Overview

- Neural Networks trained online on a correlated stream of data suffer from catastrophic forgetting.
- We propose learning a representation that is robust to forgetting.
- To learn the representation, we propose OML, a second-order meta-learning objective that directly minimizes interference.
- Highly sparse representations naturally emerge by minimizing our proposed objective.

Motivation

- **Question:** Can we learn representations that are robust to catastrophic forgetting?

Hypothesis: Some knowledge representations (right) are more conducive for continual learning than others (left).

Proposed architecture

- **Meta-parameters:** A deep neural network that transforms high-dimensional input data to a representation $\mathcal{R}^d$ more conducive for continual learning.
- **Adaptation parameters:** A simple neural network that learns continually from $\mathcal{R}^d$.

Meta-training

Task

Incrementally learn a classifier for English Alphabet

Dataset of size $k$

$X = \{A A A A A B B B B B C C C C \ P P P P P D D D D \ \ldots \ \ Z Z Z Z \}$

$Y = 00000 \ 11111 \ 22222 \ 33333 \ \ldots \ 25 \ 25 \ 25 \ 25$

**Step 1: Adaptation (Inner loop updates)**

- Use $L(Y_i, Y_i^p)$ to update $W_k$ to $W_k'$
- Use $L(Y_i, Y_i^p)$ to update $W_{k-1}$ to $W_{k-1}'$

**Step 2: Meta-loss**

Computing meta-loss on the complete task dataset

**Step 3: Meta-update**

Differentiating meta-loss through the adaptation phase — similar to MAML.

Meta-testing

Task

Incrementally learn a classifier for numerical digits

**Step 1: Adaptation (Inner loop updates)**

- Use $L(Y_i, Y_i^p)$ to update $W_0$ to $W_0'$

**Step 2: Evaluation**

Compute accuracy on the complete task dataset

Results

We compare OML with a Pretraining, a method that learns a representation by pre-training on the meta-training dataset, MAML-Rep, a MAML like fast adaptation objective that also learns an RLN and SR-NN, a recent method that learns sparse representations.

- Preliminary results show that it’s possible to use OML to update representations online using an experience replay buffer. This can extend OML to more exciting settings, such as reinforcement learning.