# Generating Pseudo-labels Adaptively for Few-shot Model-Agnostic Meta-Learning

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## Motivation

- The classifier of MAML family is highly sensitive to the pseudo query data.
- The feature extractor of MAML family is highly adaptable to the pseudo query data.
- The imbalance of pseudo query data may have negative impact.

## Contribution

- This work is the first to incorporate label propagation used in transductive methods to generate pseudo-labels for MAML.
- We propose to use adaptive picking to select instances from the pseudo query set to balance the number of samples for each class.
- We apply our Generative Pseudo-label method to two typical variants of MAML, and improve their performance, demonstrating the applicability of our approach.

## Formulation

For all tasks, we compute adapted body parameters :

$$\theta_{body_i}^{TPN} = \theta_{body} - \alpha \nabla_{\theta_{body}} \mathcal{L}_{spt_i} \left( f_{\theta_{body}, \theta_{head}} \right).$$

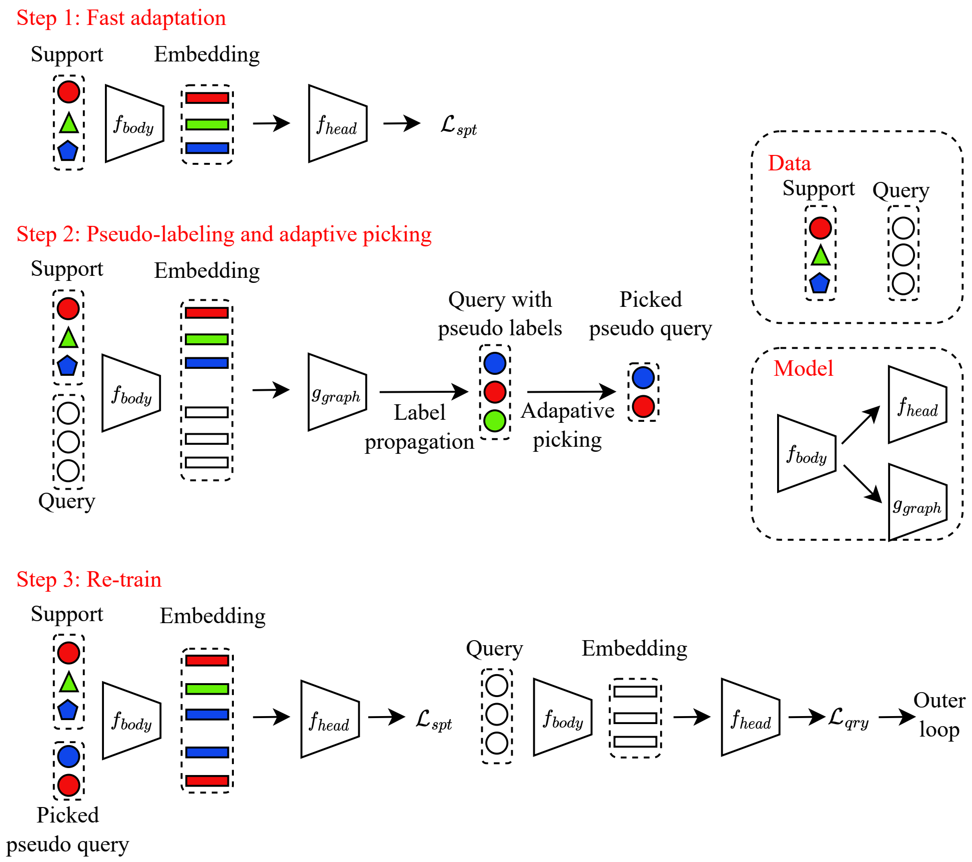
We construct the weighted graph:

$$Graph_i = g_{\theta_{graph}} (f_{\theta_{body_i}^{TPN}} (spt_i, qry_i)).$$

We Re-update parameters with new support set examples:

$$\theta'_{body_i}, \theta'_{head_i} \leftarrow \theta_{body}, \theta_{head} - \beta \nabla_{\theta_{body}, \theta_{head}} \mathcal{L}_{spt'_i} f_{\theta_{body}, \theta_{head}}.$$

## Network Architecture




- In phase 1, the few-shot model up-dates its parameters through the support set.
- In phase 2, we adopt the label propagation of TPN to label the query set, which will be filtered by adaptive picking to select the pseudo query data.
- In phase 3, the picked pseudo query data will be added to the support set for re-training, then the loss of the query set is calculated as in MAML.

## Experiments

We conduct a comprehensive experimental analysis of our GP-MAML, GP-ANIL, and GP-BOIL.

| Method | MiniImageNet | | CIFAR-FS | | FC100 | |
|---|---|---|---|---|---|---|
| | 1-shot | 5-shot | 1-shot | 5-shot | 1-shot | 5-shot |
| MAML | 48.24 | 61.52 | 57.57 | 72.31 | 36.64 | 47.26 |
| ANIL | 49.61 | 64.90 | 58.34 | 72.34 | 36.38 | 47.16 |
| BOIL | 49.82 | 67.60 | 58.69 | 75.31 | 38.80 | 51.42 |
| MAML(*w. qry*) | 34.89 | 50.11 | 43.71 | 58.40 | 25.24 | 30.51 |
| ANIL(*w. qry*) | 37.49 | 48.41 | 46.23 | 59.52 | 25.68 | 30.97 |
| BOIL(*w. qry*) | 49.88 | 68.08 | 60.91 | 76.32 | 39.67 | 52.02 |
| MAML(*w. AP*) | 51.37 | 63.82 | 62.58 | 75.08 | 38.65 | 48.92 |
| ANIL(*w. AP*) | 53.00 | 67.86 | 63.44 | 75.12 | 38.37 | 48.71 |
| BOIL(*w. AP*) | 52.42 | 69.84 | 63.51 | 77.76 | 40.76 | 52.97 |
| GP-MAML | 52.71 | 68.06 | 64.03 | 75.60 | 38.57 | 48.50 |
| GP-ANIL | **55.92** | 70.73 | 65.66 | 75.08 | 38.95 | 51.16 |
| GP-BOIL | 55.55 | **71.36** | **66.55** | **78.50** | **41.80** | **53.71** |

## Conclusion

- We generated pseudo-labels by using label propagation with adaptive picking, introduced transductive methods to typical inductive methods.
- We address the problem that inductive methods can not fully utilize information of the query set.
- We also proposed a simple yet effective method called adaptive picking to select samples from distinctclasses with balanced quantity.

## References

- [1] Chelsea Finn, Pieter Abbeel, and Sergey Levine. Model-agnostic meta-learning for fast adaptation of deep networks. In Proceedings of the 34th International Conference on Machine Learning, 2017.
- [2] Yanbin Liu, Juho Lee, Minseop Park, Saehoon Kim, Eunho Yang, Sung Ju Hwang, and Yi Yang. Learning to propagate labels: Transductive propagation network for few-shot learning. In 7th International Conference on Learning Representations, 2019