[NOTE: This is a direct translation from Spanish using atla-vista, please excuse the English.]

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INVESTIGATION

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A mathematical model that gives much game

The paradox of Parrondo: to lose + to lose = to win

Juan Manuel Rodriguez Parrondo, titular professor of the Department of Atomic, Molecular and Nuclear Physics of the Faculty of Physical Sciences, has devised two simple mathematical games of chance that are interesting to experts in very diverse areas of science. Their results are surprising in statistical terms, to play anyone of the two separately supposes to lose. However, if the player alternates both, in certain or random combinations, it wins. An effect that in articles specialised already is known like

Already almost two years ago to professor Parrondo it was happened to him to make a luck of simplified mathematical version of the operation of these rectifiers, and almost as curiosity devised two games of probability whose results presented/displayed in diverse seminaries, without seting out at least to publish them. With time they have given rise to diverse scientific studies in which already they are known like the paradoxical Parrondós games.

The process is significant from the

It is possible to be verified that if m =0 both games are right; that is to say, which in average neither one gains nor it loses. But if m is positive, in both games it is lost. Therefore, any person who plays, by means of sencillísimo computer science program, a sufficiently high number of times to anyone of the two games, will end up losing inexorably. The surprising thing is that if however combines both, in series ABAB, AABB or even of totally random form, it will end up winning with the same inexorabilidad (to see inferior graph).

"the Parrondo's Paradox".

Professor Rodriguez Parrondo found inspiration of games in his investigations on motors of Brown or motors brownianos, models of study in Physics that must his name to botanist Robert Brown, who it observed in the last century that an immersed particle very small in a fluid moves of erratic form, with abrupt changes of direction which they do not obey to any guideline pretends (browniano movement). Einstein explained east phenomenon in 1905, supposing that that movement must to that the particle continuously receives molecule collisions coming from all the points.

Motors of Brown

Much more recently it has been begun to study the behavior of these particles submissive the combat operation: for example, placing them in an electric field that can be connected and become disconnected. To point of view of the sociology of science: changing the notion of browniano rectifier by the one of game, and the magnitudes of time and space by most manageable of I number of played times and points or obterudo capital, Parrondo has managed to interest to experts of Optics or Climatology in tin phenomenon that before a scientific community very reduced only investigated.

A game of probabilities

The great virtue of the games is that they are easily comprehensible for anyone. To play can be compared with sending a currency to the air and, starting off of a determined capital, to be making or losing money according to it leaves face or cross (for example, 1,000 pesetas in each occasion).

In the game To we have a currency slightly pocketed a ball to lose: concretely, p=l/2- m gains with a probability and p=l/2+

The reason is intuited easily. When one gambles only game B, the good currency and the bad one are compensated, with a slight advantage for this last one. However, the games, the currency are alternated To, that she is bad in himself, modifies the things so that professor Parrondo is used plus the good currency of game B. and the investigators interested in this mechanism create now that he can be present in physical systems, biological or even climatologic.

Scientific applications

The games have monopolized the attention in a congress to multidiscipline celebrated east summer in Australia, where they were presented/displayed by the organizer of the same one, the engineer Derek Abbott. Also, the mathematician Charles Pearce presented/displayed two works in which he demonstrates that the example of professor Parrondo, very simple,

greater tempetatura, greater agitation takes place in the fluid and more impacts receive the browniana particle. When being made studies with a great number of particles tin has been discovered peculiar effect: if the field is connected and disconnected alternatively, these move slowly in a direction.

These systems, that turn a chaotic fluctuation into a determined movement, are now known in Physics like motors Brown or recrificadores (Brownian ratchets, Brownian motors or recrifiers in English), and thinks that they can be used in Biology for the molecule transport within a cell.

m is lost with probability (to see superior graph). In game B in fact we have two currencies: good and a very bad other. If the amount of capital that we have is multiple of three, game with the bad one, whose propabilidad is p1=l/lO- m. If he is not multiple of three, one gambles with the good currency, whose probability is p2=3/4- m. Thus, if we began playing with 10,000 pesetas, we will have to send the good currency. If we won, we will have 11,000 pesetas already and it will be called on to continue sending the good currency to us. However, if we lose we remain with 9,000 pesetas and, to the being this amount multiple of three, we will change to the other currency.

can be generalized to other many cases. A review of the Nature magazine the past emphasized month the value of the games for the understanding of the phenomena of rectification in general, as well as his possible future application in as different fields as the genetic Econornía or studies on Theory of the Evolution: the case could occur, to put an example very simple, of which the complexity of the biological Earth systems decreased separately in two certain supposed ones taken but it increased when being combined both. Once described the theoretical model the exciting possibility is opened of tracking it in the real world.

TO REMOVE PARTY

In general, at random, any physical system pequer6no has magnitudes that behave of erratic form, that is to say, that presents/displays random fluctuations. In Physics noise to these

It arrives, both games. In the B different probabilities are used according to we have an amount multiple of three or no. Down, results of playing separately the games and in different combinations (2 times To and twice B, etc.). 50,000 games have been simulated.

fluctuations is denominated, because of the real noise that takes place in the loudspeakers like result of the fluctuations produced by the components of an amplifier. Until recently one thought that the noise only could destroy the order and the complexity of a system, but in the last decade have been situations in that it has the opposite effect: it can help to that a system has a more complex behaviour. It is the case, for example, of the transport induced by noise that takes place in the systems known like Brownian motors, in which it is managed to rectify particles, leading them in a direction. Professor Parrondo has been dedicating itself for years to the study of these motors, investigating, for example, the energy interchange that takes place in them, area in which has obtained important