

The UPV Translation System for IWSLT 2009

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MIPRCV
C O N S O L I D E R I N G E N I O 2 0 1 0
Multimodal Interaction in Pattern Recognition and Computer Vision



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Motivation and Related Work

► Motivation

- PBT systems tend to be weak on target language fluency.
- Long-range dependencies or reorderings cannot be controlled by the n-gram language models.
- Extending PBT systems with syntactic information is difficult.
- Syntactic MT systems usually solve such problems but have a low sentence coverage.
- Solution proposed: Fill the gap between both approaches presenting a hybrid system that uses Stochastic Inversion Transduction Grammars.

► Related Work

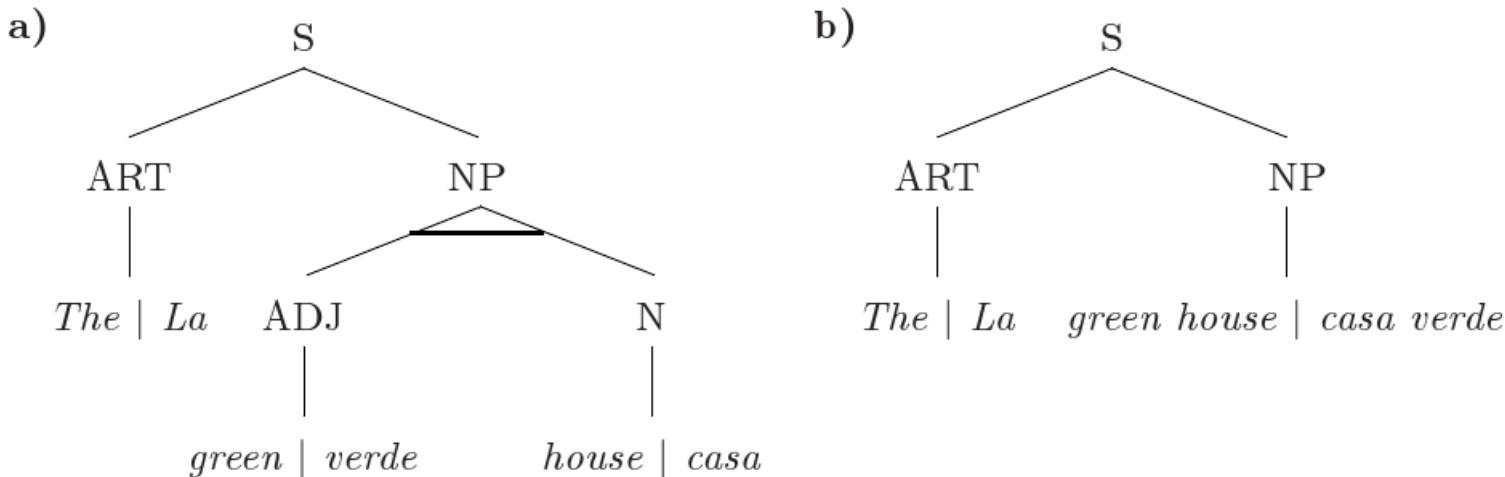
- Maximum entropy models for BTG statistical MT [Xiong06] [Xiong08].
- Hierarchical MT systems [Chiang 05]
- Syntax Augmented MT [Venugopal 06]

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Theoretical Framework: Stochastic Phrasal ITG

- ▶ Phrasal Inversion Transduction Grammars $(\mathcal{N}, \Sigma, \Delta, S, \mathcal{R})$:
 - Direct Syntactic rule: $A \rightarrow [BC]$ where $A, B, C \in \mathcal{N}$
 - Inverse Syntactic rule: $A \rightarrow \langle BC \rangle$ where $A, B, C \in \mathcal{N}$
 - Lexical rule: $A \rightarrow x/y$ where $x \in \Sigma^*$ and $y \in \Delta^*$



- ▶ SPhITG: Stochastic extension of PhITG.

$$\sum_{B,C \in \mathcal{N}} (\Pr(A \rightarrow [B C]) + \Pr(A \rightarrow \langle B C \rangle)) + \sum_{\substack{x \in \Sigma^* \\ y \in \Delta^*}} (\Pr(A \rightarrow x/y)) = 1$$

Translation Model

- ▶ Translation goal:

$$(t^*, D^*) = \underset{t, D}{\operatorname{argmax}} \Pr(S \xrightarrow{D} s/t)$$

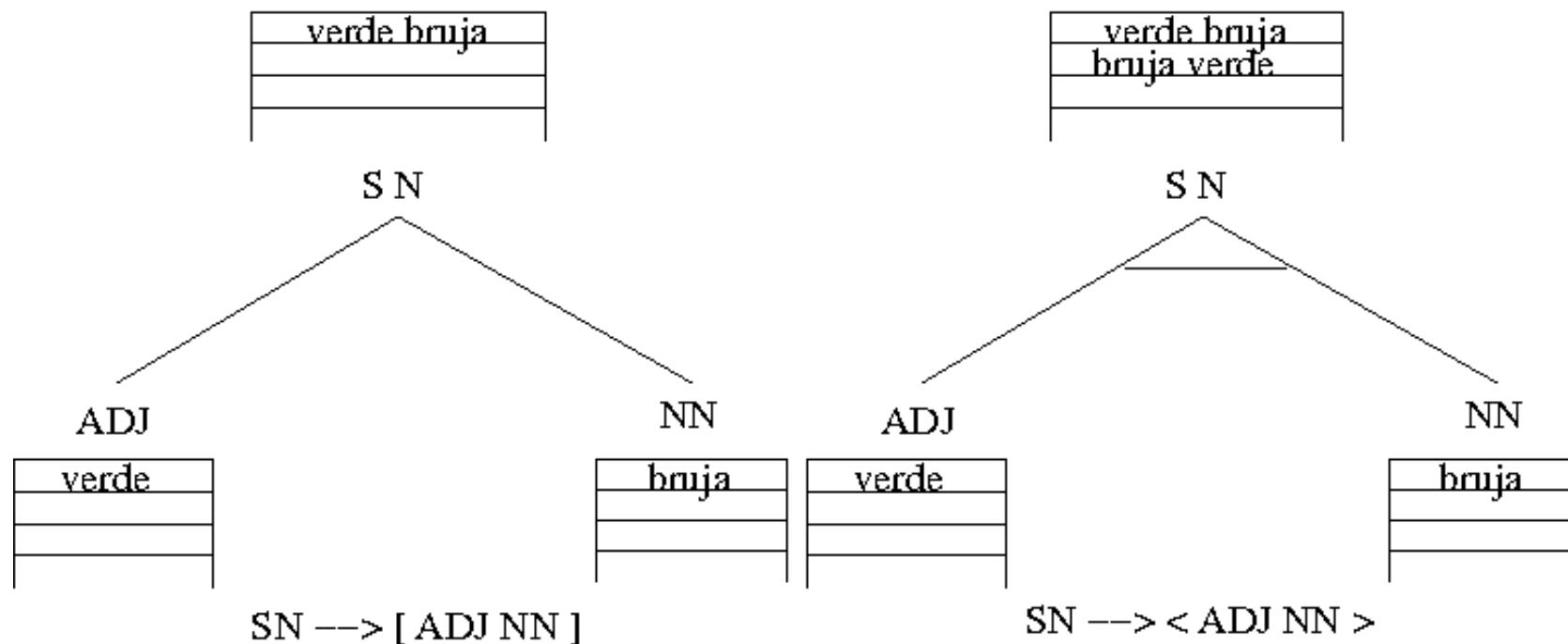
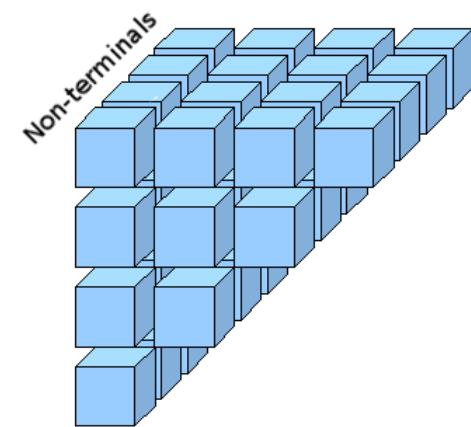
- ▶ Log-linear model over the derivations:

$$\Pr(D) = \prod_i h_i(D)^{\lambda_i}$$

- ▶ Models used: Usual models of PBT systems and the syntactic model (probability of the syntactic SITG rules used in D).

Decoding Algorithm

- ▶ Without n-gram language model: CKY-like chart decoding.
- ▶ Using the n-gram language model: A Hypotheses stack in each cell of the chart.
- ▶ Optimization strategies: Recombination of hypotheses, beam pruning and histogram pruning.



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SITG Training

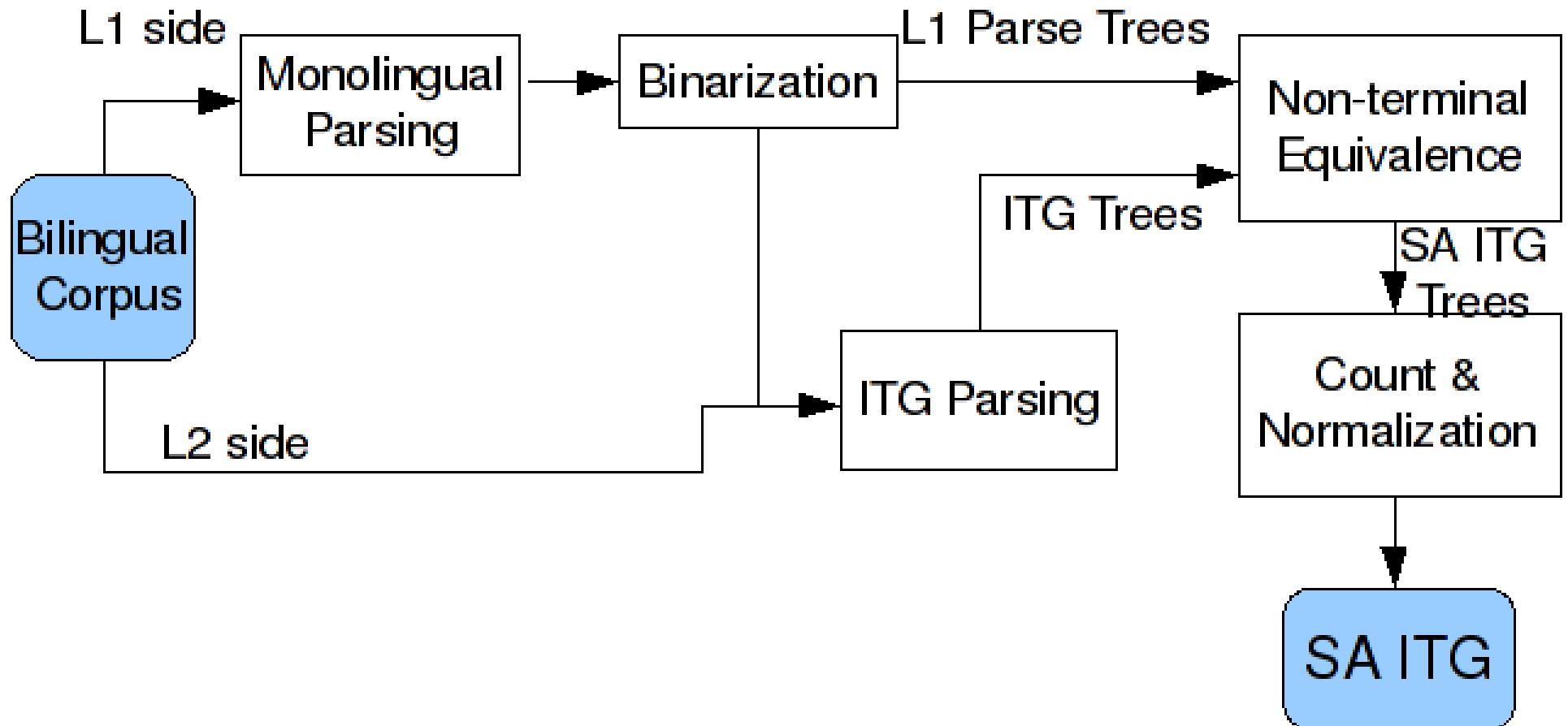
- ▶ Initial ITG:
 - Lexical rules from alignments, all with the same non-terminal.
 - All the possible syntactical rules using 4 non-terminals (from NT1 to NT4) with a random probability.

$$NT1 \rightarrow [NT1\ NT1] \dots\ NT4 \rightarrow \langle NT4\ NT4 \rangle$$

- ▶ Reestimation of the SITG using the Viterbi reestimation algorithm:
 - Get the most likely ITG parse trees.
 - Estimate probabilities by counting productions and normalizing.

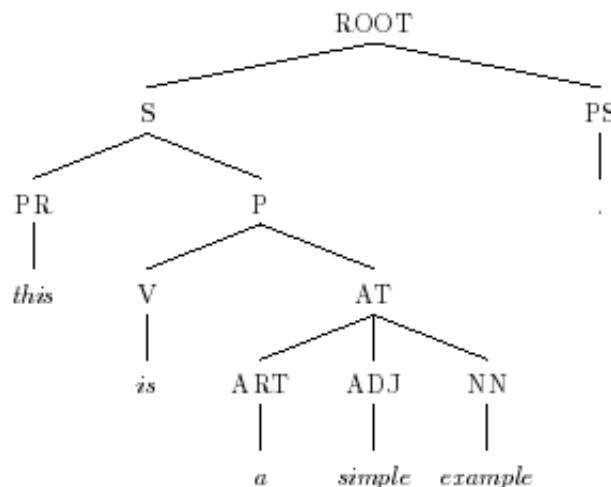
SITG Training

- ▶ Association of linguistic meaning (from the input) to the SITG non-terminals.



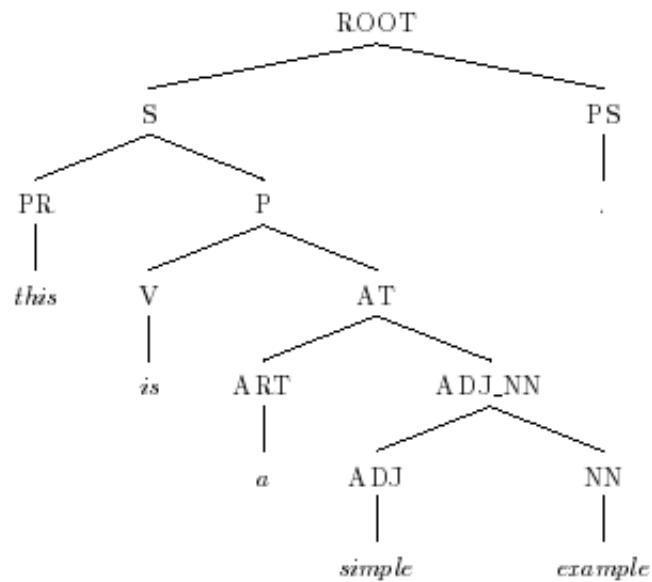
SITG Training

this is a simple example . # esto es un ejemplo simple .



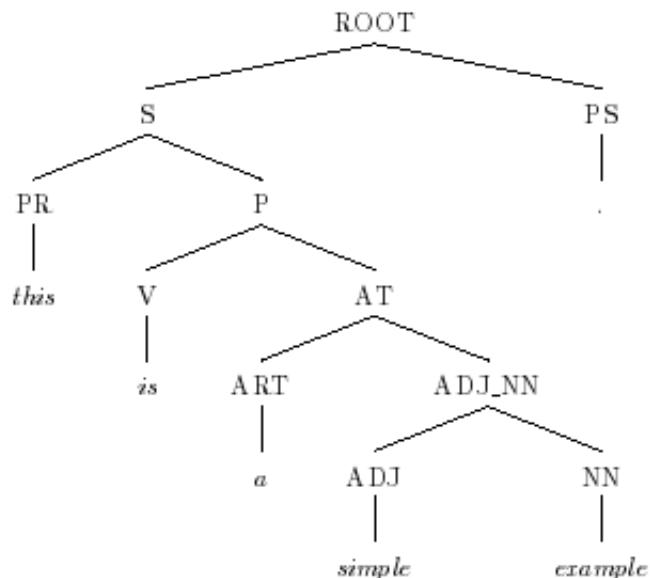
SITG Training

this is a simple example . # esto es un ejemplo simple .



SITG Training

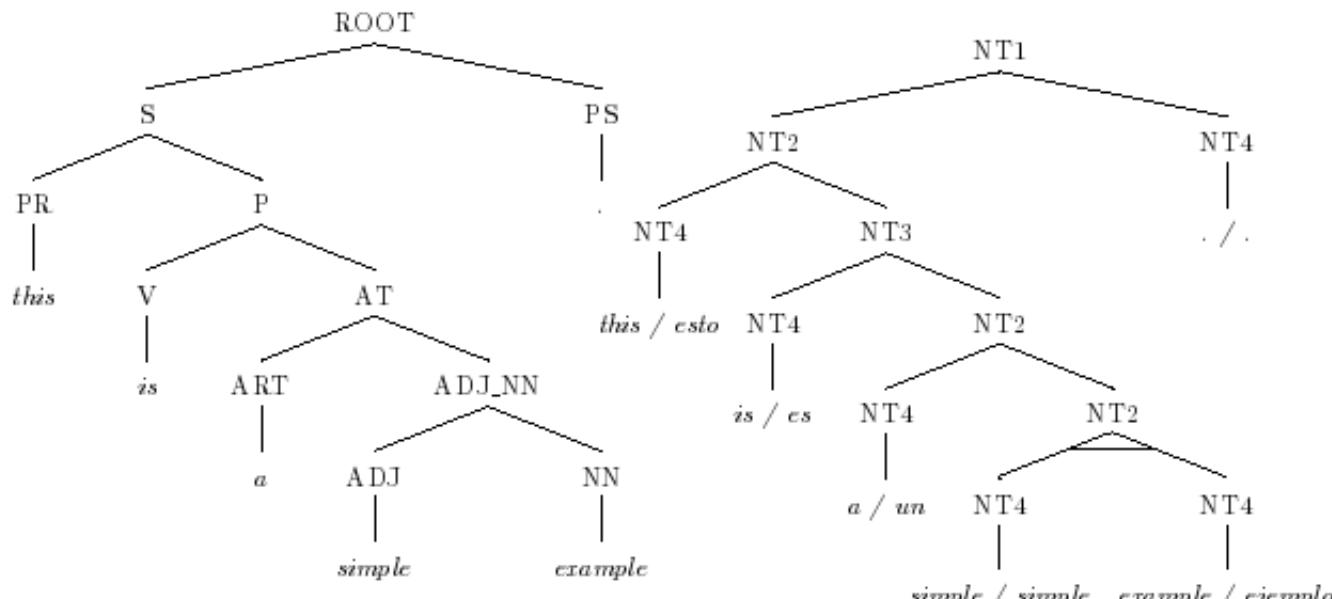
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((this (is (a (simple example)))) .) # esto es un ejemplo simple

SITG Training

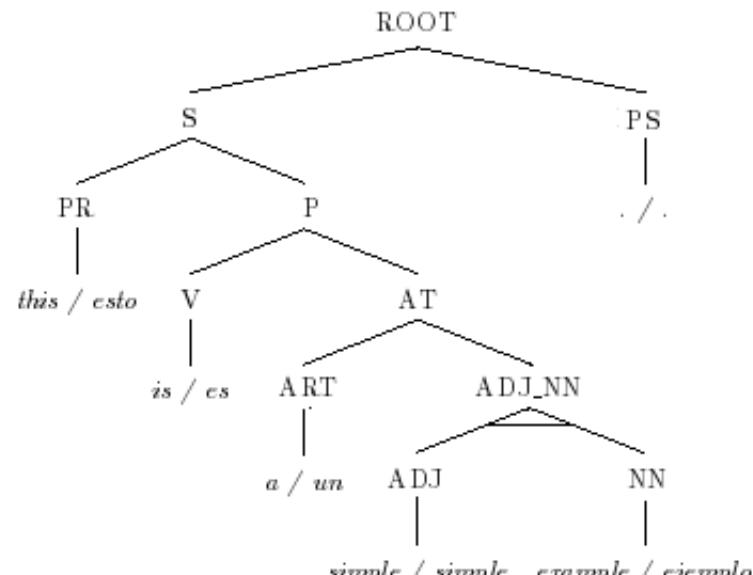
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SITG Training

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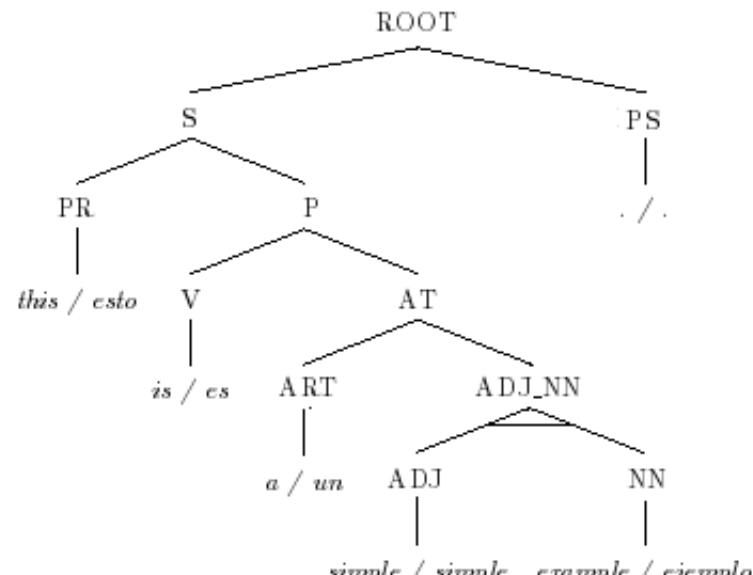


((this (is (a (simple example)))) .) # esto es un ejemplo simple

SITG Training

this is a simple example . # esto es un ejemplo simple .

```
ROOT --> [ S PS ]
S    --> [ PR P ]
P    --> [ V AT ]
AT   --> [ ART ADJ_NN ]
ADJ_NN --> < ADJ NN >
PS   --> . / .
PR   --> this / esto
V    --> is / es
ART  --> a / un
ADJ  --> simple / simple
NN   --> example / ejemplo
```



((this (is (a (simple example)))) .) # esto es un ejemplo simple

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Experimental Results

- ▶ Translation experiments over IWSLT08 Chinese-English corpus:

		Chinese	English
Training	Sentences	19.972	
	Words	171,591	188,960
	Vocabulary Size	8,428	7,182
DevSet	Sentences	489	
	Words	3,169	3,861
	OOV Words	111	115
Test	Sentences	507	
	Words	3,357	-
	OOV Words	97	-

- ▶ Baseline System: PBT system with the same phrase table.

Experiment	% BLEU
Baseline	41.1
Initial SITG	41.23
Reestimated SITG	41.79
SAITG	42.85

Experimental Results

PBT	this one and what 's the difference between ?
SAITG	what 's the difference between this with that ?
Ref	how is this one different from that one ?
PBT	call mr. is three four one four five six seven .
SAITG	call mr. is three six four five seven four one .
Ref	the number for s nicholas is three six four five seven four one .
PBT	can i go to the front row ?
SAITG	is it okay to the front row ?
Ref	can i go up to the front ?

- ▶ Some rules obtained:
 - $\Pr(QP \rightarrow [CD\ CD]) = 0.147$
 - $\Pr(QP \rightarrow \langle CD\ CD \rangle) = 0.046$
 - $\Pr(QP \rightarrow [CD\ QP]) = 0.284$
 - $\Pr(QP \rightarrow \langle QP\ CD \rangle) = 0.061$

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Conclusions

- ▶ SITG based decoder.
- ▶ Analyzed heuristics to train the SITG.
- ▶ Phrase table from a PBT system.
- ▶ When no syntactic information is used, it is almost equivalent to a PBT.
- ▶ The use of linguistic information improve the results.

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CKY-like Algorithm

$$\delta_{ij}(A) = \max_t \Pr(A \xrightarrow{*} s_i^j / t)$$

For all $A \in N$ and i, j such that $\begin{cases} 0 \leq i < j \leq |s|, \\ j - i \geq 1, \end{cases}$

$$\delta_{ij}(A) = \max(\delta_{ij}^{[]} (A), \delta_{ij}^{\langle\rangle} (A), \max_t \Pr(A \rightarrow s_i^j / t)) \quad (1)$$

where

$$\delta_{ij}^{[]} (A) = \begin{cases} \max_{\substack{B, C \in N \\ i < I \leq j}} \Pr(A \rightarrow [BC]) \delta_{iI}(B) \delta_{Ij}(C) & \text{if } j - i > 1 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

$$\delta_{ij}^{\langle\rangle} (A) = \begin{cases} \max_{\substack{B, C \in N \\ i < I \leq j}} \Pr(A \rightarrow \langle BC \rangle) \delta_{iI}(B) \delta_{Ij}(C) & \text{if } j - i > 1 \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

CKY-like Algorithm

$$\tau_{ij}(A) = \underset{t}{\operatorname{argmax}}(\Pr(A \Rightarrow^* s_i^j / t))$$

$$\tau_{ij}(A) = \begin{cases} t & \text{if } \Pr(A \rightarrow s_i^j / t) \text{ is the maximum in (1)} \\ \tau_{iI}(B)\tau_{Ij}(C) & \text{if } \Pr(A \rightarrow [BC])\delta_{iI}(B)\delta_{Ij}(C) \\ & \text{is the maximum in (1)} \\ \tau_{Ij}(C)\tau_{iI}(B) & \text{if } \Pr(A \rightarrow \langle BC \rangle)\delta_{iI}(B)\delta_{Ij}(C) \\ & \text{is the maximum in (1)} \end{cases} \quad (4)$$

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