Translation Combination using Factored Word Substitution

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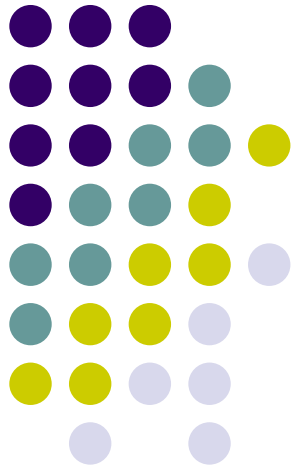
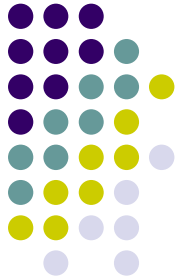


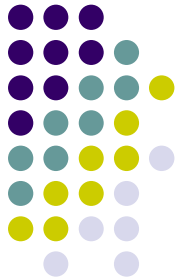
Introduction



- A word substitution approach to combine the output of different machine translation system

- Automatic substitution is guided by several decision factors
  - Part of speech
  - Local context
  - Language model probabilities

Introduction



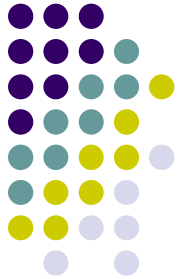
- Optimize word-level translations within a “trusted” sentence selected due to the high quality of its syntactic structure

- Add translations from four additional MT systems that have been chosen based on their performance in terms of automatic evaluation metrics

Architecture

- Compute POS tags for translations
  - Stuttgart Tree Tagger
- Create word alignment
  - GIZA++
  - Only one-to-one word alignments
- Select substitution candidates
  - Substitute nouns, verbs and adjectives

Architecture

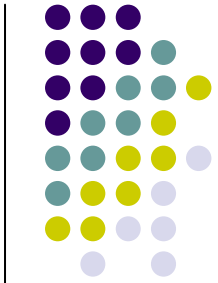


- Compute decision factors for candidates
  - Several decision factors to enable an automatic ranking of translation options
- Evaluate the decision factors and substitute
  - Using the available decision factors compute the best translation and substitute

The system’s benefit

- Language independent
  - Only requires a POS tagger
  - GIZA++ compute the word alignments
  - Target language model

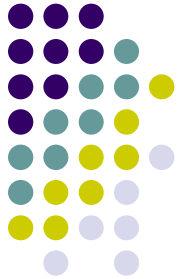
System selection



- One of the given system translations is chosen to provide the “sentence skeleton”
  - Reference systems

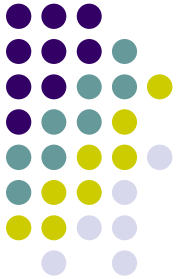
- All other systems can only contribute single words for substitution
  - Substitution sources

Reference system



- They trying to combine the strengths of rule-based MT with the virtues of statistical MT
- They choose the rule-based system (usaar) to provide the sentence frame for their combination system
- They expect the overall sentence structure to be of a sufficiently high quality

Substitution sources



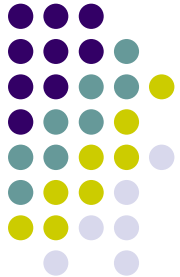
- Four substitution sources
  - Google (google)
  - University of Karlsruhe (uka)
  - University of Maryland (umd)
  - University of Stuttgart (stuttgart)

- They restrict the substitution sources to the four potentially best systems
  - Omit bad substitutions
  - Reduce the computational complexity

Decision factors

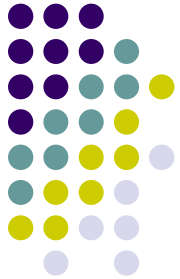
- A: Matching POS
  - This Boolean factor checks whether the target word POS tag matches the source word's POS category

Decision factors



- B: Majority vote
  - A consensus between several systems may help to identify the best translation
  - They compute an ordered list sorted by decreasing frequency
  - Both the reference system and the Google submission receive a +1 bonus.

Decision factors



- C: POS context
  - This is important as they don't want to degrade sentence structure
  - To reduce complexity, they shorten POS tags to a single character, e.g. *NN* $\rightarrow$ *N* or *NPS* $\rightarrow$ *N*
  - They conduct trials with the single word, the -1 left

Decision factors

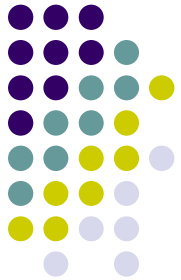
- D: Language model
  - An English language model to score the different translation options
  - They employ the bi-gram portion of the English Gigaword language model
  - Estimated using the SRILM toolkit

Factor configurations

- Consideration of the POS context
  - Strict including -1 left context versus
  - Relax including no context
- Usage of Matching POS (+A)

Configuration	Matching POS	POS context
Strict	Disabled	-1 left
Strict + A	Enabled	-1 left
Relaxed	Disabled	Single word
Relaxed + A	enabled	Single word

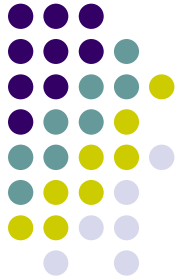
Factor configurations



- Evaluate them manually on a small set of sentences

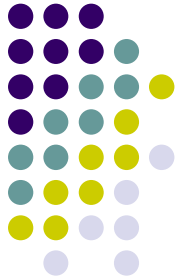
- Decisions taken by different factor combination is suggestive of the “relaxed + A” configuration to produce the best combination result

Factor substitution



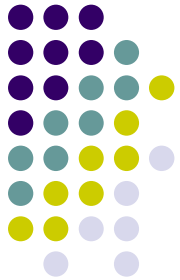
- Step 1:Matching POS?
  - Substitution of the given translation options can only be possible if the factor evaluates to true

Factor substitution



- Step 2:Majority vote winner?
  - If the majority vote yields a unique winner, this translation option is taken as the final translation
  - Example: “Rückgang”
    - Reference: “drop”
    - All of substitution sources is “decline”
    - “decline” is clearly selected as the best translation by factor B Majority vote and thus replace “drop”

Factor substitution



- Step 3:Language model
  - If several majority vote winners can be determined, the one with the best language model score is chosen
  - Example: “Tagesgeschäft“
    - Reference: “requirements”
    - Two of substitution systems indicate “business” to be a better translation
    - Due to the +1 bonus for reference translation a tie between the two possible translation emerges
    - Using language model score decision the “business”

Evaluation results

System	Relative rank
google	-2.74
uka	-3.00
umd	-3.03
stuttgart	-2.89
Usaar	-2.78
usaar-comb	-2.91

Conclusion

- Substituting particular words within a well-structured translation frame
- Further step
  - Machine learning methods to optimize the factor selection
  - Investigate the potential of phrase-based substitution taking into account multi-word alignments instead of just single word mappings