Revisiting the Limitations of Weak Ties: Comparing and Contrasting Aral and Van Alstyne (2011) and Larson (2017)

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Aral and Van Alstyne (2011) presents a groundbreaking formalization and test of the limitations of weak ties. The article considers settings of distributed information and shows that, contrary to long-held conventional wisdom, weak ties may not be the best means of quickly acquiring a large, diverse set of pieces of information. Larson (2017) offers a different formalization in a different context to identify the limitations of weak ties for spreading one piece of unexpected news widely throughout a group.

Both articles begin with the premise that weak ties may be lower capacity for information, and both share the broad conclusion that weak ties can pose problems for the ultimate spread of information within social networks. The articles differ in *what* problems are identified and *why* the problems arise. Larson (2017) was published without engaging with Aral and Van Alstyne (2011), and Larson (2017) uses some terms that were used in Aral and Van Alstyne (2011) differently. This piece aims to clarify the distinct but complementary contributions of both articles.

Common Starting Point

Both Aral and Van Alstyne (2011) and Larson (2017) start from an observation that can be traced back to Granovetter (1977): weak ties may spread information more poorly than strong ties. Because weak ties indicate relationships that are less intimate, or based on interactions that are less frequent, or founded on less trust, or connect more socially distant people, those ties may be "lower bandwidth" (in the language of Aral and Van Alstyne (2011)[1]) or "lower capacity" (in the language of Larson (2017)[2]).

Different Notions of Successful Information Spread

In Aral and Van Alstyne (2011), information is conceptualized as a set of different individual information bits. Social ties transmit information in the sense that a tie can share these bits from

[1] In Aral and Van Alstyne (2011), information is conceptualized as discrete bits. Bandwidth determines the number of bits that a tie can transmit, so that higher bandwidth ties transmit a greater number of bits.

[2] In Larson (2017), there is one relevant piece of news that can be sent or not. The capacity of a tie is the probability that, given an opportunity to do so, the sender sends information to a receiver. A higher capacity tie is one that transmits the information with greater probability.

one person to another. The question becomes: how does the lower bandwidth of weak ties affect a node's access to a large number of different bits quickly? In the words of Aral and Van Alstyne (2011), the outcome of interest is nodes receiving "more diverse information and more total non-redundant information" (p. 92).

Larson (2017) conceptualizes information spread differently. Information is a single bit– one news item, say. Social ties transmit information in the sense that a tie can share this bit from one person to another. The question becomes: does the lower capacity of weak ties affect the number of people who receive the news in some window of time, and would adding more weak ties help or hurt? The outcome of interest is the number of nodes who are informed.

Different Contexts

The differences in information transmission outcomes of interest stem from the subtly different contexts that both articles aim to capture. Aral and Van Alstyne (2011), working in the sociological tradition, considers circumstances in which bits of information are distributed among a group of people in some way, and greater access to a large, non-redundant set of that information is desirable. This may describe, for instance, a group of people in a firm tasked with producing something that requires substantially distributed knowledge, or members of a community who need jobs and are looking for tips about openings.

Although the information that any one person seeks may be freely offered by someone who knows it, we can think of these circumstances as (at least possibly) demand-driven. Those who are lacking some bits of information know they lack them and seek out opportunities to gain them. Information that is novel is of interest, where "novelty" means information that is locally scarce and so unlikely to be redundant with one's own set of information bits. Novelty in this sense is of interest because the diversity of information being used tends to be positively associated with performance or success in contexts of distributed knowledge.

In contrast, Larson (2017), working in the political science tradition, considers circumstances in which one bit of information, previously unknown to everyone, is spread from a source to others in a group. This could be, for instance, news that a foreign NGO has just arrived to sign community members up for a beneficial program, or news that anti-government rebels have just begun training exercises in the nearby countryside.

The circumstances within the scope of this work are those that are necessarily supply-driven. Those who are lacking the bit of information do not know they are lacking something and do not seek out opportunities to gain it. Instead, the onus is on those who hold the new bit of information to seek out others to pass it to or not. This work is about novel information in a different sense. "Novelty" means initial brand newness to everyone and a substantial departure from the ordinary. The model assumptions were made to capture this sense of novelty, which is of interest because the extent to which novel information has saturated a group affects a group's behavior in response– whether people participate in the NGO's program, whether people take up arms to join the rebels, and so on.

Different Models

Because both articles have different contexts in mind, they use different models to represent information transmission. Both models demonstrate that weak ties have downsides that stem from their assumed lower bandwidth/ capacity. In Aral and Van Alstyne (2011), the model shows that weak ties do not necessarily provide the best access to a diverse set of information– there are plausible conditions under which strong ties actually provide a person with a more diverse set of non-redundant information (one sense of "novelty") than weak ties do. In Larson (2017), the model shows that there are conditions under which new weak ties can be added to a network, and even though there is a strictly larger number of ties as a result, the brand new, unusual information (the other sense of "novelty") winds up reaching fewer people.

The results of the two models are compatible with one another– they simply point out two different downsides to weak ties that follow from an assumption of lower bandwidth/capacity.

The model in Aral and Van Alstyne (2011) views information transmission as a discrete sampling process. There is a set of information bits available in the universe. These information bits have an initial distribution throughout the network. Network ties provide access to others' bits, and some ties provide more access than others. The higher the bandwidth of the tie, the more access provided, modeled as a greater number of random draws without replacement of the other's information bits. A node with a high bandwidth tie to another gets to receive more information from the other than if the node instead had a low bandwidth tie to the other.

Comparative statics are presented with respect to three parameters that capture a wide range of interesting possible information environments: the extent to which information bits are spread out throughout the network (i.e. the extent to which information sets overlap), the number of total information bits in the universe, and the rate at which new information bits are added to the universe. Weak ties are less helpful for obtaining a large set of non-redundant information bits quickly when the original information overlap is high, when the total number of information bits is large, and when the rate of change is high.

Even when information bits are initially distributed in a way that should make weak ties most valuable– so that weak ties connect people with very different initial information sets– it can still be the case that the strong ties are contributing to gathering a large set of non-redundant information bits more quickly. Although weak ties in principle give access to different information, their lower bandwidth means that a person may learn that different information more quickly (maybe second- or third-hand) through their high bandwidth strong ties.

The model in Larson (2017) considers only one piece of information, originating with a single source. This one piece of information is novel in the sense that those who do not know it do not know they don't know it, and so are not seeking it out. Here too, network ties provide access to others' information, but with two caveats. The first is that, as in Aral and Van Alstyne (2011), weak ties have a lower capacity. Lower capacity here is captured by the probability of the information being sent across the link given an opportunity to do so: the probability that it is transmitted across a strong tie is higher than the probability of transmission across a weak tie.[3] The second caveat more starkly differentiates the two models: in Larson (2017), the presence of a tie does not guarantee an opportunity for transmission. The model accounts for constraints in a sender's time and opportunities to pass the information along. Each person has only a finite number of opportunities to encounter a network tie and then roll the dice to determine whether information is in fact spread. A person with five ties may have only two opportunities to pass information to any tie while it is still salient, and so only two of her five peers have any chance of hearing it from her.

The differences in the models mirror the differences in the contexts being captured. In Aral and Van Alstyne (2011), the interest is in the ultimate distribution of multiple different pieces of information in settings in which those who could use the information know to ask for it. They take samples according to the bandwidth of their ties, which results in information sets of a certain level of diversity. In Larson (2017), the interest is in the reach of one piece of information in settings in which those who do not already have the information do not know to ask for it. Those in the know spread it to as many of their ties as time allows, with more successful transmission across the strong ties.

Different Conclusions about Information Spread

The different models produce different but compatible results. The model in Aral and Van Alstyne (2011) shows that there are plausible circumstances in which strong ties provide more rapid access to a diverse set of information than weak ties do due to the differences in bandwidth, and the extent of the advantage of strong ties varies based on features of the information environment: information overlap, the total number of information bits, and rate of creation of new information bits. Moreover, it reveals a tradeoff between the extent to which a network is structurally diverse and the rate at which nodes within it would receive novel information. One implication is that networks with stronger ties would spread all bits of information more quickly.

The model in Larson (2017) shows the analogous result in a different information environment, one that is supply-driven and concerned with a single novel piece of information that only one person has at the start. Here too, networks with stronger ties would spread the information through the network more quickly. It also reveals a stronger result particular to its information environment: it is possible to add a new tie to a network (keeping all previously existing ties as well) and strictly *reduce* the rate at which information spreads through it. That is, one could take a network, add a handful of weak ties to it without deleting or replacing any existing ties, and make information spread strictly worse.

This surprising result stems from the assumption of limited opportunities. The fact that each person will only attempt to spread information to a fixed number of others, possibly less than their total number of neighbors, creates a crowding-out effect. Adding a weak tie to a person's neighborhood increases the number of others to whom she may have the opportunity to pass information,

[3]The only important difference between bandwidth, which captures the number of bits that are transmitted, and capacity, which captures the probability of transmission, is that the latter allows the possibility that even positive capacity links fail to transmit information in any one opportunity. This possibility can aggregate into large differences between weak and strong ties since Larson (2017) models a diffusion process.

which weakly (and often strictly) increases the chances that her opportunity will be with a weak tie, to whom information passes with lower probability.[4]

The Complementarity of the Different Findings

Taken together, the results of Aral and Van Alstyne (2011) and Larson (2017) demonstrate the weakness of weak ties in a variety of different information environments. In tandem, they suggest interesting advice, policy implications, and areas for future research.

An important takeaway from Aral and Van Alstyne (2011) is that when the goal is to aggregate as many different pieces of information as possible that are held by lots of potential sources, turning to one's weak ties may not actually be best, even when they know different things. One's strong ties may be the resource that helps fill out a maximally diverse portfolio of information quickly. An additional takeaway of Larson (2017) is that if time is constrained and one must make choices over whom to pass information to because time spent telling one person cuts into the time necessary to tell someone else, the presence of weak ties may hold up the process, and the *addition* of weak ties may impede the process even further. A variety of policies aim to forge admittedly shallow ties between otherwise socially distant people (for instance, conflict reduction programs) on the grounds that weak ties are better than no ties at all. Weak ties may in fact be worse than no ties at all. Moving forward, it would be useful to know whether a crowding-out effect like that found in Larson (2017) can be present in information environments like those considered in Aral and Van Alstyne (2011) in which aggregating distributed information is the goal.

References

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[4]Considered in the context of the executive recruiter data in Aral and Van Alstyne (2011), this effect would be present if a recruiter adds a new weak tie, and the new relationship takes up some of his time so that he has less time to devote to the requests of his strong ties.