UNIVERSITY OF TORONTO

CSC485/2501 A2

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Assignment 2

- Is now available.

- Due date : 23.59pm on Friday, November 3rd.

Assignment 2

- Word Sense Disambiguation

- After A2, you will be familiar with:

  NLTK, WordNet, Lesk algorithm, using Word2Vec/Bert word embeddings

NLTK Package

- WordNet.

- Tokenizer.

WordNet

```
>>> from nltk.corpus import wordnet as wn

>>> wn.synsets('motorcar')

        [Synset('car.n.01')]

>>> wn.synset('car.n.01').lemma_names()

        ['car', 'auto', 'automobile', 'machine', 'motorcar']

>>> wn.synsets('car')

[Synset('car.n.01'), Synset('car.n.02'), Synset('car.n.03'), Synset('car.n.04'), Synset('cable_car.n.01')]
```

Tokenizer

- Tokenize a string to split off punctuation other than periods.
- Input:

  s = '"Good muffins cost $3.88**\n**in New York. Please buy me two of them.**\n\n**Thanks."'

- Output:

  ['Good', 'muffins', 'cost', '$', '3.88', 'in', 'New', 'York', '.',

  'Please', 'buy', 'me', 'two', 'of', 'them', '.', 'Thanks', '.']

Tokenizer

- “$3.88”: [“$3.88”] or [“$”,”3”,”.”,”88”]

- sometimes: [“sometimes”] or [“some”,”times”]

Stopwords

```
>>> from nltk.corpus import stopwords

>>> stopwords.words('english')

['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', 'your', 'yours',

'yourself', 'yourselves', 'he', 'him', 'his', 'himself', 'she', 'her', 'hers',

……

'than', 'too', 'very', 's', 't', 'can', 'will', 'just', 'don', 'should', 'now']
```

Lesk Algorithm

Algorithm 1: The simplified Lesk algorithm.

input : a word to disambiguate and the sentence in which it appears

```
best_sense ⟵ most_frequent_sense word
best_score ⟵ 0
context ⟵ the bag of words in sentence
for each sense of word do
    signature ⟵ the bag of words in the definition and examples of sense
    score ⟵ Overlap(signature, context)
    if score > best_score then
        best_sense ⟵ sense
        best_score ⟵ score
    end
end
return best_sense
```

Score

- Count(overlap).
- Bag of words VS set of words.
- Vector representation.
  - Vector with counts.
  - Embedding.
- Vector similarity
  - Euclidean distance.
  - Cosine similarity.
  - Dot product.

Word2Vec

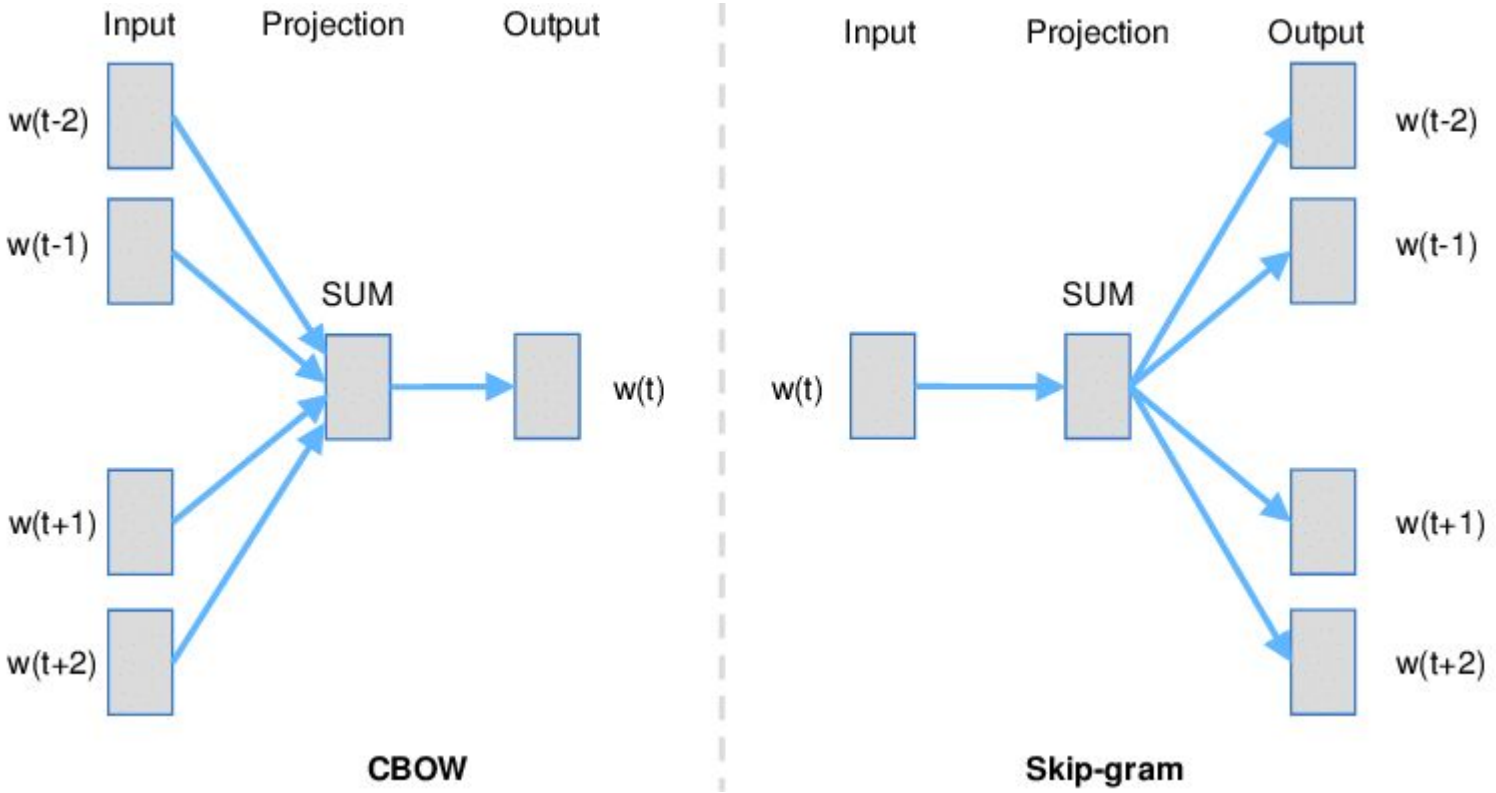
- Pretrained word vectors from large amount of text.

- Words are mapped to vectors of real numbers.

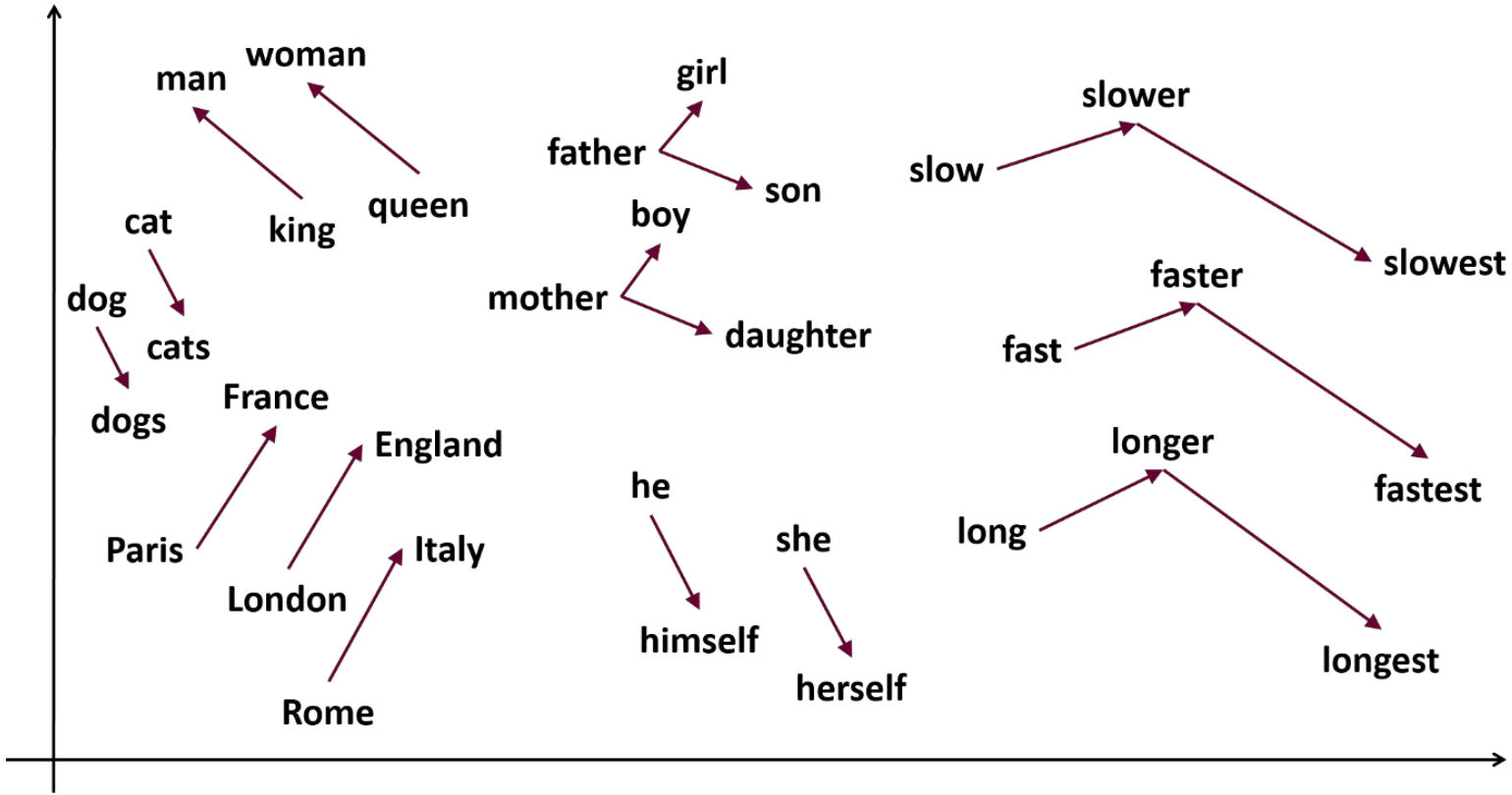
  word2vec(word:str)->vector:np.array()

- Each word only has one fixed vector representation, although it could have multiple senses.

Word2Vec


Input
Projection
Output
w(t-2)
w(t-1)
SUM
w(t)
w(t+1)
w(t+2)
CBOW
Input
Projection
Output
w(t)
SUM
w(t-2)
w(t-1)
w(t+1)
w(t+2)
Skip-gram

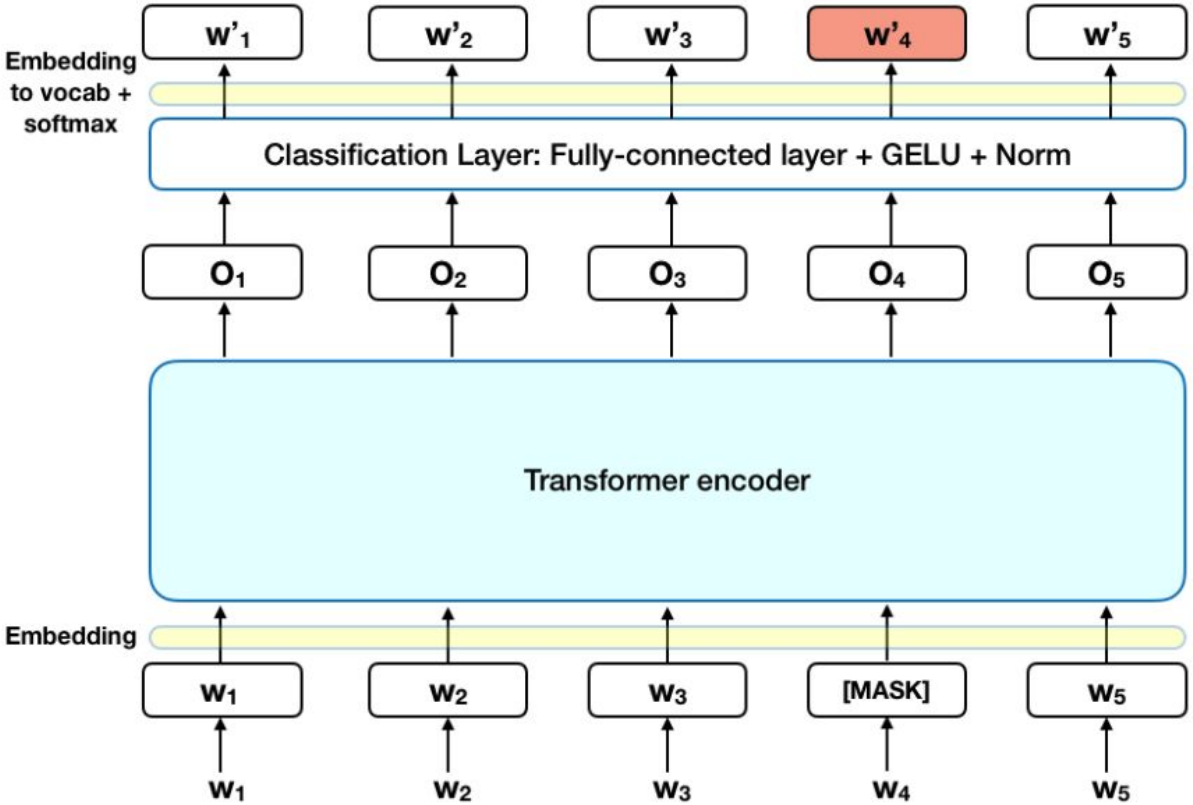
Word2Vec


man
woman
king
queen
cat
dog
cats
dogs
France
England
Paris
London
Italy
Rome
girl
father
son
boy
mother
daughter
he
she
himself
herself
slow
slower
slowest
fast
faster
fastest
long
longer
longest

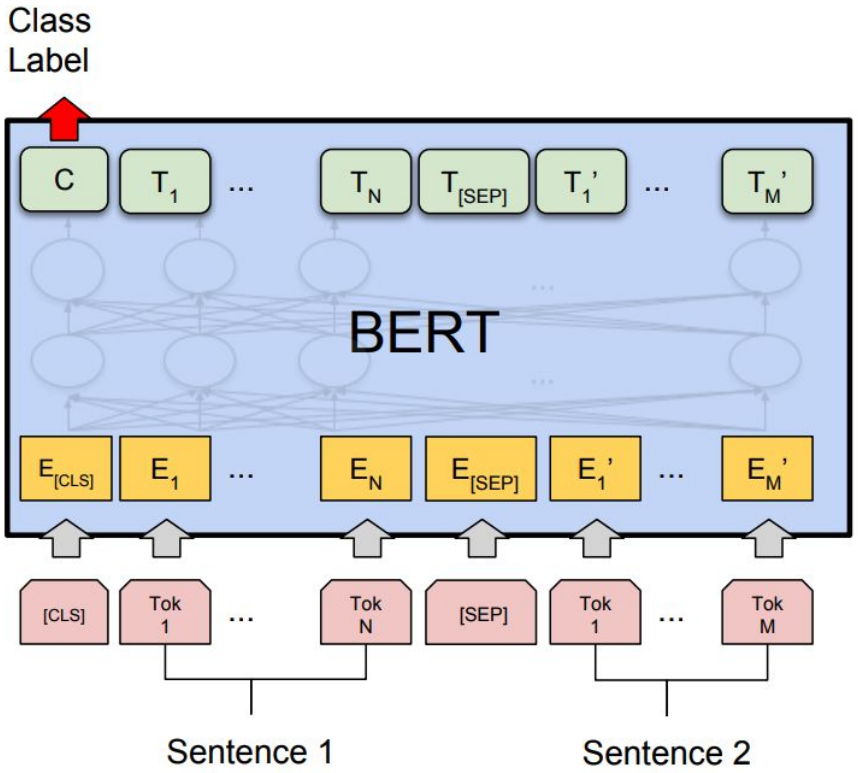
Contextual Word Embedding

	Source	Nearest Neighbors
Fixed	play	playing, game, games, played, players, plays, player, Play, football, multiplayer
Contextual	Chico Ruiz made a spectacular play on Alusik 's grounder {...}	Kieffer , the only junior in the group , was commended for his ability to hit in the clutch , as well as his all-round excellent play .
	Olivia De Havilland signed to do a Broadway play for Garson {...}	{...} they were actors who had been handed fat roles in a successful play , and had talent enough to fill the roles competently , with nice understatement .

BERT: pretrained language model



Bert: Next Sentence Prediction



BERT

- Feed model indices instead of strings.
- Input embedding layers + 12 hidden layers.
- Dimension.
- Realigning: BERT Tokenizer VS NLTK Tokenizer.

Do not use LOOP!

Consider matrix multiplication:

```
for (int i = 0; i < M; ++i)

    for (int j = 0; j < N; ++j)

        for (int k = 0; k < K; ++k)

            C[i][j] += A[i][k] * B[k][j];
```

Too slow!!!

```
>>> mat1 = torch.randn(2, 3)
>>> mat2 = torch.randn(3, 3)
>>> torch.mm(mat1, mat2)
tensor([[ 0.4851,  0.5037, -0.3633],
        [-0.0760, -3.6705,  2.4784]])
```

Questions?