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USING ANT LION ALGORITHM FOR PORTFOLIO OPTIMIZATION ON THE BASIS OF TIME PERIOD OF INVESTMENT

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ABSTRACT

Recently, the authors have applied a new nature inspired computing i.e.Antlion Algorithm (ALO) to portfolio optimization. ALO mimics the hunting mechanism of antlions in nature and can be used as an optimization technique to solve various problems in management and engineering. The stocks of top 50 Indian Companies listed on Bombay Stock Exchange (BSE) have been selected on the basis of market capitalization. In this paper, we further present findings on the use of ALO as applied to stocks listed on BSE. It is noted from the presented findings that technique can be used to make future predictions.

KEYWORDS

lion algorithm, portfolio optimization.

INTRODUCTION

Several nature inspired computing techniques are being used in finance for optimization issues. The design of a best portfolio that meets the requirements of the investors can be modelled as an optimization problem (Fabozzi et al., 2007). In case of portfolio optimization, the optimal weights of the stocks have to be found in order to meet the satisfaction of the investor, which lies in maximizing return and minimizing risk. Various traditional methods to construct portfolio have been used previously (Markowitz, 1959; Lee and Lerro, 1973; Elton and Gruber, 2001; Gupta and Aggarwal, 2009). The nature-inspired techniques derive their inspiration from nature and there are various such algorithms in literature, like Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Bacterial Foraging Algorithm (BFO), Ant Colony Optimization (AC0), Firefly Algorithm (FA), Cuckoo Optimization (CO), and Antlion Algorithm (ALO) etc. In recent years, various nature inspired optimization techniques are being used to find solution of portfolio optimization problem (Kaushal, 2016; Anagnostopoulas and Mamanis, 2011).

Many studies in finance have used Genetic Algorithm (Leinweber and Arnott, 1995; Colin, 1996; Nelly et al., 1997; Allen and Karjalainen, 1999; Soleimani et al. 2009) and Particle Swarm Optimization (Kendall and Su, 2005; Zhang and Li, 2010; Zu et al. 2011) for solving finance problems. Niu et al. (2012) have proposed a new model using 'Variance' measuring both market and liquidity risk and then employed a new swarm intelligence based method- Bacterial Foraging Optimization (BFO) to solve this model. The recently developed Firefly Algorithm, Ant Colony Optimization and Cuckoo Optimization have also been used for portfolio optimization (Bacanin and Tuba, 2014 ; Haqiqi and Kazemi, 2012; Sawaya, 2012).

The antlion optimization (ALO) algorithm is a relatively recent nature inspired heuristic algorithm that is computationally less expensive than other techniques (Mirjalili, 2015). Recently, it has been used for portfolio optimization (Kaushal, 2017). In this paper, we further investigate the area and present new findings. The next section gives overview of ALO as applied to design of optimal portfolio. Subsequent section presents findings. The work has been concluded in the last.

ALO FOR PORTFOLIO OPTIMIZATION

Antlion optimization (ALO) is a bio-inspired optimization algorithm proposed by (Mirjalili, 2015). It mimics the hunting mechanism of antlions in nature. Antlions are sometimes referred to as doodle bugs because of the strange marks they leave in sand. Antlions have very unique hunting behaviour and ALO is based on this. An Antlion larvae digs a cone shaped pit in sand by moving along a circular path and throwing out sand with its massive jaw. The larvae hide underneath the bottom of funnel after digging the pit. It sits and waits for ant to be trapped. The ant can easily get trapped in pit as edge of funnel is very sharp. The Antlion tries to catch the ant that is in the trap. The ant tries to escape but Antlion throws sand in a way that ant comes towards the bottom of pit. When caught, it consumes the ant and throws the leftovers out of the pit. Again, it becomes ready for the next hunt. This behavior of AntLion can be used as an algorithm to find optimal weights of a portfolio. A fitness function has been written that minimizes risk for a particular value of return and this function has been optimized using ALO.

Consider a portfolio with a vector of portfolio returns *R*, and a covariance matrix *K*, and the fitness function can be formulated as follows (Kaushal, 2017):

Maximize $R^T x - \quad x^T K x$ (1)

Subject to following constraints:

$\Sigma_i x_i = 1$ (2)

$x >= 0$ and $x < 1$ (3)

where x_i is the proportion of the total capital invested in stock *i*, R^T is the average return of each stock, and *K* is the covariance matrix. The first term $R^T x$ denotes the 'return' of portfolio and the second term $x^T K x$ denotes 'risk'. The covariance matrix *K* has variances in its diagonal and covariance in its off-diagonal elements. The equation (1) maximizes return (= $R^T x$) and minimizes the risk (= $x^T K x$) of the portfolio. The equations (2) and equation (3) correspond to the constraints that sum of all investments is one unit and all investments are positive.

FINDINGS ON THE BASIS OF TIME PERIOD FOR INDIAN COMPANY STOCKS

The investment weights obtained using ALO taking two year data results have been taken and analysis is done for using these as projected investment upto six years for Indian company stocks. The results obtained are quite promising and close to expected. Table shows the results obtained by projecting two years weight data for upto six years. It can be seen that these are in close agreement and thus ALO is well suitable in such scenarios. Thus, we can use the investment options based on two year data and expect similar return and risk in future.

TABLE 1: EXTENDING TWO YEAR INVESTMENT TO SIX YEARS

S.No.	Return and Risk		Weight Set in Portfolio (of 2 year data)	Actual Return and Risk obtained after six years	
	Return	Risk		Return	Risk
1	0.032	0.0533	W1	0.0293	0.0480
2	0.027	0.0434	W2	0.0280	0.0469
3	0.0242	0.042	W3	0.0225	0.0389
4	0.021	0.0386	W4	0.0208	0.0383
5	0.0163	0.0333	W5	0.0208	0.0383

Further, the investment weights obtained taking four year data results have been taken and analysis is done for using these as projected investment upto six years. The results obtained are quite promising and closest to expected. Table shows the results obtained by projecting two years weight data for upto six years. It can be seen that these are in close agreement and thus ALO is well suitable in such scenarios. Thus, we can use the investment options based on four year data and expect similar return and risk in future. The results obtained using four year data are more close to actual ones compared to that using two year data.

TABLE 2: EXTENDING FOUR YEAR INVESTMENT TO SIX YEARS

S.No.	Return and Risk		Weight Set in Portfolio (of 4 year data)	Actual Return and Risk obtained after six years	
	Return	Risk		Return	Risk
1	0.0325	0.0748	Wt1	0.0325	0.0654
2	0.0257	0.0756	Wt2	0.0271	0.0725
3	0.0234	0.0405	Wt3	0.0237	0.0391
4	0.0196	0.0346	Wt4	0.0204	0.0366
5	0.0164	0.0342	Wt5	0.0155	0.0339

TABLE 3: INVESTMENT TABLE

Stock No.	W1	W2	W3	W4	W5	Wt1	Wt2	Wt3	Wt4	Wt5
1	0.0673	0.2561	0.3038	0.0097	0.0443	0.1725	0.0344	0.0863	0.0154	0
2	0.0008	0.0003	0	0.0022	0	0.0001	0.0001	0.0002	0.0005	0.0003
3	0.0118	0.0001	0.0337	0.1234	0.0145	0.2812	0.0014	0.0077	0.0013	0.0011
4	0.1069	0.0031	0.0237	0.1408	0.0593	0.0002	0.0091	0.0342	0.0678	0.2723
5	0	0.0008	0.0074	0.01	0	0	0.0007	0.0048	0.0001	0.0002
6	0.0215	0.0219	0.0101	0.0318	0.0329	0.0406	0.001	0.0065	0.0354	0.0045
7	0.0182	0.0025	0.0002	0.0004	0	0.0156	0.0003	0.0028	0.0002	0.0131
8	0.0005	0	0.0001	0	0.0023	0.0001	0	0	0.0105	0
9	0.0527	0.2049	0.0927	0.017	0.099	0.0138	0.0225	0.1474	0.1236	0.0162
10	0	0	0	0	0	0	0	0	0	0
11	0	0.0153	0.0051	0.0029	0.012	0	0.0005	0.0019	0.0073	0.0158
12	0.0513	0.0762	0.0258	0.0217	0.0527	0.0082	0.0099	0.1393	0.0555	0.0173
13	0	0	0	0	0	0.0041	0	0	0	0
14	0	0	0	0	0	0.1602	0	0.0622	0	0
15	0.0155	0	0	0	0	0.0012	0	0.0019	0.0014	0
16	0	0	0	0	0	0	0	0	0	0
17	0.0039	0.0086	0.0129	0.0368	0.0027	0	0.0003	0.0001	0.0038	0.0184
18	0.0023	0.0027	0	0.014	0.0365	0	0.0001	0.023	0.0448	0.0101
19	0	0	0	0	0	0.0004	0.4404	0	0	0
20	0.0029	0.018	0	0.0053	0	0.0002	0.1729	0.0137	0.0173	0.0001
21	0.1377	0.0461	0.0017	0.0128	0	0.0925	0.0062	0.034	0.0088	0
22	0.0294	0.0617	0.0242	0.0074	0.016	0.0014	0.0402	0.0177	0.061	0.016
23	0.0801	0.0478	0.0471	0.0825	0.0399	0.0113	0.0341	0.0522	0.1102	0.0125
24	0.0069	0.0117	0.0314	0.0159	0.0446	0.0001	0.0194	0.0348	0.0432	0.0203
25	0.0113	0.0006	0.0189	0.0039	0.0379	0.001	0.0081	0.0099	0.0296	0.0363
26	0.0019	0.0571	0.0002	0.0004	0	0.0003	0.0091	0.0081	0	0
27	0.175	0	0.0007	0.0164	0	0.0189	0.0173	0.0049	0	0
28	0.0019	0	0.0066	0.0056	0	0.0172	0.0227	0.0005	0	0.0023
29	0	0.0287	0	0	0	0	0	0	0	0
30	0.0293	0.0001	0.0098	0.0665	0.0178	0.0018	0.092	0.0629	0.0693	0.0389
31	0	0	0.0001	0.0001	0.0126	0	0	0.0001	0.0003	0.0079
32	0	0.0005	0	0.0019	0.0048	0.0001	0.0032	0	0.0006	0.0002
33	0.0004	0.0002	0.001	0.0008	0.0049	0	0.005	0.0003	0.0027	0.0001
34	0.0084	0	0.0097	0.0256	0.0265	0.0002	0.0018	0.0155	0.0124	0.0215
35	0	0	0	0	0	0	0	0	0	0
36	0	0.0137	0	0	0	0	0	0	0	0
37	0.0279	0	0.109	0.0608	0.1643	0.0007	0.0069	0.0778	0.0963	0.099
38	0	0.0214	0	0	0	0	0	0.0001	0	0.0002
39	0.0186	0.0001	0.0124	0.0643	0.0474	0.0003	0.0066	0.0709	0.0797	0.0909
40	0.0105	0	0.0031	0.0001	0.0027	0.0002	0.0006	0.0025	0.0068	0.0002
41	0	0.039	0	0	0	0	0	0	0	0
42	0.0456	0.0002	0.0927	0.0074	0.0282	0	0.0052	0.0359	0.0059	0.0963
43	0	0.0302	0.0015	0	0	0.0001	0	0	0	0
44	0	0.0002	0.0265	0.0041	0.0137	0	0.0005	0.0013	0.0175	0.0097
45	0	0.0085	0.0159	0	0	0	0	0.0047	0	0.0001
46	0.0165	0	0.0363	0.1392	0.0409	0.0002	0.0092	0.0124	0.0264	0.0382
47	0	0.0014	0	0	0	0	0	0	0	0
48	0.0042	0.0036	0.0101	0.0173	0.0086	0	0	0	0.0078	0.0246
49	0.0227	0	0.0094	0.0318	0.1103	0.0003	0.0031	0.0028	0.0166	0.094
50	0	0	0	0	0	0.1456	0	0	0	0

CONCLUSIONS

ALO has been applied considering two year, four year and six year data of 50 companies listed on BSE on the basis of market capitalization. The solutions obtained after two year data have been simulated for six years and it has been seen the actual return is close to predicted. Similar findings are there for four year data, but these are more close to actual ones. As the findings on time basis leads to consistency in weights, this is an indication of investment. This implies that technique can be safely used for future predictions. ALO is thus a promising technique that can be used by investors for making financial decisions.

ACKNOWLEDGEMENT

The authors thank Dean, RIC, IKG Punjab Technical University, Kapurthala and Director, GNDEC, Ludhiana, for providing the necessary facilities for carrying out this research work.

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APPENDIX

APPENDIX 1: SELECTED STOCKS BASED ON MARKET CAPITALIZATION AND PERIOD OF STUDY

S. No.	Name of Stock
1	TCS
2	Reliance
3	HDFC
4	ITC
5	ONGC
6	Infosys
7	HDFC
8	SBI
9	HUL
10	Maruti Suzuki
11	IOC
12	Sun Pharma
13	ICICI Bank
14	Tata Motors
15	Kotak Mahindra
16	Larsen
17	Bharti Airtel
18	NTPC
19	Axis Bank
20	Wipro
21	HCL Tech
22	Ultra Tech Cement
23	Asian Paints
24	Power Grid Corp.
25	BPCL
26	Bajaj Auto
27	IndusInd Bank
28	M and M
29	Vedanta
30	Bosch
31	Adani Ports
32	Eicher Motors
33	Hero motorcorp
34	Lupin
35	Yes Bank
36	Bajaj finance
37	GAIL
38	Bajaj Finserv
39	Nestle
40	Godrej Consumer
41	Shree Cements
42	Cairn India
43	HPCL
44	Mothers on Sumi
45	Zee Entertain
46	Dabur India
47	Tata Steel
48	Grasim
49	Cipla
50	Tech Mahindra

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