MaTrEx: Machine Translation Using Examples

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DCU NCLT @ NIST MT 2006

Outline

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MT@DCU

- National Centre for Language Technology (NCLT) in DCU.
  A team of 12 researchers:
  - 2 M.Sc Students, 7 Ph.D. Students, 2 Postdocs
  - Supervised by Dr. Andy Way
- First Participation to NIST MT. In 2006:
  - OpenLab (TC STAR), Spanish → English
  - NIST MT, Arabic → English
  - IWSLT, Arabic → English, Italian → English
- Large-scale Example-Based Machine Translation system
  - Easily adaptable to new language pairs
  - Modular design - follow established Design Patterns
  - Hybrid system: EBMT/SMT

MT@DCU

Remarks

- Historically, we have been working on EBMT
- EBMT and SMT are showing more and more similarities (use of aligned "phrases")
- We are working more and more on the combination of EBMT and SMT resources

2006: A dry-run...

Some problems and mistakes

- Strong underestimation of the workload: only one person, part-time, for 5 weeks
- Problems with memory requirement (> 4 Gigs of RAM needed by Giza++)
- Main cluster unavailable for 3 days because of maintenance during the last week
- Buckwalter had been automatically lowercased (!!)
- LMs were not trained on English GigaWord (only UN Data)
- MERT was skipped, EBMT chunking and alignment were skipped!
- $\Longrightarrow$ the results do not reflect the capabilities of our system!

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MaTrEx: A Hybrid EBMT/SMT System

A Phrase-Based EBMT/SMT System

- Data-driven system: Makes use of aligned phrases extracted from sententially-aligned corpora
- Two types of extraction:
  - "SMT" phrases extracted from words alignments (GIZA++ + heuristic)
  - "EBMT" phrases extracted thanks to (i) a chunking and (ii) an alignment of chunks proposed by the EBMT system

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Marker-Based EBMT: *Chunking*

- Approach to EBMT based on the Marker Hypothesis

> *"The Marker Hypothesis states that all natural languages have a closed set of specific words or morphemes which appear in a limited set of grammatical contexts and which signal that context." (Green, 1979).*

- Universal psycholinguistic constraint: languages are marked for syntactic structure at surface level by closed set of lexemes or morphemes.

The Dearborn Mich., energy company stopped paying a dividend in the third quarter of 1984 because of troubles at its Midland nuclear plant

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- 3 NPs start with determiners, one with a possessive pronoun
  - Determiners & possessive pronoun - small closed-class sets
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- 3 NPs start with determiners, one with a possessive pronoun
  - Determiners & possessive pronoun - small closed-class sets
  - Predicts head nominal element will occur in the right-context.
- Four prepositional phrases, with prepositional heads
  - Again a small set of closed-class words
  - Indicates that soon thereafter an NP object will occur

Marker-Based EBMT: *Chunking (2)*

- Use a set of closed-class marker words to segment aligned source and target sentences during a pre-processing stage.
- <PUNC> used as end of chunk marker

Determiner	<DET>
Quantifiers	<Q>
Prepositions	<P>
Conjunctions	<C>
WH-Adverbs	<WH>
Possessive Pronouns	<POSS-PRON>
Personal Pronouns	<PERS-PRON>
Punctuation Marks	<PUNC>

- English Marker words extracted from CELEX and edited manually.

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Marker-Based EBMT: *Chunking (3)*

Pros

- Psycho-Linguistic motivation
- Simple (linear)
- Easily adaptable (only a list of marker-words is needed)
- Does not need expensive training on treebanks, etc.

Cons

- Blind (no context taken into account)
- Deterministic
- Not so easily adaptable to languages such as Arabic/Chinese (POS would be needed) $\Longrightarrow$ we used ASVM for Arabic chunking

Remarks

- Can be combined with different chunkers, e.g. machine-learning based chunkers (cf. CoNLL'2000 shared task)
- In the English PTB, the most frequent first words of chunks are mostly marker-words...

Chunk Alignment

- "Edit-Distance Like" Chunk Alignment. Does not depend on the chunking strategy.
  - Dynamic programming algorithm
- Conditional probabilities used:
  - Based on Marker Tags
  - Based on Cognate Information: *Lowest Common Subsequence Ratio, Dice Coefficient, Minimum Edit-Distance*
  - Based on Word Translation Probabilities
  - Combination (=> can be viewed as a log-linear model)

$$\lambda_1 d_1(a,b) + \cdots + \lambda_n d_n(a,b) \Rightarrow -\lambda_1 log P_1(a|b) \cdots - \lambda_n log P_n(a|b)$$

- "Edit-Distance" with Jumps
  - Useful for languages where the word order is different (didn't improve results for Spanish/English MT)

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Mixing chunks

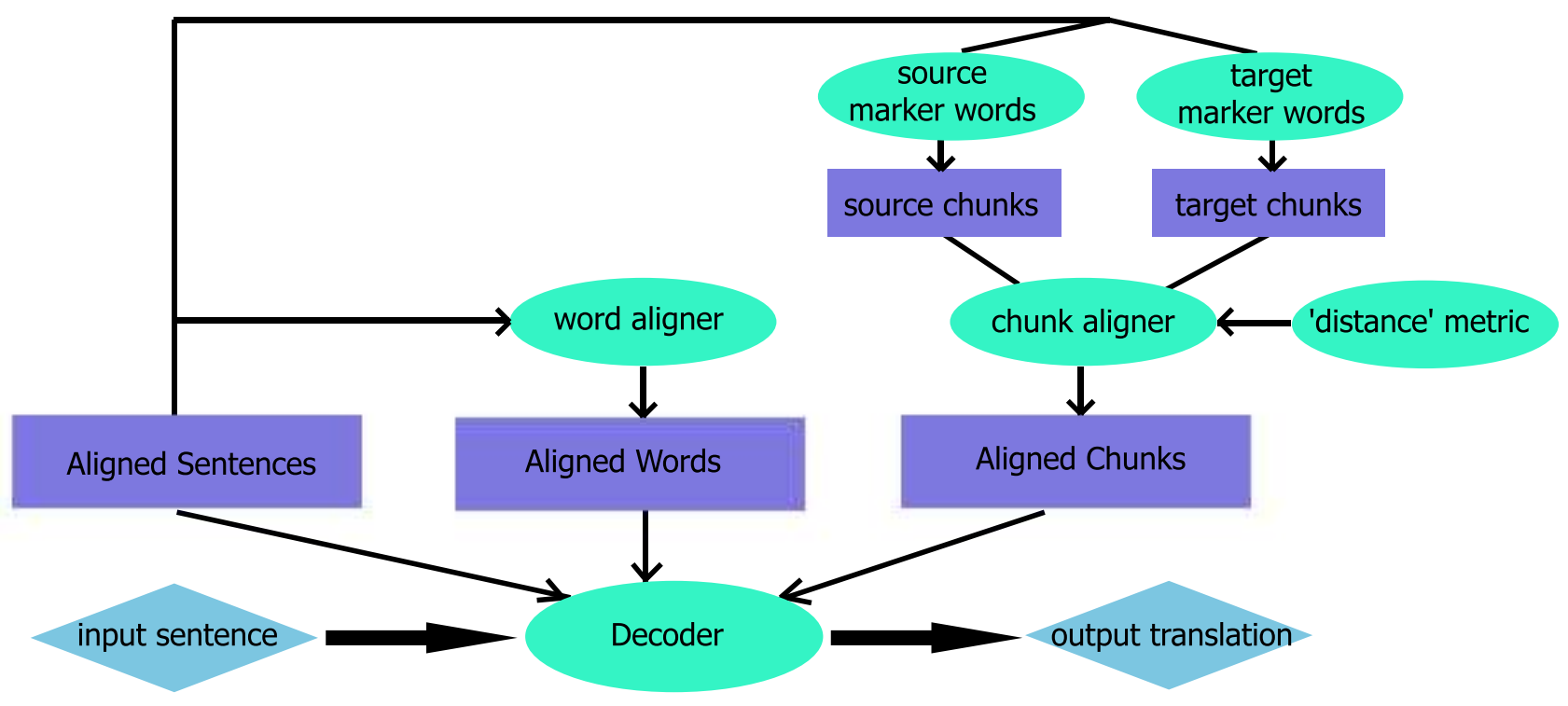
Hybridity

- "EBMT" and "SMT" aligned chunks are merged
- Adding EBMT chunks to the SMT chunks database:
  - adds good alignments which are not present otherwise
  - "boosts" already present SMT chunks (re-estimation)

Other tools

- Pre-processing
  - English: OpenNLP. Sentence segmentation and tokenization
  - Arabic: ASVM. Tokenization
- Part-of-Speech Tagging
  - English: TreeTagger
  - Arabic: ASVM
- Chunking
  - English: Marker-Based chunking/SVM chunking (Yamcha)
  - Arabic: ASVM
- Note: nothing done with dates, names, etc.

System Architecture



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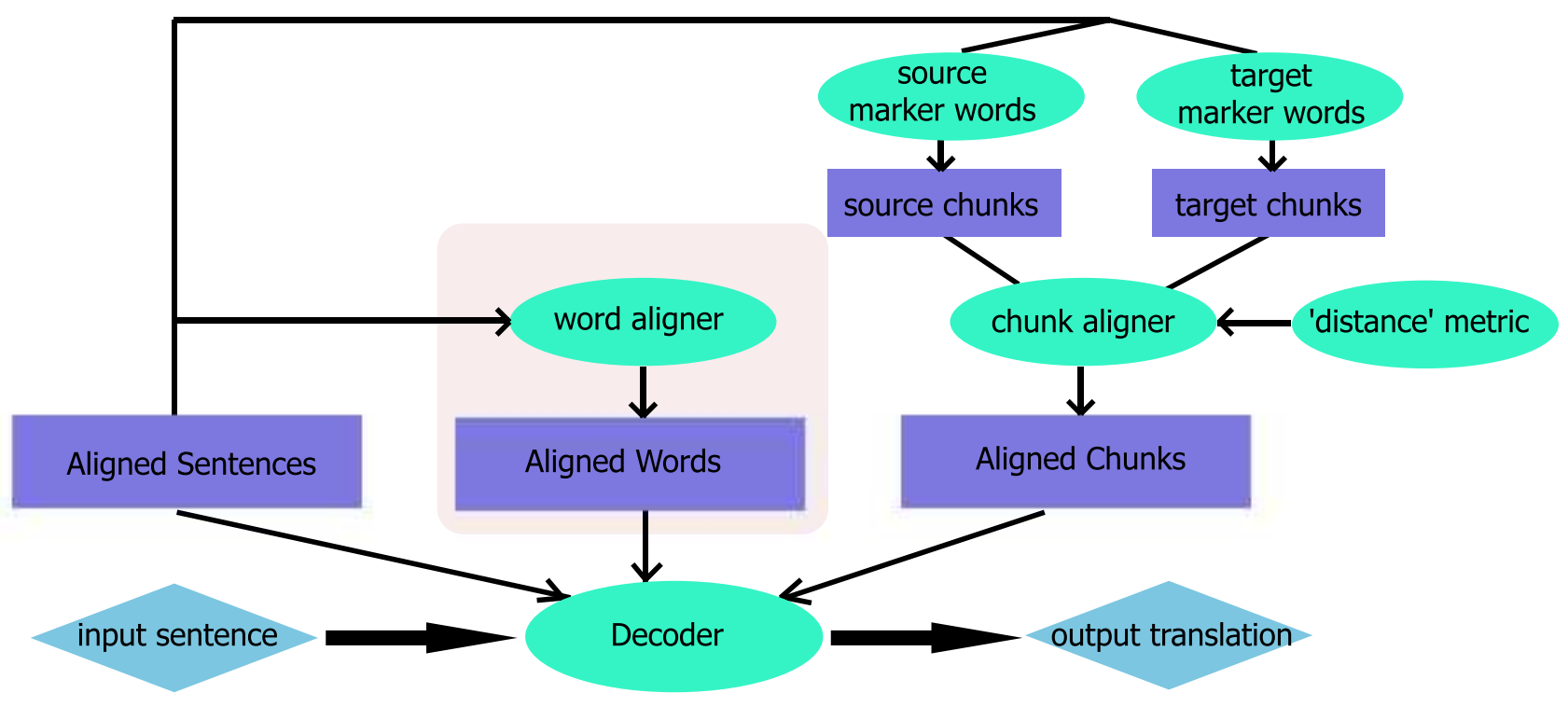

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- Modular in design

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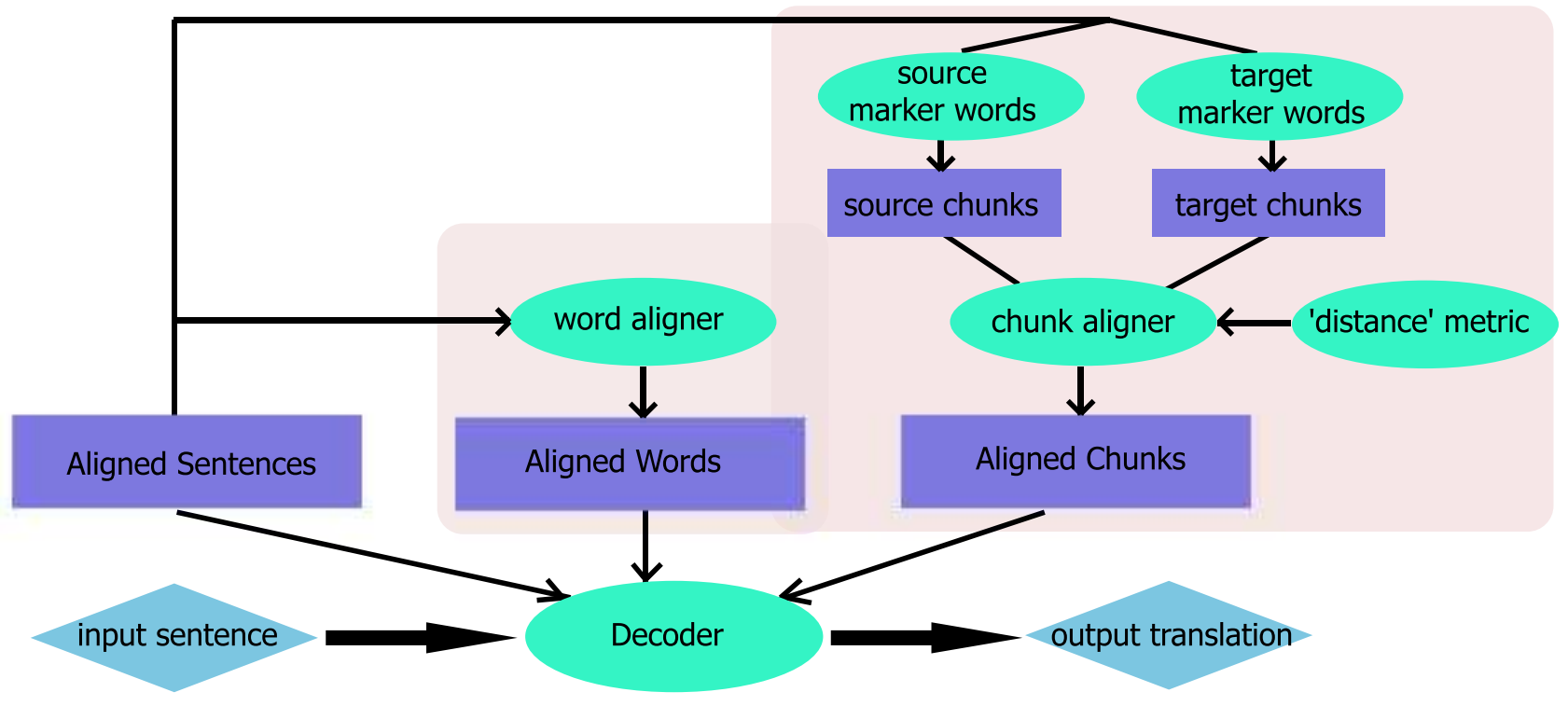

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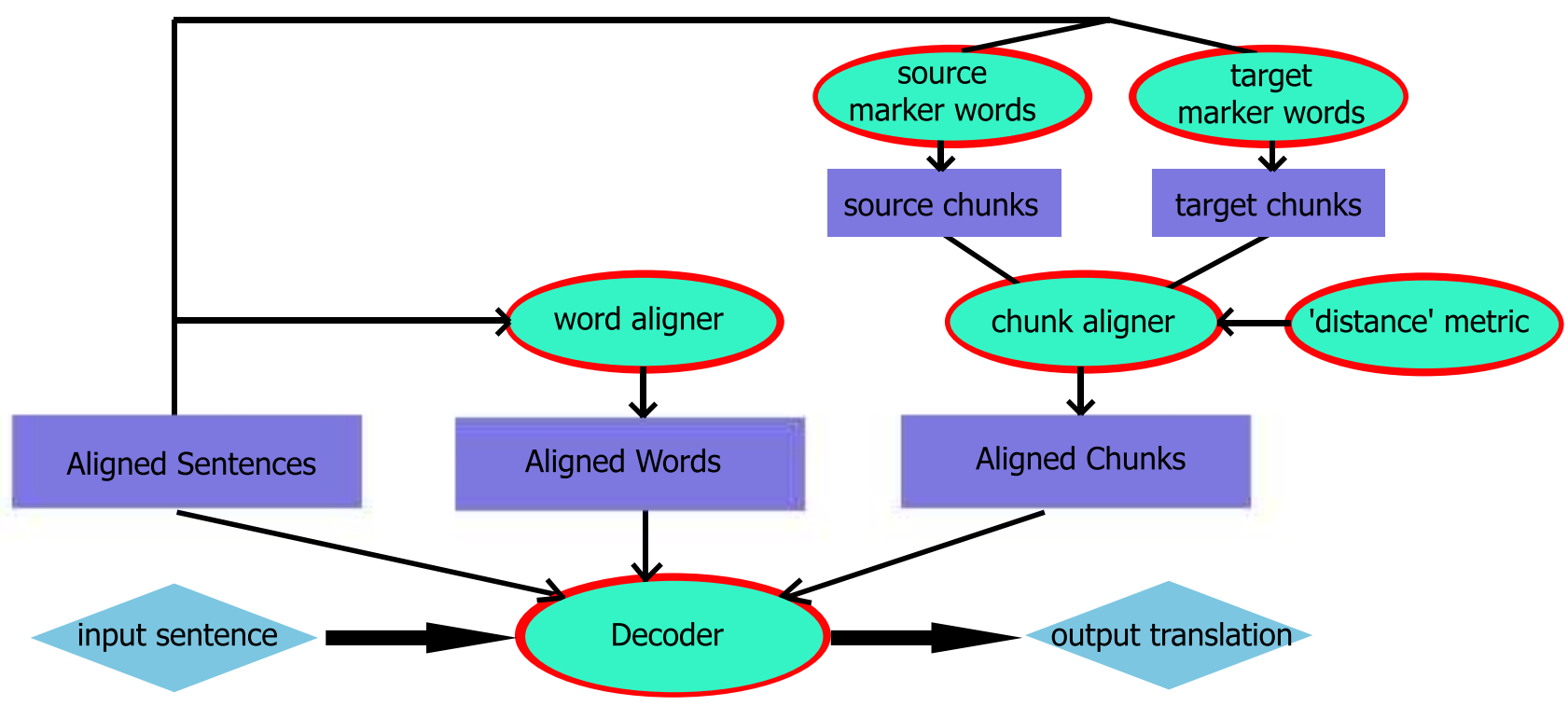

- Aligned Sentences are submitted to word alignment and chunk alignment modules to produce translation resources
- Modular in design
- Easily adaptable and extendible

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Results/Discussion

Official results

	BLEU-4	NIST	METEOR	TER
NIST Set	0.0947	4.7089	0.3863	75.270
Gale Set	0.0320	2.6949	0.3074	83.022

- What do these results mean? Virtually nothing (they are those of a broken SMT system)
- Do not reflect the system's capability
- Admitted failure to scale. Wanted to play the game anyway.

Ongoing and Future Work

- Plan to continue the development the MaTrEx system
  - Currently at early stage of development
- Implement an HMM-based chunk alignment strategy
- Investigate better the implication of hybridity
- Implement an Example-Based decoder (i.e. strong prior on chunking) + Use of generalised templates
- Big improvement expected for NIST MT 2007...

Thank you

Thank you for your attention.

http://www.computing.dcu.ie/research/nclt