Machine Translation using IBM Model 2

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1 Introduction

Our motive was to build a statistical-based machine translation model that performs better than our previously implemented model. We chose IBM Model 2 and implemented it to achieve better results.

2 Model Implementation

We first implemented the IBM Model 1 algorithm, which computes translation probabilities by initializing uniform probabilities. IBM Model 1 assumes all words from the source language are equally likely to be translated into the target language. It does not take into account the relative positioning of the words in the sentences as a factor influencing alignments.

To enhance accuracy and precision metrics, we additionally implemented IBM Model 2, which takes into account positional information of the alignments. IBM Model 2 computes alignment probabilities conditioned on the length of the source and target sentences as a factor to compute new translation probabilities and alignments.

2.1 IBM Model 2 Formula

The probability of a target sentence T and an alignment a given a source sentence S is computed as:

$$P(T, a|S) = \prod_{j=1}^{l_T} a(j|i, l_S, l_T)\, t(T_j|S_i)$$

Where $a(j|i, l_S, l_T)$ is the alignment probability of word T_j being aligned with word S_i, given the length of the source sentence l_S and the target sentence l_T. The alignment model a is introduced as an additional factor that depends on the positions of the words.

3 Results

3.1 Dice coefficent model

- **Precision:** 0.239020
- **Recall:** 0.594675
- **AER (Alignment Error Rate):** 0.681997

3.2 IBM 1 with EM

- **Precision:** 0.456311
- **Recall:** 0.603550
- **AER (Alignment Error Rate):** 0.496695

3.3 IBM 2 with EM

- **Precision:** 0.578363
- **Recall:** 0.789941
- **AER (Alignment Error Rate):** 0.354108

4 Conclusion

IBM Model 2 achieves much better results when compared to IBM Model 1. We can see that the precision and recall have increased, indicating a lesser number of incorrect alignments made by Model 2. Additionally, Model 2 has captured more true alignments that were missed by IBM Model 1.

The IBM Model 2 achieved a lower AER score, indicating better overall performance since AER combines both precision and recall. This improvement is because IBM Model 2 utilizes both word position and word translation probabilities to achieve more accurate alignments.