Deep-syntax TectoMT for English-Spanish MT

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Outline

- TectoMT architecture
- Development of a new language pair (English - Spanish)
  - Analysis
  - Transfer
  - Synthesis
- Evaluation
- Conclusions

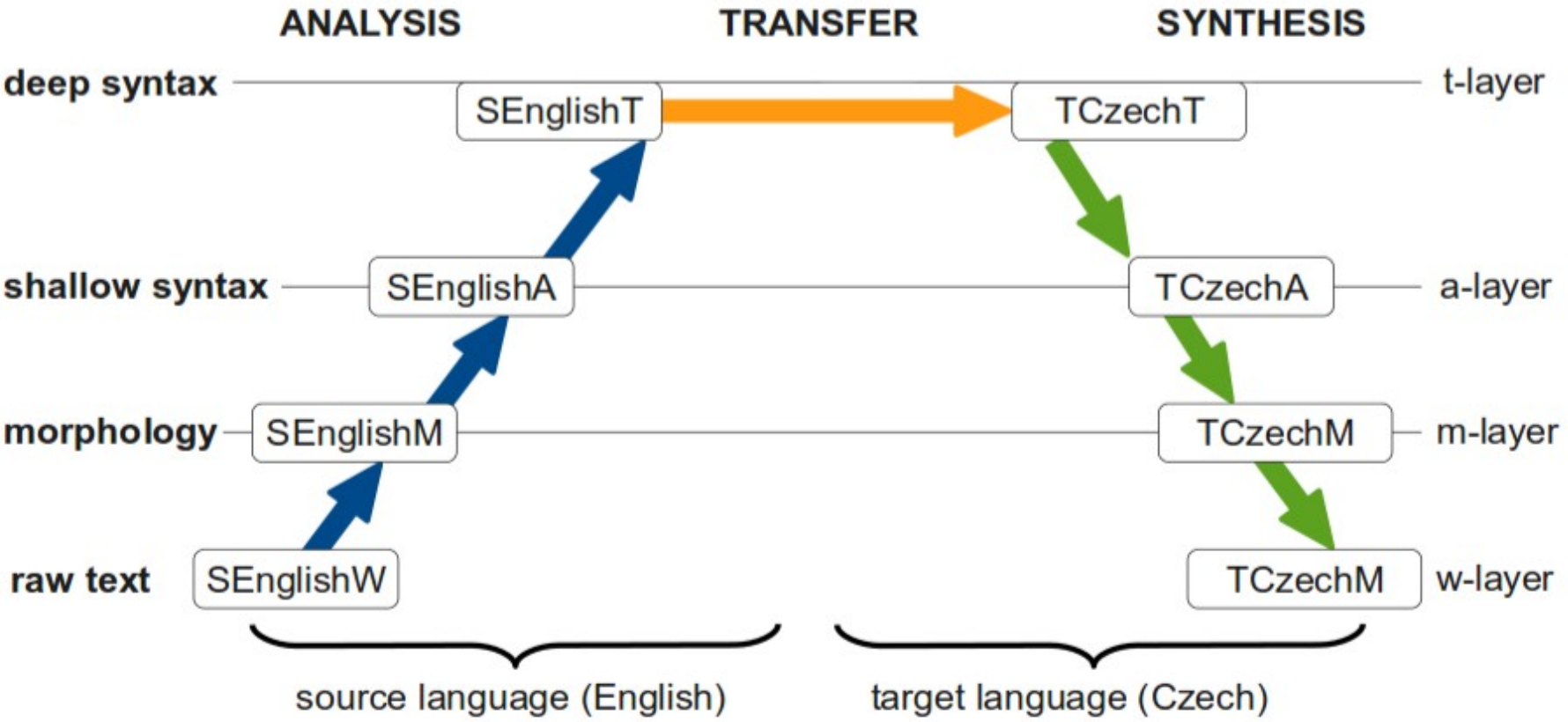
Tecto layers

- TectoMT
  - transfer-based system which works at the deep tectogrammatical level
  - combines linguistic knowledge and statistical techniques, particularly during transfer
  - originally developed for the English-Czech language direction
- Stratification approach
  - Morphological layer
  - Analytical layer (shallow-syntax dependency tree)
  - Tectogrammatical layer (deep-syntax dependency tree)

Tectogrammatical layer

- Only autosemantic nodes are keeped
- Functional words represented by attributes
- Each t-node consists on:
  - Tectogrammatical lemma
  - Functor: semantic values of syntactic dependency relations (causal adjunt, actor, effect, etc.)
  - Grammatemes: semantically oriented morphological categories (tense, number, modality, etc.)
  - Formemes: values of the morphosyntactic form in the surface sentence (subject, direct object, etc.)

TectoMT architecture



Tecto blocks and scenarios

- Blocks: reusable components of NLP subtasks that can be listed in a specific sequence, that is, rules to define, set, change and move node-information in/across the layers
- Scenarios: specific sequences of blocks to be applied to relevant data
- TectoMT includes over a thousand blocks:
  - 224 blocks specific for English
  - 237 for Czech
  - 57 for English-to-Czech transfer
  - 129 for other languages
  - 467 language-independent

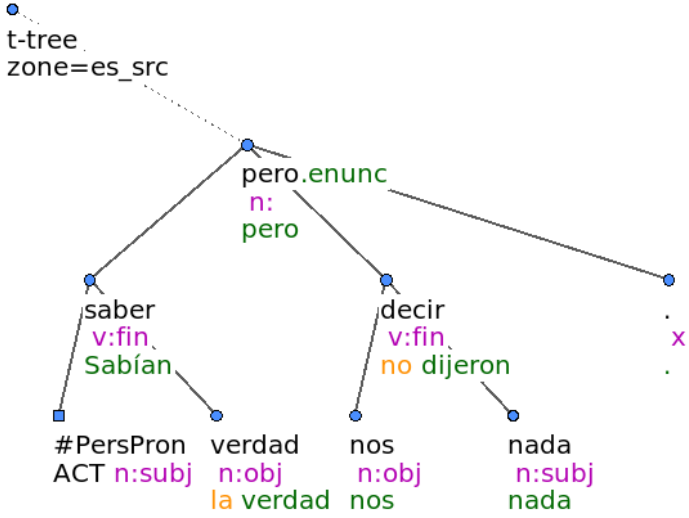
Developing a new pair

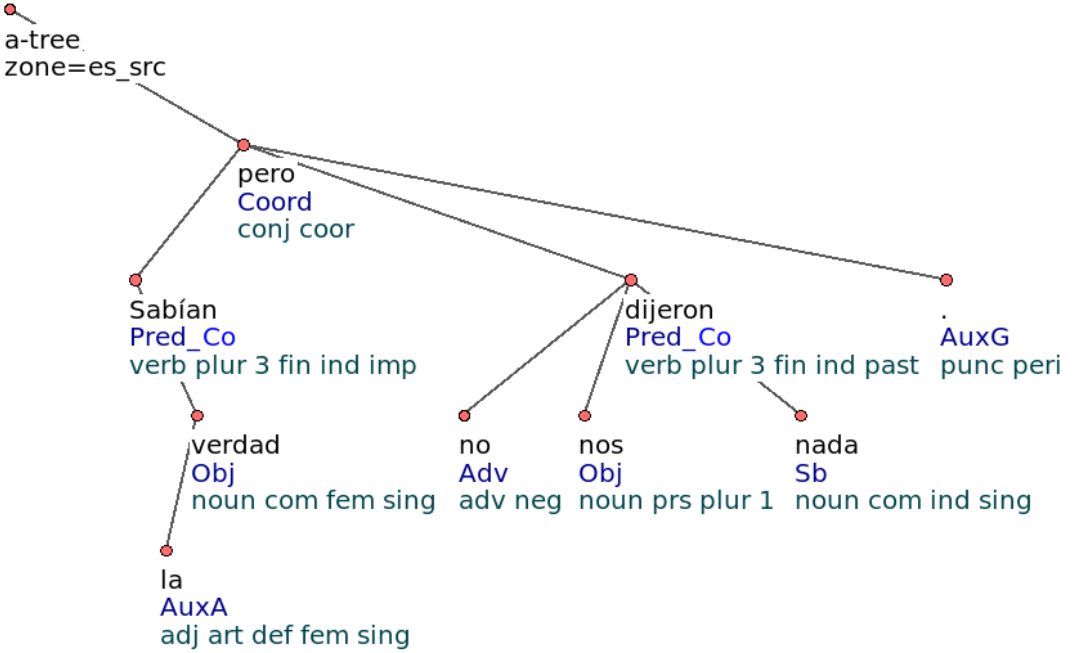
- We set to port the TectoMT system to work for the English-Spanish language pair in both directions.
  - English analysis and synthesis ready to use
  - Our focus: Spanish analysis and synthesis, and transfer stages
- TectoMT is integrated within Treex
  - Modules divided into language-specific and language independent blocks

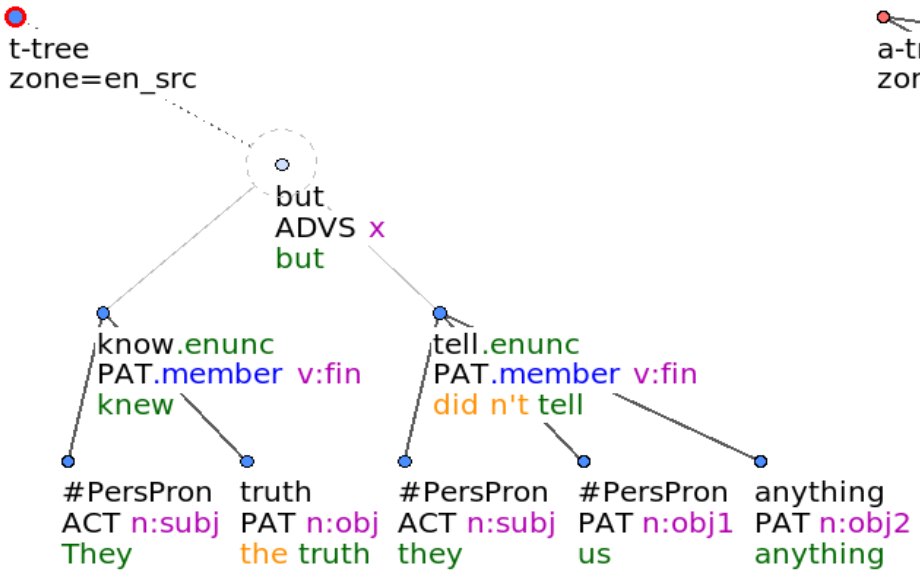
Analysis

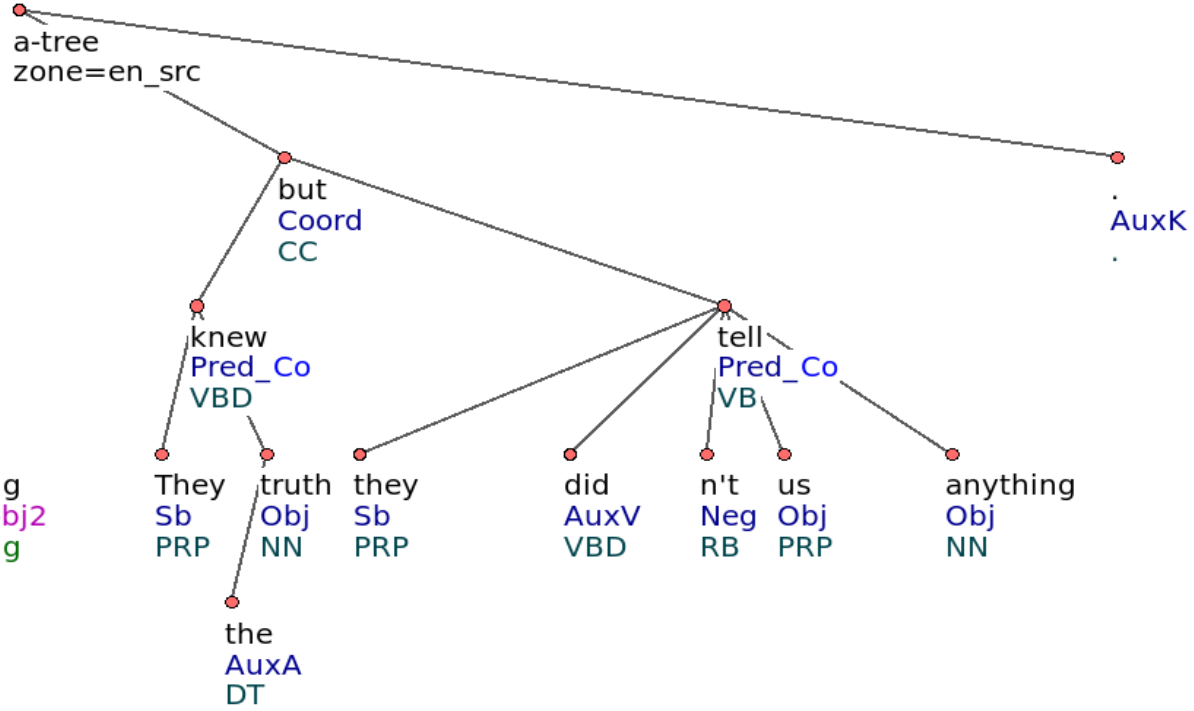
- From raw text to tecto-level
- English analysis solved
- Spanish analysis
  - Tokenization and sentence splitting: adapted modules in Treex
  - Lemmatisation and POS: integration of ixa-pipes tools (pos) in Treex
  - Dependency parsing: integration of ixa-pipes tools (srl) in Treex
    - Tagset compatibility: from AnCora to Interset
  - Spanish blocks:

Block type	Number
Language-independent blocks	11
Adapted blocks	4
New language-specific blocks	1


t-tree
zone=es_src
pero.enunc
n:
pero
saber
v:fin
Sabían
decir
v:fin
no dijeron
.
x
.
#PersPron
ACT n:subj
verdad
n:obj
la verdad
nos
n:obj
nos
nada
n:subj
nada


a-tree
zone=es_src
pero
Coord
conj coor
Sabían
Pred_Co
verb plur 3 fin ind imp
dijeron
Pred_Co
verb plur 3 fin ind past
.
AuxG
punc peri
verdad
Obj
noun com fem sing
no
Adv
adv neg
nos
Obj
noun prs plur 1
nada
Sb
noun com ind sing
la
AuxA
adj art def fem sing


t-tree
zone=en_src
but
ADVS x
but
know.enunc
PAT.member v:fin
knew
tell.enunc
PAT.member v:fin
did n't tell
#PersPron
ACT n:subj
They
truth
PAT n:obj
the truth
#PersPron
ACT n:subj
they
#PersPron
PAT n:obj1
us
anything
PAT n:obj2
anything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Obj
NN
the
AuxA
DT
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Sb
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VBD
n't
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Obj
PRP
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Obj
NN

Transfer

- Statistical transfer dictionary
  - trained on parallel corpora analyzed up to the t-level in both languages
    - lemmas, formemes and grammatemes
  - for each t-lemma and formeme in a source t-tree, the translation model assigns a score to all possible translations observed in the training data
  - probability estimate calculated as a linear combination of
    - Discriminative TM
    - Dictionary TM
- Static manual dictionary (priority resource)
  - Microsoft Terminology Collection - 22,475 entries

Transfer

- Blocks for grammateme equivalences
  - linguistically abstract, usually paralleled in the target language
- rules are inherently language-specific
- 5 blocks for English-to-Spanish direction:
  - lack of gender in English nouns (necessary in Spanish);
  - differences in definiteness and articles;
  - differences in structures such as “There is...” and relative clauses.

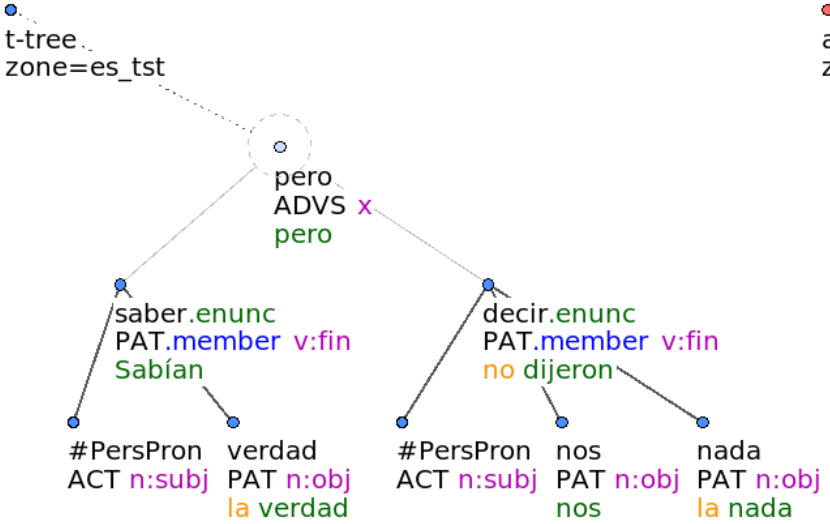
Synthesis

- From tecto-level to raw text
- English synthesis solved
- Spanish synthesis
  - Transform the t-tree into an a-tree
  - Transform the a-tree into word forms
  - Polish the output

Block type	Number
Language-independent blocks	9
Adapted blocks	12
New language-specific blocks	3

Synthesis

- Transform the t-tree into an a-tree:
  - fill in morphological attributes that will be needed in the second step
  - add function words where necessary
  - remove superfluous nodes
  - add punctuation nodes
- Transform the a-tree into word forms
  - new Spanish models in Flect (statistical morphological generator)
  - corpus: subset of morphologically annotated (530K tokens)
- Polish the output: detokenization, contractions, ...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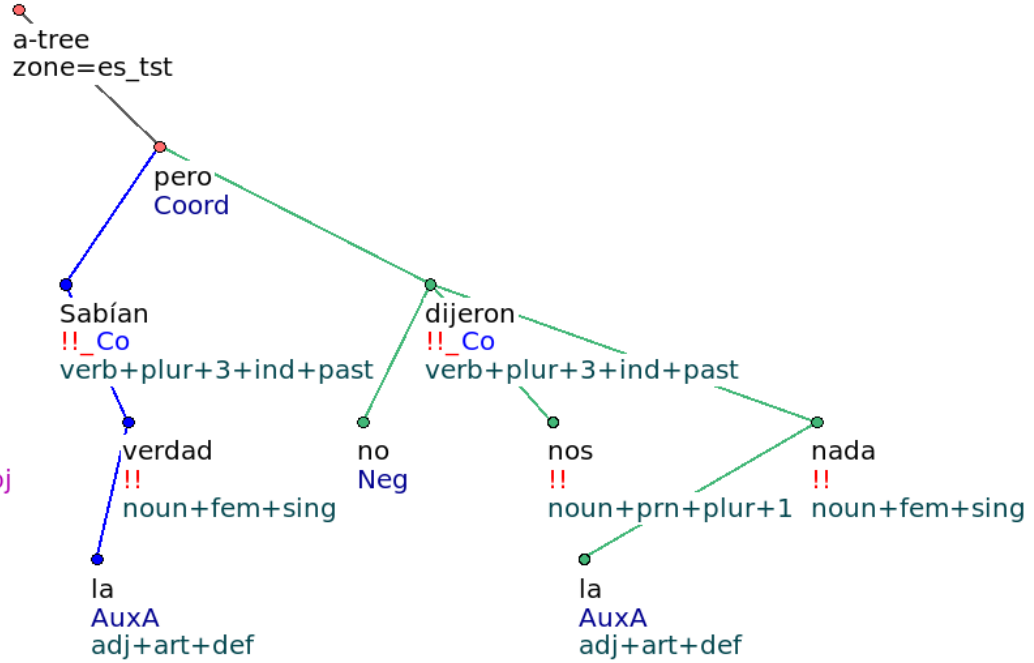
la nada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verdad
!!
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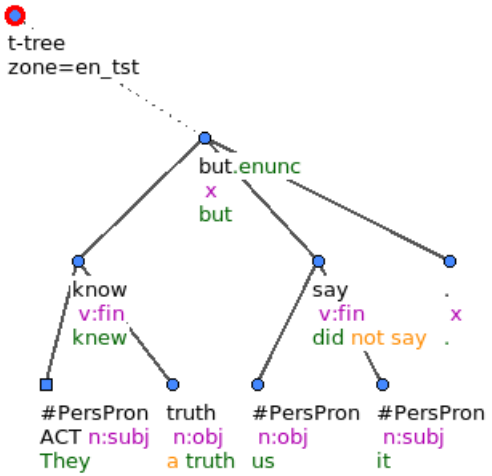
Neg
nos
!!
noun+prn+plur+1
nada
!!
noun+fem+sing
la
AuxA
adj+art+def
la
AuxA
adj+art+def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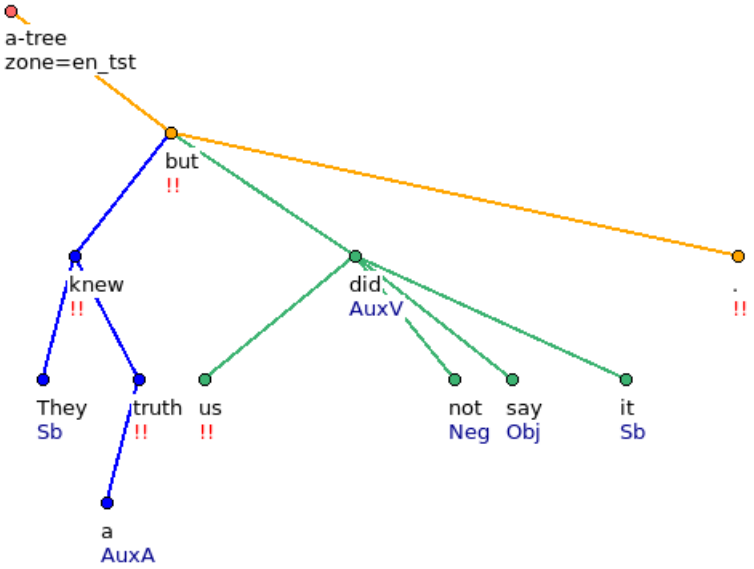
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Neg
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Obj
it
Sb
a
AuxA

Evaluation

- Compared systems:
  - PBSMT (Moses)
    - Features: mGiza, SRILM
    - Corpora:
      - Bilingual: europarl (~2M sentences)
      - Monolingual: europarl (~2M sentences)
    - Tuning: 1,000 IT-domain Q&A set - 1
  - TectoMT
    - Language-independent blocks only
    - + Spanish blocks (new + adapted)
    - + domain-specific dictionary

Evaluation

- Test-sets:
  - 1,000 IT-domain Q&A set - 2
  - WMT11 newswire test-set
- Results
  - Moses outperforms the TectoMT systems
  - BLEU increases as TectoMT customisation increases
  - en->es scores higher than es->en in accordance with the development effort
  - Systems score better for the IT set

	English-Spanish		Spanish-English	
	IT	WMT11	IT	WMT11
Moses	28.12	26.91	31.92	25.24
TectoMT – language independent blocks	12.40	8.38	12.34	8.17
TectoMT – + Spanish blocks	23.62	13.92	14.67	8.50
TectoMT – + domain dictionary	26.40	13.25	15.82	8.23

Conclusions

- Development of an entry-level deep-syntax system for the English-Spanish pair
  - Reuse of English analysis and synthesis modules
  - Integration of ixa-pipes for Spanish
  - Crafting of blocks for Spanish
  - Traininig of statistical models for transfer
  - Training of morphological models for Spanish synthesis
- Available at: https://github.com/ufal/treex
- BLEU scores still behind Moses (but close for En-Es on the IT domain!)
  - Flexible customization options
  - Further customization and tuning has potential for improvement

Thank you