

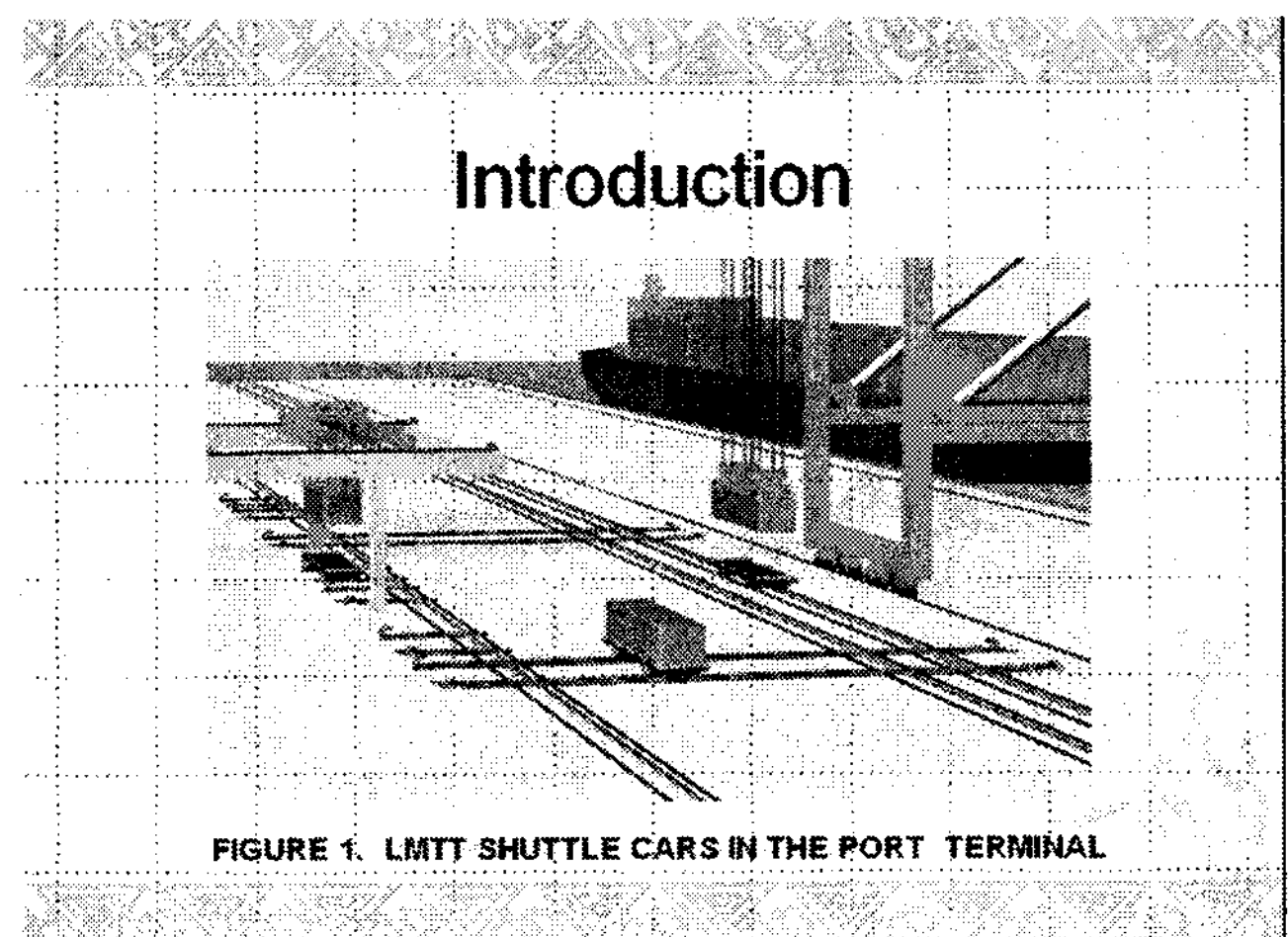
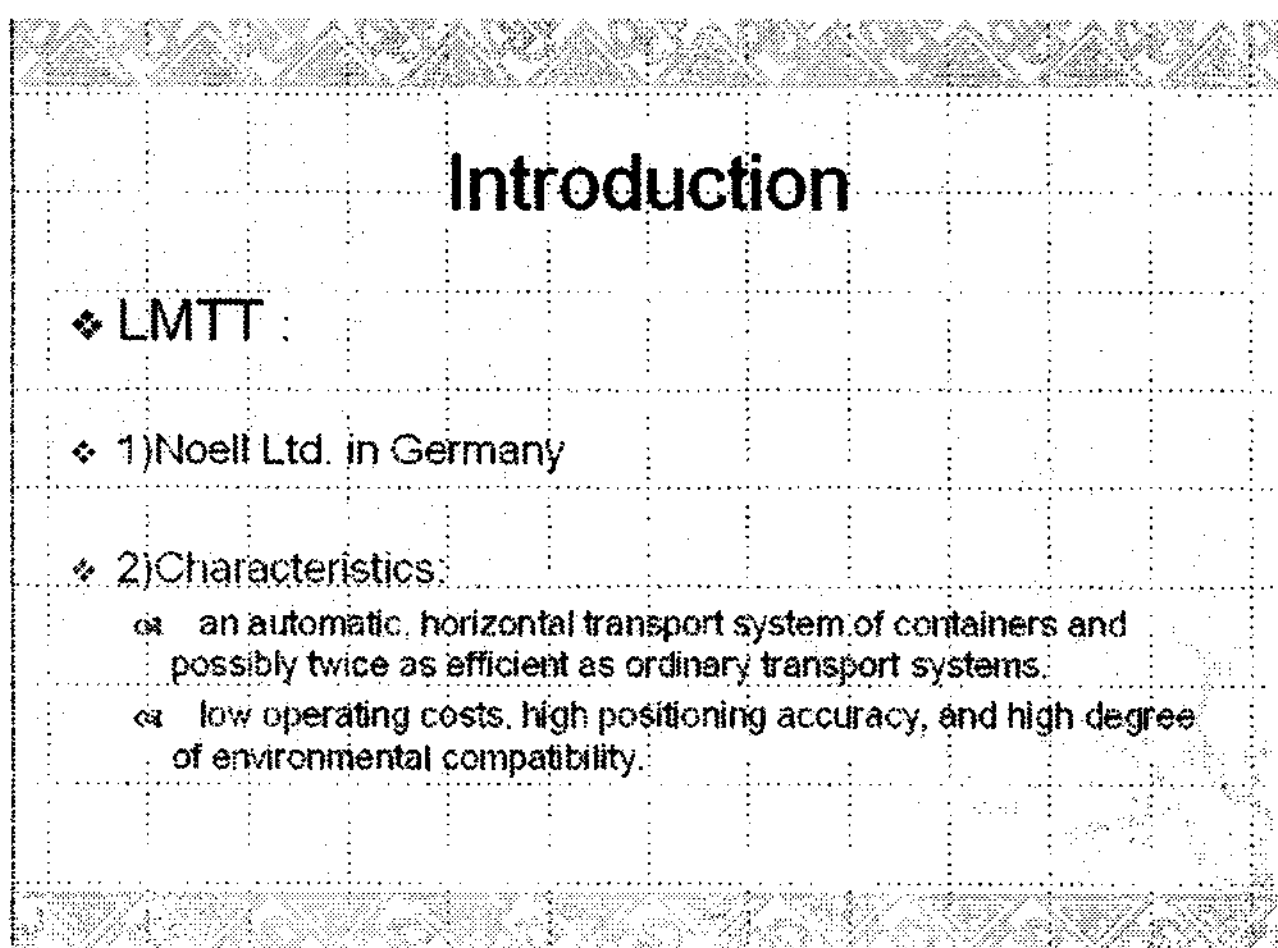
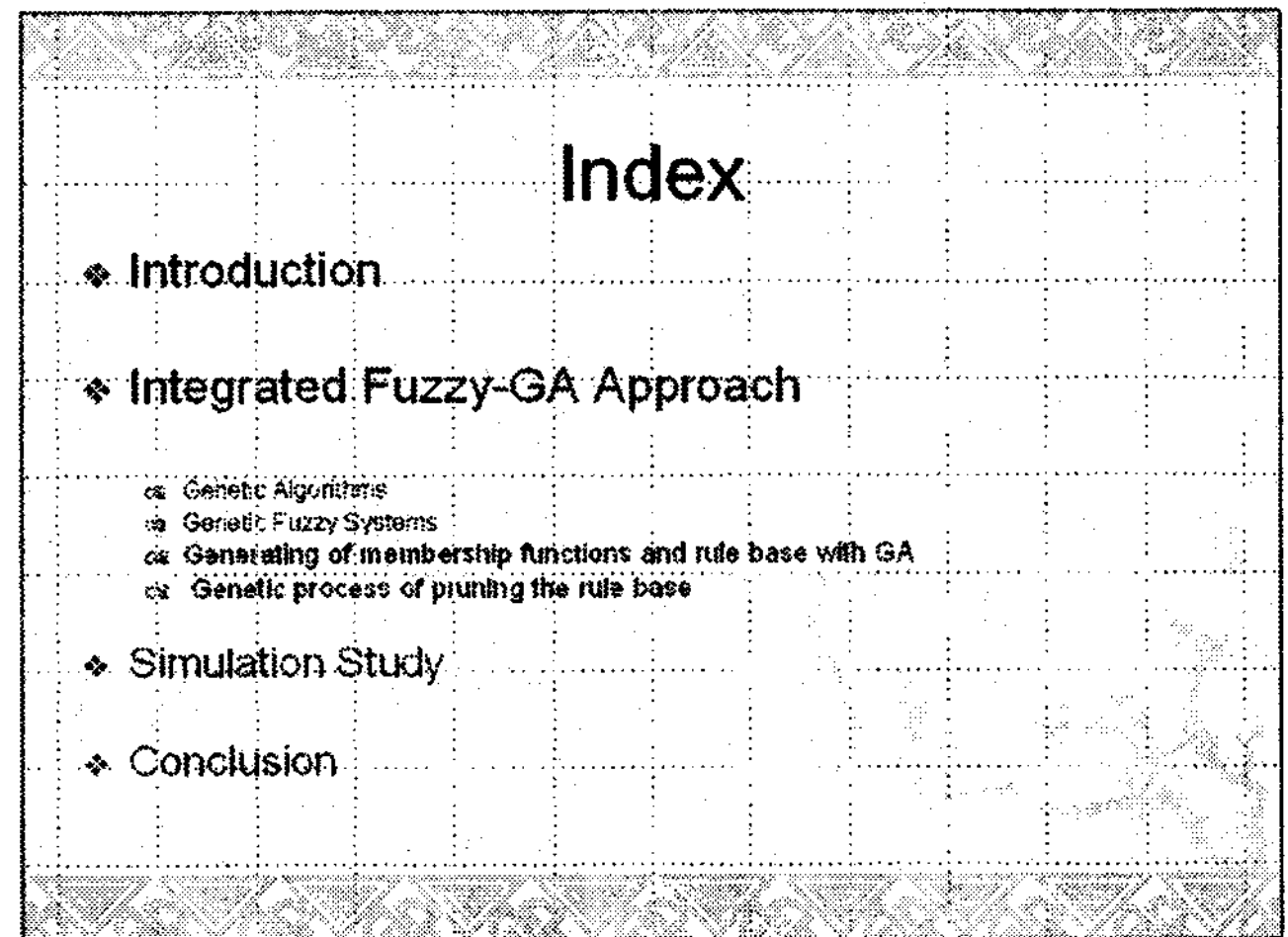
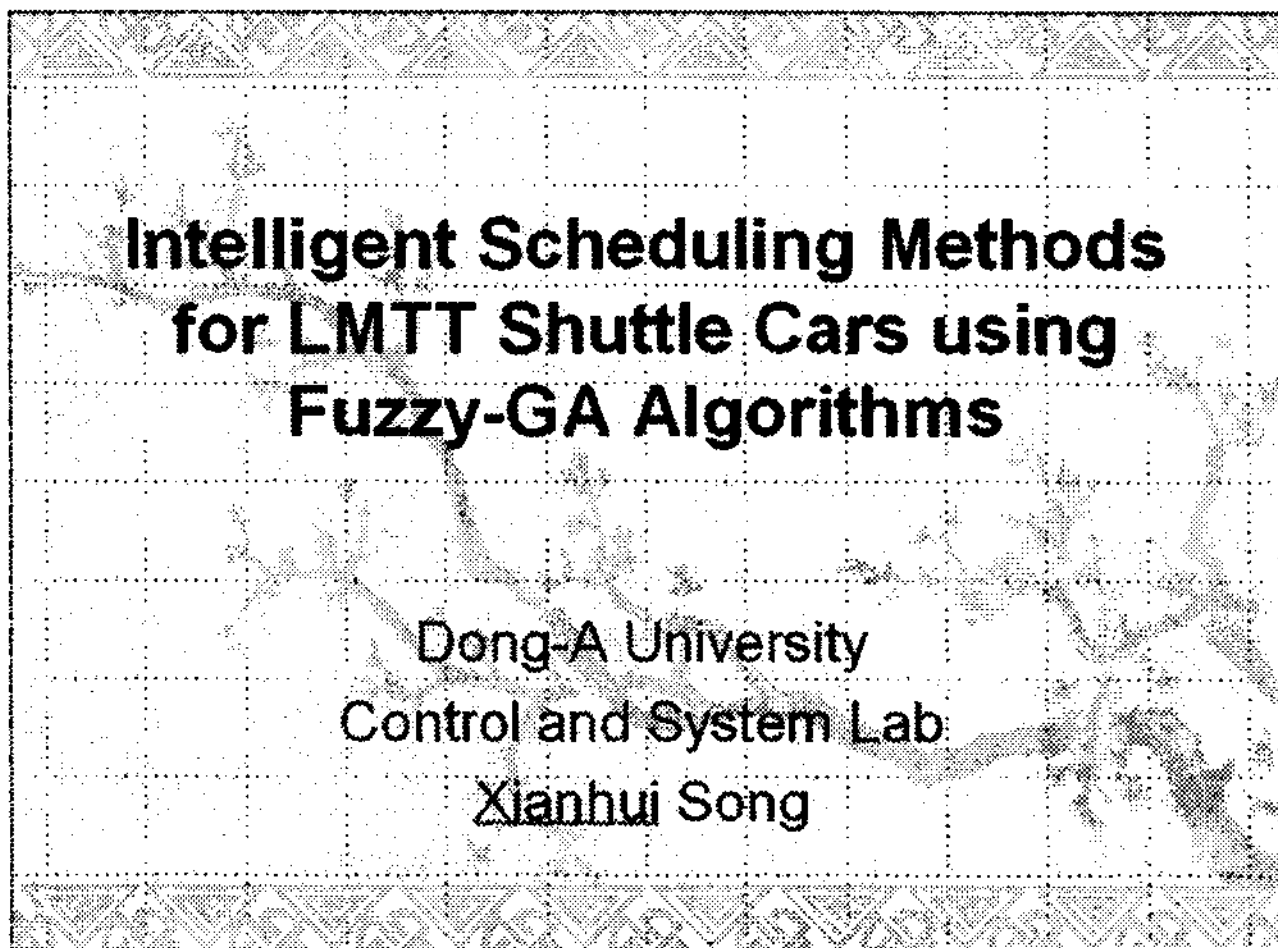
# Intelligent Scheduling Methods for LMTT Shuttle Cars using Fuzzy-GA Algorithms

† Xianhui Song\* · Hyun-Cheol Cho\*\* · Kwon-Soon Lee\*\*

Department of Electrical Engineering, Dong-A University

요 약 :

핵심용어 :

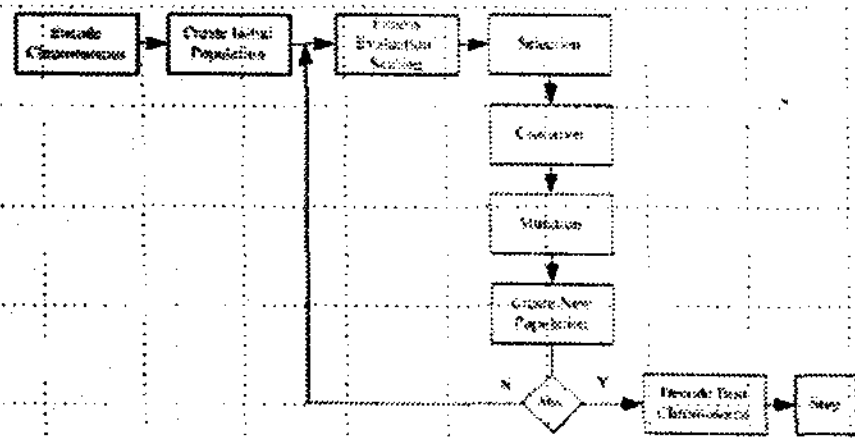


† 교신저자 : Xianhui Song [xianhui\\_song@hotmail.com](mailto:xianhui_song@hotmail.com) 051) 200 - 6950

\*\* [hyunccho@gmail.com](mailto:hyunccho@gmail.com), \*\*\* [kslee@dau.ac.kr](mailto:kslee@dau.ac.kr) 051)200 - 6950

# Integrated Fuzzy-GA Approach

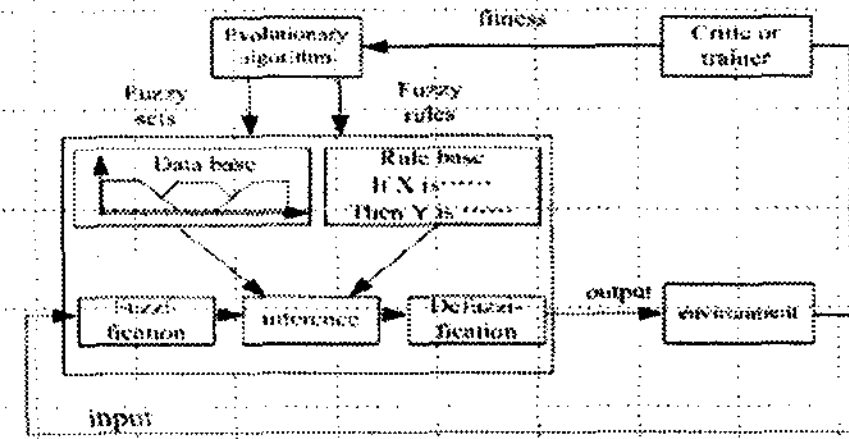
## Genetic Algorithms



BASIC MECHANISM OF GA

# Integrated Fuzzy-GA Approach

## Genetic Fuzzy Systems

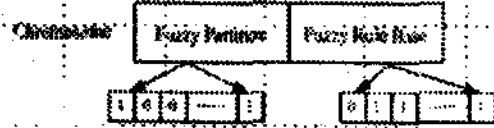


A GENERAL SCHEME OF GENETIC FUZZY SYSTEM

# Integrated Fuzzy-GA Approach

## Generating of membership functions and rule base with GA

### Coding



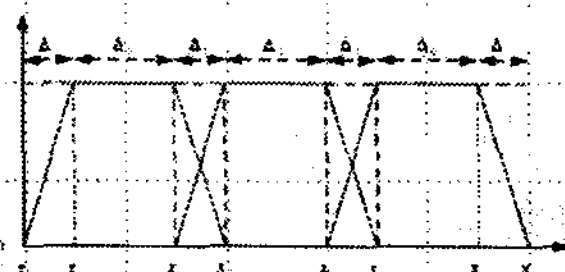
STRUCTURE OF CHROMOSOME

$$x_i = x_{i-1} + \Delta_{i-1}$$

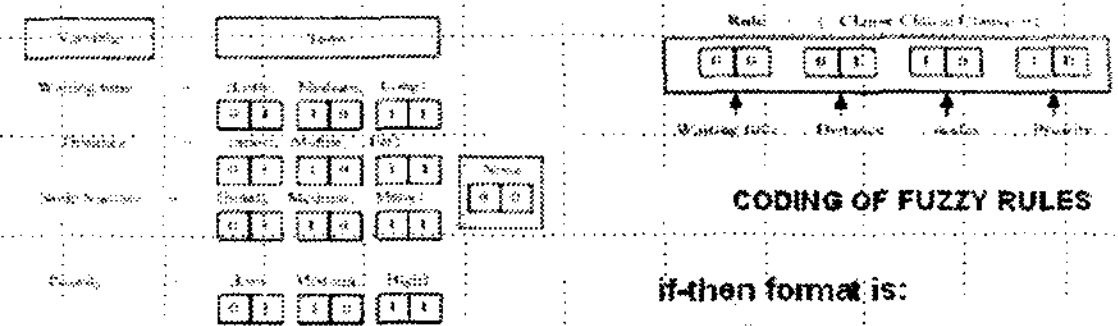
GENETIC REPRESENTATION OF FUZZY PARTITION

Membership values  $\mu_{A_i}(x)$  of all fuzzy sets  $A_i$  sum up to unity:

$$\sum_{i=1}^L \mu_{A_i}(x) = 1$$



# Integrated Fuzzy-GA Approach



CODING OF FUZZY RULES

CODING OF THE FUZZY INPUT AND OUTPUT

if-then format is:  
 If waiting time=None,  
 distance=Short, Node number=  
 Medium, then Priority=Medium.

# Integrated Fuzzy-GA Approach

### Fitness objective

$$F(C_j) = \frac{1}{N} \sum_{j=1}^N (r_j - x_j)^2, \quad F \geq 0$$

$C_j$  is chromosomes,  $r_j$  is desired values from actual terminal environments,  $x_j$  is output values generated from fuzzy systems, and  $N$  is total number of training data.

### Genetic operator

One point crossover, standard mutation and the stochastic universal sampling selection.

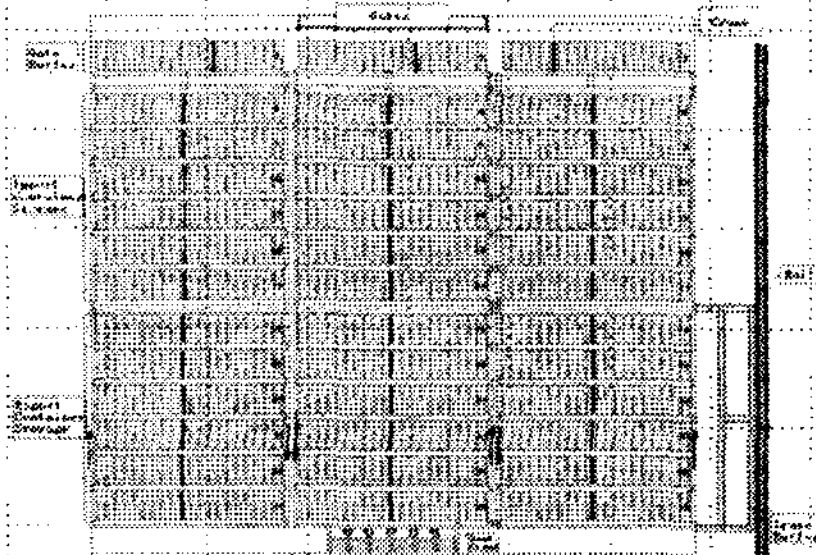
Stopping condition 500

# Integrated Fuzzy-GA Approach

## Genetic process of pruning the rule base

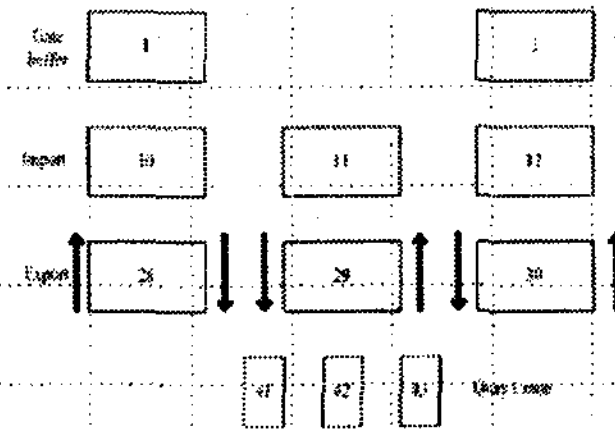
- ca coding and initial population are carried out again without any modifications in fitness objective and genetic operator selected in before section.
- ca the coding, initial population and stopping condition are some different from before section.
- ca For coding, a binary number '0' in every rules means redundant, which can be ignored canceled in rule bases, while '1' is necessary.
- ca For initial population, '1' is chosen as an initial condition of every gene such that all of its values are changed between 1 and 0 through operations.
- ca 100 is chosen as the maximum number of generations.

## Simulation Study



LAYOUT OF LMTT TERMINAL

## Simulation Study



Simulation model

- 1 Size of terminal : 1633 / 1875 ft<sup>2</sup>
- 2 Capacity of storage: 22,464 TEUs
- 3 Number of yard cranes: 6
- 4 Capacity of quay cranes: 90 seconds per a container box (for loading and unloading)
- 5 Capacity of yard cranes: 60 seconds per a container box
- 6 Speed for shuttle cars: 4 m/s for empty, 2 m/s for loaded shuttle cars
- 7 Number of shuttle cars: 10
- 8 Turning time of shuttle cars at junction points: 5 seconds

## Simulation Study

scenarios for ten shuttle cars are as follows:

Transferring of container boxes between the quay cranes and gate buffers and transferring of container boxes between the quay crane buffers and the storage areas.

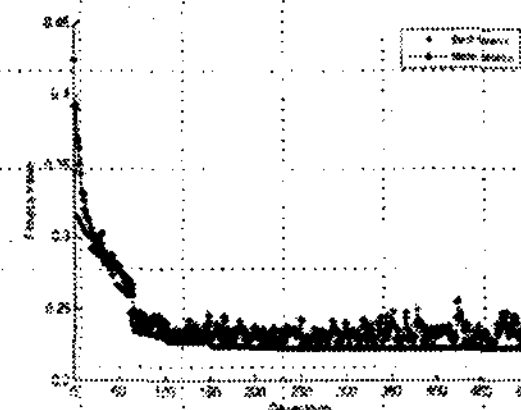
For the first scenario, an export container box placed on a shuttle car at the gate buffer is directly moved to a quay crane to load to a ship or to an export stack in port yard. Next, a shuttle car loaded with an import container box by a quay crane moves to the gate buffer or an import stacking area. Quay and yard cranes are assumed to serve shuttle cars based on First Come First Served (FCFS) queuing rule for multiple shuttle cars.

As stated in Section 2, two fuzzy dispatching rules are defined for comparative simulation as:

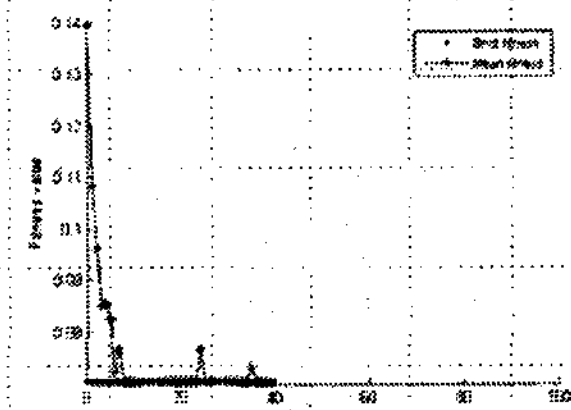
**Rule I:** Shuttle cars with fuzzy dispatching rule.

**Rule II:** Shuttle cars with the dispatching method proposed in this work.

## Simulation Study

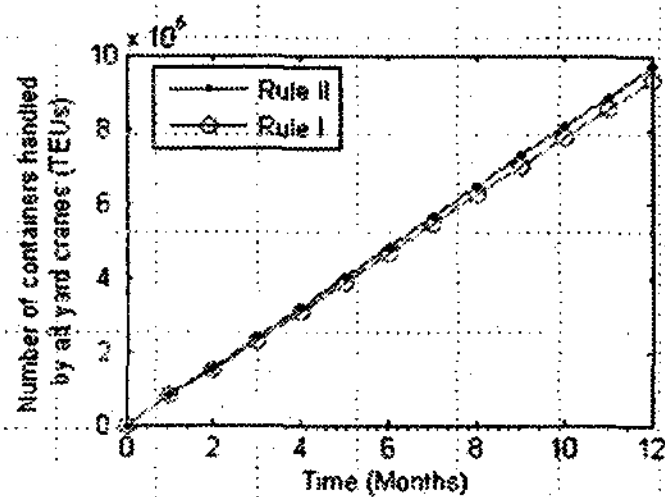


Generations of the first genetic process of Rule II



Generations of the second genetic process of Rule II

## Simulation Study



NUMBER OF CONTAINERS HANDLED BY ALL YARD CRANES USING TWO RULES (ONE YEAR)

## Conclusion

- ❖ This paper proposed a new approach for dispatching the shuttle cars of LMTT system by using genetic algorithm to optimize fuzzy membership functions and rules.
- ❖ In this work, firstly, a genetic process is proposed to generate suitable fuzzy membership functions and rule base. On the basis of the obtained rule base, another genetic process is carried out for pruning the redundant rules.
- ❖ Due to the more human-like method, not only the system is faster than before, but also a better performance is obtained.