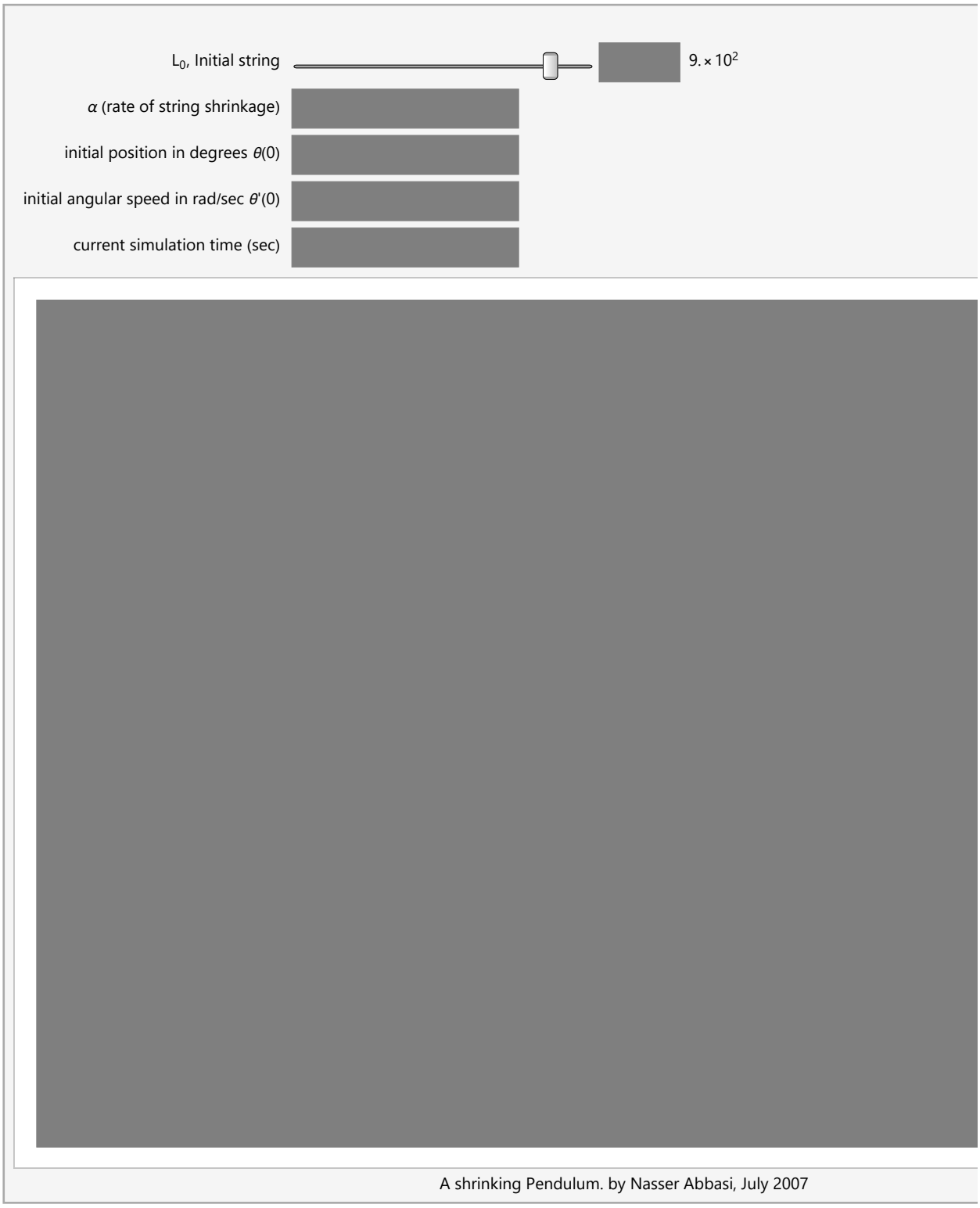
My first Manipulate program. Simulate of a pendulum which is being pulled up as it swings.

```
Remove["Global`*"];


maxLength = 1000;
u = Manipulate[Module[{g, r, simRate = 0.001},
          r = l - α t;
          eq = r θ''[t] - 2 α θ'[t] + g Sin[θ[t]];
          g = 9.8;
          maxTime = 1/α;
          s = θ /. First[NDSolve[{eq == 0, θ[0] == θ0 * Pi / 180, θ'[0] == v0}, θ, {t, 0,
                        maxTime - 0.001}, MaxSteps → 200000, MaxStepFraction → 0.0001]];


          getNormalizedAngle[θ_] := Module[{q = θ},
                {
                   If[q >= 0, q = Mod[q, 2 Pi], {q = -q;
                         q = Mod[q, 2 Pi];
                         q = -q;
                         q = q + 2 Pi}];
                   q * 180 / Pi
                }
             ];

          getQuadrent[a_] := Module[{q},
                {
                   If[a ≥ 0 && a ≤ Pi / 2, q = 1];
                   If[a > Pi / 2 && a ≤ Pi, q = 2];
                   If[a > Pi && a ≤ 3/2 Pi, q = 3];
                   If[a > 3/2 Pi && a ≤ 2 Pi, q = 4];
                   q
                }
             ];
          coordinates[s_, t_, l_, α_] := Module[{θ, p = False, q},
                {θ = s[t];
                   If[p, Print["t=", t, " θ=", θ * 180 / Pi]];
                   If[θ >= 0, θ = Mod[θ, 2 Pi], {θ = -θ;
                         θ = Mod[θ, 2 Pi];
                         θ = -θ;
                         θ = θ + 2 Pi}];
                   q = First[getQuadrent[θ]];
                   If[p, Print["after mod t=", t, " θ=", θ * 180 / Pi]];
                   If[p, Print["q=", q]];

                   r = l - α t;
```

```
            If[p, Print["r=", r]];
            If[q == 1, {x = r Sin[θ], y = -r Cos[θ]}];
            If[q == 2, {θ = θ - Pi / 2; x = r Cos[θ], y = r Sin[θ]}];
            If[q == 3, {θ = θ - Pi; x = -r Sin[θ], y = r Cos[θ]}];
            If[q == 4, {θ = θ - 3/2 Pi; x = -r Cos[θ], y = -r Sin[θ]}];
            If[p, Print["x=", x, " y=", y]];
            If[p, Print["******"]];
            {x, y}
          }
      ];
   d = coordinates[s, ts, l, α];
   Graphics[ { {Gray, Dashed , Line[{{-maxLength, 0}, {maxLength, 0}}]},
         {Gray, Dashed , Line[{{0, -maxLength}, {0, maxLength}}]},
         Text["θ= " <> ToString[First[getNormalizedAngle[ s[ts] ] ]], {.4 l, .9 l}],
         Text["current string length L(t)=L0-α t=" <> ToString[r], {.4 l, .8 l}],
         Text["current time t (sec)=" <> ToString[ts], {.4 l, .7 l}],
         Text["L[t] θ''[t]-2 α θ'[t]+g Sin[θ[t]]=0", {.4 l, .6 l}],
         Line[{ {0, 0}, First[d]} ],
         PointSize[.03], Red, Point[First[d]]},
      PlotRange → {{-l - .1 l, l + .1 l}, {-l - .1 l, l + .1 l}}, ImageSize → {450, 325}]
],
{{l, 0.9 maxLength, "L0, Initial string"}, 1, maxLength, 1, Appearance → "Labeled"},
{{α, 1, "α (rate of string shrinkage)"}, 0.1, 10, 0.1, Appearance → "Labeled"},
{{θ0, 45, "initial position in degrees θ(0)"}, 0, 360, 1, Appearance → "Labeled"},
{{v0, 0, "initial angular speed in rad/sec θ'(0)"},
   0, 100, 1, Appearance → "Labeled"},
{{ts, 0, "current simulation time (sec)"}, 0, l/α - 0.001, (0.0001 l/α),
   Appearance → "Labeled"}, ContinuousAction → True, AutorunSequencing -> {{5, 60}},
FrameLabel → "A shrinking Pendulum. by Nasser Abbasi, July 2007"]
```




```
(*Export["shrink_pendulum3.swf",u];*)
```