An Agent-Based Modeling of Drinking Behavior: A Preliminary Model and Potential Applications to Theory and Practice

Gimel Velasco, Paolo Sandoval

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Agent-Based Modeling of Drinking Behavior: A Preliminary Model and Potential Applications to Theory and Practice

Article in American Journal of Public Health · December 2006

DOI: 10.2105/AJPH.2005.063289 · Source: PubMed

Authors:

- ▶ Dennis M. Gorman, PhD
- Jadranka Mezic, MS
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Agent-Based Modeling (ABM)

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Agent-Based Modeling (ABM)

► Artificial environment that represents a simplified version of the real-world processes of interest.

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Agent-Based Modeling (ABM)

- ► Artificial environment that represents a simplified version of the real-world processes of interest.
- Observes the consequences of manipulating key input variables on attitudinal and behavioral outputs.

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Two aspects of alcohol studies that benefit from ABM

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Two aspects of alcohol studies that benefit from ABM

Answering "What if" questions.

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Two aspects of alcohol studies that benefit from ABM

- Answering "What if" questions.
- ► Spatial Dynamics and person-environment interactions.

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Objective

To develop a preliminary agent-based simulation model designed to examine agent-environment interactions that support the development and maintenance of drinking behavior at the population level.

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Drinking Behavior Model

► First Model

The model was defined on a 1-dimensional lattice along which agents may move left or right in single steps at each iteration.

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Drinking Behavior Model

► First Model

The model was defined on a 1-dimensional lattice along which agents may move left or right in single steps at each iteration.

► Second Model
A "bar" was added to the 1-dimensional lattice to attract Current Drinkers.

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Susceptible Drinker(S)
 Those who have not started drinking alcohol and display some probability of initiating this behavior.

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- Susceptible Drinker(S)
 Those who have not started drinking alcohol and display some probability of initiating this behavior.
- Current Drinker(D)
 Drinkers who continue to drink in the present.

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- Susceptible Drinker(S)
 Those who have not started drinking alcohol and display some probability of initiating this behavior.
- Current Drinker(D)
 Drinkers who continue to drink in the present.
- Former Drinker(R)
 Drinkers who have stopped drinking in the present.

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- Susceptible Drinker(S)
 Those who have not started drinking alcohol and display some probability of initiating this behavior.
- Current Drinker(D)
 Drinkers who continue to drink in the present.
- ► Former Drinker(R)
 Drinkers who have stopped drinking in the present.
- Note: Current Drinkers and Former Drinkers transition to each others state during the whole duration of the model. This movement into and out of heavy drinking is strongly affected by interpersonal influences and social context.

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No Bar/s on the lattice:

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No Bar/s on the lattice:

► An agent has the probability p of moving (50% left, 50% right) on the lattice.

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No Bar/s on the lattice:

► An agent has the probability p of moving (50% left, 50% right) on the lattice.

With Bar/s on the lattice:

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No Bar/s on the lattice:

► An agent has the probability p of moving (50% left, 50% right) on the lattice.

With Bar/s on the lattice:

▶ Only Current Drinkers (D) are affected by the presence of a bar.

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No Bar/s on the lattice:

► An agent has the probability p of moving (50% left, 50% right) on the lattice.

With Bar/s on the lattice:

- Only Current Drinkers (D) are affected by the presence of a bar.
- ▶ If a D agent is within a set proximity of a bar, it's movement favors walking towards the bar.

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No Bar/s on the lattice:

► An agent has the probability p of moving (50% left, 50% right) on the lattice.

With Bar/s on the lattice:

- Only Current Drinkers (D) are affected by the presence of a bar.
- ▶ If a D agent is within a set proximity of a bar, it's movement favors walking towards the bar.
- ▶ Else, it will move like that of any other agent.

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Agent Conversion: Interpersonal Influences & Social Context

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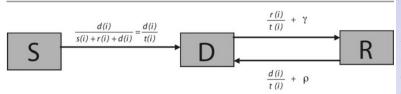
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Agent Conversion: Interpersonal Influences & Social Context



Note. Susceptibles (S): each agent examines the site it is residing on, counts current drinkers d(i), and converts to being a drinker with probability $\frac{d(i)}{s(i)+r(i)+d(i)}+\frac{d(i)}{t(i)}$, where t(i)=s(i)+r(i)+d(i) is the total number of individuals at site i. Current drinkers (D):each agent examines its site, counts former drinkers r(i), and converts to nondrinker status with probability $\frac{r(i)}{t(i)}+\gamma$, where γ is a bias defined as a probability that a drinker would stop drinking even if there were no former drinkers at this site (e.g., as a result of broader socioenvironmental influences such as the price of alcohol). Former drinkers (R): each agent examines its site, counts current drinkers, and converts to a current drinker with probability $\frac{d(i)}{t(i)}+\rho$, where ρ is a bias defined as the probability that former drinkers would resume drinking even if there were no drinkers around (e.g., with relates eaused by genetic predisposition).

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Macrolevel:

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Agents of each type on each lattice are only counted.

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Macrolevel:

- Agents of each type on each lattice are only counted.
- A particular agent cannot be tracked (no ID).

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100 Sites in Lattice.

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- ▶ 100 Sites in Lattice.
- ▶ 1000 Iterations/Days.

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- ▶ 100 Sites in Lattice.
- ▶ 1000 Iterations/Days.
- ▶ 1 Susceptible Drinker in every site.

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Initial Setup & Parameters

- ▶ 100 Sites in Lattice.
- ▶ 1000 Iterations/Days.
- ▶ 1 Susceptible Drinker in every site.
- 1 Current Drinker in the middle of the lattice.

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Drinking Model with No Bar/s

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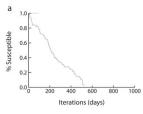
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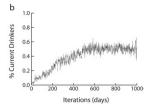
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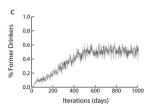
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Drinking Model with No Bar/s







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▶ Model parameters: p = .1, $\gamma = .3$, $\rho = .3$.

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- ▶ Model parameters: p = .1, $\gamma = .3$, $\rho = .3$.
- ► The population of S agents dropped to 0 at approximately 600 iterations.

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Orinking Model

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- ▶ Model parameters: p = .1, $\gamma = .3$, $\rho = .3$.
- ► The population of S agents dropped to 0 at approximately 600 iterations.
- ► The population of D agents grew linearly until 500 iterations.

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- ▶ Model parameters: p = .1, $\gamma = .3$, $\rho = .3$.
- ► The population of S agents dropped to 0 at approximately 600 iterations.
- ► The population of D agents grew linearly until 500 iterations.
- ► The population of D agents oscillated around 0.5 (half of the total population).

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- ▶ Model parameters: p = .1, $\gamma = .3$, $\rho = .3$.
- ► The population of S agents dropped to 0 at approximately 600 iterations.
- ► The population of D agents grew linearly until 500 iterations.
- ► The population of D agents oscillated around 0.5 (half of the total population).
- ► The population of R agents grew linearly until 500 iterations.

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- ► The population of S agents dropped to 0 at approximately 600 iterations.
- ► The population of D agents grew linearly until 500 iterations.
- ► The population of D agents oscillated around 0.5 (half of the total population).
- ► The population of R agents grew linearly until 500 iterations.
- ► The population of R agents oscillated around 0.5 (half of the total population).

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Effects of Different Movement Probabilities

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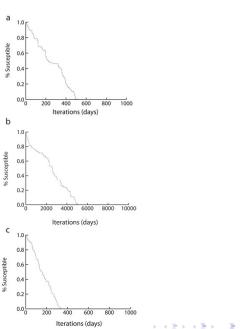
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► Model parameters:

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• a.)
$$p = .5$$
, $\gamma = .3$, $\rho = .3$

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Model parameters:

• a.)
$$p = .5$$
, $\gamma = .3$, $\rho = .3$

• b.)
$$p = .01$$
, $\gamma = .3$, $\rho = .3$

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Model parameters:

• a.)
$$p = .5$$
, $\gamma = .3$, $\rho = .3$

• b.)
$$p = .01, \gamma = .3, \rho = .3$$

• c.)
$$p = .2$$
, $\gamma = .3$, $\rho = .3$

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• a.)
$$p = .5$$
, $\gamma = .3$, $\rho = .3$

• b.)
$$p = .01, \gamma = .3, \rho = .3$$

• c.)
$$p = .2, \gamma = .3, \rho = .3$$

▶ For any p, ρ , $\gamma \neq 0$, the population of S agents went to 0.

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• a.)
$$p = .5$$
, $\gamma = .3$, $\rho = .3$

• b.)
$$p = .01, \gamma = .3, \rho = .3$$

• c.)
$$p = .2$$
, $\gamma = .3$, $\rho = .3$

- ► For any p, $\rho, \gamma \neq 0$, the population of S agents went to 0.
- ► The population of D agents and R agents oscillated around the equilibrium γ/ρ (1:1 or 2:1 or 1:2 ratio).

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• a.)
$$p = .5$$
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• b.)
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• c.)
$$p = .2, \gamma = .3, \rho = .3$$

- ▶ For any p, $\rho, \gamma \neq 0$, the population of S agents went to 0.
- ► The population of D agents and R agents oscillated around the equilibrium γ/ρ (1:1 or 2:1 or 1:2 ratio).
- ▶ Higher p makes S agent population drop faster.

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• a.)
$$p = .5$$
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• b.)
$$p = .01, \gamma = .3, \rho = .3$$

• c.)
$$p = .2$$
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- ▶ For any $p, \rho, \gamma \neq 0$, the population of S agents went to 0.
- ► The population of D agents and R agents oscillated around the equilibrium γ/ρ (1:1 or 2:1 or 1:2 ratio).
- ► Higher p makes S agent population drop faster.
- ▶ Lower p makes S agent population drop slower.

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Drinking Model with Bar/s

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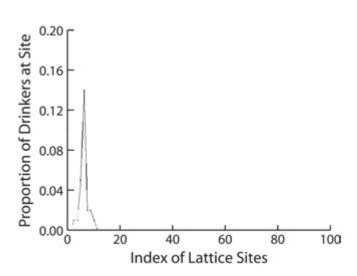
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Drinking Model with Bar/s



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▶ The population of D agents clustered around the bar.

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- ▶ The population of D agents clustered around the bar.
- ► The conversion from S agent to D agent was linear and very rapid at first, but then considerably slowed.

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- ▶ The population of D agents clustered around the bar.
- ► The conversion from S agent to D agent was linear and very rapid at first, but then considerably slowed.
- ► The population of S agents did not go to 0 after 1000 iterations but appeared to level off at a constant nonzero value.

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Effects of the Bar

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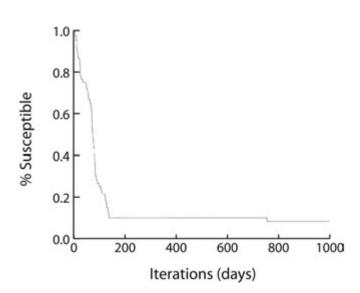
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► Since the D agents clustered at the bar, they have less chances of interacting with S agents. Thus, yielding the results showed above.

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Conclusion

The models demonstrate that the basic dynamics underlying social influences on drinking behaviour are shaped by contacts between drinkers and focused by characteristics of drinking environments.

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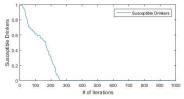
Paolo Sandoval

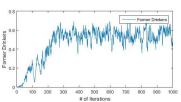
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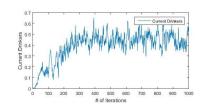
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The following results were collected from running the model

Parameters: p=.5, γ =.3, ρ =.3



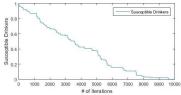


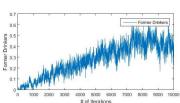


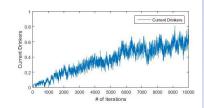
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Parameters: p=.01, γ =.3, ρ =.3







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Tielo

Introduction

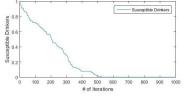
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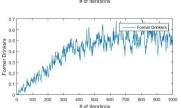
rinking Model

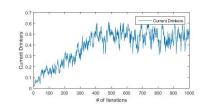
Results &

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Parameters: p=.2, γ =.3, ρ =.3







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Obiective

Orinking Model

Results &

Conclusion

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