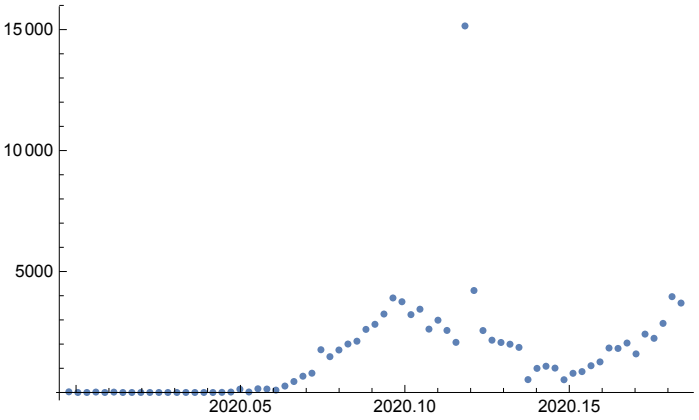
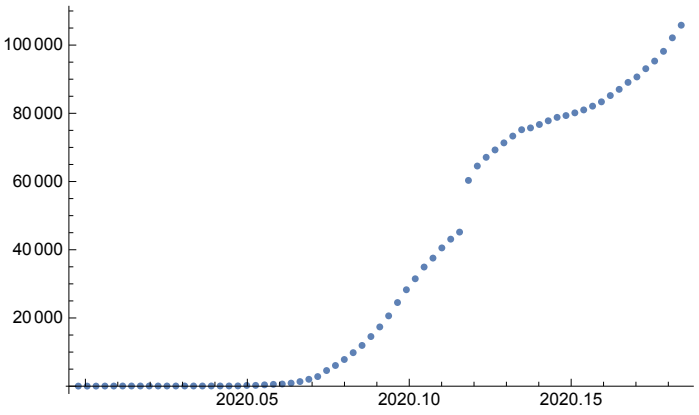
data is from here
https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

```
data = {1900 + FromDate[DateList[#[[1]]]] / (365.24 * 3600 * 24), #[[3]], #[[2]], #[[6]]} & /@
    Drop[Import["C:\\Users\\Jason
          Smith\\Desktop\\ECONDATA\\COVID-19-geographic-disbtribution-
          worldwide-2020-03-08.xls"][[1]], 1];

totals = {#[[1, 1]], Total[#[[All, 2]]]} & /@
    Split[Sort[data[[All, {1, 2}]]], #1[[1]] == #2[[1]] &];

accumulated = Transpose[{totals[[All, 1]], Accumulate[totals[[All, 2]]]}];

ListPlot[totals, PlotRange → All]
```




```
ListPlot[accumulated, PlotRange → All]
```



```
fitData = Cases[accumulated, x_ /; x[[1]] ≤ 2020.116]
nlm = NonlinearModelFit[fitData, a0/(1 + Exp[-(t - t0)/b0]),
  {
   {a0, 50 000}, {b0, 0.05}, {t0, 2020.1}
  }, t]
```

```
{{2020., 27.}, {2020., 27.}, {2020., 27.}, {2020.01, 44.}, {2020.01, 44.},
 {2020.01, 59.}, {2020.01, 59.}, {2020.02, 59.}, {2020.02, 59.}, {2020.02, 59.},
 {2020.03, 59.}, {2020.03, 59.}, {2020.03, 59.}, {2020.03, 60.}, {2020.04, 60.},
 {2020.04, 61.}, {2020.04, 61.}, {2020.04, 66.}, {2020.05, 83.}, {2020.05, 219.},
 {2020.05, 239.}, {2020.06, 392.}, {2020.06, 534.}, {2020.06, 631.},
 {2020.06, 897.}, {2020.07, 1350.}, {2020.07, 2023.}, {2020.07, 2820.},
 {2020.07, 4587.}, {2020.08, 6067.}, {2020.08, 7823.}, {2020.08, 9826.},
 {2020.09, 11 946.}, {2020.09, 14 554.}, {2020.09, 17 372.}, {2020.09, 20 615.},
 {2020.1, 24 522.}, {2020.1, 28 273.}, {2020.1, 31 491.}, {2020.1, 34 933.},
 {2020.11, 37 552.}, {2020.11, 40 540.}, {2020.11, 43 105.}, {2020.12, 45 177.}}
```

```
FittedModel[ 51 721.8 / (1 + e^(103.155 (≪19≫ - t))) ]
```

```
fitData2 = Cases[accumulated, x_ /; x[[1]] > 2020.116]
nlm2 = NonlinearModelFit[Drop[fitData2, 1],
  a0/(1 + Exp[-(t - t0)/b0]) + a1/(1 + Exp[-(t - t1)/b1]),
  {
   {a0, 75666.14697988438`},
   {b0, 1/112.7406242528004`}, {t0, 2020.1065903285187`},
   {a1, 158316.10070185905`}, {b1, 1/59.02618015129843`}, {t1, 2020.20856169607`}
  }, t]
```

```
transitions = {t0, t1} /. nlm2["BestFitParameters"]
```

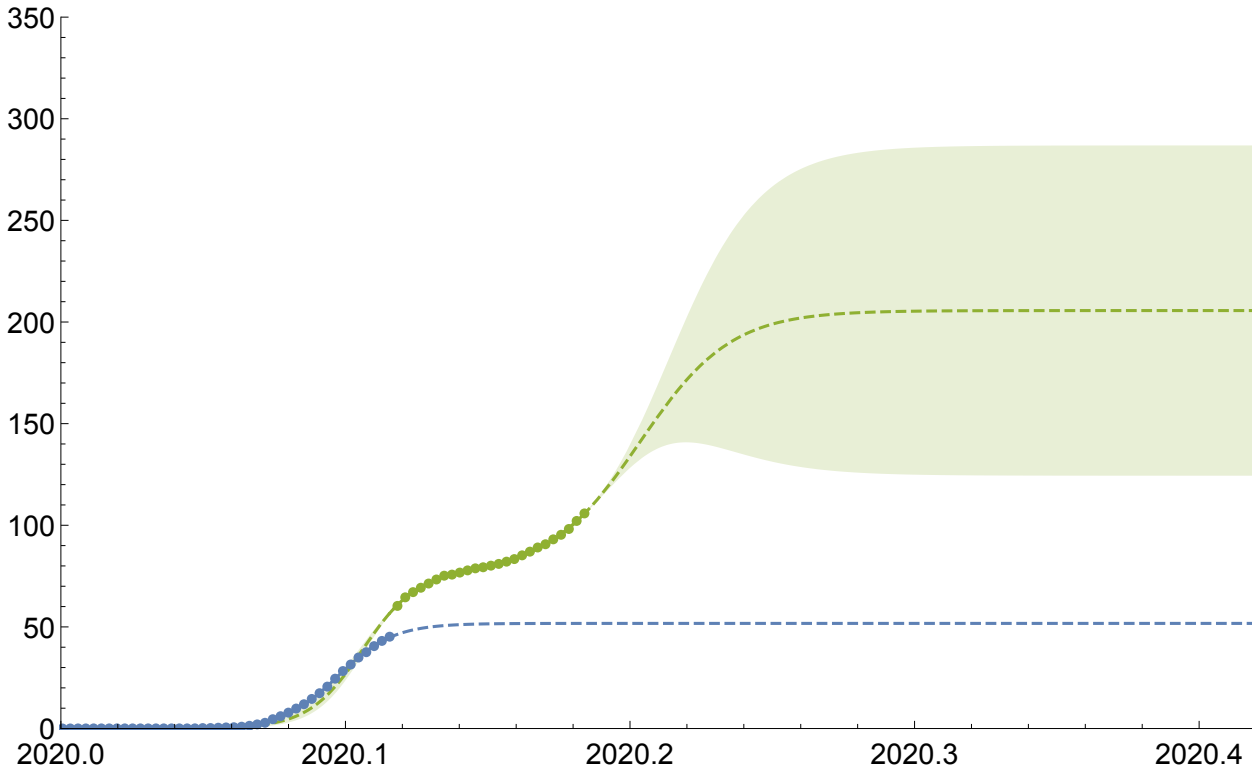
```
{{2020.12, 60 328.}, {2020.12, 64 543.}, {2020.12, 67 103.},
 {2020.13, 69 265.}, {2020.13, 71 332.}, {2020.13, 73 327.},
 {2020.13, 75 191.}, {2020.14, 75 723.}, {2020.14, 76 719.}, {2020.14, 77 804.},
 {2020.15, 78 812.}, {2020.15, 79 339.}, {2020.15, 80 132.}, {2020.15, 80 995.},
 {2020.16, 82 101.}, {2020.16, 83 365.}, {2020.16, 85 203.}, {2020.16, 87 024.},
 {2020.17, 89 068.}, {2020.17, 90 663.}, {2020.17, 93 076.}, {2020.18, 95 315.},
 {2020.18, 98 171.}, {2020.18, 102 132.}, {2020.18, 105 828.}}
```

```
FittedModel[ 76273.3/(1 + e^106.075 (≪19≫ - t)) + 129360./(1 + e^62.6001 (≪19≫ - t)) ]
```

```
{2020.11, 2020.2}
```

```
bands90 = nlm2["SinglePredictionBands", ConfidenceLevel → 0.5];
```

```
scale = 0.001;
graphLimit = 350 000;
Show[
 Plot[scale Normal[nlm], {t, 2020, fitData[[-1, 1]]},
  PlotRange → {{2020, 2020.5}, {0, scale * graphLimit}}],
 Plot[scale Normal[nlm], {t, fitData[[-1, 1]], 2021},
  PlotRange → {0, scale * 150 000}, PlotStyle → Dashed],
 Plot[scale Normal[nlm2], {t, fitData[[-1, 1]], fitData2[[-1, 1]]},
  PlotRange → {0, scale * 150 000}, PlotStyle → Directive[ColorData[97][3]]],
 Plot[scale Normal[nlm2], {t, 2020, 2020.5}, PlotRange → All,
  PlotStyle → Directive[Dashed, ColorData[97][3]]],
 Plot[Evaluate[scale bands90], {t, 2020, 2020.5}, PlotRange → All, PlotStyle → None,
  FillingStyle → Directive[Opacity[0.2], ColorData[97][3]], Filling → {1 → {2}}],
 ListPlot[{#[[1]], scale #[[2]]} & /@ fitData, PlotStyle → PointSize[0.007]],
 ListPlot[{#[[1]], scale #[[2]]} & /@ Cases[accumulated, x_ /; x[[1]] > 2020.116],
  PlotStyle → Directive[PointSize[0.007], ColorData[97][3]]],
 ImageSize → 11 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 15,
 Frame → {True, True, False, False}]
```




```
1 / 365.24
```

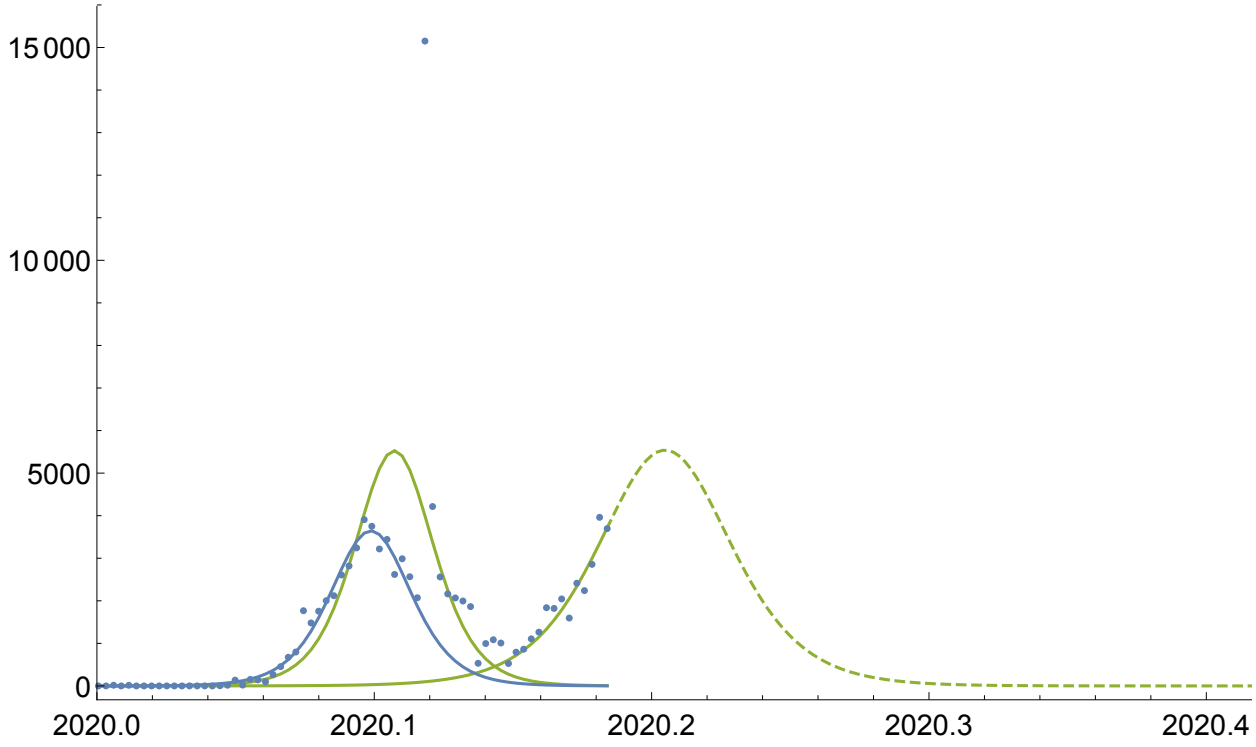
```
0.00273793
```

```
Differences[totals[[All, 1]]]
```

```
{0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793,
 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793, 0.00273793}
```

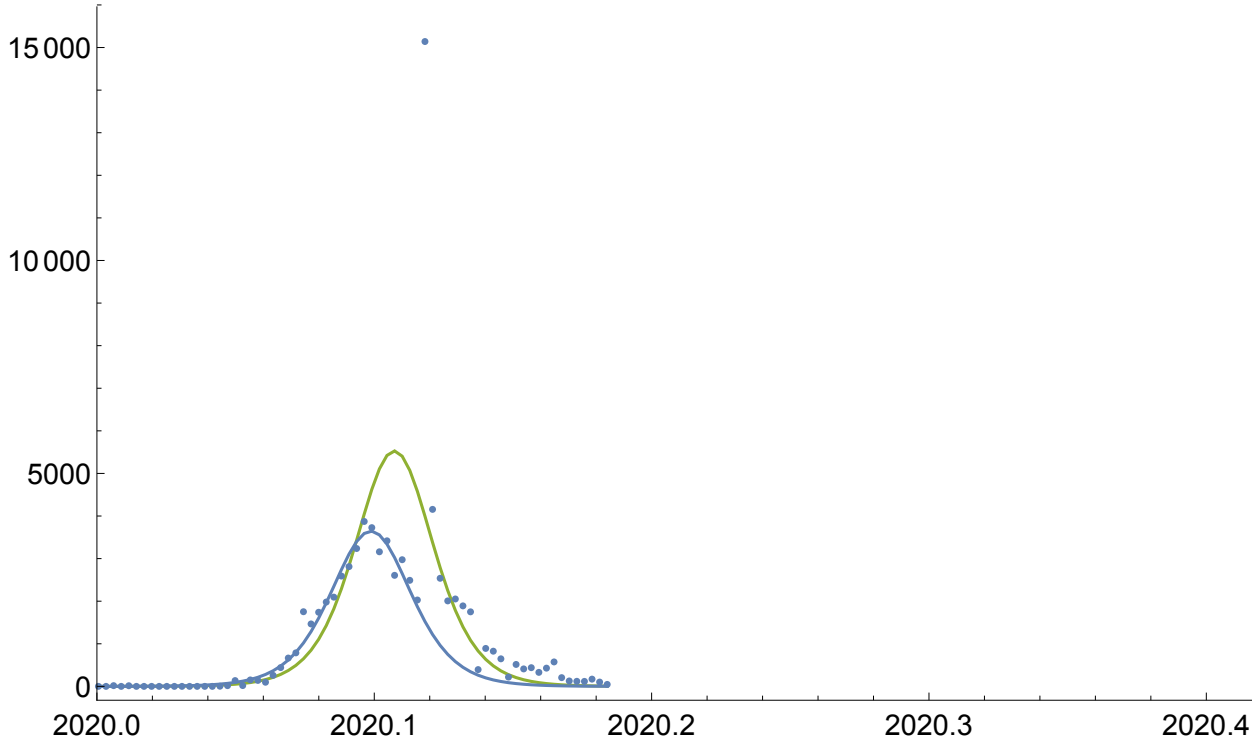
```
funcA = a0 / (1 + Exp[-(t - t0) / b0]) /. nlm["BestFitParameters"];
funcAtotals = Table[{totals[[ii, 1]], (funcA /. t → totals[[ii, 1]]) -
      (funcA /. t → totals[[ii - 1, 1]])}, {ii, 2, Length[totals]}];

func0 = a0 / (1 + Exp[-(t - t0) / b0]) /. nlm2["BestFitParameters"];
func0totals = Table[{totals[[ii, 1]], (func0 /. t → totals[[ii, 1]]) -
      (func0 /. t → totals[[ii - 1, 1]])}, {ii, 2, Length[totals]}];
func1 = a1 / (1 + Exp[-(t - t1) / b1]) /. nlm2["BestFitParameters"];
func1totals = Table[{totals[[ii, 1]], (func1 /. t → totals[[ii, 1]]) -
      (func1 /. t → totals[[ii - 1, 1]])}, {ii, 2, Length[totals]}];

func1atotals = Table[{tt, (func1 /. t → tt) - (func1 /. t → (tt - 1 / 365.24))},
   {tt, totals[[-1, 1]], 2020.5, 0.002}];
```

```
ListPlot[{totals, func0totals, func1totals, func1atotals, funcAtotals},
 PlotRange → {{2020, 2020.5}, All}, Joined → {False, True, True, True, True},
 PlotStyle → {PointSize[0.005], ColorData[97][3], ColorData[97][3],
   Directive[Dashed, ColorData[97][3]], ColorData[97][1]},

 ImageSize → 11 * 72, AspectRatio → 1 / 2,
 BaseStyle → FontSize → 15, Frame → {True, True, False, False}]
```




```
totalsChina = Cases[data, x_ /; x[[3]] == "China"][[All, {1, 2}]];

dataNotChina = DeleteCases[data, x_ /; x[[3]] == "China"];
totalsNotChina = {#[[1, 1]], Total[#[[All, 2]]]} & /@
   Split[Sort[dataNotChina[[All, {1, 2}]]], #1[[1]] == #2[[1]] &];
```

```
ListPlot[{totalsChina, func0totals, funcAtotals},
 PlotRange → {{2020, 2020.5}, All}, Joined → {False, True, True},
 PlotStyle → {PointSize[0.005], ColorData[97][3], ColorData[97][1]},
 ImageSize → 11 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 15,
 Frame → {True, True, False, False}]
```




```
{a1, b1, t1} /. nlm2["BestFitParameters"]
```

```
{129360., 0.0159744, 2020.2}
```

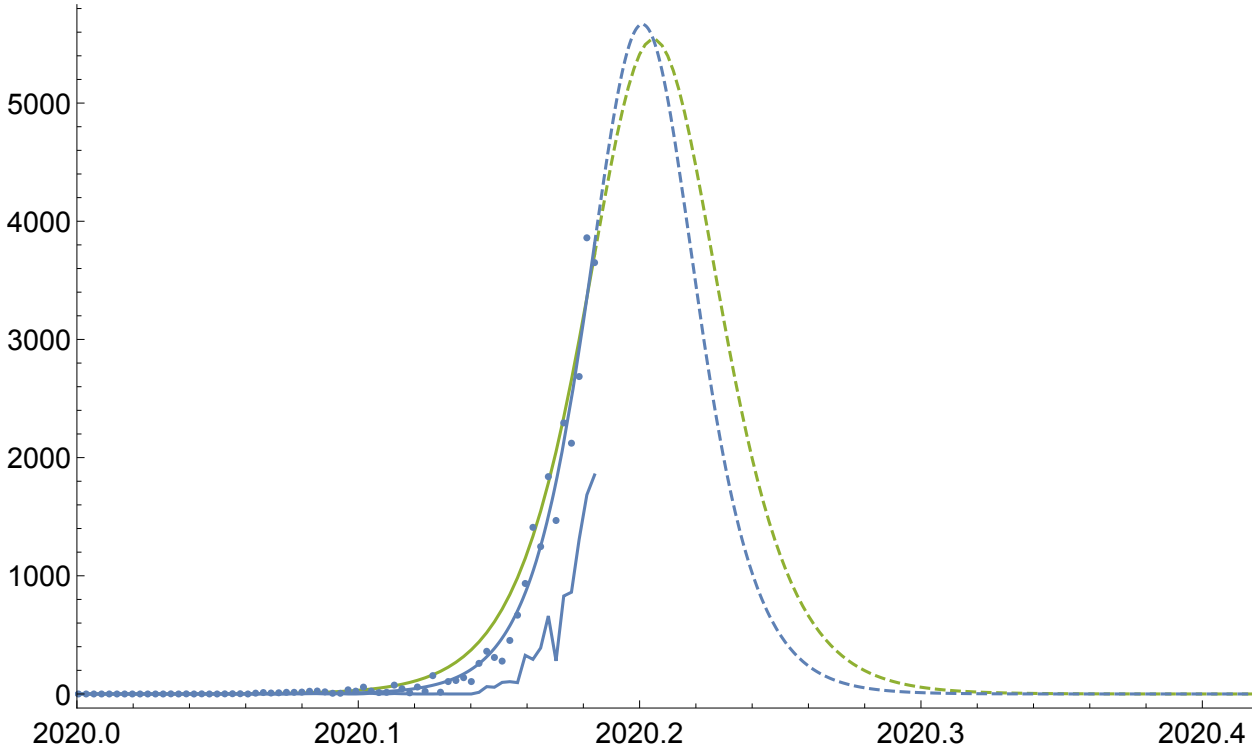
```
fitFunc = D[a1 / (1 + Exp[-(t - t1) / b1]), t]
```

```
nlmD = NonlinearModelFit[totalsNotChina, fitFunc,
  {{a1, 129359.8148811039`},
   {b1, 0.015974419434485302`}, {t1, 2020.2034983782537`}},
  t]
```

$$\frac{a1\, e^{\frac{-t+t1}{b1}}}{b1\left(1+e^{\frac{-t+t1}{b1}}\right)^2}$$

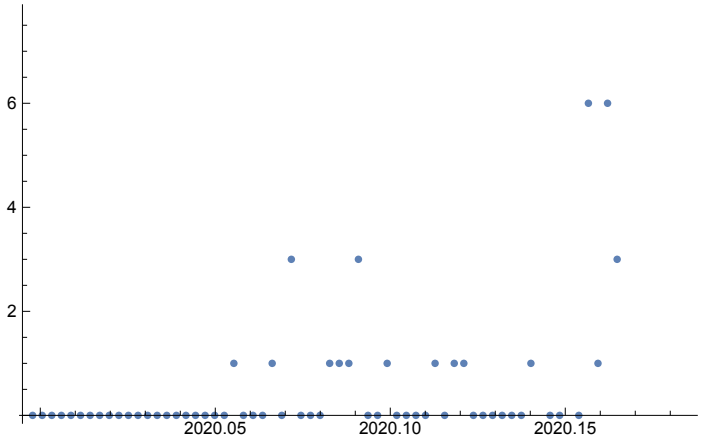
$$\text{FittedModel}\left[\frac{22665.6\, e^{76.8442\,(\ll 19\gg -t)}}{\left(1+e^{\ll 18\gg\,(\ll 19\gg -t)}\right)^2}\right]$$

```
dataEU = Cases[data, x_ /; x[[4]] == "EU"];
totalsEU = {#[[1, 1]], Total[#[[All, 2]]]} & /@
    Split[Sort[dataEU[[All, {1, 2}]]], #1[[1]] == #2[[1]] &];

Show[
 ListPlot[{totalsNotChina, func1totals, func1atotals, totalsEU},
  PlotRange → {{2020, 2020.5}, All}, Joined → {False, True, True, True, True},
  PlotStyle → {PointSize[0.005], ColorData[97][3],
    Directive[Dashed, ColorData[97][3]], ColorData[97][1]},


  ImageSize → 11 * 72, AspectRatio → 1 / 2,
  BaseStyle → FontSize → 15, Frame → {True, True, False, False}],
 Plot[Normal[nlmD], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]
```



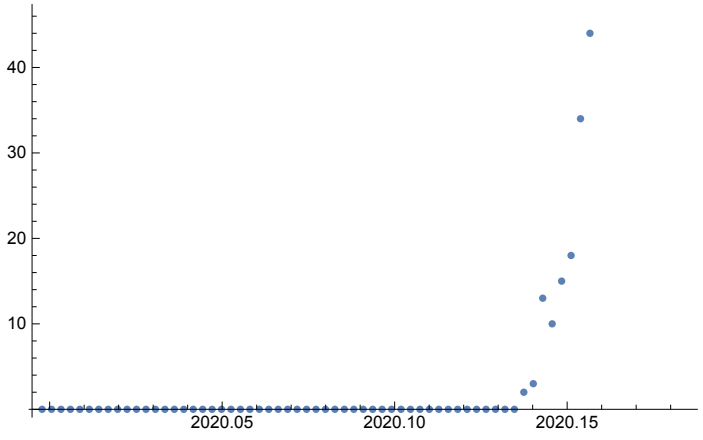

```
totalsUSA = Cases[data, x_ /; x[[3]] == "United States of America"][[All, {1, 2}]];
```

```
ListPlot[totalsUSA]
```




```
totalsIran = Cases[data, x_ /; x[[3]] == "Iran"][[All, {1, 2}]]
ListPlot[%]
```

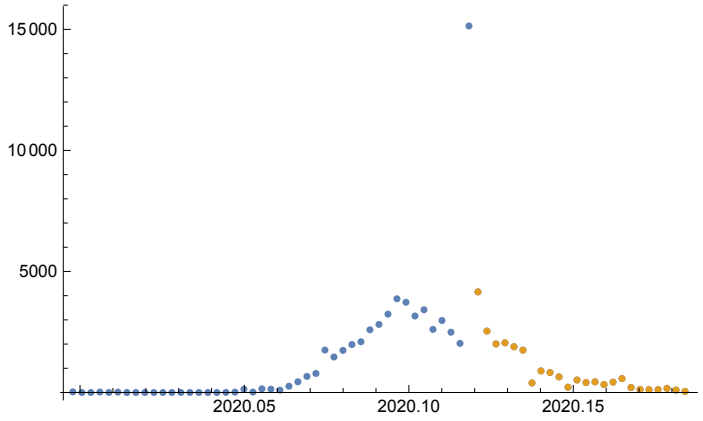
```
{{2020.18, 1076.}, {2020.18, 1234.}, {2020.18, 591.}, {2020.18, 586.},
 {2020.17, 835.}, {2020.17, 523.}, {2020.17, 385.}, {2020.16, 205.},
 {2020.16, 143.}, {2020.16, 106.}, {2020.16, 44.}, {2020.15, 34.}, {2020.15, 18.},
 {2020.15, 15.}, {2020.15, 10.}, {2020.14, 13.}, {2020.14, 3.}, {2020.14, 2.},
 {2020.13, 0.}, {2020.13, 0.}, {2020.13, 0.}, {2020.13, 0.}, {2020.12, 0.},
 {2020.12, 0.}, {2020.12, 0.}, {2020.12, 0.}, {2020.11, 0.}, {2020.11, 0.},
 {2020.11, 0.}, {2020.1, 0.}, {2020.1, 0.}, {2020.1, 0.}, {2020.1, 0.},
 {2020.09, 0.}, {2020.09, 0.}, {2020.09, 0.}, {2020.09, 0.}, {2020.08, 0.},
 {2020.08, 0.}, {2020.08, 0.}, {2020.07, 0.}, {2020.07, 0.}, {2020.07, 0.},
 {2020.07, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.},
 {2020.05, 0.}, {2020.05, 0.}, {2020.05, 0.}, {2020.04, 0.}, {2020.04, 0.},
 {2020.04, 0.}, {2020.04, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.},
 {2020.03, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.01, 0.},
 {2020.01, 0.}, {2020.01, 0.}, {2020.01, 0.}, {2020., 0.}, {2020., 0.}, {2020., 0.}}
```



various countries

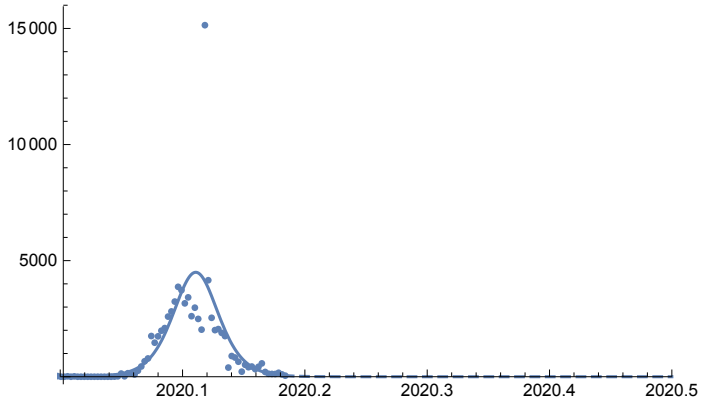
China

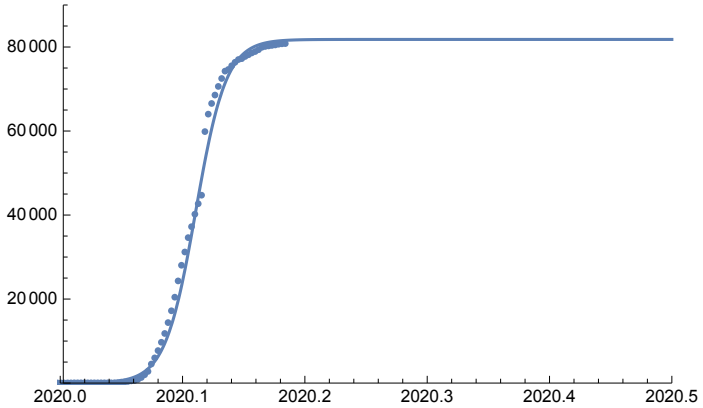
```
totalsChina = Sort[Cases[data, x_ /; x[[3]] == "China"][[All, {1, 2}]]];

ListPlot[{totalsChina, Cases[totalsChina, x_ /; x[[1]] > 2020.119]}, PlotRange → All]
```



```
fitDataD0 = totalsChina;
fitFuncD0 = D[aD / (1 + Exp[- (t - tD) / bD]), t];
nlmD0 = NonlinearModelFit[fitDataD0, fitFuncD0,
  {{aD, 50 000}, {bD, 0.01}, {tD, 2020.15}},
  t]
Show[ListPlot[fitDataD0, PlotRange → {{2020, 2020.5}, All}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]

accumulatedD0 = Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];

tempfunc = 365.24 aD / (1 + Exp[- (t - tD) / bD]) /. nlmD0["BestFitParameters"];
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]

temp = Cases[accumulatedD0, x_ /; x[[1]] > 2020.119]
nlmChina = NonlinearModelFit[temp, aD / (1 + Exp[- (t - tD) / bD]),
  {{aD, 50 000}, {bD, 0.01}, {tD, 2020.15}}, t]
Show[Plot[{Normal[nlmChina], tempfunc}, {t, 2020, 2020.5}], ListPlot[temp]]
tempD =
 Evaluate[(1 / 365.24) {D[Normal[nlmChina], t] /. t → tt, D[tempfunc, t] /. t → tt}]
Show[ListPlot[totalsChina], Plot[tempD, {tt, 2020, 2020.5}, PlotRange → All]]


funcChina = Normal[nlmChina]
```

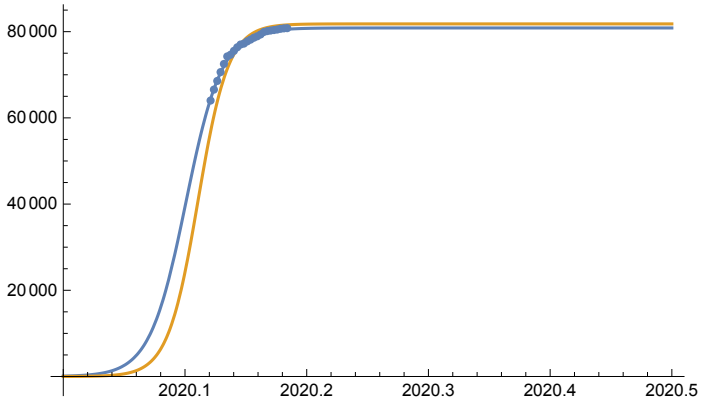
$$\text{FittedModel}\left[\frac{17\,989.1\, e^{80.3171\,(\ll 19\gg - t)}}{\left(1 + e^{\ll 18\gg\,(\ll 19\gg - t)}\right)^2}\right]$$



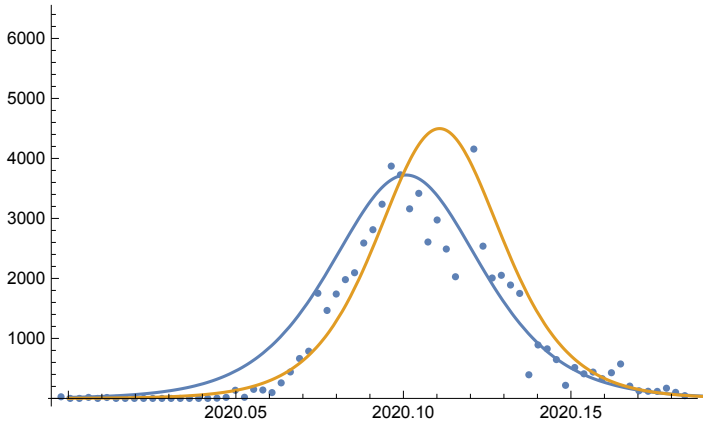



```
{{2020.12, 64 021.}, {2020.12, 66 559.}, {2020.13, 68 566.}, {2020.13, 70 618.},
 {2020.13, 72 508.}, {2020.13, 74 258.}, {2020.14, 74 652.}, {2020.14, 75 543.},
 {2020.14, 76 369.}, {2020.15, 77 016.}, {2020.15, 77 234.}, {2020.15, 77 749.},
 {2020.15, 78 159.}, {2020.16, 78 598.}, {2020.16, 78 927.}, {2020.16, 79 355.},
 {2020.16, 79 929.}, {2020.17, 80 134.}, {2020.17, 80 261.}, {2020.17, 80 380.},
 {2020.18, 80 497.}, {2020.18, 80 667.}, {2020.18, 80 768.}, {2020.18, 80 814.}}
```

$$\text{FittedModel}\left[\frac{80862.6}{1+e^{67.2714\,(\ll 19\gg -t)}}\right]$$



$$\left\{\frac{14\,893.6\, e^{67.2714\,(2020.1-tt)}}{\left(1+e^{67.2714\,(2020.1-tt)}\right)^2},\ \frac{17\,989.1\, e^{80.3171\,(2020.11-tt)}}{\left(1+e^{80.3171\,(2020.11-tt)}\right)^2}\right\}$$

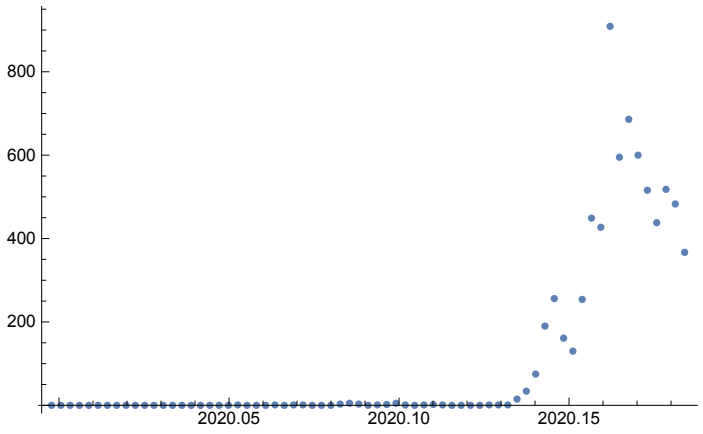


$$\frac{80\,862.6}{1+e^{67.2714\,(2020.1-t)}}$$

Korea

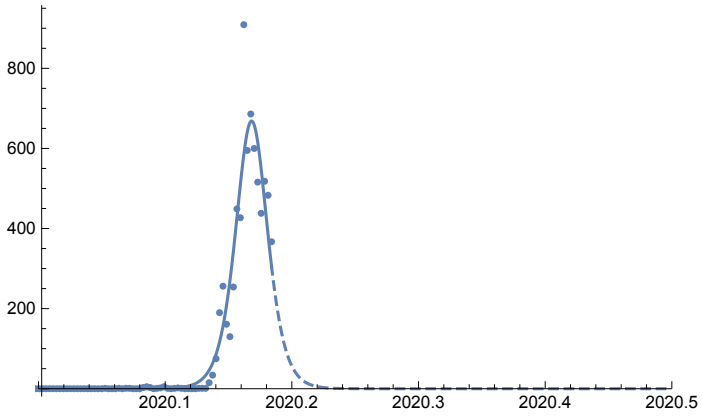
```
totalsKorea = Cases[data, x_ /; x[[3]] == "South Korea"][[All, {1, 2}]]
ListPlot[%, PlotRange → All]
```

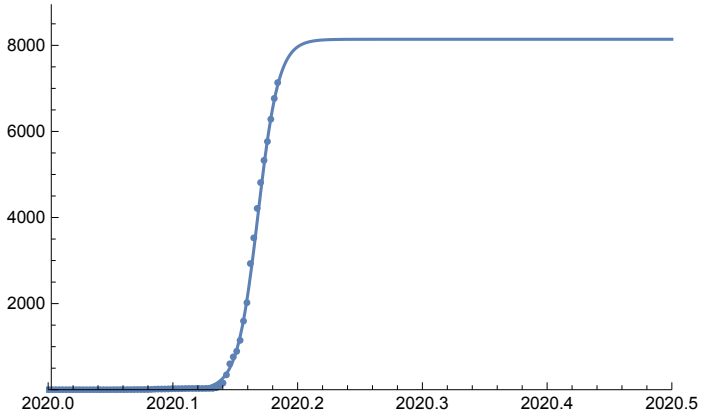
```
{{2020.18, 367.}, {2020.18, 483.}, {2020.18, 518.}, {2020.18, 438.}, {2020.17, 516.},
 {2020.17, 600.}, {2020.17, 686.}, {2020.16, 595.}, {2020.16, 909.},
 {2020.16, 427.}, {2020.16, 449.}, {2020.15, 254.}, {2020.15, 130.},
 {2020.15, 161.}, {2020.15, 256.}, {2020.14, 190.}, {2020.14, 75.}, {2020.14, 34.},
 {2020.13, 15.}, {2020.13, 1.}, {2020.13, 1.}, {2020.13, 1.}, {2020.12, 0.},
 {2020.12, 0.}, {2020.12, 0.}, {2020.12, 0.}, {2020.11, 1.}, {2020.11, 2.},
 {2020.11, 1.}, {2020.1, 0.}, {2020.1, 1.}, {2020.1, 5.}, {2020.1, 2.},
 {2020.09, 1.}, {2020.09, 0.}, {2020.09, 3.}, {2020.09, 5.}, {2020.08, 3.},
 {2020.08, 0.}, {2020.08, 0.}, {2020.07, 0.}, {2020.07, 1.}, {2020.07, 1.},
 {2020.07, 0.}, {2020.06, 1.}, {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.},
 {2020.05, 1.}, {2020.05, 0.}, {2020.05, 0.}, {2020.04, 0.}, {2020.04, 0.},
 {2020.04, 0.}, {2020.04, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.},
 {2020.03, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.01, 0.},
 {2020.01, 0.}, {2020.01, 0.}, {2020.01, 0.}, {2020., 0.}, {2020., 0.}, {2020., 0.}}
```



```
fitDataD0 = Sort[totalsKorea];
fitFuncD0 = D[aD / (1 + Exp[- (t - tD) / bD]), t];
nlmD0 = NonlinearModelFit[fitDataD0, fitFuncD0,
  {{aD, 50 000}, {bD, 0.01}, {tD, 2020.15}},
  t]
Show[ListPlot[fitDataD0, PlotRange → {{2020, 2020.5}, All}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]

accumulatedD0 = Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];

tempfunc = 365.24 aD / (1 + Exp[- (t - tD) / bD]) /. nlmD0["BestFitParameters"];
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]

funcKorea = tempfunc;
```

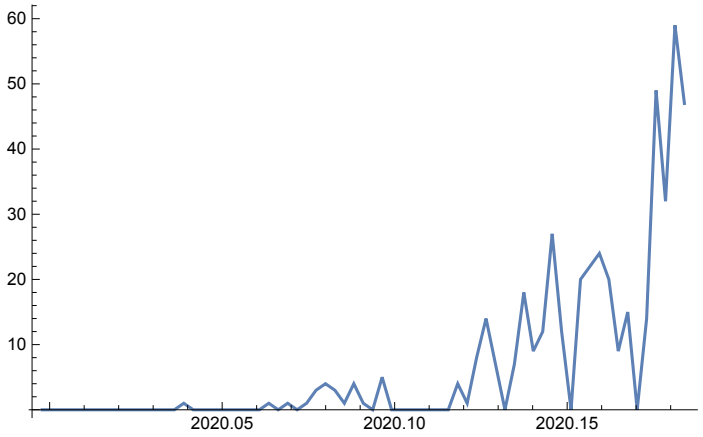
$$\text{FittedModel}\left[\frac{2673.96\, e^{119.965\,(\ll 19\gg - t)}}{\left(1 + e^{\ll 19\gg\,(\ll 19\gg - t)}\right)^2}\right]$$





Japan

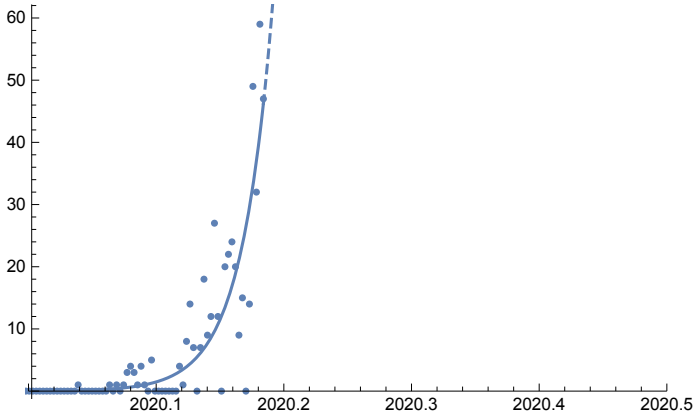
```
totalsJapan = Cases[data, x_ /; x[[3]] == "Japan"][[All, {1, 2}]];
(*totalsJapan=
  {#[[1,1]],Total[#[[All,2]]]}&/@(Split[Sort[totalsJapan],#1[[1]]==#2[[1]]&]);*)
ListPlot[%, PlotRange → All, Joined → True]
```

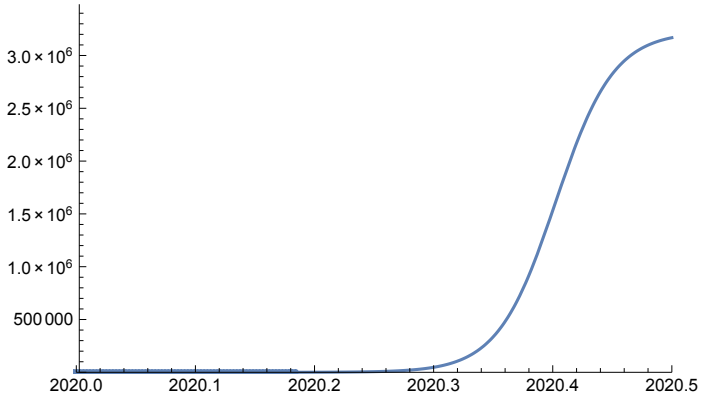


```
fitDataD0 = Sort[totalsJapan];
fitFuncD0 = D[aD / (1 + Exp[- (t - tD) / bD]), t];
nlmD0 = NonlinearModelFit[fitDataD0, fitFuncD0,
  {{aD, 50 000}, {bD, 0.01}, {tD, 2020.15}},
  t]
Show[ListPlot[fitDataD0, PlotRange → {{2020, 2020.5}, All}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]

accumulatedD0 = Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];

tempfunc = 365.24 aD / (1 + Exp[- (t - tD) / bD]) /. nlmD0["BestFitParameters"];
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]

funcJapan = tempfunc;
```

NonlinearModelFit::cvmit : Failed to converge to the requested accuracy or precision within 100 iterations. >>

$$\text{FittedModel}\left[\frac{362\,540.\, e^{41.0427\,(\ll 18\gg - t)}}{\left(1 + e^{\ll 18\gg\,(\ll 18\gg - t)}\right)^2}\right]$$

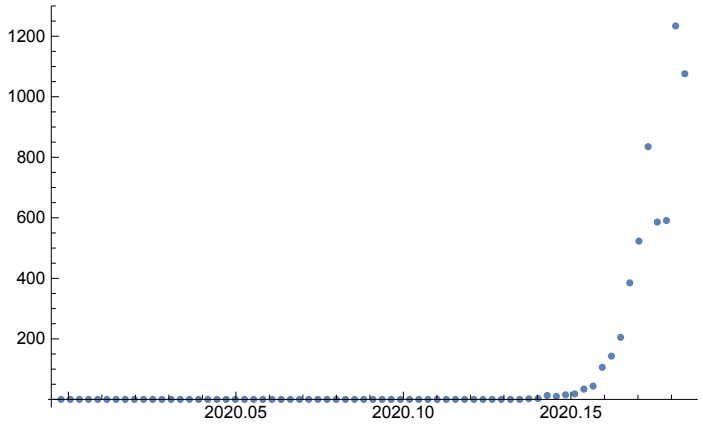




Iran

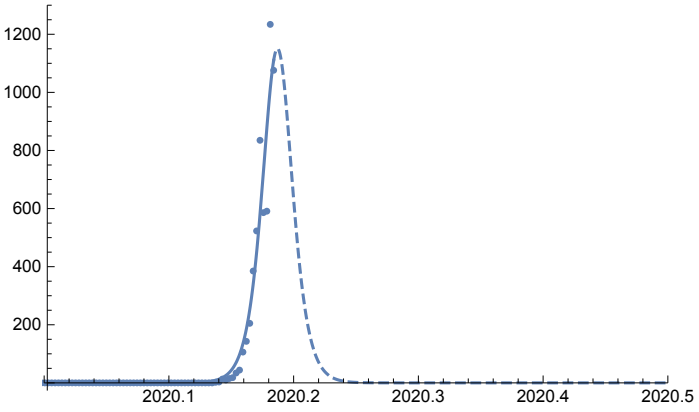
```
totalsIran = Cases[data, x_ /; x[[3]] == "Iran"][[All, {1, 2}]]
ListPlot[%, PlotRange → All]
```

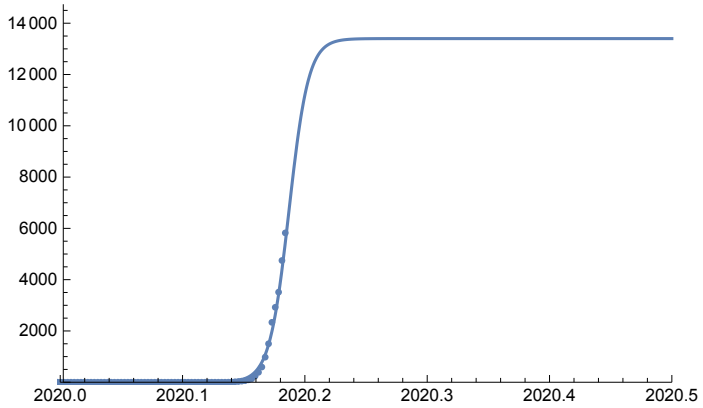
```
{{2020.18, 1076.}, {2020.18, 1234.}, {2020.18, 591.}, {2020.18, 586.},
 {2020.17, 835.}, {2020.17, 523.}, {2020.17, 385.}, {2020.16, 205.},
 {2020.16, 143.}, {2020.16, 106.}, {2020.16, 44.}, {2020.15, 34.}, {2020.15, 18.},
 {2020.15, 15.}, {2020.15, 10.}, {2020.14, 13.}, {2020.14, 3.}, {2020.14, 2.},
 {2020.13, 0.}, {2020.13, 0.}, {2020.13, 0.}, {2020.13, 0.}, {2020.12, 0.},
 {2020.12, 0.}, {2020.12, 0.}, {2020.12, 0.}, {2020.11, 0.}, {2020.11, 0.},
 {2020.11, 0.}, {2020.1, 0.}, {2020.1, 0.}, {2020.1, 0.}, {2020.1, 0.},
 {2020.09, 0.}, {2020.09, 0.}, {2020.09, 0.}, {2020.09, 0.}, {2020.08, 0.},
 {2020.08, 0.}, {2020.08, 0.}, {2020.07, 0.}, {2020.07, 0.}, {2020.07, 0.},
 {2020.07, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.},
 {2020.05, 0.}, {2020.05, 0.}, {2020.05, 0.}, {2020.04, 0.}, {2020.04, 0.},
 {2020.04, 0.}, {2020.04, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.},
 {2020.03, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.01, 0.},
 {2020.01, 0.}, {2020.01, 0.}, {2020.01, 0.}, {2020., 0.}, {2020., 0.}, {2020., 0.}}
```



```
fitDataD0 = Sort[totalsIran];
fitFuncD0 = D[aD / (1 + Exp[- (t - tD) / bD]), t];
nlmD0 = NonlinearModelFit[fitDataD0, fitFuncD0,
  {{aD, 50 000}, {bD, 0.01}, {tD, 2020.15}},
  t]
Show[ListPlot[fitDataD0, PlotRange → {{2020, 2020.5}, All}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]

accumulatedD0 = Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];

tempfunc = 365.24 aD / (1 + Exp[- (t - tD) / bD]) /. nlmD0["BestFitParameters"];
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]

funcIran = tempfunc;
```

$$\text{FittedModel}\left[\frac{4601.71\, e^{125.426\,(\ll 19\gg - t)}}{\left(1 + e^{\ll 19\gg\,(\ll 19\gg - t)}\right)^2}\right]$$

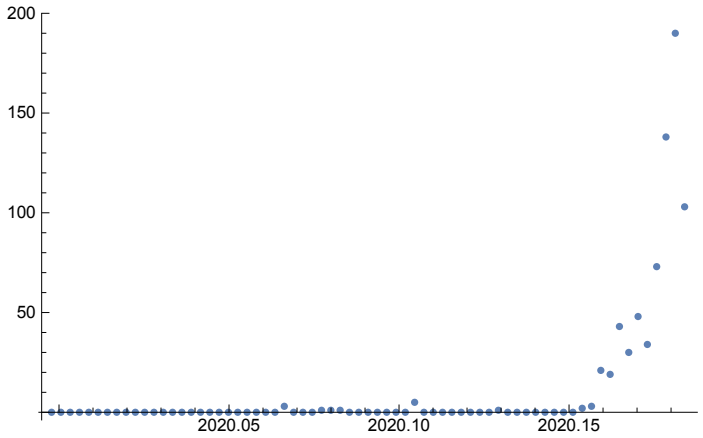




France

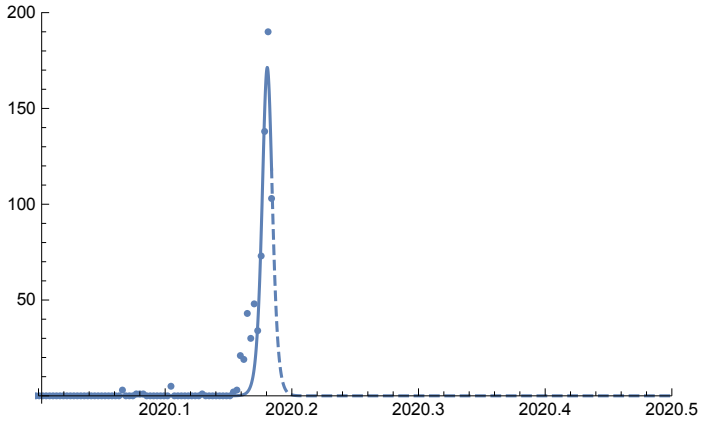
```
totalsFrance = Cases[data, x_ /; x[[3]] == "France"][[All, {1, 2}]]
ListPlot[%, PlotRange → All]
```

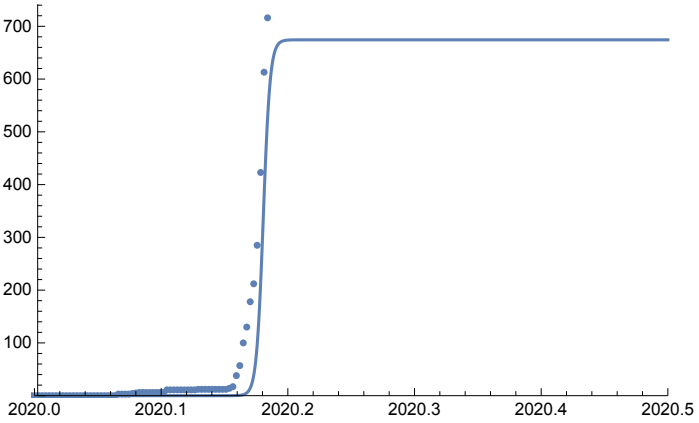
```
{{2020.18, 103.}, {2020.18, 190.}, {2020.18, 138.}, {2020.18, 73.},
 {2020.17, 34.}, {2020.17, 48.}, {2020.17, 30.}, {2020.16, 43.}, {2020.16, 19.},
 {2020.16, 21.}, {2020.16, 3.}, {2020.15, 2.}, {2020.15, 0.}, {2020.15, 0.},
 {2020.15, 0.}, {2020.14, 0.}, {2020.14, 0.}, {2020.14, 0.}, {2020.13, 0.},
 {2020.13, 0.}, {2020.13, 1.}, {2020.13, 0.}, {2020.12, 0.}, {2020.12, 0.},
 {2020.12, 0.}, {2020.12, 0.}, {2020.11, 0.}, {2020.11, 0.}, {2020.11, 0.},
 {2020.1, 5.}, {2020.1, 0.}, {2020.1, 0.}, {2020.1, 0.}, {2020.09, 0.},
 {2020.09, 0.}, {2020.09, 0.}, {2020.09, 0.}, {2020.08, 1.}, {2020.08, 1.},
 {2020.08, 1.}, {2020.07, 0.}, {2020.07, 0.}, {2020.07, 0.}, {2020.07, 3.},
 {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.05, 0.},
 {2020.05, 0.}, {2020.05, 0.}, {2020.04, 0.}, {2020.04, 0.}, {2020.04, 0.},
 {2020.04, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.},
 {2020.02, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.01, 0.}, {2020.01, 0.},
 {2020.01, 0.}, {2020.01, 0.}, {2020., 0.}, {2020., 0.}, {2020., 0.}}
```



```
fitDataD0 = Sort[totalsFrance];
fitFuncD0 = D[aD / (1 + Exp[- (t - tD) / bD]), t];
nlmD0 = NonlinearModelFit[fitDataD0, fitFuncD0,
  {{aD, 50 000}, {bD, 0.01}, {tD, 2020.15}},
  t]
Show[ListPlot[fitDataD0, PlotRange → {{2020, 2020.5}, All}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]

accumulatedD0 = Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];

tempfunc = 365.24 aD / (1 + Exp[- (t - tD) / bD]) /. nlmD0["BestFitParameters"];
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]

funcFrance = tempfunc;
```

$$\text{FittedModel}\left[\frac{685.39\, e^{371.207\,(\ll 19\gg - t)}}{\left(1 + e^{\ll 18\gg\,(\ll 19\gg - t)}\right)^2}\right]$$

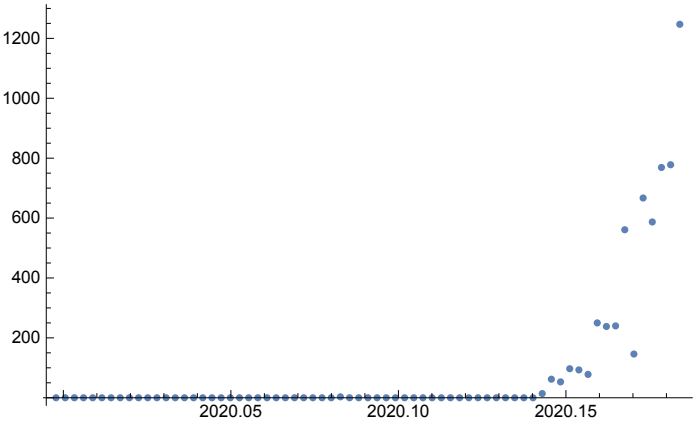




Italy

```
totalsItaly = Cases[data, x_ /; x[[3]] == "Italy"][[All, {1, 2}]]
ListPlot[%, PlotRange → All]
```

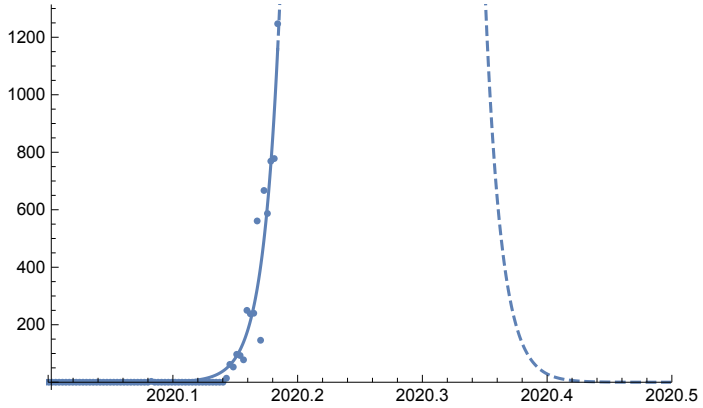
```
{{2020.18, 1247.}, {2020.18, 778.}, {2020.18, 769.}, {2020.18, 587.}, {2020.17, 667.},
 {2020.17, 146.}, {2020.17, 561.}, {2020.16, 240.}, {2020.16, 238.},
 {2020.16, 250.}, {2020.16, 78.}, {2020.15, 93.}, {2020.15, 97.}, {2020.15, 53.},
 {2020.15, 62.}, {2020.14, 14.}, {2020.14, 0.}, {2020.14, 0.}, {2020.13, 0.},
 {2020.13, 0.}, {2020.13, 0.}, {2020.13, 0.}, {2020.12, 0.}, {2020.12, 0.},
 {2020.12, 0.}, {2020.12, 0.}, {2020.11, 0.}, {2020.11, 0.}, {2020.11, 0.},
 {2020.1, 0.}, {2020.1, 0.}, {2020.1, 0.}, {2020.1, 0.}, {2020.09, 0.},
 {2020.09, 0.}, {2020.09, 0.}, {2020.09, 0.}, {2020.08, 3.}, {2020.08, 0.},
 {2020.08, 0.}, {2020.07, 0.}, {2020.07, 0.}, {2020.07, 0.}, {2020.07, 0.},
 {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.05, 0.},
 {2020.05, 0.}, {2020.05, 0.}, {2020.04, 0.}, {2020.04, 0.}, {2020.04, 0.},
 {2020.04, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.},
 {2020.02, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.01, 0.}, {2020.01, 0.},
 {2020.01, 0.}, {2020.01, 0.}, {2020., 0.}, {2020., 0.}, {2020., 0.}}
```

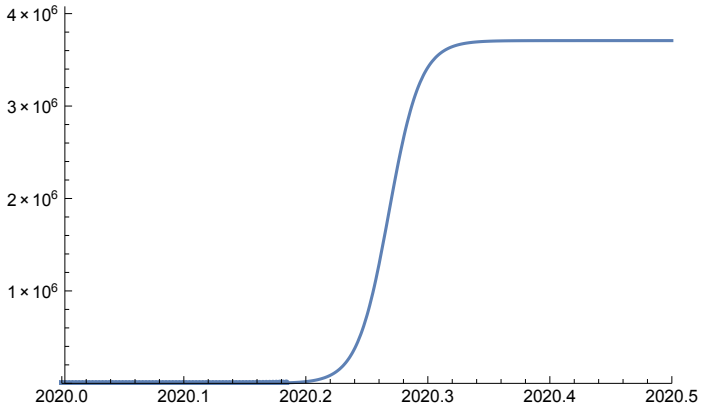


```
fitDataD0 = Sort[totalsItaly];
fitFuncD0 = D[aD / (1 + Exp[- (t - tD) / bD]), t];
nlmD0 = NonlinearModelFit[fitDataD0, fitFuncD0,
  {{aD, 50 000}, {bD, 0.01}, {tD, 2020.15}},
  t]
Show[ListPlot[fitDataD0, PlotRange → {{2020, 2020.5}, All}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]

accumulatedD0 = Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];

tempfunc = 365.24 aD / (1 + Exp[- (t - tD) / bD]) /. nlmD0["BestFitParameters"];
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]

funcItaly = tempfunc;
```

NonlinearModelFit::cvmit : Failed to converge to the requested accuracy or precision within 100 iterations. ≫

$$\text{FittedModel}\left[\frac{786\,275.\, e^{77.4488\,(\ll 19\gg - t)}}{\left(1 + e^{\ll 18\gg\,(\ll 19\gg - t)}\right)^2}\right]$$

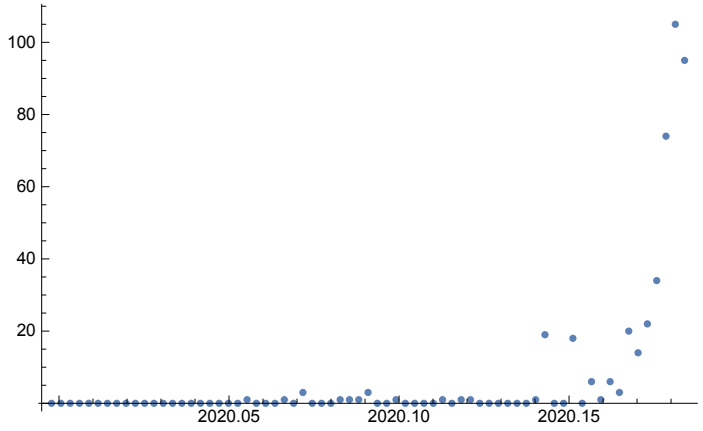




USA (fit cumulative)

```
totalsUSA = Cases[data, x_ /; x[[3]] == "United States of America"][[All, {1, 2}]]
ListPlot[%, PlotRange → All]
```

```
{{2020.18, 95.}, {2020.18, 105.}, {2020.18, 74.}, {2020.18, 34.},
 {2020.17, 22.}, {2020.17, 14.}, {2020.17, 20.}, {2020.16, 3.}, {2020.16, 6.},
 {2020.16, 1.}, {2020.16, 6.}, {2020.15, 0.}, {2020.15, 18.}, {2020.15, 0.},
 {2020.15, 0.}, {2020.14, 19.}, {2020.14, 1.}, {2020.14, 0.}, {2020.13, 0.},
 {2020.13, 0.}, {2020.13, 0.}, {2020.13, 0.}, {2020.12, 0.}, {2020.12, 1.},
 {2020.12, 1.}, {2020.12, 0.}, {2020.11, 1.}, {2020.11, 0.}, {2020.11, 0.},
 {2020.1, 0.}, {2020.1, 0.}, {2020.1, 1.}, {2020.1, 0.}, {2020.09, 0.},
 {2020.09, 3.}, {2020.09, 1.}, {2020.09, 1.}, {2020.08, 1.}, {2020.08, 0.},
 {2020.08, 0.}, {2020.07, 0.}, {2020.07, 3.}, {2020.07, 0.}, {2020.07, 1.},
 {2020.06, 0.}, {2020.06, 0.}, {2020.06, 0.}, {2020.06, 1.}, {2020.05, 0.},
 {2020.05, 0.}, {2020.05, 0.}, {2020.04, 0.}, {2020.04, 0.}, {2020.04, 0.},
 {2020.04, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.}, {2020.03, 0.},
 {2020.02, 0.}, {2020.02, 0.}, {2020.02, 0.}, {2020.01, 0.}, {2020.01, 0.},
 {2020.01, 0.}, {2020.01, 0.}, {2020., 0.}, {2020., 0.}, {2020., 0.}}
```



```
(* estimate saturation using China *)
funcChina /. t → 2020.5
% / (1.386 * 10^9)
caseSatUS = 327.2 * 10^6 * %
```

```
(* estimate saturation using Korea *)
funcKorea /. t → 2020.5
% / (51.47 * 10^6)
caseSatUS = 327.2 * 10^6 * %
```

```
80 862.6
```

```
0.0000583424
```

```
19 089.6
```

```
8141.
```

```
0.00015817
```

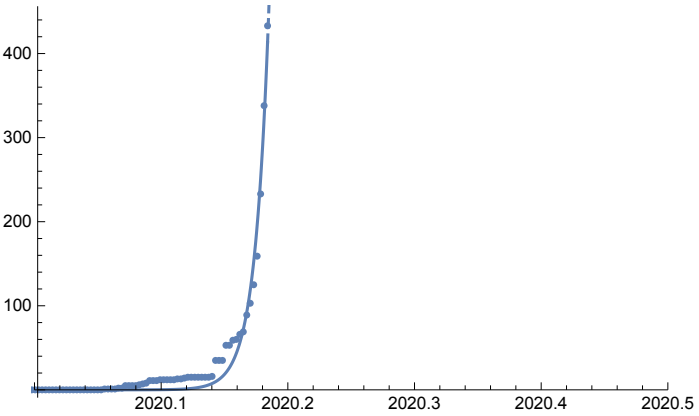
```
51 753.2
```

```
fitDataD0 = Sort[totalsUSA];
accumulatedD0 =
  Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];
fitFuncD0 = caseSatUS / (1 + Exp[- (t - tD) / bD]);
nlmD0 = NonlinearModelFit[accumulatedD0, fitFuncD0,
  {{bD, 0.01}, {tD, 2020.15}},
  t]
Show[ListPlot[accumulatedD0, PlotRange → {{2020, 2020.5}, All}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]
```

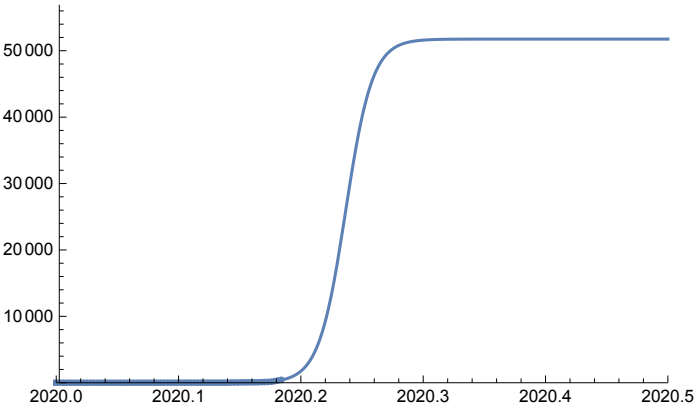
```
tempfunc = Normal[nlmD0]
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]
```

```
funcUSA = tempfunc;
```

$$\text{FittedModel}\left[\frac{51753.2}{1+e^{91.6403\,(2020.24-t)}}\right]$$

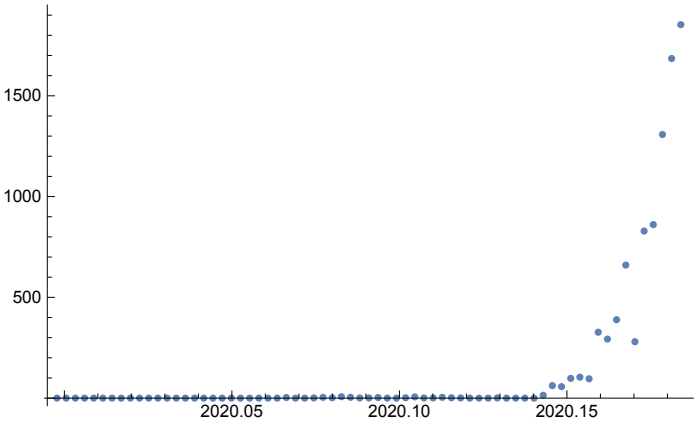


$$\frac{51\,753.2}{1 + e^{91.6403\,(2020.24 - t)}}$$



EU

```
dataEU = Cases[data, x_ /; x[[4]] == "EU"];
totalsEU = {#[[1, 1]], Total[#[[All, 2]]]} & /@
    Split[Sort[dataEU[[All, {1, 2}]]], #1[[1]] == #2[[1]] &];
ListPlot[%, PlotRange → All]
```



```
(* estimate saturation using Korea *)
funcKorea /. t → 2030.5
% / (51.47 * 10^6)
caseSatEU = (512.4 * 10^6 * %) / 365.24
```

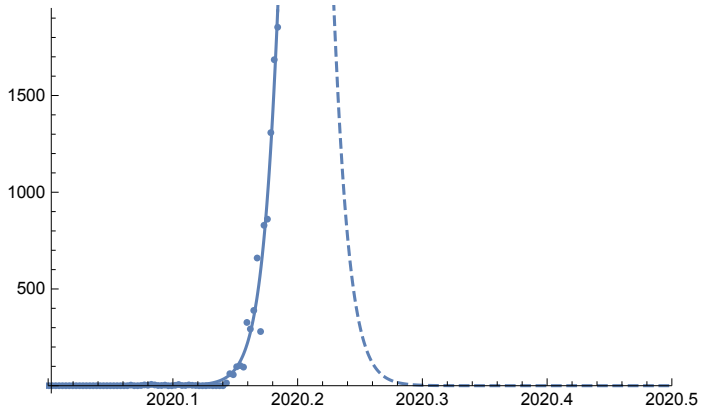
```
8141.
```

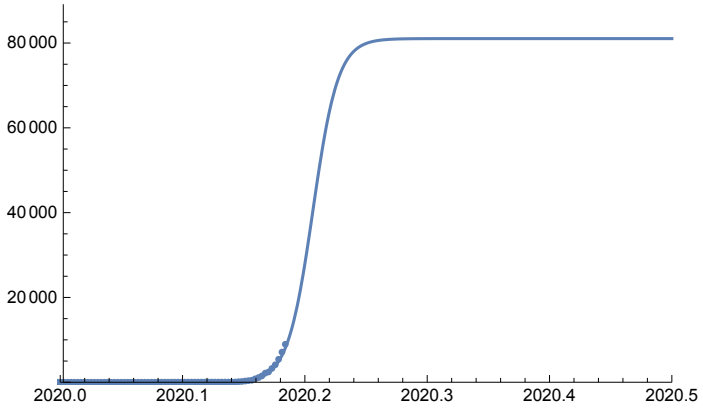
```
0.00015817
```

```
221.899
```

```
fitDataD0 = Sort[totalsEU];
fitFuncD0 = D[caseSatEU / (1 + Exp[- (t - tD) / bD]), t];
nlmD0 = NonlinearModelFit[fitDataD0, fitFuncD0,
  {(*{aD,50000},*){bD, 0.01}, {tD, 2020.15}},
  t]
Show[ListPlot[fitDataD0, PlotRange → {{2020, 2020.5}, All}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]

accumulatedD0 = Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];

tempfunc = 365.24 caseSatEU / (1 + Exp[- (t - tD) / bD]) /. nlmD0["BestFitParameters"];
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]

funcEU = tempfunc;
```

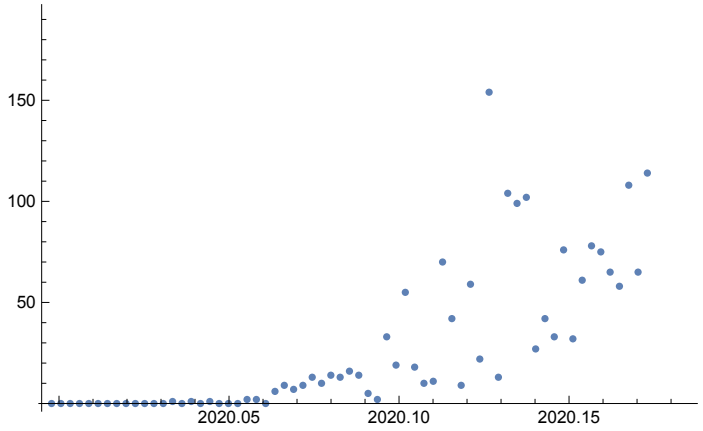
$$\text{FittedModel}\left[\frac{21640.\, e^{97.522\,(\ll 19\gg - t)}}{\left(1 + e^{\ll 18\gg\,(\ll 19\gg - t)}\right)^2}\right]$$





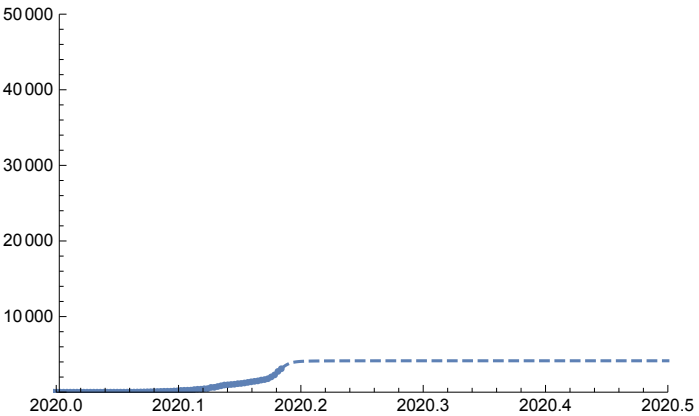
Others (fit cumulative)

```
others = DeleteCases[data, x_ /; x[[3]] == "China" ||
      x[[3]] == "South Korea" || x[[4]] == "EU" || x[[3]] == "Iran"][[All, {1, 2}]];
totalsOthers = {#[[1, 1]], Total[#[[All, 2]]]} & /@
   Split[Sort[others[[All, {1, 2}]]], #1[[1]] == #2[[1]] &];

ListPlot[totalsOthers]
```

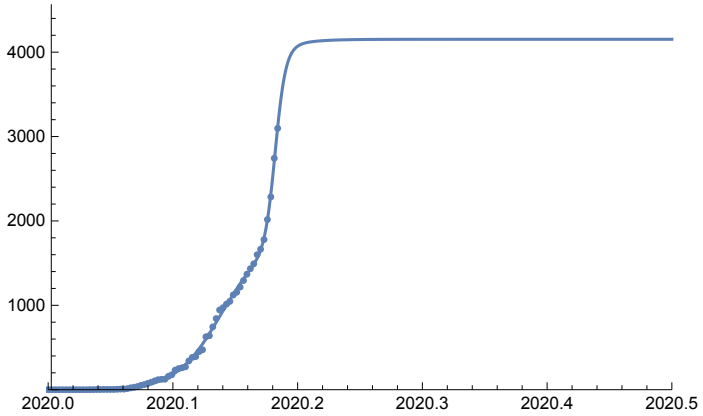


```
fitDataD0 = Sort[totalsOthers];
accumulatedD0 =
  Transpose[{fitDataD0[[All, 1]], Accumulate[fitDataD0[[All, 2]]]}];

fitFuncD0 = aD / (1 + Exp[-(t - tD) / bD]) + aD1 / (1 + Exp[-(t - tD1) / bD1]);
nlmD0 = NonlinearModelFit[accumulatedD0, fitFuncD0,
  {
   {aD, 150 000.1}, {bD, 0.01}, {tD, 2020.1},
   {aD1, 150 000.1}, {bD1, 0.01}, {tD1, 2020.2}
  },
  t, Method → Automatic]

Show[ListPlot[accumulatedD0, PlotRange → {{2020, 2020.5}, {0, 50 000}}],
 Plot[Normal[nlmD0], {t, 2020, totals[[-1, 1]]}, PlotRange → All],
 Plot[Normal[nlmD0], {t, totals[[-1, 1]], 2020.5},
  PlotRange → All, PlotStyle → Dashed]]

tempfunc = Normal[nlmD0]
Show[ListPlot[accumulatedD0,
  PlotRange → {{2020, 2020.5}, {0, 1.1 tempfunc /. t → 2020.5}}],
 Plot[tempfunc, {t, 2020, 2020.5}]]

funcOthers = tempfunc;
```

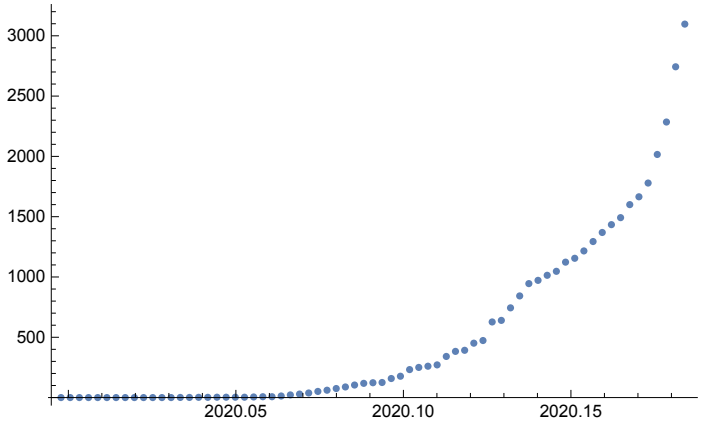
$$\text{FittedModel}\left[\frac{1764.3}{1+e^{56.8068\,(\ll 19\gg -t)}}+\frac{2388.53}{1+e^{239.781\,(\ll 19\gg -t)}}\right]$$



$$\frac{1764.3}{1+e^{56.8068\,(2020.14-t)}}+\frac{2388.53}{1+e^{239.781\,(2020.18-t)}}$$



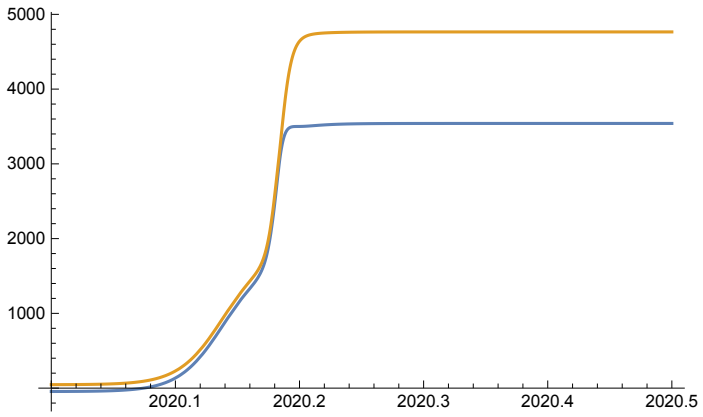

```
ListPlot[accumulatedD0]
```




```
nlmOthers = nlmD0
```

$$\text{FittedModel}\left[\frac{1764.3}{1+e^{56.8068\,(\ll 19\gg -t)}}+\frac{2388.53}{1+e^{239.781\,(\ll 19\gg -t)}}\right]$$

```
nlmOthers["SinglePredictionBands"];
Plot[%, {t, 2020, 2020.5}]
```



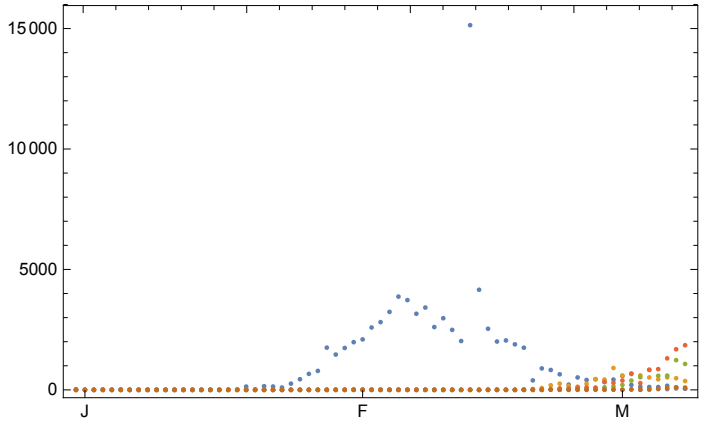
summing up (others)

```
endYear = 2020.4;
scale = 0.001;
```

```
monthList = {"J", "F", "M", "A", "M", "J", "J", "A", "S", "O", "N", "D"};
labels =
  Table[{1900 + FromDate[{2020, ii, 1, 0, 0, 0}] / (365.24 * 3600 * 24), monthList[[ii]]}, {ii, 1, 12}];
```

```
{totalsChina, totalsKorea, totalsIran, totalsEU,
   totalsJapan, totalsOthers, totalsUSA, totalsFrance, totalsItaly} =
  Sort /@ {totalsChina, totalsKorea, totalsIran, totalsEU, totalsJapan,
    totalsOthers, totalsUSA, totalsFrance, totalsItaly};
```

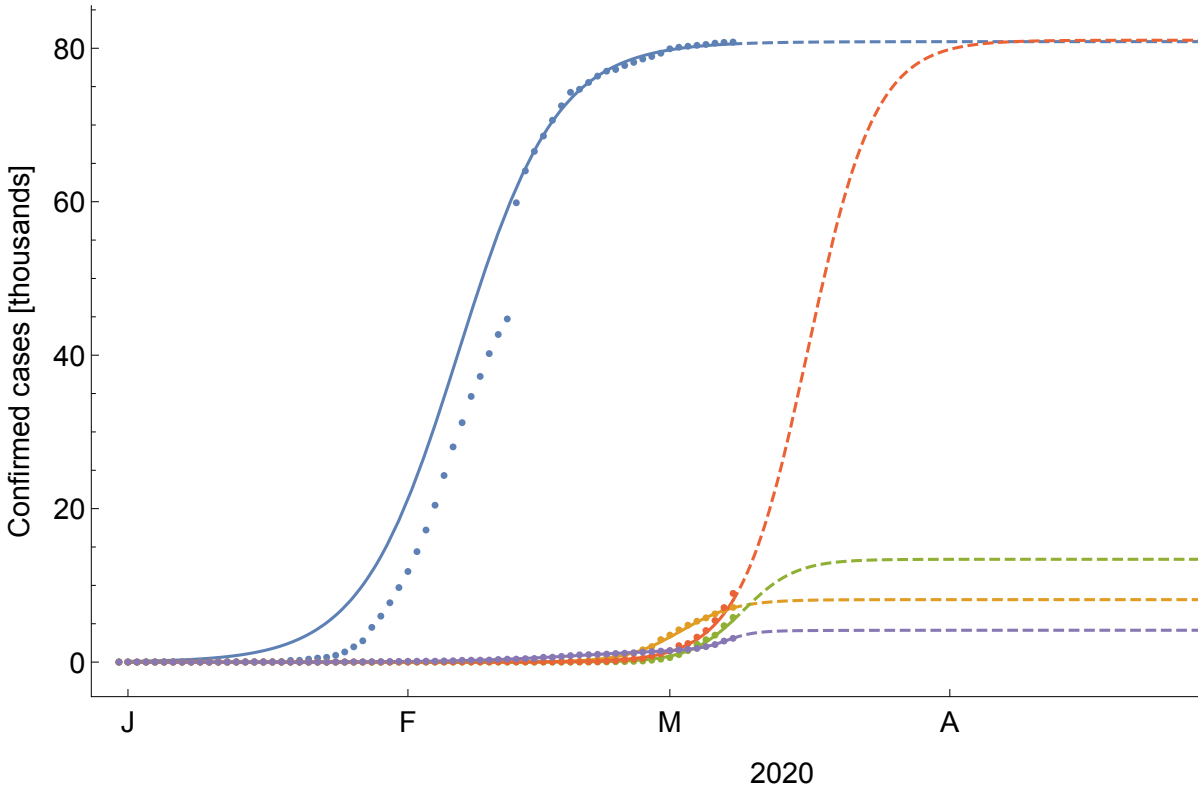
```
ListPlot[{totalsChina, totalsKorea, totalsIran, totalsEU, totalsJapan, totalsUSA},
 PlotRange → All, Frame → True,
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}}]
```



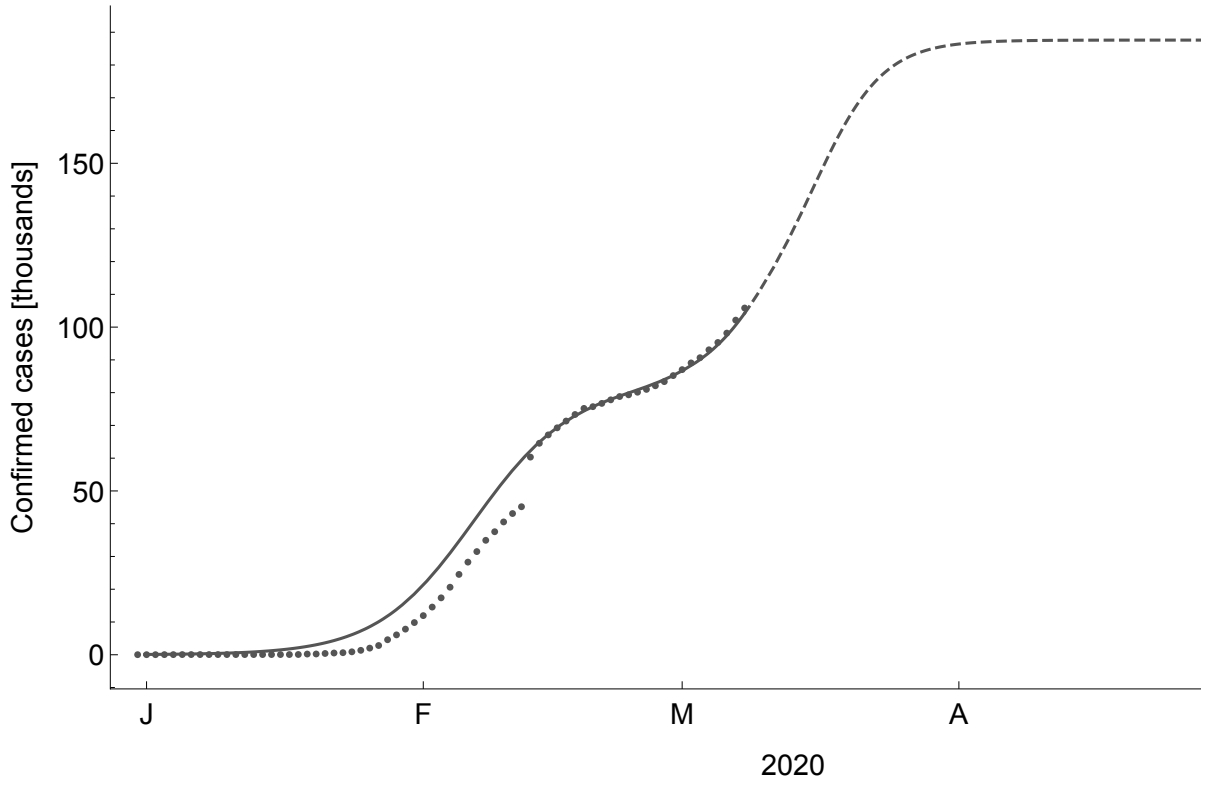
```
accumulatedChina =
  Transpose[{totalsChina[[All, 1]], scale Accumulate[totalsChina[[All, 2]]]}];
accumulatedKorea = Transpose[{totalsKorea[[All, 1]],
    scale Accumulate[totalsKorea[[All, 2]]]}];
accumulatedIran = Transpose[{totalsIran[[All, 1]],
    scale Accumulate[totalsIran[[All, 2]]]}];
accumulatedEU = Transpose[{totalsEU[[All, 1]],
    scale Accumulate[totalsEU[[All, 2]]]}];
accumulatedUSA = Transpose[{totalsUSA[[All, 1]],
    scale Accumulate[totalsUSA[[All, 2]]]}];
accumulatedOthers = Transpose[{totalsOthers[[All, 1]],
    scale Accumulate[totalsOthers[[All, 2]]]}];

accumulatedFrance =
  Transpose[{totalsFrance[[All, 1]], scale Accumulate[totalsFrance[[All, 2]]]}];
accumulatedItaly = Transpose[{totalsItaly[[All, 1]],
    scale Accumulate[totalsItaly[[All, 2]]]}];
accumulatedJapan = Transpose[{totalsJapan[[All, 1]],
    scale Accumulate[totalsJapan[[All, 2]]]}];
```

```
cums = scale {funcChina, funcKorea, funcIran, funcEU, funcOthers}
p1 = Show[
   Plot[cums, {t, 2020, totals[[-1, 1]]}, PlotRange → All,
    PlotLegends → {"China", "Korea", "Iran", "EU", "Others"}],
   Plot[cums, {t, totals[[-1, 1]], endYear}, PlotRange → All, PlotStyle → Dashed],
   ListPlot[{accumulatedChina, accumulatedKorea, accumulatedIran,
     accumulatedEU, accumulatedOthers}, PlotStyle → PointSize[0.005]],
   ImageSize → 11 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 15,
   Frame → {True, True, False, False},
   FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
   FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"}]
```

$$\left\{\frac{80.8626}{1+e^{67.2714\,(2020.1-t)}},\ \frac{8.141}{1+e^{119.965\,(2020.17-t)}},\ \frac{13.4002}{1+e^{125.426\,(2020.19-t)}},\ \frac{81.0463}{1+e^{97.522\,(2020.21-t)}},\ 0.001\left(\frac{1764.3}{1+e^{56.8068\,(2020.14-t)}}+\frac{2388.53}{1+e^{239.781\,(2020.18-t)}}\right)\right\}$$



```
p0 = Show[
  Plot[Total[cums], {t, 2020, totals[[-1, 1]]},
   PlotRange → All, PlotStyle → Lighter[Black]],
  Plot[Total[cums], {t, totals[[-1, 1]], endYear}, PlotRange → All,
   PlotStyle → Directive[Dashed, Lighter[Black]]],
  ListPlot[{#[[1]], scale #[[2]]} & /@ accumulated,
   PlotStyle → Directive[PointSize[0.005], Lighter[Black]]],
  ImageSize → 11 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 15,
  Frame → {True, True, False, False},
  FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
  FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"}]
```

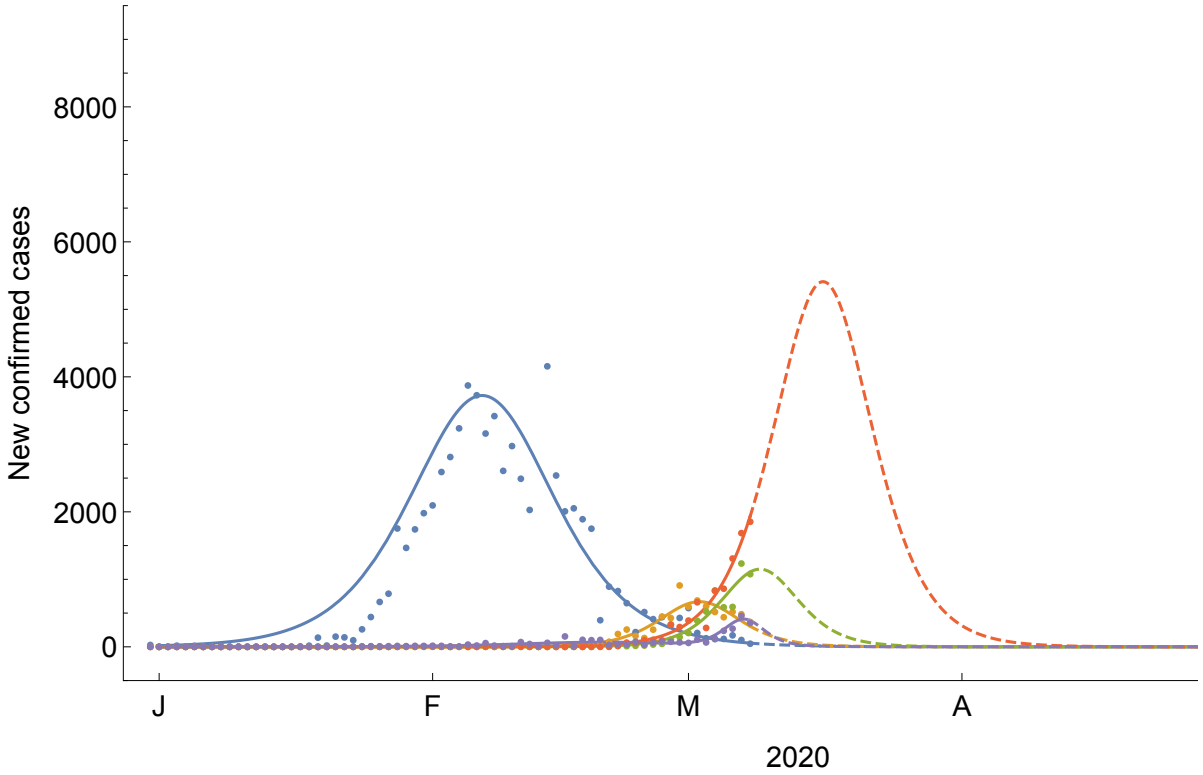


```
derivatives = (1 / 365.24)
  {D[funcChina, t], D[funcKorea, t], D[funcIran, t], D[funcEU, t], D[funcOthers, t]}
Show[
 Plot[derivatives, {t, 2020, totals[[-1, 1]]}, PlotRange → All,
  PlotLegends → {"China", "Korea", "Iran", "EU", "Others"}],
 Plot[derivatives, {t, totals[[-1, 1]], endYear},
  PlotRange → All, PlotStyle → Dashed],
 ListPlot[{totalsChina, totalsKorea, totalsIran, totalsEU, totalsOthers},
  PlotRange → Automatic, PlotStyle → PointSize[0.005]],

 ImageSize → 11 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 15,
 Frame → {True, True, False, False}, PlotRange → {0, 9000},
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
 FrameLabel → {"2020\n", "\nNew confirmed cases"}]
```

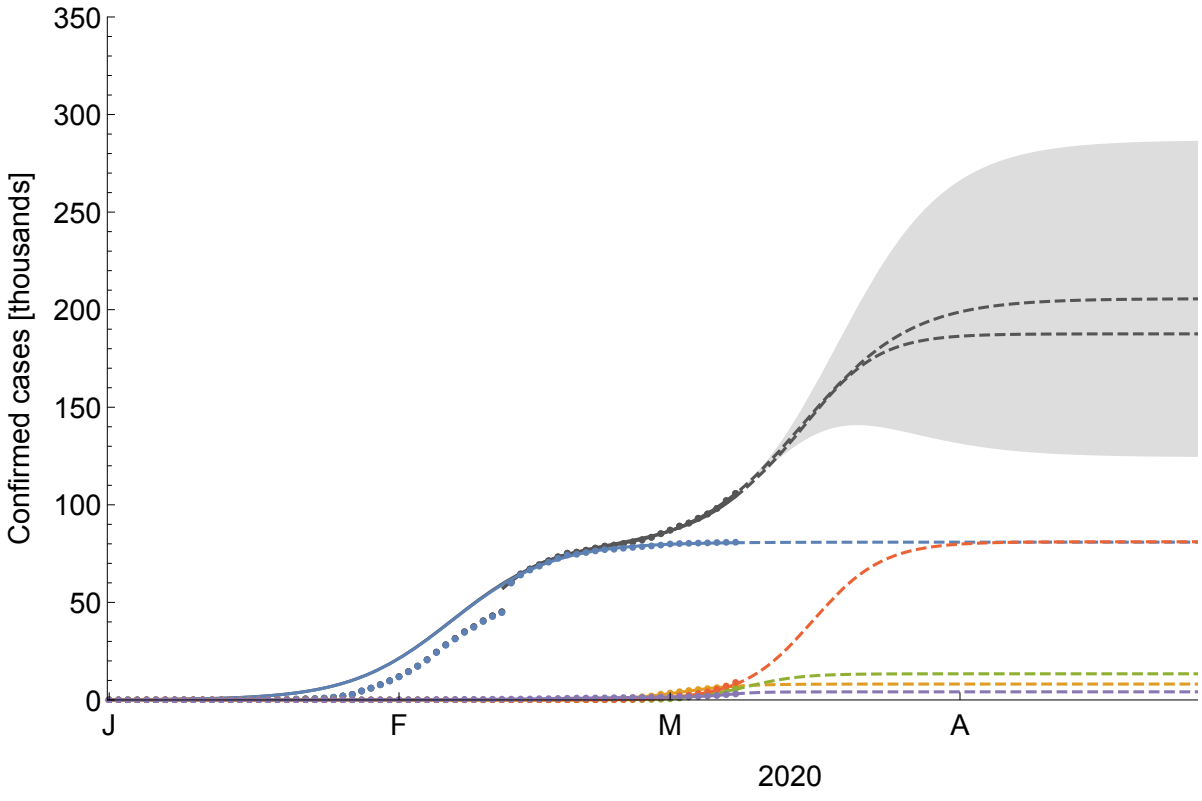
$$\left\{\frac{14\,893.6\, e^{67.2714\,(2020.1-t)}}{\left(1+e^{67.2714\,(2020.1-t)}\right)^2},\ \frac{2673.96\, e^{119.965\,(2020.17-t)}}{\left(1+e^{119.965\,(2020.17-t)}\right)^2},\right.$$

$$\frac{4601.71\, e^{125.426\,(2020.19-t)}}{\left(1+e^{125.426\,(2020.19-t)}\right)^2},\ \frac{21\,640.\, e^{97.522\,(2020.21-t)}}{\left(1+e^{97.522\,(2020.21-t)}\right)^2},$$

$$\left.0.00273793\left(\frac{100\,225.\, e^{56.8068\,(2020.14-t)}}{\left(1+e^{56.8068\,(2020.14-t)}\right)^2}+\frac{572\,723.\, e^{239.781\,(2020.18-t)}}{\left(1+e^{239.781\,(2020.18-t)}\right)^2}\right)\right\}$$

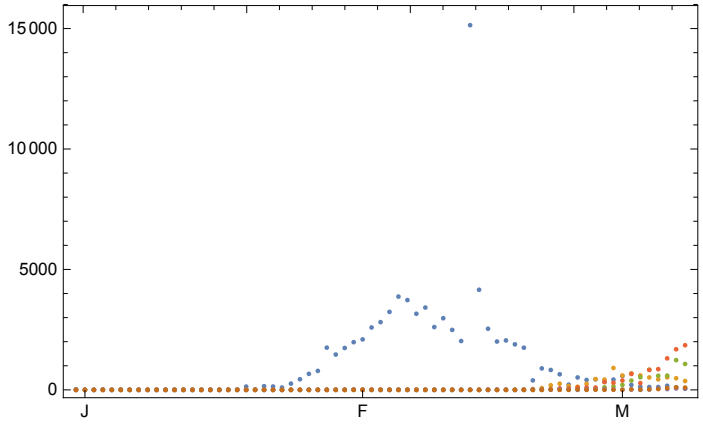


```
graphLimit = 350 000;
Show[
 Plot[scale Normal[nlm2], {t, 2020.116, endYear},
  PlotRange → {{2020, endYear}, {0, scale * graphLimit}},
  PlotStyle → Directive[Dashed, Lighter[Black]]],
 Plot[scale Normal[nlm2], {t, 2020.116, totals[[-1, 1]]},
  PlotStyle → Directive[Lighter[Black]]],
 Plot[Evaluate[scale bands90], {t, 2020.116, endYear},
  PlotRange → All, PlotStyle → None,
  FillingStyle → Directive[Opacity[0.2], Lighter[Black]], Filling → {1 → {2}}],
 ListPlot[{#[[1]], scale #[[2]]} & /@ accumulated,
  PlotStyle → Directive[PointSize[0.005], Lighter[Black]],
  PlotStyle → Directive[PointSize[0.007], ColorData[97][3]]],
 p0, p1,
 ImageSize → 11 * 72, AspectRatio → 1 / 2,
 BaseStyle → FontSize → 15, Frame → {True, True, False, False},
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
 FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"}]
```



summing up (USA)

```
endYear = 2020.4;
scale = 0.001;


monthList = {"J", "F", "M", "A", "M", "J", "J", "A", "S", "O", "N", "D"};
labels =
  Table[{1900 + FromDate[{2020, ii, 1, 0, 0, 0}] / (365.24 * 3600 * 24), monthList[[ii]]}, {ii, 1, 12}];
{totalsChina, totalsKorea, totalsIran, totalsEU, totalsJapan, totalsUSA} =
  Sort /@ {totalsChina, totalsKorea, totalsIran, totalsEU, totalsJapan, totalsUSA};
ListPlot[{totalsChina, totalsKorea, totalsIran, totalsEU, totalsJapan, totalsUSA},
 PlotRange → All, Frame → True,
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}}]
```




```
accumulatedChina =
  Transpose[{totalsChina[[All, 1]], scale Accumulate[totalsChina[[All, 2]]]}];
accumulatedKorea = Transpose[{totalsKorea[[All, 1]],
    scale Accumulate[totalsKorea[[All, 2]]]}];
accumulatedIran = Transpose[{totalsIran[[All, 1]],
    scale Accumulate[totalsIran[[All, 2]]]}];
accumulatedEU = Transpose[{totalsEU[[All, 1]],
    scale Accumulate[totalsEU[[All, 2]]]}];
accumulatedUSA = Transpose[{totalsUSA[[All, 1]],
    scale Accumulate[totalsUSA[[All, 2]]]}];
accumulatedOthers = Transpose[{totalsOthers[[All, 1]],
    scale Accumulate[totalsOthers[[All, 2]]]}];
```

```
(* estimated EU saturation based on China *)
80.86256857818246` * (0.5124 / 1.386)
```

```
(* function fit is 51.183911888429016` *)
29.8946
```

```
(* estimated EU saturation based on korea *)
8.141004638776039` * (0.5124 / 0.05747)
```

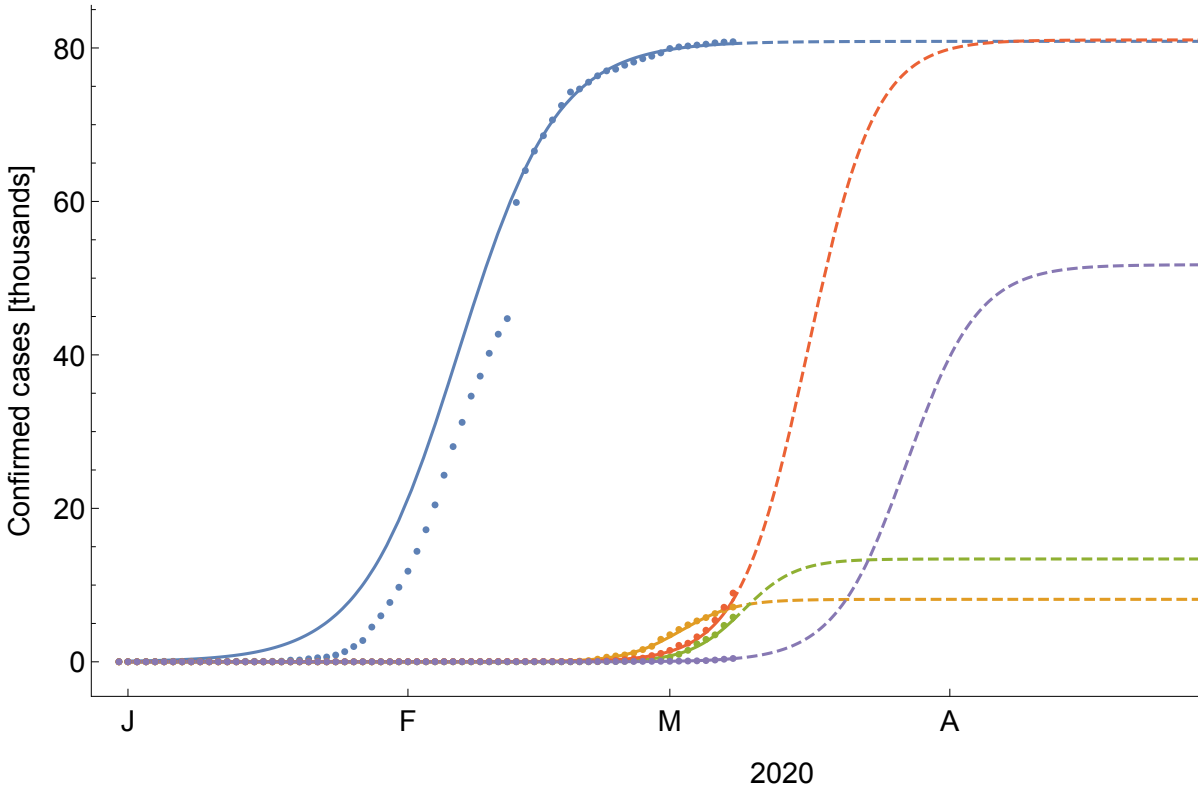
```
72.5848
```

```
(* estimated Korea saturation based on China *)
80.86256857818246` * (0.0575 / 1.386)
```

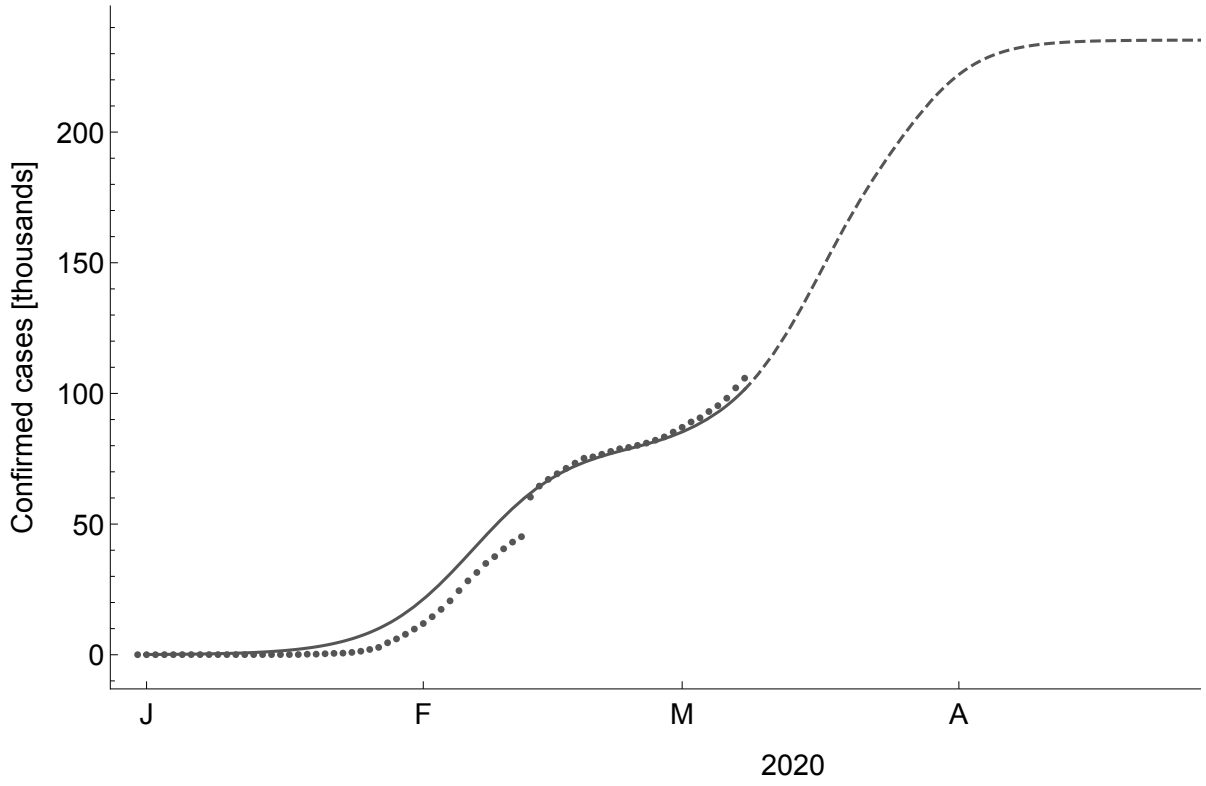
```
(* actual is 8.141004638776039` *)
3.35469
```

```
cums = scale {funcChina, funcKorea, funcIran, funcEU, funcUSA}
p1 = Show[
   Plot[cums, {t, 2020, totals[[-1, 1]]}, PlotRange → All,
    PlotLegends → {"China", "Korea", "Iran", "EU*", "USA*"}],
   Plot[cums, {t, totals[[-1, 1]], endYear}, PlotRange → All, PlotStyle → Dashed],
   ListPlot[{accumulatedChina, accumulatedKorea, accumulatedIran,
     accumulatedEU, accumulatedUSA}, PlotStyle → PointSize[0.005]],
   ImageSize → 11 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 15,
   Frame → {True, True, False, False},
   FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
   FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"}]
```

$$\left\{\frac{80.8626}{1+e^{67.2714\,(2020.1-t)}},\ \frac{8.141}{1+e^{119.965\,(2020.17-t)}},\ \frac{13.4002}{1+e^{125.426\,(2020.19-t)}},\ \frac{81.0463}{1+e^{97.522\,(2020.21-t)}},\ \frac{51.7532}{1+e^{91.6403\,(2020.24-t)}}\right\}$$

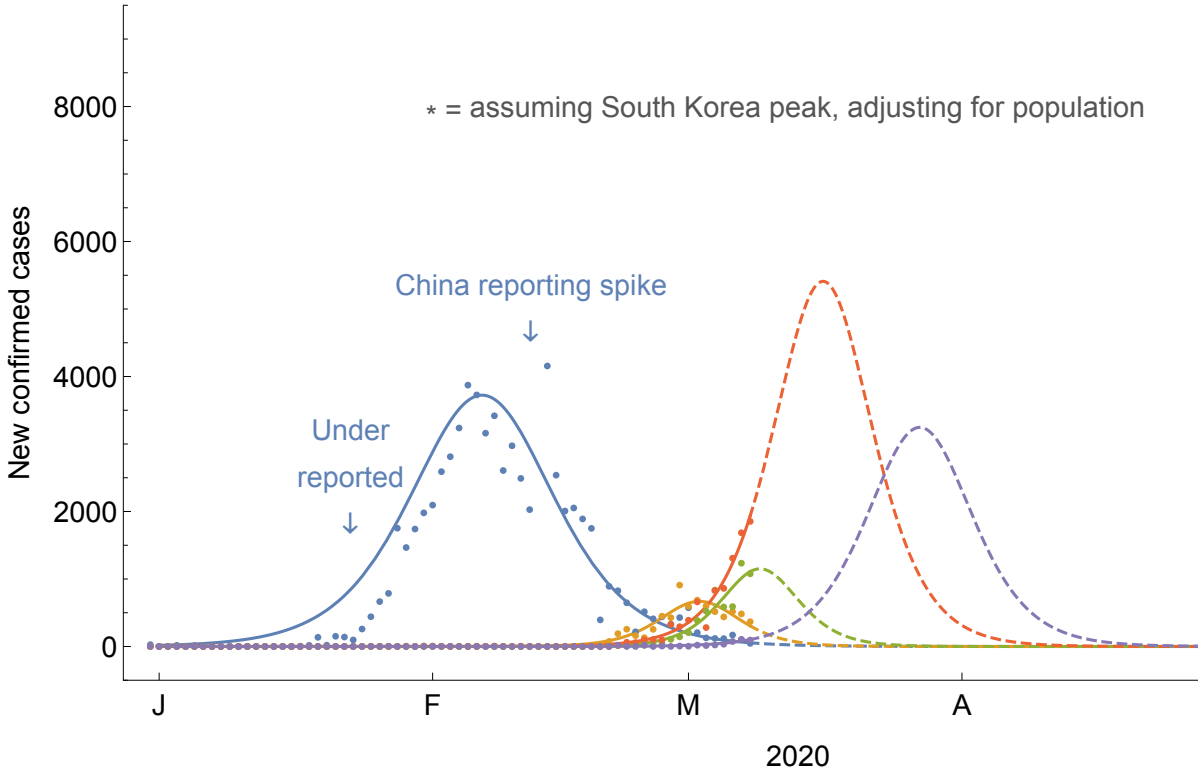


```
p0 = Show[
  Plot[Total[cums], {t, 2020, totals[[-1, 1]]},
   PlotRange → All, PlotStyle → Lighter[Black]],
  Plot[Total[cums], {t, totals[[-1, 1]], endYear}, PlotRange → All,
   PlotStyle → Directive[Dashed, Lighter[Black]]],
  ListPlot[{#[[1]], scale #[[2]]} & /@ accumulated,
   PlotStyle → Directive[PointSize[0.005], Lighter[Black]]],
  ImageSize → 11 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 15,
  Frame → {True, True, False, False},
  FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
  FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"}]
```



```
derivatives = (1 / 365.24)
  {D[funcChina, t], D[funcKorea, t], D[funcIran, t], D[funcEU, t], D[funcUSA, t]}
Show[
 Plot[derivatives, {t, 2020, totals[[-1, 1]]}, PlotRange → All,
  PlotLegends → {"China", "Korea", "Iran", "EU*", "USA*"}],
 Plot[derivatives, {t, totals[[-1, 1]], endYear},
  PlotRange → All, PlotStyle → Dashed],
 ListPlot[{totalsChina, totalsKorea, totalsIran, totalsEU, totalsUSA},
  PlotRange → Automatic, PlotStyle → PointSize[0.005]],

 ImageSize → 11 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 15,
 Frame → {True, True, False, False}, PlotRange → {0, 9000},
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
 FrameLabel → {"2020\n", "\nNew confirmed cases"},
 Epilog → {Lighter[Black],
   Text["* = assuming South Korea peak, adjusting for population",
    {2020 + 1 / 12, 8000}, {-1, 0}], ColorData[97][1],
   Text["China reporting spike\n↓", {2020.116, 5000}],
   Text["Under\nreported\n↓", {2020.06, 2500}]}]
```

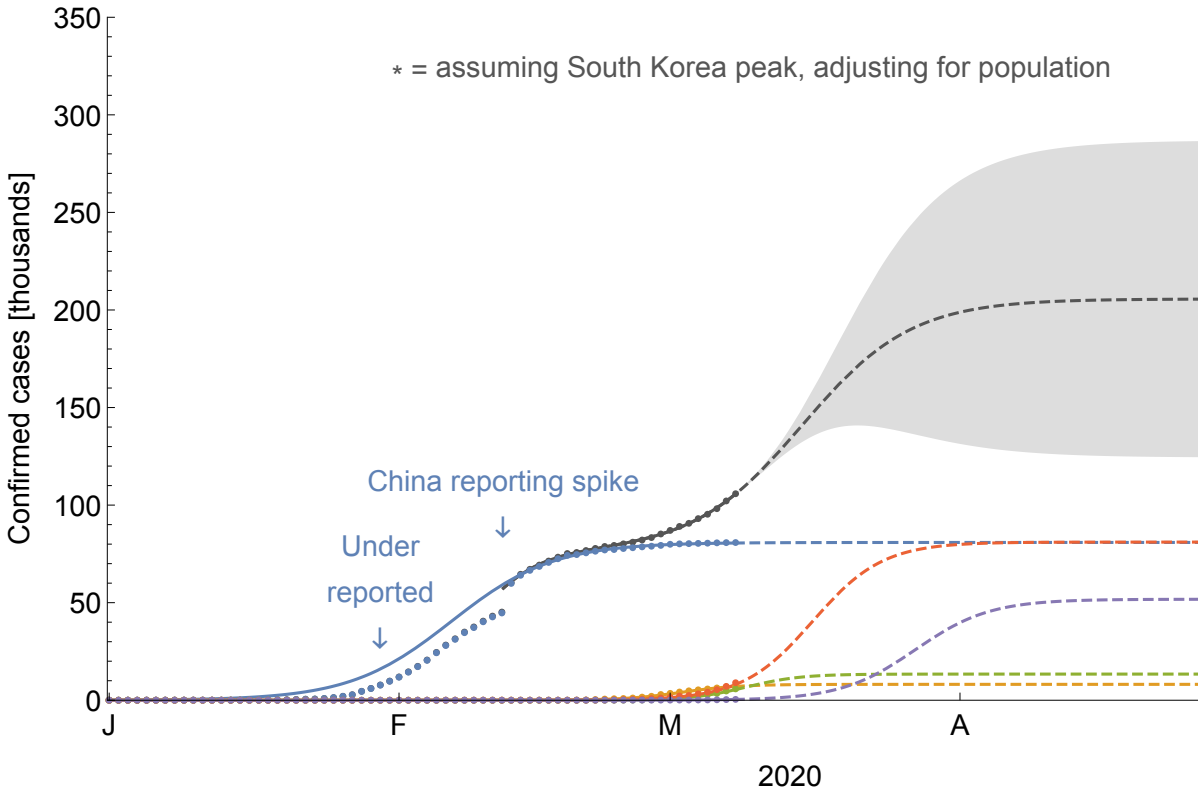
$$\left\{\frac{14\,893.6\, e^{67.2714\,(2020.1-t)}}{\left(1+e^{67.2714\,(2020.1-t)}\right)^2},\ \frac{2673.96\, e^{119.965\,(2020.17-t)}}{\left(1+e^{119.965\,(2020.17-t)}\right)^2},\right.$$
$$\left.\frac{4601.71\, e^{125.426\,(2020.19-t)}}{\left(1+e^{125.426\,(2020.19-t)}\right)^2},\ \frac{21\,640.\, e^{97.522\,(2020.21-t)}}{\left(1+e^{97.522\,(2020.21-t)}\right)^2},\ \frac{12\,985.1\, e^{91.6403\,(2020.24-t)}}{\left(1+e^{91.6403\,(2020.24-t)}\right)^2}\right\}$$




```
14893.591987011561` ℯ^(67.27136712305474` (2020.1007739265672`-t)) / (1 + ℯ^(67.27136712305474` (2020.1007739265672`-t)))^2 /. t → 2019 + 11/12 + (15/31)/12
```

```
0.937975
```

```
graphLimit = 350 000;
Show[
 Plot[scale Normal[nlm2], {t, 2020.116, endYear},
  PlotRange → {{2020, endYear}, {0, scale * graphLimit}},
  PlotStyle → Directive[Dashed, Lighter[Black]]],
 Plot[scale Normal[nlm2], {t, 2020.116, totals[[-1, 1]]},
  PlotStyle → Directive[Lighter[Black]], PlotLegends → {"World"}],
 Plot[Evaluate[scale bands90], {t, 2020.116, endYear},
  PlotRange → All, PlotStyle → None,
  FillingStyle → Directive[Opacity[0.2], Lighter[Black]], Filling → {1 → {2}}],
 ListPlot[{#[[1]], scale #[[2]]} & /@ accumulated,
  PlotStyle → Directive[PointSize[0.005], Lighter[Black]],
  PlotStyle → Directive[PointSize[0.007], ColorData[97][3]]],
 p1,
 ImageSize → 11 * 72, AspectRatio → 1 / 2,
 BaseStyle → FontSize → 15, Frame → {True, True, False, False},
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
 FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"},

 Epilog →
  {Lighter[Black], Text["* = assuming South Korea peak, adjusting for population",
    {2020 + 1 / 12, 325}, {-1, 0}], ColorData[97][1],
   Text["China reporting spike\n↓", {2020.116, 100}],
   Text["Under\nreported\n↓", {2020.08, 55}]}]
```

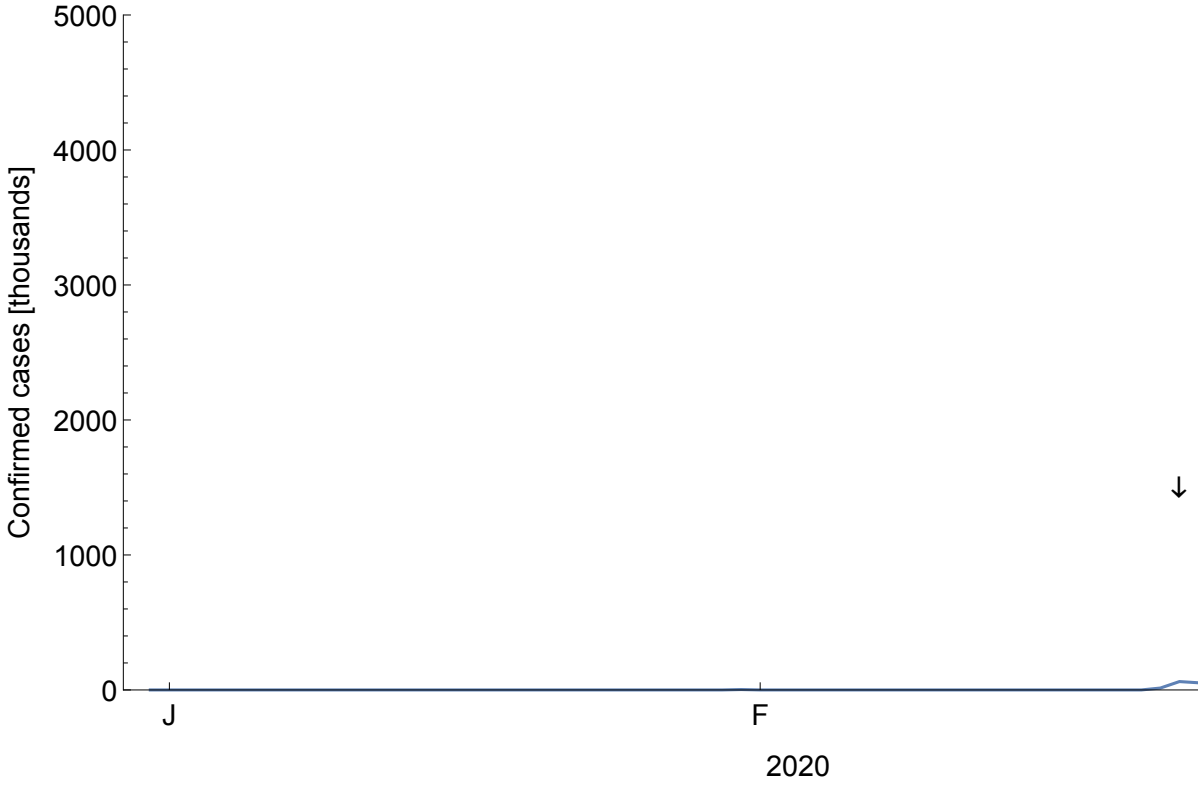


various countries

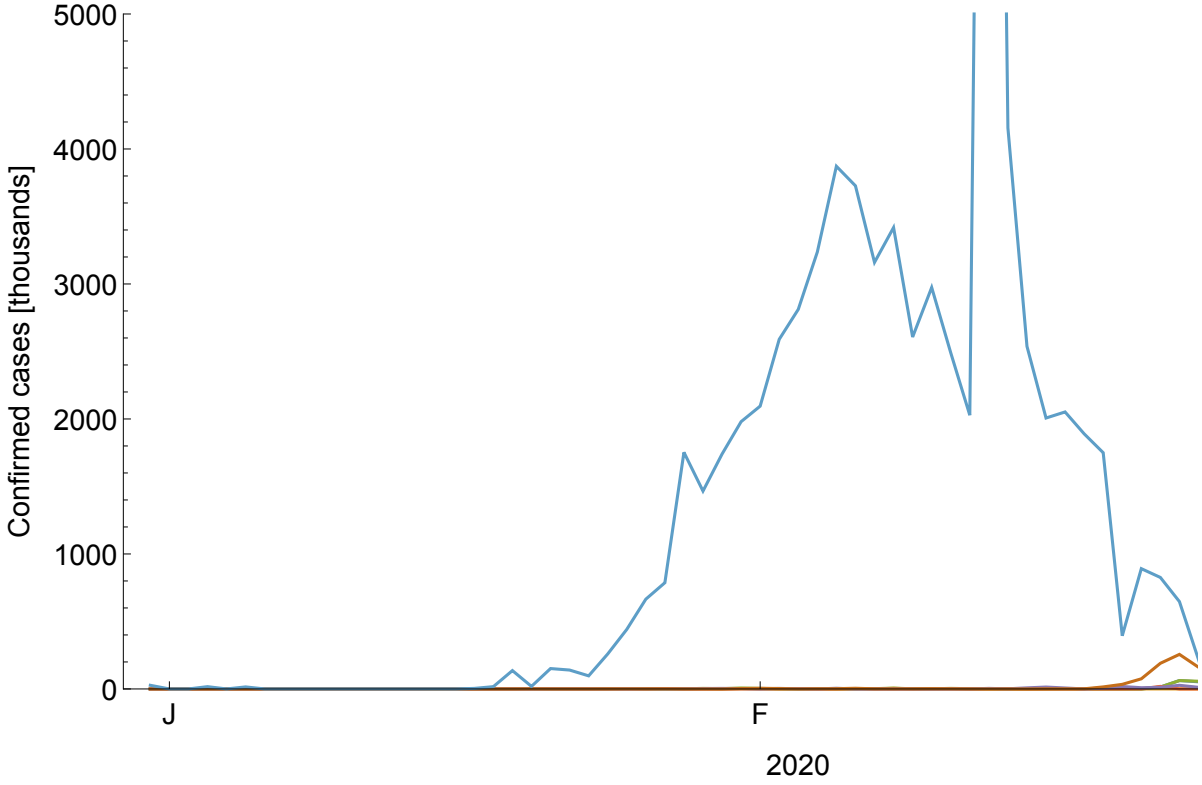
```
trip = (totalsItaly[[-1, 1]] - 14 / 365.24)
```

```
2020.15
```

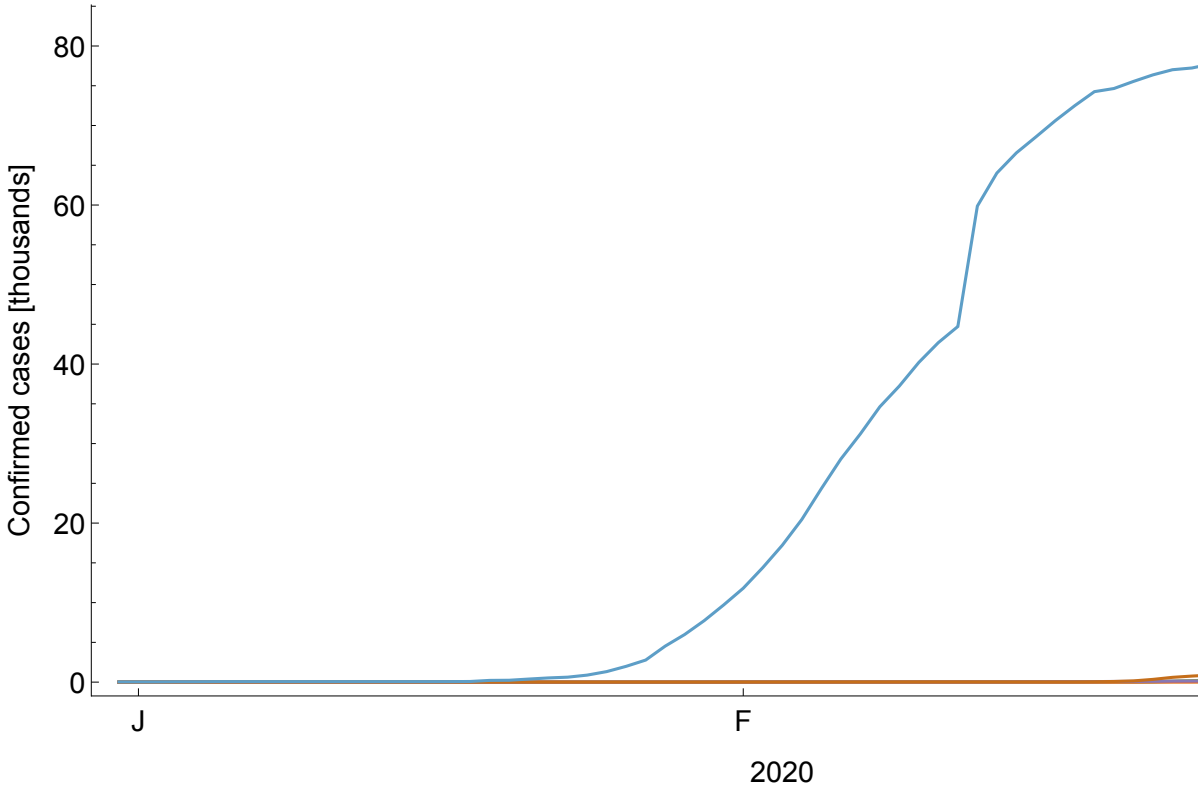
```
ListPlot[{totalsItaly}, Joined → True, PlotRange → {0, 5000}, ImageSize → 11 * 72,
 AspectRatio → 1 / 2, BaseStyle → FontSize → 15, Frame → {True, True, False, False},
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
 FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"},
 PlotLegends → {"Italy"}, Epilog → {Text["↓", {trip, 1500}]}]
```



```
ListPlot[{totalsItaly, totalsFrance, totalsEU, totalsUSA, totalsJapan, totalsKorea,
  totalsChina}, Joined → True, PlotRange → {0, 5000}, ImageSize → 11 * 72,
 AspectRatio → 1 / 2, BaseStyle → FontSize → 15, Frame → {True, True, False, False},
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
 FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"},
 PlotLegends → {"Italy", "France", "EU", "USA", "Japan", "Korea", "China"}]
```



```
ListPlot[{accumulatedItaly, accumulatedFrance, accumulatedEU,
  accumulatedUSA, accumulatedJapan, accumulatedKorea, accumulatedChina},
 Joined → True, PlotRange → All, ImageSize → 11 * 72, AspectRatio → 1 / 2,
 BaseStyle → FontSize → 15, Frame → {True, True, False, False},
 FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
 FrameLabel → {"2020\n", "\nConfirmed cases [thousands]"},
 PlotLegends → {"Italy", "France", "EU", "USA", "Japan", "Korea", "China"}]
```



math stuff

```
1 / 366.
```

```
0.00273224
```

```
mathData = {(#[[1]] - 2020 + 0.00219035) * 365.24, #[[2]]} & /@ totalsKorea
```

```
{{3.434 × 10^-6, 0.}, {1., 0.}, {2., 0.}, {3., 0.}, {4., 0.}, {5., 0.}, {6., 0.}, {7., 0.},
 {8., 0.}, {9., 0.}, {10., 0.}, {11., 0.}, {12., 0.}, {13., 0.}, {14., 0.}, {15., 0.},
 {16., 0.}, {17., 0.}, {18., 0.}, {19., 0.}, {20., 1.}, {21., 0.}, {22., 0.},
 {23., 0.}, {24., 1.}, {25., 0.}, {26., 1.}, {27., 1.}, {28., 0.}, {29., 0.},
 {30., 0.}, {31., 3.}, {32., 5.}, {33., 3.}, {34., 0.}, {35., 1.}, {36., 2.},
 {37., 5.}, {38., 1.}, {39., 0.}, {40., 1.}, {41., 2.}, {42., 1.}, {43., 0.},
 {44., 0.}, {45., 0.}, {46., 0.}, {47., 1.}, {48., 1.}, {49., 1.}, {50., 15.},
 {51., 34.}, {52., 75.}, {53., 190.}, {54., 256.}, {55., 161.}, {56., 130.},
 {57., 254.}, {58., 449.}, {59., 427.}, {60., 909.}, {61., 595.}, {62., 686.},
 {63., 600.}, {64., 516.}, {65., 438.}, {66., 518.}, {67., 483.}, {68., 367.}}
```

```
1 / (119.96536665808414`)
% * 365.24
```

```
0.00833574
```

```
3.04455
```

```
funcKorea
```

$$\frac{8141.}{1 + e^{119.965\,(2020.17-t)}}$$

```
params = {a0 → 8141.0046387760385`, b0 → 3.0, t0 → 0.17 * 365.24}
```

```
{a0 → 8141., b0 → 3., t0 → 62.0908}
```

$$\frac{a0}{1 + \text{Exp}\left[-(t - t0)/b0\right]}$$

$$\frac{a0}{1 + e^{\frac{-t+t0}{b0}}}$$

```
(Series[a0/(1 + y), {y, ∞, 1}])
Normal[%] /. y → 1/y
% /. (y → Exp[(t - t0)/b0]) // Simplify
firstOrder = % /. params
```

$$\frac{a0}{y} + O\left[\frac{1}{y}\right]^2$$

```
a0 y
```

$$a0\, e^{\frac{t-t0}{b0}}$$

$$8141.\, e^{0.333333\,(-62.0908+t)}$$

```
(Series[a0/(1 + y), {y, ∞, 2}])
Normal[%] /. y → 1/y
% /. (y → Exp[(t - t0)/b0]) // Simplify
secondOrder = % /. params
```

$$\frac{a0}{y} - \frac{a0}{y^2} + O\left[\frac{1}{y}\right]^3$$

$$a0\, y - a0\, y^2$$

$$a0\, e^{\frac{t-t0}{b0}} - a0\, e^{\frac{2\,(t-t0)}{b0}}$$

$$8141.\, e^{0.333333\,(-62.0908+t)} - 8141.\, e^{0.666667\,(-62.0908+t)}$$

```
test = a0/(1 + Exp[-(t - t0)/b0]) /. params
```

$$\frac{8141.}{1 + e^{0.333333\,(62.0908-t)}}$$

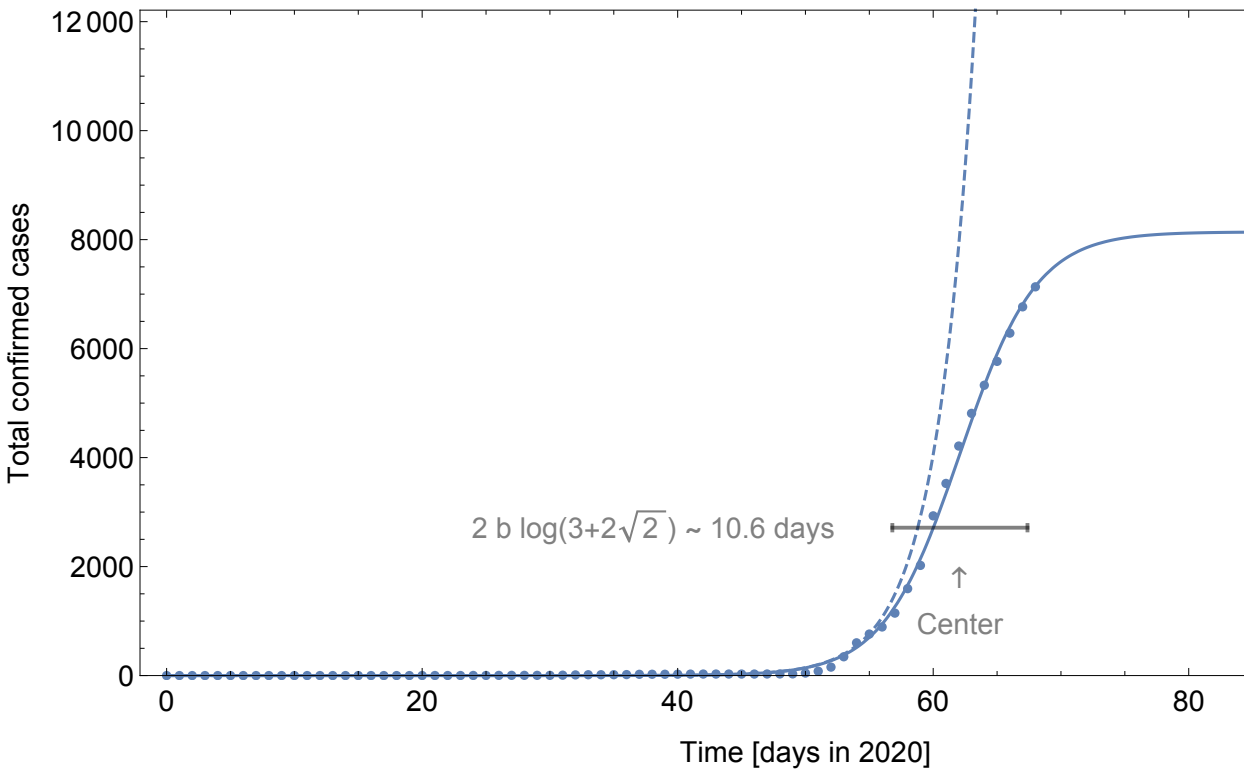
```
der = D[test, t]
```

$$\frac{2713.67\, e^{0.333333\,(62.0908-t)}}{\left(1 + e^{0.333333\,(62.0908-t)}\right)^2}$$

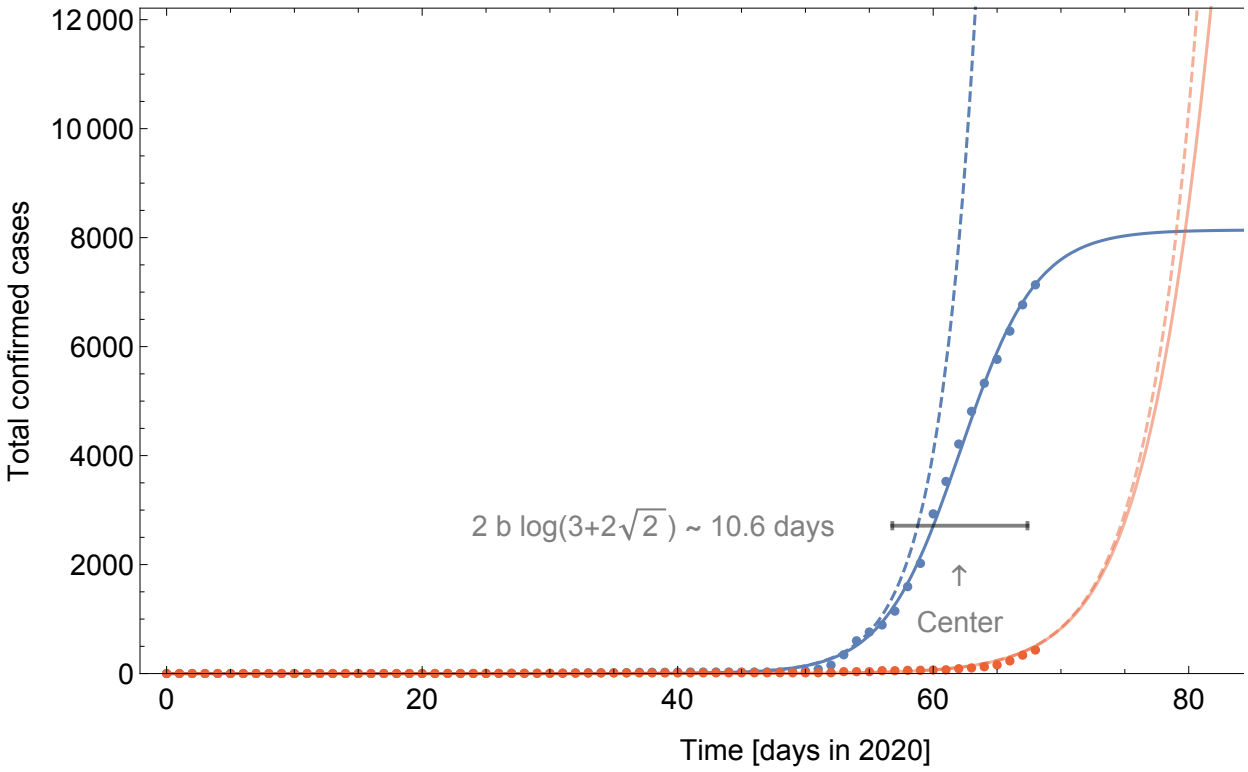
```
width = (2 Log[3 + 2 Sqrt[2]] b0 /. params)
```

10.5765

```
Show[
 Plot[{test, firstOrder}, {t, 0, 100},
  PlotRange → ({0, 1.5 a0} /. params), ImageSize → 11 * 72, AspectRatio → 1 / 2,
  BaseStyle → FontSize → 15, Frame → {True, True, True, True},
  PlotStyle → {Automatic, Directive[ColorData[97][1], Dashed]},
  FrameTicks → {{Automatic, Automatic}, {Automatic, Automatic}}, FrameLabel →
   {"Time [days in 2020]\n", "Total confirmed cases", "", ""}, Epilog → {Thick,
    Opacity[0.5],
    Text["2 b log(3+2√2) ~ " <> ToString[Round[width, 0.1]] <> " days",
     {t0 - 8 b0, a0 / (b0)} /. params],
    Text["↑\nCenter", {t0, 0.5 a0 / b0} /. params],
    Line[{{t0 - Log[3 + 2 √2] b0, a0 / b0}, {t0 + Log[3 + 2 √2] b0, a0 / b0}} /. params],
    Line[{{t0 - Log[3 + 2 √2] b0, a0 / b0 + 50},
      {t0 - Log[3 + 2 √2] b0, a0 / b0 - 50}} /. params],
    Line[{{t0 + Log[3 + 2 √2] b0, a0 / b0 + 50}, {t0 + Log[3 + 2 √2] b0, a0 / b0 - 50}} /.
     params]
   }, PlotLegends → {" a / (1 + Exp[(t - t0) / b]) (logistic)",
    "Exp[(t - t0) / b] (exponential approx)"}],
 ListPlot[{
   {(#[[1]] - 2020 + 0.00219035) * 365.24, (1 / scale) #[[2]]} & /@ accumulatedKorea
  }, PlotStyle → {PointSize[0.007], Directive[PointSize[0.007], ColorData[97][4]]},
  PlotLegends → {"Data [South Korea]"}]]
```


12 000
10 000
8000
6000
4000
2000
0
Total confirmed cases
0
20
40
60
80
Time [days in 2020]
2 b log(3+2√2) ~ 10.6 days
Center

```
Show[
 Plot[{test, firstOrder}, {t, 0, 100},
  PlotRange → ({0, 1.5 a0} /. params), ImageSize → 11 * 72, AspectRatio → 1 / 2,
  BaseStyle → FontSize → 15, Frame → {True, True, True, True},
  PlotStyle → {Automatic, Directive[ColorData[97][1], Dashed]},
  FrameTicks → {{Automatic, Automatic}, {Automatic, Automatic}}, FrameLabel →
   {"Time [days in 2020]\n", "Total confirmed cases", "", ""}, Epilog → {Thick,
    Opacity[0.5],
    Text["2 b log(3+2√2) ~ " <> ToString[Round[width, 0.1]] <> " days",
     {t0 - 8 b0, a0 / (b0)} /. params],
    Text["↑\nCenter", {t0, 0.5 a0 / b0} /. params],
    Line[{{t0 - Log[3 + 2 √2] b0, a0 / b0}, {t0 + Log[3 + 2 √2] b0, a0 / b0}} /. params],
    Line[{{t0 - Log[3 + 2 √2] b0, a0 / b0 + 50},
       {t0 - Log[3 + 2 √2] b0, a0 / b0 - 50}} /. params],
    Line[{{t0 + Log[3 + 2 √2] b0, a0 / b0 + 50}, {t0 + Log[3 + 2 √2] b0, a0 / b0 - 50}} /.
      params]
   }, PlotLegends → {"  a / (1 + Exp[(t-t0)/b])  (logistic)",
    "Exp[(t - t0)/b]  (exponential approx)"}],
 ListPlot[{
   {(#[[1]] - 2020 + 0.00219035) * 365.24, (1 / scale) #[[2]]} & /@ accumulatedKorea,
   {(#[[1]] - 2020 + 0.00219035) * 365.24, (1 / scale) #[[2]]} & /@ accumulatedUSA
  }, PlotStyle → {PointSize[0.007], Directive[PointSize[0.007], ColorData[97][4]]},
  PlotLegends → {"Data [South Korea]", "Data [USA]"}],

 Plot[{funcUSA /. t → tt / 365.24 + 2020,
   (51753.19055386672` e^-91.64028214226228` (2020.236614693027`-t)) /. t → tt / 365.24 + 2020},
  {tt, 0, 100}, PlotStyle → {Directive[ColorData[97][4], Opacity[0.5]],
    Directive[Dashed, ColorData[97][4], Opacity[0.5]]}, PlotLegends → {"USA"}]]
```



funcUSA

$$\frac{51\,753.2}{1 + e^{91.6403\,(2020.24 - t)}}$$

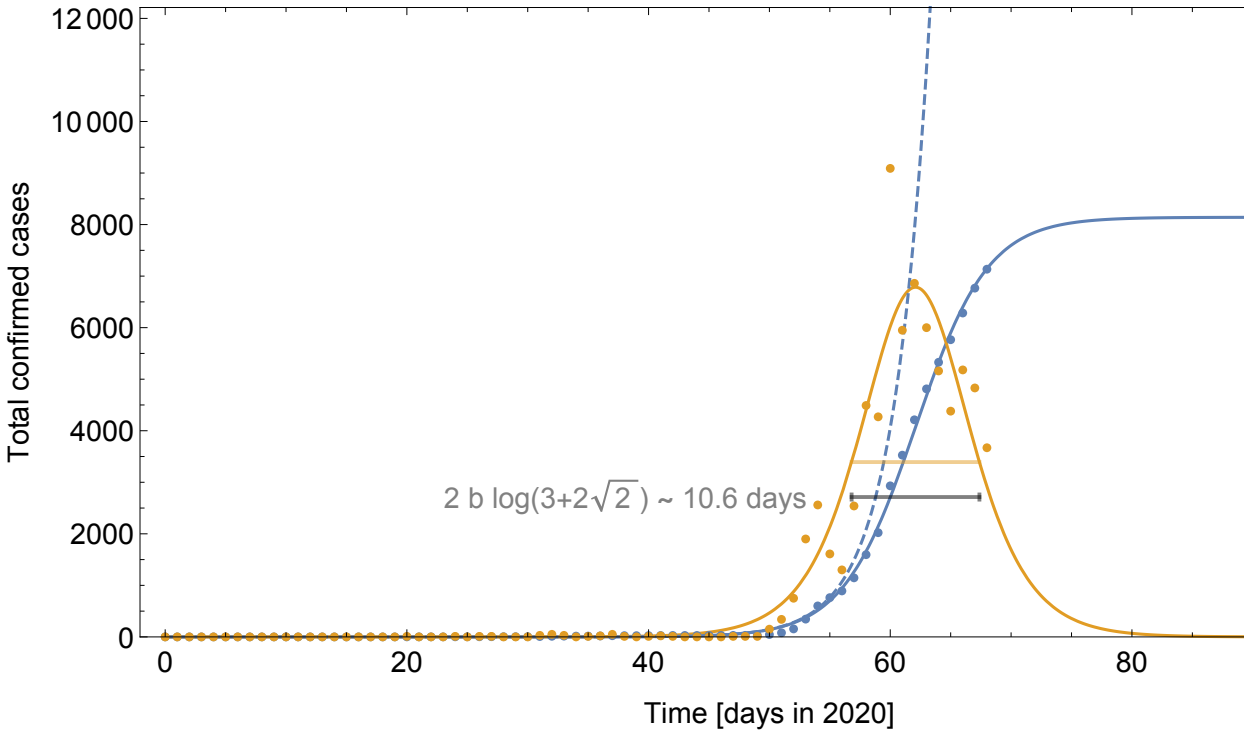
```
1 / (91.64028214226228`)
% * 365.24
% * Log[3 + 2 √2 ] * 2
```

0.0109122

3.98558

14.0512

```
Show[
 Plot[{test, 10 der, firstOrder}, {t, 0, 100},
  PlotRange → ({0, 1.5 a0} /. params), ImageSize → 11 * 72, AspectRatio → 1 / 2,
  BaseStyle → FontSize → 15, Frame → {True, True, True, True},
  PlotStyle → {Automatic, Automatic, Directive[ColorData[97][1], Dashed]},
  FrameTicks → {{Automatic, Table[{ii, ii / 10}, {ii, 0, 1.5 a0 /. params, 2000}]},
    {Automatic, Automatic}}, FrameLabel → {"Time [days in 2020]\n",
    "Total confirmed cases", "", "New confirmed cases"}, Epilog → {Thick,
    Opacity[0.5],
    Text["2 b log(3+2√2) ~ " <> ToString[Round[width, 0.1]] <> " days",
     {t0 - 8 b0, a0 / (b0)} /. params],

    Line[{{t0 - Log[3 + 2 √2] b0, a0 / b0}, {t0 + Log[3 + 2 √2] b0, a0 / b0}} /. params],
    Line[{{t0 - Log[3 + 2 √2] b0, a0 / b0 + 50},
       {t0 - Log[3 + 2 √2] b0, a0 / b0 - 50}} /. params],
    Line[{{t0 + Log[3 + 2 √2] b0, a0 / b0 + 50}, {t0 + Log[3 + 2 √2] b0, a0 / b0 - 50}} /.
      params],
    ColorData[97][2], Line[{{t0 - Log[3 + 2 √2] b0, 10 a0 / (b0 8)},
       {t0 + Log[3 + 2 √2] b0, 10 a0 / (b0 8)}} /. params]
   }, PlotLegends → {"a / (1 + Exp[(t - t0)/b])  (logistic)",
    "10× d/dt a / (1 + Exp[(t - t0)/b])  (logistic derivative)",
    "Exp[(t - t0)/b]  (exponential approx)"}],
 ListPlot[{
   {(#[[1]] - 2020 + 0.00219035) * 365.24, (1 / scale) #[[2]]} & /@ accumulatedKorea,
   {(#[[1]] - 2020 + 0.00219035) * 365.24, 10 #[[2]]} & /@ totalsKorea
  }, PlotStyle → PointSize[0.007],
  PlotLegends → {"Total cases [South Korea]", "New cases [South Korea]"}]]
```


12 000
10 000
8000
6000
4000
2000
0
Total confirmed cases
0
20
40
60
80
Time [days in 2020]
2 b log(3+2√2) ~ 10.6 days