NetLogo Tutorial 2: Networks

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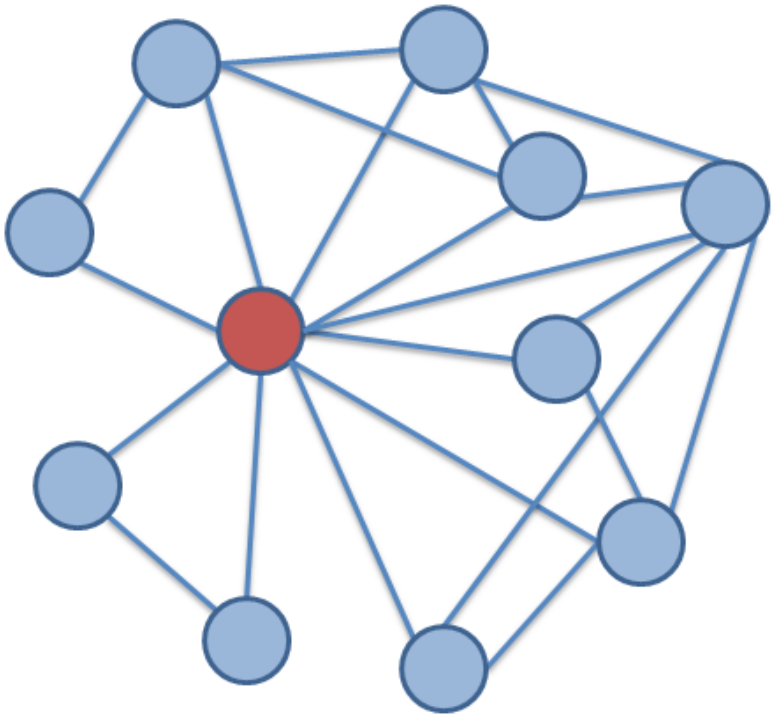
Social Networks



- Nodes
  - Represent basic object, often agents
- Edges
  - Represent types of relationships

Edges

- Undirected
  - Imply a symmetric relationship
  - *Siblings, roommates, co-authors*
- Directed
  - Imply a non-symmetric relationship
  - *In love with, trusts, supervises*

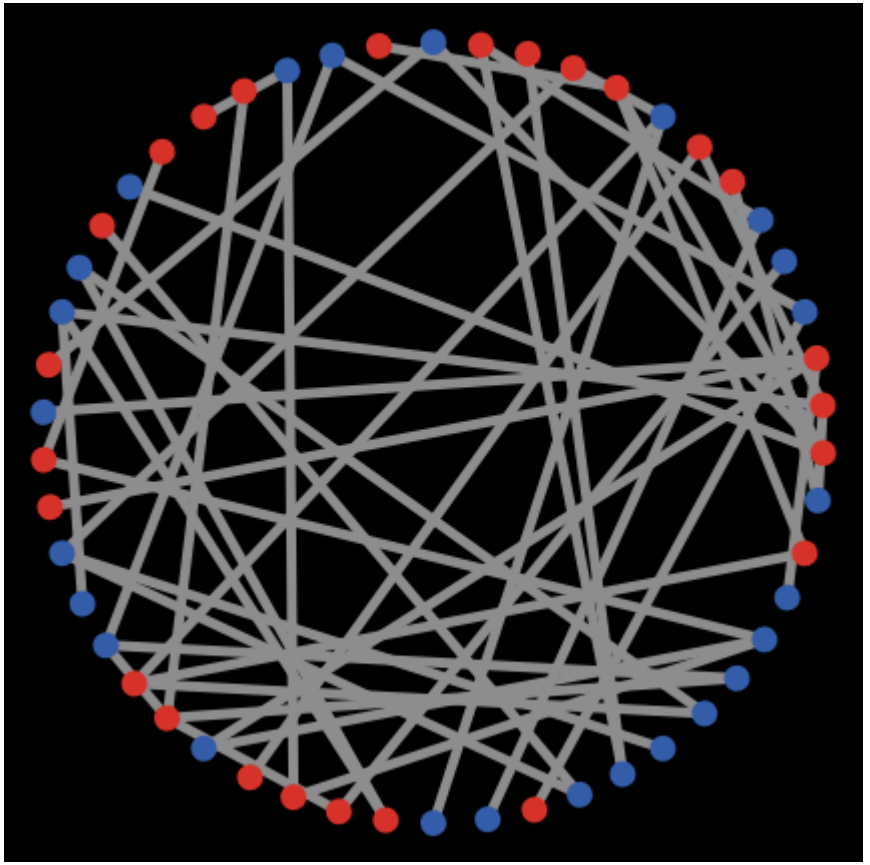
Edges

- Singular/multiple
  - *Loves* / *Shook hands*
- Labeled/unlabeled
  - *Knows* / *Facebook friends with*

Networks and game theory

- Nodes
  - Represent individuals who have strategies in a game
- Edges
  - Represent interactive pairs, who play the game
  - Also, the source of imitation

Stag Hunt



Setup function

Old

```
ask patches [
  sprout 1 [
    set payoff 0
    set strategy random 2
    set old-strategy strategy
    set shape "circle"

  ]
]
```

New

```
create-turtles NumberOfAgents [
  set payoff 0
  set strategy random 2          ;;
  set old-strategy strategy
  set shape "circle"             ;;
]

layout-circle turtles 15
```

```
ask turtles [
  create-links-with n-of 1 other turtles
]

ask links [
  set thickness 0.4
]
```

Network formation

- This algorithm guarantees that everyone has at least one “friend”

- But, others might have more

Play/Imitate function

Old

```
;; These are the people with whom I am going to play
let neighbor-patches [neighbors] of patch-here
let players turtle-set [turtles-here] of neighbor-patches
```

New

```
;; These are the people with whom I am going to play
let players link-neighbors
```

Effect of networks

- Creates “bottlenecks” that prevent the contagion process
- Multiplies the number of stable configurations

Two modifications

- Change the way the network is generated
- Change the method of learning and evaluating strategies

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Other network algorithms

- More neighbors
- Random network
- Regular network
- Preferential attachment

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More neighbors

- Create a new slider Average-Friends
- Have each turtle connect to Average-Friends other turtles

Other network algorithms

- More neighbors
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- Regular network
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Random network

- Each edge is created with some probability
- The probability for each edge is independent of every other edge

Random network

Interface

```
Create slider called Edge-Probability
Have it range in value from 0 to 1, in
    0.1 increments
```

Setup Function

```
Ask every turtle
    Create a link with every other
        turtle

Ask every edge
    Generate a random number, x, from
        [0,1)
    If x < (1 - Edge-Probability)
        Remove the link
    Otherwise
        Leave the link alone
```

Hints

```
all, ask,
create-links-
with, ifelse,
other, random-
float, turtles
```

Other network algorithms

- More neighbors
- Random network
- Regular network
- Preferential attachment

Regular network

- Every individual has exactly the same number of neighbors
- The ring is the simplest
- The grid used before was one as well

Modulus

```
n mod m
```

```
let x floor (n / m)
n - x*n
```

Modulus

```
0 mod 4, 1 mod 4, 2 mod 4, 3 mod 4,
4 mod 4, 5 mod 4, 6 mod 4, 7 mod 4 …
```

```
0, 1, 2, 3,
0, 1, 2, 3 …
```

Regular network

Setup function

```
For each value of x in {0, 1, 2, …, number of turtles}
   Ask turtle x to
      Let variable new-friend be equal to
         x mod number of turtles
      Form a link with turtle number new-friend
```

Hints

```
count, create-link-with, foreach, mod, n-values
```

Other network algorithms

- More neighbors
- Random network
- Regular network
- Preferential attachment

Preferential attachment

- *Gloss*: When people join a group, they tend to gravitate toward the already popular

- *Process*:
  - Two turtles are created
  - Each new turtle connects to one of the existing turtles at random
  - The probability that the new turtle connects to existing turtle *t* is proportional to the number of neighbors that *t* has

Preferential attachment

Header

```
Create new turtle variable called score
```

Hints

```
random, repeat,
turtles-own
```

Setup function

```
Create two turtles
Form a link between them
Repeat n - 2 times
   Assign each turtle a score: 1 + number of neighbors
   Create new turtle
      Let x be a random integer in {0, … , sum of
         turtle scores}
      Ask other turtles
         If x < number of neighbors
            Form a link between the first turtle and
               this one
         Else
            Let x equal (x - number of neighbors)
```

Two modifications

- Change the way the network is generated
- Change the method of learning and evaluating strategies

How payoff is calculated

- Currently, in the model each agent imitates her neighbor who has a higher average payoff
- What if they imitated the other who had the highest total payoff?
  - Can you guess what the effect would be?
- Find this in the code and change it

Imitation and interaction neighborhood

- Currently in the model the agents play with and imitate from the same group, their link-neighbors
- What if we changed that?
  - Imitate second-neighbors, but play with first neighbors
  - Have totally different neighborhoods

Imitate more widely

- Modify the imitate function to have agent's imitate a wider neighborhood
  - Their neighbors
  - And, their neighbors' neighbors
- Hints: `of, turtle-set`

Different imitation network

- More generally we could create two different networks, one for play and one for imitation
- This utilizes link “breeds”
  - One can define `link-breeds` in the header
  - Then the networks are created by `create-<breed>-with` in the setup function
- The two functions play and imitate would then utilize different networks using `<breed>-neighbors`

Best response

- "imitation" is not particularly sophisticated
- Myopic best response
  - On round t adopt what strategy would have been best on round $t - 1$

Different learning rule

New function "best-respond"

```
Ask turtles
    Let stag-payoff be the payoff obtained from playing
       stag against my neighbors' old-strategies
    Let hare-payoff be the payoff obtained from playing
       hare against my neighbors old-strategies
    If stag-payoff > hare-payoff
       Set strategy to stag
    If hare-payoff > stag-payoff
       Set strategy to hare
    If stag-payoff = hare-payoff
       Leave strategy the same
```

Step function

```
Replace imitate with best-respond
```