

# 11-791 HW4 Report

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## 1 Baseline System Design

## 2 Error Analysis

### 2.1 Baseline Result

This is what my baseline system got:

Score: 0.45226701686664544 rank=1 rel=1 qid=1 Classical music may never be the most popular music

Score: 0.10206207261596574 rank=1 rel=1 qid=2 Climate change and energy use are two sides of the same coin.

Score: 0.5070925528371099 rank=1 rel=1 qid=3 The best mirror is an old friend

Score: 0.2581988897471611 rank=3 rel=1 qid=4 If you see a friend without a smile, give him one of yours

Score: 0.0 rank=2 rel=1 qid=5 Old friends are best

(MRR) Mean Reciprocal Rank ::0.7666666666666667

Total time taken: 1.11

### 2.2 Conversion to Lowercase

Look at the line with qid=5, the target sentence gets a score of 0.0! This is because in the baseline system, the retrieval algorithm is case sensitive, thus even though there are common words between the query 5 and the target sentence, the system does not recognize them because of cases of those words are different. The strategy I proposed is to convert all words to lowercase before running the algorithm. That makes more sense since most pairs of words mean the same thing regardless of their cases.

After changing all words to lowercases, I got such result for the test queries:  
Score: 0.45226701686664544 rank=1 rel=1 qid=1 Classical music may never be the most popular music

Score: 0.30618621784789724 rank=1 rel=1 qid=2 Climate change and energy

use are two sides of the same coin.

Score: 0.5070925528371099 rank=1 rel=1 qid=3 The best mirror is an old friend

Score: 0.2581988897471611 rank=3 rel=1 qid=4 If you see a friend without a smile, give him one of yours

Score: 0.15811388300841897 rank=1 rel=1 qid=5 Old friends are best

(MRR) Mean Reciprocal Rank ::0.8666666666666668

Total time taken: 1.141

For the other queries, the relative rank of the target sentences did not change. The rank of the query 5's target sentence raised to 1 and the MRR was improved from 0.766 to 0.866. So this strategy is successful.

## 2.3 Stemming

We just improved a query's target document's rank. But the rank of query 4's target document's rank is still 3. Take a look at its query's term vector and documents' term vectors, I noticed that one important term in the query, "friends" does not occur in the target document's text, but the target document's text does have the singular form "friend". So stemming could help here, because those terms like "friends" and "friend" mean the same thing, they should not be treated differently. After doing stemming to the input terms, I got the result below:

Score: 0.45226701686664544 rank=1 rel=1 qid=1 Classical music may never be the most popular music

Score: 0.30618621784789724 rank=1 rel=1 qid=2 Climate change and energy use are two sides of the same coin.

Score: 0.5070925528371099 rank=1 rel=1 qid=3 The best mirror is an old friend

Score: 0.3442651863295481 rank=2 rel=1 qid=4 If you see a friend without a smile, give him one of yours

Score: 0.31622776601683794 rank=1 rel=1 qid=5 Old friends are best

(MRR) Mean Reciprocal Rank ::0.9

Total time taken: 0.973

Notice the rank of the target document of query 4 was improved to 2 and the MRR was increased to 0.9.

## 2.4 Using Stopwords

We just made another improvement, can we do better? Another idea is to remove the terms in stopwords list before doing cosine similarity.

But this does not help, look at the result I got:

Score: 0.6123724356957945 rank=1 rel=1 qid=1 Classical music may never be the most popular music

Score: 0.4629100498862757 rank=1 rel=1 qid=2 Climate change and energy use are two sides of the same coin.

Score: 0.5 rank=2 rel=1 qid=3 The best mirror is an old friend

Score: 0.3651483716701107 rank=1 rel=1 qid=4 If you see a friend without a smile, give him one of yours

Score: 0.47140452079103173 rank=1 rel=1 qid=5 Old friends are best  
(MRR) Mean Reciprocal Rank ::0.9  
Total time taken: 1.001

The ranks does not improve. I also tried the lucene stopwords list, the result is similar:

Score: 0.5773502691896257 rank=1 rel=1 qid=1 Classical music may never be the most popular music

Score: 0.43301270189221935 rank=1 rel=1 qid=2 Climate change and energy use are two sides of the same coin.

Score: 0.5 rank=1 rel=1 qid=3 The best mirror is an old friend

Score: 0.2721655269759087 rank=2 rel=1 qid=4 If you see a friend without a smile, give him one of yours

Score: 0.47140452079103173 rank=1 rel=1 qid=5 Old friends are best  
(MRR) Mean Reciprocal Rank ::0.9  
Total time taken: 1.009

But comparing to the previous subsection, the average cosine similarity of the target document was improved after stopwords removal. However, other documents' cosine similarity were also increased so all in all the relative rank did not change.

## 2.5 Other Thought

Maybe we can combine synonyms together to improve the accuracy, but without a semantic context, its hard to decide which two terms have the same meaning. So that is an intrivial task. All in all, naive approaches are hard to improve the accuracy.