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Domain Adaptation for Human Activity Recognition of Parkinson's disease Patients

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FAU I-SENSE REU Scholar 2022

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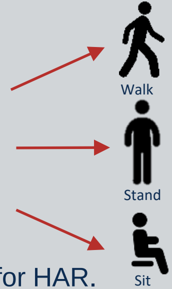
Background

- Human activity recognition (HAR) uses machine learning to classify data acquired by wearable sensors into activities
- Parkinson's Disease (PD) diagnosis and prognosis can be improved with HAR



a) A smartwatch can collect data for HAR.

b)

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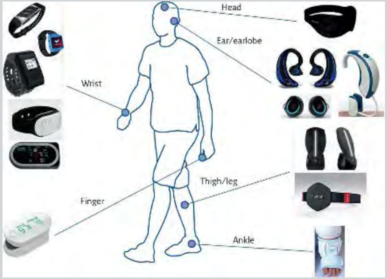
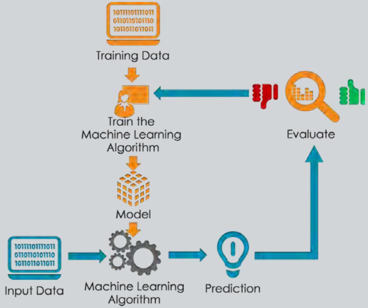
www.micro.ai.com
www.my.clevelandclinic.org

HAR Challenges

- Various sensor types, placements on body, activity variability between people
- Minimal PD patient sensor data publicly available



a) Example of sensor placements. Various placements make it difficult to generalize a machine learning model.



b) Machine learning pipeline. A large amount of training data is needed for a successful model.

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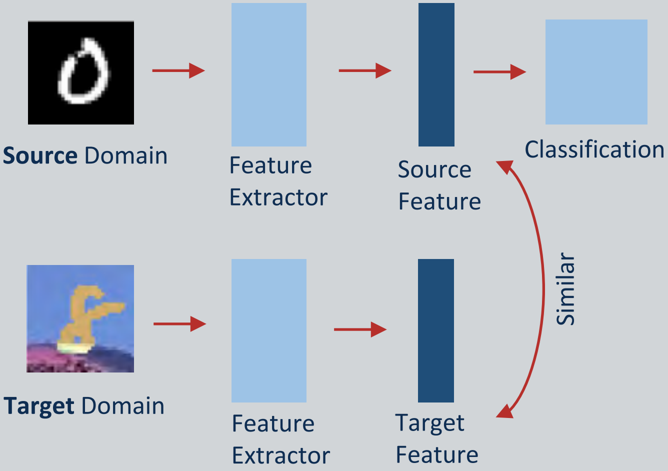
www.intellipaat.com
www.breathe.ersjournals.com

Project Aim

Accurately classify the motion data of PD patients into activities of daily living using domain adaptation

Domain Adaptation (DA)

- A way to address the domain shift between datasets



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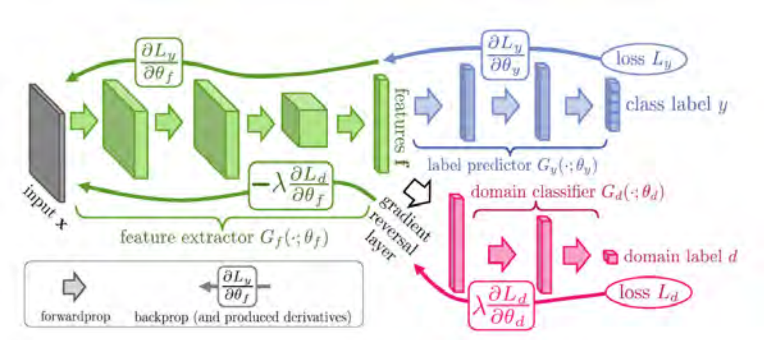
https://paperswithcode.com

Methodology - DANN

- Discriminative Adversarial Neural Network (DANN)
  - Aims to obtain features that are domain invariant
  - Goal is to minimize classification loss (Ly) and maximize discriminator loss (Ld)



a) DANN architecture

https://arxiv.org/pdf/1409.7495.pdf

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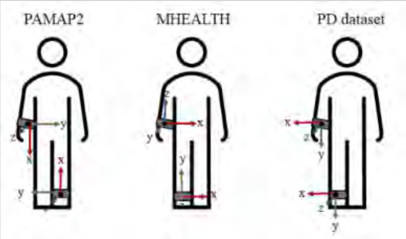
Methodology - Data

	MHEALTH	PAMAP2	PD
Sensor Placements	Chest, RW, LA	Chest, dominant side wrist/ankle	Wrist/ankle of most affected side
# Subjects	10	9	14
# Activities	12	18	8
Frequency	50 Hz	100 Hz	128 Hz
Acceleration Units	m/s^2	m/s^2	Standard gravity

a) Raw dataset summary before preprocessing

Label	Healthy Activity	PD Activity
0	Standing	Standing
1	Sitting	Sitting
2	Lying	-
3	Walking	Walking
4	Climbing stairs	-
5	Cycling	-
6	Running	-

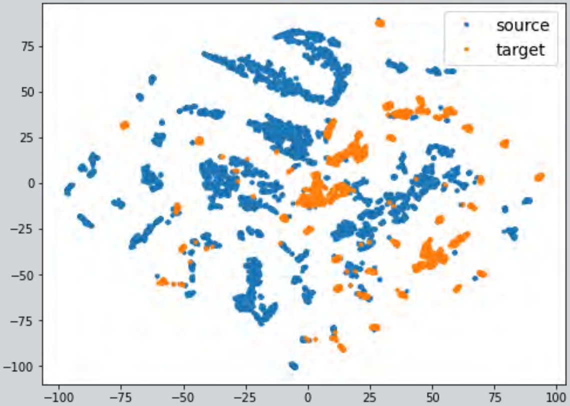
b) Mapping to common activities



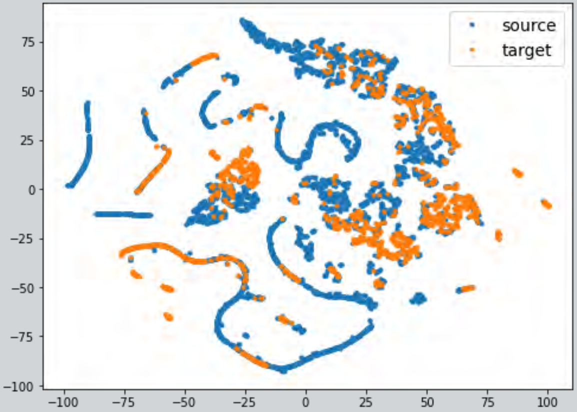
c) Axes before reorientation

Results – PAMAP2 to reoriented MHEALTH

Encoded Space tSNE for the Source Only model
(Without DA)



Encoded Space tSNE for the DANN model
(With DA)



Training: PAMAP2
Cross test: reoriented MHEALTH

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Source: PAMAP2
Target: reoriented MHEALTH

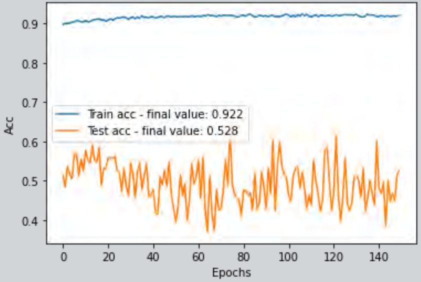
Results – PAMAP2 to reoriented MHEALTH

(averaged over 7 activities)	Without DA	**With DA**
Accuracy	48.9%	**70.7%**
Recall	48.9%	**70.7%**
Precision	63.8%	**64.1%**
F1	45.0%	**65.1%**
AUC	84.0%	**95.9%**

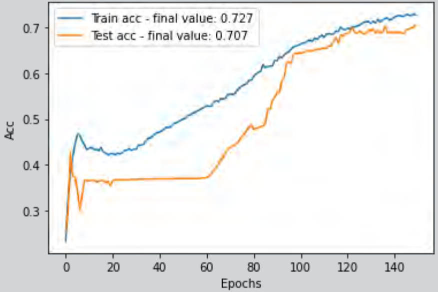
All metrics improve when DA is applied

Accuracy = (correct predictions / total predictions) * 100
Recall = TP / (TP + FN)
Precision = TP / (TP + FP)
F1 = harmonic mean of recall and precision
AUC = area under ROC curve

Without DA



With DA



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Conclusions and Future Work

- DANN is a valuable DA method
- Data augmentation exploration
- Next step is to apply DANN to PD data
  - Challenge of greater domain shift

Any questions?

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