Few-Shot Open-Set Recognition using Meta-Learning

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Few-shot open-set recognition

Few-shot classification

- Support set:
  - N class x K examples
- Query set:
  - N class x Q examples

Few-shot open-set recognition

- Support set
  - N class x K examples
- Query set:
  - N class x Q examples
  - M examples of undefined class

Our few-shot event detection

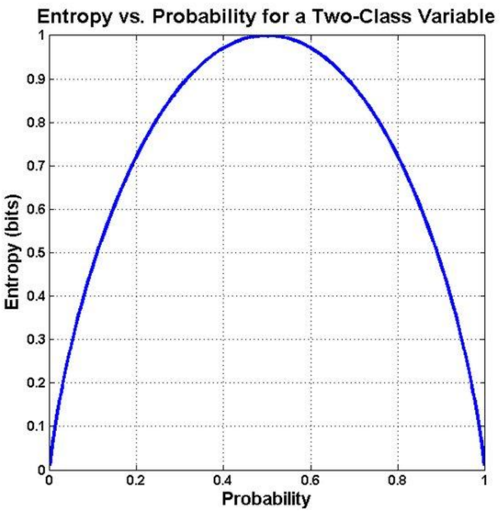
- Support set
  - N+1 class x K examples
- Query set:
  - N class x Q examples
  - 1 class x Q examples

Training with Open-set loss

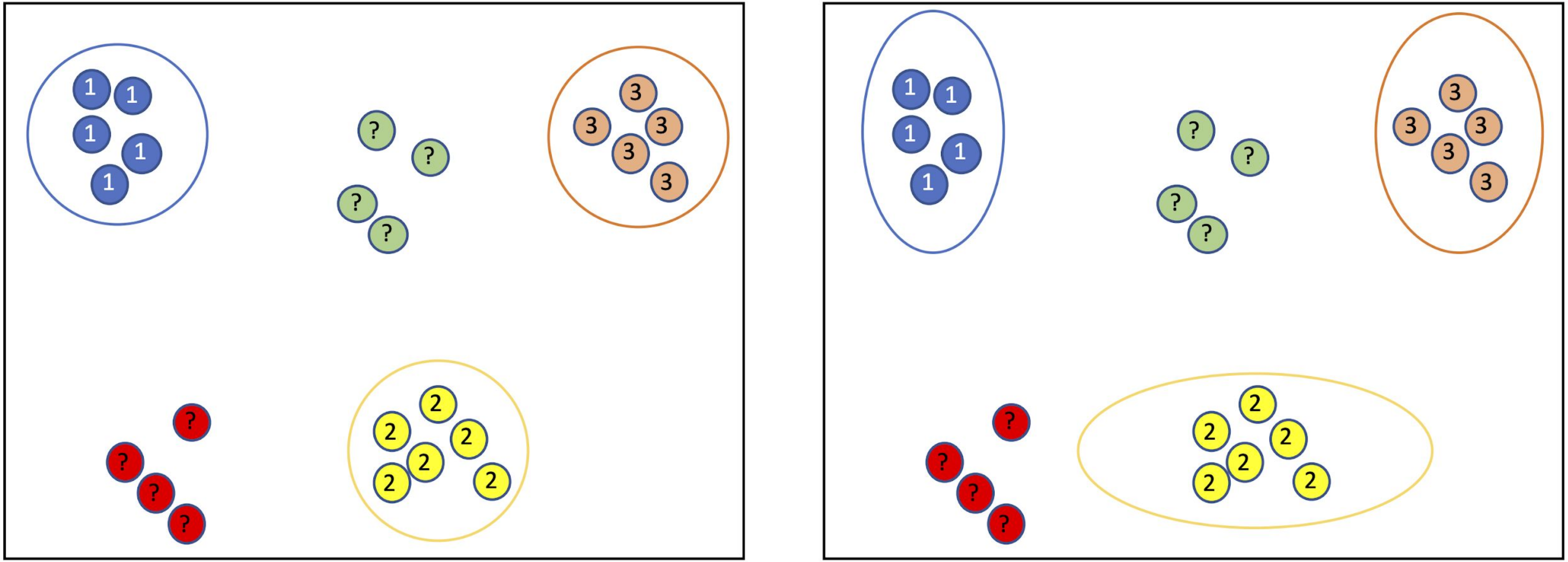
$$h^* = \arg\min_h \left\{ \sum_{(x_k, y_k) \in \mathbb{T}_i^s | y_k \in \mathbb{C}_i^s} L_c[y_k, h'(x_k)] + \lambda \sum_{(x_k, y_k) \in \mathbb{T}_i^s | y_k \in \mathbb{C}_i^u} L_o[h'(x_k)] \right\}$$

Maximize the entropy of negative examples

$$L_o[\mathbf{x}] = \sum_{k \in \mathbb{C}_i^s} p(y = k|\mathbf{x}) \log p(y = k|\mathbf{x})$$



Euclidean vs Mahalanobis distances



(c) (d)

Mahalanobis distance

$$d(f_\phi(\mathbf{x}), \mu_k) = [f_\phi(\mathbf{x}) - \mu_k]^T \Sigma_k^{-1} [f_\phi(\mathbf{x}) - \mu_k].$$

Precision matrix (Inverted covariance matrix)

$$A_k = \sum\nolimits_k^{-1}$$

$$A_k = \frac{1}{|S_k|} \sum_{(\mathbf{x}_i, y_i) \in S_k} g_\varphi(\mathbf{x}_i).$$

Results

Model	Accuracy(%)	AUROC(%)
5-way 1-shot		
GaussianE + OpenMax	57.89±0.59	58.92±0.59
GaussianE + Counterfactual	57.89±0.59	52.20±0.61
Our basic	56.31±0.57	58.94±0.60
Our basic + OpLoss	56.34±0.57	60.94±0.61
Our basic + GaussianE	57.89±0.59	58.66±0.60
Our basic + GaussianE + OpLoss	**58.31**±**0.58**	**61.66**±**0.62**
5-way 5-shot		
GaussianE + OpenMax	75.31±0.76	67.54±0.67
GaussianE + Counterfactual	75.31±0.76	53.25±0.59
Our basic	74.19±0.75	66.00±0.67
Our basic + OpLoss	74.14±0.74	67.92±0.68
Our basic + GaussianE	**75.31**±**0.76**	66.50±0.67
Our basic + GaussianE + OpLoss	75.08±0.72	**69.85**±**0.70**

Table 3. Few-shot open-set recognition results. Comparison to several baselines and prior open-set methods.