

Import necessary libraries

```
In [1]: import numpy as np
import matplotlib.pyplot as plt
from plots import plot_data, plot_confusion_matrix, plot_all_confusion_matrices
from utils import read_from_csv, result_to_df, evaluate_model, evaluate_all_model

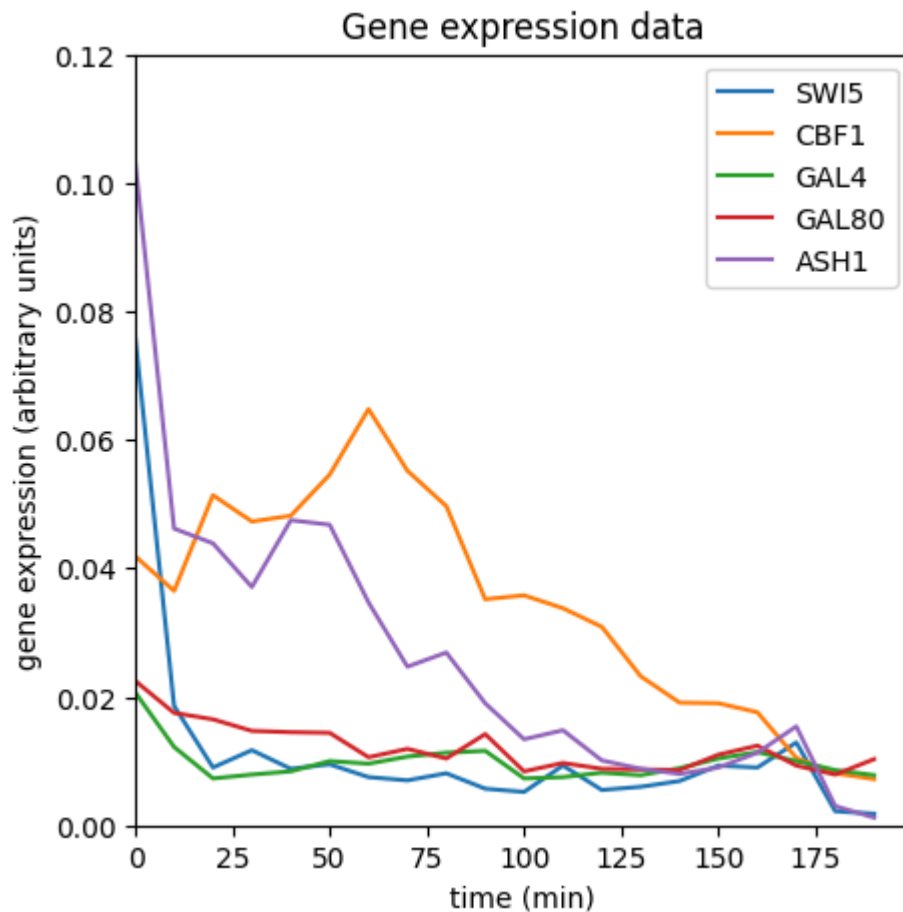
# Biological model
from odes_model import odes_estimated_params
from random_model import random_estimated_params
from sdes_model import sdes_estimated_params
from sdes_minimize_model import sdes_minimize_estimated_params
from odes_minimize_model import odes_minimize_estimated_params
from lr_model import lr_estimated_params, normalize_network, binarize_network

from sklearn.model_selection import cross_val_score
from sklearn.metrics import confusion_matrix, precision_score, recall_score, f1_
```

```
In [2]: # Read data
gene_df = read_from_csv("data.csv")
print(gene_df)
ground_truth_network_structure = result_to_df(np.array([[0, 1, 0, 0, 0],
                                                         [0, 0, 1, 0, 0],
                                                         [0, 0, 0, 0, 1],
                                                         [0, 0, 0, 0, 0],
                                                         [1, 1, 0, 1, 0]]))

# Define the ODE system
plot_data(gene_df)
```

	SWI5	CBF1	GAL4	GAL80	ASH1
time					
0	0.0760	0.0419	0.0207	0.0225	0.1033
10	0.0186	0.0365	0.0122	0.0175	0.0462
20	0.0090	0.0514	0.0073	0.0165	0.0439
30	0.0117	0.0473	0.0079	0.0147	0.0371
40	0.0088	0.0482	0.0084	0.0145	0.0475
50	0.0095	0.0546	0.0100	0.0144	0.0468
60	0.0075	0.0648	0.0096	0.0106	0.0347
70	0.0070	0.0552	0.0107	0.0119	0.0247
80	0.0081	0.0497	0.0113	0.0104	0.0269
90	0.0057	0.0352	0.0116	0.0142	0.0190
100	0.0052	0.0358	0.0073	0.0084	0.0134
110	0.0093	0.0338	0.0075	0.0097	0.0148
120	0.0055	0.0309	0.0082	0.0088	0.0101
130	0.0060	0.0232	0.0078	0.0087	0.0088
140	0.0069	0.0191	0.0089	0.0086	0.0080
150	0.0093	0.0190	0.0104	0.0110	0.0090
160	0.0090	0.0176	0.0114	0.0124	0.0113
170	0.0129	0.0105	0.0100	0.0093	0.0154
180	0.0022	0.0081	0.0086	0.0079	0.0030
190	0.0018	0.0072	0.0078	0.0103	0.0012



Random Model (Not based on the data)

```
In [3]: random_network_structure = random_estimated_params()
```

ODEs model with/without optimization

```
In [4]: # Initial conditions and parameters
y0 = [0.0760, 0.0419, 0.0207, 0.0225, 0.1033]
t = np.linspace(0, 190, 20)
odes_network_structure = odes_estimated_params(gene_df, y0, t)
odes_minimize_network_structure = odes_minimize_estimated_params(gene_df, y0, t)
```

SDEs model with/without optimization

```
In [5]: # Example usage
noise_std = 2
sdes_network_structure = sdes_estimated_params(gene_df, y0, t, noise_std)
sdes_minimize_estimated_params = sdes_minimize_estimated_params(gene_df, y0, t,
```

Linear Regression model

```
In [6]: lr_network_structure = lr_estimated_params(gene_df)
```

```
In [7]: print("Ground Truth Network Structure:")
print(ground_truth_network_structure)
print("Random Network Structure:")
print(random_network_structure)
print("ODEs Network Structure:")
print(odes_network_structure)
```

```

print("ODEs Minimize Network Structure:")
print(odes_minimize_network_structure)
print("SDEs Network Structure:")
print(sdes_network_structure)
print("SDEs Minimize Network Structure:")
print(sdes_minimize_estimated_params)
print("LR Network Structure:")
print(lr_network_structure)

```

Ground Truth Network Structure:

	ASH1	CBF1	GAL4	GAL80	SWI5
ASH1	0.0	1.0	0.0	0.0	0.0
CBF1	0.0	0.0	1.0	0.0	0.0
GAL4	0.0	0.0	0.0	0.0	1.0
GAL80	0.0	0.0	0.0	0.0	0.0
SWI5	1.0	1.0	0.0	1.0	0.0

Random Network Structure:

	ASH1	CBF1	GAL4	GAL80	SWI5
ASH1	0.380227	0.838969	0.397337	0.181657	0.017685
CBF1	0.445571	0.042501	0.024165	0.766650	0.967659
GAL4	0.963829	0.022433	0.113818	0.967696	0.071475
GAL80	0.026349	0.068411	0.135633	0.200627	0.037486
SWI5	0.939312	0.413363	0.499787	0.130218	0.844749

ODEs Network Structure:

	ASH1	CBF1	GAL4	GAL80	SWI5
ASH1	0.120077	0.033130	0.097444	0.063422	0.057740
CBF1	0.679087	0.331297	0.588553	0.452467	0.429740
GAL4	0.741199	0.364427	0.643121	0.495694	0.471073
GAL80	1.000000	0.502468	0.870486	0.675808	0.643295
SWI5	0.057965	0.000000	0.042876	0.020195	0.016407

ODEs Minimize Network Structure:

	SWI5	CBF1	GAL4	GAL80	ASH1
SWI5	0.406640	0.970249	0.197635	0.030450	0.107013
CBF1	0.511024	0.506279	0.362614	0.753362	0.000000
GAL4	0.300155	0.943889	1.000000	0.789164	0.854880
GAL80	0.651385	0.477670	0.243127	0.823437	0.948782
ASH1	0.300130	0.415499	0.841282	0.907082	0.631869

SDEs Network Structure:

	ASH1	CBF1	GAL4	GAL80	SWI5
ASH1	0.052390	0.119857	0.067946	0.033263	0.053710
CBF1	0.409138	0.679007	0.471365	0.332633	0.414419
GAL4	0.448777	0.741134	0.516190	0.365896	0.454498
GAL80	0.613939	1.000000	0.702957	0.504493	0.621493
SWI5	0.012751	0.057729	0.023122	0.000000	0.013631

SDEs Minimize Network Structure:

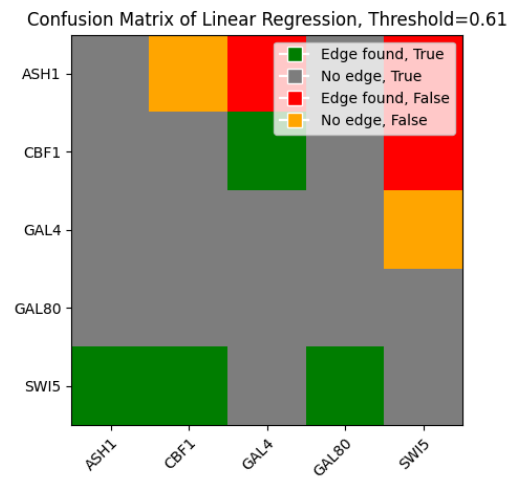
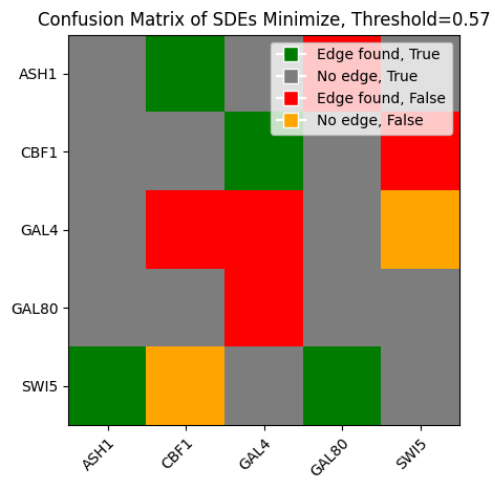
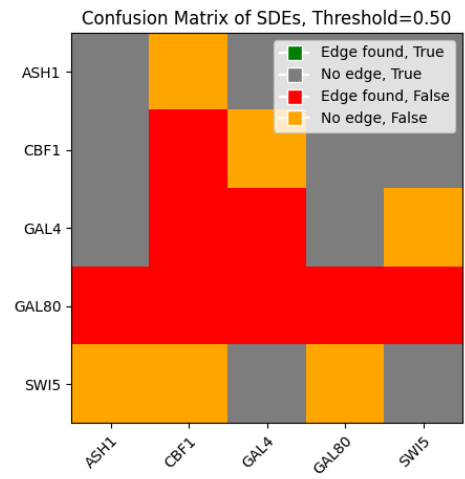
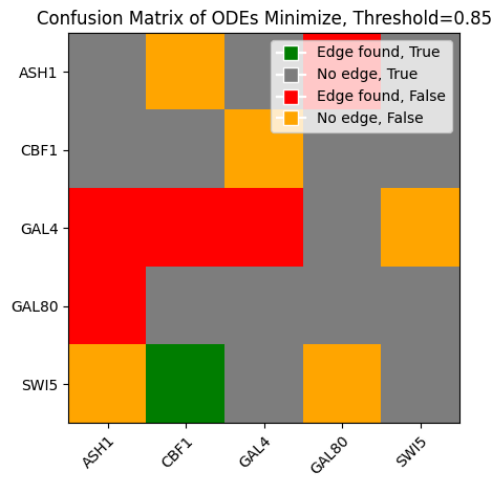
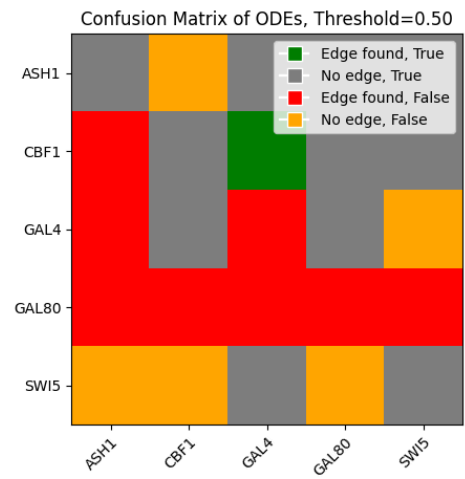
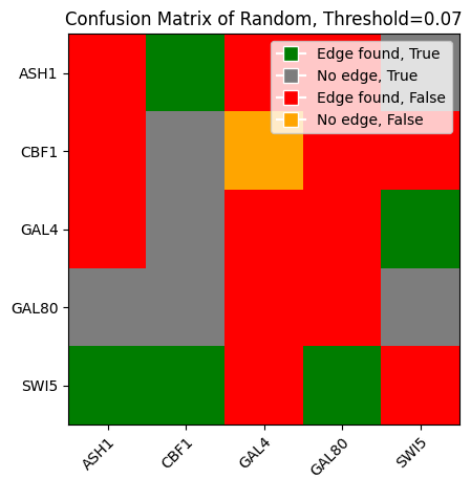
	ASH1	CBF1	GAL4	GAL80	SWI5
ASH1	0.000000	0.622345	0.419827	0.784129	0.097071
CBF1	0.472066	0.320954	0.881007	0.394292	0.621512
GAL4	0.104408	1.000000	0.836864	0.051448	0.314033
GAL80	0.219834	0.377146	0.610961	0.347797	0.447896
SWI5	0.802160	0.193535	0.285211	0.569682	0.346887

LR Network Structure:

	ASH1	CBF1	GAL4	GAL80	SWI5
ASH1	0.513593	0.445064	0.921432	0.259682	0.650908
CBF1	0.217227	0.513593	0.818090	0.000000	0.805736
GAL4	0.559458	0.521511	0.513593	0.577657	0.493767
GAL80	0.479971	0.497867	0.589028	0.513593	0.560046
SWI5	0.703988	0.607260	0.269139	1.000000	0.513593

```
In [8]: # Combining all the models together and plotting in the figure with different su
output_truth_network_structure_list = [
    random_network_structure,
    odes_network_structure,
    odes_minimize_network_structure,
    sdes_network_structure,
    sdes_minimize_estimated_params,
    lr_network_structure,
]
output_truth_network_structure_description_list = [
    "Random",
    "ODEs",
    "ODEs Minimize",
    "SDEs",
    "SDEs Minimize",
    "Linear Regression",
]
```

```
In [9]: plot_all_confusion_matrices(ground_truth_network_structure,
                                     output_truth_network_structure_list,
                                     output_truth_network_structure_description_list)
evaluate_all_models(ground_truth_network_structure,
                    output_truth_network_structure_list,
                    output_truth_network_structure_description_list)
```



Receiver Operating Characteristic

