Random Network Models - Chapter 10

Nick Lauerman

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Contents

Libraries and Data

Libraries used

```
library(igraph)
```

```
##
## Attaching package: 'igraph'
```

```
## The following objects are masked from 'package:stats':
##
##     decompose, spectrum
```

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

```
library(lattice)
#library(ergmharris)
```

data sets used

```
#data("lhds")
```

Models of Network Structures and Formation

Erdos-Renyi Random Graph Model

```
g <- erdos.renyi.game(n = 12,
                      10,
                      type = "gnm")
g
```

```
## IGRAPH e8992f5 U--- 12 10 -- Erdos renyi (gnm) graph
## + attr: name (g/c), type (g/c), loops (g/l), m (g/n)
## + edges from e8992f5:
##  [1] 2-- 4 3-- 7 1-- 8 4-- 8 3--10 5--10 3--11 4--11 2--12 9--12
```

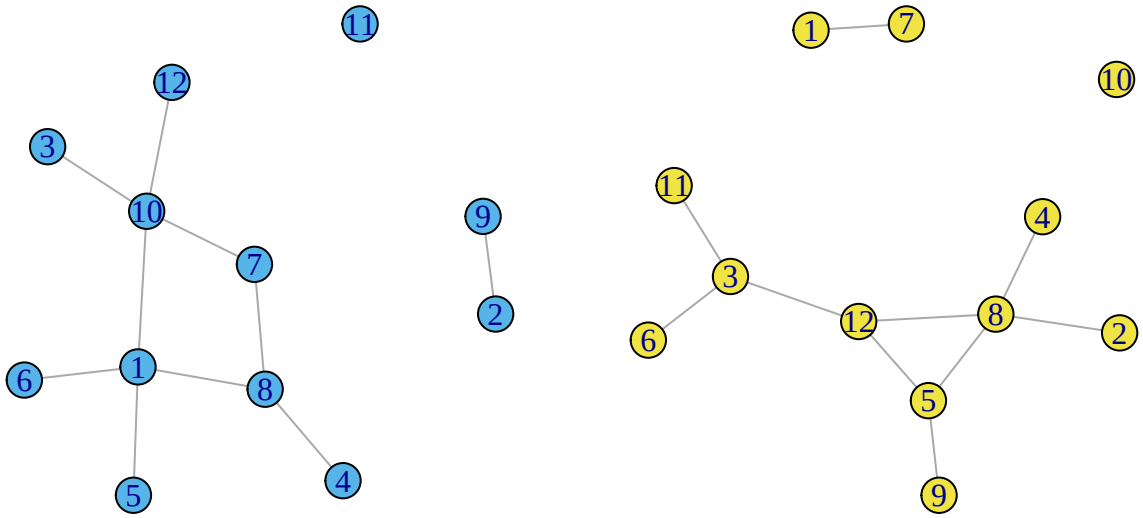
```
graph.density(g)
```

```
## [1] 0.1515152
```

```
op <- par(mar = c(0,1,3,1),
          mfrow = c(1,2))
plot(erdos.renyi.game(n = 12,
                      10,
                      type = "gnm"),
     vertex.color = 2,
     main = "first random graph")
plot(erdos.renyi.game(n = 12,
                      10,
                      type = "gnm"),
     vertex.color = 4,
     main = "second random graph")
```

first random graph

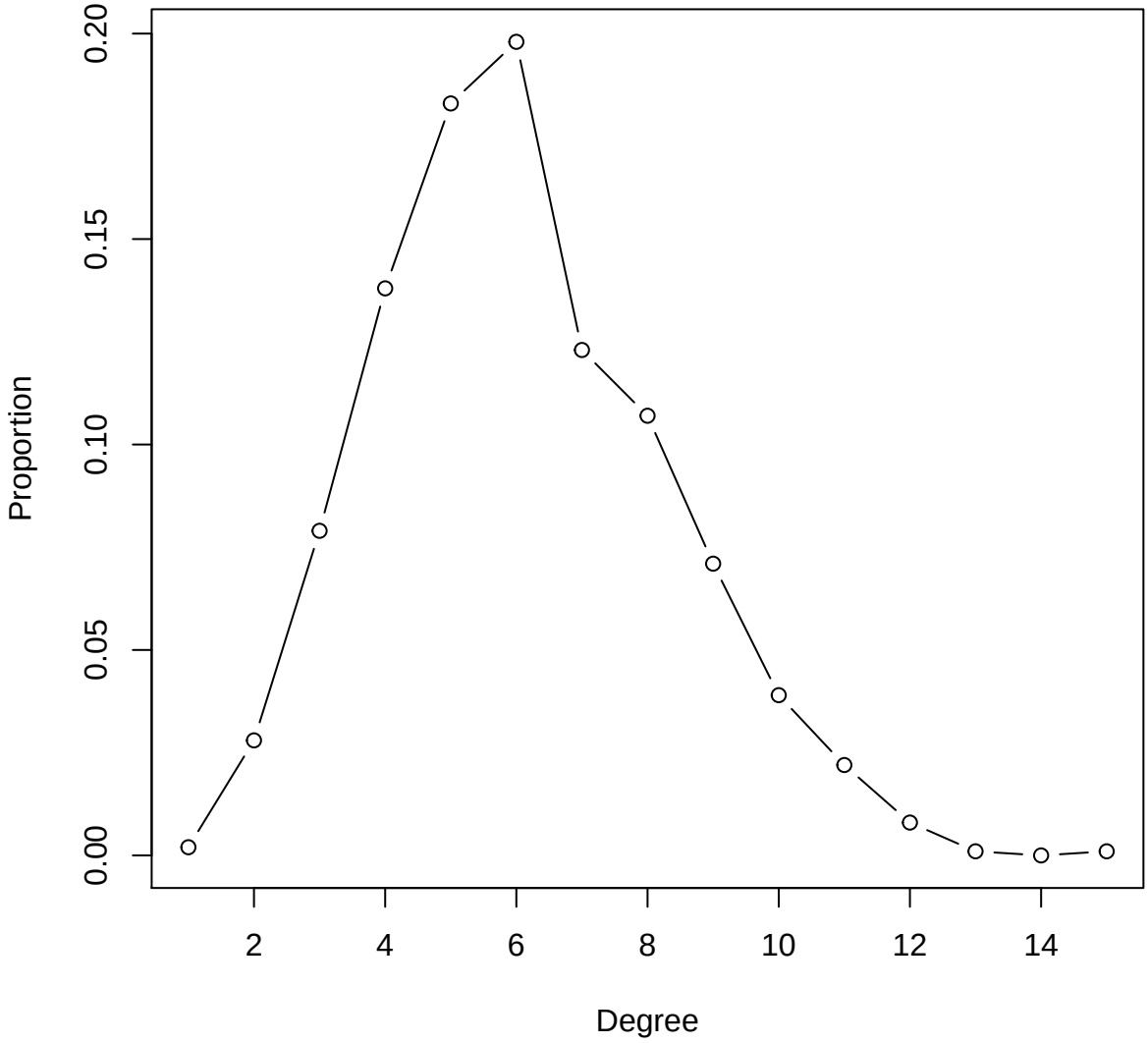
second random graph




```
par(op)
```

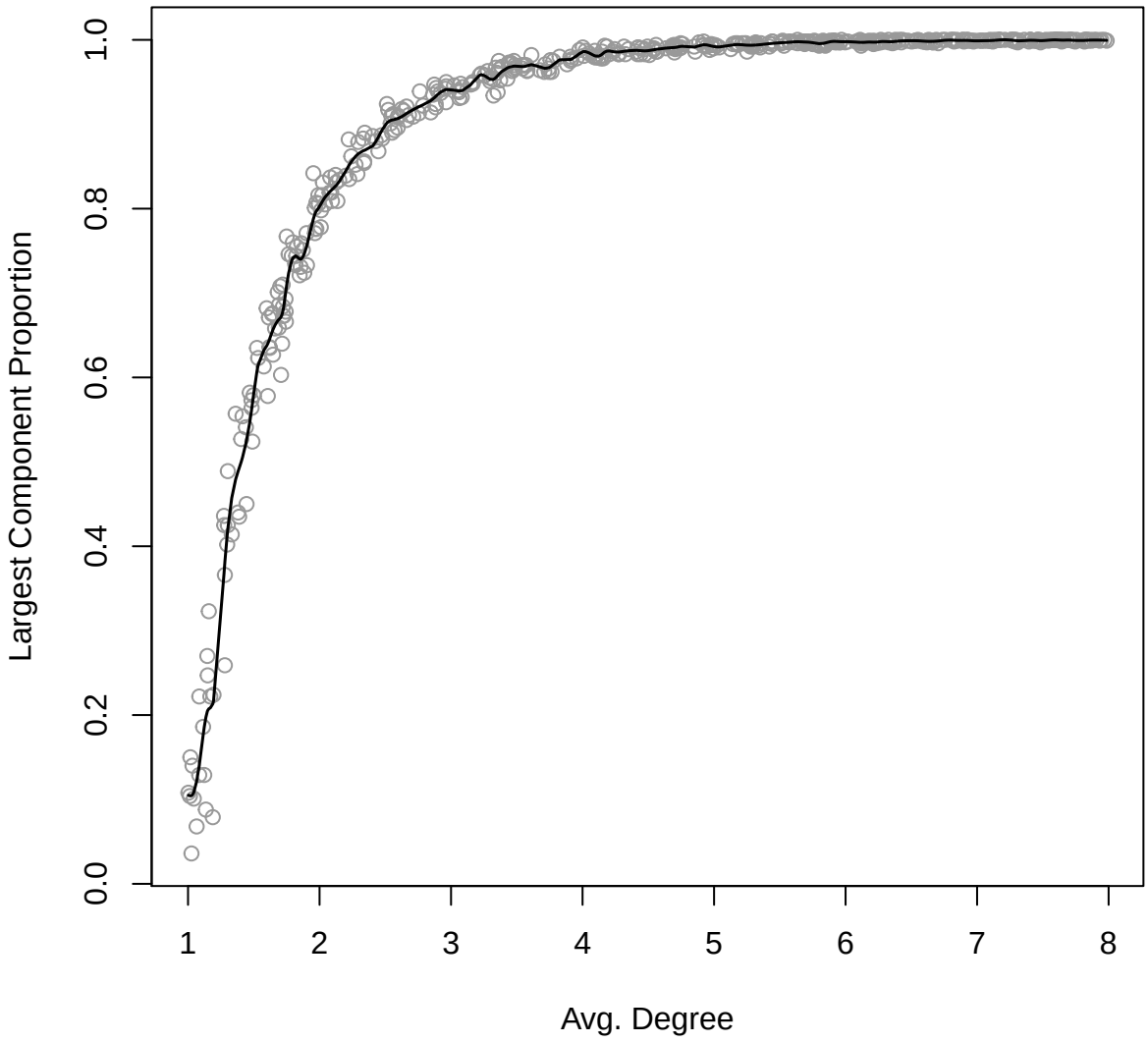
```
g <- erdos.renyi.game(n = 1000,
                      0.005,
                      type = "gnp")
```

```
plot(degree.distribution(g),
     type = "b",
     xlab = "Degree",
     ylab = "Proportion")
```



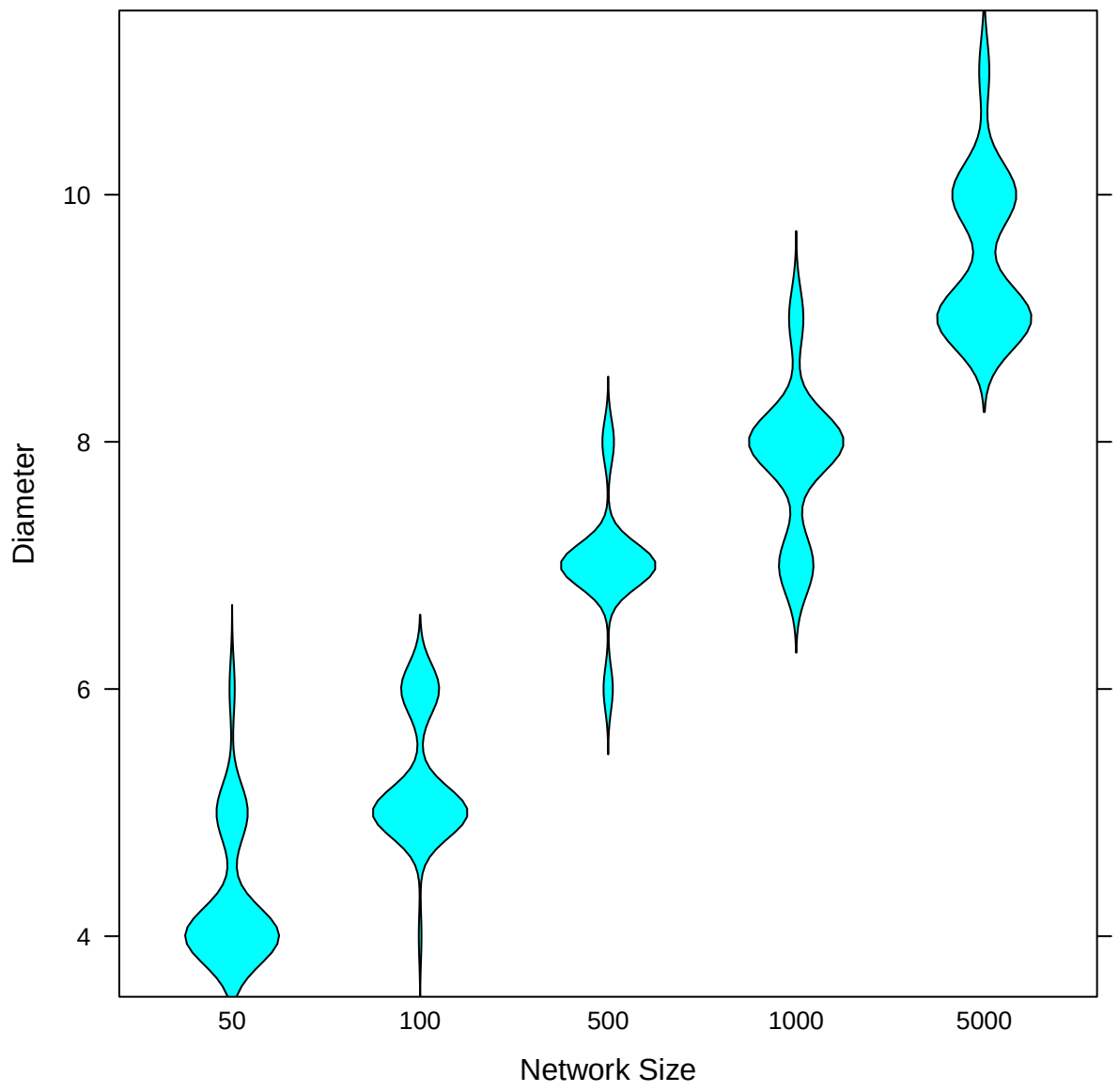

```
crnd <- runif(500, 1, 8)
cmp_prp <- sapply(crnd, function(x)
     max(clusters(erdos.renyi.game(n = 1000,
                                   p = x/999))$csize)/1000)
smoothingSpline <- smooth.spline(crnd,
                                 cmp_prp,
                                 spar = 0.25)
```

```
plot(crnd, cmp_prp,
     col = "grey60",
     xlab = "Avg. Degree",
     ylab = "Largest Component Proportion")
lines(smoothingSpline,
      lwd = 1.5)
```




```
n_vect <- rep(c(50, 100, 500, 1000, 5000),
              each = 50)
g_diam <- sapply(n_vect, function(x)
     diameter(erdos.renyi.game(n = x,
                               p = 6/(x - 1))))
library(lattice)
```

```
bwplot(g_diam ~ factor(n_vect),
       panel = panel.violin,
       xlab = "Network Size",
       ylab = "Diameter")
```

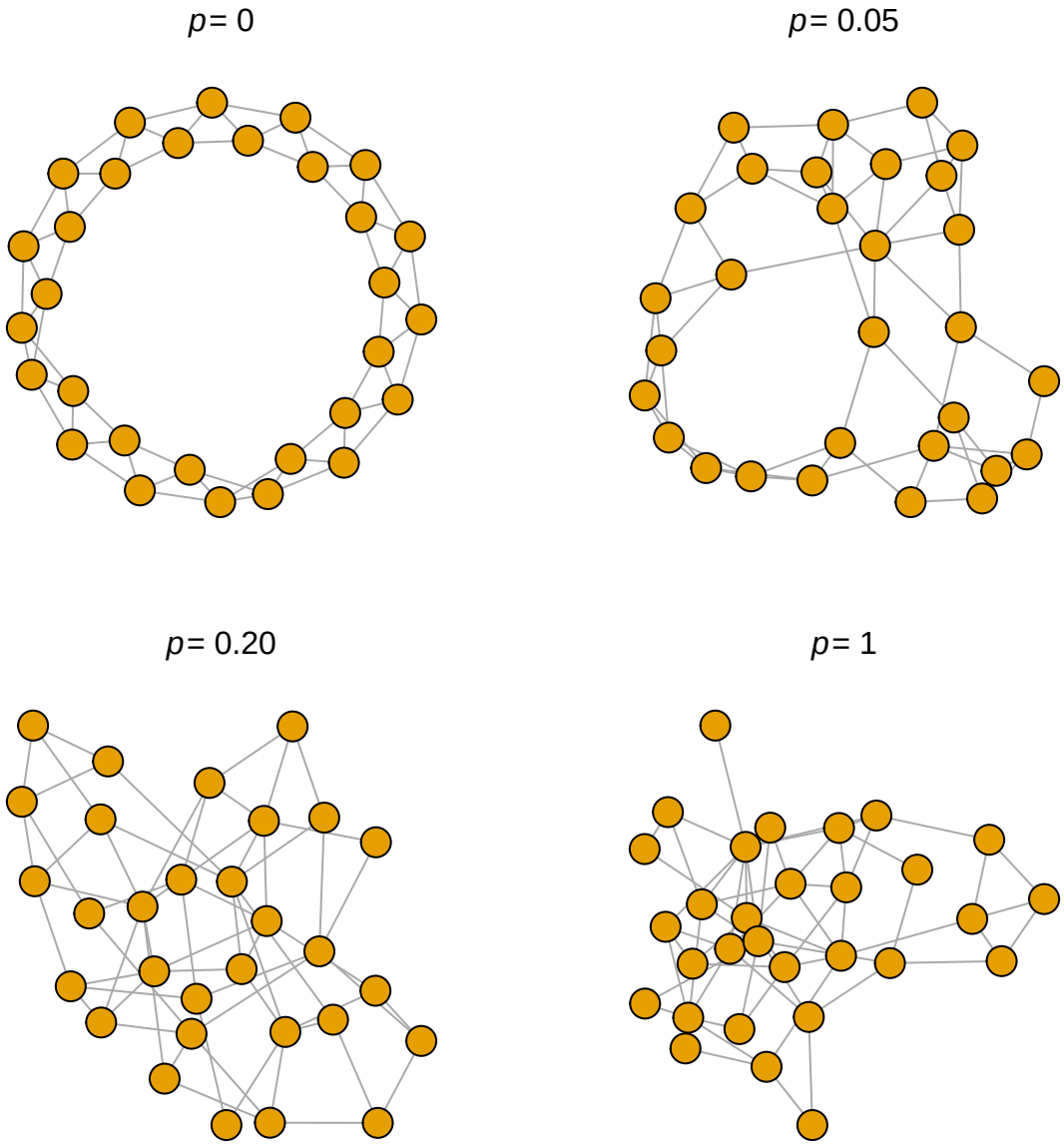


Small-World Model

```
g1 <- watts.strogatz.game(dim = 1,
                          size = 30,
                          nei = 2,
                          p = 0)
g2 <- watts.strogatz.game(dim = 1,
                          size = 30,
                          nei = 2,
                          p = 0.05)
g3 <- watts.strogatz.game(dim = 1,
                          size = 30,
                          nei = 2,
```

```
                          p = 0.20)
g4 <- watts.strogatz.game(dim = 1,
                          size = 30,
                          nei = 2,
                          p = 1)
```

```
op <- par(mar = c(2,1,3,1),
          mfrow = c(2,2))
plot(g1,
     vertex.label = NA,
     main = expression(paste(italic(p), "= 0")),
     layout = layout_with_kk)
plot(g2,
     vertex.label = NA,
     main = expression(paste(italic(p), "= 0.05")))
plot(g3,
     vertex.label = NA,
     main = expression(paste(italic(p), "= 0.20")))
plot(g4,
     vertex.label = NA,
     main = expression(paste(italic(p), "= 1")))
```




```
par(op)
```

```
g100 <- watts.strogatz.game(dim = 1,
                            size = 100,
                            nei = 2,
                            p = 0)
g100
```

```
## IGRAPH 126943f U--- 100 200 -- Watts-Strogatz random graph
## + attr: name (g/c), dim (g/n), size (g/n), nei (g/n), p (g/n), loops
## | (g/l), multiple (g/l)
## + edges from 126943f:
##  [1]  1-- 2  2-- 3  3-- 4  4-- 5  5-- 6  6-- 7  7-- 8  8-- 9  9--10 10--11
## [11] 11--12 12--13 13--14 14--15 15--16 16--17 17--18 18--19 19--20 20--21
## [21] 21--22 22--23 23--24 24--25 25--26 26--27 27--28 28--29 29--30 30--31
```

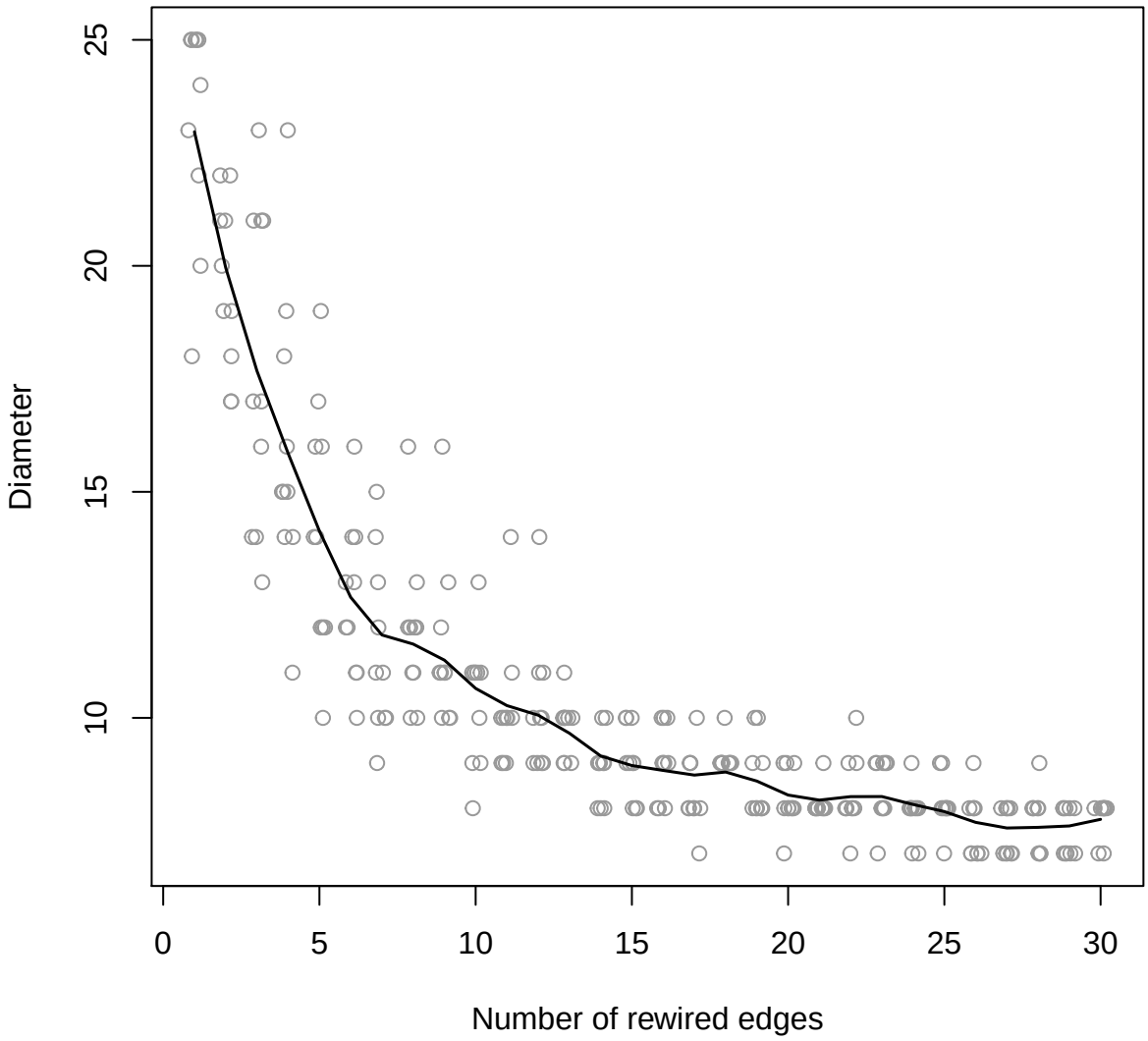
```
## [31] 31--32 32--33 33--34 34--35 35--36 36--37 37--38 38--39 39--40 40--41
## [41] 41--42 42--43 43--44 44--45 45--46 46--47 47--48 48--49 49--50 50--51
## [51] 51--52 52--53 53--54 54--55 55--56 56--57 57--58 58--59 59--60 60--61
## [61] 61--62 62--63 63--64 64--65 65--66 66--67 67--68 68--69 69--70 70--71
## + ... omitted several edges
```

```
diameter(g100)
```

```
## [1] 25
```

```
p_vect <- rep(1:30,
              each = 10)
g_diam <- sapply(p_vect,
                 function(x)
                      diameter(watts.strogatz.game(dim = 1,
                                                   size = 100,
                                                   nei = 2,
                                                   p=x/200)))
smoothingSpline <- smooth.spline(p_vect, g_diam,
                                 spar = 0.35)
```

```
plot(jitter(p_vect, 1),
     g_diam,
     col = "grey60",
     xlab = "Number of rewired edges",
     ylab = "Diameter")
lines(smoothingSpline,
      lwd = 1.5)
```



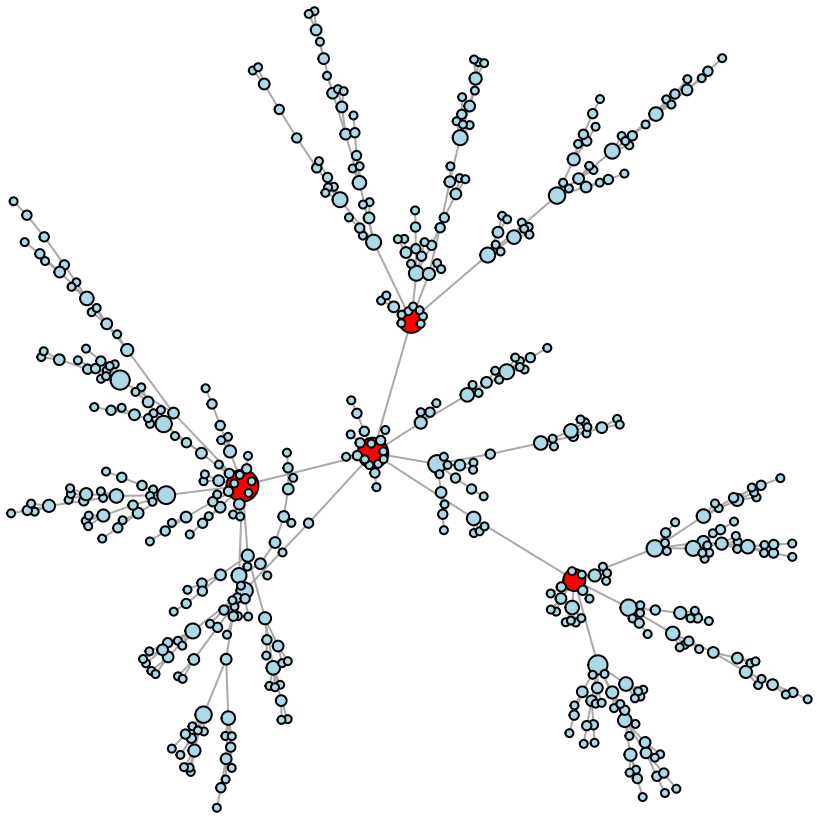
Scale-Free Models

```
# from chapter 5
rescale <- function(nchar, low, high){
  min_d <- min(nchar)
  max_d <- max(nchar)
  rscl <- ((high - low) * (nchar - min_d)) /
    (max_d - min_d) + low
  return(rscl)
}
```

```
g <- barabasi.game(500,
                   directed = FALSE)
V(g)$color <- "lightblue"
```

```
V(g)[degree(g) > 9]$color <- "red"
node_size <- rescale(nchar = degree(g),
                     low = 2,
                     high = 8)
```

```
plot(g,
     vertex.label = NA,
     vertex.size = node_size)
```



```
median(degree(g))
```

```
## [1] 1
```

```
mean(degree(g))
```

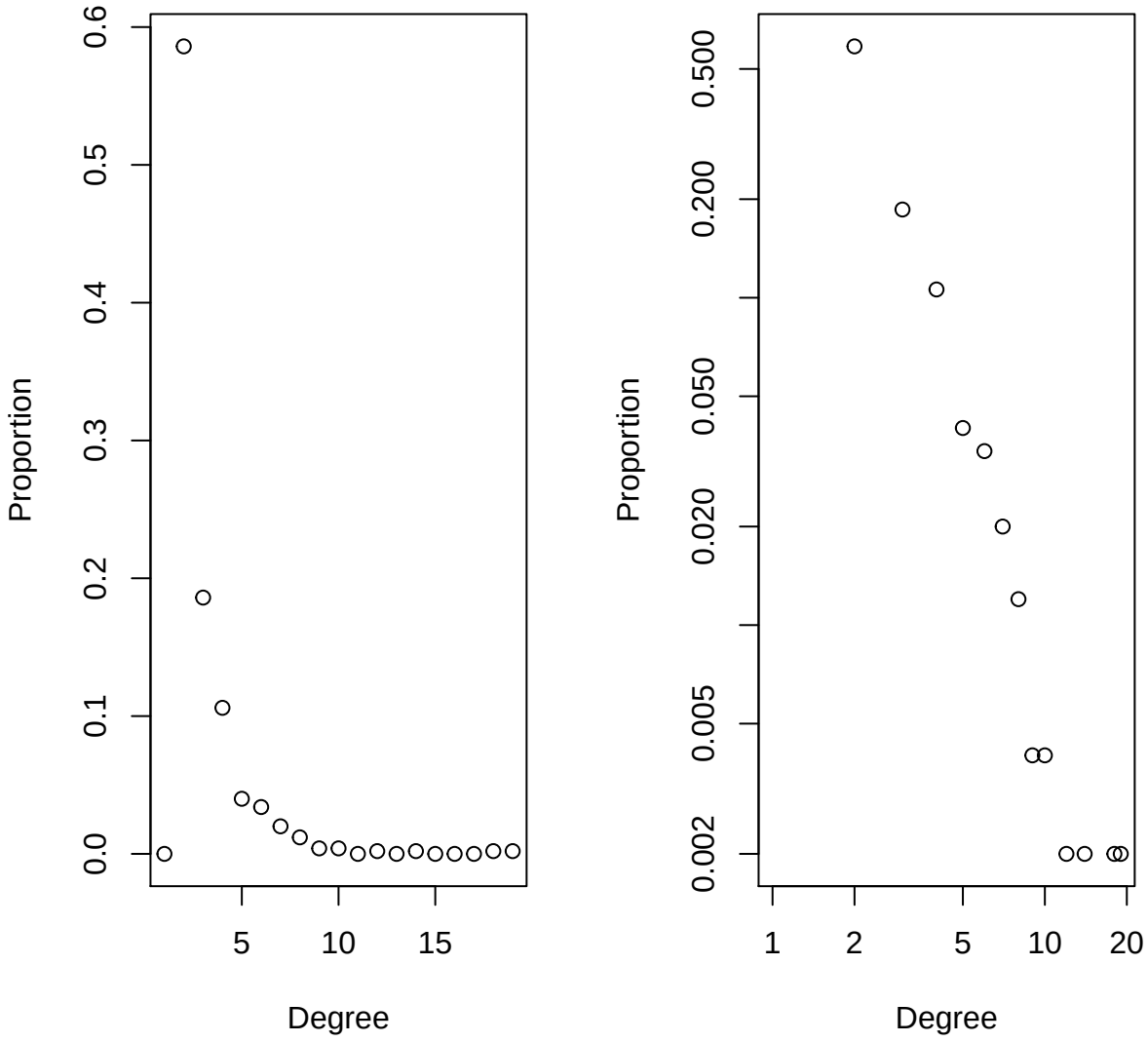
```
## [1] 1.996
```

```
table(degree(g))
```

```
##
##   1   2   3   4   5   6   7   8   9  11  13  17  18
## 293  93  53  20  17  10   6   2   2   1   1   1   1
```

```
op <- par(mfrow = c(1,2))
plot(degree.distribution(g),
     xlab = "Degree",
     ylab = "Proportion")
plot(degree.distribution(g),
     log = "xy",
     xlab = "Degree",
     ylab = "Proportion")
```

```
## Warning in xy.coords(x, y, xlabel, ylabel, log): 6 y values <= 0 omitted from
## logarithmic plot
```

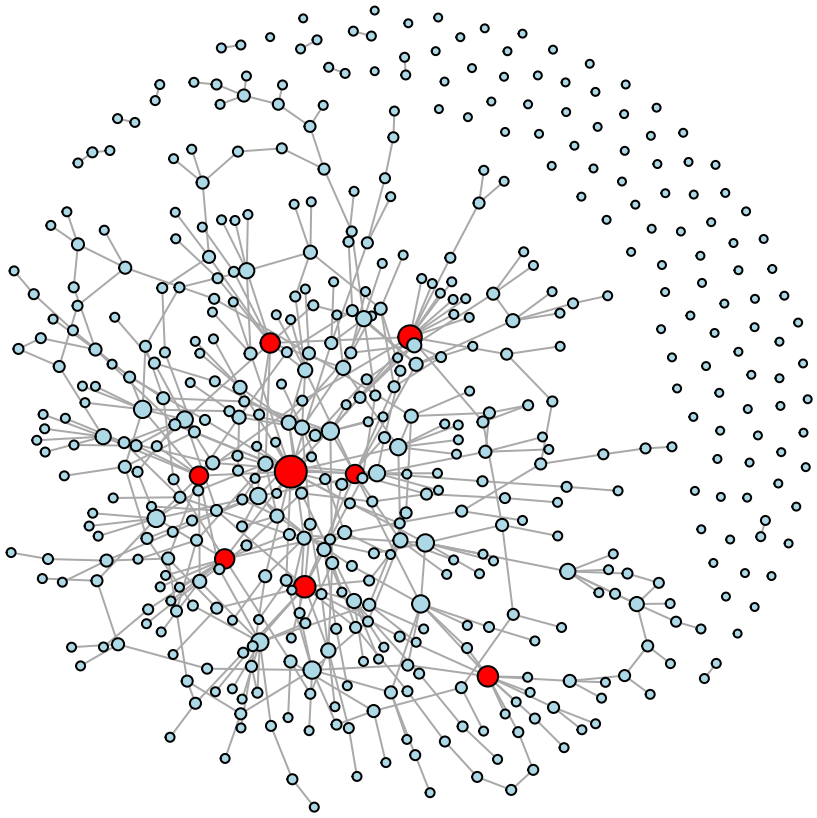



```
par(op)
```

```
g <- barabasi.game(500,
                   out.dist = c(0.25, 0.5, 0.25),
                   directed = FALSE,
                   zero.appeal = 1)
V(g)$color <- "lightblue"
V(g)[degree(g) > 9]$color <- "red"
node_size <- rescale(nchar = degree(g),
                     low = 2,
                     high = 8)
```

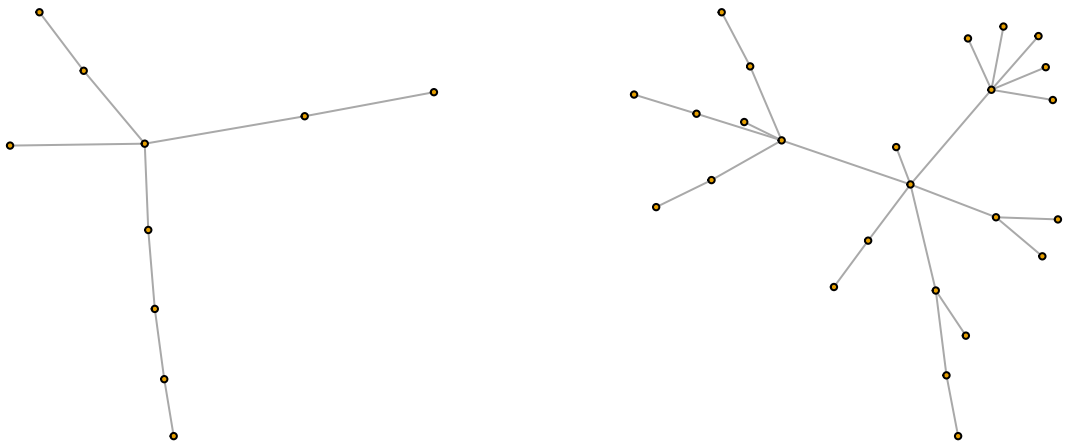
```
plot(g,
     vertex.label = NA,
```

```
     vertex.size = node_size)
```



```
g1 <- barabasi.game(10,
                    m = 1,
                    directed = FALSE)
g2 <- barabasi.game(25,
                    m = 1,
                    directed = FALSE)
g3 <- barabasi.game(50,
                    m = 1,
                    directed = FALSE)
g4 <- barabasi.game(100,
                    m = 1,
                    directed = FALSE)
```

```
op <- par(mfrow = c(2,2),
          mar = c(4, 0, 1, 0))
plot(g1,
     vertex.label = NA,
     vertex.size = 3,
     xlab = " n = 10")
plot(g2,
     vertex.label = NA,
     vertex.size = 3,
     xlab = " n = 25")
plot(g3,
     vertex.label = NA,
     vertex.size = 3,
     xlab = " n = 50")
plot(g4,
     vertex.label = NA,
     vertex.size = 3,
     xlab = " n = 100")
```




```
par(op)
```

Compairing Random Models to Emperical models

Required data set not availble!