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

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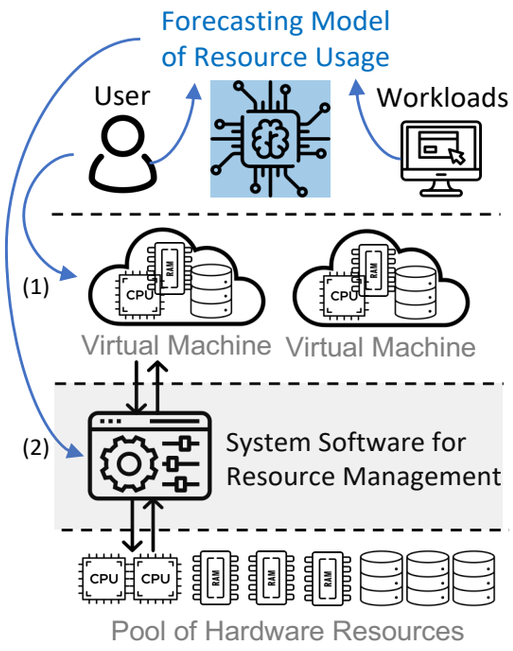
1. Problem Space



- 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

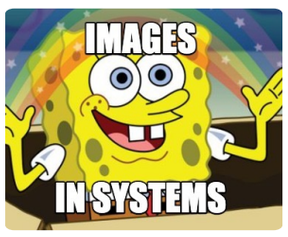
$x_0, x_1, \dots, x_t$ → LSTM-based model → $x_{t+1}, x_{t+2}, \dots, x_{t+h}$

h: forecasting horizon

Proposed Approach

$x_0, x_1, \dots, x_t$ → ConvLSTM-based model → $x_{t+1}, x_{t+2}, \dots, x_{t+h}$

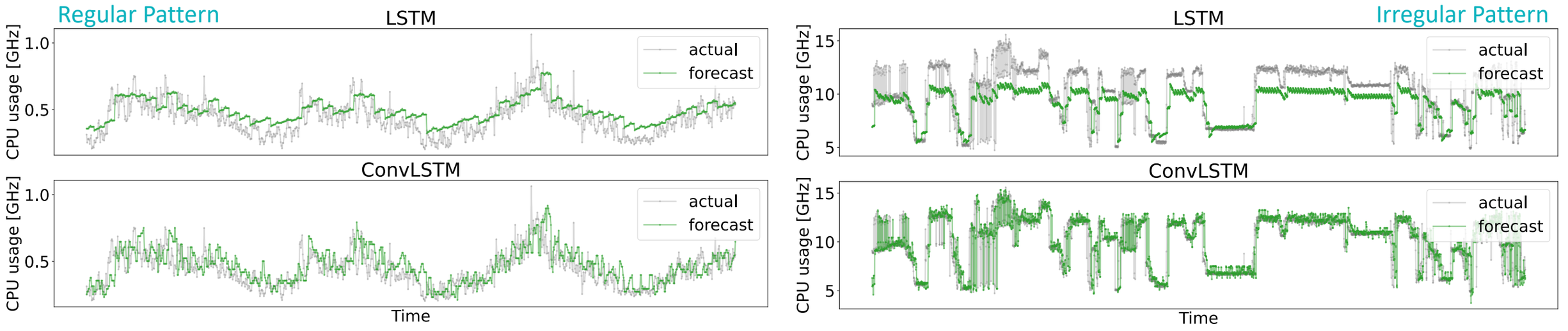
128 timesteps
black-and-white
100x128 pixels



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

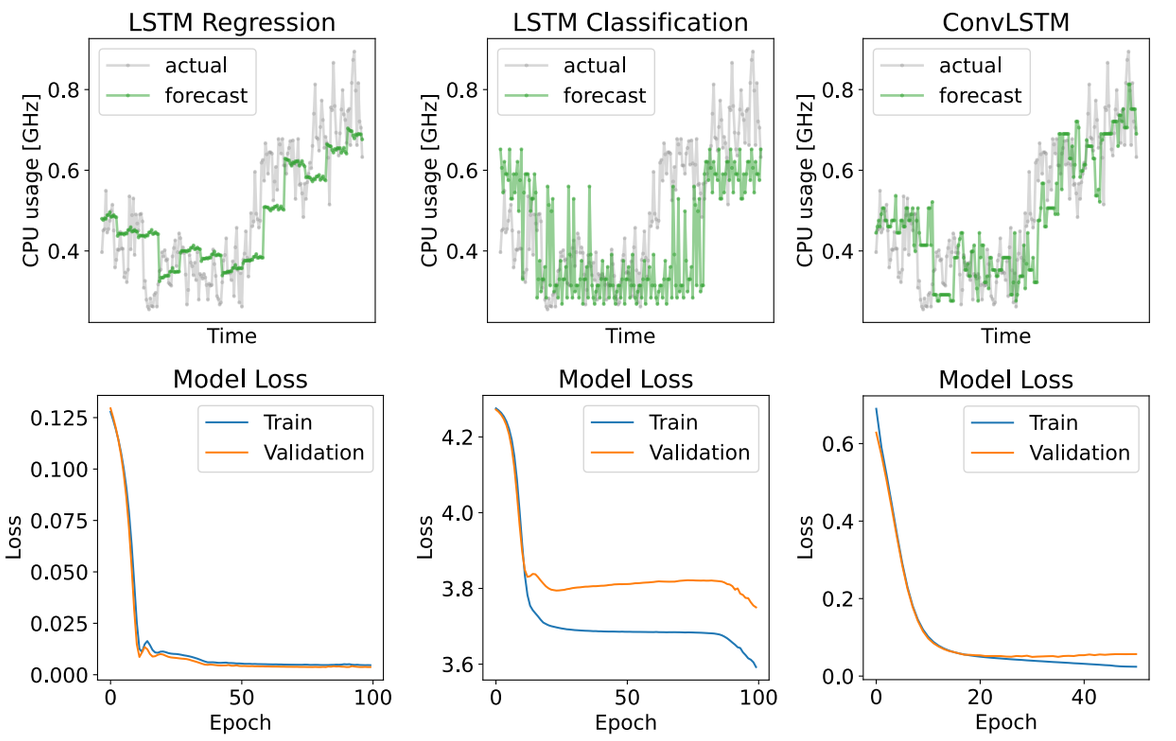
3. Evaluation

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



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

4. Why Images?

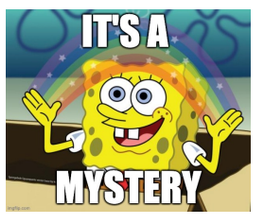


Loss function: MSE
Input: Raw Numbers

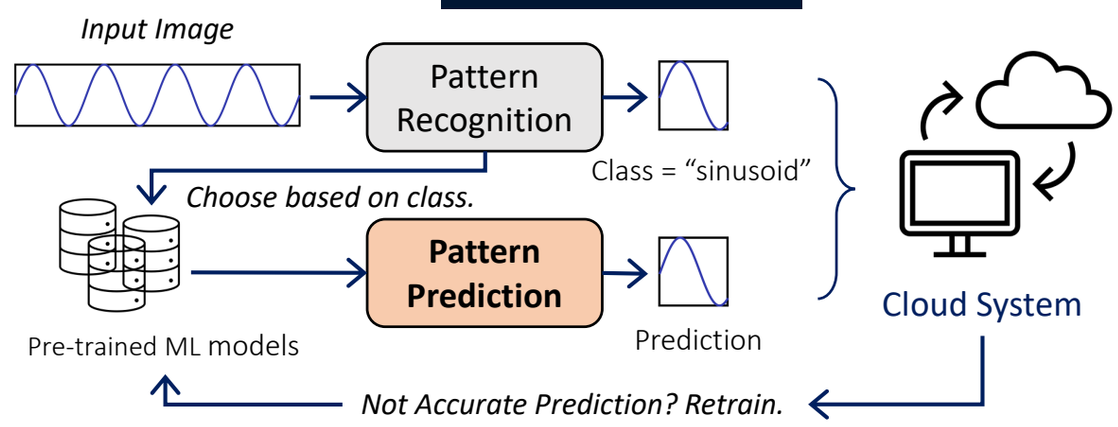
Loss: Cross Entropy
Input: Binned Numbers

Loss: Cross Entropy
Input: Images

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



5. Future Vision



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

References

- Javier Galindos Vicente. **Forecasting cloud resource utilization using Machine Learning and Computer Vision.** Master Thesis. E.T.S. de Ingenieros Informáticos (UPM).
- Thaleia Dimitra Doudali. **A Picture Is Worth a Thousand... Features! Using Computer Vision Alongside Machine Learning in Computer Systems.** Selected talk at the ASPLOS 2022 Wild and Crazy Ideas (WACI) Session, March 2022, Lausanne, Switzerland.

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Scan for Talk