Project Report

On

NURSES' SCHEDULING SYSTEM

(USING GENETIC ALGORITHM)

Team Members
Ankit Yadav (170001007)
Vinayak Mohite (170004040)

Computer Science and Engineering

B. Tech. 3rd Year

Under the Guidance of

Dr. Kapil Ahuja

Department of Computer Science and Engineering

Indian Institute of Technology Indore

Spring 2019

1. INTRODUCTION

Nurse scheduling problem (NSP), also called the nurse rostering problem (NRP), is the problem of determining an optimal way to assign nurses to shifts, typically with a set of hard constraints which all valid solutions must follow, and a set of simple constraints which define the relative quality of valid solutions. Answers to the nurse scheduling problem can be applied to constrained scheduling problems in other fields.

The nurse scheduling problem has been analysed since 1969 and is known to have NP-hard complexity!

2. GENERAL DESCRIPTIPON

In the nurse scheduling problem, we have to assign shifts and holidays to nurses, find a schedule which respects nurses' wishes and needs of the hospital, e.g., a nurse doesn't want to work a day shift just after a night shift, the hospital needs to have a certain number of nurses at night.

- Morning shift
- Evening shift
- Night shift

Nurses are categorized, depending upon their skill-set, into either of three classes i.e., class A, class B, class C. Here, class A nurses are most skilled and class C nurses least skilled.

3. ALGORITHM DESIGN

We defined our population size p = 100 schedules.

Total Nurse = 10

Class	Number of Nurses
A	5
B	3
C	2

Initially we randomly initialized all the 100 schedules.

- **Step 1:**

To calculate fitness value of each schedule, we assigned some score to each of the constraint. More influential the constraint, the higher is the penalty associated with it.

Sr. No.	Constraint	Fitness Score
1.	There must be at least one nurse allocated to every shift in every day	300
2.	There must be exactly one holiday in a week for every nurse	250
3.	Certain shift-patterns are not allowed i. Morning shift after night shift ii. ii. Evening shift after night shift	200
4.	There must be at least one nurse of class A in every morning and evening shift	150
5.	There must be exactly one nurse of class A in night shift	100
6.	There must be at least one and at most two-night shifts in a week for every nurse	50

- **Step 2:**

  If least fitness value in the population is zero, then stop executing the algorithm. The corresponding schedule will be the optimized schedule satisfying all the constraints.

- **Step 3:**
  - *Selection Operation:*

    We sorted the schedules in order of increasing fitness value. Top 10% schedules (in our case: 10 schedules) are directly included in the next generation.
  - *Crossover Operation:*

    To find remaining 90% schedules of next generation two schedules are chosen at random from top 50% schedules and crossover sites are chosen randomly. Then the shifts at these crossover sites are either exchanged (in 90% cases) and mutated to completely new value (in 10 % cases).

Return to Step 1.

> Note:
> There are many possible optimal schedules (schedules having fitness value zero). One of them will be displayed when the algorithm completely executed completely.

4. Implementation and Result

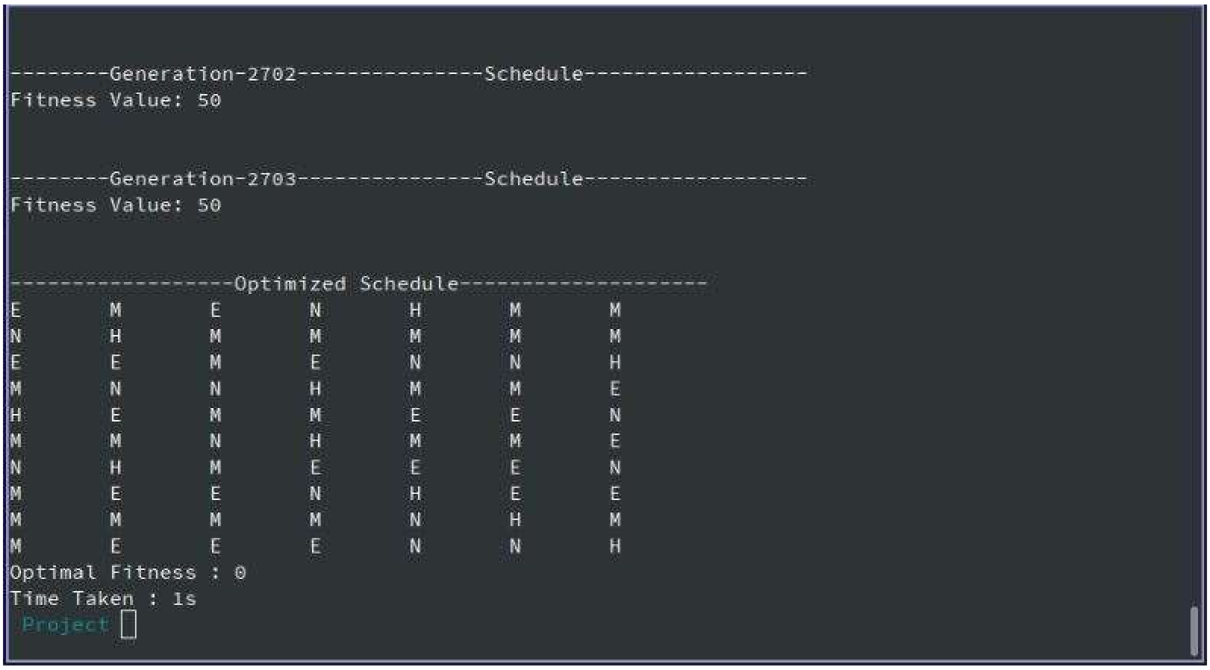
Objective function to be minimized:

$$F = C_1 * 300 + C_2 * 250 + C_3 * 200 + C_4 * 150 + C_5 * 100 + C_6 * 50$$

where C_1, C_2, C_3, C_4, C_5, and C_6 denotes number of occurrence of constraints 1, 2, 3, 4, 5 and 6, respectively.

Hence C_1, C_2, C_3, C_4, C_5, and $C_6 >= 0$.

After executing the algorithm, one of the possible optimal schedules is displayed as shown in picture.



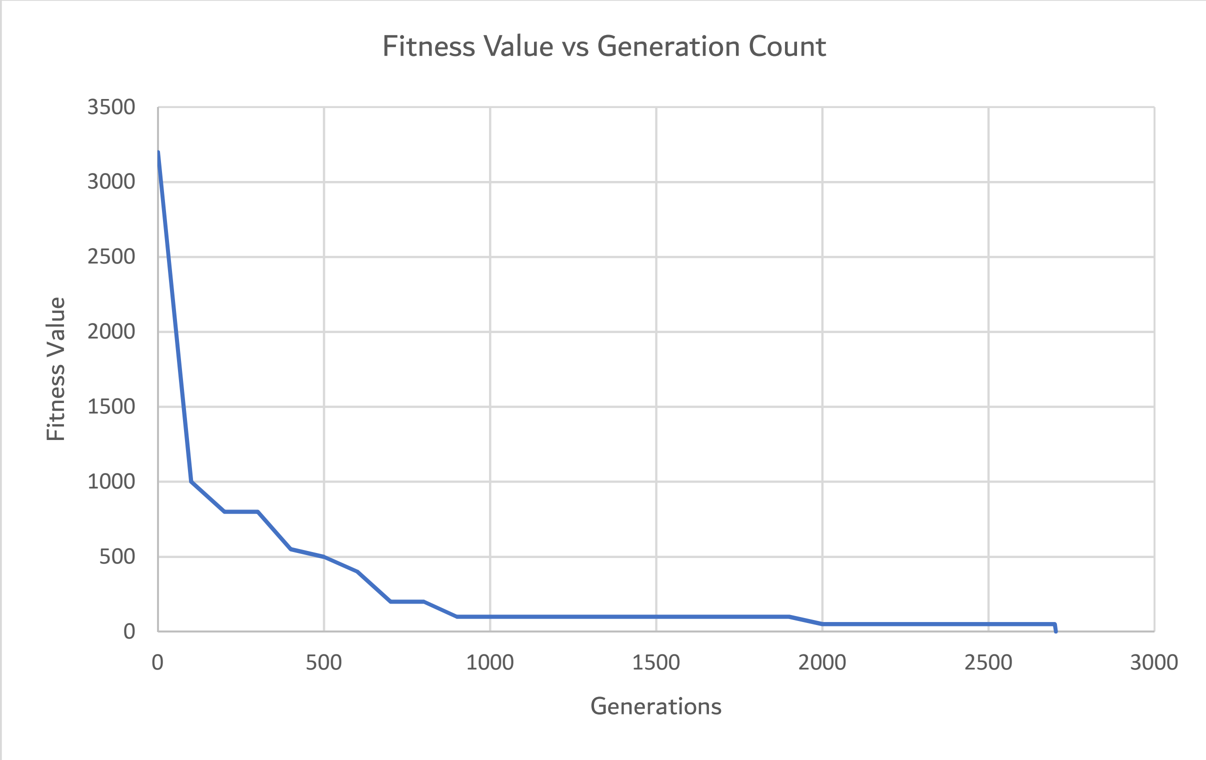
```
--------Generation-2702---------------Schedule------------------
Fitness Value: 50

--------Generation-2703---------------Schedule------------------
Fitness Value: 50

------------------Optimized Schedule--------------------
E       M       E       N       H       M       M
N       H       M       M       M       M       M
E       E       M       E       N       N       H
M       N       N       H       M       M       E
H       E       M       M       E       E       N
M       M       N       H       M       M       E
N       H       M       E       E       E       N
M       E       E       N       H       E       E
M       M       M       M       N       H       M
M       E       E       E       N       N       H
Optimal Fitness : 0
Time Taken : 1s
 Project
```

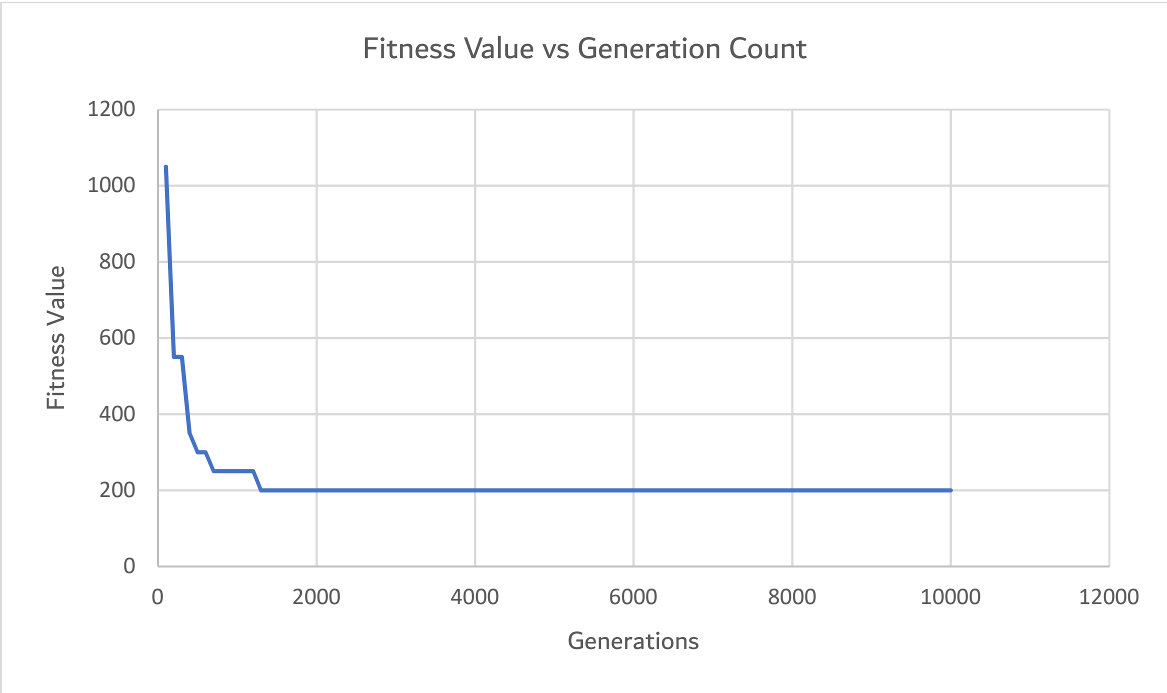
Here M stands for morning shift, E stands for evening Shift, N stands for night shift, H stands for Holiday.

In our implementation,

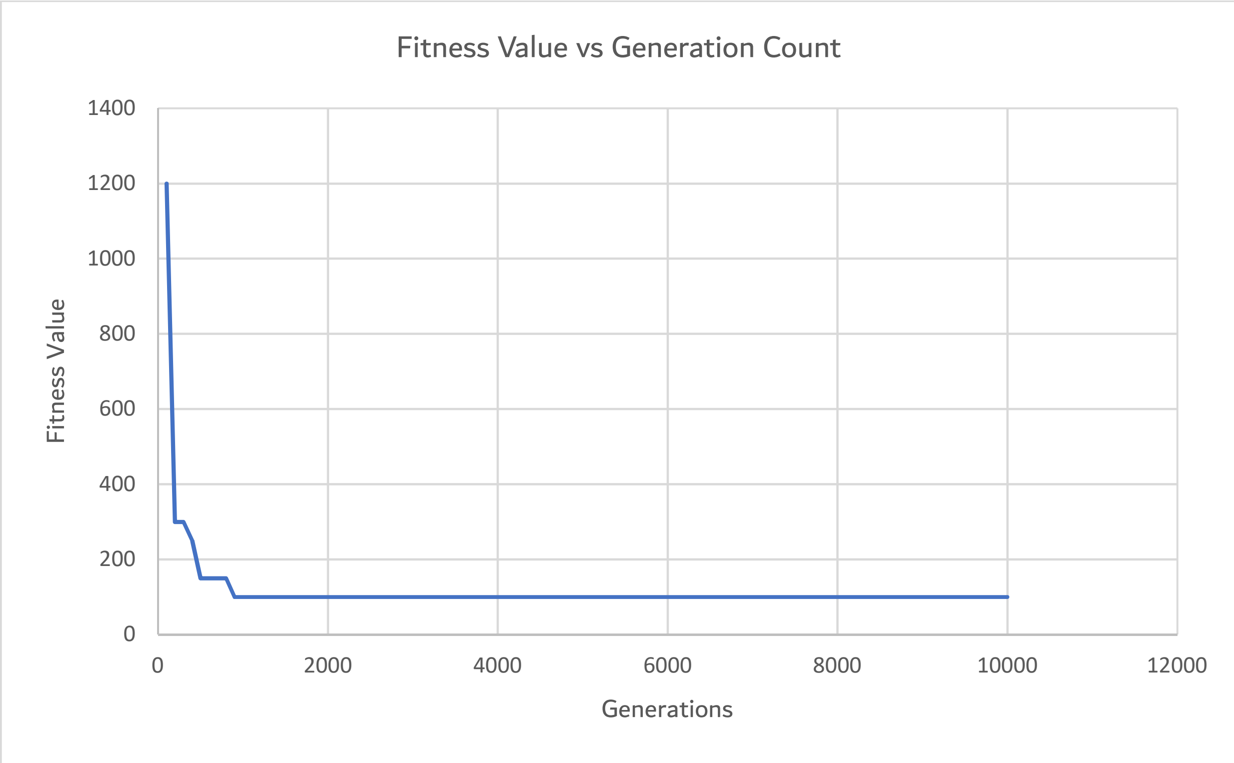


The following are the graphical illustrations of fitness value vs the generation count.

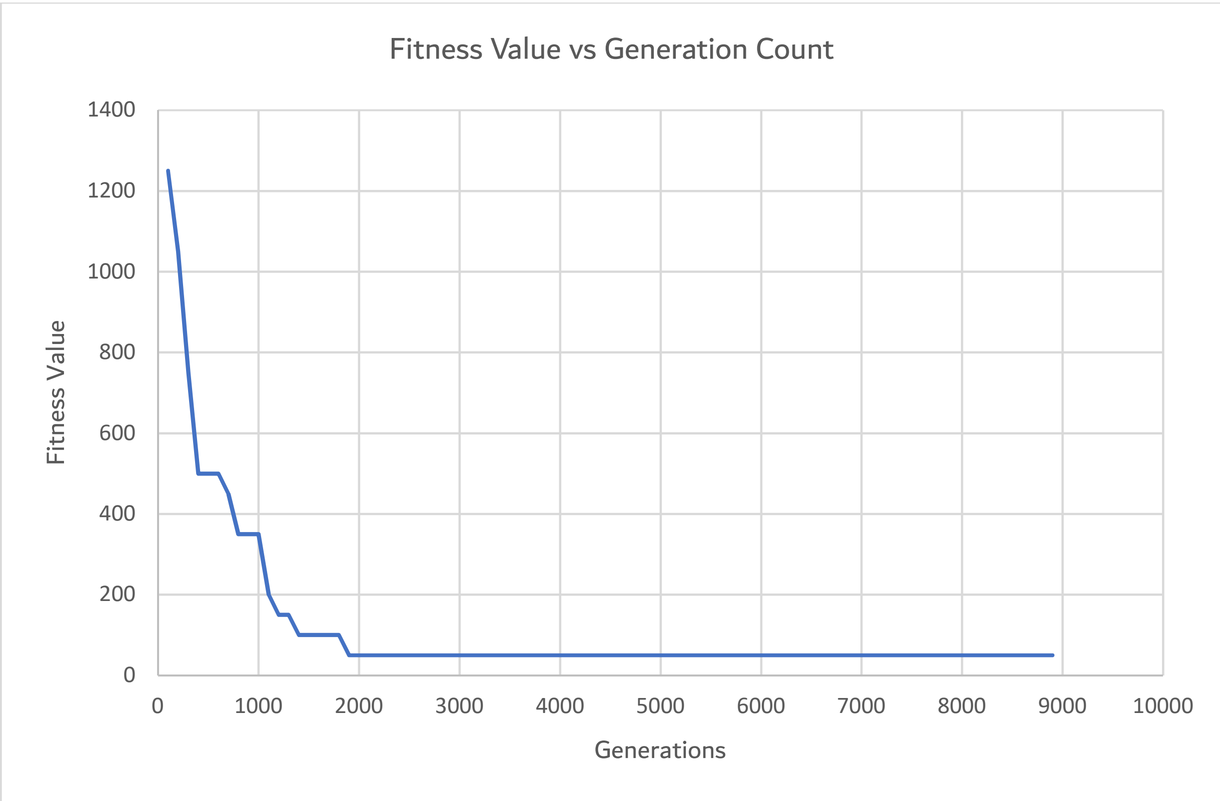
Population size = 50



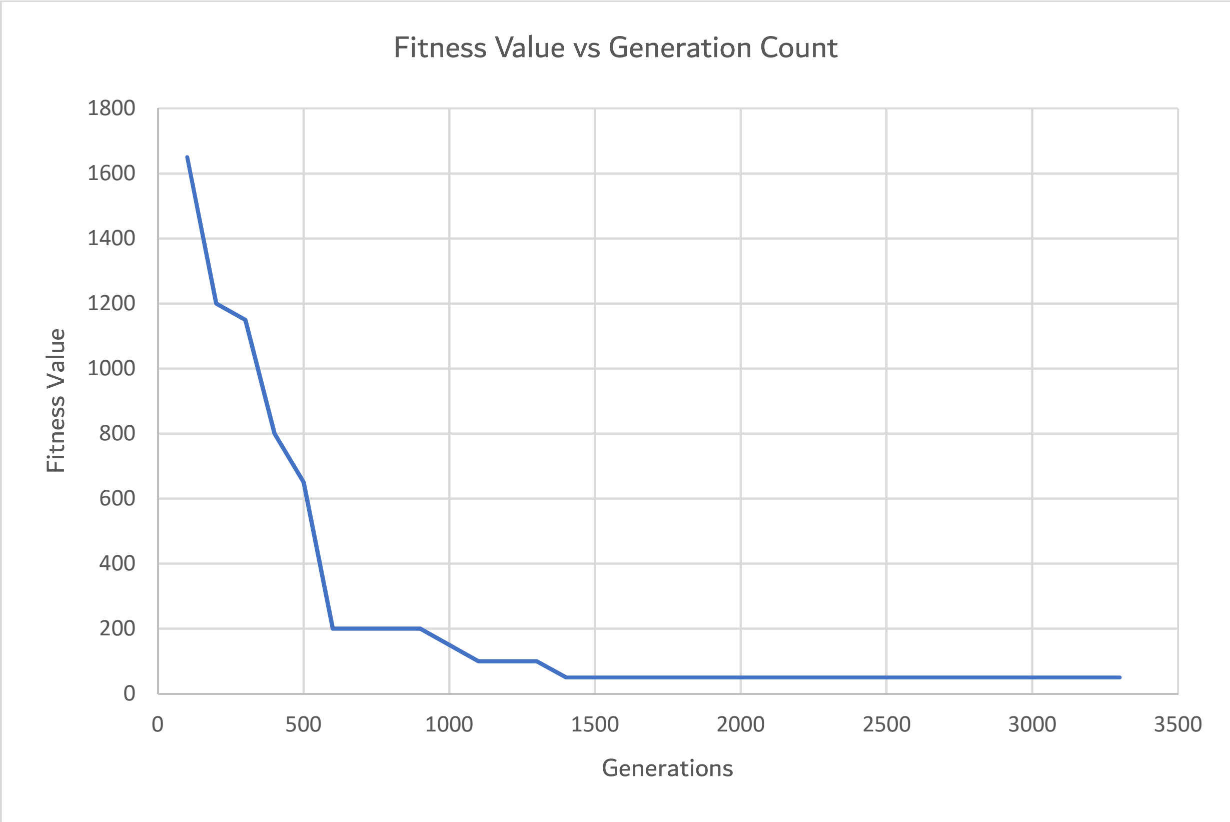
Population size = 100



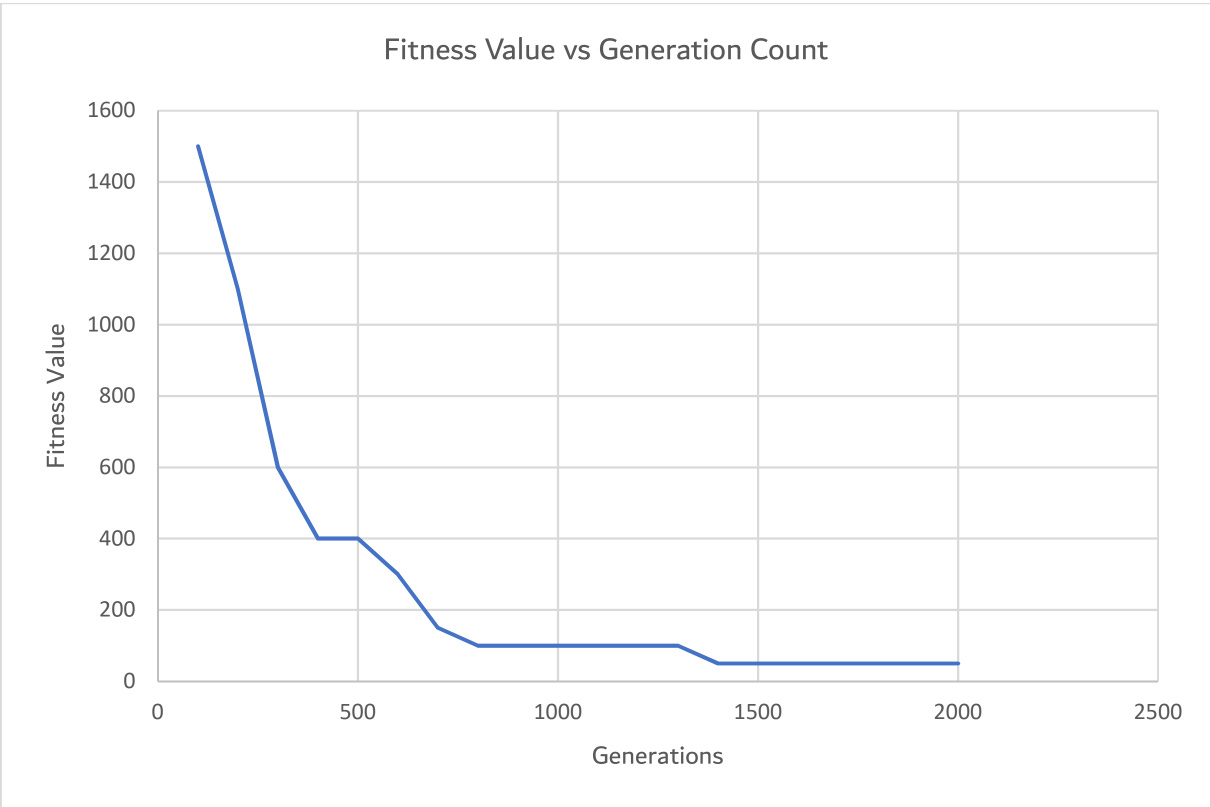
Population size = 200



Population size = 500



Population size = 1000



From the earlier graphs, it can be inferred that as population size grows, the rate of convergence for the algorithm increases. In other words, it takes lesser generations to reach an optimal solution when population size is bigger (Refer the limiting generation for each graph).

5. REFERENCES

https://www.chcf.org/wp-content/uploads/2017/12/PDF-AdoptingOnlineNurseSchedulingAndStaffing.pdf

https://en.wikipedia.org/wiki/Nurse_scheduling_problem

https://ieeexplore.ieee.org/document/934317

https://en.wikipedia.org/wiki/Genetic_algorithm