AENSI Journals

Australian Journal of Basic and Applied Sciences

ISSN:1991-8178

Journal home page: www.ajbasweb.com

Applying GA-Based Simulation on Schedulin

[1]Abdul Talib Bon, [2]Siti Hasziani Ahmad and [3]Sie Long Kek

[1]*Faculty of Technology Management, Business and Entrepreneurship, Universiti Tun Hussein Onn Malaysia*
[2]*Faculty of Technology Management, Business and Entrepreneurship, Universiti Tun Hussein Onn Malaysia* Country
[3]*Center for Research of Computational Mathematics, Universiti Tun Hussein Onn Malaysia*

ARTICLE INFO

Article history:
Received 25 November 2014
Received in revised form 26 December 2014
Accepted 1 January 2015
Available online 10 January 2015

Keywords:
Genetic Algorithm, Simulation, Scheduling, Total Cost Expensed, Total Time

ABSTRACT

This paper discusses the simulation of a project scheduling based on the genetic algorithm (GA). Our aim is to revise the project scheduling so that each activity in the project can be estimated as well as reducing the cost expensed. In this simulation, the operators of GA, which are selection, crossover and mutation, are employed. We propose the uniform distribution in selecting the parents. For the generated parents, one-point crossover is implemented to produce the offspring. Follow from this, the mutation is taken place, where one point of the offspring is chosen randomly. Then the value of the point is refined according to the formula of the uniform distribution. After completing the GA operators, the chromosomes of the gene of the offspring represents the earliest finish time and the last chromosome show the total time to finish the project. Consequently, the duration of each activity is calculated and the fitness value, which is the total cost expensed, is computed. In conclusion, the GA-based simulation provides an alternative schedule, which is shortened the original completion time of the project and save the corresponding cost expensed.

© 2015 AENSI Publisher All rights reserved.

To Cite This Article: Abdul Talib Bon, Siti Hasziani Ahmad and Sie Long Kek., Applying GA-Based Simulation on Schedulin. ***Aust. J. Basic & Appl. Sci.,*** *9(3): 113-117, 2015*

INTRODUCTION

In project management, three phases, which are planning scheduling and controlling, are involved (Heizer, J. and B. Render, 2008). Scheduling is a key role in implementing a project. It is important to make a project operating in order and to estimate when a project can be completed.

In handling a project schedule, managers make a decision on how long each activity will take, and calculate how many workers and raw material will be needed at each stage of the production. As mentioned in (Yan, Y., G. Wang, 2007), analytical technique, meta-heuristic algorithm, rule-based approach and simulation approach are the approaches that could be applied in scheduling. In real world, when the scheduling problem become complex, the extra time, which is more than the expected time, would be taken.

Since there are more than hundreds scheduling guidelines have been accomplished and studied now, but no such single rule is efficient for all the scheduling problems, which is the finest under all conceivable situations. In fact, the effectiveness of a regulation depends on factors such as performance criteria, system configuration and system load levels (Sabuncuoglu, I., 1998).

In this study, a simulation, which is based on the genetic algorithm (GA), is applied to scheduling a project. Gas are the strong general-purpose search program based on the tool of natural selection and natural genetic (Holland, J., 1975). By nature and based on the fitness of a chromosome, GA is run by three main operators of selection, reproduction and mutation (Mayer, M.K., 1999).

By using simulation, the process of the GA is described briefly. First, the uniform distribution is employed to generate the gene of the parents. Second, one-point crossover is used to produce the offspring. Third, one chromosome of the offspring is chosen randomly and is refined by using the uniform distribution. The chromosomes of the gene of the offspring represent the earliest finish time and the last chromosome show the total time to finish the project. The duration of each activity is calculated. Forth, the fitness value, which is the total cost expensed, is computed. The process of the GA is coded in MATLAB so as the simulation can be run effectively.

The rest of the paper is organized as follows. In Section 2, a scheduling problem in the construction is described. In Section 3, the GA-based simulation is further discussed. In Section 4, the result and the discussion are given. Finally, concluding remarks are made.

Corresponding Author: Abdul Talib Bon, Faculty of Technology Management, Business and Entrepreneurship, Universiti Tun Hussein Onn Malaysia

Scheduling Problem:

In the construction, problem such as project fails to finish according to the schedule, or out of materials is always happening. It is reported that only 30% of construction projects were completed according to the schedule and the average of projects that has time overrun was between 10% and 30% (Assaf, S.A., S. Al-Hejji, 2006). When the completion time of the project is more than the expected finish time, the total cost of the project will increase upon the extra time taken.

The aim of this paper is to reduce the completion time of the project as well as reducing the cost expensed. The data of a construction project, where four boundary walls are built at the different four places, are shown in Table I.

Table I: Data of the Project.

Task	Activity	Duration (days)	Start Time	Finish Time
1	Preliminaries	99	Mon 12/2/13	Sat 3/26/14
2	Site Mobilization	7	Mon 12/2/13	Mon 12/9/13
	NIBONG ROAD 4			
3	Excavation	18	Mon 12/9/13	Sat 12/28/13
4	Lean concrete	17	Wed 12/11/13	Mon 12/30/13
5	Base formwork	17	Thu 12/12/13	Tue 12/31/13
6	Reinforcement	17	Fri 12/13/13	Wed 1/1/14
7	Concrete	17	Mon 12/16/13	Fri 1/3/14
8	Formwork wall	26	Mon 12/23/13	Tue 1/21/14
9	Reinforcement wall	24	Fri 12/27/13	Thu 1/23/14
10	Concrete wall	23	Mon 12/30/13	Fri 1/24/14
11	Reinforcement column	16	Mon 1/27/14	Thu 2/13/14
12	Formwork column	17	Wed 1/29/14	Mon 2/17/14
13	Concrete column	14	Mon 2/3/14	Tue 2/18/14
	NIBONG ROAD 3			
14	Excavation	18	Mon 12/30/13	Sat 1/18/14
15	Lean concrete	17	Tue 12/31/13	Sat 1/18/14
16	Base formwork	17	Wed 1/1/14	Mon 1/20/14
17	Reinforcement	17	Thu 1/2/14	Tue 1/21/14
18	Concrete	14	Mon 1/7/14	Wed 1/22/14
19	Formwork wall	24	Fri 1/24/14	Thu 2/20/14
20	Reinforcement wall	23	Mon 1/27/14	Fri 2/21/14
21	Concrete wall	12	Tue 2/10/14	Sat 2/22/14
22	Reinforcement column	11	Tue 2/11/14	Sat 2/22/14
23	Formwork column	10	Fri 2/14/14	Tue 2/25/14
24	Concrete column	10	Mon 2/17/14	Thu 2/27/14
	TENGAR ROAD			
25	Excavation	14	Mon 1/20/14	Tue 2/4/14
26	Lean concrete	14	Tue 1/21/14	Wed 2/5/14
27	Base formwork	15	Wed 1/22/14	Fri 2/7/14
28	Reinforcement	16	Thu 1/23/14	Mon 2/10/14
29	Concrete	14	Mon 1/27/14	Tue 2/11/14
30	Formwork wall	16	Mon 2/17/14	Thu 3/6/14
31	Reinforcement wall	17	Thu 2/20/14	Tue 3/11/14
32	Concrete wall	13	Tue 2/25/14	Tue 3/11/14
33	Reinforcement column	11	Fri 2/28/14	Wed 3/12/14
34	Formwork column	10	Mon 3/3/14	Thu 3/13/14
35	Concrete column	9	Wed 3/5/14	Fri 3/14/14
	NIBONG ROAD 5			
36	Reinforcement column	11	Wed 3/12/14	Mon 3/24/14
37	Formwork column	11	Thu 3/13/14	Tue 3/25/14
38	Concrete column	5	Fri 3/21/14	Wed 3/26/14

The Earliest Start Time (ES), which is the time an activity can start with the assumption of all predecessors have been completed, and the Earliest Finish Time (EF), which is the time an activity is completed, are determined by

$$EF = ES + \text{duration} \quad (1)$$

Methodology:

To obtain the respective duration of each activity in scheduling the project and to reduce the total completion time of the project such that the cost expensed can be saved, the simulation approach that is based on the GA is proposed. Here, three main operators of GA, which are selection, crossover and mutation, are manipulated.

GA Operators:

(1) Selection:

Selection of the genes of the parents is performed via the uniform distribution, which is given by

$$a + r \times (b - a) \quad (2)$$

where *a* is the ES, *b* is the EF and *r* is the random number. The values of *a* and *b* are the real data taken from a construction company as shown in Table I. The random number *r* is generated by using the command *rand* () in MATLAB.

(2) Crossover:

Crossover is used to create a new population that is available in the mating pool after applying selection. It exchanges the information of the gene between the populations in the mating pool (Bhattachsriya, R.K., 2012).

Here, one-point crossover is employed. The point from the beginning of the chromosome to the selected crossover point is copied from the first parent and the rest chromosome is copied from the second parent. In such way, two offspring are produced (Abdul Talib Bon, 2008).

3) Mutation:

Mutation is applied to dodge the result of crossover operation that is failing into a local optimum (Yan, Y., G. Wang, 2007). Here, one point in the respective offspring is chosen randomly. Then, by using (2), the value of the selected point is refined according to (2). This way is done for both offspring produced.

Concept of GA:

In applying the GA operations, consider ES and EF denote, respectively, by *a* = 0, 2, 3, …, 92 and *b* = 18, 19, 20, …, 97. The number of activities of the project is represented by N. The procedure of the GA-based simulation is summarized as follows.

Step 1 Generate the genes of the parents by using (2).

Step 2 Produce the offspring. The one-point crossover is applied, where the crossover point is chosen randomly.

Step 3 Perform the mutation. One chromosome of the genes of the offspring is chosen randomly. The value of this chromosome is refined by using (2)

Step 4 Calculate the fitness value from (3).

Fitness Function:

The fitness function counts for the optimality of a population. A particular population is ranked by the value of the fitness function and then it is used to against all the other values of the fitness function in the population. A fitness value is assigned to each population accordingly if it closes to the optimal value of the fitness in the population [6].

The fitness function represents the total cost expensed for completing the project, which is calculated from

$$\frac{\text{new completion time}}{\text{actual completion time}} \times \text{total cost of project} \quad (3)$$

RESULT AND DISCUSSION

The values of the respective ES and EF are shown in Table II.

Table II: Duration before Simulation.

ES	EF	Duration	ES	EF	Duration
0	18	18	55	67	12
2	19	17	56	67	11
3	20	17	59	69	10
4	21	17	61	71	10
6	23	17	38	52	14
12	38	26	39	53	14
16	40	24	40	55	15
18	41	23	41	57	16
42	58	16	44	58	14
44	61	17	62	78	16
48	62	14	65	82	17
19	37	18	69	82	13
20	37	17	72	83	11
21	38	17	74	84	10
22	39	17	76	85	9

26	40	14	83	94	11
41	65	24	84	95	11
43	66	23	92	97	5

Follow from the simulation procedure, the result of parents (P1 and P2), offspring after crossover (OF1 and OF2), and offspring after mutation (M1 and M2) are shown in Table III. The one-point crossover happened at 25^{th} position of the chromosomes of the parents, where the chromosomes are in bold. Mutation is happened at 34^{th} and 35^{th} points, respectively, for Offspring 1 and 2. Since the last point of the offspring represents the total completion time of the project, the minimum value of the last point between the offspring is suggested as the new completion time of the project. Hence, the new completion of the project is 96 days.

Table III: Result of Simulation.

P1	P2	OF1	OF2	M1	M2
2	9	2	9	2	9
8	11	8	11	8	11
10	10	10	10	10	10
7	8	7	8	7	8
6	22	6	22	6	22
29	36	29	36	29	36
28	30	28	30	28	30
36	31	36	31	36	31
49	46	49	46	49	46
57	48	57	48	57	48
49	59	49	59	49	59
31	32	31	32	31	32
31	27	31	27	31	27
28	35	28	35	28	35
27	36	27	36	27	36
37	38	37	38	37	38
53	56	53	56	53	56
65	53	65	53	65	53
56	65	56	65	56	65
63	60	63	60	63	60
69	61	69	61	69	61
68	67	68	67	68	67
43	40	43	40	43	40
39	45	39	45	39	45
43	51	51	43	51	43
47	54	54	47	54	47
54	52	52	54	52	54
65	77	77	70	77	70
70	81	81	72	81	72
72	74	74	73	74	73
73	79	79	76	79	76
76	74	74	83	74	83
83	79	79	90	79	90
90	87	87	91	89	91
91	84	84	97	84	94
97	96	96	97	96	97
Fitness value = 1.2606e+06					

The duration, which is the difference between EF and EF, for each activity of the project, is shown in Table IV.

Table IV: Duration after Simulation.

ES	EF	Duration	ES	EF	Duration
0	2	2	55	56	1
2	8	6	56	63	7
3	10	7	59	69	10
4	7	3	61	68	7
6	6	0	38	43	5
12	29	17	39	39	0
16	28	12	40	51	11
18	36	18	41	54	13
42	49	7	44	52	8
44	57	13	62	77	15
48	49	1	65	81	16
19	31	12	69	74	5
20	31	11	72	79	7

21	28	7	74	74	0
22	27	5	76	79	3
26	37	11	83	89	6
41	53	12	84	84	0
43	65	22	92	96	4

After taking the GA-based simulation, the completion time of the project is reduced from 99 days to 96 days, where the company finishes the project four days earlier than the expected time. Hence, the company saves the cost of RM39, 393, where the expected total cost is RM1, 300, 000 and the refined total cost is RM1, 260, 606.

Conclusion:

The GA-based simulation for the project scheduling was discussed in the paper. Since GA is the common technique in simulation, it is used in scheduling in order to reduce cost and time of the project or production. It is proven that by using GA, the completion time of the project with the corresponding cost expensed is reduced. In conclusion, the simulation optimization is the powerful tool in solving the problem of the scheduling.

REFERENCES

Abdul Talib Bon, Jean Marc Ogier, Ahmad Mahir Razali, Ihsan M. Yassin, 2008. Feature Selection in Beltline Moulding Proces.

Assaf, S.A., S. Al-Hejji, 2006. "Causes of delay in large construction projects". Int J Project Manage, 24(4): 349-57.

Bhattachsriya, R.K., 2012."Introduction To Genetic Algorithms". Department of Civil Engineering, Indian Institute of Technology Guwahati.

Heizer, J. and B. Render, 2008. *Operation Management*, 9th Ed, Pearson Prentice Hall.

Holland, J., 1975. "Adaptation in natural and artificial systems", University of Michigan Press, Ann Arbor.

Mayer, M.K., 1999. "A Network Parallel Genetic Algorithm For The One Machine Sequencing Problem". Computers & Mathematics with Applications, 37(3): 71-78.

Sabuncuoglu, I., 1998. "A study of scheduling rules of flexible manufacturing system: a simulation approach," Int. J. Prod. Res., 36(2): 527-546.

Yan, Y., G. Wang, 2007. "A job shop scheduling approach based on simulation optimization". IEEE International Conference on Industrial Engineering and Engineering Management, 1816-1822.