Load-balance Modeling based on Fuzzy Logic

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Data Structures

- Client
- Server
- Cluster

Client

```
export interface Client {
 ramUsage: number;
 cpuUsage: number;
 hardUsage: number;
}
```

- ramUsage: is the amount of ram a client uses from server total ram capacity and it’s stored in megabytes.
- cpuUsage: is the percentage of cpu a client uses from one core of a server.
- hardUsage: is the amount of ram a client uses from server total ram capacity and it’s stored in megabytes.

Server

```
export interface Server {
 ram: number;
 cpu: number;
 name?: string;
 hard: number;
 clients?: Array<Client>;
 ramUsage?: number;
 cpuUsage?: number;
 hardUsage?: number;
 ramUtilization?: number;
 cpuUtilization?: number;
 hardUtilization?: number;
 load?: number;
 fuzzyLoad?: fuzzyLoad;
 fuzzyOutput?: fuzzyOutput;
 status?: status;
 loadMinusAverage?: fuzzyLoad;
}
```

Server

- Ram: Total ram capacity of server.
- Cpu: number core * 100.
- Hard: Total hard capacity of server.
- Clients: A list of clients that is assigned to this server.
- ramUsage: Is calculated by adding ramUsage of clients that are assigned to this server.
- cpuUsage: Is calculated by adding cpuUsage of clients that are assigned to this server.
- hardUsage: Is calculated by adding hardUsage of clients that are assigned to this server.
- ramUtilization, cpuUtilization, hardUtilization: All calculated by function named calServerUtilization.
- Load: Is determined by a function called calcServerLoad,
- fuzzyLoad: An array calculated by fuzzifying load **[very low, low, medium, high, very high].**
- fuzzyOutput: Fuzzy output of controller for each server **[r, n, s]**
- Status: Can take 3 values: -1 | 0 | 1, -1 means: receiver, 0 means: neutral and 1 means: sender.
- loadMinusAverage: Is also an array of [very low, low, medium, high, very high]

Cluster

```
export interface Cluster {
 servers: Array<Server>;
 delay: number;
 name?: string;
...
 load?: number;
 fuzzyLoad?: fuzzyLoad;
 status?: Array<status>;
 active?: boolean;
 senderIndex?: number;
 receiverIndex?: number;
 senderKey?: string;
 receiverKey?: string;
 sens?: number;
}
```

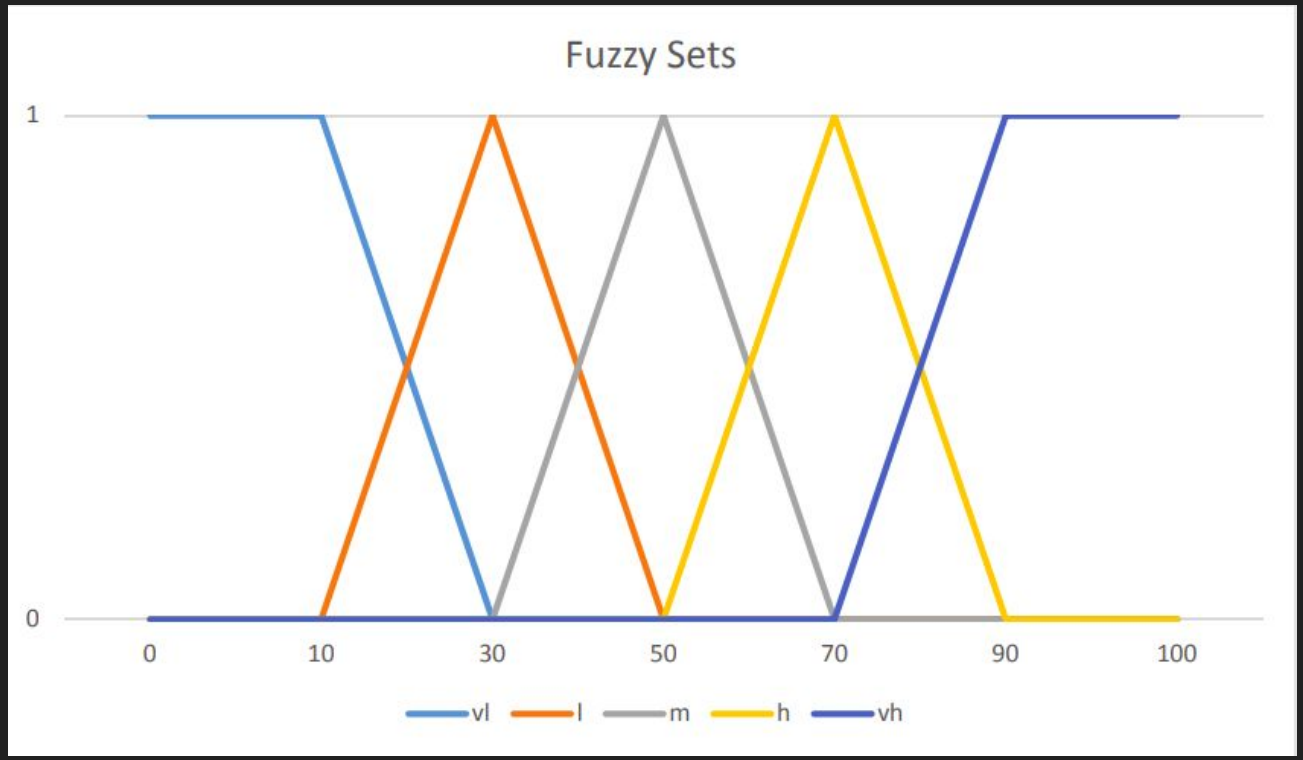
Cluster

- sens: determines the sensitivity of algorithm meaning how much cluster tries to balance it self
- active: If the load balancing finished or not
- delay: stored in milliseconds, determines the delay between submission to the database

The Algorithm Flow

- The user creates a cluster by specifying sensitivity, delay and a name.
- Then adds some servers by specifying server name, number of cores, ram capacity, hard capacity.
- Then the users adds some clients to servers.
- Now algorithm can start balancing clients between servers.

Load Fuzzy Sets



The Algorithm Flow

- Calculate Server Utilization
- Calculate Server Load
- Calculate Server FuzzyLoad
- Calculate Cluster Capacity And Usage
- Calculate Cluster Utilization
- Calculate Cluster Load (Average Load)
- Calculate Cluster FuzzyLoad
- Calculate Fuzzy Output
- Calc Output