Examining the role of "Place" in Twitter Networks through the Lens of Contentious Politics

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Abstract

From Tehran Square to Gezi Park, Twitter is an emergent tactic of protestors in the public square. Our work utilizes the theoretical framework of contentious politics and its human geographic extension as a framework for examining the role of "place" in Twitter-based networks of resistance. We examine Twitter traffic about local instantiations of Occupy Wall Street across eight cities. The study addresses mutual communications between Twitter participants in hashtags related to each of these local instantiations.

This work explores the role of place as a constitutive component of these networks. To do so, we employ descriptive statistical and chi-square tests to examine the significance of user-defined metadata regarding place to the exchanges between users within a network. We conclude that place matters and point to future directions in computational and traditional qualitative analysis, spatial-temporal studies of social media, and the effects of locational propinquity for network development.

1. Introduction

Social media are capturing the popular imagination as a new communicative tactic utilized for public protest. Beginning with Tunisia in the Arab Spring of 2011, and followed by the Spanish *indignados*, Occupy Wall Street, [18] and now protests trending in Turkey as #direngezi and #occupygezi, Twitter has been one of many tools in protesters' repertoire of contention, or the toolkit of strategies and tactics used for resistance [56]. Folks resist unjust distribution of power and resources through a show of solidarity in public squares, which can be rendered visible in Cartesian space through maps, as well as the relational public squares of digital interaction. Simply, social media are of increasing importance to the ways in which oppression can be challenged and thus worthy of careful interdisciplinary consideration.

The Occupy protests are one example of activists utilizing Twitter to mobilize, motivate, and acquire resources. However, Occupy is geographically grounded in a way that most Twitter topics are not. The evidence for this could be seen in the occupations of public spaces in major urban centers from mi-September to the end of December, 2001. Following Twitter in the context of occupy then likely offers uniquely geographic insights about the use of social media within social movements as a way of diffusing information.

Our work contributes to ongoing conversations in geography, sociology, and information science regarding the role of social media in contentious politics. We use multiple lenses of SNA modeling and McAdam et al's theoretical framework [43] later extended by human geographers [34,35,38] to make the following contributions: 1) an empirical demonstration of the relevance of Cartesian location to understanding digital communication and interaction; and 2) an approach for studying contentious politics, their use of public expressions through social media, and the emergence of place-based networks of resistance.

Place, conceptually, is not *location* or *space*. Place and its conceptualization is the subject of decades of work in human geography [4,41,59], and as such, a full treatment of what place entails is outside the scope of this work. However, we take place to mean "the bounded setting in which social relations and identity are constituted" as "recognized geographical entities or more informally organized sites of intersecting social relations, meanings, and collective memory" [26]. More simply, *place* is not just Cartesian location, but the socio-historical construction of contested spaces [29]. Thus geography is more than just "where a person is," but includes one's relationship to and identification with the geographic spaces, cities, neighborhoods, and communities in which we live.

Geographic information need not be limited to strictly location either. In his seminal reflections regarding the beginning of geographic information

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science, Goodchild reminds us that geographic information need not be strictly composed of merely latitude and longitude coordinates and topological relationships [21]. That is, geographic *information* is at the root of inquiry, and not merely what today's *information systems* are capable of analyzing. Perhaps most importantly, we don't think of place as a location precise to 3 meters, but in relation to the cities, neighborhoods, and communities in which we live.

The "geography" of Twitter is inexplicably over reliant on a Cartesian conception of *space,* despite glaring challenges to using this approach with social media data. Latitude/longitude coordinate metadata, or "geotags," are notoriously unreliable. The spatial accuracy of these data is variable and difficult to compare; some use low-accuracy consumer-grade GPS units in smartphones, while other coordinates are dervived from cell-phone tower triangulation [17,36]. Simply put, folks aren't necessarily "where" we think they are to the 6 decimal degrees of accuracy (roughly 1/9 meter) provided in the geotag. Moreover, the number of people that provide geotagged metadata are relatively few, ranging between 1 and 2%, with our own data containing geotags in roughly 0.5% of tweets. And while no empirical study exists that confirms that all demographics of people are equally likely to geotag tweets, we have many empirical studies of user-generated data that seem to mirror existing inequality [13,22,36,62]. It therefore seems unlikely that geotagging is a strictly egalitarian practice. Due to these limitations, studies of location are insufficient for defining what a "geography of social media" might be.

Unfortunately, socio-historical construction is not a metadata field in Twitter data. However, users are given the opportunity to identify their location in a free form text field on their user profiles. A review of the many ways in which users use this field [24] suggests to us that users are not identifying with a Cartesian location, but instead self-identifying with this notion of place. We likewise understand identity to be a component of claims made during contentious politics [42]. We argue that this identity of place is a compelling conceptualization of "geography" for network theorists.

Our methodology advances understandings of place within social media as existing beyond metadata containing latitude/longitude coordinates. We add place to the repertoire of factors within social network analysis, and suggest future work to introduce place-based context into future models.

We argue that place is an integral part of the process of contentious politics as illustrated through our analysis of Occupy Wall Street communicative networks. To show this, we first engage McAdam, Tilly, & Tarrow's theoretical framework of contentious politics [43]. Geographers extend this framework further, abandoning the state as the sole focus of opposition and calling for relational networks to be considered as another mode of spatial understanding. [35]. We then turn to the research program of social network analysis, and its focus on relational interaction between actors, to provide background for our methodological decisions [60]. We use these results as empirical evidence of place's role in bridging communicative interactions between individuals. This points to exciting opportunities for studies of organizational formation, political participation, social network analysis, and geography's role in the increasingly blurry interplay between the digital and urban.

2. Literature

We are informed by three literatures that we understand as conceptually overlapping: contentious politics, human geography, and social network analysis. We use theories that pair these literatures with one another to illustrate an empirical gap at the intersection of the three when taken as a whole. Place, contentious politics, and social network analysis can be used in conjunction to understand communication, interaction, and place-based networks of resistance.

2.1. Changing Geographies of Contentious Politics

The theoretical framework of contentious politics [42,43,55,56,57,58] is ideal for analyzing Occupy Wall Street through a hybrid collaborative lens that blends the work of geographers with that of social network analysis. McAdam, Tilly, and Tarrow introduce contentious politics as "the public, collective, and episodic interactions between makers of claims when a) at least some of the interaction adopts non-institutional forms, b) at least one government is a claimant, an object of claims, or a party to the claims, and c) the claims would, if realized, affect the interests of at least one of the claimants" [43:7]. The interactions of Occupy Wall Street were non-institutional, both in sites of physical protest as well as digital interactions through social media such as Twitter. For example, protestors both led marches across Zucotti Park as well as participated in the information exchanges contained by the #ows hashtag on Twitter. The United States was one governmental claimant, held partly responsible for the banking-led financial collapse of 2008. And despite the variety of proposed solutions from occupiers, those claims would

almost certainly affect the interests of a variety of actors at a global level.

Contentious politics offers additional value as a framework particular to research of Occupy Wall Street for its rejection of the "social movement" as a unit of analysis. Consider the "civil rights movement" as a social movement, with clear goals and a largely unified set of claims against oppression. In contrast, claiming oneself as an occupier required little more than self-identification. Also, Occupy lacked formal demands or organizational leadership. Contentious politics as a framework is germane for its separation of resistance from these more formally structured social movements, allowing for the consideration of multiple resistances sometimes held in tension with one another. No unified message is required for resistance, but instead consists of multiple negotiations between and within groups of participants.

Geographers' literary work extends framing of contentious politics to include consideration of the spatial dimension, and thus useful to our understanding of an urban-political phenomenon such as Occupy Wall Street. Geographers have illustrated resistance across a number of spatial registers, including comparison of activism across global and local scales [31,40], neighborhood or community-based organizing [15,16,40], place-framing (using contexts of place as communicative framing) [39], and institutional hierarchies [35,38]. Place is an important component to processes of resistance.

The tactics used by Occupy Wall Street are adapted from a number of processes that occur across several spatial scales. The art of occupation is drawn from international resistances, such as those in Tehran and Spain; Occupy Wall Street as a concept is both a national phenomenon and locally instantiated in Zucotti Square of New York; and the local occupations that sprung up in response are uniquely influenced by the places in which they arose. Thus, Occupy Wall Street wasn't merely a movement, but a series of resistances at once both hyper-local and international.

Leitner et. al [35] (-) make two other important interventions relevant to our case study of the Occupy Wall Street communicative Twitter networks through a lens of contentious politics: the divorce of contentious politics from claims against the state, and the call to consider multiple spatialities beyond an oft-ambiguous reference to scale [35].

We favor Leitner et. al's redefinition of contentious politics for its ability to allow the consideration of non-state centric resistance. They write, "Contentious politics refers to concerted, counter-hegemonic social and political action, in which differently positioned participants come together to challenge dominant systems of authority, in order to promote and enact alternative imaginaries" [35:157]. This allows us to consider resistances directed toward powers that are not state-centric. Not every Occupier was directly upset with the state per se, instead directing anger at the financial sector or other rich elite perceived as being above apparati of state. Thus we consider this extension useful for considering the multiple ways in which protestors challenged different dimensions of power.

Leitner et. al's second intervention, the emphasis on a move away from scale as the sole arbiter of what makes contentious politics "spatial" [35], enables us to consider communicative networks as also constitutive of place-based contentious politics. Following an extended debate on the role of scale within geographic literature (e.g., [34,37]), Leitner et. al called for the consideration of multiple spatialities within contentious politics. They specifically calls our attention to the role of networks within contentious politics [35] at time where researchers outside of geography are pointing to technology's role in constructing social structures that can be described by way of networks [7,33]. Thus Twitter-exchanges mark a particular bounding of the Occupy Wall Street activities that allow us leverage a framework of contentious politics using these communicative, placed networks.

The newest literatures that engage with contentious politics examine the ways in which networks are spatiality co-implicated with resistance. Geographers are just beginning to grapple with networks in relation to contentious politics, much in the same way that they grappled with scale in relation to contentious politics. The newest extensions of literature along these lines encourage us to examine these relational network dynamics as they relate to place-framing [50], power formation [48], and protest [8].

2.2. Social Network Analysis

Social network analysis (SNA) is a set of concepts and techniques that support the conceptualization, measurement and analysis of social structures emerging out of the interactions of social actors [6,60]. SNA models can help us understand how social distance between actors is related to the degree to which those actors exhibit similar behavior [10], how contextual environment such as geographic propinquity and being in the same organization support the formation of homophilous relations [44], and how the type of the relationship that actors share influences how likely they are to share novel information [23] as well as how the type of connection is related to influencing behavior [3,5,20].

Certeau argues that the unfolding of a city's being is the result of multiple, banal interactions that come

about as a result of "everyday living" [9] -- much like the interactions that SNA scholars seek to uncover through their quantitative models. Twitter is an aspect of everyday living that enables these connections as an unfolding of existing networks and the creation of new, novel interactions.

2.3. Twitter Research

Thus it is not surprising that Twitter has been gaining traction as an object of research across the literatures of studies of resistance, social network analysis, and human geography. Those that research political resistance suggest that Twitter is a tactic of growing importance to modern modes of contentious politics. Social network analysts utilize Twitter data as a source of data regarding folks' online interactions and use statistical models to explore this social behavior. Nascent research in a geographic direction leans heavily on Cartesian representations of phenomena using geotags, or latitude/longitude coordinates attached to metadata. While these approaches suggest that place remains relevant in digital interactions, human geographers are pressing the field to move "beyond the geotag" [12] to examine representations of place that are not precisely mappable.

The networked nature of protest [8] is alive and well on Twitter. Mainstream media lauded the role of Twitter in the "Arab Spring" revolutions earlier in 2011 [25,27]. The paper by González-Bailón et al. speak to the ways protestors are recruited through online networks and the ways in which networks become rewired through information transmission [20], and Gerbaudo examines Twitter activity across the Arab Spring, the work of the Spanish indignados, and even Occupy Wall Street more broadly [18]. Twitter plays an important role in the development and deployment of networked protest activity, though as Gerbaudo notes, it also greatly overshadows the work of more traditional protest in popular media [18]. And a preliminary exploration of Occupy Wall Street data suggests that protestors used Twitter to share news, information, and wishes of Solidarity to protestors within Occupy Wall Street [46].

SNA techniques have been employed on Twitter data to uncover social interactions. Kawk et al. provide descriptive statistics of the *explicit* network of Twitter followers (as declared in user's lists of who they follow) and made an entire 41.7 million user network available online [32]. However, there are alternatives ways to measure network effects using Twitter data. For example, Wu et al. examine who listens to who on Twitter by looking at user's *lists*, which is a feature that allows users to filter Tweets based on groups of users they follow [61]. More relevant to our own work, Conover et al. construct a Twitter communication network from users who mention each other in tweet text [11].

To date, research within geography treats Twitter as an instantiation of the "geoweb" or "geospatial web" [51]. This is a broader rubric that posits the geoweb as web 2.0-styled user generated content that contains locational metadata, most often in the form of geotags. Theorizations of the geoweb have touched on many digitally locational phenomena. For example, a study of Google Maps placemarks following Hurricane Katrina reveals deeply inscribed structural inequalities that echoed spatial distributions of race [13]. Unevenly distributed spatial representations are also observed in a study of Wikipedian editors who largely write from places in the global north about places in the global south [22], suggesting that digital representations will likely always reproduce existing arrangements of inequality, such as race, class, and neocolonialism.

In geographically styled studies of Twitter more specifically, a reliance on latitude/longitude coordinate metadata is the norm. This is still relatively nascent in human geography. Tweets have been used to correlate topic models with the location of fast food establishments [19], observed as reproductions of existing spatial, temporal, and socioeconomic patterns [36], or mapping the multiple interpretations of Syria with respect to place [52]. Outside of geography's disciplinary silo lies a network analysis that suggests Twitter @-mention networks are best modeled against airplane traffic data [54]. This work is further expanded by geographers examining triadic network structures, relating geographic distance to the strong and weak ties posited by Grannovetter [23,53].

Sadly, these studies all rely on Cartesian locational metadata that fall short of considering an individual's relational association with place. Crampton et. al forcefully call scholars of the geoweb to move "beyond the geotag" and consider the myriad of other ways that place is represented within the geoweb and social media more broadly [12]. We know that geotags are often presented as more precise than what careful study reveals. The geographic accuracy of those coordinates varies widely, according to the method used to obtain them, from an accuracy of several meters for GPS and up to several thousand for triangulation via a cellular network [36]. Moreover, places derived from IP lookup are only as accurate as the databases from which they pull data [36]. And geotagged posts are hardly representative of Twitter traffic as a whole, only representing between 1-2% of all tweets at a given time.

Considering place rather than location within social media is thus necessarily more than the simple

geotagging of a location. The folks involved in the #occupyseattle hashtag aren't necessarily in Seattle, but are interested in the activities taking place there [36]. Likewise, folks that claim Seattle in a user-defined field for designating location may be actually in Seattle, or (as an example) may only hold Seattle in their hearts as their hometown. The geographic imaginary of place and our relationship to it is often different than our geographic coordinates.

We therefore identify an empirical gap at the theoretical intersection of human geography, social network analysis, and contentious politics, through which we contribute further understanding of network formation with relation to place and resistance. While we have many studies that consider Twitter networks in relation to location (CITE), studies that link networks and social movements together in geography (CITE), and studies that study communicative exchange networks (CITE), no empirical work has yet studies the role of *place* rather than *location* in network formation, addressing some of the limitations in previous work on the geographies of Twitter exchanges. We begin to fill this gap through an initial exploration guided by the following questions:

1) What is the relationship between users' identification with place and their linking patterns in networks of contention within those places? Is the difference between the frequencies of people that link to another while sharing a place-identity and the frequency of people that do not a significant one?

2) While the first question may seem obvious, this paper will show that the same answer does not hold true for all communication-based networks. What can the descriptive differences in network structure in these data suggest as possible future directions for place-based rather than location-based Twitter research?

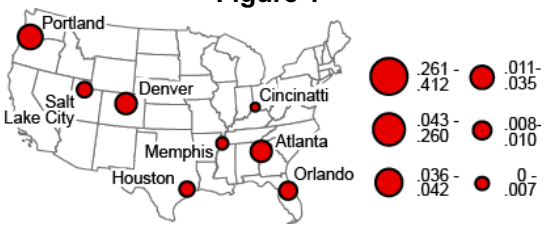
3. Methods

We employ statistical techniques in this exploratory study in order to examine the relationship between a user's self-represented place and network formation. In the context of this study, network formation is represented by users' communication behavior on Twitter, within the context of the Occupy movement. We provide descriptive statistics of user's linking behavior and employ a Chi-squared test to examine the significance of the differences we observe. Further, we calculate various network descriptive measures in an effort to tease out how they may be related to this observed linking behavior.

3.2. Network Construction and Analysis

We explore linking behavior in 8 separate place-based Twitter communication networks, each limited to tweets with one of these hashtags: #OccupyCincinnati, #OccupyAtlanta, #OccupyDenver, #OccupyMemphis, #OccupyHouston, #OccupySLC, #OccupyOrlando, and #OccupyPortland. So for tweets to be included in our Denver network, they must contain the hashtag #OccupyDenver. These Occupy cities were selected with the intention of representing varied network sizes and geographic location to increase reliability. A map displaying the ratio of tweets within a hashtag to the total tweets within the dataset is seen in Figure 1.

Figure 1



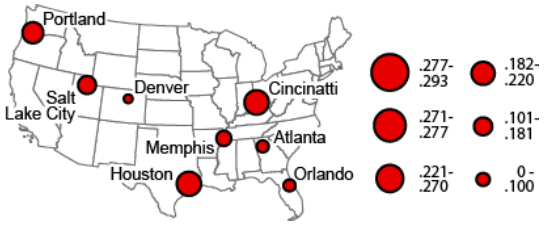
Ratio of Tweets within a given occupy hashtag to the total tweets within the entire dataset.

Each network is further bound by only including tweets that contain an *@-mention*. An @-mention is a feature of the Twitter platform alerts another user by placing an @ in front of the user handle in the text of the tweet.@-mentions also occur when a user "retweets," or shares, another user's tweets. The text of such a tweet automatically is prepended with "RT," followed by the @-mention of the user whose tweet is being shared.

By taking a @-mention as a signal of communication between user accounts, we use tweets as communication trace data that form the links, or arcs, between users. This is known as an "arc sample method," which takes *relations* rather than nodes as the sample for analysis [6]. @-mention communication networks have been constructively employed to study political polarization within Twitter [11].

When we construct the networks, all nodes are given an attribute labeled *in-place*. Our network construction algorithm reads the tweet's metadata field for the user's profile-listed place. If this matches the network city name (e.g. Denver), based on a case insensitive regular expression match, the in-place attribute for that user is set to true (see the data section for more detail about Twitter's metadata). A map displaying the ratio of tweets deemed to be "in place" to the total tweets within a given hashtag is seen in Figure 2.

Figure 2



Ratio of Tweets deemed "in place" to total tweets.

In order to bound our networks to communicative interactions, we remove users (and their links) who do not have at least one in-coming link (they were @-mentioned) and one out-going link (they @-mentioned someone). This narrows the network to those individuals engaging with one another and helps reduce (but not eliminate) broadcast-style spam in the datasets.

The final network for each place is computed as a matrix that captures the direction of the communication (e.g., that A may @-mention B even if B does not reciprocate) as well as the frequency of these dyadic interactions. From each of these networks we calculate attributes of the networks, reported in table 3, and derive a contingency table of in-place linking (@-mentioning) behavior.

Each contingency table is a 2 x 2 matrix where the rows represent links *from* users (either those identified as in-place or those not identified as in-place), and the columns represent the target users (who are identified as in-place or those not identified as in-place). The cells contain the number of times users who are in-place (or not) @-mentioned other users who are in-place (or not). To test the significance of differences observed in these tables we employ a chi-square test [49].

3.1. Data

Using Twitter's streaming application programming interface (API) we continuously collected tweets related to Occupy Wall Street from October 19th, 2011 to November 19th, 2011. Twitter's streaming API returns tweets where a given search term(s) occurs in the text, hashtags, @-mentions, or URLs within a tweet. Also, the data returned includes rich metadata, including items such the time when tweet was sent, the number of a user's followers, and the location the user sets in their profile, among others.

Twitter offers three pieces of locational metadata with each tweet, provided the user has provided that information. "Location" refers to a latitude/longitude pairing of coordinates (a "geotag"). Location is gathered via two methods here: either cell phone tower triangulation, or through GPS. As such, accuracy is variable and estimates put it somewhere between X and Y [36]. "Place" (here an attribute rather than the theoretical concept) can be derived in one of two ways. The first is when a user has GPS or cell phone triangulation engaged, but has the security settings on their account tuned to disallow direct lat/long coordinates. The coordinates are evaluated and if they are found to be within a city bounding polygon (as defined by Twitter and not the city) then place is set to match the name attribute of that polygon. This is reported in the metadata at the level of city, state, or nation depending on the user's security settings. The second way place can be reported in the metadata is if a user reports place from a non-geo-enabled device, the IP address is compared against a geoIP database, and matches are assigned a city. Both of these methods of designating place have issues of validity that frequently go unaddressed in studies of geolocation [36]. Notwithstanding these issues, "location" and "place" is only available as metadata for 2-4% of all twitter data, thus the need to move "beyond the geotag" [12].

We have elected instead to go with the "user_defined" place feature as a piece of user-defined metadata associated with the user profile rather than the tweet. Of course, this isn't necessarily an accurate representation of place either [53]. However, we do have a set of place-based hashtags that represent each given occupy location with which to triangulate these user definitions. We therefore identify users as "in place" when their user-defined place matched the place-based hashtags. So for #occupydenver, if the user profile contained "denver" anywhere within it, that user would be "in place".

This is not a perfect approach. For instance, people who lived in one location when they began their account and moved to another may not be found to be in place. Likewise, the graduate student in a city other than her hometown may still be extremely active in the #occupy activity of her hometown, thus represent her location as her hometown, yet live elsewhere. For our work this is more than acceptable. We are not so much interested in an actual Cartesian location, but a relative identification with a place. The user's activities tied to their affective relationship to place remain relevant in the process of that city's network forming. Thus, our approach is preferred over a Cartesian location since the Cartesian location doesn't necessarily determine whether or not a user has relational ties to a location (such as a strong sense of loyalty to a hometown's baseball team or friends left behind for a graduate program). As we're interested in the development of the digital as a relational space, it makes less sense to use a geotag than a user-defined field.

In cases where users tweeted more than once, the listed place may change over the course of the event. In these cases we included users as in place if they

matched once. Finally, it is worth noting that users sometimes use slang for their location; e.g. "mile high city" for Denver. In future work we intend to expand our matching criteria for place.

Table 3 provides descriptive information about each of our eight networks. The first section lists the total tweets, users and @-mentions in the raw, pre-network construction dataset. The *Network Users* section of the table lists the number of users in each constructed network, the number and percent of users who are in-place (IP) for that network.

The section related to links contains information about the links for a given network. The frequency of @-mentions within a network (Mentions) and how many of those mentions are in-place (IP Mentions) are shown. Also, frequencies that users in-place mention other users in-place (IP-IP), users in-place mention other users out-of-place (IP-OP), and frequencies of other possible directional link configurations (OP-IP and OP-OP). We also show the ratio of IP-IP mentions to the total of @-mentions from IP users. Since a user can @-mention someone more than once, the frequency of links may include multiple @-mentions, and thus is weighted in the network matrix by the frequency of times user A mentions user B.

Table 2

	Cincinnati	Memphis	Salt Lake	Houston	Orlando	Atlanta	Denver	Portland
Raw Data								
Tweets	1124	1864	5937	6114	7407	33773	52655	85629
Users	560	814	2027	1700	2148	11897	12715	17644
@	601	1227	4629	4268	4799	24611	40457	62425
Network Users								
Nodes	58	86	275	353	293	1671	2170	3437
IP	17	19	80	64	79	292	219	953
IP%	*29%*	*22%*	*27%*	*29%*	*18%*	*17%*	*10%*	*27%*
Network Links (weighted) / @-mentions								
Links	60	205	1191	1410	1241	6294	14326	26092
Mentions	90	354	2852	3068	2643	9910	23487	45432
IP Mentions	45	146	1731	1099	1018	2206	6429	18162
IP-IP	36	103	1267	605	456	1331	3016	9977
IP-Out	9	43	464	494	562	875	3413	8185
IP-IP ratio	.8	.705	.732	.551	.448	.603	.469	.549
Out-IP	15	129	795	921	772	3416	5536	10862
Out-Out	30	79	326	1048	853	4288	11522	16408
Network Measures								
Diameter	6	35	17	15	23	23	26	46
Density	.018	.028	.015	.016	.011	.002	.003	.002
Degree	.070	.137	.544	.404	.173	.104	.307	.234
Authority	0	0	.012	.004	.002	0	0	0
Hub	0	.0025	.0028	.0008	.0026	.0006	.0006	.0011
Assort	.4531	.0904	-.013	.0622	.0141	.1369	.0901	.1601

The last section of the table contains a sample of the network measures we investigated for this study. The first, diameter is a measure of the minimum path between two nodes deemed to be farthest apart in the network, while the density is the ratio of links to the total possible links for the network. The metric for the number of links, in this case out-going links, is listed as *degree*. For *authority* and *hub* we draw on Kleinberg [28]. Hub nodes tend to receive many links from many sources but send links to relatively fewer sources. Authorities can thus be identified by being the recipients of links from hubs.

These algorithms calculate scores for each node, which we then report as the median value for a network-level characteristic.

The last entry in the table is *assortativity*. This provides a network level measurement of the tendency of nodes to link to similar nodes, based on a given node-level attribute [47], for which we've selected the in-place variable. The assortative measure is analogous to a correlation in that it gives direction and strength of the effect with 1 (-1) indicating perfect assortative (non- assortative) mixing patterns.

4. Findings

Table 4 adds p-values for the chi-squared test in addition to values reported in the methods section. Networks where the p-value was significant are in italic-bold face. Our chi-square test was significant for 5 of 8 of our networks: Cincinnati, Houston, Atlanta, Denver and Portland. This indicates that the differences we observe in linking behavior in these networks is significant and can be interpreted.

Thus, for Cincinnati, Houston, Atlanta and Portland we find that people who are in-place will tend to link to others who identify as in-place more frequently than they do with people out of place. Interestingly, in Denver we can interpret the linking behavior to indicate that those using the hashtag #OccupyDenver have tended to link more frequently to those not identifying as in-place.

Table 3

	Cincinnati	Memphis	Salt Lake	***Houston***	Orlando	***Atlanta***	***Denver***	***Portland***
Ratio IP-IP / (IP-IP and IP-OP)								
IP-IP ratio	***.8***	.705	.732	***.551***	.448	***.603***	***.469***	***.549***
Chi-Square p-value								
p-value	***0***	.121	.120	***0***	.186	***0***	***0***	***0***
Network Measures								
Hub	***0***	.0025	.0028	***.0008***	.0026	***.0006***	***.0006***	***.0011***
Assort	***.4531***	.0904	-.013	***.0622***	.0141	***.1369***	***.0901***	***.1601***

With respect to the networks with no significant difference in linking behavior, we find some interesting patterns. In general, the assortative measure is smaller for the non-significant networks, while hub score tends higher for these networks.

Recall that for the hub measurement we take the median score of the nodes in the network. The higher median for the non-significant networks indicates that more of the actors in the networks are acting as hubs and linking to authoritative sources within the networks.

Note that other measures we explored did not suggest a relationship with

5. Discussion

To relate this back to the theory of contentious politics, self-identified place is a constituent component in some of our networks of resistance. We note that of the 5 networks where we could detect a significant difference in linking behavior, 4 exhibited ratios supporting the assertion that place is a constituent component in our networks.

The degree to which place matters differs among our city-based networks, as can be seen by the differing ratios of in-place to in-place linking behavior (table 3). This suggests that any number of other factors could be at play in the construction of these networks. For example, Denver may be more internet and security savvy than our other locations, and thus may under-report being in-place. Alternately, Denver may have made concerted efforts to reach outside of their venues, or taken a central role in a network of cities. The result would be that we would have a disproportionately large number of #OccupyDenver tweets from occupiers of different places.

We also found that hub scores were higher in those networks where our chi square tests were not significant. In these networks, we may be seeing many in-place users re-tweeting or otherwise @-mentioning prominent or authoritative sources outside of the place-based network. Due to the heterogeneity of the actors and claims made related to Occupy, we would expect low hub scores from these "leaderless" organizations as communication is exchanged across interests.. We suggest that high hub scores in the insignificant networks may indicate a lack of diversity of interest of viewpoints in a given network. Evaluating the qualitative components of these tweets using topic modeling might offer support for this suggestion.

Adequately examining the role of place in these networks of contention will require employing models that allow us to control for other factors. Network variance models such as multiple regression quadratic assignment procedure (MR-QAP) [14,30] could be useful except that they are not robust for data with outliers. Outliers exist in each of our networks but removing them is an unappealing option since power-law distributions are frequently observed in many social networks [1,2]. The outliers in our networks are likely influential users. Removing these users may lead to a model with better fit, but would also bias the findings in failing to include key users in the network. Thus in future work we will explore the use of exponential-family random graph models (ERGM) [45], which may allow us to control for various factors while maintaining robustness in the face of power-law distributed data.

We suggest that seeking further contextual qualities of place would lead to a more robust model. Other modes of inquiry will be needed to ascertain the processes through which place asserts itself in contentious politics, but our work provides evidence to justify further work in this area. We suggest mixed methods approaches, including computational topic modeling and qualitative interviews, for ascertaining contextual qualities of these information exchanges that can be attributed to place. Topic modeling will offer us contextual information regarding the discussion within a placed hashtag, giving us a way to move beyond rote metadata fields to develop novel mixed methods approaches for including context computationally. Finally, examining the ways in which protestors are co-located in place and converse across place-based hashtags might further inform our understanding of the exchange of information during protest activities.

6. Conclusion

We fill an empirical gap identified by the theoretical intersection of human geography, social network analysis, and contentious politics, determining that place is significant in the formation of networks of resistance. In doing so, we also make a methodological

contribution to the field of human geography with regard to the relationship between social media and the networked spaces of resistance.

We highlight the self-representation of *place* here, but recognize that this piece also contributes to future work to deepen the contextualization of place with regard to social network analysis. These methods also form a research approach novel to social network analysis in that we highlight place as an alternative to coordinated-based location metadata.

Likewise, we uncover justification for exploring alternative methods, such as network variance models and utilizing SNA measures to explore the differences among different place-based networks of contention.

We point toward future work that will look at variance both within individual networks and between place-based networks. Our methodological contribution suggests contextualized and nuanced considerations of place may be fundamental to network formation through social media.

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