# Models of Social Dynamics
## An Introductory Module

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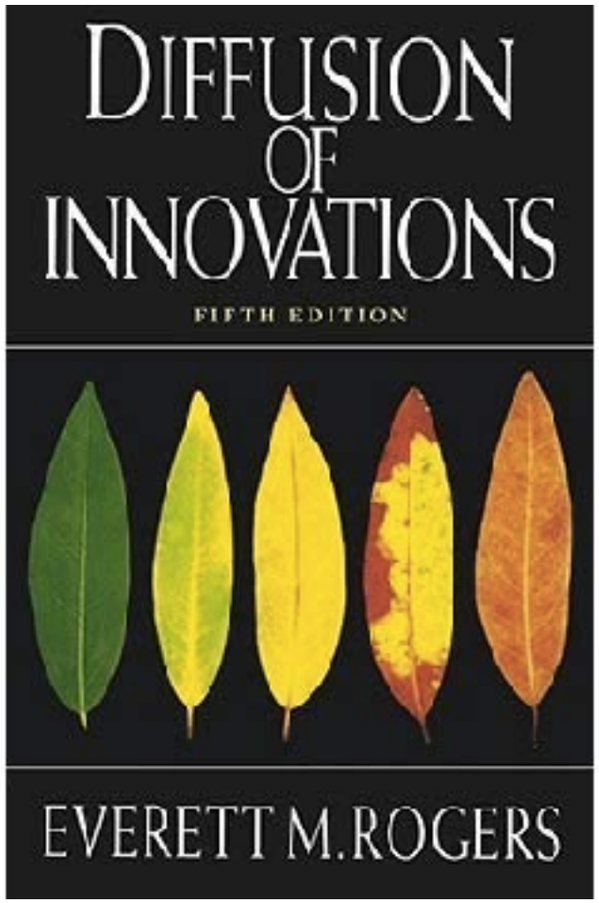
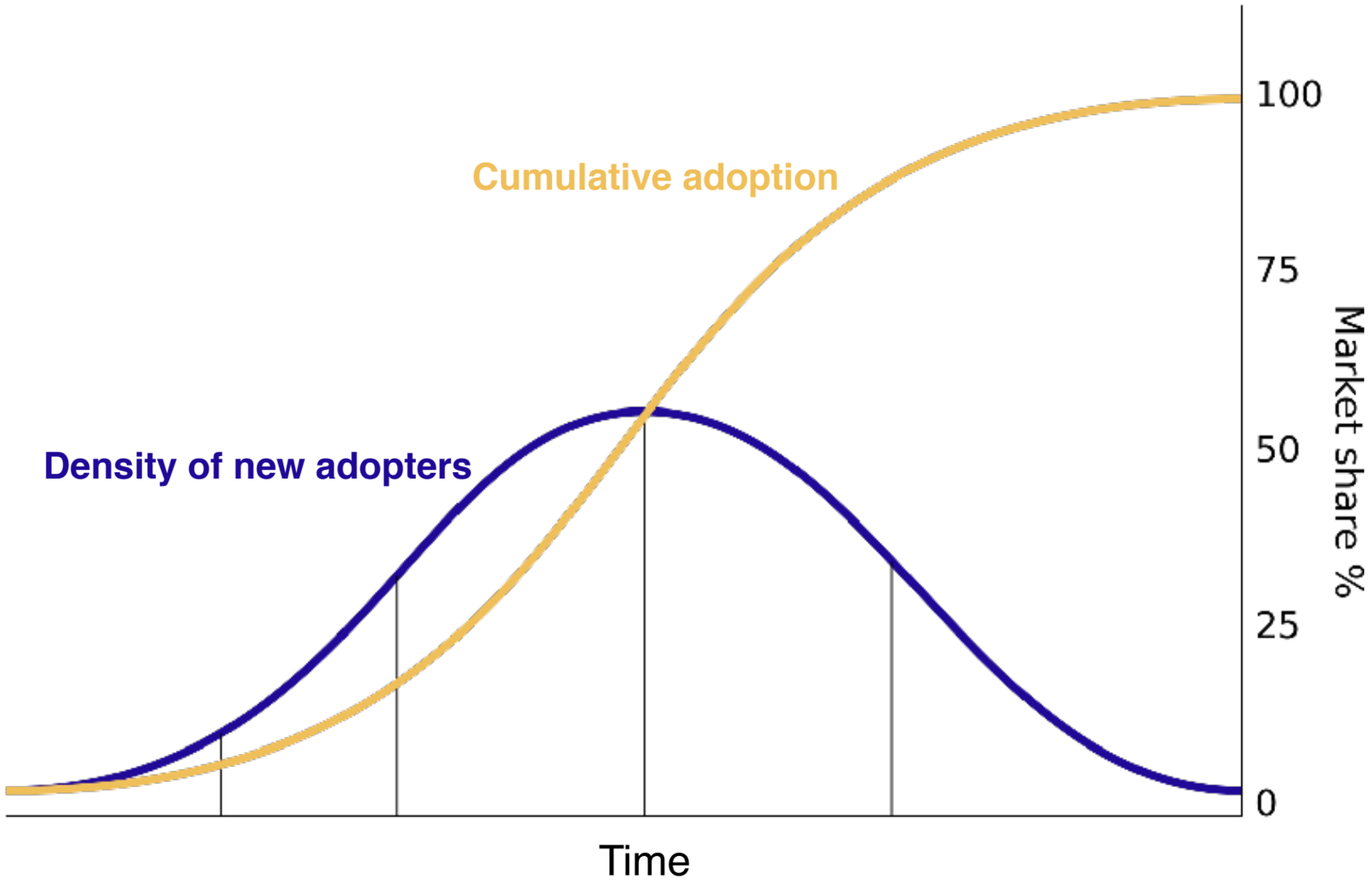
## Unit 2:
# Contagion

Things spread from one person to another.

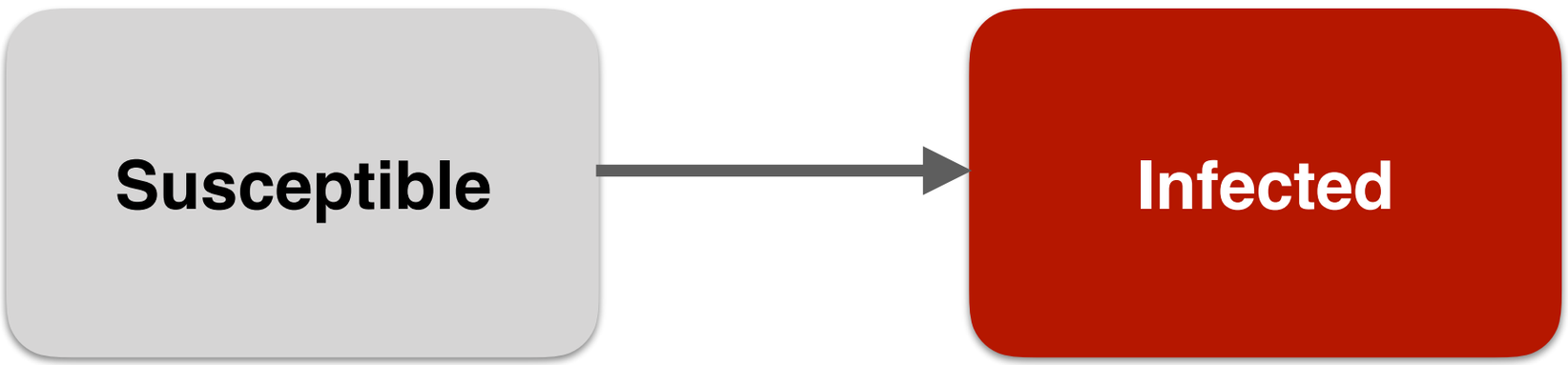
Diseases, information, behavior, technology.

What is the time course of contagion?


DIFFUSION
OF
INNOVATIONS
FIFTH EDITION
EVERETT M. ROGERS

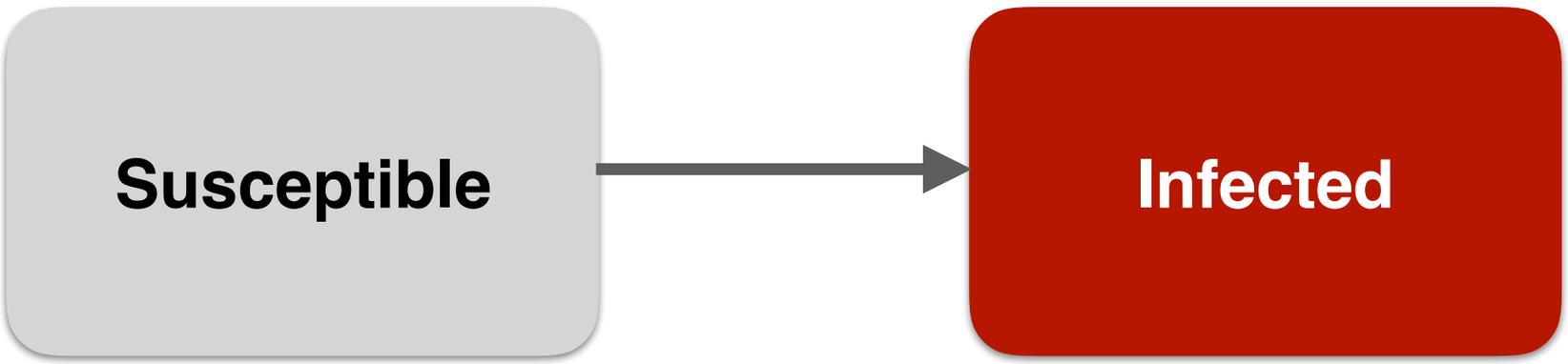

Cumulative adoption
Density of new adopters
100
75
50
25
0
Market share %
Time

# A two-state model



# Spontaneous adoption

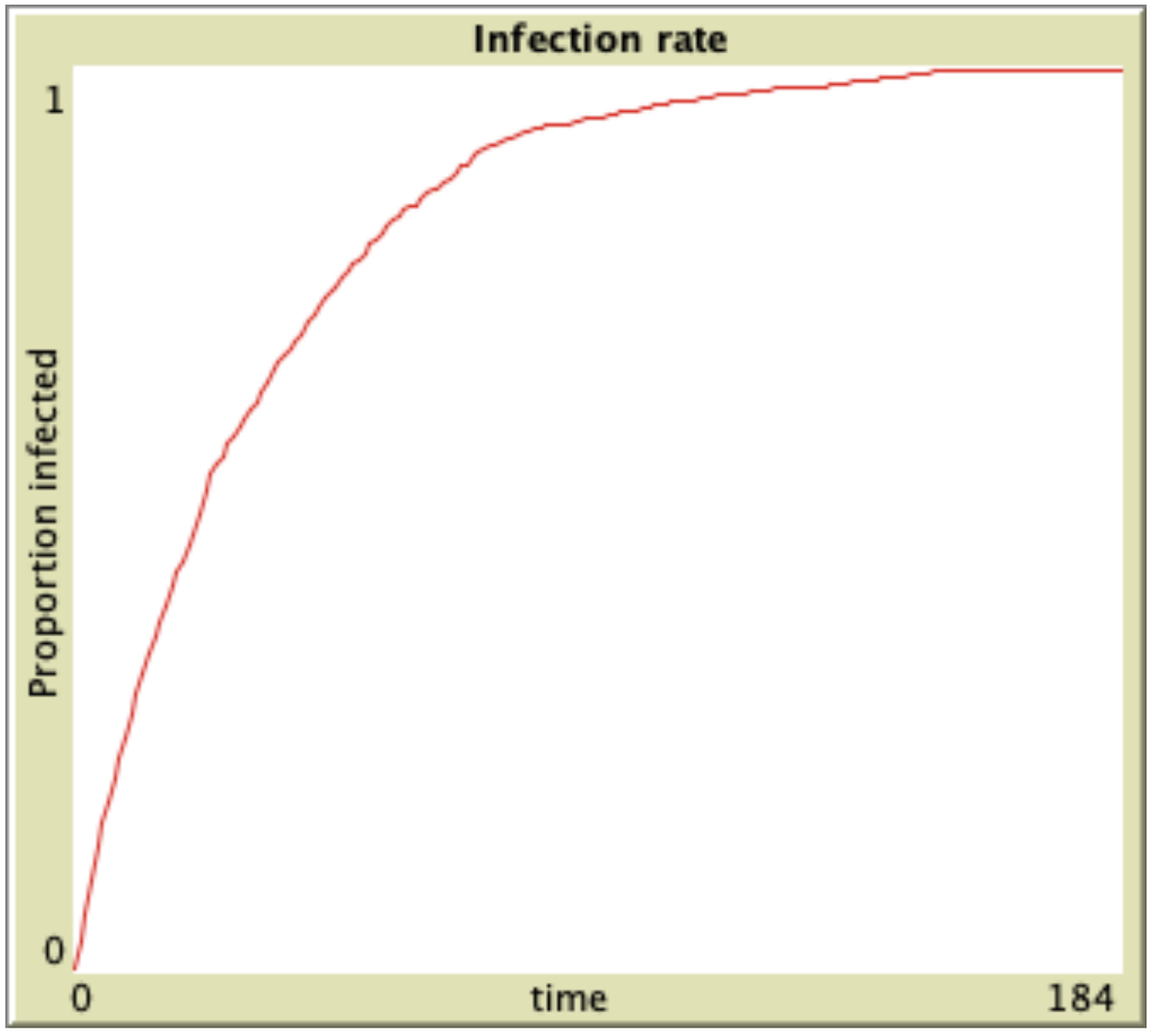
- All agents have the same information about the product or behavior
- Each unit of time, all agents adopt with a fixed probability



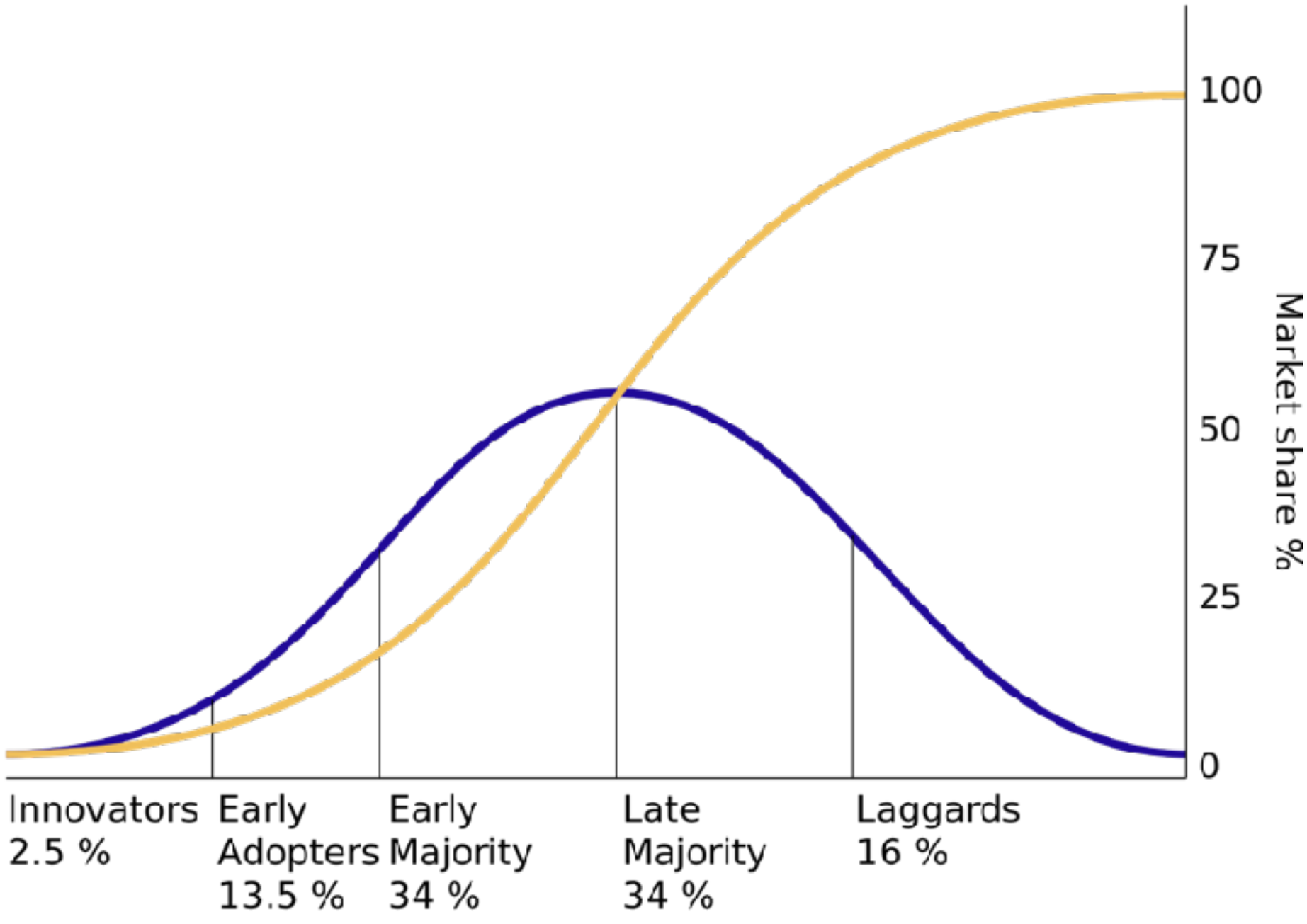
a model of spontaneous adoption

**CODE:** contagion_spontaneous.nlogo

# spontaneous adoption yields an r-shaped adoption curve



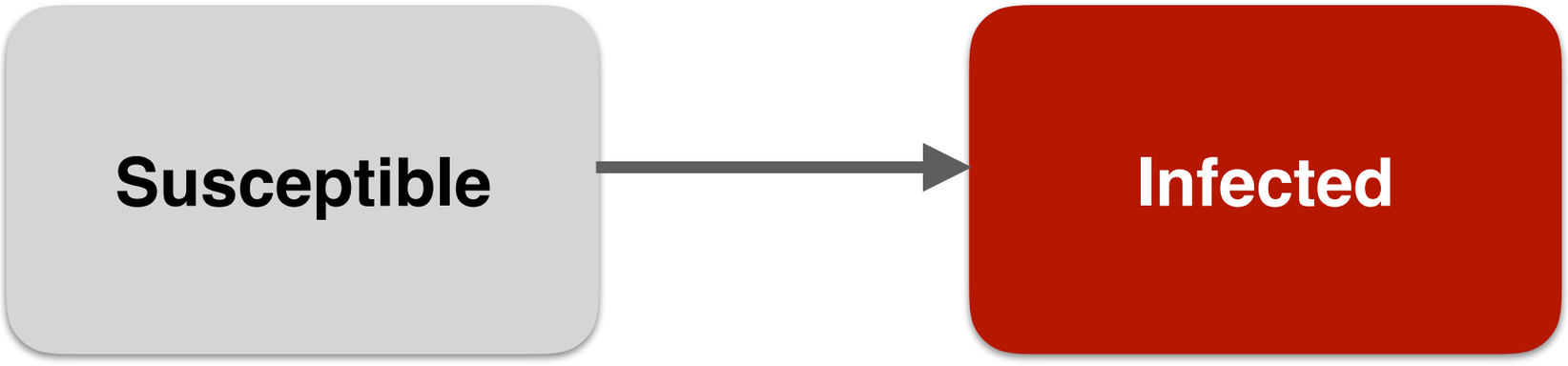
# Rogers' Theory



# Social influence

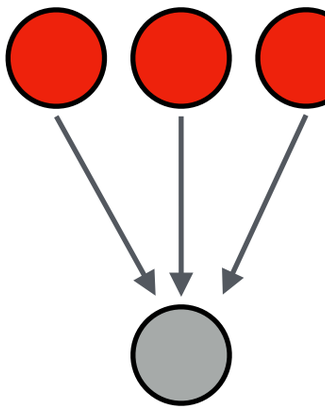
- Adoption is like a contagion. More exposures makes one more likely to adopt.

- Each unit of time, every time an agent comes into contact with someone who has adopted, they increase their change of adopting.



# Transmissibility

- $\tau$ = the probability of a contact leading to adoption



- What if we contact several individuals at once?

- $n$ = number of neighbors who have adopted

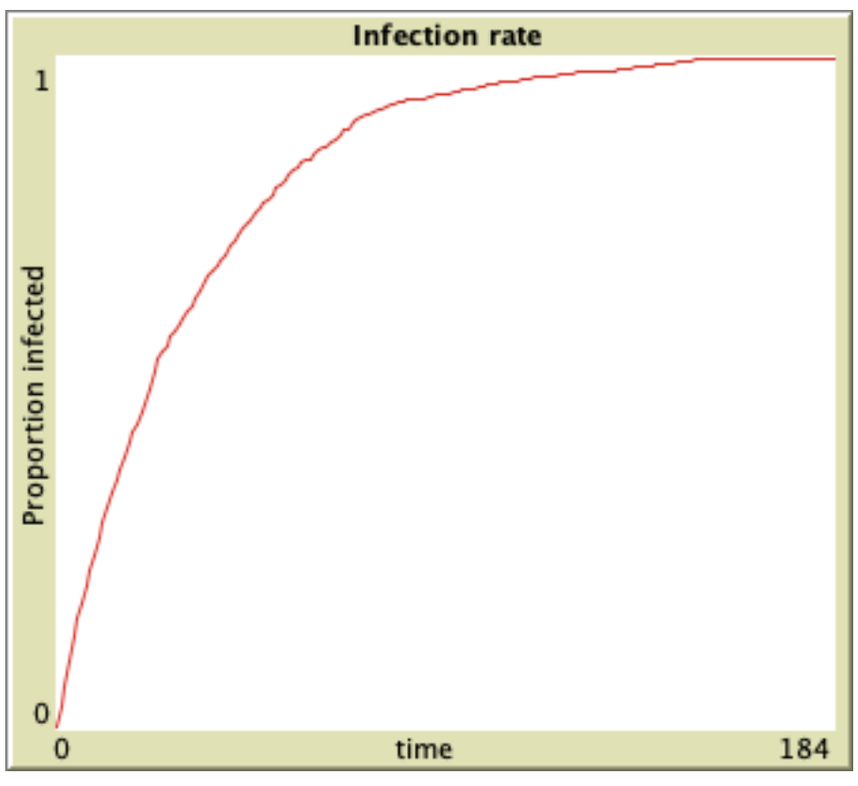
$$\Pr(\textbf{adopt}) = 1 - (1 - \tau)^n$$

a model of social influence

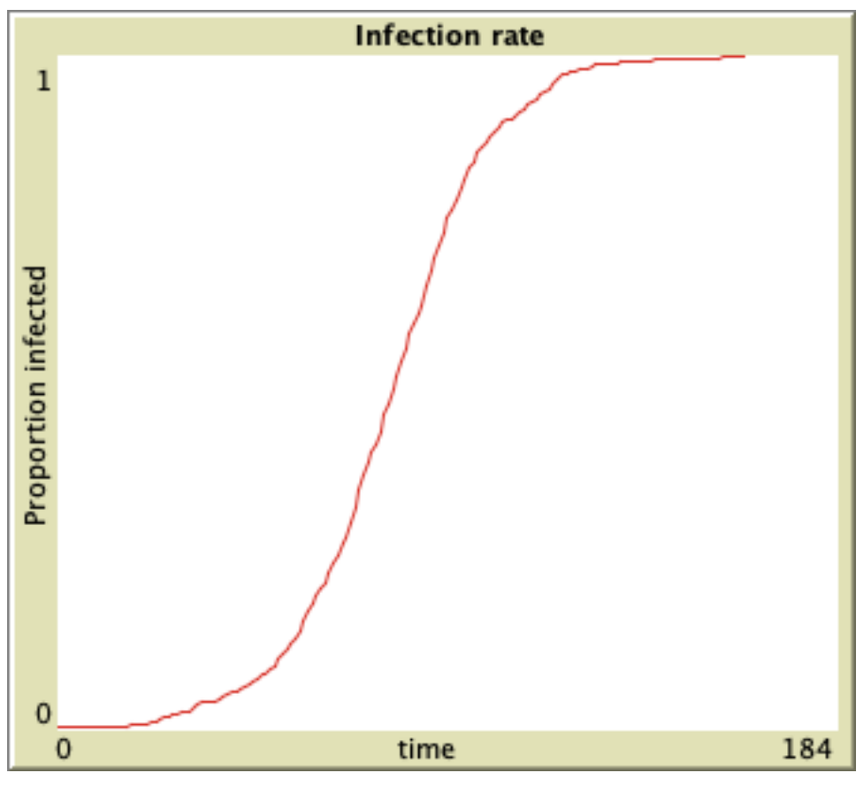
**CODE:** contagion_SI.nlogo

# The social influence model fits the data better than the spontaneous adoption model

spontaneous adoption

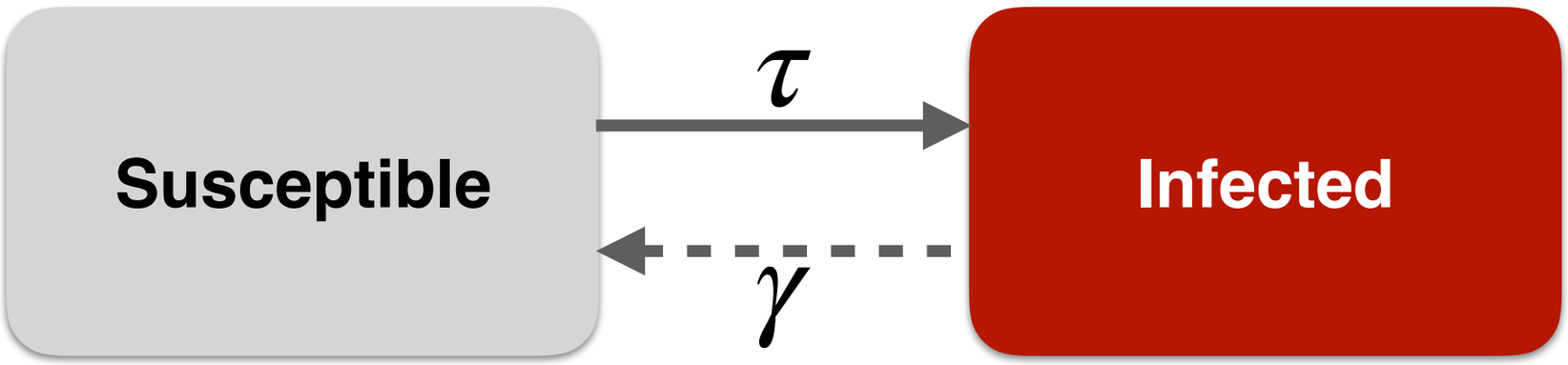



social influence



# Recovery: The SIS model

- All agents adopt via social influence, based on the transmissibility, $\tau$
- Agents who have adopted *dis-adopt* with probability $\gamma$



# a model of social influence with recovery

**CODE:** contagion_SIS.nlogo

# Further directions

## Transmission biases

*Learning & Behavior*
*2004, 32 (1), 4-14*

### Social learning strategies

KEVIN N. LALAND
*University of St. Andrews, St. Andrews, Scotland*

In most studies of social learning in animals, no attempt has been made to examine the nature of the strategy adopted by animals when they copy others. Resea in exploring the psychological processes that underlie social recording purported social learning in the field, but the conte unexplored. Yet, theoretical models used to investigate the to the conclusion that social learning cannot be indiscrimin gies that dictate the circumstances under which they copy ticle, I discuss a number of possible strategies that are pr *copy when uncertain*, *copy the majority*, and *copy if bet* support of each, drawing from both the animal and human s learning strategies may be organized hierarchically, their b and asocially learned strategies prove ineffective but befor

Trends in Cognitive Sciences

CellPress
REVIEWS

Review

### Social Learning Strategies: Bridge-Building between Fields

Rachel L. Kendal,[1,*] Neeltje J. Boogert,[2] Luke Rendell,[3] Kevin N. Laland,[3] Mike Webster,[3] and Patricia L. Jones[4]

**While social learning is widespread, indiscriminate copying of others is rarely beneficial. Theory suggests that individuals should be selective in what, when, and whom they copy, by following 'social learning strategies' (SLSs). The SLS concept has stimulated extensive experimental work, integrated theory, and empirical findings, and created impetus to the social learning and cultural evolution fields. However, the SLS concept needs updating to accommodate recent findings that individuals switch between strategies flexibly, that multiple**

#### Highlights

Accumulating evidence supports theoretical predictions that humans and nonhumans are selective in what, when, and whom they copy, suggesting the use of SLSs.

Recent studies indicate that SLS use is flexible and changes with ontogeny, experience, state, and context.

# Further directions

## Complex contagion

**Complex Contagions and the Weakness of Long Ties**[1]

Damon Centola
*Harvard University*

Michael Macy
*Cornell University*

The strength of weak ties
socially distant locations
The authors test whethe
from simple to complex
social affirmation from
spread of high-risk soci
unproven technologies.
increase, long ties can imp
primarily on the width
their length. Wide bridges
networks, which may ac
dency for social moveme

**The Spread of Behavior in an Online Social Network Experiment**

Damon Centola

How do social networks affect the spread of behavior? A popular hypothesis states that networks with many clustered ties and a high degree of separation will be less effective for behavioral diffusion than networks in which locally redundant ties are rewired to provide shortcuts across the social space. A competing hypothesis argues that when behaviors require social reinforcement, a network with more clustering may be more advantageous, even if the network as a whole has a larger diameter. I investigated the effects of network structure on diffusion by studying the spread of health behavior through artificially structured online communities. Individual adoption was much more likely when participants received social reinforcement from multiple neighbors in the social network. The behavior spread farther and faster across clustered-lattice networks than across corresponding random networks.

# Further directions

## Emotion contagion

PROCEEDINGS OF THE ROYAL SOCIETY B

*Proc. R. Soc. B* (2010) **277**, 3827–3835
doi:10.1098/rspb.2010.1217
*Published online* 7 July 2010

### Emotions as infectious diseases in a large social network: the SISa model

**Alison L. Hill[1,2,6,*,†], David G. Rand[1,3,†], Martin A. Nowak[1,4] and Nicholas A. Christakis[5,7]**

[1]*Program for Evolutionary Dynamics,* [2]*Biophysics Program,* [3]*Berkman Center for Internet and Society,* [4]*Departments of Mathematics and Organismic and Evolutionary Biology, and* [5]*Department of Sociology, Harvard University, Cambridge, MA 02138, USA*

[6]*Harvard-MIT Division of Health Sciences and Technology, Massachusetts Institute of Technology, Cambridge, MA 02139, USA*

[7]*Departments of Medicine and Health Care Policy, Harvard Medical School, Boston, MA 02115, USA*

Human populations are arranged in social networks that determine interactions and influence the spread of diseases, behaviours and ideas. We evaluate the spread of long-term emotional states across a social network. We introduce a novel form of the classical susceptible–infected–susceptible disease model which includes the possibility for 'spontaneous' (or 'automatic') infection, in addition to disease transmission (the SISa model). Using this framework and data from the Framingham Heart Study, we provide formal evidence that positive and negative emotional states behave like infectious diseases spreading across social networks over long periods of time. The probability of becoming content is increased by 0.02 per year for each content contact, and the probability of becoming discontent is increased by 0.04 per year per discontent contact. Our mathematical formalism allows us to derive various quantities from the data, such as the average lifetime of a contentment 'infection' (10 years) or discontentment 'infection' (5 years). Our results give insight into the transmissive nature of positive and negative emotional states. Determining to what extent particular emotions or behaviours are infectious is a promising direction for

# Further directions

## In-group bias and adoption

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2017, VOL. 41, NO. 1, 26–45
http://dx.doi.org/10.1080/0022250X.2016.1250083

Routledge
Taylor & Francis Group

### Adoption as a social marker: Innovation diffusion with outgroup aversion

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**ABSTRACT**

Social identities are among the key factors driving behavior in complex societies. Signals of social identity are known to influence individual behaviors in the adoption of innovations. Yet the population-level consequences of identity signaling on the diffusion of innovations are largely unknown. Here we use both analytical and agent-based modeling to consider the spread of a beneficial innovation in a structured population in which there exist two groups who are averse to being mistaken for each other. We investigate the dynamics of adoption and consider the role of structural factors such as demographic skew and communication scale on population-level outcomes. We find that outgroup aversion can lead to adoption being

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**KEYWORDS**
Agent-based model; identity signaling; innovation diffusion; networks; polarization; social identity

# Next up:

# Opinions and polarization