

## Supplementary Material for: Topic Compositional Neural Language Model

### A Detailed model inference

We provide the detailed derivation for the model inference. Start from (16), we have

$$\begin{aligned}
 & \log p(y_{1:M}, \mathbf{d} | \mu_0, \sigma_0^2, \beta) \\
 &= \log \int_{\mathbf{t}} \frac{p(\mathbf{t})}{q(\mathbf{t}|\mathbf{d})} q(\mathbf{t}|\mathbf{d}) p(\mathbf{d}|\mathbf{t}) \prod_{m=1}^M p(y_m | y_{1:m-1}, \mathbf{t}) d\mathbf{t} \\
 &= \log \mathbb{E}_{q(\mathbf{t}|\mathbf{d})} \left( \frac{p(\mathbf{t})}{q(\mathbf{t}|\mathbf{d})} p(\mathbf{d}|\mathbf{t}) \prod_{m=1}^M p(y_m | y_{1:m-1}, \mathbf{t}) \right) \\
 &\geq \mathbb{E}_{q(\mathbf{t}|\mathbf{d})} \left( \log p(\mathbf{d}|\mathbf{t}) - \log \frac{q(\mathbf{t}|\mathbf{d})}{p(\mathbf{t})} + \sum_{m=1}^M \log p(y_m | y_{1:m-1}, \mathbf{t}) \right) \\
 &= \underbrace{\mathbb{E}_{q(\mathbf{t}|\mathbf{d})} (\log p(\mathbf{d}|\mathbf{t})) - \text{KL}(q(\mathbf{t}|\mathbf{d}) || p(\mathbf{t} | \mu_0, \sigma_0^2))}_{\text{neural topic model}} \\
 &\quad + \underbrace{\mathbb{E}_{q(\mathbf{t}|\mathbf{d})} \left( \sum_{n=1}^M \log p(y_n | y_{1:n-1}, \mathbf{t}) \right)}_{\text{neural language model}}.
 \end{aligned}$$

### B Documents used to infer topic distributions

The documents used to infer the topic distributions plotted in Figure 2 are provided below.

**Apnews** : colombia 's police director says six police officers have been killed and a seventh wounded in ambush in a rural southwestern area where leftist rebels operate . gen. jose roberto leon tells the associated press that the officers were riding on four motorcycles when they were attacked with gunfire monday afternoon on a rural stretch of highway in the cauca state town of padilla . he said a front of the revolutionary armed forces of colombia , or farc , operates in the area . if the farc is responsible , the deaths would bring to 15 the number of security force members killed since the government and rebels formally opened peace talks in norway on oct. 18 . the talks to end a nearly five-decade-old conflict are set to begin in earnest in cuba on nov. 15 .

**IMDB** : having just watched this movie for a second time , some years after my initial viewing , my feelings remain unchanged . this is a solid sci-fi drama that i enjoy very much . what sci-fi elements there are , are primarily of added interest rather than the main substance of the film . what this movie is really about is wartime conflict , but in a sci-fi setting . it has a

solid cast , from the ever reliable david warner to the up and coming freddie prinze jr , also including many british tv regulars ( that obviously add a touch of class :) , not forgetting the superb tcheky karyo . i feel this is more of an ensemble piece than a starring vehicle . reminiscent of wwii films based around submarine combat and air-combat ( the fighters seem like adaptations of wwii corsairs in their design , evoking a retro feel ) this is one of few american films that i felt was not overwhelmed by sentiment or saccharine . the sets and special effects are all well done , never detracting from the believability of the story , although the kill-rathi themselves are rather under developed and one dimensional . this is a film more about humanity in conflict rather than a film about exploring a new and original alien race or high-brow sci-fi concepts . forget that it 's sci-fi , just watch and enjoy .

**BNC**: an army and civilian exercise went ahead in secret yesterday a casualty of the general election . the simulated disaster in exercise gryphon 's lift was a midair collision between military and civilian planes over catterick garrison . hamish lumsden , the ministry of defence 's chief press officer who arrived from london , said : ' there 's an absolute ban on proactive pr during an election . ' journalists who reported to gaza barracks at 7.15 am as instructed were told they would not be allowed to witness the exercise , which involved 24 airmobile brigade , north yorkshire police , fire and ambulance services , the county emergency planning department and ' casualties ' from longlands college , middlesbrough . the aim of the gryphon lift was to test army support for civil emergencies . brief details supplied to the press outlined the disaster . a fully loaded civilian plane crashes in mid-air with an armed military plane over catterick garrison . the 1st battalion the green howards and a bomb disposal squad cordon and clear an area scattered with armaments . 24 airmobile field ambulance , which served in the gulf war , tends a burning , packed youth hostel hit by pieces of aircraft . 38 engineer regiment from claro barracks , ripon , search a lake where a light aircraft crashed when hit by flying wreck age . civilian emergency services , including the police underwater team , were due to work alongside military personnel under the overall co-ordination of the police . mr lumsden said : ' there is a very very strict rule that during a general election nothing that the government does can intrude on the election process . '

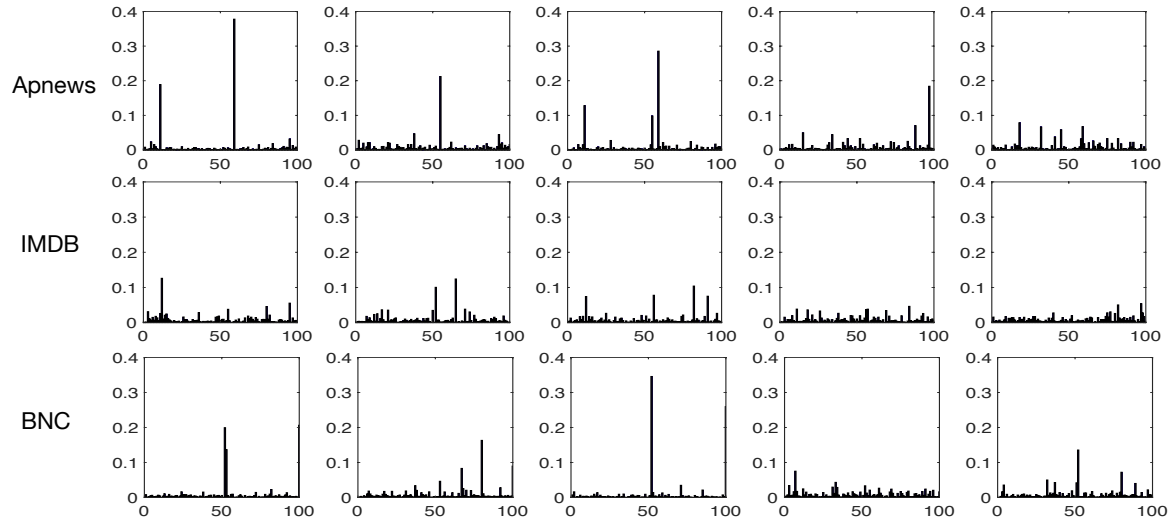


Figure 3: Inferred topic distributions for the first 5 documents in the development set over each dataset.

### C More inferred topic distribution examples

We present the inferred topic distributions for the first 5 documents in the development set over each dataset in Figure 3.

### D More generated sentences

We present generated sentences using the topics listed in Table 3 for each dataset. The generated sentences for a single topic are provided in Table 7, 8, 9; the generated sentences for a mixed combination of topics are provided in Table 10.

Topic	Generated Sentences
army	<ul style="list-style-type: none"> <li>• a female sergeant, serving in the fort worth, has served as she served in the military in iraq .</li> <li>• obama said the obama administration is seeking the state 's expected endorsement of a family by afghan soldiers at the military in world war ii, whose lives at the base of kandahar .</li> <li>• the vfw announced final results on the u.s. and a total of \$ 5 million on the battlefield , but he 's still running for the democratic nomination for the senate .</li> </ul>
animal	<ul style="list-style-type: none"> <li>• most of the bear will have stumbled to the lake .</li> <li>• feral horses takes a unique mix to forage for their pets and is birth to humans .</li> <li>• the zoo has estimated such a loss of half in captivity , which is soaked in a year .</li> </ul>
medical	<ul style="list-style-type: none"> <li>• physicians seeking help in utah and the nih has had any solutions to using the policy and uses offline to be fitted with a testing or body .</li> <li>• that triggers monday for the study were found behind a list of breast cancer treatment until the study , as does in nationwide , has 60 days to sleep there .</li> <li>• right stronger , including the virus is reflected in one type of drug now called in the clinical form of radiation .</li> </ul>
market	<ul style="list-style-type: none"> <li>• the company said it expects revenue of \$ &lt;unk&gt; million to \$ &lt;unk&gt; million in the third quarter .</li> <li>• biglari said outside parliament district of january, up \$ 4.30 to 100 cents per share , the last summer of its year to \$ 2 .</li> <li>• four analysts surveyed by zacks expected \$ &lt;unk&gt; billion .</li> </ul>
lottery	<ul style="list-style-type: none"> <li>• the numbers drawn friday night were &lt;unk&gt; .</li> <li>• where the winning numbers drawn up for a mega ball was sold .</li> <li>• the jackpot is expected to be in july .</li> </ul>
terrorism	<ul style="list-style-type: none"> <li>• the russian officials have previously said the senior president made no threats .</li> <li>• obama began halting control of the talks friday and last year in another round of the peace talks after the north 's artillery attack there wednesday have &lt;unk&gt; their highest debate over his cultural weapons soon .</li> <li>• the turkish regime is using militants into mercenaries abroad to take on gates was fired by the west and east jerusalem in recent years</li> </ul>
law	<ul style="list-style-type: none"> <li>• the ecoc lawsuit says it 's entitled to work time for repeated reporting problems that would kick a nod on cheap steel from the owner</li> <li>• the state allowed marathon to file employment , and the ncaa has a broken record of sale and fined for \$ &lt;unk&gt; for a check</li> <li>• the taxpayers in the lawsuit were legally alive and march &lt;unk&gt; , or past at improper times of los alamos</li> </ul>
art	<ul style="list-style-type: none"> <li>• quentin tarantino 's announcements that received the movie &lt;unk&gt; spanish</li> <li>• cathy johnson , jane 's short-lived singer steve dean and " the broadway music musical show , " the early show , " adds classics , &lt;unk&gt; or 5,500 , while restaurants have picked other &lt;unk&gt; next</li> <li>• katie said , he 's never created the drama series : the movies could drops into his music lounge and knife away in a long forgotten gown</li> </ul>
transportation	<ul style="list-style-type: none"> <li>• young and bernard madoff would pay more than \$ 11 million in banks , the airline said announced by the &lt;unk&gt;</li> <li>• the fraud case included a delta 's former business travel business official whose fake cards " led to the scheme , " and to have been more than \$ 10,000 .</li> <li>• a former u.s. attorney 's office cited in a fraud scheme involving two engines , including mining companies led to the government from the government .</li> </ul>
education	<ul style="list-style-type: none"> <li>• the state 's &lt;unk&gt; school board of education is not a &lt;unk&gt; .</li> <li>• assembly member &lt;unk&gt;, charter schools chairman who were born in new york who married districts making more than lifelong education play the issue , tells the same story that they 'll be able to support the legislation .</li> <li>• the state 's leading school of grant staff has added the current schools to &lt;unk&gt; students in a &lt;unk&gt; class and ripley aims to serve child &lt;unk&gt; and social sciences areas filled into in may and the latest resources</li> </ul>

Table 7: More generated sentences using topics learned from APNEWS.

Topic	Generated Sentences
horror	<ul style="list-style-type: none"> <li>• the killer is a guy who is n't even a zombie .</li> <li>• the cannibals want to one scene , the girl has something out of the head and chopping a concert by a shark in the head , and he heads in the shower while somebody is sent to &lt;unk&gt; .</li> <li>• a bunch of teenage slasher types are treated to a girl who gets murdered by a group of friends .</li> </ul>
action	<ul style="list-style-type: none"> <li>• the action is a bit too much , but the action is n't very good .</li> <li>• some really may be that the war scene was a trademark &lt;unk&gt; when fighting sequences were used by modern kung fu 's rubbish .</li> <li>• action packed neatly , a fair amount of gunplay and science fiction acts as a legacy to a cross between 80s and , great gunplay and scenery .</li> </ul>
family	<ul style="list-style-type: none"> <li>• the film is also the story of a young woman whose &lt;unk&gt; and &lt;unk&gt; and very yet ultimately sympathetic , &lt;unk&gt; relationship , &lt;unk&gt; , and palestine being equal , and the old man , a &lt;unk&gt; .</li> <li>• catherine seeks work and her share of each other , a &lt;unk&gt; desire , and submit to her , but he does not really want to rethink her issues , or where he aborted his mother 's quest to &lt;unk&gt; .</li> <li>• then i 'm about the love , but after a family meeting , her friend aditya ( tatum &lt;unk&gt; ) marries a 16 year old girl , will be able to understand the amount of her boyfriend anytime</li> </ul>
children	<ul style="list-style-type: none"> <li>• snoopy starts to learn what we do but i 'm still bringing up in there .</li> <li>• i consider this movie to be a children 's film for kids .</li> <li>• my favorite childhood is a touch that depicts her how the mother was what they apparently would 've brought it to the right place to fox .</li> </ul>
war	<ul style="list-style-type: none"> <li>• the documentary is a documentary about the war and the &lt;unk&gt; of the war.</li> <li>• one of the major failings of the war is that the germans also struggle to overthrow the death of the muslims and the nazi regime , and &lt;unk&gt; .</li> <li>• the film goes , far as to the political , but the news that will be &lt;unk&gt; at how these people can be reduced to a rescue .</li> </ul>
detective	<ul style="list-style-type: none"> <li>• hopefully that 's starting &lt;unk&gt; as half of rochester takes the character in jane 's way , though holmes managed to make tyrone power perfected a lot of magical stuff , playing the one with hamlet today .</li> <li>• while the film was based on the stage adaptation , i know she looked up to suspect from the entire production .</li> <li>• there was no previous version in my book i saw , only to those that read the novel , and i thought that no part that he was to why are far more professional .</li> </ul>
sci-fi	<ul style="list-style-type: none"> <li>• the monster is much better than the alien in which the &lt;unk&gt; was required for nearly every moment of the film .</li> <li>• were the astronauts feel like enough to challenge the space godzilla , where it first prevails</li> <li>• but the adventure that will arise from the earth is having a monster that can make it clear that the aliens are not wearing the &lt;unk&gt; all that will &lt;unk&gt; the laser .</li> </ul>
negative	<ul style="list-style-type: none"> <li>• the movie reinforces my token bad ratings - it 's the worst movie i have ever seen .</li> <li>• it was pretty bad , but aside from a show to the 2 idiots in their cast members , i 'm psychotic.</li> <li>• we had the garbage using peckinpah 's movies with so many &lt;unk&gt; , i can not recommend this film to anyone else .</li> </ul>
ethic	<ul style="list-style-type: none"> <li>• englund earlier in a supporting role , a closeted gay gal reporter who apparently hopes to disgrace the girls in being sexual .</li> <li>• this film is just plain stupid and insane , and a little bit of cheesy .</li> <li>• the film is well made during its turbulent , exquisite , warm and sinister joys , while a glimpse of teen relationships .</li> </ul>
episode	<ul style="list-style-type: none"> <li>• 3 episodes as a &lt;unk&gt; won 3 emmy series !</li> <li>• i remember the sopranos on tv , early 80 's , ( and in my opinion it was an abc show made to a minimum ) . .</li> <li>• the show is notable ( more of course , not with the audience ) , and most of the actors are excellent and the overall dialogue is nice to watch ( the show may have been a great episode )</li> </ul>

Table 8: More generated sentences using topics learned from IMDB.

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Topic	Generated Sentences
environment	<ul style="list-style-type: none"> <li>environmentalists immediate base calls to defend the world .</li> <li>on the formation of the political and the federal space agency , the ec 's long-term interests were scheduled to assess global warming and aimed at developing programmes based on the american industrial plants .</li> <li>companies can reconstitute or use large synthetic oil or gas .</li> </ul>
education	<ul style="list-style-type: none"> <li>the school has recently been founded by a &lt;unk&gt; of the next generation for two years .</li> <li>the institute for student education committees depends on the attention of the first received from the top of lasmo 's first round of the year .</li> <li>66 years later the team joined blackpool , with &lt;unk&gt; lives from the very good and beaten for all support crew – and a new &lt;unk&gt; student calling under ulster news may provide an &lt;unk&gt; modern enterprise .</li> </ul>
politics	<ul style="list-style-type: none"> <li>the restoration of the government announced on nov. 4 that the republic's independence to direct cuba ( three years of electoral &lt;unk&gt; would be also held in the united kingdom ( &lt;unk&gt; ) .</li> <li>a new economy in which privatization was announced on july 4 .</li> <li>agreements were hitherto accepted from simplified terms the following august 1969 in the april elections [ see pp. &lt;unk&gt; . ]</li> </ul>
business	<ul style="list-style-type: none"> <li>net earnings per share rose &lt;unk&gt; % to \$ &lt;unk&gt; in the quarter , and \$ &lt;unk&gt; m , on turnover that rose &lt;unk&gt; % to \$ &lt;unk&gt; m .</li> <li>the insurance management has issued the first quarter net profit up &lt;unk&gt; - \$ &lt;unk&gt; m , during turnover up &lt;unk&gt; % at \$ &lt;unk&gt; m ; net profit for the six months has reported the cumulative losses of \$</li> <li>the first quarter would also have a small loss of five figures in effect , due following efforts of \$ 7.3 .</li> </ul>
facilities	<ul style="list-style-type: none"> <li>the hotel is situated in the &lt;unk&gt; and the &lt;unk&gt; .</li> <li>all rooms have excellent amenities .</li> <li>the restaurant is in a small garden , with its own views and &lt;unk&gt; .</li> </ul>
sports	<ul style="list-style-type: none"> <li>the &lt;unk&gt; , who had a &lt;unk&gt; win over the &lt;unk&gt; , was a &lt;unk&gt; goal .</li> <li>harvey has been an thrashing goal for both &lt;unk&gt; and the institutional striker fell gently on the play-off tip and , through in regular &lt;unk&gt; to in the season .</li> <li>botham 's team took the fourth chance over a season without playing .</li> </ul>
art	<ul style="list-style-type: none"> <li>radio code said the band 's first album ' newest ' army club and &lt;unk&gt; album .</li> <li>they have a &lt;unk&gt; of the first album , ' run ' for a ' &lt;unk&gt; ' , the orchestra , which includes the &lt;unk&gt; , which is and the band 's life .</li> <li>nearly all this year 's album 's a sell-out tour !</li> </ul>
award	<ul style="list-style-type: none"> <li>super french for them to meet winners : the label &lt;unk&gt; with just # 50,000 should be paid for a very large size .</li> <li>a spokeswoman for &lt;unk&gt; said : this may have been a matter of practice .</li> <li>female speaker they 'll start discussing music at their home and why decisions are celebrating children again , but their popularity has arisen for environmental research .</li> </ul>
expression	<ul style="list-style-type: none"> <li>roirbak stared at him , and the smile hovering .</li> <li>but they must have seen it in the great night , aunt , so you made the blush poor that fool .</li> <li>making her cry , it was fair .</li> </ul>
crime	<ul style="list-style-type: none"> <li>the prosecution say the case is not the same .</li> <li>the chief inspector supt michael &lt;unk&gt; , across bristol road , and delivered on the site that the police had been accused to take him job because it is not above the legal services .</li> <li>she was near the same time as one of the eight men who died taken prisoner and subsequently stabbed , where she was hit away .</li> </ul>

Table 9: More generated sentences using topics learned from BNC.

Data	Topic	Generated Sentences
APNEWS	army+terrorism	<ul style="list-style-type: none"> <li>the taliban 's presence has earned a degree from the 1950-53 korean war in pakistan 's historic life since 1964 , with two example of &lt;unk&gt; soldiers from wounded iraqi army shootings and bahrain in the eastern army .</li> <li>at the same level , it would eventually be given the government administration 's enhanced military force since the war .</li> <li>the &lt;unk&gt; previously blamed for the attacks in afghanistan , which now covers the afghan army , and the united nations will be a great opportunity to practice it .</li> </ul>
	animal+lottery	<ul style="list-style-type: none"> <li>when the numbers began , the u.s. fish and wildlife service unveiled a gambling measure by agreeing to acquire a permit by animal protection staff after the previous permits became selected from the governor 's office .</li> <li>she told the newspaper that she was concerned that the buyer was in a neighborhood last year and had a gray wolf .</li> <li>the tippecanoe county historical society says it was n't selling any wolf hunts .</li> </ul>
IMDB	horror+negative	<ul style="list-style-type: none"> <li>if this movie was indeed a horrible movie i think i will be better off the film .</li> <li>he starts talking to the woman when the person gets the town, she suddenly loses children for blood and it 's annoying to death even though it is up to her fans and baby.</li> <li>what 's really scary about this movie is it 's not that bad .</li> </ul>
	sci-fi+children	<ul style="list-style-type: none"> <li>mystery inc is a lot of smoke , when a trivial , whiny girl &lt;unk&gt; troy &lt;unk&gt; and a woman gets attacked by the &lt;unk&gt; captain ( played by hurley ) .</li> <li>paul thinks him has to make up when the &lt;unk&gt; eugene discovers defeat in order to take too much time without resorting to mortal bugs , and then finds his wife and boys .</li> <li>the turtles are grown up to billy ( as he takes the rest of the fire ) and the scepter is a family and is dying .</li> </ul>
BNC	environment+politics	<ul style="list-style-type: none"> <li>&lt;unk&gt; shallow water area complex in addition an international activity had been purchased to hit &lt;unk&gt; tonnes of nuclear power at the un plant in &lt;unk&gt; , which had begun strike action to the people of southern countries .</li> <li>the national energy minister , michael &lt;unk&gt; of &lt;unk&gt; , has given a " right " route to the united kingdom 's european parliament , but to be passed by &lt;unk&gt; , the first and fourth states .</li> <li>the commission 's report on oct. 2 , 1990 , on jan. 7 denied the government 's grant to " the national level of water " .</li> </ul>
	art+crime	<ul style="list-style-type: none"> <li>as well as 36 , he is returning freelance into the red army of drama where he has finally been struck for their premiere .</li> <li>by alan donovan , two arrested by one guest of a star is supported by some teenage women for the queen .</li> <li>after the talks , the record is already featuring shaun &lt;unk&gt; 's play ' &lt;unk&gt; ' in the quartet of the ira bomb .</li> </ul>

Table 10: More generated sentences using a mixed combination of topics.