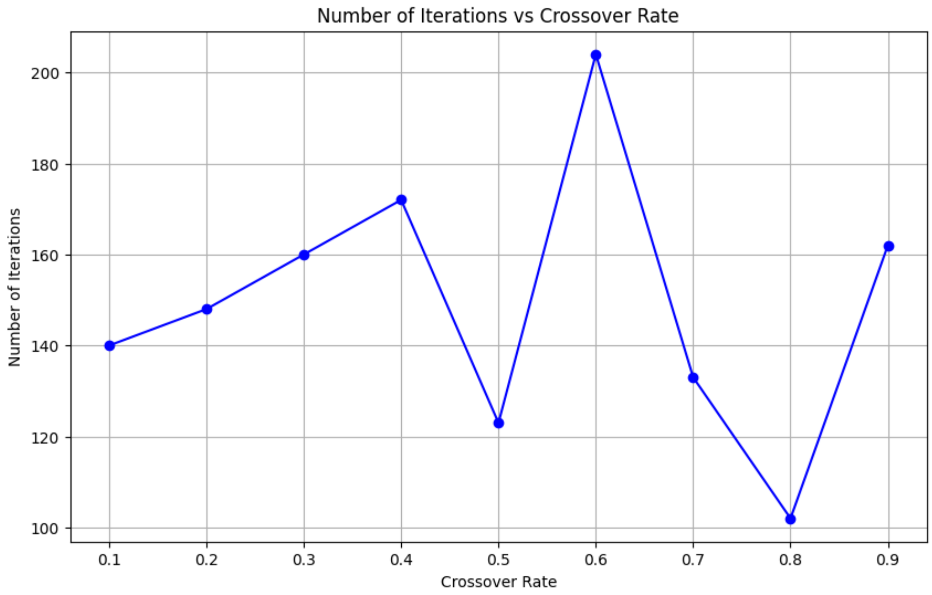
Parameters Changes in Genetic Algorithm and Circuit Simulator

In the Genetic Algorithm part, there are several parameters that can be adjusted, which influence the effectiveness of the algorithm.

In the process of the circuit simulator, there are many parameters that influence the iterations and the final result of circuit optimization. These parameters include the number of units, the price of gerardium and waste, and the purity of the input feed. Additionally, many physical values in the calculation formula can be freely changed. The model is always improving, so the data in this may not be the latest and greatest.

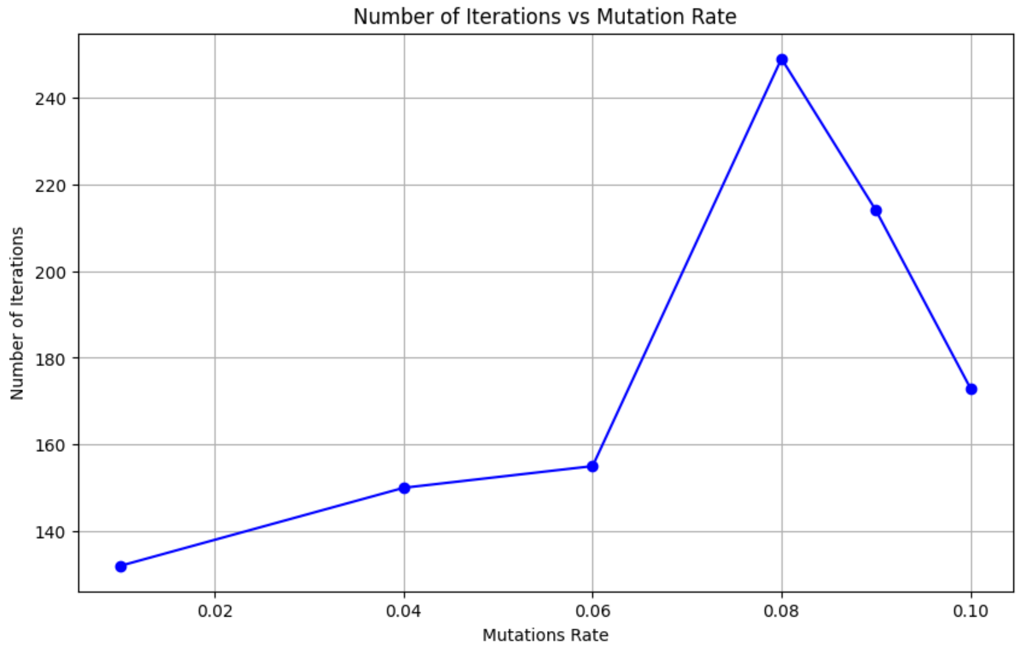
GA model parameters



This graph illustrates the relationship between the crossover rate and the number of iterations required.

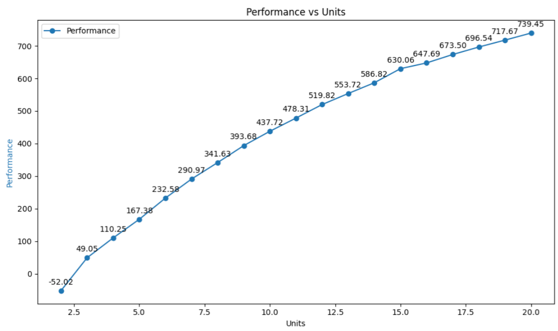
1. The number of iterations starts at approximately 140 for a crossover rate of 0.1.
2. As the crossover rate increases from 0.1 to 0.4, the number of iterations rises gradually, peaking at about 180 iterations.
3. There is a notable dip at a crossover rate of 0.5, where the number of iterations drops to around 120.
4. The number of iterations then spikes sharply, reaching a maximum of approximately 200 at a crossover rate of 0.6.
5. Another significant decrease occurs at a crossover rate of 0.7, with the number of iterations falling to around 110, the lowest point in the graph.
6. Beyond this point, the number of iterations increases again, reaching around 160 at a crossover rate of 0.9.

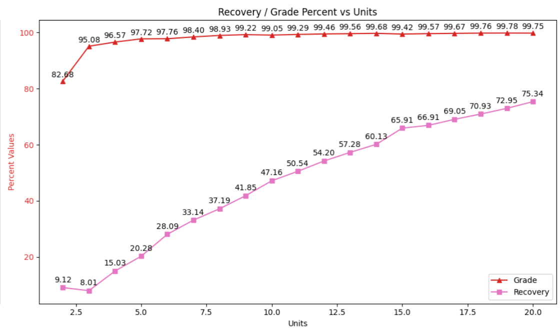
Overall, the graph shows a fluctuating pattern with multiple peaks and valleys, indicating that the number of iterations required is highly sensitive to changes in the crossover rate. There are specific crossover rates where the number of iterations is minimized, suggesting optimal points for crossover efficiency.



This graph depicts the relationship between the mutation rate and the number of iterations required.
As the mutation rate increases from 0.02 to 0.04, there is a slight increase in the number of iterations needed, rising from around 140 to approximately 160. The number of iterations remains relatively stable between the mutation rates of 0.04 and 0.06. There is a significant increase in the number of iterations required as the mutation rate rises from 0.06 to 0.08, reaching a peak at around 240 iterations. After the peak at 0.08, the number of iterations decreases as the mutation rate increases to 0.10, falling to around 180 iterations.
There is an optimal mutation rate where the number of iterations required is minimized, and beyond that point, the efficiency decreases.

Number of units

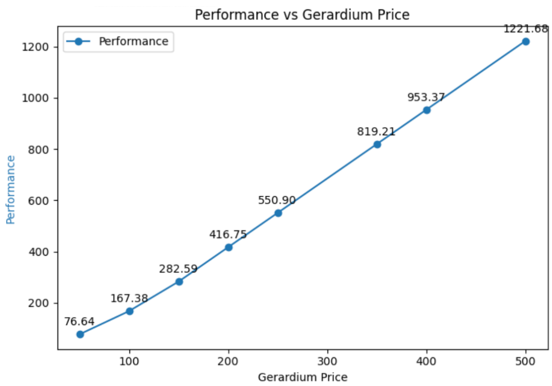


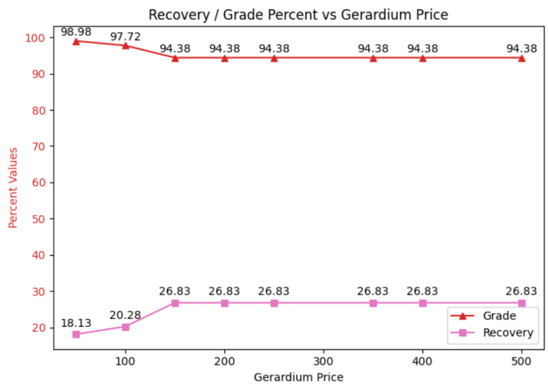


As the number of units increases, performance also improves, showing a clear upward trend. Performance starts at around -52.02 with 2 units and gradually increases to approximately 718.15 with 20 units. The improvement in performance with more units is nonlinear but generally consistent. But it does not increase indefinitely, it approaches a ceiling.

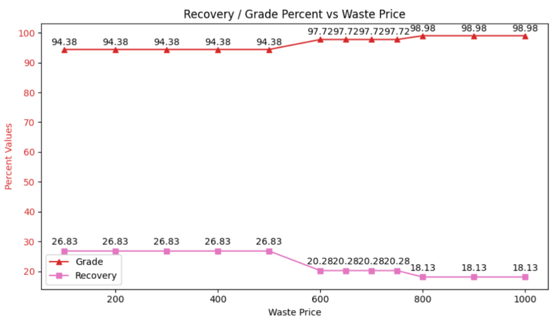
The grade percentage is about 82.68% with 2 units and quickly increases to around 97.72% with 5 units. After that, the increase is very small, reaching a peak of about 99.79% with 20 units. This indicates that the grade percentage quickly reaches a high value and then stabilizes. The recovery percentage is 9.12% with 2 units and steadily increases to about 75.34% with 20 units. Unlike the grade, the recovery shows a more consistent upward trend without early stabilization, indicating that each additional unit continues to bring steady benefits.

Price for gerardium and waste



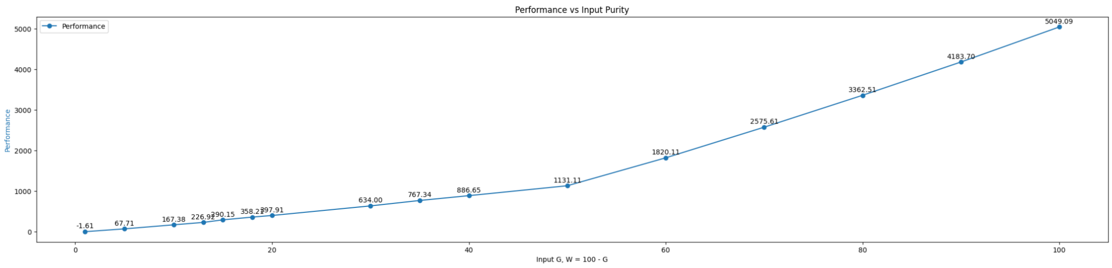


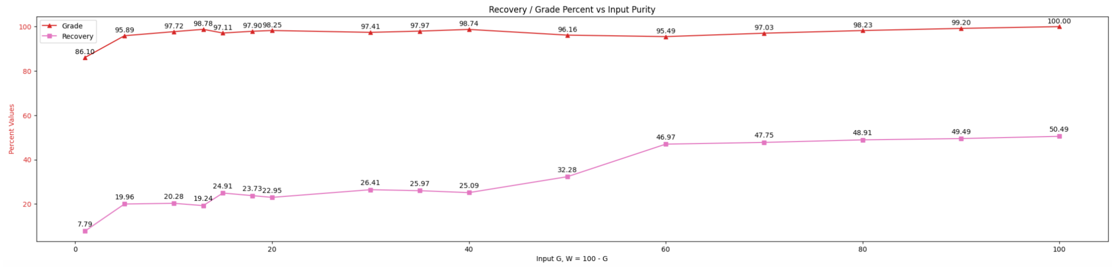
The picture about the Gerardium price shows a clear linear upward trend, indicating that as the price of Gerardium increases, and performance improves linearly with the increase in Gerardium price. The grade percentage is high at lower Gerardium prices and then stabilizes, indicating that the change in grade occurs early on. The recovery percentage shows steady improvement, but the overall magnitude is small, and then go to steady.



The figure on waste price illustrates a negative correlation between performance and waste price. In the first half, there is a significant decline, indicating a somewhat linear relationship. In the second half, the decline is smaller but still demonstrates a linear trend. The grade percentage is low at lower Waste prices and then stabilizes. The recovery percentage shows steady decreasing, but the overall magnitude is small, and then go to steady.

Purity of the input feed





For a specific vector, assuming the value of G + W is constantly 100. For a 5-unit vector, the economic parameters are {100, -750}, and the changing curve vs purity is as shown.

As the input purity increases, performance increases almost linearly. When the G_flow input is 0 (the W_flow is 100), the performance is -11.2252. It grows gradually at first, with performance rising slowly. However, when G > 50, there appears to be a turning point where the slope increases, and the rise becomes faster.

Regarding Grade, when G_flow is 1, it starts very low (7.79%). It rises rapidly and stabilizes around 96%, indicating that the grade rate is efficient and stable even at low input purity. The grade rate gradually approaches 100 as G increases.

The recovery rate generally rises, with some fluctuations. At lower input purity, the recovery rate fluctuates greatly, rising rapidly from 7.79 to 19.96. When G is between 5 and 40, recovery rate shows some fluctuation, then gradually rises and maintains a steady increase when G > 40.

Physical values in the formula

Higher k_i^C will increase the proportion of material recovered in the high-grade concentration stream. Higher k_i^{I} will increase the proportion of the material recovered in the intermediate grade flow. Adjusting these constants changes the distribution of the material between the concentrate stream, the intermediate stream, and the tailings.

Residence time τ depends on unit volume V, solid volume fraction ϕ, and total feed rate.

When τ increases, R_i^C and $\mathrm{R}_i^{\mathrm{I}}$ will increase, because they are proportional to τ.

This results in increased recovery rates for high and intermediate grade flows, thereby reducing the material in the tailings.

When Increasing the Feed Rate F_i directly increases the absolute amounts of material recovered to each stream. It does not directly impact the recovery rates R_i, but influences the mass flow rates C_i, I_i, and T_i.

Changes in density affect the residence time τ, impacting recovery rates. Higher density reduces τ, lowering recovery rates.

Solids Volume Fraction ϕ, given as 0.1 (10%). Higher ϕ increases τ, leading to higher recovery rates. Lower ϕ reduces τ, decreasing recovery rates.

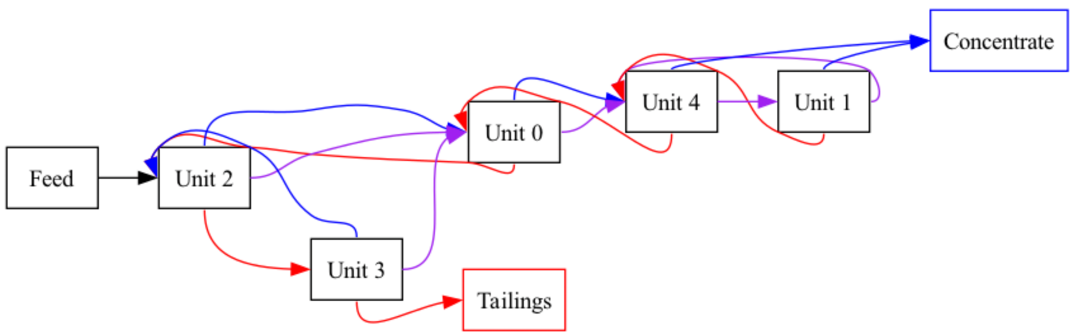
Summary:

- Recovery Rates: Dependent on the rate constants k_i^{I} and k_i^C and residence time τ. Changes in these values adjust how much of each component is recovered in high-grade and intermediate streams.
- Mass Flow Rates: Directly proportional to the feed rates F_i and recovery rates R_i^C and $\mathrm{R}_i^{\mathrm{I}}$. Adjustments in feed rates influence the quantity of material recovered but not the recovery proportions.
- Residence Time: Influenced by cell volume V, solids volume fraction ϕ, and feed rate. Changes in residence time impact the effectiveness of recovery for both high-grade and intermediate streams.

Adjusting these parameters allows for optimization of the separation unit's performance, balancing the recovery of valuable materials against the rejection of waste.

Keep the unit number and other parameters as original, change the physical parameters as below, the result changes.

ρ	ϕ	V	
3000	0.2	10.0	
k_{G}^{C}	$k_{\mathrm{G}}^{\mathrm{I}}$	$k_{\mathrm{W}}^{\mathrm{C}}$	$k_{\mathrm{W}}^{\mathrm{I}}$
0.004	0.08	0.0002	0.001



Feed	Unit 0			Unit 1			Unit 2			Unit 3			Unit 4		
2	4	4	2	5	4	4	0	0	3	2	0	6	5	1	0

Performance	Recovery	Grade
944.22	95.30%	99.88%