Machine Learning for Deep-syntactic MT

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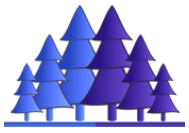
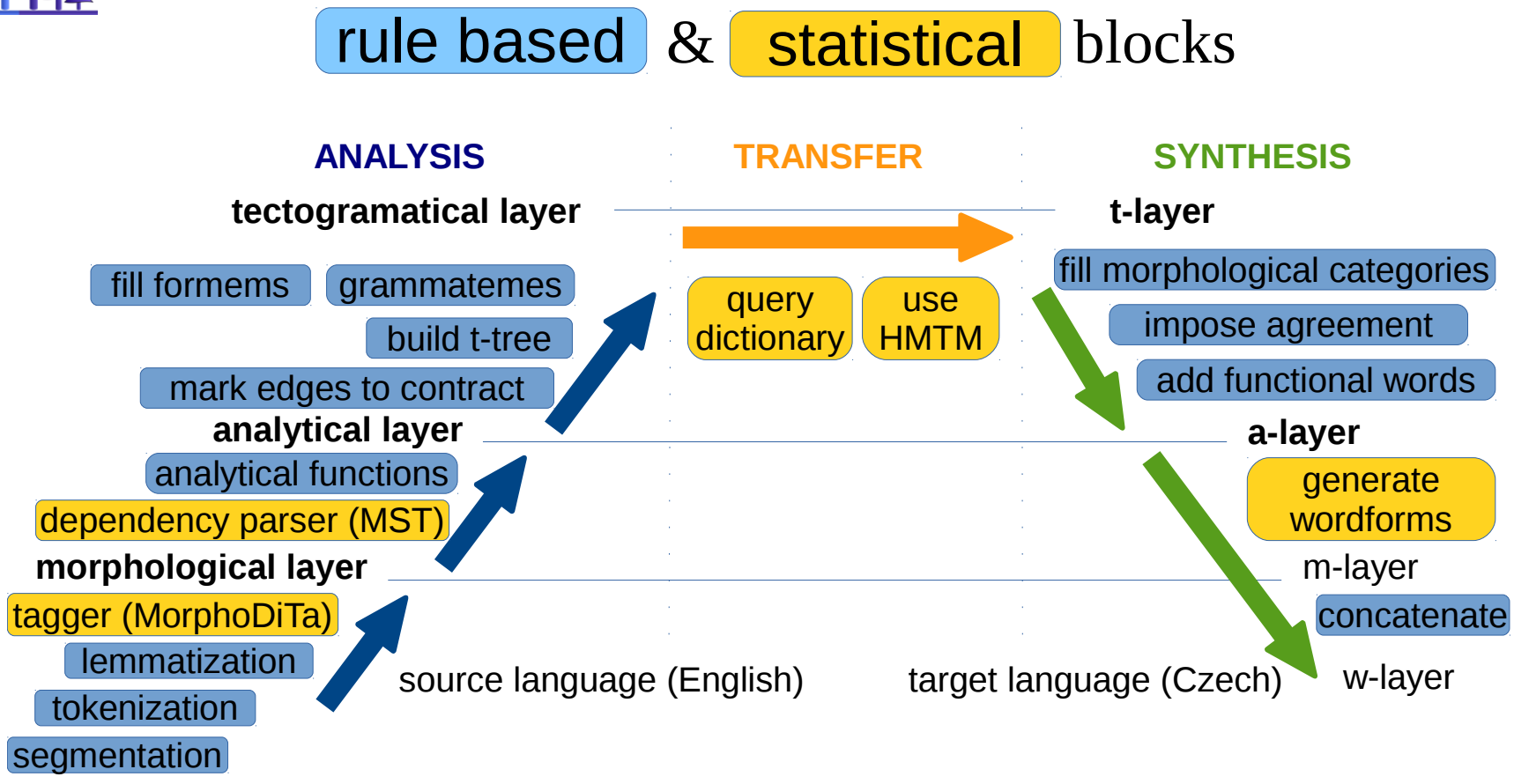
Charles University in Prague and Hamburg University

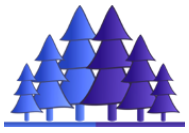
Outline

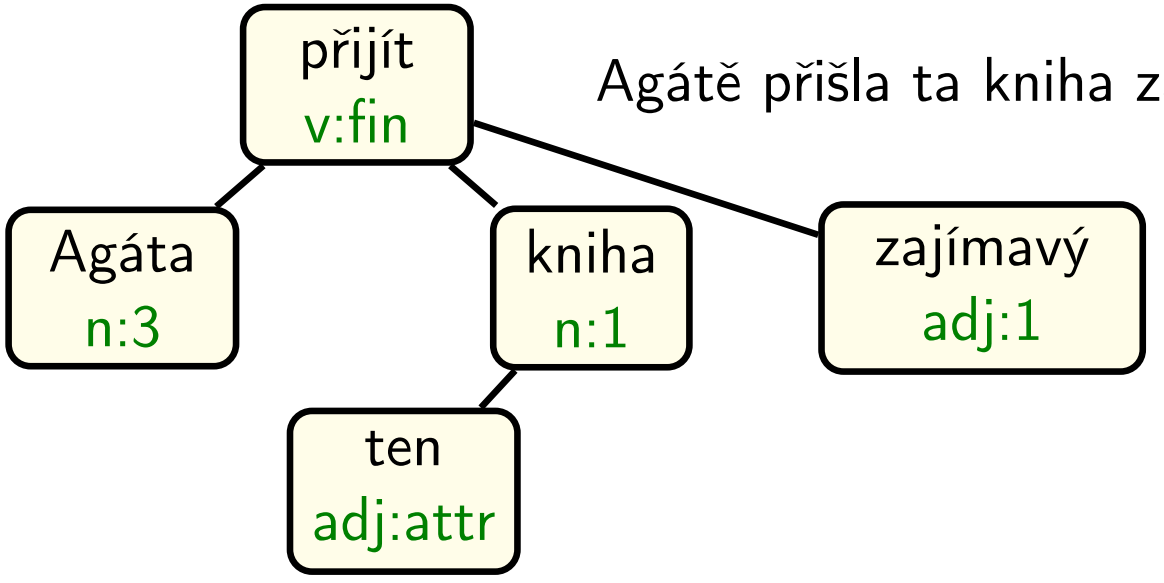
TectoMT: analysis, transfer, synthesis



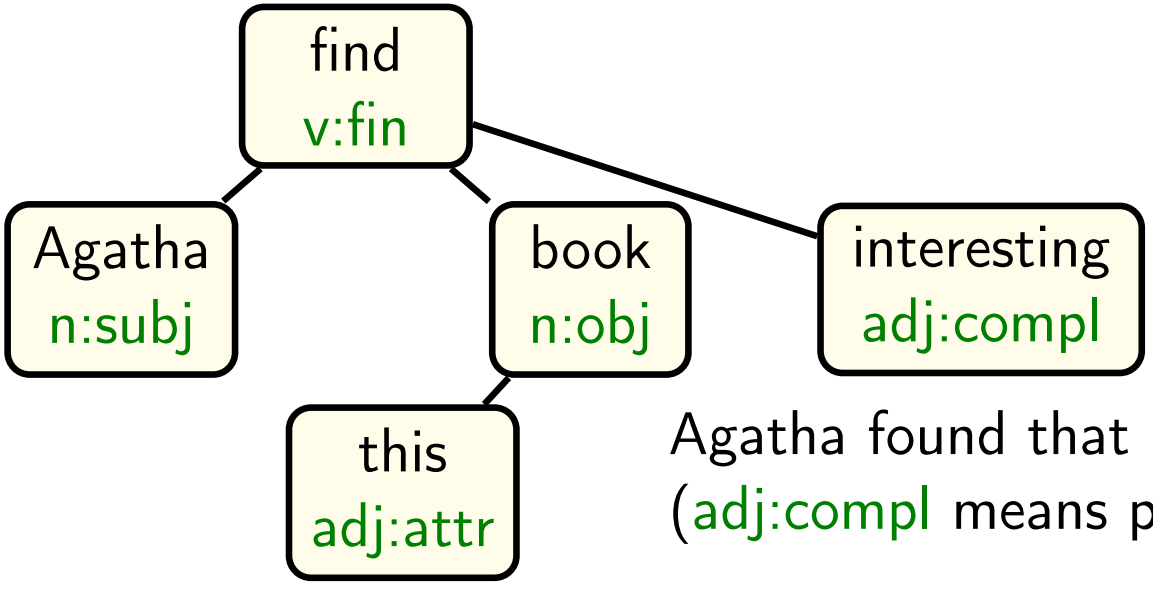


TectoMT: isomorphic transfer (1-1 node mapping)





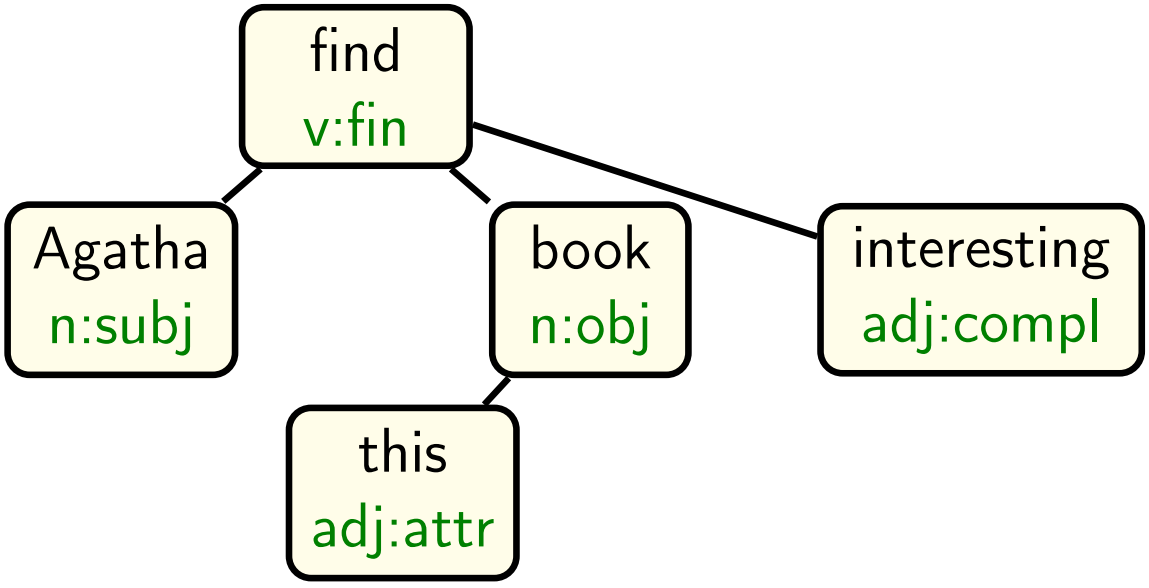
Agátě přišla ta kniha zajímavá.



Agatha found that book interesting.
(adj:compl means predicative adjective)

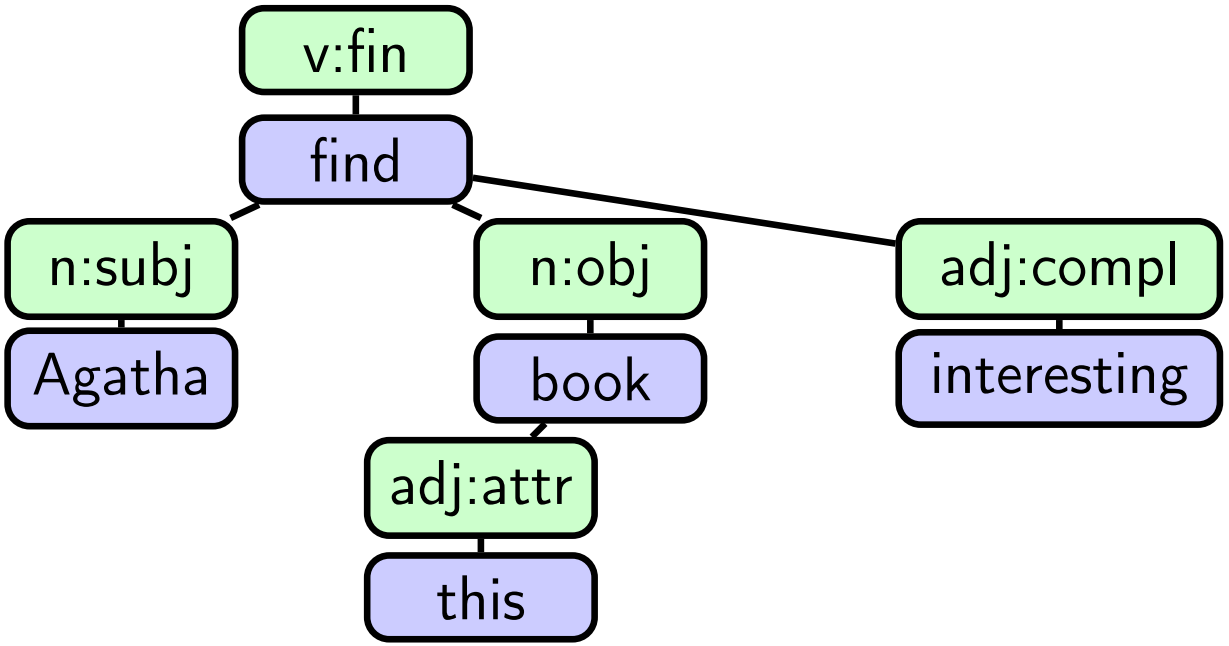
Representation of t-layer

lemma and formeme as two attributes



Representation of t-layer

lemma and formeme as interleaved "sub-nodes"



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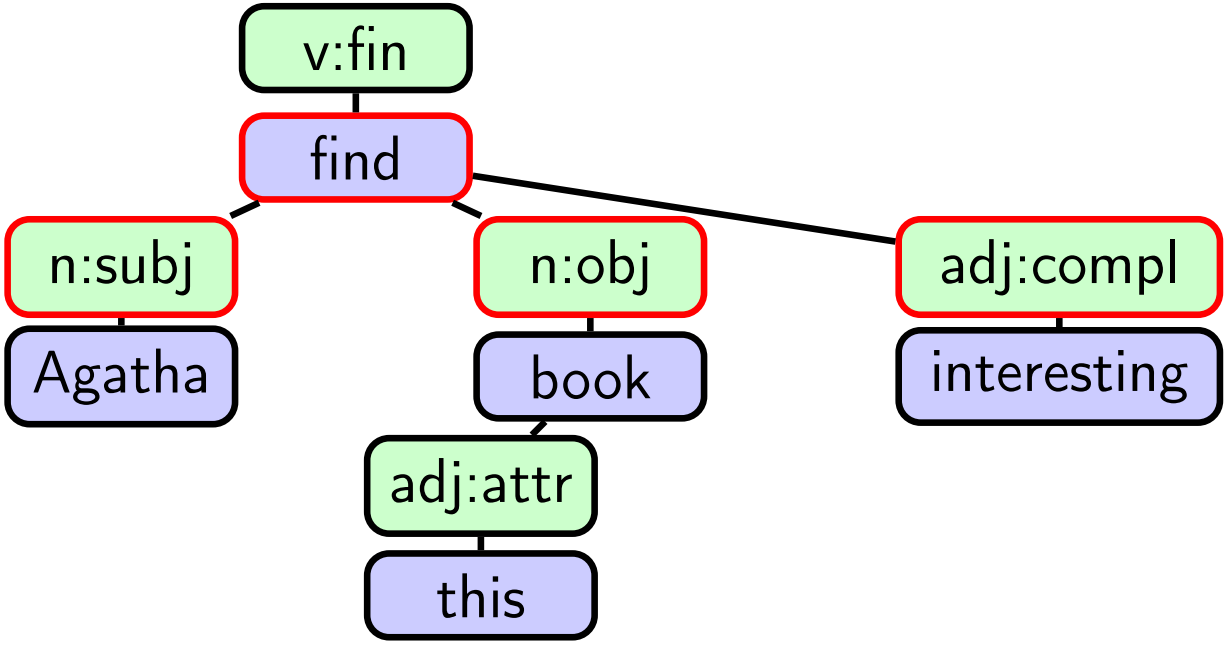

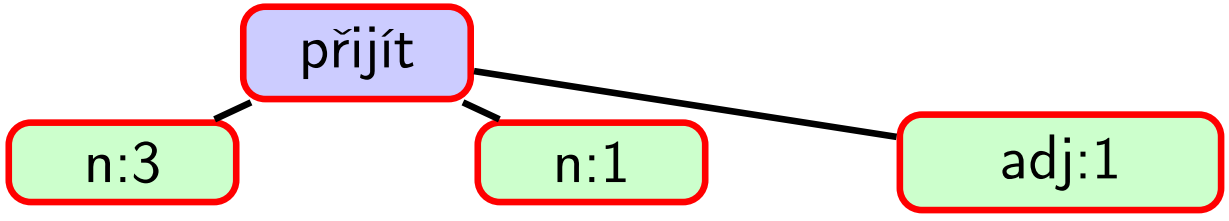

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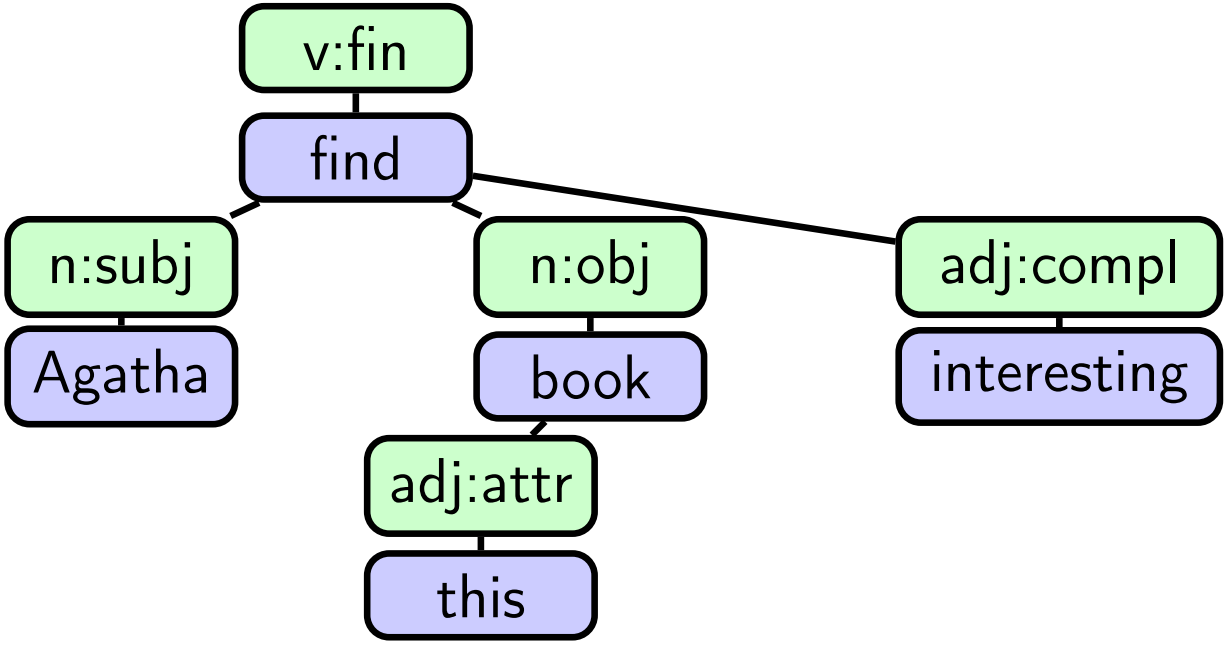

grammatemes:

- translated in postprocessing (current approach)
- as subnodes (leaves, children of lemmas)
- encoded within lemma, but only if grammateme changed

Handling non-isomorphic transfer

- preprocessing or postprocessing within transfer (current approach)
- natively in the main transfer algorithm
- convert training data to isomorphic trees [not tried yet]
  - n-1 alignment: add special [delete_node] label to the target side
  - 1-n alignment: encode added nodes (L+F) into the "main" lemma
  - encode topology change: as_child, as_sibling, as_parent

TectoMT transfer over years

year	*BLEUdiff*	*method*
2008		initial baseline
2009	+1.5	HMTM (TreeViterbi, TreeLM)
2010	+0.8	HMTM + MaxEnt
2012	-2.2	TectoMoses
2012	NA	Gibbs sampling treelets
2013	-3.0	Easy-first treelets
2013	-2.0	Interpol treelets
2014	+0.1	VowpalWabbit

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2015	+8.6	QTLeap en→cs in two months

2008: baseline TectoMT transfer

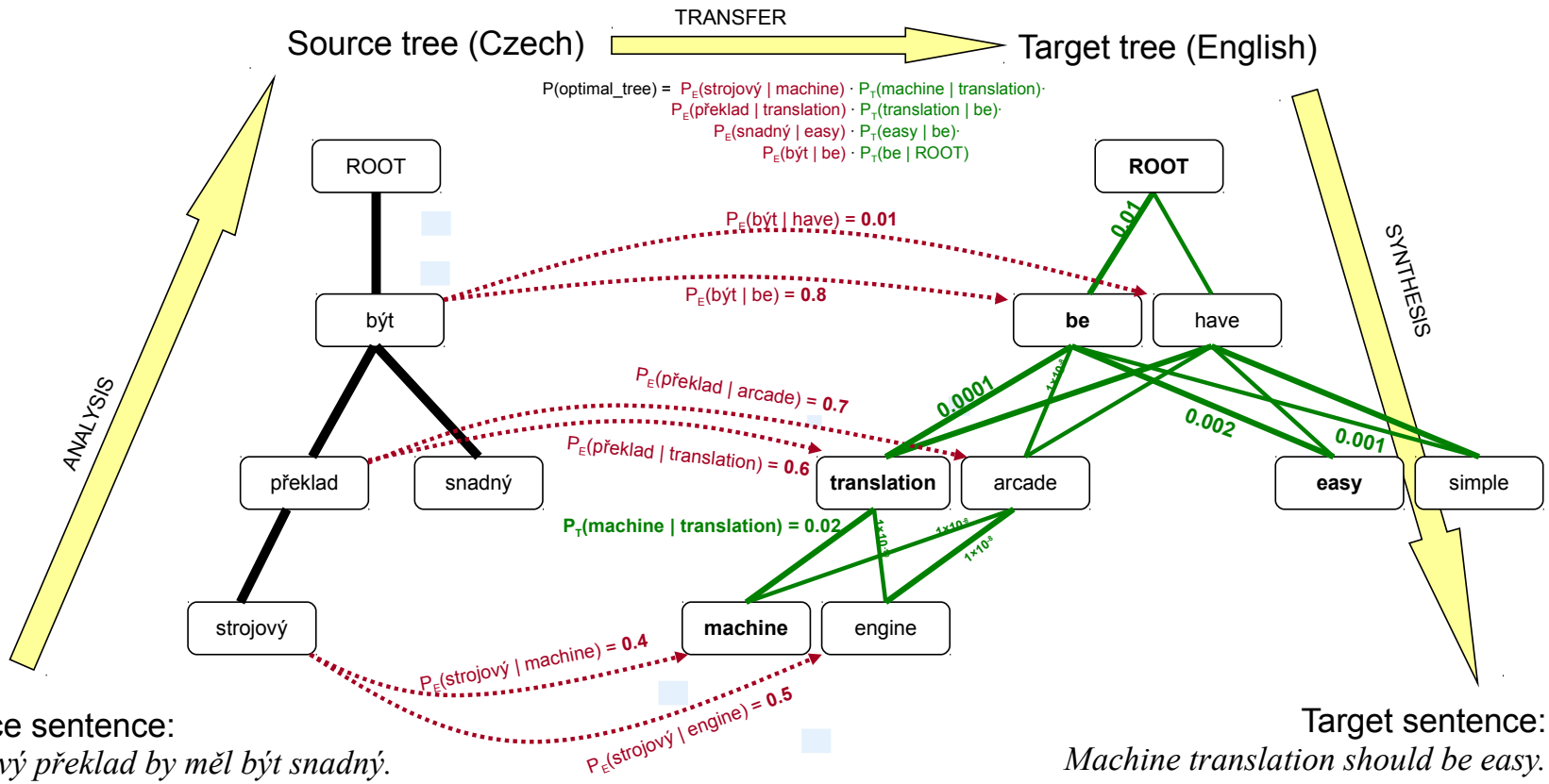
- "static" translation model $P(target|source) = \frac{\#(source,target)}{\#(source)}$
- first translate formemes, then lemmas
- use **only the top variant**

WMT 2009 en→cs results

	BLEU	human score
Moses (CUNI)	14.2	61
Google	13.6	66
Moses (UEdin)	13.5	53
Eurotran XP	9.5	67
PC Translator	9.4	67
TectoMT	7.3	48

2009: Hidden Markov Tree Model (HMTM)

- still using "static" translation models, but also
- TreeLM (target lemma-formeme and parent-child compatibility)
- best labeling is found via HMTM (Tree Viterbi)

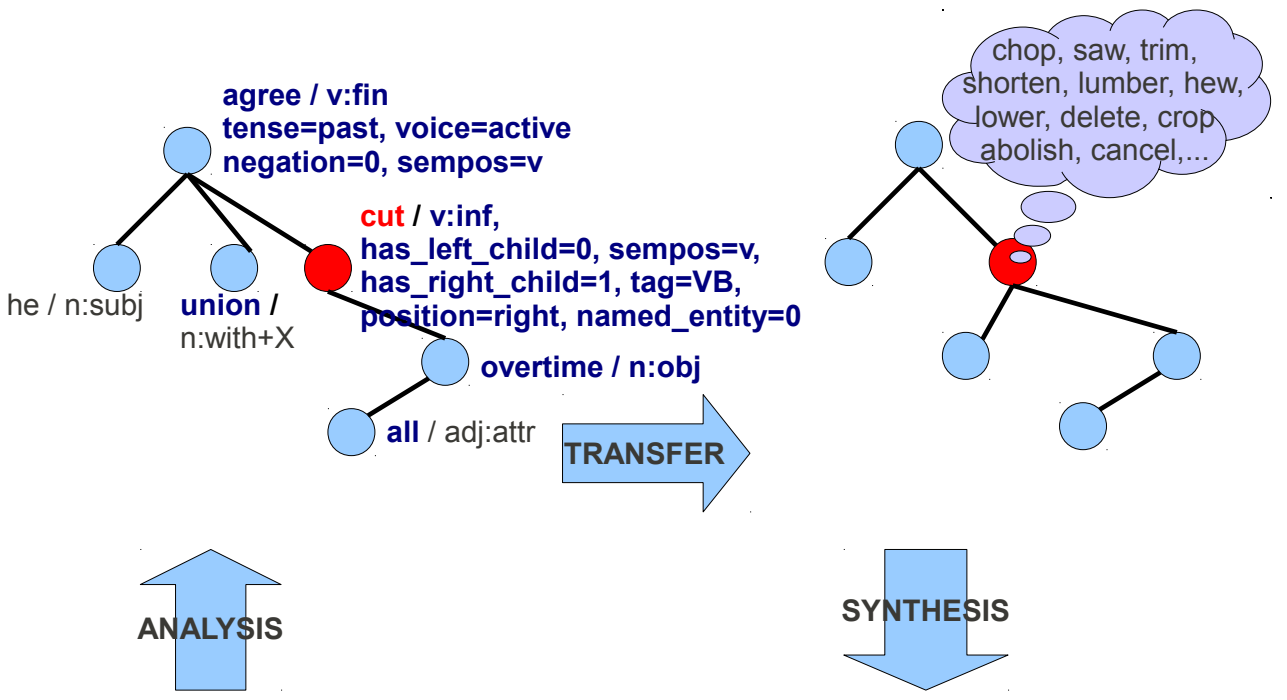


P_E(source | target) … emission probabilities … **translation model**

P_T(dependent | governing) … transition probabilities … **target-language tree model**

2010: Maximum Entropy translation model

- still using HMTM (and generative TreeLM),
- but the "static" model P(lemma | src_lemma) interpolated with
- context-sensitive discriminative (MaxEnt) model P(lemma | src_lemma, **other features**)



2014: VowpalWabbit-based transfer

- VW is an ultra-fast and modular machine learning toolkit
- optimized SGD (AdaGrad, dense+sparse features,...)
- cost-sensitive one-against-all reduction to binary classification
- logistic loss enables probabilistic interpretation (for HMTM)
- all lemmas in one model, fixed memory requirements
- label-dependent features (features shared for more lemmas)

VowpalWabbit Example

training data:

```
shared |S lemma=start formeme=v;for+ger neg=neg1 tag=VBG ...
1:0 _začít#V       |T start^začít#V      |P start^V
2:1 _zahájení#N    |T start^zahájení#N   |P start^N
3:1 _začínat#V     |T start^začínat#V    |P start^V
...
21:1 _spouštění#N |T start^spouštění#N |P start^N
```

training command:

```
vw -d train.data -c -f my.model
--loss_function=logistic --csoaa_ldf=mc -b 29 -qST
--holdout_off --passes 1 -l 3
```

test command:

```
vw -d test.data -c -i my.model -t -r out.predictions
```

Future plans

- non-isomorphic transfer
- experiments with VowpalWabbit
- include word embeddings (word2vec) as features
  - of the translated word (for rare words)
  - of its dependency context (for ambiguous words)
  - plus target-language embeddings of the translation
  - NN with a hidden layer

Thank you