Deep Learning based Changepoint Detection for Robot Learning

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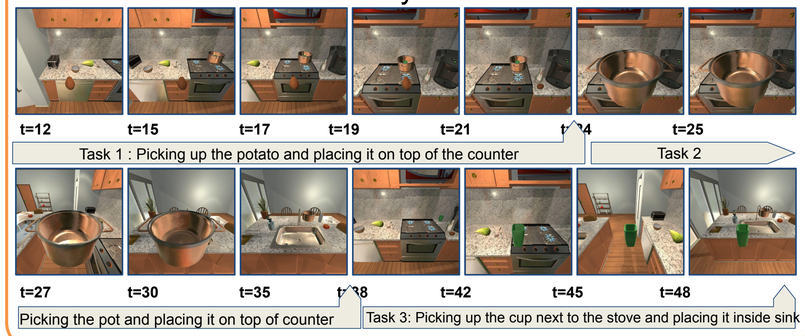
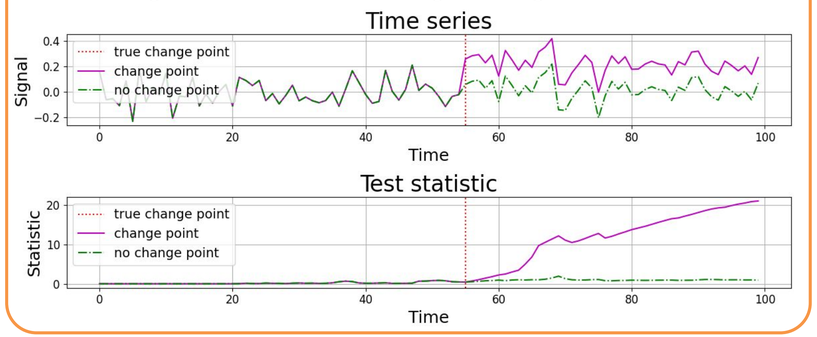
Motivation

The study focuses on breaking down long-horizon tasks for robots using changepoint detection. Robot learning is enhanced by using neural networks, a computationally efficient method not commonly used in this context.



Research Method

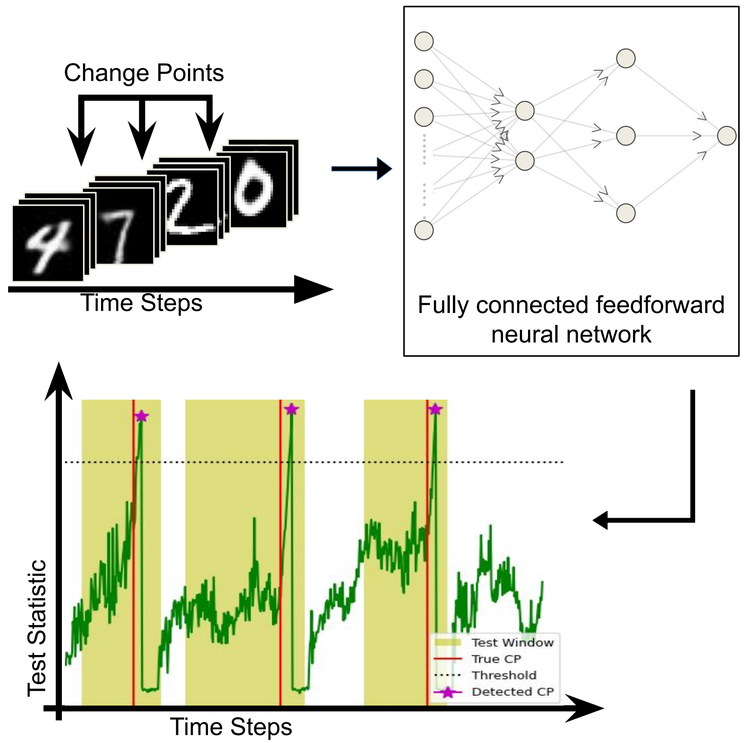
- We employ statistical testing methods to segment long-horizon tasks into manageable segments.
- By optimizing a measure between pre-change and post-change data points, confirming the statistical significance.
- This precise method reduces random fluctuations, ensuring reliable and meaningful insights.



Related Work

- Contrastive Approach to Change Point Detection[1]
- Sequential Changepoint Detection using checkpoints[2]

Architecture



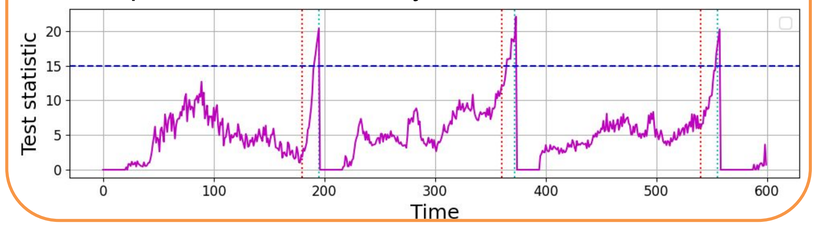
- The model analyzes data with changepoints using a two-hidden-layer neural network. Input layer size matches dataset dimensions.
- The network produces a 1D output for calculating the test statistic. Changepoints are identified when the test statistic in a specific window exceeds a threshold.

Progress

- Established the baseline results with the WISDM dataset, with the suitable statistical testing algorithm.
- Expanded the experimentation to honeyBee dataset(3D) and MNIST dataset(28x28)

Challenges

- Type I error: Mitigated by implementing a minimum threshold for test statistic
- Detection Delay: Introducing non-asymptotic bounds on the expected detection delay



Results

Dataset	False Alarm	Detection Delay
Synthetic Data	0	5.70s ± 2.40s
WISDM Dataset	5	19.64s ± 5.40s
Bee Dataset	2	41.50s ± 14.90s
MNIST Dataset	7	11.72s ± 1.60s

References

[1] Puchkin, N. and Shcherbakova, V., 2023, April. A contrastive approach to online change point detection.
[2] Titsias, M.K. et al. 2022. Sequential changepoint detection in neural networks with checkpoints.

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