Mining Big Data - Intermediate Report

Investigating Paragraph Vectors

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Introduction

This document describes our progress towards achieving our project goals. We have three primary project goals:

- 1. Replicate the results claimed by Le and Mikolov in their 2014 paper [1].
- 2. Compare doc2vec backed with k-nearest-neighbours with standard approaches to determining document similarity [2].
- 3. Apply doc2vec to source code, and explore how it distributes code segments.

Our work so far has mostly been towards the first and second of these goals.

Current Progress

Work on the IMDB dataset

Some exploratory analysis and testing, using gensim [3] as an implementation of doc2vec, and the tests have been run as per the paper [1]. So far the results are disappointing. Despite several attempts to replicate the paper's experiment, and obtain a working sentiment classifier, so far, we have not come close to achieving the accuracy described in the paper, or achieved by other approaches. So far, only an accuracy of 68% has been obtained, in contrast with the 92% claimed by Le and Mikolov.

Work on the Wikipedia dataset

We again used gensim [3] to run doc2vec on the wikipedia corpus [4]. Even with only 2 training iterations on the corpus (compared with a desired 10-20), this took over 100 CPU hours. From the word and paragraph vectors trained on this data, we qualitatively evaluated the algorithm's performance on three axes:

- 1. Did the learned word vectors capture semantic meaning well?
- 2. Did the learned document vectors capture semantic meaning well?
- 3. Could the document vectors be used for similarity analysis?

Current Experimental Progress

All source code necessary to reproduce our results is available at https://github.com/mbd-doc2vec-team/mbd-doc2vec/, the IMDB dataset is available as referenced in Maas et al. 's work [5], and the wikipedia dataset is available at [4].

Experiments on the IMDB Dataset

The approach taken followed the method described in the paper as best as possible. Gensim [3] was used for the doc2vec implementation, with parameters as in Table 1 and Keras [6] backed with Theano was chosen for the neural network library, since neither were specified in the paper. It is unlikely that either of these choices were the cause for low performance, and more likely that our implementation was flawed. Both of these libraries were relatively easy to use which was good.

While the paper gives clear descriptions of most components and parameters in the classifier architecture, critical details are overlooked and explained poorly. Replicating the results without clear descriptions or values falls to trial and error, where any number of confounding variables could be in effect. One such ambiguity is the dimension of the document vectors, which can have large effects on accuracy.

Parameter	IMBD model	Wikipedia model
Vector size	200	200
Context distance	5	8
Training iterations	20	2

Table 1: Parameters used for doc2vec for each experiment

Experiments on the Wikipedia Dataset

Similarly to the IMDB dataset, we

Future Work

IMDB Dataset

Further clarification of the architecture would improve the performance far better than continued tuning. Unless there is any insight disclosed in discussion around the paper, contacting the author of the paper seems like the only way this might be achieved. Which is unfortunate, given the author has been so far unwilling to help others in discussion groups. In order to obtain higher accuracy, there is the possibility that running the training for longer could help. Both the embedding and the classifier could benefit from this, however over-fitting the data is a concern. Currently, achieving an accuracy within 10% of that claimed by Le and Mikolov [1] seems unlikely, and as such, serves as a goal for our next experiments.

Wikipedia Dataset

The most pressing, and most time-consuming, future work for the Wikipedia dataset is to train the model for more generations. While the word vectors and document vectors were somewhat coherent, there was clearly noise caused by under-fitting. While training for 20 generations will take 1000 CPU hours, the benefits of training for a significant number of iterations should be worthwhile.

After this, we will compare the similarity metric that can be obtained using doc2vec with those obtained from the k-shingles method, particularly with intent to quantitatively compare the speed of finding similar documents, and qualitatively assess how well the similarity metric compares to a human notion of similarity.

Chromium Dataset

References

- [1] Quoc V Le and Tomas Mikolov. "Distributed Representations of Sentences and Documents." In: *ICML*. Vol. 14, 2014, pp. 1188–1196.
- [2] Andrei Z Broder. "On the resemblance and containment of documents". In: Compression and Complexity of Sequences 1997. Proceedings. IEEE. 1997, pp. 21–29.
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- [4] Meta. Data dump torrents Meta, discussion about Wikimedia projects. [Online; accessed 9-August-2016]. 2016. URL: https://meta.wikimedia.org/w/index.php?title=Data_dump_torrents.
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- [6] Keras: Deep Learning library for Theano and TensorFlow. URL: https://keras.io/.
- [7] Laurens van der Maaten and Geoffrey Hinton. "Visualizing data using t-SNE". In: *Journal of Machine Learning Research* 9.Nov (2008), pp. 2579–2605.

Appendices

Wikipedia model	IMBD model
apricot	kahuna
cherry	mines
onion	interpreters
mango	explosive
persimmon	imperialist
indigo	catholic
hazelnut	conservatory
pomegranate	pilling
yahoo	craftsmanship
ibm	casing

Table 2: Words similar to 'apple'

Wikipedia model	IMBD model
screwball	screwball
slapstick	slapstick
erotic	romance
modernist	stand-up
realist	slap-stick
satirical	physical
absurdist	teen
bromantic	sophisticated
improvisational	erotic
surreal	frothy

Table 3: Words similar to 'romantic'

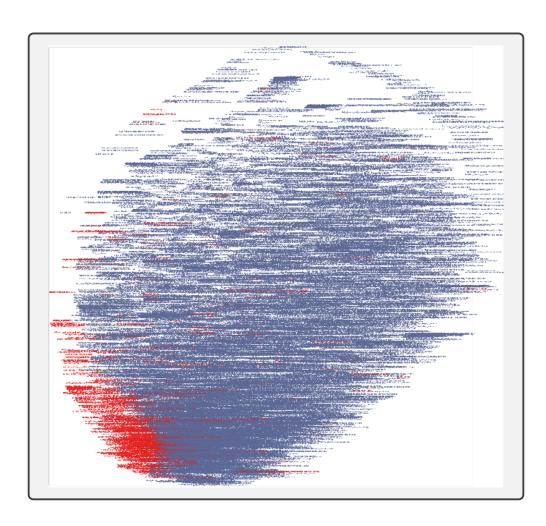
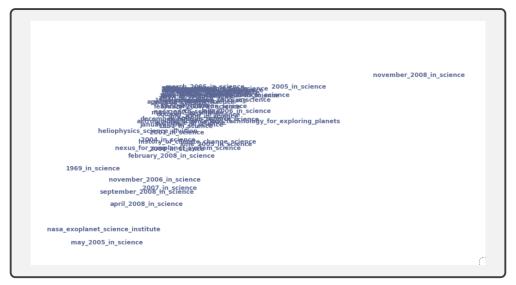


Figure 1: t-sne [7] used to visualize mining (red) and science (blue) wikipedia pages. Concepts such as 'School of Geological Sciences' are nearer the meeting point of the groups.



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Figure 2: Some conceptual clusters from Figure 1.

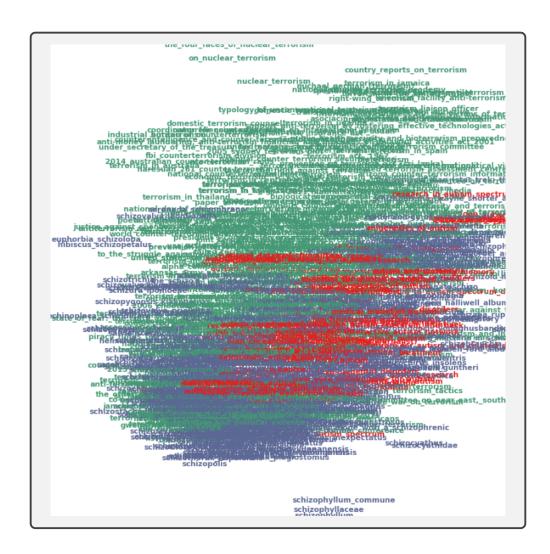


Figure 3: t-sne [7] used to visualize autism (red), terrorism (blue) and schizo.* (blue) Wikipedia pages. Note how autism and schizophrenia are clustered together, in the top right.

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		schizoo	cosa					izothorax_ocor	nori	,	ies_pennie	
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schizoserideae					iggthorax_pregla							
enthus				.mzura_umee	ma		hizothorax	epidethorax.				
list_of_terrorism_films					schizothorax			scnizotnorax_	granami			
	combating_t&	Aignan_Uhter			schizothorax	beipanensis				schizotho	rax_prenantischizotho	rax_huegelii
				schiz	ophonic	schizot	horax_arge	ntatus				
			chizopyge_niger		schizochytriu	m limacinum			schizothorax_e	longatus		
						-	schia	othorax				
chizothorax_cryptolepis	thorax_davidi	schizothorax_dulonge	ensis			othorax oligo	lands.					
			schizot	thorax vunna	nensis vunnaner		iepis					
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				rax_yunnane	nsis schizoid man							
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	schizoth	norax_nepalensis						scinzotnora	x_pragrostomus			

uggish_schizophrenia ^C	•	pigenetics_of_autism	history_of_schizophrenia		
hiza_koenigiana		heritability_of_autism	post-schizophrenic_depre	ession	
	effects_of_estrogen_c	on_schizophrenia epigenetics_of_schi	schizophrenia zophrenia	schizachne	
	schizophrenia_and_smoking	dia	agnosis_of_schizอกกid_schizophrenia		
	prognosis_of_schizophrenia schizotypy	pediatric_schizo	schizoaffective_disorder phrenia construction_of_schizophrenia		schizo
nics) childhood_autism_rat	ting_scale				
	management of schizophrania causes of Schizophrenia	_schizophrenia			
	con	nparison_of_bipolar_diso	schizophreniform_disorder rder_and_schizophrenia		
interpre	etation_of_schizophrenia				
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n_embassy_bioterrorism_hoa	dopamine_hypothesis of schizo mechanisms	pphrenia s_of_schizophrenia			
	animal_model_of_	visual_processing_abno schizophrenia	ormalities_in_schizophrenia schizo	chilus	
schizotypal_personal	lity_disorder	autism_and_m	nemon/		

Figure 4: Some conceptual clusters from Figure 3. $\,$