1 Import Libraries

In [1]:

```
import pandas as pd
import pickle
```

2 Read Tuning Parameter Results

In [2]:

```
glvq_tuning_results = pd.read_csv('informations/glvq_tuning_results.csv')
pso_tuning_results = pd.read_csv('informations/psoshi_tuning_parameters_results.csv')
```

2.1 GLVQ tuning results

In [3]:

```
df_glvq = glvq_tuning_results.copy(deep=True)
```

In [4]:

```
df_glvq.insert(1,'parameter_alpha', df_glvq['alpha'])
df_glvq.insert(2,'parameter_codebook', df_glvq['codebook'])
df_glvq.insert(3,'parameter_max_epoch', df_glvq['max_epoch'])
df_glvq.insert(4,'parameter_min_error', df_glvq['min_error'])
df_glvq.drop(['alpha', 'codebook', 'max_epoch', 'min_error'], axis=1, inplace=True)
```

In [5]:

```
df_glvq
```

Out[5]:

	combination_name	parameter_alpha	parameter_codebook	parameter_max_epoch	parameter
0	Codebook--1_Alpha--0.1_MaxEpoch--100_MinError-...	0.1	1	100	
1	Codebook--1_Alpha--0.2_MaxEpoch--100_MinError-...	0.2	1	100	
2	Codebook--1_Alpha--0.3_MaxEpoch--100_MinError-...	0.3	1	100	
3	Codebook--1_Alpha--0.4_MaxEpoch--100_MinError-...	0.4	1	100	
4	Codebook--1_Alpha--0.5_MaxEpoch--100_MinError-...	0.5	1	100	
5	Codebook--1_Alpha--0.6_MaxEpoch--100_MinError-...	0.6	1	100	
6	Codebook--1_Alpha--0.7_MaxEpoch--100_MinError-...	0.7	1	100	
7	Codebook--1_Alpha--0.8_MaxEpoch--100_MinError-...	0.8	1	100	
8	Codebook--1_Alpha--0.9_MaxEpoch--100_MinError-...	0.9	1	100	
9	Codebook--2_Alpha--0.1_MaxEpoch--100_MinError-...	0.1	2	100	
10	Codebook--2_Alpha--0.2_MaxEpoch--100_MinError-...	0.2	2	100	
11	Codebook--2_Alpha--0.3_MaxEpoch--100_MinError-...	0.3	2	100	
12	Codebook--2_Alpha--0.4_MaxEpoch--100_MinError-...	0.4	2	100	

	combination_name	parameter_alpha	parameter_codebook	parameter_max_epoch	parameter
13	Codebook--2_Alpha--0.5_MaxEpoch--100_MinError-...	0.5	2	100	
14	Codebook--2_Alpha--0.6_MaxEpoch--100_MinError-...	0.6	2	100	
15	Codebook--2_Alpha--0.7_MaxEpoch--100_MinError-...	0.7	2	100	
16	Codebook--2_Alpha--0.8_MaxEpoch--100_MinError-...	0.8	2	100	
17	Codebook--2_Alpha--0.9_MaxEpoch--100_MinError-...	0.9	2	100	
18	Codebook--3_Alpha--0.1_MaxEpoch--100_MinError-...	0.1	3	100	
19	Codebook--3_Alpha--0.2_MaxEpoch--100_MinError-...	0.2	3	100	
20	Codebook--3_Alpha--0.3_MaxEpoch--100_MinError-...	0.3	3	100	
21	Codebook--3_Alpha--0.4_MaxEpoch--100_MinError-...	0.4	3	100	
22	Codebook--3_Alpha--0.5_MaxEpoch--100_MinError-...	0.5	3	100	
23	Codebook--3_Alpha--0.6_MaxEpoch--100_MinError-...	0.6	3	100	
24	Codebook--3_Alpha--0.7_MaxEpoch--100_MinError-...	0.7	3	100	
25	Codebook--3_Alpha--0.8_MaxEpoch--100_MinError-...	0.8	3	100	
26	Codebook--3_Alpha--0.9_MaxEpoch--100_MinError-...	0.9	3	100	

	combination_name	parameter_alpha	parameter_codebook	parameter_max_epoch	parameter
27	Codebook--4_Alpha--0.1_MaxEpoch--100_MinError-...	0.1	4	100	
28	Codebook--4_Alpha--0.2_MaxEpoch--100_MinError-...	0.2	4	100	
29	Codebook--4_Alpha--0.3_MaxEpoch--100_MinError-...	0.3	4	100	
30	Codebook--4_Alpha--0.4_MaxEpoch--100_MinError-...	0.4	4	100	
31	Codebook--4_Alpha--0.5_MaxEpoch--100_MinError-...	0.5	4	100	
32	Codebook--4_Alpha--0.6_MaxEpoch--100_MinError-...	0.6	4	100	
33	Codebook--4_Alpha--0.7_MaxEpoch--100_MinError-...	0.7	4	100	
34	Codebook--4_Alpha--0.8_MaxEpoch--100_MinError-...	0.8	4	100	
35	Codebook--4_Alpha--0.9_MaxEpoch--100_MinError-...	0.9	4	100	
36	Codebook--5_Alpha--0.1_MaxEpoch--100_MinError-...	0.1	5	100	
37	Codebook--5_Alpha--0.2_MaxEpoch--100_MinError-...	0.2	5	100	
38	Codebook--5_Alpha--0.3_MaxEpoch--100_MinError-...	0.3	5	100	
39	Codebook--5_Alpha--0.4_MaxEpoch--100_MinError-...	0.4	5	100	
40	Codebook--5_Alpha--0.5_MaxEpoch--100_MinError-...	0.5	5	100	

	combination_name	parameter_alpha	parameter_codebook	parameter_max_epoch	parameter
41	Codebook--5_Alpha--0.6_MaxEpoch--100_MinError-...	0.6	5	100	
42	Codebook--5_Alpha--0.7_MaxEpoch--100_MinError-...	0.7	5	100	
43	Codebook--5_Alpha--0.8_MaxEpoch--100_MinError-...	0.8	5	100	
44	Codebook--5_Alpha--0.9_MaxEpoch--100_MinError-...	0.9	5	100	

2.2 PSO tuning results

In [6]:

```
df_pso = pso_tuning_results.copy(deep=True)
```

In [7]:

```
df_pso.insert(1,'parameter_phi1', df_pso['phi1'])
df_pso.insert(2,'parameter_phi2', df_pso['phi2'])
df_pso.insert(3,'parameter_inertia', df_pso['inertia'])
df_pso.insert(4,'parameter_n_particles', df_pso['n_particles'])
df_pso.insert(5,'parameter_max_iter', df_pso['max_iter'])
df_pso.drop(['phi1', 'phi2', 'inertia', 'n_particles', 'max_iter'], axis=1, inplace=True)
```

In [8]:

```
df_pso
```

Out[8]:

	combination_name	parameter_phi1	parameter_phi2	parameter_inertia	parameter_n_particle
0	phi1-2.1_phi2-2.1_inertia-0.5_nParticle-30_max...	2.1	2.1	0.5	3
1	phi1-2.1_phi2-2.1_inertia-0.6_nParticle-30_max...	2.1	2.1	0.6	3
2	phi1-2.1_phi2-2.1_inertia-0.7_nParticle-30_max...	2.1	2.1	0.7	3
3	phi1-2.1_phi2-2.1_inertia-0.8_nParticle-30_max...	2.1	2.1	0.8	3
4	phi1-2.1_phi2-2.1_inertia-0.9_nParticle-30_max...	2.1	2.1	0.9	3
...	...	...	...	...	
145	phi1-2.5_phi2-2.5_inertia-0.6_nParticle-30_max...	2.5	2.5	0.6	3
146	phi1-2.5_phi2-2.5_inertia-0.7_nParticle-30_max...	2.5	2.5	0.7	3
147	phi1-2.5_phi2-2.5_inertia-0.8_nParticle-30_max...	2.5	2.5	0.8	3
148	phi1-2.5_phi2-2.5_inertia-0.9_nParticle-30_max...	2.5	2.5	0.9	3
149	phi1-2.5_phi2-2.5_inertia-1.0_nParticle-30_max...	2.5	2.5	1.0	3

150 rows × 12 columns

3 Prepare pickle format

3.1 Load Optimal Parameter Hasil Tuning GLVQ

In [9]:

```
# optimal GLVQ parameter
optimal_parameters_glvq = pickle.load(open('informations/optimal_parameters_glvq.pkl','rb')
optimal_codebook = optimal_parameters_glvq['optimal_codebook']
optimal_alpha = optimal_parameters_glvq['optimal_alpha']
optimal_max_epoch = optimal_parameters_glvq['optimal_max_epoch']
optimal_min_error = optimal_parameters_glvq['optimal_min_error']
optimal_glvq_mean_accuracy = df_glvq['mean_accuracy'].max()
```

3.2 Load Optimal Parameter Hasil Tuning PSO

In [10]:

```
optimal_parameters_pso_shi = pickle.load(open('informations/optimal_parameters_pso_shi.pkl'
optimal_phi1_shi = optimal_parameters_pso_shi['optimal_phi1']
optimal_phi2_shi = optimal_parameters_pso_shi['optimal_phi2']
optimal_inertia_shi = optimal_parameters_pso_shi['optimal_inertia']
optimal_n_particles_shi = optimal_parameters_pso_shi['optimal_n_particles']
optimal_max_iter_shi = optimal_parameters_pso_shi['optimal_max_iter']
optimal_pso_mean_accuracy = df_pso['mean_accuracy'].max()
```

3.3 Siapkan dictionary

In [11]:

```
tuning_parameter_results = {
    'GLVQ': {
        'tuning_results': df_glvq.to_numpy(),
        'columns_tuning_results': df_glvq.columns.values,
        'optimal_parameter': {
            'alpha': optimal_alpha,
            'codebook': optimal_codebook,
            'max_epoch': optimal_max_epoch,
            'min_error': optimal_min_error,
        },
        'optimal_mean_accuracy': optimal_glvq_mean_accuracy
    },
    'PSO': {
        'tuning_results': df_pso.to_numpy(),
        'columns_tuning_results': df_pso.columns.values,
        'optimal_parameter': {
            'phi1': optimal_phi1_shi,
            'phi2': optimal_phi2_shi,
            'inertia': optimal_inertia_shi,
            'n_particles': optimal_n_particles_shi,
            'max_iter': optimal_max_iter_shi
        },
        'optimal_mean_accuracy': optimal_pso_mean_accuracy
    }
}
```

In [12]:

```
tuning_parameter_results
```

Out[12]:


```
{'GLVQ': {'tuning_results': array([['Codebook--1_Alpha--0.1_MaxEpoch--100_
MinError--1e-06', 0.1, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.912087912087912, 0.934065934065934, 0.934065934065934,
          0.934065934065934],
         ['Codebook--1_Alpha--0.2_MaxEpoch--100_MinError--1e-06', 0.2, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.9230769230769232, 0.934065934065934, 0.945054945054945,
          0.9384615384615383],
         ['Codebook--1_Alpha--0.3_MaxEpoch--100_MinError--1e-06', 0.3, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.9230769230769232, 0.934065934065934, 0.945054945054945,
          0.9384615384615383],
         ['Codebook--1_Alpha--0.4_MaxEpoch--100_MinError--1e-06', 0.4, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.9230769230769232, 0.934065934065934, 0.945054945054945,
          0.9384615384615383],
         ['Codebook--1_Alpha--0.5_MaxEpoch--100_MinError--1e-06', 0.5, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.9230769230769232, 0.934065934065934, 0.945054945054945,
          0.9384615384615383],
         ['Codebook--1_Alpha--0.6_MaxEpoch--100_MinError--1e-06', 0.6, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.9230769230769232, 0.934065934065934, 0.945054945054945,
          0.9384615384615383],
         ['Codebook--1_Alpha--0.7_MaxEpoch--100_MinError--1e-06', 0.7, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.9230769230769232, 0.934065934065934, 0.945054945054945,
          0.9384615384615383],
         ['Codebook--1_Alpha--0.8_MaxEpoch--100_MinError--1e-06', 0.8, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.9230769230769232, 0.934065934065934, 0.945054945054945,
          0.9384615384615383],
         ['Codebook--1_Alpha--0.9_MaxEpoch--100_MinError--1e-06', 0.9, 1,
          100, 1e-06, 0.956043956043956, 0.934065934065934,
          0.9230769230769232, 0.934065934065934, 0.945054945054945,
          0.9384615384615383],
         ['Codebook--2_Alpha--0.1_MaxEpoch--100_MinError--1e-06', 0.1, 2,
          100, 1e-06, 0.967032967032967, 0.934065934065934,
          0.912087912087912, 0.956043956043956, 0.945054945054945,
          0.9428571428571428],
         ['Codebook--2_Alpha--0.2_MaxEpoch--100_MinError--1e-06', 0.2, 2,
          100, 1e-06, 0.967032967032967, 0.934065934065934,
          0.9230769230769232, 0.956043956043956, 0.956043956043956,
          0.9472527472527472],
         ['Codebook--2_Alpha--0.3_MaxEpoch--100_MinError--1e-06', 0.3, 2,
          100, 1e-06, 0.967032967032967, 0.934065934065934,
          0.912087912087912, 0.945054945054945, 0.956043956043956,
          0.9428571428571428],
         ['Codebook--2_Alpha--0.4_MaxEpoch--100_MinError--1e-06', 0.4, 2,
          100, 1e-06, 0.967032967032967, 0.934065934065934,
          0.912087912087912, 0.9230769230769232, 0.934065934065934,
          0.934065934065934],
         ['Codebook--2_Alpha--0.5_MaxEpoch--100_MinError--1e-06', 0.5, 2,
```

```
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.945054945054945,
 0.9406593406593406],
['Codebook--2_Alpha--0.6_MaxEpoch--100_MinError--1e-06', 0.6, 2,
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.9428571428571428],
['Codebook--2_Alpha--0.7_MaxEpoch--100_MinError--1e-06', 0.7, 2,
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.912087912087912, 0.912087912087912, 0.956043956043956,
 0.9362637362637362],
['Codebook--2_Alpha--0.8_MaxEpoch--100_MinError--1e-06', 0.8, 2,
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.9428571428571428],
['Codebook--2_Alpha--0.9_MaxEpoch--100_MinError--1e-06', 0.9, 2,
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.9428571428571428],
['Codebook--3_Alpha--0.1_MaxEpoch--100_MinError--1e-06', 0.1, 3,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.9230769230769232, 0.956043956043956, 0.978021978021978,
 0.9538461538461538],
['Codebook--3_Alpha--0.2_MaxEpoch--100_MinError--1e-06', 0.2, 3,
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.934065934065934, 0.934065934065934, 0.956043956043956,
 0.945054945054945],
['Codebook--3_Alpha--0.3_MaxEpoch--100_MinError--1e-06', 0.3, 3,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.945054945054945],
['Codebook--3_Alpha--0.4_MaxEpoch--100_MinError--1e-06', 0.4, 3,
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.912087912087912, 0.956043956043956, 0.956043956043956,
 0.945054945054945],
['Codebook--3_Alpha--0.5_MaxEpoch--100_MinError--1e-06', 0.5, 3,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.945054945054945],
['Codebook--3_Alpha--0.6_MaxEpoch--100_MinError--1e-06', 0.6, 3,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.934065934065934, 0.967032967032967,
 0.945054945054945],
['Codebook--3_Alpha--0.7_MaxEpoch--100_MinError--1e-06', 0.7, 3,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.945054945054945],
['Codebook--3_Alpha--0.8_MaxEpoch--100_MinError--1e-06', 0.8, 3,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.967032967032967,
 0.9472527472527472],
['Codebook--3_Alpha--0.9_MaxEpoch--100_MinError--1e-06', 0.9, 3,
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.912087912087912, 0.934065934065934, 0.967032967032967,
 0.9428571428571428],
['Codebook--4_Alpha--0.1_MaxEpoch--100_MinError--1e-06', 0.1, 4,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.9230769230769232, 0.945054945054945, 0.978021978021978,
 0.9516483516483516],
['Codebook--4_Alpha--0.2_MaxEpoch--100_MinError--1e-06', 0.2, 4,
 100, 1e-06, 0.956043956043956, 0.934065934065934,
```

```
 0.9010989010989012, 0.945054945054945, 0.956043956043956,
 0.9384615384615383],
['Codebook--4_Alpha--0.3_MaxEpoch--100_MinError--1e-06', 0.3, 4,
 100, 1e-06, 0.989010989010989, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.9472527472527472],
['Codebook--4_Alpha--0.4_MaxEpoch--100_MinError--1e-06', 0.4, 4,
 100, 1e-06, 0.989010989010989, 0.934065934065934,
 0.912087912087912, 0.956043956043956, 0.956043956043956,
 0.9494505494505494],
['Codebook--4_Alpha--0.5_MaxEpoch--100_MinError--1e-06', 0.5, 4,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.9230769230769232, 0.945054945054945, 0.956043956043956,
 0.9472527472527472],
['Codebook--4_Alpha--0.6_MaxEpoch--100_MinError--1e-06', 0.6, 4,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.9010989010989012, 0.945054945054945, 0.956043956043956,
 0.9428571428571428],
['Codebook--4_Alpha--0.7_MaxEpoch--100_MinError--1e-06', 0.7, 4,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.945054945054945],
['Codebook--4_Alpha--0.8_MaxEpoch--100_MinError--1e-06', 0.8, 4,
 100, 1e-06, 0.989010989010989, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.967032967032967,
 0.9494505494505494],
['Codebook--4_Alpha--0.9_MaxEpoch--100_MinError--1e-06', 0.9, 4,
 100, 1e-06, 0.989010989010989, 0.934065934065934,
 0.9010989010989012, 0.945054945054945, 0.956043956043956,
 0.945054945054945],
['Codebook--5_Alpha--0.1_MaxEpoch--100_MinError--1e-06', 0.1, 5,
 100, 1e-06, 0.989010989010989, 0.945054945054945,
 0.934065934065934, 0.945054945054945, 0.967032967032967,
 0.956043956043956],
['Codebook--5_Alpha--0.2_MaxEpoch--100_MinError--1e-06', 0.2, 5,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.956043956043956, 0.967032967032967,
 0.9494505494505494],
['Codebook--5_Alpha--0.3_MaxEpoch--100_MinError--1e-06', 0.3, 5,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.978021978021978,
 0.9494505494505494],
['Codebook--5_Alpha--0.4_MaxEpoch--100_MinError--1e-06', 0.4, 5,
 100, 1e-06, 0.967032967032967, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.9428571428571428],
['Codebook--5_Alpha--0.5_MaxEpoch--100_MinError--1e-06', 0.5, 5,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.967032967032967,
 0.9472527472527472],
['Codebook--5_Alpha--0.6_MaxEpoch--100_MinError--1e-06', 0.6, 5,
 100, 1e-06, 0.989010989010989, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.956043956043956,
 0.9472527472527472],
['Codebook--5_Alpha--0.7_MaxEpoch--100_MinError--1e-06', 0.7, 5,
 100, 1e-06, 0.978021978021978, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.967032967032967,
 0.9472527472527472],
['Codebook--5_Alpha--0.8_MaxEpoch--100_MinError--1e-06', 0.8, 5,
 100, 1e-06, 0.989010989010989, 0.934065934065934,
 0.912087912087912, 0.945054945054945, 0.945054945054945,
```

```
          0.945054945054945],
         ['Codebook--5_Alpha--0.9_MaxEpoch--100_MinError--1e-06', 0.9, 5,
          100, 1e-06, 0.978021978021978, 0.934065934065934,
          0.912087912087912, 0.945054945054945, 0.956043956043956,
          0.945054945054945]], dtype=object),
  'columns_tuning_results': array(['combination_name', 'parameter_alpha',
'parameter_codebook',
         'parameter_max_epoch', 'parameter_min_error', 'Fold-1', 'Fold-2',
         'Fold-3', 'Fold-4', 'Fold-5', 'mean_accuracy'], dtype=object),
  'optimal_parameter': {'alpha': 0.1,
   'codebook': 5,
   'max_epoch': 100,
   'min_error': 1e-06},
  'optimal_mean_accuracy': 0.956043956043956},
 'PSO': {'tuning_results': array([['phi1-2.1_phi2-2.1_inertia-0.5_nParticl
e-30_maxIter-100_Codebook-5',
          2.1, 2.1, ..., 0.912087912087912, 0.8681318681318682,
          0.868131868131868],
         ['phi1-2.1_phi2-2.1_inertia-0.6_nParticle-30_maxIter-100_Codebook
-5',
          2.1, 2.1, ..., 0.8461538461538461, 0.7802197802197802,
          0.832967032967033],
         ['phi1-2.1_phi2-2.1_inertia-0.7_nParticle-30_maxIter-100_Codebook
-5',
          2.1, 2.1, ..., 0.8681318681318682, 0.9010989010989012,
          0.8571428571428571],
         ...,
         ['phi1-2.5_phi2-2.5_inertia-0.8_nParticle-30_maxIter-100_Codebook
-5',
          2.5, 2.5, ..., 0.8351648351648352, 0.7252747252747253,
          0.843956043956044],
         ['phi1-2.5_phi2-2.5_inertia-0.9_nParticle-30_maxIter-100_Codebook
-5',
          2.5, 2.5, ..., 0.912087912087912, 0.8351648351648352,
          0.8571428571428571],
         ['phi1-2.5_phi2-2.5_inertia-1.0_nParticle-30_maxIter-100_Codebook
-5',
          2.5, 2.5, ..., 0.8571428571428571, 0.8681318681318682,
          0.843956043956044]], dtype=object),
  'columns_tuning_results': array(['combination_name', 'parameter_phi1',
'parameter_phi2',
         'parameter_inertia', 'parameter_n_particles', 'parameter_max_ite
r',
         'Fold-1', 'Fold-2', 'Fold-3', 'Fold-4', 'Fold-5', 'mean_accurac
y'],
        dtype=object),
  'optimal_parameter': {'phi1': 2.4,
   'phi2': 2.1,
   'inertia': 0.6,
   'n_particles': 30,
   'max_iter': 100},
  'optimal_mean_accuracy': 0.9186813186813187}}
```

4 Simpan Hasil dalam format pickle

In [13]:

```
pickle.dump(tuning_parameter_results, open('results/tuning_parameter_results.pkl','wb'))
```