SOCIAL INFLUENCE:
FROM CONTAGION TO A RICHER CAUSAL UNDERSTANDING

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Beyond contagion

- Contagion assumption ensuring: 'influentials' adopt a behavior is sufficient to ensure that a large population to adopt this behavior — known to be over-simplistic (e.g. [3]),
- Correlation does not imply causation,
- Must find a way to distinguish social influence from alternative causes of observed behaviors: personal traits, focal item traits, and external circumstances.

Objectives

Construct a theoretical framework which will allow one to:

- Move beyond correlations and make more robust cause-effect claims, and
- Leverage existing expertise from the social sciences, serving as a methodology for computational social science.

Causes behind observed behaviors

As has long been established in the social science literature (sociology, social psychology, management, marketing), two people i and j may adopt the same action, behavior, or belief with respect to a focal item (e.g. an idea, a product, a news item) because of:

- **Social Influence:** The example j set was so persuasive, inspirational, or impressive that i was convinced and became inclined to also adopt it.
- **Personal Traits:** They both have one or more personal traits in common, e.g. interests, values, beliefs, opinions, needs, or demographic characteristics.
- **Focal Item Traits:** The focal item has properties known to entice people into such a behavior, e.g. features that invoke emotional arousal, or activating emotions like anger or excitement, make a message or product more likely to be discussed or bought.
- **External Circumstances:** That is, factors like social trends, the current economic or political environment, e.g. two people post the same URL on social media because it relates to an important current news item.

Graphical Causal Models

Graphical causal models allow one to reason about cause-effect relations [1]. For example, we want to estimate the causal effect of X of Y, denoted by the arrow $X \to Y$, in the presence of a **common cause** U, as per Figure 1.

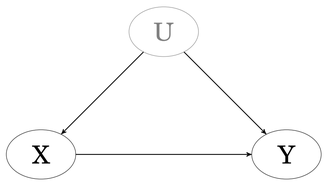


Figure 1: Example graphical causal model

However, the so-called backdoor path $X \leftarrow U \to Y$ introduces confounding bias into our causal estimate. In such cases, to be able to identify the causal effect and remove the bias, all variables in the **deconfounding set** Z (in this example, $Z = U$) should be measured and adjusted for, using the backdoor adjustment formula:

$$P(Y = y|do(X = x)) = \sum_z P(Y = y|X = x, Z = z)P(Z = z) \quad (1)$$

In general, to remove confounding and obtain the unbiased causal effect of X on Y, our ***deconfounding strategy*** is:

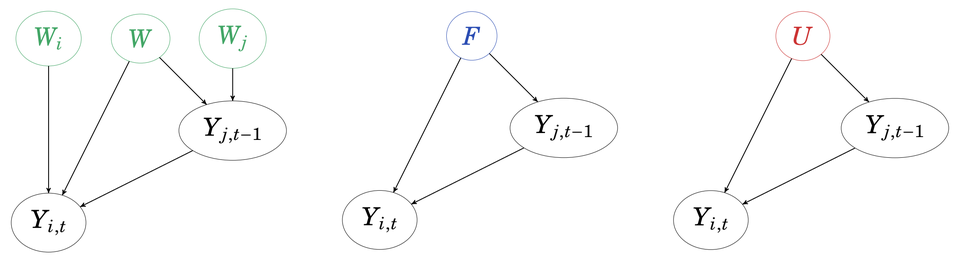
1. *Select a large random sample from the population of interest,*
2. *For every individual in the sample, measure X, Y, and all variables in Z, and*
3. *Adjust for Z by partitioning the sample into groups that are homogeneous relative to Z, assess the effect of X on Y in each homogeneous group, and then average the results, as per Equation 1.*

Causal Models for Social Influence

Expanding on the work of [2], we show that, for each of the three alternative causes, there is a backdoor path of the form shown in Figure 1, meaning that each of these causes is confounded with social influence.

Notation:

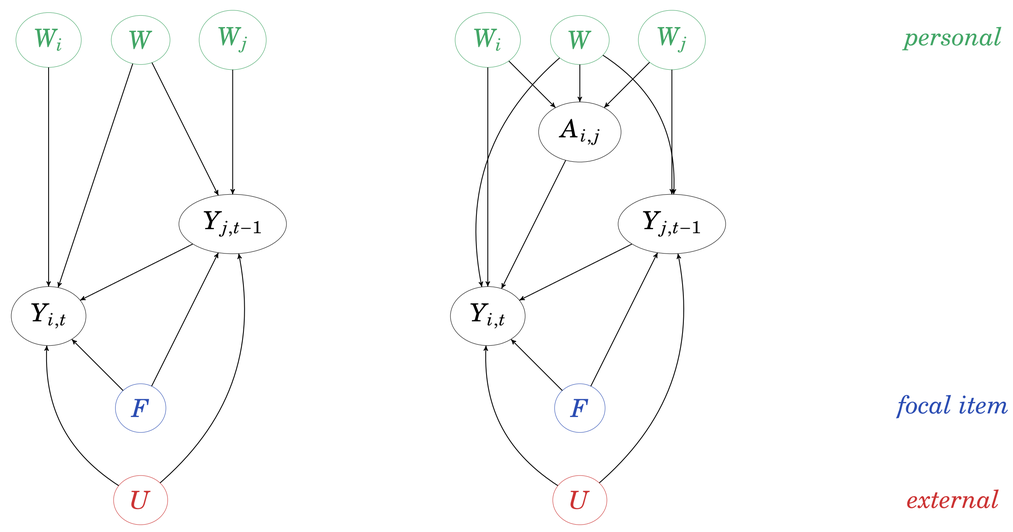
Symbol	Meaning
i, j	The two individuals under study
$Y_{i,t}$	Person i adopts a behaviour Y that relates to a focal item, at time t
W	The personal traits that i and j have in common
W_i, W_j	The remaining personal traits of i and j that they do not have in common
F	Traits of the focal item
U	External circumstances
$A_{i,j}$	Whether i considers j a friend



a: Common personality traits **b:** Focal item traits **c:** External common cause

Figure 2: Graphical causal models for social influence versus similarity in personality traits (a), focal item traits (b), and external circumstances (c)

Putting all these together, we obtain the following two models, one without and one with a social tie $A_{i,j}$:



a: Full model without social tie **b:** Full model with social tie **c:** Context

Figure 3: Full graphical causal models for social influence versus other causes, without social ties (a), and with social ties (b), with the legend (c) on the right showing the context of each latent causal variable

Therefore, the minimal deconfounding set for Figure 3(a) is $Z = \{F, U, W\}$, and for Figure 3(b) it is $Z' = \{F, U, W, W_j\}$. That is, the alternative causes to social influence introduce confounding bias, so they should be measured and adjusted for, as per our **deconfounding strategy**.

Key Results and Conclusions

Based on the structure of our causal model and on its application to a variety of previous studies, we find that:

- The three alternative causes to social influence cannot just be ignored, as they do introduce confounding bias to one's estimates of social influence.
- Ensuring our sample is randomised does not adjust for confounders - those still need to be measured and adjusted for using the deconfounding strategy.
- Overall, our framework allows one to systematically evaluate, strengthen and qualify causal claims one can make from given observational data, in a variety of interaction settings, offering a promising interdisciplinary methodology for computational social science.

References

[1] Judea Pearl. *Causality*. Cambridge University Press, 2009.

[2] Cosma Rohilla Shalizi and Andrew C Thomas. Homophily and contagion are generically confounded in observational social network studies. *Sociological methods & research*, 40(2):211–239, 2011.

[3] Duncan J Watts. *Everything is obvious:* Once you know the answer*. Crown Business, 2011.

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