Reproducibility Report for ACM SIGMOD 2023 Paper: "LightCTS: A Lightweight Framework for Correlated Time Series Forecasting"

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The core results of the paper of Lai et al. [1], that is, Tables 5 - 7, could be reproduced with minor deviations. However, the figures could not be fully reproduced. As they are not crucial for the main thesis of the paper, the core results are still reproducible.

1 INTRODUCTION

This is a reproducibility report for the paper *LightCTS: A Lightweight Framework for Correlated Time Series Forecasting* by Zhichen Lai et al. [1]. The authors propose a new framework, 'LightCTS' for Correlated Time Series (CTS) forecasting. LightCTS provides near-state-of-the-art accuracy for reduced computational costs and less storage overhead. We were able to reproduce the results of Tables 5 - 7 with minor deviations. Thus, we can reproduce the main claim of the paper, i. e., LightCTS achieves nearly as accurate results as state-of-the-art approaches with less overhead.

The authors also did a parameter study to justify their parameter choice. We were unable to fully reproduce the corresponding Figures 5 and 6. However, these are not crucial for the core thesis of the paper.

2 SUBMISSION

The source code and scripts for reproducing the paper results are available on GitHub. The submission contains the following:

- GitHub repository with code and scripts at: https://github.com/ryanlaics/Artifact-LightCTS
- detailed ReadMe file describing the steps to reproduce the results
- URLs to download the required data manually and a Python script that downloads all data automatically
- URL to pre-trained models and their checkpoints: https://github.com/AI4CTS/lightcts

In the submission, the authors state that they are not reproducing the *latency* and *peak memory* measurements as these are highly dependent on the underlying hardware.

3 HARDWARE AND SOFTWARE ENVIRONMENT

Table 1 provides an overview of the hardware, software, and versions used. The different hardware influences the reported runtime and memory usage but not the overall trends and general findings.

4 REPRODUCIBILITY EVALUATION

4.1 Process

First, we installed the required dependencies and ran the script to download the data automatically, which was easily accomplished by following the instructions in the README.

The authors provided commands to execute specific experiments of their paper. For executing the experiments, we had to make some minor changes:

- Add backslash before space to the file path in the run command

Table 1. Hardware & Software environment

	Paper	Repro Review
CPU	Intel Xeon Gold 5215(training) / X86 380 MHz (inference)	AMD EPYC 7763 64-Core
RAM	64GB (training)/4GB (inference)	1 TB
GPU	NVIDIA Tesla P100 (training)/ N/A (inference)	NVIDIA A100-SXM4-40GB
OS	Ubuntu 20.04.6 LTS (training)/ Windows 10 Pro (inference)	Ubuntu 20.04.6 LTS
Python	3.7.13	3.7.13
CUDA Version	11.1	12.2
PyTorch Version	1.13.0	1.13.1

- Create output folder (*logs*)
- Explicitly specify the path to the input files in the run commands
- Change several arguments from `float` to `int` because otherwise, the code can not be executed with changed parameters

After these changes, the code could be executed easily. To execute the experiments for Tables 5 - 7, the same experiments had to be executed with different 'horizon' parameter values (from the command line).

Executing the figures was not possible. We asked the authors for help and the code was executable on the next day. However, the code plots random numbers as placeholders for the actual parameter values. So, to reproduce Figures 5 and 6, the experiments had to be executed with different parameter values, and then the results had to be copied into the Python script manually.

4.2 Results

Tables 5-7 show the original results of the paper in comparison to our reproduced results. The reproduced results are very close to the ones in the paper and mostly differ only at the second decimal place. We marked the two largest deviations with 0.7% (MAPE in Table 2 for 60 mins) and 4% (RRSE in Table 4 for 24-th horizon). However, these variations are minimal, and the key statement of nearly state-of-the-art accuracy with less overhead still holds.

Table 2. Accuracy and Lightness Comparison for Multi-Step Traffic Flow Forecasting.

Data	Models	FLOPs (unit: M)	Params (unit: K)	MAE	RMSE	MAPE
PEMS04	Original	147	185	18.79	30.14	12.80
	Reproduced	147	185	18.84	30.14	12.92
PEMS08	Original	70	177	14.63	23.49	9.43
	Reproduced	70	177	14.75	23.65	**10.2**

With the manual instructions of the authors, we were able to create Figures 5 and 6. They showed some different trends as in the paper, however they are only parameter variations and are not crucial for the core thesis of the paper. Furthermore, the y-axis in the paper has very close limitations, which leads to a different trend even with minimal deviations. For instance, Figure 1 shows the difference of our reproduced Figure 5a and the one from the paper.

Table 3. Accuracy and Lightness Comparison for Multi-Step Traffic Speed Forecasting.

Data	Models	Flops (unit: M)	Params (unit: K)	15 mins			30 mins			60 mins		
				MAE	RMSE	MAPE	MAE	RMSE	MAPE	MAE	RMSE	MAPE
METRA-LA	Original	70	133	2.67	5.16	6.82	3.03	6.16	8.11	3.44	7.21	9.46
	Reproduced	70	133	2.68	5.13	6.79	3.06	6.16	8.14	3.51	7.34	9.63
PEMS-BAY	Original	208	236	1.30	2.75	2.71	1.61	3.65	3.59	1.89	4.32	4.39
	Reproduced	208	236	1.31	2.76	2.70	1.62	3.66	3.56	1.90	4.38	4.36

Table 4. Accuracy and Lightness Comparison for Single-Step CTS Forecasting.

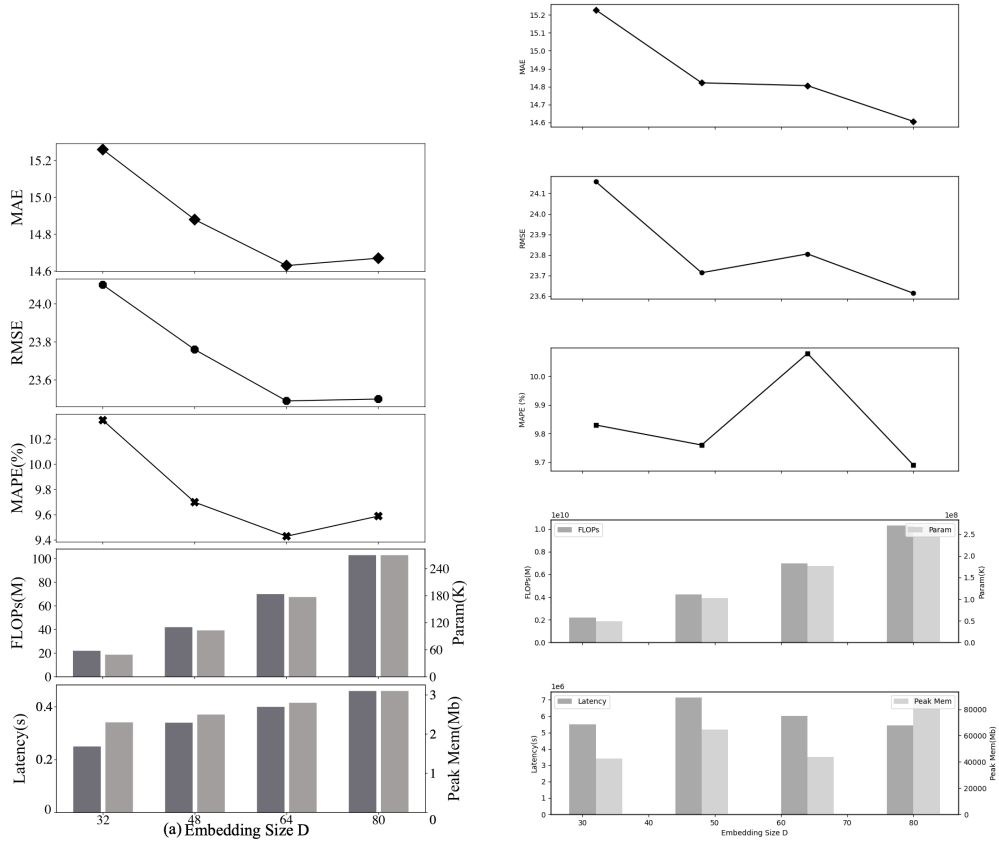
Data	Models	Flops (unit: M)	Params (unit: K)	3-th		6-th		12-th		24-th	
				RRSE	CORR	RRSE	CORR	RRSE	CORR	RRSE	CORR
Solar-Energy	Original	169	38	0.1714	0.9864	0.2202	0.9772	0.2955	0.9568	0.4129	0.9084
	Reproduced	169	38	0.1717	0.9863	0.2151	0.9772	0.2964	0.9555	**0.4590**	**0.8932**
Electricity	Original	239	27	0.0736	0.9445	0.0831	0.9343	0.0898	0.9261	0.0952	0.9234
	Reproduced	239	27	0.0738	0.9442	0.0825	0.9359	0.0897	0.9279	0.0940	0.9234

5 SUMMARY

The core results from the paper were reproduced. The results for the parameter study deviated from the results in the paper. However, these results are not crucial for the core thesis of the paper.

REFERENCES

[1] Zhichen Lai, Dalin Zhang, Huan Li, Christian S. Jensen, Hua Lu, and Yan Zhao. 2023. LightCTS: A Lightweight Framework for Correlated Time Series Forecasting. *Proc. ACM Manag. Data* 1, 2, Article 125 (jun 2023), 26 pages. https://doi.org/10.1145/3589270



(a) Figure 5a from [1] (b) Reproduced Figure

Fig. 1. Comparison of results from Figure 5a from the paper and our reproduced results.