Non-Linguistic Supervision for Contrastive Learning of Sentence Embeddings

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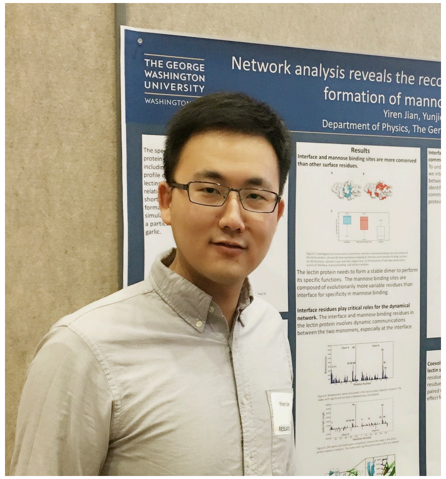
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Network analysis reveals the reco
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Results

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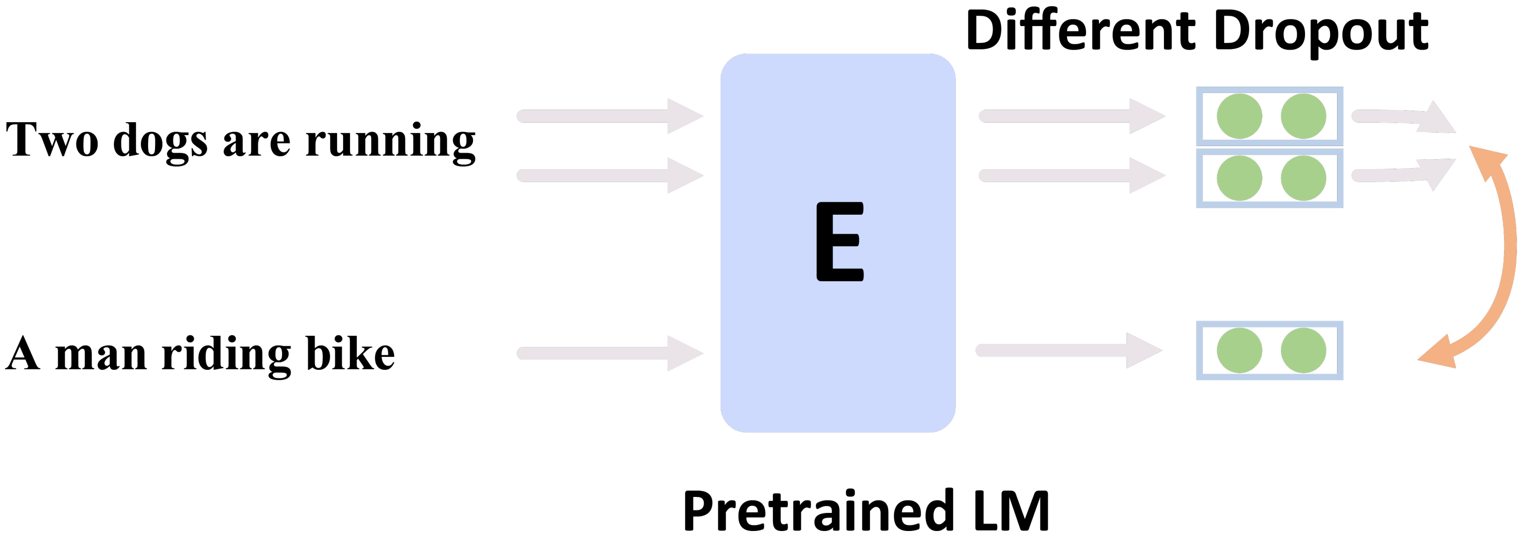
Background: Sentence Embedding Learning

Goal: Semantic similar sentences should have “close” embeddings

Solution: Contrastive learning (SimCSE)



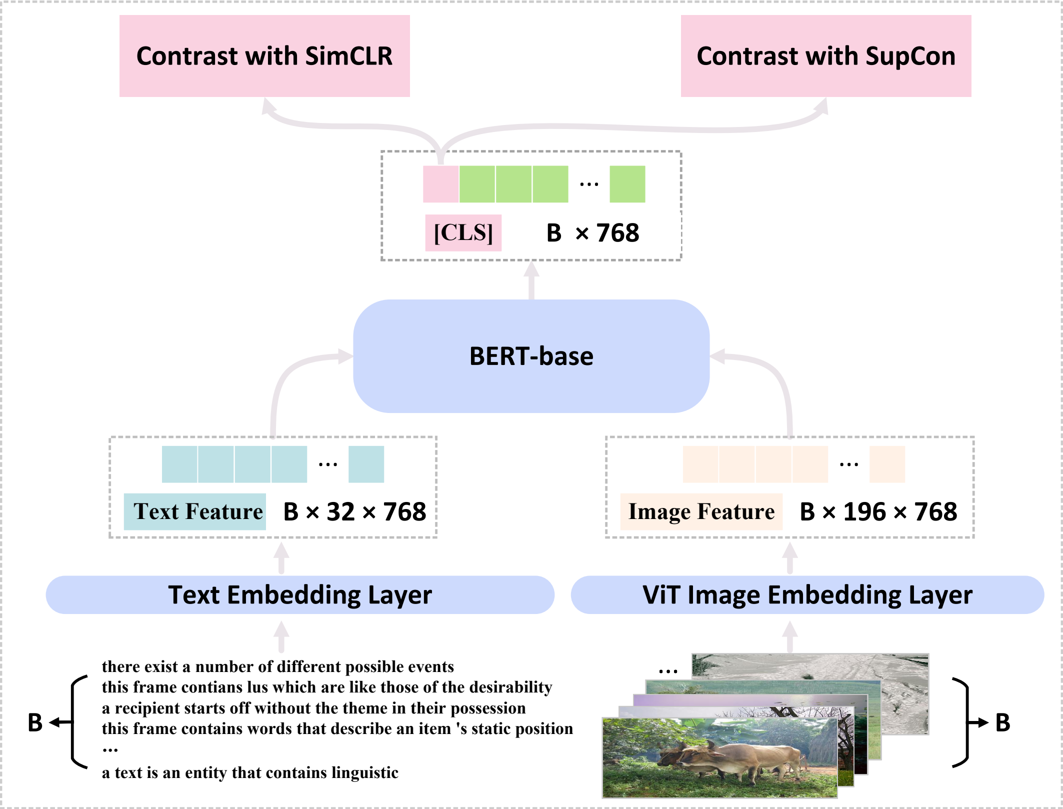
Gao T, Yao X, Chen D. Simcse: Simple contrastive learning of sentence embeddings[J]. arXiv preprint arXiv:2104.08821, 2021.

Sentence Embedding Models as General Contrastive Learners

Treating SimCSE as a contrastive learner:

- SimCSE basically contrasts test examples under different views
- We propose to learn a more generalized contrastive learner by examples from other modalities, *e.g.*, **images** or **audio**
- It doesn’t require to aligned (paired) examples

VisualCSE: Learning CSE with Text and Image

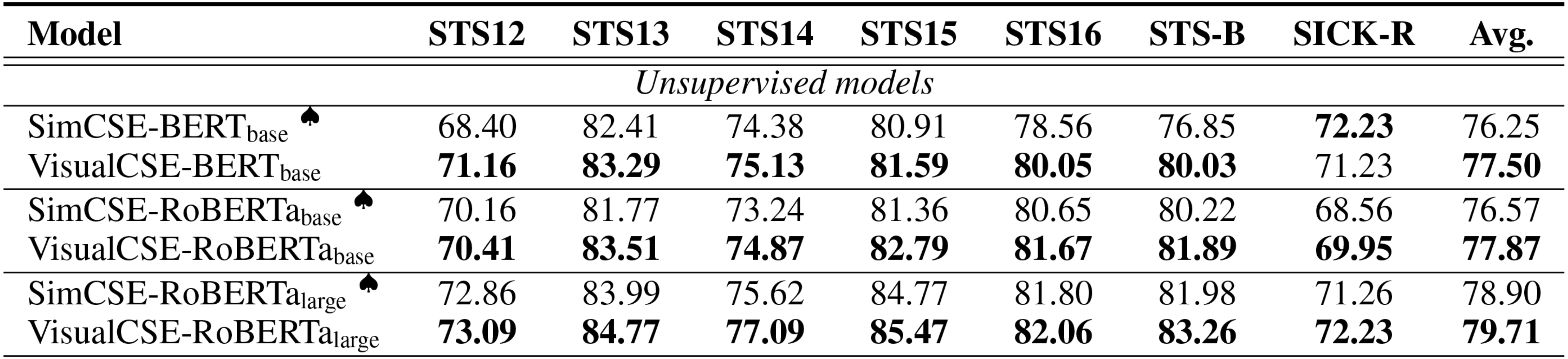


there exist a number of different possible events
this frame contians lus which are like those of the desirability
a recipient starts off without the theme in their possession
this frame contains words that describe an item 's static position
...
a text is an entity that contains linguistic

$$\mathcal{L}_{\text{text}}^{\text{unsup}} = \sum_{i=1}^{N} -\log \frac{e^{\text{sim}(\mathbf{h}_i^{z_i}, \mathbf{h}_i^{z'_i})/\tau}}{\sum_{j=1}^{N} e^{\text{sim}(\mathbf{h}_i^{z_i}, \mathbf{h}_j^{z'_j})/\tau}}$$

$$\mathcal{L}_{\text{image}}^{\text{SupCon}} = \sum_{i=1}^{N} -\log \frac{e^{\text{sim}(\mathbf{f}'_i, \mathbf{f}''_i)/\tau} + \sum_{y_i \text{ and } y_j \text{ from same class}} e^{\text{sim}(\mathbf{f}'_i, \mathbf{f}''_j)/\tau}}{\sum_{y_i \text{ and } y_j \text{ from different class}} e^{\text{sim}(\mathbf{f}'_i, \mathbf{f}''_j)/\tau}}$$

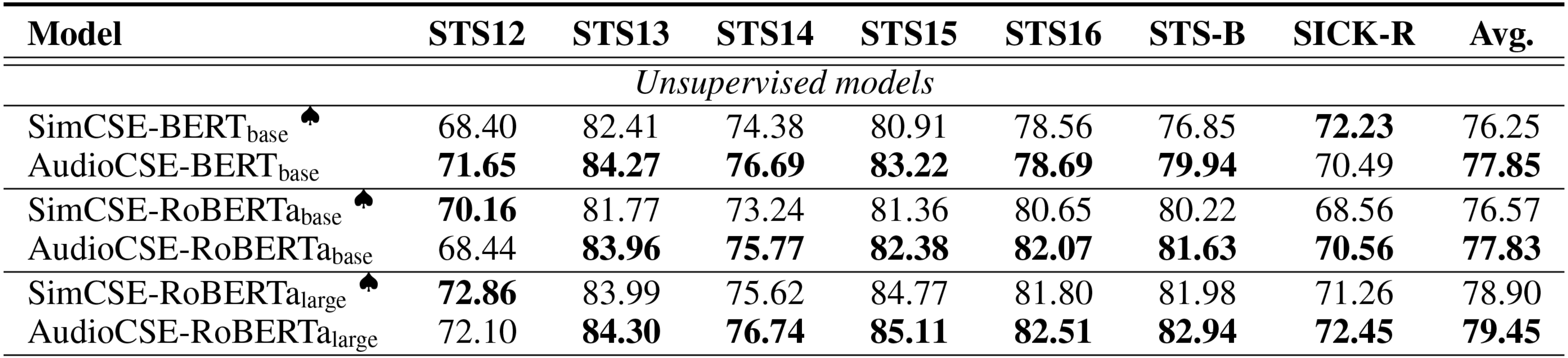
Results of VisualCSE



Model	STS12	STS13	STS14	STS15	STS16	STS-B	SICK-R	Avg.
Unsupervised models								
SimCSE-BERT$_{\text{base}}$ ♠	68.40	82.41	74.38	80.91	78.56	76.85	**72.23**	76.25
VisualCSE-BERT$_{\text{base}}$	**71.16**	**83.29**	**75.13**	**81.59**	**80.05**	**80.03**	71.23	**77.50**
SimCSE-RoBERTa$_{\text{base}}$ ♠	70.16	81.77	73.24	81.36	80.65	80.22	68.56	76.57
VisualCSE-RoBERTa$_{\text{base}}$	**70.41**	**83.51**	**74.87**	**82.79**	**81.67**	**81.89**	**69.95**	**77.87**
SimCSE-RoBERTa$_{\text{large}}$ ♠	72.86	83.99	75.62	84.77	81.80	81.98	71.26	78.90
VisualCSE-RoBERTa$_{\text{large}}$	**73.09**	**84.77**	**77.09**	**85.47**	**82.06**	**83.26**	**72.23**	**79.71**

Results of AudioCSE

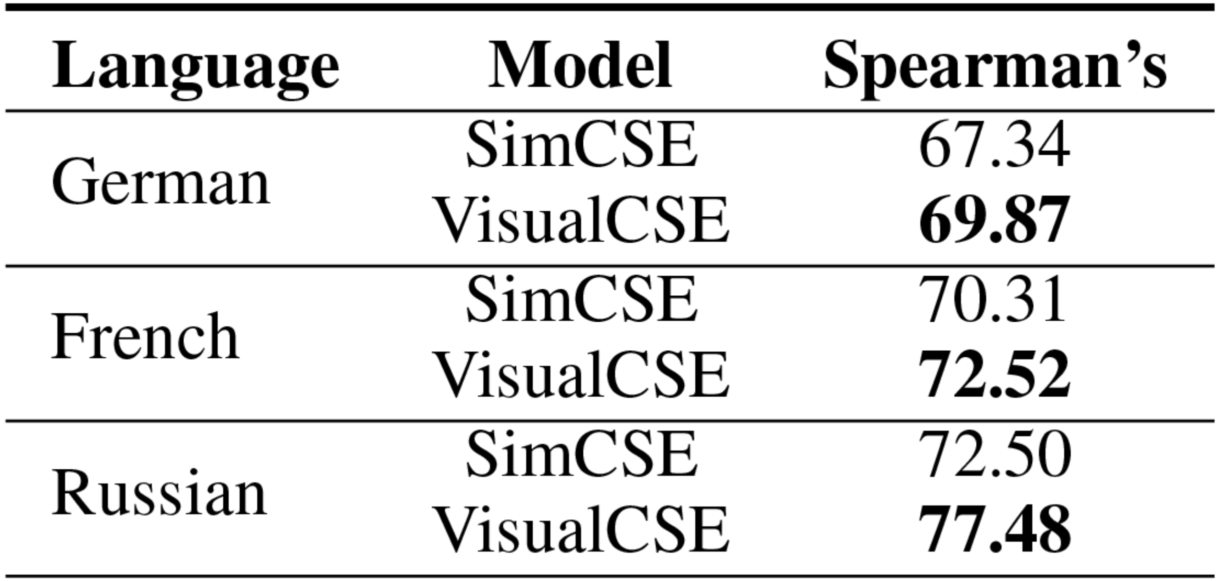
Replacing images with audios



Model	STS12	STS13	STS14	STS15	STS16	STS-B	SICK-R	Avg.
				Unsupervised models				
SimCSE-BERT$_{\text{base}}$ ♠	68.40	82.41	74.38	80.91	78.56	76.85	**72.23**	76.25
AudioCSE-BERT$_{\text{base}}$	**71.65**	**84.27**	**76.69**	**83.22**	**78.69**	**79.94**	70.49	**77.85**
SimCSE-RoBERTa$_{\text{base}}$ ♠	**70.16**	81.77	73.24	81.36	80.65	80.22	68.56	76.57
AudioCSE-RoBERTa$_{\text{base}}$	68.44	**83.96**	**75.77**	**82.38**	**82.07**	**81.63**	**70.56**	**77.83**
SimCSE-RoBERTa$_{\text{large}}$ ♠	**72.86**	83.99	75.62	84.77	81.80	81.98	71.26	78.90
AudioCSE-RoBERTa$_{\text{large}}$	72.10	**84.30**	**76.74**	**85.11**	**82.51**	**82.94**	**72.45**	**79.45**

Evaluating on other languages

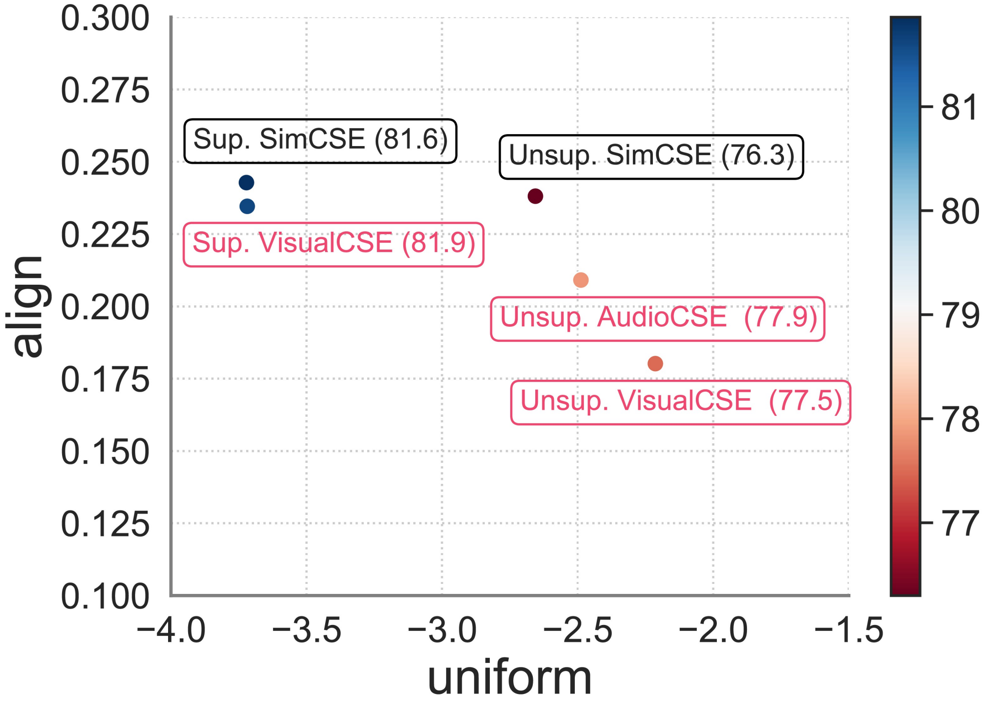
A key advantage of our Non-linguistic CSE is that it does not require aligned (paired) examples, allowing us to apply them to different languages.



Language	Model	Spearman's
German	SimCSE	67.34
	VisualCSE	**69.87**
French	SimCSE	70.31
	VisualCSE	**72.52**
Russian	SimCSE	72.50
	VisualCSE	**77.48**

What does additional supervision improve?

Non-linguistic supervision improves the alignment of sentence embeddings.



Discussion and Conclusion

- A novel framework to learn **generalized contrastive learners** from unpair examples to improve sentence embeddings.
- A finding that knowledge transfer between language and images/audio could be transferred using “unpaired” examples.