VSR++: *Improving Visual Semantic Reasoning for Fine-Grained Image-Text Matching*

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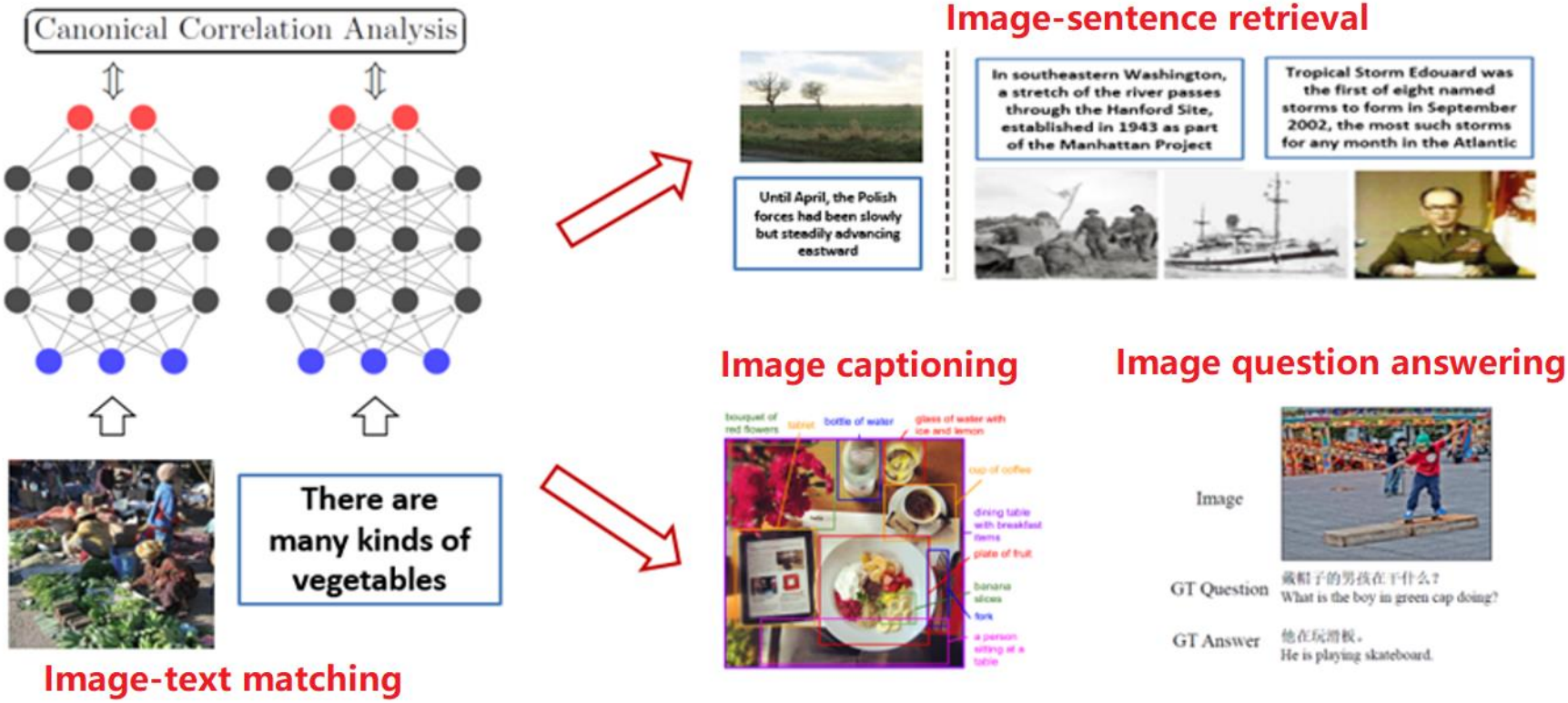
Outline

- **Introduction**
- **Method**
- **Experiments**

➢Introduction

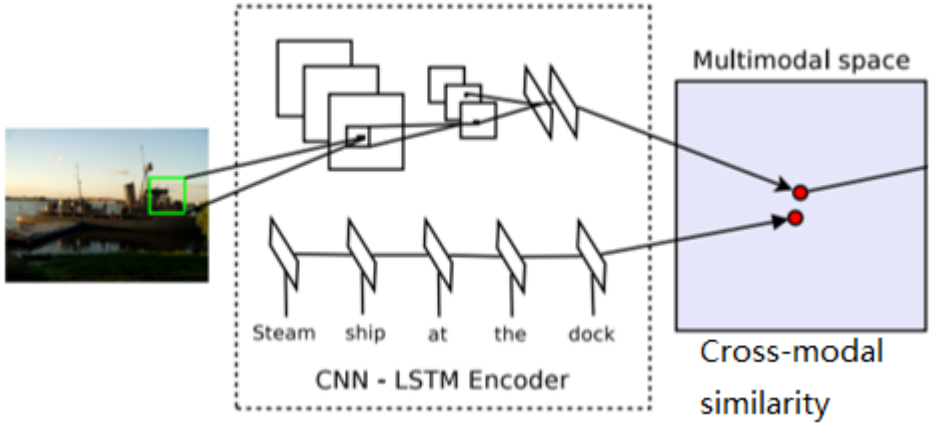
Image-Text Matching



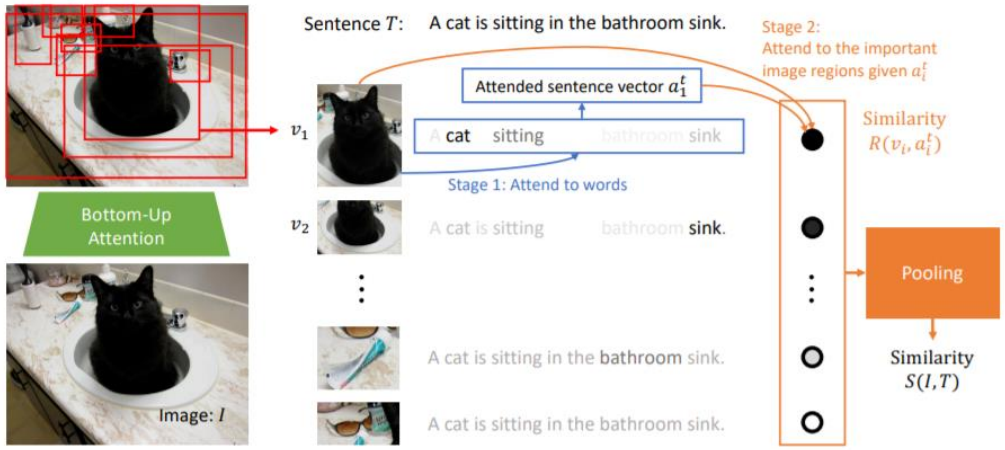
two retrieval sub-tasks:

- ✓ image annotation: given an image query to find mached texts
- ✓ image search :given a text query to retrieve matched images

Motivation



Coarse-grained image-text matching

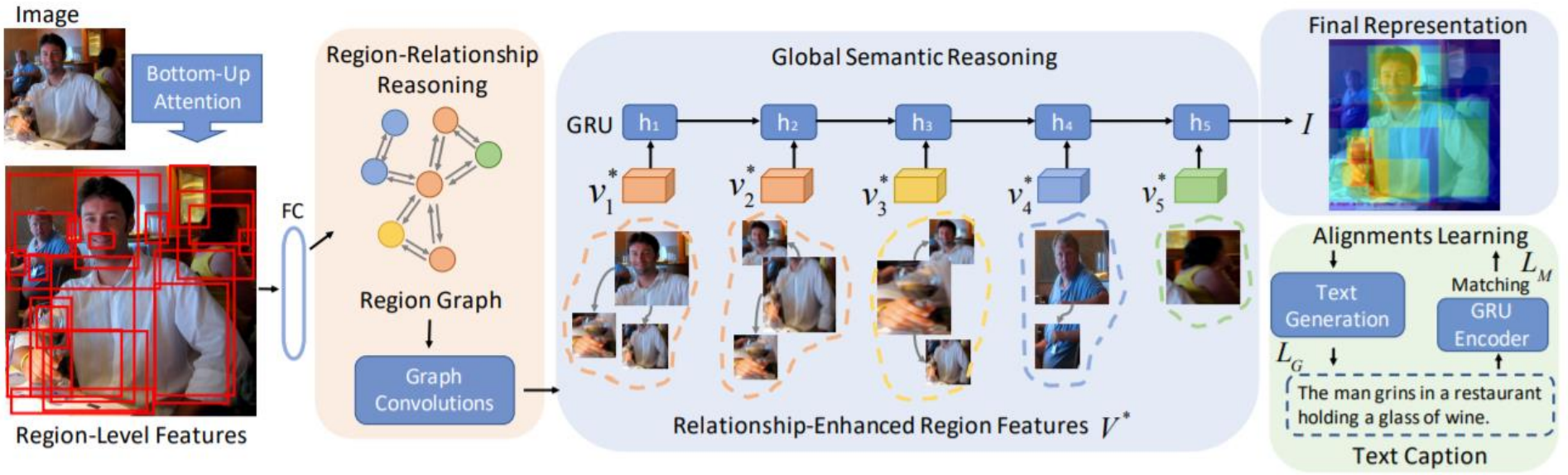


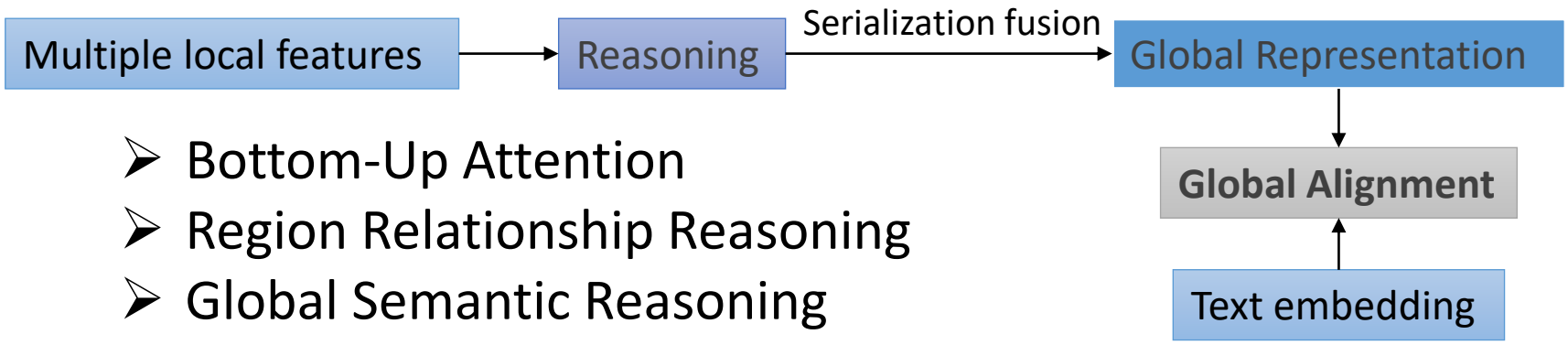
Fine-grained image-text matching

Incorporating the complementary advantages of global alignment and local correspondence, as well as balancing their relative importance.

➢Method

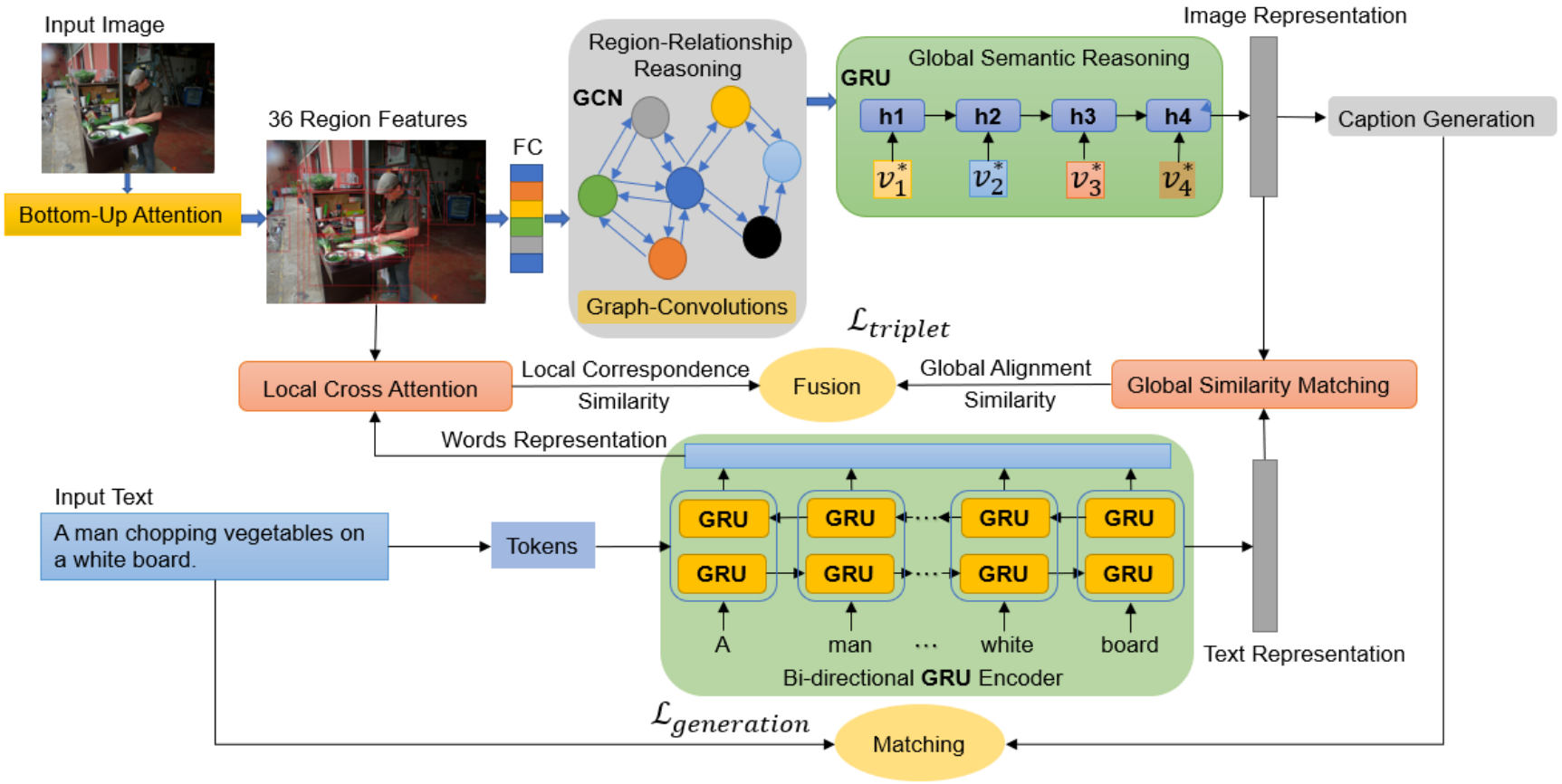
Visual Semantic Reasoning Network(VSRN)





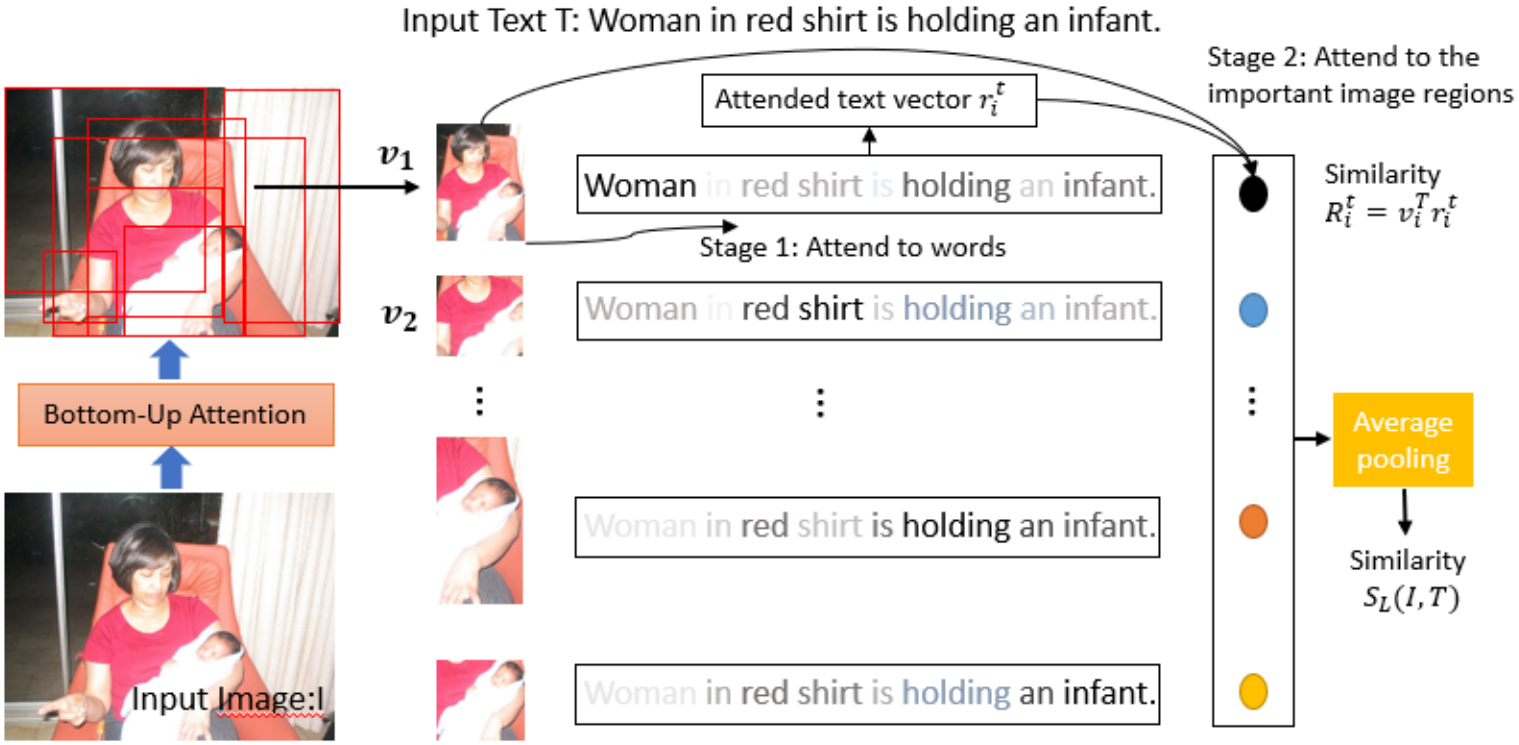
- Bottom-Up Attention
- Region Relationship Reasoning
- Global Semantic Reasoning
- GRU Encoder Text:
- Text Generation Modual

Ours(VSR++) Framework



- Incorporating the complementary advantages of global alignment and local correspondence in our VSR++ method.
- develop a suitable learning strategy to balance their relative importance.

Local Cross-Modal Attention



$$s_{ij} = v_i^T e_j, i\epsilon[1,k], j\epsilon[1,n], \quad (1)$$

$$w_{ij} = softmax(\lambda \hat{s}_{ij}) \quad (2)$$

$$r_i^t = \sum_{j=1}^{n} w_{i,j}\, e_j \quad (3)$$

$$R_i^t = v_i^T\, r_i^t, \quad (4)$$

$$S_L(I,T) = \frac{\sum_{i=1}^{k} norm(R_i^t)}{k} \quad (5)$$

Model Learning Strategy

- Global-local similarity fusion

$$\boldsymbol{S(I,T) = S_G(I,T) + \mu S_L(I,T)}$$

- triplet ranking loss cross-modal learning

$$\mathcal{L}_{triplet} = max[0, \alpha - S(I,T) + S(I,\hat{T})] + max[0, \alpha - S(I,T) + S(\hat{I},T)]$$

Caption generation:

$$\mathcal{L}_{generation} = -\sum_{t=1}^{l} logp(y_t | y_{t-1}, V^*; \theta)$$

maximize the log-likelihood of the predicted output caption.

- Our final loss function: $\mathcal{L} = \mathcal{L}_{triplet} + \mathcal{L}_{generation}$

➢ Experiments

Ablation Study

Table 1: Ablation studies on Flickr30k to investigate the effect of different network structures and different association ways. Results are reported in terms of recall@k(R@K).

Methods	Flickr30k dataset					
	Text Retrieval			Image Retrieval		
	R@1	R@5	R@10	R@1	R@5	R@10
Global	71.3	90.6	96.0	54.7	81.8	88.2
Local	67.4	90.3	95.8	48.6	77.7	85.2
Fusion-loss	71.5	90.6	95.8	55.1	82.0	88.2
Fusion-similarity	72.2	92.5	97.0	56.1	82.3	89.0
VSR++ (GRU)	72.0	92.1	96.5	55.6	82.0	88.5
VSR++ (full)	**72.6**	**92.7**	**97.2**	**56.3**	**82.7**	**89.0**

- Significantly improve the cross-modal similarity.
- Bi-GRU is better than GRU encoding.
- Similarity fusion is significantly better than other fusion ways.

Table 2: Ablation studies on Flickr30k to analyze the impact of different values of the association parameter μ between the global image-text alignment and local region-word correspondence.

Methods	Flickr30k dataset					
	Text Retrieval			Image Retrieval		
	R@1	R@5	R@10	R@1	R@5	R@10
VSR++ (μ=0.5)	66.4	89.1	94.6	53.9	81.7	88.2
VSR++ (μ=1.0)	69.3	91.5	96.1	56.0	82.6	89.0
VSR++ (μ=1.5)	72.0	92.2	97.1	56.1	82.7	89.0
VSR++ (μ=2.5)	72.4	93.0	96.8	54.9	81.8	88.8
VSR++ (μ=3.0)	72.1	93.3	96.7	54.5	81.4	88.4
VSR++ (μ=2.0)	**72.6**	**92.7**	**97.2**	**56.3**	**82.7**	**89.0**

- The optimal fusion coefficient μ=2.0.

Comparisons with the SOTA

Table 3: The result of VSR++ on MS-COCO (1K test) dataset.

Methods	MS-COCO 1K dataset						
	Text Retrieval			Image Retrieval			mR
	R@1	R@5	R@10	R@1	R@5	R@10	
VSE++ [1]	64.6	89.1	95.7	52.0	83.1	92.0	79.4
SCO [3]	69.9	92.9	97.5	56.7	87.5	94.8	83.2
SCAN [2]	72.7	94.8	98.4	58.8	88.4	94.8	84.7
GVSE [12]	72.2	94.1	98.1	60.5	89.4	95.8	85.0
SAEM [6]	71.2	94.1	97.7	57.8	88.6	94.9	84.0
VSRN [4]	76.2	94.8	98.2	62.8	89.7	95.1	86.1
VSR++	**76.6**	**95.2**	**98.2**	**63.4**	**90.6**	**95.7**	**86.6**

R@1 **+0.4** **+0.6**

Table 4: The result of VSR++ on Flickr30K dataset.

Methods	Flickr30k dataset						
	Text Retrieval			Image Retrieval			mR
	R@1	R@5	R@10	R@1	R@5	R@10	
VSE++ [1]	52.9	79.1	87.2	39.6	69.6	79.5	68.0
SCO [3]	55.5	82.0	89.3	41.1	70.5	80.1	69.7
SCAN [2]	67.4	90.3	95.8	48.6	77.7	85.2	77.5
GVSE [12]	68.5	90.9	95.5	50.6	79.8	87.6	78.8
SAEM [6]	69.1	91.0	95.1	52.4	81.1	88.1	79.4
VSRN [4]	71.3	90.6	96.0	54.7	81.8	88.2	80.4
VSR++	**72.6**	**92.7**	**97.2**	**56.3**	**82.7**	**89.0**	**81.8**

R@1 **+1.3** **+1.6**

Visualization Analysis

Image -> Text Retrieval

Query Image (a)

Method(a):VSRN(Global image-text alignment)
1: A very young child in a denim baseball cap eats a green apple. ✔
2: An infant wearing a hat, holding an apple in his right hand. ✔
3: A young child has a popsicle stick in his mouth. ✘

Method(b):VSR++(Global and Local Association)
1: A very young child in a denim baseball cap eats a green apple. ✔
2: A young boy in a blue hat and bib eating a green apple. ✔
3: An infant wearing a hat, holding an apple in his right hand. ✔

Query Image (b)

Method(a):VSRN(global image-text alignment)
1: Two young men, one in a white jersey and one in a red jersey, playing basketball. ✔
2: Two young men playing basketball , one defending the other attempting to make a basket. ✔
3: Two young boys playing in a dirt top playground. ✘

Method(b):VSR++(global and local association learning)
1: 3 basketball players vying for the ball and one in red jersey trying to take ball from guy in white jersey. ✔
2: A player in a white and red uniform goes for a layup , while the player with a red and black uniform blocks the attempted shot. ✔
3: Two young men, one in a white jersey and one in a red jersey, playing basketball. ✔

Text -> Image Retrieval

Query (a): A couple is sitting on the sand with their feet in the water , and they are shaking hands.

Query (b): Six people ride mountain bikes through a jungle environment.

Thank you!

Suggestion Questions

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