Text classification based on the word subspace representation

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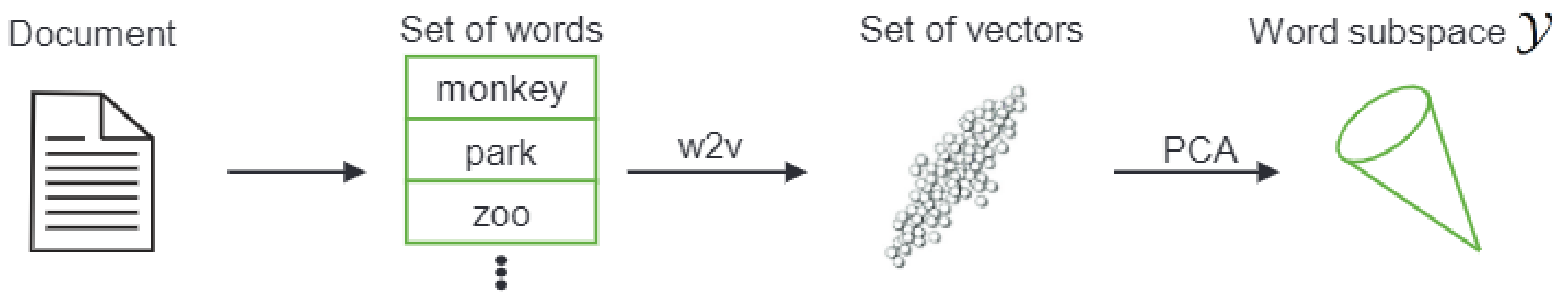
(1) Motivation and objective

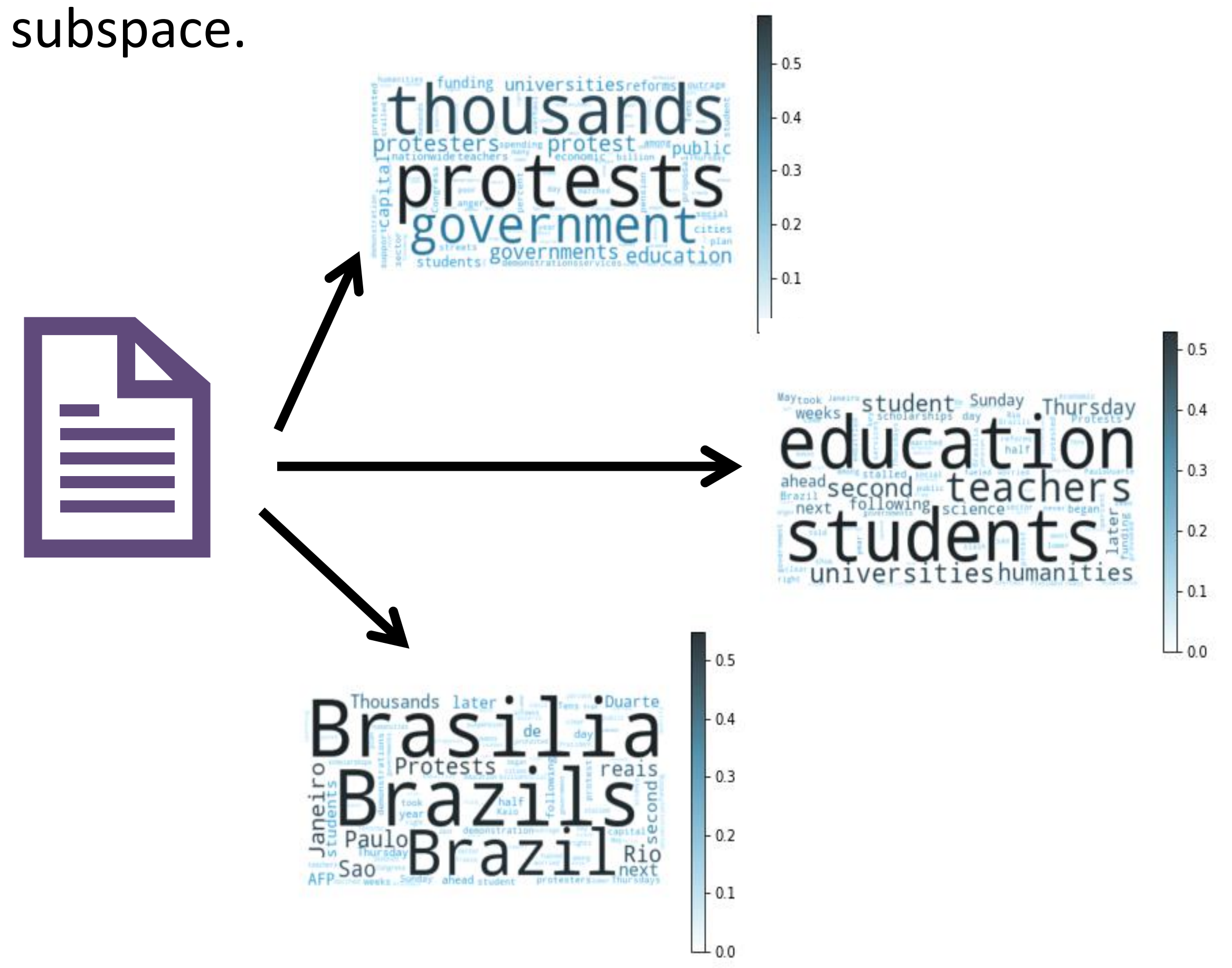
- Exploring the applications of the subspace-based methods on **Word Embeddings**.
- Word Embeddings: Arithmetic and distance calculation between two word vectors -> Semantic relationship.
- **Word subspace [1]:**
  - Modeled using the Principal Components Analysis -> Low computational cost;
  - No restriction to the number of words;
  - Basis vectors = Main hidden topics;
  - Texts can be easily compared based on **subspace similarity**.
- Already applied to text summarization [2] and content generation [3];
- **Our goal**: Topic Classification and Sentiment Analysis.

(2) Word Subspace Modeling



(3) What does the Word Subspace represent?

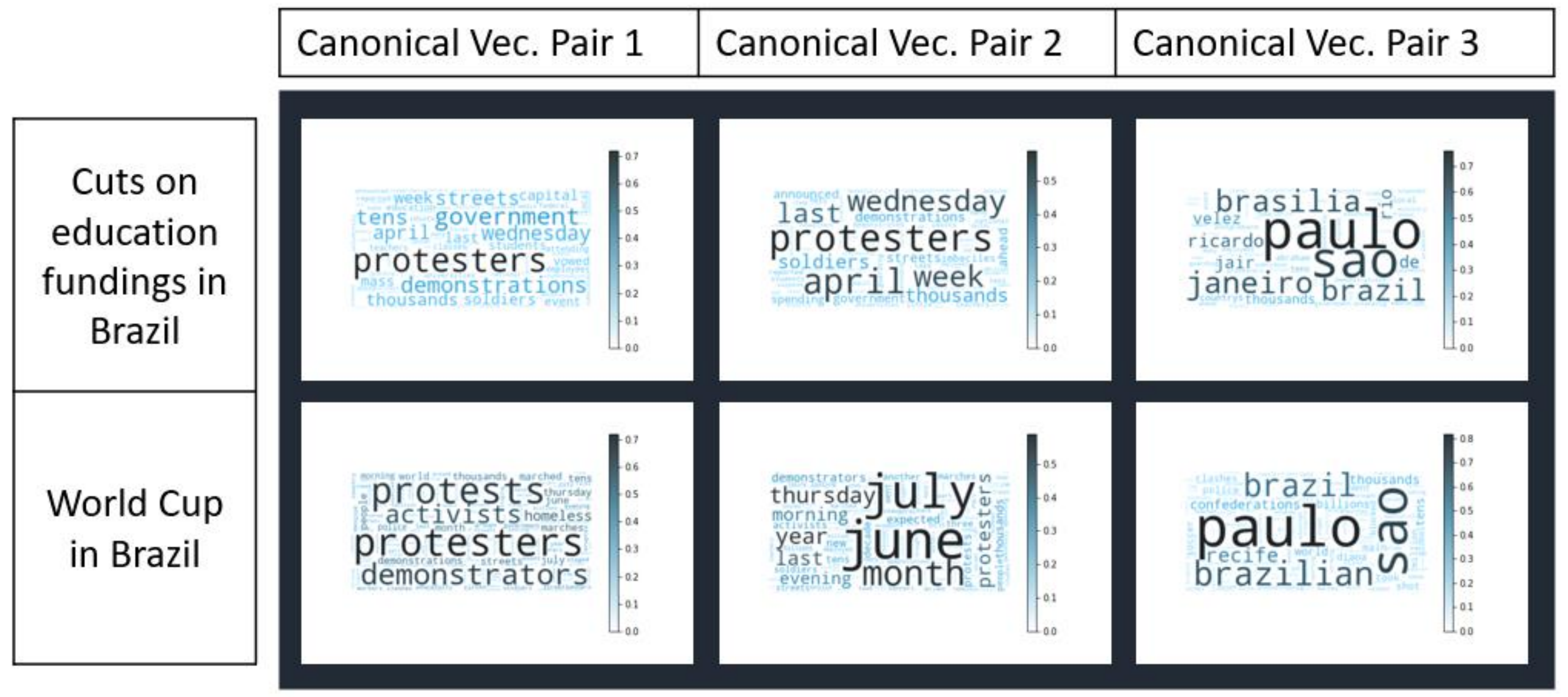
- Text about protests against cuts in education funding in Brazil.
- Closest words to the basis vectors of the word subspace.



(4) Relationship between Word Subspaces

- Similarity is based on the **canonical angles**;

$$S_{(Y_c,Y_q)}[t] = \frac{1}{t}\sum_{i=1}^{t}\cos^2\theta_i,\ 1 \le t \le m_q,\ m_q \le m_c$$



(5) Topic classification

- Used the Mutual Subspace Method [4];

Method	Text Model	R8			20n		
		P	R	F1	P	R	F1
MSM	u-WSub	95.00	94.83	94.81	**74.93**	**74.73**	**74.65**
MSM	WSub	95.51	95.29	95.34	74.32	73.86	73.77
SVM	PCA	83.83	83.42	83.41	55.43	54.67	54.77
SVM	p-mean	96.69	96.67	96.65	72.20	71.65	71.79
SVM	DCT	96.98	96.98	96.94	72.20	71.58	71.73
SVM	EigenSent	**97.18**	**97.13**	**97.14**	72.24	71.62	71.78

- For more details:

E Shimomoto, L Souza, B Gatto, K Fukui, **Text Classification based on Word Subspace with Term-Frequency** (IJCNN18).

(6) Sentiment Analysis

- Challenges:
  - Lack of sentiment information in word embeddings;
  - Same sentiment class can have texts of different topics.
- Proposed solutions:
  - Add discriminative power by using OMSM [5];
  - Represent sentiment class on the Grassmann manifold by using GSM and GOSM.

Word Emb.	Method	Text Model	Movie Review	SST-2
w2v	MSM	WSub	76.45	75.53
	GOSM	WSub	**84.25**	72.91
	LogReg	PCA	65.74	71.94
	LogReg	p-mean	76.30	79.90
	LogReg	DCT	77.10	**81.00**
GloVe	MSM	WSub	76.80	77.12
	GOSM	WSub	**85.75**	67.80
	LogReg	PCA	63.43	50.58
	LogReg	p-mean	77.10	80.20
	LogReg	DCT	77.05	79.63
	LogReg	WR	-	82.20
	LogReg	GEM	78.80	**83.60**

(7) Conclusions and Future Work

- We presented the Word Subspace to model texts based on Word Embeddings;
- We demonstrated its efficiency in the tasks of topic classification and sentiment analysis.
- Include word order -> RTW, SSA, SFA.

(8) References

[1] Shimomoto, E. K., Souza, L. S., Gatto, B. B., and Fukui, K., "Text classification based on word subspace with term-frequency," in 2018 International Joint Conference on Neural Networks (IJCNN), pp. 1-8, IEEE, 2018.

[2] Gong, H., Sakakini, T., Bhat, S., Xiong, J.: Document similarity for texts of varying lengths via hidden topics. In: Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers), pp. 2341-2351. Association for Computational Linguistics, Melbourne, Australia (2018).

[3] Shimomoto, Erica K., et al. "News2meme: An Automatic Content Generator from News Based on Word Subspaces from Text and Image." 2019 16th International Conference on Machine Vision Applications (MVA). IEEE, 2019.

[4] Fukui, K. and Maki, A., "Difference subspace and its generalization for subspace-based methods." IEEE transactions on pattern analysis and machine intelligence. 2015.

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