Intro to Neural Nets

RNNs for Text

Today's Agenda

Background on NLP
- Use Cases
- Quick review on bag of words approaches, etc.

TextVectorization Layer
- This implements basic standardization and punctuation removal. It assumes 1-grams, then one-hot encodes.
- No stemming or stop word removal, by default.

Sequence vs. Bag-of-Words
- Conceptually

Architectures for Sequences
- Bidirectional LSTM

Quick Review of NLP Concepts

Pre-processing Text

- Lower-casing, stop word removal, stemming, removing punctuation, stripping rare tokens, etc.
- Tokenization (this may be chars, words, sentences, etc.
- Integer encoding / indexing the tokens.
- Finally, I may or may not leverage sequence information.
- *Q: what is a bag of words approach? What are n-grams?*

	Database	SQL	Index	Regression	Likelihood	linear
D1	24	21	9	0	0	3
D2	32	10	5	0	3	0
D3	12	16	5	0	0	0
D4	6	7	2	0	0	0
D5	43	31	20	0	3	0
D6	2	0	0	18	7	6
D7	0	0	1	32	12	0
D8	3	0	0	22	4	4
D9	1	0	0	34	27	25

Weighting Term-Documents: TF-IDF

Not all phrases are of equal importance…

- E.g., David less important than Beckham
- If a term occurs all the time, observing its presence is less informative

Inverse-document frequency (IDF) helps address this.

$$\mathrm{IDF} = \log(N/n_j)$$

- Term ‘weighting’ is then calculated as Term Frequency (TF) x IDF
- n_j= # of docs containing the term, N = total # of docs
- A term is deemed important if it has a high TF and/or a high IDF.
- As TF goes up, the word is more common generally. As IDF goes up, it means very few documents contain this term.

TextVectorization Layer

Pre-processing Text

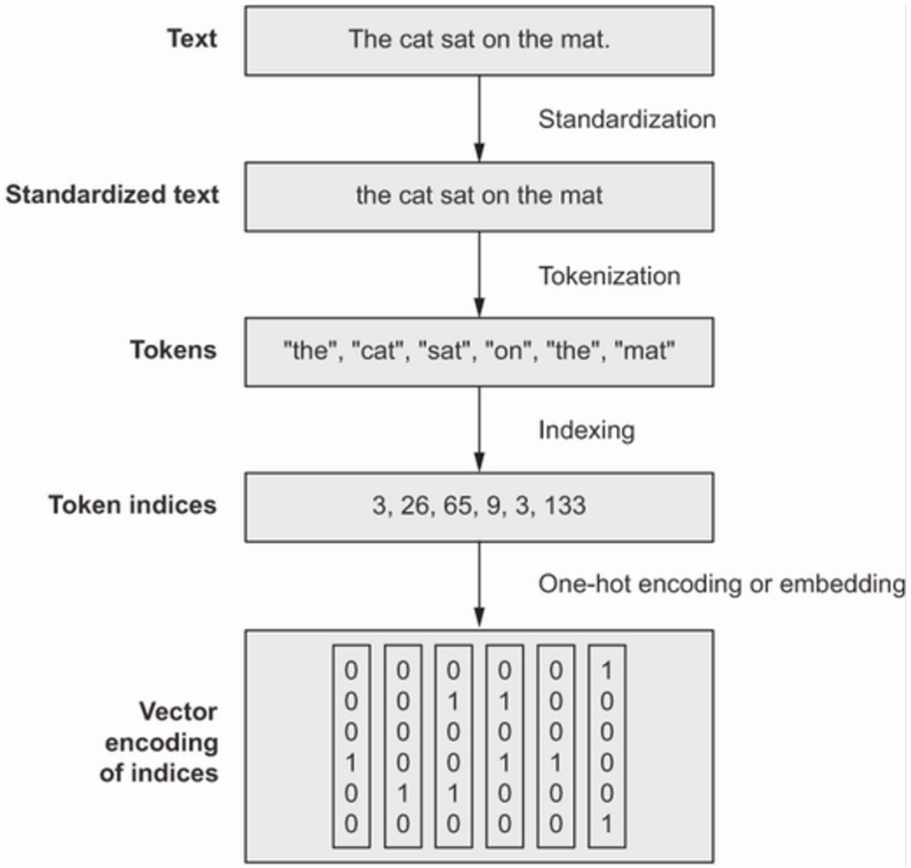
- Standardization, tokenization (words), one-hot-encoding / vectorization.
- The Keras TextVectorization() layer achieves these steps quickly.

Customization

- You can work with n-grams, and do other sorts of pre-processing, using arguments.

Options

- Include as part of TF Dataset pipeline (more efficient)
- Include as a layer in your Keras model.



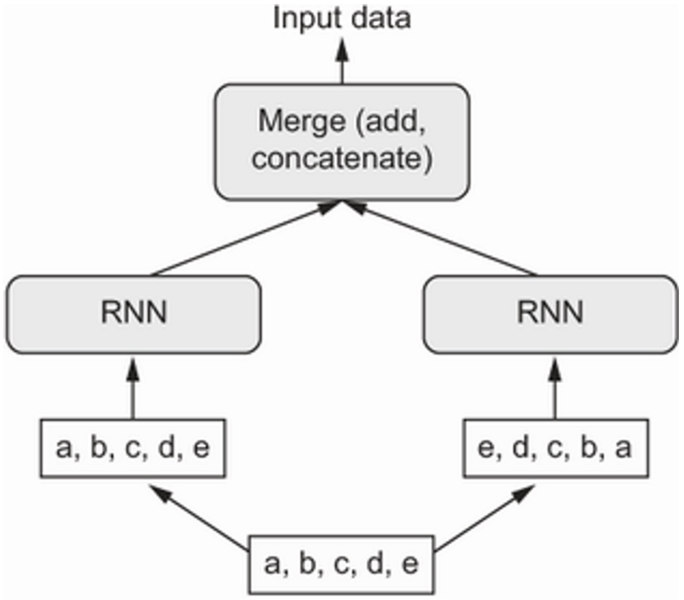
Bidirectional LSTM

We Saw This Last Time

- Take each sequence as input data, as well as a flipped/reversed copy.
- Was state of the art for text processing until relatively recently (transformers now dominate).

Instead of Time Series We Pass…

- Sequences of one-hot-encodings of terms.
- Sequences of pre-trained vector embeddings of terms.



Embedding Layer

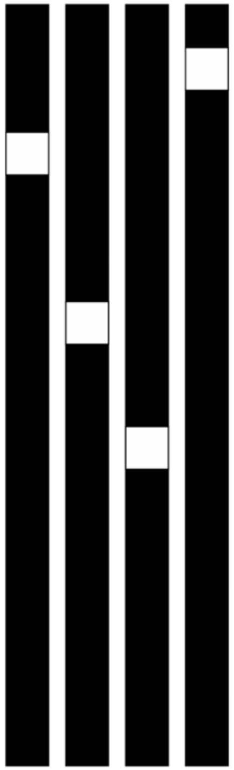
With Hot Encodings, Model Will Still Struggle to Figure Out Semantics

- Despite having sequence, the model is "told" that the tokens are orthogonal / independent of one another in their meanings. But that's not true!

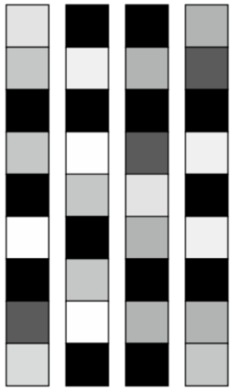
Textual Embedding Layer First Provides Dimensionality Reduction

- Represent words into a lower dimensional space – similar vector = similar meaning.
- The Embedding layer is a lookup table that maps tokens to vectors. For each token in the vocabulary, the network learns a vector representation. The vectors are initially random, and the network updates them in training to learn representations that help in prediction (just like with convolution filters!).
- In practice, it is learning semantic relationships…
- This is much better for an RNN than a hot encoding, because 120 values (for example) is << 20,000!

Numeric (Vector) Representations of Text



One-hot word vectors:
- Sparse
- High-dimensional
- Hardcoded



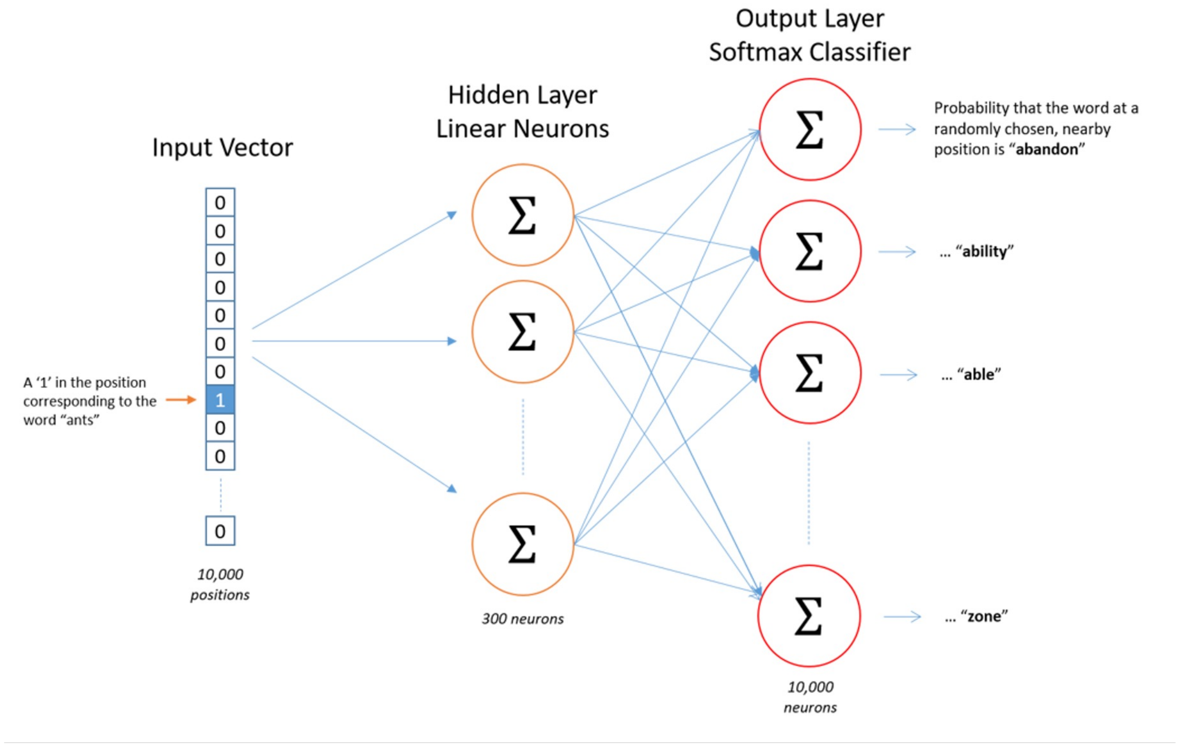
Word embeddings:
- Dense
- Lower-dimensional
- Learned from data

Pre-Trained Embeddings: Word2Vec

Word2Vec

- Two types: CBoW and Skipgram
- Construct training examples and labels.

Source Text	Training Samples generated from source text			
I will have orange juice and eggs for breakfast	(will, I)	(will, have)	(will, orange)	
I will have orange juice and eggs for breakfast	(have, I)	(have, will)	(have, orange)	(have, juice)
I will have orange juice and eggs for breakfast	(orange, will)	(orange, have)	(orange, juice)	(orange, and)
I will have orange juice and eggs for breakfast	(juice, have)	(juice, orange)	(juice, and)	(juice, eggs)
I will have orange juice and eggs for breakfast	(and, orange)	(and, juice)	(and, eggs)	(and, for)
I will have orange juice and eggs for breakfast	(eggs, juice)	(eggs, and)	(eggs, for)	(eggs, breakfast)
I will have orange juice and eggs for breakfast	(for, and)	(for, eggs)	(for, breakfast)	



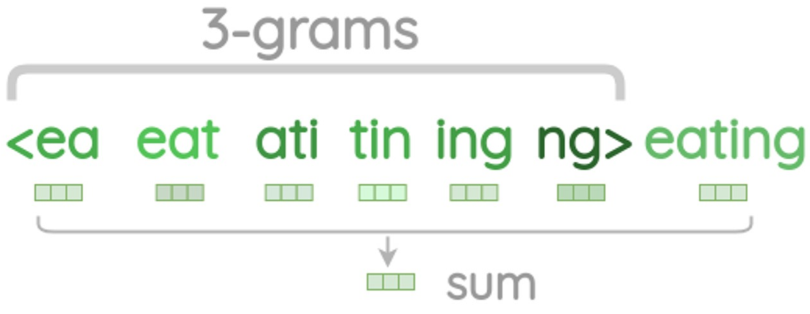
Pre-Trained Embeddings: Limitation

Out of Sample Words

- Both GloVe and Word2Vec are limited to words you've seen before in training. They cannot handle new words. Those words thus get omitted / dropped, or you need to do something different.

FastText

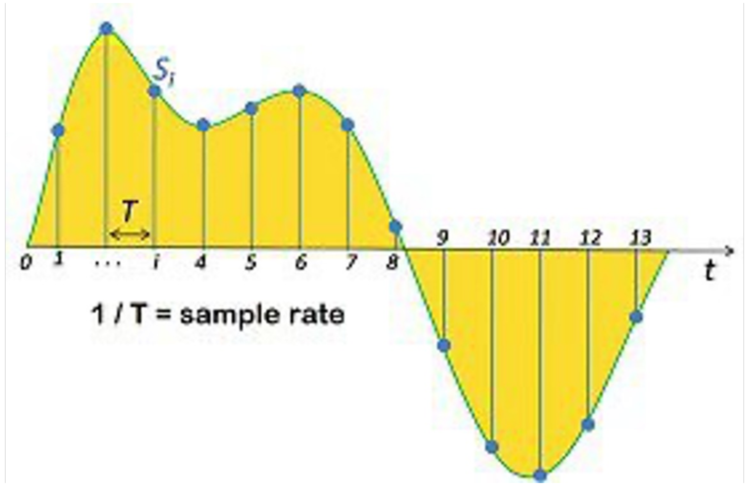
- An extension to Word2Vec which learns character n-grams of words. So, instead of embedding words, we embed portions of words (e.g., a 3-gram character representation would break up the word 'coffee' into 'cof', 'off', 'ffe', … and then learn vector embeddings of each.



RNN for Audio

Same Sequence Concepts Work for Audio Data

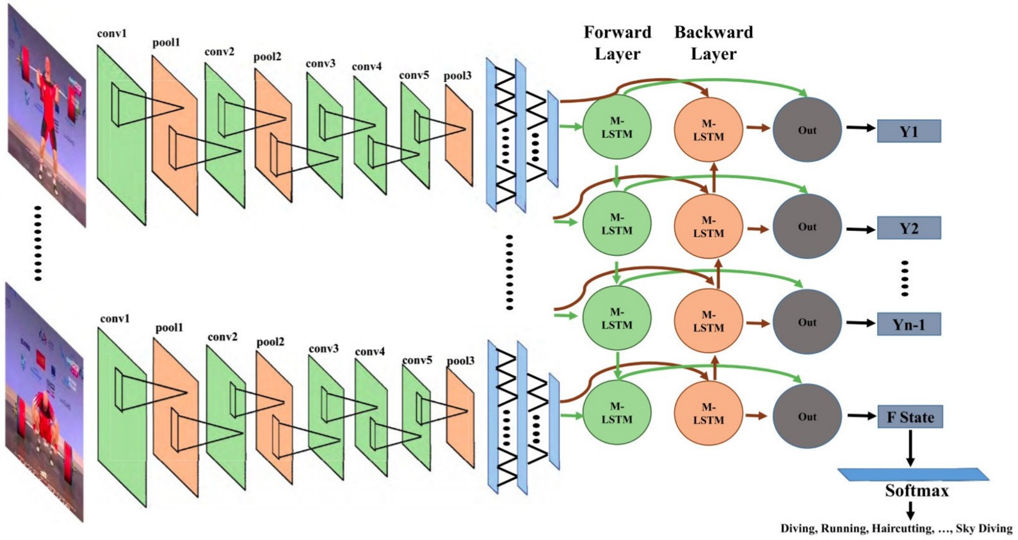
- Audio files are just sequences of numeric values (amplitude), possibly two if it was recorded in stereo.
- Once we recognize this, we realize we can predict things about audio sequences too!



CNN-RNN for Video

Hybrid Topology for Image Sequences

- We Use CNN's to detect features at a given input.
- We feed those feature maps into an RNN architecture, like LSTM.
- We can use this topology to predict things about videos.
- You might pre-process frames using a pre-trained CNN and pass feature maps as sequences to an RNN.



Questions?