MFSC: Matching by Few-Shot Classification

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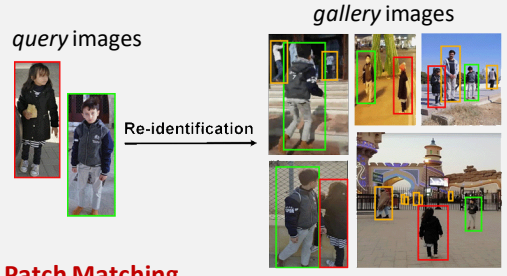
GitHub: github.com/Elie-1996/MFSC-Matching-By-Few-Shot-Classification

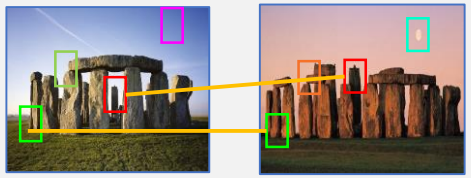
MATCHING

- The task of comparing sets of related items: e.g. images / patches

Person Re-identification

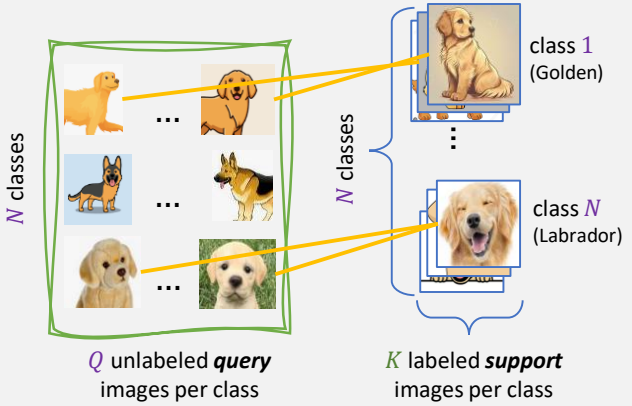


Patch Matching



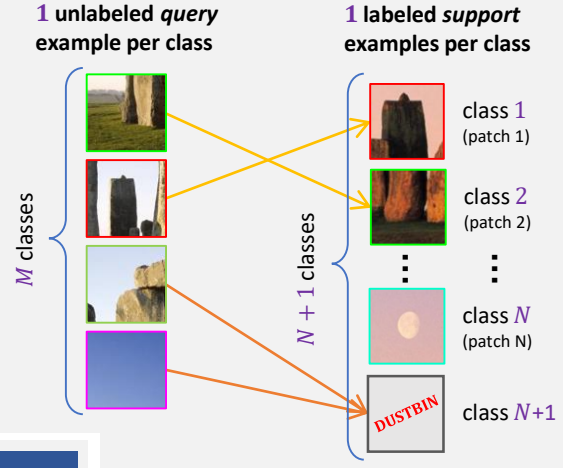
FEW-SHOT CLASSIFICATION (FSC)

- The N-way K-shot Q-query classification task
- Common setup is 20-way 1-shot 15-query
- A well studied field. e.g.:
  - **meta-learning** (*MAML* [1])
  - **transductive learning** (*PT-MAP* [2]).



From MATCHING to FSC

- Re-formulating set-matching using tools from meta- and few-shot classification
- A matching *task* is typically composed of large N (e.g., N = number of patches) with small Q and K, which is a challenging FSC setup



MATCHING of PATCHES

- *HPatches* [3] dataset
- 2.5 million patches from 116 image sequences
- Matching between the set of extracted patches of pairs of images (typically 1000-2000 per pair)

method	category	'easy'	'hard'	'tough'	*mean*
Hnet++ [25]	learned	72.2%	56.2%	37.9%	55.4%
Hnet-PS [27]		69.3%	58.6%	44.6%	57.5%
L2-Net [36]		73.0%	57.5%	39.1%	56.6%
DOAP-ST-LM [15]		74.5%	66.9%	57.0%	66.3%
SOSNet [37]		76.3%	68.4%	56.5%	67.1%
MFSC-MAML [2, 12]	meta	77.8%	65.9%	50.8%	64.9%
MFSC-LapShot [47] (HNet++)	transductive	79.9%	70.3%	55.1%	68.3%
MFSC-PTMAP [16] (HNet++)		82.2%	71.6%	52.8%	68.8%
MFSC-PTMAP [16] (HNet-PS)		79.5%	73.1%	61.6%	71.4%
MFSC-PTMAP [16] (SOSNet)		84.3%	80.0%	71.6%	78.6%
MFSC-PTMAP [16] (HNet++)	meta + transductive	77.9%	73.0%	63.9%	71.6%
MFSC-PTMAP [16] (SOSNet)		**85.2%**	**81.1%**	**73.1%**	**79.8%**

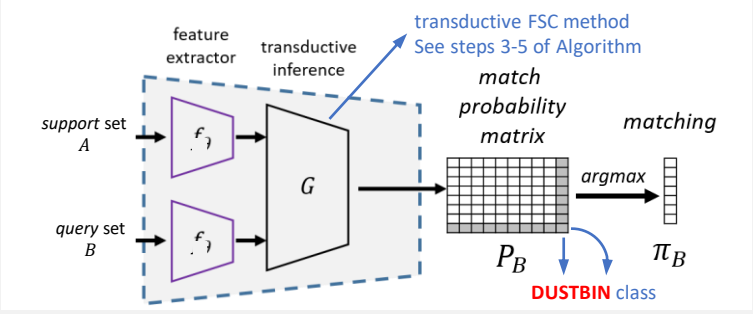
IMAGE ALIGNEMENT

- *FM-Bench* [4] benchmark
- 1000s of image matching pairs, over several datasets
- Matching pipelines for fundamental matrix estimation

desc	fit	prune	*recall*	*IR-m*	*IR*	*corrs-m*	*corrs*
SIFT	RSC	RT	28.2	48.1	67.2	415.3	60.5
		MFSL	**34.5**	53.4	82.0	352.0	54.0
	LMS	RT	45.5	48.1	75.4	415.3	208.3
		MFSL	**52.8**	53.4	81.8	352.0	177.0
HardNet++	RSC	RT	49.5	80.0	87.2	259.1	52.7
		MFSL	**52.4**	78.5	88.3	367.7	70.5
	LMS	RT	61.9	80.0	88.3	259.1	130.5
		MFSL	**64.3**	78.5	88.8	367.7	184.9

MFSC Framework

- Adopt a **transductive classifier** to utilize all the data effectively
- End-to-end training framework for using **meta-learning**
- Support variety of Few-Shot learning methods.



ALGORITHM

- MFSC transductive matching module
- Uses *PT-MAP* [2] for transductive inference

Transd-FSC (image sets A, B; extractor f)

1. $f_A = f(A)$; $f_B = f(B)$; # feature extraction
2. $f_A = PT(f_A)$; $f_B = PT(f_B)$; # power transform
3. $C = f_A$ # initialize class centers
4. **repeat** k times:
   (a) $D = dists(f_B, C)$ # $N \times M$ feature-center ℓ_2 dists
   (b) $P_B = Sinkhorn(D, mode)$ # opt. transport (remove last non-match row/col in 'partial' mode)
   (c) $C = \frac{\alpha}{2}(f_A + f_B P_B) + (1-\alpha)C$ # update centers
5. **return** P_B # match prob. matrix

REFERENCES

[1] Hu, Gripon, Pateux. *Leveraging the feature distribution in transfer-based few-shot learning*. ICANN, 2021.

[2] Finn, Abbeel, Levine. *Model-agnostic meta-learning for fast adaptation of deep networks*. ICML. 2017.

[3] Balntas, Lenc, Vedaldi, Tuytelaars, Matas, and Mikolajczyk. Hpatches: *A benchmark and evaluation of handcrafted and learned local descriptors*. tPAMI, 2019.

[4] Bian, Wu, Zhao, Liu, Zhang, Cheng, Reid. *An evaluation of feature matchers for fundamental matrix estimation*. BMVC, 2019.

[5] Li, Zhao, Xiao, Wang. *Deepreid: Deep filter pairing neural network for person re-identification*. CVPR, 2014.

[6] Zheng, Shen, Tian, Wang, Wang, and Tian. *Scalable person re-identification: A benchmark*. ICCV, 2015.

PERSON RE-ID

- *CUHK03* [5] and *Market-1501* [6] benchmarks
- Rank the similarities of each *query* image (identity) against a large *gallery* set
- Large scale MFSC tasks (N~10,000).

benchmark	CUHK03-det		CUHK03-lab		Market-1501	
network	***mAP***	***Rank-1***	***mAP***	***Rank-1***	***mAP***	***Rank-1***
MHN [7]	65.4	71.7	72.4	77.2	85.0	95.1
OSNet [46]	67.8	72.3	–	–	84.9	94.8
BDB [10]	73.6	76.4	76.7	79.4	86.2	94.5
MFSC-BDB	**75.8**	**77.3**	**80.4**	**89.8**	**87.0**	**95.2**