

QUANTITATIVE AND SOCIOLOGICAL ANALYSIS OF BLOG NETWORKS

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This paper examines the emerging phenomenon of blogging, using three different Polish blogging services as the base of the research. Authors show that blog networks are sharing their characteristics with complex networks (γ coefficients, small worlds, cliques, *etc.*). Elements of sociometric analysis were used to prove existence of some social structures in the blog networks.

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1. Introduction

1.1. *Blog — what is it?*

Blog^{1 2} is a diary published on the author's website. Because the Internet is used as a medium, authors feel free to express their opinions and views on different subjects, without fear of censorship.

¹ <http://www.matisse.net/files/glossary.html#Blog>

² http://www.blogger.com/tour_start.g

1.2. How blog networks are created?

As *blogging* becomes very popular, many internet portals offer (mostly free of charge) blogging facilities to their customers. That causes aggregation of blogs in one “place”, and encourages building communities. Bloggers (as we call people who run their blogs) very often place hypertext links to their friends and colleagues sharing similar views or describing similar subjects. Such connections create what we call *blog networks* which are subject of our research.

1.3. Examined blogging services

We examined three different Polish blogging services:

1. `blog.onet.pl` — one of the most popular services, about 150,000 registered blogs;
2. `blog.gery.pl` — moderately known service, about 15,000 blogs;
3. `jogger.pl` — niche service, gathering mostly tech-savvy people, only around 1,500 blogs.

It should be noted that many of blogs may be abandoned by their authors and no longer updated. They are still available however, and were taken into account.

2. Collecting the data

We used standard GNU/Linux tools to automate process of collecting the data:

- text-mode *lynx* browser for downloading the content of WWW pages;
- *grep* for filtering out unnecessary information;
- *sort* for sorting the blog list;
- *uniq* for removing the duplicate blog list entries;
- *bash* shell which provided a scripting framework.

Usually blogging services provide users with possibility of listing all existing blogs. We used this feature to create a list of all bloggers for each service. For example `jogger.pl` blog list has the following URL:

`http://jogger.pl/users.php?sort=1&start=offset`

where `offset` is the CGI parameter for specifying position in the list. It has 100 blog links presented on each page, so it was possible to gather all the blog links by starting from `offset=0` and increasing it by 100 in a loop until no more blogs were presented. In each loop iteration content of the list

page was downloaded by using *lynx* browser in HTML source dump mode. Then *grep* was used to filter out all data apart from blog URL addresses. We found it convenient to sort the resulting list and remove duplicate entries.

When the list was ready, content of every listed blog page was downloaded and links to other blogs in the same service were filtered out in similar manner. In the result, list of all outgoing connections for each blogger in the service was created. This process was repeated for each examined blogging service.

3. Quantitive analysis

This section presents results of quantitative analysis performed on data collected from the services we examined.

3.1. Vertices

The terminology we used comes from the graph theory. Each blog is represented by a vertex in the connection graph.

Average vertex degrees for each service:

1. `blog.onet.pl`: 0.8105
2. `blog.gery.pl`: 0.5243
3. `jogger.pl`: 0.4392

It is clearly seen that these graphs are very sparse. We will try to show that the function of degree distribution is of power-law type: $\text{Count}(k) \propto k^{-\gamma}$, where k represents vertex degree.

Histograms presented in figures 1, 2 and 3 are very similar, even though number of blogs in each service is different by an order of magnitude. That shows us that scaling is also very similar in these networks.

γ coefficients of the vertices degree functions are presented in Table I below. R^2 represents the square of the correlation coefficient.

TABLE I

γ coefficients of the vertices degree functions.

Service	blog.onet.pl		blog.gery.pl		jogger.pl	
	γ	R^2	γ	R^2	γ	R^2
Outgoing edges	2.96	0.97	3.00	0.96	2.14	0.91
Incoming edges	2.68	0.97	2.25	0.93	2.24	0.95
Incoming and outgoing edges combined	2.70	0.97	2.38	0.96	2.05	0.92

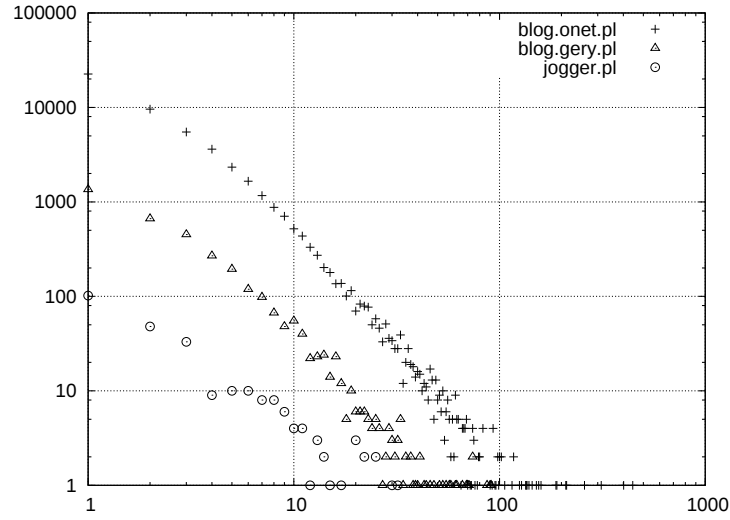


Fig. 1. Histogram of vertex degrees: incoming and outgoing edges combined, log-log plots.

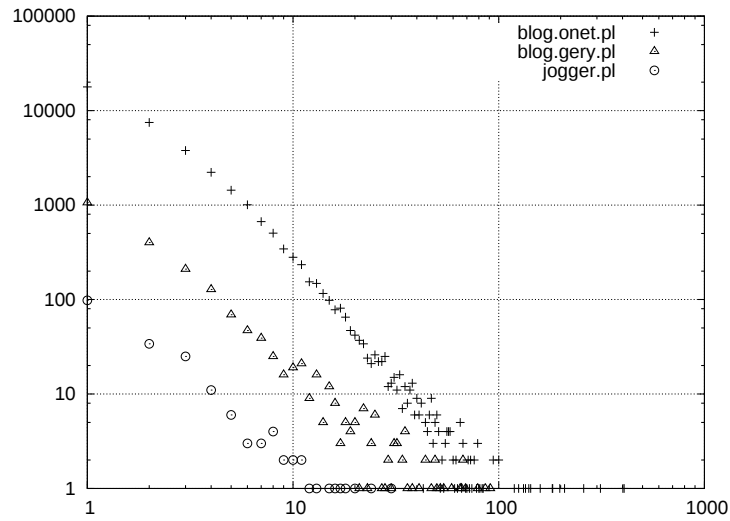


Fig. 2. Histogram of vertex degrees: incoming edges, log-log plots.

Vertices with maximal degrees are listed in Table II.

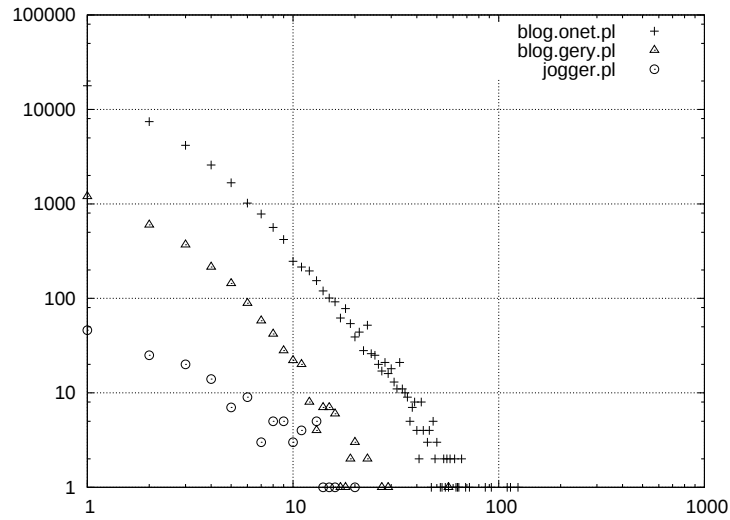


Fig. 3. Histogram of vertex degrees: outgoing edges, log-log plots.

TABLE II

Vertices with maximal degrees.

Service	blog.onet.pl		blog.gery.pl		jogger.pl	
	Name	Deg.	Name	Deg.	Name	Deg.
Outgoing edges	zycielily	407	martus	91	jpc	30
Incoming edges	blizniaczki777	124	www*	57	siwa	20
Incoming and outgoing edges combined	zycielily	444	martus	91	marcoos	32

*Home page of the service.

3.2. Average path length

Average path lengths for each service are presented in Table III. Standard deviation is represented by the σ symbol.

TABLE III

Average path lengths.

Service	blog.onet.pl	blog.gery.pl	jogger.pl
Average path length	7.60	6.76	3.78
σ	3.46	3.74	2.64

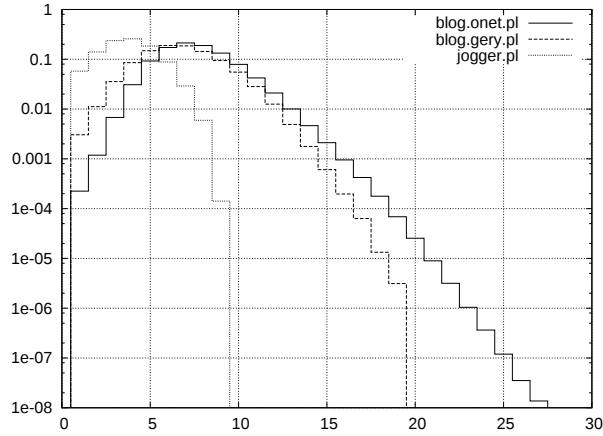


Fig. 4. Histogram of path lengths in each service, log plot.

3.3. Cliques

Two different kinds of connections between the vertices are distinguished — *weak* (idols and fans) and *strong* (friends). We call a connection between vertices A, B *weak* when there's only one edge, going either from A to B or B to A . That means that only one blog links to the other, which resembles relationship between fan and his idol. On the other hand, connection is called *strong* when two edges between A and B can be found. First goes from A to B and the other from B to A . If we assume that linking to somebody's blog means liking that person, then such relation means that A and B are friends as they like each other.

We also measured average cliquity for each service. Cliquity c_i represents “completeness” of the neighbourhood of vertex i [8, 9], *i.e.* c_i is 1 in case of a complete subgraph, 0 when a vertex is isolated.

Average cliquities for each service are presented in Table IV. Figures 5–7 and 8–10 show histograms of vertex cliquities for each examined service, *weak* and *strong* connections, respectively. Overdominance of isolated vertices is evident. When *strong* connections are considered, full subgraphs can be observed in larger services.

TABLE IV

Average cliquities for each service.

Service	blog.onet.pl		blog.gery.pl		jogger.pl	
	c	σ	c	σ	c	σ
Weak relations	0.067	0.107	0.015	0.050	0.030	0.068
Strong relations	0.013	0.091	0.002	0.039	0.004	0.046

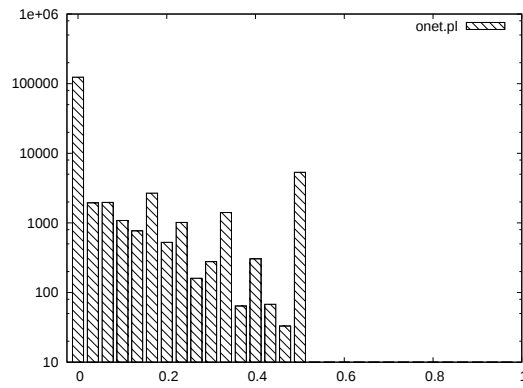


Fig. 5. Histogram of cliquity for `blog.onet.pl`, weak relations, log plot.

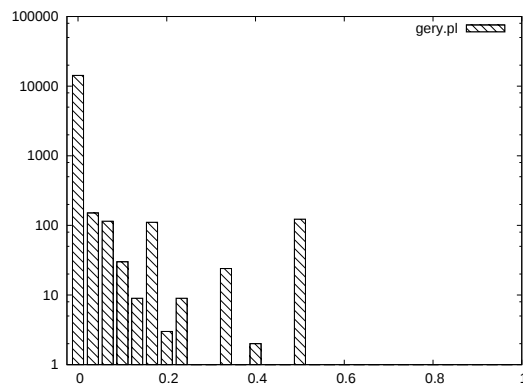


Fig. 6. Histogram of cliquity for `blog.gery.pl`, weak relations, log plot.

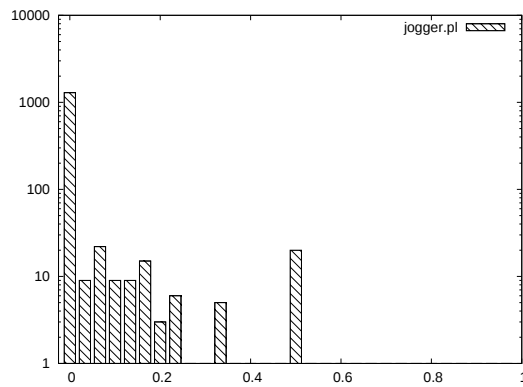


Fig. 7. Histogram of cliquity for `jogger.pl`, weak relations, log plot.

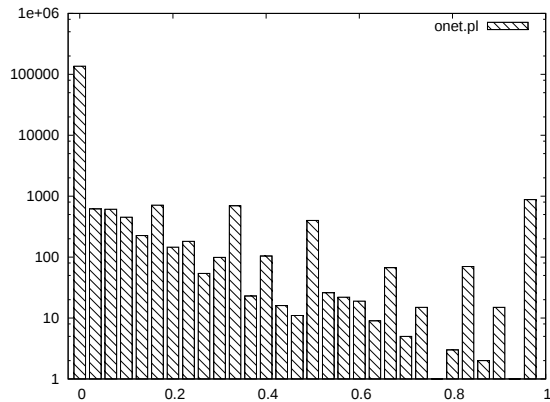


Fig. 8. Histogram of cliquity for `blog.onet.pl`, strong relations, log plot.

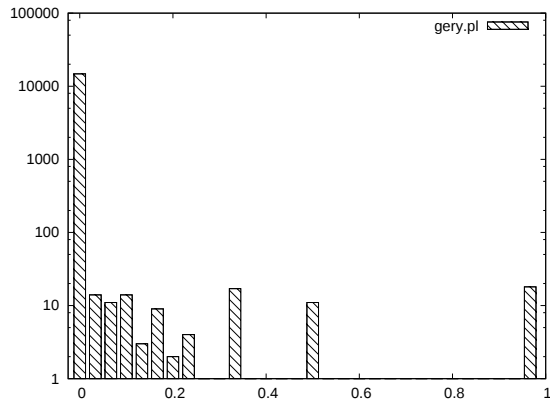


Fig. 9. Histogram of cliquity for `blog.gery.pl`, strong relations, log plot.

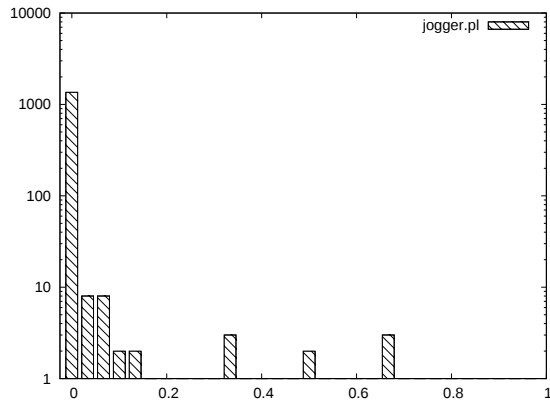


Fig. 10. Histogram of cliquity for `jogger.pl`, strong relations, log plot.

4. Sociometric analysis

Connected graph is a graph in which every two vertices are connected with a path. Two subgraph groups have been generated: strong relationship graphs — when one blog is referring to another, the other mutually referring to the first one (“friends”) and weak relationship graphs — where references are not mutual.

Frequencies of vertex degrees depending on the type of relationship are shown in Fig. 11. The number of isolated persons was established (no references to other blogs on their pages). The result is given in Table V.

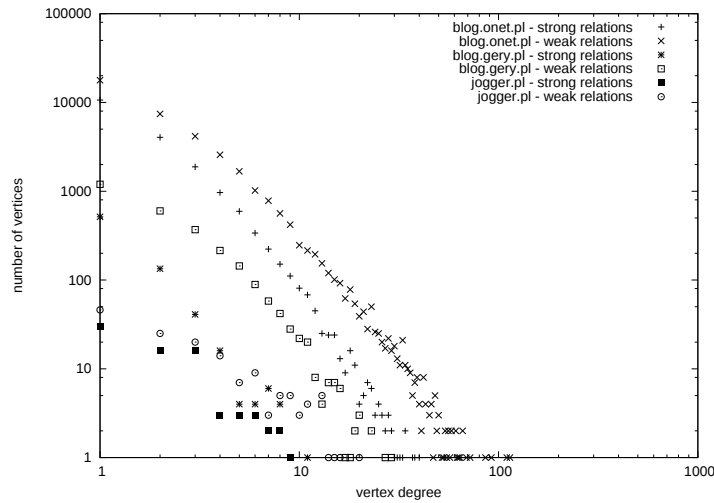


Fig. 11. Histogram of vertex degrees.

TABLE V

Number of isolated users and blogs in surveyed services.

Portal	jogger.pl	blog.gery.pl	blog.onet.pl
Number of users	1391	14861	141755
Number of isolated blogs	1315	14135	122412
Percent of isolated blogs	94.5%	95.1%	86.3%
Percent of not isolated blogs	5.5%	4.9%	13.7%
Average number of users	9.5	3.24	5
Number of strong subgraphs	8	224	3797

Having given number of isolated persons from particular blog service, it is possible to establish group integration index. The integration index is calculated with the following method [3]:

$$IG = \frac{1}{\text{Number of isolated persons}}$$

These are respectively: $IG_{\text{gery}} = 7.8715 \times 10^{-5}$, $IG_{\text{onet}} = 9.5524 \times 10^{-6}$.

As a result of computer-aided calculations we have been able to determine the number of blog pairs for `blog.onet.pl` and `blog.gery.pl` services where authors chose each other mutually (placed links in their weblogs). For `blog.gery.pl` this was 554 of total 14861; in case of `blog.onet.pl` this value reached 21160 of total number of 141755 weblogs. Connection index is given by formula [3]:

$$SG = \frac{\text{Number of pairs with mutual choices}}{C_2^N}$$

Consequently, connection indices for these blogs are respectively: $SG_{\text{gery}} = 5.0173 \times 10^{-6}$, $SG_{\text{onet}} = 2.106 \times 10^{-6}$. Notice that despite a tenfold population difference between the two services, connection indices differ only about 2 times.

Idol is a sociometric structure which describes person who got the large number of positive choices, though making small number of choices by itself (that means that it has small positive expansion) [1, 4, 7]. With *idol* is connected the person of *eminence grise* — who is the person chosen by *idol* (illustrated in Fig. 12).

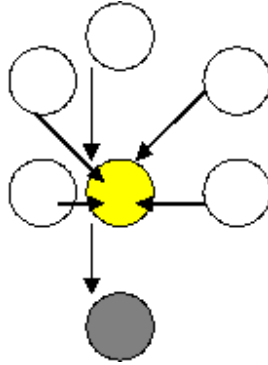


Fig. 12. *Idol* and *eminence grise*.

Blog `jpc` (shown in Fig. 13) is an *idol* with relatively large positive expansion (21 choices). *Eminence grise* is clearly visible (blog `antlan`), and is chosen by `jpc` without mutuality. Text analysis suggests that authors of both blogs are friends from university, from the “real” life. The more experienced user (`jpc`) promotes his friend’s weblog in bloggers’ community. This

however does not work very well — although blog *jpc* was established in November 2003 and is regularly updated, blog *antlan* is an ephemeron. For the 5 months of its existence it was updated only once.

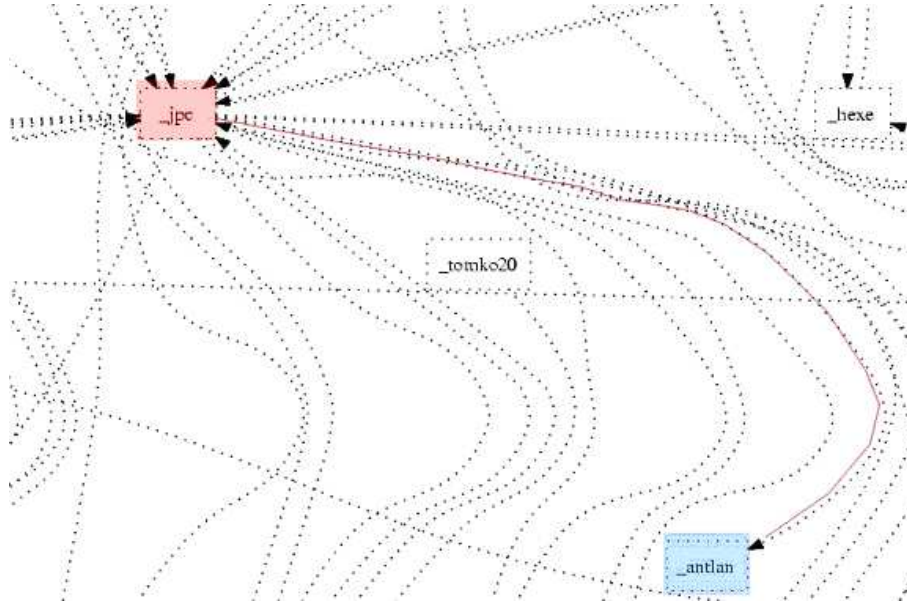


Fig. 13. *Idol* and *eminence grise* structure found in *jogger.pl* service network.

In Fig. 14 the basic sociometric structures are presented — *diad* which is mutual positive choice between 2 persons and *triad* which is mutual positive choice among 3 persons [1, 5, 6].

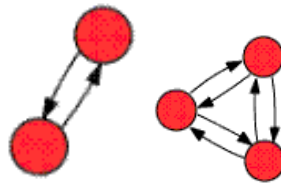


Fig. 14. The most popular sociometrical systems by J. Moreno [1, 2, 7] — *diad* and *triad*.

In the left picture of Fig. 15 the example of *triad* is shown — three mutual choices from *jogger.pl* service. One can see that the positive expansion of these blogs is small, despite relatively high sociometric status (with blog *kalma* having the smallest number of choices within the *triad*). Text analysis provides explanation of this — all three blogs belong to one family, a marriage with a 2 years old child. *koraga* is a blog describing events from child's

life written from its “point of view” by his mother, *kalma* is a weblog of its father while *ika* belongs to mother. Right picture of Fig. 15 shows the chain structure consisting of a number of *diads*. Text analysis shows that these people are connected with historical internet portal *Histmag*. Such choice structure has been established despite large outlook differences.

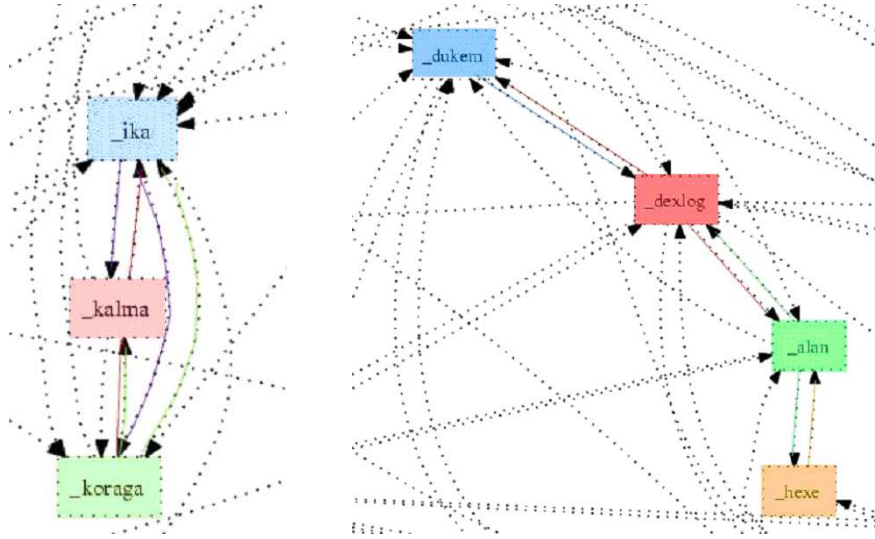


Fig. 15. Example of *triad* (left side) and chain of *diads* (right side) from `jogger.pl`.

5. Summary

Sparsity is the first apparent property of examined blogs networks. The highest observed average vertex degree is 0.81, that means that most of the vertices are not connected with others at all (about 90%).

γ coefficients describing power-law of the decay of the vertex degree function is below 3.0 in all examined services. That indicates that blogs are in fact scale-free networks [8, 9].

We do not observe notable increase of the average path length along with the increasing graph size. While the number of vertices of `blog.onet.pl` and `blog.gery.pl` services differs by order of magnitude, the difference between their average path lengths is only 0.84. It can be observed that as the graph is growing, we do not need respectively longer paths to “travel” between its vertices. That property is called *small world* [10].

The proportion between strong and weak relations in cliques does not change with the size of the graph. However, small graphs are dominated by very dense (many connections) and loose cliques (no connections at all,

isolated vertices). That contrast could be explained by saying that in smaller communities some people are very sociable, while others do not tend to “connect” with others at all. More balanced behaviour is rare.

In larger graphs, average cliquity is much greater (almost an order of magnitude) than in smaller ones, so we reckon that larger structures tend to help building stronger relations between their participants. In smaller structures the border between the “liked” and isolated ones is much stronger.

We also tried to implement a sociometric analysis method, a domain of microsociology, to analyse a large net of virtual interpersonal connections. Although treating blog networks as such can be controversial, we believe that for the purpose of this analysis such interpretation can be proved valid.

In large groups it is possible to find some regular sociometric structures. Structures described in this work were sociologically explainable despite vast differences of relationships among blog authors.

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