Deriving Effective Human Activity Recognition Systems Through Objective Task Complexity Assessment

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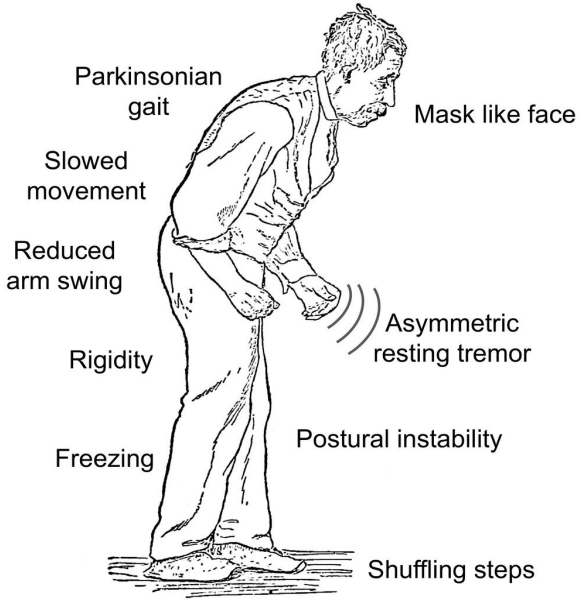
GT UBICOMP

HAR TASK: ASSESSMENT OF PARKINSON'S DISEASE (PD)

- Application driven - clinical assessment
- Stakeholders - clinicians; health practitioners
- HAR solutions - detect relevant disease states; pilot studies
- Resources - data collection, annotations, ML and HCI researchers



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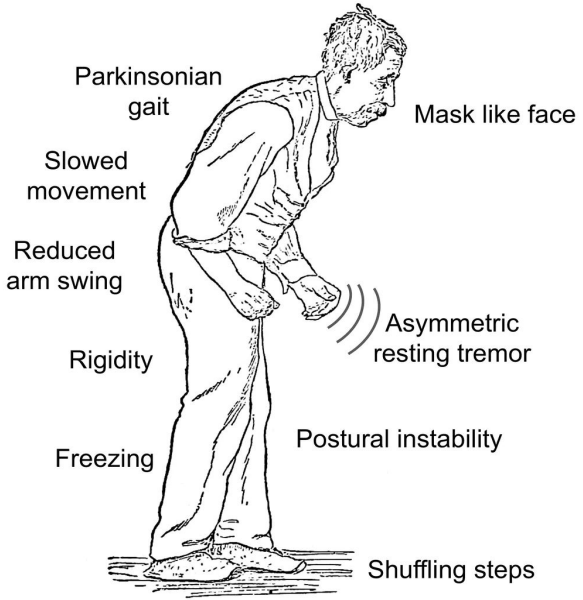

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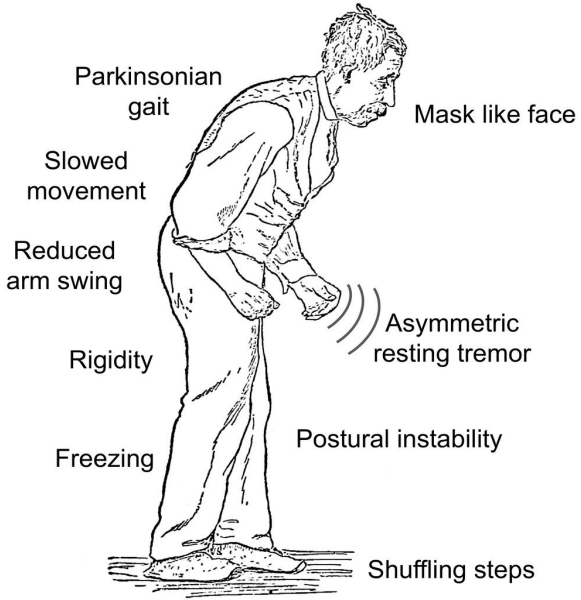

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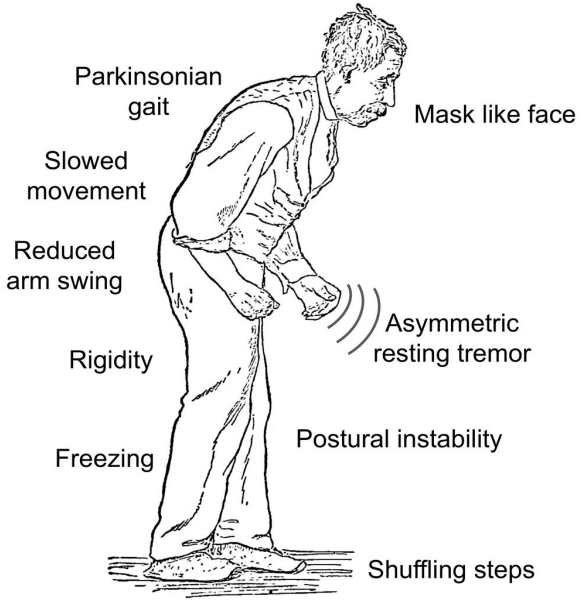

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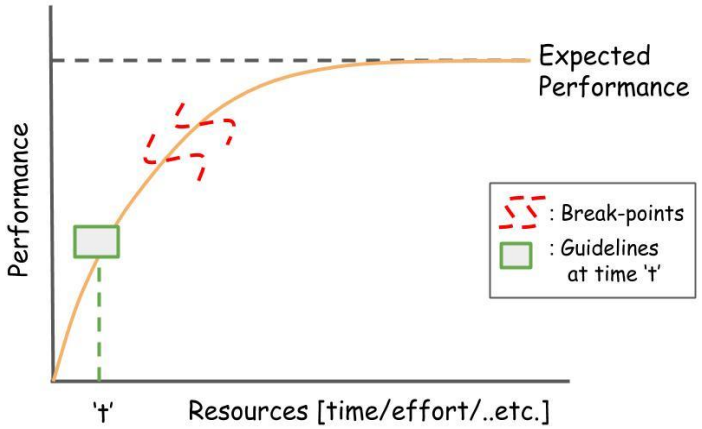
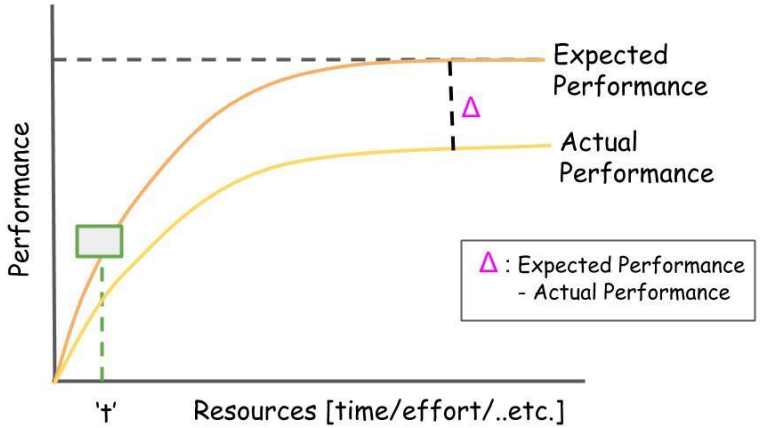
HAR DEPLOYMENT SCENARIOS



(1) Scenario 1: Expected HAR performance can be achieved but is unclear what resources are required



(2) Scenario 2: Even with unlimited resources the expected HAR performance can never be achieved

Possible outcome scenarios for practitioner-based HAR deployments

OBJECTIVE TASK COMPLEXITY ASSESSMENT

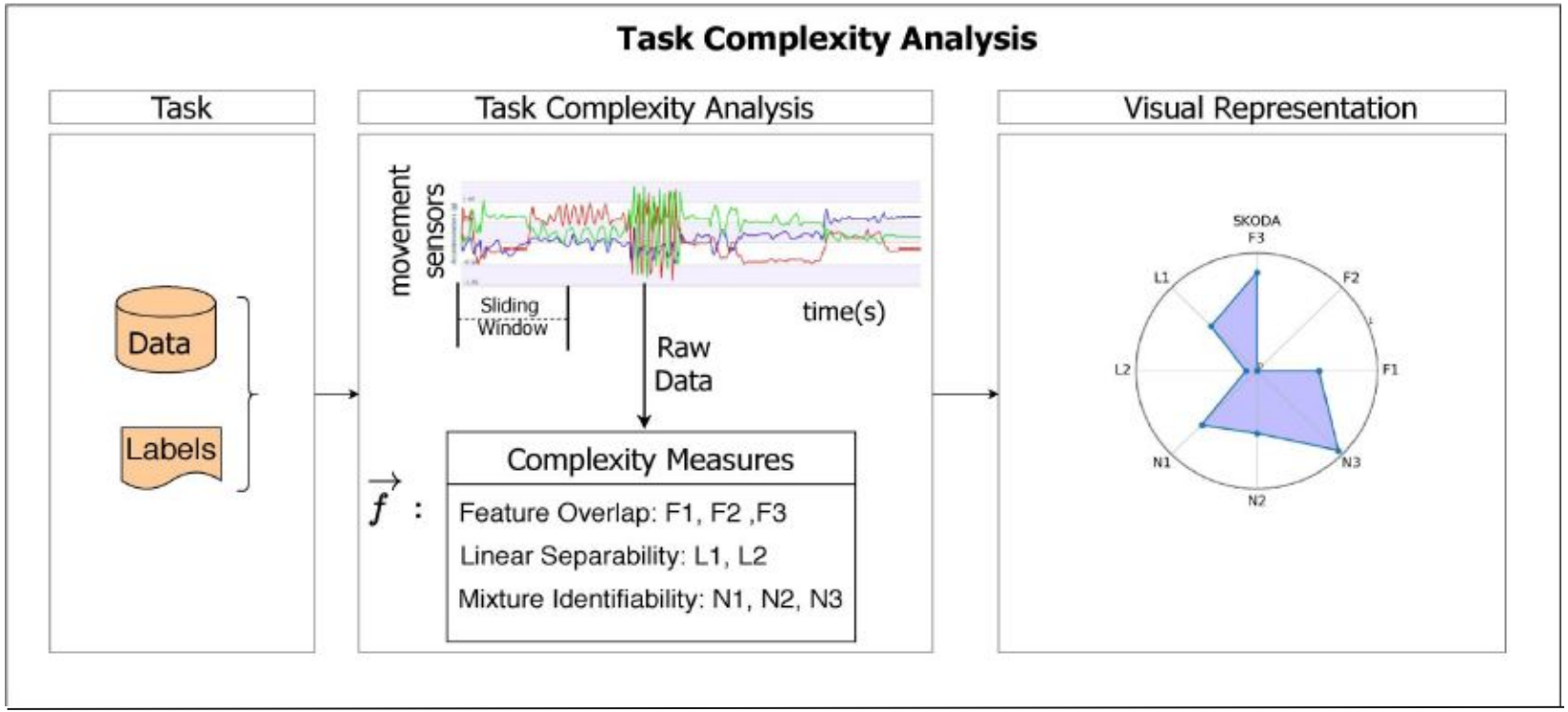
Inform Practitioners:

- Assess challenges associated with a task
- Provide performance estimates *before* solving the task

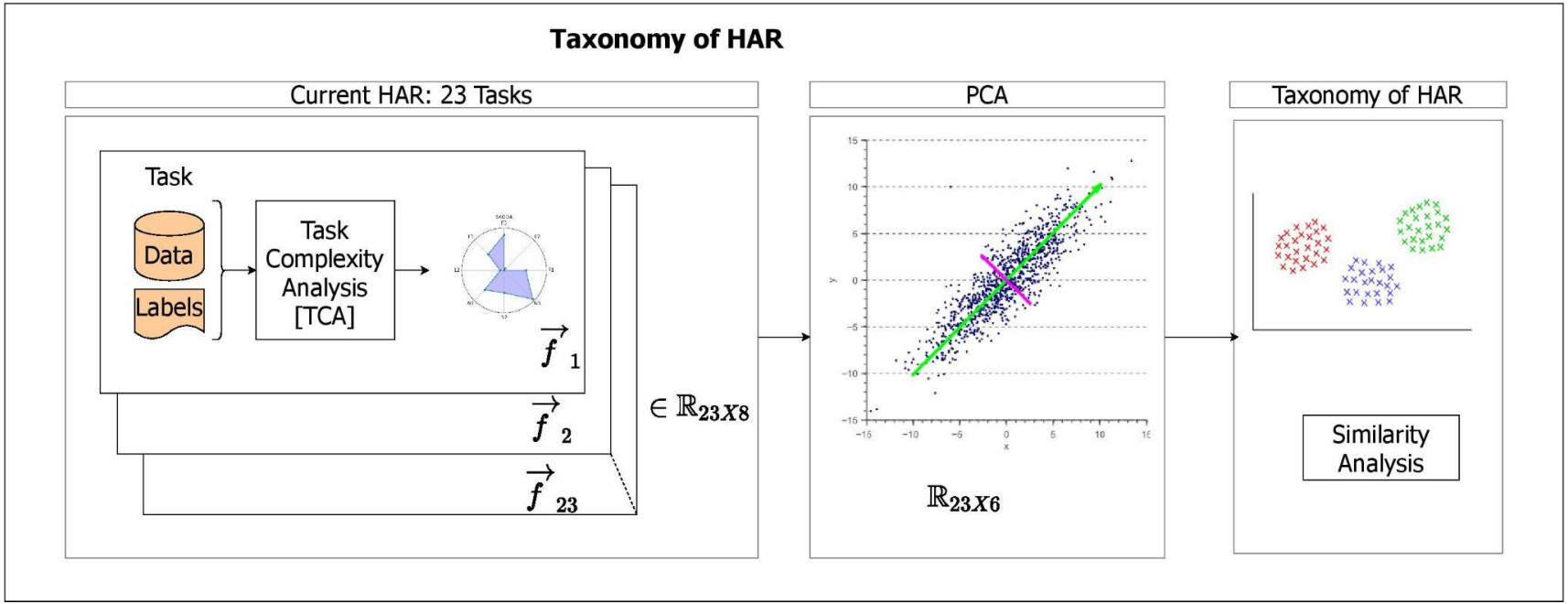
Systematic Approach:

- Complexity of a task
- Provide guidelines for HAR systems

TASK COMPLEXITY BASED CHARACTERIZATION OF HAR TASK



TASK COMPLEXITY BASED CATEGORIZATION OF HAR TASKS



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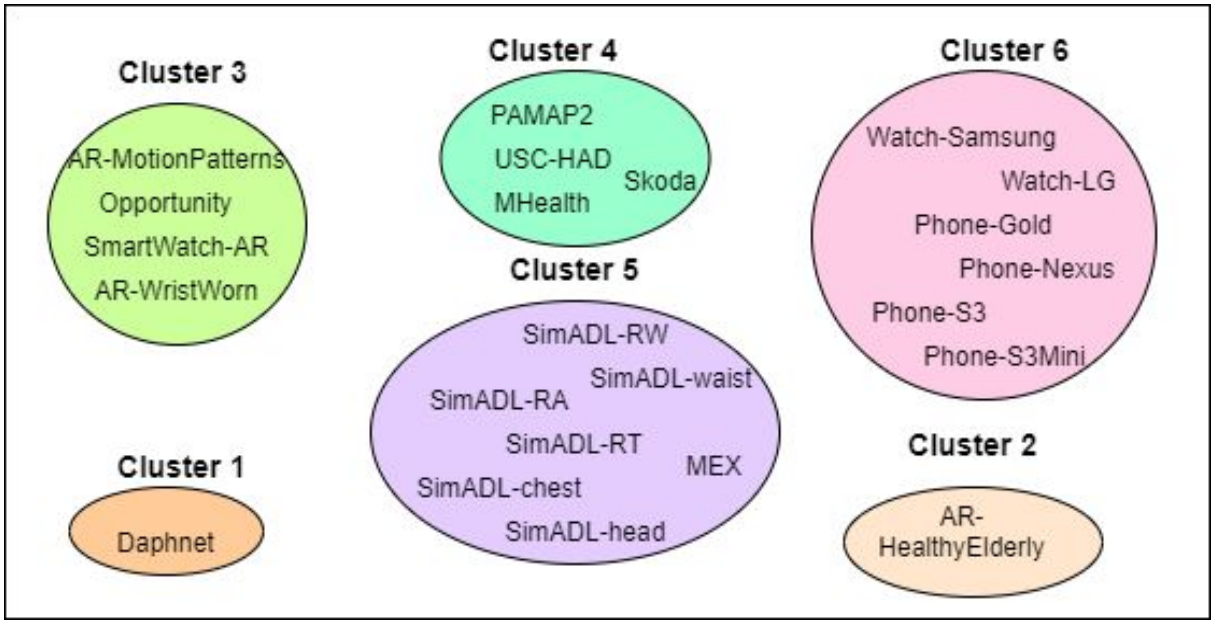
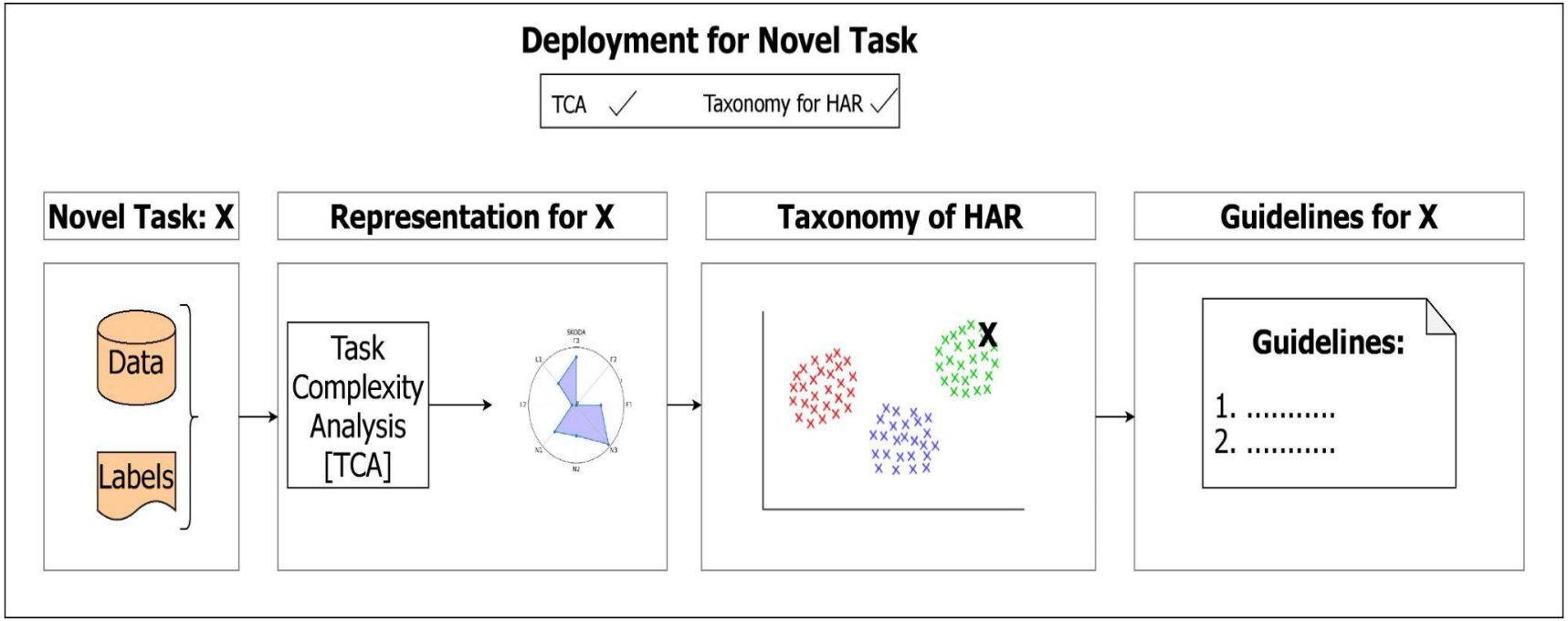


TASK COMPLEXITY BASED DEPLOYMENT FOR NOVEL TASK



TASK COMPLEXITY BASED DEPLOYMENT FOR NOVEL TASK

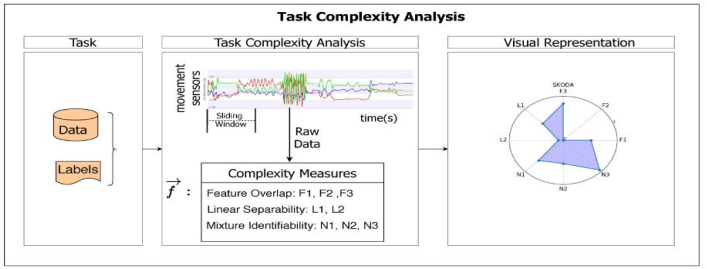
Task	Baseline Configuration	Optimized Configuration	F1-score
Phone-S3 Mini	1-sec sliding window; 50% overlap; raw data; linear classifier (SVM)	2-sec sliding window; 50% overlap; ECDF features; non-linear -classifier (RF).	34.8 → 88.7
SimADL-waist	1-sec sliding window; 50% overlap; raw data; linear classifier (SVM)	5-sec sliding window; 3-sec overlap; DCT as features; instance-based (KNN) classifier.	17.7 → 20.5
Daphnet	1-sec sliding window; 50% overlap; raw data; linear classifier (SVM)	no dataset to derive SOA techniques from; will require technical expertise if performance obtained using baseline is sub-par.	54.1 → N/A

14 tasks

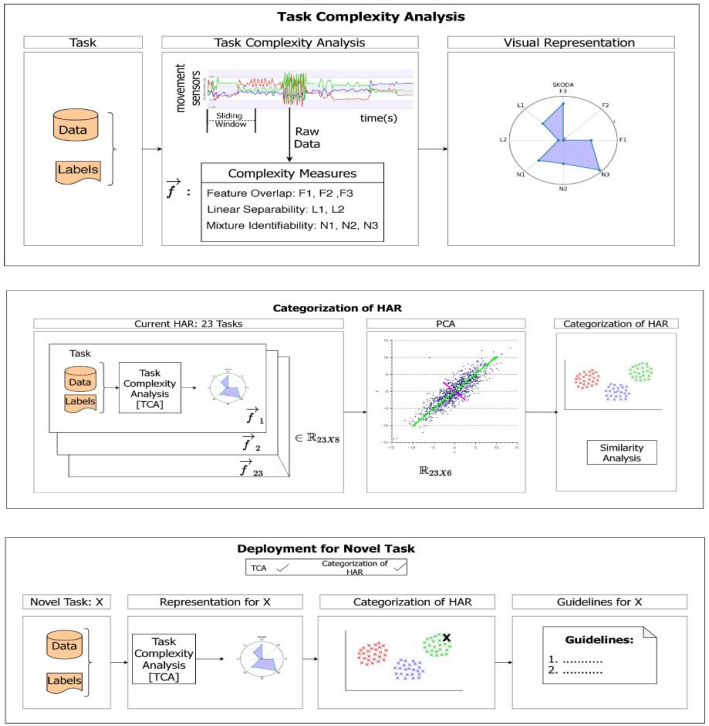
6 tasks

3 tasks

CONCLUSION

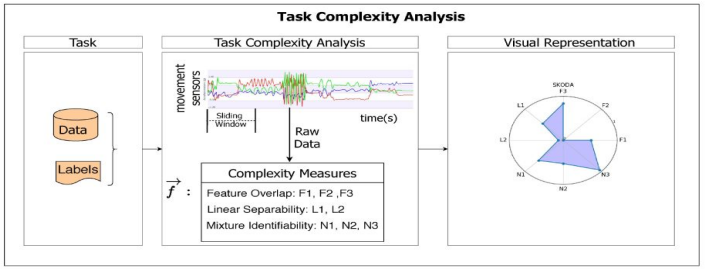

Task Complexity Analysis
Task
Task Complexity Analysis
Visual Representation
movement sensors
Sliding Window
time(s)
Raw Data
Data
Labels
Complexity Measures
Feature Overlap: F1, F2 ,F3
Linear Separability: L1, L2
Mixture Identifiability: N1, N2, N3
Categorization of HAR
Current HAR: 23 Tasks
PCA
Categorization of HAR
Task
Task Complexity Analysis [TCA]
Similarity Analysis
Deployment for Novel Task
TCA
Categorization of HAR
Novel Task: X
Representation for X
Categorization of HAR
Guidelines for X
Guidelines:
1. .....
2. .....

CONCLUSION



Characterize a task using complexity measures

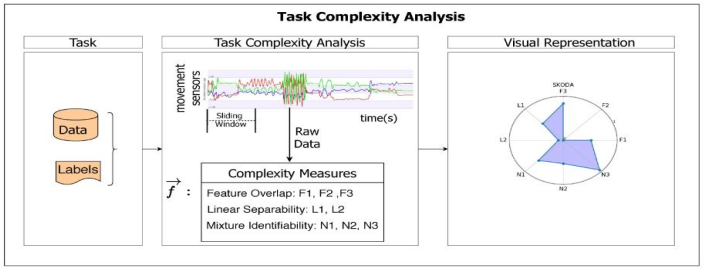
CONCLUSION

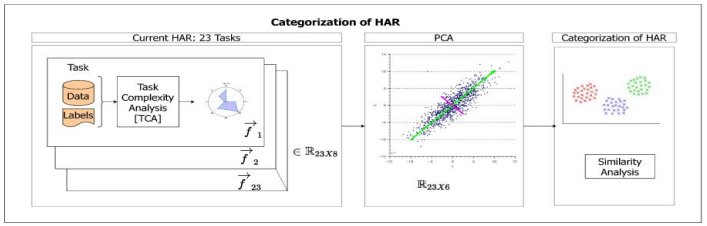


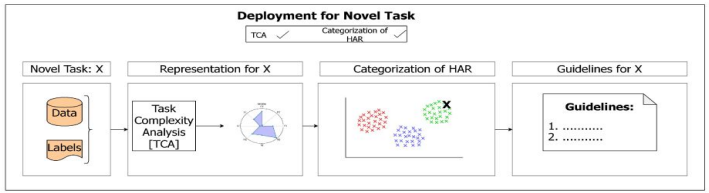
Characterize a task using complexity measures

Categorize tasks using similarity mapping

CONCLUSION







Characterize a task using complexity measures

Categorize tasks using similarity mapping

Guidelines for novel task