Hybrid Machine Translation Guided by a Rule–Based System

Cristina España-Bonet, **Gorka Labaka**, Lluís Màrquez, Arantza Díaz de Ilarraza, Kepa Sarasola

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Motivation

- All the current MT approaches have their pros and cons.
- Rule-Based MT
- Statistical MT
- We would like to get the best of each world.

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- Rule-Based MT
  - \+ Syntactically better translations: long distance reordering, agreement
  - – Worse lexical selection
  - – Performance degradation for unexpected syntactic structures
- Statistical MT
- We would like to get the best of each world.

Motivation

- All the current MT approaches have their pros and cons.
- Rule-Based MT : +syntax, −lexical selection, −unexpected structures
- Statistical MT
  - \+ Better lexical selection and fluency
  - – Structurally worse translations
  - – Performance degradation for *out-domain* texts.
- We would like to get the best of each world.

Motivation

- All the current MT approaches have their pros and cons.
- Rule-Based MT : +syntax, −lexical selection, −unexpected structures
- Statistical MT : +lexical selection, −long distance reordering, −out-domain performance
- We would like to get the best of each world.
  - RBMT's grammatical correctness.
  - SMT's lexical selection
  - SMT tolerance to unexpected structures.

Outline

1. SMatxinT: RBMT leaded hybrid system
2. Experimental Results
3. Conclusions

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Statistical machine translator(s)

- SMTb (Moses with default configuration):
  - phrase and lexical translation probabilities
  - 3-gram LM
  - lexicalized reordering
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  - Default Moses configuration: phrase and lexical prob., 3-gram LM, ...
  - Word generation phase to go from segmented text to final words
  - Word level LM added using n-best list

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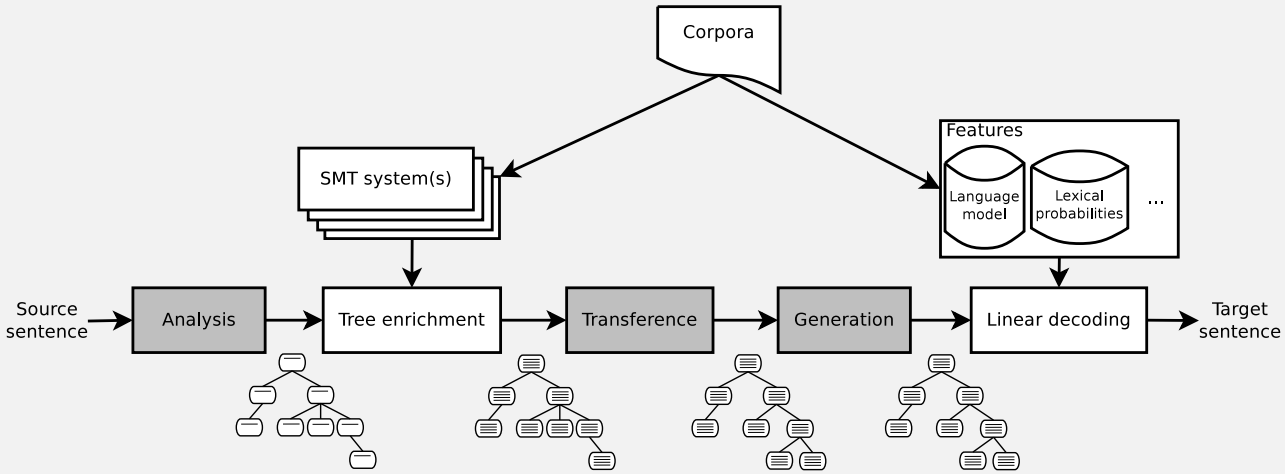
Matxin, a rule-based translator

- In-house developed Open-Source Rule-Based MT system.
- Classical transfer-based approach: analysis, transfer and generation.
- Chunk-based dependency tree:
  - Dependency trees + chunk boundaries.

SMatxinT: RBMT guided Hybrid MT

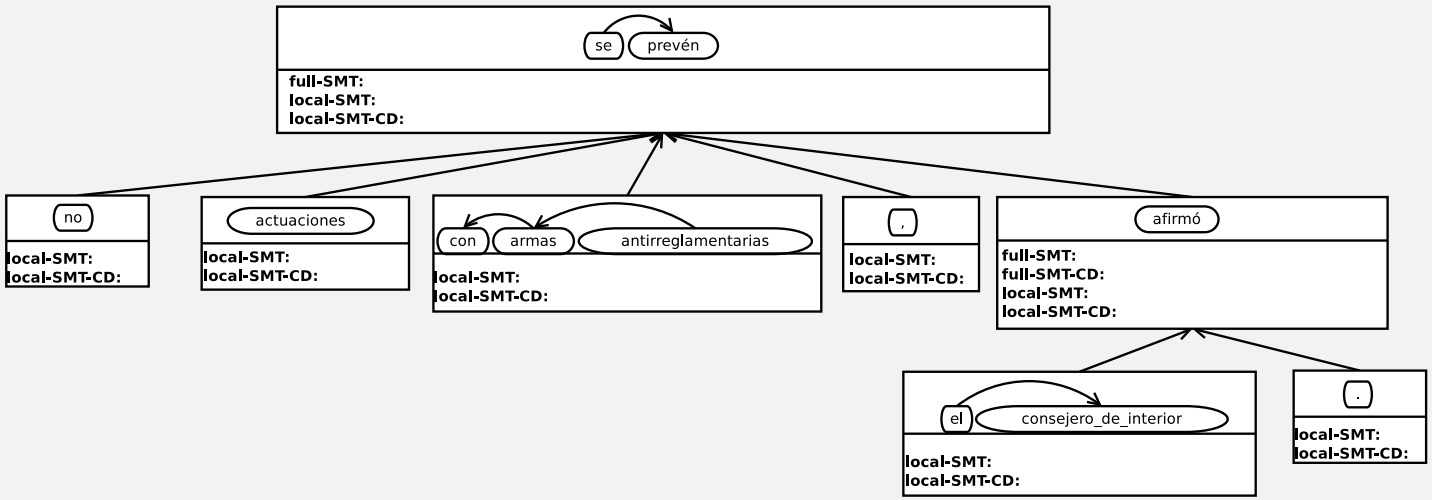
- Translation process is guide by the Rule-Based system.
  - Ensures syntactic correctness.
  - Takes care of long distance reordering.
- Allow substitution of RBMT partial translations with their SMT counterparts.
  - Substitutions of short strings improve lexical selection.
  - Longer substitutions allow to overcome wrong syntactic analysis.

SMatxinT architecture



- Two new modules are added to the RBMT architecture.
  - Tree enrichment (between analysis and transfer).
  - linear decoding (after generation).

Tree enrichment



- After analysis, and before transfer.
- Each phrase in the tree is enrich with one (or several) SMT translation counterpart.
- Two types of SMT correspondences:

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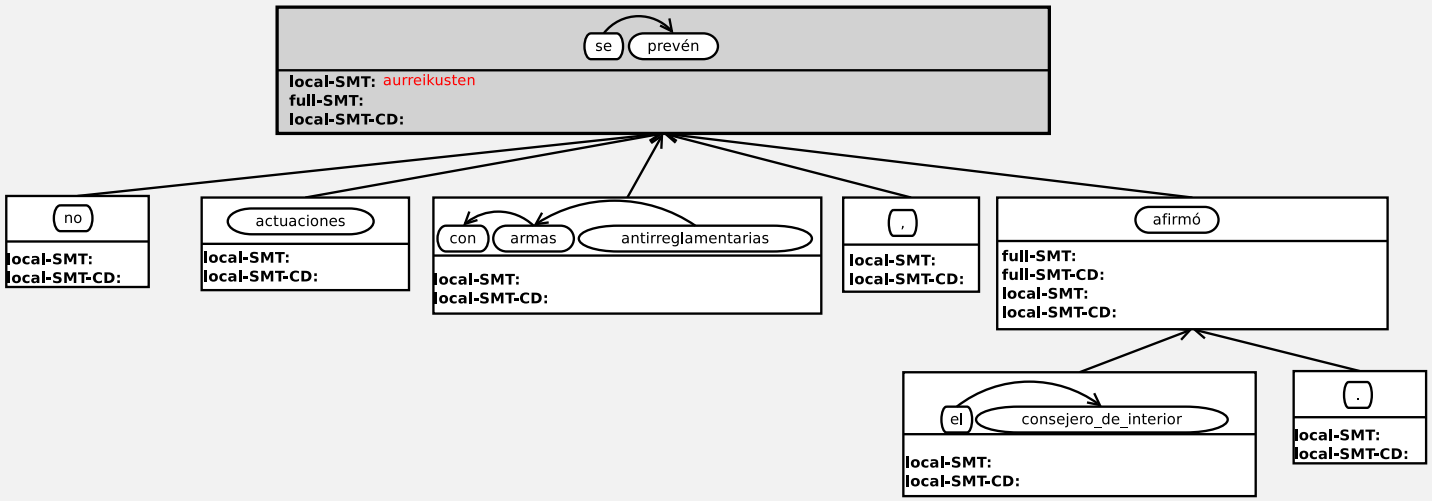

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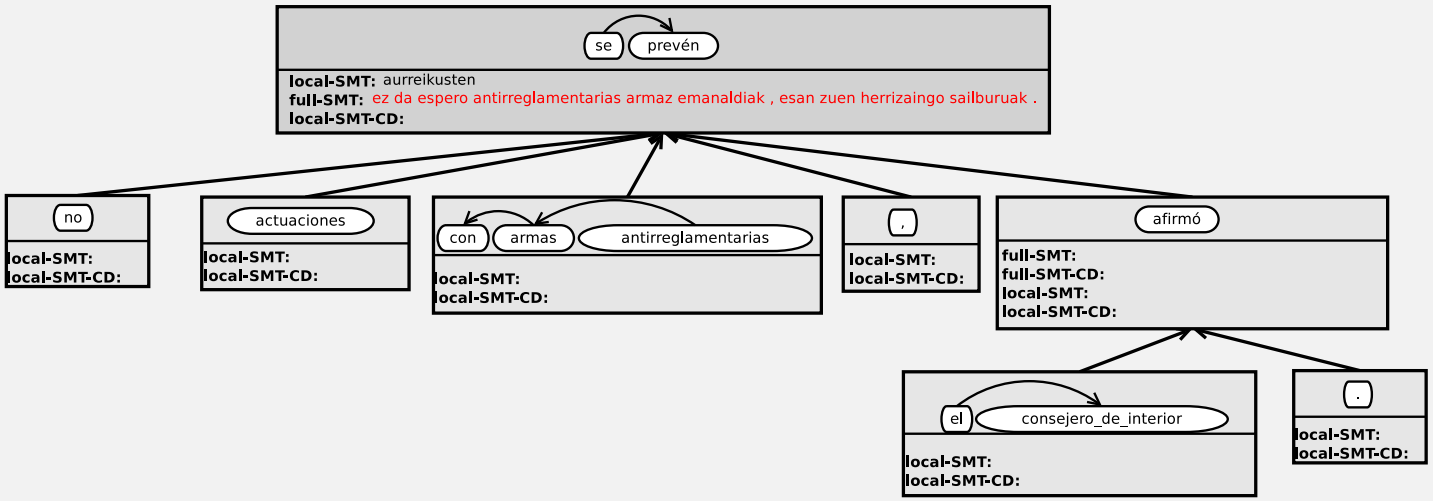

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- Each phrase in the tree is enrich with one (or several) SMT translation counterpart.
- Two types of SMT correspondences:
  - local: Allows SMatxinT to use SMT lexical selection
  - full subtree: Allows SMatxinT to overcome analysis errors.

Tree enrichment: Context Discriminate translations

- Many chunks are too small to SMT
  - Few context to get proper translation.
- We also extract corresponding local translation form longer SMT translations.
  - Based on alignment provided by SMT.
  - Allows the SMT to use the context.

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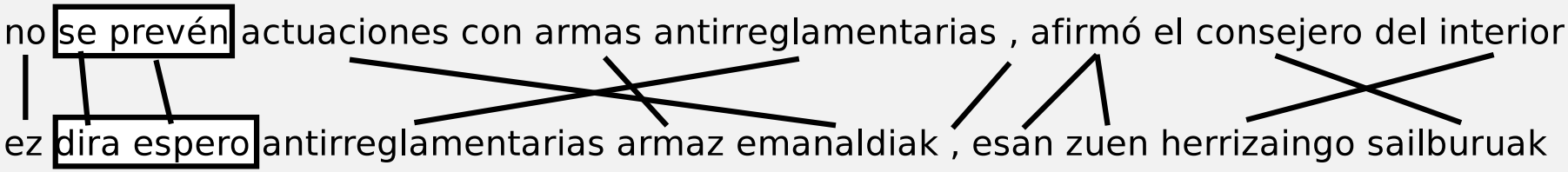

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Linear decoding

- After tree enrichment, transfer and generation are applied as usual.
- RBMT translation enriched with several candidates for each phrase.

emanaldiak ez dituzte aurreikusten arauz kontrako armekin , barne sailburua baieztetu zuen

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  - We used Moses (in monotonous way) as linear decoder.
  - A wide range or features are defined.

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Linear decoding: Features

Standard SMT features

- Language model
- Word penalty
- Phrase penalty

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Source/consensus features

- Counter ($1...n$)
- SMT ($1/e$)
- RBMT ($1/e$)
- Both ($e^{\#}$)

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Lexical features

- Corpus lexical probabilities (eu2es & es2eu)
- Dictionary lexical probabilities (eu2es & es2eu)

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2. Experimental Results
   - Corpora
   - Systems
   - Results

3. Conclusions

Corpora

Language pair

- Spanish–Basque

Training corpus

- Administrative documents and descriptions of TV programs
- 491,853 parallel sentences

Development and test corpora

- *Elhuyar dev & test:* Administrative documents (1500 sentences)
- *EITB:* News (1500 sentences, 1 reference)
- *NEWS:* News (1500 sentences, 2 references)

Systems

Individual systems

- SMTb
- SMTm
- Matxin

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Hybrid systems

- SMatxinT$_0$: Hybrid system where only SMT translations are used
- SMatxinT

Systems

Individual systems

- SMTb
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Hybrid systems

- SMatxinT$_0$
- SMatxinT

Control system

- Google

Automatic Metrics

	Elhuyar		EITB		NEWS	
	BLEU	**TER**	**BLEU**	**TER**	**BLEU**	**TER**
Matxin	5.10	83.32	5.77	87.73	11.72	82.04
SMTb	14.96	70.20	8.03	83.27	14.74	78.63
SMTm	13.71	71.64	7.64	85.59	14.58	78.90
Google	7.32	78.43	6.73	86.32	12.01	81.84
SMatxinT$_0$	14.50	69.73	8.45	82.17	14.90	77.29
SMatxinT	14.73	69.18	8.81	81.33	15.31	76.54

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BLEU and TER scores are generally low

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All systems outperform the RBMT

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Results of hybrid system are comparable but not better than SMT subsystems

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SMatxinT and SMatxinT$_0$ are consistently better than single systems

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SMatxinT results are slightly better than SMatxinT$_0$

Source systems

System	SMatxinT		sBLEU Oracle	
	chunks	tokens	chunks	tokens
SMT	2,682 (44.2%)	11,391 (65.4%)	3,202 (38.4%)	9,043 (51.2%)
SMT-CD	523 (8.6%)	1,737 (10.0%)	779 (9.3%)	1,890 (10.7%)
RBMT	401 (6.6%)	1,279 (7.3%)	969 (11.6%)	2,554 (14.4%)
BOTH	2,454 (40.5%)	3,013 (17.3%)	3,389 (40.6%)	4,192 (23.7%)
Total	6,060 (100%)	17,420 (100%)	8,339 (100%)	17,679 (100%)

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Hybrid system use very few RBMT translations

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The fragments are in average shorter

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Linear decoding fails in use RBMT correct information.

Human Evaluation

- 100 random sentences from NEWStest
- Preference between SMT and SMatxinT (2 assessment per sentence)

Assessments	SMT	Tied	SMatxinT
All	45 (22.5%)	64 (32.0%)	91 (45.5%)
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Results confirms that SMatxinT overcomes best SMT system.

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Summary

- We present a hybrid machine translation system that combines RBMT with phrase-based SMT.
- The RBMT system leads the translation process and generates the syntactic structure in the target language.
- The SMT system generates multiple candidate translations of any fragment in this tree. A posterior linear decoder selects the best combination to create the final output.
  - Short translation alternatives correct RBMT lexical selection errors.
  - Longer ones allow to overcome syntactic analysis error.

Conclusions

- SMatxinT achieves statistically significant improvements on out-of-domain test sets for the Spanish-to-Basque translation, according automatic metrics.
- This advantage has been corroborated by a manual evaluation conducted on a set of 100 samples
- The analysis of the oracles shows that there is still a large room for improvement
- Oracle translations tend to be composed by more and shorter chunks, and a larger proportion of chunks coming from RBMT.

Future work

- Define new linguistically based features for the linear decoder to identify correct RBMT translations.
- Alleviate the strong dependence of SMatxinT on the initial syntactic parsing incorporating multiple syntactic trees from the side of the rule based system.
- A more detailed manual comparison of the outputs of the different systems
- Broadening the study to other language pairs.

Thanks

Thanks for your attention.

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