
IT'S A SMALL WORLD!

Manhattan School of Music

Upon the recommendation of the Faculty and by the authority of the

Board of Trustees, this Institution has conferred upon

Devon Carlisle Estes

the degree of

Master of Music

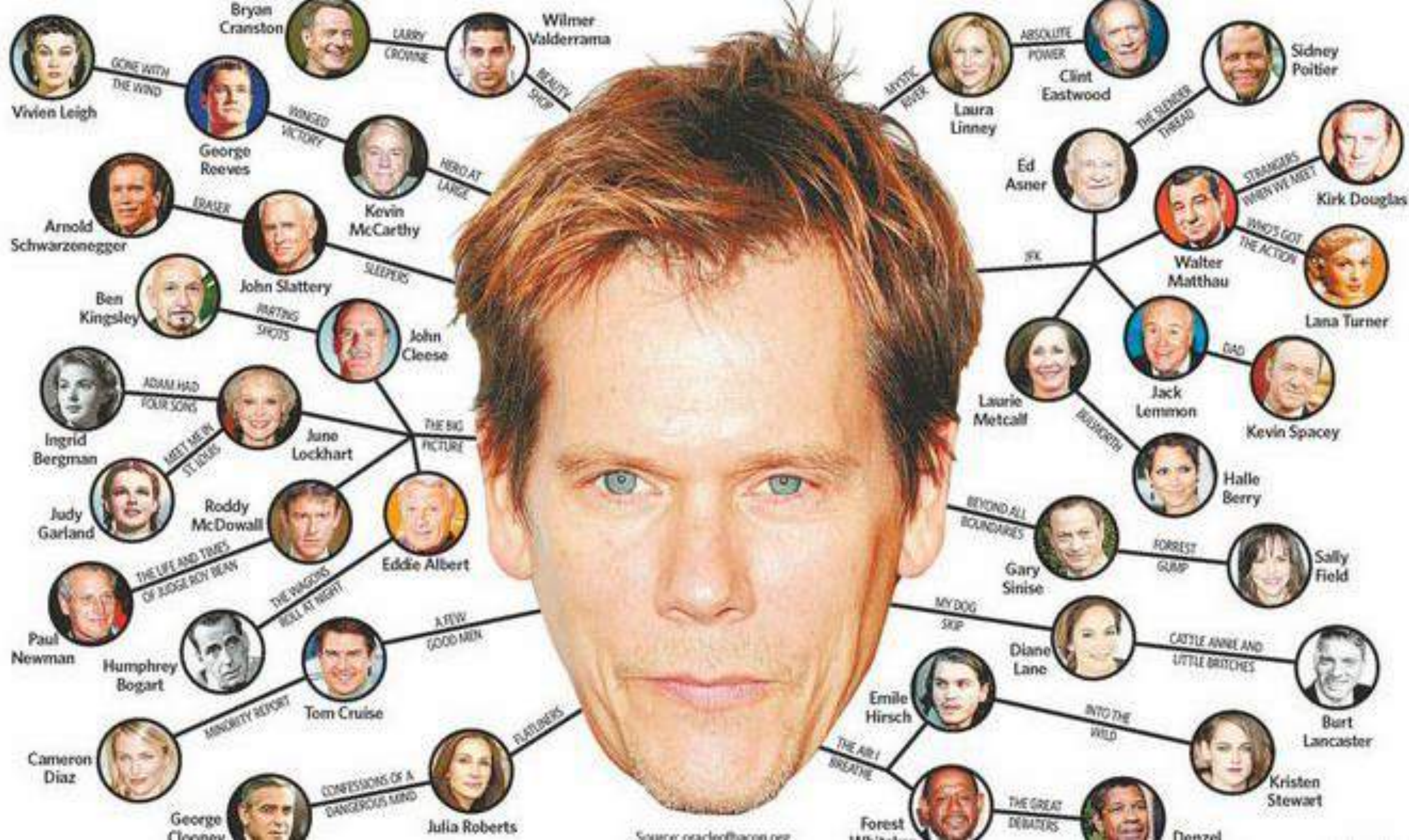
with all the rights, privileges and honors thereunto appertaining.

In witness whereof, the authorities of the Manhattan School of Music have affixed their signatures

this thirty-first day of May, two thousand and nine.







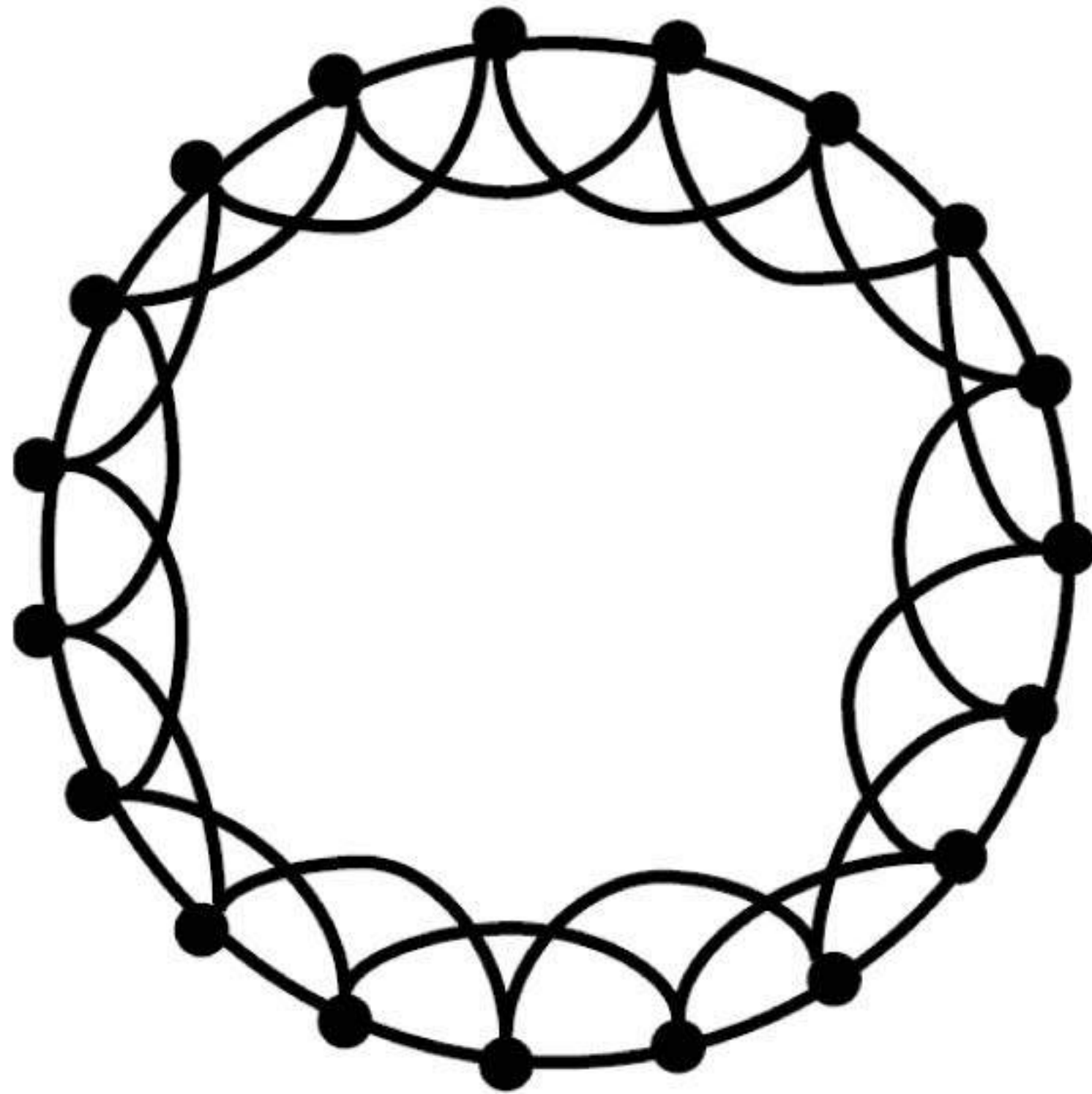


Duncan Watts

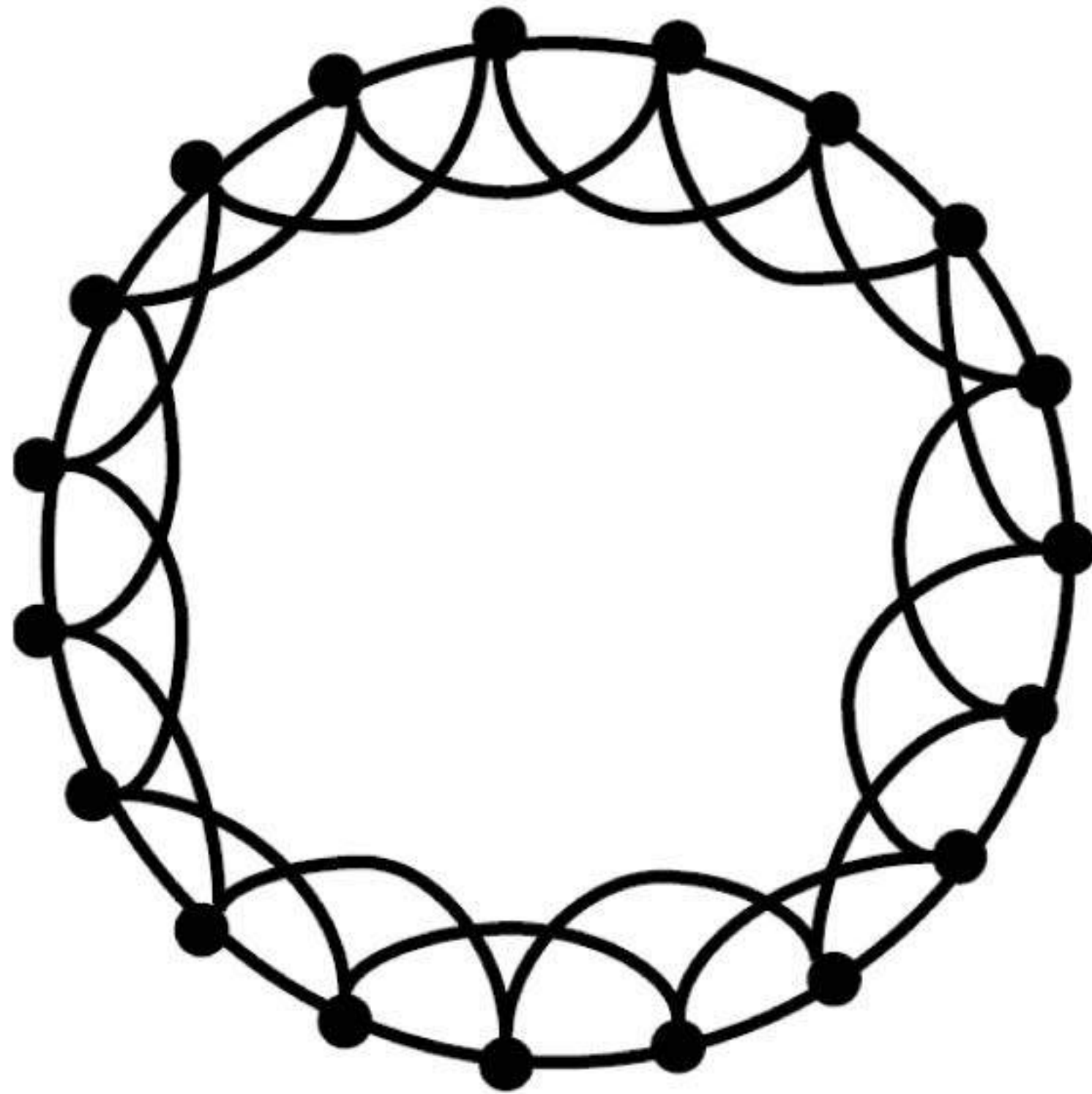


Steven Strogatz

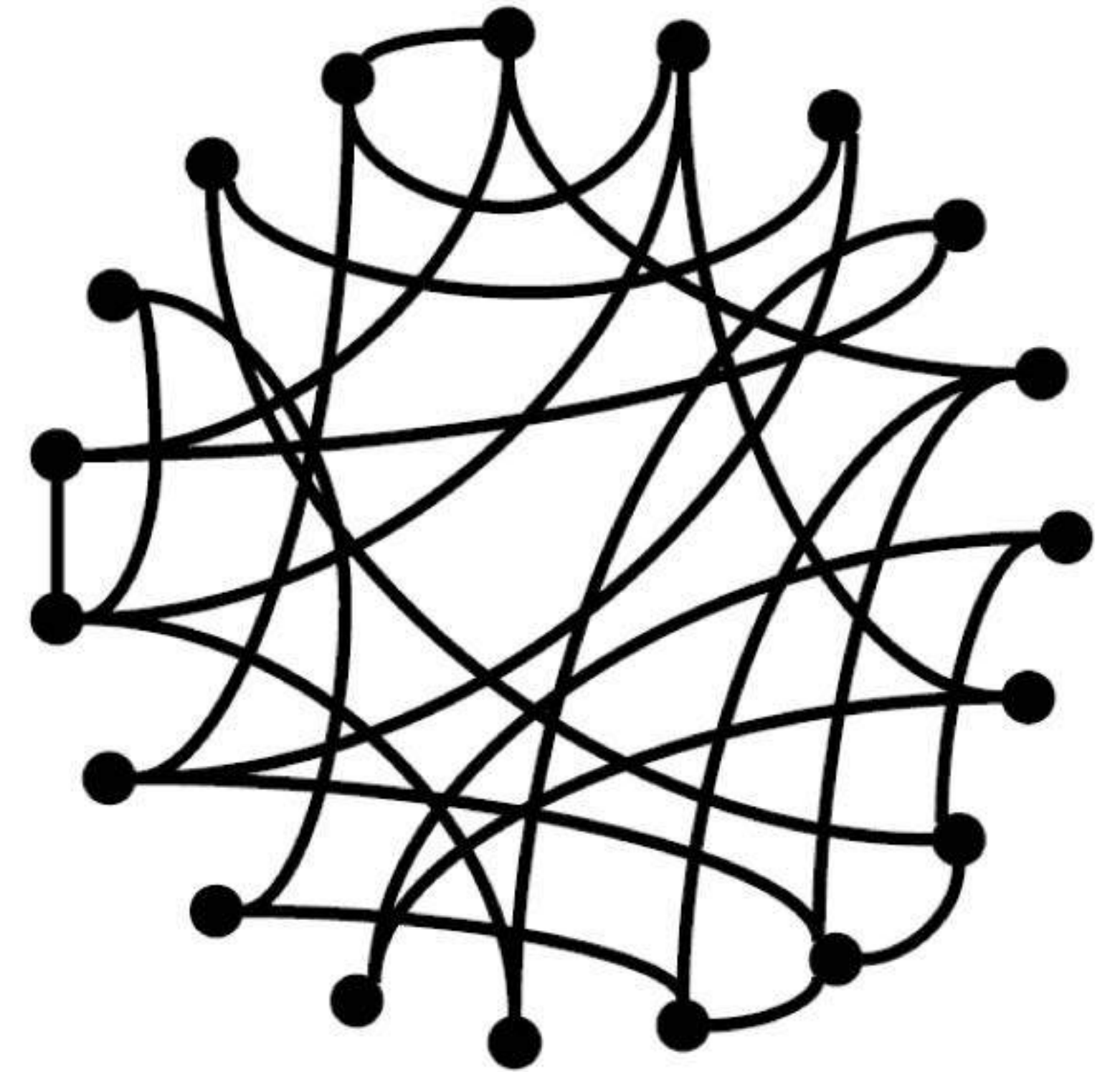
regular



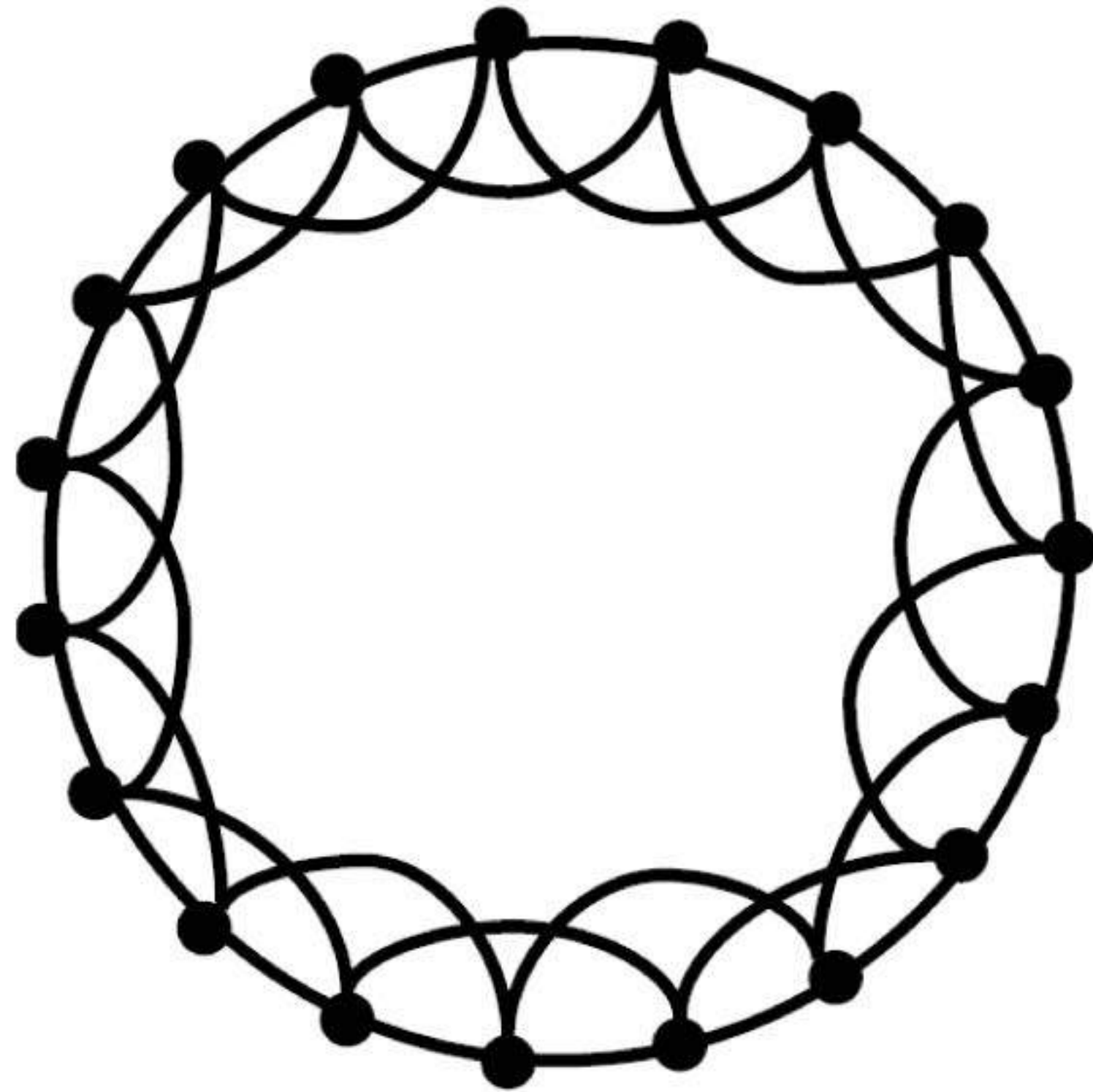
regular



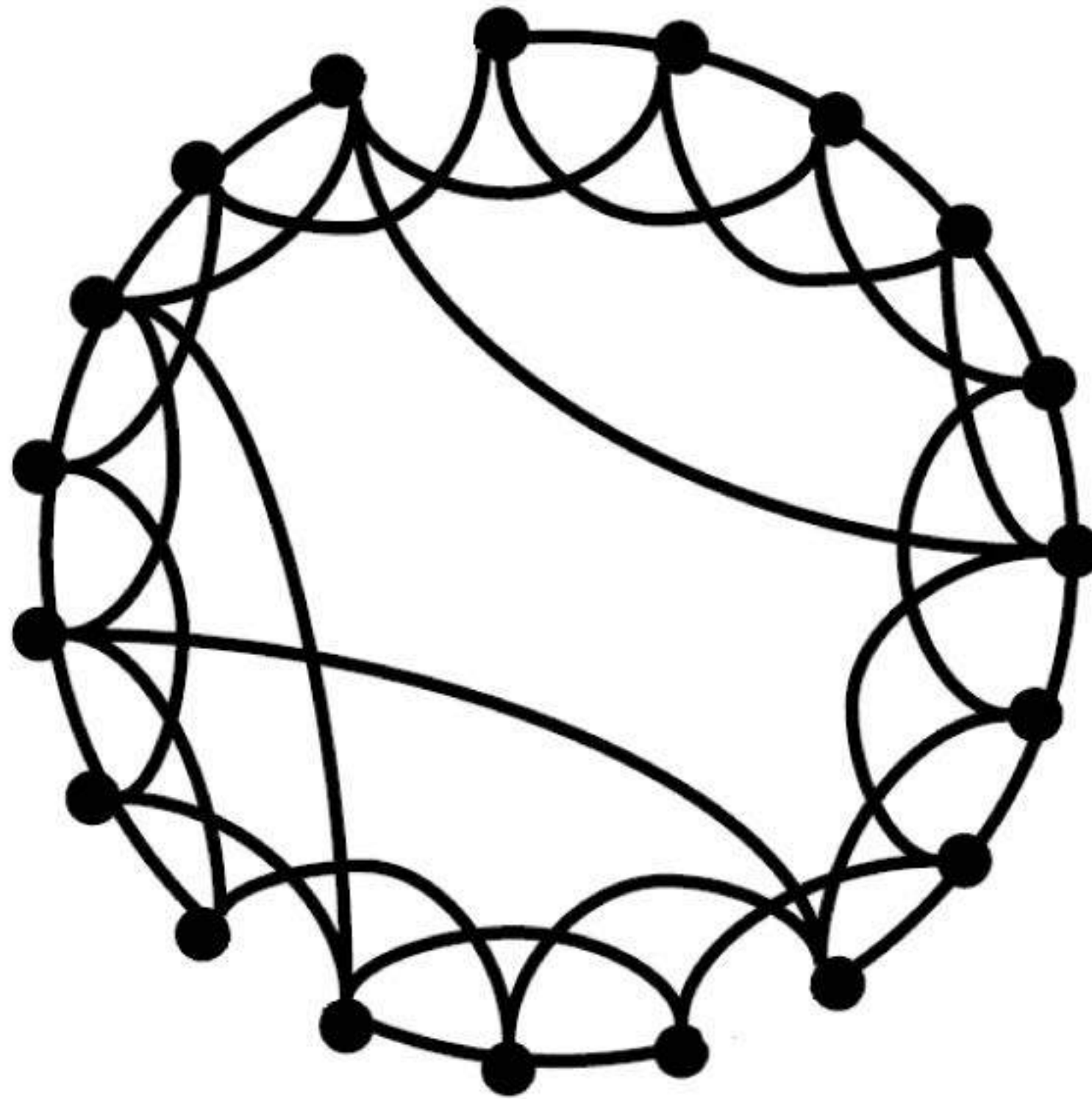
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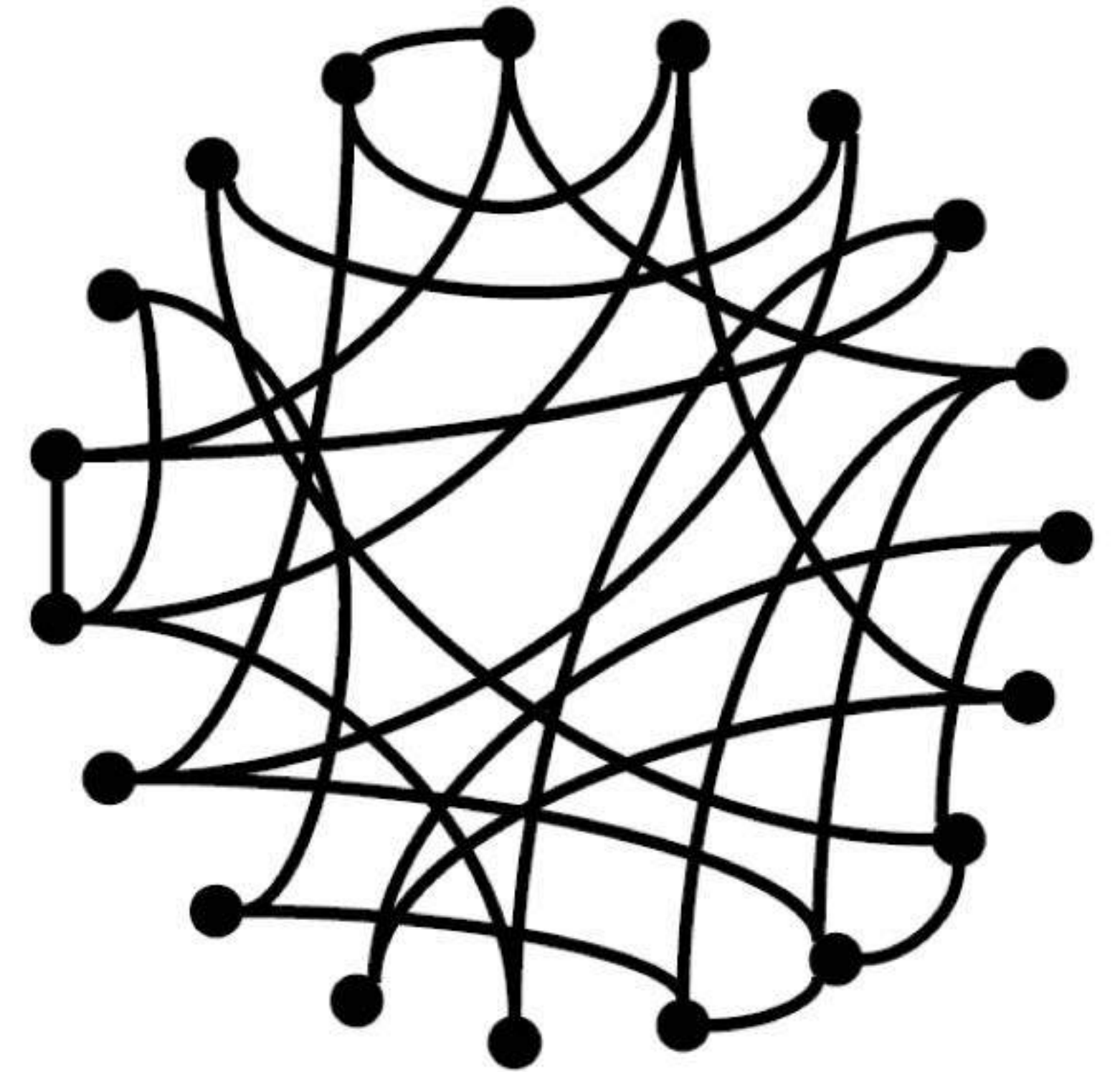
regular



small-world



random



$\beta = 0$

Increasing randomness

$\beta = 1$

CALCULATING A CLUSTERING COEFFICIENT

CALCULATING A CLUSTERING COEFFICIENT

$$C_i = \frac{2|\{e_{jk} : v_j, v_k \in N_i, e_{jk} \in E\}|}{k_i(k_i - 1)}.$$

CALCULATING A CLUSTERING COEFFICIENT

$$C_i = \frac{2|\{e_{jk} : v_j, v_k \in N_i, e_{jk} \in E\}|}{k_i(k_i - 1)}.$$

$$\bar{C} = \frac{1}{n} \sum_{i=1}^n C_i.$$

CALCULATING A CLUSTERING COEFFICIENT

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CALCULATING A CLUSTERING COEFFICIENT

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- For a single node:

CALCULATING A CLUSTERING COEFFICIENT

- For a single node:
 - How many neighbors do I have?

CALCULATING A CLUSTERING COEFFICIENT

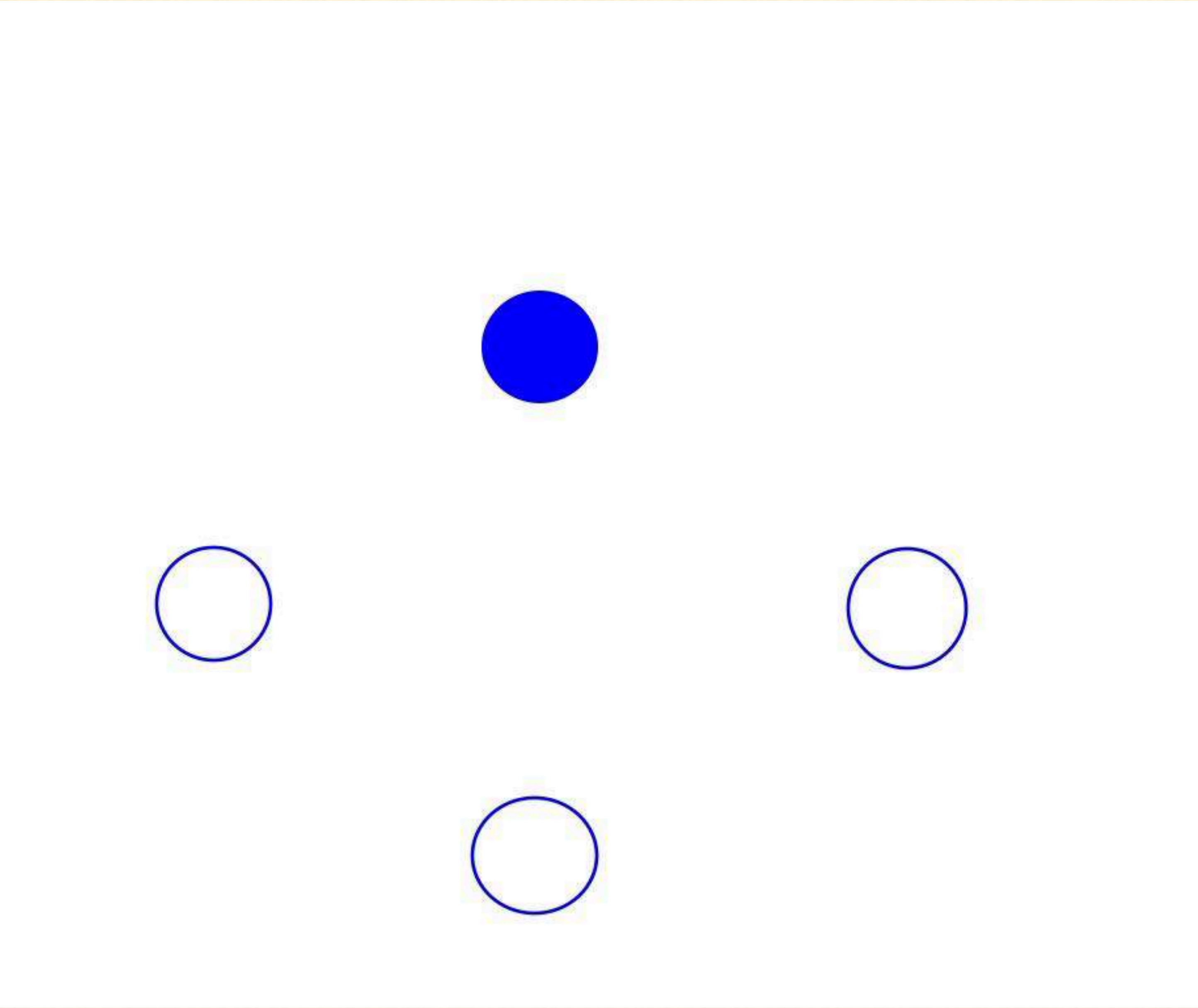
- For a single node:
 - How many neighbors do I have?
 - How many possible connections are there between my neighbors?

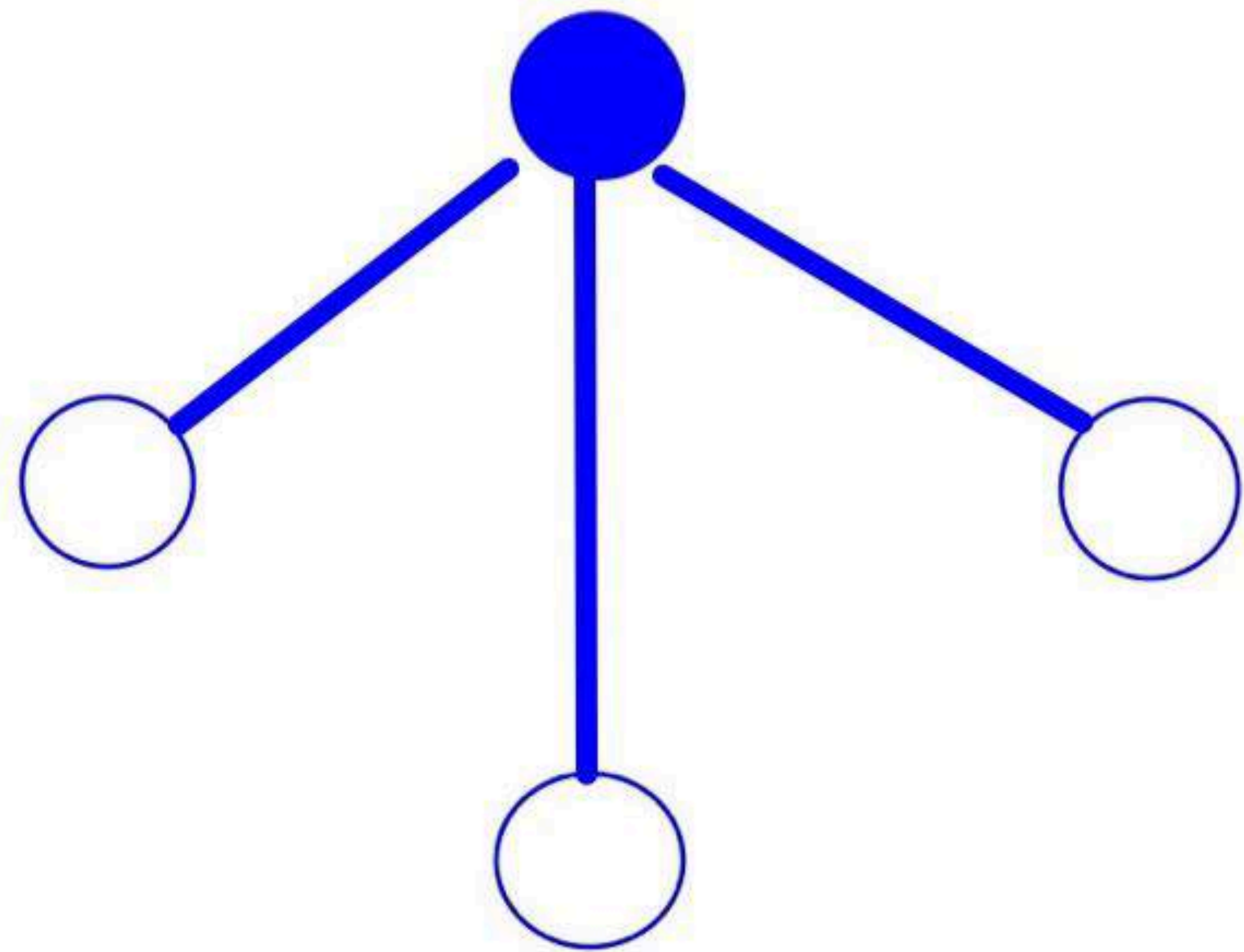
CALCULATING A CLUSTERING COEFFICIENT

- For a single node:
 - How many neighbors do I have?
 - How many possible connections are there between my neighbors?
 - How many actual connections are there between my neighbors?

CALCULATING A CLUSTERING COEFFICIENT

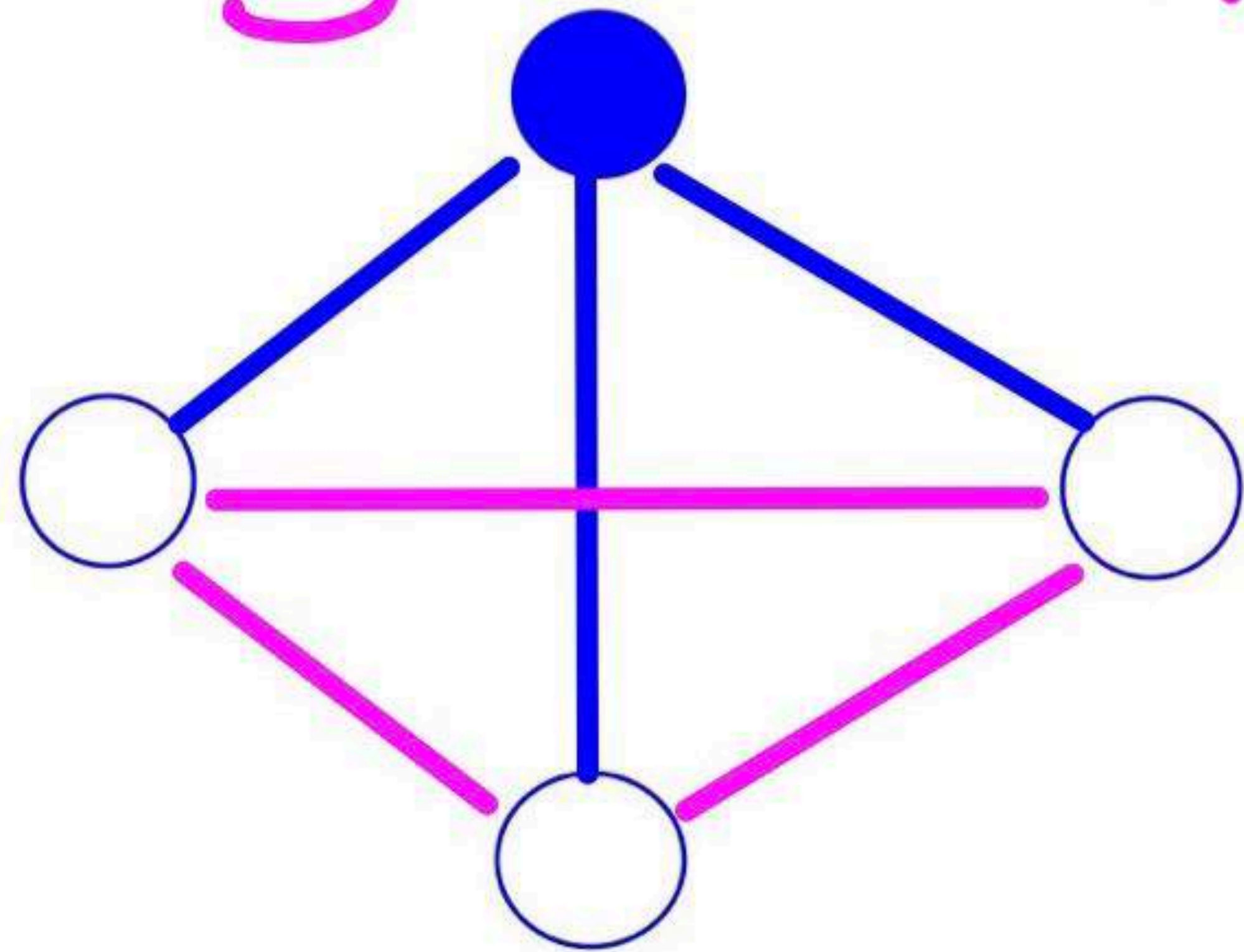
- For a single node:
 - How many neighbors do I have?
 - How many possible connections are there between my neighbors?
 - How many actual connections are there between my neighbors?
 - $\text{Clustering coefficient} = \text{Actual connections} / \text{Possible connections}$



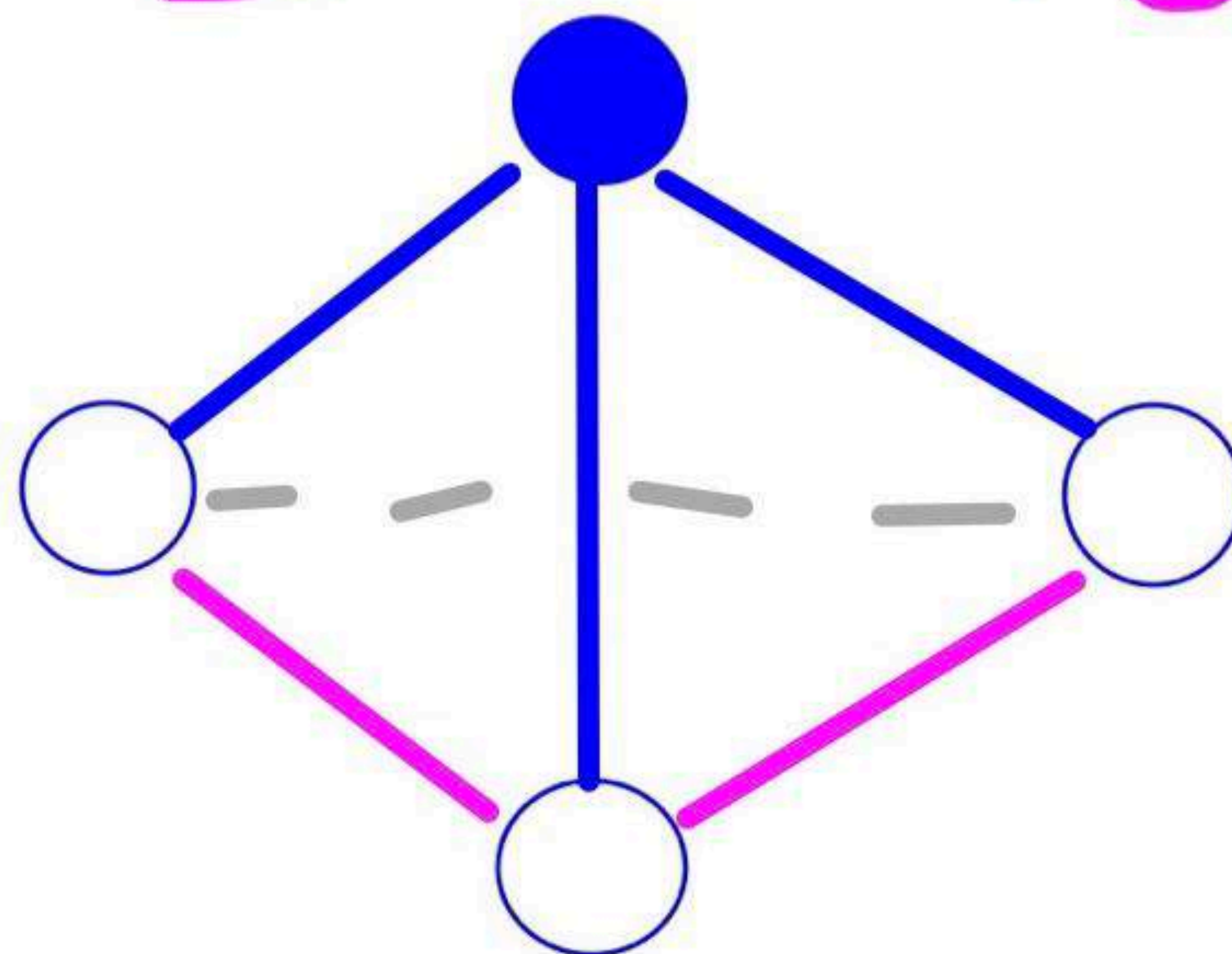


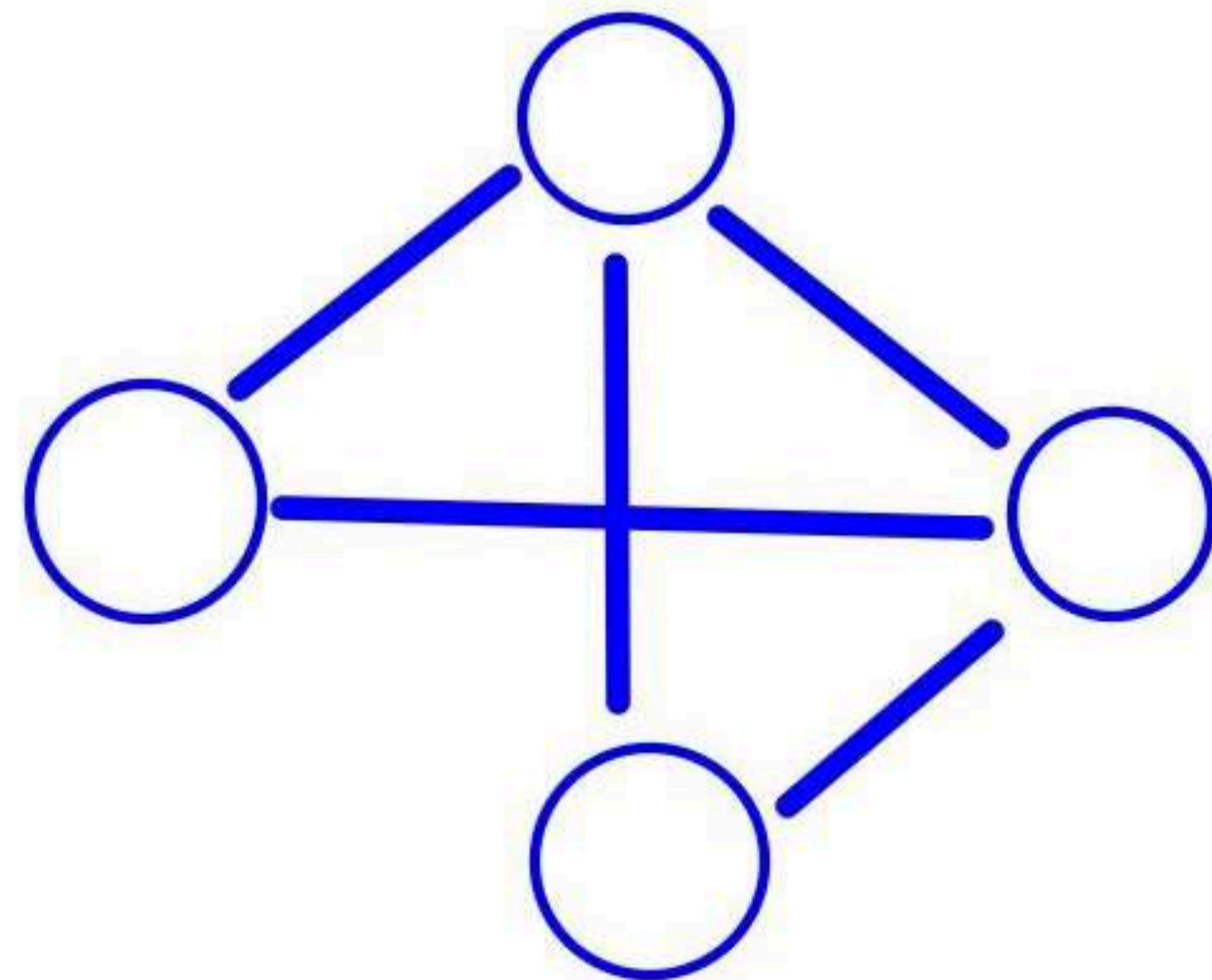
3/3

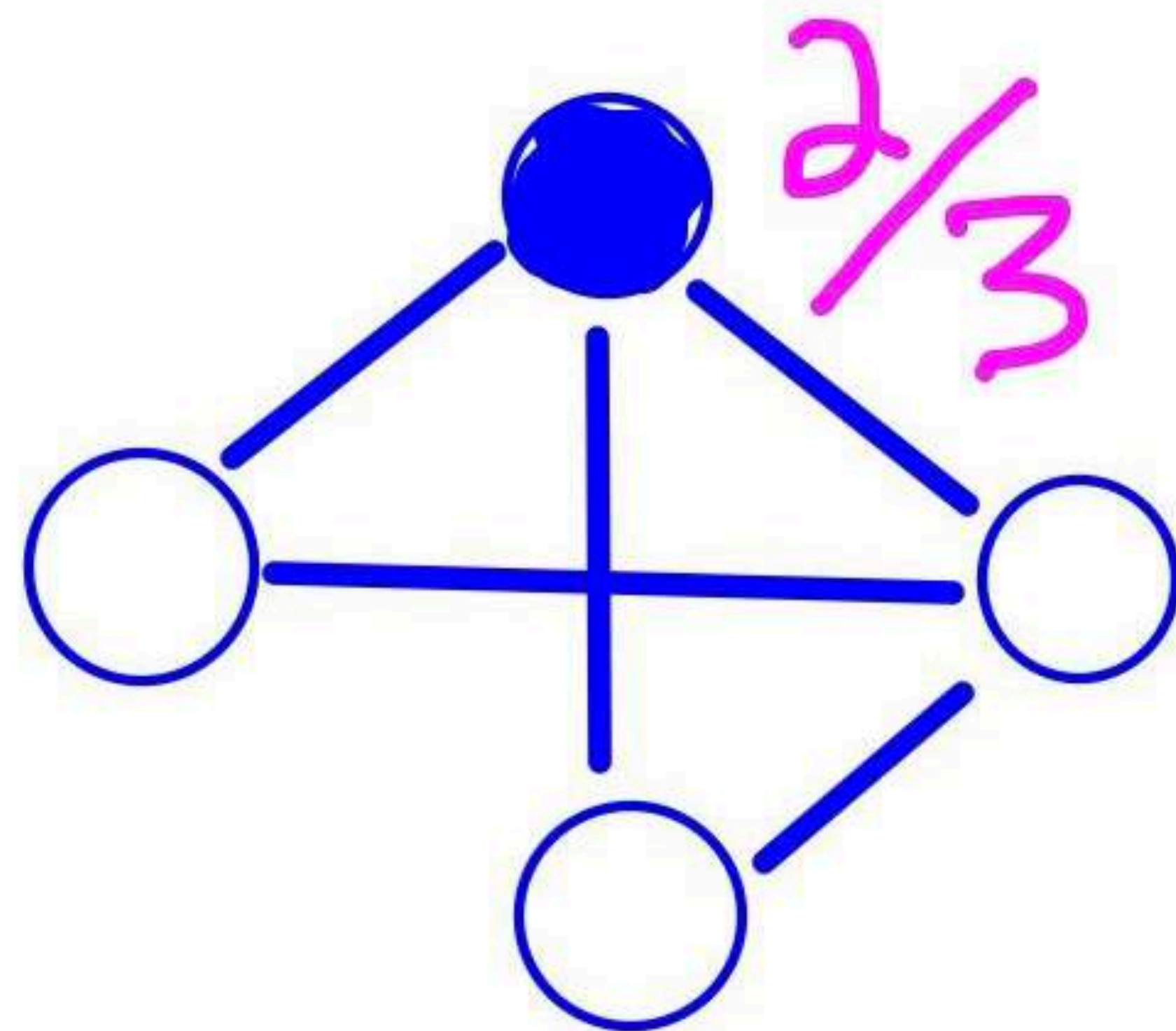
1.0

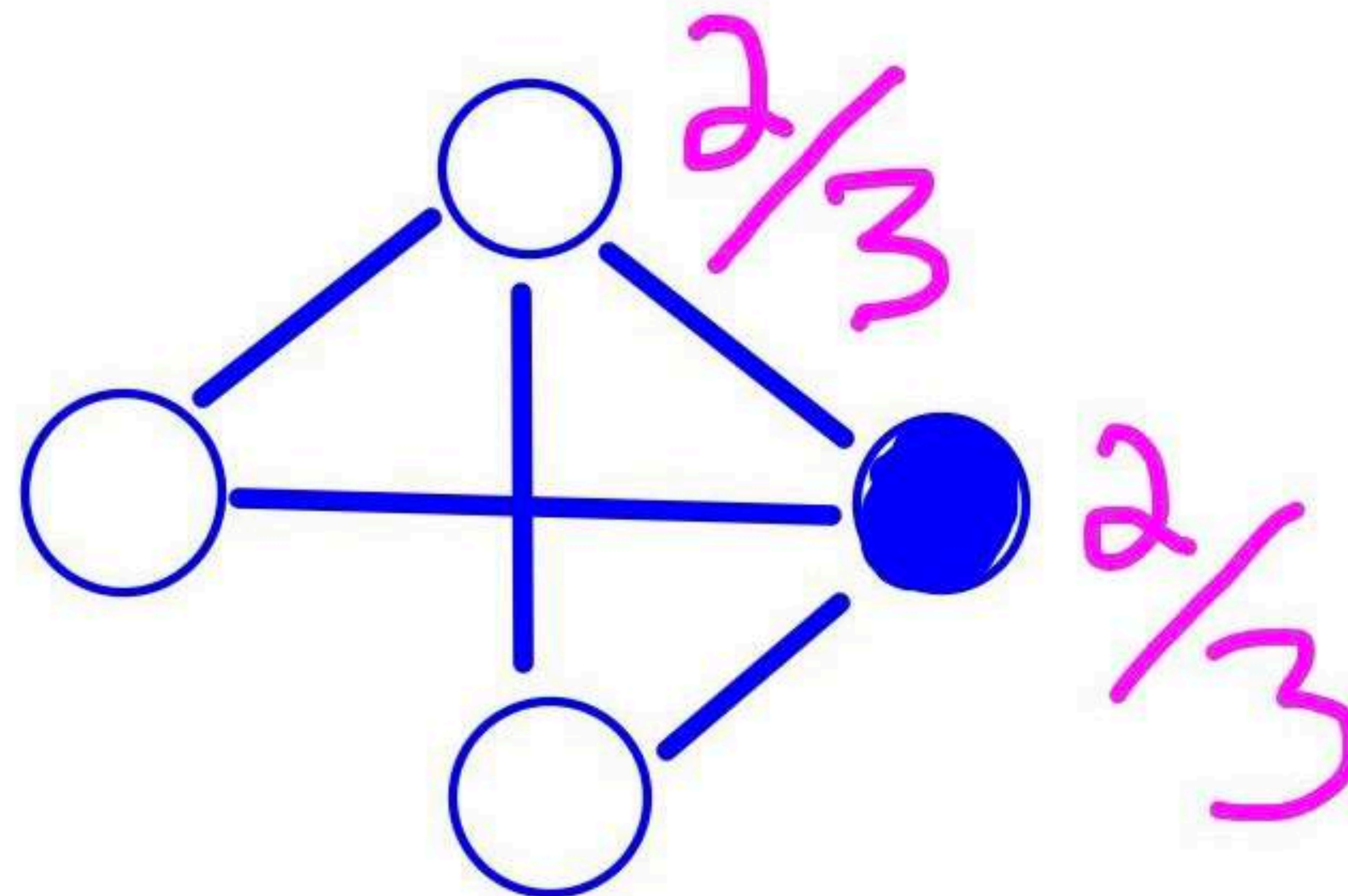


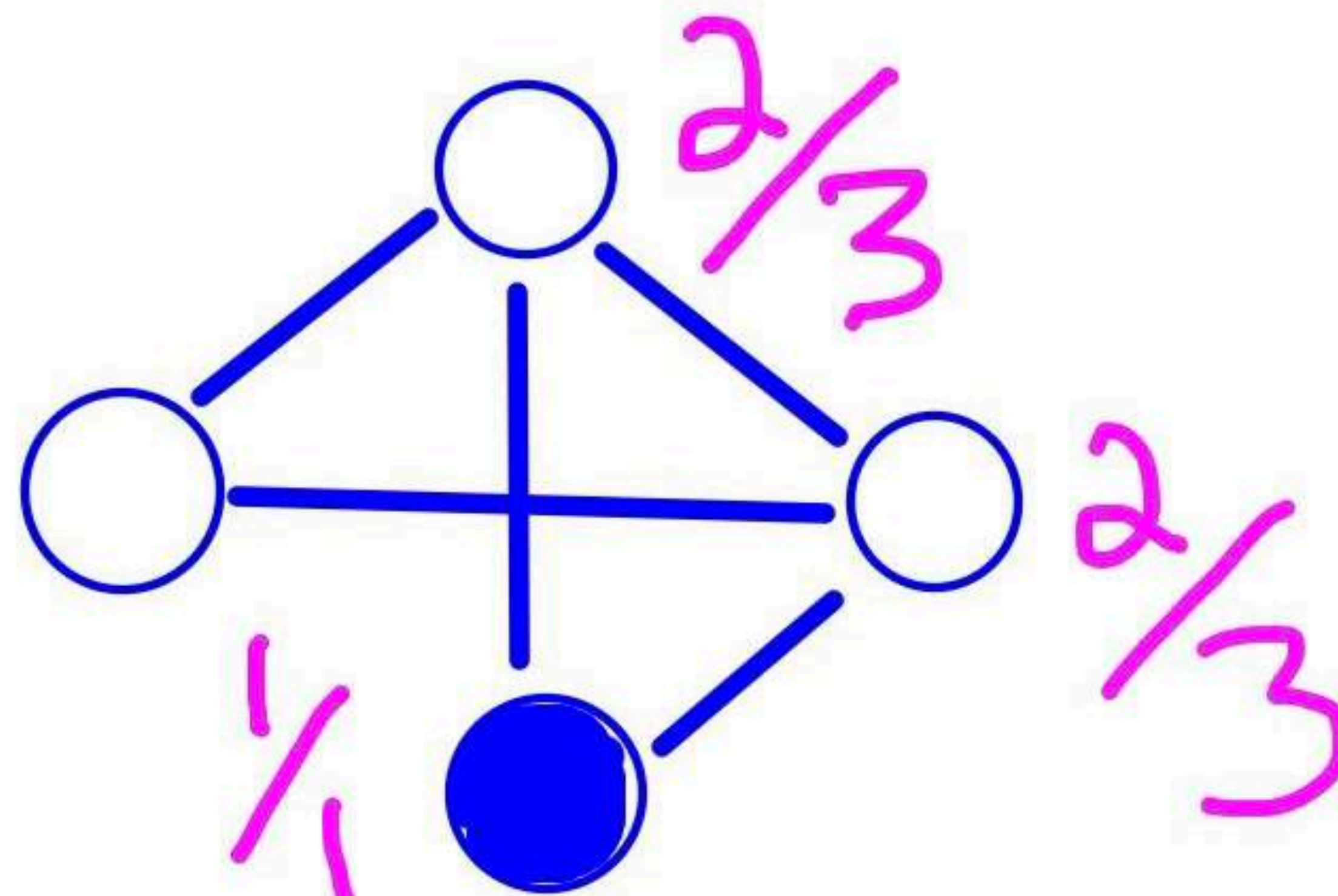
$$\frac{2}{3} \qquad 0.\overline{6}$$

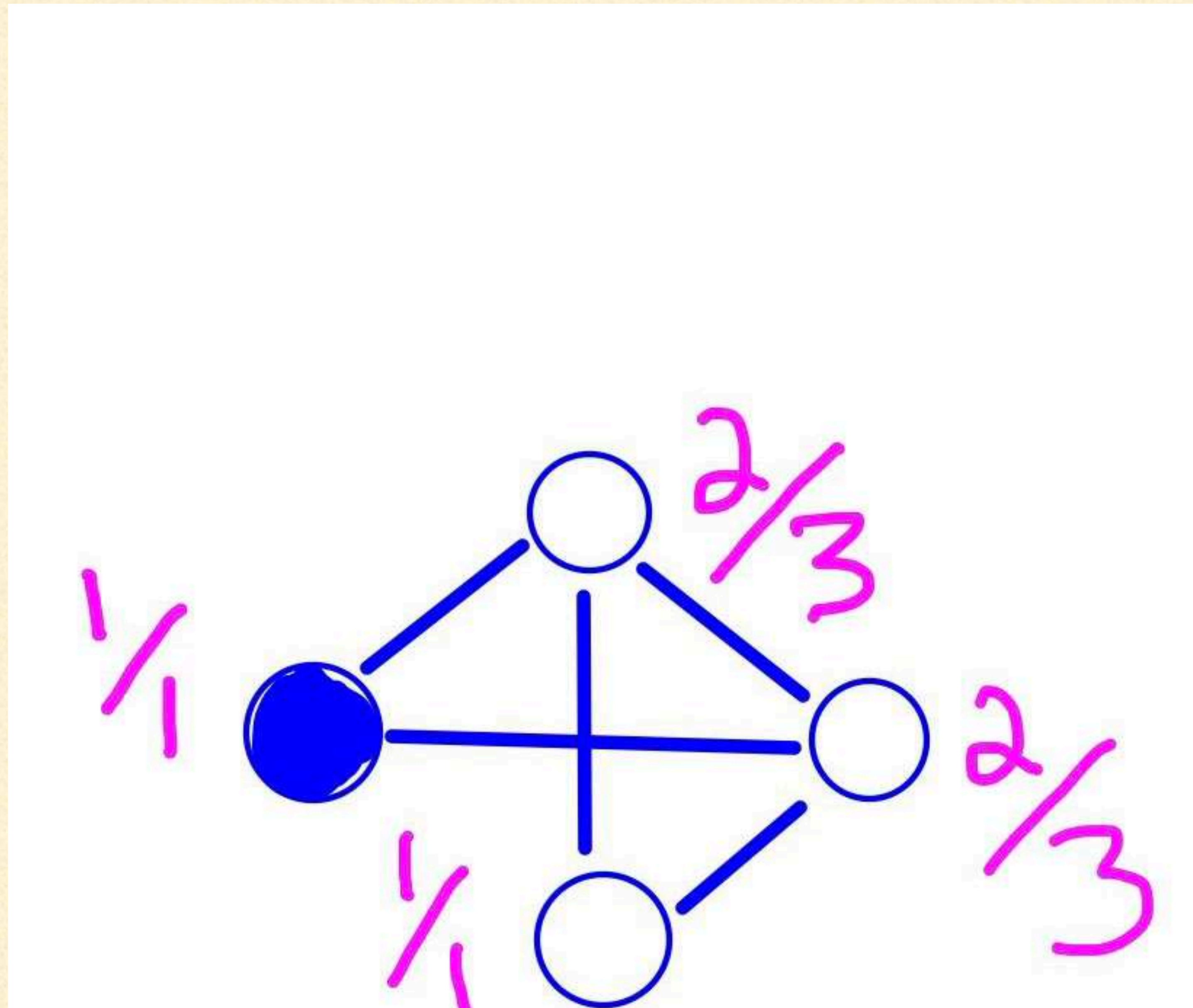




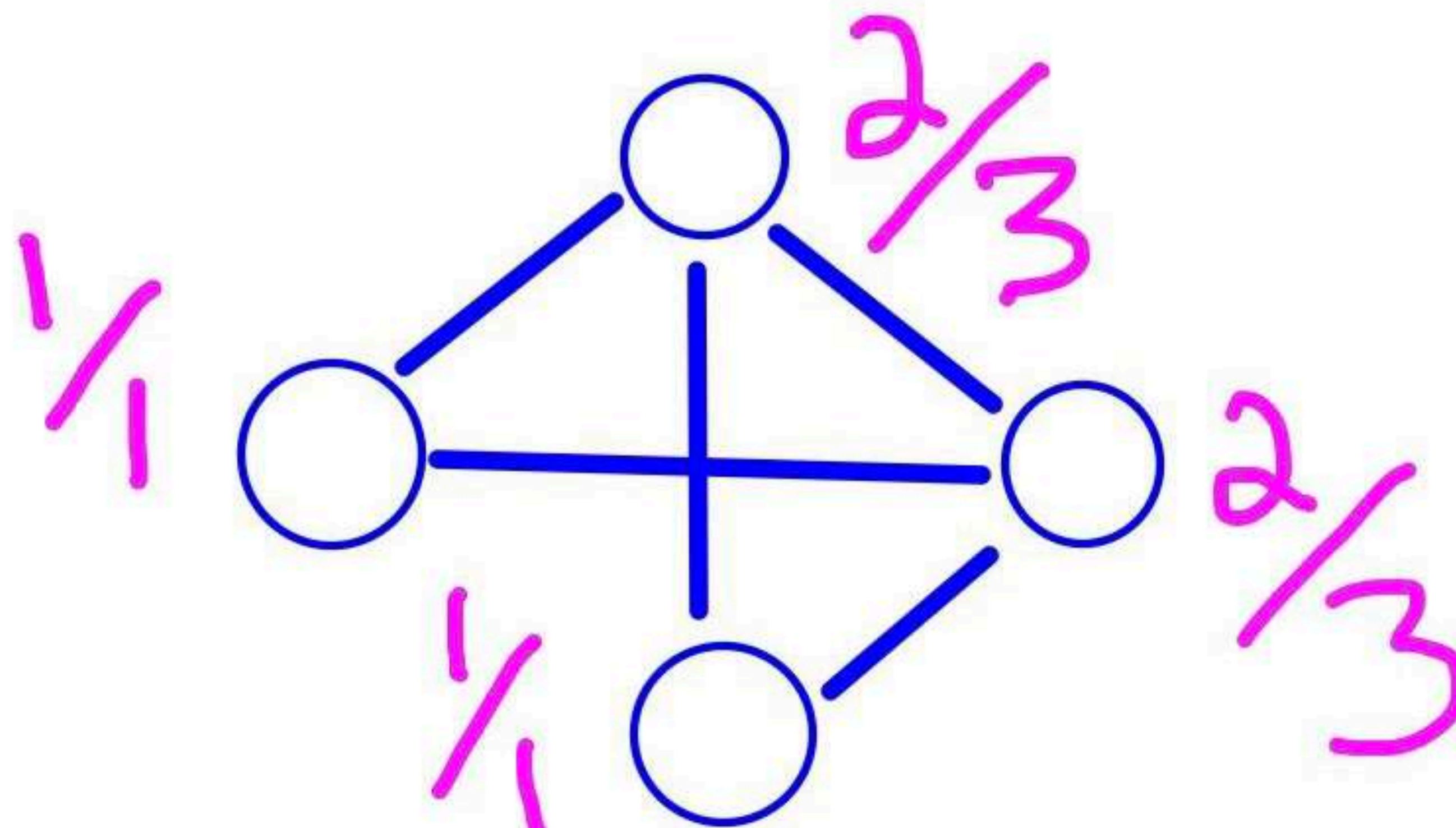




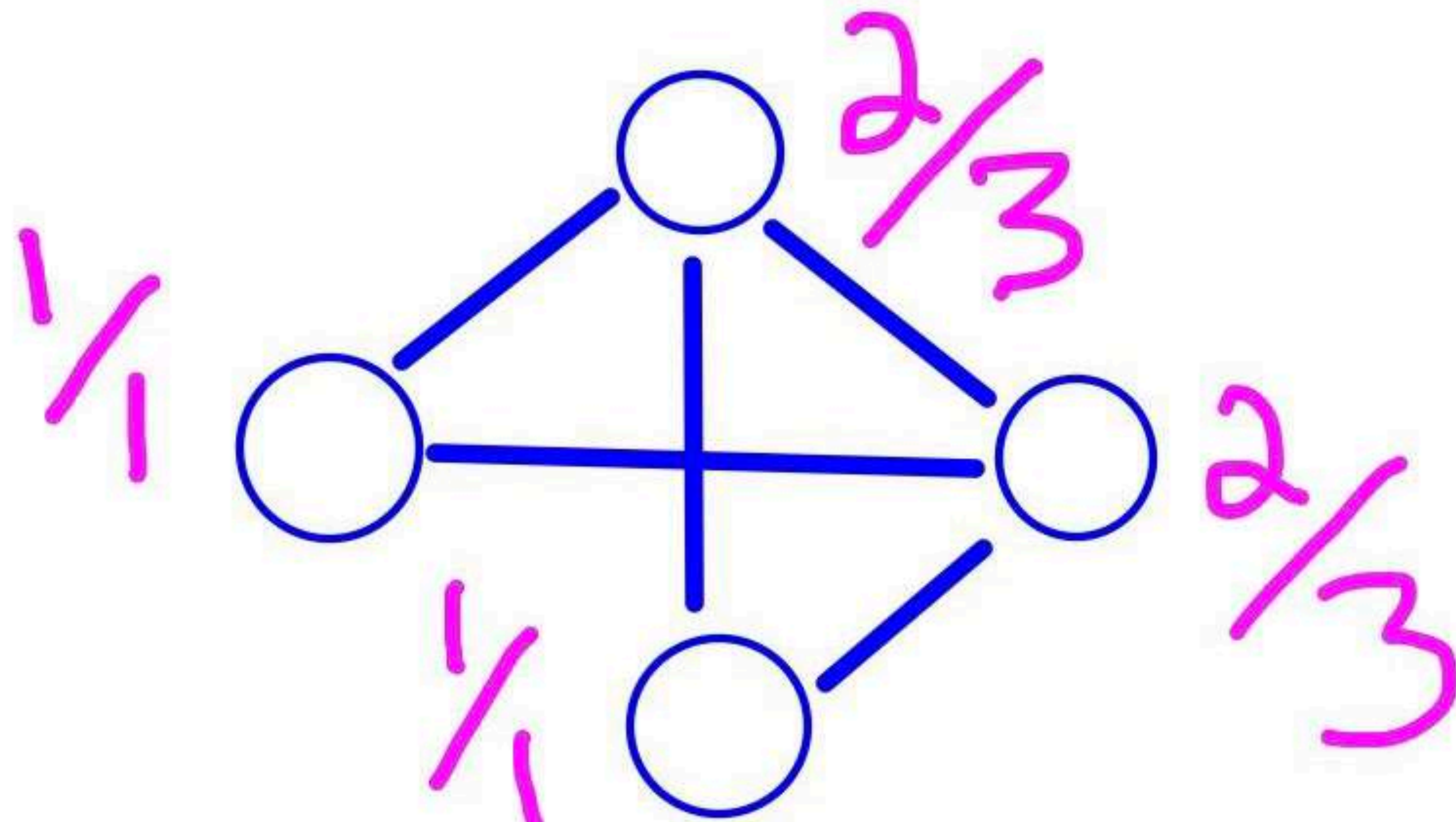




Average: $2.5 / 3$



Average: $0.4\bar{3}$



CALCULATING AVERAGE SHORTEST PATH

CALCULATING AVERAGE SHORTEST PATH

- Take all possible pairs of nodes in a graph

CALCULATING AVERAGE SHORTEST PATH

- Take all possible pairs of nodes in a graph
- For each pair, find the shortest path length

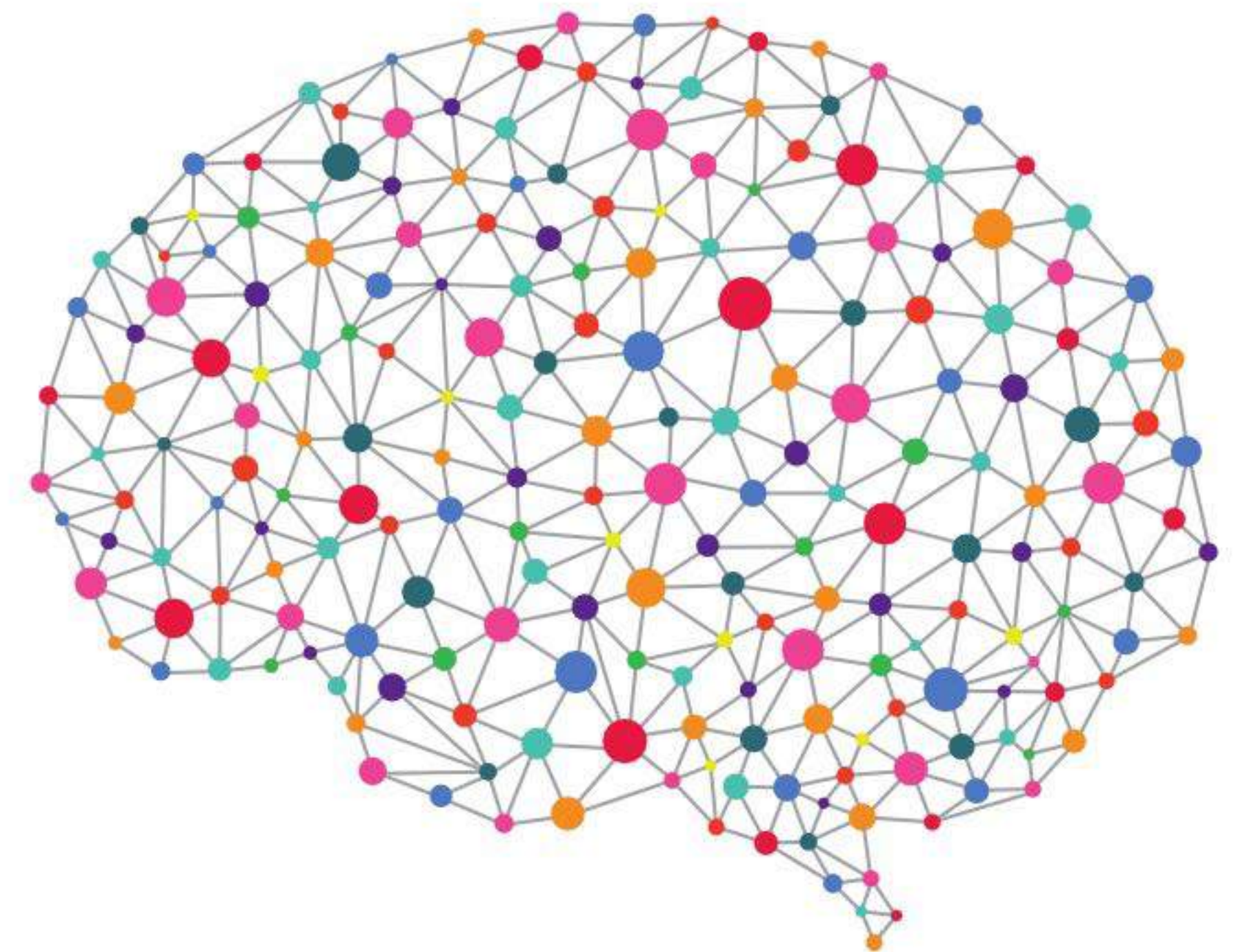
CALCULATING AVERAGE SHORTEST PATH

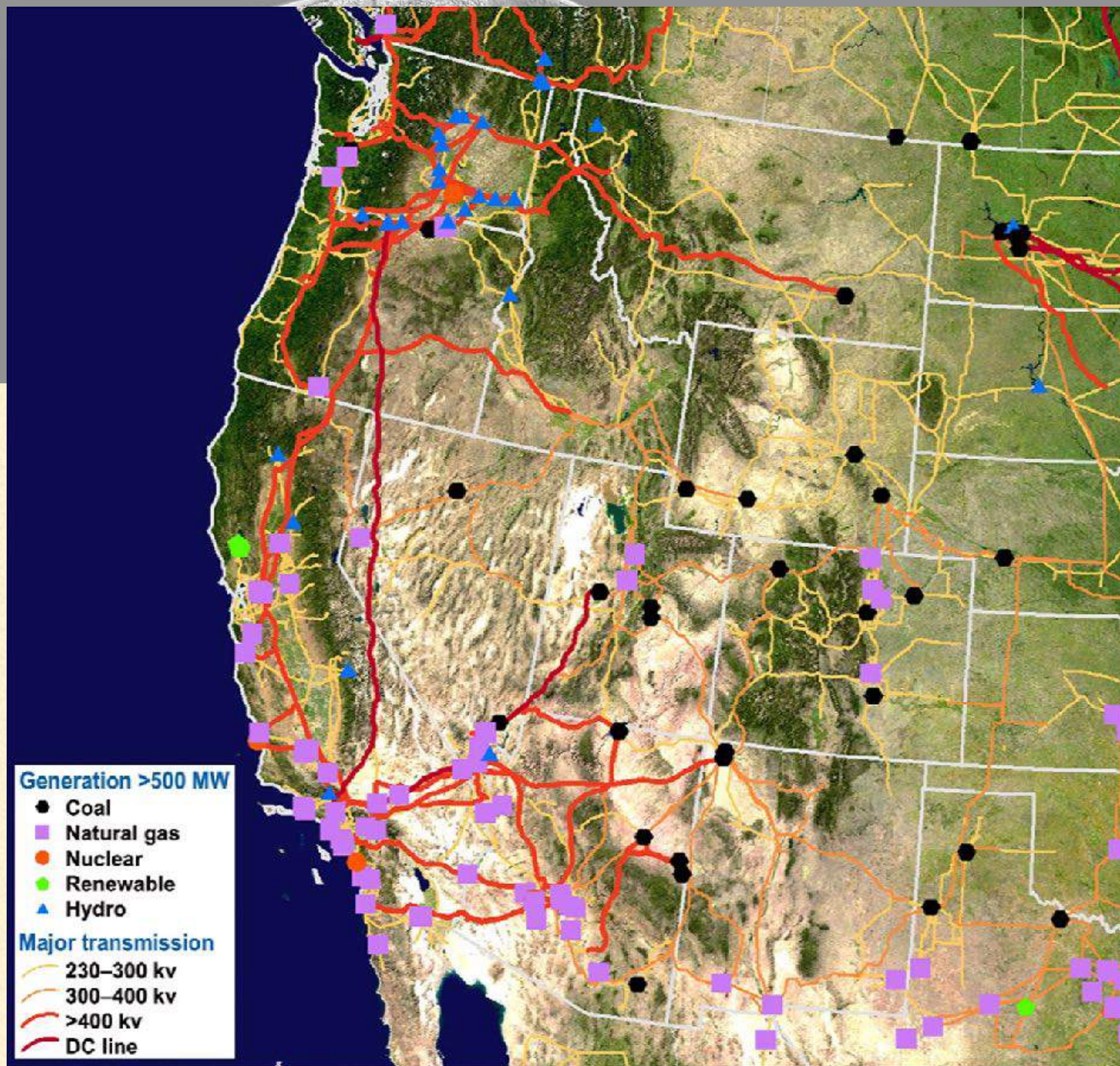
- Take all possible pairs of nodes in a graph
- For each pair, find the shortest path length
- Average all shortest path lengths

“Models of dynamical systems with small-world coupling display enhanced signal-propagation speed, computational power, and synchronizability.”

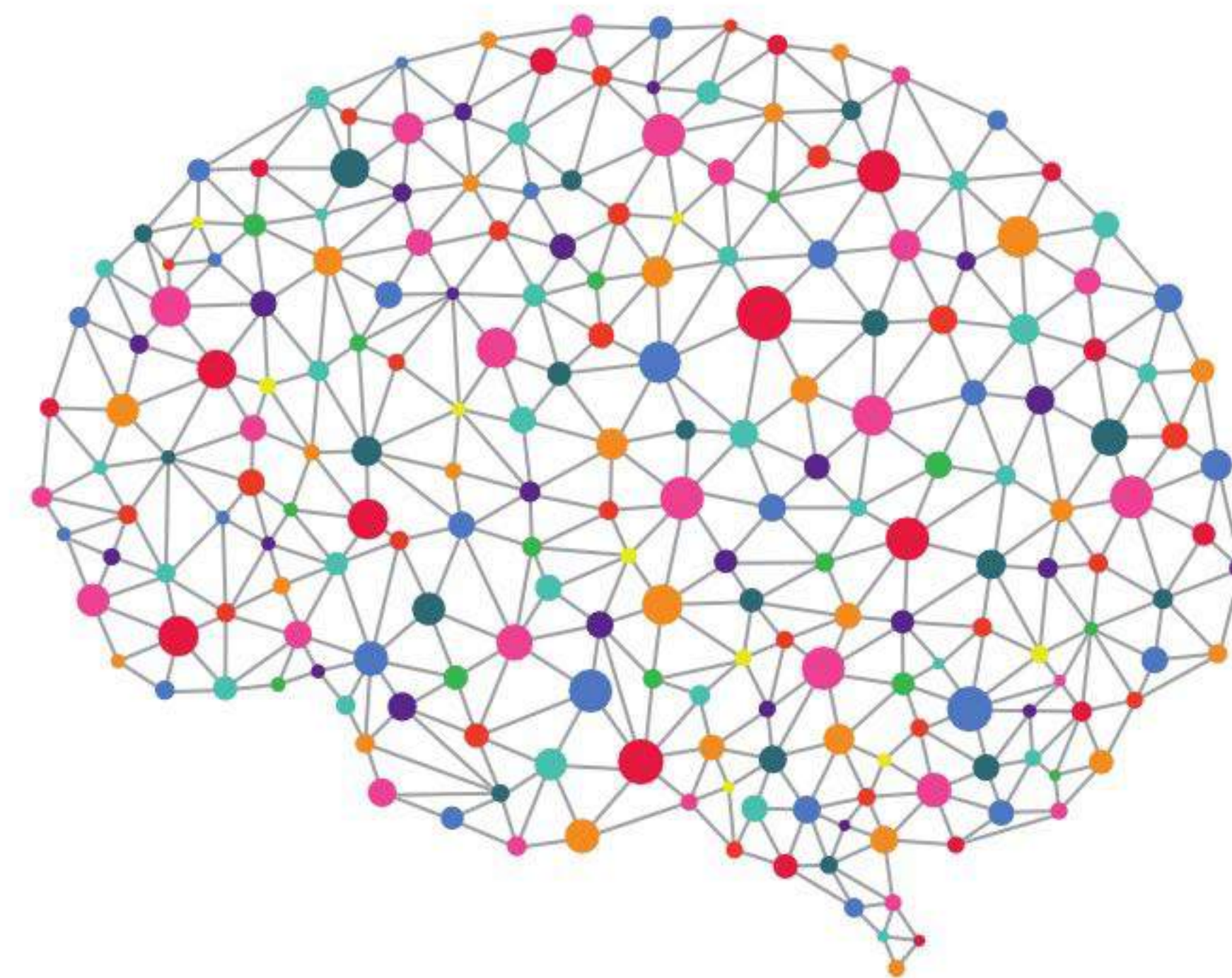
– “*Collective dynamics of ‘small-world’ networks*” by Duncan J. Watts & Steven H. Strogatz





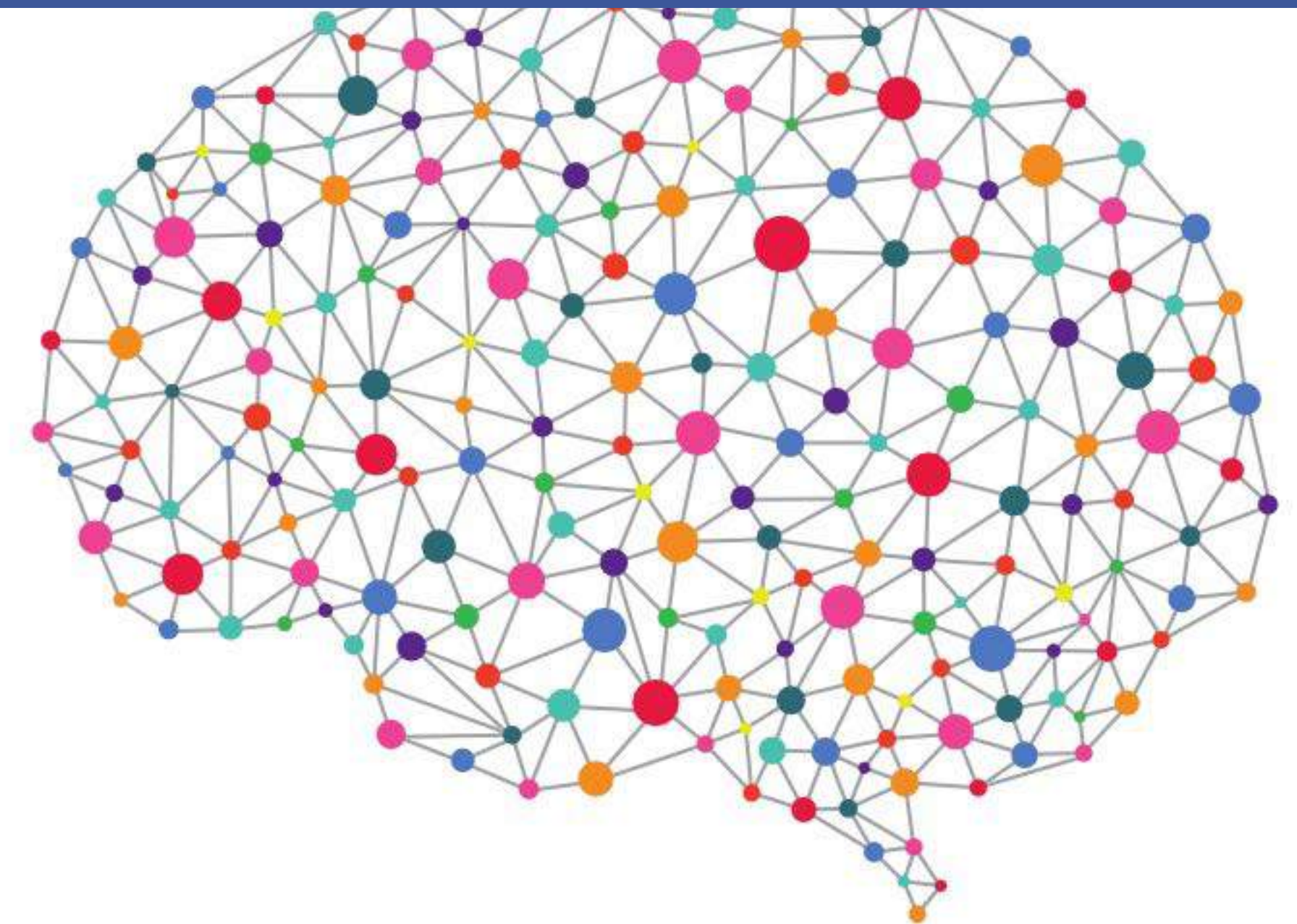
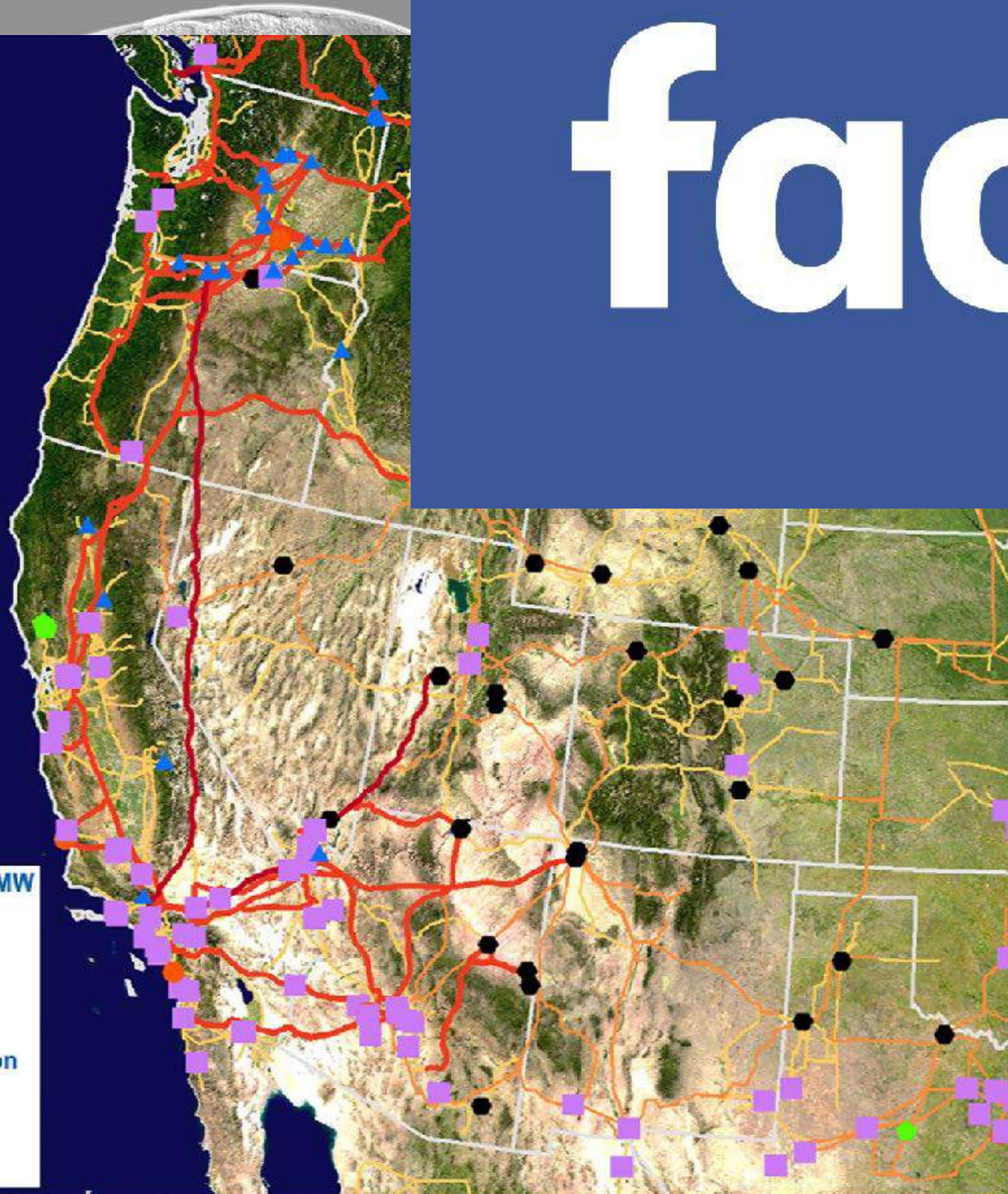


ys 2018

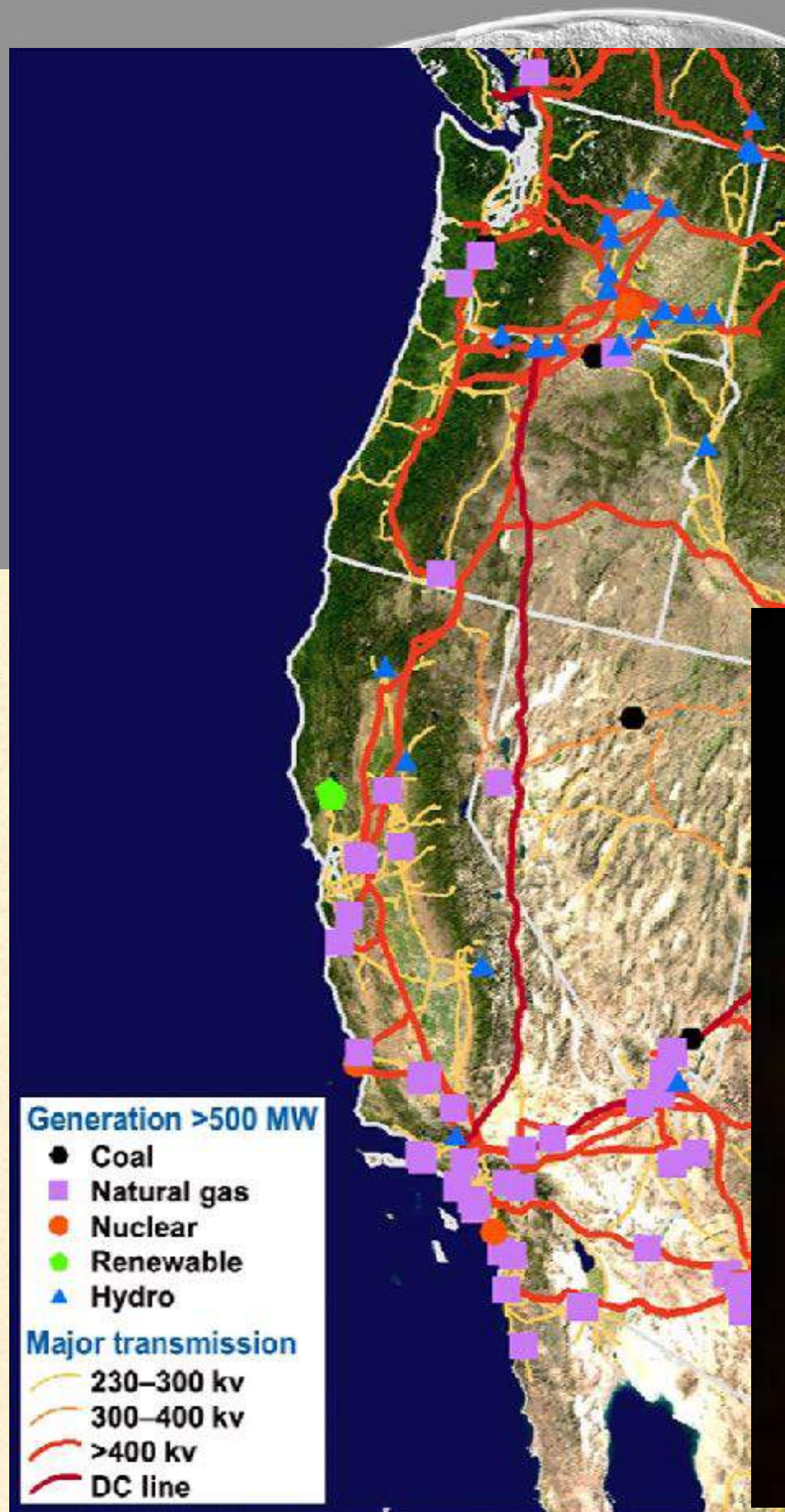


@devoncestes

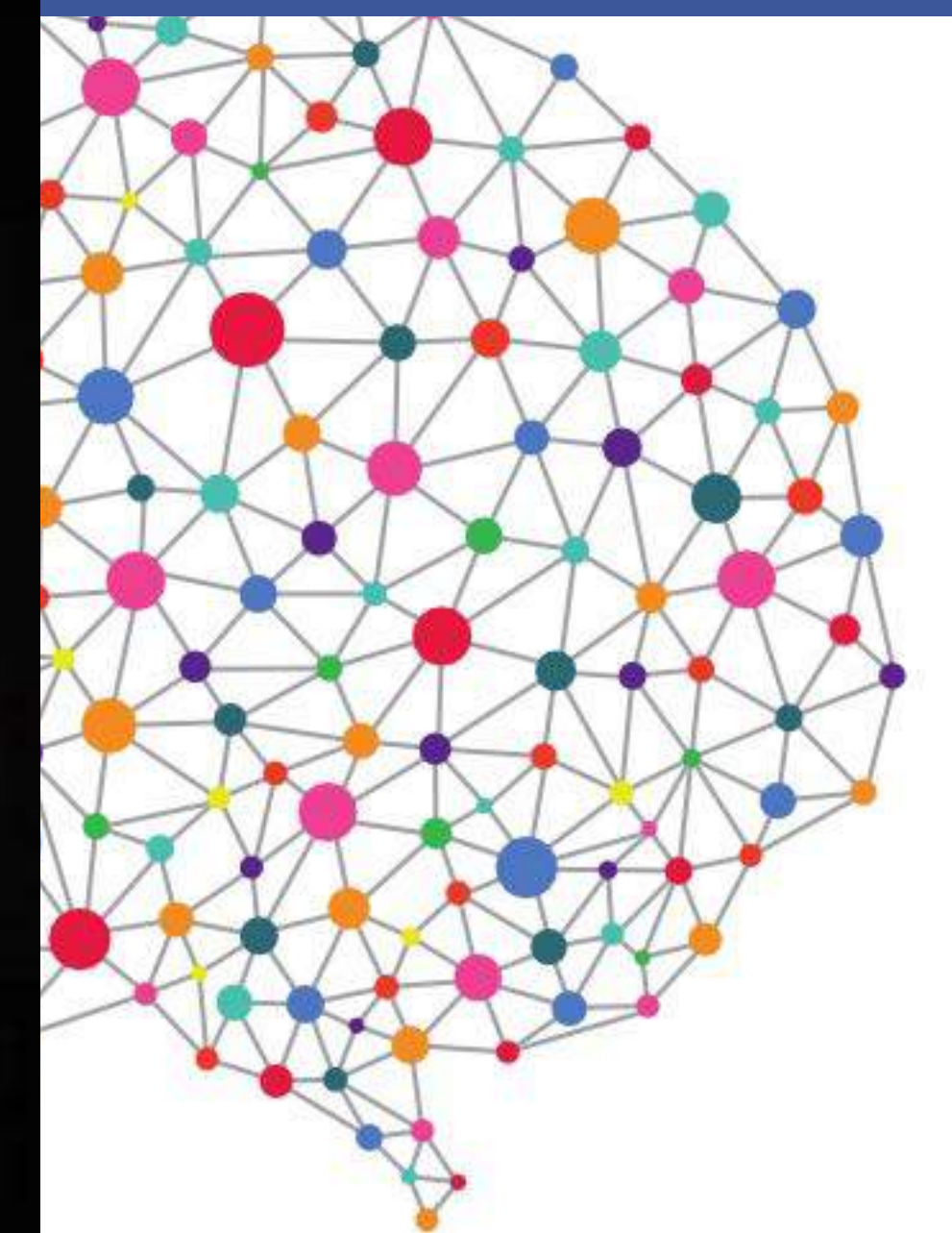
facebook



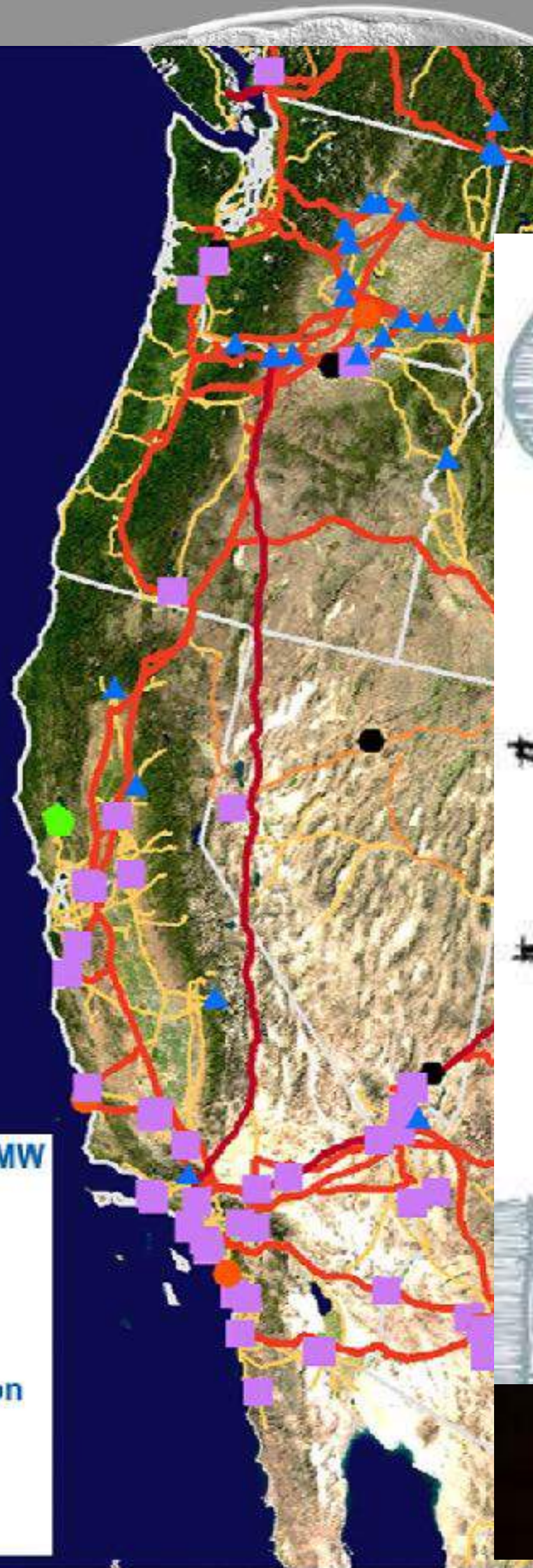
facebook



GAME OF THRONES™

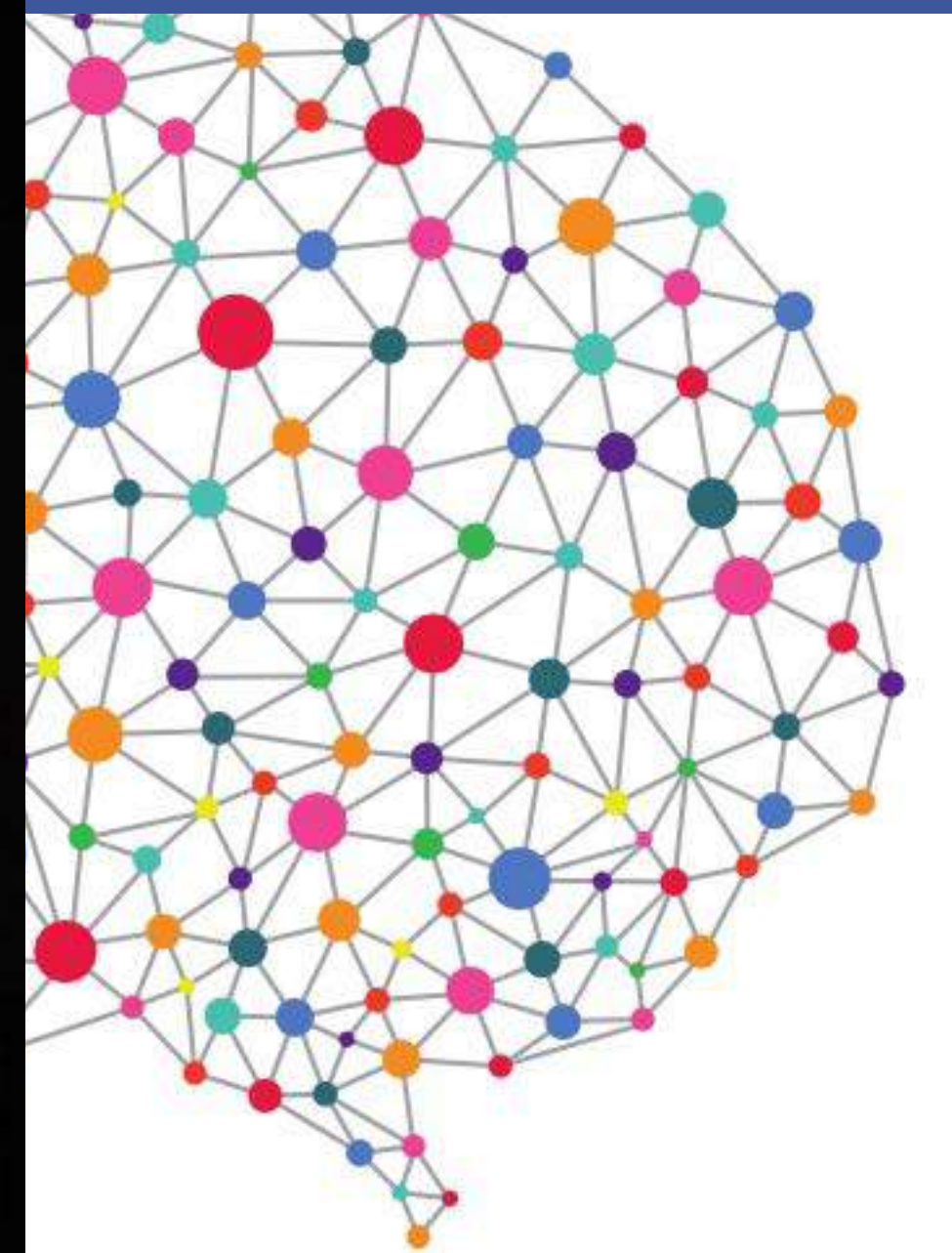


@devoncestes



facebook

699 punctuation
! adjective
Language
noun verb



ARE THEY IN OUR SOFTWARE?

ARE THEY IN OUR CODE?



This repository

Search

Pull requests

Issues

Marketplace

Explore



devonestes / module_dependency_visualizer

Unwatch

1

★ Star

2

🍴 Fork

0

<> Code

Issues 0

Pull requests 0

Projects 0

Wiki

Insights

Settings

Visualize the dependencies between modules in your Elixir applications

Edit

Add topics

5 commits

1 branch

0 releases

1 contributor

Branch: master

New pull request

Create new file

Upload files

Find file

Clone or download



devonestes update readme

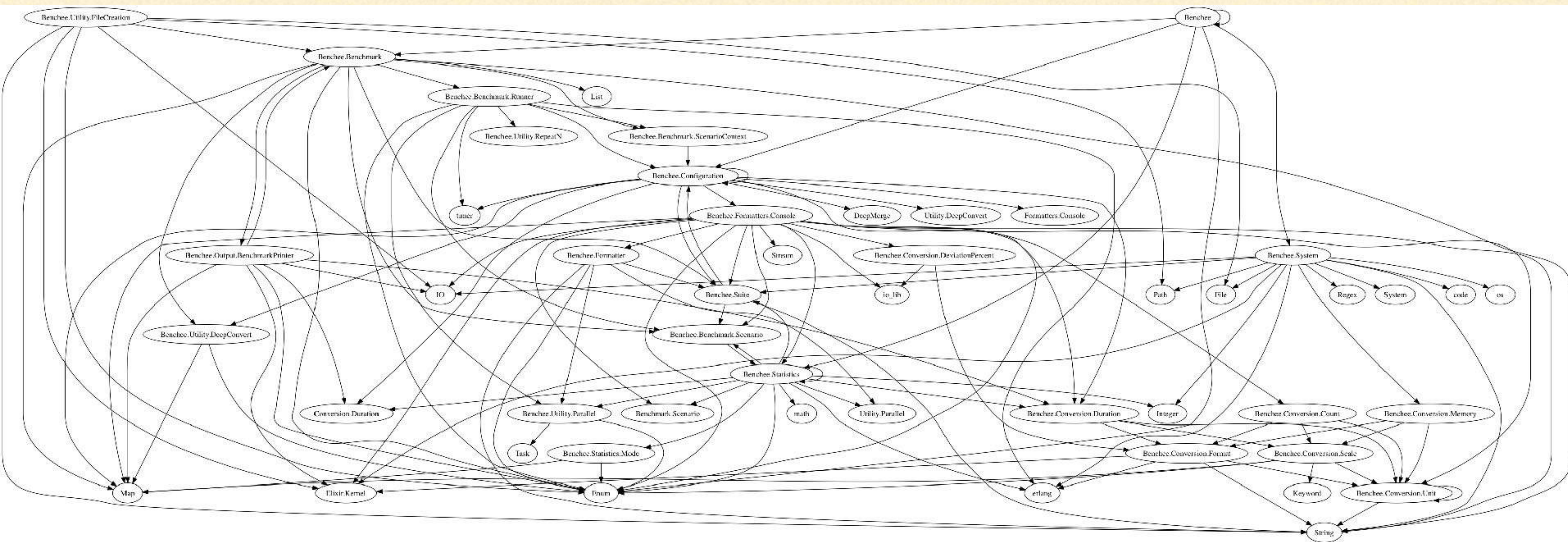
Latest commit 333e2cd on Oct 31, 2017

config	Initial commit	3 months ago
lib	update readme	3 months ago
test	All tests passing!	3 months ago
.gitignore	Initial commit	3 months ago
README.md	update readme	3 months ago
mix.exs	Initial commit	3 months ago
run.exs	update readme	3 months ago

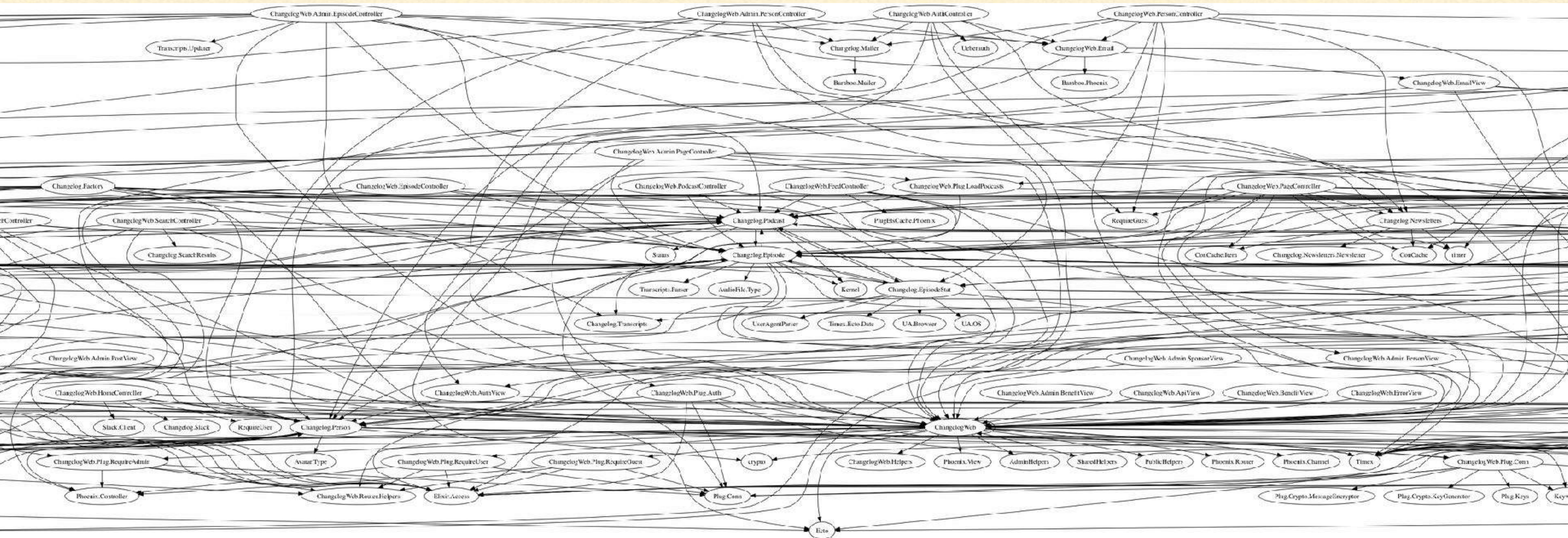
README.md

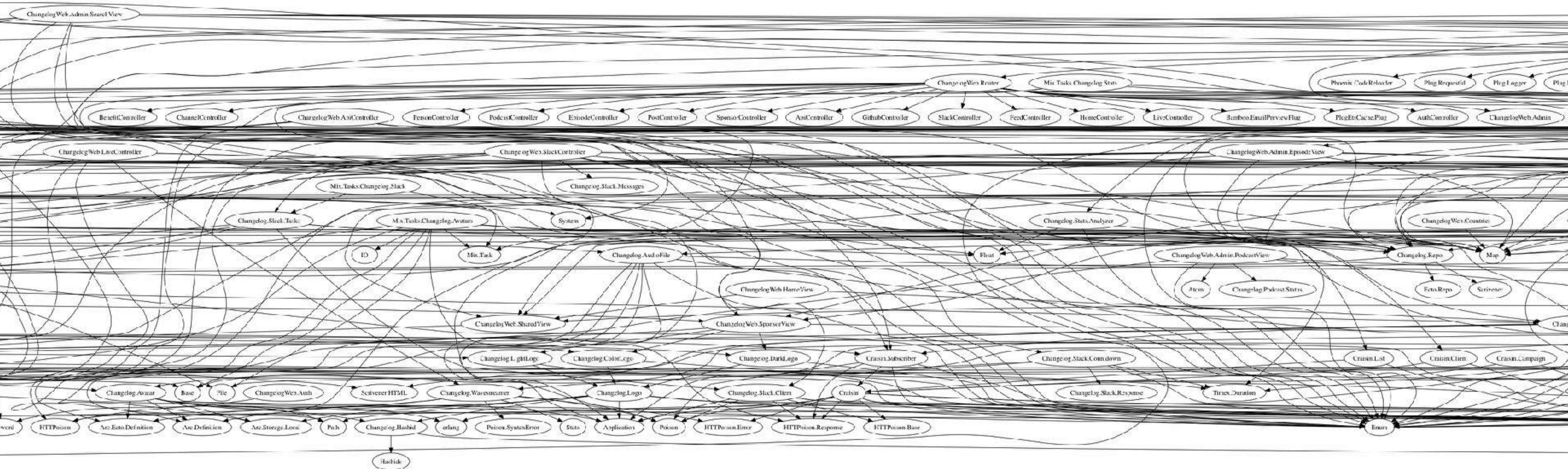
ModuleDependencyVisualizer

What is this?

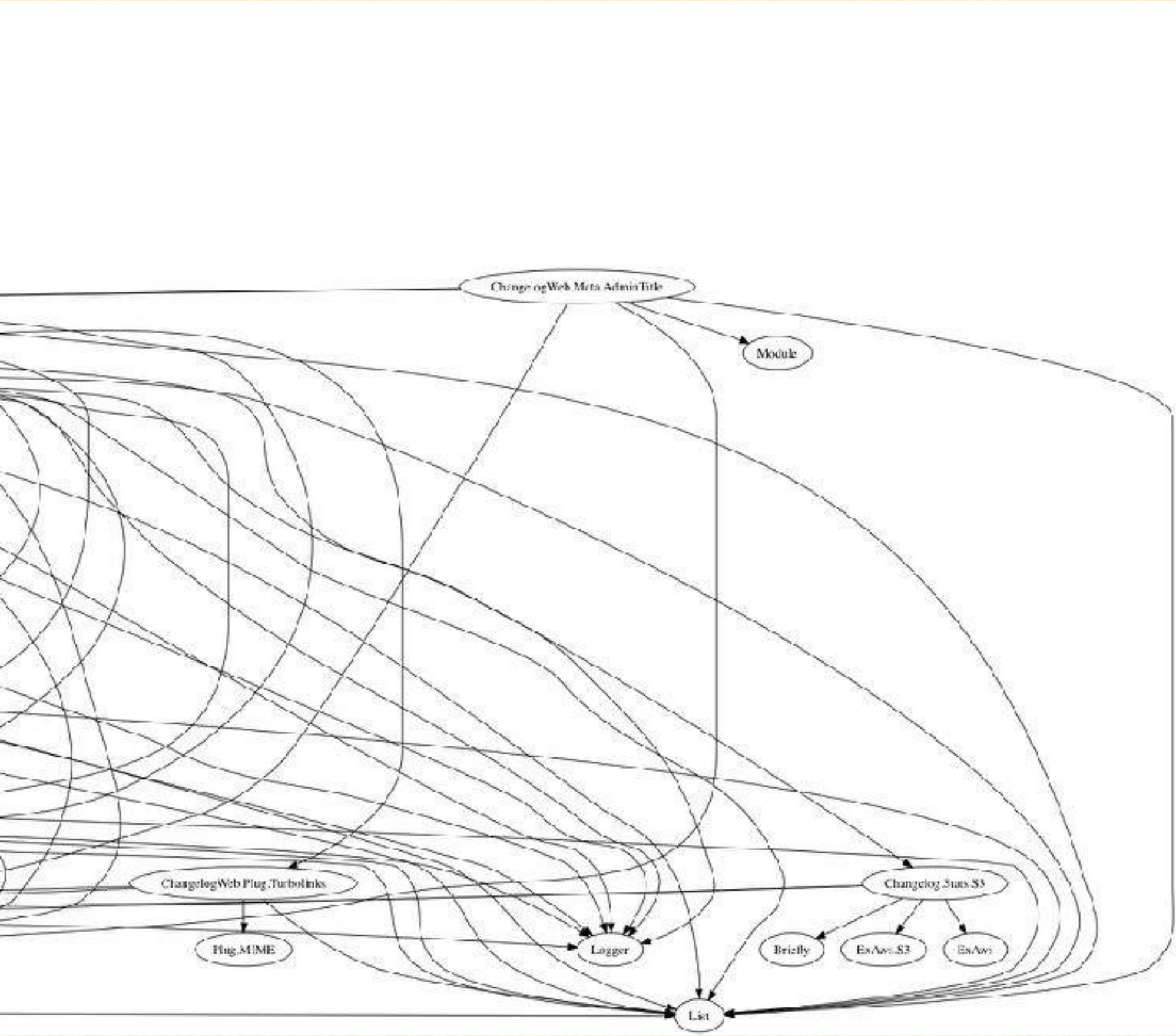


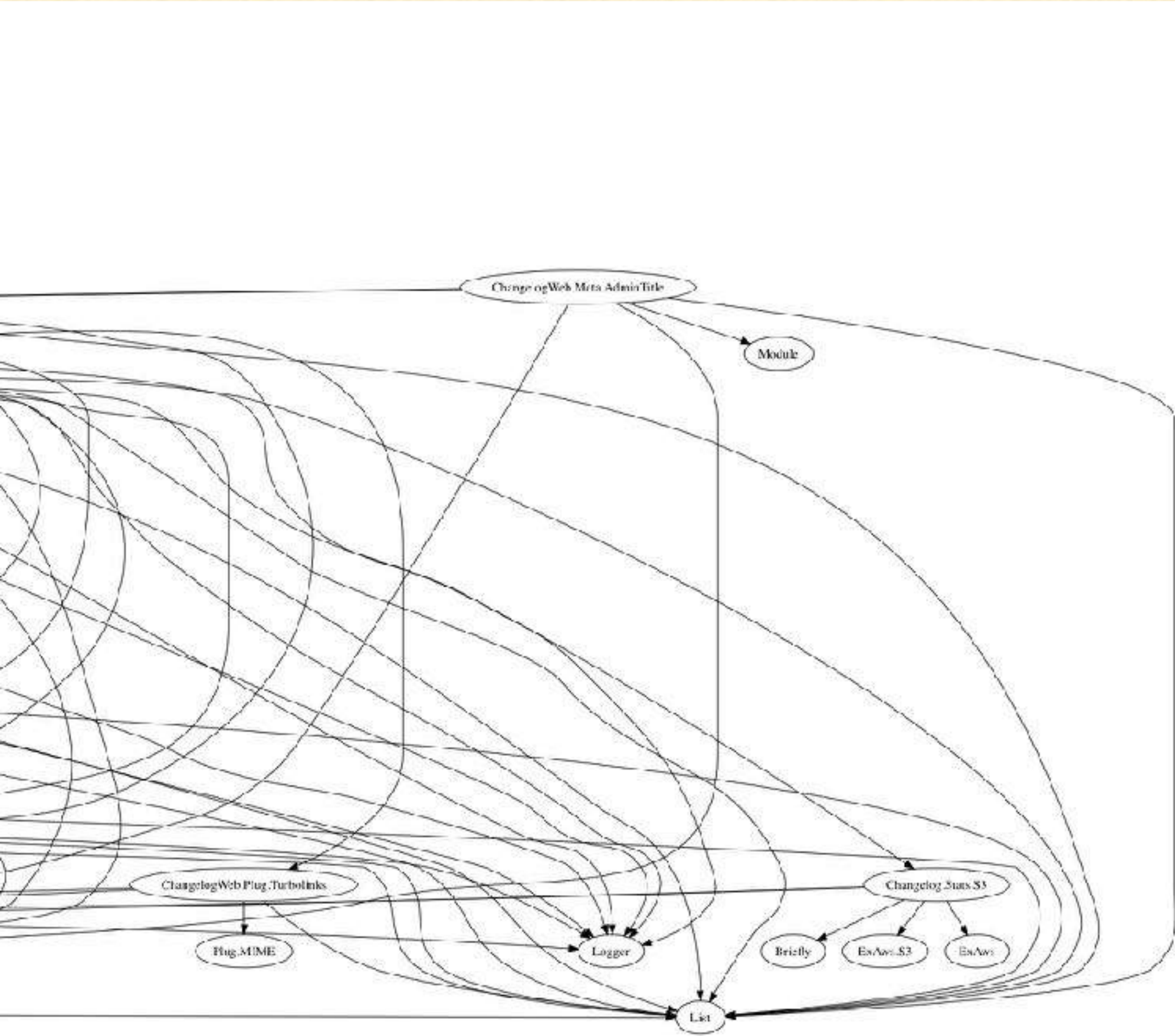












The Open Graph Viz Platform

Gephi is the leading visualization and exploration software for all kinds of graphs and networks. Gephi is open-source and free.

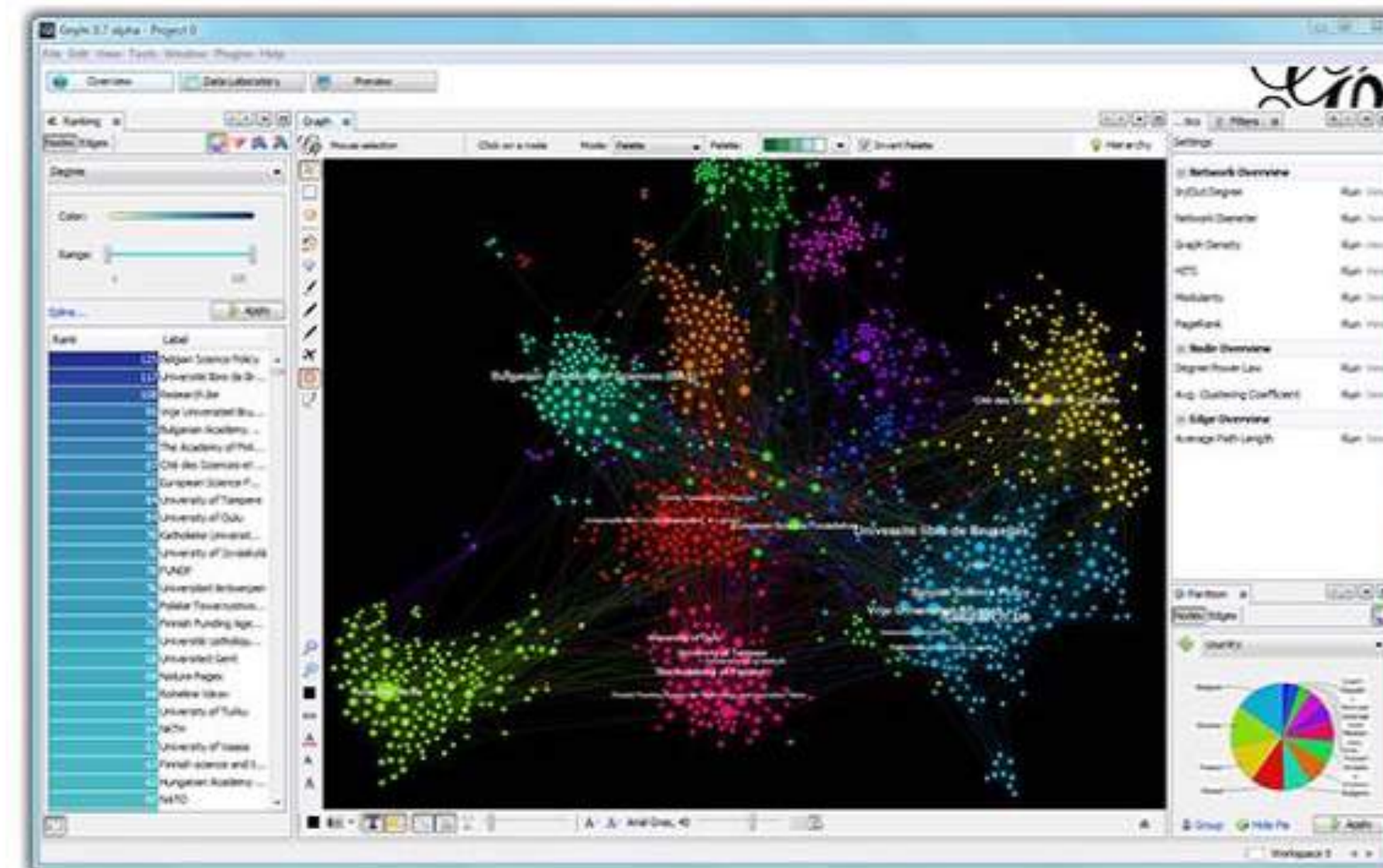
Runs on Windows, Mac OS X and Linux.

[Learn More on Gephi Platform »](#)



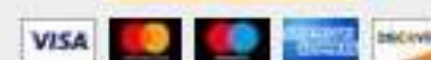
[Release Notes](#) | [System Requirements](#)

- [Features](#)
- [Quick start](#)
- [Screenshots](#)
- [Videos](#)



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APPLICATIONS

- ✓ **Exploratory Data Analysis:** intuition-oriented analysis by networks manipulations in real time.
- ✓ **Link Analysis:** revealing the underlying structures of associations between objects.
- ✓ **Social Network Analysis:** easy creation of social data connectors to map community organizations and small-world networks.
- ✓ **Biological Network analysis:** representing patterns of biological data.
- ✓ **Poster creation:** scientific work promotion with hi-quality printable maps.

[Learn More »](#)

METRICS READY

Like Photoshop™ for graphs.

— the Community

LATEST NEWS

- [Gephi updates with 0.9.2 version](#)
- [Gephi updates with 0.9.1 version](#)
- [A close look at the Gephi user community](#)
- [Gephi 0.9 released: Play with network data again](#)
- [Gephi boosts its performance with new "GraphStore" core](#)

[See All »](#)

Tweets by [@Gephi](#)



PAPERS



Bastian M., Heymann S., Jacomy M. (2009). *Gephi*:

14 applications

14 applications

5 Phoenix web applications

14 applications

5 Phoenix web applications

9 libraries

14 applications

5 Phoenix web applications

9 libraries

* I am not a real scientist





Gephi 0.9.2 - benchee.gephi

Overview Data Laboratory Preview

Workspace 1 Workspace 2 Workspace 3

Data Table

Nodes Edges Configuration Add node Add edge Search/Replace Import Spreadsheet Export table More actions Filter: Id

Id	Label	Interval	Clustering Coefficient	Eccentricity	Closeness Centrality	Harmonic Closeness Centrality	Betweenness Centrality
timer	timer		0.5	4.0	0.357664	0.39966	0.0
io_lib	io_lib		0.5	4.0	0.357664	0.397959	0.0
Benchmark.Scenario	Benchmark.Scenario		0.5	4.0	0.379845	0.423469	0.0
Benchee.Utility.DeepC...	Benchee.Utility.DeepC...		0.333333	4.0	0.401639	0.452381	1.452381
Benchee.Benchmark.Sc...	Benchee.Benchmark.S...		0.333333	4.0	0.376923	0.426871	1.142857
Benchee.Conversion.Unit	Benchee.Conversion.Unit		0.303571	4.0	0.422414	0.489796	17.90126
Benchee	Benchee		0.266667	3.0	0.480392	0.520408	48.141938
Benchee.Benchmark.Sc...	Benchee.Benchmark.S...		0.25	4.0	0.453704	0.501701	11.221007
Benchee.Conversion.C...	Benchee.Conversion.C...		0.25	4.0	0.376923	0.433673	4.362734
Benchee.Suite	Benchee.Suite		0.196429	4.0	0.515789	0.566327	71.979627
Benchee.Conversion.D...	Benchee.Conversion.D...		0.166667	4.0	0.365672	0.414966	2.7421
Benchee.Conversion.M...	Benchee.Conversion.M...		0.166667	4.0	0.376923	0.437075	23.938813
Benchee.Formatter	Benchee.Formatter		0.166667	3.0	0.441441	0.496599	27.793001
Benchee.Statistics.Mode	Benchee.Statistics.Mode		0.166667	4.0	0.392	0.435374	2.559524
Benchee.Utility.Parallel	Benchee.Utility.Parallel		0.15	4.0	0.411765	0.469388	53.225372
String	String		0.142857	3.0	0.49	0.547619	53.760112
Benchee.Configuration	Benchee.Configuration		0.119048	3.0	0.505155	0.598639	222.020749
Map	Map		0.119048	4.0	0.441441	0.511905	30.761555
Benchee.Conversion.D...	Benchee.Conversion.D...		0.119048	4.0	0.453704	0.52381	41.118261
Benchee.Statistics	Benchee.Statistics		0.114286	3.0	0.494949	0.591837	179.524698
Enum	Enum		0.108974	3.0	0.544444	0.615646	150.808986
Benchee.Benchmark.R...	Benchee.Benchmark.R...		0.097222	3.0	0.453704	0.527211	91.907487
Benchee.Benchmark	Benchee.Benchmark		0.090909	3.0	0.471154	0.561224	101.087157
Benchee.Formatters.C...	Benchee.Formatters.C...		0.073529	3.0	0.538462	0.639456	253.695153
Benchee.Conversion.Sc...	Benchee.Conversion.Sc...		0.071429	3.0	0.415254	0.479592	68.823855
Benchee.Conversion.Fo...	Benchee.Conversion.F...		0.071429	4.0	0.408333	0.481293	30.082489
Benchee.Output.Bench...	Benchee.Output.Bench...		0.047619	3.0	0.429825	0.493197	24.669867
Benchee.Utility.FileCre...	Benchee.Utility.FileCre...		0.047619	3.0	0.429825	0.493197	50.845932
Benchee.System	Benchee.System		0.005495	4.0	0.457944	0.566327	260.796209
List	List		0.0	4.0	0.322368	0.353741	0.0
Benchee.Utility.RepeatN	Benchee.Utility.RepeatN		0.0	4.0	0.314103	0.341837	0.0
erlang	erlang		0.0	4.0	0.449541	0.491497	41.291916
DeepMerge	DeepMerge		0.0	4.0	0.337931	0.369048	0.0

Add column Merge columns Delete column Clear column Copy data to other column Fill column with a value Duplicate column Create a boolean column from regex match Create column with list of regex matching groups Negate boolean values Convert column to dynamic

Parameters:

Network Interpretation: undirected

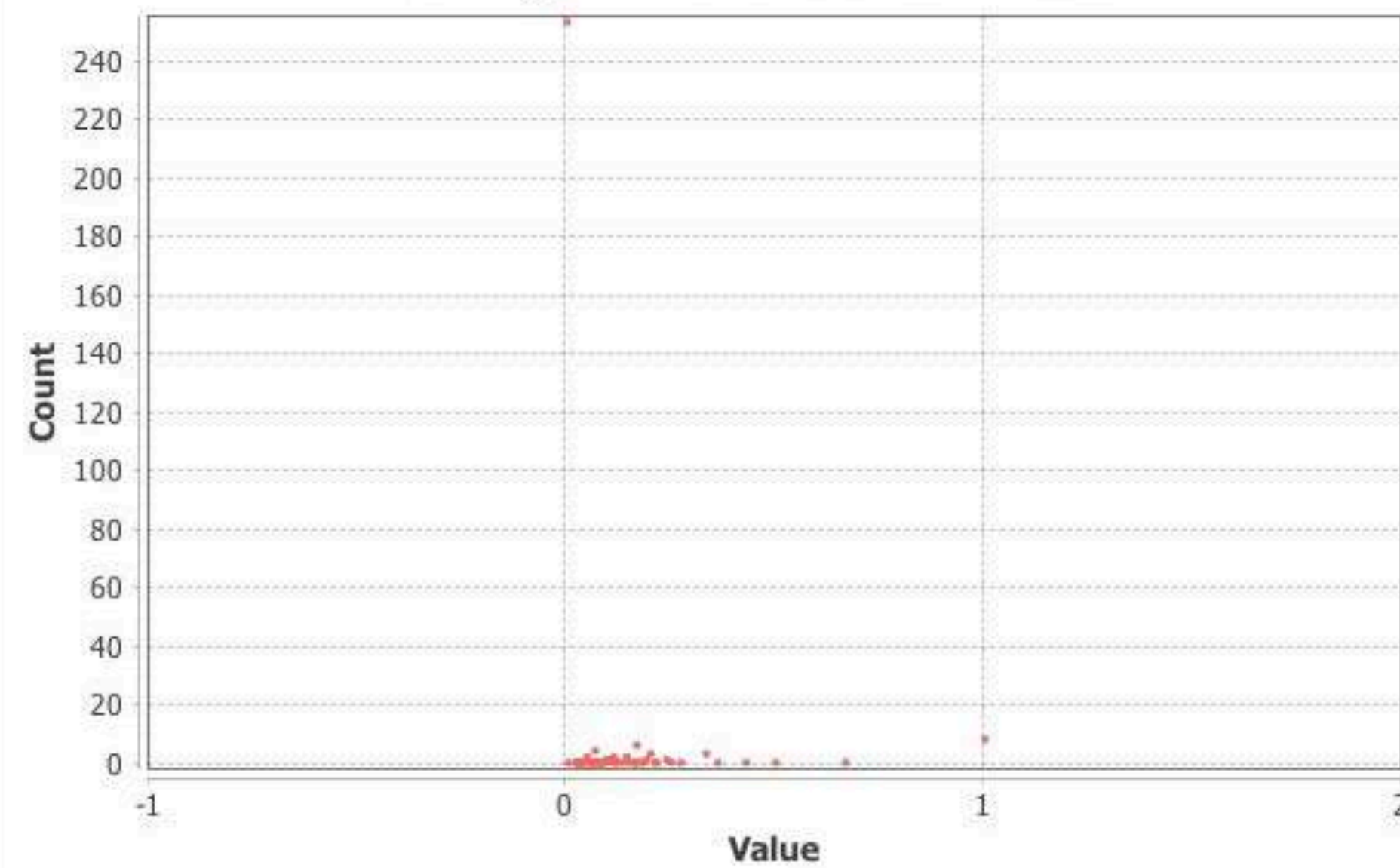
Results:

Average Clustering Coefficient: 0.104

Total triangles: 275

The Average Clustering Coefficient is the mean value of individual coefficients.

Clustering Coefficient Distribution



Algorithm:

Matthieu Latapy, *Main-memory Triangle Computations for Very Large (Sparse (Power-Law)) Graphs*, in Theoretical Computer Science (TCS) 407 (1–3), pages 458–473, 2008

Parameters:

Network Interpretation: undirected

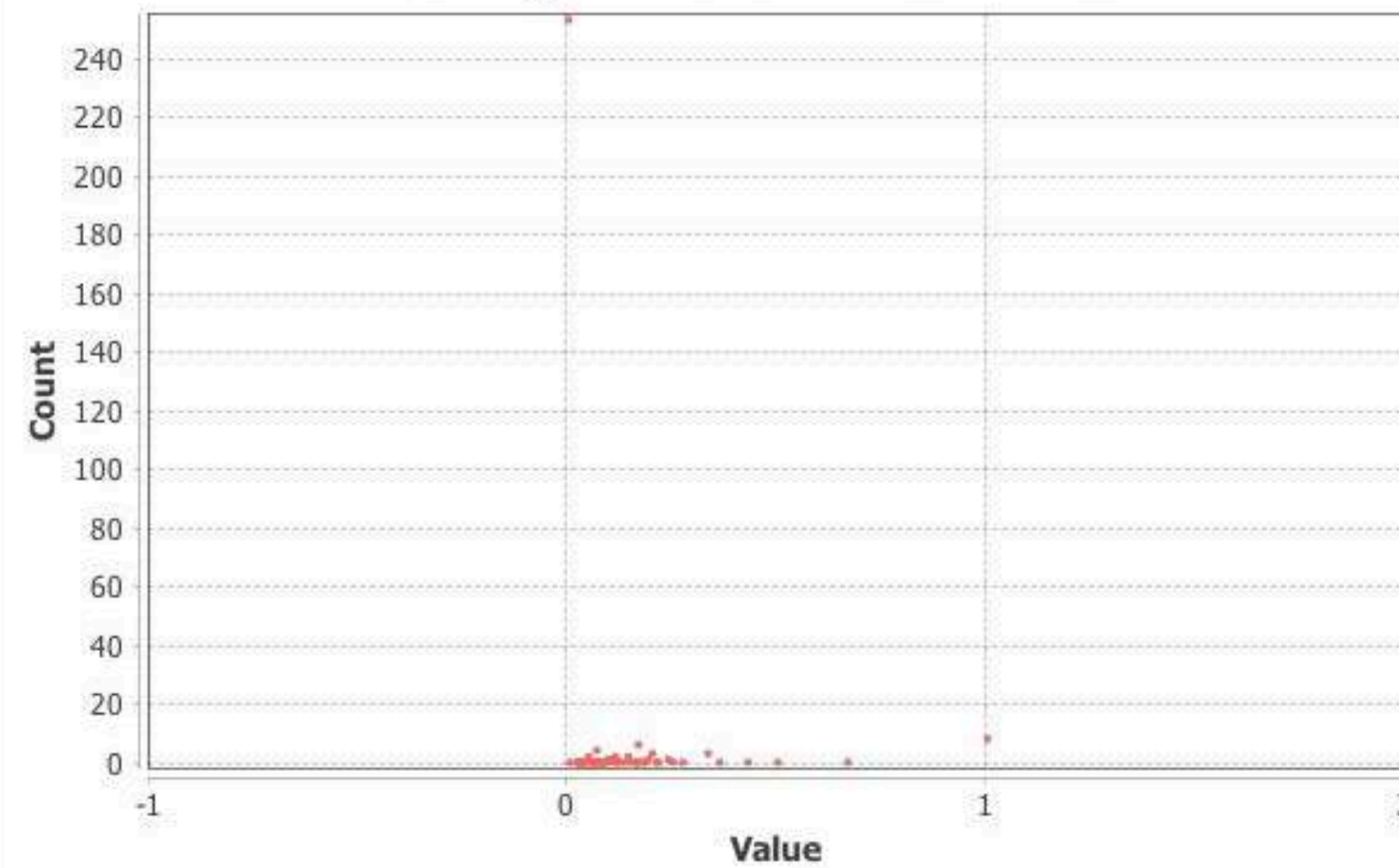
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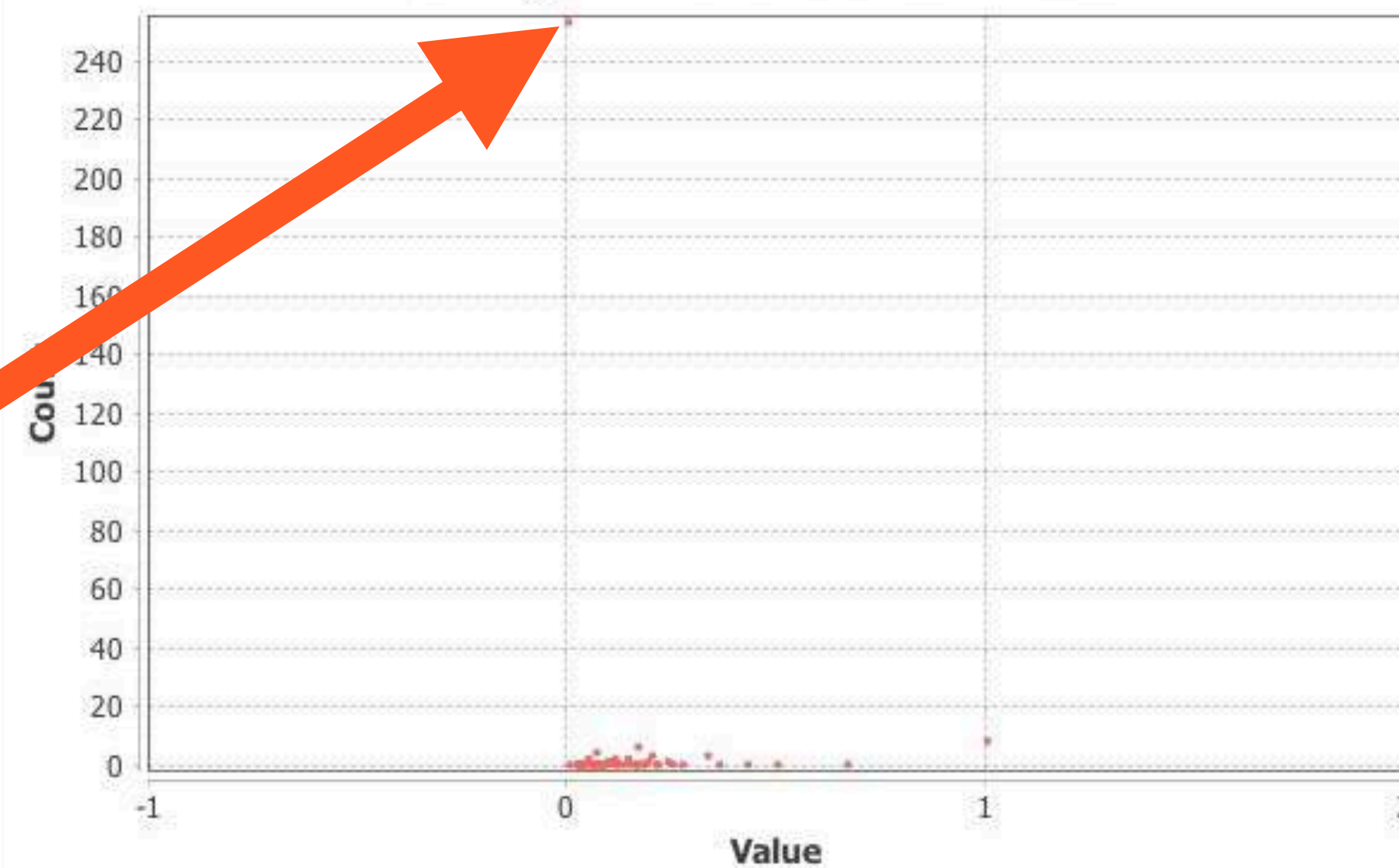
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Matthieu Latapy, *Main-memory Triangle Computations for Very Large (Sparse (Power-Law)) Graphs*, in Theoretical Computer Science (TCS) 407 (1-3), pages 458-473, 2008

Clustering Coefficient Metric Report

Parameters:

Network Interpretation: undirected

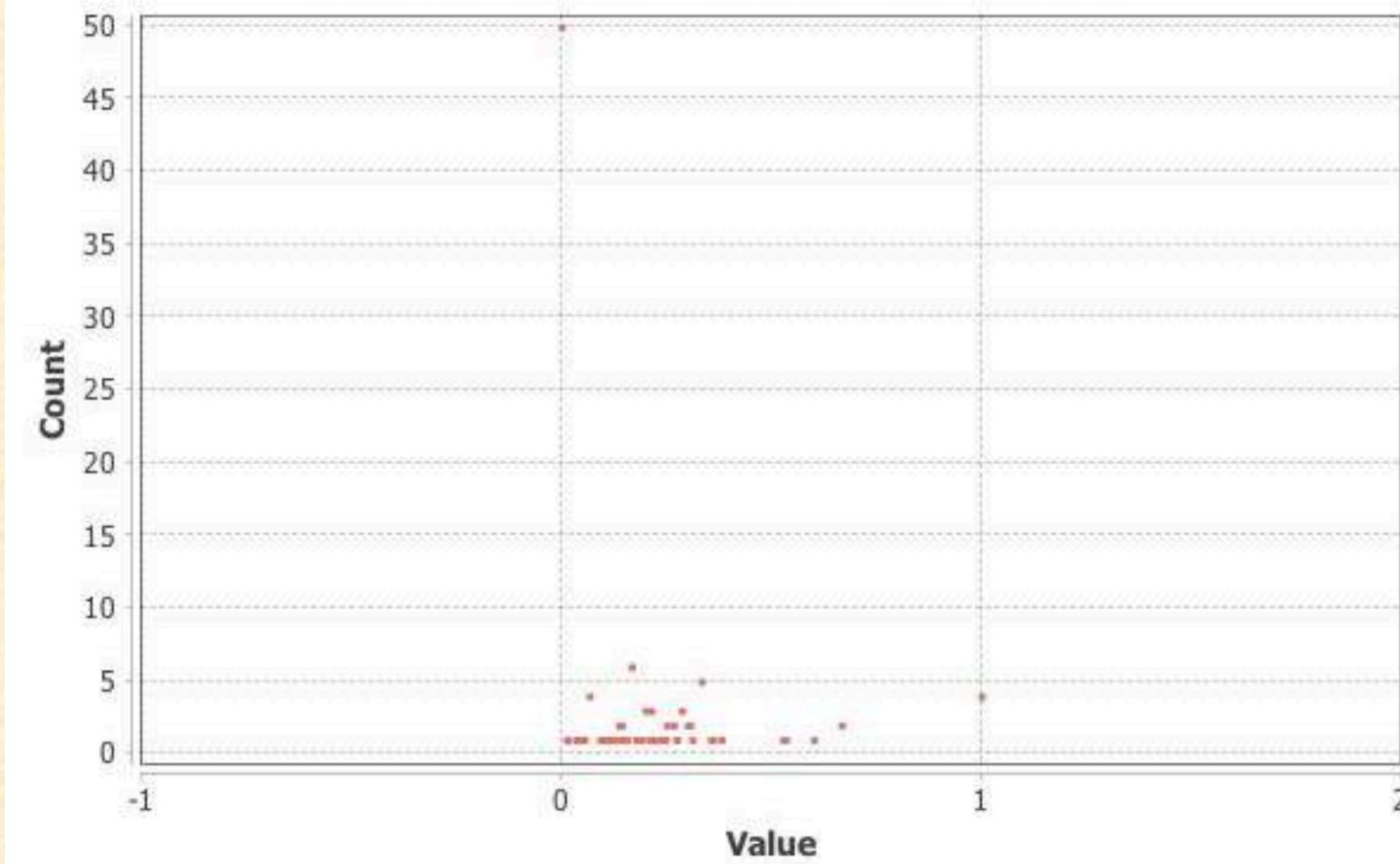
Results:

Average Clustering Coefficient: 0.211

Total triangles: 277

The Average Clustering Coefficient is the mean value of individual coefficients.

Clustering Coefficient Distribution



Algorithm:

Matthieu Latapy, *Main-memory Triangle Computations for Very Large (Sparse (Power-Law)) Graphs*, in Theoretical Computer Science (TCS) 407 (1-3), pages 458-473, 2008

Clustering Coefficient Metric Report

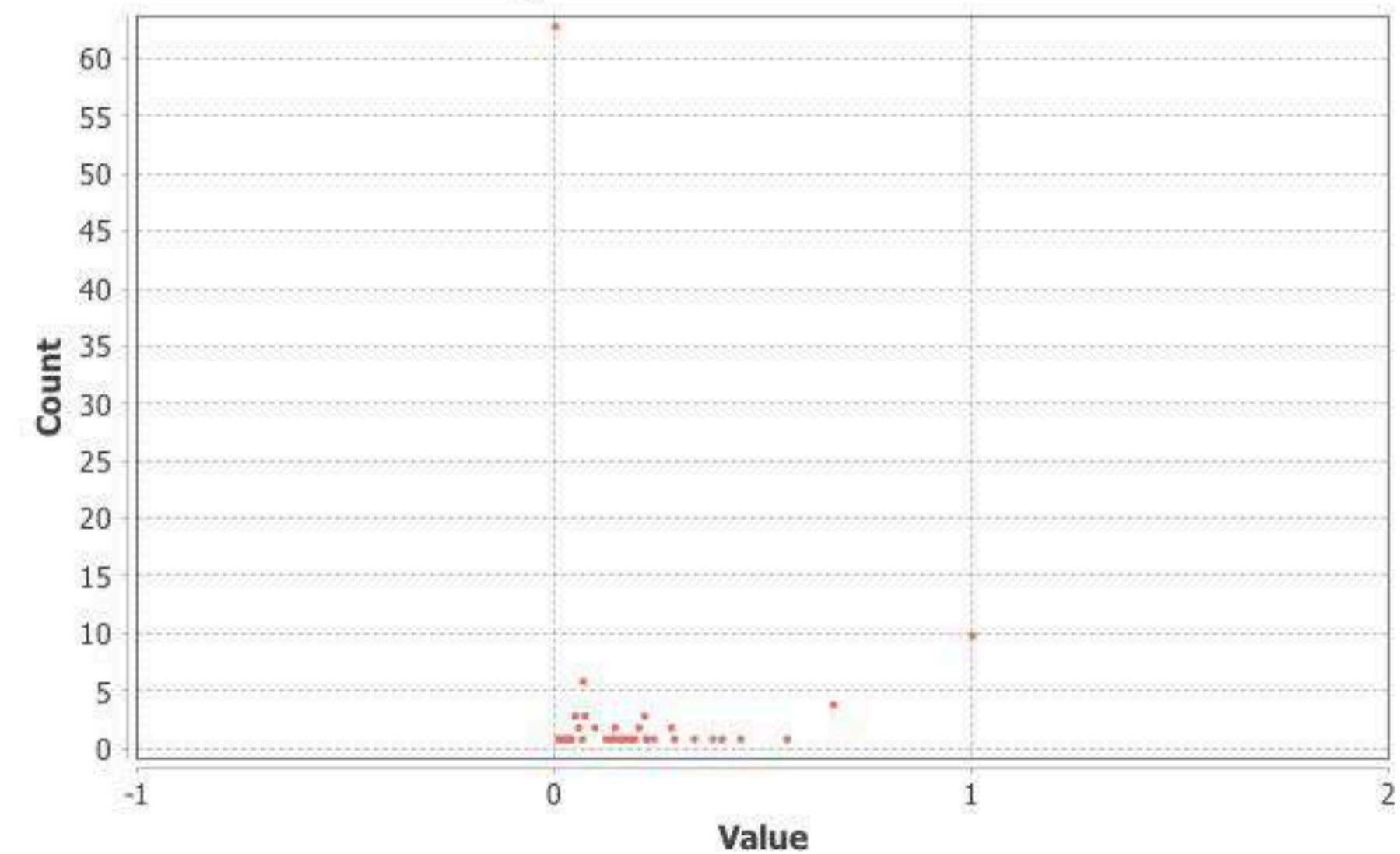
Parameters:

Network Interpretation: undirected

Results:

Average Clustering Coefficient: 0.207
Total triangles: 143
The Average Clustering Coefficient is the mean value of individual coefficients.

Clustering Coefficient Distribution



Algorithm:

Matthieu Latapy, *Main-memory Triangle Computations for Very Large (Sparse (Power-Law)) Graphs*, in Theoretical Computer Science (TCS) 407 (1-3), pages 458-473, 2008

Clustering Coefficient Metric Report

Parameters:

Network Interpretation: undirected

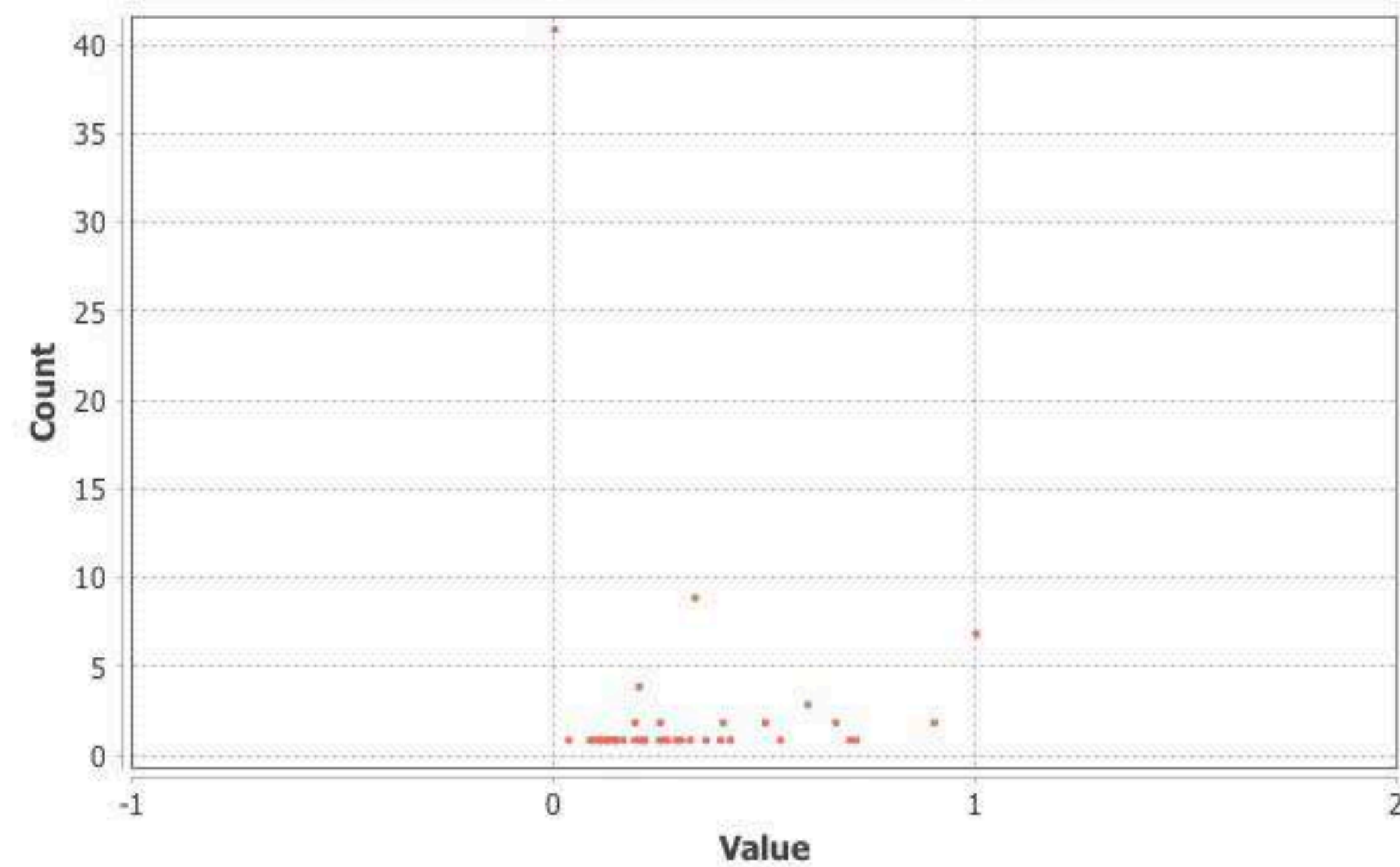
Results:

Average Clustering Coefficient: 0.337

Total triangles: 249

The Average Clustering Coefficient is the mean value of individual coefficients.

Clustering Coefficient Distribution



Clustering Coefficient Metric Report

Parameters:

Network Interpretation: undirected

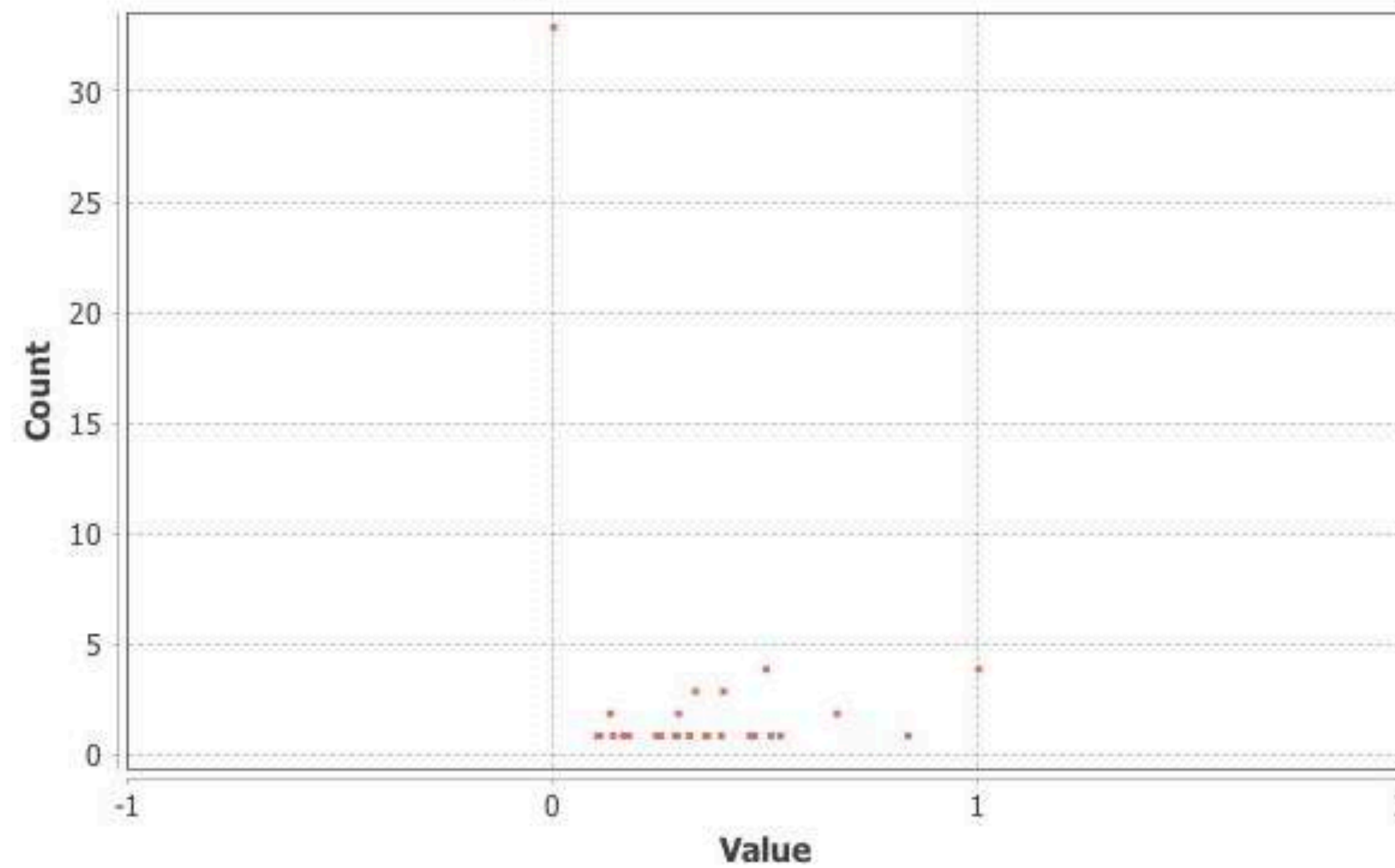
Results:

Average Clustering Coefficient: 0.319

Total triangles: 262

The Average Clustering Coefficient is the mean value of individual coefficients.

Clustering Coefficient Distribution



Clustering Coefficient Metric Report

Parameters:

Network Interpretation: undirected

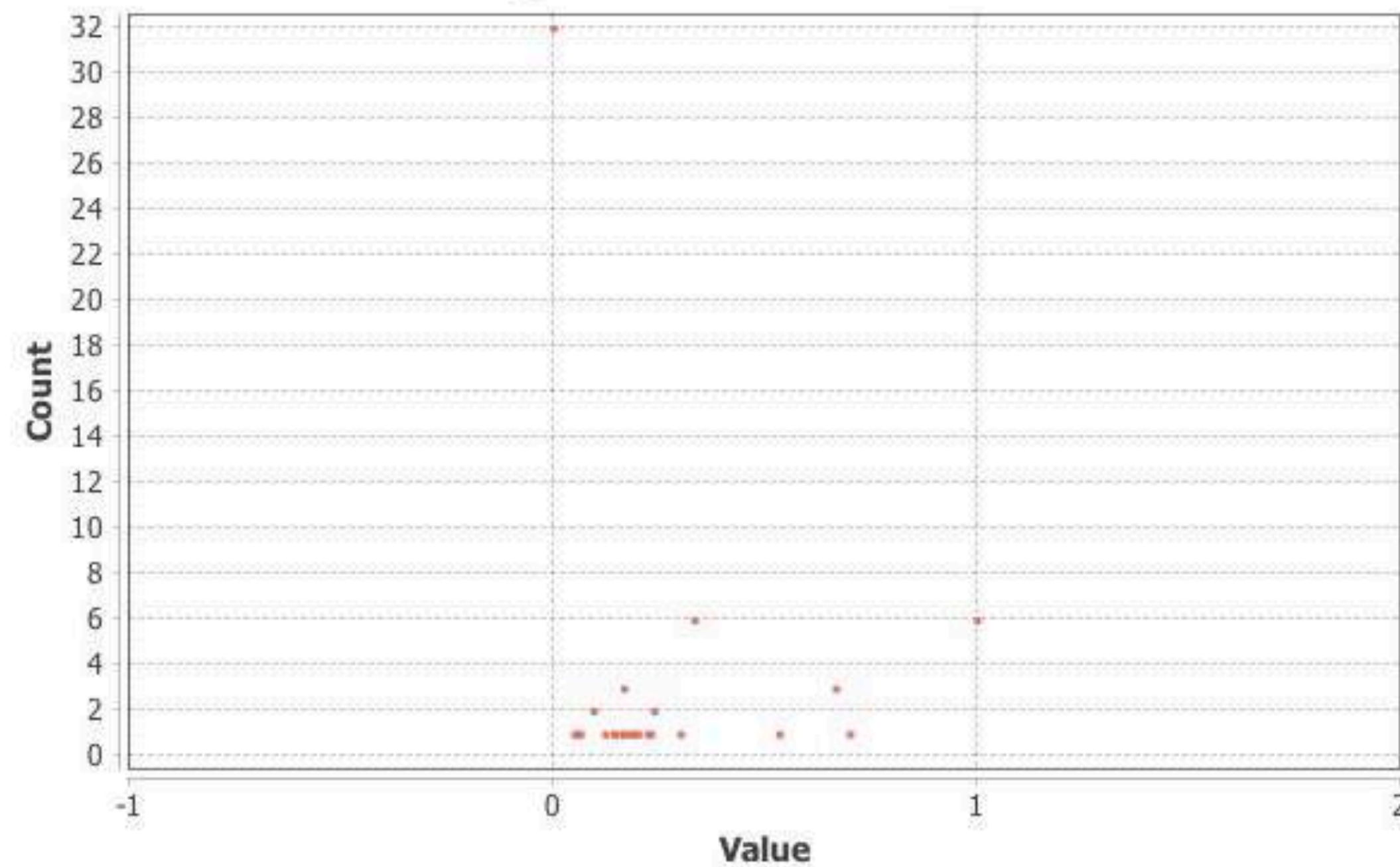
Results:

Average Clustering Coefficient: 0.315

Total triangles: 87

The Average Clustering Coefficient is the mean value of individual coefficients.

Clustering Coefficient Distribution



Clustering Coefficient Metric Report

Parameters:

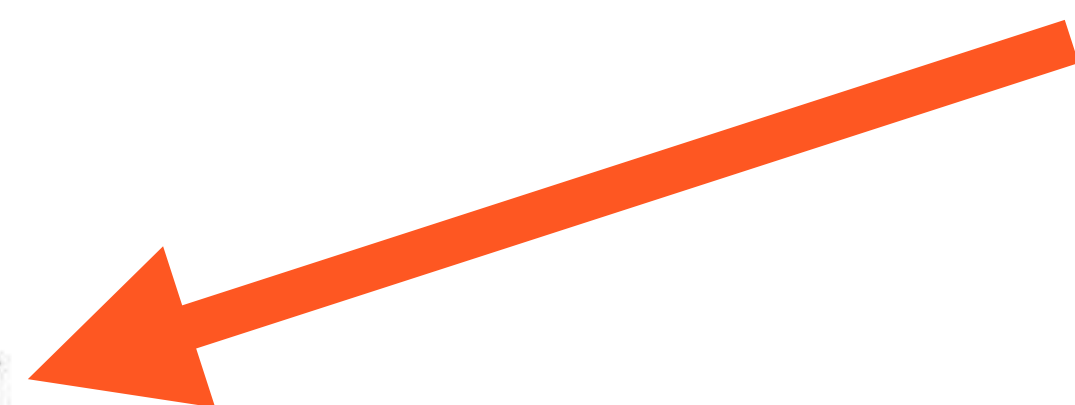
Network Interpretation: undirected

Results:

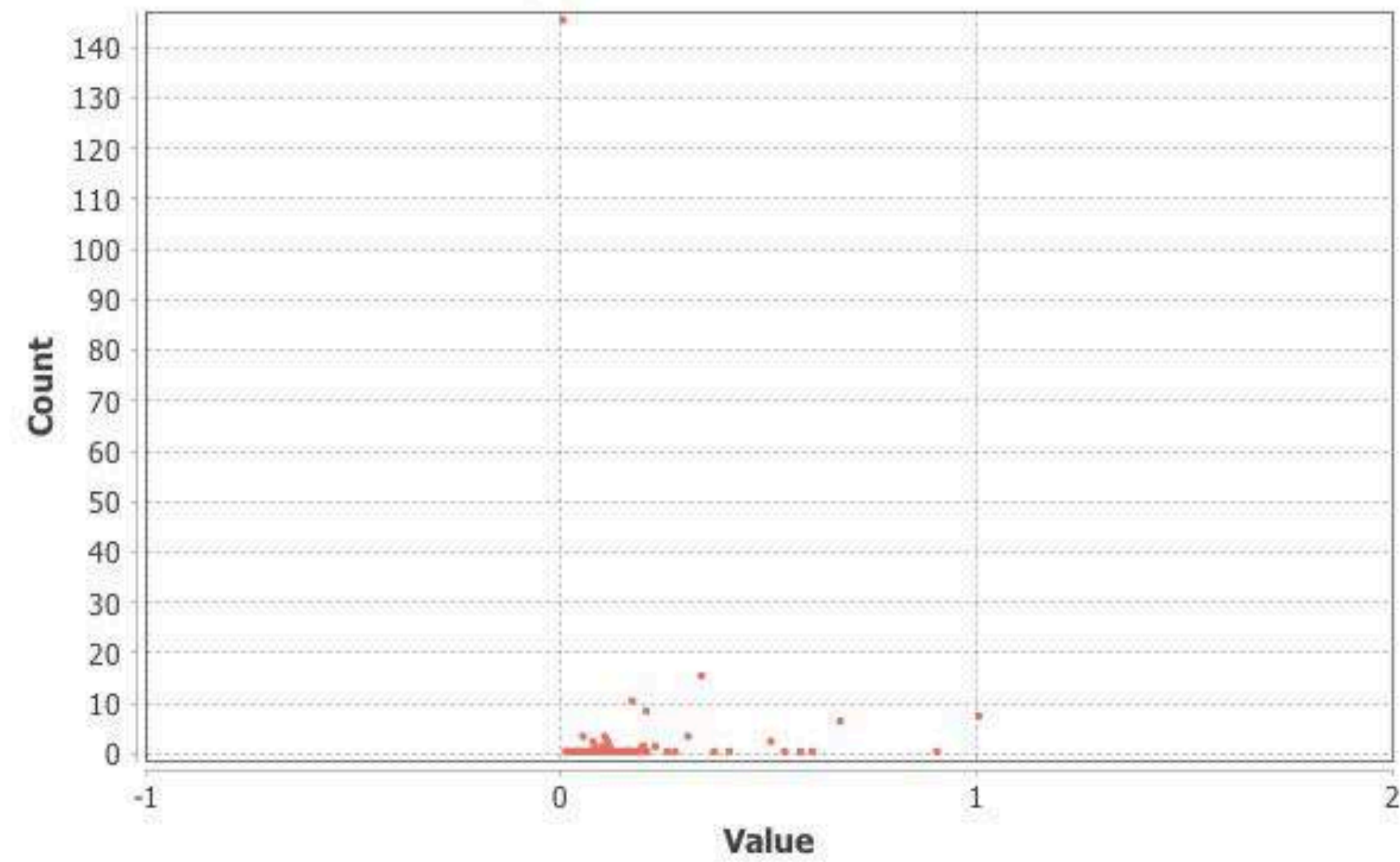
Average Clustering Coefficient: 0.207

Total triangles: 319

The Average Clustering Coefficient is the mean value of individual coefficients.



Clustering Coefficient Distribution



SMALL-WORLD NETWORK NOT FOUND 🙄

Graph Distance Report

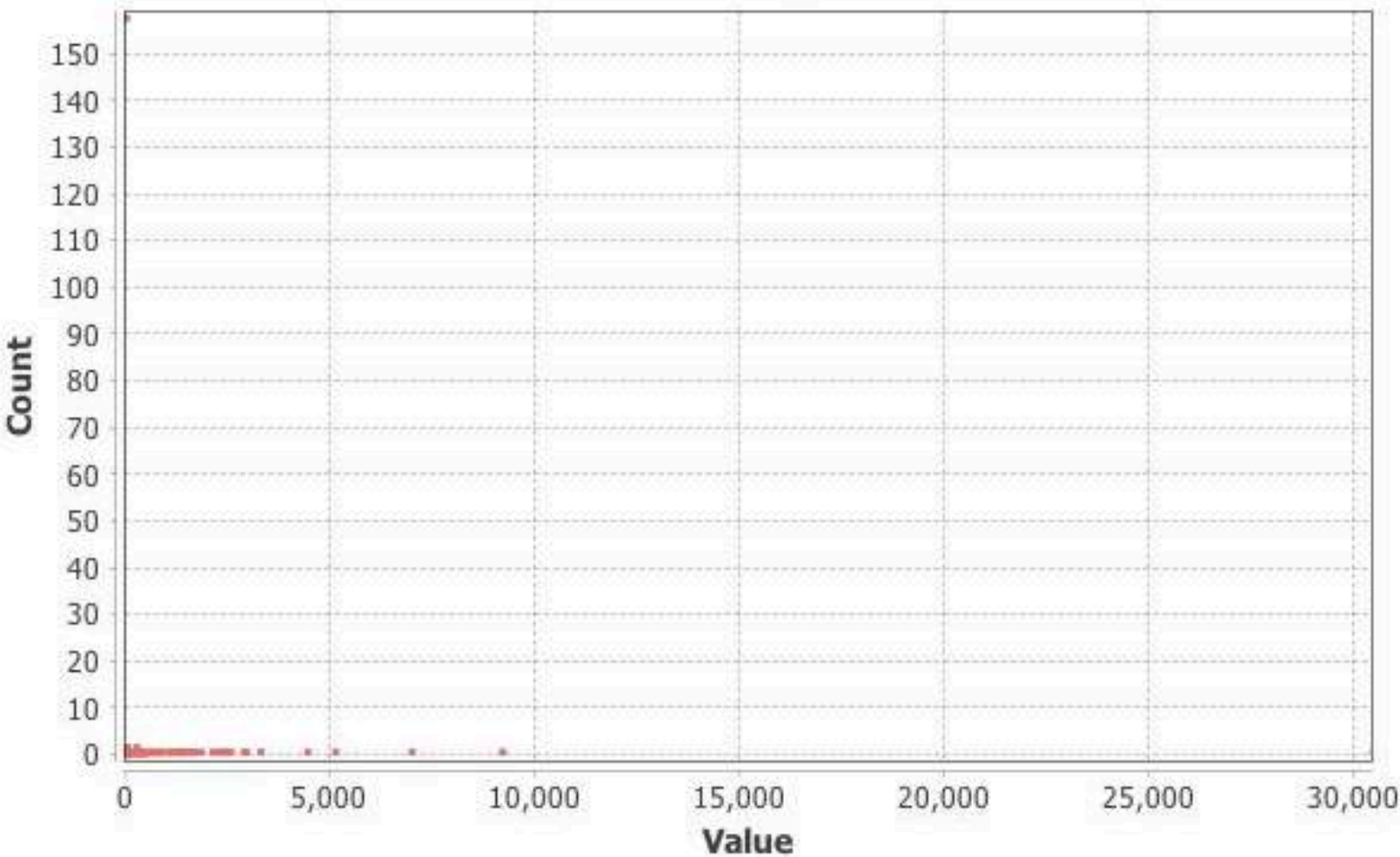
Parameters:

Network Interpretation: undirected

Results:

Diameter: 6
Radius: 4
Average Path length: 3.145054945054945

Betweenness Centrality Distribution



Closeness Centrality Distribution



Print Copy Save

Close

Graph Distance Report

Parameters:

Network Interpretation: undirected

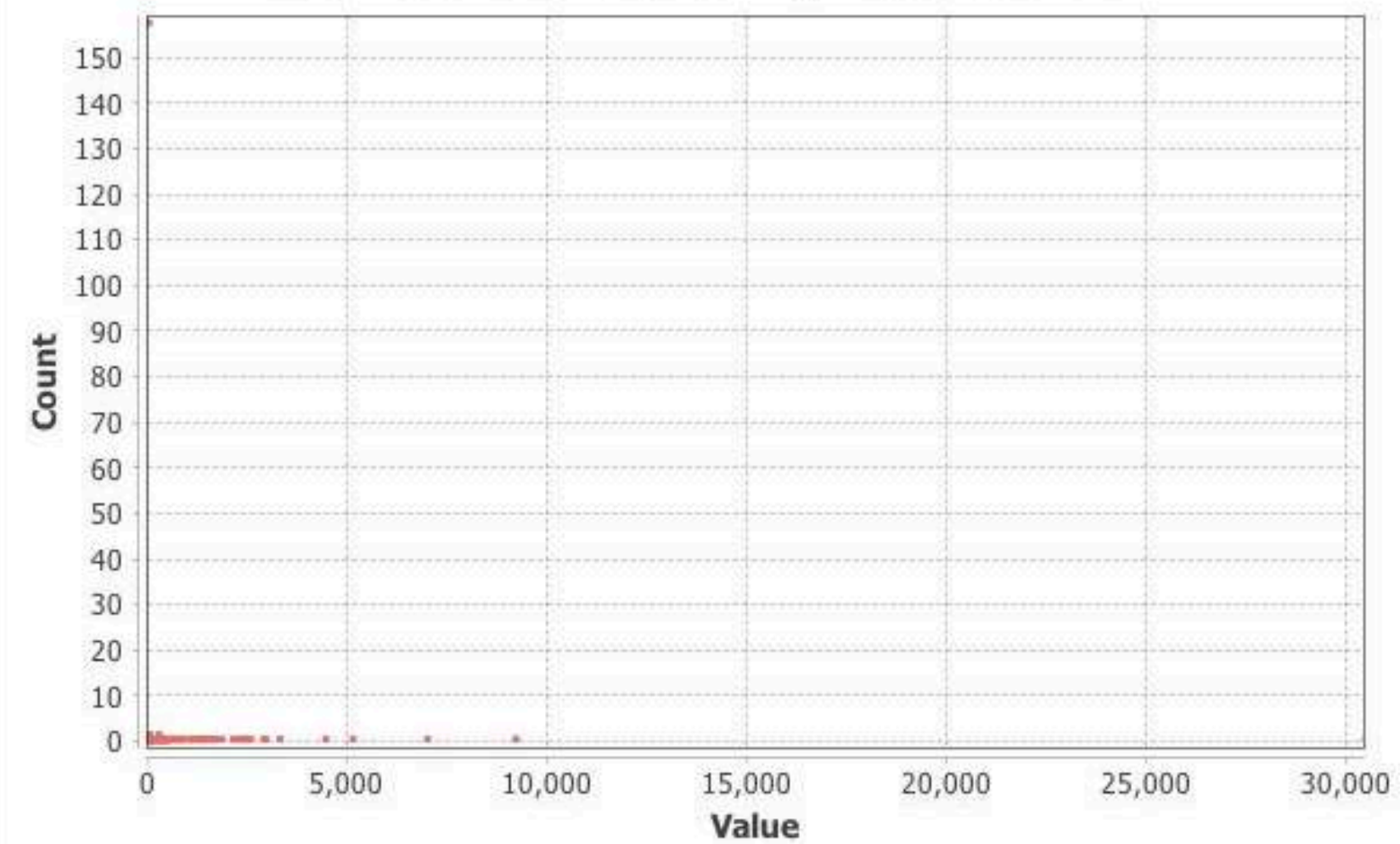
Results:

Diameter: 6

Radius: 4

Average Path length: 3.145054945054945

Betweenness Centrality Distribution



Closeness Centrality Distribution



Print Copy Save

Close





```
defmodule Benchee do
  def run(jobs, config_opts) do
    # convert user config_opts into structured data
    # get information about the system on which the benchmarks are running
    # convert user given benchmarking jobs into structured data
    # take benchmarking measurements
    # calculate statistics from measurements
    # output results to terminal
  end
end
```



```
defmodule Benchee do
  def run(jobs, config_opts) do
    config
    |> convert_user_opts()
    |> get_system_info()
    |> add_benchmarking_jobs(jobs)
    |> measure_runtimes()
    |> calculate_statistics()
    |> output_results()
  end

  def convert_user_opts(config_opts) do
    # ...
  end

  def get_system_info(benchmarking_suite) do
    # ...
  end

  # ...
end
```



```
defmodule Benchee do
  # ...

  def convert_user_opts(config_opts) do
    config_opts
    |> step_1
    |> step_2
    |> step_3
    |> step_4
    |> step_5
  end

  defp step_1(data) do
    # ...
  end

  defp step_2(data) do
    # ...
  end

  # ...
end
```

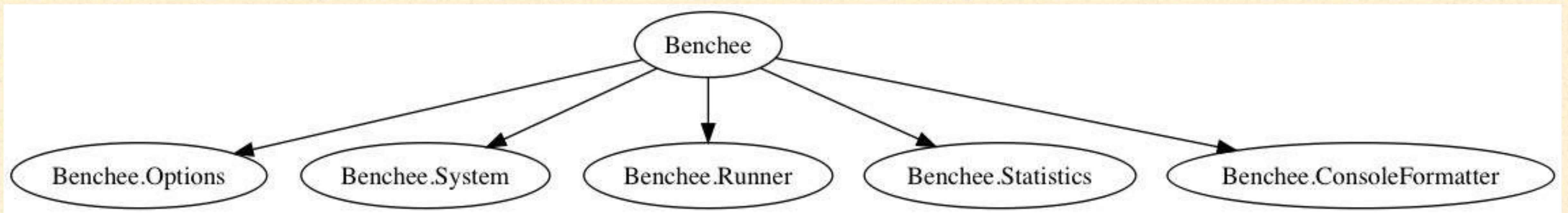


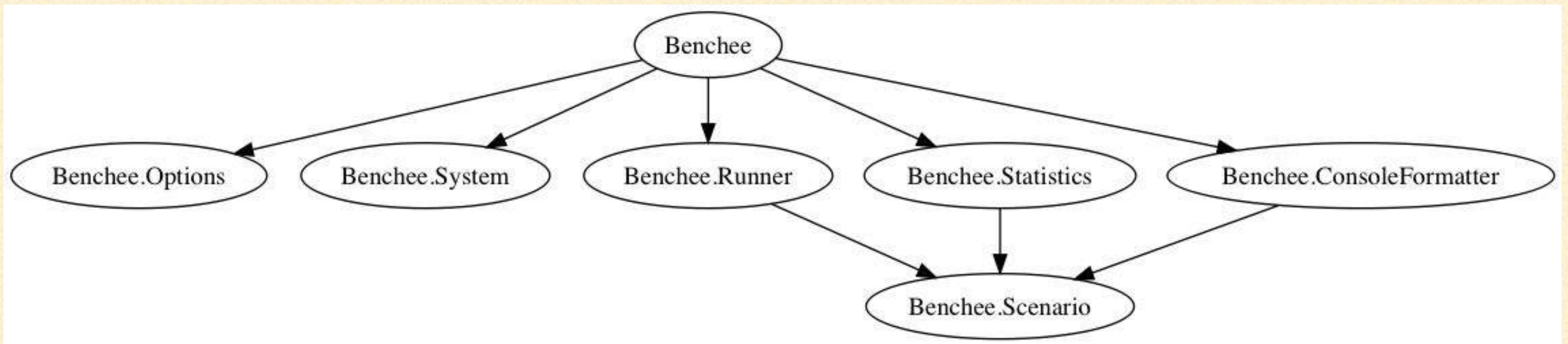
```
defmodule Benchee do
  def run(jobs, config_opts) do
    config
    |> Benchee.Options.convert()
    |> Benchee.System.info()
    |> Benchee.Benchmark.add(jobs)
    |> Benchee.Runner.run()
    |> Benchee.Statistics.calculate()
    |> Benchee.ConsoleFormatter.output_results()
  end
end

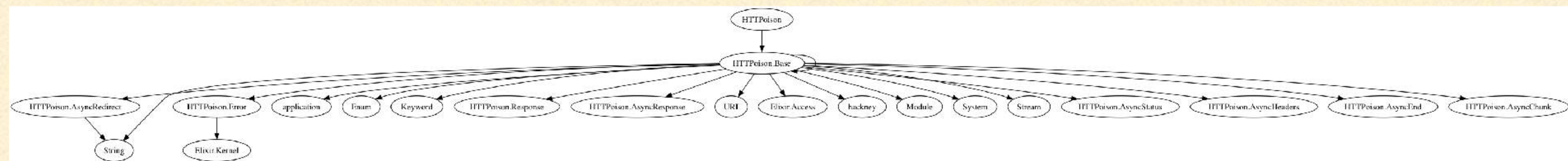
defmodule Benchee.Options do
  # ...
end

defmodule Benchee.System do
  # ...
end

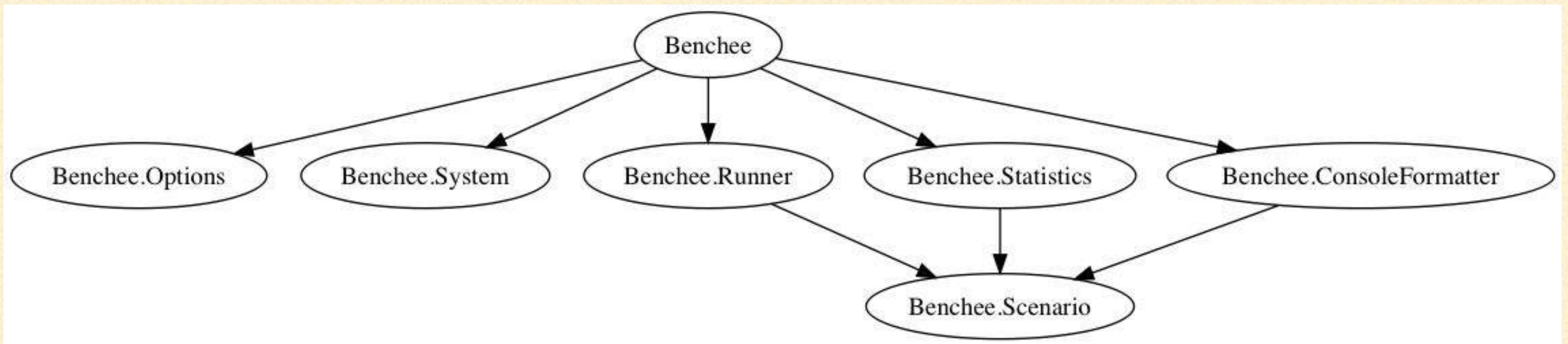
# ...
```

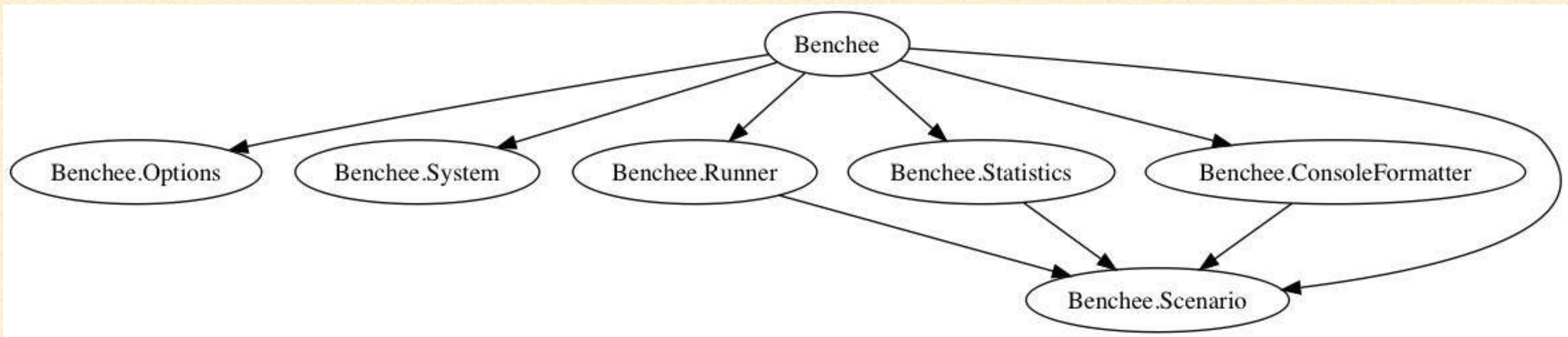



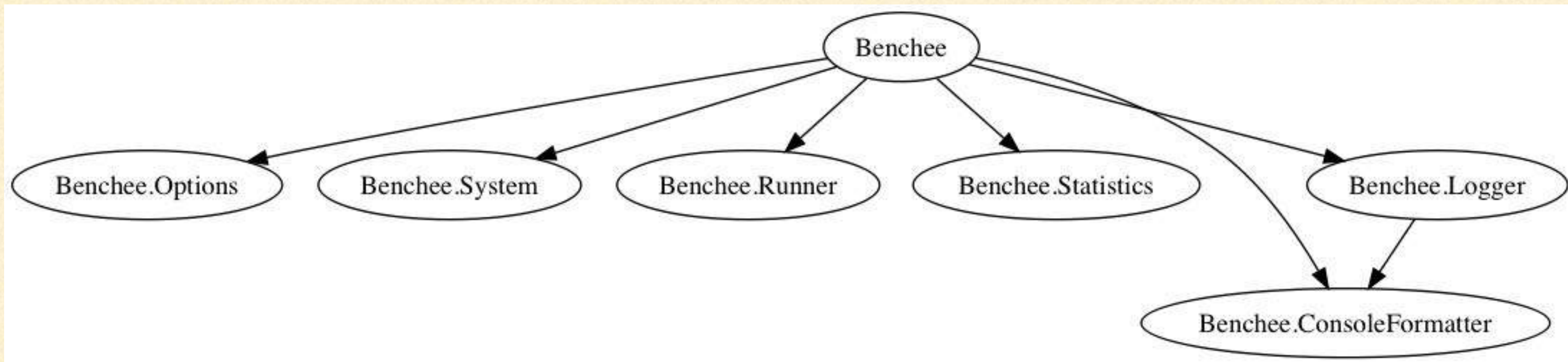


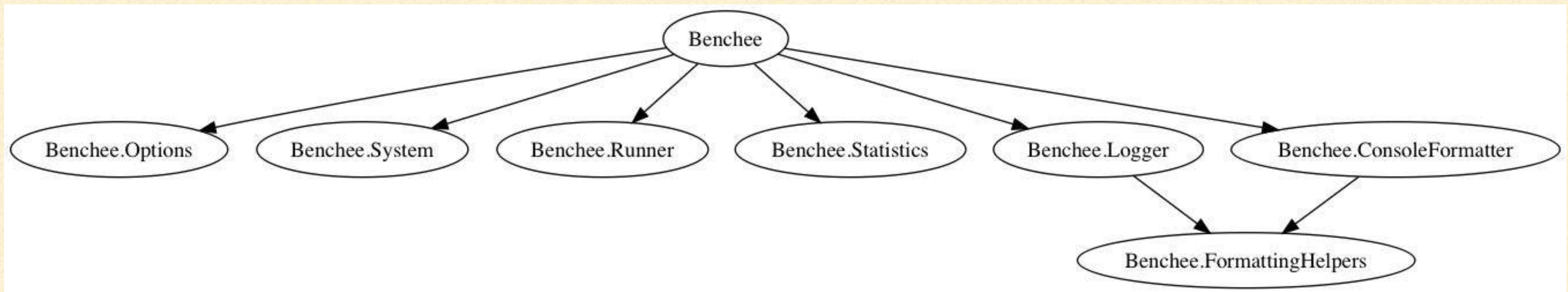


WHERE DOES CLUSTERING COME FROM?









“We hope that our work will stimulate further studies of small world networks... Although small-world architecture has not received much attention, we suggest that it will probably turn out to be widespread in biological, social and man-made systems, often with important dynamical consequences.”

— *“Collective dynamics of ‘small-world’ networks” by Duncan J. Watts & Steven H. Strogatz*

FURTHER RESEARCH IDEAS

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- Relationships between types?

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- Message sending in a large scale OTP application?

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- Relationships between services in a microservice architecture?

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FURTHER RESEARCH IDEAS

- Relationships between types?
- Message sending in a large scale OTP application?
- Relationships between services in a microservice architecture?
- Consensus seeking algorithms in distributed systems?
- Blockchain?

THANK YOU 🇵🇱!