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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 TwoDLaSiInt                                               *)
(*                                                                   *)
(*********************************************************************)

$TextStyle = {FontFamily -> "Times", FontSize → 12};
Off[General::"spell", General::"spell1"]

TwoDLaSiInt[function_, NodesX_, NodesY_] := Module[{},
  (*** INITIAL CONDITION ***)
  φ[x_, y_] := function;
  {hhX, hhY} = {1/(NodesX - 1), 1/(NodesY - 1)};
  x_i_ := (i - 1) * hhX;
  y_i_ := (i - 1) * hhY;
  x1_i_ := -1/2 (Cos[(i - 1) * π/(NodesX - 1)] - 1);
  y1_i_ := -1/2 (Cos[(i - 1) * π/(NodesY - 1)] - 1);

  (*** Lagrange polynomial definition***)

  Lagr1X[j_, x_] := ∏_{p=1}^{NodesX} (If[p ≠ j, (x - x1_p)/(x1_j - x1_p), 1]);

  Lagr1Y[j_, y_] := ∏_{p=1}^{NodesY} (If[p ≠ j, (y - y1_p)/(y1_j - y1_p), 1]);

  FunctionLagr1[x_, y_] :=
   ∑_{m=1}^{NodesY} ∑_{k=1}^{NodesX} ((φ[x, y] /. {x → x1_k, y → y1_m}) * Lagr1X[k, x] * Lagr1Y[m, y]);

  (*** Sinc function definition ***)

  SincX[j_, x_] := Which[0 ≤ x ≤ 1 && x != (j - 1) * hhX,
    Sin[π * (x - (j - 1) * hhX)/hhX] / (π * (x - (j - 1) * hhX)/hhX), x == (j - 1) * hhX, 1];
  SincY[j_, y_] := Which[0 ≤ y ≤ 1 && y != (j - 1) * hhY,
    Sin[π * (y - (j - 1) * hhY)/hhY] / (π * (y - (j - 1) * hhY)/hhY), y == (j - 1) * hhY, 1];

  FunctionSinc[x_, y_] :=
   ∑_{m=1}^{NodesY} ∑_{k=1}^{NodesX} (φ[x, y] /. {x -> x_k, y → y_m}) * SincX[k, x] * SincY[m, y];


  Plot3D[Evaluate[FunctionSinc[x, y]], {x, 0, 1}, {y, 0, 1}, PlotRange → All,
   AxesLabel → TraditionalForm /@ {x, y, "w(x,y)"}, Ticks → {{0, 1}, {0, 1}, {0, 1}},
   PlotLabel -> "Sinc Interpolation", PlotPoints → 51];
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  Plot3D[Evaluate[FunctionLagr1[x, y]], {x, 0, 1}, {y, 0, 1}, PlotRange → All,
   AxesLabel → TraditionalForm /@ {x, y, "w(x,y)"}, Ticks → {{0, 1}, {0, 1}, {0, 1}},
   PlotPoints → 51, PlotLabel -> "Lagrange Interpolation"];

  Plot3D[Evaluate[100000 * Abs[φ[x, y] - FunctionSinc[x, y]]],
   {x, 0, 1}, {y, 0, 1}, PlotRange → {{0, 1}, {0, 1}, {0, 1}},
   AxesLabel → TraditionalForm /@ {x, y, "ℰⁿ*10⁵"}, Ticks → {{0, 1}, {0, 1}, {0, 1}},
   PlotPoints → 51, PlotLabel → "Error (Sinc interpolation)"];

  Plot3D[Evaluate[1000 * Abs[φ[x, y] - FunctionLagr1[x, y]]], {x, 0, 1},
   {y, 0, 1}, PlotRange → All, AxesLabel → TraditionalForm /@ {x, y, "ℰⁿ*10³"},
   Ticks → {{0, 1}, {0, 1}, {0, 4}}, PlotPoints → 51,
   PlotLabel → "Error (Lagrange interpolation)"]
 ];

{function, NodesX, NodesY} = {Exp[-25 (2 x - 1)^2 - 25 (2 y - 1)^2], 15, 15};
TwoDLaSiInt[function, NodesX, NodesY]
```