DANA: Dimension-Adaptive Neural Architecture for Multivariate Sensor Data

Mohammad Malekzadeh, Richard G. Clegg, Andrea Cavallaro, and Hamed Haddadi
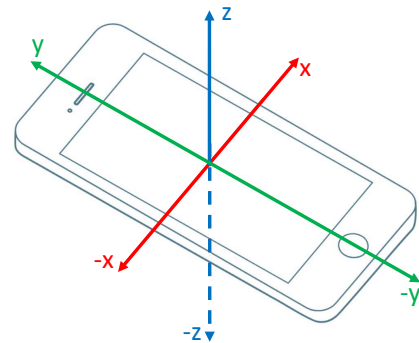
Presented by

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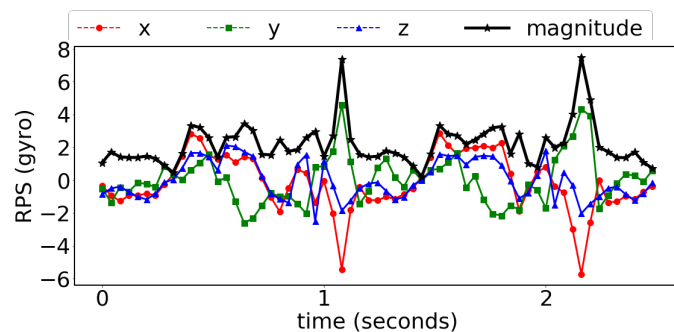
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Problem

1. Not all the **sensors** might be **available** all the time!

2. Sensors' **sampling rate** might be variable.

Sensor Data of Variable Dimensions

Reasons:
   * hardware faults
   * power saving requirements
   * heterogeneous devices
   * privacy or user's control on data sharing

Non-Adaptive Architectures

- Deep neural network (DNN) for sensor data processing:
  - *With applications in health & wellness, elderly monitoring, gaming, …*

- **These works assume fixed data dimensions at inference time!**

Basic Solutions
(to "fix" the data)

- **Data Imputation for Missing Data**
  - What data should be used?
    - Copy available sensor streams?
    - Use zeros or mean?

- **Re-Sampling**
  - Down- or Up-sampling?
  - What fixed sampling rate?
    - 5Hz? 25Hz? 50Hz?

Our Contribution

We show that existing deep neural networks can be ***transformed*** *and* ***trained*** *for* ***adaptive*** *and* ***accurate*** *performance on sensor data of variable dimensions at inference time.*
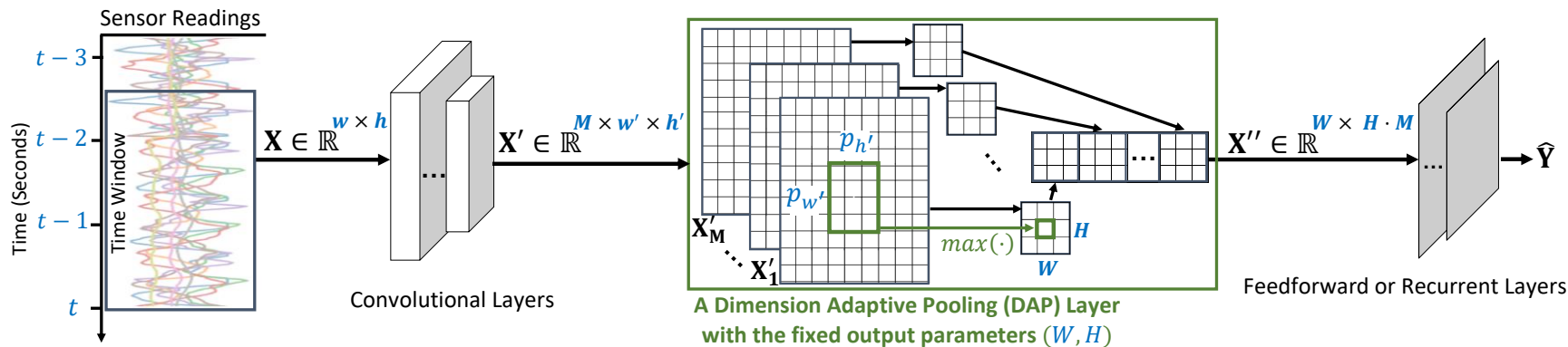
Dimension Adaptive Pooling (DAP)
+
Dimension Adaptive Training (DAT)
=
Dimension-Adaptive Neural Architecture (DANA)

Dimension Adaptive Pooling (DAP)

A Dimension Adaptive Pooling (DAP) Layer with the fixed output parameters (W, H)

Better accuracy than existing solutions

Capturing correlations among sensors

Working with both FNNs and LSTMs

Two customizable parameters **W** and **H**
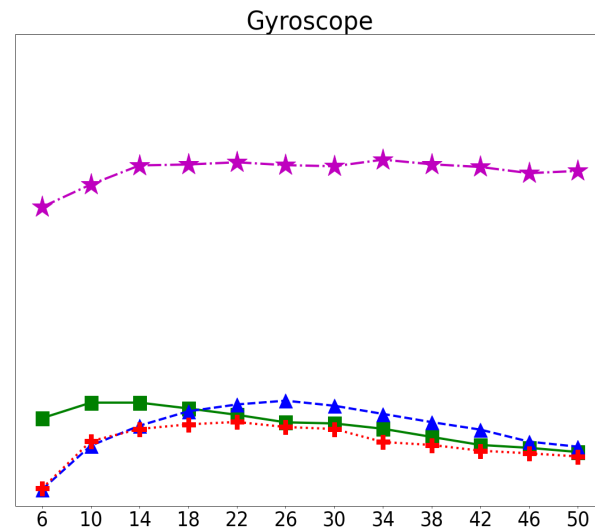
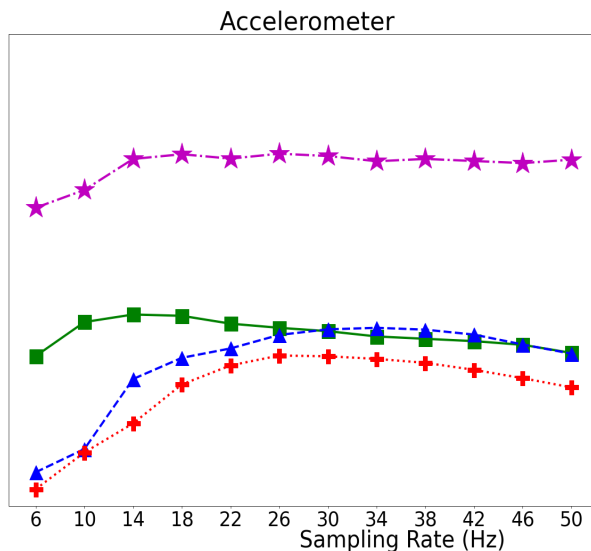No change in the model's size/parameters
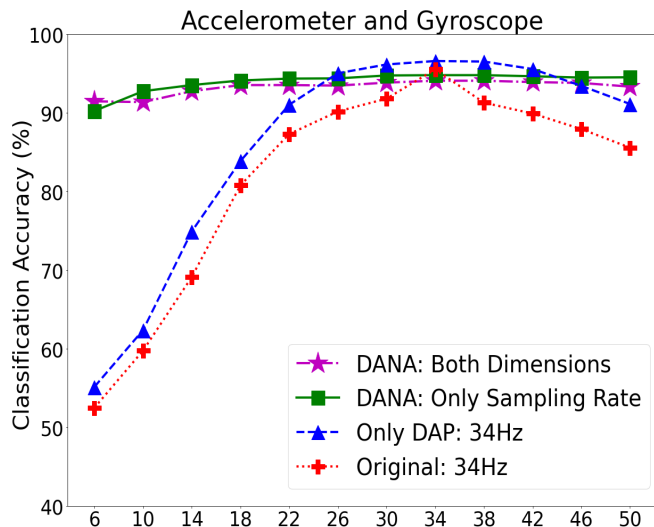
Dimension Adaptive Training (DAT)
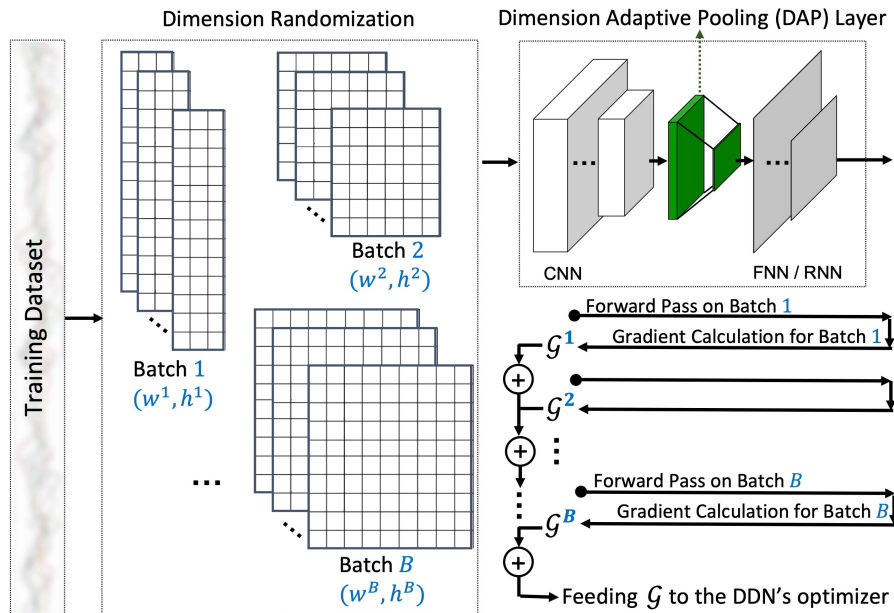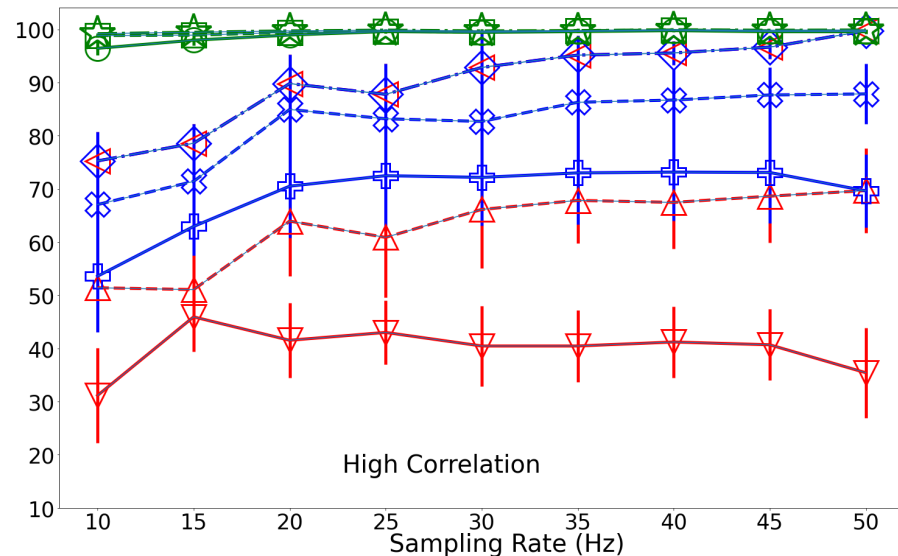

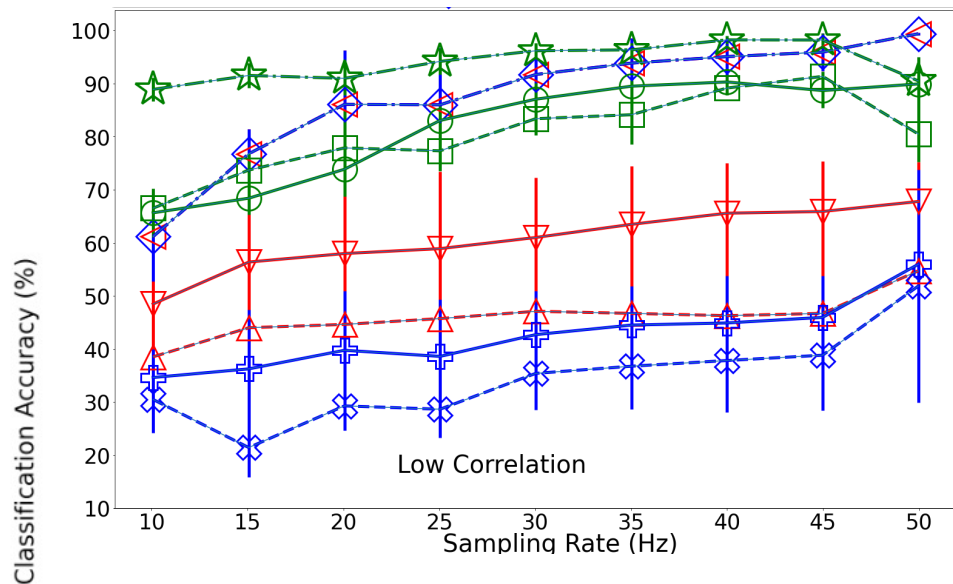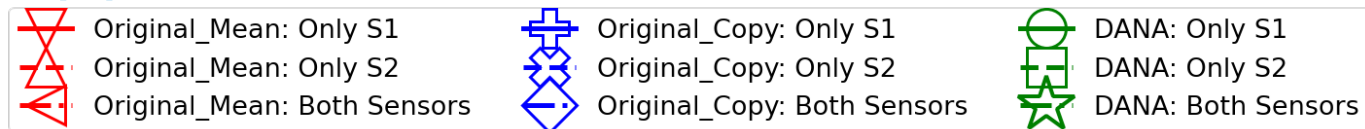More efficient than other potential training:
- Standard, weight averaging or meta-learning
- In terms of both accuracy and training time

Results (1)

DANA vs. Only DAP vs. Original Model

Results (2)

Capturing the Correlation

Thank you!

Take-away

Deep nets can be **transformed** and **trained** for **reliable** and **accurate** performance on sensor data of **variable dimensions** at inference time.

Code and Tutorials:

github.com/mmalekzadeh/dana

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