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A Mathematical Model For Simultaneous Optimization Of The Ultimate Pit Limit And Block Sequencing In Open Pit Mining

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Abstract: The aim of this paper is to develop a mathematical model for defining the ultimate pit limit using through net present value (NPV) maximization approach. In the following, two new algorithms were presented to simultaneously determine ultimate pit outline and mining sequence based on the maximization of NPV.

Keywords: Open Pit Mine, Ultimate Pit Limit, Optimization, Heuristic algorithm.

INTRODUCTION

The ultimate pit limit is an important problem, which is determined by the maximization of undiscounted profit or NPV. The floating cone algorithm [1] and its modified versions [2,3] methods were developed to generate ultimate pit limit based on the maximization of the undiscounted profit. Nevertheless, it is better to determine the pit outline based on the maximization of NPV. To achieve this goal a few algorithms, such as [4-6] were established.

The next step of open pit design is optimization of the production scheduling [7-10]. In this paper, at first a binary model was developed for determining the ultimate pit limit by NPV maximization. Then, because the model is strongly NP-Hard, two heuristic algorithms were presented to determine the ultimate pit limit and blocks extraction orders simultaneously.

MODELLING

Binary and nonlinear mathematical models were presented to determine the ultimate pit limit on the basis of maximizing NPV and few suggestions for its linearization. To reduce the number of binary decision variables firstly the useless waste blocks were removed from the model. To determine the useless waste blocks, it is necessary to define an outline that contains all the ore blocks with regard to the mining

constraints. This outline is called the biggest possible pit (BPP). The other techniques to reduce the number of binary variables are to use the concepts of earliest and latest extraction time for each block within BPP.

HEURISTIC ALGORITHMS

This model is a strongly NP-Hard problem and so diffcult to be solved with mathematical method. Therefore, two heuristic algorithms are developed to determine the mining sequence and ultimate pit limit based on the maximization of the NPV with the use of the concepts of positional weight, updated earliest extraction.

RESULTS AND CONCLUSIONS

The developed algorithms were applied for 2D and 3D block models and the obtained results obtained indicated that they are able to produce acceptable outputs. Complexity of the algorithms is low and easy to use and they can also be used for educational purpose.

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