Multi-modal optimization

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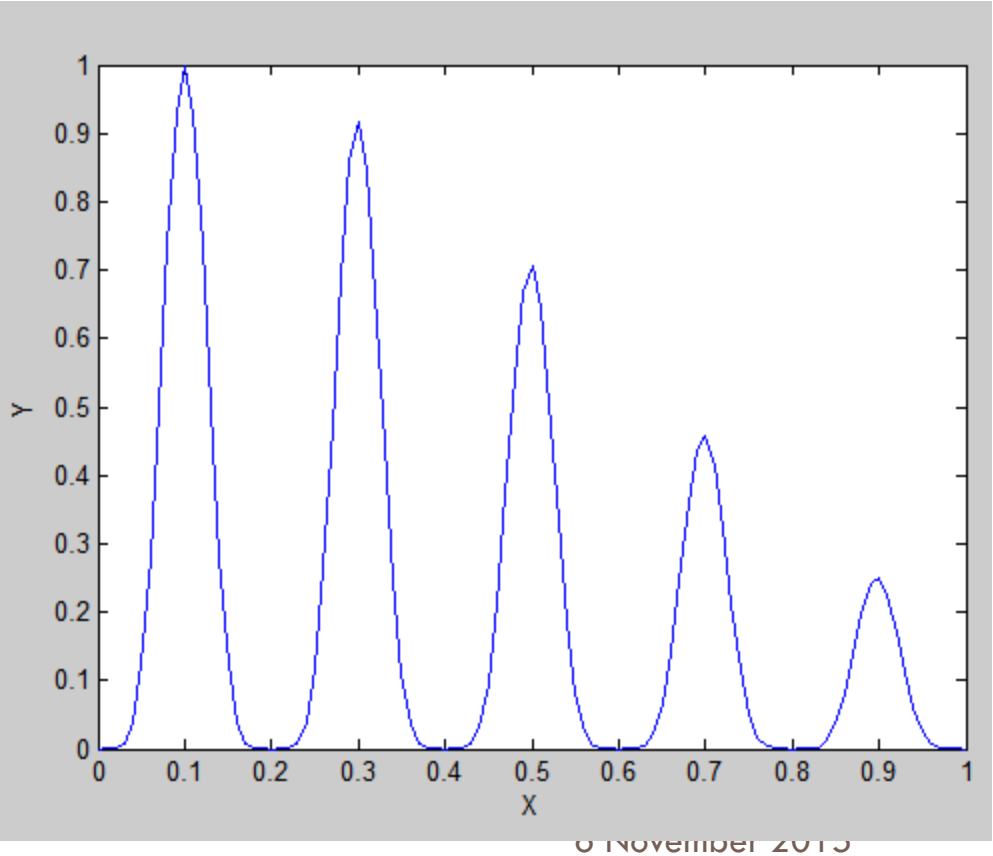
6 November 2015

Multi-modal optimization

$$Minimize\ f(x) = 2^{-2\left(\frac{(x-0.1)}{0.8}\right)^2} sin^6(5\pi x)$$

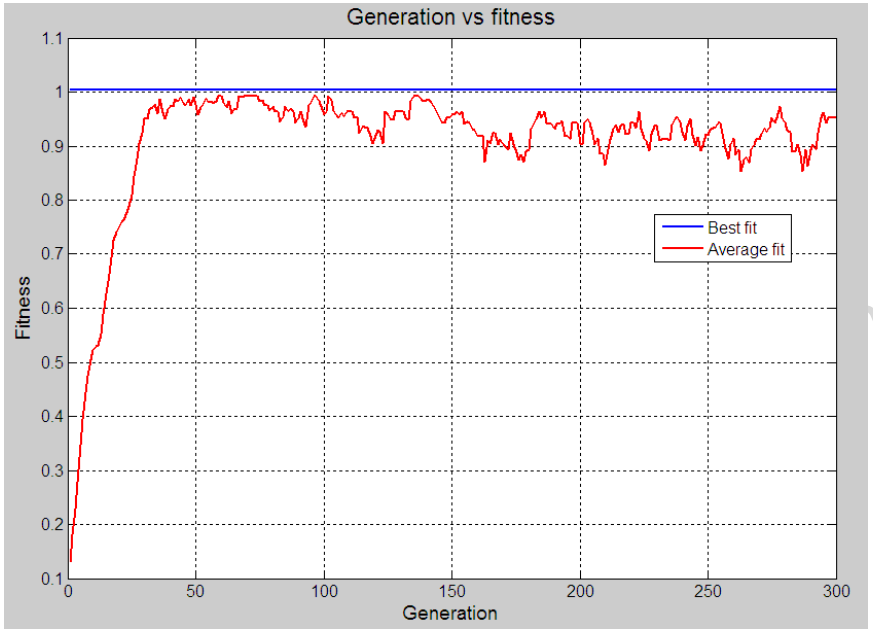
$$0 \leq x \leq 1$$

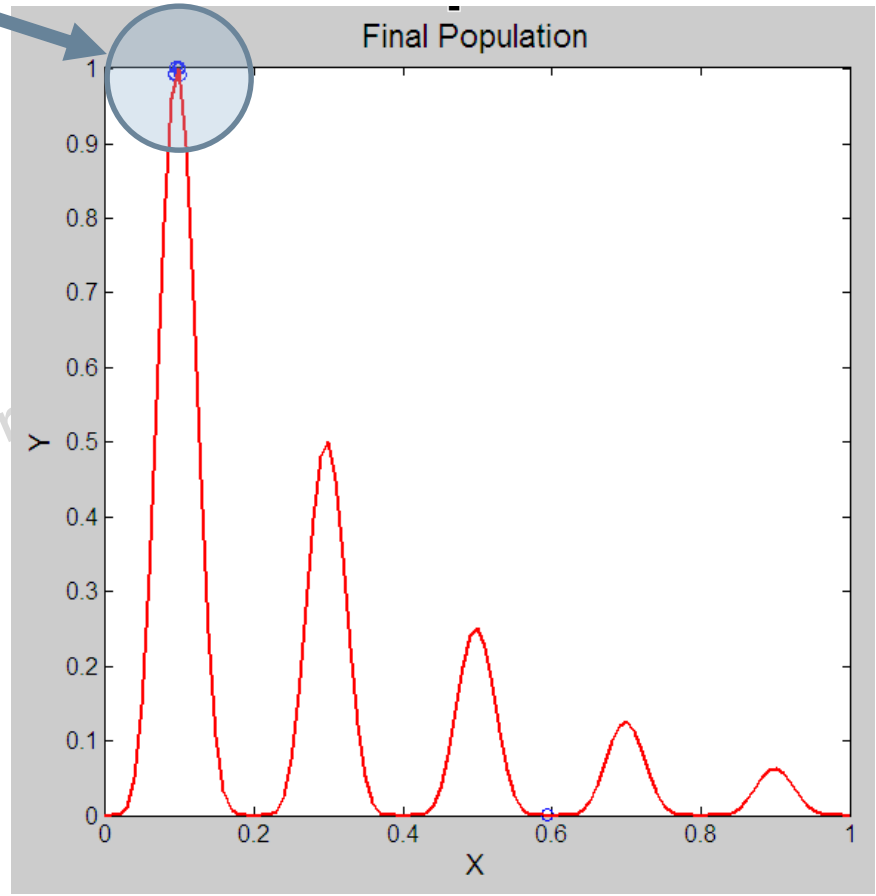
Solve this problem using simple Genetic Algorithms



After Generation 200

The population are in and around the global optimal solution





Multi-modal optimization

Simple modification of Simple Genetic Algorithms can capture all the optimal solution of the problem including global optimal solutions

Basic idea is that reduce the fitness of crowded solution, which can be implemented using following three steps.

Sharing function $$Sh(d_{ij}) = \begin{cases} 1 - (d_{ij}/\sigma), & \text{if } d_{ij} < \sigma; \\ 0, & \text{otherwise.} \end{cases}$$

Niche count $$nc_i = \sum_{j=1}^{N} Sh(d_{ij})$$

Modified fitness $$f_i' = \frac{f_i}{nc_i}$$

Hand calculation

Maximize $f(x) = |sin(\pi x)|$

$$0 \leq x \leq 2$$

Sol	String	Decoded value	x	f
1	110100	52	1.651	0.890
2	101100	44	1.397	0.942
3	011101	29	0.921	0.246
4	001011	11	0.349	0.890
5	110000	48	1.524	0.997
6	101110	46	1.460	0.992

Distance table

dij	1	2	3	4	5	6
1	0	0.254	0.73	1.302	0.127	0.191
2	0.254	0	0.476	1.048	0.127	0.063
3	0.73	0.476	0	0.572	0.603	0.539
4	1.302	1.048	0.572	0	1.175	1.111
5	0.127	0.127	0.603	1.175	0	0.064
6	0.191	0.063	0.539	1.111	0.064	0

Sharing function values

sh(dij)	1	2	3	4	5	6	nc
1	1	0.492	0	0	0.746	0.618	2.856
2	0.492	1	0.048	0	0.746	0.874	3.16
3	0	0.048	1	0	0	0	1.048
4	0	0	0	1	0	0	1
5	0.746	0.746	0	0	1	0.872	3.364
6	0.618	0.874	0	0	0.872	1	3.364

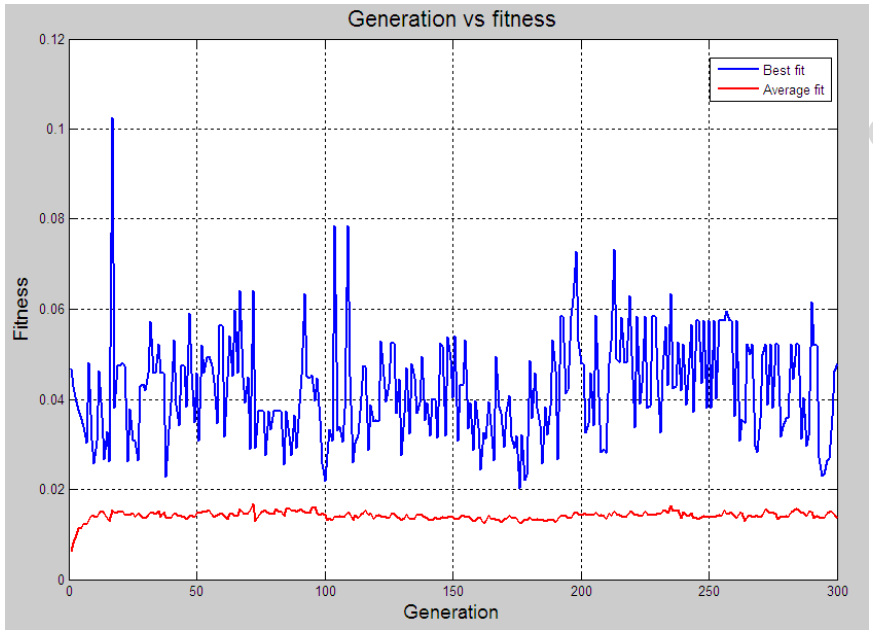
Sharing fitness value

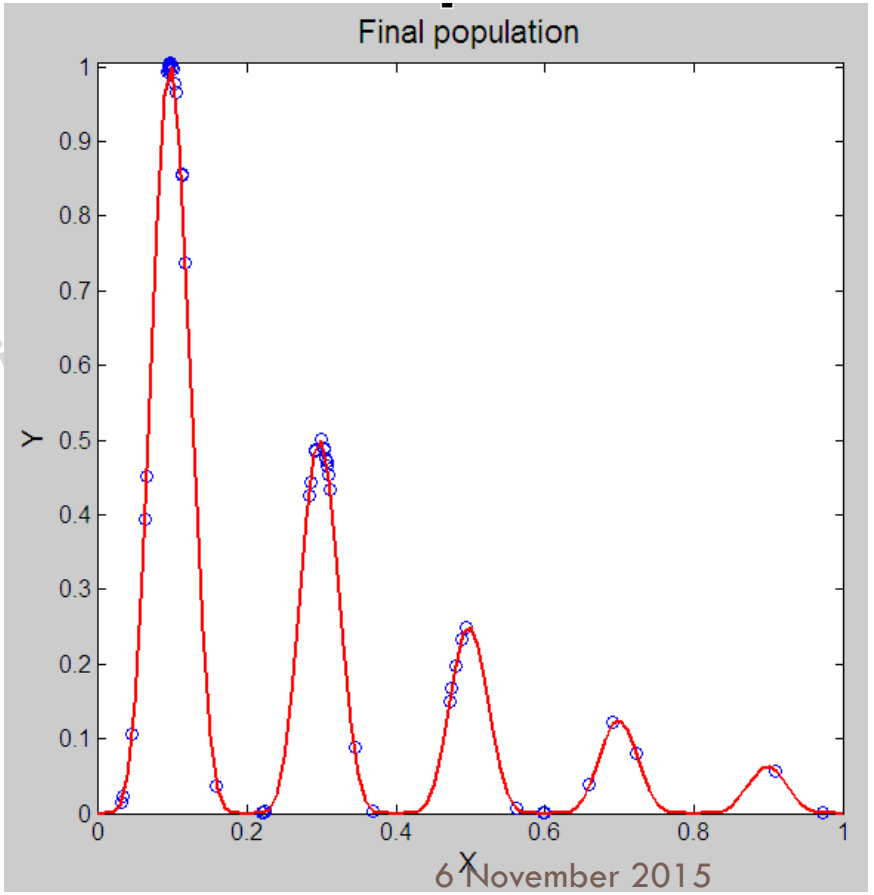
Sol	String	Decoded value	x	f	nc	f'
1	110100	52	1.651	0.890	2.856	0.312
2	101100	44	1.397	0.942	3.160	0.300
3	011101	29	0.921	0.246	1.048	0.235
4	001011	11	0.349	0.890	1.000	0.890
5	110000	48	1.524	0.997	3.364	0.296
6	101110	46	1.460	0.992	3.364	0.295

Solutions obtained using modified fitness value

$$Minimize\ f(x) = 2^{-2\left(\frac{(x-0.1)}{0.8}\right)^2} sin^6(5\pi x)$$

$$0 \le x \le 1$$





Q. For a two variables (x, y) problem, arrange the following solutions in descending order as per crowding distance criteria. First six bits represent the variable x and the rest bits represent the variable y. The solutions are 0110110011, 1010111100, 0010001110, 1111001101 and 1100110001. Take $\sigma_{share} = 5$ and $\alpha = 1$, lower and upper bounds of x and y as 0 and 10, respectively.

Bin Value		DV		x	y
011011	0011	27	3	4.29	2.00
101011	1100	43	12	6.83	8.00
001000	1110	8	14	1.27	9.33
111100	1101	60	13	9.52	8.67
110011	0001	51	1	8.10	0.67

	1	2	3	4	5
1	0.00	6.52	7.93	8.48	4.04
2	6.52	0.00	5.71	2.78	7.44
3	7.93	5.71	0.00	8.28	11.03
4	8.48	2.78	8.28	0.00	8.13
5	4.04	7.44	11.03	8.13	0.00

	1	2	3	4	5	nc
1	1.00	0.00	0.00	0.00	0.19	1.19
2	0.00	1.00	0.00	0.44	0.00	1.44
3	0.00	0.00	1.00	0.00	0.00	1.00
4	0.00	0.44	0.00	1.00	0.00	1.44
5	0.19	0.00	0.00	0.00	1.00	1.19

			nc
0010001110		3	1.00
0110110011		1	1.19
1100110001		5	1.19
1010111100		2	1.44
1111001101		4	1.44

THANKS

6 November 2015