

Natural Language Processing and Tabular Data sets in Federated Continual Learning

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A usability study of FCL in domains beyond Image classification

1. Background

Federated Learning (FL) is where a centralized global model [1] is aggregated by the use of multiple local models on a clients edge device.

Continual Learning (CL) is the process of learning from a sequence of tasks iteratively rather than simultaneously as done in conventional systems [2].

Federated Continual Learning (FCL) combines both concepts of FL and CL together where local continual learning models are aggregated into a centralized global model [1].

2. Research Questions

How can FCL (Federated Continual Learning) work in other tasks (NLP or tabular data) apart from Image classification?

- How do we assess FCL model performance?
- How does FCL differ from traditional CL?
- Under which conditions to FCL perform better in NLP and Tabular tasks in comparison with CL?

References

- [1] Daniel Ramage Seth Hampson Blaise Aguera y Arcas H. Brendan McMahan, Eider Moore. Communication efficient learning of deep networks from decentralized data. In Proceedings of the 20th International Conference on Artificial Intelligence and Statistics. Google Inc., 2017.
- [2] Hang Su Jun Zhu Fellow IEEE Liyuan Wang, Xingxing Zhang. A comprehensive survey of continual learning: Theory, method and application. IEEE, ArXiv, 2023.
- [3] Y. Lecun, L. Bottou, Y. Bengio, and P. Haffner, "Gradient-based learning applied to document recognition," Proceedings of the IEEE, vol. 86, no. 11, pp. 2278–2324, 1998.

3. Methodology

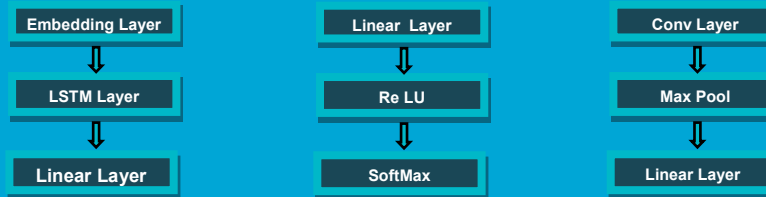
Baseline CL Algorithms	FCL Algorithms	Metrics	Measure
EWC	FedEWC	Average Accuracy	Accuracy
GEM	FedGEM	Backwards Transfer	Memory Stability
	FedWEIT		

Models and Tasks

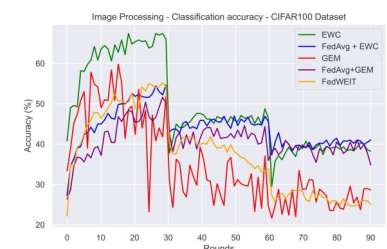
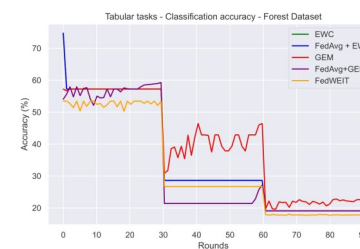
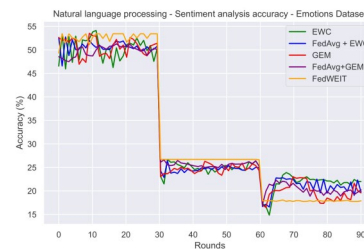
NLP Tasks:
Sentiment Analysis with a Long-Short Term Memory Model.

Tabular Tasks:
Tabular classification with a Deep Neural Network.

Image Tasks :
Image classification with an LeNet-5 network.[3]



4. Results



Domain	Mean Accuracy per Task			Relative Accuracy (RA) per Task		
	Task 1	Task 2	Task 3	RA Task 1	RA Task 2	RA Task 3
NLP	50.84	25.33	20.05	1.0	0.50	0.39
Tabular	56.43	29.12	19.34	1.0	0.52	0.34
Image	49.00	40.40	34.11	1.0	0.83	0.71

4. Conclusions

- Federated Continual Learning methods perform better for image classification task.
- Sentiment analysis and Tabular classification have lower memory stability but higher learning plasticity than Image classification.
- CL baselines achieve a higher accuracy than their federated counterparts.

5. Future works

- Larger language models can be tested such as transformers and BERT in FCL setting.
- Explore a wider range of tasks such as natural language generation, named entity recognition, generation and regression.
- Test in the horizontal federated learning methods for tabular data.