Estimating 'rainflow' cycle distribution and fatigue damage in random processes

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In this talk we discuss about "fatigue" problems in mechanical components and about some related statistical aspects. The "fatigue" is a mode of fracture of metals; if we apply a time-varying load (as for example a sine wave) to a small piece of metal, this will cause fracture, even if the max value in the load will not produce by itself any break. It seems that the presence of each repeated "cycle" in the varying load has produced a kind "damage" in the material, which appears weakened: this is what we intend with the term "fatigue damage". Obviously, real component in their service life are not subjected to simple sine waves, but to more complicated (i.e. more irregular) type of loads. The goal of assessing the life of a component in such a situation becomes obviously a complex problem: for example, we have to identify "cycles" in the irregular load and evaluate the damage for each of them. A possible approach is to use the concept of stochastic process as a model for the irregular load, and to derive analytical epressions to assess the fatigue damage. Some existing methods for fatigue damage estimation under stationary Gaussian processes will be reviewed; a new existing method will also be proposed, and then further extended to non-Gaussian processes. Results from numerical simulations and from experimental data show how the new method could be a sound approach in this kind of problems.