Who loses twice, wins

Parrondo's paradox: Confusing for laymen, obvious for mathematicians, but unfortunately useless for gamblers.

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(Translated from the German original by Stephan Endering, Sam Mickan and Derek Abbott)

Adelaide - Do you sometimes feel like a born loser? Don't fear! A Spanish physicist has proven that losing twice can help to win. Mathematicians call this phenomenon, which contradicts intuition, `Parrondo's paradox' - named after Juan Parrondo of the University of Complutense in Madrid, who discovered it in 1997. Australian scientists have now confirmed the paradox with the help of computer simulations and have pointed to applications. With the help of the model, investment strategies could possibly be created, or perhaps how life on earth developed could be explained. In order to illustrate the nature of the mathematical mechanism, the researcher Parrondo invented a situation from two tossing games using three coins, which are heavier on one side and fall therefore with largely different probabilities on their "winning sides." In game A, a player throws - we call him Peter - Coin One, where the chance of winning is a little smaller than 50 per cent. If Peter wins, he gets a dollar, if he loses he will have to pay a dollar to his opponent Heidi. After a set of throws Peter finds himself on a losing streak, as expected.

Game B is however more complicated. Here Peter throws coins number two and three. Coin Two has a chance of winning of approximately 75 per cent; Coin Three leads however to a loss in approximately nine out of ten cases. Peter now alternates the two coins according to a simple rule: Every time when the total amount of his available cash - the game capital - comes to a multiple of three, he plays the "heavy loss" Coin Three. Since this case arises comparatively rarely, this implies that Peter throws Coin Two about twice as frequently. He will lose over the long term nevertheless, because Coin Three, with approximately 90 per cent exposure to loss, more than counterbalances the good chances of Coin Two.

Does playing A and B together drive Peter into the failure, as well? By no means! "Each game by itself is a losing game," says Juan Parrondo, "the astonishing thing is, however, that changing between the two games leads to victory." A puzzling effect that is nevertheless mathematically proven. In order to understand this paradox, one uses the picture of a ratchet. These devices with inclined "saw teeth" are, for example, in clock mechanisms of wristwatches, or move to draw themselves up in a lifting platform rack. A catch, which fits between these teeth, permits a movement of the ratchet in one direction and blocks it, however, in the opposite direction.

Strictly, Parrondo's paradox is based on a "flashing ratchet": a system, with which for example biologists themselves explain the transport of molecules in a cell. The teeth of these special ratchets fold periodically in and out - as with stairs, their levels are alternately "there" again and then not. A tennis ball would roll down an inclined slope or down a staircase, in either case downward. Changing between the two states, however, moves the ball upward, to a certain extent.

Even without this stair model, one may still have faith in Parrondo's paradox: The researchers Gregory Harmer and Derek Abbott of

The game theory helps to make a decision

Game theory examines how humans or organisations behave and decide under certain conditions. A classical example is the Prisoner's Dilemma, specified as follows: Two people are arrested and both are suspected to have committed a criminal offence, which involves max. five years imprisonment.

Now the judge proposes to each person several alternatives. First of all, if you betray your partner, you get off without punishment and he must serve the full 5 years. Secondly, if you are both are silent, there is sufficient circumstantial evidence to condemn both of you for two years detention. Thirdly, if you both confess, you must both spend 4 years behind bars.

How will the prisoners decide? In game theory, a payoff matrix is set up - a table, in which all decision possibilities of the prisoners are entered and evaluated with points. The higher the score, the more favourable for the prisoner. The application of this procedure lends itself particularly to complex conflict situations. Thus game theory was used with a set of confrontations in the cold war, for instance, to judge the reaction of the Soviet Union during the Cuba missile crisis of 1962.

A special version of such analyses involve 2-person zero-sum games - that is a game in which one opponent wins and the other one loses - such as Parrondo's paradox, for example.

the University of Adelaide in Australia recently computer simulated the coin tossing game. Result: With 50,000 trials they found the result predicted by the Spanish scientist accurate. More still: Even if game A and game B are not played periodically, but in random order, the two researchers wrote in the science magazine Nature, "this still produces a winning expectation."
Confusing for laymen, obvious for mathematicians. Meanwhile Juan Parrondo is looking for situations, in which his paradox actually occurs. He has already have found a situation in chaos research: He deformed geometrical shapes, for example bee honeycombs, with a certain transformation until they became indiscernible - and then combined the rules for deformation again. Result: From two chaotic rules a regular mosaic develops.

Researchers look for practical applications for the effect

This phenomenon could be useful for instance in the theory of evolution, Parrondo says:
"complex structures such as organisms could have resulted from changing environmental conditions, such as day/night or summer/winter." The physicist proposes that molecular ratchets could support evolution tending towards greater complexity.
Meanwhile, other scientists look for practical applications of the effect. For example Sergey Maslov, a physicist at the Brookhaven National Laboratory in New York, analyses investment strategies. He found that two or more loss-yielding shares could be combined with cash reserves by the "ratchet effect." Result: "the whole is sometimes more than the total of its sections." Maslov's model is however too strongly simplified to apply at the stock exchange. Something similar applies to other applications of the principle: With genuine games of luck Parrondo's paradox never occurs - unfortunately.

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