7th International Electronic Conference on Sensors and Applications

ADAPTATION AND SELECTION TECHNIQUES BASED ON DEEP LEARNING FOR HUMAN ACTIVITY RECOGNITION USING INERTIAL SENSORS

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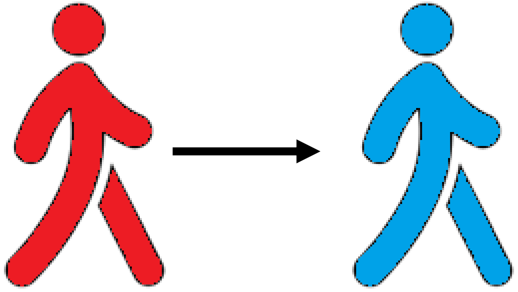
Introduction

- Human Activity Recognition (HAR)
  - Recognize different activities performed by a person
- Challenge: training and testing with different subjects (LOSO)
- Each user presents unique movement patterns not easily generalizable
- This work
  - Unsupervised learning adaptation techniques for HAR

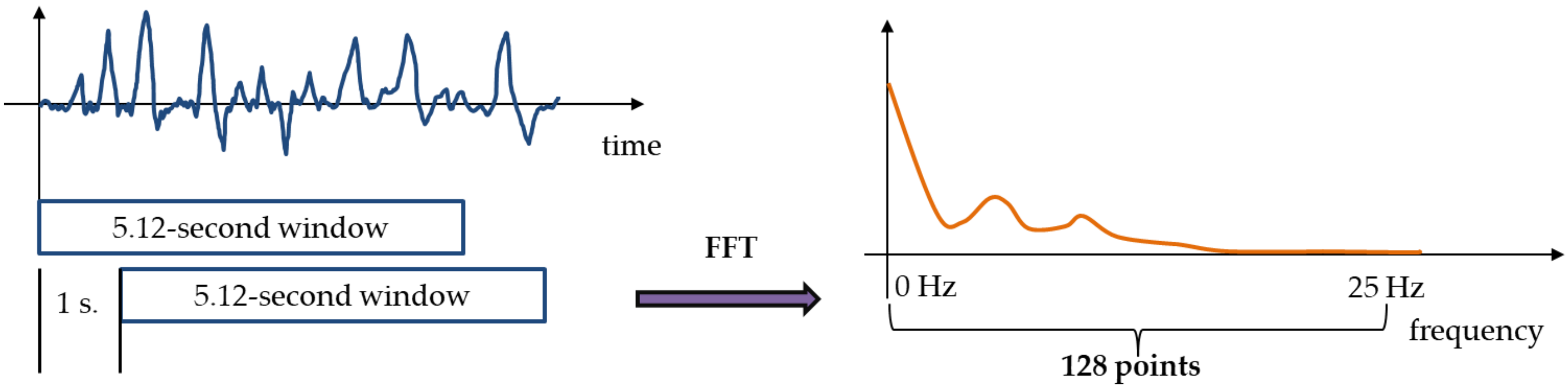


Dataset description

- PAMAP2 database
  - 12 physical activities, 9 subjects
  - 3 IMUs in hand, chest and ankle
  - Accelerometer sampling at 100 Hz

Signal processing

- Fast Fourier Transform (FFT) of acceleration signals
  - 5.12-second windows separated by 1 second
  - 128 points represent 0-25Hz frequency range

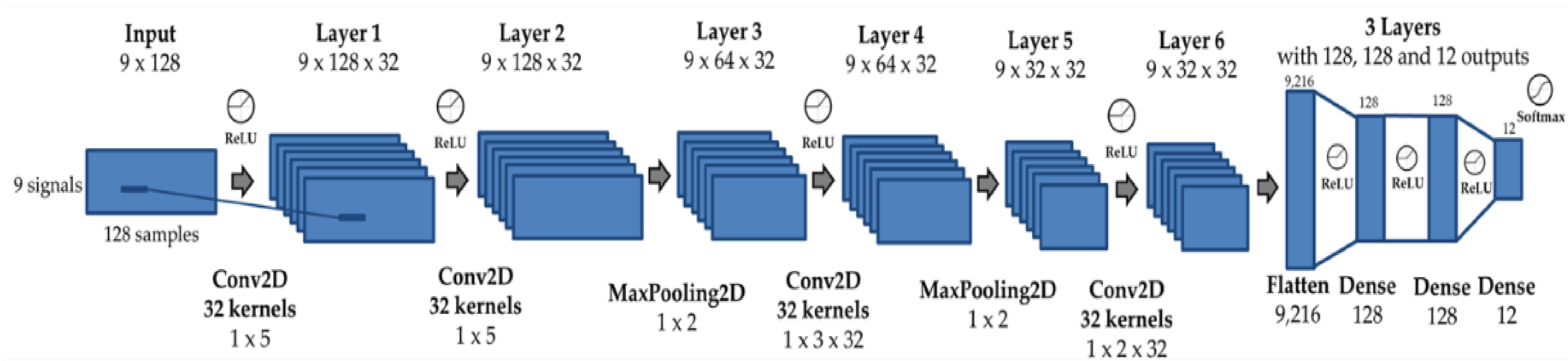


Time domain: 5.12-second windows of raw data

Frequency domain: spectrum of 5.12-second windows

Deep learning architecture baseline

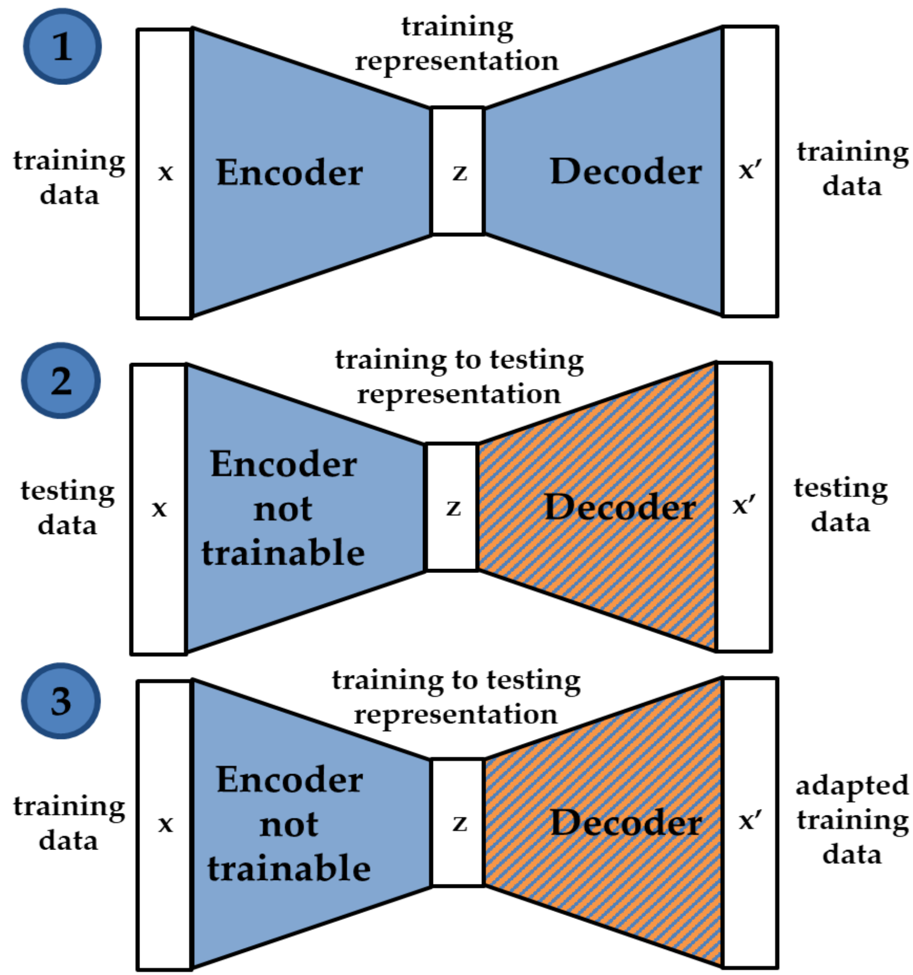
- Deep learning architecture composed of four convolutional and two max-pooling layers as baseline



- Baseline configuration
  - Dropout layers
  - ReLU activation function
  - RMS optimizer

Autoencoders

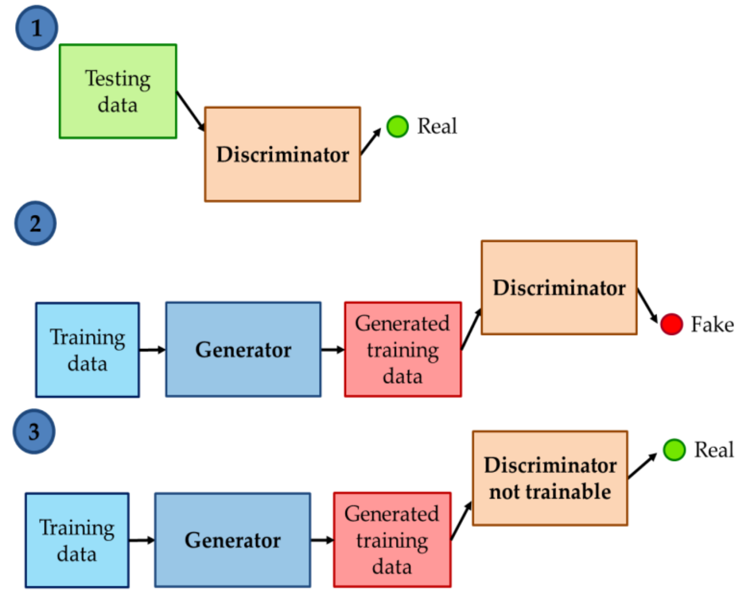
- Adaptation process:
  1. Autoencoder trained with training data.
  2. Decoder replaced and encoder not trainable. Decoder is trained with testing data.
  3. Training data could be transformed to the testing domain: adapted training data.



- Selection process:
  – value $_{\text{RMS - adapted data}} >= \mu_{\text{RMS - adapted data}} + \gamma * \sigma_{\text{RMS - adapted data}}$

Generative Adversarial Networks (GANs)

- Adaptation process:
  1. Discriminator is trained with testing data (real).
  2. Random training data (fake) is processed through the generator and its output is processed through the discriminator.
  3. GAN is trained with training data with discriminator not trainable. Generator cheats the discriminator with generated examples similar to testing data.



- Selection process with generator:
  - $\text{value}_{\text{RMS - adapted data}} >= \mu_{\text{RMS - adapted data}} + \gamma * \sigma_{\text{RMS - adapted data}}$
- Selection process with discriminator:
  - $\text{value}_{\text{discriminator output}} < \mu_{\text{discriminator output}} - \gamma * \sigma_{\text{discriminator output}}$

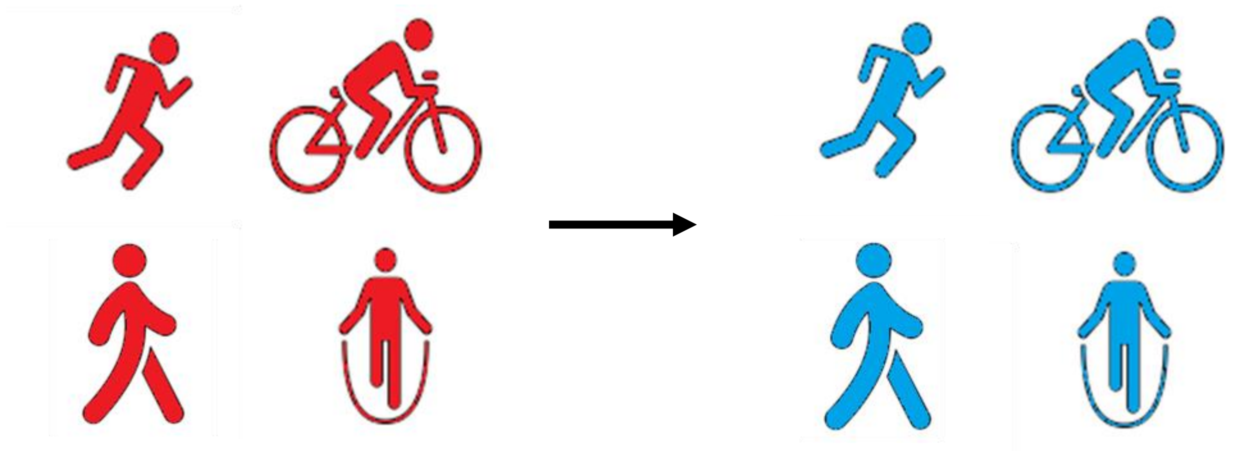
Results

- Activity classification accuracy and confidence intervals.
  - Significant improvement and deterioration highlighted in green and red, respectively. No color when no statistical difference.

Experiment		Subject									
		101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**All**
Baseline	Acc (%)	86.34	87.93	85.91	89.76	87.69	85.15	92.04	87.61	96.88	87.85
	CI (±%)	1.35	1.24	1.63	1.23	1.23	1.39	1.10	1.26	4.26	0.46
Adapt. Auto.	Acc (%)	86.26	82.88	89.23	93.35	87.36	86.23	91.91	90.62	93.75	**88.36**
	CI (±%)	1.35	1.44	1.45	1.02	1.25	1.35	1.11	1.12	5.93	0.45
Select. Auto.	Acc (%)	86.50	87.17	88.95	91.45	88.06	85.83	92.65	92.30	87.50	**89.06**
	CI (±%)	1.34	1.28	1.47	1.14	1.22	1.37	1.06	1.02	8.10	0.44
Select. GAN Gen.	Acc (%)	85.58	85.84	90.38	90.15	88.39	88.04	92.04	91.69	98.44	**88.94**
	CI (±%)	1.38	1.33	1.38	1.21	1.20	1.27	1.10	1.06	3.04	0.44
Select. GAN Discr.	Acc (%)	87.46	88.99	87.57	84.45	89.75	86.79	93.08	90.62	96.88	**88.68**
	CI (±%)	1.30	1.19	1.55	1.48	1.14	1.33	1.03	1.12	4.26	0.45

Discussion and conclusions

- Adaptation for HAR is a very difficult task.
- Selection approaches could remove from training data the examples that differ from testing domain and improve the general performance of the system.
- Unsupervised learning adaptation approaches could pave the way for future research on domain adaptation in HAR.



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THANK YOU FOR YOUR ATTENTION

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