Statement of Interest

University of British Columbia – Ph.D. in Mining Engineering

Applicant: Bill Tubbs
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Research Goal: Evaluate the potential of machine learning and other empirical techniques to optimize mineral processing operations

Application: SAG and ball mill circuits are notoriously difficult to control at optimum operating conditions due to the fact that the internal state of the process is unobservable, the complex/non-linear nature of the process, and variability in the ore feed (among other things). Since grinding consumes a large amount of power and represents a significant proportion of total mine operating costs (13-20%) any improvement in throughput, uptime, or unit cost has a significant payback as well as environmental benefits such as reduced energy and water consumption.

Background: Generally, there are no theoretical models of the process dynamics realistic enough to use for online process control so most companies rely on experienced operators or 'fuzzy logic' decision-support tools to monitor and adjust process parameters.

Various machine learning techniques have the capability to 'learn' complex behaviour from raw measurement data. Techniques such as recurrent neural networks and reinforcement learning have been shown to learn complex tasks without requiring a prior model of the system dynamics and also to learn from expert example (imitation learning). However, these unstructured methods also present serious problems in industrial process applications such as lack of robustness, inability to guarantee performance, and require large amounts of training data.

Approach: This research will evaluate various model-based and model-free machine learning algorithms alongside conventional dynamic optimization methods, first in a simulated environment to determine the most promising candidates then in a real-world setting based on actual operating data from a processing plant and to determine if these new techniques can improve on the performance of an experienced human operator.

Solving this problem will require a combination of expertise from different disciplines – mineral processing, control theory, applied math/statistics and machine learning – to identify, develop, and thoroughly test solutions that

are robust, stable, and safe enough to apply to real industrial processing environments.

My background: I'm an expert in operations management and production optimization. I have over 17 years experience working in chemical manufacturing, oil and gas and mining. I have a mechanical engineering degree and a masters in resource management.