#6 - Clustering Cardiopulmonary Exercise Tests Results for Personalized E-bike Training

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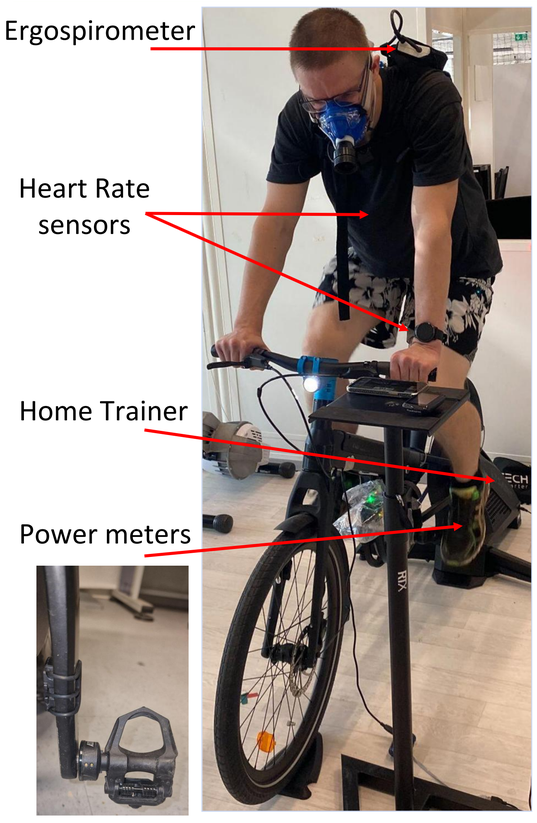
INTRODUCTION



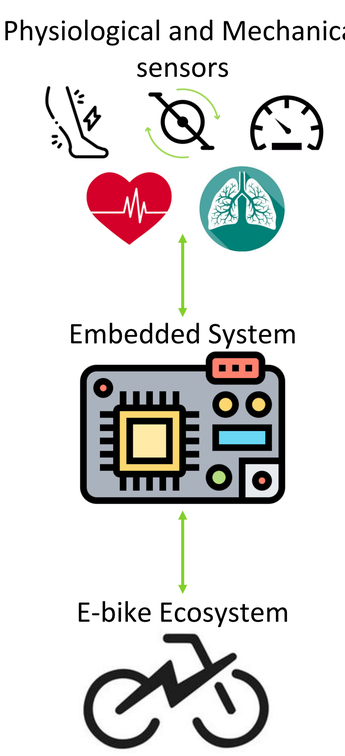
CEPT Tests Setup

Cardiopulmonary Exercise Tests (CPET) are frequently performed in medical and sports centers to assess the efficiency and limitations of the cardiorespiratory system, particularly in oxygen delivery [1].

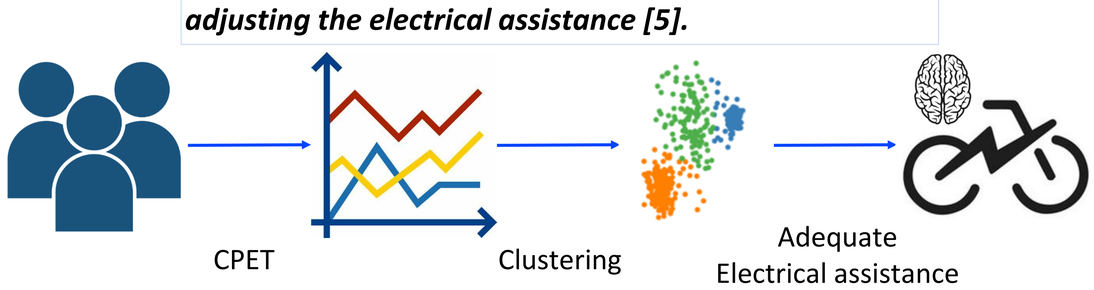
CPET provides healthcare professionals with the means to diagnose and identify diseases linked to the cardiopulmonary system. Addressing these conditions early can help to prevent chronic non-communicable diseases [2-3].

E-bikes, also known as electric bikes, promote physical activity by integrating exercise into everyday travel. They make it more accessible for individuals with lower physical fitness levels to ride comfortably.

In earlier research [4], we examined e-bike systems that regulate electrical assistance according to physiological parameters to balance the rider's perceived effort.



Combining these facts led to the hypothesis of searching for specific markers in the population of e-bike users using the results of CPET tests. By analyzing these markers, individuals could be classified into different groups, enabling personalized training by adjusting the electrical assistance [5].



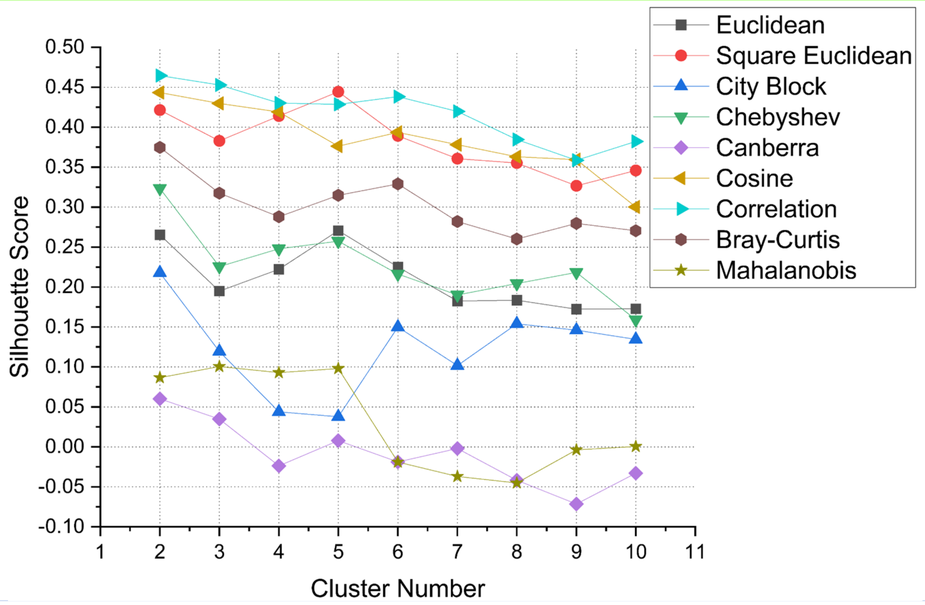
MATERIALS AND METHOD

Metamax 3B-R2 ergospirometer

Pythron Library

- Data Recollection and Preprocessing
  - 232 Men and Women CEPT Tests
  - Centering data at VO_2max
  - Z-Score Standardization
- Dimensionality Reduction
  - Principal Components Analysis
- Clustering Algorithms Evaluation
  - Elbow method
  - Silhouette method
  - Information criteria (AIC - BIC)
- Unsupervised Learning Algorithms
  - Kmeans (Exclusive)
  - Fuzzy C-means (Overlapping)
  - Gaussian Mixture Models (Probability)

RESULTS AND DISCUSSION



The best results were obtained using the Fuzzy C-means algorithm along with the Correlation distance metric. For our database, the optimal number of clusters was found to be 2 in each women's and men's dataset. More data is needed to validate this number of clusters further. We formulate the hypothesis that with a bigger dataset, it is possible to refine the population into more clusters and thus propose to each of them a suitable control algorithm for their e-bike.

CONCLUSIONS

Using clustering algorithms, we aim to determine the optimal number of clusters for a given population. The ultimate objective is to develop a better-suited control algorithm for a smart health e-bikes system [5]. Achieving this will require a larger database to obtain a more accurate representation of the population. With the optimal number of clusters identified, we intend to extract the relevant features that will enable the classification of a new individual, providing them with the appropriate control algorithm for the e-bike's electrical assistance. That will be the objective of future works.

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