A Few Papers about Security for CLIP Retrieval Unlearning

Paper Reading by Luohao Lin

2025.09.03

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

- Safe-CLIP
- Hyperbolic-CLIP
- Hyperbolic vs Euclidean
- CLIPErase
- 总结

Safe-CLIP: Removing NSFW Concepts from Vision-and-Language Models

Samuele Poppi*[1,2], Tobia Poppi*[1,2], Federico Cocchi*[1,2], Marcella Cornia[1], Lorenzo Baraldi[1], and Rita Cucchiara[1,3]

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Safe-CLIP

Tobia Poppi

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Hyperbolic Safety-Aware Vision-Language Models T Poppi, T Kasarla, P Mettes, L Baraldi, R Cucchiara IEEE/CVF Conference on Computer Vision and Pattern Recognition	2	2025
Uncovering the background-induced bias in RGB based 6-DOF object pose estimation E Govi, D Sapienza, C Scribano, T Poppi, G Franchini, P Ardón, ... arXiv preprint arXiv:2304.08230	1	2023
Improving LLM First-Token Predictions in Multiple-Choice Question Answering via Prefilling Attack S Cappelletti, T Poppi, S Poppi, ZX Yong, D Garcia-Olano, M Cornia, ... arXiv preprint arXiv:2505.15323		2025

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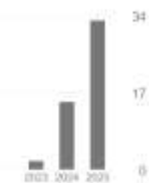

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Detecting moving objects, ghosts, and shadows in video streams R Cucchiara, C Grana, M Piccardi, A Prati IEEE transactions on pattern analysis and machine intelligence 25 (10), 1337 ...	2305	2003
Visual tracking: An experimental survey AWM Smeulders, DM Chu, R Cucchiara, S Calderara, A Dehghan, ... IEEE transactions on pattern analysis and machine intelligence 36 (7), 1442-1468	2090	2013
Meshed-memory transformer for image captioning M Cornia, M Stefanini, L Baraldi, R Cucchiara Proceedings of the IEEE/CVF conference on computer vision and pattern ...	1388	2020

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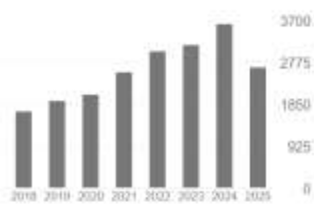

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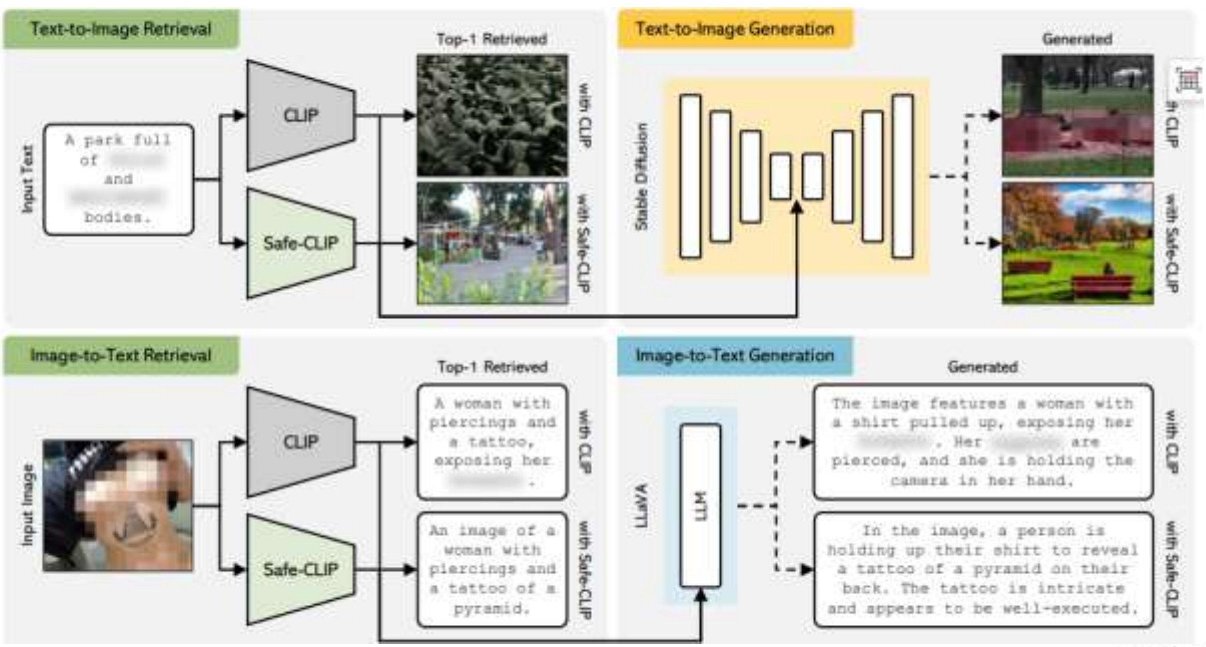
Safe-CLIP

模型训练过程中混入NSFW数据，导致：

- ➢ 跨模态检索时，NSFW文本检索到有害图片
- ➢ T2I时，生成包含NSFW概念的图片
- ➢ I2T时，触发有毒的描述性文本

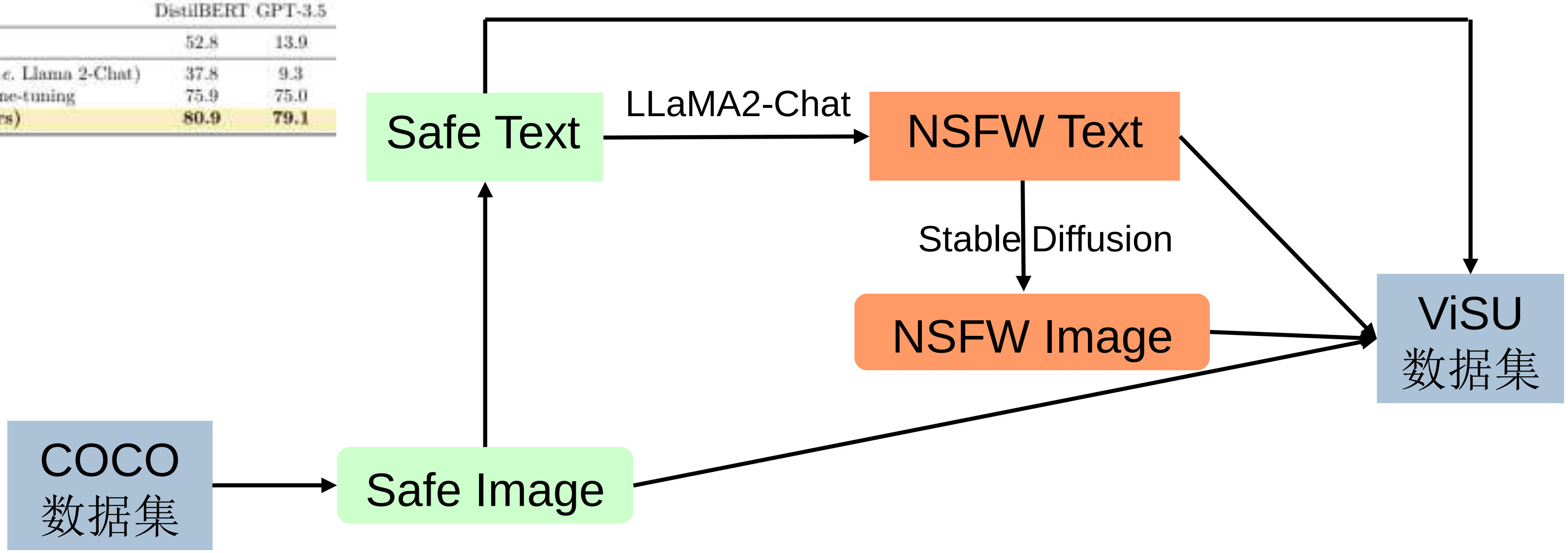


Safe-CLIP

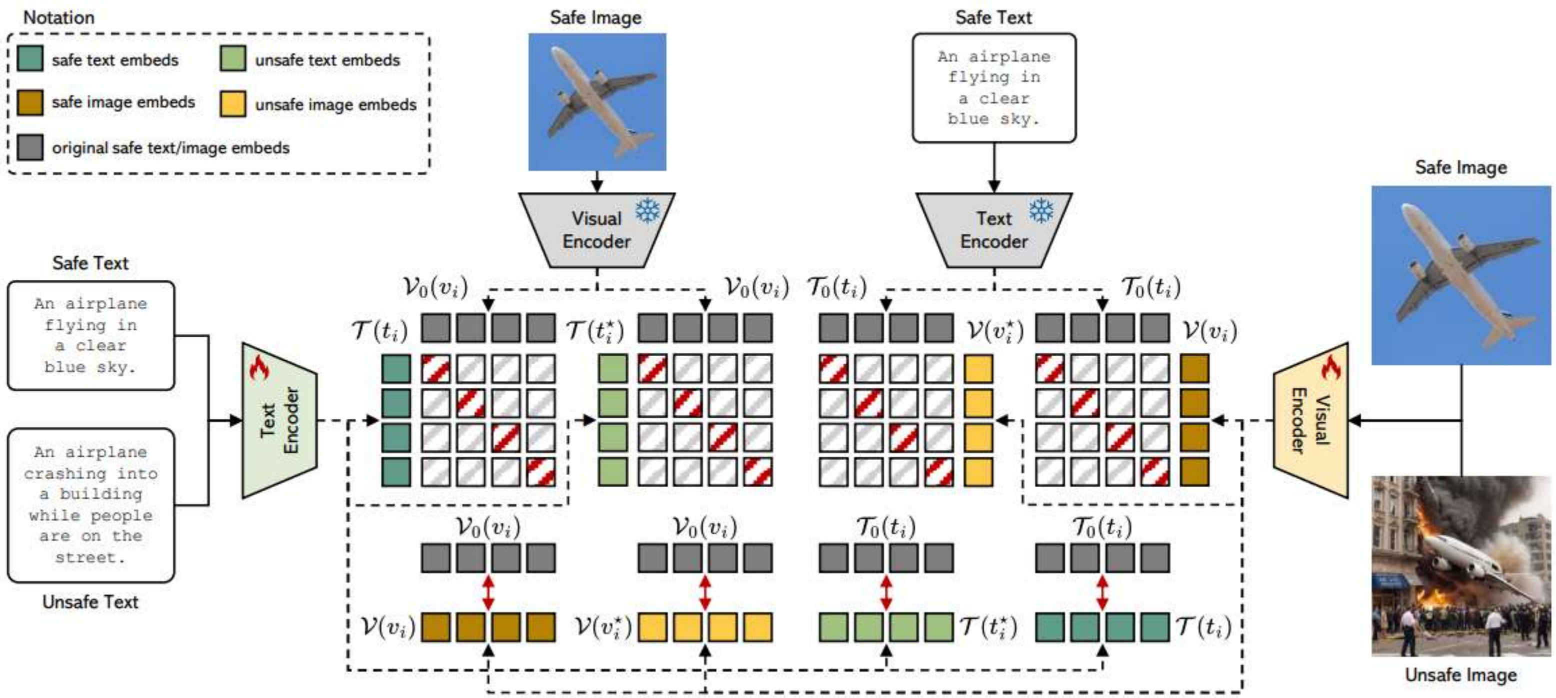

```
{
    "incremental_id": 0,
    "safe": "A young man holding an umbrella next to a herd of cattle.",
    "nsfw": "A young man holding a gun next to a herd of cattle, with a grin on his face and a wicked look in his eyes. ",
    "coco_id": "000000184613",
    "tag": "weapons",
    "prompt_id": 16
},
```


$$\text{rank}(t_i^\star, t_i) = \text{CLIP-Sim}(t_i^\star, t_i) + \text{NSFWRate}(t_i^\star),$$

Dataset	% NSFW DistilBERT	% NSFW GPT-3.5
I2P [44]	52.8	13.9
w/o SFT (*i.e.* Llama 2-Chat)	37.8	9.3
w/o DPO fine-tuning	75.9	75.0
ViSU (Ours)	**80.9**	**79.1**



Safe-CLIP



$$L_{\text{redir},1} = -\frac{1}{N}\left(\sum_{i=1}^{N}\log\frac{\exp(\cos(\mathcal{T}(t_i^\star),\mathcal{V}_0(v_i))/\tau)}{\sum_{j=1}^{N}\exp(\cos(\mathcal{T}(t_j^\star),\mathcal{V}_0(v_i))/\tau)} + \sum_{i=1}^{N}\log\frac{\exp(\cos(\mathcal{T}(t_i^\star),\mathcal{V}_0(v_i))/\tau)}{\sum_{j=1}^{N}\exp(\cos(\mathcal{T}(t_i^\star),\mathcal{V}_0(v_j))/\tau)}\right. \tag{4}$$

$$\left.+\sum_{i=1}^{N}\log\frac{\exp(\cos(\mathcal{V}(v_i^\star),\mathcal{T}_0(t_i))/\tau)}{\sum_{j=1}^{N}\exp(\cos(\mathcal{V}(v_j^\star),\mathcal{T}_0(t_i))/\tau)} + \sum_{i=1}^{N}\log\frac{\exp(\cos(\mathcal{V}(v_i^\star),\mathcal{T}_0(t_i))/\tau)}{\sum_{j=1}^{N}\exp(\cos(\mathcal{V}(v_i^\star),\mathcal{T}_0(t_j))/\tau)}\right)$$

$$L_{\text{redir},2} = -\frac{1}{N}\left(\sum_{i=1}^{N}\cos(\mathcal{T}(t_i^\star),\mathcal{T}_0(t_i)) + \sum_{i=1}^{N}\cos(\mathcal{V}(v_i^\star),\mathcal{V}_0(v_i))\right)$$

$$L_{\text{pres},1} = -\frac{1}{N}\left(\sum_{i=1}^{N}\cos(\mathcal{T}(t_i),\mathcal{T}_0(t_i)) + \sum_{i=1}^{N}\cos(\mathcal{V}(v_i),\mathcal{V}_0(v_i))\right).$$

$$L_{\text{pres},2} = -\frac{1}{N}\left(\sum_{i=1}^{N}\log\frac{\exp(\cos(\mathcal{V}_0(v_i),\mathcal{T}(t_i))/\tau)}{\sum_{j=1}^{N}\exp(\cos(\mathcal{V}_0(v_i),\mathcal{T}(t_j))/\tau)} + \sum_{i=1}^{N}\log\frac{\exp(\cos(\mathcal{V}_0(v_i),\mathcal{T}(t_i))/\tau)}{\sum_{j=1}^{N}\exp(\cos(\mathcal{V}_0(v_j),\mathcal{T}(t_i))/\tau)}\right. \tag{7}$$

$$\left.+\sum_{i=1}^{N}\log\frac{\exp(\cos(\mathcal{T}_0(t_i),\mathcal{V}(v_i))/\tau)}{\sum_{j=1}^{N}\exp(\cos(\mathcal{T}_0(t_i),\mathcal{V}(v_j))/\tau)} + \sum_{i=1}^{N}\log\frac{\exp(\cos(\mathcal{T}_0(t_i),\mathcal{V}(v_i))/\tau)}{\sum_{j=1}^{N}\exp(\cos(\mathcal{T}_0(t_j),\mathcal{V}(v_i))/\tau)}\right).$$

Safe-CLIP

Model	Text-to-Image ($\mathbf{T}$-to-$\mathbf{V}$)			Image-to-Text ($\mathbf{V}$-to-$\mathbf{T}$)			Text-to-Image ($\mathbf{T}^\star$-to-$\mathbf{V} \cup \mathbf{V}^\star$)			Image-to-Text ($\mathbf{V}^\star$-to-$\mathbf{T} \cup \mathbf{T}^\star$)		
	R@1	R@10	R@20	R@1	R@10	R@20	R@1	R@10	R@20	R@1	R@10	R@20
CLIP (ViT-L) [39]	36.8	71.6	81.5	39.8	74.2	83.5	2.0	24.8	33.2	4.5	32.9	40.6
DataComp-1B (ViT-L) [13]	46.7	79.7	87.4	47.0	81.3	88.9	1.6	28.1	35.6	5.5	37.5	44.9
w/o inap. content redirection	49.9	83.7	90.3	48.1	83.6	90.5	1.6	30.4	40.1	6.1	35.2	42.6
w/o negative cosine similarities	41.9	78.5	87.3	41.5	77.8	86.9	**8.2**	46.0	56.6	13.7	60.4	68.2
Safe-CLIP	45.9	81.8	89.7	45.3	82.3	89.7	8.0	**46.9**	**58.0**	**19.1**	**62.9**	**71.1**

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- 总结

Hyperbolic Safety-Aware Vision-Language Models

Tobia Poppi*[1,2] Tejaswi Kasarla*[3] Pascal Mettes[3] Lorenzo Baraldi[1] Rita Cucchiara[1,4]
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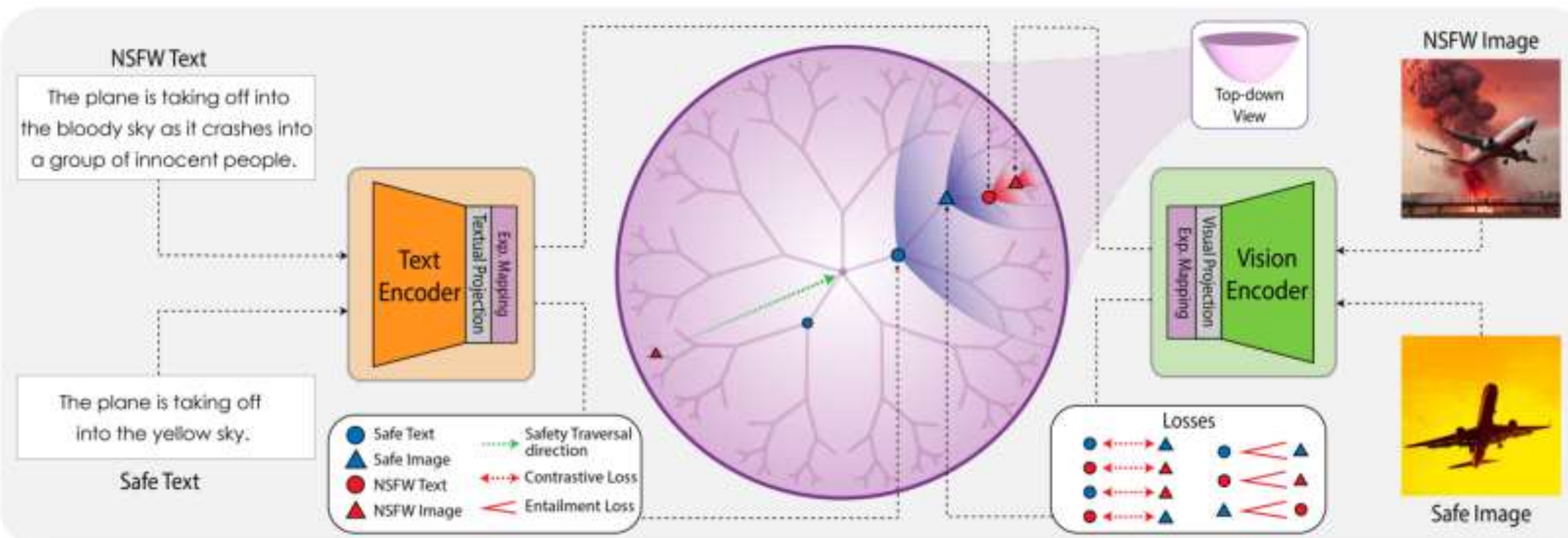
Hyperbolic-CLIP

单纯的遗忘 -> 对安全和NSFW内容的有效区分



$$g_T(T_k) \ll g_I(I_k) \ll g_T(T_k^\star) \ll g_I(I_k^\star).$$

Hyperbolic-CLIP

$$L(I,T,I^\star,T^\star) = L_{\text{hSC}}(I,T,I^\star,T^\star) + L_{\text{hSE}}(I,T,I^\star,T^\star).$$

$$L_{\text{hSC}}(I,T,I^\star,T^\star) = L^\star_{cont}(I,T) + L^\star_{cont}(I^\star,T^\star) + L^\star_{cont}(I,T^\star) + L^\star_{cont}(I^\star,T).$$

$$L_{\text{hSE}}(I,T,I^\star,T^\star) = L^\star_{ent}(I,T) + L^\star_{ent}(T^\star,I) + L^\star_{ent}(I^\star,T^\star).$$

$$L^*_{cont}(I,T) = -\sum_{i\in B} \log \frac{\exp(d_{\mathcal{L}}(g_I(I_i),g_T(T_i))/\tau)}{\sum_{k=1,k\neq i}^{B} \exp(d_{\mathcal{L}}(g_I(I_i),g_T(T_k))/\tau)},$$

$$L^\star_{ent}(I,T) = \max(0, \phi(I_k,T_k) - \eta\omega(T_k)) \text{ and}$$
$$L^\star_{ent}(I^\star,T^\star) = \max(0, \phi(I^\star_k,T^\star_k) - \eta\omega(T^\star_k)),$$

Hyperbolic-CLIP

Model	Text-to-Image (T-to-I) R@1	R@10	R@20	Image-to-Text (I-to-T) R@1	R@10	R@20	Text-to-Image ($T^\star$-to-$I \cup I^\star$) R@1	R@10	R@20	Image-to-Text ($I^\star$-to-$T \cup T^\star$) R@1	R@10	R@20
CLIP [69]	36.8	71.6	81.5	39.8	74.2	83.5	2.0	24.8	33.2	4.6	32.9	40.6
MERU [20]	14.9	43.0	54.2	14.7	42.3	53.8	2.2	15.2	21.5	4.4	22.6	29.4
HyCoCLIP [63]	34.3	71.2	80.6	34.4	71.3	82.2	2.8	25.3	33.2	8.2	37.8	45.7
Safe-CLIP [66]	45.9	81.8	89.7	45.3	82.3	89.8	8.0	46.9	58.0	19.1	62.9	71.1
MERU*	50.0	84.1	91.1	51.2	85.3	92.3	2.3	39.9	49.4	5.7	47.9	54.7
HyCoCLIP*	47.7	81.9	89.1	46.7	82.7	90.4	1.5	32.7	42.3	6.9	45.2	53.6
HySAC	**49.8**	**84.1**	**90.7**	**48.2**	**84.2**	**91.2**	**30.5**	**62.8**	**71.8**	**42.1**	**73.3**	**79.8**

Table 1. **Safe content retrieval performance on ViSU test set.** Across all tasks and recall rates, HySAC improves over existing safety unlearning CLIP and hyperbolic CLIP models, highlighting that our approach is able to navigate unsafe image or text inputs towards relevant but safe retrieval outputs. * CLIP fine-tuned in hyperbolic space on ViSU training set with MERU/HyCoCLIP losses.

Model	Text-to-Image ($T^\star$-to-$I^\star$) R@1	R@10	R@20	Image-to-Text ($I^\star$-to-$T^\star$) R@1	R@10	R@20	Text-to-Image ($T^\star$-to-$I^\star \cup I$) R@1	R@10	R@20	Image-to-Text ($I^\star$-to-$T^\star \cup T$) R@1	R@10	R@20
CLIP [69]	73.1	94.9	97.6	72.8	95.2	97.7	68.4	92.3	95.9	67.1	93.3	96.7
MERU [20]	29.4	62.4	72.2	25.8	57.7	67.8	23.5	54.0	64.3	19.5	51.1	61.2
HyCoCLIP [63]	69.5	93.1	95.8	65.0	91.1	95.0	63.7	89.7	93.7	55.2	88.0	92.7
Safe-CLIP [66]	58.0	86.2	91.4	56.0	85.1	91.0	47.7	80.0	85.8	32.1	77.1	84.6
HySAC	**81.4**	**98.4**	**99.4**	**82.2**	**97.8**	**99.2**	**81.1**	**98.4**	**99.4**	**80.5**	**97.2**	**98.9**

Table 2. **Unsafe content retrieval performance on ViSU test set.** Akin to safe content retrieval, our approach performs best. This is a result of our objective, as we assign different content to different regions, enabling us to maintain valuable safety information.

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- 总结

Machine Unlearning in Hyperbolic vs. Euclidean Multimodal Contrastive Learning: Adapting Alignment Calibration to MERU

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Machine Unlearning in Hyperbolic vs. Euclidean Multimodal Contrastive Learning: Adapting Alignment Calibration to MERU ÀP Vidal, K Nasrollahi, TB Moeslund, S Escalera Proceedings of the Computer Vision and Pattern Recognition Conference, 1644-1653	1	2025
Machine Unlearning in Hyperbolic vs. Euclidean Multimodal Contrastive Learning: Adapting Alignment Calibration to MERU À Pujol Vidal, S Escalera, K Nasrollahi, TB Moeslund arXiv e-prints, arXiv: 2503.15166		2025

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Survey on emotional body gesture recognition F Noroozi, CA Corneanu, D Kamińska, T Sapiński, S Escalera, ... IEEE transactions on affective computing 12 (2), 505-523	604	2018
Bi-directional ConvLSTM U-Net with densley connected convolutions R Azad, M Asadi-Aghbolaghi, M Fathy, S Escalera Proceedings of the IEEE/CVF international conference on computer vision ...	601	2019

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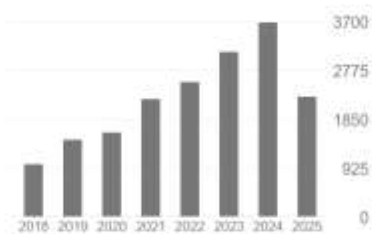

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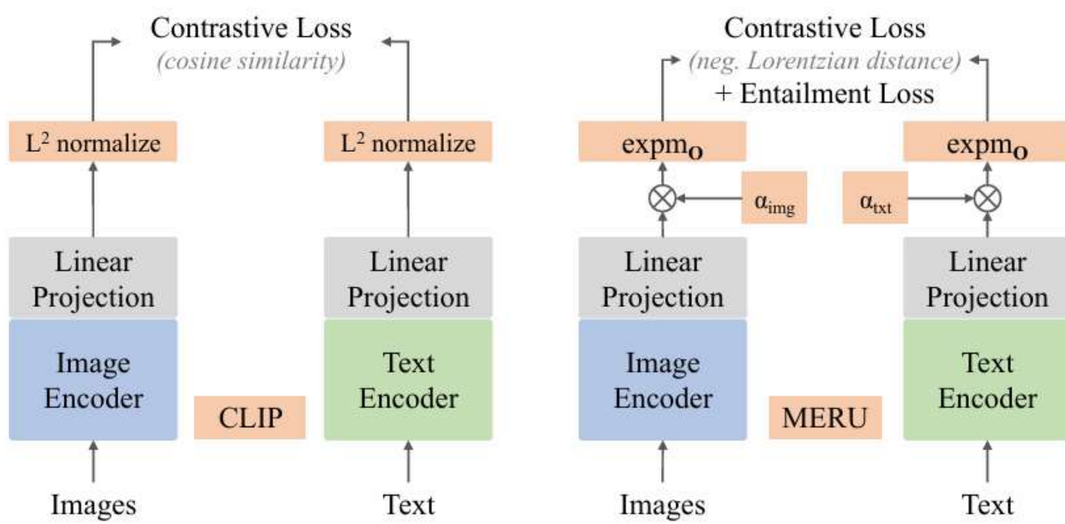
Hyperbolic vs Euclidean



Hyperbolic vs Euclidean

AC（Alignment Calibration）：

Published in Transactions on Machine Learning Research (08/2025)

MUC: Machine Unlearning for Contrastive Learning with Black-box Evaluation

$$L_{\text{neg}} = -\frac{1}{2N^2}\sum_{i=1}^{N}\sum_{j=1, j\neq i}^{N}\frac{\text{sim}(x_i'^f, t_j'^f) + \text{sim}(x_j'^f, t_i'^f)}{\tau}.$$

$$L_{\text{pos}} = \frac{1}{N}\sum_{i=1}^{N}\text{sim}(x_i'^f, t_i'^f)/\tau.$$

$$L_{\text{retain}} = -\frac{1}{2N}\sum_{i=1}^{N}\left[\log\frac{\exp(\text{sim}(x_i'^r, t_i'^r)/\tau)}{\sum_{j=1}^{2N}\exp(\text{sim}(x_i'^r, t_j')/\tau)} + \log\frac{\exp(\text{sim}(x_i'^r, t_i'^r)/\tau)}{\sum_{j=1}^{2N}\exp(\text{sim}(x_j', t_i'^r)/\tau)}\right].$$

$$L_{\text{perf}} = \frac{1}{2N}\sum_{i=1}^{N}\left[\log\left(\frac{1}{2N}\sum_{j=1}^{2N}\exp(\text{sim}(x_i'^f, t_j')/\tau)\right)\right. \tag{9}$$

$$\left.+\log\left(\frac{1}{2N}\sum_{j=1}^{2N}\exp(\text{sim}(x_j', t_i'^f)/\tau)\right)\right] \tag{10}$$

$$L_{\text{forget}} = \alpha\cdot L_{\text{neg}} + \beta\cdot L_{\text{pos}} + \gamma\cdot L_{\text{perf}}.$$

$$L_{\text{AC}} = L_{\text{retain}} + \varepsilon\cdot L_{\text{forget}},$$

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Hyperbolic vs Euclidean

HAC（Hyperbolic Alignment Calibration）：

$$L_{\text{r-ent}} = \frac{1}{N}\sum_{i=1}^{N} \max(0, \text{ext}(x_i^{'r}, t_i^{'r}) - \text{aper}(t_i^{'r})),$$

$$L_{\text{f-ent}} = \frac{1}{N}\sum_{i=1}^{N} \max(0, \text{aper}(t_i^{'f}) - \text{ext}(x_i^{'f}, t_i^{'f})),$$

$$L_{\text{HAC}} = L_{\text{retain}} + \varepsilon \cdot L_{\text{forget}} + \omega_r \cdot L_{\text{r-ent}} + \omega_f \cdot L_{\text{f-ent}}.$$

$$L_{\text{norm-reg}} = \frac{1}{N}\sum_{i=1}^{N} (||x_i^{'f}||_{\mathcal{L}} + ||t_i^{'f}||_{\mathcal{L}}),$$

$$L_{\text{HAC-reg}} = L_{\text{HAC}} + \lambda \cdot L_{\text{norm-reg}}$$

Hyperbolic vs Euclidean

Method	Weights α, γ	Weights β	CIFAR-10 R-acc↑	CIFAR-10 F-acc↓	O-IIIT Pets R-acc↑	O-IIIT Pets F-acc↓
AC	0.75	0	**60.5**	45.6	73.6	66.2
		0.25	60.3	31.7	73.5	48.7
		0.5	58.7	**21.2**	**74.9**	31.5
		0.75	58.4	24.9	73.9	**24.6**
f-C	0	0	58.9	48.1	74.6	69.9
f-C-R			60.6	63.6	72.3	72.2
O-C			59.4	66.4	74.6	73.2
HAC	0.5	0	55.2	73.6	74.8	63.9
		0.25	34.7	**0.0**	62.1	**15.8**
		0.5	49.9	**0.0**	69.6	17.9
		0.75	39.6	0.03	63.9	16.1
f-M	0	0	**56.4**	73.0	**75.2**	65.9
f-M-R			41.7	95.7	71.8	65.8
O-M			38.1	94.6	72.0	70.8

Method	Weights α, γ	Weights β	CIFAR-10 R-acc↑	CIFAR-10 F-acc↓	O-IIIT Pets R-acc↑	O-IIIT Pets F-acc↓
AC	0.5	0.5	**58.8**	24.0	74.6	32.9
	0.75		58.7	**21.2**	**74.9**	**31.5**
	1		57.2	27.4	73.6	41.5
HAC	0.5	0.5	**49.9**	**0.0**	**69.6**	**17.9**
	0.75		40.7	0.02	67.5	18.0
	1		42.7	0.04	68.6	19.8

Task	Method	Unlearn Set	CIFAR-10[18] R-acc↑	CIFAR-10[18] F-acc↓	CIFAR-100[19] R-acc↑	CIFAR-100[19] F-acc↓	STL-10[1] R-acc↑	STL-10[1] F-acc↓	O-IIIT Pets[26] R-acc↑	O-IIIT Pets[26] F-acc↓	Food101[3] R-acc↑	Food101[3] F-acc↓	Flowers102[25] R-acc↑	Flowers102[25] F-acc↓
Zero-shot Classification	AC	A	**58.7**	21.2	**27.9**	-	**88.1**	83.1	**74.9**	31.5	**72.4**	-	**44.7**	-
		B	**90.3**	71.4	**26.6**	-	**90.3**	71.4	-	53.4	**72.5**	-	**45.0**	-
		C	**90.0**	77.0	**23.4**	57.2	**90.0**	77.0	-	64.0	-	0.16	-	19.2
	HAC-reg	A	54.0	**0.0**	20.6	-	84.3	**38.0**	66.3	**10.8**	67.6	-	40.1	-
		B	83.5	**2.1**	21.8	-	83.5	**2.1**	-	**25.7**	59.6	-	36.4	-
		C	82.7	**22.1**	18.8	**21.6**	82.7	**22.1**	-	**28.7**	-	**0.08**	-	**0.04**

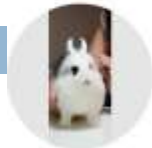
- Safe-CLIP
- Hyperbolic-CLIP
- Hyperbolic vs Euclidean
- CLIPErase
- 总结

CLIPErase: Efficient Unlearning of Visual-Textual Associations in CLIP

Tianyu Yang[1], Lisen Dai[2], Xiangqi Wang[1], Minhao Cheng[3],
Yapeng Tian[4], Xiangliang Zhang[1*]

[1]University of Notre Dame
[2]Columbia University
[3]Pennsylvania State University
[4]University of Texas at Dallas

CLIPErase



Tianyu Yang

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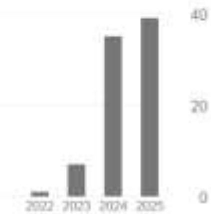
	总计	2020 年至今
引用	82	82
h 指数	4	4
i10 指数	3	3



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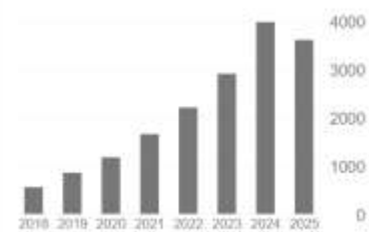
	总计	2020 年至今
引用	18321	15622
h 指数	68	59
i10 指数	259	237



计算实验室

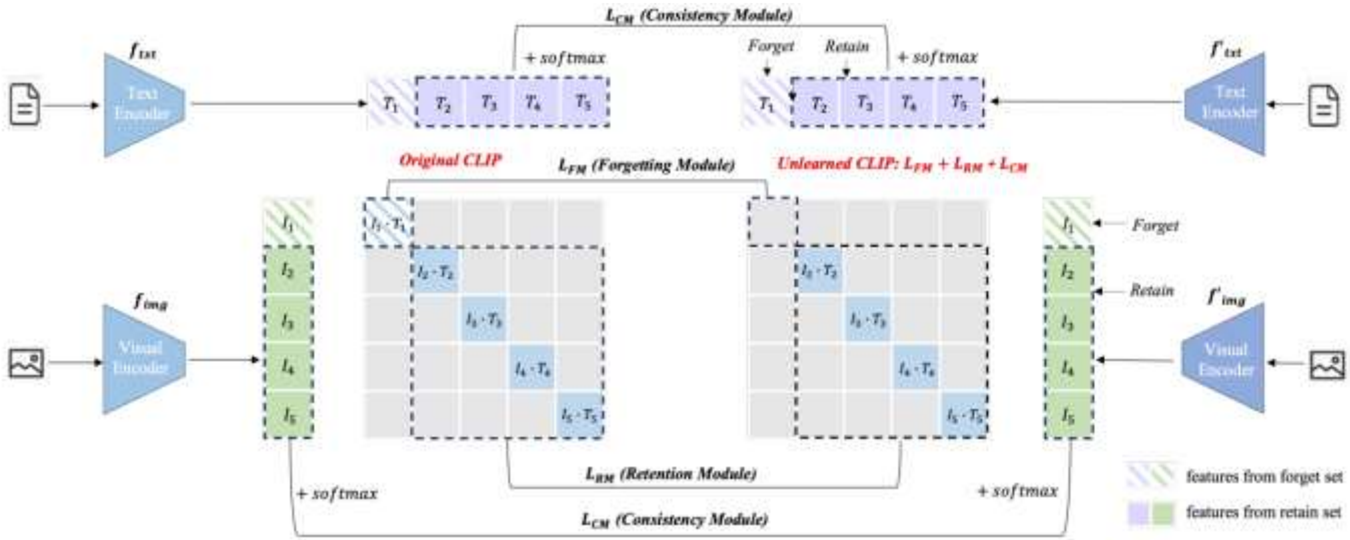
tent Computing Lab

CLIPErase

两个挑战：

- 跨模态关联破坏风险
- 概念区分精度不足

CLIPErase



$$\mathcal{L}_{\mathrm{FM}} = \frac{1}{N_f} \sum_{n=1}^{N_f} \left(f_{\mathrm{img}}(x_i^n) \cdot f_{\mathrm{txt}}(x_t^n) \right)$$

$$\mathcal{L}_{\mathrm{RM}} = -\frac{1}{N_r} \sum_{n=1}^{N_r} \log \operatorname{softmax}(f_{\mathrm{img}}(x_i^n) \cdot f_{\mathrm{txt}}(x_t^n)/\tau) \quad (3)$$

$$\mathcal{L}_{\mathrm{CM}} = \frac{1}{N_r} \sum_{n=1}^{N_r} \left[\mathrm{KL}\left(\mathbf{p}_o^{\mathrm{img}} \parallel \mathbf{p}_u^{\mathrm{img}} \right) + \mathrm{KL}\left(\mathbf{p}_o^{\mathrm{txt}} \parallel \mathbf{p}_u^{\mathrm{txt}} \right) \right]$$

$$\mathcal{L} = \lambda_1 \mathcal{L}_{\mathrm{RM}} + \lambda_2 \mathcal{L}_{\mathrm{FM}} + \lambda_3 \mathcal{L}_{\mathrm{CM}}$$

CLIPErase

Dataset	Method	ZS Prediction (%)		ZS Retrieval (%)	
		Acc.$D_f \downarrow$	Acc.$D_r \uparrow$	Acc.$D_f \downarrow$	Acc.$D_r \uparrow$
CIFAR-100	CLIP	86.08	72.85	88.61	73.43
	CLIP+GA	4.43	5.22	0.63	5.39
	CLIP+GradDiff	0.00	89.96	0.00	90.64
	CLIP+KL	91.88	80.88	91.77	81.51
	CLIP+ENMN	0.00	12.46	0.00	17.94
	CLIPErase (ours)	0.00	90.99	0.00	91.85
Conceptual 12M	CLIP	96.20	93.60	94.48	92.77
	CLIP+GA	38.22	4.15	1.17	5.38
	CLIP+GradDiff	4.96	97.01	5.64	97.46
	CLIP+KL	99.04	98.41	98.83	98.02
	CLIPErase (ours)	0.74	97.10	0.74	97.62

FM	RM	CM	Accuracy (%)		Improvement (%)	
			$\downarrow D_f$	$\uparrow D_r$	$\downarrow D_f$	$\uparrow D_r$
✗	✗	✗	86.08	72.85	-	-
✓	✗	✗	18.57	64.12	$\downarrow$ 67.5	$\downarrow$ 8.73
✓	✓	✗	9.40	73.14	$\downarrow$ 76.68	$\uparrow$ 0.56
✓	✓	✓	0	90.80	$\downarrow$ 86.08	$\uparrow$ 17.95

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总结与思考

- 遗忘不彻底，往往有残留
- 遗忘特定有害数据而不影响相似但无害的内容
- 单文本多概念的选择性遗忘

谢谢大家！