# Group MATLAB Assignment 1 – Mine Economics

In this assignment, you are going to consider a simple model for mine economics, and use that model to identify the optimal extraction strategy for a new mine. Note: while we will be making **many** simplifying assumptions in this assignment, the mathematical approach you will be using is at the foundation of many financial forecasting tools.

**Scenario**: a new silver mine is being proposed for development, and the geologists have a good estimate on the total quantity of silver in the ore body. For simplicity, we will treat this total amount as E = 100 (%). The financial operations team would like the extraction period to last at most 30 years.

To model the rate of extraction, you will use the family of functions , which represents the rate of extraction in percent per year, with being a parameter that you will will experiment with.

To find the percentage of the total extracted between two time points, you would compute the integral of the extraction rate:

Given the extraction rate and the price of silver (in normalized units), we can determine the revenue rate. For generality, we won’t specifically use a currency, but use a price in “money units/percent extracted”, which gives us a Revenue Rate in money units/year:

The rate of expenditure for the extraction (labour and capital) depends directly on the extraction rate, also in money units/year:

Note that the quadratic element here is a penalty on higher rates of extraction, because the scaling-up and shut-down costs would both be increased by an aggressive shorter-term extraction.

With these ingredients we can find the rate of profit generation at any time, in money units/year:

Finally, there is an economic principle that states that “money now is worth more than money later”, due to the fact that money now can be invested and will grow until a later date. To allow one-to-one comparisons of various extraction strategies, all profits will be invested at an interest rate , and the *future value* of all the profits will be compared at the 30 year mark. The future value at the 30 year mark is given by

Assignment:

We will consider 4 possible values: 0.1, 0.2, 0.6, 1.2; these each correspond to an extraction strategy over the 30 years.

1. For each of the values, find the matching value that leads to a complete extraction of the mine ore over 30 years. I.e. Find such that .
2. Generate a figure showing the four curves, over the 30 year period . (one curve per value).
3. Identify the value that corresponds to the earliest extraction of most of the ore.
4. Using the following constants,
   * and interest rate (or 5%),

Produce a table that shows the four k values and the corresponding Future Value for that extraction strategy.

1. Identify the optimal value that maximizes the Future Value for this scenario.
2. Now consider the same scenario, except where the price of silver is lower. Based on your intuition, how should you change the extraction rate if the price is lower?
3. Confirm (or contradict) your intuition by changing = 10 (keeping other constants the same), and producing a new table that shows the four k values and the corresponding Future Value.

Bonus question:

We considered explicitly only four values, but that was an artificial limitation. Either manually or by using the MATLAB optimization tools, identify to the nearest 0.01 the value of that leads to the greatest possible Future Value for the mine operation. Use the original parameters,

* + and interest rate (or 5%).

Include your final value, the resulting Future Value, and the comparison to your answer in Question 5 above. Also include a graph of the Extraction Rate over the 30 year period.

**Submission:** you can submit your assignment solutions as a Word or a PDF document. You should also submit any MATLAB scripts you wrote as part of your analysis.