An Edge-Centric Ensemble Scheme for Queries Assignment

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Outline

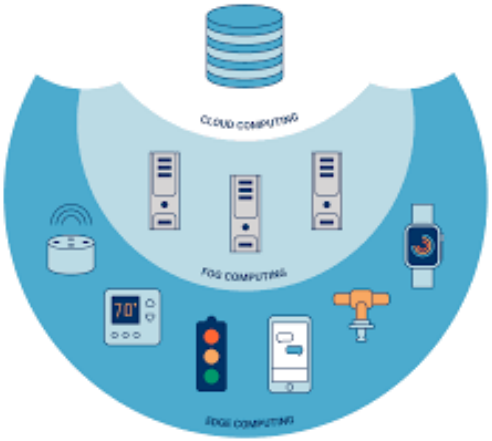
- Introduction
- Edge Nodes
- High Level Description
- Delivering the Complexity Class
- The Ensemble Scheme
- The Matching Process
- Experimental Evaluation
- Conclusions and Future Work

Introduction

- In the era of the Internet of Things (IoT), numerous devices form a vast infrastructure
- Devices can process tasks and exchange data
- Data can be processed at the devices, at the edge of the network (Edge/Fog) or at the Cloud

Edge Nodes

- Current research efforts focus on the data streams management at the edge
- Edge Nodes (ENs) act as distributed data repositories where queries can be executed
- ENs are responsible to report the results to the requested entity



Edge Nodes

- We deal with queries allocation to the appropriate ENs
- Queries are reported into a set of Query Controllers (QCs)
- It is a multi-dimensional problem involving queries and ENs characteristics

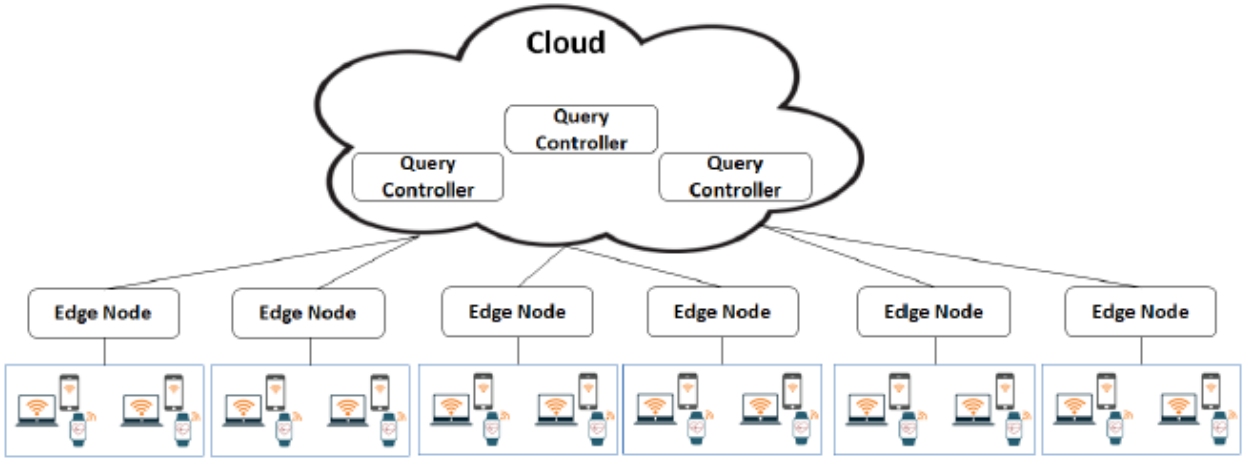
High Level Description

- Step 1. Classify queries into a set of complexity classes
- Step 2. Compare the requirements of queries with the ENs' load
- We propose models for both steps
  - An ensemble similarity scheme for the estimation of the complexity class
  - Decision for the selection of ENs based on the current and future load

High Level Description

- A Query Processor (QP) is adopted in every EN to respond to any incoming query

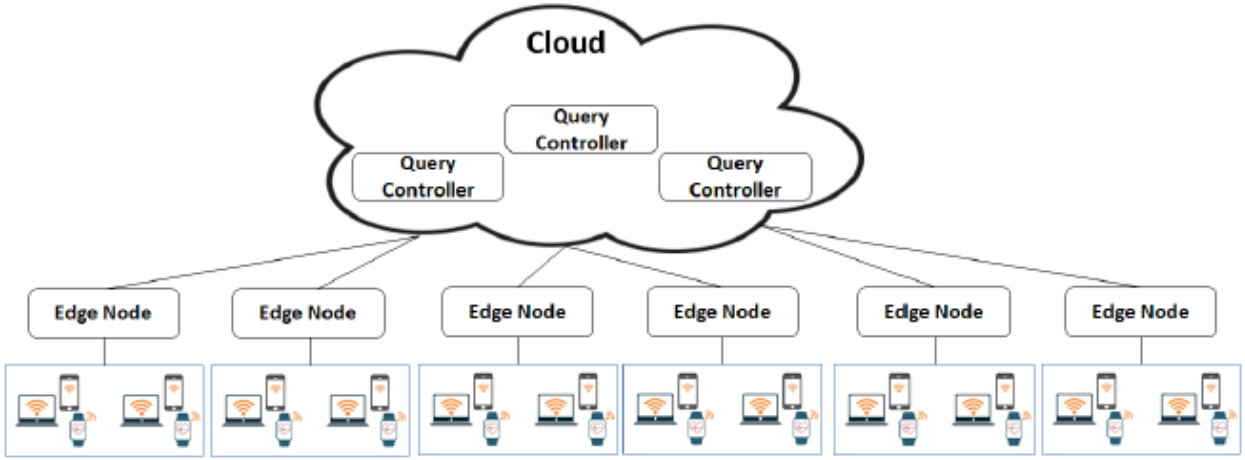
- QCs receive queries, `invoke' the appropriate QPs, get their responses and return the final result



High Level Description

- In each EN, a dataset is formulated i.e., a geodistributed local data repository

- Each dataset stores multivariate data



Matching Queries with Processors

- Every EN/QP exhibits specific characteristics
- We adopt:
  - The load
  - The speed
- Queries also have a set of characteristics
- We adopt:
  - The complexity
  - The need for instant response
- We focus on the query class; it depicts the complexity

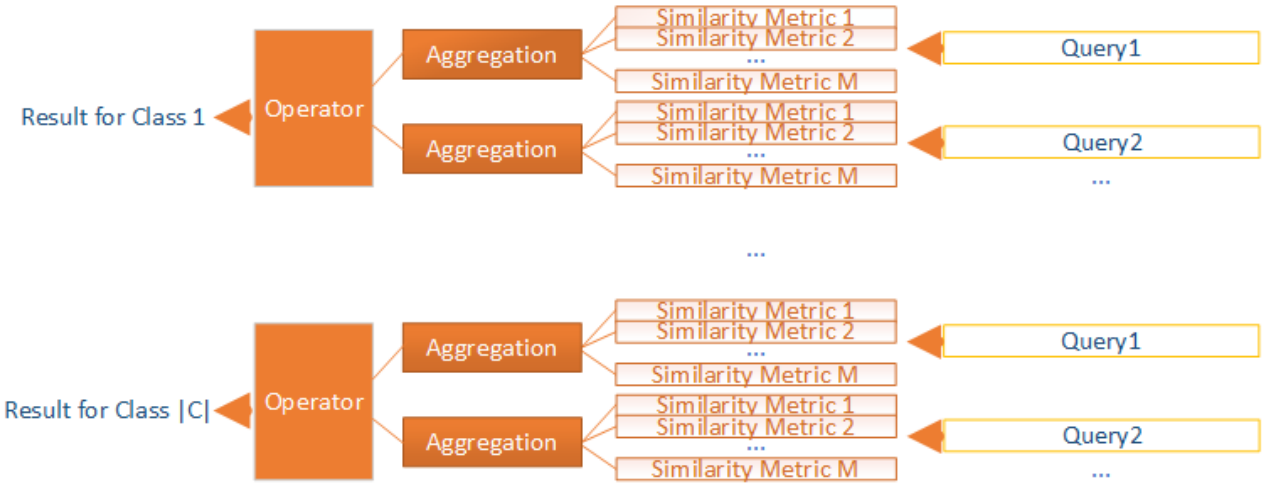
Delivering the Query Complexity

- For delivering the complexity class, we propose a `fuzzy' approach and define a Fuzzy Classification Process (FCP)
- The FCP derives the membership of a query in each of the pre-defined classes

- We also adopt a dataset of historical queries together with their corresponding classes
- The same class may be involved in multiple tuples, thus, in multiple queries

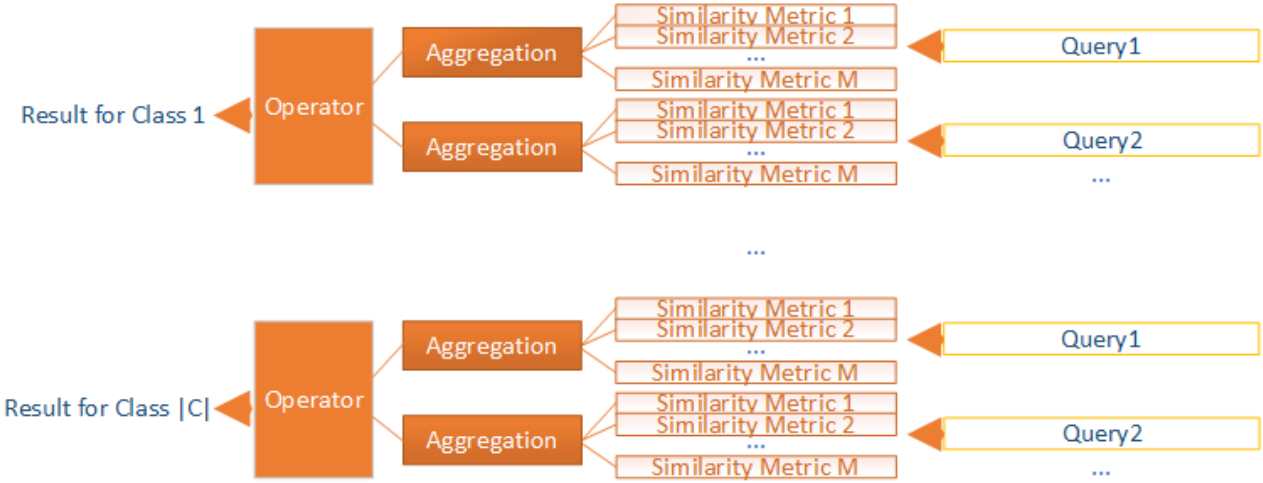
Delivering the Query Complexity

- We build on top of a function f
- f gets the query and delivers a similarity vector
- Example: q^s = <0.2, 0.8, 0.3>
- The ensemble scheme evaluates the final similarity between the query and every tuple in the training set



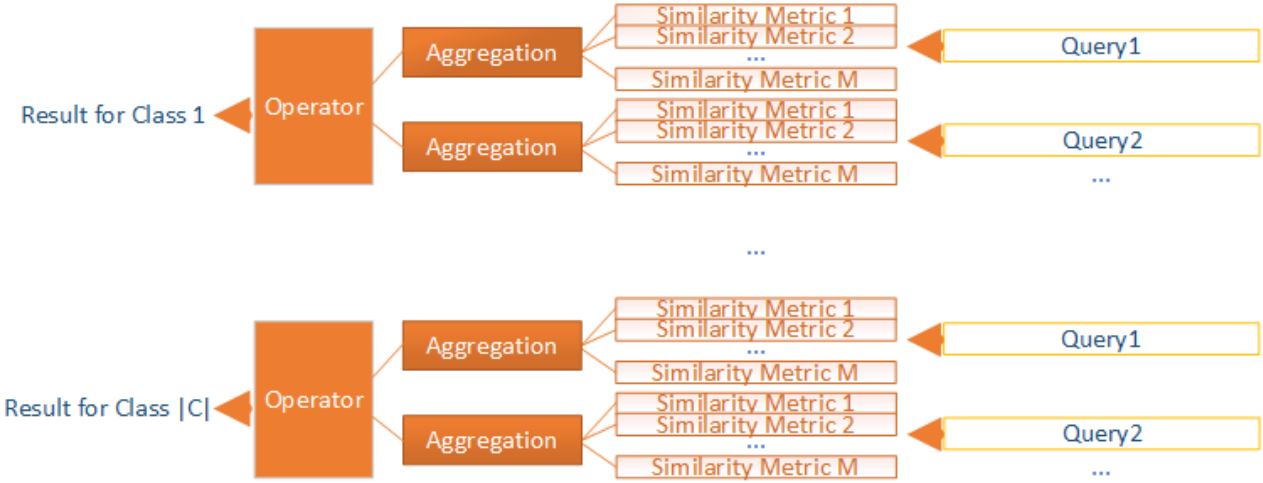
The Ensemble Scheme

- Similarity metrics are applied on each tuple classified into a class
- All the results are aggregated
- Every single result represents the membership of the query to a 'virtual' fuzzy set
- We adopt the Hamacher product for the final aggregation



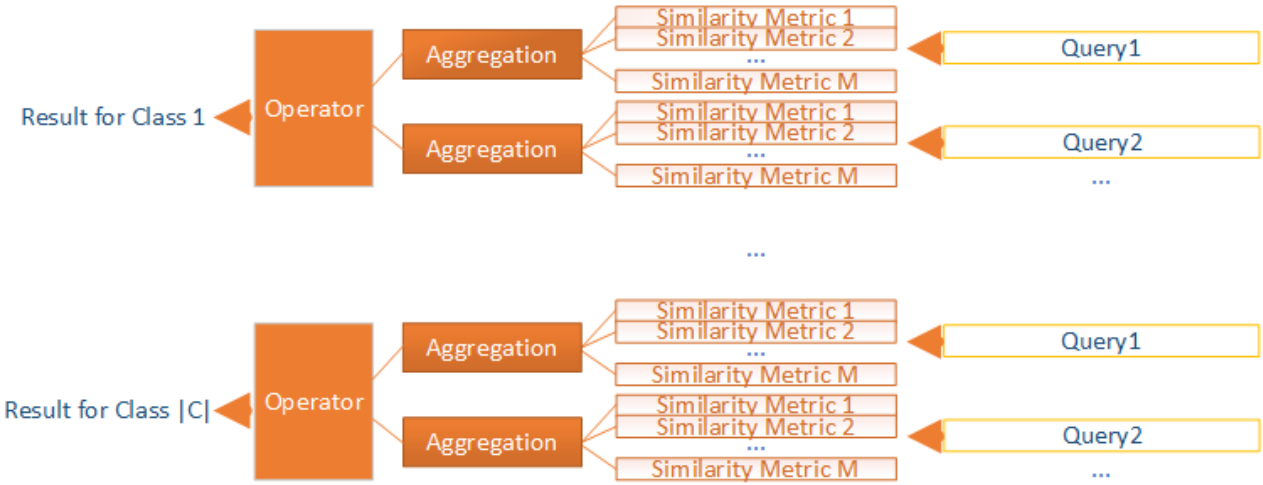
The Ensemble Scheme

- Disagreements are managed through the use of top-k similarity values based on their significance level
- The Significance Level (SL) depicts if a value is 'representative' for many other results
- Density based: Only values with a 'dense' neighborhood are considered



The Ensemble Scheme

- Over a set of aggregated similarity values for a class, we apply an operator
- We adopt the Quasi-Arithmetic mean for the second level of aggregation



The Matching Process

- We consider an additional vector containing steps for each complexity class
- The expected number of steps for a query is compared with the available load
- When the number of steps can be covered: reward
- Otherwise: penalty
- We process both, the current and the future load

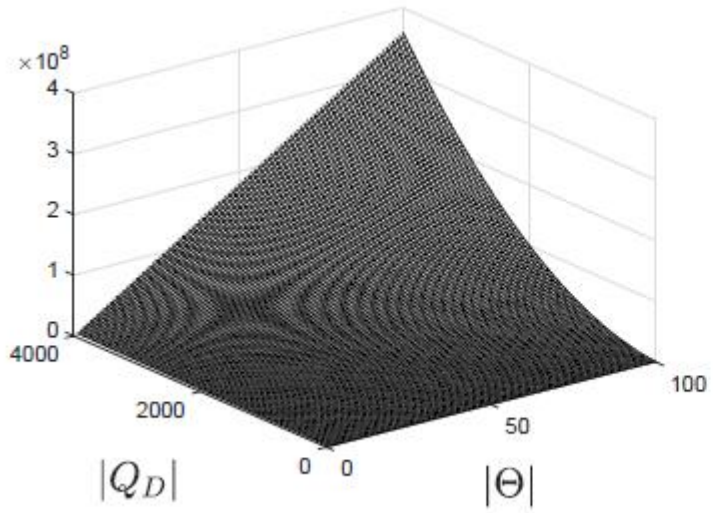
Experimental Evaluation

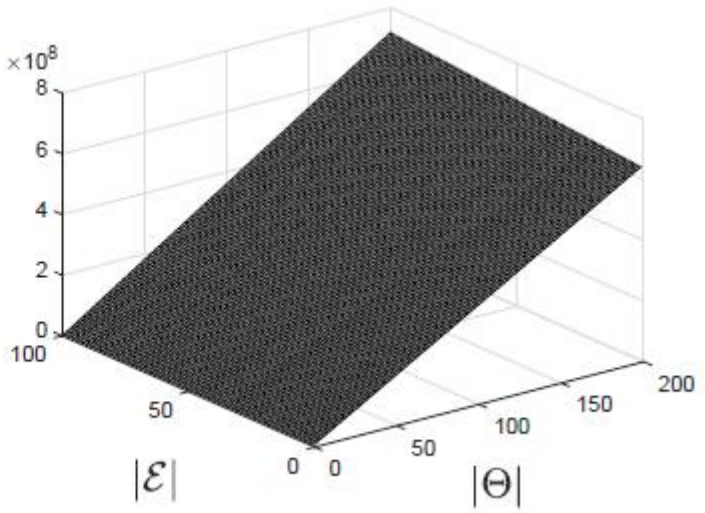
- Datasets
  - Queries found at http://www.tpc.org
  - For each, we define the complexity class (six classes)*
- Performance Metrics
  - Ψ: seconds to allocate a query
  - Ξ: difference of the selected load with the lowest
- Ties management
  - Scenario A: Random selection
  - Scenario B: The lowest load first

* Vashistha, A., Jain, S., 'Measuring Query Complexity in SQLShare Workload', Proc. of the Int. Conf. on Management of Data, 2016.

Experimental Evaluation

- Complexity of the scheme*





* $|Q_D|$: size of the training dataset, $|E|$: number of similarity metrics, $|\Theta|$: number of classes

Experimental Evaluation

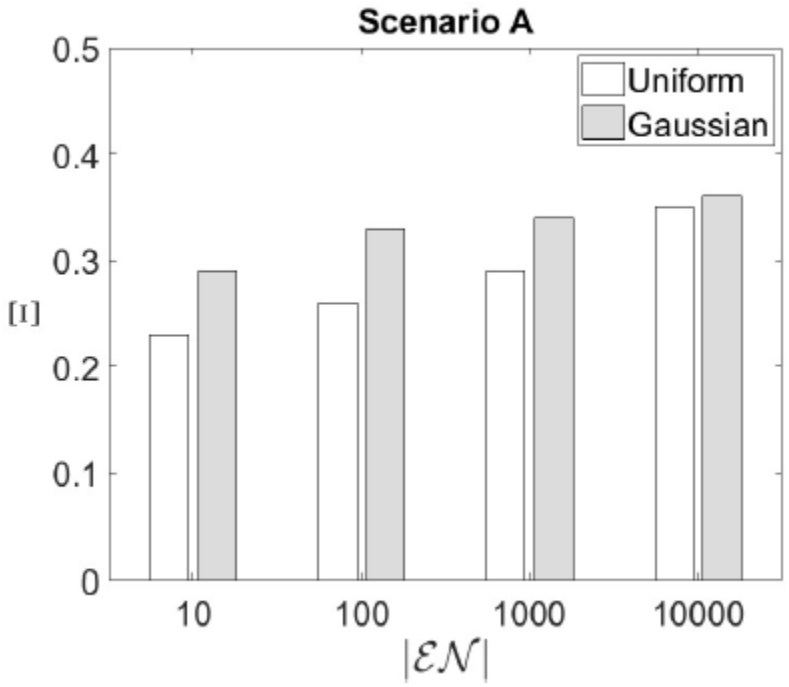
- Conclusion time (in seconds)

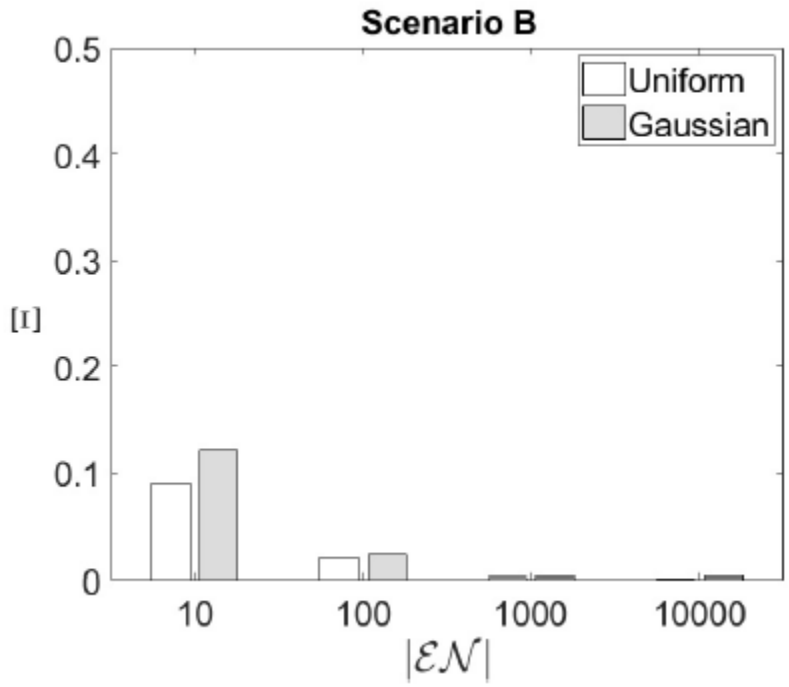
$\lvert\mathcal{EN}\rvert$	Ψ Uniform	Ψ Gaussian
10	0.008	0.008
100	0.012	0.010
1,000	0.055	0.370
10,000	0.251	0.276

* |EN|: number of nodes

Experimental Evaluation

- The load of the selected EN





Conclusions and Future Work

- The proposed model exhibits good performance
- We manage to perform efficient allocations

- Our future research plans involve the incorporation of more parameters
  - the deadline
  - the statistics of data
- The aim is to provide an adaptive mechanism

Thank You!!

Questions?