Automated Monitoring of Large-scale Computing Systems

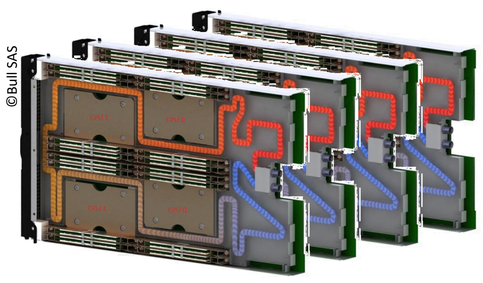
A Light-weight and Unsupervised Method for Near Real-time Behavioral Analysis Using Operational Data Measurement

Tom Richard Vargis, Siavash Ghiasvand

[Scan to reproduce]

Motivation

Operational data of computing systems are correlated. Changes in the value of this data and the balance between them is a reflection of the system's behavior. Detection of deviation of system behavior in early stages would prevent major failures which otherwise could cause additional damages. This work proposes a light-weight and fully unsupervised method for near real-time behavioral analysis using energy consumption and temperature measurements of large computing systems.



Taurus HPC Cluster[1]

MetricQ[2]

Timestamp	Avg. power	CPU0 power	CPU1 power	CPU0 temp.	CPU1 temp.
2022-07-13 00:00:07	131.5206	33.27999	26.91096	59.0	57.0
2022-07-13 00:00:17	114.7102	24.99287	20.10629	60.0	57.0
2022-07-13 00:00:27	136.3787	36.36461	27.79525	60.0	57.0
2022-07-13 00:00:37	129.5102	31.33605	25.26149	59.0	57.0
2022-07-13 00:00:47	118.3239	26.30085	21.37567	60.0	57.0

Data Preparation

Layer (type)	Output Shape	Param #
encoder_1 (LSTM)	(None, 4, 64)	17920
encoder_2 (LSTM)	(None, 4, 32)	12416
encoder_3 (LSTM)	(None, 16)	3136
encoder_decoder_bridge	(None, 4, 16)	0
decoder_1 (LSTM)	(None, 4, 16)	2112
decoder_2 (LSTM)	(None, 4, 32)	6272
decoder_3 (LSTM)	(None, 4, 64)	24832
time_distributed	(None, 4, 5)	325

Pattern identification

[Autoencoder]

Calculating threshold

Proposed method

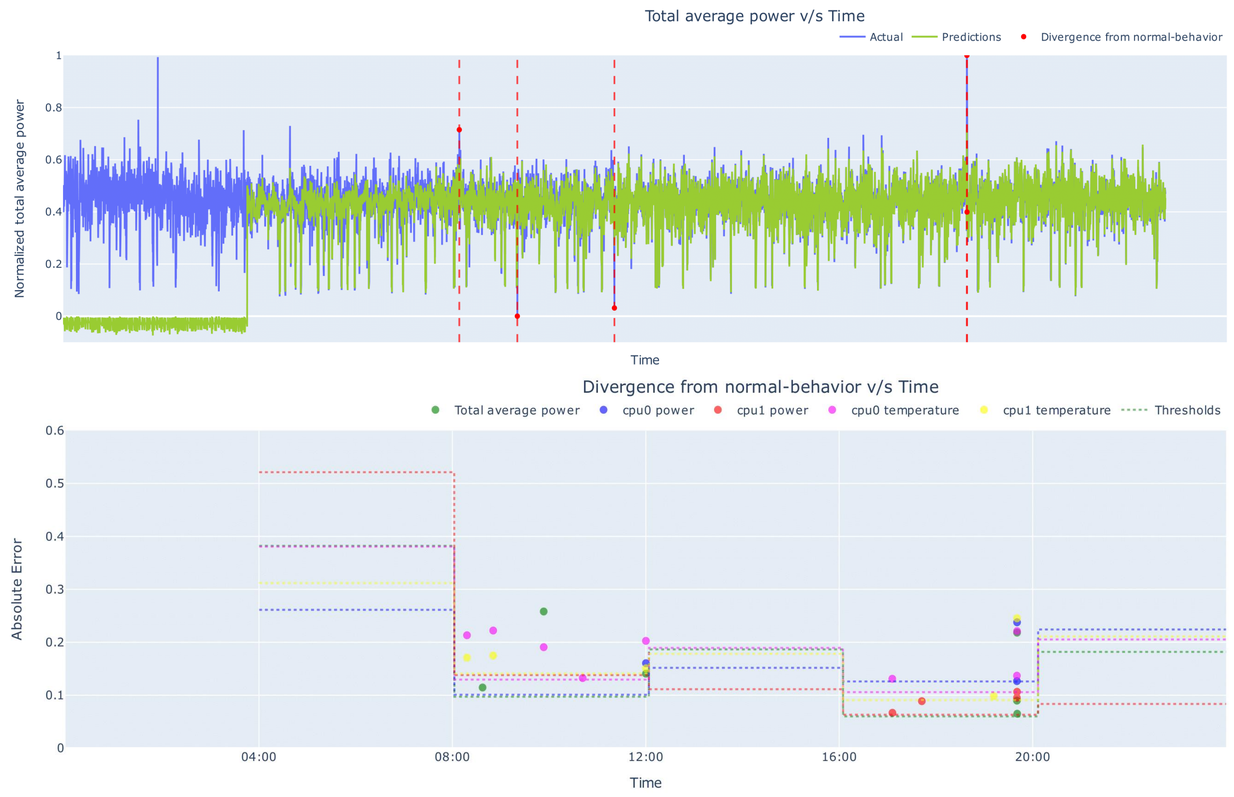
- Collection and streaming of temperature and energy consumption data using MetricQ[2]
- Preprocessing, normalization and down sampling of collected operational data
- Progressive training of a purposely designed light-weight LSTM Autoencoder
- Continues update of the trained model to reflect current systems behavioral pattern
- Automatic adjustment of threshold value based on most current normal behavior
- Identifying divergence from normal behavior

Main characteristics

- Minimal training data and iterations (4 hours and 50 epochs)
- Accurate prediction of systems behavior (approx. 96%)
- Near real-time behavioral analysis (< 2 min)
- System users behavioral pattern awareness
- Rapid automatic adaptation to system changes

Future work

- Adaptive threshold calculation
- Identification of failures type/category
- Further optimization of hyper parameters
- Definitive decision based on the identified anomalies



Predictions & Unexpected behaviours

1. https://doc.zih.tu-dresden.de/jobs_and_resources/hardware_overview/
2. https://github.com/metricq/metricq

AUTHORS

TU DRESDEN
Tom Richard Vargis
tom_Richard.Vargis@tu-dresden.de

TU DRESDEN
Siavash Ghiasvand
siavash.ghiasvand@tu-dresden.de

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