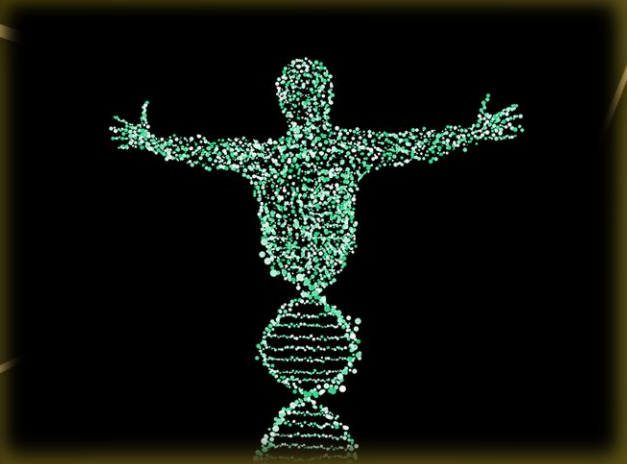


Optimization and Heuristic Methods Project

Colony of Genetic Artifical Bees (CoGAB) for optimzing bank loan lending decisions

19IM10039 – Debraj Chatterjee
Department of Industrial and Systems Engineering

Heuristics

Genetic Algorithm

Artificial Bee Colony

Colony of Genetic Artificial Bees

D	60	Dataset for 10 Customers								
K	0.15									
Loan Size	10	25	4	11	18	3	17	15	9	10
Interest	0.021	0.022	0.021	0.027	0.025	0.026	0.023	0.023	0.028	0.022
Rating	AAA	BB	A	AA	BBB	AAA	BB	AAA	A	A
Loss (λ)	0.0002	0.0058	0.0001	0.0003	0.0024	0.0002	0.0058	0.0002	0.001	0.001

Problem Formulation

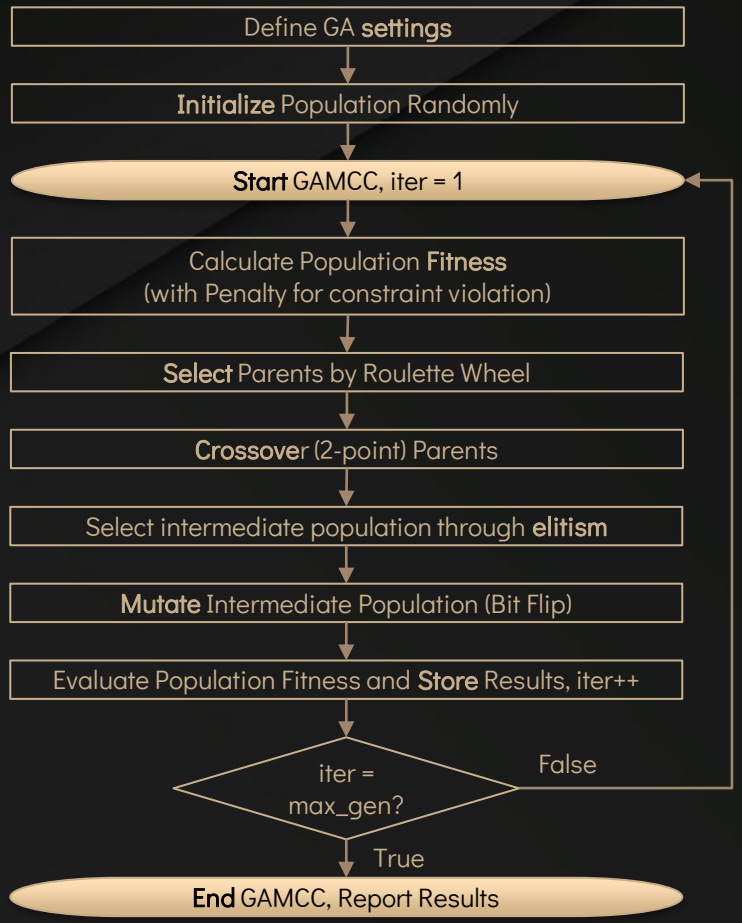
ID	1	2	3	4	5	6	7	8	9	10
Value	1	0	0	1	0	0	1	0	0	0

Loan Size	25
Interest	0.022
Rating	BB
Loss (λ)	0.0058

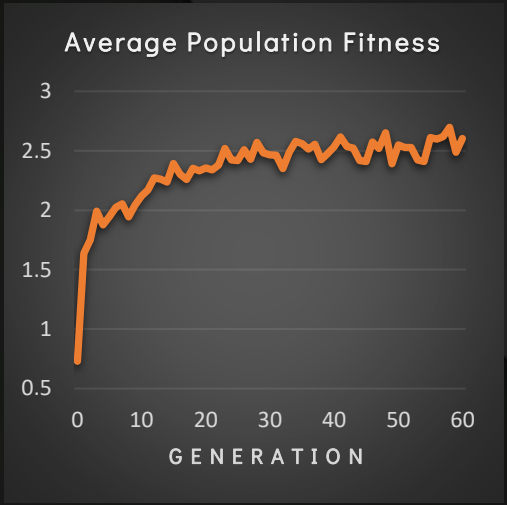
Not Selected

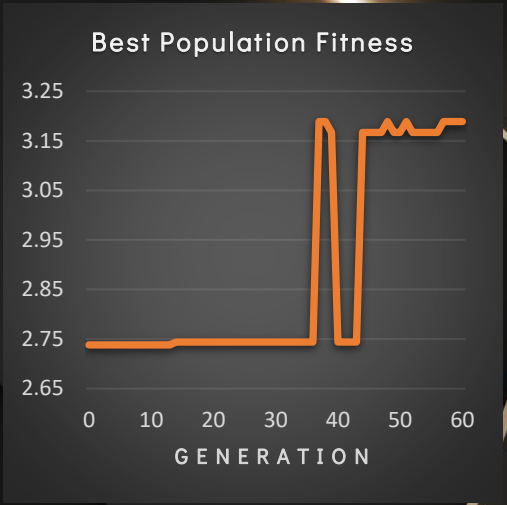
Selected

Pure Genetic Algorithm with Credit Crunch Constraint (GAMCC)



Results and Inferences





Chromosome	1	0	1	1	0	1	0	0	1	1
Loan Size	10	25	4	11	18	3	17	15	9	10
Rating	AAA	BB	A	AA	BBB	AAA	BB	AAA	A	A

Number of Loans Approved	6
Total Loan Amount	47
Max Loan Amount	51

High Credit Rating, yet Rejected !
More Small Loans preferred over single large loan.
More Transaction Fees!

Elapsed Time	0.039s
Best Fitness	3.189

But GAMCC is not enough!

Problem

Inconsistent Output / Lack of Robustness

Run	Best Fitness	Final Average Fitness
1	3.189	2.929
2	2.7908	2.4716
3	3.189	2.9589
4	3.189	2.2141
5	3.189	2.5263
6	2.7908	2.5428
7	3.189	2.6541
8	2.744	2.5835
9	3.189	2.5889
10	3.1672	2.4510

Average of Average Population Fitness	2.5920

- Whole Algorithm is run for 10 runs
- Optimal Solution reached only **6/10** times
- The algorithm is getting **stuck in local optimum**
- Depending on **luck not acceptable** in such an important decision
- Average fitness of population not good – **population not converging**

Reason

Excessive dependence on good population initialization

- GAMCC being a heuristic algorithm, it is not always expected that the optimal solution will be reached
- However, GA has a notorious reputation of **requiring a good initial solution set** (initial population)
- Currently, the initial population is being generated randomly **(i.e. LUCK!)**
- **Feeding a good initial population** may provide consistently better results

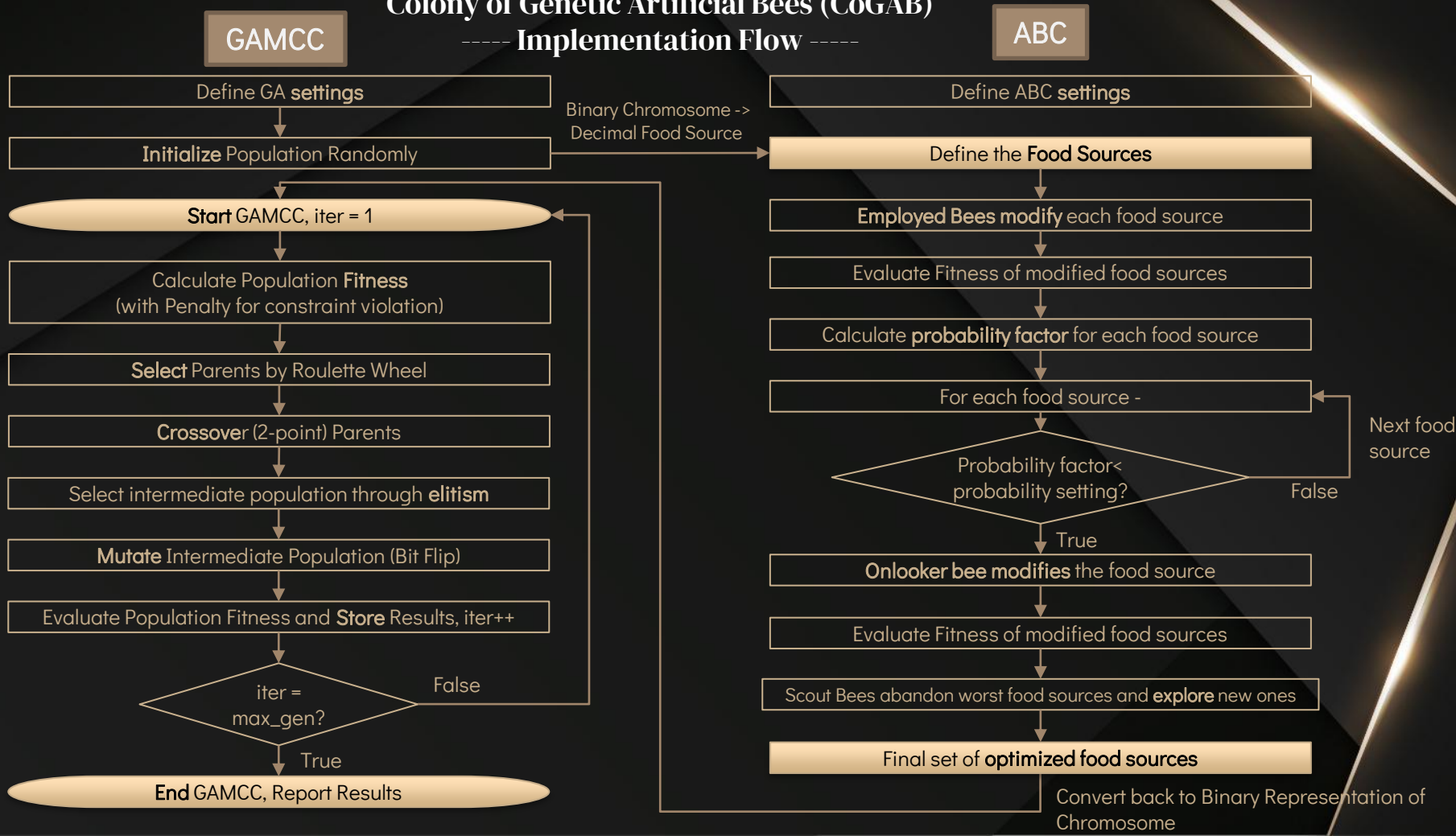
Solution

Use Artificial Bee Colony (ABC) to improve the initial population

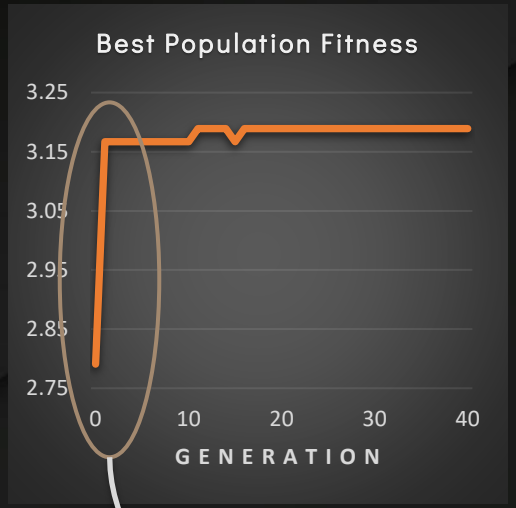
Why ABC?

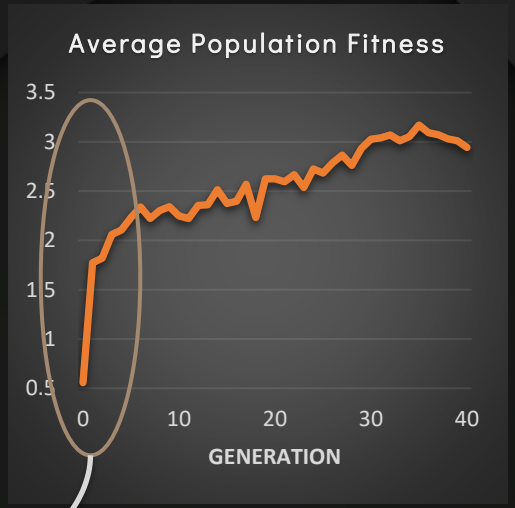
- Employed + Onlooker Bees **share past information** (absent in GA – provides synergy)
- **Fast selection** unlike computationally expensive roulette wheel (problematic in GA)
- Great mix of **exploitation** (Modified + Onlooker bees) and **Exploration** (Scout Bees)
- **Worst solutions eliminated** by Scout bees – population gets refined in a good way

Colony of Genetic Artificial Bees (CoGAB)
----- Implementation Flow -----



Results – Colony of Genetic Artificial Bees (CoGAB)





Chromosome	1	0	1	1	0	1	0	0	1	1
Loan Size	10	25	4	11	18	3	17	15	9	10
Rating	AAA	BB	A	AA	BBB	AAA	BB	AAA	A	A

Number of Loans Approved	6
Total Loan Amount	47
Max Loan Amount	51

Immediate finding of global optima due to optimized initial population.
Superior quality of population is also indicated by steep rise in average population fitness

Elapsed Time	0.038s
Best Fitness	3.189

Same result in lesser time and space! (less iterations required to reach optimality consistently)

Comparison – GAMCC vs CoGAB

Run	GAMCC		CoGAB	
	Best Fitness	Final Average Fitness	Best Fitness	Final Average Fitness
1	3.189	2.929	3.189	3.055
2	2.7908	2.4716	3.189	2.6293
3	3.189	2.9589	3.189	3.0246
4	3.189	2.2141	3.189	2.6848
5	3.189	2.5263	3.189	2.6522
6	2.7908	2.5428	3.189	3.0132
7	3.189	2.6541	3.189	2.5925
8	2.744	2.5835	3.189	2.9036
9	3.189	2.5889	3.189	3.0824
10	3.1672	2.4510	3.189	2.845
Average of Average Population Fitness	2.5920			2.8483

- **CoGAB is more reliable** (reached global optimum in 10/10 runs compared to 6/10 for GAMCC)
- **Average population fitness is also greater** for CoGAB, that too in 40 generations compared to 60 used in GAMCC

Thank You

References –

1. Noura Metawa, M. Kabir Hassan, Mohamed Elhoseny, Genetic algorithm based model for optimizing bank lending decisions, Expert Systems with Applications, Volume 80, 1 September 2017, Pages 75-82, ISSN 0957-4174. (doi: 10.1016/j.eswa.2017.03.021)

2. Bansal, J.C., Sharma, H. and Jadon, S.S. (2013) 'Artificial bee colony algorithm: a survey', Int. J. Advanced Intelligence Paradigms, Vol. 5, Nos. 1/2, pp.123–159