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PILOT: A Pre-Trained Model-Based Continual Learning Toolbox

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Differences with Other Toolkits. Given that the current machine learning community lacks a toolbox that includes numerous PTM-based methods, there is an urgent need to develop a dedicated PTM-based toolbox. This toolbox will facilitate cutting-edge research and allow for fair comparisons between traditional methods and PTM-based methods using the same backbone. Moreover, it introduces several significant enhancements and extensions. Specifically, our new toolbox integrates pre-trained checkpoints, which markedly improves the performance and applicability of the class-incremental learning baselines. Additionally, we have included more recent state-of-the-art algorithms and expanded the range of datasets supported, providing a more comprehensive tool for researchers in this field. Finally, since current methods in the PTM-based CIL setting are only compared with other pre-trained methods, we have extended traditional methods to the pre-trained architectures. This aims to facilitate a fair comparison between PTM-based methods and traditional methods. We provide the differences in Table 1.

1. **Incorporation of PTMs: PILOT** not only encompasses traditional incremental learning methods but also extends support for the latest incremental learning that leverages PTMs. However, traditional toolkits have mainly focused on conventional incremental learning methods and have not delved into the realm of integrating PTMs. Consequently, it is necessary to reproduce different kinds of CIL algorithms in the same framework for a holistic understanding. As shown in Table 1, other toolboxes are not compatible with these PTMs, while **PILOT** suits this requirement.

2. **Network Architecture and Parameter Tuning:** By transitioning from the typical ResNet backbone to using PTMs, **PILOT** design a unique parameter setting and tuning approach. PTMs, depending on their complexity, may have different architectural intricacies and might need distinct optimization strategies. While traditional toolkits could potentially be extended to accommodate PTMs, they were primarily designed with CNN networks, so the parameters and hyper-parameters suited for CNN might not be optimal for PTMs. For example, the MEMO method extends specialized layers based on the shared generalized representations, efficiently extracting diverse representations at a modest cost and maintaining representative exemplars. In the traditional backbone, its implementation is mainly based on CNNs. However, due to the significant differences between the architectures of CNNs and ViTs, migrating traditional architectures to PTM-based architectures is very costly. Overall, this process is extremely demanding, requiring substantial time, effort, and toolbox design.

3. **Benchmark and Datasets: PILOT** offers benchmarks and datasets specifically curated for scenarios involving PTMs. Such dedicated resources can play a pivotal role in obtaining accurate performance metrics and evaluations tailored to incremental learning with PTMs. Conventional methods were predominantly designed for the "training from scratch" paradigm, so the benchmark and datasets are outdated and may be unsuitable for PTM-based methods due to data overlapping. As shown in Table 1, other toolboxes are built for traditional CIL benchmarks (CIFAR100 and ImageNet), while our **PILOT** supports the interface for the benchmarks in the era of PTM, such as ImageNet-R, ImageNet-A, CUB200, OmniBenchmark, VTAB, and ObjectNet.

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Table 1 The main differences between **PILOT** and other incremental toolkits.

Toolkit	PTM-based Algs	Traditional Algs with PTM	Datasets for PTMs
avalanche	✗	✗	✗
FACIL	✗	✗	✗
PyCIL	✗	✗	✗
PILOT	✓	✓	✓