



Composed Image Retrieval for Remote Sensing

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Explosive Growth of Remote Sensing Data



Explosive Growth of Remote Sensing Data

- Challenge in managing and extracting relevant information



Explosive Growth of Remote Sensing Data

- Challenge in managing and extracting relevant information
- Organize image archives and retrieve images is crucial!



Remote Sensing Image Retrieval

- Search and retrieve images from RS archives
- Key solution!

Agouris et al., An environment for content-based image retrieval from large spatial databases, ISPRS Journal, 1999

Remote Sensing Image Retrieval

query image



Dongyang et al., Exploiting low dimensional features from the mobilenets for remote sensing image retrieval, Earth Science Informatics, 2020

Remote Sensing Image Retrieval

query image



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query image



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Remote Sensing Image Retrieval

query image



top-k retrieved images



descending order of
similarity to the query image

Remote Sensing Image Retrieval

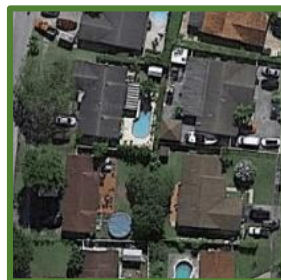
query image



residential



top-k retrieved images



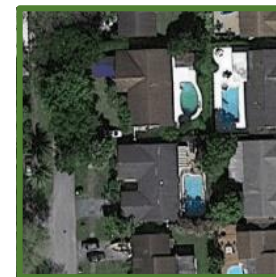
residential



basketball
court

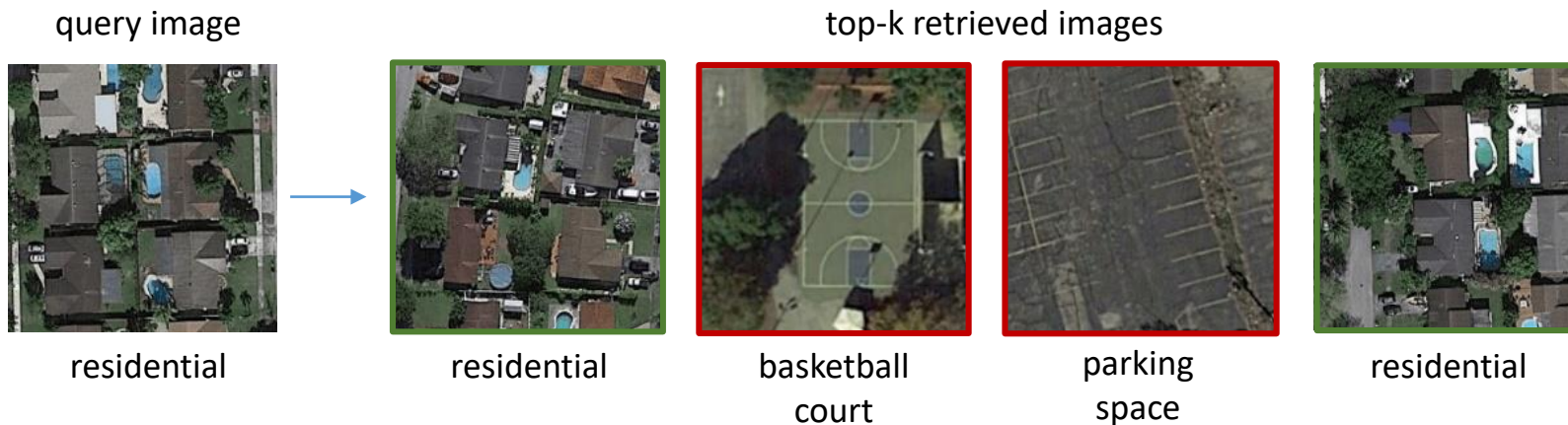


parking
space



residential

Remote Sensing Image Retrieval



Dongyang et al., Exploiting low dimensional features from the mobilenets for remote sensing image retrieval, Earth Science Informatics, 2020

Remote Sensing Image Retrieval

unisource

Remote Sensing Image Retrieval

unisource

cross-source

Remote Sensing Image Retrieval

unisource

single-label

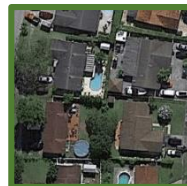
query image



residential



top-k retrieved images



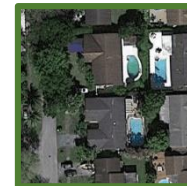
residential



basketball
court



parking
space

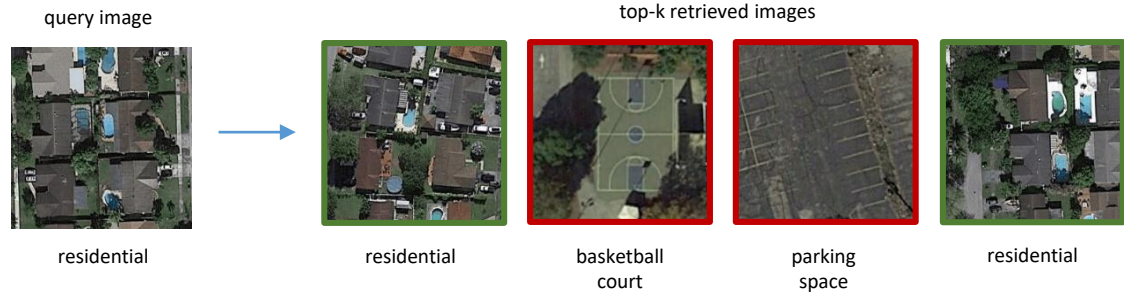


residential

cross-source

Remote Sensing Image Retrieval

single-label
unisource



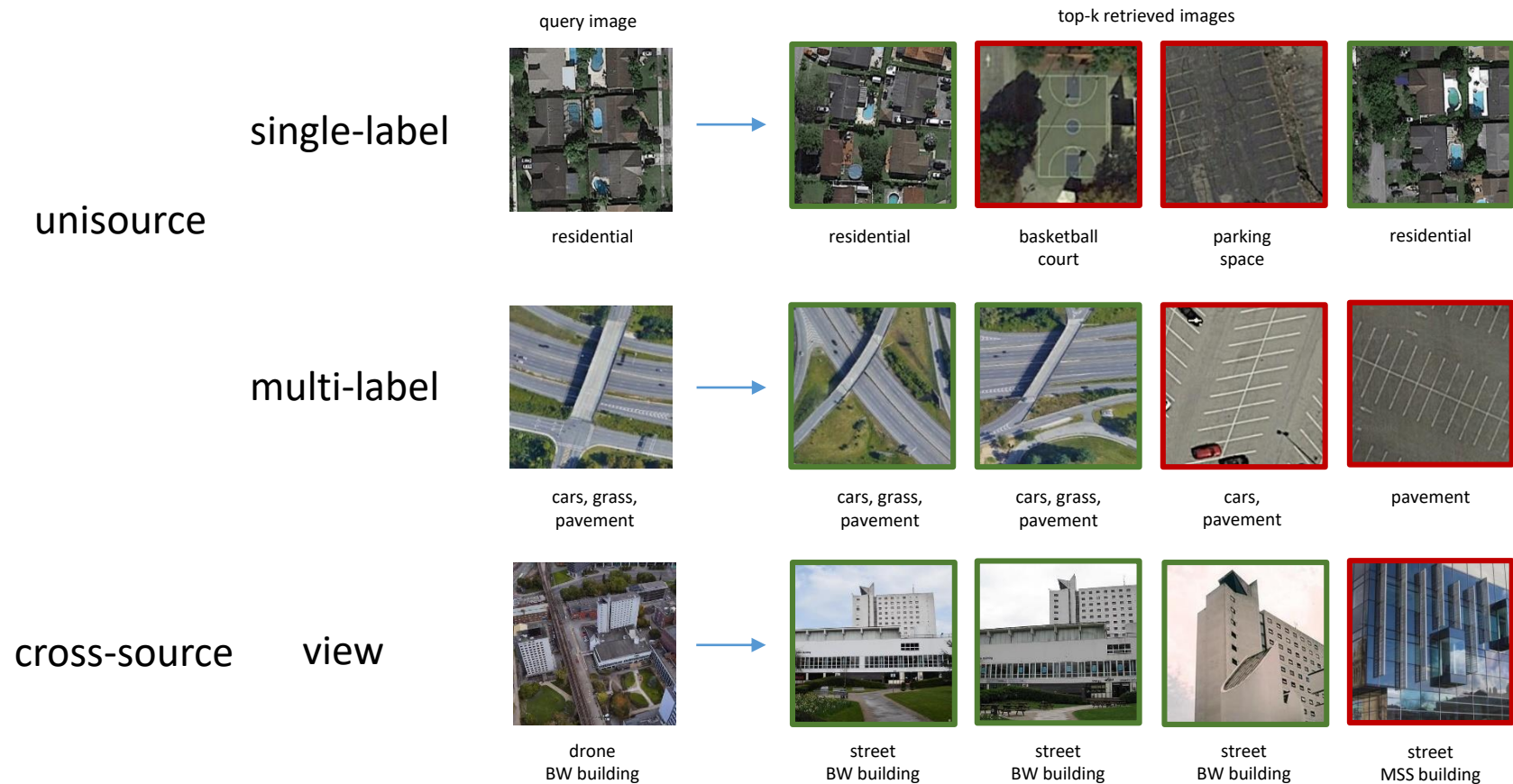
multi-label



cross-source

Zhou et al., Remote sensing image retrieval in the past decade: Achievements, challenges, and future directions, IEEE J-STARS, 2023

Remote Sensing Image Retrieval



Limitation of Remote Sensing Image Retrieval

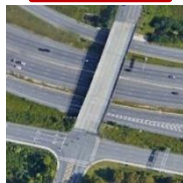
query image



single-label

unisource

query image



multi-label

query image



cross-source

view

query of
single modality!

Limitation of Remote Sensing Image Retrieval

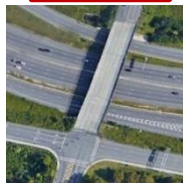
query image



single-label

unisource

query image



multi-label

query image



cross-source

view

query of
single modality!

restricts users
from expressing
specific
requirements...

Remote Sensing Composed Image Retrieval

Remote Sensing Composed Image Retrieval

query image



Remote Sensing Composed Image Retrieval

query image



query text

“dense”

Remote Sensing Composed Image Retrieval

query image



query text

“dense”



Remote Sensing Composed Image Retrieval

query image



query text

“dense”



Remote Sensing Composed Image Retrieval

query image



query text

“dense”



Remote Sensing Composed Image Retrieval

query image



query text

“dense”

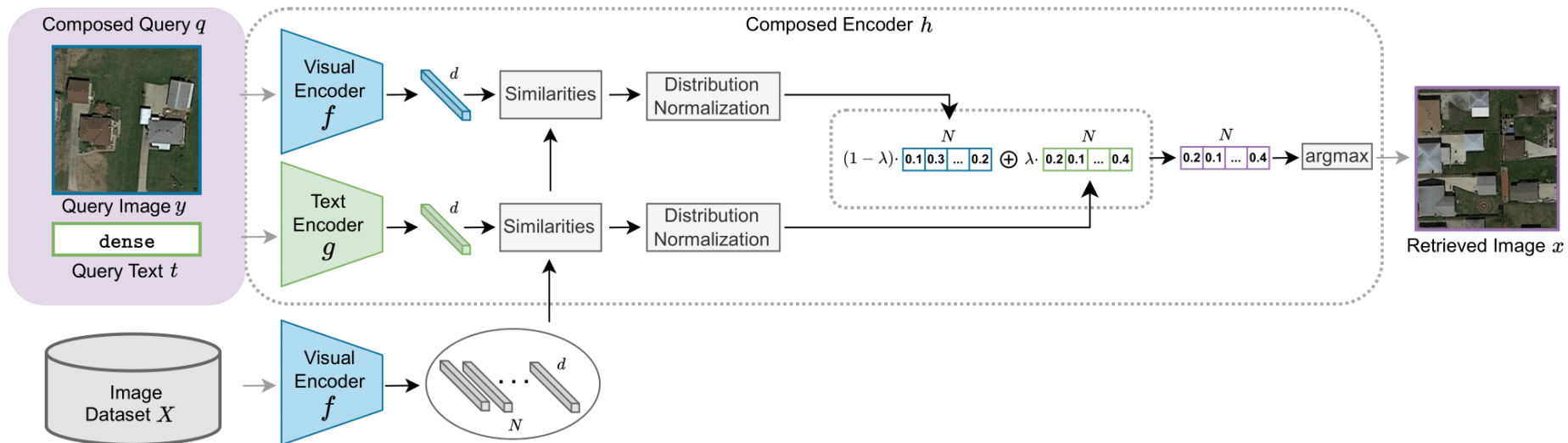


top-k retrieved images



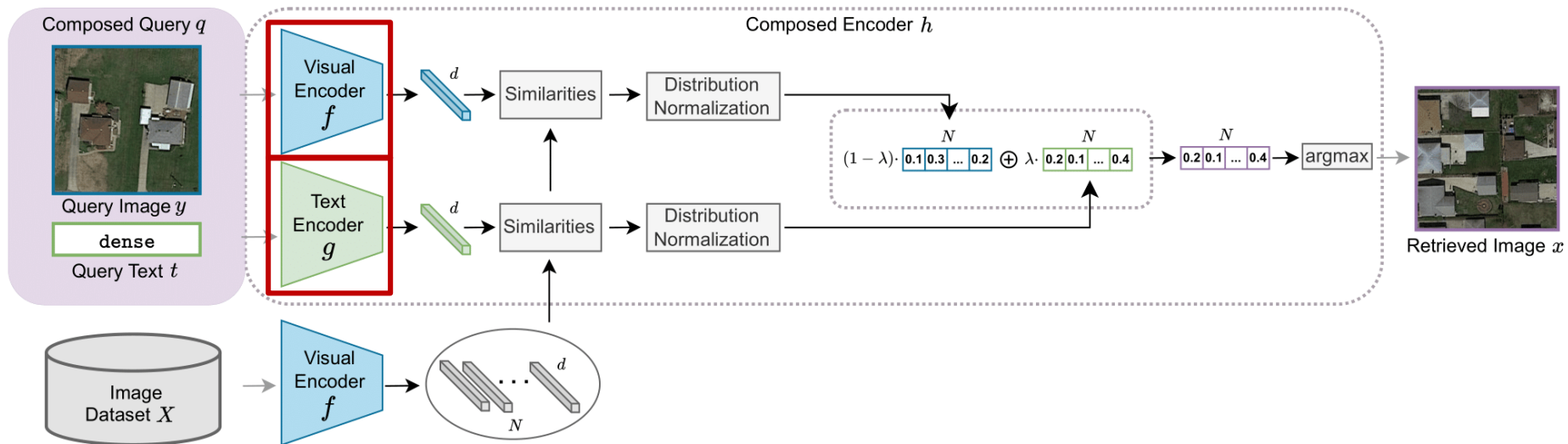
expressive and flexible
search!

Our method, WeiCom

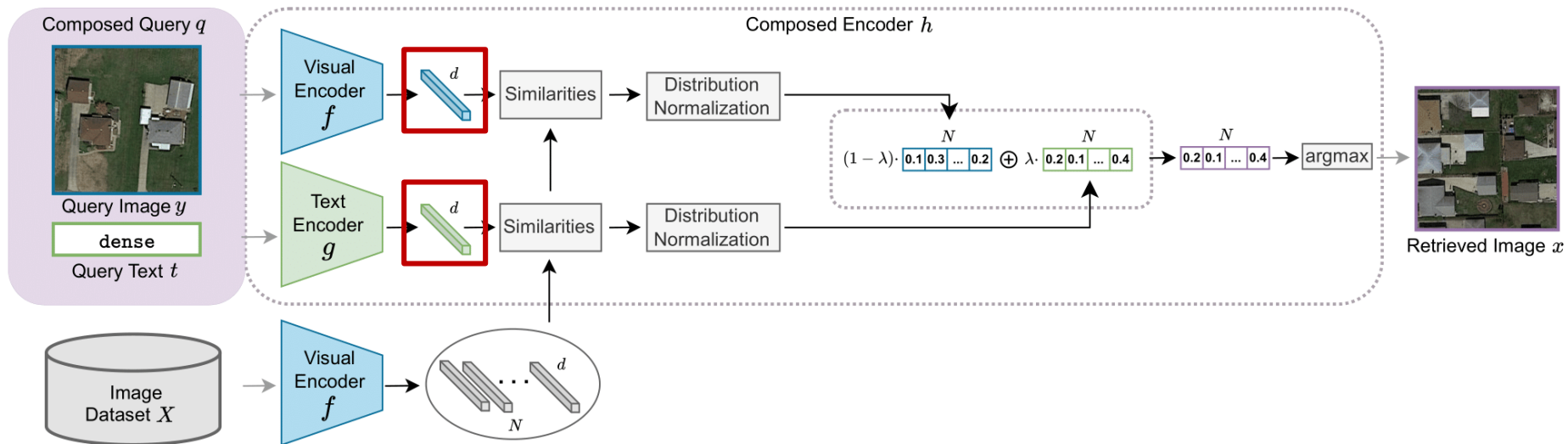


Radford et al., Learning transferable visual models from natural language supervision, ICML, 2021
Liu et al., Remoteclip: A vision language foundation model for remote sensing, IEEE TGRS, 2024

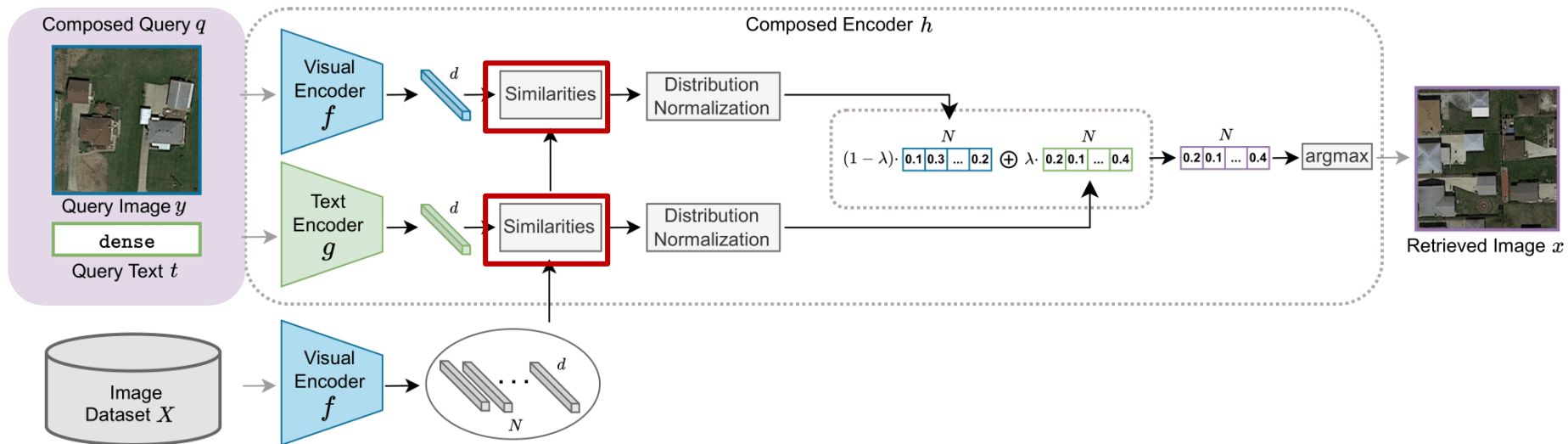
Our method, WeiCom



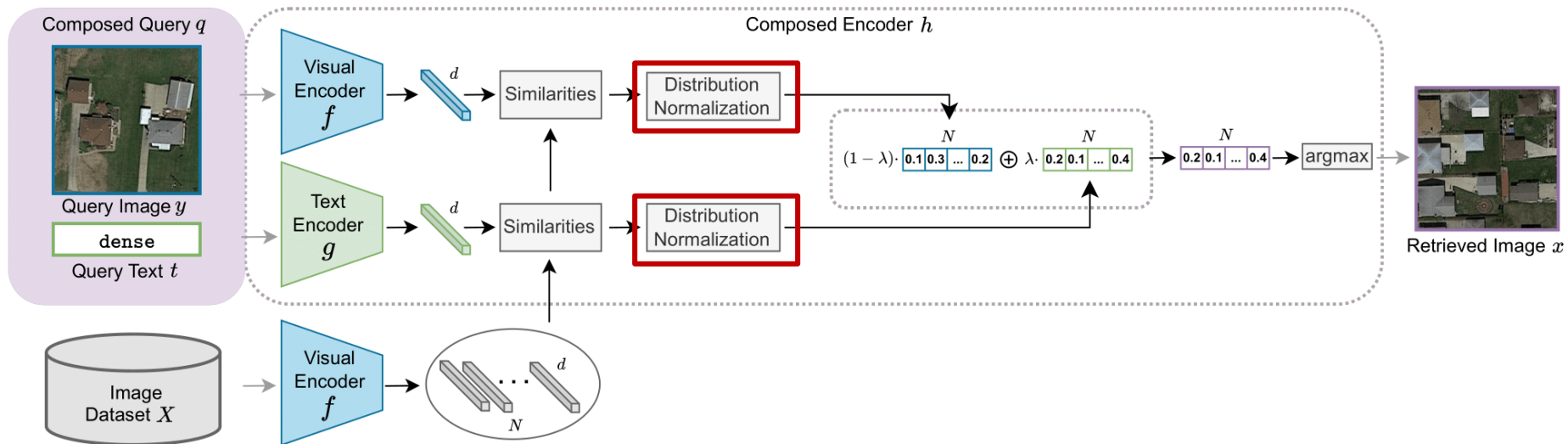
Our method, WeiCom



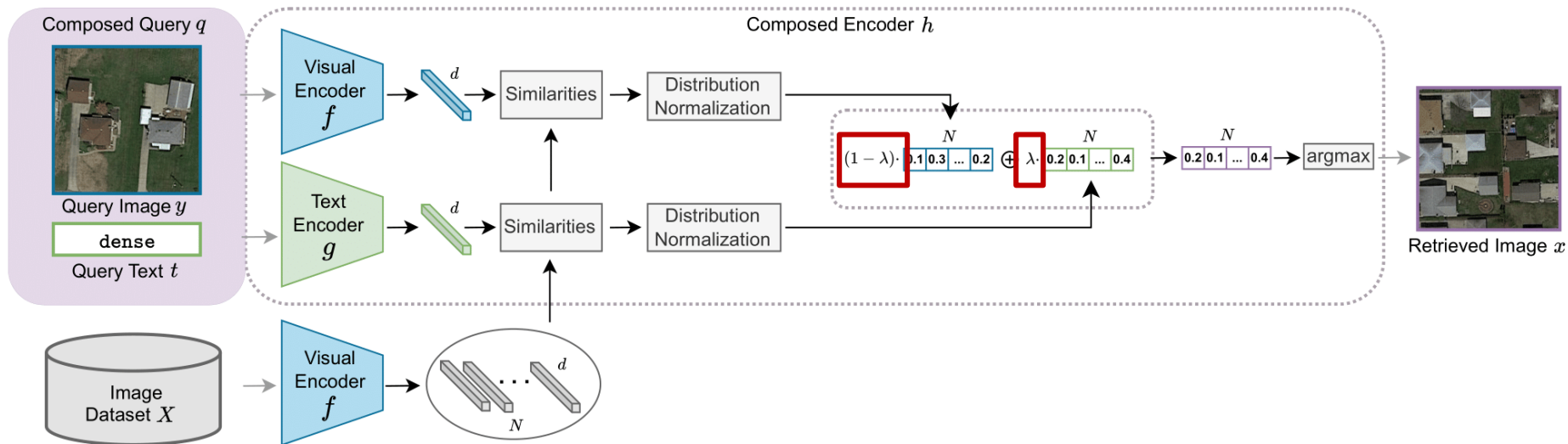
Our method, WeiCom



Our method, WeiCom

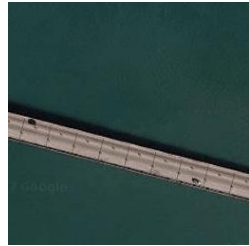


Our method, WeiCom



WeiCom's control parameter λ

query image

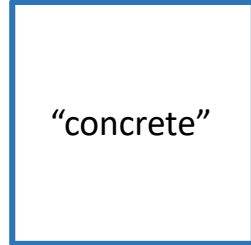
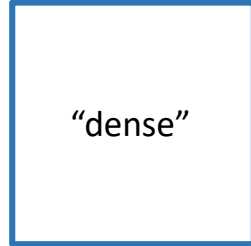


WeiCom's control parameter λ

query image



query text



WeiCom's control parameter λ

query image



retrieved images

image only
 $\lambda=0$

$\lambda=0.5$

$\lambda=0.75$

$\lambda=0.95$

text only
 $\lambda=1$

query text

“dense”

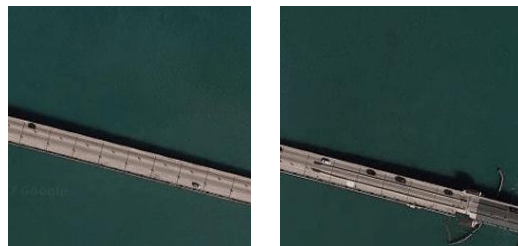
“concrete”

WeiCom's control parameter λ

query image



retrieved images



query text

“dense”

“concrete”

image only
 $\lambda=0$

$\lambda=0.5$

$\lambda=0.75$

$\lambda=0.95$

text only
 $\lambda=1$

WeiCom's control parameter λ

query image



retrieved images

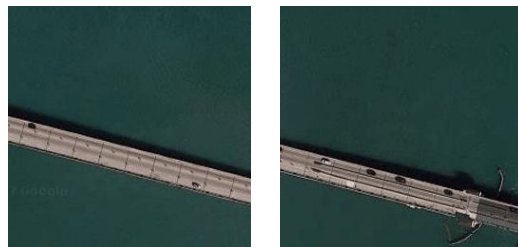


image only
 $\lambda=0$

$\lambda=0.5$

$\lambda=0.75$

$\lambda=0.95$



query text

“dense”



“concrete”

text only
 $\lambda=1$

WeiCom's control parameter λ

query image

retrieved images

query text

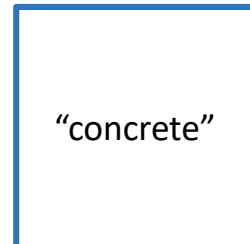
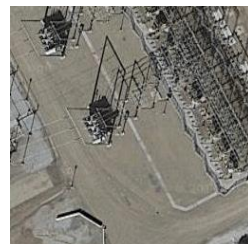
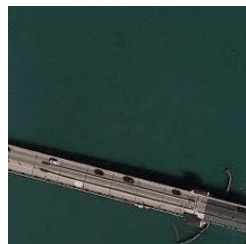
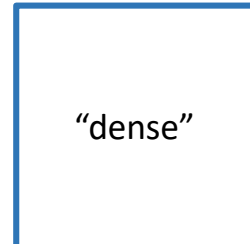
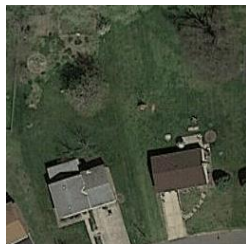


image only
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WeiCom's control parameter λ

query image

retrieved images

query text

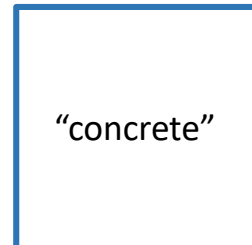
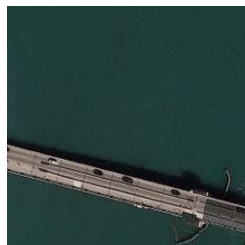
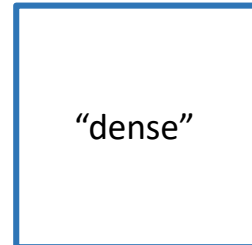


image only
 $\lambda=0$

$\lambda=0.5$

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$\lambda=0.95$

text only
 $\lambda=1$

WeiCom's control parameter λ

query image

retrieved images

query text

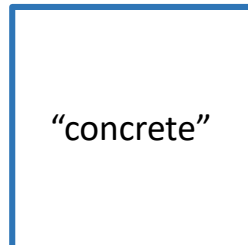
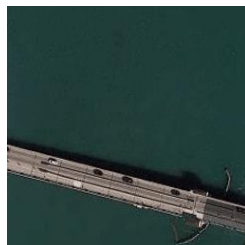
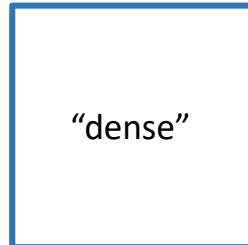


image only
 $\lambda=0$

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$\lambda=0.75$

$\lambda=0.95$

text only
 $\lambda=1$

PatternCom, our benchmark dataset

ATTRIBUTE	CLASS	VALUE	#POSITIVES	#QUERIES
color	airplane	white	672	53
		purple	53	672
	nursing home	white	85	383
		gray	383	85
	crosswalk	white	412	388
		yellow	388	412
		blue	339	287
	tennis court	brown	2	624
		gray	50	576
		green	211	415
red		24	602	
shape	swimming pool	rectangular	261	299
		oval	52	508
		kidney-shaped	247	313
	river	curved	177	623
		straight	623	177
	road	cross	800	800
		round	800	800

Statistics for **color** and **shape** attributes of PatternCom

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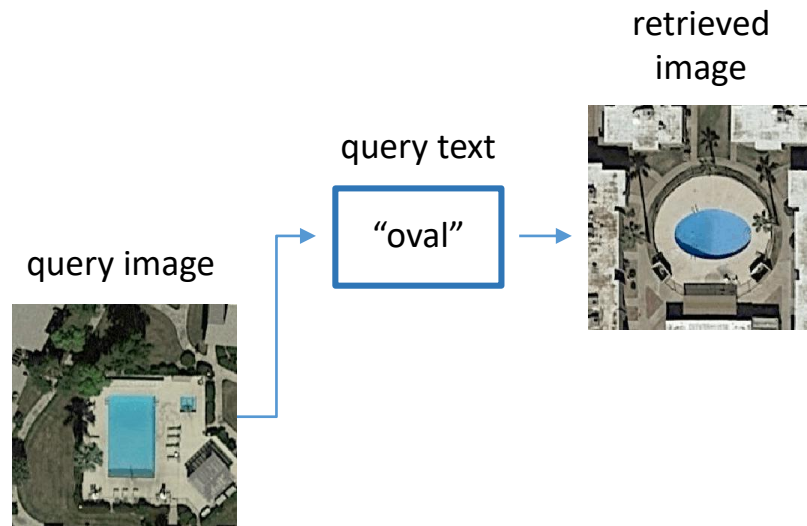
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		straight	623	177
	road	cross	800	800
		round	800	800

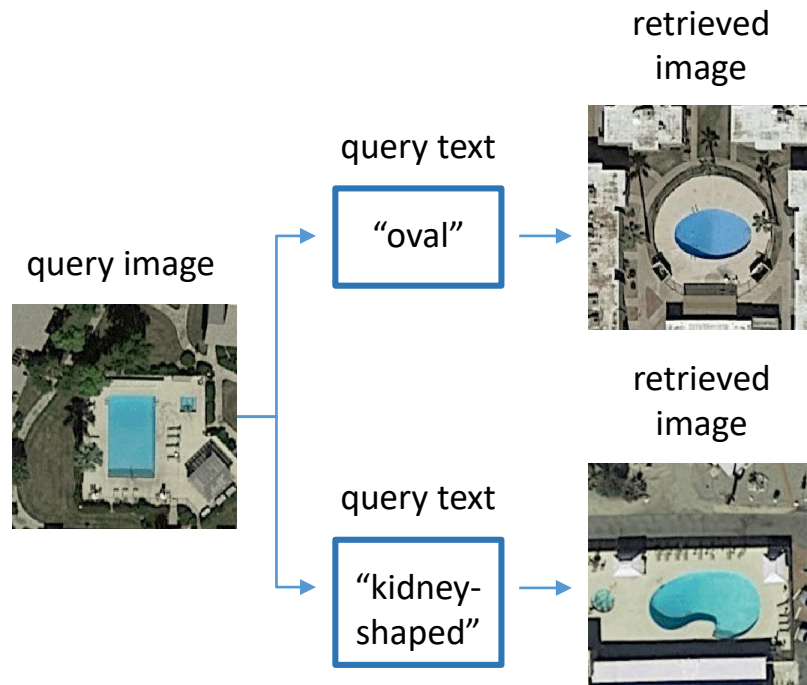
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Statistics for color and shape attributes of PatternCom

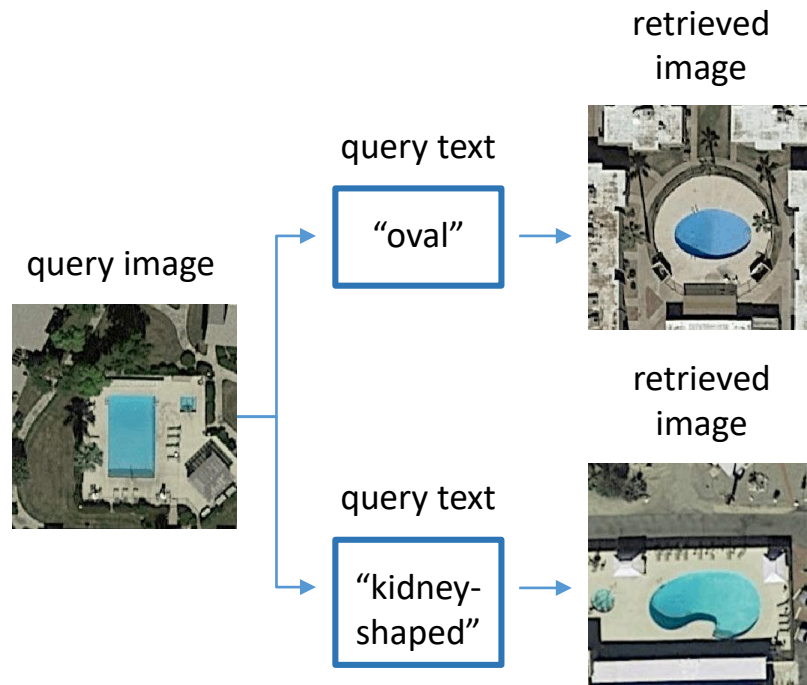


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	river	curved	177	623
		straight	623	177
	road	cross	800	800
		round	800	800

Statistics for color and shape attributes of PatternCom

>21k queries in total!



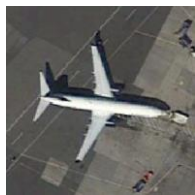
PatternCom: attributes

query image

query text

retrieved image

(a) color



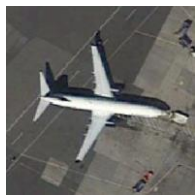
PatternCom: attributes

query image

query text

retrieved image

(a) color

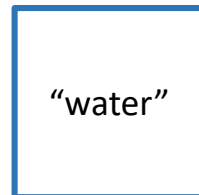
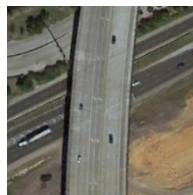


query image

query text

retrieved image

(b) context



PatternCom: attributes

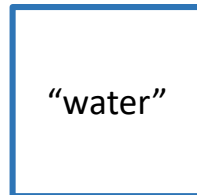
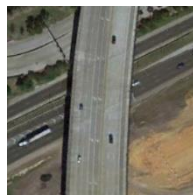
query image query text retrieved image

(a) color



query image query text retrieved image

(b) context



(c) density



PatternCom: attributes

query image

query text

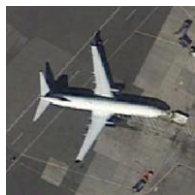
retrieved image

query image

query text

retrieved image

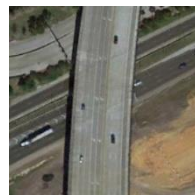
(a) color



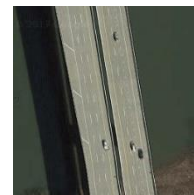
“purple”



(b) context



“water”



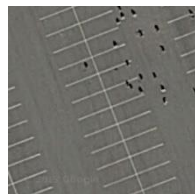
(c) density



“dense”



(d) existence



“full”



PatternCom: attributes

query image

query text

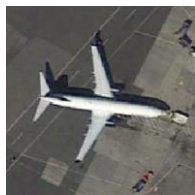
retrieved image

query image

query text

retrieved image

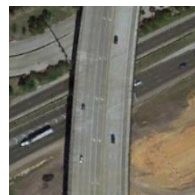
(a) color



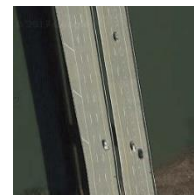
“purple”



(b) context



“water”



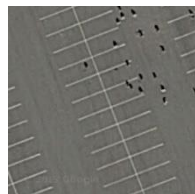
(c) density



“dense”



(d) existence



“full”



(e) quantity



“four”



PatternCom: attributes

query image

query text

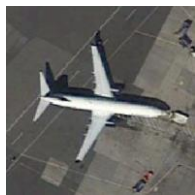
retrieved image

query image

query text

retrieved image

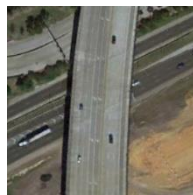
(a) color



“purple”



(b) context



“water”



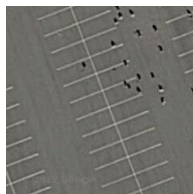
(c) density



“dense”



(d) existence



“full”



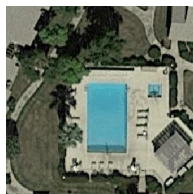
(e) quantity



“four”



(f) shape



“oval”



Quantitative Evaluation

	METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
CLIP	Text	14.14	4.83	3.58	4.38	6.30	6.22	6.58
	Image	11.80	8.32	13.49	13.50	6.30	15.76	11.53
	Text & Image	19.59	11.02	15.87	13.77	7.82	21.38	14.91
	WEICOM$_{\lambda=0.5}$	41.15	17.45	16.49	9.24	18.00	23.97	21.05
	WEICOM$_{\lambda=0.3}$	40.71	20.97	22.07	12.07	18.40	26.22	23.41

Quantitative Evaluation

CLIP

METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
Text	14.14	4.83	3.58	4.38	6.30	6.22	6.58
Image	11.80	8.32	13.49	13.50	6.30	15.76	11.53
Text & Image	19.59	11.02	15.87	13.77	7.82	21.38	14.91
WEICOM$_{\lambda=0.5}$	41.15	17.45	16.49	9.24	18.00	23.97	21.05
WEICOM$_{\lambda=0.3}$	40.71	20.97	22.07	12.07	18.40	26.22	23.41

RemoteCLIP

METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
Text	11.89	8.87	22.16	12.49	12.56	24.12	16.99
Image	11.72	6.62	15.11	9.29	5.41	15.18	11.19
Text & Image	19.84	10.01	18.45	10.56	6.23	19.63	14.85
WEICOM$_{\lambda=0.5}$	40.08	31.45	39.94	14.27	14.14	29.78	28.28
WEICOM$_{\lambda=0.6}$	38.20	31.59	41.56	14.79	14.53	31.24	28.65

Attribute modification mAP (%); comparison of WeiCom with baselines.

For each attribute value, average mAP over all the rest attribute values.

Quantitative Evaluation

CLIP

METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
Text	14.14	4.83	3.58	4.38	6.30	6.22	6.58
Image	11.80	8.32	13.49	13.50	6.30	15.76	11.53
Text & Image	19.59	11.02	15.87	13.77	7.82	21.38	14.91
WEICOM$_{\lambda=0.5}$	41.15	17.45	16.49	9.24	18.00	23.97	21.05
WEICOM$_{\lambda=0.3}$	40.71	20.97	22.07	12.07	18.40	26.22	23.41

8.5%

RemoteCLIP

METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
Text	11.89	8.87	22.16	12.49	12.56	24.12	16.99
Image	11.72	6.62	15.11	9.29	5.41	15.18	11.19
Text & Image	19.84	10.01	18.45	10.56	6.23	19.63	14.85
WEICOM$_{\lambda=0.5}$	40.08	31.45	39.94	14.27	14.14	29.78	28.28
WEICOM$_{\lambda=0.6}$	38.20	31.59	41.56	14.79	14.53	31.24	28.65

Attribute modification mAP (%); comparison of WeiCom with baselines.
For each attribute value, average mAP over all the rest attribute values.

Quantitative Evaluation

CLIP

METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
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RemoteCLIP

METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
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WEICOM$_{\lambda=0.5}$	40.08	31.45	39.94	14.27	14.14	29.78	28.28
WEICOM$_{\lambda=0.6}$	38.20	31.59	41.56	14.79	14.53	31.24	28.65

11.7%

Attribute modification mAP (%); comparison of WeiCom with baselines.
 For each attribute value, average mAP over all the rest attribute values.

Quantitative Evaluation

CLIP

METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
Text	14.14	4.83	3.58	4.38	6.30	6.22	6.58
Image	11.80	8.32	13.49	13.50	6.30	15.76	11.53
Text & Image	19.59	11.02	15.87	13.77	7.82	21.38	14.91
WEICOM$_{\lambda=0.5}$	41.15	17.45	16.49	9.24	18.00	23.97	21.05
WEICOM$_{\lambda=0.3}$	40.71	20.97	22.07	12.07	18.40	26.22	23.41

5.2%

RemoteCLIP

METHOD	COLOR	CONTEXT	DENSITY	EXISTENCE	QUANTITY	SHAPE	AVG
Text	11.89	8.87	22.16	12.49	12.56	24.12	16.99
Image	11.72	6.62	15.11	9.29	5.41	15.18	11.19
Text & Image	19.84	10.01	18.45	10.56	6.23	19.63	14.85
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WEICOM$_{\lambda=0.6}$	38.20	31.59	41.56	14.79	14.53	31.24	28.65

Attribute modification mAP (%); comparison of WeiCom with baselines.
For each attribute value, average mAP over all the rest attribute values.

Conclusion

- ✓ Introduce **Remote Sensing Composed Image Retrieval**, accompanied with **PatternCom**, a benchmark dataset
- ✓ Demonstrate its versatility through use cases **modifying attributes** like **color** and **shape**
- ✓ Introduce **WeiCom**, a **training-free** method utilizing a **modality control parameter λ**

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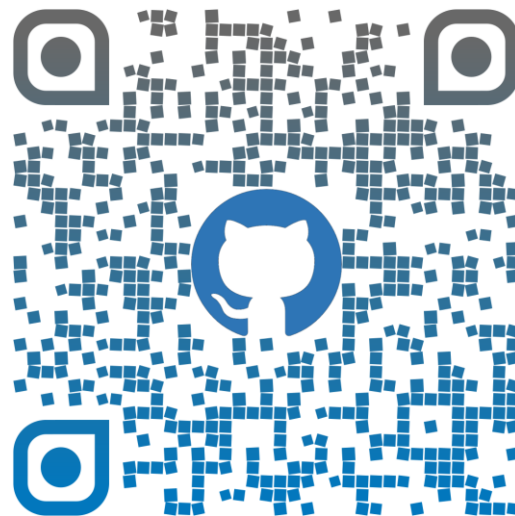


Konstantinos
Karantzalos

Thanks for your attention!



paper



code and dataset