Section 1: Philosophy of the Physical Sciences

A COMPUTATIONAL PHYSICIST'S VIEW OF POPPER'S "CONJECTURES AND REFUTATIONS"

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Falsifiability of trial answers is the core of the scientific method. But do practical methods exist in science that really implement Popper's epistemological principle? We propose that some successful computational methods in modern physics do.

Quantum-systems properties can be calculated recurring to various computational methods whose accuracy depends on the number of particles and on the complexity of the system. Large parallel computer facilities all over the world suite very well for these efforts, allowing predictions of physical quantities that were once predictable just only in a principle way, to become truly effective. Among the methods, a class of them known as "Quantum Monte Carlo" calculations is particularly effective and scales reasonably with the number of particles, giving answers with no uncontrolled approximations. These methods, apart of their differences, share a common, fascinating ground: Monte Carlo is the solution by probabilistic methods of nonprobabilistic problems. Numbers related to physical quantities are let to evolve randomly in order to "sample" the domain, and are subjected to a selection process depending on their response to specific "driving" conditions, like the change in energy related to their evolution. This idea strictly and interestingly resembles both an evolutionary model and an acquisition of knowledge through a sequence of casual conjectures and successive refutations. Numbers differentiate in their proper environment and survive and reproduce if they lead the stochastic process to the deterministic solution, or, in other words, the conjecture of their move in the stochastic chain is accepted or refused depending on how much they match the real conditions in which the particles are supposed to be. In this method therefore, falsifiable solutions are drawn by imagination and creativity, represented by random walks in the phase space of the quantum system.

Explanations of Monte Carlo methods, their successes and their role in representing very well the way in which falsifiability may practically work in science will be explained using a fair non technical language.