

Opinion dynamics

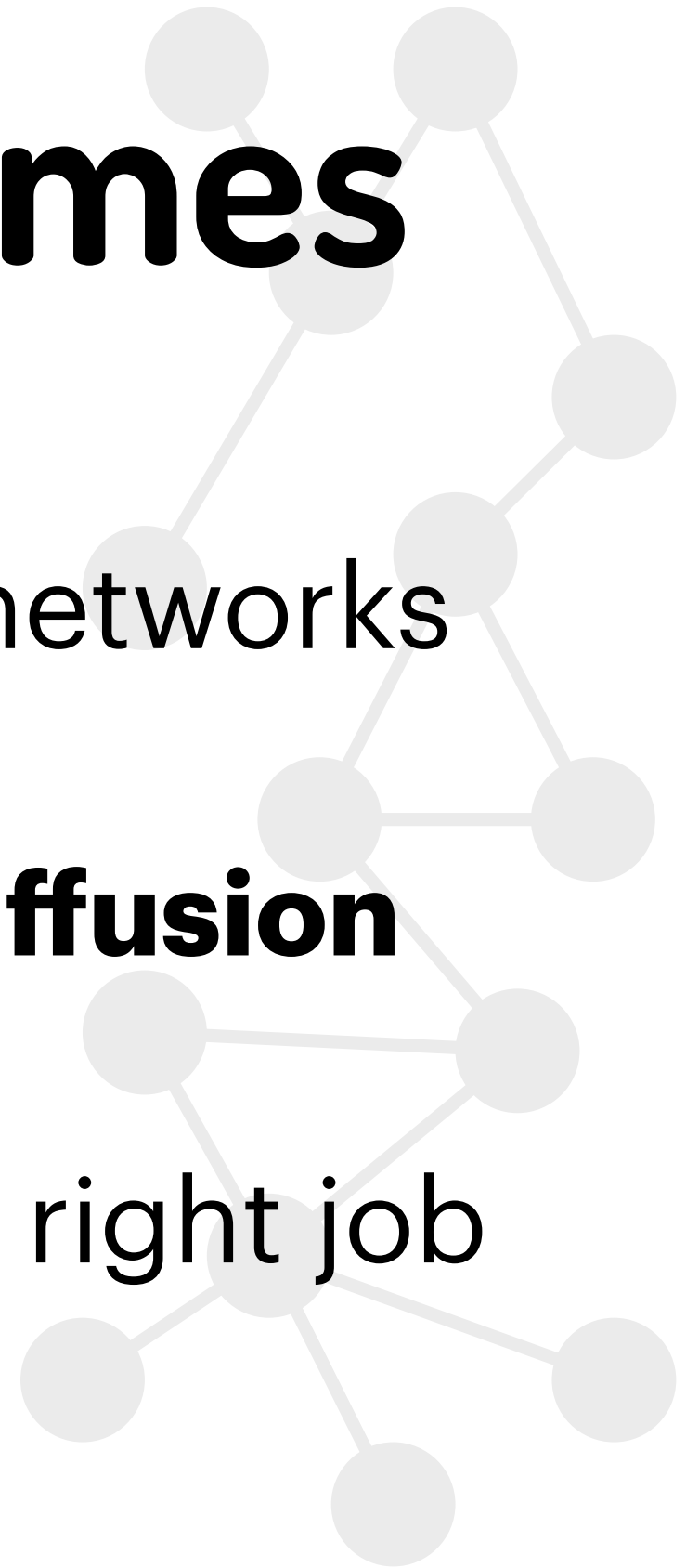


Learning outcomes

How things **propagate** across networks

Compare different models of **diffusion**

Choose the right model for the right job

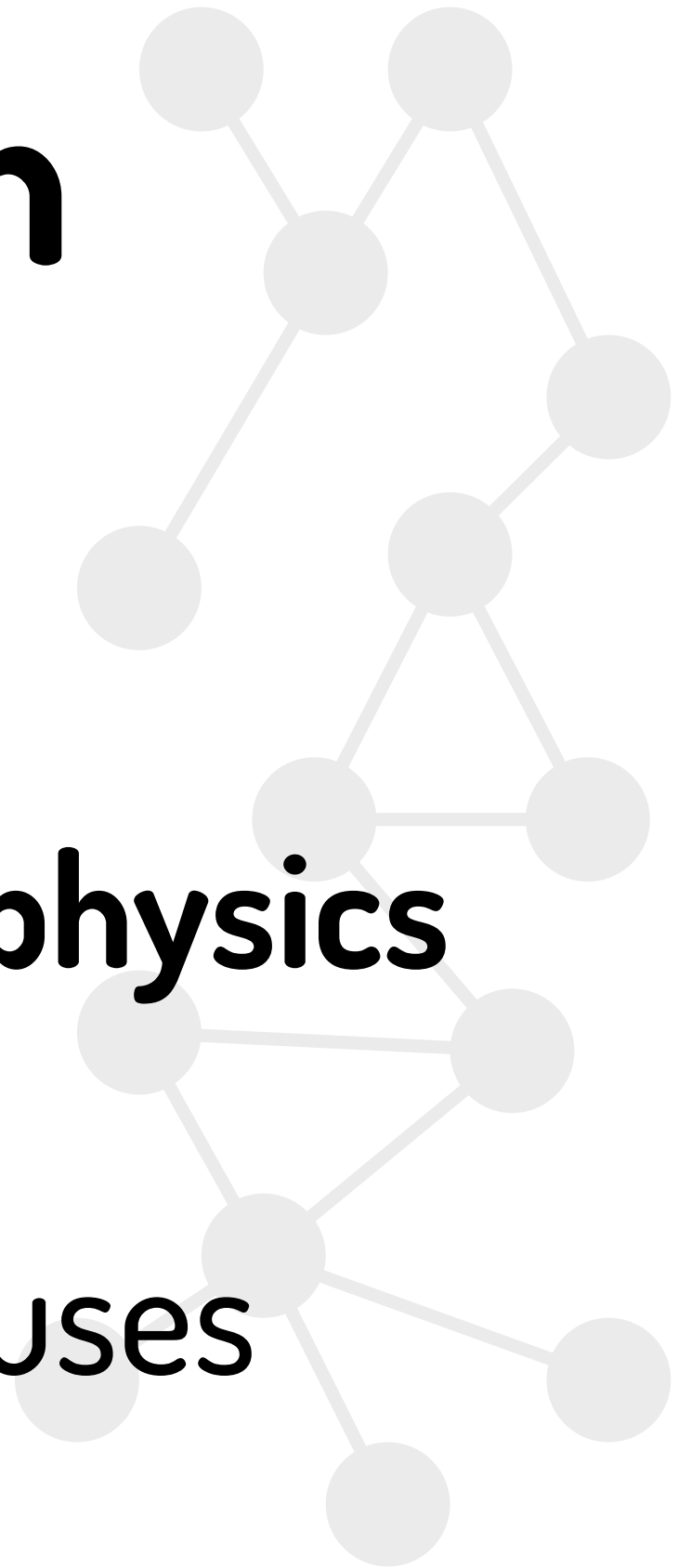


Introduction

Started in the 1970s

Original models were from **physics**

Many disciplines, **different** uses



Introduction

**Ideas, behaviours, rumours,
information, opinions, fake news, etc.**



Opinion **Markets Insight**

How herd behaviour drives action on r/WallStreetBets

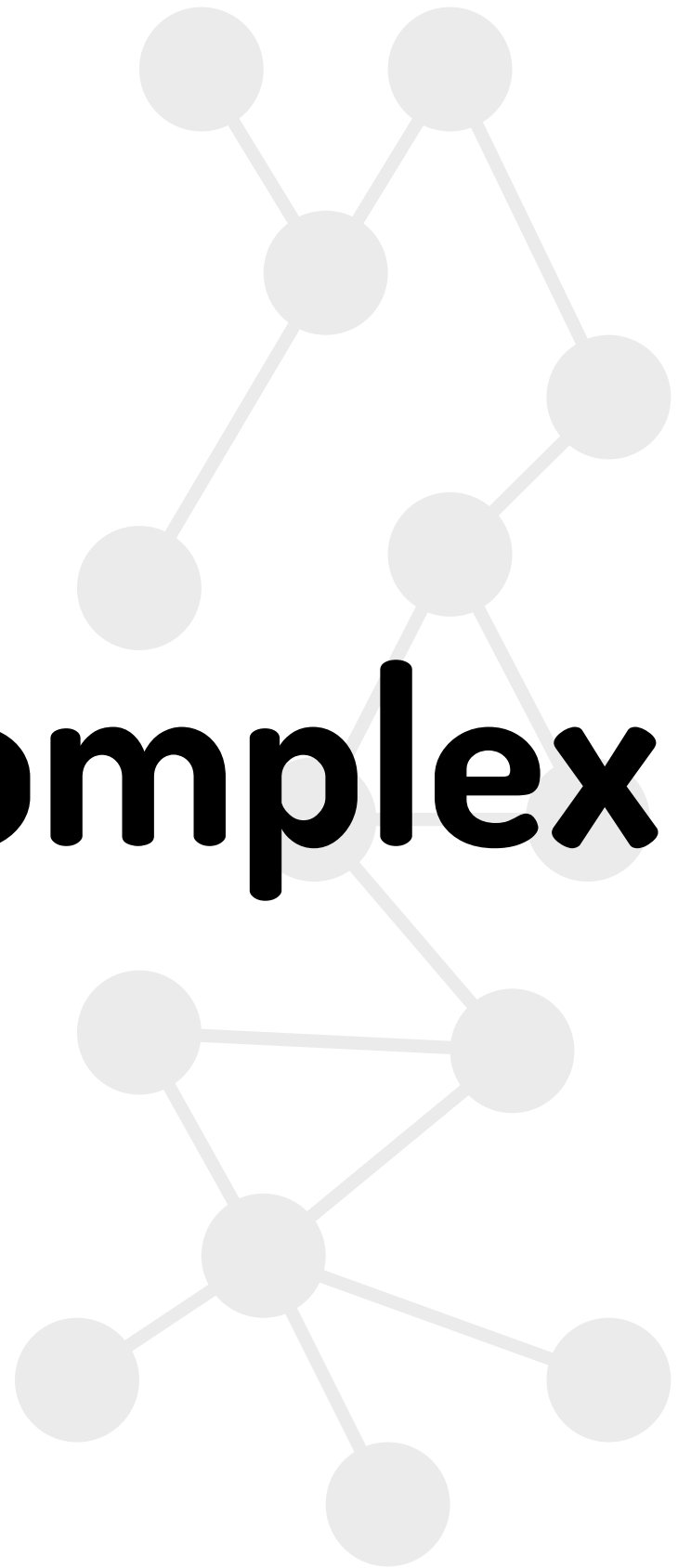
Oxford research shows influence of social contagion on stocks such as Tesla and GameStop

IAN GOLDIN

+ Add to myFT



**Simple models, complex
models**



Simple contagion

Agents can be “infected” directly

Complex contagion

Non-linear or repeated interactions
for agents to be “infected”



Independent cascade

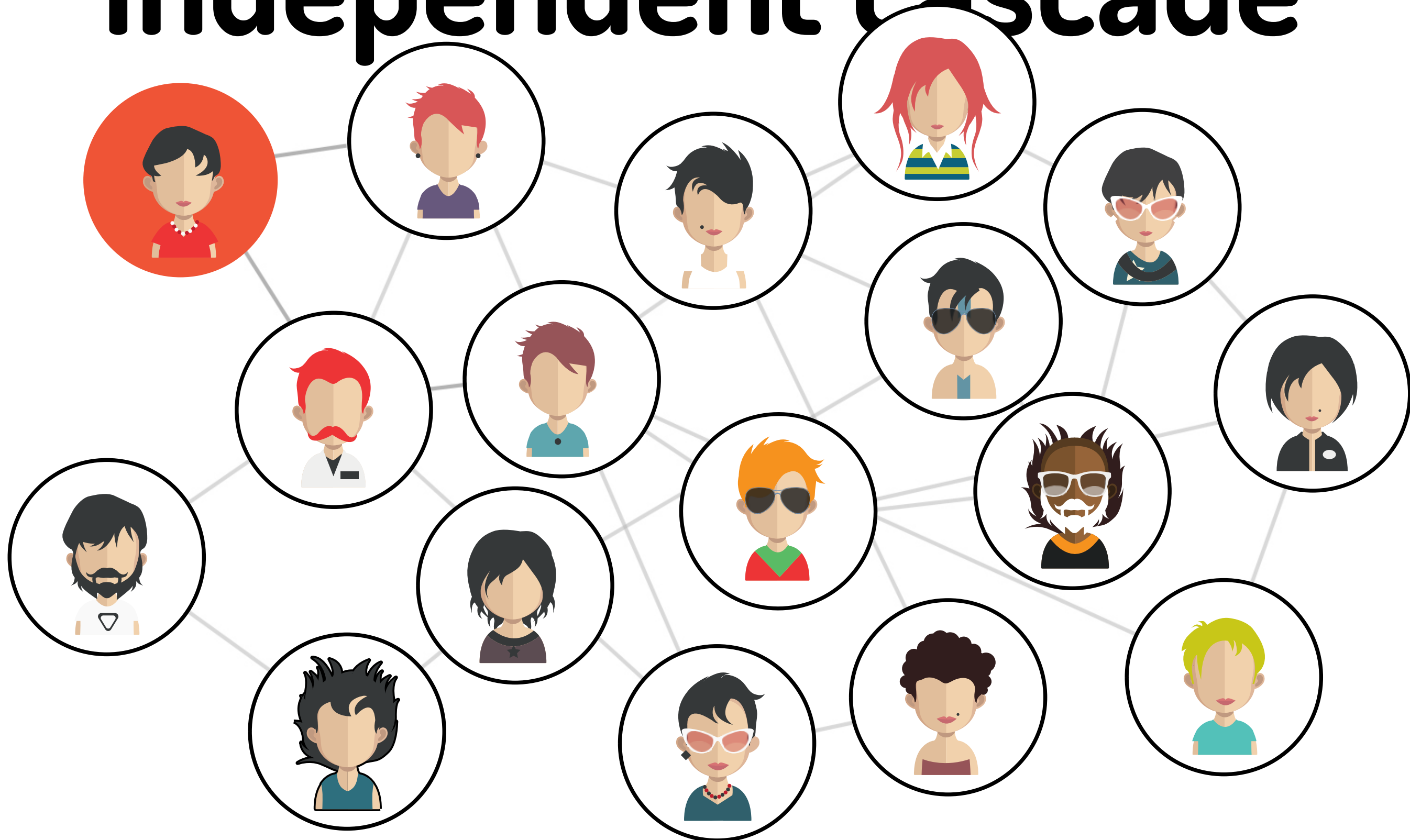
Irreversible states

Easy to **compute**

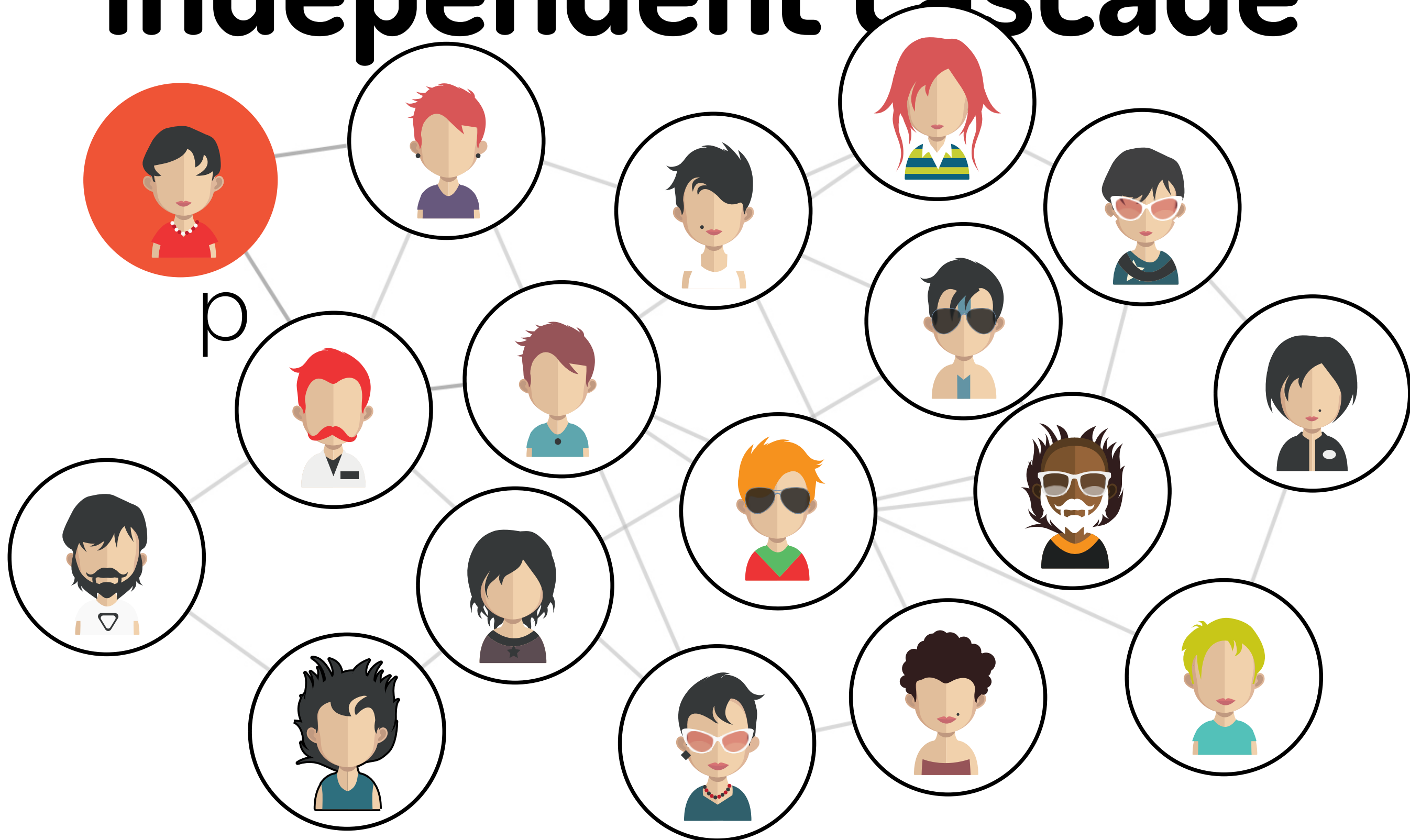
Easy to **extend** to influence maximisation



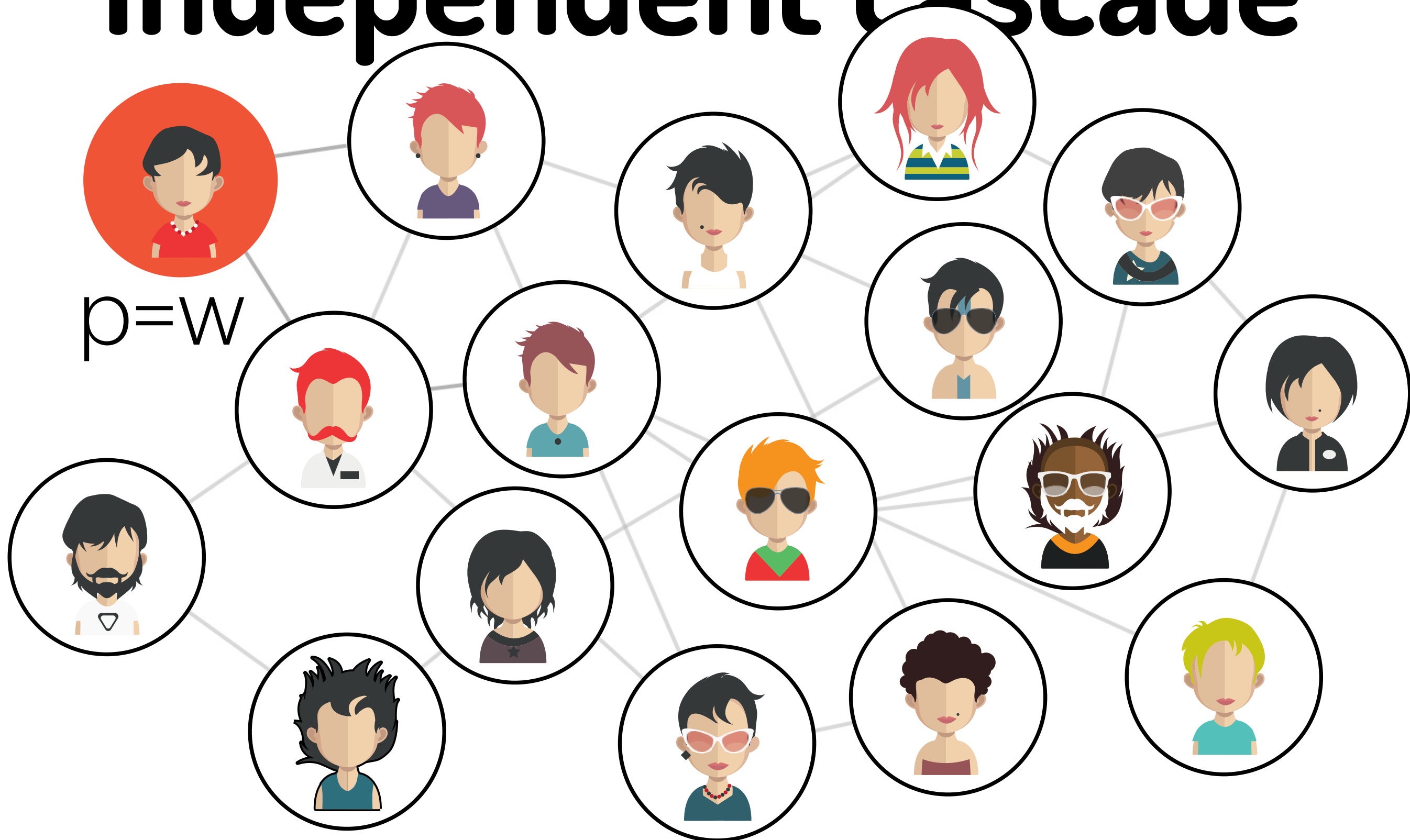
Independent cascade



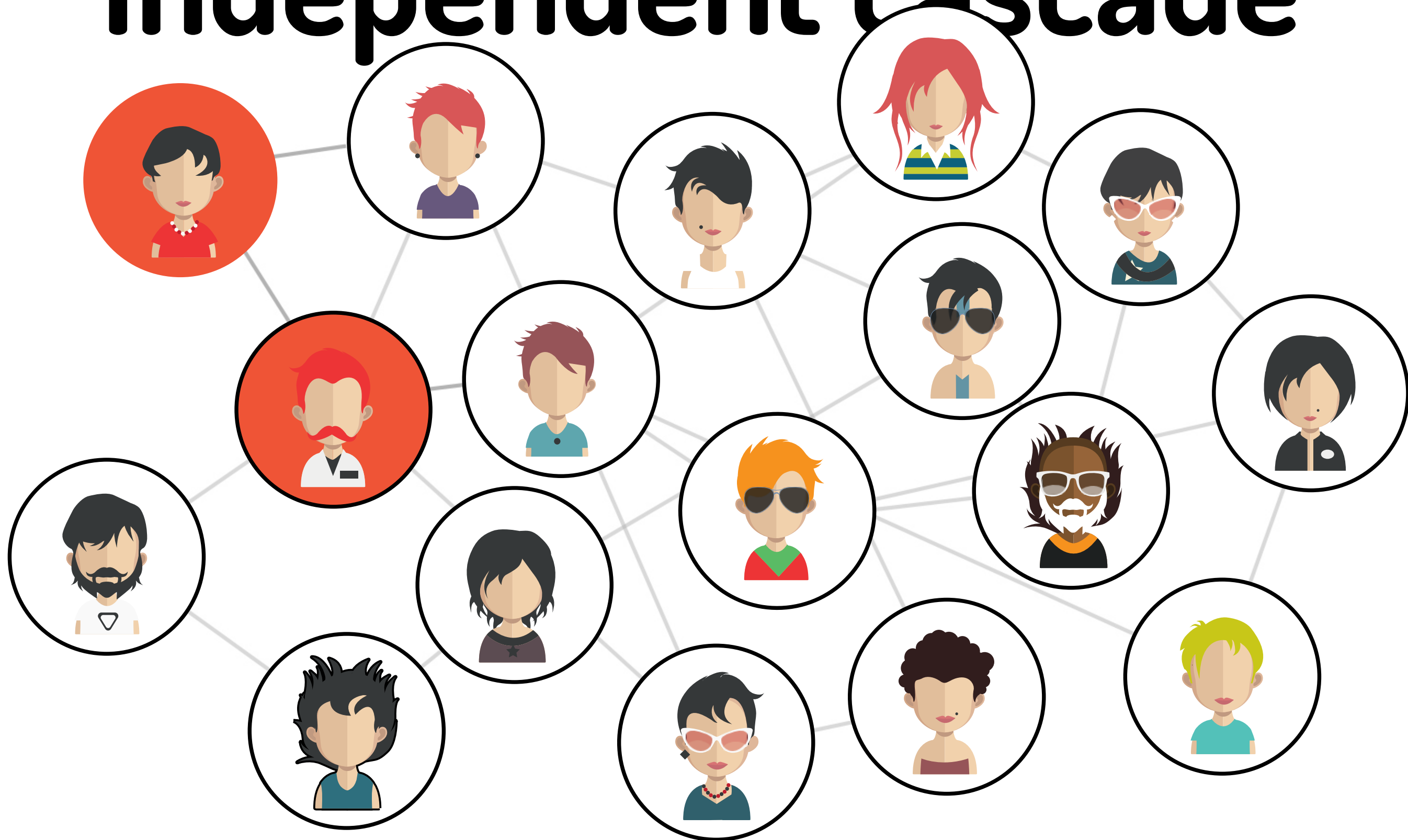
Independent cascade



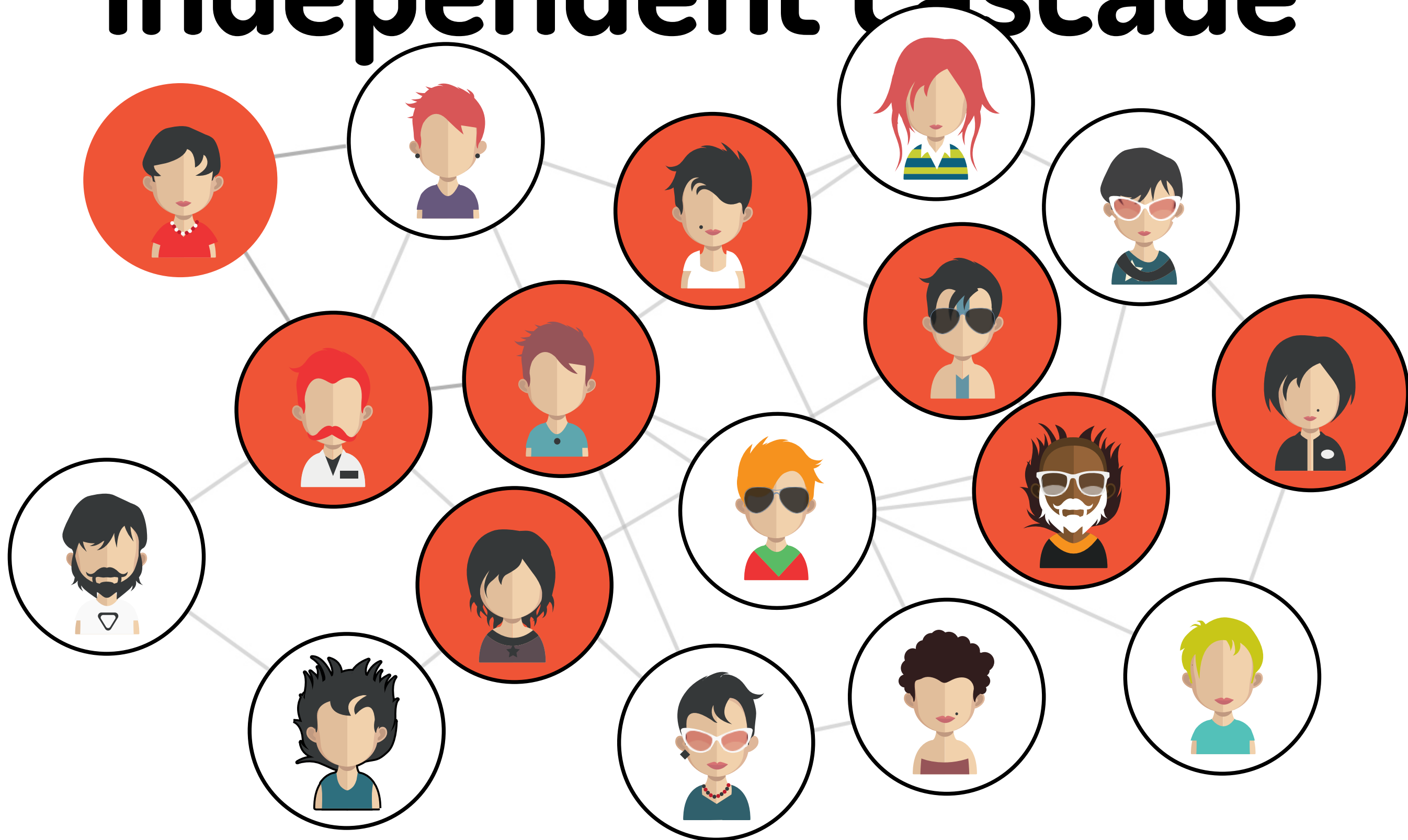
Independent cascade



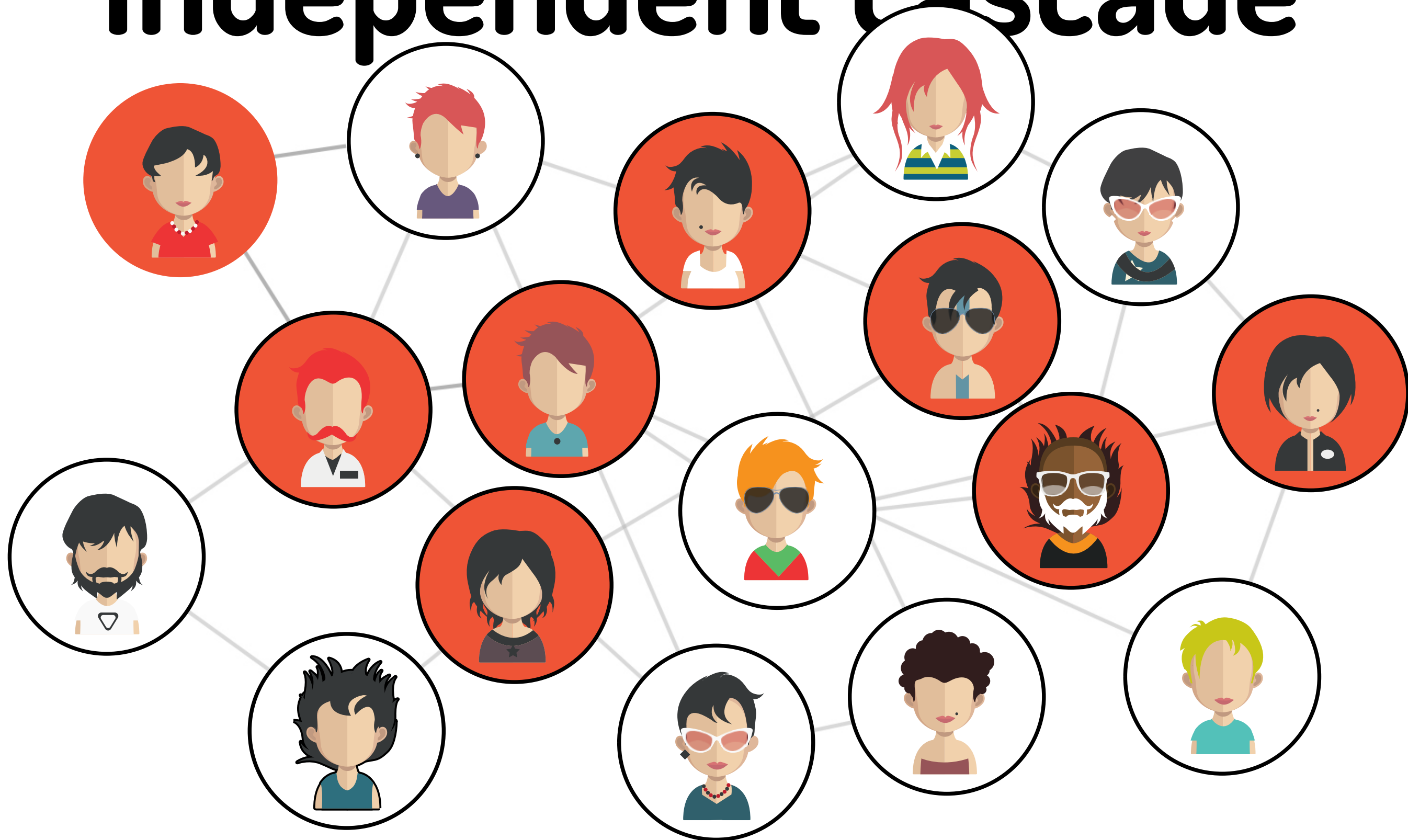
Independent cascade



Independent cascade



Independent cascade



scade

agation

Good for:

information and rumor propagation

Linear threshold model

Irreversible states

Easy to compute

Toy model for complex contagion

Linear threshold model



Linear threshold model



Linear threshold model



Linear threshold model



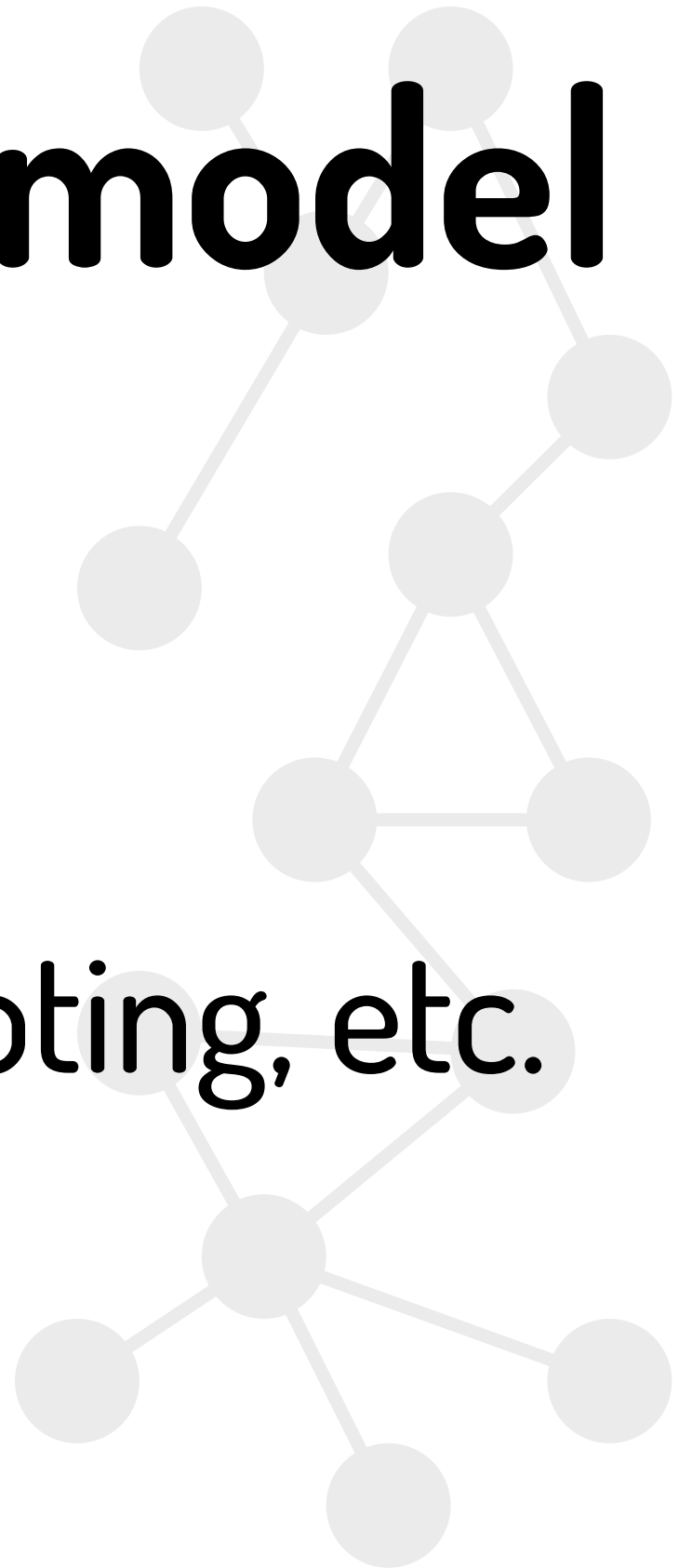
Time to play!

www.ncase.me/crowds

Linear threshold model

Good for:

Group decisions, majority voting, etc.



Voter model

Flipping states

**Simple, analytical solution for
equilibrium**

Fails when opinions are fine-grained



Voter model

Properties

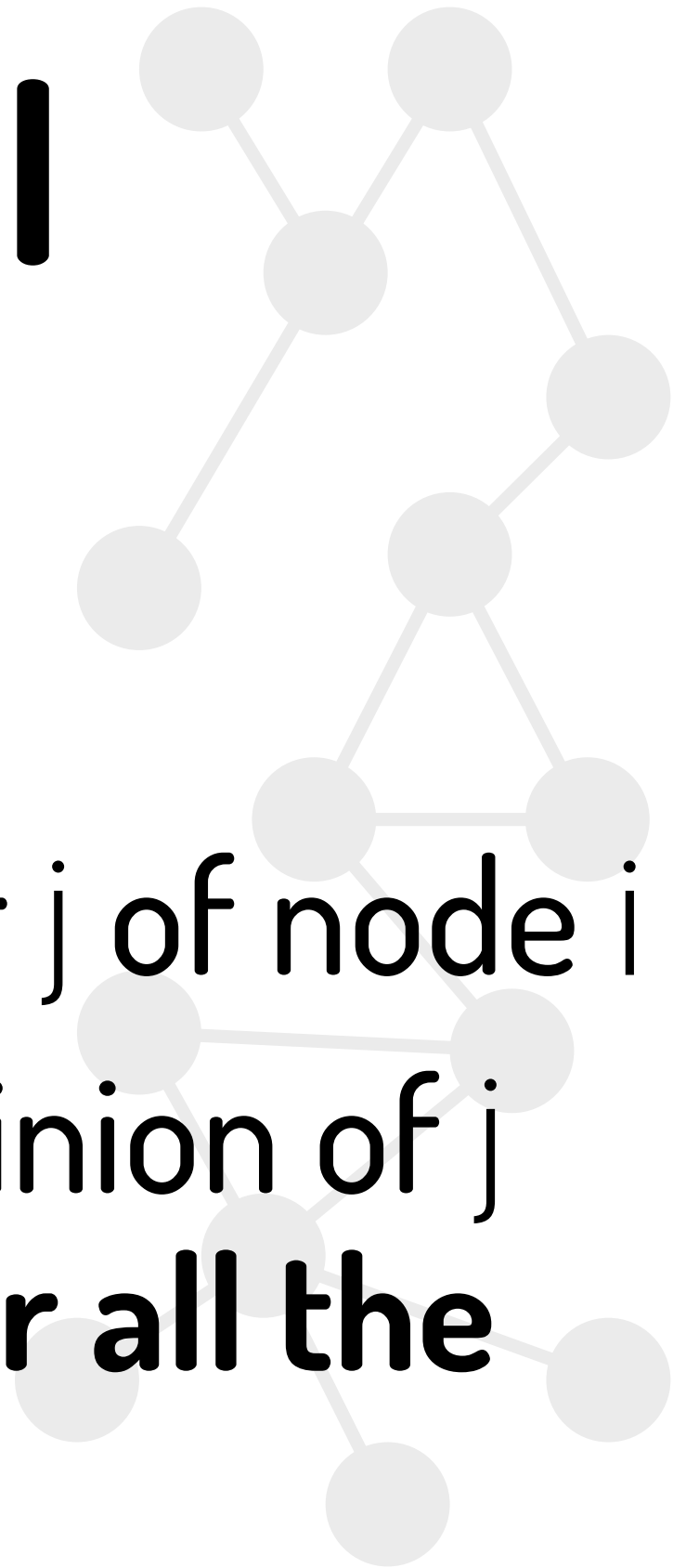
“Always” reach consensus

Analytical formula for equilibrium

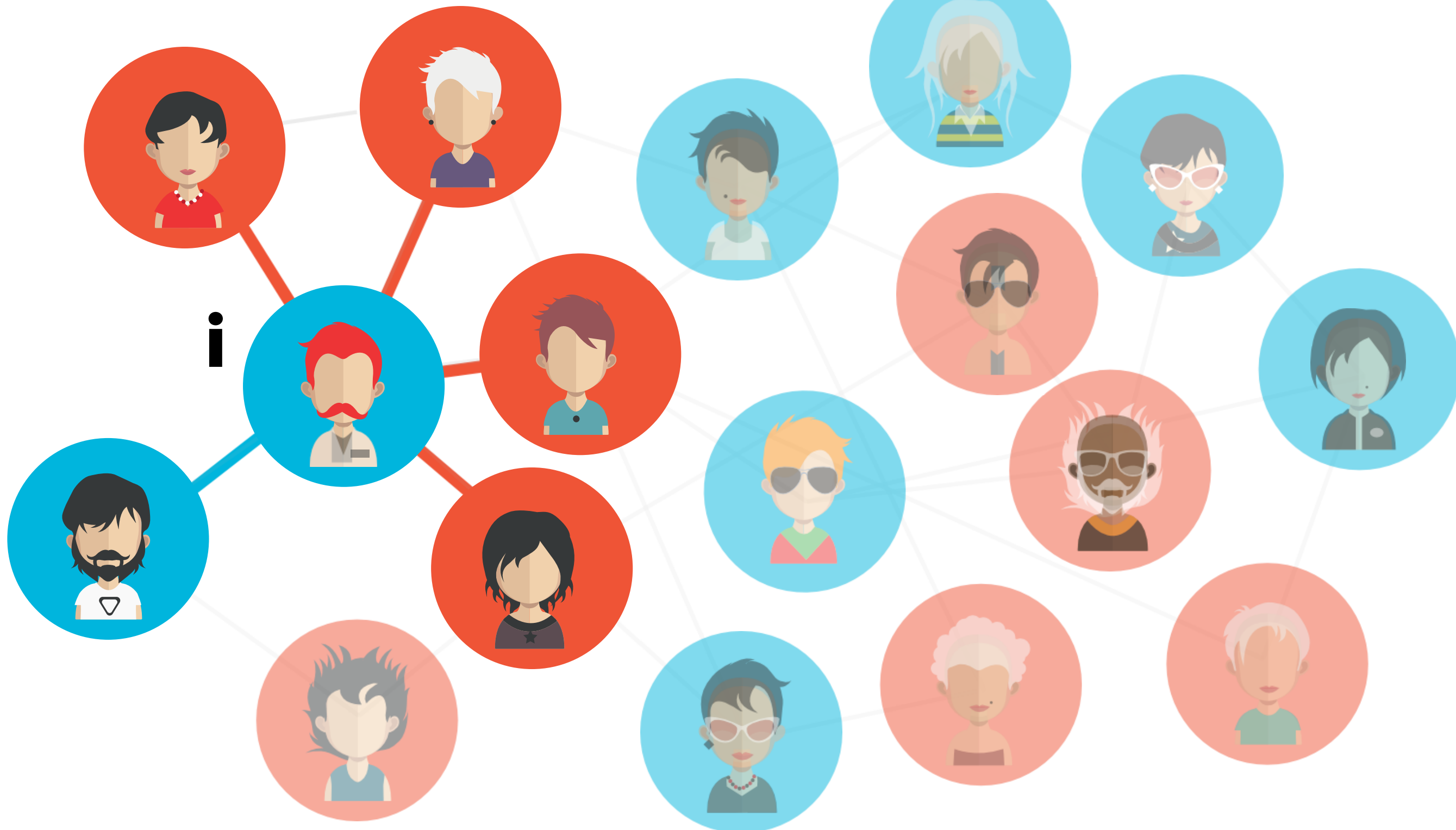
Many possible extensions

Voter model

- 1) Pick a random node i
 - 2) pick a random neighbour j of node i
 - 3) change opinion of i to opinion of j
- Do this simultaneously for all the nodes**



Voter model



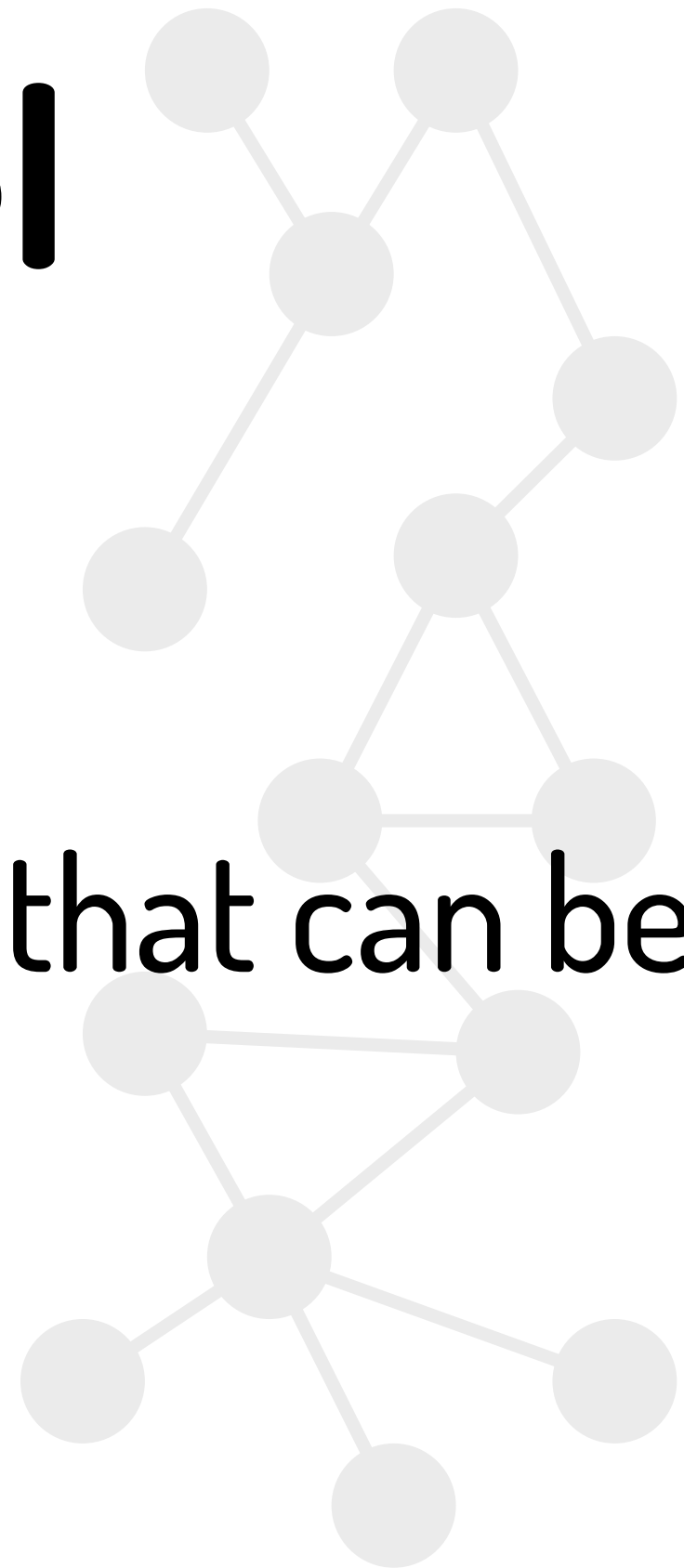
What will be the next colour of i?



Voter model

Good for:

anything with binary states that can be
reverted

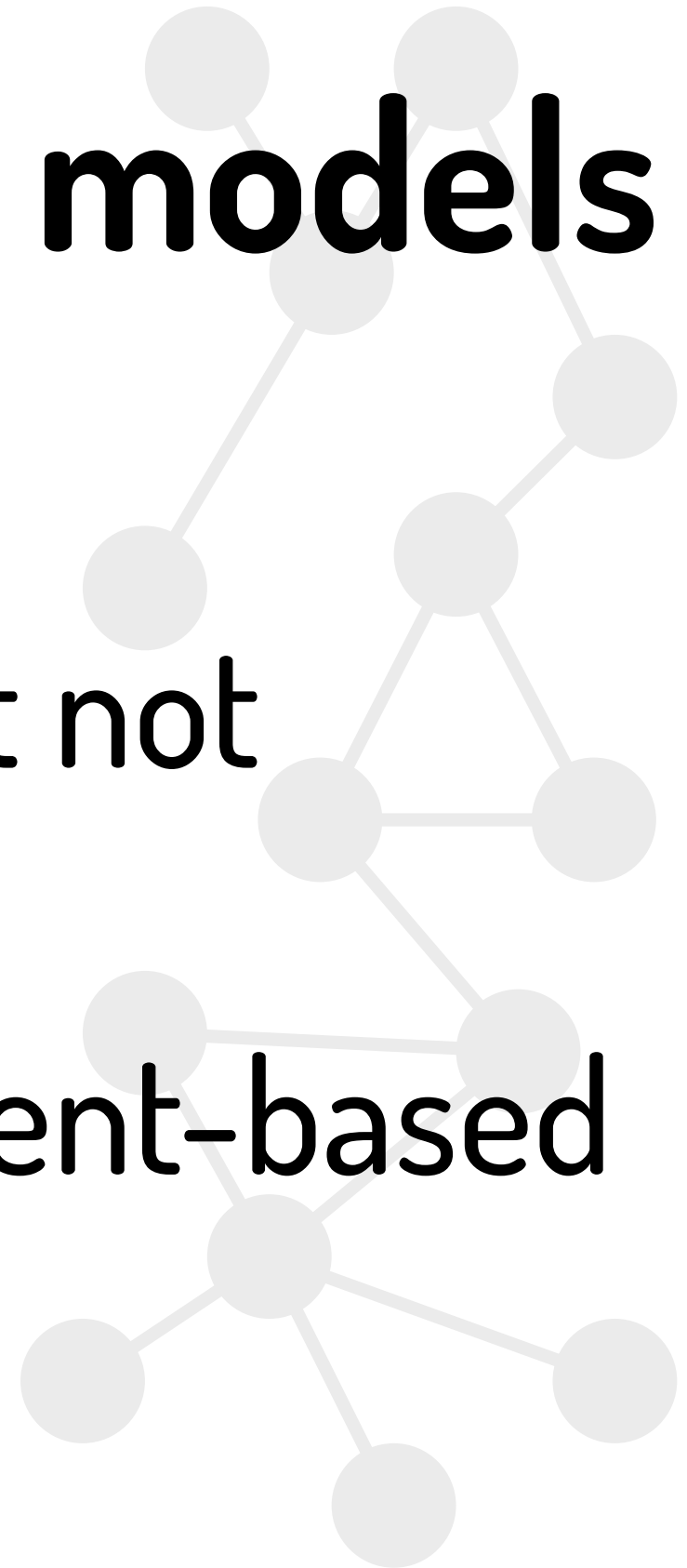


Bounded confidence models

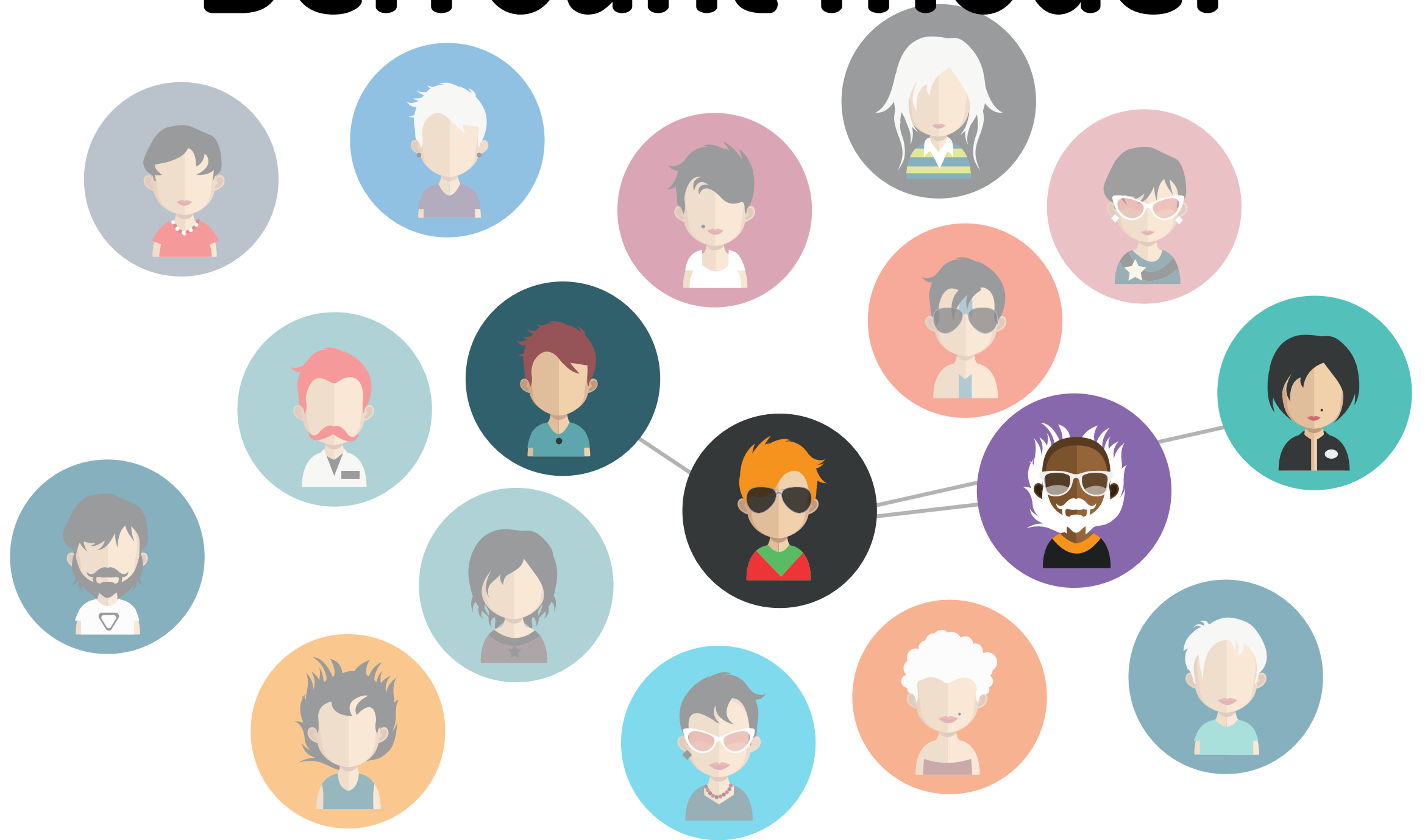
Continuous opinions

Usually between 0 and 1 but not necessarily

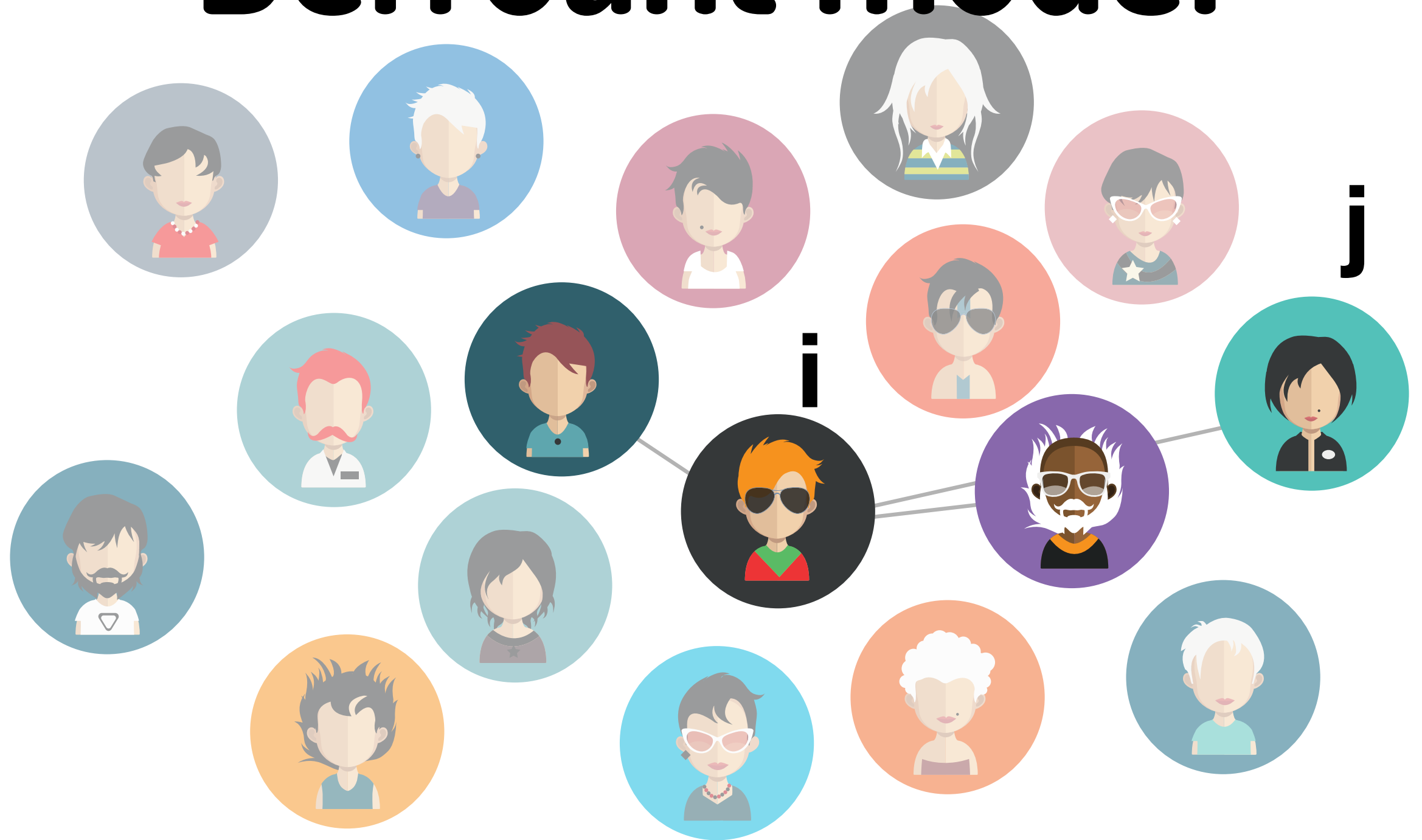
Easy to implement with agent-based models



Deffuant model



Deffuant model



Deffuant model

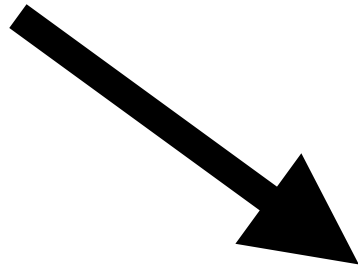
Equations

$$\begin{cases} o_i(t+1) = o_i(t) + \mu(o_j(t) - o_i(t)) \\ o_j(t+1) = o_j(t) + \mu(o_i(t) - o_j(t)) \end{cases}$$

Deffuant model

Opinion agent i

Equations



$$\begin{cases} o_i(t+1) = o_i(t) + \mu(o_j(t) - o_i(t)) \\ o_j(t+1) = o_j(t) + \mu(o_i(t) - o_j(t)) \end{cases}$$

Deffuant model

Opinion agent i

Equations

Convergence parameter


$$\begin{cases} o_i(t+1) = o_i(t) + \mu(o_j(t) - o_i(t)) \\ o_j(t+1) = o_j(t) + \mu(o_i(t) - o_j(t)) \end{cases}$$

Deffuant model

Opinion agent i

Equations

Convergence parameter


$$\begin{cases} o_i(t+1) = o_i(t) + \mu(o_j(t) - o_i(t)) \\ o_j(t+1) = o_j(t) + \mu(o_i(t) - o_j(t)) \end{cases}$$

Only If $|o_i(t) - o_j(t)| < \epsilon$

TO EVERYONE WHO RESPECTS

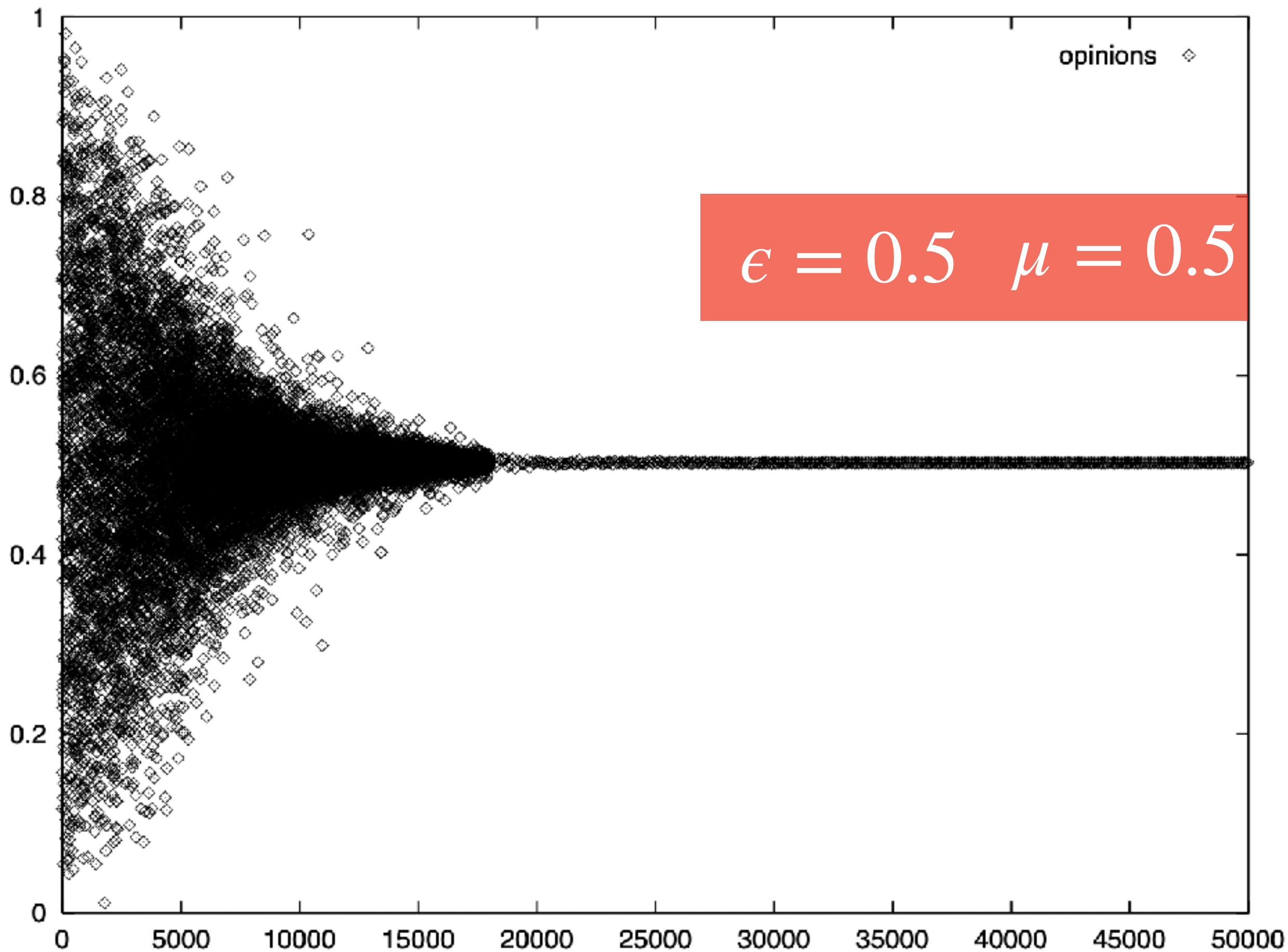
$$|o_i - o_j| < \epsilon$$

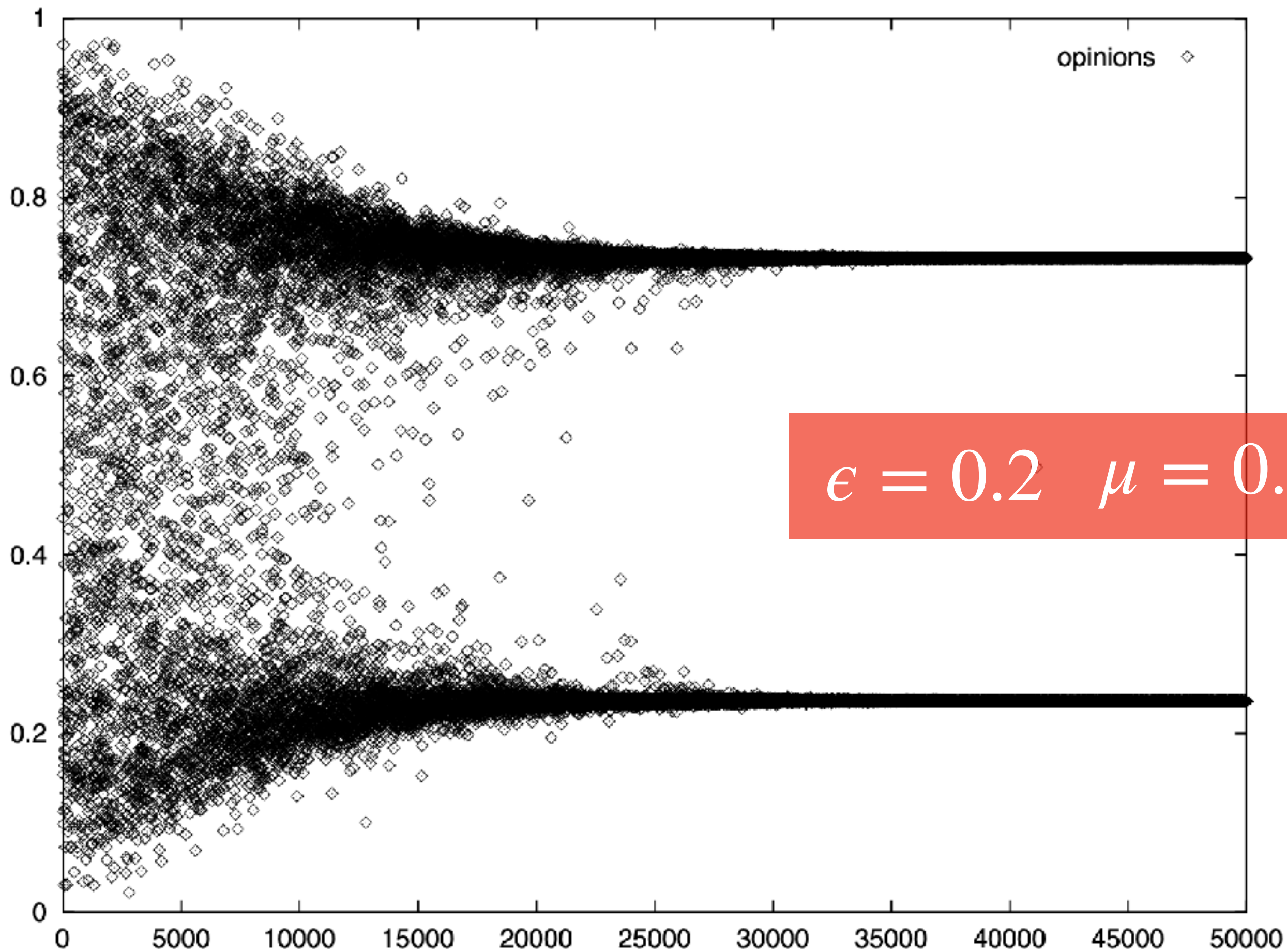
DIFFERENT OPINIONS

I DON'T ALWAYS LISTEN TO OTHER'S OPINIONS,

$$|o_i - o_j| > \epsilon$$

**BUT WHEN I DO, I PUT ON MY
'I DON'T GIVE A SHIT' FACE.**

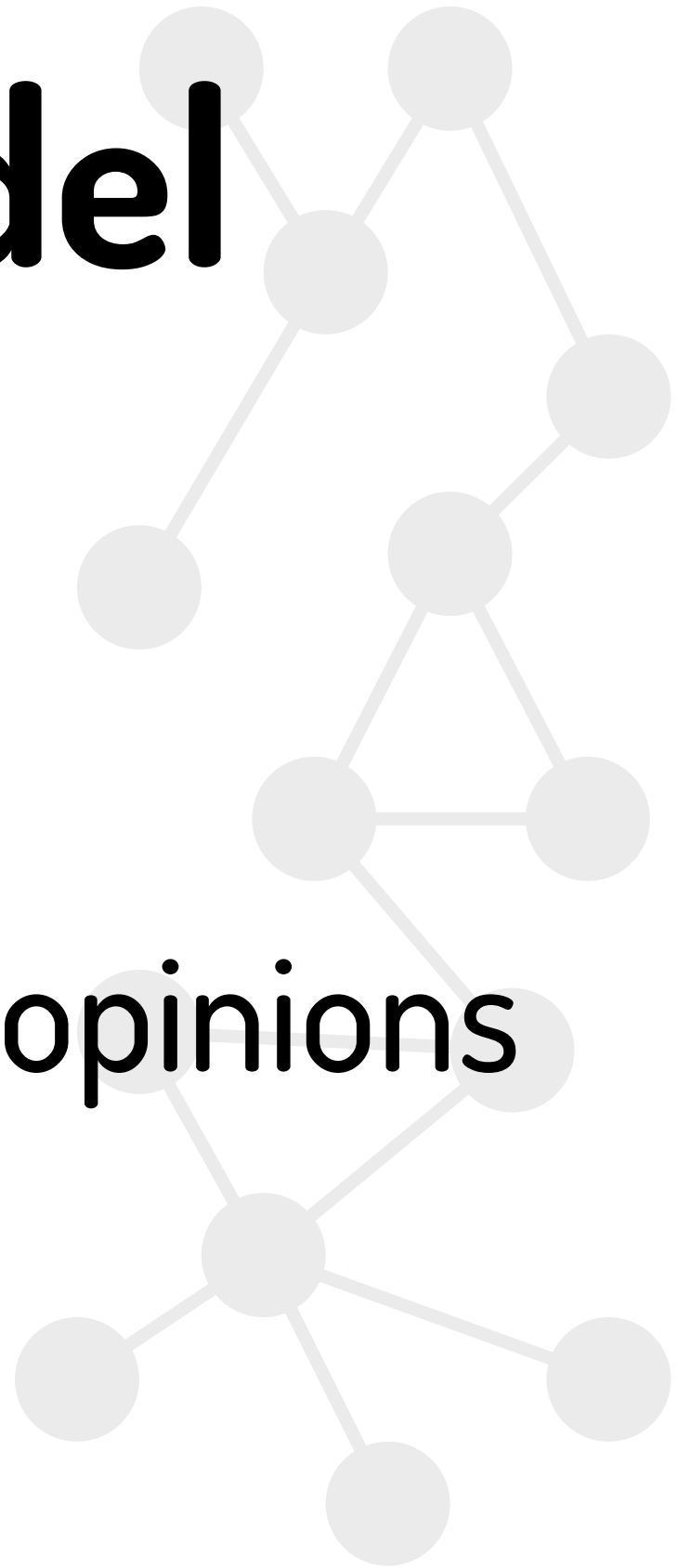




Deffuant model

Good for:

when you need continuous opinions



Case study



Case study

An opinion dynamics model for prediction markets



Prediction markets

Premier League

Arsenal

Fulham

01 Apr

19:45

ARSENAL

1.45

DRAW

4.6

FULHAM

8.6

BB

Popular

More markets (133)

Wolverhampton

West Ham

01 Apr

19:45

WOLVERHAMPT_

2.48

DRAW

3.30

WEST HAM

3.10

BB

More markets (139)

Nottm Forest

Man Utd

01 Apr

20:00

NOTTM FOREST

2.22

DRAW

3.55

MAN UTD

3.30

BB

More markets (140)

Prediction markets

Markets on events that have a **definite end-point**

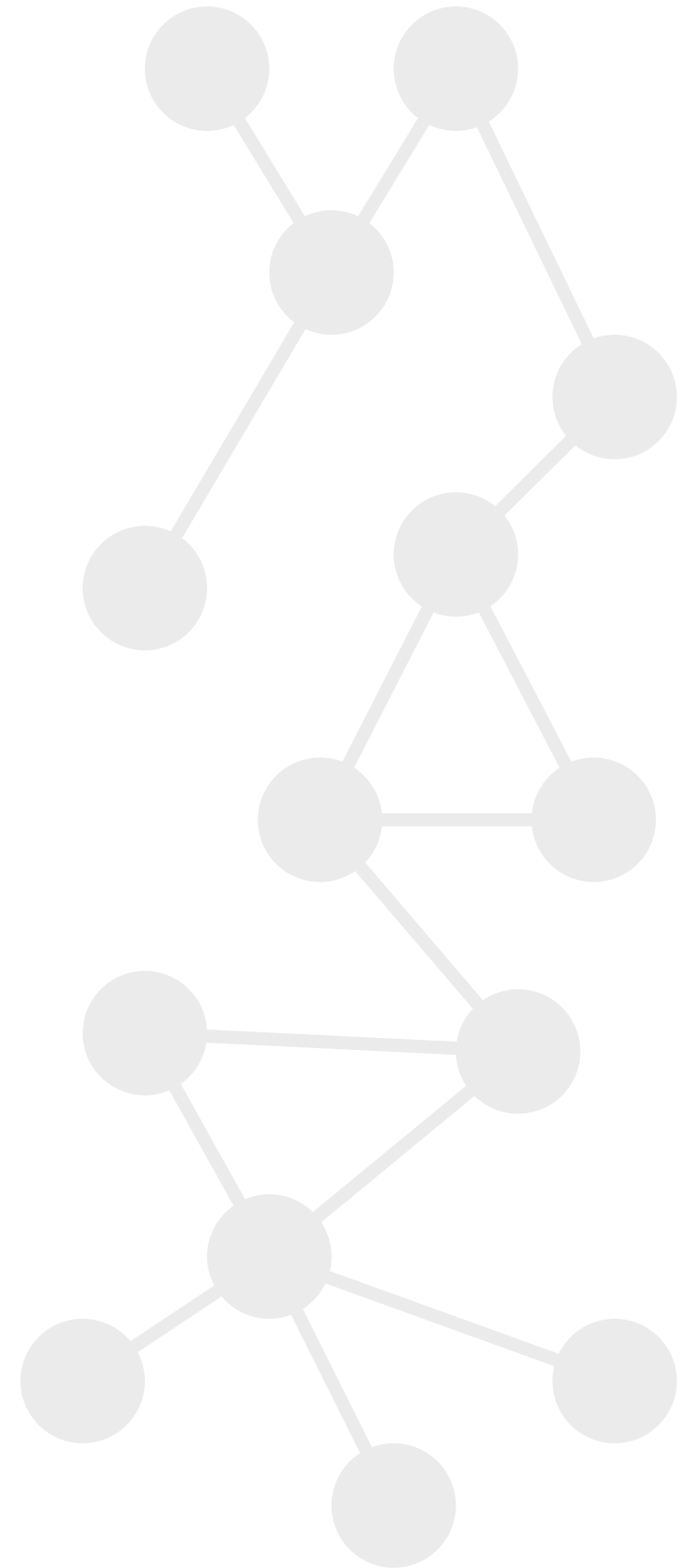
(e.g. political elections, football match, price of stock at time t)

Contract **pays 1** if correct **0 otherwise**

Price reflect **perceived probability** of that outcome to occur

Model

Agents start with **random opinions**
(uniform, between 0 and 1)



Model

Agents start with **random opinions**
(uniform, between 0 and 1)

They “live” on a **barabasi-albert** network



Model

Agents start with **random opinions**
(uniform, between 0 and 1)

They “live” on a **barabasi-albert** network

They **communicate** with random neighbour



Model

Agents start with **random opinions**
(uniform, between 0 and 1)

They “live” on a **barabasi-albert** network

They **communicate** with random neighbour

Some of them participate in the **market**. They buy if price is less than their opinion, and sell otherwise



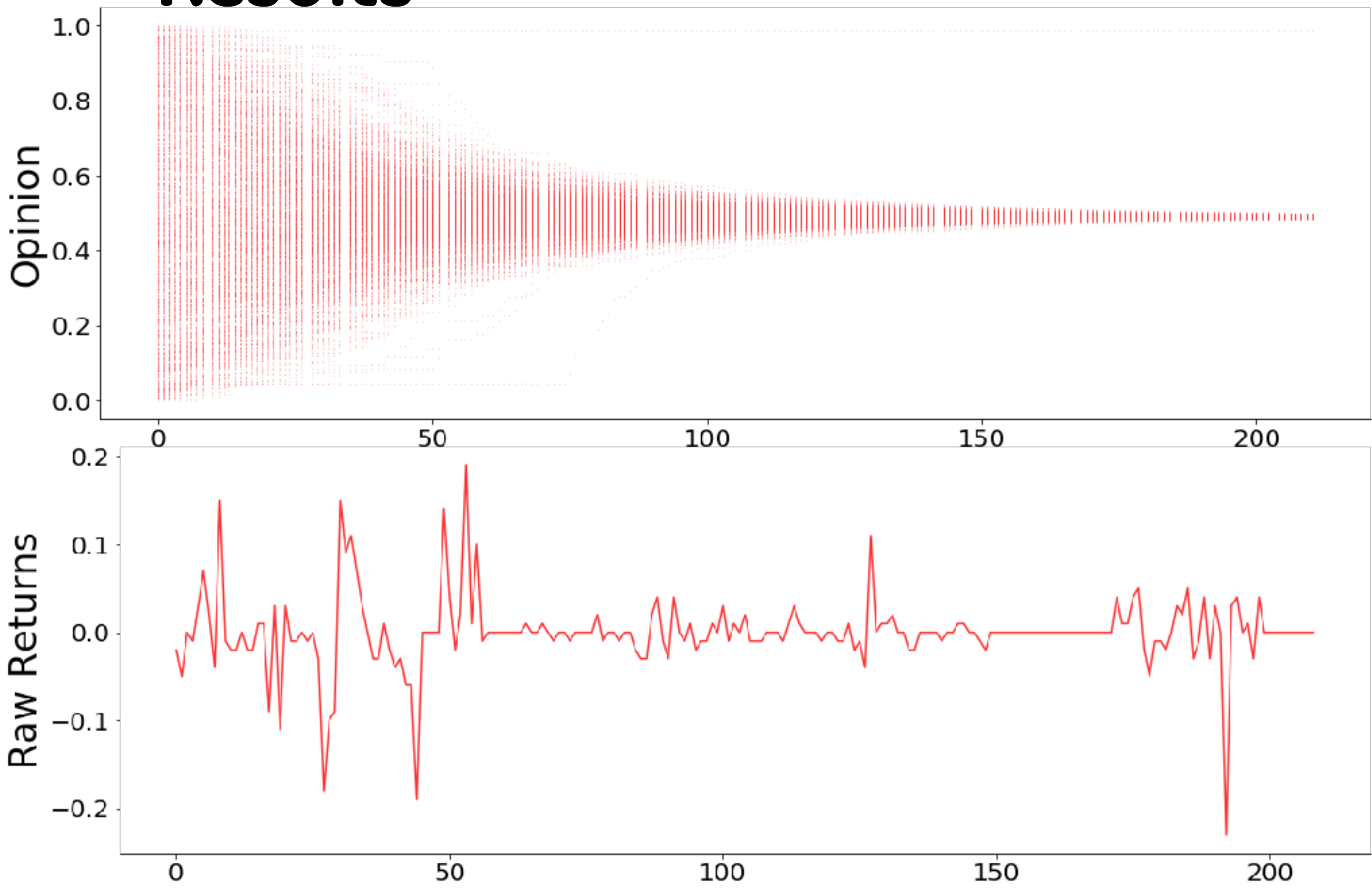
Simulations

Generate price data with simulations

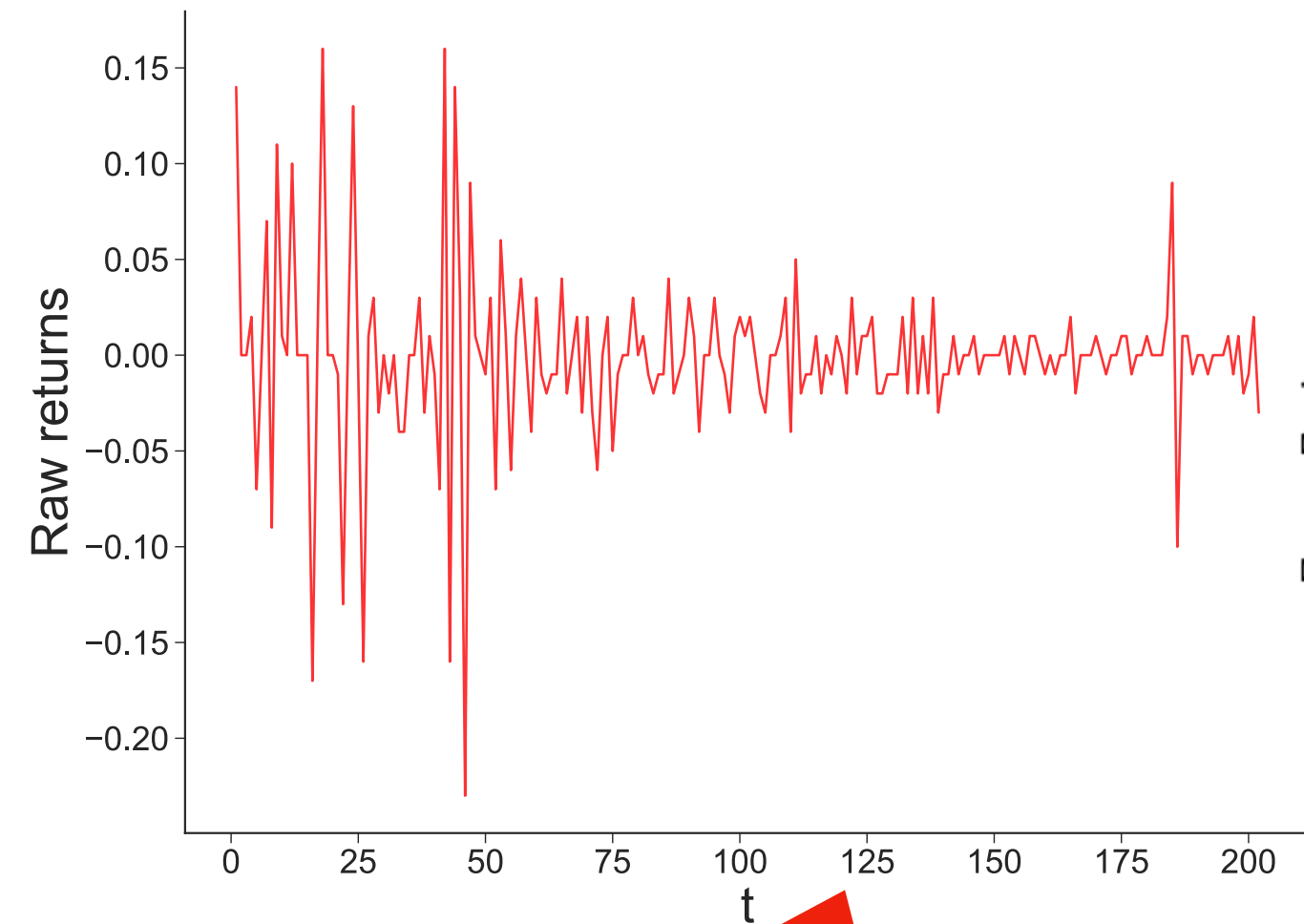
**Compare with empirical data (3385
markets)**



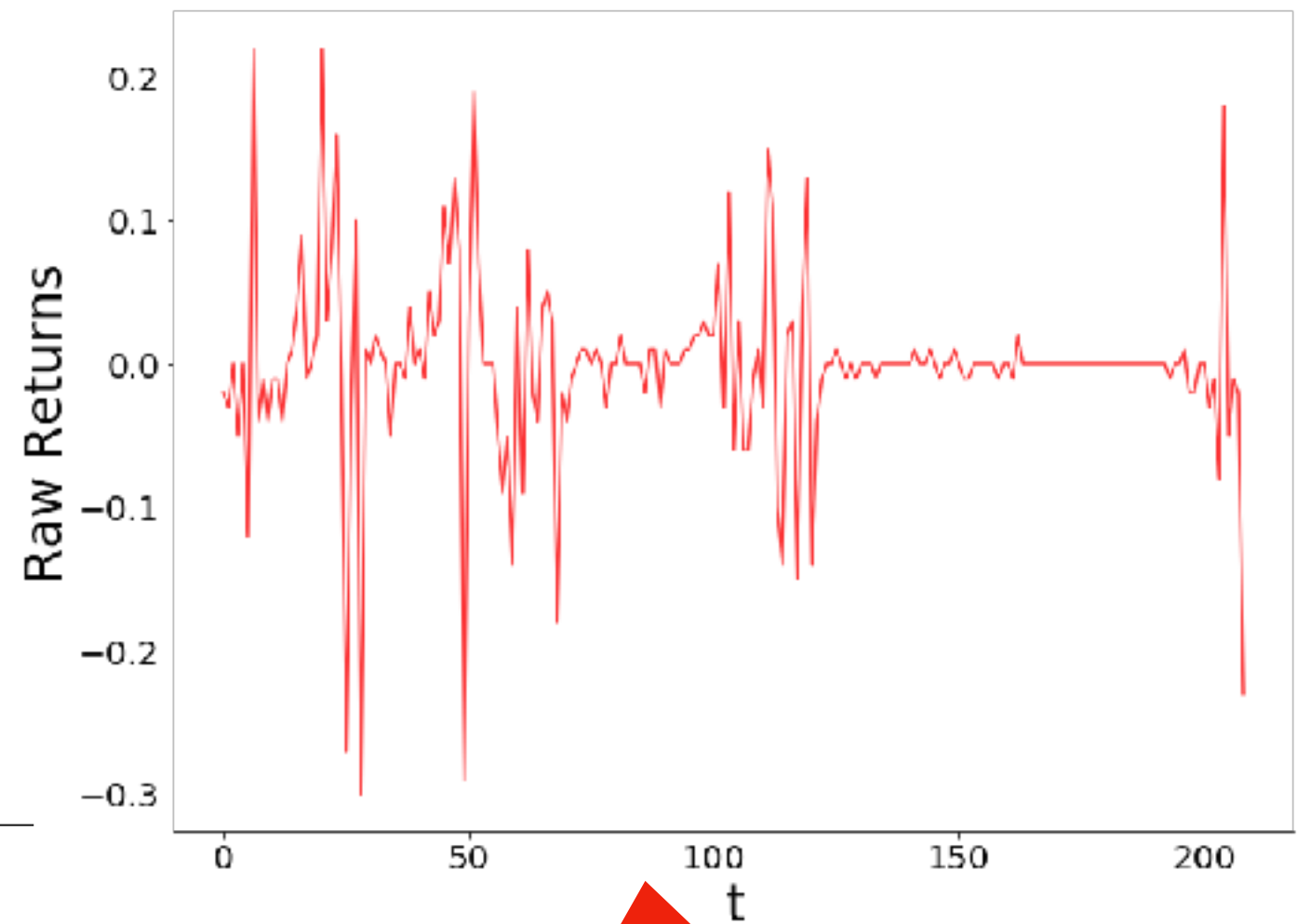
Results



Results

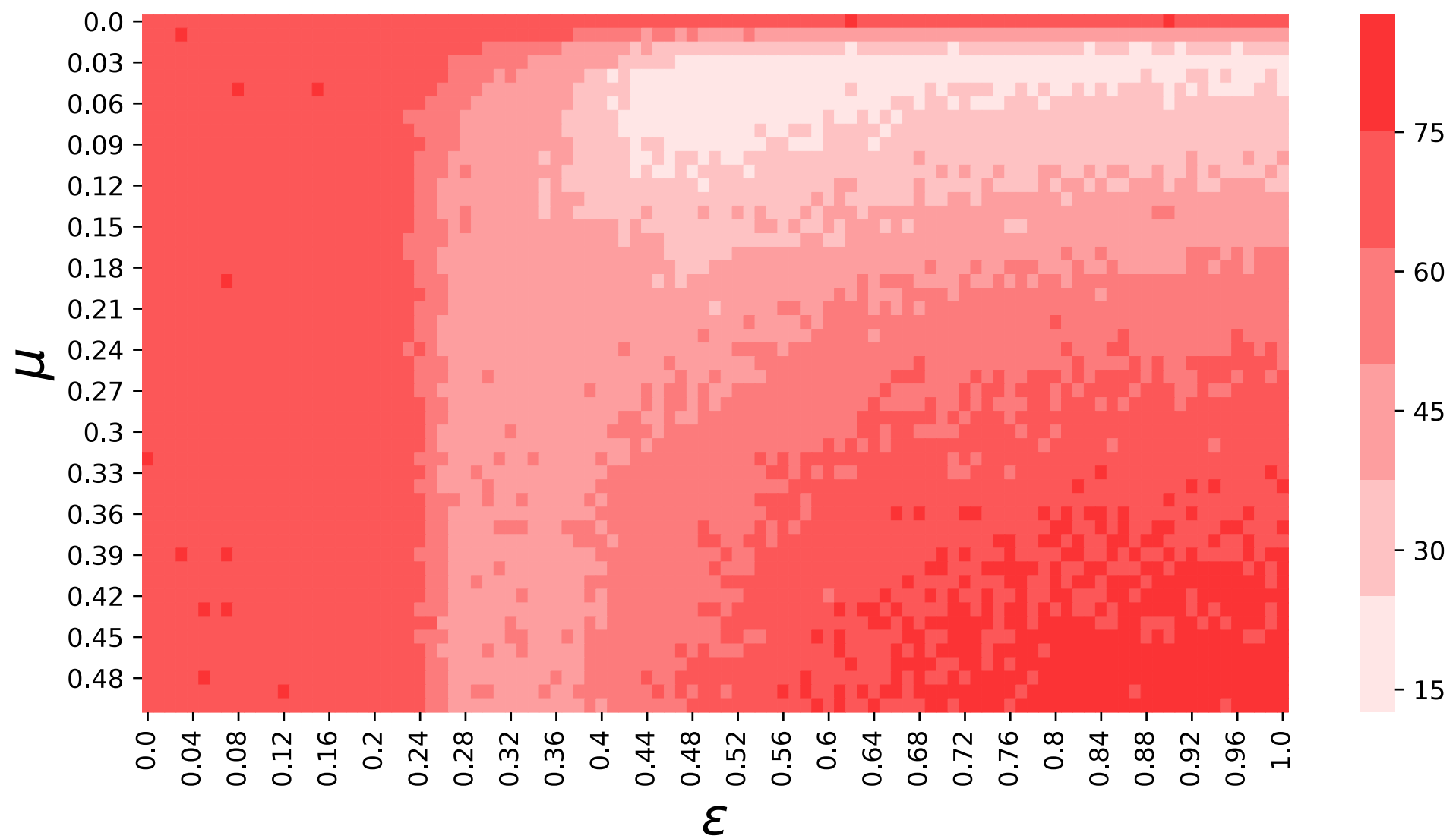


Historical (Brexit)

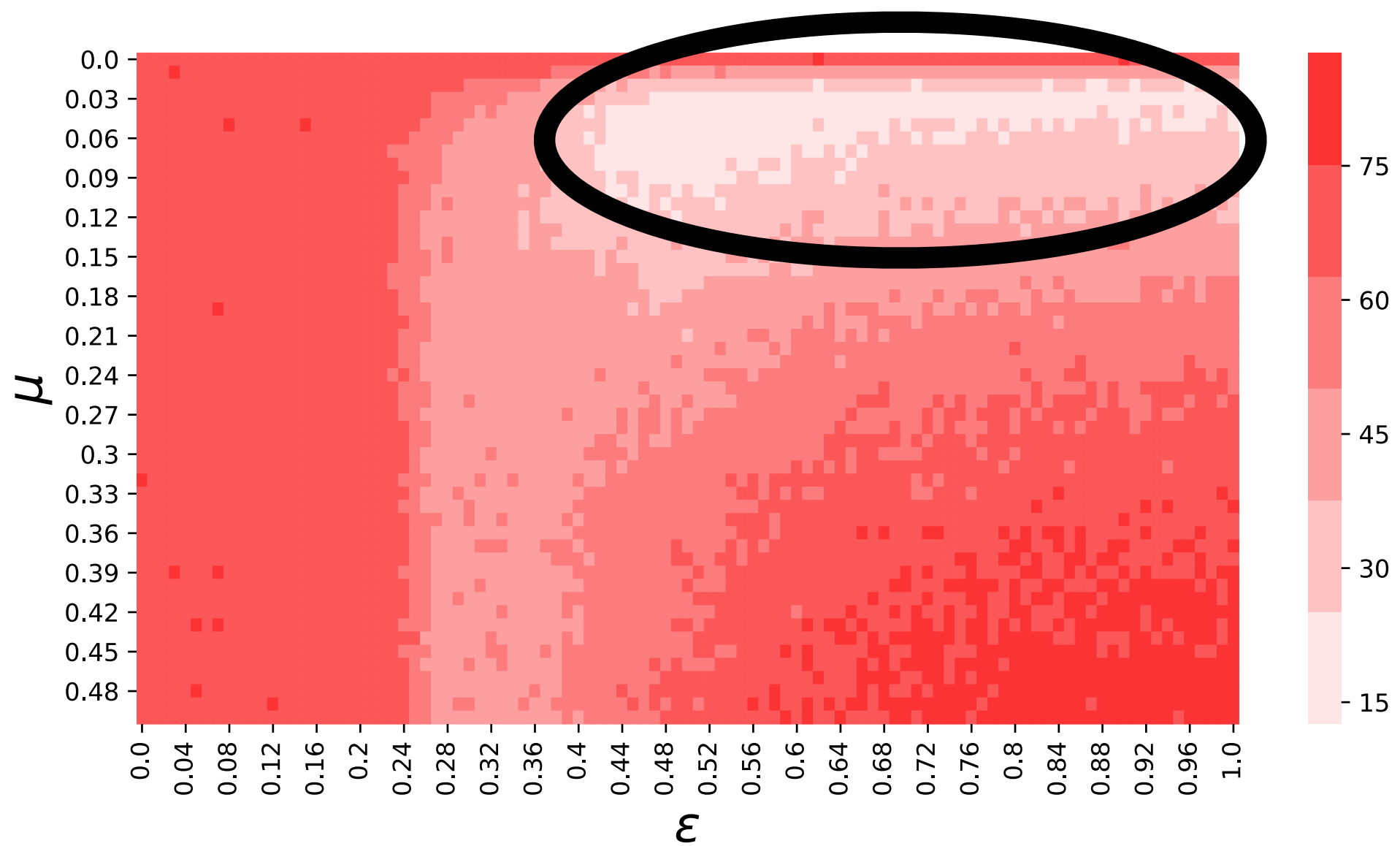


Simulated

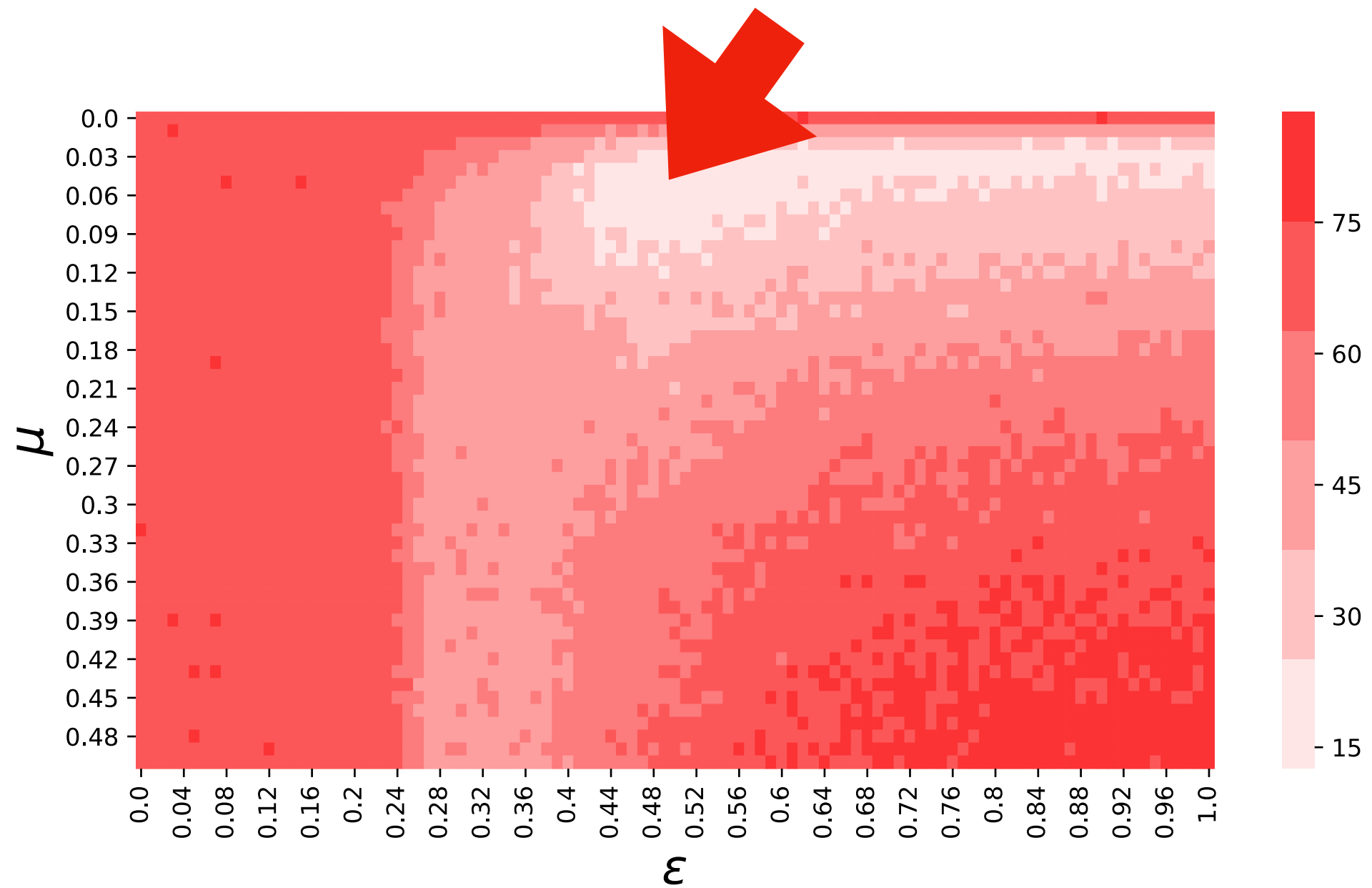
Results



Results

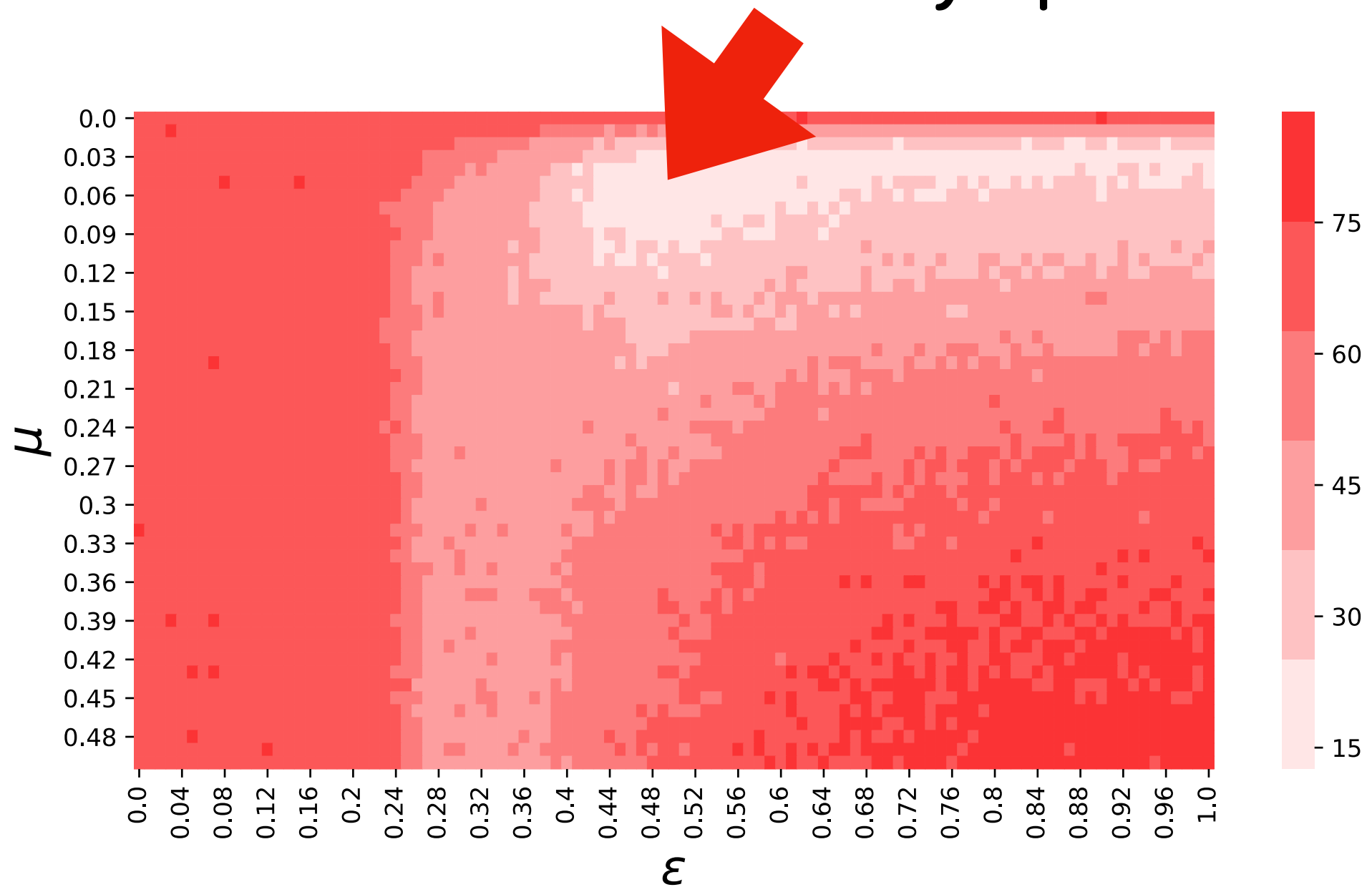


Results

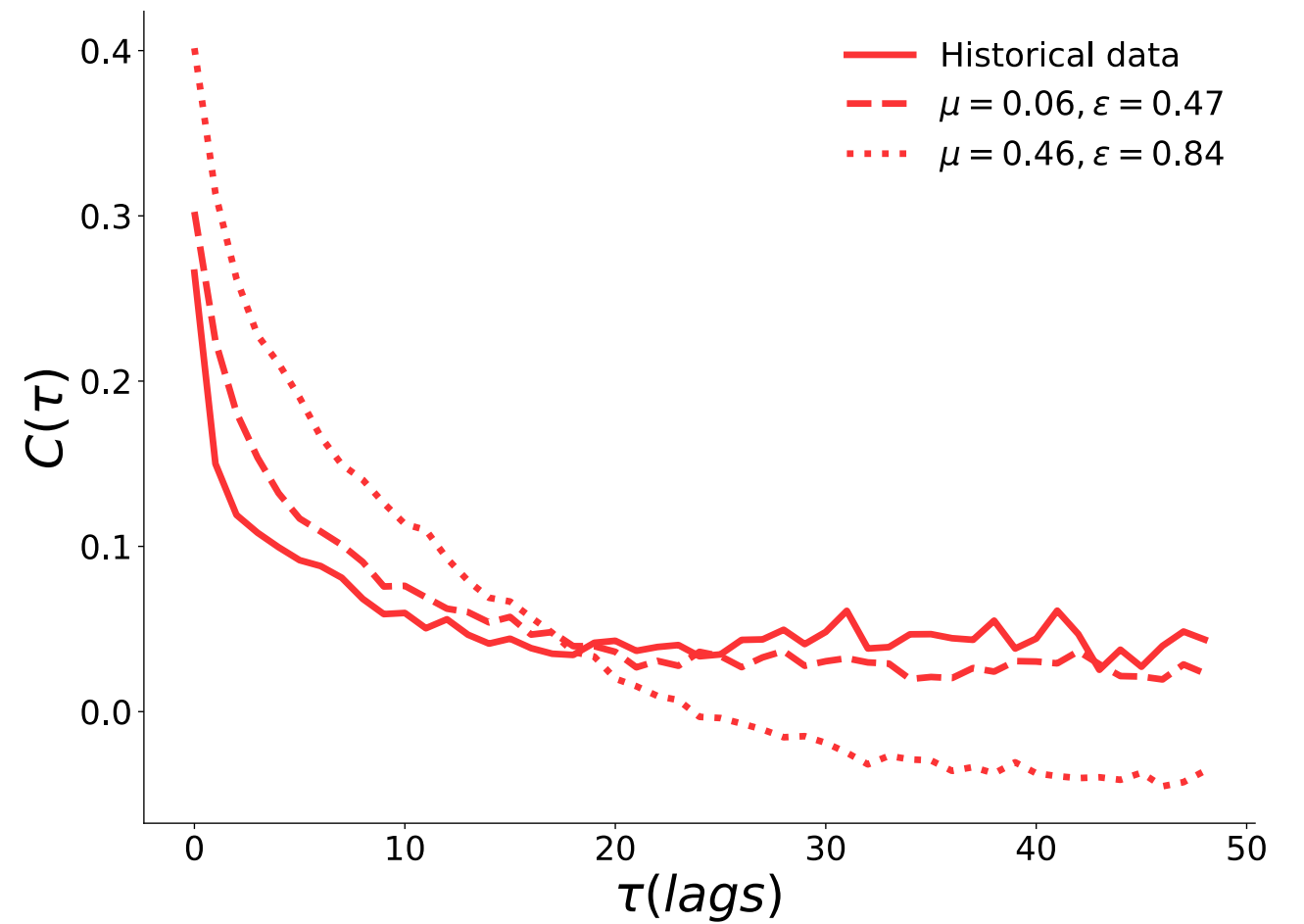
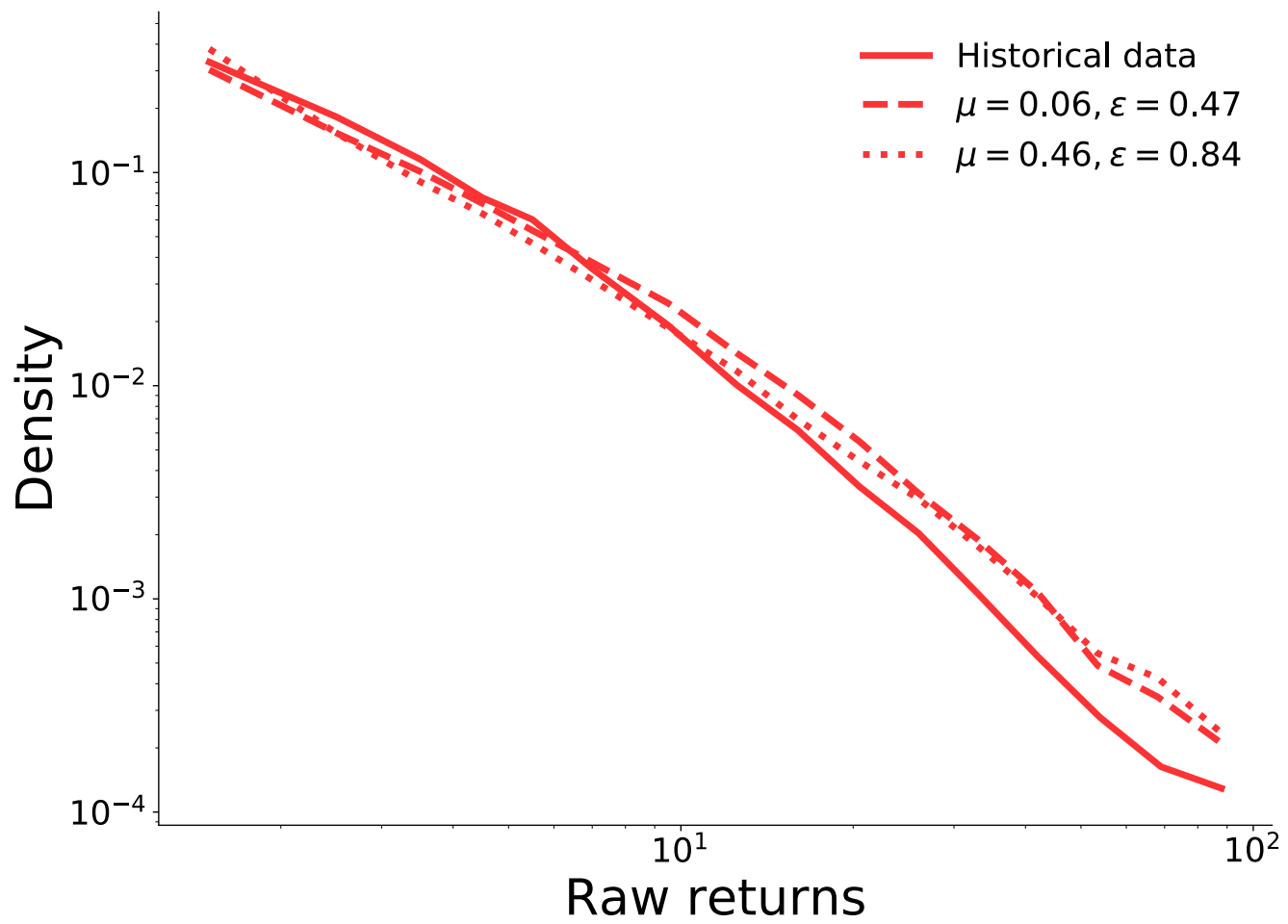


Results

People exchange opinions with many,
but barely update theirs



Results

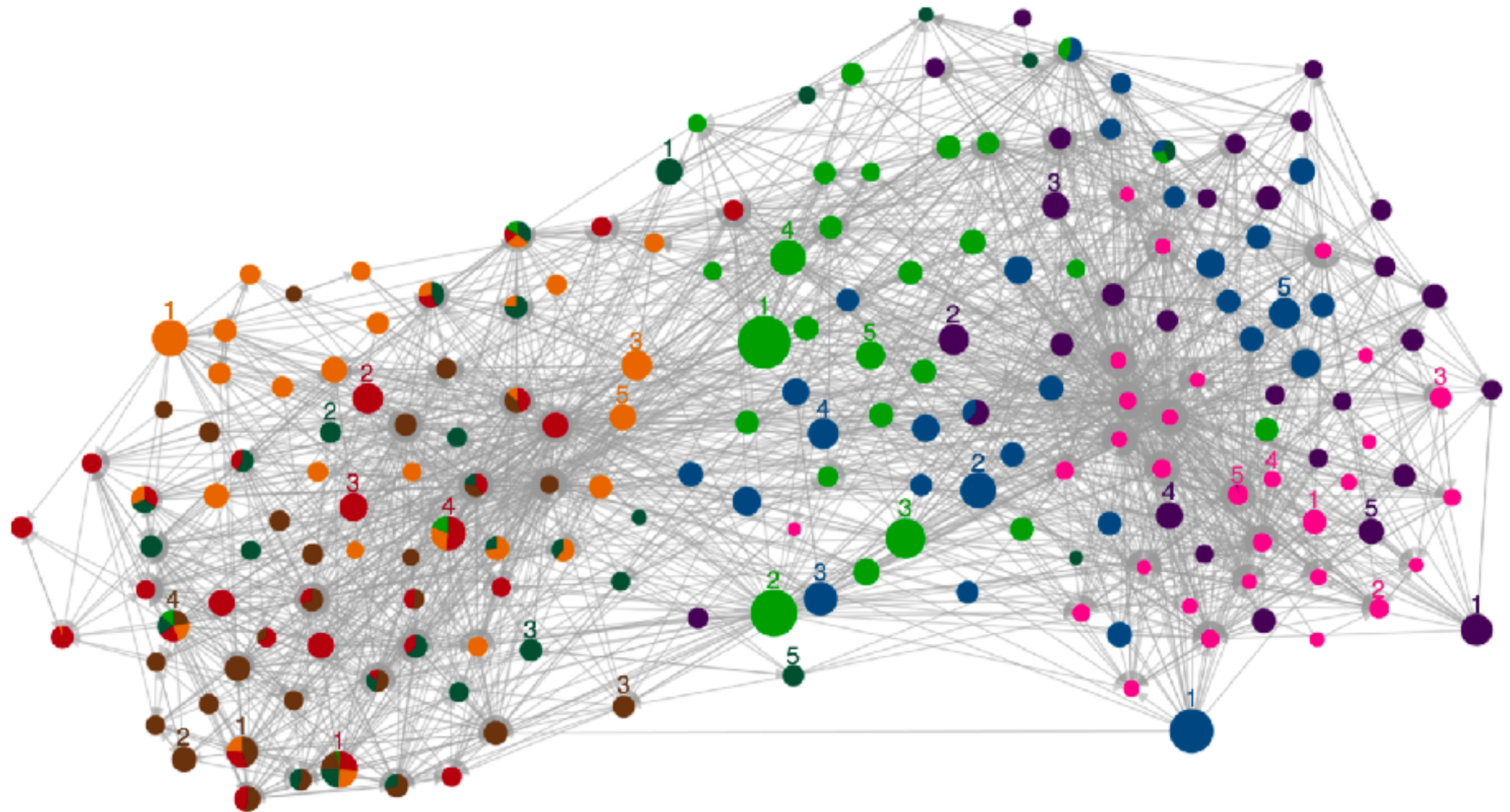


Case study II

Fake news and empirical
Opinion dynamics on **twitter**



Empirical opinion dynamics



Fake news

- 1 @PrisonPlanet
- 2 @RealAlexJones
- 3 @zerohedge
- 4 @DRUDGE_REPORT^{4,5}
- 5 @realDonaldTrump^{1,2,4}

Extreme bias (right)

- 1 @realDonaldTrump^{2,4,5}
- 2 @DailyCaller
- 3 @BreitbartNews
- 4 @wikileaks
- 5 @DRUDGE_REPORT^{4,4}

Right

- 1 @FoxNews
- 2 @realDonaldTrump^{1,4,5}
- 3 @dco Examiner
- 4 @DRUDGE_REPORT^{4,5}
- 5 @nypost

Right leaning

- 1 @WSJ
- 2 @WashTimes
- 3 @RT_com
- 4 @realDonaldTrump^{1,2,5}
- 5 @RT_America

Center

- 1 @CNN
- 2 @thehill
- 3 @politico
- 4 @CNNPolitics
- 5 @Reuters

Left leaning

- 1 @nytimes
- 2 @washingtonpost
- 3 @ABC
- 4 @NBCNews
- 5 @Slate

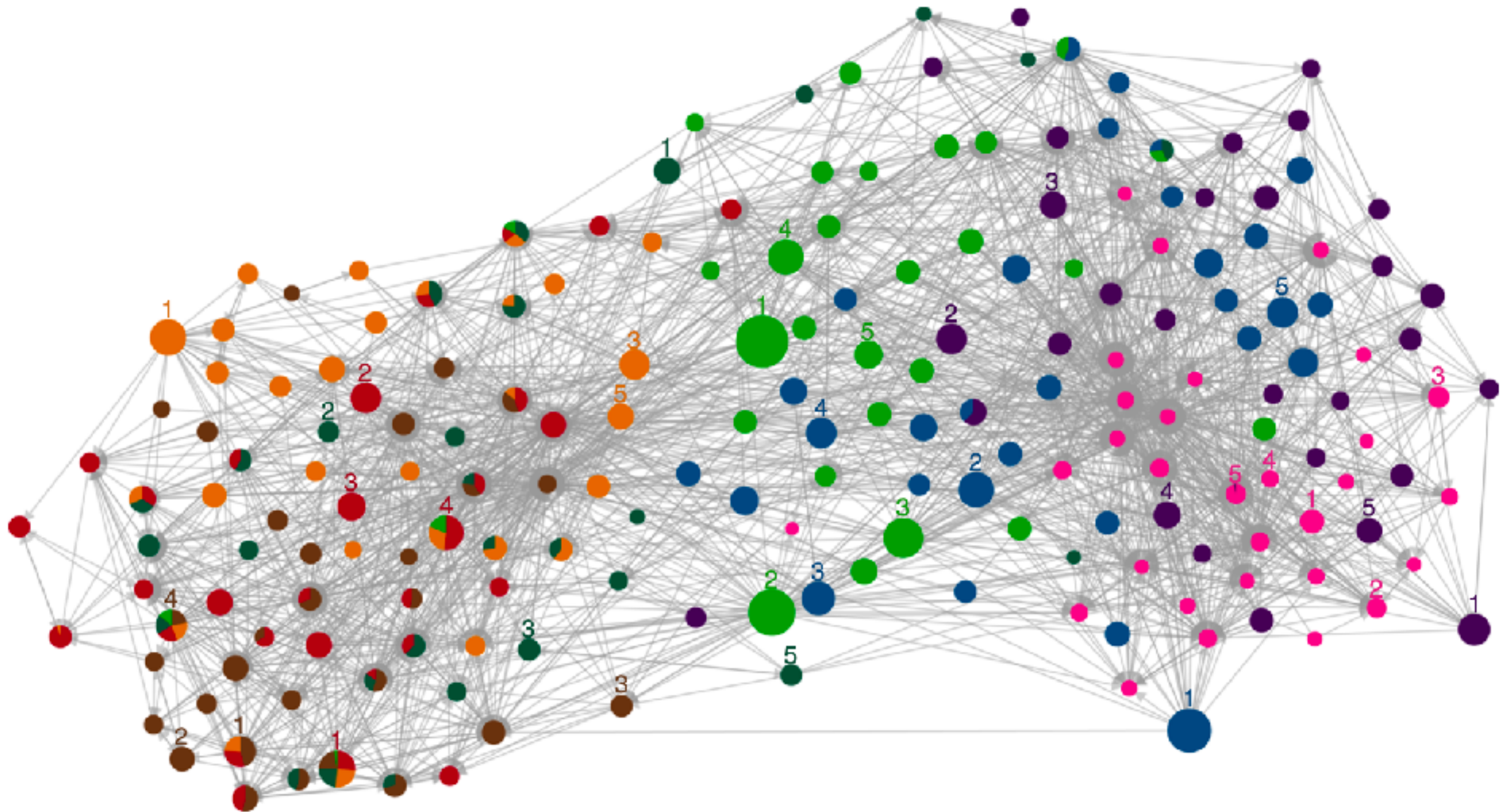
Left

- 1 @HuffPost
- 2 @TIME
- 3 @thedailybeast
- 4 @RawStory
- 5 @HuffPostPol

Extreme bias (left)

- 1 @Bipartisanism
- 2 @PalmerReport
- 3 @peterdaou
- 4 @crooksandliars
- 5 @BoldBlueWave

Empirical opinion dynamics



Fake news

- 1 @PrisonPlanet
- 2 @RealAlexJones
- 3 @zerohedge
- 4 @DRUDGE_REPORT^{4,5}
- 5 @realDonaldTrump^{1,2,4}

Extreme bias (right)

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- 2 @DailyCaller
- 3 @BreitbartNews
- 4 @wikileaks
- 5 @DRUDGE_REPORT^{4,4}

Right

- 1 @FoxNews
- 2 @realDonaldTrump^{1,4,5}
- 3 @dcexaminer
- 4 @DRUDGE_REPORT^{4,5}
- 5 @nypost

Right leaning

- 1 @WSJ
- 2 @WashTimes
- 3 @RT_com
- 4 @realDonaldTrump^{1,2,5}
- 5 @RT_America

Center

- 1 @CNN
- 2 @thehill
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- 1 @nytimes
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Extreme bias (left)

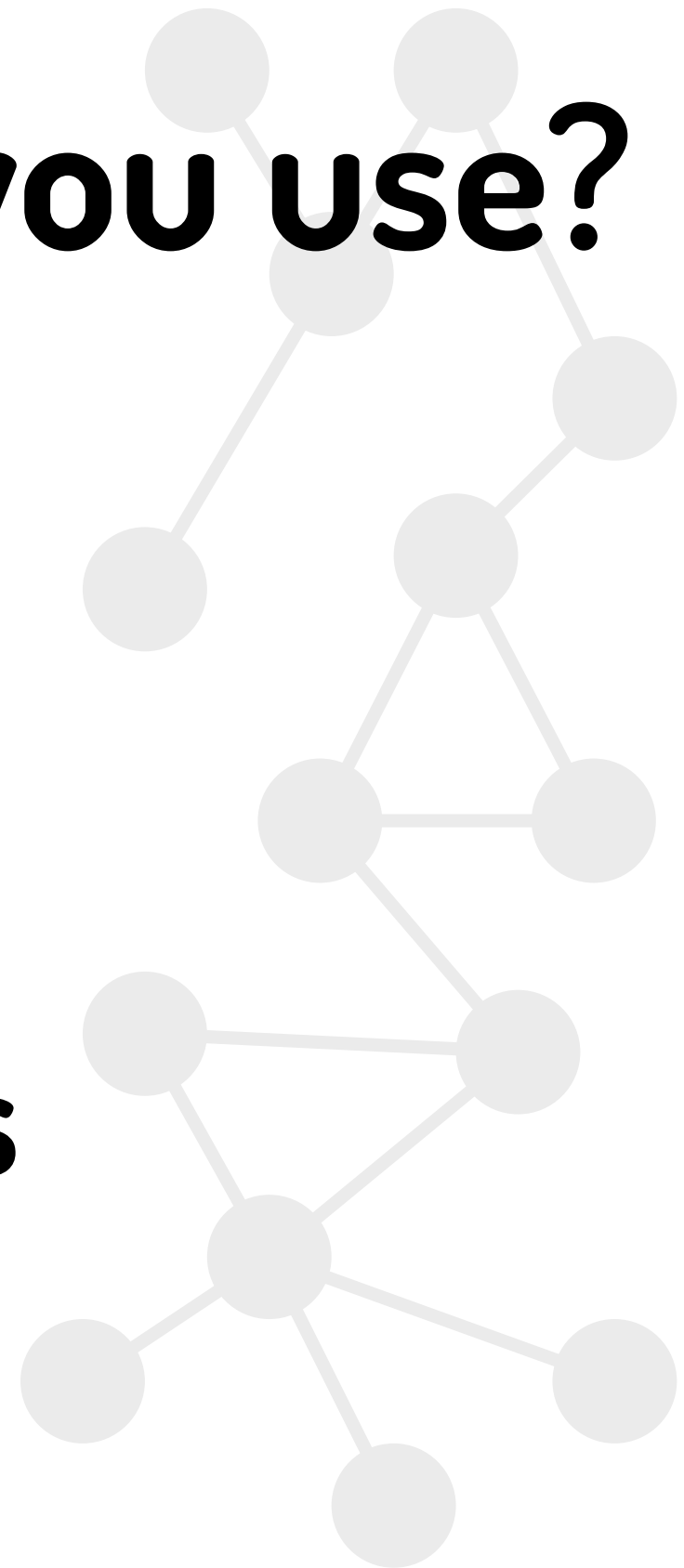
- 1 @Bipartisanism
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Which model would you use?

Video becoming viral

Marketing

Opinions on stock markets



Summary

Several models of opinion dynamics

Practical applications

Case studies

