

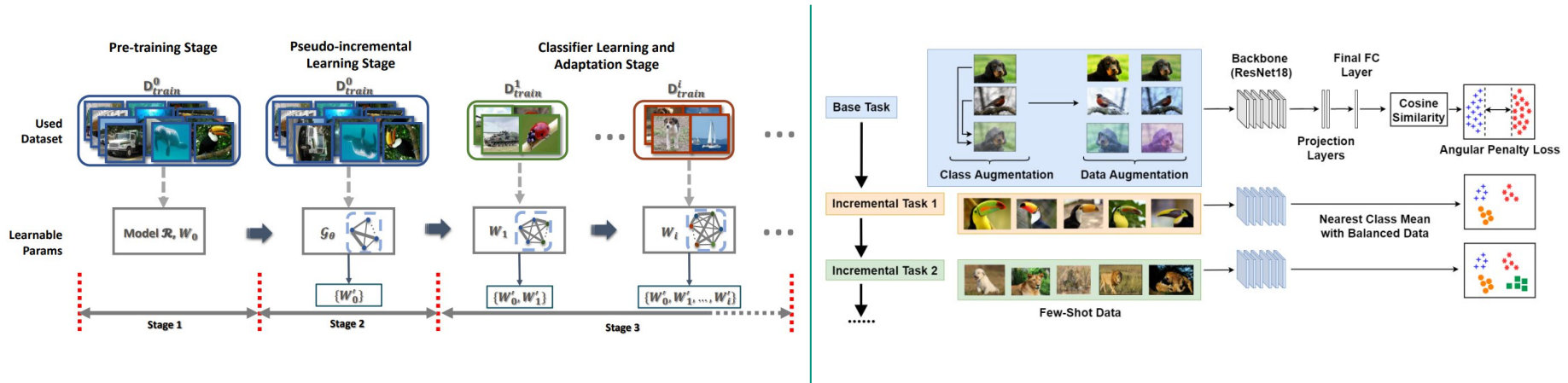
Advanced Topics in Continual / Organic Machine Learning

Interactive Systems Lab (ISL)
Institute for Anthropomatics and Robotics (IAR)

Winter 22-23 Topics

Few-shot Class Incremental Learning (FSCIL)

- Freezing backbone model during learning of new classes
- Decoupled learning strategy to separate classifier and representations to avoid knowledge forgetting
- Proposed continually evolved classifier to fulfil FSCIL [Zhang et al.]
- Similar approach but adapted to open-set problem using feature dist. + metric learning [Peng et al.]



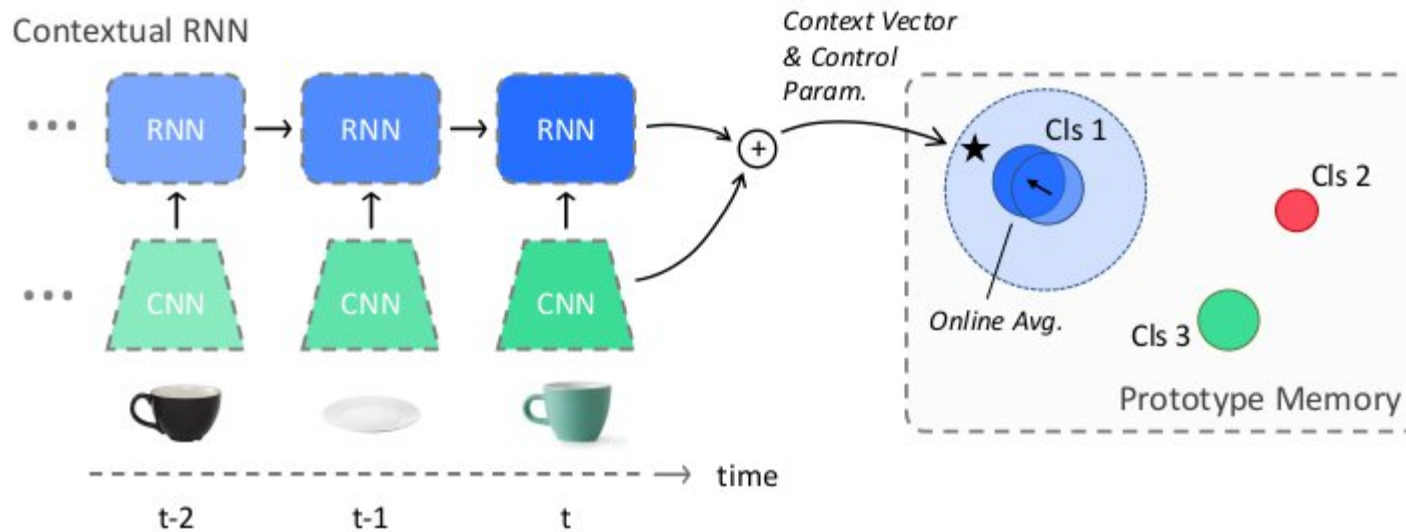
Papers:

Zhang, Chi, et al. "Few-Shot Incremental Learning with Continually Evolved Classifiers", CVPR 2021

Peng, Can, et al. "Few-Shot Class-Incremental Learning from an Open-Set Perspective", ECCV 2022

Online Contextualized Few-shot Learning

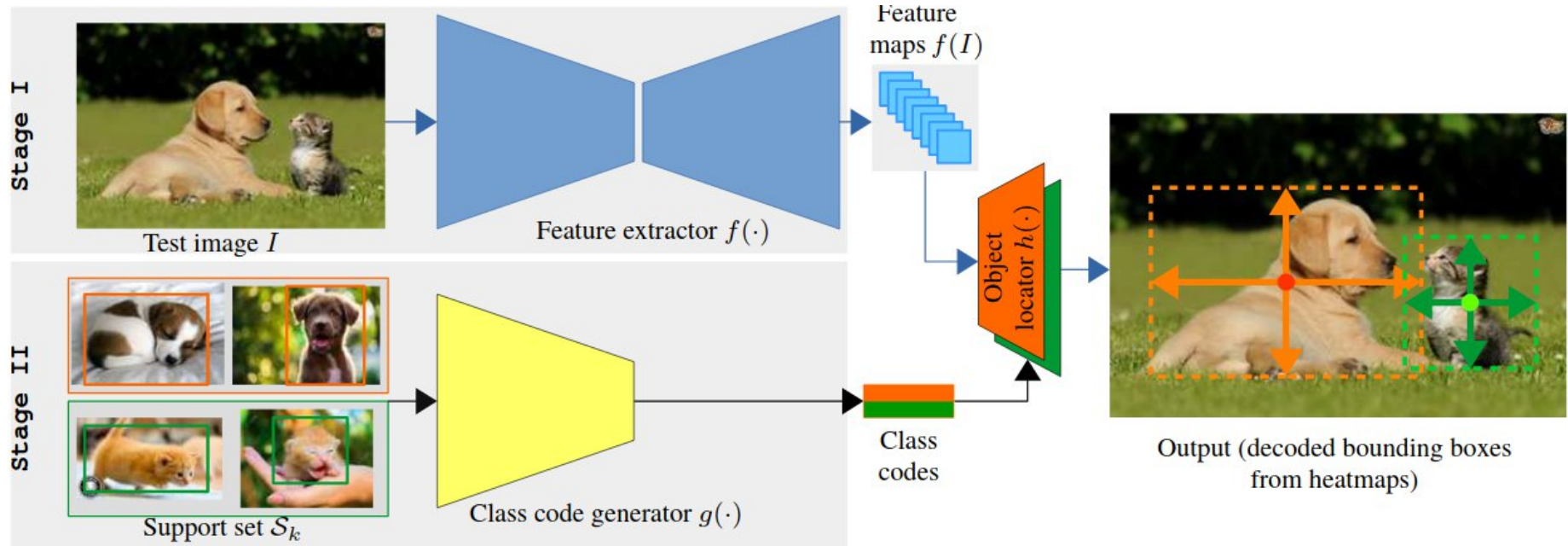
- Few-shot incremental learning in online/continual setting.
- Classes are organized based in context
- To encode temporal contextual information → RNN
- Prototypical memory to remember prev. learned classes



Paper:

Ren, Mengye, et al. "Wandering within a world: Online contextualized few-shot learning", ICLR 2021

Incremental Few-Shot Object Detection



- New will be learned incrementally without revisiting base classes
- Learn to detect new classes using only few images

Papers:

Perez-Rua, Juan-Manuel, et al. "Incremental few-shot object detection", CVPR 2020

Yin, Li, e al. "Sylph: A Hypernetwork Framework for Incremental Few-shot Object Detection", CVPR 2022

Multimodal Few-Shot-Learning

- Huge language models (LMs) like GPT-3 show zero/few-shot learning capabilities although only trained to predict next word
- Transfer this to multimodal setting
- From simple frozen LM to advanced adapter layers

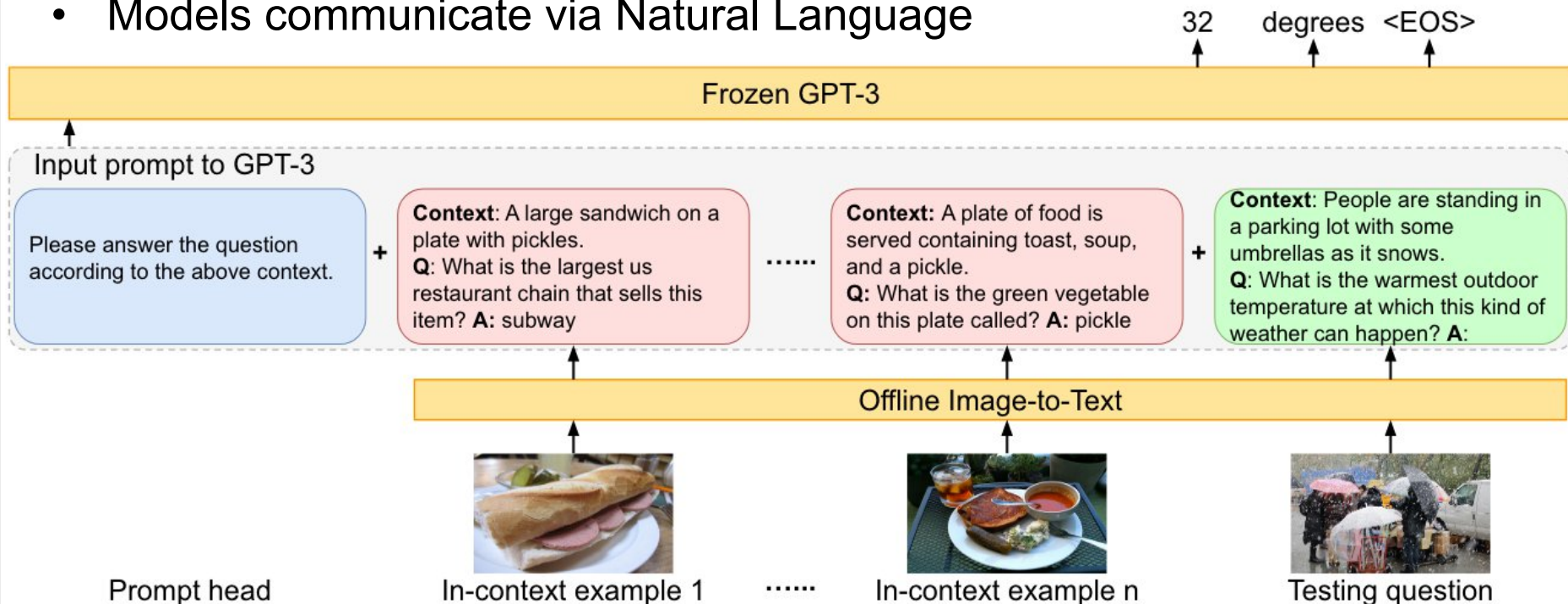


Papers:

- Tsimpoukelli et al., "Multimodal Few-Shot Learning with Frozen Language Models," (NIPS, 2021)
- Alayrac et al., "Flamingo: A Visual Language Model for Few-Shot Learning" (arXiv, 2022)
- Yang et al., "Zero-Shot Video Question Answering via Frozen Bidirectional Language Models" (arXiv, 2022)

Zero-Shot Model Interaction

- Foundation models (LLMs/VLMs/etc.) show zero-shot learning
- Multimodal setting & new tasks can be solved with zero-shot combination of models
- Models communicate via Natural Language

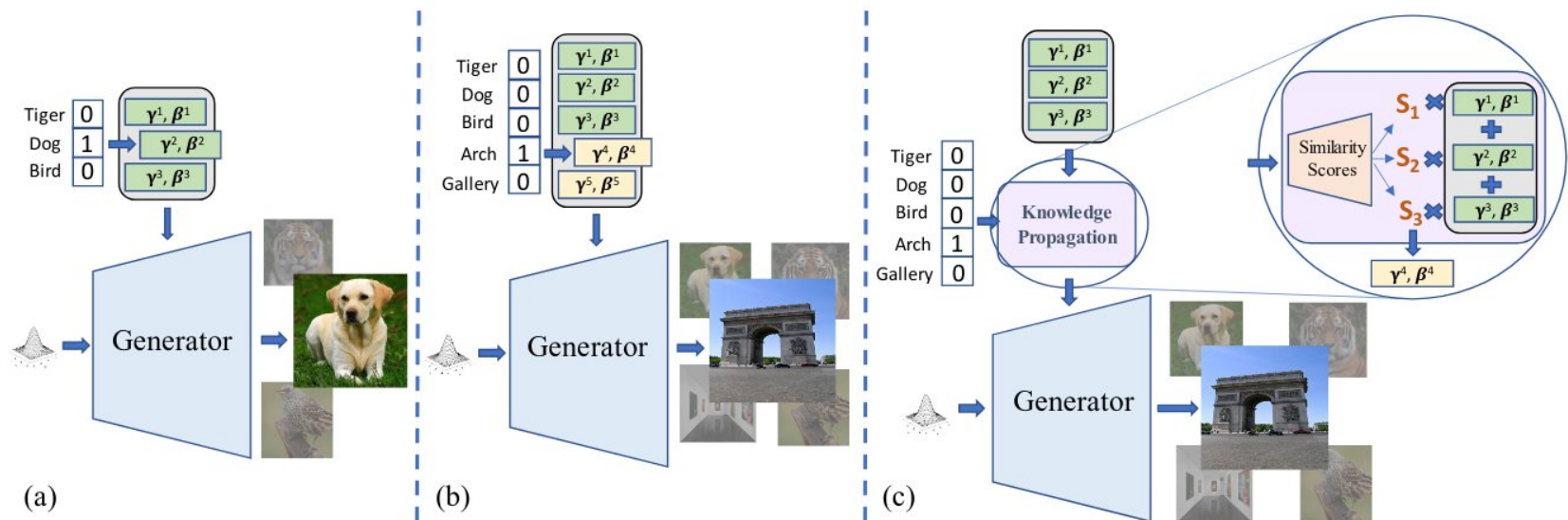


Papers:

- Zhengyuan Yang et al., “An Empirical Study of GPT-3 for Few-Shot Knowledge-Based VQA,” (AAAI 2022)
- Andy Zeng et al., “Socratic Models: Composing Zero-Shot Multimodal Reasoning with Language” (arXiv, 2022)

Efficient Conditional GAN Transfer with Knowledge Propagation across Classes

- **Task:** Conditional Image Generation with GAN
- **Method:**
 - GAN transfer method to explicitly propagate the knowledge from the old classes to the new classes
 - Enforce batch normalization (BN) to learn class-specific information of new classes with implicit knowledge sharing among the new ones.



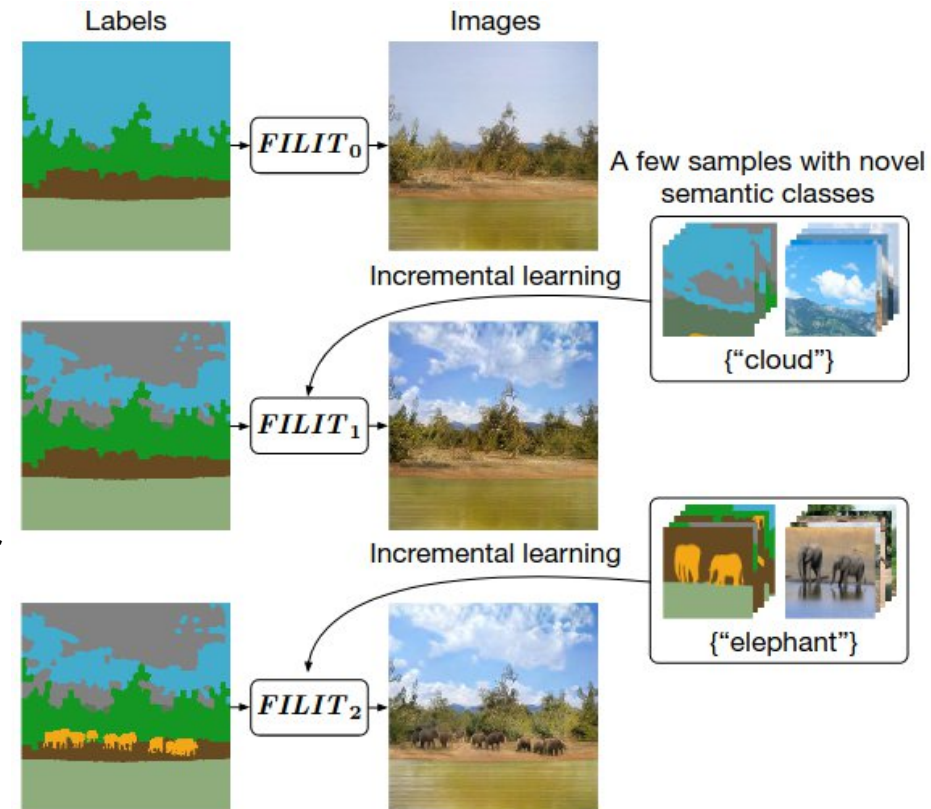
Paper:

- Shahbazi, Mohamad, et al. "Efficient conditional gan transfer with knowledge propagation across classes." CVPR 2021.

(https://openaccess.thecvf.com/content/CVPR2021/papers/Shahbazi_Efficient_Conditional_GAN_Transfer_With_Knowledge_Propagation_Across_Classes_CVPR_2021_paper.pdf)

Few-Shot Incremental Learning for Label-to-Image Translation

- Generate images from semantic label maps.
- Learn novel classes one-by-one from a few samples
- Semantically-adaptive convolution filters
- Model learns a few extra parameters of class-specific modulation during the incremental learning.
- Modulation transfer strategy for better initialization



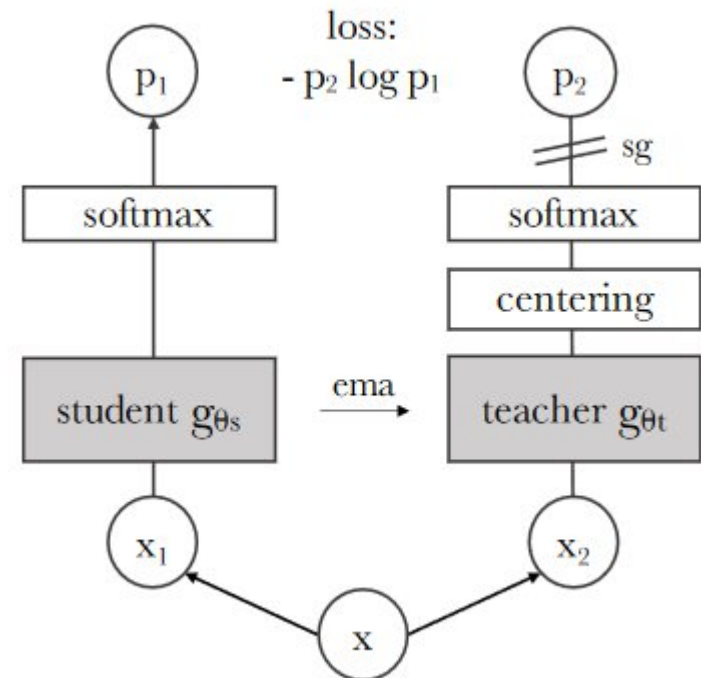
Paper: Chen, Pei, et al. "Few-Shot Incremental Learning for Label-to-Image Translation." *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2022.

Online Continual Learning of End-to-End Speech Recognition Models

- Task: Explain Online Gradient Episodic Memory (GEM) method and the application to speech recognition
- Yang, Muqiao, Ian Lane, and Shinji Watanabe. "Online Continual Learning of End-to-End Speech Recognition Models." arXiv preprint arXiv:2207.05071 (2022).

Self-Supervised Learning

- A machine learning system that uses supervised learning techniques (e.g. NNs) to learn from automatically labelled data
 - No labelled data needed
 - Explain methods/applications
- Emerging properties in self-supervised vision transformers (Caron et al. 2021)



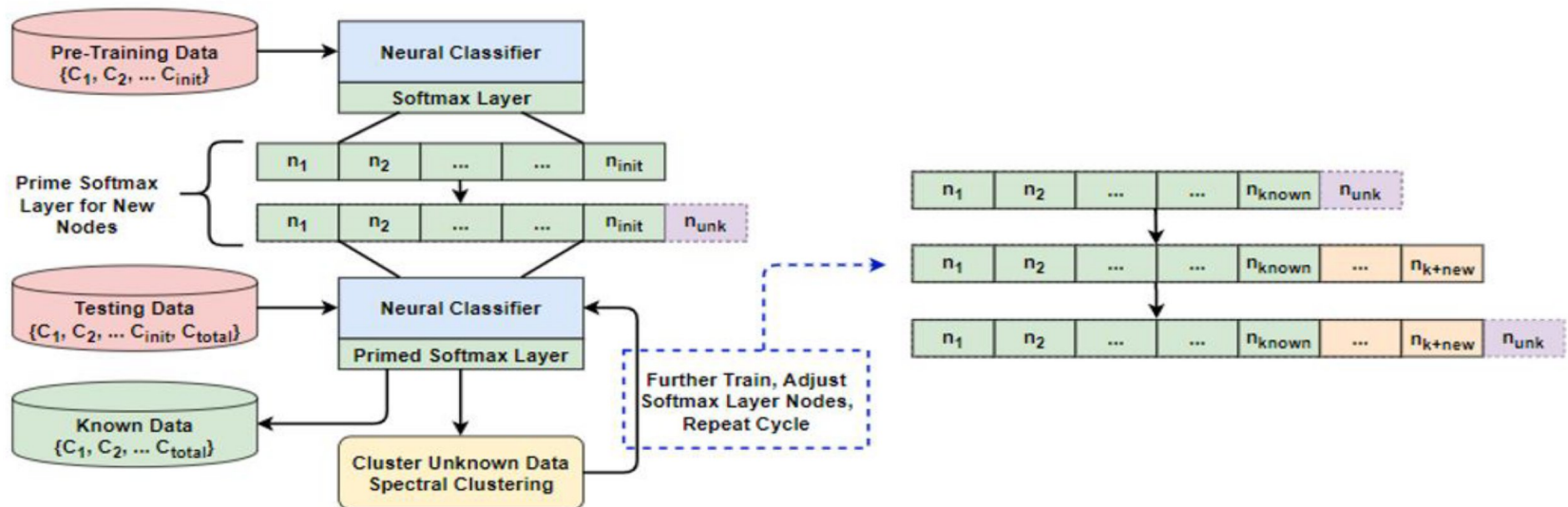
Variable Few Shot Class Incremental and Open World Learning

- Previous work: Fixed-Few-Shot Class Incremental Learning (number of ways and shots are known, but this is not true in real-world cases)
- Number of ways: how many new classes are added
- Number of shots: how many examples per class are provided
- Variable-Few-Shot Class Incremental Learning (Up-to N-Ways, Up-to K-Shots class incremental learning)
- Detect unknown classes
- Main paper assumes labels for unknown classes, possible solution in real-world: ask user for labels (organic learning like a child)

Paper: Ahmad, Dhamija, Jafarzadeh, Cruz, Rabinowitz, Li, Boulton, “Variable Few Shot Class Incremental and Open World Learning”, IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), 2022

Incremental Deep Neural Network Learning Using Classification Confidence Thresholding

- model with its own architecture and initial trained set of data can identify unknown classes during the testing phase and autonomously update itself if evidence of a new class is detected
- threshold approach to prime neural networks for incremental learning to keep accuracies high by limiting forgetting
- lean method to reduce resources used in the retraining



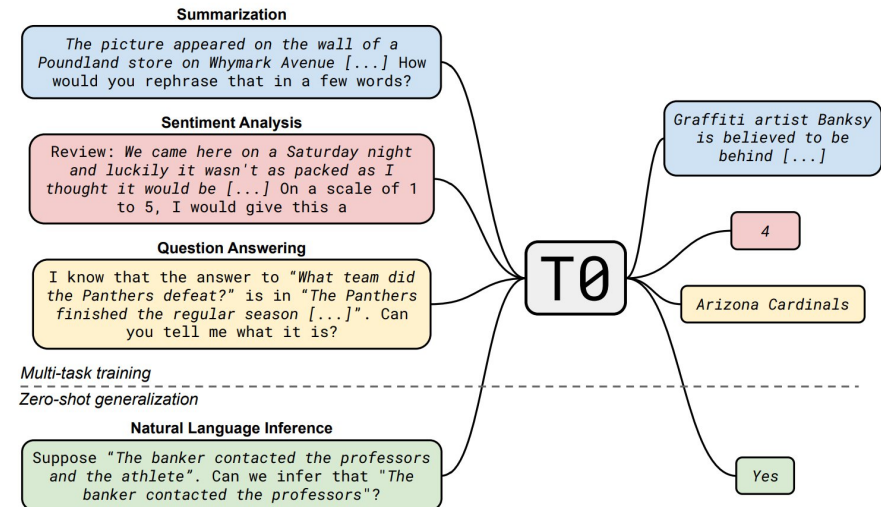
Paper: Justin Leo and Jugal Kalita, “Incremental Deep Neural Network Learning Using Classification Confidence Thresholding”, IEEE Transactions on Neural Networks and Learning Systems, 2021

Zero-Shot Task Generalization in Language Models

- Language models like GPT-3⁴ have shown to obtain reasonable zero-shot capabilities
- Since then several works have been done in the area of instruction tuning and prompt engineering
- **Review recent approaches in the area of zero-shot learning with language models such as [1] [2] [3]**

Papers:

- ¹*Multitask Prompted Training Enables Zero-Shot Task Generalization, Sanh et al. (2022)*
- ²*Finetuned Language Models Are Zero-Shot Learners, Wei et al. (2021)*
- ³*Adapting language models for zero-shot learning by meta-tuning on dataset and prompt collections, Zhong et al. (2021)*
- ⁴*Language models are few-shot learners, Brown et al. (2020)*
- ⁵*Pre-train, Prompt, and Predict: A Systematic Survey of Prompting Methods in Natural Language Processing, Liu et al. (2021)*



(Few-Shot) Fine-Tuning of Pretrained Language Models

- **Review methods for (few-shot) fine-tuning of pretrained language models (PLM)**
- Most current approaches involve prompt engineering or require huge language models
 - ICL (In-Context Learning)
 - PET (Pattern Exploiting Training⁴)
 - PEFT (Parameter-Efficient Finetuning³)
- SetFit¹ and PERFECT² promise prompt-free few-shot learning without any handcrafting

Papers (Suggestions):

- ¹*Efficient Few-Shot Learning Without Prompts*, Tunstall et al. (2022)
- ²*PERFECT: Prompt-free and Efficient Few-shot Learning with Language Models*, Mahabadi et al. (2022)
- ³*Improving and Simplifying Pattern Exploiting Training*, Tam et al. (2021)
- ⁴*Exploiting cloze-questions for few-shot text classification and natural language inference*, Schick et al. (2021)

