Discrepancies in Expressed and Private Opinions on Influence Networks

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Opinion Dynamics on Influence Networks

- A set of social actors (individuals or organisations) who interact according to a set of social relationships/connections.

- Each individual has an opinion value (real number) on an issue/topic (e.g. the 2003 US-led Invasion of Iraq was justified)

- Individuals interact and discuss their opinions, which can lead to opinions changing over time under social influence

Friedkin-Johnsen Model [R1]

For a given topic and n individuals in a network, individual i's opinion $x_i \in \mathbb{R}$ evolves as:

$$x_i(t+1) = \lambda_i w_{ii} x_i(t) + \lambda_i \sum_{j \neq i}^{n} w_{ij} x_j(t) + (1 - \lambda_i) x_i(0)$$

- Influence weight from individual j to individual i: $w_{ij} \geq 0 \; \forall \; i, j$

- $\sum_{j=1}^{n} w_{ij} = 1$ for all i

- Susceptibility $\lambda_i \in [0,1]$ for all i

[R1] N. E. Friedkin and E. C. Johnsen, "Social Influence and Opinions," *Journal of Mathematical Sociology*, vol. 15, no. 3-4, pp. 193-206, 1990.

Background: In many situations, we have for one reason or another expressed a view which is different to our private view. Pressures from group dynamics *altered* our expression.

Example: I secretly believe the Earth is flat, but in the presence of everyone here, I express the opposite position.

Question: How does the pressure from group dynamics affect the process of opinion dynamics?

Literature from social psychology, sociology, political science, and economics studies private vs. expressed opinions/actions and pressure to conform.

- Group pressure can modify and distort an individual's judgement even in the face of overwhelming facts [R1]

- Pluralistic ignorance is a phenomenon whereby an individual believes the public majority support position A, but in reality, the majority support position B [R2]

- Active enforcement of an unpopular norm by a majority of individuals who privately reject the same norm [R3]

[R1] Asch, S.E. and Guetzkow, H., 1951. Effects of Group Pressure Upon the Modification and Distortion of Judgments. *Groups, Leadership, and Men*, pp.222-236, Pittsburgh: Carnegie Press.
[R3] O'Gorman H.J. 1975. Pluralistic Ignorance and White Estimates of White Support for Racial Segregation. *Public Opinion Quarterly*, 39(3):313–330.
[R4] Centola, D., Willer, R. and Macy, M., 2005. The emperor's dilemma: A computational model of self-enforcing norms. *American Journal of Sociology*, 110(4), pp.1009-1040.

Let x_i be individual i's true/private opinion, and $\hat{x}_i$ be his/her expressed opinion:

$$x_i(t+1) = \lambda_i w_{ii} x_i(t) + \lambda_i \sum_{j \neq i}^{n} w_{ij} \underline{\hat{x}_j(t)} + (1 - \lambda_i) x_i(0)$$

$$\hat{x}_i(t) = \underline{\phi_i x_i(t)} + \underline{(1 - \phi_i)} \underline{\hat{x}_{avg}(t-1)}$$

- Replace x_j with $\hat{x}_j$ in the update of the private opinion: individual i only learns of j's expressed opinion

- $\hat{x}_{avg} = \frac{1}{n} \sum_{i}^{n} \hat{x}_i$ is the average expressed view: **the public opinion**

- $\phi_i \in [0,1]$ is individual i's resilience to the pressure of the public opinion

Let the vector of opinions be $\boldsymbol{x} = [x_1, \ldots, x_n]^\top$, and $\widehat{\boldsymbol{x}} = [\hat{x}_1, \ldots, \hat{x}_n]^\top$

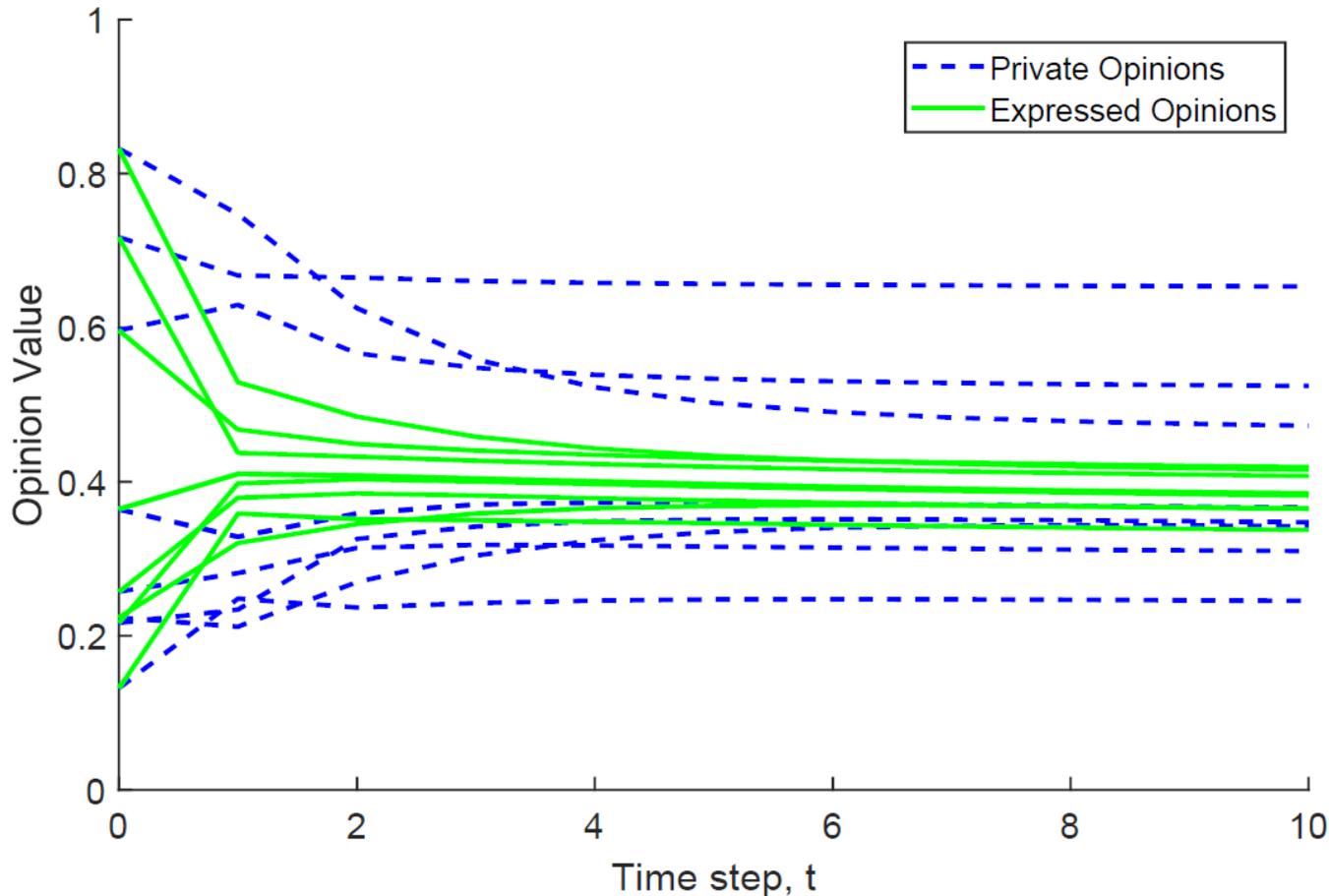The network dynamics can be expressed as a linear time-invariant system

$$\begin{bmatrix} \boldsymbol{x}(t+1) \\ \hat{\boldsymbol{x}}(t) \end{bmatrix} = \begin{bmatrix} \boldsymbol{P}_{11} & \boldsymbol{P}_{12} \\ \boldsymbol{P}_{21} & \boldsymbol{P}_{22} \end{bmatrix} \begin{bmatrix} \boldsymbol{x}(t) \\ \hat{\boldsymbol{x}}(t-1) \end{bmatrix} + \begin{bmatrix} \boldsymbol{B}\boldsymbol{x}(0) \\ \boldsymbol{0}_n \end{bmatrix}$$

Under the mild assumptions of

- Strong connectivity of the influence network (standard)
- $\phi_i, \lambda_i \in (0,1)$ for all i

the opinions converge to a steady state exponentially fast.

The convergence result itself is not unexpected or difficult to conclude. Much deeper insight is obtained by study of the final opinion distribution.
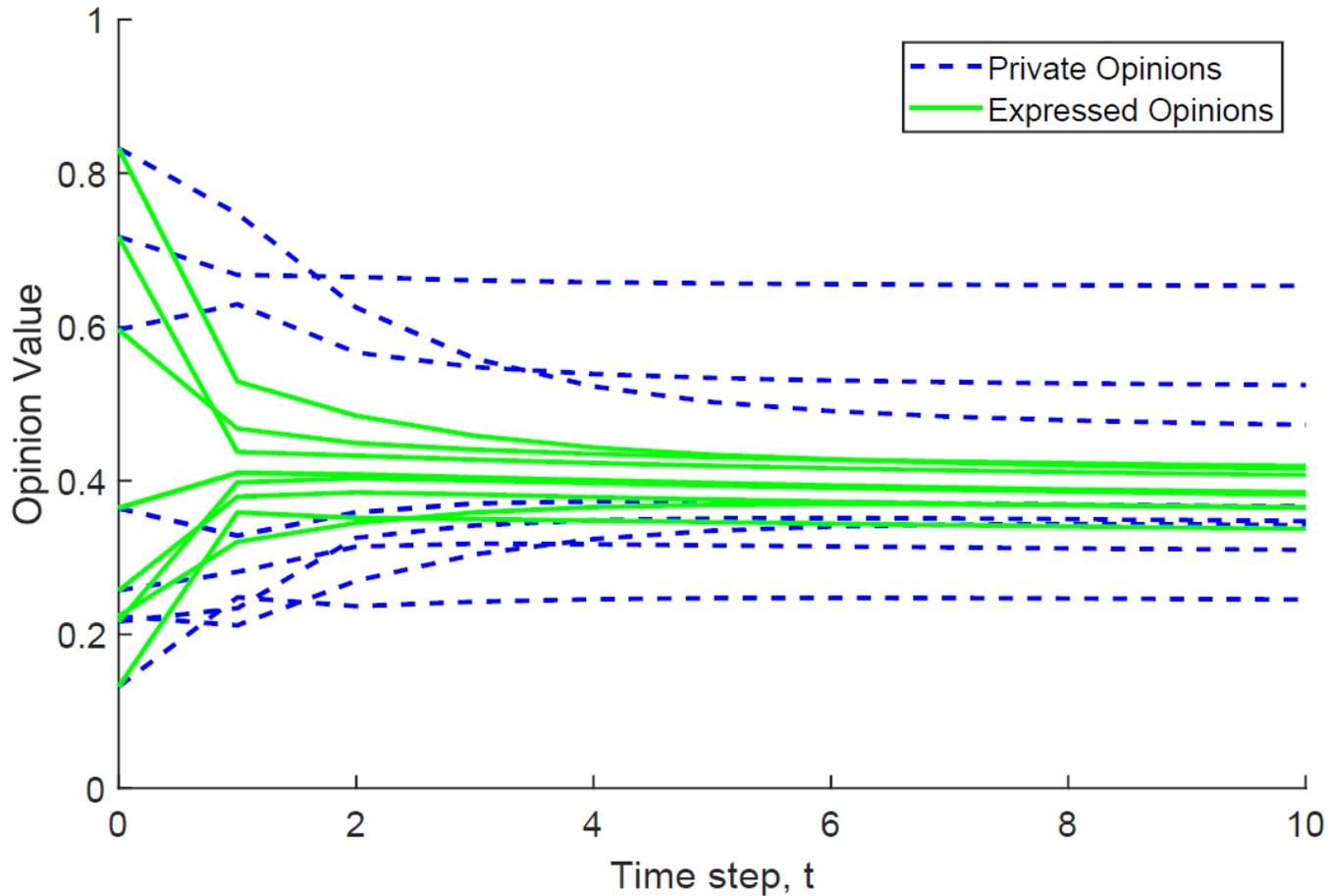
Final opinions

$$\boldsymbol{x}^* = [x_1^*, ..., x_n^*]^\top$$

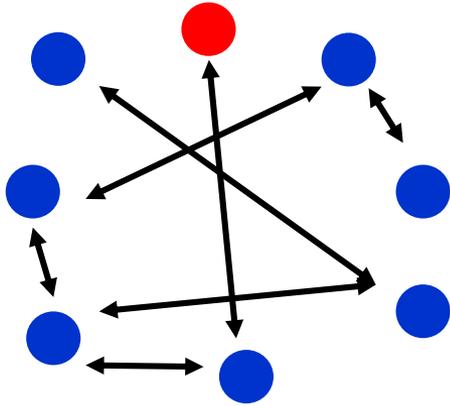$$\widehat{\boldsymbol{x}}^* = [\hat{x}_1^*, ..., \hat{x}_n^*]^\top$$

$x_i^* \neq \hat{x}_i^*$: stubbornness (λ_i) and pressure to conform (ϕ_i) create a discrepancy in the private and expressed opinions in the same individual

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Larger disagreement among private opinions than observed from expressed opinions: it is possible to estimate the private disagreement
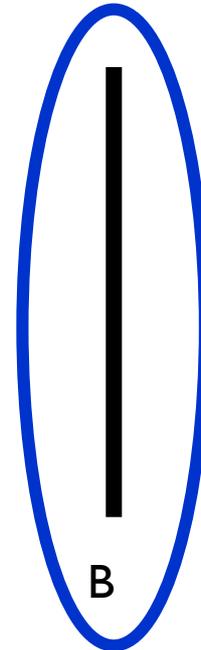
Asch's Experiment Revisited (1951)

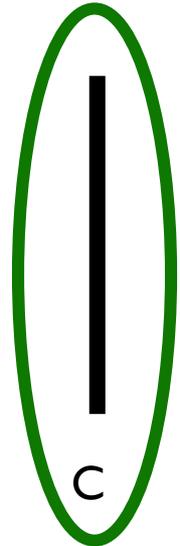Perhaps one of the most famed sociological experiments on conformity

7 blue confederates choose B. How does the red person react?
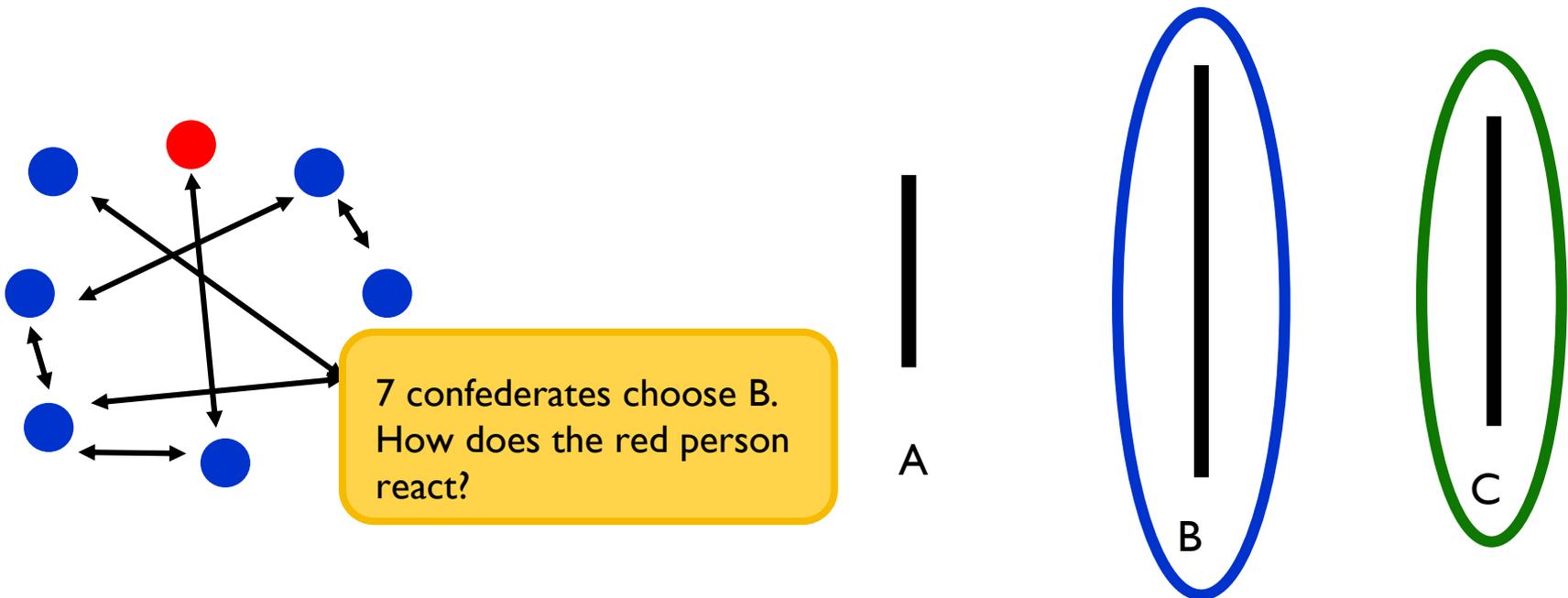
A

B

C

[R1] Asch, S.E. and Guetzkow, H., 1951. Effects of Group Pressure Upon the Modification and Distortion of Judgments. *Groups, Leadership, and Men*, pp.222-236, Pittsburgh: Carnegie Press.
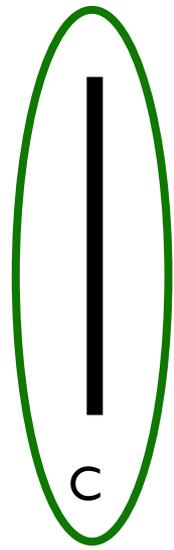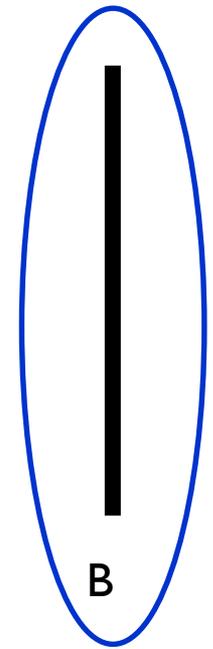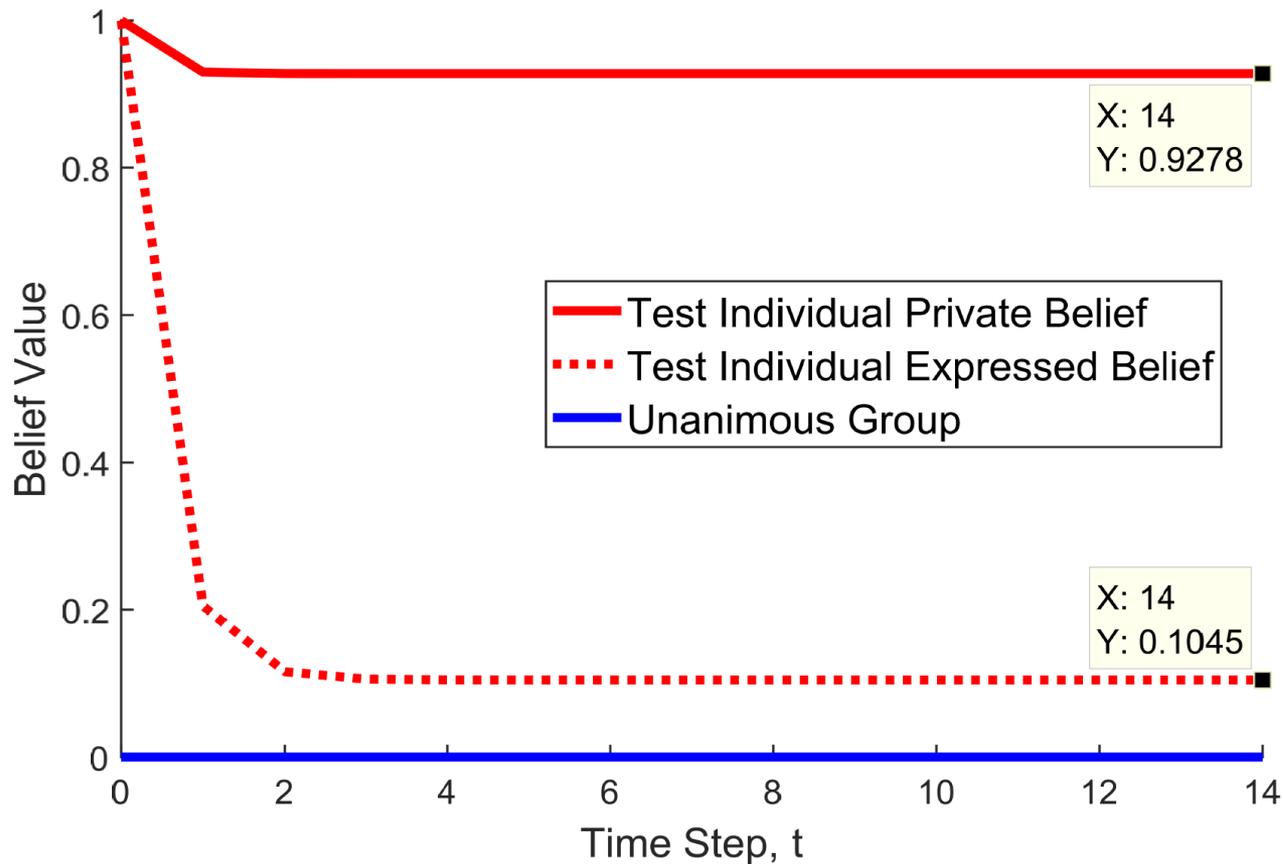
Observed Responses of Red Person:

1. He remained insistent that C was the correct answer

2. He expressed B as the correct answer but in a post-interview reaffirmed C as true.

3. He expressed B as the correct answer and in a post-interview still chose B.

Result: All three behaviours can be observed in our model depending on how susceptible and resilient an individual is (parameters λ_i, ϕ_i).

Example simulation showing a *yielding individual with distortion of action*

How certain are you that C is the correct answer?

Conclusions

– A novel model was proposed to describe differences in expressed and private opinions due to pressure to conform

– Analytical results obtained giving relations between expressed and private opinions

– Asch Conformity Experiments studied using the model

Current/Future Work

– Expressed variable $\hat{x}_i$ is binary, i.e. a decision/action: coevolution of opinions and decisions

– Used to study
  - Enforcement, and stability of unpopular norms [R1]
  - The role of opinions in diffusion of innovation
  - Formation and changes of social norms [R2]

– Event-based communication

– Prediction and the "spiral of silence"

[R1] D. Centola, R. Willer, and M. Macy, "The Emperor's Dilemma: A Computational Model of Self-Enforcing Norms," *American Journal of Sociology*, vol. 110, no. 4, pp. 1009–1040, 2005.
[R2] H. Peyton Young, "The Evolution of Social Norms," *Annual Review of Economics*, vol. 7, no. 1, pp. 359–387, 2015.

Thanks for listening!
Questions?

Pluralistic Ignorance: Group of people privately reject a view, but incorrectly assume majority supports the view.

Example:

White Americans in 1960s overestimated the amount of support for racial segregation among white Americans [R1]
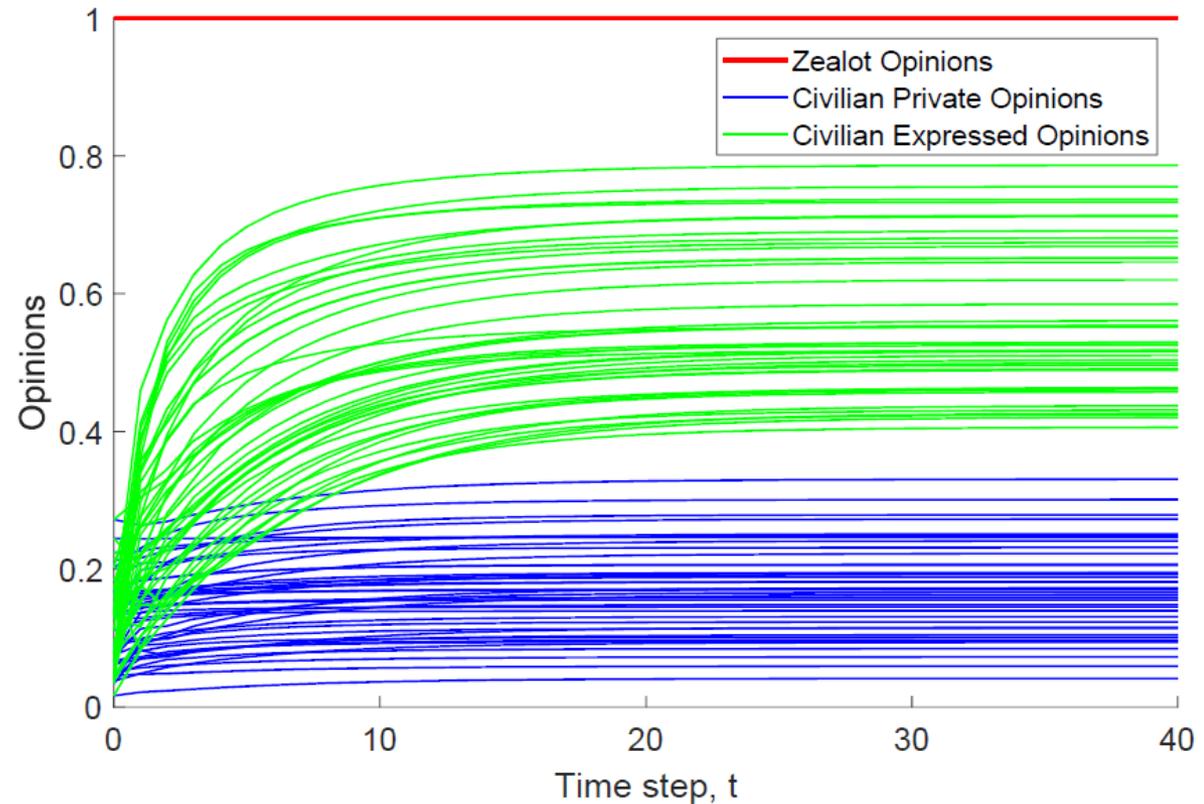
Students overestimated other students' comfort levels with Princeton University's heavy drinking culture [R2]

[R1] H. J. O'Gorman. Pluralistic Ignorance and White Estimates of White Support for Racial Segregation. *Public Opinion Quarterly,* 39(3):313–330, 1975.
[R2] Prentice, D. A., & Miller, D. T. (1993). Pluralistic ignorance and alcohol use on campus: some consequences of misperceiving the social norm. *Journal of personality and social psychology*, 64(2), 243.

A few high degree zealots (highly stubborn, highly resilient) with extreme views are able to create pluralistic ignorance among the general population (civilians)
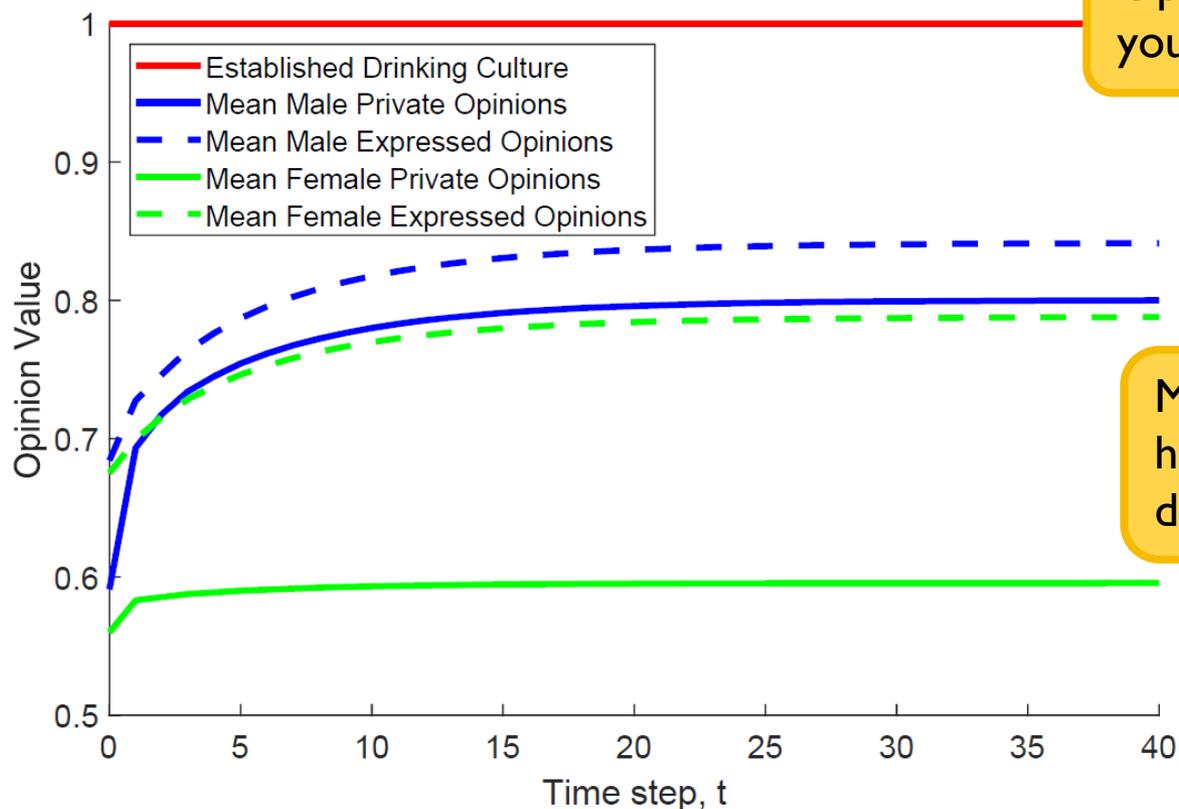
5 zealots in 200 person network

Prentice and Miller's Study (1993)

Data collected on 50 students in September, and again in December (temporal)

- Female students continued to show pluralistic ignorance
- Male students absorbed the pluralistic ignorance over time

Opinion: How comfortable are you with the drinking culture?

Male and female students have same ϕ_i but different λ_i distributions

Estimating Disagreement in Private Opinions

$$\hat{x}_i(t) = \phi_i x_i(t) + (1 - \phi_i)\hat{x}_{avg}(t-1)$$

Expressed opinion spread

Private opinion spread

Result:

$$\frac{\max_i \hat{x}_i^* - \min_j \hat{x}_j^*}{1 - \frac{\phi_{\min}}{\phi_{\max}}(1 - \phi_{\max})} < \max_i x_i^* - \min_j x_j^*$$

1. The DeGroot model has been supported by experimental results in various settings [R1, R2].

2. The Friedkin-Johnsen model has been supported by small/medium group experiments [R3, R4].

[R1] Chandrasekhar, A.G., Larreguy, H. and Xandri, J.P., 2012. Testing models of social learning on networks: Evidence from a framed field experiment. *Work. Pap., Mass. Inst. Technol., Cambridge, MA.*

[R2] Becker, J., Brackbill, D. and Centola, D., 2017. Network dynamics of social influence in the wisdom of crowds. *Proceedings of the National Academy of Sciences, 114*(26), pp.E5070-E5076.

[R3] Friedkin, N.E. and Johnsen, E.C., 2011. *Social influence network theory: A sociological examination of small group dynamics* (Vol. 33). Cambridge University Press.

[R4] Friedkin, N.E. and Bullo, F., 2017. How truth wins in opinion dynamics along issue sequences. *Proceedings of the National Academy of Sciences, 114*(43), pp.11380-11385.