The Peter Principle Revisited: A Computational Study

Alessandro Pluchino
Dipartimento di Fisica e Astronomia, Università di Catania, and INFN sezione di Catania, Via S. Sofia 64, I-95123 Catania, Italy

Andrea Rapisarda
Dipartimento di Fisica e Astronomia, Università di Catania, and INFN sezione di Catania, Via S. Sofia 64, I-95123 Catania, Italy

Cesare Garofalo
Dipartimento di Sociologia e Metodi delle Scienze Sociali, Università di Catania, Via Vittorio Emanuele II 8, I-95131 Catania, Italy

Abstract

In the late sixties the Canadian psychologist Laurence J. Peter advanced the apparently paradoxical principle, named since then after him, which can be summarized as follows: 'Every new member in a hierarchical organization climbs the hierarchy until he/she reaches his/her level of maximum incompetence'. Despite its apparent unreasonableness, such a principle would realistically act in any organization where the way of promotion rewards the best members and where the competence at their new level in the hierarchical structure does not depend on the competence they had at the previous level, usually because the tasks of the levels are very different between each other. Here we show, by means of agent based simulations, that if the latter two features actually hold in a given model of an organization with a hierarchical structure, then not only the Peter principle is unavoidable, but it yields in turn a significant reduction of the global efficiency of the organization. Within a game theory-like approach, we explore different promotion strategies and we find, counter intuitively, that in order to avoid such an effect the best ways for improving the efficiency of a given organization are either to promote each time an agent at random or to promote randomly the best and the worst members in terms of competence.

Key words: Peter Principle, Organizations Efficiency, Agent Based Models
1 Introduction: The Peter Principle

The efficiency of an organization in terms of improving the ability to perform a job minimizing the respective costs is a key concept in several fields like economy [1] and game-theory [2]. But it could also be very important in ecology to understand the behaviour of social insects [3], in computer science when you have to allocate different tasks to a cluster of computers having different performances [4] or in science policy concerning how individual tasks are distributed among the thousands of members of a big collaboration, like that working for example at a large collider. Common sense has always been widely used in any hierarchical organization to manage the system of promotions: it tells us that a member who is competent at a given level, will be competent also at an higher level of the hierarchy, so it seems a good deal, as well as a meritorious action, to promote such a member to the next level in order to ensure the global efficiency of the system. The problem is that common sense, in many areas of our everyday life, often deceives us. In 1969 the Canadian psychologist Laurence J. Peter warned that the latter statement could be true also for the promotions management in a hierarchical organization [5]. Actually, the simple observation that a new position in the organization requires different work skills for performing effectively the new task (often completely different from the previous one), could suggest that the competence of a member at the new level could not be correlated to the old one. Peter speculated that we may consider this new degree of competence as a random variable, even taking into account any updating course the organization could require before the promotion: this is what we call Peter hypothesis. If the Peter hypothesis holds, and if one promotes each time the most competent member of the involved level, it could turn out a paradoxical process for which competent members will climb up the hierarchical ladder indefinitely, until they will reach a position where they will be no longer competent and therefore no longer promoted. This is the so called Peter principle, whose long term consequence seems to imply an unavoidable spreading of the incompetence over all the organization and would be in danger of causing a collapse in its efficiency [6,7,8]. Nowadays the Peter principle is probably underestimated in the context of business management. In any case, as far as we know, it still lacks a numerical study which would be able to quantify its effects and especially which would be able to propose alternative strategies in order to find the most advantageous way for improving the efficiency of a given organization.

In the last years the help of hard sciences, like physics or mathematics, has been frequently advocated in order to get a more quantitative understanding of social sciences mechanisms [9,10,11]. It is now largely accepted that

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Email addresses: alessandro.pluchino@ct.infn.it (Alessandro Pluchino), andrea.rapisarda@ct.infn.it (Andrea Rapisarda), cesaregarofalo@yahoo.com (Cesare Garofalo).
simple models and simulations inspired to statistical physics are able to take into account collective behaviour of large group of individuals, discovering emergent features independent by their individual psychological attributes and very often counterintuitive and difficult to predict following the common sense [15,13,14]. Along these lines, by means of an agent based simulation approach [15,16,17] here we study the Peter Principle process within a general context where different promotions strategies compete one with the others for maximizing the global efficiency of a given hierarchical system.

2 Dynamical Rules of the Model

In order to simplify the problem, we chose for our study a prototypical pyramidal organization, see Fig.1, made by a total of 160 positions distributed over six levels numbered from 6 (the bottom level) to 1 (the top one), with 81 members (agents) in level 6, 41 in level 5, 21 in level 4, 11 in level 3, 5 in level 2 and 1 in level 1. We verified that the numerical results we found for such an organization are very robust and show only a little dependence on the number of levels or on the number of agents per level (as long as it decreases going from the bottom to the top). Each agent is characterized only by an
age and by a degree of competence. The degree of competence, which includes all the features (efficiency, productivity, care, diligence, ability to acquire new skills) characterizing the average performance of an agent in a given position at a given level, etc., is a real variable with values ranging from 1 to 10 and is graphically represented with a colour scale with increasing intensity. The age, instead, is an integer variable included in the range 18-60, which increases one unit per each time step.

The snapshot reported in Fig.1 shows, as an example, a given realization of the initial conditions, where both the competence and the age of each agent have been selected randomly inside two appropriate normal distributions with, respectively, means 7.0 and 25 and standard deviations 2.0 and 5. At each time step all the agents with a competence under a fixed dismissal-threshold or with an age over a fixed retirement-threshold leave the organization and their positions become empty, while their color becomes yellow (the dismissal-threshold is arbitrarily fixed to 4 and the retirement-threshold to an age of 60). Simultaneously, any empty position at a given level is filled by promoting one member from the level immediately below, going down progressively from the top of the hierarchy until the bottom level has been reached. Finally, empty positions at the bottom level are filled with the recruitment of new members with the same normal distribution of competences described before.

We consider two possible ways for the transmission of the competence of an agent from one level to the next one: the Common Sense hypothesis, where a member inherits his/her old competence in his/her new position with a small random variation $\delta$ (where $\delta$ can assume random values included within $\pm10\%$ of the maximum value in the competence scale, i.e. $\delta \in [-1, 1]$), and the Peter hypothesis, where the new competence of every agent is independent from the old one and is assigned randomly (again with the same normal distribution than before). For each one of these two cases we take into account three different ways for choosing the agent to promote at the next level: the most competent (The Best strategy, suggested by the common sense and adopted also in the Peter principle), the less competent (The Worst strategy) or one agent at random (Random strategy).

At this point, in order to evaluate the global performance of the organization, we introduce a parameter, called global efficiency, which is calculated by summing the competences of the members level by level, multiplied by a level-dependent factor of responsibility $(r_i$, with $i = 1, 2, ..., 6$) ranging from 0 to 1 and increasing by climbing the hierarchy (such a factor, shown in the left side of Fig.1, takes into account the weight that the performance of the agents of different levels have on the global efficiency of the organization). Finally, the result is normalized to its maximum possible value $(Max(E))$ and to the total number of agents $(N)$, so that the global efficiency $(E)$ can be expressed in percentage. Therefore, if $C_i$ is the total competence of level $i$-th, the resulting expression for the efficiency is $E(\%) = \frac{\sum_{i=1}^{6} C_i r_i}{Max(E) N} \cdot 100$, being $Max(E) = \sum_{i=1}^{6} 10 \cdot r_i / N$.  


Fig. 2. *Efficiency time evolution for different strategies*. This figure shows the time evolution of the global efficiency averaged over 50 realizations of the initial competence distribution (events). Starting from the same initial average value (dashed line), the efficiency is plotted along 1000 time steps for the six combinations of the CS and PH ways with the three different promotion strategies (*The Best*, *The Worst* and *Random*).

3 Strategies in Competition: Simulations Results

We realized all the simulations presented in the paper with NetLogo [17], a programmable environment designed for developing agent-based simulations of complex systems. In Fig.2 we show the time evolution of the global efficiency considering the six possible combinations among the ways of competence transmission and the promotion strategies. The evolution is calculated along 1000 time-steps, a duration long enough to reach a stationary (in average) asymptotic value, and is further averaged over 50 different realizations of the initial conditions. The corresponding standard deviations are $\sim 1\%$ and are not reported. The simulations start always from the same 50 initial configurations of competences, so that the initial average efficiency is fixed at the value 69.68\% (dashed line). At t=0 all the curves seem to start from a point slightly above this line because the initial random distribution of competences produces many empty positions which are immediately filled in the first few steps then producing, regardless of the other parameters, a sudden small ini-
Looking at Fig.2 it clearly appears that, if one always promotes the best member as usually done by all real organizations, the asymptotic value of the average efficiency (AE) significantly increases (+9%) with respect to the initial efficiency only if the common sense (CS) transmission holds: if, on the contrary, one assumes as valid the Peter hypothesis (PH), a significant decrement of AE occurs (−10%) as intuitively predicted by Peter. Since in general it is difficult to know which way is actually acting in a given real organization, that of promoting the best member does not result to be an always winning strategy! Let us consider the opposite strategy, i.e. promoting the worst member. Again the resulting AE strictly depends on the transmission way, but in the opposite way: in fact, in this case the strategy is a winning one for PH (+12%), while it is a losing one for CS (−5%). Finally, the third strategy that of promoting one agent at random gives more similar results in both cases, although the improvement of the initial efficiency is limited (+2% for CS, +1% for PH).

In order to obtain exactly the same efficiency for both CS and PH, in Fig.3 we
Table 1

*Comparison of gains and losses for all the strategies adopted.* The table summarizes the average gain and loss percentage calculated with respect to the average initial efficiency by following the different promotion strategies. Results of loosing strategies are reported in red. The table indicates that *The Best* and *The Worst* strategies provide at the same time significant gains and consistent losses, depending on the ways of competence transmission at stake (common sense or Peter hypothesis), therefore the best strategies to adopt when such a mechanism is unknown are clearly the *Random* or the alternating *Best-Worst* ones (the latter, for \( p = 0.47 \), gives also exactly the same positive gain for the two scenarios).

Introduce a fourth *Best-Worst* strategy, where the best and the worst agents are chosen alternatively with a variable percentage \( p \). For \( p = 0 \) and \( p = 1 \) we recover respectively *The Worst* and *The Best* cases shown in Fig.2, while for values \( p \in [0, 1] \) all the intermediate situations between these limiting two cases are obtained. Interpolating the numerical results for the CS and PH scenarios, we found that an alternating strategy with an almost random choice between the best and the worst members (\( p = 0.47 \), see green square) produces in average the same asymptotic value of the global efficiency in the two cases, with a limited gain (+1.5%) but without losses.

We summarize in Table 1 the percentages of gain or loss obtained for the different strategies applied. These results confirm that, within a game theory-like approach, if one does not know what way of competence transmission is acting in a given organization, as usually one has in the majority of the typical situations, the best promotion strategies seem to be that of choosing a member at random or, at least, that of choosing alternatively, in a random sequence, the best or the worst members. This result is quite unexpected and counterintuitive, since the common sense tendency would be that of promoting always the best member, a choice that, if the Peter hypothesis holds, turns out to be completely wrong. On the other hand, by applying one of the two strategies *Random* and *Best-Worst*, losses can be successfully avoided without any further (possibly expensive) precaution of the organization’s managers (such as specialization or updating courses).

Finally, in Fig.3 we quantitatively verified the apparently surprising statement of the Peter principle, i.e. the fact that each member in a hierarchical organization climbs the hierarchy until he/she reaches the level where his/her competence is minimal. We found that no matter the number of level an agent crosses in his career: if one adopts the strategy of promoting the best member and if the PH holds, then all the members will end their career at the level where their competence is minimal or, that is the same, where their incompetence is the greatest one. Therefore Peters intuition is definitively correct: this
Fig. 4. *Careers evolutions*. We show in the figure the behaviour of the competence per level calculated while each agent climbs the hierarchy for the six different cases of Fig. 2. It is the computational verification of the Peter’s statement: ‘Everyone in a hierarchical organization climbs the hierarchy until he reaches his level of maximum incompetence’. Each point is an average over all the agents which, in a single event, go up from the sixth bottom level to one of the upper levels. As expected, the Peter effect clearly appears only in the PH cases with the strategy of promoting the best agent (full black circles). Furthermore it does not depend on the number of levels the agents cross in their careers.

dangerous mixture yields the rapid decrease of efficiency observed in Fig. 2. It is interesting to notice that if instead the PH is combined with the strategy of promoting the worst member, then the situation is diametrically opposite, i.e. each agent climbs the hierarchy until he/she reaches the level where his/her competence is at the maximum. Finally, the other PH lines in Fig. 3, corresponding to the random promotion strategy, show constant competences during all the careers, and the same happens in the analogous case with the CS way.

4 Conclusions

In conclusion, our computational study of the Peter principle process applied to a prototypical organization with pyramidal hierarchical structure shows that the strategy of promoting the best members in the PH case induces a rapid decrease of efficiency, while it works good only if members would ideally maintain their competence at each level, hypothesis that, although in
agreement with the common sense, seems in practice very unrealistic in the
majority of the real situations. On the other hand we obtained the counterin-
tuitive result that the best strategies to improve, or at least not to diminish,
the efficiency of an organization, when one ignores the actual way of compet-
tence transmission, are those of promoting an agent at random or of randomly
alternating the promotion of the best and the worst members. We think that
these results could be useful to guide the management of large real hierarchical
systems of different nature and in different fields [18].

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[18] For users that would like to verify our findings, a Java applet of the NetLogo program used to perform the simulations presented in this paper is available at the following web address:

[http://www.ct.infn.it/cactus/peter_principle_sup_material.html](http://www.ct.infn.it/cactus/peter_principle_sup_material.html)