



The MITLL/AFRL IWSLT-2006 MT System

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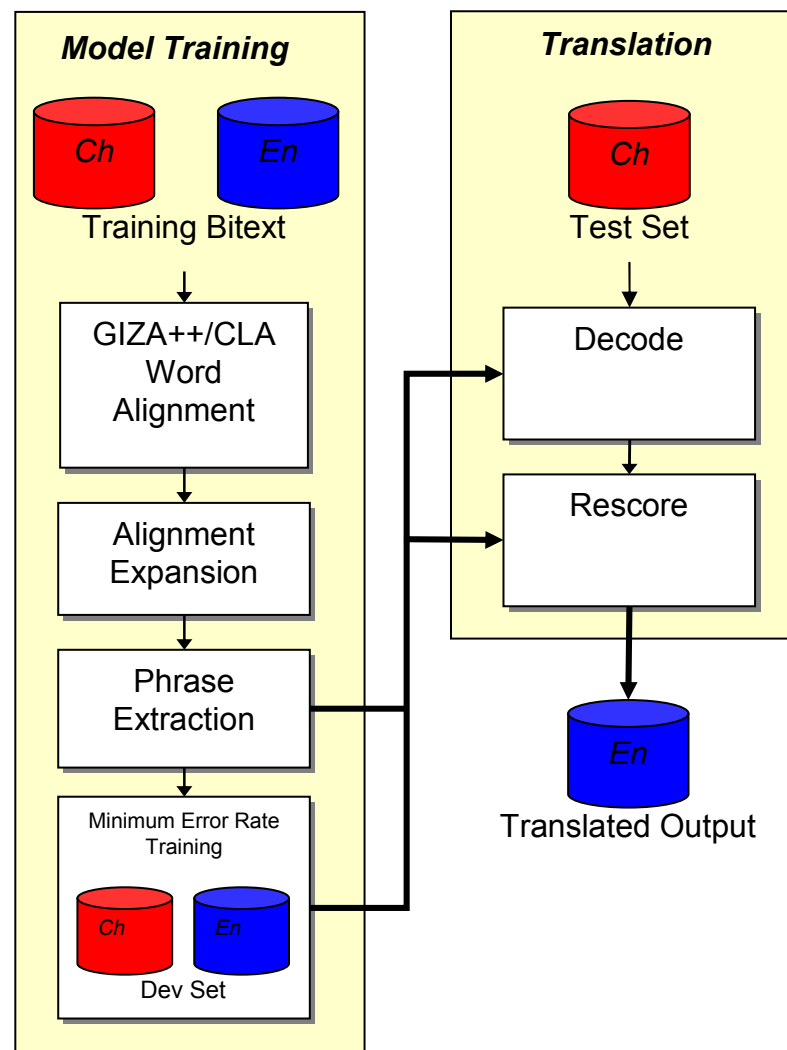
MIT Lincoln Laboratory



Statistical Translation System

Experimental Architecture

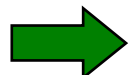
- **Standard Statistical Architecture**
- **New this year**
 - Improved Training
 - Better Decoders
 - internal decoder
 - `moses`
 - Rescoring Features
- **Participated in**
 - Chinese \Rightarrow English
 - Japanese \Rightarrow English
 - Italian \Rightarrow English
- **Focus on Chinese \Rightarrow English**





The MITLL/AFRL MT System

Overview



- **Improved Training**
 - CLA and GIZA++ alignments
 - Factored Models: Hybrid Alignment templates
- **Better Decoding**
 - Reordering Constraints
 - Higher-order LMs
- **Development Experiments**
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 - ASR Transcription
- **Next Steps**



Improved Training

Segmentation and Alignment

- **Added CLA Alignments**

- Assumes 1-1 alignment
- Poor quality phrases without IBM models
- Simple Greedy Algorithm [Melamed 2000]
- Simple symmetric Likelihood function

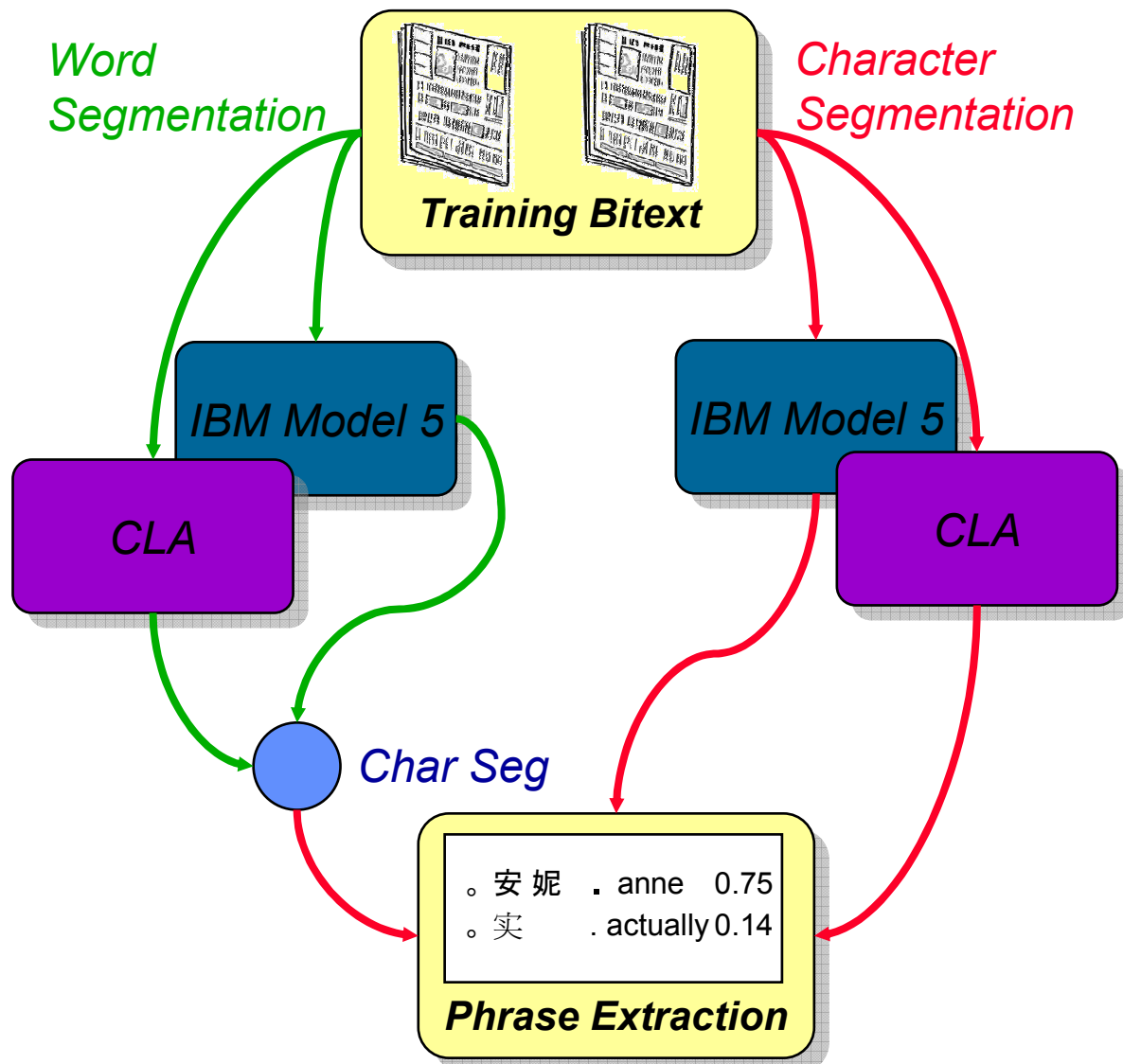
$$L(e, f) = X_{ef}^2 = \sum_{s=i}^N \frac{(x_s - E_{ef})^2}{E_{ef}}$$

	Open	up	.
打	0.2	0.8	0.0
开	0.7	0.1	0.2
。	0.1	0.1	0.8



Improved Training

Alignment and Segmentation



- **Phrase extraction**
 - Word and Character Segmentation
 - CLA and IBM Model 5 alignments
 - Resegment Words (Chinese)
- **All decoding done with char-seg (Chinese)**

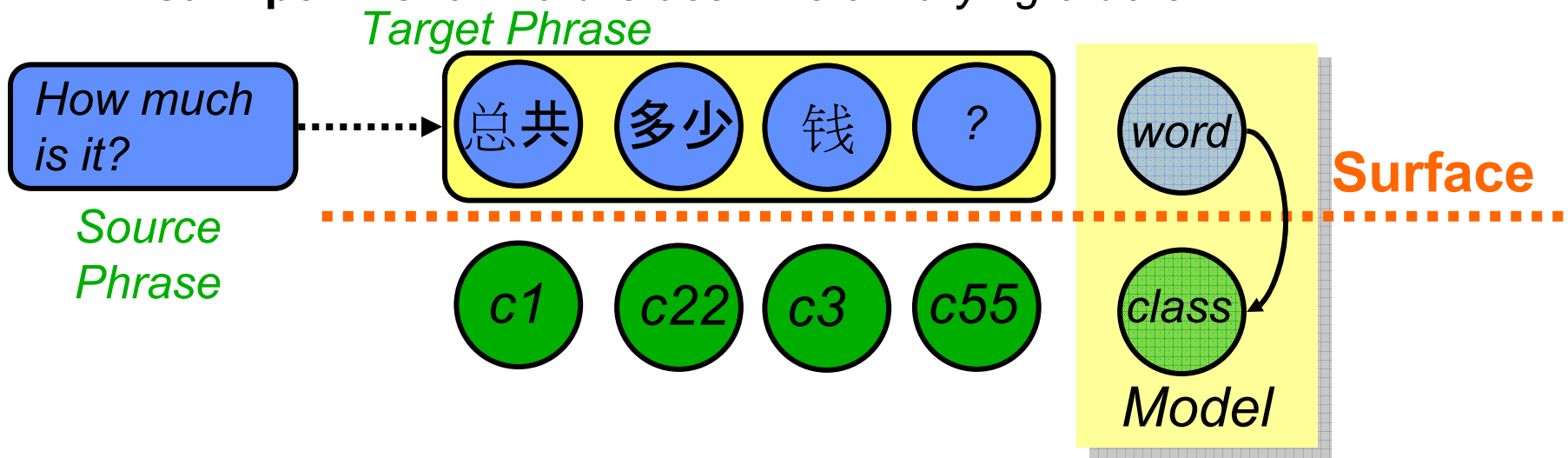
Seg/Align	Word	Char
Model 5	ALL	Chinese
CLA	ALL	Chinese



Improved Training

Hybrid Alignment Template Models

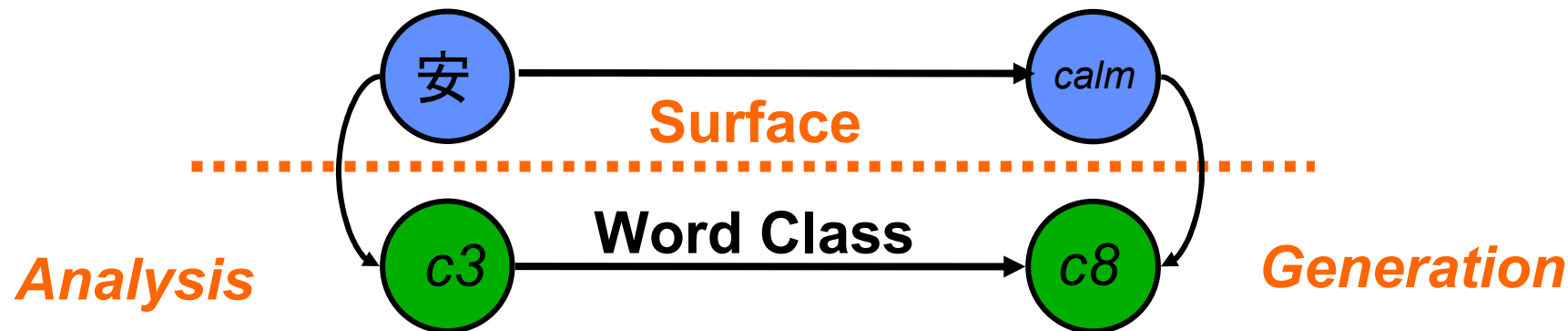
- Apply Factored Models using Unsupervised Word Classes
 - Words represented by different linguistic factors
 - Factors can be translated separately
 - LMs can be applied to factors independently
- Can we use automatic word classes to learn general sequence constraints?
- First Experiment: Word Class LMs of varying orders





IWSLT Chinese

Alignment Templates for Translation

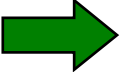


- **Second Experiment:** *Extend Class-based LM to the translation Model*
- **Bigram word classes for source and target**
- **Translate alignment templates similar to [Och 98] + surface**
- **Apply LM to surface and Class**



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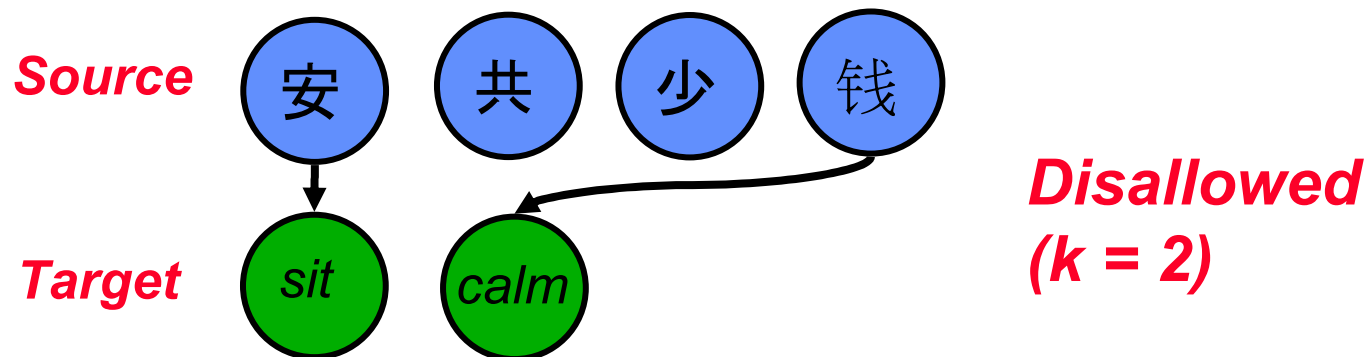
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Better Decoding

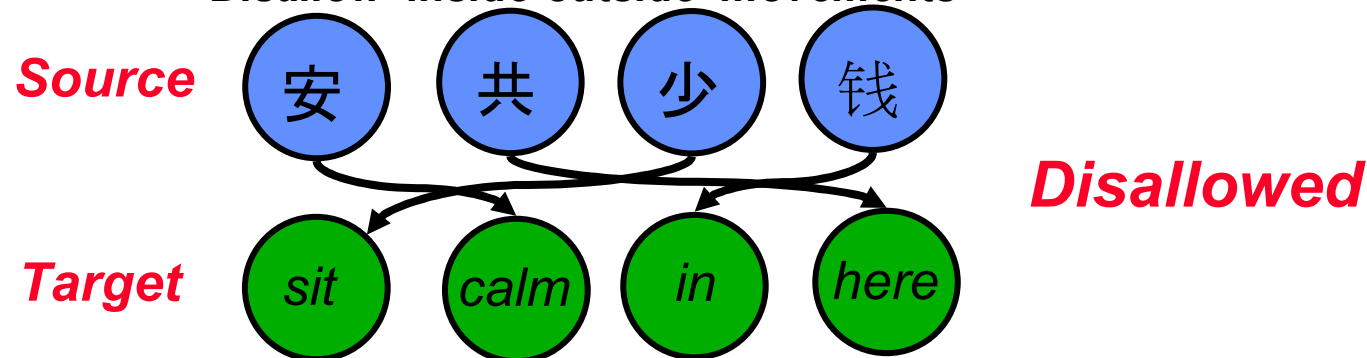
Reordering Constraints

- Revisit Reordering Constraints [Zens 03]
 - IBM Constraints: *Must cover first K uncovered positions*



- ITG Constraints [Wu 95, 97]

Disallow 'inside-outside' movements



- Faster, some BLEU improvement in Japanese



Better Decoding

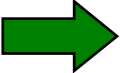
Higher Order LMs

- **Used both `moses` and internal decoder for IWSLT-2006**
- **Both modified to support n-gram LMs > order 3**
- **Consistent and Significant Gain with 4-gram LM**
- **Allowed**
 - **high-order Class LM (with `moses`)**
 - **integrated TrueCasing with 4-gram LM**



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Development Experiments

Segmentation and Alignment

- All Results reported on Dev-4
- Official Eval Condition
 - Mixed-case + Punctuation
- Optimized using Dev-1
 - With Rescoring Features
 - Development done w/Chinese

Chinese

Configuration	BLEU
Character Segmented	21.24
Word + Char Seg	21.21
Word Segmented	21.01
Word + Char Seg + CLA	22.18

Japanese

Configuration	BLEU
Word Segmented	23.63
Word Seg + Char Backoff	23.82
Word Segmented + CLA	23.34
Word + Char Backoff + CLA	24.28

Italian

Configuration	BLEU
Word Segmented	35.13
Word Segmented + CLA	37.40



Development Experiments

Rescoring

Chinese

Configuration	BLEU
Baseline 4-gram Decode	21.39
+ 5-gram rescore LM	21.55
+ 6-gram class-based LM	21.52
+ Model 1	21.86
+ Sentence Length Posterior*	22.10

- Eval Configuration
 - 5-gram rescore
 - 6-gram class-based LM
 - Model 1

* Length posterior added post-eval

Japanese

Configuration	BLEU
Baseline 4-gram Decode	21.92
All Rescoring Features	24.28

Italian

Configuration	BLEU
Baseline 4-gram Decode	36.92
All Rescoring Features	37.40



Development Experiments

Pre/Post-Processing

Chinese

Configuration	BLEU
Remove Source Punctuation	21.86
Re-punctuated Source	
<i>TrueCase with 3gram</i>	21.93
<i>TrueCase with 4gram</i>	22.10
<i>TrueCase with 5gram</i>	22.10

- Remove Source Punctuation
 - Truecased with 4gram LM
- Final Configuration
 - Repunctuate source
 - Truecase with 4gram

Japanese

Configuration	BLEU
Remove Source Punctuation	23.14
Re-punctuated Source	24.28

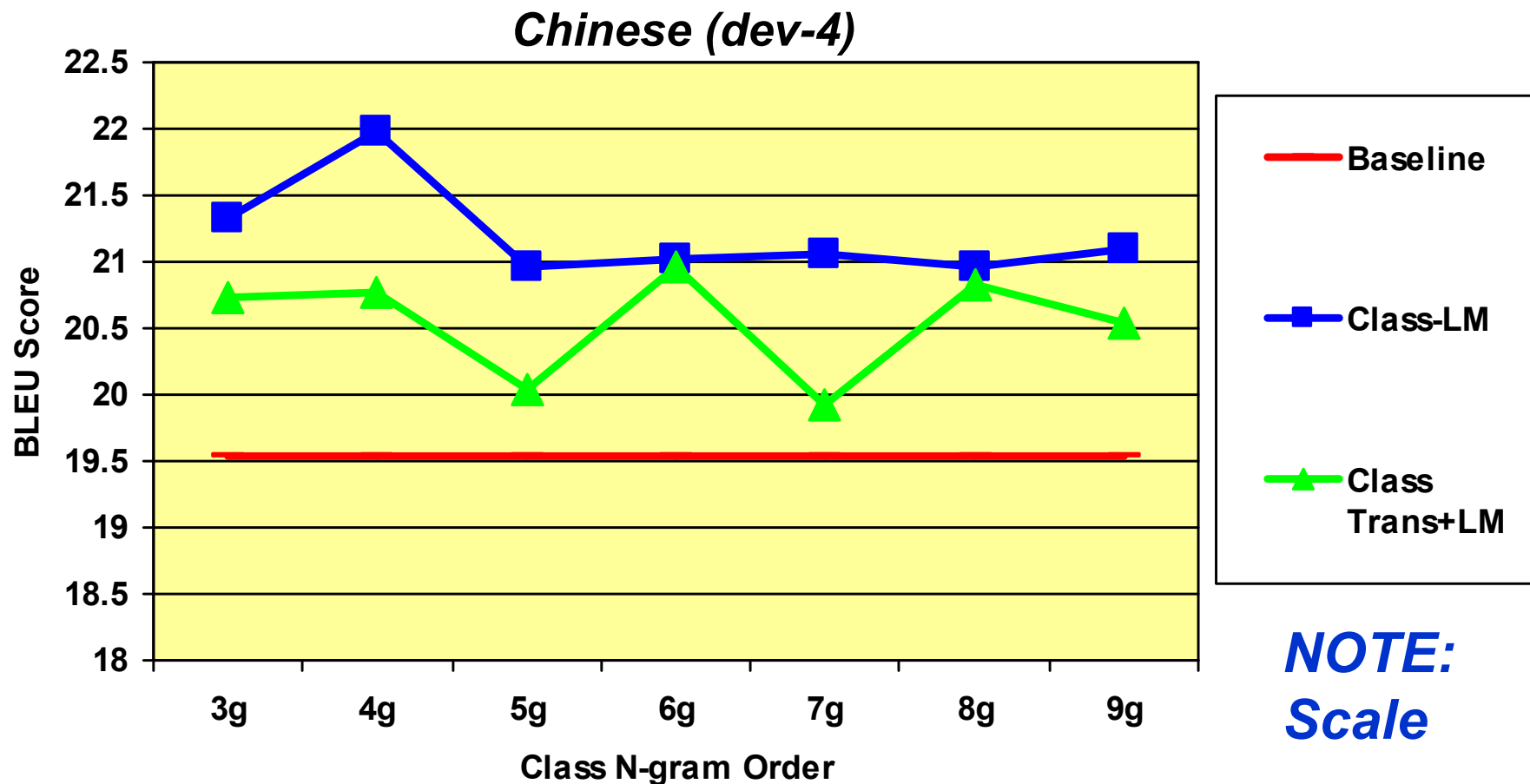
Italian

Configuration	BLEU
Remove Source Punctuation	36.64
Re-punctuated Source	37.40



Development Experiments

Hybrid Alignment Template

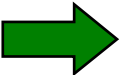


- **Baseline:** word segmented, 3-gram no rescore
- **Class-LM** significantly better ($p=0.05$, ~1.0 BLEU)
- **Class-Trans** may be limited by synchronous PT constraint



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Evaluation Results

Manual Transcription

Chinese

Configuration	BLEU
Optimized (Dev Set 4)	21.57
Optimized (Dev Set 1)	20.66
No Rescore (Opt Dev4)	21.27

Japanese

Configuration	BLEU
Optimized (Dev Set 4)	20.99
Optimized (Dev Set 1)	20.24

- Rank

- Chinese: 2nd of 13
- Italian: 2nd
- Japanese: 4th

Italian

Configuration	BLEU
Optimized (Dev Set 4)	35.74
Optimized (Dev Set 1)	34.40



Evaluation Results

ASR Transcription

Chinese (Read)

Configuration	BLEU
1-best ASR (Opt Dev4)	18.61
10-best ASR (Opt Dev4)	17.42
1-best ASR (Opt Dev1)	18.46

Chinese (Spontaneous)

Configuration	BLEU
1-best ASR (Opt Dev4)	16.57
10-best ASR (Opt Dev4)	16.57*

- Rank
 - Chinese: 3rd of 13
 - Italian: 4th
(secondary system: 2nd)
 - Japanese: 4th

Japanese

Configuration	BLEU
1-best ASR (Opt Dev4)	18.91
1-best ASR (Opt Dev1)	18.43

Italian

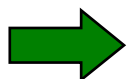
Configuration	BLEU
1-best ASR (Opt Dev4)	27.98
10-best ASR (Opt Dev4)	28.81
1-best ASR (Opt Dev1)	27.64
10-best ASR (Opt Dev1)	27.81



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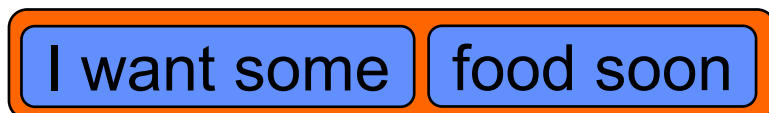
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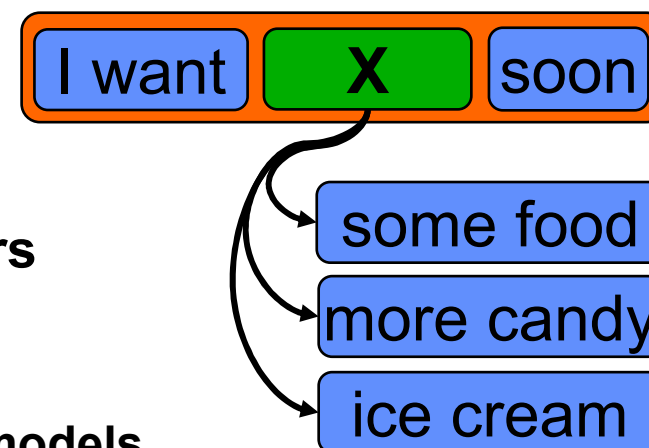
Next Steps

- Work with MIT/SLS on
 - Hybrid hierarchical translation for Chinese

Current Model



New Model



- Better sparse data models with Factors
 - Asynchronous Factor Decoding
 - Allow longer class templates
 - Integration of POS and morphology models

