|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outline | | | Guiding questions | Own ODD+D Model description |
| 1. **Overview** | | I.i Purpose | I.i.a What is the purpose of the study? | The purpose of the study is to explore under whether university students can experience intense marginalisation (which is how we defined bullying) by the process of selecting interaction partners. |
| I.ii.b For whom is the model designed? | For everyone interested in inclusion- exclusion and bullying phenomena. |
| I.ii Entities, state variables, and scales | I.ii.a What kinds of entities are in the model? | Agents reflect students and links are the unidirectional relationships of each student with the other. |
| I.ii.b By what attributes (i.e. state variables and parameters) are these entities characterized? | Attributes of an agent:  **External-characteristics** : the agent’s characteristics readily available by just looking at the other agent such as the hair colour (array of numbers),  **Internal-characteristics** : the characteristics that are exposed during interactions such as shyness (array of numbers),  Tolerance: the range around the ideal value of a characteristic that the agent perceives as acceptable, (same for all characteristics)  **#negative interactions**: the number of negative interactions the agent has experienced since the beginning of time ,  **#positive interactions**: the number of positive interactions the agent has experienced since the beginning of time,  **#refused interactions**: the number of refused interactions the agent has experienced since the beginning of time,  Attributes of links:  **Attraction** for the agent the link is directed to,  **Known-indices**: memory for other agent’s characteristics, |
| **I.ii.c What are the exogenous factors / drivers of the model?** | We assume that external to the agents, there are idealised values for each external and internal characteristic (**Ex\_ideal\_chars** and **In\_ideal\_chars** respectively). Agents accept these idealised values and customise them by setting a range around them, the range of accepted values. The range is defined by the tolerance of each agent. The maximum value of tolerance named **Max\_judg** is set manually. Whenever they interact with others, they compare the characteristic values of others to their accepted range. Based on this comparison, they assess interactions as positive or negative. The more positive interactions the higher the attraction link towards that agent and vice versa. After each interaction the attraction increases (when the interaction is positive) or decreases (if the interaction is negative) by the value of **Attracttion\_change** , which is set manually.  Whether agents refuse or not an interaction depends on the attraction link towards that specific agent and some randomness.  The number of internal characteristics and external characteristics (named **num-external-characteristics** and **num-internal-characteristics** respectively) is set manually.  The number of students (named **num-students**) is set manually.  The Average value (named **Average\_char**) of all chars is set manually.  The Standard Deviation (named **Stdev\_char**) of all chars is set manually.  The Initial attraction towards others called **Attitude** (same for everyone) is set manually.  The amount of internal characteristics exposed during interactions (called **charlearned\_interaction**) is set manually. |
| **I.ii.d If applicable, how is space included in the model?** | Not applicable |
| I.ii.e What are the temporal and spatial resolutions and extents of the model? | Each time step represents a ‘day’ and therefore the simulation last 100 number of time steps, resembling thus a whole university semester. |
| I.iii Process overview and scheduling | I.iii.a What entity does what, and in what order? | Every time step individuals performs two different interactions with half the number of the students (without including the agent) “( num-students - 1 ) / 2 )”.  The first type of interactions is the hang-out interactions (forced interactions): students are paired randomly and interact by evaluating the external and internal characteristics of their interaction partner. Note that at initialization, the internal characteristics of others are unknown, but they get uncovered as interaction goes by.  The second type of interactions are social interactions (free interactions): here an agent picks another randomly. Then, the agent decides whether to interact or not on basis of its attraction link to the randomly picked agent. If the agent decides to interact, the target agent decides whether to accept or not the interaction, based on the attraction link towards the agent initiating the interaction. The agent may thus accept or refuse the interaction. If the interaction is refused the initiator agent updates his/her #refusedintearctions.  At the end of the interaction, links update their attraction and known indices. If the evaluation of the other interaction partner’s characteristics is considered positive then the interaction is positive and the other way around. Afterwards a new time step is started. |
|  | | **II.i Theoretical and Empirical Background** | II.i.a Which general concepts, theories or hypotheses are underlying the model’s design at the system level or at the level(s) of the submodel**(s) (apart from the decision model)?** What is the link to complexity and the purpose of the model? | Real world observations:   * External characteristics represent conspicuous features of persons such as physical appearance; internal characteristics may represent more personal features such as interest, way of thinking, etc. which are only know through communication. * During forced interactions everybody can pick an interaction partner: this may represent interactions that occur during a class or course. Social interactions represent intended social interactions, here the probability of interacting with another depends on the attraction link towards that specific person. Social Interactions have a stochastic element and a rational element. * People judge first external characteristics and when they get to know each other they judge internal characteristics * Memory for other agent’s characteristics: People usually remember important characteristics of other people. * Regarding exclusion, perceptions of exclusion change gradually.   Adhoc rules:   * We assumed that agents adopt cultural idealized values . The range of acceptance of others depend on this idealized value +/- a judgement variation. The larger the judgement variation the more accepting the agent is towards other agent’s characteristics and vice versa. * There are two arenas (types) for interactions: classrooms we meet people and interactions may be considered mandatory, and social settings (outside classroom interactions like recess or group work) in which individuals are free to interact with whomever they want. |
| **II.i.b On what assumptions is/are the agents’ decision model(s) based?** | Established Theories:   * Social Exchange Theory 🡪 The result of the interaction is based on the compatibility of each agent’s characteristics, Agents choose based on outcomes of previous interactions which is expressed through the attraction link.   Real world observations:   * Everybody has a chance to interact with everybody: the less the attraction link the less the probability to interact (Social Interactions have a stochastic element and a rational element). |
| ***II.i.c Why is a/are certain decision model(s) chosen?*** | Decision is based on social exchange theory (more specifically the part developed by Thibault and Kelly) with the addition of stochasticity. |
| **II.i.d If the model / a submodel (e.g. the decision model) is based on empirical data, where does the data come from?** | The model is theoretical |
| **II.i.e At which level of aggregation were the data available?** | Individual level and group level. On the individual level, if the exclusion index of the student is over 0.8, we consider this agent marginalized? (marginalized? = true). Also, if the average attraction the agent received (average\_attraction\_in) from other agents is lower than 0.2, we consider this agent marginalized\_attraction? ( marginalized\_attraction? = true). On the group level, we store in the variable “Students\_ marginalized” the percentage of students who are marginalized based on marginalized? and in the variable “Students\_ marginalized\_attraction“ the percentage of students who are marginalized based on marginalized\_attraction?. |
| **II.ii Individual Decision Making** | **II.ii.a What are the subjects and objects of decision-making? On which level of aggregation is decision-making modeled? Are multiple levels of decision making included?** | The subjects are the agents and agents decide whether to socially interact with others or not. All decisions are made at the individual level. The decision to interact or not with another depends on the attraction link towards that specific agent. |
| **II.ii.b What is the basic rationality behind agents’ decision-making in the model?** Do agents pursue an explicit objective or have other success criteria? | The rationality for agents is to interact with other agents that are within the range of acceptance of their idealized external and internal characteristics values. |
| **II.ii.c How do agents make their decisions?** | During social interactions:  Agents select interaction partners at random. Whether they try to interact or not with the randomly picked partner depends on the comparison between the attraction link towards the partner and  a random number between [0,1].. The general rule is if attraction link > random number, it means that the agent will proceed to interact with the randomly picked partner, and then it is up to the partner to accept or not the invitation. This decision is again based on the attraction link of the partner towards the agent initiating the interaction. If attraction link < random number, then the interaction is not initiated. Note that attraction links may not be symmetrical between the two agents.  The evaluation |
| **II.ii.d Do the agents adapt their behavior to changing endogenous and exogenous state variables? And if yes, how?** | Not for this version |
| **II.ii.e Do social norms or cultural values play a role in the decision-making process?** | The idealised values for external and internal characteristics is assumed to be the effect of cultural norms on people’s judgement. |
| **II.ii.f Do spatial aspects play a role in the decision process?** | Not for this version. |
| **II.ii.g Do temporal aspects play a role in the decision process?** | As interactions go by, agents learn more and more about each other’s internal characteristics. |
| **II.ii.h To which extent and how is uncertainty included in the agents’ decision rules?** | Uncertainty is introduced by comparing attraction links with a random number before the agent decides to have (accept) interact with others. |
| II.iii Learning | II.iii.a Is individual learning included in the decision process? How do individuals change their decision rules over time as consequence of their experience? | Individual learn about each other’s internal characteristics as interactions go by. Depending on the values of these characteristics and acceptance range, agents may increase or decrease their attraction links towards others. |
| **II.iii.b Is collective learning implemented in the model?** | No |
| **II.iv Individual** Sensing | II.iv.a What **endogenous** and **exogenous** state variables are individuals assumed to sense and consider in their decisions? **Is the sensing process erroneous?** | Every agent knows the external characteristics of all other agents. Their sensing is always correct. |
| II.iv.b What state variables of which other individuals can an individual perceive? **Is the sensing process erroneous?** | Every agent knows for the other whether they are in the process of interaction with another agent. Later the know individually if they are in a positive or negative interaction. The sensing is always correct. |
| II.iv.c What is the spatial scale of sensing? | Global |
| II.iv.d Are the mechanisms by which agents obtain information modelled explicitly, or are individuals simply assumed to know these variables? | Learning about the internal characteristics of others can only happen when individuals interact. |
| **II.iv.e Are costs for cognition and costs for gathering information inclu­ded in the model?** | There are no costs for cognition. |
| II.v Individual Prediction | **II.v.a Which data uses the agent to predict future conditions?** | Agent anticipates outcome of next interaction based on attraction link. |
| II.v.b What internal models are agents assumed to use to estimate future conditions or consequences of their decisions? | It is assumed that an agent judges another person’s characteristic positive (1) if the characteristic’s value fall within the range (ideal value – tolerance, ideal value + tolerance), and negative (-1) otherwise. Then the result of the interaction is based on the sum of the evaluation of each characteristic the agent knows about the interaction partner . If the sum is positive, the interaction is positive and the other way around. |
| **II.v.c Might agents be erroneous in the prediction process, and how is it implemented?** | The agents judge based on the characteristics they know (known indices) and from external characteristics. Therefore, when they do not know all characteristics their judgement is limited. |
| II.vi Interaction | II.vi.a Are interactions among agents and entities assumed as direct or indirect? | The interactions are direct |
| **II.vi.b On what do the interactions depend?** | The agents are randomly paired in forced interactions and then decision rules and stochasticity influence the number of interactions that take place. |
| II.vi.c If the interactions involve communication, how are such communications represented? | Exchange of values of internal characteristics |
| **II.vi.d If a coordination network exists, how does it affect the agent behaviour? Is the structure of the network imposed or emergent?** | No coordination needed |
| II.vii Collectives | II.vii.a Do the individuals form or belong to aggregations that affect, and are affected by, the individuals? Are these aggregations imposed by the modeller or do they emerge during the simulation? | Aggregations may emerge in terms of agents having a positive attraction link towards each other, but they are not modelled |
| II.vii.b How are collectives represented? | Collectives are not modelled |
| **II.viii Heterogeneity** | **II.viii.a Are the agents heterogeneous? If yes, which state variables and/or processes differ between the agents?** | Agents are heterogeneous in their characteristics and tolerance |
| **II.viii.b Are the agents heterogeneous in their decision-making? If yes, which decision models or decision objects differ between the agents?** | Agents decide based on the same decision rule. |
| II.ix Stochasticity | II.ix.a What processes (including initialization) are modeled by assuming they are random or partly random? | Initialisation includes randomness, paired agents are chosen randomly, initialising agent is chosen randomly, target agent is chosen randomly. |
| II.x Observation | II.x.a What data are collected from the ABM for testing, understanding, and analyzing it, and how and when are they collected? | For agents:  Agent ID  internal-characteristics  external-characteristics  tolerance  #positiveinteractions,  #negativeinteractions  #refusedinteractions  Exclusion index  For links:  Agent 1 in the link, Agent 2 in the link  Known-indices  Attraction  average\_attraction\_out for Agent 1  stdev\_attraction\_out Agent 1  average\_attraction\_in Agent 1  stdev\_attraction\_in of agents Agent 1  Data analysis:  Students\_ marginalized: the percentage of students for which marginalized? is true on the simulation  Students\_ marginalized\_attraction: the percentage of students for which marginalized\_attraction? is true on the simulation |
| II.x.b What key results, outputs or characteristics of the model are emerging from the individuals? (Emergence) |  |
| 1. **Details** | | **II.i Implementation Details** | **III.i.a How has the model been implemented?** | The model is implemented in NetLogo |
| **III.i.b Is the model accessible and if so where?** |  |
| III.ii Initialization | III.ii.a What is the initial state of the model world, i.e. at time t=0 of a simulation run? | **Initialization of parameters**  Idealized values for external and internal characteristics: initialised manually (stable for all characteristics for this version)  Number of characteristics: initialised manually  Values of external and internal characteristics of agents: random number generated from normal distribution with Average\_char as average value and Stdev\_char as standard deviation (min value 0 , max value 1)  Tolerance: random value between 0 and max\_judgement.  #of negative interactions: 0  #of positive interactions: 0  #of refused interactions: 0  Attitude: initialised manually  Max\_judg: initialised manually  Known-indices : empty array  Attraction change: initialised manually  Random position of students  average\_attraction\_out: 0  stdev\_attraction\_out: 0  average\_attraction\_in: 0  stdev\_attraction\_in: 0  Precision of variables 2 decimals |
| III.ii.b Is initialization always the same, or is it allowed to vary among simulations? | Initialisation rules are the same but produce different outcomes because of randomness and sliders. |
| III.ii.c Are the initial values chosen arbitrarily or based on data? | Initial values are chosen arbitrarily for first version. |
|  | III.iii Input Data | | III.iii.a Does the model use input from external sources such as data files or other models to represent processes that change over time? | There are no input data. |
| III.iv Submodels | | III.iv.a What, in detail, are the submodels that represent the processes listed in ‘Process overview and scheduling’? | Sub models are not created yet. |
| III.iv.b What are the model parameters, their dimensions and reference values? | See table |
| III.iv.c How were submodels designed or chosen, and how were they parameterized and then tested? | Justifications, references to literature, independent implementation, testing, calibration, analysis of submodels |

Tabell 1. Model Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Group variables** | **Description** | **Range** | **Increment** |
| Num-students | Number of students in the simulation | [2,100] | 1 |
| Num-internal-characteristics | Number of internal characteristics per agent | [1,100] | 1 |
| Num-external-characteristics | Number of external characteristics per agent | [1,100] | 1 |
| Average\_char | Average value “Average\_char” and standard deviation “Stdev\_char” of the truncated (min 0 and max 1) normal distribution from which values are drawn for the agents’ characteristics | [0,1] | 0.1 |
| Stdev\_char | [0,0.5] | 0.01 |
| Attraction\_change | Change in the attraction link of an interaction partner after a positive or negative interaction. | [0,0.5] | 0.05 |
| Attitude | Initial attraction link value towards the other interaction partners. | [0,1] | 0.1 |
| Max\_judg | Maximum value of the uniform distribution from which values of tolerance are drawn. | [0,0.5] | 0.05 |
| Charlearned | Number of internal-characteristics an agent learns about an interaction partner during an interaction | [0,20] | 1 |
| In\_ideal\_chars | Optimal cultural value of the internal characteristics(shared for all agents). | [0,1] | 0.1 |
| Ex\_ideal\_chars | Optimal cultural value of the external characteristics(shared for all agents). | [0,1] | 0.1 |