HW 1: Degrees and Distributions

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Introduction

Welcome to Homework Assignment No. 1. For this week's assignment, you'll need to visit the course website. There, you'll find a shiny app to generate the graph you'll need for your homework assignment.

Instructions

- Input your first and last name
- Input the due date of the assignment [April 23, 2025]
- Download the `.RDS` file which contains your graph
- Load that `.RDS` file into your `R` environment and begin the assignment
  - This can be done with the command, 'readRDS()"

  Note: you may review the answers to graphs from any other **past** date. So, if you'd like to check if your code is correct, feel free to do so; however, you may not view the answers for any future dates. **Be sure to submit the graph/answers for the due date above!**

```r
library(igraph)
```

```
Attaching package: 'igraph'

The following objects are masked from 'package:stats':

    decompose, spectrum
```

```
The following object is masked from 'package:base':

    union
```

```r
library(poweRlaw)
```

```r
hw_graph <- readRDS("hw_graph.rds")
```

Below, you will find a template of the questions and fields to provide answers in either `R` or text format. Please use a mix of code and text to answer each question.

Questions

Question 1. Identify the vertex with the highest Degree

Answer

```r
deg <- degree(hw_graph)
max_deg <- which(deg == max(deg))
```

> The vertex with the highest degree is Node 32

Question 2. Identify the vertex with the highest Closeness

Answer

```r
clos <- closeness(hw_graph)
max_clos <- which(clos == max(clos))
```

> The vertex with the highest closeness is Node 32

Question 3. Identify the vertex with the highest Betweenness

Answer

```r
bet <- betweenness(hw_graph)
max_bet <- which(bet == max(bet))
```

> The vertex with the highest betweenness is Node 32

Question 4. Which Degree Distribution is likely to have generated your graph?

Answer

The graph is likely generated from an Erdős–Rényi distribution.

Question 5. Calculate the Density of your graph

Answer

```
ed <- edge_density(hw_graph)
```

The graph density is given by 0.4. That means that approximately 40% of the possible edges are present.

Question 6. Determine the Diameter of your graph

Answer

```
dia <- diameter(hw_graph)
```

The longest shortest path between any two nodes is 2 steps.

Question 7. Calculate the Average Path Length

Answer

```
apl <- mean_distance(hw_graph)
```

On average, any two vertices are 1.6 steps apart.

Question 8. If you believe your graph is a Barabasi-Albert power law or an Erdos-Renyi random graph, perform a statistical test to support your claim. Alternatively, discuss–and provide evidence–that your graph is a Watts-Strogatz small-world graph.

Answer

```r
degrees <- degree(hw_graph)

is.erdosrenyi <- dispois$new(degrees)
is.erdosrenyi$setXmin(estimate_xmin(is.erdosrenyi))

bs.er <- bootstrap_p(is.erdosrenyi, no_of_sims = 500, threads = 12)
```

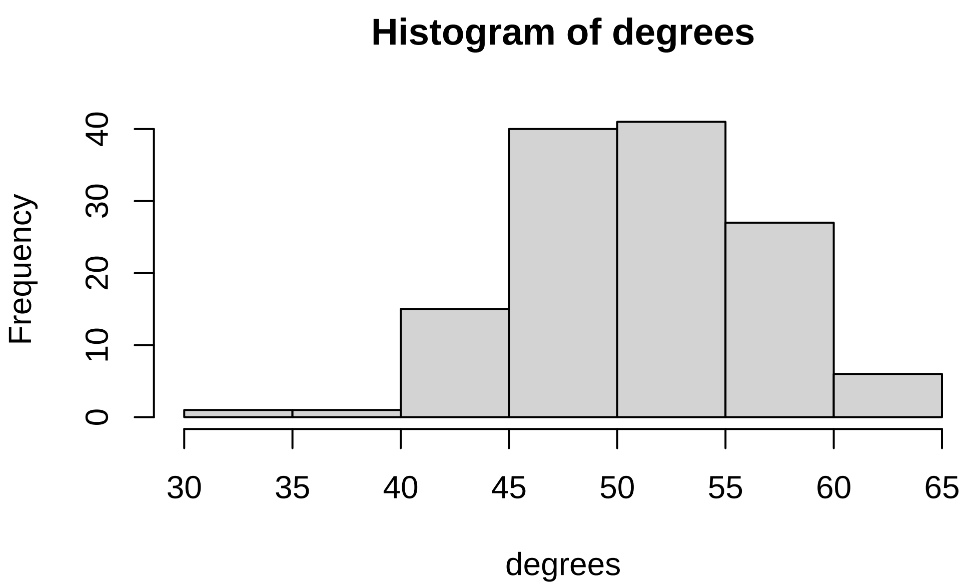
```
Expected total run time for 500 sims, using 12 threads is 0.654 seconds.
```

We do not have evidence to reject the null hypothesis that the graph was generated from a Poisson distribution: KS $= 0.045$, $p = 0.712$

Question 9. Visualize the degree distribution implied by your graph

Answer

```r
hist(degrees)
```



Question 10 [Bonus]. Write out the formulation of a graph (G) that gives rise to a bipartite graph. Define both V and E

Answer