In[1]:= (*FUNCTIONS and their Plots*)

In[2]:= (*1*)

In[3]:= Clear[f, x]; f = Sin[x] / x

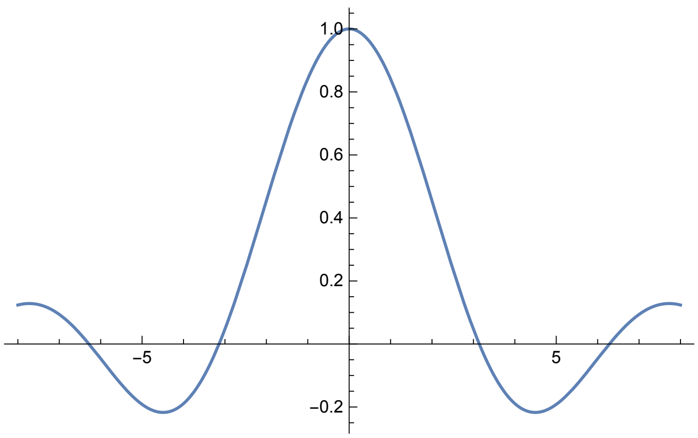
Out[3]= $\frac{\text{Sin}[x]}{x}$

In[4]:= f /. x → Pi / 2 (*replacement /. *)

Out[4]= $\frac{2}{\pi}$

In[5]:= Plot[f, {x, -8, 8}]

Out[5]=



In[6]:= (*2*)Clear[f]; f[x_] := Sin[x] / x

In[7]:= f[y]

Out[7]= $\frac{\text{Sin}[y]}{y}$

In[8]:= f[3.]

Out[8]= 0.04704

In[9]:= Plot[f[x], {x, -8, 8}]; (*same output*)

In[10]:= (*3 - risky but fast; must clear x*) Clear[f, x]; f[x_] = Sin[x] / x

Out[10]= $\frac{\text{Sin}[x]}{x}$

In[11]:= Plot[f[x], {x, -8, 8}]; (*same*)

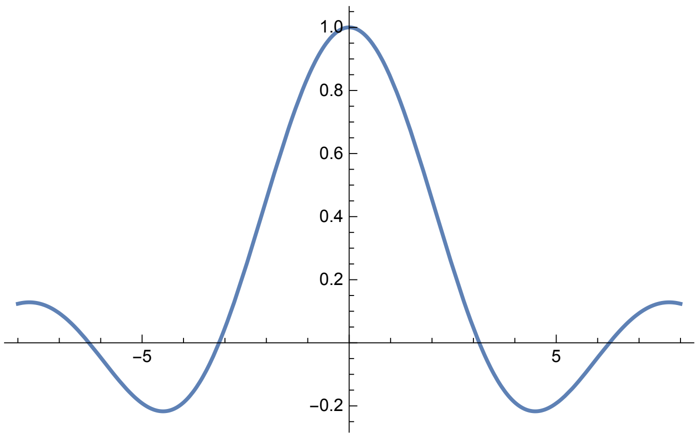
In[12]:= (*4 - pure function, note "&"*)Clear[f]; f := Sin[#] / # &

In[13]:= f[z]

Out[13]= $\frac{\text{Sin}[z]}{z}$

```
In[14]:= f[Cos[x]]

Out[14]= Sec[x] Sin[Cos[x]]

In[15]:= (*plot same as before*)

In[16]:=

In[17]:=

In[18]:= (*for external graphics*)

In[19]:= disp := Export["t.ps", #1, "EPS"] &

In[20]:= Plot[f[x], {x, -8, 8}, PlotStyle → Thick]
```

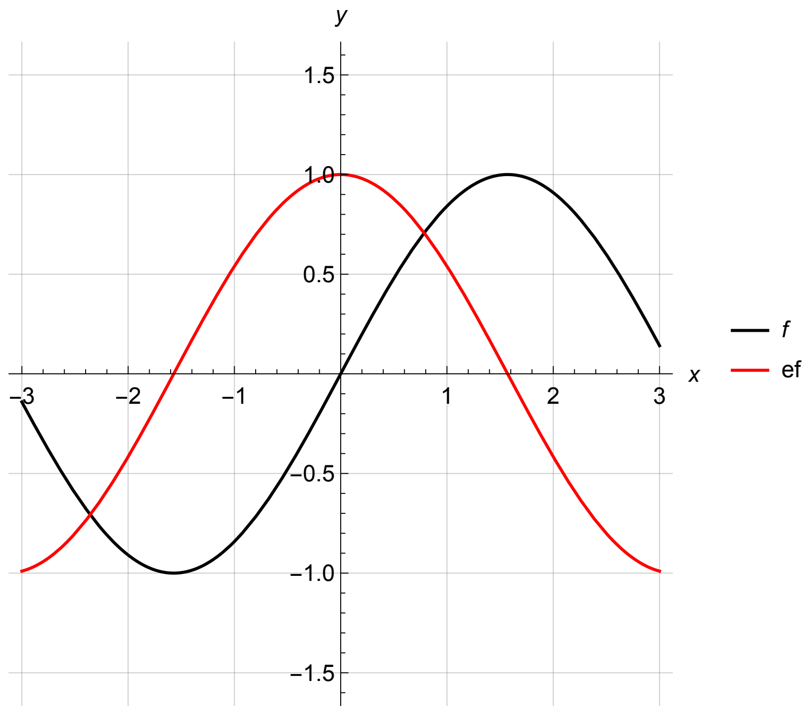
Out[20]=




```
In[21]:= disp[%] (*creates "t.ps" *)

Out[21]= t.ps

In[22]:=

In[23]:=

In[24]:= (*plotting with options*)
```

In[25]:=
```
Clear[f, ef, x]; f = Sin[x]; ef = D[f, x];
Show[Plot[{f, ef}, {x, -3, 3}, PlotStyle → {Black, Red,},
  PlotLegends → "Expressions", LabelStyle → Medium], PlotRange → {-1.5, 1.5},
 GridLines → Automatic, AxesLabel → {x, y}, AspectRatio → 1]
```

Out[25]=



In[26]:=
```
disp[%]
```

Out[26]= t.ps

In[27]:=

In[28]:=

```
(*MORE on PURE FUNCTIONS*)
```

In[52]:=
```
Clear[f]; f := 1/(1 + #) &
```

In[53]:=
```
f[x]
```

Out[53]= $\frac{1}{1+x}$

In[54]:=
```
f[%]
```

Out[54]= $\frac{1}{1+\frac{1}{1+x}}$

In[55]:=
```
(*continued fraction; Nest command does it*)
```

In[56]:= `Nest[f, x, 4]`

Out[56]= $$\frac{1}{1+\frac{1}{1+\frac{1}{1+\frac{1}{1+x}}}}$$

In[57]:= `(*Newton's method to find roots*)`

In[58]:= `der := D[#, x] & (*derivative, but in x only*)`

In[59]:= `step := # - (f / der[f] /. x → #) & (*one step in Newton's method*)`

`Clear[f]; f = x^2 - 2; (*to find Sqrt[2]; 3 will be initial guess; 4 iterations*)`

In[61]:= `Nest[step, 3, 4]`

Out[61]= $$\frac{10\,390\,190\,017}{7\,346\,972\,688}$$

In[62]:= `% - Sqrt[2] // N (*after only 4 steps with a poor initial guess!!*)`

Out[62]= 2.17674×10^{-7}

```
(*NestList
 "remebers the intermediate steps; will improve the initial guess  to 2*)
```

In[66]:= `NestList[step, 2, 6]`

Out[66]= $\left\{2, \frac{3}{2}, \frac{17}{12}, \frac{577}{408}, \frac{665\,857}{470\,832}, \frac{886\,731\,088\,897}{627\,013\,566\,048}, 1\,572\,584\,048\,032\,918\,633\,353\,217 / 1\,111\,984\,844\,349\,868\,137\,938\,112\right\}$

In[67]:= `% - Sqrt[2.]`

Out[67]= $\{0.585786, 0.0857864, 0.0024531, 2.1239\times10^{-6}, 1.59472\times10^{-12}, 0., -2.22045\times10^{-16}\}$

In[68]:= `N[%% - Sqrt[2], 20]`

Out[68]= $\{0.58578643762690495120, 0.08578643762690495120, 0.0024531042935716178650, 2.1239014147551198799\times10^{-6}, 1.5948618246068546804\times10^{-12}, 8.9929283216504531005\times10^{-25}, 2.8592838433339512253\times10^{-49}\}$

`(*note:number of correct digits DOUBLES with every step*)`

In[69]:= `(*illustrative plot with a bad 1st guess*)`

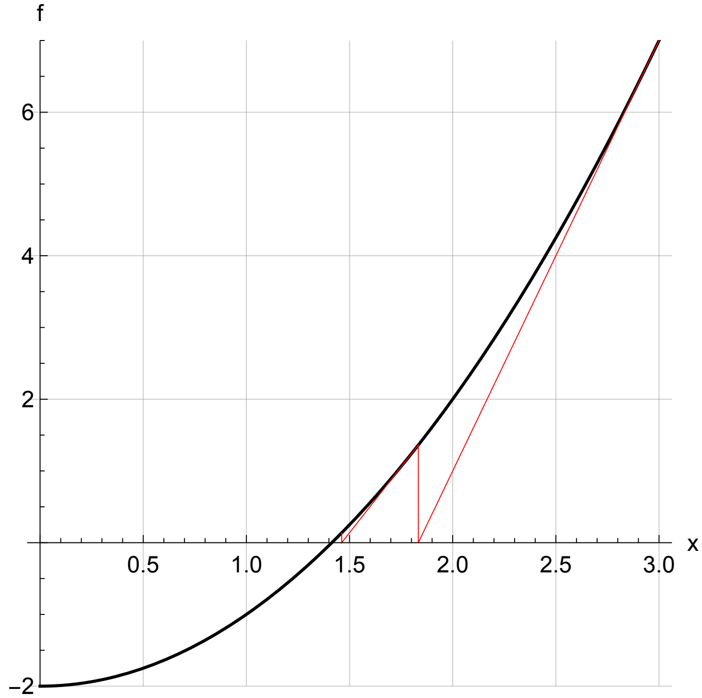
In[70]:= `list = NestList[step, 3, 4];`

In[71]:= `flist = f /. x → list // N`

Out[71]= $\{7., 1.36111, 0.137798, 0.00222056, 6.15675\times10^{-7}\}$

In[76]:=
```
Show[Plot[{f}, {x, 0, 3}, PlotStyle → {Black}, PlotRange → {-2, 7},
  GridLines → Automatic, AxesLabel → {"x", "f"}, LabelStyle → Medium], Graphics[
  {Red, Line[{{list[[1]], flist[[1]]}, {list[[2]], 0}, {list[[2]], flist[[2]]},
     {list[[3]], 0}, {list[[3]], flist[[3]]}}]}], AspectRatio → 1]
```

Out[76]=



In[38]:=

In[39]:=

In[40]:=

In[41]:=

In[42]:=

In[43]:=

In[44]:=

In[45]:=

In[46]:=

In[47]:=

In[48]:=

In[49]:=

In[50]:=

In[51]:=