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6.11)

Initially Red is assigned for WA and blue is assigned for V. The rest of cities have a possibility of taking any one of 3 colors such that two cities are adjacent to each other don't have same color using AC-3 algorithm:-

	WA	NT	SA	Q	NSW	V	T	Removing
Initial	R	RGB	RGB	RGB	RGB	B	RGB	-
SA-WA	R	RGB	GB	RGB	RGB	B	RGB	R from SA
SA-V	R	RGB	G	RGB	RGB	B	RGB	B from SA
NT-SA	R	RB	G	RGB	RGB	B	RGB	G from NT
NT-WA	R	B	G	RGB	RGB	B	RGB	R from NT
Q-NT	R	B	G	RG	RGB	B	RGB	B from Q
Q-SA	R	B	G	R	RGB	B	RGB	G from Q
NSW-V	R	B	G	R	RG	B	RGB	B from NSW
NSW-SA	R	B	G	R	R	B	RGB	G from NSW
NSW-Q	R	B	G	R		B	RGB	R from NSW

------------ Leaving no domain for NSW

Leaving only blue for NT

Leaving only green for SA

Leaving only red for Q

Leaving no domain for NSW shows that arc consistency can detect the inconsistency of the partial assignment.

2 A)

f(x)= x(sin(x^-1)) =x(sin(1/x)) is one of the mathematical function which has more than one local minimum.

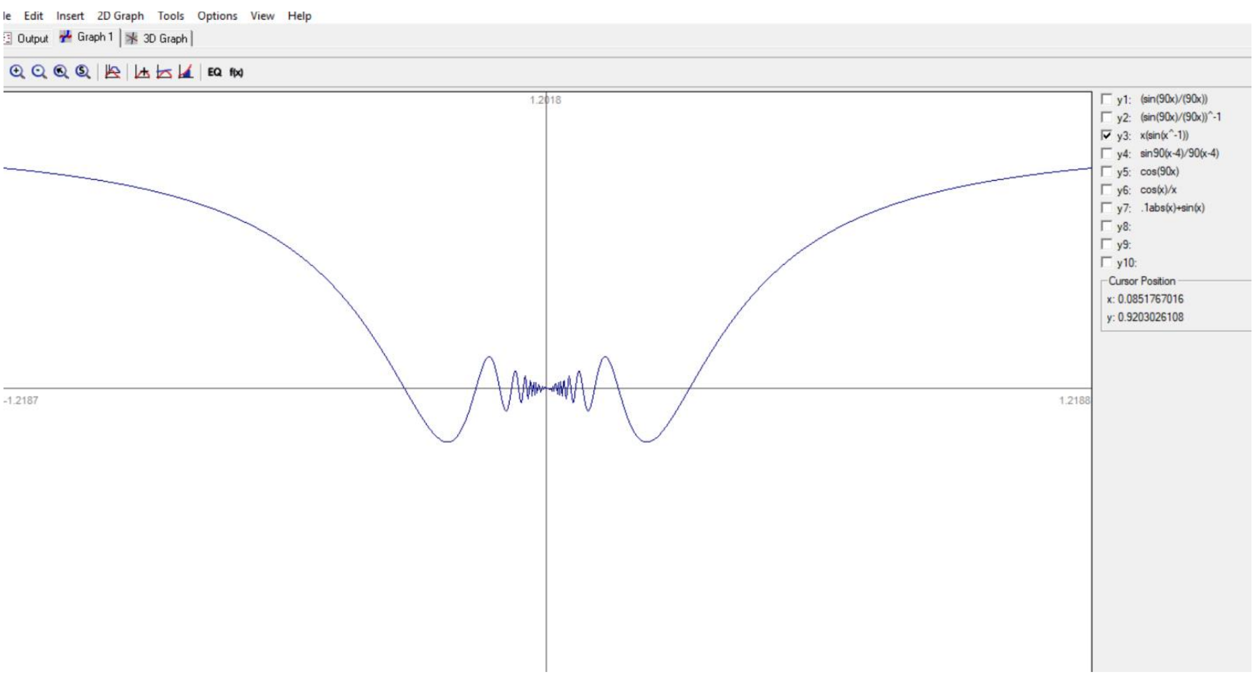

Fig 1 Plot of the function x(sin(x^-1))

2 B)

Observed x and f(x) (global minimum) values were x = - 0.221, f(x)= - 0.2162 and at x=0.221, f(x)= - 0.2162

When plotted the function f(x)= x(sin(x^-1)) over range of x values, with the help of graph we could point out that at x = - 0.221, f(x)= - 0.2162 and at x=0.221, f(x)= - 0.2162 were the global minimum i.e. the graph has two global minima

Changing the settings at the top:

- Changed the chrome length in the program to 20 bits to find the global minimum to a precision of 20 bits

- When the population size was 20 the global minimum was found to be -0.2106 at x = -0.2353 and when the population size was 40 at x= -0.2224 global minima is -0.2172, So when the population size is more we are obtaining a global minimum close to observed values from the graph.
- When the mutation is 0.09 global minimum is -0.2068 at x= -0.2078 which is less accurate and when the mutation is 0.01 at x= 0.2193 global minimum = -0.2168 which is also less accurate from the observed values. But when mutation is 0.05 and 0.03, at x= -0.2224 global minima is -0.2172 which is closer to observed values.
- Too high mutation rate increases the probability of searching more areas in search space, however, prevents population to converge to any optimum solution. On the other hand, too small mutation rate may result to premature convergence (falling to local optima instead of global optimum). So, for the intermediate mutation values the accuracy is better. When the population size is more and when mutation is less the values are approximately equal to observed values.
- When the no of generations =200 at x=-0.2225 global minimum = -0.2172 which more efficient. Higher the no of generations accurate is the global minimum.
- Elitism involves copying a small proportion of the fittest candidates, unchanged, into the next generation. When elite is 1 the global minimum almost matches the observed values (x= -0.2255 Fitness = -0.2169.When elite is 0 the global minimum value to some extent (-0.2224 Fitness = -0.2172)

Changing conv Range function:

- The graph is plotted in the range of 4,-4 along x -axis and 2,-2 along y -axis. When the convrange function is ((((double)raw)/65535.0)*120.0)-60.0 (-60,60) then the accuracy of the global minimum is less, but when the convrange function is ((((double)raw)/65535.0)*10.0)-5.0 (-5, 5) the accuracy is more because the plot of the function falls in that range.

2C) The different combinations tried:

- When POPULATION_SIZE **20** CHROM_LENGTH **25**
  Decoded value = -0.2106 at x = -0.2353 the global minimum values are not nearest to the observed values

- POPULATION_SIZE **10** MAX_GEN **200**
  Decoded value = - 0.2102 Fitness = -0.2332 the global minimum values are not nearest to the observed values

- POPULATION_SIZE **10** PMUT **0.05** MAX_GEN **25**
  Decoded value = -0.2735 Fitness = -0.1346
  When the max generation is 25 for population size 10 there is drastic difference in global minimum from the observed values from graph

- POPULATION_SIZE **200** PMUT **0.03** MAX_GEN **20**
  Decoded value = -0.2232 Fitness = -0.2172 almost equal to the observed global minimum value from graph

- POPULATION_SIZE **200** PMUT **0.03** MAX_GEN
  Decoded value = -0.2232 Fitness = -0.2172
  When the max generation is 10,20 for population size 200 the global minimum is approximately equal to observed values. Hence when the population size is 200 or 300 the algorithm is efficient

Conclusion:

- When the population size is 10 or 20 and when the max generations are changed from 25 to 200, there is much difference in the global minimum from the observed values of the global minimum from the graph.
- When the population size is 200 or 300 and when the max generations are changed from 25 to 200, the global minimum obtained is consistent and is approximately equal to the observed values of the global minimum from the graph.
- When the population size is 75, 90 or150 the obtained values of global minimum were approximately equal to the observed values of global minimum from graph.
- Hence the Genetic Algorithm is more efficient at finding a solution when using a large population (200 or more) or something in between(70,90,150) than using a small population (10 or 20)

3A)

Tried with two set of 15 points

1st set

in-list

(-0.222, -0.129, -0.0931, -0.0716, -0.058, -0.0473, -0.043, -0.0358, -0.0286, -0.019, -0.004, 0, 0.0058, 0.010, 0.012))

out-list

(-0.213, 0.217,-0.088, 0.068,-0.0506, 0.046, -0.028, 0.036, 0.024, -0.022, 0.003, 0, 0.0053, 0.0070, 0.0146))

For

N1=10 N2=20 Error = 0.392378948132

N1=10 N2=10 Error= 0.2026044146335887

2nd set

in-list

(-5.145, -0.438, -0.071, -0.058, -0.0080,-0.0037, -0.0015, -0.0001, 0.0003, 0.0021, 0.0055, 0.0337, 0.2224, 0.990, 7.211)

out-list

(0.997, 0.3864, 0.070, -0.058, 0.0076, 0.0031, -0.0014, 0.0002, -0.0003, 0.0021, -0.0052, -0.0330, -0.2171, 0.8647, 1.0182)

For

N1=6 N2=20 Error = 0.1902832938238393

N1=5 N2=20 Error = 0.1173787176402398

3B)

For N1=5 N2=20 Error= 0.1173787176402398 with the 2nd set of points

After converting the prefix expression, we obtained a function **sin(x/(x-1))** and plotted the same in the graphic calculator and its plot is similar to the function **x(sin(x^-1))** which we designed.

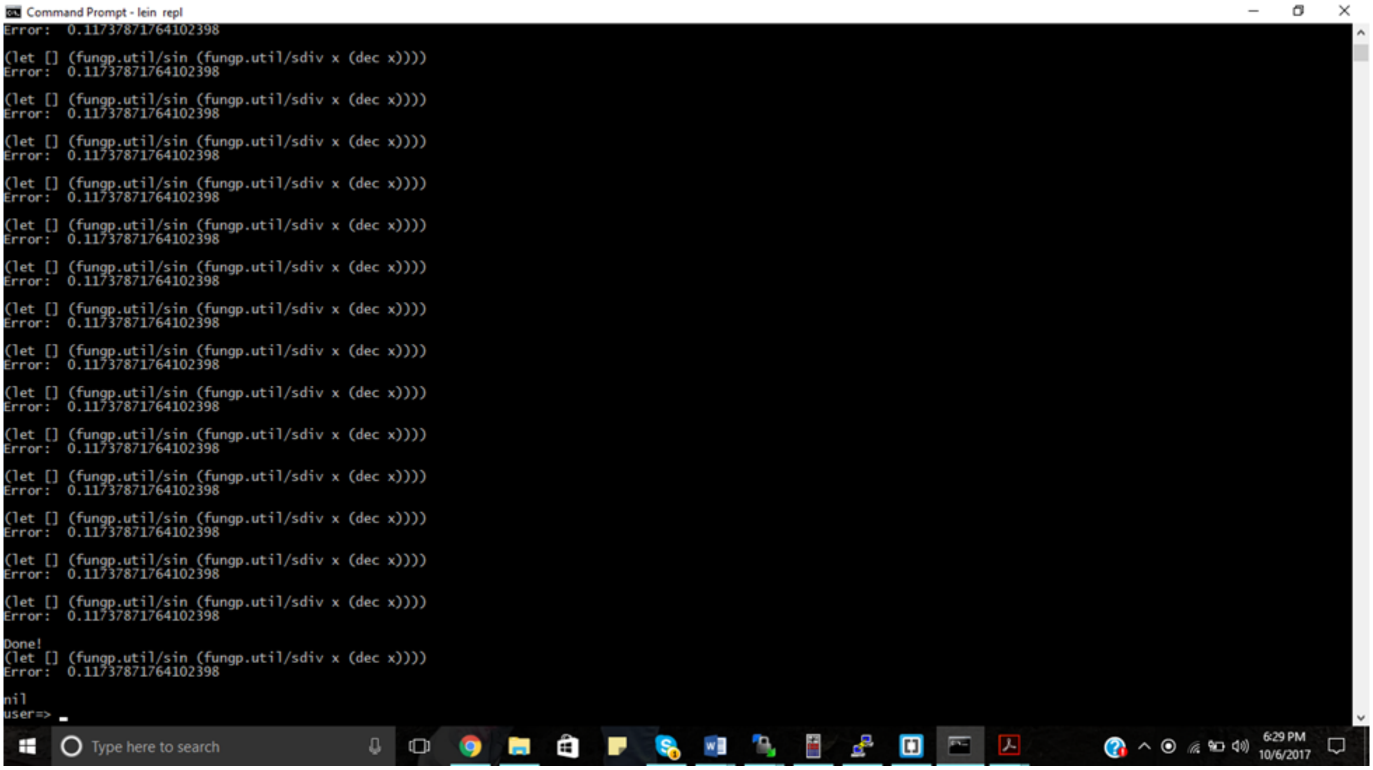

Fig 2: The error rate and the prefix expression for N1=5 and N2=20

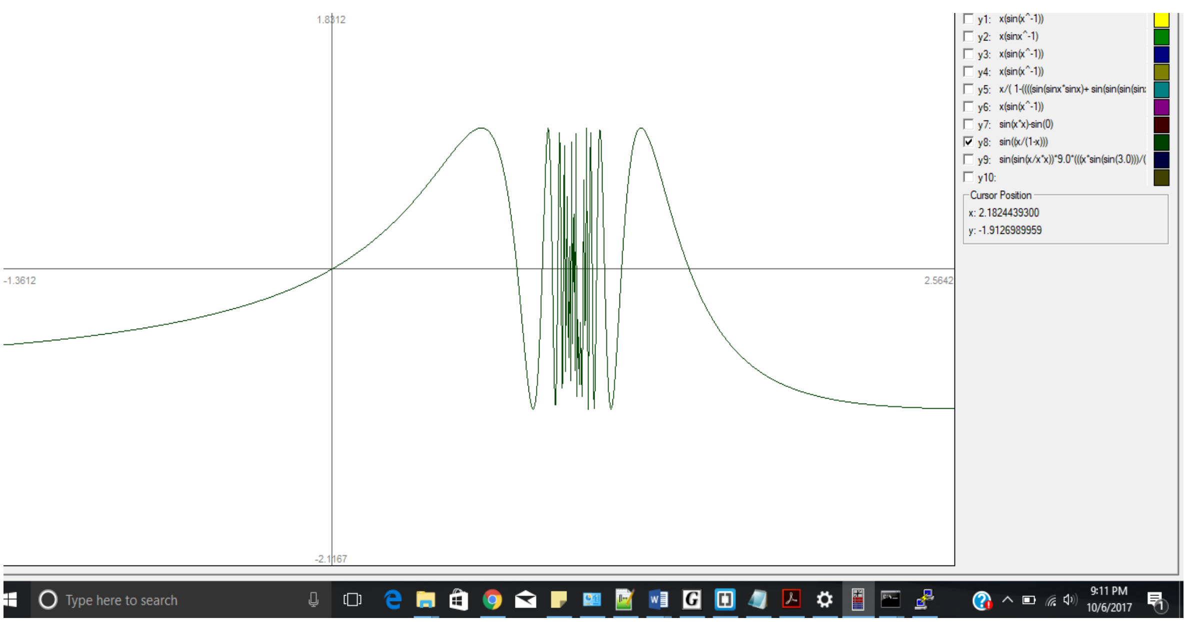

Fig 3 Plot of the function sin(x/(x-1))

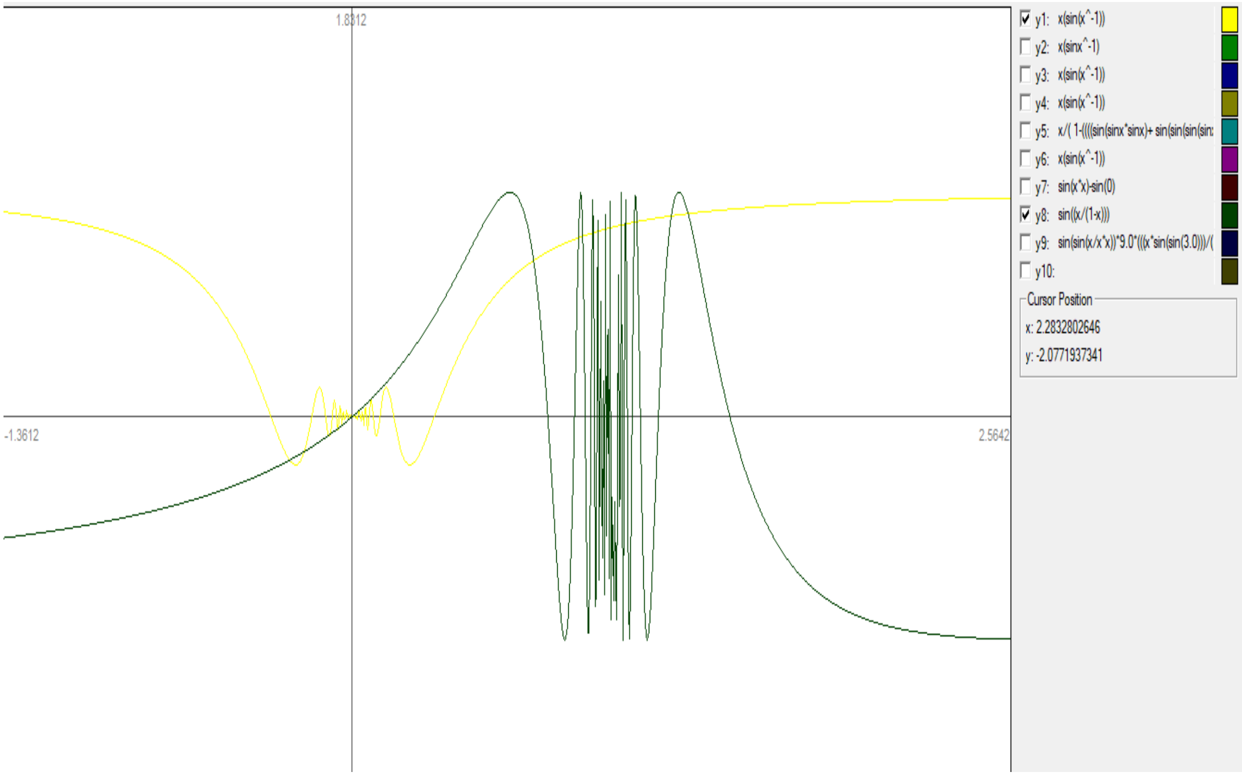

Figure 4 Comparing the plot of both the original function (yellow) and the fungp function (green)

- The function **sin(x/(x-1))** is shown in green color and its obtained by using points of the plot of the function **x(sin(x^-1))** which is shown in yellow color.
- The function obtained from fungp is similar to original function, where the graph of the function from fungp is shifted slightly towards the 1st quadrant and this function also has two global minimum similar to that of the original function.
- Both the global minima of the function obtained from fungp is in 1st quadrant, but the two global minimum of the original function is in 1st and 2nd quadrants
- the original function and the function obtained from fungp has almost same no of local minima and two global maxima.Hence the fungp function is almost close to the original function

The reason for not getting exact match from our analysis is that the range of the function **x(sin(x^-1))** is very small and it becomes stable at point (2.2 , 0.9) as shown in the figure below. So, within this small range we need to identify more no of points which form an accurate set and give these inputs to fungp for accurate analysis. But we have provided only 15 input points which is not enough for the fungp to produce the graph accurately.

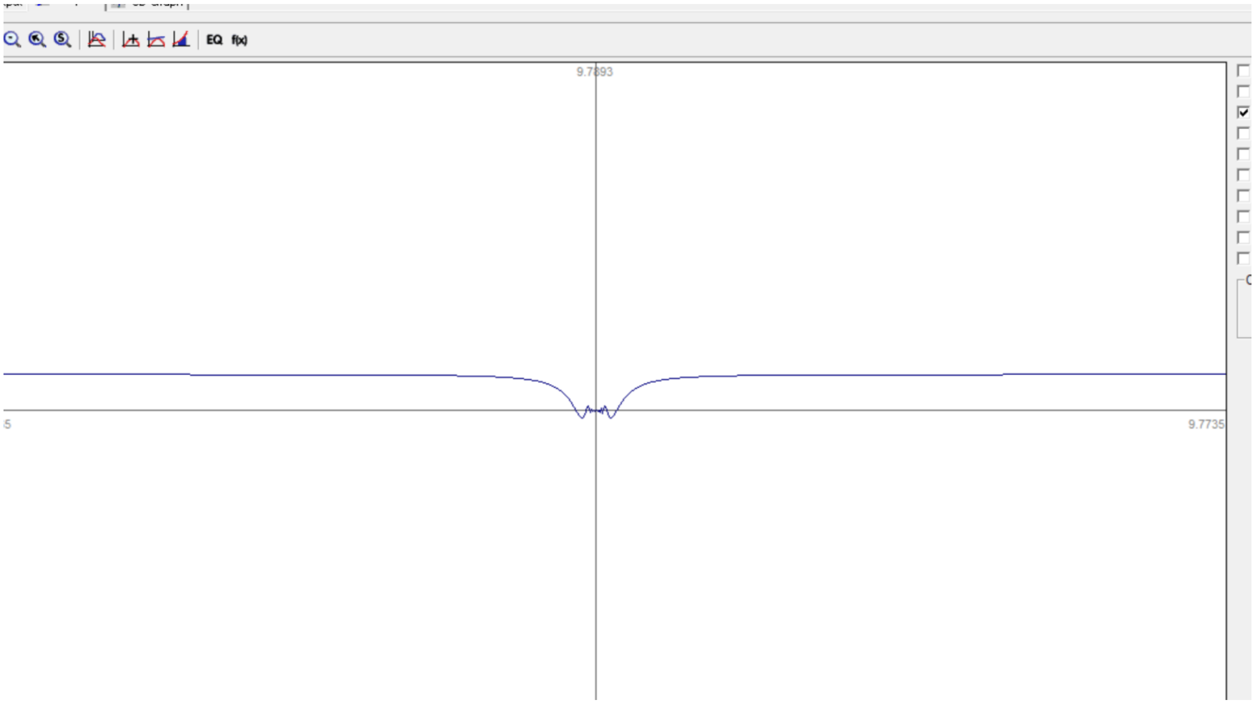

Fig 5 Plot of the function x(sin(x^-1)) becomes stable at point (2.2,0.9)