EPToolbox package file

This notebook auto-generates the EPToolbox.m package file.

Package Start

```
BeginPackage["EPToolbox`"];
```

Complex root finder

```
FindComplexRoots [equations_List, domainSpecifiers__, ops : OptionsPattern[]] :=
  Block[{seeds, tolerances},
    If[! IntegerQ[Rationalize[OptionValue[Seeds]]] || OptionValue[Seeds] ≤ 0,
      Message[FindComplexRoots ::seeds, OptionValue[Seeds]]];
    If[! (OptionValue[Tolerance] === Automatic || OptionValue[Tolerance] ≥ 0),
      Message[FindComplexRoots ::tol, OptionValue[Seeds]]];

    seeds = OptionValue[SeedGenerator][
        {domainSpecifiers}[[All, {2, 3}]], OptionValue[Seeds]];
    tolerances = Which[
        ListQ[OptionValue[Tolerance]], OptionValue[Tolerance],
        True, ConstantArray[
          Which[
            NumberQ [OptionValue[Tolerance]], OptionValue[Tolerance],
            True, 10^If[NumberQ [OptionValue[WorkingPrecision]],
                2-OptionValue[WorkingPrecision], 2-$MachinePrecision]
          ]
          , Length[{domainSpecifiers}]]
      ];

    If[OptionValue[Verbose], Hold[], Hold[FindRoot::lstol]] /. {
        Hold[messageSequence___ ] :> Quiet[
            DeleteDuplicates[
              Select[
                Check[
                      FindRoot[
                        equations
                        , Evaluate[Sequence@@Table[{{domainSpecifiers}[[j, 1]],
                                #[[j]]}, {j, Length[{domainSpecifiers}]}]]
                        , Evaluate[Sequence @@ FilterRules[{ops},
                              Options[FindRoot]]]
                      ],
                      ## &[]
                    ] &/@seeds,
                Function[
                  repList,
```

```
                    ReplaceAll[
                      Evaluate[And@@Table[
                            And[
                              Re[{domainSpecifiers}[[j, 2]]] ≤ Re[{domainSpecifiers}[[
                                    j, 1]]] ≤ Re[{domainSpecifiers}[[j, 3]]],
                              Im [{domainSpecifiers}[[j, 2]]] ≤ Im [
                                   {domainSpecifiers}[[j, 1]]] ≤ Im [
                                   {domainSpecifiers}[[j, 3]]]
                            ]
                            , {j, Length[{domainSpecifiers}]}]]
                        , repList]
                    ]
                  ],
                  Function[{repList1, repList2},
                    And@@Table[
                        Abs[({domainSpecifiers}[[j, 1]] /. repList1) -
                              ({domainSpecifiers}[[j, 1]] /. repList2)] < tolerances[[j]]
                        , {j, Length[{domainSpecifiers}]}]
                  ]
                ]
                , {messageSequence }]}
  ]
FindComplexRoots [e1_ == e2_, {z_, zmin_ , zmax_ }, ops : OptionsPattern[]] :=
  FindComplexRoots [{e1 == e2}, {z, zmin , zmax }, ops]
```

```
FindComplexRoots ::usage =
    "FindComplexRoots [e1==e2, {z, zmin , zmax }] attempts  to
        find complex  roots of the equation e1==e2 in the
        complex  rectangle with corners zmin  and zmax .

FindComplexRoots [{e1==e2, e3==e4, ...}, {z1, z1min , z1max }, {z2, z2min ,
        z2max }, ...] attempts  to find complex  roots of the given
        system  of equations in the multidimensional  complex
        rectangle with corners z1min , z1max , z2min , z2max , ....";
Seeds::usage = "Seeds is an option for FindComplexRoots  which
        determines  how many  initialseeds are used to
        attempt  to find roots of the given equation.";
SeedGenerator::usage = "SeedGenerator is an option for FindComplexRoots
        which determines  the function  used to generate the
        seeds for the internal FindRoot call. Its value can
        be RandomComplex  , RandomNiederreiterComplexes  ,
        RandomSobolComplexes  , DeterministicComplexGrid , or any
        function f such that f[{zmin , zmax }, n] returns n complex
        numbers  in the rectancle with corners zmin  and zmax .";

Options[FindComplexRoots ] =
    Join[Options[FindRoot], {Seeds -> 50, SeedGenerator -> RandomComplex  ,
        Tolerance -> Automatic , Verbose -> False}];
SyntaxInformation [FindComplexRoots ] = {"ArgumentsPattern " ->
        {_, {_, _, _}, OptionsPattern[]}, "LocalVariables" -> {"Table", {2, ∞}}};
FindComplexRoots ::seeds =
    "Value of option Seeds -> `1` is not a positive integer.";
FindComplexRoots ::tol =
    "Value of option Tolerance -> `1` is not Automatic  or a number  in [0,∞).";

Protect[Seeds];
Protect[SeedGenerator];

Begin["`Private`"];
FindComplexRoots [equations_List, domainSpecifiers__, ops : OptionsPattern[]] :=
  Block[{seeds, tolerances},
    If[! IntegerQ[Rationalize[OptionValue[Seeds]]] || OptionValue[Seeds] ≤ 0,
      Message[FindComplexRoots ::seeds, OptionValue[Seeds]]];
    If[! (OptionValue[Tolerance] === Automatic || OptionValue[Tolerance] ≥ 0),
      Message[FindComplexRoots ::tol, OptionValue[Seeds]]];

    seeds = OptionValue[SeedGenerator][
        {domainSpecifiers}[[All, {2, 3}]], OptionValue[Seeds]];
    tolerances = Which[
        ListQ[OptionValue[Tolerance]], OptionValue[Tolerance],
        True, ConstantArray[
          Which[
            NumberQ [OptionValue[Tolerance]], OptionValue[Tolerance],
```

```
            True, 10^If[NumberQ [OptionValue[WorkingPrecision]],
                2-OptionValue[WorkingPrecision], 2-$MachinePrecision]
          ]
          , Length[{domainSpecifiers}]]
      ];

    If[OptionValue[Verbose], Hold[], Hold[FindRoot::lstol]] /. {
        Hold[messageSequence___ ] :> Quiet[
            DeleteDuplicates[
              Select[
                Check[
                      FindRoot[
                        equations
                        , Evaluate[Sequence@@Table[{{domainSpecifiers}[[j, 1]],
                                #[[j]]}, {j, Length[{domainSpecifiers}]}]]
                        , Evaluate[Sequence @@ FilterRules[{ops},
                              Options[FindRoot]]]
                      ],
                      ## &[]
                    ] &/@seeds,
                Function[
                  repList,
                  ReplaceAll[
                    Evaluate[And@@Table[
                          And[
                            Re[{domainSpecifiers}[[j, 2]]] ≤ Re[{domainSpecifiers}[[
                                  j, 1]]] ≤ Re[{domainSpecifiers}[[j, 3]]],
                            Im [{domainSpecifiers}[[j, 2]]] ≤ Im [
                                 {domainSpecifiers}[[j, 1]]] ≤ Im [
                                 {domainSpecifiers}[[j, 3]]]
                          ]
                          , {j, Length[{domainSpecifiers}]}]]
                    , repList]
                  ]
                ],
                Function[{repList1, repList2},
                  And@@Table[
                      Abs[({domainSpecifiers}[[j, 1]] /. repList1) -
                            ({domainSpecifiers}[[j, 1]] /. repList2)] < tolerances[[j]]
                      , {j, Length[{domainSpecifiers}]}]
                ]
              ]
              , {messageSequence }]}
  ]
FindComplexRoots [e1_ == e2_, {z_, zmin_ , zmax_ }, ops:OptionsPattern[]] :=
  FindComplexRoots [{e1 == e2}, {z, zmin , zmax }, ops]
End[];
```

Quasirandom number generators

RandomSobolComplexes

```
RandomSobolComplexes ::usage =
    "RandomSobolComplexes [{zmin , zmax }, n] generates a
        low-discrepancy Sobol sequence of n quasirandom complex
        numbers in the rectangle with corners zmin and zmax .

RandomSobolComplexes [{{z1min ,z1max },{z2min ,z2max },...},n]
        generates a low-discrepancy Sobol sequence of n
        quasirandom complex numbers in the multi -dimensional
        rectangle with corners {z1min ,z1max },{z2min ,z2max },....";

Begin["`Private`"];
RandomSobolComplexes [pairsList_, number_ ] := Map[
    Function[randomsList ,
      pairsList[[All, 1]] + Complex @@@ Times [
            ReIm [pairsList[[All, 2]] - pairsList[[All, 1]]],
            randomsList
          ]
    ],
    BlockRandom [
      SeedRandom [
        Method → {"MKL", Method → {"Sobol", "Dimension " → 2 Length[pairsList]}}];
      SeedRandom [];
      RandomReal [{0, 1}, {number , Length[pairsList], 2}]
    ]
  ]
RandomSobolComplexes [{zmin_ ?NumericQ , zmax_ ?NumericQ }, number_ ] :=
  RandomSobolComplexes [{{zmin , zmax }}, number ][[All, 1]]
End[];
```

RandomNiederreiterComplexes

```
RandomNiederreiterComplexes ::usage =
    "RandomNiederreiterComplexes [{zmin , zmax }, n] generates a
        low-discrepancy Niederreiter sequence of n quasirandom complex
        numbers in the rectangle with corners zmin and zmax .

RandomNiederreiterComplexes [{{z1min ,z1max },{z2min ,z2max },...},n]
        generates a low-discrepancy Niederreiter sequence of n
        quasirandom complex numbers in the multi -dimensional
        rectangle with corners {z1min ,z1max },{z2min ,z2max },....";
```

```
Begin["`Private`"];
RandomNiederreiterComplexes [pairsList_, number_ ] := Map[
    Function[randomsList ,
      pairsList[[All, 1]] + Complex @@@ Times [
            ReIm [pairsList[[All, 2]] - pairsList[[All, 1]]],
            randomsList
          ]
    ],
    BlockRandom [
      SeedRandom [Method →
          {"MKL", Method → {"Niederreiter", "Dimension" → 2 Length[pairsList]}}];
      SeedRandom [];
      RandomReal [{0, 1}, {number , Length[pairsList], 2}]
    ]
  ]
RandomNiederreiterComplexes [{zmin_ ?NumericQ , zmax_ ?NumericQ }, number_ ] :=
  RandomNiederreiterComplexes [{{zmin , zmax }}, number ][[All, 1]]
End[];
```

DeterministicComplexGrid

```
DeterministicComplexGrid ::usage =
    "DeterministicComplexGrid [{zmin , zmax }, n] generates
        a grid of about n equally spaced complex  numbers
        in the rectangle with corners zmin  and zmax .

DeterministicComplexGrid [{{z1min ,z1max },{z2min ,z2max },...},n]
        generates a regular grid of about n equally spaced
        complex  numbers  in the multi -dimensional  rectangle
        with corners {z1min ,z1max },{z2min ,z2max },....";
```

```
Begin["`Private`"];
DeterministicComplexGrid [pairsList_, number_ ] :=
  Block[{sep, separationsList, gridPointBasis, k},
    sep = NestWhile[0.99 # &, Min[Flatten[ReIm [pairsList[[All, 2]] - pairsList[[All, 1]]]]],
        Times @@ 1/(0.99 #) Floor[Flatten[ReIm [pairsList[[All, 2]] - pairsList[[All, 1]]]],
                0.99 #] ≤ number  &];
    separationsList = Round[1/sep Floor[Flatten[ReIm [
              pairsList[[All, 2]] - pairsList[[All, 1]]]], sep]];
    gridPointBasis = MapThread[
        Function[{l, n}, Range[l[[1]], l[[2]], (l[[2]] - l[[1]])/(n + 1)][[2 ;; -2]]],
        {Flatten[Transpose[ReIm [pairsList], {1, 3, 2}], 1], separationsList}
      ];
    Flatten[Table[
        Table[k[2 j - 1] + i k[2 j], {j, 1, Length[pairsList]}],
        Evaluate[
          Sequence @@ Table[{k[j], gridPointBasis[[j]]}, {j, 1, 2 Length[pairsList]}]]
      ], Evaluate[Range[1, 2 Length[pairsList]]]]
  ]
DeterministicComplexGrid [{zmin_ ?NumericQ , zmax_ ?NumericQ }, number_ ] :=
  DeterministicComplexGrid [{{zmin , zmax }}, number ][[All, 1]]
End[];
```

Contour plot cleaner

This function cleans up automatically generated contour plots. Generically, a contour plot is made of a Polygon with a vast number of vertices in its interior, which are not necessary and only slow the plot down - including a large use of CPU when the mouse hovers above it, which is definitely unwanted. (In addition, these polygons can give rise to white edges inside each contour when printed to pdf, which is also undesirable.) This function changes such Polygons to FilledCurve constructs which no longer contain the unwanted mid-contour points.

This function was written by Szabolcs Horvát (http://mathematica.stackexchange.com/users/12/szabolcs) and was originally posted at http://mathematica.stackexchange.com/a/3279 under a CC-BY-SA license.

```
cleanContourPlot::usage =
    "cleanContourPlot[plot] Cleans up a contour plot by coalescing
        complex  polygons into single FilledCurve instances.
        See MM.SE/a/3279 for source and documentation .";
```

```
Begin["`Private`"];
cleanContourPlot[cp_] :=
Module[{points, groups, regions, lines},
 groups =
 Cases[cp, {style__, g_GraphicsGroup} :> {{style}, g}, Infinity];
 points =
 First@Cases[cp, GraphicsComplex [pts_, ___] :> pts, Infinity];
 regions = Table[
  Module[{group, style, polys, edges, cover, graph},
  {style, group} = g;
  polys = Join@@ Cases[group, Polygon[pt_, ___] :> pt, Infinity];
  edges = Join@@ (Partition[#, 2, 1, 1] & /@ polys);
  cover = Cases[Tally[Sort /@ edges], {e_, 1} :> e];
  graph = Graph[UndirectedEdge@@@ cover];
  {Sequence @@ style,
  FilledCurve[
   List /@ Line /@ First /@
    Map[First,
     FindEulerianCycle/@ (Subgraph[graph, #] &) /@
      ConnectedComponents [graph], {3}]]}
 ],
 {g, groups}];
 lines = Cases[cp, _Tooltip, Infinity];
 Graphics[GraphicsComplex [points, {regions, lines}],
 Sequence @@ Options[cp]]
]
End[];
```

Dynamics profiler

This function produces a profiling suite for any dynamics constructs, which can be used to see which parts of a Dynamic application take up the most processing time and calls.

This function was written by Rui Rojo (http://mathematica.stackexchange.com/users/109/rojo)and was originally posted at http://mathematica.stackexchange.com/a/8047 under a CC-BY-SA license.

```
profileDynamics::usage =
    "profileDynamics[dynamicsConstruct ] Produces a profiling suite
        for the Dynamic  statements  in its argument .
        See MM.SE/a/8047 for source and documentation .";
```

```
Begin["`Private`"];
ClearAll[profileDynamics];
Options[profileDynamics] = {"Print" -> False};
profileDynamics[d_, OptionsPattern[]] := With[
 {print = OptionValue["Print"]},
 Module[{counter = {}},
 DynamicModule [
 {diag, start, tag},
 diag[] := CreateDocument [Column [{
  Button["Reset counter", counter = start],
  Dynamic @Grid[Join[
   {{"Dynamic  expression", "Count", "Time "}},
   MapAt[Short, #, 1] & /@ counter
   ]]
  }]];
 CellPrint@
 ExpressionCell[Button["See profiling information ", diag[]]];
 d //. {
  i : Annotation[_, {tag, ___}] :> i,
  e : Dynamic [sth : Except[First[{_, tag}]], rest___] :> With[
   {pos = 1 + Length@counter,
   catalog =
    Annotation[
     InputForm @e, {tag, Unique["profileDynamics`annot "]}]},
   AppendTo[counter, {catalog, 0, 0.}];
   Dynamic [First@{Refresh[
     If[print, Print[catalog]]; ++counter[[pos, 2]];
     (counter[[pos, 3]] += First@#; Last@#) &[
     AbsoluteTiming [Refresh[sth]]],
     None], tag}, rest] /; True
   ]
  } // (start = counter; #) &
 ]
 ]
 ]
End[];
```

Package End

```
EndPackage[];
```