Directed networks

NETWORK ANALYSIS IN R

James Curley

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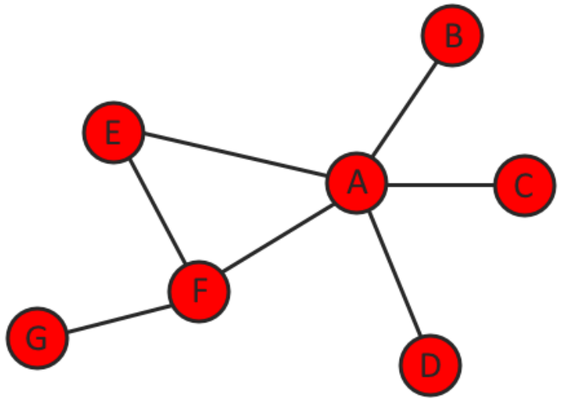
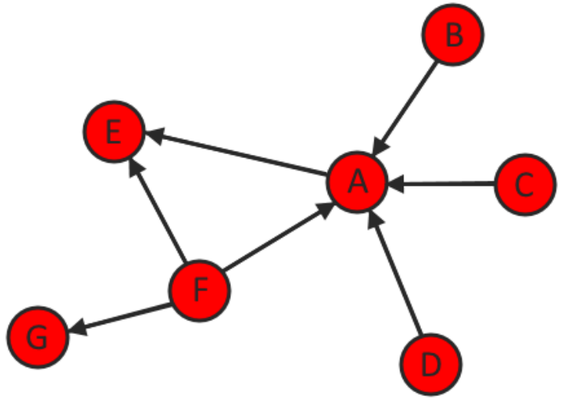
Directionality

Undirected



Directed



Examining the igraph object

Undirected:

```
IGRAPH UN-- 7 7 --
+ attr: name (v/c)
+ edges (vertex names):
[1] A--B A--C A--D A--E A--F E--F F--G
```

Directed:

```
IGRAPH DN-- 7 7 --
+ attr: name (v/c)
+ edges (vertex names):
[1] A->E B->A C->A D->A F->A F->E F->G
```

Checking igraph objects

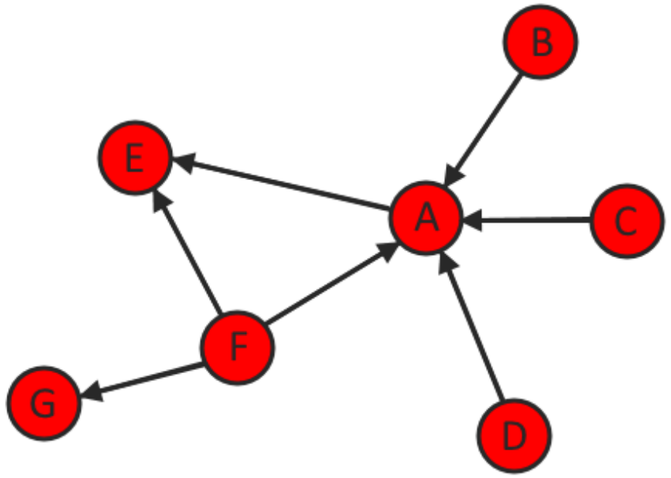
```
is.directed(g)
```

```
[1] TRUE
```

```
is.weighted(g)
```

```
[1] FALSE
```

In-degree and out-degree



	out-degree	in-degree
A	1	4
B	1	0
C	1	0
D	1	0
E	0	2
F	3	0
G	0	1

Is there an edge between A & E?

```
g['A','E']
```

```
[1] 1
```

Show all edges to or from A:

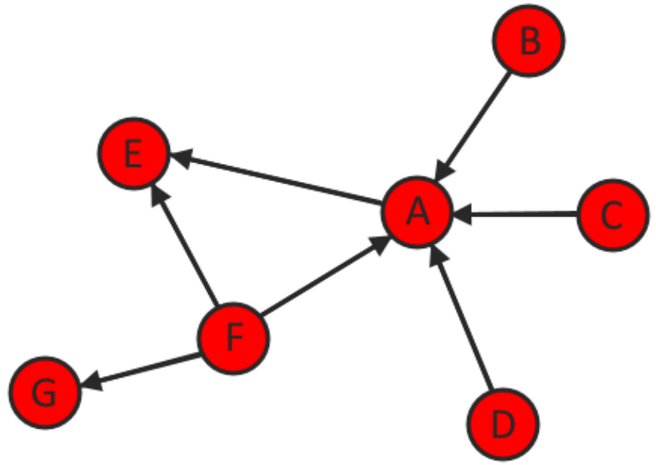
```
incident(g,'A', mode=c("all"))
```

```
+ 5/7 edges (vertex names):
[1] A->E B->A C->A D->A F->A
```

Find the starting vertex of all edges:

```
head_of(g, E(g))
```

```
+ 7/7 vertices, named:
[1] A B C D F F F
```



Let's practice!

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Relationships between vertices

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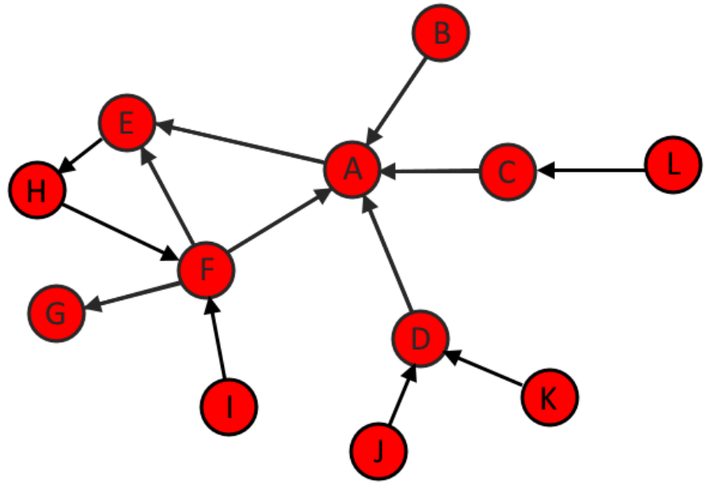
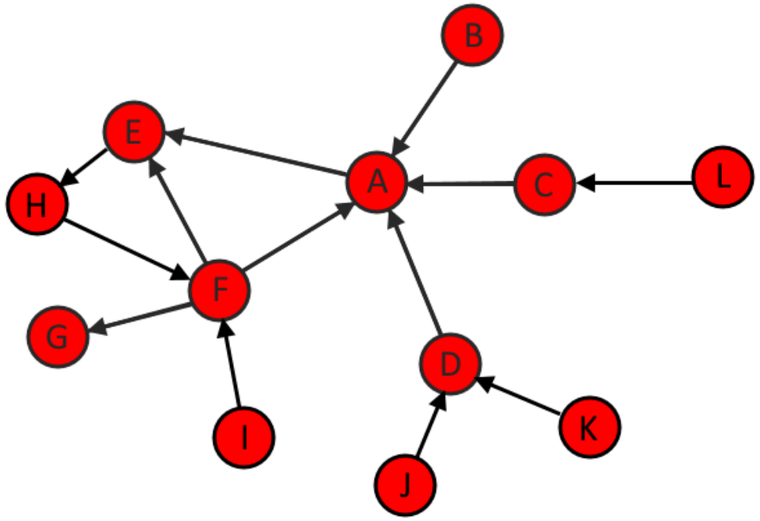
Identifying neighbors




```
neighbors(g, "F", mode = c("all"))
```

```
+ 5/12 vertices, named:
[1] A E G H I
```

Identifying neighbors in common



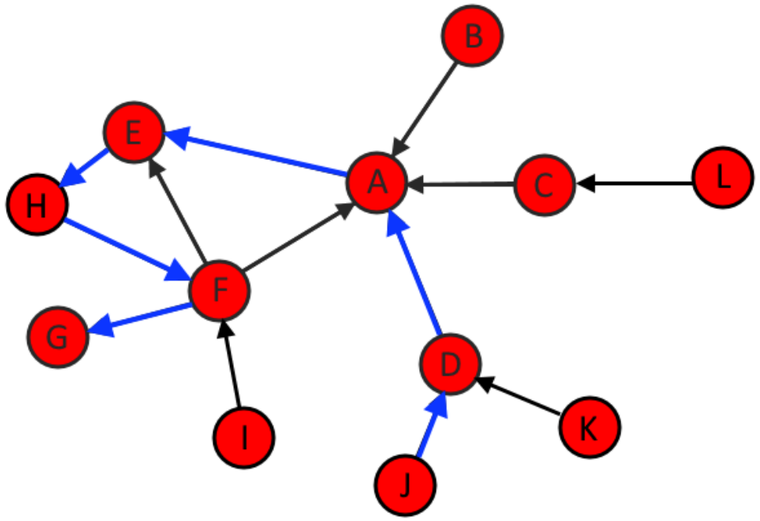

```
x <- neighbors(
  g, "F", mode = c("all")
)

y <- neighbors(
  g, "D", mode = c("all")
)

intersection(x,y)
```

```
A
```

Paths




```
farthest_vertices(g)
```

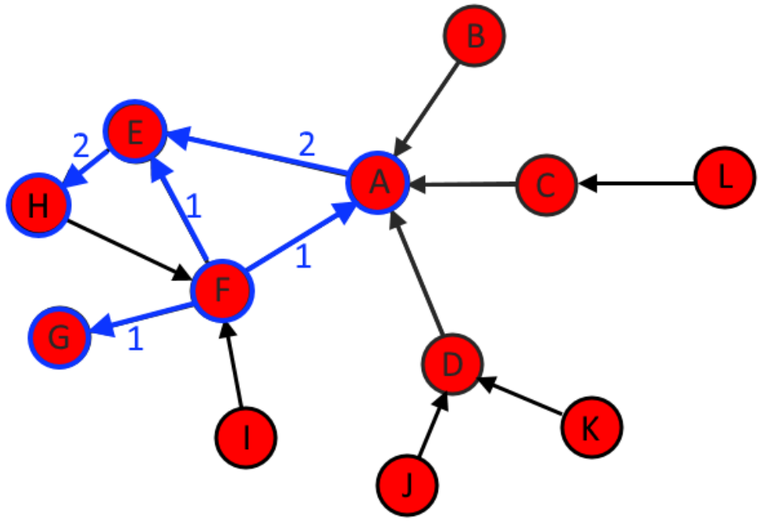
```
$vertices
+ 2/12 vertices, named:
[1] J G

$distance
[1] 6
```

```
get_diameter(g)
```

```
+ 7/12 vertices, named:
[1] J D A E H F G
```

Identifying vertices reachable in N steps




```
ego(g, 2, 'F', mode=c('out'))
```

```
+ 5/12 vertices, named:
[1] F A E G H
```

Let's practice!

NETWORK ANALYSIS IN R

Important and influential vertices

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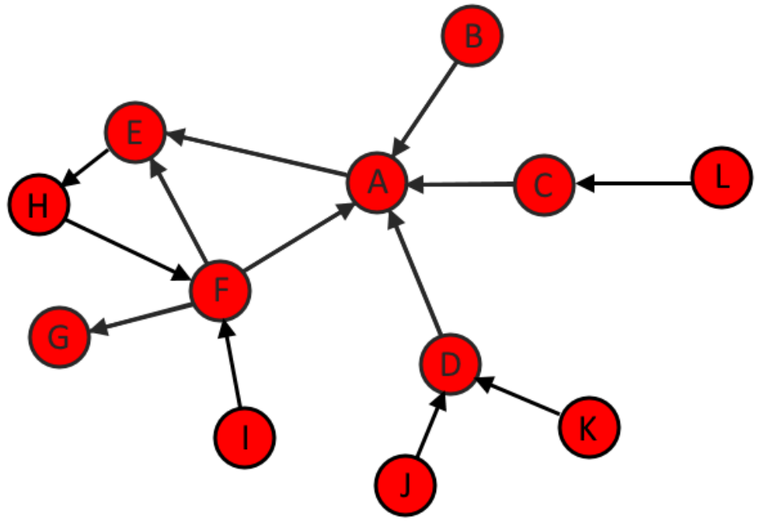
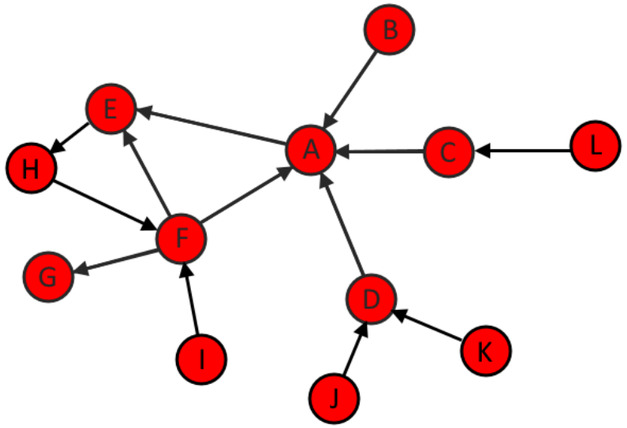
Measures of vertex importance

- degree
- betweenness
- eigenvector centrality
- closeness centrality
- pagerank centrality



Out-degree and in-degree

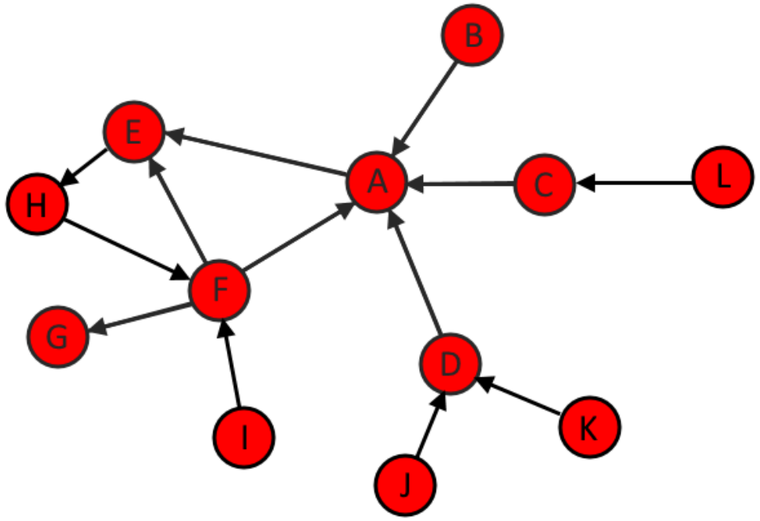


	out-degree	in-degree
A	1	4
B	1	0
C	1	1
D	1	2
E	1	2
F	3	2
G	0	1
H	1	1
I	0	1
J	1	0
K	1	0

```
degree(g, mode = c("out"))
```

```
A B C D E F G H I J K L
1 1 1 1 1 3 0 1 1 1 1 1
```

Betweenness



I to H:

```
I -> F -> E -> H
I -> F -> A -> E -> H
```

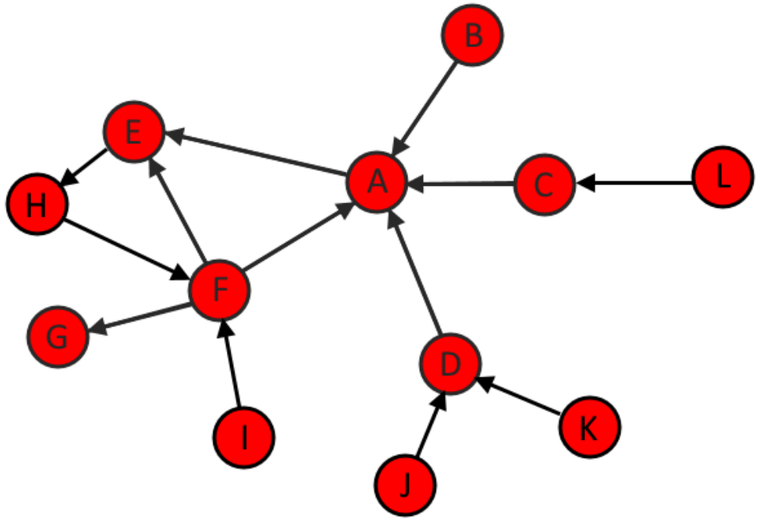
K to E:

```
K -> D -> A -> E
```

B to G:

```
B -> A -> E -> H -> F -> G
```

Betweenness




```
betweenness(g, directed = TRUE)
```

```
 A  B  C  D  E  F  G  H  I  J  K  L
24  0  5 10 23 16  0 17  0  0  0  0
```

```
betweenness(g, directed = TRUE,
            normalized = TRUE)
```

```
   A    B    C    D    E    F
0.22 0.00 0.05 0.09 0.21 0.15
   G    H    I    J    K    L
0.00 0.15 0.00 0.00 0.00 0.00
```

Let's practice!

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