I can't believe there's no images!
Learning Visual Tasks Using Only Language Supervision

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VLM，modality gap，text as image

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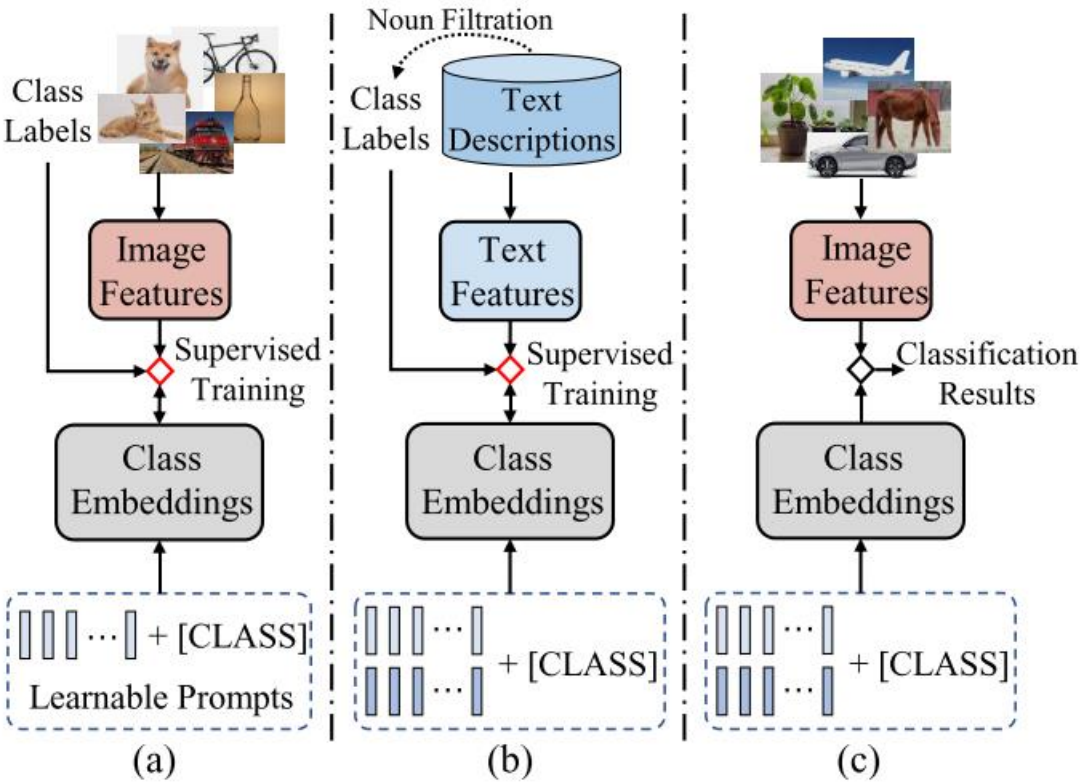
智能多媒体内容计算实验室
Intelligent Multimedia Content Computing Lab

- 研究背景
- 研究方法
- 实验效果
- 总结

Text as image

- 在视觉语言模型中，用文字代替图像进行训练
  - 收集训练集的成本低
  - Cross modality transfer



语料生成

- 成对：
  - 现有caption数据集
  - Label+LLM扩写
- 扩展语料库（不一定成对）
  - 网络数据
  - 书籍
  - LLM生成

Modality Gap

- 两种模态间存在gap
  - 模态间共有的信息→对齐
  - 模态内独特的信息→不能强迫对齐

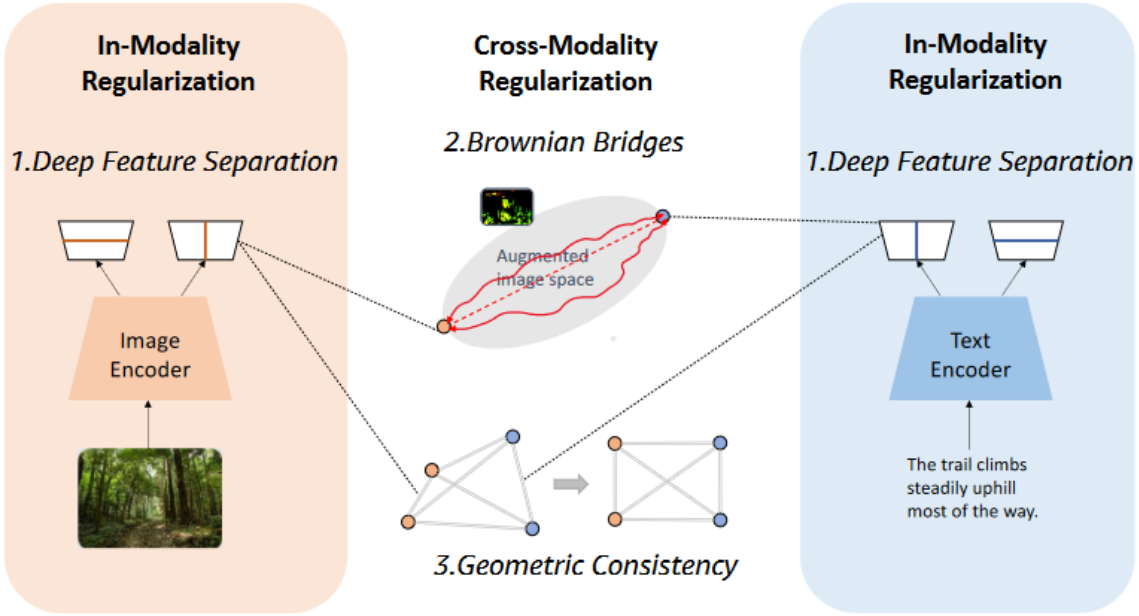


Figure 1. Constructing latent modality structures to improve multi-modal representation learning.

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Method

- 总体框架：
  - 训练时采用text encoder，测试时替换成image encoder
  - 可以用于各种多模态任务：VQA，caption，visual entailment，visual news

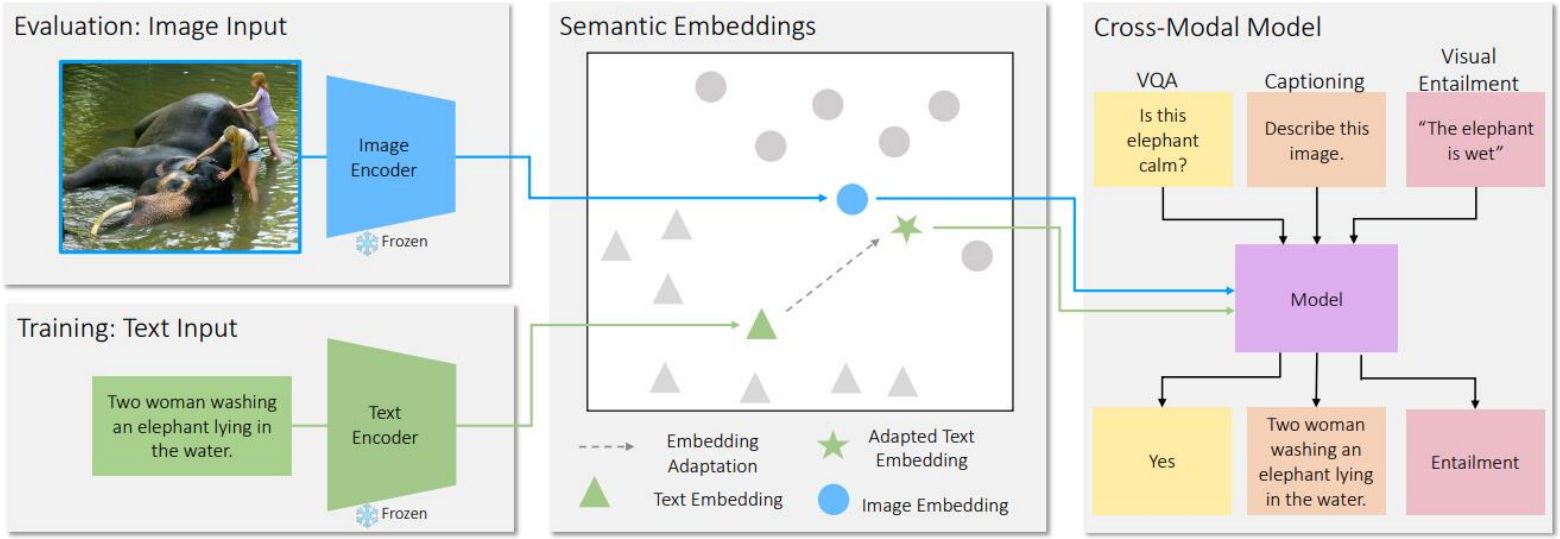
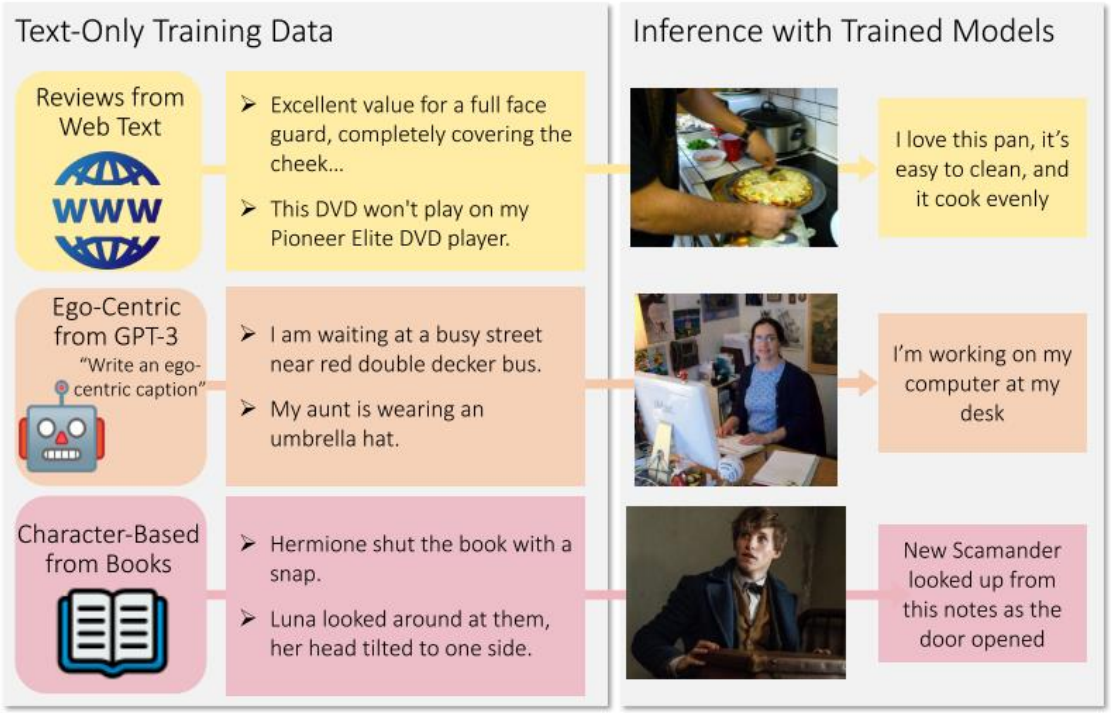


Figure 1: Overview of CLOSE. During training, input text is encoded into a vector with a text encoder and adapted with an adaptation method. A model learns to use the vector to perform a task such as VQA, captioning, or visual entailment. During testing, an input image is encoded with an image encoder instead to allow cross-modal transfer.

语料获取

- 不同风格的训练语料：
  - 网络数据，评论
  - 大语言模型，第一人称描述
  - 书籍，人物



语料获取

- 大语言模型：
  - Instruction tuning的方式获取高质量caption

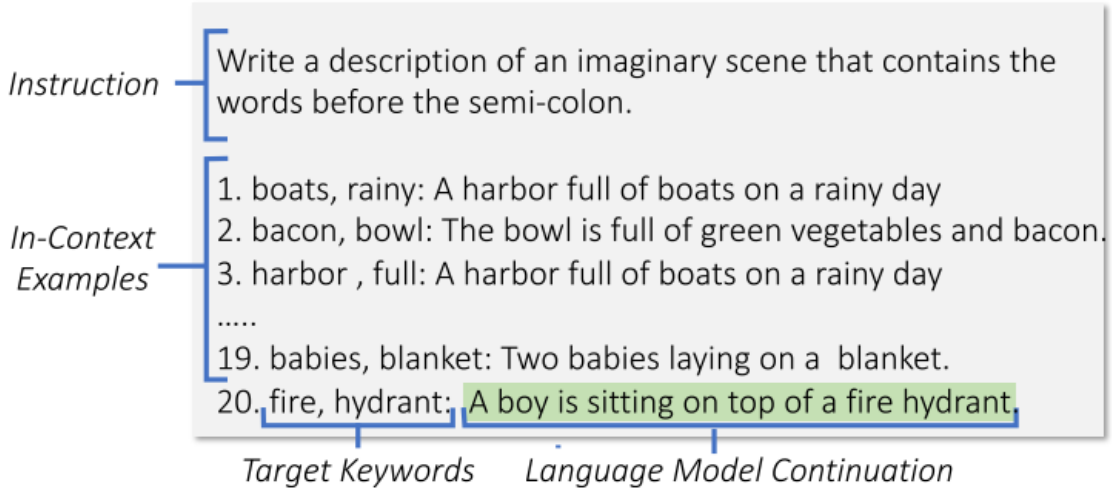


Figure 4: Prompt used to generate a synthetic caption from a language model. The language model's continuation (highlighted text) is used as a synthetic caption.

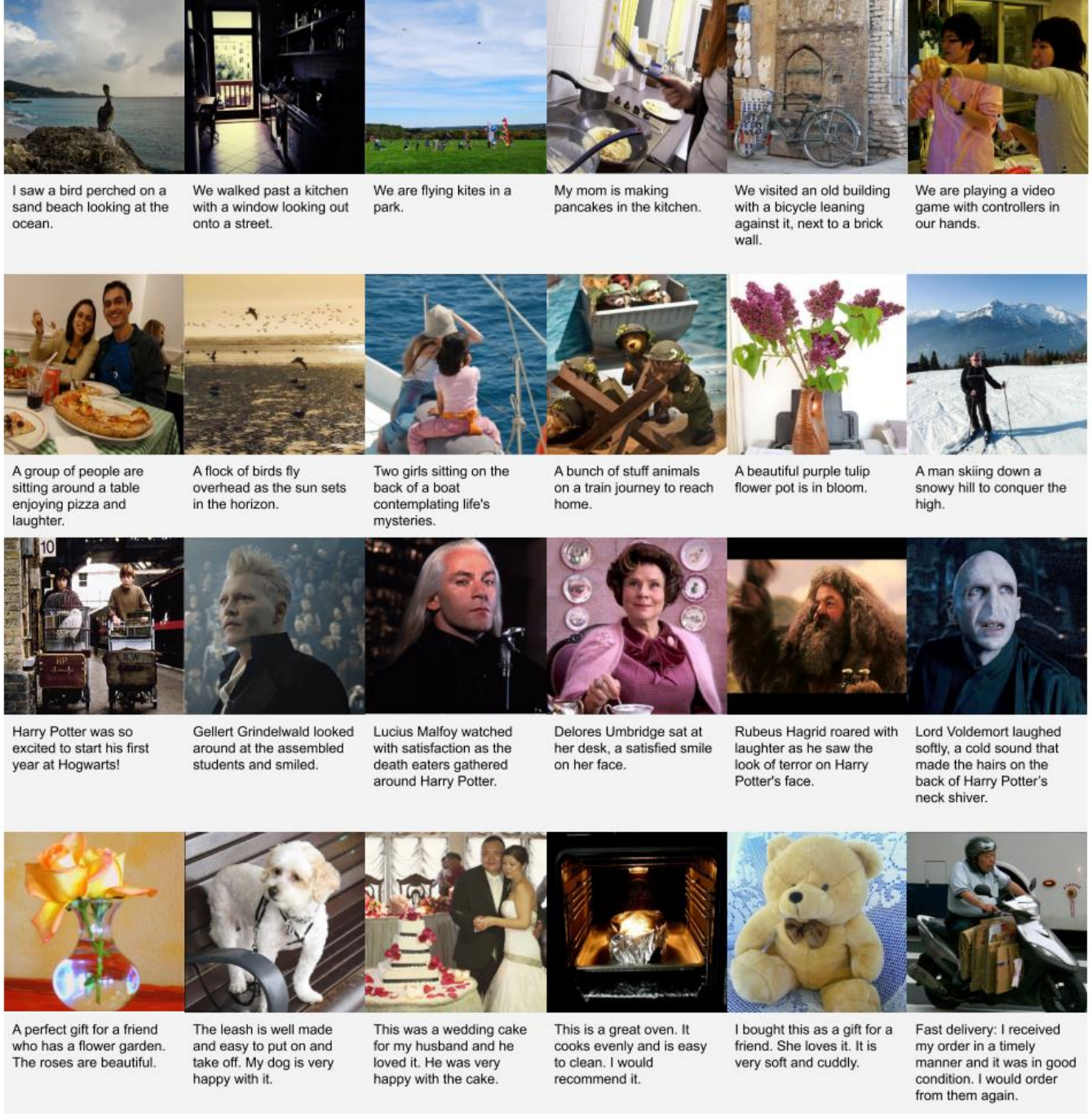
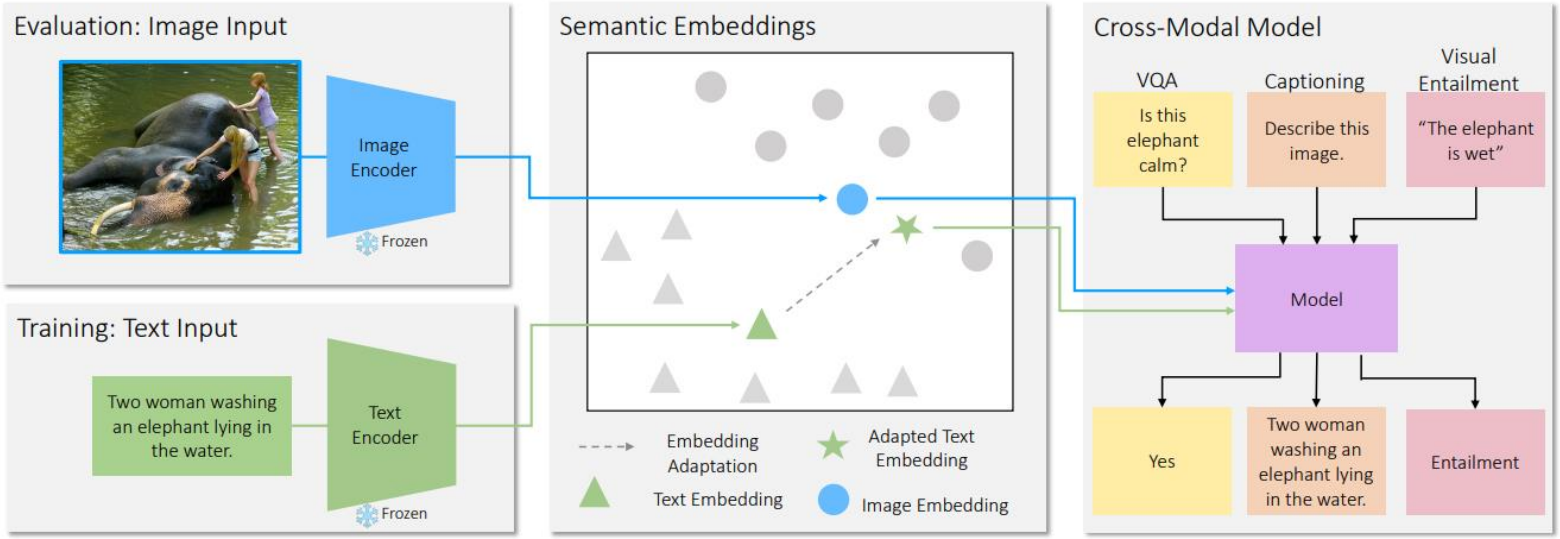


Figure 5: Examples of stylistic captions produced by CLOSE trained with only text data, and then applied 0-shot to images.

Modality Gap

- Modality Gap
  - 在CoCo中，图文对的平均相似度为0.26，两个不相关caption的平均相似度为0.35
  - 因为对比学习损失只要求匹配的图文对相似度相对于随机图文对的更高即可，不约束相似度绝对值的大小。



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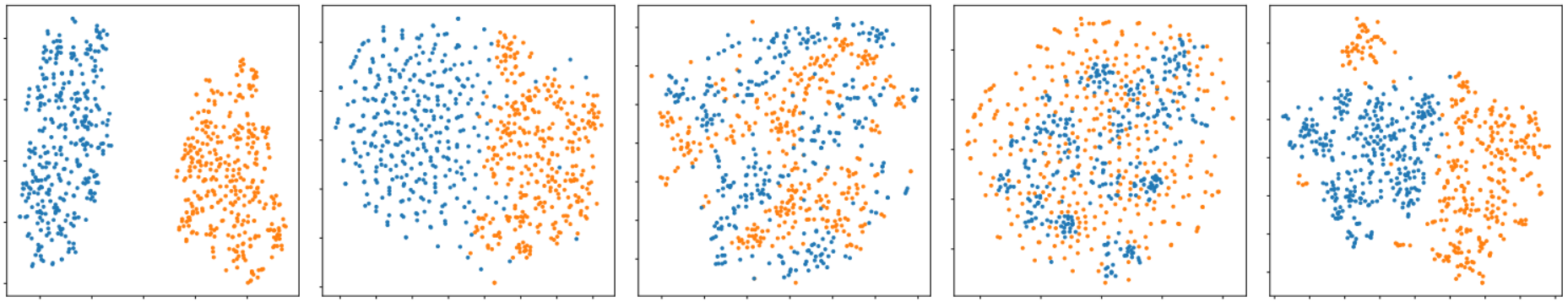
Modality Gap

- 缓解modality gap的方法：在文本向量上添加高斯噪声



(a) No Adapter (b) Gaussian Noise (c) Mean Shift (d) Mean Shift + Noise (e) CC3M Mean Shift

Figure 3: t-SNE [65] plots for various adapters on 350 randomly selected image vectors (blue) and paired caption vectors (orange) from COCO captions. The first two panels demonstrate CLOSE, and the remaining three show additional adapters we study in our analysis (Section 4).

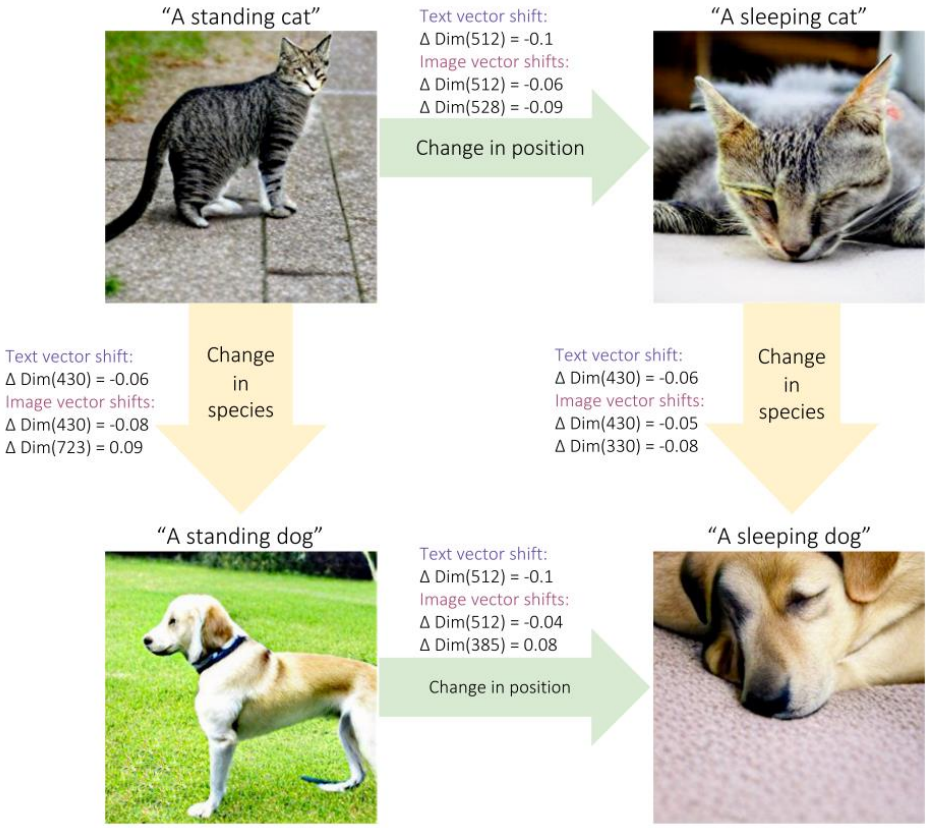
Modality Gap分析

- text vector的敏感性分析
  - 平移量，modality gap，与原向量的相似度

Bias	Mag.	MG	Δ	Cap.	VE	VQA
none	0.0	0.26	1.00	94.4	64.3	75.9
mean	0.8	0.62	0.69	92.8	64.7	75.4
-mean	0.8	-0.10	0.85	84.3	62.0	71.8
RNG	0.2	0.25	0.98	93.5	63.9	75.3
RNG	0.5	0.24	0.89	92.5	64.2	75.3
RNG	0.8	0.20	0.78	89.3	63.7	74.8
RNG	1.0	0.18	0.71	87.2	63.8	74.2
RNG	2.0	0.11	0.45	73.7	61.4	71.3

Modality Gap分析

- Text，image vector对偏移的敏感度不同
  - 因为图像中细节信息更多，而文本语义不易改变



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实验效果

- 在不同任务上的性能

Model	Text-Only	Cap. (Single)	Cap. (Mult.)	VE	VQA	E-VQA	VN
Prior Work	✓	-	ESPER Style [79] 78.2	CLIP Cls. [57] 66.6	TAP-C [57] 38.7	-	-
CLOSE w/o Noise	✓	16.4	68.7	68.2	60.2	59.8	32.1
CLOSE (Ours)	✓	80.5	95.3	75.9	59.6	62.9	80.8
CLOSE w/Tuned Noise		95.4	98.4	75.9	61.9	64.3	80.8
CLOSE w/Images		113.2	113.2	77.7	65.4	67.9	105.7

Table 1: Results on V&L tasks. Models in the last two rows require images and so are upper bounds for CLOSE. We report CIDEr [66] for captioning with single and multiple captions, visual entailment test accuracy, VQA 2.0 test-dev accuracy, E-VQA validation accuracy, visual news test CIDEr. See Appendix 2 for other metrics and more detailed results.

Ablation

- 不同底座模型的消融实验

CLIP Model	T5 Model	Cap.	VE	VQA
ViT-L/14	small	94.4	74.9	59.9
ViT-L/14	base	95.4	76.1	64.3
ViT-L/14	large	93.9	75.1	65.2
ViT-B/32	base	91.1	75.3	61.4
RN101	base	90.0	75.4	59.8
RN50	base	90.2	75.3	60.4
RN50×4	base	92.0	75.3	61.5
RN50×16	base	93.4	74.4	62.5
RN50×64	base	96.1	75.8	64.2
OpenCLIP [24]	base	99.2	**76.3**	65.1
EVA-CLIP [13]	base	**101.7**	75.53	**66.6**

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总结

- Text合成部分考虑了不同风格、连贯性，值得参考
- 模态间的gap/cross modality transfer是这类问题的关键，本文给出了详尽分析

Thanks!