CMU-UKA Syntax Augmented Machine Translation

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Outline

Issues Addressed

- Extended Translation models for SMT
- Data Processing (Case + Punctuation)
- Syntax Augmenented Machine Translation via Chart Parsing

Generalized Rules

- Extending the model of translational equivalence
- he does not go , *il ne va pas*
- does not go , *ne va pas*
- does not X , *ne X pas*
  - Chiang, 05, Watanabe et al. 06
- S $\rightarrow$ does not VB0 , *ne X0 pas*
  - Galley, 04, Zollmann, Venugopal, 06, Galley et al. 06

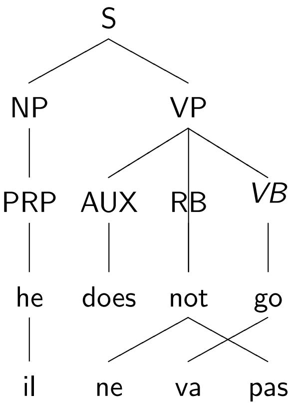
Automatic Induction of Rules

- Start with word alignments (a) on f, e + phrase based model
- We want to model target language syntactic structure
- Take advantage of target side parse tree π

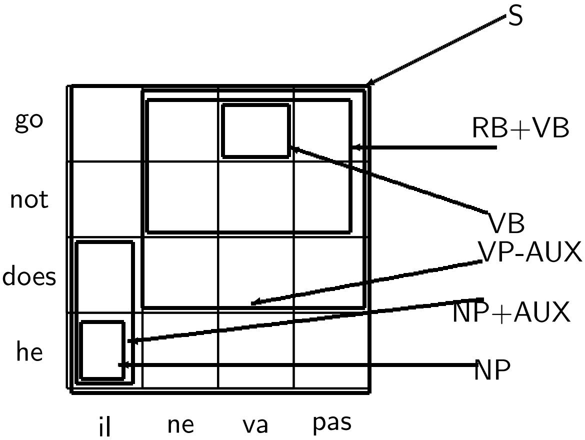
Data Oriented Approach

- Consider $\pi, f, e, phrases(a)$ as given
- Extract rules consistent with $phrases(a)$
- Begin with contiguous src, tgt phrases
- Annotate, Generalize, Re-order
- Producing “flattened” xRS style rules
- CCG style operations-add/subtract

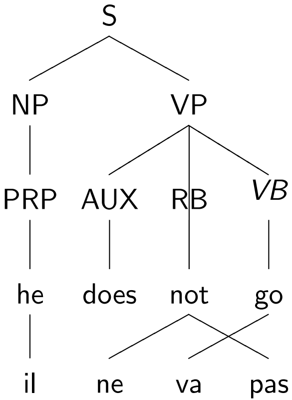
Alignment Graph



Extraction Approach



Alignment Graph



- INITIAL+ANNOTATED
  - PRP $\rightarrow$ he, *il*
  - VB $\rightarrow$ go, *va*
  - VP $\rightarrow$ does not go, *ne va pas*
  - S $\rightarrow$ he does not go, *il ne va pas*
  - PRP+AUX $\rightarrow$ il, he does
- GENERALIZED
  - S $\rightarrow$ he VP_0, il $x0$
  - VP $\rightarrow$ does not VP_0, ne $x0$ pas

All rules extracted

- S $\rightarrow$ PP ne VB pas , 1 do not 2
- PP+AUX $\rightarrow$ PP , 1 do
- S $\rightarrow$ PP+AUX RB+VB , 1 2
- RB+VB $\rightarrow$ ne vais pas , not go
- S $\rightarrow$ PP+AUX ne vais pas , 1 not go
- S $\rightarrow$ je RB+VB , i do 1
- S $\rightarrow$ PP RB+VB , 1 do 2
- VP $\rightarrow$ ne VB pas , do not 1
- S $\rightarrow$ je ne VB pas , i do not 1
- S $\rightarrow$ je VP , i 1
- PP $\rightarrow$ je , i
- RB+VB $\rightarrow$ ne VB pas , not 1
- VB $\rightarrow$ vais , go
- S $\rightarrow$ je ne vais pas , i do not go

Chart Parser Based Decoding

- Earley style bottom-up parsing
- We do not require rule binarization as in (Huang, 06)
- Integrated N-gram Language Model (Wu, 98)
  - Single-pass Cube Pruning (Chiang, 05)
  - Multi-pass heuristic search (Zollmann, Venugopal, 06)
- All rules stored in Berkeley DB

Log-Linear translation model features

- Source, target conditioned lexical weights as in Koehn, 2003
- Relative frequencies conditioned on $\cdots$
  - Left-hand side category
  - Source phrase
  - Target phrase
- Counters: Rule applications, Target words generated
- Bias terms
  - IsPurelyLexical
  - IsPurelyAbstract
  - IsXRule (non-syntactic span)
  - IsGlueRule
- Penalty features
  - Rareness: $e^{1-RuleFrequency}$
  - Lexical Length Balance: $|MeanTargetSourceRatio \times |src| \times tgt|$

Case Handling

- Training vs Translation time options
- TrainLowerCase: training lower case + true-case output
- TrainTrueCase: training true case
- SmartCase: the ambiguity is in the first word!
  - Upper-case words used within the sentence tend to be consistent
  - For each first-word - estimate non-first word case frequency
  - Use most common case consistently
  - Upper-case first word of output

SmartCasing on Training Data

English word	Frequency	Fr. of lower-case variant
I	21611	10
Japan	1939	0
Japanese	1816	0
Tokyo	813	0
Hotel	703	1166
Mr.	691	0
New	487	315
York	438	0
English	372	0
Boston	318	0

Punctuation

- Remove punctuation in source training to match test
- Move sentence-end marks ".?!" to the beginning
- Train model that generates punctuation
- Move leading punctuation to end in output

Times and Numbers

- Number handling based on quantifier markers
- Specific handling for Chinese “point” symbol

Data Conditions

- C-Star Data Track participants
- Focussing on correct transcription evaluation
- Note: Error in data alignment, only Supplied Data was parallel
- 2006 Development development data only

Comparison of Casing - PostEval

Processing	Dev IBM-BLEU	Test IBM-BLEU
TrainLowerCase	22.04 (23.91)	19.16 (21.55)
TrainTrueCase	22.47 (24.05)	19.23 (20.48)
SmartCase	23.50 (25.17)	20.04 (21.76)

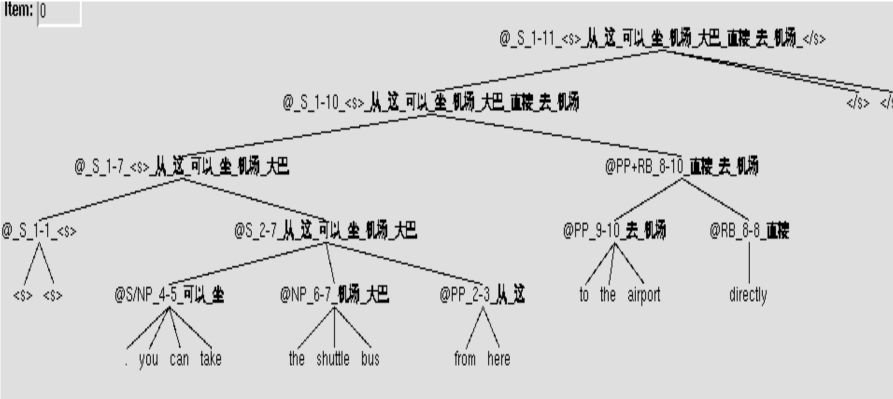
Table: *Comparison of different case-handling methods using the syntax-augmented translation system evaluated on the official case- and punctuation-sensitive IBM-BLEU metric. The numbers in parentheses indicate the IBM-BLEU score when case (but not punctuation) is ignored.*

Comparison of Models - PostEval

Rules	Dev IBM-BLEU	Test IBM-BLEU
Chiang-sim	21.25	18.08
Pharaoh	*23.2* $\rightarrow$ 22.0	19.3
SAMT	23.50	20.04

Table: *Comparison of translation-models system using "SmartCase", evaluated on the official case and punctuation sensitive IBM-BLEU metric. Note the change for the Pharaoh result. The initial result was run with the incorrect version of BLEU*

Example


Item: 0
@_S_1-11_<s>_从_这_可以_坐_机场_大巴_直接_去_机场_</s>
@_S_1-10_<s>_从_这_可以_坐_机场_大巴_直接_去_机场
</s>
@_S_1-7_<s>_从_这_可以_坐_机场_大巴
@PP+RB_8-10_直接_去_机场
@_S_1-1_<s>
@S_2-7_从_这_可以_坐_机场_大巴
@PP_9-10_去_机场
@RB_8-8_直接
<s> <s>
@S/NP_4-5_可以_坐
@NP_6-7_机场_大巴
@PP_2-3_从_这
to the airport
directly
. you can take
the shuttle bus
from here

Decoding Time

- Decoding Time depends on the kind of rules extracted
- Two particularly problematic rules
  - Purely abstract - flattenned full sentence structure
  - Target only - insertion of target words with no src
- Runtime in evaluation: 50 minutes for Dev 06
- Runtime w/o abstract/tgt only: 5 minutes for Dev 06
- End-to-end system available at
  www.cs.cmu.edu/ zollmann/samt

Future Work

- Shift emphasis to speech-translation task
- Evaluate parsing for ASR output
- Directly decode ASR lattices