New Language Pairs in TectoMT

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Introduction

- TectoMT – competing in WMT since 2008, just English-Czech
- **New language pairs** added in the QTLeap project:
  - Dutch, Spanish, Basque, Portuguese (to and from English)
  - **Czech-English** – new language pair in WMT'15

New Languages: Standards & Training

- Treex blocks for new languages made easier:
  - Common morphology – Interset
  - Common syntactic style – HamleDT 1.5 (3.0 / UD planned)
  - Base language-independent blocks
- Makefiles for easy translation model training

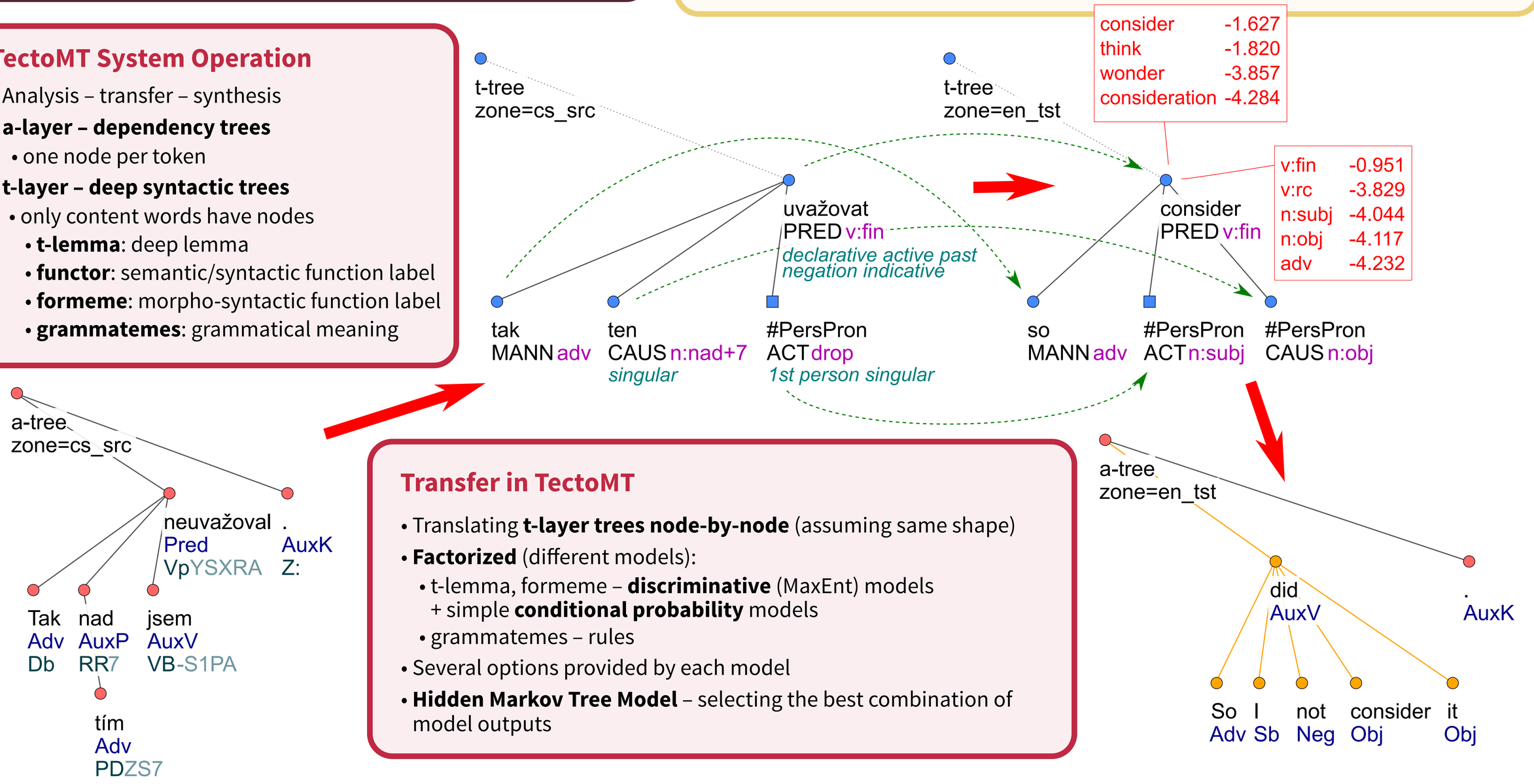
New Languages: Simple Model Combination

- Combining t-lemma + formeme predictions
- **No training required**, as opposed to Hidden Markov Tree Model
- Five **non-parametric functions combining the models' outputs**:
  - AM-P – arithmetic mean of model-predicted probabilities
  - GM-P – harmonic mean of probs
  - HM-P – harmonic mean of probs
  - GM-Log-P – geometric mean of log-probs
  - HM-Log-P – harmonic mean of log-probs
- Tested on QTLeap corpus for 3 language pairs
- Performance **better than baseline** (using 1st variant of lemma and formeme)
- **HMTM is better, if available**

Func/BLEU	EN-CS	EN-ES	EN-PT
Baseline	27.85	16.70	16.77
HMTM	**28.76**	-	-
AM-P	28.11	18.08	**17.19**
GM-P	28.18	18.06	17.11
HM-P	**28.20**	18.06	16.20
GM-Log-P	28.17	**18.09**	17.19
HM-Log-P	28.10	18.08	17.19

TectoMT System Operation

- Analysis – transfer – synthesis
- **a-layer – dependency trees**
  - one node per token
- **t-layer – deep syntactic trees**
  - only content words have nodes
    - **t-lemma**: deep lemma
    - **functor**: semantic/syntactic function label
    - **formeme**: morpho-syntactic function label
    - **grammatemes**: grammatical meaning



Transfer in TectoMT

- Translating **t-layer trees node-by-node** (assuming same shape)
- **Factorized** (different models):
  - t-lemma, formeme – **discriminative** (MaxEnt) models + simple **conditional probability** models
  - grammatemes – rules
- Several options provided by each model
- **Hidden Markov Tree Model** – selecting the best combination of model outputs

New in WMT'15: Czech-English Translation

Analysis

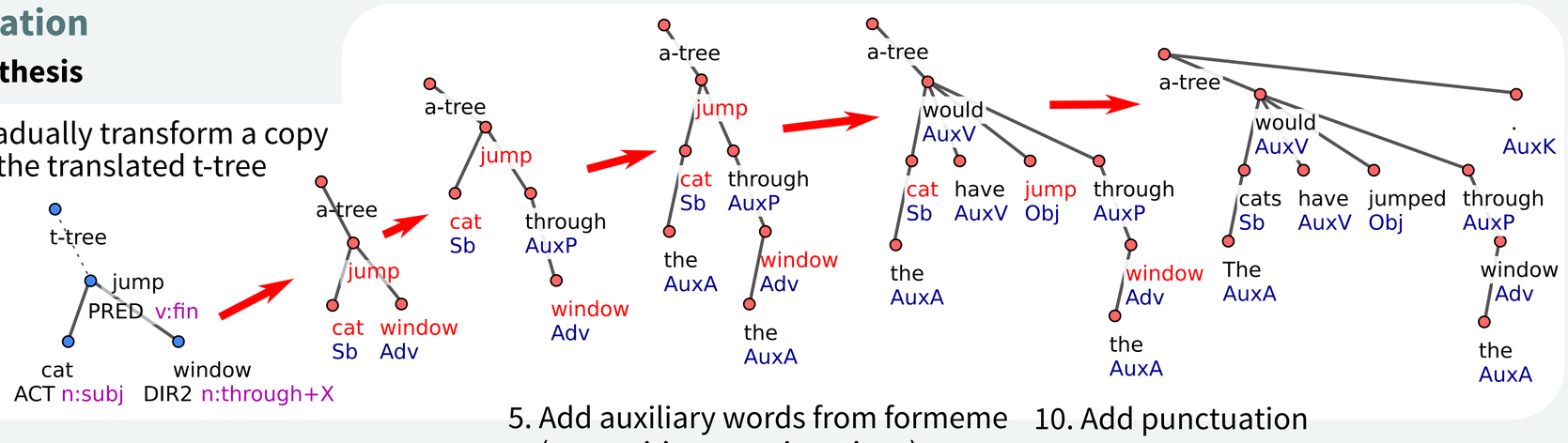
- Modified from CzEng, English-Czech TectoMT training
- MorphoDiTa tagger
- MST parser adapted for Czech

Transfer

- Basic t-lemma + formeme models with rule-based overrides
- Czech gender removed
- Double negatives removed
- Name translation fixes
- Grammateme fixes, e.g.: *těstoviny* (pl) -> *pasta* (sg)

Synthesis

- Gradually transform a copy of the translated t-tree



1. Fill in morphological attributes (based on grammatemes)
2. Mark subject (for agreement)
3. Enforce basic word order
4. Enforce subject-predicate agreement
5. Add auxiliary words from formeme (prepositions, conjunctions)
6. Add articles
7. Add auxiliary verbs
8. Remove imperative subjects
9. Add negation particles
10. Add punctuation
11. Inflect words (Morphodita + Flect)
12. Transform *a* -> *an*
13. Delete repeated prepositions and conjuctions in coordinations
14. Capitalize first word in sentence

WMT'15 Results

- **English-Czech: 13.9% BLEU** – among the last, human eval. same
- **used in Chimera, overall winner** in automatic+human ranking
  - 8.0% of reference tokens are only in TectoMT (and not Moses)
  - more than half of these tokens were used in Chimera
  - TectoMT is essential for Chimera's success
- **Czech-English: 12.8% BLEU** – last, human eval. 2nd-to-last
  - pruning was too eager (bug)

Conclusion and Future Work

- **Improvements and bugfixes required**
  - Hidden Markov Tree Model for Czech-English
  - word order fixes, article assignment (English)
- Further development plans:
  - **Interset** instead of grammatemes on t-layer, **Universal Dependencies**
  - **Vowpal Wabbit** and **word embedding features** in transfer models
  - possibilities of non-isomorphic transfer

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