

# HW2 Q2

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```
e1 <- read_csv("~/CompStats/HW/hw_2/hero-network.csv")
```

```
## Parsed with column specification:
## cols(
##   hero1 = col_character(),
##   hero2 = col_character()
## )
```

```
e1 = as.matrix(e1)
```

```
marvel <- graph.edgelist(e1,directed=FALSE)
```

## Avenger analysis

Below we investigate the universe of the Avengers as compared to Captain America's neighborhood. This will give us insight into the relative importance of the Avengers

```
marvel_nodes <- V(marvel)
```

```
captain_america <- which(marvel_nodes$name == 'CAPTAIN AMERICA')
```

```
thor <- which(marvel_nodes$name == 'THOR/DR. DONALD BLAK')
```

```
iron_man <- which(marvel_nodes$name == 'IRON MAN/TONY STARK')
```

```
black_panther <- which(marvel_nodes$name == 'BLACK PANTHER/T\CHAL')
```

```
captain_marvel <- which(marvel_nodes$name == 'CAPTAIN MARVEL II/MO')
```

```
ghost_rider <- which(marvel_nodes$name == 'GHOST RIDER II/JOHNN')
```

```
she_hulk <- which(marvel_nodes$name == 'SHE-HULK/JENNIFER WA')
```

```
hulk <- which(marvel_nodes$name == 'HULK/DR. ROBERT BRUC')
```

```
black_widow <- which(marvel_nodes$name == 'BLACK WIDOW/NATASHA')
```

```
dr_strange <- which(marvel_nodes$name == 'DR. STRANGE/STEPHEN')
```

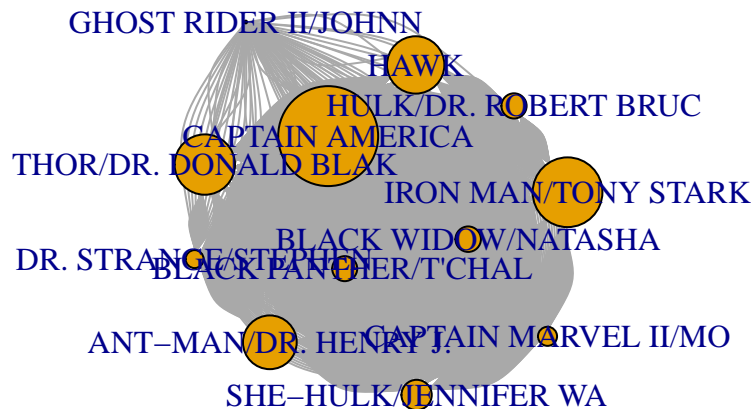
```
ant_man <- which(marvel_nodes$name == 'ANT-MAN/DR. HENRY J.')
```

```
hawk <- which(marvel_nodes$name == 'HAWK')
```

```
avenger_ids <- c(captain_america, thor, iron_man, black_panther, black_widow, captain_marvel, ghost_rider, she_hulk, hulk, black_widow, dr_strange, ant_man, hawk)
```

```
avengers <- induced.subgraph(marvel, avenger_ids)
```

```
plot(avengers, layout = layout.kamada.kawai, vertex.size = degree(avengers)/50)
```



```
betweenness(avengers) %>% sort(decreasing=T)
```

```
##      CAPTAIN AMERICA  BLACK WIDOW/NATASHA  THOR/DR. DONALD BLAK
##      0.59587143      0.35689566      0.26439218
##  IRON MAN/TONY STARK  DR. STRANGE/STEPHEN  ANT-MAN/DR. HENRY J.
##      0.26217077      0.13692511      0.13689140
##      HAWK  HULK/DR. ROBERT BRUC  BLACK PANTHER/T'CHAL
##      0.12020409      0.10887434      0.01777503
##  SHE-HULK/JENNIFER WA  GHOST RIDER II/JOHNN  CAPTAIN MARVEL II/MO
##      0.00000000      0.00000000      0.00000000
```

```
eigen centrality(avengers)$vector %>% sort(decreasing=T)
```

```
##      CAPTAIN AMERICA  IRON MAN/TONY STARK  THOR/DR. DONALD BLAK
##      1.0000000      0.8130392      0.7133454
##      HAWK  ANT-MAN/DR. HENRY J.  SHE-HULK/JENNIFER WA
##      0.6736223      0.6413664      0.3387975
##  BLACK PANTHER/T'CHAL  BLACK WIDOW/NATASHA  HULK/DR. ROBERT BRUC
##      0.3069200      0.2990746      0.2497170
##  CAPTAIN MARVEL II/MO  DR. STRANGE/STEPHEN  GHOST RIDER II/JOHNN
##      0.2230927      0.1673285      0.0232608
```

Now we will visualize Captain America's ego network. This is a subgraph of popular heroes connected to Captain America who are also highly-connected in the network.

```
ego.captain <- induced.subgraph(marvel, igraph::neighborhood(marvel, 1, 'CAPTAIN AMERICA')[[1]])
vertices.captain <- V(ego.captain)
friends <- degree(ego.captain) %>% sort(decreasing=T)
irrelevant <- degree(ego.captain) < friends[20] #only keep his most connected friends
ego.cap <- delete_vertices(ego.captain, vertices.captain[irrelevant])
vertices.captain <- V(ego.cap)

captain_america <- which(vertices.captain$name == 'CAPTAIN AMERICA')
thor <- which(vertices.captain$name == 'THOR/DR. DONALD BLAK')
iron_man <- which(vertices.captain$name == 'IRON MAN/TONY STARK')
black_widow <- which(vertices.captain$name == 'BLACK WIDOW/NATASHA')
black_panther <- which(vertices.captain$name == 'BLACK PANTHER/T\'CHAL')
captain_marvel <- which(vertices.captain$name == 'CAPTAIN MARVEL II/MO')
ghost_rider <- which(vertices.captain$name == 'GHOST RIDER II/JOHNN')
she_hulk <- which(vertices.captain$name == 'SHE-HULK/JENNIFER WA')
hulk <- which(vertices.captain$name == 'HULK/DR. ROBERT BRUC')
black_widow <- which(vertices.captain$name == 'BLACK WIDOW/NATASHA')
```

```

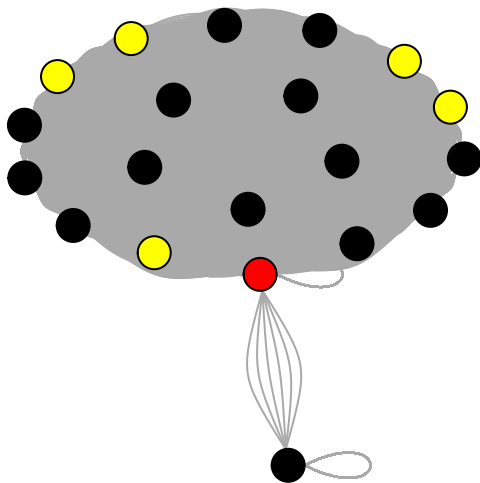
dr_strange <- which(vertices.captain$name == 'DR. STRANGE/STEPHEN')
ant_man <- which(vertices.captain$name == 'ANT-MAN/DR. HENRY J.')
hawk <- which(vertices.captain$name == 'HAWK')

avenger_ids <- c(captain_america, thor, iron_man, black_panther, hulk, black_widow, captain_marvel, ghost)

isAvenger <- rep(1,vcount(ego.cap))
isAvenger[avenger_ids] <- 2
isAvenger[captain_america] <- 3

# specify a vector of 2 colors for Avengers or other
colorvec <- c('black','yellow', 'red')
# assign colors to nodes
V(ego.cap)$color <- colorvec[isAvenger]
plot(ego.cap, layout = layout.kamada.kawai, vertex.label = NA)

```



Now we check closeness centrality for Captain America's co-hero network.

```

closeness(ego.cap, mode = c("out", "in", "all", "total"),
  weights = NULL, normalized = FALSE)

```

```

## IRON MAN/TONY STARK HULK/DR. ROBERT BRUC SPIDER-MAN/PETER PAR
##      0.05000000      0.05000000      0.05000000
## WASP/JANET VAN DYNE      HAWK  SCARLET WITCH/WANDA
##      0.05000000      0.05000000      0.05000000
## CAPTAIN AMERICA      WOLVERINE/LOGAN      VISION
##      0.05263158      0.05000000      0.05000000
## STORM/ORORO MUNROE S MR. FANTASTIC/REED R THING/BENJAMIN J. GR
##      0.05000000      0.05000000      0.05000000
## INVISIBLE WOMAN/SUE BEAST/HENRY &HANK& P CYCLOPS/SCOTT SUMMER
##      0.05000000      0.05000000      0.05000000
## THOR/DR. DONALD BLAK PROFESSOR X/CHARLES HUMAN TORCH/JOHNNY S
##      0.05000000      0.05000000      0.05000000
## ANT-MAN/DR. HENRY J. PATRIOT/JEFF MACE
##      0.05000000      0.02702703

```

It appears everyone is approximately equidistant on this network.

Now we look at eigenvector centrality. It is interesting to note that after Captain America, the most central nodes are all part of the Fantastic Four. A few X-Men show up here too, which confirms that those leagues

are the most popular and influential in the MCU.

```
eigenvector centrality <- eigen centrality(ego.cap, directed = FALSE)$vector  
eigenvector centrality %>% sort(decreasing=T)
```

```
## CAPTAIN AMERICA THING/BENJAMIN J. GR HUMAN TORCH/JOHNNY S  
## 1.00000000 0.97710945 0.96919580  
## MR. FANTASTIC/REED R INVISIBLE WOMAN/SUE IRON MAN/TONY STARK  
## 0.96672860 0.92793912 0.81591066  
## SCARLET WITCH/WANDA VISION WASP/JANET VAN DYNE  
## 0.74739953 0.73365024 0.71218653  
## THOR/DR. DONALD BLAK HAWK ANT-MAN/DR. HENRY J.  
## 0.70212065 0.63019048 0.62260462  
## BEAST/HENRY &HANK& P SPIDER-MAN/PETER PAR HULK/DR. ROBERT BRUC  
## 0.41757826 0.37056642 0.30975186  
## CYCLOPS/SCOTT SUMMER WOLVERINE/LOGAN PROFESSOR X/CHARLES  
## 0.29683752 0.28458036 0.26377313  
## STORM/ORORO MUNROE S PATRIOT/JEFF MACE  
## 0.26174395 0.01520648
```