Project CEED 2024-25

M.Sc. in Informatics and Computing Engineering (M.EIC), 2nd Year

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Outline

- kNN Machine Learning Algorithm
- kNN for Classification
- kNN Code Provided
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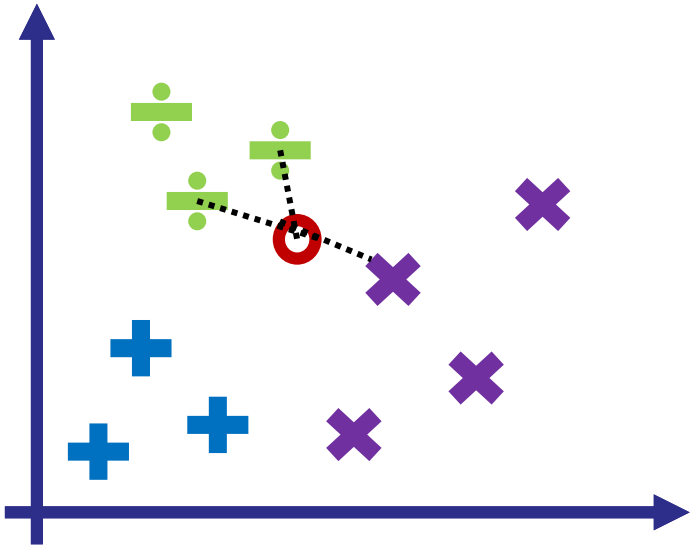
kNN Machine Learning Algorithm

- Supervised machine learning algorithm
  - Used for regression and for classification
  - Simple and based on the K nearest neighborhoods
  - Scalability problems as it requires the calculation of the distances of the instance to classify to every instance in the training set (knowledge base)
- Lazy training algorithm
  - Training set is stored and no model is built from the training set
  - => Neglected overhead for online/incremental learning
- There are optimization schemes for kNN that:
  - Represent the knowledge base in data structures (e.g., KD-tree) that make the classification/regression more efficient
  - Provide implementations of approximate kNN (i.e., kNN that may not give results based on the true k NNs)
  - For both see, e.g., Cunningham and Delany, ACM CSUR, 2021)

kNN Algorithm for Classification

- Giving an instance to classify, the algorithm infers/outputs a class for that instance
- Example with vectors with two features (2D space), K=3, 10 instances in the training dataset, and 3 classes:



Instance to classify

Training instance of class A

Training instance of class B

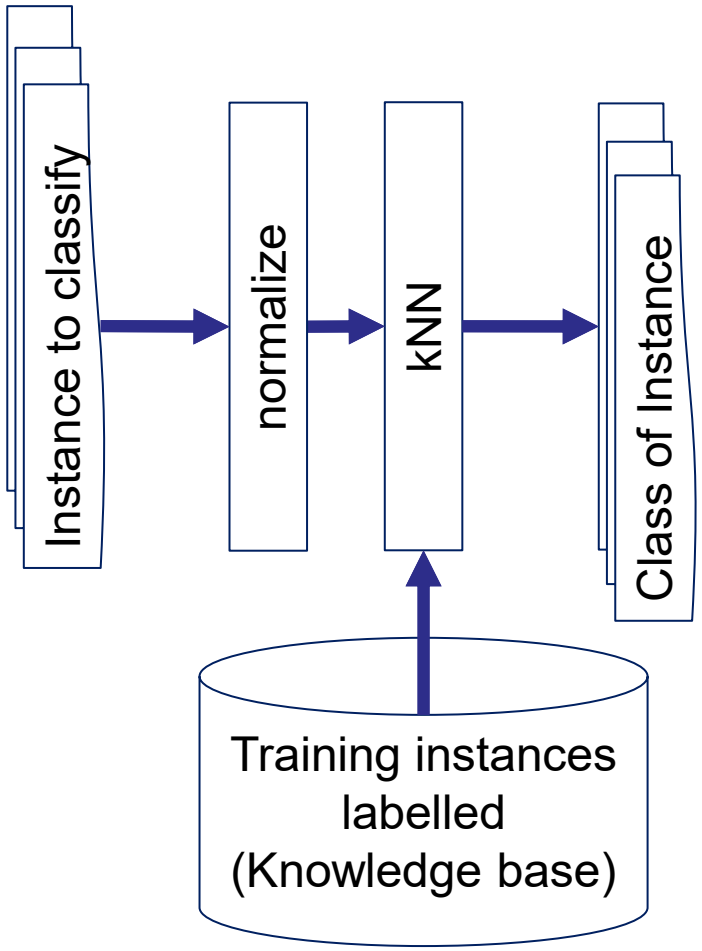
Training instance of class C

Answer: Instance is of class B

kNN Code Provided

- C code of a possible implementation of the typical kNN
- Distance calculations use the Euclidean distance
- The implementation is targeting a HAR (Human-Activity Recognition) system for embedded devices and provides data for testing
- Code includes a couple of scenarios, including the training and the testing datasets
- The implementation does not consider the noise reduction and extraction of features typically needed in this kind of HAR systems

kNN Code Structure



- Main includes the outer loop that input the instance to classify to kNN, and kNN returns the inferred class of the instance
- Each instance is represented as a *Point* struct which includes the vector of features
- Prototype of the knn function: *knn_classifyinstance(Point new_point, int k, int num_classes, Point *known_points, int num_points, int num_features);*

Project Goals

- Accelerate the kNN implementation by code optimizations/transformations and by using hardware accelerators
- In the end:
  - Report about the work done and analysis of the intermediate and final results
  - Presentation and discussion of the project

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