Immediate *vs* deferred assignment

Katharine Long

Department of Mathematics and Statistics, Texas Tech University

There are a number of ways to assign values to variables. Full documentation is at:
http://reference.wolfram.com/language/guide/Assignments.html
The most common assignment methods (and the only ones you'll need to use in my courses on DE, Math Methods, or Numerical Analysis) will be Immediate (the "=" operator) and Deferred (the ":=" operator). This document is to explain why you'll sometimes use immediate assignment, sometimes deferred assignment.

You will most often use immediate assignment ("=")

Use this when the expression on the RHS of the assignment can be evaluated

In[∘]:=
```
f[x_] = Sin[x] / (1 + x ^ 2)
```

Out[∘]= $\frac{\sin(x)}{x^2+1}$

The expressions 2 and $\frac{\sin(x)}{1+x^2}$ can be evaluated at the time of assignment, so immediate assignment is used.

Deferred evaluation (":=")

If the RHS of the assignment can't be evaluated at the time of assignment, use deferred evaluation. This is easiest to explain by example .

Example: Writing a function to compute arc length of a function to be specified

Recall that the arc length of the curve defined by $f(x)$ is

$$L = \int_a^b \sqrt{1+\left(\frac{\mathrm{df}}{\mathrm{dx}}\right)^2}\ \mathrm{dx}.$$

We can't evaluate the integral until the function $f(x)$ has been specified. In writing a Mathematica function to evaluate arc length given a function f, we must use deferred evaluation.

In[∘]:=
```
arcLength[f_, a_, b_] := Integrate[Sqrt[1 + D[f, x] ^ 2], {x, a, b}]
```

The arc length of a constant function $f(x) = c$ on [0, 1] is 1.

In[∘]:=
```
arcLength[c, 0, 1]
```

Out[∘]= 1

The arc length of $f(x) = x$ on [0, 1] is $\sqrt{2}$.

In[∘]:=
```
arcLength[x, 0, 1]
```

Out[∘]= $\sqrt{2}$

The arc length of $f(x) = \frac{1}{2}x^2$ is $\int_0^1 \sqrt{1 + x^2}\, dx$.

In[∘]:=
```
arcLength[x^2/2, 0, 1]
```

Out[∘]= $\frac{1}{2}\left(\sqrt{2} + \sinh^{-1}(1)\right)$

The arc length of $\sin(x)$ is an elliptic integral. There is no closed-form representation of this function.

In[∘]:=
```
arcLength[Sin[x], 0, Pi/2]
```

Out[∘]= $\sqrt{2}\, E\left(\frac{1}{2}\right)$

If the integral can't be done in terms of known functions, it's returned unevaluated.

In[∘]:=
```
arcLength[g[x], 0, 1]
```

Out[∘]= $\int_0^1 \sqrt{g'(x)^2 + 1}\, dx$

In[∘]:=
```
arcLength[Exp[-x^2 + x], 0, 1]
```

Out[∘]= $\int_0^1 \sqrt{e^{2x-2x^2}(1-2x)^2 + 1}\, dx$

- ## Example: Writing a plotter for a function with a parameter

We can't plot $(x - t)^2$ against x until the parameter t has been given a value.

In[∘]:=
```
doPlot[t_] := Plot[(x - t)^2, {x, -2, 2}, PlotRange → {0, 12}]
```

In[∘]:=
```
GraphicsRow[{doPlot[0], doPlot[1/2], doPlot[1]}]
```

Out[∘]=