Toward Cloud Resource Forecasting Using an Image-based Machine Learning Pipeline

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1. Problem Space

- Forecasting models are used in resource management, provisioning and scheduling.
- LSTMs are state-of-the-art machine learning models for forecasting timeseries.
- LSTMs fail to forecast cloud resource data for forecasting horizons in the future.
- Need for frequent retraining and inference.

How to accurately predict data for long forecasting horizons?

2. Approach

Current Solutions

\[
x_0, x_1, \ldots, x_t, x_{t+1}, x_{t+2}, \ldots, x_{t+h}
\]

LSTM-based model

Proposed Approach

\[
x_0, x_1, \ldots, x_t, x_{t+1}, x_{t+2}, \ldots, x_{t+h}
\]

ConvLSTM-based model

Learn visual representations of timeseries to leverage the power of image-based machine learning solutions.

3. Evaluation

CPU usage across time for two virtual machines, recorded every 5 minutes (Bitbrains dataset). Forecasting horizon: 80 minutes.

Regular Pattern

LSTM

ConvLSTM

Irregular Pattern

LSTM

ConvLSTM

The image-based ML model (ConvLSTM) makes more accurate predictions compared to the numeric (LSTM).

4. Why Images?

LSTM Regression

Model Loss

Loss function: MSE

Input: Raw Numbers

\[\text{Loss function: MSE} \quad \text{Input: Raw Numbers}\]

LSTM Classification

Model Loss

Loss: Cross Entropy

Input: Binned Numbers

ConvLSTM

Model Loss

Loss: Cross Entropy

Input: Images

We will look for more answers:
- Interpretability
- Feature Correlations.
- Other datasets and patterns.

5. Future Vision

Pattern Recognition

Input Image

Pattern Prediction

Cloud System

Not Accurate Prediction? Retrain.

We envision image-based system pipelines using Computer Vision + Machine Learning for pattern recognition and prediction.

References