A Multilingual Topic Model for Learning Weighted Topic Links Across Corpora with Low Comparability

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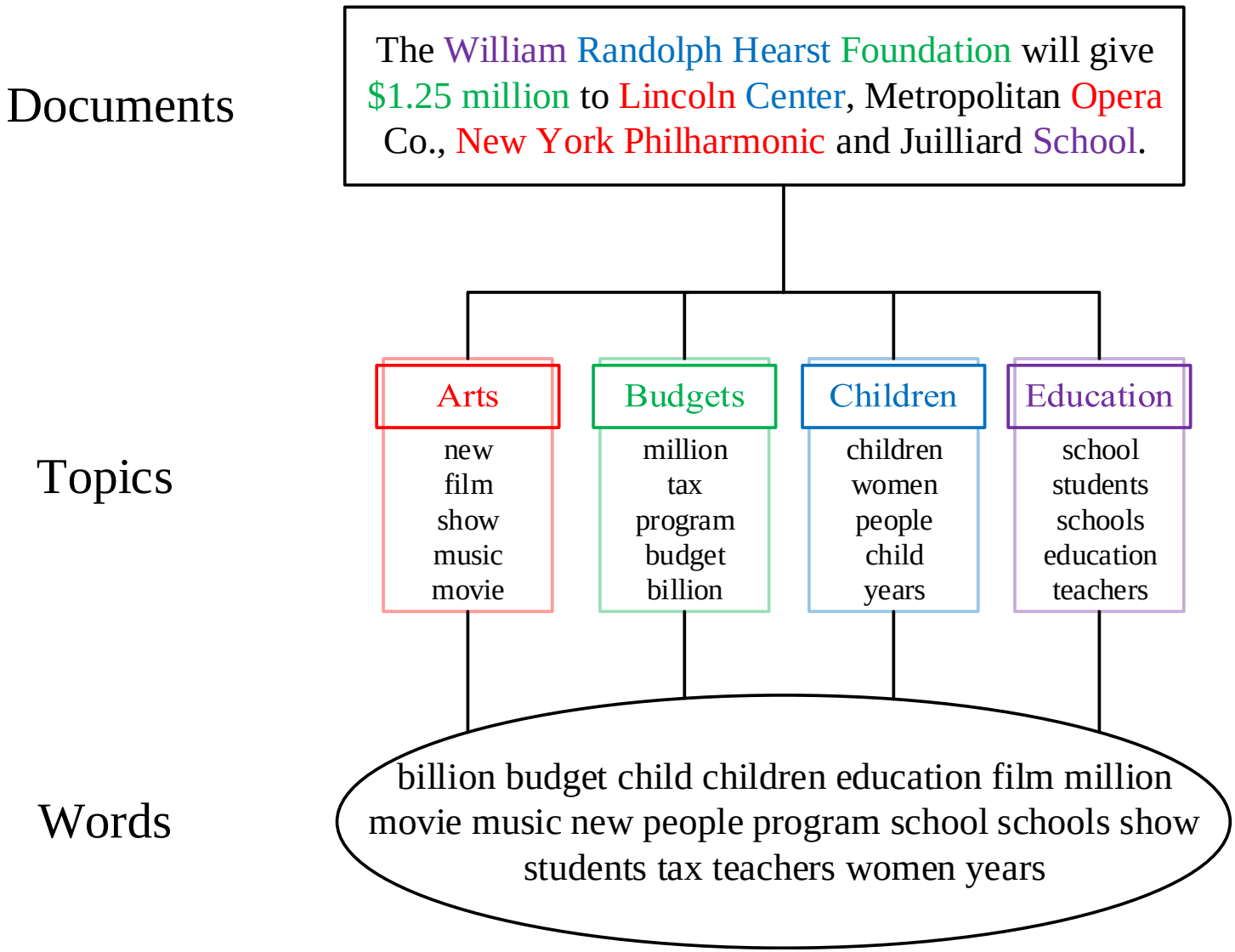
[2]Facebook, [3]Google AI Zürich

November 5, 2019

Topic Models



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- When modeling topics multilingually, it is not a good idea to assume an aligned topic space.
- Keep the topics of different languages separated and connect them by weighted topic links.

Weighted Topic Links

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- Each language's topic distributions consist of the words in that language *only*.

sports, match, referee, tournament, champion	技术，信息，计算机，智能，系统
economics, dollars, million, invest, income	教育，大学，学校，学生，教师
politics, president, government, bill, vote	运动，比赛，裁判，锦标赛，冠军
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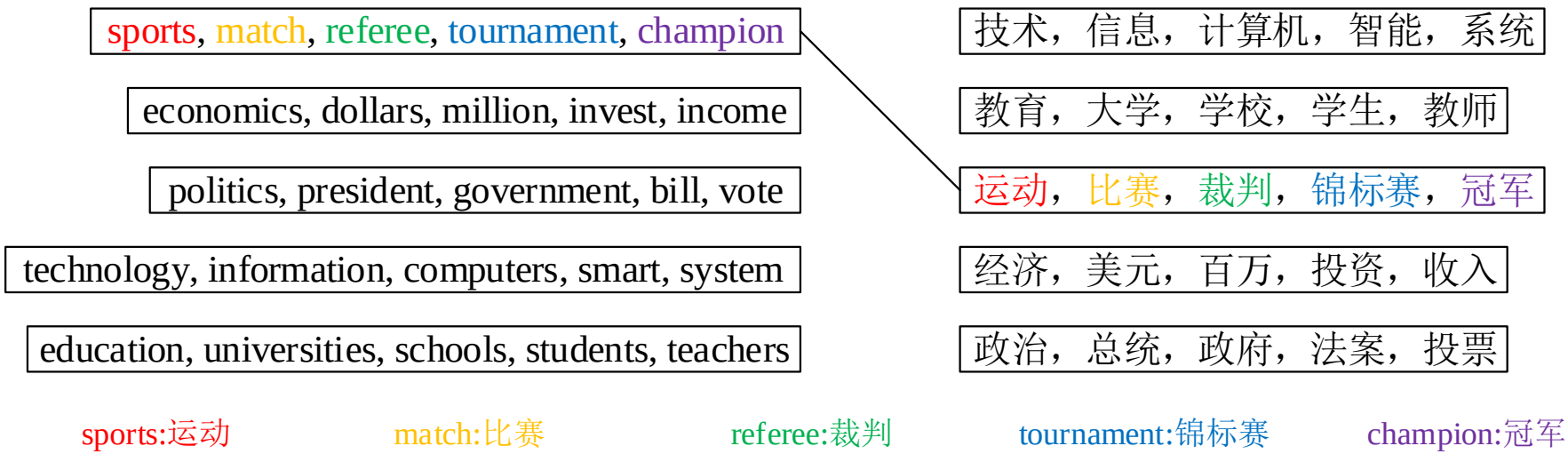

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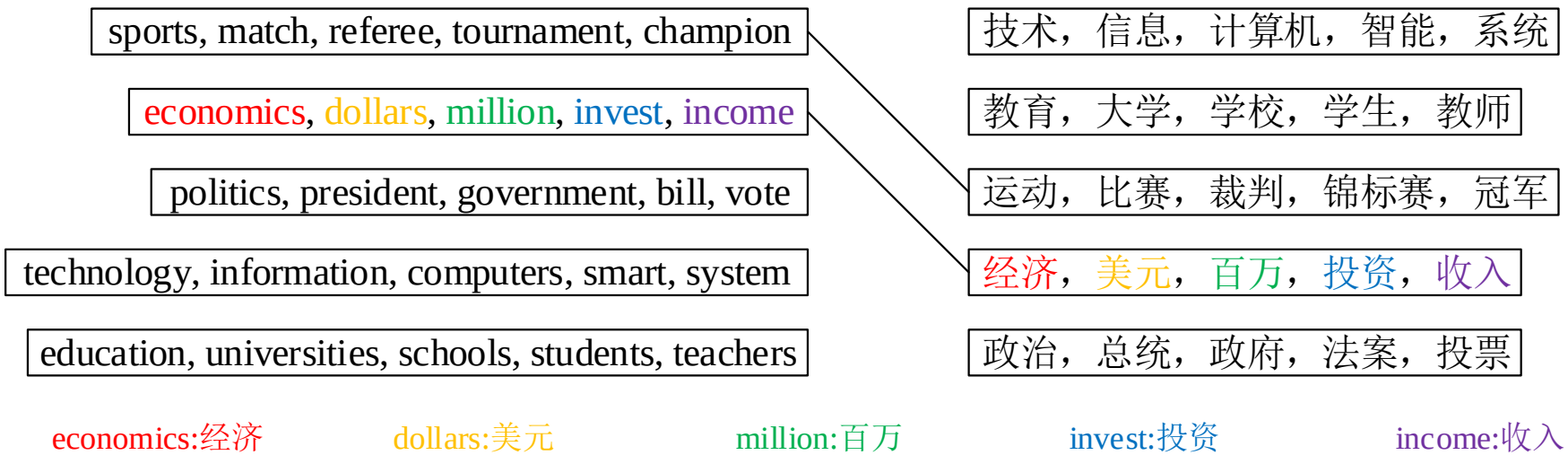

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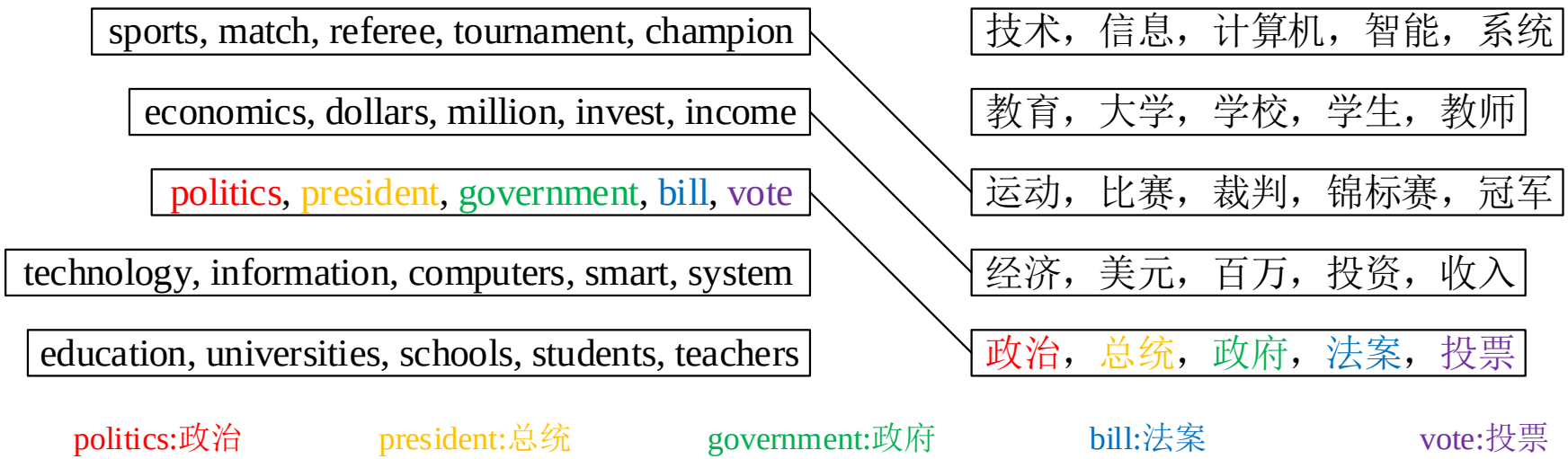

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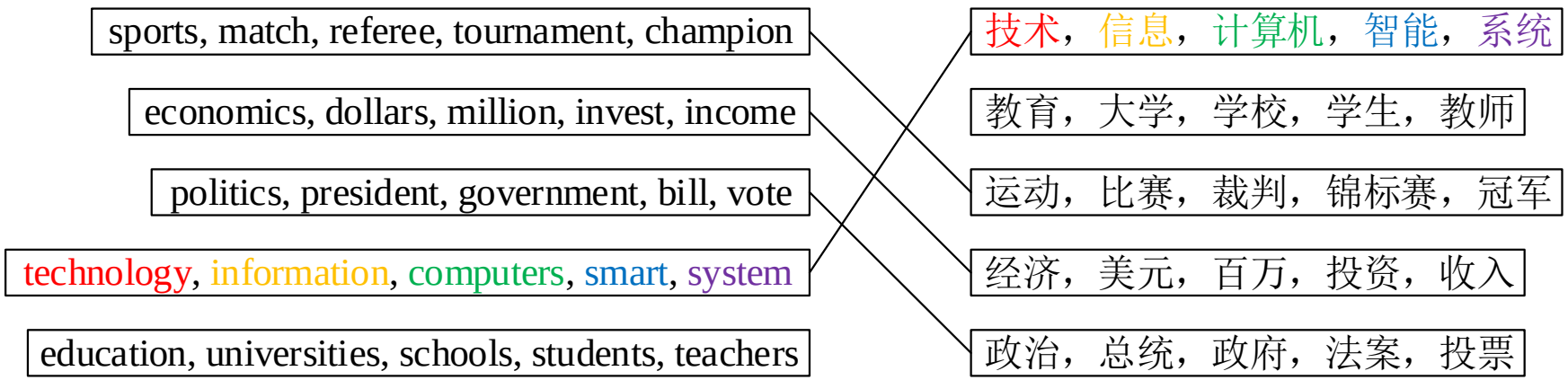

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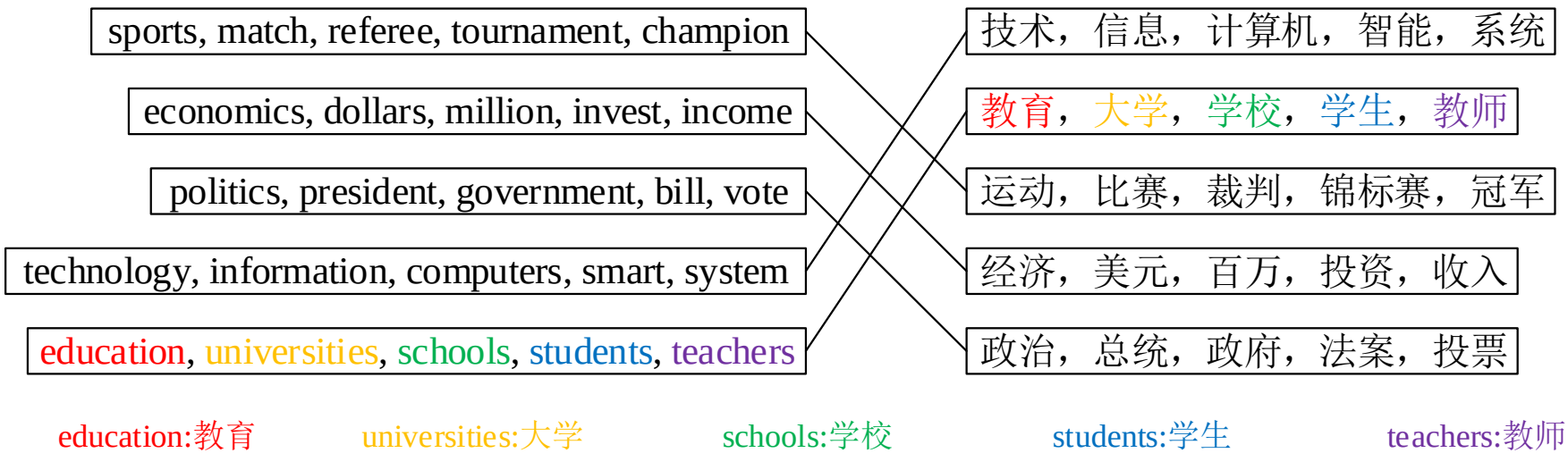

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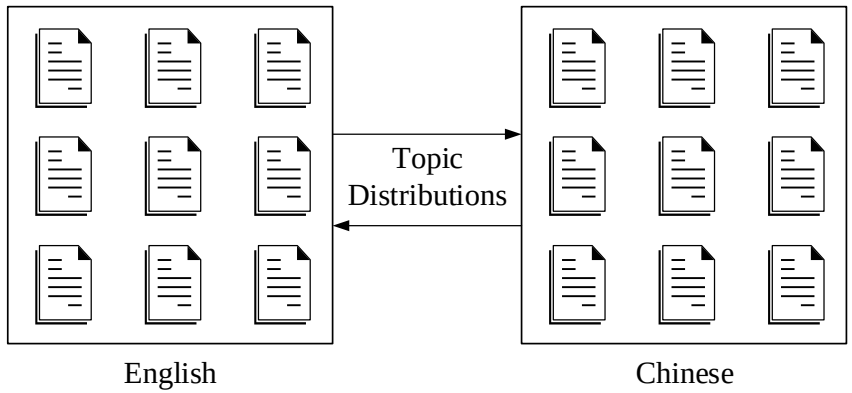

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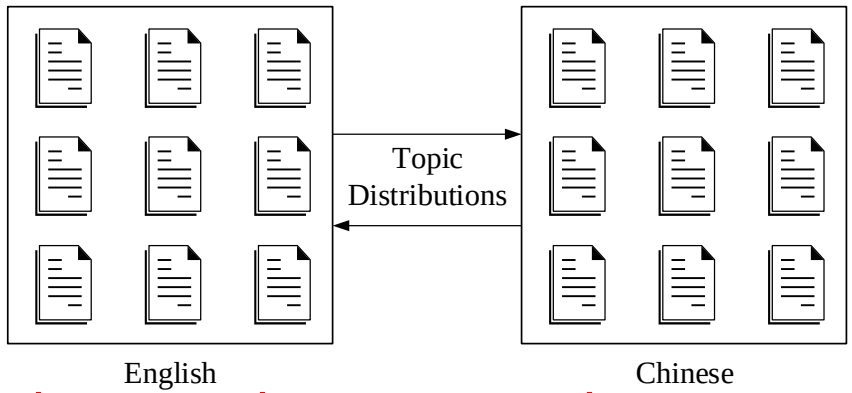
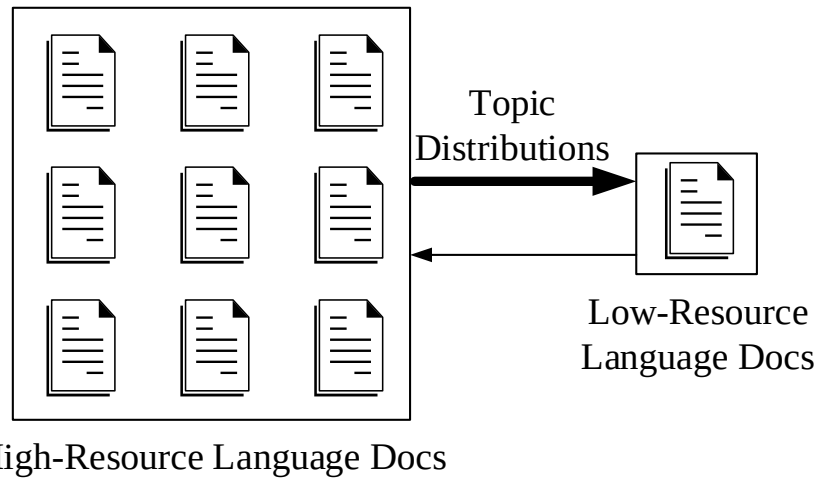


- Improve topic quality on a low-resource language with a high-resource one



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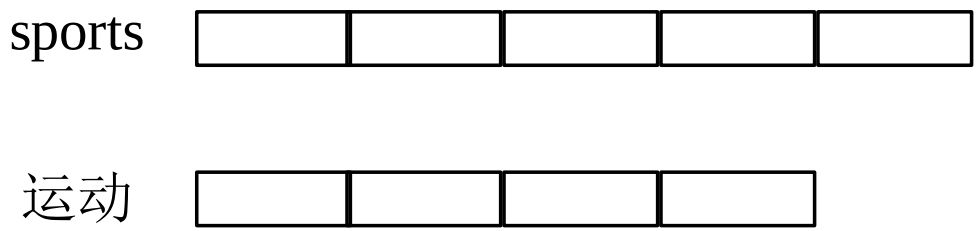

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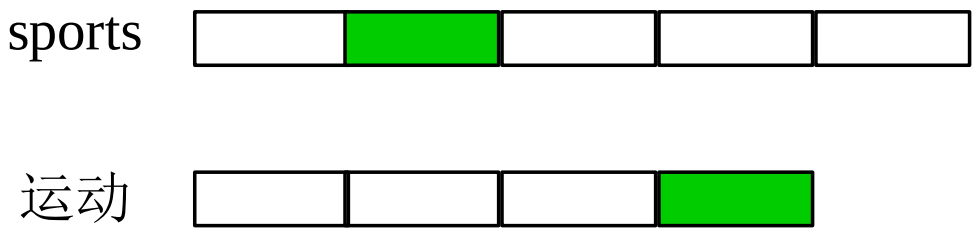

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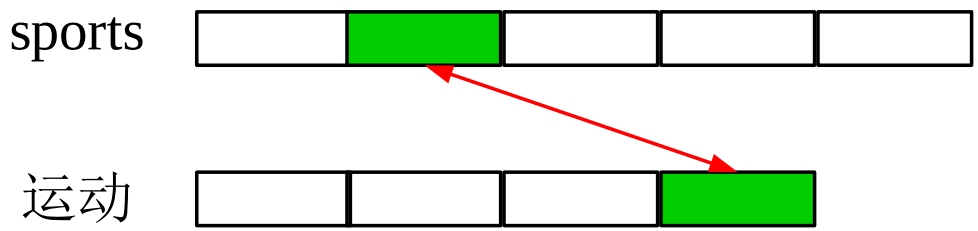

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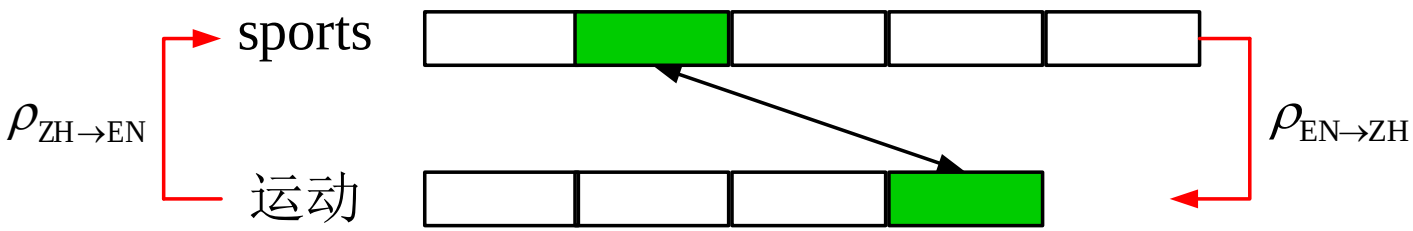
- We use two matrices $\rho_{\text{EN}\to\text{ZH}}$ and $\rho_{\text{ZH}\to\text{EN}}$ to learn the topic relationships.



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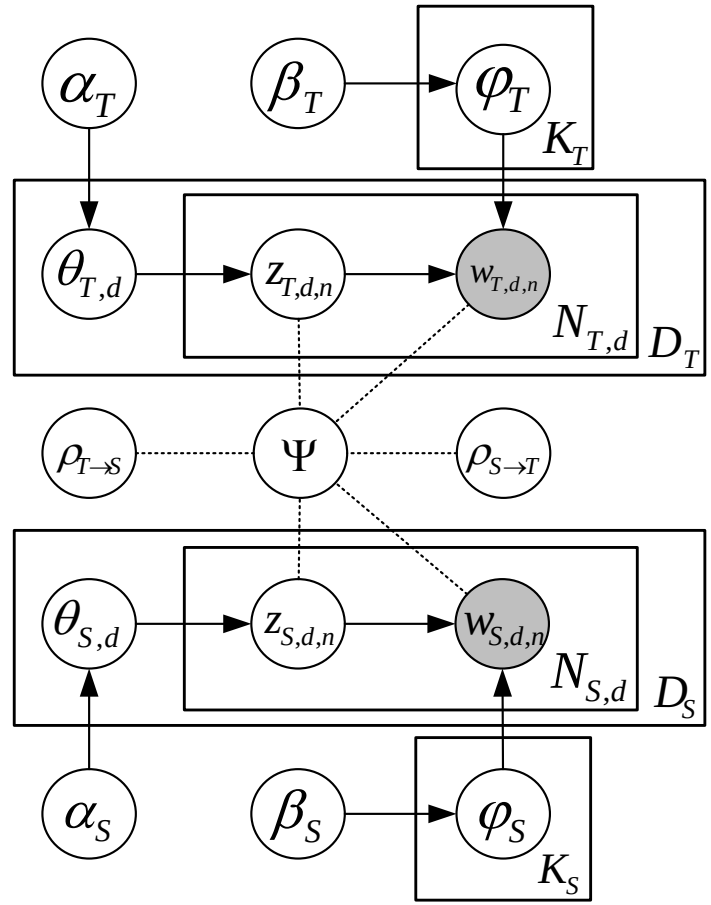

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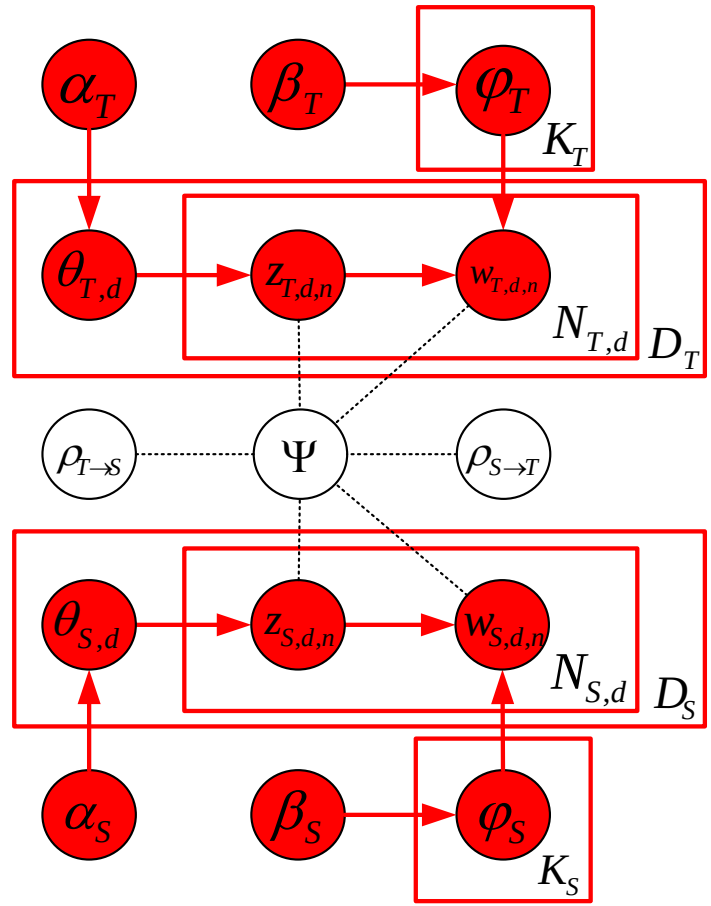

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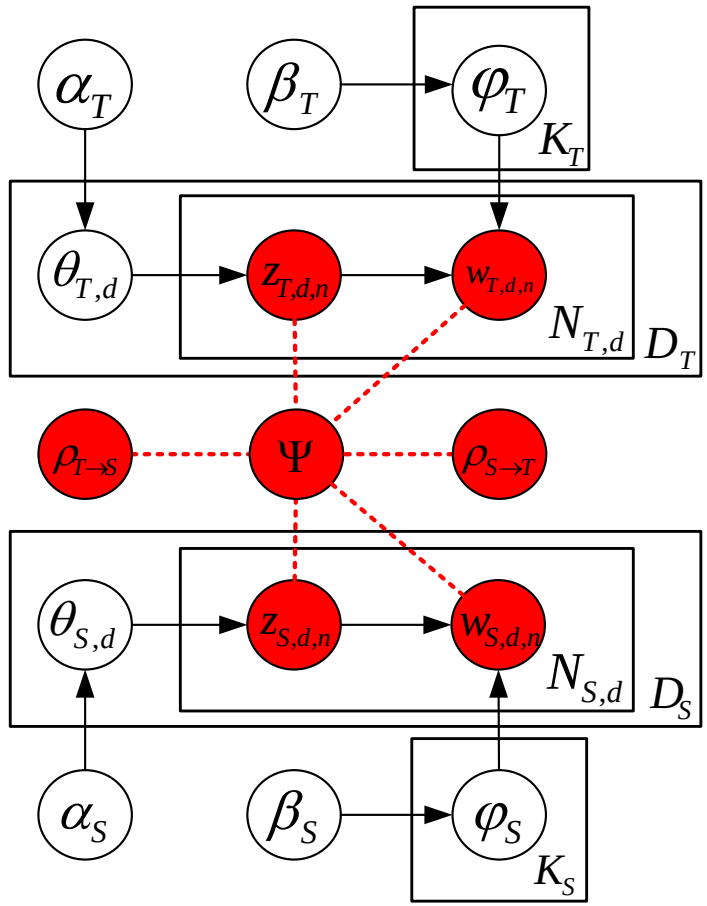

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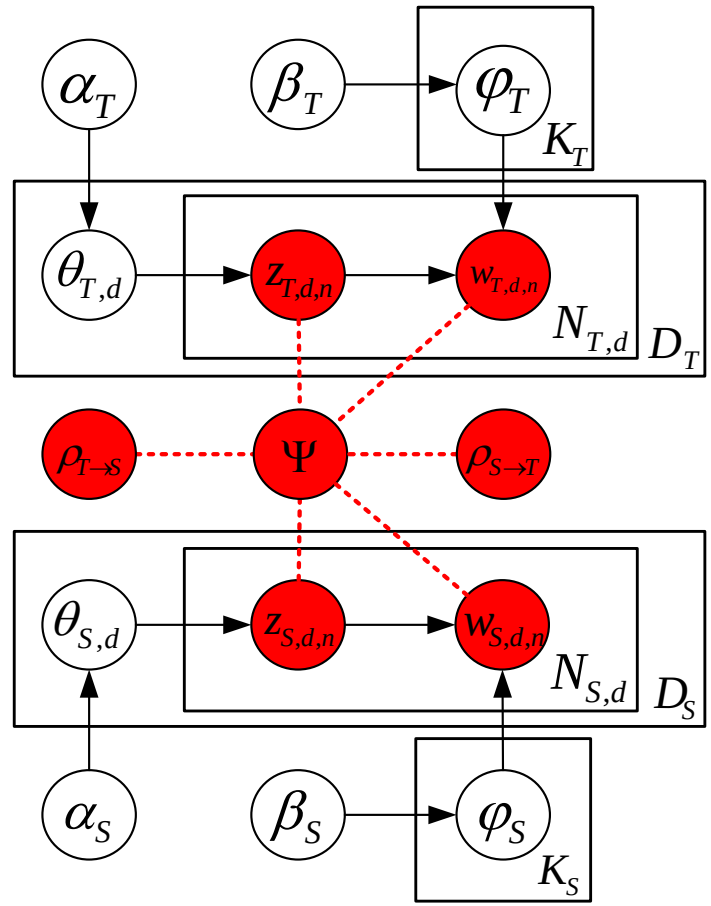
  - We optimize Ψ to minimize the topic distribution distances of translation pairs after transformation.

$$\Psi = \left(\prod_{c=1}^{C} \left[\mathrm{Dis}\left(\boldsymbol{\Omega}_{S,c}, \boldsymbol{\rho}_{T \to S} \boldsymbol{\Omega}_{T,c} \right) \right]^{\eta_c} \right)^{-1} \times \left(\prod_{c=1}^{C} \left[\mathrm{Dis}\left(\boldsymbol{\rho}_{S \to T} \boldsymbol{\Omega}_{S,c}, \boldsymbol{\Omega}_{T,c} \right) \right]^{\eta_c} \right)^{-1} \quad (1)$$



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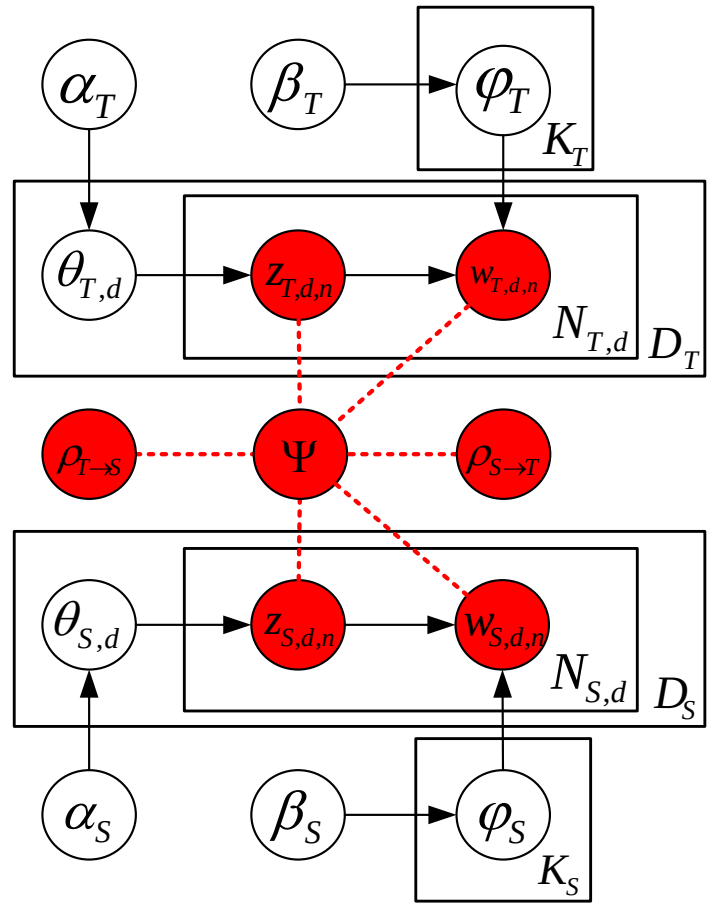

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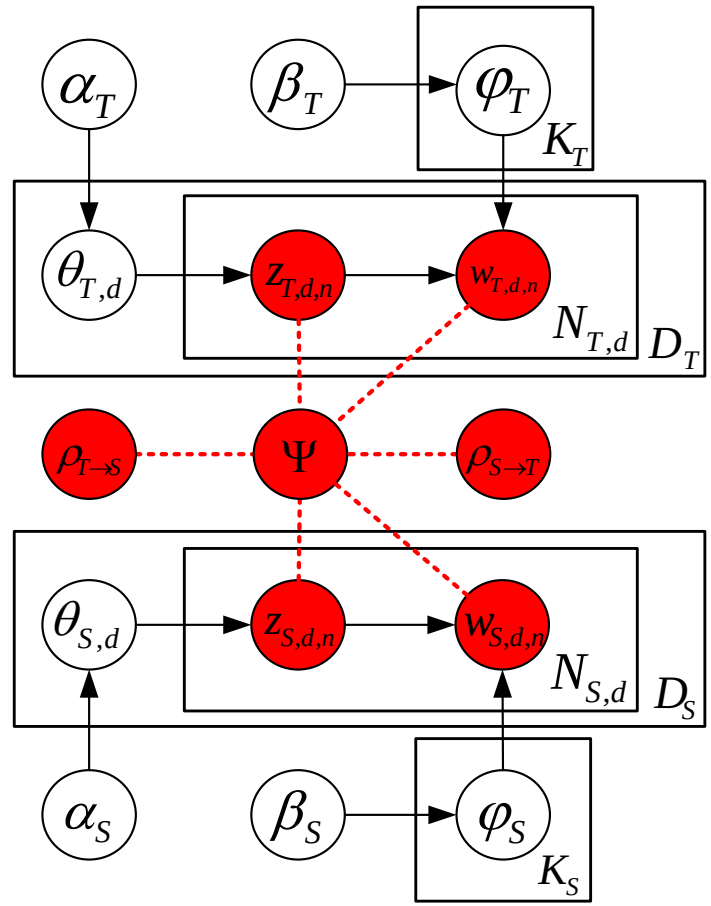
  - Each translation pair can also be weighted.



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  - Equal weights
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Intra-Lingual Classification Results

- Train and test classifiers on the same language.

Dataset	Method	EN	SI/ZH
LORELEI	MCTA	12.99	26.53
	MTAnchor	20.78	32.65
	LDA	27.78	24.01
	tLDA	12.77	18.18
	MTM	**42.86**	23.08
	MTM + TF-IDF	26.67	**38.10**
Wikipedia	MCTA	51.56	33.35
	MTAnchor	80.71	75.33
	LDA	92.08	83.37
	tLDA	91.58	83.33
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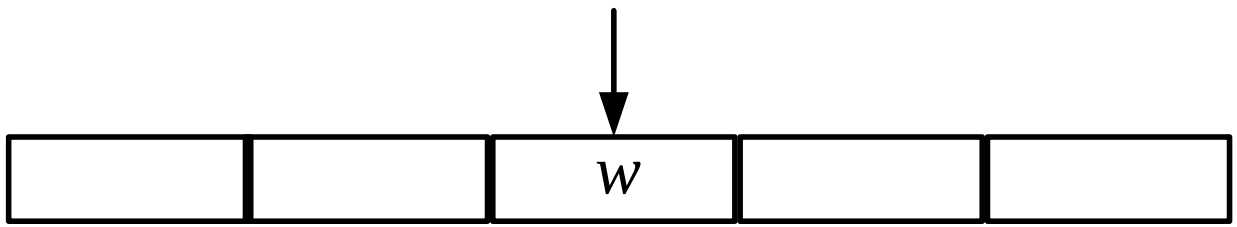

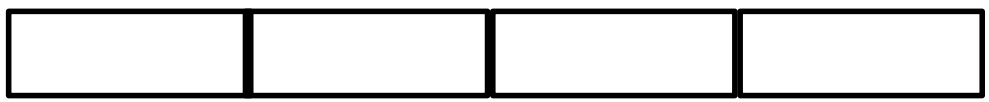

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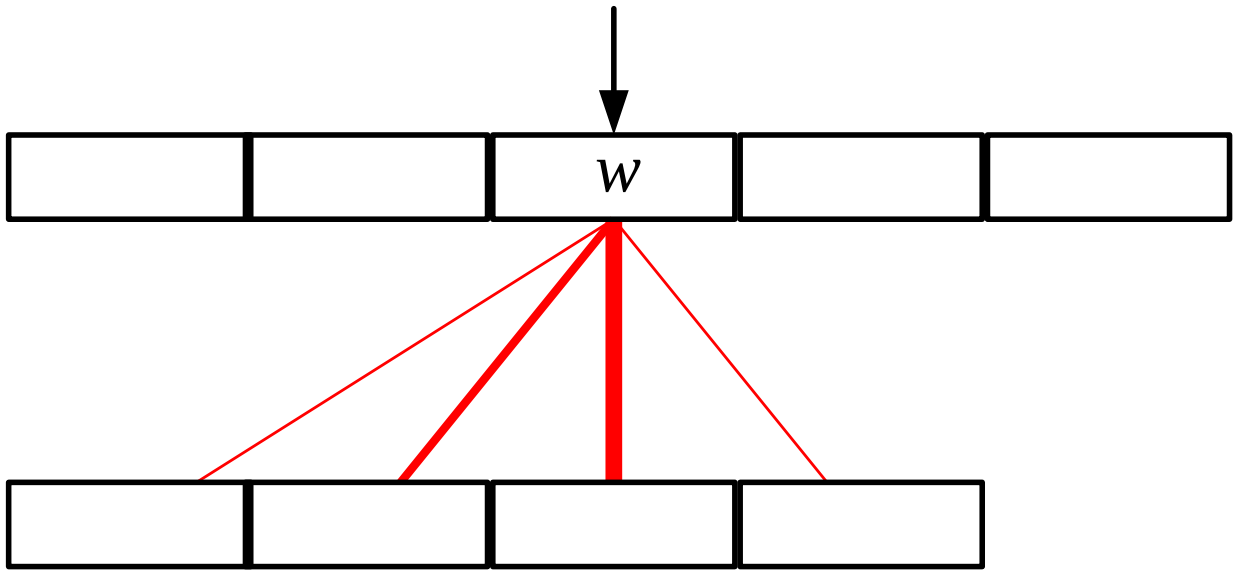

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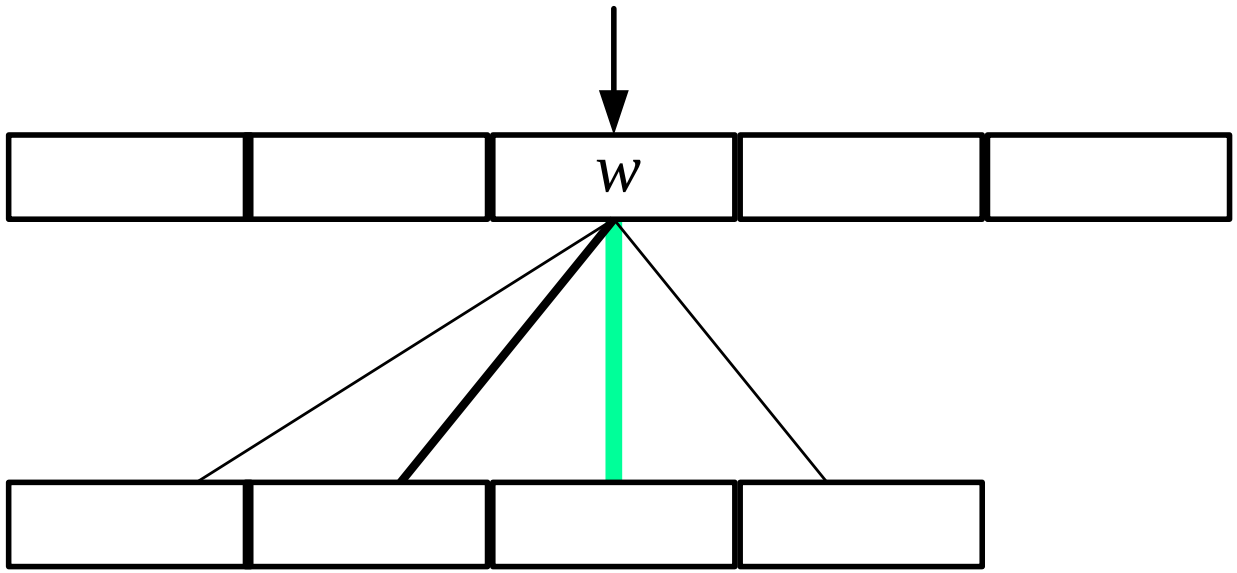

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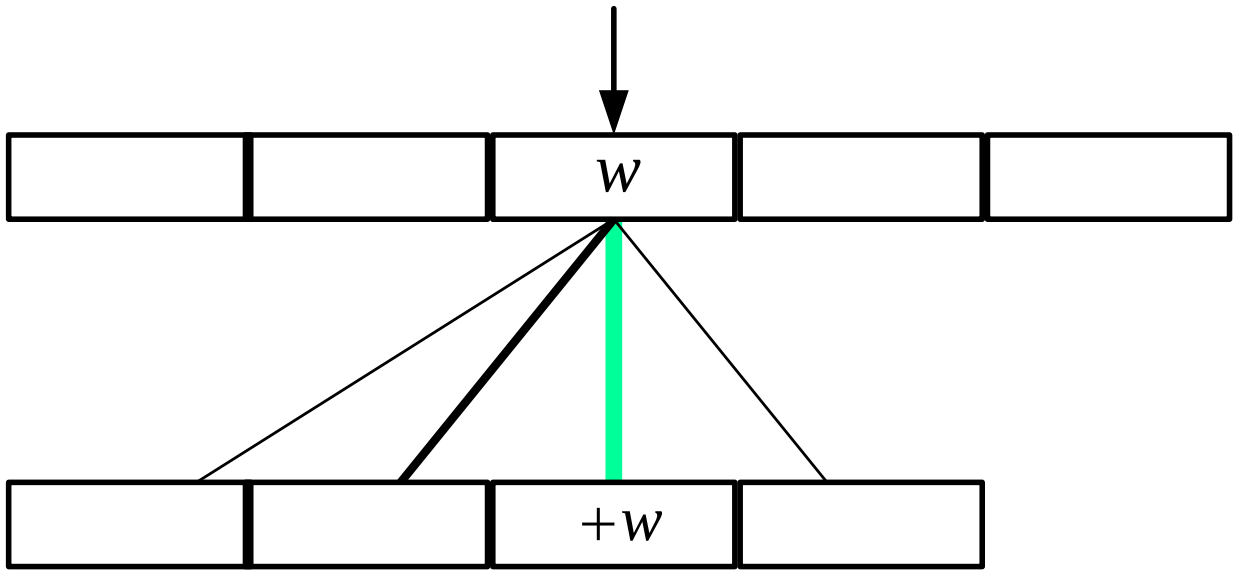

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	MTM	22.22	26.67
	MTM + TOP	**35.29**	**33.33**
	MTM + TF-IDF	14.46	15.09
	MTM + TF-IDF + TOP	14.46	11.43
Wikipedia	MCTA	23.24	39.79
	MTAnchor	57.62	54.54
	LDA	16.52	10.46
	tLDA	2.85	21.02
	MTM	74.69	64.48
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Selected Topics

Model	Lang.	Words
MCTA	ZH	主演 (starring), 改编 (adapt), 本 (this), 小说 (novel), 拍摄 (shoot), 角色 (role), 战士 (fighter)
	EN	dog, san, movie, mexican, fighter, novel, california
MTAnchor	ZH	主演 (starring), 改编 (adapt), 饰演 (act), 本片 (this movie), 演员 (actor), 编剧 (playwright), 讲述 (narrate)
	EN	kong, hong, movie, official, martial, box, reception
LDA	ZH	电影 (movie), 部 (movie quantifier), 美国 (USA), 上映 (release), 英语 (English), 剧情 (plot), 片 (movie)
	EN	film, star, direct, release, action, plot, character
tLDA	ZH	电影 (movie), 胶片 (film), 星 (star), 动作 (action), 释放 (release), 影片 (movie), 剧情 (plot)
	EN	film, star, direct, action, release, plot, write
MTM	ZH	电影 (movie), 部 (movie quantifier), 上映 (release), 动画 (animation), 故事 (story), 作品 (works), 英语 (English)
	EN	film, direct, star, release, action, plot, production
MTM + TF-IDF	ZH	电影 (movie), 部 (movie quantifier), 上映 (release), 美国 (USA), 英语 (English), 导演 (director), 片 (movie)
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	EN	dog, san, movie, mexican, fighter, novel, california
MTAnchor	ZH	主演 (starring), 改编 (adapt), 饰演 (act), 本片 (this movie), 演员 (actor), 编剧 (playwright), 讲述 (narrate)
	EN	kong, hong, movie, official, martial, box, reception
LDA	ZH	电影 (movie), 部 (movie quantifier), 美国 (USA), 上映 (release), 英语 (English), 剧情 (plot), 片 (movie)
	EN	film, star, direct, release, action, plot, character
tLDA	ZH	电影 (movie), 胶片 (film), 星 (star), 动作 (action), 释放 (release), 影片 (movie), 剧情 (plot)
	EN	film, star, direct, action, release, plot, write
MTM	ZH	电影 (movie), 部 (movie quantifier), 上映 (release), 动画 (animation), 故事 (story), 作品 (works), 英语 (English)
	EN	film, direct, star, release, action, plot, production
MTM + TF-IDF	ZH	电影 (movie), 部 (movie quantifier), 上映 (release), 美国 (USA), 英语 (English), 导演 (director), 片 (movie)
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Selected Topic Links

Lang.	Weight	Words
ZH-0	–	学名 (scientific name), 它们 (they), 呈 (show), 白色 (white), 长 (long), 黑色 (black), 厘米 (centimeter)
EN-12	0.57	specie, bird, eagle, genus, white, owl, black
EN-19	0.13	breed, chicken, white, goose, bird, black, list
EN-10	–	album, release, record, music, song, single, feature
ZH-9	0.30	专辑 (album), 张 (album quantifier), 发行 (release), 音乐 (music), 首 (song quantifier), 唱片 (record), 歌手 (singer)
ZH-17	0.20	音乐 (music), 乐团 (musical group), 艺术 (art), 创作 (create), 奖 (prize), 演出 (perform), 担任 (serve)
ZH-14	–	主义 (-ism), 组织 (organization), 美国 (USA), 革命 (evolution), 运动 (campaign), 政府 (government), 人民 (people)
EN-16	0.32	sex, law, act, sexual, marriage, court, legal
EN-11	0.17	traffic, victim, government, trafficking, child, force, country

Selected Topic Links

- Most topics are linked based on mutual top words.

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Selected Topic Links

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- For some topics, our MTM can even learn the links beyond words.

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Topic Coherence on Low-Comparability Data

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  - English
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  - Incomparable (INCO): No documents have direct translations.

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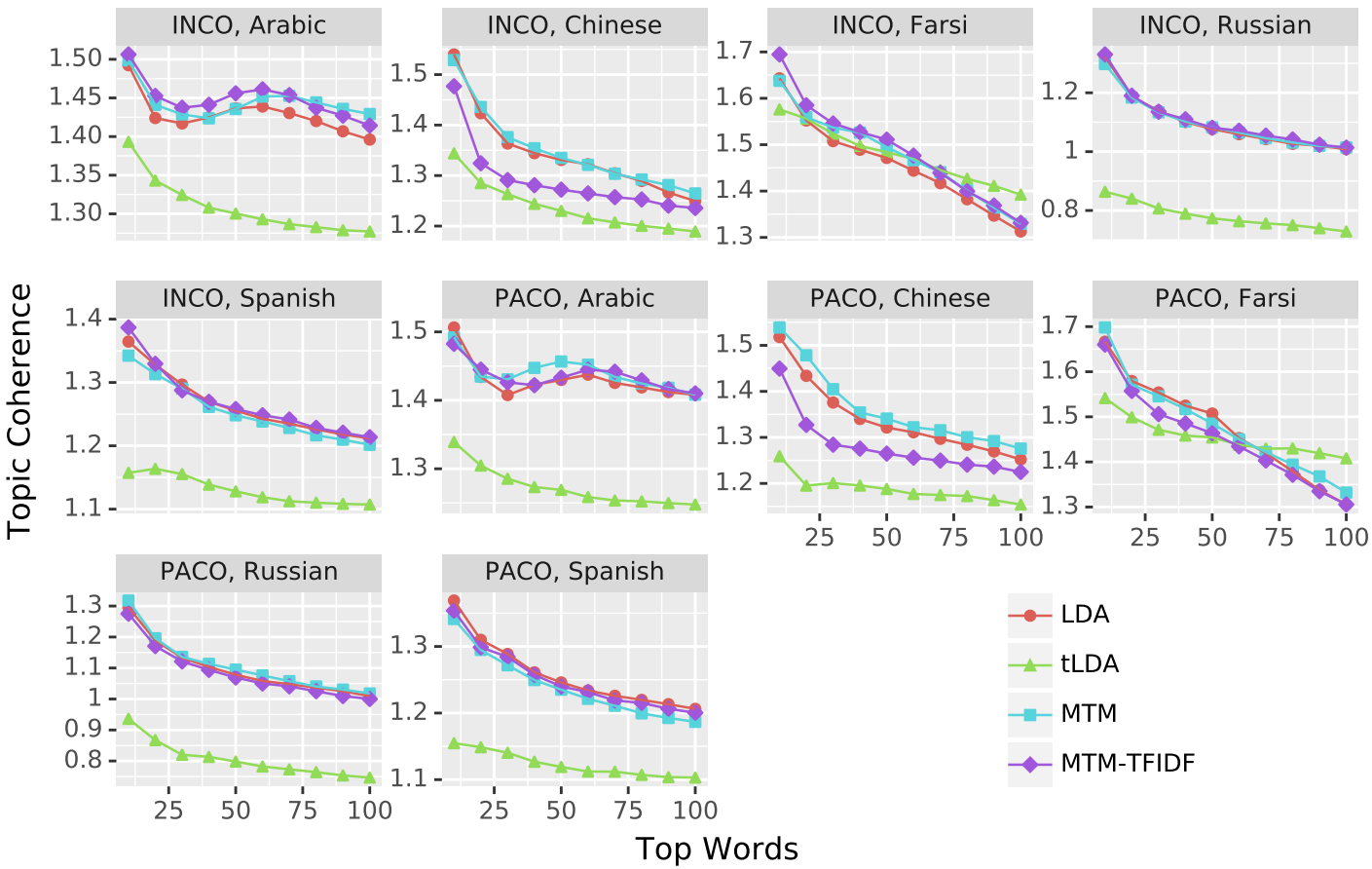
- Baselines
  - Monolingual LDA
  - tLDA with tree priors of a word translation dictionary

Topic Coherence Results on Low-Comparability Data



Topic Coherence Results on Low-Comparability Data

- MTM mostly performs as well as monolingual LDA.
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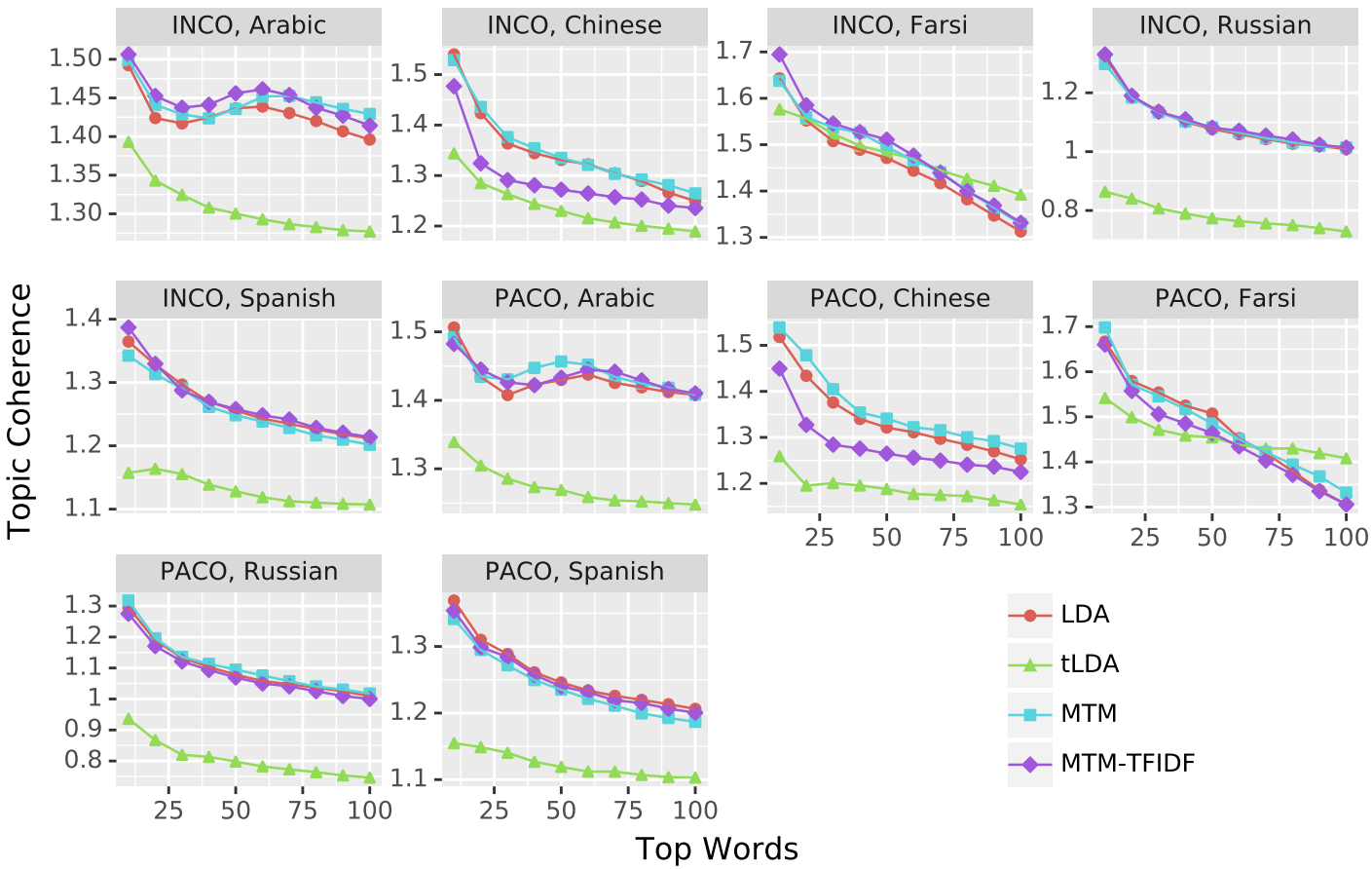
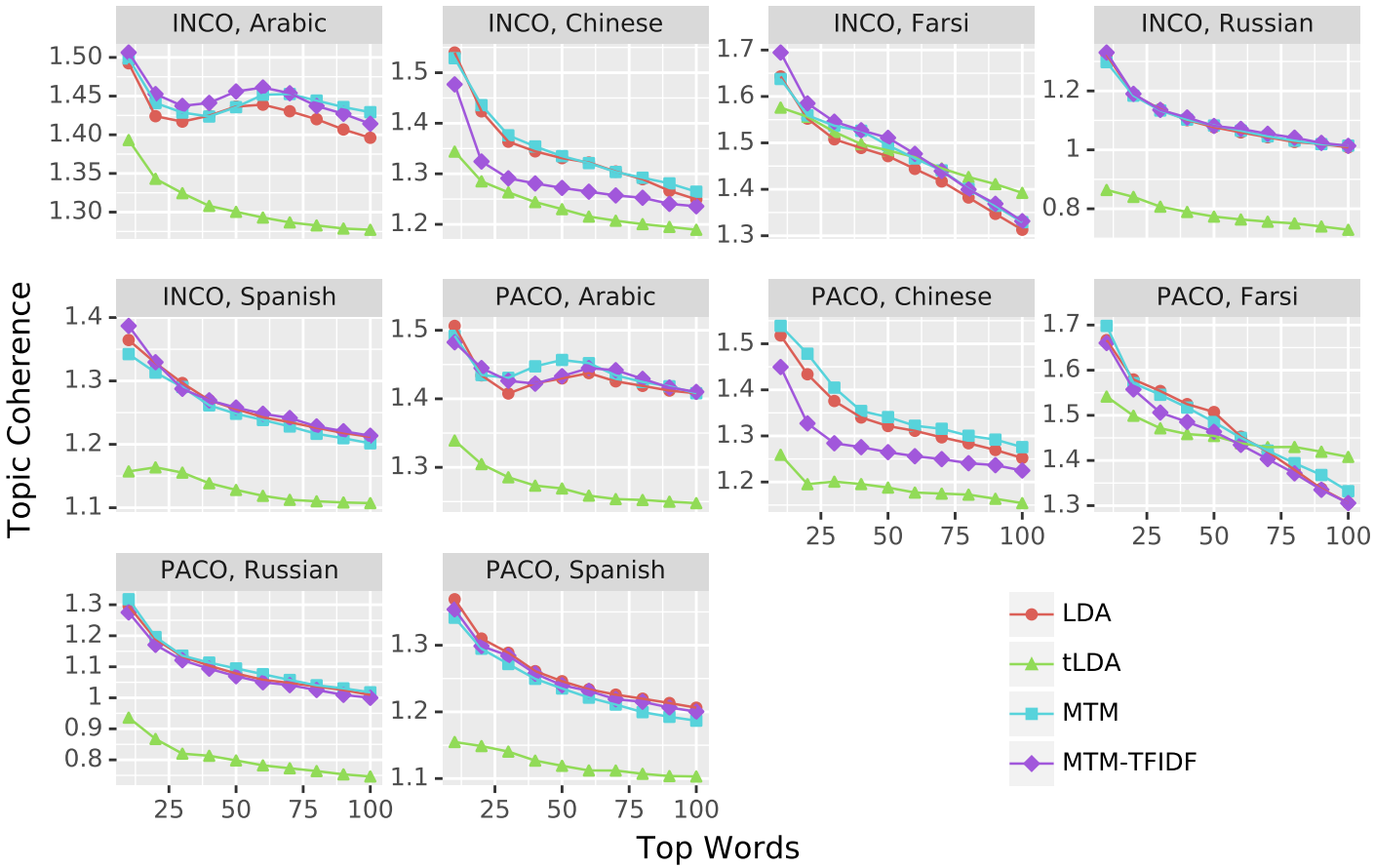


Topic Coherence Results on Low-Comparability Data

- MTM mostly performs as well as monolingual LDA.
  - Proves MTM's robustness on low-comparability data.
- tLDA sacrifices topic coherence for topic alignment.



Summary

- A multilingual topic model for learning weighted topic links
  - Does not force topic alignment and only connects topics when necessary
  - Improves classification performance both intra- and cross-lingually using the topic posteriors as features
  - Gives coherent topics and meaningful topic links
  - Robust when the data are less comparable or incomparable

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- Jordan Boyd-Graber (UMD/Google AI Zürich)
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Funders

Raytheon
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