

# Building\_single-sample\_regulatory\_networks\_using\_LIONESS\_and\_netZooPy

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## 1 Building single-sample regulatory networks using LIONESS and netZooPy

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### 1.1 1. Introduction

In this tutorial, we will briefly walk through the steps to perform analysis with Lioness algorithm using netZooPy package. Lioness is an algorithm for estimating sample-specific gene regulatory networks in a population. LIONESS infers individual sample networks by applying linear interpolation to the predictions made by existing aggregate network inference approaches [1]. In this tutorial, we will use Panda as our basic network inference approach to build sample-specific networks.

### 1.2 2. Installation of netZooPy.

netZooPy comes with full support for Lioness algorithm. netZooPy can be installed through pip command. For more details, please refer to the installation guide at netZooPy documentation site [here](#).

### 1.3 3. Load required modules

We will need Panda and Lioness python classes from netZooPy package. We will also need read\_csv() function from pandas package for demonstrating the input data sets.

```
[1]: from netZooPy.panda import Panda
    from netZooPy.lioness import Lioness
    from netZooPy.lioness.analyze_lioness import AnalyzeLioness
    import pandas as pd
```

## 1.4 4. Load input data

Now let's look at the three data sets to get a sense about what the inputs look like.

```
[3]: exp_data = pd.read_csv('netZooPy/tests/ToyData/ToyExpressionData.  
    ↳txt',header=None, index_col = 0, sep = "\t")  
motif_data = pd.read_csv('netZooPy/tests/ToyData/ToyMotifData.txt',header=None,␣  
    ↳sep = "\t")  
ppi_data = pd.read_csv('netZooPy/tests/ToyData/ToyPPIData.txt',header=None, sep␣  
    ↳= "\t")
```

Expression data is a matrix where rows are genes and columns are samples. There are 1000 genes and 50 samples in this expression dataset

```
[4]: exp_data
```

	1	2	3	4	5	6	7	\
0								
AACSL	0.141431	-4.153056	2.854971	0.413670	1.082093	1.882361	1.450223	
AAK1	3.528478	-0.949701	1.039986	-1.618816	-1.228012	-0.171763	-2.822020	
ABCA17P	-2.597842	3.970710	-2.809212	0.474679	-2.714377	-0.474146	-6.738092	
ABCB8	0.352052	-1.866545	-0.007765	3.289632	2.675149	3.819294	0.668285	
ABCC1	-4.638927	2.440799	-1.655580	0.506424	3.289914	2.460479	-1.003678	
...	...	...	...	...	...	...	...	
ZNF826	-4.294209	-4.498573	2.786462	-1.588052	1.542248	3.222761	-0.005525	
ZNF845	-1.661144	-6.986089	2.273928	-2.426933	-4.627002	-4.044476	-3.991184	
ZNF878	3.395504	-6.274497	0.455548	0.592239	-0.852212	1.373684	-2.638325	
ZSWIM3	-0.494841	2.840674	-3.816640	3.052187	4.979421	-5.889279	-6.640408	
ZWILCH	0.694298	-2.725693	-1.752258	-1.789789	2.228141	-4.494592	1.233303	
	8	9	10	...	41	42	43	\
0				...				
AACSL	2.130209	0.548923	0.583043	...	-4.551870	-6.645621	-3.970460	
AAK1	0.047464	-0.456019	1.134087	...	2.808942	-0.035529	0.473384	
ABCA17P	-2.811364	-1.017466	-1.646993	...	-2.324379	-0.999586	0.987566	
ABCB8	2.608310	3.342104	-2.792534	...	-3.666569	-0.074404	4.630231	
ABCC1	1.537393	-1.342323	-1.003316	...	-0.375289	-3.214583	5.531917	
...	...	...	...	...	...	...	...	
ZNF826	-4.711981	-0.580551	2.152243	...	-1.023105	-1.675647	3.320340	
ZNF845	-0.903110	1.558416	0.672473	...	-0.990304	-1.806129	1.643056	
ZNF878	4.028651	-1.117790	-2.844150	...	-4.858309	1.752461	1.630060	
ZSWIM3	3.711903	-3.156978	0.475878	...	-2.065756	1.069487	-1.682956	
ZWILCH	-1.748305	2.534993	0.819987	...	-4.033845	2.497995	-3.744730	
	44	45	46	47	48	49	50	
0								
AACSL	-2.041915	0.811989	0.979641	0.063161	3.652624	-2.387639	0.929521	
AAK1	-1.971053	1.759803	3.151289	-5.189503	-0.233187	0.349614	0.704183	
ABCA17P	2.591347	-1.445705	-2.788339	2.295727	0.953828	-1.094031	-2.104951	
ABCB8	0.883074	-1.573444	4.909868	0.866853	2.374492	1.410069	-3.828003	

ABCC1	-1.693335	1.506472	1.020980	4.933972	2.268159	-0.734398	-2.618825
...	...	...	...	...	...	...	...
ZNF826	2.108714	-5.961589	1.679723	-1.473783	1.871397	1.968646	-1.017821
ZNF845	1.932765	1.084221	-1.214410	-2.985126	-10.986240	0.159237	0.906706
ZNF878	-0.079563	-0.545380	-2.694063	-0.535988	-0.038242	-1.353040	-1.713555
ZSWIM3	4.824188	-0.930484	-3.155203	-4.252213	-6.578125	-6.558922	-0.104826
ZWILCH	-2.536536	-3.004383	3.336575	-1.095170	-3.466885	1.519252	-0.729152

[1000 rows x 50 columns]

Motif data should be formatted into a three-column list, where first column contains TF IDs and second column the target gene IDs and third column the interaction scores.

```
[5]: motif_data
```

```
[5]:      0      1      2
0    AHR    41157  1.0
1    AHR     AAK1  1.0
2    AHR  ABCA17P  1.0
3    AHR   ABCB8  1.0
4    AHR   ABCC1  1.0
...    ...     ...  ...
14592 YY1   ZNF776  1.0
14593 YY1   ZNF826  1.0
14594 YY1   ZNF878  1.0
14595 YY1   ZSWIM3  1.0
14596 YY1   ZWILCH  1.0
```

[14597 rows x 3 columns]

There are 87 unique TFs and 913 unique motifs in this motif dataset.

```
[6]: motif_data[0].unique().shape[0]
```

```
[6]: 87
```

```
[7]: motif_data[1].unique().shape[0]
```

```
[7]: 913
```

PPI (protein protein interaction) data should be formatted into a three-column list, where first two columns contain protein IDs and third column contains a score for each interaction

```
[8]: ppi_data
```

```
[8]:      0      1      2
0    AHR   ESR1      1
1    AHR   RELA      1
2    AHR  NR2F1      1
3     AR    SP1      1
4  RUNX1    JUN      1
..    ...     ...  ..
233 NFKB1   RELA      1
```

```

234 DDIT3 HOXA5 1
235 NR3C1 NR2E3 1
236 HLF MYB 1
237 PPARG NR2E3 1

```

```
[238 rows x 3 columns]
```

This PPI dataset has 238 interactions among 87 TFs.

```
[9]: pd.concat([ppi_data[0], ppi_data[1]]).unique().size
```

```
[9]: 87
```

## 1.5 5. Run Panda

Before running Lioness, we will first need to generate a Panda object. This will be used later to run Lioness. Note that the argument `keep_expression_matrix` should be specified as `True`. As Lioness iterations need to call Panda function to build networks, which needs expression matrix as input.

```
[17]: panda_obj = Panda('netZooPy/tests/ToyData/ToyExpressionData.txt',
                        'netZooPy/tests/ToyData/ToyMotifData.txt',
                        'netZooPy/tests/ToyData/ToyPPIData.txt',
                        remove_missing=False,
                        keep_expression_matrix=True)
```

```
Loading motif data ...
```

```
Unique TFs: 87
```

```
Elapsed time: 0.01 sec.
```

```
Loading expression data ...
```

```
Expression matrix: (1000, 50)
```

```
Elapsed time: 0.01 sec.
```

```
Loading PPI data ...
```

```
Number of PPIs: 238
```

```
Elapsed time: 0.00 sec.
```

```
Calculating coexpression network ...
```

```
Elapsed time: 0.03 sec.
```

```
Creating motif network ...
```

```
Elapsed time: 0.02 sec.
```

```
Creating PPI network ...
```

```
Elapsed time: 0.00 sec.
```

```
Normalizing networks ...
```

```
Elapsed time: 0.07 sec.
```

```
Saving expression matrix and normalized networks ...
```

```
Elapsed time: 0.02 sec.
```

```
Running PANDA algorithm ...
```

```
step: 0, hamming: 0.7189662815459754
```

```
step: 1, hamming: 0.3899291546314954
```

```
step: 2, hamming: 0.40236683889692043
```

```

step: 3, hamming: 0.4005209618112847
step: 4, hamming: 0.38904060163854676
step: 5, hamming: 0.37050927774796627
step: 6, hamming: 0.346813714233211
step: 7, hamming: 0.3197200219092709
step: 8, hamming: 0.290805929638121
step: 9, hamming: 0.2614076747991081
step: 10, hamming: 0.2325667493310834
step: 11, hamming: 0.2050473463652485
step: 12, hamming: 0.17936756642941445
step: 13, hamming: 0.15582820203948794
step: 14, hamming: 0.13456406927299874
step: 15, hamming: 0.11558769817777673
step: 16, hamming: 0.09882404071423921
step: 17, hamming: 0.08414234823461533
step: 18, hamming: 0.07137863350560043
step: 19, hamming: 0.060352597421148776
step: 20, hamming: 0.05087989460076123
step: 21, hamming: 0.04278075541305479
step: 22, hamming: 0.03588517917018383
step: 23, hamming: 0.030036230563844166
step: 24, hamming: 0.025091497107547298
step: 25, hamming: 0.020923570455323975
step: 26, hamming: 0.01741975365490937
step: 27, hamming: 0.014481280791973365
step: 28, hamming: 0.012022271977958703
step: 29, hamming: 0.009968530625360775
step: 30, hamming: 0.008256316822080976
step: 31, hamming: 0.006831152395943062
step: 32, hamming: 0.005646666396278005
step: 33, hamming: 0.004663540428062875
step: 34, hamming: 0.0038485478068236807
step: 35, hamming: 0.0031736932436243577
step: 36, hamming: 0.002615452884106168
step: 37, hamming: 0.002154108616081292
step: 38, hamming: 0.0017731679664810425
step: 39, hamming: 0.0014588635383778908
step: 40, hamming: 0.001199723701073244
step: 41, hamming: 0.0009862051158053544
Running panda took: 1.31 seconds!

```

## 1.6 6. Run Lioness to estimate sample-specific networks

We will first use the Panda object as input for Lioness object. Then Lioness will run Panda algorithm in its iterations to estimate sample-specific network for each sample.

```
[18]: lioness_obj = Lioness(panda_obj)
```

Loading input data ...  
Elapsed time: 0.00 sec.  
Running LIONESS for sample 1:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.05 sec.  
Inferring LIONESS network:  
step: 0, hamming: 0.6451915130131665  
step: 1, hamming: 0.6067461274659866  
step: 2, hamming: 0.6105604110178086  
step: 3, hamming: 0.5875350566544837  
step: 4, hamming: 0.553598317095621  
step: 5, hamming: 0.5130977642028344  
step: 6, hamming: 0.46888897174383587  
step: 7, hamming: 0.42325335262309544  
step: 8, hamming: 0.3780071410446651  
step: 9, hamming: 0.3345126063650471  
step: 10, hamming: 0.29371889150860553  
step: 11, hamming: 0.256215635375215  
step: 12, hamming: 0.2223029668802453  
step: 13, hamming: 0.19205902295385965  
step: 14, hamming: 0.16540299653390683  
step: 15, hamming: 0.14214587924488872  
step: 16, hamming: 0.12203018089850888  
step: 17, hamming: 0.10475927721891459  
step: 18, hamming: 0.09001790128025045  
step: 19, hamming: 0.07748617353400274  
step: 20, hamming: 0.06684920778474639  
step: 21, hamming: 0.05780549039322097  
step: 22, hamming: 0.050075273181656076  
step: 23, hamming: 0.04341014640011884  
step: 24, hamming: 0.037602349632078355  
step: 25, hamming: 0.03249107812351406  
step: 26, hamming: 0.027962472467870057  
step: 27, hamming: 0.023942393402995726  
step: 28, hamming: 0.020384212163623416  
step: 29, hamming: 0.017255759085262883  
step: 30, hamming: 0.014529132197793934  
step: 31, hamming: 0.012174934686279325  
step: 32, hamming: 0.010160473548057764  
step: 33, hamming: 0.008450451023408795  
step: 34, hamming: 0.007008679501096658  
step: 35, hamming: 0.005799847383305951  
step: 36, hamming: 0.0047908698579349875  
step: 37, hamming: 0.003951715021127739  
step: 38, hamming: 0.0032557729560454525  
step: 39, hamming: 0.0026798912102928003

```

step: 40, hamming: 0.0022041994917917375
step: 41, hamming: 0.0018118190733138475
step: 42, hamming: 0.001488523179360306
step: 43, hamming: 0.0012223905275455405
step: 44, hamming: 0.0010034762989084775
step: 45, hamming: 0.0008235128661467359
Running panda took: 1.57 seconds!
  Elapsed time: 1.57 sec.
Saving LIONESS network 1 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 2:
Computing coexpression network:
  Elapsed time: 0.01 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6445476038755726
step: 1, hamming: 0.6066183636796103
step: 2, hamming: 0.6105445645592841
step: 3, hamming: 0.5875332090279166
step: 4, hamming: 0.5536082244075643
step: 5, hamming: 0.5131126090450783
step: 6, hamming: 0.4689036142976634
step: 7, hamming: 0.42326732437298714
step: 8, hamming: 0.37801889244651393
step: 9, hamming: 0.3345221998366117
step: 10, hamming: 0.2937266882099521
step: 11, hamming: 0.25622198762640763
step: 12, hamming: 0.2223082180455078
step: 13, hamming: 0.19206345829316707
step: 14, hamming: 0.16540684598000693
step: 15, hamming: 0.14214929350383065
step: 16, hamming: 0.12203326585701965
step: 17, hamming: 0.10476213861746786
step: 18, hamming: 0.09002061402300268
step: 19, hamming: 0.07748873372939052
step: 20, hamming: 0.06685160145106347
step: 21, hamming: 0.05780769330088383
step: 22, hamming: 0.05007728699579842
step: 23, hamming: 0.043411967564035835
step: 24, hamming: 0.03760397086506173
step: 25, hamming: 0.03249250247772415
step: 26, hamming: 0.02796370867990171
step: 27, hamming: 0.023943455630073416
step: 28, hamming: 0.020385117331234274
step: 29, hamming: 0.017256526537376273
step: 30, hamming: 0.014529780088585704
step: 31, hamming: 0.01217547887586061

```

```

step: 32, hamming: 0.01016092964904858
step: 33, hamming: 0.00845083256181436
step: 34, hamming: 0.007008998275263656
step: 35, hamming: 0.00580011293166026
step: 36, hamming: 0.004791090473343346
step: 37, hamming: 0.003951898060626234
step: 38, hamming: 0.0032559245644580514
step: 39, hamming: 0.002680016580549968
step: 40, hamming: 0.002204303033904436
step: 41, hamming: 0.0018119045001386948
step: 42, hamming: 0.0014885935906914863
step: 43, hamming: 0.0012224485182821007
step: 44, hamming: 0.001003524027229864
step: 45, hamming: 0.0008235521248684664
Running panda took: 1.44 seconds!
  Elapsed time: 1.44 sec.
Saving LIONESS network 2 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 3:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.05 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6452294464816625
step: 1, hamming: 0.6066718767537945
step: 2, hamming: 0.6105013812906783
step: 3, hamming: 0.5874769465007303
step: 4, hamming: 0.5535467800773778
step: 5, hamming: 0.5130509623219737
step: 6, hamming: 0.46884619807330846
step: 7, hamming: 0.42321422343773074
step: 8, hamming: 0.37797019212390504
step: 9, hamming: 0.3344779785095642
step: 10, hamming: 0.29368704884702534
step: 11, hamming: 0.2561872040679576
step: 12, hamming: 0.22227787688473338
step: 13, hamming: 0.19203719585754386
step: 14, hamming: 0.1653841888050198
step: 15, hamming: 0.14212975837567024
step: 16, hamming: 0.12201639360763507
step: 17, hamming: 0.10474755327204792
step: 18, hamming: 0.09000797360987653
step: 19, hamming: 0.07747770691527577
step: 20, hamming: 0.06684195286417426
step: 21, hamming: 0.05779924885457799
step: 22, hamming: 0.0500699126573237
step: 23, hamming: 0.04340556363927608

```



```

step: 24, hamming: 0.03759846201370095
step: 25, hamming: 0.032487809256736604
step: 26, hamming: 0.027959741303826367
step: 27, hamming: 0.023940126981286655
step: 28, hamming: 0.020382340568109492
step: 29, hamming: 0.017254219929107445
step: 30, hamming: 0.014527868465885224
step: 31, hamming: 0.01217389759028471
step: 32, hamming: 0.010159622712944908
step: 33, hamming: 0.008449753233040156
step: 34, hamming: 0.00700810750381105
step: 35, hamming: 0.005799378246977346
step: 36, hamming: 0.004790484906859
step: 37, hamming: 0.003951399167495922
step: 38, hamming: 0.0032555137716483097
step: 39, hamming: 0.0026796785137800714
step: 40, hamming: 0.0022040249594432525
step: 41, hamming: 0.0018116758740187896
step: 42, hamming: 0.00148840570066346
step: 43, hamming: 0.0012222941612371428
step: 44, hamming: 0.001003397260817946
step: 45, hamming: 0.0008234480506902851
Running panda took: 1.45 seconds!
  Elapsed time: 1.45 sec.
Saving LIONESS network 3 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 4:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6451852429809524
step: 1, hamming: 0.6065219652377924
step: 2, hamming: 0.6104344926479942
step: 3, hamming: 0.5874558460006224
step: 4, hamming: 0.5535449632471361
step: 5, hamming: 0.5130643774408143
step: 6, hamming: 0.4688705437378891
step: 7, hamming: 0.4232496104307795
step: 8, hamming: 0.37801701958351697
step: 9, hamming: 0.3345340739226694
step: 10, hamming: 0.2937480738815744
step: 11, hamming: 0.2562488692873377
step: 12, hamming: 0.22233727067256506
step: 13, hamming: 0.19209248683867375
step: 14, hamming: 0.16543446318988872
step: 15, hamming: 0.1421747497816679

```

```

step: 16, hamming: 0.12205609283083738
step: 17, hamming: 0.10478214956850972
step: 18, hamming: 0.09003785868900757
step: 19, hamming: 0.07750337290976046
step: 20, hamming: 0.06686386614000324
step: 21, hamming: 0.05781785478415813
step: 22, hamming: 0.05008562777061508
step: 23, hamming: 0.04341877501262821
step: 24, hamming: 0.03760951592560502
step: 25, hamming: 0.032497011652074345
step: 26, hamming: 0.02796736911372712
step: 27, hamming: 0.02394642097778111
step: 28, hamming: 0.020387520088663666
step: 29, hamming: 0.017258473103985816
step: 30, hamming: 0.01453135749256901
step: 31, hamming: 0.012176759183597896
step: 32, hamming: 0.010161970824797953
step: 33, hamming: 0.008451681020184565
step: 34, hamming: 0.007009691223106571
step: 35, hamming: 0.005800680312786872
step: 36, hamming: 0.004791555961913859
step: 37, hamming: 0.003952280550194627
step: 38, hamming: 0.003256239262093696
step: 39, hamming: 0.002680275699607181
step: 40, hamming: 0.0022045164857199522
step: 41, hamming: 0.0018120803581844042
step: 42, hamming: 0.001488738520630177
step: 43, hamming: 0.0012225679351576834
step: 44, hamming: 0.0010036223951606135
step: 45, hamming: 0.0008236331272743101
Running panda took: 1.37 seconds!
  Elapsed time: 1.37 sec.
Saving LIONESS network 4 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 5:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6446007808140573
step: 1, hamming: 0.6066561612626608
step: 2, hamming: 0.6105143267305174
step: 3, hamming: 0.5875153809819785
step: 4, hamming: 0.5536025207133696
step: 5, hamming: 0.5131152115952171
step: 6, hamming: 0.46890851450749593
step: 7, hamming: 0.42326886776988776

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step: 8, hamming: 0.3780158211356529  
step: 9, hamming: 0.3345152633298887  
step: 10, hamming: 0.2937178419931415  
step: 11, hamming: 0.2562128416941286  
step: 12, hamming: 0.22229937209191528  
step: 13, hamming: 0.19205541566268614  
step: 14, hamming: 0.16539967610526804  
step: 15, hamming: 0.14214304912137624  
step: 16, hamming: 0.12202778290912641  
step: 17, hamming: 0.10475728352365837  
step: 18, hamming: 0.090016151593947  
step: 19, hamming: 0.07748448858975361  
step: 20, hamming: 0.06684754079961647  
step: 21, hamming: 0.05780382637771552  
step: 22, hamming: 0.050073651393493325  
step: 23, hamming: 0.04340859802170938  
step: 24, hamming: 0.0376009243886287  
step: 25, hamming: 0.032489808432629164  
step: 26, hamming: 0.027961372564714912  
step: 27, hamming: 0.023941467122490446  
step: 28, hamming: 0.020383446949155247  
step: 29, hamming: 0.01725513600007104  
step: 30, hamming: 0.014528627076186464  
step: 31, hamming: 0.012174525611025123  
step: 32, hamming: 0.010160143004486255  
step: 33, hamming: 0.008450183672932479  
step: 34, hamming: 0.0070084629144963285  
step: 35, hamming: 0.005799671567508494  
step: 36, hamming: 0.00479072675513629  
step: 37, hamming: 0.00395159839993978  
step: 38, hamming: 0.0032556778303245086  
step: 39, hamming: 0.002679813604130495  
step: 40, hamming: 0.0022041361378598878  
step: 41, hamming: 0.0018117673263748355  
step: 42, hamming: 0.0014884808938152954  
step: 43, hamming: 0.00122355966581887  
step: 44, hamming: 0.001003448045910429  
step: 45, hamming: 0.0008234897655709236  
Running panda took: 1.46 seconds!

Elapsed time: 1.46 sec.

Saving LIONESS network 5 to lioness\_output using npy format:

Elapsed time: 0.05 sec.

Running LIONESS for sample 6:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6449147271756762  
step: 1, hamming: 0.6066459340545902  
step: 2, hamming: 0.6105137892381169  
step: 3, hamming: 0.5875076422353582  
step: 4, hamming: 0.553580794787596  
step: 5, hamming: 0.5130868604034443  
step: 6, hamming: 0.4688806568825481  
step: 7, hamming: 0.42324491174509904  
step: 8, hamming: 0.37799750607572563  
step: 9, hamming: 0.3345019592116213  
step: 10, hamming: 0.29370783535904643  
step: 11, hamming: 0.25620490280375174  
step: 12, hamming: 0.2222927405692275  
step: 13, hamming: 0.19204960851436953  
step: 14, hamming: 0.16539452124403728  
step: 15, hamming: 0.14213836522146303  
step: 16, hamming: 0.12202359171841876  
step: 17, hamming: 0.1047535348014802  
step: 18, hamming: 0.09001300549732213  
step: 19, hamming: 0.07748198595168344  
step: 20, hamming: 0.06684561523161113  
step: 21, hamming: 0.057802393319260764  
step: 22, hamming: 0.05007261907425589  
step: 23, hamming: 0.043407887819397944  
step: 24, hamming: 0.03760046113425871  
step: 25, hamming: 0.032489527040096326  
step: 26, hamming: 0.027961217331469623  
step: 27, hamming: 0.023941395280352783  
step: 28, hamming: 0.020383428084858147  
step: 29, hamming: 0.01725514805667612  
step: 30, hamming: 0.01452865748618028  
step: 31, hamming: 0.012174566104760925  
step: 32, hamming: 0.010160186691797834  
step: 33, hamming: 0.008450226110780602  
step: 34, hamming: 0.007008501791631318  
step: 35, hamming: 0.005799706008307911  
step: 36, hamming: 0.004790756420696588  
step: 37, hamming: 0.003951623456964681  
step: 38, hamming: 0.0032556987003403777  
step: 39, hamming: 0.00267983077356759  
step: 40, hamming: 0.002204150177080668  
step: 41, hamming: 0.0018117787582195696  
step: 42, hamming: 0.0014884901773124216  
step: 43, hamming: 0.0012223635096057386  
step: 44, hamming: 0.0010034541834039374  
step: 45, hamming: 0.0008234947565908472

Running panda took: 1.28 seconds!

Elapsed time: 1.28 sec.

Saving LIONESS network 6 to lioness\_output using npy format:

Elapsed time: 0.05 sec.

Running LIONESS for sample 7:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6446977027334075  
step: 1, hamming: 0.6064843916807414  
step: 2, hamming: 0.6103824327902414  
step: 3, hamming: 0.5873860105971278  
step: 4, hamming: 0.553462428350063  
step: 5, hamming: 0.5129759831080029  
step: 6, hamming: 0.46877915323218355  
step: 7, hamming: 0.42315760514309164  
step: 8, hamming: 0.37792629014527557  
step: 9, hamming: 0.3344456468150189  
step: 10, hamming: 0.29366421996136893  
step: 11, hamming: 0.25617114055220225  
step: 12, hamming: 0.22226630385566215  
step: 13, hamming: 0.19202874698683792  
step: 14, hamming: 0.1653778736143681  
step: 15, hamming: 0.14212484935803069  
step: 16, hamming: 0.12201243940238896  
step: 17, hamming: 0.10474418411446189  
step: 18, hamming: 0.09000497478051857  
step: 19, hamming: 0.07747497601974164  
step: 20, hamming: 0.06683946462194991  
step: 21, hamming: 0.05779698175620105  
step: 22, hamming: 0.05006786610992063  
step: 23, hamming: 0.04340371997910614  
step: 24, hamming: 0.03759681143075524  
step: 25, hamming: 0.03248634755930704  
step: 26, hamming: 0.02795846902706734  
step: 27, hamming: 0.02393903917646325  
step: 28, hamming: 0.02038142735532686  
step: 29, hamming: 0.017253462963678155  
step: 30, hamming: 0.014527247466191108  
step: 31, hamming: 0.012173391298399968  
step: 32, hamming: 0.01015921171833301  
step: 33, hamming: 0.008449420102928758  
step: 34, hamming: 0.007007837027271363  
step: 35, hamming: 0.005799158448934519  
step: 36, hamming: 0.0047903059897394145  
step: 37, hamming: 0.00395125337010865  
step: 38, hamming: 0.0032553948541319587  
step: 39, hamming: 0.0026795814132303665

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step: 40, hamming: 0.0022039455997269423
step: 41, hamming: 0.0018116109753956073
step: 42, hamming: 0.001488352605143334
step: 43, hamming: 0.0012222507105209746
step: 44, hamming: 0.0010033616948213154
step: 45, hamming: 0.0008234189320553584
Running panda took: 1.28 seconds!
  Elapsed time: 1.28 sec.
Saving LIONESS network 7 to lioness_output using npy format:
  Elapsed time: 0.05 sec.
Running LIONESS for sample 8:
Computing coexpression network:
  Elapsed time: 0.01 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6459338403224688
step: 1, hamming: 0.6066595645190107
step: 2, hamming: 0.6104610627797932
step: 3, hamming: 0.5874377958138726
step: 4, hamming: 0.5535034427944524
step: 5, hamming: 0.5130076219885701
step: 6, hamming: 0.4688044641107459
step: 7, hamming: 0.423176090435273
step: 8, hamming: 0.37793707228730244
step: 9, hamming: 0.3344497542143437
step: 10, hamming: 0.29366290145773
step: 11, hamming: 0.2561661870411493
step: 12, hamming: 0.22225964953219257
step: 13, hamming: 0.19202134254653253
step: 14, hamming: 0.16537035801892333
step: 15, hamming: 0.14211767839413378
step: 16, hamming: 0.12200586248374187
step: 17, hamming: 0.10473836447075487
step: 18, hamming: 0.08999993448755682
step: 19, hamming: 0.07747066783111718
step: 20, hamming: 0.06683582626078943
step: 21, hamming: 0.05779392295165678
step: 22, hamming: 0.05006528552822069
step: 23, hamming: 0.04340155522633314
step: 24, hamming: 0.037595006417562825
step: 25, hamming: 0.03248484646178138
step: 26, hamming: 0.02795721995514243
step: 27, hamming: 0.023938001058869156
step: 28, hamming: 0.020380561586156625
step: 29, hamming: 0.017252738442971302
step: 30, hamming: 0.014526640538941682
step: 31, hamming: 0.01217288260449653

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step: 32, hamming: 0.010158785500792763
step: 33, hamming: 0.008449063051904343
step: 34, hamming: 0.007007538802914241
step: 35, hamming: 0.005798910108587993
step: 36, hamming: 0.004790099693035461
step: 37, hamming: 0.003951082234771278
step: 38, hamming: 0.003255253101132006
step: 39, hamming: 0.0026794641739463394
step: 40, hamming: 0.0022038487570621673
step: 41, hamming: 0.0018115310562277815
step: 42, hamming: 0.0014882867079583828
step: 43, hamming: 0.0012221964189122285
step: 44, hamming: 0.0010033169964392779
step: 45, hamming: 0.0008233821537042111
Running panda took: 1.37 seconds!
  Elapsed time: 1.37 sec.
Saving LIONESS network 8 to lioness_output using npy format:
  Elapsed time: 0.06 sec.
Running LIONESS for sample 9:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.05 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6448351993831178
step: 1, hamming: 0.6064879489440816
step: 2, hamming: 0.6103640777269351
step: 3, hamming: 0.5873512050264047
step: 4, hamming: 0.5534219407870923
step: 5, hamming: 0.5129356817661761
step: 6, hamming: 0.46874212604373694
step: 7, hamming: 0.42312367964198355
step: 8, hamming: 0.37789569142567153
step: 9, hamming: 0.33441876359267736
step: 10, hamming: 0.2936404320381599
step: 11, hamming: 0.25615039464431727
step: 12, hamming: 0.2222483777256884
step: 13, hamming: 0.1920133441212464
step: 14, hamming: 0.16536460861948546
step: 15, hamming: 0.14211341395771593
step: 16, hamming: 0.12200253916357386
step: 17, hamming: 0.10473558500674482
step: 18, hamming: 0.08999750917615142
step: 19, hamming: 0.07746846011445688
step: 20, hamming: 0.0668337240386083
step: 21, hamming: 0.05779188696902117
step: 22, hamming: 0.05006331165089908
step: 23, hamming: 0.043399650735111435

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step: 24, hamming: 0.03759319857032193
step: 25, hamming: 0.03248315937467175
step: 26, hamming: 0.02795567387570829
step: 27, hamming: 0.023936604678199185
step: 28, hamming: 0.02037932226923581
step: 29, hamming: 0.01725165670698856
step: 30, hamming: 0.014525707823730277
step: 31, hamming: 0.012172086330504326
step: 32, hamming: 0.010158111149147997
step: 33, hamming: 0.008448495729481618
step: 34, hamming: 0.007007063860617916
step: 35, hamming: 0.00579851383581758
step: 36, hamming: 0.004789769960958664
step: 37, hamming: 0.003950808640232261
step: 38, hamming: 0.0032550265635088458
step: 39, hamming: 0.002679276999410677
step: 40, hamming: 0.0022036943194786497
step: 41, hamming: 0.001811403763151287
step: 42, hamming: 0.0014881818789435535
step: 43, hamming: 0.0012221101496973927
step: 44, hamming: 0.0010032460442440812
step: 45, hamming: 0.0008233238300691795
Running panda took: 1.40 seconds!
Elapsed time: 1.40 sec.
Saving LIONESS network 9 to lioness_output using npy format:
Elapsed time: 0.02 sec.
Running LIONESS for sample 10:
Computing coexpression network:
Elapsed time: 0.02 sec.
Normalizing networks:
Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6446385831077224
step: 1, hamming: 0.6067294163043444
step: 2, hamming: 0.6105288665126055
step: 3, hamming: 0.5875025168461764
step: 4, hamming: 0.5535668756916815
step: 5, hamming: 0.5130674611873675
step: 6, hamming: 0.46885934016141356
step: 7, hamming: 0.42322390362455425
step: 8, hamming: 0.3779784610738321
step: 9, hamming: 0.3344846104039679
step: 10, hamming: 0.2936914468258334
step: 11, hamming: 0.25618942581891635
step: 12, hamming: 0.2222783089112929
step: 13, hamming: 0.19203629520565335
step: 14, hamming: 0.1653823459684807
step: 15, hamming: 0.14212736448871935

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step: 16, hamming: 0.12201379782743489  
step: 17, hamming: 0.10474497350107494  
step: 18, hamming: 0.09000555414562793  
step: 19, hamming: 0.07747554704258397  
step: 20, hamming: 0.06684008398127479  
step: 21, hamming: 0.05779766899483368  
step: 22, hamming: 0.05006859159088394  
step: 23, hamming: 0.04340445929636734  
step: 24, hamming: 0.03759753082194868  
step: 25, hamming: 0.03248701536330191  
step: 26, hamming: 0.027959057287518876  
step: 27, hamming: 0.02393953329078775  
step: 28, hamming: 0.02038182485122052  
step: 29, hamming: 0.01725377205537819  
step: 30, hamming: 0.01452748155142716  
step: 31, hamming: 0.012173565486877314  
step: 32, hamming: 0.010159339518948408  
step: 33, hamming: 0.008449513032409811  
step: 34, hamming: 0.0070079049394139465  
step: 35, hamming: 0.005799208359310959  
step: 36, hamming: 0.004790342845117792  
step: 37, hamming: 0.003951280675493335  
step: 38, hamming: 0.0032554152008438713  
step: 39, hamming: 0.0026795966888212373  
step: 40, hamming: 0.002203957150287452  
step: 41, hamming: 0.0018116197541239662  
step: 42, hamming: 0.0014883593143951975  
step: 43, hamming: 0.0012222558625903603  
step: 44, hamming: 0.0010033656704848055  
step: 45, hamming: 0.0008234220134066718

Running panda took: 1.48 seconds!

Elapsed time: 1.48 sec.

Saving LIONESS network 10 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 11:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6445970723339552  
step: 1, hamming: 0.6063968880265759  
step: 2, hamming: 0.610362895089462  
step: 3, hamming: 0.5873891776463085  
step: 4, hamming: 0.5534802081887703  
step: 5, hamming: 0.5130020812531749  
step: 6, hamming: 0.4688120305062983  
step: 7, hamming: 0.42319558082755515

step: 8, hamming: 0.377968666349301  
step: 9, hamming: 0.33449062529413504  
step: 10, hamming: 0.29370943003793337  
step: 11, hamming: 0.25621479946024567  
step: 12, hamming: 0.22230732905919456  
step: 13, hamming: 0.1920663351741951  
step: 14, hamming: 0.16541153798715838  
step: 15, hamming: 0.1421545477565385  
step: 16, hamming: 0.12203842025372977  
step: 17, hamming: 0.10476672314281757  
step: 18, hamming: 0.0900244111748685  
step: 19, hamming: 0.07749164789418152  
step: 20, hamming: 0.06685368125563591  
step: 21, hamming: 0.05780905110180941  
step: 22, hamming: 0.05007803092604655  
step: 23, hamming: 0.04341221333469125  
step: 24, hamming: 0.03760386116781324  
step: 25, hamming: 0.03249215842908325  
step: 26, hamming: 0.027963237690867417  
step: 27, hamming: 0.023942944227938814  
step: 28, hamming: 0.02038462017381501  
step: 29, hamming: 0.017256076965424815  
step: 30, hamming: 0.014529391608107678  
step: 31, hamming: 0.01217515416538417  
step: 32, hamming: 0.01016066495007358  
step: 33, hamming: 0.008450619213181505  
step: 34, hamming: 0.007008827032421282  
step: 35, hamming: 0.0057999760866447245  
step: 36, hamming: 0.004790981350177024  
step: 37, hamming: 0.003951810943599431  
step: 38, hamming: 0.003255854969433177  
step: 39, hamming: 0.0026799609209546132  
step: 40, hamming: 0.0022042584544433395  
step: 41, hamming: 0.0018118687383047569  
step: 42, hamming: 0.001488564864698104  
step: 43, hamming: 0.001224254093928496  
step: 44, hamming: 0.001003505414610442  
step: 45, hamming: 0.0008235371154278103  
Running panda took: 1.46 seconds!

Elapsed time: 1.46 sec.

Saving LIONESS network 11 to lioness\_output using npy format:

Elapsed time: 0.03 sec.

Running LIONESS for sample 12:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6449227035246179  
step: 1, hamming: 0.6067351153769638  
step: 2, hamming: 0.6106375012468723  
step: 3, hamming: 0.5876437952563218  
step: 4, hamming: 0.5537178078810691  
step: 5, hamming: 0.5132213547717154  
step: 6, hamming: 0.4690101547789507  
step: 7, hamming: 0.42336856484025914  
step: 8, hamming: 0.37811364961234867  
step: 9, hamming: 0.3346090555291644  
step: 10, hamming: 0.29380462591393197  
step: 11, hamming: 0.25629077493594926  
step: 12, hamming: 0.2223680768718527  
step: 13, hamming: 0.1921150818070645  
step: 14, hamming: 0.1654509766214052  
step: 15, hamming: 0.14218673742040683  
step: 16, hamming: 0.12206484516686276  
step: 17, hamming: 0.10478861898320703  
step: 18, hamming: 0.09004269287907357  
step: 19, hamming: 0.0775070250720587  
step: 20, hamming: 0.06686675609772613  
step: 21, hamming: 0.05782028426552099  
step: 22, hamming: 0.05008776953393789  
step: 23, hamming: 0.043420696376732626  
step: 24, hamming: 0.037611262734358726  
step: 25, hamming: 0.03249860924051235  
step: 26, hamming: 0.027968830176749445  
step: 27, hamming: 0.023947752343236338  
step: 28, hamming: 0.020388722079863027  
step: 29, hamming: 0.017259546093626295  
step: 30, hamming: 0.014532302553875647  
step: 31, hamming: 0.01217758101100222  
step: 32, hamming: 0.010162676990644747  
step: 33, hamming: 0.00845228151463363  
step: 34, hamming: 0.0070101971767046085  
step: 35, hamming: 0.005801103434029777  
step: 36, hamming: 0.0047919078009273945  
step: 37, hamming: 0.003952571735671334  
step: 38, hamming: 0.0032564793806740514  
step: 39, hamming: 0.0026804732113290546  
step: 40, hamming: 0.00220467863067728  
step: 41, hamming: 0.0018122132860573486  
step: 42, hamming: 0.0014888473474811738  
step: 43, hamming: 0.0012226569714781802  
step: 44, hamming: 0.0010036952106255875  
step: 45, hamming: 0.0008236926599718468

Running panda took: 1.44 seconds!

Elapsed time: 1.44 sec.

Saving LIONESS network 12 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 13:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.05 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6454815045482025  
step: 1, hamming: 0.6064888334615245  
step: 2, hamming: 0.610353785046755  
step: 3, hamming: 0.5873467987983988  
step: 4, hamming: 0.5534173891580667  
step: 5, hamming: 0.5129251262883208  
step: 6, hamming: 0.4687264900712108  
step: 7, hamming: 0.4231036921678549  
step: 8, hamming: 0.37787210728432713  
step: 9, hamming: 0.3343925087997385  
step: 10, hamming: 0.2936124890554121  
step: 11, hamming: 0.2561217809997432  
step: 12, hamming: 0.22222032595119312  
step: 13, hamming: 0.19198634671852602  
step: 14, hamming: 0.16533917584848354  
step: 15, hamming: 0.14208990495011609  
step: 16, hamming: 0.12198119524882962  
step: 17, hamming: 0.10471648707194936  
step: 18, hamming: 0.08998053903852753  
step: 19, hamming: 0.07745350260977645  
step: 20, hamming: 0.06682062957867617  
step: 21, hamming: 0.05778050118366357  
step: 22, hamming: 0.05005347176858947  
step: 23, hamming: 0.04339119603182728  
step: 24, hamming: 0.03758595561496705  
step: 25, hamming: 0.03247697829457956  
step: 26, hamming: 0.0279504168476757  
step: 27, hamming: 0.023932149875743877  
step: 28, hamming: 0.020375560744930254  
step: 29, hamming: 0.01724848885084861  
step: 30, hamming: 0.014523048953008225  
step: 31, hamming: 0.012169862212797655  
step: 32, hamming: 0.010156256059334054  
step: 33, hamming: 0.008446951777683006  
step: 34, hamming: 0.007005781213394501  
step: 35, hamming: 0.0057974502702537525  
step: 36, hamming: 0.004788889434590357  
step: 37, hamming: 0.00395008054412097  
step: 38, hamming: 0.003254425165595956  
step: 39, hamming: 0.0026787806466122715

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step: 40, hamming: 0.0022032850078452723
step: 41, hamming: 0.0018110664850589518
step: 42, hamming: 0.0014879041422859187
step: 43, hamming: 0.0012218815774630238
step: 44, hamming: 0.0010030580312243072
step: 45, hamming: 0.0008231692507589999
Running panda took: 1.63 seconds!
  Elapsed time: 1.63 sec.
Saving LIONESS network 13 to lioness_output using npy format:
  Elapsed time: 0.05 sec.
Running LIONESS for sample 14:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.04 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6443394902350985
step: 1, hamming: 0.6066808238313083
step: 2, hamming: 0.610500062853496
step: 3, hamming: 0.5874753808094995
step: 4, hamming: 0.5535342710047162
step: 5, hamming: 0.5130322757657333
step: 6, hamming: 0.46882485488303
step: 7, hamming: 0.42319334974995554
step: 8, hamming: 0.37795210281175695
step: 9, hamming: 0.3344633679474344
step: 10, hamming: 0.2936753764324572
step: 11, hamming: 0.2561774279980078
step: 12, hamming: 0.2222694459009427
step: 13, hamming: 0.19203006056522645
step: 14, hamming: 0.16537809623297536
step: 15, hamming: 0.14212455805772894
step: 16, hamming: 0.1220119905197326
step: 17, hamming: 0.10474380875818415
step: 18, hamming: 0.0900048204529394
step: 19, hamming: 0.07747506491160117
step: 20, hamming: 0.06683975370409437
step: 21, hamming: 0.05779742984599143
step: 22, hamming: 0.050068421477429015
step: 23, hamming: 0.04340433264758675
step: 24, hamming: 0.03759742735740401
step: 25, hamming: 0.03248692677678964
step: 26, hamming: 0.0279589832412535
step: 27, hamming: 0.023939475652045558
step: 28, hamming: 0.020381784048555823
step: 29, hamming: 0.017253746643295972
step: 30, hamming: 0.01452746881029944
step: 31, hamming: 0.012173562253857687

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step: 32, hamming: 0.010159342835363386
step: 33, hamming: 0.008449520673285471
step: 34, hamming: 0.0070079141991438425
step: 35, hamming: 0.00579921781960979
step: 36, hamming: 0.004790352300931194
step: 37, hamming: 0.003951289630160982
step: 38, hamming: 0.003255423348636021
step: 39, hamming: 0.0026796039355505563
step: 40, hamming: 0.002203963484083054
step: 41, hamming: 0.0018116252199462351
step: 42, hamming: 0.0014883639807463862
step: 43, hamming: 0.0012222598171972375
step: 44, hamming: 0.0010033690024990156
step: 45, hamming: 0.0008234248099945843
Running panda took: 1.51 seconds!
  Elapsed time: 1.51 sec.
Saving LIONESS network 14 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 15:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.06 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6442838140322693
step: 1, hamming: 0.6065432591877655
step: 2, hamming: 0.6104256202756483
step: 3, hamming: 0.587423936441978
step: 4, hamming: 0.553504385366511
step: 5, hamming: 0.513017729482651
step: 6, hamming: 0.46881952598171256
step: 7, hamming: 0.42319353876507343
step: 8, hamming: 0.3779564465155286
step: 9, hamming: 0.3344697612732674
step: 10, hamming: 0.29368304260522193
step: 11, hamming: 0.256185917293156
step: 12, hamming: 0.2222781858231914
step: 13, hamming: 0.19203847272328894
step: 14, hamming: 0.16538591145842108
step: 15, hamming: 0.14213154151205495
step: 16, hamming: 0.12201804684367129
step: 17, hamming: 0.1047489180035845
step: 18, hamming: 0.09000896576805427
step: 19, hamming: 0.07747832725281115
step: 20, hamming: 0.06684227158737589
step: 21, hamming: 0.05779932753307891
step: 22, hamming: 0.05006981276657544
step: 23, hamming: 0.0434053519354664

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step: 24, hamming: 0.037598189054180546
step: 25, hamming: 0.032487520650437404
step: 26, hamming: 0.027959467696440886
step: 27, hamming: 0.02393988620692473
step: 28, hamming: 0.020382138917549576
step: 29, hamming: 0.017254056868073374
step: 30, hamming: 0.014527740108929025
step: 31, hamming: 0.012173798233668112
step: 32, hamming: 0.010159546268615193
step: 33, hamming: 0.008449694062619568
step: 34, hamming: 0.007008060926552585
step: 35, hamming: 0.005799341301245978
step: 36, hamming: 0.004790455394888105
step: 37, hamming: 0.00395137536393676
step: 38, hamming: 0.0032554944712860395
step: 39, hamming: 0.0026796628068911574
step: 40, hamming: 0.002204012129634986
step: 41, hamming: 0.0018116653686568124
step: 42, hamming: 0.0014883970876660615
step: 43, hamming: 0.0012222870952029131
step: 44, hamming: 0.0010033914641085341
step: 45, hamming: 0.0008234432936021232
Running panda took: 1.87 seconds!
  Elapsed time: 1.87 sec.
Saving LIONESS network 15 to lioness_output using npy format:
  Elapsed time: 0.03 sec.
Running LIONESS for sample 16:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.04 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6451357933509941
step: 1, hamming: 0.6066460429428087
step: 2, hamming: 0.6104672809769208
step: 3, hamming: 0.5874429022191956
step: 4, hamming: 0.5535053796996751
step: 5, hamming: 0.5130102568327171
step: 6, hamming: 0.4688078805102339
step: 7, hamming: 0.4231820754210904
step: 8, hamming: 0.37794630825110404
step: 9, hamming: 0.3344617217511006
step: 10, hamming: 0.29367695762019436
step: 11, hamming: 0.2561810037908881
step: 12, hamming: 0.22227406388621243
step: 13, hamming: 0.19203490092286687
step: 14, hamming: 0.16538281310135527
step: 15, hamming: 0.14212890528332245

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step: 16, hamming: 0.12201583114277065
step: 17, hamming: 0.10474707223510565
step: 18, hamming: 0.09000753562825538
step: 19, hamming: 0.07747728987948438
step: 20, hamming: 0.0668415436219817
step: 21, hamming: 0.05779884394184241
step: 22, hamming: 0.05006952159265663
step: 23, hamming: 0.04340519640748409
step: 24, hamming: 0.03759811012297122
step: 25, hamming: 0.03248747270773837
step: 26, hamming: 0.027959425880675678
step: 27, hamming: 0.023939839110948585
step: 28, hamming: 0.020382085146816525
step: 29, hamming: 0.01725399643445798
step: 30, hamming: 0.014527676899527598
step: 31, hamming: 0.01217373502349932
step: 32, hamming: 0.010159486018898028
step: 33, hamming: 0.00844963874092018
step: 34, hamming: 0.007008011615450409
step: 35, hamming: 0.0057992982643482755
step: 36, hamming: 0.004790418528106762
step: 37, hamming: 0.003951344147935315
step: 38, hamming: 0.003255468222274782
step: 39, hamming: 0.0026796408398129684
step: 40, hamming: 0.002203993820812893
step: 41, hamming: 0.0018116502262686585
step: 42, hamming: 0.001488384584632186
step: 43, hamming: 0.0012222767839663953
step: 44, hamming: 0.0010033829666874518
step: 45, hamming: 0.000823436296690418
Running panda took: 1.47 seconds!
  Elapsed time: 1.47 sec.
Saving LIONESS network 16 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 17:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6453372188039735
step: 1, hamming: 0.6066676287287168
step: 2, hamming: 0.6104644764183814
step: 3, hamming: 0.5874393760760523
step: 4, hamming: 0.553506577030067
step: 5, hamming: 0.513009831711223
step: 6, hamming: 0.46880493446531923
step: 7, hamming: 0.42317541168503875

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step: 8, hamming: 0.3779353604570779  
step: 9, hamming: 0.3344472571824323  
step: 10, hamming: 0.2936601064819789  
step: 11, hamming: 0.2561633601925414  
step: 12, hamming: 0.2222568377191461  
step: 13, hamming: 0.19201879569174002  
step: 14, hamming: 0.16536830973066033  
step: 15, hamming: 0.14211622482773686  
step: 16, hamming: 0.1220048801756969  
step: 17, hamming: 0.10473769975276605  
step: 18, hamming: 0.08999949865507745  
step: 19, hamming: 0.07747042421728799  
step: 20, hamming: 0.06683571528299426  
step: 21, hamming: 0.057793931389394995  
step: 22, hamming: 0.0500654130944078  
step: 23, hamming: 0.043401792301824775  
step: 24, hamming: 0.037595325807174514  
step: 25, hamming: 0.032485225085799395  
step: 26, hamming: 0.027957631020622514  
step: 27, hamming: 0.023938413555977034  
step: 28, hamming: 0.020380954334854536  
step: 29, hamming: 0.017253098946343814  
step: 30, hamming: 0.01452696113853556  
step: 31, hamming: 0.0121731618457686  
step: 32, hamming: 0.010159024956166727  
step: 33, hamming: 0.008449266035746398  
step: 34, hamming: 0.00700770946888819  
step: 35, hamming: 0.005799052725515067  
step: 36, hamming: 0.004790218419084312  
step: 37, hamming: 0.0039511807920843516  
step: 38, hamming: 0.0032553347191006422  
step: 39, hamming: 0.0026795316594392425  
step: 40, hamming: 0.002203904483139546  
step: 41, hamming: 0.0018115770171323303  
step: 42, hamming: 0.0014883245770206238  
step: 43, hamming: 0.001222275926846026  
step: 44, hamming: 0.0010033426427683537  
step: 45, hamming: 0.0008234032422371877  
Running panda took: 1.44 seconds!

Elapsed time: 1.44 sec.

Saving LIONESS network 17 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 18:

Computing coexpression network:

Elapsed time: 0.03 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6449357768289141  
step: 1, hamming: 0.6067478759109104  
step: 2, hamming: 0.6105187387290015  
step: 3, hamming: 0.5874835466275927  
step: 4, hamming: 0.5535417550864121  
step: 5, hamming: 0.5130402196441705  
step: 6, hamming: 0.4688318533055642  
step: 7, hamming: 0.4231991954317866  
step: 8, hamming: 0.3779561923867192  
step: 9, hamming: 0.3344661242851883  
step: 10, hamming: 0.2936772734231136  
step: 11, hamming: 0.2561788722687788  
step: 12, hamming: 0.22227085717962167  
step: 13, hamming: 0.19203122760644709  
step: 14, hamming: 0.1653790756966992  
step: 15, hamming: 0.1421253806373162  
step: 16, hamming: 0.12201265787241682  
step: 17, hamming: 0.10474431714590451  
step: 18, hamming: 0.09000515595301478  
step: 19, hamming: 0.07747531799818602  
step: 20, hamming: 0.06683996904018245  
step: 21, hamming: 0.05779759760298822  
step: 22, hamming: 0.05006852906896944  
step: 23, hamming: 0.04340439208110958  
step: 24, hamming: 0.03759745306277047  
step: 25, hamming: 0.032486925619651025  
step: 26, hamming: 0.02795896080983829  
step: 27, hamming: 0.023939439452491516  
step: 28, hamming: 0.020381738530574928  
step: 29, hamming: 0.017253695360279313  
step: 30, hamming: 0.014527415793591236  
step: 31, hamming: 0.012173510704249178  
step: 32, hamming: 0.010159294487304502  
step: 33, hamming: 0.008449476113258234  
step: 34, hamming: 0.007007874287828733  
step: 35, hamming: 0.005799182820196558  
step: 36, hamming: 0.004790321840049439  
step: 37, hamming: 0.003951263491362449  
step: 38, hamming: 0.0032554011485745617  
step: 39, hamming: 0.0026795851877981086  
step: 40, hamming: 0.0022039477307740163  
step: 41, hamming: 0.0018116120424978204  
step: 42, hamming: 0.0014883529993387446  
step: 43, hamming: 0.001222250689760564  
step: 44, hamming: 0.00100336143314437  
step: 45, hamming: 0.0008234185581224598

Running panda took: 1.39 seconds!

Elapsed time: 1.39 sec.

Saving LIONESS network 18 to lioness\_output using npy format:

Elapsed time: 0.03 sec.

Running LIONESS for sample 19:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6455081786434624  
step: 1, hamming: 0.6064194187335534  
step: 2, hamming: 0.6103607543150151  
step: 3, hamming: 0.5873862777167242  
step: 4, hamming: 0.553480413292402  
step: 5, hamming: 0.5130026093014715  
step: 6, hamming: 0.4688113588544863  
step: 7, hamming: 0.4231895358092202  
step: 8, hamming: 0.3779544175944803  
step: 9, hamming: 0.334468551809112  
step: 10, hamming: 0.29368214409431076  
step: 11, hamming: 0.2561851448411255  
step: 12, hamming: 0.22227745758160627  
step: 13, hamming: 0.19203763284596798  
step: 14, hamming: 0.16538496739496927  
step: 15, hamming: 0.14213058508151208  
step: 16, hamming: 0.12201710874059979  
step: 17, hamming: 0.10474810732061204  
step: 18, hamming: 0.0900083402499391  
step: 19, hamming: 0.0774778918911271  
step: 20, hamming: 0.06684199669576119  
step: 21, hamming: 0.05779919229936601  
step: 22, hamming: 0.05006980214737102  
step: 23, hamming: 0.043405433551497834  
step: 24, hamming: 0.03759834459496707  
step: 25, hamming: 0.03248771827770938  
step: 26, hamming: 0.027959694807564463  
step: 27, hamming: 0.02394012862051738  
step: 28, hamming: 0.02038238580092493  
step: 29, hamming: 0.017254298712404578  
step: 30, hamming: 0.014527969806710518  
step: 31, hamming: 0.012174010998701936  
step: 32, hamming: 0.010159739559041087  
step: 33, hamming: 0.008449866915345706  
step: 34, hamming: 0.007008213042126161  
step: 35, hamming: 0.005799473355581618  
step: 36, hamming: 0.004790568744366452  
step: 37, hamming: 0.003951471883857407  
step: 38, hamming: 0.0032555761831291967  
step: 39, hamming: 0.0026797315837817073

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step: 40, hamming: 0.0022040697609956353
step: 41, hamming: 0.0018117134754357936
step: 42, hamming: 0.001488437118285034
step: 43, hamming: 0.001222320323319217
step: 44, hamming: 0.001003418986989929
step: 45, hamming: 0.0008234660519401803
Running panda took: 1.68 seconds!
  Elapsed time: 1.68 sec.
Saving LIONESS network 19 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 20:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6439395298412646
step: 1, hamming: 0.6064446364151149
step: 2, hamming: 0.6103874530759167
step: 3, hamming: 0.587378224328637
step: 4, hamming: 0.5534408069230905
step: 5, hamming: 0.5129461968109986
step: 6, hamming: 0.4687480609928045
step: 7, hamming: 0.42312972606616733
step: 8, hamming: 0.37790354425769523
step: 9, hamming: 0.3344283359725711
step: 10, hamming: 0.29365126515501877
step: 11, hamming: 0.2561617693952472
step: 12, hamming: 0.2222599888792307
step: 13, hamming: 0.19202452498598022
step: 14, hamming: 0.16537501759571194
step: 15, hamming: 0.14212288137746554
step: 16, hamming: 0.1220110190534544
step: 17, hamming: 0.10474308059192004
step: 18, hamming: 0.09000401407761763
step: 19, hamming: 0.0774741244284439
step: 20, hamming: 0.06683863595804257
step: 21, hamming: 0.057796138871261137
step: 22, hamming: 0.05006700914121158
step: 23, hamming: 0.04340287535360048
step: 24, hamming: 0.03759601882243467
step: 25, hamming: 0.032485634181046795
step: 26, hamming: 0.027957849133881683
step: 27, hamming: 0.023938508535798857
step: 28, hamming: 0.020380978291102247
step: 29, hamming: 0.01725308408299542
step: 30, hamming: 0.014526928573715066
step: 31, hamming: 0.01217312410619027

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step: 32, hamming: 0.01015898896686592
step: 33, hamming: 0.008449235814467613
step: 34, hamming: 0.007007685785454703
step: 35, hamming: 0.00579903522329828
step: 36, hamming: 0.004790206180267455
step: 37, hamming: 0.003951172904489711
step: 38, hamming: 0.0032553302873377606
step: 39, hamming: 0.0026795297588183783
step: 40, hamming: 0.002203904360801872
step: 41, hamming: 0.0018115780790296146
step: 42, hamming: 0.0014883263714357698
step: 43, hamming: 0.001222297878657692
step: 44, hamming: 0.0010033450031440966
step: 45, hamming: 0.0008234056073751168
Running panda took: 1.44 seconds!
  Elapsed time: 1.44 sec.
Saving LIONESS network 20 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 21:
Computing coexpression network:
  Elapsed time: 0.01 sec.
Normalizing networks:
  Elapsed time: 0.05 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6450848367279335
step: 1, hamming: 0.6066233811194319
step: 2, hamming: 0.6104738378033745
step: 3, hamming: 0.5874590505004481
step: 4, hamming: 0.5535293117119651
step: 5, hamming: 0.5130347272475934
step: 6, hamming: 0.4688311364101987
step: 7, hamming: 0.423201202950783
step: 8, hamming: 0.3779600554810355
step: 9, hamming: 0.33447046880848674
step: 10, hamming: 0.29368153860449103
step: 11, hamming: 0.256182992647495
step: 12, hamming: 0.2222745986871024
step: 13, hamming: 0.19203454863632288
step: 14, hamming: 0.16538197139376912
step: 15, hamming: 0.14212785490634228
step: 16, hamming: 0.12201474746203655
step: 17, hamming: 0.10474604616613903
step: 18, hamming: 0.09000658579037368
step: 19, hamming: 0.07747648716459518
step: 20, hamming: 0.06684087416347566
step: 21, hamming: 0.057798285097580865
step: 22, hamming: 0.05006904051012411
step: 23, hamming: 0.04340476637970672

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step: 24, hamming: 0.03759772603328491
step: 25, hamming: 0.03248712996303483
step: 26, hamming: 0.027959118987273036
step: 27, hamming: 0.02393956316965707
step: 28, hamming: 0.020381838360275333
step: 29, hamming: 0.01725377713847119
step: 30, hamming: 0.014527483895349053
step: 31, hamming: 0.012173567305814021
step: 32, hamming: 0.010159341931297581
step: 33, hamming: 0.008449516089574678
step: 34, hamming: 0.007007908113106247
step: 35, hamming: 0.005799211545052685
step: 36, hamming: 0.004790346079477176
step: 37, hamming: 0.0039512838325598924
step: 38, hamming: 0.0032554181896431323
step: 39, hamming: 0.0026795994570336656
step: 40, hamming: 0.002203959671213237
step: 41, hamming: 0.0018116220164900933
step: 42, hamming: 0.0014883613416886985
step: 43, hamming: 0.0012222576717636868
step: 44, hamming: 0.0010033672638236294
step: 45, hamming: 0.0008234234034135413
Running panda took: 1.49 seconds!
  Elapsed time: 1.50 sec.
Saving LIONESS network 21 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 22:
Computing coexpression network:
  Elapsed time: 0.04 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6453859638093248
step: 1, hamming: 0.6066965790988161
step: 2, hamming: 0.610491835290849
step: 3, hamming: 0.5874671302827961
step: 4, hamming: 0.5535319083441806
step: 5, hamming: 0.5130343438245889
step: 6, hamming: 0.46883010704011946
step: 7, hamming: 0.42319927931184576
step: 8, hamming: 0.377958105463949
step: 9, hamming: 0.3344683776483375
step: 10, hamming: 0.2936795511371286
step: 11, hamming: 0.2561812888003239
step: 12, hamming: 0.22227300354666066
step: 13, hamming: 0.19203305839021254
step: 14, hamming: 0.1653805885957311
step: 15, hamming: 0.14212657310449728

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step: 16, hamming: 0.12201356805469017  
step: 17, hamming: 0.10474498314173354  
step: 18, hamming: 0.09000563040511554  
step: 19, hamming: 0.07747556450073831  
step: 20, hamming: 0.06684002119191149  
step: 21, hamming: 0.05779753362320707  
step: 22, hamming: 0.05006839068356394  
step: 23, hamming: 0.0434042189139166  
step: 24, hamming: 0.037597278056102544  
step: 25, hamming: 0.032486767572642544  
step: 26, hamming: 0.02795883192482231  
step: 27, hamming: 0.023939341310999906  
step: 28, hamming: 0.0203816693839802  
step: 29, hamming: 0.017253650955294648  
step: 30, hamming: 0.014527390237321747  
step: 31, hamming: 0.01217349800996446  
step: 32, hamming: 0.01015929016531572  
step: 33, hamming: 0.008449476812725697  
step: 34, hamming: 0.007007877819352467  
step: 35, hamming: 0.005799187804456239  
step: 36, hamming: 0.004790327214202527  
step: 37, hamming: 0.0039512686521922325  
step: 38, hamming: 0.003255405875696191  
step: 39, hamming: 0.002679589392770105  
step: 40, hamming: 0.002203951397817051  
step: 41, hamming: 0.0018116151924508805  
step: 42, hamming: 0.001488355679500168  
step: 43, hamming: 0.001222252954038418  
step: 44, hamming: 0.0010033633357891538  
step: 45, hamming: 0.0008234201342693884

Running panda took: 1.60 seconds!

Elapsed time: 1.60 sec.

Saving LIONESS network 22 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 23:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.05 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6435616555805806  
step: 1, hamming: 0.6065774661127371  
step: 2, hamming: 0.610468595413635  
step: 3, hamming: 0.5874707578579492  
step: 4, hamming: 0.5535538083324445  
step: 5, hamming: 0.5130651148399519  
step: 6, hamming: 0.4688591784891974  
step: 7, hamming: 0.4232231791435239

step: 8, hamming: 0.37797491630976726  
step: 9, hamming: 0.33447914071665064  
step: 10, hamming: 0.29368549481398054  
step: 11, hamming: 0.2561836385957451  
step: 12, hamming: 0.22227301663758198  
step: 13, hamming: 0.19203158876314616  
step: 14, hamming: 0.16537816530669008  
step: 15, hamming: 0.14212379235777955  
step: 16, hamming: 0.12201066274790016  
step: 17, hamming: 0.10474203578042608  
step: 18, hamming: 0.09000269743578625  
step: 19, hamming: 0.07747275376080467  
step: 20, hamming: 0.06683734743392257  
step: 21, hamming: 0.0577950210516337  
step: 22, hamming: 0.05006608553256088  
step: 23, hamming: 0.04340213107403853  
step: 24, hamming: 0.03759541702968891  
step: 25, hamming: 0.03248513867836511  
step: 26, hamming: 0.02795742639550285  
step: 27, hamming: 0.023938141602490862  
step: 28, hamming: 0.020380652363289783  
step: 29, hamming: 0.017252792040855003  
step: 30, hamming: 0.014526666851716616  
step: 31, hamming: 0.01217289023901222  
step: 32, hamming: 0.010158780660191595  
step: 33, hamming: 0.00844905057468564  
step: 34, hamming: 0.007007521946824564  
step: 35, hamming: 0.0057988910697919045  
step: 36, hamming: 0.0047900800900266445  
step: 37, hamming: 0.00395106318079814  
step: 38, hamming: 0.003255235281823731  
step: 39, hamming: 0.002679448012328946  
step: 40, hamming: 0.0022038343696844176  
step: 41, hamming: 0.0018115184280166996  
step: 42, hamming: 0.001488275744870974  
step: 43, hamming: 0.0012221869810817728  
step: 44, hamming: 0.0010033089289654207  
step: 45, hamming: 0.0008233752989717561  
Running panda took: 1.69 seconds!

Elapsed time: 1.69 sec.

Saving LIONESS network 23 to lioness\_output using npy format:

Elapsed time: 0.04 sec.

Running LIONESS for sample 24:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.05 sec.

Inferring LIONESS network:



step: 0, hamming: 0.6451374874258013  
step: 1, hamming: 0.6065597248100142  
step: 2, hamming: 0.6104785268315843  
step: 3, hamming: 0.5874892432769232  
step: 4, hamming: 0.553567791572826  
step: 5, hamming: 0.5130739316093188  
step: 6, hamming: 0.46886944915852663  
step: 7, hamming: 0.42323727854509435  
step: 8, hamming: 0.3779939472775404  
step: 9, hamming: 0.3345015214724543  
step: 10, hamming: 0.2937094193739473  
step: 11, hamming: 0.2562077730351674  
step: 12, hamming: 0.22229629530279874  
step: 13, hamming: 0.1920534367947331  
step: 14, hamming: 0.1653983848286492  
step: 15, hamming: 0.14214207545812796  
step: 16, hamming: 0.1220271673144806  
step: 17, hamming: 0.10475689437070312  
step: 18, hamming: 0.09001608575237811  
step: 19, hamming: 0.0774847471094978  
step: 20, hamming: 0.06684806346197888  
step: 21, hamming: 0.05780455531349575  
step: 22, hamming: 0.05007450535329472  
step: 23, hamming: 0.043409517421342025  
step: 24, hamming: 0.03760185201290928  
step: 25, hamming: 0.032490701336341195  
step: 26, hamming: 0.027962198197821787  
step: 27, hamming: 0.023942208045912385  
step: 28, hamming: 0.020384097306212396  
step: 29, hamming: 0.017255699648224446  
step: 30, hamming: 0.014529113182227082  
step: 31, hamming: 0.01217494163127554  
step: 32, hamming: 0.010160495993560507  
step: 33, hamming: 0.00845048121903037  
step: 34, hamming: 0.007008712784988987  
step: 35, hamming: 0.005799880479159791  
step: 36, hamming: 0.0047909007626825515  
step: 37, hamming: 0.003951742881773004  
step: 38, hamming: 0.003255797494304968  
step: 39, hamming: 0.002679912466988639  
step: 40, hamming: 0.0022042177025821627  
step: 41, hamming: 0.0018118345457225505  
step: 42, hamming: 0.001488536241043407  
step: 43, hamming: 0.0012224015057432389  
step: 44, hamming: 0.0010034854919391913  
step: 45, hamming: 0.0008235205432486311

Running panda took: 1.63 seconds!

Elapsed time: 1.63 sec.

Saving LIONESS network 24 to lioness\_output using npy format:

Elapsed time: 0.03 sec.

Running LIONESS for sample 25:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.05 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6457395627686134  
step: 1, hamming: 0.6064608877070141  
step: 2, hamming: 0.6103727825941946  
step: 3, hamming: 0.5873823343108445  
step: 4, hamming: 0.5534684140947953  
step: 5, hamming: 0.5129868713457605  
step: 6, hamming: 0.4687928920384118  
step: 7, hamming: 0.42317106468860927  
step: 8, hamming: 0.37793701543032326  
step: 9, hamming: 0.33445323750400024  
step: 10, hamming: 0.2936686849697661  
step: 11, hamming: 0.2561730726924933  
step: 12, hamming: 0.22226674885043102  
step: 13, hamming: 0.19202822641393982  
step: 14, hamming: 0.16537671830260126  
step: 15, hamming: 0.14212334810171473  
step: 16, hamming: 0.1220107685282419  
step: 17, hamming: 0.10474248793357539  
step: 18, hamming: 0.0900033014058808  
step: 19, hamming: 0.07747333480760729  
step: 20, hamming: 0.06683787049330008  
step: 21, hamming: 0.057795449353665554  
step: 22, hamming: 0.05006637373531308  
step: 23, hamming: 0.04340227376591354  
step: 24, hamming: 0.037595421359931186  
step: 25, hamming: 0.03248502656477799  
step: 26, hamming: 0.027957229203086794  
step: 27, hamming: 0.023937892823722058  
step: 28, hamming: 0.02038038336070406  
step: 29, hamming: 0.017252529167439003  
step: 30, hamming: 0.014526424760499897  
step: 31, hamming: 0.012172676375081907  
step: 32, hamming: 0.010158597046433316  
step: 33, hamming: 0.00844889606081156  
step: 34, hamming: 0.007007393568975931  
step: 35, hamming: 0.005798785453088683  
step: 36, hamming: 0.00478999387390706  
step: 37, hamming: 0.003950993159323441  
step: 38, hamming: 0.0032551785601338114  
step: 39, hamming: 0.0026794020858112943

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step: 40, hamming: 0.0022037972259520604
step: 41, hamming: 0.001811488397401411
step: 42, hamming: 0.0014882514628416364
step: 43, hamming: 0.0012221673419373596
step: 44, hamming: 0.0010032930382546355
step: 45, hamming: 0.0008233624337668082
Running panda took: 1.46 seconds!
  Elapsed time: 1.46 sec.
Saving LIONESS network 25 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 26:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6454967053255309
step: 1, hamming: 0.6066220697004651
step: 2, hamming: 0.6104569962998728
step: 3, hamming: 0.5874394872323973
step: 4, hamming: 0.5535107400339879
step: 5, hamming: 0.5130174988541942
step: 6, hamming: 0.46881371156127255
step: 7, hamming: 0.423183189727278
step: 8, hamming: 0.3779417340382216
step: 9, hamming: 0.33445240537930465
step: 10, hamming: 0.29366433099533695
step: 11, hamming: 0.25616701474636144
step: 12, hamming: 0.22226007042599116
step: 13, hamming: 0.19202153205178443
step: 14, hamming: 0.16537042896642054
step: 15, hamming: 0.14211769909143143
step: 16, hamming: 0.12200588715609277
step: 17, hamming: 0.10473835923993632
step: 18, hamming: 0.08999989292935066
step: 19, hamming: 0.07747064160809622
step: 20, hamming: 0.0668358086697313
step: 21, hamming: 0.05779392045356974
step: 22, hamming: 0.0500653033441485
step: 23, hamming: 0.04340157748923955
step: 24, hamming: 0.03759501485574575
step: 25, hamming: 0.032484830736557
step: 26, hamming: 0.02795717839135787
step: 27, hamming: 0.023937933402786545
step: 28, hamming: 0.020380473632123763
step: 29, hamming: 0.017252638944378788
step: 30, hamming: 0.014526536911014595
step: 31, hamming: 0.012172781802429688

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step: 32, hamming: 0.010158691621547707
step: 33, hamming: 0.008448978359003058
step: 34, hamming: 0.007007463803651777
step: 35, hamming: 0.005798844650285859
step: 36, hamming: 0.004790043434414072
step: 37, hamming: 0.003951034364586719
step: 38, hamming: 0.0032552126647618614
step: 39, hamming: 0.0026794302159438544
step: 40, hamming: 0.002203820368039428
step: 41, hamming: 0.0018115074140994402
step: 42, hamming: 0.0014882670710365021
step: 43, hamming: 0.001222180142905843
step: 44, hamming: 0.0010033035277769954
step: 45, hamming: 0.0008233710253226156
Running panda took: 1.31 seconds!
  Elapsed time: 1.31 sec.
Saving LIONESS network 26 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 27:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.04 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6453631316746891
step: 1, hamming: 0.6065851763245883
step: 2, hamming: 0.6104687108084997
step: 3, hamming: 0.5874708414567839
step: 4, hamming: 0.553550407750318
step: 5, hamming: 0.5130590911886108
step: 6, hamming: 0.46885507018779043
step: 7, hamming: 0.42322248970490667
step: 8, hamming: 0.3779776691218549
step: 9, hamming: 0.3344846767623718
step: 10, hamming: 0.2936929239245133
step: 11, hamming: 0.25619229570609636
step: 12, hamming: 0.22228219573712402
step: 13, hamming: 0.19204076380694882
step: 14, hamming: 0.16538705195619063
step: 15, hamming: 0.1421320864636762
step: 16, hamming: 0.12201829280274731
step: 17, hamming: 0.10474902300437654
step: 18, hamming: 0.09000903326934918
step: 19, hamming: 0.07747844392157899
step: 20, hamming: 0.06684245770007373
step: 21, hamming: 0.05779957445832755
step: 22, hamming: 0.05007009118596108
step: 23, hamming: 0.04340563042618257

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step: 24, hamming: 0.03759844243481214
step: 25, hamming: 0.032487722556562154
step: 26, hamming: 0.027959603794912816
step: 27, hamming: 0.023939953980151817
step: 28, hamming: 0.020382151479531888
step: 29, hamming: 0.017254024423504023
step: 30, hamming: 0.01452767604514493
step: 31, hamming: 0.012173715629341518
step: 32, hamming: 0.010159456372537531
step: 33, hamming: 0.008449604489718605
step: 34, hamming: 0.007007976542379953
step: 35, hamming: 0.005799264728544192
step: 36, hamming: 0.004790387758916941
step: 37, hamming: 0.003951316728991019
step: 38, hamming: 0.003255444306355403
step: 39, hamming: 0.0026796202983168293
step: 40, hamming: 0.002203976375195701
step: 41, hamming: 0.0018116354595427964
step: 42, hamming: 0.0014883721681424754
step: 43, hamming: 0.001222663986386547
step: 44, hamming: 0.0010033743151023403
step: 45, hamming: 0.0008234291107443008
Running panda took: 1.40 seconds!
  Elapsed time: 1.40 sec.
Saving LIONESS network 27 to lioness_output using npy format:
  Elapsed time: 0.06 sec.
Running LIONESS for sample 28:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.05 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6451358310824151
step: 1, hamming: 0.6067202812268652
step: 2, hamming: 0.6105084509106121
step: 3, hamming: 0.5874770766110782
step: 4, hamming: 0.5535401297746914
step: 5, hamming: 0.5130406798275531
step: 6, hamming: 0.468834505899187
step: 7, hamming: 0.42320295085821286
step: 8, hamming: 0.37796147500536265
step: 9, hamming: 0.33447178250965853
step: 10, hamming: 0.29368269158902255
step: 11, hamming: 0.2561841423380478
step: 12, hamming: 0.22227561563567477
step: 13, hamming: 0.19203539669004427
step: 14, hamming: 0.16538265059792898
step: 15, hamming: 0.14212839414046055

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step: 16, hamming: 0.12201518520640055  
step: 17, hamming: 0.10474641185408667  
step: 18, hamming: 0.0900068778671942  
step: 19, hamming: 0.07747669705672466  
step: 20, hamming: 0.06684104136237137  
step: 21, hamming: 0.05779843506391113  
step: 22, hamming: 0.0500691794290296  
step: 23, hamming: 0.04340488739282701  
step: 24, hamming: 0.03759781991517671  
step: 25, hamming: 0.032487194607542826  
step: 26, hamming: 0.027959154377771425  
step: 27, hamming: 0.02393957466123415  
step: 28, hamming: 0.02038183196273885  
step: 29, hamming: 0.0172537603782067  
step: 30, hamming: 0.014527461133636087  
step: 31, hamming: 0.012173542661750416  
step: 32, hamming: 0.010159317402521097  
step: 33, hamming: 0.008449492965825199  
step: 34, hamming: 0.0070078870284569885  
step: 35, hamming: 0.005799192688495383  
step: 36, hamming: 0.004790329522725734  
step: 37, hamming: 0.003951269494190278  
step: 38, hamming: 0.0032554058740101068  
step: 39, hamming: 0.002679588945293777  
step: 40, hamming: 0.002203950746453343  
step: 41, hamming: 0.0018116144780692205  
step: 42, hamming: 0.0014883549740263417  
step: 43, hamming: 0.0012222522977348154  
step: 44, hamming: 0.0010033627438220327  
step: 45, hamming: 0.0008234196121337722

Running panda took: 1.47 seconds!

Elapsed time: 1.47 sec.

Saving LIONESS network 28 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 29:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6455351008769453  
step: 1, hamming: 0.606672749921852  
step: 2, hamming: 0.6104835041920981  
step: 3, hamming: 0.5874613800094756  
step: 4, hamming: 0.5535261027676674  
step: 5, hamming: 0.5130277394158711  
step: 6, hamming: 0.4688217647975806  
step: 7, hamming: 0.42319024909743624

step: 8, hamming: 0.3779481583579115  
step: 9, hamming: 0.3344579933187368  
step: 10, hamming: 0.29366902135579265  
step: 11, hamming: 0.25617054999127764  
step: 12, hamming: 0.22226262032373947  
step: 13, hamming: 0.19202326345396323  
step: 14, hamming: 0.16537148632869755  
step: 15, hamming: 0.142118264201008  
step: 16, hamming: 0.12200609786553838  
step: 17, hamming: 0.10473832871874272  
step: 18, hamming: 0.08999971271249907  
step: 19, hamming: 0.07747039064766185  
step: 20, hamming: 0.06683555388538215  
step: 21, hamming: 0.057793686110969834  
step: 22, hamming: 0.05006509427037561  
step: 23, hamming: 0.0434014084405363  
step: 24, hamming: 0.03759489383654498  
step: 25, hamming: 0.03248476025786066  
step: 26, hamming: 0.027957153083011842  
step: 27, hamming: 0.02393794536063863  
step: 28, hamming: 0.020380515556205  
step: 29, hamming: 0.017252700679045323  
step: 30, hamming: 0.014526608601153243  
step: 31, hamming: 0.012172855437592786  
step: 32, hamming: 0.010158762007530757  
step: 33, hamming: 0.008449042800011774  
step: 34, hamming: 0.007007520983952693  
step: 35, hamming: 0.0057988942286212805  
step: 36, hamming: 0.004790085658922592  
step: 37, hamming: 0.003951069946375388  
step: 38, hamming: 0.003255242407783724  
step: 39, hamming: 0.0026794549366581924  
step: 40, hamming: 0.0022038408329425082  
step: 41, hamming: 0.0018115242912096789  
step: 42, hamming: 0.0014882809567832705  
step: 43, hamming: 0.0012221915474429238  
step: 44, hamming: 0.0010033128856263504  
step: 45, hamming: 0.0008233786956426912  
Running panda took: 1.48 seconds!

Elapsed time: 1.48 sec.

Saving LIONESS network 29 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 30:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6441925069818978  
step: 1, hamming: 0.6063136112432318  
step: 2, hamming: 0.6103932208346182  
step: 3, hamming: 0.5874474722143483  
step: 4, hamming: 0.5535649464335758  
step: 5, hamming: 0.5130928337695615  
step: 6, hamming: 0.4688939095266525  
step: 7, hamming: 0.42325885276505987  
step: 8, hamming: 0.3780087198271526  
step: 9, hamming: 0.3345100558700422  
step: 10, hamming: 0.29371427477324347  
step: 11, hamming: 0.2562107598757153  
step: 12, hamming: 0.22229857181764945  
step: 13, hamming: 0.19205531145425267  
step: 14, hamming: 0.16539978011088832  
step: 15, hamming: 0.14214287312471557  
step: 16, hamming: 0.12202708424928997  
step: 17, hamming: 0.10475587118837182  
step: 18, hamming: 0.09001400820385419  
step: 19, hamming: 0.07748166638509849  
step: 20, hamming: 0.06684413555730546  
step: 21, hamming: 0.05779998950120317  
step: 22, hamming: 0.050069556133776956  
step: 23, hamming: 0.04340444199041316  
step: 24, hamming: 0.03759688450174655  
step: 25, hamming: 0.03248603443830073  
step: 26, hamming: 0.027957966759979882  
step: 27, hamming: 0.023938483652704984  
step: 28, hamming: 0.020380896229155798  
step: 29, hamming: 0.017252993901731097  
step: 30, hamming: 0.014526852479589947  
step: 31, hamming: 0.012173067882295998  
step: 32, hamming: 0.010158950869745383  
step: 33, hamming: 0.008449210882153614  
step: 34, hamming: 0.007007669688350223  
step: 35, hamming: 0.0057990246081408205  
step: 36, hamming: 0.0047901987375082965  
step: 37, hamming: 0.003951167141327133  
step: 38, hamming: 0.003255325350745026  
step: 39, hamming: 0.0026795253550045642  
step: 40, hamming: 0.00220390032018264  
step: 41, hamming: 0.00181157433539964  
step: 42, hamming: 0.0014883229143649352  
step: 43, hamming: 0.001222266229141624  
step: 44, hamming: 0.0010033421337824068  
step: 45, hamming: 0.0008234030345286952

Running panda took: 1.34 seconds!

Elapsed time: 1.34 sec.



Saving LIONESS network 30 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 31:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6453374894828801  
step: 1, hamming: 0.6066967069145408  
step: 2, hamming: 0.6104840389078136  
step: 3, hamming: 0.5874565733434927  
step: 4, hamming: 0.5535188219795216  
step: 5, hamming: 0.513020487378786  
step: 6, hamming: 0.46881505964233633  
step: 7, hamming: 0.4231847518707811  
step: 8, hamming: 0.37794456875278254  
step: 9, hamming: 0.33445666843682814  
step: 10, hamming: 0.29366950408238246  
step: 11, hamming: 0.25617272617649023  
step: 12, hamming: 0.2222658147874626  
step: 13, hamming: 0.1920270800407892  
step: 14, hamming: 0.1653756413311506  
step: 15, hamming: 0.14212251274972568  
step: 16, hamming: 0.12201028566869024  
step: 17, hamming: 0.10474235378727428  
step: 18, hamming: 0.09000359838145934  
step: 19, hamming: 0.07747406299496645  
step: 20, hamming: 0.06683892024429142  
step: 21, hamming: 0.05779672357526197  
step: 22, hamming: 0.05006780392032587  
step: 23, hamming: 0.043403791059584765  
step: 24, hamming: 0.03759695373852516  
step: 25, hamming: 0.032486517555771505  
step: 26, hamming: 0.027958627760509547  
step: 27, hamming: 0.023939165045318303  
step: 28, hamming: 0.020381512374332632  
step: 29, hamming: 0.017253509321226976  
step: 30, hamming: 0.01452726248992399  
step: 31, hamming: 0.01217338409078206  
step: 32, hamming: 0.01015918998360408  
step: 33, hamming: 0.008449389939631924  
step: 34, hamming: 0.007007803396138958  
step: 35, hamming: 0.00579912466367174  
step: 36, hamming: 0.004790274070575606  
step: 37, hamming: 0.0039512242592668854  
step: 38, hamming: 0.0032553690960775276  
step: 39, hamming: 0.0026795590154728125

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step: 40, hamming: 0.002203926367689019
step: 41, hamming: 0.0018115946043863235
step: 42, hamming: 0.0014883387657010927
step: 43, hamming: 0.001222390734737921
step: 44, hamming: 0.0010033519517067167
step: 45, hamming: 0.000823410802845809
Running panda took: 1.45 seconds!
  Elapsed time: 1.45 sec.
Saving LIONESS network 31 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 32:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6449746310280959
step: 1, hamming: 0.6067058332082043
step: 2, hamming: 0.6105227585080634
step: 3, hamming: 0.5874998685226731
step: 4, hamming: 0.5535644118765825
step: 5, hamming: 0.5130637409325514
step: 6, hamming: 0.46885520719749507
step: 7, hamming: 0.4232205988814208
step: 8, hamming: 0.37797509767336696
step: 9, hamming: 0.33448191453778936
step: 10, hamming: 0.2936901232265988
step: 11, hamming: 0.25618939533535684
step: 12, hamming: 0.22227946486100847
step: 13, hamming: 0.19203833582770793
step: 14, hamming: 0.16538499865483383
step: 15, hamming: 0.14213033937025302
step: 16, hamming: 0.12201684471858767
step: 17, hamming: 0.10474787876788032
step: 18, hamming: 0.09000825020978294
step: 19, hamming: 0.07747800883938391
step: 20, hamming: 0.06684228198432347
step: 21, hamming: 0.057799594299135344
step: 22, hamming: 0.050070253711365226
step: 23, hamming: 0.043405873825744117
step: 24, hamming: 0.03759871933174081
step: 25, hamming: 0.03248800162100365
step: 26, hamming: 0.027959871764145786
step: 27, hamming: 0.023940202435957004
step: 28, hamming: 0.0203823727736058
step: 29, hamming: 0.01725422092678858
step: 30, hamming: 0.014527849564486101
step: 31, hamming: 0.01217386793079806

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step: 32, hamming: 0.010159588465741652
step: 33, hamming: 0.008449718062226332
step: 34, hamming: 0.007008073488535551
step: 35, hamming: 0.005799346994199016
step: 36, hamming: 0.004790456976200907
step: 37, hamming: 0.003951374637817454
step: 38, hamming: 0.003255492594470654
step: 39, hamming: 0.0026796605246515556
step: 40, hamming: 0.002204009784151208
step: 41, hamming: 0.0018116631348835933
step: 42, hamming: 0.0014883950460219354
step: 43, hamming: 0.001222285278787714
step: 44, hamming: 0.0010033898748033553
step: 45, hamming: 0.0008234419197268525
Running panda took: 1.49 seconds!
  Elapsed time: 1.49 sec.
Saving LIONESS network 32 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 33:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.645656780846221
step: 1, hamming: 0.6066002678232713
step: 2, hamming: 0.6105813100451256
step: 3, hamming: 0.5876366440945432
step: 4, hamming: 0.5537384939042065
step: 5, hamming: 0.5132510551234207
step: 6, hamming: 0.46903516653762006
step: 7, hamming: 0.42338117383780194
step: 8, hamming: 0.3781135868865883
step: 9, hamming: 0.33459944752452325
step: 10, hamming: 0.2937892636785368
step: 11, hamming: 0.25627321887464255
step: 12, hamming: 0.22235047832920657
step: 13, hamming: 0.1920987613785881
step: 14, hamming: 0.16543669817665527
step: 15, hamming: 0.14217460617494093
step: 16, hamming: 0.12205478208053704
step: 17, hamming: 0.1047804213053023
step: 18, hamming: 0.09003612775603831
step: 19, hamming: 0.07750184049531987
step: 20, hamming: 0.06686269734372635
step: 21, hamming: 0.057817121269325866
step: 22, hamming: 0.050085333681801514
step: 23, hamming: 0.043418854271905304

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step: 24, hamming: 0.037609897086251905
step: 25, hamming: 0.03249761930169969
step: 26, hamming: 0.02796812163890966
step: 27, hamming: 0.02394725318637872
step: 28, hamming: 0.020388370931300064
step: 29, hamming: 0.01725930031609945
step: 30, hamming: 0.014532130574808764
step: 31, hamming: 0.012177459602951909
step: 32, hamming: 0.010162590210066961
step: 33, hamming: 0.008452218615141232
step: 34, hamming: 0.007010150880511294
step: 35, hamming: 0.005801068940490524
step: 36, hamming: 0.004791881667170446
step: 37, hamming: 0.003952551627023813
step: 38, hamming: 0.0032564637102903927
step: 39, hamming: 0.0026804608719384142
step: 40, hamming: 0.002204668841868316
step: 41, hamming: 0.0018122054772229607
step: 42, hamming: 0.0014888410848218324
step: 43, hamming: 0.0012226519307712387
step: 44, hamming: 0.0010036911397340626
step: 45, hamming: 0.0008236893647987569
Running panda took: 1.57 seconds!
  Elapsed time: 1.57 sec.
Saving LIONESS network 33 to lioness_output using npy format:
  Elapsed time: 0.03 sec.
Running LIONESS for sample 34:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6449981971449824
step: 1, hamming: 0.6065931831332113
step: 2, hamming: 0.6105293103087643
step: 3, hamming: 0.5875457591281373
step: 4, hamming: 0.5536260899397788
step: 5, hamming: 0.5131280856850265
step: 6, hamming: 0.4689154027720692
step: 7, hamming: 0.42327401236915707
step: 8, hamming: 0.37802087584233957
step: 9, hamming: 0.3345210485552016
step: 10, hamming: 0.2937231499498878
step: 11, hamming: 0.25621717754897094
step: 12, hamming: 0.2223028366559903
step: 13, hamming: 0.19205800982166413
step: 14, hamming: 0.16540159888503908
step: 15, hamming: 0.14214436276067294

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step: 16, hamming: 0.12202874055933112
step: 17, hamming: 0.10475804762546265
step: 18, hamming: 0.09001694647451311
step: 19, hamming: 0.07748544549209825
step: 20, hamming: 0.06684869516951136
step: 21, hamming: 0.05780513650530213
step: 22, hamming: 0.0500750561258025
step: 23, hamming: 0.04341002702171404
step: 24, hamming: 0.03760230583906534
step: 25, hamming: 0.032491088953373076
step: 26, hamming: 0.027962521329952538
step: 27, hamming: 0.02394247114838837
step: 28, hamming: 0.020384308356420206
step: 29, hamming: 0.017255866049331867
step: 30, hamming: 0.0145292430032475
step: 31, hamming: 0.012175043490551072
step: 32, hamming: 0.010160576904046068
step: 33, hamming: 0.008450545793374795
step: 34, hamming: 0.00700876423318378
step: 35, hamming: 0.005799922014886081
step: 36, hamming: 0.0047909345756680976
step: 37, hamming: 0.003951770460150725
step: 38, hamming: 0.003255820005222335
step: 39, hamming: 0.0026799308615177105
step: 40, hamming: 0.0022042327414596497
step: 41, hamming: 0.0018118468450875748
step: 42, hamming: 0.0014885463019372101
step: 43, hamming: 0.0012224097309378745
step: 44, hamming: 0.0010034922163639059
step: 45, hamming: 0.0008235260380245241
Running panda took: 1.42 seconds!
  Elapsed time: 1.42 sec.
Saving LIONESS network 34 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 35:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6426000250494666
step: 1, hamming: 0.6063071921865066
step: 2, hamming: 0.6104809784525866
step: 3, hamming: 0.5875787789957998
step: 4, hamming: 0.5536924206915095
step: 5, hamming: 0.5132239248844174
step: 6, hamming: 0.4690279451515534
step: 7, hamming: 0.4234005441297798

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step: 8, hamming: 0.37815866164971773  
step: 9, hamming: 0.3346641106844513  
step: 10, hamming: 0.29386522327545833  
step: 11, hamming: 0.25635291398589544  
step: 12, hamming: 0.22242780353078664  
step: 13, hamming: 0.1921699165297888  
step: 14, hamming: 0.16549975125668107  
step: 15, hamming: 0.14222892834479822  
step: 16, hamming: 0.12210051057291259  
step: 17, hamming: 0.10481816001497271  
step: 18, hamming: 0.0900667032672284  
step: 19, hamming: 0.07752617005100722  
step: 20, hamming: 0.0668817243872407  
step: 21, hamming: 0.0578317689475502  
step: 22, hamming: 0.05009647661533095  
step: 23, hamming: 0.04342729230869476  
step: 24, hamming: 0.037616314867588554  
step: 25, hamming: 0.03250255684979377  
step: 26, hamming: 0.027971999052752584  
step: 27, hamming: 0.023950359393898557  
step: 28, hamming: 0.020390900537206765  
step: 29, hamming: 0.017261384985951662  
step: 30, hamming: 0.014533860839728177  
step: 31, hamming: 0.01217890040608688  
step: 32, hamming: 0.010163791137853356  
step: 33, hamming: 0.008453219201499561  
step: 34, hamming: 0.007010983652762791  
step: 35, hamming: 0.0058017611584794  
step: 36, hamming: 0.004792456415076777  
step: 37, hamming: 0.003953028346447055  
step: 38, hamming: 0.0032568587382547807  
step: 39, hamming: 0.00268078789777572  
step: 40, hamming: 0.002204939377727329  
step: 41, hamming: 0.0018124290872041863  
step: 42, hamming: 0.0014890257649965678  
step: 43, hamming: 0.0012228043489239575  
step: 44, hamming: 0.001003816846444069  
step: 45, hamming: 0.000823792977083675  
Running panda took: 1.43 seconds!

Elapsed time: 1.43 sec.

Saving LIONESS network 35 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 36:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.64538220832322  
step: 1, hamming: 0.6066969273795093  
step: 2, hamming: 0.6105383132265271  
step: 3, hamming: 0.5875246652799395  
step: 4, hamming: 0.5535923400428431  
step: 5, hamming: 0.5130969212335403  
step: 6, hamming: 0.4688916302793686  
step: 7, hamming: 0.42325914937362835  
step: 8, hamming: 0.378015222114137  
step: 9, hamming: 0.33452209514331444  
step: 10, hamming: 0.2937286374246192  
step: 11, hamming: 0.25622520736811455  
step: 12, hamming: 0.22231178357995593  
step: 13, hamming: 0.1920670653122524  
step: 14, hamming: 0.16541028792801002  
step: 15, hamming: 0.14215237669006922  
step: 16, hamming: 0.12203588566680589  
step: 17, hamming: 0.10476421069641416  
step: 18, hamming: 0.09002215316977837  
step: 19, hamming: 0.07748976024988688  
step: 20, hamming: 0.06685218168838661  
step: 21, hamming: 0.05780791039379919  
step: 22, hamming: 0.050077221528608516  
step: 23, hamming: 0.0434117205050181  
step: 24, hamming: 0.037603623119995024  
step: 25, hamming: 0.03249211431074741  
step: 26, hamming: 0.027963316385545108  
step: 27, hamming: 0.023943089250558148  
step: 28, hamming: 0.020384791637139868  
step: 29, hamming: 0.017256245588859704  
step: 30, hamming: 0.014529542455540409  
step: 31, hamming: 0.012175281230148284  
step: 32, hamming: 0.010160766715614722  
step: 33, hamming: 0.008450698522426137  
step: 34, hamming: 0.007008887974781527  
step: 35, hamming: 0.005800022398900317  
step: 36, hamming: 0.004791016237650568  
step: 37, hamming: 0.003951837291752234  
step: 38, hamming: 0.00325587489135729  
step: 39, hamming: 0.0026799760260441635  
step: 40, hamming: 0.0022042699447564137  
step: 41, hamming: 0.0018118775067475124  
step: 42, hamming: 0.0014885715795620964  
step: 43, hamming: 0.0012224305718871041  
step: 44, hamming: 0.0010035093959526774  
step: 45, hamming: 0.0008235401960124153

Running panda took: 1.34 seconds!

Elapsed time: 1.34 sec.

Saving LIONESS network 36 to lioness\_output using npy format:

Elapsed time: 0.03 sec.

Running LIONESS for sample 37:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6450937603753659  
step: 1, hamming: 0.6064436660837454  
step: 2, hamming: 0.6105412861118334  
step: 3, hamming: 0.5876066009972608  
step: 4, hamming: 0.5537181506446464  
step: 5, hamming: 0.513240162239385  
step: 6, hamming: 0.46903005243019497  
step: 7, hamming: 0.4233816338164551  
step: 8, hamming: 0.37811730216131945  
step: 9, hamming: 0.33460427640855356  
step: 10, hamming: 0.2937937095904566  
step: 11, hamming: 0.2562765055577094  
step: 12, hamming: 0.2223522829719493  
step: 13, hamming: 0.19209908884148155  
step: 14, hamming: 0.16543565555984818  
step: 15, hamming: 0.14217249050227085  
step: 16, hamming: 0.12205187338509321  
step: 17, hamming: 0.10477697957160514  
step: 18, hamming: 0.09003236276240753  
step: 19, hamming: 0.07749793593084385  
step: 20, hamming: 0.06685876647177448  
step: 21, hamming: 0.057813243887915165  
step: 22, hamming: 0.0500815676624227  
step: 23, hamming: 0.04341524699674483  
step: 24, hamming: 0.03760647449990497  
step: 25, hamming: 0.032494402723185246  
step: 26, hamming: 0.027965137026658638  
step: 27, hamming: 0.023944516079917964  
step: 28, hamming: 0.020385898620171303  
step: 29, hamming: 0.0172570960909915  
step: 30, hamming: 0.014530191634674654  
step: 31, hamming: 0.012175775564193877  
step: 32, hamming: 0.010161143736087765  
step: 33, hamming: 0.008450987745447076  
step: 34, hamming: 0.007009111445933513  
step: 35, hamming: 0.0058001966698539  
step: 36, hamming: 0.004791153274172695  
step: 37, hamming: 0.003951945757724806  
step: 38, hamming: 0.003255961297104378  
step: 39, hamming: 0.0026800452215014355



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step: 40, hamming: 0.0022043256087412007
step: 41, hamming: 0.001811922446478194
step: 42, hamming: 0.0014886079619687155
step: 43, hamming: 0.0012224600919155365
step: 44, hamming: 0.0010035333901201558
step: 45, hamming: 0.0008235597257708738
Running panda took: 1.47 seconds!
  Elapsed time: 1.47 sec.
Saving LIONESS network 37 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 38:
Computing coexpression network:
  Elapsed time: 0.03 sec.
Normalizing networks:
  Elapsed time: 0.06 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6440630972479127
step: 1, hamming: 0.6065362164769551
step: 2, hamming: 0.6104532026394006
step: 3, hamming: 0.5874604045897802
step: 4, hamming: 0.5535439576972261
step: 5, hamming: 0.5130532048778697
step: 6, hamming: 0.46884617663248196
step: 7, hamming: 0.4232106291765286
step: 8, hamming: 0.37796351385560756
step: 9, hamming: 0.3344694203478319
step: 10, hamming: 0.29367784651746603
step: 11, hamming: 0.25617791005946733
step: 12, hamming: 0.2222690261377353
step: 13, hamming: 0.19202898759027917
step: 14, hamming: 0.16537677619988342
step: 15, hamming: 0.1421232526413549
step: 16, hamming: 0.12201074582554954
step: 17, hamming: 0.10474263477818664
step: 18, hamming: 0.09000370065023104
step: 19, hamming: 0.07747402152715009
step: 20, hamming: 0.06683879577708175
step: 21, hamming: 0.0577965551811048
step: 22, hamming: 0.05006760738559485
step: 23, hamming: 0.04340357349694229
step: 24, hamming: 0.03759672349751944
step: 25, hamming: 0.032486280205226196
step: 26, hamming: 0.027958392107693967
step: 27, hamming: 0.023938938938551046
step: 28, hamming: 0.02038130226939476
step: 29, hamming: 0.017253319330902392
step: 30, hamming: 0.014527095084336914
step: 31, hamming: 0.012173239529471589

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step: 32, hamming: 0.010159067354651505
step: 33, hamming: 0.008449287001086303
step: 34, hamming: 0.007007717820632078
step: 35, hamming: 0.005799053624028304
step: 36, hamming: 0.004790215055454622
step: 37, hamming: 0.003951175336782719
step: 38, hamming: 0.0032553284588682867
step: 39, hamming: 0.002679525308582267
step: 40, hamming: 0.0022038984233926826
step: 41, hamming: 0.0018115714471615197
step: 42, hamming: 0.0014883195860679434
step: 43, hamming: 0.001222231985379237
step: 44, hamming: 0.0010033388191364957
step: 45, hamming: 0.0008233999448704641
Running panda took: 1.71 seconds!
  Elapsed time: 1.71 sec.
Saving LIONESS network 38 to lioness_output using npy format:
  Elapsed time: 0.05 sec.
Running LIONESS for sample 39:
Computing coexpression network:
  Elapsed time: 0.03 sec.
Normalizing networks:
  Elapsed time: 0.05 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6450086728222191
step: 1, hamming: 0.6066279590964608
step: 2, hamming: 0.6105189710157038
step: 3, hamming: 0.5875129702246185
step: 4, hamming: 0.5535881728916275
step: 5, hamming: 0.5130942680692989
step: 6, hamming: 0.46888370874519314
step: 7, hamming: 0.4232446919415762
step: 8, hamming: 0.3779945678456299
step: 9, hamming: 0.3344972254062106
step: 10, hamming: 0.2937027228697728
step: 11, hamming: 0.2561999698599468
step: 12, hamming: 0.22228841230441748
step: 13, hamming: 0.19204594680519657
step: 14, hamming: 0.1653914528419214
step: 15, hamming: 0.1421357904234999
step: 16, hamming: 0.12202150658243802
step: 17, hamming: 0.10475182786542589
step: 18, hamming: 0.0900115144619496
step: 19, hamming: 0.077480629396115
step: 20, hamming: 0.06684439090269251
step: 21, hamming: 0.057801297739797815
step: 22, hamming: 0.050071632819650706
step: 23, hamming: 0.043407005970971885

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step: 24, hamming: 0.03759966095033141
step: 25, hamming: 0.032488803075486614
step: 26, hamming: 0.027960560323392912
step: 27, hamming: 0.02394080074258424
step: 28, hamming: 0.020382896359423756
step: 29, hamming: 0.017254678449675067
step: 30, hamming: 0.014528247886828674
step: 31, hamming: 0.012174211893688459
step: 32, hamming: 0.010159883384549461
step: 33, hamming: 0.008449969131479785
step: 34, hamming: 0.007008285718950414
step: 35, hamming: 0.005799525161101376
step: 36, hamming: 0.004790605850968227
step: 37, hamming: 0.003951498594437272
step: 38, hamming: 0.00325559543899562
step: 39, hamming: 0.002679745529938822
step: 40, hamming: 0.002204079908626591
step: 41, hamming: 0.0018117209077095206
step: 42, hamming: 0.0014884425909900134
step: 43, hamming: 0.0012223243766523934
step: 44, hamming: 0.001003422008988331
step: 45, hamming: 0.0008234683171750291
Running panda took: 1.63 seconds!
  Elapsed time: 1.63 sec.
Saving LIONESS network 39 to lioness_output using npy format:
  Elapsed time: 0.03 sec.
Running LIONESS for sample 40:
Computing coexpression network:
  Elapsed time: 0.03 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6446899829950575
step: 1, hamming: 0.6065720657385845
step: 2, hamming: 0.6104769060458073
step: 3, hamming: 0.587468913447344
step: 4, hamming: 0.553541697529604
step: 5, hamming: 0.5130476369210645
step: 6, hamming: 0.4688442859318447
step: 7, hamming: 0.42321479157426
step: 8, hamming: 0.3779745725802862
step: 9, hamming: 0.33448614616016825
step: 10, hamming: 0.2936979376976792
step: 11, hamming: 0.2561994062741515
step: 12, hamming: 0.22229019835157474
step: 13, hamming: 0.19204895567253832
step: 14, hamming: 0.16539501582991112
step: 15, hamming: 0.14213947488622694

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step: 16, hamming: 0.12202499625028415
step: 17, hamming: 0.10475511557113841
step: 18, hamming: 0.09001460630282851
step: 19, hamming: 0.07748348660857823
step: 20, hamming: 0.06684699483703208
step: 21, hamming: 0.05780364640854137
step: 22, hamming: 0.050073752658040344
step: 23, hamming: 0.04340891190950424
step: 24, hamming: 0.03760138090088408
step: 25, hamming: 0.03249034534683271
step: 26, hamming: 0.027961940282617167
step: 27, hamming: 0.02394202780317782
step: 28, hamming: 0.020383977524069206
step: 29, hamming: 0.017255623043299223
step: 30, hamming: 0.014529064889671081
step: 31, hamming: 0.012174912034662342
step: 32, hamming: 0.010160478451575828
step: 33, hamming: 0.008450471314942093
step: 34, hamming: 0.007008707096476387
step: 35, hamming: 0.005799877499710264
step: 36, hamming: 0.0047908995699176915
step: 37, hamming: 0.00395174269330924
step: 38, hamming: 0.0032557978512664297
step: 39, hamming: 0.002679913100611091
step: 40, hamming: 0.0022042184426658354
step: 41, hamming: 0.0018118352905121414
step: 42, hamming: 0.0014885369392666512
step: 43, hamming: 0.0012224021313626207
step: 44, hamming: 0.0010034860389152175
step: 45, hamming: 0.0008235210127976292
Running panda took: 1.75 seconds!
  Elapsed time: 1.75 sec.
Saving LIONESS network 40 to lioness_output using npy format:
  Elapsed time: 0.03 sec.
Running LIONESS for sample 41:
Computing coexpression network:
  Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.03 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6439588770722169
step: 1, hamming: 0.6066729641072987
step: 2, hamming: 0.610570644142953
step: 3, hamming: 0.5875671840941767
step: 4, hamming: 0.5536412525576695
step: 5, hamming: 0.5131442161431155
step: 6, hamming: 0.46893158026561005
step: 7, hamming: 0.42328943886764275

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step: 8, hamming: 0.3780348238806754  
step: 9, hamming: 0.33453258916311723  
step: 10, hamming: 0.2937325823349309  
step: 11, hamming: 0.2562249355349886  
step: 12, hamming: 0.2223091005920621  
step: 13, hamming: 0.1920630661505349  
step: 14, hamming: 0.16540567166944584  
step: 15, hamming: 0.142147668817602  
step: 16, hamming: 0.12203143924750813  
step: 17, hamming: 0.10476020433355153  
step: 18, hamming: 0.09001866866683568  
step: 19, hamming: 0.07748681890195007  
step: 20, hamming: 0.06684977392071134  
step: 21, hamming: 0.0578060040584336  
step: 22, hamming: 0.050075759807870907  
step: 23, hamming: 0.04341058715028377  
step: 24, hamming: 0.03760274175604868  
step: 25, hamming: 0.03249142680963005  
step: 26, hamming: 0.02796277245679931  
step: 27, hamming: 0.023942649977909784  
step: 28, hamming: 0.020384429573280502  
step: 29, hamming: 0.017255942798246847  
step: 30, hamming: 0.0145292867393714  
step: 31, hamming: 0.012175064147083636  
step: 32, hamming: 0.010160581814379425  
step: 33, hamming: 0.00845054093972525  
step: 34, hamming: 0.007008754041534421  
step: 35, hamming: 0.005799908869690069  
step: 36, hamming: 0.004790920217625292  
step: 37, hamming: 0.003951756159188346  
step: 38, hamming: 0.0032558065114434266  
step: 39, hamming: 0.0026799185423229273  
step: 40, hamming: 0.0022042217409228154  
step: 41, hamming: 0.0018118371780350322  
step: 42, hamming: 0.0014885379101339346  
step: 43, hamming: 0.0012224025182755501  
step: 44, hamming: 0.0010034860661721843  
step: 45, hamming: 0.0008235208251140585  
Running panda took: 1.82 seconds!

Elapsed time: 1.82 sec.

Saving LIONESS network 41 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 42:

Computing coexpression network:

Elapsed time: 0.03 sec.

Normalizing networks:

Elapsed time: 0.06 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6450900888790349  
step: 1, hamming: 0.6066516738621498  
step: 2, hamming: 0.6104985666021202  
step: 3, hamming: 0.5874788063748753  
step: 4, hamming: 0.553540130637487  
step: 5, hamming: 0.5130397114128462  
step: 6, hamming: 0.46883365127766485  
step: 7, hamming: 0.42320294317071977  
step: 8, hamming: 0.3779626905033644  
step: 9, hamming: 0.3344747386057253  
step: 10, hamming: 0.2936868597522509  
step: 11, hamming: 0.2561887985822545  
step: 12, hamming: 0.2222804132814435  
step: 13, hamming: 0.1920401220158585  
step: 14, hamming: 0.16538712296890065  
step: 15, hamming: 0.14213253273283047  
step: 16, hamming: 0.12201908520533228  
step: 17, hamming: 0.10475002765824205  
step: 18, hamming: 0.09001017467263965  
step: 19, hamming: 0.077479699555011  
step: 20, hamming: 0.0668437502548238  
step: 21, hamming: 0.057800867645357974  
step: 22, hamming: 0.05007135445772276  
step: 23, hamming: 0.04340683431558541  
step: 24, hamming: 0.03759956900963259  
step: 25, hamming: 0.03248876286486136  
step: 26, hamming: 0.02796055963694356  
step: 27, hamming: 0.02394082711040951  
step: 28, hamming: 0.020382937686533594  
step: 29, hamming: 0.01725472869077617  
step: 30, hamming: 0.014528302543333647  
step: 31, hamming: 0.01217426646707725  
step: 32, hamming: 0.010159934842999263  
step: 33, hamming: 0.008450015826353949  
step: 34, hamming: 0.007008327003644892  
step: 35, hamming: 0.005799561059886949  
step: 36, hamming: 0.004790636812690914  
step: 37, hamming: 0.003951524989153562  
step: 38, hamming: 0.0032556177779712583  
step: 39, hamming: 0.0026797643542427973  
step: 40, hamming: 0.0022040957228296318  
step: 41, hamming: 0.0018117341418863388  
step: 42, hamming: 0.0014884536410248769  
step: 43, hamming: 0.0012223335797172294  
step: 44, hamming: 0.0010034296580480636  
step: 45, hamming: 0.0008234746634137485

Running panda took: 1.63 seconds!

Elapsed time: 1.63 sec.

Saving LIONESS network 42 to lioness\_output using npy format:

Elapsed time: 0.03 sec.

Running LIONESS for sample 43:

Computing coexpression network:

Elapsed time: 0.02 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.644052761896358  
step: 1, hamming: 0.6068467935854113  
step: 2, hamming: 0.6107288577190169  
step: 3, hamming: 0.5877376684115262  
step: 4, hamming: 0.5538142766265394  
step: 5, hamming: 0.5133115341098062  
step: 6, hamming: 0.46908987086502824  
step: 7, hamming: 0.4234332320104306  
step: 8, hamming: 0.3781623554018538  
step: 9, hamming: 0.33464371916895425  
step: 10, hamming: 0.29382891080082413  
step: 11, hamming: 0.25630804132509455  
step: 12, hamming: 0.22238058991015805  
step: 13, hamming: 0.1921244069073419  
step: 14, hamming: 0.1654581795748105  
step: 15, hamming: 0.14219255890384128  
step: 16, hamming: 0.12206981536725257  
step: 17, hamming: 0.10479308912740204  
step: 18, hamming: 0.09004682418382233  
step: 19, hamming: 0.07751094005916007  
step: 20, hamming: 0.06687044755283782  
step: 21, hamming: 0.057823710017225756  
step: 22, hamming: 0.05009090857316944  
step: 23, hamming: 0.04342352724644388  
step: 24, hamming: 0.03761374284334517  
step: 25, hamming: 0.032500717866233104  
step: 26, hamming: 0.027970567103492504  
step: 27, hamming: 0.023949145946046777  
step: 28, hamming: 0.020389814594208796  
step: 29, hamming: 0.01726038967332538  
step: 30, hamming: 0.014532948325301727  
step: 31, hamming: 0.012178073966408829  
step: 32, hamming: 0.010163053860804863  
step: 33, hamming: 0.00845257088969216  
step: 34, hamming: 0.007010420899916855  
step: 35, hamming: 0.005801277650771889  
step: 36, hamming: 0.0047920442777004526  
step: 37, hamming: 0.003952679304999426  
step: 38, hamming: 0.0032565646292526955  
step: 39, hamming: 0.0026805410775311805

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step: 40, hamming: 0.002204732881227192
step: 41, hamming: 0.001812256795704004
step: 42, hamming: 0.0014888823408190444
step: 43, hamming: 0.0012226851824785948
step: 44, hamming: 0.0010037179959729236
step: 45, hamming: 0.0008237110939490818
Running panda took: 1.40 seconds!
  Elapsed time: 1.40 sec.
Saving LIONESS network 43 to lioness_output using npy format:
  Elapsed time: 0.03 sec.
Running LIONESS for sample 44:
Computing coexpression network:
  Elapsed time: 0.01 sec.
Normalizing networks:
  Elapsed time: 0.02 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6455018706675433
step: 1, hamming: 0.6066771889037847
step: 2, hamming: 0.6104927458207806
step: 3, hamming: 0.5874724098807874
step: 4, hamming: 0.5535381852036291
step: 5, hamming: 0.5130412181815369
step: 6, hamming: 0.4688357436456271
step: 7, hamming: 0.4232060516712834
step: 8, hamming: 0.3779651681944427
step: 9, hamming: 0.3344757818245871
step: 10, hamming: 0.29368699908851514
step: 11, hamming: 0.25618810836906636
step: 12, hamming: 0.22227915239937626
step: 13, hamming: 0.19203863188744116
step: 14, hamming: 0.16538554120286303
step: 15, hamming: 0.1421309400195572
step: 16, hamming: 0.12201736565539252
step: 17, hamming: 0.10474825814801286
step: 18, hamming: 0.09000844987911948
step: 19, hamming: 0.07747797083444699
step: 20, hamming: 0.06684205040520512
step: 21, hamming: 0.057799246297848224
step: 22, hamming: 0.05006983470329826
step: 23, hamming: 0.0434054377789933
step: 24, hamming: 0.03759830798077482
step: 25, hamming: 0.032487644623876356
step: 26, hamming: 0.027959585227725074
step: 27, hamming: 0.02393999328159403
step: 28, hamming: 0.020382235303793003
step: 29, hamming: 0.017254142326846075
step: 30, hamming: 0.0145278165923739
step: 31, hamming: 0.012173865559254836

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step: 32, hamming: 0.010159605065697939
step: 33, hamming: 0.008449745022944615
step: 34, hamming: 0.0070081047551232775
step: 35, hamming: 0.005799378660948919
step: 36, hamming: 0.004790486921682077
step: 37, hamming: 0.003951402165785128
step: 38, hamming: 0.00325551714323014
step: 39, hamming: 0.002679681888018422
step: 40, hamming: 0.002204028114908212
step: 41, hamming: 0.0018116787055630656
step: 42, hamming: 0.0014884081765578659
step: 43, hamming: 0.0012222962914605212
step: 44, hamming: 0.0010033990729403487
step: 45, hamming: 0.0008234495793931098
Running panda took: 1.11 seconds!
  Elapsed time: 1.11 sec.
Saving LIONESS network 44 to lioness_output using npy format:
  Elapsed time: 0.05 sec.
Running LIONESS for sample 45:
Computing coexpression network:
  Elapsed time: 0.01 sec.
Normalizing networks:
  Elapsed time: 0.02 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6451609513913849
step: 1, hamming: 0.60682301694336
step: 2, hamming: 0.6106083346123937
step: 3, hamming: 0.5875838988028538
step: 4, hamming: 0.5536474918555494
step: 5, hamming: 0.5131464111654228
step: 6, hamming: 0.46893531465023547
step: 7, hamming: 0.4232953952543082
step: 8, hamming: 0.3780435892681105
step: 9, hamming: 0.33454365128594754
step: 10, hamming: 0.29374508748769934
step: 11, hamming: 0.25623779090891435
step: 12, hamming: 0.22232178821340307
step: 13, hamming: 0.1920751280646255
step: 14, hamming: 0.16541683124420956
step: 15, hamming: 0.1421577806735096
step: 16, hamming: 0.12204047685598642
step: 17, hamming: 0.10476822857697907
step: 18, hamming: 0.09002567471379645
step: 19, hamming: 0.07749288793781219
step: 20, hamming: 0.06685499297134434
step: 21, hamming: 0.05781044528986368
step: 22, hamming: 0.050079503532131836
step: 23, hamming: 0.043413743732357984

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step: 24, hamming: 0.037605400712792725  
step: 25, hamming: 0.032493655647963006  
step: 26, hamming: 0.027964640608281126  
step: 27, hamming: 0.02394421340556936  
step: 28, hamming: 0.02038573503818736  
step: 29, hamming: 0.01725703100015745  
step: 30, hamming: 0.014530192108341453  
step: 31, hamming: 0.012175817632282378  
step: 32, hamming: 0.010161208009430479  
step: 33, hamming: 0.008451061098622103  
step: 34, hamming: 0.007009185612316628  
step: 35, hamming: 0.00580026658609169  
step: 36, hamming: 0.004791216556223985  
step: 37, hamming: 0.003952001550810154  
step: 38, hamming: 0.003256009551690285  
step: 39, hamming: 0.0026800863984453036  
step: 40, hamming: 0.0022043604008479102  
step: 41, hamming: 0.0018119516331865852  
step: 42, hamming: 0.001488632316391934  
step: 43, hamming: 0.001222480334695352  
step: 44, hamming: 0.001003550166649101  
step: 45, hamming: 0.0008235735965779479

Running panda took: 1.10 seconds!

Elapsed time: 1.10 sec.

Saving LIONESS network 45 to lioness\_output using npy format:

Elapsed time: 0.06 sec.

Running LIONESS for sample 46:

Computing coexpression network:

Elapsed time: 0.01 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6444561373205833  
step: 1, hamming: 0.6065980545917278  
step: 2, hamming: 0.6105128971327527  
step: 3, hamming: 0.5875110985863032  
step: 4, hamming: 0.553588190940493  
step: 5, hamming: 0.513091592106618  
step: 6, hamming: 0.46888363850009035  
step: 7, hamming: 0.42324816999840126  
step: 8, hamming: 0.3780016536091072  
step: 9, hamming: 0.3345068620657478  
step: 10, hamming: 0.2937130015631493  
step: 11, hamming: 0.2562101677520667  
step: 12, hamming: 0.22229782461584252  
step: 13, hamming: 0.19205431495200018  
step: 14, hamming: 0.16539873221832643  
step: 15, hamming: 0.14214201379337854

step: 16, hamming: 0.1220266912618745  
step: 17, hamming: 0.10475621059832578  
step: 18, hamming: 0.09001529971582535  
step: 19, hamming: 0.07748388708610993  
step: 20, hamming: 0.06684718843182245  
step: 21, hamming: 0.05780369052361184  
step: 22, hamming: 0.05007369620781047  
step: 23, hamming: 0.04340879060521527  
step: 24, hamming: 0.0376012098195711  
step: 25, hamming: 0.03249013651071767  
step: 26, hamming: 0.027961701647830434  
step: 27, hamming: 0.023941767943218586  
step: 28, hamming: 0.020383707109450016  
step: 29, hamming: 0.01725535251678685  
step: 30, hamming: 0.014528803438411068  
step: 31, hamming: 0.01217466719343373  
step: 32, hamming: 0.010160255136051028  
step: 33, hamming: 0.008450271975505554  
step: 34, hamming: 0.0070085325302855425  
step: 35, hamming: 0.005799726752184737  
step: 36, hamming: 0.004790770756328508  
step: 37, hamming: 0.003951633741495327  
step: 38, hamming: 0.003255706284492107  
step: 39, hamming: 0.002679836512915268  
step: 40, hamming: 0.0022041546289165003  
step: 41, hamming: 0.001811782285088026  
step: 42, hamming: 0.0014884930203235185  
step: 43, hamming: 0.0012223658117307841  
step: 44, hamming: 0.001003456049299198  
step: 45, hamming: 0.0008234962794548331

Running panda took: 1.19 seconds!

Elapsed time: 1.19 sec.

Saving LIONESS network 46 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 47:

Computing coexpression network:

Elapsed time: 0.01 sec.

Normalizing networks:

Elapsed time: 0.02 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6451094435014055  
step: 1, hamming: 0.6067224879320419  
step: 2, hamming: 0.6104855876766591  
step: 3, hamming: 0.5874302260560214  
step: 4, hamming: 0.5534812095958548  
step: 5, hamming: 0.5129821856517685  
step: 6, hamming: 0.46878098398796686  
step: 7, hamming: 0.42315657041730403

step: 8, hamming: 0.3779239978979505  
step: 9, hamming: 0.3344427227132656  
step: 10, hamming: 0.29366102731476706  
step: 11, hamming: 0.25616821630801284  
step: 12, hamming: 0.22226395137122443  
step: 13, hamming: 0.19202681658475132  
step: 14, hamming: 0.16537625986764548  
step: 15, hamming: 0.1421235728034832  
step: 16, hamming: 0.12201150665910697  
step: 17, hamming: 0.10474353103231468  
step: 18, hamming: 0.09000454950906786  
step: 19, hamming: 0.07747470953904385  
step: 20, hamming: 0.06683930742299432  
step: 21, hamming: 0.0577968871587979  
step: 22, hamming: 0.050067790022936765  
step: 23, hamming: 0.04340365566162159  
step: 24, hamming: 0.03759676223186337  
step: 25, hamming: 0.03248631716762015  
step: 26, hamming: 0.027958452078804107  
step: 27, hamming: 0.023939028616903366  
step: 28, hamming: 0.020381419449167232  
step: 29, hamming: 0.017253456558720872  
step: 30, hamming: 0.014527240970954446  
step: 31, hamming: 0.012173384845798182  
step: 32, hamming: 0.010159205498888376  
step: 33, hamming: 0.008449414288126912  
step: 34, hamming: 0.007007832514285143  
step: 35, hamming: 0.005799155320694112  
step: 36, hamming: 0.0047903042325213785  
step: 37, hamming: 0.003951252628490434  
step: 38, hamming: 0.0032553948817023257  
step: 39, hamming: 0.0026795820184424913  
step: 40, hamming: 0.0022039466024797332  
step: 41, hamming: 0.0018116122118621097  
step: 42, hamming: 0.001488353952046178  
step: 43, hamming: 0.001222520794900526  
step: 44, hamming: 0.0010033630290072102  
step: 45, hamming: 0.0008234201909991941  
Running panda took: 1.47 seconds!

Elapsed time: 1.47 sec.

Saving LIONESS network 47 to lioness\_output using npy format:

Elapsed time: 0.02 sec.

Running LIONESS for sample 48:

Computing coexpression network:

Elapsed time: 0.04 sec.

Normalizing networks:

Elapsed time: 0.04 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6450729208857102  
step: 1, hamming: 0.6063501512150873  
step: 2, hamming: 0.6103715026046174  
step: 3, hamming: 0.5874284484527396  
step: 4, hamming: 0.5535259596516843  
step: 5, hamming: 0.513054704775382  
step: 6, hamming: 0.4688708582148043  
step: 7, hamming: 0.42325992634308324  
step: 8, hamming: 0.37803721253202954  
step: 9, hamming: 0.33456092176953284  
step: 10, hamming: 0.29377908789293194  
step: 11, hamming: 0.25628124480181685  
step: 12, hamming: 0.22236874382375207  
step: 13, hamming: 0.19212159497551798  
step: 14, hamming: 0.165460467724724  
step: 15, hamming: 0.1421972940894272  
step: 16, hamming: 0.12207523597375464  
step: 17, hamming: 0.10479810759599201  
step: 18, hamming: 0.09005092233539186  
step: 19, hamming: 0.07751386224984219  
step: 20, hamming: 0.06687216133585415  
step: 21, hamming: 0.05782432168099327  
step: 22, hamming: 0.050090599604048575  
step: 23, hamming: 0.04342254449049325  
step: 24, hamming: 0.03761235473029859  
step: 25, hamming: 0.03249915130287423  
step: 26, hamming: 0.027968991909988243  
step: 27, hamming: 0.023947673742928513  
step: 28, hamming: 0.02038850792929859  
step: 29, hamming: 0.01725926821592624  
step: 30, hamming: 0.01453200904050933  
step: 31, hamming: 0.012177299988630045  
step: 32, hamming: 0.010162422517800813  
step: 33, hamming: 0.008452059415929542  
step: 34, hamming: 0.007010008256905795  
step: 35, hamming: 0.005800945322716098  
step: 36, hamming: 0.004791776880461754  
step: 37, hamming: 0.003952464204685849  
step: 38, hamming: 0.003256391557054846  
step: 39, hamming: 0.002680401761524582  
step: 40, hamming: 0.0022046206611944417  
step: 41, hamming: 0.0018121663562190118  
step: 42, hamming: 0.0014888093898348762  
step: 43, hamming: 0.0012226262844574846  
step: 44, hamming: 0.0010036704002436745  
step: 45, hamming: 0.0008236725986009702

Running panda took: 1.82 seconds!

Elapsed time: 1.82 sec.

Saving LIONESS network 48 to lioness\_output using npy format:

Elapsed time: 0.10 sec.

Running LIONESS for sample 49:

Computing coexpression network:

Elapsed time: 0.04 sec.

Normalizing networks:

Elapsed time: 0.03 sec.

Inferring LIONESS network:

step: 0, hamming: 0.6450184972229365  
step: 1, hamming: 0.6068240235253974  
step: 2, hamming: 0.6105965948530254  
step: 3, hamming: 0.5875567675582667  
step: 4, hamming: 0.5536089018867548  
step: 5, hamming: 0.5130991941025522  
step: 6, hamming: 0.4688833696500004  
step: 7, hamming: 0.42324358671229345  
step: 8, hamming: 0.3779936855263689  
step: 9, hamming: 0.334497167054918  
step: 10, hamming: 0.29370268379408965  
step: 11, hamming: 0.2561996389154925  
step: 12, hamming: 0.22228779180603883  
step: 13, hamming: 0.19204512280533334  
step: 14, hamming: 0.165390605047534  
step: 15, hamming: 0.14213514394319682  
step: 16, hamming: 0.12202099792941379  
step: 17, hamming: 0.1047515095155968  
step: 18, hamming: 0.09001138629352734  
step: 19, hamming: 0.07748073876203371  
step: 20, hamming: 0.06684470509459198  
step: 21, hamming: 0.057801763448754456  
step: 22, hamming: 0.05007220261612099  
step: 23, hamming: 0.043407622810912906  
step: 24, hamming: 0.03760028270759244  
step: 25, hamming: 0.03248939173711593  
step: 26, hamming: 0.027961098540398806  
step: 27, hamming: 0.023941274385556592  
step: 28, hamming: 0.020383301206956795  
step: 29, hamming: 0.01725501788997063  
step: 30, hamming: 0.014528528671629803  
step: 31, hamming: 0.012174442900517382  
step: 32, hamming: 0.010160072735999443  
step: 33, hamming: 0.008450124179654742  
step: 34, hamming: 0.007008412715800017  
step: 35, hamming: 0.005799629423267298  
step: 36, hamming: 0.004790691480475807  
step: 37, hamming: 0.003951568960336357  
step: 38, hamming: 0.0032556533190094545  
step: 39, hamming: 0.002679793182593864

```

step: 40, hamming: 0.0022041191628976997
step: 41, hamming: 0.0018117532364711271
step: 42, hamming: 0.0014884692131398446
step: 43, hamming: 0.0012223462917056505
step: 44, hamming: 0.0010034400411097599
step: 45, hamming: 0.0008234831485799553
Running panda took: 1.69 seconds!
  Elapsed time: 1.69 sec.
Saving LIONESS network 49 to lioness_output using npy format:
  Elapsed time: 0.02 sec.
Running LIONESS for sample 50:
Computing coexpression network:
  Elapsed time: 0.03 sec.
Normalizing networks:
  Elapsed time: 0.05 sec.
Inferring LIONESS network:
step: 0, hamming: 0.6452671619076494
step: 1, hamming: 0.6066848794849177
step: 2, hamming: 0.610527587312023
step: 3, hamming: 0.5875201390790639
step: 4, hamming: 0.5535905216591732
step: 5, hamming: 0.5130937685955773
step: 6, hamming: 0.46888589482515114
step: 7, hamming: 0.42325035103333314
step: 8, hamming: 0.3780020754008558
step: 9, hamming: 0.33450587862635867
step: 10, hamming: 0.29371071766895035
step: 11, hamming: 0.2562069560043886
step: 12, hamming: 0.22229411692149156
step: 13, hamming: 0.1920505169749237
step: 14, hamming: 0.16539508199998465
step: 15, hamming: 0.14213872037052777
step: 16, hamming: 0.12202392388371457
step: 17, hamming: 0.10475390584465225
step: 18, hamming: 0.09001338394595736
step: 19, hamming: 0.07748237123447736
step: 20, hamming: 0.0668460176169171
step: 21, hamming: 0.0578028088348542
step: 22, hamming: 0.050073032857744684
step: 23, hamming: 0.04340828693081746
step: 24, hamming: 0.03760082097488881
step: 25, hamming: 0.03248982737352425
step: 26, hamming: 0.027961447158616017
step: 27, hamming: 0.02394155483809075
step: 28, hamming: 0.020383526490059086
step: 29, hamming: 0.017255198122503472
step: 30, hamming: 0.014528673059252924
step: 31, hamming: 0.01217455915612517

```

```

step: 32, hamming: 0.01016016655328855
step: 33, hamming: 0.008450200171028089
step: 34, hamming: 0.00700847469606477
step: 35, hamming: 0.005799679944846653
step: 36, hamming: 0.004790732721068612
step: 37, hamming: 0.003951602686458481
step: 38, hamming: 0.003255680919601843
step: 39, hamming: 0.002679815808328271
step: 40, hamming: 0.0022041377219136423
step: 41, hamming: 0.0018117684679712833
step: 42, hamming: 0.0014884817149678213
step: 43, hamming: 0.001222356555124916
step: 44, hamming: 0.0010034484651433174
step: 45, hamming: 0.0008234900629489587
Running panda took: 1.50 seconds!
Elapsed time: 1.50 sec.
Saving LIONESS network 50 to lioness_output using npy format:
Elapsed time: 0.02 sec.

```

## 1.7 7. Run Lioness with co-expression matrix

Lioness can work with co-expression matrix. To compute Lioness with coexpression matrix, we can set motif data to None:

```

[15]: motif = None

# Make sure to keep expression matrix for next step
panda_obj = Panda('netZooPy/tests/ToyData/ToyExpressionData.txt',
                  None,
                  'netZooPy/tests/ToyData/ToyPPIData.txt',
                  save_tmp=True,
                  remove_missing=False,
                  keep_expression_matrix=True)
lioness_obj = Lioness(panda_obj)

```

```

Loading expression data ...
Expression matrix: (1000, 50)
Elapsed time: 0.02 sec.
Loading PPI data ...
Number of PPIs: 238
Elapsed time: 0.01 sec.
Calculating coexpression network ...
Elapsed time: 0.03 sec.
Returning the correlation matrix of expression data in
<Panda_obj>.correlation_matrix
Loading input data ...
Elapsed time: 0.00 sec.
Running LIONESS for sample 1:
Computing coexpression network:

```



Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 1 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 2:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.18 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 2 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 3:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 3 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 4:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.07 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 4 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 5:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.05 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 5 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 6:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.

Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 6 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 7:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.09 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 7 to lioness\_output using npy format:  
Elapsed time: 0.06 sec.  
Running LIONESS for sample 8:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 8 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 9:  
Computing coexpression network:  
Elapsed time: 0.04 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 9 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 10:  
Computing coexpression network:  
Elapsed time: 0.04 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 10 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 11:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 11 to lioness\_output using npy format:

Elapsed time: 0.04 sec.  
Running LIONESS for sample 12:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 12 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 13:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 13 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 14:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 14 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 15:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 15 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 16:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 16 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 17:  
Computing coexpression network:

Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 17 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 18:  
Computing coexpression network:  
Elapsed time: 0.04 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 18 to lioness\_output using npy format:  
Elapsed time: 0.03 sec.  
Running LIONESS for sample 19:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 19 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 20:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 20 to lioness\_output using npy format:  
Elapsed time: 0.03 sec.  
Running LIONESS for sample 21:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 21 to lioness\_output using npy format:  
Elapsed time: 0.03 sec.  
Running LIONESS for sample 22:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.05 sec.

Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 22 to lioness\_output using npy format:  
Elapsed time: 0.03 sec.  
Running LIONESS for sample 23:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 23 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 24:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 24 to lioness\_output using npy format:  
Elapsed time: 0.06 sec.  
Running LIONESS for sample 25:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 25 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 26:  
Computing coexpression network:  
Elapsed time: 0.04 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 26 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 27:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 27 to lioness\_output using npy format:

Elapsed time: 0.07 sec.  
Running LIONESS for sample 28:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 28 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 29:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 29 to lioness\_output using npy format:  
Elapsed time: 0.08 sec.  
Running LIONESS for sample 30:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 30 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 31:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 31 to lioness\_output using npy format:  
Elapsed time: 0.03 sec.  
Running LIONESS for sample 32:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 32 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 33:  
Computing coexpression network:

Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 33 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 34:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 34 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 35:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 35 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 36:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 36 to lioness\_output using npy format:  
Elapsed time: 0.06 sec.  
Running LIONESS for sample 37:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.04 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 37 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 38:  
Computing coexpression network:  
Elapsed time: 0.06 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.

Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 38 to lioness\_output using npy format:  
Elapsed time: 0.06 sec.  
Running LIONESS for sample 39:  
Computing coexpression network:  
Elapsed time: 0.02 sec.  
Normalizing networks:  
Elapsed time: 0.03 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 39 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 40:  
Computing coexpression network:  
Elapsed time: 0.04 sec.  
Normalizing networks:  
Elapsed time: 0.08 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 40 to lioness\_output using npy format:  
Elapsed time: 0.08 sec.  
Running LIONESS for sample 41:  
Computing coexpression network:  
Elapsed time: 0.04 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 41 to lioness\_output using npy format:  
Elapsed time: 0.04 sec.  
Running LIONESS for sample 42:  
Computing coexpression network:  
Elapsed time: 0.04 sec.  
Normalizing networks:  
Elapsed time: 0.07 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 42 to lioness\_output using npy format:  
Elapsed time: 0.09 sec.  
Running LIONESS for sample 43:  
Computing coexpression network:  
Elapsed time: 0.05 sec.  
Normalizing networks:  
Elapsed time: 0.07 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 43 to lioness\_output using npy format:



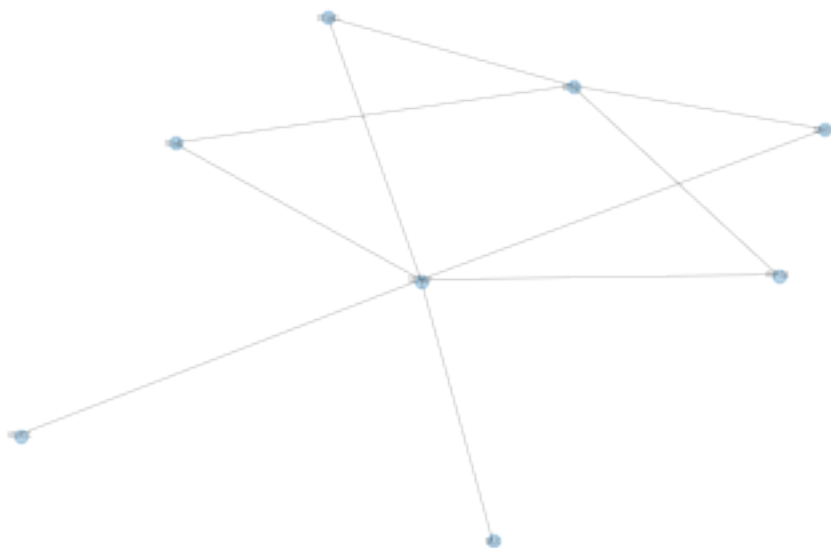
Elapsed time: 0.06 sec.  
Running LIONESS for sample 44:  
Computing coexpression network:  
Elapsed time: 0.05 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 44 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 45:  
Computing coexpression network:  
Elapsed time: 0.04 sec.  
Normalizing networks:  
Elapsed time: 0.08 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 45 to lioness\_output using npy format:  
Elapsed time: 0.06 sec.  
Running LIONESS for sample 46:  
Computing coexpression network:  
Elapsed time: 0.03 sec.  
Normalizing networks:  
Elapsed time: 0.06 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 46 to lioness\_output using npy format:  
Elapsed time: 0.05 sec.  
Running LIONESS for sample 47:  
Computing coexpression network:  
Elapsed time: 0.05 sec.  
Normalizing networks:  
Elapsed time: 0.08 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 47 to lioness\_output using npy format:  
Elapsed time: 0.06 sec.  
Running LIONESS for sample 48:  
Computing coexpression network:  
Elapsed time: 0.08 sec.  
Normalizing networks:  
Elapsed time: 0.08 sec.  
Inferring LIONESS network:  
Elapsed time: 0.00 sec.  
Saving LIONESS network 48 to lioness\_output using npy format:  
Elapsed time: 0.08 sec.  
Running LIONESS for sample 49:  
Computing coexpression network:

```
Elapsed time: 0.02 sec.
Normalizing networks:
  Elapsed time: 0.04 sec.
Inferring LIONESS network:
  Elapsed time: 0.00 sec.
Saving LIONESS network 49 to lioness_output using npy format:
  Elapsed time: 0.08 sec.
Running LIONESS for sample 50:
Computing coexpression network:
  Elapsed time: 0.03 sec.
Normalizing networks:
  Elapsed time: 0.06 sec.
Inferring LIONESS network:
  Elapsed time: 0.00 sec.
Saving LIONESS network 50 to lioness_output using npy format:
  Elapsed time: 0.08 sec.
```

## 1.8 8. Visualize Lioness results

AnalyzeLioness() can be used to visualize lioness network. You may select only the top genes to be visualized in the graph. In current version of Lioness. Only the network of the first sample will be visualized using `.top_network_plot()` function.

```
[19]: analyze_lioness_obj = AnalyzeLioness(lioness_obj)
      analyze_lioness_obj.top_network_plot(top = 10, file = "lioness_top_10.png")
```



## 1.9 9. Save Lioness results

We can save Lioness results by using `save_lioness_results()` method of the Lioness object. The edge weights of Lioness predictions will be saved into output file. We can get TF and target IDs from the `.export_panda_results` property of Panda object. Each row correspond to a row in the Lioness output file.

```
[20]: panda_obj.export_panda_results
```

```
[20]:      tf      gene motif      force
0      AHR    AACSL    0.0 -53.984356
1       AR    AACSL    0.0  27.276521
2    ARID3A    AACSL    1.0 -64.531519
3      ARNT    AACSL    1.0 -70.183704
4     BRCA1    AACSL    0.0 -57.854191
...     ...     ...     ...     ...
86995   TLX1  ZWILCH    0.0  15.673701
86996   TP53  ZWILCH    0.0  23.789647
86997   USF1  ZWILCH    0.0  -6.855873
86998    VDR  ZWILCH    0.0  20.885728
86999    YY1  ZWILCH    1.0 -80.408914
```

```
[87000 rows x 4 columns]
```

```
[21]: lioness_obj.save_lioness_results(file = 'lioness.txt')
```

## 1.10 References

Kuijjer ML, Tung MG, Yuan GC, Quackenbush J, Glass K: Estimating Sample-Specific Regulatory Networks. iScience 2019.