ASSIGNMENT-2

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To manually calculate the BLEU score for the translated output, we need to compare the candidate translation (output from the Transformer model) with one or more reference translations (ground truth). The BLEU score is calculated based on n-gram precision, with a brevity penalty to penalize short translations.

Let's assume the following hypothetical candidate translations from the Transformer model for the given French sentences:

1) French Sentence 1:
   Reference: "Chicago is famous for its deep dish pizza, jazz and stunning architecture."
   Candidate: "Chicago is known for its deep pizza, jazz, and amazing architecture."

2) French Sentence 2:
   Reference: "I translated this sentence from French to English."
   Candidate: "I have translated this sentence from French into English."

3) French Sentence 3:
   Reference: "You have now completed the second assignment of this course."
   Candidate: "You have now finished the second assignment of this course."

We will calculate BLEU-1, BLEU-2, BLEU-3, and BLEU-4 scores for these translations.

Step 1: Calculate n-gram precision:
For each n-gram (1-gram, 2-gram, 3-gram, 4-gram), count the number of matching n-grams between the candidate and reference translations, and divide by the total number of n-grams in the candidate.

Sentence 1:

Reference: "Chicago is famous for its deep dish pizza, jazz and stunning architecture."
Candidate: "Chicago is known for its deep pizza, jazz, and amazing architecture."

1-gram (BLEU-1):

Matching unigrams: "Chicago", "is", "for", "its", "deep", "pizza", "jazz", "and"
Total unigrams in candidate: 10
Precision: 8/10 = 0.8

2-gram (BLEU-2):

Matching bigrams: "Chicago is", "for its", "deep pizza", "jazz and"
Total bigrams in candidate: 9
Precision: 4/9 ≈ 0.444

3-gram (BLEU-3):

Matching trigrams: "Chicago is known", "for its deep", "its deep pizza", "jazz and amazing"
Total trigrams in candidate: 8
Precision: 0/8 = 0

4-gram (BLEU-4):

Matching 4-grams: None
Total 4-grams in candidate: 7
Precision: 0/7 = 0

Sentence 2:
Reference: "I translated this sentence from French to English."
Candidate: "I have translated this sentence from French into English."

1-gram (BLEU-1):

Matching unigrams: "I", "translated", "this", "sentence", "from", "French", "English"
Total unigrams in candidate: 9
Precision: 7/9 ≈ 0.778

2-gram (BLEU-2):
Matching bigrams: "I have", "translated this", "this sentence", "from French", "French into"
Total bigrams in candidate: 8
Precision: 5/8 = 0.625

3-gram (BLEU-3):
Matching trigrams: "I have translated", "translated this sentence", "this sentence from", "from French into"
Total trigrams in candidate: 7
Precision: 4/7 ≈ 0.571

4-gram (BLEU-4):
Matching 4-grams: "I have translated this", "translated this sentence from", "this sentence from French", "from French into English"
Total 4-grams in candidate: 6
Precision: 4/6 ≈ 0.667

Sentence 3:
Reference: "You have now completed the second assignment of this course."
Candidate: "You have now finished the second assignment of this course."

1-gram (BLEU-1):
Matching unigrams: "You", "have", "now", "the", "second", "assignment", "of", "this", "course"

Total unigrams in candidate: 10

Precision: 9/10 = 0.9

2-gram (BLEU-2):

Matching bigrams: "You have", "have now", "now finished", "the second", "second assignment", "assignment of", "of this", "this course"
Total bigrams in candidate: 9
Precision: 8/9 ≈ 0.889

3-gram (BLEU-3):

Matching trigrams: "You have now", "have now finished", "now finished the", "the second assignment", "second assignment of", "assignment of this", "of this course"
Total trigrams in candidate: 8
Precision: 7/8 = 0.875

4-gram (BLEU-4):

Matching 4-grams: "You have now finished", "have now finished the", "now finished the second", "the second assignment of", "second assignment of this", "assignment of this course"
Total 4-grams in candidate: 7
Precision: 6/7 ≈ 0.857

Step 2: Calculate brevity penalty
The brevity penalty (BP) is applied to penalize short translations. It is calculated as: BP={1 if c>r, e^(1−r/c) if c≤r}
where:
c = length of candidate translation
r = length of reference translation

For simplicity, assume all candidate translations are of appropriate length, so BP = 1.

Step 3: Compute BLEU score
The BLEU score is calculated as:

BLEU=BP·exp(n=1=>N∑(w_n.log(p_n)))
where:
w_n = weight for each n-gram (typically w_n=1/N)
p_n = n-gram precision

For BLEU-1, BLEU-2, BLEU-3, and BLEU-4, we use N=1,2,3,4 respectively.

Sentence 1:
BLEU-1: 1·exp(log(0.8))=0.8

BLEU-2: 1·exp(1/2·(log(0.8)+log(0.444)))≈0.58

BLEU-3: 1·exp(1/3·(log(0.8)+log(0.444)+log(0)))=0

BLEU-4: 1·exp(1/4·(log(0.8)+log(0.444)+log(0)+log(0)))=0

Sentence 2:
BLEU-1: 1·exp(log(0.778))≈0.778

BLEU-2: 1·exp(1/2·(log(0.778)+log(0.625)))≈0.69

BLEU-3: 1·exp(1/3·(log(0.778)+log(0.625)+log(0.571)))≈0.65

BLEU-4: 1·exp(1/4·(log(0.778)+log(0.625)+log(0.571)+log(0.667)))≈0.67

Sentence 3:
BLEU-1: 1·exp(log(0.9))=0.9

BLEU-2: 1·exp(1/2·(log(0.9)+log(0.889)))≈0.894

BLEU-3: 1·exp(1/3·(log(0.9)+log(0.889)+log(0.875)))≈0.888

BLEU-4: 1·exp(1/4·(log(0.9)+log(0.889)+log(0.875)+log(0.857)))≈0.88

Final BLEU Scores:
Sentence 1: BLEU-1 = 0.8, BLEU-2 ≈ 0.58, BLEU-3 = 0, BLEU-4 = 0

Sentence 2: BLEU-1 ≈ 0.778, BLEU-2 ≈ 0.69, BLEU-3 ≈ 0.65, BLEU-4 ≈ 0.67

Sentence 3: BLEU-1 = 0.9, BLEU-2 ≈ 0.894, BLEU-3 ≈ 0.888, BLEU-4 ≈ 0.88