GA OPTIMISATION OF NON-SINGLETON FUZZY LOGIC FOR ECG CLASSIFICATION

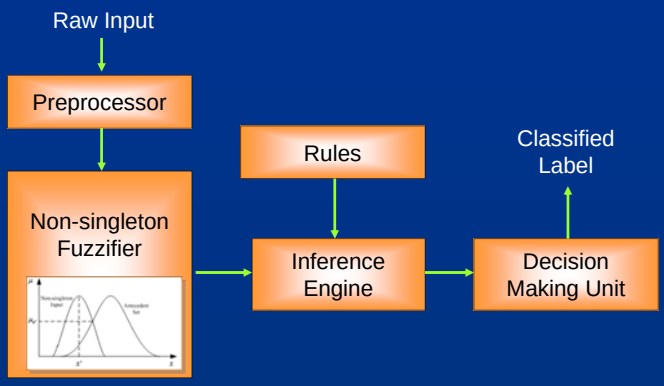
NUS National University of Singapore

Chua Teck Wee and Tan Woei Wan

1. Objective

- Investigate if NSFLS evolved using genetic algorithm (GA) can better cope with the fuzziness present in the extracted features compared to SFLS.

2. Non-singleton Fuzzy Classifier



- Advantages of NSFLS:
  - Noise suppression capability

True signal

$$m_{X_k} = m_{X_{k0}} + n_k$$

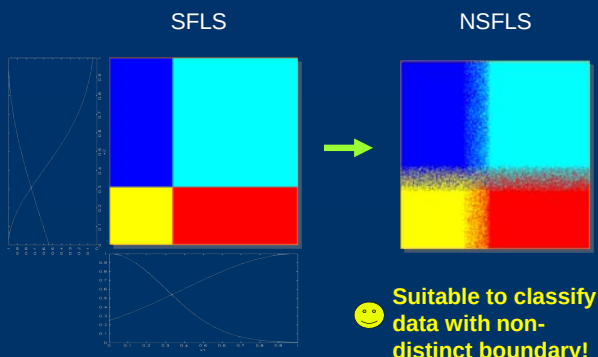
Corrupted signal — Noise

With minimum inference method, the input is transformed into :

$$x^l_{\max} = \frac{\sigma_{X_{k0}} m_{F^l_k} + \sigma_{F^l_k} m_{F^l_k}}{\sigma_{X_{k0}} + \sigma_{F^l_k}} + \frac{\sigma_{F^l_k} n_k}{\sigma_{X_{k0}} + \sigma_{F^l_k}}$$

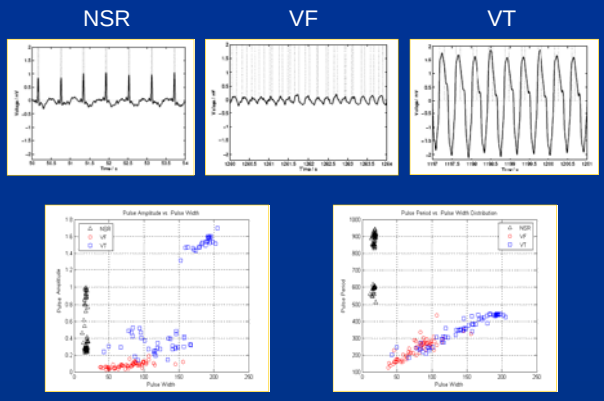
Suppression factor

  - Fuzzy decision boundary



Suitable to classify data with non-distinct boundary!

3. Application to ECG Classification



Period is easier to extract but the boundary is non-distinct compared to amplitude.

- Rule-base:

IF x_1 is Fi and x_2 is F_j , THEN C_k

where *i*, *j* = 1, 2, 3 (small, medium, large) and *k* = 1, 2, 3, 4 (CT, NSR, VF, VT).

- Inference method:

max-min → winner takes all

- GA optimisation
  - Chromosome

$m^1_{x_1}$	$\sigma^1_{x_1}$	…	$m^3_{x_2}$	$\sigma^3_{x_2}$	r_1	…	r_9

Antecedent sets — Rules

  - Single-point crossover with rate = 0.8
  - Bit-wise flipping mutation with rate = 0.03
- Results

Input	Amplitude & Width		Period & Width	
Classifier	**SFLS**	**NSFLS**	**SFLS**	**NSFLS**
Accuracy (%)	98.33	100.00	91.67	99.44

NSFLS achieves good accuracy using features that are easier to extract, but contain more uncertainties.