The LOGON MT infrastructure
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
  • *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) 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)
Is MRS an interlingua?

• Could MRS be used to encode an interlingua?

• Could our grammar produce such an MRS-encoded interlingua?
Copestake Volcano

SL strings

TL strings
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 <> 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 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.
A basic VPM for Matrix grammars.

event          <> e
ref-ind        <> x
individual     <> i
handle         <> h
non_event      <> p
*              >> u
semsort        << 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

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

<table>
<thead>
<tr>
<th>sg</th>
<th>sg</th>
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<tbody>
<tr>
<td>pl</td>
<td>pl</td>
</tr>
<tr>
<td>du</td>
<td>du</td>
</tr>
<tr>
<td>dist</td>
<td>dist</td>
</tr>
<tr>
<td>coll</td>
<td>coll</td>
</tr>
<tr>
<td>*</td>
<td>!</td>
</tr>
</tbody>
</table>

### PNG.GEND : GEND

<table>
<thead>
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<th>animate</th>
<th>animate</th>
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<tbody>
<tr>
<td>inanimate</td>
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<tr>
<td>human</td>
<td>human</td>
</tr>
<tr>
<td>nonhuman</td>
<td>nonhuman</td>
</tr>
<tr>
<td>*</td>
<td>!</td>
</tr>
</tbody>
</table>

### E.MOOD : MOOD

<table>
<thead>
<tr>
<th>irrealis</th>
<th>irrealis</th>
</tr>
</thead>
<tbody>
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<td>iterative</td>
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<tr>
<td>potential</td>
<td>potential</td>
</tr>
<tr>
<td>*</td>
<td>!</td>
</tr>
</tbody>
</table>

### E.ASPECT : ASPECT

<table>
<thead>
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<th>continuative</th>
<th>continuative</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>!</td>
</tr>
</tbody>
</table>
PNG.PERNUM : PER 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

  * >> no-aspect
  no-aspect << [e]

• Attempt translation

• Work on VPM
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