IMPLEMENTATION OF SAND CAT SWARM OPTIMIZATION FOR UNIFORM T-WAY TEST SUITE GENERATION

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INTRODUCTION

Software technology has grown rapidly, making daily tasks easier and increasing demand. People trust these systems to work reliably.

System failures can have severe consequences, leading to:

- Disruptions that impact user experience and operations.
- Risks to personal safety and compromises in privacy.

Software testing can take up to 40% of the total software development cost, making it one of the most expensive phases in the process.

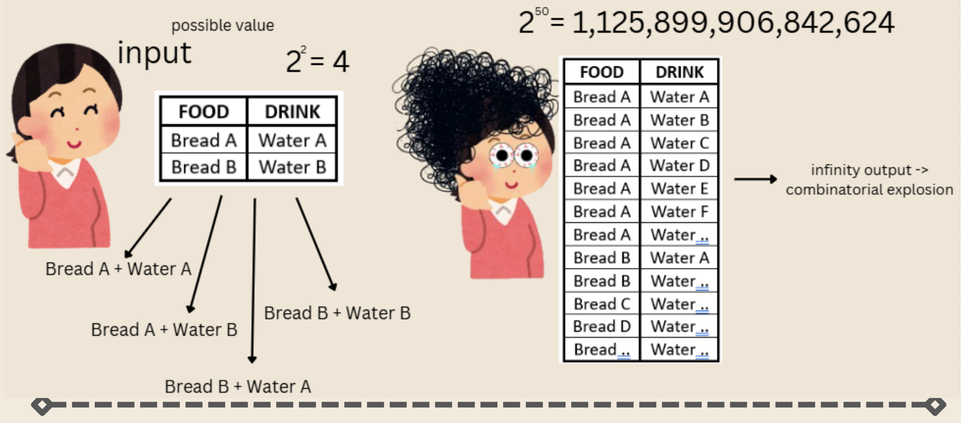
OBJECTIVES

1. To design the framework of a Sand Cat Swarm Optimization (SCSO) algorithm for t-way combinatorial testing
2. To develop the Sand Cat Swarm Optimization (ESCSO) algorithm based combinatorial test suite generator.
3. To evaluate the performance of SCSO, by adopting various established benchmarked experiments.

PROBLEM STATEMENTS

- Combinatorial explosion makes exhaustive testing impractical, demanding smarter generation algorithms.
- SCSO gets trapped in local optima, limiting its effectiveness for t-way test suite generation.
- Lack of dynamic phase control in SCSO hinders its ability to adapt and optimize test suite size.

EXHAUSTIVE TESTING ISSUE



EXHAUSTIVE TESTING → T-WAY TESTING

TC	Test Case	TC	Test Case	TC	Test Case	TC	Test Case
1	G1L1P1R1A1	19	G1L2P2R1A1	37	G2L1P1R1A1	55	G2L2P2R1A1
2	G1L1P1R1A2	20	G1L2P2R1A2	38	G2L1P1R1A2	56	G2L2P2R1A2
3	G1L1P1R2A1	21	G1L2P2R2A1	39	G2L1P1R2A1	57	G2L2P2R2A1
4	G1L1P1R2A2	22	G1L2P2R2A2	40	G2L1P1R2A2	58	G2L2P2R2A2
5	G1L1P1R3A1	23	G1L2P2R3A1	41	G2L1P1R3A1	59	G2L2P2R3A1
6	G1L1P1R3A2	24	G1L2P2R3A2	42	G2L1P1R3A2	60	G2L2P2R3A2
7	G1L1P2R1A1	25	G1L3P1R1A1	43	G2L1P2R1A1	61	G2L3P1R1A1
8	G1L1P2R1A2	26	G1L3P1R1A2	44	G2L1P2R1A2	62	G2L3P1R1A2
9	G1L1P2R2A1	27	G1L3P1R2A1	45	G2L1P2R2A1	63	G2L3P1R2A1
10	G1L1P2R2A2	28	G1L3P1R2A2	46	G2L1P2R2A2	64	G2L3P1R2A2
11	G1L1P2R3A1	29	G1L3P1R3A1	47	G2L1P2R3A1	65	G2L3P1R3A1
12	G1L1P2R3A2	30	G1L3P1R3A2	48	G2L1P2R3A2	66	G2L3P1R3A2
13	G1L2P1R1A1	31	G1L3P2R1A1	49	G2L2P1R1A1	67	G2L3P2R1A1
14	G1L2P1R1A2	32	G1L3P2R1A2	50	G2L2P1R1A2	68	G2L3P2R1A2
15	G1L2P1R2A1	33	G1L3P2R2A1	51	G2L2P1R2A1	69	G2L3P2R2A1
16	G1L2P1R2A2	34	G1L3P2R2A2	52	G2L2P1R2A2	70	G2L3P2R2A2
17	G1L2P1R3A1	35	G1L3P2R3A1	53	G2L2P1R3A1	71	G2L3P2R3A1
18	G1L2P1R3A2	36	G1L3P2R3A2	54	G2L2P1R3A2	72	G2L3P2R3A2

Total Ouput: 72

Interacting Parameter GL

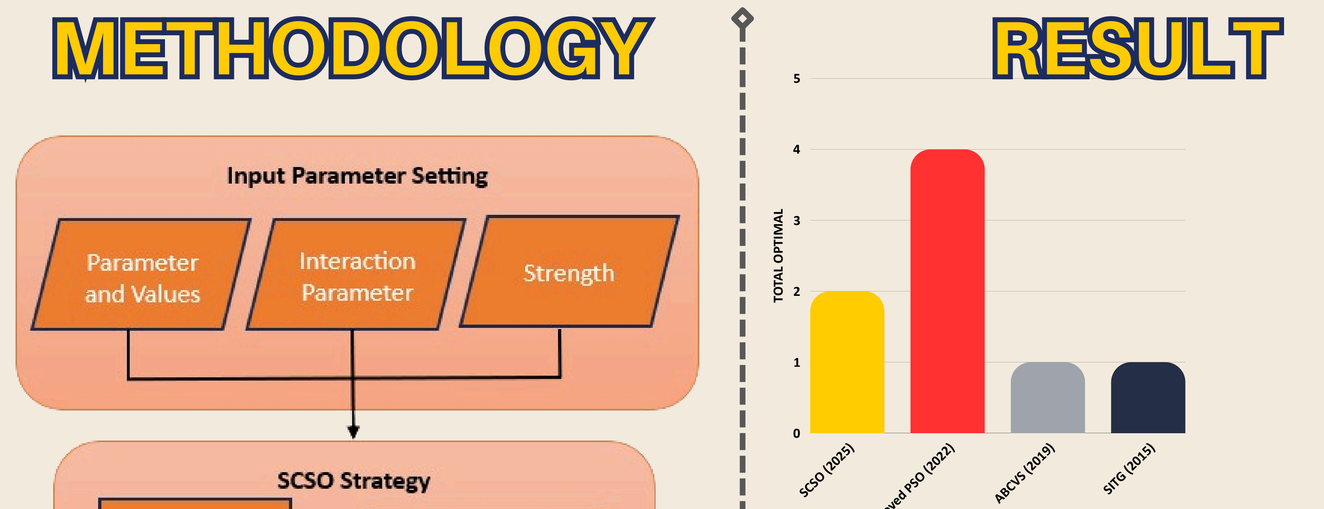
TC	G	L	P	R	A
1	G1	L1	P1	R1	A1
2	G1	L2	P2	R3	A1
3	G1	L3	P1	R2	A2
4	G2	L1	P1	R1	A2
5	G2	L2	P2	R3	A1
6	G2	L3	P1	R2	A2

Sampling *Apply DC value*

TC	Test Case	TC	Test Case	TC	Test Case
1	G1L1P1R1A1	7	G1L3P1R1A1	13	G1L3P1R3A2
2	G1L2P2R3A1	8	G1L1P2R2A2	14	G2L2P2R2A1
3	G1L3P1R2A2	9	G2L2P1R2A2	15	G1L3P2R1A1
4	G2L1P1R1A2	10	G2L3P2R3A1	16	G2L2P2R2A1
5	G2L2P2R3A1	11	G1L2P2R1A2	17	G1L2P1R2A2
6	G2L3P1R2A2	12	G1L1P2R2A1	18	G2L1P1R3A2

Total Ouput: 18

SAND CAT SWARM OPTIMIZATION



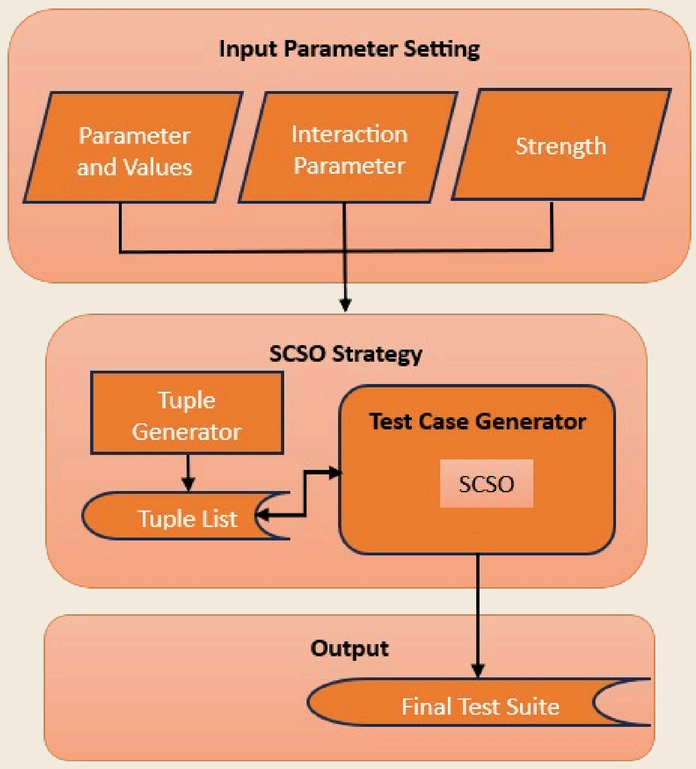
Exploration

The sand cat explores wide desert areas, using sensitive hearing to detect low-frequency sounds below 2 kHz, sensing prey even beneath sand or from afar.

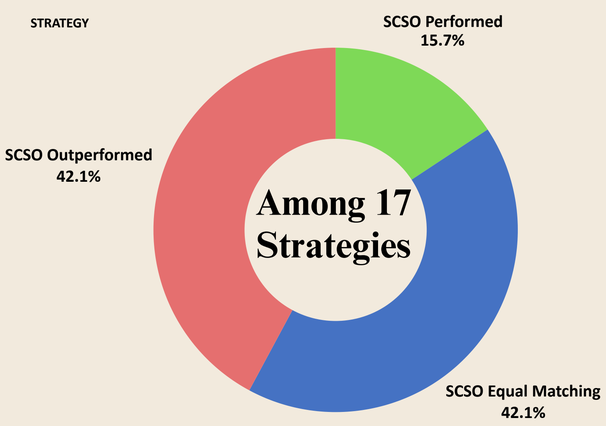
Exploitation

As prey approaches, the sand cat exploits the moment. It will focusing sharply and digging with precision using its strong, specialized claws.

METHODOLOGY



RESULT



RESEARCH IMPACT

- Contributes to Combinatorial Testing Literature: Provides benchmarked results and statistical analysis that aid future comparative studies and algorithm development in the testing domain.
- Reduces Testing Costs: Demonstrates potential to generate smaller, efficient test suites that can minimizing time and resource usage in large-scale software validation processes.
- Industrial Relevance: Offers scalable solutions for testing configurable systems (e.g., IoT platforms, embedded systems), especially where exhaustive testing is infeasible.

CONCLUSION AND FUTURE WORKS

SCSO demonstrates stable and promising behavior for uniform t-way test suite generation. However, its limited exploration in later iterations highlights the need for enhancement in complex configurations.

Future Work:

- Strengthen exploration mechanisms to reduce risk of premature convergence.
- Hybridize with Reinforcement Learning to adaptively guide search, balance exploration-exploitation, and improve convergence stability.
- Expand application to variable-strength and input-output-based t-way testing.