Feynman diagrams are the most celebrated and powerful tool of theoretical physics usually associated with the analytic approach. I will argue that diagrammatic expansions form an ideal setup for Monte Carlo studies with enormous and yet to be explored potential for solving interacting many-body systems by direct simulation of Feynman diagrams for the proper self-energies and polarization operators up to high order. Though the series based on bare propagators are sign-alternating and often divergent one can determine the answer behind them by using proper series re-summation techniques and working with skeleton diagrams, i.e. by making the entire scheme self-consistent. The first results for the resonant Fermi gas and the Fermi-Hubbard model at $U/t=4$ away from half-filling prove that this approach is promising.