



Challenge #1

Reservoir Evaluation

Oleg Cheremisin
(mktoid)

Pure ML solution

Let's assume that we know nothing about underlying physics and learn from the data using quite powerful machine learning model that can deal with non-linearities.

So if we have data prepared using the same process, we can train the model on dataset with known target (Fluid_Fraction) and then make a prediction for other dataset

Technathon

Data Structure

1 Clustering

- Lab_Curves
- Logs-5
- Logs-4

Lab_Curves

Label	Reference	Location	Characteristic_1	Characteristic_2	Fluid_Fraction	Lab_Pressure
5336	418.2	Well 1	0.1009	0.453	0.783	1.616244071
5336	417.6	Well 1	0.1009	0.453	0.783	1.81827458
5336	417.6	Well 1	0.1009	0.453	0.783	2.020305089

Logs

Reference	Track_1	Track_2	Track_3	Track_4	Characteristic_1
323.154	375.5337	54.98823	0.26032	20.55477	0.018835231
322.81	378.6266	59.73301	0.390857	20.16844	0.026940663
322.451	383.1449	66.51939	0.410837	20.37502	0.025029718

2 Training

- Logs-B
- Logs-C
- Logs-D_Lost_Sections

Logs

Reference	Track_1	Track_2	Track_3	Track_4	Characteristic_1	Fluid_Fraction
558.401	449.5211	106.7918	0.924423	18.24576	0.0449602	0.03132
557.951	494.7774	124.7232	1.356371	17.91681	0.062601744	0.03132
557.46	530.2455	126.3241	1.759663	16.71797	0.09048816	0.03132

3 Testing

- Logs-A
- Logs-D_Lost_Sections

Logs

Reference	Track_1	Track_2	Track_3	Track_4	Characteristic_1
978.173	612.3953	94.66523	1.811031	15.6434	0.106912968
977.689	608.0019	93.84432	1.893699	15.73843	0.105824448
977.205	606.6861	93.17545	1.948597	15.80422	0.105495448

Permutation importance / Mean Decrease Accuracy (MDA)

black-box estimator measuring how score decreases when a feature is not available

```
In [19]: from sklearn.model_selection import train_test_split  
  
X_tr, X_va, y_tr, y_va = train_test_split(X_train, y_train, test_size=0.5, random_state=random_state)
```

```
In [20]: from sklearn.ensemble import RandomForestRegressor  
  
reg = RandomForestRegressor(criterion="mae").fit(X_tr.fillna(-1), y_tr)
```

```
In [21]: import eli5  
from eli5.sklearn import PermutationImportance  
  
perm = PermutationImportance(reg).fit(X_va.fillna(-1), y_va)  
eli5.show_weights(perm, feature_names = X_va.columns.tolist())
```

```
Out[21]:
```

	Weight	Feature
	1.1987 ± 0.1199	Characteristic_1
	0.0561 ± 0.0083	Track_1
	0.0522 ± 0.0063	Reference
	0.0196 ± 0.0054	Track_4
	0.0155 ± 0.0062	Track_3
	0.0098 ± 0.0021	Track_2

we see that all features bring information to the model,
there are no random/pure noise features

Model

```
In [22]: train['Fluid_Fraction'].mean()
```

```
Out[22]: 0.09827387829826342
```

```
In [23]: params = {
    'objective': 'mae',
    'metric': 'mae'
}
n_fold = 4
n_estimators = 25000
nthread = multiprocessing.cpu_count()
folds = KFold(n_splits=n_fold, shuffle=True, random_state=random_state)
model = lgb.LGBMRegressor(**params, n_estimators = n_estimators, nthread = nthread, n_jobs = -1)
```

```
In [24]: prediction_a = np.zeros(X_test_a.shape[0])
prediction_d = np.zeros(X_test_d.shape[0])

for fold_n, (train_index, test_index) in enumerate(folds.split(X_train)):
    print('Fold:', fold_n)
    X_tr, X_va = X_train.iloc[train_index], X_train.iloc[test_index]
    y_tr, y_va = y_train.iloc[train_index], y_train.iloc[test_index]

    model.fit(X_tr, y_tr,
              eval_set=[(X_va, y_va)],
              verbose=100, early_stopping_rounds=100)

    y_pred_a = model.predict(X_test_a, num_iteration=model.best_iteration_)
    y_pred_d = model.predict(X_test_d, num_iteration=model.best_iteration_)
    prediction_a += y_pred_a
    prediction_d += y_pred_d

prediction_a /= n_fold
prediction_d /= n_fold
```

```
[1100] training's l2: 0.00330886    valid_1's l2: 0.00166081
[1200] training's l2: 0.0033053    valid_1's l2: 0.00166046
[1300] training's l2: 0.0033037    valid_1's l2: 0.00166025
[1400] training's l2: 0.00330153    valid_1's l2: 0.00165986
[1500] training's l2: 0.00330044    valid_1's l2: 0.00165976
Early stopping, best iteration is:
[1441] training's l2: 0.00330141    valid_1's l2: 0.0016597
Fold: 2
Training until validation scores don't improve for 100 rounds.
[100] training's l2: 0.00401257    valid_1's l2: 0.00673536
[200] training's l2: 0.00383554    valid_1's l2: 0.00673536
```

Model:

Gradient boosting

Cross-validation:

4 folds

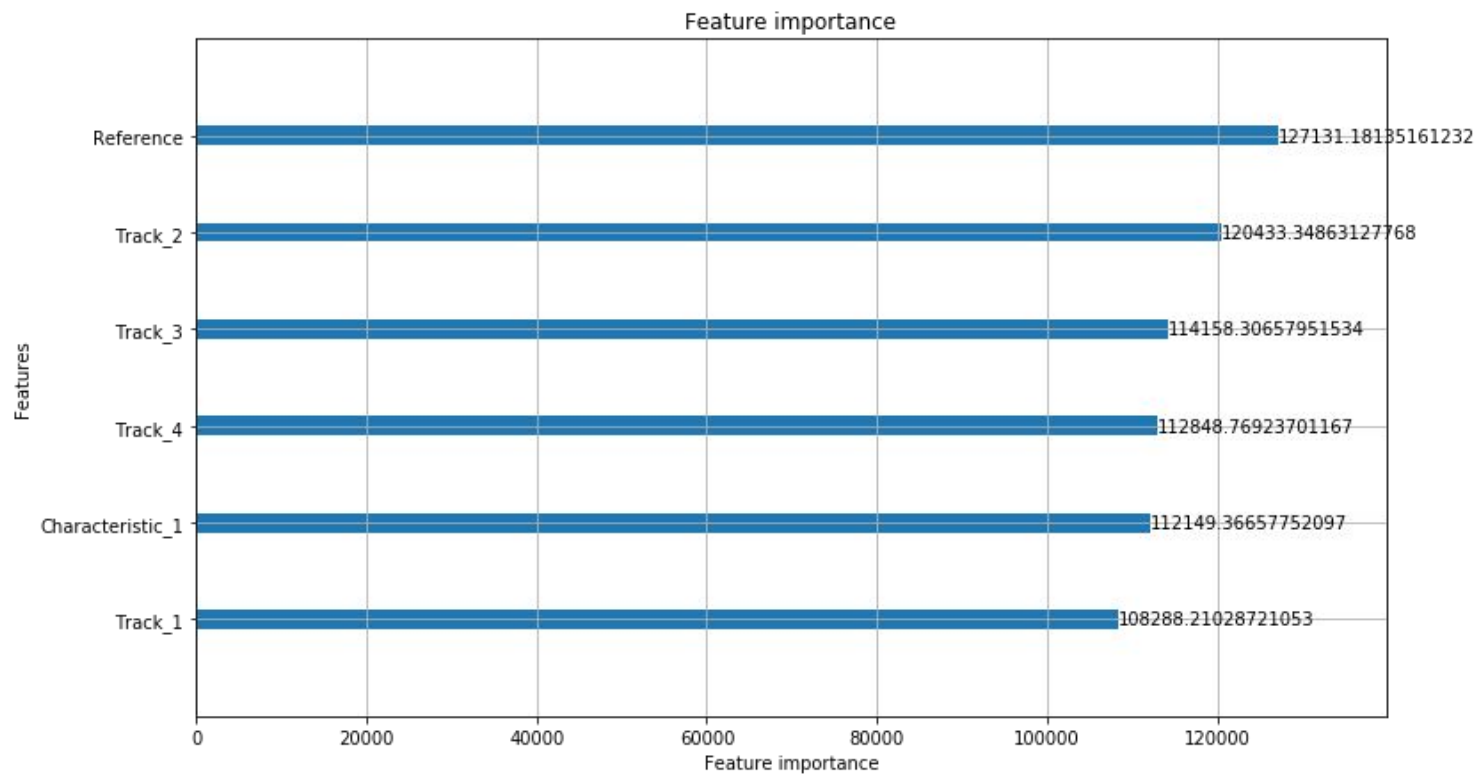
Metric:

Mean absolute error

$$mae = \frac{\sum_{i=1}^n abs(y_i - \lambda(x_i))}{n}$$

early stopping to prevent overfitting

Feature importance



Thanks



<https://github.com/mktoid/Aramco-Upstream-Solutions-Technaton>