PREDICTIVE ANALYTICS USING NETWORKED DATA IN R

# Basic Network features

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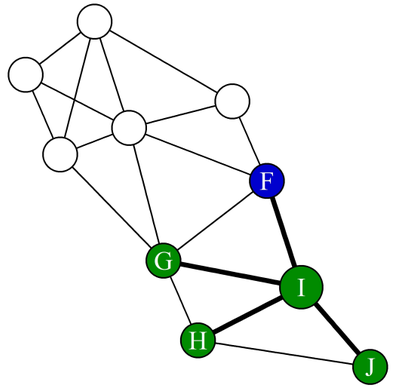
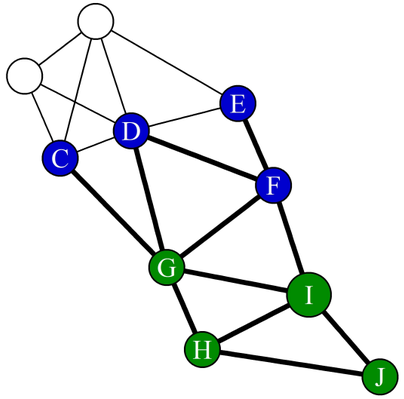
# Neighborhood features




- First order degree
  - Number of connected nodes

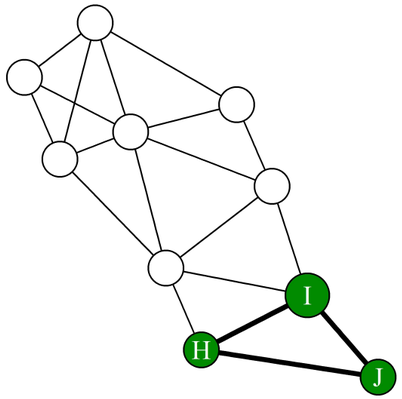
```
degree(g)
A B C D E F G H I J
4 3 4 6 3 4 5 3 4 2
>
```

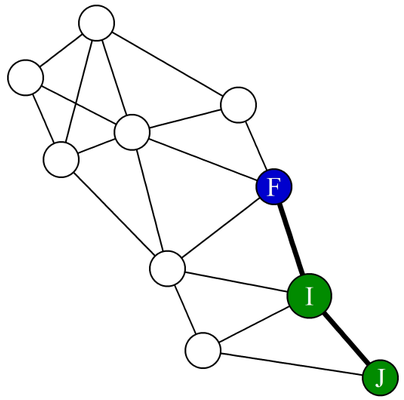



- Second order degree
  - Number of connected nodes that are two or less edges away

```
neighborhood.size(g, order = 2)
 [1]  7  7  9  9  8 10 10  7  8  5
```

# Neighborhood features - triangles

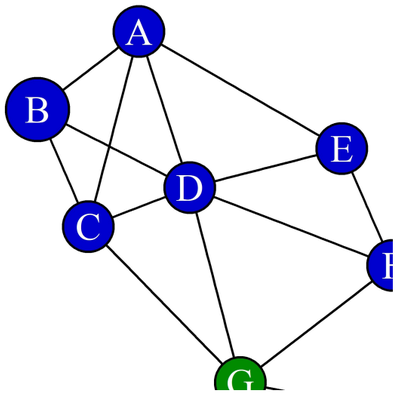


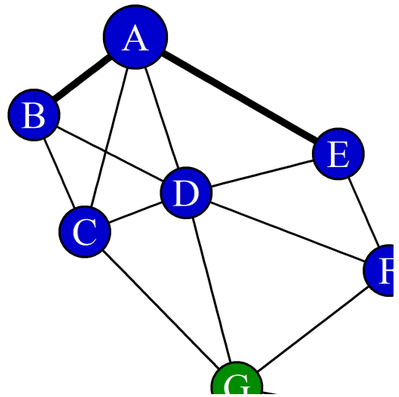

```
count_triangles(g)
 [1] 4 3 4 7 2 3 4 2 3 1
```

# Centrality Features

- Betweenness



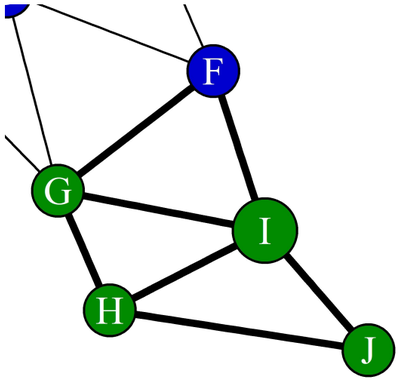

- Closeness

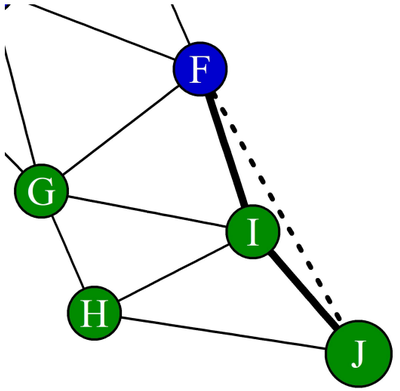



```
betweenness(g)
    A     B     C     D     E     F     G     H     I     J
 1.00  0.00  3.32  8.10  0.92  5.37 11.47  2.07  5.77  0.00

closeness(g)
   A    B    C    D    E    F    G    H    I    J
0.06 0.05 0.07 0.08 0.06 0.07 0.08 0.06 0.06 0.04
```

# Transitivity




```
transitivity(g,type = 'local')
 [1] 0.67 1.00 0.67 0.47 0.67 0.50 0.40 0.67 0.50 1.00
```

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# Let's practice!

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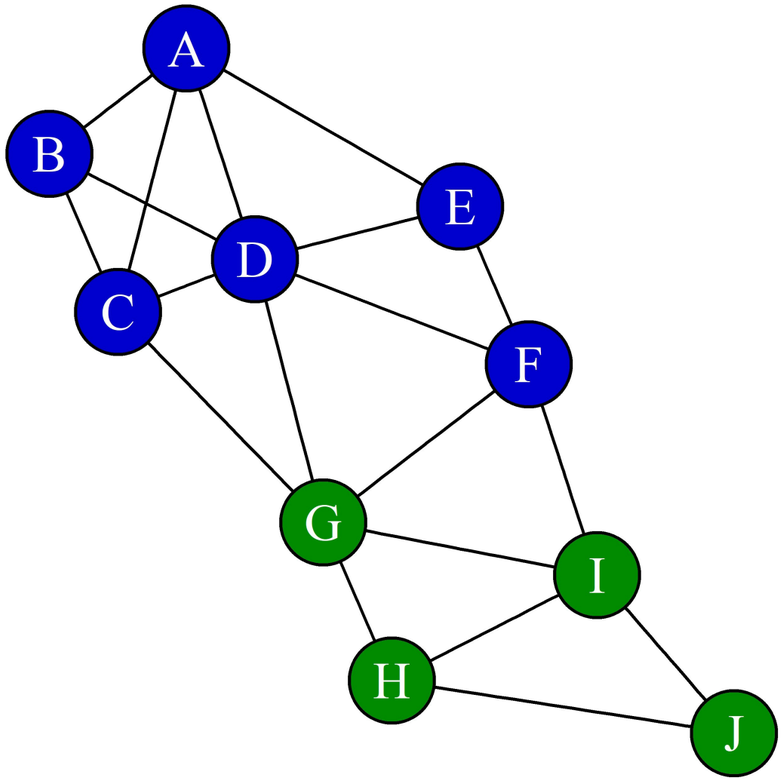
# Link Based Features

María Óskarsdóttir, Ph.D.
Post-doctoral researcher

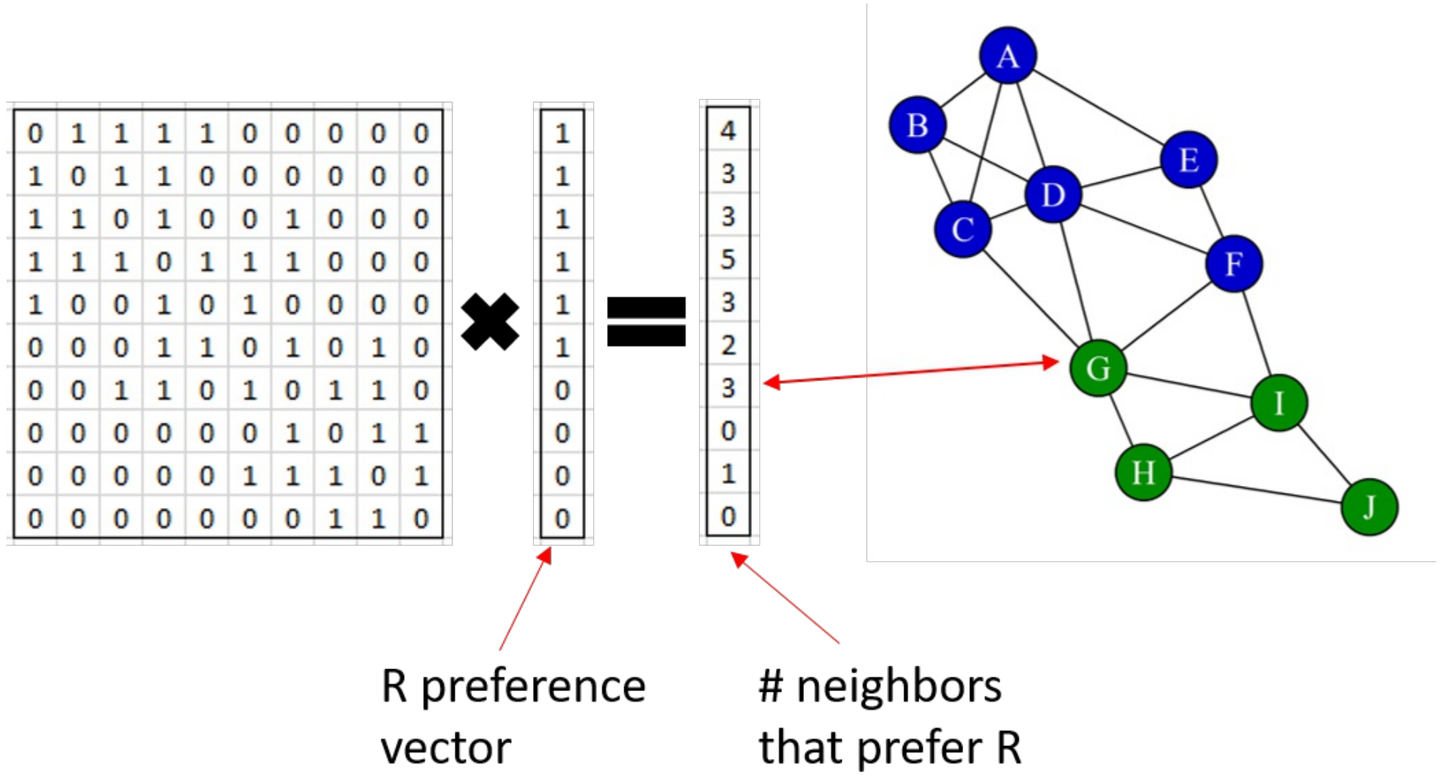
# Adjacency Matrices

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| B | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| D | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| E | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| F | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| G | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| H | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| I | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| J | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

```
A <- get.adjacency(g)
```

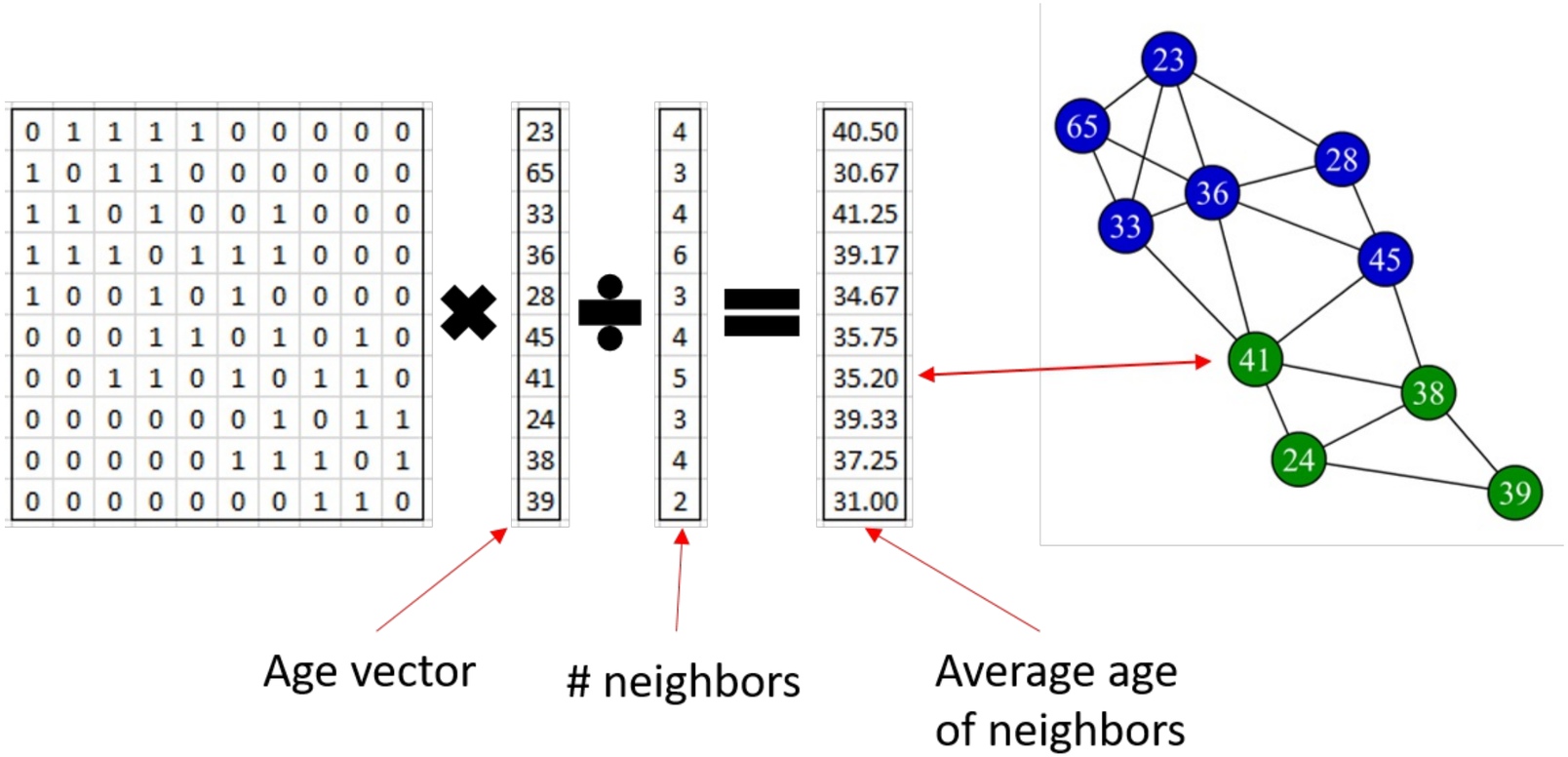


# Link based features




```
preference <- c(1,1,1,1,1,1,0,0,0,0)
rNeighbors <- A %*% preference
as.vector(rNeighbors)
[1] 4 3 3 5 3 2 3 0 1 0
```

# Neighborhood features




```
age <- c(23,65,33,36,28,45,41,24,38,39)
degree <- degree(g)
averageAge <- A %*% age / degree
```

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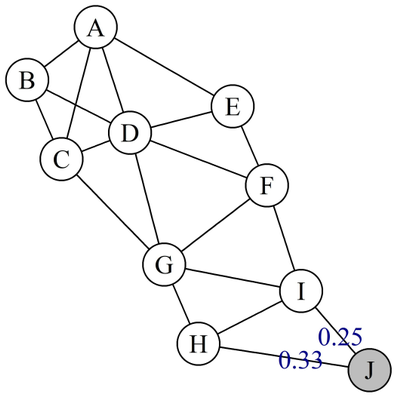
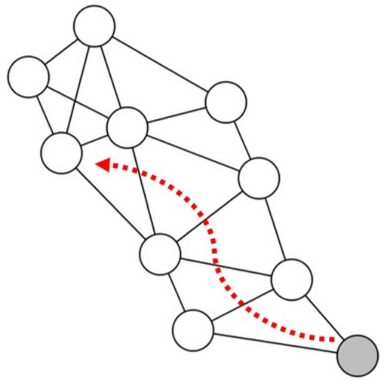
# PageRank

María Óskarsdóttir, Ph.D.
Post-doctoral researcher

# The PageRank Algorithm



$$\text{PageRank}_J = \alpha \cdot (\tfrac{1}{3} \cdot \text{PageRank}_H + \tfrac{1}{4} \cdot \text{PageRank}_I) + (1 - \alpha) \cdot e_J$$

# The PageRank Algorithm

$$PR = \alpha \cdot A \cdot PR + (1 - \alpha) \cdot e$$

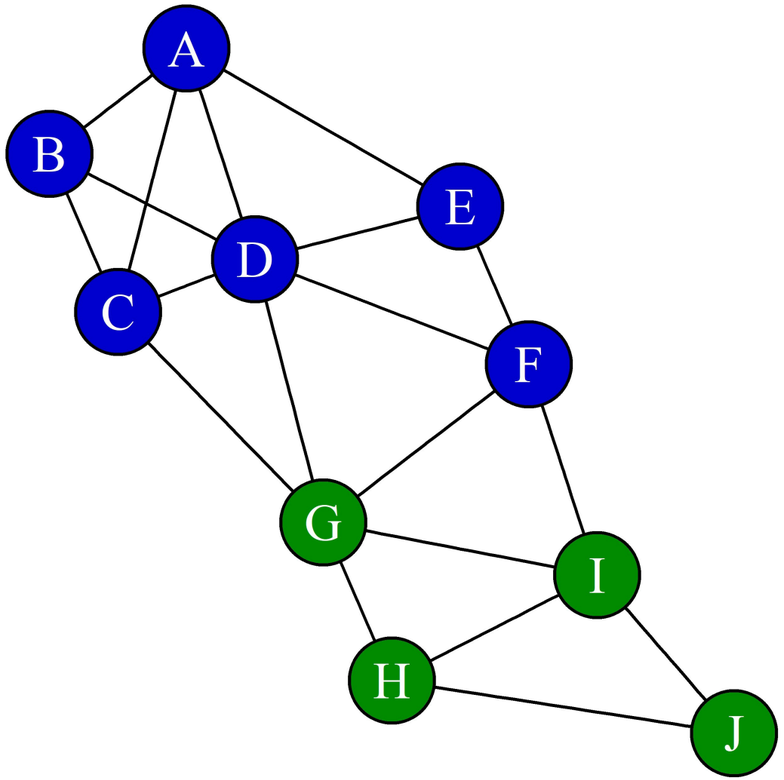
```
page.rank(g)
```

```
$vector
         A          B          C          D          E          F          G
0.10238312 0.07917232 0.10164910 0.14693274 0.07953551 0.10335821 0.12732387
         H          I          J
0.08675903 0.10994175 0.06294435

$value
[1] 1

$options
NULL
```

# Personalized PageRank




```
> page.rank(g,
 personalized = c(1,0,0,0,0,0,0,0,0,0))
$vector
         A          B          C
0.25528911 0.10363533 0.12156935
         D          E          F
0.16625582 0.09366836 0.07466596
         G          H          I
0.08473039 0.03285162 0.04785657
         J
0.01947748

$value
[1] 1

$options
NULL
```

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