Toward Multimodal Model-Agnostic Meta-Learning

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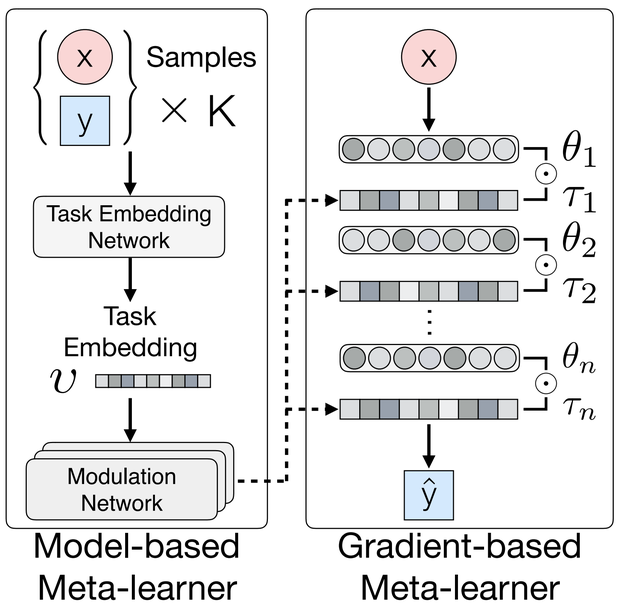
Introduction & Model Overview

Multimodal Task Distributions
- Knowledge transferable between modes

The limitation of the MAML family
- Learns a single initialization, which is suboptimal for far apart modes

Multi-Modal MAML (MuMoMAML)
- Model-based meta-learner
  - Identify task modes
- Gradient-based meta-learner
  - Fast adaptation through gradient steps

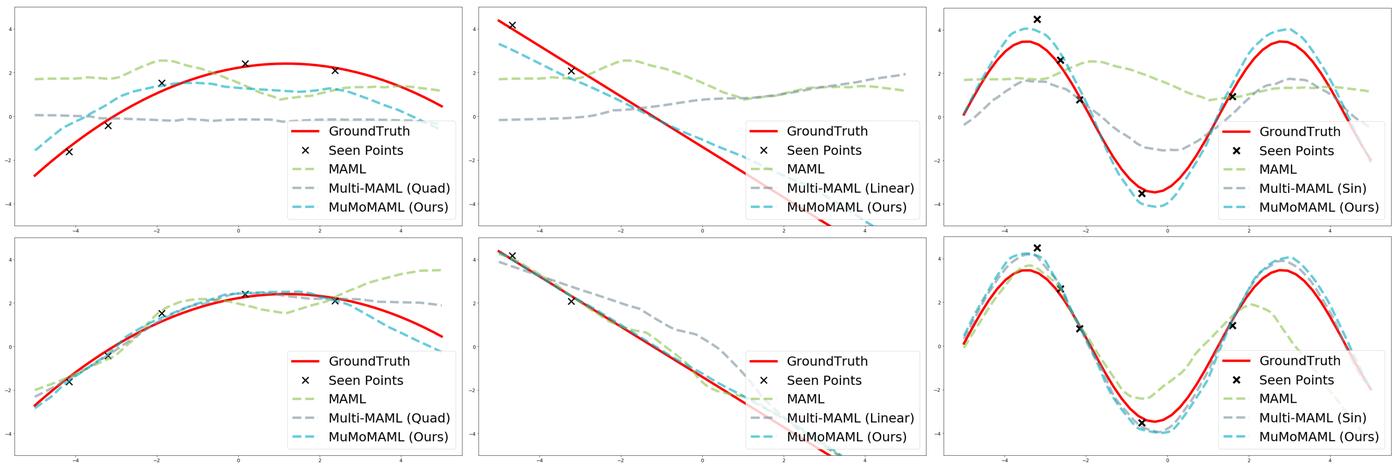


Algorithm 1 META-TRAINING PROCEDURE.

Input: Task distribution $P(\mathcal{T})$, Hyper-parameters α and β
Randomly initialize θ and ω.
while not DONE **do**
  Sample batches of tasks $\mathcal{T}_j \sim P(\mathcal{T})$
  for all j **do**
    Infer $\tau = g(\{x, y\}; \omega)$ with K samples from $\mathcal{D}^{train}_{\mathcal{T}_j}$
    Evaluate $\nabla_\theta \mathcal{L}_{\mathcal{T}_j}\left(f(x; \theta, \tau); \mathcal{D}^{train}_{\mathcal{T}_j}\right)$ w.r.t the K samples
    Compute adapted parameter with gradient descent: $\theta'_{\mathcal{T}_j} = \theta - \alpha \nabla_\theta \mathcal{L}_{\mathcal{T}_j}\left(f(x; \theta, \tau); \mathcal{D}^{train}_{\mathcal{T}_j}\right)$
  end for
  Update $\theta \leftarrow \theta - \beta \nabla_\theta \sum_{\mathcal{T}_j \sim P(\mathcal{T})} \mathcal{L}_{\mathcal{T}_j}\left(f(x; \theta', \tau); \mathcal{D}^{val}_{\mathcal{T}_j}\right)$
  Update $\omega \leftarrow \omega - \beta \nabla_\omega \sum_{\mathcal{T}_j \sim P(\mathcal{T})} \mathcal{L}_{\mathcal{T}_j}\left(f(x; \theta', \tau); \mathcal{D}^{val}_{\mathcal{T}_j}\right)$
end while

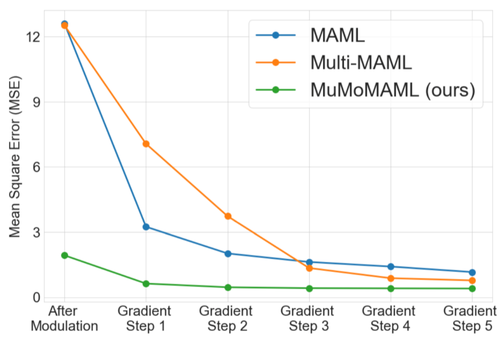
Few-shot Regression

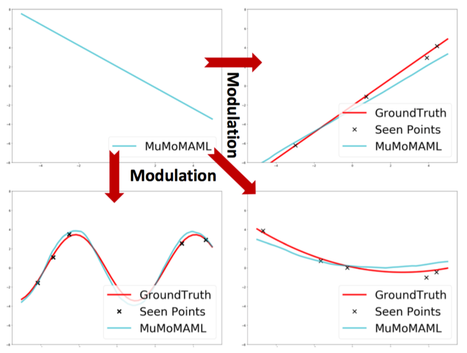
Configuration		Two Modes (MSE)		Three Modes (MSE)	
Method	Modulation	Post Modulation	Post Adaptation	Post Modulation	Post Adaptation
MAML [5]	-	15.9255	1.0852	12.5994	1.1633
Multi-MAML	GT	16.2894	0.4330	12.3742	0.7791
MuMoMAML (ours)	Softmax	3.9140	0.4795	0.6889	0.4884
MuMoMAML (ours)	Sigmoid	1.4992	0.3414	2.4047	0.4414
MuMoMAML (ours)	FiLM	1.7094	**0.3125**	1.9234	**0.4048**



Few-shot Image Classification

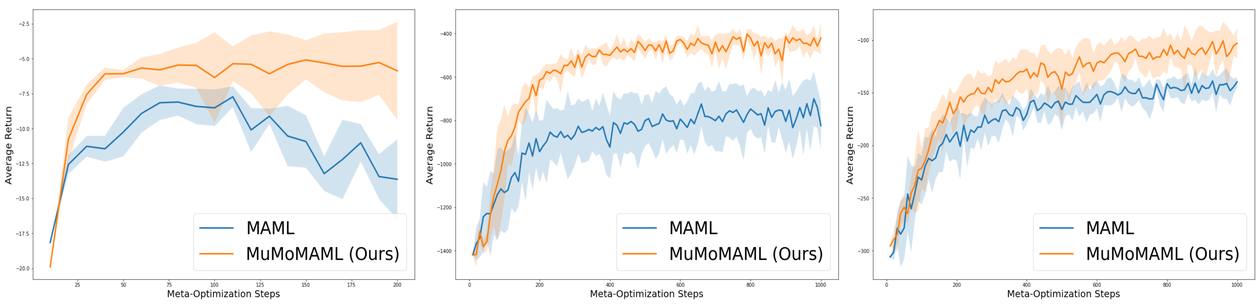
Method	Omniglot 5 Way Accuracy (in %) 1-shot	5-shot	20 Way Accuracy (in %) 1-shot	5-shot
Siamese nets [10]	97.3	98.4	88.2	97.0
Matching nets [28]	98.1	98.9	93.8	98.5
Meta-SGD [12]	99.5	**99.9**	95.9	99.0
Prototypical nets [23]	97.4	99.3	96.0	98.9
SNAIL [14]	99.1	99.8	**97.6**	**99.4**
T-net [11]	99.4	-	96.1	-
MT-net [11]	99.5	-	96.2	-
MAML [5]	98.7	**99.9**	95.8	98.9
MuMoMAML (ours)	**99.7**	**99.9**	97.2	**99.4**





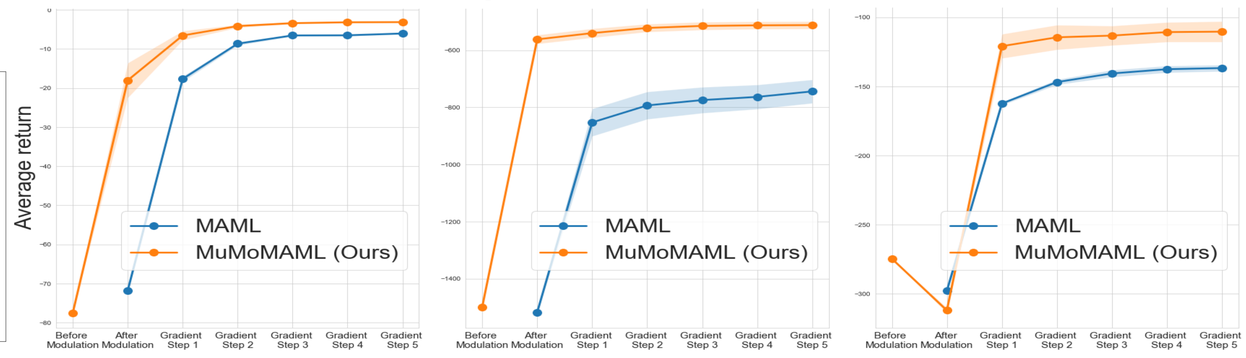
Reinforcement Learning

Training Curves



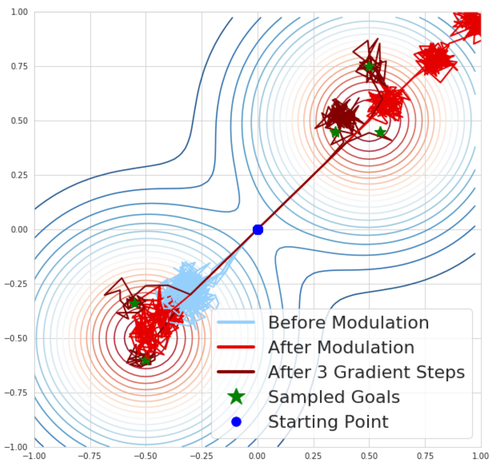
2D Navigation | Target Location | Target Speed

Adaptation Curves

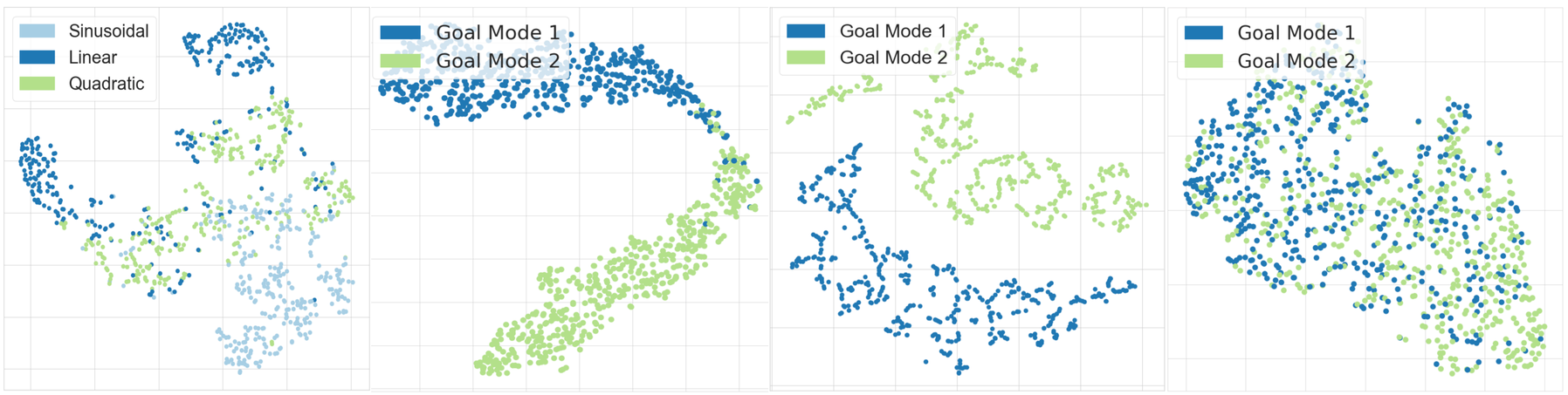


2D Navigation | Target Location | Target Speed

2D Navigation Trajectory



Task Embedding tSNE Plots



Regression | 2D Navigation | Target Location | Target Speed

*The work was done while Risto Vuorio worked at SK T-Brain. The authors are grateful for the computation resources provided by the company.