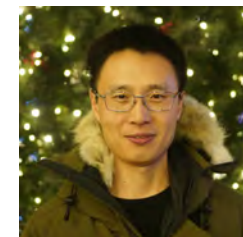
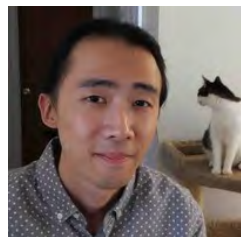


Large-Scale Long-Tailed Recognition in an Open World

Ziwei Liu* Zhongqi Miao* Xiaohang Zhan Jiayun Wang Boqing Gong Stella X. Yu

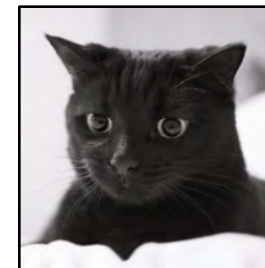
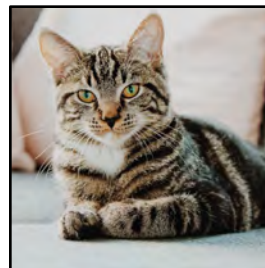
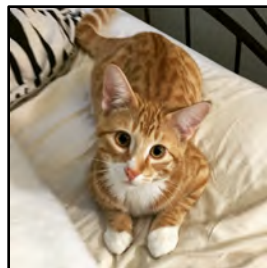


The Chinese University of Hong Kong

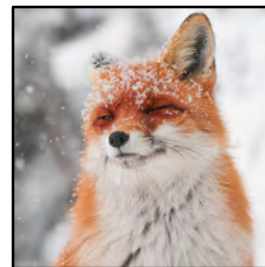
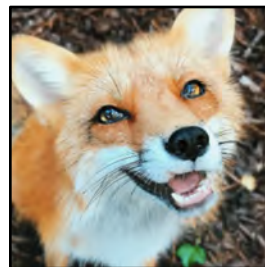
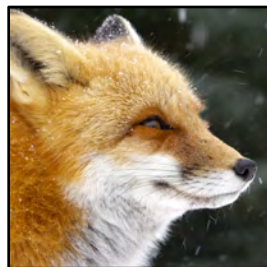


UC Berkeley / ICSI

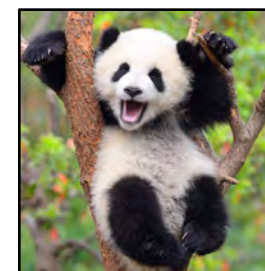
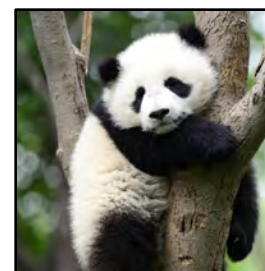
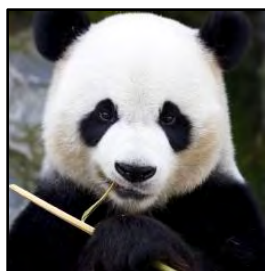
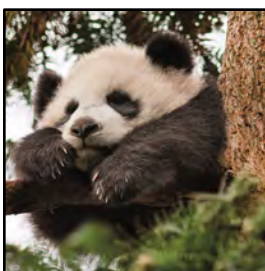
Train



Cat

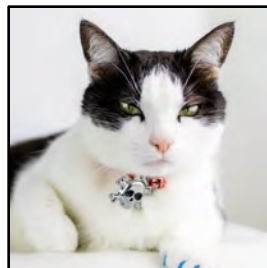


Fox






Panda

Test

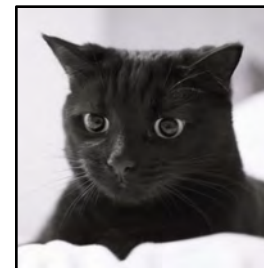
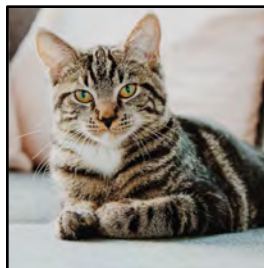
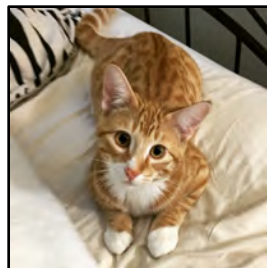


Cat 
Fox 
Panda 

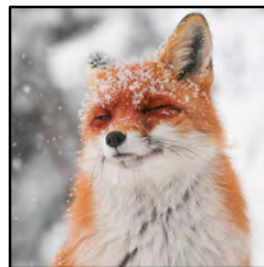
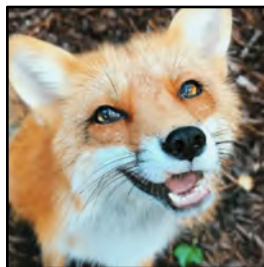
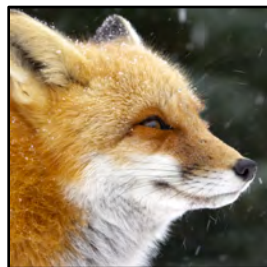


Cat 
Fox 
Panda 

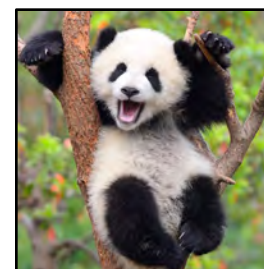
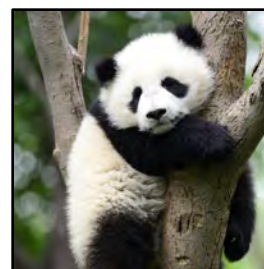
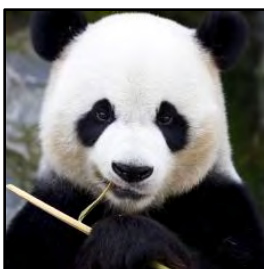
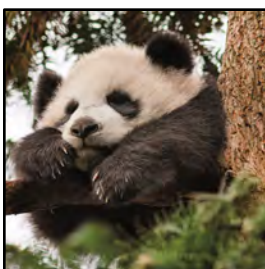
Train



Cat
(many-shot
class)

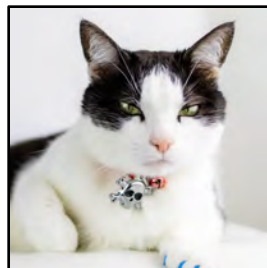





Fox
(medium-shot
class)






Panda
(few-shot
class)

Test



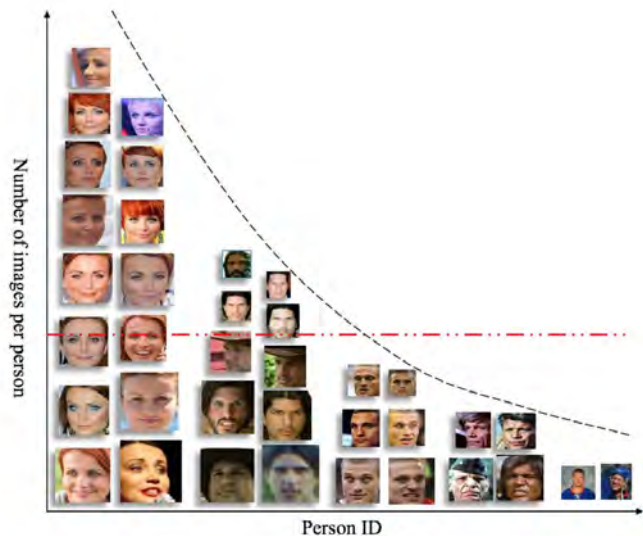
Cat 
Fox 
Panda 



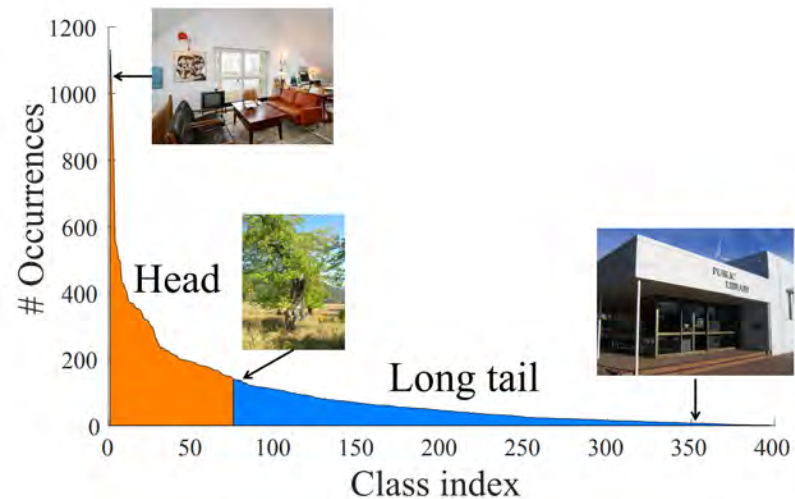
Cat 
Fox 
Panda 



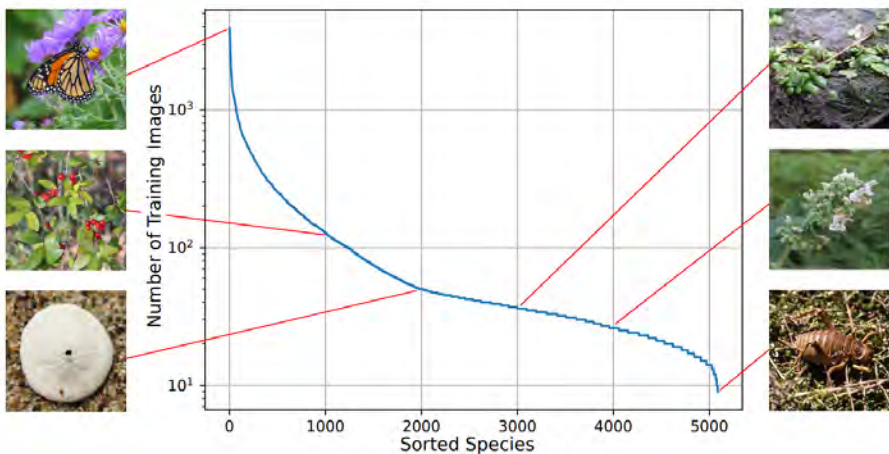
?
(open class)



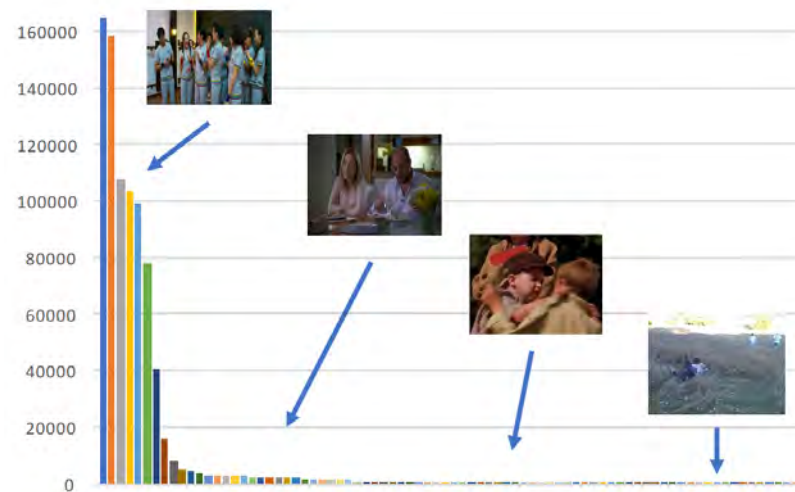
Faces [Zhang et al. 2017]



Places [Wang et al. 2017]

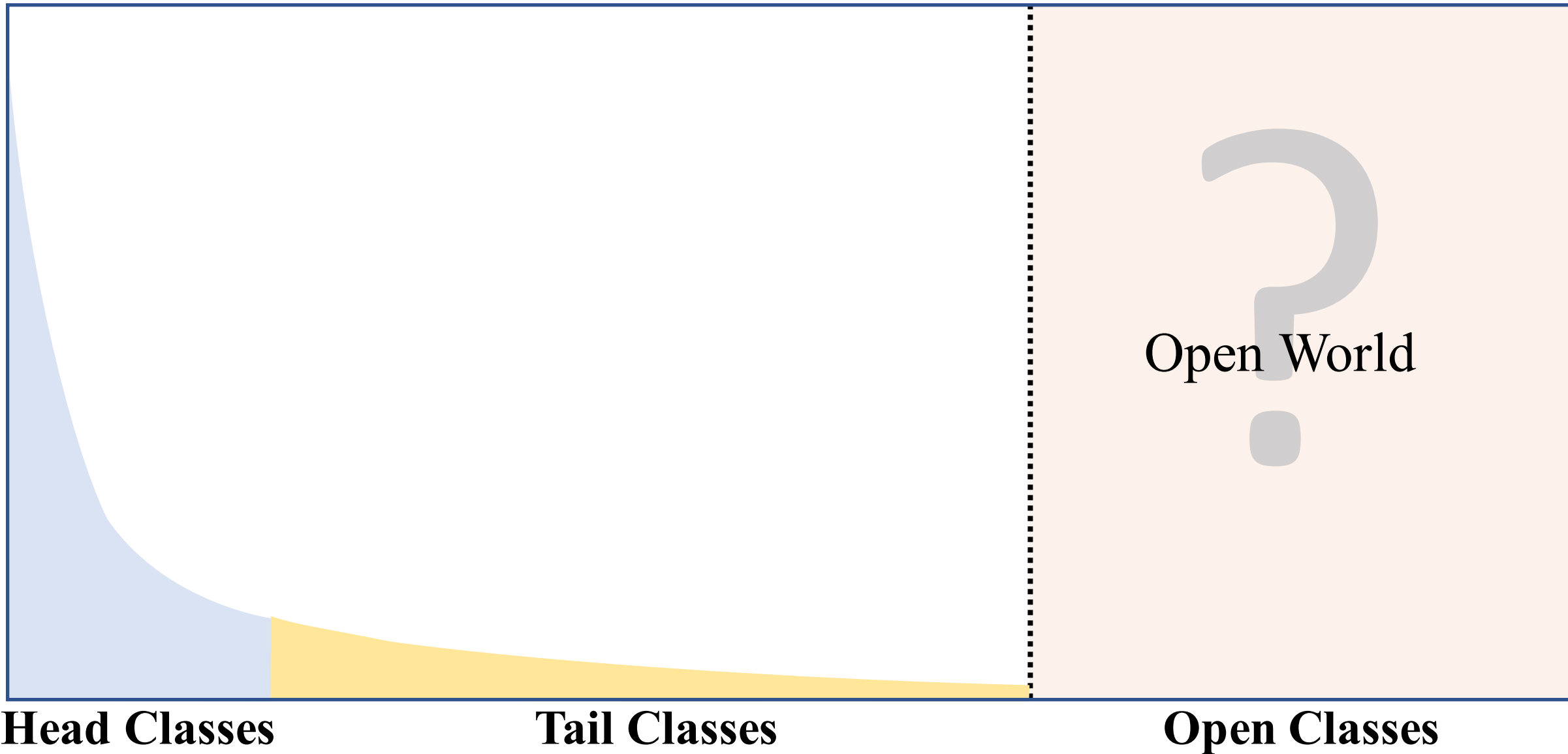


Species [Van Horn et al. 2019]

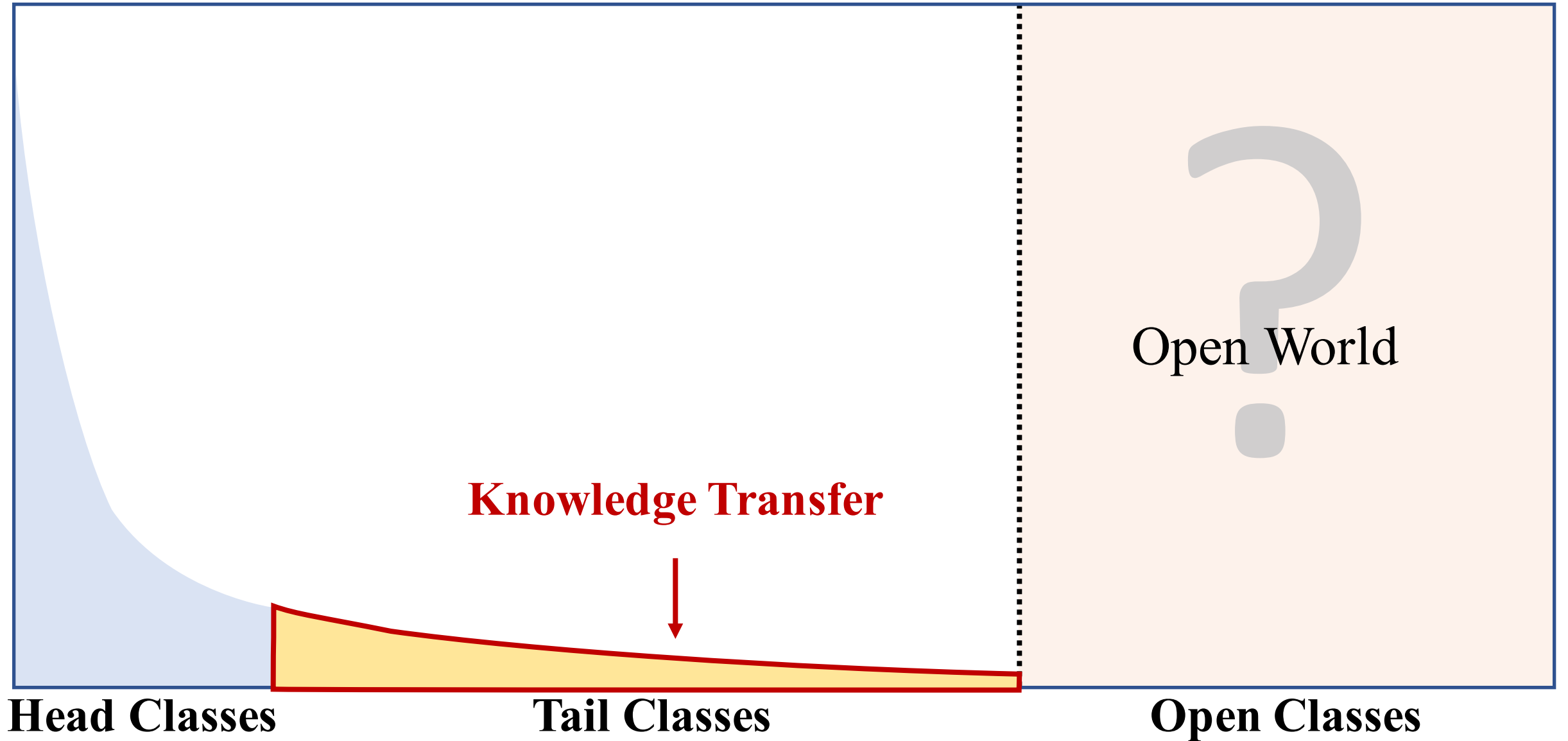


Actions [Zhang et al. 2019]

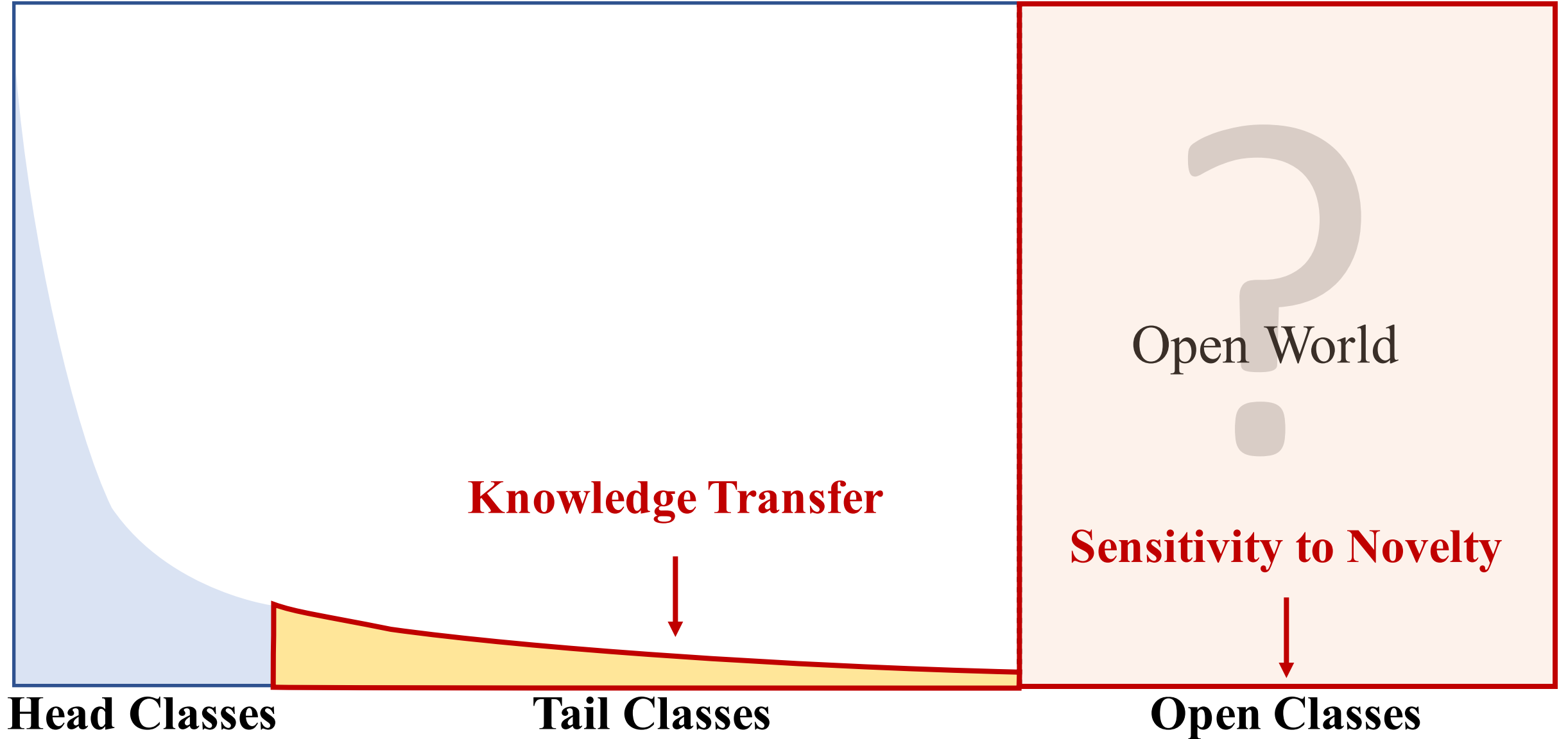
Open Long-Tailed Recognition



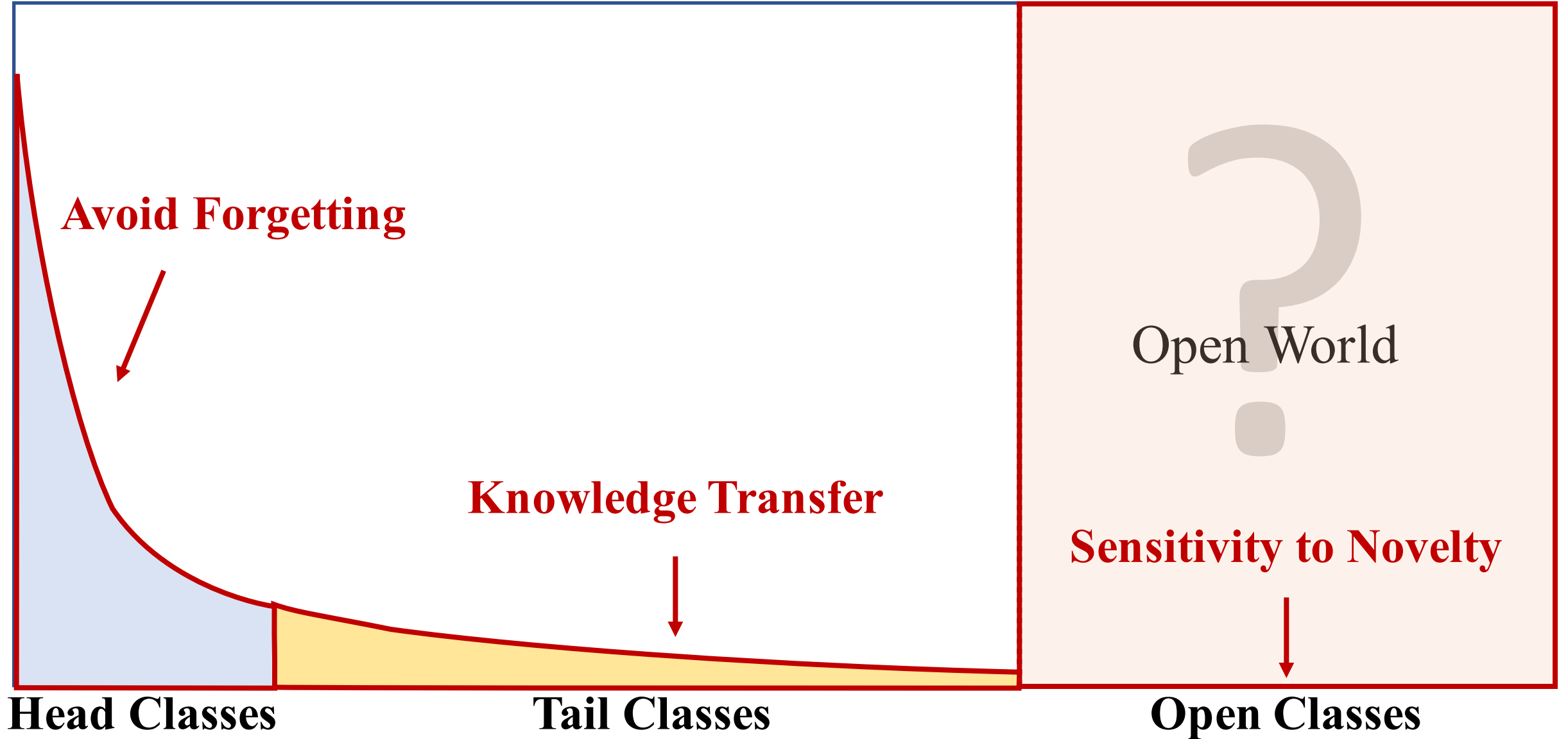
Open Long-Tailed Recognition



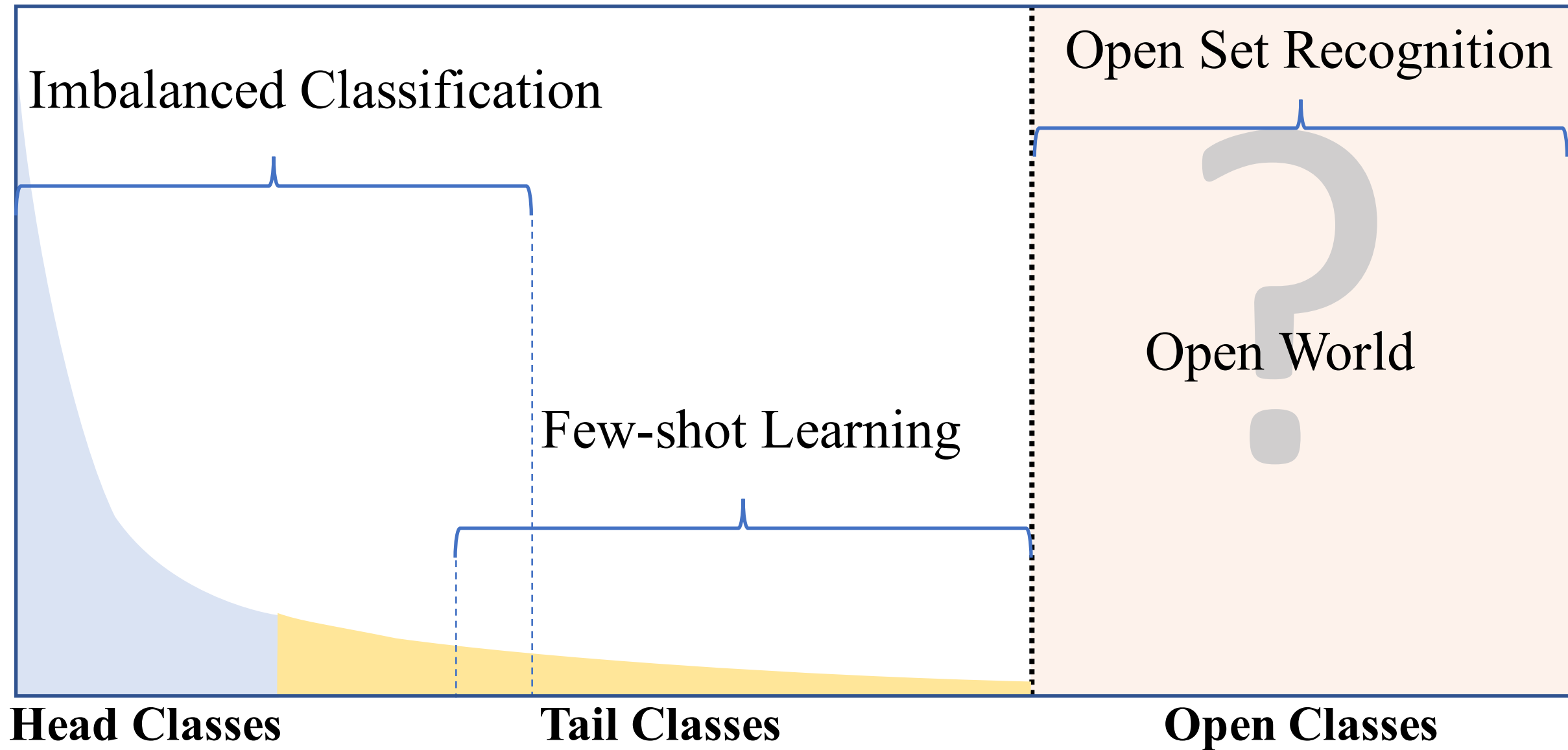
Open Long-Tailed Recognition



Open Long-Tailed Recognition

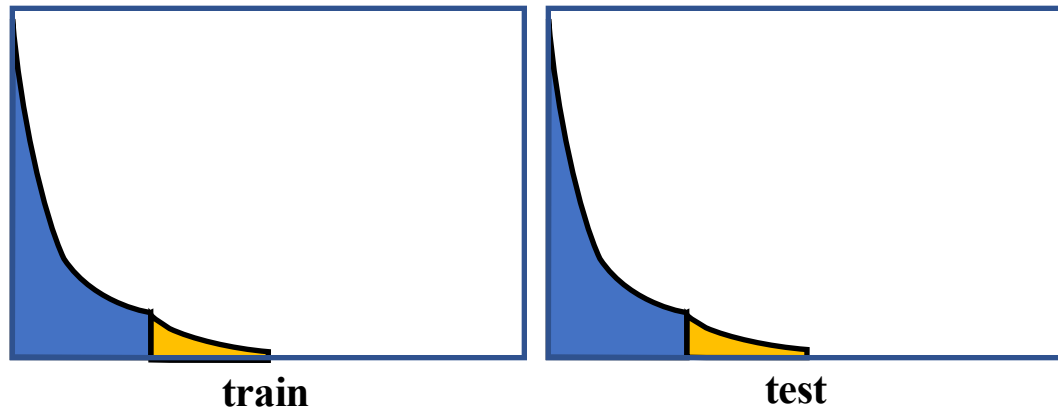


Open Long-Tailed Recognition



Imbalanced Classification

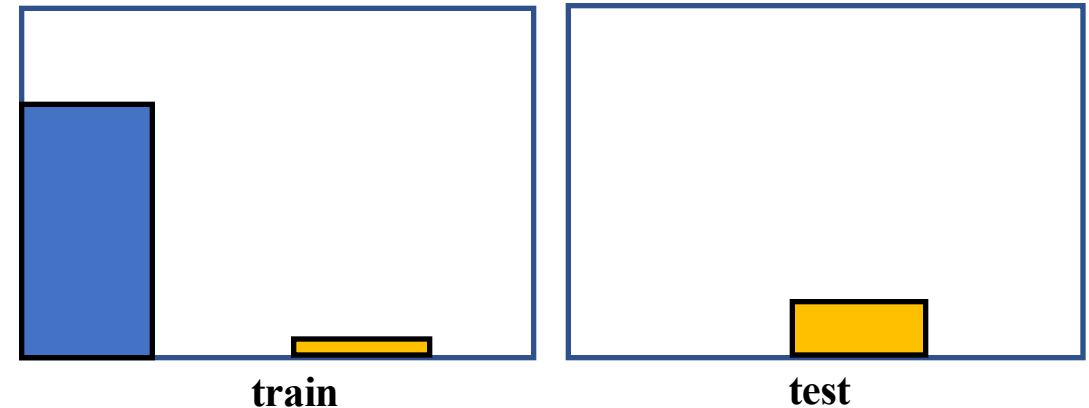
(metric learning, re-sampling, re-weighting)



Sensitivity to Novelty ✘

Few-Shot Learning

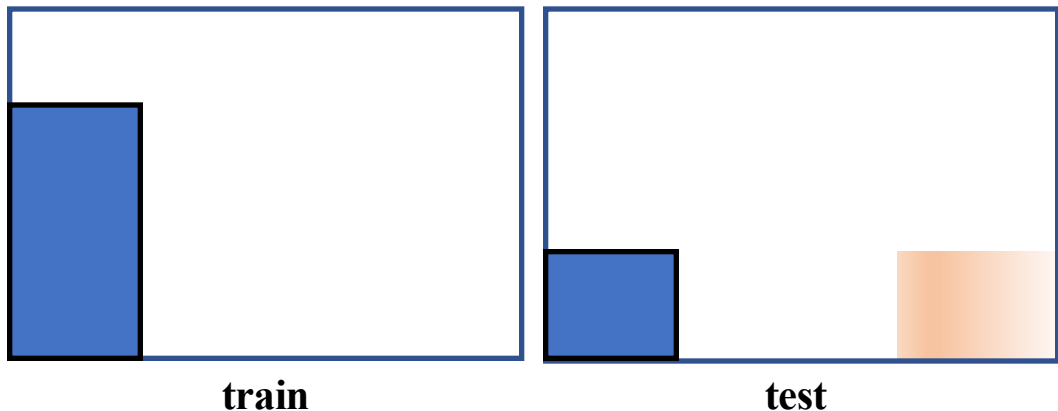
(meta learning, classifier dynamics)



Avoid Forgetting ✘

Open Set Recognition

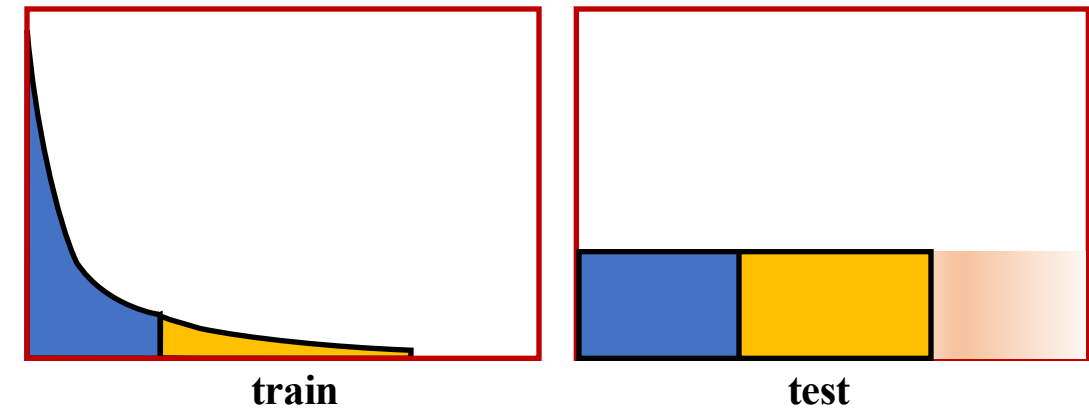
(distribution rectification, out-of-distribution detection)



Knowledge Transfer ✘

Open Long-Tailed Recognition

(dynamic meta-embedding)

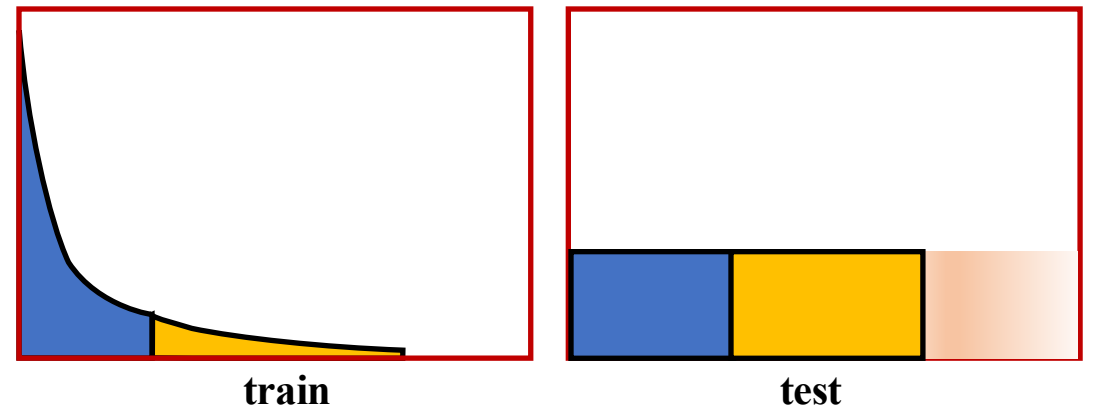


Knowledge Transfer

Sensitivity to Novelty

Avoid Forgetting

Open Long-Tailed Recognition (dynamic meta-embedding)



Knowledge Transfer

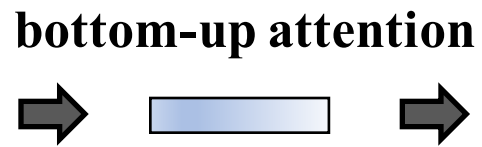
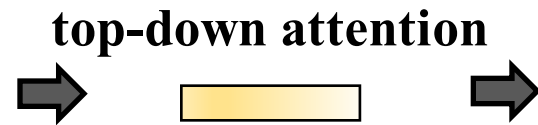
Sensitivity to Novelty

Avoid Forgetting

visual memory



FLY

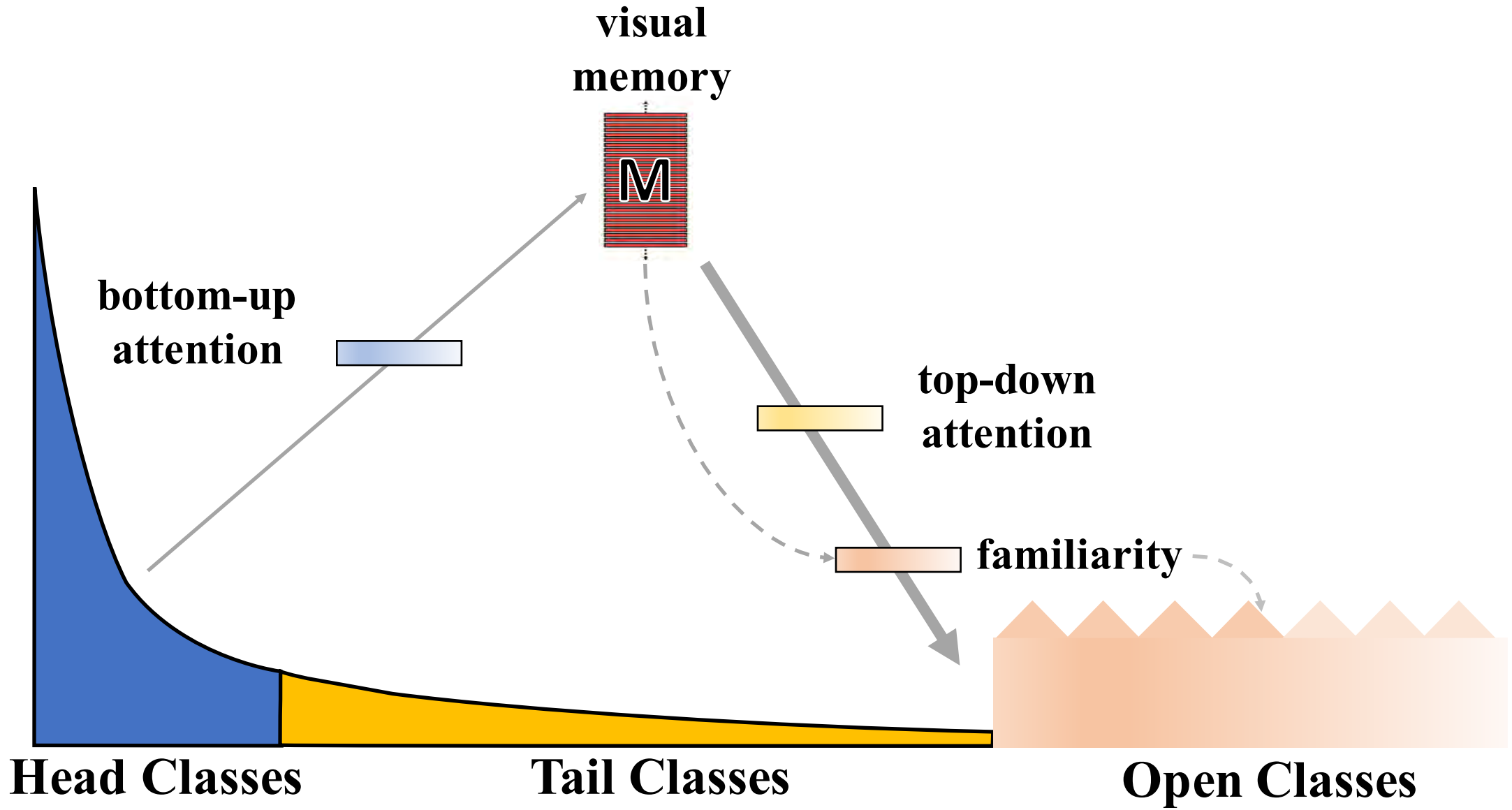


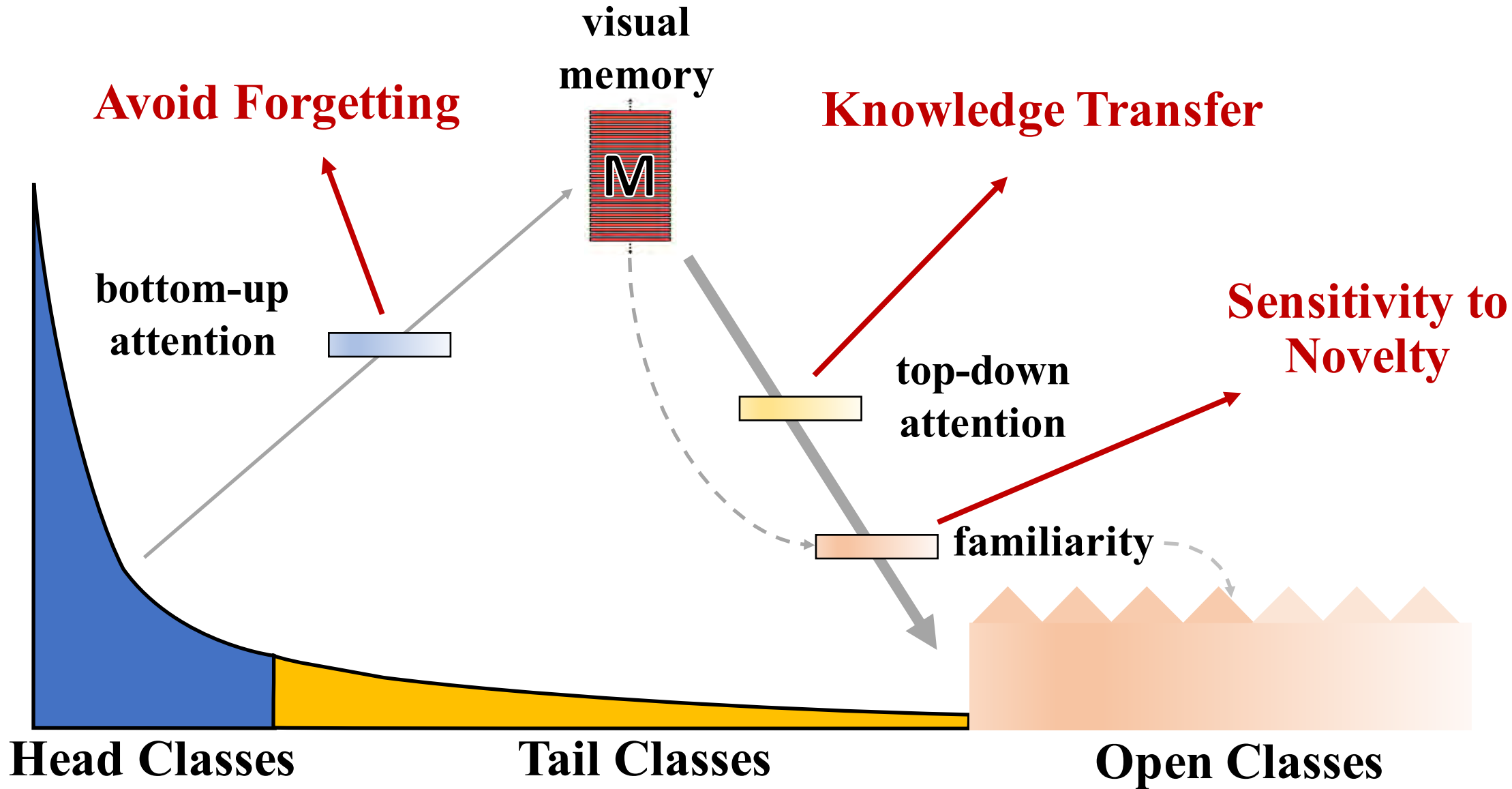
direct
embedding

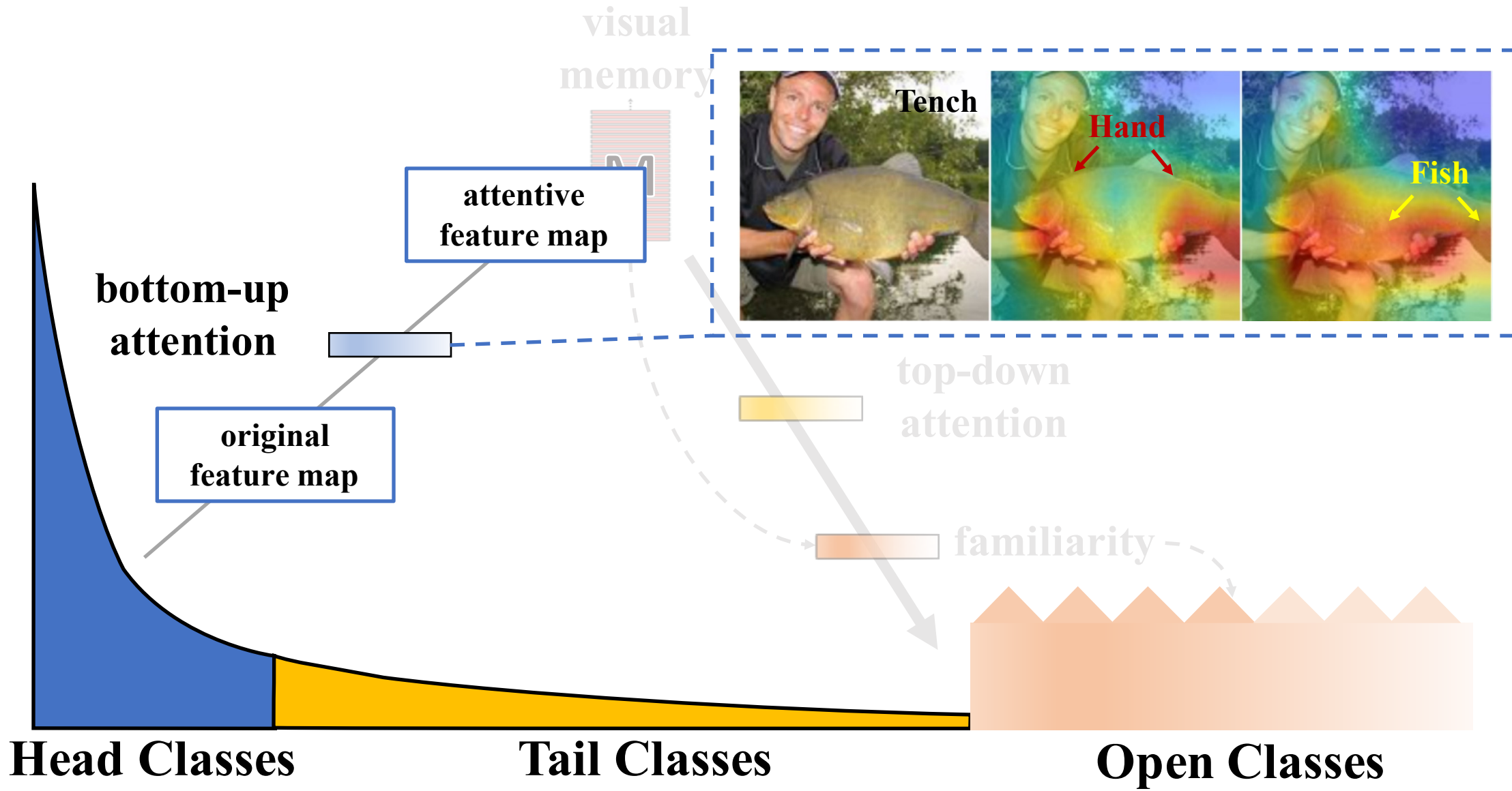
enhanced
embedding

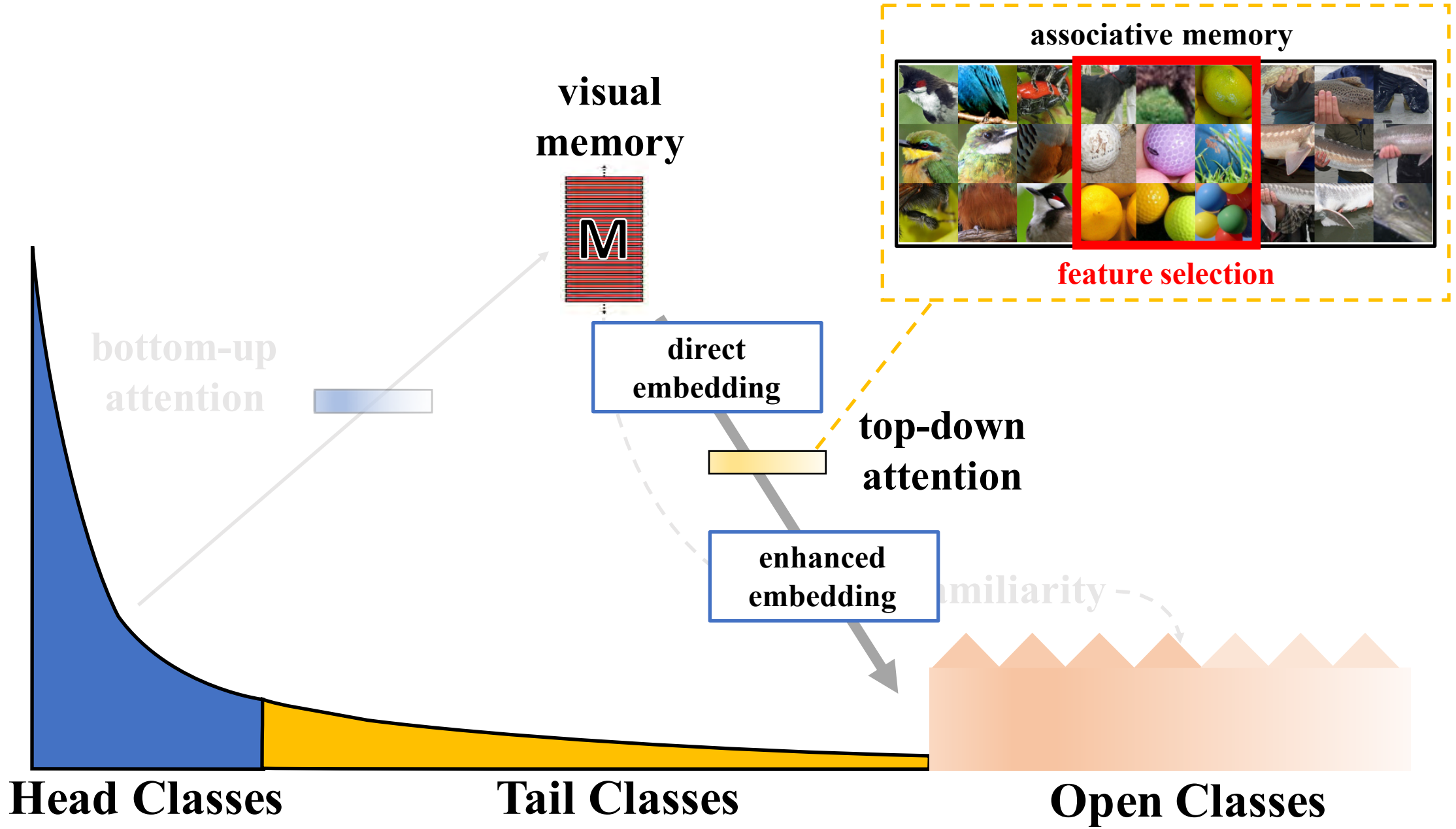


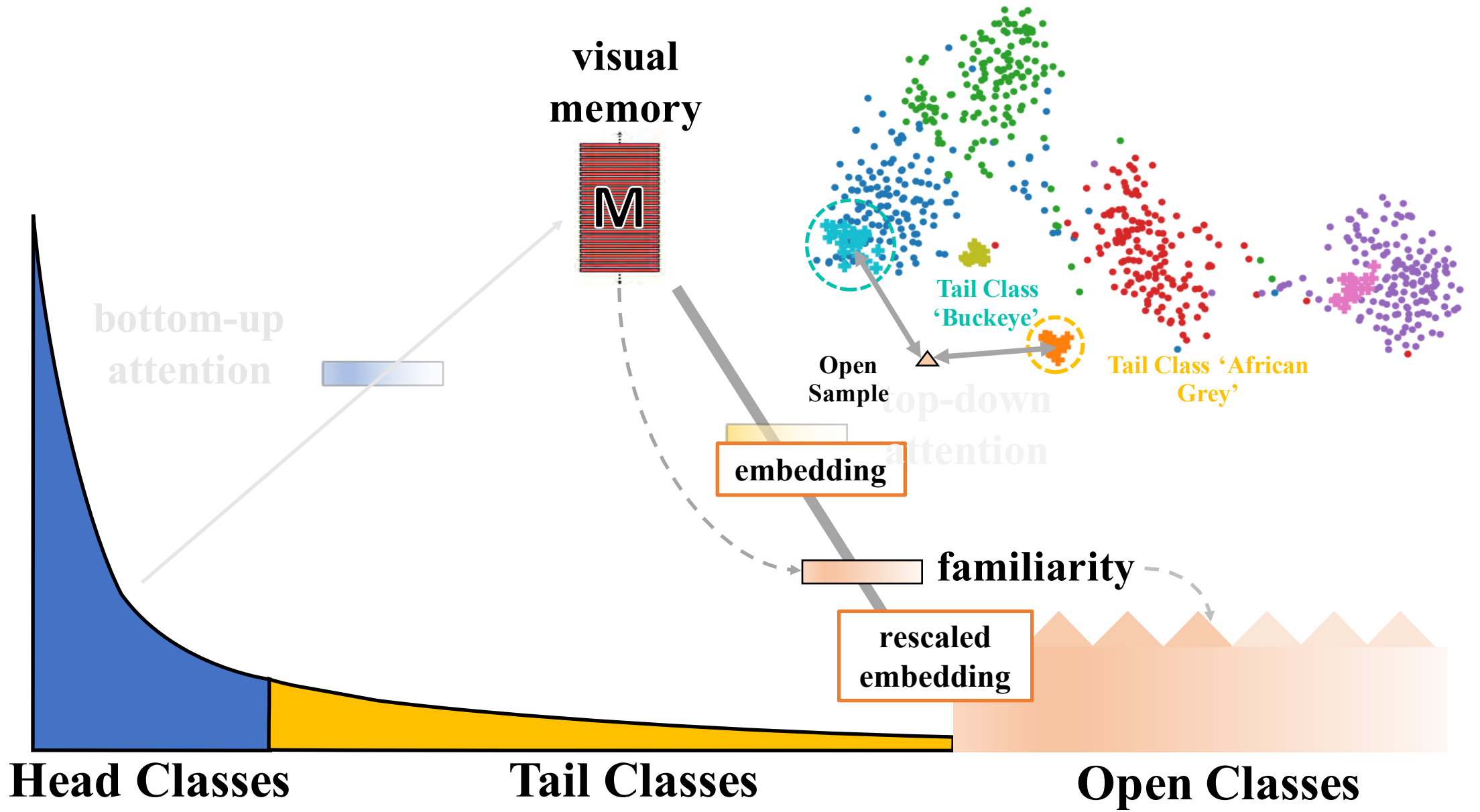
FLY





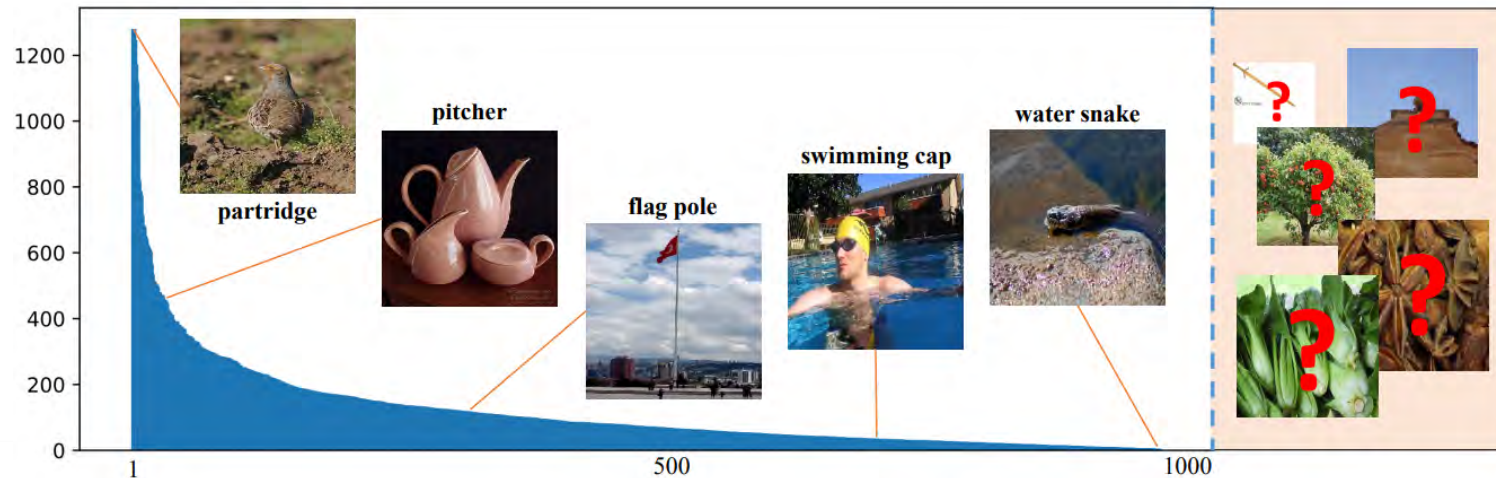






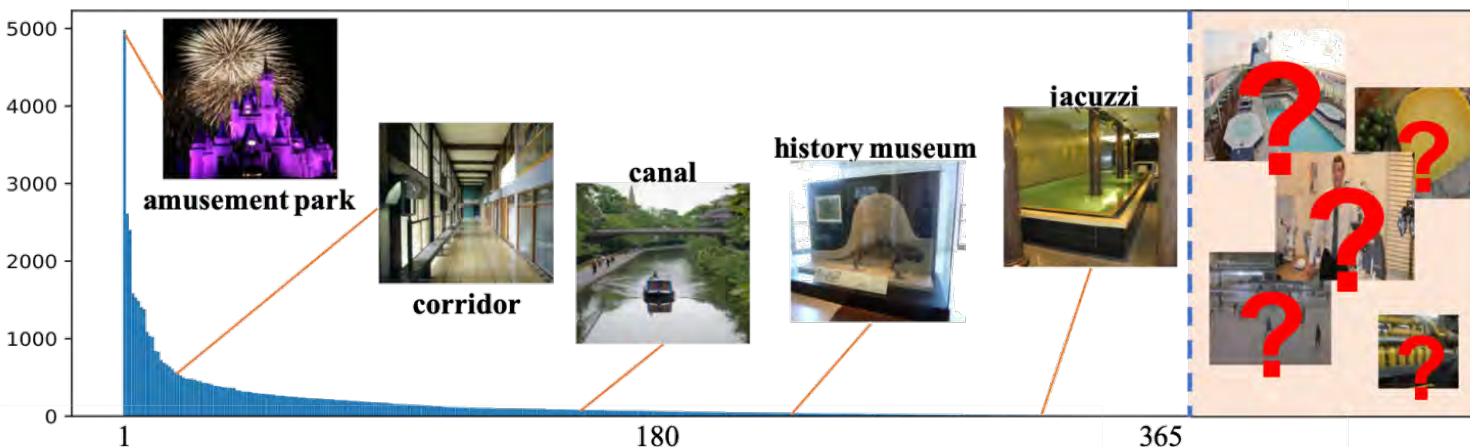
ImageNet-LT Benchmark

Absolute Performance Gain: ~20%



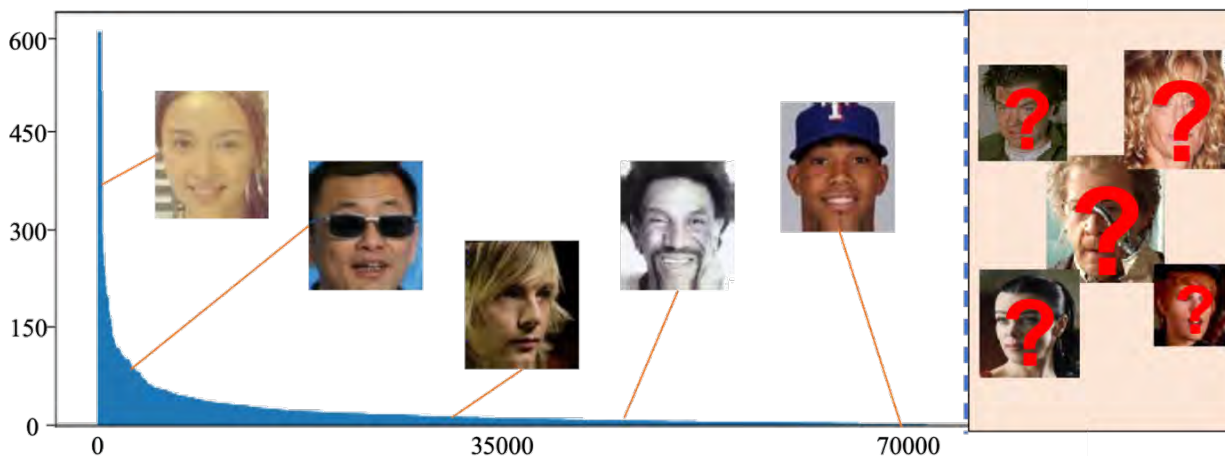
Places-LT Benchmark

Absolute Performance Gain: ~10%



MS1M-LT Benchmark

Absolute Performance Gain: ~2%



Overall F1 Score on ImageNet-LT, Places-LT and MS1M-LT Benchmarks

Methods	ImageNet-LT	Places-LT	MS1M-LT
Plain Model	0.295	0.366	0.738
Sample Re-weighting (Focal Loss)	0.371	0.453	-
Metric Learning (Range Loss)	0.373	0.457	0.722
Open Set Recognition (OpenMax)	0.368	0.458	-
Few-shot Learning (FSLwF)	0.347	0.375	-
Dynamic Meta-Embedding	0.474	0.464	0.745

Overall F1 Score on ImageNet-LT, Places-LT and MS1M-LT Benchmarks

Methods	ImageNet-LT	Places-LT	MS1M-LT
Plain Model	0.295	0.366	0.738
Sample Re-weighting (Focal Loss)	0.371	0.453	-
Metric Learning (Range Loss)	0.373	0.457	0.722
Open Set Recognition (OpenMax)	0.368	0.458	-
Few-shot Learning (FSLwF)	0.347	0.375	-
Dynamic Meta-Embedding	0.474	0.464	0.745

Overall F1 Score on ImageNet-LT, Places-LT and MS1M-LT Benchmarks

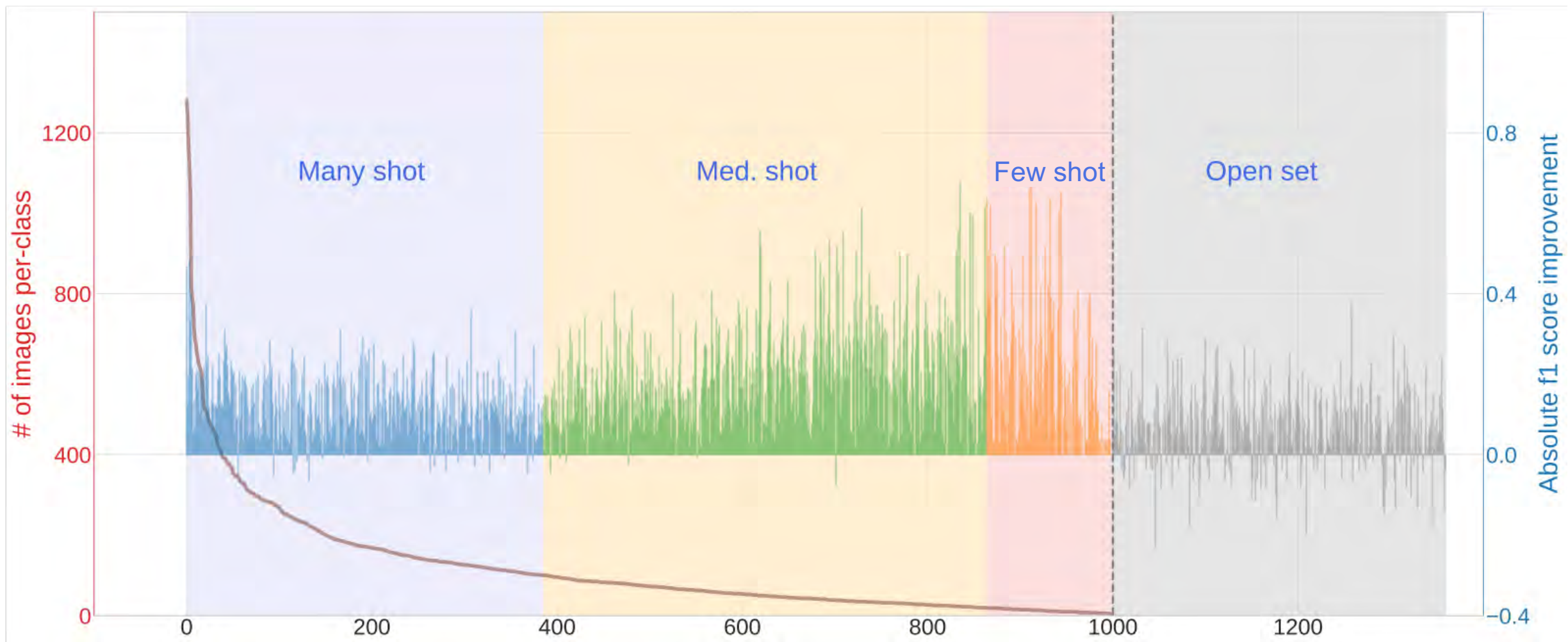
Methods	ImageNet-LT	Places-LT	MS1M-LT
Plain Model	0.295	0.366	0.738
Sample Re-weighting (Focal Loss)	0.371	0.453	-
Metric Learning (Range Loss)	0.373	0.457	0.722
Open Set Recognition (OpenMax)	0.368	0.458	-
Few-shot Learning (FSLwF)	0.347	0.375	-
Dynamic Meta-Embedding	0.474	0.464	0.745

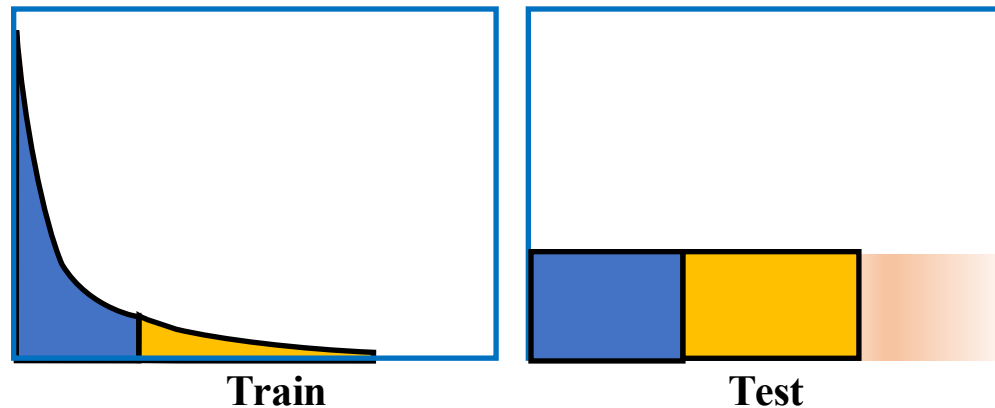
Overall F1 Score on ImageNet-LT, Places-LT and MS1M-LT Benchmarks

Methods	ImageNet-LT	Places-LT	MS1M-LT
Plain Model	0.295	0.366	0.738
Sample Re-weighting (Focal Loss)	0.371	0.453	-
Metric Learning (Range Loss)	0.373	0.457	0.722
Open Set Recognition (OpenMax)	0.368	0.458	-
Few-shot Learning (FSLwF)	0.347	0.375	-
Dynamic Meta-Embedding	0.474	0.464	0.745

Overall F1 Score on ImageNet-LT, Places-LT and MS1M-LT Benchmarks

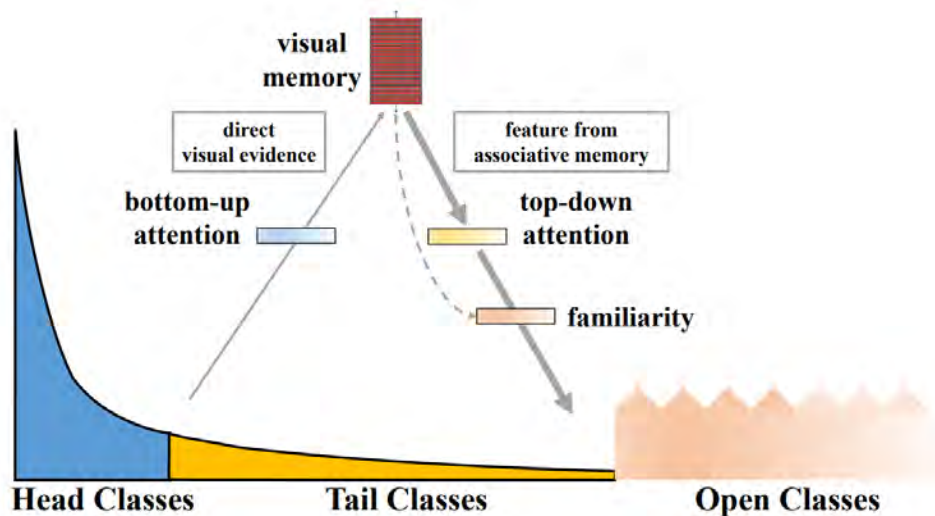
Methods	ImageNet-LT	Places-LT	MS1M-LT
Plain Model	0.295	0.366	0.738
Sample Re-weighting (Focal Loss)	0.371	0.453	-
Metric Learning (Range Loss)	0.373	0.457	0.722
Open Set Recognition (OpenMax)	0.368	0.458	-
Few-shot Learning (FSLwF)	0.347	0.375	-
Dynamic Meta-Embedding	0.474	0.464	0.745





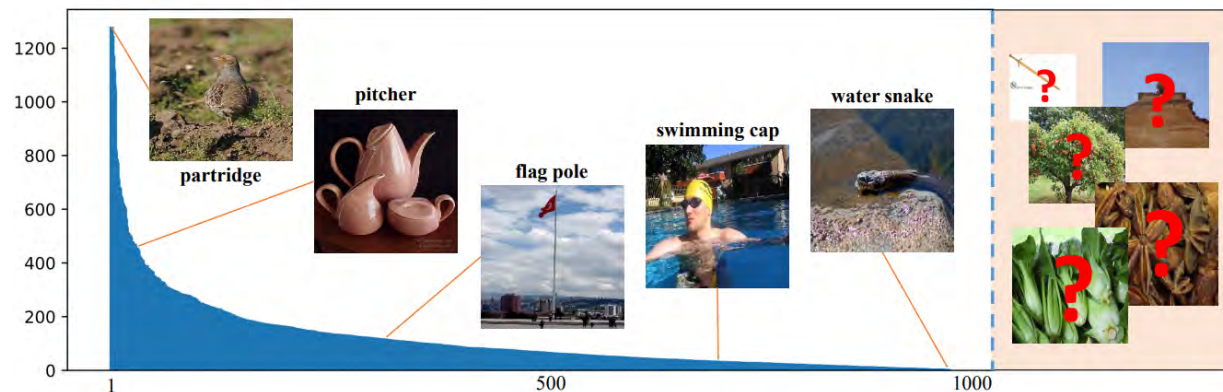
New Task

Open Long-Tailed Recognition (OLTR)



New Approach

Dynamic Meta-Embedding



New Benchmarks

ImageNet-LT Places-LT MS1M-LT

Poster #170

Thanks!

Code, models and benchmarks are available at

Project Page: <https://liuziwei7.github.io/projects/LongTail.html>