



A Unified Framework for phrase-based, Hierarchical and Syntax SMT

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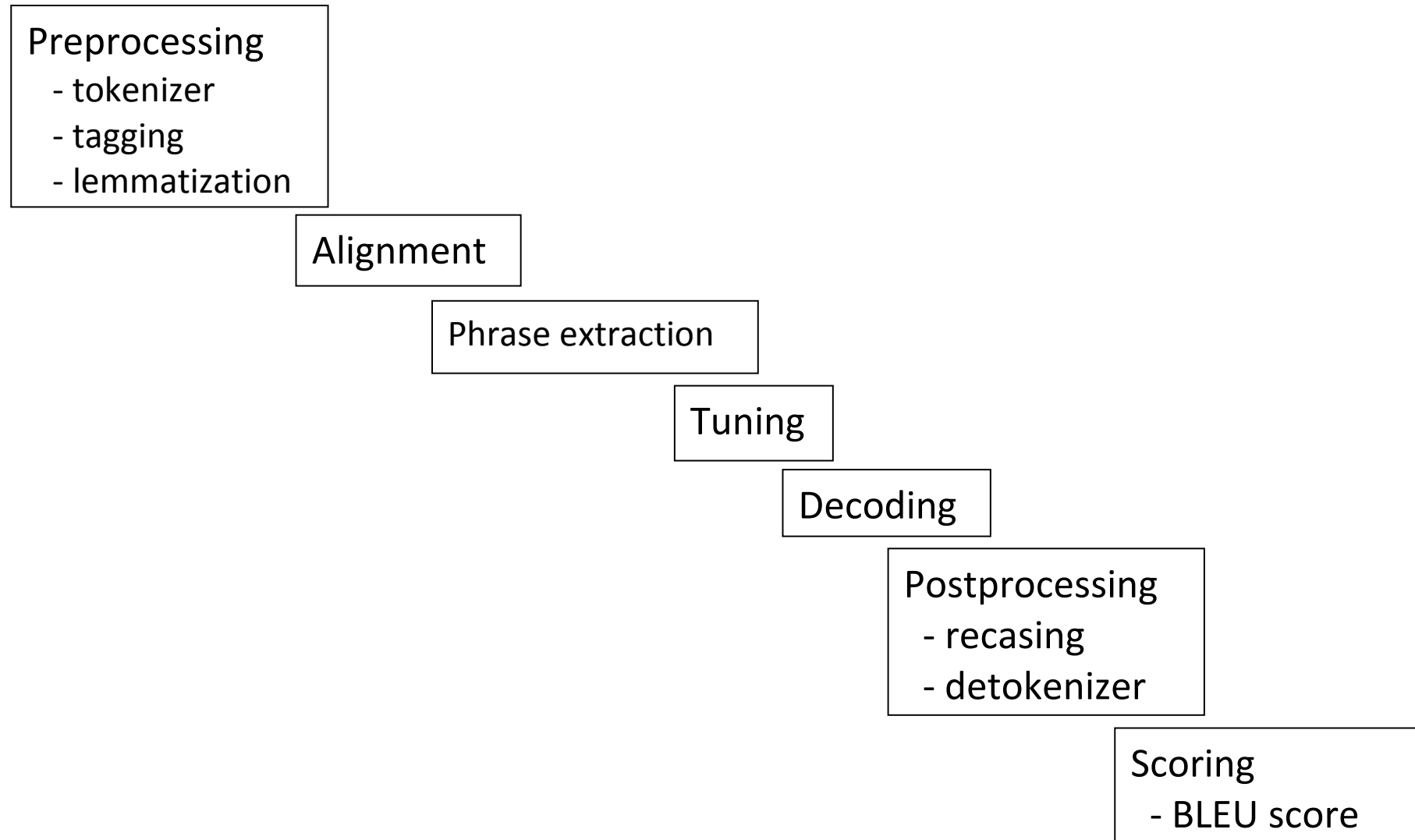
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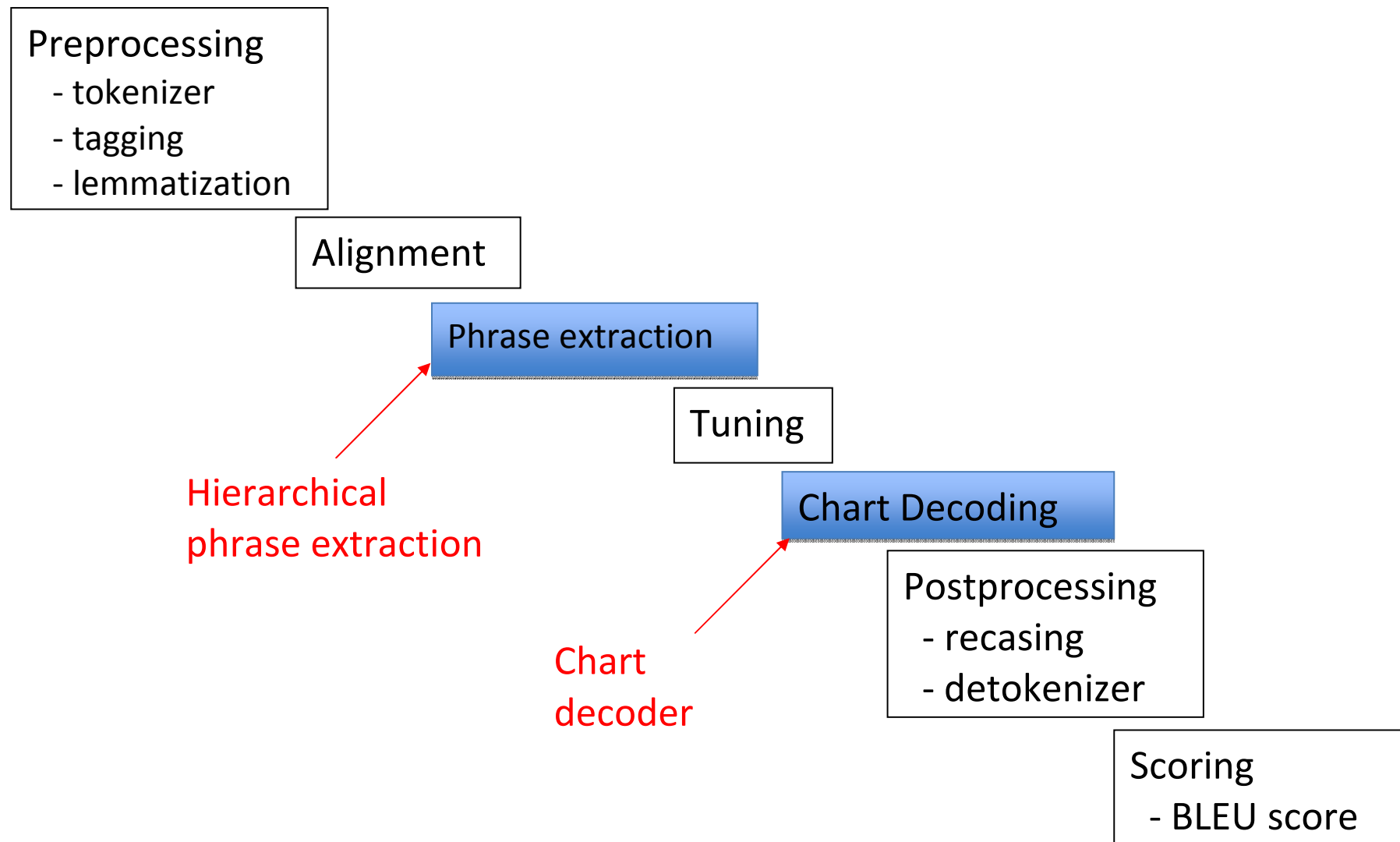
Decoding methods

- Phrase Based
 - Alignment Template System (Och 2004)
 - Pharaoh (Koehn 2003)
 - Moses (Koehn et al 2007)
- Hierarchical
 - Hiero (Chiang 2007)
 - ITG (Wu 1997)
- Syntactic
 - ISI (Yamada and Knight 2001)
 - SAMT (Zollmann 2006)

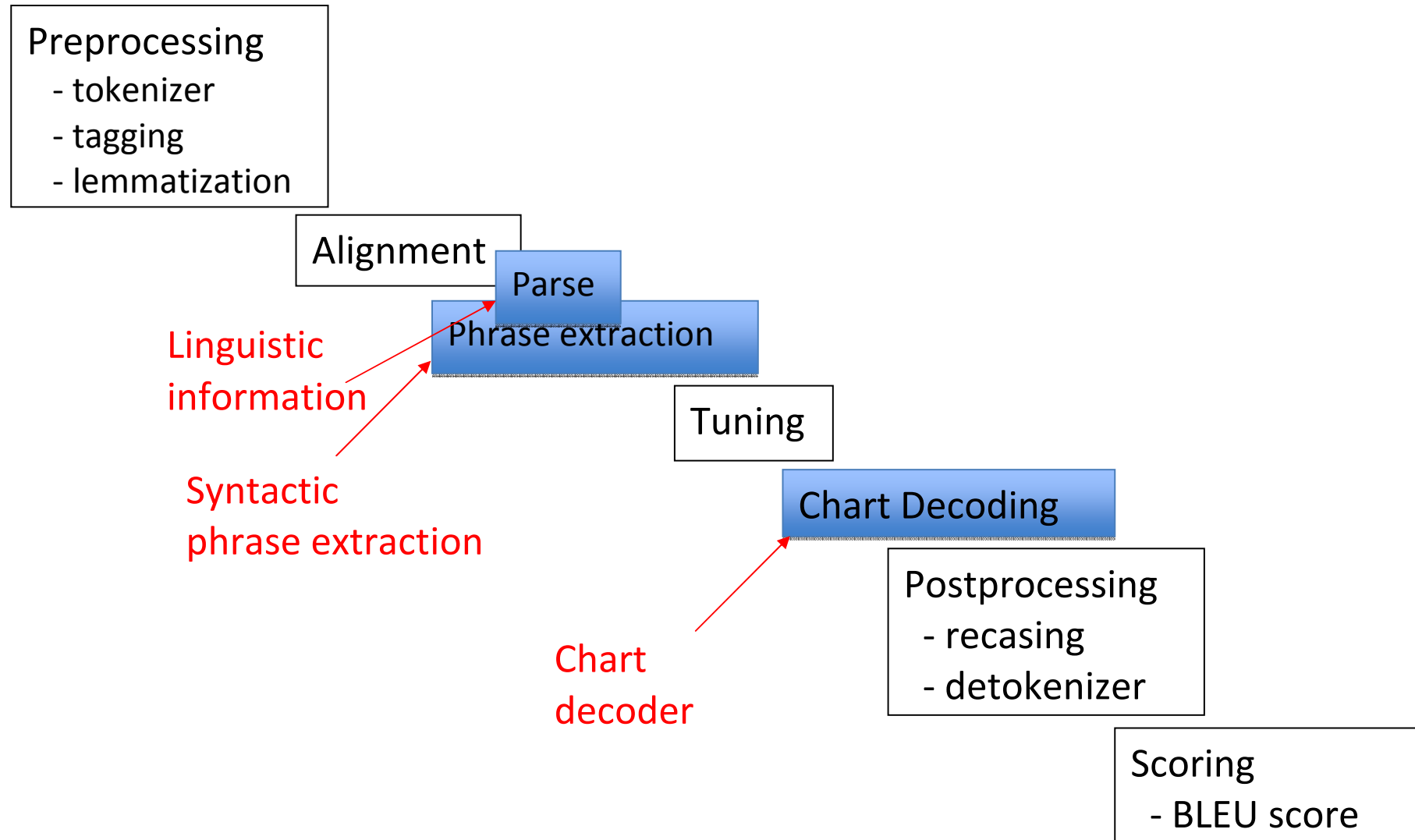
Phrase-based Decoding Pipeline



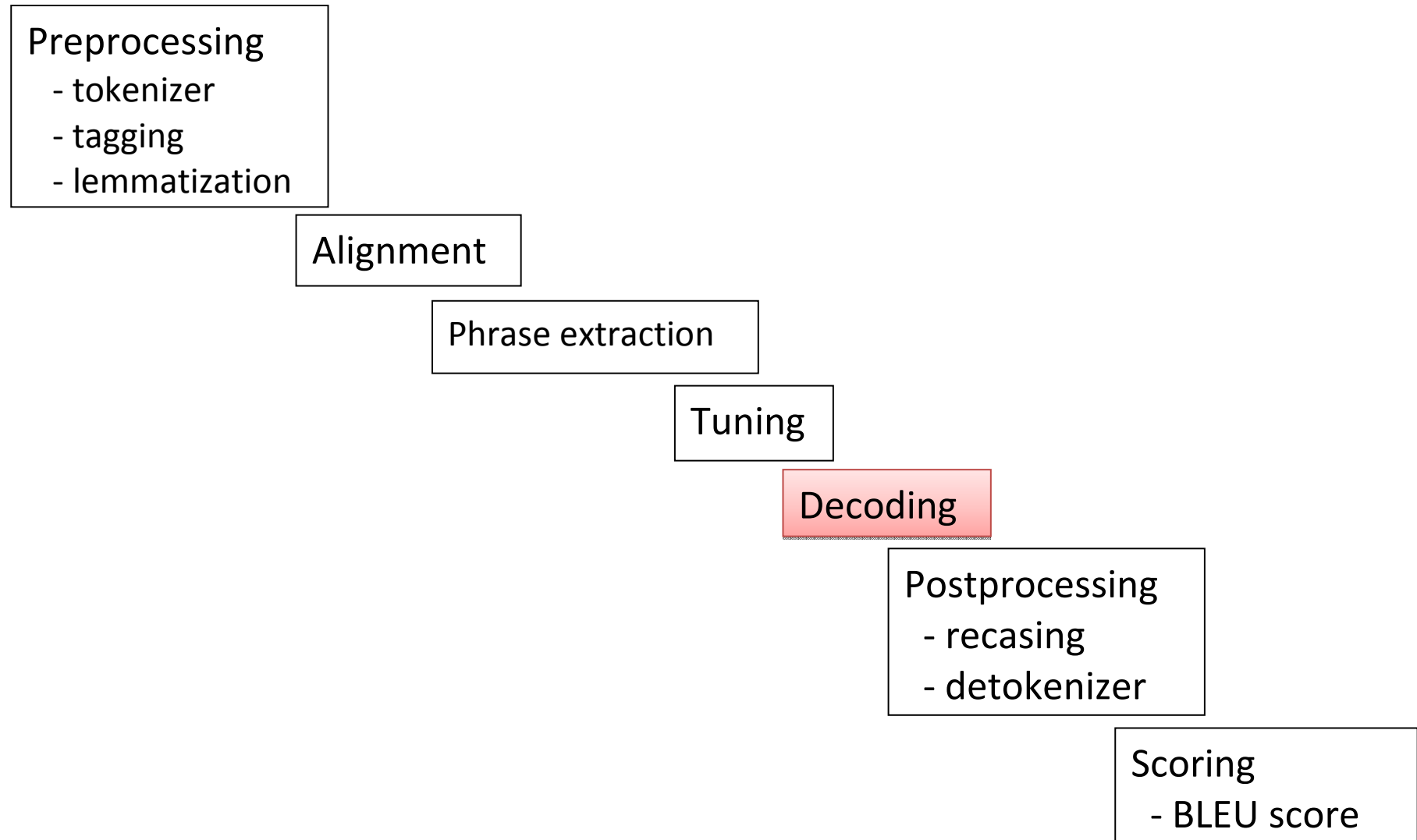
Hierarchical Decoding Pipeline



Syntactic Decoding Pipeline



Decoding



Phrase-Based

- Translate contiguous phrases

assumes || geht davon aus, dass
with regard to || bezüglich
translation system ||
Übersetzungssystem

- Finite state machine decoding
 - Stack based
 - Beam search

Hierarchical

- Discontiguous phrases

$X \rightarrow$ take X_1 into account || berücksichtigt X_1

$X \rightarrow$ must explain X_1 || muss X_1 erklären

$X \rightarrow$ either X_1 or X_2 || entweder X_1 oder X_2

- CKY+ decoding algorithm

- chart decoding

- simultaneous parsing and generation

Syntax

- Discontiguous phrases
- Labeled non-terminals

VP \rightarrow take NP_1 into account || berücksichtigt NP_1

VP \rightarrow must explain NP_1 || muss NP_1 erklären

S \rightarrow either S_1 or S_2 || entweder S_1 oder S_2

- CKY+ decoding

Similarities

- Trained using aligned corpus
- Phrase tables
- Linear scoring
- N-best list for weight tuning
- Dynamic programming
- Language model context

Phrase-based decoder

- Base functionality
 - Incremental scoring
 - LM context
 - Dynamic programming
 - Search graph
- Decoding
 - Stacks
 - 1 stack for number of words covered
 - Future cost for better intra-stack comparison.
 - Search strategy
 - Bottom up, least number of words first

Hierarchical decoder

- Base functionality
 - Incremental scoring
 - LM context
 - Dynamic programming
 - Search graph
- Decoding
 - Stacks
 - 1 stack for each source contiguous coverage
 - Search strategy
 - Bottom up, smallest span first

Syntax decoder

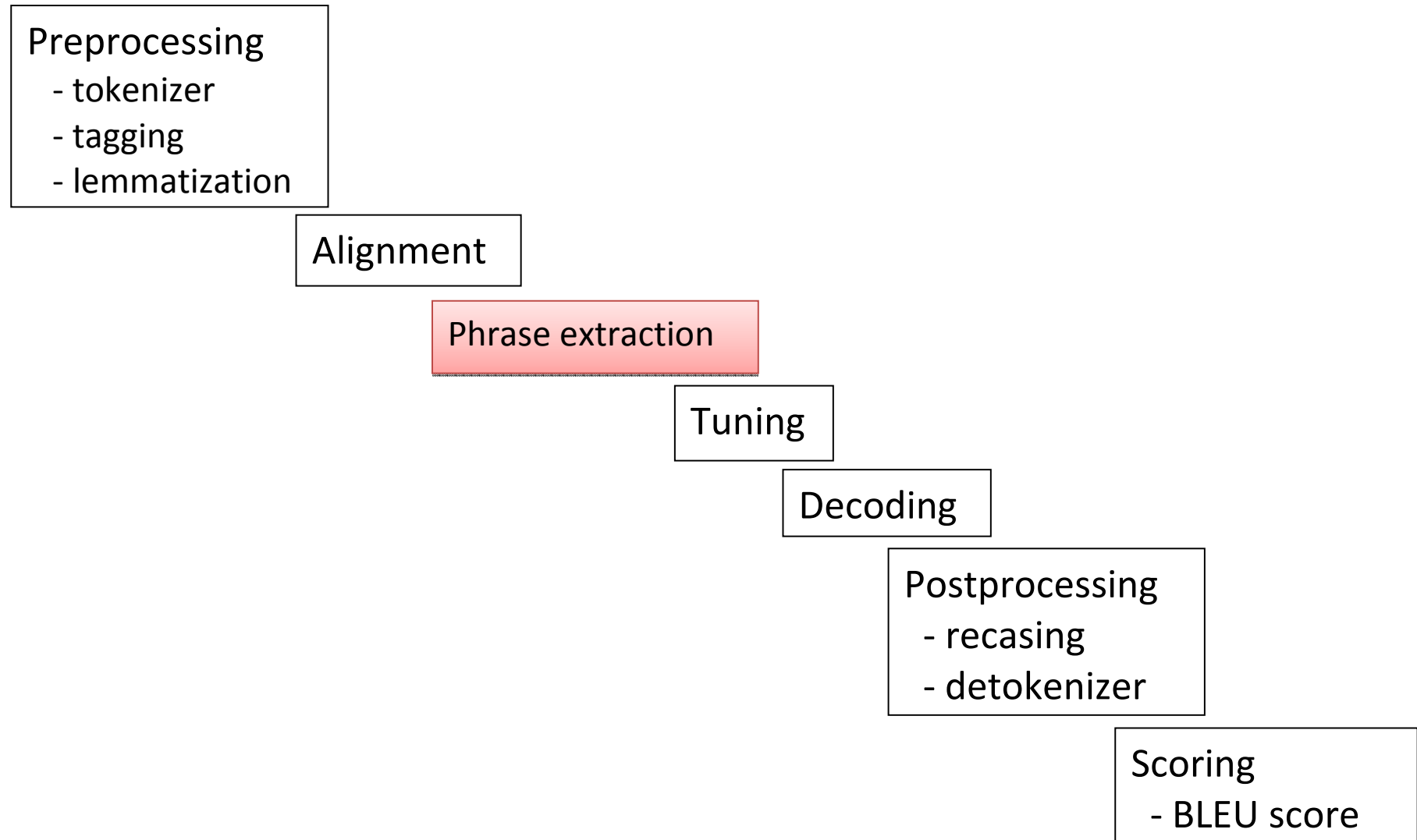
- Base functionality
 - Incremental scoring
 - LM context
 - Dynamic programming
 - Search graph
- Decoding
 - Stacks
 - 1 stack for each non-terminal, for each source contiguous coverage
 - Search strategy
 - Bottom up, smallest span first

Inherited from the Moses decoder

- Factored word representation
- Multiple language models
- Multiple phrase tables

- Multiple implementations of LM and phrase tables

Phrase-based Decoding Pipeline



Phrase-based rule extraction

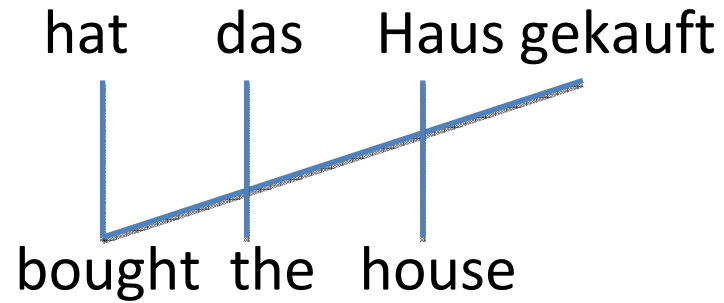
- Heuristic algorithms
 - Phrase extraction
- Probability estimates
 - Phrase and lexical probabilities
 - Smoothing
- Filtering

Hierarchical rule extraction

- Heuristic algorithms
 - Phrase extraction
 - Replace subphrases with non-terminals
- Probability estimates
 - Phrase and lexical probabilities
 - Smoothing
- Filtering

Hierarchical rule extraction

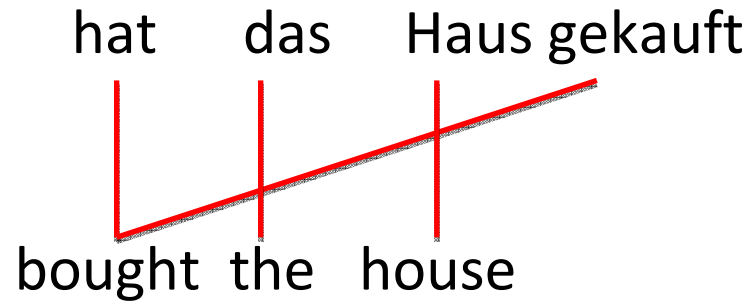
Alignment



Extracted Phrase

Hierarchical rule extraction

Alignment

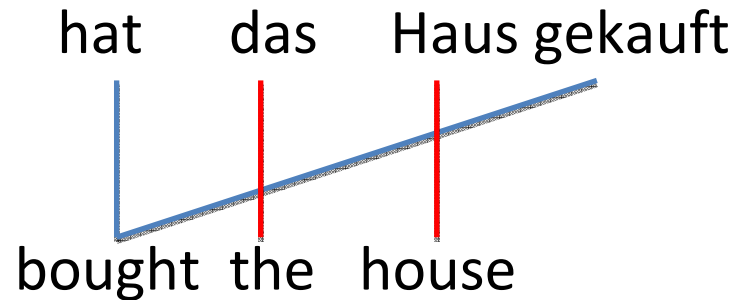


Extracted Phrase

X → Ich hat das Haus gekauft | | bought the house

Hierarchical rule extraction

Alignment



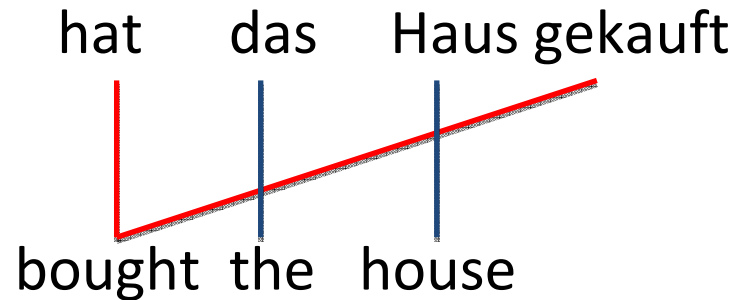
Extracted Phrase

X → hat das Haus gekauft || bought the house

X → das Haus || the house

Hierarchical rule extraction

Alignment



Extracted Phrase

X → hat das Haus gekauft || bought the house

X → das Haus || the house

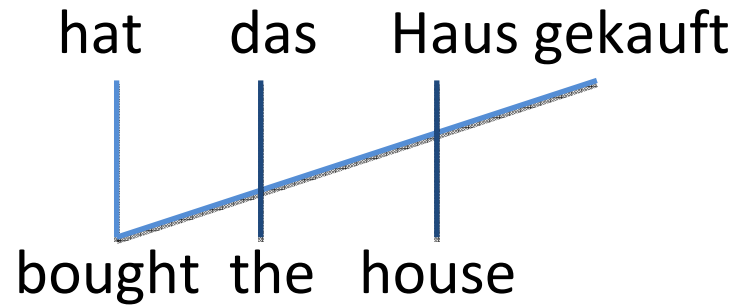
X → hat X gekauft || bought X

Syntactic rule extraction

- Heuristic algorithms
 - Phrase extraction
 - Replace subphrases with non-terminals
 - New rule
 - Labeled non-terminals
 - Constrain extraction
 - merge non-terminal symbols - SAMT
 - Binarization
- Probability estimates
 - Phrase and lexical probabilities
 - Smoothing
- Filtering

Syntactic rule extraction

Alignment



Extracted Phrase

X → hat das Haus gekauft || bought the house

X → das Haus || the house

X → hat NP gekauft || bought NP

Results

German-English

- WMT09 new commentary corpus
 - 82k sentences
 - 1.8m German, 1.7m English words

Model	Rule count	BLEU %
Phrase-based	6.2m	13.0
Hierarchical	59.1m	12.9
Target syntax	2.2m	12.5
SAMT syntax	35.1m	12.9

Summary

- Extend Moses toolkit
 - Synchronous CFG formalism
 - Hierarchical
 - Syntactic decoding
 - Decoding algorithm
 - Rule extraction
- Re-use mature SMT pipeline
- Comparison of different decoding models
 - Use the same training data
 - Use the same translation & language models
- Merge different models