The structure of a social network and human dynamics in a virtual society: An experimental study

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Introduction

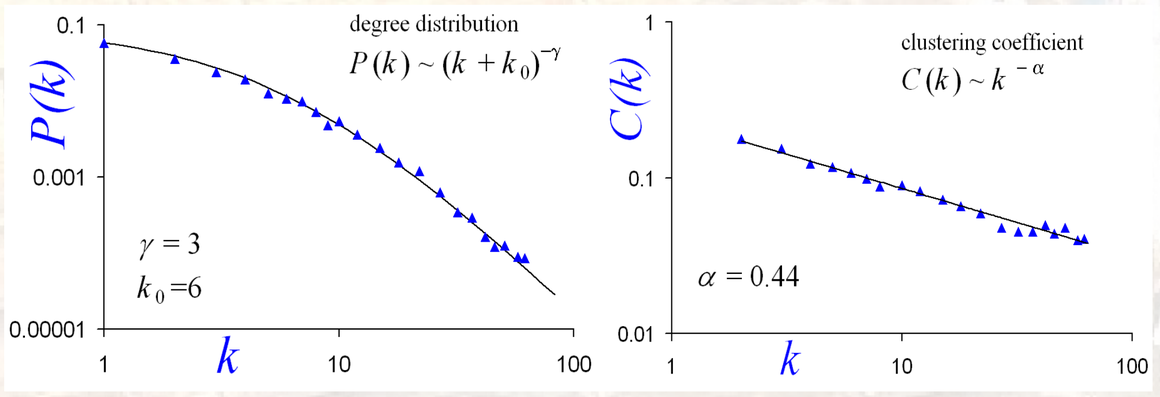
We study a large social network consisting of 3×10^4 individuals, who interact in a large virtual world of Massive Multiplayer Online Role Playing Games (MMORPGs). On the basis of the players' list of friends and the playing time received from the on-line game server, we investigate the structure of the network and human dynamics.

MMORPG is a network game in which players enter a virtual world as characters playing roles invented by themselves - gaining virtual life. This virtual world takes the form of a game server connected to the Internet, on which accounts are registered for users who log in through a special game client programs. Thousands of people can play on one server - they become a virtual society - so they share the common culture, area, identity and interactions in the network of interpersonal relationships.

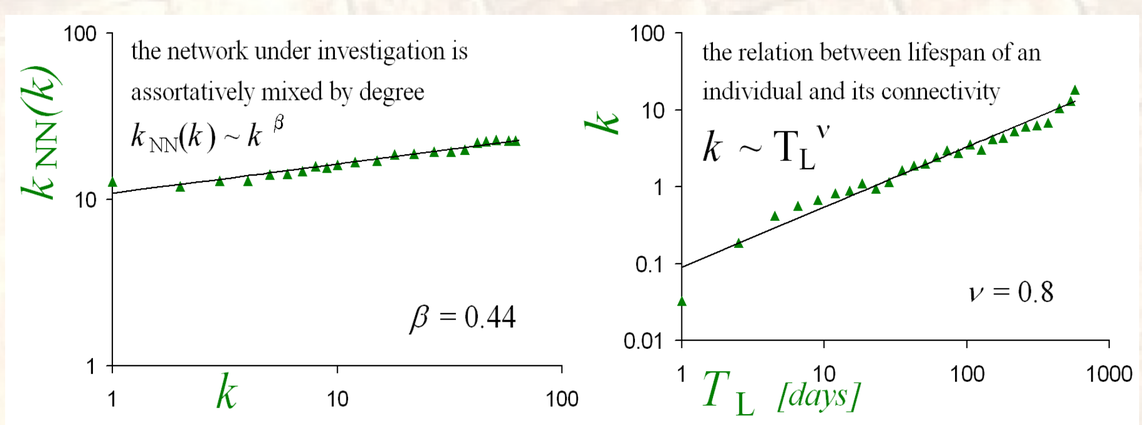
Friendship network

The structure of this friendship network is very similar to the structure of different social networks. Average properties of the whole network and the giant component (GC) and comparison with a random graph (RG), Barabási-Albert network (BA) and small-world network model proposed by Strogatz (SW) with the same number of nodes N and the same average connectivity $\langle k \rangle$ are presented in the table. In the case of SW network the probability of creating of a shortcut equals φ=0.01.

	N	C	$\langle l \rangle$	$\langle k \rangle$	$k_{\max}$
Network	28011	0.02	-	1.4	64
RG	28011	0.006	29	1.4	-
GC	6065	0.1	4.8	6.4	64
RG	6065	0.006	4.8	6.4	-
BA	6065	0.01	4.0	6.4	-
SW	6065	0.6	6.3	6.4	-



The power-law relation $P(k)$ is common in many types of networks, also in social networks. It is interesting that the same value of the exponent γ is observed in the model of a growing network with a linear preferential attachment. The power-law relation $C(k)$ is similar to the relationship observed in hierarchical networks. Such power laws hint at the presence of a hierarchical architecture: when small groups organize themselves into increasingly larger groups in a hierarchical manner, local clustering decreases on different scales according to such a power law.

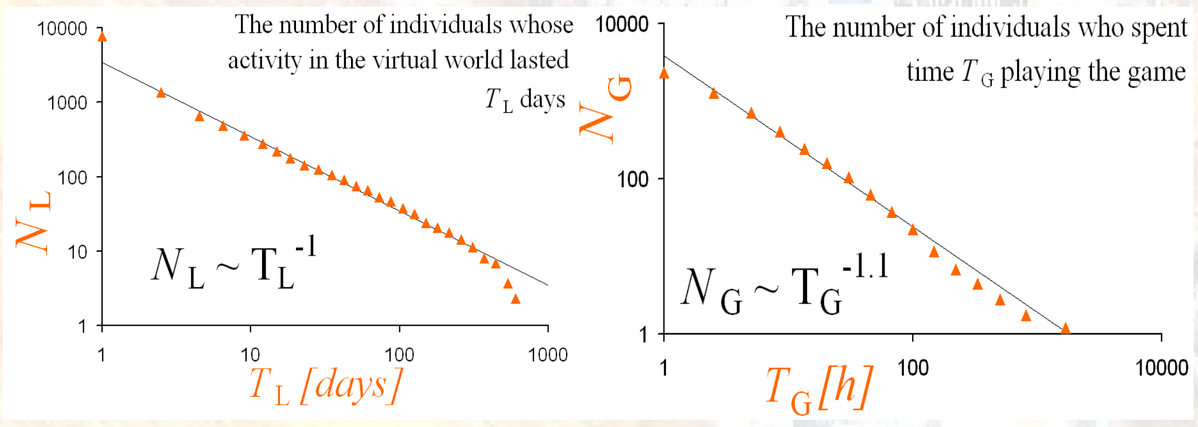


Social network in virtual and real world

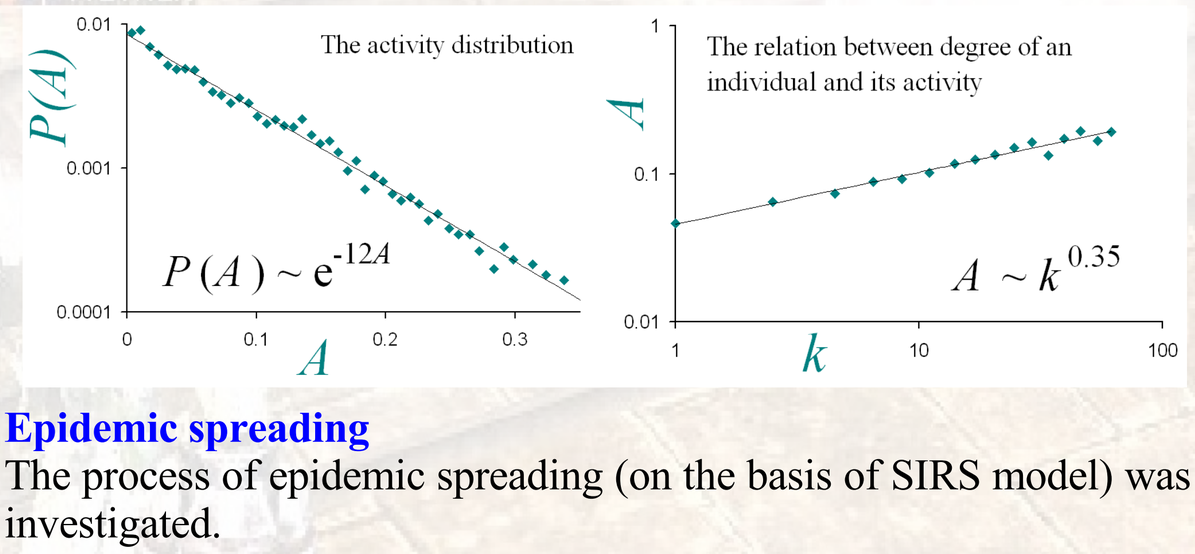
In order to investigate the relation between networks of acquaintances in virtual and real worlds, we carried out a survey among the players. The average number of pre-existing acquaintances is very small, hence, the friendship network in virtual world did not develop as a growing graph of underlaying social acquaintance network in the real one. Our results indicate that on-line games have strong influence on the network of acquaintances in the real world, and large number of contacts from virtual world are maintained in the real one.

Human dynamics

We found very interesting scaling laws concerning human dynamics. Our research has shown how long people are interested in a single task, and how much time they devote to it. It is surprising that exponent values in both cases are close to minus one.



We calculate the activity of individuals, i.e. the relative time daily devoted to interactions with others. Our research has shown that distribution of activity is not uniform and is highly correlated with node degree and that such a behavior of human activity has significant influence on dynamic phenomena, e.g. epidemic spreading, in complex networks.

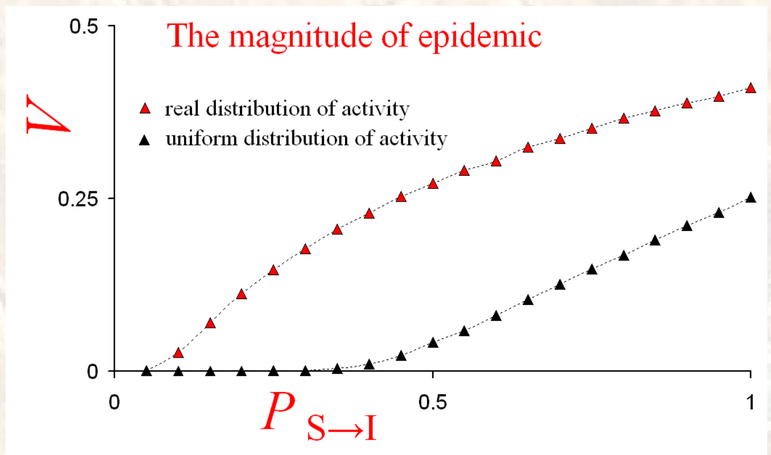


Epidemic spreading

The process of epidemic spreading (on the basis of SIRS model) was investigated.

S *(susceptible)* → ***I*** *(ill)* → ***R*** *(resistant)* → ***S*** *(susceptible)*

It occurs that the epidemic spreads faster and for a large range of values of the control parameters the magnitude of epidemic is larger in the case of real distribution of activity, as result of the presence of super-spreaders in the social network.



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