Natural Language Processing

Lecture 9: Classification 2
Features and Embeddings
What are the Features?
Sample Representation

• List of features → Category
• Category: “small” finite discrete # of classes
  - E.g. LanguageID, POS tag, Movie genre
• Features: list of real numbers
  - All samples must have same # of features
How to represent words

• Samples are movie reviews:
  - A few sentences of text
  - A class: 1-5 (1 very bad, 5 very good)
• Class: simple int
• Features: ???
  - Encode first n words (?)
How to represent words

- # of words
- # of sentences
- # of exclamations points!!!!
- Does “good” appear?
- Does “bad” appear?
Discrete Classes

- Categories to numbers
  - Business \([1,0,0]\)
  - Sports \([0,1,0]\)
  - Entertainment \([0,0,1]\)
  - “one hot” representations

- Usually better than
  - Business \(\rightarrow 1\)
  - Sports \(\rightarrow 2\)
  - Entertainment \(\rightarrow 3\)
How to represent words

• Decide on vocabulary size + _other_
  - Occurrence of word
  - Array of vocab size: set to 1 if word appears
    • (or set to # of occurrences of word)
  - Vocab should be most frequent/relevant words in corpus
    • Including very high frequency words?
    • Only content words?
    • Only words appearing more than once?
How to represent words

• One big vector for whole movie review
  - Lots of zeros and few ones
  - Might be 1000, 10,000 wide (or more)

• Often called “bag of words”
  - Not care about word order
  - Not care about # of occurrences of word
  - Same length vector independent of length of review
Bag of Words

• Reviews are “similar” if vectors are similar
  - Similar means similar word distribution
  - e.g. simple difference, edit difference, cos similarity

• But
  - “I love the film” equally different from
  - “I hate the film” or
  - “I like the film”
Bag of Words

- Word similarity ("love" vs "hate" vs "like")
  - Need not just be binary representation
- Contextual effects ("good" vs "not good")
  - Need longer context
  - Can add bi-gram feature to vector
  - A vector with value for each bi-gram
Word Differences

• “like” and “love” more similar than
• “like” and “hate”
• Sparse vector treat distance the same

Word Embeddings
  - Dense (not sparse) representations
  - Distance metrics more “meaningful”
  - Do dimensions in word embeddings
  - mean something? (maybe/maybe not)
Word Embeddings

• Use existing pretrained library
  - Word2vec, GloVe, elmo/bert

• Train your own
  - Word2vec, skip-gram

• Consider:
  - Is your data like others?
  - Do you have enough examples?
  - Are there special meanings in your domain
Word Embeddings

• How long should the dense vector be?
  - 300? 768? 1000? floats

• We don’t really know
  - It’s not the size of the space represented
  - It’s if the dimensions found are useful

• Hard to implicitly control meaning in vectors
  - Easy to explicitly do it,
    • concat: word, pos, dependency parent
Word Embeddings

• New embedding techniques
  - Word2Vec and GloVe were standard
  - “Everything is better with Bert”
  - BERT [Devlin et al 2019]
    • Contextualized word embedding with transformers
    • Give SOTA performance in 11 standard NLP tasks
• But better ones being developed (e.g. XLNet)
Sentence/Document Embeddings

• But we need a fixed sized vector for the doc
  - So add up all the vectors
  - So find the average of all the vectors
  - So find the max of each value in vectors
  - Do something else
    • Learn a representation from sequence of word embeddings (e.g. sequence model)
    • Train something on all documents
Too many words

• Contextualized word embeddings
  - Care about some context
• Could concat previous and next word vectors
• But it gets very big very quickly
  - Even with case folding
• POS is more limited size
  - e.g 45ish tags, smaller representation
  - Smaller number of contexts
Too Many Features

• If you have too many features
  - Each sample has some unique combination
  - Training works well, but no generalization

• How much is too much/too little?
  - Depends
  - Pretraining is good (usually, if in similar domain)
  - Ask yourself if the system has the features you think are important for task
Summary

• Features (must) be numeric
• Convert discrete features to one-hot
• Sparse vs Dense word representations
• Bag of Words (bi-grams/tri-grams)
• Word Embeddings (dense)
  - Pretrained vs trained
• Are your features enough/not enough
• Does it work? When does it fail? Why?