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EECS 372

Designing and Constructing Models with Multi-Agent Languages

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**Safe Sex Attitudes and Behaviors**

**Overview**

This NetLogo model aims to simulate the spread and development of safe sex attitudes and behaviors in response to the presenceof a sexually transmitted infection (STI) throughout a social network of young adults. It also takes into account how these variables interact with one another and change over time using theories of attitude change and certainty.

This project specifically focuses on modeling college students in the United States. Male and female students come to universities with diverse backgrounds, including education and attitudes regarding (towards?) safe sex (behaviors?). It was of interest to see if the NetLogo model could emulate those behaviors. The model also aimed at modeling the complex social behavior associated with sexual partnering.

**Relevance and Motivation**

This model will focus more on the sexual attitudes and behaviors of agents in relation to the spread of STIs. This contrasts with previous models in the NetLogo literature that focused on the actual spread of AIDS or on a virus.

**Guiding Questions**

* What factors seem to be most influential in determining whether an individual will contract an STI?
* What factors influence the spread of attitudes towards safe sex?
* Are the two above questions interdependent? What implications could this have for targeting information campaigns to this age group?

**Model Parameters**

**Social network:** Parameters are provided to initialize a simple social network, consisting primarily of discrete social groups (cliques). Users can control the number and size (number of members) of cliques (**num-cliques** and **clique-size** sliders), and whether they are initialized with a limited number of inter-group links between “clique leaders” (**social-butterflies?** switch enabled). These cliques consist of agents that primarily interact with members of the same group. Each agent has a specified number of desired friends (**avg-num-friends** slider) which generates a fixed number of links within the group. Specific values for each agent start with random value drawn from a normal distribution.

**STI characteristics:** users can control the likelihood (out of 100%) of an infection spreading during an unprotected sexual encounter (**infection-chance** slider), and which genders (if any) show symptoms of the infection (**symptomatic?** chooser). When the user presses **setup**, one random agent in the model will be infected by default. However, the user can also choose to **select** an agent in the model to infect with their mouse, or press **infect-random** to infect an additional agent in the model with a sexually transmitted infection. These functions are optional, but can be called multiple times before, or at any time during, the simulation.

**Agent Parameters Impacting Practice of Safe Sex**

**Attitude:** users can separately define the initial tendency of the male or female agent to practice safe sex, i.e., condom use (using the **avg-male-condom-intention** and **avg-female-condom-intention** sliders, both with ranges 0 to 100%). The desire that an agent wants to practice safe sex is set by a normally distributed random variable ranging from 0 to 100% which is gender dependent.

**Certainty:** agents have an initial confidence in their attitude [towards safe sex], which influences how resistant they will be to adopting alternate viewpoints. This variable reflects how much of their upbringing encouraged safe sex. These views might consist of parents' beliefs, life experiences, religious attitudes, etc. hence why/so The initial average population value is set with the **avg‑mesosystem-condom-encouragement** [slider 0-100]. A derivative variable which would be [100 - certainty] would be willingness to change their attitude.

**Justification:** agents have an initial reasoning why they have their attitude and what logical explanations they have to back up their attitude. Users can indicate the percentage of agents that receive sexual education including condom use, (**%-receive-condom-sex-ed** [slider 0‑100]). Agents that receive sex education including information about condoms as protection against STIs will have a higher level accurate knowledge about safe sex practices and benefits, and those who don’t will have a lower level of accurate knowledge. But both values will be normally distributed over the higher or lower value.

These variables of **attitude**, **certainty**, and **justification**, which influence their **likelihood** of engaging in safe sex using protection, will interact and ultimately determine whether the agent practices safe sex.

The likelihood of an agent practicing safe sex is demonstrated through the color of each agent. Enabling the **show-labels?** switch will also display the exact likelihood of each agent to engage in safe sex behaviors. The user can press **go-once** to see changes per step (often very useful if examining a person that was just infected) or press **go** to view a continuous progression of the model simulation.

**Agent Parameters**

Individual agents are initialized by setting gender and unique member variables. The global variables indicated above are used, as well as some additional ones.

**Attitude:** Attitude evolves during the course of the model and changes on each tick.

**Certainty:** Certainty is initially set to mesosystem-condom-encouragement. Certainty is the best determination of behavior, according to research. However, this NetLogo model has certainty as an influencing variable for Attitude, which ultimately determines whether safe sex is practiced.

**Justification:** Justification is initially set to the level of accurate education this agent has about safe sex and condom usage. (revisit)

**Shape**: Agent shape is determined by gender and health status. Infected turtles have a dot on their shape, and the color of the dot indicates whether or not they “know” they are infected (white: known? = true; black: known? = false;).

**Color**: The color of the agent indicates his or her individual/personal likelihood of practicing safe sex. A green agent is more likely to engage in safe sex, while a red agent is less likely to use a condom. The likelihood is a scale from 0 to 100, and agents that are 50% likely of having safe sex are displayed as white.

**Label**: The labels, if enabled, also indicate each agent’s likelihood of practicing safe sex, but it is more accurate because it shows the exact value, whereas color changes by increments of 5.

**Links**: In this model, turtles can have multiple friends, but only one sexual partner at a time.

Relationship type is determined by link breeds. Color of link indicates type of relationship between the two agents: a blue link denotes friendship, and magenta link denotes a sexual partnership link.

**Model Setup**

The network is arranged as mostly discrete social circles, with some social butterflies that have links to members of other social groups. Turtles start with a certain number of friend links, and no sexual partner links. Establishing networks consisting of "friendship" links and "sexual partner" links (differentiated by color). Friend links are gender independent, sexual partners are not. Individual variables per agent are assigned randomly following a normal distribution based on slider or global values [assign-normally-distributed-member-variables]

When the model is set up, everyone is initially single and uninfected.

The system has several stop conditions:

* If every single agent/turtle is infected
* If certainty of every agent gets so high that attitudes won’t change anymore based on this model’s implementation
* If every agent comes to the same attitude consensus
* If several key variables remain unchanged for a certain number of ticks

**Agent Behavior**

The turtles do not move, but

On each tick:

* Agents talk to their friends (indicated with blue links), and potentially update their opinions about safe sex (and consequently their likelihood to practice safe sex).
  + Agents talk to their friends and sexual partner (if any), which might impact their personal likelihood of practicing safe sex ( **talk-to-peers** )
* Agents look for a sexual partner (male-female coupling).
  + If they are not coupled, they might try to find another single turtle of the opposite gender, i.e., someone to mate with (based on their personal coupling tendency). First they look at friends of the opposite sex; if they have none, then they choose a person of the opposite sex within their friend group; and if there isn’t one, then they resort to choosing the closest non-linked opposite sex turtle. The probability of successfully coupling decreases for each of these three types of potential partners. If both partners are willing to become a couple, they form a sexual‑partner link (if the two turtles were previously friends, this destroys their friendship link).
  + If they are already coupled with a sexual partner, they just increase length of relationship (turtles are monogamous in this simulation)
  + If they are NOT coupled, a turtle tries to find a mate. Any turtle can initiate mating if they are not coupled (and random chance permits)
* Agents make friends. This gives everyone (coupled or not) a chance to make a friend.
  + everyone should attempt to make friends on each tick as well, because otherwise, all the sexual partner links break, then it becomes single-sex clusters and no sexual behavior happens
  + If this agent already has reached their maximum limit of friends, they don't try to create any more friend links
  + If this agent has not reached their maximum limit of friends, they try to make a friend **[ make-friends ]**
* Agents can uncouple or potentially break up. Agents will **uncouple** if the length of the relationship reaches the commitment threshold for one of the partners.
  + A restriction is placed on who can couple after uncoupling, to simulate that exes wouldn’t be friending each other again, and this model doesn't (intend to) simulate instant rebounds
* If agents are still in a couple, each tick they have sex. The likelihood that the couple will engage in safe sex depends on the attitudes of both participants. If turtles are coupled (have a sexual partner), they will have sex on each tick, and thus will have the potential of spreading an STI if they have unprotected sex.
  + If they mate, there is a probability they will use a form of protection. This probability will be influenced by attitudes and behaviors towards safe sex that a given turtle has, and these attitudes are influenced by the other turtles (“friend group”) that the turtle is linked with.
  + If the turtles are coupled, on each tick, they have sex, and have a chance of using protection based on a probability derived from a function based on attitude. If the couple does choose to use a condom, there is additionally a chance that they will use the condom correctly, based on available statistics. If one of the partners is infected, on each tick with their partner, there is a chance that they will spread the disease to them. This chance is based on whether or not the couple chose to use a condom, whether or not the condom was used correctly (which influences how successful the condom is at preventing infection), and the infectiousness of the disease.
  + If one of the partners is infected and the couple has unprotected sex, there is a chance that the other partner will become infected. An infected agent is distinguished by a dot on their shape.
* Turtles check to see if they are infected only after having sex, because symptoms take a while to show up. Only agents of genders that are symptomatic (set by the symptomatic? slider) will know they are infected. If an agent knows s/he is infected, s/he will always want to practice safe sex for the rest of the simulation.
  + Depending on the disease and whether an agent is male or female, the agent will feel symptoms. It will be assumed that if the agent detects symptoms, they get checked by a doctor, are diagnosed, and are gradually cured of the infection.
  + If an agent has unsafe sex and doesn’t notice any consequences (either is not infected, or is not symptomatic), that agent’s inclination to practice safe sex will decrease.

**Rationale for agent rules:** *Why did you give the agents these rules?*

Assumption development was based on studies drawn from the scientific literature.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*stop reviewing\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

-- Determining what factors inform/influence attitudes towards safe sex (and consequently behaviors), and to what extent they do so [potential options: attitudes of parents/friends/sexual partners, infection history of self or friends, education/awareness of safe sex practices]

**Explanation of theories of petty, etc. \*\*\***

Attitude – asdkfj

Certainty – asdkfj

Justification – asdkfj

Likelihood – asdkfj

**Likelihood**

description of coming up with the formula for likelihood, deciding on attitude, justification, certainty, etc. possibly include a chart

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Initial factors** | **Increase** | **Decrease** |
| **Attitude** | Condom desire | Talking to peers with similar attitude   * (only slightly above? Or also slightly below, but on same pole as you?   If they have sex with a partner that is infected and use protection…??? proposed  Super boosted if contract an STI and know it | Proposed: Think you “got away with” unsafe sex   * but actually, increases justification, just attitude gets more negative? So initially likelihood should take safe sex justification and use it to potentially bump up lower likelihoods, which are most influenced by attitude…? |
| **Certainty** | Mesosystem influence | Every time you repeat your attitude to someone else  If you feel like others have the same/similar attitude as you  Super boosted if contract an STI and know it | Attitude challenged   * *(in opposite direction?? Does it have to be < 50 vs. > 50?)* |
| **Justification** | Sex ed including condoms | Super boosted if contract an STI and know it | Current: Think you “got away with” unsafe sex   * but actually, increases justification, just attitude gets more negative? So initially likelihood should take safe sex justification and use it to potentially bump up lower likelihoods, which are most influenced by attitude…? |

***Evolution of equation***

* rather than whole change happen only fraction of change - dampening
* First bug: realizing that including certainty was making negative people eventually go up to positive 🡪 certainty only impacts how much their **attitude/likelihood???** will change by talking to peers 🡪 **attitude/likelihood???** (change?) is a function of certainty, so updated **attitude/likelihood???** only depends on previous attitude and justification
* Second: distinguishing between likelihood and attitude
* likelihood higher than either attitude or justification alone…?? - can't force numerical score though (????) \*\*\*
* Third: incorporating if attitudes are too different
* Making sure the likelihood went in the right direction, dealing with scales 0-100 when maybe should’ve done -50 to 50 or -100 to 100
* Dealing with 0’s in equations

**Model/System Behavior:** *How does the overall system behave/work?*

Ideally supposed to show… system behavior: The NetLogo system will model the spread of sexually transmitted diseases (STIs) between young adults (male and female), based on their attitudes and behaviors regarding safe sex. … and the interaction between the two? ( partial duplicate from above). Actual results indicated… go into results.

**Invisible Model Parameters???**

**PLOTS….. Data of interest….?? Will be discussed below in further detail, but includes:**

**Components of safe sex behavior**

**average safe sex likelihood --> histogram**

**% of Population Infected**

**Things to try:**

Set one of the genders to not be symptomatic. What happens to their certainty, in comparison to the other gender? What happens to their attitude adjustment overall? (might need to change vocab….)\*\*\*

If you start with at least 1 person infected, can everyone have a positive attitude without infection spreading significantly? How long does it take for the most opposed person to change their mind significantly? How can this time be reduced?/what parameters can be changed?

Can everyone get negative? With a STI present in the population? Without a STI present?

Can everyone get positive? With a STI present in the population? Without a STI present?

Can some cliques form attitudes significantly different from those of other cliques?

Can there be someone who just refuses to change his or her mind?

Making sure that these outcomes, which I felt were reasonable, could happen, also helped me adjust formulas…. (discussed above)

Model/system behavior con’t:…

Simplifications here???

**Analysis & Sample Trials / Sample Outcomes**

Members of the same social group influence one another’s attitudes

Still has a negative attitude towards wearing a condom, because he doesn’t realize he is infected

Dot color indicates whether the agent knows they have an STI (based on being symptomatic)

Once an agent realizes they have an STI, they form a strong desire for safe sex

(For reference, the current value in America is about 48%) 🡪 justification, use for trials \*\*\*\*\*

**Sample Outcome/”case study”**

Do a sample simulation?? With pictuers!!

Female 0 is infected. She is not symptomatic. She mates with male 0, and he becomes symptomatic, immediately changing his attitude towards safe sex from pretty negative to strongly positive. By talking to his peers, he persuades them to improve their attitudes as well. Since he is very certain of his opinion, he talks to all his friends. However, direct experience is more powerful than second hand experience, so they are not super duper impacted by his story, but their attitudes may improve slightly. If they are very polarized (super negative), they will react negatively to talking to male 0, and become more certain of their negative attitude???

**Analysis of home life influence vs. education influence**

Lkj;lkj;lkjl

**Model output:** *Do you think your model currently provides a good description of the system’s behavior? Why or why not?*

However, there were a significant number of assumptions/limitaitons/simplifications to this model….

Transition to assumptions/simplifications? Or rearrange order talked about?

Talk about simplifications.

However/Despite these/ because of all of these limitations/assumptions, in combination with a lack of research (and likelihood of inaccurate research given the private nature of the topic), difficult to determine if my model output is valid.

However, did do analysis… and results of analysis indicate…

Going back to guiding questions, was most interested in how intervention could help increase attitudes, certainty, and justification (and consequently likelihood of safe sex behavior) ina social network demographic.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*continue reviewing\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Assumptions, Simplifications, Limitations**

**Assumptions:**

* There is only one type of STI
* Condoms are the only form of STI protection
* Agents are serially monogamous
* Agents are not malicious; if they know they are infected, they want to use safe sex. If they are symptomatic, they will know they have an STI, and will want to always practice safe sex from there forward
* Since agents that contract an STI will want to practice safe sex from that point forward, no allocation is made for STI treatment or recovery
* Social networks are limited: no friendships die (unless it became a sexual relationship), no social group membership changes, and an agent can’t be part of more than one social group
* Different sexual behaviors (monogamy, abstinence), likelihood of using protection for different sex acts and likelihood of transmission through them (would get pretty explicit)
* sexual partners don’t break up due to different attitudes!!! This could be big area of conflict, suggest an extension

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*stop reviewing\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Explain how **percentages of types of sexual education throughout america/ levels of knowledge of safe sex when entering college were created. decided** Don't need stats on percentages of prevalence of STIs in target demographic, to start out simulation (rather than having person choose to infect people) …. since could vary, and want to also simulate without an infection present, which could potentially be younger kids??

from have-sex: **limitations:**

* doesn’t account for if some people have a all safe sex always policy
* doesn’t account for potential conversation at mating which may influence opinion or relationship
* \*\*\*possibly using protection could improve your attitude towards it?

\*\*\*\*\*\*\*\*\*\*\*start reviewing\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Simplifying Assumptions**

This model only simulates heterosexual, college-aged young adults - both male and female. Agents in the simulation can only have a maximum of one partner at a time. The complexities of different types of sexual behaviors (abstinence, long-term monogamy, or strictly hook-ups) are not included in the model.

Although STIs may be transmitted through avenues other than sexual behavior, as in drug needles, childbirth, or breastfeeding, this model focuses on the sexual interactions, as they are most common form of transmission - especially in the age demographic in question. Additionally, although there are forms of protection against STIs/STDs other than condoms, it is the form of sexual protection that is most prevalent and accessible for the demographic of interest.

Although some members of the cliques have or develop links to agents in other groups, the social groups are generated at the beginning of the simulation and remain fairly static. Agents cannot change group affiliation over time, and are not able to be part of more than one social group at a time.

**Extending the Model**

This model assumes that safe sex (using a condom) is always 100% effective in preventing the spread of infection - thus there is no [random] chance of the infection spreading if a condom is used. This could be modified in extensions to be more realistic and account for factors like incorrect/inconsistent condom usage, condom failure, or STIs passed through other means.

Symptoms of sexually transmitted infections aren't always visible or known, and some STIs display symptoms differently in different genders. These factors impact how often a particular gender might choose to get tested or use protection in sexual encounters. To better simulate real-life behaviors, implement the chance that females have a high likelihood of experiencing symptoms, while males do not. If a person experiences symptoms, they can become treated and cured of the infection in some defined amount of time. You can also implement the condition that if a person thinks they are infected, they will definitely use protection. See how these changes impact the outcome of the model.

In different relationships, condom use may vary. Additionally, condoms are not always effective or properly used, and may be used for some sexual acts, but not others. To more accurately account for likelihood of condom use and consequent transmission of infections, create different condom-use tendencies for each sexual orientation and create a probability that a condom is ineffective.

Condom use for the purpose of protection against sexually transmitted diseases (vs. just for pregnancy prevention) increased when fear of HIV/AIDS was prevalent in the media. Incorporate an element of media influence that impacts the attitudes and/or behaviors of the agents.

**Extensions/didn’t get to**

* interaction between sexual partners and peers equal or no?
* sexual partners don’t break up due to different attitudes!!! This could be big area of conflict, suggest an extension (duplicate above)
* media/environment influences - since a lot of articles written during time that hiv/aids was exploding, prior to that condom use/protection/safe sex more about preventing pregnancy…
* Social networks limited: 🡪 extension potential for both generation and analysis
* Creating “advocates” – at NU, SHAPE program
* More realistic interactions between groups, less social butterfly potential?
* strength of relationships 🡪 stronger relationship sexually = less to use condom? Stronger with friends = more likely to talk about it?? Didn’t find research to support these, but seems intuitive
* the ONLY way someone can know theyre infected is through beings ymptomatic.. incorporate telling past partners if you realize you have an std, more responsible behavior. But also include a likelihood of people to do this.
* -- talking to partner is different than just friends, possible different genders of friends too
* -- use the networks extension
* ;; don't need a had-std? variable or need to get treated, because assumption made is that having just 1 std will deter the person from having unsafe sex... but this isnt true
* -- monogamy
* getting randomly tested, like in aids model, and cost of treatment factors??

**Evolution of Model:**

I had originally been primarily interested in seeing how an STI that is symptomatic for only one gender travels through the population and potentially reaches some sort of stable state. However, based on the feedback I have received, I think I will focus more on the sexual attitudes and behaviors of agents in relation to the spread of STIs. Hopefully this will also more clearly distinguish my model from the AIDS or Virus model, which was a concern that both the TA and I had. I still need to find some supporting articles/other research in order to root some of the assumptions of my model.

Turtles will move around randomly mostly within a specified area, in order to try to recreate circles of friends or divisions of populations. This has not yet been implemented, but the NW extension or links may be used to confine movement. 🡪 got rid of movement, they stay in one place

network connections could potentially be a reasonable way to model friend circles, which could influence behavioral choices and attitudes towards sex and using protection.

Rather than having turtles generate a network, just generate it for them to simplify.

Mostly discrete social circles, with some social butterflies that have links to members of other social groups. [repeat sentence from above] (in creating this functionality, used Sophia sullivans final project on modeling commons as a starting point, then adjusted breeds and other parameters as necessary).

-- Determining what factors inform/influence attitudes towards safe sex (and consequently behaviors), and to what extent they do so [potential options: attitudes of parents/friends/sexual partners, infection history of self or friends, education/awareness of safe sex practices]

(duplicated from above)

🡪 Implementing (or deciding whether it is valid to implement) whether a particular gender is symptomatic of an STI, therefore becoming aware of it, getting treated, and potentially changing their future behaviors 🡪 originally this was up in the air, but I considered it essential for what I wanted to model, as symptomaticness of stis can play a big role (citation???) especially for young adult minds that Ihave not fully developed and may not see positive

Since sexual partner links will break any sort of link between 2 turtles when the relationship ends (rather than going back to being friends), turtles also have the chance/opportunity to make more links than their original number – this helped fix/account for all links between genders breaking and becoming discrete, gender-segregated friend groups, which isn’t realistic.

;; The initial number of friends that an agent had (num-friends)

;; is used as a maximum number of friend links to create

;; Otherwise, the agents will keep making way too many friends (eliminated the movement/shifting of positions)

;; and if updating layout is enabled, will keep moving closer,

;; and all cluster in middle of screen

Limitation/assumption or evolution progress?? Not sure

cliques aren’t formed on the basis of shared attitudes (but would they really, in real life? Possibly based on education received, but it was hard to accurately do that through my implementation)

gender balance (or not balance?) cliques?? no, it is randomized

**decided to eliminate:**

turtles also don’t randomly get tested, nor is likelihood of getting tested based on gender – this is better covered by other models (aids)

Additionally, there is a chance that a turtle will randomly get tested, despite whether they are currently symptomatic – this probability may also be impacted by their attitudes towards safe sex…. No, took this out

vocality - used certainty instead for simplification. but could be an extension? this model assumes that the agents are willing to talk about the sensitive topic of safe sex behaviors with their peers, which may not be true at all se

If a turtle is closely linked to another turtle of the appropriate gender to mate with, there is a probability they will mate. 🡪 got rid of strength of relationships

-- Investigating whether a female being on birth control is a valid parameter that might impact whether she chooses to engage in safe sex 🡪 didn’t find any supportive research

was interested in media/environment influences - since a lot of articles written during time that hiv/aids was exploding, prior to that condom use/protection/safe sex more about preventing pregnancy…. but left as extension for user

-- Implementing likelihood of proper use of sexual protection based on statistics, and consequently different potential rates of transmission

If the coupled turtles use protection, there is a probability of using it correctly – if protection is used correctly, it is assumed that the disease will not be passed on. If the protection is used incorrectly or no protection is used, there is a higher probability that the infection will be passed to the partner of the agent. 🡪 couldn’t find stats for std prevention, just pregnancy, this could be an extension \*\*

**NetLogo Features**

~~should I have 2 breeds of sexual links? or just one with a type and color….? 2 breeds~~

* Breeds are used for the genders of turtles, as well as for distinguishing friend links from sexual partner links.
* n-of is used to split the agent population into two genders evenly.
* The random-near function generates many small random numbers and adds them together to determine individual tendencies. This produces an approximately normal distribution of values across the population.

;; Set genders of turtles to be 50% male, 50% female

ask n-of (count turtles / 2) turtles [set breed females ]

**References, Related Models**

used sophias as a starting point, but only took relevant stuff, mostly just network generation and creating spatially separated clusters - e.g. no equivalent to bosses in my model, so removed...

Virus

AIDS

Disease Solo

Virus on a Network

STI model (Lizz Bartos & Landon Basham for LS 426, Winter 2013)

Sophia Sullivan Final Project (EECS372 Spring 11): http://modelingcommons.org/browse/one\_model/3023

**Questions:** What questions do you have about your model?

**Next steps:** Briefly list your next steps for improving the model.

**num-cliques** (range 1-20) [slider]

**clique-size** (range 1-35) [slider]

**avg-num-friends** (range 2- 1-cliquesize) [slider]

**social-butterflies?** [switch] Enable to initialize a limited number of inter-group links between "clique leaders".

**infection-chance** (0-100) [slider] The chance out of 100 that an infected person will transmit infection during one week of couplehood if they have unsafe/unprotected sex (without a condom) (infectivity)

**symptomatic?:** [chooser] Specify which genders (if any) show symptoms of the infection

**Thorough description/explanation of Agent Parameters:**

**had-unsafe-sex?:** Whether this person had sex without a condom on the last tick

**infected?:** If true, the person is infected (and infectious)

**known?:** The person is infected and knows it (due to being symptomatic)

Note: The agent will not "know" they are infected (and set the known? to true) until check-infected is called…and even then, they will only be aware of their infected state if his/her gender is symptomatic. ……An agent will not ever know if they are infected (their known? variable never = true) if they are not symptomatic/of a symptomatic gender, which may enable an STI to more easily spread through a population \*\*\*\*\*\*

Note: In this model, agents that know they are infected always use condoms to protect their sexual partners

**coupled?:** If true, the person is in a sexually active couple.

**partner:** The person that is our current partner in a couple.

**couple-length:** How long the person has been in a couple.

**friendship-tendency:** How likely this person is to make a new friend. (doesn't change)

**coupling-tendency:** How likely the person is to join a couple. (doesn't change)

**commitment:**  How long the person will stay in a couple/relationship. (doesn't change)

**num-friends:** The ideal/goal number of friends that an agent wants to have

Friendships can only break if the friend was of an opposite sex, they formed a sexual relationship, and then they broke up, which breaks all links between them. Setting this parameter allows agents to try to keep their desired number of friend connections. Sexual partners are not counted in the friend count. This value is set to the initial number of friends/links an agent has, which is generated randomly on a normal distribution at setup….???

**group-membership:** which cluster/friend group the friends and leaders are mainly part of

This still applies to social butterflies - assume they have a core friend group

in addition to more out-group links than others

## WHAT IS IT?

## HOW IT WORKS

Agents in this model are either male or female - the difference between these agents is distinguishable by their shape. Their color indicates their likelihood of engaging in safe sex (red = least likely --> green = most likely).

An agent's likelihood of engaging in safe sex is a probability that depends on his or her:

-- Attitude: their personal desire/intention to have safe sex (CONDOM-USAGE) is originally set by sliders dependent on gender.

-- Certainty: their conviction with which they hold their attitude. The influence of an individual's upbringing, such as parental beliefs and religious attitudes (symbolized by the MESOSYSTEM-CONDOM-ENCOURAGEMENT variable), represents their initial certainty.

-- Justification: the strength of the logical explanations to back up their attitude. Initially, this will be set to a variable representing a level of sex ed. Experiences such as contracting an STD, or a friend contracting an STD, would increase this parameter.

;; On each tick, agents talk to their friends (and partner, if any),

;; and potentially update their attitude about safe sex

Each time step (tick), if an agent is coupled, they increment the length of their relationship. The sexual relationship lasts for a limited period of time (based on the commitment levels of each partner), soif their relationship length has gotten too long, the two will break all links to one another when the sexual relationship ends.

If an agent is does not have a sexual partner on a tick, they attempt to find a mate that is single and of the opposite gender. First they examine their friends, if that is unsuccessful, they try finding a agent within the same social circle that they are not linked to, and as a last resort, they try to find the closest potential mate.

Every agent, regardless of coupled status, has a chance to make a new friend each tick, if their friend count has not already reached a maximum. (A maximum friend count is required so that the clusters remain somewhat discrete and do not form one large clump in the middle of the screen.)

On every tick while the two agents are coupled, if one partner is infected, the other partner is at risk for infection based on a probability of having sex and using protection. If an agent becomes infected through this interaction (and is of a symptomatic gender), they do not realize they are infected until the next tick.

## HOW TO USE IT

Using the sliders, choose the number of social groups (NUM-CLIQUES) to create and how many people should make up each social group (CLIQUE-SIZE). The agents within the clique are only connected to others within their social group, and will have about AVG-NUM-LINKS "friends", that they are connected to via a blue link. One of these links will be to the central "leader" of the clique. This "leader" is identical to other agents, except it additionally has links to all other clique "leaders", which helps set up a visual layout and generates a very loosely connected social network containing mostly discrete clusters.

Whether a central "clique leader" should have links to leaders of other cliques. Initializes limited links between groups, otherwise there are none on setup.

The SETUP button generates this network and assigns unique values to each individual, based on a normal distribution centered around the average values indicated by the sliders AVG-MESOSYSTEM-CONDOM-ENCOURAGEMENT and AVG-MALE-CONDOM-INTENTION/AVG-FEMALE-CONDOM-INTENTION (depends on agent's gender),as well as setting other variables that are not visible to the user in the same fashion (e.g. tendency to make a friend or sexual partner, maximum length of time willing to spend coupled with a sexual partner).

SETUP will infect one person in the population by default. If the user wants to infect another agent, they can do so through pressing the SELECT button and clicking on an agent, or pressing INFECT-RANDOM. This can also be done while the model is running.

An infected person is denoted with the addition of a dot on their body, and they will have a INFECTION-CHANCE chance of infecting a partner during unprotected sex. If they are of a gender that is symptomatic of the STI (set by the SYMPTOMATIC? chooser), they are aware of their infected status, the dot will be white, and the agent will automatically practice safe sex to protect his or her partners. However, if the agent is not a gender that is symptomatic, the dot will appear black, they will be oblivious to their infected state, and continue their normal probability of practicing safe sex.

The model stops when the entire population is infected, or if all agents have reached a single, unchanging safe-sex-attitude of either 0 or 100.

### Simplifying assumptions

## THINGS TO NOTICE

## THINGS TO TRY

## EXTENDING THE MODEL

## NETLOGO FEATURES

## RELATED MODELS, CREDITS AND REFERENCES

**TODO:**

**NEED TO MAKE SURE DOT STAYS BLACK FOR 1 TICK**

**Use word “robust”**

**Check that “Opinion” isn’t used in a confusing way**

Check all past info tabs

Include address to arthurs questions, including referencing networks extension

;; TODO: FIGURE OUT BEST PLACE TO PUT CHEKC INFECTED \*\*\*\*\*

**(“What is it”)**

This model aims to simulate the spread and development of safe sex attitudes and behaviors in response to the prevalence of a sexually transmitted infection (STI) throughout a social network of young adults. It also takes into account how these variables influence one another and change over time using theories of attitude change and certainty.