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

https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide

---

initialize the notebook

In[1]:=
```
dateFile = "2020-10-30"
```
Out[1]= 2020-10-30

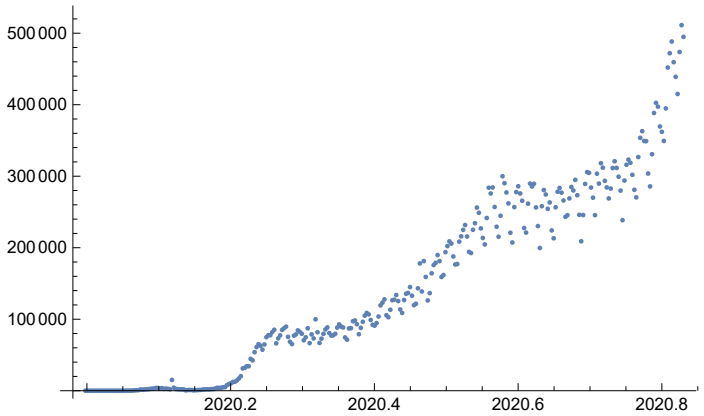
In[2]:=
```
plotEndYear = 2021.1
```
Out[2]= 2021.1

In[3]:=
```
data =
  {1900 + FromDate[{IntegerPart[#[[4]]], IntegerPart[#[[3]]], IntegerPart[#[[2]]], 0, 0,
        0}] / (365.24 * 3600 * 24), #[[5]]
    (* deaths = 6, cases = 5 *), #[[7]], #[[8]]} & /@ Drop[Import[
   "C:\\Users\\thatj\\Desktop\\ECONDATA\\COVID-19-geographic-disbtribution-worldwide-
      " <> dateFile <> ".xlsx"][[1]], 1];
```

In[4]:=
```
totals = {#[[1, 1]], Total[#[[All, 2]]]} & /@
   Split[Sort[data[[All, {1, 2}]]], #1[[1]] == #2[[1]] &];
```

In[5]:=
```
accumulated = Transpose[{totals[[All, 1]], Accumulate[totals[[All, 2]]]}];
```

In[6]:=
```
ListPlot[totals, PlotRange → All]
```
Out[6]=



In[7]:=
```
(* list of top countries *)
```

In[8]:=
```
monthList = {"J", "F", "M", "A", "M", "J", "J", "A", "S", "O", "N", "D"};
monthList = Join[monthList, monthList];
labels = Table[{1900 + FromDate[{2020, ii, 1, 0, 0, 0}] / (365.24 * 3600 * 24),
    If[Mod[ii, 12] == 1, monthList[[ii]] <> "\n" <> ToString[Round[2020 + ((ii - 1)/12)]],
     monthList[[ii]]}, {ii, 1, Length[monthList]}];
```

In[11]:=
```
data[[1]]
```

Out[11]=
```
{2020.83, 123., Afghanistan, AF}
```

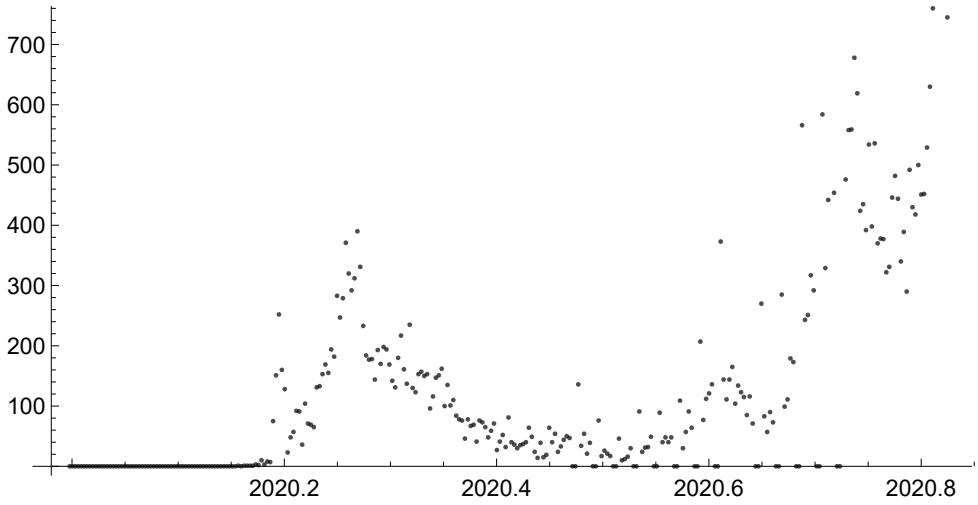
In[12]:=
```
countryData = Sort[Cases[data, x_ /; x[[-1]] == "DK"][[All, {1, 2}]]];
```

In[13]:=
```
accumulatedData = countryData;
accumulatedData[[All, 2]] = Accumulate[countryData[[All, 2]]];
```

DIEM model fit (cases)

In[15]:=
```
ListPlot[countryData, PlotStyle → Directive[PointSize[0.005], Black, Opacity[0.7]],
 ImageSize → 7 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 12]
```

Out[15]=



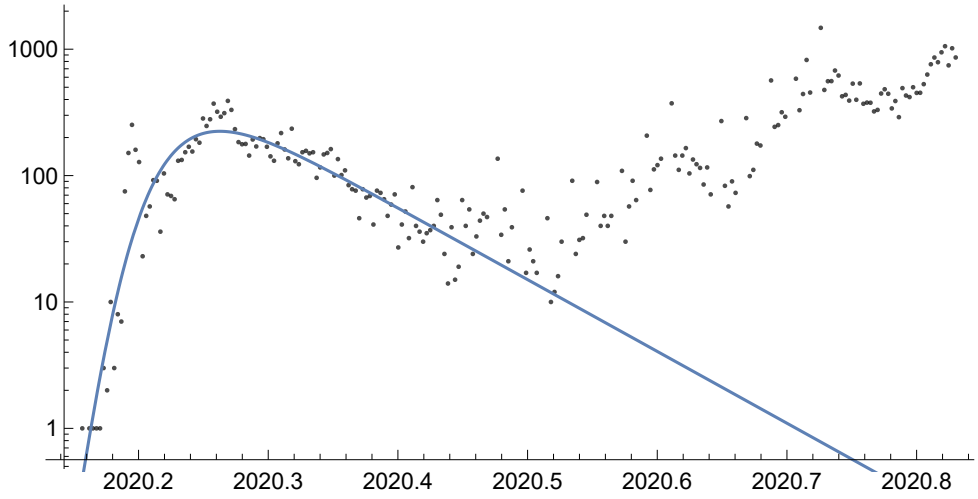
In[16]:=
```
modeFitData = {#[[1]], Log[#[[2]]]} & /@ Cases[countryData, x_ /; x[[2]] > 0];
```

In[17]:=
```
nlmInitialShock = NonlinearModelFit[
  Cases[modeFitData, x_ /; x[[1]] < 2020.4],
  a0 / (1 + Exp[(t-t0)/b0]) + α (t - 2020) + c,
  {
   {a0, 1.0}, {b0, -0.02}, {t0, 2020.25},
   {α, -16.0}, {c, 0}
  }, t]
```

Out[17]=
$$\text{FittedModel}\left[-10.2199+\frac{19.471}{1+e^{-33.2413\,(-\ll 19\gg+t)}}-13.0826\,(-2020+t)\right]$$

In[18]:=
```
Show[ListLogPlot[countryData,
  PlotStyle → Directive[PointSize[0.005], Black, Opacity[0.7]]],
 LogPlot[Exp[Normal[nlmInitialShock]], {t, 2020, plotEndYear}],
 ImageSize → 7 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 12]
```

Out[18]=



In[19]:=
```
nlmSurges = NonlinearModelFit[
  modeFitData,
  Normal[nlmInitialShock] + a1 / (1 + Exp[(t - t1) / b1]) + a2 / (1 + Exp[(t - t2) / b2]) + a3 / (1 + Exp[(t - t3) / b3]),
  {
   {a1, 2.0}, {b1, -0.02}, {t1, 2020.55},
   {a2, 2.0}, {b2, -0.02}, {t2, 2020.7},
   {a3, 2.0}, {b3, -0.02}, {t3, 2020.8}
  }, t]
```

Out[19]=
```
FittedModel[
```

$$-10.2199 + \frac{1.85502}{1 + e^{-102.135\,(-\ll 19\gg + t)}} + \frac{2.53202}{1 + e^{-\ll 17\gg\,(\ll 1\gg)}} + \frac{4.21141}{1 + e^{\ll 1\gg}} + \frac{19.471}{1 + e^{-33.2413\,(\ll 1\gg)}} - 13.0826\,(-2020 + t)$$

```
]
```

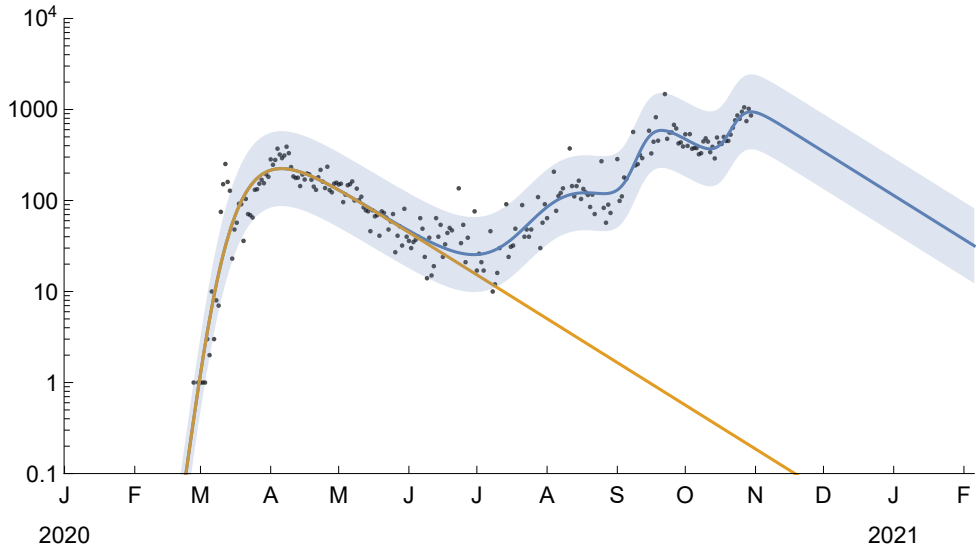
In[20]:=
```
σModel = (#[[2]] - Normal[nlmSurges] /. t → #[[1]]) & /@ modeFitData // StandardDeviation
```

Out[20]=
```
0.474413
```

In[21]:=
```
bands2σ = Exp[Normal[nlmSurges] + 2 {σModel, -σModel}];
```

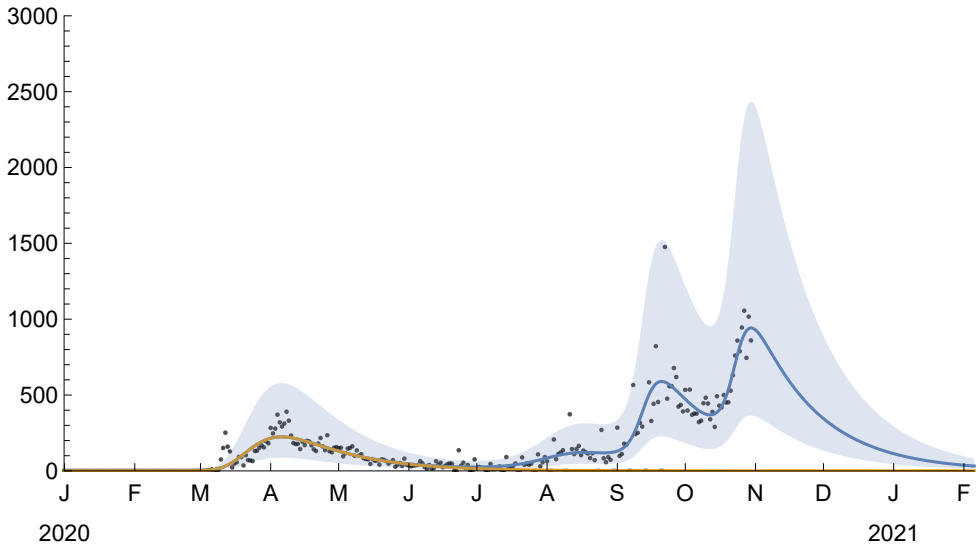
In[22]:=
```
Show[
 ListLogPlot[countryData, PlotRange → {{2020, plotEndYear}, {0.1, 10000}},
  PlotStyle → Directive[PointSize[0.005], Black, Opacity[0.7]],
  Frame → {True, True, False, False},
  FrameTicks → {{Automatic, Automatic}, {labels, Automatic}}], LogPlot[
  {Exp[Normal[nlmSurges]], Exp[Normal[nlmInitialShock]]}, {t, 2020, plotEndYear}],
 LogPlot[bands2σ, {t, 2020, plotEndYear}, PlotStyle → None, Filling → {1 → {2}}],
 ImageSize → 7 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 12]
```

Out[22]=



In[23]:=
```
Show[
 ListPlot[countryData, PlotRange → {{2020, plotEndYear}, {0, 3000}},
  PlotStyle → Directive[PointSize[0.005], Black, Opacity[0.7]],
  Frame → {True, True, False, False},
  FrameTicks → {{Automatic, Automatic}, {labels, Automatic}}],
 Plot[{Exp[Normal[nlmSurges]], Exp[Normal[nlmInitialShock]]},
  {t, 2020, plotEndYear}, PlotRange → All],
 Plot[bands2σ, {t, 2020, plotEndYear}, PlotStyle → None, Filling → {1 → {2}},
  PlotRange → All], ImageSize → 7 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 12]
```

Out[23]=



In[24]:=
```
nObservations = Length[modeFitData]
```

Out[24]= 220

In[25]:=
```
accumulatednlmDIEM =
  Table[{tt - 1 / 365.24, (365.24) NIntegrate[Exp[Normal[nlmSurges]], {t, 2020.0, tt}]},
   {tt, 2020, plotEndYear, 0.01}];
accumulatednlmDIEMband1 = Table[{tt - 1 / 365.24,
    (365.24) NIntegrate[Exp[Normal[nlmSurges] + 2 σModel / √nObservations], {t, 2020.0, tt}]},
   {tt, 2020, plotEndYear, 0.01}];
accumulatednlmDIEMband2 = Table[{tt - 1 / 365.24,
    (365.24) NIntegrate[Exp[Normal[nlmSurges] - 2 σModel / √nObservations], {t, 2020.0, tt}]},
   {tt, 2020, plotEndYear, 0.01}];
```

In[28]:=
```
Show[ListPlot[accumulatedData, PlotRange → {{2020, plotEndYear}, {0.1, 100 000}},
  PlotStyle → Directive[PointSize[0.003], Black, Opacity[0.7]],
  Frame → {True, True, False, False},
  FrameTicks → {{Automatic, Automatic}, {labels, Automatic}},
  ImageSize → 7 * 72, AspectRatio → 1 / 2, BaseStyle → FontSize → 12],
 ListPlot[{#[[1]], #[[2]]} & /@ accumulatednlmDIEM, Joined → True, PlotStyle → Dashed],
 ListPlot[{{#[[1]], #[[2]]} & /@ accumulatednlmDIEMband1,
   {#[[1]], #[[2]]} & /@ accumulatednlmDIEMband2},
  Joined → True, PlotStyle → None, Filling → {1 → {2}}]]
```

Out[28]=