CLAIMS

1. A control system for configuring a system/device to accommodate a future state of the system/device or further events related to the system/device, the control system comprising:

data processing system for generating a future behaviour simulation of the system/device, the simulation comprising a set of output parameters; and, a feedback controller for using the simulation generated by the data processing system as feedback for the control system to configure the system/device,

in which the data processing system comprises one or more processors configured to implement:

an input/output module configured to receive sets of values of one or more variables from one or more external parties;

an input factor module configured to determine one or more input scenarios based on the received sets of values;

an approximation module having an approximation generator and an approximation evaluator, the approximation module being configured to determine an approximated value of each of one or more parameters in a first domain based on the one or more input scenarios, the one or more parameters being dependent on the one or more variables which vary stochastically in a second domain, the one or more variables being determined using a Monte Carlo method, and the one or more parameters being determined by one or more functions which relate the sets of values of the one or more variables in the second domain to corresponding values in the first domain; and

a metric module configured to calculate one or more standard metrics based on the approximated parameters in the first domain so as to generate the set of output parameters to be output via the input/output module,

in which the approximation generator is configured to:

determine a plurality of anchor points in the second domain, each anchor point comprising one of the received sets of values of the one or more variables in the second domain, and the anchor points being the zeros of each of a series of orthogonal functions, or a subset of the zeros;

evaluate, at each anchor point, the one or more functions to generate corresponding values of each of the parameters in the first domain; and,

generate an approximation function to each of the one or more functions by fitting the series of orthogonal functions or an approximation to the series of orthogonal functions to the corresponding values of the parameters in the first domain,

in which the approximation evaluator is configured to use the approximation functions to generate the approximated value of each of the one or more parameters in the first domain, the approximation evaluator being configured to generate a plurality of the approximated parameter values to generate at least one scenario or time step for the metric module, and

in which the number of anchor points, N_E, is selected so that:

$$\frac{N_S \cdot T}{N_E \cdot T + N_S \cdot t} > 1$$

in which N_S is the number of scenarios, t is the time taken to run the one or more approximation functions, and T is the time taken to run the one or more parameter functions.

2. A control system according to Claim 1, in which the approximation module is configured to transform the one or more functions into one or more intermediary functions before generating the one or more approximation functions, in which the intermediary functions are a linear transformation of the functions, and in which the approximation module is configured to approximate the intermediary functions to generate the approximation functions.

3. A control system according to Claim 2, in which transforming the one or more functions comprises linearly transforming the functions into a predetermined range.

4. A control system according to Claim 1, 2 or 3, in which the series of orthogonal functions is one of the group comprising: sines, cosines, sines and cosines, Bessel functions, Gegenbauer polynomials, Hermite polynomials, Laguerre polynomials, Chebyshev polynomials, Jacobi polynomials, Spherical harmonics, Walsh functions, Legendre polynomials, Zernike polynomials, Wilson polynomials, Meixner–Pollaczek polynomials, continuous Hahn polynomials, continuous dual Hahn polynomials, a classical polynomials described by the Askey scheme, Askey–Wilson polynomials, Racah polynomials, dual Hahn

polynomials, Meixner polynomials, piecewise constant interpolants, linear interpolants, polynomial interpolants, gaussian process based interpolants, spline interpolants, barycentric interpolants, Krawtchouk polynomials, Charlier polynomials, sieved ultraspherical polynomials, sieved Jacobi polynomials, sieved Pollaczek polynomials, Rational interpolants, Trigonometric interpolants, Hermite interpolants, Cubic interpolants, and Rogers–Szegő polynomials.

5. A control system according to any preceding claim, in which the series of orthogonal functions is a series of orthogonal polynomials.

6. A control system according to any preceding claim, in which the approximation to the series of orthogonal functions is an approximation to a series of orthogonal polynomials.

7. A control system according to any preceding claim in which the approximation module is configured to select a series of orthogonal functions or an approximation to a series of orthogonal functions before generating the one or more approximation functions, and in which the approximation module is configured to use the selected series of orthogonal functions or the approximation to the series of orthogonal functions to generate the approximation functions.

8. A control system according to any preceding claim, in which the approximation module is configured to hold the values of all but one variable in the set to be constant when evaluating the one or more functions.

9. A control system according to any preceding claim, in which the speed of the calculation is increased with no loss of accuracy in the standard metrics, and/or the accuracy of the standard metrics increase with no decrease in the speed of the calculation when using the one or more approximation functions.

10. A control system according to any preceding claim, in which there is a difference between the approximated value of the parameter and the parameter in the 2^{nd} significant figure when compared at the same point in the first domain.

11. A control system according to any of Claims 1 to 9, in which there is a difference between the approximated value of the parameter and the parameter in between the 4^{th} and the 6^{th} significant figure when compared at the same point in the first domain.

12. A control system according to any of Claims 1 to 9, in which there is a difference between the approximated value of the parameter and the parameter in the 15th significant figure when compared at the same point in the first domain.

13. A control system according to any preceding claim, in which the number of scenarios or time steps is significantly greater than the number of anchor points.

14. A control system according to any preceding claim, in which the one or more functions are one of the group comprising: a Black–Scholes model, a Longstaff-Schwartz model, a binomial options pricing model, a Black model, a Garman–Kohlhagen model, a Vanna–Volga method, a Chen model, a Merton's model, a Vasicek model, a Rendleman–Bartter model, a Cox–Ingersoll–Ross model, a Ho–Lee model, a Hull–White model, a Black–Derman–Toy model, a Black–Karasinski model, a Heston model, a Monte Carlo based pricing model, a binomial pricing model, a trinomial pricing model, a tree based pricing model, a finite-difference based pricing model, a Heath–Jarrow–Morton model, a variance gamma model, a Fuzzy pay-off method, a Single-index model, a Chepakovich valuation model, a Markov switching multifractal, a Datar Mathews method, and a Kalotay–Williams–Fabozzi model.

15. A control system according to any preceding claim, in which the approximation module is configured to generate the one or more approximating functions using an interpolation scheme.

16. A control system according to Claim 15, in which the interpolation scheme is one from the group comprising: piecewise constant interpolants, linear interpolants, polynomial interpolants, gaussian process based interpolants, spline interpolants, barycentric interpolants, Rational interpolants, Trigonometric interpolants, Hermite interpolants and Cubic interpolants.