The LOGON MT infrastructure

Ling 567
May 20, 2013

Overview

- MRS and MT: Some history
- The Grammar Matrix and massively multilingual MT
- The LOGON architecture
    - Processing steps
    - Transfer rules
    - VPM
- Lab 8 practicalities
- Next week: Transfer rules

MRS and MT: Some history

- Copestake et al 1995: Original motivation for MRS included MT applications
- Resolving scope ambiguities is hard, and usually not necessary
  - Logical form equivalence is undecidable even in FOPL (Shieber 1993)
- Mimicking syntactic structure in semantics makes transfer harder
  - *young black cat* <> *gato negro y feroz* (Spanish)
  - *young black bull* <> *novillo negro*
- MRS gives logical forms with less syntactic complexity and underspecification wherever possible.

MRS and MT: Some history

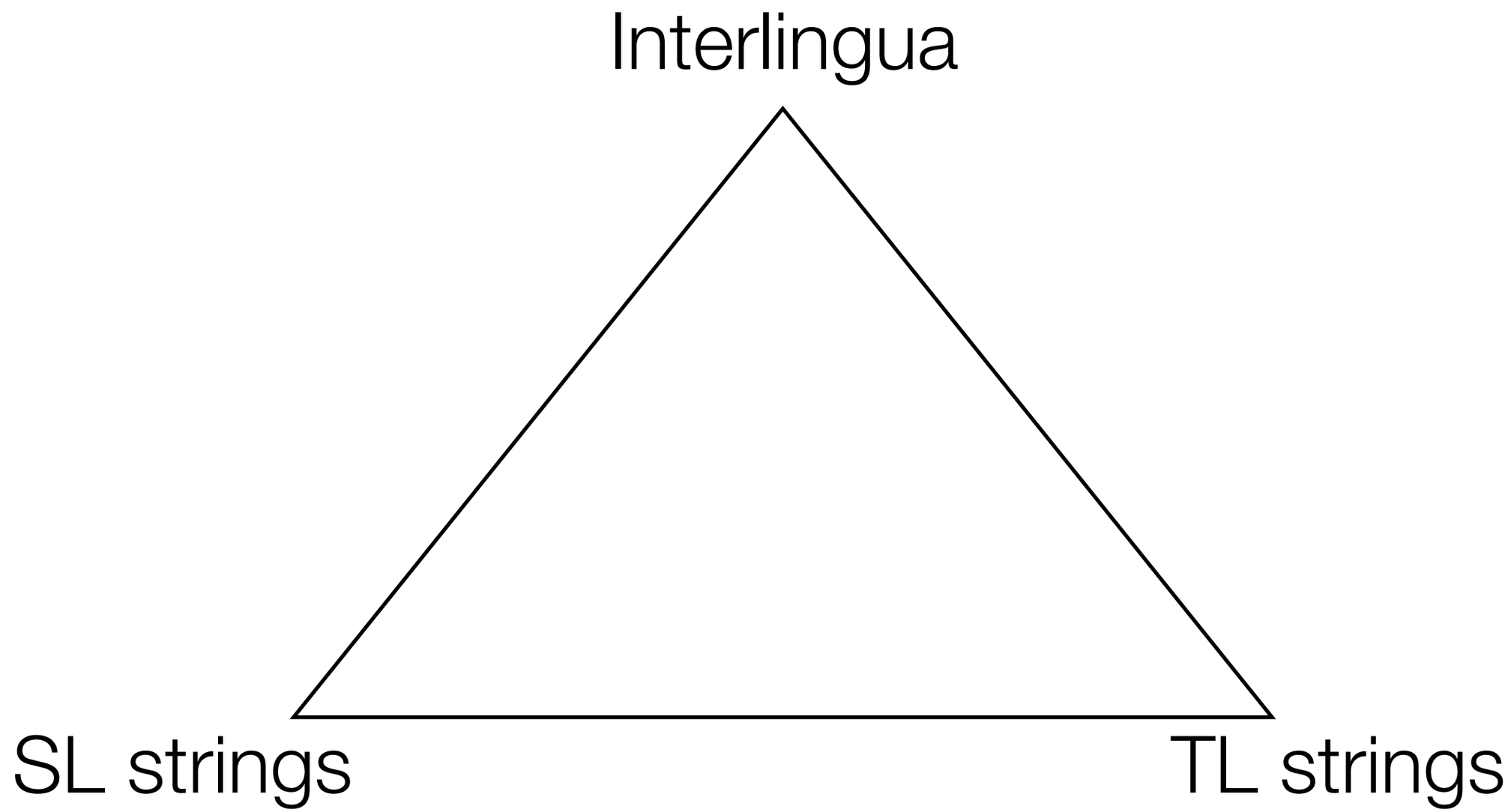
- MRS originally developed in the context of Verb*Mobil* but not fully deployed for transfer-based MT in that project.

- In 2003, LOGON picks up the thread and builds the first MRS-based MT system. (Norwegian -> English; tourism brochures)

- Input is LFG, with MRSs projected from f-structure.

- Output is generated by the English Resource Grammar (HPSG; Flickinger 2000)

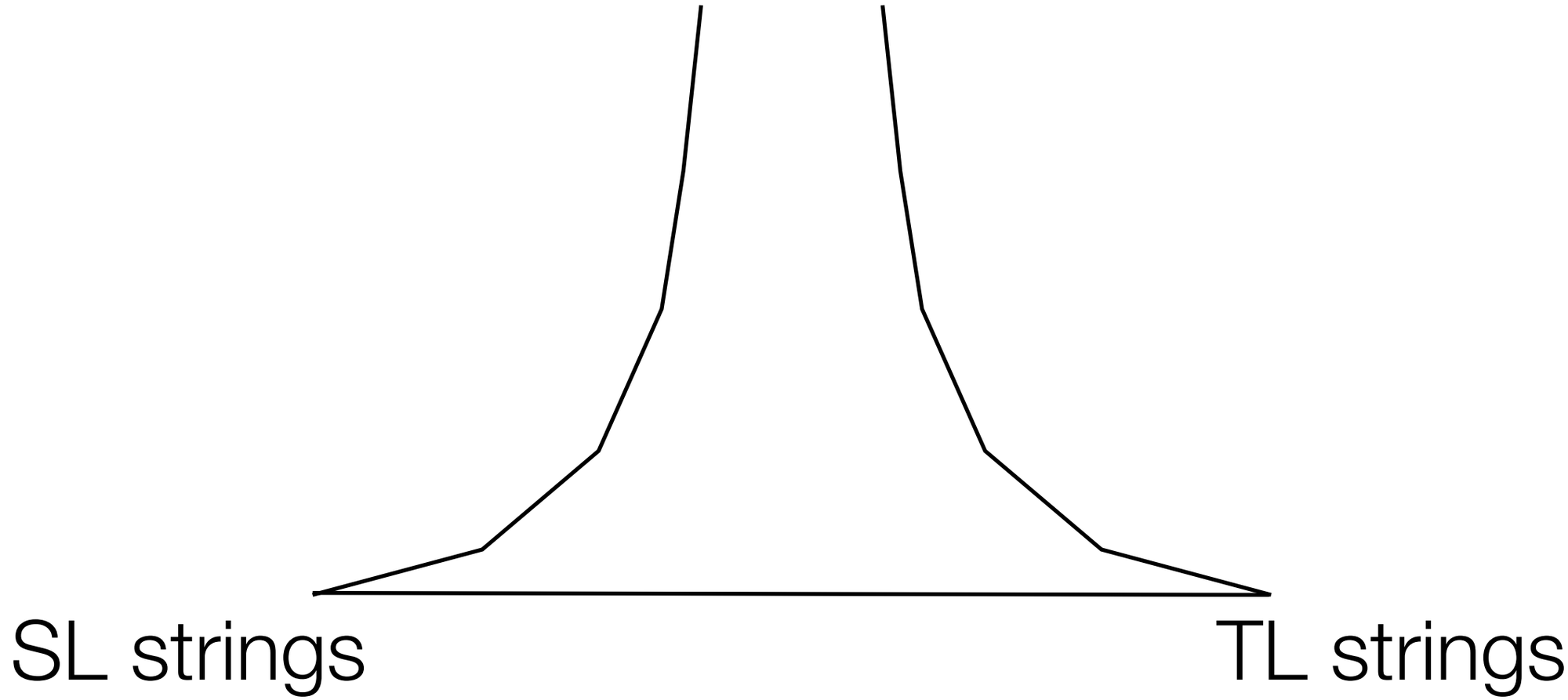
Vauquois Pyramid (ObMT Triangle)



Is MRS an interlingua?

- Could MRS be used to encode an interlingua?
- Could our grammar produce such an MRS-encoded interlingua?

Copestake Volcano



Massively Multilingual MT

- Problem of combinatory explosion (*n x n*):
- 2 languages: 2 sets of transfer rules
- 4 languages: 9 sets of transfer rules
- 24 languages: 552 sets of transfer rules
- 6000 languages: 35,994,000 sets of transfer rules

What are the alternatives?

- Design an interlingua (or select a pivot language), and create two grammars for each language
  - strings <> ordinary MRS
  - ordinary MRS <> interlingua (transfer grammar)
- Hybrid interlingual/transfer-based model
  - partial lexical interlingua or PanDictionary-derived rules
  - TL-side “accommodation” transfer grammars: O(n)
  - transfer matrix to capture generalizations
- How far will approach 2 scale?
- How much mismatch is there?

Mismatch: Translation divergences (Dorr 1994)

- Categorial divergence: Translation of words in one language into words that have a different part of speech in another language.

- Conflational divergence: The translation of two or more words in one language into one word in another language

- Structural divergence: The realization of verb arguments in different syntactic configurations in different languages.

- Head swapping divergence: The inversion of the structural dominance relation between two semantically equivalent words when translating from one language to another.

- Thematic divergence: The realization of verb arguments in different configurations that reflect different thematic to syntactic mapping orders.

MRS ‘harmonization’ helps

- Just because it’s not an interlingua doesn’t mean the grammars can’t be brought closer together.

- Example 1: Demonstratives (adjectives v. determiners)

- Example 2: COG-ST et al, reduction in quantifier-rel inventory

- Further potential for harmonization: pronouns v. pro-drop (but cf. information structure marking on overt pronouns)

- Other examples?

LOGON processing steps

- Parse in source language
  - visualization tools for parses and MRSs
- Apply source language's transfer grammar to produce new MRS
  - visualization tools for transfer outputs
- Generate in target language from new MRSs
  - visualization tools for input MRSs
  - compare to MRS produced by parsing expected output
  - generator chart

Anatomy of a transfer rule

- Quadruple: [CONTEXT:] INPUT [!FILTER] -> OUTPUT
- Each item above is a (partial) MRS
- Rules apply to complete MRSs to produce partially rewritten MRSs.
- Resource sensitive: INPUT is consumed in producing OUTPUT.
- CONTEXT: Additional properties beyond the INPUT that must be satisfied. (Not consumed.)
- FILTER: Negative constraints; contexts in which the rule should not apply.

Anatomy of a transfer rule

- Rules can be obligatory or optional.
- Optional rules produce non-determinism in the transfer process.
- Pairing each optional rule with one obligatory rule cuts down the transfer search space.
- Rules can also be grouped into sets for ‘extrinsic’ ordering (which we probabl won’t need).
- Handled with chart-based processing.

Types and translation

- Many transfer rules share most of their properties, differing only in lexical predicates/other small details.
  - Define types of transfer rules, with particular instances, analogous to lexical types and lexical entries.
- Types mentioned in transfer rules will unify with compatible types in actual MRS.
- In addition, the generator will allow some unification of different (but compatible) types for feature values.

Example type

```
monotonic_mtr := mrs_transfer_rule &
 [ CONTEXT.HOOK.LTOP #h,
   INPUT.HOOK.LTOP #h,
   OUTPUT.HOOK.LTOP #h ].
```

Example rule instance

```
pro-insert-arg1-mtr := monotonic_mtr &
[ INPUT.RELS <! !>,
  CONTEXT.RELS <! [ ARG0.SF prop-or-ques,
                    ARG1 #x & x ] !>,
  FILTER.RELS <! [ ARG0 #x ] !>,
  OUTPUT [ RELS <! [ PRED "_pronoun_n_rel",
                     ARG0 #x,
                     LBL #larg ],
                   [ PRED "exist_q_rel",
                     ARG0 #x,
                     RSTR #harg ] !>,
        HCONS <! qeq &
                 [ HARG #harg,
                   LARG #larg ] !> ],
FLAGS.EQUAL < #x > ].
```

What about features of indices?

- Can’t change value from input to output while maintaining identity of index with other positions.

- Person and number can be harmonized (in principle at least) by extending hierarchies on both sides, but we can’t harmonize between PERNUM and separate PER and NUM features.

- Tense and aspect (and others) can likewise be harmonized at least somewhat, but inventories vary greatly.

- Variable property mapping allows grammar-internal variable properties to differ from grammar-external universe.

    - We’ll use this for harmonization (e.g., of PERNUM) and setting of defaults.

A side note on gender

- Represented in MRS because of its role in reference resolution.
- Pretty language specific.
- You might think you want to keep it on pronouns and discard it on nouns, but even that only works for closely related languages.
- Long term solution: Anaphora resolution on the SL language side and assignment of gender properties to pronouns based on projections of this information.
- For now: drop gender through vpm.

```
;;; -*- Mode: TDL; Coding: utf-8 -*-
; A basic VPM for Matrix grammars.
event          <> e
ref-ind        <> x
individual     <> i
handle         <> h
non_event      <> p
*              >> u
semarg         << u

SORT : SORT
  * <> *
  semsort << *

E.TENSE : E.TENSE
  * <> *

SF : SF
  prop <> prop
  ques <> ques
  prop-or-ques >> prop-or-ques
  prop << prop-or-ques
  comm <> comm

COG-ST : COG-ST
  type-id <> type-id
  uniq-id <> uniq-id
  familiar <> familiar
  activated <> activated
  in-foc <> in-foc
  activ+fam <> activ+fam
  uniq+fam <> uniq+fam
  activ-or-more <> activ-or-more
  uniq-or-less <> uniq-or-less
  uniq+fam+act <> uniq+fam+act
  fam-or-more <> fam-or-more
  fam-or-less <> fam-or-less
  uniq-or-more <> uniq-or-more
  activ-or-less <> activ-or-less

PNG.PER : PNG.PER
  1st <> 1st
  2nd <> 2nd
  3rd <> 3rd
  * <> !
```

```
PNG.NUM : PNG.NUM
  sg <> sg
  pl <> pl
  du <> du
  dist <> dist
  coll <> coll
  * <> !

PNG.GEND : PNG.GEND
  animate <> animate
  inanimate <> inanimate
  human <> human
  nonhuman <> nonhuman
  * <> !

E.ASPECT : ASPECT
  continuative <> continuative
  * <> !

E.MOOD : MOOD
  irrealis <> irrealis
  resemblative <> resemblative
  quotative <> quotative
  apparitional <> apparitional
  iterative <> iterative
  potential <> potential
  * <> !
```

```
PNG.PERNUM : PNG.PER PNG.NUM
  1singular <> 1st singular
  2singular <> 2nd singular
  3singular <> 3rd singular
  1plural <> 1st plural
```

Practicalities

- Get one more test corpus example working
- Grammar clean-up
    - Reduce number of strings generated per input to (ideally) those that are motivated.
    - Harmonize MRSs
    - Use VPM to set defaults for e.g., ASPECT
- Attempt translation
- Work on VPM

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