Mathematica Oveview

Freshman Seminar

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This tweet was sent

In[21]:=
```
ServiceConnect["Twitter"]
```

Out[21]= ServiceObject[Twitter Connected]

In[22]:=
```
SendMessage["Twitter", "Intro to #Mathematica at #UML
    Freshman Math Seminar on Friday December 7 at 11 AM in Olsen 410"]
```

Out[22]= Intro to #Mathematica at #UML Freshman Math Seminar on Friday December 7 at 11 AM in Olsen 410

Types of Input

What is the integral of $x^2 \sin x$ with respect to x?

- **Free-Form Input**

In[23]:=
What is the integral of x^2 sin x?
```
Integrate[x^2 * Sin[x], x]
```

Out[23]= $2\,x\sin(x) - (x^2 - 2)\cos(x)$

- **Wolfram Language Input**
- **Wolfram Alpha Input**

The Basic Input-Output Process

```
Integrate[(x^2 + 1) Sin[x], x]
```

$2\,x\sin(x) - (x^2 - 2)\cos(x)$

Some Syntax and Grouping

"System Names" like `Integrate` are always capitalized.

```
Integrate[(x^2 + 1) Sin[x], x]
```

A typical Mathematica *expression* is a name followed by a sequence of zero or more expressions (called arguments)

separated by commas that are enclosed in square brackets. In addition, an expression can be a symbol, number, string, or Boolean (True or False).

```
Integrate[(x^2 + 1) Sin[x], x]
```

```
Integrate[(x^2 + 1) Sin[x], x]
```

Parentheses are used for grouping. Without them here, you would be integrating a different function.

```
Integrate[x^2 + 1 Sin[x], x]
```

Braces (Curly brackets) are used for lists.

In[68]:=
```
Range[1, 10]
```

Out[68]= {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}

In[69]:=
```
Prime[Range[1, 10]]
```

Out[69]= {2, 3, 5, 7, 11, 13, 17, 19, 23, 29}

Some lists are *iterators*.

In[73]:=
```
Integrate[(x^2 + 1) Sin[x], {x, 0, Pi}]
```

Out[73]= $\pi^2 - 2$

Algebra/Calculus

In[24]:=
```
Expand[(x + y)^8]
```

Out[24]= $x^8 + 8\,x^7\,y + 28\,x^6\,y^2 + 56\,x^5\,y^3 + 70\,x^4\,y^4 + 56\,x^3\,y^5 + 28\,x^2\,y^6 + 8\,x\,y^7 + y^8$

In[25]:=
```
Factor[3 x^2 - 13 x + 10]
```

Out[25]= $(x - 1)\,(3\,x - 10)$

In[26]:=
```
Solve[3 x^2 - 13 x + 10 == 0, x]
```

Out[26]= $\left\{\{x \to 1\}, \left\{x \to \frac{10}{3}\right\}\right\}$

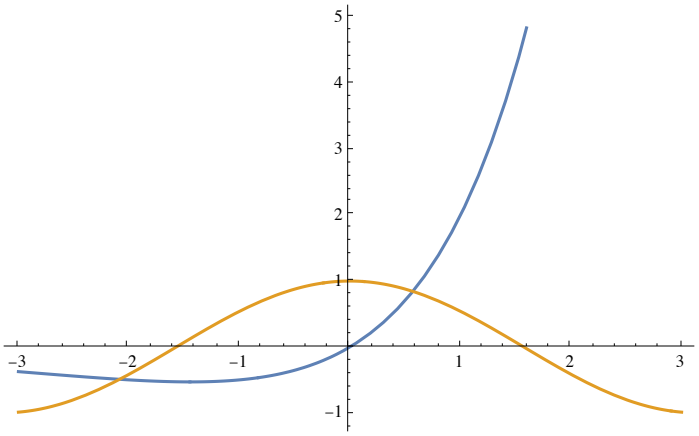
In[27]:=
```
Solve[x 2^x == Cos[x], x]
```

Solve: This system cannot be solved with the methods available to Solve.

Out[27]= Solve[$2^x\,x = \cos(x)$, x]

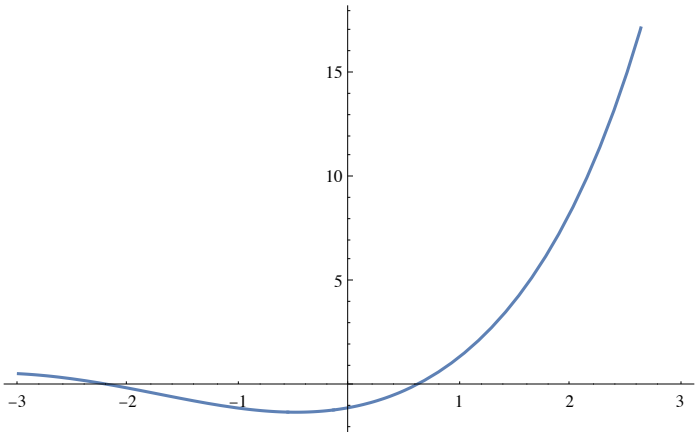
In[28]:=
```
Plot[{x 2^x, Cos[x]}, {x, -3, 3}]
```

Out[28]=



In[29]:=
```
Plot[{x 2^x - Cos[x]}, {x, -3, 3}]
```

Out[29]=



In[30]:=
```
FindRoot[x 2^x == Cos[x], {x, 1}]
```

Out[30]= $\{x \to 0.56836\}$

In[31]:=
```
FindRoot[x 2^x == Cos[x], {x, -3}]
```

Out[31]= $\{x \to -2.08457\}$

In[32]:=
```
y = x Sin[2 x + 1]
```

Out[32]= $x \sin(2x + 1)$

In[33]:=
```
D[y, x]
```

Out[33]= $\sin(2x + 1) + 2x \cos(2x + 1)$

In[34]:=
```
Integrate[y, x]
```

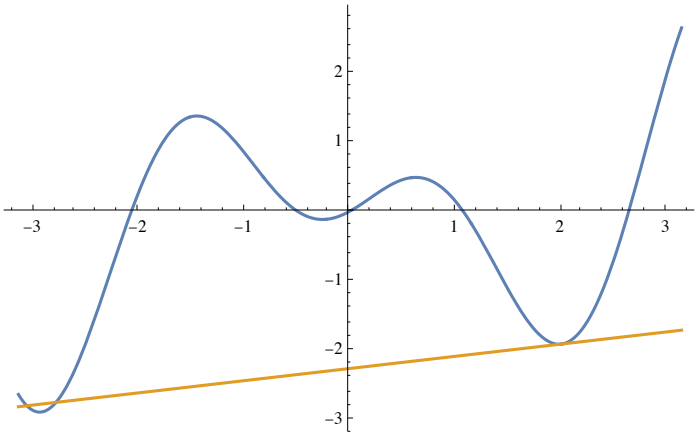
Out[34]= $\frac{1}{4}\sin(2x + 1) - \frac{1}{2}x \cos(2x + 1)$

In[35]:=
```
Integrate[y, {x, 0, Pi}]
```

Out[35]= $-\frac{1}{2}\pi \cos(1)$

In[36]:=
```
a = 2;
b = y /. {x → a};
m = D[y, x] /. {x → a};
Plot[{y, m (x - a) + b}, {x, -Pi, Pi}]
```

Out[39]=

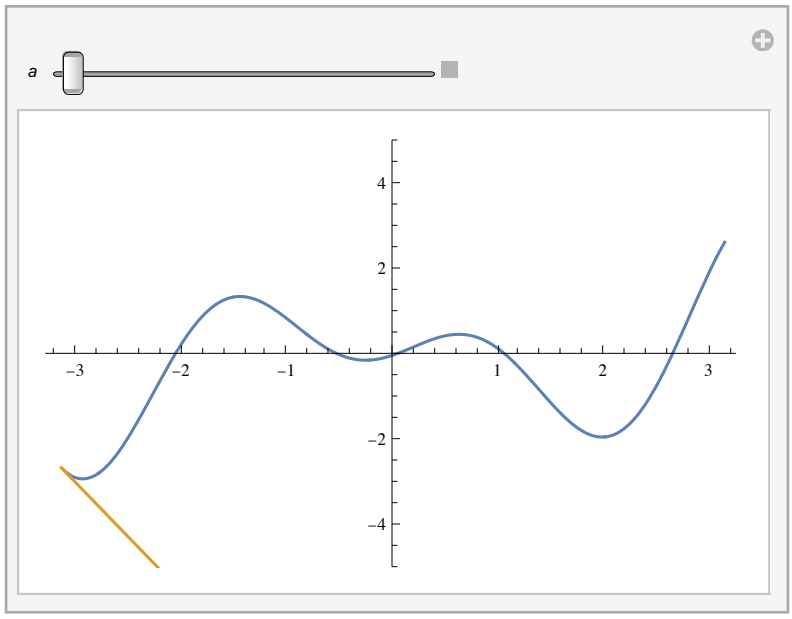


In[40]:=
```
D[f[x]^2, x]
```

Out[40]= $2 f(x) f'(x)$

In[41]:=
```
Clear[a]
Manipulate[b = y /. {x → a};
 m = D[y, x] /. {x → a};
 Plot[{y, m (x - a) + b}, {x, -Pi, Pi}, PlotRange → {-5, 5}], {a, -Pi, Pi}]
```

Out[42]=

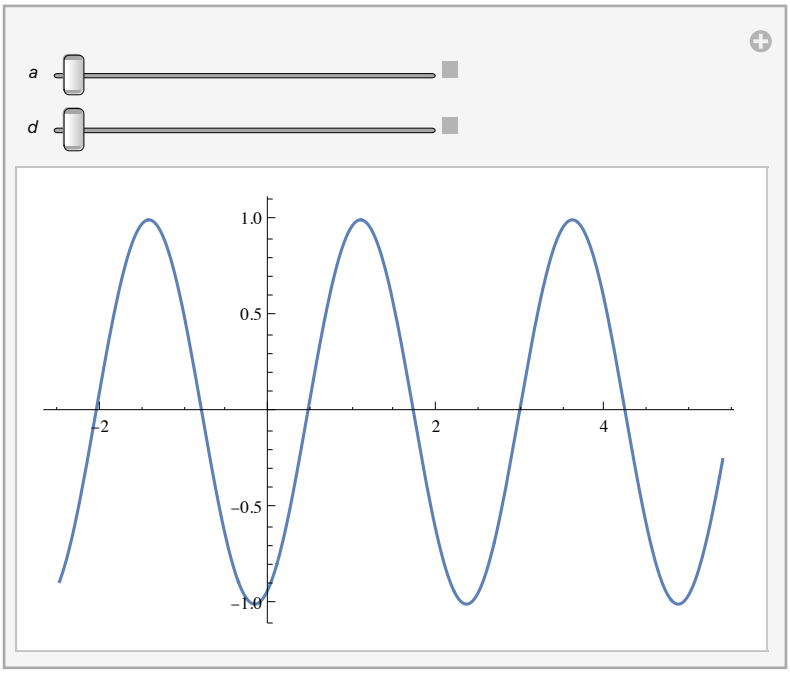


In[43]:=
```
Sin[a x + d]
```

Out[43]= $\sin(a\,x + d)$

In[44]:=
```
Manipulate[Plot[Sin[d + a x], {x, -2.4945, 5.39498}], {a, -2.4945, 5.39498}, {d, -2, 2}]
```

Out[44]=



Differential Equations

In[45]:=
```
DSolve[{w'[t] == w[t] - 1, w[0] == 3}, w[t], t]
```

Out[45]= $\{\{w(t) \to 2\, e^{t} + 1\}\}$

In[53]:=
```
DSolve[w''[t] - 4 w[t] == 5, w[t], t]
```

Out[53]= $\left\{\left\{w(t) \to c_1\, e^{2\,t} + c_2\, e^{-2\,t} - \frac{5}{4}\right\}\right\}$

Probabiity & Statistics, Modeling

In[54]:=
```
Probability[heads == 5, heads ≈ BinomialDistribution[10, 0.5]]
```

Out[54]= 0.246094

If off line, the intended data is listed below.

In[55]:=
```
temps = Import["http://faculty.uml.edu/klevasseur/Data/Tdata.csv"]
```

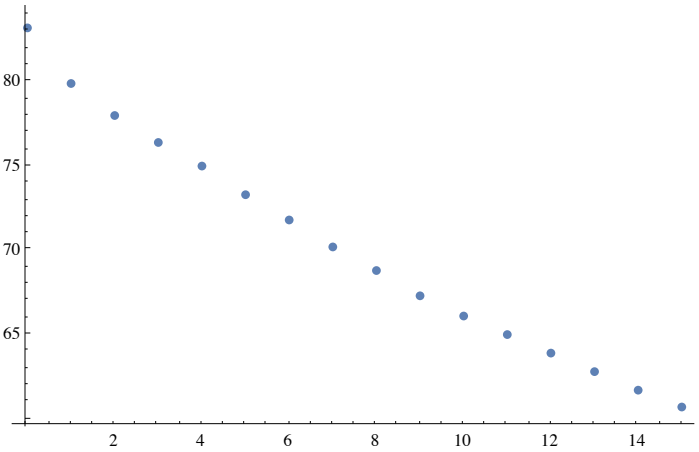
Out[55]=
$$\begin{pmatrix} 0. & 83.2 \\ 1. & 79.9 \\ 2. & 78. \\ 3. & 76.4 \\ 4. & 75. \\ 5. & 73.3 \\ 6. & 71.8 \\ 7. & 70.2 \\ 8. & 68.8 \\ 9. & 67.3 \\ 10. & 66.1 \\ 11. & 65. \\ 12. & 63.9 \\ 13. & 62.8 \\ 14. & 61.7 \\ 15. & 60.7 \end{pmatrix}$$

In[56]:=
```
Mean[temps[[All, 2]]]
```

Out[56]= 70.2563

In[57]:=
```
ListPlot[temps]
```

Out[57]=

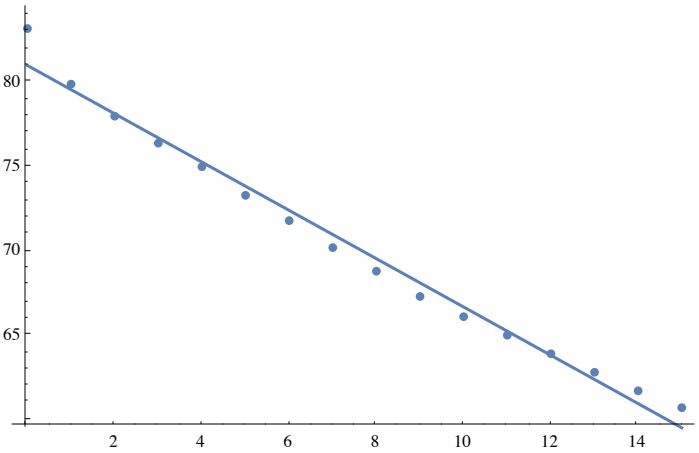


In[58]:=
```
bestline = Fit[temps, {1, t}, t]
```

Out[58]= $81.0066 - 1.43338\, t$

In[59]:=
```
Show[{ListPlot[temps], Plot[bestline, {t, 0, 15}]}]
```

Out[59]=

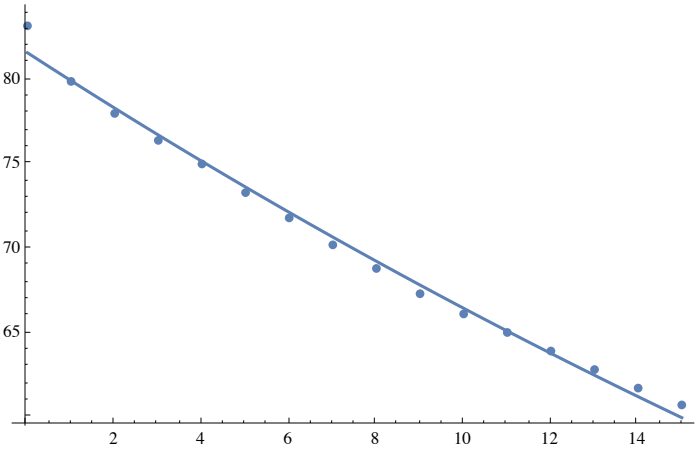


In[60]:=
```
Clear[a, b];
expofit = NonlinearModelFit[temps, {a e^(b t)}, {a, b}, {t}] // Normal
```

Out[61]=
$$81.6013\, e^{-0.0205615\, t}$$

In[62]:=
```
Show[{ListPlot[temps], Plot[expofit, {t, 0, 15}]}]
```

Out[62]=



Numbers

```
FactorInteger[18 310 090 399 898 533 906 089 943 279]
```

Is 74274943 a prime?

```
PrimeQ[74 274 943]
```

```
PrimeQ[74 274 943]
```

```
Prime[1 000 000]
```

```
N[Pi, 1000]
```

Graphics

Enrollment in Calculus I one semester, by level

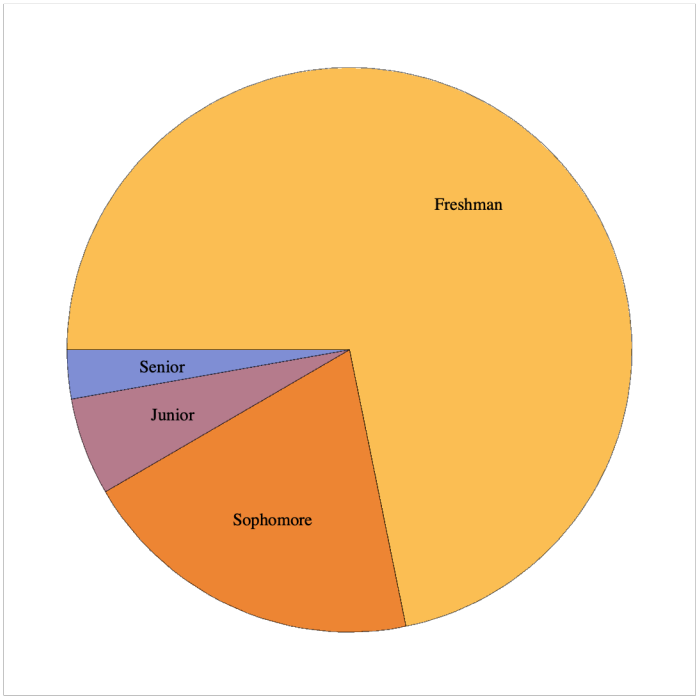
In[63]:=
```
calcOne = {{"Freshman", 308}, {"Sophomore", 85}, {"Junior", 24}, {"Senior", 12}}
```

Out[63]=

Freshman	308
Sophomore	85
Junior	24
Senior	12

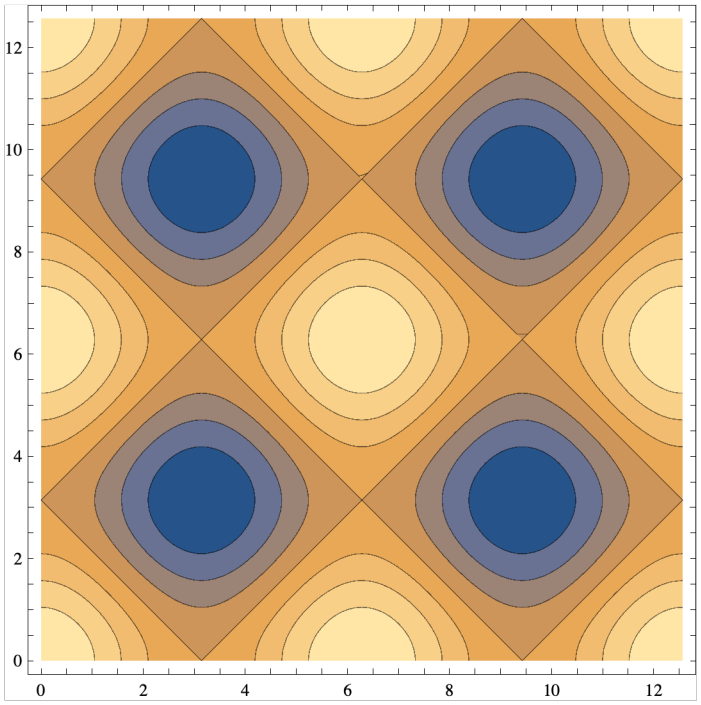
In[64]:=
```
PieChart[calcOne[[All, 2]], ChartLabels → calcOne[[All, 1]]]
```

Out[64]=



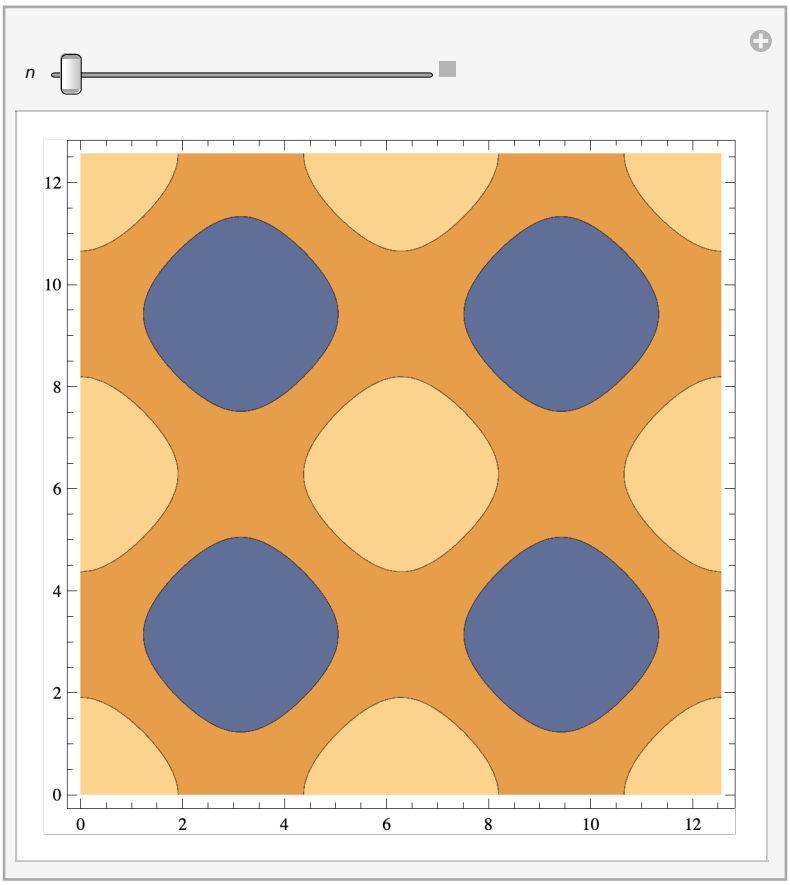
In[65]:=
```
ContourPlot[Cos[x] + Cos[y], {x, 0, 4 Pi}, {y, 0, 4 Pi}]
```

Out[65]=



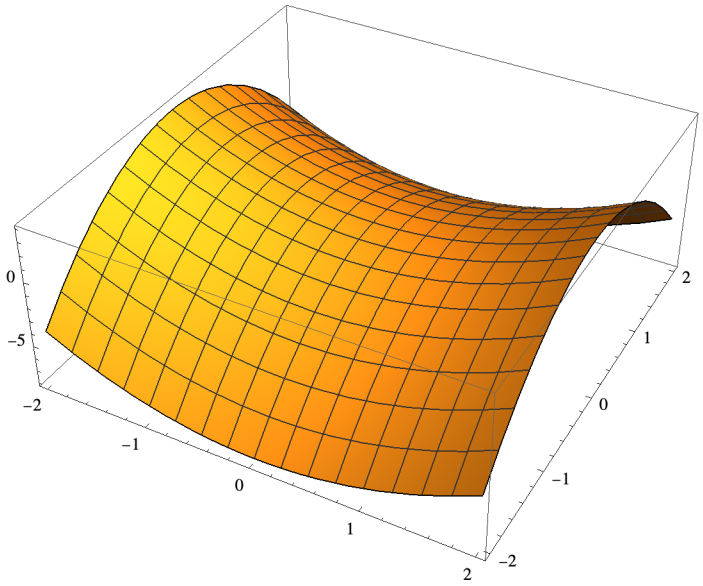
In[66]:=
```
Manipulate[ContourPlot[Cos[x] + Cos[y], {x, 0, 4 Pi},
  {y, 0, 4 Pi}, Contours → Range[-2, 2, 4 / n]], {n, 3, 20}]
```

Out[66]=



In[67]:=
```
Plot3D[x^2 - 2 y^2, {x, -2, 2}, {y, -2, 2}]
```

Out[67]=



Not Included

99% of *Mathematica*, including the programming language, data bases, and many other mathematical/scientific topics.

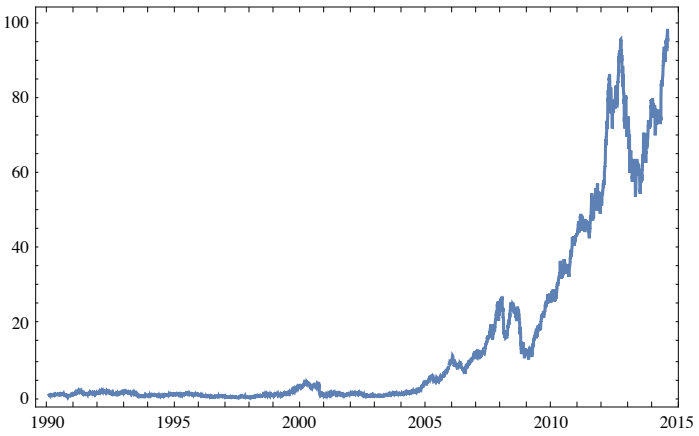
Here are a few data base expressions.

```
ChemicalData["Acetone", "BoilingPoint"]
```

```
WeatherData[{"Atlanta", "Georgia"}, "Temperature"]
```

```
CityData[{"Lowell", "Massachusetts"}, "Population"]
```

```
DateListPlot[FinancialData["AAPL", {{1990, 1}, {2014, 8}}], PlotRange → All]
```



Data

just in case you are off line.

$$\text{temps} = \begin{pmatrix} 0.` & 83.2` \\ 1.` & 79.9` \\ 2.` & 78.` \\ 3.` & 76.4` \\ 4.` & 75.` \\ 5.` & 73.3` \\ 6.` & 71.8` \\ 7.` & 70.2` \\ 8.` & 68.8` \\ 9.` & 67.3` \\ 10.` & 66.1` \\ 11.` & 65.` \\ 12.` & 63.9` \\ 13.` & 62.8` \\ 14.` & 61.7` \\ 15.` & 60.7` \end{pmatrix}$$