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Contextual stochastic optimization of industrial mining complexes

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Contextual stochastic optimization of industrial mining complexes

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Abstract : In mining complexes or mineral value chains, materials flow from extraction sites (mines) through crushers, stockpiles, waste dump and tailings, and processing plants to supply minerals to customers and market. New developments over the last decade have developed new advanced technologies for the simultaneous stochastic optimization of a mining complex, integrating upstream and downstream decisions into a single stochastic optimization model, that also manages the related supply (geological) and demand (market) uncertainties. This comprehensive approach addresses shared resources and operational interdependencies but results in large-scale, NP-hard problem that challenges existing solvers. To further tackle computational complexities, a novel framework leveraging contextual stochastic optimization is proposed to decompose the simultaneous stochastic model into interconnected upstream and downstream components. The proposed upstream model relies on pertinent block properties treated as random variables influenced by simultaneous model parameters, effectively capturing blending and processing activities. In particular, decision rules and end-to-end methods of contextual stochastic optimization are proposed. This framework enhances decision quality, manages risks, and offers a scalable solution for optimizing mining complexes under uncertainty.

Contextual Stochastic Optimization of Mining Complexes

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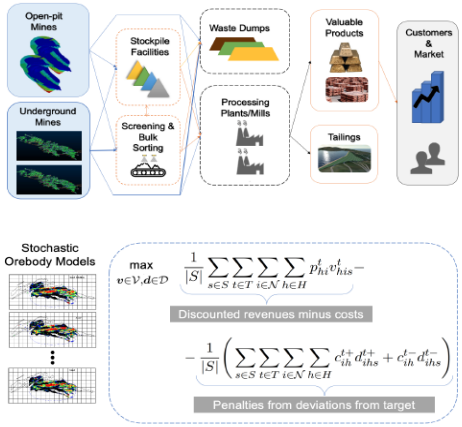
Abstract

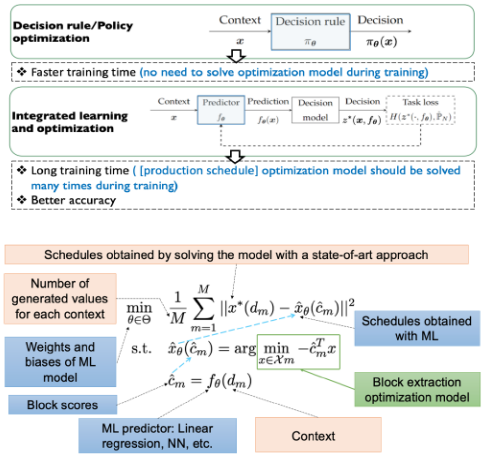
In mining complexes (mineral value chains), materials flow from extraction sites through crushers, stockpiles, and processing plants to customers or waste dumps. Traditional optimization treats extraction (upstream) and supply chain (downstream) separately, leading to suboptimal decisions as upstream models rely on block economic values (BEVs) that ignore processing, blending, and market dynamics. Recent research integrates upstream and downstream decisions into a single stochastic model, improving outcomes but creating large, NP-hard problems.

We propose a novel framework using contextual stochastic optimization (CSO) to decompose this model into interconnected components. Instead of BEVs, the upstream model uses block scores as random variables influenced by simultaneous model parameters, capturing blending and processing effects. This approach improves decision quality, manages risks, and scales effectively under uncertainty.

Preliminaries



Methods & Results



Experiments: the proposed approach was tested on the small-scale instances with FNN. Both train and test losses generated desired curves.

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