Lizz Bartos

EECS 372

Designing and Constructing Models with Multi-Agent Languages

Prof. Uri Wilensky

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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.

**Relevance and Motivation**

This project specifically focuses on modeling college students in the United States, a specific demographic which contain young adults who may have multiple sex partners and who would engage in sexual activity frequently enough that this lifestyle would be impacted by STIs. Male and female students come to universities with diverse backgrounds, including different educational levels and attitudes towards practicing safe sex. 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.

This model focuses more on the impact of sexual (safe sex?) attitudes and behaviors of agents in relation to the spread of STIs, rather than the biological mechanism of the spread of sexually transmitted infections themselves. This contrasts with previous models in the NetLogo library that focus on the actual spread of a disease, such as the AIDS model, the Virus model, or the Virus on a Network model.

**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 and NetLogo Interface Structure**

**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 friend links within the group. Specific values for each agent start with random value drawn from a normal distribution centered around a specified mean value.

**STI characteristics:** Users can control the likelihood (out of 100%) of an infection spreading during an unprotected sexual encounter (**infection-chance** slider), and [choose] which genders (if any) show symptoms of the infection (using the **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. (why no comma before or or after during?)

**Agent Parameters Impacting Practice of Safe Sex**

**Global Averages of Agent Parameters Impacting Likelihood of Practicing Safe Sex**

**Attitude:** users can separately define the [average] initial intention of a male vs. female agent in the model to practice safe sex, i.e., condom use(age?) (using the **avg-male-condom-intention** and **avg-female-condom-intention** sliders, both with ranges/which both range 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 practicing safe sex, which influences how resistant they will be to adopting alternate viewpoints~~/changing their attitude~~. The initial average population certainty value is set with the **avg-mesosystem-condom-encouragement** slider [range 0-100%]. This variable reflects how much of their upbringing encouraged safe sex. These views might consist of parents' beliefs, life experiences, religious attitudes, etc. Certainty can influence the likelihood of practicing safe sex, but is independent of attitude. Willingness to change one’s attitude would be proportional to a corresponding variable equal to [100 - attitude].

Note: Chose mesosystem terminology based on Bronfenbrenner’s word, but not his theory. 🡪 don’t include this in rationale section, include in parameter section

**Justification:** Justification is the/agents have an/ initial reasoning why agents 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 health education including information about condoms as protection against STIs will have a higher level of accurate knowledge about safe sex practices and benefits, and those who don’t will have a lower level of accurate knowledge. Both values will be normally distributed over the higher or lower value and used as the initial J/justification for a given agent.

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

The approximate likelihood of an agent practicing in safe sex is demonstrated through the color of each agent. Enabling the **show-labels?** switch will also? display the exact likelihood value 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. Custom values for each agent are generated randomly following a[n approximately] normal distribution using the average global variables indicated above, as well as some additional variables that are hard-coded and invisible to the user. The actual functional dependence of the three [major?] components of Attitude, Justification and Certainty on the Likelihood of practicing safe sex will be discussed in [further] detail below [in context of rationalization…? Or what section?].

**Attitude:** An agent’s attitude is initially set to [condom intention] …a random selection from a normally distributed range centered around a user specified mean. Attitude evolves over the course of the model and changes/has the potential to change [on each tick] is updated on each tick based on talking to peers or getting infected.

**Certainty:** Certainty is initially set to a value near? (redundant if already talked about normal random distribution?) a randomly generated value using the variable avg-mesosystem-condom-encouragement. Certainty is the best determination of behavior, according to research (citation). However, this NetLogo model has certainty as an influencing variable for Attitude, which ultimately determines the L/likelihood of 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)

**Agent Appearance** **(Agent Screen Characteristics)**

**Shape:** Shape – Agent shape is determined by gender and health/infection 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), which is based on being symptomatic. [is this clear to the reader what this means?]. Explanation of shape – Male and female agents have shapes similar to those used to distinguish bathroom signs..??

**Color:** Color – The color of the agent indicates his or her individual 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:** Label – The labels, if enabled, also indicate each agent’s likelihood of practicing safe sex as a(n exact?) value from 0 to 100 and is more accurate because color is set to only a total of 20 different hues over the same range.

**Links:** Links – In this model, turtles can have multiple friends, but only one sexual partner at a time. The type of relationship between the two agents is distinguished by color of the connecting link: a blue link denotes friendship, and magenta link denotes a sexual partnership.

**Model Setup**

The social network of agents is arranged as mostly discrete social circles, with some (optional) central agents (“social butterflies”) that have links to central members of other social groups in addition to links to all members in their clique. Agents start with a certain number of friendship links (limited to between others in their clique), and no sexual partner links. Friend links are gender independent, but sexual partners are not – they require a coupling of one male and one female agent. Individual agent variables are assigned randomly following a normal distribution based on slider or global values.

The model initiates/initializes by having/making one agent contract a sexually transmitted infection (an STI).

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

Before describing the agents rules themselves, explain overall what happens, and what outputs you see

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

The system has several stop conditions:

* If every single agent in the model is infected
* If the certainty of every agent gets so high that attitudes will not change anymore (based on this model’s implementation)
* If every agent comes to the same attitude consensus (need to implement, its only on polar ends right now)
* If attitudes/likelihoods???/some variables? aren’t changing any more…. reach some sort of stable state?
* (If likelihoods of all agents stop changing significantly, the simulation will stop.

START PART 2 ---------------------------------------------------------------------

**Agent behavior and rationale: -----**

**Agent Behavior:** *How do the agents behave/work?*

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 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
  + The number of people they talk to is based on their certainty, the amount their attitude might changed is based on…
* Agents look for a sexual partner (male-female coupling).
  + If they are NOT coupled, an agent tries to find a mate. Any agent can initiate mating if they are not coupled (and random chance permits)
  + If they are not coupled, they might try to find another single agent 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 (two?) 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, the two agents just increase length of their relationship (agents are monogamous in this simulation).
* Agents make friends.
  + As long as they have not reached their maximum limit of friends, every agent (coupled or not) gets a chance to make a friend on each tick.
    - Otherwise, all the sexual partner links break, then it becomes single-sex clusters (don’t think this actually could happen anymore… possibly reword)
  + If this agent has not reached their maximum limit of friends (and random chance permits), they try to make a friend.
* Agents that (currently) have a sexual partner can potentially uncouple ~~or potentially break up~~. Agents will uncouple if the length of the relationship reaches the commitment threshold for one of the partners.
  + The order in which these functions are called on each tick (uncouple after make-friends and couple) helps restrict/place a restriction on who can couple after uncoupling, simulate that exes would not be immediately friending each other again, and this model doesn't (intend to) simulate instant rebounds
* If agents are coupled (have a sexual partner), still in/part of a couple, ~~each tick,~~ they have sex/ they will have sex on each tick ~~and have the potential of spreading an STI if they have unprotected sex…. and one of them doesn’t know they are infected??~~. The likelihood that the couple will engage in safe sex depends on the **safe-sex-likelihood** of both [check code!!] participants.
  + 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/behaviors 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…. ~~If the couple does choose to use a condom, there is a chance that they will use the condom correctly, based on stats from WHERE???~~ 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.
* Agents check ~~to see~~ if they are infected only after having sex, [verify in code] and talking to friends, because symptoms [of STIs often] take a while [period of time?] to show up [don’t present themselves instantly].
  + ~~,…. In order to best simulate that STIs may not present symptoms immediately, don't check if infected [ check-infected ] (known determined by being symptomatic) until after talking to friends about attitude and having sex~~
  + 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. (reflect in color?)
  + Additionally… mention shape change / dot color??
  + ~~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. (clarify this!!)~~
  + If an agent has unsafe sex and doesn’t notice any consequences (either is not infected, or is not symptomatic, regardless of infection status), that agent’s inclination to practice safe sex will decrease.

The turtles do not move, (which isn’t totally realistic?) but/in order to… allows the user to view spread of attitudes easier…?

START PART 3 -----------------------------------------------------------------------------

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

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

In order to…. [ stuff here that I couldn’t decide on]

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

**Below: Rationale for choosing different parameters/assumptions of the model**

**Why I chose the parameters I did for the model itself, agent rules, values, etc.**

**Networks Rationale:**

Researchers have repeatedly identified that social networks are crucial in examining the spread of different types of infections, as well as attitudes – many of these have specifically been on STDs like HIV/AIDS during the early 90s or whatever. However, difference between a social network and a infection spread network, may not coincide.

**My major inspiration source explanation…?/research background**

Couldn’t find any research articles/scholarly theories specifically geared towards development of attitudes and/or knowledge regarding safe sex and condom usage, so I used existing literature relating to attitude development/certainty in general. The majority/Most of my assumptions were derived from the work of Tormala and Rucker (2007), who reviewed existing literature about attitude certainty over the past XX years, and additionally proposed a model of [something]. ... metacognitive/multifactor model of attitude certainty attributional logic model

In trying to address the question “How do people’s perceptions of their own responses to persuasive messages affect attitude certainty?” (pg. ???) The authors propose/take an approach that "focused on the metacognitive factors that shape attitude certainty" (475). Through their research, which "focused primarily on the way attitude certainty is influenced by people’s encounters with persuasive messages" (p. 475), they "[suggest] that people "form attribution-like inferences about their attitudes" (475) and can become either more or less certain of their attitudes following an encounter with a persuasive message, depending on their perceptions of their response to that message and the situation in which it occurs." (p. 476). 🡪 reference the “appraisals” terminology??

By "focus[ing] on two forms of attitude certainty: attitude clarity and attitude correctness." (p. 482), the authors "… have proposed a multifactor model of attitude certainty, suggesting that the general state of attitude certainty … might reflect a number of different certainty- type assessments." (p. 482)

"Furthermore, we posit that these effects can occur in the absence of any differences in the structure of people’s attitudes or the underlying content of their cognition" (p. 475)

"… That is, regardless of whether people actually were resistant to or persuaded by a message, or whether their resistance or persuasion was correct or impressive in some way, they can become more or less certain of their attitudes when their subjective assessment of their message response leads them to a positive or negative appraisal, respectively." (p. 476)

However, I changed some of the terminology in order to be more clear, and also chose to focus more on attitude than certainty… kind of made it my own in a way that was easier to understand. Transition to my choice of attitude, certainty, justification, and how they are defined and justified, and influence likelihood.

**Parameters influencing safe sex likelihood 🡪 (Attitude, Certainty, Justification) Rationale:**

**Terms Tormena and Rucker used and equivalents to how I used them in my model….?**

Tormala and Rucker define attitude certainty as “the sense of conviction one has about one’s attitude, or the extent to which one feels confident or sure about one’s attitude.” (p. ???, 2007)

Types of attitude certainty:

Attitude Clarity

Attitude Correctness

Terms:

Petrocelli et al. (2007)… determined/reasoned/found through (analysis of surveys or something?) "… [attitude] clarity and [attitude] correctness could be measured separately, and each appeared to explain unique variance in global feelings of attitude certainty." (Petrocelli et al. 2007, p. 482)

Petrocelli et al. (p. 483)

Increased clarity: "repeatedly expressing the same attitude should facilitate the subjective sense that one knows what one’s attitude on a topic is"

No change to correctness: "without making that attitude seem any more correct or valid."

Increased correctness: "believing that other individuals share one’s attitude should bolster one’s sense that that attitude is valid or justified"

No change to clarity: "without making it seem any more one’s own."

**Attitude Rationale/Explanation**

Need to fill in…. attitude clarity really

**Certainty Rationale/Explanation** *(actually the focus of/studied by tormala/rucker)*

[One reason that?] attitude certainty is/has been of interest in research/scientific/scholarly literature in part because (one of) the most notable consequence(s) of attitude certainty is attitude-behavior correspondence...since/and/as "it is well established that high certainty attitudes are more predictive of behavior than low certainty attitudes (…)." (p. 487), (and?) "as attitude certainty increases, attitudes become increasingly likely to guide behavior (...). " (p. 473)

Furthermore/Additional [important] consequences of attitude certainty include…

Additionally/furthermore, "attitude certainty [also?] has important implications for the durability and impact of an attitude.", (p. 473) including "an attitude’s tendency to resist persuasive attack, an attitude’s general persistence or stability over time, and people’s motivation to process new information. (p. 473)"

"Attitude certainty is considered to be a dimension of attitude strength" (p. 469) and in general, "strong attitudes are more likely to guide behavior, more likely to resist influence attempts, and more likely to persist across time" (p. 470)

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Chose mesosystem terminology based on Bronfenbrenner’s word, but not his theory (include this in rationale section or include in parameter section??) Some articles, especially the Hispanic one, suggest heavy family influence.

Other studies have explored the internet and other media. The general consensus seems to be that multimedia is the way to go (for interventions/adjusting behavior), but direction to these resources should ideally come from trusted people/role models in their lives… i.e. parental influence (mesosystem slider) still most important according to research I found.

**Justification Rationale/Explanation**

stuff

**Knowledge/Justification:**

The feeling of greater knowledge "has been shown to foster greater attitude certainty (e.g., Smith, Fabrigar, MacDougal, & Wiesenthal, forthcoming)." (p. 471).

"Smith et al. (forthcoming) recently demonstrated that ... The more consistent one’s underlying [attitude-relevant] knowledge, the more certain one is of one’s attitude." (p. 472)

**Rationale for effects of behaviors in model:** *🡪 make more sense to do this alongside description of agent rules???*

**Actions involved in Talking to others:**

**Repeating self 🡪 Increased certainty**

As indicated in Tormala and Rucker’s (2007) review of attitude certainty, repeating one’s attitude to others has been shown to increase attitude certainty (p. 471).

"Petrocelli et al. reasoned that … repeated expression might increase feelings of attitude clarity but not correctness as repeatedly expressing the same attitude should facilitate the subjective sense that one knows what one’s attitude on a topic is without making that attitude seem any more correct or valid." (p. 483)

"repeated attitude expression, for instance, affects attitude certainty but not attitude ambivalence (Petrocelli et al., 2007)." (p. 485)

**Increased certainty 🡪 Less willing to listen to new info and/or change**

"…attitudes held with high certainty are more likely than attitudes held with low certainty to resist persuasive attacks or other influence attempts (…)." (p. 473)

"attitudes held with greater certainty are more persistent over time than attitudes held with less certainty (Bassili, 1996; see also Bizer et al., 2006)." (p. 474)

"high certainty tends to be associated with decreased information processing activity compared to low certainty (Edwards, 2003; Tiedens & Linton, 2001; Weary & Jacobson, 1997)." (p. 474)

"Conversely, uncertainty indicates that people do not have sufficient knowledge, and scrutinizing additional information offers one way to acquire knowledge and restore or establish certainty." (p. 474)

**Social consensus/similar attitudes**

Tormala & Rucker (2007) noted/observed/pointed out/summarized/concluded based on their research that…. People tend to be more certain of their attitudes when they believe other people hold similar attitudes. This may be because "attitude consensus, or perceived social support for one’s attitude," (p. ???), [also referred to as "social consensus" (p. 472) or "response similarity" (p. 480)] "is thought to signal that all the evidence points to the same attitude, which boosts attitude certainty if one holds that attitude oneself." (pp. 472-473) …"In essence, people infer validity from social consensus" (p. 472)

"When one’s own response matches (mismatches) the responses of others, one forms more positive (negative) response appraisals, producing higher (lower) levels of attitude certainty." (Tormala & Rucker, 2007, pp. 480-481)

"Petrocelli et al. reasoned that … attitude consensus, or perceived social support for one’s attitude, might influence feelings of attitude correctness but not clarity. The rationale in this case is that believing that other individuals share one’s attitude should bolster one’s sense that that attitude is valid or justified, without making it seem any more one’s own." (p. 483)

**Talking to others / Getting infected:**

As Tormala and Rucker summarized/noted through their review of literature, "people tend to be more certain of their attitudes when those attitudes are formed through direct (e.g., first hand interactions) rather than indirect (e.g., second hand viewing or reading) experience.” (Tormala & Rucker, 2007, pp. 470-471)

**Formula:**

* "univalent attitudes tend to be more resistant to persuasive attack (…) and more predictive of attitude-relevant behavior (…) than their ambivalent counterparts." (p. 485)
* "Participants’ attitudes were more resistant to this attack when they were high rather than low in clarity, as well as when they were high rather than low in correctness." (p. 484)
* "perhaps people become more certain of their newly changed attitudes when they believe those attitudes have been changed by strong, and thus valid, arguments." (p. 478)

**Likelihood / Impact of factors**

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…? |

**Why I chose the parameters I did for testing/data analysis**

(this is a good transition between rationale for model parameters and research, because research should have informed what stats I could reasonably use to model real life and get meaningful simulation results that could imply something about the world)

Females have better health practices, have more to lose from unprotected sex (pregnancy OR sti)

Reference the guiding question, and why that made me choose testing params I did

START PART 4, DATA ANLYSIS AND STUFF ---------------------------------------------------

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

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

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.

In figuring out if my model provided a good simulation, I came up with a lsit of “things to try”, as indicated in my info tab of the netlogo model. Making sure that these outcomes, which I felt were reasonable, could happen, also helped me adjust formulas…. (discussed above? Reference discussion of formula or something?)

**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.

**Assumptions, Simplifications, Limitations**

**Simplifying Assumptions:**

* There is only one type of sexually transmitted infection (STI)
  + other models can simulate specific diseases better (virus, aids, etc)
* Condoms are the only form of STI protection / in question/explored in this model / condom usage…safe sex behavior…?
  + Chose specifically/**only** condoms because most prevalent/accessible / and cheapest?? form of ~~safe sex~~ protection in the US young adult demographic I’m interested in modeling, [[as it does not require an age limit, prescription, etc…. and college campus usually have condoms freely available.???]]
* Agents are serially monogamous – they can only have one sexual partner at a time
* Agents can/will only know that they have contracted an STI if they are symptomatic/ of a gender that is symptomatic
  + – no testing, or communication between partners, takes place. turtles also don’t randomly get tested, nor is likelihood of getting tested based on gender – this is better covered by other models (aids)….
* Agents are not malicious; if an agent knows he or she is infected, they want to practice ~~use~~ safe sex. If an agent is symptomatic, s/he will know they have an STI, and will want to always practice safe sex from there forward.
* Agents are not malicious; if an agent knows he or she is infected, they will always want to practice safe sex [i.e. use condoms] from there forward.
* Since agents that know they have contracted an STI/are infected will [always] ~~want to~~ practice safe sex from that point forward, no allocation is made for STI testing, treatment, or recovery.
* Condoms are assumed to be used perfectly and entirely effective against the spread of STIs. (move up to where condoms are discussed?)

~~(consequent??)~~ Limitations

**Limitations:**

* The social network implementation is limited/Social networks are fairly static: 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
* Condoms are the only form of STI protection …only Form of safe sex protection?? in question/explored in this model … is specifically/**only**??? condoms,
* if an agent knows he or she is infected, they want to practice (use) safe sex. If an agent is symptomatic, s/he will know they have an STI, and will want to always practice safe sex from there forward. This doesn’t always convince someone entirely, could be explored further

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?

From **rationale**:

Limitation: doesn’t take into account ethnicities. Some articles say that African Americans keep STDs within their own race, others examine the attitudes/practices of specific ethnicities – even classic Jefferson high school was pretty homogenous, and this is not necessarily representative of a college campus…though there is always self segregation

This model is also not intended to represent sexual attitudes and behaviors as people get older. College is a special time, and a unique time of higher risk (reference?) due to hookup culture of millennials

Std transmission network may be different not only on existence of std, but stad of epidemic

Assortative or disassortative?? …???

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Explain how **p**ercentages 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??

**Simplifying Assumptions** (further explanation of…?)

This model only simulates heterosexual/heteronormative(cisgendered), college-aged young adults - both male and female. Agents in the simulation can only have a maximum of one partner at a time. (also allude to super frequent coupling and friending) 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.

**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

* + Every agent, coupled or not, gets a chance to make a friend on each tick. 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 nothing cool happens

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:**

* 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. (clarify this!! – duplicated above)

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 \*\*

***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

**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

**assign-normally-distributed-member-variables:** Individual agent variables are assigned randomly following a normal distribution based on slider or global values

**talk-to-peers**:

* Agents talk to their friends and sexual partner (if any), which might impact their personal likelihood of practicing safe sex
* Agents talk to their friends (indicated with blue links), and potentially update their opinions about safe sex (and consequently likelihood to practice safe sex).

**couple**: kjal;kdfjs

**make-friends**: Agents make friends. ~~This gives everyone (coupled or not) a chance to make a friend.~~

If this agent has not reached their maximum limit of friends (and random chance permits), they try to make a friend (regardless of it they are coupled or not)

As long as they have not reached their maximum limit of friends, every agent (coupled or not) gets a chance to make a friend on each tick.

Otherwise, all the sexual partner links break, then it becomes single-sex clusters (don’t think this actually could happen anymore… possibly reword)

If this agent has not reached their maximum limit of friends, they try to make a friend

If this agent has not reached their maximum limit of friends (and random chance permits), they try to make a friend.

every agent, coupled or not, gets a chance to make a friend on each tick, as long as they have not reached their maximum limit of friends.

;; If this agent already has reached their maximum limit of friends,

;; they don't try to create any more friend links

make friends (will only be called if the turtle has not reached their maximum friend limit) and their tendency is acceptable 🡪 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 nothing cool happens

**uncouple**:

Agents that (currently) have a sexual partner can potentially uncouple ~~or potentially break up~~.

Agents will uncouple if the length of the relationship reaches the commitment threshold for one of the partners.

**have-sex**: If agents are coupled (have a sexual partner), still in/part of a couple, ~~each tick,~~ they have sex/ they will have sex on each tick ~~and have the potential of spreading an STI if they have unprotected sex…. and one of them doesn’t know they are infected??~~. The likelihood that the couple will engage in safe sex depends on the **safe-sex-likelihood** of both [check code!!] participants

**check-infected:** asdfasdf

**INFO TAB TEXT**

## WHAT IS IT?

**(“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.

## 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

**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?

## EXTENDING THE MODEL

**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.

if coupled, have sex EVERY time! and if not coupled, ALWAYS looking for a partner….. 🡪 extension??

**Extensions/didn’t get to**

* interaction between sexual partners and peers equal or no?
* -- talking to partner is different than just friends, possible different genders of friends too
* 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
* 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
  + More realistic interactions between groups, less social butterfly potential?
  + -- use the networks extension
* Creating “advocates” – at NU, SHAPE program
* the ONLY way someone can know they are 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.
* ;; 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??

## NETLOGO FEATURES

**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.

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

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

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

## RELATED MODELS, CREDITS AND REFERENCES

**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

*wants to practice (attitude) and likelihood they will practice safe sex are different!! \*\**

*Selecting an agent to infect can be particularly useful/interesting when…???*

**TODO:**

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

**Use word “robust”, facet?**

**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 \*\*\*\*\*