Accidental Politicians: How Randomly Selected Legislators Can Improve Parliament Efficiency

A.Pluchino, C.Garofalo, A.Rapisarda, S.Spagano, M.Caserta

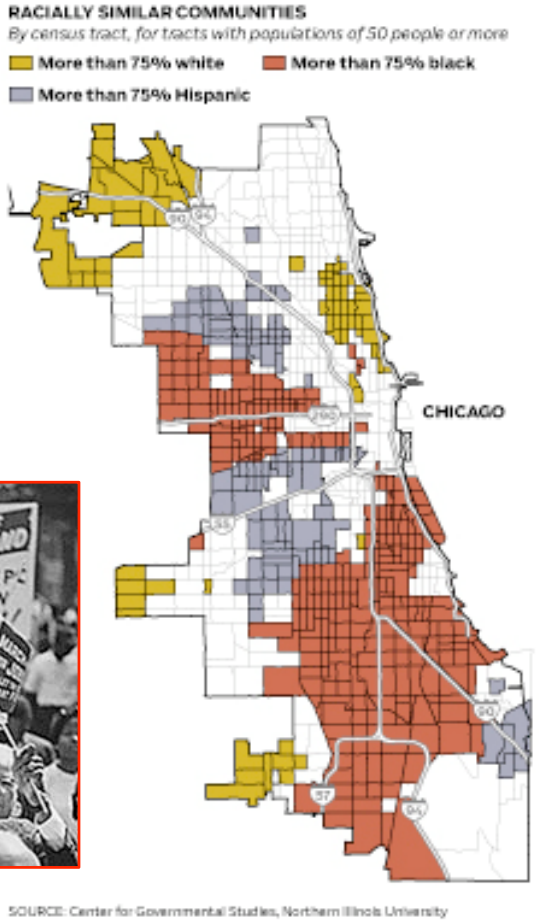
CICLO DI SEMINARI SCIENTIFICI

Aula XII della Facoltà di Economia - Palazzo delle Scienze – Catania

Martedì 24 Maggio 2011

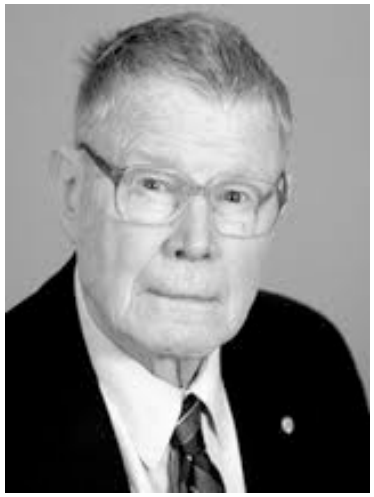
Gli albori della Sociofisica: Razzismo e Segregazione

Nei primi anni Settanta sembrava piuttosto ovvio che il tenace perdurare della segregazione razziale in molti centri urbani degli Stati Uniti, tra cui ad esempio New York e Chicago, fosse dovuta al razzismo dei bianchi, che vivevano nei ricchi sobborghi, confinando i neri in quartieri di disperata povertà.



Segregation (1971)

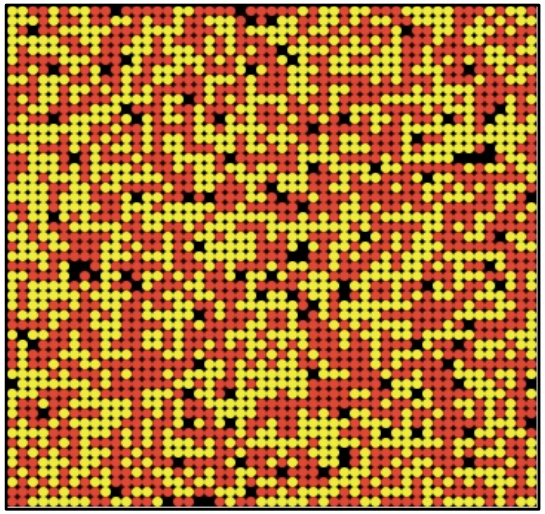
“La segregazione razziale nelle città americane è veramente sintomo di razzismo?”

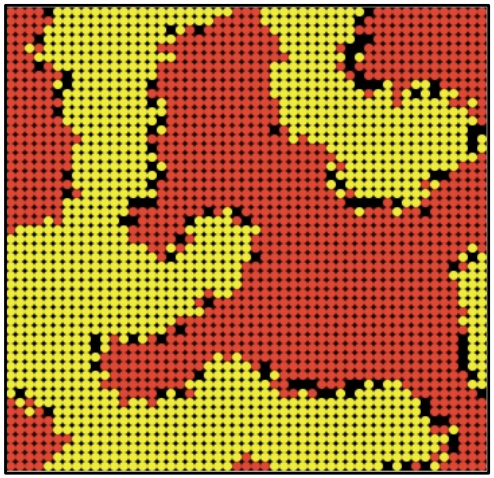


Thomas Schelling (Nobel per l’Economia 2005)

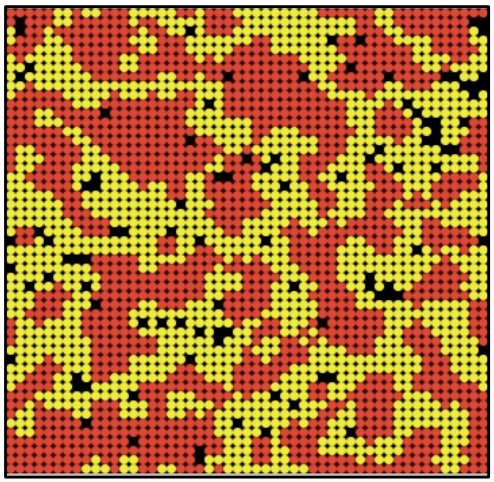
”Anche se ogni traccia di razzismo svanisse dall’oggi al domani, qualcosa di analogo a una legge della fisica potrebbe continuare a tenere le razze separate, come avviene per l’olio e per l’acqua”

2 comunità etniche





Ipotesi razzista:
70% di vicini
della stessa razza

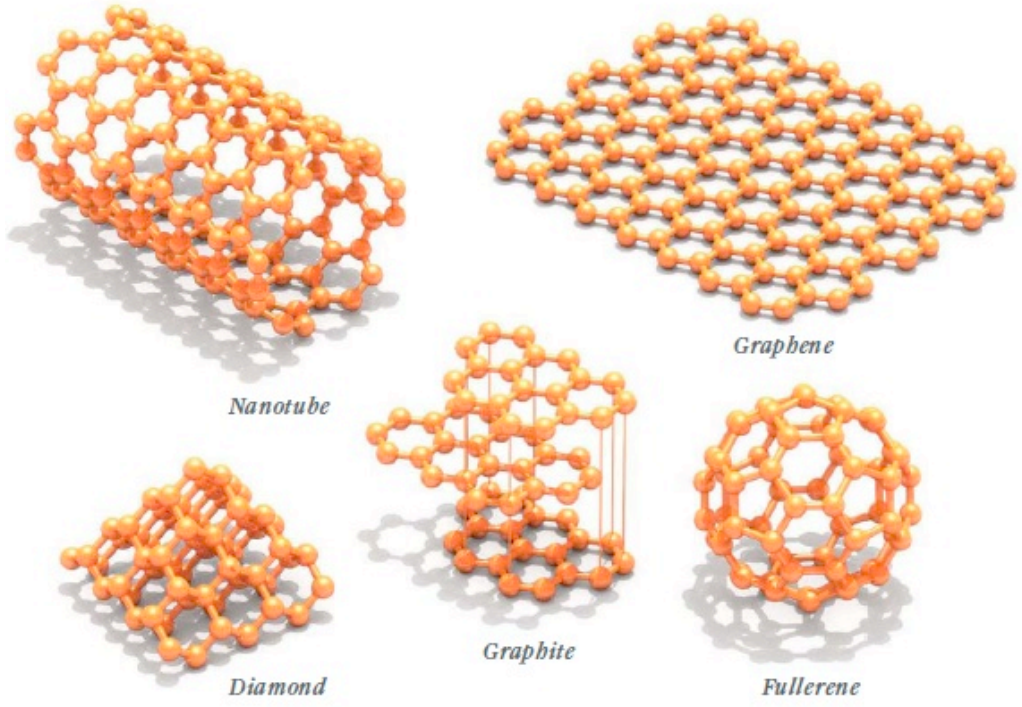


Ipotesi non razzista:
30% di vicini
della stessa razza

Lezioni dalla Fisica...

L'esperimento di Shelling dimostra che è pericoloso farsi guidare dal senso comune quando si ha a che fare con **fenomeni sociali complessi**: l'idea (propria delle Scienze Sociali ed Economiche classiche) che il comportamento di un gruppo sociale o di una comunità riflettano, più o meno direttamente, il carattere e il comportamento dei singoli individui che li costituiscono, può rivelarsi spesso sbagliata.

In **Fisica**, invece, è normale attribuire ai sistemi materiali macroscopici, composti da numerosissime particelle, proprietà che le singole particelle, a livello microscopico, non posseggono (solidità, pressione, temperatura, colore, trasparenza, etc..).



Inoltre, una delle lezioni più importanti della fisica moderna è che spesso, a contare più di ogni altra cosa, non sono le proprietà delle singole parti che costituiscono un sistema (gli atomi o le molecole), ma piuttosto la loro organizzazione e la loro struttura, ovvero le **relazioni tra le parti**.

Verso una “Fisica Sociale”?

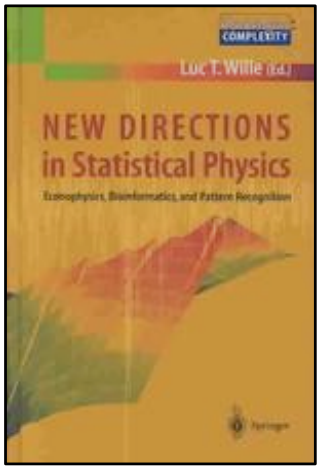
Le ricerche più recenti mostrano che, analogamente a quanto accade nel contesto della fisica statistica, se pure il comportamento di una singola persona é essenzialmente impredicibile, l’organizzazione globale di molti individui interagenti presenta spesso strutture e patterns generali prevedibili che vanno oltre gli specifici attributi individuali e possono emergere in contesti anche molto diversi tra loro.

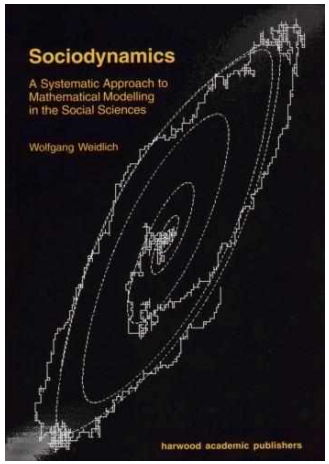
Diversi decenni di importanti ricerche sperimentali hanno mostrato infatti che, soprattutto quando siamo vincolati all’interno di strutture sociali collettive che limitano i nostri “gradi di libertà”, il nostro comportamento perde molta della sua complessità e finiamo per seguire regole assai semplici. A rendere il mondo sociale così complesso, dunque, non è la complessità di noi individui ma piuttosto i modi spesso sorprendenti in cui cooperiamo a creare strutture.

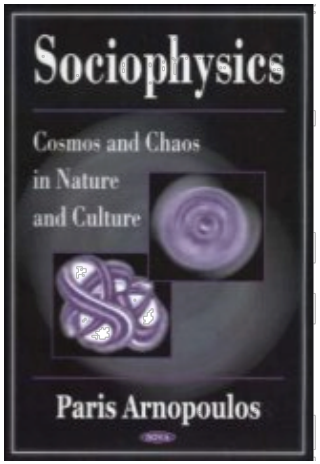
Ma se questo è vero, ne deriva che eventi e fenomeni sociali in apparenza complicati possono avere spesso, come ha mostrato Shelling, origini piuttosto semplici e che è dunque possibile scoprire tale semplicità immaginando noi stessi come “**atomi sociali**” soggetti a leggi non diverse da quelle della fisica.

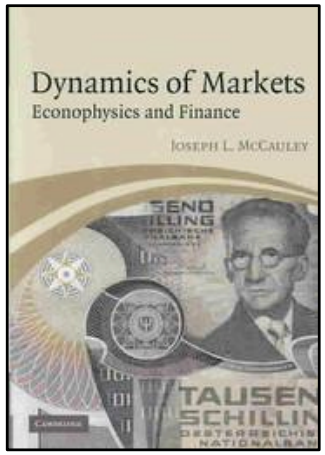
Mark Buchanan

*"Il fiorire delle ricerche in quella che mi piace chiamare "Fisica Sociale" (o "**Sociofisica**") mi ha convinto che ci troviamo a una svolta importante nella storia. Stiamo assistendo a una "rivoluzione quantistica" nelle scienze sociali. Siamo probabilmente ben lontani dall'identificare rigorose "leggi" per il mondo umano, tuttavia gli scienziati hanno scoperto in esso strutture e regolarità somiglianti a leggi, che non sono affatto in conflitto con l'esistenza del libero arbitrio individuale: possiamo essere individui liberi le cui azioni, combinate, portano in ambito collettivo a risultati prevedibili. Non molto diversamente da come, in fisica, il caos a livello atomico conduce alla precisione cronometrica della termodinamica o del moto planetario"*
(tratto da "L'atomo sociale", 2008)









Ruolo costruttivo del Caso nella dinamica dei Sistemi Sociali ed Economici

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The Peter principle revisited: A computational study

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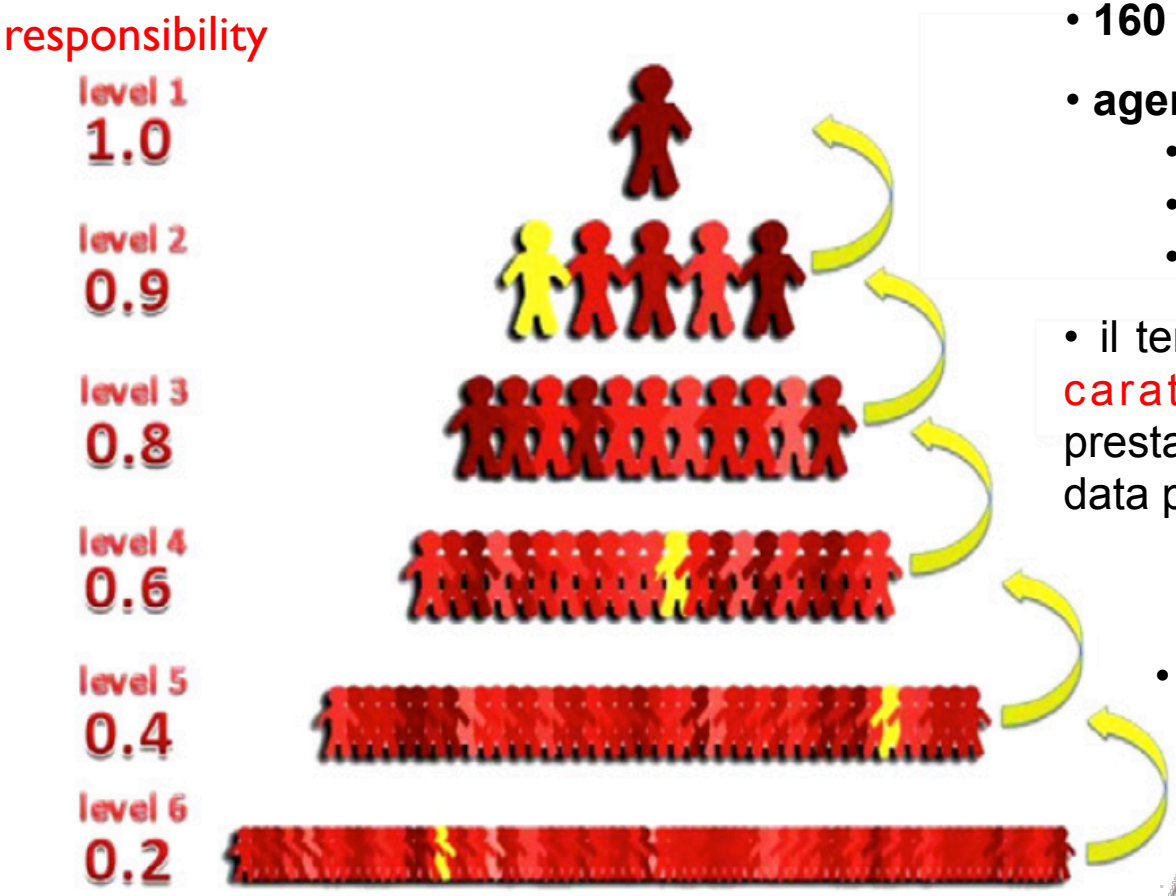
ABSTRACT

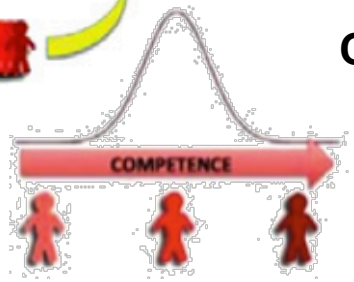
In the late sixties the Canadian psychologist Laurence J. Peter advanced an apparently paradoxical principle, named since then after him, which can be summarized as follows: *'Every new member in a hierarchical organization climbs the hierarchy until he/she reaches his/her level of maximum incompetence'*. Despite its apparent unreasonableness, such a principle would realistically act in any organization where the mechanism 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 to 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 is the Peter principle unavoidable, but also 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, counterintuitively, 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.

Simulazione ad agenti di una organizzazione gerarchica prototipica



- **160 posizioni** su **6 livelli;**
- **agenti eterogenei** caratterizzati da:
  - **età** (18-60 anni)
  - **competenza** (1-10, intensità colore)
  - **responsabilità** (0.2-1.0)
- il termine "**competenza"** include tutte le caratteristiche che influenzano la prestazione media di un agente in una data posizione di un certo livello

- **Posizioni vacanti:** in giallo
  - **età > 60 anni** (pensionamento)
  - **competenza < 4** (licenziamento)



Condizioni iniziali e nuove assunzioni:
normal distribution for both **age** (average 25y - std-dev 5y) and **competence** (average 7 - std-dev 2)

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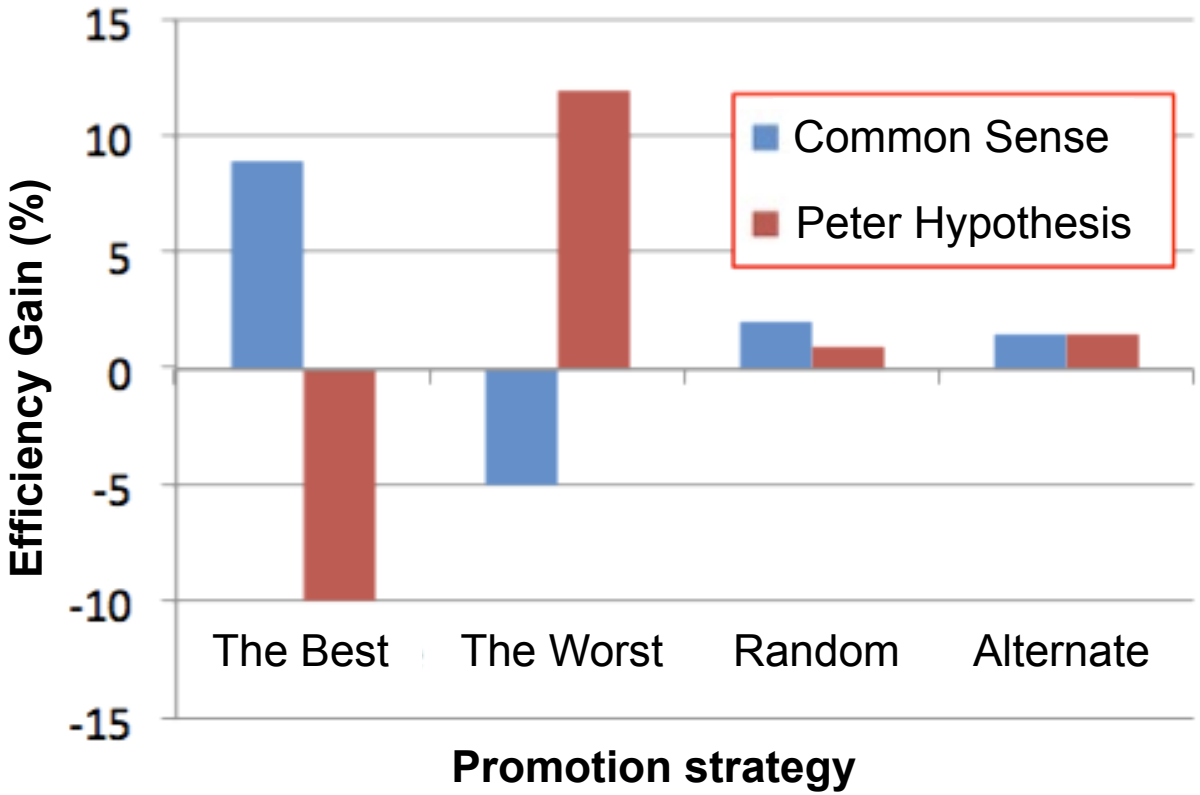
A.Pluchino, A.Rapisarda, C.Garofalo - **The Peter Principle Revisited: a Computational Study** - Physica A 389 (2010) 467-472

Risultati

I nostri risultati confermano che, **se non è chiaro quale sia il meccanismo di trasmissione delle competenze che agisce in una data organizzazione**, la migliore strategia di promozione sembra essere quella di scegliere di volta in volta un membro a caso o, quanto meno, quella di scegliere alternativamente, con sequenza casuale, il membro migliore e quello peggiore!



A.Pluchino, A.Rapisarda, C.Garofalo - **The Peter Principle Revisited: a Computational Study** - Physica A 389 (2010) 467-472

Analogie con il Paradosso di Parrondo in Teoria dei Giochi (Nature, 1999)

Game theory

Losing strategies can win by Parrondo's paradox

In a game of chess, pieces can sometimes be sacrificed in order to win the overall game. Similarly, engineers know that two unstable systems, if combined in the right way, can paradoxically become stable. But can two losing gambling games be set up such that, when they are played one after the other, they becoming winning? The answer is yes. This is a striking new result in game theory called Parrondo's paradox, after its discoverer, Juan Parrondo[1,2]. Here we model this behaviour as a flashing ratchet[3], in which winning results if play alternates randomly between two games.

There are actually many ways to construct such gambling scenarios, the simplest of which uses three biased coins (Fig. 1a). Game A consists of tossing a biased coin (coin 1) that has a probability (p_1) of winning of less than half, so it is a losing game. Let $p_1 = 1/2 - \epsilon$, where ϵ, the bias, can be any small number, say 0.005.

Game B (Fig. 1a) consists of playing with two biased coins. The rule is that we play coin 2 if our capital is a multiple of an integer M and play coin 3 if it is not. The value of M is not important, but for simplicity let us say that $M = 3$. This means that, on average, coin 3 would be played a

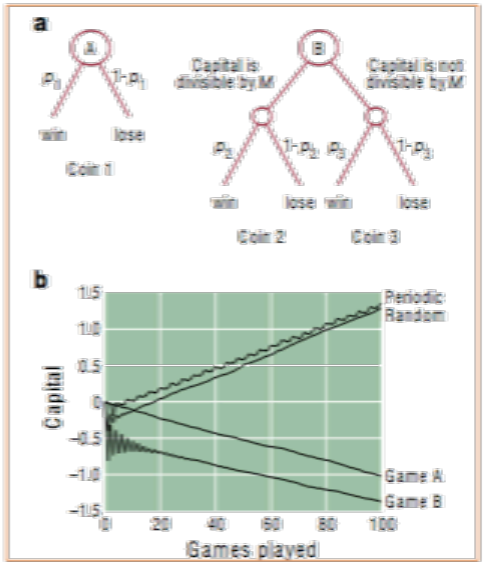


Figure 1 Game rules and simulation. **a**, An example of two games, consisting of only three biased coins, which demonstrate Parrondo's paradox, where p_1, p_2 and p_3 are the probabilities of winning for the individual coins. For game A, if $\epsilon = 0.005$ and $p_1 = 1/2 - \epsilon$, then it is a losing game. For game B, if $p_2 = 1/10 - \epsilon$, $p_3 = 3/4 - \epsilon$ and $M = 3$ then we end up with coin 3 more often than coin 2. But coin 3 has a poor probability of winning, so B is a losing game. The paradox is that playing games A and B in any sequence leads to a win. **b**, The progress of playing games A and B individually and when switching between them. The simulation was performed by playing game A twice and game B twice, and so on, until 100 games were played; this is indicated by the line labelled 'Periodic'. Randomly switched games result in the line labelled 'Random'. The results were averaged from 50,000 trials with $\epsilon = 0.005$.

slope, the particles are massaged uphill. This is only possible if the sawtooth shape is asymmetrical in a way that favours particles spilling over a higher tooth.

The flat slope is like game A, where the bias ϵ is like the steepness of the slope. Game B is like the sawtooth slope, where the difference between coin 2 and coin 3 is like the asymmetry in the tooth shape. In the brownian ratchet case, there are two types of slope, with falling particles, but when they are switched the particles go uphill. Similarly, two of Parrondo's games have declining capital that increases if the games are switched or alternated. The games can be thought of as being a discrete ratchet and are known collectively as a parrondian ratchet.

Game theory is linked to various disciplines such as economics and social dynamics, so the development of parrondian-like strategies may be useful, for example for modelling cases in which declining birth and death processes combine in a beneficial way.

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The New York Times
Magazine

Dicembre 2009

The New York Times
Saturday, February 13, 2010
Magazine

THE 9TH ANNUAL YEAR IN IDEAS

Random Promotions

In 1969, the Canadian psychologist Laurence J. Peter posited the "Peter Principle": people in a workplace are promoted until they reach their "level of incompetence." This happens, Peter argued, because we wrongly assume that people who are good at their jobs will also be good at jobs that are one rung up on the corporate ladder — so we promote them. But often the new job is so different from the previous job that the employee can't handle it. Now performing incompetently, the employee stays in place, dragging the efficiency of the firm downward. Eventually the entire economy becomes like the paper company Dunder Mifflin in "The Office" — clogged with incompetence.

Is there any way to avoid this trap? Yes, by promoting people at random. That's what a trio of Italian scientists discovered this year. They created a computer model of a 160-person corporation and programmed it with Peter Principle-like logic: the best performers were promoted, but they had only a random likelihood of being good at their new jobs. Sure enough, the firm was soon cluttered with incompetents, and its efficiency plunged. But then the researchers tried something different: they reprogrammed the firm so that it promoted people entirely randomly, and the overall efficiency of the firm improved.

ILLUSTRATION BY OPEN

They also tried alternately promoting the absolute best and absolute worst performers. That, too, worked out better than promoting on merit. The scientists say these strategies work because they harness "Parrondo's Paradox," a piece of game theory in which you win by alternating between two losing strategies. "In physics or game theory, this isn't new," says Andrea Rapisarda, a physicist at the University of Catania in Italy and a co-author of the study, which was recently published in the journal Physica A.

As Rapisarda points out, if you could know for sure that the people being promoted would excel in their new jobs, that would be the best strategy of all. But if you aren't sure — and in the real world, we rarely are — then random works better. CLIVE THOMPSON

NewScientist

Dicembre 2009

Mark Buchanan

Incompetence rules

So your organisation is managed by people who couldn't run a burger stand? Here's why

"It sounds counter-intuitive, but the best promotion strategy might be to choose people at random"

IN THIS season of goodwill, spare a thought for that much-maligned bunch, the men and women at the top of the management tree. Yes, the murky machinations of the banking bosses might have needlessly plunged millions into penury. Yes, the actions of our political leaders might seem to be informed more by dubious wheeler-dealing than by Socratic wisdom. And yes, the high-ups in your own company might well be the self-important time-wasters you've always held them for.

Don't blame them, though. It's not their fault. There are good reasons to expect that bosses can't help but be incompetent – adrift on a sea of troubles they neither understand nor can control. Better to take pity on the poor souls: there with the grace of the promotion committee go all of us.

The idea that high-level incompetence is inevitable was formulated in the 1969 best-selling book *The Peter Principle: Why things always go wrong*. Its authors, psychologist Laurence Peter and playwright Raymond Hull, started from the observation that while jobs generally get more difficult the higher up any ladder you climb, most people only come equipped with a more or less fixed level of talent that corresponds to their intelligence, knowledge and energy. At some point, then, they will be promoted into a job they can't quite handle. They will, as Peter and Hull put it, "reach the level of their own incompetence". And there they will stay, fouling up operations until they either retire or some egregiously inept act gets them fired.

The problem is what they get up to in the meantime. "They end up distracting us from their crummy work with giant desks," says Robert Sutton of the Stanford Graduate School of Business in California. "They replace action with incomprehensible acronyms, blame others for failure, and cheat to create the illusion of progress." Meanwhile, Peter and Hull concluded, the actual work gets done by those who have not yet scaled the summit of their own incompetence. That would be you and me, then.

Pervasively inept

The "Peter principle" undoubtedly appeals to the cynic in all of us. It is also quite possibly true, if subsequent academic studies are to be believed. The longer a person stays at a particular level in an organisation, the more most measures of their performance fall – including subjective evaluations and the frequency and size of pay rises and bonuses. It is a finding entirely consistent with the idea that people eventually become bogged down by their own incompetence.

Economist Edward Lazear, also of Stanford, is one person who has tried to pin down why. His suggestion is that it is down to chance. People mostly get promoted because they have performed a particular task unusually well. That could be because they are generally competent, but equally they might just by fluke have been well-suited to that one job.

Lazear postulated that every worker's ability to do his or her job well is determined by their basic competence plus an additional transitory component determined by circumstance. There is no guarantee that this transitory component will be maintained after a promotion, especially if the new position requires different abilities. An electrician doing excellent work on the factory floor might not have the interpersonal skills needed to manage a team of electricians. A skilled and sensitive doctor might flounder when faced with the multitudinous difficulties of running a hospital. A cabinet minister prudently managing the finances of a nation might not necessarily be the best choice to step up and lead it.

In other words, following promotion a person is likely to regress to their baseline competence, losing that extra something that prompted their rise. That baseline might be above or below the degree of competence demanded in the new, high-level job. If in a particular workplace the staff who are promoted consistently fall short in this respect, promotion can become the dominant force driving pervasive ineptitude, Lazear's mathematical models showed.

It is a view underpinned by simulations of promotion dynamics performed in early 2009 by physicist Alessandro Pluchino and colleagues at the University of Catania in Italy (*Physica A*, vol 389, p 467). They started by accepting the conventional notion that people who do well at one level will do well at the next one up. If the employees who are most successful in their job are always selected to move up the ladder, then the organisation rapidly fills with competent individuals, especially at the higher levels.

But what happens if the conventional idea is false and employees' ability to perform at higher levels has no link to their competence at lower levels? The result is profoundly different, as you might expect. Promoting the best-performing employees merely takes people out of positions where they are doing well and pushes them upwards until they arrive at a position for which they lack the requisite skills. Their promotion history then comes to an end: the Peter principle wins out.

"The system locks incompetence in to place," says sociologist Cesare Garofalo, one of the authors. "This might happen in any organisation where the tasks of the different levels are very different from each other."

As he points out, companies often try to avoid this outcome by giving employees extra training before a promotion, in the expectation that this will supply any missing skills. But the new analysis suggests that there may be another way to achieve a similar end: subvert the seemingly inescapable logic that the best should always be promoted, and at least sometimes promote the poor performers too. By removing people from jobs for which they have low competence, such a strategy increases overall organisational efficiency, measured as a weighted average of employee competence, with higher-level positions counting for more.

Of course, such a strategy is not without its dangers. Doing your job badly is all too easy, and a promotion paradigm that obviously rewards underperformance would spell disaster. Garofalo suggests how to work round this problem and still use promotion to release poorly performing employees from jobs unsuited to their skills. "This is obviously counter-intuitive," he says, "but the best promotion strategy seems to involve choosing people more or less at random."

"This is a really interesting alternative approach to looking at the Peter principle," says Rajiv Mehta, a professor of marketing at the New Jersey Institute of Technology in Newark. "But it would turn on its head almost every established theory of human behaviour and would face a multitude of problems."

Among other things, random promotion seems certain to undermine the morale of staff who work hard at their jobs. "I think you'd have dissatisfied and alienated employees with low commitment," says Mehta. "They'd be disloyal corporate citizens and from there it's only a hop, skip and a jump to conclude that there'd be high rates of dysfunctional employee turnover." A better way to stop people getting locked in jobs they do badly, he suggests, would be the more conventional strategy of regular job rotation.

With no obvious solution in sight, perhaps we should just resign ourselves to being ruled by supposed betters who are in fact hopeless incompetents. At least – and here's a thought to take into the new working year – it means that when things go wrong at the top, it is most probably a cock-up, not a conspiracy. ■

Mark Buchanan is a writer based in the UK.

Ig Nobel vinto da italiani, piu' efficaci promozioni a 'caso'

Il riconoscimento alla scienza 'che fa prima ridere e poi pensare' sponsorizzato da Harvard a Pluchino, Rapisarda e Garofalo

01 ottobre, 12:16

1 Ottobre 2010

di Pier David Malloni

ROMA - Forse non piacera' al ministro Brunetta, ma di sicuro la ricerca degli italiani Alessandro Pluchino, Andrea Rapisarda, e Cesare Garofalo dell'universita' di Catania ha entusiasmato la giuria dei premi Ig Nobel, che li hanno eletti vincitori di quello 'per il management'. I tre hanno dimostrato per la prima volta con un modello matematico il 'principio di Peter', enunciato negli anni '60, che afferma che in una organizzazione gerarchica spesso chi arriva al vertice raggiunge un minimo nella sua competenza.

1 di 3

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Alessandro Pluchino

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+ Ecco le ricerche più pazze

"Abbiamo anche studiato possibili strategie per evitare gli effetti negativi del fenomeno - spiegano i tre da Boston, dove si e' tenuta la cerimonia di consegna del premio organizzato dalla rivista Annals of Improbable Research e sponsorizzato dall'universita' di Harvard - Per quanto possa sembrare paradossale, una strategia che promuova ai ranghi superiori in maniera casuale sembra dare dei buoni risultati ed aumenta l'efficienza dell'organizzazione".

http://www.pluchino.it/ignobel.html


promoted people
at random.
Frank Wilczek
(Nobel Fisica 2004)
Sheldon Glashow
(Nobel Fisica 1979)
Roy Glauber
(Nobel Fisica 2005)

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Ig Nobel, un premio all'Italia per le scoperte improbabili

La cerimonia in diretta web e radiofonica, si è svolta per il ventesimo an americana. Ai ricercatori di Catania il riconoscimento per il Managemen casuale e non meritocratica delle promozioni aziendali

di KATIA RICCARDI

ROMA - "La frase più

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The New York Times

Saturday, October 23, 2010

EN QU... DE SCIENCES

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Aziende più efficienti se promuovono i dipendenti a caso. Così tre italiani vincono l'Ig Nobel

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Scherzando in attesa dei Nobel

Gli IgNobel del 2010

Una ricerca ha dimostrato che se d'inverno si cammina su una strada ghiacciata portando i calzini al di sopra delle scarpe, si cade meno

Come sempre, alla vigilia dell'assegnazione dei premi Nobel, alla Harvard University, di Cambridge, in Massachusetts, sono stati assegnati gli IgNobel, scelti da un comitato di serissimi scienziati, alle ricerche scientificamente più "improbabili".

Fra i premiati quest'anno figurano anche tre italiani – Alessandro Pluchino, Andrea Rapisarda, e Cesare Garofalo dell'Università di Catania – insigniti del premio per uno studio sulla gestione aziendale e in particolare "per aver dimostrato matematicamente che enti e aziende sarebbero più efficienti se promuovessero le persone in modo del tutto casuale"

(The Peter Principle Revisited: A Computational Study, Alessandro Pluchino, Andrea Rapisarda, and Cesare Garofalo, *Physica A*, vol. 389, no. 3, February 2010, pp. 467-72.)

IgNobel a tre ricercatori di Catania: promozioni a caso un bene per l'azienda

Applicazioni ad aziende reali...

Abbiamo anche scoperto molto recentemente che qualcuno aveva già adottato un sistema simile con successo.

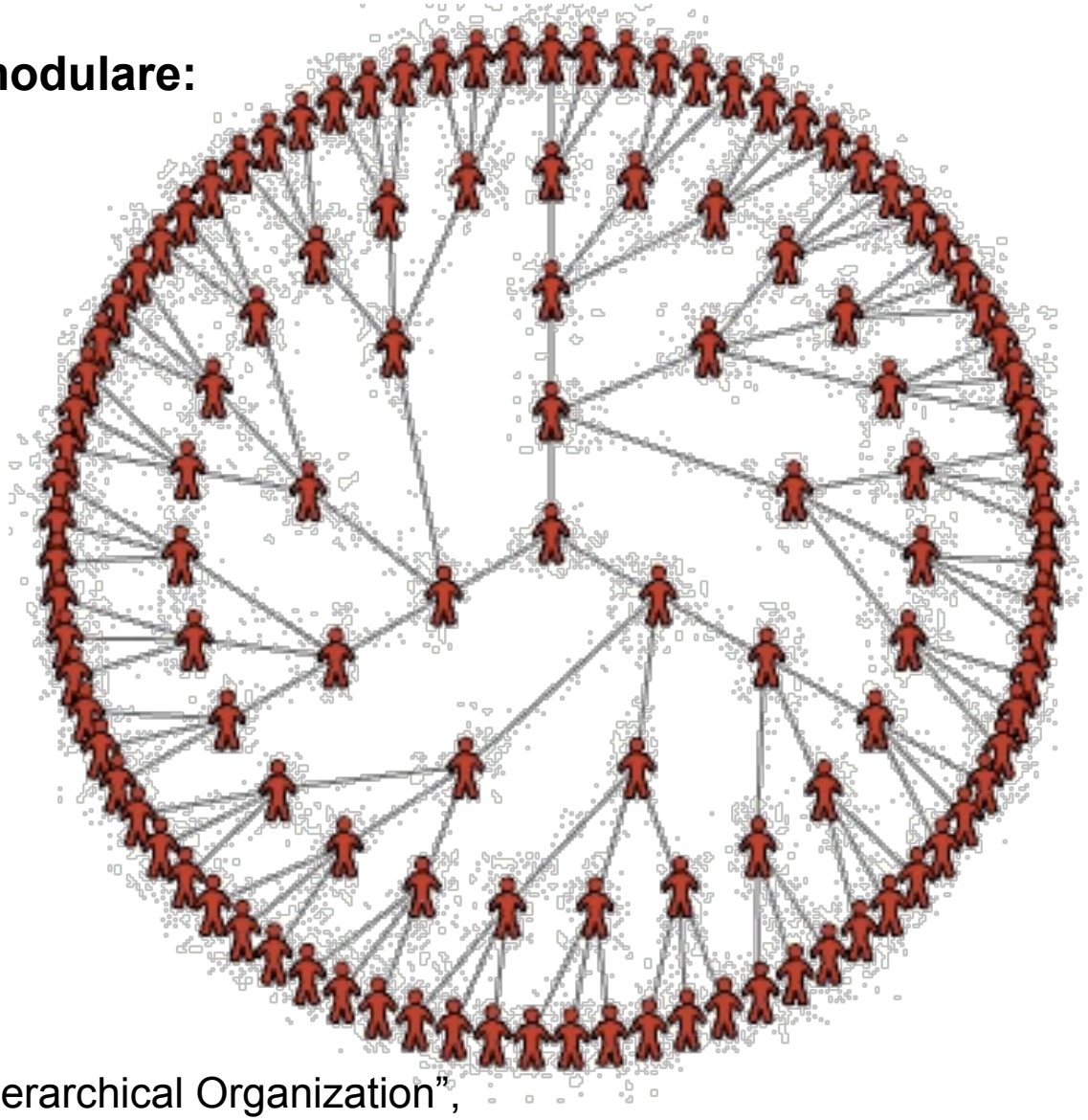
E' il caso della SEMCO e del suo manager Ricardo Semler che è riuscito a inventarsi un sistema di gestione aziendale rivoluzionario e partecipativo basato sulla rotazione dei ruoli , un meccanismo molto simile alla promozione casuale

Simulazioni con organizzazioni più complesse
(reti gerarchiche modulari)

Organizzazione gerarchica modulare:
K livelli
L subordinati ad ogni livello

Numero totale di membri:
N=$(L^K - 1)/(L-1)$

K=5, L=3 → **N**=121



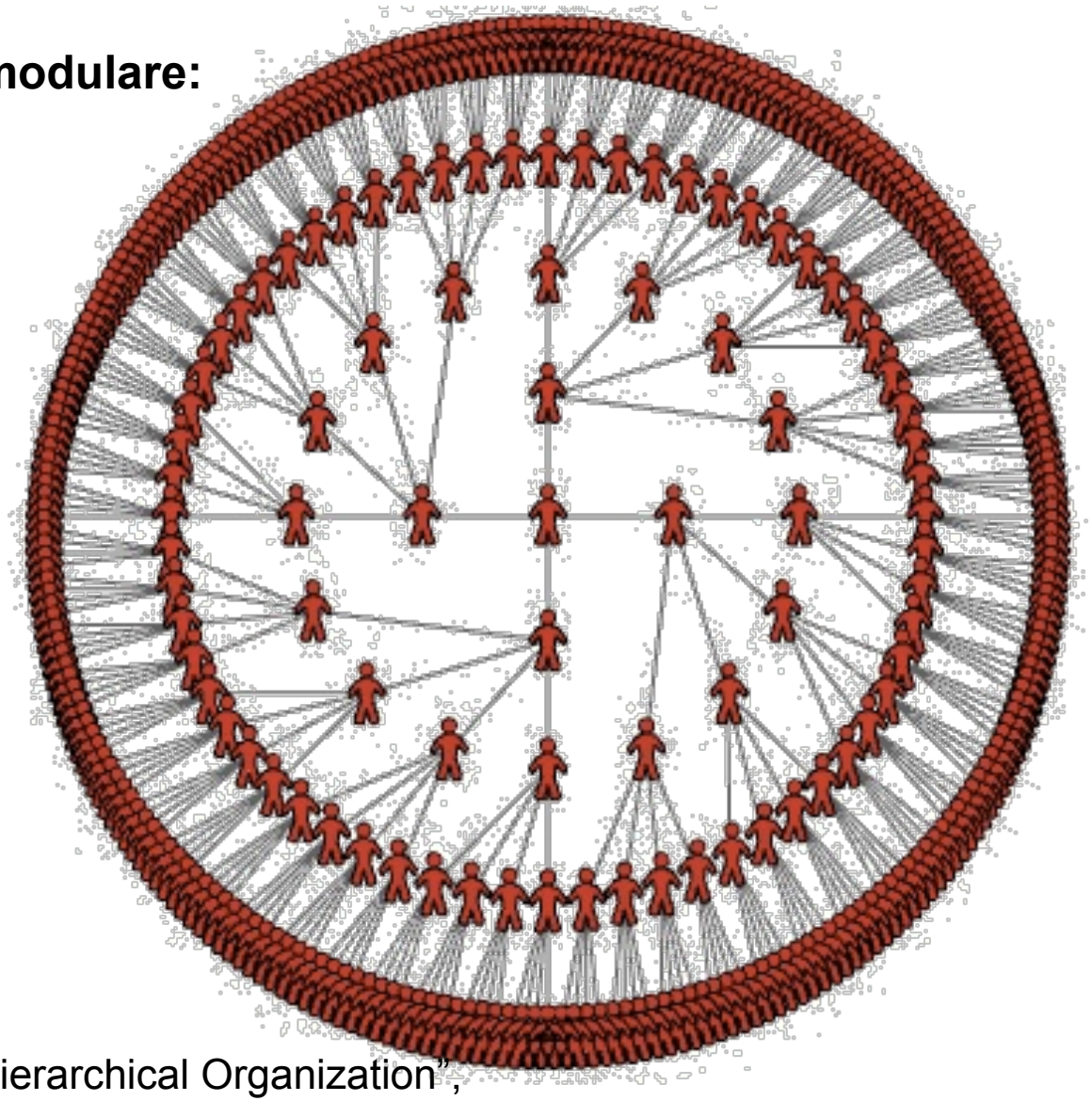
A.Pluchino, A.Rapisarda, C.Garofalo
"Efficient Promotion Strategies in a Hierarchical Organization",
Physica A in press (arXiv:1102.2837v1 [physics.soc-ph])

Simulazioni con organizzazioni più complesse
(reti gerarchiche modulari)

Organizzazione gerarchica modulare:
K livelli
L subordinati ad ogni livello

Numero totale di membri:
N=$(L^K - 1)/(L-1)$

K=5, L=4 → **N**=341



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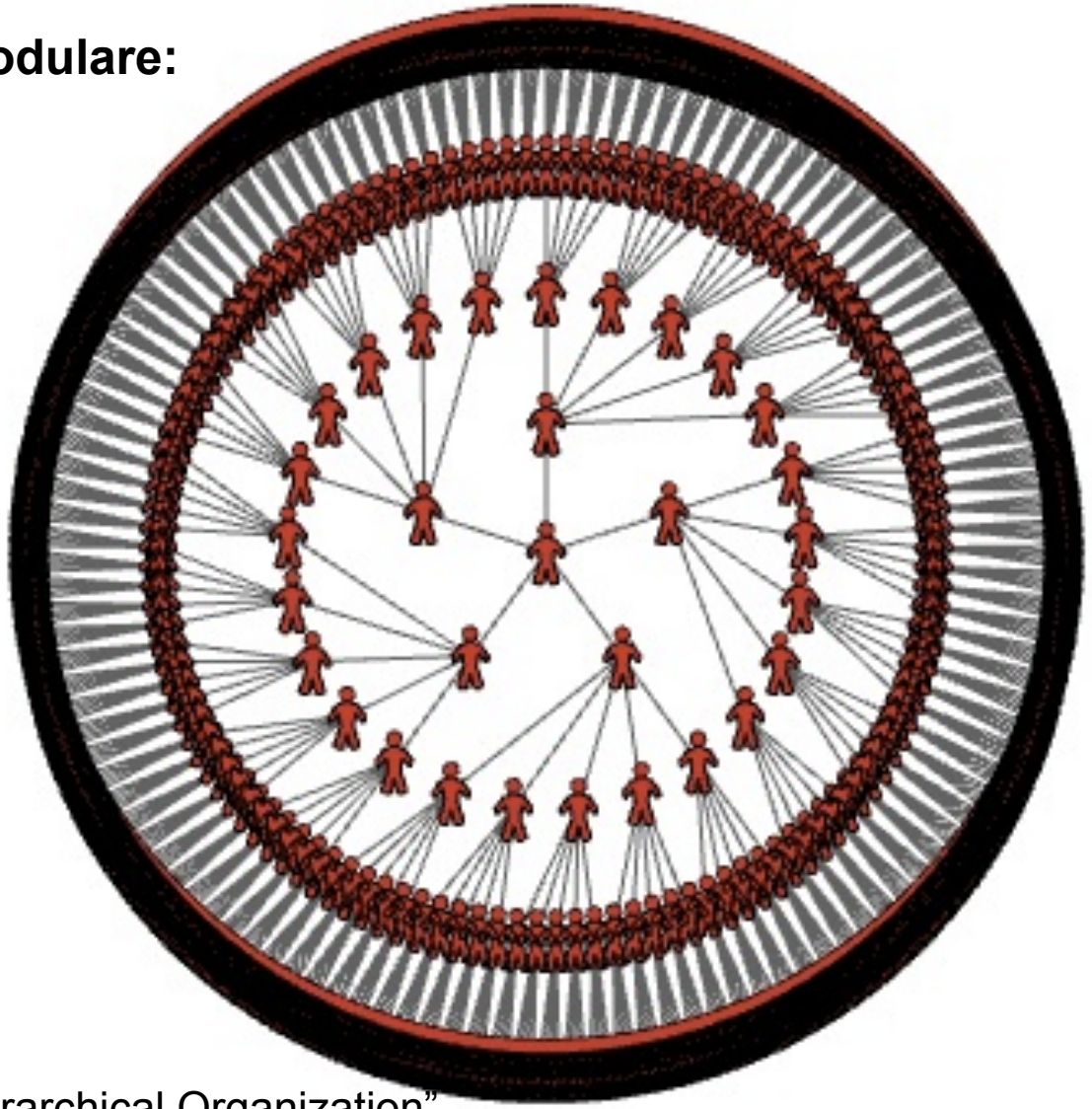
Simulazioni con organizzazioni più complesse
(reti gerarchiche modulari)

Organizzazione gerarchica modulare:
K livelli
L subordinati ad ogni livello

Numero totale di membri:
N=$(L^K - 1)/(L-1)$

K=5, L=5 → **N**=781



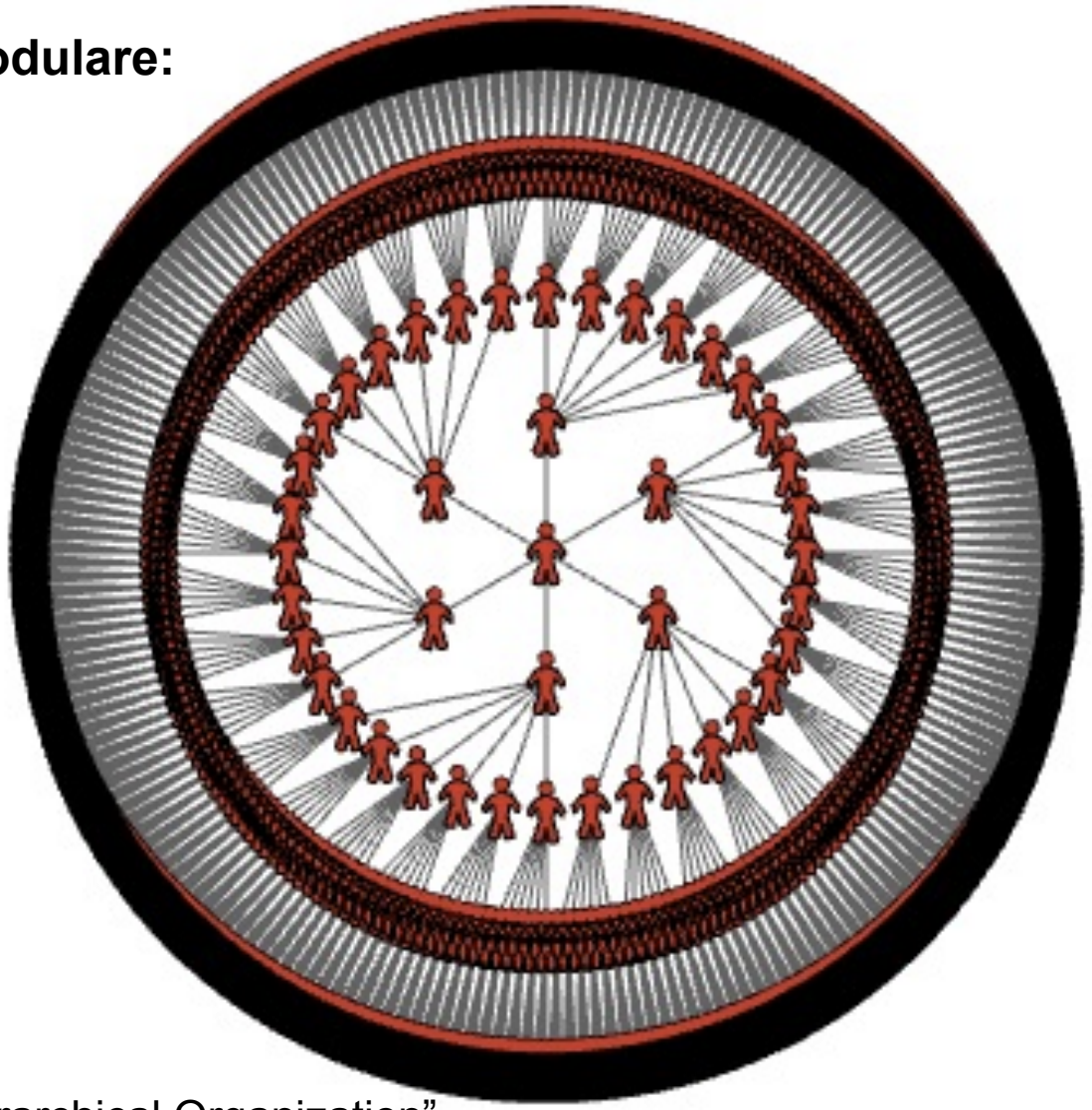
A.Pluchino, A.Rapisarda, C.Garofalo
"Efficient Promotion Strategies in a Hierarchical Organization",
Physica A in press (arXiv:1102.2837v1 [physics.soc-ph])

Simulazioni con organizzazioni più complesse
(reti gerarchiche modulari)

Organizzazione gerarchica modulare:
K livelli
L subordinati ad ogni livello

Numero totale di membri:
N=$(L^K - 1)/(L-1)$

K=5, L=6 → **N**=1555

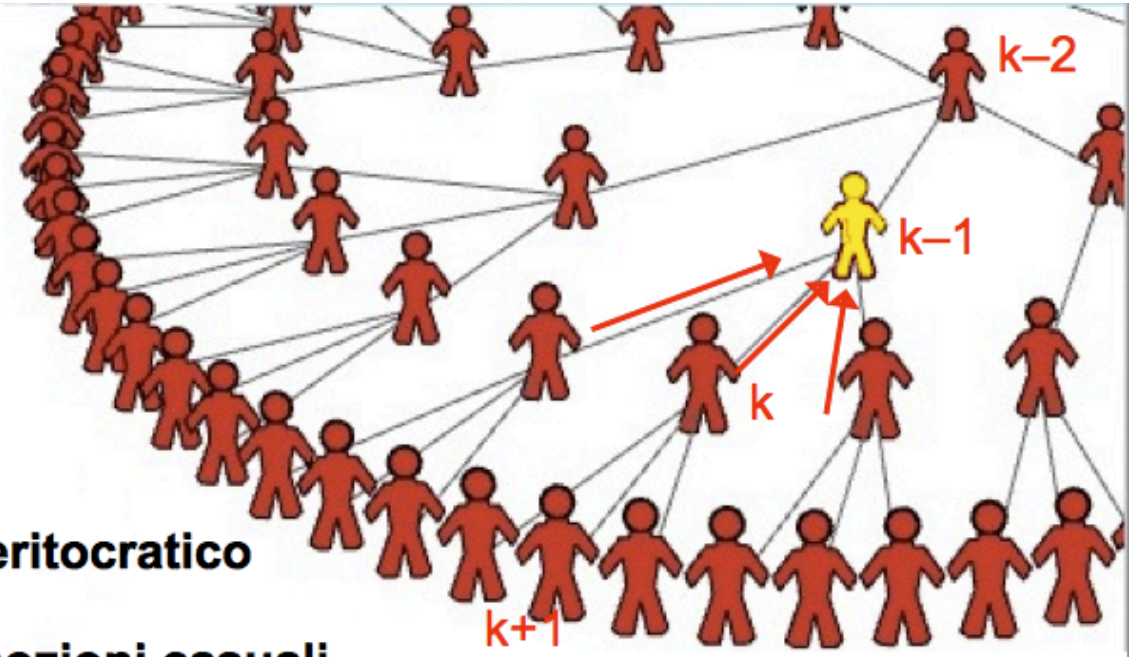


A.Pluchino, A.Rapisarda, C.Garofalo
"Efficient Promotion Strategies in a Hierarchical Organization",
Physica A in press (arXiv:1102.2837v1 [physics.soc-ph])

Introduzione di nuove regole....

Promozioni: Global - Neighbors

Una posizione al livello (k–1) può essere occupato dai suoi primi vicini (subordinati) al livello k



Introduzione di un transiente meritocratico

Percentuale variabile delle promozioni casuali

Variazione temporale delle competenze individuali

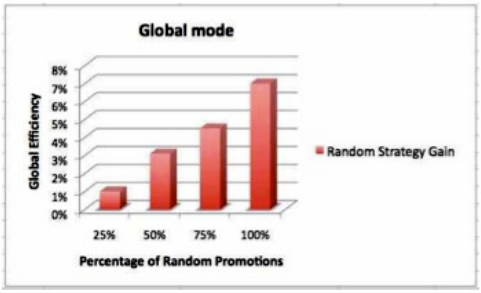
Scala non lineare per l'incremento della responsabilità con il livello

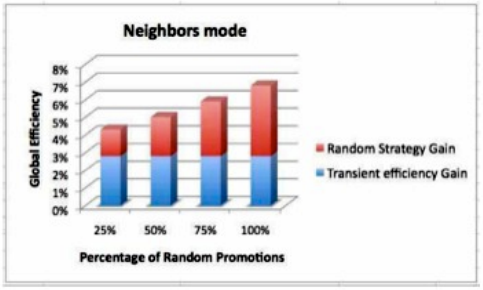
Ipotesi mista per la trasmissione delle competenze da un livello al successivo

Evoluzione temporale dell'efficienza in aziende con un numero variabile di posizioni occupate (contrazione ed espansione)

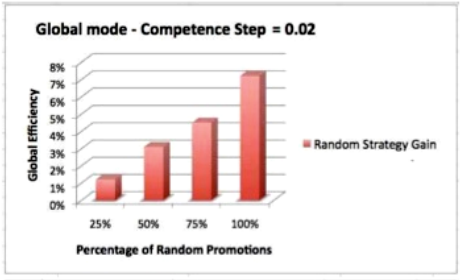
Nuovi Risultati: robustezza delle strategie random!

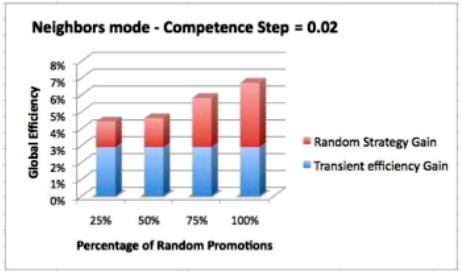
Percentuale variabile di promozioni casuali



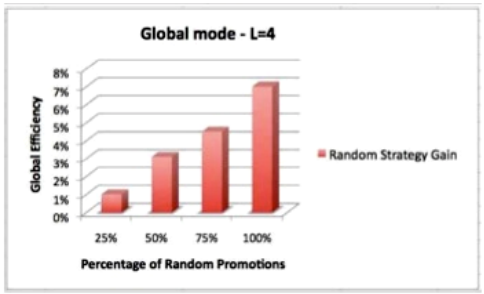


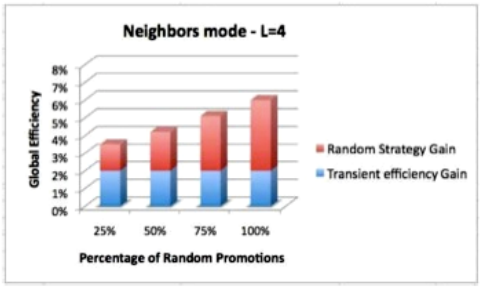
Variazione temporale delle competenze individuali



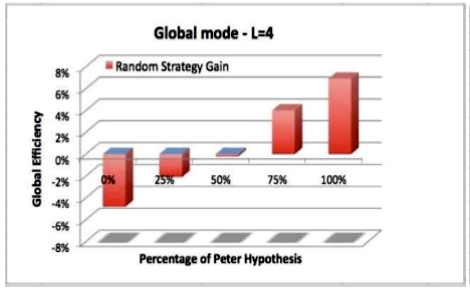


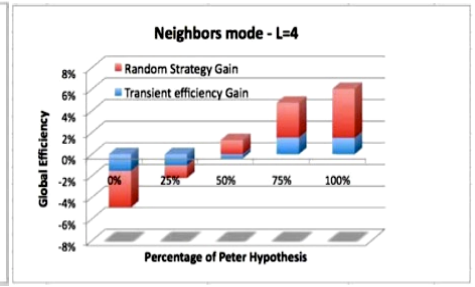
Scala non lineare per l'incremento della responsabilità



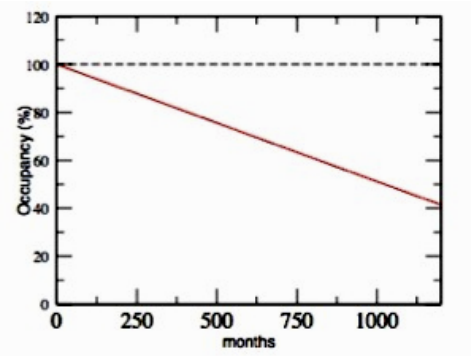


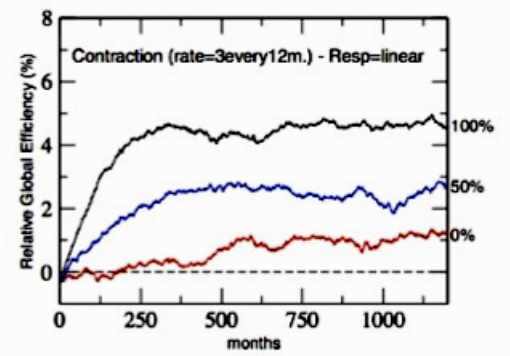
Ipotesi mista per la trasmissione delle competenze

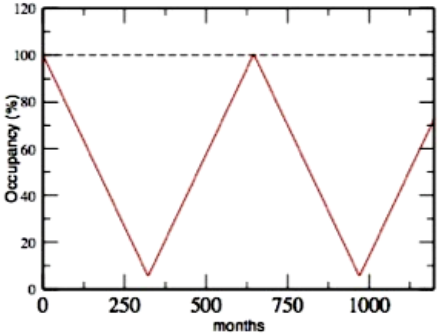


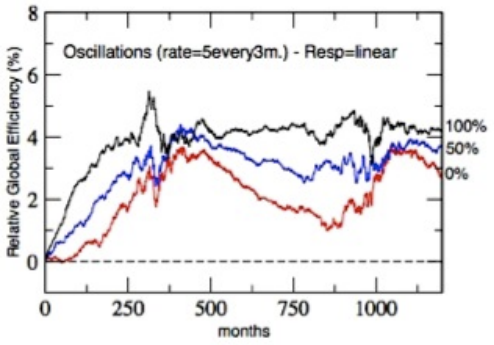


Evoluzione temporale dell'efficienza in aziende con un numero variabile di posizioni occupate (contrazione ed espansione)

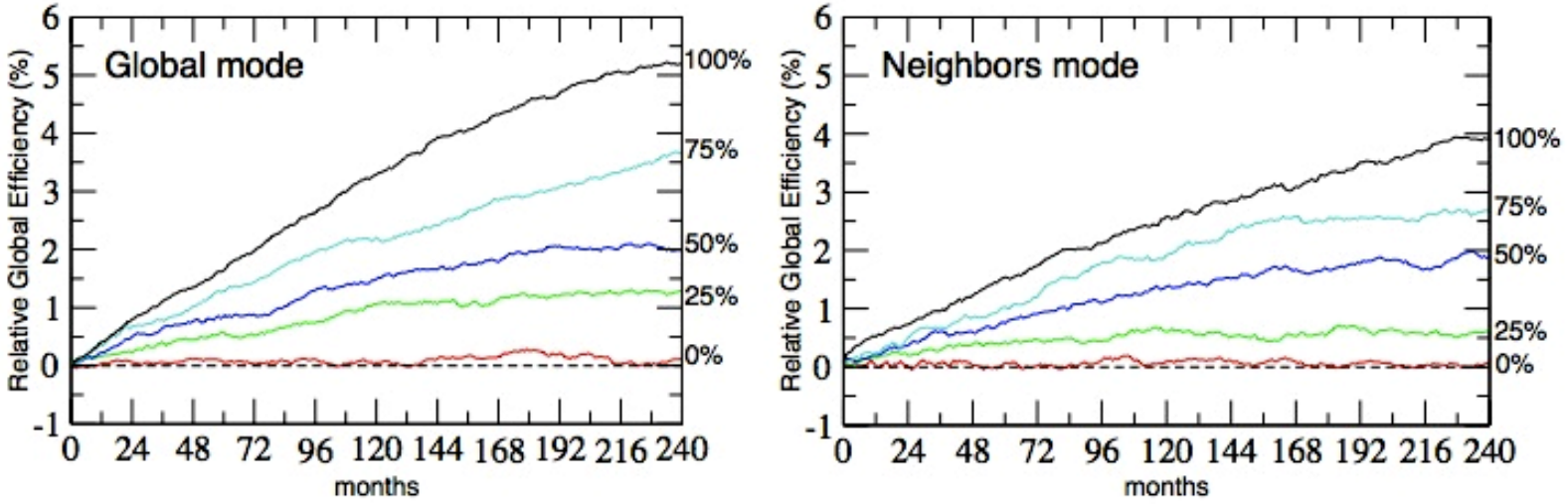








Analisi dei primi venti anni di utilizzo delle strategie random da parte di un'azienda



Global Mode - % of rnd prom.	*Trans.Eff.Gain*	*Rnd.Eff.Gain*	N_d	N_r	N_p
0%	0.00%	0.36%	22	206	84
25%	0.00%	1.01%	22	205	94
50%	0.00%	2.37%	20	206	96
75%	0.00%	3.80%	24	209	111
100%	0.00%	5.25%	23	204	116

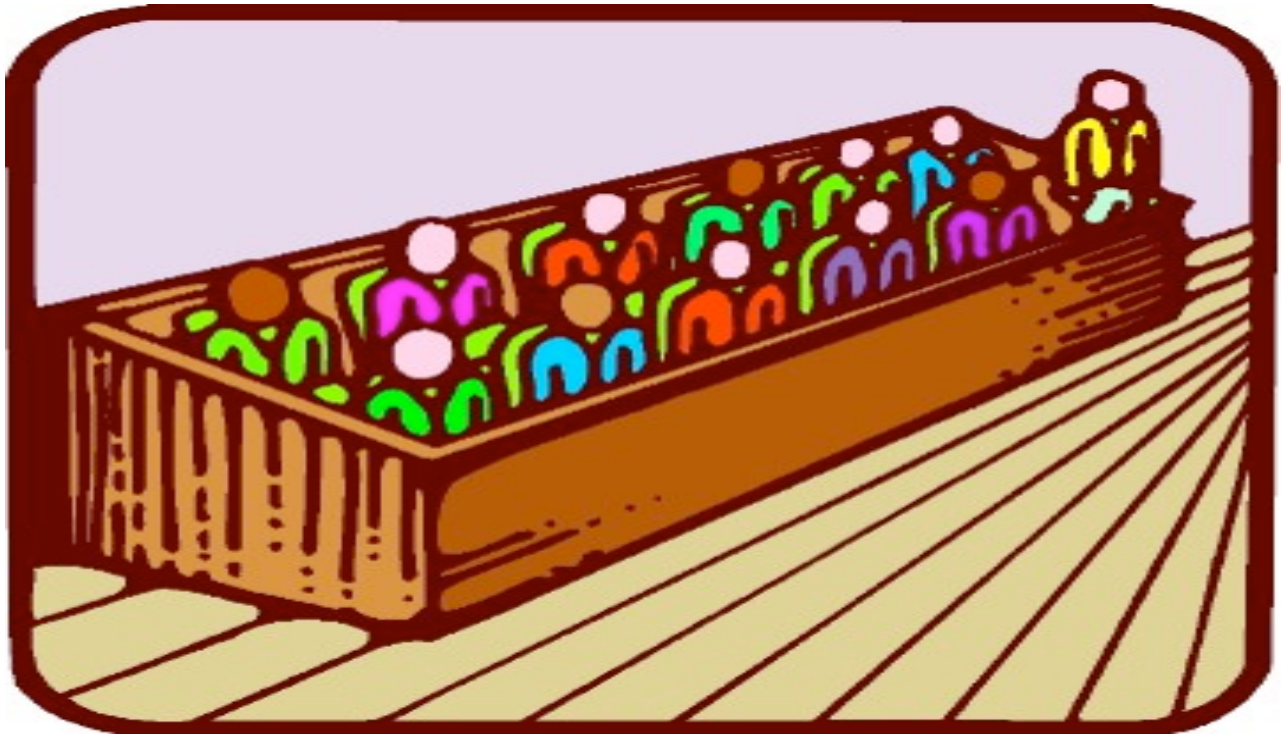
Global Mode - % of rnd prom.	N_5	N_4	N_3	N_2	N_1
0%	167	44	12	4	1
25%	161	46	14	4	2
50%	158	48	14	4	2
75%	155	54	17	5	2
100%	146	56	17	6	2

Neigh. Mode - % of rnd prom.	*Trans.Eff.Gain*	*Rnd.Eff.Gain*	N_d	N_r	N_p
0%	2.70%	0.14%	22	203	135
25%	2.70%	1.12%	24	204	136
50%	2.70%	1.42%	23	204	138
75%	2.70%	2.83%	25	201	144
100%	2.70%	3.70%	25	202	146

Neigh. Mode - % of rnd prom.	N_5	N_4	N_3	N_2	N_1
0%	133	61	21	8	2
25%	134	63	22	7	2
50%	132	63	23	7	2
75%	128	64	25	6	3
100%	128	65	24	7	3

La proposta di Segoléne Royal...

Una recente proposta della leader socialista francese Ségolène Royal va in una direzione analoga a quella delle promozioni casuali in quanto prevede l'introduzione di una **giuria popolare di cittadini estratti a sorte** che a scadenze fisse si pronunci sull'operato di deputati, sindaci e ministri.



Applicazione di strategie casuali al Parlamento

Estrarre a sorte una certa percentuale di deputati tra tutti i candidati in lista, e dunque renderli indipendenti dai partiti politici, può migliorare l'efficienza del Parlamento?

Accidental Politicians: How Randomly Selected Legislators Can Improve Parliament Efficiency

A. Pluchino[1], C. Garofalo[2], A. Rapisarda[1], S. Spagano[3] and M. Caserta[3]

[1] *Dipartimento di Fisica e Astronomia, Università di Catania, and INFN sezione di Catania, - Via S. Sofia 64, I-95123 Catania, Italy*
[2] *Dipartimento di Analisi dei Processi Politici, Sociali e Istituzionali, Universitá di Catania, Via Vittorio Emanuele II 8, I-95131 Catania, Italy*
[3] *Dipartimento di Economia e Metodi Quantitativi, Universitá di Catania, Corso Italia 55, I-95100 Catania, Italy*

arXiv:1103.1224v1 [physics.soc-ph]
http://www.pluchino.it/parliament.html

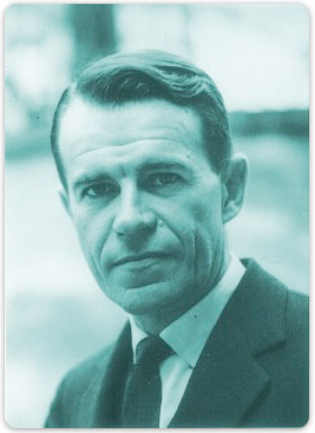
The Team (from left to right): A. Pluchino, C. Garofalo, M. Caserta (bottom), S. Spagano (top), A. Rapisarda

Utilizzo della Selezione Casuale nella Democrazia Ateniese e nel Rinascimento Italiano

Discussion and Historical Review. – Probably, for a modern political observer, our findings could sound very strange. In fact, today, most people think that democracy means elections, i.e. believe that only electoral mechanism could ensure representativeness in democracy. However, as already anticipated in the introduction, in the first significant democratic experience, namely the Athenian democracy, elections worked side by side with random selection (*sortition*) and direct participation. Actually, in that period Parties did not exist at all and random selection was the basic criterion when the task was impossible to be executed collectively in the Assembly, where usually Athenian citizens directly made the most important decisions. Of course only the names of those who wished to be considered were inserted into the lottery machines, the *kleroteria* [1–6].

Sortition was not used in Athens only. Probably, already others Greek city-states adopted the Athenian method, even if historical documentation is dubious. For sure, many others cities in the history used some kind of lot as rule, such as Bologna, Parma, Vicenza, San Marino, Barcelona and some parts of Switzerland. Lot was also used in Florence in the 13th and 14th century and in Venice from 1268 until the fall of the Venetian Republic in 1797, providing opportunities to minorities and resistance to corruption [22].

Modellare un Parlamento: il Diagramma di Cipolla



C.M.Cipolla, "The Basic Laws of Human Stupidity", The Mad Millers (1976)

Obiettivi dei Parlamentari:

1. **Interesse Personale: essere rieletti, acquisire vantaggi dalla propria posizione**
2. **Interesse Collettivo: incrementare il Social Welfare**

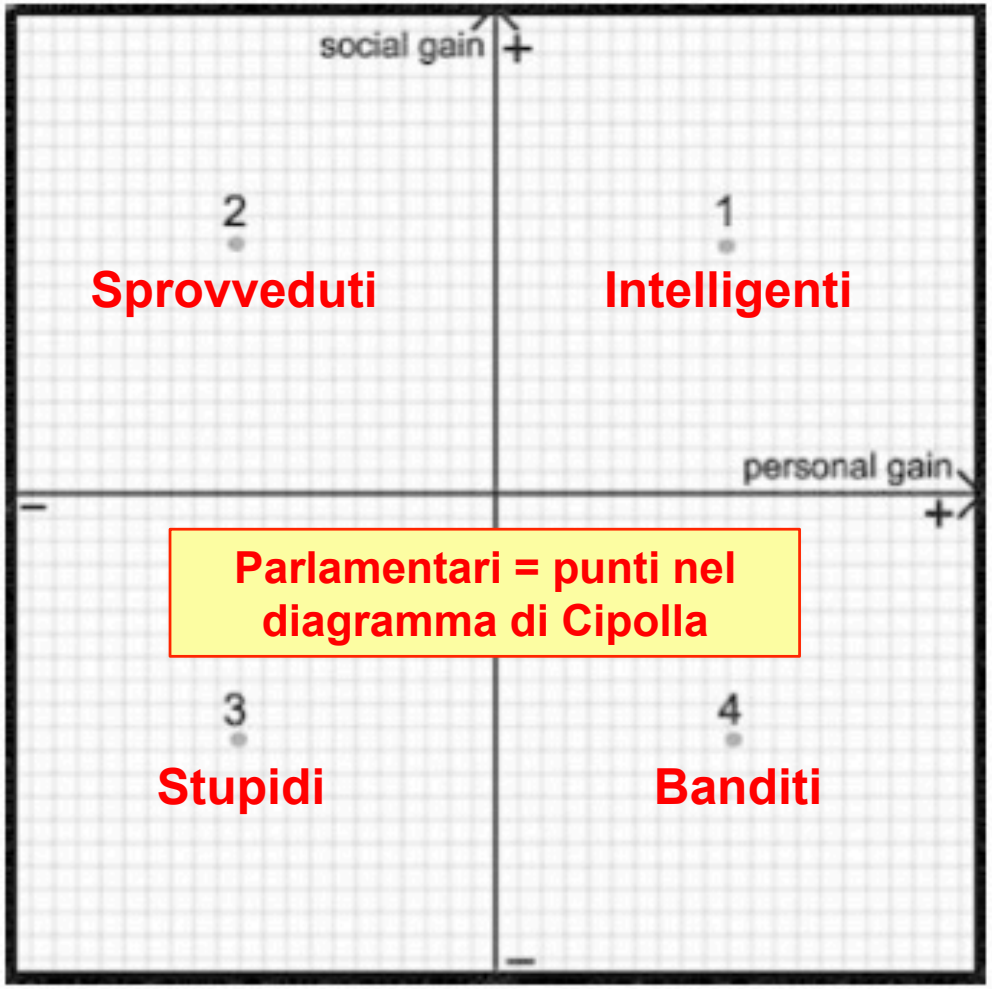


Fig. 1. *Cipolla Diagram. Both the axes have the same range [-1,1].*

2 Partiti o Coalizioni - il Cerchio di Tolleranza

1 Camera
N=500 deputati
P_1 (60%)
P_2 (40%)

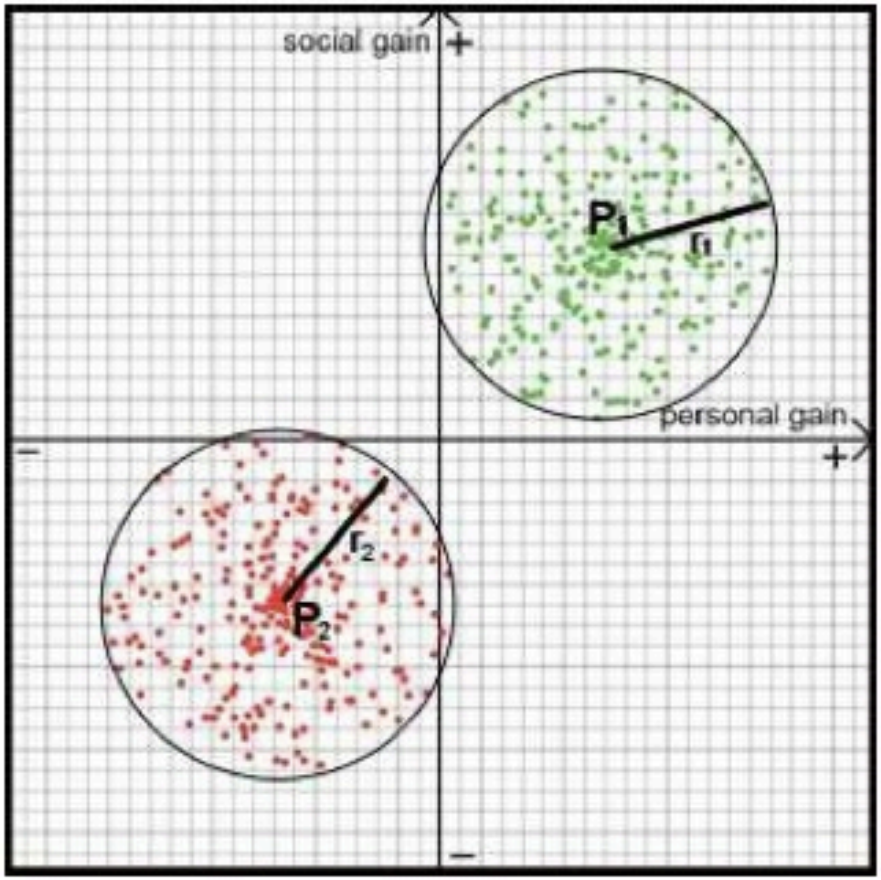
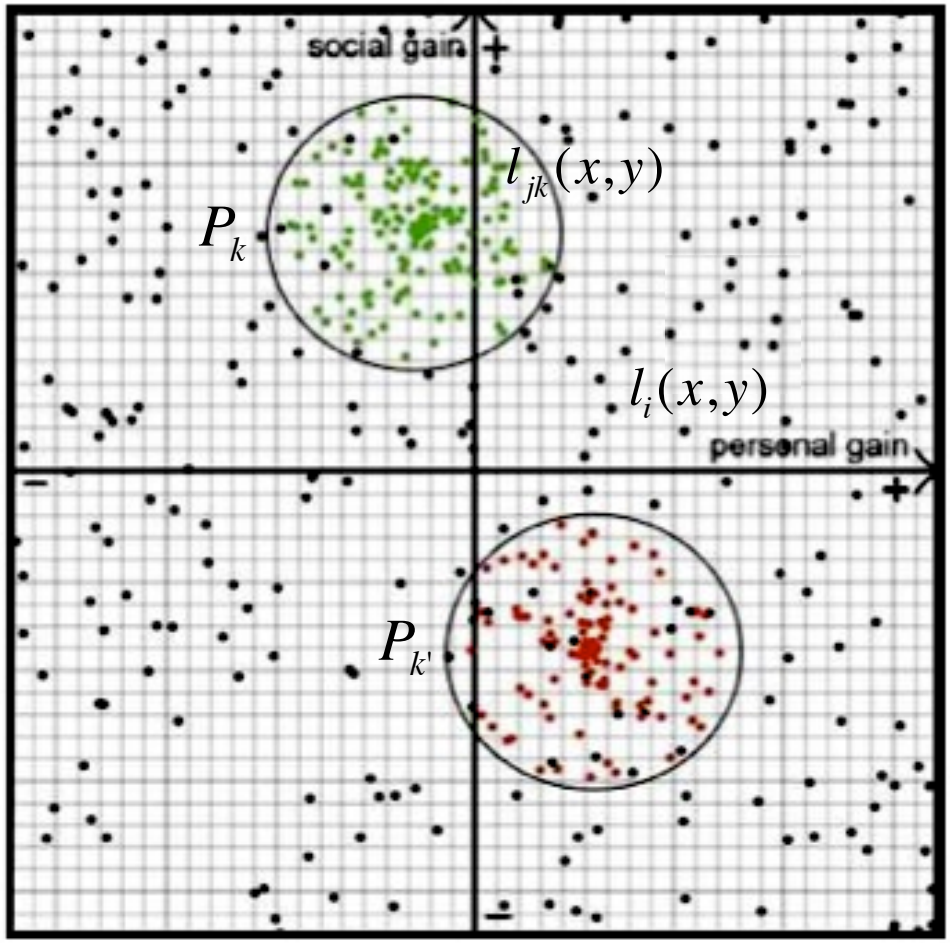


Fig. 2. *Cipolla Diagram for Parliaments with* $K = 2$ *parties. For each Party the respective* ***"circle of tolerance"****, equal for the two Parties and with a radius of* 0.4 *units, has been drawn. Each point inside a given circle represent a legislator* l_{ik} *member of the Party* k*-th.*

Introduzione di N_{ind} Parlamentari Indipendenti scelti a caso tra tutti i candidati



$l_i(x,y) \equiv$

i-mo deputato indipendente

$l_{jk}(x,y) \equiv$

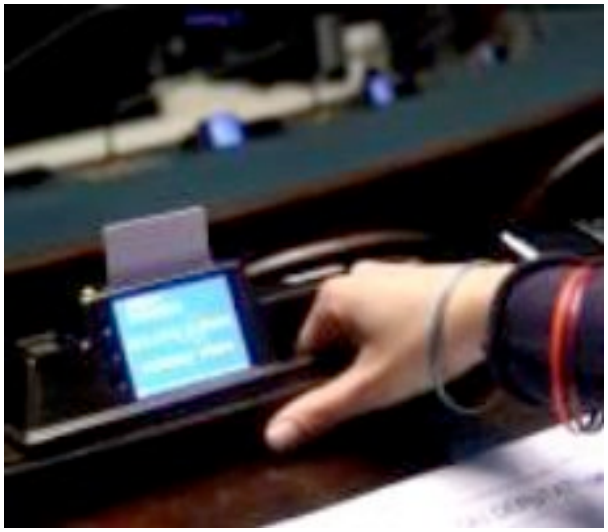
j-mo deputato del partito *k*-mo

Ai due partiti o coalizioni vengono assegnati, rispettivamente, il 60% e il 40% dei rimanenti (N – Nind) deputati

Fig. 3. *Example of a Parliament with two Parties and 250 independent members (black free points l_i) over a total of 500 legislators. Both the free points and the centers of the Parties are uniformly distributed over the diagram.*

Le Due Possibili Azioni dei Deputati durante una Legislatura L con 1000 proposte di legge:

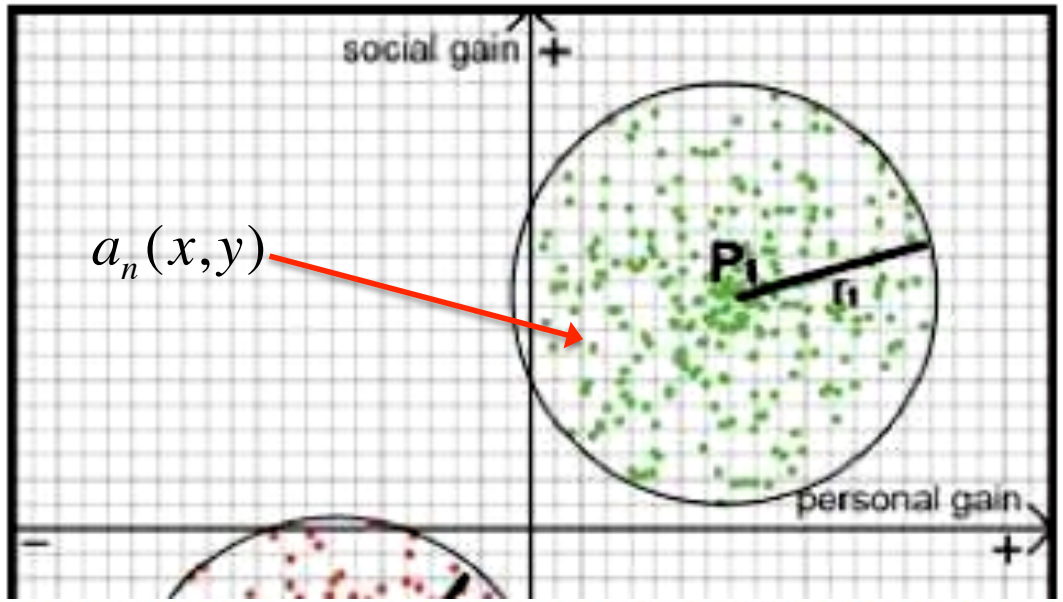
1.Avanzare una o più proposte di legge



2.Votare pro o contro le proposte di legge avanzate

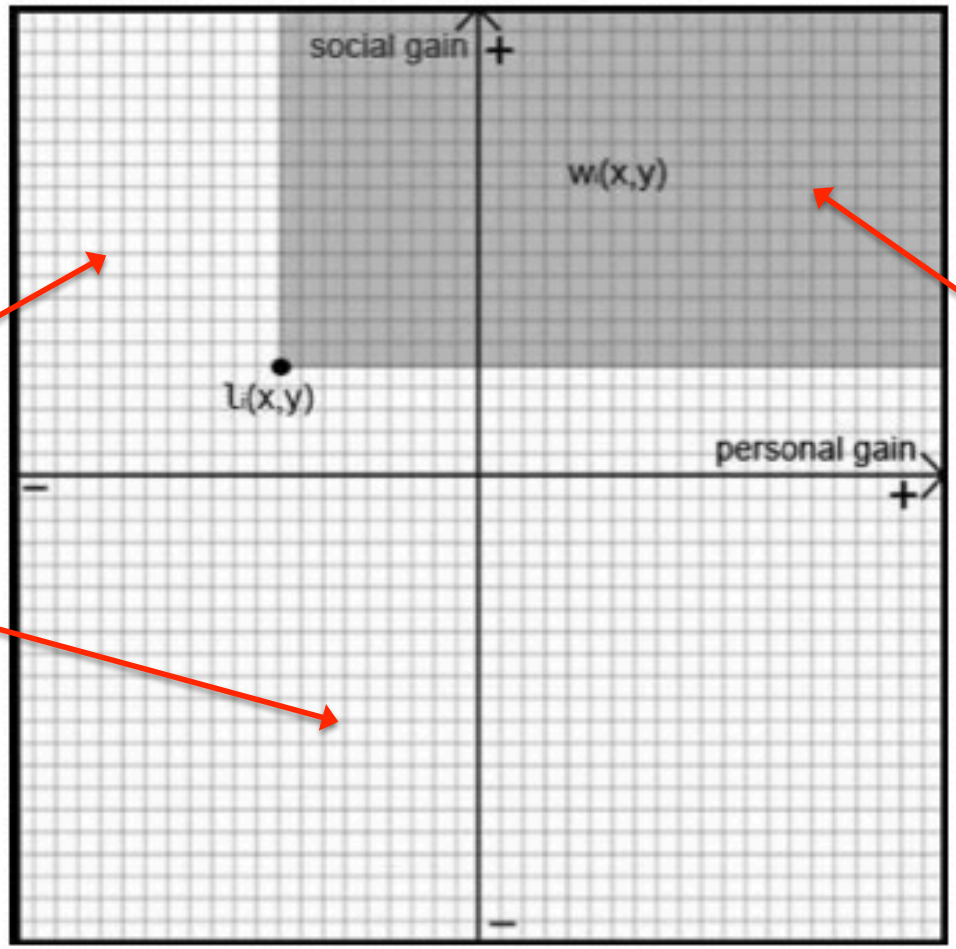
Una proposta di legge viene approvata se riceve il voto favorevole del 50% + 1 dei votanti (N/2 + 1)

Le proposte di legge



During a Legislature L, each member (legislator) l_{ik} of a Party k-th (where i goes from 1 to N_k, being N_k the total number of members of Party k-th, i.e. $\sum_k N_k = N$) proposes one or more acts of Parliament (a_n, with $n = 1, ..., N_a$, being N_a the total number of acts proposed during the Legislature) with a given personal and social advantage, depending on his/her position $l_{ik}(x, y)$ on the diagram (in other words $a_n(x, y) = l_{ik}(x, y)$ for every act proposed). Of course the size of the ***"circle of tolerance"*** indicates the extent to which the proposed act a_n (or the member who proposes it) may depart from the center of the Party k-th to which legislator l_{ik} belongs. In any case one has, for each Party, $P_k(x, y) \sim N_k{}^{-1} \sum_i l_{ik}(x, y)$, therefore the position of the center P_k of the Party will characterize the average legislative behavior of its members, in terms of obtaining personal benefits or achieving social welfare through their acts of Parliaments.

Il voto (a): la “Acceptance Window”



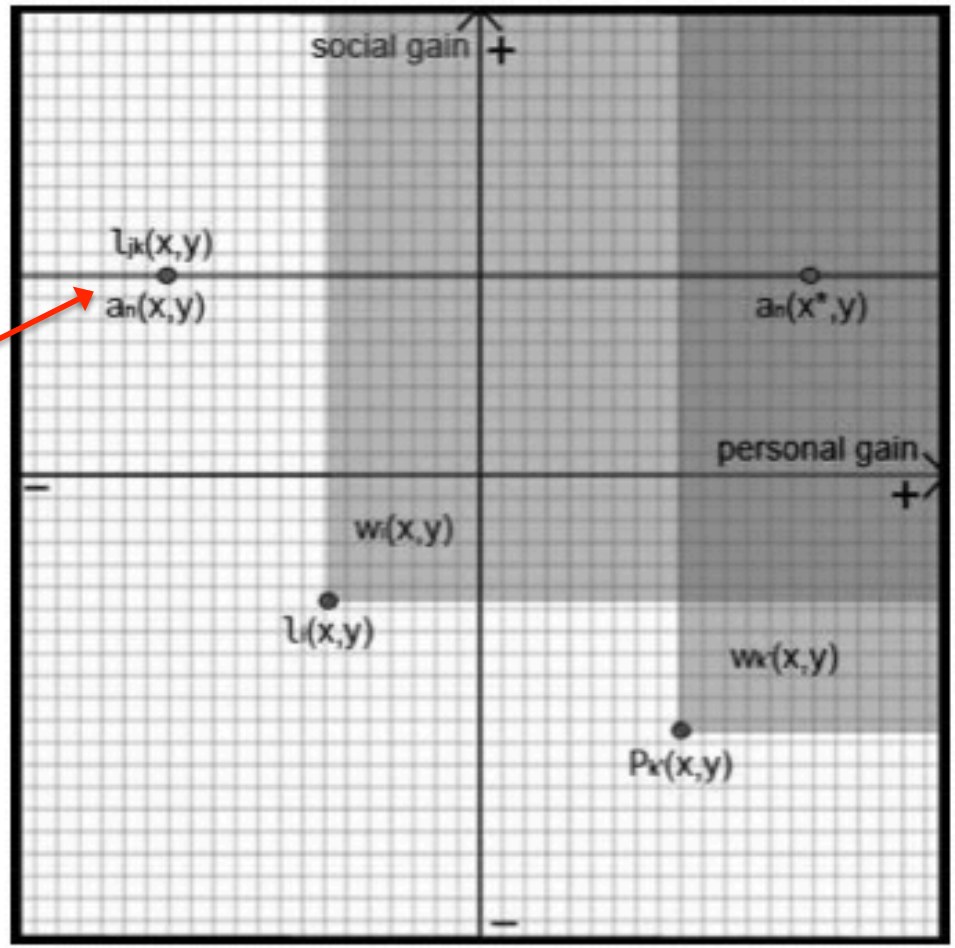
Se la proposta di legge cade fuori la “acceptance window”: il voto è **contrario**!

Se la proposta di legge cade dentro la “acceptance window”: il voto è **favorevole**!

Fig. 4. *In this example, the acceptance window for a free legislator l_i is represented in gray. It is defined as the subset* $w_i := \{(x, y) \in \Re \times \Re \mid x(l_i) \leq x \leq 1 \wedge y(l_i) \leq y \leq 1\}$. *An analogous window could be defined for a Party starting from its center* P_k.

Il voto (b): il "Voting Point"

L'interesse personale $x(a_n)$ di ciascun deputato rispetto a una proposta di legge di un altro deputato è casuale



Solo l'interesse collettivo $y(a_n)$ assicurato da una proposta di legge è definito in maniera univoca

Fig. 5. *In this example a new "voting point" $a_n(x^*, y)$ has been randomly extracted over the voting line (in gray) and compared with the acceptance window of legislator $l_{ik'}$: since the voting point falls within the window, $l_{ik'}$ should vote the correspondent act. The same voting point would be voted also by all the members of the Party since it falls within the window $w_{k'}$.*

L'Algoritmo di Voto

More in general, in presence of several Parties ($K \geq 2$) and of a certain number N_{ind} of independent legislators, for a given act of Parliament a_n we have the following possibilities:

- if the proponent is an independent legislator l_j

  - another independent legislator l_i (with $i \neq j$) votes the act only if the correspondent voting point $a_n(x^*, y)$ (randomly extracted from a uniform distribution and different for each legislator) falls within his/her acceptance window w_i (of course l_j will vote his own proposal in any case);

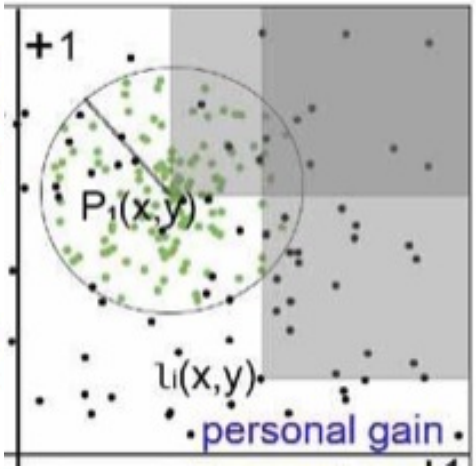
  - a legislator l_{ik}, member of the Party k-th, votes the act only if the correspondent voting point $a_n(x^*, y)$ (randomly extracted from a uniform distribution only one time for all the members of the Party) lies in the acceptance window of the Party w_k;

- if the proponent is a legislator l_{jk}, member of Party k-th

  - an independent legislator l_i votes the act only if the correspondent voting point $a_n(x^*, y)$ (randomly extracted from a uniform distribution and different for each legislator) falls within his/her acceptance window w_i:

  - a legislator $l_{ik'}$ belonging to the same Party with respect to l_{jk}, i.e. with $k' = k$, votes the act in any case;

  - a legislator $l_{ik'}$ not belonging to the same Party with respect to l_{jk}, i.e. with $k' \neq k$, votes the act only if the correspondent voting point $a_n(x^*, y)$ (randomly extracted from a uniform distribution only one time for all the members of Party k'-th) lies in the acceptance window of his/her Party $w_{k'}$.



Efficienza del Parlamento durante una Legislatura

At this point we need some global quantity which in some way would be able to express the efficiency of the Parliament during a Legislature L, being the latter defined as a sequence (array) of N_a acts of Parliament. An immediate measure of the Parliament activity is of course the number of accepted proposals (laws), N_{acc}, expressed as a percentage of the total number of proposed acts, i.e.

$$N_{\%acc}(L) = (N_{acc}/N_a) * 100 \quad (1)$$

Percentuale di leggi approvate (da 0% a 100%)

But another important quantity is surely the average social welfare ensured by all the accepted acts of Parliament, expressed by:

$$Y(L) = {N_{acc}}^{-1} \sum_{m=1}^{N_{acc}} y(a_m) \quad (2)$$

Social Welfare medio assicurato dalle leggi approvate (tra -1 e 1)

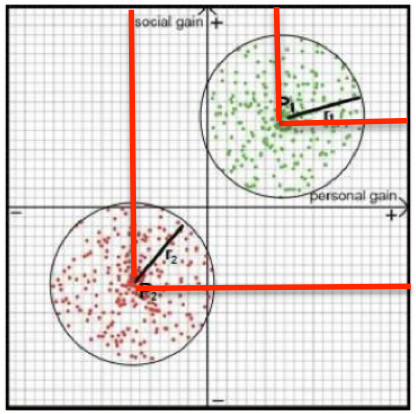
Therefore it is straightforward to take the product of these two quantities in order to obtain the efficiency of a Legislature:

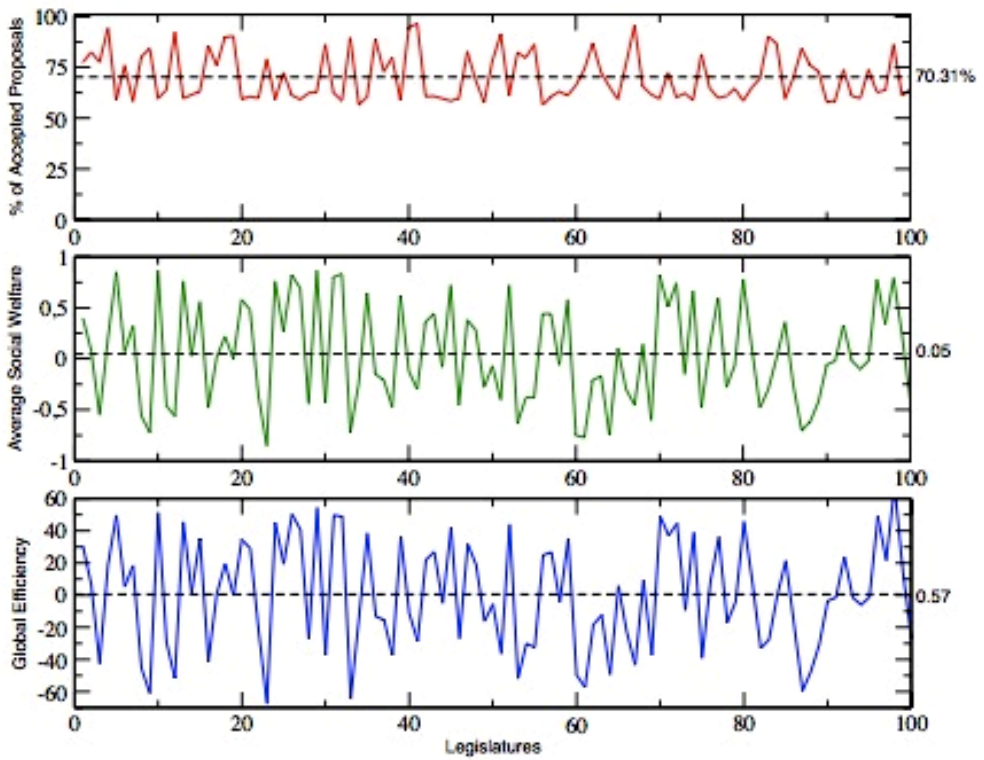
$$Eff(L) = N_{\%acc}(L) * Y(L). \quad (3)$$

Efficienza globale (tra -100 e 100)

Simulazioni: Caso N_{ind}=0

Il Parlamento è composto dai soli 2 Partiti P_1 (60%) e P_2 (40%)





Molte leggi approvate

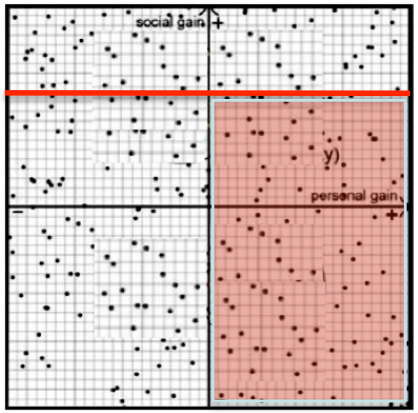
Scarso social welfare medio

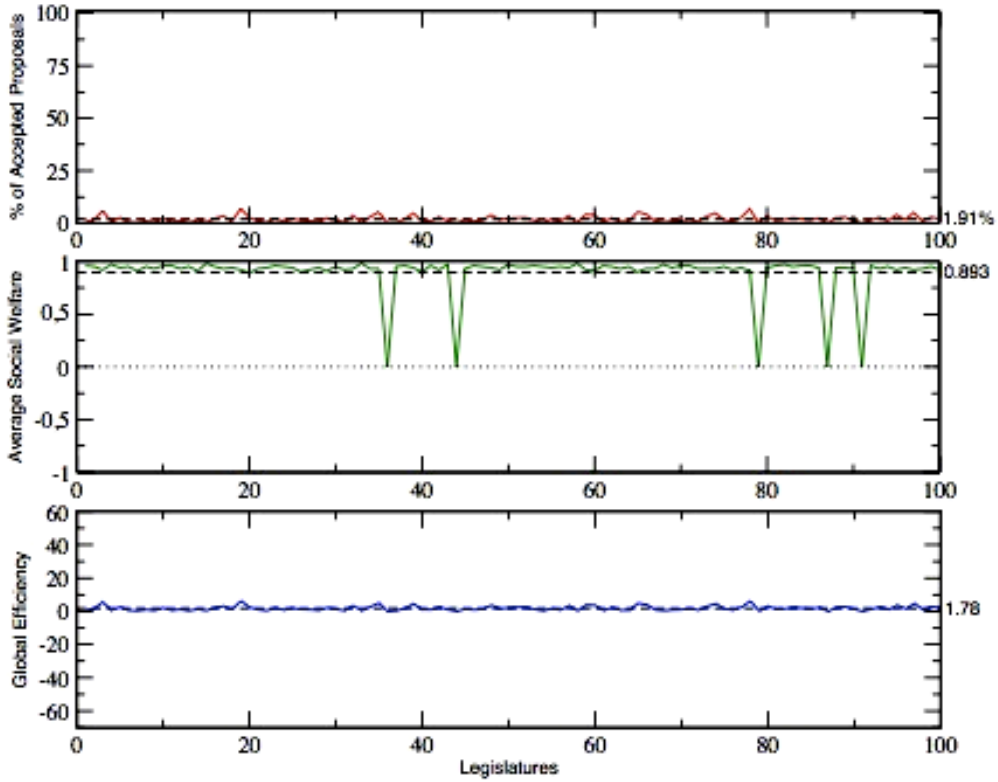
L'Efficienza Globale è quasi nulla!

Fig. 6. *Simulation results for a Parliament with* 500 *members distributed into two Parties* P_1 *and* P_2 *with, respectively, the* 60% *and* 40% *of legislators (as shown in Fig.2) and radius* $r_1 = r_2 = r = 0.1$. *No independent legislators are present* ($N_{ind} = 0$). *In the three panels we plot (from top to bottom), for a set of* $N_L = 100$ *Legislatures (each one with a different position of* P_1 *and* P_2 *over the Cipolla diagram), the percentage of accepted proposals* $N_{\%acc}(L)$, *the average social Welfare* $Y(L)$ *and the correspondent efficiency, calculated as the product* $Eff(L) = N_{\%acc}(L) * Y(L)$. *For each Legislature* L *an array of* $N_a = 1000$ *proposals has been considered. The averaged values for the three quantities are reported on the right and are sketched with a dashed line inside the panels.*

Simulazioni: Caso N_{ind}=N

Il Parlamento è composto solamente da deputati indipendenti





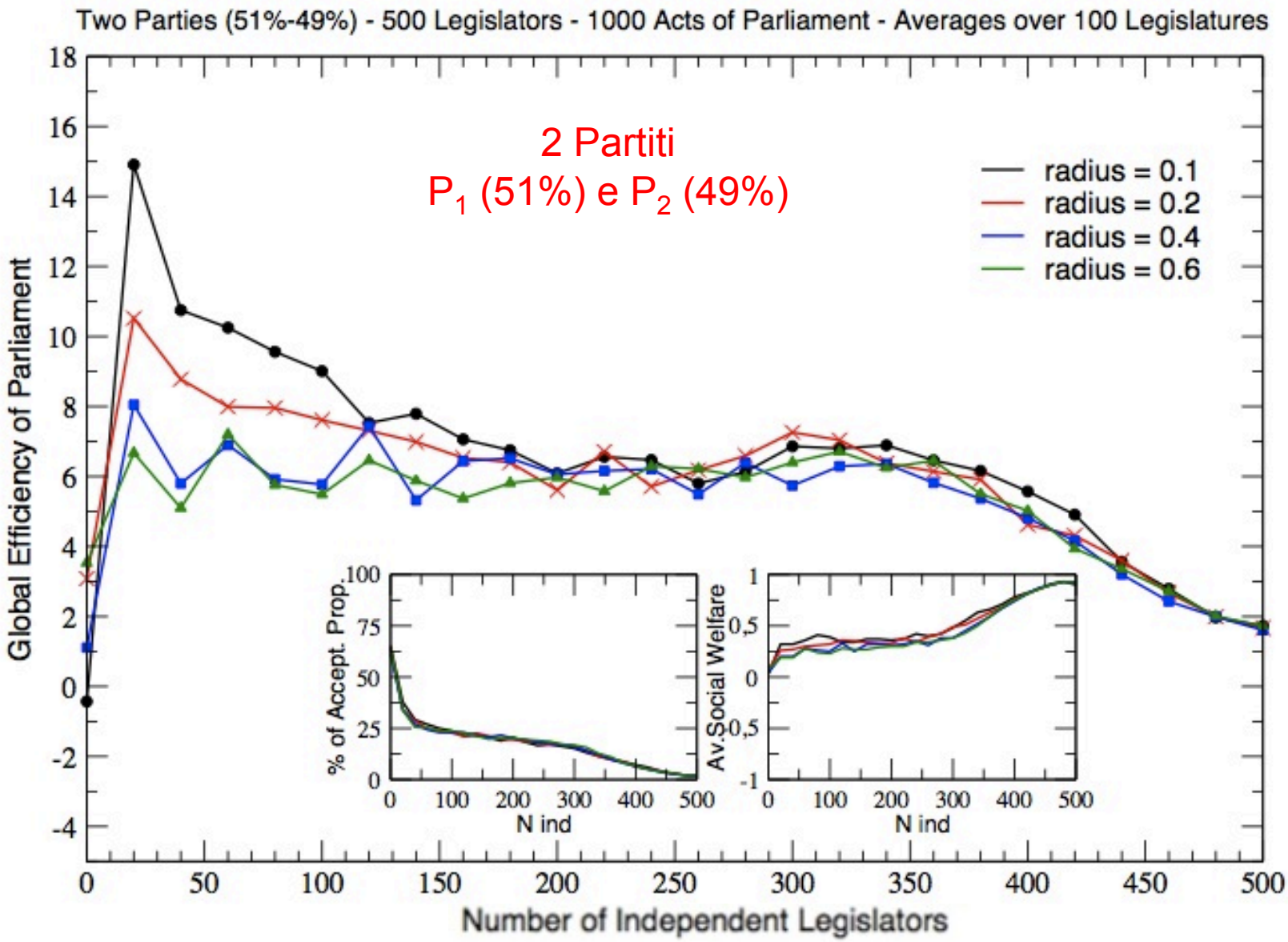
Poche leggi approvate

Elevatissimo social welfare medio

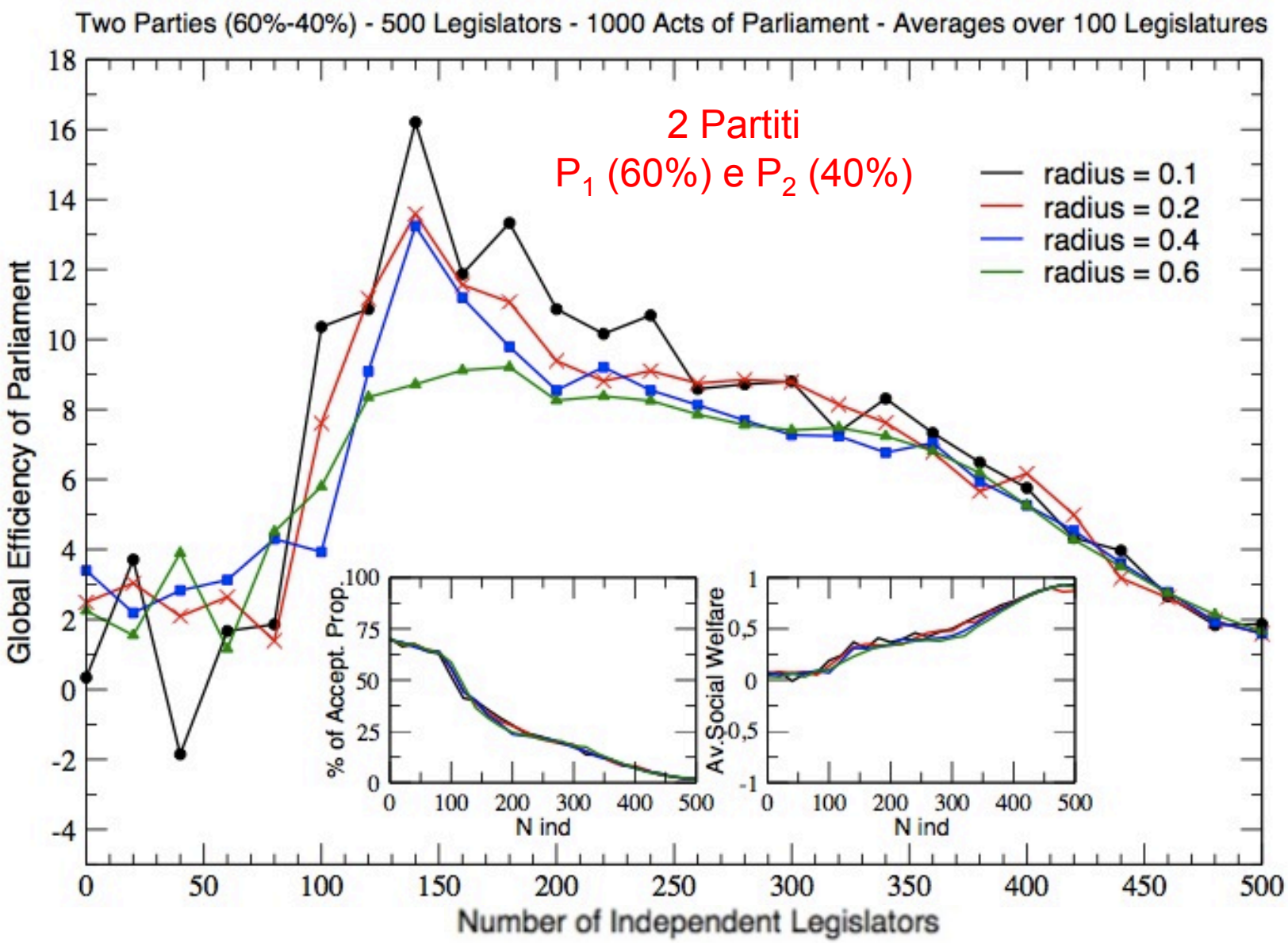
L'Efficienza Globale è di nuovo molto bassa!

Fig. 7. *Simulation results for a Parliament with* ($N_{ind} = 500$) *independent members, without any Parties. As in the previous figure, in the three panels we plot (from top to bottom), for a set of* $N_L = 100$ *Legislatures (each one with a different distribution of free points, representing the independent legislators), the percentage of accepted proposals* $N_{\%acc}(L)$*, the average social Welfare* $Y(L)$ *and the correspondent efficiency, calculated as the product* $Eff(L) = N_{\%acc}(L) * Y(L)$*. For each Legislature* L *an array of* $N_a = 1000$ *proposals has been considered. The averaged values for the three quantities are reported on the right and are sketched with a dashed line inside the panels.*

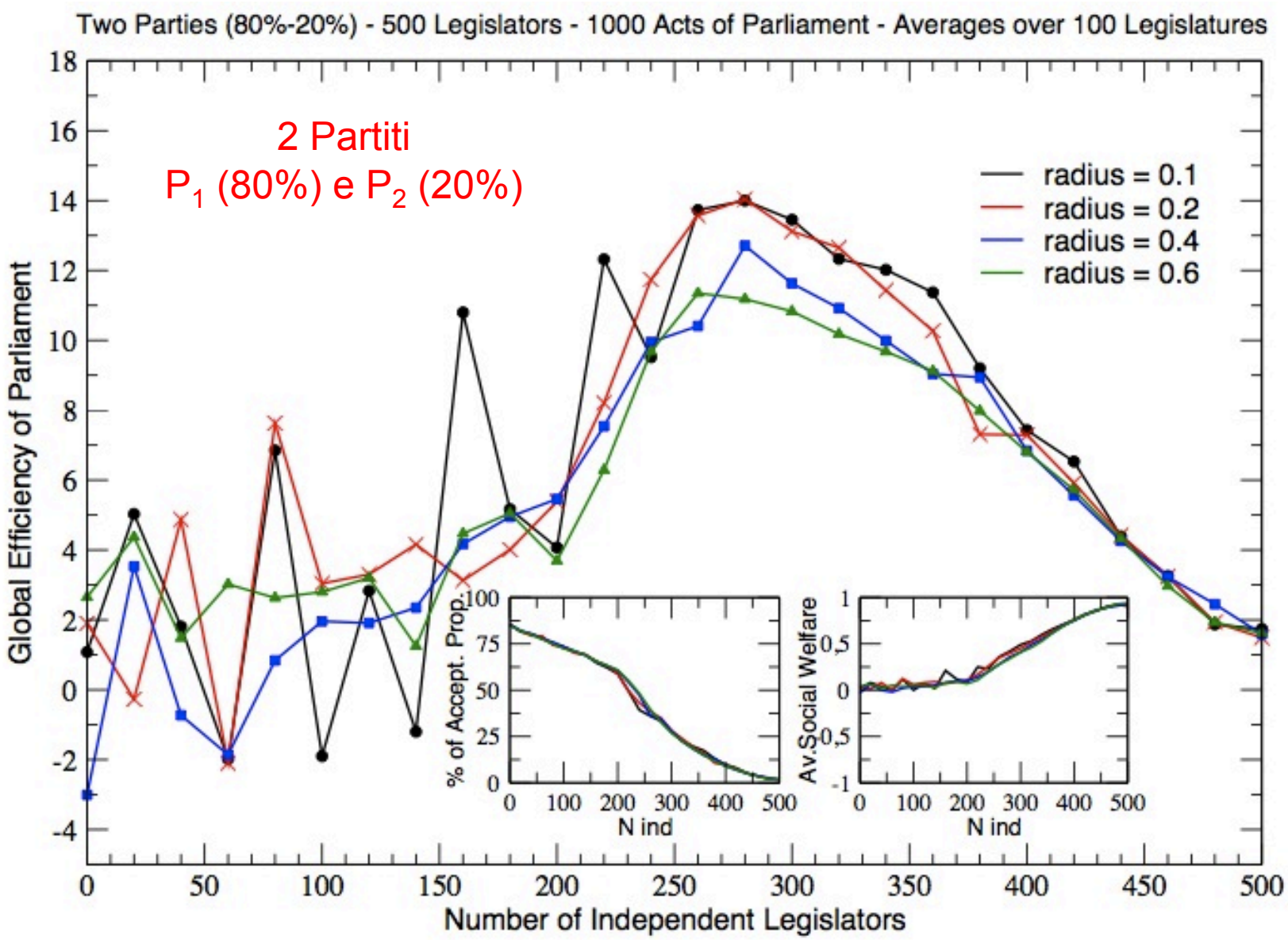
Simulazioni: Caso N_{ind} variabile



Simulazioni: Caso N_{ind} variabile

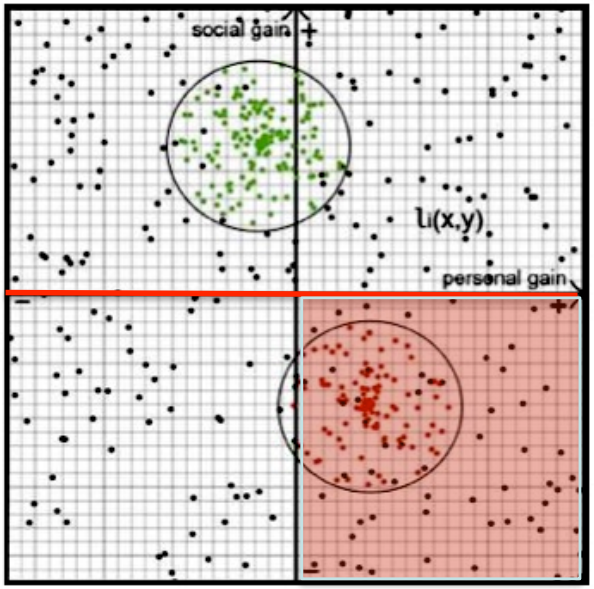


Simulazioni: Caso N_{ind} variabile



Efficiency Golden Rule

$$(N - N^*_{ind}) \cdot \frac{p}{100} + \frac{N^*_{ind}}{4} = \frac{N}{2} + 1 \longrightarrow N^*_{ind} = \frac{2N - 4N \cdot (p/100) + 4}{1 - 4 \cdot (p/100)}$$



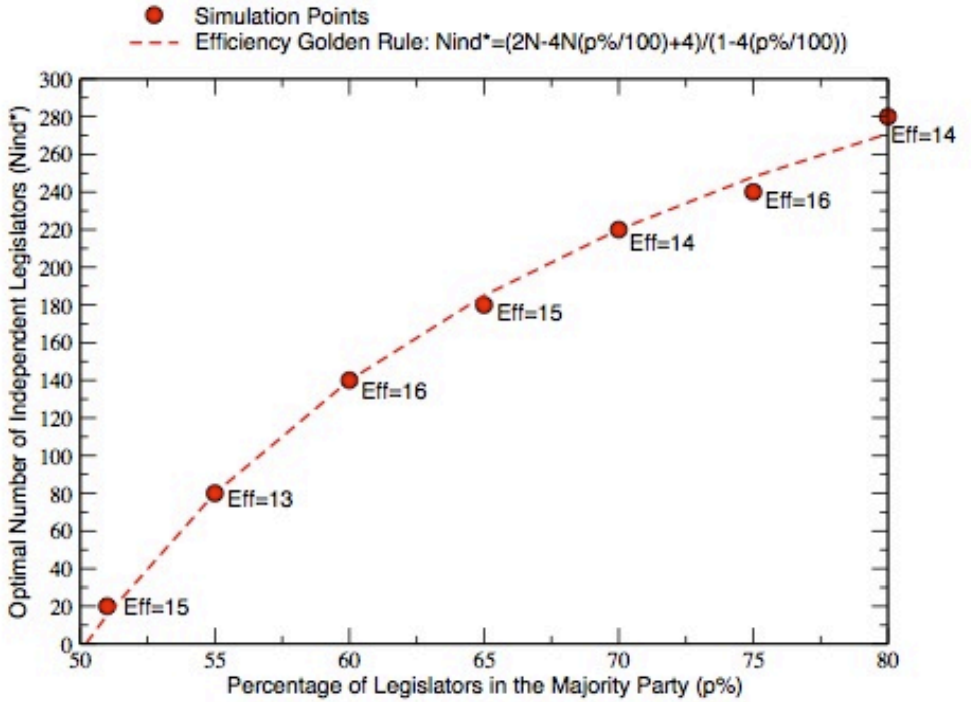
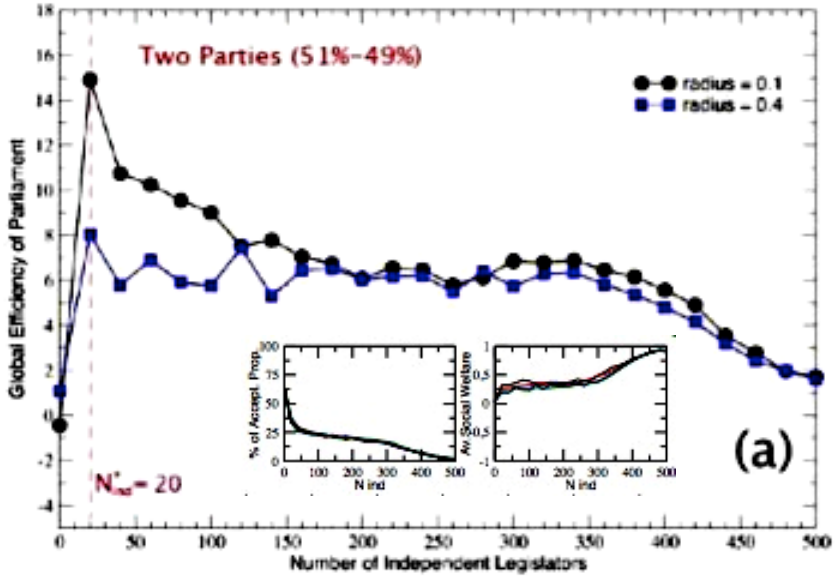
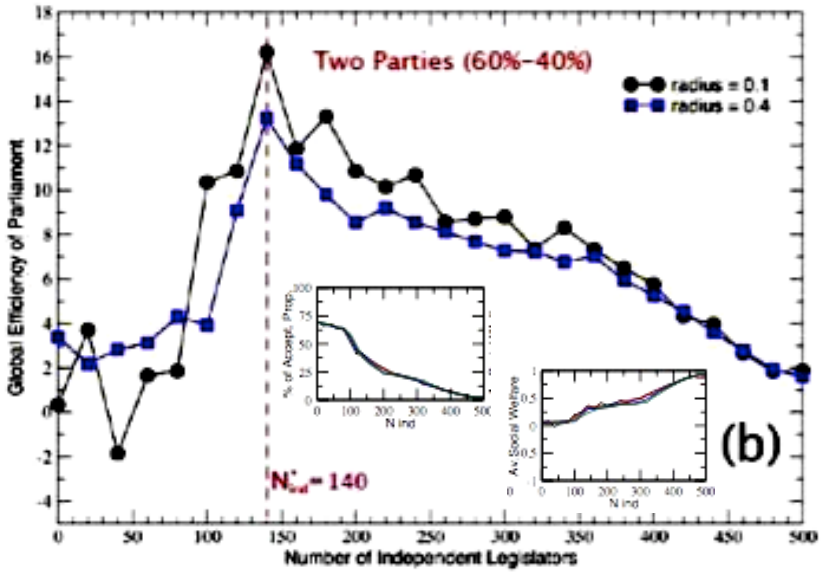
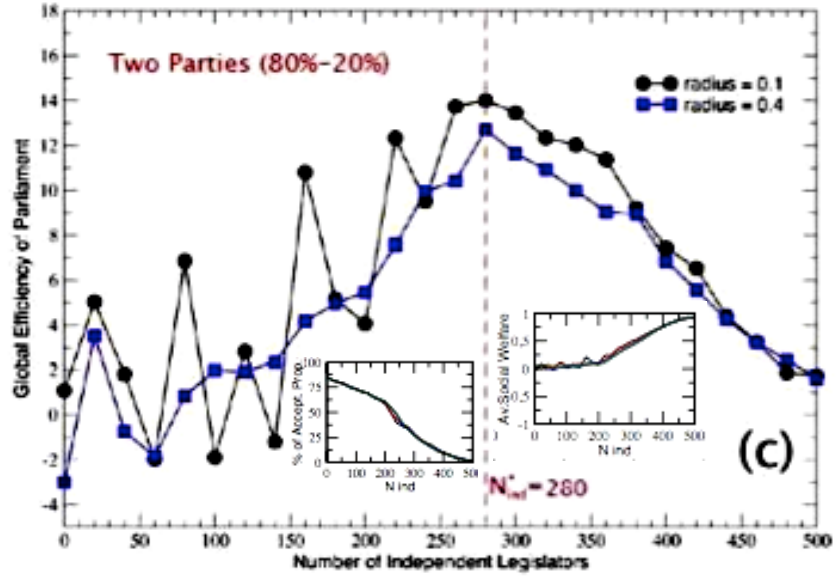


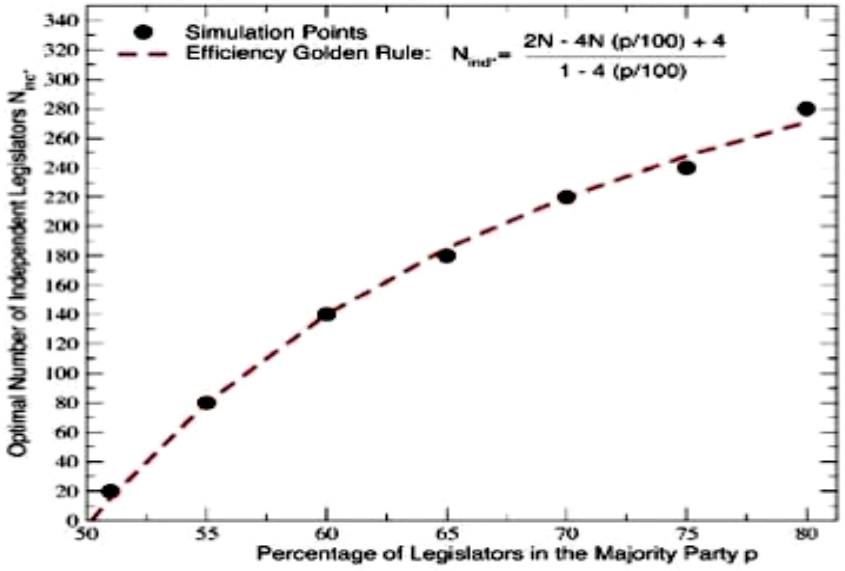
Fig. 9. *The optimal number of independent legislators* N^*_{ind} *is plotted (full circles) as function of the size of the majority Party* P_1*, for a Parliament with* $N = 500$ *members and two Parties* P_1 *and* P_2 *with circles of* ***tolerance*** *of radius* $r = 0.1$*. As usual, an average over* 100 *Legislatures, each one with* 1000 *proposals of acts of Parliament, has been performed. On the right side of each point, the correspondent value of the maximum global efficiency* $AV(Eff)[N^*_{ind}]$ *is reported. This plot is invariant for values of the radius* $0.1 < r < 0.5$*. The dashed line represents the prediction of the "efficiency golden rule" (see text).*

Riepilogo dei Risultati









Applicazione all'ARS (elezioni 2008)

Candidati	Voti	%	Partiti	Voti	%	Seggi
Raffaele Lombardo 	1.862.959	65,3	Pdl – Berlusconi Presidente MPA – Alleati per il Sud Udc Lombardo Presidente Democratici Autonomisti	900.149 371.418 336.826 119.892 101.449	33,5 13,8 12,5 4,5 3,8	35 15 11 – –
Anna Finocchiaro 	866.044	30,4	Pd – Finocchiaro Presidente La Sinistra L'Arcobaleno – Rita Borsellino Anna Finocchiaro Presidente Italia dei Valori Lista di Pietro	505.420 131.213 83.700 49.726	18,8 4,9 3,1 1,8	19 – – –
Sonia Alfano 	69.511	2,4	Amici di Beppe Grillo – Con Sonia Alfano	46.396	1,7	–
Ruggero Razza 	45.605	1,6	La Destra Fiamma Tricolore	39.143	1,5	–
Giuseppe Bonanno Conti 	6.606	0,2	Forza Nuova	3.876	0,1	–

$$N = 90 \begin{cases} N_1 = 63 & \rightarrow p_1 = 70\% \\ N_2 = 27 & \rightarrow p_2 = 30\% \end{cases}$$

$$N^*_{ind} = \frac{2N - 4N \cdot (p/100) + 4}{1 - 4 \cdot (p/100)}$$

$$p_1/100 = p/100 = 0.7$$

Rappresentazione attuale nell'ARS

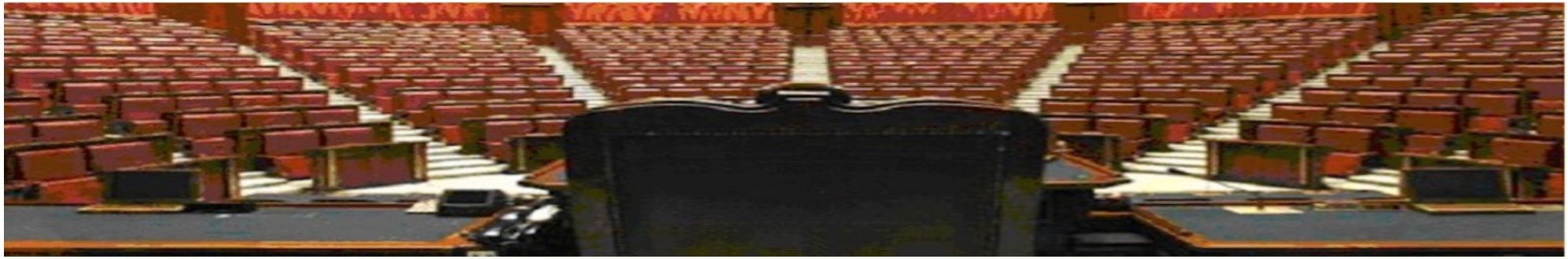
Gruppo	Presidente	Seggi
Partito Democratico	Antonello Cracolici	27
Il Popolo della Libertà	Innocenzo Leontini	20
Movimento per l'Autonomia	Francesco Musotto	12
Unione di Centro verso il Partito della Nazione	Giulia Adamo	8
I Popolari di Italia Domani	Raimondo Luigi Bruno Maira	6
Forza del Sud	Giambattista Bufardeci	5
Futuro e Libertà per l'Italia	Livio Marrocco	4
Misto	*Dino Fiorenza*	8
	Totale	***90***

Efficiency Golden Rule Output:

$$N^*_{ind} = 38$$

$$N_1 = 36$$

$$N_2 = 16$$



Blogs and links about our paper: (arXiv:1103.1224v1 - 07/03/2011)

- Improbable Research (USA, 08/03/2011) "Math: Advantage of selecting politicians randomly"
- Technology Review, MIT (USA, 09/03/2011) "Why Randomly-Selected Politicians Would Improve Democracy"
- Visionaire Berichten (Netherlands 10/03/2011) "Random politici verbeteren democratie"
- Galileo. Giornale di Scienza Online (Italy, 11/03/2011) "Scienza made in Italy"
- 20minutes - Politique (France, 11/03/2011) "Tirer au sort des hommes politiques, plus efficace que de voter?"
- Neo Fronteras (Espana, 11/03/2011) "Legisladores aleatorios y eficacia"
- Green Mass Group (USA, 12/03/2011) "Scientists propose randomly selecting certain fraction of legislators"
- Noticias.com (Espana, 13/03/2011) "La democracia mejora con parlamentarios elegidos al azar"
- Spacecollective.org (USA, 14/03/2011) "Randomly selected politicians"
- Equality by Lot: the Blog of the Kleroterians (USA, 16/03/2011)
- ABC News (USA 18/03/2011) "Random selection could 'improve democracy' "
- ABC Sydney (Australia 18/03/2011) "Random selection could 'improve democracy' "
- TopNews (USA 18/03/2011) "Research says randomness could 'improve democracy' "
- IndiaTalkies: News at Your Tips (India 18/03/2011) "Research says randomness could 'improve democracy' "
- Mojasocjologia.pl (Poland 22/03/2011) "Naukowcy: losowanie bardziej sprzyja demokracji niz wybory"
- Hotelslaevi.com (Russia 22/03/2011) "How to make the parliament work more efficient"
- Discovery News (USA 25/03/2011) "Randomly selected leaders may make politics more efficient"
- Science on MSNBC (USA 28/03/2011) "Can randomly selected leaders improve politics?"
- Step1 - Intervista (Italia 21/04/2011) "Quelli dell'IG-Nobel la buttano in politica"
- NWT-Magazine (Netherlands 05/2011) "'Willekeurig gekozen kamerleden goed voor politiek'"
- The NonProfit Quarterly (USA 11/05/2011) "Would randomly-selected politicians improve democracy?"
- Edward Willet Blog (Canada 21/05/2011) "The case for accidental politicians"

Grazie dell'attenzione!

- A.Pluchino, A.Rapisarda, C.Garofalo, "**The Peter Principle Revisited: a Computational Study**", Physica A 389 (2010) 467
- A.Pluchino, A.Rapisarda, C.Garofalo, "**Efficient Promotion Strategies in a Hierarchical Organization**", arXiv:1102.2837v1 [physics.soc-ph], Physica A in press
- A.Pluchino, A.Rapisarda, C.Garofalo, S.Spagano, M.Caserta, "**Accidental Politicians: How Randomly Selected Legislators Can Improve Parliament Efficiency**", arXiv:1103.1224v1 [physics.soc-ph]

Main References:
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- J.W.Headlam, "Election by Lot at Athens", Cambridge University Press (1933)
- R.Michels, "Political Parties: A Sociological Study of the Oligarchical Tendencies of Modern Democracies", Dover (1959)
- J.Buchanan, "The Limits of Liberty: Between Anarchy and Leviathan", University of Chicago Press (1975)
- O.Dowlen, G.Delannoi, "Sortition: Theory and Practice", Imprint Academic (2010)
- C.Boyle, "Lotteries for Education", Imprint Academic (2010)

Materiale supplementare on-line:

http://www.dfa.unict.it/home/pluchino/

http://www.pluchino.it/ignobel.html

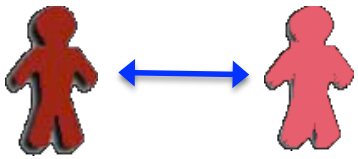
http://www.pluchino.it/parliament.html

Quattro strategie per selezionare un membro da promuovere al livello più alto

•***The Best :*** viene selezionato il membro più competente dal livello precedente

•***The Worst :*** viene selezionato il membro meno competente dal livello precedente

•**Random :** viene selezionato un membro scelto a caso dal livello precedente (con distribuzione uniforme)

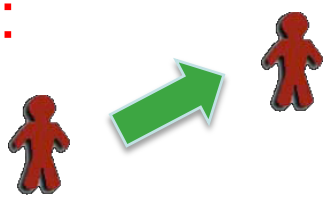


•**Alternate :** vengono selezionati di volta in volta il migliore e il peggiore membro del livello precedente, con probabilità, rispettivamente, p e (1 – p)

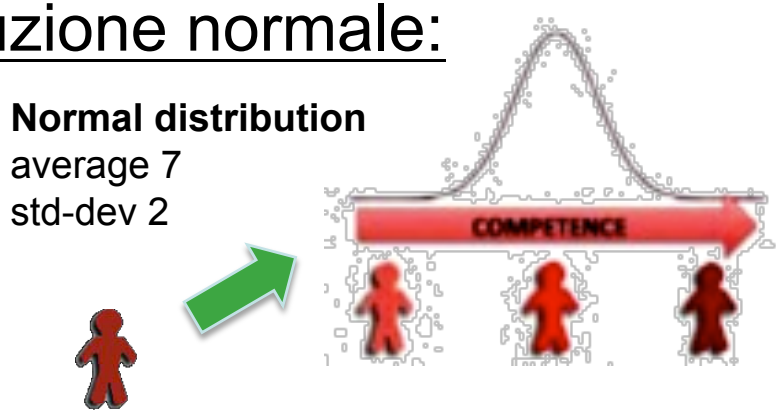
A.Pluchino, A.Rapisarda, C.Garofalo - **The Peter Principle Revisited: a Computational Study** - Physica A 389 (2010) 467-472

Due ipotesi per la trasmissione delle competenze:

- ***Common Sense***: ogni agente mantiene la stessa competenza (con un piccolo errore casuale) quando viene promosso al livello successivo:



- ***Peter Hypothesis***: gli agenti non mantengono la loro competenza quando vengono promossi al livello superiore ma la loro nuova competenza viene assegnata con una distribuzione normale:



A.Pluchino, A.Rapisarda, C.Garofalo - **The Peter Principle Revisited: a Computational Study** - Physica A 389 (2010) 467-472

Calcolo della efficienza dell'organizzazione

Definiamo l'Efficienza Globale della organizzazione come:

$$E(\%) = \frac{\sum_{i=1}^{6} C_i r_i}{E_{max}} \cdot 100$$

dove: r_i with $i = 1, 2, ..., 6$ Grado di responsabilità del livello *i-esimo*

C_i with $i = 1, 2, ..., 6$ Competenza complessiva del livello *i-esimo*

E_{max} Efficienza massima

A.Pluchino, A.Rapisarda, C.Garofalo - **The Peter Principle Revisited: a Computational Study** - Physica A 389 (2010) 467-472

Effetto domino di Granovetter

Quando scoppia una rissa?

Gruppo A

Soglia media di attivazione: 4,5

La rissa inizia!

Gruppo A'

E' quasi identico al gruppo A, ma manca l'elemento con soglia 1: la rissa non inizia!

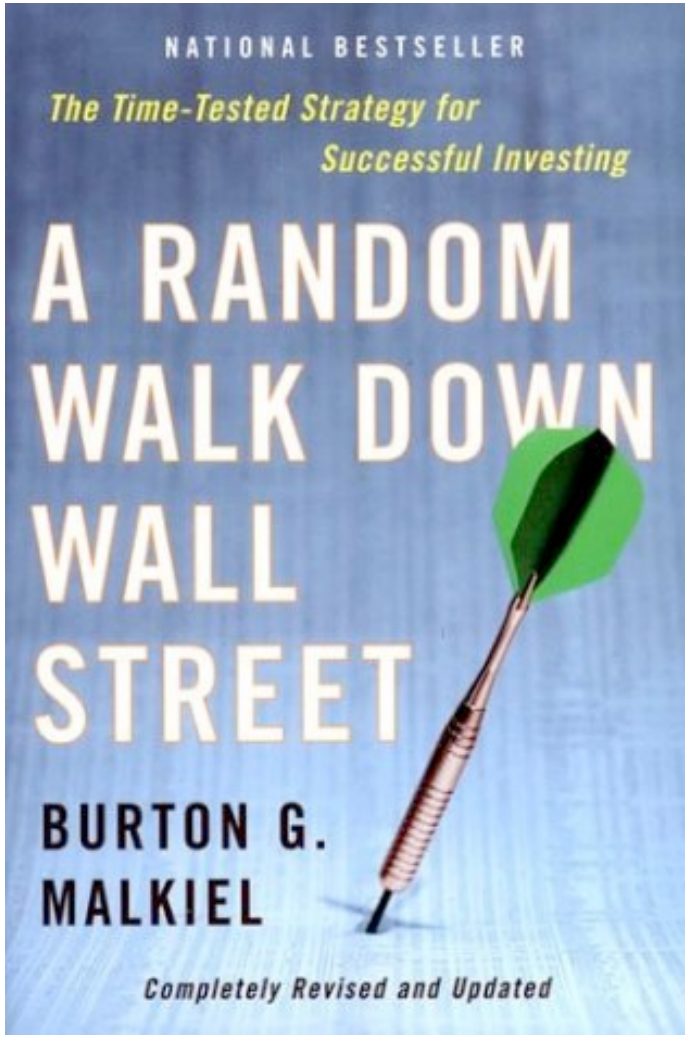
Gruppo B

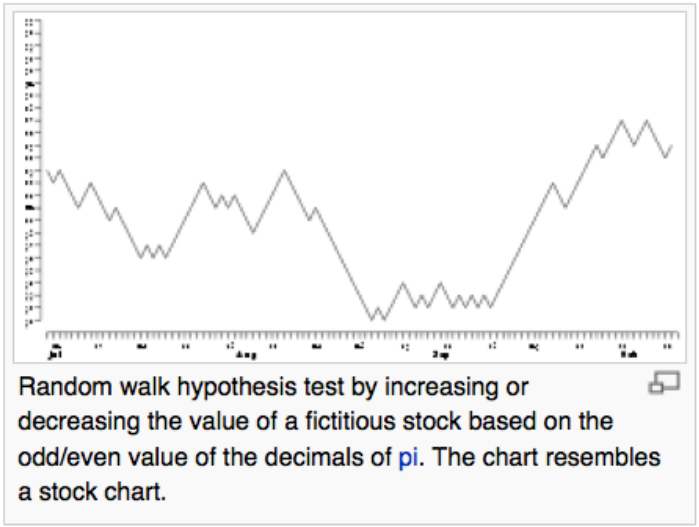
Soglia media di attivazione: 1

Nonostante vi sia una minore soglia di attivazione media rispetto al gruppo A, quì manca l'elemento con soglia 0, quindi la rissa non inizia!

Efficacia delle Strategie Random

L'Ipotesi del Random Walk in Finanza





Random walk hypothesis test by increasing or decreasing the value of a fictitious stock based on the odd/even value of the decimals of pi. The chart resembles a stock chart.

Burton G. Malkiel (1973). *A Random Walk Down Wall Street* - W.W. Norton & Company, Inc.

Efficacia delle Strategie Random

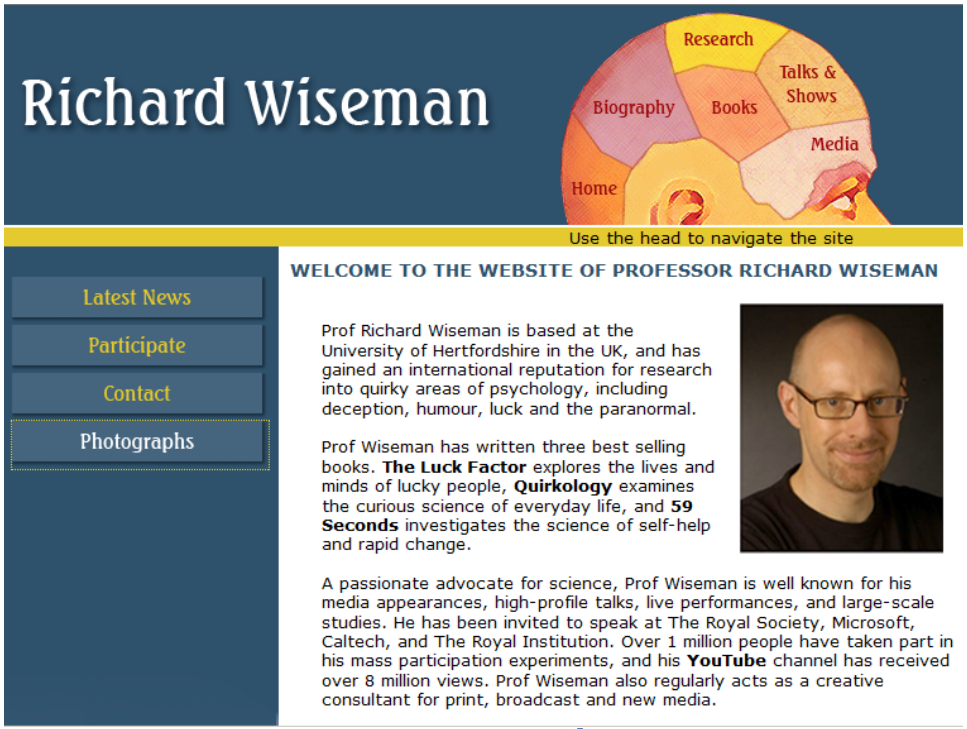
Esperimento sull'andamento dei mercati finanziari: la ragazzina, l'analista finanziario e l'astrologa

Dopo 1 settimana

Ragazzina:	**- 4,6%**
Analista finanziario:	**- 7,1%**
Astrologa:	**- 10,1 %**

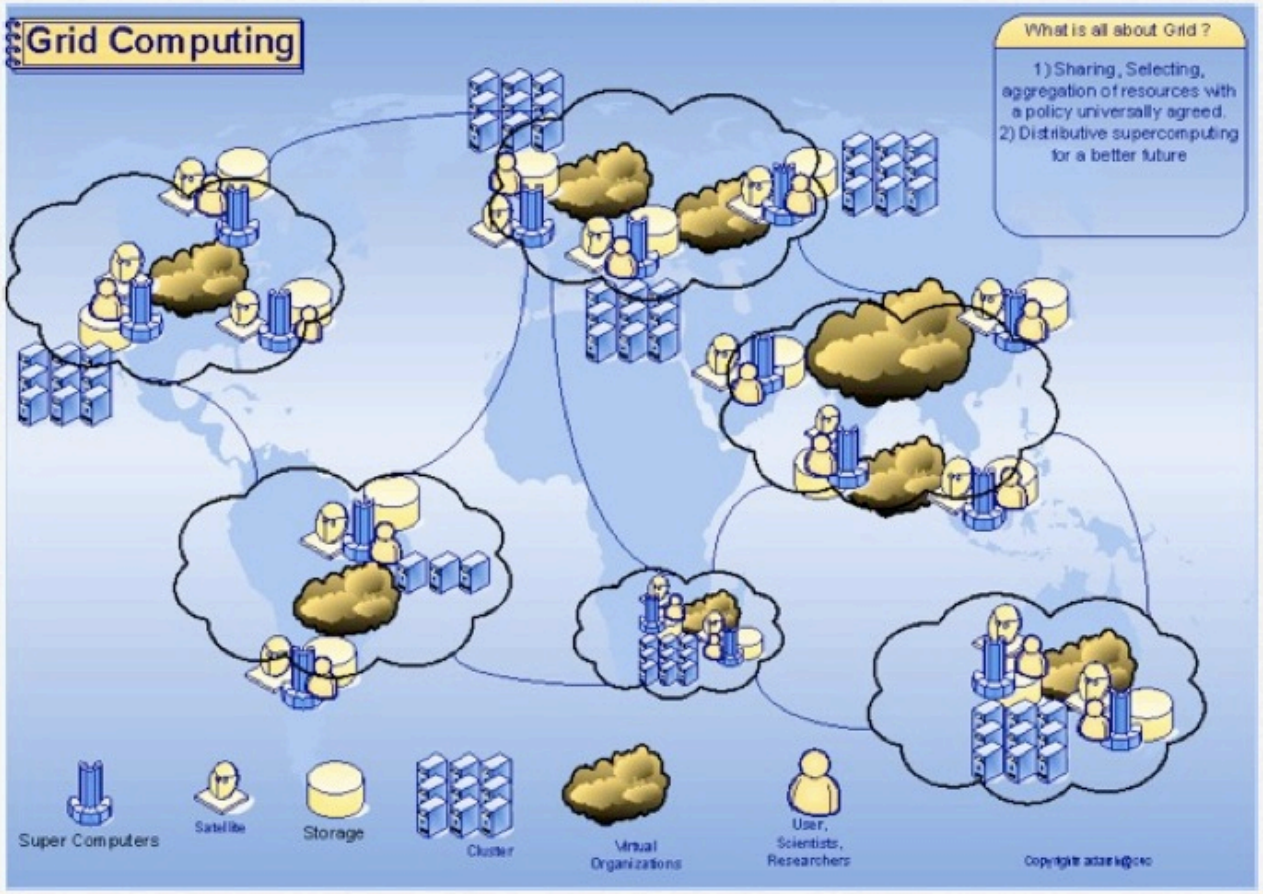
Dopo 1 anno

Ragazzina:	**+ 5,8%**
Astrologa:	**- 6,2%**
Analista finanziario:	**- 46,2%**

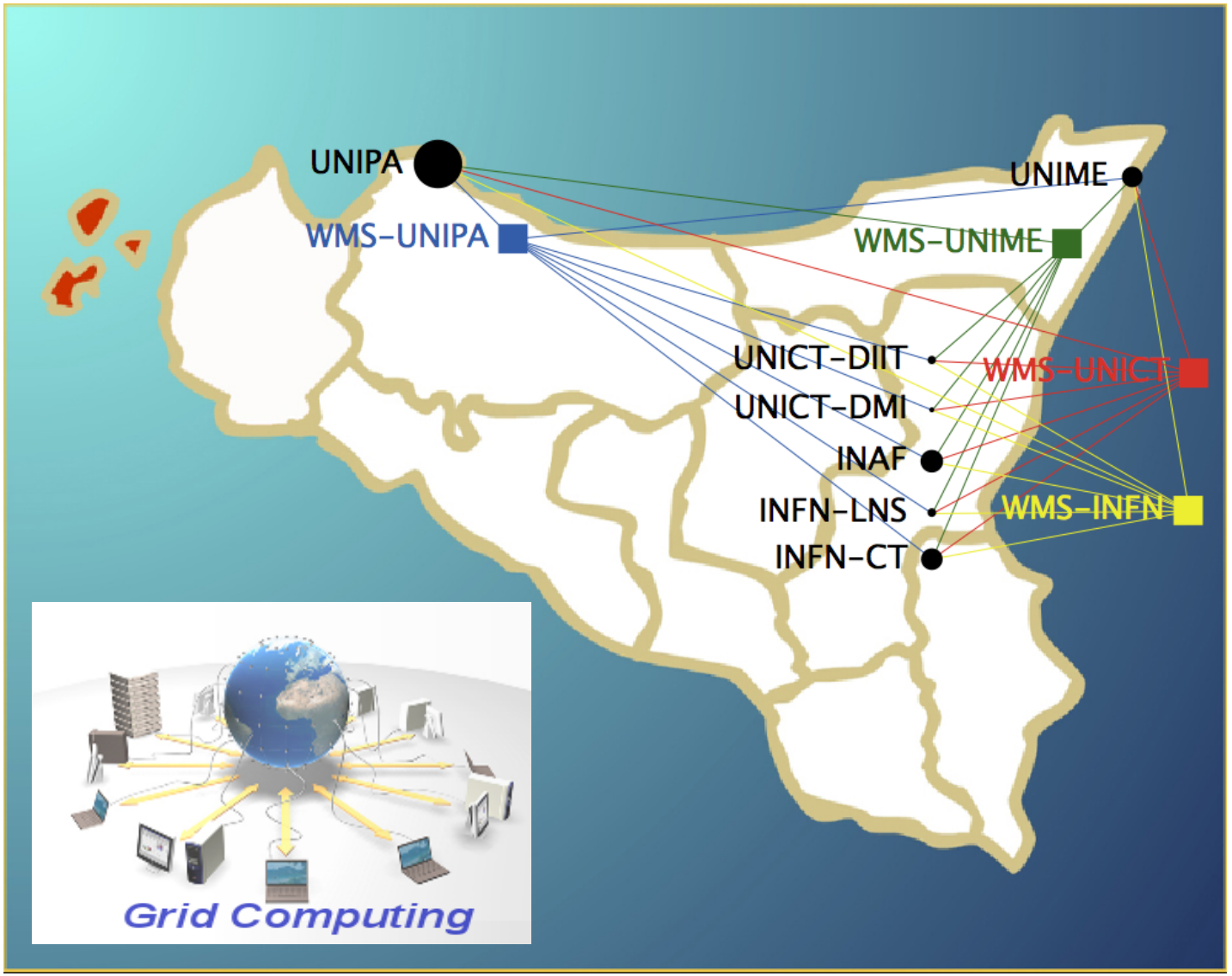


Applicazioni delle strategie random al Grid Computing...

Strategie simili potrebbero rivelarsi molto utili anche per il calcolo parallelo per ottimizzare la distribuzione dei compiti all'interno di clusters di computers con una organizzazione di tipo gerarchico come ad esempio quelli di GRID.



Progetto GridLogo (INFN – Catania)



Lipari School on Computational Social Science

Jacob T. Schwartz International School for Scientific Research

Computational Social Science: Text and Decisions

July 16 - July 23, 2011, Lipari Island, Italy

Deadline: May 29, 2011

(Admission notification will start on April 1st according to registration time)

The recent growth of socially interesting data logs generated by modern media usage could hardly be overlooked by social scientists. However, traditional social scientists' analytical techniques cannot cope with databases of such large size. The fledging interdisciplinary field of Computational Social Science (CSS) includes automated information extraction as one of its foci. CSS lies at the intersection of social science, computational science, and complexity science. The new Lipari School on Computational Social Science will address this topic through seminar sessions by world-class researchers in the field. The "Text and Decisions" theme of this 2011 edition will focus on text and data mining techniques to support decision processes in the realm of social science.

http://lipari.cs.unict.it/LipariSchool/ComputationalSocialScience/

La proposta di Nicolaides...

Una interessante proposta fatta in questi giorni dal Prof. P. Nicolaides (professore all'European Institute of Public Administration di Maastricht, Olanda) sulla base del nostro studio

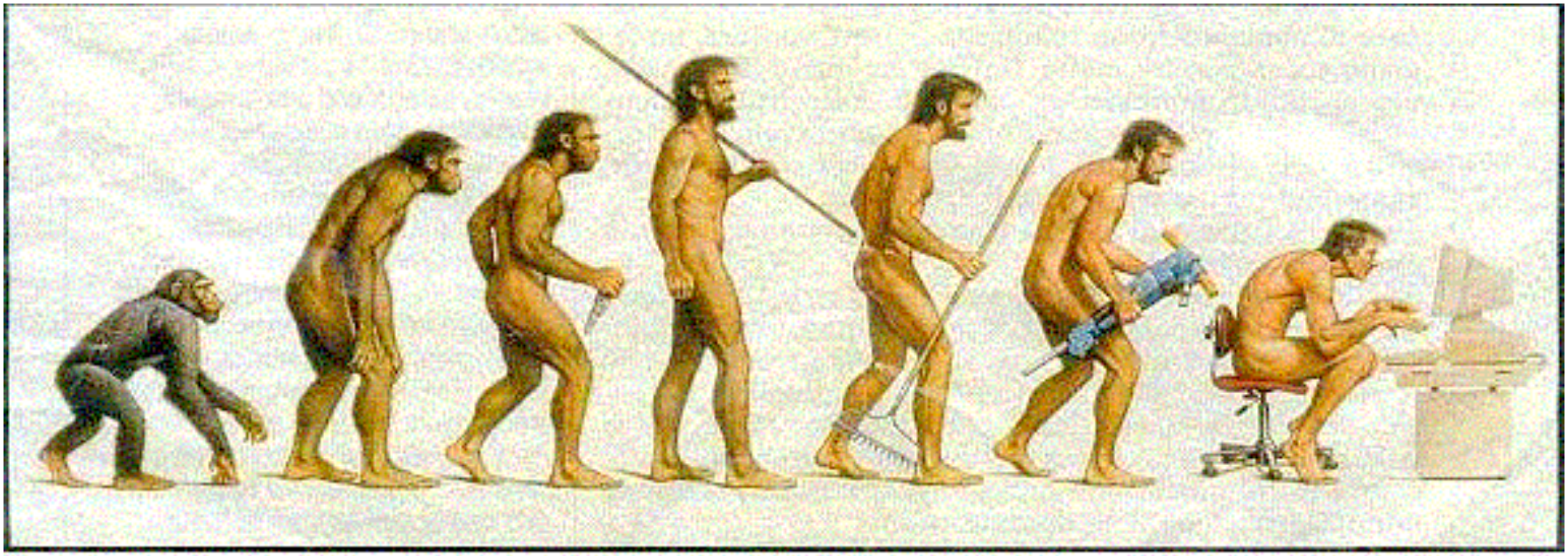
Scegliere in maniera casuale i membri delle commissioni valutatrici per le promozioni

Qui di seguito il link al suo articolo

http://www.cyprus-mail.com/opinions/how-promoting-incompetent-increases-efficiency/20101010#comment-38317

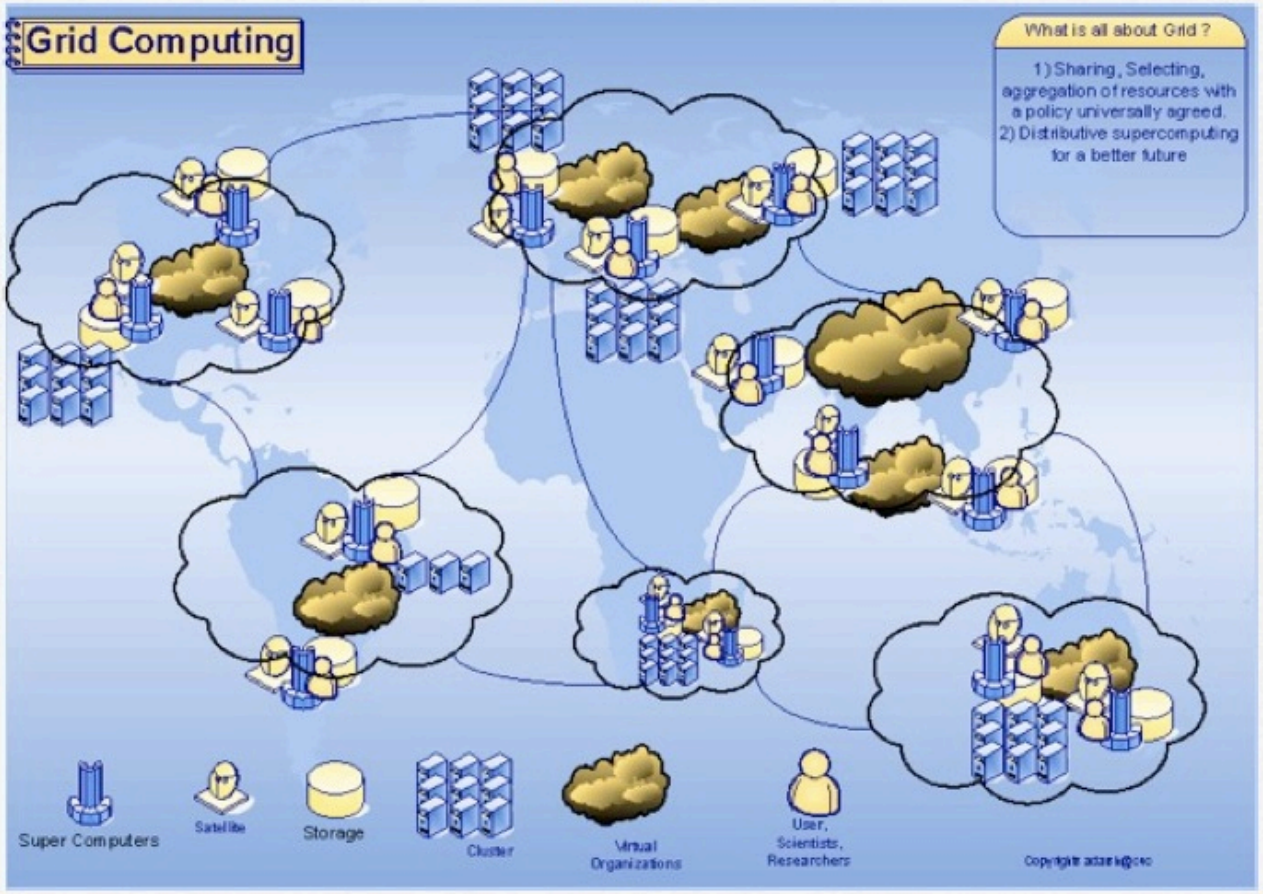
Ruolo costruttivo del caso nell'Evoluzione delle Specie

Può sembrare strano e paradossale promuovere in maniera casuale.... ma in natura l'evoluzione procede esattamente così: *mutazioni casuali vengono rafforzate e non rimosse se danno un vantaggio alla specie!*



Applicazioni delle strategie random al Grid Computing...

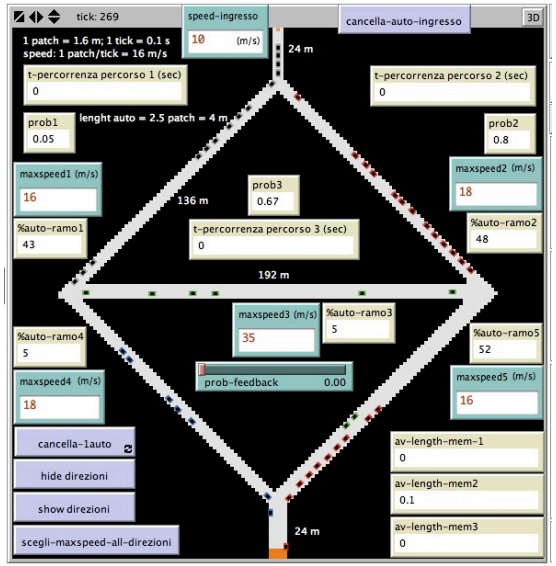
Strategie simili potrebbero rivelarsi molto utili anche per il calcolo parallelo per ottimizzare la distribuzione dei compiti all'interno di clusters di computers con una organizzazione di tipo gerarchico come ad esempio quelli di GRID.



Le giurie popolari

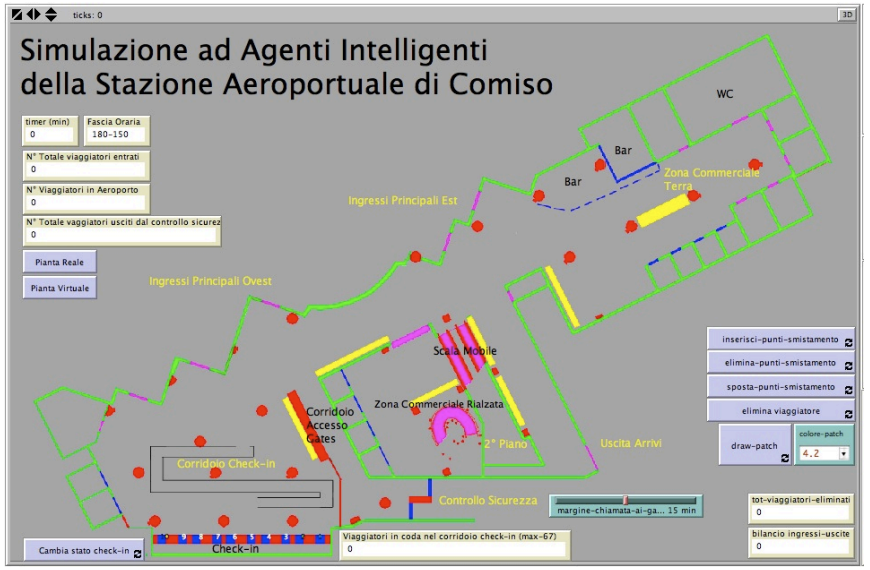
Del resto un meccanismo di selezione casuale viene da anni utilizzato negli USA (ma anche in altri paesi) per formare le **giurie popolari** che nei processi affiancano i giudici togati (i giurati decidono sul merito e i giudici sulla pena di diritto). I giurati vengono **estratti a sorte** tra tutti i cittadini in regola e incensurati. Tutti possono essere scelti (non occorrono cioè conoscenze specifiche). Nel corso dell'udienza preliminare, poi, le parti vengono a contatto coi giurati e possono bocciarne fino a 3.

Alcuni nostri progetti di sociodinamica in collaborazione con i Dipartimenti di Ingegneria Civile e Ambientale e di Informatica dell'Università di Catania



Traffico

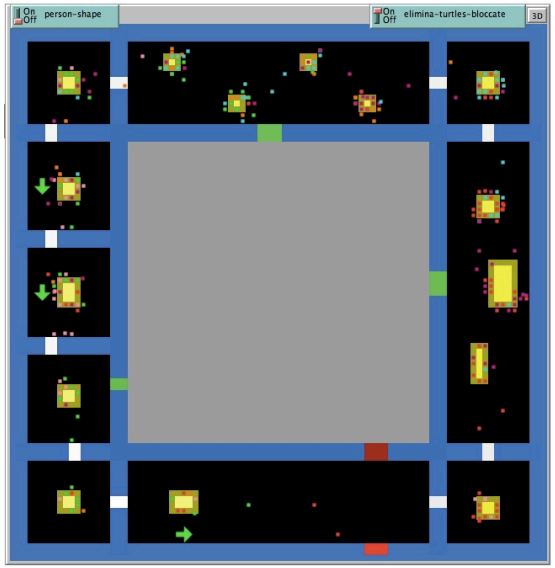
(paradosso di Braess)



Aeroporto di Comiso

NetLogo

Dinamiche di acquisto nei supermercati



Castello Ursino