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Optimal project adjustment and selection

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ABSTRACT

These days companies are competing in a fast changing environment. To keep its competitiveness, the company needs not only to seek and select new investment opportunities but also to adjust its existing projects. This paper discusses an optimal project selection and adjusting problem under capital and land resource limitations. Due to the complex and dynamic nature of the economic environment, the project parameters such as initial outlays, upgrade expenditures and net cash flows are treated as random variables. Net present value method is employed to calculate the investment return, and a mean–variance optimal adjustment and selection model is developed. To solve the proposed optimization problem with big number decision variables, a cellular binary particle swarm optimization which hybridizes cellular automation and particle swarm optimization is proposed. As an illustration of the proposed algorithm, a numerical example is also presented.

1. Introduction

To keep competitiveness and the healthy development of the corporation, top corporation managers must make good use of investment capital. On one hand, they should seek and choose suitable new projects. On the other hand, the projects already in operation may have room for improvement. For example, production lines may need upgrading to guarantee increased product quantity or better product quality and type. Or it may be better to give up some of the existing projects due to the change of customer demand. This type of problem is project adjustment and selection problem. In the past, scholars used to pay their attention to new project selection. For example, Lee and Kim (2001), and Dickinson et al. (2001) discussed interdependent project selection problem. Gustafsson and Salo (2005) developed contingent portfolio programming model for the management of risky projects. Sun and Ma (2005), and Medaglia et al. (2008) studied simultaneous selection and scheduling of project portfolios. Huang discussed project selection with fuzzy project parameters (Huang, 2007a) and random fuzzy project parameters (Huang, 2007b). Gemici-Ozkan et al. (2010) developed a three-phase decision support structure for a R & D project portfolio selection. Shakhsi-Niaei et al. (2011) proposed a two-phase framework to select projects under uncertainty and real world constraints like segmentation, logical and budget constraints. Zhang et al. (2011) provided a selection method for projects located in different countries. In addition, to solve the complex new project selection problem, Hsieh and Liu (2004) presented a genetic algorithm for optimization of infrastructure investment under time resource constraints. Medaglia et al. (2007) offered a multiobjective evolutionary approach based on nondominated sorting genetic algorithm for linearly constrained project selection. Carazo et al. (2010) developed a Scatter Search based metaheuristic algorithm to handle multiobjective project portfolio selection. However, so far little research has been found on project selection considering both existing project adjustment and new project selection. In fact, adjusting existing projects can release more capital and land resources for more suitable projects. Thus, the company can make better use of its resources by simultaneously considering the adjustment of existing project and the selection of new project. In this paper, we will discuss the existing project adjusting problem together with new project selection. Due to the complex and dynamic nature of the economic environment, it is hard to accurately predict the future net cash flows, initial outlays and upgrade expenditures. For example, various economic factors such as fiscal and monetary measures, and inflation will affect the prices. Customers' preference and demand is changing. Ross et al. (2009) pointed out that anything may happen during the predicted periods. Therefore, it is almost impossible to exactly predict the future values of project parameters. However, by making use of historical data of similar projects and by doing careful product market investigation, investors can get statistical data about the project parameters. In this paper, we assume that statistical data can be obtained and treat the project parameters such as net cash flows, initial outlays and upgrade expenditures as random variables. Since it is difficult to use traditional method to solve the problem when the number of candidate projects is large, we will hybridize cellular automation and particle swarm optimization to present a cellular binary particle swarm optimization (CBPSO) algorithm for solving the problem.

The rest of the paper is organized as follows. In Section 2 we will describe a project adjustment and selection problem and

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develop an optimization model for dealing with the problem. Then in Section 3 we will present a CBPSO algorithm to solve the problem. To illustrate the modeling idea and to test the effectiveness of the proposed CBPSO, we will present a numerical example in Section 4. Finally, in Section 5 we will give some concluding remarks.

2. Project adjustment and selection model

To understand a project adjustment and selection problem, consider a company which has k numbers of projects in operation. Due to the change of market environment and economic policy, the company may need to adjust some of the existing projects. For an existing project, the company has three choices, i.e., giving it up, keeping it as it is and upgrading it. In the meantime, the company may need to select some new projects from n-k numbers of new candidate projects. The company's objective is to obtain a maximum investment return by adjusting the existing projects and/or selecting new projects under capital and land resource constraints with risk control. Suppose each existing project and each new project has no salvage at the end of lifetime. For discussion convenience, we use the following notations:

$NCF_{i,t}$ the net cash flow of project i at the end of the t-th year;
$IO_{i,t}$ the initial outlay or upgrade expenditure of project i at the beginning of the t-th year;
M_i the land occupation of project i;
S_i the investment or upgrade duration of project i, and $S = S_1 \vee S_2 \vee \ldots \vee S_n$;
T_i the end year of project i;
NI_i the net income of project i if the project i is given up and sold, $i = 1, 2, \ldots, k$;
W_t the available investment capital at the beginning of the t-th year, $t = 1, 2, \ldots, S$;
r the discount rate;
x_i, y_i decision variables which are defined by

$$x_i = \begin{cases} 1, & \text{if project i is kept or selected,} \\ 0, & \text{if project i is given up or not selected,} \end{cases} \quad i = 1, 2, \cdots, n, \quad \text{and}$$

$$y_i = \begin{cases} 1, & \text{if project i is upgraded,} \\ 0, & \text{otherwise,} \end{cases} \quad i = 1, 2, \cdots, k.$$

Let downward arrows represent investment outlays or expenditures, and upward arrows net cash flows. Then the investment outlays and the net cash flows of the new project i can be reflected by Fig. 1. It is easy to see that the net present value (NPV) of the new project i, $i = k+1, k+2, \ldots, n$, can be calculated via

$$\text{NPV}_i = \sum_{t=S_i}^{T_i} \frac{NCF_{i,t}}{(1+r)^t} - \sum_{t=1}^{S_i} \frac{IO_{i,t}}{(1+r)^{t-1}}, \quad i = k+1, k+2, \cdots, n.$$

Then the investment return in NPV form from the selected new projects is

$$OB_1 = \sum_{i=k+1}^{n} \left[\sum_{t=S_i}^{T_i} \frac{NCF_{i,t}}{(1+r)^t} - \sum_{t=1}^{S_i} \frac{IO_{i,t}}{(1+r)^{t-1}} \right] x_i. \tag{1}$$

For the existing project i, $i = 1, 2, \ldots, k$, the initial outlay previously spent is the sunk cost and has no effect on the decision now. However, the future net cash flows of the existing project i if it is not adjusted from the present to the end of its life should be treated as the opportunity cost. Let ONPV_i denote the opportunity cost of the existing project i, $i = 1, 2, \cdots, k$, respectively. Then ONPV_i can be calculated via

$$\text{ONPV}_i = \sum_{t=1}^{T_i} \frac{NCF_{i,t}}{(1+r)^t}, i = 1, 2, \cdots, k.$$

If the existing project i is given up, i.e., $x_i = 0$, the company can get a net income NI_i by selling the machines, production lines and the left stocks of the products in the market. In this case, the NPV_i is obtained according to the following formula

$$\text{NPV}_i = NI_i - \text{ONPV}_i, i = 1, 2, \cdots, k. \tag{2}$$

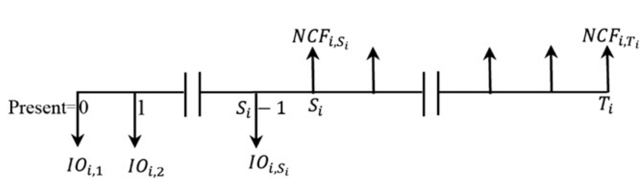

Fig. 1. Cash flows of the new project i.