

In[1]:= 5!

Out[1]= 120

In[2]:= Factorial[5]

Out[2]= 120

In[3]:= NoDuplication[Days_, Num_] := Factorial[Days] / Factorial[Days - Num]

In[4]:= NoDuplication[365, 2]

Out[4]= 132 860

In[5]:= 365 * 364

Out[5]= 132 860

In[6]:= ProbNoDup[Days_, Num_] := Factorial[Days] / Factorial[Days - Num] / Days ^ Num

In[7]:= ProbNoDup[365, 2]

Out[7]= $\frac{364}{365}$

In[8]:= ProbNoDup[365, 3]

Out[8]= $\frac{132\ 132}{133\ 225}$

In[9]:= (365 * 364 * 363) / 365 ^ 3

Out[9]= $\frac{132\ 132}{133\ 225}$

In[10]:= ProbDup[Days_, Num_] := 1 - Factorial[Days] / Factorial[Days - Num] / Days ^ Num

In[11]:= ProbDup[365, 3]

Out[11]= $\frac{1093}{133\ 225}$

In[12]:= N[ProbDup[365, 3]]

Out[12]= 0.00820417

In[13]:= N[ProbDup[365, 3], 12]

Out[13]= 0.00820416588478

In[14]:= NUM = 100

Out[14]= 100

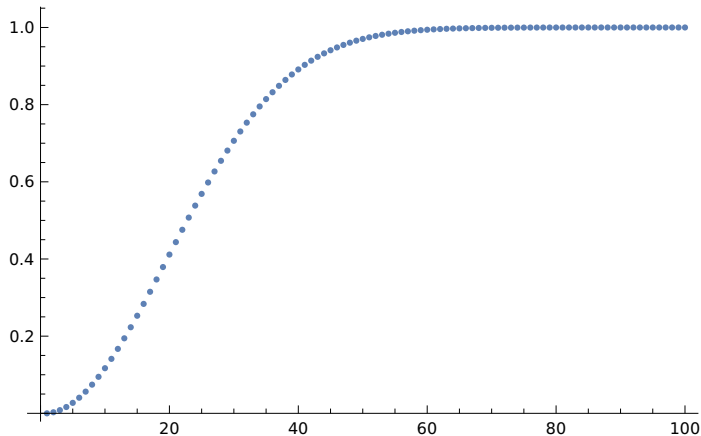
```
In[15]:= probs = Table[{i, N[ProbDup[365, i], 12]}, {i, NUM}]
```

```
Out[15]=
```

```
{{1, 0}, {2, 0.00273972602740}, {3, 0.00820416588478}, {4, 0.0163559124666},
{5, 0.0271355736998}, {6, 0.0404624836491}, {7, 0.0562357030960}, {8, 0.0743352923517},
{9, 0.0946238338892}, {10, 0.116948177711}, {11, 0.141141378322}, {12, 0.167024788838},
{13, 0.194410275232}, {14, 0.223102512005}, {15, 0.252901319764}, {16, 0.283604005253},
{17, 0.315007665297}, {18, 0.346911417872}, {19, 0.379118526032}, {20, 0.411438383581},
{21, 0.443688335165}, {22, 0.475695307663}, {23, 0.507297234324}, {24, 0.538344257915},
{25, 0.568699703969}, {26, 0.598240820136}, {27, 0.626859282263}, {28, 0.654461472342},
{29, 0.680968537478}, {30, 0.706316242719}, {31, 0.730454633729}, {32, 0.753347527850},
{33, 0.774971854176}, {34, 0.795316864620}, {35, 0.814383238875}, {36, 0.832182106380},
{37, 0.848734008216}, {38, 0.864067821082}, {39, 0.878219664367}, {40, 0.891231809818},
{41, 0.903151611482}, {42, 0.914030471562}, {43, 0.923922855656}, {44, 0.932885368551},
{45, 0.940975899466}, {46, 0.948252843367}, {47, 0.954774402833}, {48, 0.960597972879},
{49, 0.965779609323}, {50, 0.970373579578}, {51, 0.974431993334}, {52, 0.978004509334},
{53, 0.981138113484}, {54, 0.983876962759}, {55, 0.986262288816}, {56, 0.988332354885},
{57, 0.990122459341}, {58, 0.991664979389}, {59, 0.992989448418}, {60, 0.994122660865},
{61, 0.995088798805}, {62, 0.995909574895}, {63, 0.996604386831}, {64, 0.997190478967},
{65, 0.997683107312}, {66, 0.998095704640}, {67, 0.998440042979}, {68, 0.998726391254},
{69, 0.998963666308}, {70, 0.999159575965}, {71, 0.999320753177}, {72, 0.999452880641},
{73, 0.999560805556}, {74, 0.999648644445}, {75, 0.999719878174}, {76, 0.999777437453},
{77, 0.999823779244}, {78, 0.999860954581}, {79, 0.999890668397}, {80, 0.999914331949},
{81, 0.999933108508}, {82, 0.999947952922}, {83, 0.999959645690}, {84, 0.999968822149},
{85, 0.999975997326}, {86, 0.999981586990}, {87, 0.999985925398}, {88, 0.999989280166},
{89, 0.999991864674}, {90, 0.999993848356}, {91, 0.999995365200}, {92, 0.999996520725},
{93, 0.999997397693}, {94, 0.999998060747}, {95, 0.999998560171}, {96, 0.999998934921},
{97, 0.999999215051}, {98, 0.999999423654}, {99, 0.999999578399}, {100, 0.999999692751}}
```

```
In[16]:= dataplot = ListPlot[probs]
```

```
Out[16]=
```



```
In[17]:= Logistic[L_, k_, x0_, x_] := L / (1 + Exp[-k (x - x0)])
```

```
In[18]:= Logistic[1, 1, 20, 23]
```

```
Out[18]=
```

$$\frac{1}{1 + \frac{1}{e^3}}$$

```
In[19]:= myfit = FindFit[probs, Logistic[L, k, x0, x], {{L, 1}, {k, 1}, {x0, 20}}, x]
```

```
Out[19]=
```

$$\{L \rightarrow 0.996875175357, k \rightarrow 0.138524053956, x0 \rightarrow 23.3218870706\}$$

```
In[20]:= myfit[[1]]
```

```
Out[20]=
```

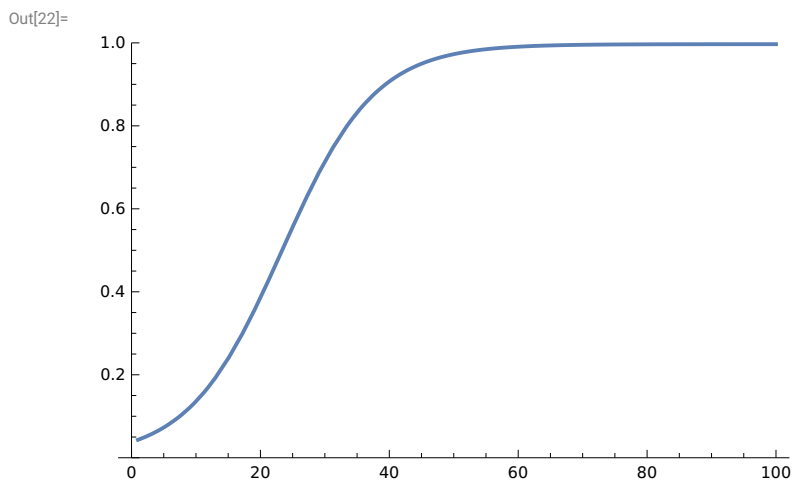
$$L \rightarrow 0.996875175357$$

```
In[21]:= Values[myfit[[1]]]
```

```
Out[21]=
```

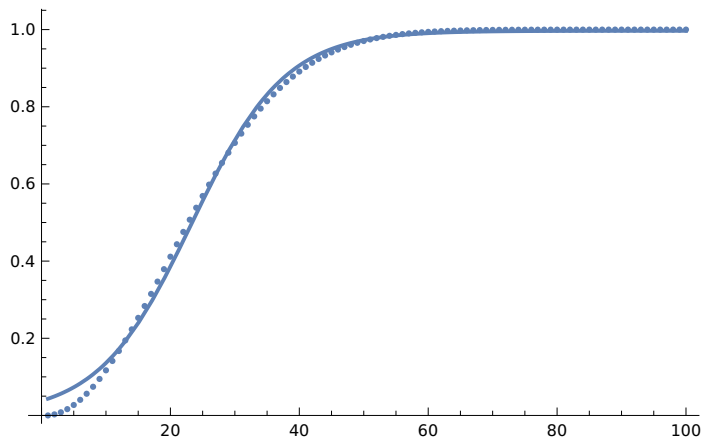
$$0.996875175357$$

```
In[22]:= logistplot = Plot[Logistic[Values[myfit[[1]], Values[myfit[[2]], Values[myfit[[3]], x],
    {x, 1, 100}, PlotRange -> {0, 1}]
```



```
In[23]:= Show[dataplot, logistplot]
```

```
Out[23]=
```



```
In[24]:= Bell2[b_, x0_, x_] := 1 - Exp[-b * (x - x0)^ 2]
```

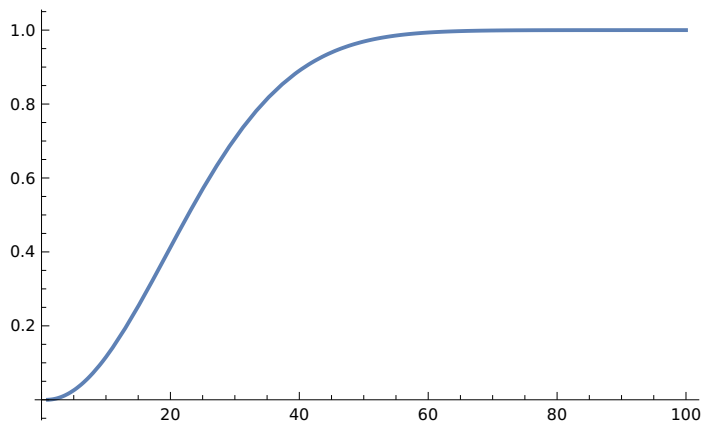
```
In[25]:= myfit2 = FindFit[probs, Bell2[b, x0, x], {{b, 1}, {x0, 2}}, x]
```

```
Out[25]=
```

```
{b -> 0.00143319915949, x0 -> 0.737402032172}
```

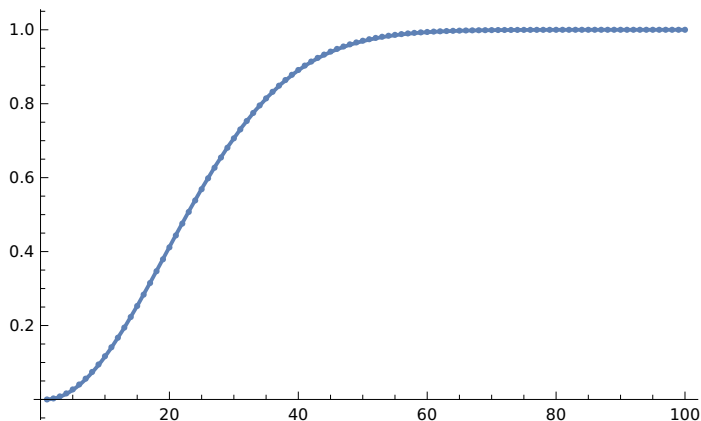
```
In[26]:= bell2fit = Plot[Bell2[Values[myfit2[[1]], Values[myfit2[[2]], x], {x, 1, 100}]
```

```
Out[26]=
```



In[27]:= **Show**[bell2fit, dataplot]

Out[27]=



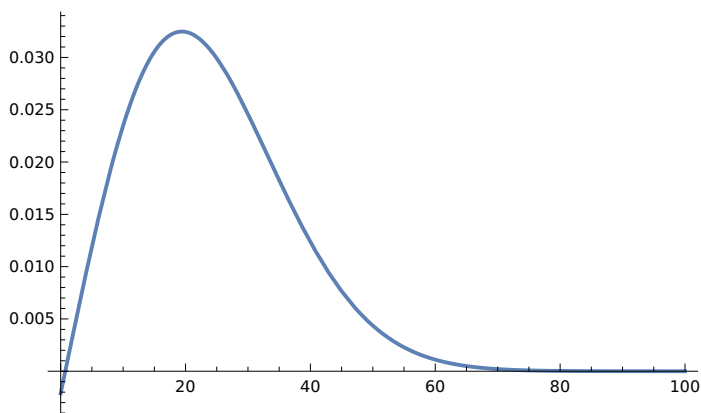
In[28]:= **first** = **D**[Bell2[Values[myfit2[[1]], Values[myfit2[[2]], x], x]

Out[28]=

$$0.00286639831898 e^{-0.00143319915949 (-0.737402032172+x)^2} (-0.737402032172 + x)$$

In[29]:= **Plot**[first, {x, 0, 100}]

Out[29]=



In[30]:= **second** = **D**[first, x]

Out[30]=

$$0.00286639831898 e^{-0.00143319915949 (-0.737402032172+x)^2} - 8.2162393230 \times 10^{-6} e^{-0.00143319915949 (-0.737402032172+x)^2} (-0.737402032172 + x)^2$$

In[31]:= **Solve**[second == 0, x]

Solve: Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information.

Out[31]=

{{x → -17.9406591509}, {x → 19.4154575193}}

Time on Mars is easily divided into days based on its rotation rate and years based on its orbit. Sols, or Martian solar days, are only 39 minutes and 35 seconds longer than Earth days, and there are 668 sols (687 Earth days) in a Martian year.

<https://www.planetary.org/articles/mars-calendar>

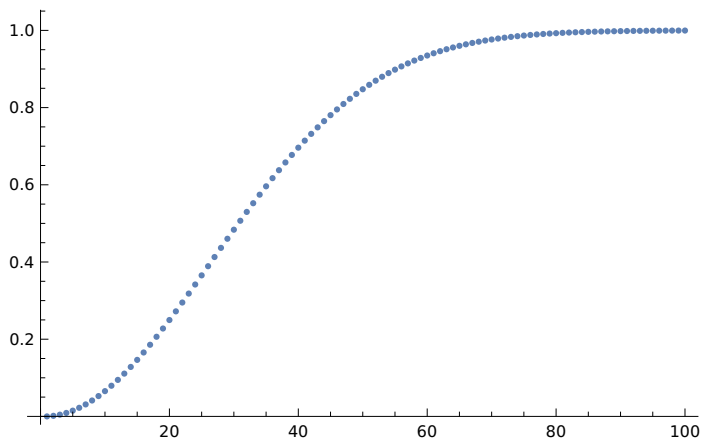
```
In[32]:= marsProbs = Table[{i, N[ProbDup[668, i], 12]}, {i, NUM}]
```

```
Out[32]=
```

```
{{1, 0}, {2, 0.00149700598802}, {3, 0.00448653591022}, {4, 0.00895740476092},
 {5, 0.01489179155588}, {6, 0.0222653559932}, {7, 0.0310474036939}, {8, 0.0412010985653},
 {9, 0.0526837201394}, {10, 0.0654469634309}, {11, 0.0794372783496}, {12, 0.0945962453229},
 {13, 0.110860983431}, {14, 0.128164587047}, {15, 0.146436586719}, {16, 0.165603429832},
 {17, 0.185588976423}, {18, 0.206315005466}, {19, 0.227701726876}, {20, 0.249668294524},
 {21, 0.272133315646}, {22, 0.295015352131}, {23, 0.318233409396}, {24, 0.341707408773},
 {25, 0.365358639595}, {26, 0.389110187515}, {27, 0.412887335905}, {28, 0.436617937597},
 {29, 0.460232754584}, {30, 0.483665763741}, {31, 0.506854427047}, {32, 0.529739925193},
 {33, 0.552267353926}, {34, 0.574385882849}, {35, 0.596048876835}, {36, 0.617213980594},
 {37, 0.637843167269}, {38, 0.657902752315}, {39, 0.677363374189}, {40, 0.696199943660},
 {41, 0.714391563800}, {42, 0.731921422909}, {43, 0.748776662786}, {44, 0.764948224912},
 {45, 0.780430677163}, {46, 0.795222023761}, {47, 0.809323501167}, {48, 0.822739362612},
 {49, 0.835476653921}, {50, 0.847544983199}, {51, 0.858956286852}, {52, 0.869724594293},
 {53, 0.879865793540}, {54, 0.889397399741}, {55, 0.898338328504}, {56, 0.906708675708},
 {57, 0.914529505290}, {58, 0.921822646305}, {59, 0.928610500369}, {60, 0.934915860366},
 {61, 0.940761741171}, {62, 0.946171222891}, {63, 0.951167306994}, {64, 0.955772785526},
 {65, 0.960010123440}, {66, 0.963901353943}, {67, 0.967467986637}, {68, 0.970730928097},
 {69, 0.973710414459}, {70, 0.976425955480}, {71, 0.978896289487}, {72, 0.981139348538},
 {73, 0.983172233127}, {74, 0.985011195675}, {75, 0.986671632082}, {76, 0.988168080576},
 {77, 0.989514227097}, {78, 0.990722916488}, {79, 0.991806168755}, {80, 0.992775199695},
 {81, 0.993640445241}, {82, 0.994411588857}, {83, 0.995097591422}, {84, 0.995706723027},
 {85, 0.996246596179}, {86, 0.996724199959}, {87, 0.997145934695}, {88, 0.997517646793},
 {89, 0.997844663383}, {90, 0.998131826495}, {91, 0.998383526518}, {92, 0.998603734732},
 {93, 0.998796034739}, {94, 0.998963652657}, {95, 0.999109485966}, {96, 0.999236130926},
 {97, 0.999345908517}, {98, 0.999440888867}, {99, 0.999522914153}, {100, 0.999593619990}}
```

```
In[33]:= marsDataPlot = ListPlot[marsProbs]
```

```
Out[33]=
```



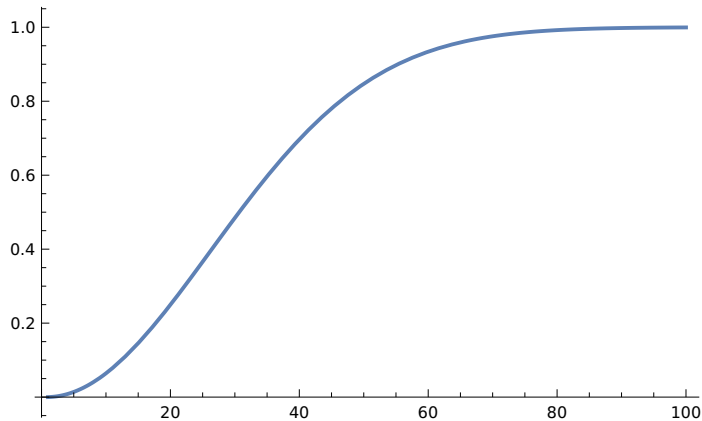
```
In[34]:= marsfit2 = FindFit[marsProbs, Bell2[b, x0, x], {{b, 1}, {x0, 2}}, x]
```

```
Out[34]=
```

```
{b → 0.000773661010173, x0 → 0.732306041427}
```

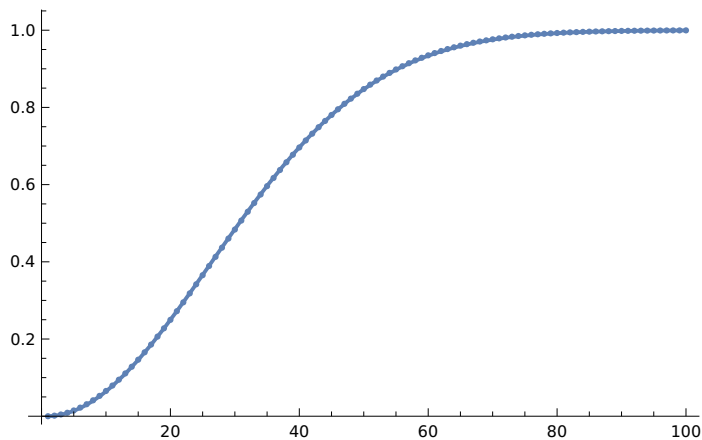
```
In[35]:= marsFitPlot = Plot[Bell2[Values[marsfit2][1], Values[marsfit2][2], x], {x, 1, 100}]
```

```
Out[35]=
```



```
In[36]:= Show[marsDataPlot, marsFitPlot]
```

```
Out[36]=
```



How long is a year on Jupiter? One year on Jupiter is 11.862 Earth years, or 4,332.59 Earth days. One day on Jupiter ("Jovian day") is just under 10 hours long. There are 10,475.8 Jovian days in a Jovian year.

<https://www.spacecentre.nz/resources/faq/solar-system/jupiter/year.html>

```
In[37]:= jupiterProbs = Table[{i, N[ProbDup[10 476, i], 12]}, {i, 2 * NUM}]
```

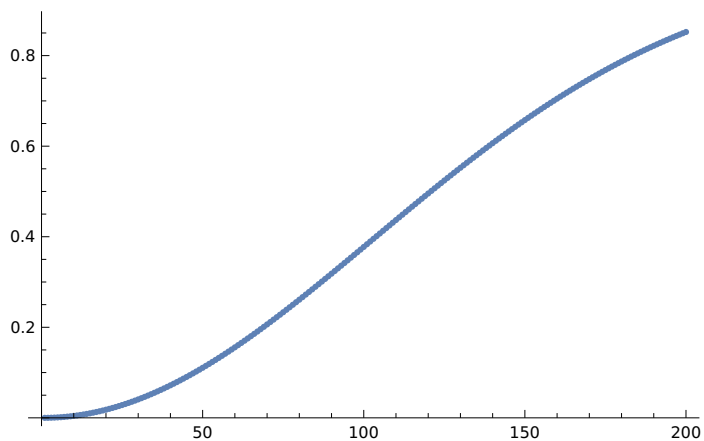
```
Out[37]=
```

```
{{1, 0}, {2, 0.0000954562810233}, {3, 0.000286350619267}, {4, 0.000572637460441},
 {5, 0.000954243937165}, {6, 0.00143106989939}, {7, 0.00200298795787},
 {8, 0.00266984354056}, {9, 0.00343145496207}, {10, 0.00428761350592},
 {11, 0.00523808351975}, {12, 0.00628260252331}, {13, 0.00742088132912},
 {14, 0.00865260417589}, {15, 0.00997742887440}, {16, 0.0113949869659},
 {17, 0.0129048838931}, {18, 0.0145066991826}, {19, 0.0161999866411}, {20, 0.0179842745615},
```

{21, 0.0198590659426}, {22, 0.0218238387199}, {23, 0.0238780460078}, {24, 0.0260211163536},
 {25, 0.0282524540022}, {26, 0.0305714391731}, {27, 0.0329774283466}, {28, 0.0354697545622},
 {29, 0.0380477277268}, {30, 0.0407106349333}, {31, 0.0434577407898}, {32, 0.0462882877577},
 {33, 0.0492014965007}, {34, 0.0521965662425}, {35, 0.0552726751340}, {36, 0.0584289806295},
 {37, 0.0616646198713}, {38, 0.0649787100837}, {39, 0.0683703489742}, {40, 0.0718386151435},
 {41, 0.0753825685030}, {42, 0.0790012506996}, {43, 0.0826936855479}, {44, 0.0864588794694},
 {45, 0.0902958219382}, {46, 0.0942034859333}, {47, 0.0981808283967}, {48, 0.102226790698},
 {49, 0.106340299102}, {50, 0.110520265248}, {51, 0.114765586624}, {52, 0.119075147056},
 {53, 0.123447817193}, {54, 0.127882455002}, {55, 0.132377906265}, {56, 0.136933005077},
 {57, 0.141546574351}, {58, 0.146217426323}, {59, 0.150944363062}, {60, 0.155726176978},
 {61, 0.160561651336}, {62, 0.165449560774}, {63, 0.170388671812}, {64, 0.175377743373},
 {65, 0.180415527300}, {66, 0.185500768874}, {67, 0.190632207329}, {68, 0.195808576373},
 {69, 0.201028604705}, {70, 0.206291016530}, {71, 0.211594532075}, {72, 0.216937868102},
 {73, 0.222319738424}, {74, 0.227738854413}, {75, 0.233193925506}, {76, 0.238683659716},
 {77, 0.244206764132}, {78, 0.249761945419}, {79, 0.255347910316}, {80, 0.260963366128},
 {81, 0.266607021216}, {82, 0.272277585485}, {83, 0.277973770861}, {84, 0.283694291767},
 {85, 0.289437865602}, {86, 0.295203213199}, {87, 0.300989059291}, {88, 0.306794132968},
 {89, 0.312617168125}, {90, 0.318456903905}, {91, 0.324312085143}, {92, 0.330181462792},
 {93, 0.336063794352}, {94, 0.341957844288}, {95, 0.347862384440}, {96, 0.353776194433},
 {97, 0.359698062067}, {98, 0.365626783714}, {99, 0.371561164699}, {100, 0.377500019672},
 {101, 0.383442172978}, {102, 0.389386459015}, {103, 0.395331722587}, {104, 0.401276819244},
 {105, 0.407220615616}, {106, 0.413161989744}, {107, 0.419099831390}, {108, 0.425033042352},
 {109, 0.430960536761}, {110, 0.436881241371}, {111, 0.442794095843}, {112, 0.448698053018},
 {113, 0.454592079179}, {114, 0.460475154308}, {115, 0.466346272331}, {116, 0.472204441353},
 {117, 0.478048683889}, {118, 0.483878037076}, {119, 0.489691552886}, {120, 0.495488298324},
 {121, 0.501267355617}, {122, 0.507027822395}, {123, 0.512768811863}, {124, 0.518489452961},
 {125, 0.524188890517}, {126, 0.529866285389}, {127, 0.535520814603}, {128, 0.541151671470},
 {129, 0.546758065710}, {130, 0.552339223549}, {131, 0.557894387823}, {132, 0.563422818063},
 {133, 0.568923790573}, {134, 0.574396598501}, {135, 0.579840551900}, {136, 0.585254977777},
 {137, 0.590639220143}, {138, 0.595992640040}, {139, 0.601314615572}, {140, 0.606604541921},
 {141, 0.611861831357}, {142, 0.617085913238}, {143, 0.622276234001}, {144, 0.627432257153},
 {145, 0.632553463240}, {146, 0.637639349822}, {147, 0.642689431430}, {148, 0.647703239523},
 {149, 0.652680322432}, {150, 0.657620245299}, {151, 0.662522590011}, {152, 0.667386955123},
 {153, 0.672212955774}, {154, 0.677000223602}, {155, 0.681748406645}, {156, 0.686457169243},
 {157, 0.691126191923}, {158, 0.695755171292}, {159, 0.700343819911}, {160, 0.704891866173},
 {161, 0.709399054165}, {162, 0.713865143539}, {163, 0.718289909361}, {164, 0.722673141966},
 {165, 0.727014646807}, {166, 0.731314244295}, {167, 0.735571769633}, {168, 0.739787072656},
 {169, 0.743960017654}, {170, 0.748090483196}, {171, 0.752178361953}, {172, 0.756223560512},
 {173, 0.760225999190}, {174, 0.764185611842}, {175, 0.768102345666}, {176, 0.771976161006},
 {177, 0.775807031154}, {178, 0.779594942139}, {179, 0.783339892531}, {180, 0.787041893221},
 {181, 0.790700967221}, {182, 0.794317149441}, {183, 0.797890486478}, {184, 0.801421036399},
 {185, 0.804908868520}, {186, 0.808354063187}, {187, 0.811756711549}, {188, 0.815116915343},
 {189, 0.818434786660}, {190, 0.821710447725}, {191, 0.824944030670}, {192, 0.828135677304},
 {193, 0.831285538889}, {194, 0.834393775906}, {195, 0.837460557834}, {196, 0.840486062914},
 {197, 0.843470477927}, {198, 0.846413997958}, {199, 0.849316826175}, {200, 0.852179173597}

```
In[38]:= jupiterDataPlot = ListPlot[jupiterProbs]
```

```
Out[38]=
```



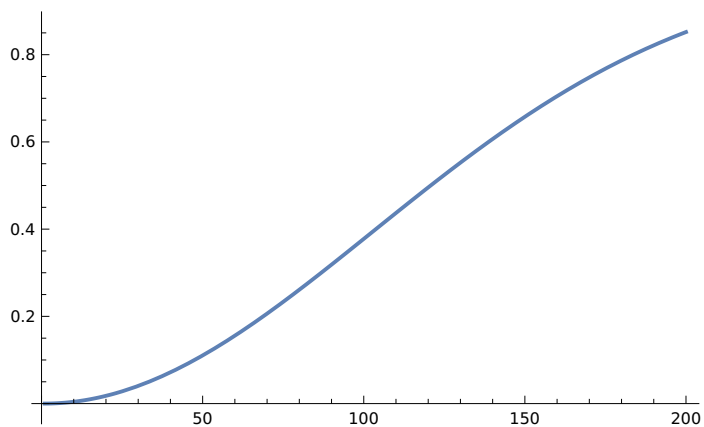
```
In[39]:= jupiterfit2 = FindFit[jupiterProbs, Bell2[b, x0, x], {{b, 1}, {x0, 2}}, x]
```

```
Out[39]=
```

```
{b → 0.0000480684706204, x0 → 0.670857324181}
```

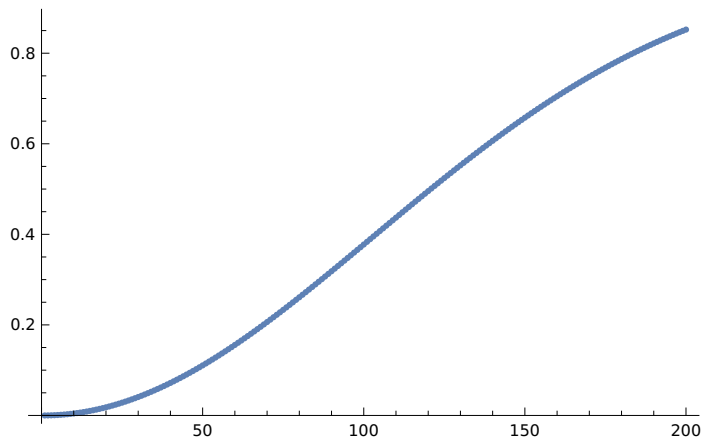
```
In[40]:= jupiterFitPlot = Plot[Bell2[Values[jupiterfit2[[1]], Values[jupiterfit2[[2]], x], {x, 1, 200}]
```

```
Out[40]=
```



```
In[41]:= Show[jupiterDataPlot, jupiterFitPlot]
```

```
Out[41]=
```



```
In[42]:= bdata = {{1/365, 0.001433}, {1/668, 0.00077366}, {1/10476, 0.000048068}}
```

```
Out[42]=
```

```
{{1/365, 0.001433}, {1/668, 0.00077366}, {1/10476, 0.000048068}}
```

```
In[43]:= ListPlot[bdata]
```

```
Out[43]=
```

