Topic Modeling as Multi-Objective Contrastive Optimization

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ICLR International Conference On Learning Representations

Paper Code

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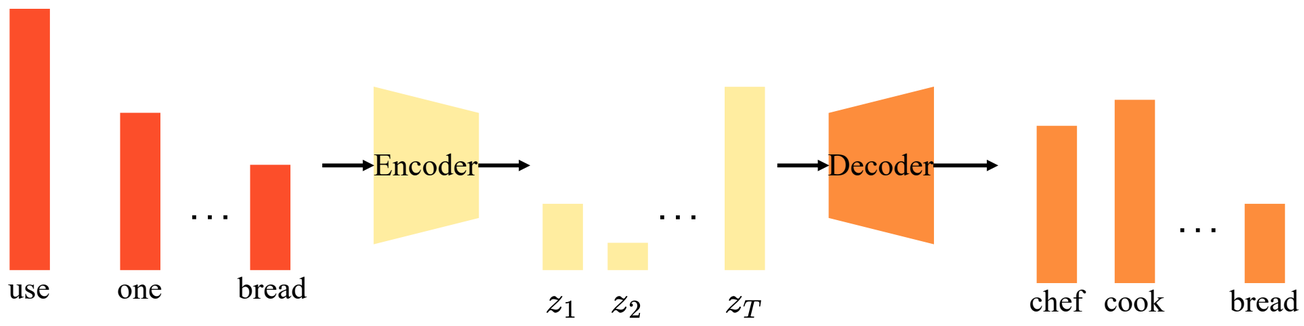
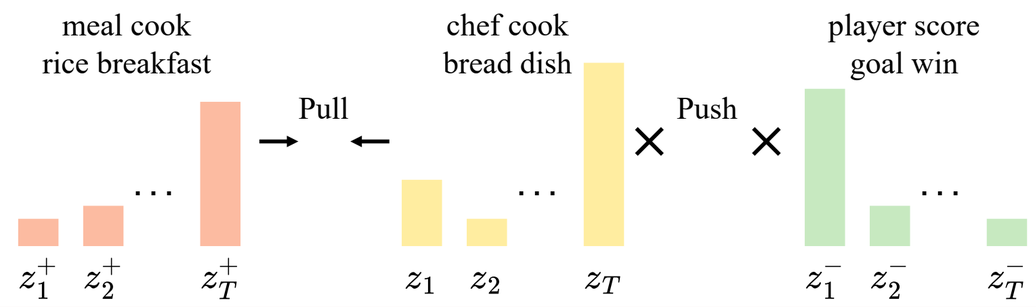
Contrastive Learning for Topic Modeling

Topic Modelling (TM)

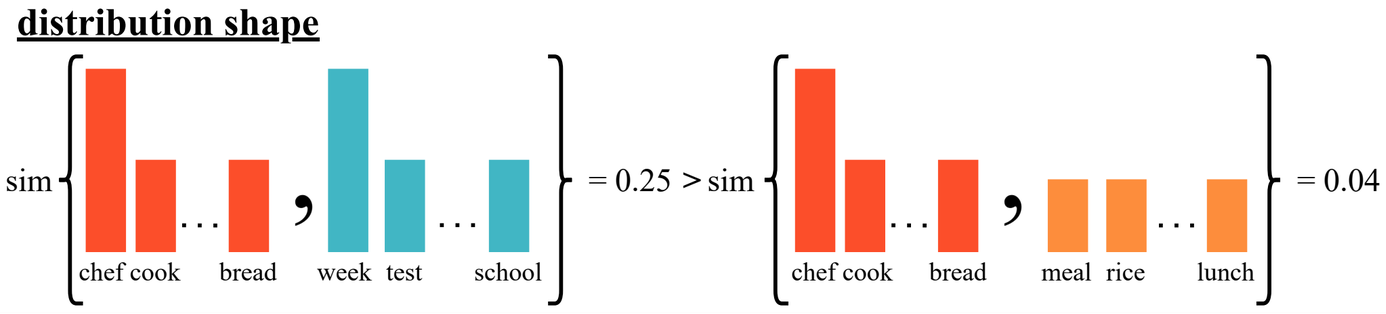


Instance-based Contastive Learning (Instance-based CL)



Problem: Instance-based Contrastive Learning Overwhelms Topic Modeling

1) Instance CL may make topic model focus on low-level feature, *e.g.* distribution shape

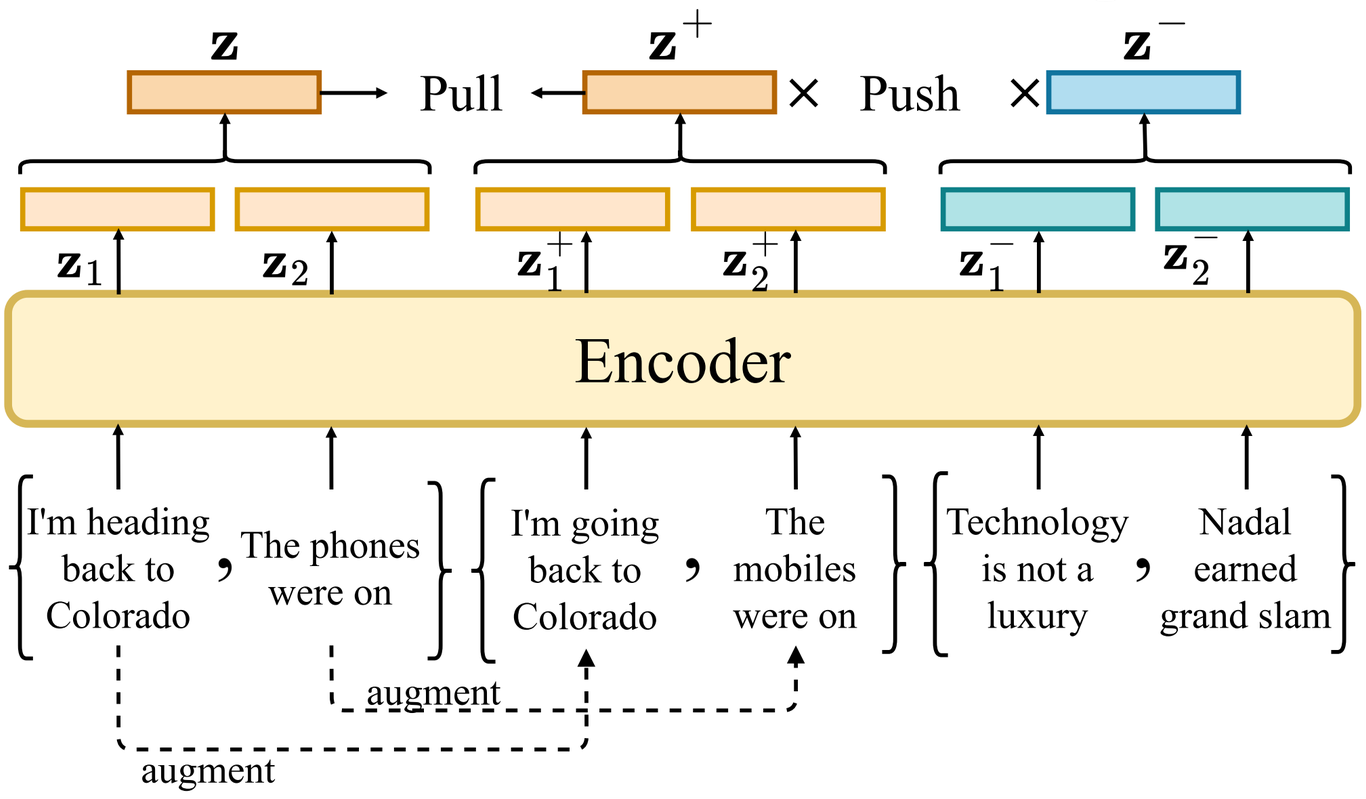


2) Instance CL loss may make topic model focus on peculiar words.

sim (shuttle land on planet, job career ask development) = 0.0093

sim (shuttle land on planet **zeppelin**, job career ask development **zeppelin**) = 0.9741

Set-based Contrastive Learning



Parameter α to balance CL and TM

Optimization objective: $\alpha \cdot L_{\text{CL}} + (1 - \alpha) \cdot L_{\text{TM}}$

We find α that achieves a balance through solving this optimization problem:

$$\min_{\alpha} \left\{ ||\alpha \nabla_\theta L_{\text{CL}}(\theta) + (1 - \alpha) \nabla_\theta L_{\text{TM}}(\theta, \phi)||_2^2, \alpha \geq 0 \right\}$$

→ Solution: use derivative!

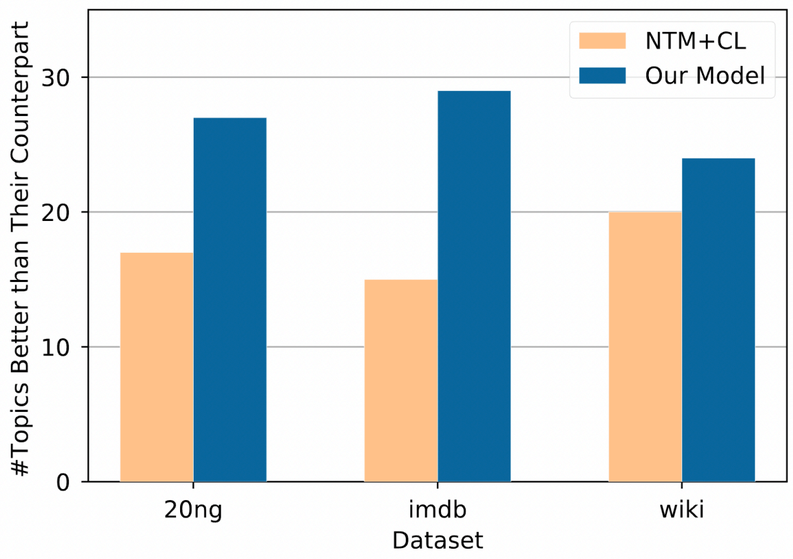
Then, we optimize the objective which is weighted by the found α.

Experiments

Quantitative Results

Method	20NG				IMDb			
	$T = 50$		$T = 200$		$T = 50$		$T = 200$	
	NPMI	TD	NPMI	TD	NPMI	TD	NPMI	TD
NTM	0.283±0.004	0.734±0.009	0.277±0.003	0.686±0.004	0.170±0.008	0.777±0.021	0.169±0.003	0.690±0.015
ETM	0.305±0.006	0.776±0.022	0.264±0.002	0.623±0.002	0.174±0.001	0.805±0.019	0.168±0.001	0.687±0.007
DVAE	0.320±0.005	0.824±0.017	0.269±0.003	0.786±0.005	0.183±0.004	0.836±0.010	0.173±0.006	0.739±0.005
BATM	0.314±0.003	0.786±0.014	0.245±0.001	0.623±0.008	0.065±0.008	0.619±0.016	0.090±0.004	0.652±0.008
W-LDA	0.279±0.003	0.719±0.026	0.188±0.001	0.614±0.002	0.136±0.007	0.692±0.016	0.095±0.003	0.666±0.009
SCHOLAR	0.319±0.007	0.788±0.008	0.263±0.002	0.634±0.006	0.168±0.002	0.702±0.014	0.140±0.001	0.675±0.005
SCHOLAR + BAT	0.324±0.006	0.824±0.011	0.272±0.002	0.648±0.009	0.182±0.002	0.825±0.008	0.175±0.003	0.761±0.010
NTM+CL	0.332±0.006	0.853±0.005	0.277±0.003	0.699±0.004	0.191±0.004	0.857±0.010	0.186±0.002	0.843±0.008
HyperMiner	0.305±0.006	0.613±0.023	0.254±0.002	0.646±0.004	0.182±0.004	0.485±0.009	0.177±0.002	0.658±0.012
WeTe	0.304±0.005	0.749±0.018	0.254±0.001	0.742±0.005	0.167±0.004	0.831±0.010	0.163±0.005	0.738±0.008
TSCTM	0.271±0.007	0.668±0.019	0.226±0.001	0.662±0.006	0.149±0.003	0.741±0.008	0.145±0.002	0.658±0.012
Our model	**0.340**±0.005	**0.913**±0.019	**0.291**±0.003	**0.905**±0.004	**0.200**±0.007	**0.916**±0.008	**0.197**±0.003	**0.892**±0.007

We have more better topics than baseline model.



Qualitative Results

Dataset	Method	NPMI	Topic
20NG	NTM+CL	0.2766	mouse monitor orange gateway video apple screen card port vga
	Our Model	0.3537	vga monitor monitors colors video screen card mhz cards color
IMDb	NTM+CL	0.1901	seagal ninja martial arts zombie zombies jet fighter flight helicopter
	Our Model	0.3143	martial arts seagal jackie chan kung hong ninja stunts kong
Wiki	NTM+CL	0.1070	architectural castle architect buildings grade historic coaster roller sculpture tower
	Our Model	0.2513	century building built church house site castle buildings historic listed