Wolfram Mathematica Book

Chapter 2: A Demo Project

life expectancy in the US »

Input interpretation

United States COUNTRY [life expectancy]

Assuming "life expectancy" is international data | Use as referring to life expectancy data instead

Input interpretation:

United States COUNTRY [life expectancy]

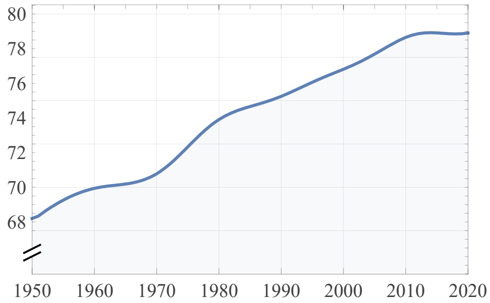
United States	life expectancy

Result:

78.9 yr

78.9 years (world rank: 66th)

Life expectancy history:



(from 1950 to 2020)

(in years)

Demographics: Show rates Show distribution Show non–metric

```
Dataset[EntityValue[ United States COUNTRY ,
{ population , population density , population growth ,
life expectancy , median age }, "PropertyAssociation"]]
```

population	336 million people (world rank: 3rd) (2021 estimate)
population density	36.8 people/km^2 (people per square kilometer) (world rank: 183rd) (2021 estimate)

population growth	0.298 %/yr (world rank: 171st) (2021 estimate)
life expectancy	78.9 years (world rank: 66th) (2020 estimate)
median age	37.7 years (world rank: 72nd) (2021 estimate)

+ Units

Unit conversions:

28 800 days

691 200 hours

4.147×10^7 minutes

7.885 average Gregorian decades

2.488×10^9 seconds

In[ ]:=
```
CountryData["UnitedStates", "LifeExpectancy"]
```
Out[ ]=
```
80.43 yr
```

In[ ]:=
```
United States COUNTRY [ life expectancy ]
```
Out[ ]=
```
78.9 yr
```

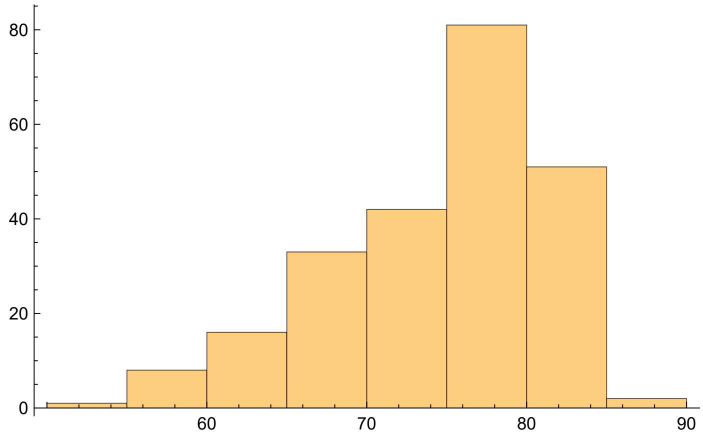
In[ ]:=
```
CountryData[All]
```

In[ ]:=
```
data = DeleteCases[
   Table[{i, CountryData[i, "LifeExpectancy"]}, {i, CountryData[All]}], {_, _Missing}];
```

In[ ]:=
```
Short[data]
```
Out[ ]//Short=
```
{{Afghanistan, 53.25 yr}, {Albania, 79.23 yr}, {Algeria, 77.79 yr},
 {American Samoa, 75.06 yr}, {Andorra, 83.23 yr}, {Angola, 61.71 yr},
 {Anguilla, 82 yr}, {Antigua and Barbuda, 77.55 yr}, {Argentina, 78.07 yr},
 {Armenia, 75.86 yr}, <<214>>, {Uzbekistan, 75.03 yr}, {Vanuatu, 74.87 yr},
 {Venezuela, 72.22 yr}, {Vietnam, 75.25 yr}, {Wallis and Futuna Islands, 80.45 yr},
 {West Bank, 76.12 yr}, {Western Sahara, 63.8 yr},
 {Yemen, 67.18 yr}, {Zambia, 65.92 yr}, {Zimbabwe, 62.83 yr}}
```

In[∘]:=
```
SortBy[data, Last] // Short
```
Out[∘]//Short=
```
{{Afghanistan, 53.25 yr}, {Central African Republic, 55.07 yr},
 {Somalia, 55.32 yr}, {Mozambique, 56.49 yr}, {South Sudan, 58.6 yr},
 {Chad, 58.73 yr}, {Lesotho, 58.9 yr}, {Eswatini, 59.13 yr},
 {Niger, 59.7 yr}, {Sierra Leone, 60.19 yr}, <<214>>, {Israel, 83.15 yr},
 {Andorra, 83.23 yr}, {Hong Kong, 83.41 yr}, {Iceland, 83.45 yr},
 {Canada, 83.62 yr}, {San Marino, 83.68 yr}, {Japan, 84.65 yr},
 {Macau, 84.81 yr}, {Singapore, 86.19 yr}, {Monaco, 89.4 yr}}
```

In[∘]:=
```
Histogram[data⟦All, 2⟧]
```
Out[∘]=



In[∘]:=
```
dataAfrica = DeleteCases[
   Table[{i, CountryData[i, "LifeExpectancy"]},
    {i, CountryData["Africa"]}], {_, _Missing}];
```

In[∘]:=
```
meanAfrica = Mean[dataAfrica⟦All, 2⟧]
```
Out[∘]=
```
66.4587 yr
```

In[∘]:=
```
dataAsia = DeleteCases[
   Table[{i, CountryData[i, "LifeExpectancy"]},
    {i, CountryData["Asia"]}], {_, _Missing}];
```

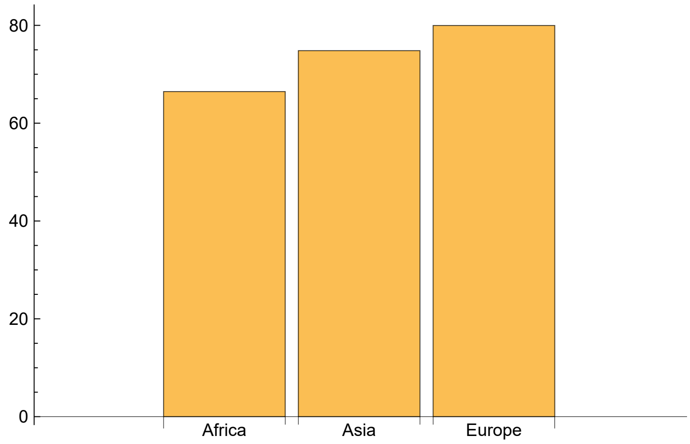
In[∘]:=
```
meanAsia = Mean[dataAsia⟦All, 2⟧]
```
Out[∘]=
```
74.8257 yr
```

In[∘]:=
```
dataEurope = DeleteCases[
   Table[{i, CountryData[i, "LifeExpectancy"]},
    {i, CountryData["Europe"]}], {_, _Missing}];
```

In[∘]:=
```
meanEurope = Mean[dataEurope[[All, 2]]]
```
Out[∘]=

79.971 yr

In[∘]:=
```
BarChart[{meanAfrica, meanAsia, meanEurope}, ChartLabels → {"Africa", "Asia", "Europe"}]
```
Out[∘]=

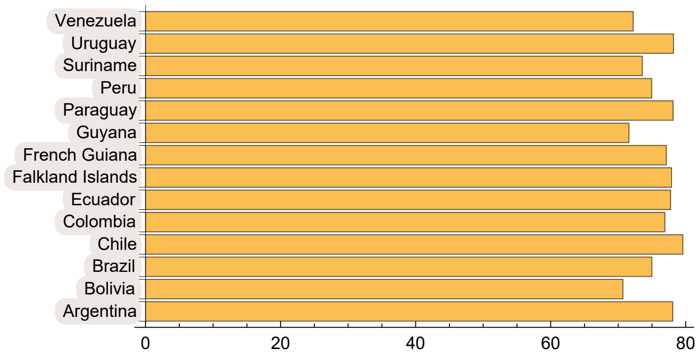


In[∘]:=
```
dataSA = DeleteCases[
   Table[{i, CountryData[i, "LifeExpectancy"]},
    {i, CountryData["SouthAmerica"]}], {_, _Missing}];
```

In[∘]:=
```
Take[dataSA, 3]
```
Out[∘]=

{{Argentina, 78.07 yr}, {Bolivia, 70.7 yr}, {Brazil, 74.98 yr}}

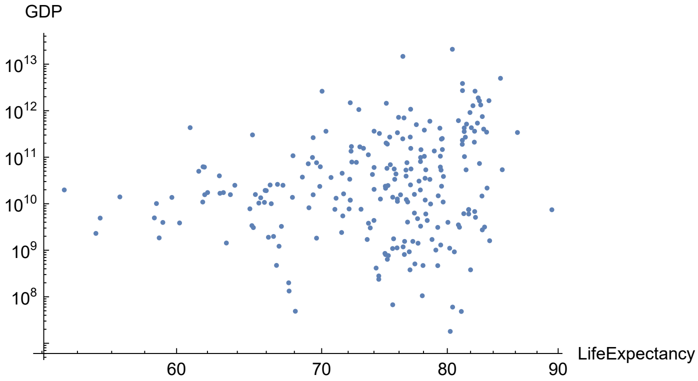
In[∘]:=
```
BarChart[dataSA[[All, 2]], ChartLabels → dataSA[[All, 1]], BarOrigin → Left]
```
Out[∘]=



In[∘]:=
```
data = Table[Tooltip[{CountryData[i, "LifeExpectancy"], CountryData[i, "GDP"]},
    CountryData[i, "Name"]], {i, CountryData[]}];
```

```
In[•]:= ListLogLogPlot[data, AxesLabel → {"LifeExpectancy", "GDP"}]
```

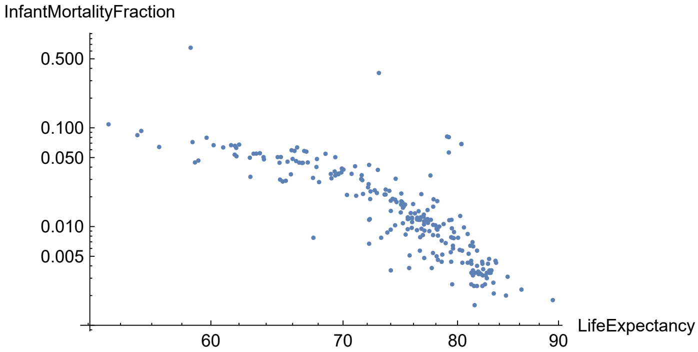
Out[•]=




```
In[•]:= data = Table[Tooltip[
          {CountryData[i, "LifeExpectancy"], CountryData[i, "InfantMortalityFraction"]},
          CountryData[i, "Name"]], {i, CountryData[]}];
```

```
In[•]:= ListLogLogPlot[data, AxesLabel → {"LifeExpectancy", "InfantMortalityFraction"}]
```

Out[•]=




```
In[•]:= Manipulate[
         plotFn[Table[Tooltip[{CountryData[i, "LifeExpectancy"], CountryData[i, prop]},
            CountryData[i, "Name"]], {i, CountryData[All]}],
          AxesLabel → {"LifeExpectancy", prop}],
         {prop, {"InfantMortalityFraction", "GDP", "LiteracyFraction"}},
         {{plotFn, ListLogLogPlot}, {ListPlot, ListLogPlot, ListLogLogPlot}},
         SaveDefinitions → True]
```

```
In[•]:= Clear[data, dataAfrica, meanAfrica, dataAsia, meanAsia, dataEurope, meanEurope, dataSA]
```

Chapter 3: Input and Output

Chapter 4: Typesetting

Chapter 5: Presentation

In[*]:=
```
Row[{"item1", "item2", "item3"}, Spacer[10]]
```
Out[*]=
```
item1   item2   item3
```

In[*]:=
```
Style[Grid[{
    {Style[a, Bold, Red], b, c},
    {d, e, f},
    {g, h, i}
  }, Alignment → Left, Frame → True, Dividers → Center],
 FontFamily → "Times New Roman"]
```
Out[*]=

a	b	c
d	e	f
g	h	i

In[*]:=
```
Row[Table[i, {i, 0, 5}], Spacer[10]]
```
Out[*]=
```
0   1   2   3   4   5
```

In[*]:=
```
Row[Table[Sin[x t], {x, 0, 10}, {t, 1, 6}], Spacer[10]]
```
Out[*]=
```
{0, 0, 0, 0, 0, 0}   {Sin[1], Sin[2], Sin[3], Sin[4], Sin[5], Sin[6]}
   {Sin[2], Sin[4], Sin[6], Sin[8], Sin[10], Sin[12]}
 {Sin[3], Sin[6], Sin[9], Sin[12], Sin[15], Sin[18]}
 {Sin[4], Sin[8], Sin[12], Sin[16], Sin[20], Sin[24]}
 {Sin[5], Sin[10], Sin[15], Sin[20], Sin[25], Sin[30]}
   {Sin[6], Sin[12], Sin[18], Sin[24], Sin[30], Sin[36]}
   {Sin[7], Sin[14], Sin[21], Sin[28], Sin[35], Sin[42]}
   {Sin[8], Sin[16], Sin[24], Sin[32], Sin[40], Sin[48]}
   {Sin[9], Sin[18], Sin[27], Sin[36], Sin[45], Sin[54]}
   {Sin[10], Sin[20], Sin[30], Sin[40], Sin[50], Sin[60]}
```

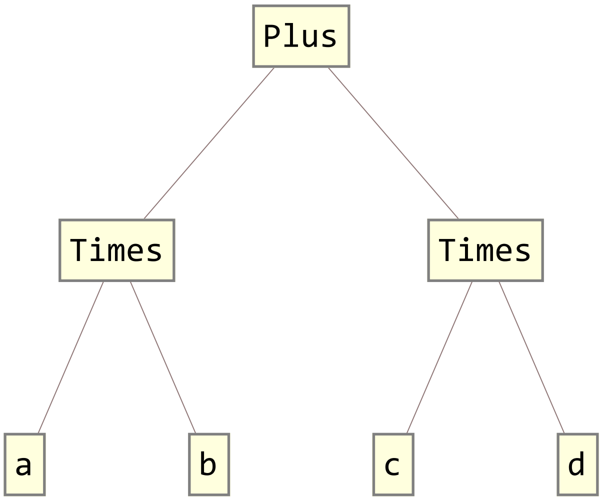
In[*]:=
```
Grid[{
   Prime[Range[1, 4]],
   Prime[Range[5, 8]],
   Prime[Range[9, 12]],
   Prime[Range[13, 16]]
  }]
```
Out[*]=

2	3	5	7
11	13	17	19
23	29	31	37
41	43	47	53

Chapter 6: Basic Wolfram Language

In[∘]:=
```
FullForm[a b + c d]
```
Out[∘]//FullForm=
```
Plus[Times[a, b], Times[c, d]]
```

In[∘]:=
```
TreeForm[a b + c d]
```
Out[∘]//TreeForm=



In[∘]:=
```
Table[π, 100]
```
Out[∘]=
```
{π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π,
 π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π,
 π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π,
 π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π, π}
```

In[∘]:=
```
Table[{i, i^2}, {i, 1, 10}]
```
Out[∘]=
```
{{1, 1}, {2, 4}, {3, 9}, {4, 16}, {5, 25}, {6, 36}, {7, 49}, {8, 64}, {9, 81}, {10, 100}}
```

In[∘]:=
```
π squared is N[π^2]
```
Out[∘]=
```
31.0063 is squared
```

In[∘]:=
```
"π squared is: " <> ToString[N[π^2]]
```
Out[∘]=
```
π squared is: 9.8696
```

2 feet

2 ft

Input interpretation:

2 ft

2 feet

Unit conversions:

More digits | Exact forms

24 inches

6.096 dm (decimeters)

60.96 cm (centimeters)

609.6 mm (millimeters)

0.6096 meters

Comparisons as length:

≈ (0.6 to 0.9)

≈ (1.1 to 2)

≈ 7.1 × typical length of a credit card (85.6 mm)

Comparison as height:

≈ 4.7 × height of a stair riser (4 to 7 in)

Comparison as depth:

≈ 2 × depth of a stair tread (≈ 11 in)

Comparison as radius:

≈ 2.7 × inner radius of an NBA basketball rim (9 in)

Comparisons as circumference:

≈ (0.5 to 0.9)

≈ 0.88 × FIFA-sanctioned soccer ball circumference (68 to 70 cm)

Comparisons as wavelength:

≈ 0.88 × sound wavelength at 500 Hz (fourth octave) in air at 21 °C (≈ 0.69 m)

≈ (1 to 5)

≈ 6 × smallest microwave wavelength (≈ 0.1 m)

Electromagnetic frequency range:

Show electromagnetic spectrum

microwave | UHF (ultra high frequency) | decimeter band

Frequency allocation for Singapore (ITU region 3):

primary use	fixed | mobile | broadcasting

Interpretations:

More

length

height

depth

radius

circumference

wavelength

Corresponding quantities:

Light travel time t in vacuum from $t = x/c$:
2 ns (nanoseconds)

Light travel time t in an optical fiber $t = 1.48x/c$:
3 ns (nanoseconds)

Wavelength λ from $\lambda = 2\pi\bar{\lambda}$:
3.83 meters

Frequency ν of a photon in a vacuum from $\nu = 2\pi c/\bar{\lambda}$:
3.09 GHz (gigahertz)

Spectroscopic wavenumber $\tilde{\nu}$ from $\tilde{\nu} = 2\pi/\bar{\lambda}$:
10.31 m^{-1} (reciprocal meters)

Wavenumber k from $k = 1/\bar{\lambda}$:
1.6 m^{-1} (reciprocal meters)

Angular wavelength $\bar{\lambda}$ from $\bar{\lambda} = \lambda/(2\pi)$:
0.09702 meters

Frequency ν of electromagnetic radiation in a vacuum from $\nu = c/\lambda$:
492 MHz (megahertz)

Frequency ν of sound from $\nu = v/\lambda$:
558 Hz (hertz)
(assuming speed of sound ≈ 340.27 m/s)

Spectroscopic wavenumber $\tilde{\nu}$ from $\tilde{\nu} = 1/\lambda$:
1.6 m^{-1} (reciprocal meters)

Wavenumber k from $k = 2\pi/\lambda$:
10.31 m^{-1} (reciprocal meters)

Corrresponding angle θ around the earth's equator from $\theta = s/a_{\oplus}$:
$5.476 \times 10^{-6\circ}$ (degrees)
96 nrad (nanoradians)

Out[∘]=

2 ft

In[∘]:= 2 ft + 3 m

Out[∘]=

$$\frac{1504}{127}\text{ ft}$$

In[∘]:= Quantity[2, "Feet"]

Out[∘]=

2 ft

In[∘]:= Quantity[2, "Feet"] + Quantity[3, "Meters"]

Out[∘]=

$$\frac{1504}{127}\text{ ft}$$

In[∘]:= UnitConvert$\left[\text{Quantity}\left[\frac{1504}{127}, \text{"Feet"}\right], \text{"Meters"}\right]$

Out[∘]=

$$\frac{2256}{625}\text{ m}$$

In[∘]:= UnitConvert[%, "Meters"]

Out[∘]=

$$\frac{2256}{625}\text{ m}$$

In[∘]:=

0.25 miles < height of the Empire State Building »

0.25 mi < Empire State Building BUILDING [total height]

Out[∘]=

True

In[∘]:= Empire State Building BUILDING ["Elevation"]

Out[∘]=

27. m

In[∘]:= Quantity[7, "days"] + Quantity[2, "weeks"]

Out[∘]=

21 days

In[∘]:=

7 days + 2 weeks

7 days + 2 wk

Out[∘]=

21 days

```
In[•]:= 2 wk

Out[•]=
2 wk

In[•]:= Today

Out[•]=
Fri 21 Jul 2023

In[•]:= DateList[DateObject[{2016, 7, 15}]]

Out[•]=
{2016, 7, 15, 0, 0, 0.}

In[•]:= DatePlus[Today, 7]

Out[•]=
Fri 28 Jul 2023

In[•]:= DayName[DatePlus[Today, Quantity[5, "months"]]]

Out[•]=
Thursday

In[•]:= f[x_] := x^2

In[•]:= f[2]

Out[•]=
4

In[•]:= f[π]

Out[•]=
π^2

In[•]:= f[1.2345]

Out[•]=
1.52399

In[•]:= f[{1, 2, 3}]

Out[•]=
{1, 4, 9}

In[•]:= h[a_, b_] := a^b

In[•]:= h[10, 10]

Out[•]=
10 000 000 000

In[•]:= Clear[x, a, f, b]
```

In[ ]:=

how much bang is 600kg »

bang

Basic properties

```
Dataset[EntityValue[Mambila Cameroon LANGUAGE ,
 {total number of speakers , total number of native speakers ,
 place with most speakers , original location , codes }, "PropertyAssociation"]]
```

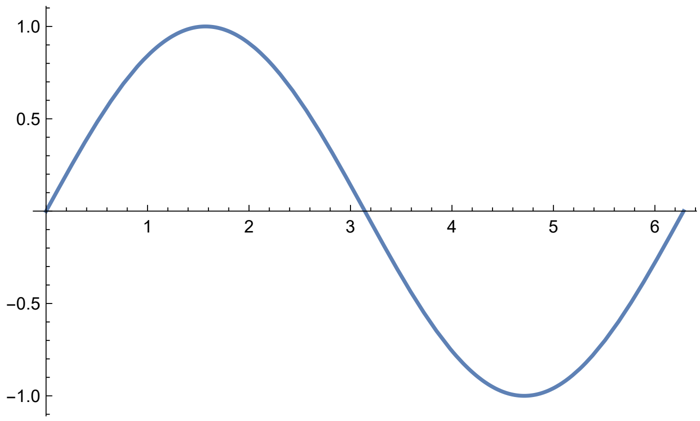
Out[ ]=

total number of speakers	3.00×10^4 people
total number of native speakers	3.00×10^4 people
place with most speakers	Cameroon
original location	Cameroon
codes	{mcu}

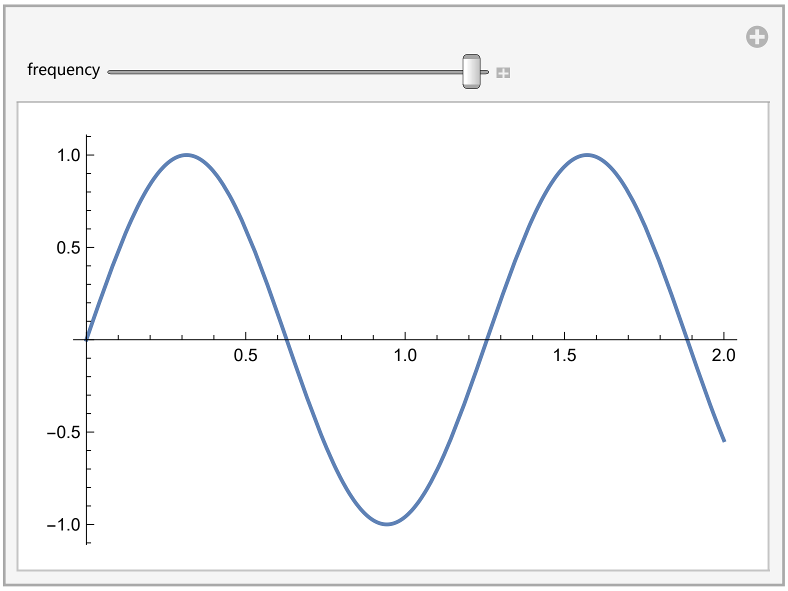
Chapter 7: Manipulate

In[ ]:=
```
Plot[Sin[x], {x, 0, 2 π}]
```

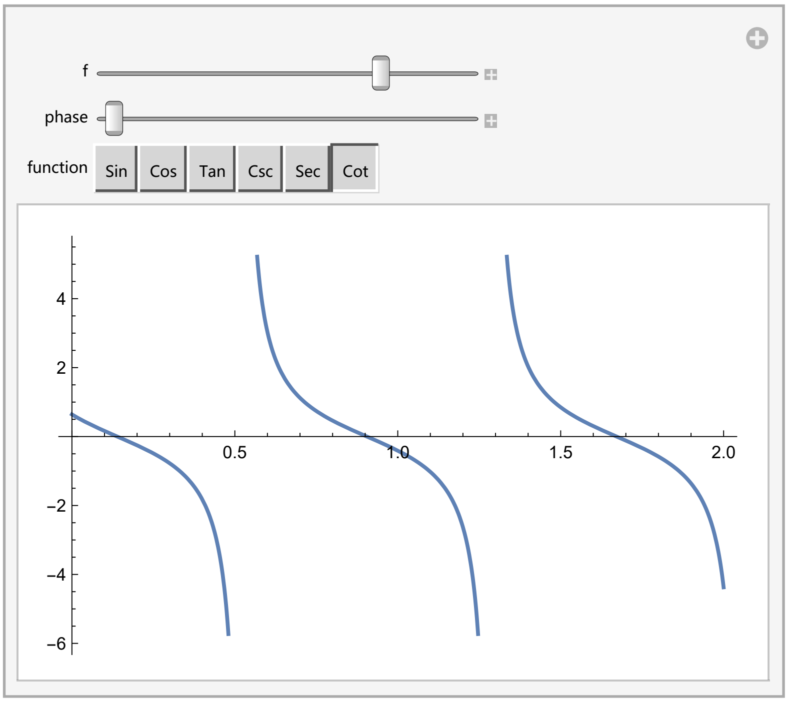
Out[ ]=



In[ ]:=
```
Manipulate[
 Plot[Sin[frequency * x], {x, 0, 2 }],
 {frequency, 1, 5}]
```
Out[ ]=



In[ ]:=
```
Manipulate[
 Plot[function[f * x + phase], {x, 0, 2}],
 {f, 1, 5},
 {phase, 1, 10},
 {function, {Sin, Cos, Tan, Csc, Sec, Cot}, ControlType → SetterBar}]
```
Out[ ]=



In[∘]:=
```
Manipulate[
 Expand[(a + b)^n], {n, 2, 10, 1}]
```

Out[∘]=

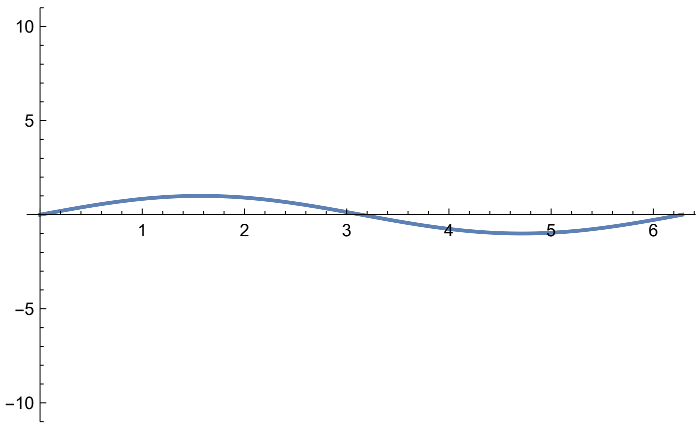
n

$$a^{10} + 10\,a^9\,b + 45\,a^8\,b^2 + 120\,a^7\,b^3 + 210\,a^6\,b^4 + 252\,a^5\,b^5 + 210\,a^4\,b^6 + 120\,a^3\,b^7 + 45\,a^2\,b^8 + 10\,a\,b^9 + b^{10}$$

In[4]:=
```
Manipulate[
 Plot[a * Sin[x], {x, 0, 2 Pi},
  PlotRange → {-11, 11}],
 {a, 1, 10}]
```

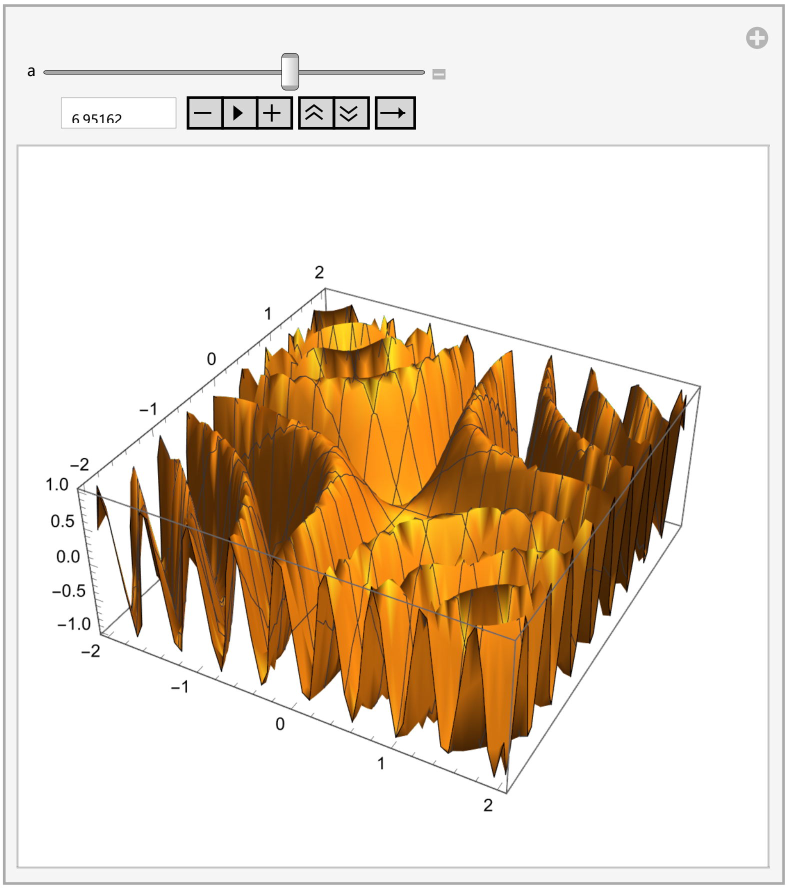
Out[4]=

a



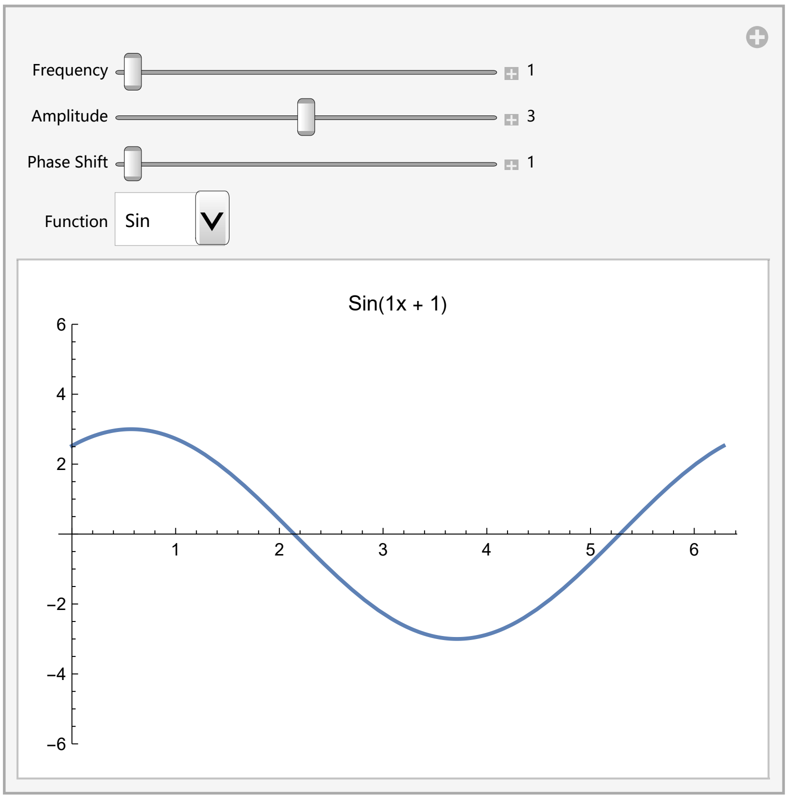
In[7]:=
```
Manipulate[
 Plot3D[Sin[a x y], {x, -2, 2}, {y, -2, 2},
  PerformanceGoal → "Quality"],
 {a, 1, 10}]
```

Out[7]=



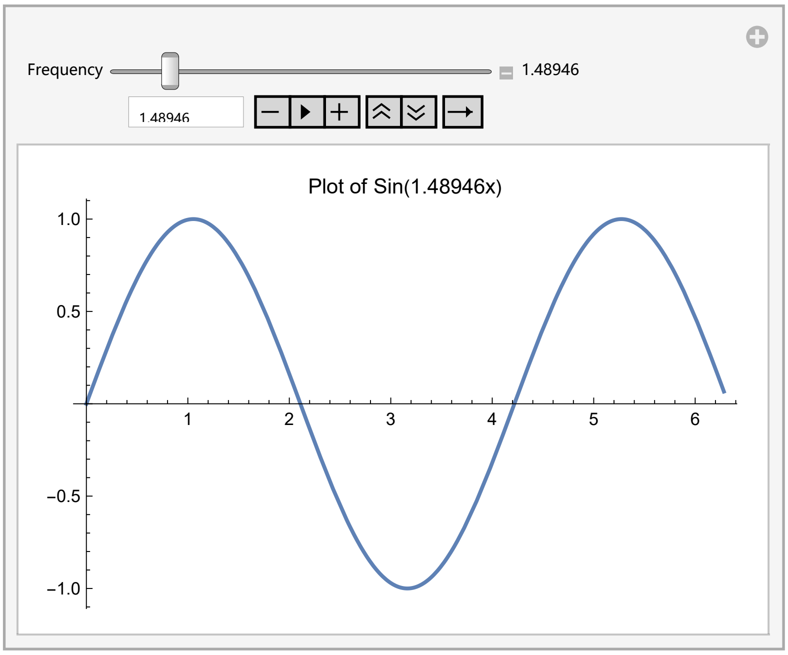
In[16]:=
```
Manipulate[
 Plot[a * fn[f * x + ps], {x, 0, 2 Pi},
  PlotRange → 6,
  PlotLabel → "Sin(" <> ToString[f] <> "x + " <> ToString[ps] <> ")"],
 {{f, 1, "Frequency"}, 1, 5, Appearance → "Labeled"},
 {{a, 3, "Amplitude"}, 1, 5, Appearance → "Labeled"},
 {{ps, 1, "Phase Shift"}, 1, 10, Appearance → "Labeled"},
 {{fn, Sin, "Function"}, {Sin, Cos, Tan, Csc, Sec, Cot}}]
```

Out[16]=



In[13]:=
```
Manipulate[
 Plot[Sin[f x], {x, 0, 2 Pi},
  PlotLabel → "Plot of Sin(" <> ToString[f] <> "x)"],
 {{f, 1, "Frequency"}, 1, 5, Appearance → "Labeled"}]
```

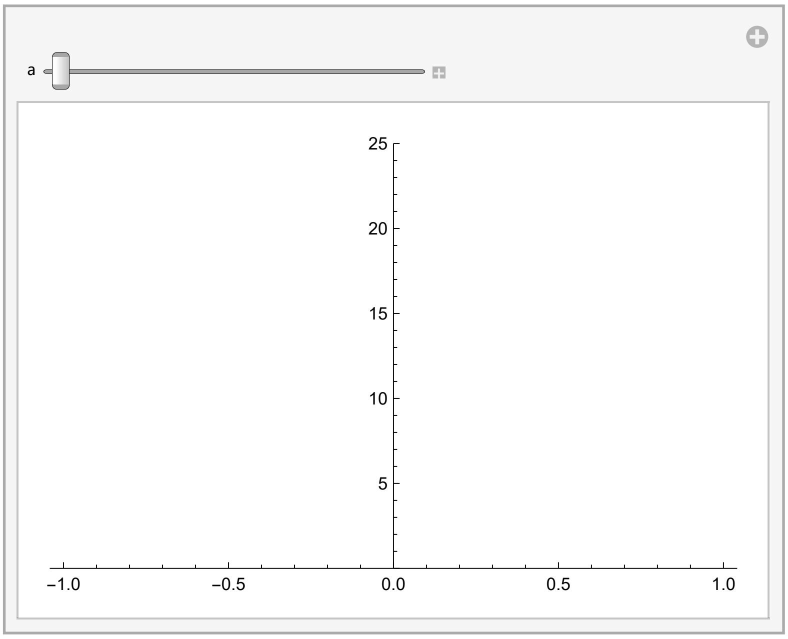
Out[13]=



In[17]:=
```
f[x_] := 2 x^2 + 2 x + 1
```

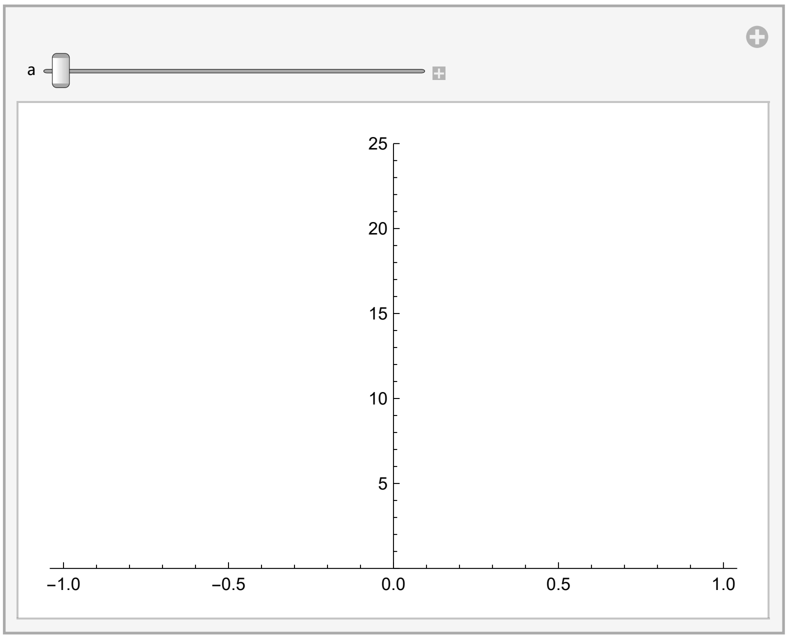
In[19]:=
```
Manipulate[
 Plot[f[a x], {x, -4, 4},
  PlotRange → {0, 25}],
 {a, -1, 1},
 Initialization :→ (f[x_] := 2 x^2 + 2 x + 1)]
```

Out[19]=



In[20]:=
```
Manipulate[
 Plot[f[a x], {x, -4, 4},
  PlotRange → {0, 25}],
 {a, -1, 1},
 SaveDefinitions → True]
```

Out[20]=



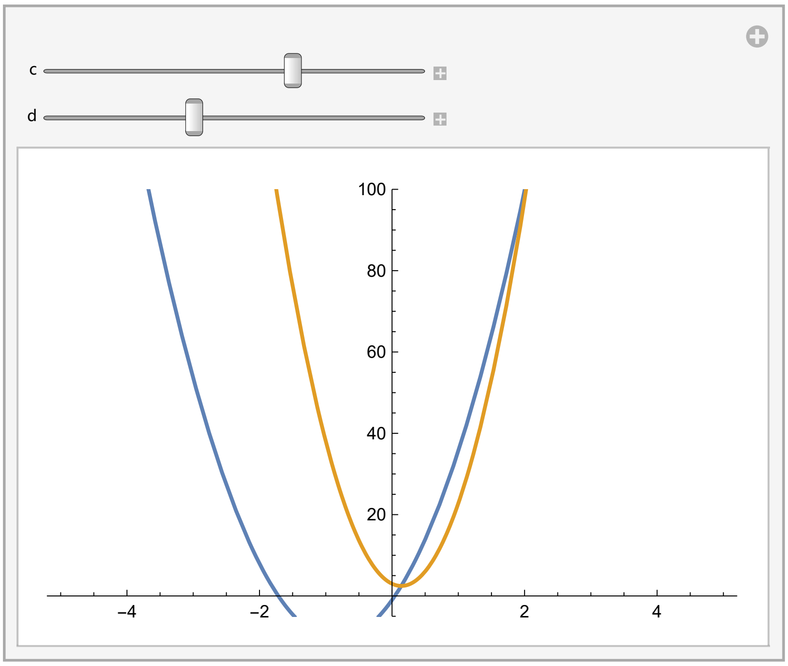
In[21]:=
```
Clear[f]
```

In[23]:=
```
Manipulate[
 {x, x^2 + 1, x^3 + 1},
 {x, 1, 10, 1}]
```

Out[23]=

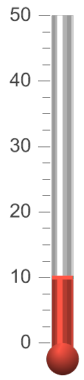
In[27]:=
```
Manipulate[
 Plot[{c x^2 + 3 d x - 1, 2 c x^2 - d x + 3}, {x, -5, 5},
  PlotRange → {-5, 100}],
 {c, 1, 20},
 {d, 0, 20}]
```

Out[27]=



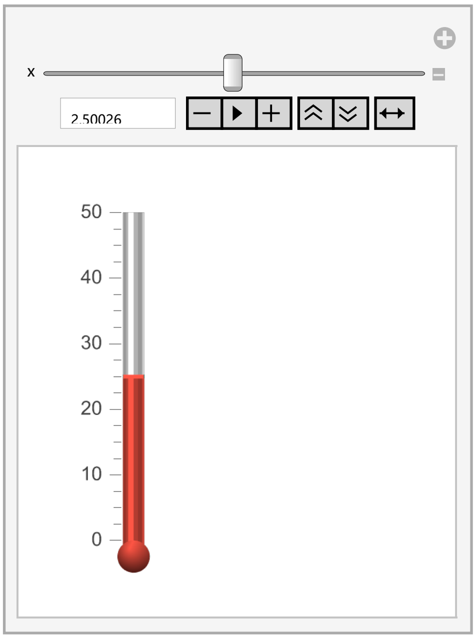
In[28]:=
```
ThermometerGauge[10, {0, 50}]
```

Out[28]=



In[30]:=
```
Manipulate[
 ThermometerGauge[10 x, {0, 50}],
 {x, 0, 5}]
```

Out[30]=



Chapter 8: Sharing Mathematica Notebooks