

# The LOGON MT infrastructure

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Ling 567

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# Overview

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- MRS and MT: Some history
- The Grammar Matrix and massively multilingual MT
- The LOGON architecture
  - Processing steps
  - Anatomy of a transfer rule
  - Types and translation
- Lab 9 practicalities

# MRS and MT: Some history

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- 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.

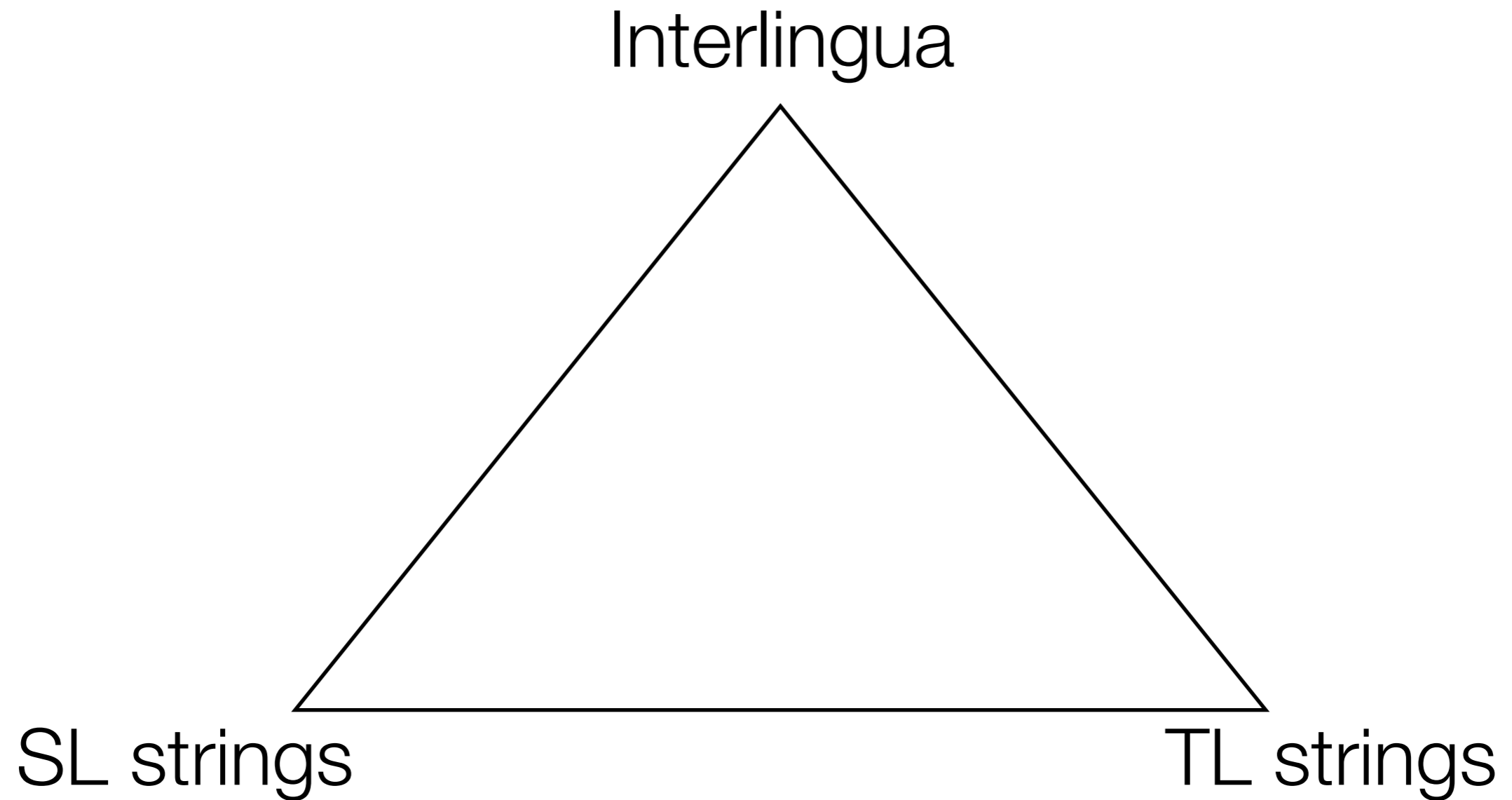
# MRS and MT: Some history

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- MRS originally developed in the context of *VerbMobil* 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)

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# Is MRS an interlingua?

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

# 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 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 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

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

# Example rule instance

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```
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.

# Practicalities

- Grammar clean-up
  - Reduce number of strings generated per input to (ideally) those that are motivated.
  - Harmonize MRSs
- Transfer matrix
  - Transfer rules for residue
  - Minimize use of transfer rules to maximize nxn system
  - Post to GoPost if you need new transfer rules
  - Generate based on inputs from English and Italian

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