Supplementary Material for "OML-AD: Online Machine Learning for Anomaly Detection in Time Series Data"

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1 Supplementary Figures

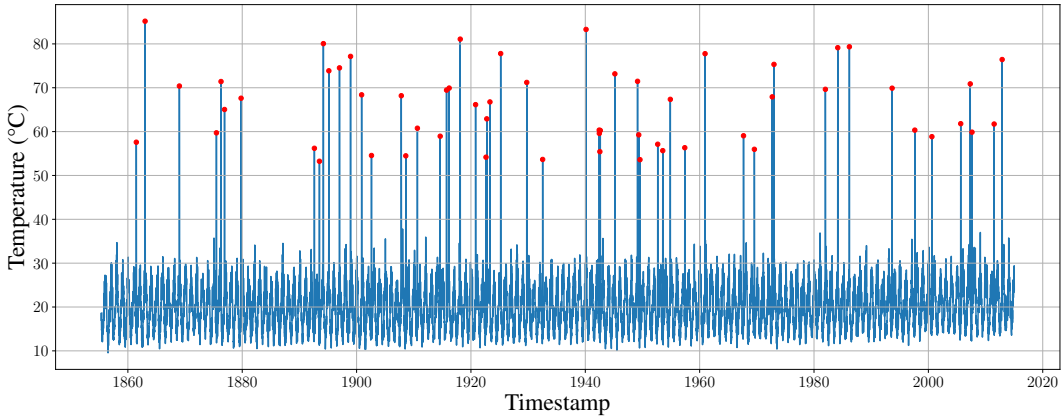

Fig. 1. Weekly Temperature Data with Synthesized Anomalies

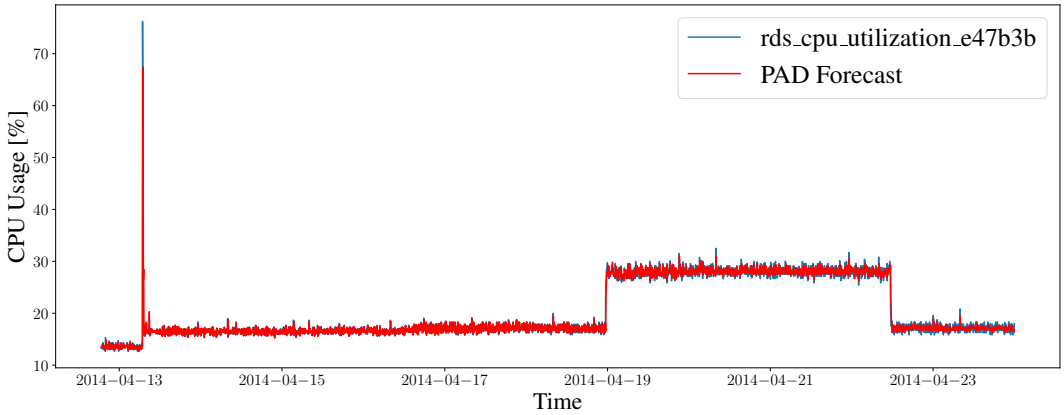

Fig. 2. OML-AD Forecast on CPU Utilization Data

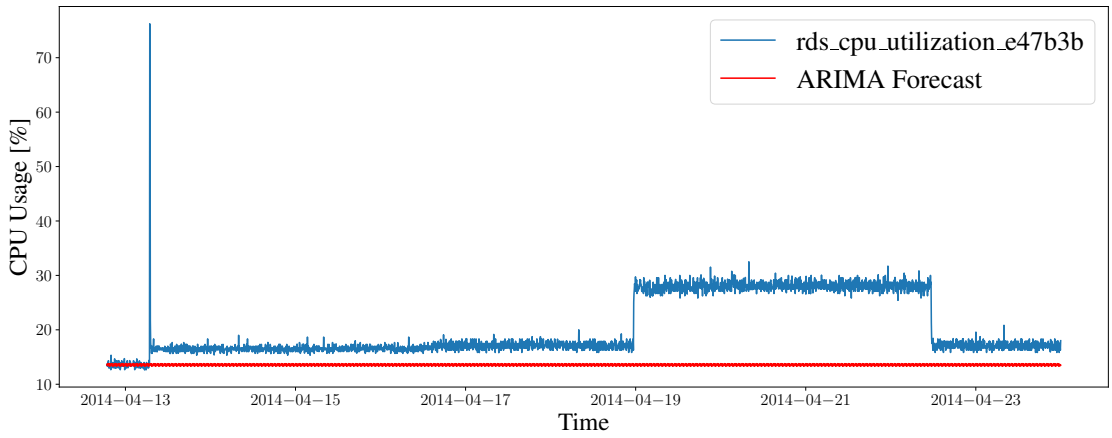

Fig. 3. SARIMA Forecast on CPU Utilization Data without Retraining

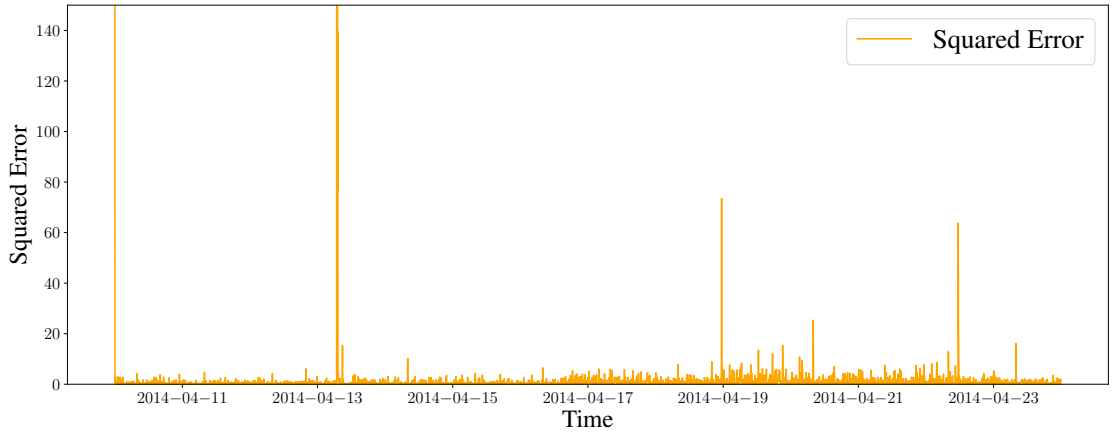

Fig. 4. Error of OML-AD Forecast on CPU Utilization Data

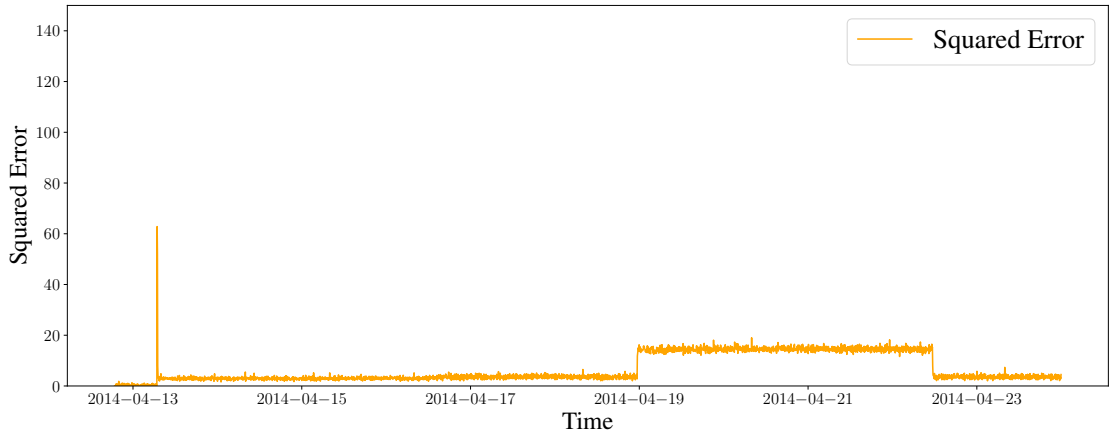

Fig. 5. Error of SARIMA Forecast on CPU Utilization Data

2 Supplementary Tables

Table 1. Forecasting and detection performance on weather data with synthesized anomalies

City	Algorithm		MAE	MSE	F1	AUC ROC
Sydney	OML-AD		2.7504	**8.0843**	**0.9503**	0.9879
	SARIMA	No Retraining	6.3630	69.0261	0.1320	0.9765
		Scheduled Retraining	2.5258	21.9888	0.6170	0.9861
		Dynamic Retraining	**2.4962**	20.9147	0.8862	**0.9968**
	Prophet	No Retraining	16.3098	387.5487	0.0398	0.8558
		Scheduled Retraining	6.5243	68.9949	0.7420	0.9651
		Dynamic Retraining	2.5856	23.6932	0.8025	0.9677
Melbourne	OML-AD		2.7637	**7.9064**	**0.9747**	**0.9998**
	SARIMA	No Retraining	6.0970	66.6365	0.1370	0.9584
		Scheduled Retraining	2.5819	22.5574	0.5987	0.9957
		Dynamic Retraining	**2.4129**	21.1346	0.9014	0.9989
	Prophet	No Retraining	17.0762	404.8067	0.0402	0.8425
		Scheduled Retraining	6.6228	69.2407	0.7230	0.9975
		Dynamic Retraining	2.6378	23.7981	0.8318	0.9987
Robe	OML-AD		2.6104	**7.5719**	**0.9719**	**0.9988**
	SARIMA	No Retraining	6.4173	68.7132	0.1372	0.9490
		Scheduled Retraining	2.5203	23.6533	0.5857	0.9942
		Dynamic Retraining	2.5432	20.1169	0.8599	0.9939
	Prophet	No Retraining	18.0550	397.8834	0.0389	0.8043
		Scheduled Retraining	6.6134	66.2162	0.7011	0.9454
		Dynamic Retraining	**2.4831**	24.0231	0.8046	0.9621

Table 2. Forecasting and detection performance on CPU utility data with real anomalies

Algorithm		MAE	MSE	F1	AUC ROC
OML-AD		**0.7525**	**2.4217**	0.4444	**0.9992**
SARIMA	No Retraining	6.7164	75.5092	**0.5000**	0.8438
	Scheduled Retraining	4.2726	39.9807	**0.5000**	0.8420
	Dynamic Retraining	1.2050	5.9659	0.0615	0.9906
Prophet	No Retraining	8.0303	99.8151	**0.5000**	0.8438
	Scheduled Retraining	3.9737	29.1455	**0.5000**	0.8686
	Dynamic Retraining	10.0246	470.6927	0.0190	0.7545

Table 3. Time and resource consumption on weather data with synthesized anomalies

City	Algorithm		Mean Time [ms]	Std [ms]	CPU [%]	RAM [%]
Sydney	OML-AD		**628.83**	**364.26**	**3.95**	**22.09**
	SARIMA	No Retraining	58913.33	774.78	15.05	29.52
		Scheduled Retraining	164313.09	2098.46	15.83	29.10
		Dynamic Retraining	344827.70	4911.51	15.23	30.57
	Prophet	No Retraining	2078.27	459.57	4.20	33.21
		Scheduled Retraining	6482.84	2669.68	12.91	29.42
		Dynamic Retraining	12132.69	1178.52	11.95	29.21
Melbourne	OML-AD		**660.78**	**352.42**	**4.16**	**23.00**
	SARIMA	No Retraining	57674.96	741.55	14.78	30.92
		Scheduled Retraining	164430.49	2013.63	15.79	30.01
		Dynamic Retraining	340427.43	4686.40	15.32	29.71
	Prophet	No Retraining	2173.90	460.67	4.22	31.76
		Scheduled Retraining	6445.34	2715.17	13.33	30.41
		Dynamic Retraining	12274.80	1149.53	11.78	29.84
Robe	OML-AD		**699.30**	**353.24**	4.16	**21.86**
	SARIMA	No Retraining	60707.34	781.29	15.52	32.69
		Scheduled Retraining	155240.83	1941.19	15.93	28.45
		Dynamic Retraining	342832.87	4883.07	14.80	29.97
	Prophet	No Retraining	2171.43	445.04	**4.06**	31.07
		Scheduled Retraining	6506.64	2823.17	13.42	29.28
		Dynamic Retraining	11824.89	1115.07	11.36	30.04

Table 4. Time and resource consumption on CPU utility data with real anomalies

Algorithm		Mean Time [ms]	Std [ms]	CPU [%]	RAM [%]
OML-AD		**154.96**	**7.04**	2.82	**31.38**
SARIMA	No Retraining	6074.72	1128.20	6.13	48.11
	Scheduled Retraining	43000.47	6034.02	9.71	41.56
	Dynamic Retraining	31035.75	3293.89	9.99	39.81
Prophet	No Retraining	592.08	33.82	**2.39**	42.04
	Scheduled Retraining	2194.62	579.22	9.04	41.18
	Dynamic Retraining	4442.64	260.73	7.09	41.43