

# Mathematical Modeling of Social Phenomena

Model exposé

# Exposé will cover

- Supply & Demand - again
- Thomas Schelling's segregation model
- Game theory
- Mark Granovetter's Threshold model

# Is this a model?

$$(*) \quad \sin 2x = \sin x$$

$$(1) \quad 2 \sin x \cos x = \sin x$$

$$(2) \quad 2 \sin x \cos x - \sin x = 0$$

$$(3) \quad 2 \sin x (\cos x - 1/2) = 0$$

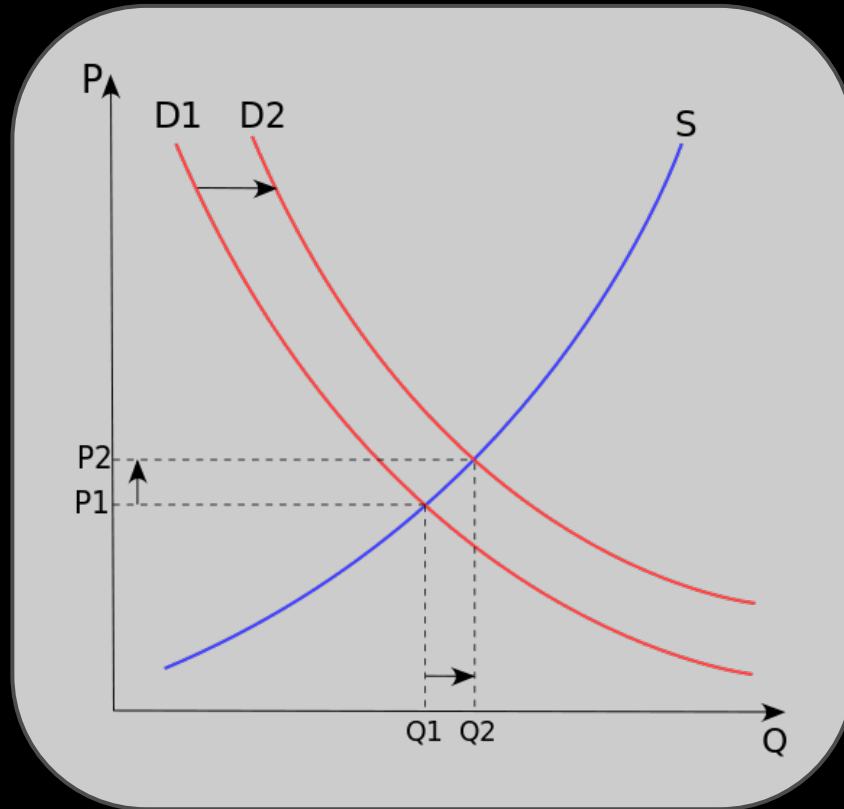
$$(4.1) \quad \sin x = 0$$

$$x = \underline{n\pi}$$

$$(4.2) \quad \cos x = 1/2 = \cos(\pi/3)$$

$$x = \underline{\pm\pi/3 + n2\pi}$$

# Supply & Demand: Introduction



# Supply & Demand: Determinants

1. If demand increases and supply remains unchanged, the equilibrium price rises.
2. If demand decreases and supply remains unchanged, the equilibrium price falls.
3. If demand remains unchanged and supply increases (supply curve shifts to the right), the equilibrium price falls.
4. If demand remains unchanged and supply decreases (supply curve shifts to the left), a shortage occurs, leading to a higher equilibrium price.

Hence, it has the usage bit!

# Supply & Demand: Ontology

## Supply

1. Production costs: how much a goods costs to be produced. Production costs are the cost of the labor and materials.
2. Firms' expectations
3. Number of suppliers

Clear?

## Demand

1. Income.
2. Tastes & preferences
3. Prices of related goods and services.
4. Consumers' expectations about future prices and incomes that can be checked.
5. Number of potential consumers.

# Supply & Demand: A general model

Deirdre McCloskey:

*The vaguer the model the better the story can fit into the historical world, while the more exact the model, the more absurd the history becomes.*

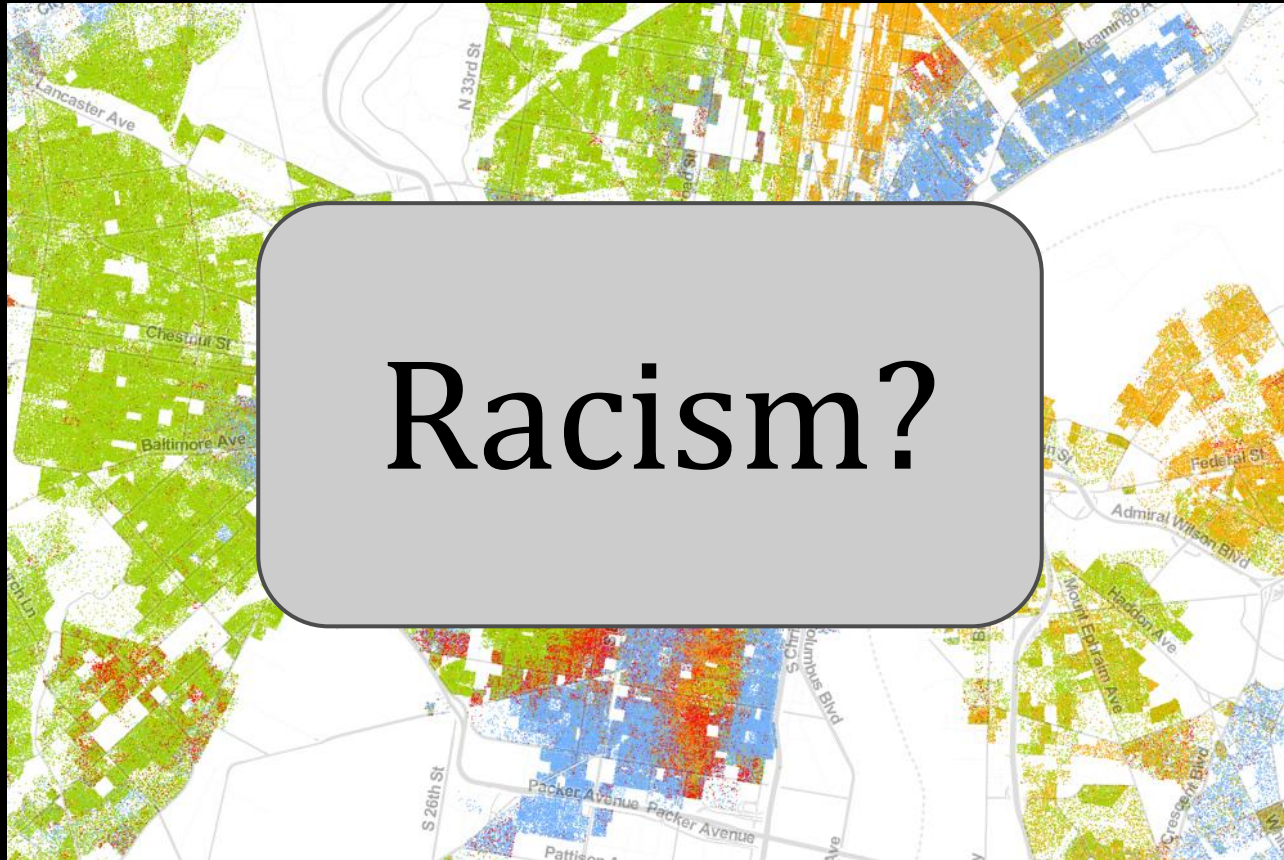
# Supply & Demand: Outro

Comments?

Is this a good model?



# Schelling: The idea



# Schelling: How do it actually look?



# Schelling: The Agent-based model

- Everyone has a rule for when to move
- Moving works in a given way
- A two-dimensional grid imposes limitations
- Neighborhood definitions: Egocentric, pre-defined. Represent what? Which is best?

# Schelling: The model - agents

Assumptions about agents:

- Act in according to her preferences
- Not think strategically about others' action
- Have the same type of preferences as the rest
- Full information about the current ratios

# Schelling: The model - preferences

Tolerance

Distributions

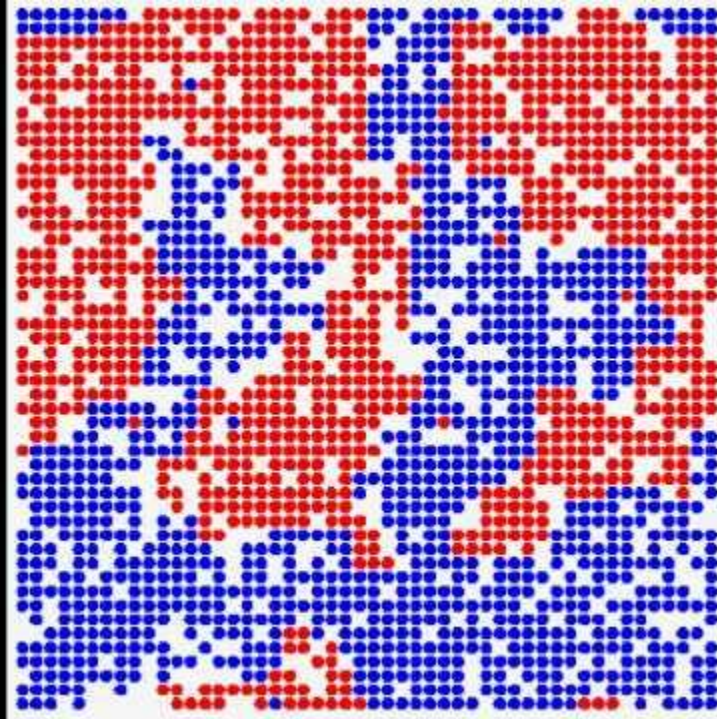
Non-minority

and so forth ... Why choose either?

# Schelling: The tipping dynamics

- Genesis tipping
- Exodus tipping

# Schelling: Simulations



# Schelling: Micro & Macro

Given a macrobehavior, what is the micromotives?

Does it matter?

Why not just ask people?



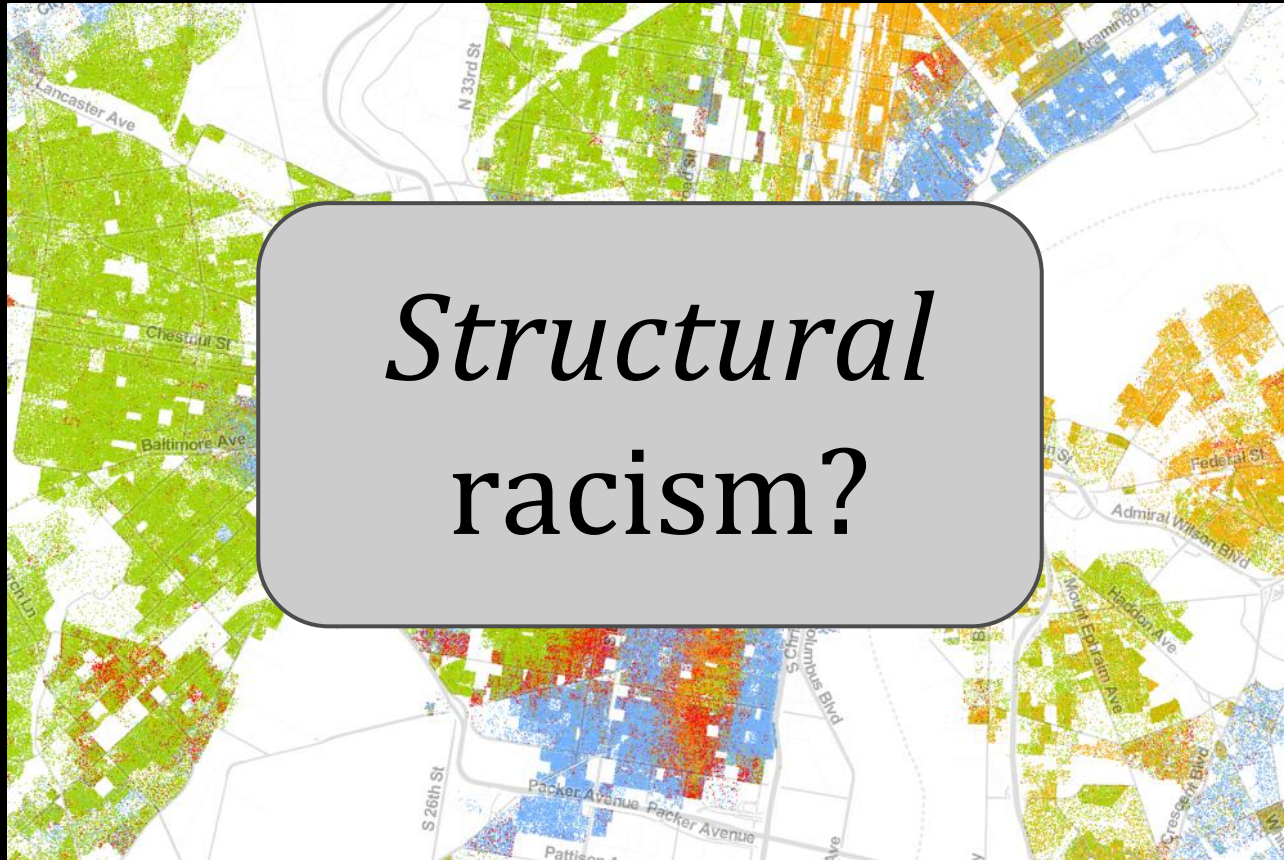
# Schelling: Predictions/insights

What does Schelling's model teach us about:

- West
- China
- Ritter

Segregation in  
general?

# Schelling: The idea



**Schelling: How do we test it?**

Strategies? Ideas?

# Schelling: Other applications

What could it apply to more?

What is a generic description of what it models?

Quite general for stories - somewhat specific model

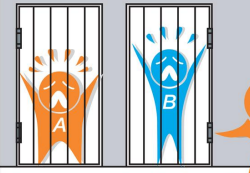

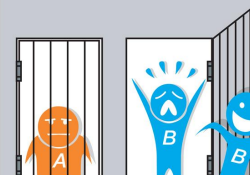
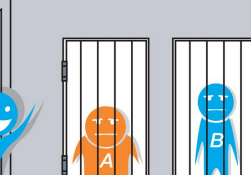
# Schelling: Outro

Comments?

Is this a good model?

Pause

# Prisoner's dilemma: Recap

Prisoners' dilemma		prisoner B			
		confess		remain silent	
prisoner A	confess	 5 years   5 years	 0 year   20 years		
	remain silent	 20 years   0 year	 1 year   1 year		

# Prisoner's dilemma: Applications

- Arms races
- Negative campaigning
- Competition on prices
- Sharing food



# Prisoner's dilemma: Rational choice

- Do they know what game they play?
- Are they perfectly rational?
- Utility functions - are they really actual?

# Prisoner's dilemma: Extensions

General models: A basis

- Repetition / reputation
- Belief formation and learning
- Similarity

# Prisoner's dilemma: Outro

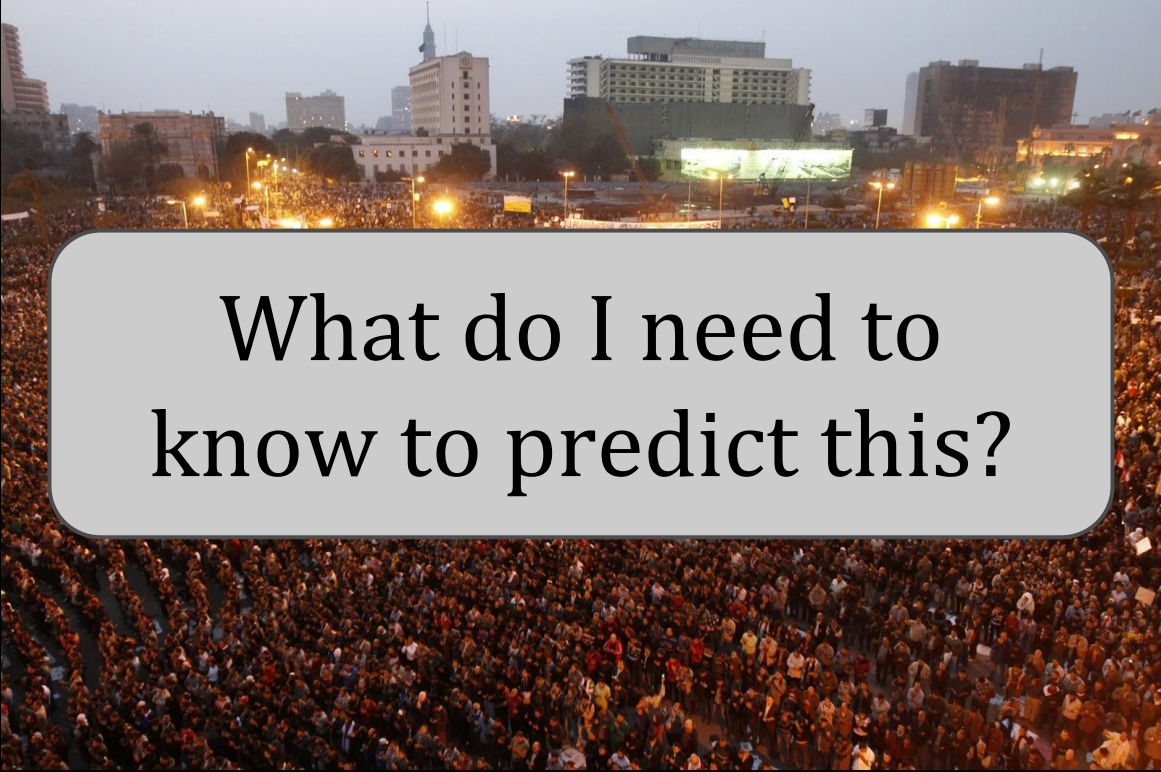
Any comments?

Is this a good model?

# Granovetter: The idea



# Granovetter: Question?



What do I need to know to predict this?

# Granovetter: The model

Peer effect threshold model

A threshold per agent

Then, potential bandwagoning

# Granovetter: Assumption about agents

Threshold holders - agnostic

Expected costs

Expected rewards, and what not.

Full knowledge about current amount committed

No strategic thinking

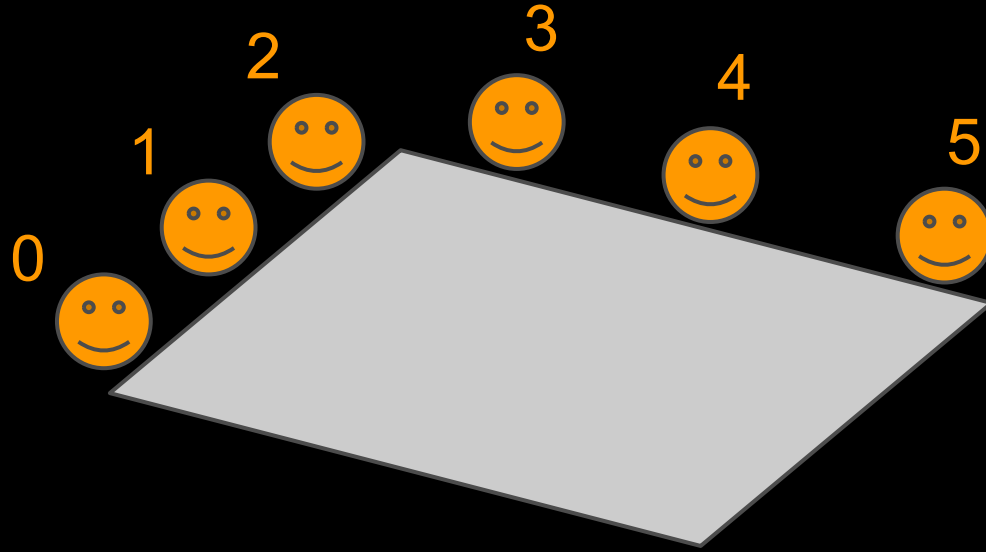
All equal - no ones participation counts for more

# Granovetter: Dynamics

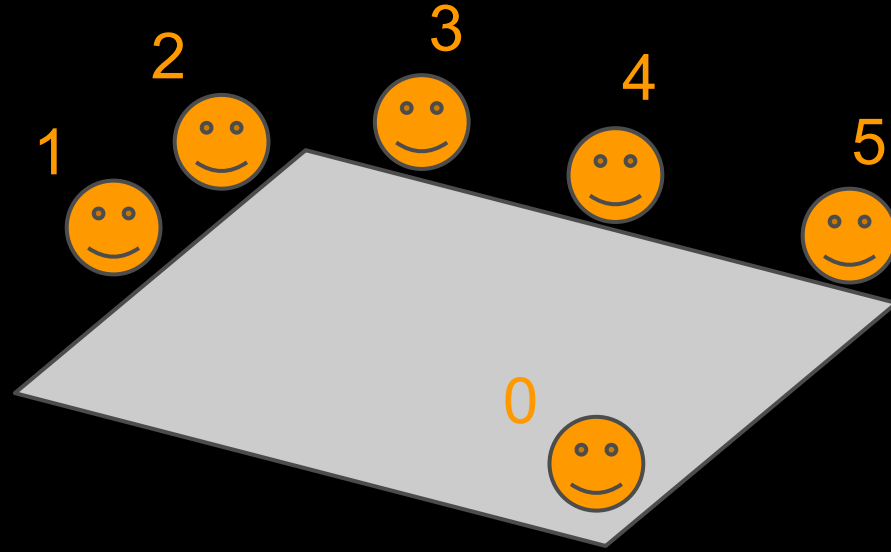
Lower thresholds, higher chance of success



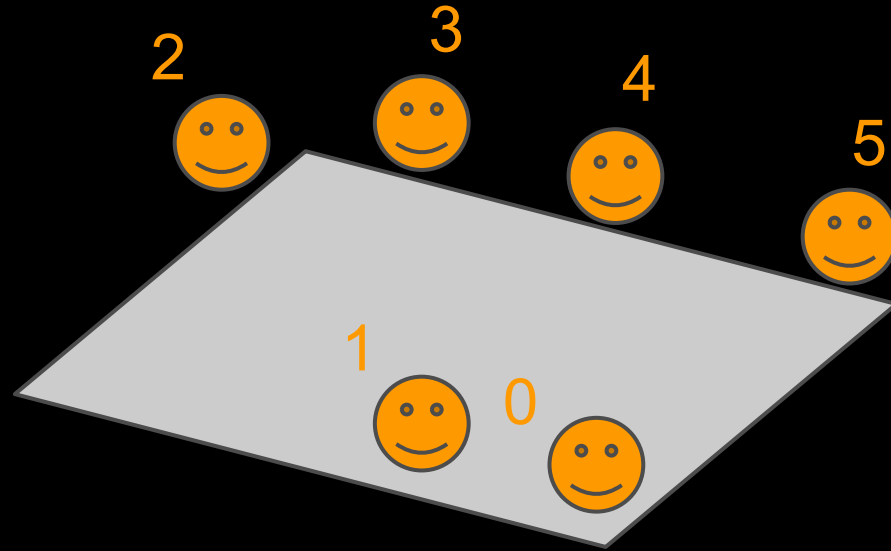
# Granovetter: The model



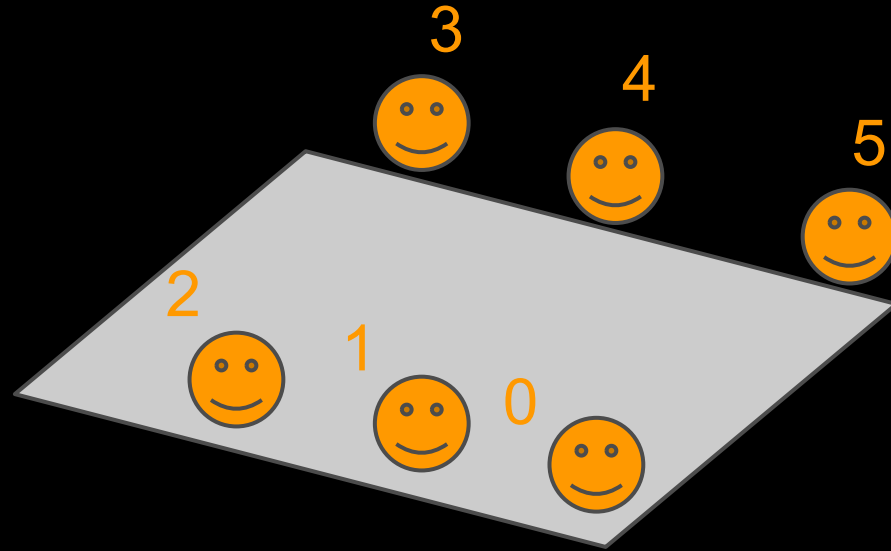
# Granovetter: The model



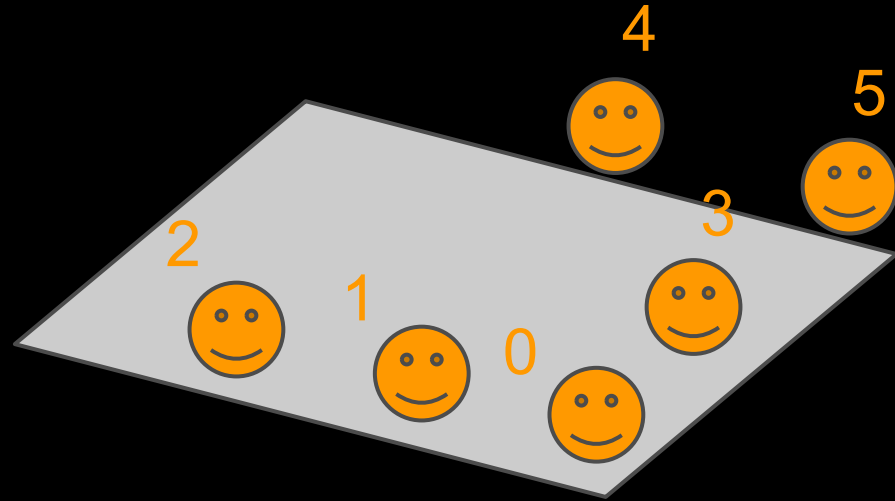
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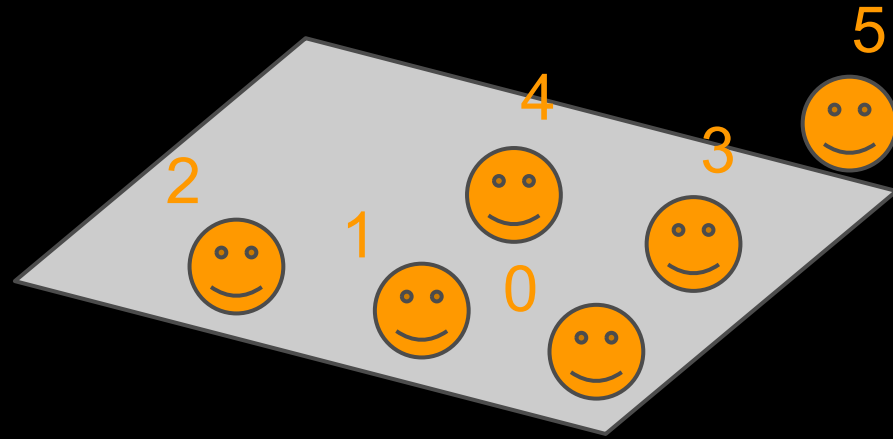
# Granovetter: The model



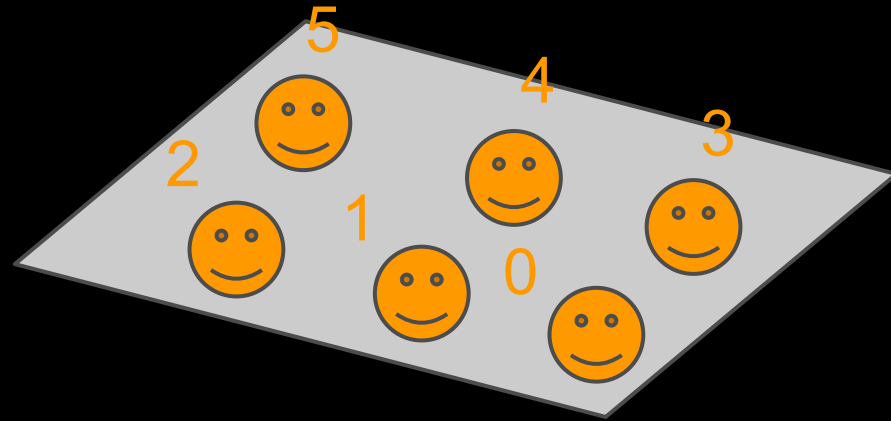
# Granovetter: The model



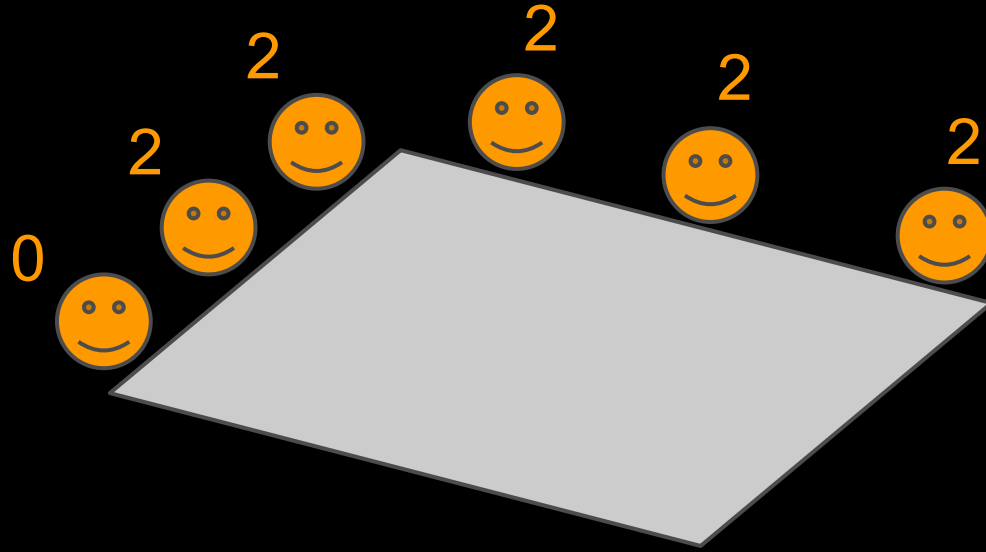
# Granovetter: The model



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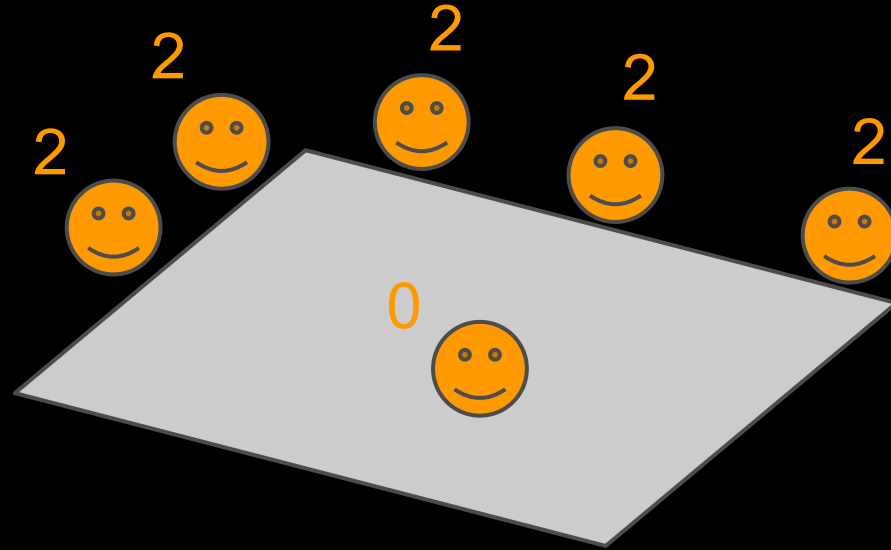


# Granovetter: The model





# Granovetter: The model



# Granovetter: Message

Threshold distributions matter!

$$\begin{aligned}\text{First case, average: } (0+1+2+3+4+5)/6 &= \\ &= 2 + 1/2\end{aligned}$$

$$\begin{aligned}\text{Second case, average: } (0+2+2+2+2+2)/6 &= \\ &= 1 + 2/3\end{aligned}$$

# Granovetter: Ontology

Who are the agents?

What is the setting - “the plaza” ?

# Refined Granovetter: The question

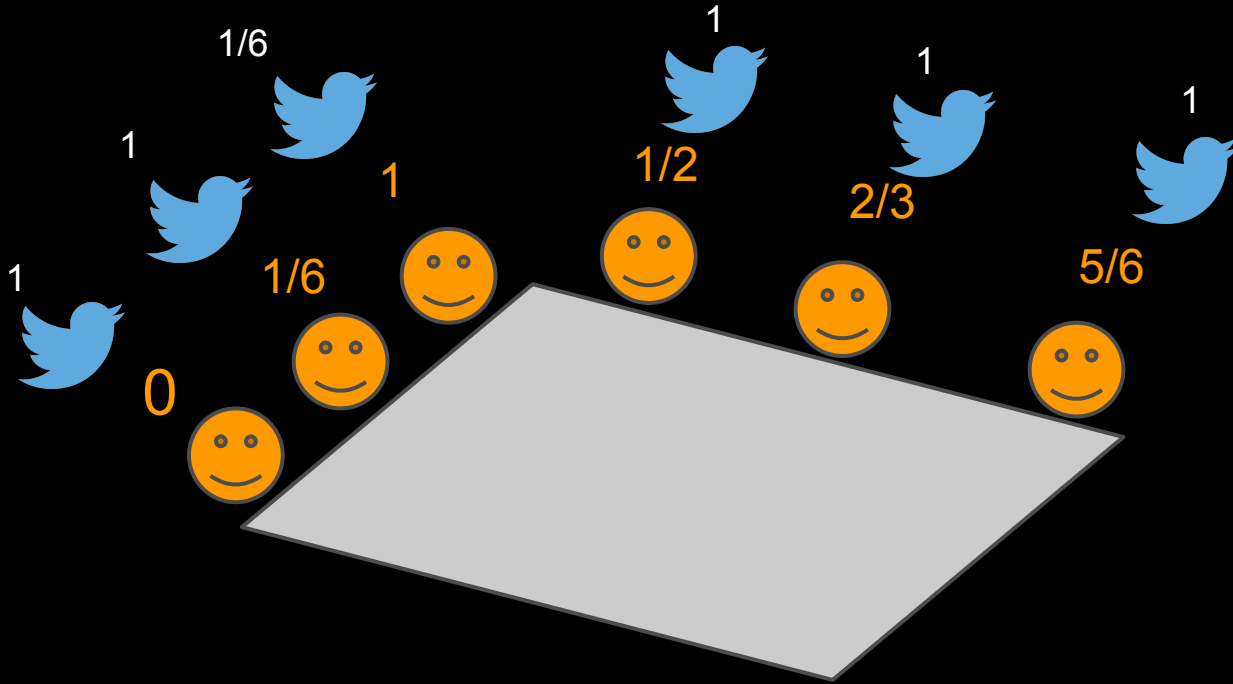



# Refined Granovetter: The hunch

If we could just invent a new technology the bandwagoning would continue. But how do we manifest that?

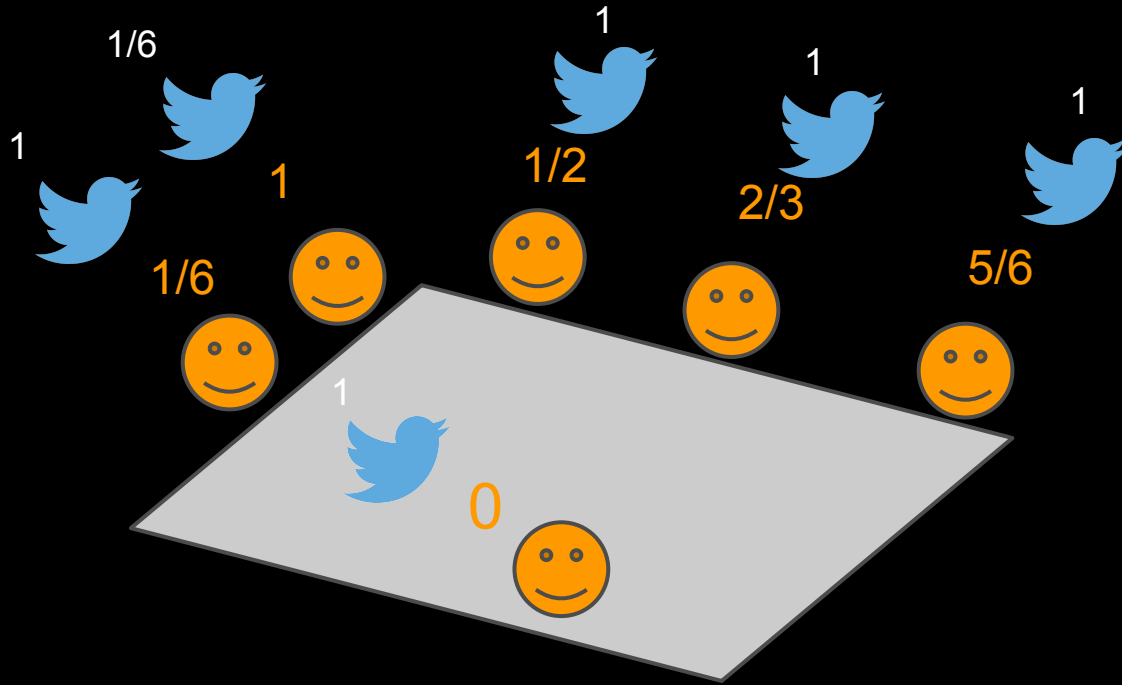
How to represent it?


# Refined Granovetter: The model



Median difficulty = Signal  : 1

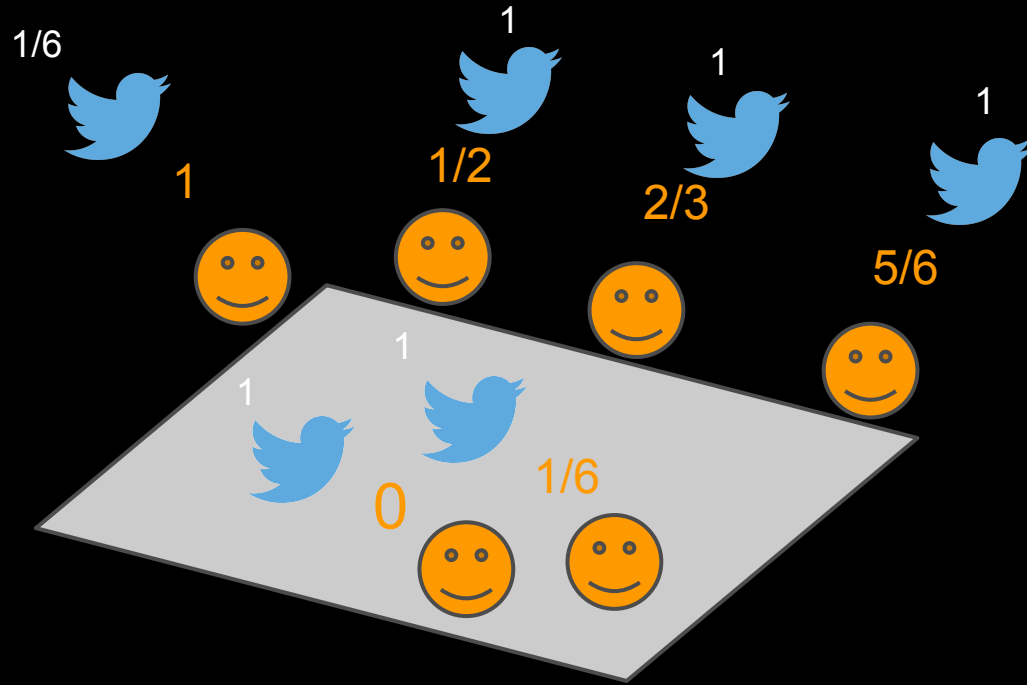
# Refined Granovetter: The model




Median difficulty = Signal  : 1

Societal commitment level: 1/6

# Refined Granovetter: The model

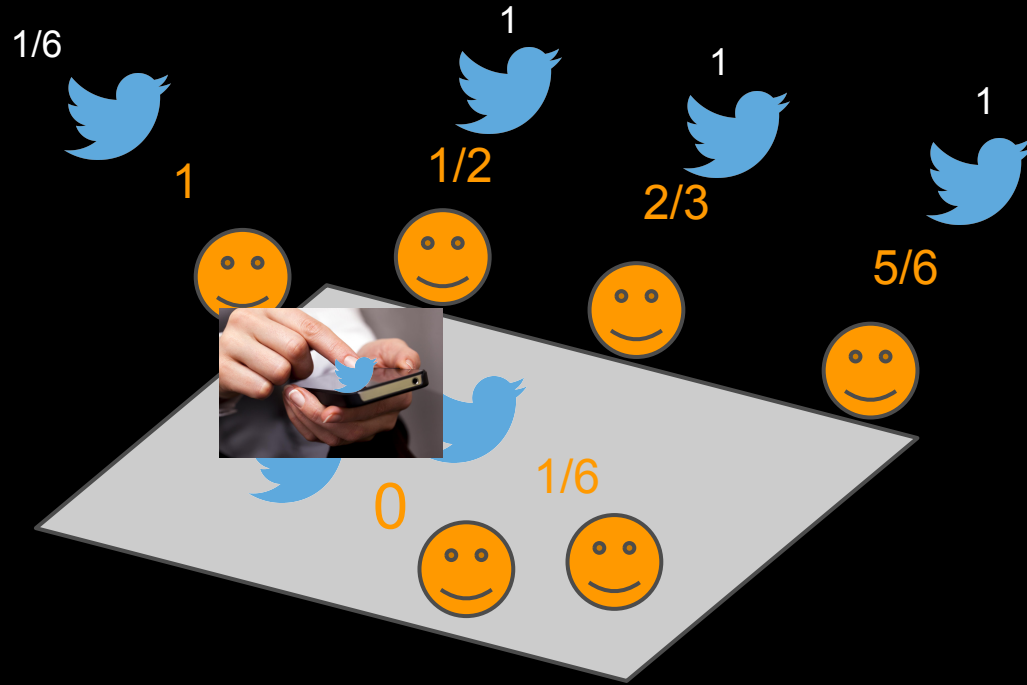



Median difficulty = Signal  : 1

Societal commitment level: 1/3



# Refined Granovetter: The model



Median difficulty = Signal  : 1

Societal commitment level: 1/2

# Refined Granovetter: Results

- Instigators will win if they can invent a participation method with arbitrary signal
- A dictator might to make punishment both higher and lower for an action, depending on what actions exists.

# Refined Granovetter: Comment

A more specific model become way less general,  
fits fewer stories.

Other comments?

A good model?

# Rounding up

What was the best model? Motivate.

# Parenthesis: Conway's Game of Life

<http://pmav.eu/stuff/javascript-game-of-life-v3.1.1/>