Introduction to TectoMT

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Outline

- PART 1
  - What is TectoMT?
  - TectoMT's architecture
  - Overview of TectoMT's tools and applications
- PART 2 - demo

What is TectoMT?

- multi-purpose NLP software framework
- created at UFAL since 2005

- main linguistic features
  - layered language representation
  - linguistic data structures adopted from the Prague Dependency Treebank

- main technical features
  - highly modular, open-source
  - numerous NLP tools already integrated (both existing and new)
  - all tools communicating via a uniform OO infrastructure
  - Linux + Perl
  - reuse of PDT technology (tree editor TrEd, XML…)

Why "TectoMT" ?

- Tecto..
  - refers the (Praguian) tectogrammar
  - deep-syntactic dependency-oriented sentence representation
  - developed by Petr Sgall and his colleagues since 1960s
  - large scale application in the Prague Dependency Treebank
- .....MT
  - the main application of TectoMT is Machine Translation
- however, not only "tecto" and not only "MT" !!!
- re-branding planned for 2011: TectoMT → Treex

What is not TectoMT?

- TectoMT (as a whole) is not an end-user application
  - it is rather an experimental lab for NLP researchers
- however, releasing of single-purpose stand-alone applications is possible

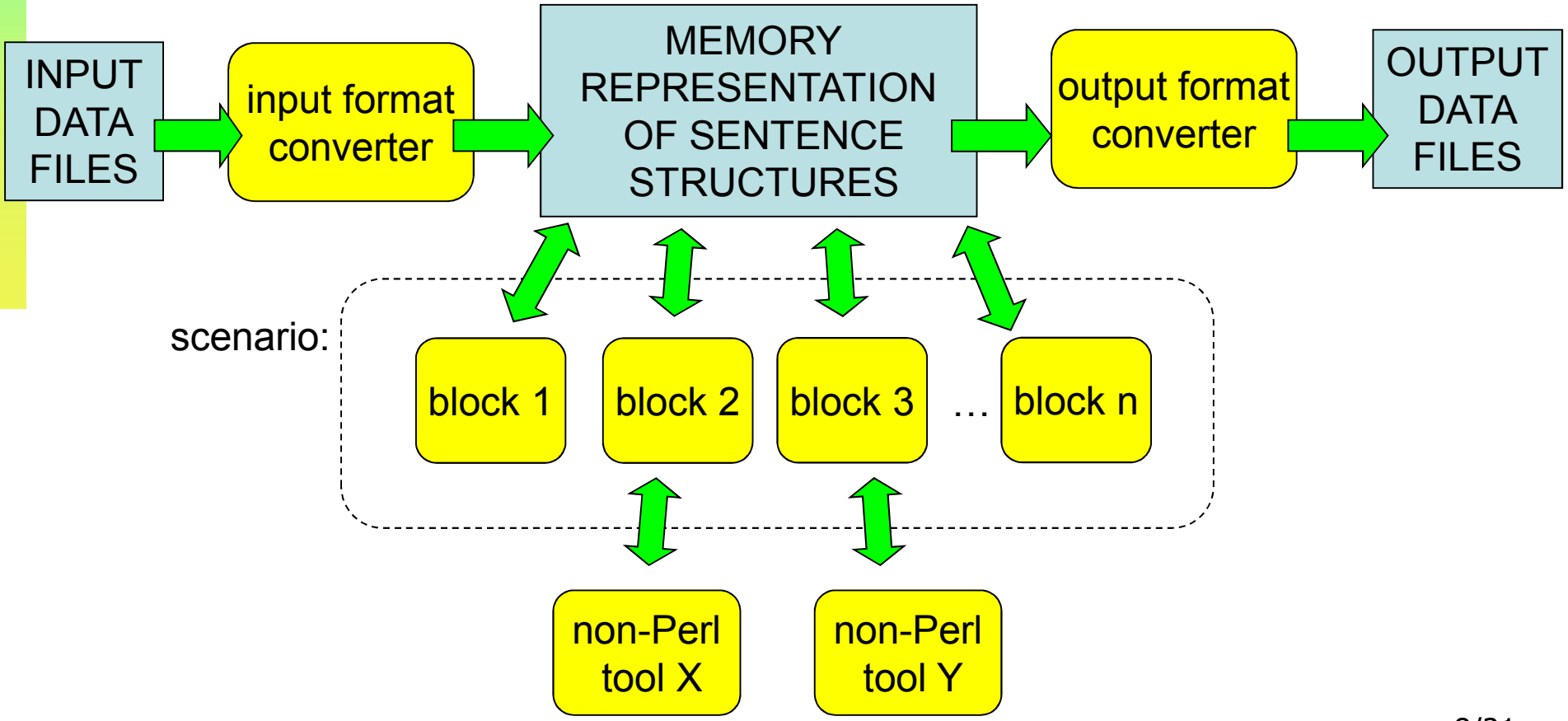
Motivation for creating TectoMT

- First, technical reasons:
  - Want to make use of more than two NLP tools in your experiment? Be ready for endless data conversions, need for other people's source code tweaking, incompatibility of source code and model versions…
  - $\Rightarrow$ unified software infrastructure might help us in many aspects.
- Second, our long-term MT plan:
  - We believe that tectogrammar (deep syntax) as implemented in Prague Dependency Treebank might help to (1) **reduce data sparseness**, and (2) find and **employ structural similarities** revealed by tectogrammar even between typologically different languages.

Main Design Decisions

- Linux
- Perl as the core language
- set of well-defined, linguistically relevant layers of language representation
- neutral w.r.t. chosen methodology ("rules vs. statistics")
- emphasis on modularity
  - each task implemented by a sequence of blocks
  - each block corresponds to a well-defined NLP subtask
  - reusability and substitutability of blocks
- support for distributed processing

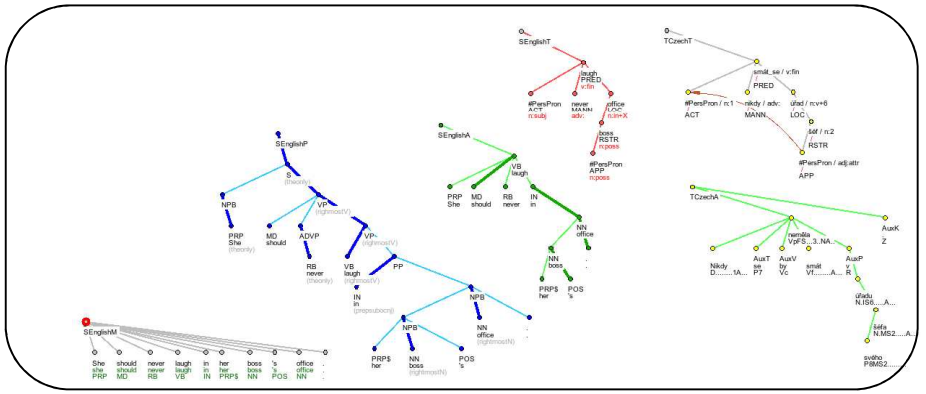
Data Flow Diagram in a typical application in TectoMT



Hierarchy of data-structure units

- **document**
  - the smallest independently storable unit (~ xml file)
  - represents a text as a sequence of bundles, each representing one sentence (or sentence tuples in the case of parallel documents)
- **bundle**
  - set of tree representations

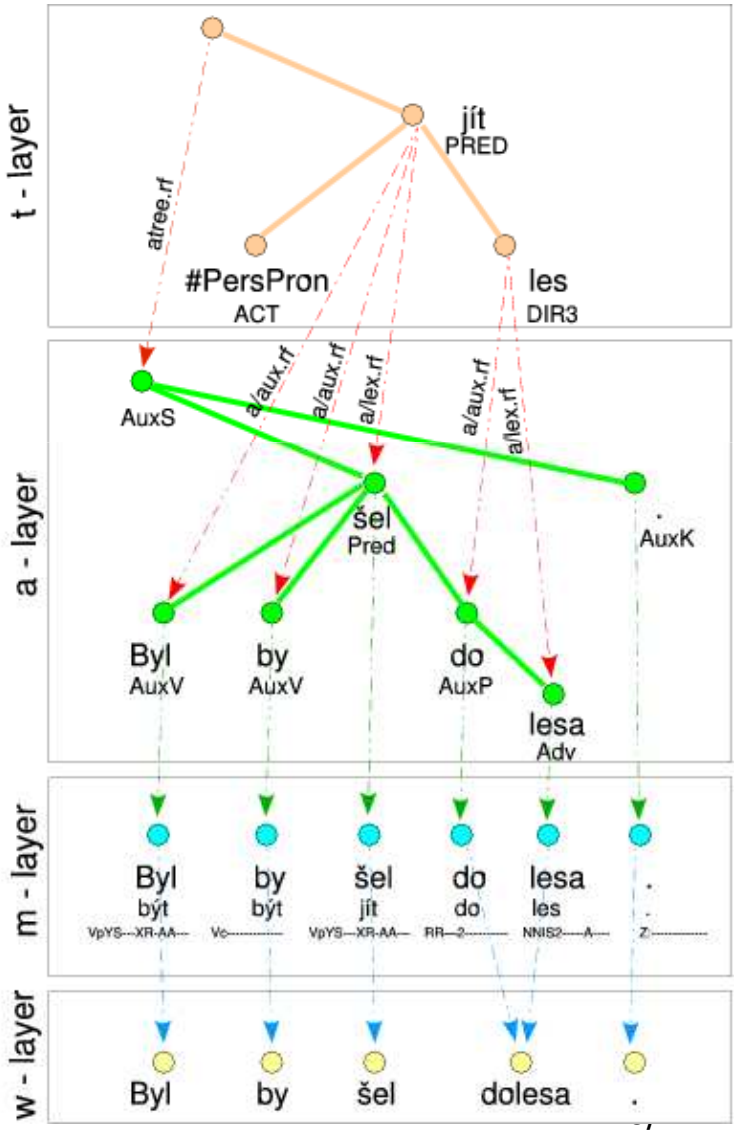
  of a given sentence



- **tree**
  - representation of a sentence on a given layer of linguistic description
- **node**
- **attribute**
  - document's, node's, or bundle's name-value pairs

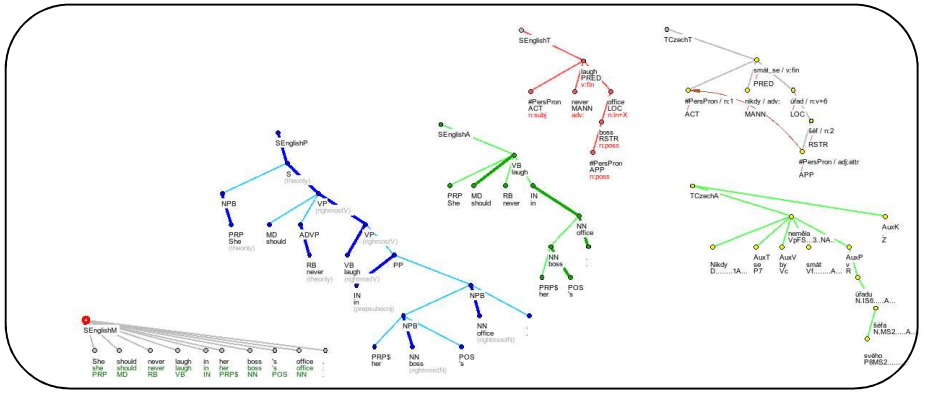
Tree types adopted from PDT

- tectogrammatical layer
  - deep-syntactic dependency tree
- analytical layer
  - surface-syntactic dependency tree
  - 1 word (or punct.) ~ 1 node
- morphological layer
  - sequence of tokens with their lemmas and morphological tags



Trees in a bundle

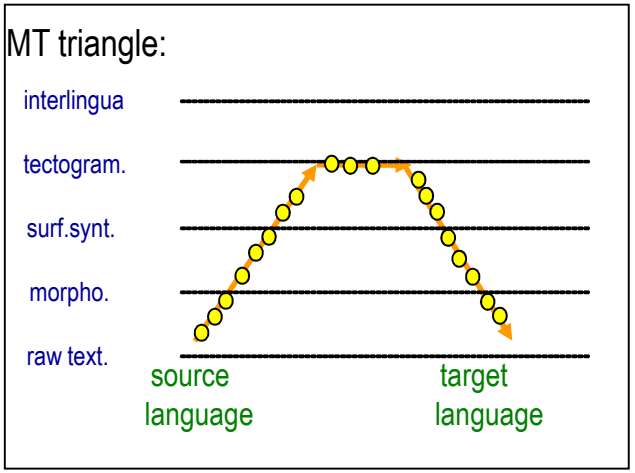
- in each bundle, there can be at most one tree for each "layer"
- set of possible layers = {S,T} x {English,Czech,...} x {M,A,T,P, N}
- S - source, T-target (analysis vs. synthesis, MT perspective)
- M - morphological analysis
- P - phrase-structure tree
- A - analytical tree
- T - tectogrammatical tree
- N - instances of named entities



- Example: SEnglishA - tectogrammatical analysis of an English sentence on the source-language side

Hierarchy of processing units

- block
  - the smallest individually executable unit
  - with well-defined input and output
  - block parametrization possible (e.g. model size choice)
- scenario
  - sequence of blocks, applied one after another on given documents
- application
  - typically 3 steps:
  - 1. conversion from the input format
  - 2. applying the scenario on the data
  - 3. conversion into the output format



Blocks

- technically, Perl classes derived from TectoMT::Block
- either method **process_bundle** (if sentences are processed independently) or method **process_document** must be defined
- several hundreds blocks in TectoMT now, for various purposes:
  - blocks for analysis/transfer/synthesis, e.g.

```
SEnglishW_to_SEnglishM::Lemmatize_mtree
SEnglishP_to_SEnglishA::Mark_heads
TCzechT_to_TCzechA::Vocalize_prepositions
```

  - blocks for alignment, evaluation, feature extraction, etc.
- some of them only implement simple rules, some of them call complex probabilistic tools
- English-Czech tecto-based translation currently composes of roughly 140 blocks

Tools available as TectoMT blocks

- to integrate a stand-alone NLP tool into TectoMT means to provide it with the standardized block interface
- already integrated tools:
  - taggers
    - Hajič's tagger, Raab&Spoustová Morče tagger, Rathnaparkhi MXPOST tagger, Brants's TnT tager, Schmid's Tree tagger, Coburn's Lingua::EN::Tagger
  - parsers
    - Collins' phrase structure parser, McDonalds dependency parser, Malt parser, ZŽ's dependency parser
  - named-entity recognizer
    - Stanford Named Entity Recognizer, Kravalová's SVM-based NE recognizer
  - miscel.
    - Klimeš's semantic role labeller, ZŽ's C5-based afun labeller, Ptáček's C5-based Czech preposition vocalizer, ...

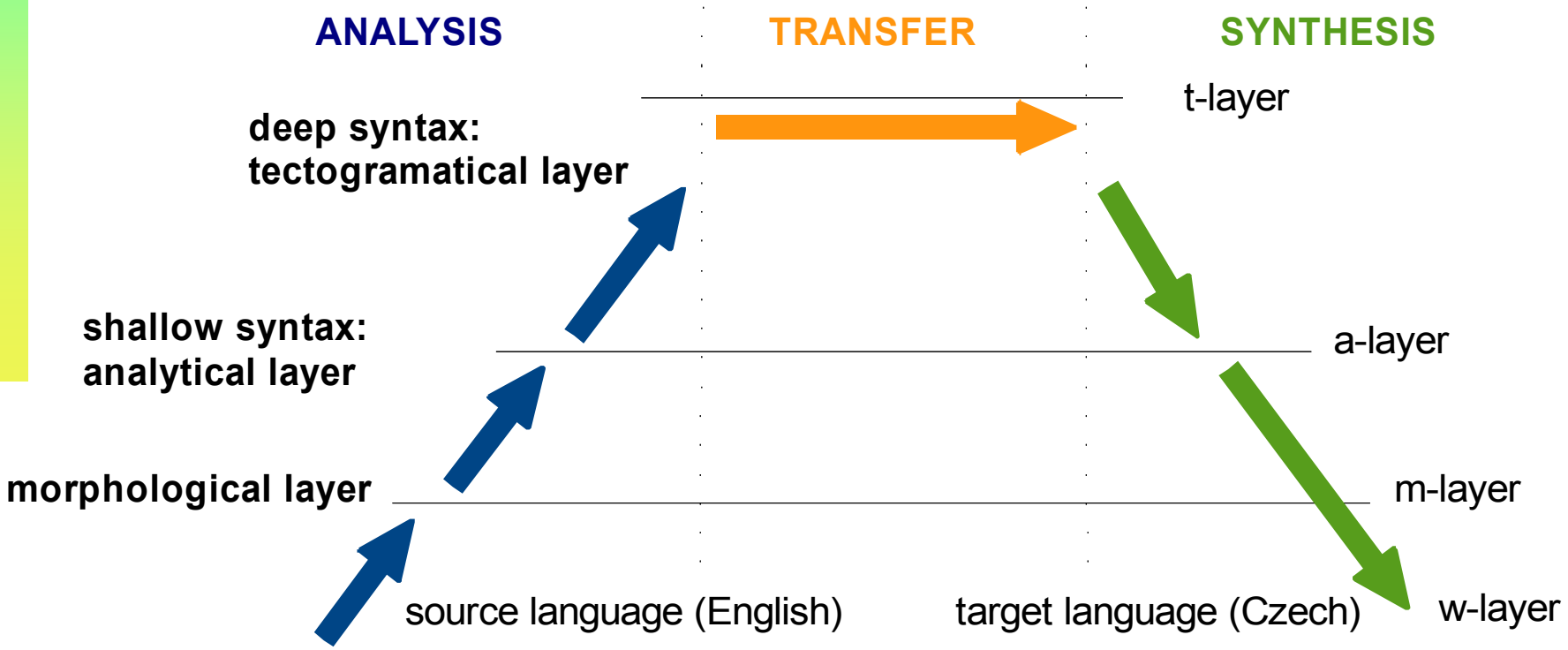
Other TectoMT components

- "core" - Perl libraries forming the core of TectoMT infrastructure, esp. for memory representation of (and interface to) to the data structures
- numerous file-format converters (e.g. from PDT, Penn treebank, Czeng corpus, WMT shared task data etc. to our xml format)
- TectoMT-customized Pajas' tree editor TrEd
- tools for parallelized processing (Bojar)
- data, esp. trained models for the individual tools, morphological dictionaries, probabilistic translation dictionaries...
- tools for testing (regular daily tests), documentation...

Languages in TectoMT

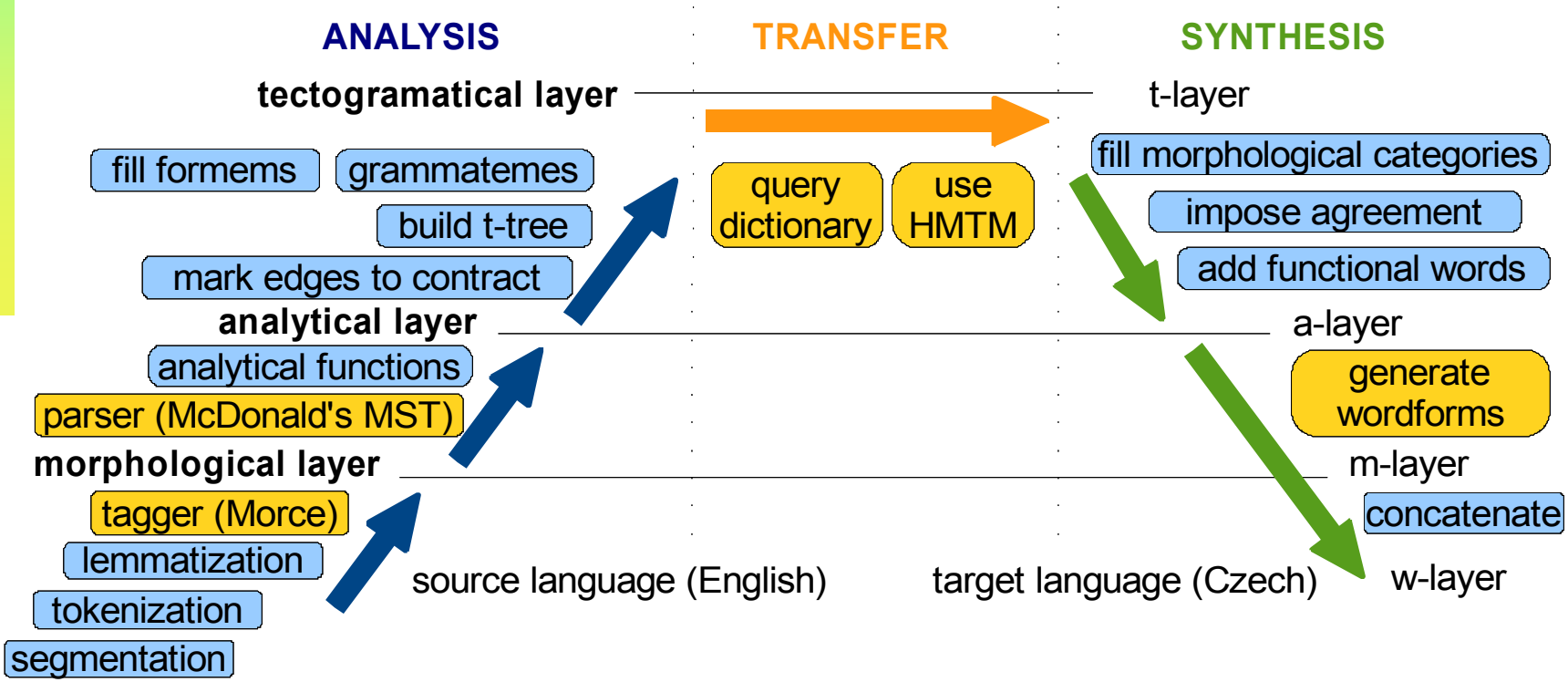
- full-fledged sentence PDT-style analysis/transfer/synthesis for English and Czech
  - using state-of-the-art tools
- prototype implementations of PDT-style analyses for a number of other languages
  - mostly created by students
  - Polish, French, German, Tamil, Spanish, Esperanto…

English-Czech translation in TectoMT



English-Czech translation in TectoMT

rule based & statistical blocks

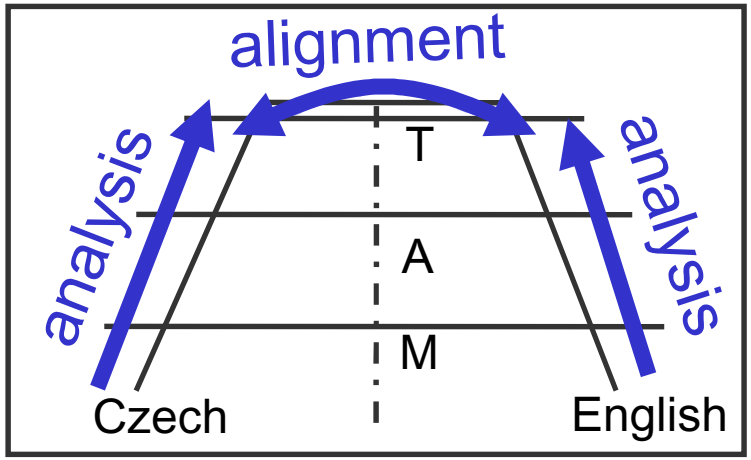


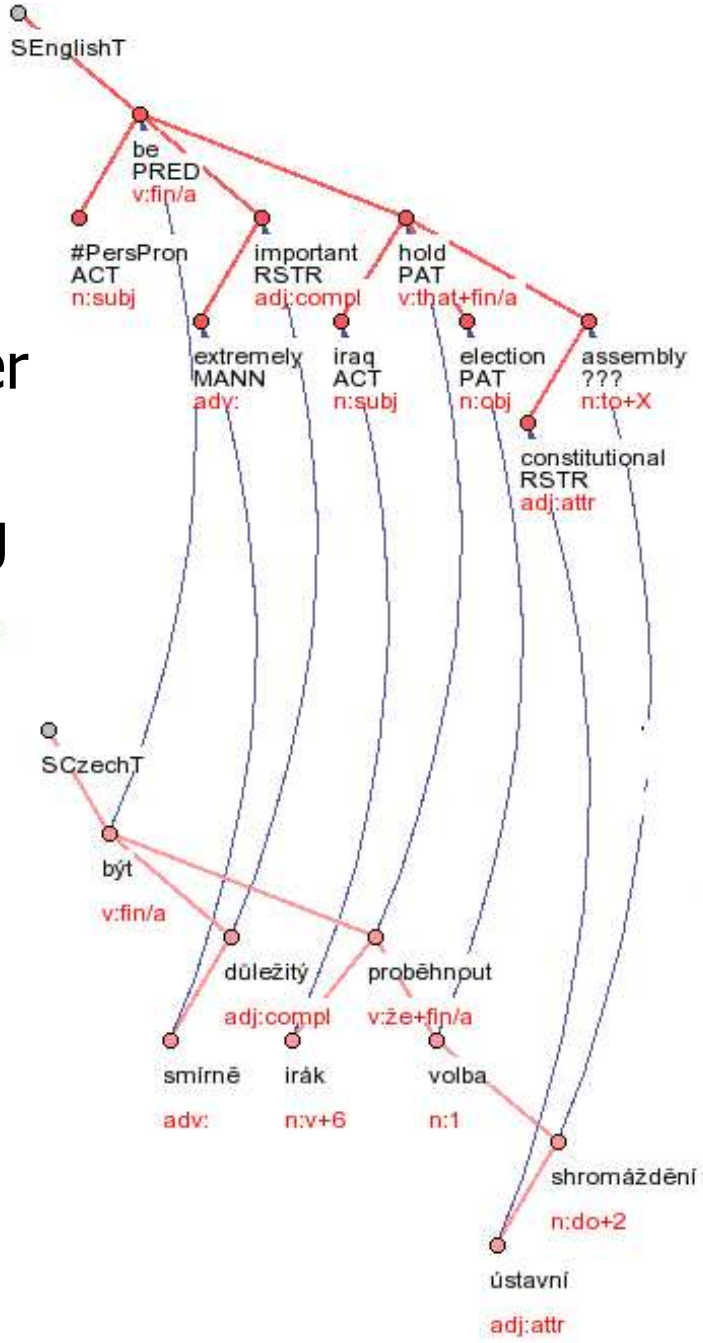
Real Translation Scenario

SEnglishW_to_SEnglishM::
Tokenization
Normalize_forms
Fix_tokenization
TagMorce
Fix_mtags
Lemmatize_mtree
SEnglishM_to_SEnglishN::
Stanford_named_entities
Distinguish_personal_names
SEnglishM_to_SEnglishA::
McD_parser
Fill_is_member_from_deprel
Fix_tags_after_parse
McD_parser REPARSE=1
Fill_is_member_from_deprel
Fix_McD_topology
Fix_nominal_groups
Fix_is_member
Fix_atree
Fix_multiword_prep_and_conj
Fix_dicendi_verbs
Fill_afun_AuxCP_Coord
Fill_afun
SEnglishA_to_SEnglishT::
Mark_edges_to_collapse
Mark_edges_to_collapse_neg
Build_ttree
Fill_is_member
Move_aux_from_coord-
_to_members
Fix_tlemmas
Assign_coap_functors
Fix_either_or
Fix_is_member
Mark_clause_heads
Mark_passives
Assign_functors
Mark_infin
Mark_relclause_heads
Mark_relclause_coref
Mark_dsp_root
Mark_parentheses
Recompute_deepord
Assign_nodetype
Assign_grammatemes
Detect_formeme
Rehang_shared_attr
Detect_voice
Fix_imperatives
Fill_is_name_of_person
Fill_gender_of_person
Add_cor_act
Find_text_coref
SEnglishT_to_TCzechT::
Clone_ttree
Translate_LF_phrases
Translate_LF_joint_static
Delete_superfluous_tnodes
Translate_F_try_rules
Translate_F_add_variants
Translate_F_rerank
Translate_L_try_rules
Translate_L_add_variants
Translate_LF_numerals_by_rules
Translate_L_filter_aspect
Transform_passive_constructions
Prune_personal_name_variants
Remove_unpassivizable_variants
Translate_LF_compounds
Cut_variants
Rehang_to_eff_parents
Translate_LF_tree_Viterbi
Rehang_to_orig_parents
Fix_transfer_choices
Translate_L_female_surnames
Add_noun_gender
Add_relpron_below_rc
Change_Cor_to_PersPron
Add_PersPron_below_vfin
Add_verb_aspect
Fix_date_time
Fix_grammatemes_after_transfer
Fix_negation
Move_adjectives_before_nouns
Move_genitives_to_postposit
Move_relclause_to_postposit
Move_dicendi_closer_to_dsp
Move_PersPron_next_to_verb
Move_enough_before_adj
Fix_money
Recompute_deepord
Find_gram_coref_for_refl_pron
Neut_PersPron_gender_from_antec
Override_pp_with_phrase_translation
Valency_related_rules
Fill_clause_number
Turn_text_coref_to_gram_coref
TCzechT_to_TCzechA::
Clone_atree
Distinguish_homonymous_mlemmas
Reverse_number_noun_dependency
Init_morphcat
Fix_possessive_adjectives
Mark_subject
Impose_pron_z_agr
Impose_rel_pron_agr
Impose_subjpred_agr
Impose_attr_agr
Impose_compl_agr
Drop_subj_pers_prons
Add_prepositions
Add_subconjs
Add_reflex_particles
Add_auxverb_compound_passive
Add_auxverb_modal
Add_auxverb_compound_future
Add_auxverb_conditional
Add_auxverb_compound_past
Add_clausal_expletive_pronouns
Resolve_verbs
Project_clause_number
Add_parentheses
Add_sent_final_punct
Add_subord_clause_punct
Add_coord_punct
Add_apposition_punct
Choose_mlemma_for_PersPron
Generate_wordforms
Move_clitics_to_wackernagel
Recompute_ordering
Delete_superfluous_prepos
Delete_empty_nouns
Vocalize_prepositions
Capitalize_sent_start
Capitalize_named_entities
TCzechA_to_TCzechW::
Concatenate_tokens
Ascii_quotes
Remove_repeated_tokens

Parallel analysis

- data needed for training the transfer phase models
- Czech-English parallel corpus CzEng
- 8 mil. pairs of sentences with automatic PDT-style analyses and alignment





Summary of Part I

- TectoMT (→Treex)
  - environment for NLP experiments
  - multipurpose, multilingual
  - PDT-style linguistic structures
  - Linux+Perl, open-source
  - modular architecture (several hundreds of modules)
  - capable of processing massive data
  - will be released at CPAN