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Using Parallel Features in Parsing of Machine-Translated Sentences for Correction of Grammatical Errors

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Parsing of SMT Outputs

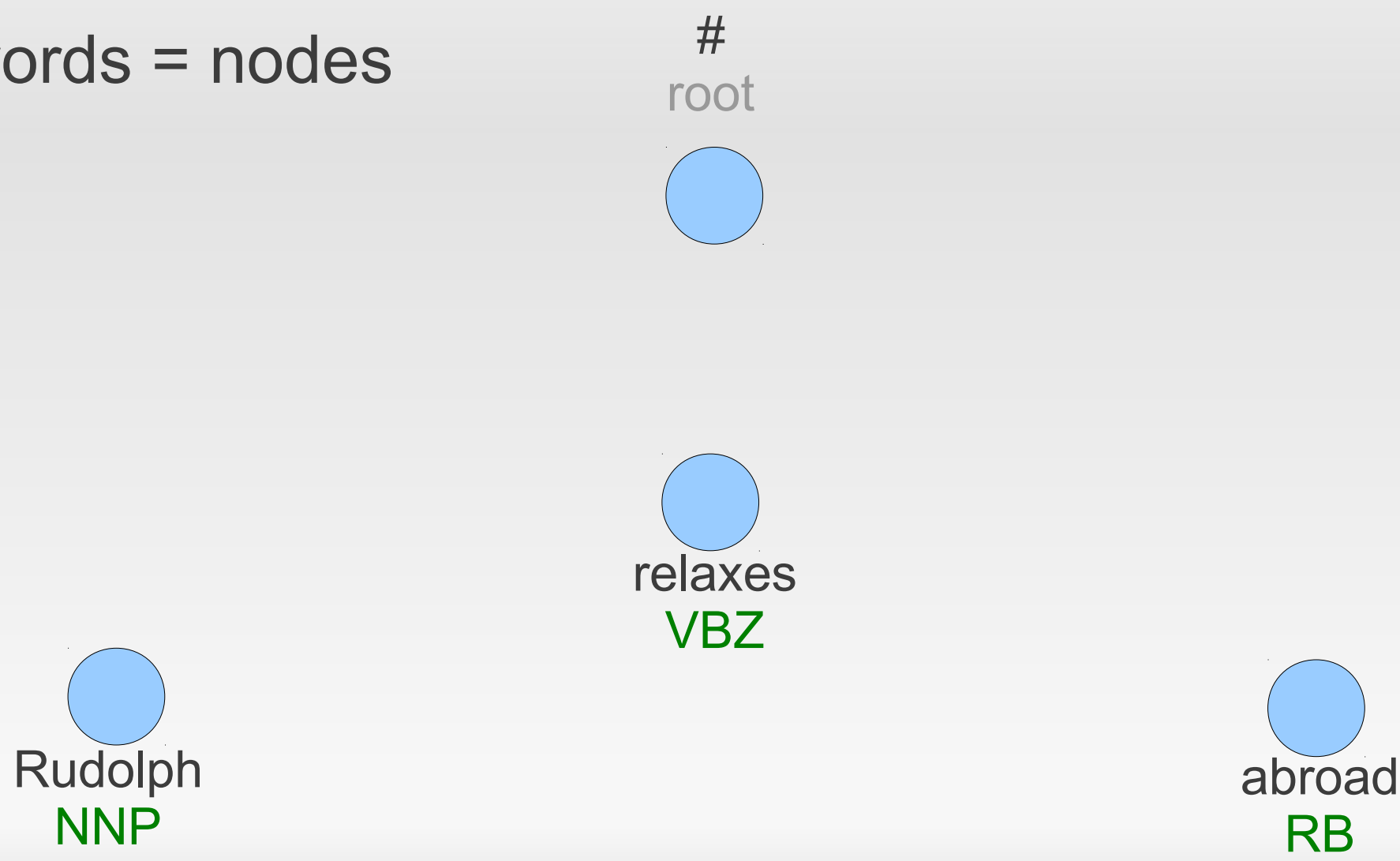
- can be useful in many applications
  - automatic classification of translation errors
  - **automatic correction of translation errors (Depfix)**
  - confidence estimation, multilingual question answering...
- ✔ we have the source sentence available
  - Can we use it to help parsing?
- ✗ SMT outputs noisy (errors in fluency, grammar...)
  - parsers trained on gold standard treebanks
  - Can we adapt parser to noisy sentences?

MST Parser

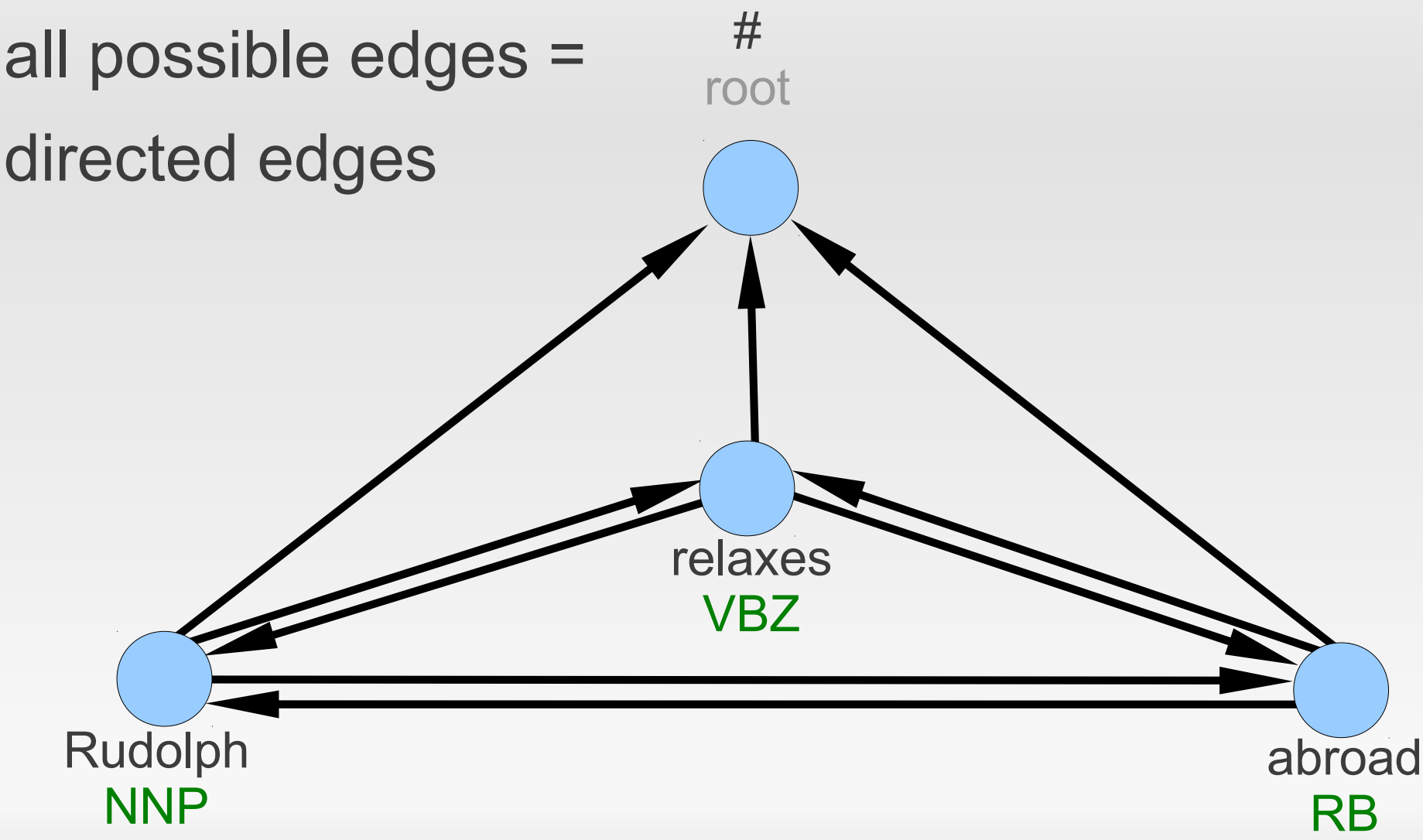
- Maximum Spanning Tree dependency parser
- by Ryan McDonald

(1) Words and Tags

words = nodes



(2) (Nearly) Complete Graph

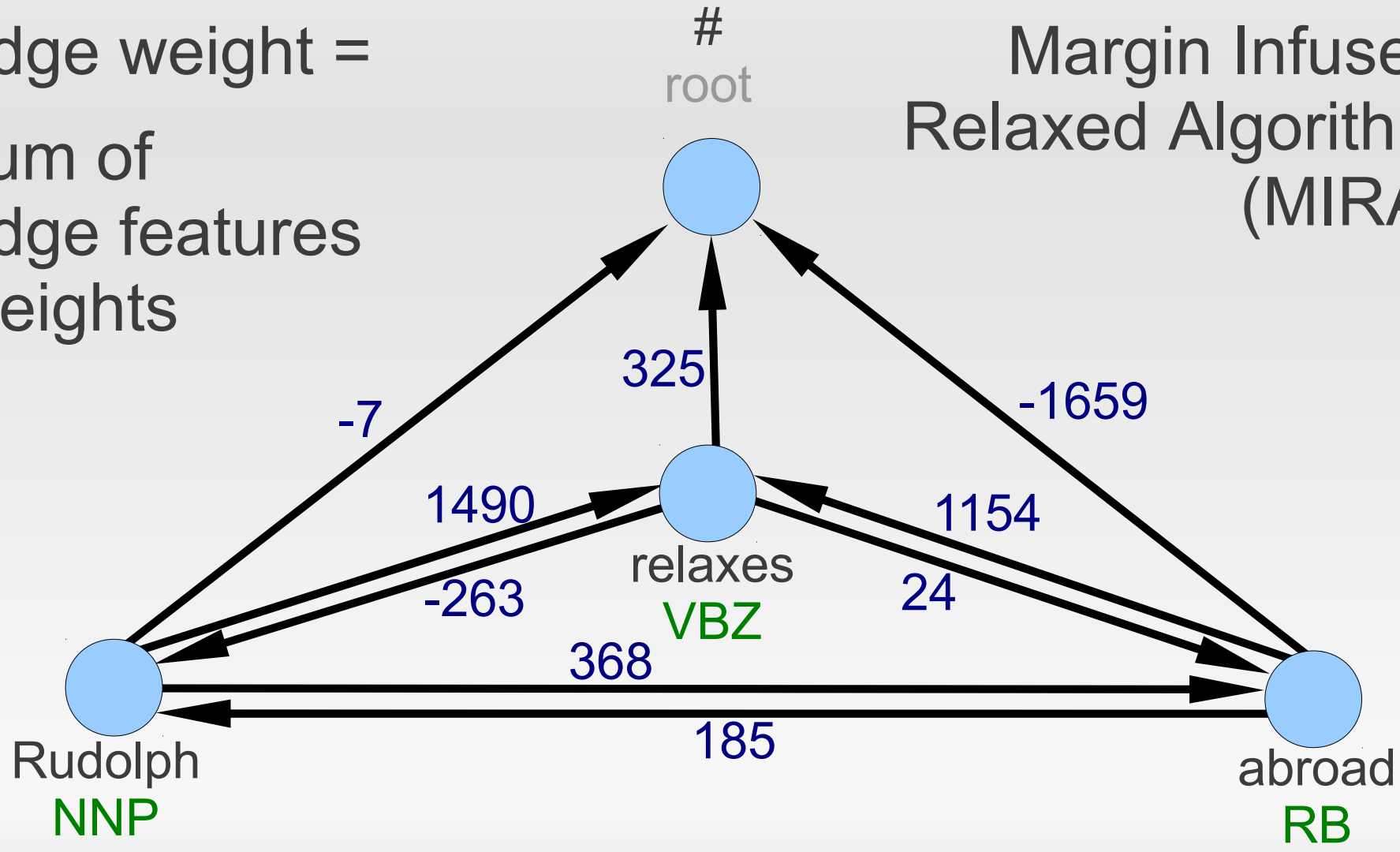


(3) Assign Edge Weights

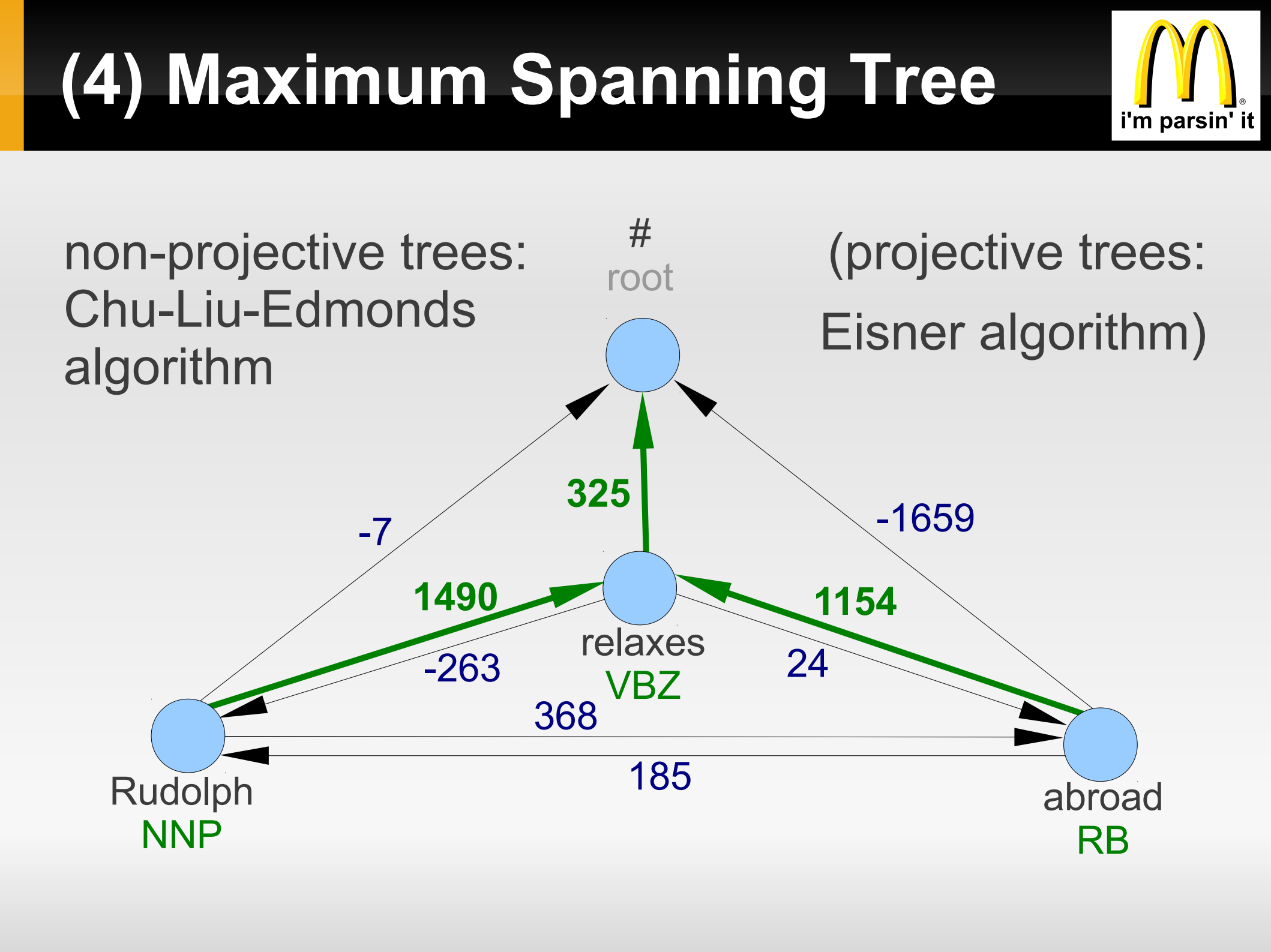
edge weight =

sum of
edge features
weights

Margin Infused
Relaxed Algorithm
(MIRA)



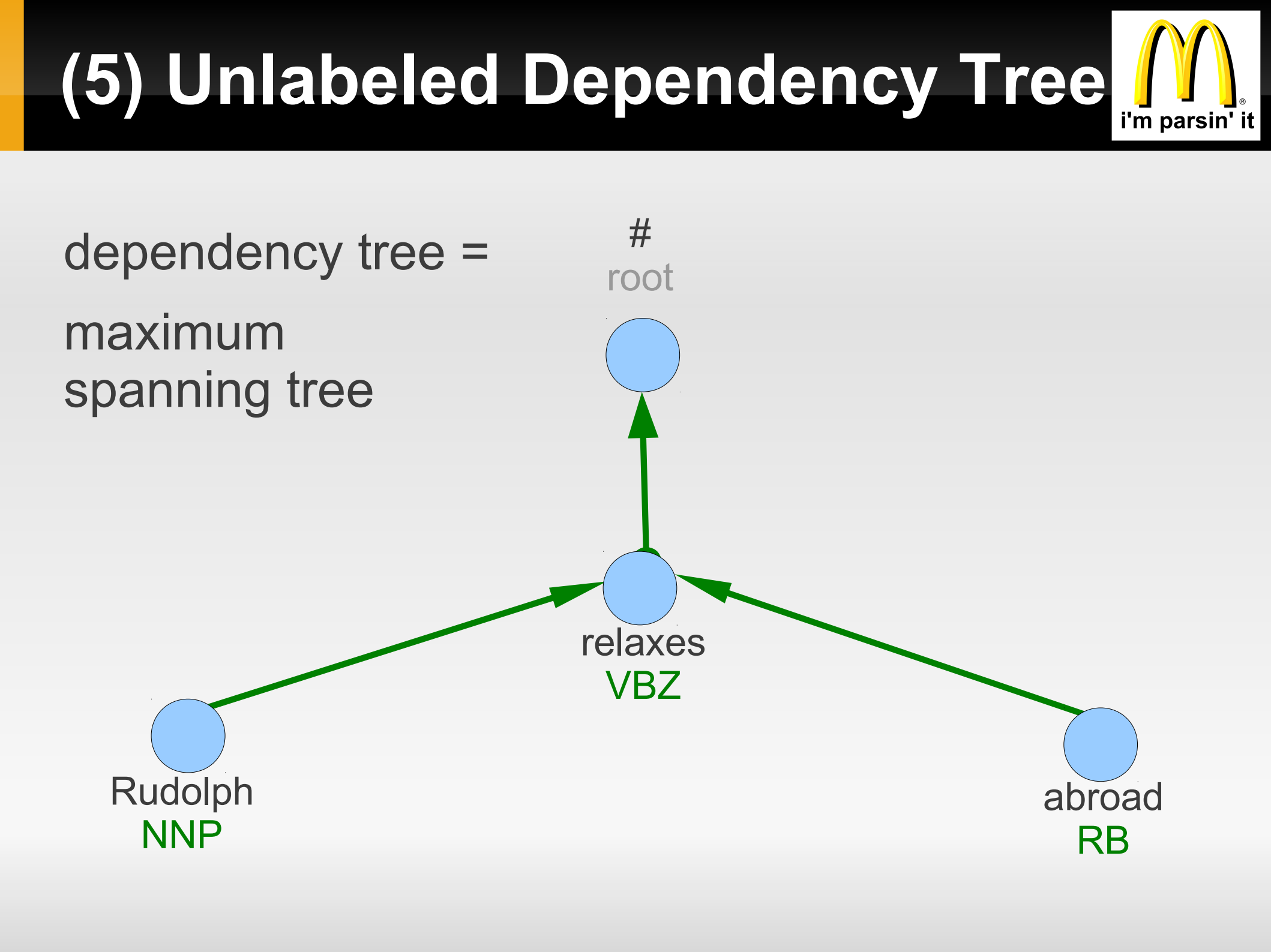
(4) Maximum Spanning Tree



non-projective trees:
Chu-Liu-Edmonds
algorithm

(projective trees:
Eisner algorithm)

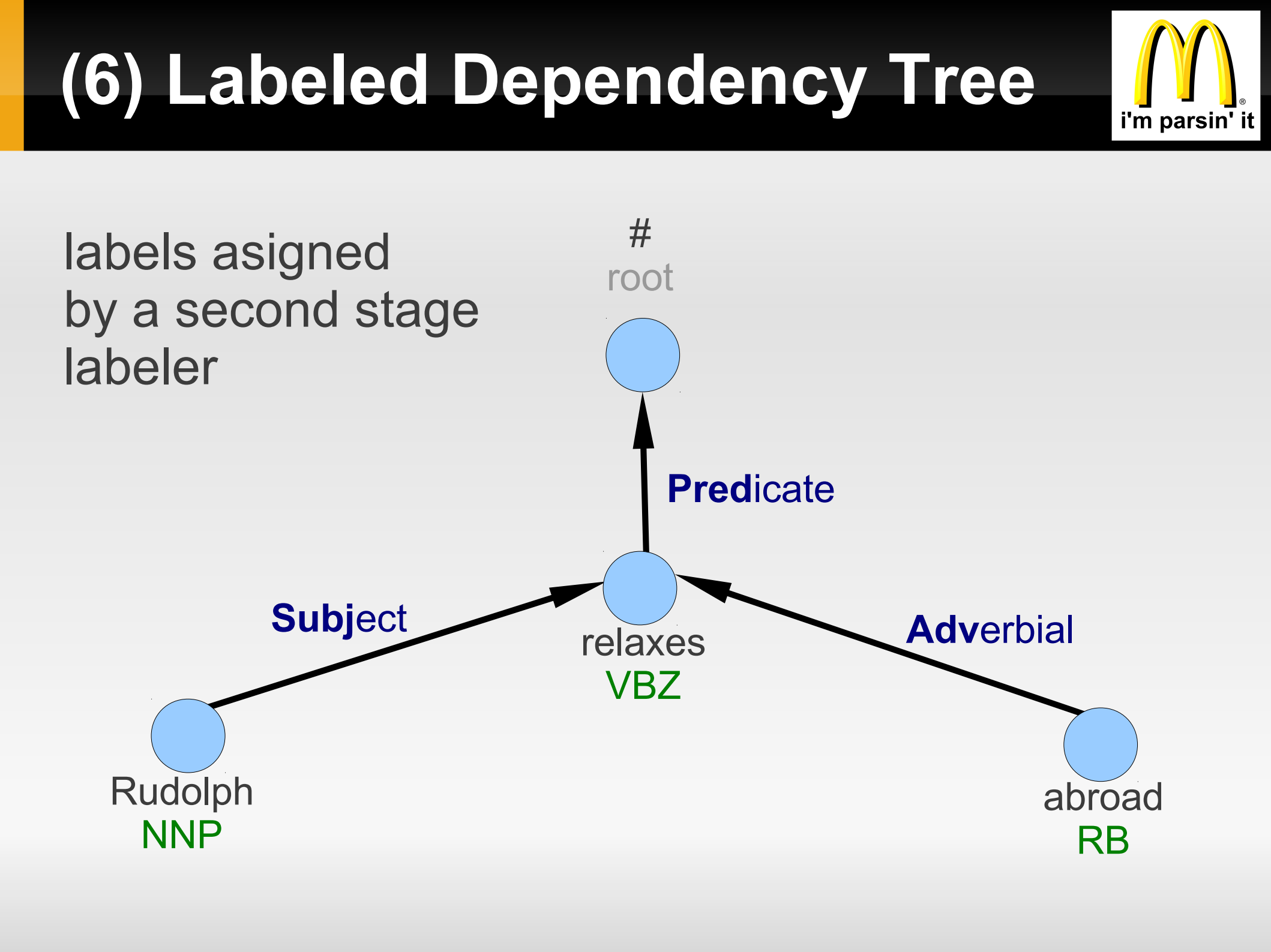
(5) Unlabeled Dependency Tree



dependency tree =

maximum spanning tree

(6) Labeled Dependency Tree



labels asigned
by a second stage
labeler

RUR Parser

- reimplementation of MST Parser
  - (so far only) first-order, non-projective
- adapted for SMT outputs parsing
  - parallel features
  - ”worsening” the training treebank

English-to-Czech SMT

- Czech language
  - highly flective
    - 4 genders, 2 numbers, 7 cases, 3 persons...
    - Czech grammar requires agreement in related words
  - word order relatively free: word order errors not crucial
- Phrase-Based SMT often makes inflection errors:
  - ➔ Rudolph's car is black.
  - ✗ Rudolfov**a**/***fem*** auto/***neut*** je černý/***masc***.
  - ✔ Rudolfov**o**/***neut*** auto/***neut*** je černé/***neut***.

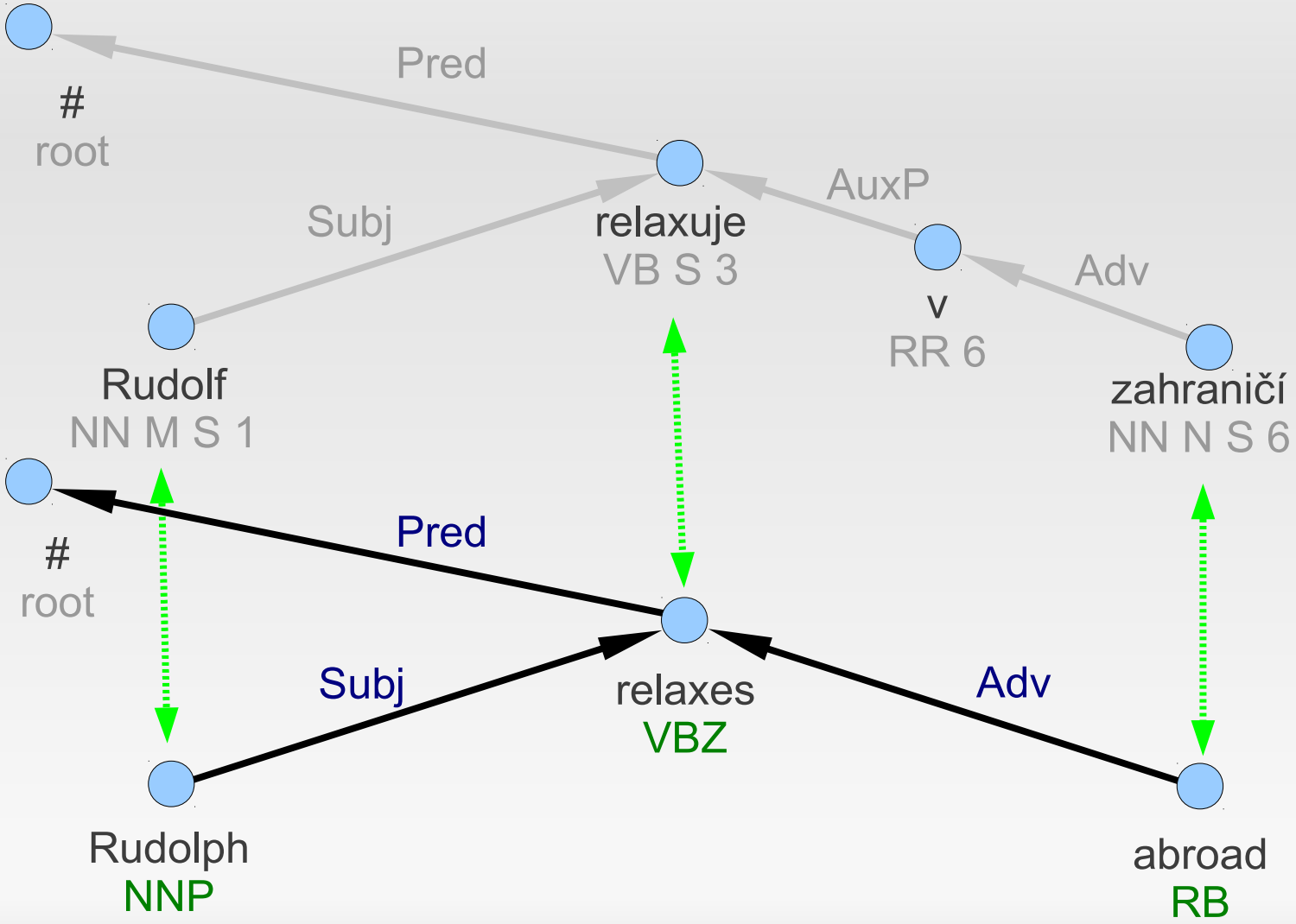
Parser Training Data

- Prague Czech-English Dependency Treebank
  - parallel treebank
  - 50k sentences, 1.2M words
  - morphological tags, surface syntax, deep syntax
  - word alignment

Parallel Features

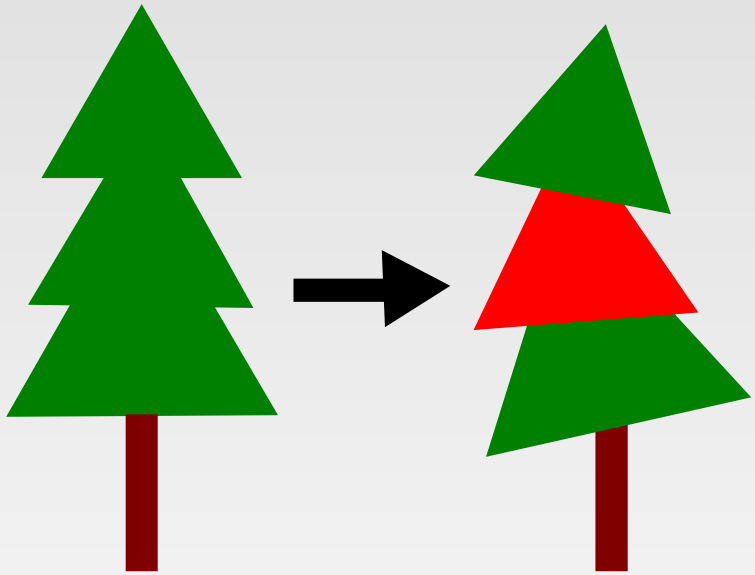
- word alignment (using GIZA++)
- additional features (if aligned node exists):
  - aligned tag (NNS, VBD...)
  - aligned dependency label (Subject, Attribute...)
  - aligned edge existence (0/1)

Parallel Features Example

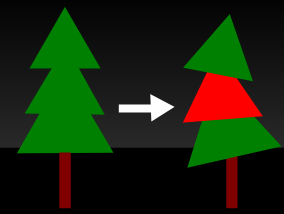


Worsening the Treebank

- treebank used for training contains correct sentences
- SMT output is noisy
  - grammatical errors
  - incorrect word order
  - missing/superfluous words
  - …
- let's introduce similar errors into the treebank!
  - so far, we have only tried inflection errors

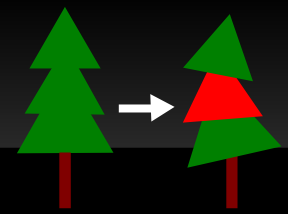


Worsen (1): Apply SMT



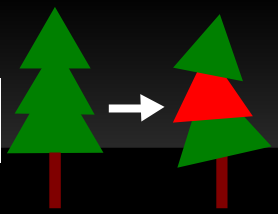
- translate English side of PCEDT to Czech
  - by an SMT system (we used Moses)
- now we have (e.g.):
  - Gold English
    - Rudolph's car is black.
  - Gold Czech
    - Rudolfovo$_{NEUT}$ auto$_{NEUT}$ je černé$_{NEUT}$.
  - SMT Czech
    - Rudolfova$_{FEM}$ auto$_{NEUT}$ je černý$_{MASC}$.

Worsen (2): Align SMT to Gold



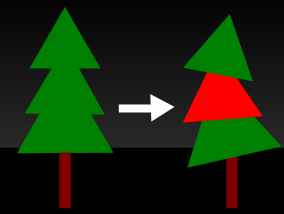
- align SMT Czech to Gold Czech
- Monolingual Greedy Aligner
  - alignment link score = linear combination of:
    - similarity of word forms (or lemmas)
    - similarity of morphological tags (fine-grained)
    - similarity of positions in the sentence
    - indication whether preceding/following words aligned
  - repeat: align best scoring pair until below threshold
  - no training: weights and threshold set manually

Worsen (3): Create Error Model



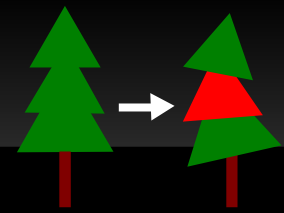
- for each tag:
  - estimate probabilities of SMT system using an incorrect tag instead of the correct tag (Maximum Likelihood Estimate)
- Czech tagset: fine-grained morphological tags
  - part-of-speech, gender, number, case, person, tense, voice...
  - 1500 different tags in training data

Worsen (3): Error Model



- Adjective, Masculine, Plural, Instrumental case (`AAMP7`), e.g. *lingvistickými* (linguistic)
  - **0.2** Adjective, Masculine, Singular, Nominative case
    - e.g. *lingvistický*
  - **0.1** Adjective, Masculine, Plural, Nominative case
    - e.g. *lingvističtí*
  - **0.1** Adjective, Neuter, Singular, Accusative case
    - e.g. *lingvistické*
- … altogether 2000 such change rules

Worsen (4): Apply Error Model



- take Gold Czech
- for each word:
  - assign a new tag randomly sampled according to Tag Error Model
  - generate a new word form
    - rule-based generator, generates even unseen forms
    - new_form = generate_form(lemma, tag) || old_form
- → get Worsened Czech
- use resulting *Gold English-Worsened Czech* parallel treebank to train the parser

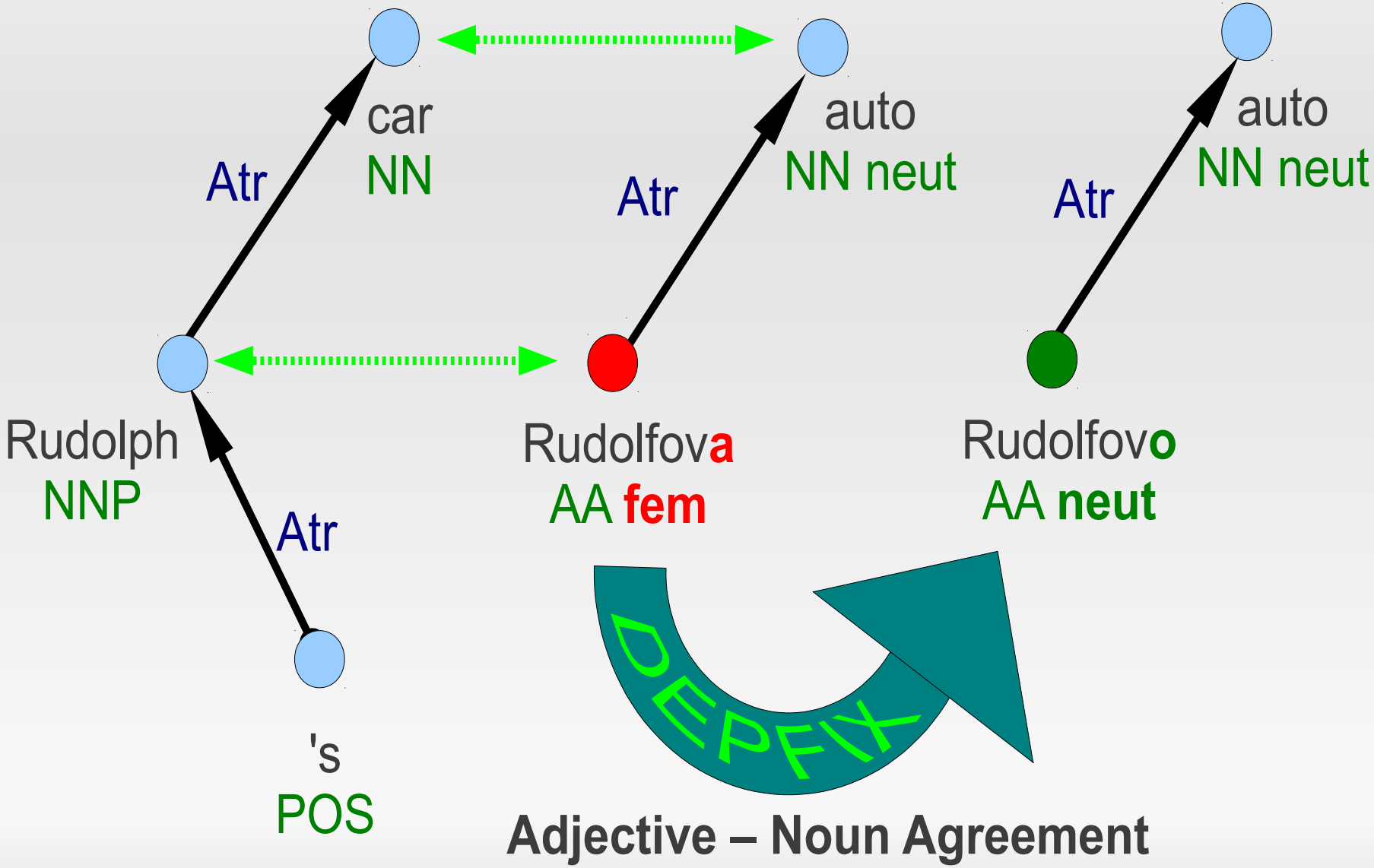
Direct Evaluation by Inspection

- manual inspection of several parse trees
  - comparing baseline and adapted parser ouputs
- examples of improvements:
  - subject identification even if not in nominative case
  - adjective-noun dependence identification even if agreement violated (gender, number, case)
- hard to do reliably
  - trying to find a correct parse tree for an (often) incorrect sentence – not well defined

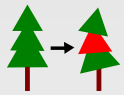
Indirect Evaluation: in Depfix

- rule-based grammar correction of SMT outputs
- input = aligned, tagged and **parsed** sentences:
  - target (Czech) sentence – to be corrected
  - source (English) sentence – additional information
- applies 20 correction rules:
  - noun – adjective agreement (gender, number, case)
  - subject – predicate agreement (gender, number)
  - preposition – noun agreement (case)
  - …

Depfix: Rudolph's Car



Indirect Evaluation Results

- differences in Depfix corrections evaluated by humans: better / worse / indefinite
- three different parsers
  - RUR + parallel features + worsened treebank 
  - 

 – original McDonald's MST Parser
  - RUR – our baseline setup

	RUR + parallel features + worsened treebank		
	better	worse	indefinite
	**51%**	30%	18%
RUR	**54%**	28%	18%

Conclusion

- SMT outputs often hard to parse
- RUR parser – adapted to parsing SMT outputs
  - parallel features (tag, dep. label, edge existence)
  - worsening the training treebank (tag error model)
- outputs of English-to-Czech translation
- evaluated in Depfix
  - SMT errors correction system

Future Work

- more sophisticated parallel features
- more experiments on worsening
- more languages

- parallel tagging

Thank you for your attention

For this presentation and other information, visit:

http://ufal.mff.cuni.cz/~rosa/depfix/

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