Optical Microscope Algorithm: A Novel Metaheuristic for Solving Engineering Optimization Problems

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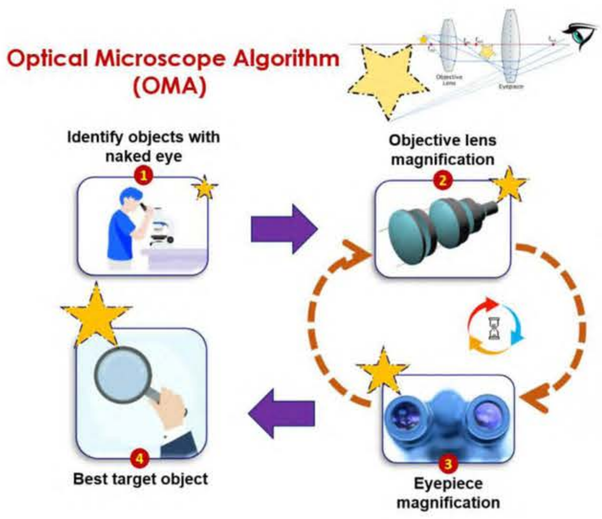
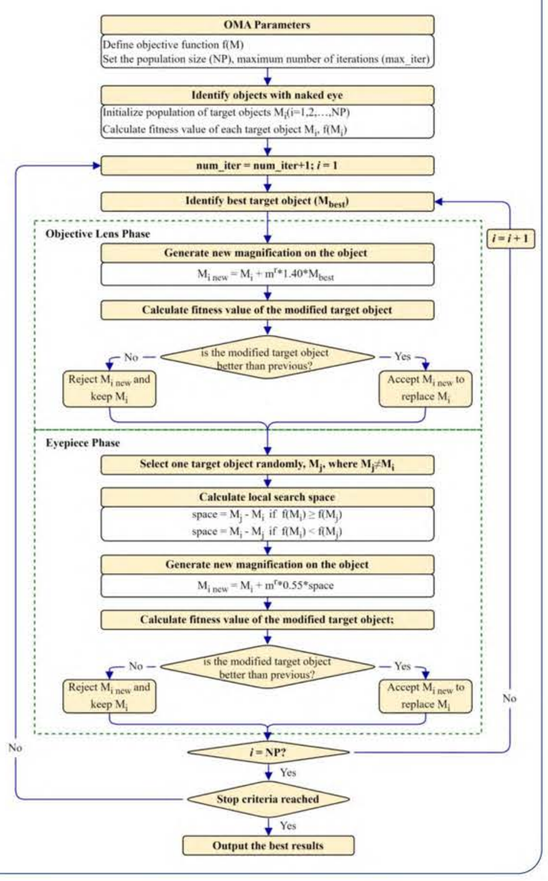
1. Introduction

Engineering optimization is a challenging field that encourages researchers to refine further and optimize current engineering designs. A novel optimization algorithm called the optical microscope algorithm (OMA) is developed and applied in this study. Drawing inspiration from the magnification capabilities of an optical microscope on the target object, OMA uses the naked eye for initial observation and simulates the magnification process through an objective lens and an eyepiece. The novel OMA, which is robust, easy to implement, and uses fewer control parameters, can be deployed to solve for various numerical optimization problems.

2. Optical Microscope Algorithm (OMA)

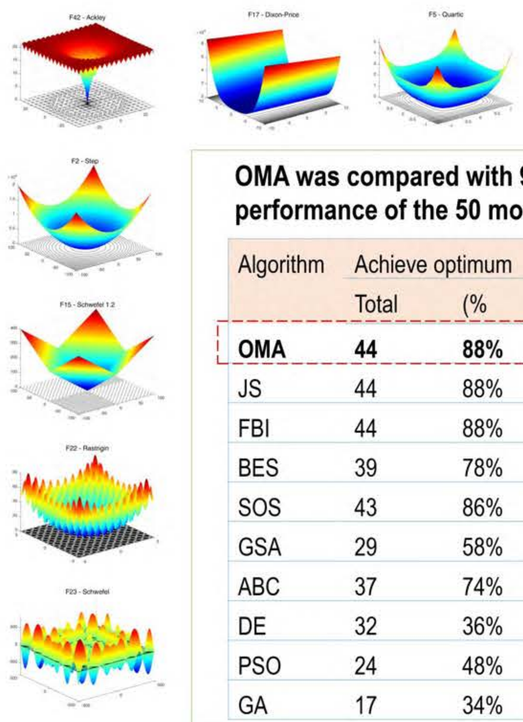




OMA Principles:

1) **Naked eye:** Observation begins by properly mounting the object on the specimen stage.
2) **Objective lens:** The magnifying power (MP) is factor used to determine image magnification and is a fixed variable.
3) **Eyepiece:** The eyepiece further magnifies the objective lens and its magnifying power (MP).
4) **Best target object:** The results of each magnification cycle are compared to obtain the magnification value.

3. Mathematical Benchmark Problems



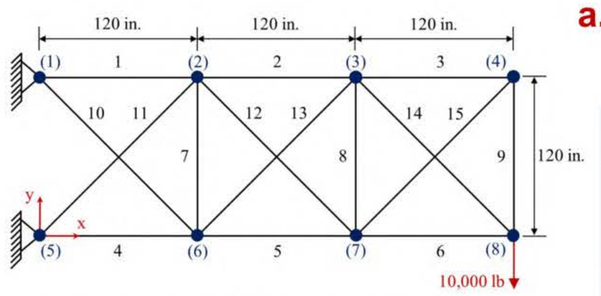
50 benchmark functions:
5 unimodal separable (US) functions
12 unimodal non-separable (UN) functions
9 multimodal separable (MS) functions
24 multimodal non-separable (MN) functions

OMA was compared with 9 well-known algorithm representations in the performance of the 50 most renowned benchmark functions:

Algorithm	Achieve optimum		Best performance		(OMA vs.)			Trial	t(s)
	Total	(%)	Total	(%)	+	-	≈	number	
OMA	**44**	**88%**	**47**	**94%**				**1236**	**65.93**
JS	44	88%	45	90%	4	1	45	1204	54.31
FBI	44	88%	45	90%	4	2	44	1130	70.08
BES	39	78%	39	78%	10	1	39	1085	112.04
SOS	43	86%	44	88%	6	1	43	1135	99.88
GSA	29	58%	29	58%	21	0	29	810	511.27
ABC	37	74%	37	74%	13	0	37	1036	187.09
DE	32	36%	32	36%	17	1	42	918	154.22
PSO	24	48%	24	48%	26	0	24	675	157.17
GA	17	34%	17	34%	33	0	17	502	171.61

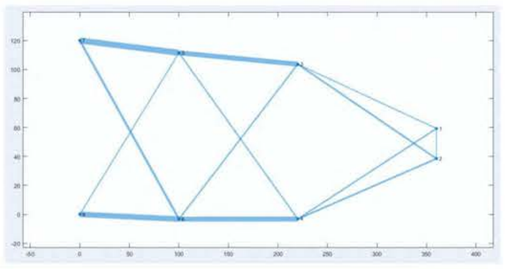
4. Engineering Design Problems

a. Case Study 1: 15 Bar-Truss



The objective: to minimize the structure's weight.

Truss structure visualization

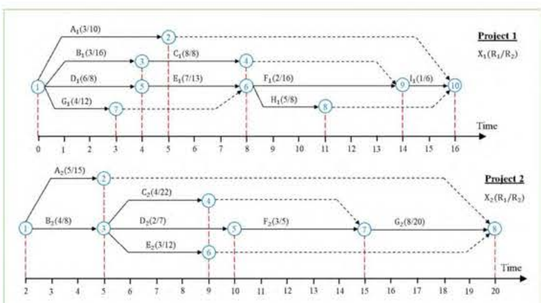


Optimal design comparison

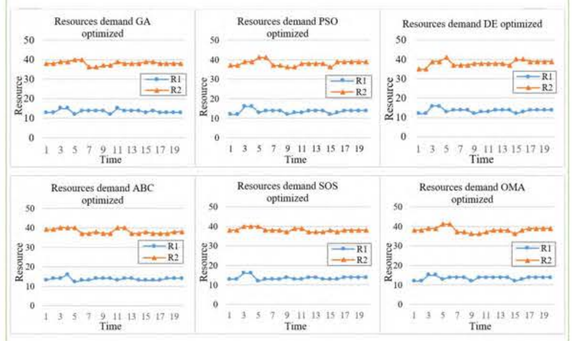
Design variables	Improved-GA	FA	R-ICDE	D-ICDE	SOS	**OMA**
Best weight (lb.)	79.820	75.550	80.569	74.682	73.596	**73.596**
Worst weight (lb.)	N/A	N/A	N/A	N/A	N/A	**80.156**
Average weight (lb.)	N/A	N/A	N/A	N/A	79.900	**76.411**
Standard deviation	N/A	N/A	N/A	N/A	2.881	**1.922**
No. of analyses	8000	8000	7980	7980	12900	**8250**
Ranking	4	3	5	2	1	**1**

b. Case Study 2: Multiple Resources Leveling in the Multiple Projects

The objective: to minimize the daily variance in resource utilization without changing the total project duration.



Resource profile of projects by different algorithms



5. Conclusions

The results support that OMA is superior to the best-known and most recently introduced metaheuristic algorithms because: (a) Efficiency: Highly efficient at solving various problems; (b) Speed: Solve problems using less computational time; (c) Power: The power to achieve an optimal solution is faster than competitors.

Reference: Cheng, M. Y., & Sholeh, M. N. (2023). Optical microscope algorithm: A new metaheuristic inspired by microscope magnification for solving engineering optimization problems. *Knowledge-Based Systems*, *279*, 110939.