of the respective national sign languages. The original ViSiCAST proposal stated an internal milestone at the end of month 3 to have firmed this up. However, as this really impinges on deliverables by the end of month 18, collectively we have not viewed the slippage as serious up to this point. Needless to say, we should look to make progress on this in the next two months or so.

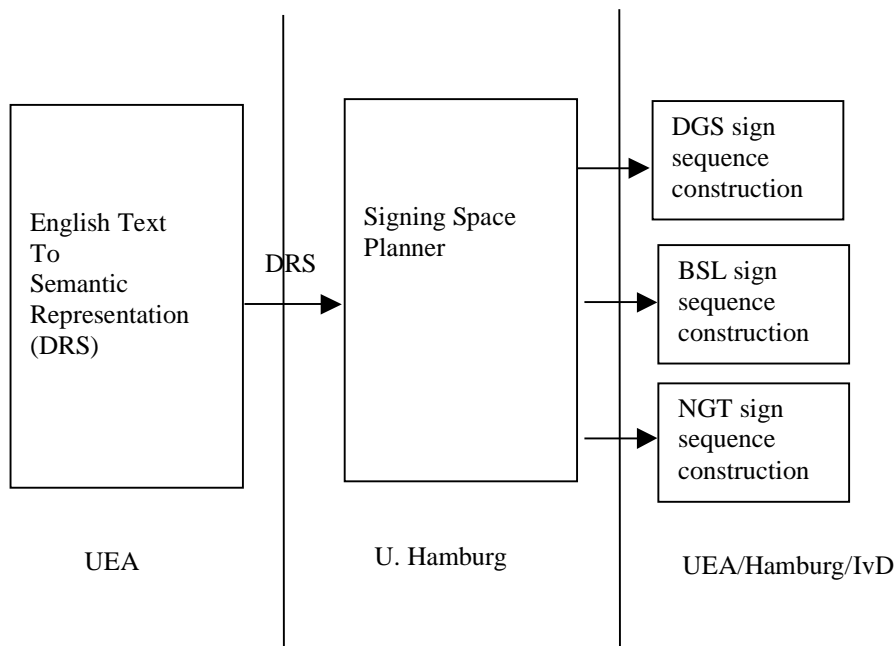
With that in mind, herein I have tried to make more explicit a framework which I think is embedded in the ViSiCAST proposals in order that we (I) can

- (i) clarify that we agree on where we see the division of labour,
- (ii) give some rationale for the original choice of DRSs and thus for some of preoccupations in the proposed formulation below,
- (iii) begin to firm up on what the interface might look like,
- (iv) present a small number of examples within this.

Finally as a disclaimer, I am certain some detail herein is inaccurate, please feel free to notify me of any corrections either in misconstruing the framework or in the detail.

Framework

The original VisiCAST proposal envisaged the following division of effort



The extracted DRS representation is to be a semantic representation from which quality signed presentations can be generated. I have assumed in this framework that the mapping from semantic concepts in the DRS into sign visemes in the target languages is a backend activity (i.e. that each target language is equipped with a semantic concept to sign language dictionary appropriate to that language). In addition, the mapping will probably be many to one, in the sense that the front-end conversion to DRS conversion will not be concerned with a set of semantic 'primitive' concepts, but that it will be concerned with word sense disambiguation with reference to some particular English lexicons (e.g. WordNet). Thus for nouns, verbs, adjectives and adverbs DRS predicates will identify particular senses and each target language backend will map these senses to signs in the respective languages. Temporal aspects, and further grammatical characteristics will need to be synthesised for the target languages from information in the DRS.

Sign Language Characteristics

From my perspective, I can only discuss BSL characteristics with a little confidence, hence I rely on Thomas, Margriet and others to correct and enhance comments here with respect to DGS and NGT. My comments here are to invite comment on either misunderstanding of BSL or differences with DGS and NGT.

The proposal of DRS as the intermediate semantic representation is based upon this semantic representation capturing characteristics that are significant in sign languages. In particular :-

(i) anaphora and placement. Repeated reference to the same individuals in a text can be replaced by references to positions in signing space. The DRS representation makes explicit anaphoric references by associating the same variable with multiple references across sentences/propositions. The sign space planner will then manage consistent allocation of such variables to significant positions in signing space.

(ii) organisation of the back-end dictionary as a 'SignNet' analogous to WordNet gives the potential of using classifier shapes as pronominal references inside signs for verbs which incorporate subject/object information. In BSL, such 'proforms' are usually associated with information about verb object roles.

(iii) BSL signals temporal information significantly differently from English. In particular, English tenses are not signaled in a comparable way in sign language. Hence, the semantic representation should be as accurate as possible with respect to temporal information to allow conversion to sign language using e.g. appropriate time lines (such as BSLs three/four major time lines).

(iv) BSL makes a significant grammatical distinction between a single event involving a group of objects and a repetitive event involving single objects. For example, the ambiguity of

The lecturer spoke to the students.

as either

The lecturer spoke individually to each student.

or

The lecturer spoke to the students collectively.

needs to be resolved in order to appropriately sign one of these alternatives. DRSs allow the explicit representation of the set and individuals of the set. It may be possible to determine from the surrounding context which of these is appropriate or may require human intervention, however the representation will have required that the ambiguity is resolved.

At the Hamburg meeting, Thomas raised the issue of underspecification. Our notes from the time show an example of 'next to' as underspecified as 'left of' / 'right of', but at previous times we have also aired different aspects of underspecification. I may be missing some particular point but generally I thought this was less of an issue, in particular that different kinds of underspecification will be resolved prior to the DRS (e.g. i. Syntactic underspecification - genuine ambiguity would have to be determined in context (by human intervention) and resolved. This poses particular problems for certain kinds of jokes but I think this would be very hard to address at this stage.

ii. Quantifier scope underspecification - I though we had discussed this some little time ago and agreed this would be resolved prior to passing on the DRS (rather than using an underspecification representation. I am not particularly enthusiastic to be too concerned with quantifier ambiguities if some judicious use of the word 'each' can allow the user to resolve these.

iii. Lexical underspecification (in the source language) will be resolved by reference to a particular word sense in a dictionary, and in context (possibly with human intervention for words such as 'we').

iv. Lexical underspecification (in the target language) arises if the the source language proposition is sufficiently vague that multiple interpretations can be constructed in the target language. For positional cases such as the one above, my view is that this would need to be resolved consistently in the Signing Space Planner. Thomas and I exchanged some early notes and I thought there was some agreement that at least initially we would not be looking to handle texts in which the anaphora and placement had to be consistent with some extra-textual environment, hence the main concern will be internal consistency of the Sign Space Planner.

The following proposal is largely based upon the formulation of DRSs of Kamp and Reyle in

[1] van Eijck, J & Kamp, H, 1993, *From Discourse to Logic*, Vols 1 & 2, Kluwer.

[2] van Eijck, J & Kamp, H, 1997, 'Representing Discourse In Context', in *Handbook of Logic & Language*, van Benthem, J & Ter Meulen, A, eds, Elsevier, 1997.

Labeling of propositions is taken from [1], though in [2] these are presented as an additional argument to each predicate.

In general terms, this makes provision for their interval temporal framework coupled with first order predicate logic and extensions to allow sets of objects as arguments to predicates, plus any further extensions we might consider desirable. For example the labeling of attributive propositions merely extends Kamp and Reyle's notation in [1] but allows the possibility of $[a1:big(X)$ and $very(a1)]$ as ways of handling some modifiers. From a logical viewpoint this looks suspect but from a practical point of view, BSL facial expressions associated with intensity could be associated with such higher order predicates.

The description makes no provision for ease of identification of particular kinds of proposition, though we could agree to group these appropriately (e.g. all temporal relation propositions together etc.)

I have followed Kamp and Reyle's hints in [1] to convert to predicate calculus in the main rather than use their box notation. The box notation will be of little use as a machine readable form so I have used square brackets at the outer level though in effect this could be an existentially quantified proposition.

Finally, there is currently no provision for associating the different parts of the DRS with its origination in the English text or additional information. This may or not be desirable, however it would be potentially useful to associate with predicates further information such as identification as topic v. comment in the original sentence structure. A rather provisional idea would be to associate these as attributes of variables denoting individuals and with predicate labels.

Following this initial formulation are two example sentences and their DRS counterparts.

DRS BNF / Ontology

DRS ::= [*VariableList* : *LabelledPropositions*]

VariableList ::=

To consider format

List of all variables / labels used in the DRS

Possibly segmented into different categories for ease of extraction.

LabelledPropositions ::=

LabelledProposition |

LabelledProposition & *LabelledPropositions* |

LabelledProposition \Rightarrow *LabelledProposition*

(last production may have undesirable consequences, permitting

LocationalPropositions, *CollectivePropositions*, *ReferentRelationProposition*,

TemporalRelationProposition as antecedents - possibly need to subcategorise.)

LabelledProposition ::=

EventProposition |

StateProposition |

TemporalProposition |

LocationalProposition |

AttributiveProposition |

CollectiveProposition |

ReferentRelationProposition |

TemporalRelationProposition

EventProposition ::=

Evar : *Proposition*

StateProposition ::=

Svar : *Proposition*

TemporalProposition ::=

Tvar : **when** ([*Evar* | *Svar*])

(*Tvar* denotes an interval)

LocationalProposition ::=

Lvar : **where** ([*Evar* | *Svar*])

AttributiveProposition ::=

Avar : *Proposition*

CollectiveDefinition ::=

Cvar = Σ *Var* : *LabelledPropositions*

ReferentRelationProposition ::-
 $Var = Var \mid Var \in CVar$

TemporalRelationProposition ::-
 $Tvar \ TemporaOperator \ Tvar$

TemporalOperator ::-
 $= \mid < \mid > \mid \subseteq \mid \supseteq$
(temporal precedence and inclusion)
(possibly others for completeness)

Proposition ::-
UniversalQuantification |
ExistentialQuantification |
Predicate (*VarList*)

UniversalQuantification::-
 $Qvar : \forall Var : LabelledPropositions$

ExistentialQuantification::-
 $Qvar : \exists Var : LabelledPropositions$

Predicate ::-
 $PredName . Sense$

PredName ::-
A lexical name, what restrictions do we wish to impose if any here?

Sense ::-
An item identifying the sense of the lexical item and the specific sense according to that source (e.g. Wordnet.3)

VarList ::-
 $Var \mid$
 $Var , VarList$

Where

$Var \in \{v1,v2,v3, \dots \}$
 $Evar \in \{e1,e2,e3, \dots \}$
 $Svar \in \{s1,s2,s3, \dots \}$
 $Tvar \in \{t1,t2,t3, \dots \}$
 $Lvar \in \{l1,l2,l3, \dots \}$
 $Qvar \in \{q1,q2,q3, \dots \}$
 $Avar \in \{a1,a2,a3, \dots \}$
 $Cvar \in \{c1,c2,c3, \dots \}$

Example single sentences.

Five little fox cubs who lost their mothers were taken in by staff at the wildlife hospital at East Winch near King's Lynn.

```
[v1, v3, v4, v5, v6, v7, t1, t2, e1, e2, l1, a1, a2, a3, a4, a5,
q1 |
  v1 =  $\Sigma_{v2}$ . [v2 |
    a1: fox-cub(v2) &
    q1:  $\forall_{v3}$ . a2: mother(v3,v2) ? e1: lose(v2,v3) &
    t1: when(e2) &
    t1 < now

    |v1| = 5 &
  a3: staff(v4,v5)

  a4: wildlife-hospital(v5) &
  l1: where(v5) &
  l1 = East-Winch &
  a5: near(l1,v6) &
  v6 = King's-Lynn

  v7 / v4 &
  v7 =v4 &

  e2: take-in(v4,v7) &
  t2: when(e2) &
  t2 < now

]

infer t1 < t2 ?

n.b. WordNet suffixes omitted on predicates
```

Each individual fox 'lost' their mother, foxes 'taken in' as a collection!

The cubs are all about four months old and were found in various parts of Norfolk.

```
[ v8, v9, v10, v11, v12, l2, t3, e3, a6, a7, a8, a9, a10,
a11 |
  a6: cubs(v8)
  q2:  $\forall v9 \perp v8 \cdot$ 
       $\exists v10 \cdot$ 
      a7: age(v9) = v10 &
      a8: value(v10, 4) &
      a9: approximate(a8)
      a10: units(v10, months) &

  q3:  $\forall v9 \perp v8 \cdot$ 
       $\exists v11, v12 \cdot$ 
      e3: find(v11, v9) &
      l2: where(e3, v12) &
      a11: v12  $\perp$  Norfolk &
      t3: when(e3) &
      t3 < now &

]
```

```
Infer during DRS composition
  t3 < t2
  t1 < t3 ?
  v8 = v4
```

This analysis treats the finding of each individual fox rather than a set of foxes.
Possible signing, Sign case for fox1, then 'fox2 same, etc' or 'all same'

