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(*)
(*) Generalized Collocation Methods: Solutions to Nonlinear Problems *)
(*) Bellomo, N., Lods, B., Revelli, R., Ridolfi, L. *)
(*) A Birkhäuser book *)
(*) ISBN: 978-0-8176-4525-0 *)
(*) *)
(*) Program OneDLag *)
(*) *)
(*****)

OneDLag[function_, nodes_] :=
Module[{},
  φ[x_] := function;

  (** Definition of the equispaced and Chebyshev collocation **)

  hh =  $\frac{1}{nodes - 1}$ ;
  xi_ := (i - 1) * hh;
  x1i_ :=  $-\frac{1}{2} \left( \cos \left[ (i - 1) * \frac{\pi}{nodes - 1} \right] - 1 \right)$ ;

  (** Lagrange polynomial with Chebyshev collocation **)

  Lagr1[j_, x_] :=  $\prod_{p=1}^{nodes} \left( \text{If}[p \neq j, \frac{x - x1_p}{x1_j - x1_p}, 1] \right)$ ;
  FuncLagr1[x_] :=  $\sum_{k=1}^{nodes} ((\phi[x] /. x \rightarrow x1_k) * \text{Lagr1}[k, x])$ ;

  (** Lagrange polynomial with equispaced collocation **)

  Lagr2[j_, x_] :=  $\prod_{p=1}^{nodes} \left( \text{If}[p \neq j, \frac{x - x_p}{x_j - x_p}, 1] \right)$ ;
  FuncLagr2[x_] :=  $\sum_{k=1}^{nodes} ((\phi[x] /. x \rightarrow x_k) * \text{Lagr2}[k, x])$ ;

  (** Plot of the results **)

  Plot[Evaluate[{φ[x], FuncLagr1[x], FuncLagr2[x]}], {x, 0, 1}, PlotRange → All,
    PlotStyle → {Dashing[{0.0}], {Dashing[{0.001, 0.005}]}, {Dashing[{0.02, 0.008}]}}},
    FrameLabel → {"x", "u(x)"}, AxesOrigin → {0, 0}, Frame → True,
    FrameTicks → {{0, 0, .02}, {0.5, 0.5, .02}, {1, 1, 0.02}},
    {{-4, -4, .02}, {0, 0, .02}, {4, 4, 0.02}}, None, None]];

];

{function, nodes} = {Tanh[10 x - 5] + 0.2 Sin[π (10 x - 5.)], 21};
OneDLag[function, nodes]

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