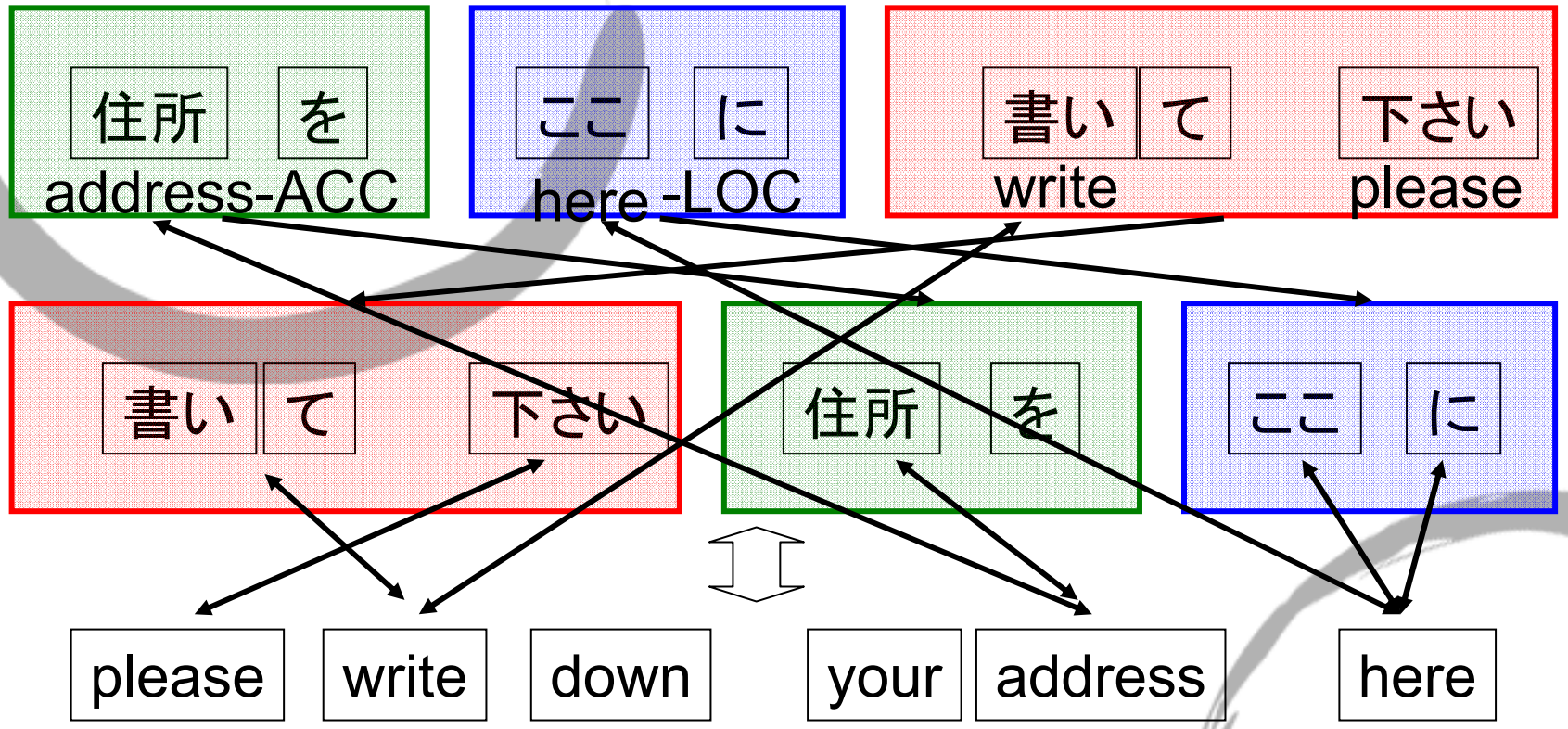
Phrase Reordering for Statistical Machine Translation Based on Predicate-Argument Structure

Mamoru Komachi, Yuji Matsumoto
Nara Institute of Science and Technology
Masaaki Nagata
NTT Communication Science Laboratories

Overview of NAIST-NTT System

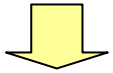


- Improve translation model by phrase reordering

Motivation

- Translation model using syntactic and semantic information has not yet succeeded

Improve statistical machine translation by using predicate-argument structure



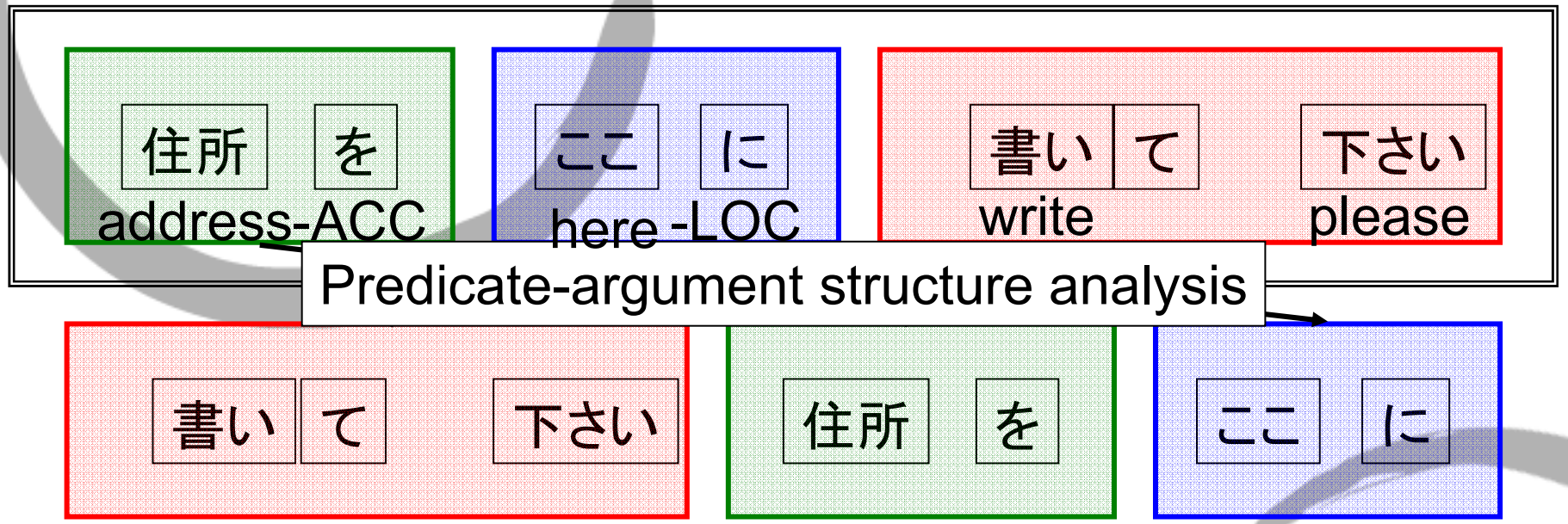
- Improve distortion model between language pairs with different word orders

Improve word alignment by phrase reordering

Outline

- Overview
- Phrase Reordering by Predicate-argument Structure
- Experiments and Results
- Discussions
- Conclusions
- Future Work

Phrase Reordering by Predicate-argument Structure

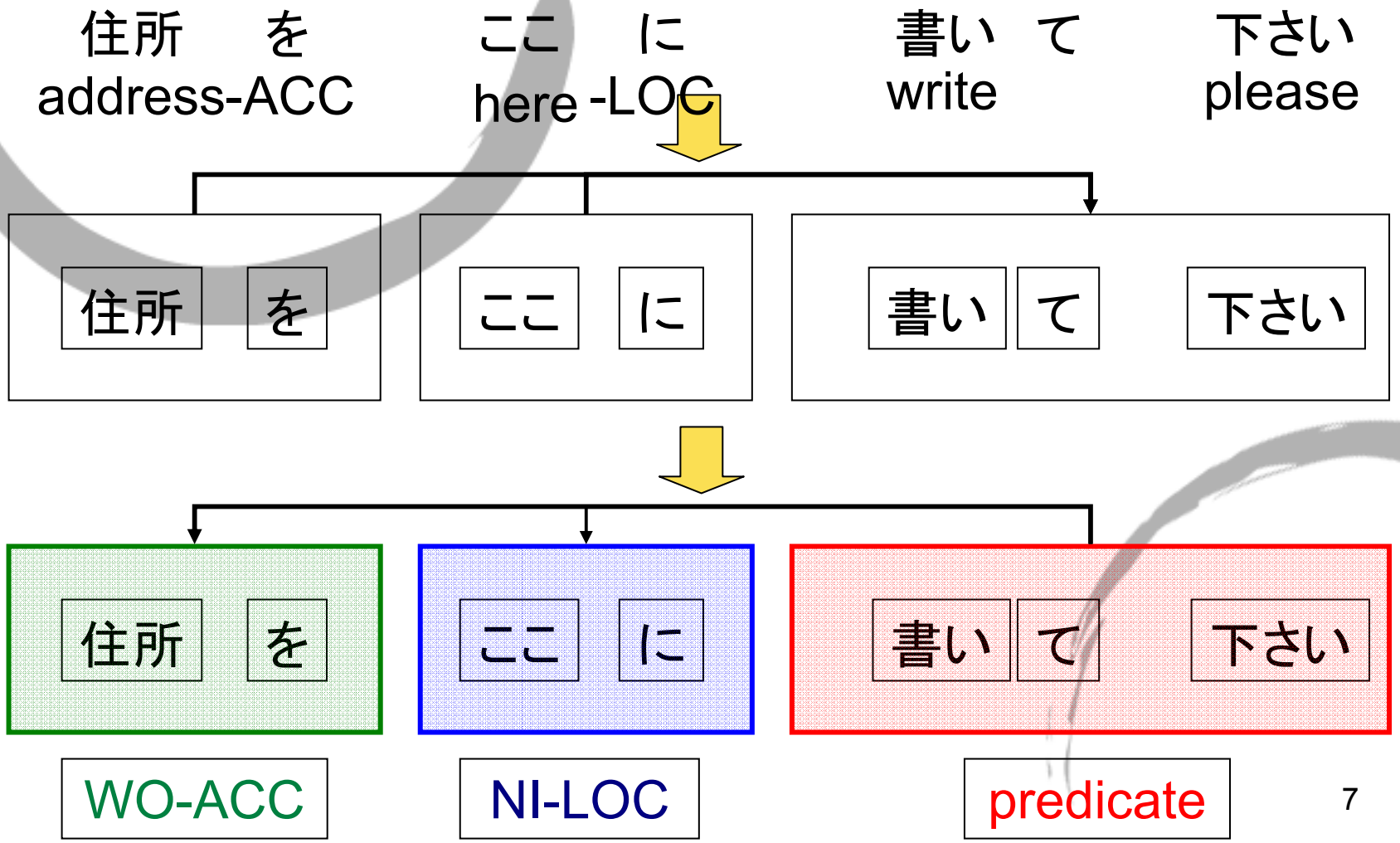


- Phrase reordering by morphological analysis (Niessen and Ney, 2001)
- Phrase reordering by parsing (Collins et al., 2005)

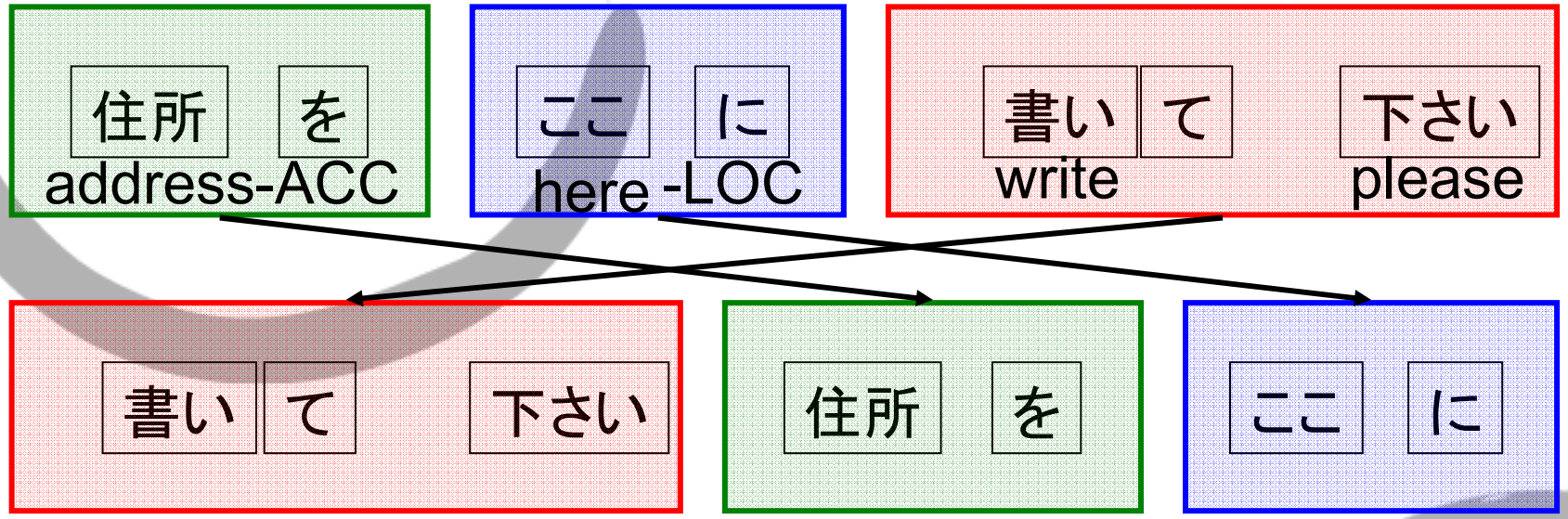
Predicate-argument Structure Analyzer: SynCha

- Predicate-argument structure analyzer based on (Iida et al., 2006) and (Komachi et al., 2006)
  - Identify predicates (verb/adjective/event-denoting noun) and their arguments
  - Trained on NAIST Text Corpus http://cl.naist.jp/nldata/corpus/
  - Can cope with zero-anaphora and ellipsis
- Achieves F-score 0.8 for arguments within a sentence

Predicate-argument Structure Analysis Steps



Phrase Reordering Steps



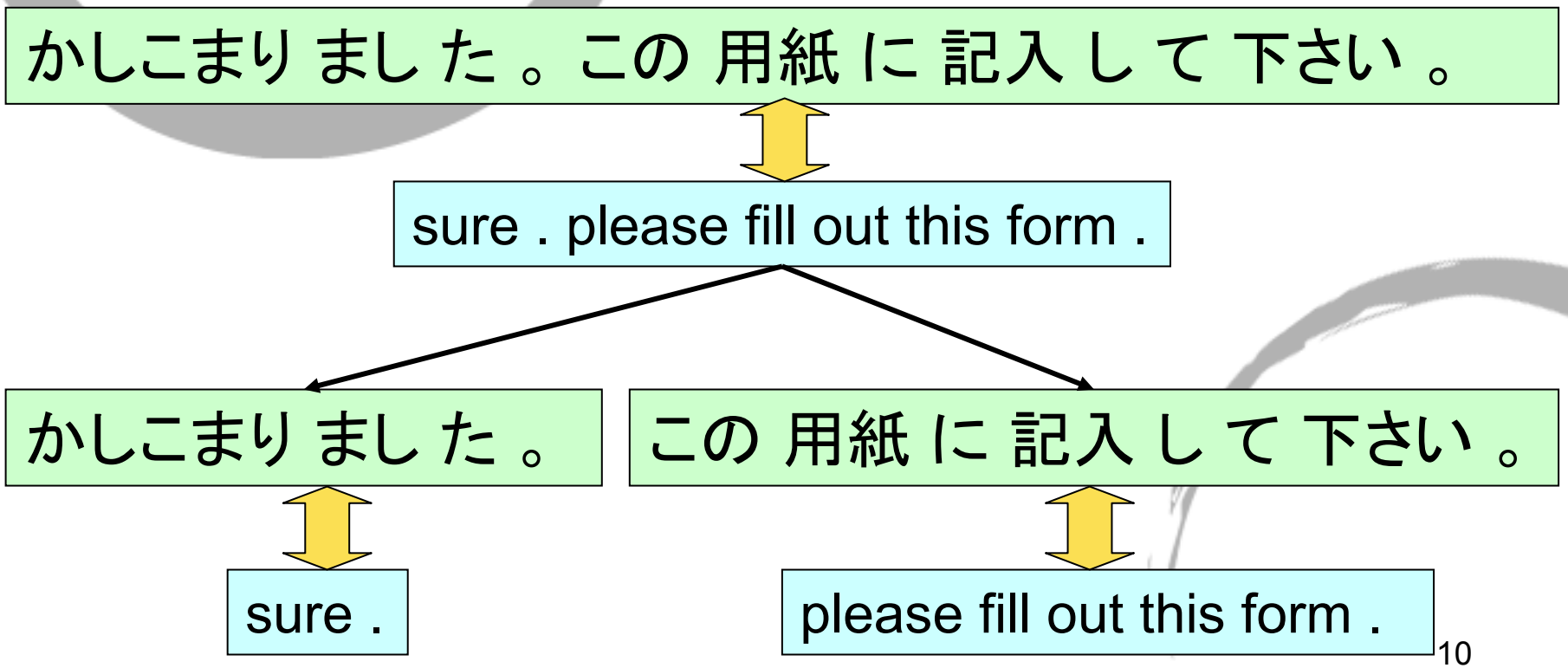
- Find predicates(verb/adjective/event-denoting noun)
- Use heuristics to match English word order

Preprocessing

- Japanese side
  - Morphological analyzer/Tokenizer: ChaSen
  - Dependency parser: CaboCha
  - Predicate-argument structure: SynCha
- English side
  - Tokenizer: tokenizer.sed (LDC)
  - Morphological analyzer: MXPOST
  - All English words were lowercased for training

Aligning Training Corpus

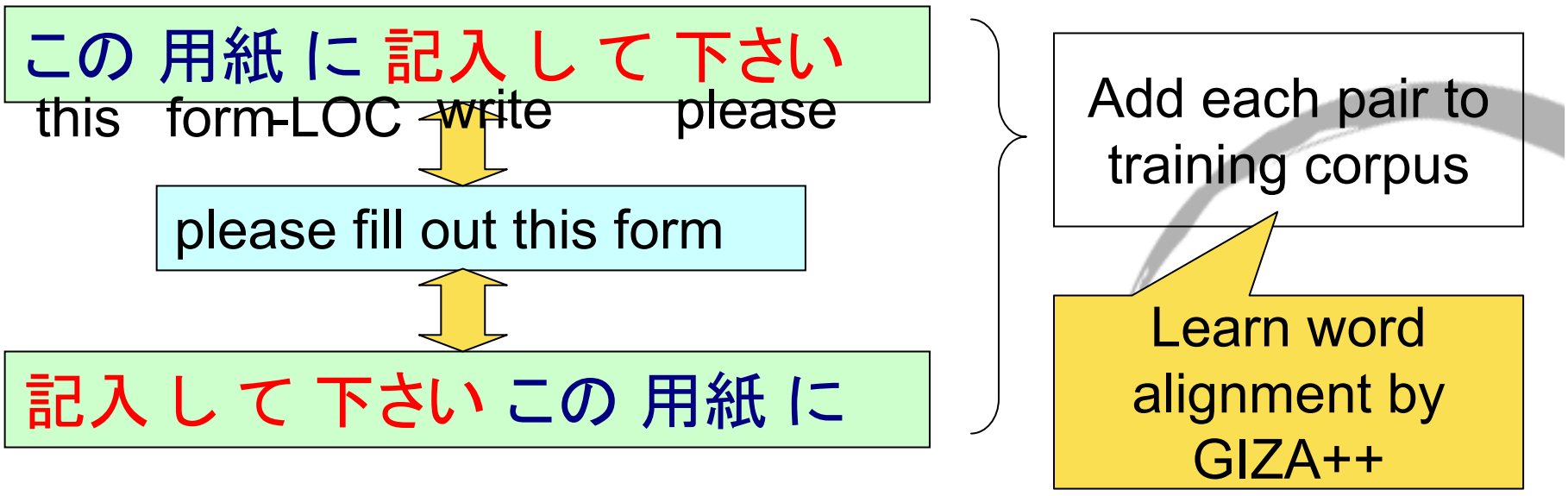
- Manually aligned 45,909 sentence pairs out of 39,953 conversations



Training Corpus Statistics

	# of sent.
Improve alignment	33,874
Degrade alignment	7,959
No change	4,076
Total	45,909

	# of sent.
Reordered	18,539
Contain crossing	39,979



Experiments

- WMT 2006 shared task baseline system trained on normal order corpus with default parameters
- Baseline system trained on pre-processed corpus with default parameters
- Baseline system trained on pre-processed corpus with parameter optimization by a minimum error rate training tool (Venugopal, 2005)

Translation Model and Language Model

- Translation model
  - GIZA++ (Och and Ney, 2003)
- Language model
  - Back-off word trigram model trained by Palmkit (Ito, 2002)
- Decoder
  - WMT 2006 shared task baseline system (Pharaoh)

Minimum Error Rate Training (MERT)

- Optimize translation parameters for Pharaoh decoder
  - Phrase translation probability (JE/EJ)
  - Lexical translation probability (JE/EJ)
  - Phrase penalty
  - Phrase distortion probability
- Trained with 500 normal order sentences

Results

	System	BLEU	NIST
ASR 1-BEST	Baseline	0.1081	4.3555
	Proposed (w/o MERT)	0.1366	4.8438
	Proposed (w/ MERT)	0.1311	4.8372
Correct recognition	Baseline	0.1170	4.7078
	Proposed (w/o MERT)	0.1459	5.3649
	Proposed (w/ MERT)	0.1431	5.2105

Results for the Evaluation Campaign

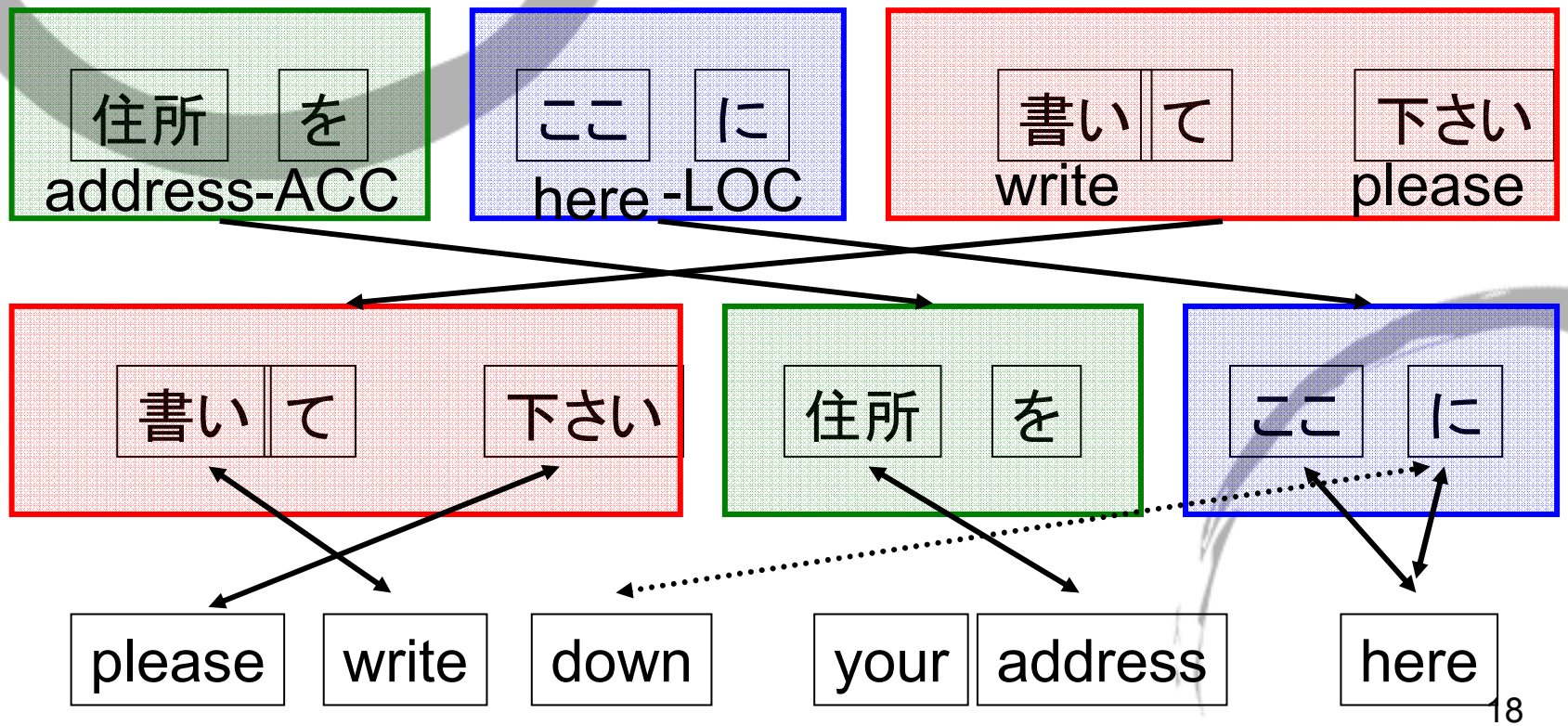
- While it had high accuracy on translation of content words, it had poor results on individual word translation
  - ASR: BLEU 12/14, NIST 11/14, METEOR 6/14
  - Correct Recognition: BLEU 12/14, NIST 10/14, METEOR 7/14
  - Pretty high WER

Discussion

- Better accuracy over the baseline system
  - Improve translation model by phase reordering
- Degrade accuracy by MERT
  - Could not find a reason yet
  - Could be explained by the fact that we did not put any constraints on reordered sentences (They may be ungrammatical on Japanese side)
- Predicate-argument structure accuracy
  - SynCha is trained on newswire sources (not optimized for travel conversation)

Discussion (Cont.)

- Phrase alignment got worse by splitting a case marker from its dependent verb



Conclusions

- Present phrase reordering model based on predicate-argument structure
- The phrase reordering model improved translation accuracy over the baseline method

Future work

- Investigate the reason why MERT does not work
  - Make reordered corpus more grammatical (reorder only arguments)
- Use newswire sources to see the effect of correct predicate-argument structure
- Reorder sentences which have crossing alignments only
- Use verb clustering and map arguments automatically