



# A Novel Fuzzy Approach to Speech Recognition

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Ramin Halavati, Saeed B. Shouraki, Pujan Ziaie  
Sharif University of Technology  
Tehran, Iran

Presented by: Pujan Ziaie ([pujan\\_nacon@yahoo.com](mailto:pujan_nacon@yahoo.com))

# Summery

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- Introduction: Speech Recognition
- Proposed Model
- Recognition Approach
- Training process
- Results

# Speech Recognition

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## □ Several Methods

- HMM ( Hidden Markof Models), TDNN (Time Delay NN),  
...

## □ Common Problems:

- Effect of Noise
- Recognition Speed

## □ Fuzzy approach:

- To Ignore details such as noise.
- similarity with human recognition process.

# Human Voice Recognition

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- Imprecise processing
- Deciding upon a rough measurement of amplitude
- No counting on speech frames (relative lengths)
- Sensitive to lower frequencies

# Proposed Model

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## □ Base Data:

- Speech Spectrogram
- Phonemes Specification (developed by using GA)

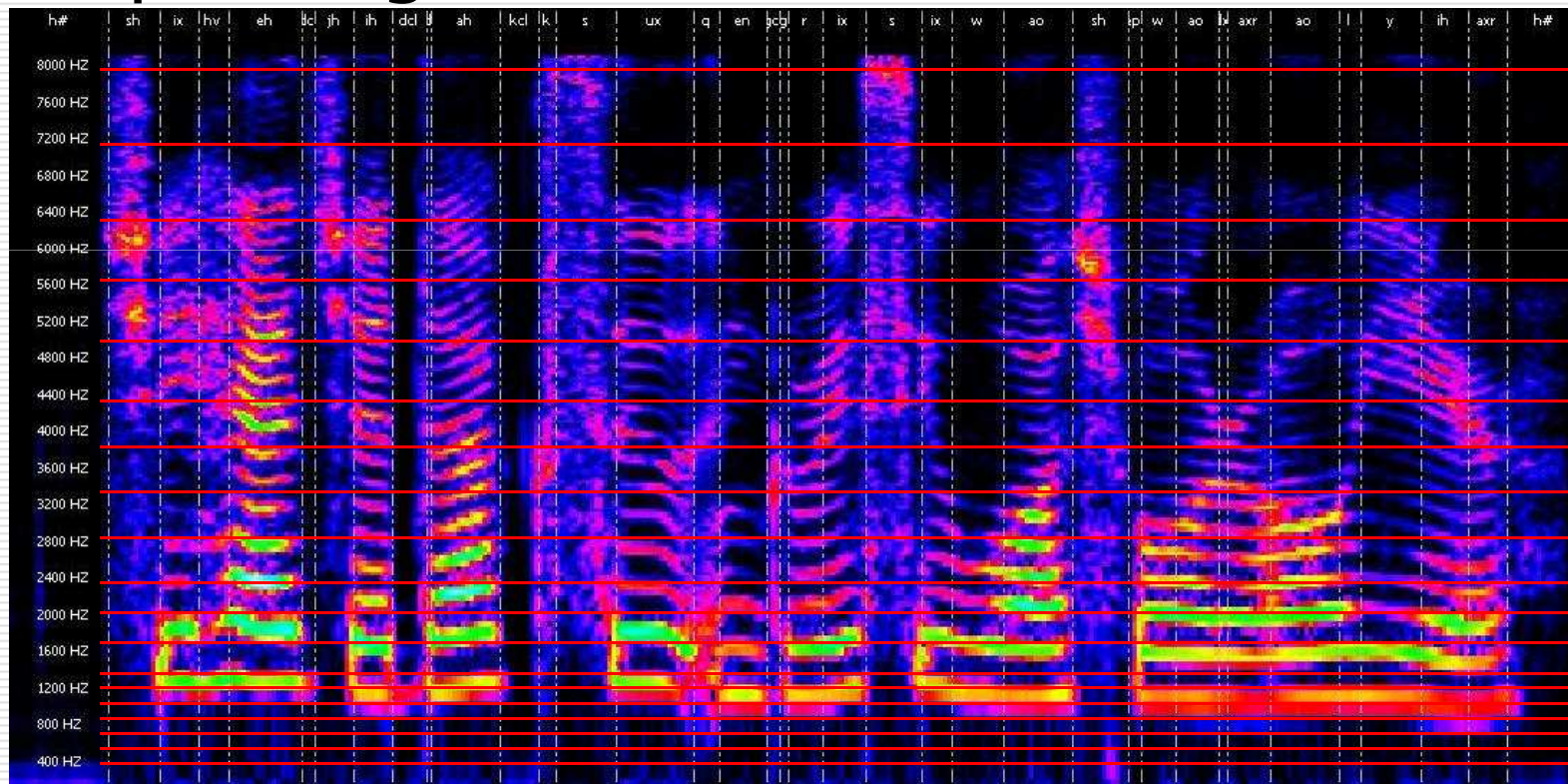
## □ Data manipulation:

- Stretching Using MEL Filter Banks. (Human's ear is more sensitive to low frequencies and less to high ones.)
- Fuzzification to reduce amount of data. (Human do not use that much precise data.)
- Calculating the belongness to each phoneme

# Proposed Model

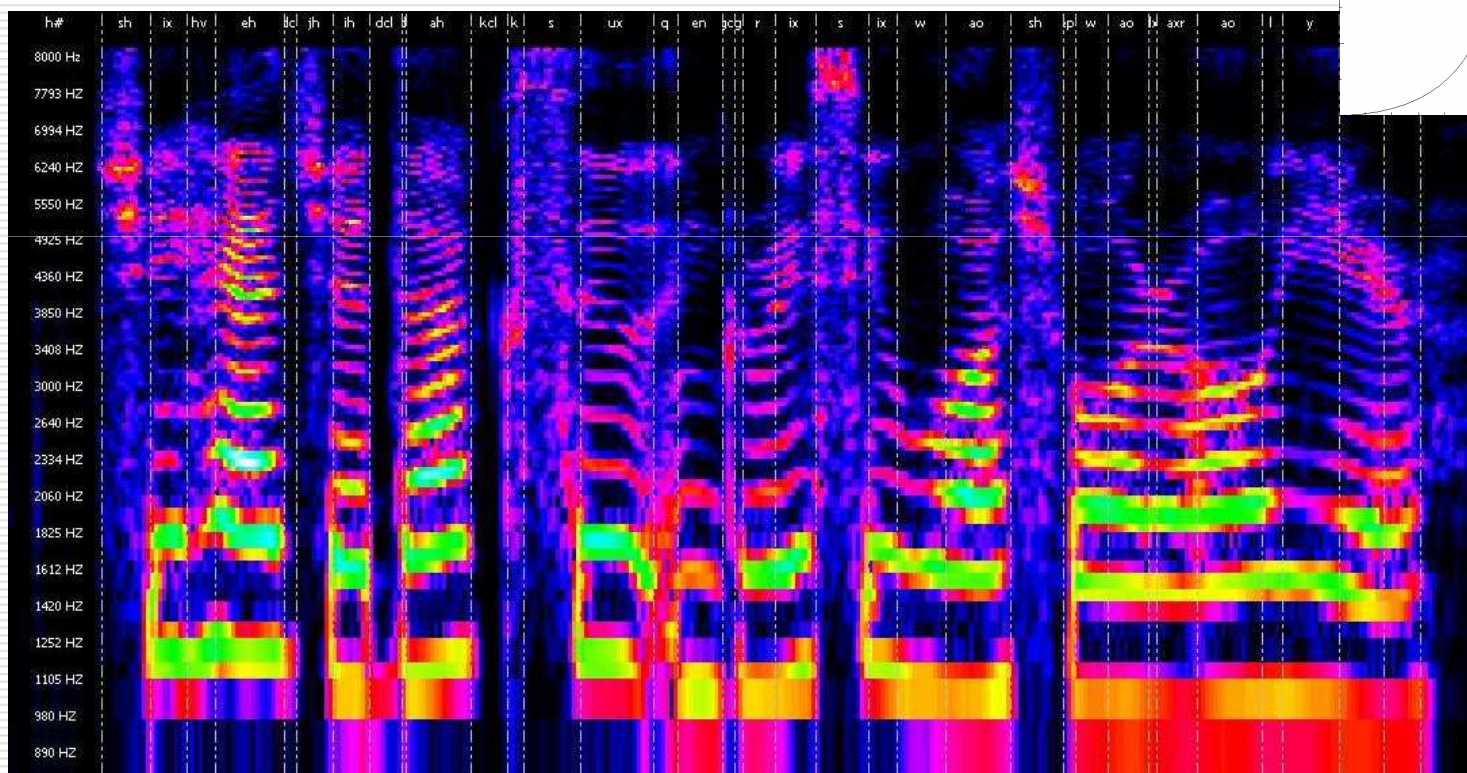
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## □ Spectrogram:



# Proposed Model

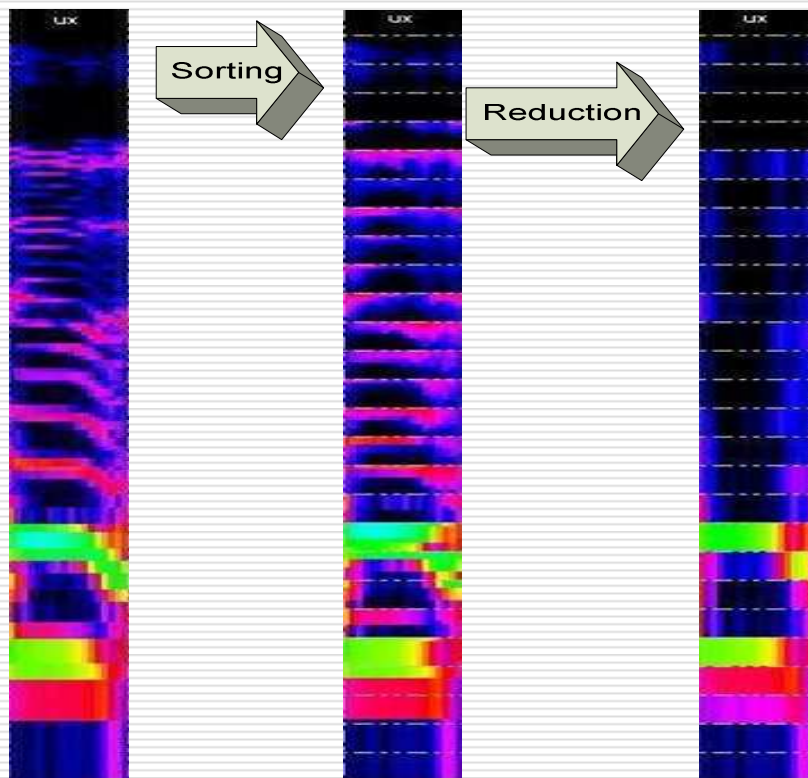
□ After MEL-Stretching



# Proposed Model

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## □ Data Reduction (Fuzzification)



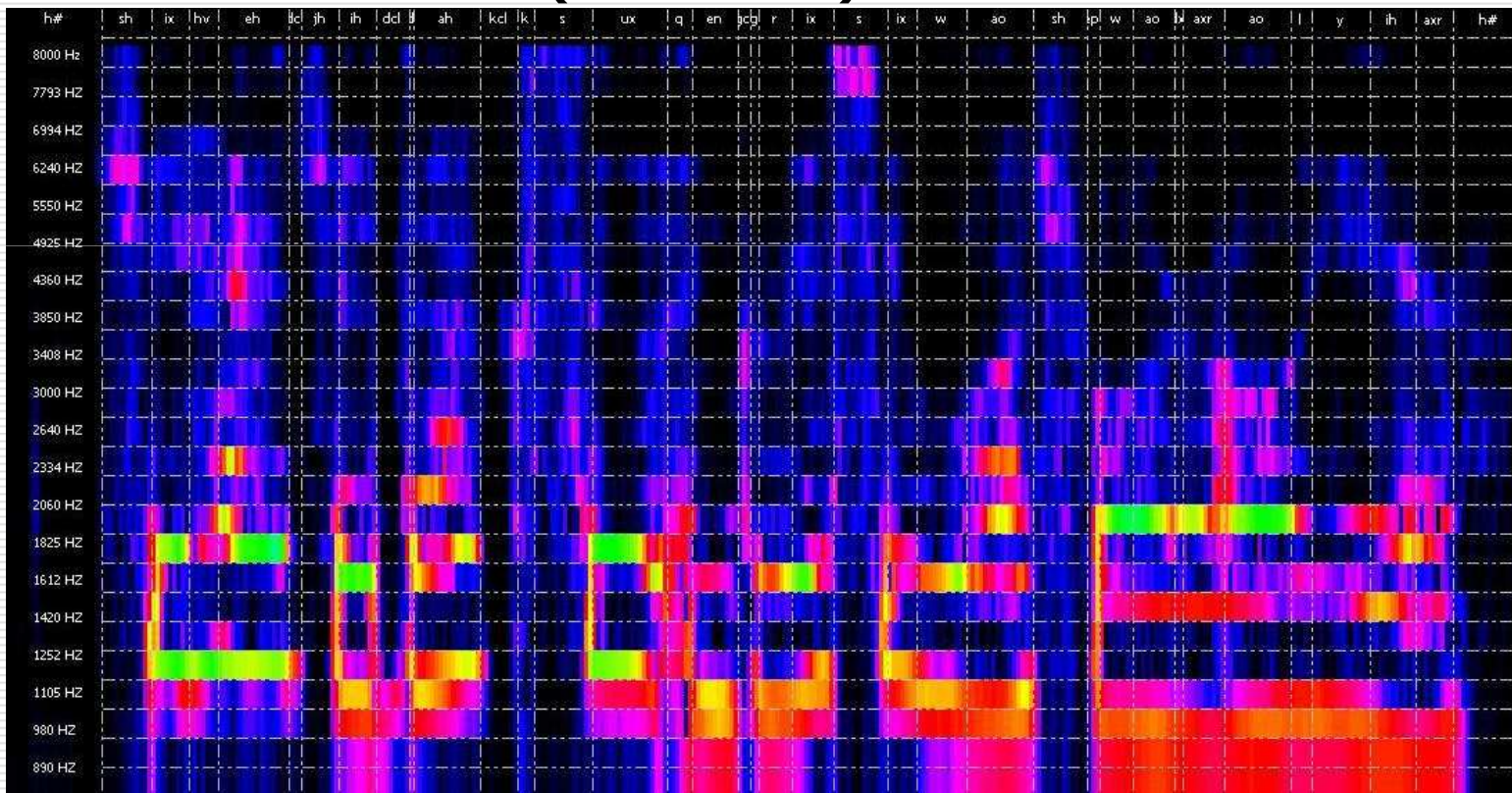
In the first step, the original signal frames are divided into 25 vertical ranges and then, the values inside each range are sorted so that the more powerful ones are moved to top.

In the second step, the top 10% values of each range are chosen and averaged and the result is replaced with the all the value of that range, making all values in each vertical range similar.

# Proposed Model

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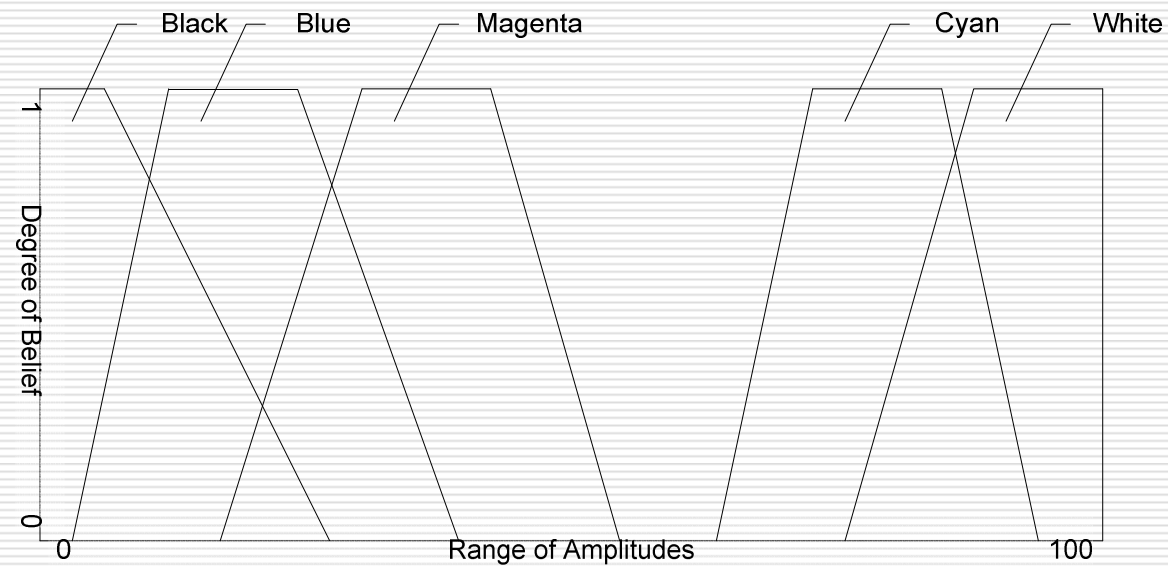
## □ Fuzzification (Contd.)



# Proposed Model

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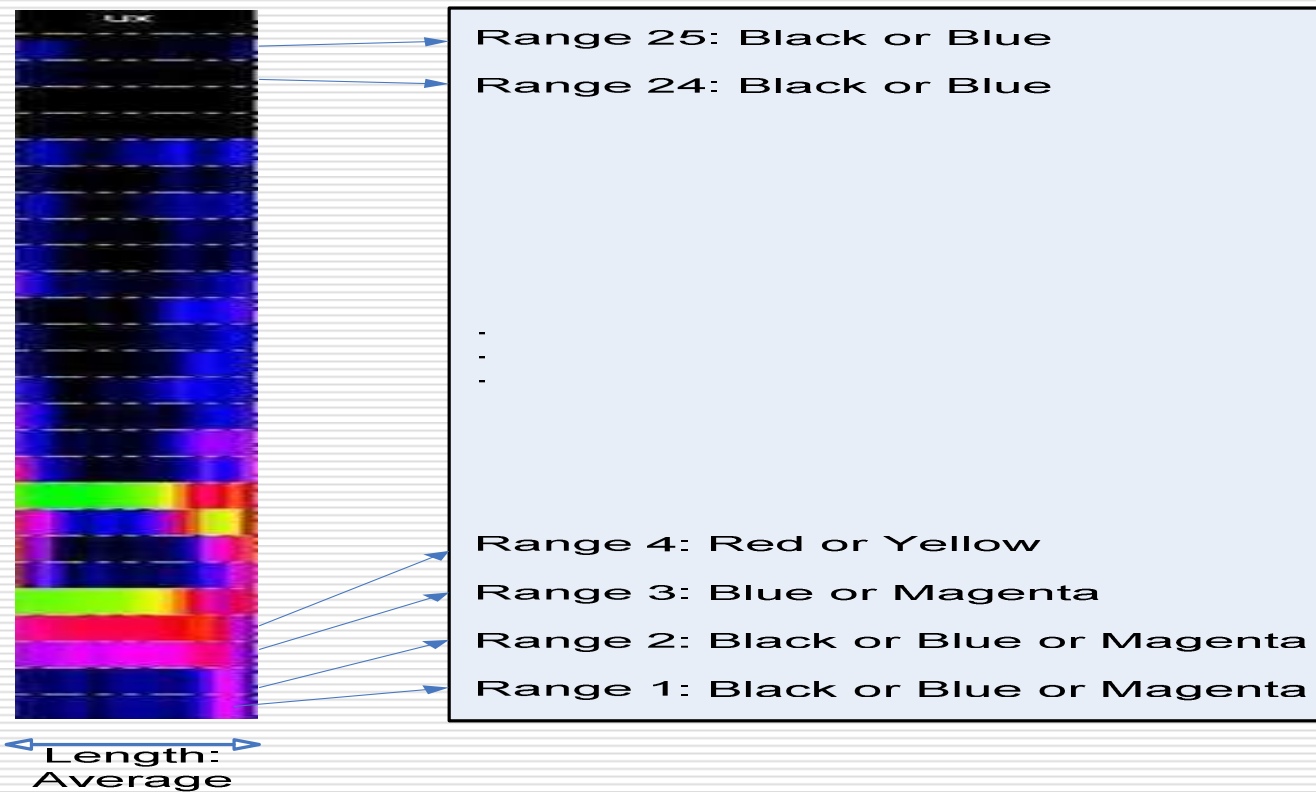
- Phoneme definition necessities:
  - Colors
  - Lengths (5 MFs)



# Proposed Model

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## □ Sample Phoneme Definition:



# Recognition Method

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- The existence of appropriate phoneme definitions is assumed
- Recognition
  - Compare the given sample with all phoneme definitions
  - Choose the one with highest compatibility value

# Recognition Method

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- Single Phoneme Comparison:
  - Comparing the color pattern of the phoneme with all frames of the given sample.
  - Finding the matching sequences.
  - Comparing the length of a matching sequence with the required length.

# Recognition Method

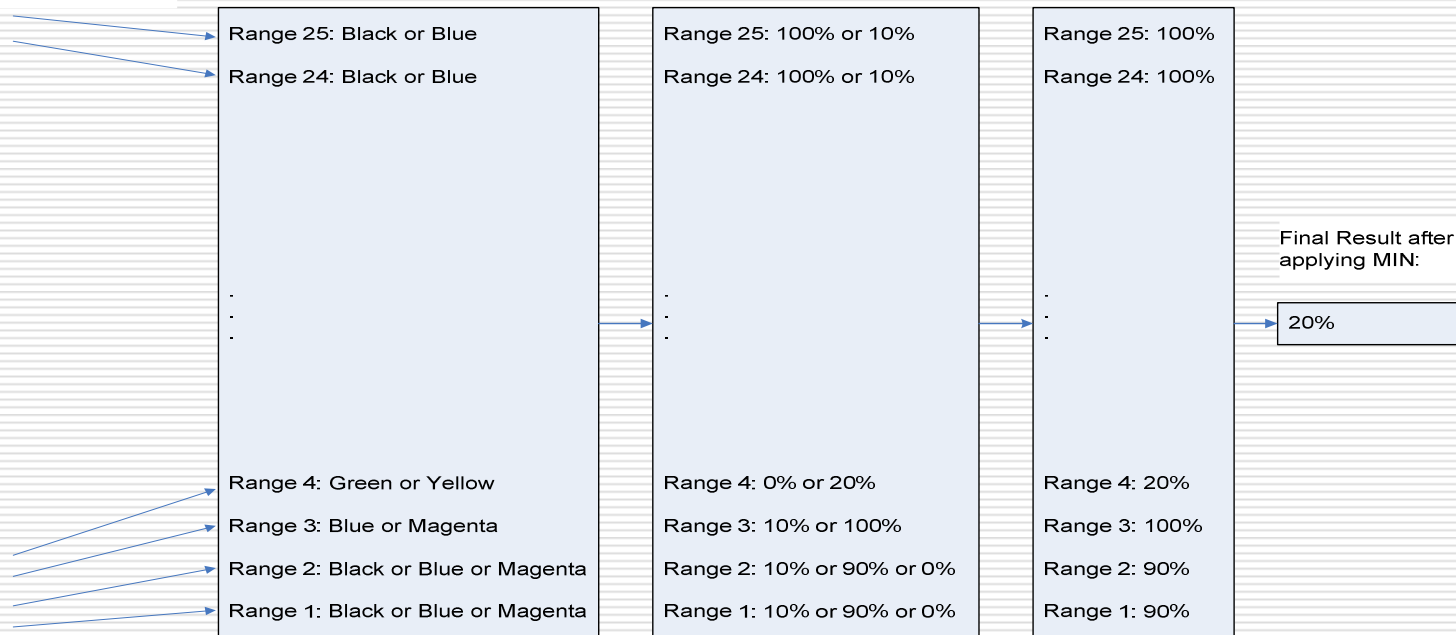
## □ Sample, Step One:

Input:  
( A column of the colors of  
the signal which is to be  
recognized)

Pattern:  
(The color pattern of the phoneme  
which is to be evaluated.)

Compatibility:  
(The compatibility measure  
between the signal colors and  
the phoneme's pattern.)

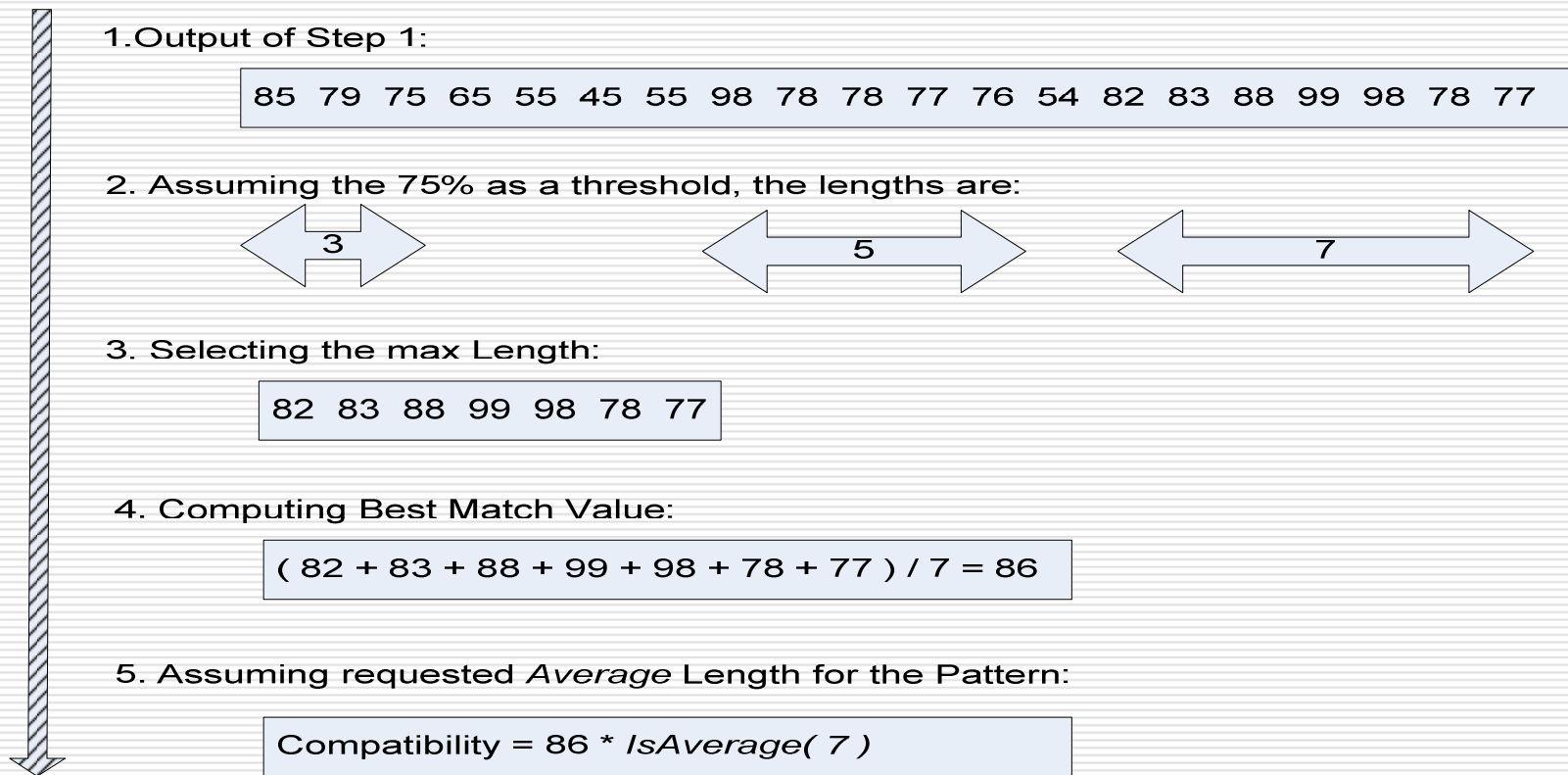
After applying MAX:



# Recognition Method

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## □ Sample, Step Two:



# Training

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- To get the proper phoneme's specification (colors and length)
- Using GA for data improvement

# Training Method

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## Genetic Algorithm

### ■ Each Genome:

- Color Definitions
- Length Definitions
- Phoneme Descriptions

### ■ Cross Over:

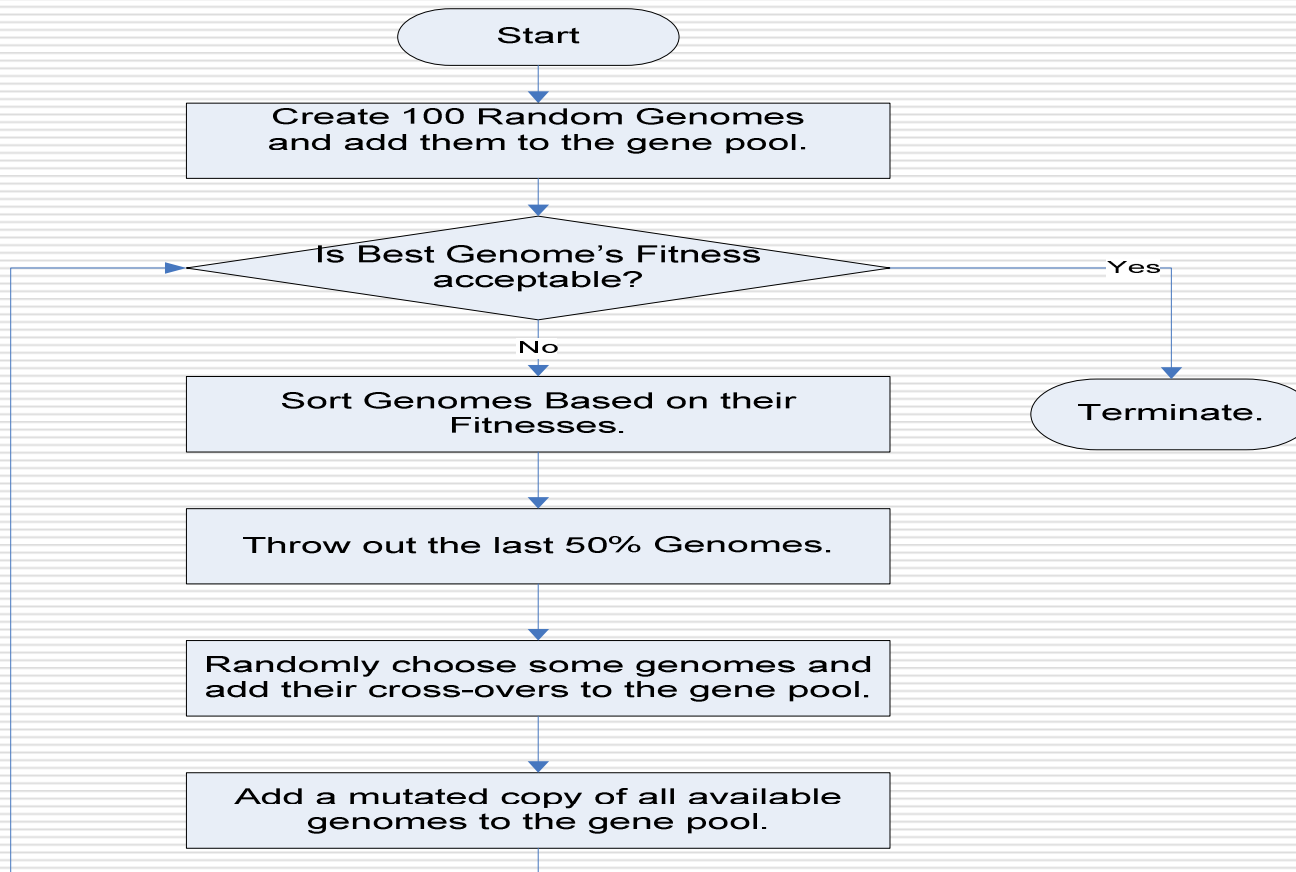
- Combination of two genomes phoneme Description part

### ■ Mutation:

- Randomly change a color or length definition.
- Randomly change a phoneme description part

# Training Approach: flowchart

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# Experimental Results

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## □ Comparison with HMM

	Fuzzy Approach	HMM Approach
1 <sup>st</sup> correct answers:	85%	62.28
3 <sup>rd</sup> correct answers (out of 62) <sup>[1]</sup> :	95%	79.60
6 <sup>th</sup> correct answers (out of 62):	98%	86.98

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<sup>[1]</sup> One of the top three guesses has been correct.

# Future Works

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- ❑ To encounter color transitions in the model.
- ❑ To enhance horizontal segmentations.
- ❑ To test noise immunities.
- ❑ To alter model to represent and recognize words.

# Acknowledgment

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- Special thanks to professor Hirota (TIT) for his useful advices and also giving me the opportunity to participate in the conference

# Thank you

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Any questions?

