

The LOGON MT infrastructure

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Overview

- MRS and MT: Some history
- The Grammar Matrix and massively multilingual MT
- The LOGON architecture
 - Processing steps
 - Transfer rules
 - VPM

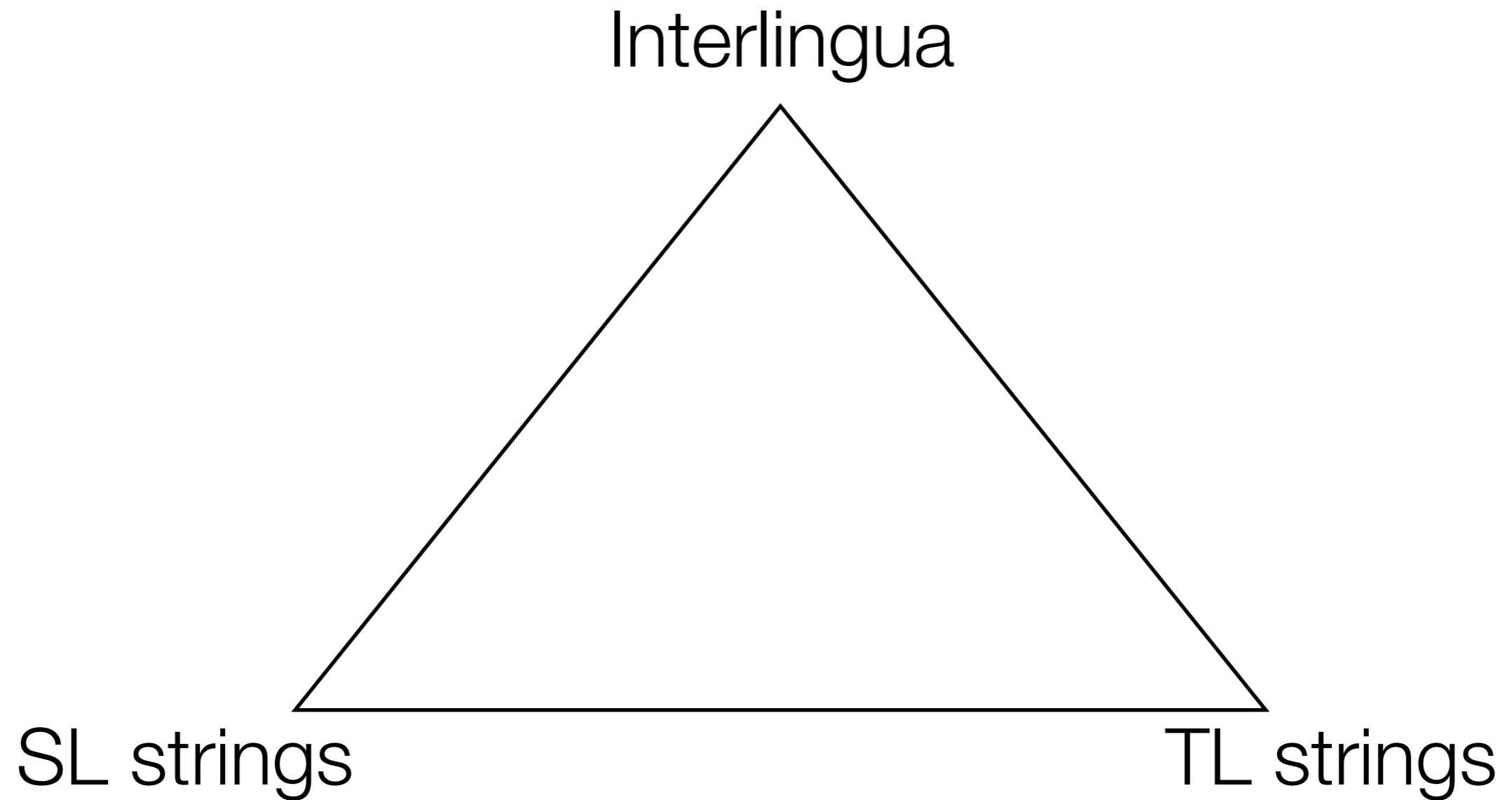
MRS and MT: Some history

- 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
 - *fierce 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 *VerbMobil* but not fully deployed for transfer-based MT in that project.
- In 2003, LOGON (Oepen et al 2004, 2007) 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)
- Further projects have built LOGON-based MT systems for other language pairs, notably JaEn (Bond et al 2011)

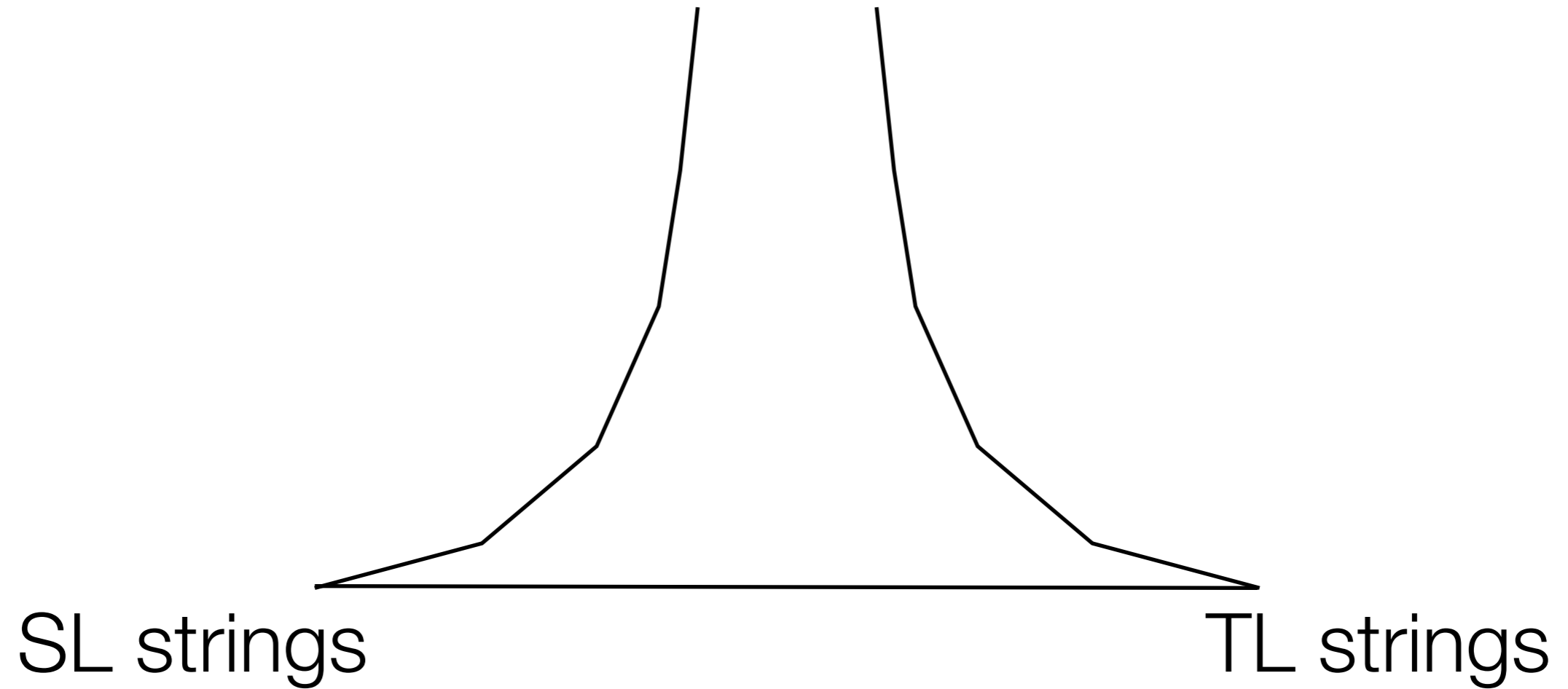
Vauquois Pyramid (ObMT Triangle)



Is MRS an interlingua?

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

Copestake Volcano



Massively Multilingual MT

- Problem of combinatory explosion ($n \times n$):
- 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 \leftrightarrow ordinary MRS
 - ordinary MRS \leftrightarrow interlingua (transfer grammar)
- Hybrid interlingual/transfer-based model
 - partial lexical interlingua or PanLex-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 target 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 probably 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.

semi.vpm in mmt/grammars/eng

PNG.PERNUM : PER NUM

1sg <> first sg
1pl <> first pl
2sg <> second sg
2pl <> second pl
3sg <> third sg
3pl <> third pl
1st <> first !
1st << first *
2nd <> second !
2nd << second *
3rd <> third !
3rd << third *
sg <> ! sg
sg << * sg
pl <> ! pl
pl << * pl
* <> ! !

E.TENSE : TENSE

present <> present
past <> past
future <> future
past << non-future
tense <> *

E.ASPECT : ASPECT

prog <> prog
aspect <> *

E.MOOD : MOOD

mood <> *

-> look over lab6, play with mmt