New Directions of Internet Research

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Abstract: Our purpose is to overview some quantitative and qualitative methodologies of Internet research, such as: (i) Social Network Analysis, conceiving the Internet as a socio-technical medium, in which social networks are co-evolving and interfering with computer networks. ii) Ethnography, including various methodologies for the collection of rich, descriptive and contextually situated data and the analysis of the embedded practices. (iii) Chaotic time-series analysis determining whether Internet traffic data (e.g. congestions) possess certain regularities, as if a deterministic process produced them, or they are random and non-deterministic.

Keywords: Internet research, social network analysis, ethnography, chaos theory

1. Introduction

Internet research (Jones, 1999) is recently concentrating the interest of many scholars not only because of the ubiquitousness of this new medium. Some, as Paccagnella (1997), hope that these studies could transcend the traditional quality/quantity divide in social research (cf., Miles & Huberman, 1994, pp. 40-43). In fact, the idea of an interpretive social science combined with statistical methods is not new at all. For instance, Max Weber (1949 [1922]) advocated the interplay between explanation (*Erklären*) and understanding (*Verstehen*). More recently, Pierre Bourdieu has made extensive use of correspondence analysis because the latter as a relational technique of data analysis corresponds exactly to what, in his view, "the reality of the social world is" and "it is a technique which 'thinks' in terms of relation" (Bourdieu & Wacquant, 1992, p. 96).

In the sequel, we intend to overview three different approaches (social network analysis, ethnography and chaos theory) and exhibit some examples of their contributions to Internet research.

2. Social Network Analysis

A social network is a set of actors and relations occurring among them. Actors can be

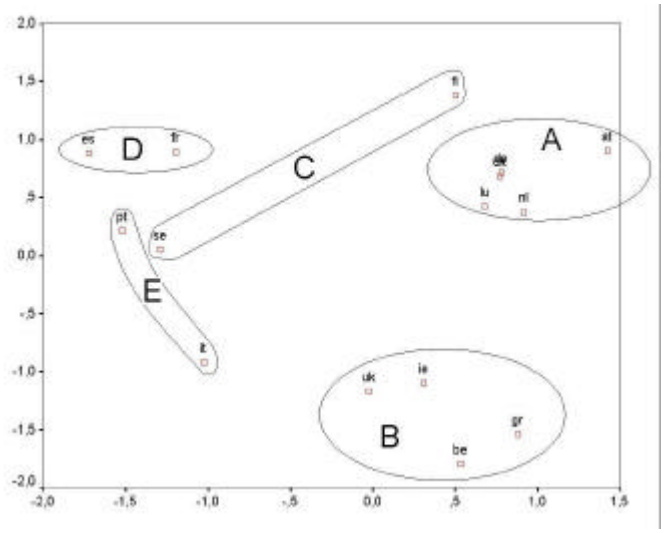
individual people, objects or events as far as certain relations hold them all together; actors can be also aggregate units such as organizations, institutions, communities, groups, families etc. The very idea of the social network approach is that relations or interactions between actors are the building blocks or the key factors that sustain and define the network (Wellman, 1988; Wasserman & Faust, 1994). Typically interactions between actors result from exchange of resources, either material or informational, such as goods, money, information, services, social or emotional support, trust, influence etc. Each kind of resource exchange is considered a social network relation and actors maintaining the relation are said to maintain a tie. The strength of a tie may range from weak to strong depending on the quantity, quality and frequency of the exchanges between actors (Marsden & Campbell, 1984). Patterns of who is tied to whom reveal the structure of the underlying network: they show how resources flow among actors and how actors are interconnected in the network. A few very well known examples of social network analyses are: Granovetter (1973, 1974) who investigated exchange of job information among acquaintances and found that weak ties are quite operationally strong for the diffusion of such information. Wilson (1997) found that the urban poor in isolated Black ghettoes lack connections with sources of work. Burt (1992) studied the dependency of social capital on 'structural holes' (which are particular kinds of network positioning in which a focal actor is connected to other actors which themselves are not connected with one another); thus, according to Burt, social capital is not a direct attribute of actors but rather of their ability to sustain flexible configurations within a network.

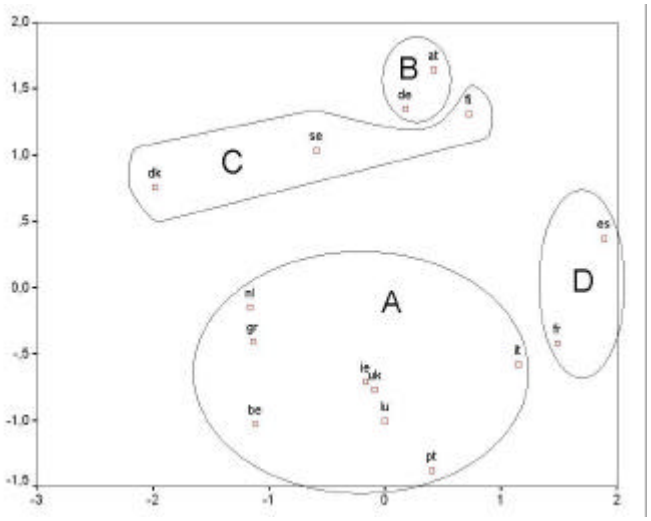
Now, computer networks in general and in particular the Internet are clearly social networks (Wellman *et al*., 1996). In these social networks, actors may be human, such as users, communicants, information producers and consumers, citizens, public or market organizations etc., or non-human, such as computer machines, information databases, (hyper-) documents, multimedia resources etc. Relations among the human Internet actors refer to informative and communicative uses, access, provision, procurement, commerce, work, education etc. Although human actors are always beneath the non-human ones,[1] typical relations among the latter consist of information (data) flows, traffic, exchanges of e-mails and postings in web pages, links, connections, network topologies etc.

In this way, there are applications of social network analysis to study the Internet such as: Garton, Haythornthwaite and Wellman (1999) tried to assess the role of e-mail and desktop videoconferencing within the context of overall communication. Haythornthwaite (2000) collected data from four computer-supported distance-learning classes in order to build a picture of the size and composition of personal online networks. Haythornthwaite (2001) has studied the strength of interpersonal ties among new media communicants arguing that, when the medium changes, weak ties are more vulnerable to dissolution while strong ties remain more robust.

[1] Some have been attracted by the idea that in a complex heterogeneous translation network agency can be performed by both humans and machines. This is the dogma of the 'Actor Network Theory,' in which the development and stabilization of scientific and technological objects (facts and artefacts) results from the construction of heterogeneous networks as concrete alignments between human actors, natural phenomena and social or technical intervening aspects (Callon, 1986; Latour, 1987). However, not everybody would subscribe to these ideas; for some this is a controversial theory and serious objections are risen against it (Collins, 1994).

As another example, we will refer to the work currently done in the 5th FP IST-Eurostat project EICSTES ('European Indicators, Cyberspace and the Science-Technology-Economy System'). Among other data (collected by automatic intelligent agents scanning various Search Engines), we are measuring the number of links among almost all of the University sites in the 15 EU countries: Austria (at), Belgium (be), Denmark (dk), Finland (fi), France (fr), Germany (de), Greece (gr), Ireland (ie), Italy (it), Luxembourg (lu), the Netherlands (nl), Portugal (pt), Spain (es), Sweden (su) and UK (uk). The following two sociograms show the relational positioning of the EU countries according to the incoming and outgoing links of their University sites, respectively (obtained by MDS while the clustering in groups of countries has resulted by SPSS factor analysis):



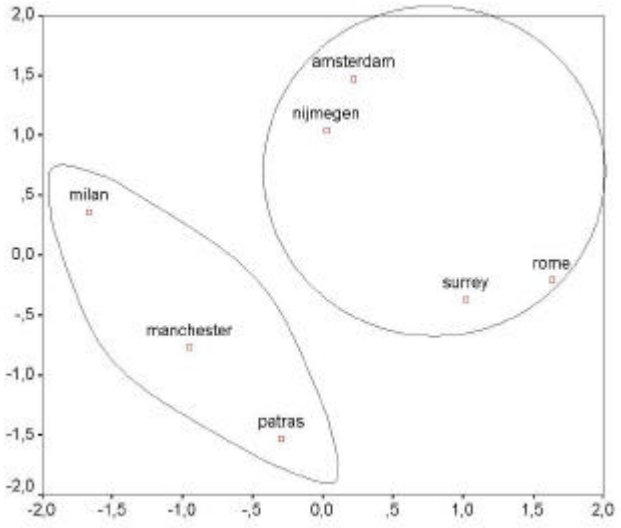


Another application of social network analysis to the Internet concerns the communicative

activities of the members of a mailing list. The motivation of this application comes from the fact that social network analysis can not only simplify the complex interpersonal connections in various social networks but it can also aid in investigating conspiratorial crime (Davis, 1981).

As an example, let us consider the members of a mailing list who, by exchanging e-mails, participate in multiple threads of discussions. By processing the archives of the mailing list, we can extract data on the members' participations in such threads of messages and from these data we can derive the corresponding sociograms [2] of interactions among the mailing list members. In such networks, the proximity between nodes (representing participants) is manifesting the extent of their interaction through their participation in a large number of common threads of discussions. On the other side, a possible divergence or isolation of certain nodes (participants) will indicate their reluctance to interact within the group of recipients of the mailing list.

For instance, we have applied the above ideas to the mailing list COMMORG, in which the discussions were about a 5th FP IST programme. The communicants in the mailing list were grouped according to the location of the participant institution at the project: Rome (coordinator), Milan, Patras, Amsterdam, Nijmegen, Manchester and Surrey. The following sociogram maps the relational positioning of communicants according to their interactions in the mailing list through their participation in threads of messages (obtained by MDS and the clustering in two groups having resulted by SPSS factor analysis):



3. Ethnography

[2] Scientometric methods (which in particular can be considered as network methods) have been already used to measure the accumulation of knowledge and to evaluate the dynamic structure underlying various research activities (Callon & Courtial, 1997).

Let us first start with a very short outline of ethnography. At the heart of ethnographic methods lies the 'reflexive turn' in anthropology and sociology, "based upon the human capacity for participant observation and the capability for reflecting upon it" (Titscher *et al*., 2000, p. 91). "We act in the social world and yet are able to reflect upon ourselves and our actions as objects in that world" (Hammersley & Atkinson, 1995, p.25). In particular, ethnography analyzes human practices in the context of culture. Culture "denotes an historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate and develop their knowledge about and attitudes towards life" (Geertz, 1979, p. 89).

So, doing ethnography "in its most characteristic form [it] involves the ethnographer participating, overtly and covertly, in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are the focus of the research" (Hammersley & Atkinson, 1995, p. 1). In this way, ethnographic methods are trying to interpret data (such as texts) extracted from the flow of social discourse against the background of cultural structures. "Doing ethnography is like trying to read (in the sense of 'construct a reading of') a manuscript […] written not in conventionalized graphs of sound but in transient examples of shaped behavior" (Geertz, 1973, p. 10). At the same time, ethnographic analyses are concerned with using their data in order to attain a reconstruction of key events in social discourse, a disclosure of emergent cultural patterns. For the visualization of these patterns it is often suggested that "maps, flowcharts and matrices of these patterns all help to crystallize and display consolidated information" (Fetterman, 1989, p. 95). However, we need to stress that, in ethnographic studies, data analysis is not a separable phase from data collection, as a dialectic interplay between them is commonly postulated (Hammersley & Atkinson, 1995, p. 205).

Now, it should be mentioned that the heterogeneity[3] of ethnographical studies has made ethnography to appear as "one of those catchall words whose meaning is extremely general and vague" (Harper, 1999, p. 241). Two representative examples of classical ethnographical research are Goffman's studies of how inmates in an asylum deal with their predicament through personal and social habits (Goffman, 1959, 1961); and Skolnick's study of the way police officers are compromised by tensions between 'due processes' and what they perceive as 'moral justice' in their dealings with criminals (Skolnick, 1966).

Furthermore, various hybrid approaches (combining ethnography, audience research, discourse analysis, textual analysis, autobiography etc.) have been and are applied to online analyses of the Internet and cyberculture. As a matter of fact, the Internet provides easily and inexpensively a plethora of digital data (from logs, messages and links to online interviews, surveys and polling) in order to develop longitudinal strategies of research comparing virtual life, communities and patterns over different periods of time and different geographical, social or cultural contexts. In this way, investigating the new ethnography

[3] In general, ethnography displays similarities with grounded theory and ethnomethodology. Ethnography of communication resembles conversation analysis but differs from linguistic methods such as discourse analysis and functional pragmatics. See Silverman (1993) and Titscher *et al*. (2000) for a discussion about similarities and differences among all these approaches.

required by the Internet (the 'virtual ethnography'), Christine Hine (2000) is led to rethink traditional ways of studying 'culture' and 'society.'

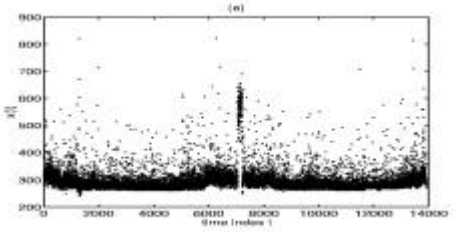
Some examples of ethnographic-type analyses of the Internet are: Paccagnella (1997) who studied as a participant observer the Italian virtual community named cyber_punk hosted by a non-profit BBS network over a period of 18 months. Denzin (1999) who tried to interpret the gendered 'narratives of self' in a newsgroup focusing on recovery from alcoholism. Rodino (1997) who observed the multiple and even contradictory ways of performing gender on an IRC channel. Baym (1995, 1998, 2000) who conducted a three-year study of the newsgroup rec.arts.tv.soap devoted to the recreational discussion of daytime soap operas. McLaughlin, Osborne and Smith (1995) who collected all articles posted in five newsgroups for three weeks in 1993 and analyzed episodes of normative discourse such as remedial or corrective sequences generated by an unacceptable post/reply or habitual pattern of the same communicant. Tepper (1997) who analyzed the use of humor as a policing mechanism on the newsgroup alt.folklore.urban. Hine (2000) who performed an ethnographic analysis of the Louise Woodward case, a teenage British nanny tried in Boston for the murder of a child who had been in her care. Branwyn (1994) who studied cybersex. Correll (1995) who observed a lesbian net café. Dibbell (1994) who gave an autobiographical account of a rape scenario played on a LambdaMoo. Markham (1998) who conducted online interviews in order to research real experiences in virtual spaces. Argyle (1966) who explored her own reactions to the death of a mailing list member to which she was participating, whom she had never met. Aycock and Buchignani (1995) who created some fictional reflections on the online activities of somebody who subsequently murdered four people at Concordia University in 1992.

4. Chaos Theory Analysis

In this section we will present the results on a chaotic time series analysis of 'ping' data that we have obtained in the project SOEIS ('Self-Organization of the European Information Society'). Here, the Internet data come from the 'symbolic-representational' character of digital information flows on the Internet. Apparently, these data are semantically context-free in the tradition of Shannon and Weaver's classical communication theory.

More specifically, one way to estimate the traffic on the Internet is by measuring the round-trip times for ICMP *ping* packets sent from one host to a second one. In this way, we obtain a time series (herein called 'ping time series'), which we process through linear statistical methods and methods of chaotic non-linear analysis. Thus, we may investigate whether certain patterns emerge, i.e., there exists some kind of structure in the data, or the data are completely random, such as, e.g., the outcome of a random number generator. Certainly, one expects that, if any, the underlying mechanism is a complicated one that cannot be identified using the classical statistical tools, such as autocorrelation and Fourier spectrum analyses. (General literature on the field: Kay, 1988, Priestley, 1988, Tsonis, 1992.)

In our work (Kugiumtzis & Boudourides, 1998) we examined a specific time series composed of ping times in between two hosts, one at the Democritus University of Thrace in Greece and the other at the University of California at Irvine in USA.



This ping time series (measured at the scale of 15 sec) was following a repeated pattern, composed of a background, corresponding to a subsided Internet traffic, and succeeded by a sudden peak, corresponding to a short congestion period of the order of a minute or less. In the measured set of round trip times, a data window of larger magnitude was detected corresponding to a large congestion period of more than half an hour, during which the net was overloaded. The presence of this data window introduced nonstationarity and, therefore, it altered the results of some of the applied methods. Particularly, the inclusion of the long congestion period resulted substantially larger estimated linear correlations over many lags, which was apparently a misleading result. Nevertheless, removing the long congestion period, no correlation was detected. Moreover, the False Nearest Neighbors method suggested erroneously that there was more structure in the long congestion period data.

The findings of the applied methods have not given any definite evidence whether the ping data were simply white noise or not. Obviously, the data was following a nonsymmetrical distribution resembling the lognormal distribution and, so, the data was not white noise of a Gaussian or uniform type. Some methods, such as the estimation of the autocorrelation, mutual information and correlation dimension, suggested that there was no correlation and structure in the ping data. On the other hand, the prediction with Autoregressive models and the Local Linear Prediction, as well as the Largest Lyapunov Exponent method, indicated that there were small correlations and some structure in the data, as they have given different results than those expected for the white noise case.

5. Conclusions

Although the Internet is a network, the well known ‘identity fluidity’ in it (Jordan, 1999) undoubtedly contrasts its rigid structural modality. As a matter of fact, all social networks suffer a similar theoretical vacillation. According to a common criticism of social network analysis, the latter is imputed on its static structuralism, which is incapable to grasp the dynamic and transformative attributes of human agency (Emirbayer & Goodwin, 1994; Emirbayer & Mische, 1998). Social action is the key concept to assist a theoretical understanding of the interplay between structural relations and discursive processes, i.e., social network analyses and ethnographic studies. Because “social action is interaction that induces interpretations and thus builds continuing relations” (Mische & White, 1998, p. 695).

One of the ways that has been suggested to achieve a commingling of ‘conversations and

situations' is by conducting a paradigm shift, an exploration of new operational metaphors to describe social topologies (Urry, 2000, 31, 38-39). From the network paradigm, grounded in an imagery of atomic particles, it has been suggested to pass to the flow paradigm, grounded on an imagery of fluids, where "neither boundaries nor relations mark the difference between one place and another; instead, sometimes boundaries come and go, allow leakage or disappear altogether, while relations transform themselves without fracture" (Mol & Law, 1994, p. 643).

Such a 'phase transition' (a liquidation of solid structures) is assumed to be produced by two interacting kinds of uncertainty (White, 1992, pp. 102-115). On the one side, there is ambiguity, designating uncertainty in purely cultural context. On the other side, there is what Harrison White calls 'ambage,' designating uncertainty in purely social-structural contexts. Ambiguity is about fuzzy meanings and interpretations while ambage "concerns the concrete world of social ties, in networks of ties and corporates among nodes" (p. 107). According to White, "A polymer gel is more like social networks. These very long molecules reptate through messy, inhomogeneous environments which include other such chains and induce new ties" (p. 70). "We are creatures living within social goos, shards, and rubbery gels made up by and of ourselves" (p. 337).

The above metaphors designate some possible future directions towards which social networks might develop in order to synthesize adequately social structural and cultural analyses and to reconcile the structure/agency (or social topology/dynamics) dichotomy. It is interesting that, by highlighting processes of uncertain interactions and dynamic social change, these directions appear to approach the fractal landscapes of nonlinear dynamics and complex systems by following certain precipitous non-Euclidean sticky pathways.

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