

Salman Qavi
ID: 109470856
CSE 538: NLP
Fall 2019
Assignment 1

Results of Analogy Task

Cross-Entropy experimentation with different Parameters

Trial No.	batch_size	embedding_size	skip_window	num_skips	max_num_steps	learning rate	Loss	Avg. Accuracy	Observations and Comment
1	128	128	4	8	200001	1.0	4.853	32.1%	Default Parameters
2	128	128	8	8	200001	1.0	4.878	32.9%	Doubling skip_window
3	256	128	4	8	200001	1.0	5.488	32.7%	Doubling batch_size
4	512	128	4	8	200001	1.0	6.110	33.6%	Quadrupling the default batch_size increased the loss significantly and the training time more than doubled
5	64	128	4	8	200001	1.0	4.209	31.1%	Halving the batch size decreases slightly both accuracy and loss
6	128	128	4	8	200001	0.001	4.878	34.5%	Making the learning rate very small increases the accuracy heavily although loss is the same
7	128	128	4	8	400001	0.001	4.870	34.4%	Doubling training steps and making learning rate very slow have no change from the last step
8	128	128	8	16	200001	0.00001	4.897	34.5%	Increasing the num_skips and skip_window increases accuracy from the default value
9	256	128	4	8	200001	4.0	5.524	32.2%	Increasing learning rate more than one worsens the loss but accuracy stays almost same
10	128	128	4	8	800001	0.00001	4.895	34.5%	Quadrupling the number of training steps and making learning extremely small increases accuracy significantly

NCE experimentation with different Parameters

Trial No.	batch_size	embedding_size	skip_window	num_skips	max_num_steps	learning rate	K = Num_sampled	Loss	Avg. Accuracy	Observations and Comment
1	128	128	4	8	200001	1.0	64	1.459	34.0%	Default Parameters
2	256	128	4	8	200001	1.0	64	1.160	33.2%	Increasing batch_size decreased the loss but also decreased the average. Accuracy
3	128	128	8	16	200001	1.0	64	1.806	32.3%	Increasing num_skips and skip_window increased the loss as well as decreased accuracy.
4	128	128	4	8	400001	1.0	64	1.316	34.0%	Doubling the training steps does not seem to have affect on the accuracy but decreased loss.
5	256	128	4	8	100001	0.01	64	1.263	33.7%	No observable change
6	256	128	2	4	200001	1.0	64	1.244	34.4%	By decreasing num_skips and skip_window by half, the accuracy increases
7	256	128	1	2	200001	1.0	32	0.82	33.8%	Decreasing skip_window and num_skips have decreased the loss less than 1.
8	256	128	1	2	200001	1.0	8	0.206	33.5%	Decreasing the negative samples significantly decreased the loss.
9	512	128	1	2	200001	1.0	8	0.043	33.2%	Increasing the batch size lowers the loss by 4 times but the accuracy stays the same
10	512	128	1	2	400001	1.0	8	0.312	33.2%	Now doubling the training steps again deteriorates the loss but accuracy stays same

Justification of NCE

Although the implementation of NCE loss function is messier than Cross-Entropy, it is straight-forward once understood. NCE is an effective way of learning parameters for an arbitrary locally normalized language model. NCE avoids the expensive computation required by Softmax Normalization at the output layer.

For every training sample, the NCE classifier is passed a pair of arguments (a target word and its contexts) and a number of k randomly corrupted pairs (a target word and a randomly chosen word from the vocabulary). The NCE Classifier becomes efficient by learning to distinguish the true pairs from the corrupted pairs, and in the process, the classifier learns the word vectors.

In Word2Vec, the process is called negative sampling because the words for the negative or corrupted samples are drawn from a designed distribution, which favors less frequent words to be drawn more. Negative sampling prevents summation and normalization over the entire vocabulary after every time the classifier learns something, thereby avoiding huge computation.

Top 20 Similar Words

a) Using Best Cross Entropy Model

Most similar to **first**:

last, name, following, during, most, original, second, same, until, end, after, best, before, book, city, main, united, next, beginning, title

Most similar to **american**:

german, british, french, english, italian, its, war, russian, european, understood, international, of, irish, canadian, borges, united, trade, d, other, autres

Most similar to **would**:

not, that, could, will, been, we, said, must, india, they, do, does, who, did, you, to, families, if, should, may

b) Best NCE Model

Most similar to **first**:

book, work, until, most, war, use, term, state, up, word, at, law, early, before, time, capital, when, but, proudhon, famous

Most similar to **american**:

english, french, modern, would, society, i, could, proudhon, joseph, they, free, political, including, him, also, against, social, state, so, using

Most similar to **would**:

could, will, i, did, him, they, so, has, see, american, t, but, also, through, using, proudhon, modern, joseph, where, not

Appendix:

Similar Words:

Trial No.	Top 20 Similar Words using Cross-Entropy
1	{'first': ['world', 'second', 'the', 'war', 'name', 'time', 'game', 'last', 'being', 'original', 'following', 'term', 'third', 'country', 'story', 'book', 'same', 'city', 'outside', 'film'], 'american': ['german', 'english', 'french', 'modern', 'british', 'russian', 'war', 'western', 'european', 'italian', 'irish', 'the', 'between', 'portuguese', 'slow', 'canadian', 'samoa', 'non', 'bowl', 'north'], 'would': ['could', 'will', 'must', 'have', 'been', 'we', 'do', 'did', 'can', 'be', 'does', 'you', 'they', 'should', 'may', 'had', 'india', 'said', 'found', 'believed']}
2	{'first': ['second', 'following', 'book', 'name', 'last', 'war', 'after', 'before', 'game', 'original', 'state', 'part', 'during', 'death', 'history', 'language', 'world', 'power', 'theory', 'work'], 'american': ['british', 'german', 'french', 'english', 'war', 'new', 'united', 'international', 'states', 'player', 'european', 'under', 'most', 'trade', 'soviet', 'state', 'through', 'has', 'italian', 'north'], 'would': ['will', 'could', 'india', 'must', 'if', 'they', 'does', 'but', 'we', 'only', 'do', 'said', 'been', 'you', 'into', 'so', 'even', 'made', 'did', 'have']}
3	{'first': ['second', 'last', 'time', 'the', 'name', 'game', 'term', 'war', 'book', 'during', 'world', 'same', 'film', 'album', 'recorded', 'following', 'title', 'story', 'word', 'before'], 'american': ['english', 'german', 'british', 'french', 'italian', 'spirit', 'russian', 'author', 'european', 'intending', 'irish', 'war', 'trade', 'football', 'modern', 'international', 'samoa', 'spanish', 'actor', 'society'], 'would': ['could', 'will', 'we', 'must', 'should', 'can', 'do', 'does', 'india', 'did', 'you', 'have', 'be', 'said', 'may', 'they', 'become', 'not', 'never', 'that']}
4	{'first': ['second', 'name', 'last', 'game', 'time', 'recorded', 'film', 'term', 'during', 'president', 'book', 'album', 'the', 'world', 'person', 'before', 'leguntur', 'slide', 'reliever', 'gwatar'], 'american': ['english', 'italian', 'german', 'british', 'war', 'international', 'french', 'film', 'actor', 'baserunners', 'intending', 'football', 'spirit', 'terminal', 'mumia', 'european', 'irish', 'endtime', 'author', 'langston'], 'would': ['could', 'will', 'must', 'we', 'should', 'do', 'india', 'can', 'said', 'you', 'did', 'be', 'have', 'does', 'become', 'may', 'they', 'not', 'make', 'that']}
5	{'first': ['could', 'against', 'place', 'ever', 'english', 'use', 'name', 'must', 'brought', 'monism', 'immune', 'diner', 'thought', 'computational', 'regrouped', 'which', 'begging', 'free', 'nantucket', 'never'], 'american': ['german', 'english', 'british', 'french', 'main', 'social', 'society', 'second', 'state', 'like', 'north', 'scottish', 'area', 'states', 'development', 'south', 'both', 'soviet', 'size', 'prohibit'], 'would': ['could', 'up', 'do', 'ever', 'power', 'we', 'you', 'used', 'said', 'they', 'will', 'crowley', 'greater', 'gave', 'them', 'into', 'different', 'though', 'never', 'historicity']}
6	{'first': ['last', 'name', 'following', 'during', 'most', 'original', 'second', 'same', 'until', 'end', 'after', 'best', 'before', 'book', 'city', 'main', 'united', 'next', 'beginning', 'title'], 'american': ['german', 'british', 'french', 'english', 'italian', 'its', 'war', 'russian', 'european', 'understood', 'international', 'of', 'irish', 'canadian', 'borges', 'united', 'trade', 'd', 'other', 'autres'], 'would': ['not', 'that', 'could', 'will', 'been', 'we', 'said', 'must', 'india', 'they', 'do', 'does', 'who', 'did', 'you', 'to', 'families', 'if', 'should', 'may']}
7	{'first': ['last', 'name', 'following', 'during', 'most', 'original', 'second', 'same', 'until', 'end', 'after', 'best', 'before', 'book', 'city', 'main', 'united', 'next', 'title', 'beginning'], 'american': ['german', 'british', 'french', 'english', 'italian', 'war', 'its', 'russian', 'european', 'understood', 'international', 'of', 'irish', 'canadian', 'borges', 'united', 'trade', 'd', 'other', 'autres'], 'would': ['not', 'that', 'could', 'will', 'been', 'we', 'said', 'must', 'india', 'they', 'do', 'does', 'who', 'did', 'you', 'to', 'families', 'if', 'should', 'but']}
8	{'first': ['last', 'name', 'following', 'during', 'most', 'original', 'second', 'same', 'until', 'end', 'after', 'best', 'before', 'book', 'city', 'united', 'main', 'next', 'beginning', 'title'], 'american': ['german', 'british', 'french', 'english', 'italian', 'its', 'war', 'russian', 'european', 'understood', 'international', 'of', 'irish', 'canadian', 'borges', 'united', 'trade', 'd', 'other', 'autres'], 'would': ['not', 'that', 'could', 'will', 'been', 'we', 'said', 'must', 'india', 'they', 'do', 'does', 'who', 'did', 'you', 'to', 'families', 'if', 'should', 'may']}
9	{'first': ['persecution', 'word', 'final', 'lost', 'return', 'petersburg', 'last', 'largest', 'huadu', 'disturbs', 'second', 'fruitarians', 'next', 'term', 'microorganism', 'before', 'definition', 'performance', 'home', 'manorialism'], 'american': ['native', 'businesspeople', 'german', 'microbreweries', 'stripped', 'director', 'north', 'association', 'african', 'raffaello', 'indian', 'central', 'eastern', 'undermined', 'radamanthus', 'indented', 'lull', 'singer', 'scope', 'alkyl'], 'would': ['should', 'might', 'must', 'likely', 'become', 'will', 'appears', 'refer', 'never', 'make', 'we', 'can', 'be', 'noted', 'appear', 'it', 'seems', 'intended', 'do', 'cannot']}
10	{'first': ['last', 'name', 'following', 'during', 'most', 'original', 'second', 'same', 'until', 'end', 'after', 'best', 'before', 'book', 'city', 'united', 'main', 'next', 'beginning', 'title'], 'american': ['german', 'british', 'french', 'english', 'italian', 'its', 'war', 'russian', 'european', 'understood', 'international', 'of', 'irish', 'canadian', 'borges', 'united', 'trade', 'd', 'other', 'autres'], 'would': ['not', 'that', 'could', 'will', 'been', 'we', 'said', 'must', 'india', 'they', 'do', 'does', 'who', 'did', 'you', 'to', 'families', 'if', 'should', 'may']}

Trial No.	Top 20 Similar Words using NCE
1	{'first': ['during', 'time', 'english', 'before', 'since', 'he', 'law', 'attitudes', 'revolution', 'ideas', 'history', 'had', 'human', 'recorded', 'zeno', 'disagreement', 'labour', 'however', 'communitistic', 'kropotkin'], 'american': ['british', 'german', 'french', 'international', 'united', 'union', 'soviet', 'widely', 'russian', 'canadian', 'irish', 'slow', 'terminal', 'italian', 'riaais', 'war', 'harassing', 'understood', 'touches', 'arlo'], 'would': ['will', 'could', 'does', 'must', 'did', 'do', 'been', 'we', 'india', 'such', 'become', 'so', 'him', 'said', 'not', 'once', 'who', 'you', 'where', 'cimmerian']}
2	{'first': ['during', 'war', 'book', 'before', 'use', 'until', 'time', 'since', 'early', 'term', 'zeno', 'french', 'western', 'individual', 'english', 'civil', 'modern', 'man', 'at', 'law'], 'american': ['war', 'english', 'french', 'western', 'modern', 'civil', 'association', 'during', 'use', 'its', 'history', 'individual', 'first', 'law', 'social', 'political', 'book', 'zeno', 'brought', 'UNK'], 'would': ['could', 'will', 'can', 'did', 'should', 't', 'to', 'only', 'him', 'i', 'must', 'do', 'had', 'using', 'been', 'might', 'no', 'have', 'later', 'any']}
3	{'first': ['so', 'early', 'movement', 'modern', 'ancient', 'will', 'published', 'all', 't', 'religious', 'being', 'found', 'english', 'did', 'until', 'the', 'active', 'joseph', 'property', 'l'], 'american': ['spanish', 'british', 'french', 'german', 'football', 'united', 'mentioned', 'player', 'binocular', 'december', 'international', 'cresphontes', 'exports', 'william', 'vallabhbhai', 'sedgwick', 'european', 'dutch', 'chalmers', 'sold'], 'would': ['could', 'must', 'who', 'india', 'does', 'we', 'said', 'while', 'him', 'if', 'even', 'do', 'may', 'up', 'families', 'made', 'into', 'you', 'because', 'when']}
4	{'first': ['during', 'time', 'before', 'since', 'however', 'while', 'at', 'english', 'harmonious', 'had', 'place', 'history', 'law', 'mutual', 'man', 'revolution', 'based', 'governance', 'he', 'working'], 'american': ['german', 'british', 'french', 'russian', 'terminal', 'italian', 'leftists', 'autres', 'henna', 'writer', 'd', 'enrollment', 'composer', 'pensiero', 'actress', 'aneroood', 'faces', 'canadian', 'thunderbolt', 'international'], 'would': ['will', 'did', 'could', 'be', 'has', 'been', 'does', 'have', 'must', 'had', 'should', 'can', 'goods', 'was', 'do', 'says', 'wish', 'wealth', 'i', 'detailed']}
5	{'first': ['most', 'during', 'was', 'name', 'at', 'of', 'in', 'after', 'one', 'on', 'to', 'and', 's', 'war', 'he', 'is', 'nine', 'from', 'which', 'three'], 'american': ['british', 'german', 'french', 'english', 'war', 'its', 'states', 'of', 'united', 'european', 'sale', 'international', 'however', 'union', 'autres', 'other', 'italian', 'borges', 'sholay', 'understood'], 'would': ['not', 'they', 'that', 'been', 'who', 'to', 'will', 'could', 'from', 'but', 'with', 'had', 'it', 'he', 'this', 'for', 'only', 'on', 'a', 'three']}
6	{'first': ['book', 'work', 'until', 'most', 'war', 'use', 'term', 'state', 'up', 'word', 'at', 'law', 'early', 'before', 'time', 'capital', 'when', 'but', 'proudhon', 'famous'], 'american': ['english', 'french', 'modern', 'would', 'society', 'i', 'could', 'proudhon', 'joseph', 'they', 'free', 'political', 'including', 'him', 'also', 'against', 'social', 'state', 'so', 'using'], 'would': ['could', 'will', 'i', 'did', 'him', 'they', 'so', 'has', 'see', 'american', 't', 'but', 'also', 'through', 'using', 'proudhon', 'modern', 'joseph', 'where', 'not']}
7	{'first': ['most', 'during', 'at', 'united', 'before', 'against', 'term', 'to', 'after', 'original', 'when', 'same', 'following', 'where', 'and', 'until', 'word', 'through', 'last', 'although'], 'american': ['international', 'french', 'british', 'italian', 'german', 'other', 'european', 'united', 'english', 'ancient', 'are', 'all', 'against', 'would', 'first', 'were', 'including', 'russian', 'and', 'most'], 'would': ['will', 'could', 'been', 'they', 'who', 'can', 'he', 's', 'had', 'should', 'does', 'did', 'must', 'zero', 'do', 'were', 'are', 'or', 'has', 'isbn']}
9	{'first': ['name', 'last', 'most', 'following', 'until', 'second', 'before', 'book', 'same', 'after', 'original', 'which', 'one', 'government', 'united', 'th', 'he', 'but', 'war', 'best'], 'american': ['german', 'english', 'british', 'italian', 'french', 'international', 'russian', 'borges', 'terminal', 'by', 'canadian', 'irish', 'composer', 'from', 'autres', 'understood', 'european', 'united', 'an', 'adages'], 'would': ['could', 'will', 'must', 'do', 'did', 'we', 'india', 'does', 'said', 'they', 'you', 'who', 'i', 'families', 'should', 'so', 'may', 'not', 'wanted', 't']}
10	{'first': ['most', 'during', 'was', 'name', 'at', 'of', 'in', 'after', 'one', 'on', 'to', 'and', 's', 'war', 'he', 'is', 'nine', 'from', 'which', 'three'], 'american': ['british', 'german', 'french', 'english', 'war', 'its', 'states', 'of', 'united', 'european', 'sale', 'international', 'however', 'union', 'autres', 'other', 'italian', 'borges', 'sholay', 'understood'], 'would': ['not', 'they', 'that', 'been', 'who', 'to', 'will', 'could', 'from', 'but', 'with', 'had', 'it', 'he', 'this', 'for', 'only', 'on', 'a', 'three']}