

# Continual Learning in an Open and Dynamic World

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## Abstract

Building autonomous agents that can process massive amounts of real-time sensor-captured data is essential for many real-world applications including autonomous vehicles, robotics and AI in medicine. As the agent often needs to explore in a dynamic environment, it is thus a desirable as well as challenging goal to enable the agent to learn over time without performance degradation. Continual learning aims to build a *continual learner* which can learn new concepts over the data stream while preserving previously learnt concepts. In the talk, I will survey three pieces of my recent research on continual learning (i) supervised continual learning, (ii) unsupervised continual learning, and (iii) multi-modal continual learning. In the first work, I will discuss a supervised continual learning algorithm called MEGA which dynamically balances the old tasks and the new task. In the second work, I will discuss unsupervised continual learning algorithms which learn representation continually without access to the labels. In the third work, I will elaborate an efficient continual learning algorithm that can learn multiple modalities continually without forgetting.

A significant step towards artificial general intelligence is to enable the learning agent to acquire the ability of remembering past experiences while being trained on a continuum of tasks. Deep neural networks are capable of achieving remarkable performance on a single task. However, when the network is retrained on a new task, its performance drops drastically on previously trained tasks, a phenomenon which is referred to as catastrophic forgetting. In contrast, the human cognitive system is capable of acquiring new knowledge without damaging previously learned experiences. The goal of continual learning aims to train a machine learning model on a sequence of tasks without performance drop. It is essential for many practical applications including autonomous driving, robotics and AI in medicine.

In this talk, I will discuss three research papers on continual learning. In this first paper, an algorithm called *mixed stochastic gradient descent* (MEGA) (Guo et al. 2020c) is proposed which allows the model to maintain the performance on old tasks while being trained on a new task. In the second paper, an algorithm called SCALE (Yu et al. 2023) is proposed to learn from a sequence of unlabeled data con-

tinually. In the third paper (Pian et al. 2023), AV-CIL is introduced, featuring the integration of the Dual-Audio-Visual Similarity Constraint (D-AVSC) to uphold both instance-aware and class-aware semantic similarity across audio-visual modalities. Additionally, Visual Attention Distillation (VAD) is employed to preserve the previously acquired audio-guided visual attentive ability.

## Speaker Bio

Yunhui Guo is an Assistant Professor of Computer Science at the University of Texas at Dallas. He was a postdoctoral research associate working with Professor Stella Yu at UC Berkeley/ICSI. He received Ph.D in 2020 from the Department of Computer Science, University of California San Diego, under the supervision of Professor Tajana Rosing. His expertise is in the overall area of Machine Learning, Computer Vision and Deep Learning. In particular, he mainly works on problems related to transfer learning (Guo et al. 2019, 2020b), continual learning (Guo et al. 2020c; Yu et al. 2023; Pian et al. 2023; Zhu et al. 2023) and few-shot learning (Guo et al. 2020a).

## References

- Guo, Y.; Codella, N. C.; Karlinsky, L.; Codella, J. V.; Smith, J. R.; Saenko, K.; Rosing, T.; and Feris, R. 2020a. A broader study of cross-domain few-shot learning. In *European conference on computer vision*, 124–141. Springer.
- Guo, Y.; Li, Y.; Wang, L.; and Rosing, T. 2020b. Adafilter: Adaptive filter fine-tuning for deep transfer learning. In *AAAI*, volume 34, 4060–4066.
- Guo, Y.; Liu, M.; Yang, T.; and Rosing, T. 2020c. Improved Schemes for Episodic Memory-based Lifelong Learning. *Advances in Neural Information Processing Systems*, 33.
- Guo, Y.; Shi, H.; Kumar, A.; Grauman, K.; Rosing, T.; and Feris, R. 2019. Spottune: transfer learning through adaptive fine-tuning. In *CVPR*, 4805–4814.
- Pian, W.; Mo, S.; Guo, Y.; and Tian, Y. 2023. Audio-Visual Class-Incremental Learning. *arXiv preprint arXiv:2308.11073*.
- Yu, X.; Guo, Y.; Gao, S.; and Rosing, T. 2023. SCALE: Online Self-Supervised Lifelong Learning without Prior Knowledge. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, 2483–2494.
- Zhu, X.; Hao, J.; Guo, Y.; and Liu, M. 2023. AUC Maximization in Imbalanced Lifelong Learning. In *Uncertainty in Artificial Intelligence*, 2574–2585. PMLR.