Enhancing Pit Optimization with Direct Block Scheduling (DBS) and the Bienenstock Zuckerberg (BZ) Algorithm: Maximizing NPV and Efficiency

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# ABSTRACT

Direct Block Scheduling (DBS) has become an essential tool in modern mine planning. It is particularly important in open pit optimization because it ensures an optimal net present value (NPV) by modelling intricate mining systems. DBS maximises NPV by leveraging dynamic cut-off grades, blending constraints, and capital expenditure considerations. This paper presents the use of DBS to integrate the Bienenstock Zuckerberg (BZ) algorithm with mixed-integer linear programming (MILP); and clustering algorithms to generate mining phases. This integration offers a highly efficient solution to complex pit optimization challenges.

DBS excels in modelling multi-mine and multi-block model systems. The method offers a significant advantage in strategic planning where ore blending strategies may incorporate numerous pits and/or regions. The early-stage integration of blending constraints in DBS ensures that ore quality is maintained, enhancing downstream processing efficiency. In addition, the ability to strategically manage capital expenditure phases over time makes DBS a powerful tool for long-term financial planning in mining projects.

The BZ algorithm enhances DBS by allowing it to solve complex scheduling problems within a reasonable timeframe. The reduced time required to solve complex linear relaxations is a substantial improvement over traditional MILP method. The computational efficiency of BZ algorithm allows for the generation of high-quality, optimized strategic mining strategy that aligns with both operational and financial objectives, even in large-scale mining environments.

The use of a clustering algorithm to augment DBS offers significant strategic advantages for schedule optimization. It does this by grouping similar blocks based on DBS period, ore quality, proximity, or operational characteristics. This clustering of mining tasks into phases/pushbacks transitions the optimized mining sequence into an efficient mining production schedule.

This paper discusses the combined use of DBS (with the BZ algorithm) and clustering techniques. It demonstrates the collective impact on optimizing pit designs, maximizing NPV, managing capital expenditures, and enhancing operational profitability. The current approach offers superior results for mining operations that need a comprehensive solution to the challenge of producing an optimized schedule for complex mining operations.