Модель для оптимизации золотодобывающей отрасли

Постановка задачи и описание данных

- Компания разрабатывает решения для эффективной работы промышленных предприятий.
- Необходимо разработать прототип модели машинного обучения, которая предскажет коэффициент восстановления золота из золотосодержащей руды.
- Модель поможет оптимизировать производство, чтобы не запускать предприятие с убыточными характеристиками.

В нашем распоряжении данные с параметрами добычи и очистки.

В процессе работы с данными предлагается самостоятельно решить, какие детали нужны для построения модели, а какие — нет.

Данные находятся в трёх файлах:

- gold_recovery_train_new.csv — обучающая выборка;
- gold_recovery_test_new.csv — тестовая выборка;
- gold_recovery_full_new.csv — исходные данные.

- Данные индексируются датой и временем получения информации (признак date).
- Соседние по времени параметры часто похожи.
- Некоторые параметры недоступны, потому что замеряются и/или рассчитываются значительно позже, из-за чего в тестовой выборке отсутствуют некоторые признаки, которые могут быть в обучающей.
- в тестовом наборе нет целевых признаков; исходный датасет содержит обучающую и тестовую выборки со всеми признаками.

Требуется:

- Подготовить данные;
- Провести исследовательский анализ данных;
- Построить и обучить модель.

In [1]:
```
#basic
import pandas as pd
import numpy as np
import seaborn as sns

#basic instruments
import random
#import math

#plotting
import matplotlib.pyplot as plt
from pandas.plotting import scatter_matrix

#date and time
import datetime
from datetime import datetime, date
```

```
#machine learning models
#from sklearn.tree import DecisionTreeClassifier
#from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import RandomForestRegressor
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import Lasso

#machine learning instruments
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
#from sklearn.dummy import DummyClassifier
from sklearn.dummy import DummyRegressor

from sklearn.utils import shuffle
from sklearn.metrics import homogeneity_score, make_scorer

#machine learning metrics
from sklearn.metrics import mean_squared_error
from sklearn.metrics import accuracy_score, roc_auc_score, precision_score,
recall_score, f1_score, confusion_matrix
from sklearn.metrics import precision_recall_curve, roc_curve


#dataset settings
pd.set_option('display.max_columns', 40) #макс кол-во колонок в выводимых данных
pd.set_option('display.max_rows', 30) #макс кол-во строк в выводимых данных
pd.set_option('display.width', 80) #макс кол-во символов в строке

from sklearn.model_selection import GridSearchCV

#magic
%matplotlib inline

#warnings and other settings
import warnings
warnings.simplefilter('ignore')

pd.options.mode.chained_assignment = None

#data engineering instruments
#from pyspark.sql import SparkSession
```

Загрузка и первичное исследование данных

In [2]:
```
try:
    df_train=pd.read_csv('/datasets/gold_recovery_train_new.csv')
    df_test=pd.read_csv('/datasets/gold_recovery_test_new.csv')
    df_full=pd.read_csv('/datasets/gold_recovery_full_new.csv')

except:
    df_train=pd.read_csv('datasets/gold_recovery_train_new.csv')
    df_test=pd.read_csv('datasets/gold_recovery_test_new.csv')
    df_full=pd.read_csv('datasets/gold_recovery_full_new.csv')
```

Посмотрим на датасеты

- _df*train*

In [3]:
```
df_train.shape
```

Out[3]: (14149, 87)

In [4]:
```
df_train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14149 entries, 0 to 14148
Data columns (total 87 columns):
 #   Column                                              Non-Null Count  Dtype

---  ------                                              --------------  -----

 0   date                                                14149 non-null  objec
t
 1   final.output.concentrate_ag                         14148 non-null  float
64
 2   final.output.concentrate_pb                         14148 non-null  float
64
 3   final.output.concentrate_sol                        13938 non-null  float
64
 4   final.output.concentrate_au                         14149 non-null  float
64
 5   final.output.recovery                               14149 non-null  float
64
 6   final.output.tail_ag                                14149 non-null  float
64
 7   final.output.tail_pb                                14049 non-null  float
64
 8   final.output.tail_sol                               14144 non-null  float
64
 9   final.output.tail_au                                14149 non-null  float
64
 10  primary_cleaner.input.sulfate                       14129 non-null  float
64
 11  primary_cleaner.input.depressant                    14117 non-null  float
64
 12  primary_cleaner.input.feed_size                     14149 non-null  float
64
 13  primary_cleaner.input.xanthate                      14049 non-null  float
64
 14  primary_cleaner.output.concentrate_ag               14149 non-null  float
64
 15  primary_cleaner.output.concentrate_pb               14063 non-null  float
64
 16  primary_cleaner.output.concentrate_sol              13863 non-null  float
64
 17  primary_cleaner.output.concentrate_au               14149 non-null  float
64
 18  primary_cleaner.output.tail_ag                      14148 non-null  float
64
 19  primary_cleaner.output.tail_pb                      14134 non-null  float
64
 20  primary_cleaner.output.tail_sol                     14103 non-null  float
64
 21  primary_cleaner.output.tail_au                      14149 non-null  float
64
 22  primary_cleaner.state.floatbank8_a_air              14145 non-null  float
64
 23  primary_cleaner.state.floatbank8_a_level            14148 non-null  float
```

64
 24 primary_cleaner.state.floatbank8_b_air   14145 non-null float
64
 25 primary_cleaner.state.floatbank8_b_level   14148 non-null float
64
 26 primary_cleaner.state.floatbank8_c_air   14147 non-null float
64
 27 primary_cleaner.state.floatbank8_c_level   14148 non-null float
64
 28 primary_cleaner.state.floatbank8_d_air   14146 non-null float
64
 29 primary_cleaner.state.floatbank8_d_level   14148 non-null float
64
 30 rougher.calculation.sulfate_to_au_concentrate   14148 non-null float
64
 31 rougher.calculation.floatbank10_sulfate_to_au_feed 14148 non-null float
64
 32 rougher.calculation.floatbank11_sulfate_to_au_feed 14148 non-null float
64
 33 rougher.calculation.au_pb_ratio   14149 non-null float
64
 34 rougher.input.feed_ag   14149 non-null float
64
 35 rougher.input.feed_pb   14049 non-null float
64
 36 rougher.input.feed_rate   14141 non-null float
64
 37 rougher.input.feed_size   14005 non-null float
64
 38 rougher.input.feed_sol   14071 non-null float
64
 39 rougher.input.feed_au   14149 non-null float
64
 40 rougher.input.floatbank10_sulfate   14120 non-null float
64
 41 rougher.input.floatbank10_xanthate   14141 non-null float
64
 42 rougher.input.floatbank11_sulfate   14113 non-null float
64
 43 rougher.input.floatbank11_xanthate   13721 non-null float
64
 44 rougher.output.concentrate_ag   14149 non-null float
64
 45 rougher.output.concentrate_pb   14149 non-null float
64
 46 rougher.output.concentrate_sol   14127 non-null float
64
 47 rougher.output.concentrate_au   14149 non-null float
64
 48 rougher.output.recovery   14149 non-null float
64
 49 rougher.output.tail_ag   14148 non-null float
64
 50 rougher.output.tail_pb   14149 non-null float
64
 51 rougher.output.tail_sol   14149 non-null float
64
 52 rougher.output.tail_au   14149 non-null float

64
 53 rougher.state.floatbank10_a_air   14148 non-null float
64
 54 rougher.state.floatbank10_a_level   14148 non-null float
64
 55 rougher.state.floatbank10_b_air   14148 non-null float
64
 56 rougher.state.floatbank10_b_level   14148 non-null float
64
 57 rougher.state.floatbank10_c_air   14148 non-null float
64
 58 rougher.state.floatbank10_c_level   14148 non-null float
64
 59 rougher.state.floatbank10_d_air   14149 non-null float
64
 60 rougher.state.floatbank10_d_level   14149 non-null float
64
 61 rougher.state.floatbank10_e_air   13713 non-null float
64
 62 rougher.state.floatbank10_e_level   14149 non-null float
64
 63 rougher.state.floatbank10_f_air   14149 non-null float
64
 64 rougher.state.floatbank10_f_level   14149 non-null float
64
 65 secondary_cleaner.output.tail_ag   14147 non-null float
64
 66 secondary_cleaner.output.tail_pb   14139 non-null float
64
 67 secondary_cleaner.output.tail_sol   12544 non-null float
64
 68 secondary_cleaner.output.tail_au   14149 non-null float
64
 69 secondary_cleaner.state.floatbank2_a_air   13932 non-null float
64
 70 secondary_cleaner.state.floatbank2_a_level   14148 non-null float
64
 71 secondary_cleaner.state.floatbank2_b_air   14128 non-null float
64
 72 secondary_cleaner.state.floatbank2_b_level   14148 non-null float
64
 73 secondary_cleaner.state.floatbank3_a_air   14145 non-null float
64
 74 secondary_cleaner.state.floatbank3_a_level   14148 non-null float
64
 75 secondary_cleaner.state.floatbank3_b_air   14148 non-null float
64
 76 secondary_cleaner.state.floatbank3_b_level   14148 non-null float
64
 77 secondary_cleaner.state.floatbank4_a_air   14143 non-null float
64
 78 secondary_cleaner.state.floatbank4_a_level   14148 non-null float
64
 79 secondary_cleaner.state.floatbank4_b_air   14148 non-null float
64
 80 secondary_cleaner.state.floatbank4_b_level   14148 non-null float
64
 81 secondary_cleaner.state.floatbank5_a_air   14148 non-null float

```
64
 82  secondary_cleaner.state.floatbank5_a_level          14148 non-null  float
64
 83  secondary_cleaner.state.floatbank5_b_air            14148 non-null  float
64
 84  secondary_cleaner.state.floatbank5_b_level          14148 non-null  float
64
 85  secondary_cleaner.state.floatbank6_a_air            14147 non-null  float
64
 86  secondary_cleaner.state.floatbank6_a_level          14148 non-null  float
64
dtypes: float64(86), object(1)
memory usage: 9.4+ MB
```

In [5]:
```
df_train=df_train.set_index('date')
```

In [6]:
```
df_train.head()
```

Out[6]:

date	final.output.concentrate_ag	final.output.concentrate_pb	final.output.concentrate_sol	final.c
2016-01-15 00:00:00	6.055403	9.889648	5.507324	
2016-01-15 01:00:00	6.029369	9.968944	5.257781	
2016-01-15 02:00:00	6.055926	10.213995	5.383759	
2016-01-15 03:00:00	6.047977	9.977019	4.858634	
2016-01-15 04:00:00	6.148599	10.142511	4.939416	

5 rows × 86 columns

- _df*test*

In [7]:
```
df_test.shape
```

Out[7]:
```
(5290, 53)
```

In [8]:
```
df_test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5290 entries, 0 to 5289
Data columns (total 53 columns):
 #   Column                                      Non-Null Count  Dtype
---  ------                                      --------------  -----
 0   date                                        5290 non-null   object
 1   primary_cleaner.input.sulfate               5286 non-null   float64
 2   primary_cleaner.input.depressant            5285 non-null   float64
 3   primary_cleaner.input.feed_size             5290 non-null   float64
```

```
 4   primary_cleaner.input.xanthate              5286 non-null   float64
 5   primary_cleaner.state.floatbank8_a_air      5290 non-null   float64
 6   primary_cleaner.state.floatbank8_a_level    5290 non-null   float64
 7   primary_cleaner.state.floatbank8_b_air      5290 non-null   float64
 8   primary_cleaner.state.floatbank8_b_level    5290 non-null   float64
 9   primary_cleaner.state.floatbank8_c_air      5290 non-null   float64
 10  primary_cleaner.state.floatbank8_c_level    5290 non-null   float64
 11  primary_cleaner.state.floatbank8_d_air      5290 non-null   float64
 12  primary_cleaner.state.floatbank8_d_level    5290 non-null   float64
 13  rougher.input.feed_ag                       5290 non-null   float64
 14  rougher.input.feed_pb                       5290 non-null   float64
 15  rougher.input.feed_rate                     5287 non-null   float64
 16  rougher.input.feed_size                     5289 non-null   float64
 17  rougher.input.feed_sol                      5269 non-null   float64
 18  rougher.input.feed_au                       5290 non-null   float64
 19  rougher.input.floatbank10_sulfate           5285 non-null   float64
 20  rougher.input.floatbank10_xanthate          5290 non-null   float64
 21  rougher.input.floatbank11_sulfate           5282 non-null   float64
 22  rougher.input.floatbank11_xanthate          5265 non-null   float64
 23  rougher.state.floatbank10_a_air             5290 non-null   float64
 24  rougher.state.floatbank10_a_level           5290 non-null   float64
 25  rougher.state.floatbank10_b_air             5290 non-null   float64
 26  rougher.state.floatbank10_b_level           5290 non-null   float64
 27  rougher.state.floatbank10_c_air             5290 non-null   float64
 28  rougher.state.floatbank10_c_level           5290 non-null   float64
 29  rougher.state.floatbank10_d_air             5290 non-null   float64
 30  rougher.state.floatbank10_d_level           5290 non-null   float64
 31  rougher.state.floatbank10_e_air             5290 non-null   float64
 32  rougher.state.floatbank10_e_level           5290 non-null   float64
 33  rougher.state.floatbank10_f_air             5290 non-null   float64
 34  rougher.state.floatbank10_f_level           5290 non-null   float64
 35  secondary_cleaner.state.floatbank2_a_air    5287 non-null   float64
 36  secondary_cleaner.state.floatbank2_a_level  5290 non-null   float64
 37  secondary_cleaner.state.floatbank2_b_air    5288 non-null   float64
 38  secondary_cleaner.state.floatbank2_b_level  5290 non-null   float64
 39  secondary_cleaner.state.floatbank3_a_air    5281 non-null   float64
 40  secondary_cleaner.state.floatbank3_a_level  5290 non-null   float64
 41  secondary_cleaner.state.floatbank3_b_air    5290 non-null   float64
 42  secondary_cleaner.state.floatbank3_b_level  5290 non-null   float64
 43  secondary_cleaner.state.floatbank4_a_air    5290 non-null   float64
 44  secondary_cleaner.state.floatbank4_a_level  5290 non-null   float64
 45  secondary_cleaner.state.floatbank4_b_air    5290 non-null   float64
 46  secondary_cleaner.state.floatbank4_b_level  5290 non-null   float64
 47  secondary_cleaner.state.floatbank5_a_air    5290 non-null   float64
 48  secondary_cleaner.state.floatbank5_a_level  5290 non-null   float64
 49  secondary_cleaner.state.floatbank5_b_air    5290 non-null   float64
 50  secondary_cleaner.state.floatbank5_b_level  5290 non-null   float64
 51  secondary_cleaner.state.floatbank6_a_air    5290 non-null   float64
 52  secondary_cleaner.state.floatbank6_a_level  5290 non-null   float64
dtypes: float64(52), object(1)
memory usage: 2.1+ MB
```

In [9]:
```
df_test=df_test.set_index('date')
```

In [10]:
```
df_test.head()
```

Out[10]:

	primary_cleaner.input.sulfate	primary_cleaner.input.depressant	primary_cleaner.input.feed_si

date	primary_cleaner.input.sulfate	primary_cleaner.input.depressant	primary_cleaner.input.feed_si
date			
2016-09-01 00:59:59	210.800909	14.993118	8.0800
2016-09-01 01:59:59	215.392455	14.987471	8.0800
2016-09-01 02:59:59	215.259946	12.884934	7.7866
2016-09-01 03:59:59	215.336236	12.006805	7.6400
2016-09-01 04:59:59	199.099327	10.682530	7.5300

5 rows × 52 columns

- _df*full*

In [11]:
```
df_full.shape
```

Out[11]:
```
(19439, 87)
```

In [12]:
```
df_full.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 19439 entries, 0 to 19438
Data columns (total 87 columns):
 #   Column                                              Non-Null Count  Dtype

---  ------                                              --------------  -----

 0   date                                                19439 non-null  objec
t
 1   final.output.concentrate_ag                         19438 non-null  float
64
 2   final.output.concentrate_pb                         19438 non-null  float
64
 3   final.output.concentrate_sol                        19228 non-null  float
64
 4   final.output.concentrate_au                         19439 non-null  float
64
 5   final.output.recovery                               19439 non-null  float
64
 6   final.output.tail_ag                                19438 non-null  float
64
 7   final.output.tail_pb                                19338 non-null  float
64
 8   final.output.tail_sol                               19433 non-null  float
64
```

```
 9   final.output.tail_au                                19439 non-null  float
64
 10  primary_cleaner.input.sulfate                       19415 non-null  float
64
 11  primary_cleaner.input.depressant                    19402 non-null  float
64
 12  primary_cleaner.input.feed_size                     19439 non-null  float
64
 13  primary_cleaner.input.xanthate                      19335 non-null  float
64
 14  primary_cleaner.output.concentrate_ag               19439 non-null  float
64
 15  primary_cleaner.output.concentrate_pb               19323 non-null  float
64
 16  primary_cleaner.output.concentrate_sol              19069 non-null  float
64
 17  primary_cleaner.output.concentrate_au               19439 non-null  float
64
 18  primary_cleaner.output.tail_ag                      19435 non-null  float
64
 19  primary_cleaner.output.tail_pb                      19418 non-null  float
64
 20  primary_cleaner.output.tail_sol                     19377 non-null  float
64
 21  primary_cleaner.output.tail_au                      19439 non-null  float
64
 22  primary_cleaner.state.floatbank8_a_air              19435 non-null  float
64
 23  primary_cleaner.state.floatbank8_a_level            19438 non-null  float
64
 24  primary_cleaner.state.floatbank8_b_air              19435 non-null  float
64
 25  primary_cleaner.state.floatbank8_b_level            19438 non-null  float
64
 26  primary_cleaner.state.floatbank8_c_air              19437 non-null  float
64
 27  primary_cleaner.state.floatbank8_c_level            19438 non-null  float
64
 28  primary_cleaner.state.floatbank8_d_air              19436 non-null  float
64
 29  primary_cleaner.state.floatbank8_d_level            19438 non-null  float
64
 30  rougher.calculation.sulfate_to_au_concentrate       19437 non-null  float
64
 31  rougher.calculation.floatbank10_sulfate_to_au_feed  19437 non-null  float
64
 32  rougher.calculation.floatbank11_sulfate_to_au_feed  19437 non-null  float
64
 33  rougher.calculation.au_pb_ratio                     19439 non-null  float
64
 34  rougher.input.feed_ag                               19439 non-null  float
64
 35  rougher.input.feed_pb                               19339 non-null  float
64
 36  rougher.input.feed_rate                             19428 non-null  float
64
 37  rougher.input.feed_size                             19294 non-null  float
64
```

```
 38  rougher.input.feed_sol                      19340 non-null  float
64
 39  rougher.input.feed_au                       19439 non-null  float
64
 40  rougher.input.floatbank10_sulfate           19405 non-null  float
64
 41  rougher.input.floatbank10_xanthate          19431 non-null  float
64
 42  rougher.input.floatbank11_sulfate           19395 non-null  float
64
 43  rougher.input.floatbank11_xanthate          18986 non-null  float
64
 44  rougher.output.concentrate_ag               19439 non-null  float
64
 45  rougher.output.concentrate_pb               19439 non-null  float
64
 46  rougher.output.concentrate_sol              19416 non-null  float
64
 47  rougher.output.concentrate_au               19439 non-null  float
64
 48  rougher.output.recovery                     19439 non-null  float
64
 49  rougher.output.tail_ag                      19438 non-null  float
64
 50  rougher.output.tail_pb                      19439 non-null  float
64
 51  rougher.output.tail_sol                     19439 non-null  float
64
 52  rougher.output.tail_au                      19439 non-null  float
64
 53  rougher.state.floatbank10_a_air             19438 non-null  float
64
 54  rougher.state.floatbank10_a_level           19438 non-null  float
64
 55  rougher.state.floatbank10_b_air             19438 non-null  float
64
 56  rougher.state.floatbank10_b_level           19438 non-null  float
64
 57  rougher.state.floatbank10_c_air             19438 non-null  float
64
 58  rougher.state.floatbank10_c_level           19438 non-null  float
64
 59  rougher.state.floatbank10_d_air             19439 non-null  float
64
 60  rougher.state.floatbank10_d_level           19439 non-null  float
64
 61  rougher.state.floatbank10_e_air             19003 non-null  float
64
 62  rougher.state.floatbank10_e_level           19439 non-null  float
64
 63  rougher.state.floatbank10_f_air             19439 non-null  float
64
 64  rougher.state.floatbank10_f_level           19439 non-null  float
64
 65  secondary_cleaner.output.tail_ag            19437 non-null  float
64
 66  secondary_cleaner.output.tail_pb            19427 non-null  float
64
```

```
 67  secondary_cleaner.output.tail_sol                   17691 non-null  float
64
 68  secondary_cleaner.output.tail_au                    19439 non-null  float
64
 69  secondary_cleaner.state.floatbank2_a_air            19219 non-null  float
64
 70  secondary_cleaner.state.floatbank2_a_level          19438 non-null  float
64
 71  secondary_cleaner.state.floatbank2_b_air            19416 non-null  float
64
 72  secondary_cleaner.state.floatbank2_b_level          19438 non-null  float
64
 73  secondary_cleaner.state.floatbank3_a_air            19426 non-null  float
64
 74  secondary_cleaner.state.floatbank3_a_level          19438 non-null  float
64
 75  secondary_cleaner.state.floatbank3_b_air            19438 non-null  float
64
 76  secondary_cleaner.state.floatbank3_b_level          19438 non-null  float
64
 77  secondary_cleaner.state.floatbank4_a_air            19433 non-null  float
64
 78  secondary_cleaner.state.floatbank4_a_level          19438 non-null  float
64
 79  secondary_cleaner.state.floatbank4_b_air            19438 non-null  float
64
 80  secondary_cleaner.state.floatbank4_b_level          19438 non-null  float
64
 81  secondary_cleaner.state.floatbank5_a_air            19438 non-null  float
64
 82  secondary_cleaner.state.floatbank5_a_level          19438 non-null  float
64
 83  secondary_cleaner.state.floatbank5_b_air            19438 non-null  float
64
 84  secondary_cleaner.state.floatbank5_b_level          19438 non-null  float
64
 85  secondary_cleaner.state.floatbank6_a_air            19437 non-null  float
64
 86  secondary_cleaner.state.floatbank6_a_level          19438 non-null  float
64
dtypes: float64(86), object(1)
memory usage: 12.9+ MB
```

In [13]:
```
df_full=df_full.set_index('date')
```

In [14]:
```
df_full.head()
```

Out[14]:

date	final.output.concentrate_ag	final.output.concentrate_pb	final.output.concentrate_sol	final.c
2016-01-15 00:00:00	6.055403	9.889648	5.507324	
2016-01-15 01:00:00	6.029369	9.968944	5.257781	

date	final.output.concentrate_ag	final.output.concentrate_pb	final.output.concentrate_sol	final.c
2016-01-15 02:00:00	6.055926	10.213995	5.383759	
2016-01-15 03:00:00	6.047977	9.977019	4.858634	
2016-01-15 04:00:00	6.148599	10.142511	4.939416	

5 rows × 86 columns

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```
In [15]: set(df_train.columns) - set(df_test.columns)
```

```
Out[15]: {'final.output.concentrate_ag',
 'final.output.concentrate_au',
 'final.output.concentrate_pb',
 'final.output.concentrate_sol',
 'final.output.recovery',
 'final.output.tail_ag',
 'final.output.tail_au',
 'final.output.tail_pb',
 'final.output.tail_sol',
 'primary_cleaner.output.concentrate_ag',
 'primary_cleaner.output.concentrate_au',
 'primary_cleaner.output.concentrate_pb',
 'primary_cleaner.output.concentrate_sol',
 'primary_cleaner.output.tail_ag',
 'primary_cleaner.output.tail_au',
 'primary_cleaner.output.tail_pb',
 'primary_cleaner.output.tail_sol',
```

df_test не содержит output по всем этапам, по понятным причинам - т.к. это целевые признаки, а также не содержит признаков calculation для этапа обогащение(ro поскольку, видимо, эти данные не доступны во время технологическ процесса и появляются позже.

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 'rougher.calculati
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 'rougher.calculati
on.sulfate_to_au_co
ncentrate',
 'rougher.output.co
ncentrate_ag',
 'rougher.output.co
ncentrate_au',
 'rougher.output.co
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 'rougher.output.co
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 'rougher.output.ta
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 'rougher.output.ta
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 'secondary_cleane
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 'secondary_cleane
r.output.tail_au',
 'secondary_cleane
r.output.tail_pb',
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r.output.tail_sol'}
```