Attempt to make function of random variables UI. The idea is that one will enter a function Y of a random variable X and see the transformation on the screen. It works for basic functions, but this still needs much work to make it of more use. This was something I was trying.

by Nasser Abbasi 2007

```
Manipulate[process[firstPDF, func, funcPars, firstPDFpars, centerAround, width, yaxis],

 {{firstPDF, 1, "Select X random variable density distribution f_X(x):"},
  {1 → "Normal", 2 → "Exponential", 3 → "Gamma"}, ControlType → PopupMenu},

 {{firstPDFpars, HoldForm[{μ → 1, σ → 1}],
   "Type in numerical values for all parameters for above distribution:"},
  ControlType → InputField[]},

 {{func, HoldForm[a X + b], "Type in the random variable function: Y="},
  ControlType → InputField[]},

 {{funcPars, HoldForm[{a → 2, b → 4}],
   "Type in numerical values for any unknowns in function above:"},
  ControlType → InputField[]},

 {{centerAround, 0, "[x axis] centered around? ="}, -100, 100, 1, Appearance → "Labeled"},
 {{width, 33, "[x axis]  width around center? ="}, 0.001, 500, 0.1, Appearance → "Labeled"},
 {{yaxis, 5, "[y axis]  adjust? ="}, 0.0001, 500, 0.1, Appearance → "Labeled"},
 Initialization :→
  {
   gDebug = False;
   (*****************************************)
   (*  getXParameters                       *)
   (*****************************************)
   getXParameters[firstPDFID_] := Module[{s},
     Which[firstPDFID == 1, s = Row[{"Mean=", Text[Mean[NormalDistribution[μ, σ]]],
         "  Variance=", Text[Variance[NormalDistribution[μ, σ]]]}],
      firstPDFID == 2, s = Null,
      True, s = Null
     ];
     s
    ];
   (*****************************************)
   (*  getNormalParameters                  *)
   (*****************************************)
   getNormalParameters[yPDFsymbolic_] := Module[{s, var, mean, tmp},
     tmp = DeleteCases[yPDFsymbolic, 1 / Sqrt[2 Pi]];
     If[gDebug, Print[tmp]];
     tmp = DeleteCases[tmp, Exp[x_]];
     If[gDebug, Print[tmp]];
     var = Denominator[tmp];
     If[gDebug, Print[var]];
     var = var^2;
     tmp = Cases[yPDFsymbolic, Exp[x_] → x];
     If[gDebug, Print[tmp]];
```

```
  tmp = tmp * 2 σ^2;
  tmp = Cases[tmp, -(x_)^2 → x];
  If[gDebug, Print[tmp]];

  tmp = First@Solve[tmp == 0, y];
  mean = y /. tmp;
  If[gDebug, Print[mean]];
  s = Row[{"Mean=", Text[mean], "  Variance=", Text[var]}]
 ];

(*****************************************)
(*  getYParameters                       *)
(*****************************************)
getYParameters[yPDFsymbolic_, firstPDFID_] := Module[{s},
  Which[firstPDFID == 1,
   s = getNormalParameters[yPDFsymbolic], firstPDFID == 2, s = Null, True, s = Null];
  s
 ];

(*****************************************)
(*  sim                                  *)
(*****************************************)
sim[firstPDF_, func_, funcPars_, firstPDFpars_, centerAround_,
  width_, firstPDFID_, yaxis_] := Module[{z, p1, p2, title, yPDFsymbolic,
   yPDFnumeric, xPDFnumeric, sy, sx, nSolutions, i, allSolutions, tmp, sign},

  If[gDebug, Print["func= ", func]];
  allSolutions = X /. Solve[func, X];
  nSolutions = Length[allSolutions];
  yPDFsymbolic = 0;
  yPDFnumeric = 0;

  For[i = 1, i ≤ nSolutions, i++,
   {
    z = allSolutions[[i]] /. {Y → y};
    If[gDebug, Print["solution is ", z]];
    tmp = D[z, y] PDF[firstPDF, x] /. {x → z};
    If[gDebug, Print["tmp ", tmp]];
    If[nSolutions > 1, If[Mod[i, 2] == 0, sign = (1), sign = (-1)], sign = (1)];
    If[gDebug, Print["sign is ", sign]];
    yPDFsymbolic = yPDFsymbolic + (sign * tmp);
    If[gDebug, Print["Now yPDFsymbolic ", yPDFsymbolic]];
    tmp = tmp /. firstPDFpars;
    tmp = tmp /. funcPars;
    yPDFnumeric = yPDFnumeric + sign * tmp;

    If[gDebug, Print["yPDFsymbolic ", yPDFsymbolic]];
    If[gDebug, Print["yPDFnumeric ", yPDFnumeric]];
   }
  ];

  If[gDebug, Print["**yPDFsymbolic ", yPDFsymbolic]];
  If[gDebug, Print["**yPDFnumeric ", yPDFnumeric]];
```

```
    xPDFnumeric = Simplify[ PDF[firstPDF, x] /. firstPDFpars];
    yPDFsymbolic = Simplify[ yPDFsymbolic];
    yPDFnumeric = Simplify[ yPDFnumeric];

    p1 = Plot[ xPDFnumeric
      , {x, centerAround - width / 2, centerAround + width / 2},
      PlotRange → {All, {-yaxis, yaxis}},
      PlotStyle → Red
     ];


    (*sy=getYParameters[yPDFsymbolic,firstPDFID];*)
    sx = getXParameters[firstPDFID];

    title = Row[{"fx(x)=", Text[PDF[firstPDF, x]], " =", Text[xPDFnumeric], "\t",
       sx, "\n",
       "fy(y)=", Text[yPDFsymbolic], " =", Text[yPDFnumeric]}];

    p2 = Plot[ yPDFnumeric, {y, centerAround - width / 2, centerAround + width / 2},
      PlotRange → {All, {-yaxis, yaxis}}];


    Show[{p1, p2}, PlotLabel → title]
   ];

  (*****************************************)
  (*  process                              *)
  (*****************************************)
  process[firstPDFID_, func_, funcPars_, firstPDFpars_, centerAround_, width_, yaxis_] :=
   Module[{firstPDF, firstPDFpars2, func2, mapping, funcPars2},
    (*sim[firstPDF,func,funcPars,firstRpars]*)

    If[funcPars == Null, funcPars = {}];

    Which[firstPDFID == 1, firstPDF = NormalDistribution[μ, σ],
     firstPDFID == 2, firstPDF = ExponentialDistribution[λ], True, firstPDF = 0];

    func2 = ReleaseHold[func];
    funcPars2 = ReleaseHold[funcPars];
    firstPDFpars2 = ReleaseHold[firstPDFpars];

    mapping = Y == func2;
    sim[firstPDF, mapping, funcPars2,
     firstPDFpars2, centerAround, width, firstPDFID, yaxis]
   ];

 }
]
```

Select X random variable density distribution $f_X(x)$: Normal

Type in numerical values for all parameters for above distribution: $\{\mu \to 1, \sigma \to 1\}$

Type in the random variable function: Y= a X + b

Type in numerical values for any unknowns in function above: $\{a \to 2, b \to 4\}$

[x axis] centered around? = 0

[x axis] width around center? = 33

[y axis] adjust? = 0.4

0.4

$$f_x(x)=\frac{e^{-\frac{(x-\mu)^2}{2\sigma^2}}}{\sqrt{2\pi}\ \sigma}=\frac{e^{-\frac{1}{2}(x-1)^2}}{\sqrt{2\pi}}$$

Mean=μ Variance=σ^2

$$f_y(y)=\frac{e^{-\frac{(b-y+a\mu)^2}{2a^2\sigma^2}}}{a\sqrt{2\pi}\ \sigma}=\frac{e^{-\frac{1}{8}(y-6)^2}}{2\sqrt{2\pi}}$$