

Project_1_Notebook

February 7, 2022

Import the needed modules

```
[1]: from importlib.metadata import requires
import numpy as np
import torch
from torch import nn
from torch import optim
import pandas
import os
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore", category=UserWarning)

torch.autograd.set_detect_anomaly(True)
```

```
[1]: <torch.autograd.anomaly_mode.set_detect_anomaly at 0x1ac28c59190>
```

Create the sigmoid data structure with a built in forward, update, and loss function

```
[2]: class model_sigmoid(nn.Module):
    # Initialize the model
    def __init__(self, c1=10.5, c2=3, c3=1.0, c4=1.0, c5=1.0, c6=-22.0, c7=1.0, ↴
     ↴c8=1.0):
        super(model_sigmoid, self).__init__()

        # Alpha (learning rate) hyperparameter of the model
        self.alpha_start = 0.001
        self.alpha = self.alpha_start

        # Parameters of the model
        self.c1 = torch.tensor(c1, dtype=torch.float64, requires_grad=True)
        self.c2 = torch.tensor(c2, dtype=torch.float64, requires_grad=True)
        self.c3 = torch.tensor(c3, dtype=torch.float64, requires_grad=True)
        self.c4 = torch.tensor(c4, dtype=torch.float64, requires_grad=True)
        self.c5 = torch.tensor(c5, dtype=torch.float64, requires_grad=True)
        self.c6 = torch.tensor(c6, dtype=torch.float64, requires_grad=True)
        self.c7 = torch.tensor(c7, dtype=torch.float64, requires_grad=True)
        self.c8 = torch.tensor(c8, dtype=torch.float64, requires_grad=True)
```

```

# Get a prediction from the model
# Inputs:
#   x - The inputs into the model
def forward(self, x):
    return (self.c1)/torch.pow((self.c2+self.c3*torch.exp(-self.c4*(self.
→c5*x + self.c6))), self.c7)+self.c8

# Update the model parameters
# Inputs:
#   loss - The loss from the model
#   numIter - Number of time to update the model
#   currIter - The current update iteration
def update(self, loss, numIter, currIter):
    # Compute the gradients
    loss.backward()

    # Update the model parameters
    self.c1 = torch.tensor(self.c1 - self.alpha*self.c1.grad, u
→requires_grad=True)
    self.c2 = torch.tensor(self.c2 - self.alpha*self.c2.grad, u
→requires_grad=True)
    self.c3 = torch.tensor(self.c3 - self.alpha*self.c3.grad, u
→requires_grad=True)
    self.c4 = torch.tensor(self.c4 - self.alpha*self.c4.grad, u
→requires_grad=True)
    self.c5 = torch.tensor(self.c5 - self.alpha*self.c5.grad, u
→requires_grad=True)
    self.c6 = torch.tensor(self.c6 - self.alpha*self.c6.grad, u
→requires_grad=True)
    self.c7 = torch.tensor(self.c7 - self.alpha*self.c7.grad, u
→requires_grad=True)
    self.c8 = torch.tensor(self.c8 - self.alpha*self.c8.grad, u
→requires_grad=True)

    # Decrease the learning rate
    self.alpha = self.alpha_start*(1-(currIter/numIter))

# The loss function used to evaluate the model. This loss
# function is a modified form of the MSE loss where
#  $2*(1-self.c2)**2$  is added to the loss value. This term
# convinced the function to not have a massive range and to
# keep the c2 term around 1.
# Inputs:
#   preds - The predictions from the model
#   labels - The true values we want the model to predict

```

```

def getLoss(self, preds, labels):
    return torch.sum((labels-preds)**2)/(preds.shape[0])+2*(1-self.c2)**2

# Get the parameters from the model
def getParams(self):
    return self.c1, self.c2, self.c3, self.c4, self.c5, self.c6, self.c7, self.c8

```

Now let's train the sigmoid model

To start, we need to load in the data as well as specify a few variables which we will use later

```
[3]: # The number of times to train the model
updates = 50000

# True if the graph should be shown while training. False otherwise
showGraph = True

# Load in the data
data = pandas.read_csv(os.path.join("data", "data2.csv"))
```

Now let's split the data to get all years after 1300 for both the train years and population

```
[4]: # Get the World data from the dataset
years = torch.tensor(data["year"].values[11300:]).astype(np.float64), requires_grad=False)
values = torch.tensor(data["World Population"].values[11300:]).astype(np.float64), requires_grad=False)
```

So the model can learn better, we will make both the values and years have a smaller range by dividing the populations by 1 billion and the years by 100

```
[6]: # Divide the values by 1 billion to help the model learn
values = values/10000000000

# Divide the years by 100 to help the model learn
years = years/100
```

Now initialize a sigmoid model

```
[9]: # Initialize the model
m = model_sigmoid()
```

Now we need to start training the model, we will do so for `updates` times and will show a graph every 50 updates if `showGraph` is True

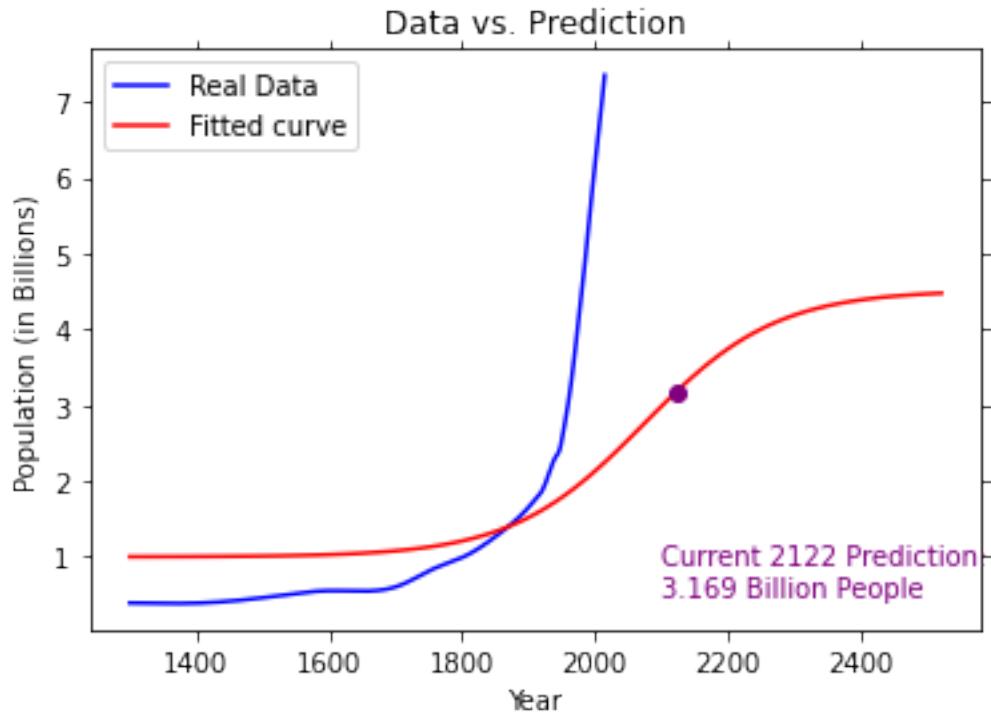
```
[11]: # Iterate "updates" number of times and update the model
for i in range(0, updates):
    # Get some predictions from the model
    preds = m(years)

    # Calculate the loss
    loss = m.getLoss(preds, values)

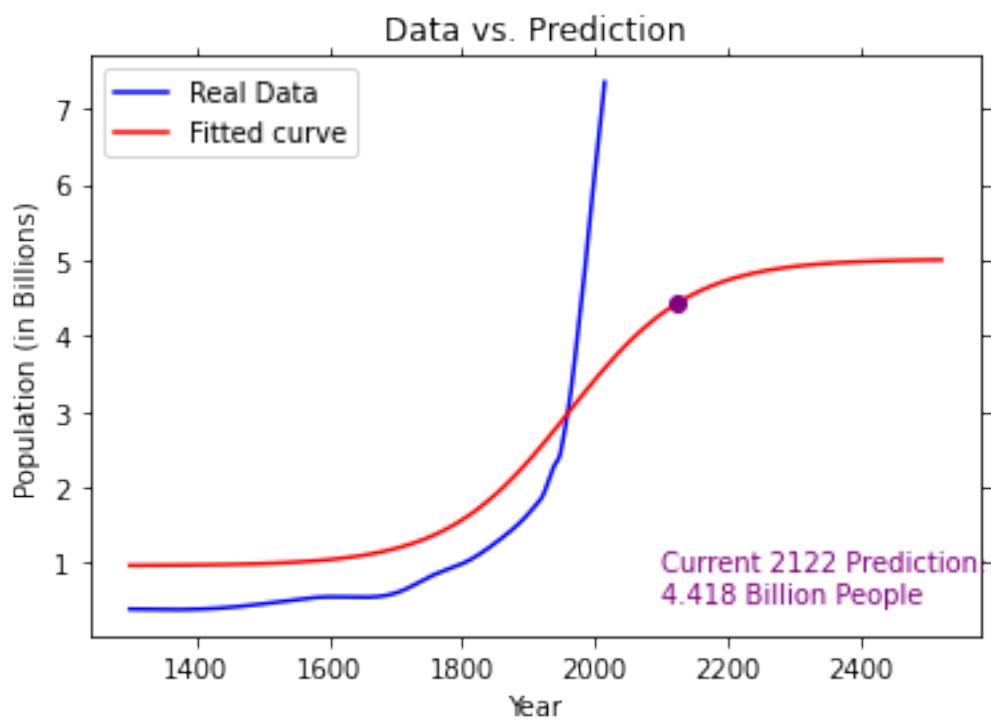
    # Update the model
    m.update(loss, updates, i)

# Plot the graph with some data and show the loss every so often
if i % 50 == 0:
    print(f"Iteration #{i}, Loss: {loss}")
    if showGraph == True:
        testX = torch.from_numpy(np.linspace(13, 25.22, 100))
        testY = m(testX).detach()
        plt.cla()
        plt.plot(years*100, values, c="blue", label="Real Data")
        plt.plot(testX*100, testY, c="red", label="Fitted curve")
        plt.plot(21.22*100, m(21.22).detach(), 'o', c="purple")
        plt.text(21.00*100, 0.5, f"Current 2122 Prediction: \n{m(21.22).
→detach().numpy().round(3)} Billion People", c="purple")
        plt.xlabel("Year")
        plt.ylabel("Population (in Billions)")
        plt.title("Data vs. Prediction")
        plt.legend(loc="upper left")
        plt.pause(0.0001)
        #plt.savefig(f'gif/img{i/50}.png')
```

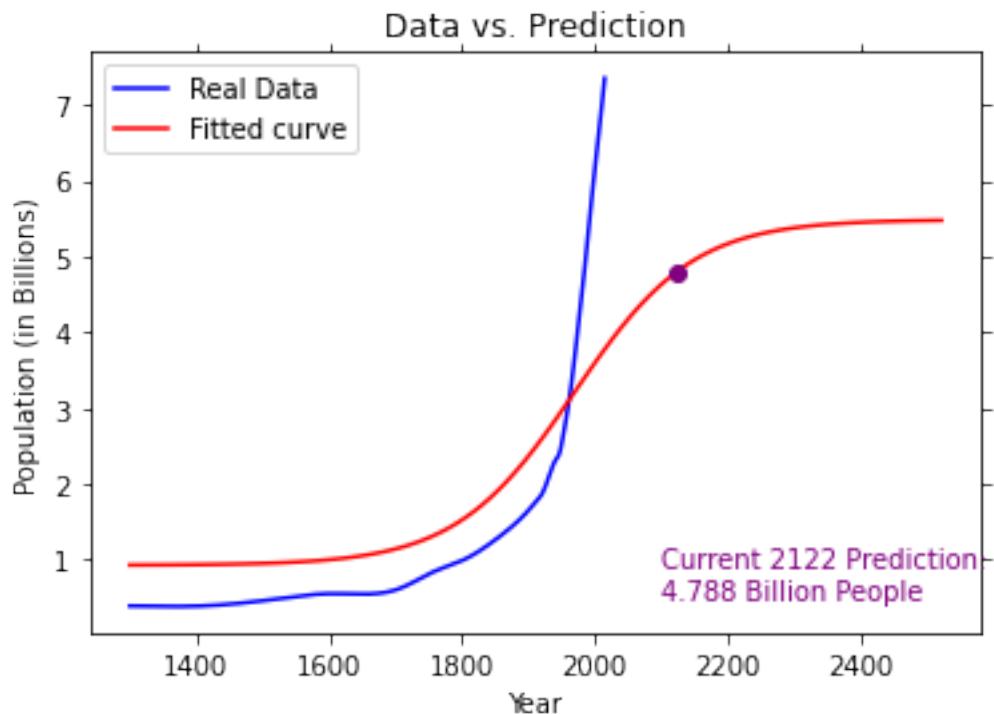
Iteration #0, Loss: 9.117896845091432



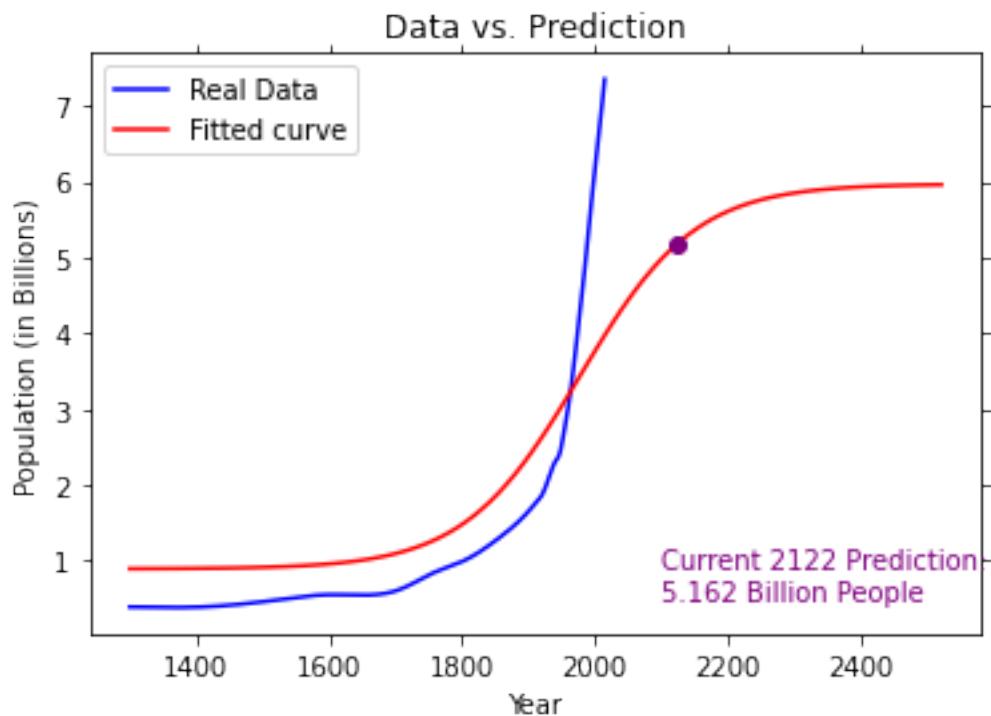
Iteration #50, Loss: 5.9849995471794815



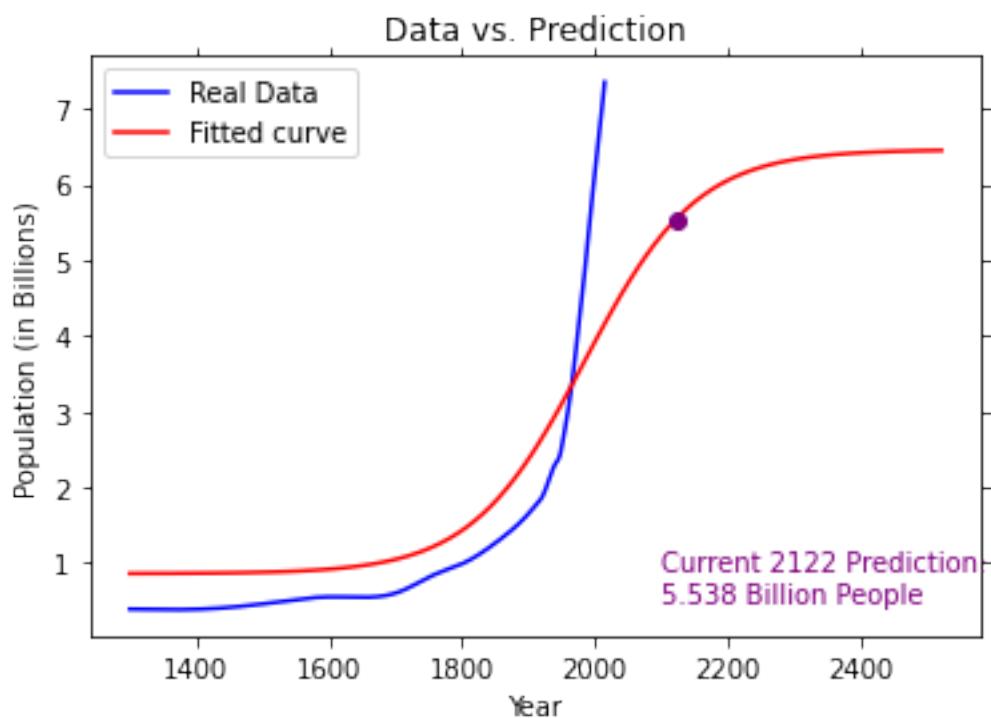
Iteration #100, Loss: 4.121899676202034



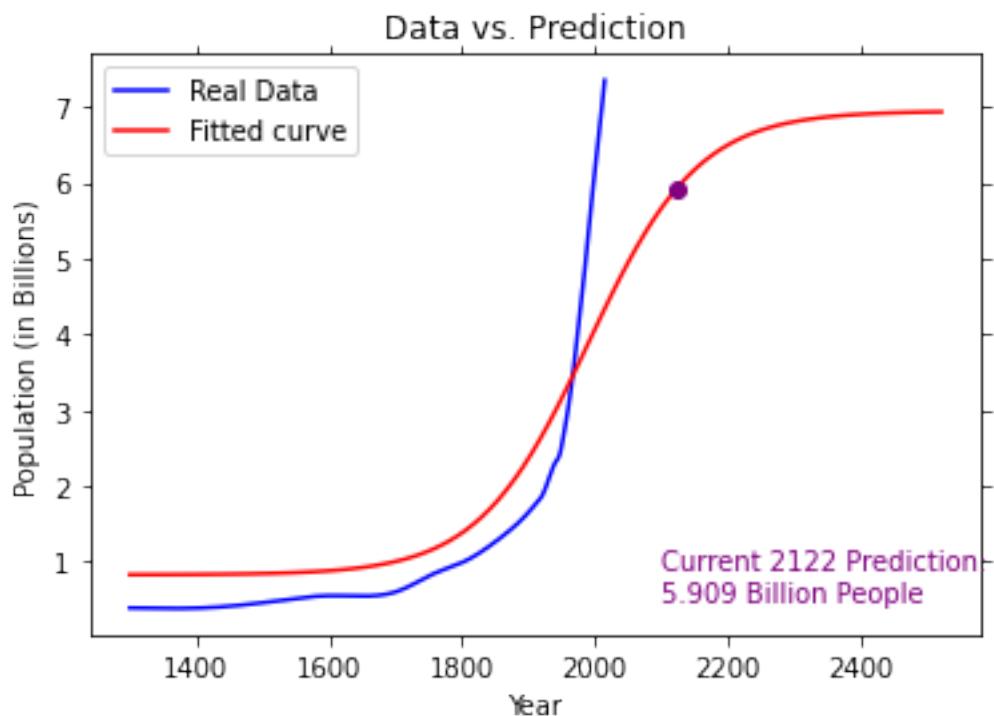
Iteration #150, Loss: 2.8602438508578096



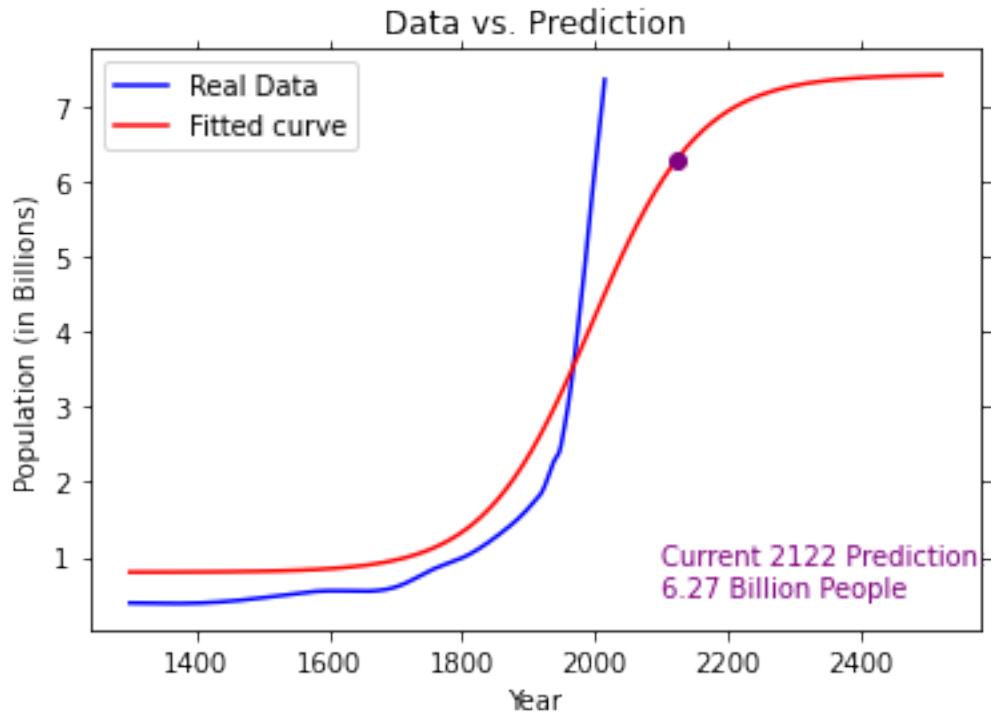
Iteration #200, Loss: 2.003356744528839



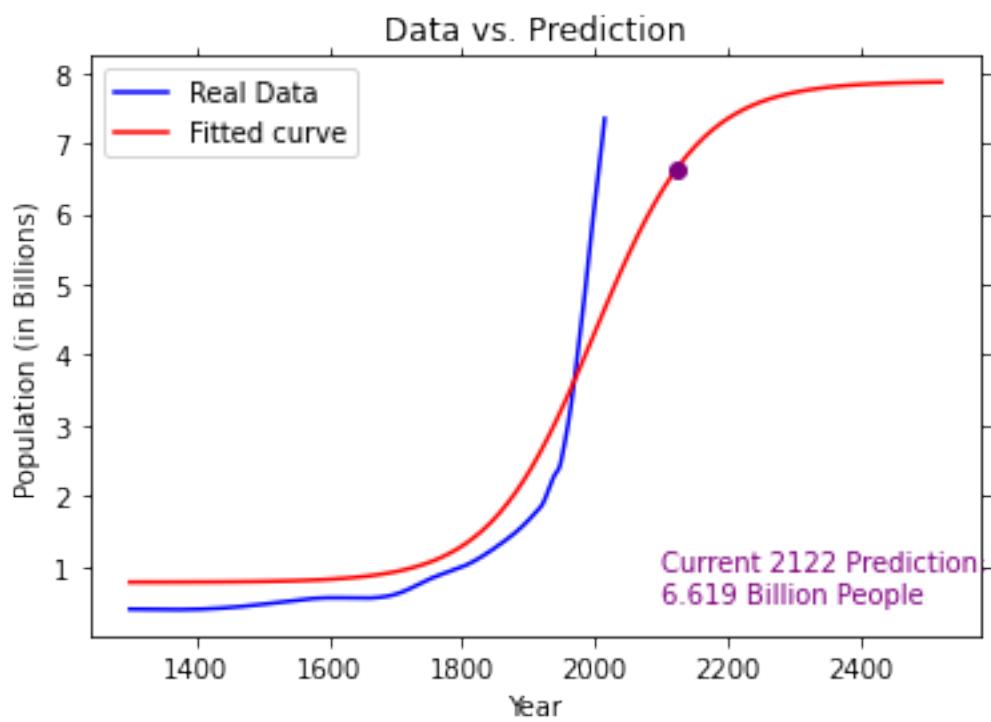
Iteration #250, Loss: 1.4194241903884632



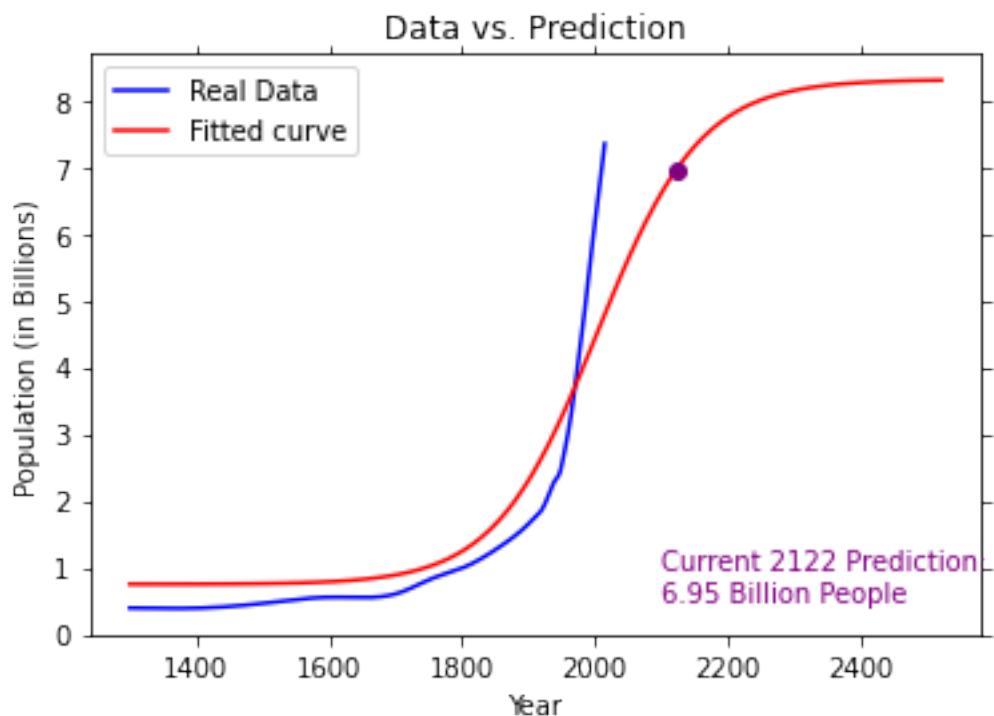
Iteration #300, Loss: 1.0199716807044021



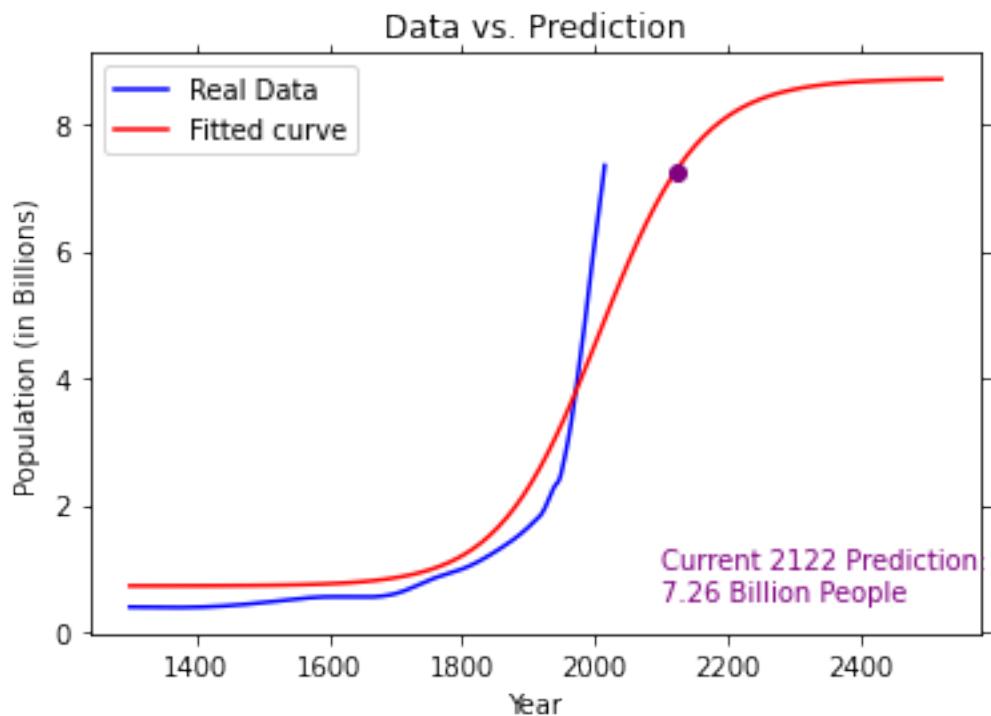
Iteration #350, Loss: 0.7455119651979131



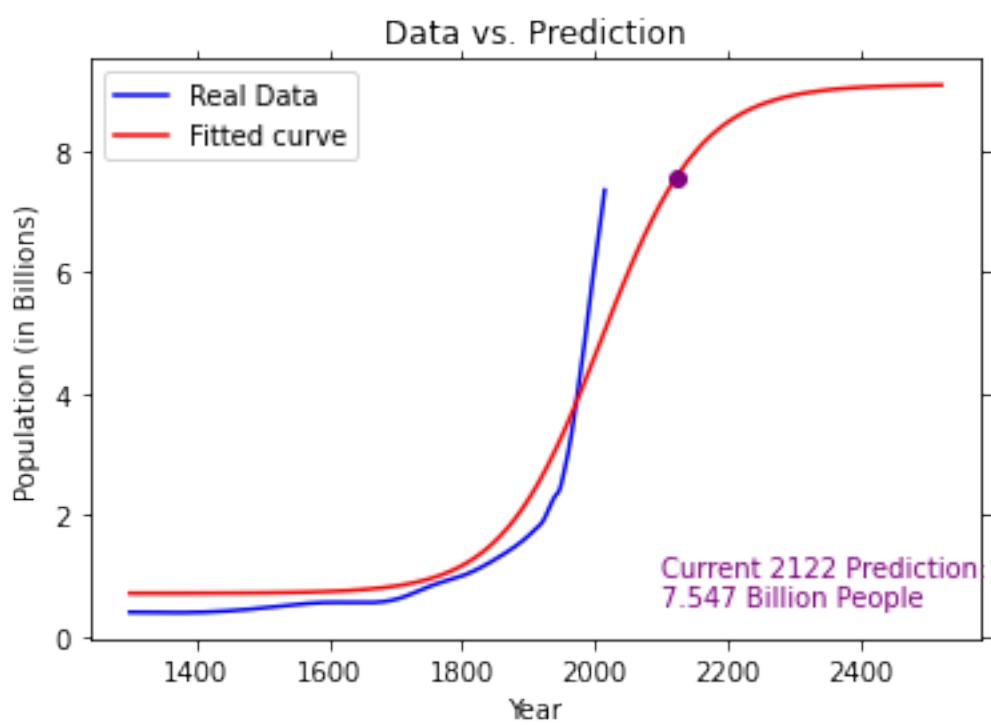
Iteration #400, Loss: 0.5559707393070373



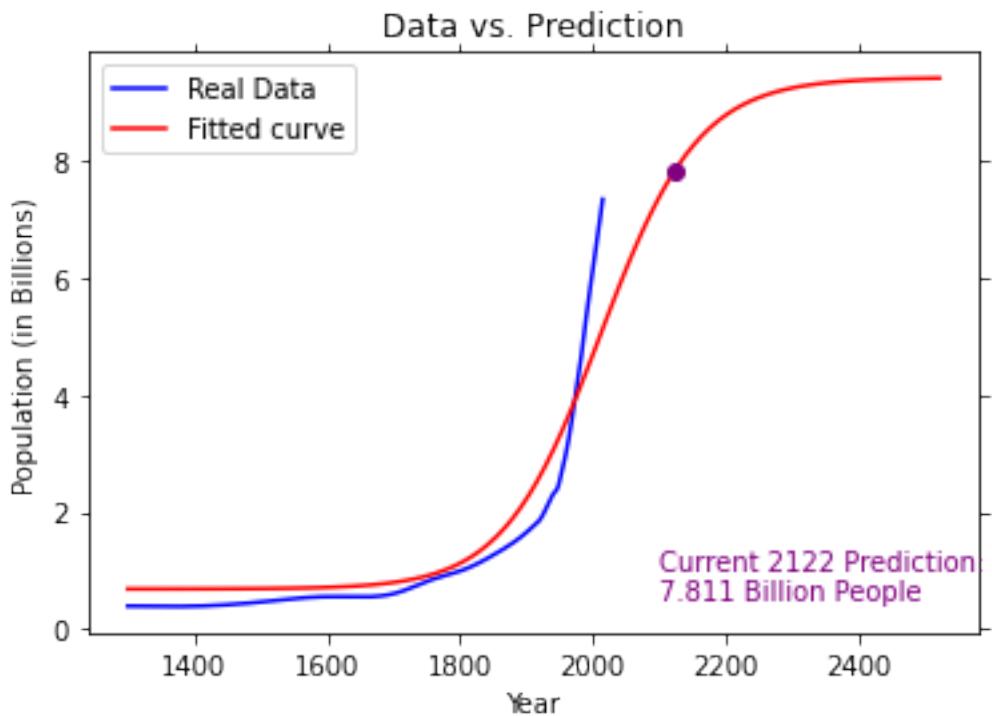
Iteration #450, Loss: 0.42429534298997507



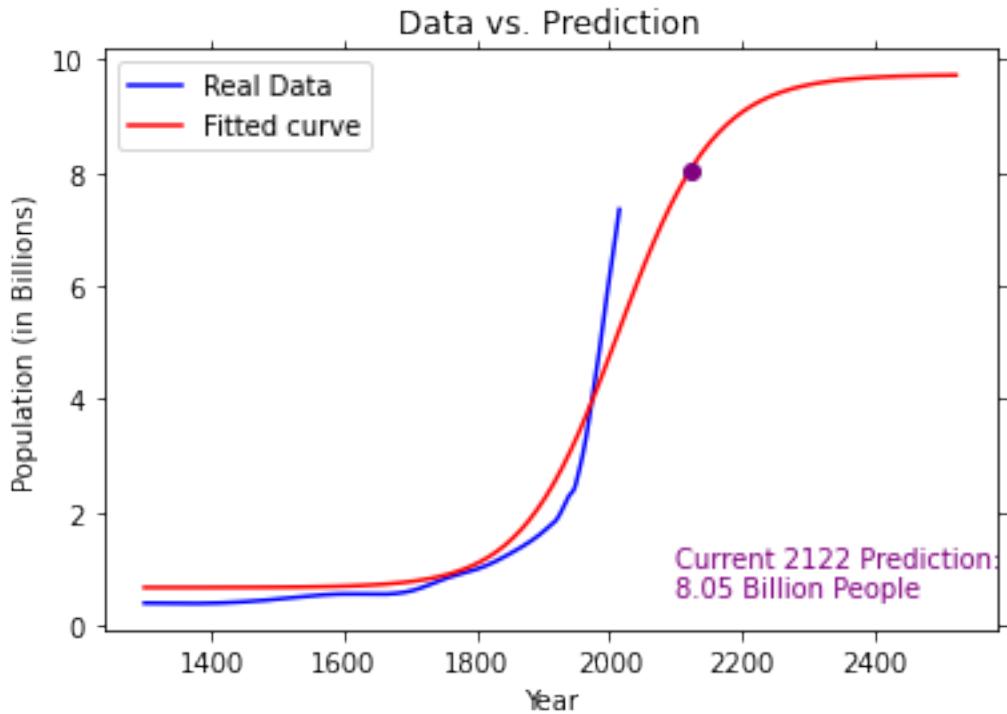
Iteration #500, Loss: 0.3321834356937127



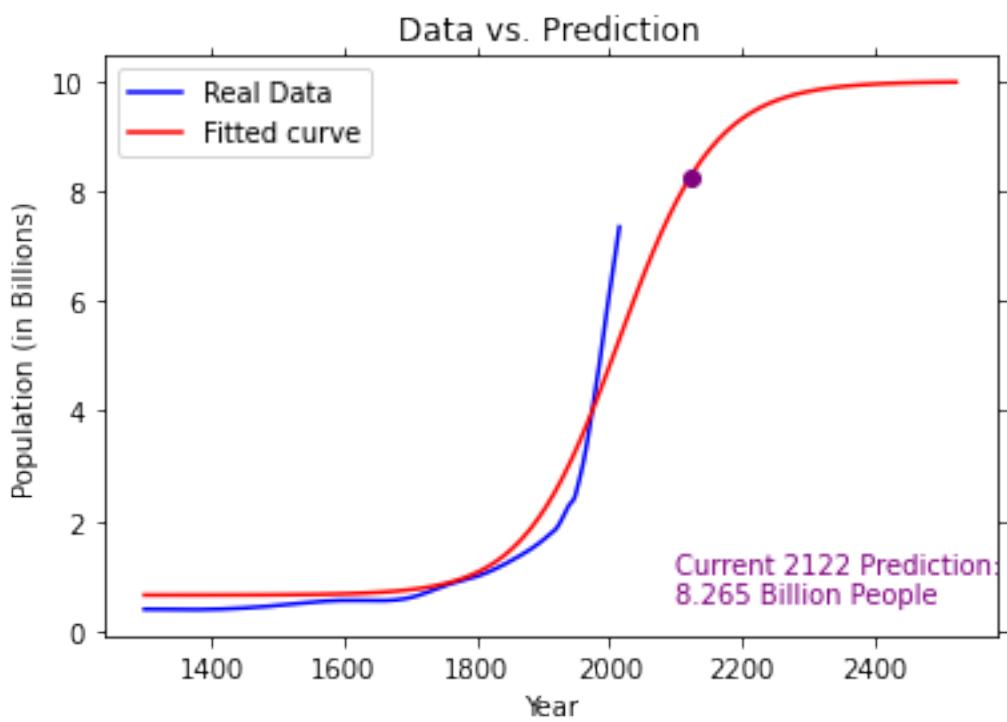
Iteration #550, Loss: 0.267224083557084



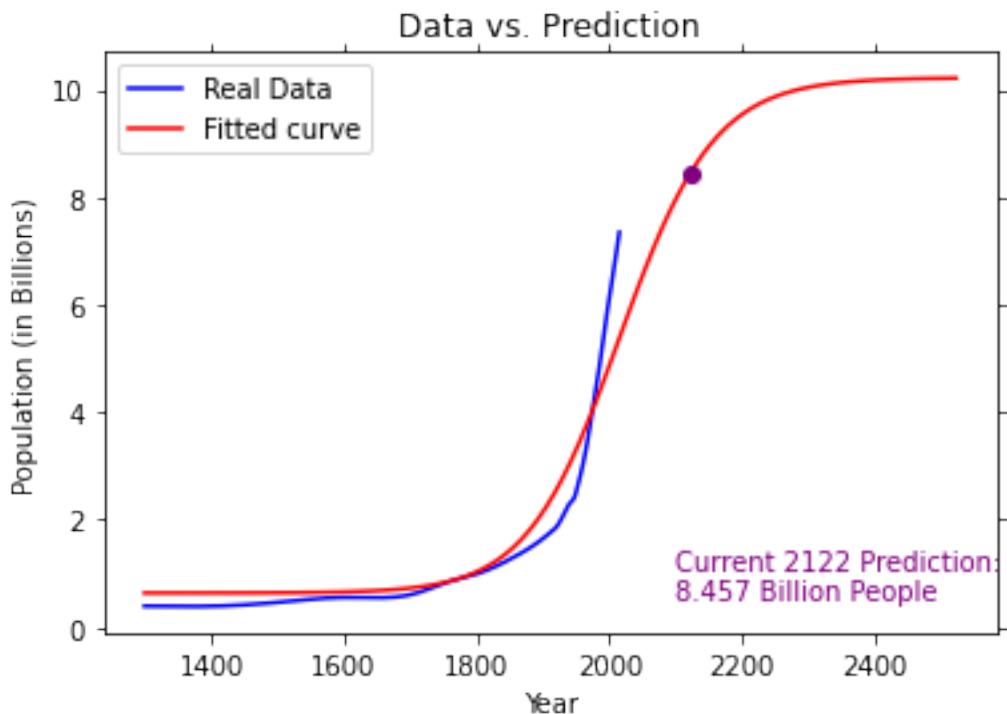
Iteration #600, Loss: 0.22098074187684114



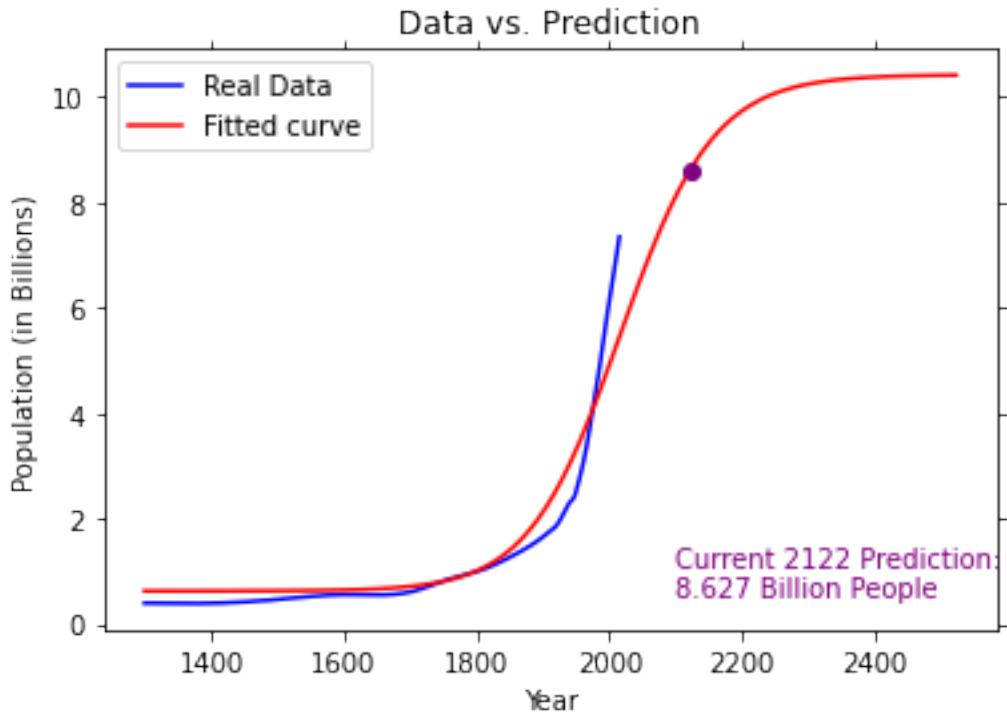
Iteration #650, Loss: 0.1877033110780304



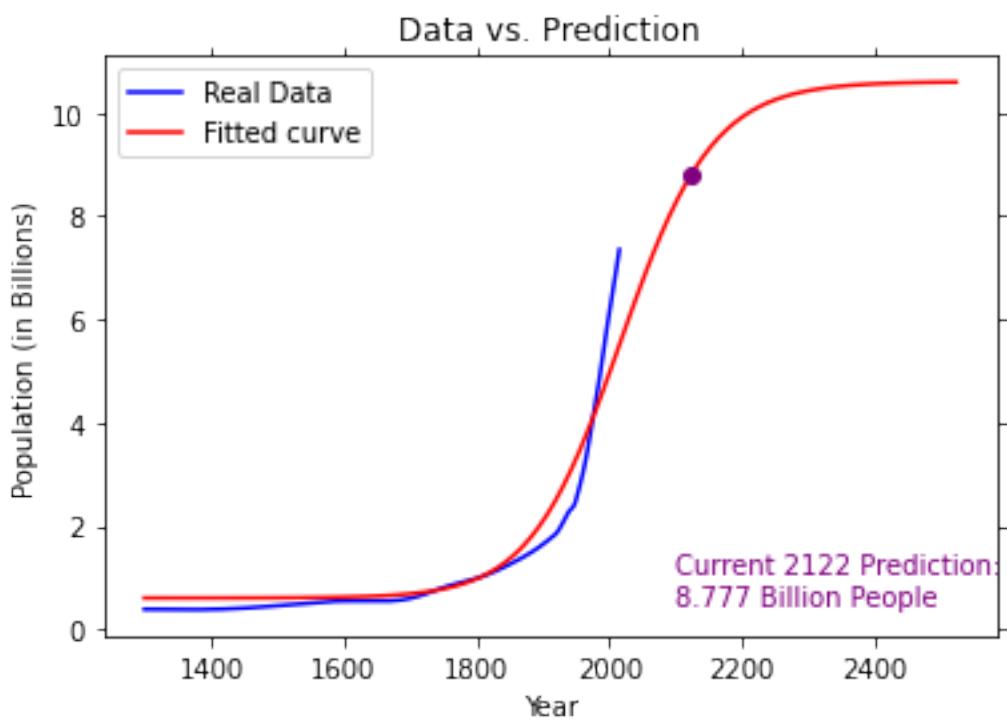
Iteration #700, Loss: 0.16346114210012674



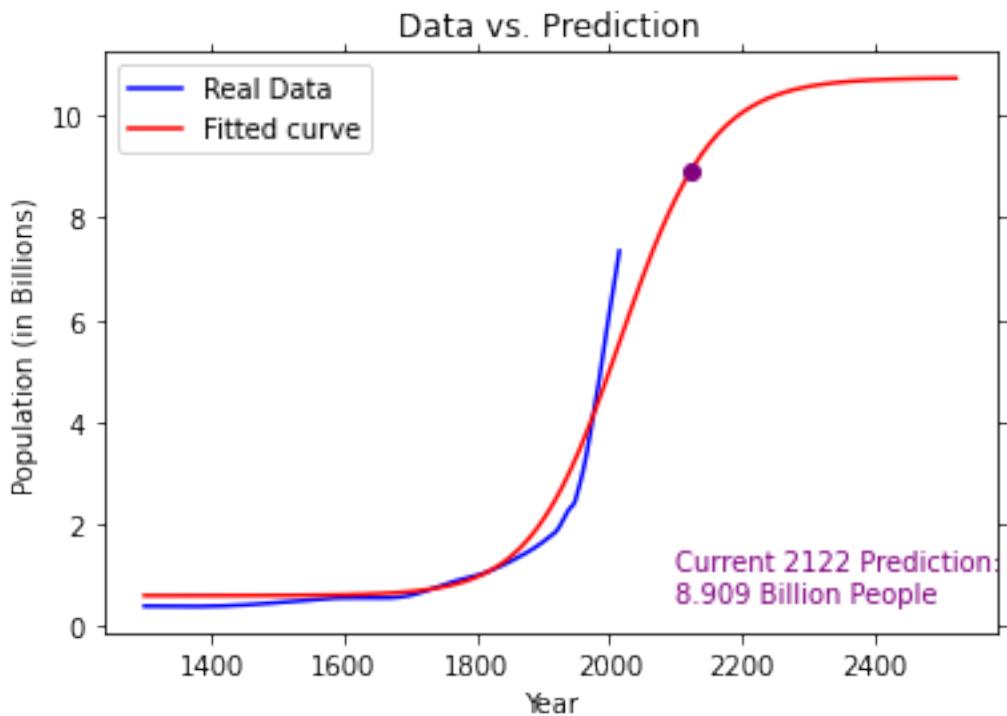
Iteration #750, Loss: 0.14555831387833532



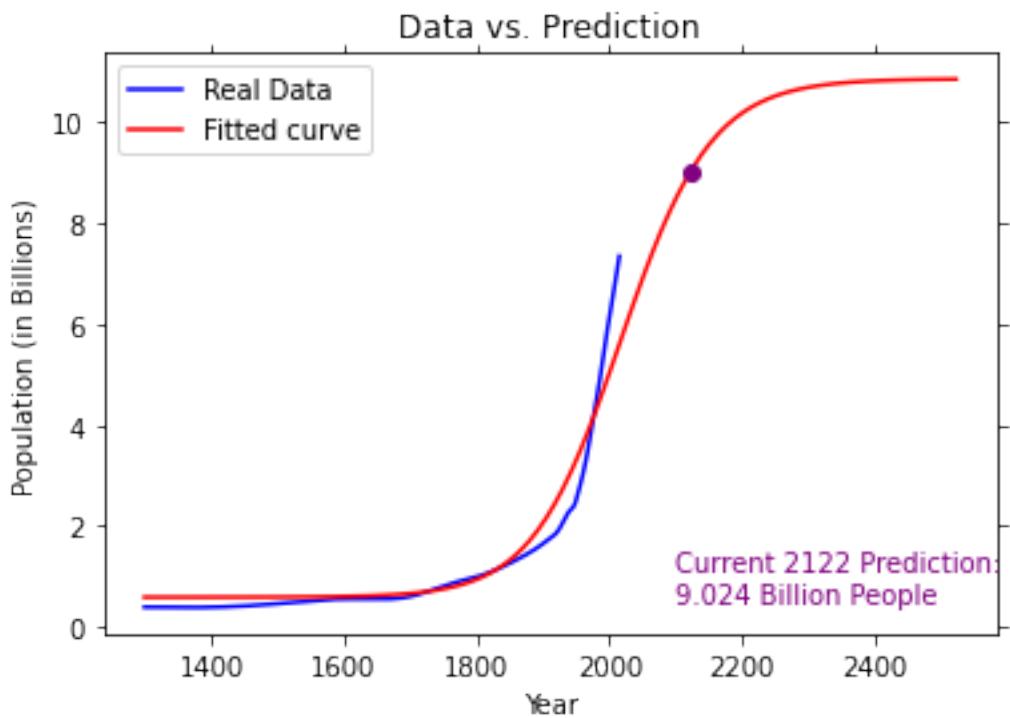
Iteration #800, Loss: 0.13213858693505592



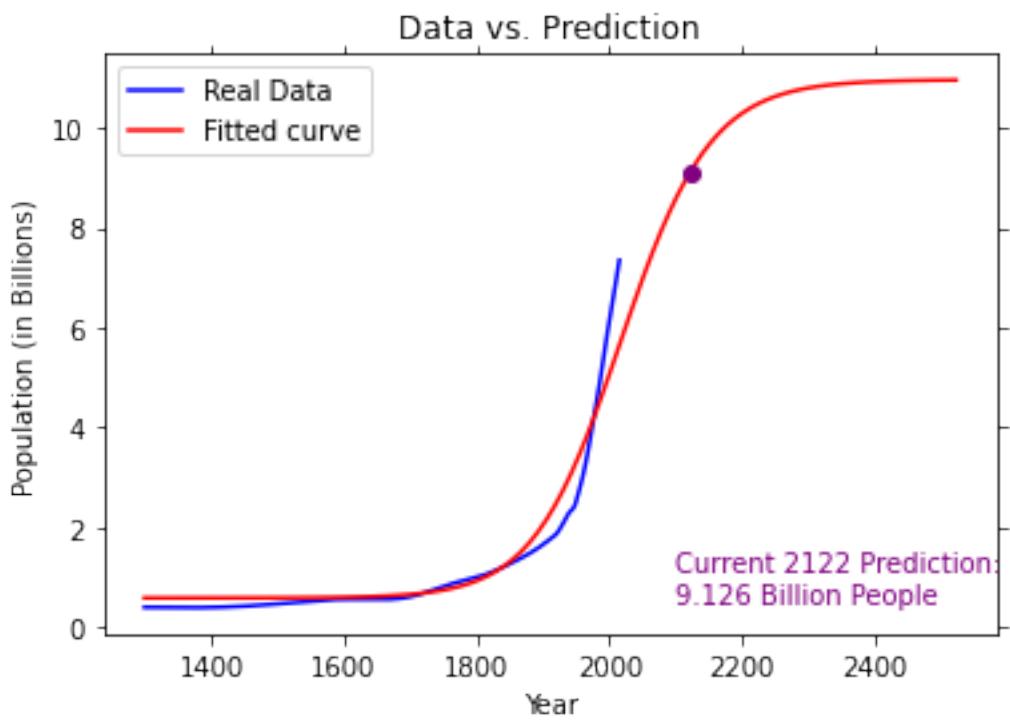
Iteration #850, Loss: 0.12191806075724361



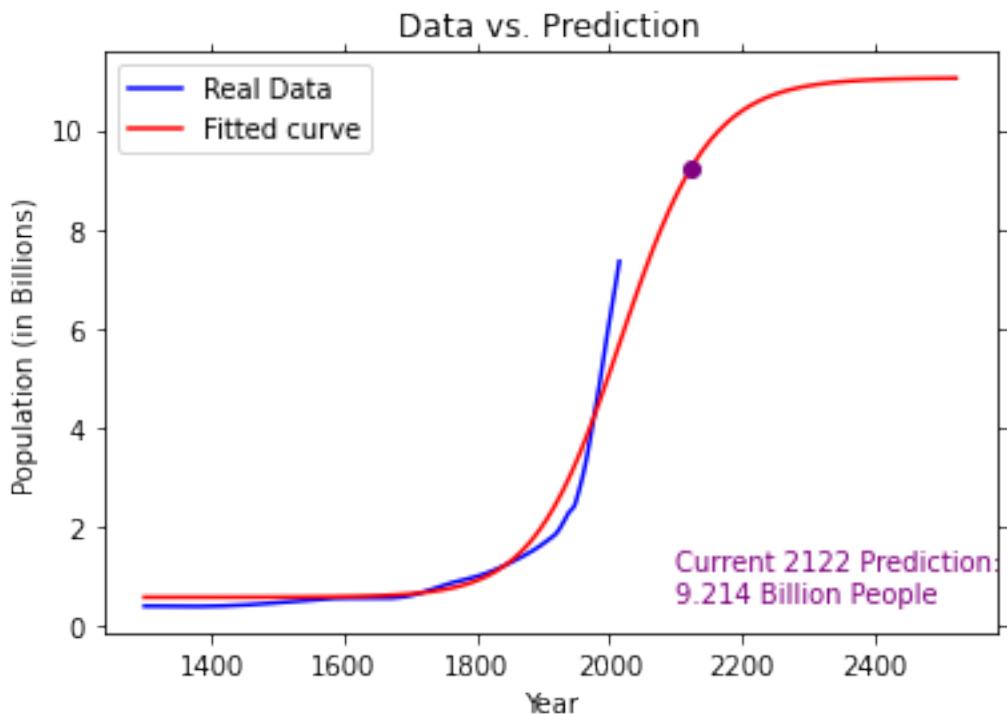
Iteration #900, Loss: 0.1140039609357824



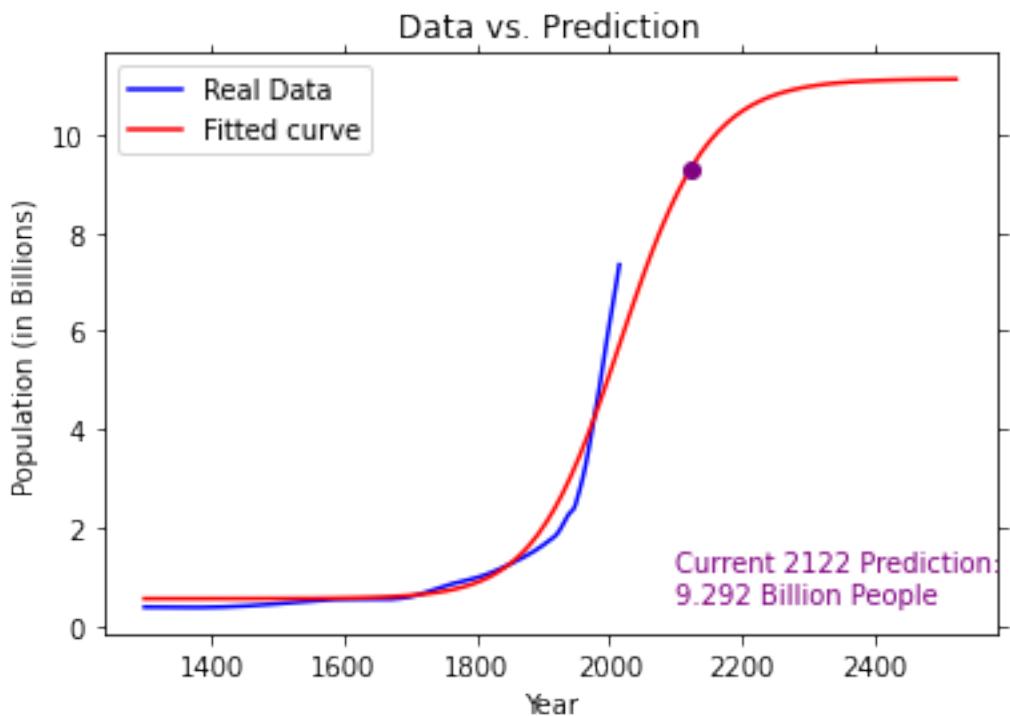
Iteration #950, Loss: 0.10777160592514352



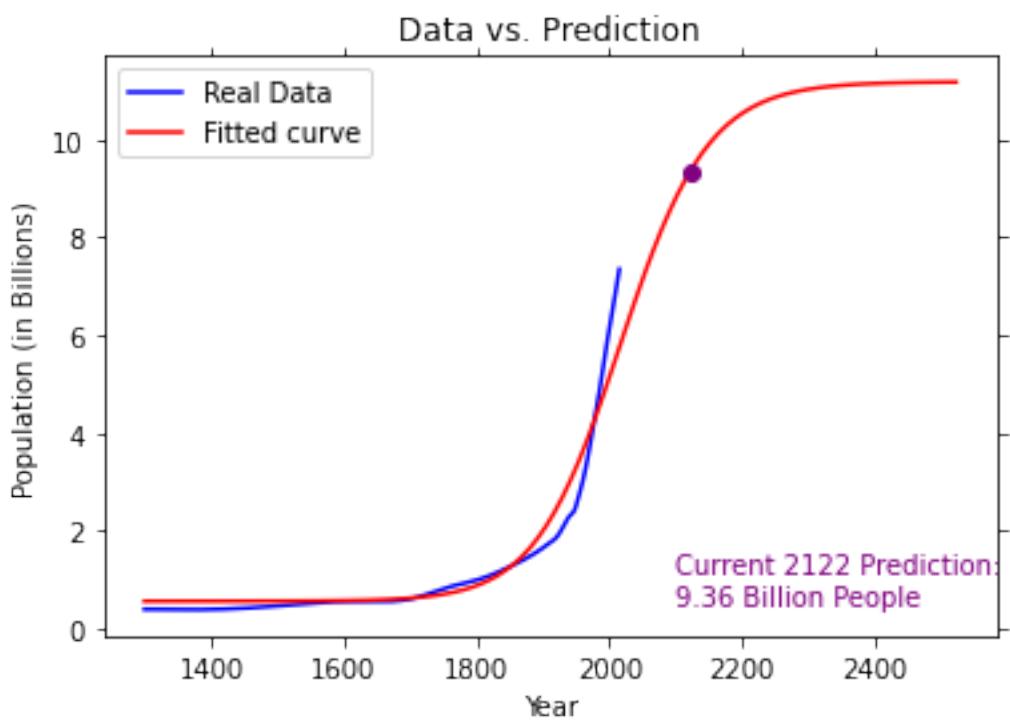
Iteration #1000, Loss: 0.10278072731105138



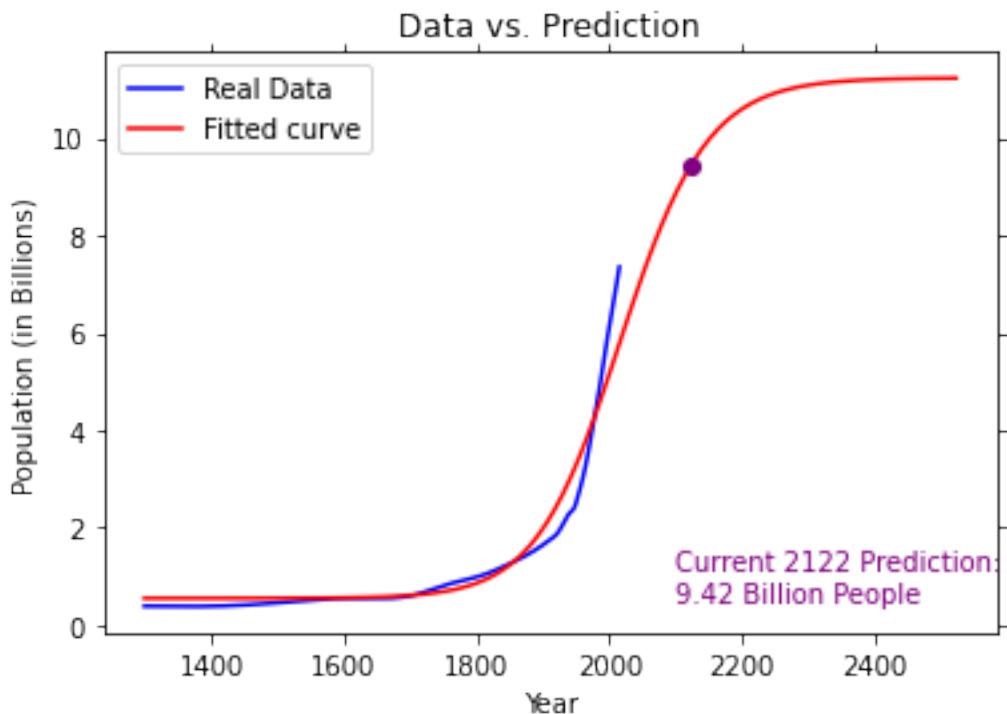
Iteration #1050, Loss: 0.09871844312131559



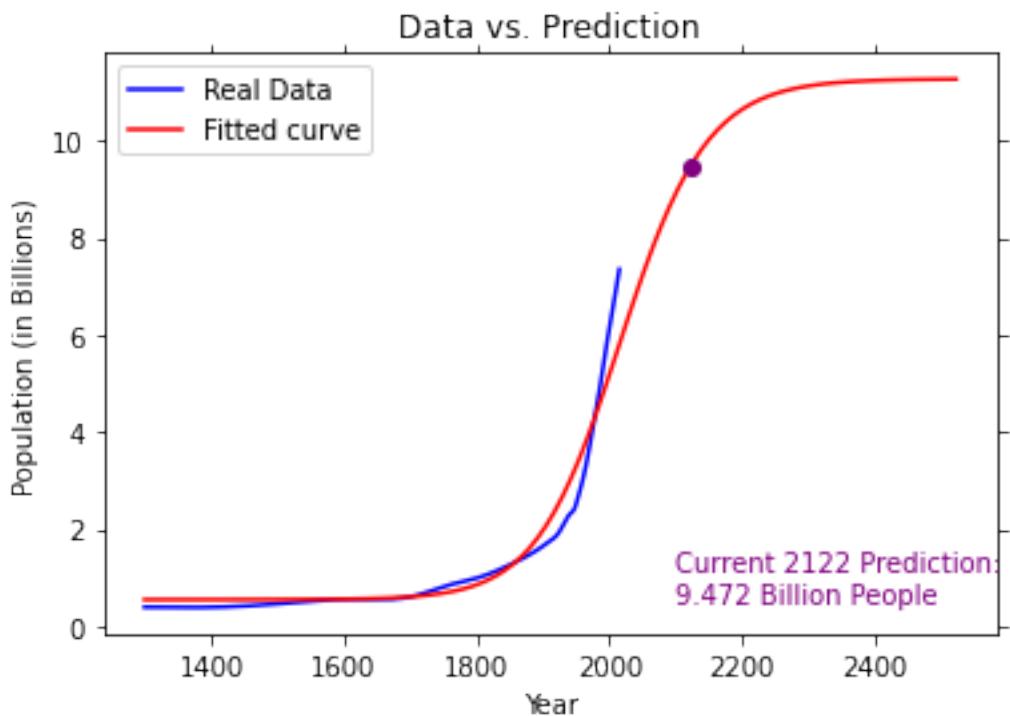
Iteration #1100, Loss: 0.09536030506735468



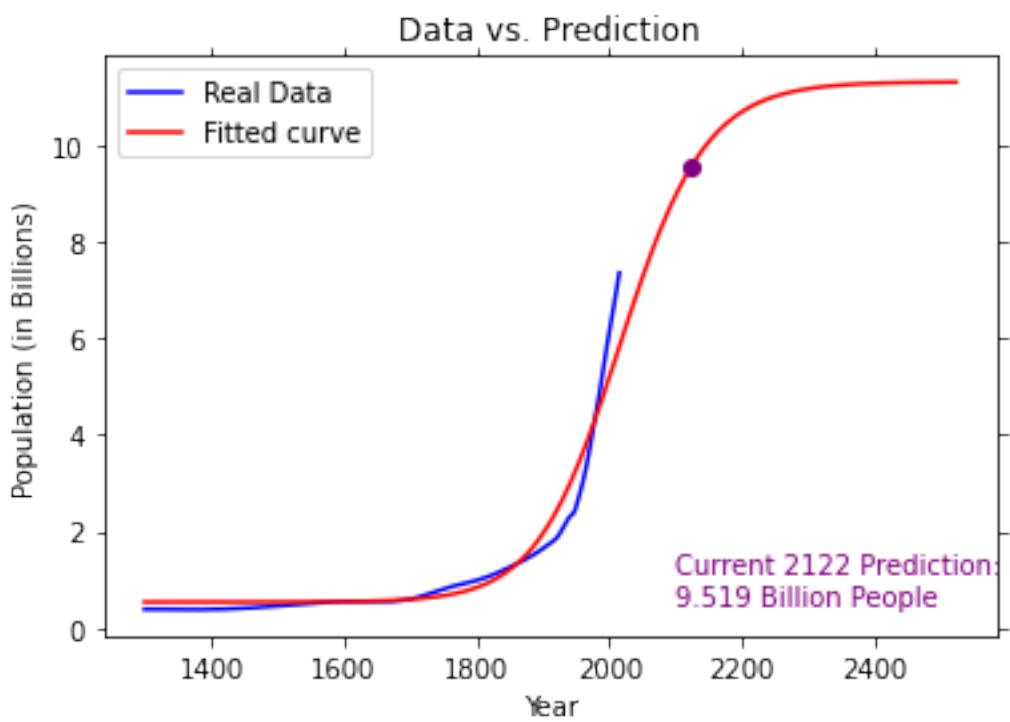
Iteration #1150, Loss: 0.09254361824773907



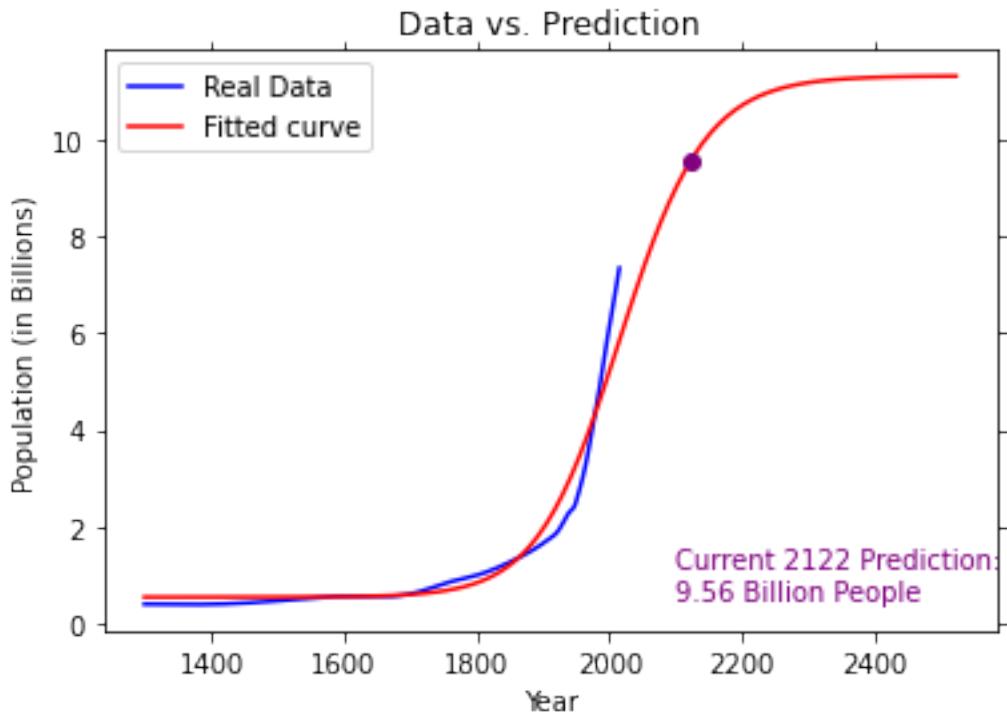
Iteration #1200, Loss: 0.09014910641214902



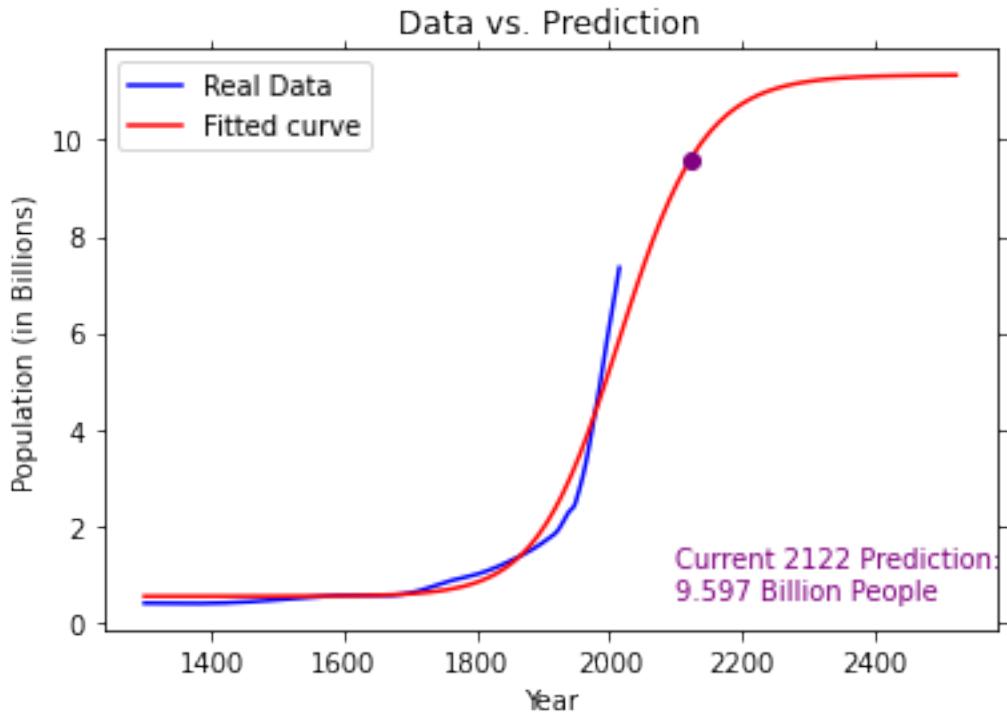
Iteration #1250, Loss: 0.0880882623103534



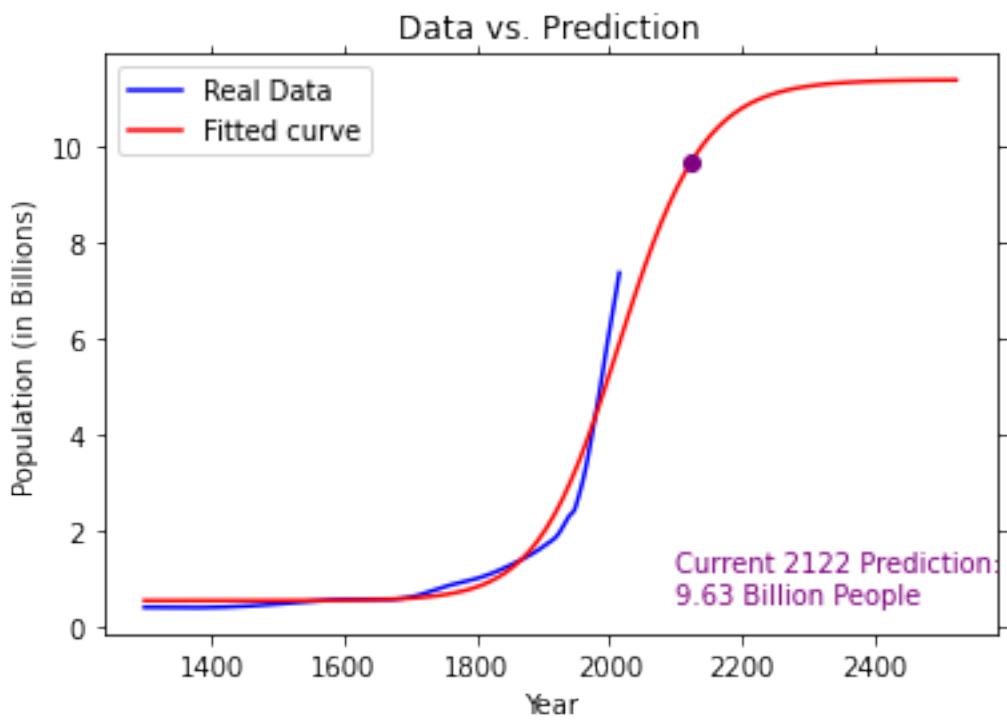
Iteration #1300, Loss: 0.08629457893082237



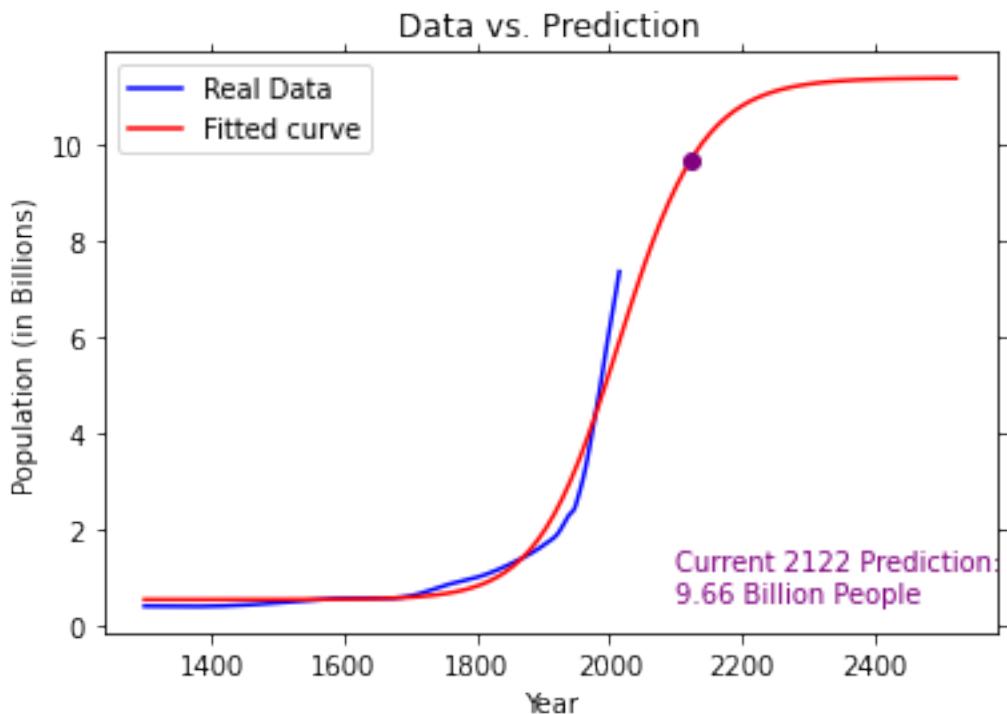
Iteration #1350, Loss: 0.0847174367939503



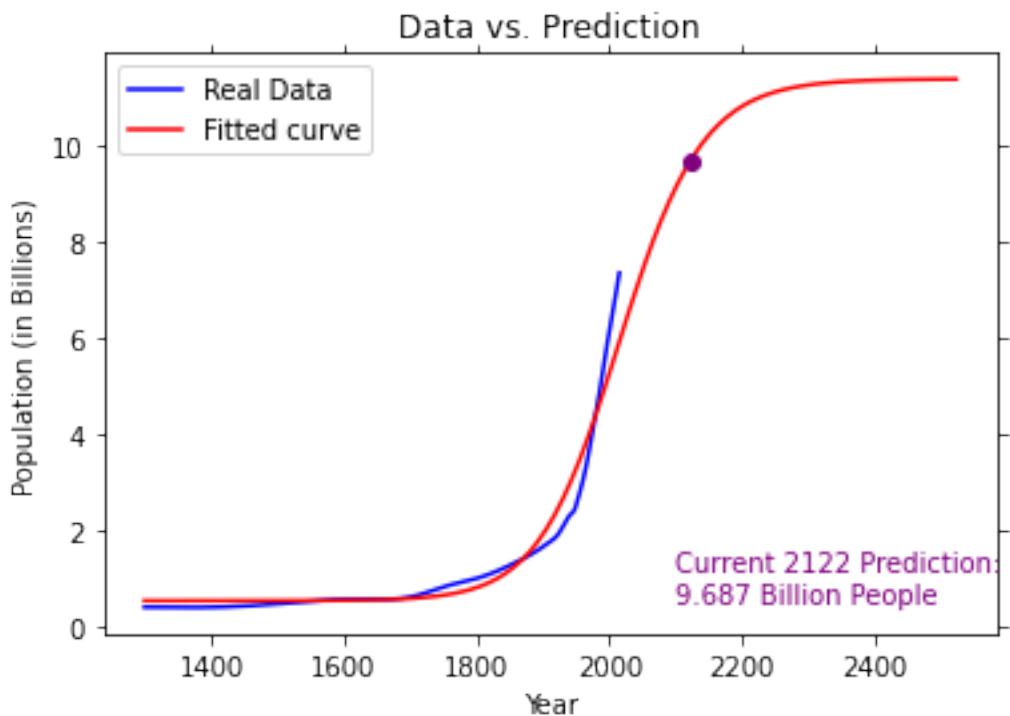
Iteration #1400, Loss: 0.08331781470800531



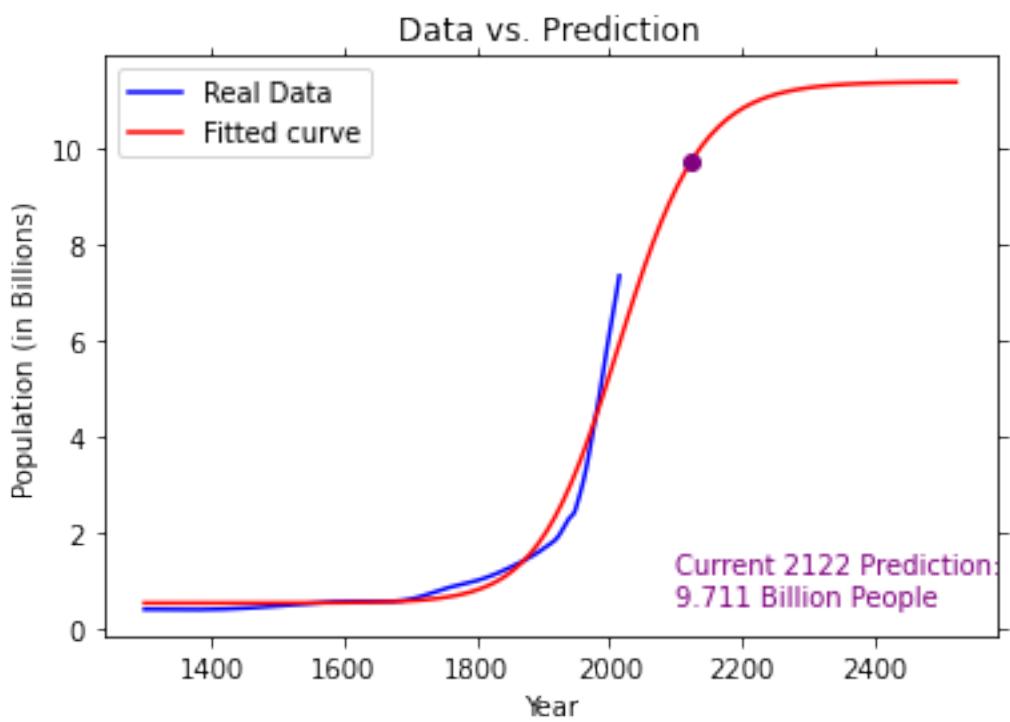
Iteration #1450, Loss: 0.08206525712958183



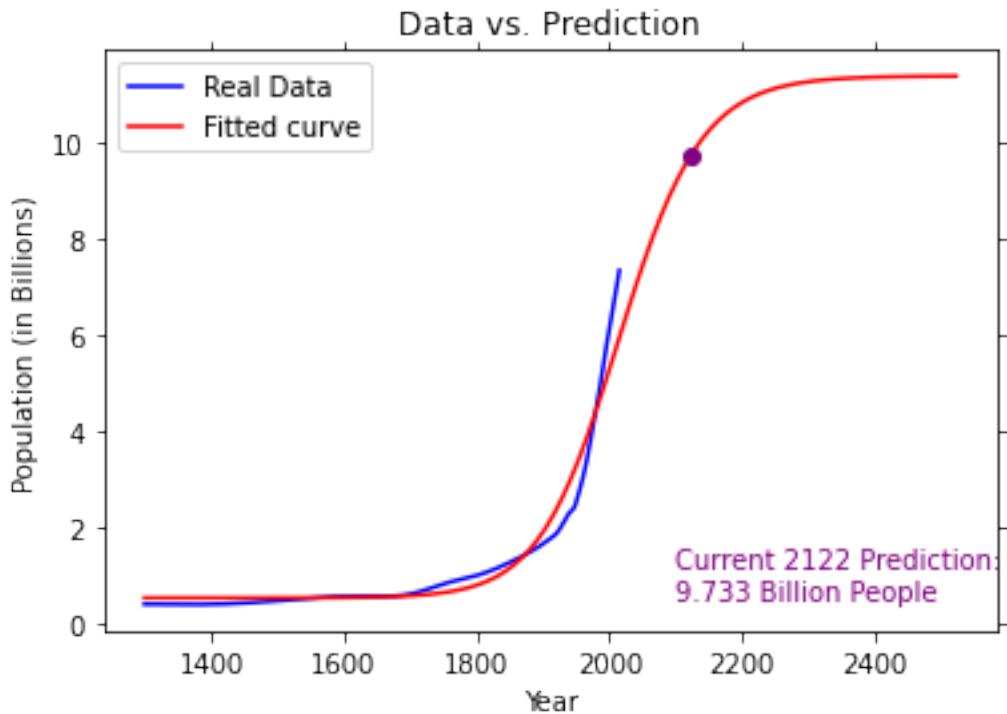
Iteration #1500, Loss: 0.08093571143331667



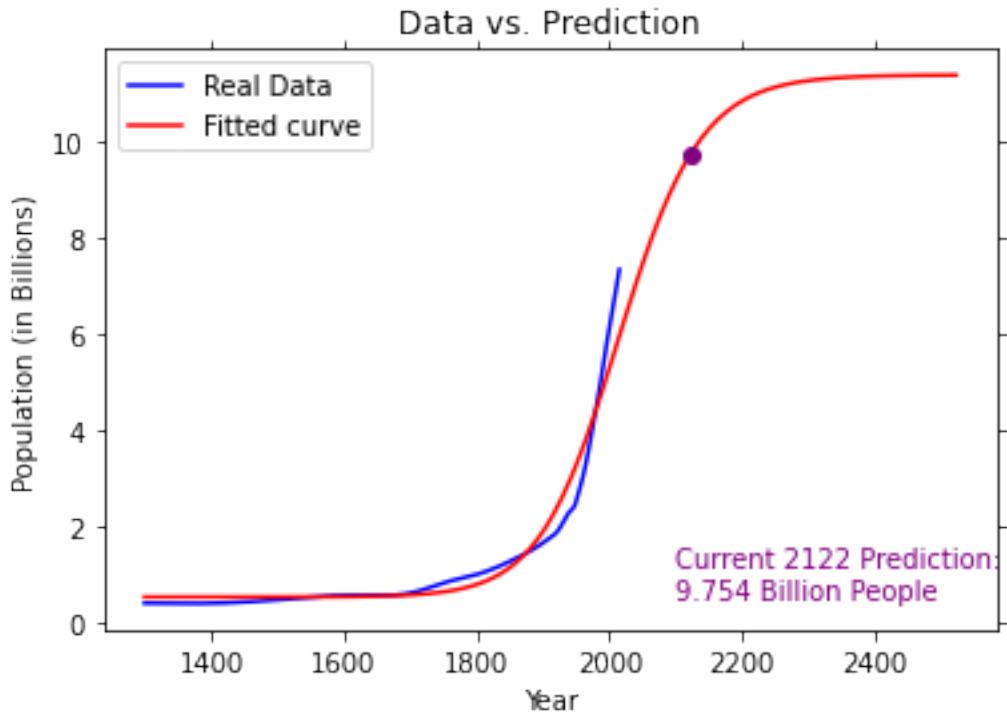
Iteration #1550, Loss: 0.07990997065641355



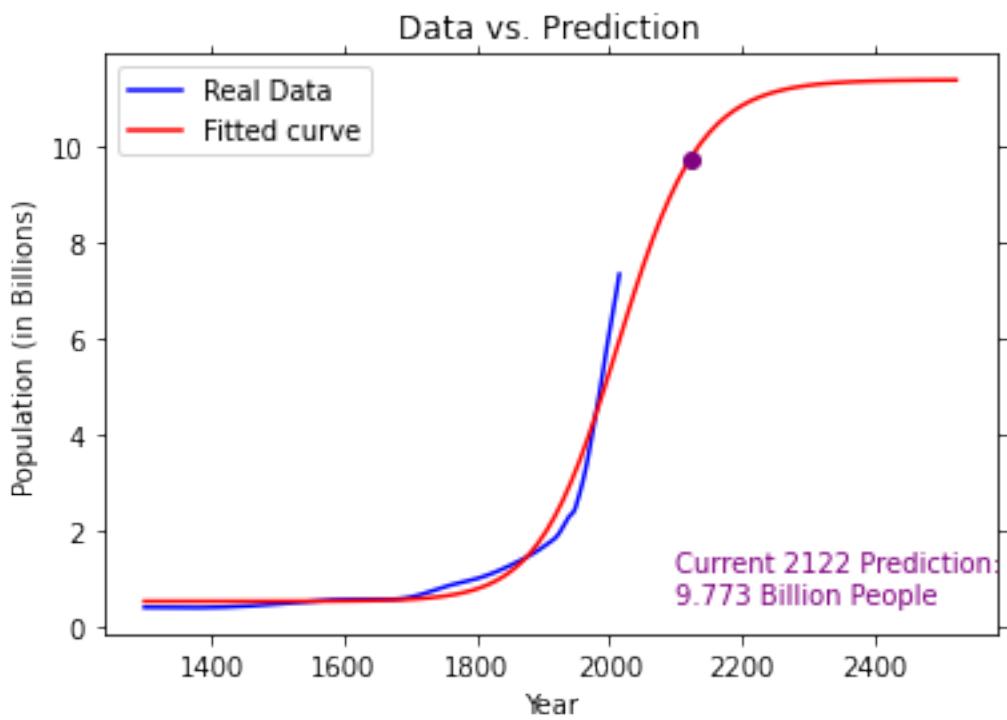
Iteration #1600, Loss: 0.07897254034809503



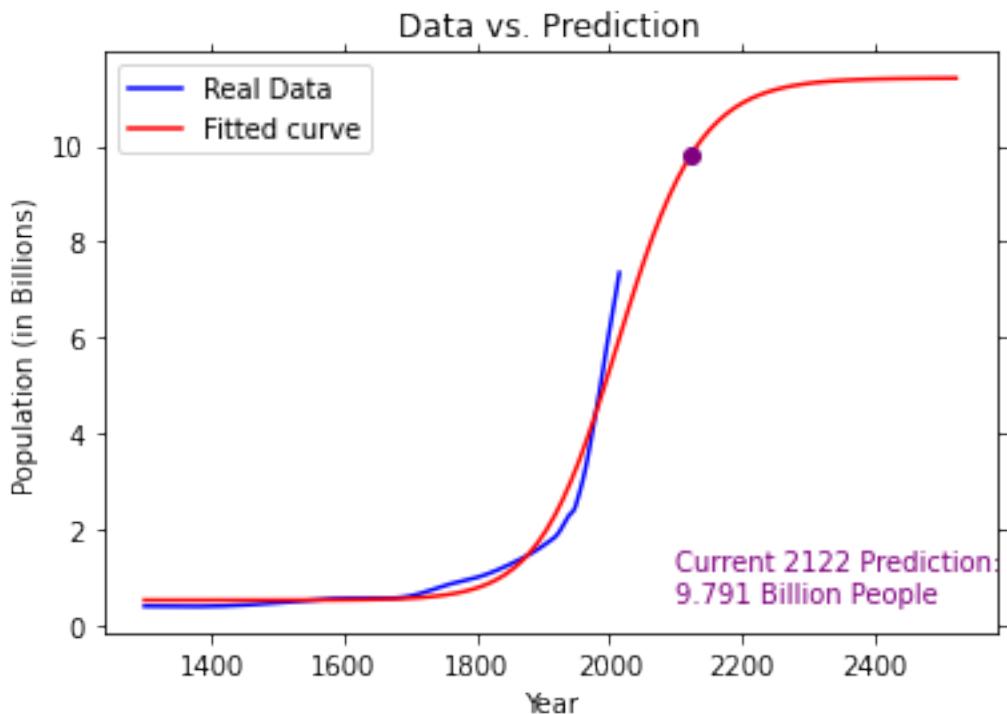
Iteration #1650, Loss: 0.07811080467234505



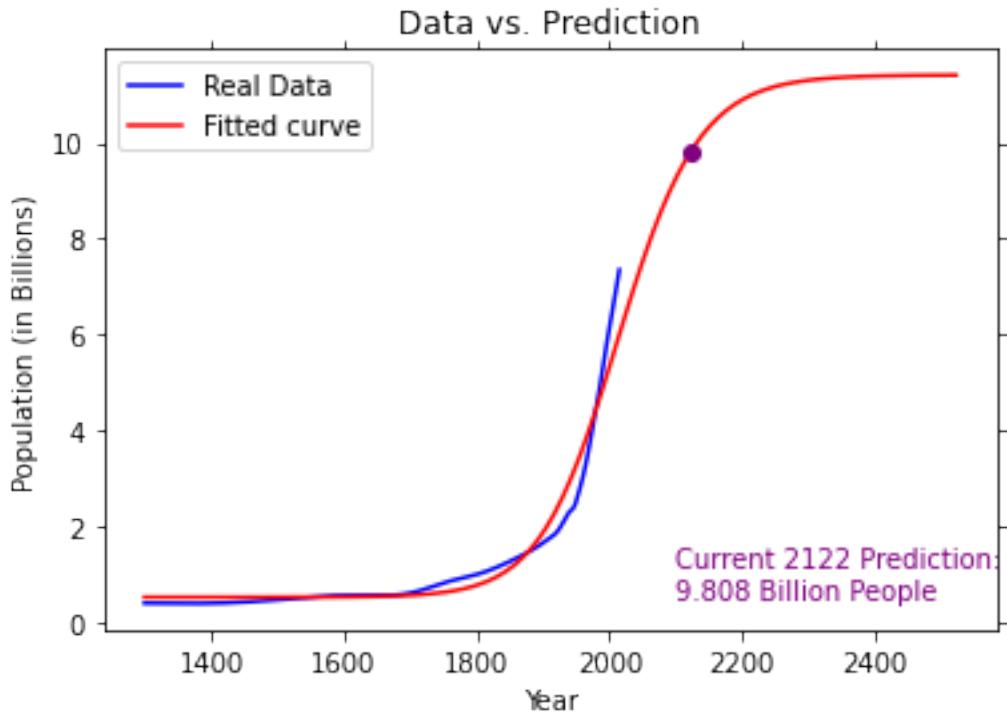
Iteration #1700, Loss: 0.07731440544006499



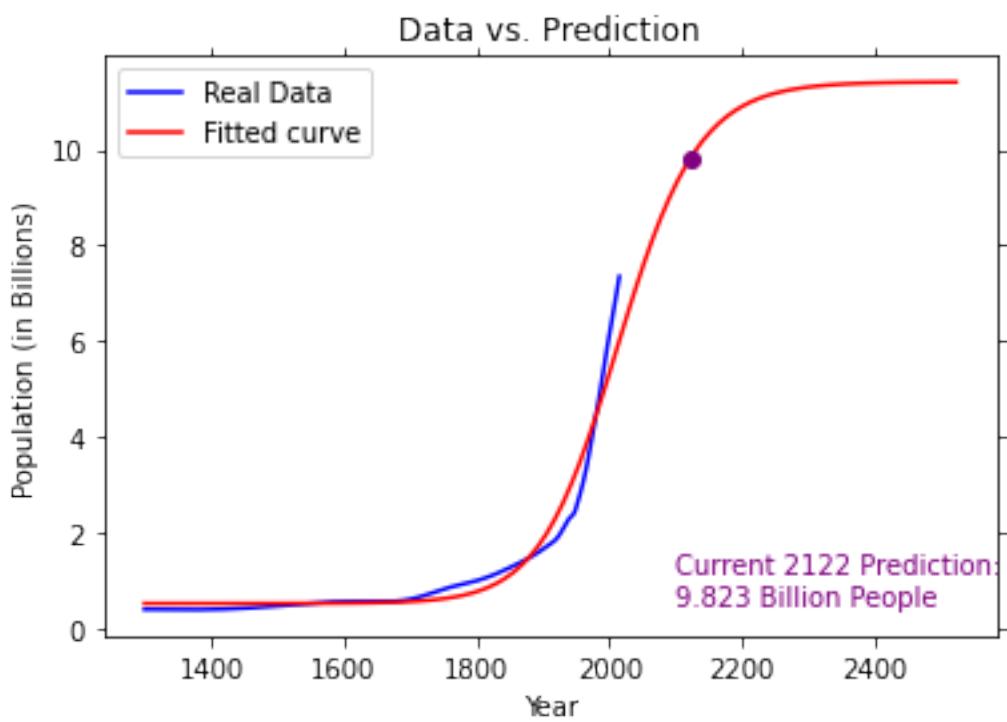
Iteration #1750, Loss: 0.07657477407218219



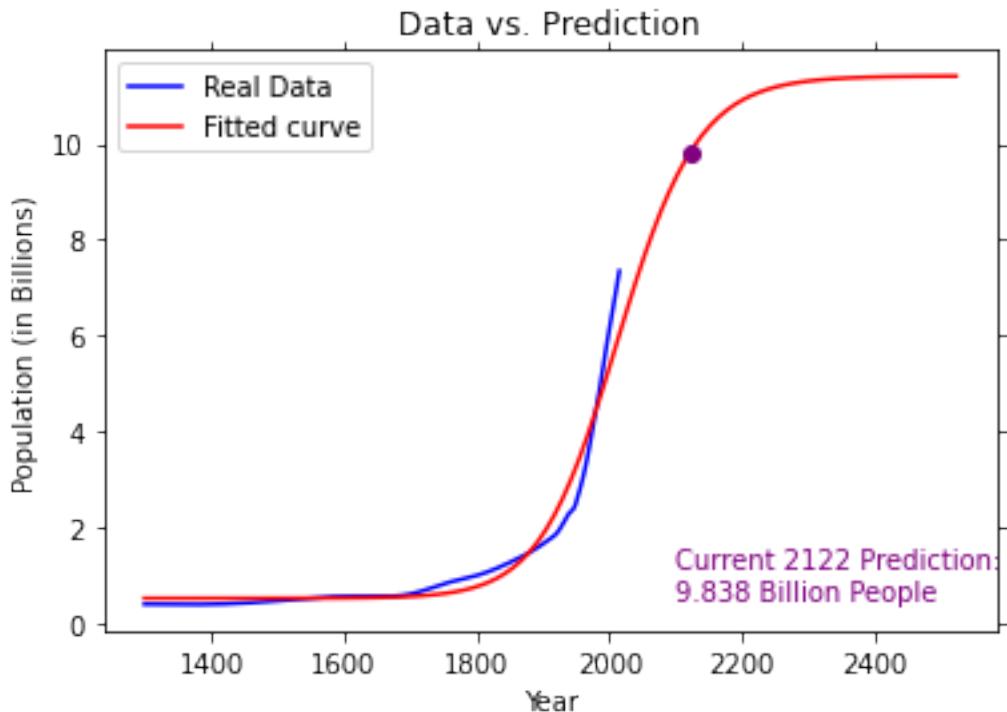
Iteration #1800, Loss: 0.07588477453508757



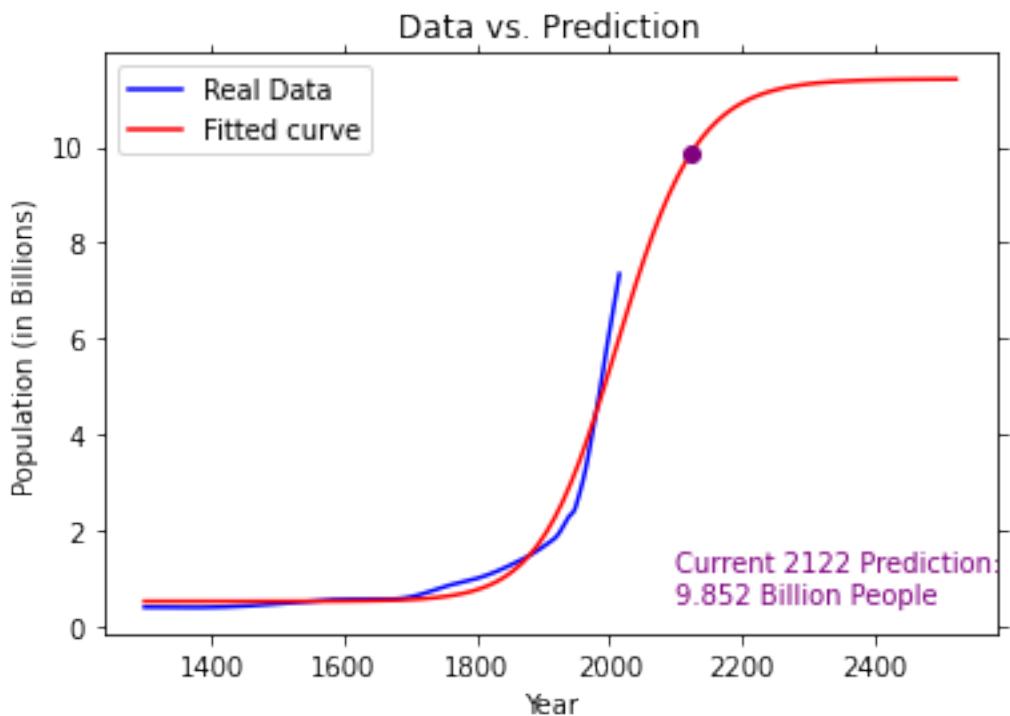
Iteration #1850, Loss: 0.07523842769558757



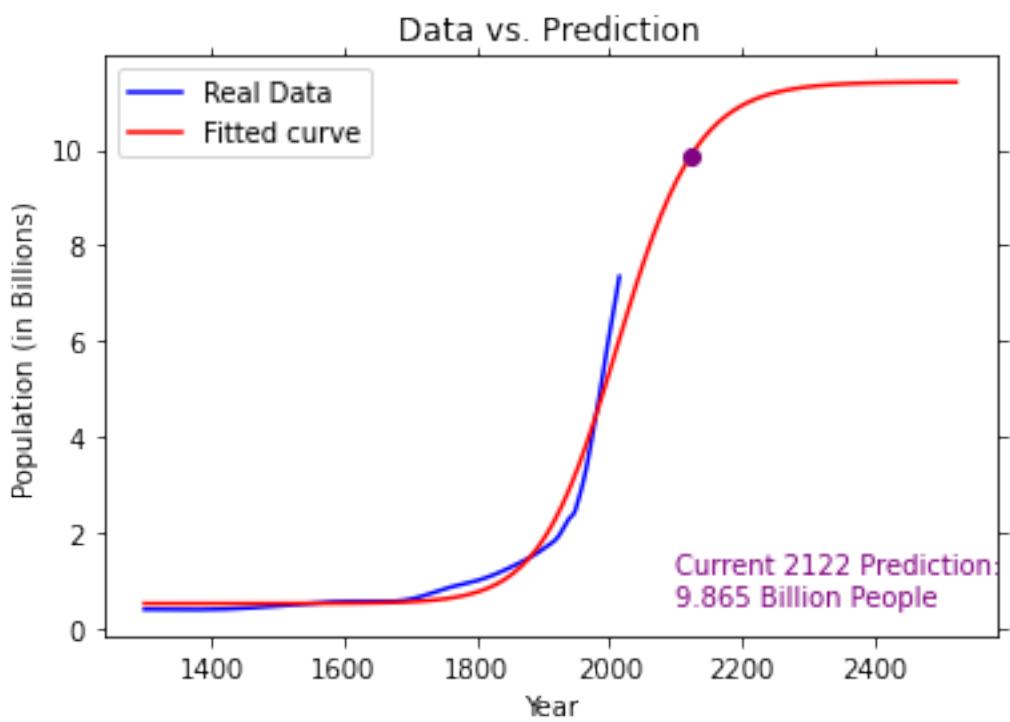
Iteration #1900, Loss: 0.07463069611035854



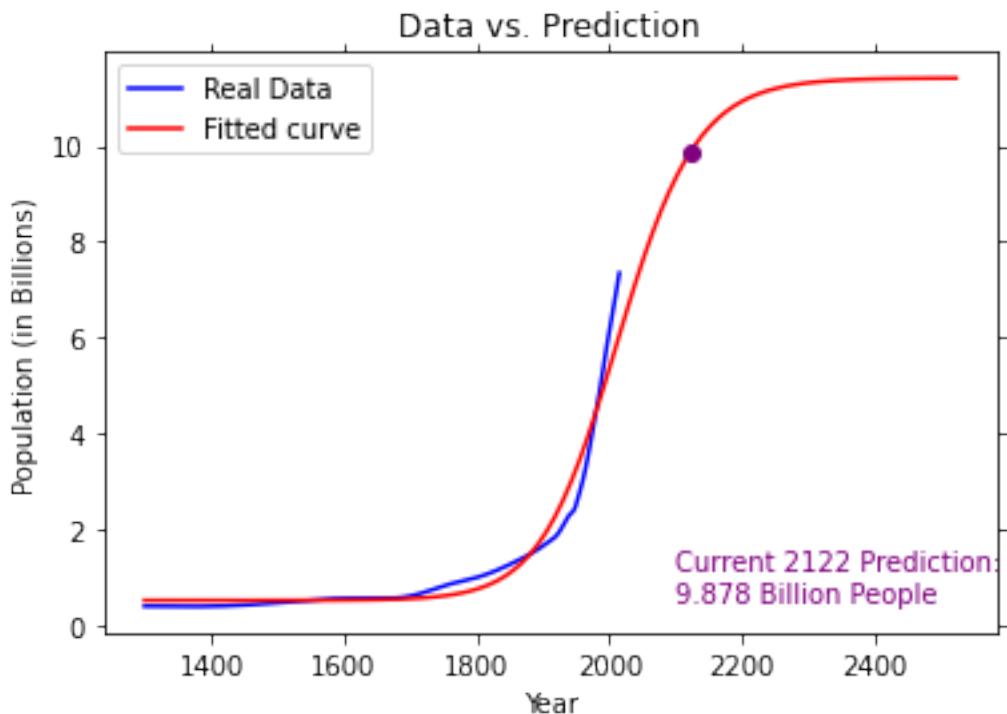
Iteration #1950, Loss: 0.07405731421223138



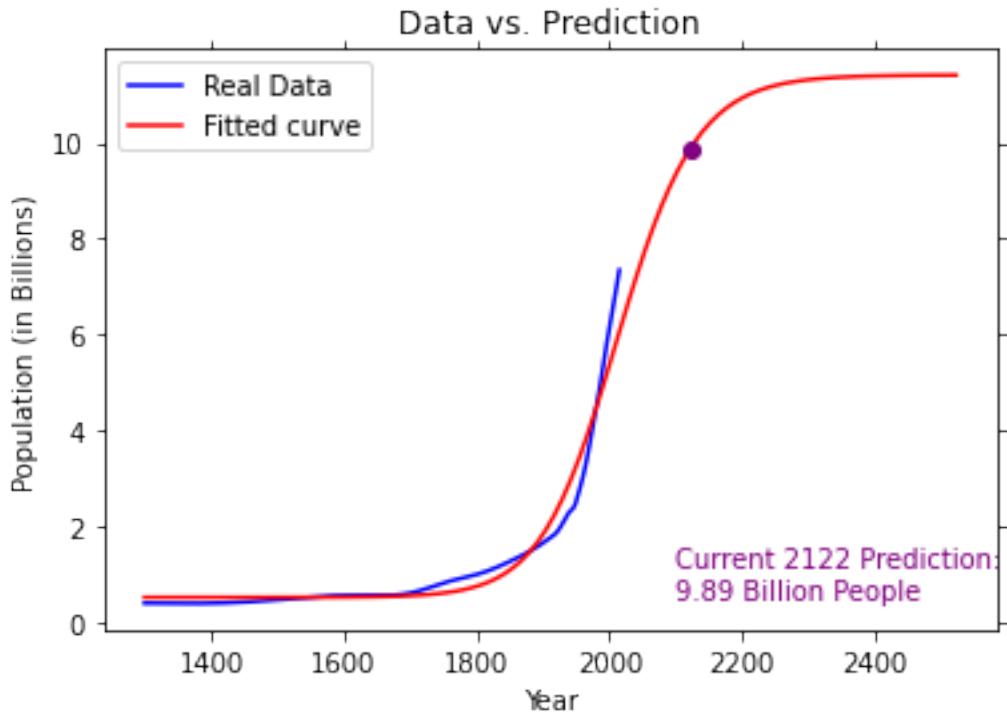
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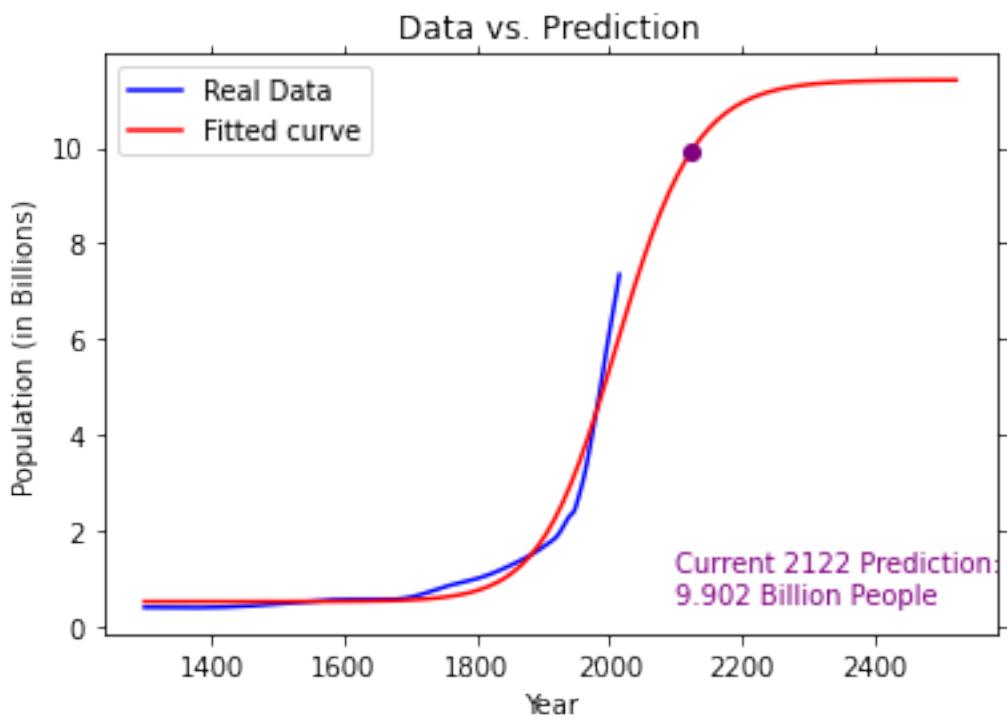
Iteration #2050, Loss: 0.07299961132858708



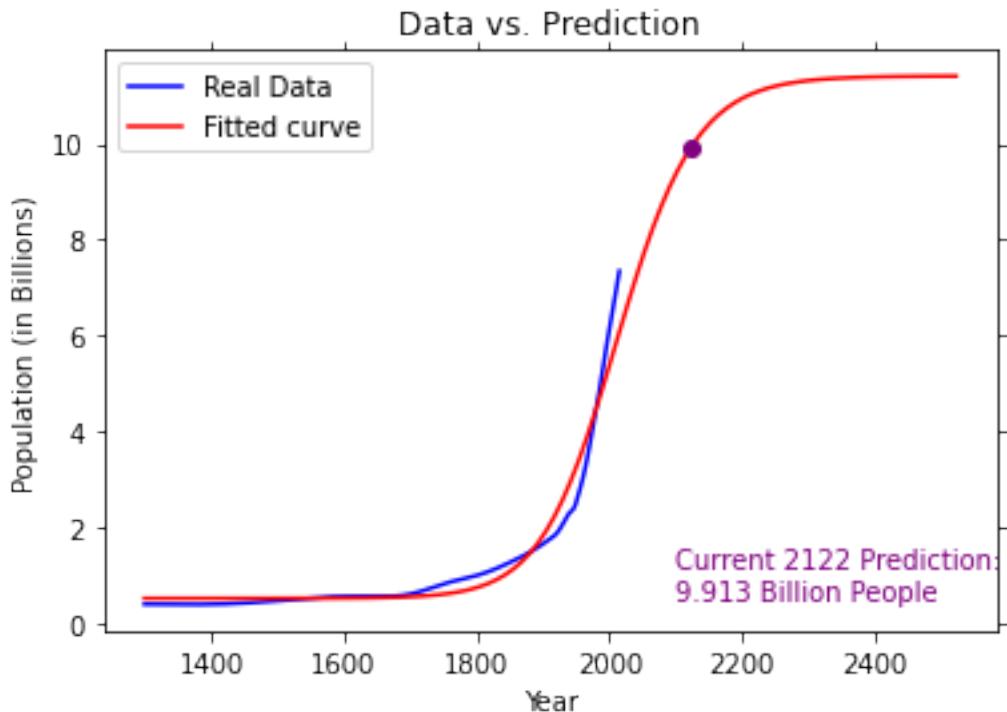
Iteration #2100, Loss: 0.07250952772199992



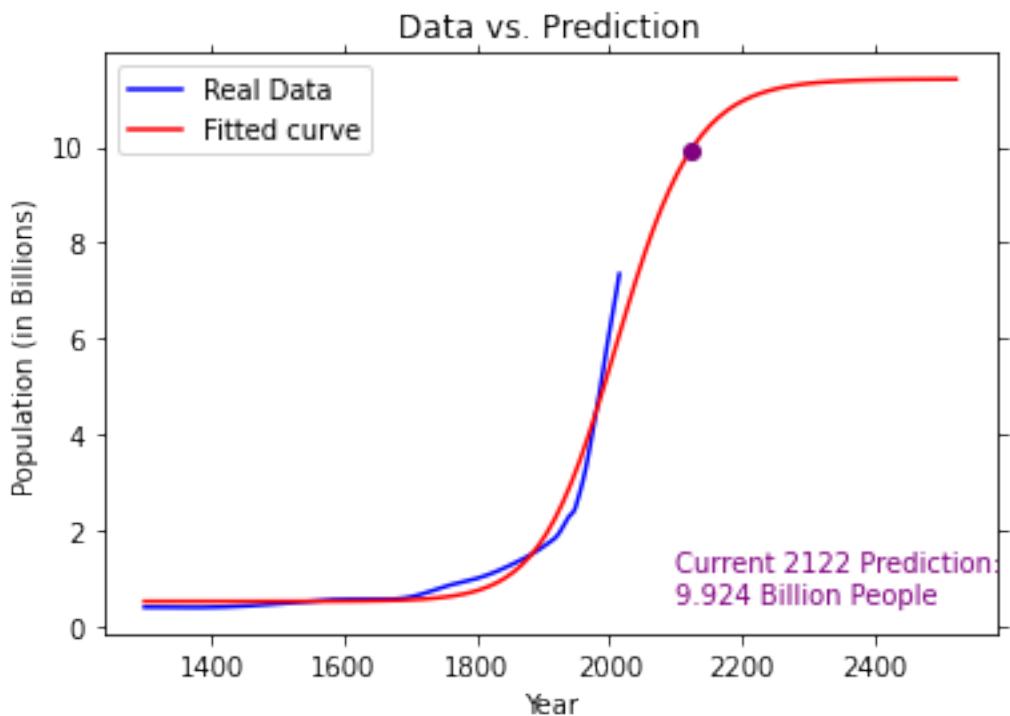
Iteration #2150, Loss: 0.0720421086001404



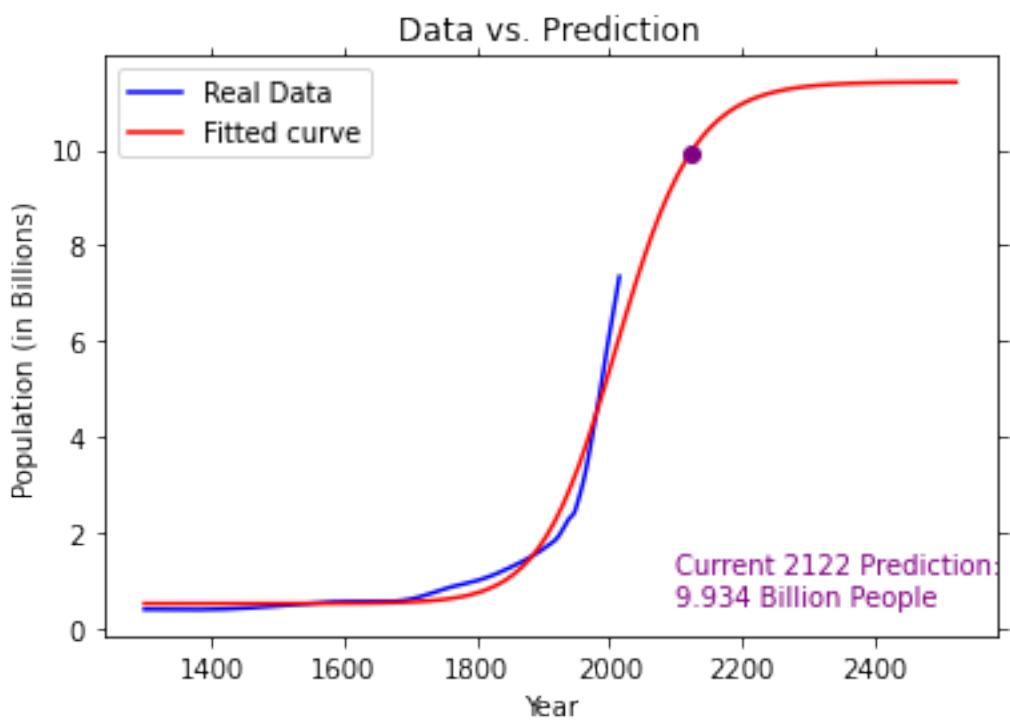
Iteration #2200, Loss: 0.07159536926883996



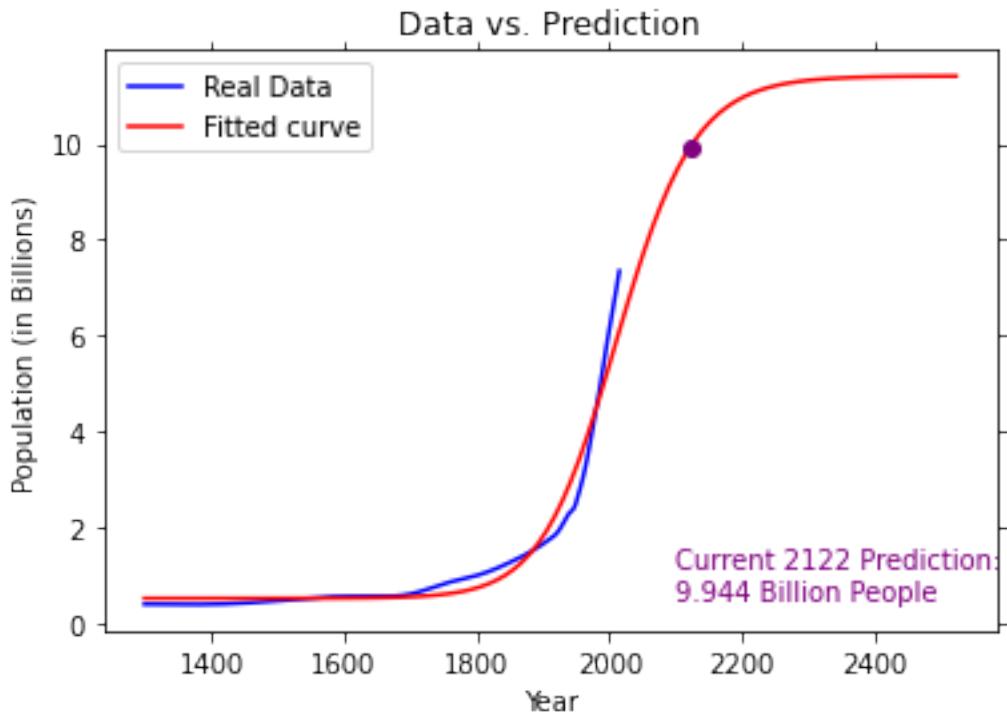
Iteration #2250, Loss: 0.07116758529111337



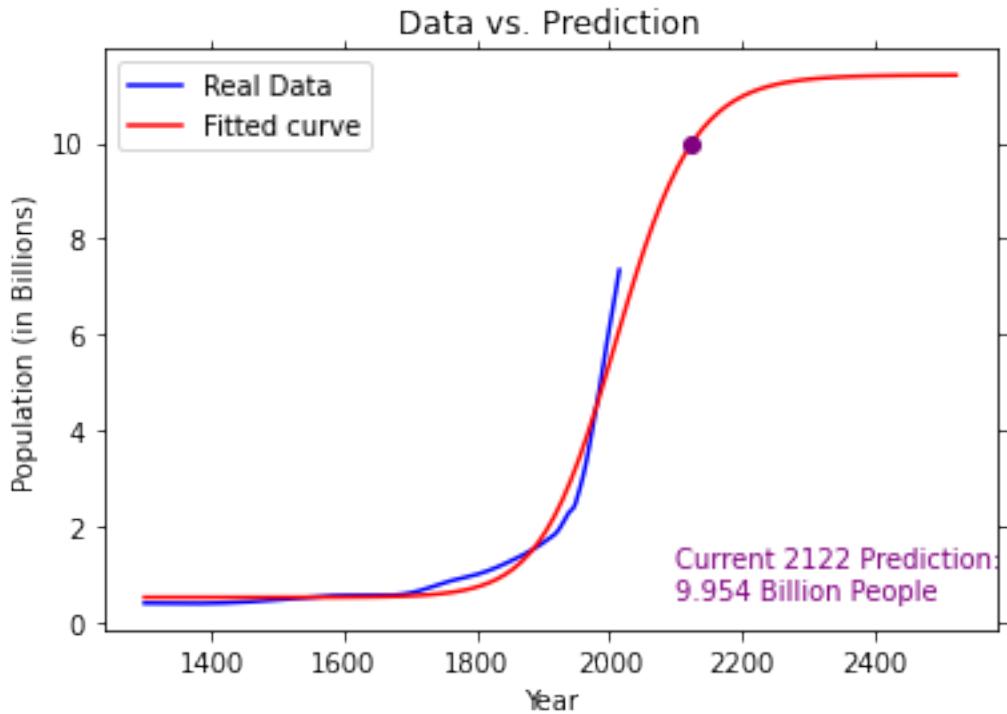
Iteration #2300, Loss: 0.07075725218923737



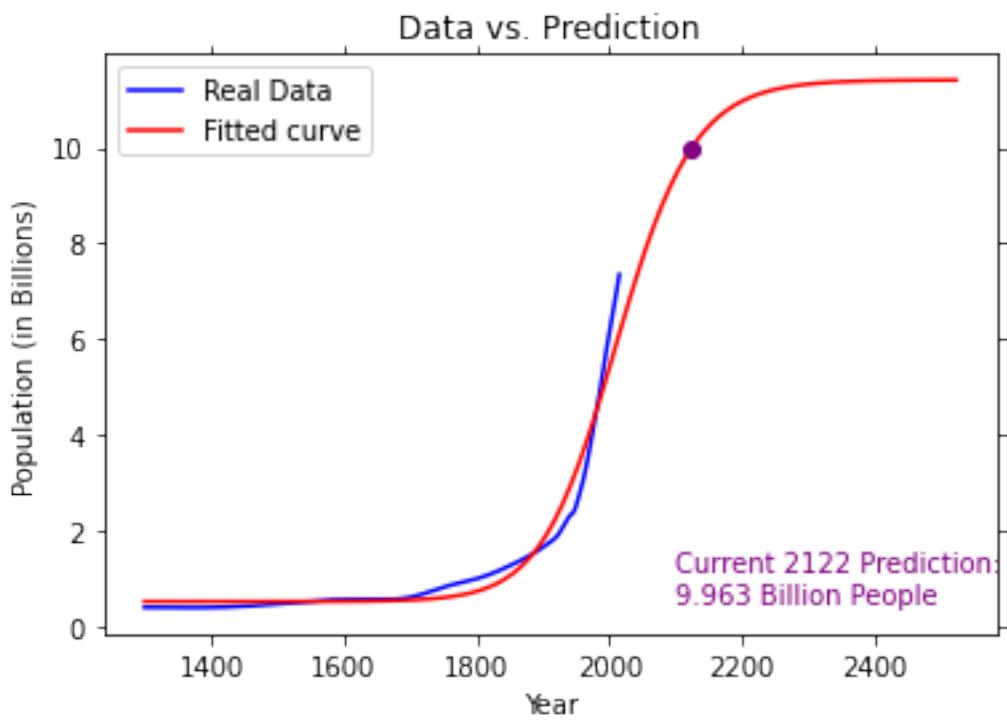
Iteration #2350, Loss: 0.07036305192705836



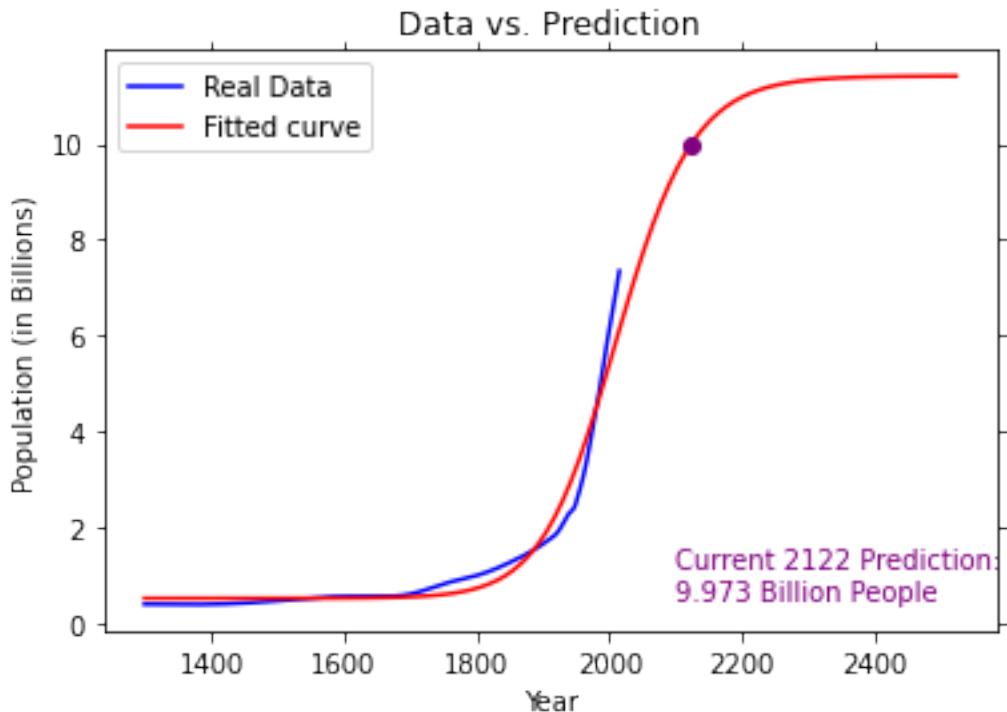
Iteration #2400, Loss: 0.06998382493814836



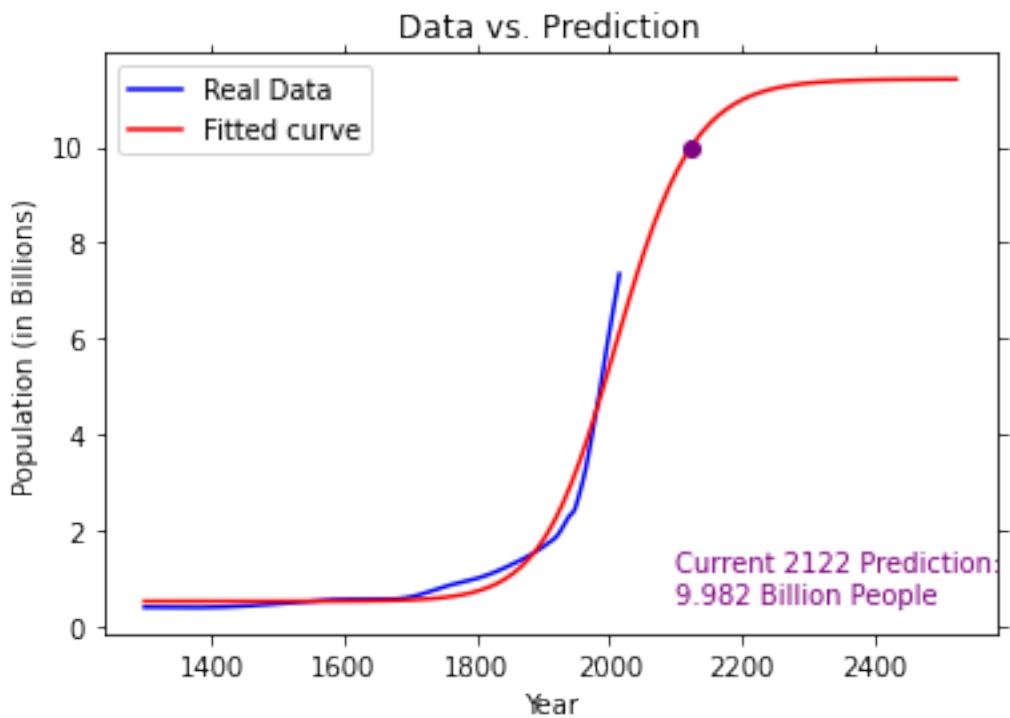
Iteration #2450, Loss: 0.06961854671384816



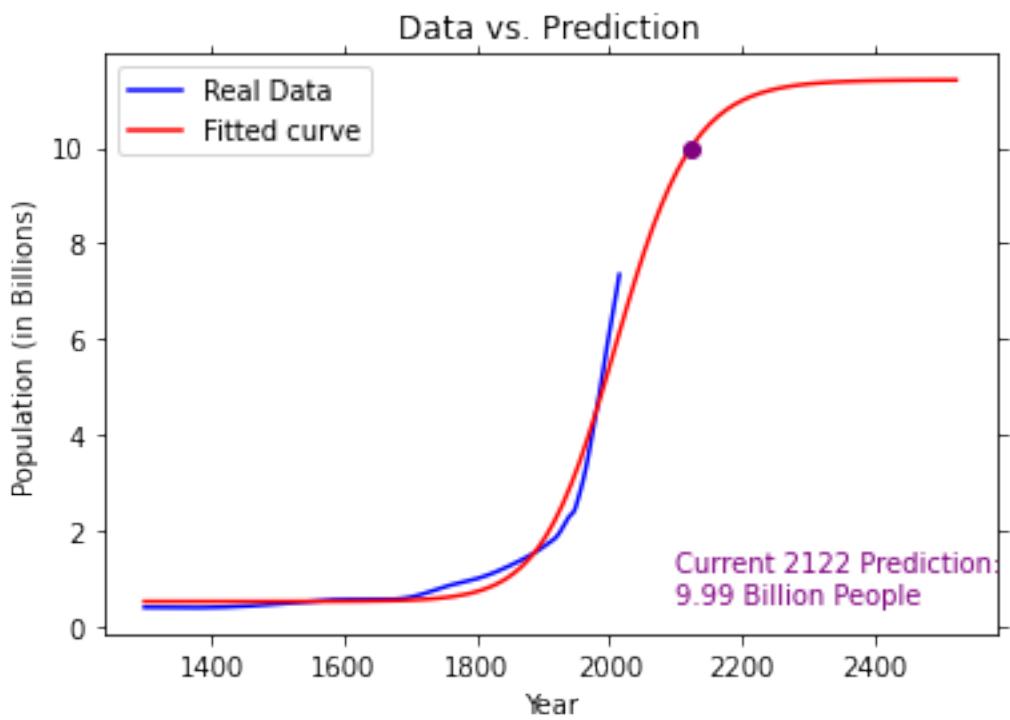
Iteration #2500, Loss: 0.06926630815732043



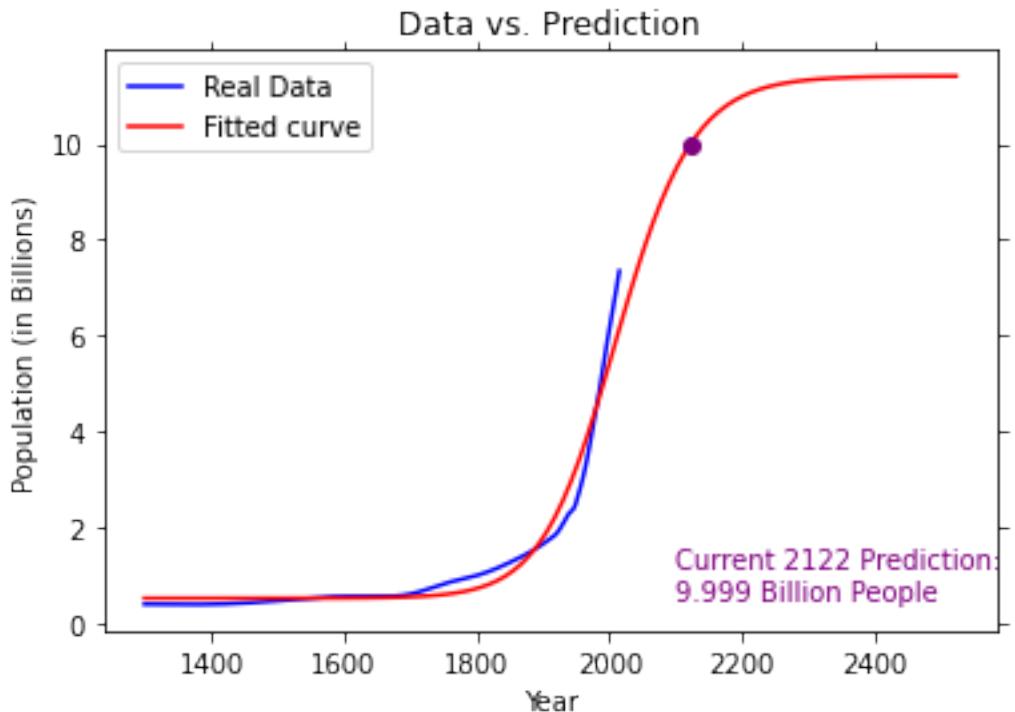
Iteration #2550, Loss: 0.06892629905985923



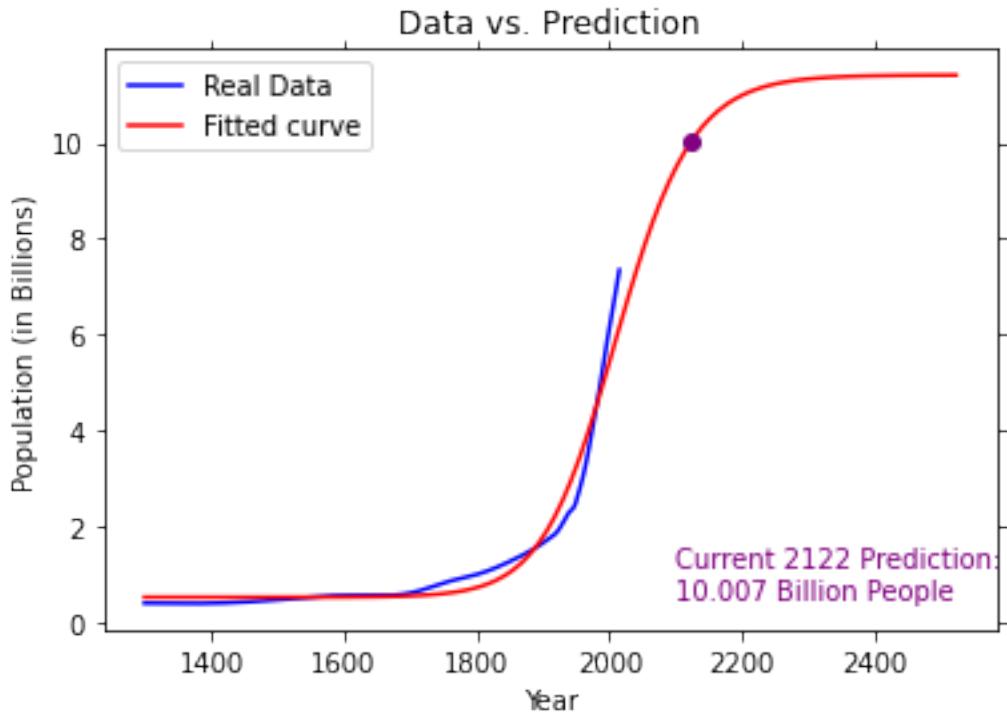
Iteration #2600, Loss: 0.06859779417421094



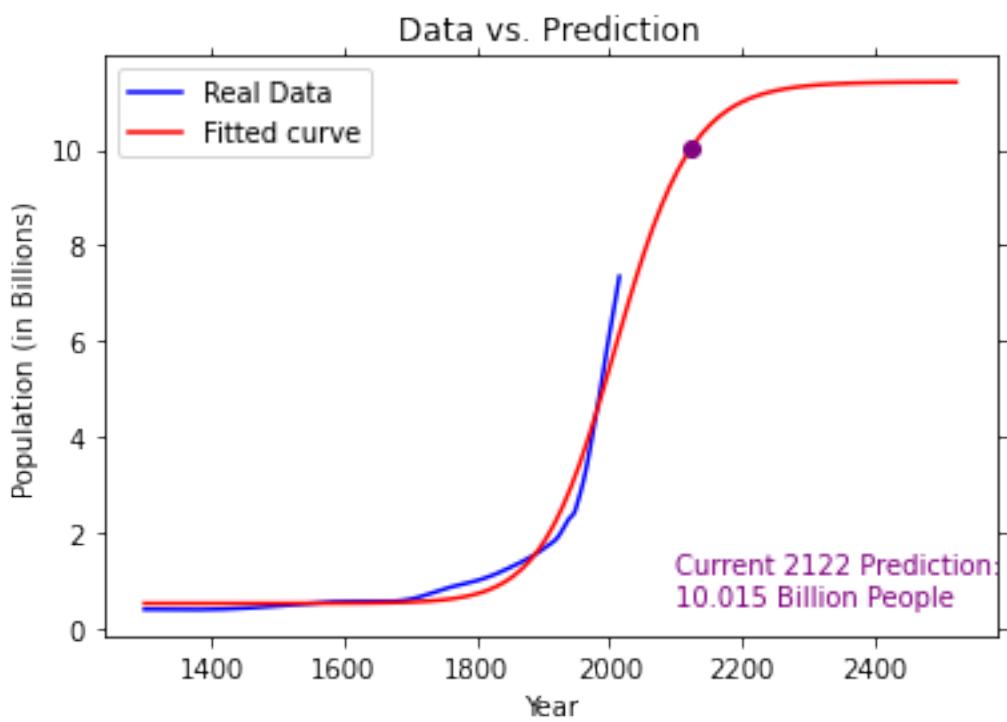
Iteration #2650, Loss: 0.0682801414540677



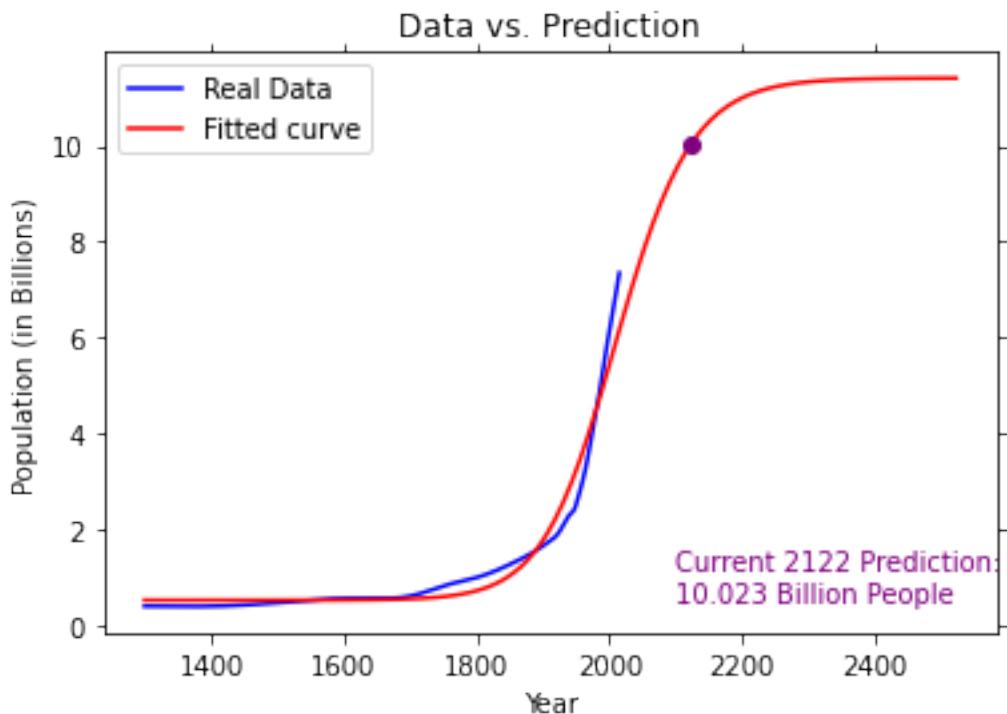
Iteration #2700, Loss: 0.06797275210471831



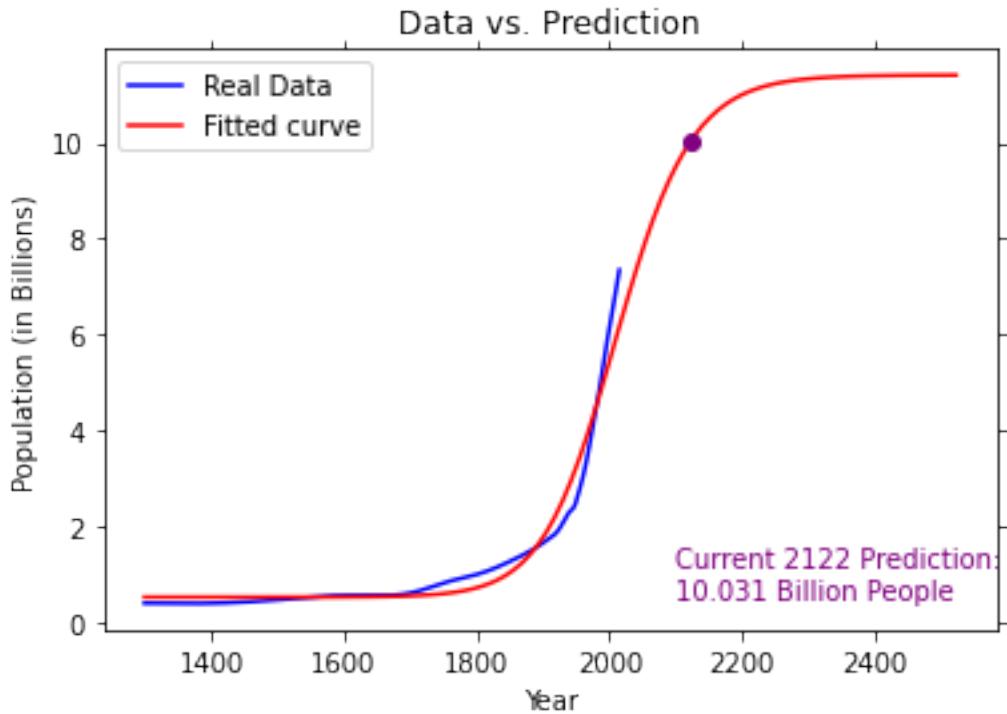
Iteration #2750, Loss: 0.0676750921511758



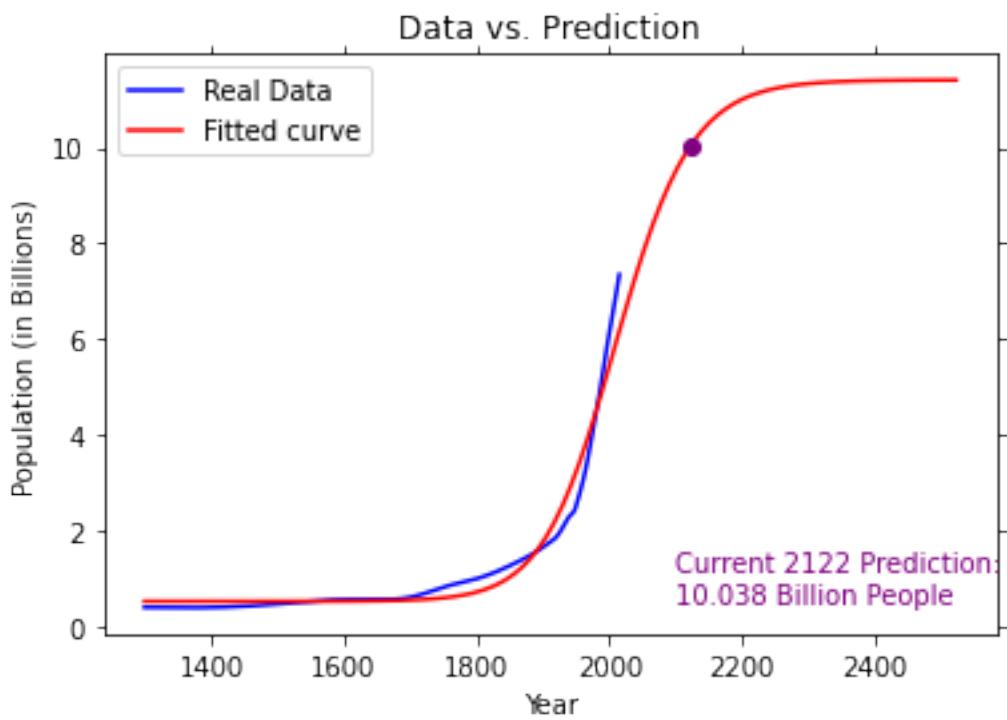
Iteration #2800, Loss: 0.06738667528004091



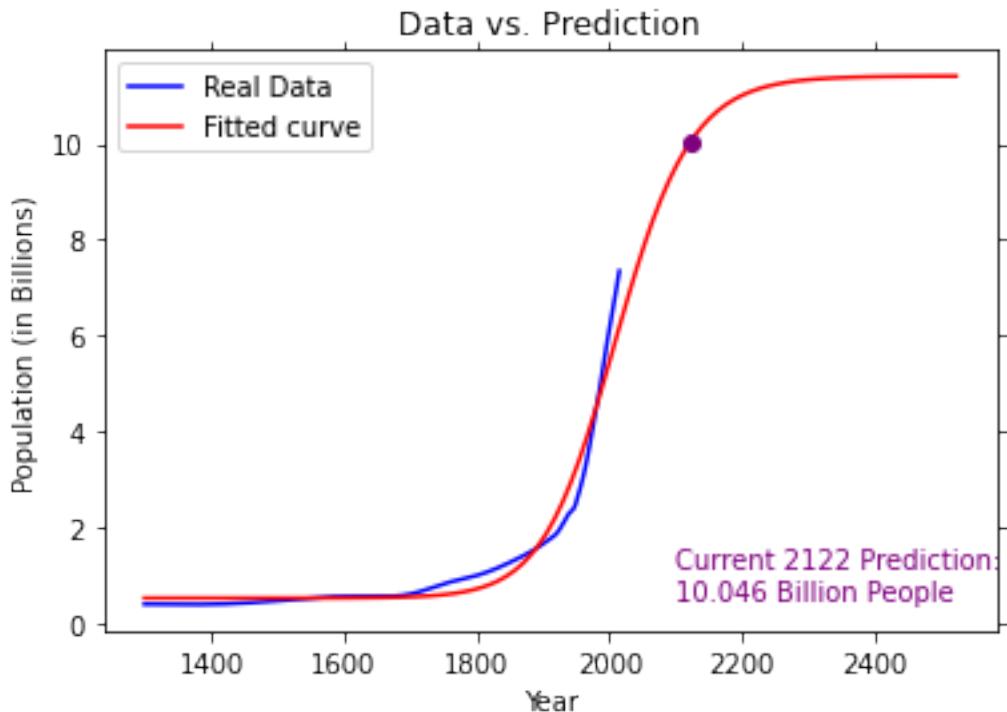
Iteration #2850, Loss: 0.06710705675223397



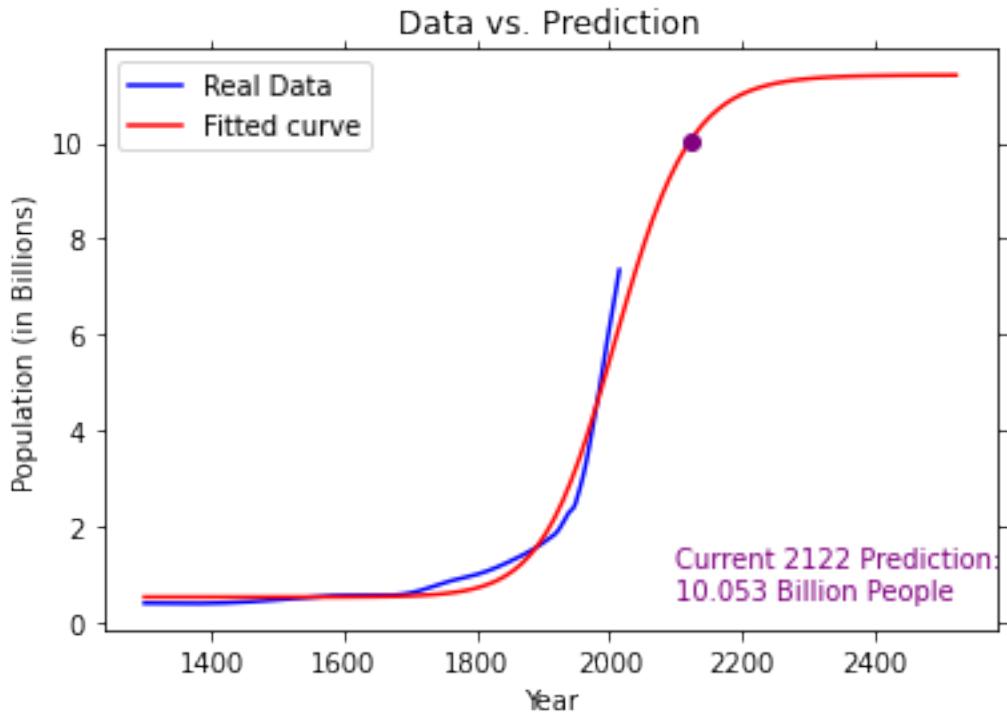
Iteration #2900, Loss: 0.06683582821734478



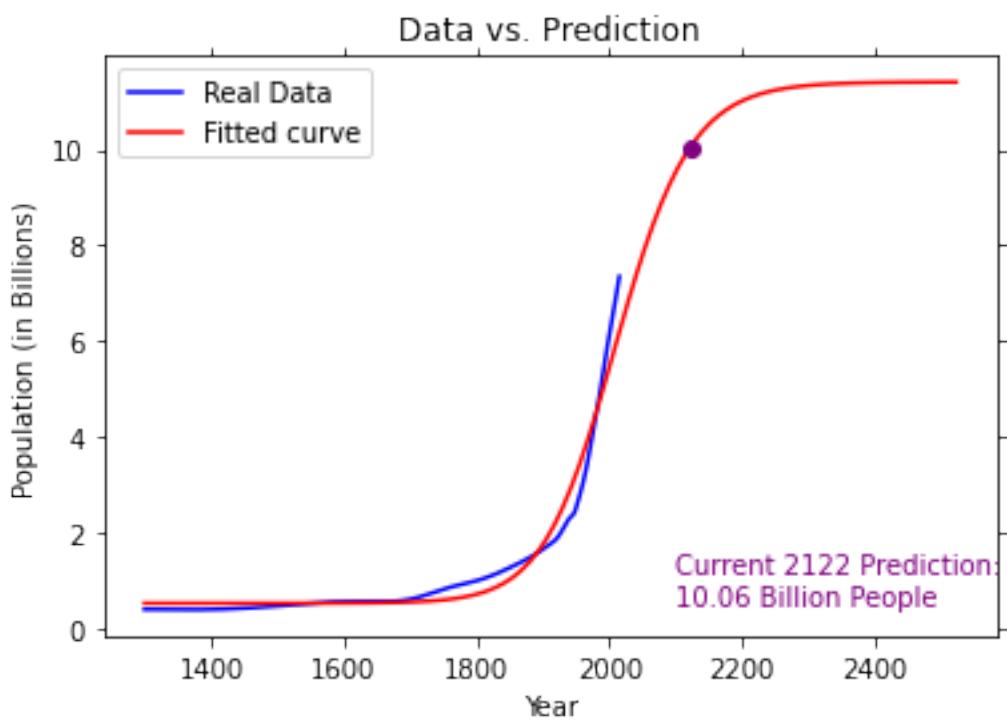
Iteration #2950, Loss: 0.0665726132881076



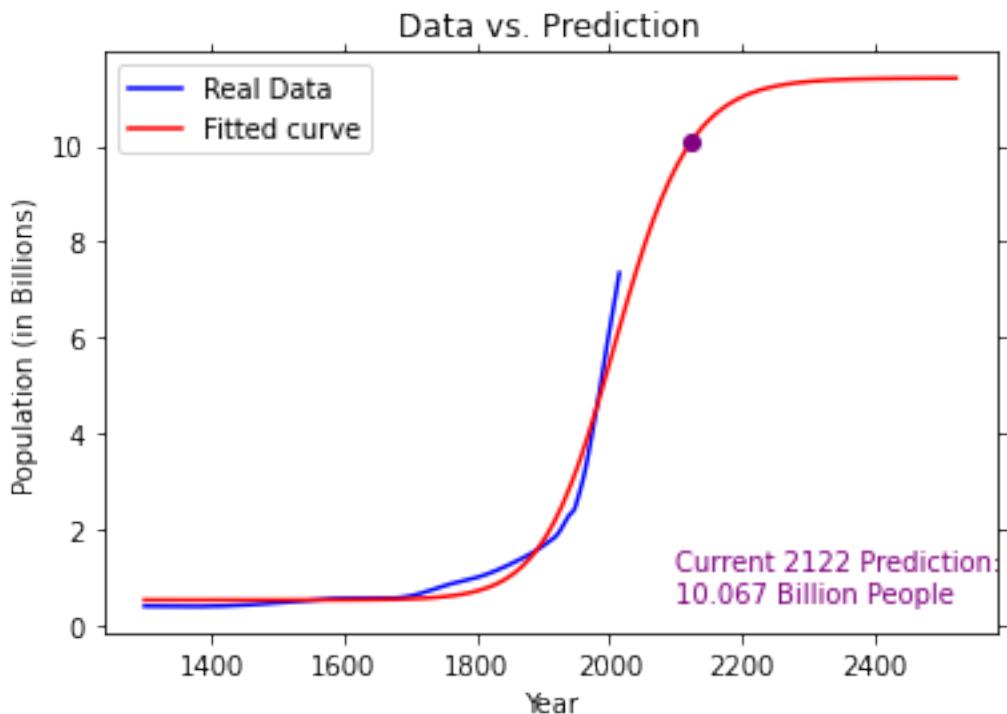
Iteration #3000, Loss: 0.06631706375651074



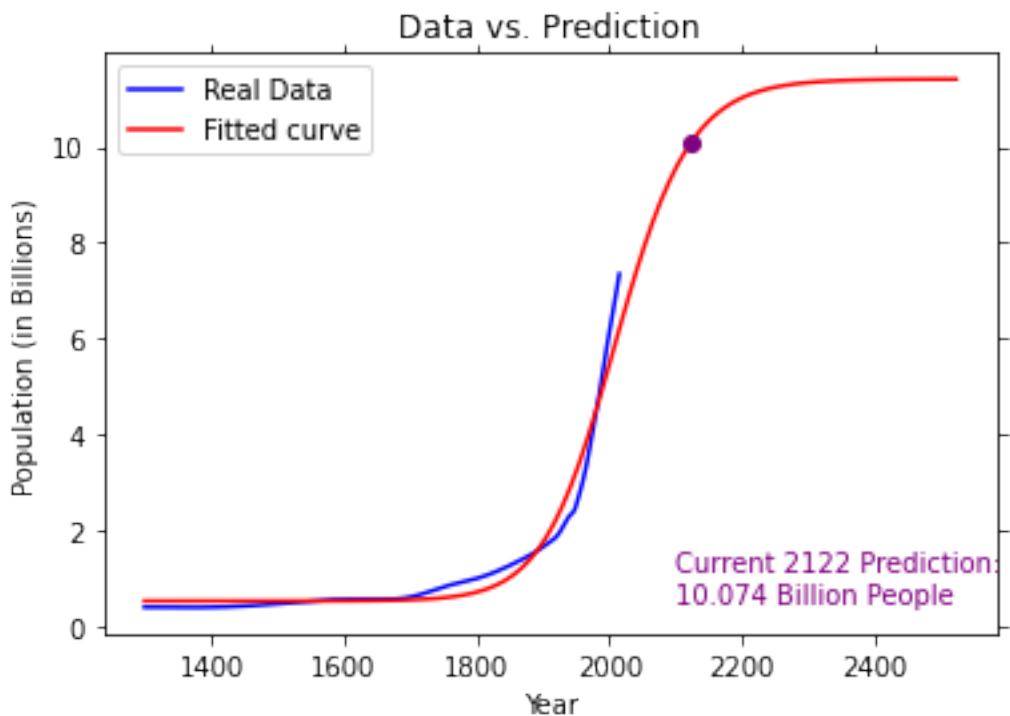
Iteration #3050, Loss: 0.06606885635215258



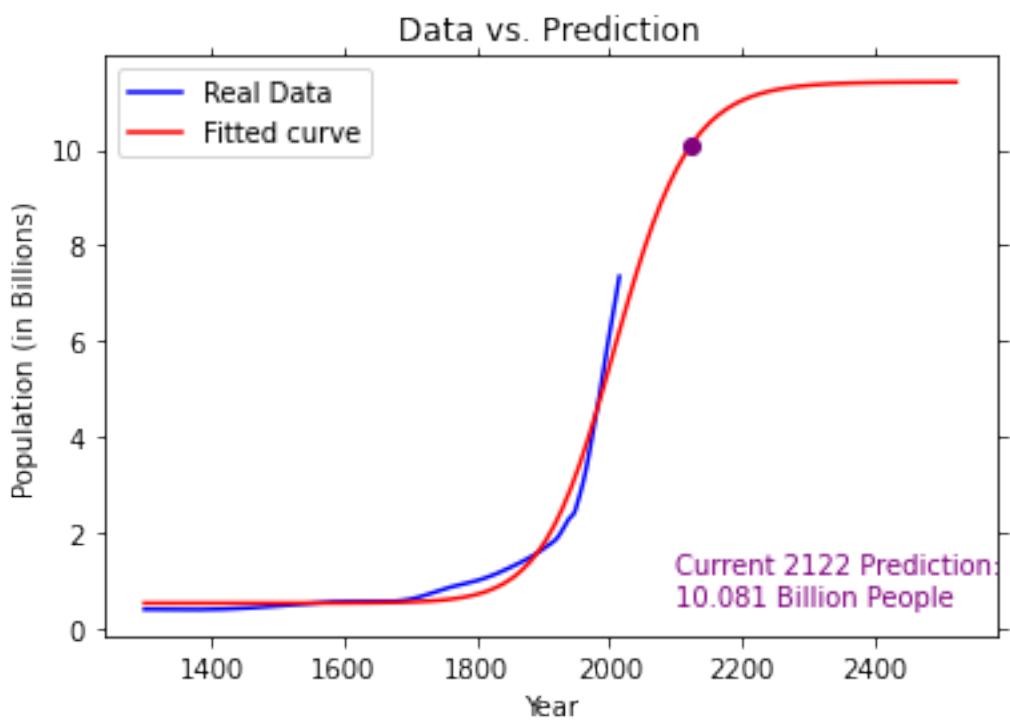
Iteration #3100, Loss: 0.06582768995938183



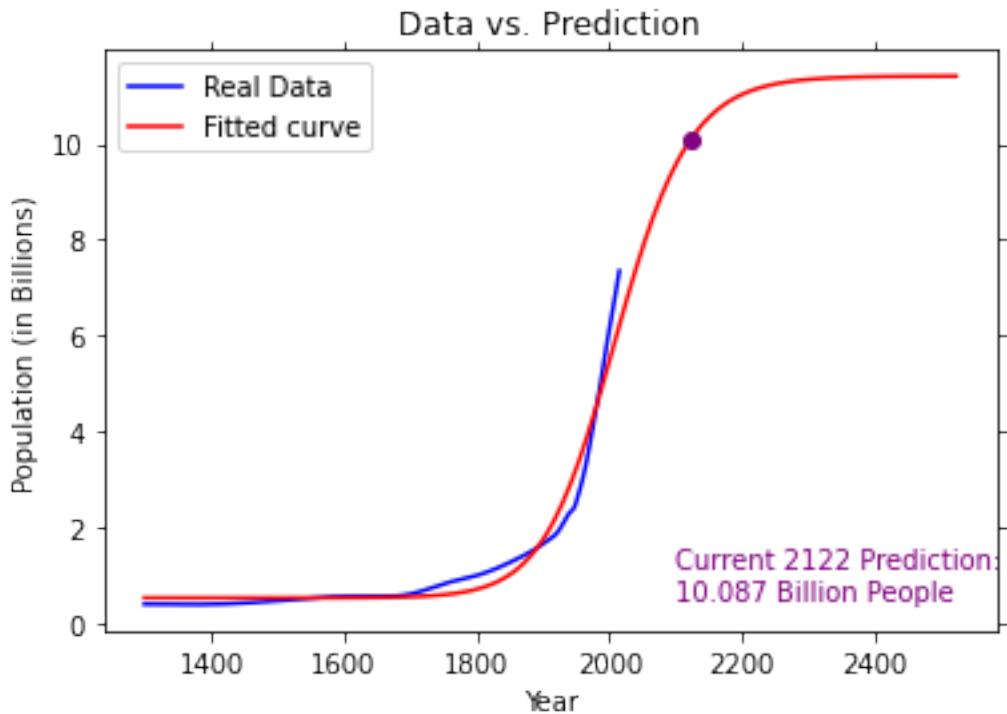
Iteration #3150, Loss: 0.0655932832230425



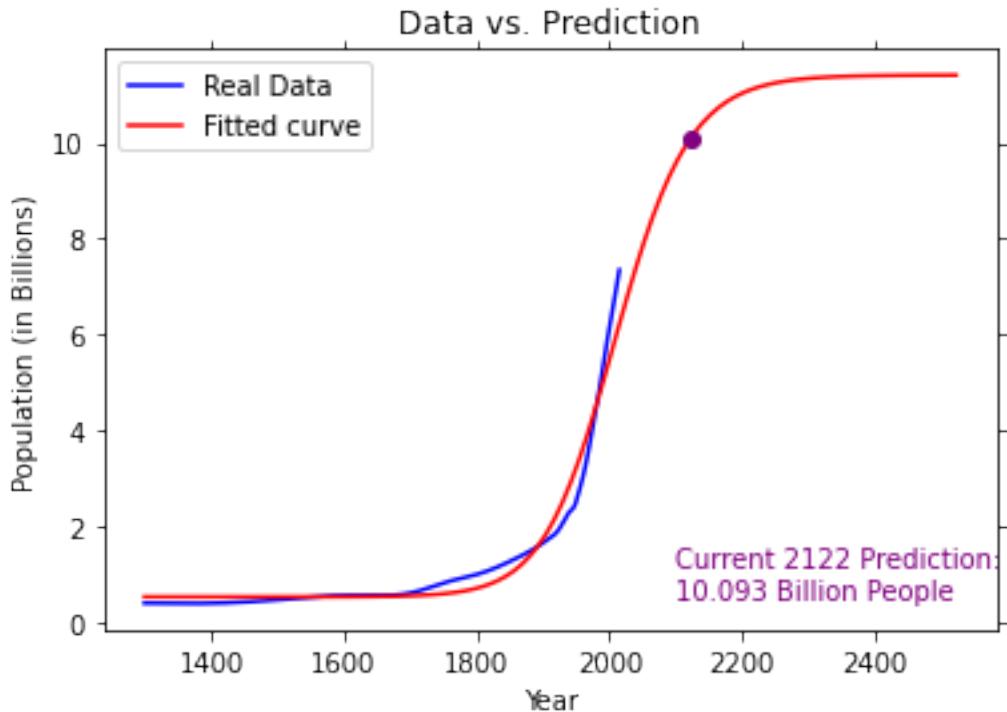
Iteration #3200, Loss: 0.06536537248375435



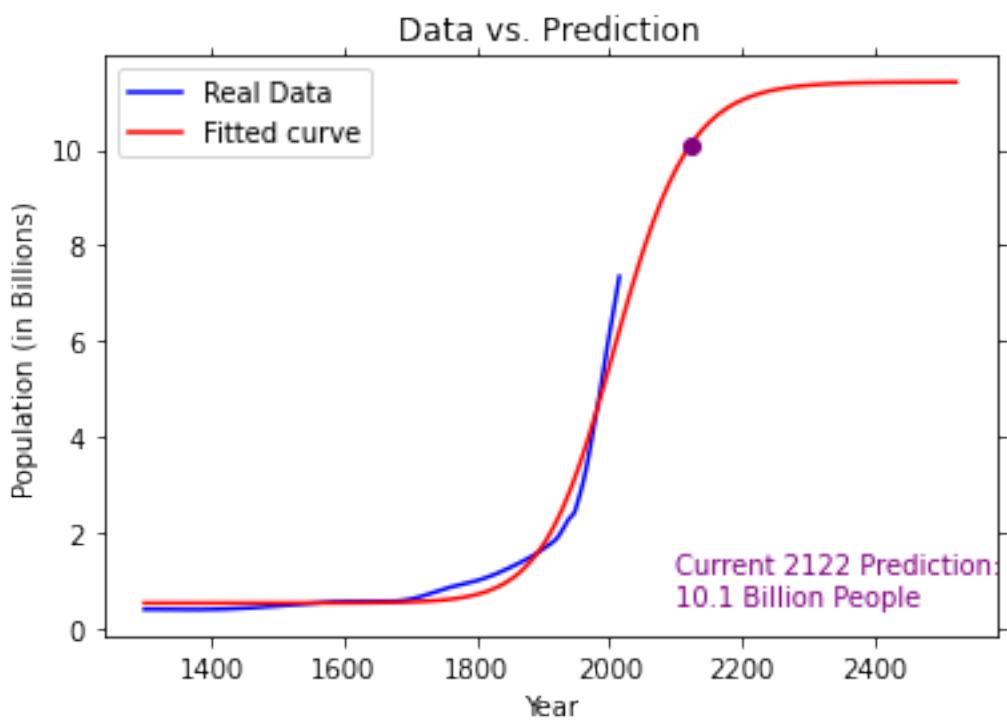
Iteration #3250, Loss: 0.0651437099929624



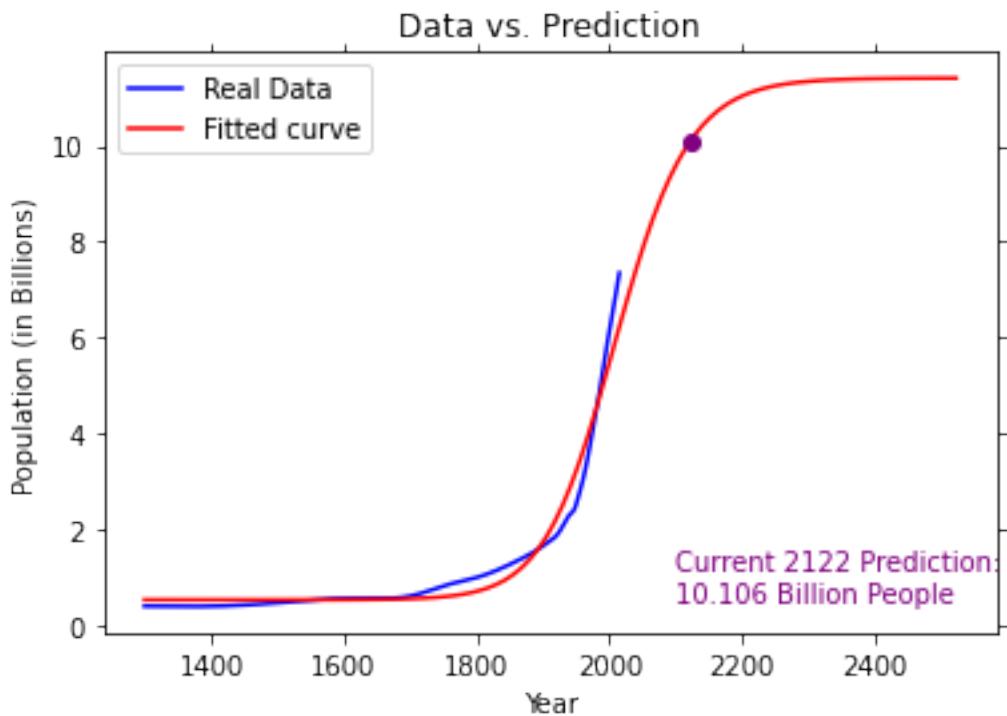
Iteration #3300, Loss: 0.06492806236579596



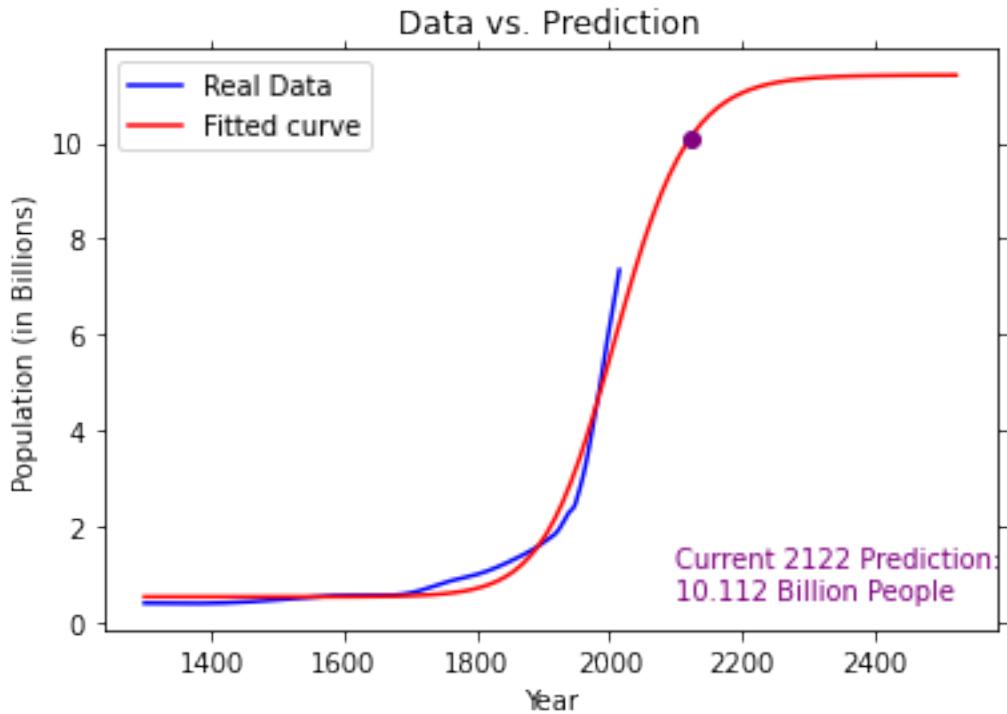
Iteration #3350, Loss: 0.06471820923631785



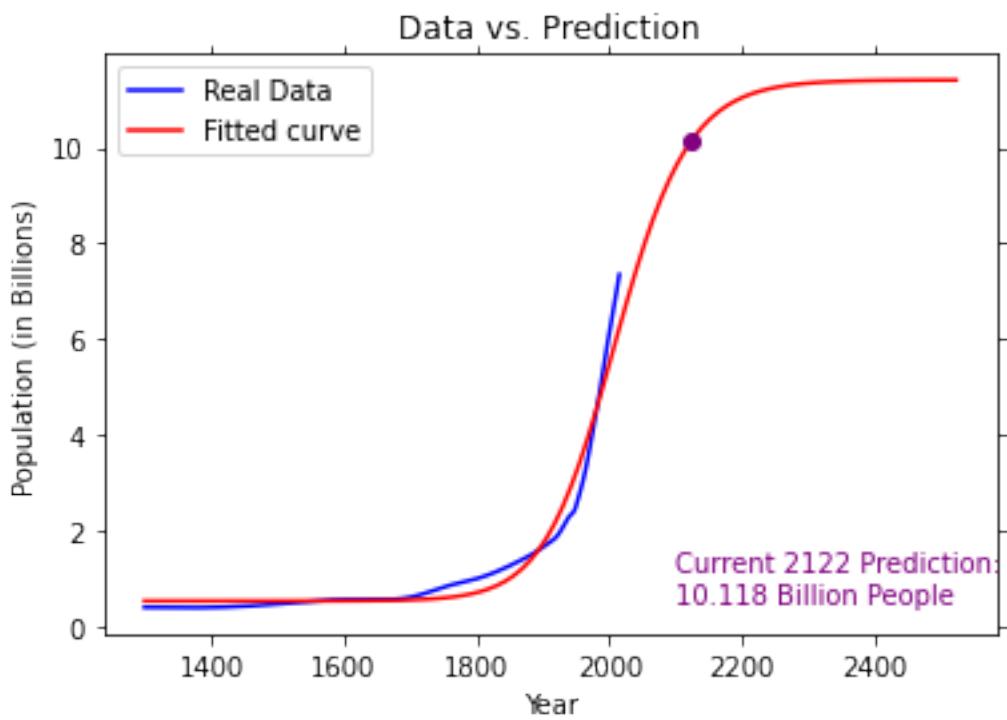
Iteration #3400, Loss: 0.06451394208525636



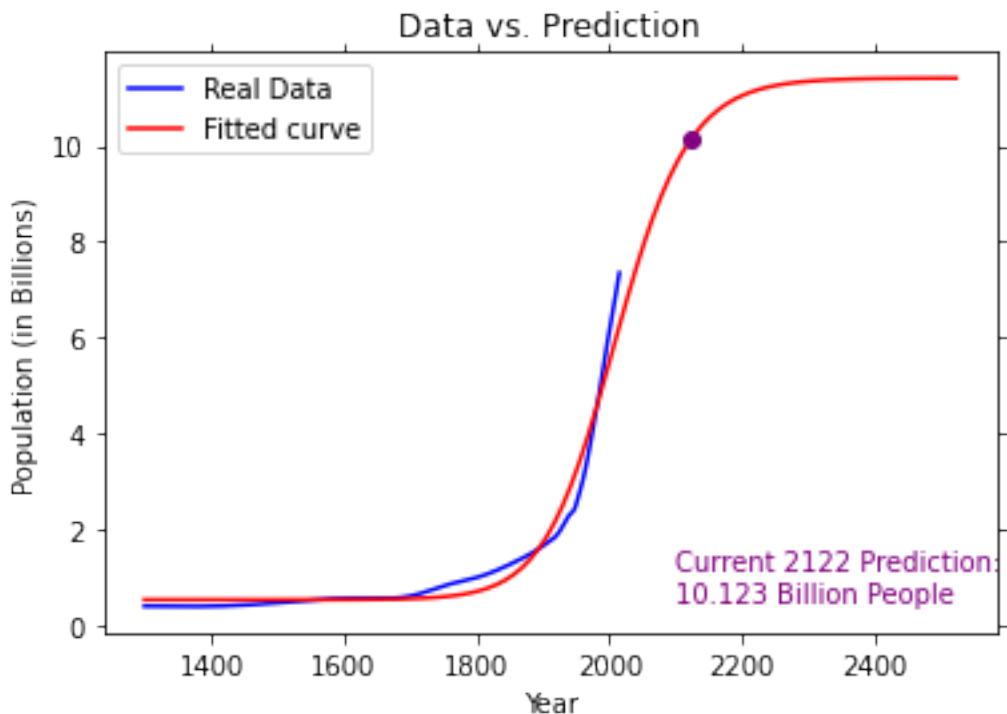
Iteration #3450, Loss: 0.06431506321493621



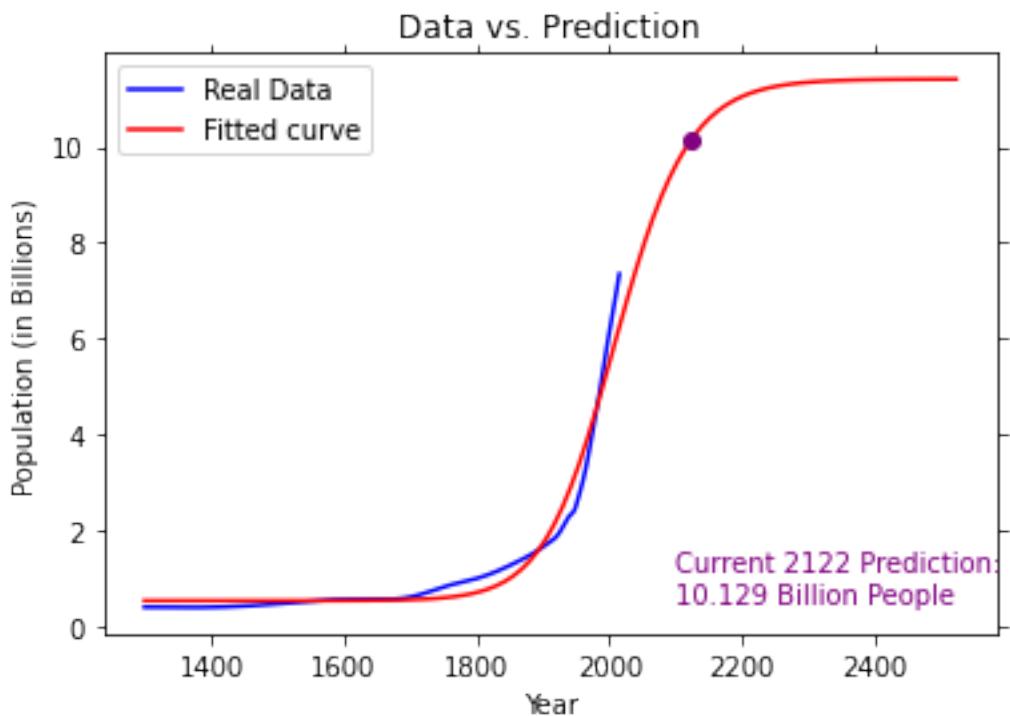
Iteration #3500, Loss: 0.06412138485002009



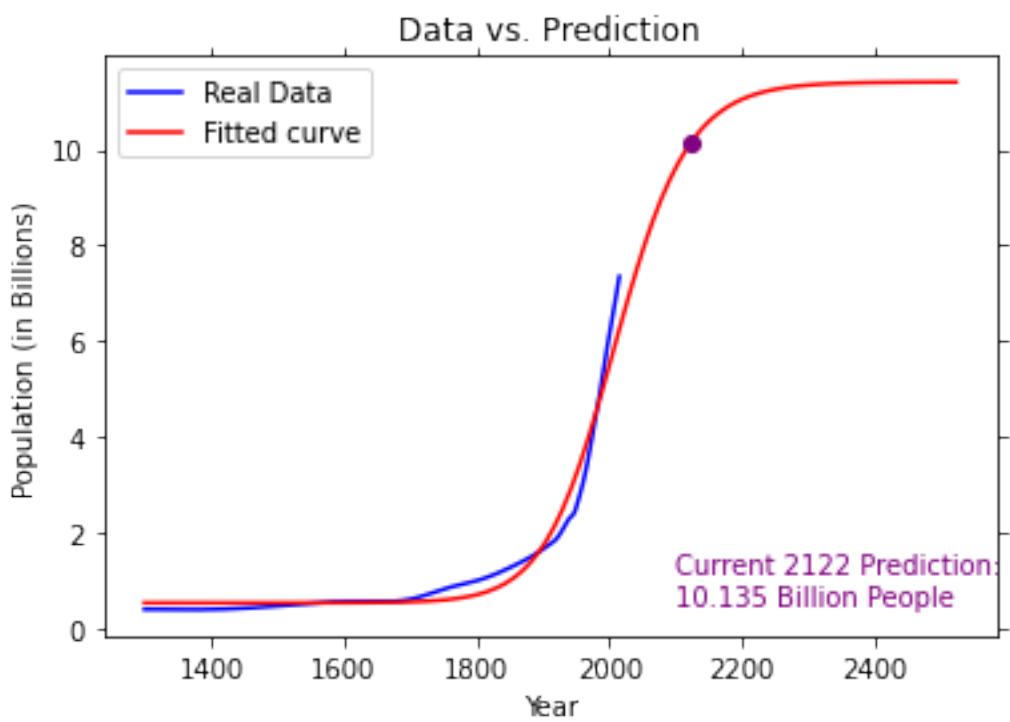
Iteration #3550, Loss: 0.06393272834595758



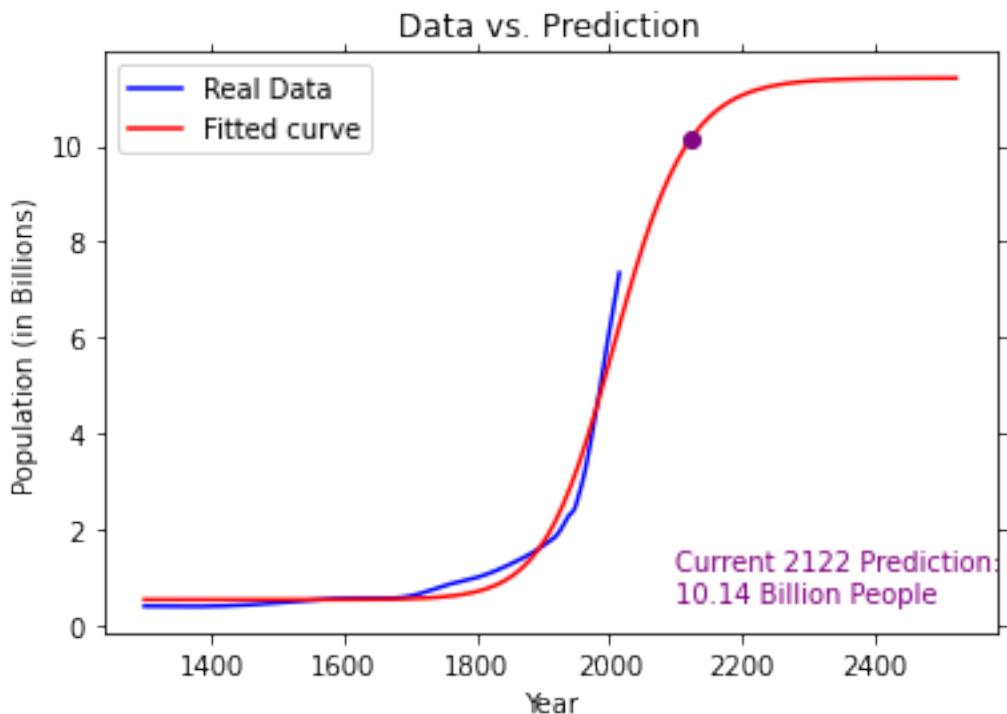
Iteration #3600, Loss: 0.06374892348979888



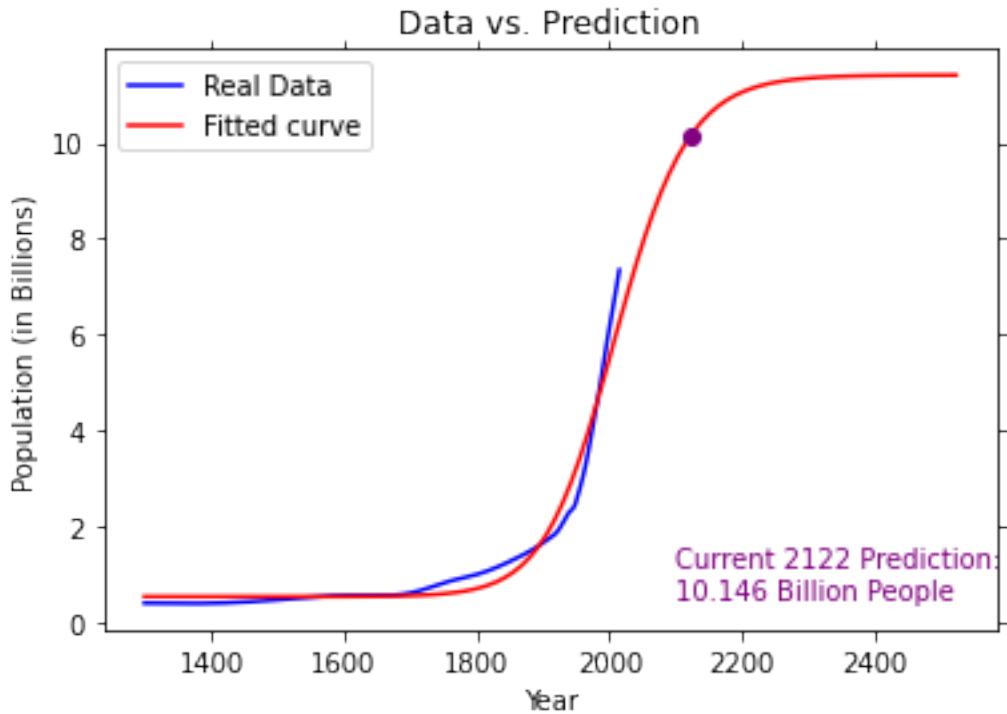
Iteration #3650, Loss: 0.06356980788036663



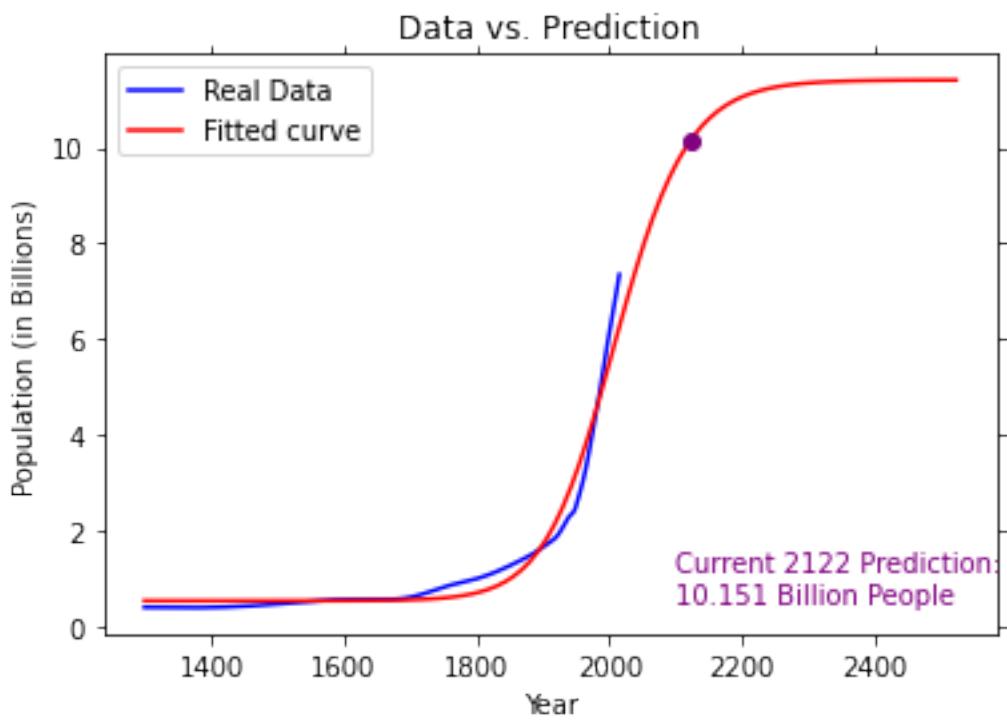
Iteration #3700, Loss: 0.06339522637674633



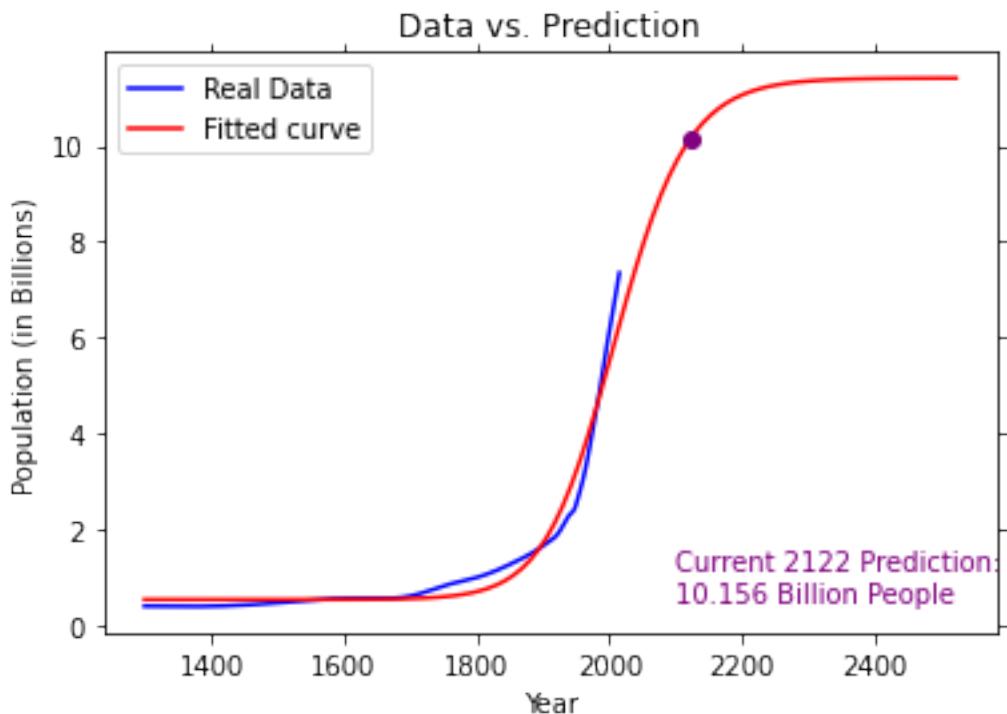
Iteration #3750, Loss: 0.06322503060571641



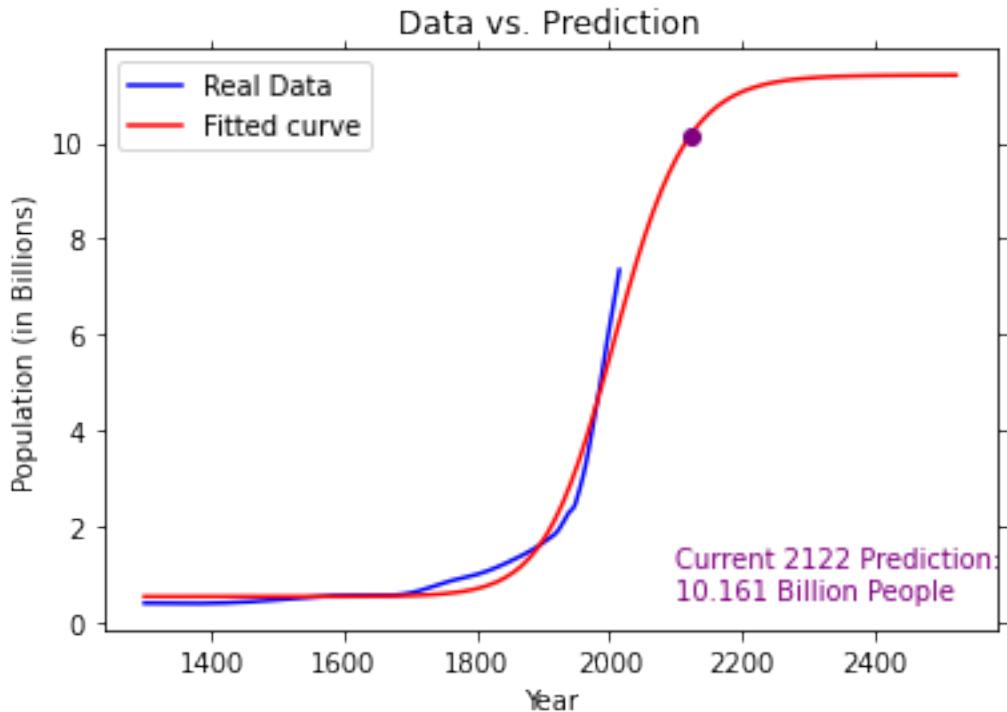
Iteration #3800, Loss: 0.06305907852014536



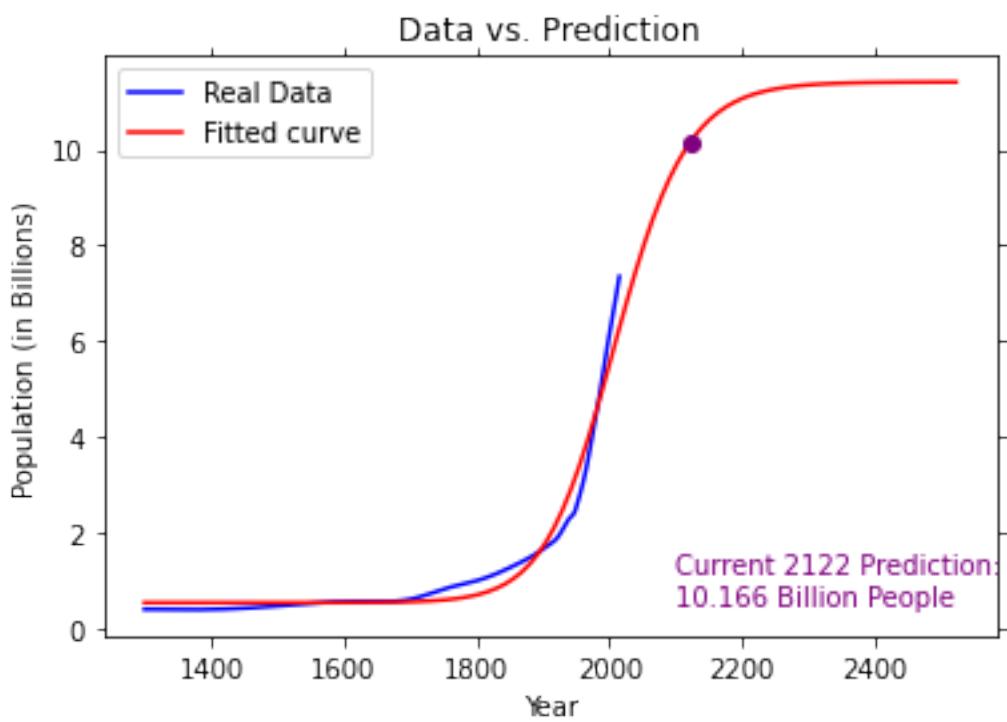
Iteration #3850, Loss: 0.06289723400156683



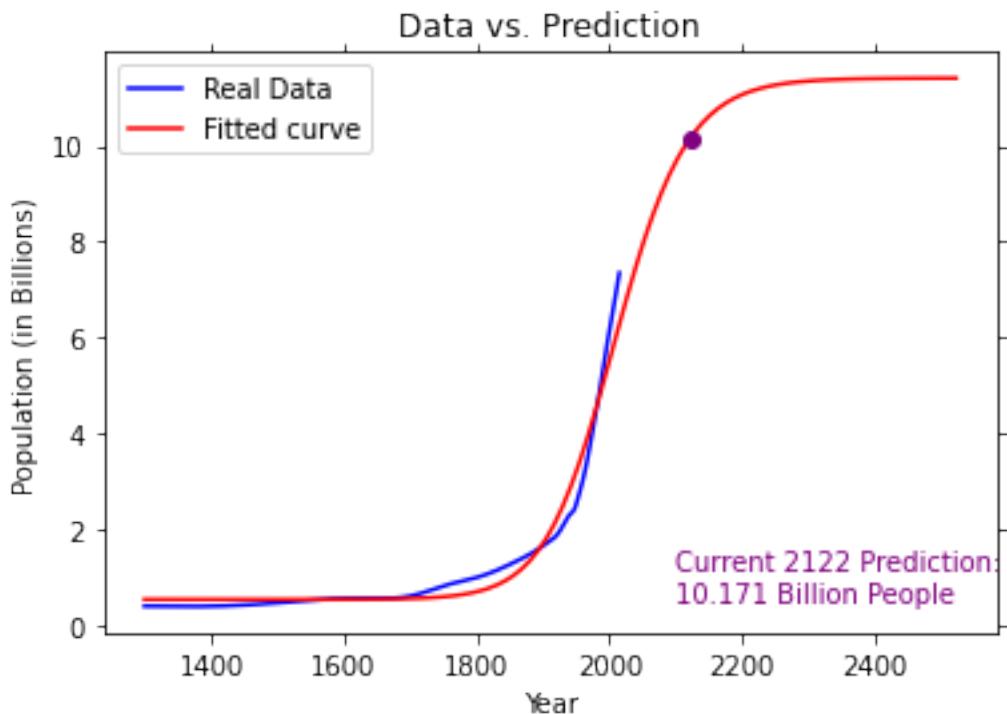
Iteration #3900, Loss: 0.06273936650115117



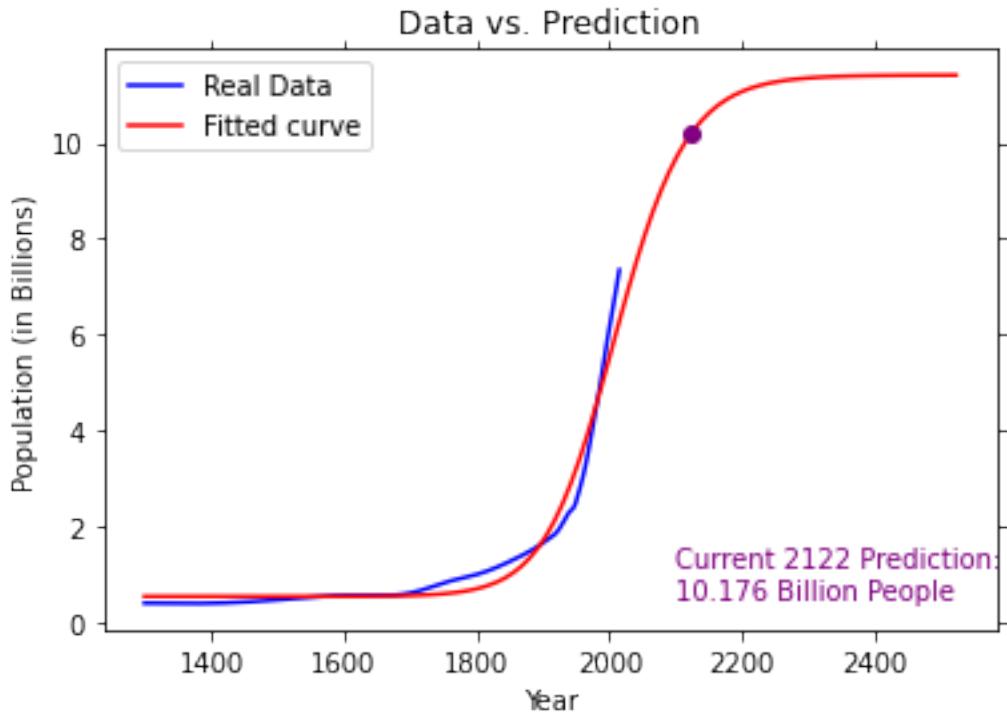
Iteration #3950, Loss: 0.06258535071413492



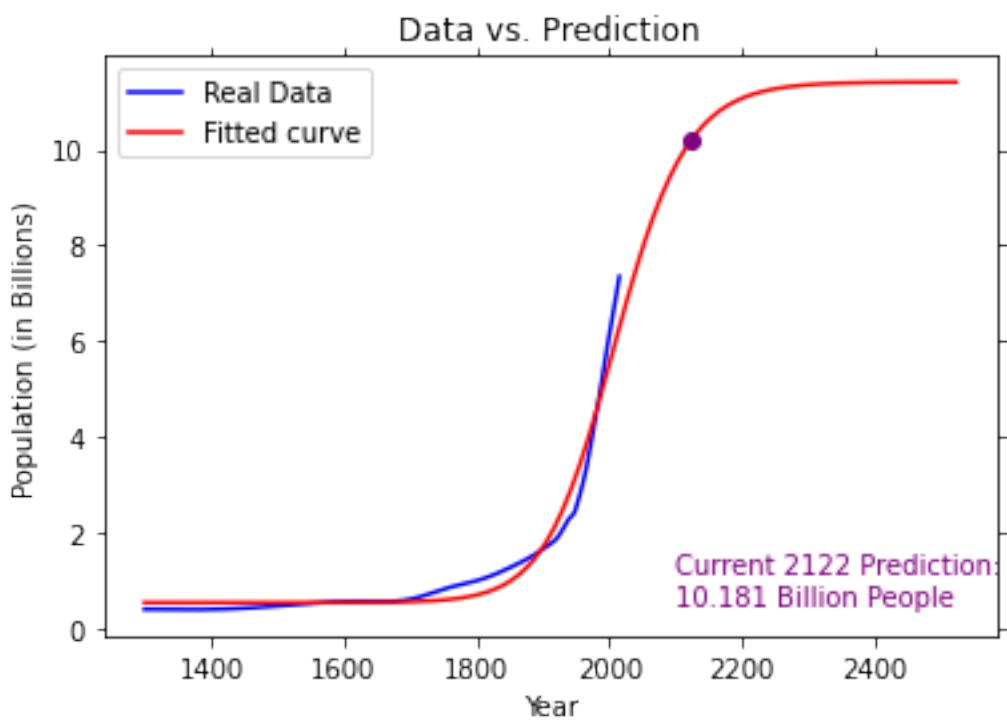
Iteration #4000, Loss: 0.062435066283497063



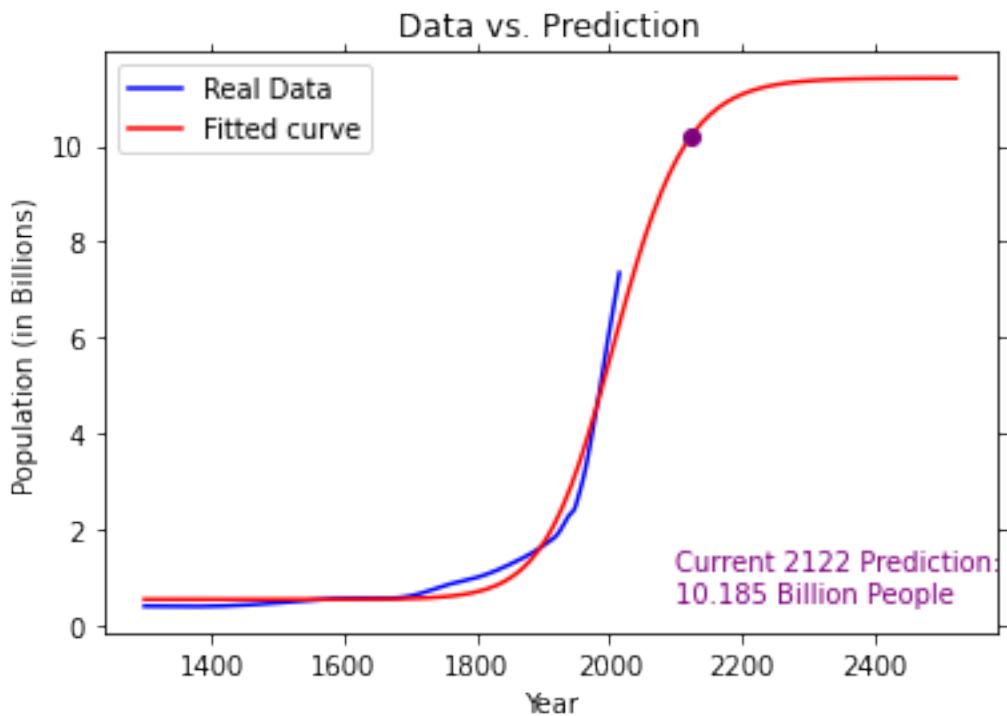
Iteration #4050, Loss: 0.06228839752927248



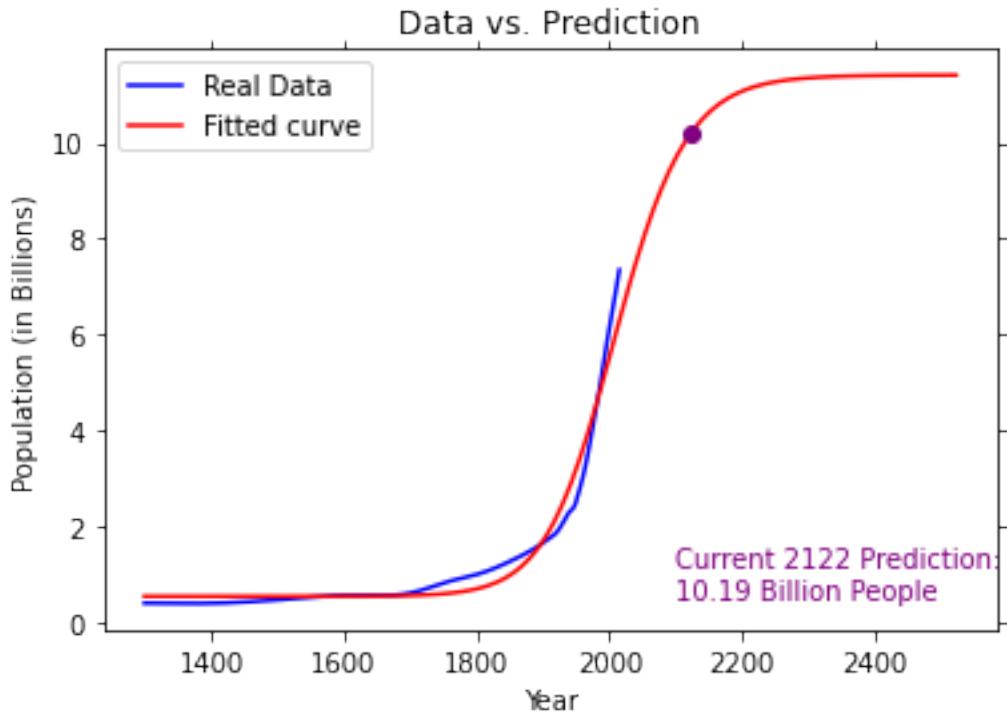
Iteration #4100, Loss: 0.06214523320041406



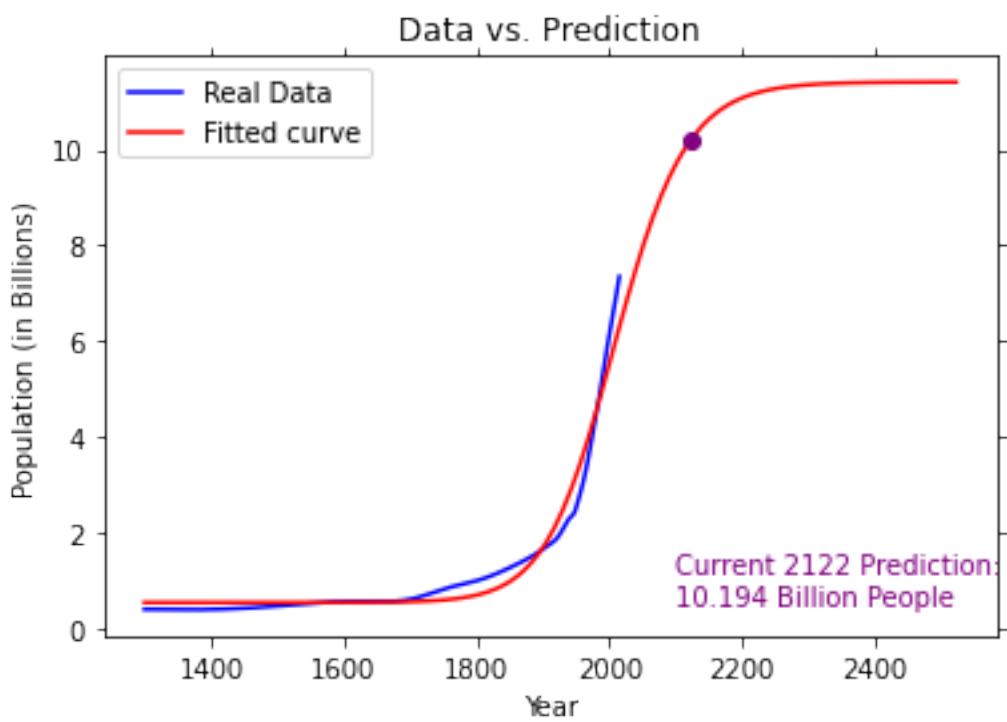
Iteration #4150, Loss: 0.06200546624655051



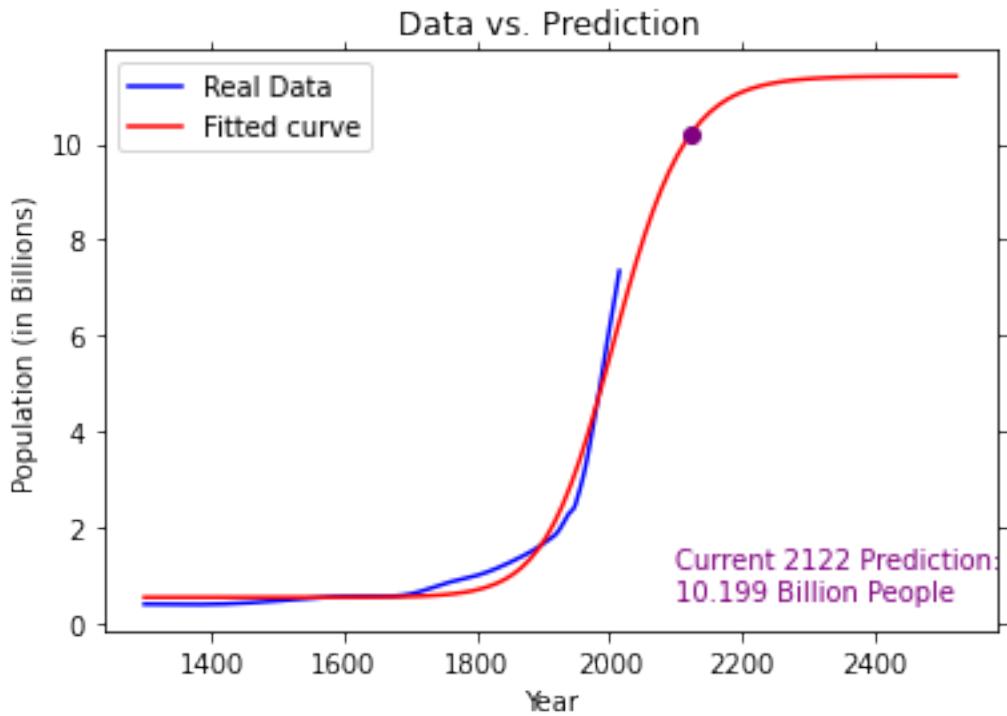
Iteration #4200, Loss: 0.06186899360736192



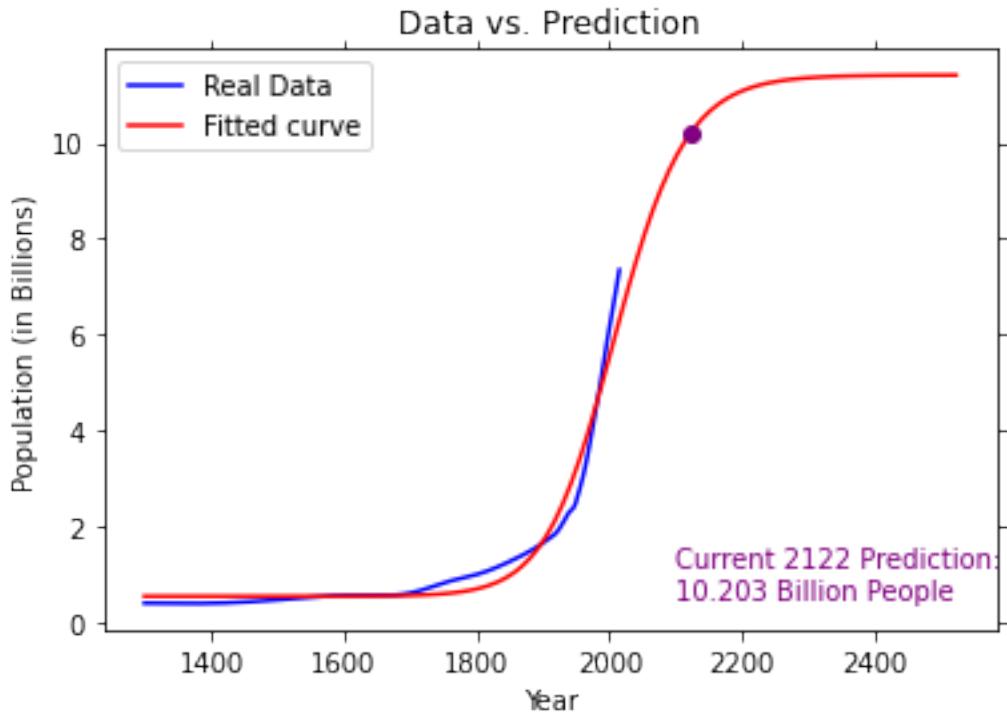
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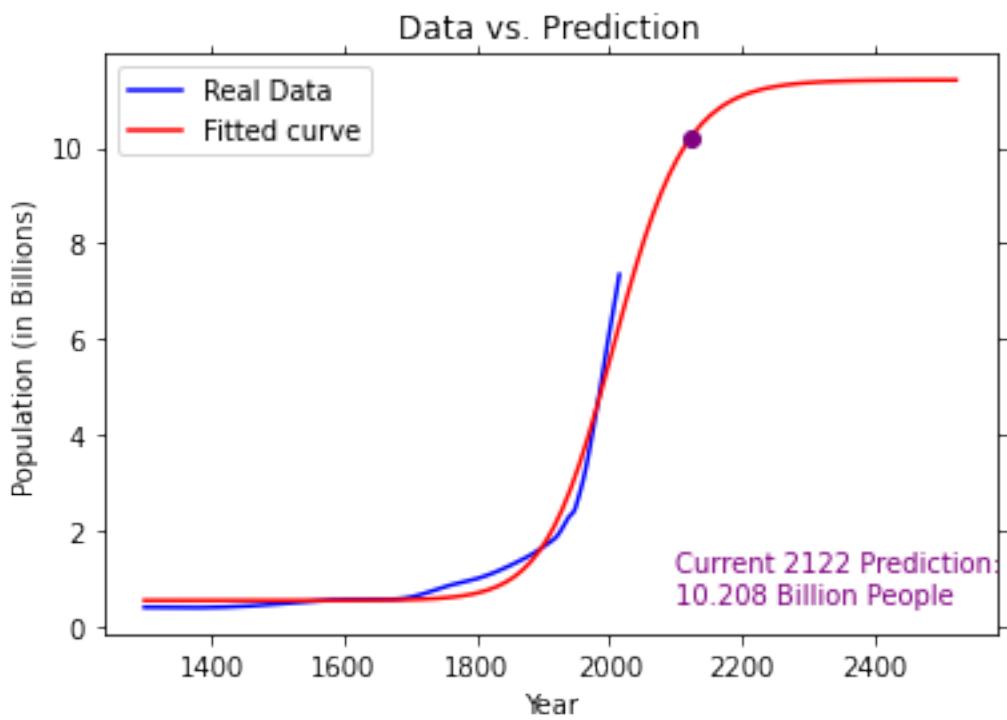
Iteration #4300, Loss: 0.061605537826108586



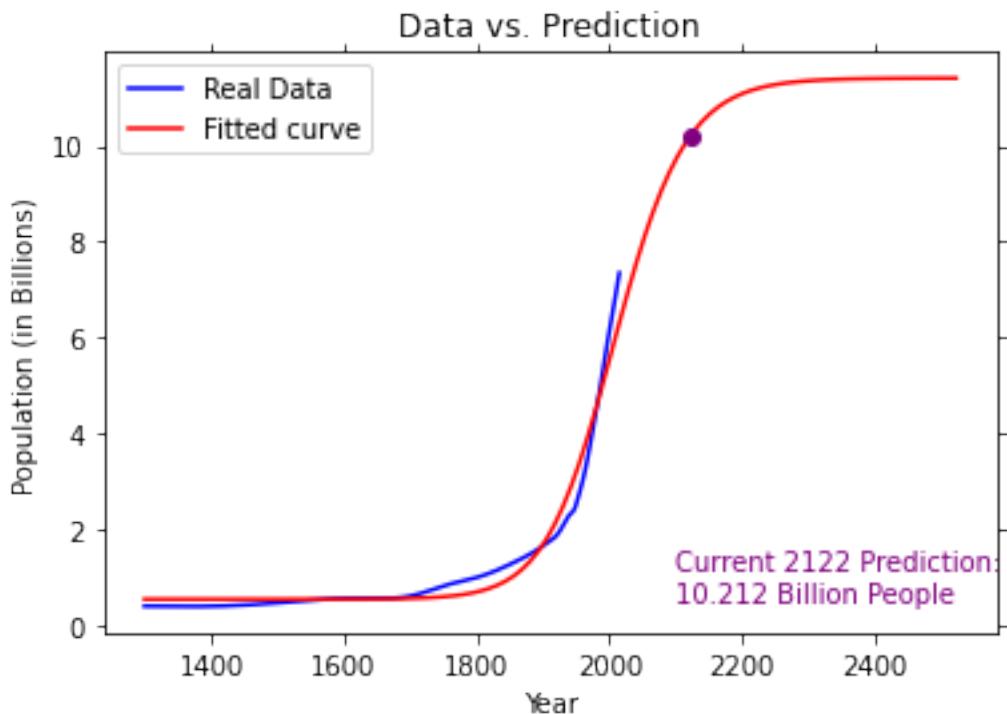
Iteration #4350, Loss: 0.061478366827231457



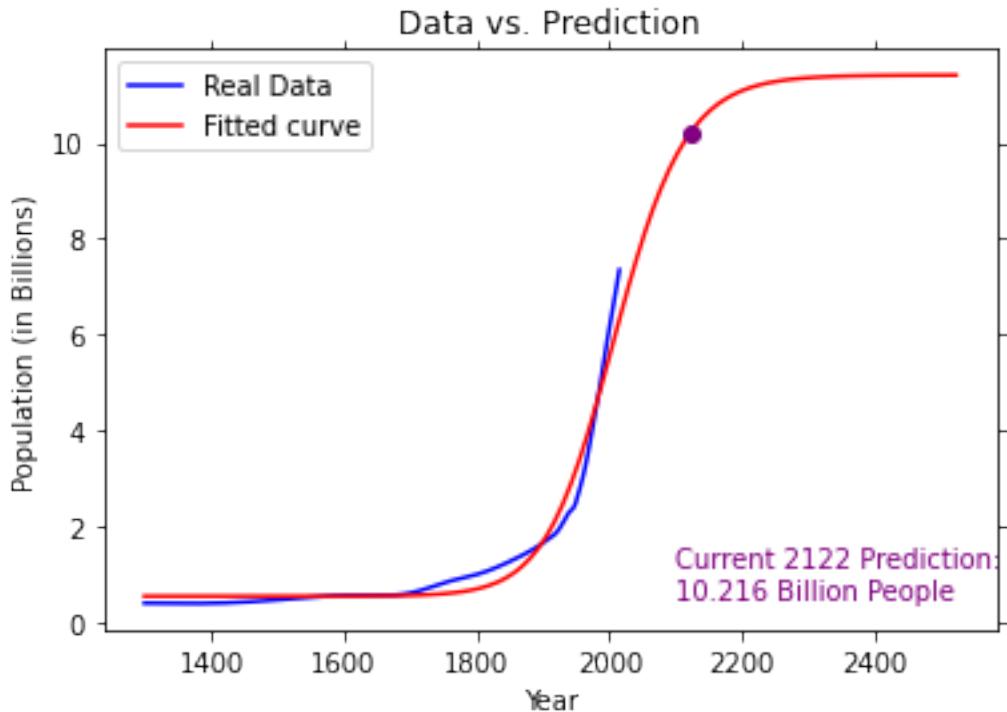
Iteration #4400, Loss: 0.0613541141035789



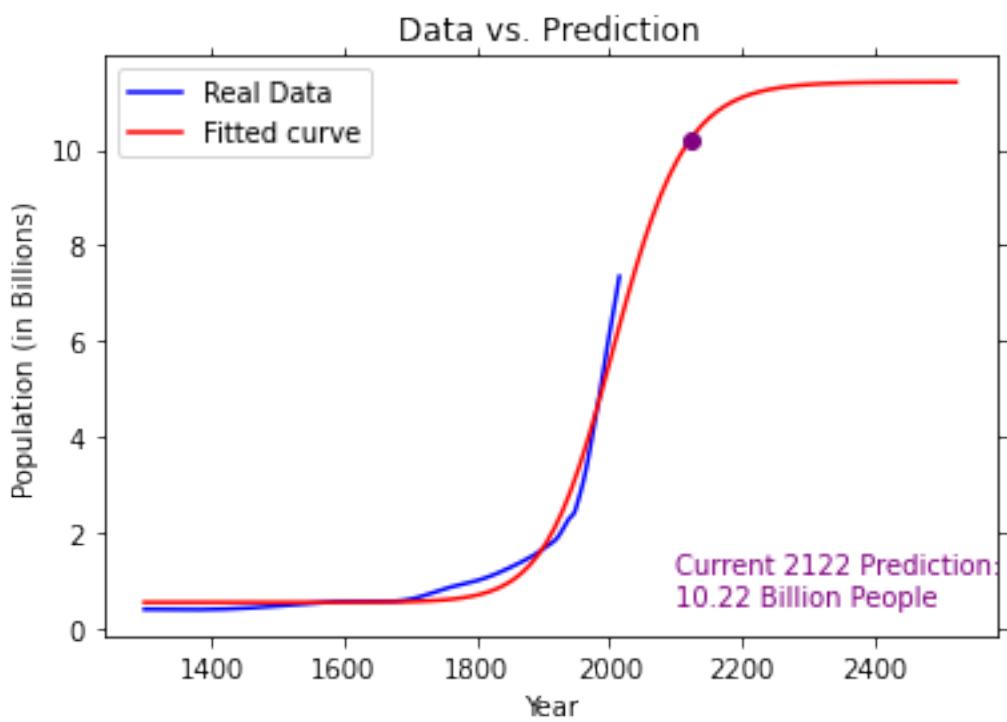
Iteration #4450, Loss: 0.06123269387880512



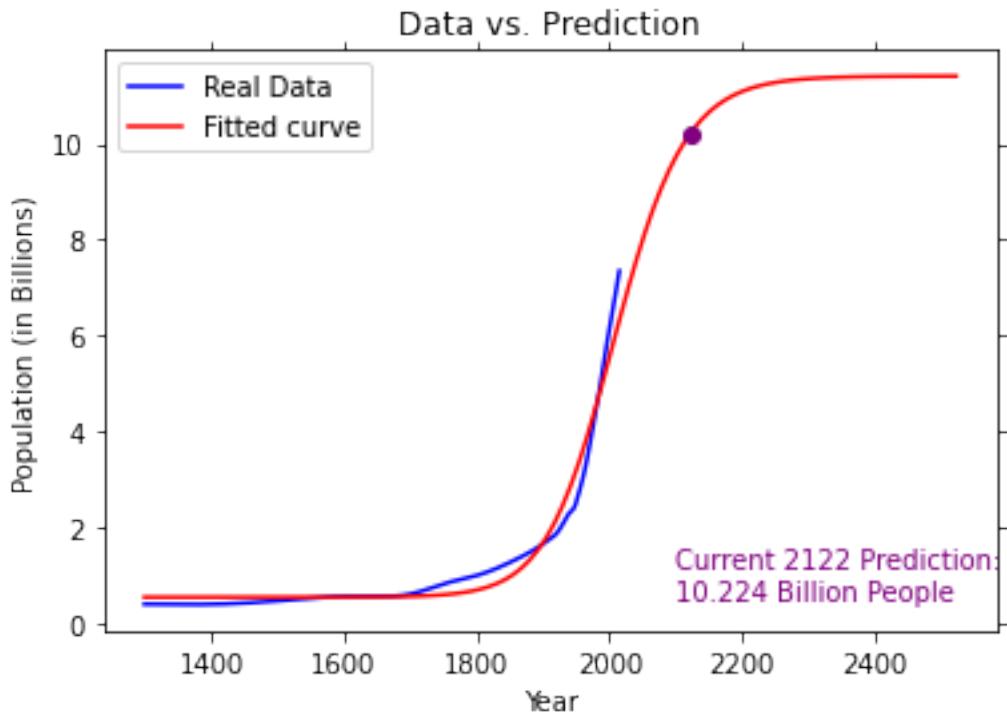
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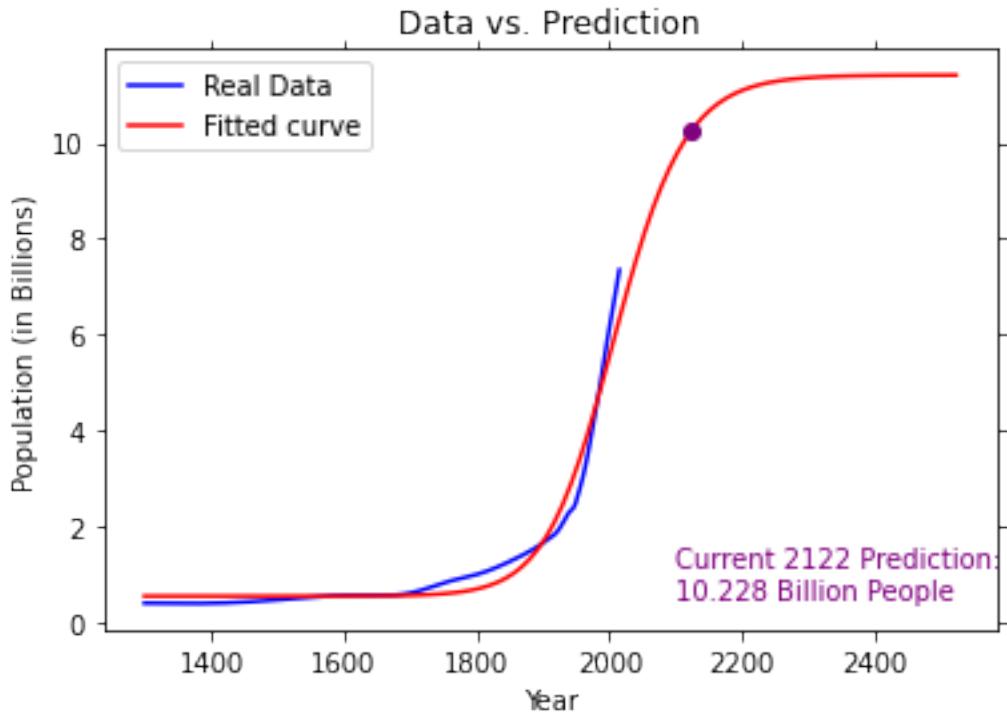
Iteration #4550, Loss: 0.06099802270586436



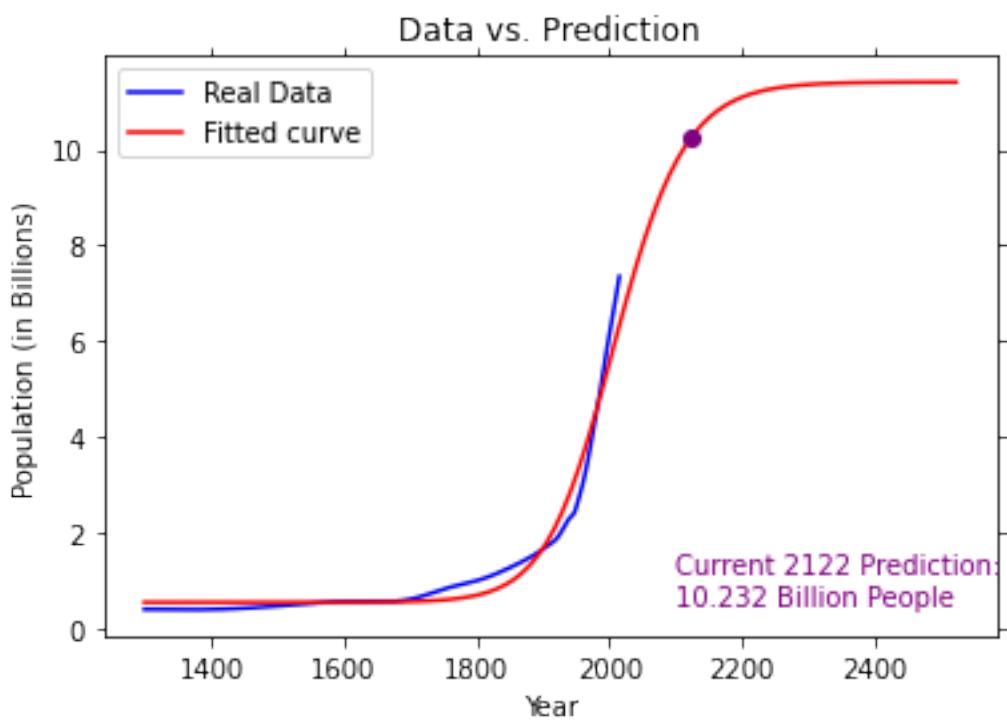
Iteration #4600, Loss: 0.06088461470875394



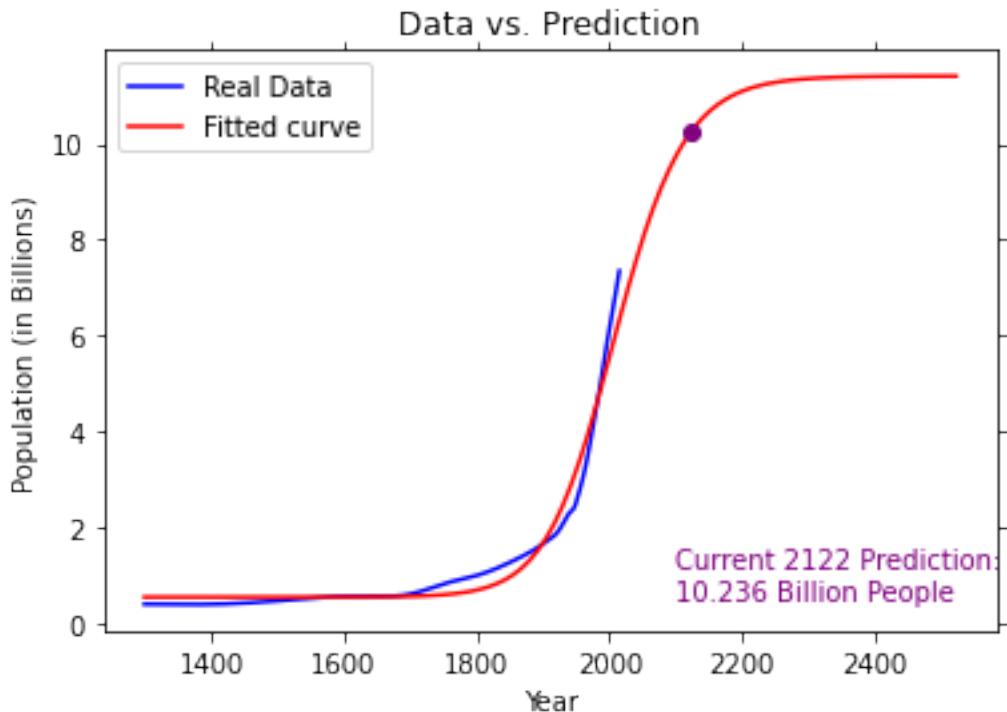
Iteration #4650, Loss: 0.06077372487525295



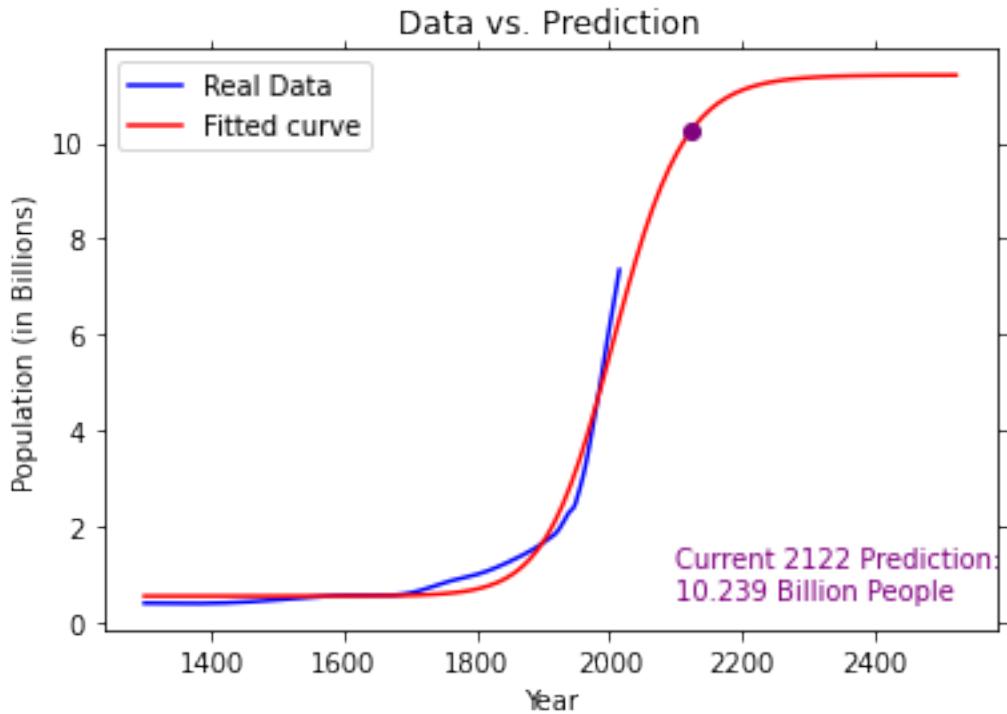
Iteration #4700, Loss: 0.060665281219393616



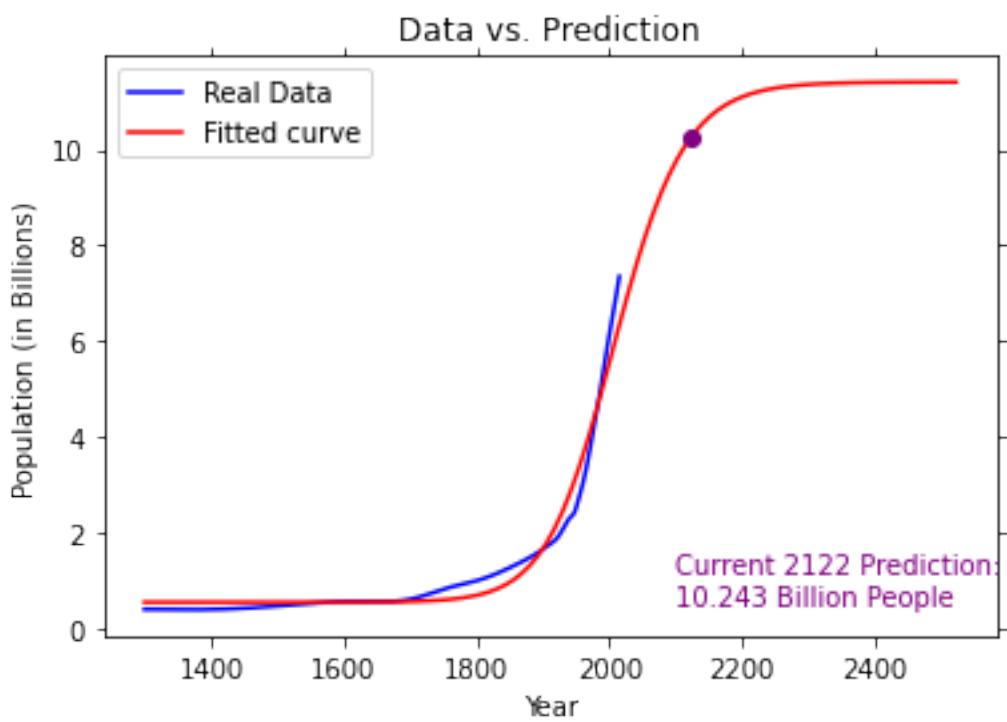
Iteration #4750, Loss: 0.060559214179202854



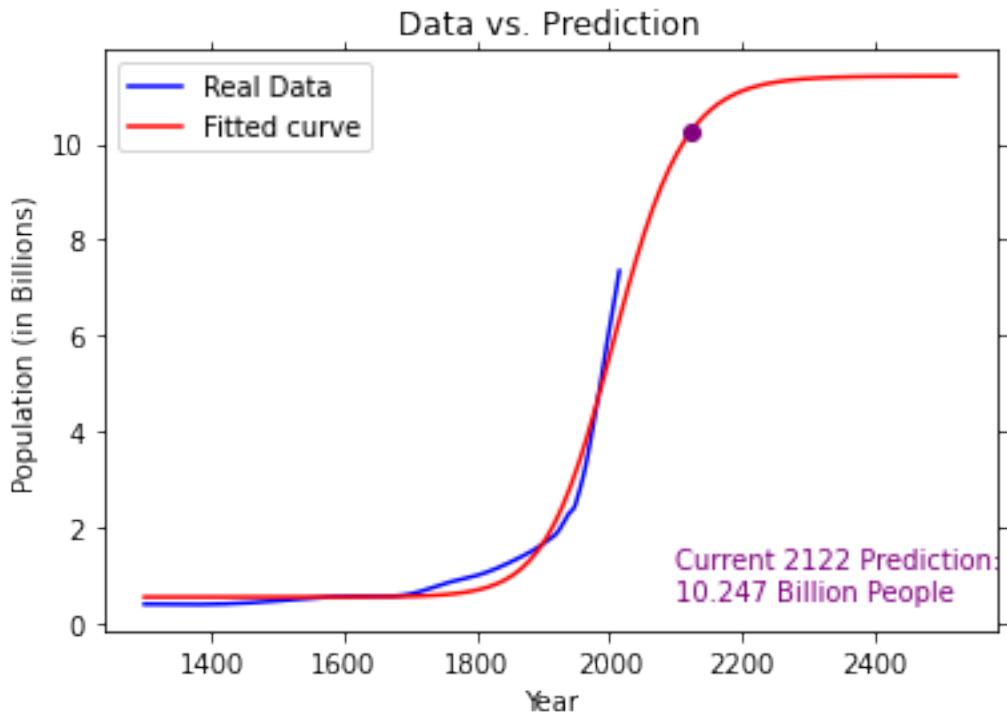
Iteration #4800, Loss: 0.06045545651906371



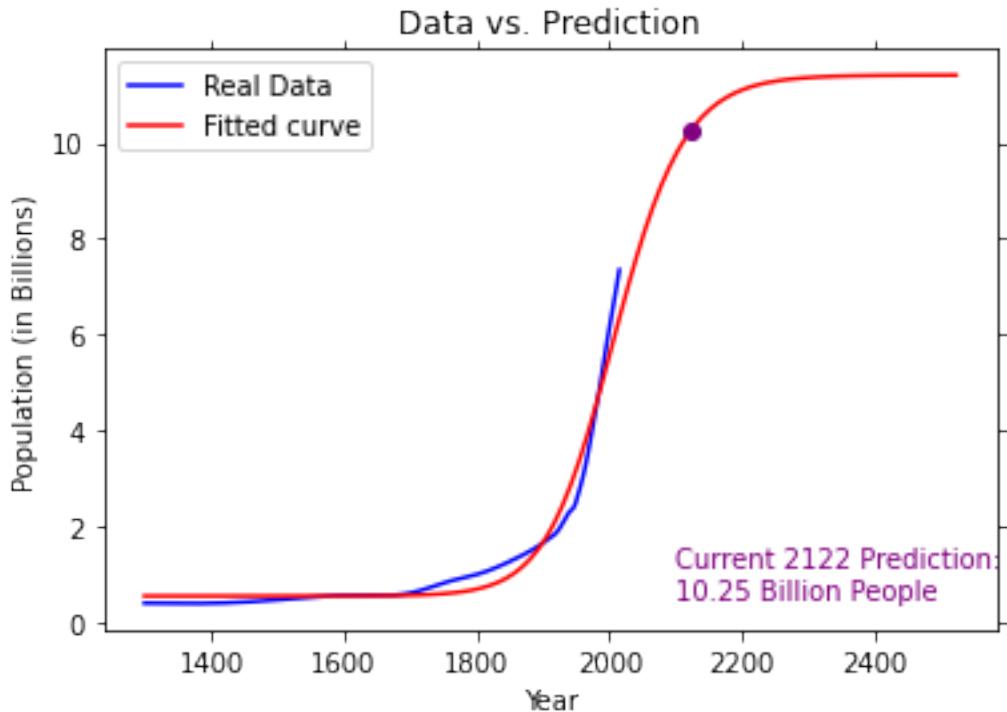
Iteration #4850, Loss: 0.06035394323707025



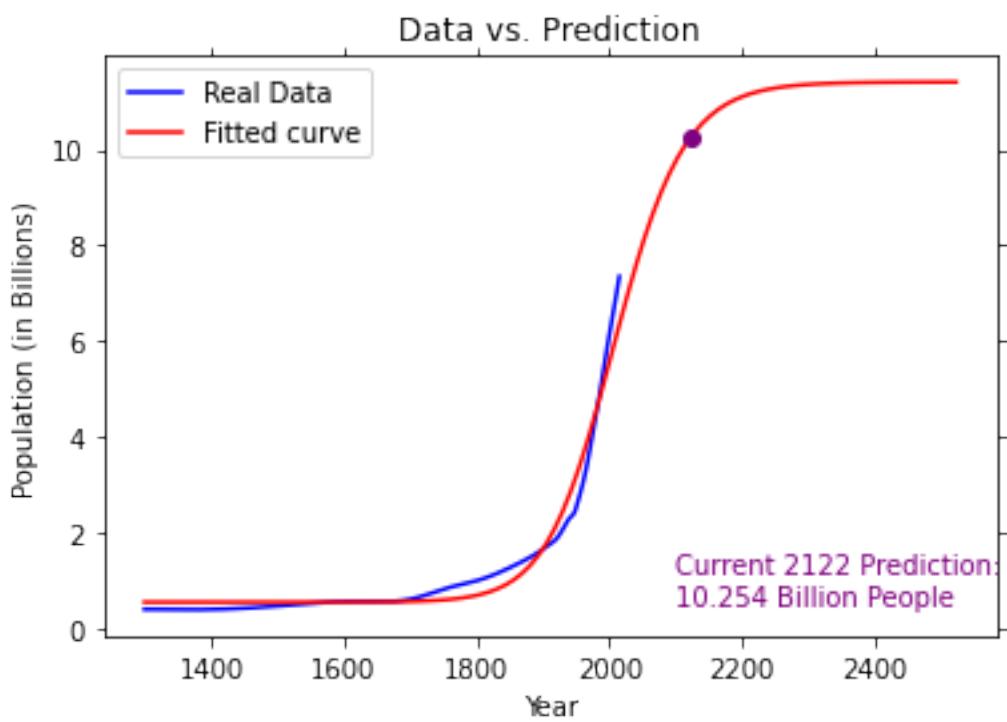
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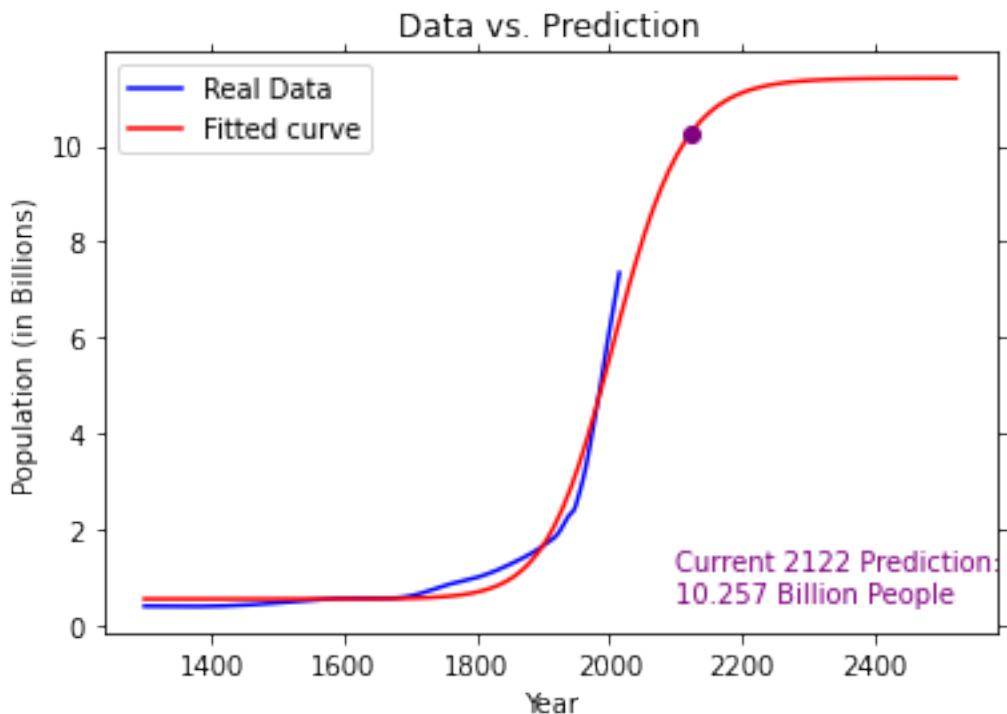
Iteration #4950, Loss: 0.06015740044471833



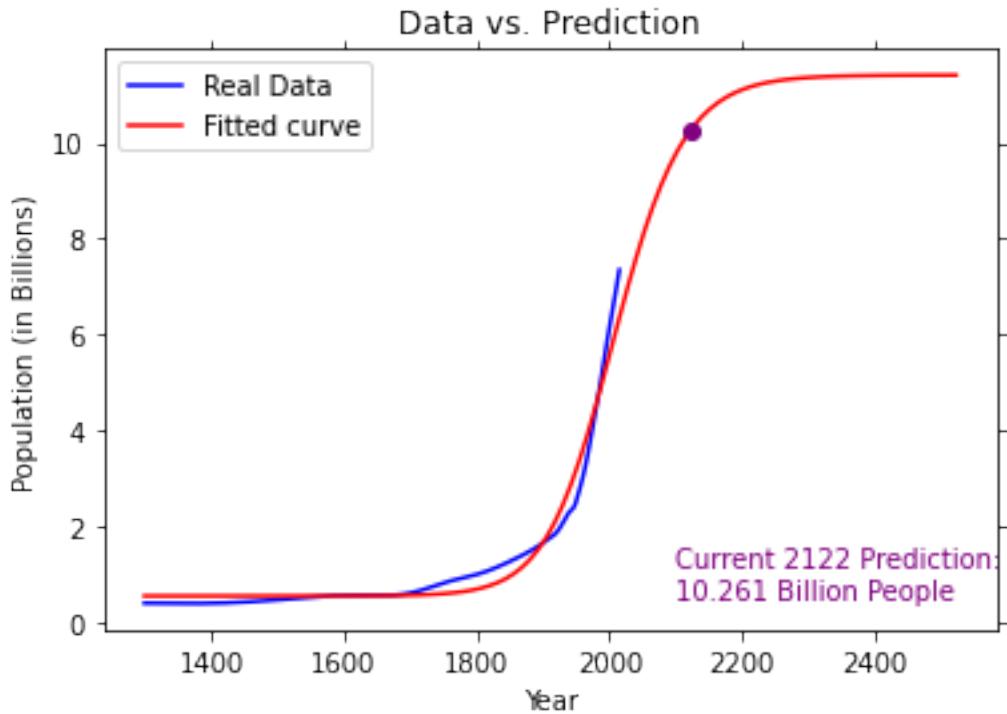
Iteration #5000, Loss: 0.06006225132831242



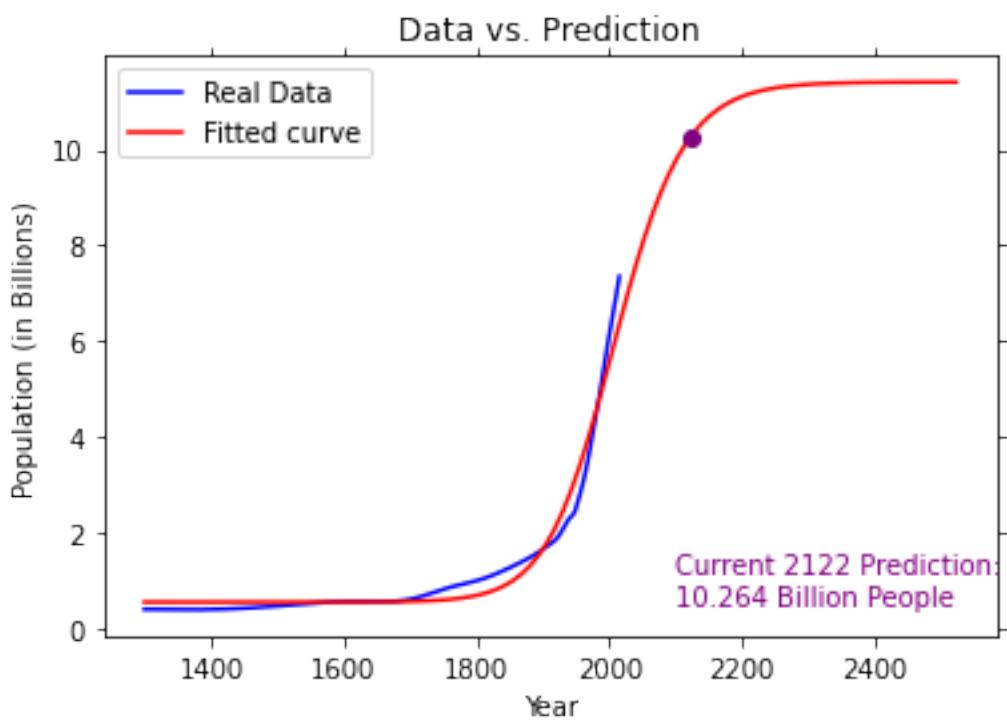
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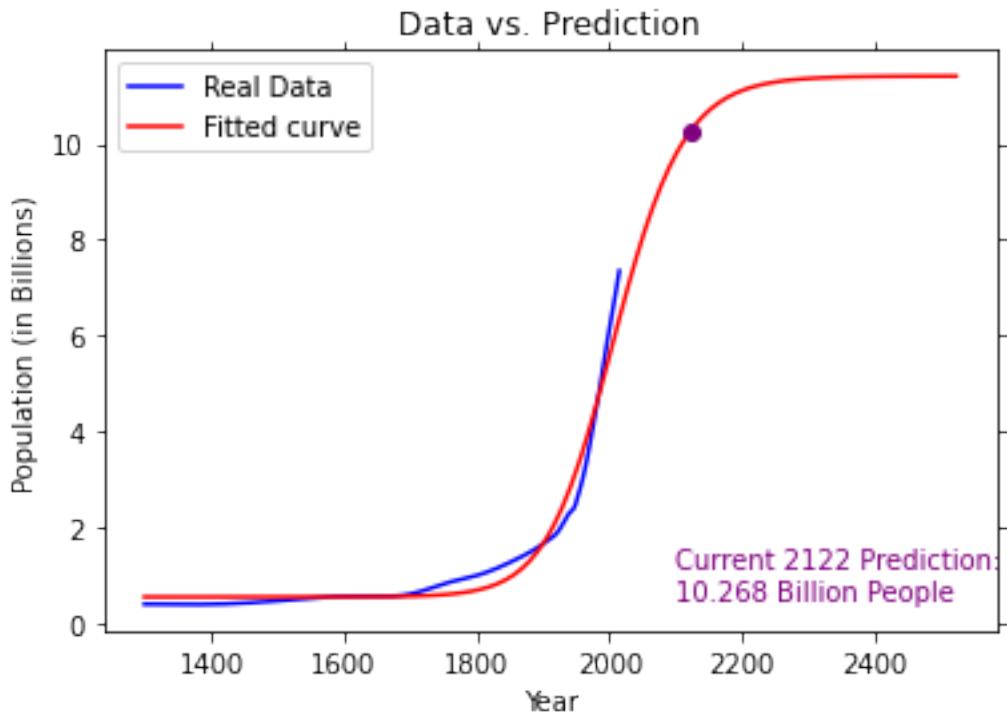
Iteration #5100, Loss: 0.05987791305556479



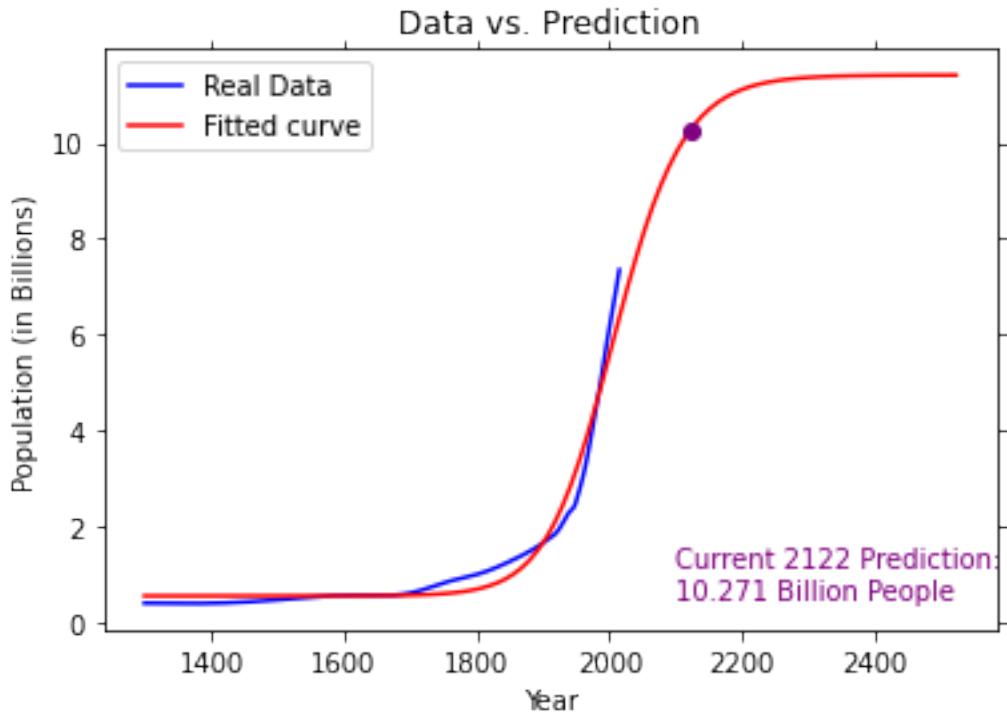
Iteration #5150, Loss: 0.05978861552148049



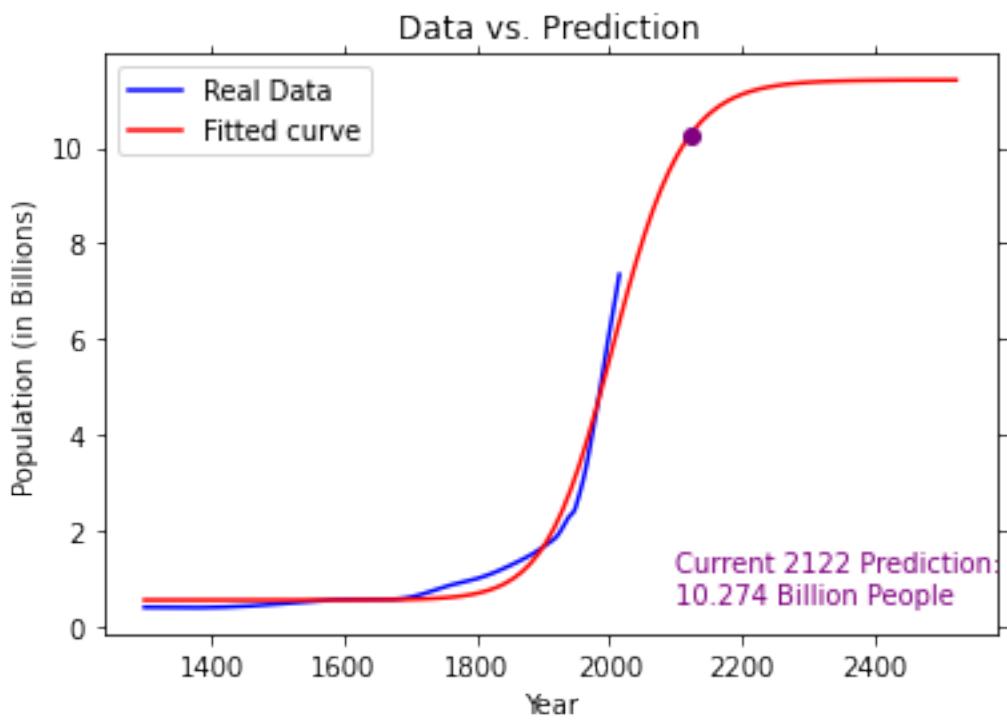
Iteration #5200, Loss: 0.05970116301278174



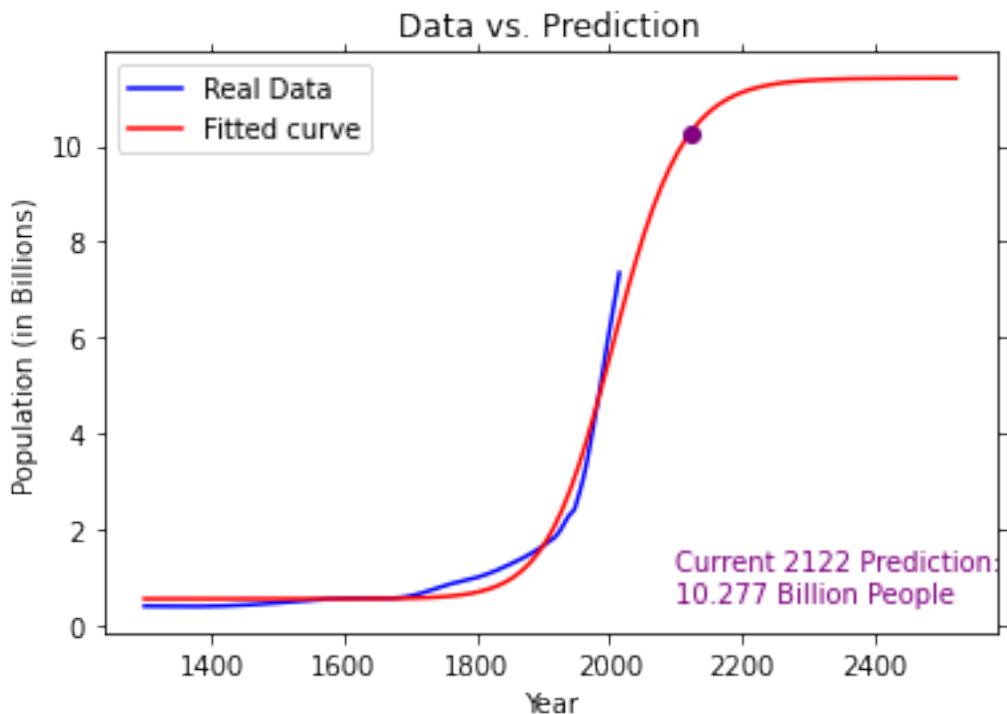
Iteration #5250, Loss: 0.05961550555812763



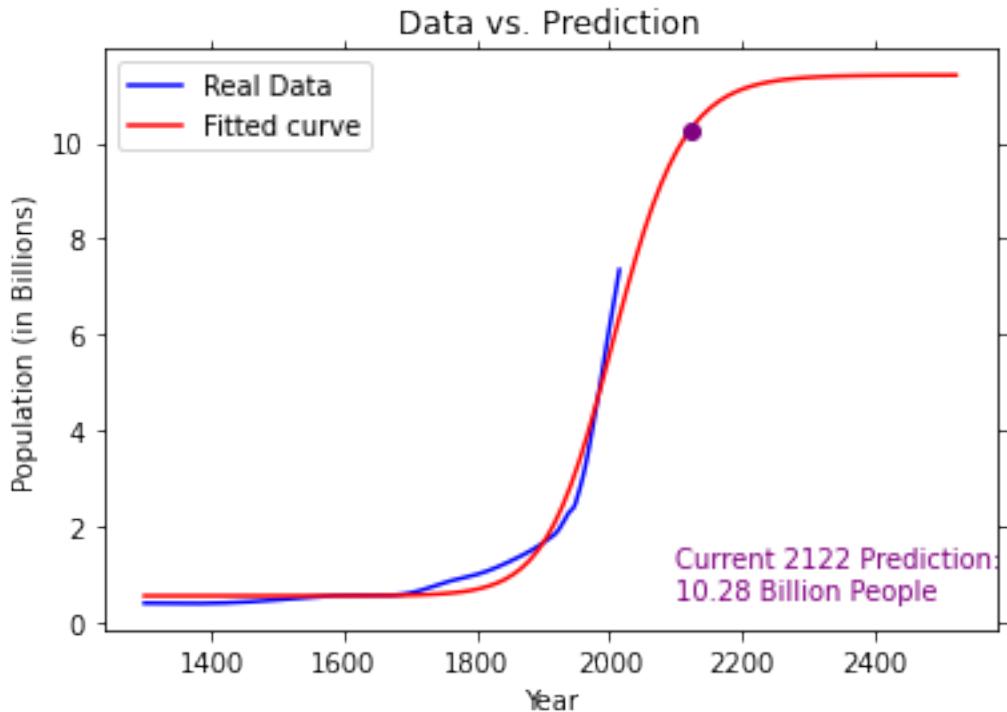
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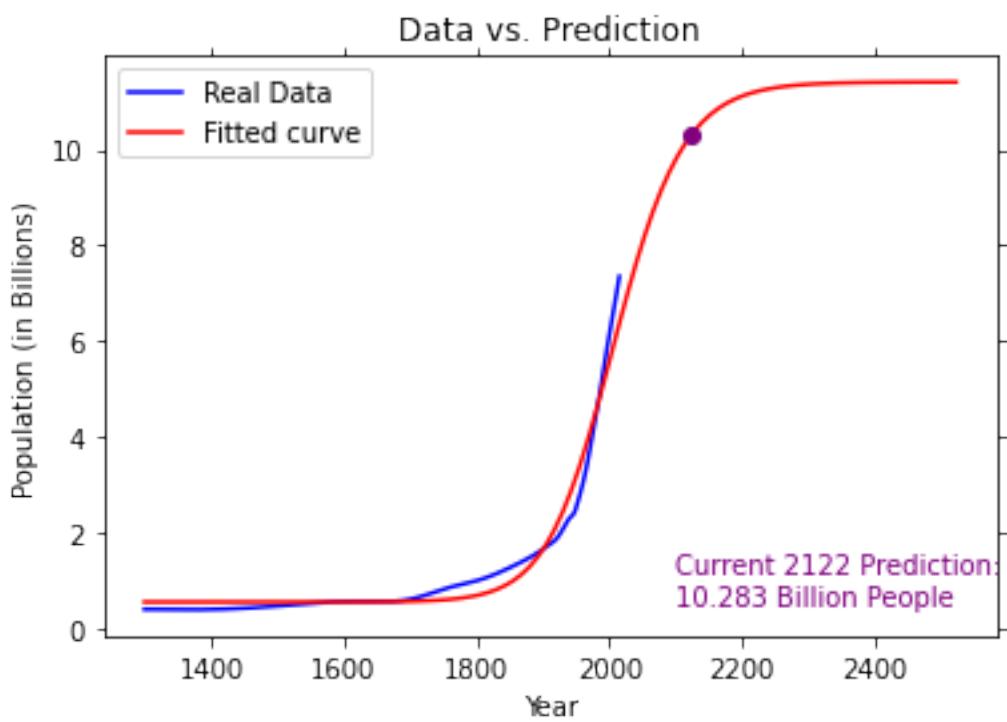
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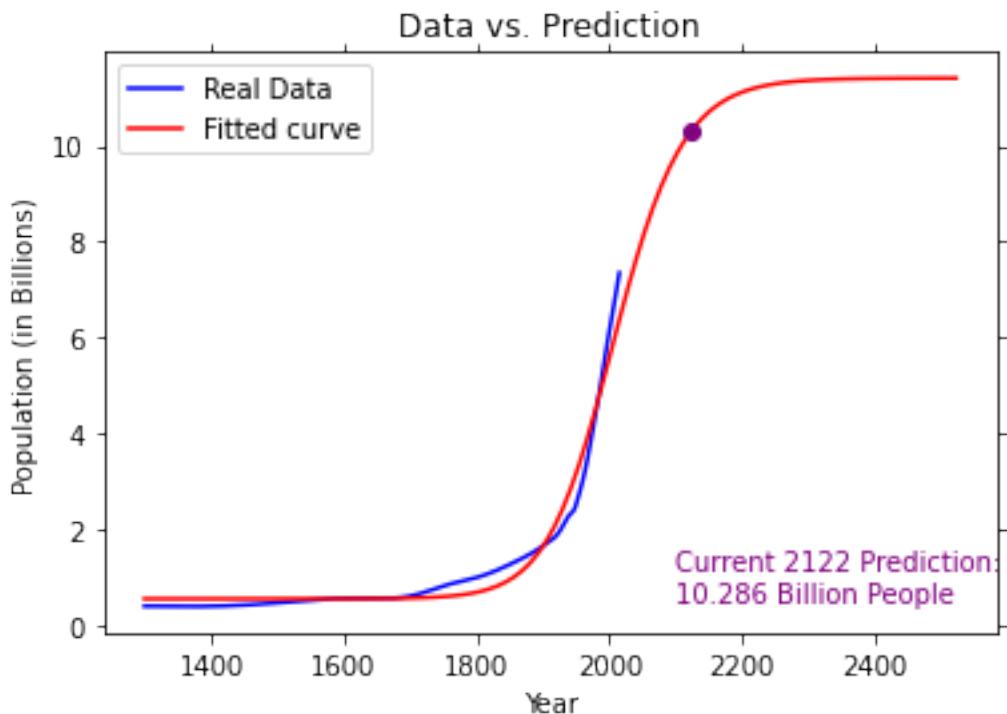
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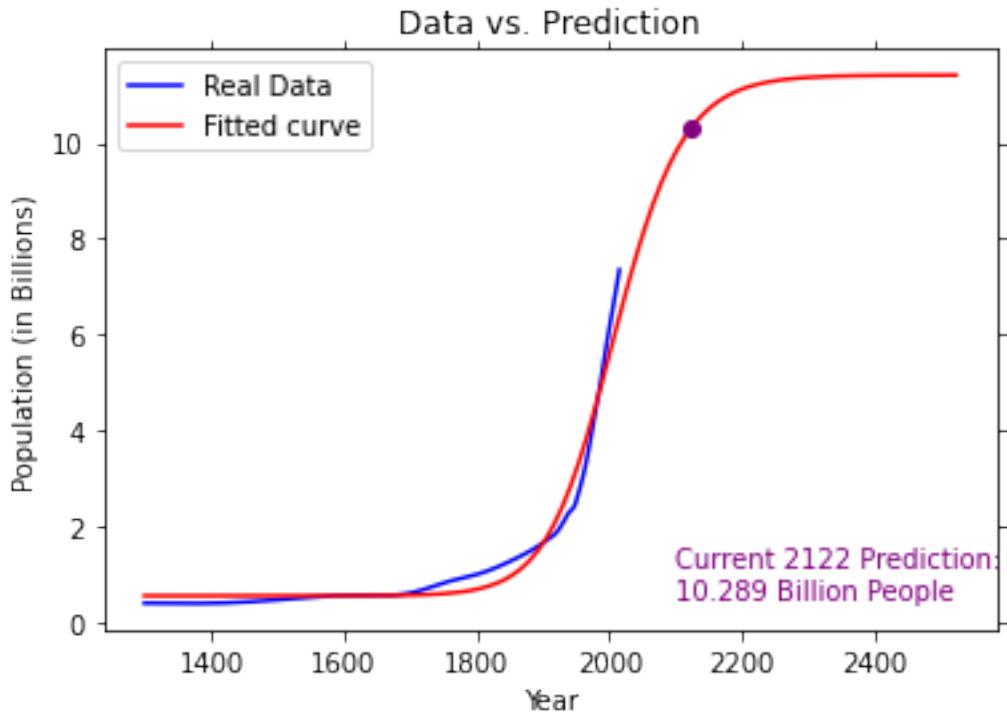
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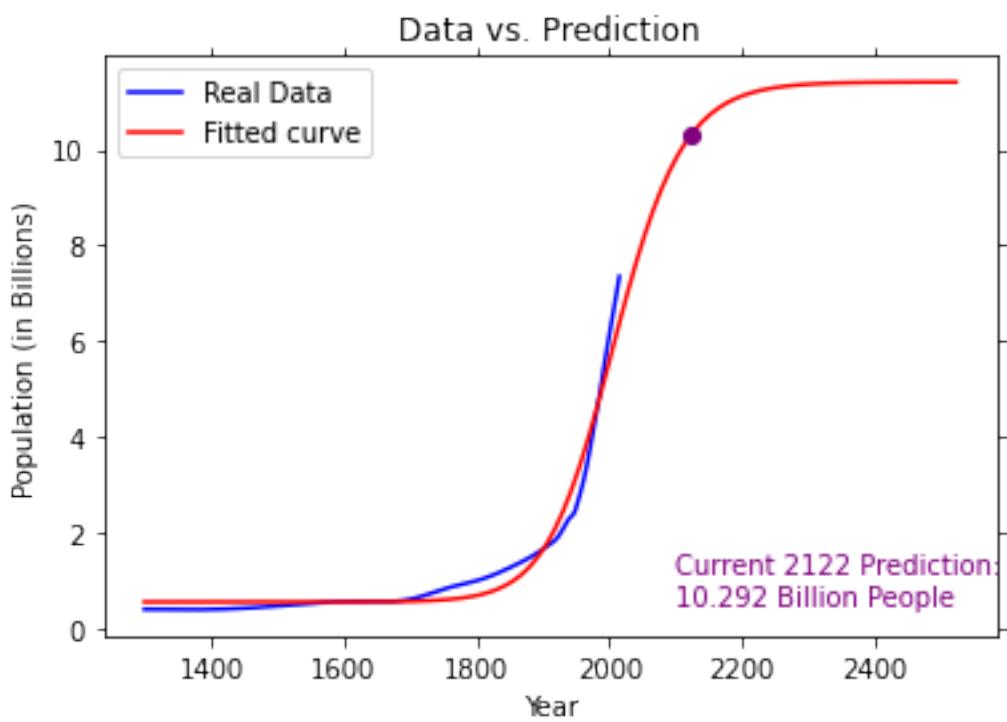
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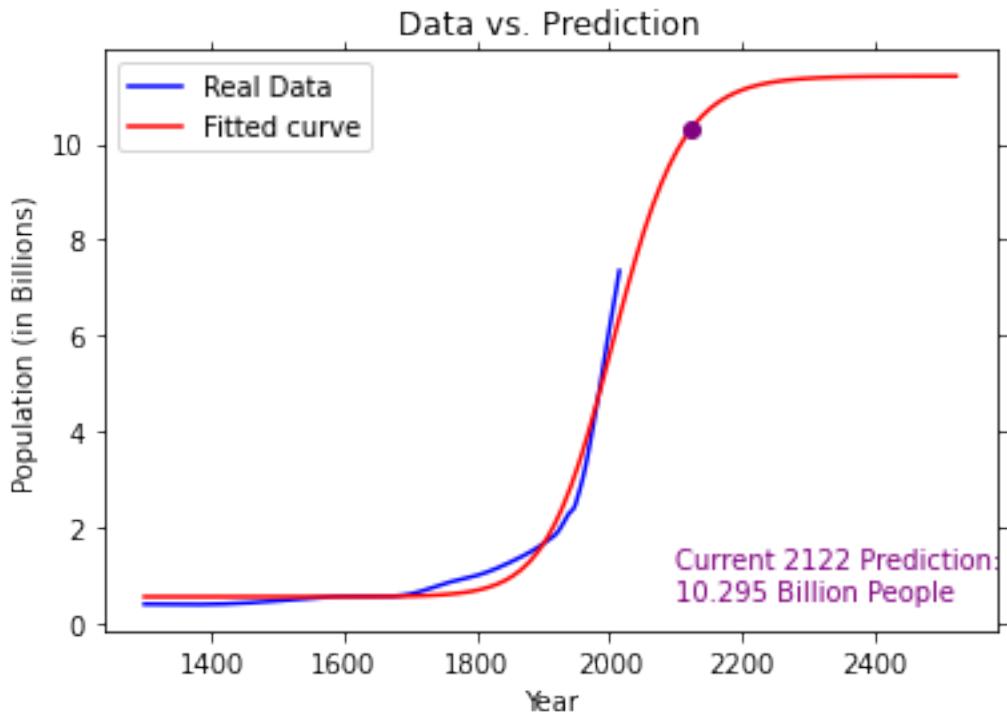
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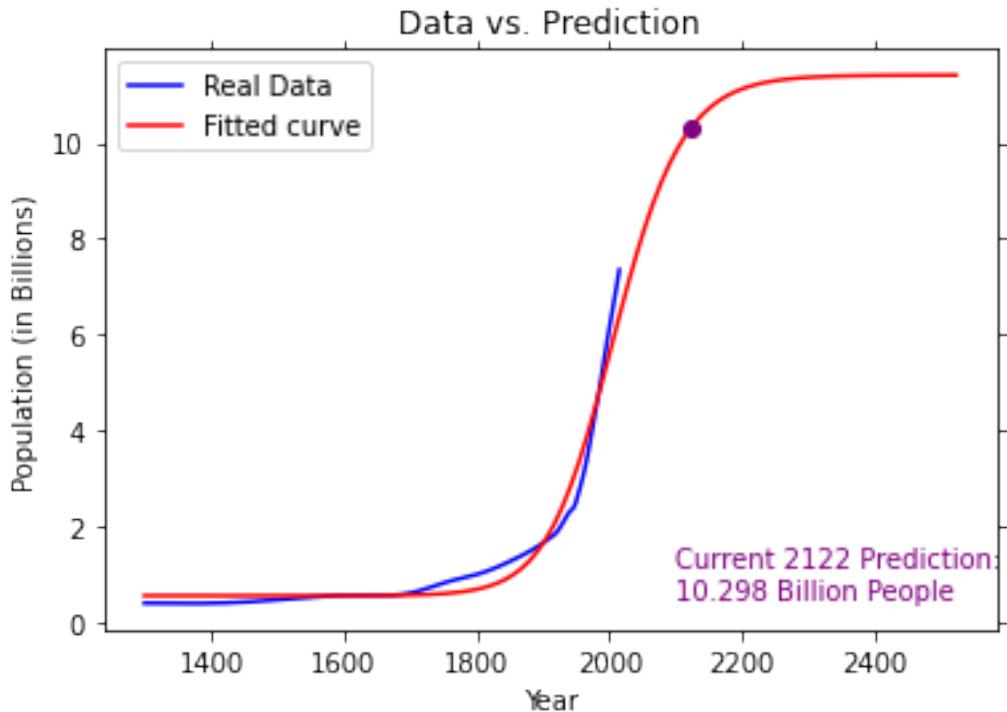
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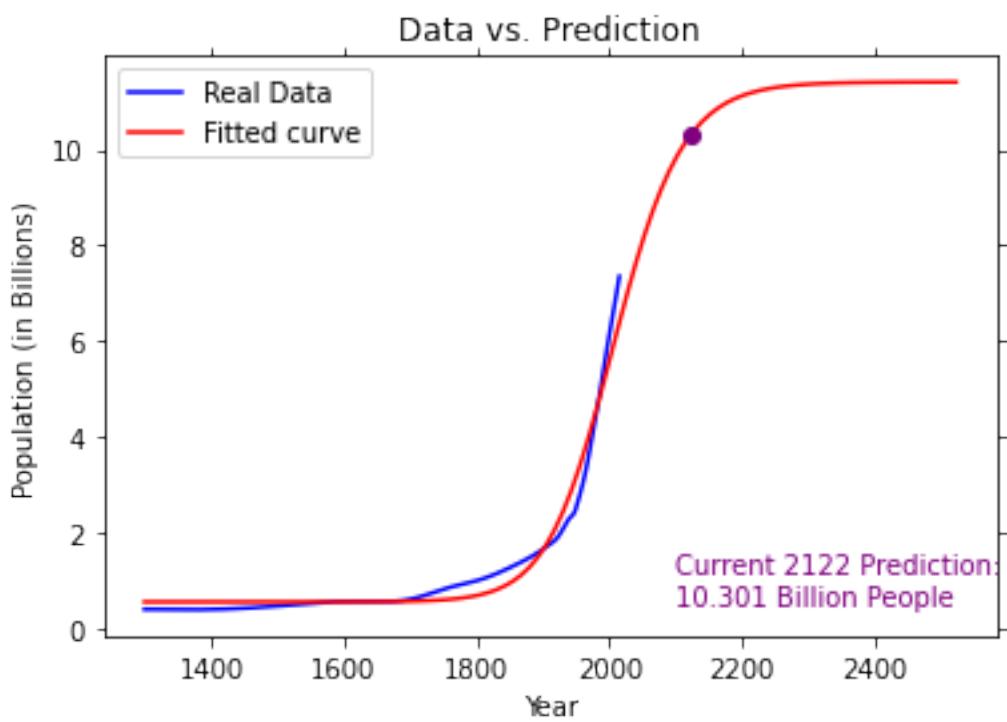
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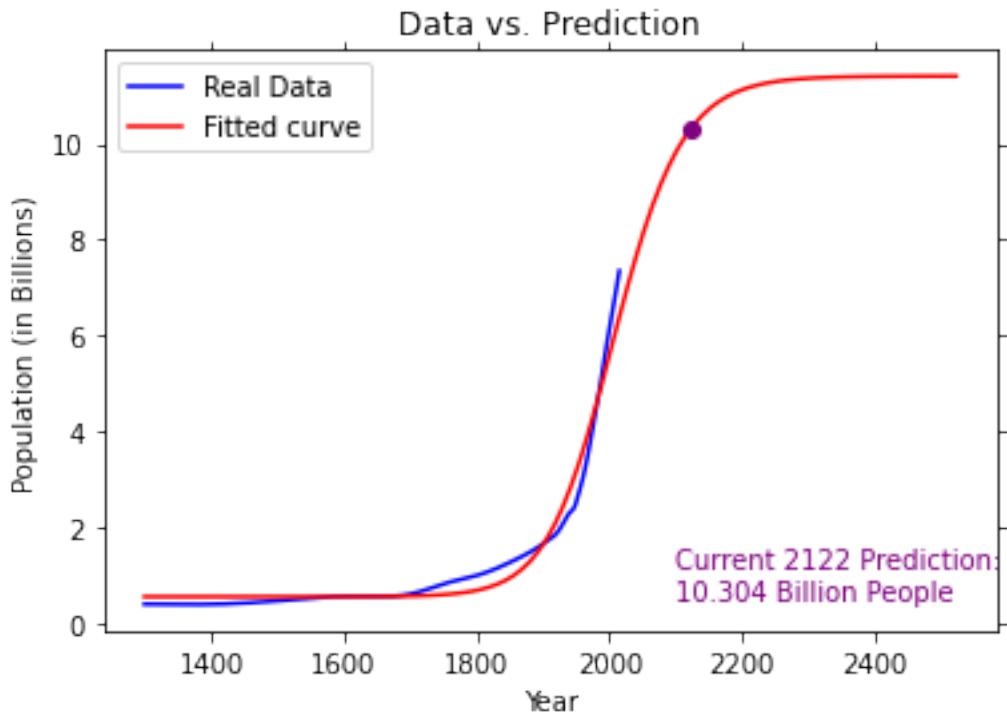
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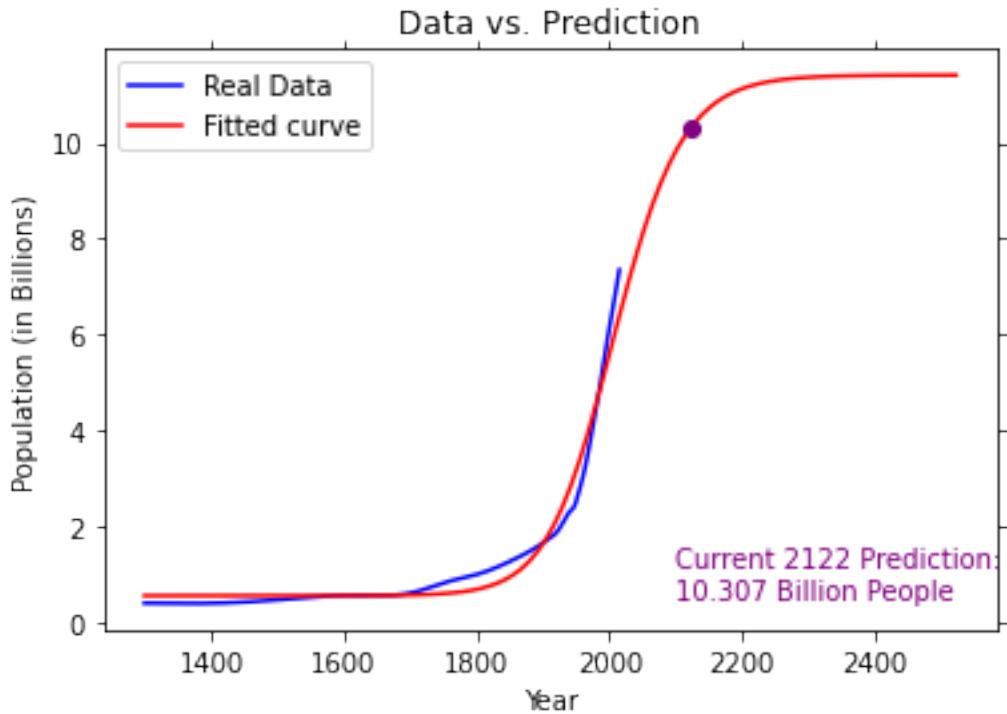
Iteration #5750, Loss: 0.058847721798038426



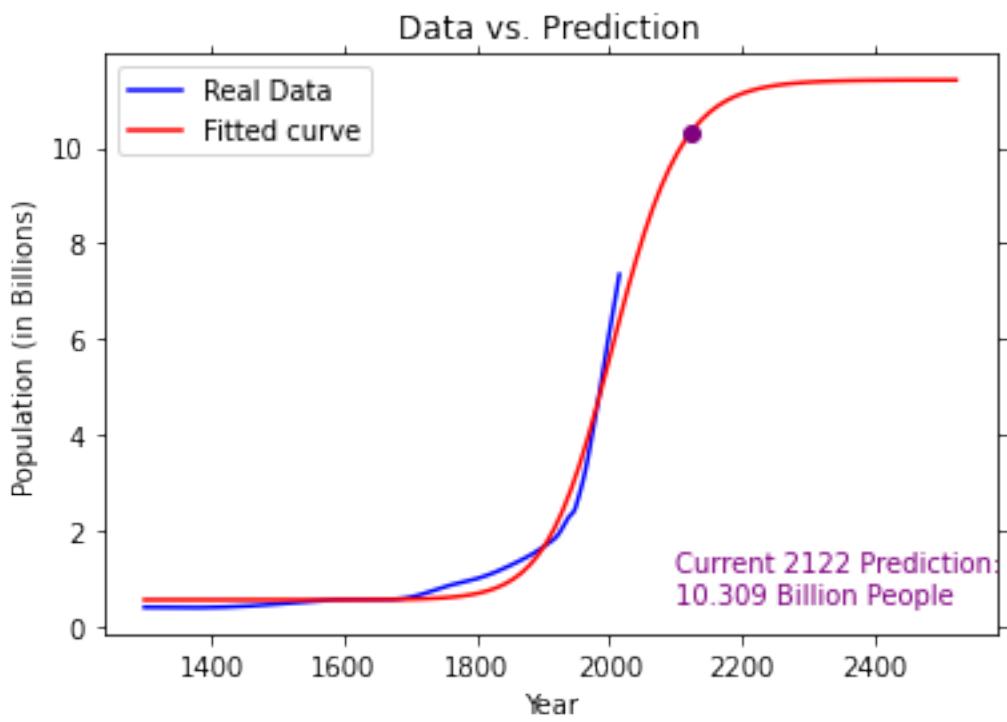
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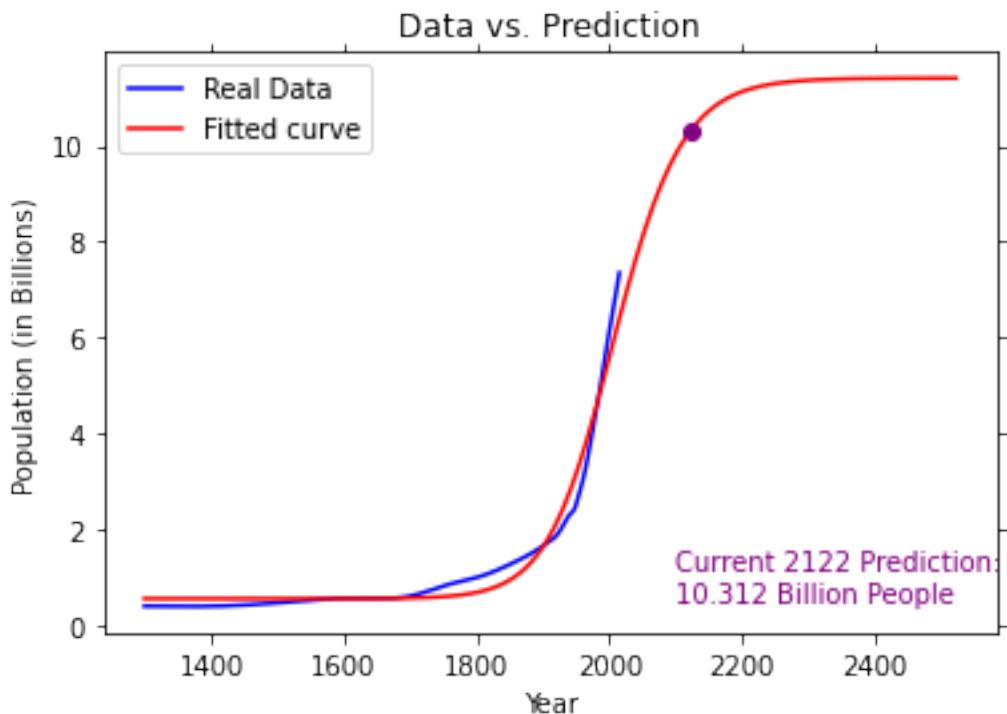
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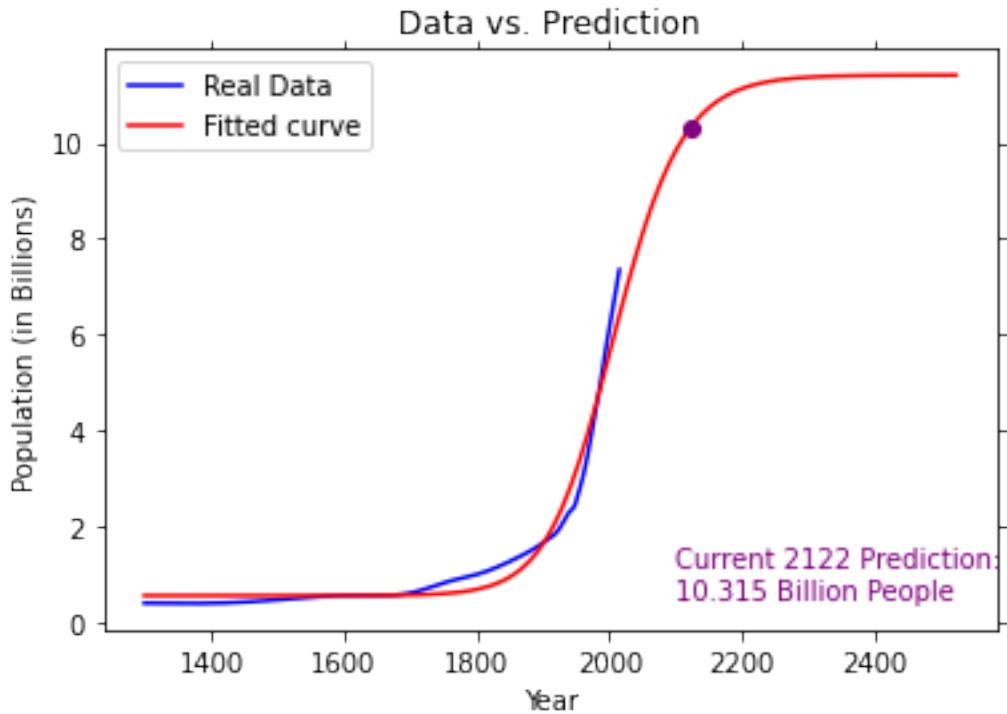
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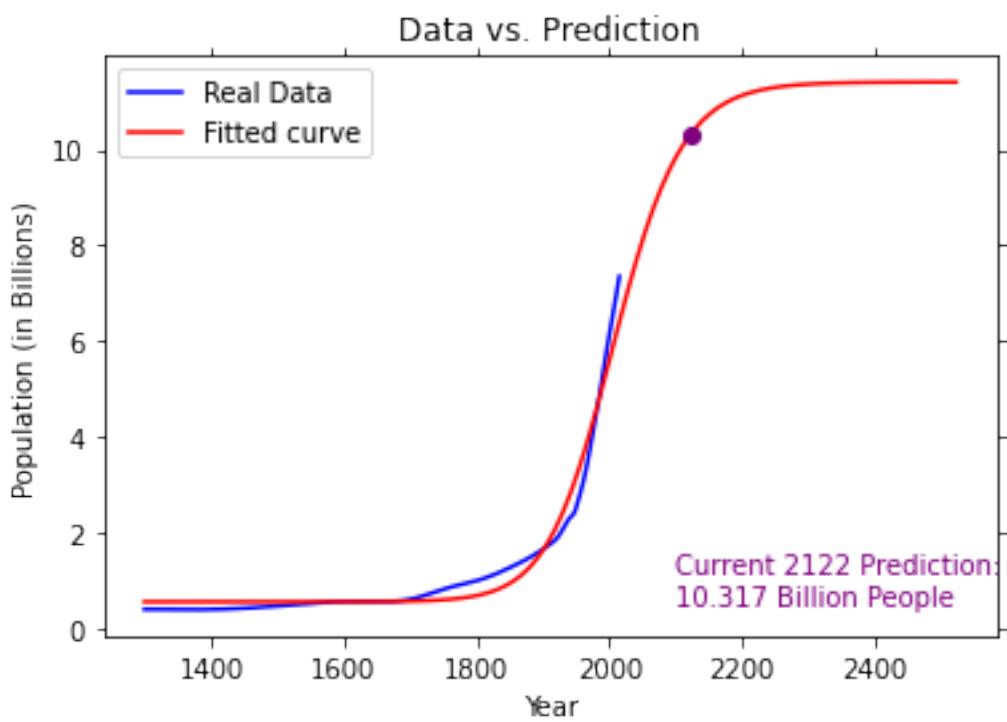
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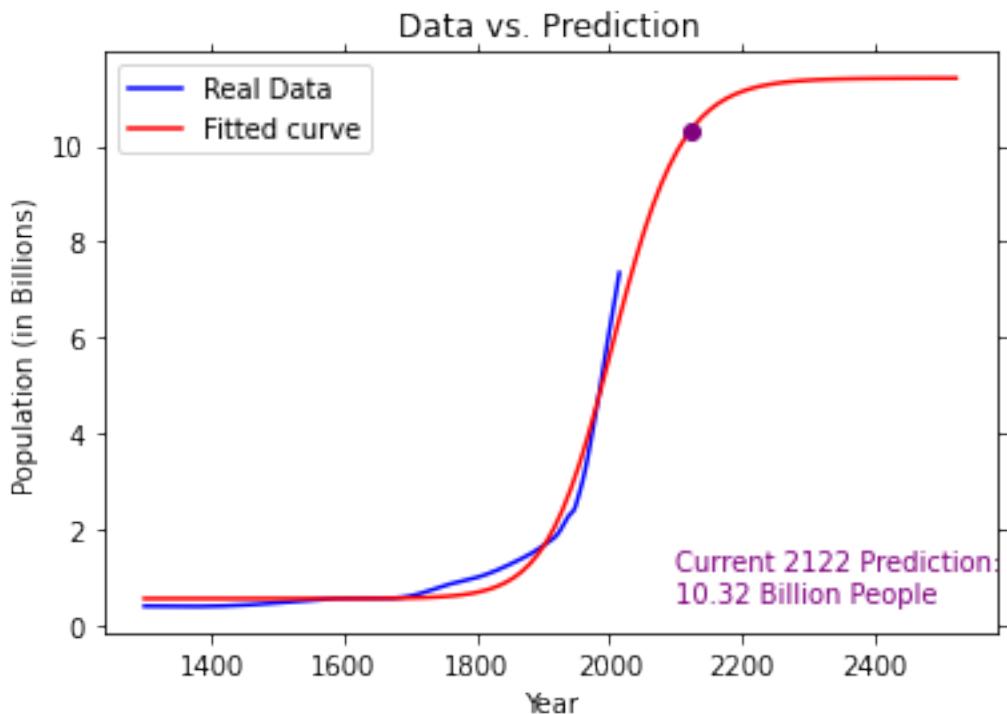
Iteration #6000, Loss: 0.05851643976173033



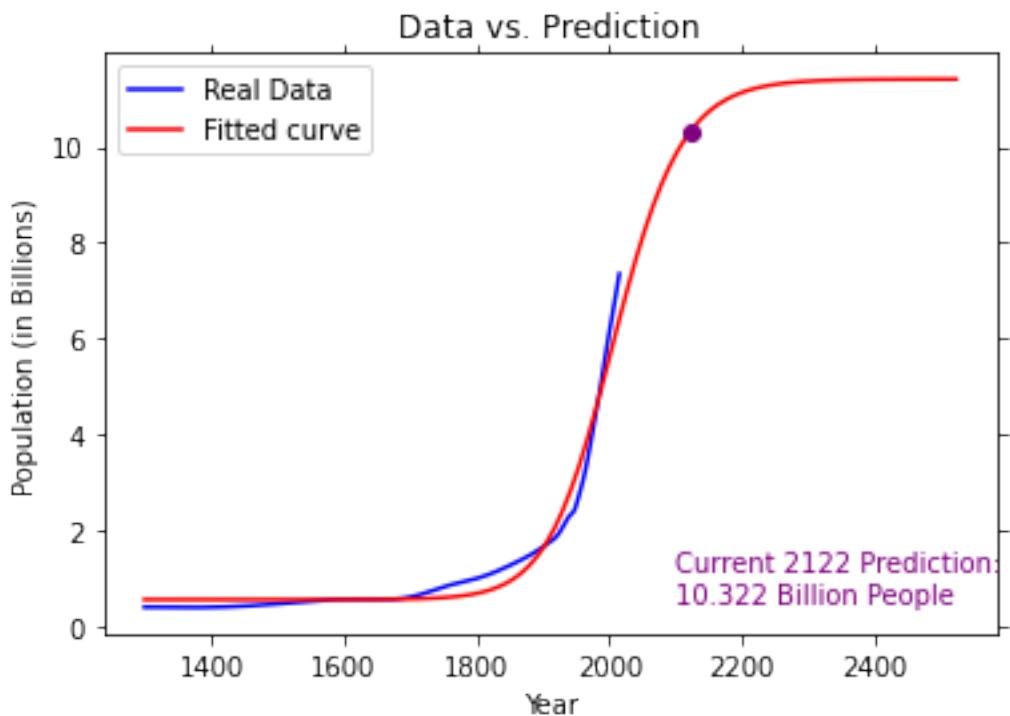
Iteration #6050, Loss: 0.0584538355257418



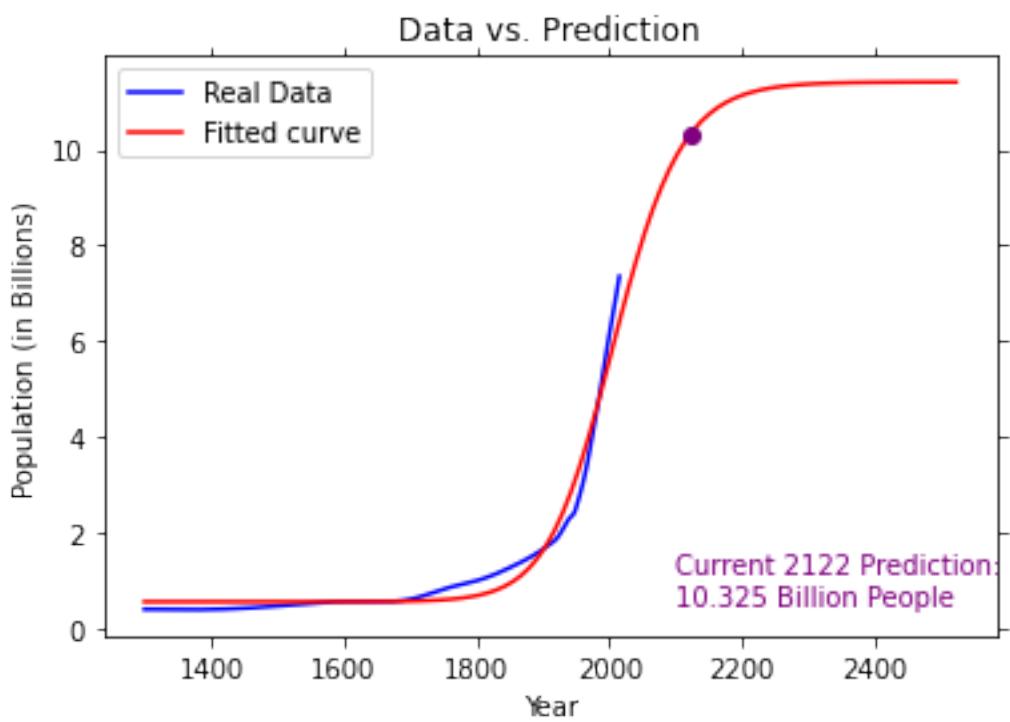
Iteration #6100, Loss: 0.058392377481884306



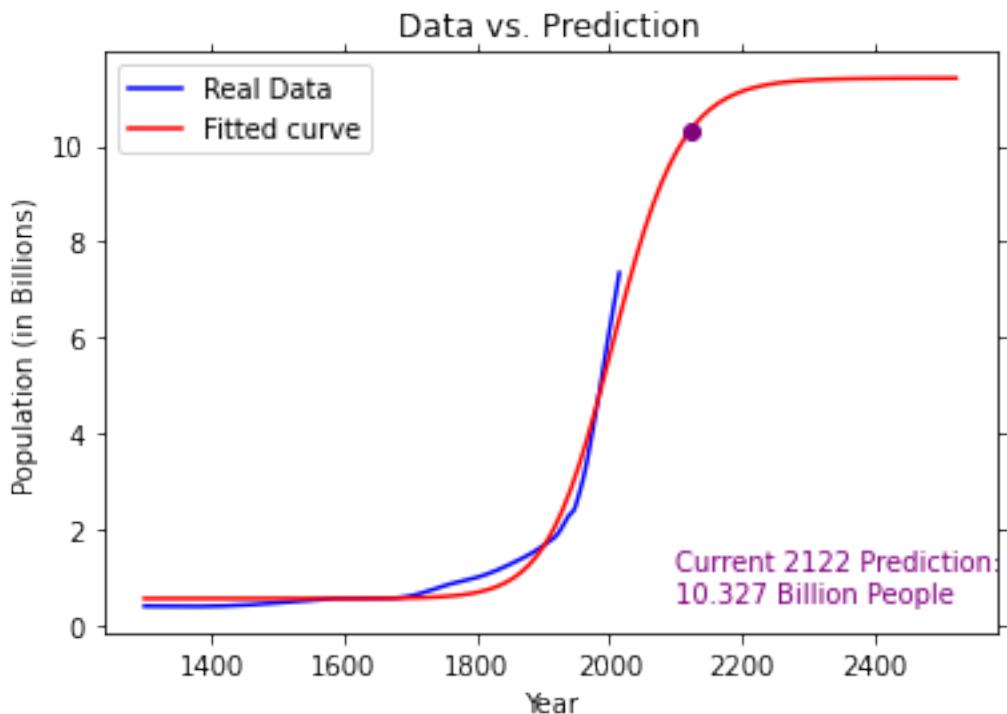
Iteration #6150, Loss: 0.058332036887179764



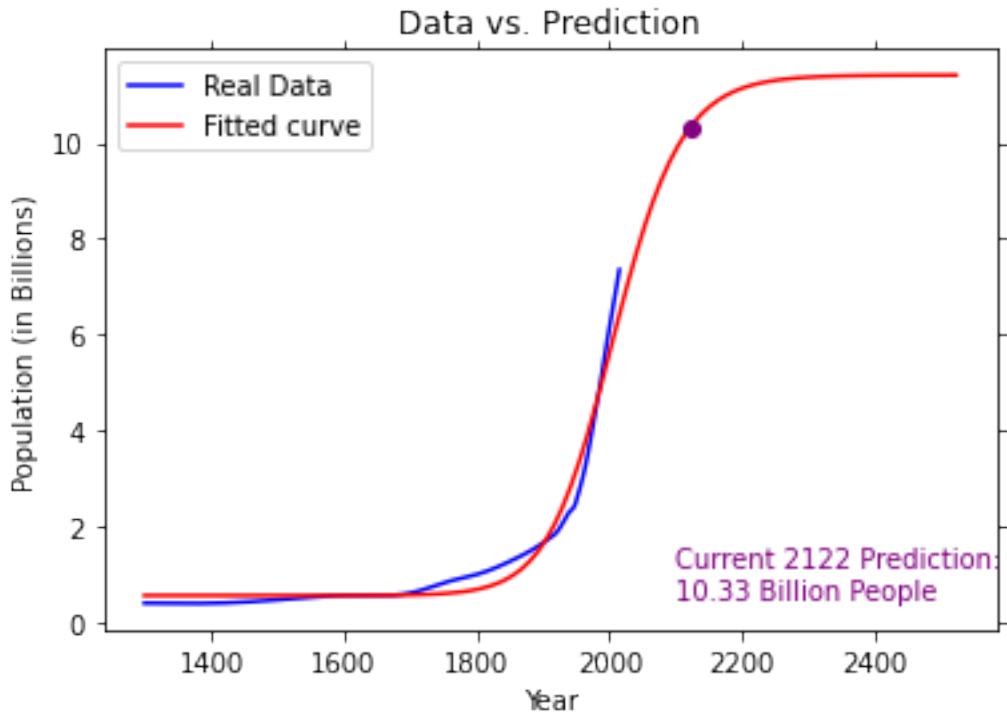
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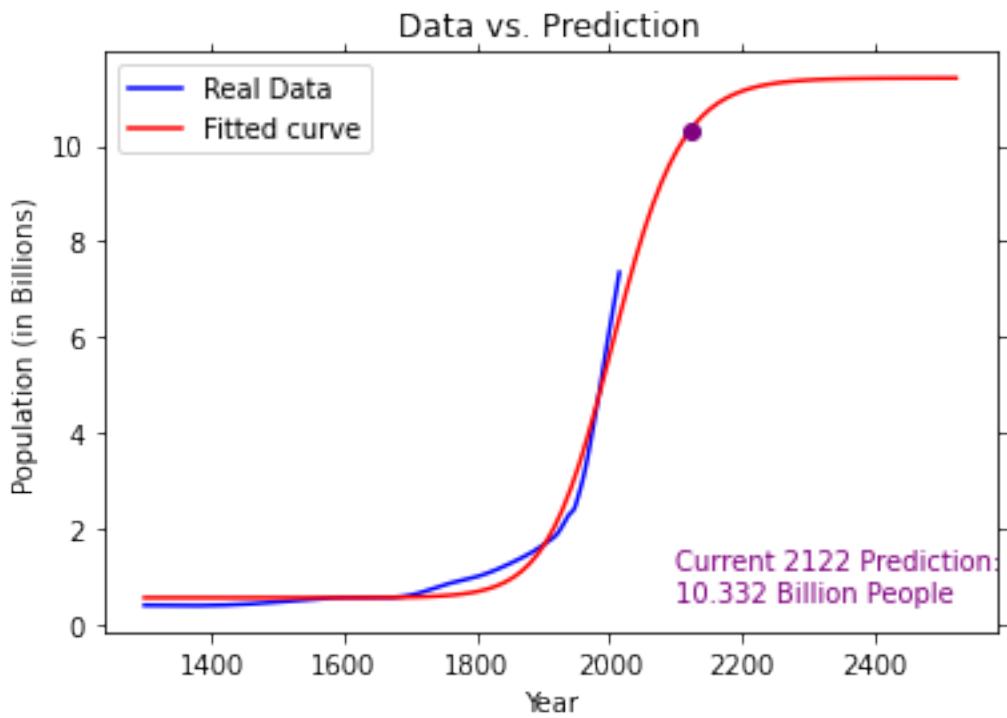
Iteration #6250, Loss: 0.05821459720704075



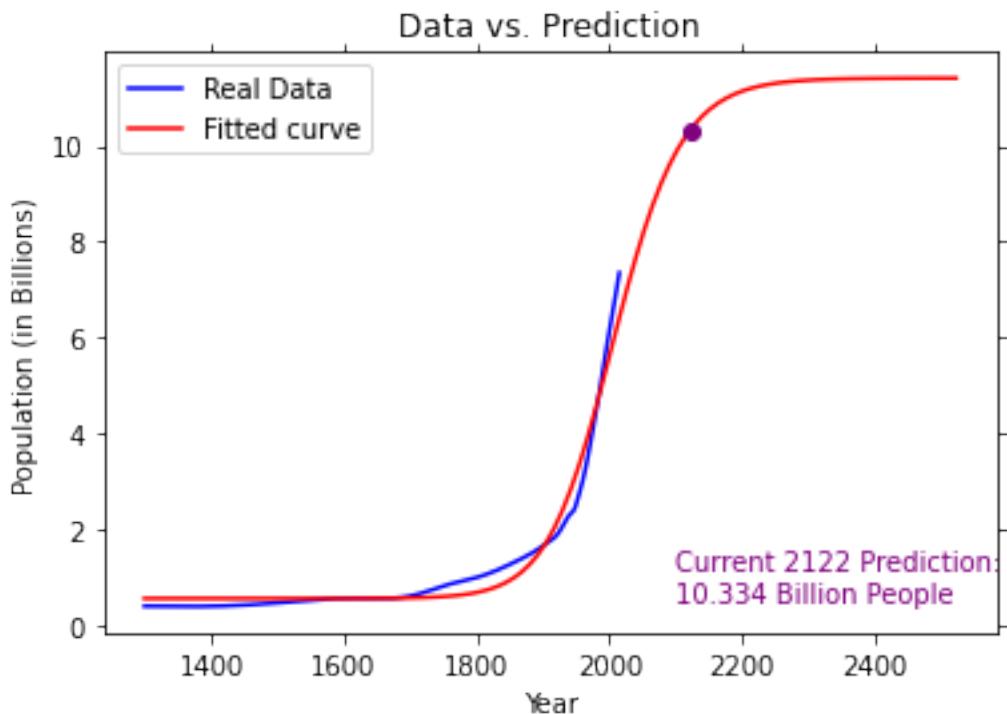
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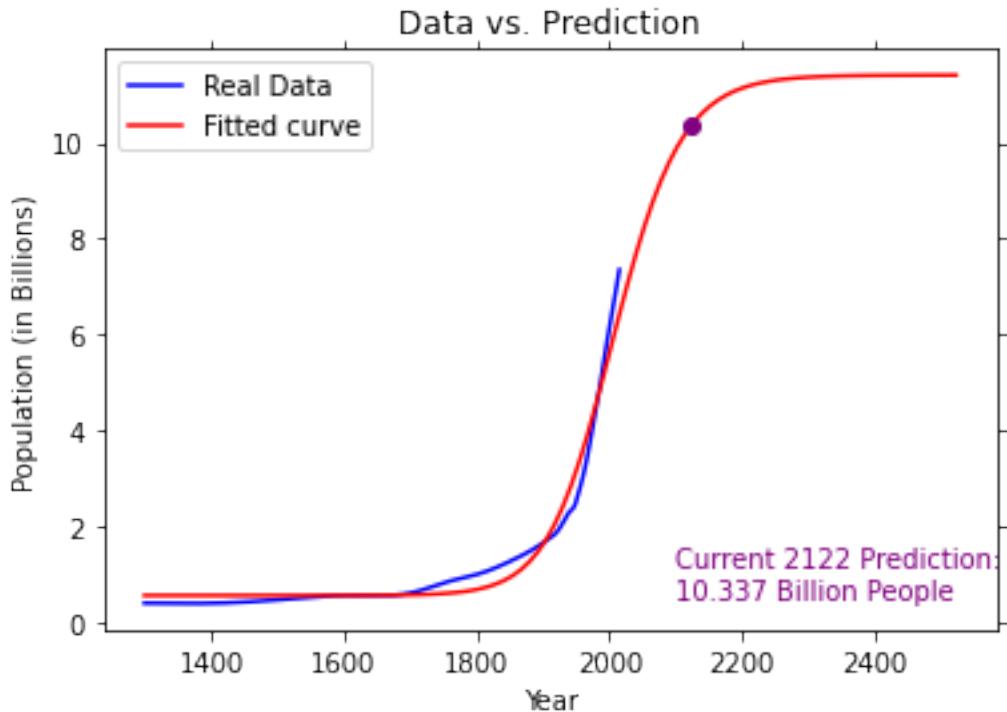
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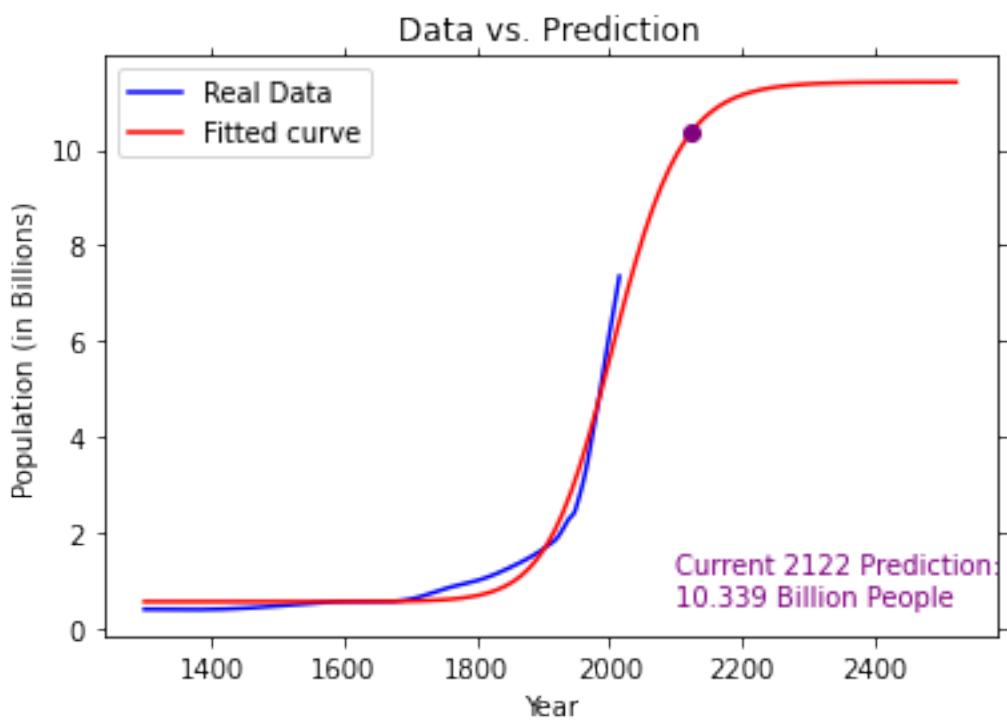
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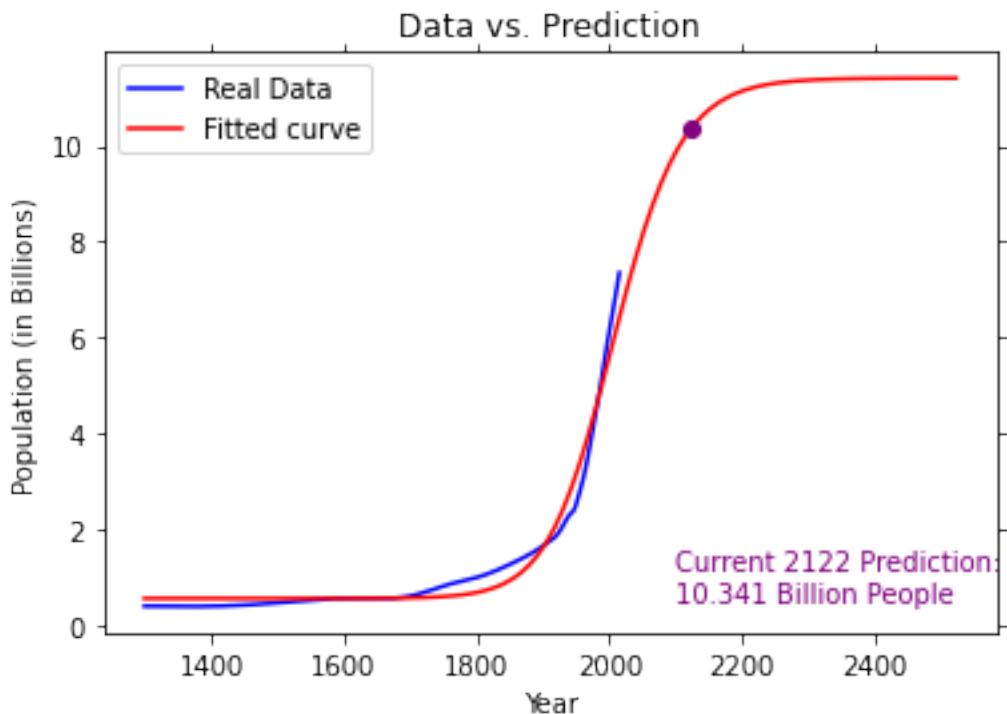
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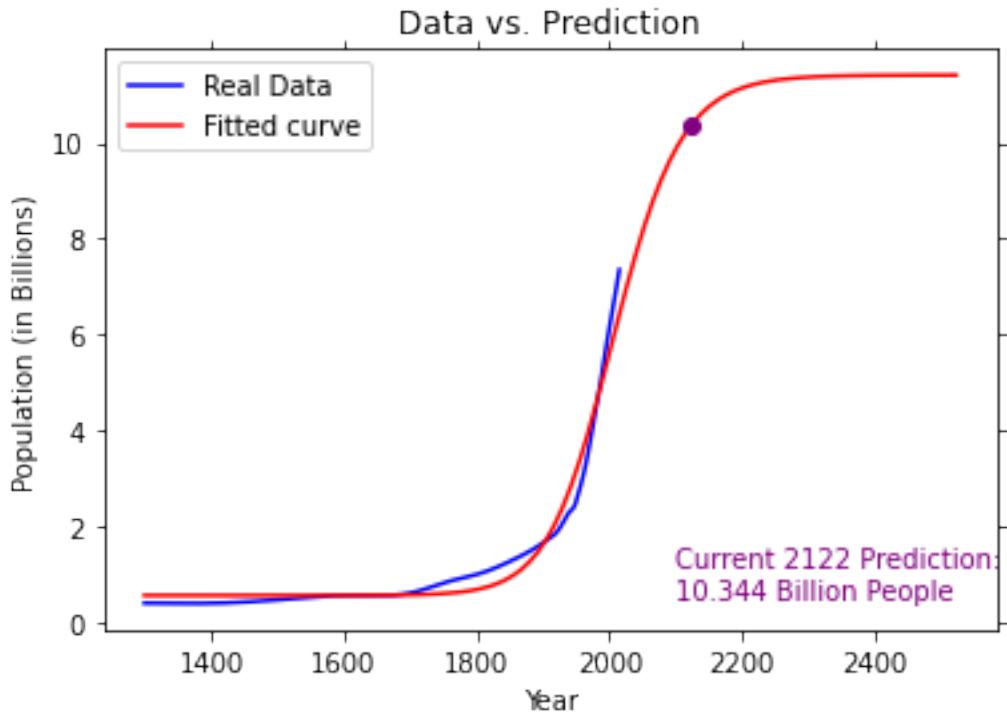
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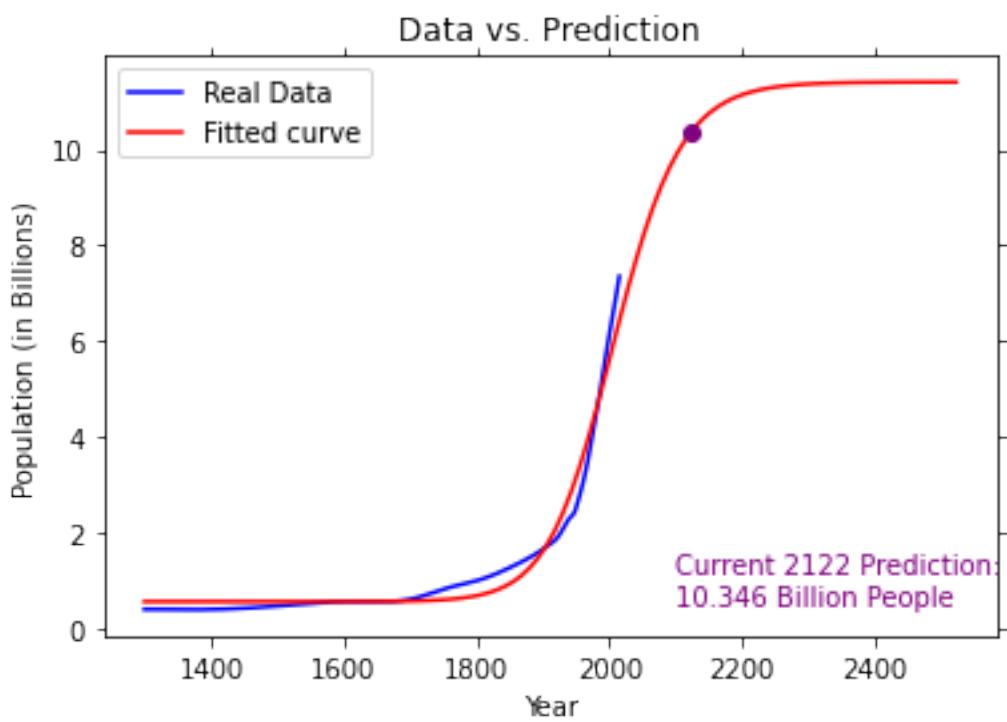
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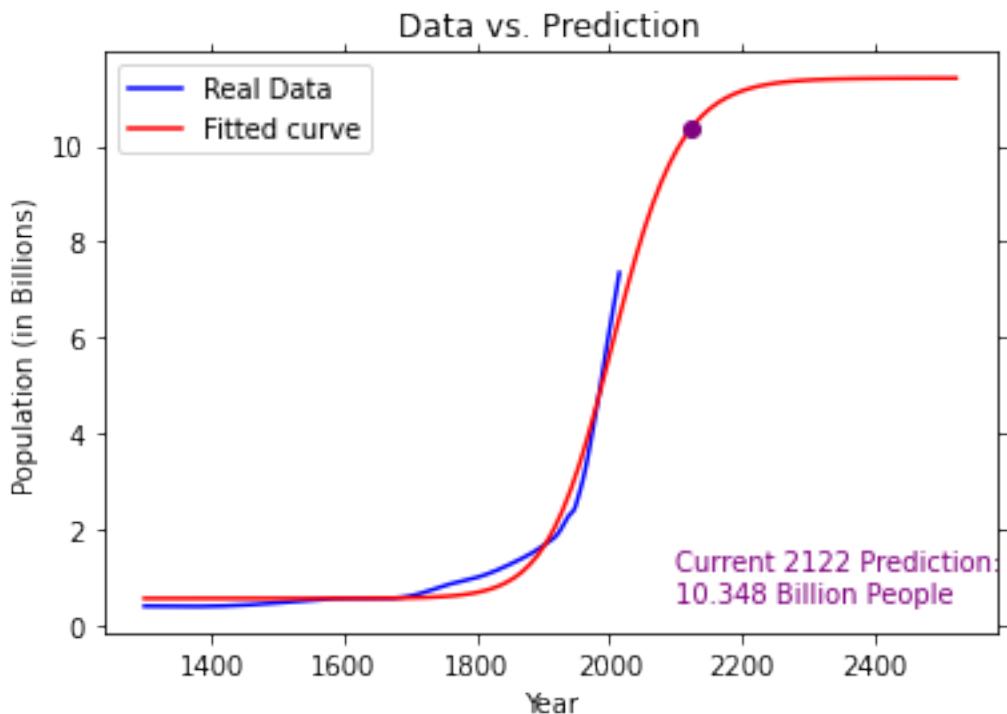
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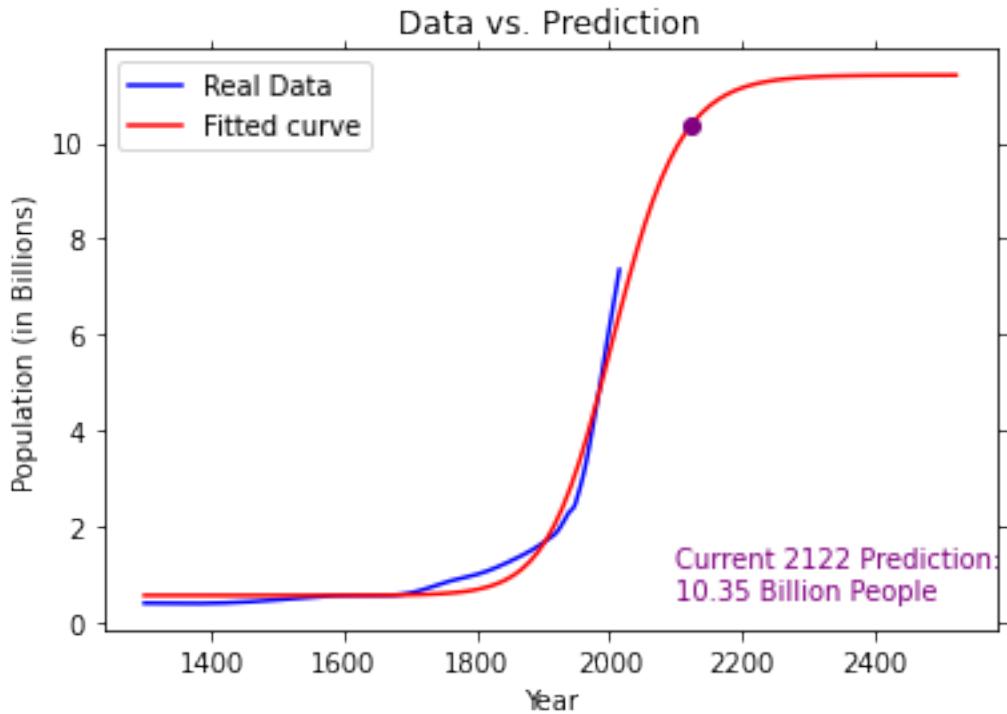
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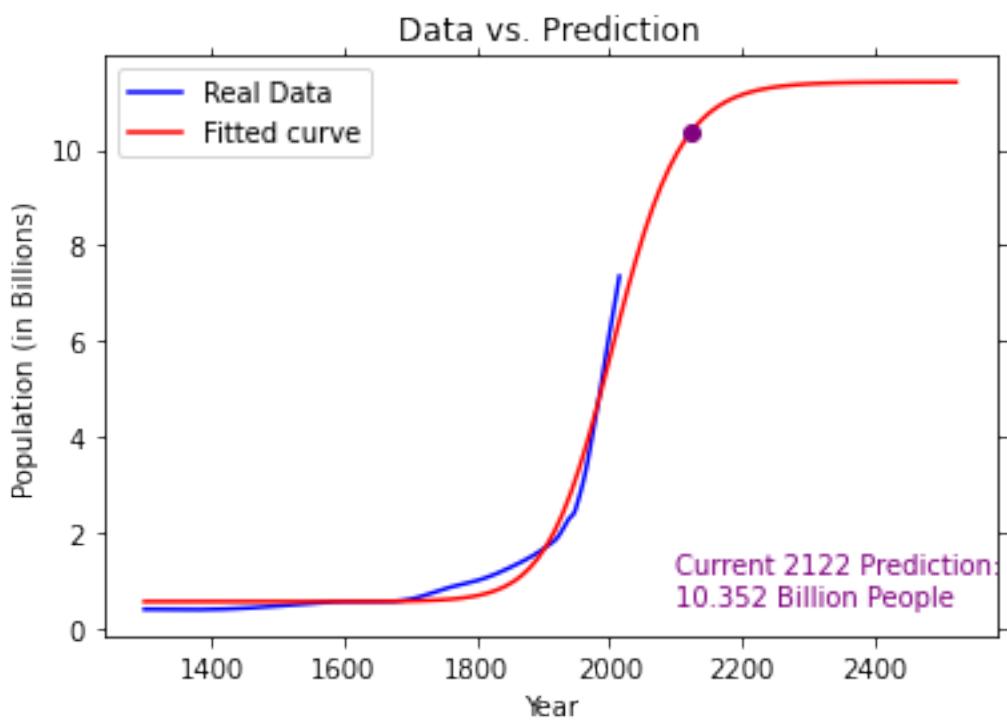
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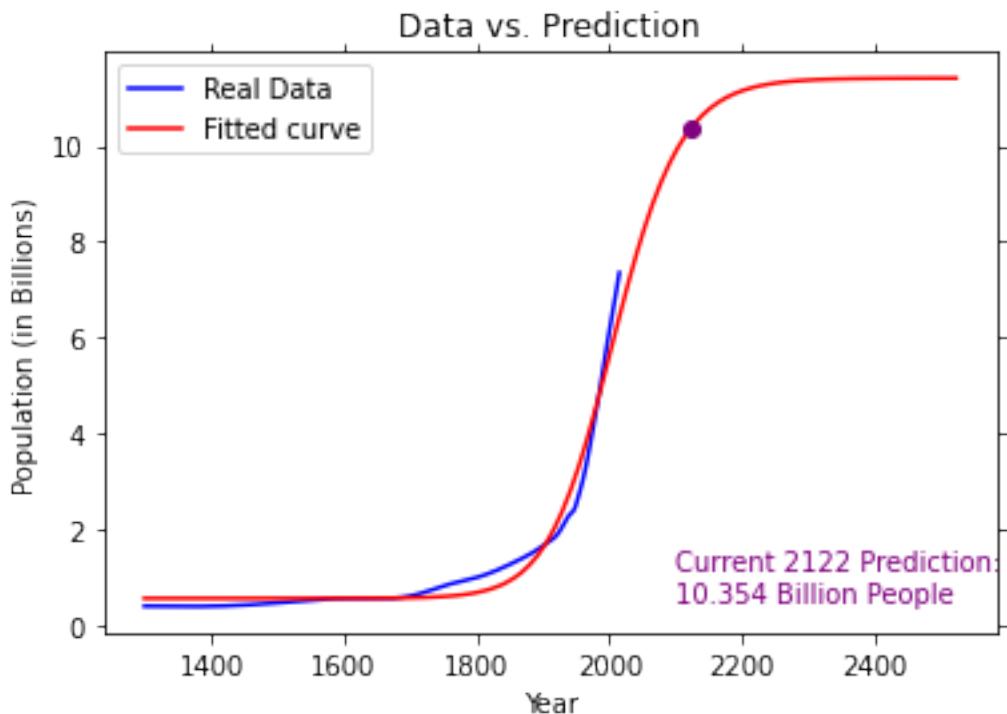
Iteration #6750, Loss: 0.057685706446214804



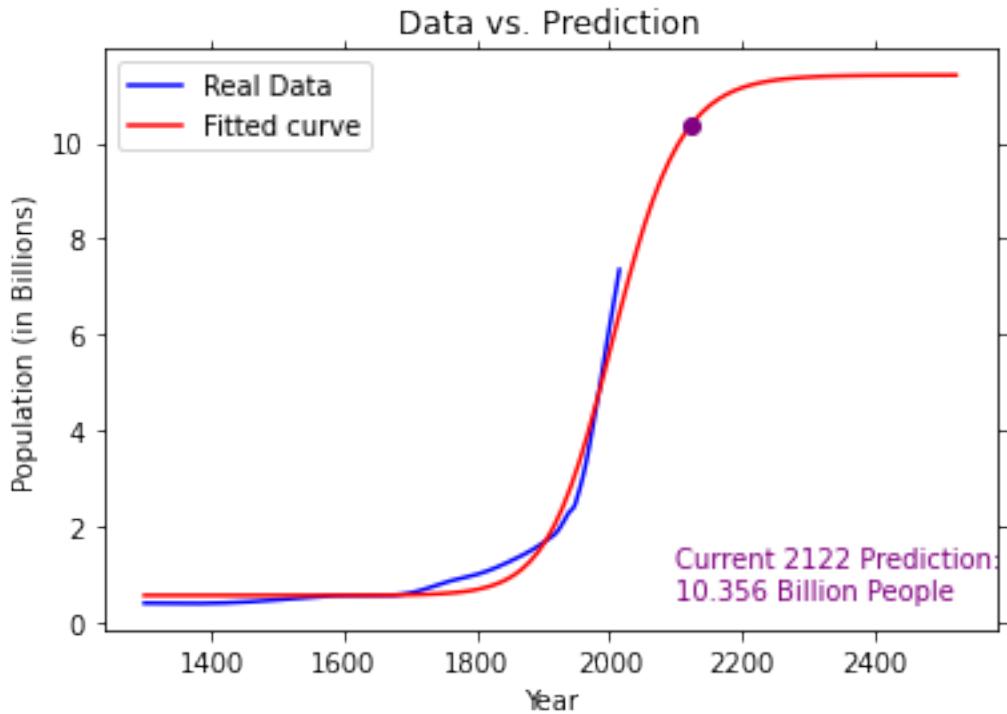
Iteration #6800, Loss: 0.05763762100737627



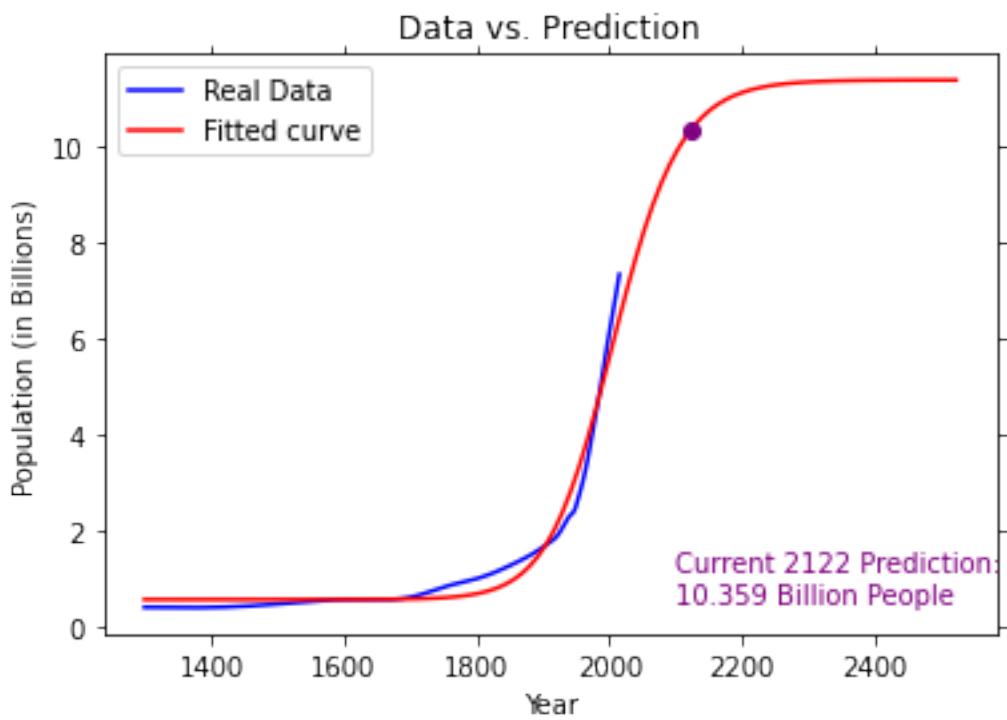
Iteration #6850, Loss: 0.057590326745014644



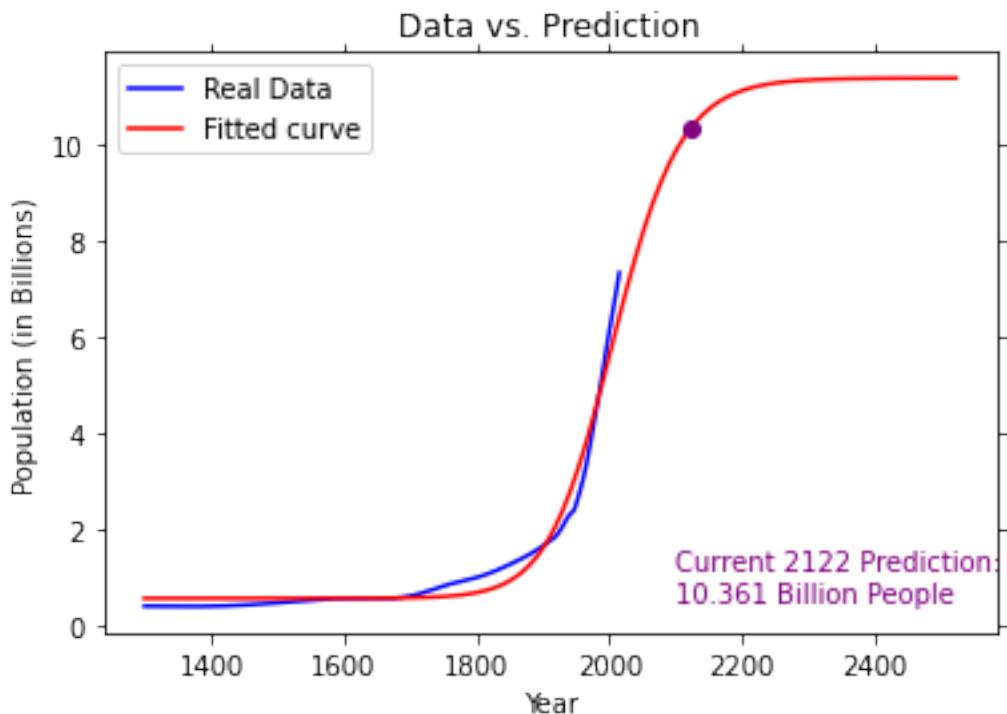
Iteration #6900, Loss: 0.0575438049214544



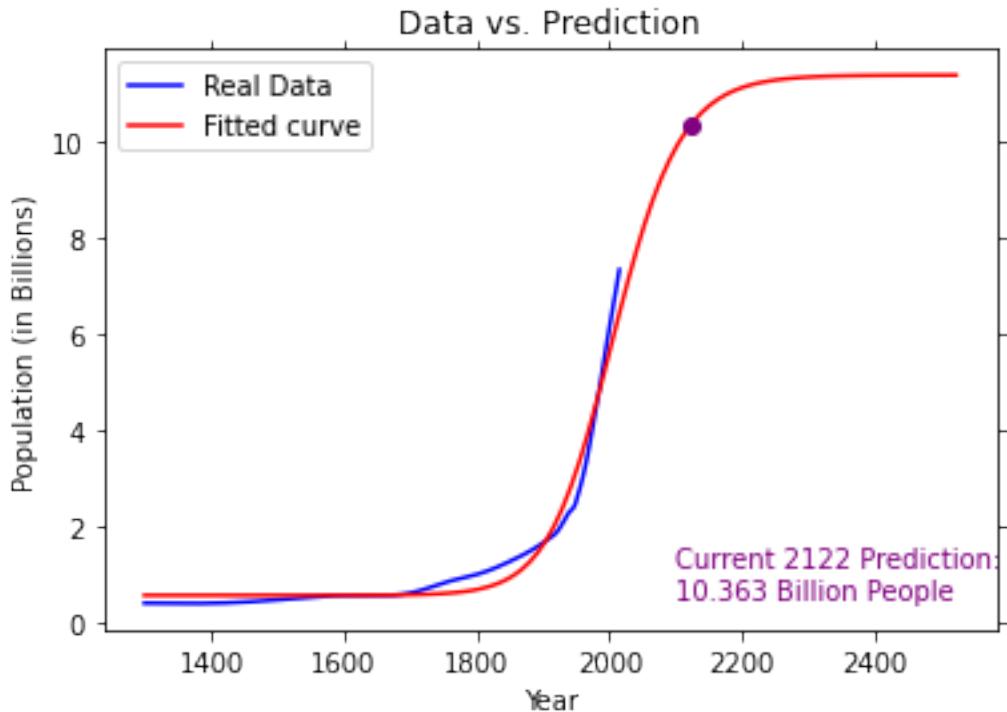
Iteration #6950, Loss: 0.05749803730905637



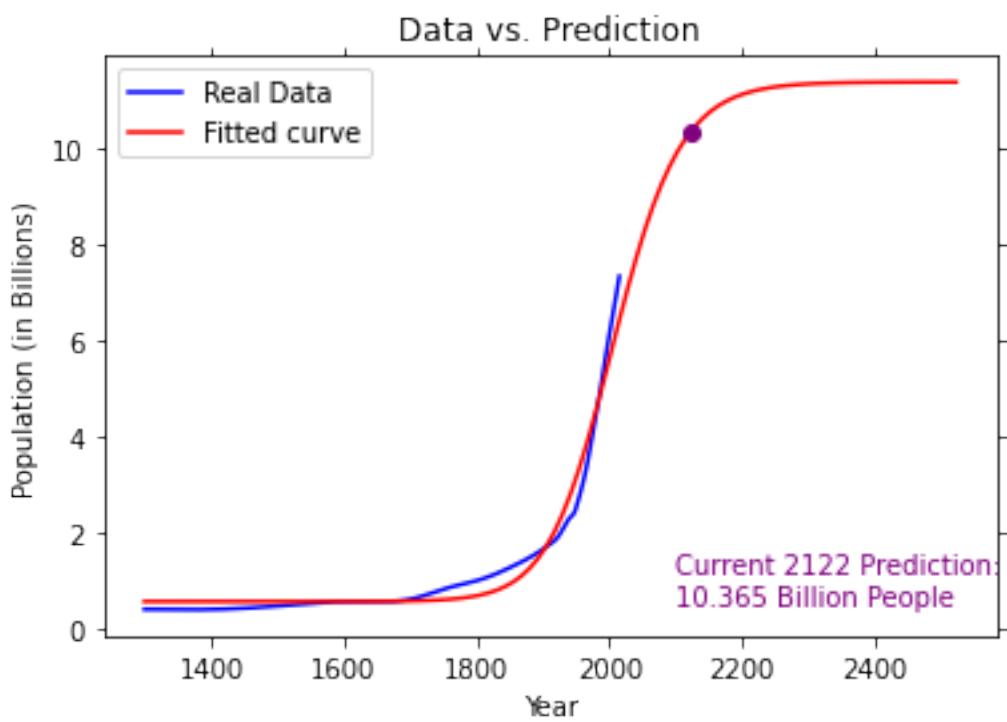
Iteration #7000, Loss: 0.05745300617441097



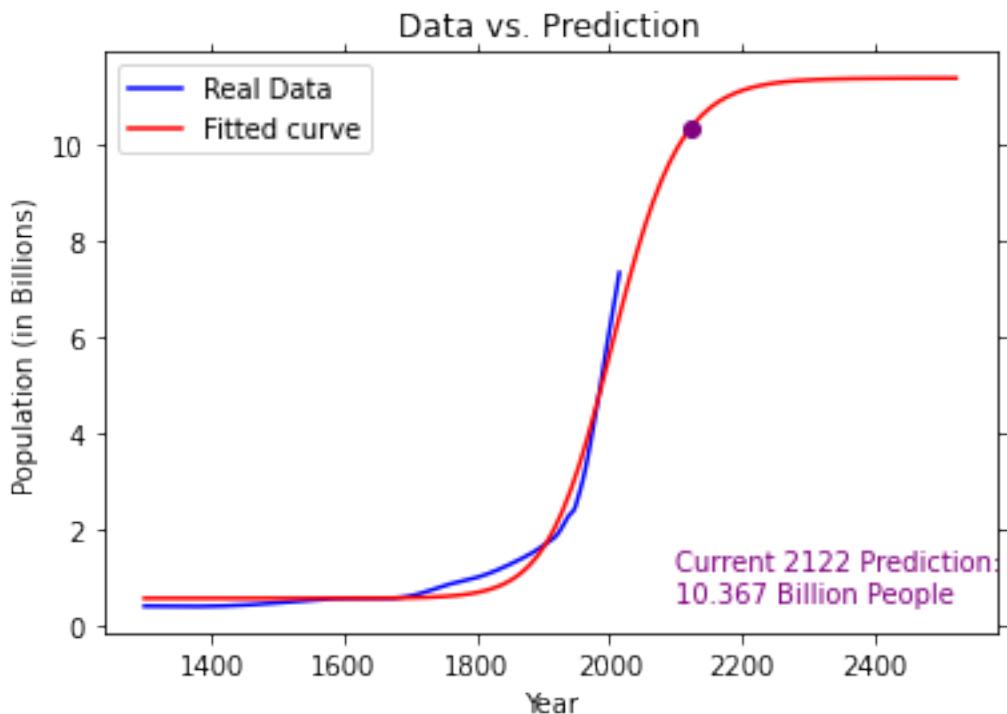
Iteration #7050, Loss: 0.05740869426308678



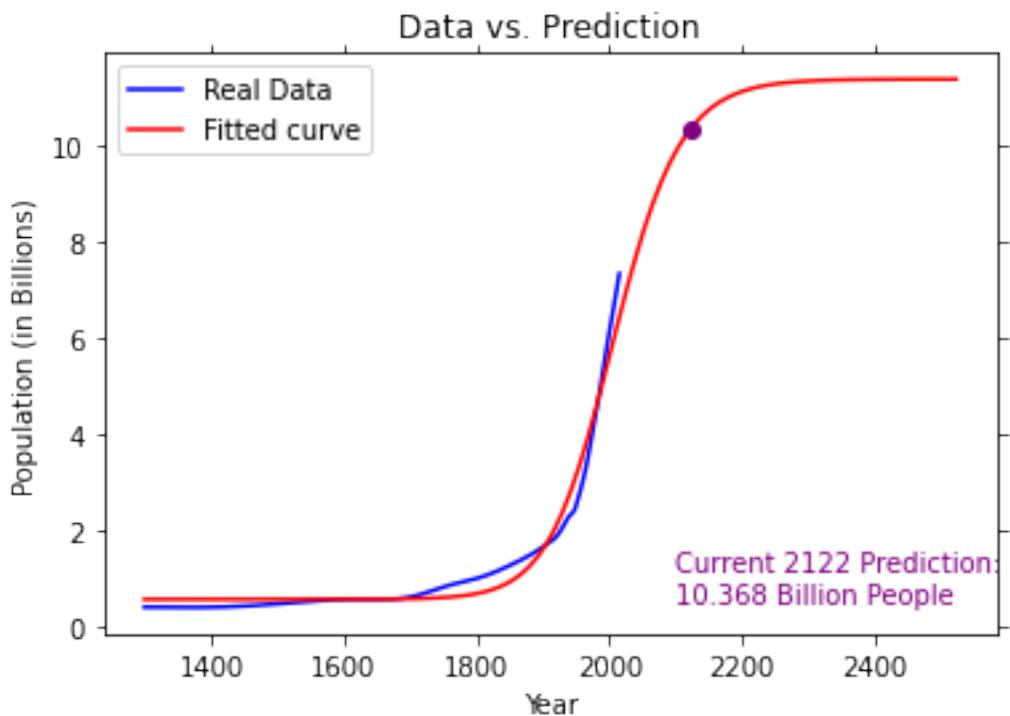
Iteration #7100, Loss: 0.05736508478491077



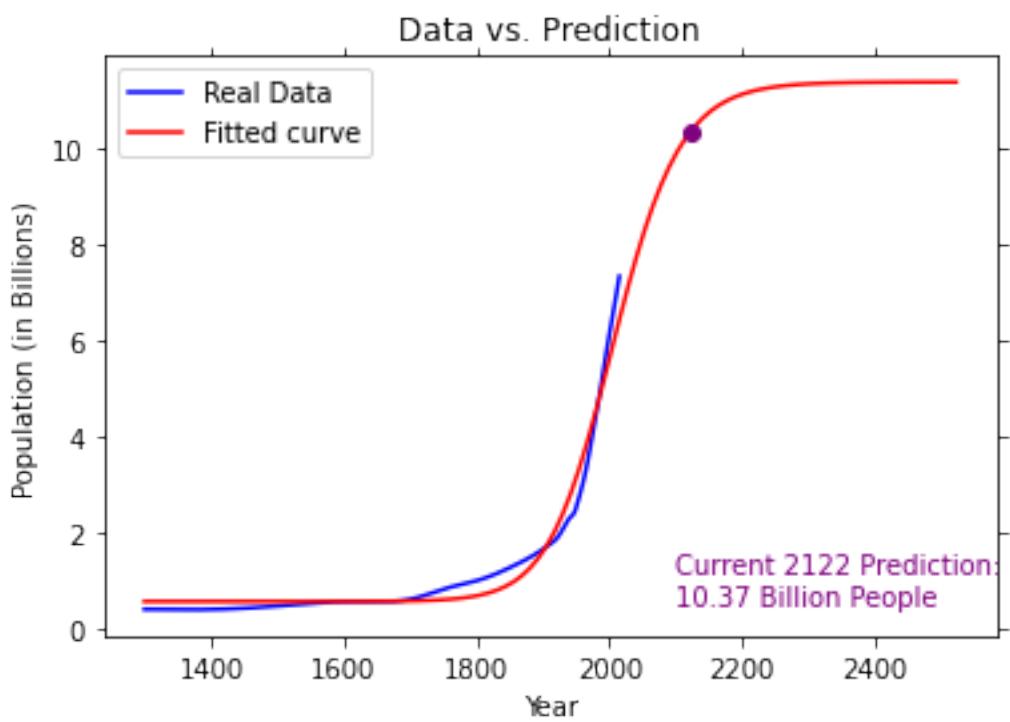
Iteration #7150, Loss: 0.05732216139976412



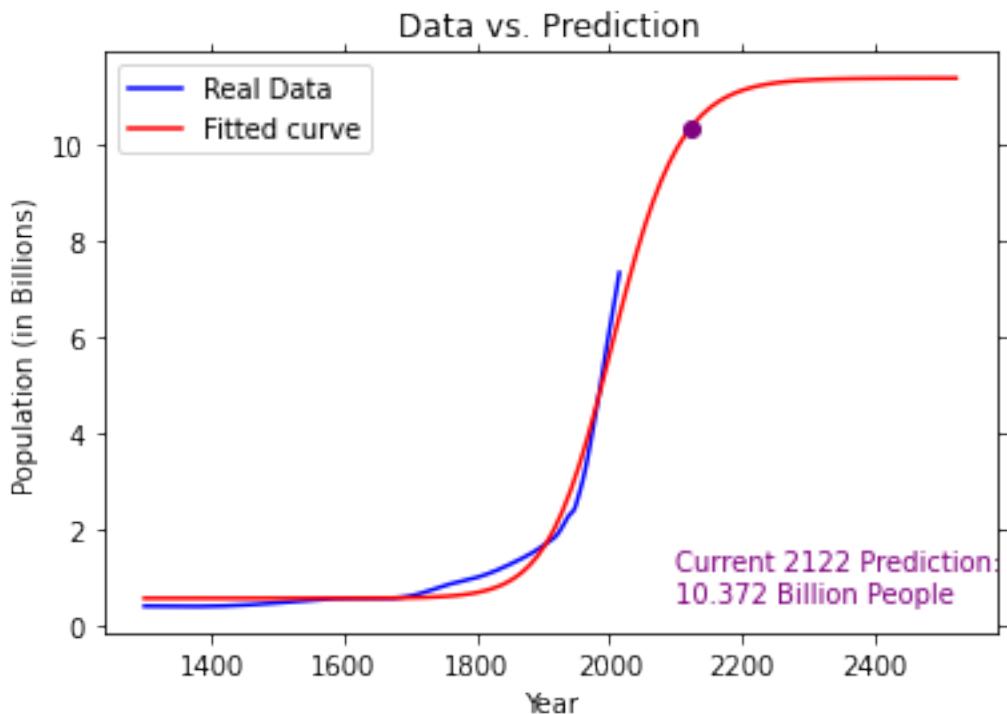
Iteration #7200, Loss: 0.057279908203867344



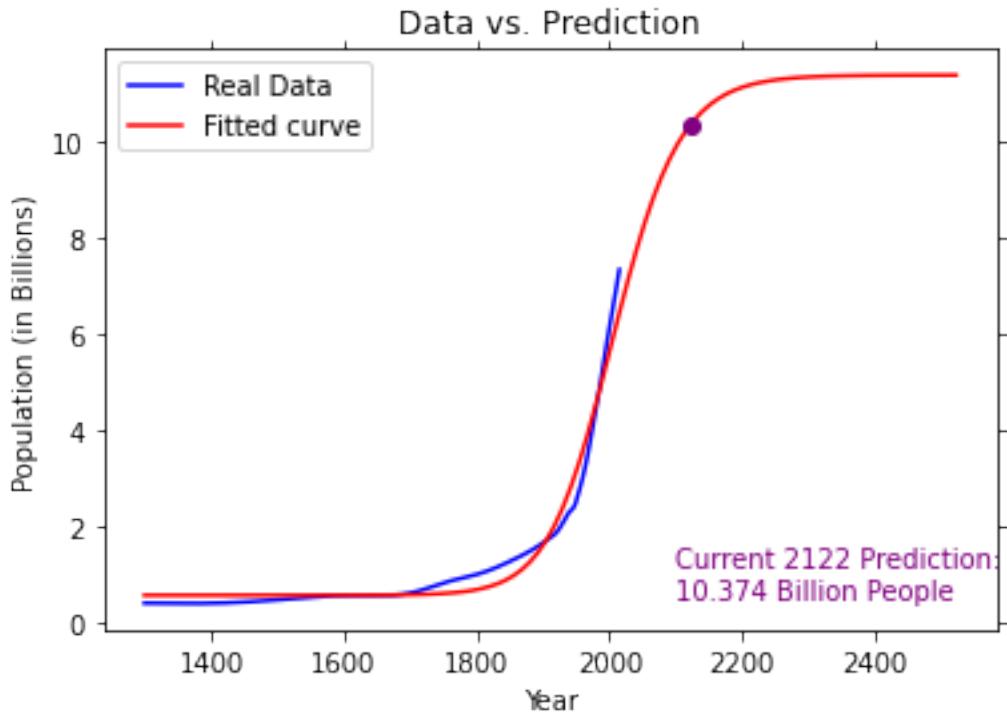
Iteration #7250, Loss: 0.057238309716541355



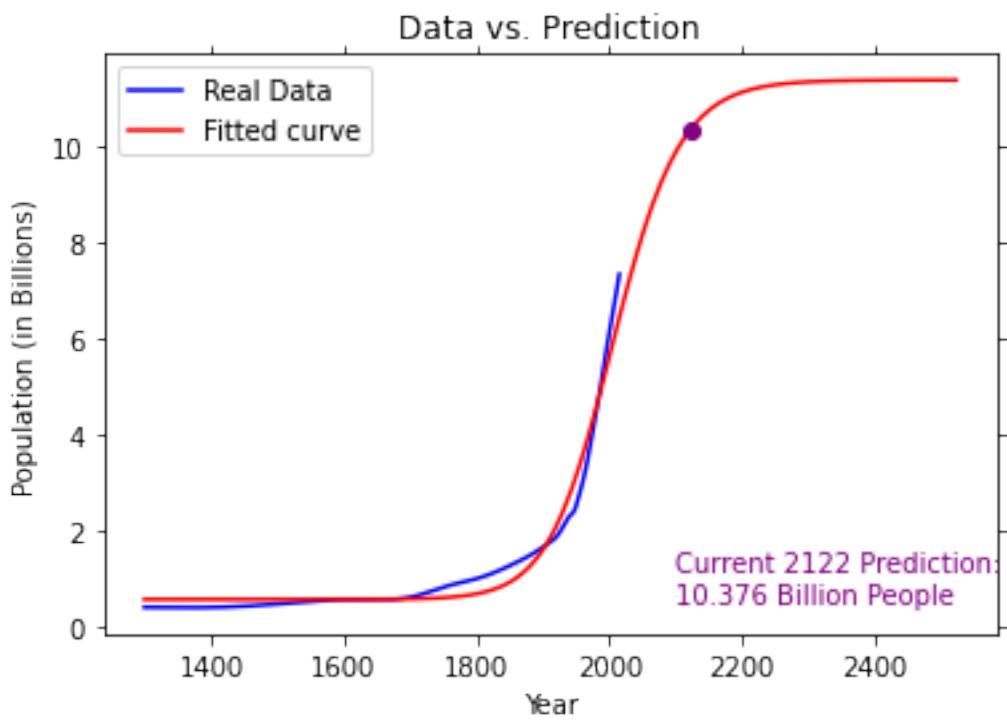
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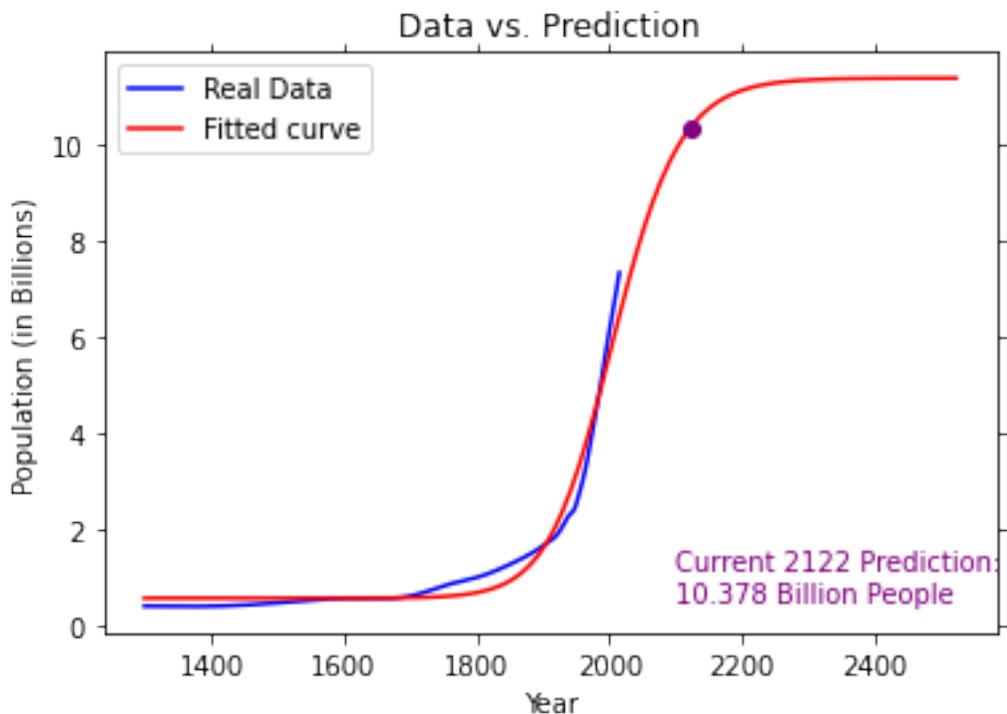
Iteration #7350, Loss: 0.057157016984109146



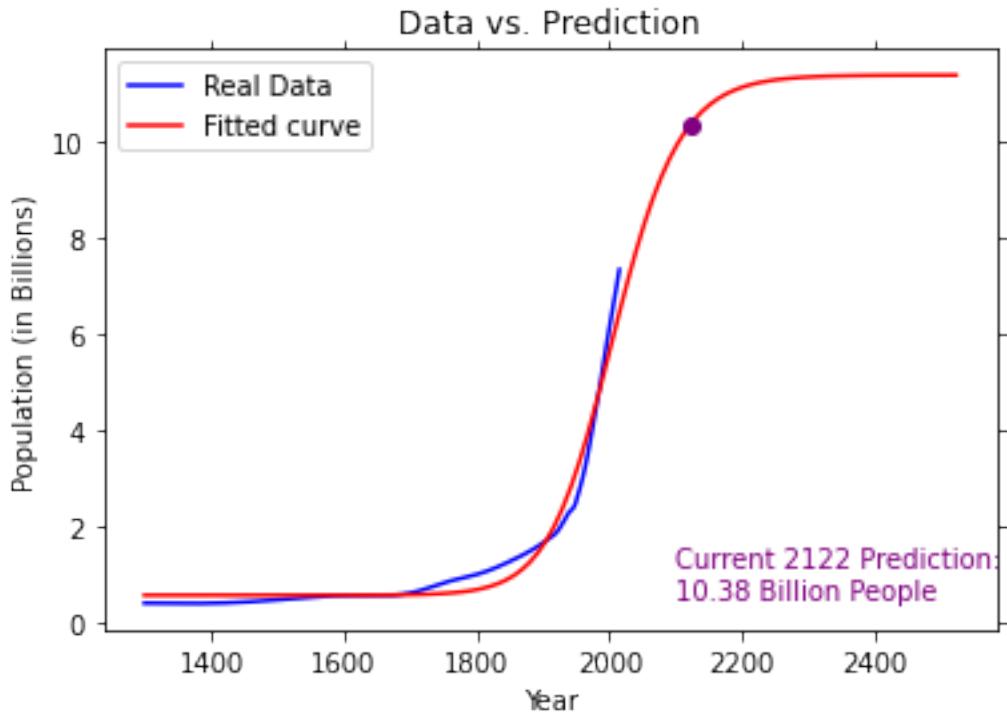
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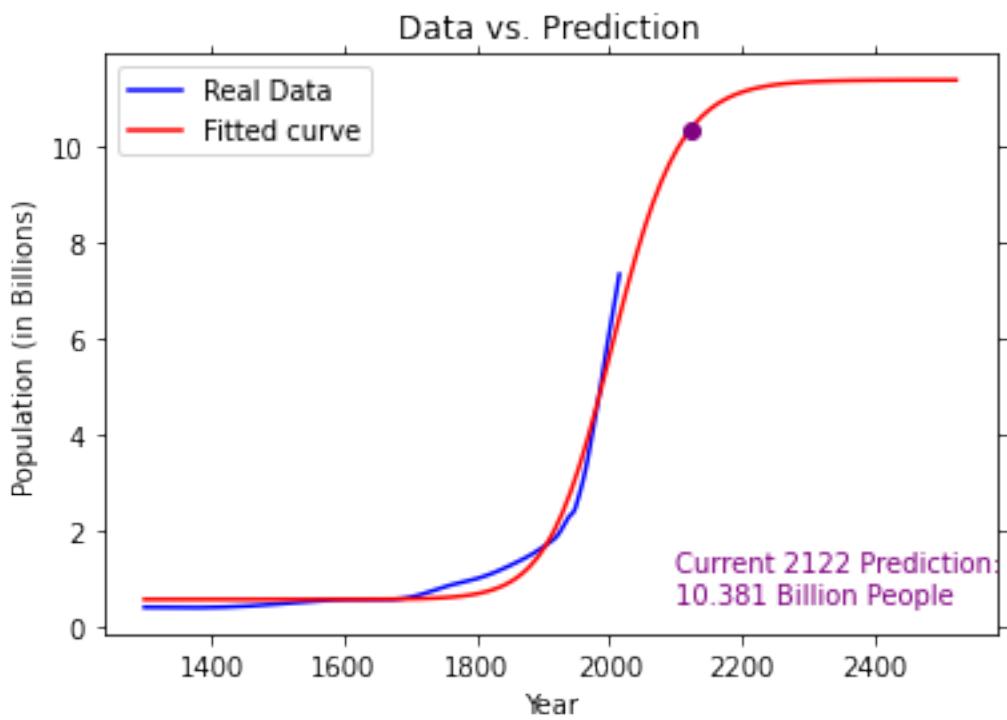
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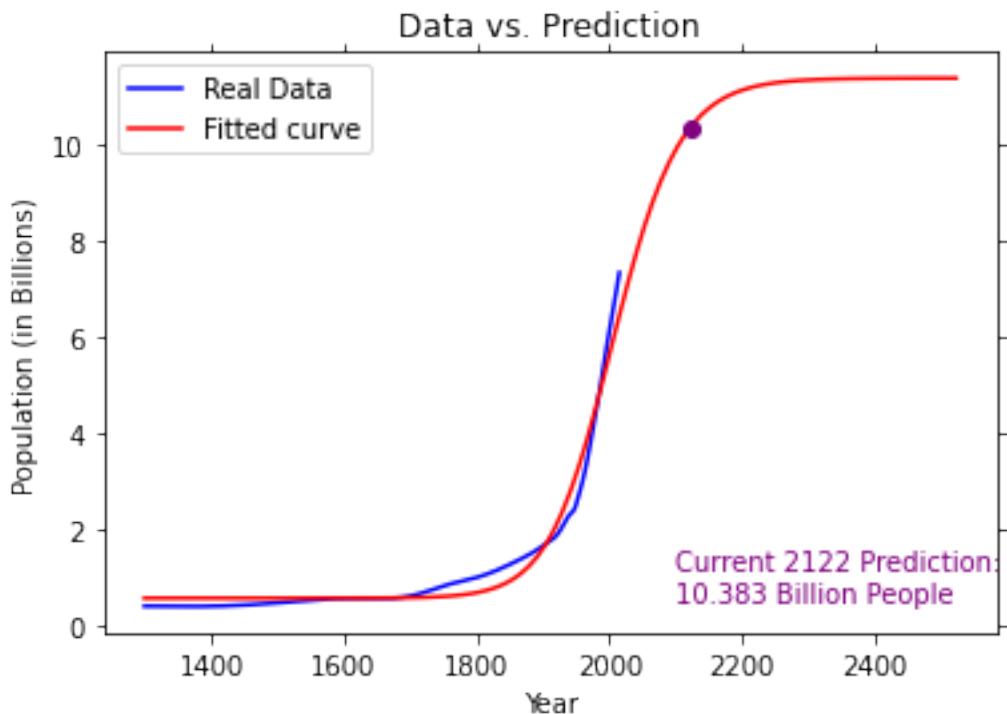
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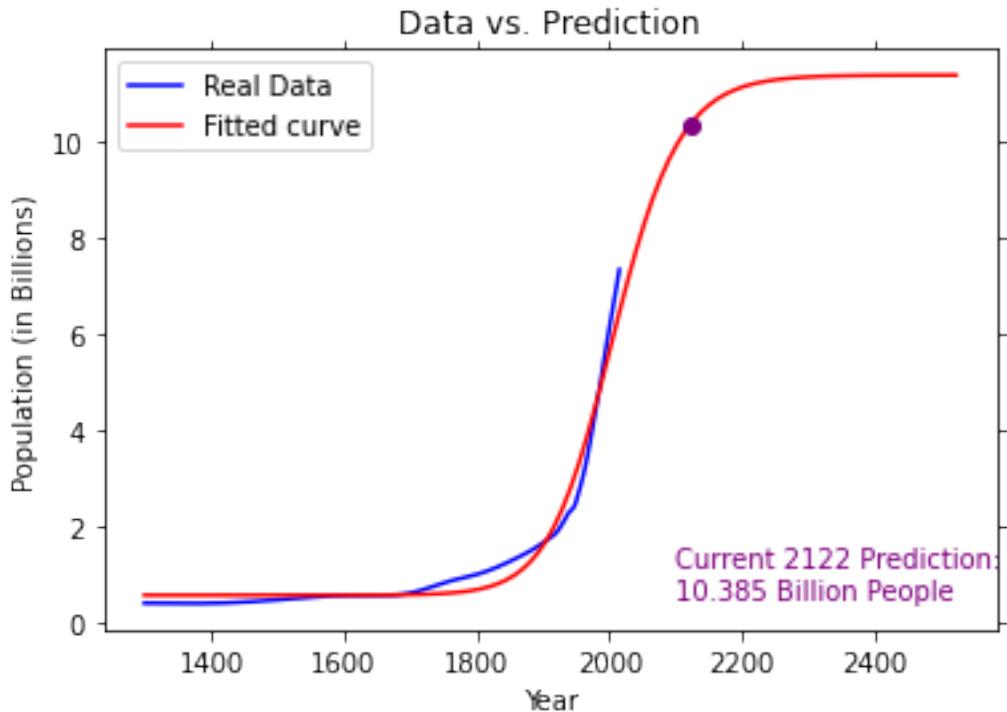
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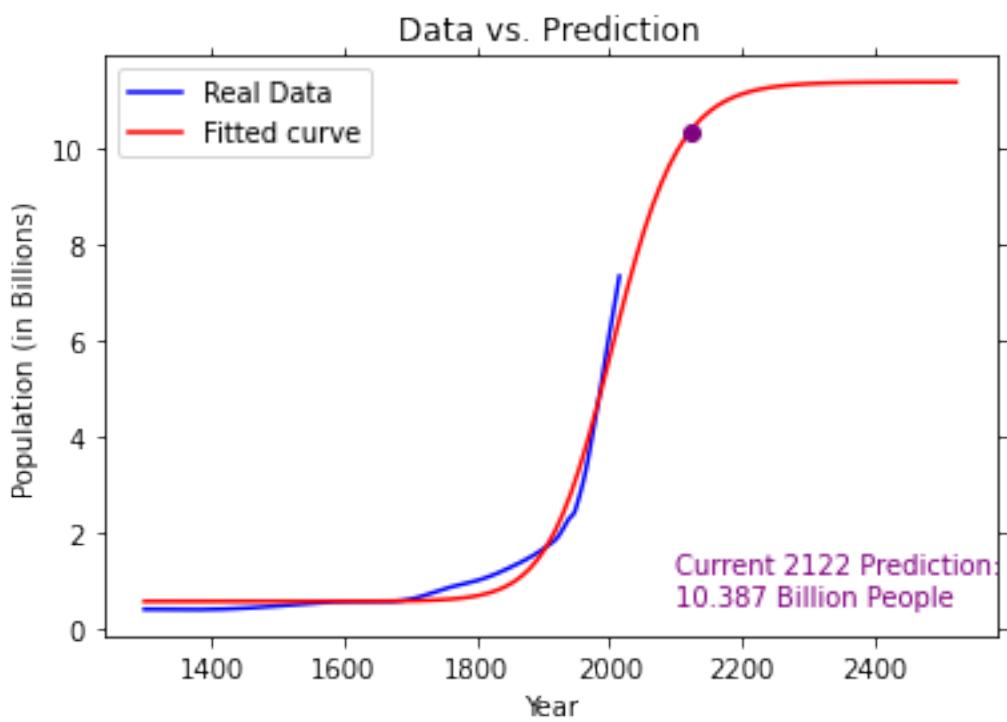
Iteration #7600, Loss: 0.05696423490909039



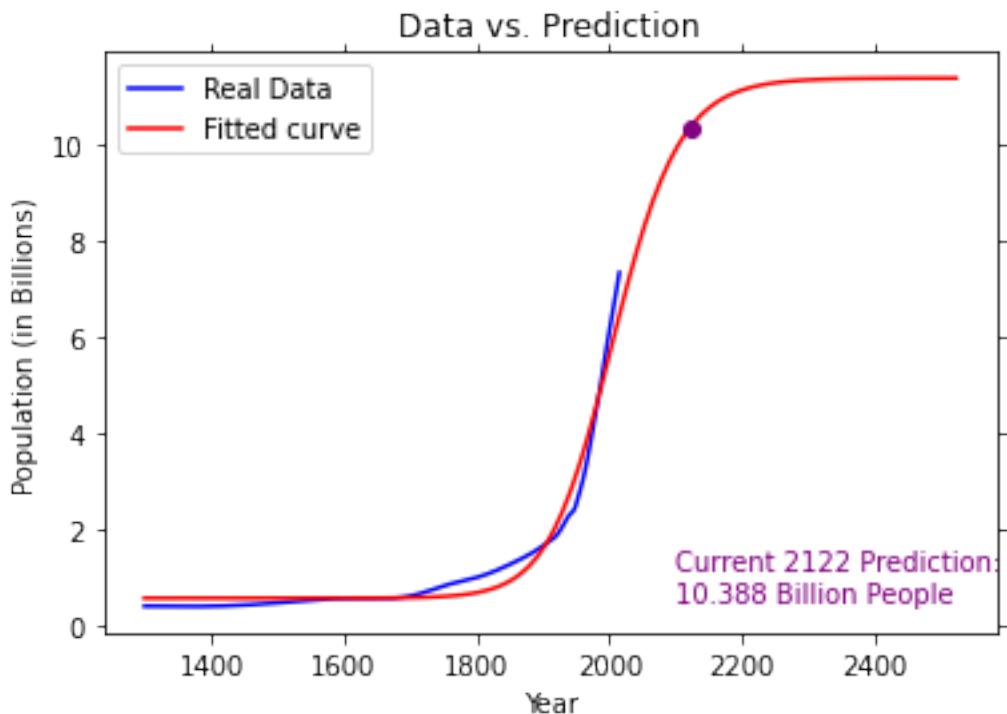
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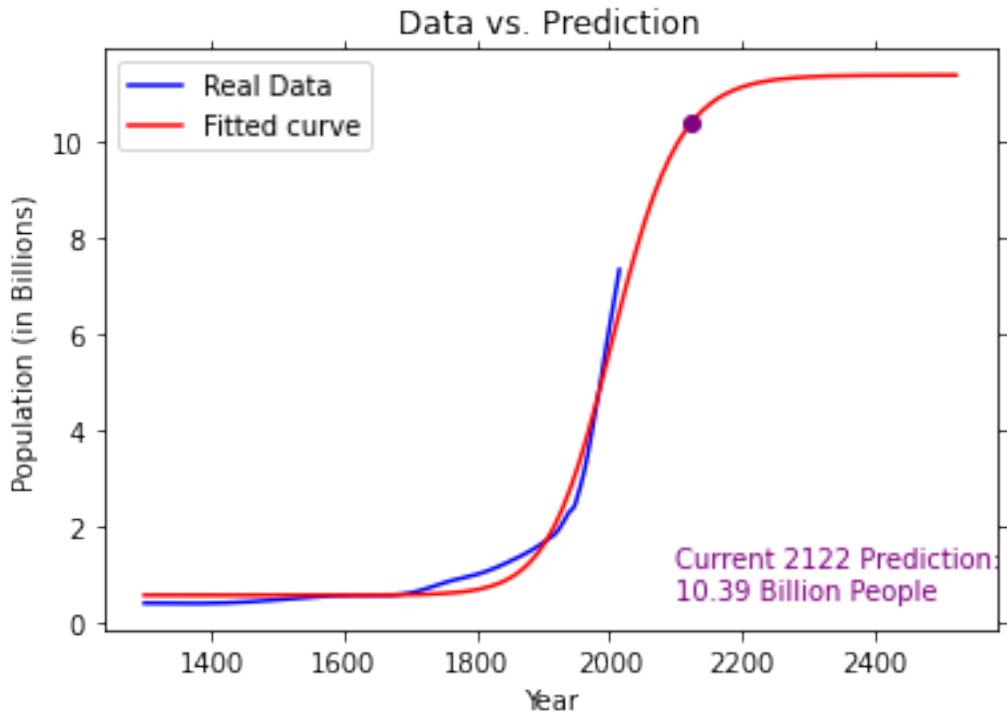
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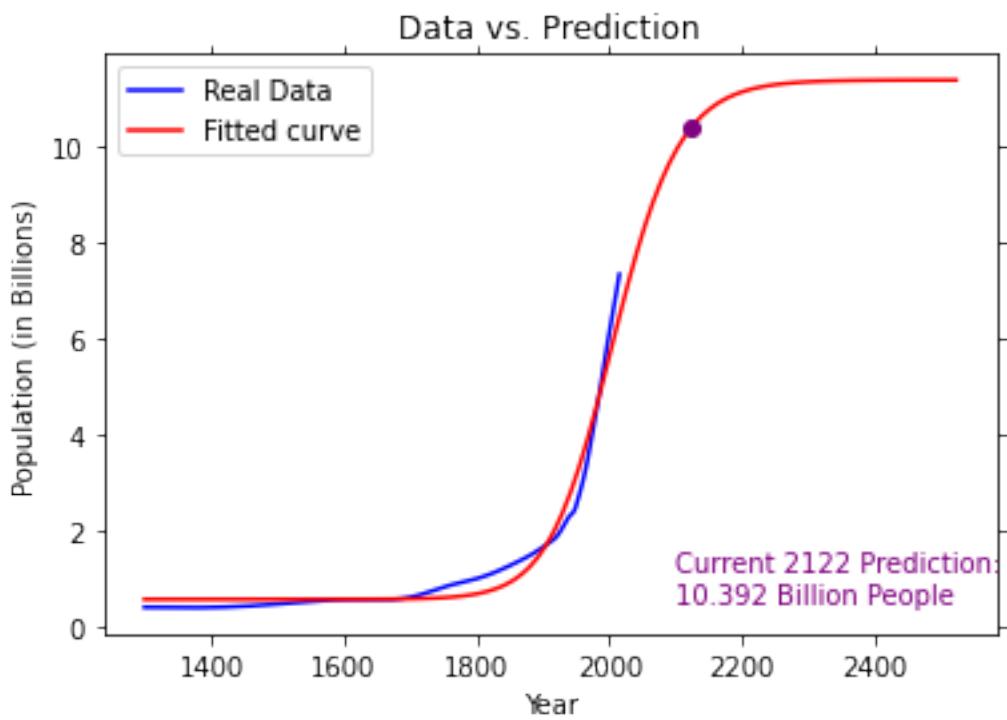
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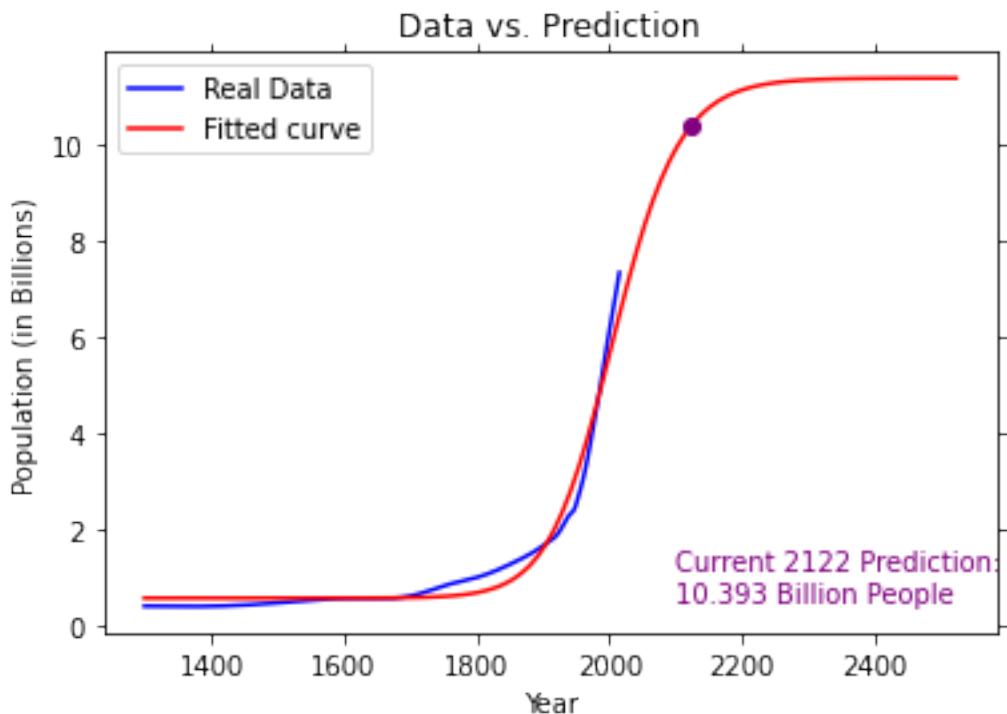
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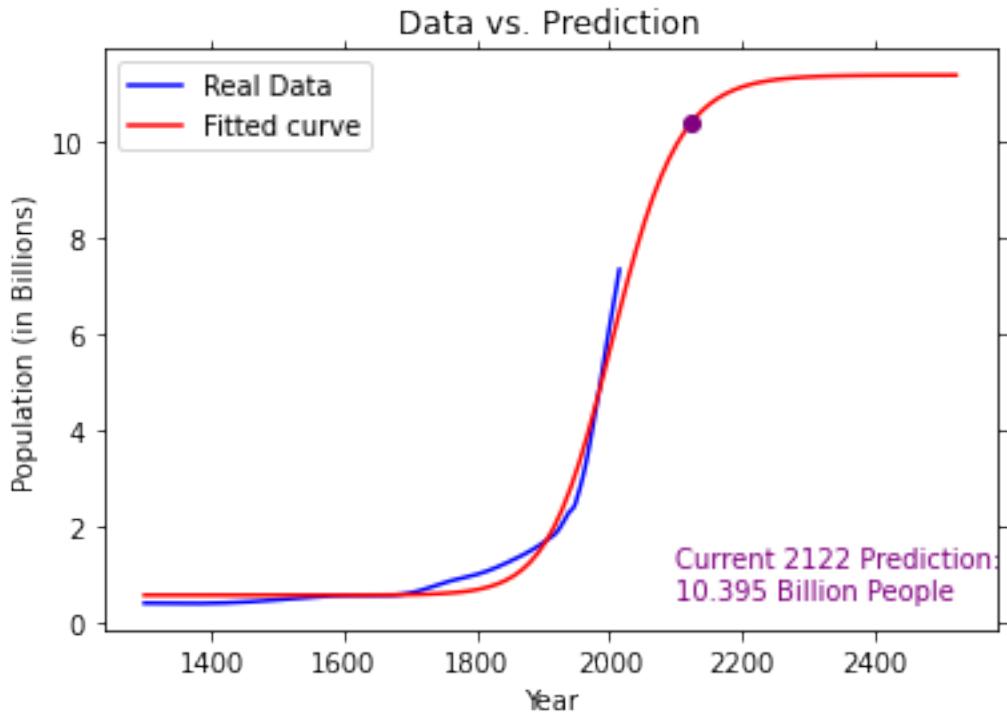
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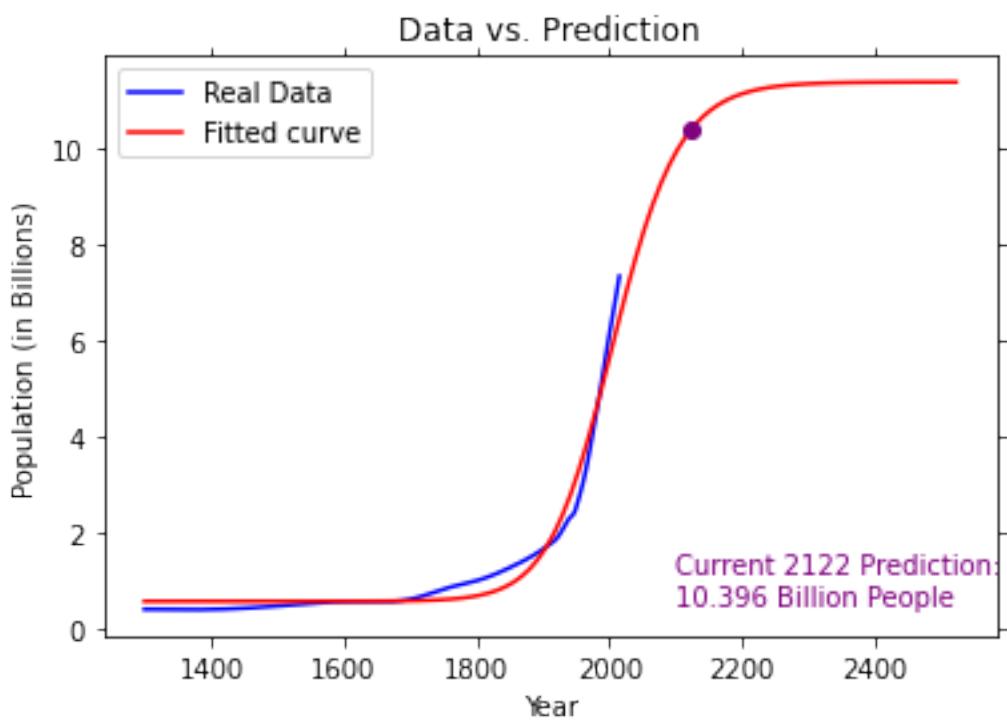
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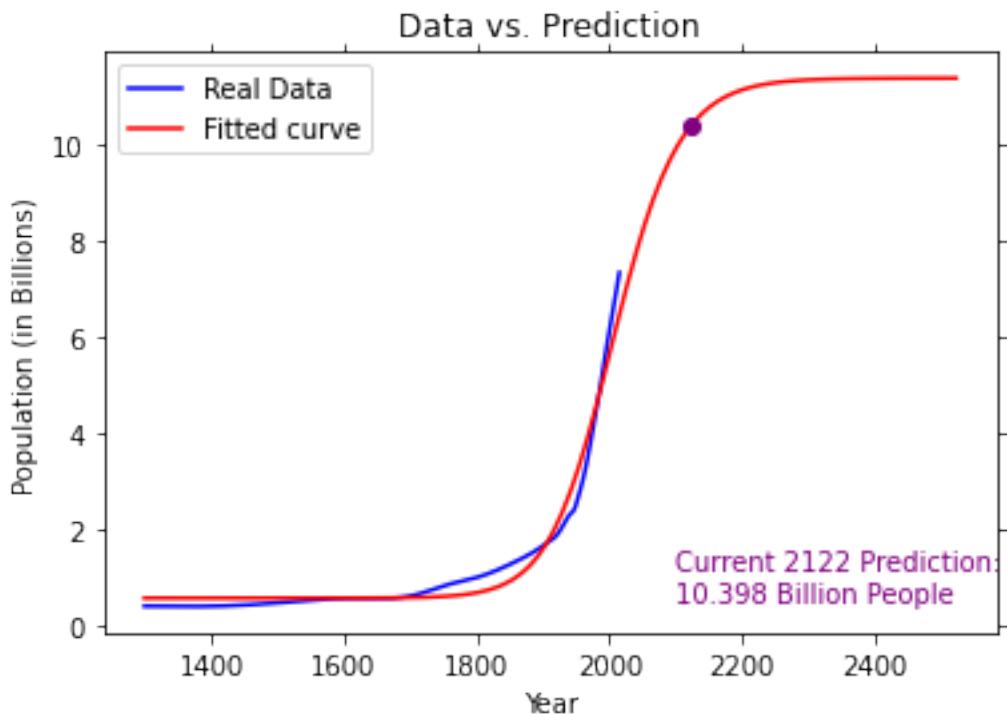
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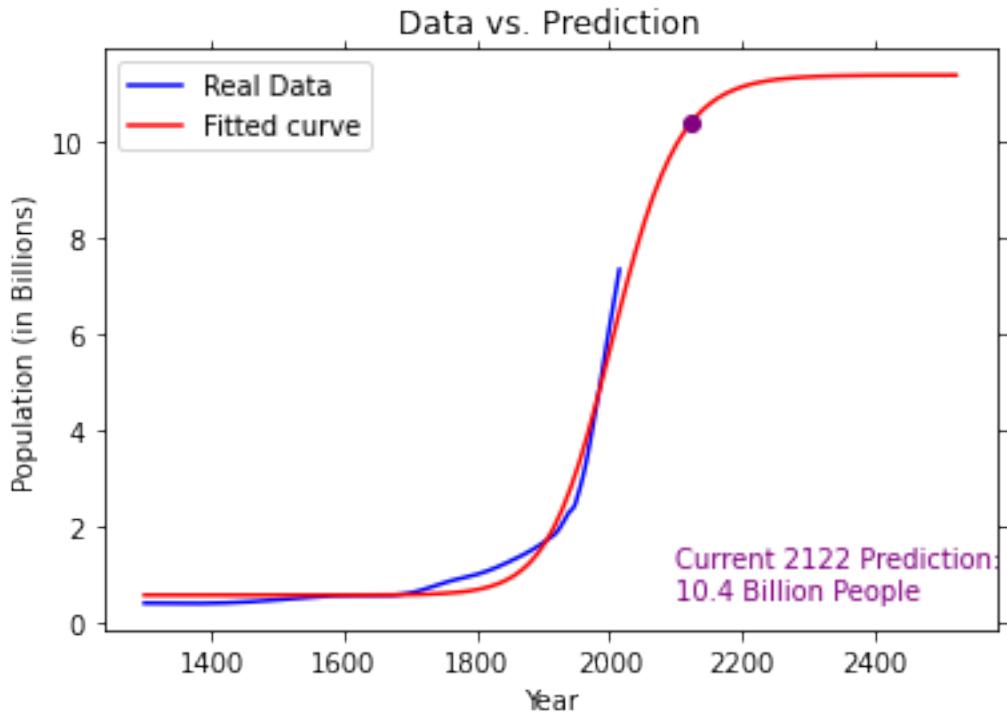
Iteration #8000, Loss: 0.0566835276679153



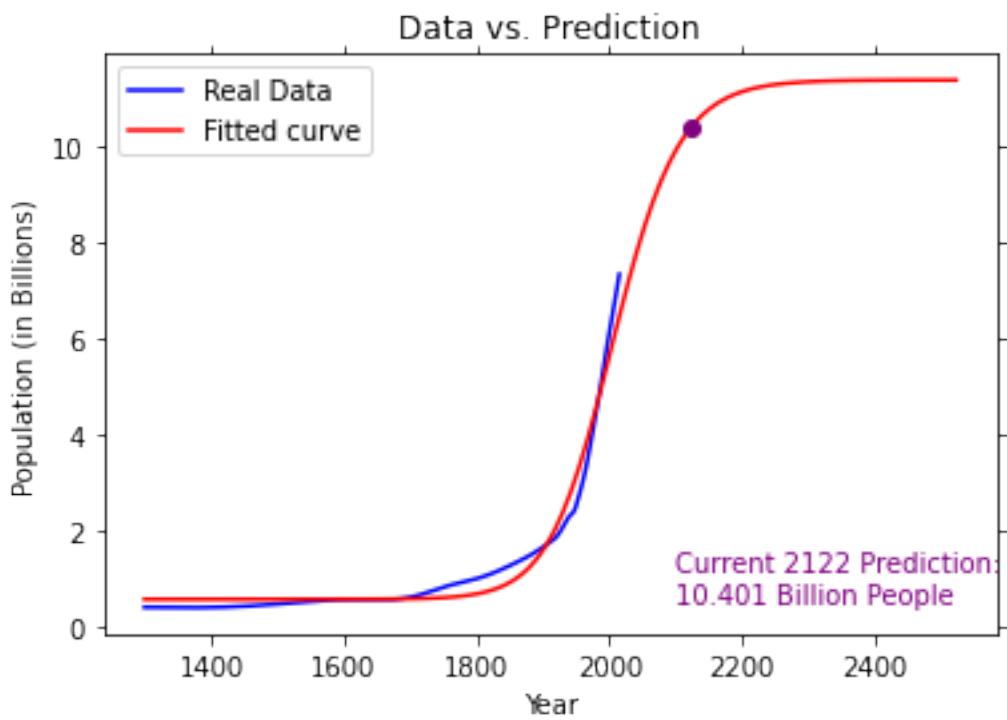
Iteration #8050, Loss: 0.05665059950474369



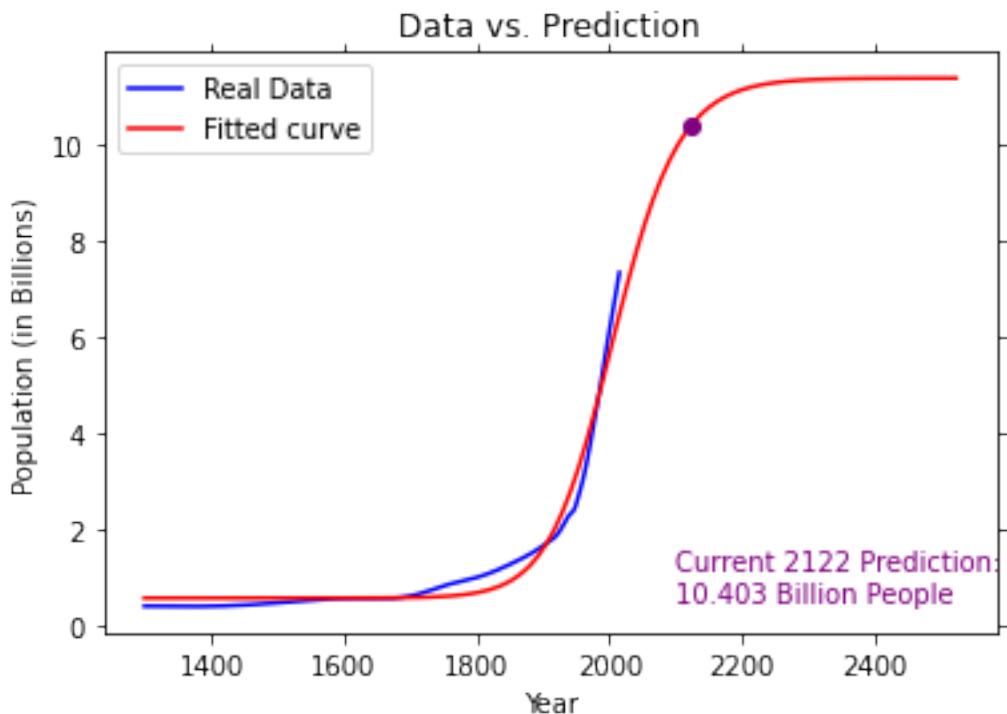
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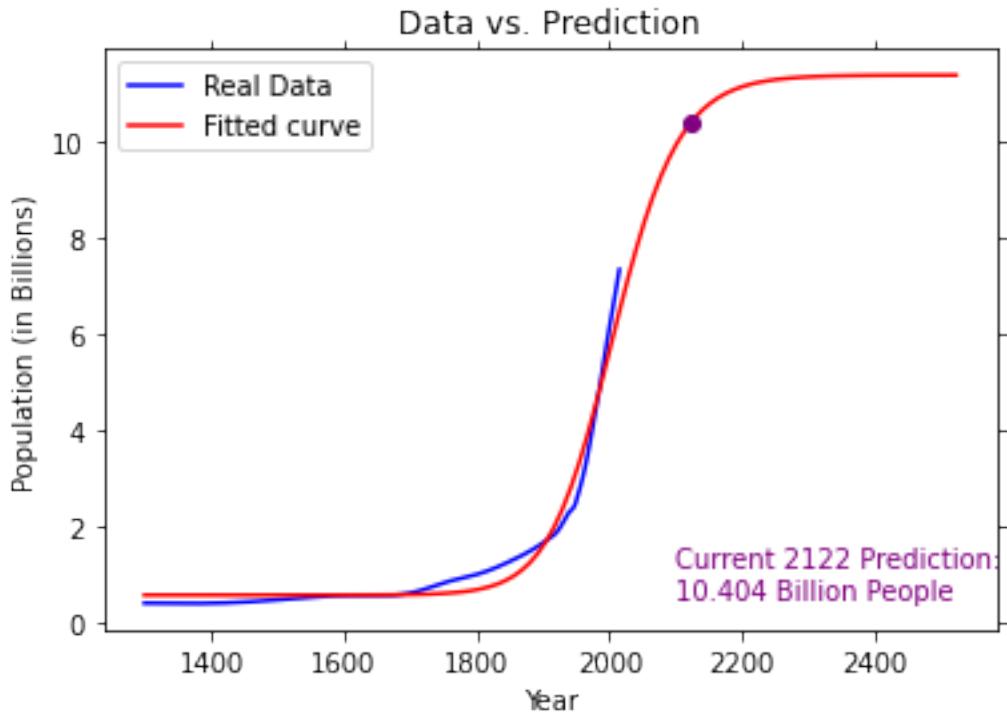
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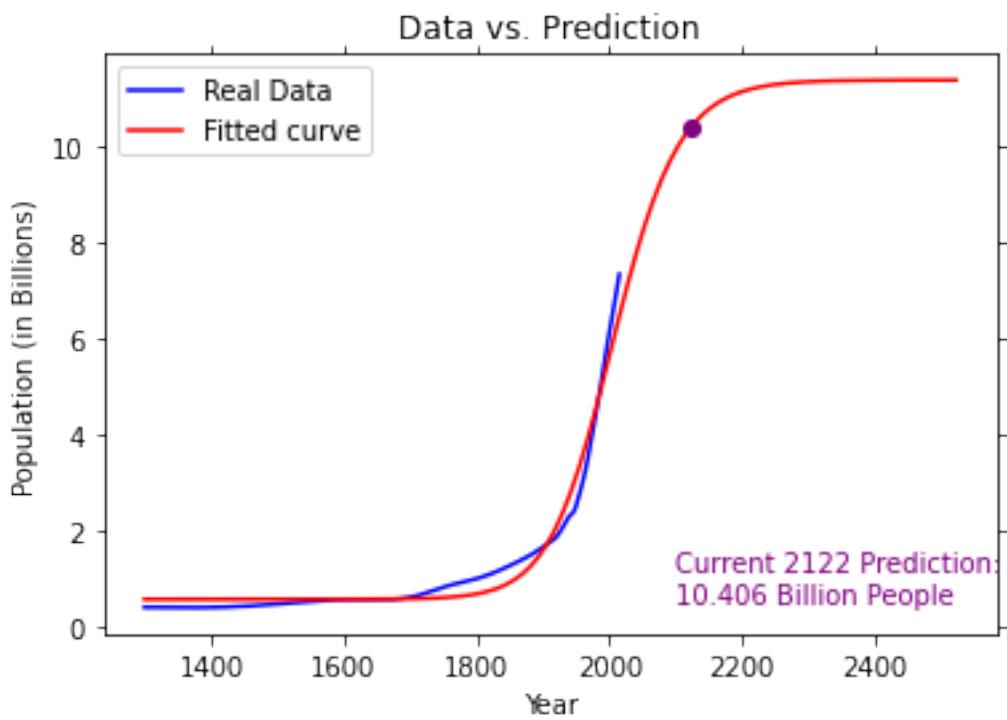
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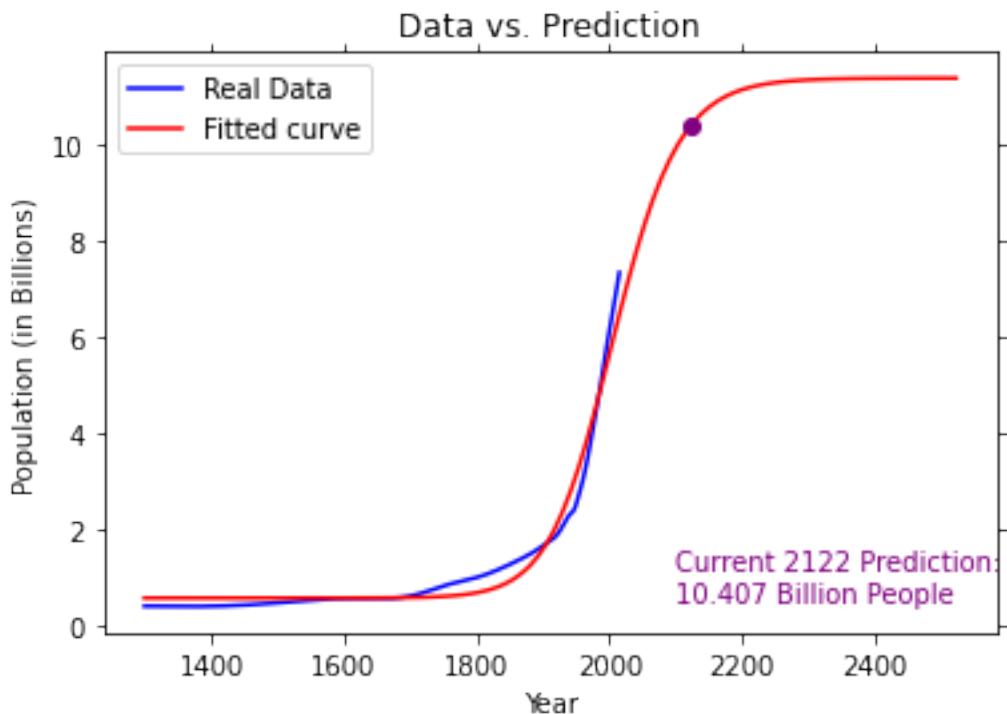
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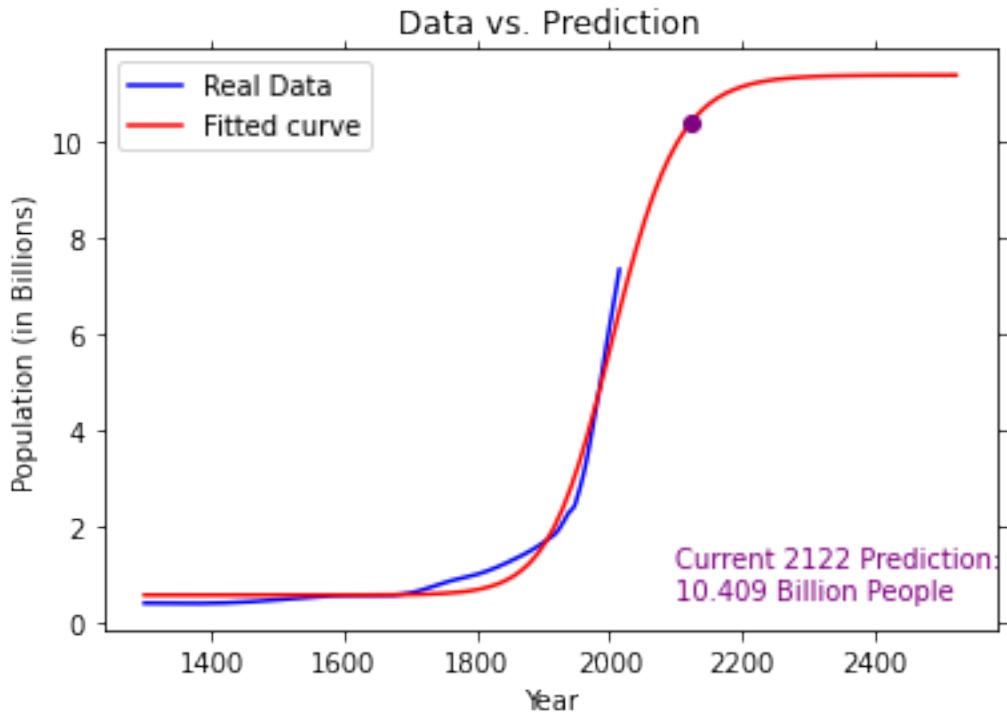
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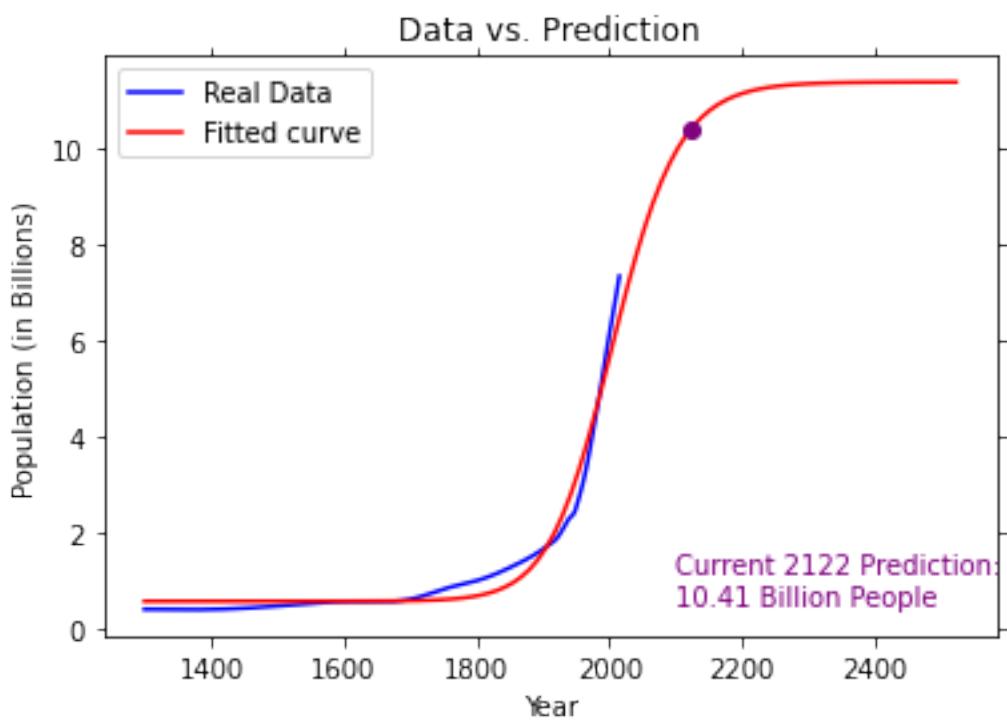
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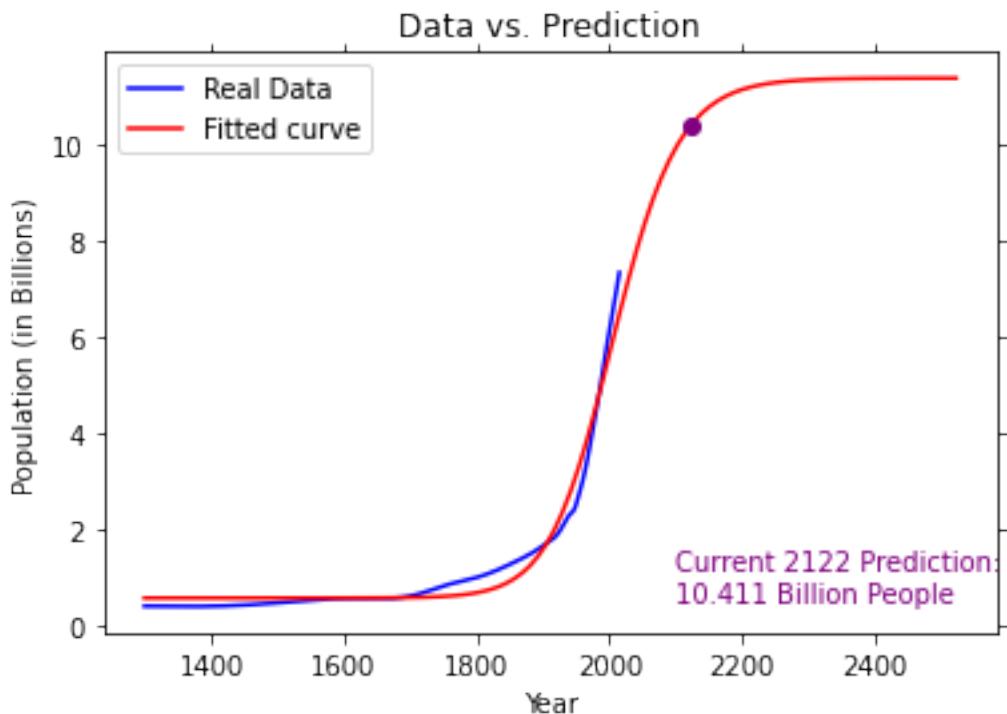
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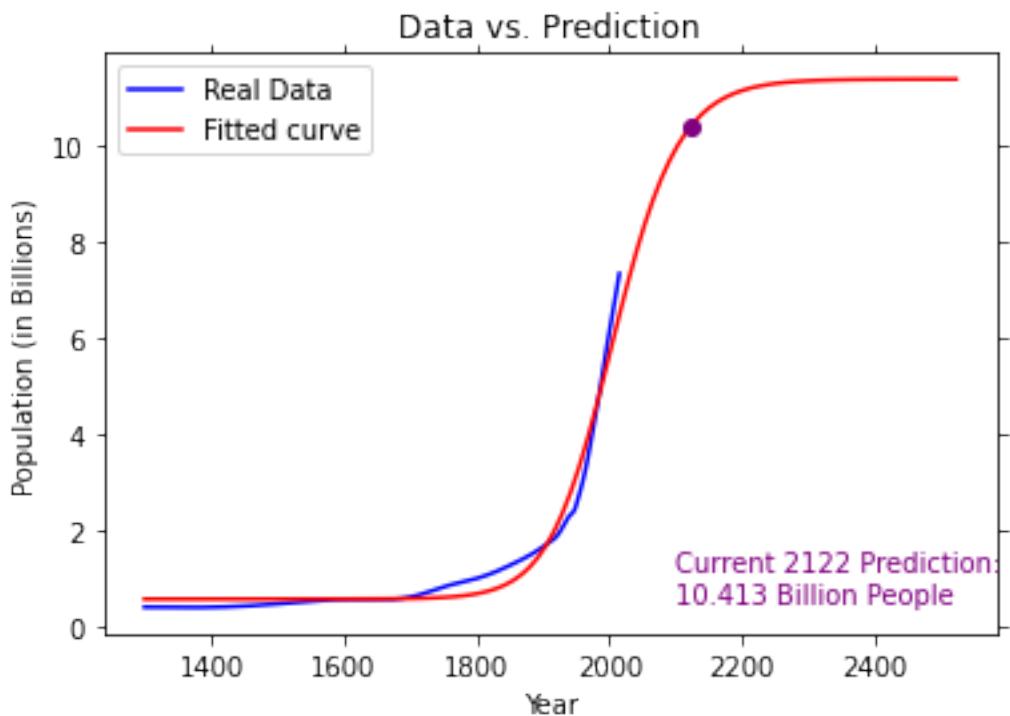
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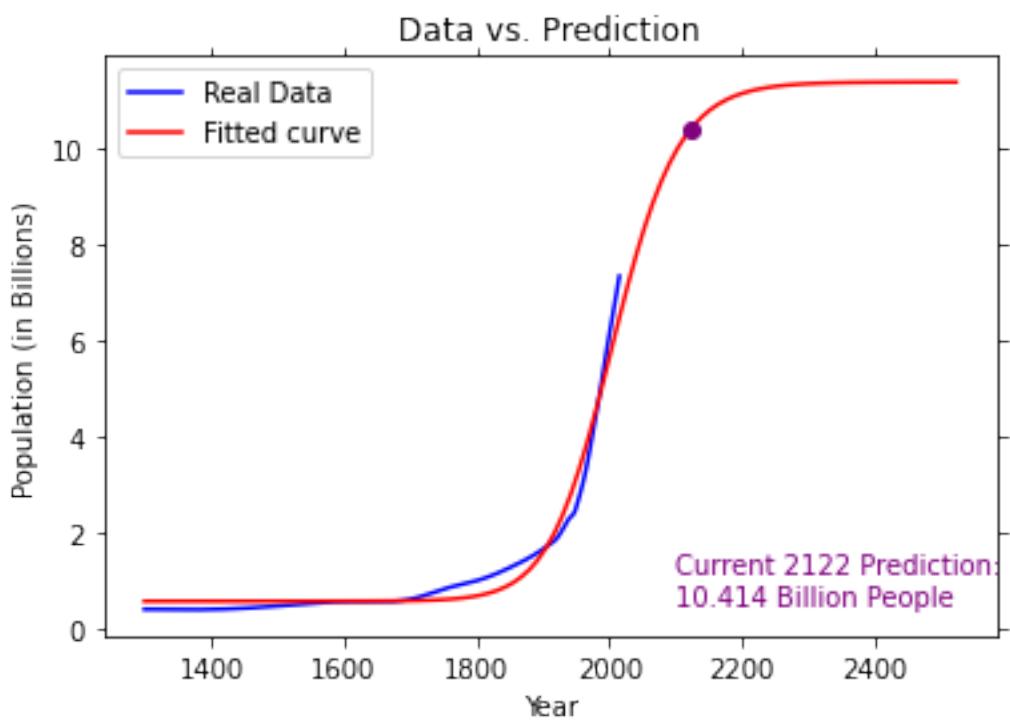
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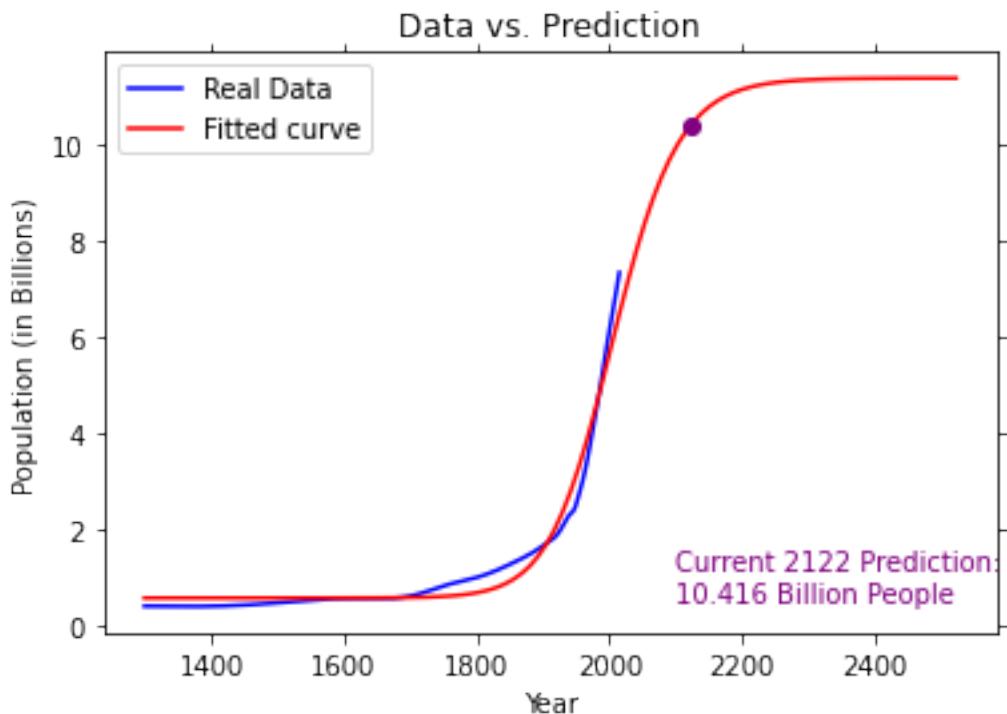
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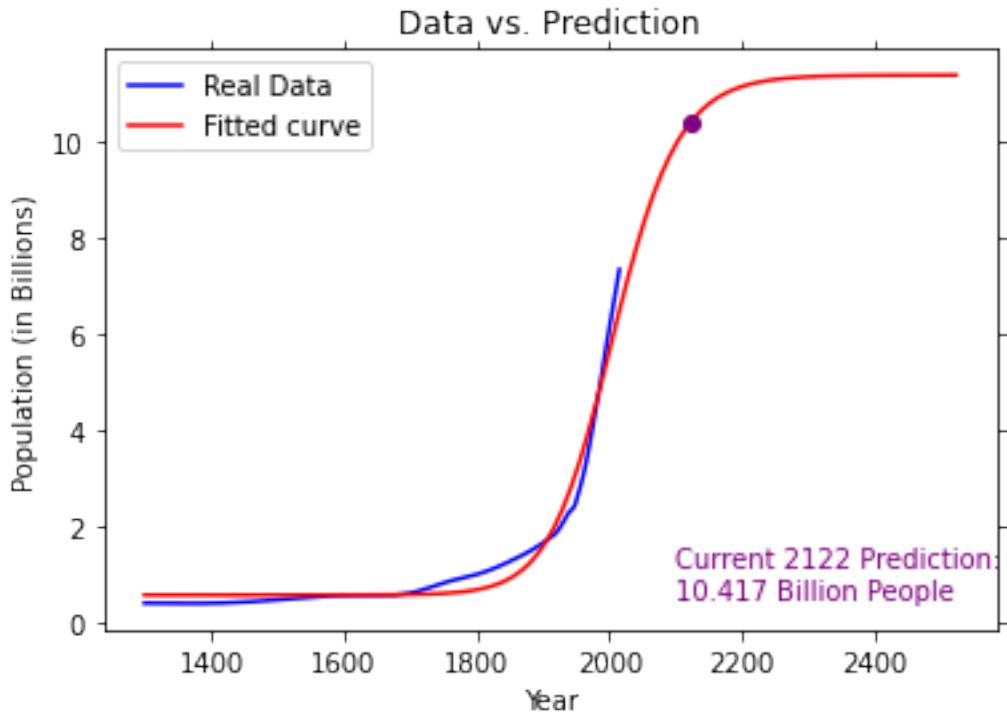
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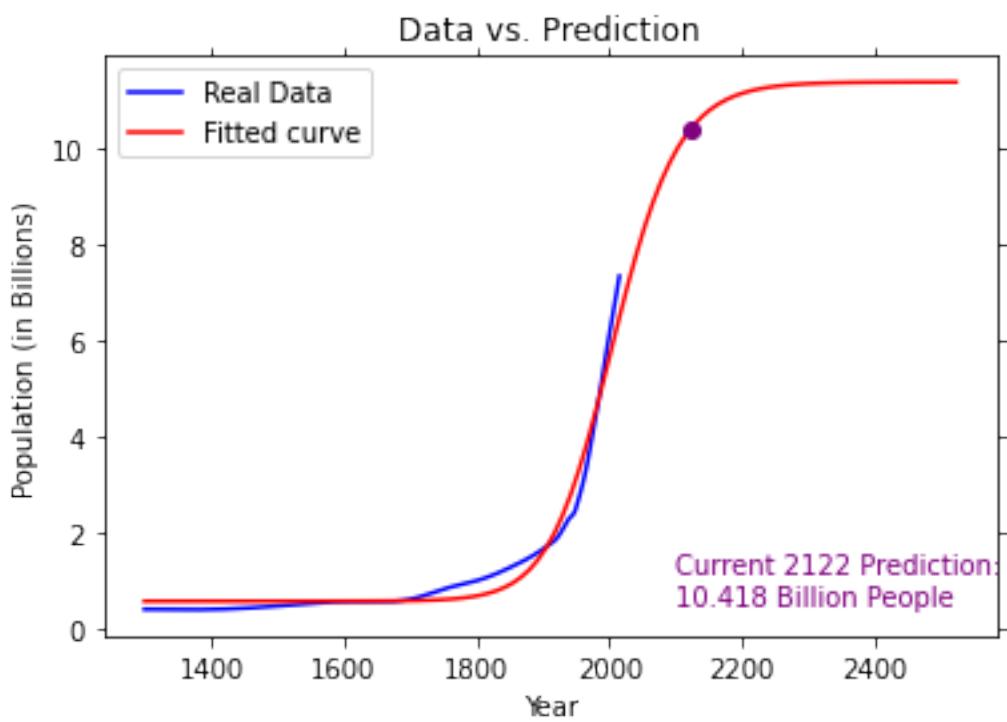
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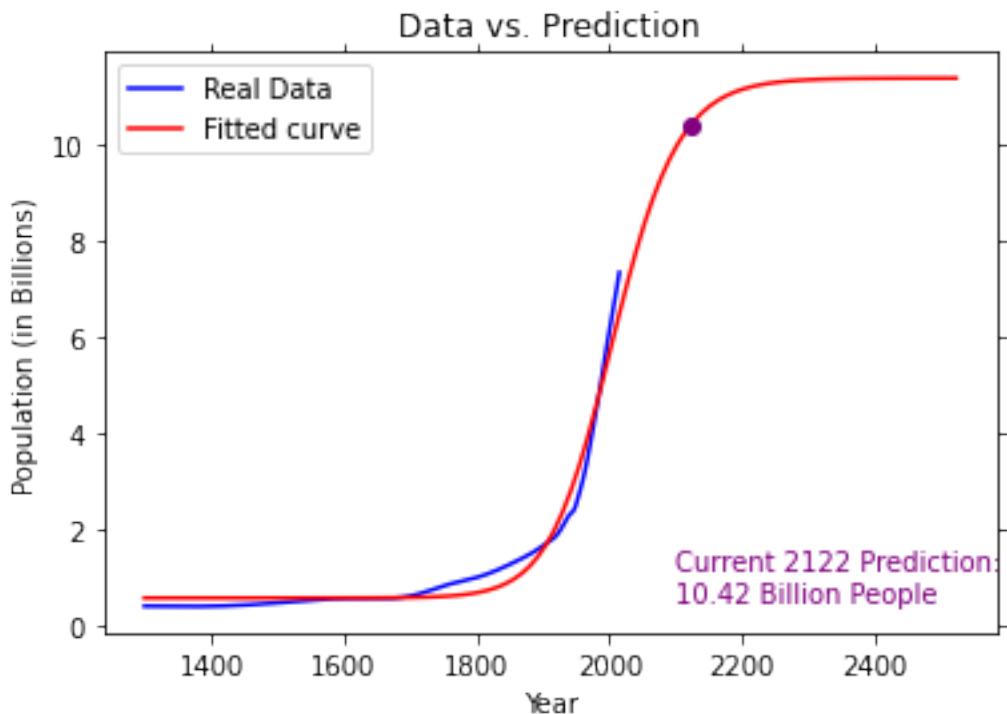
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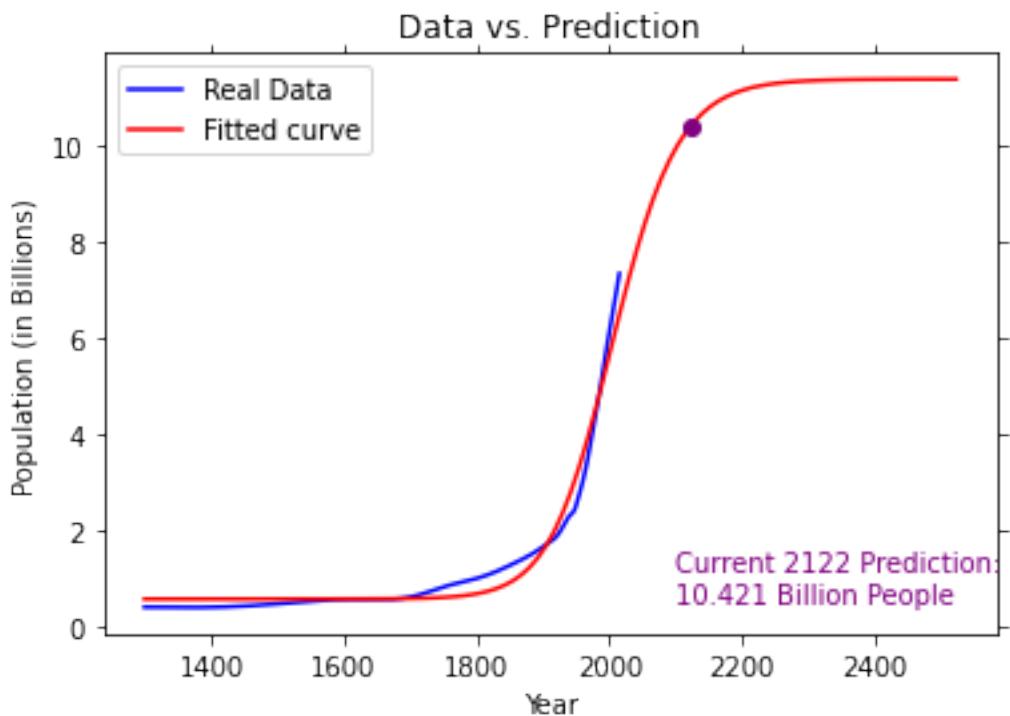
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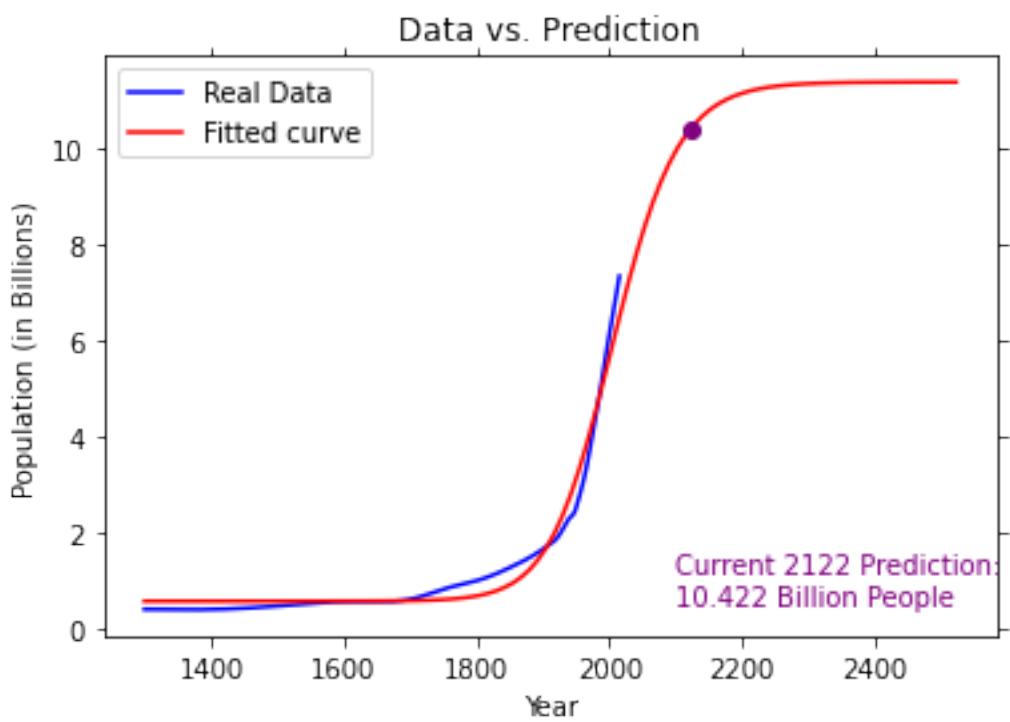
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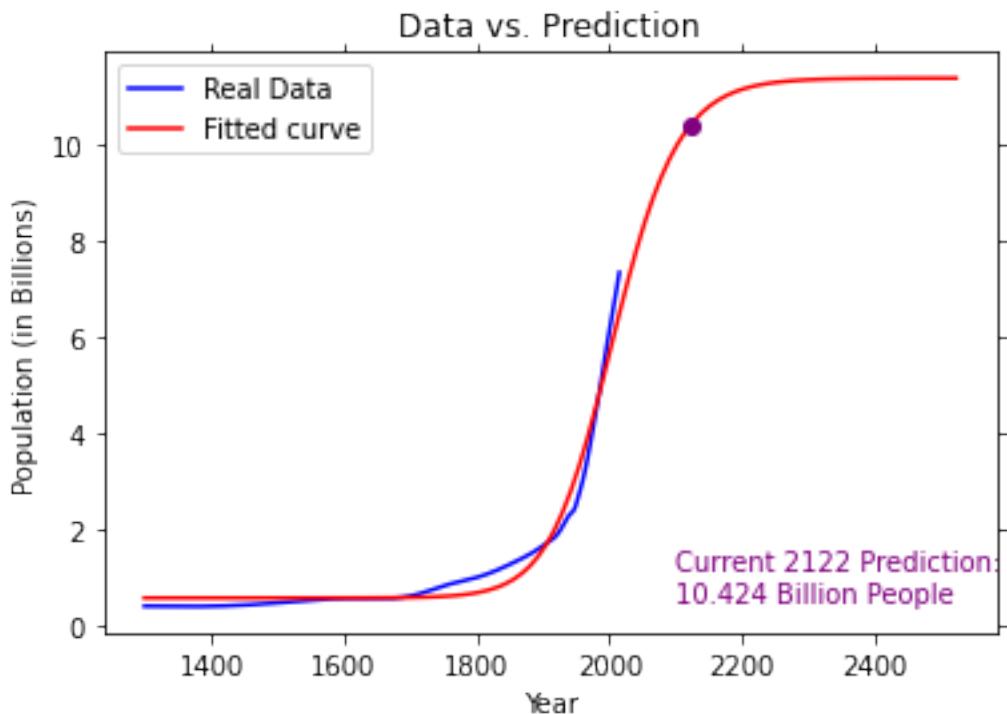
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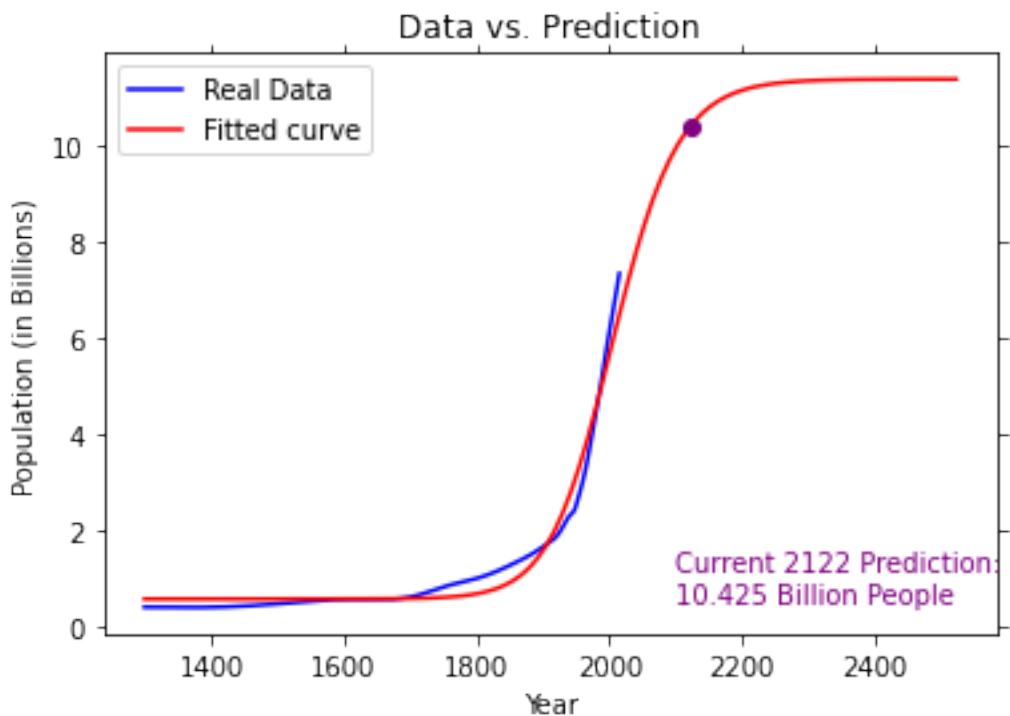
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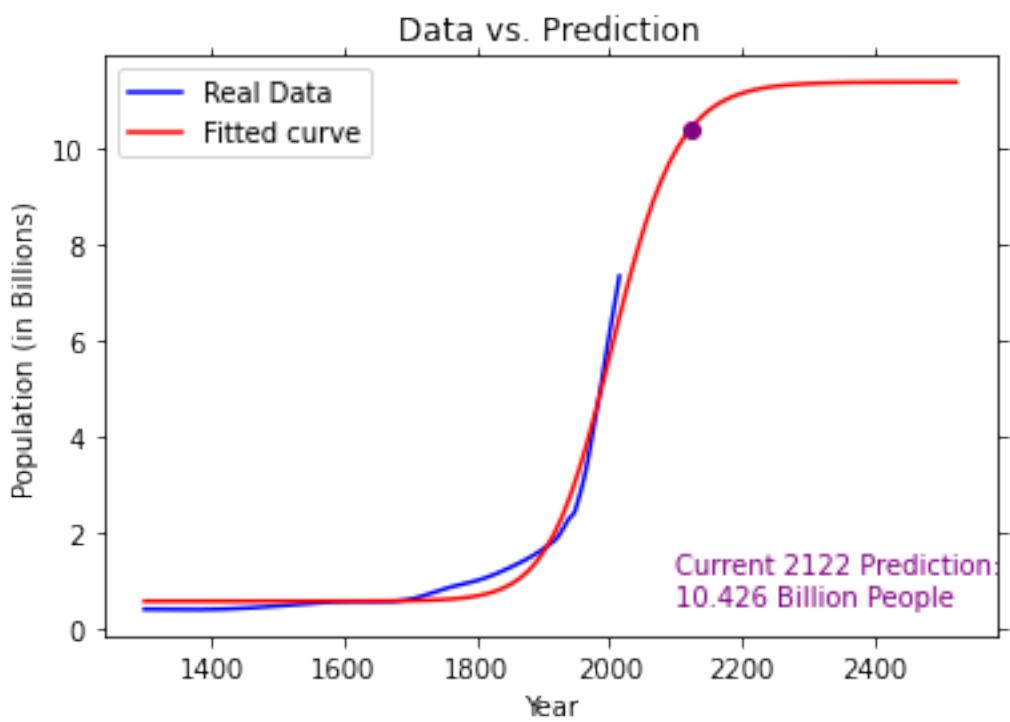
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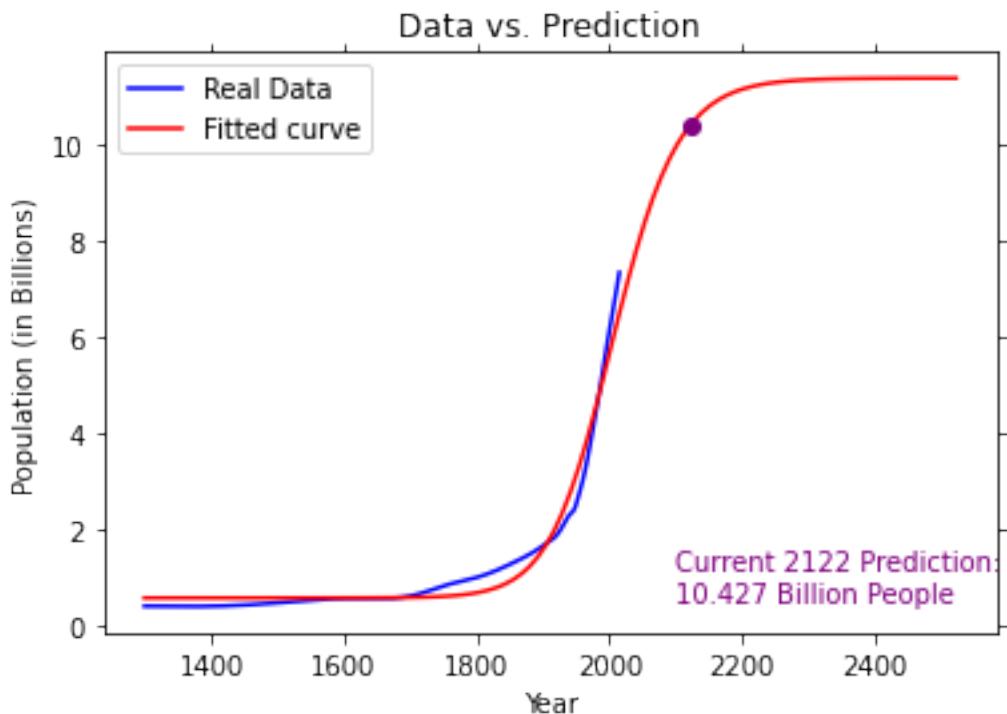
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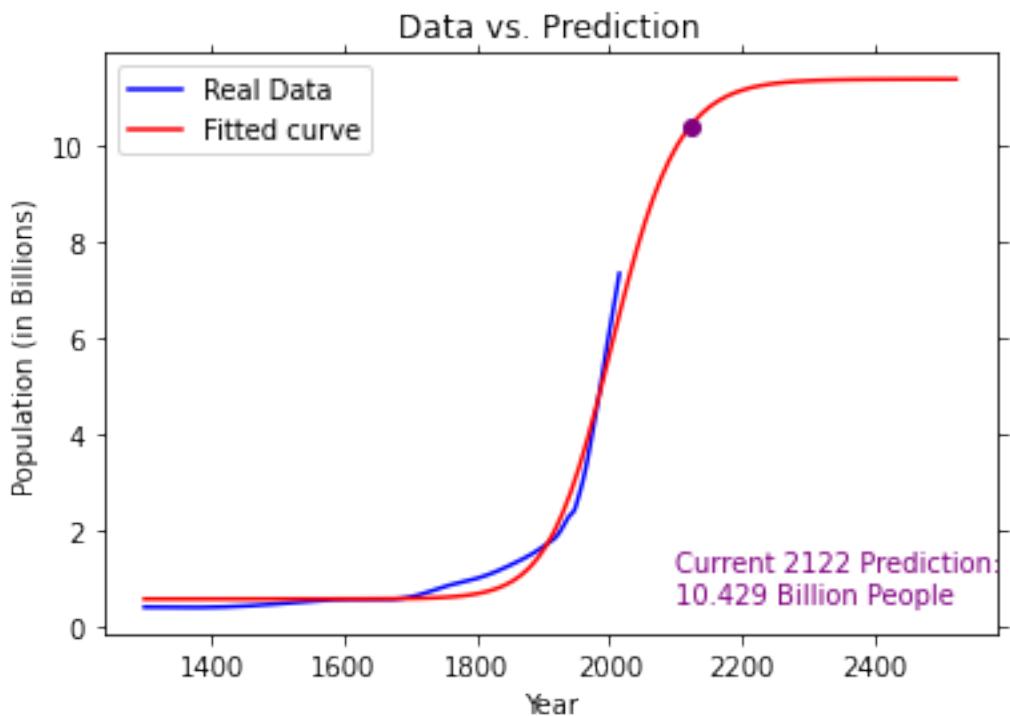
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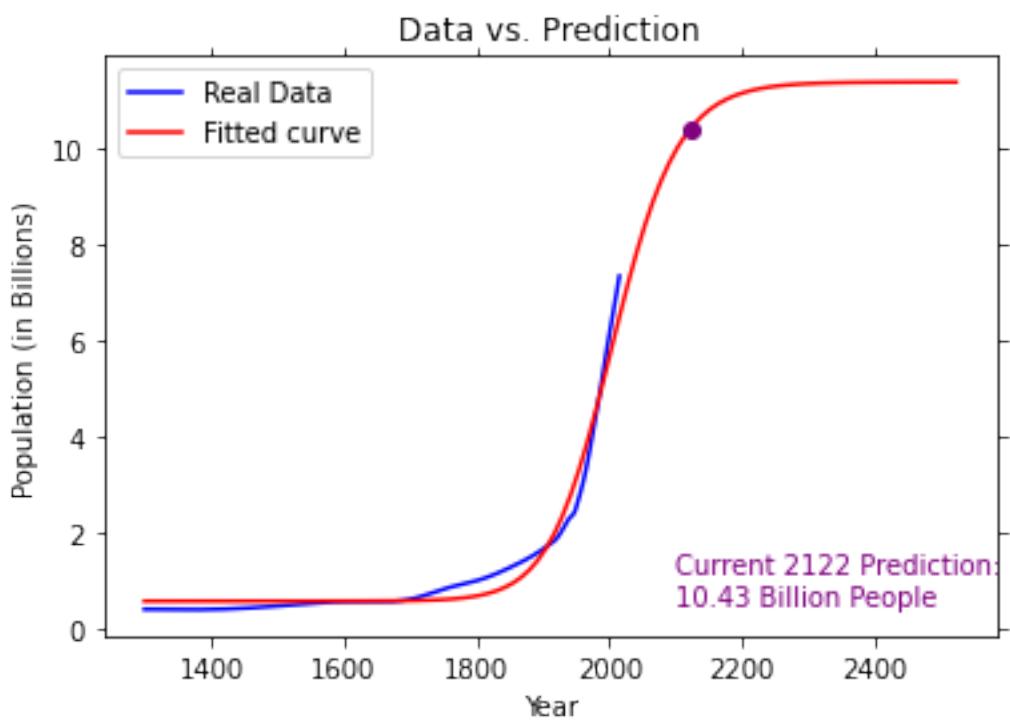
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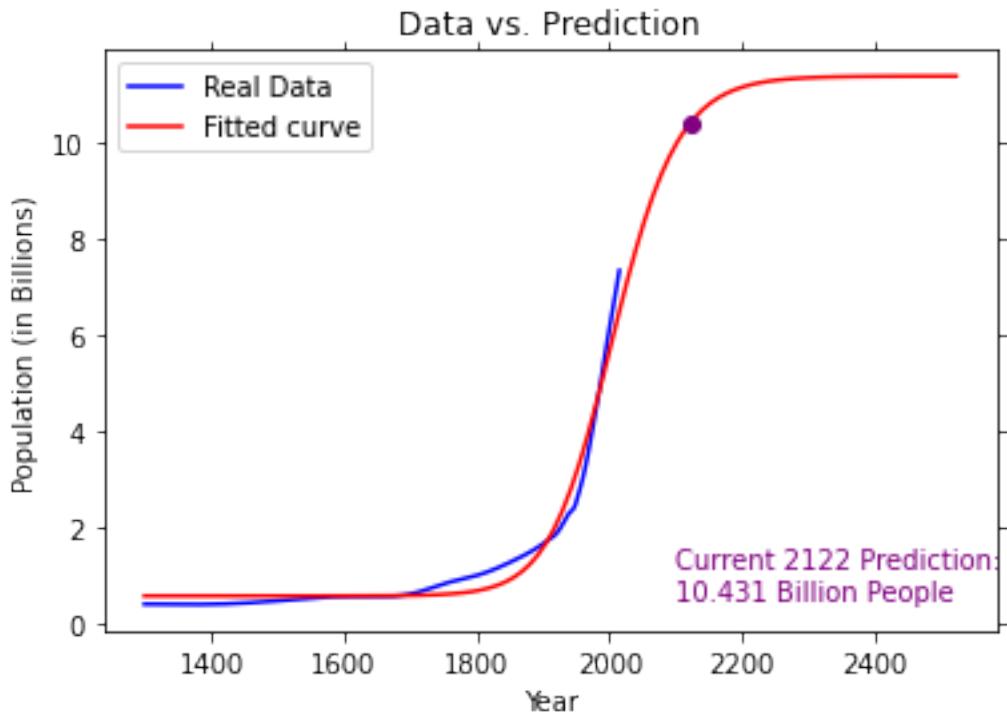
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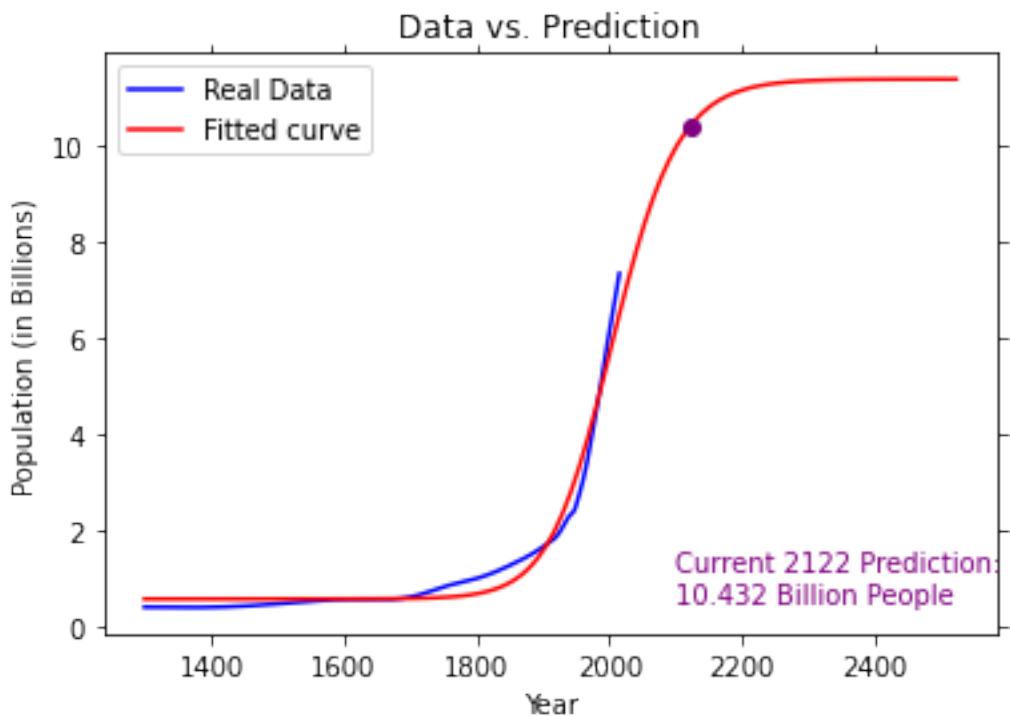
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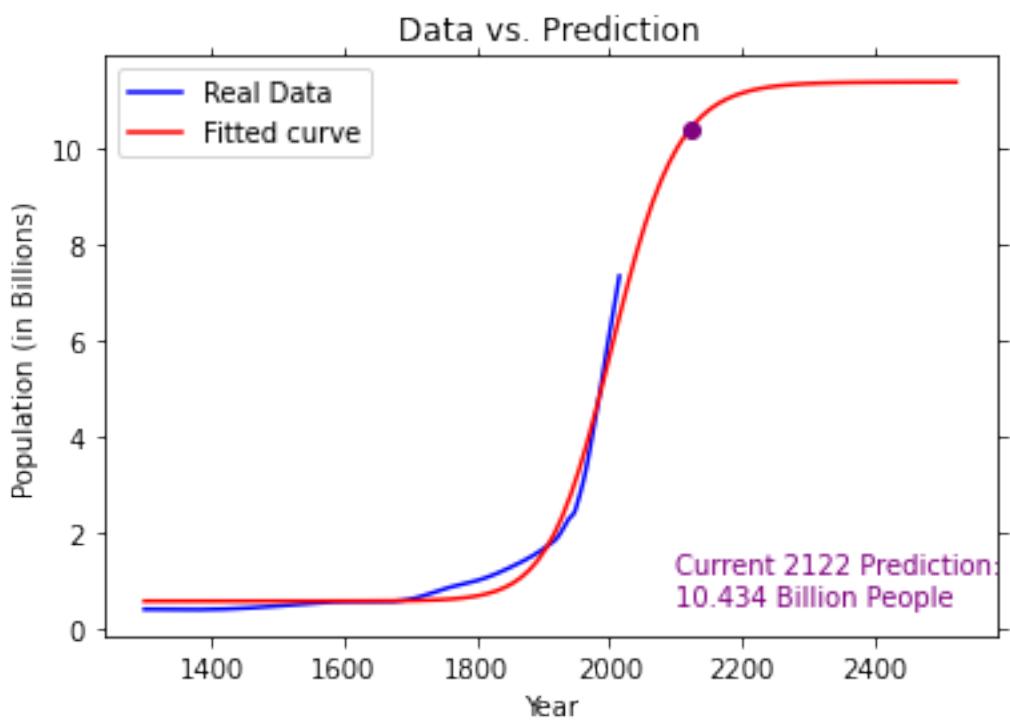
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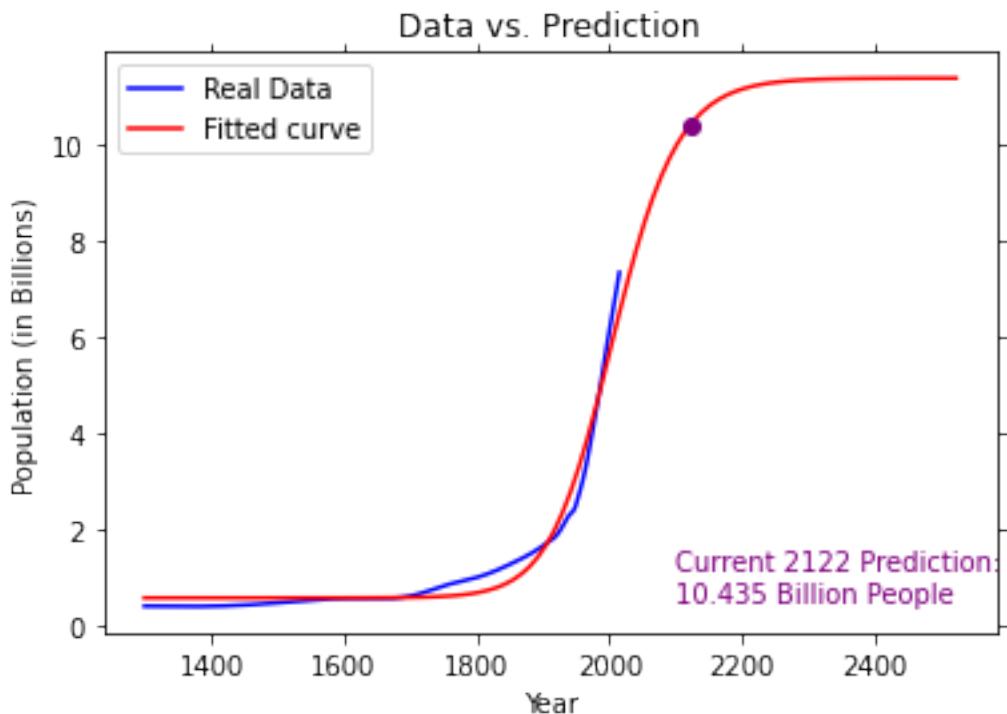
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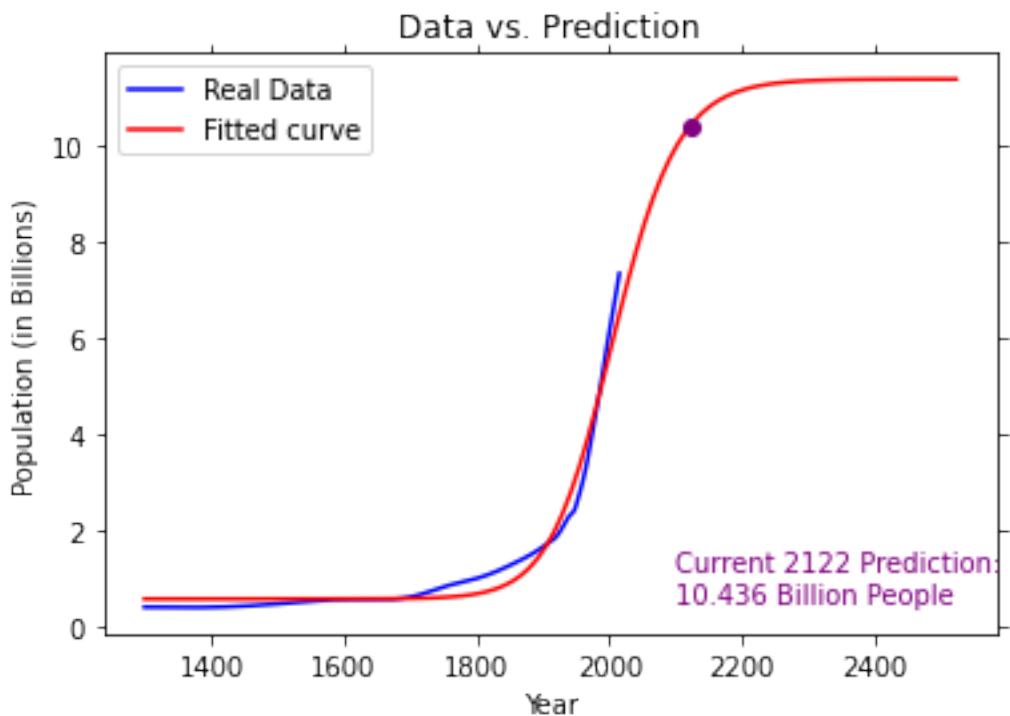
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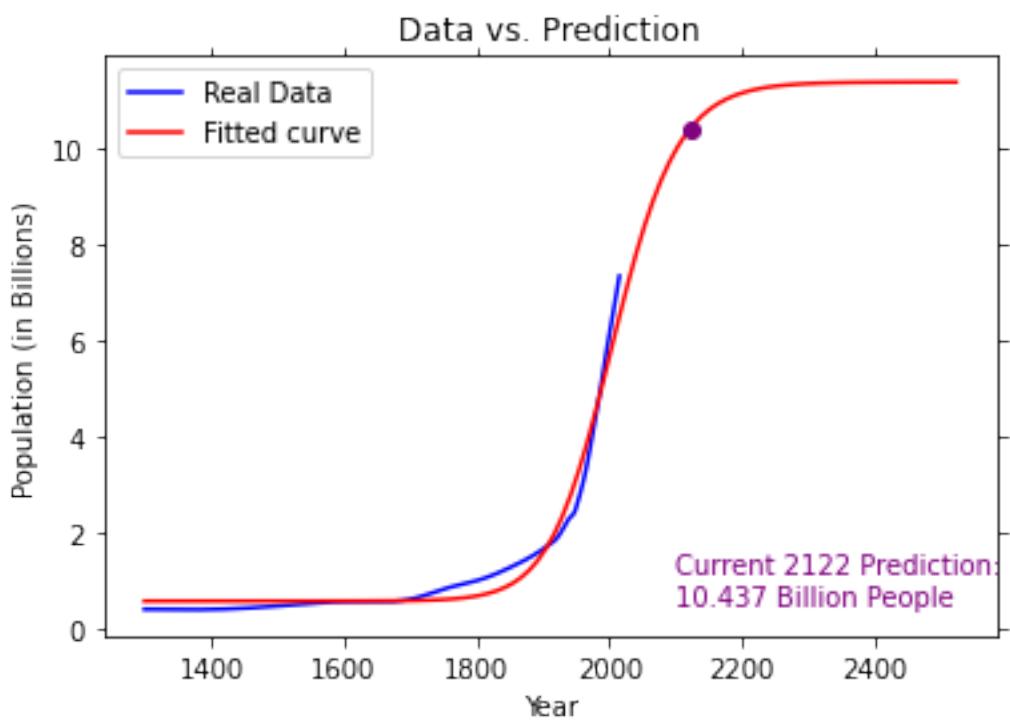
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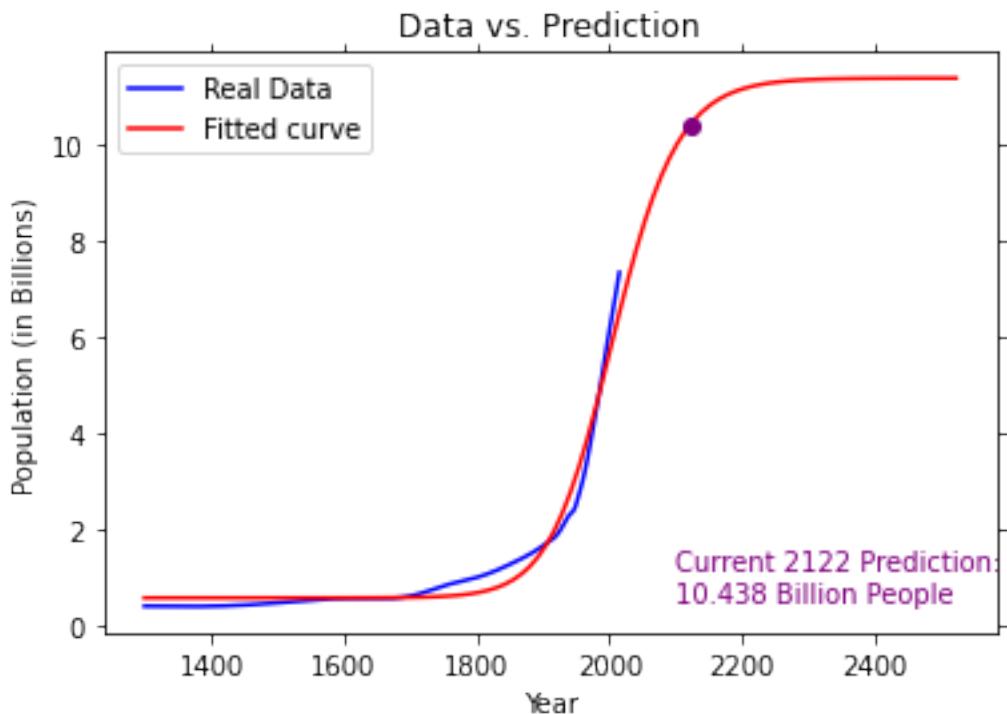
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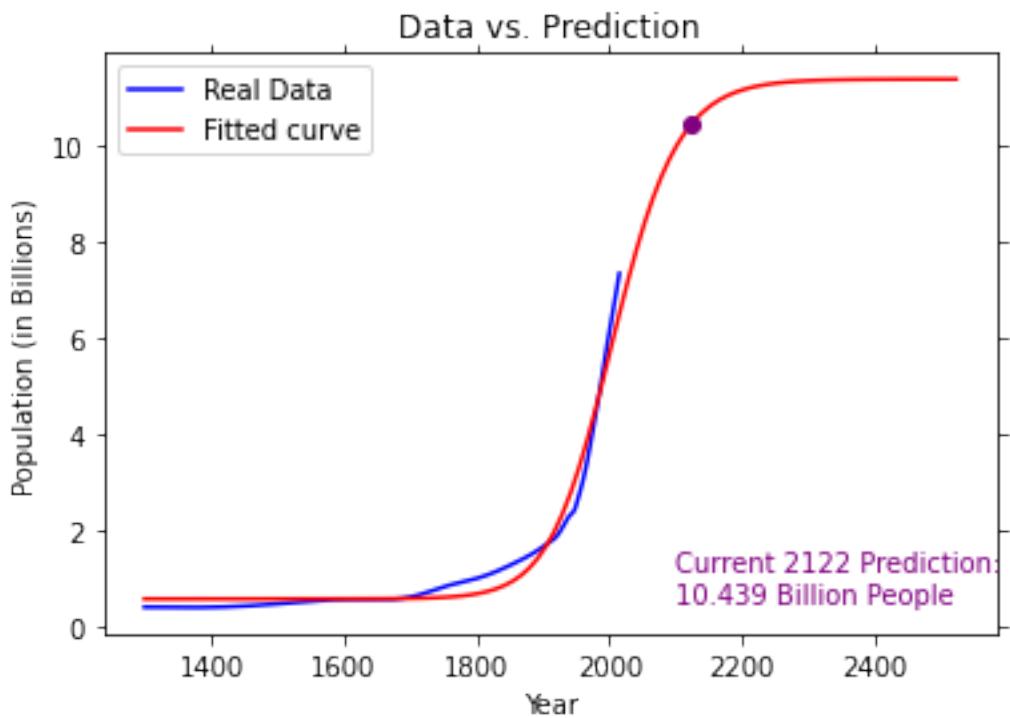
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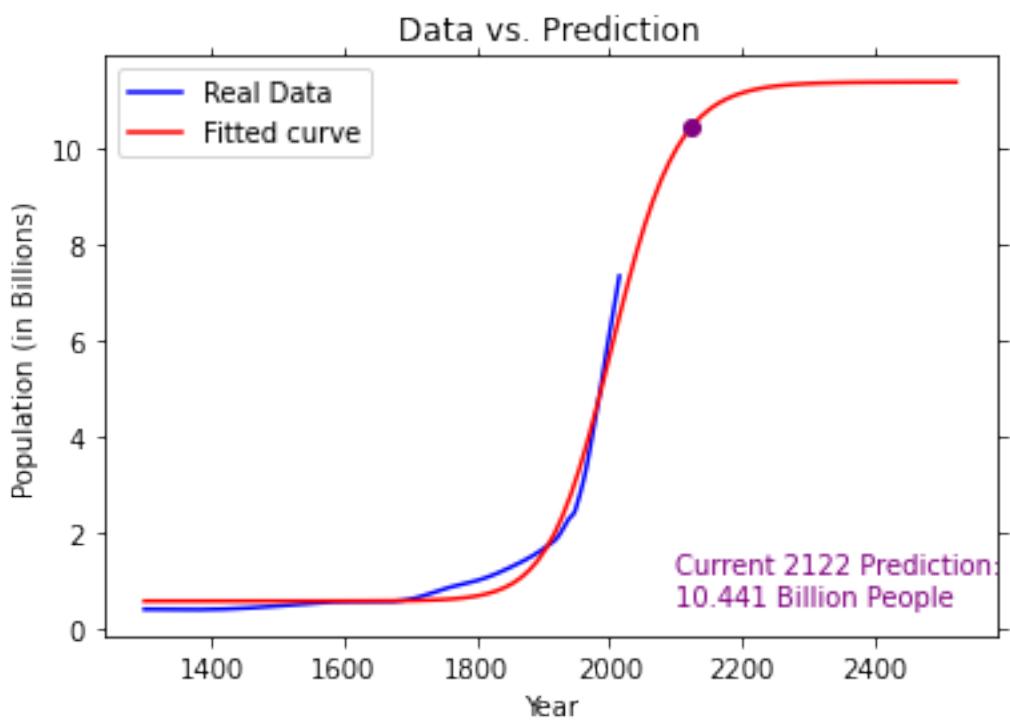
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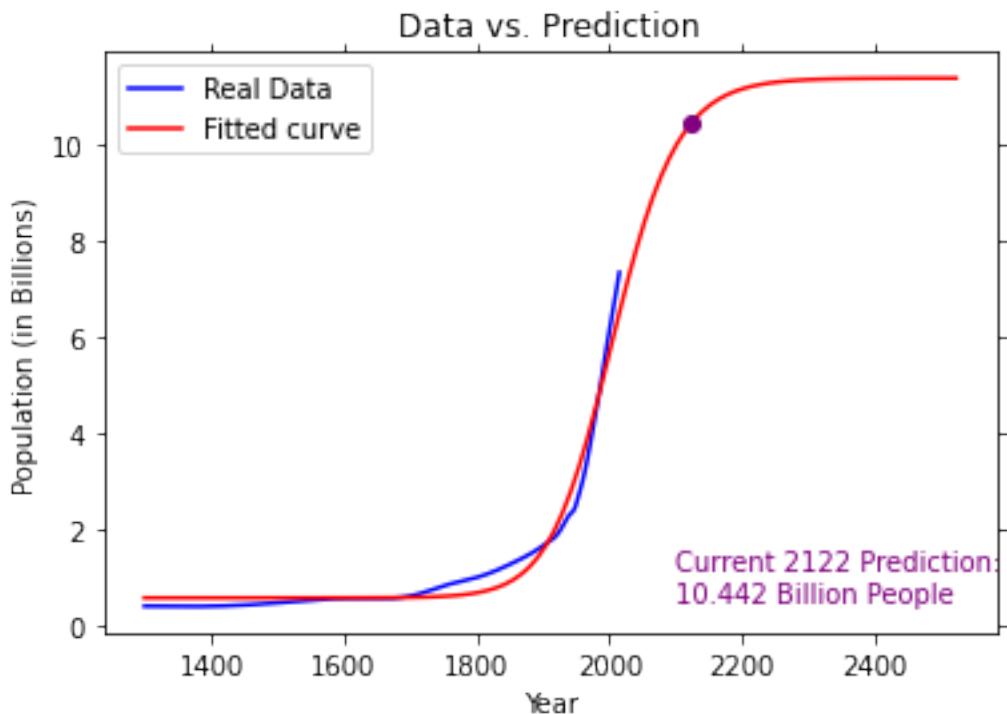
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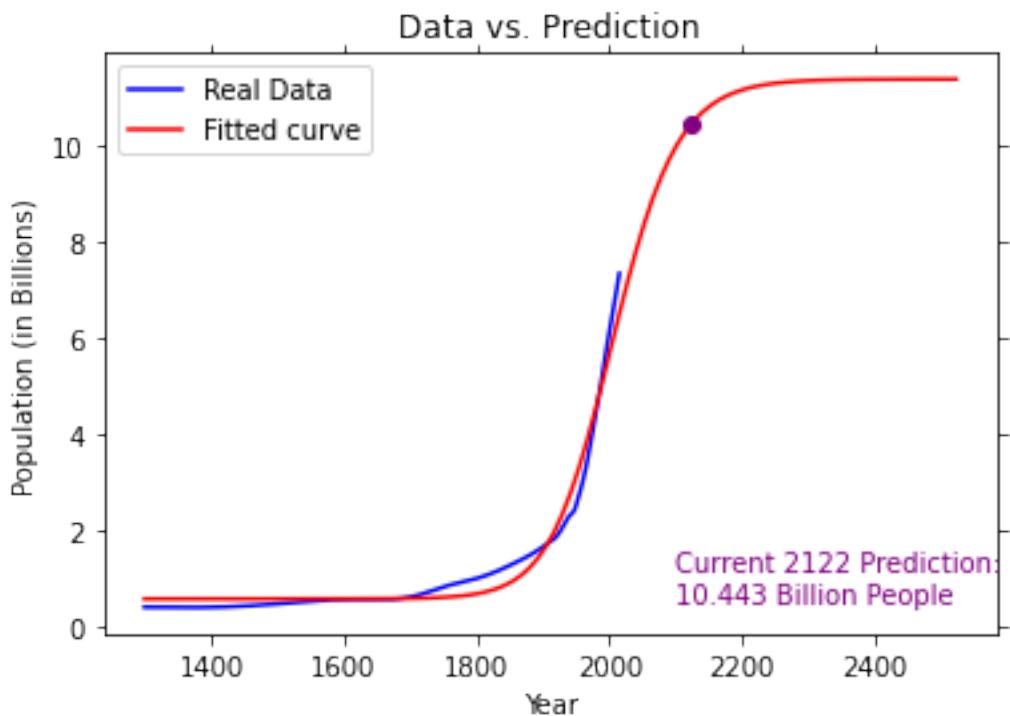
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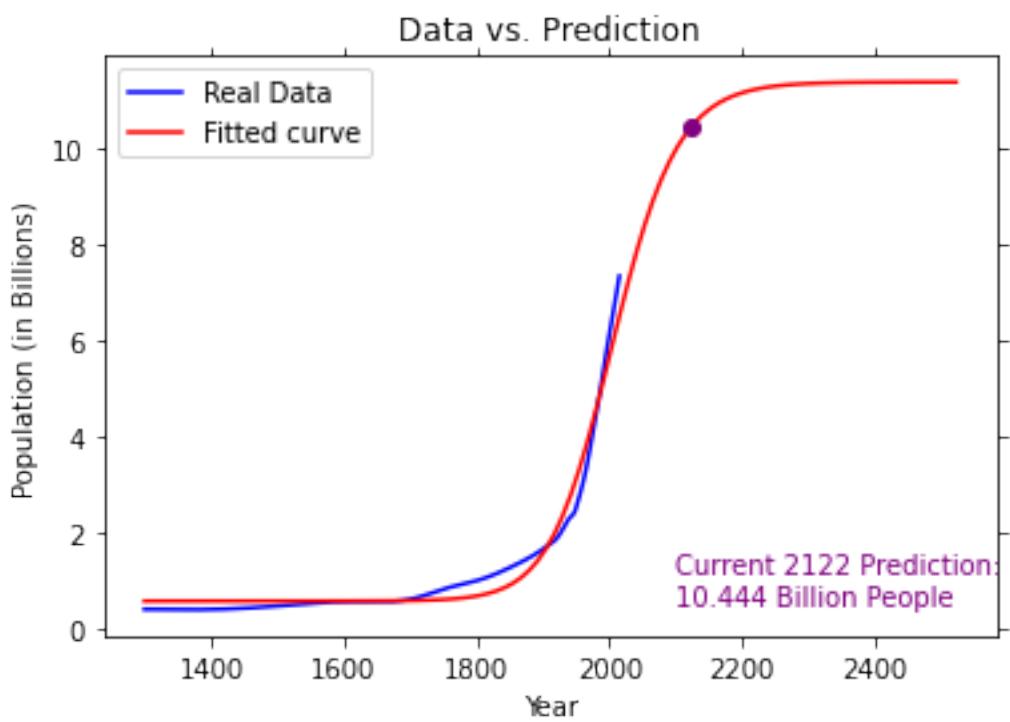
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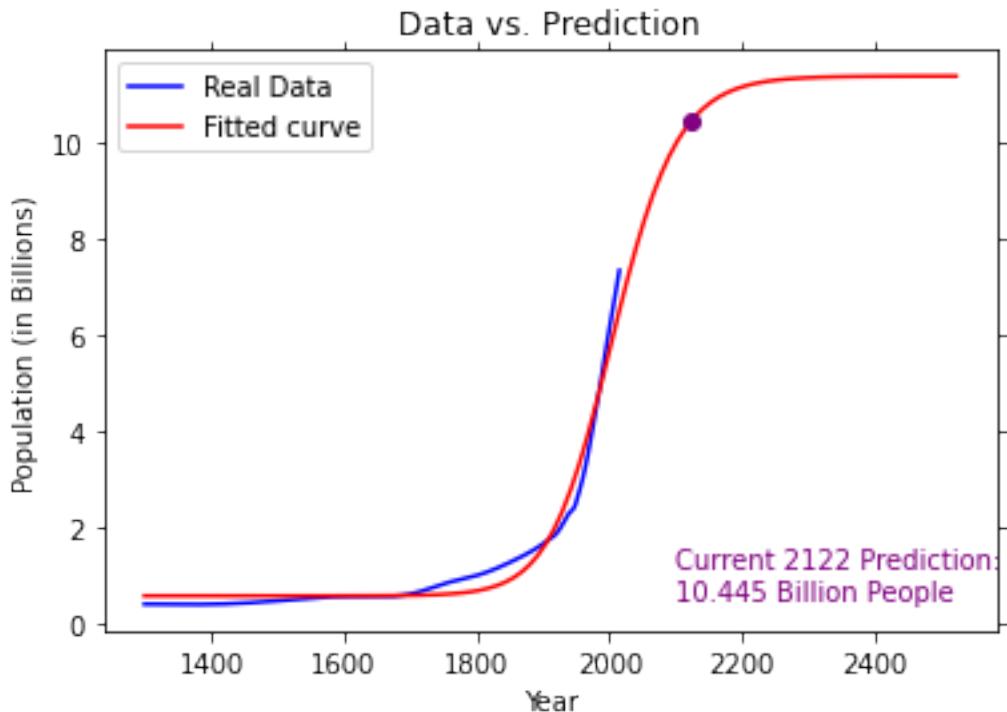
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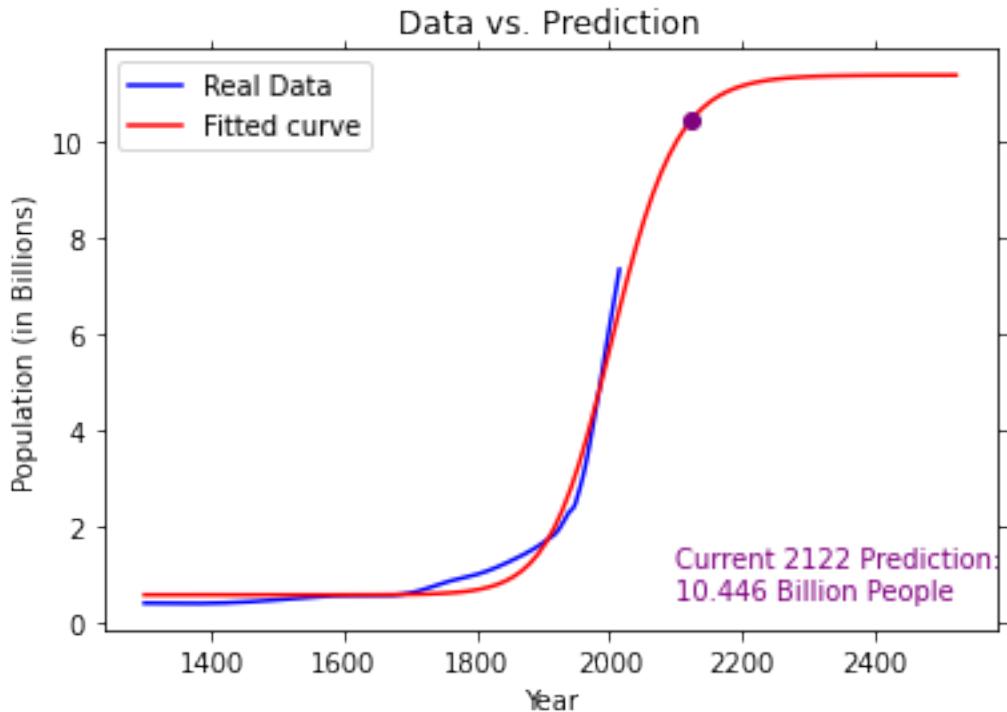
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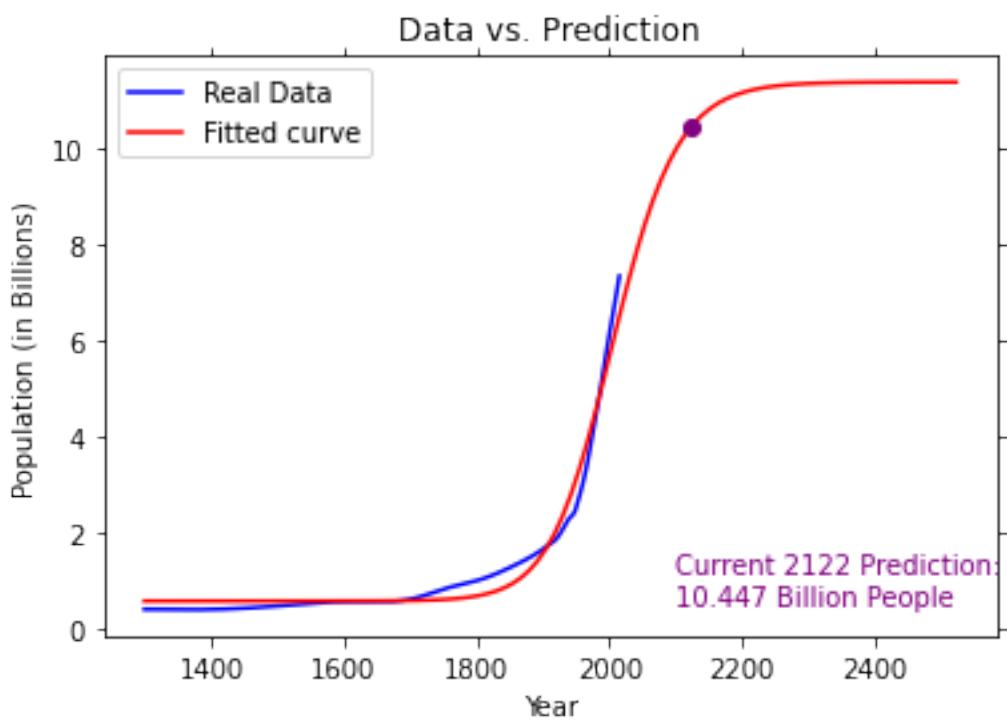
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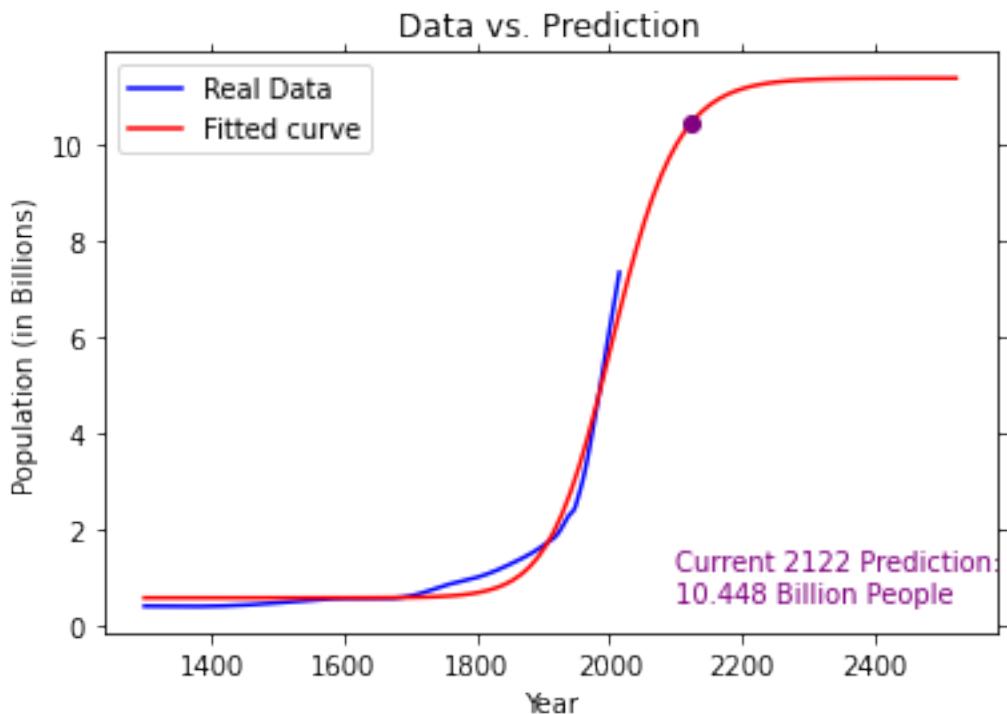
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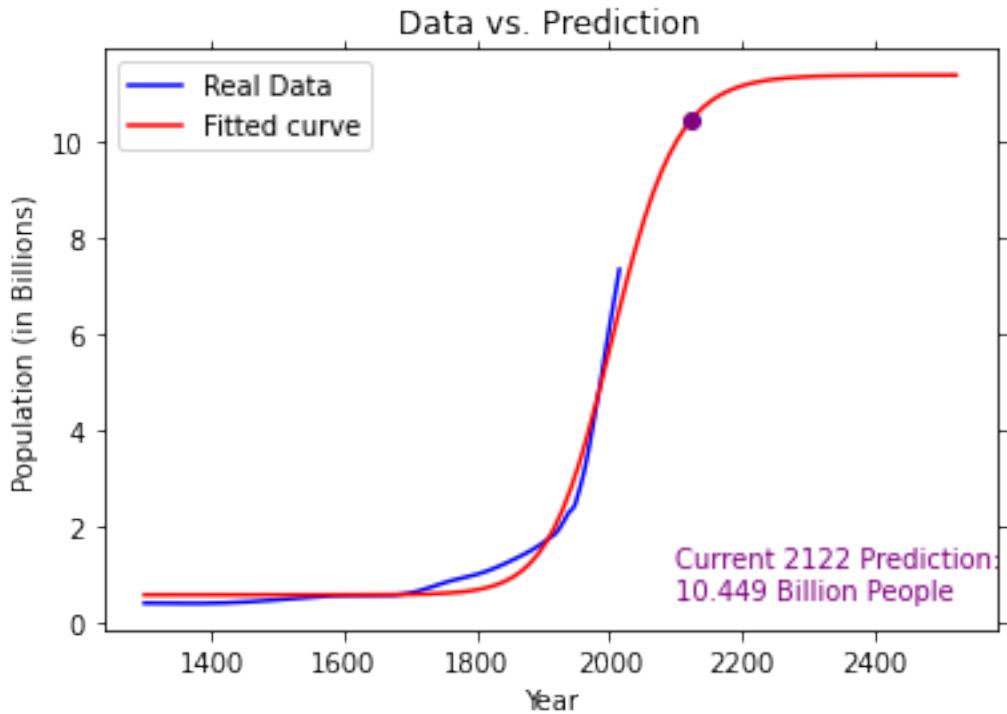
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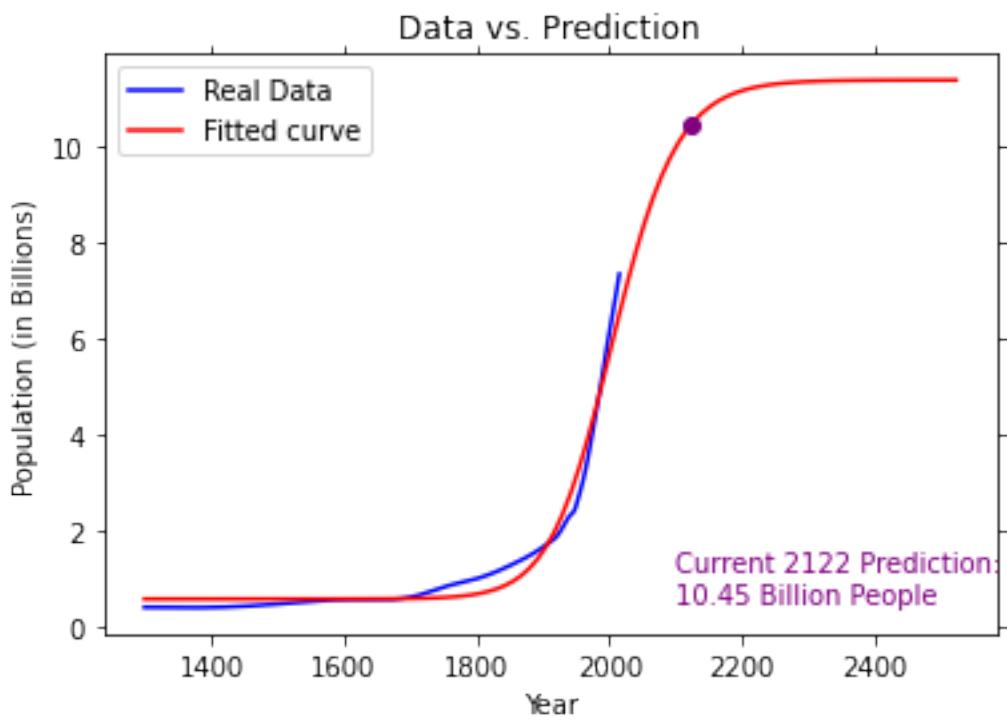
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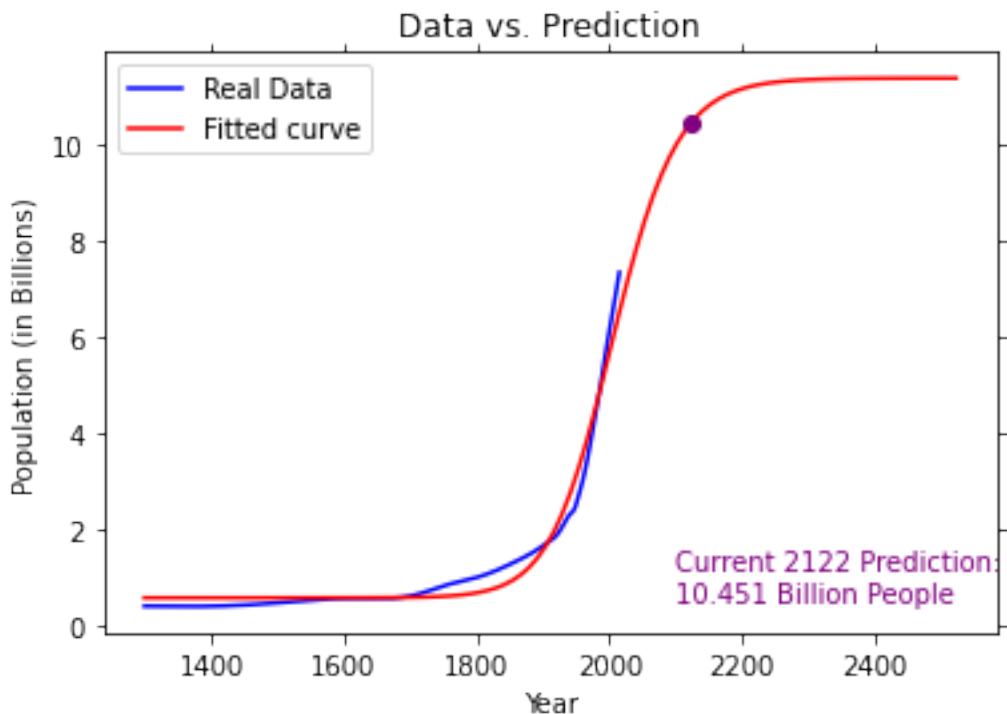
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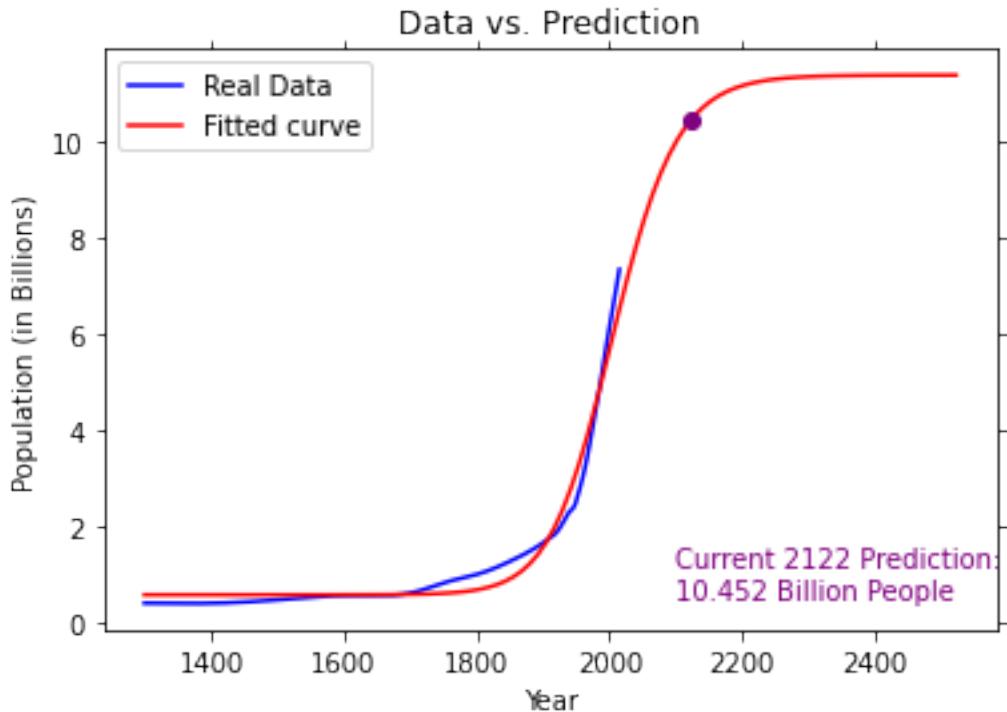
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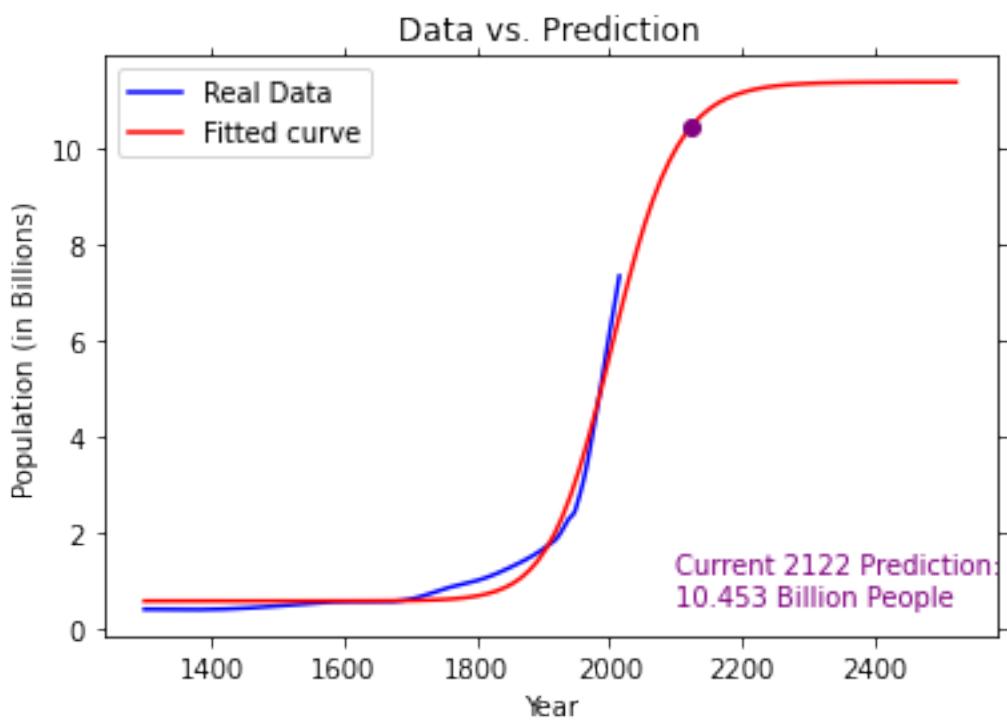
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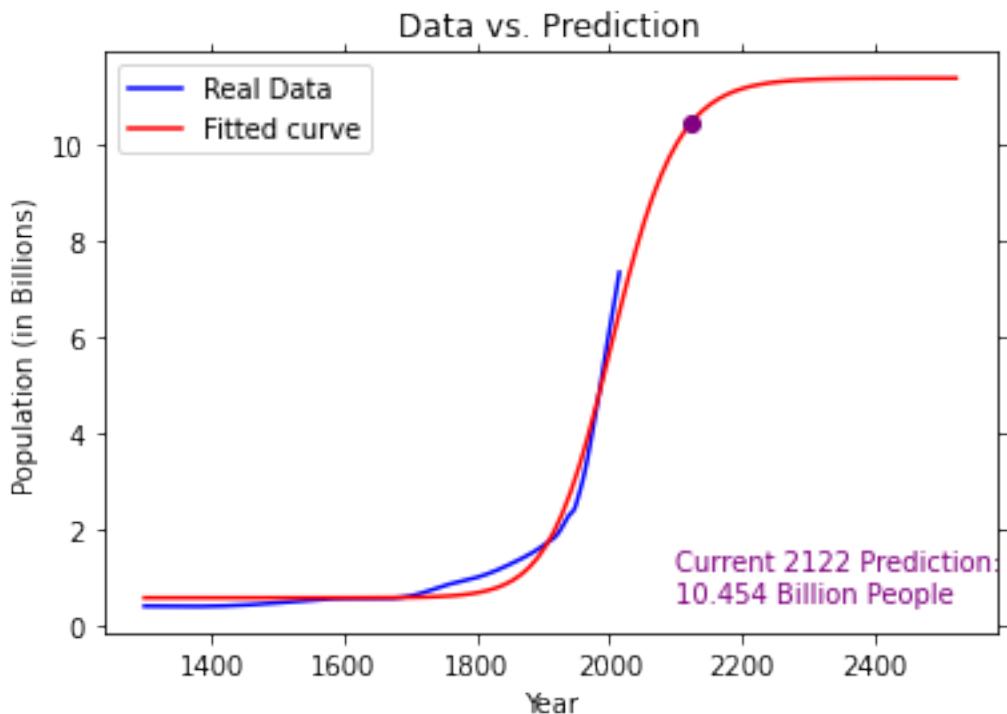
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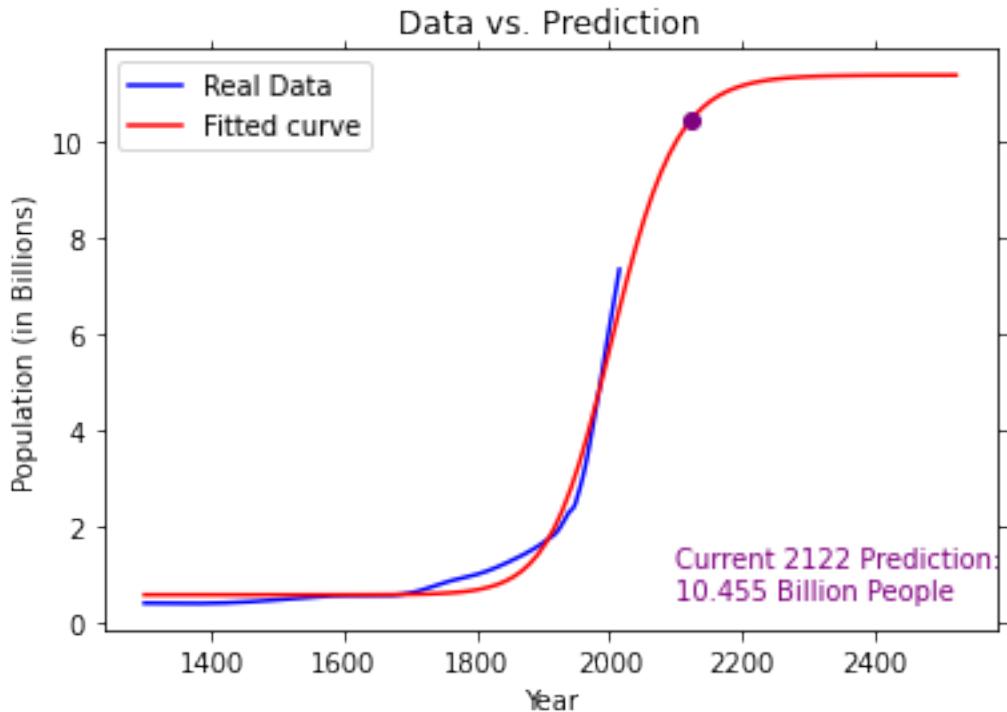
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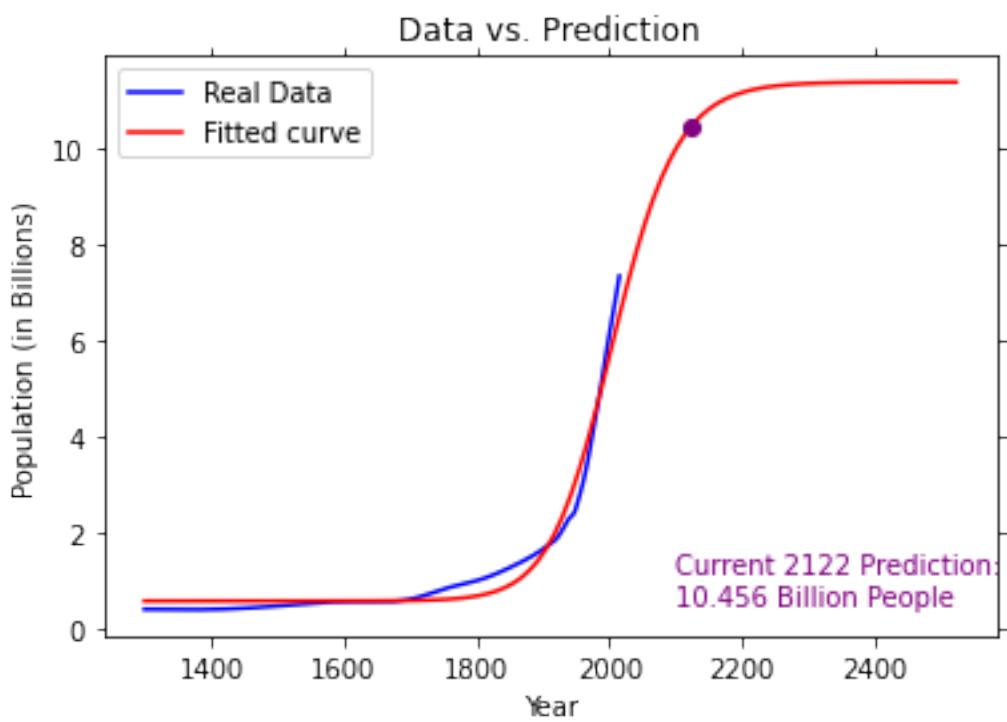
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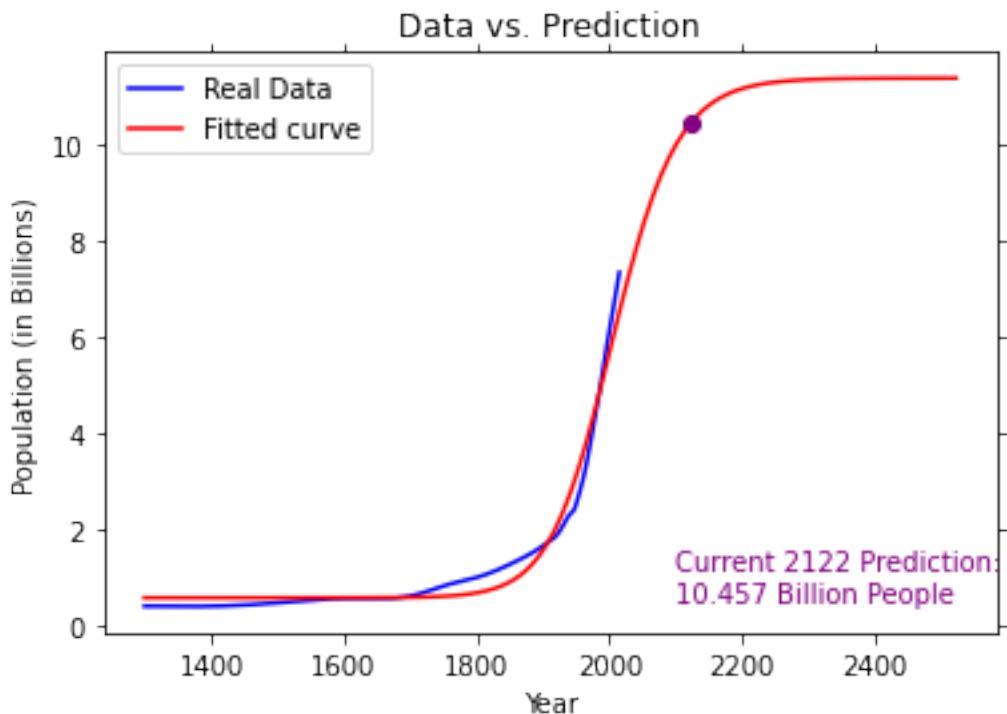
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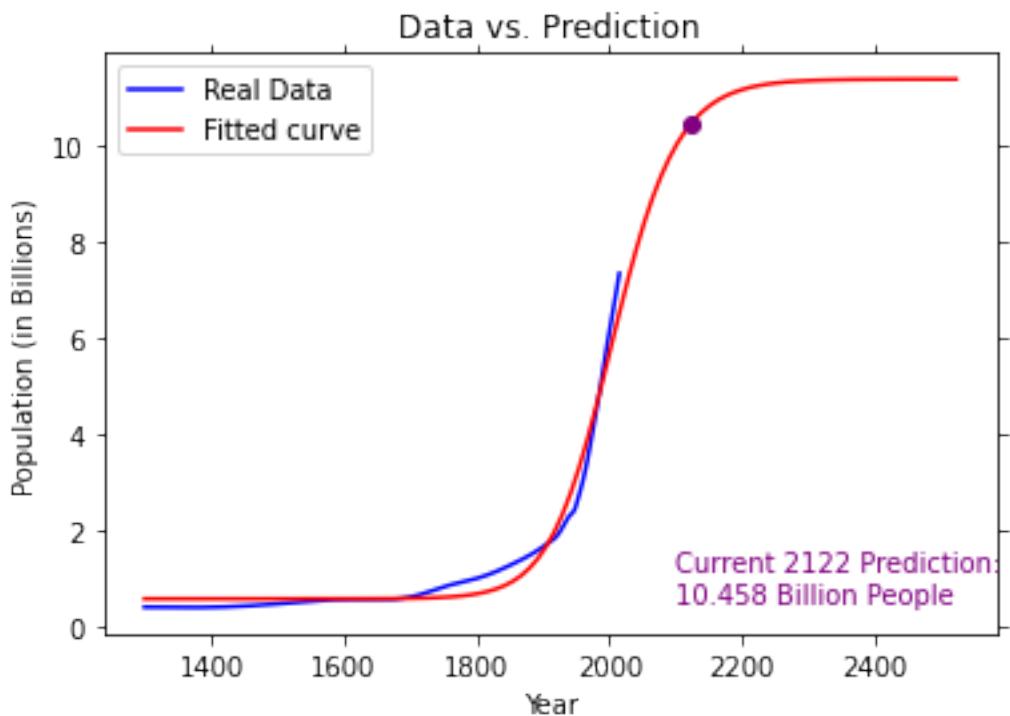
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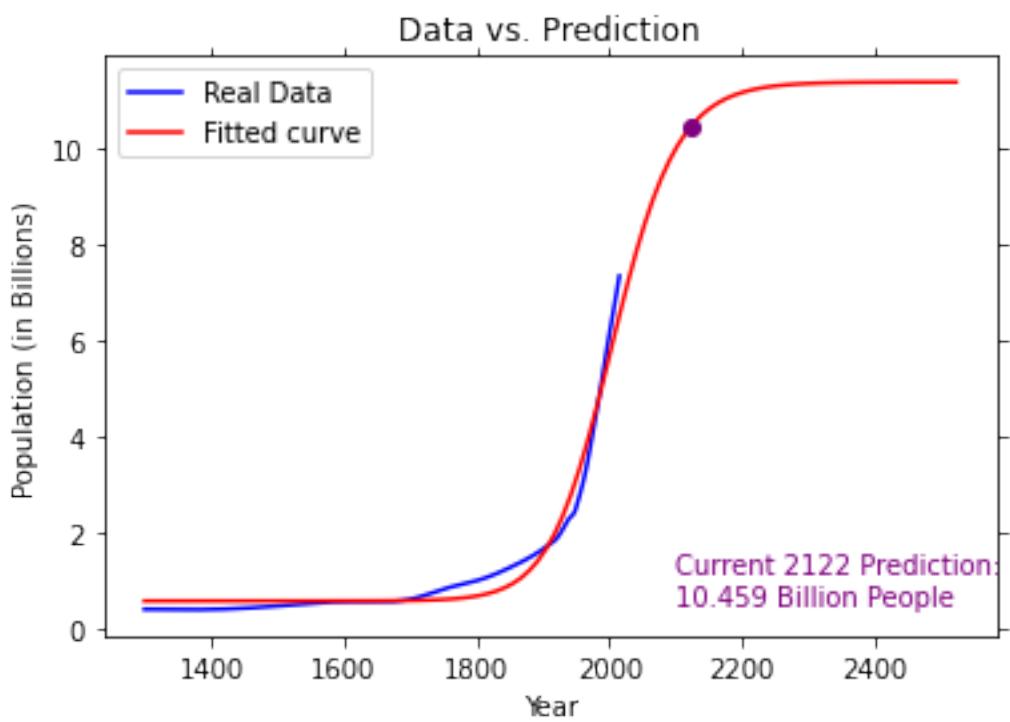
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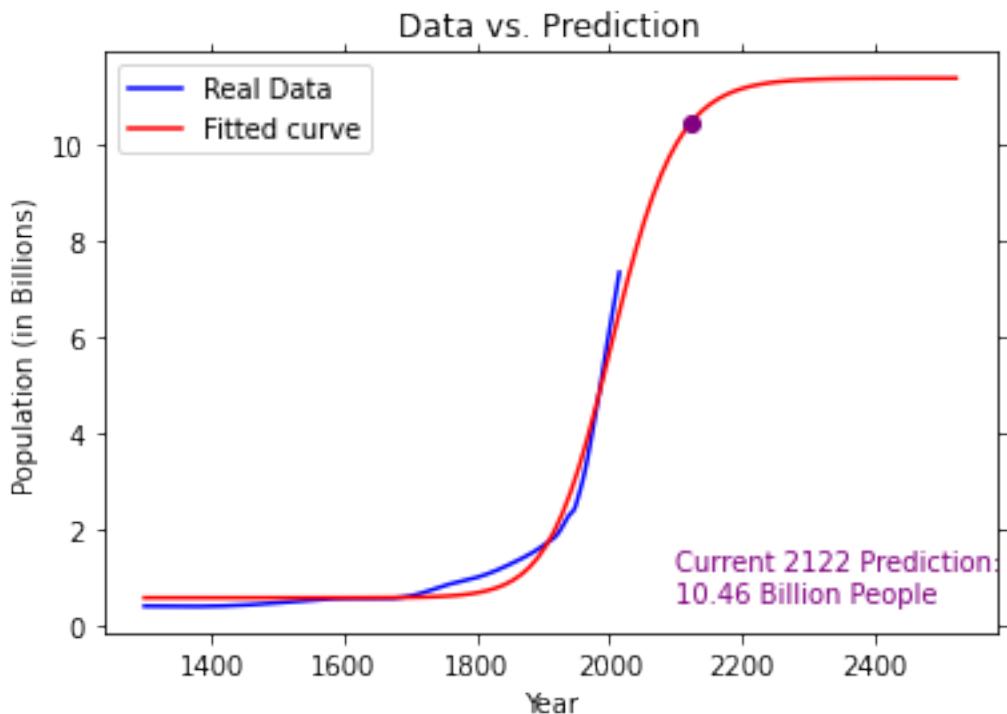
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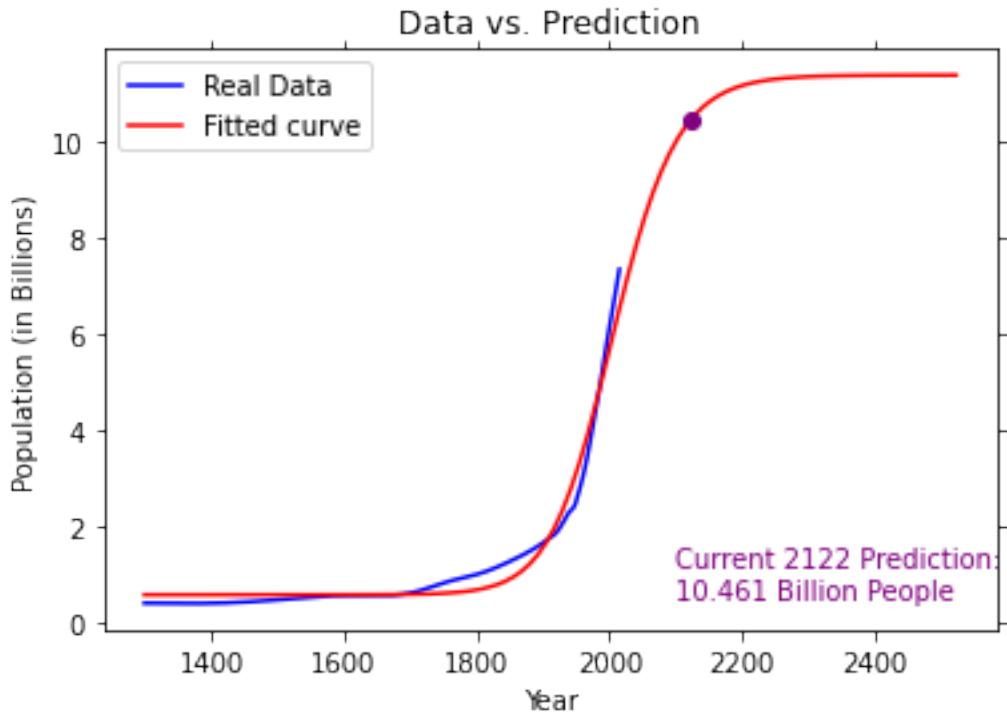
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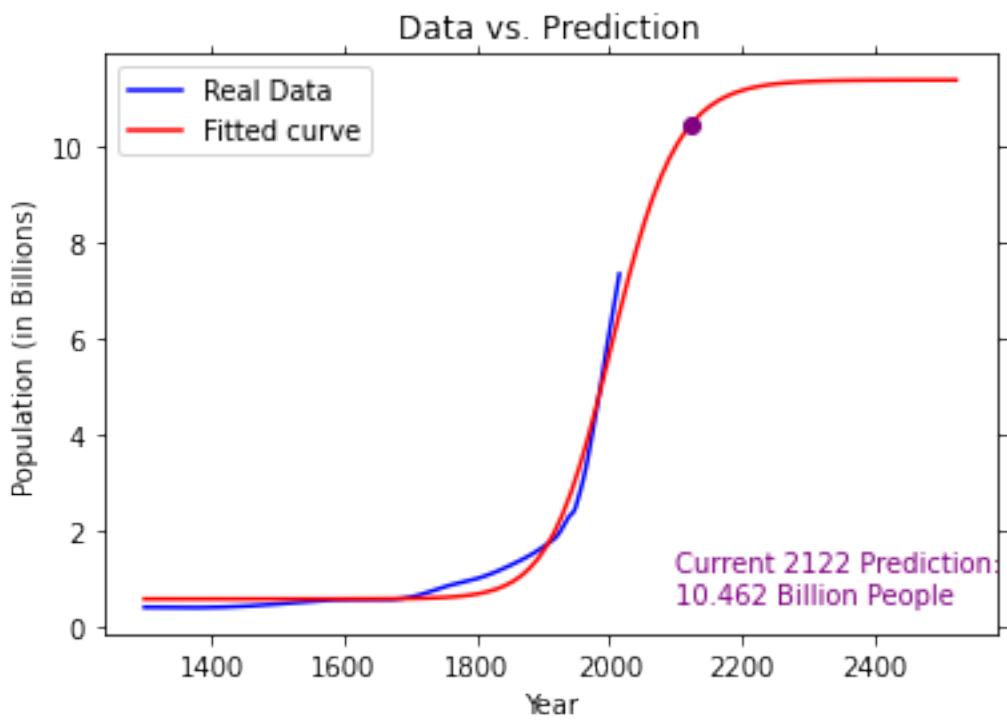
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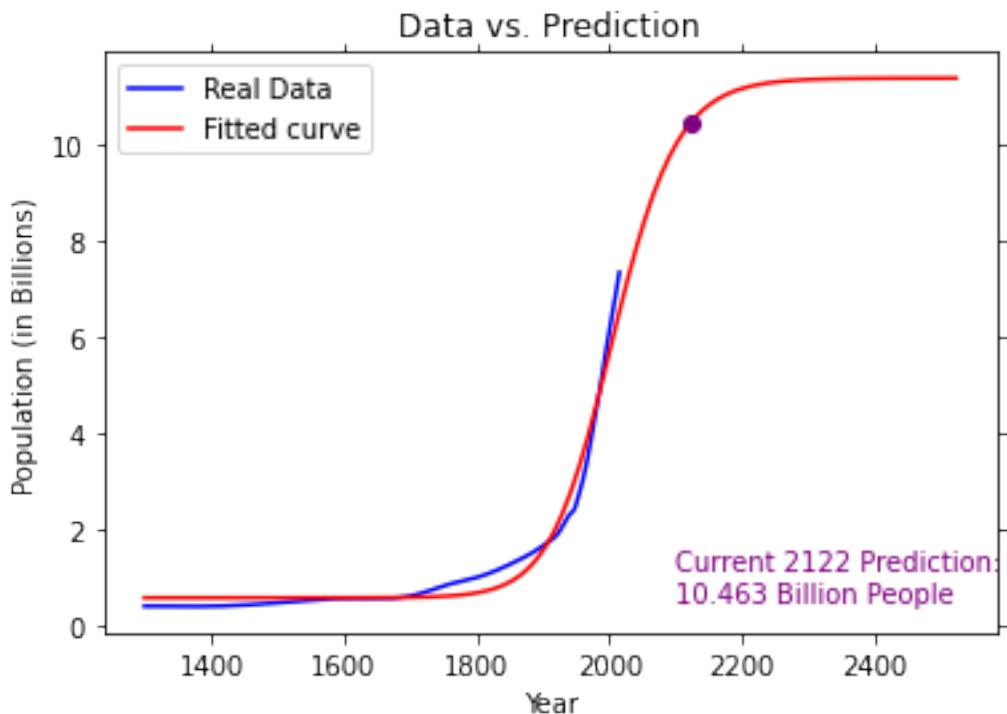
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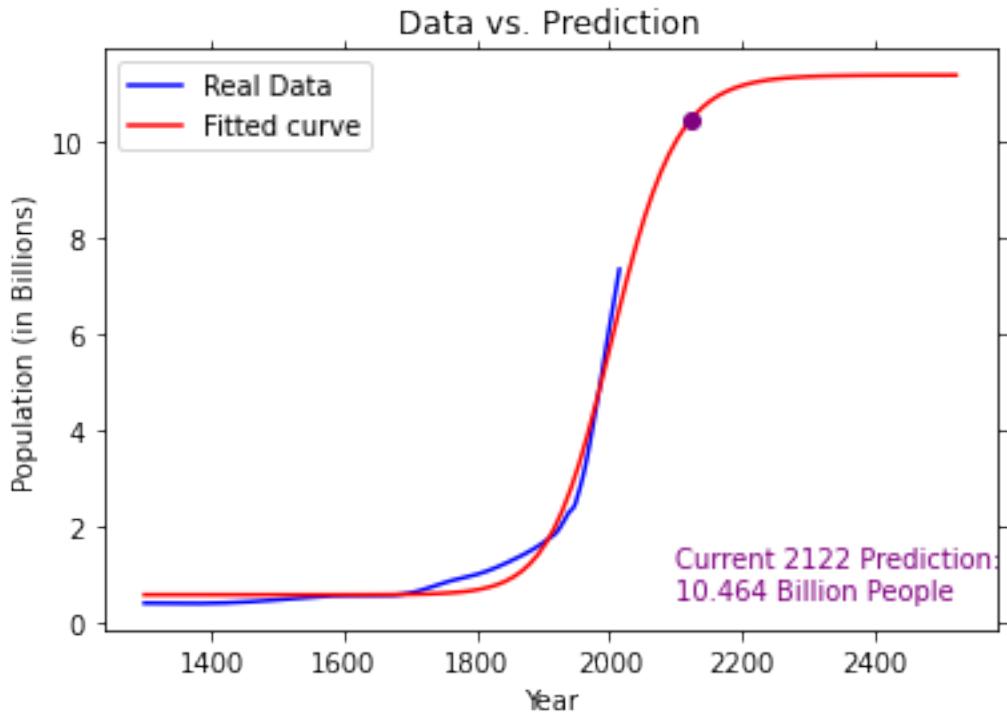
Iteration #10700, Loss: 0.05536186308547704



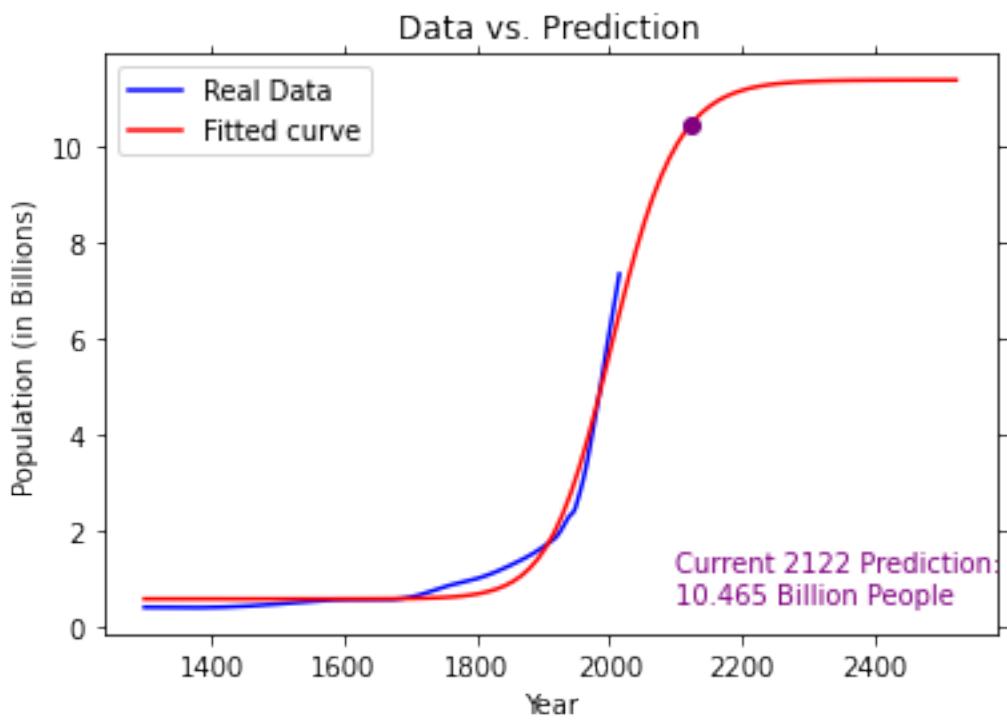
Iteration #10750, Loss: 0.055343492836120244



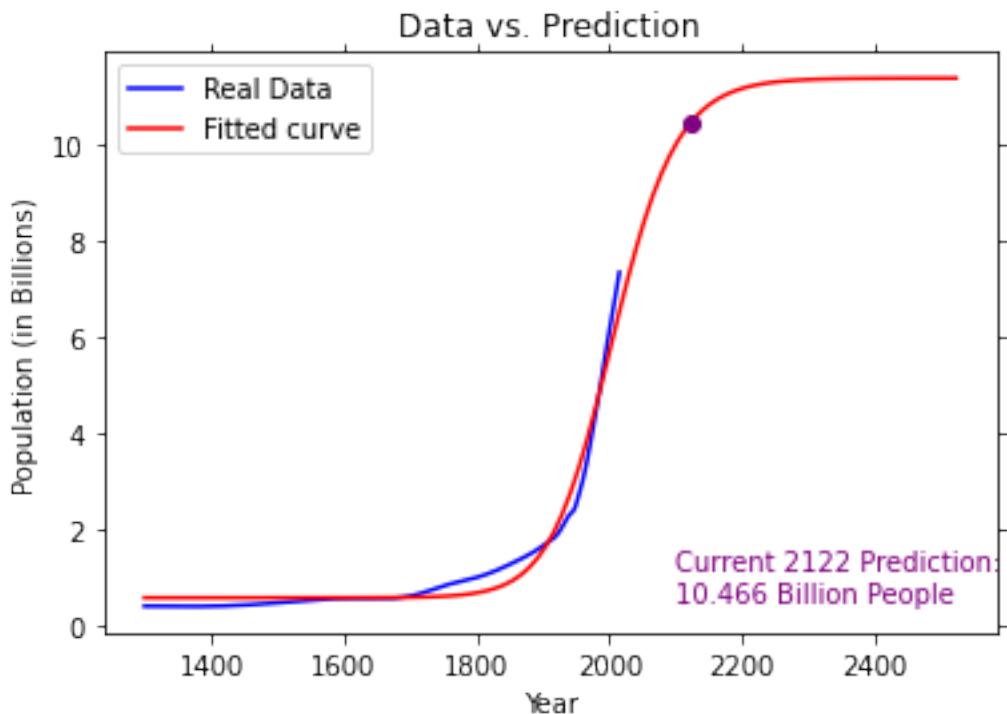
Iteration #10800, Loss: 0.055325271927114145



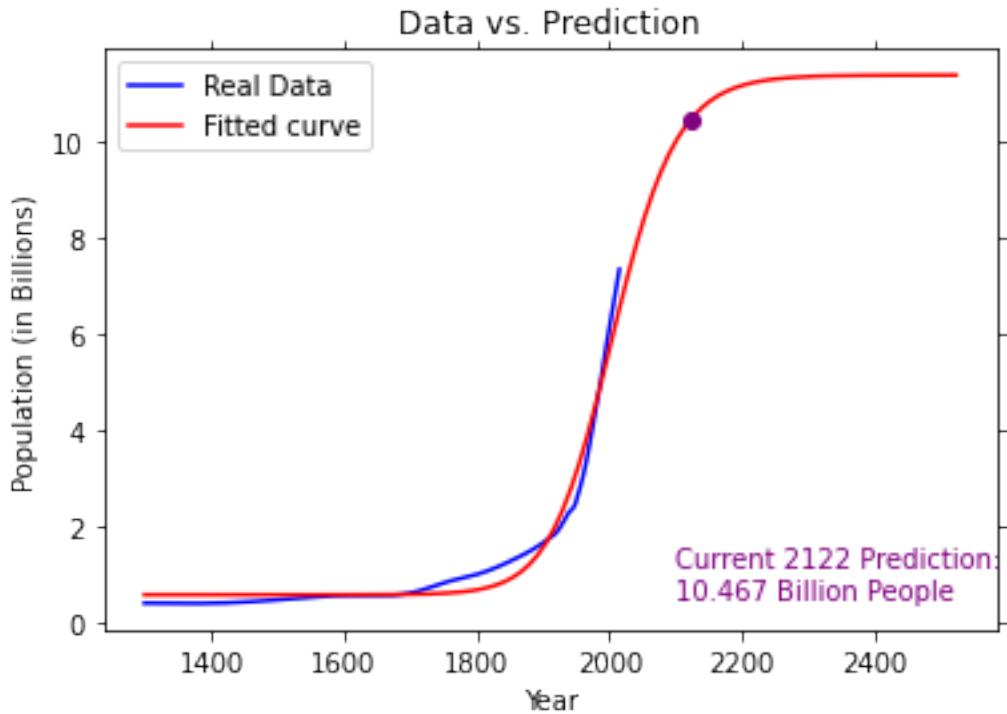
Iteration #10850, Loss: 0.05530719761840092



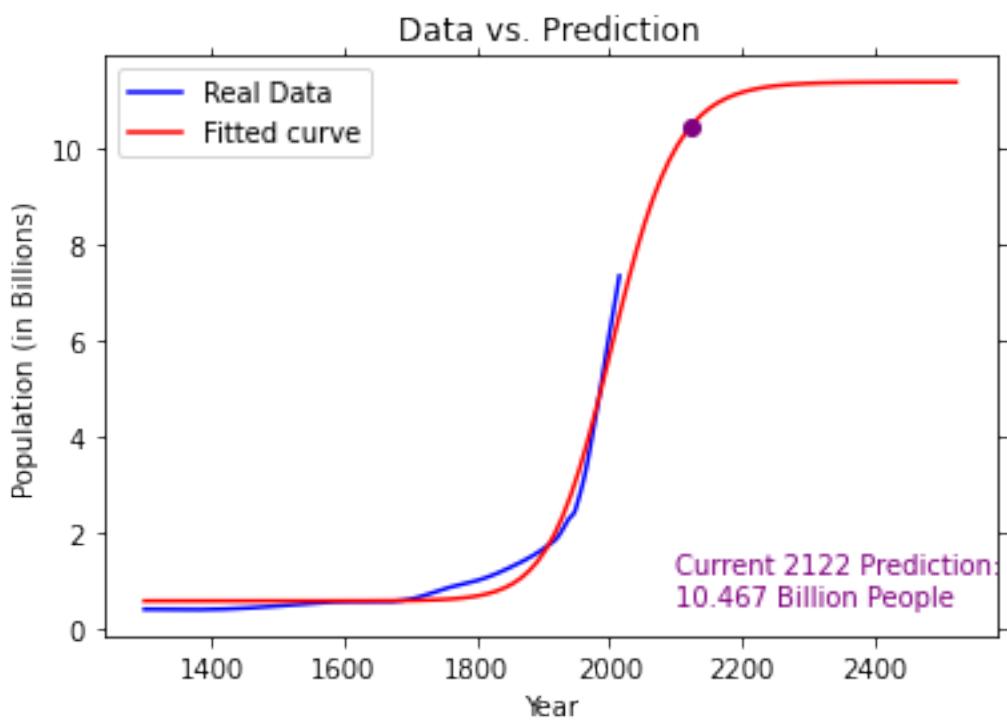
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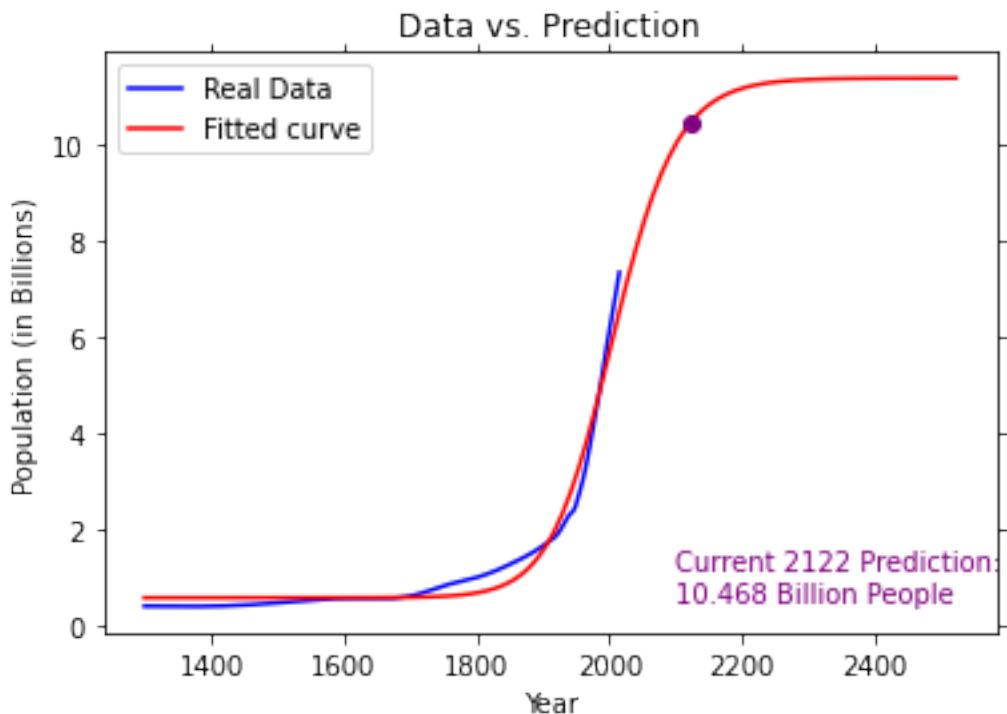
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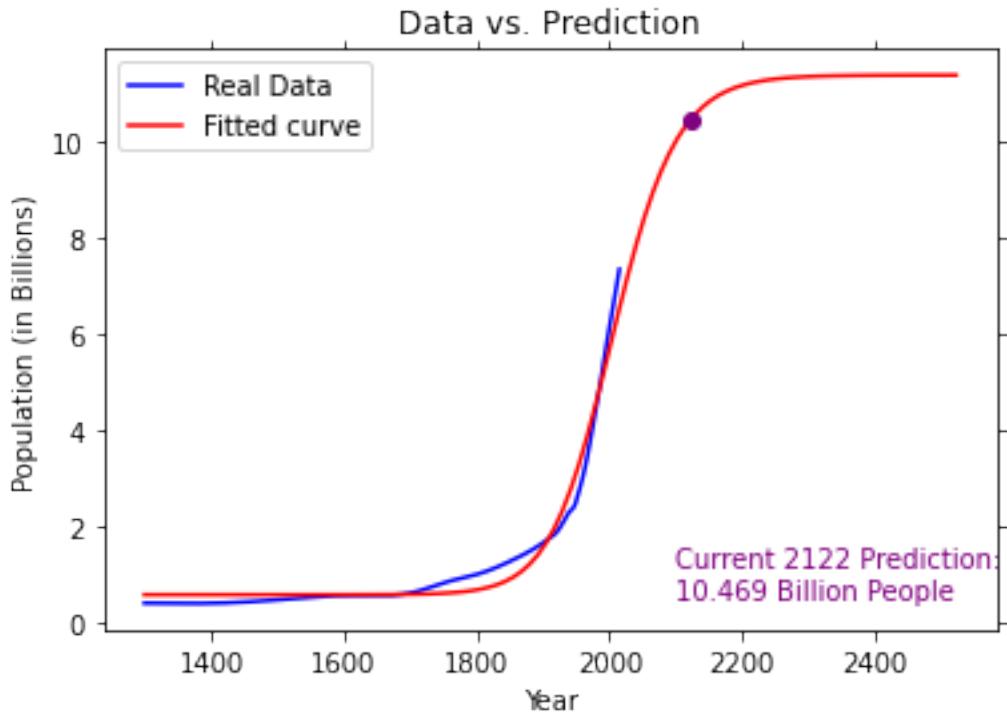
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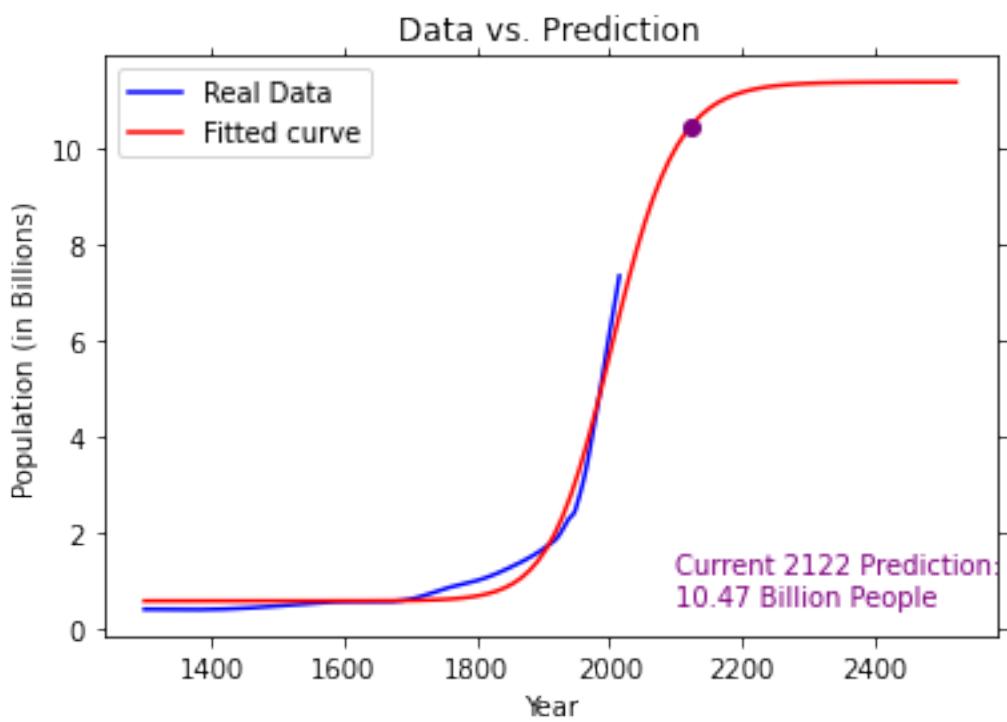
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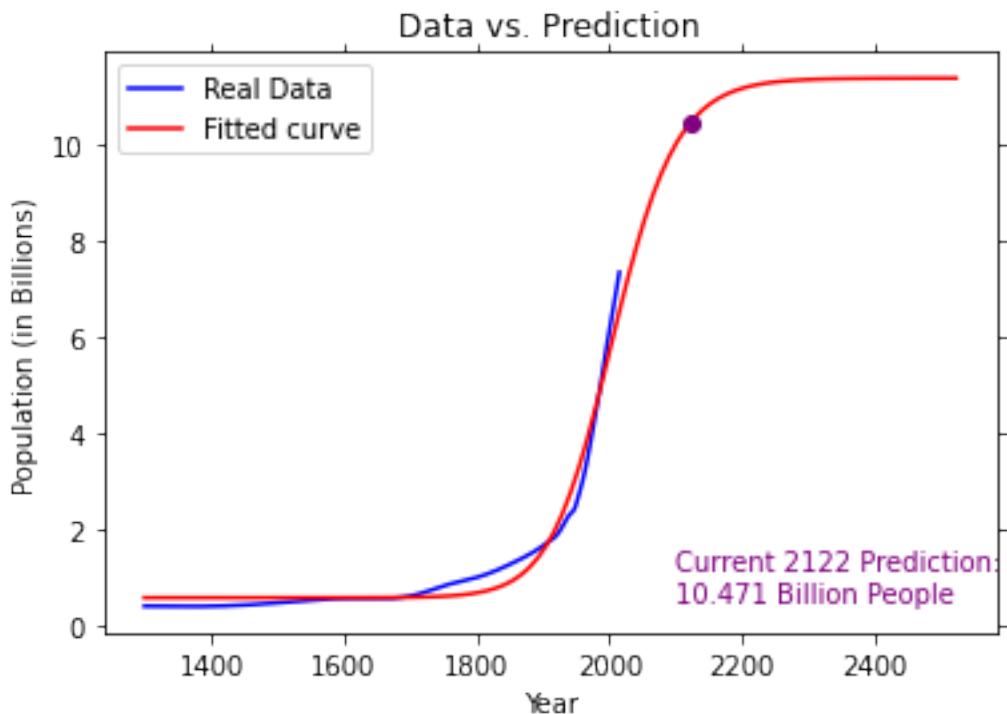
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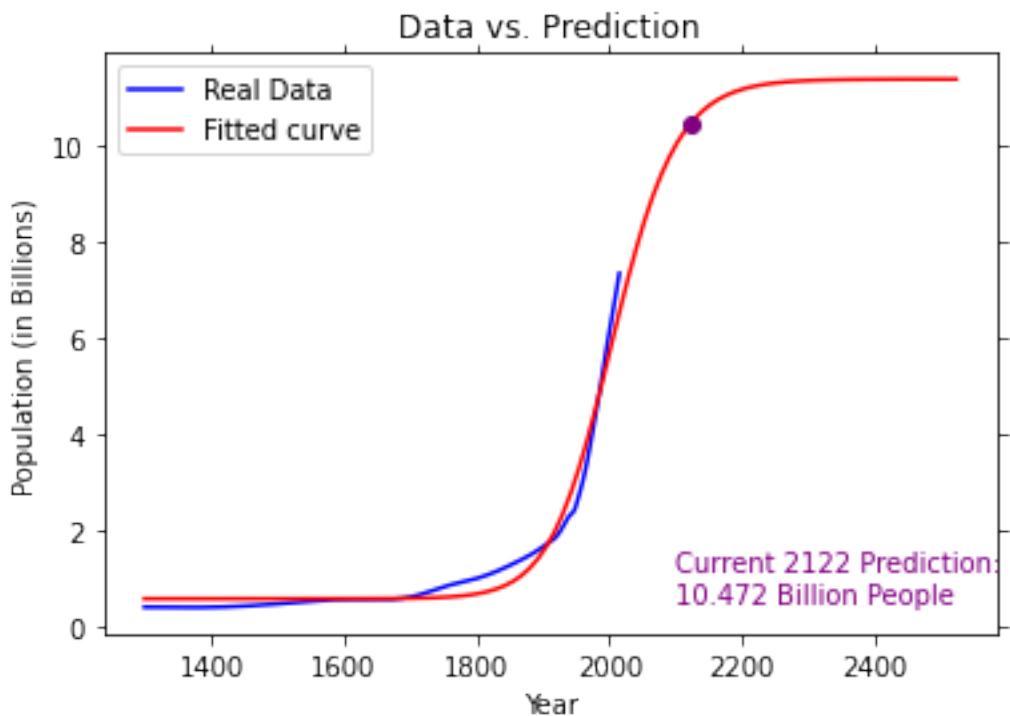
Iteration #11150, Loss: 0.05520168420239396



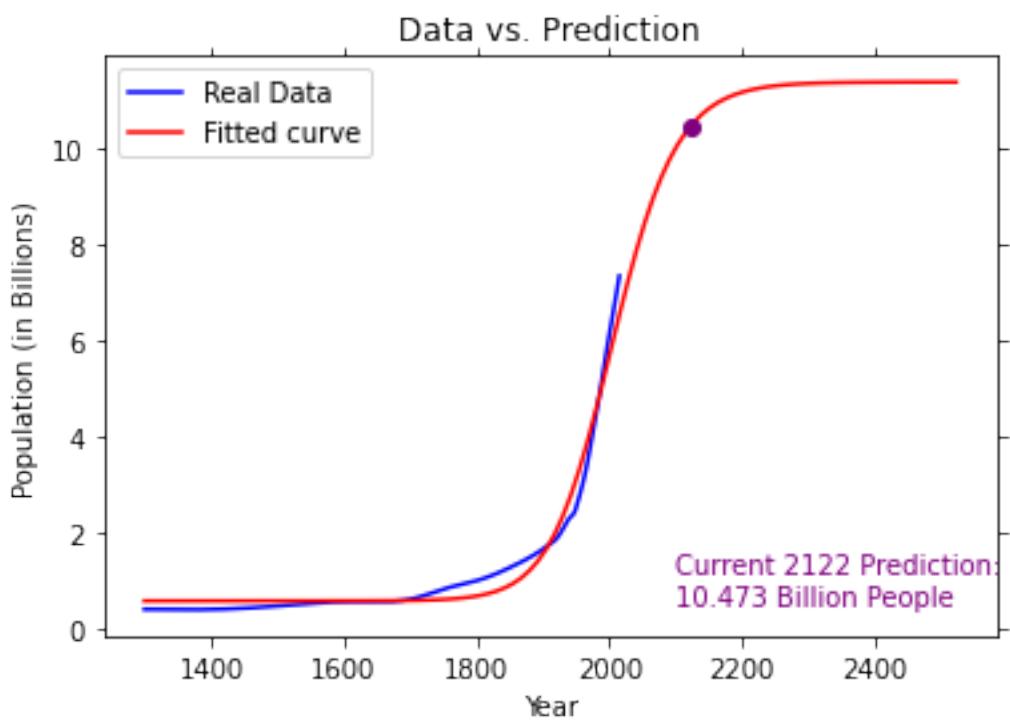
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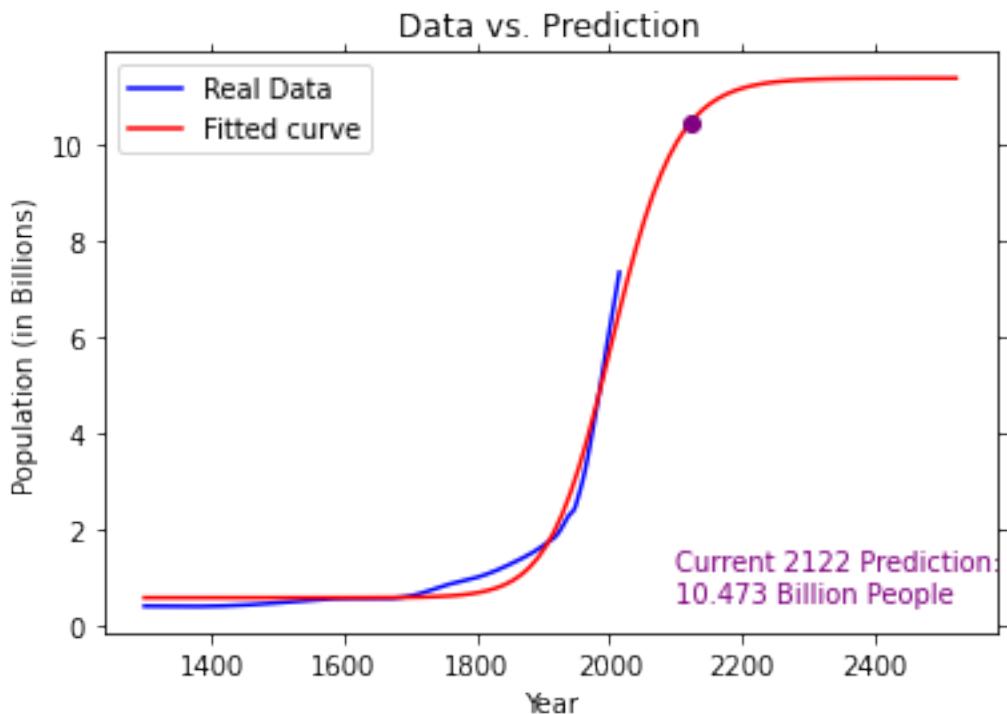
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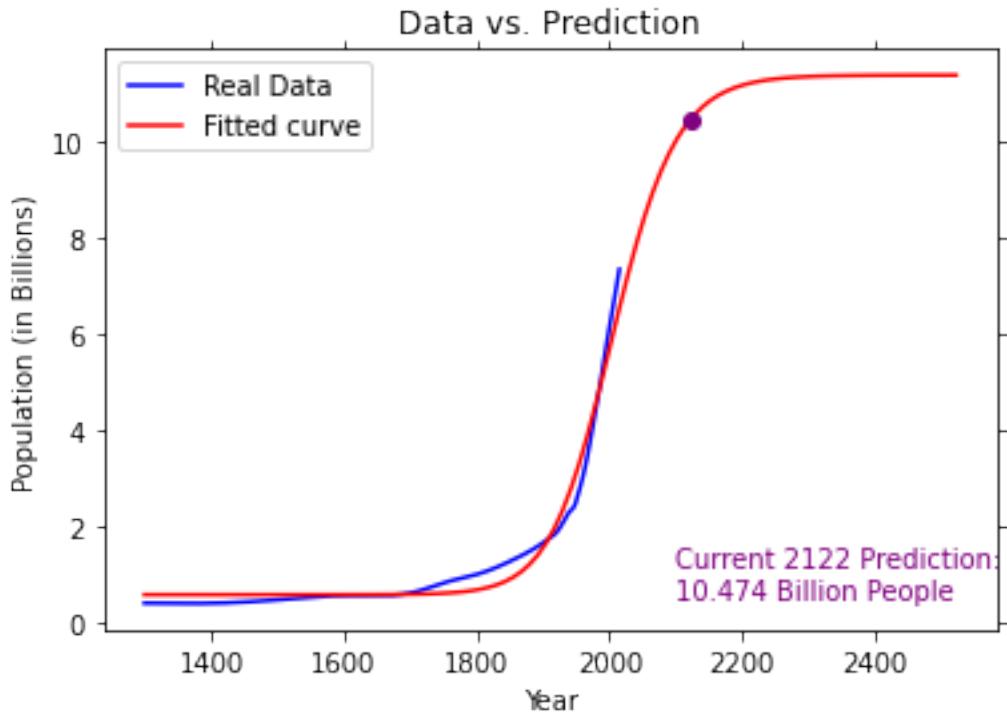
Iteration #11300, Loss: 0.055150701923647474



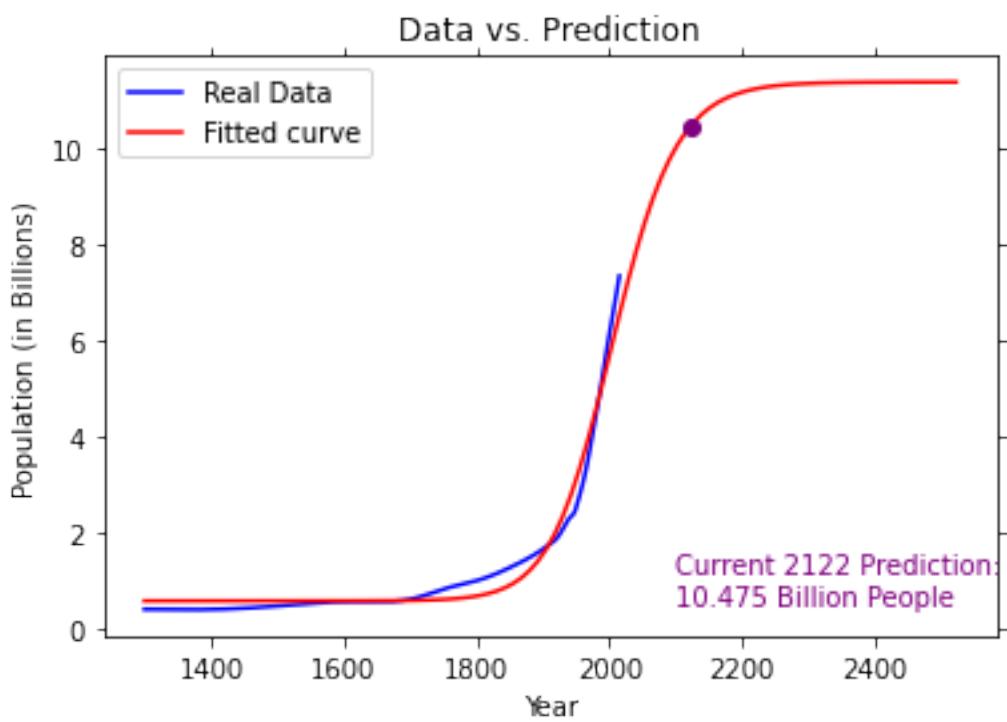
Iteration #11350, Loss: 0.05513395525271982



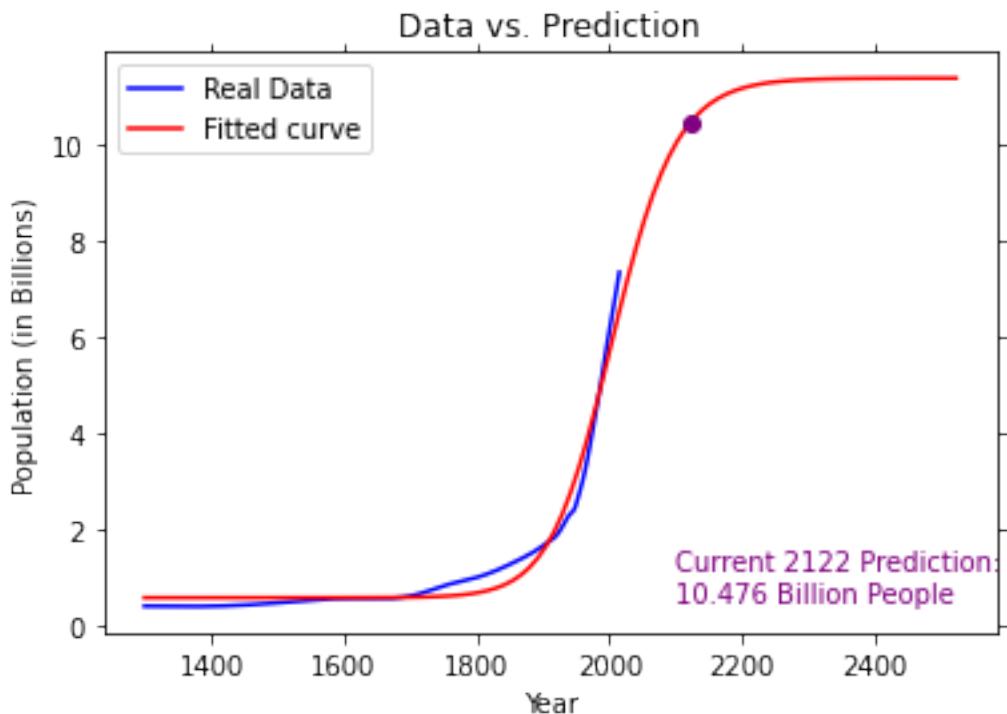
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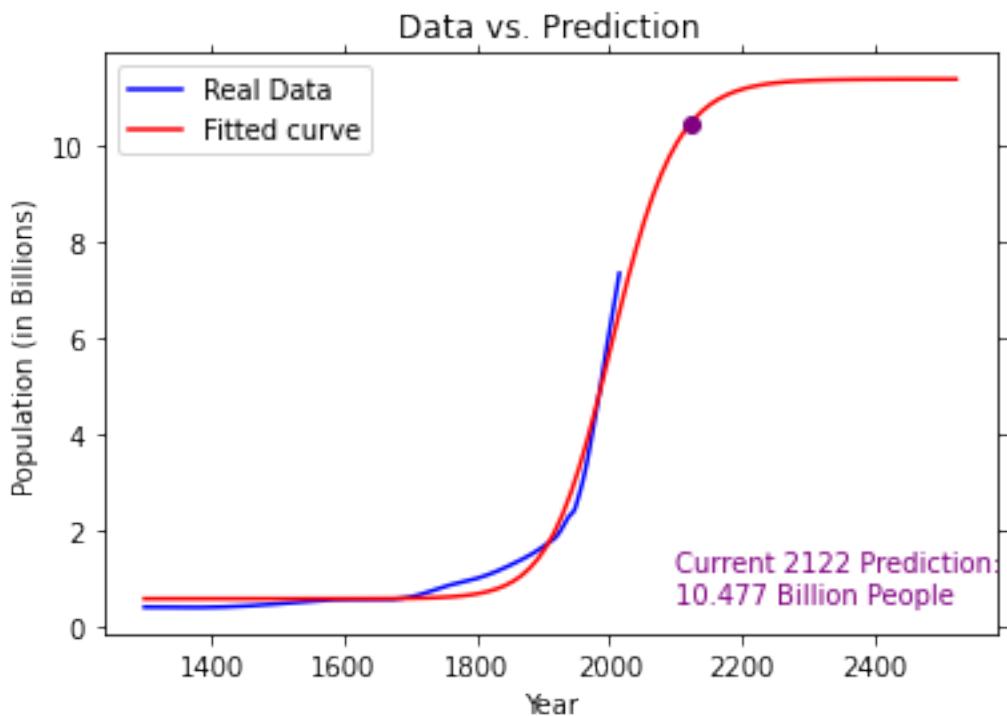
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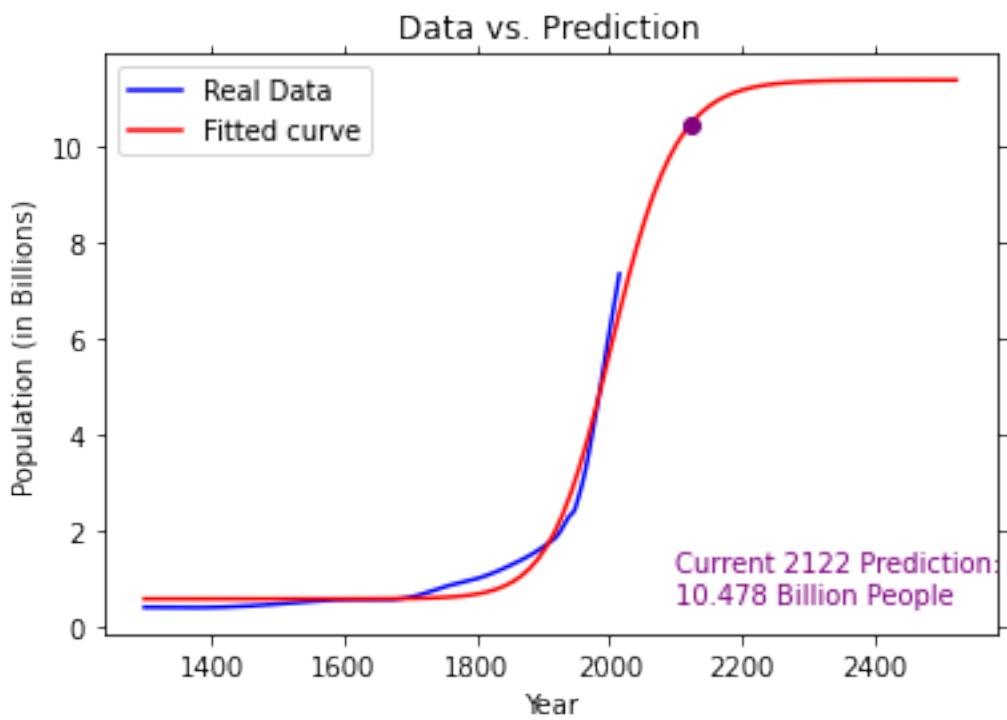
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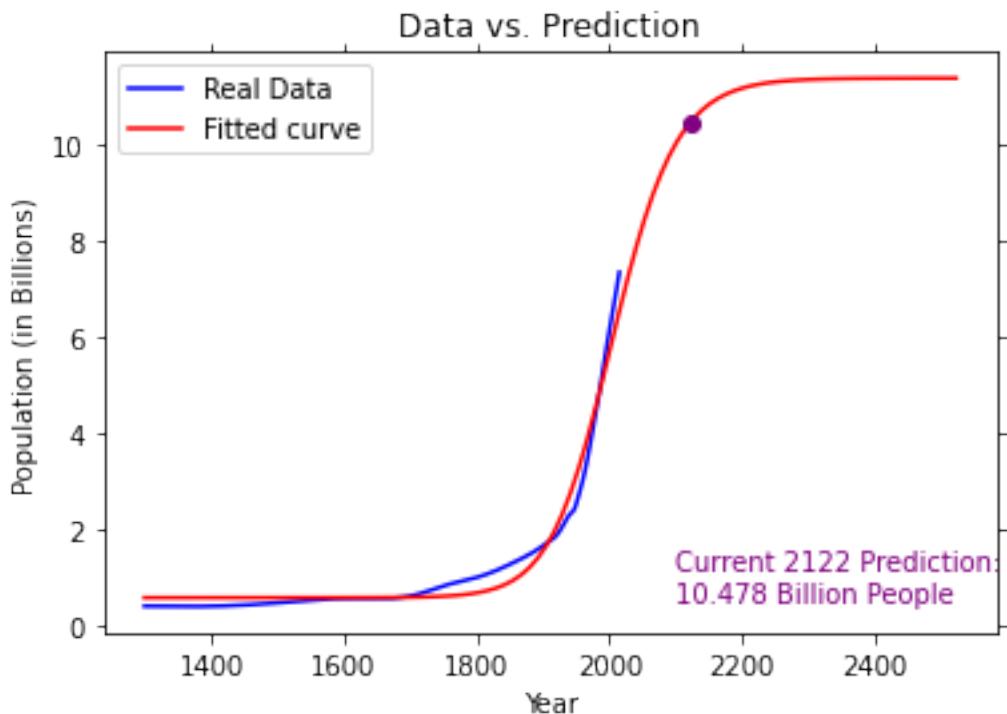
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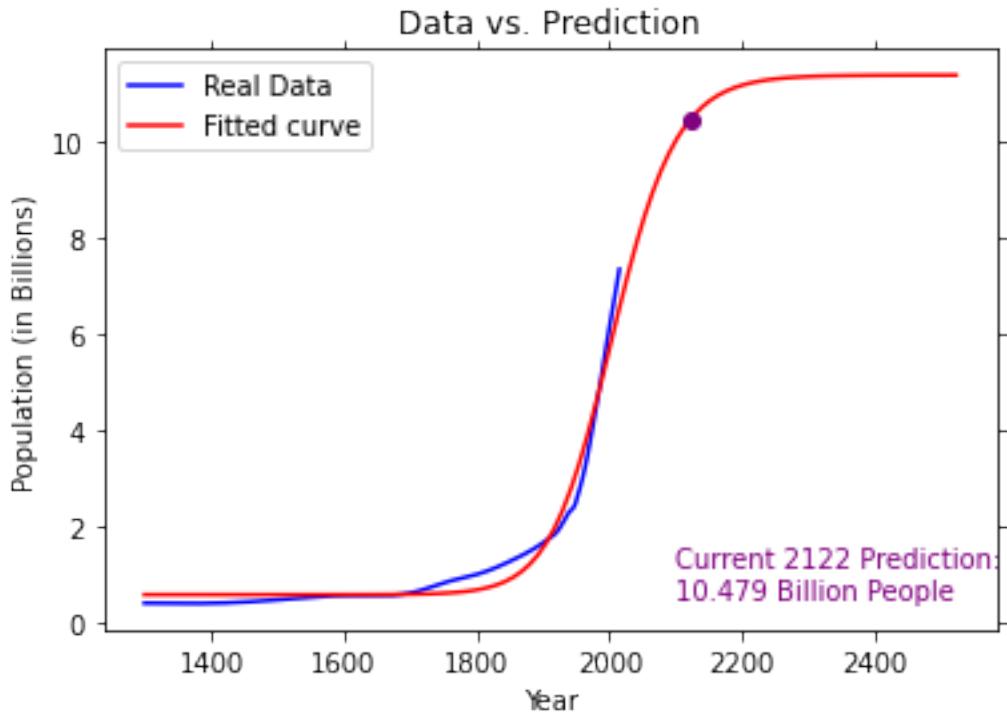
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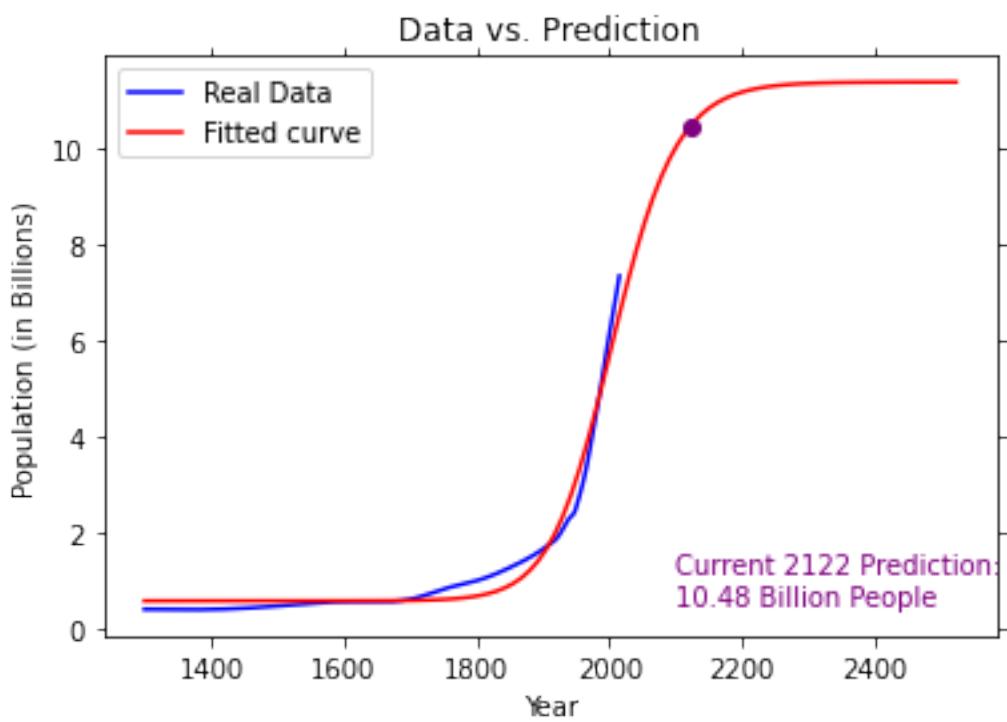
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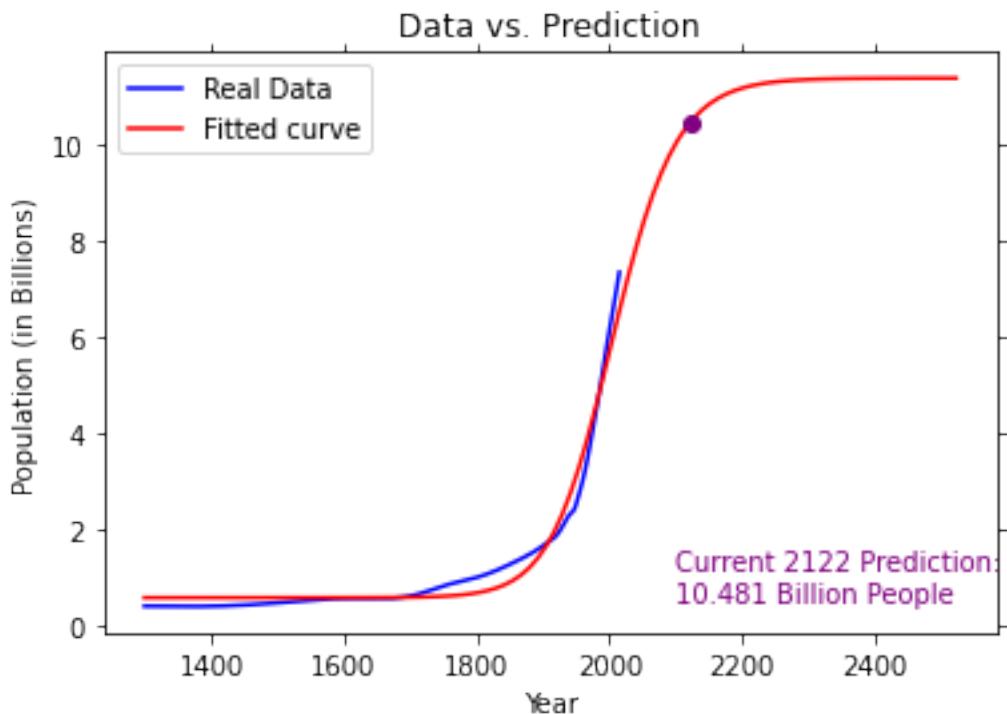
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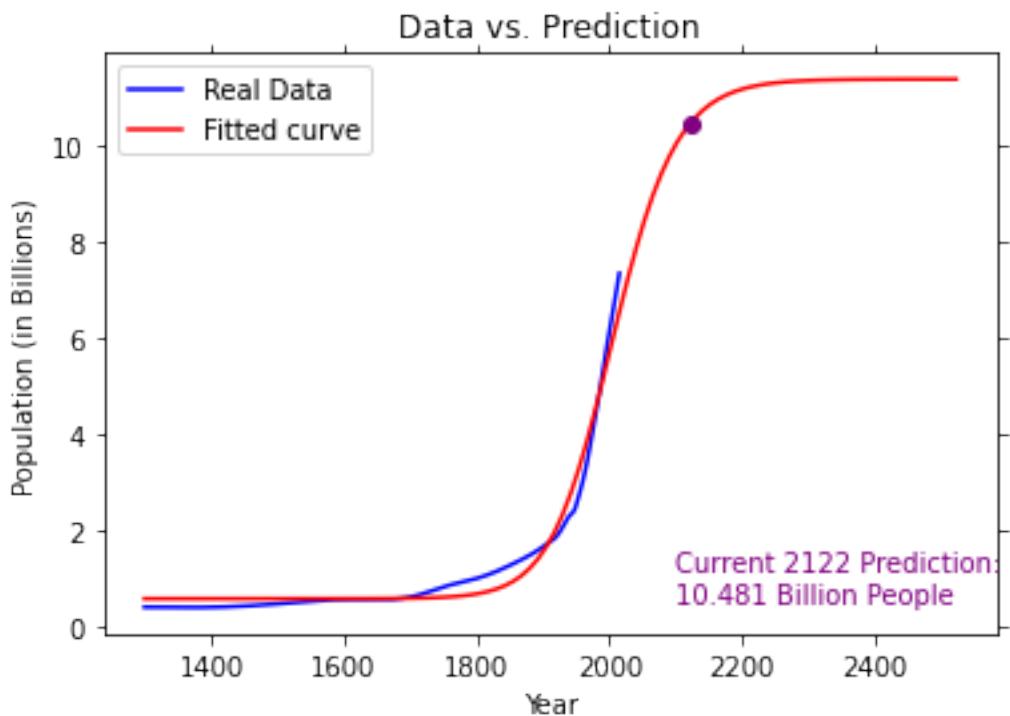
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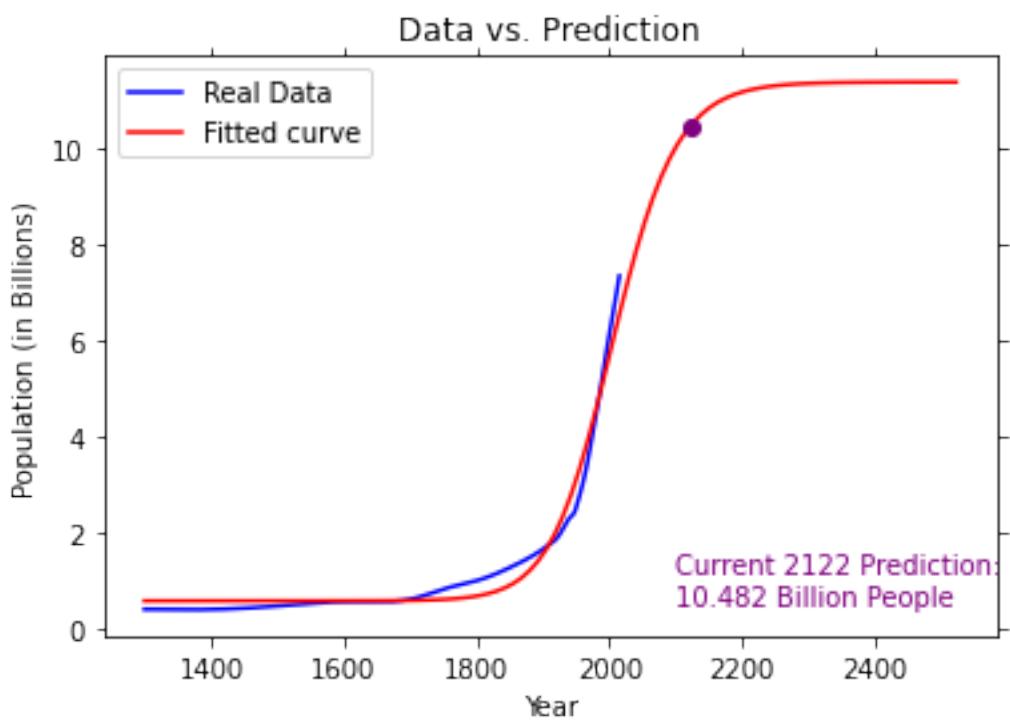
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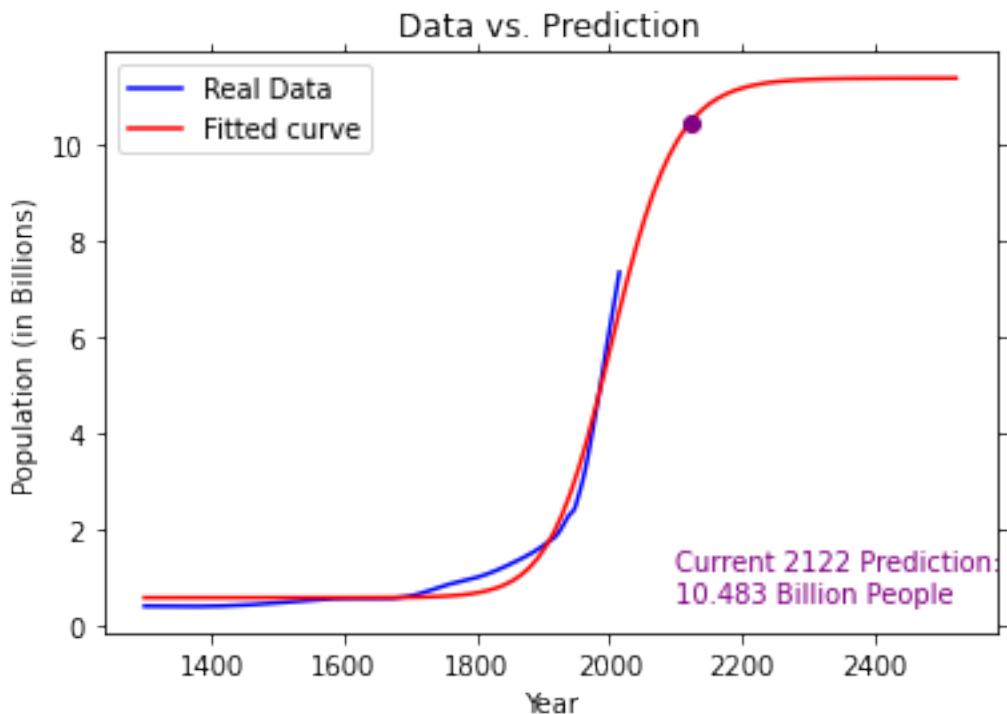
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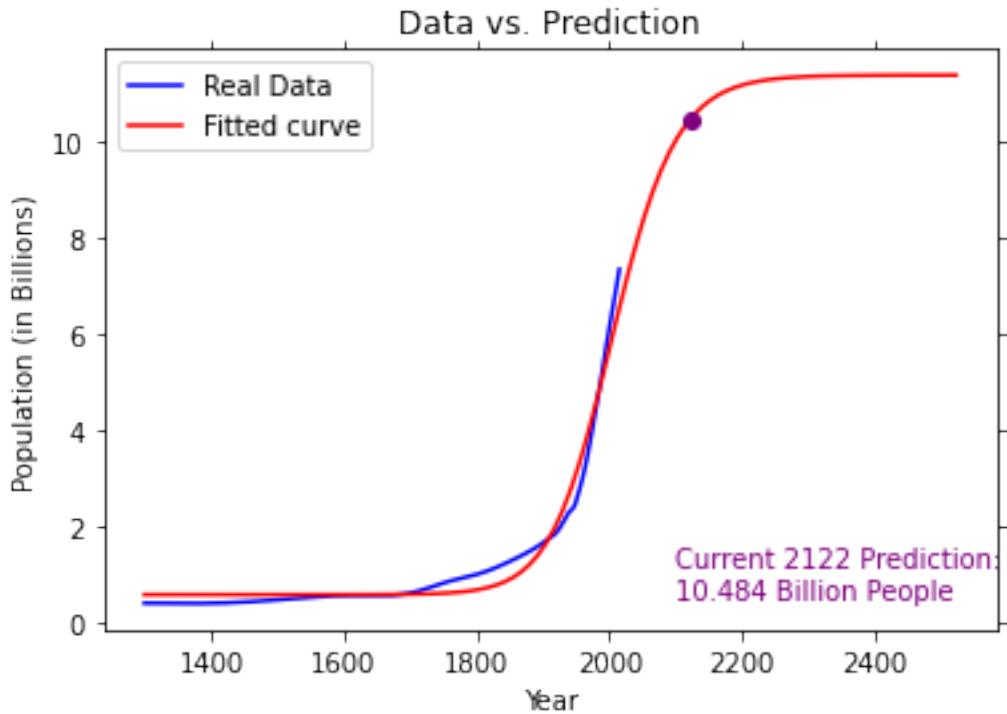
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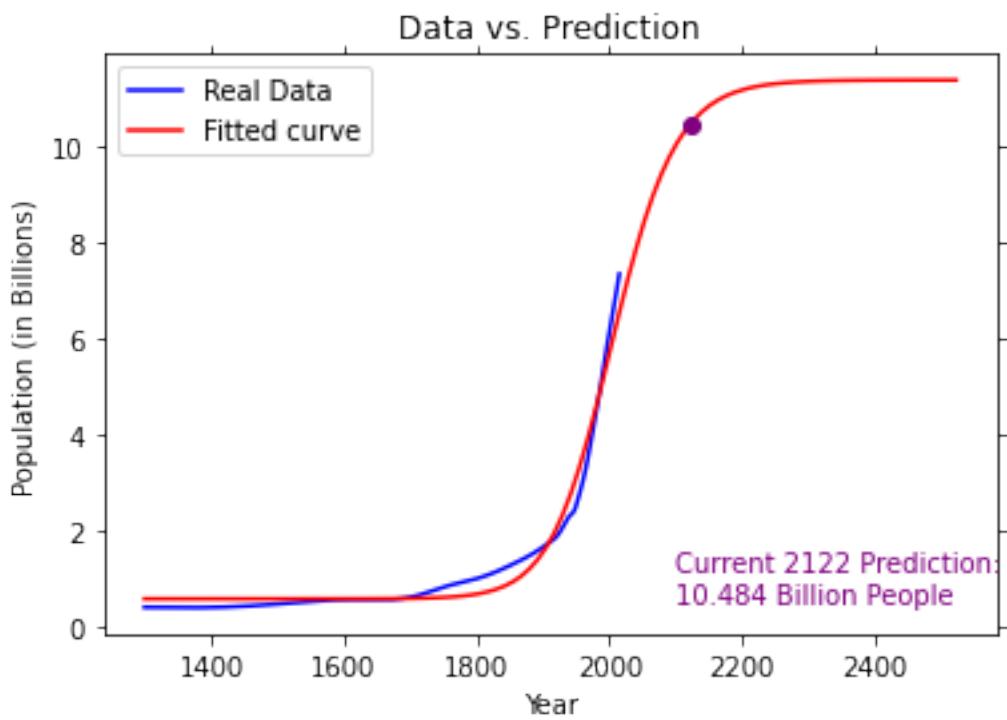
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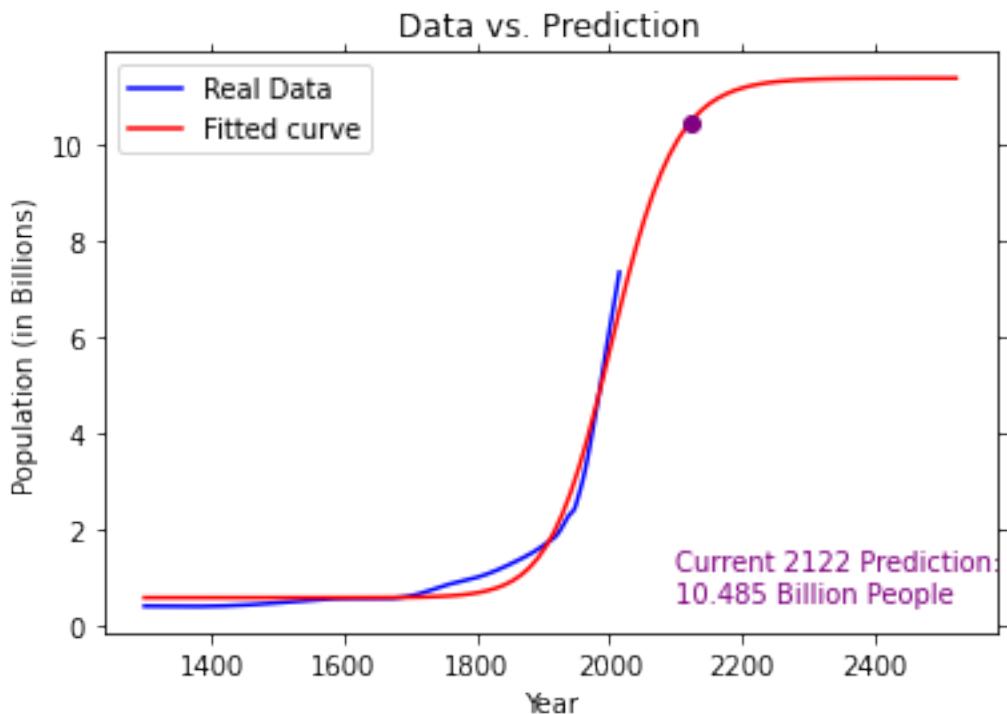
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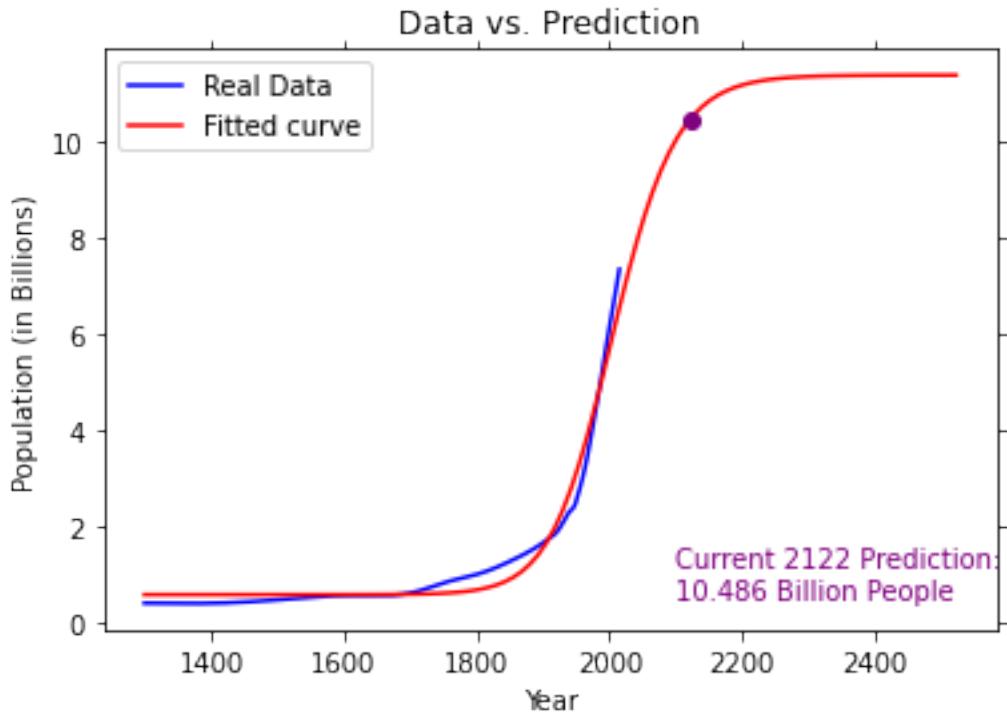
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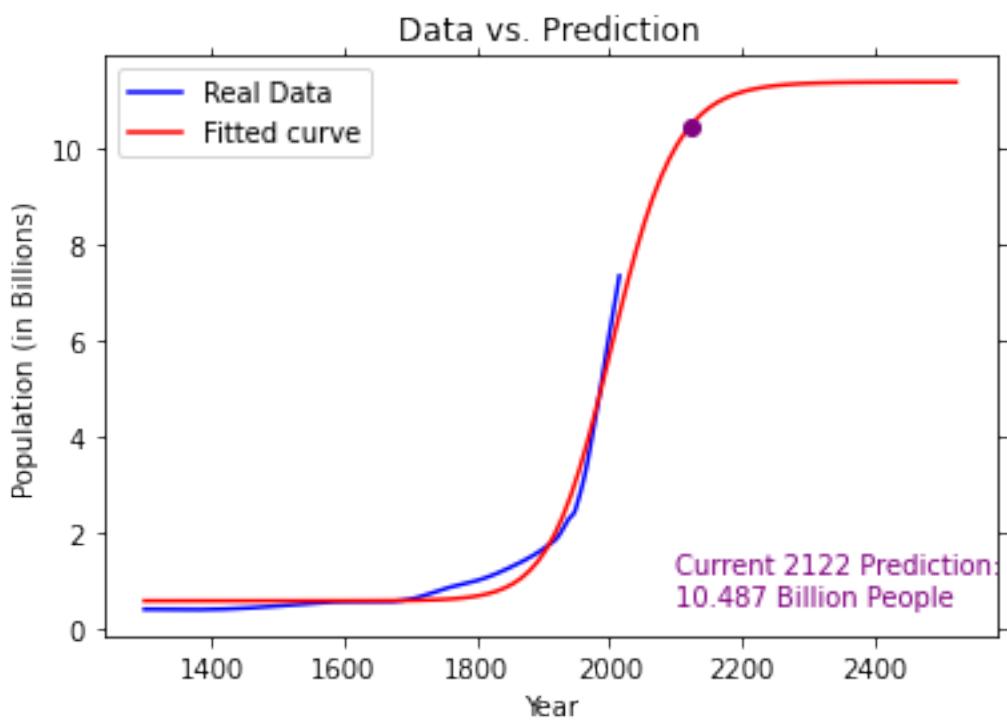
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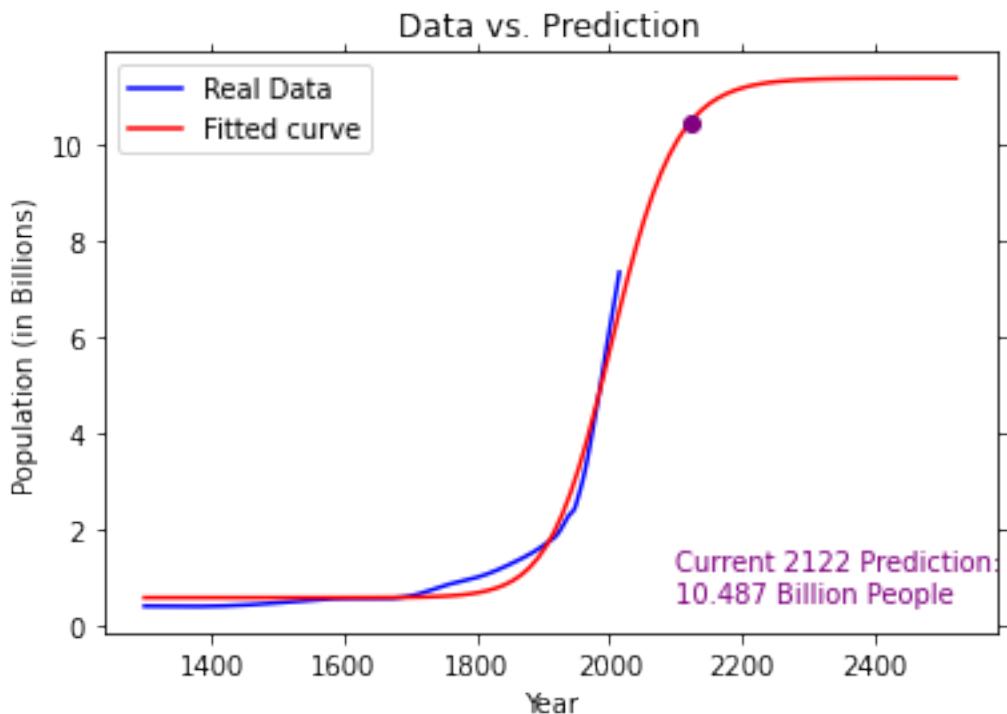
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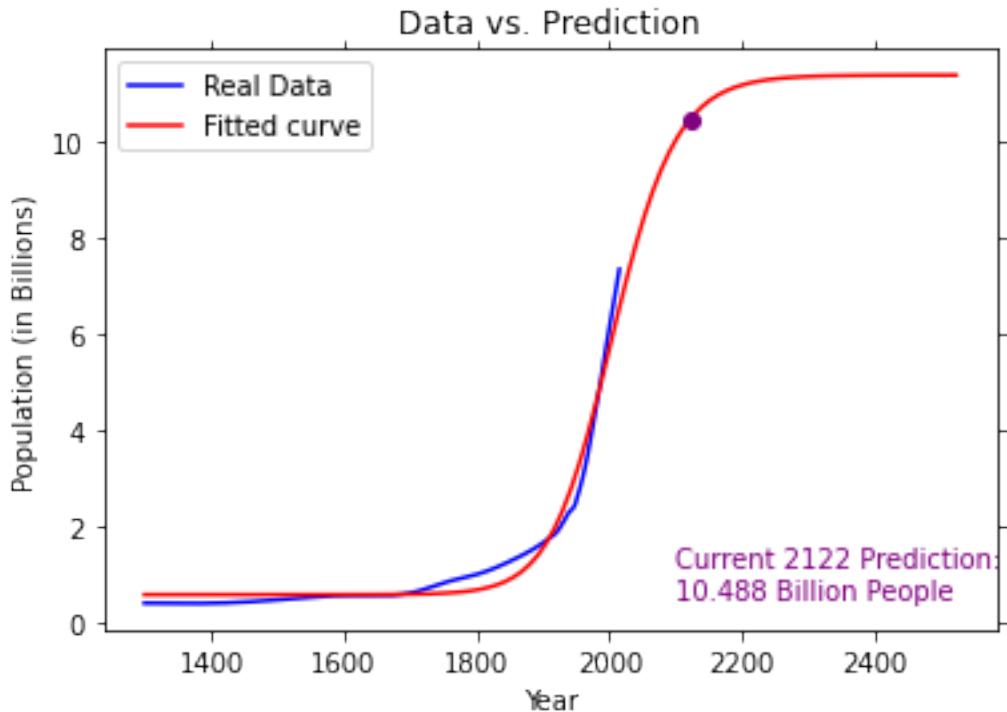
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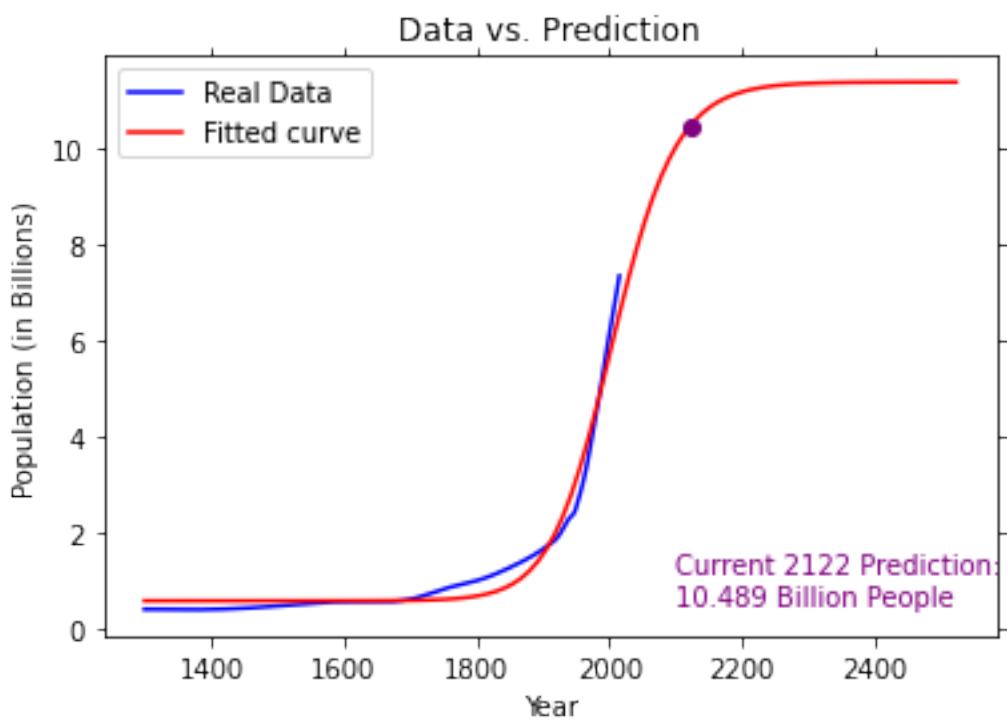
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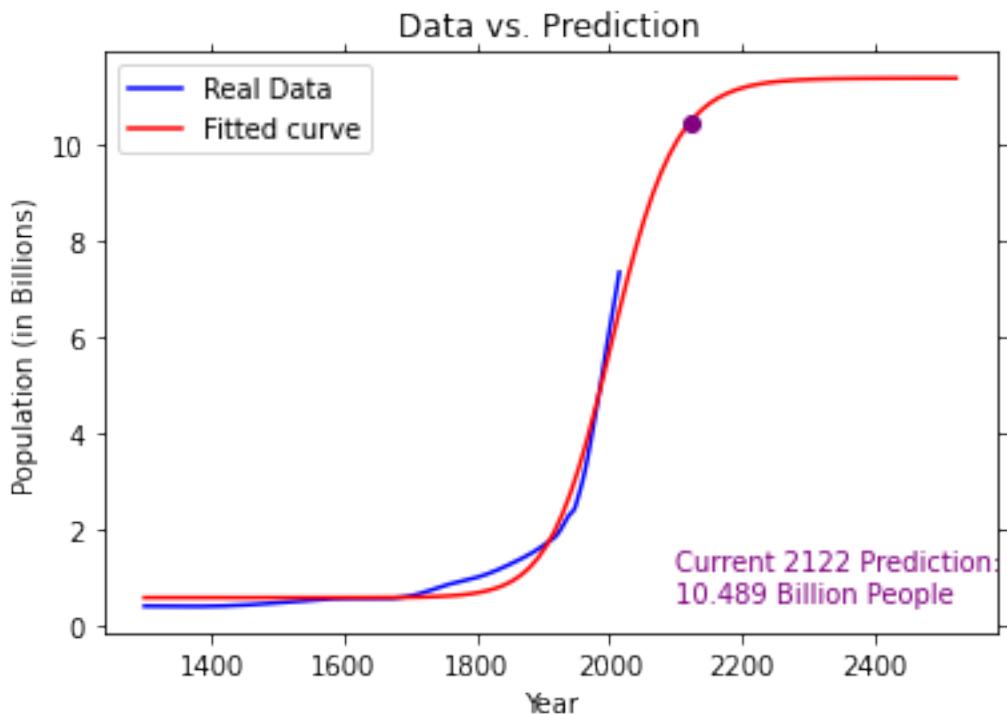
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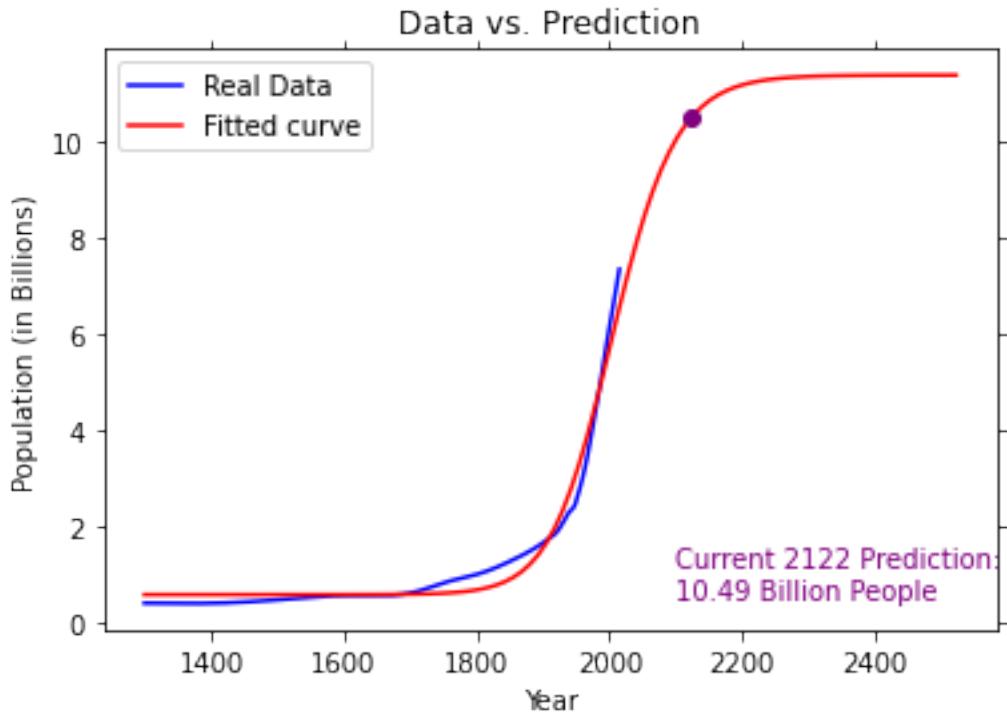
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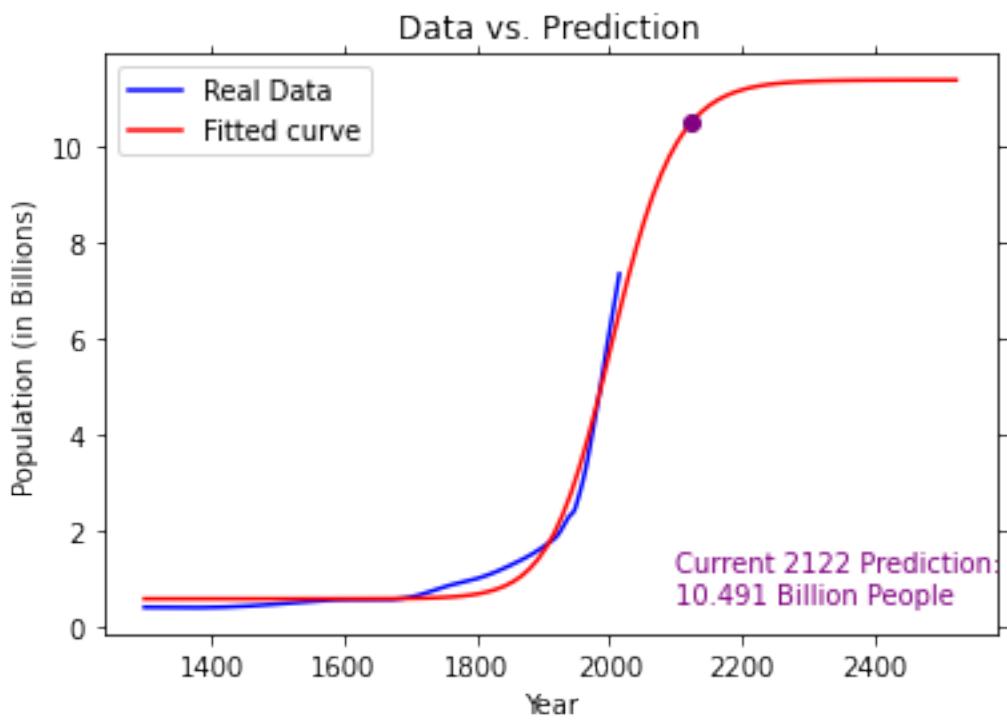
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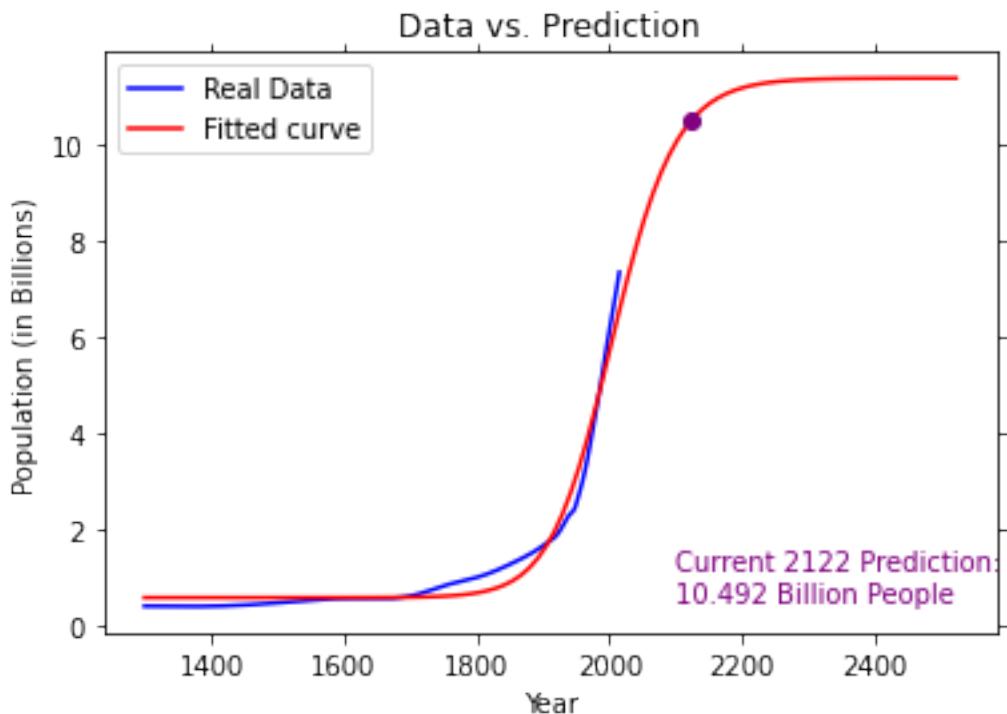
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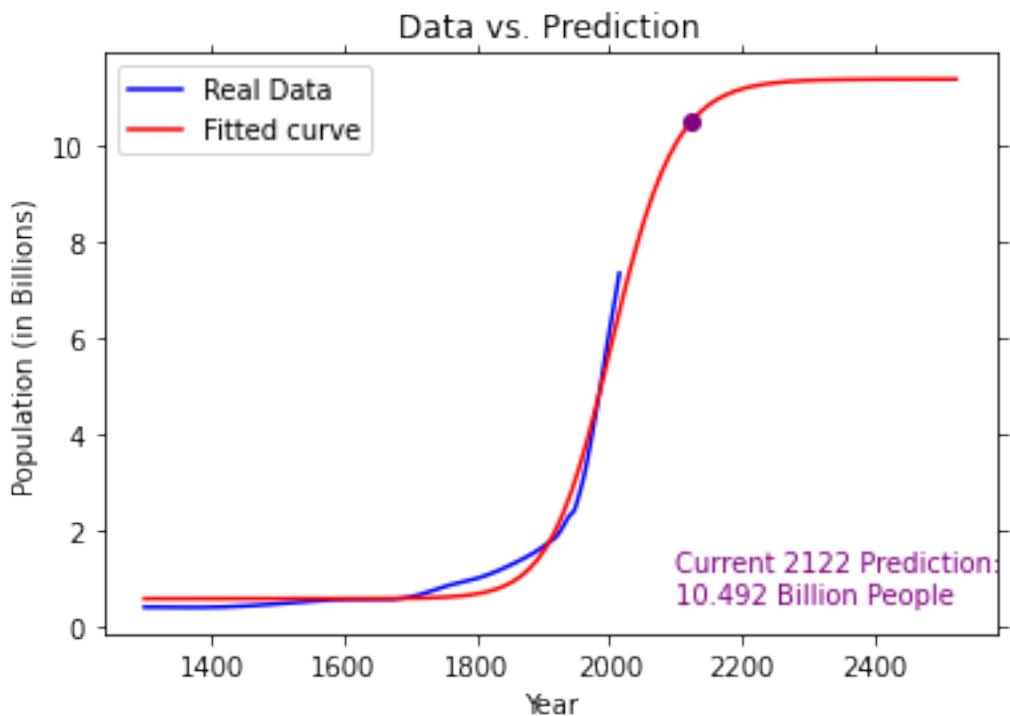
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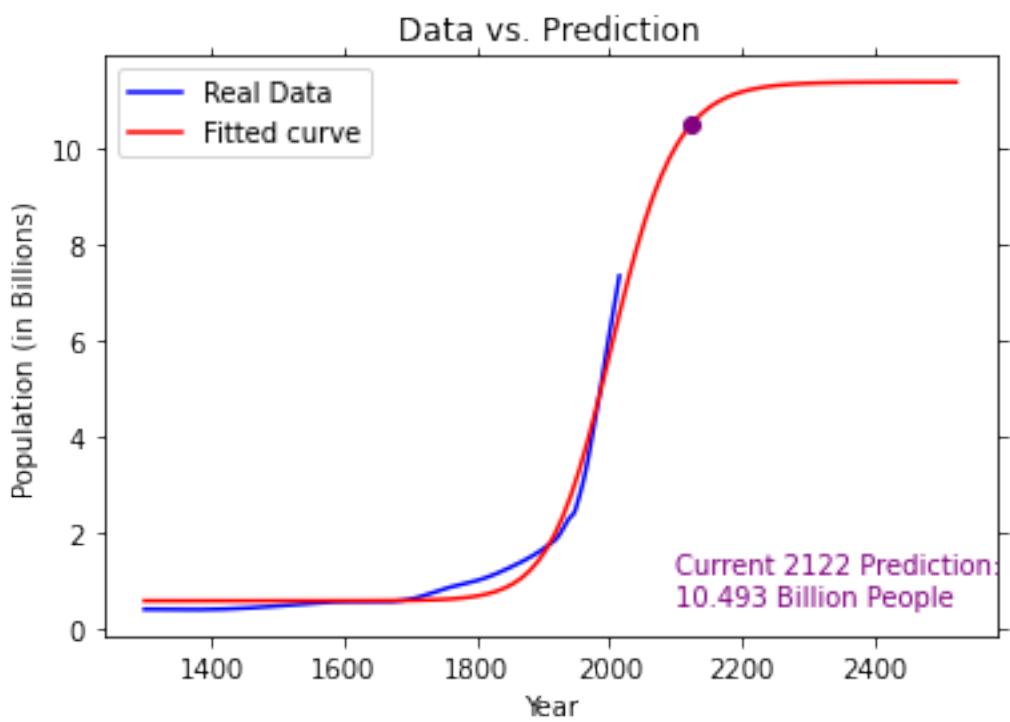
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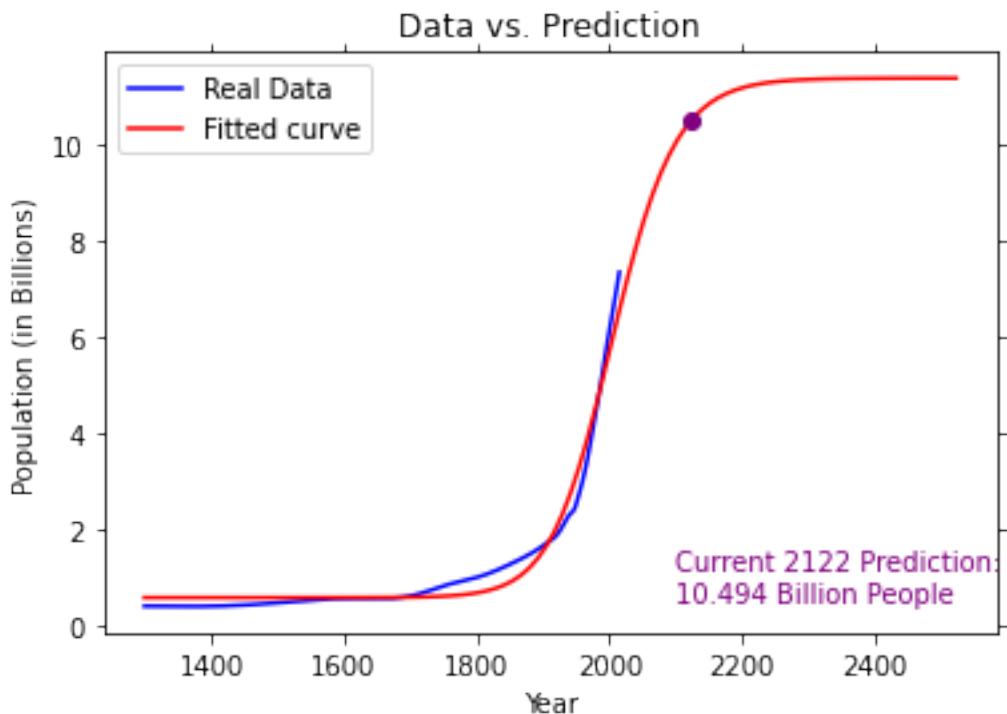
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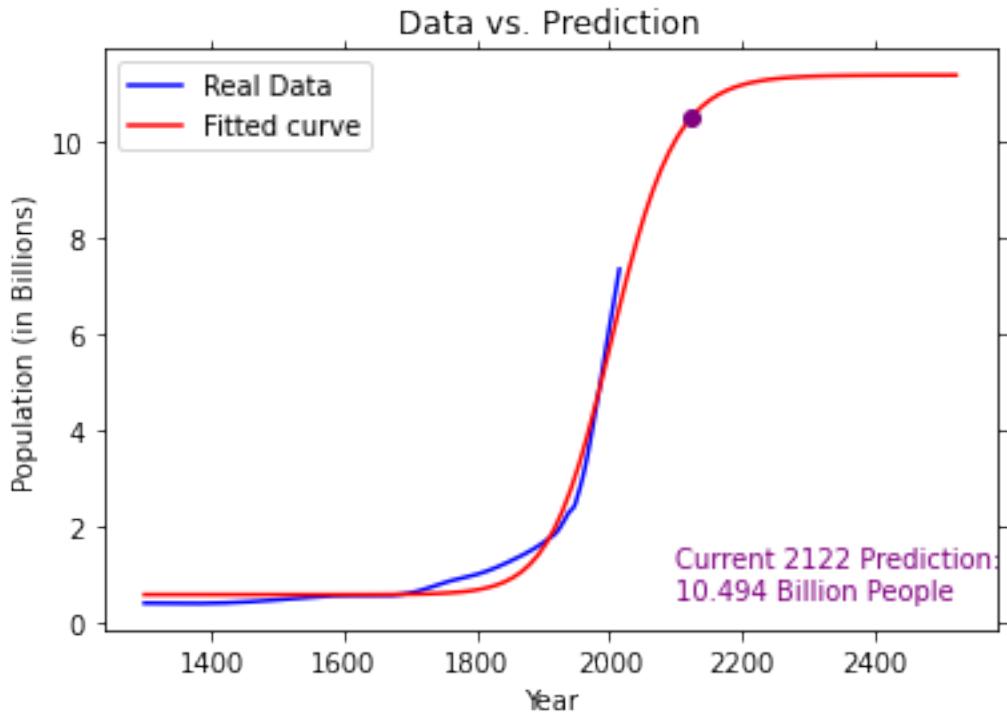
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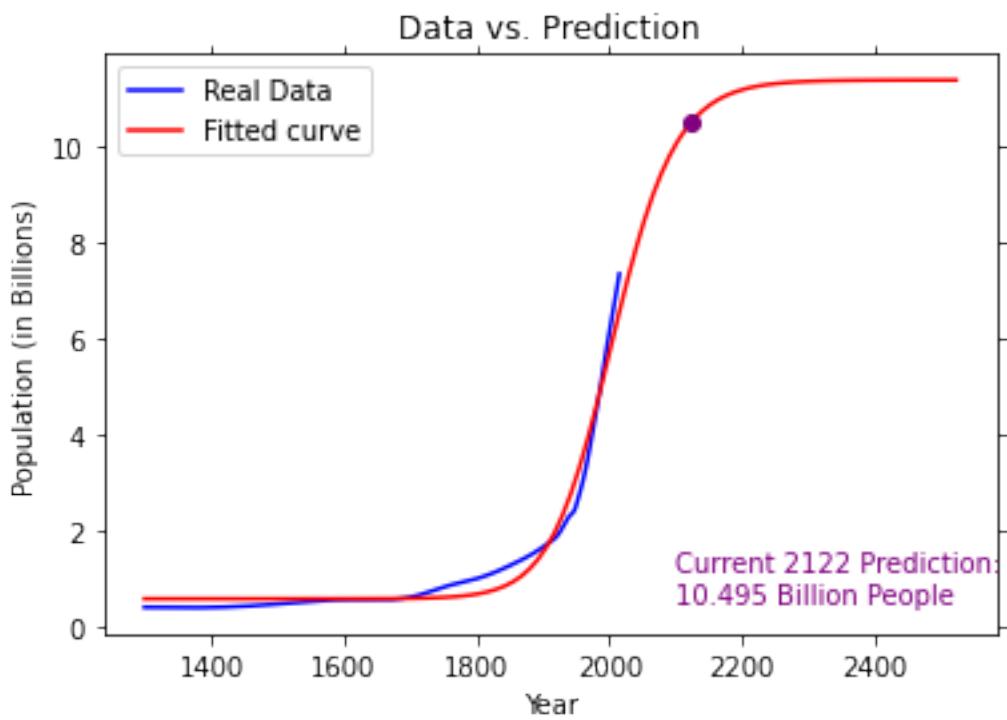
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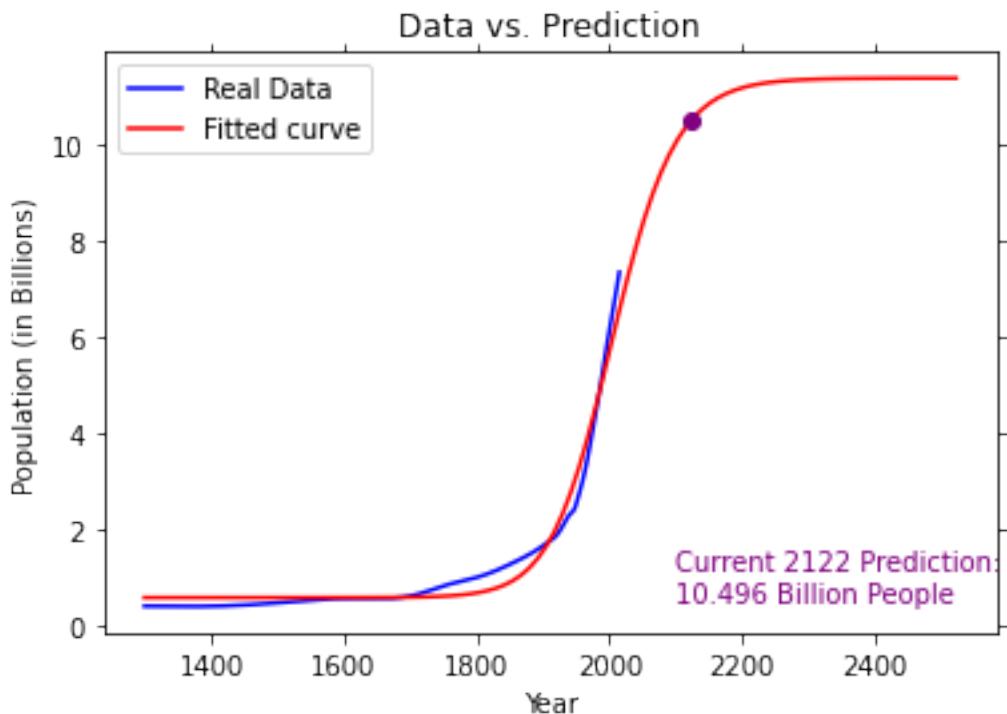
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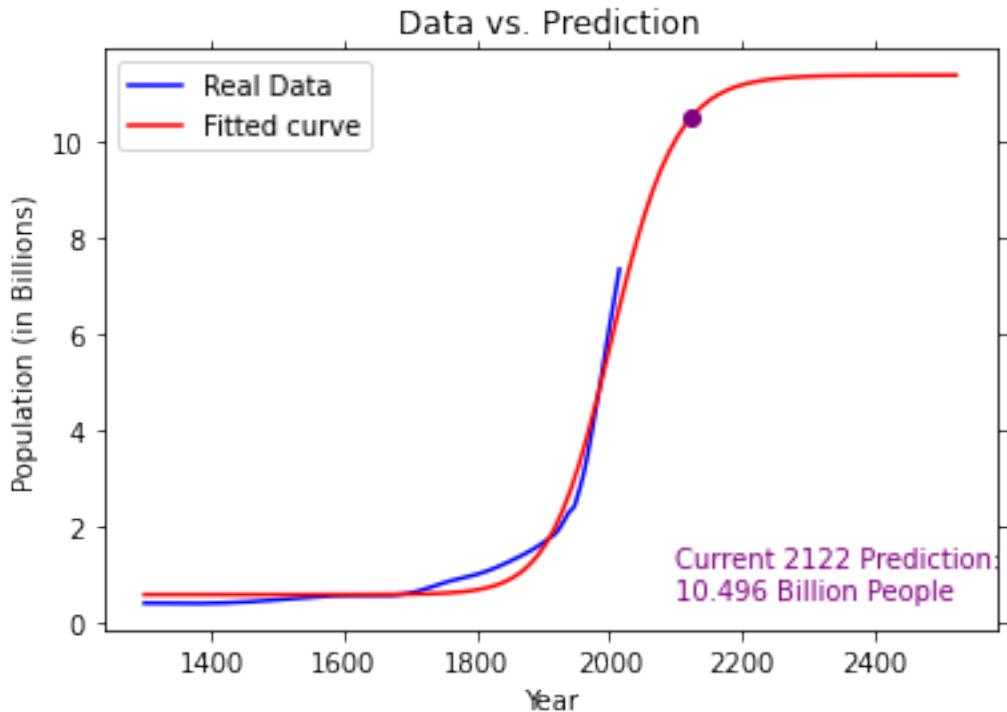
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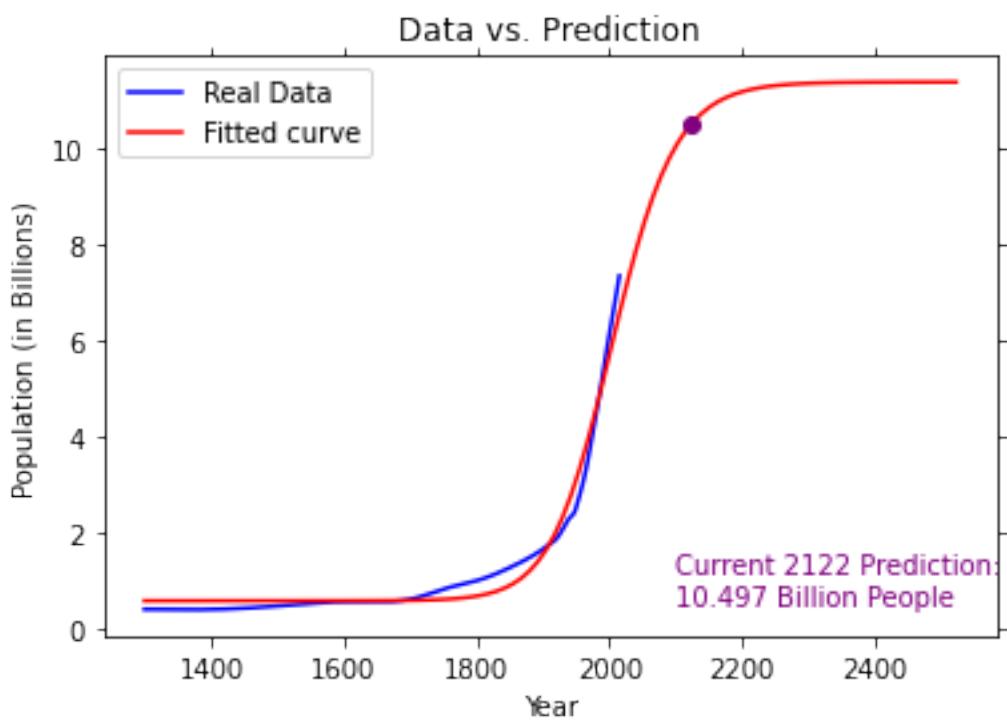
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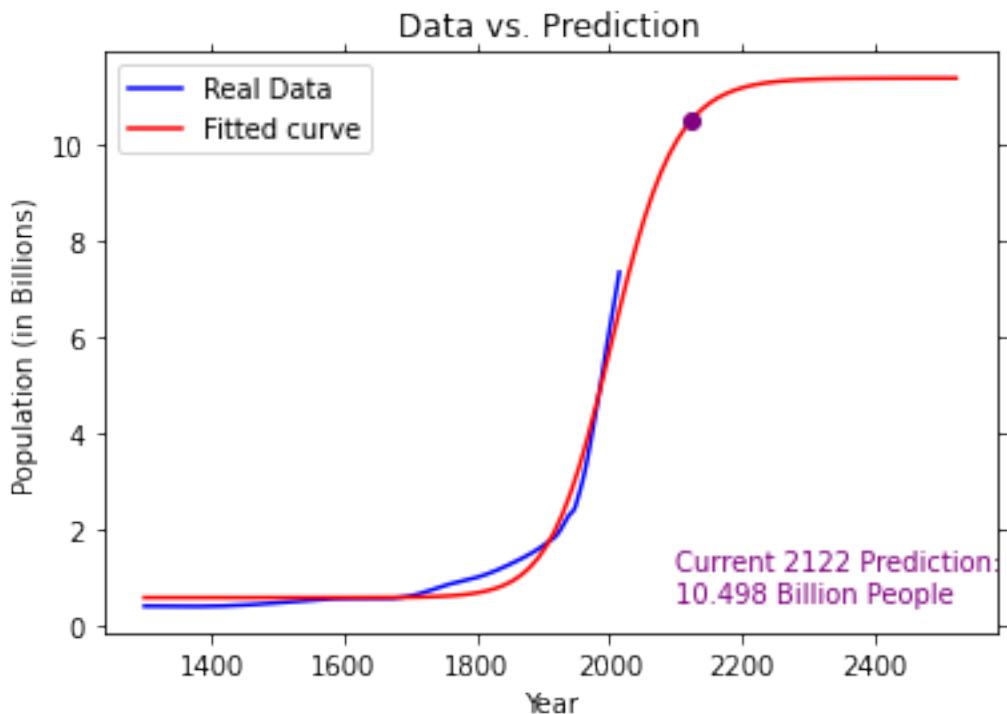
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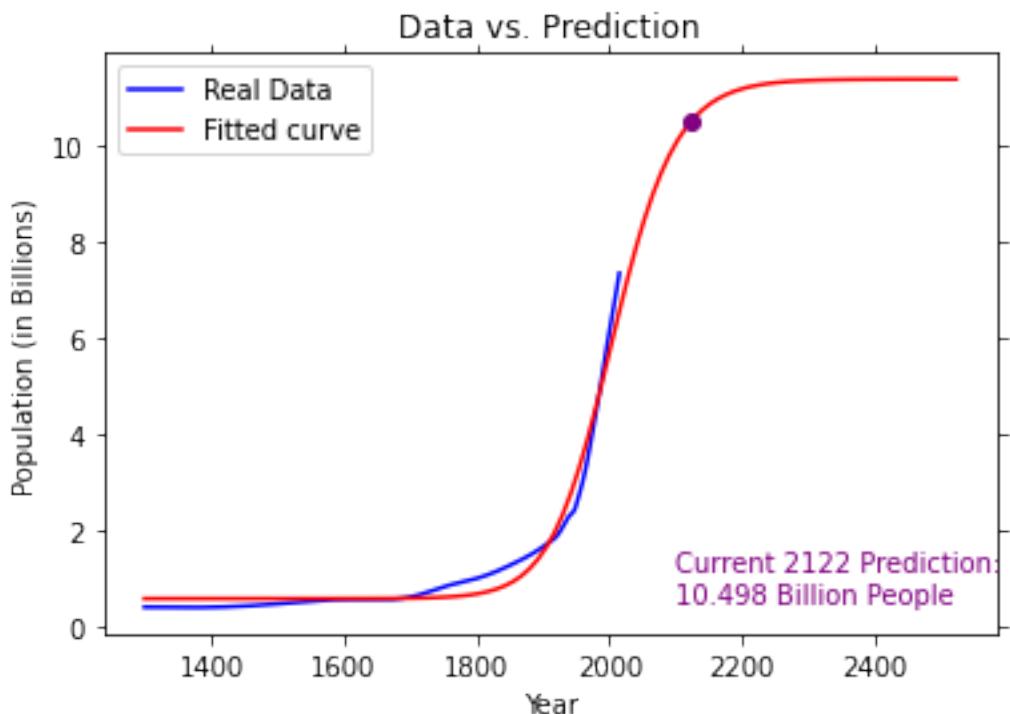
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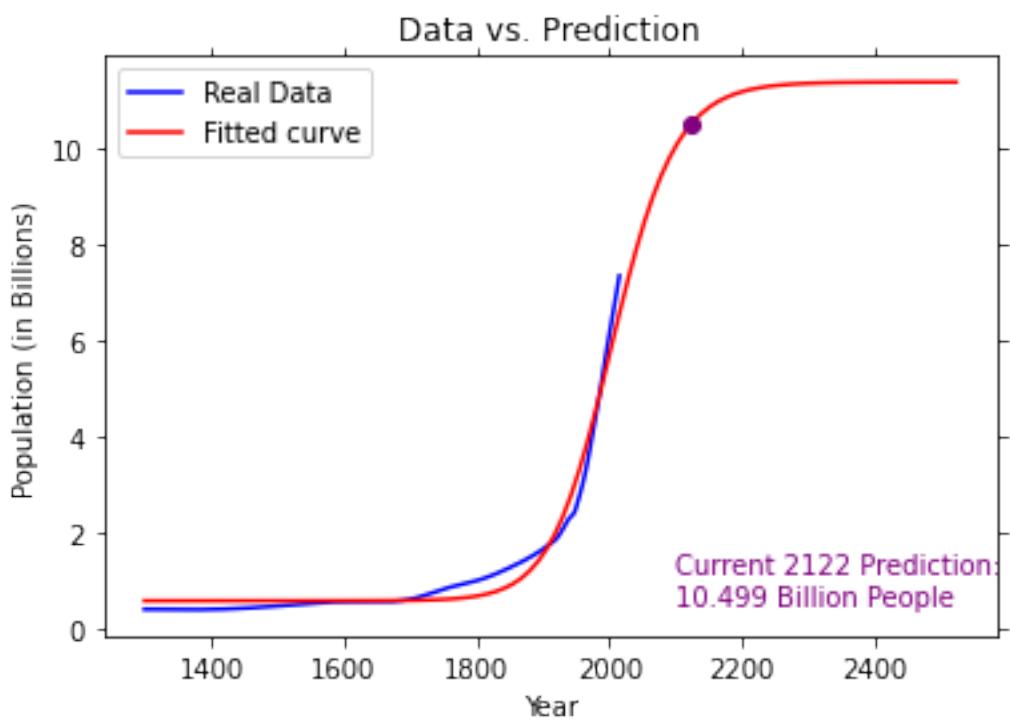
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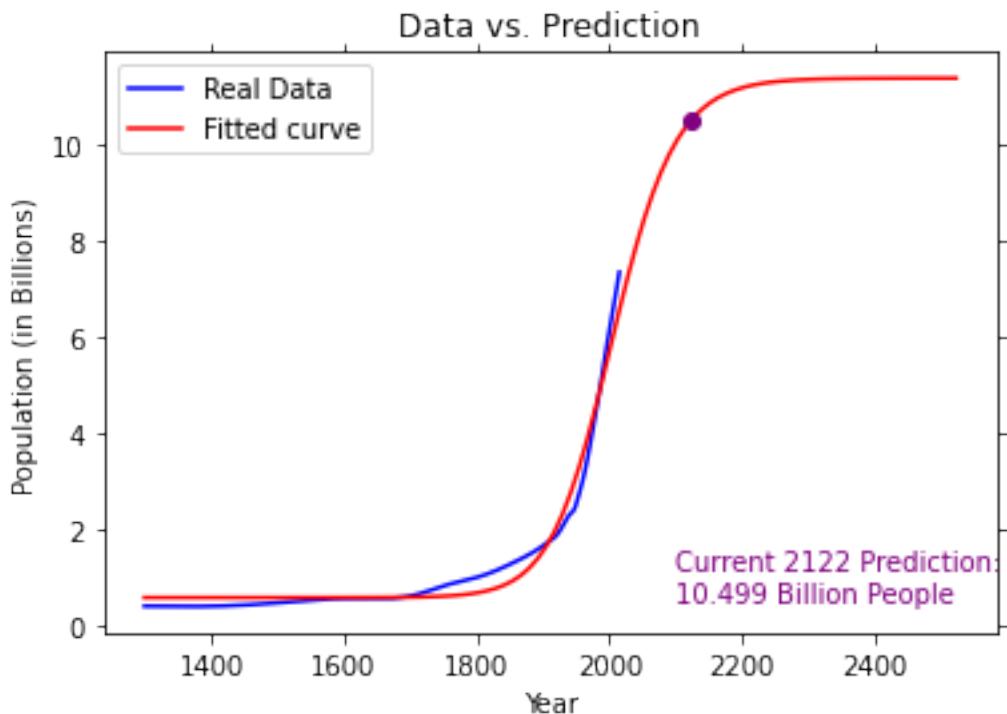
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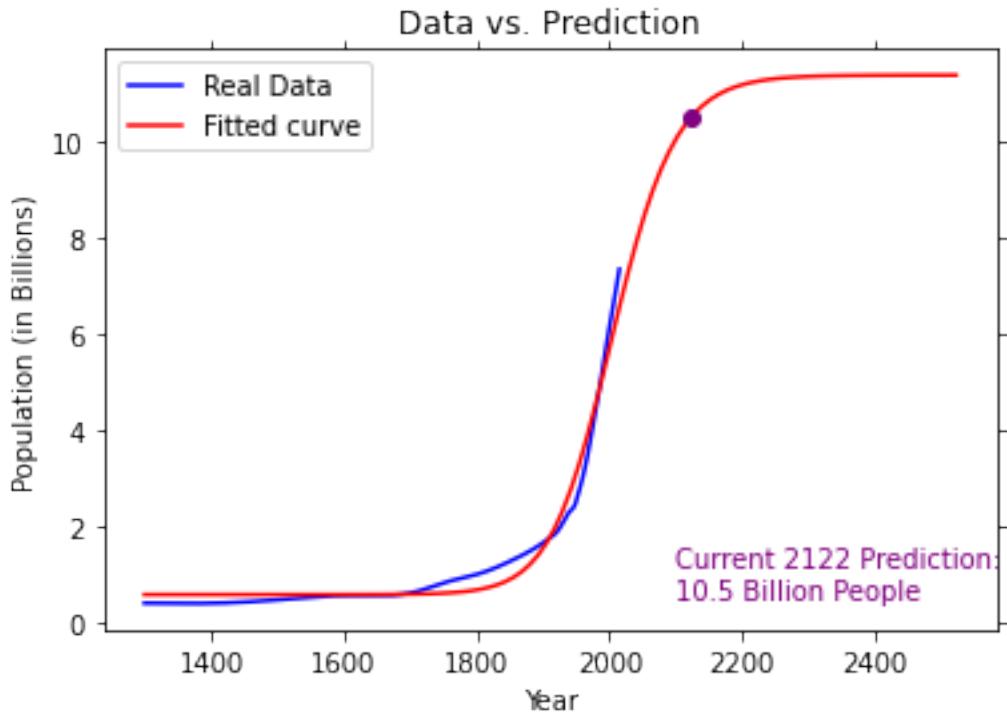
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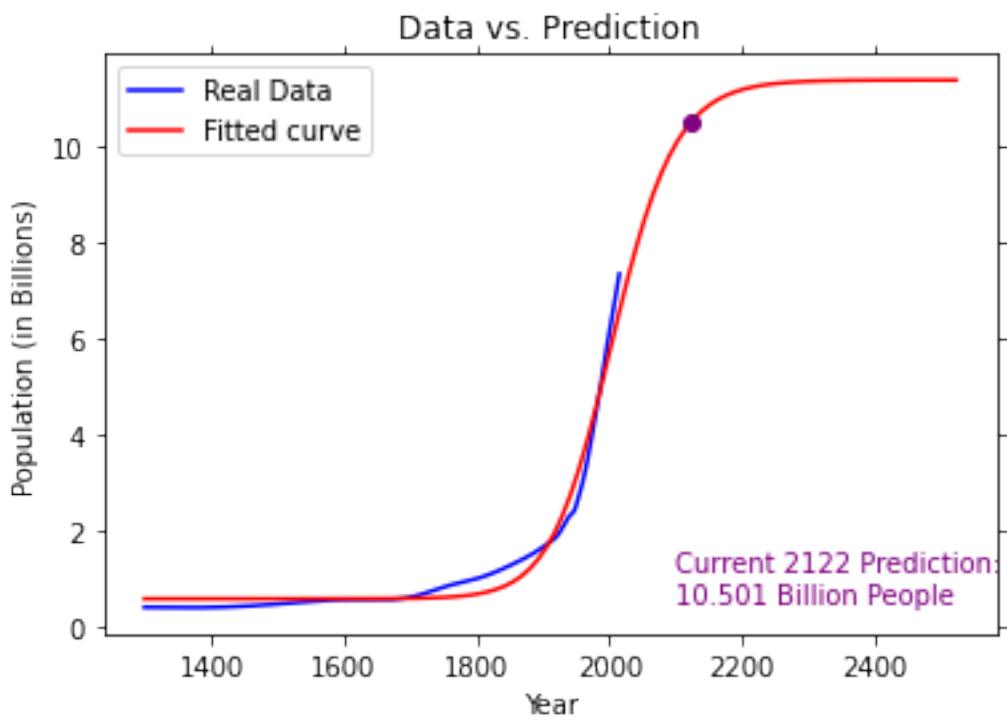
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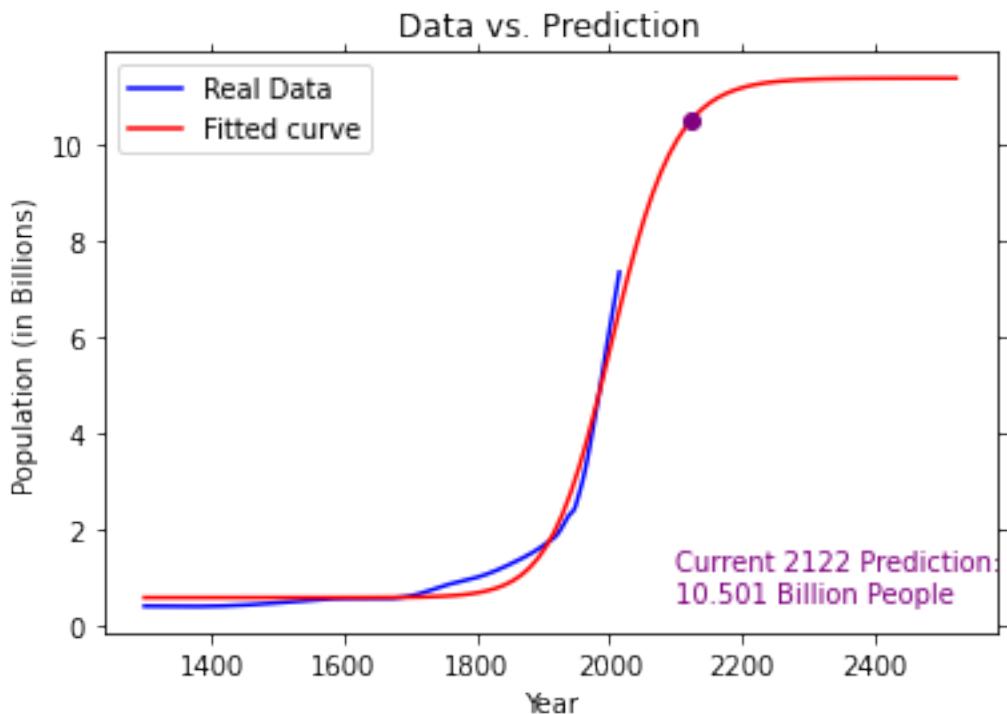
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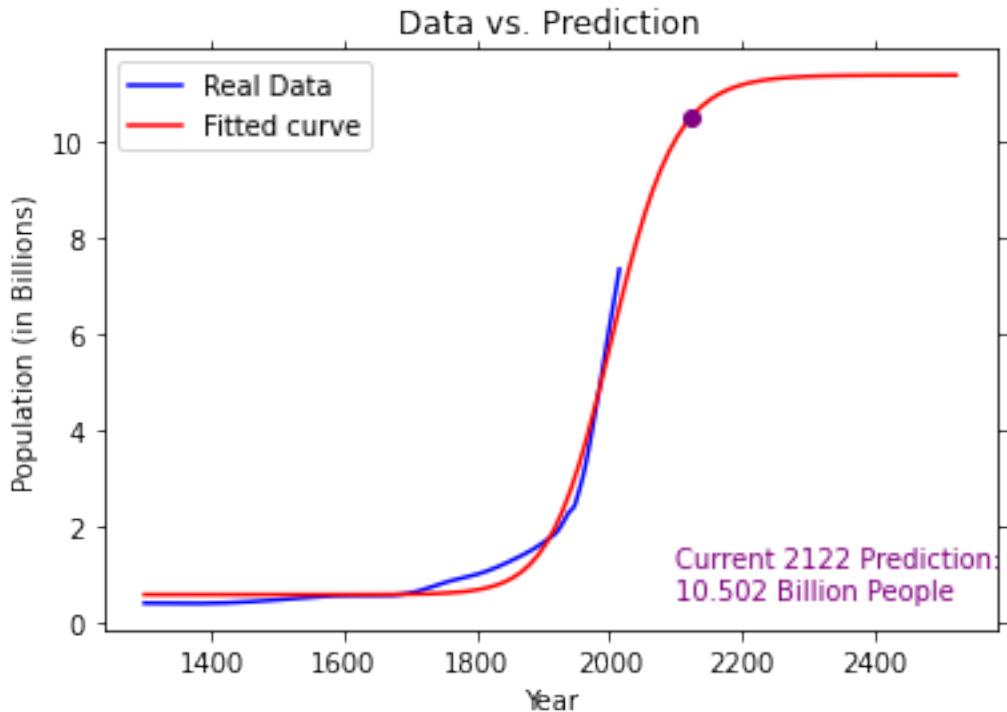
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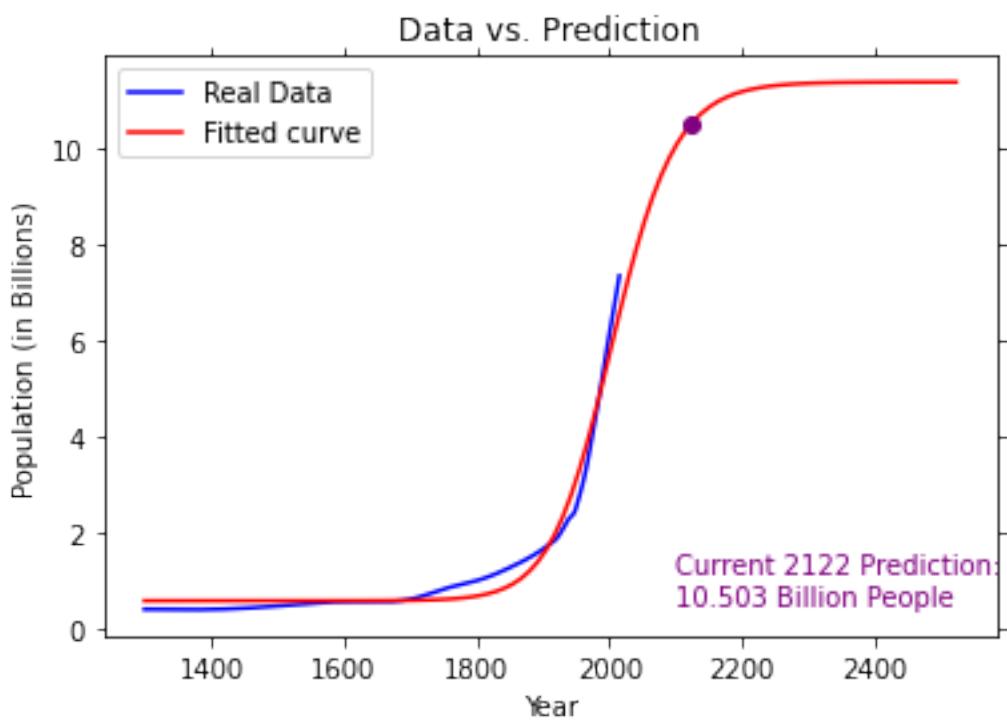
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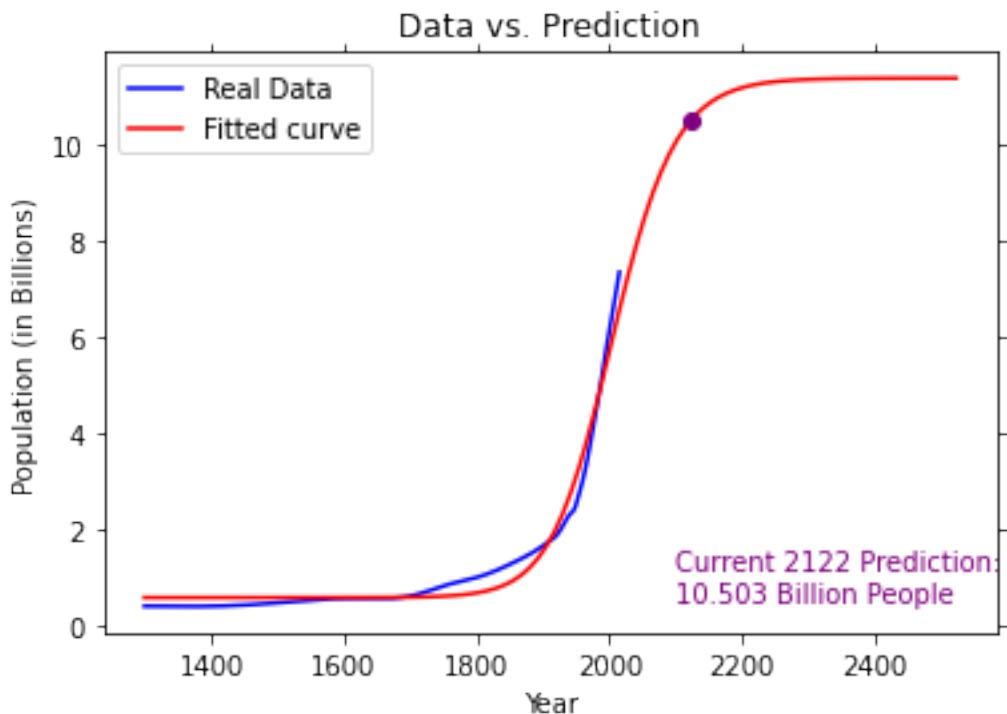
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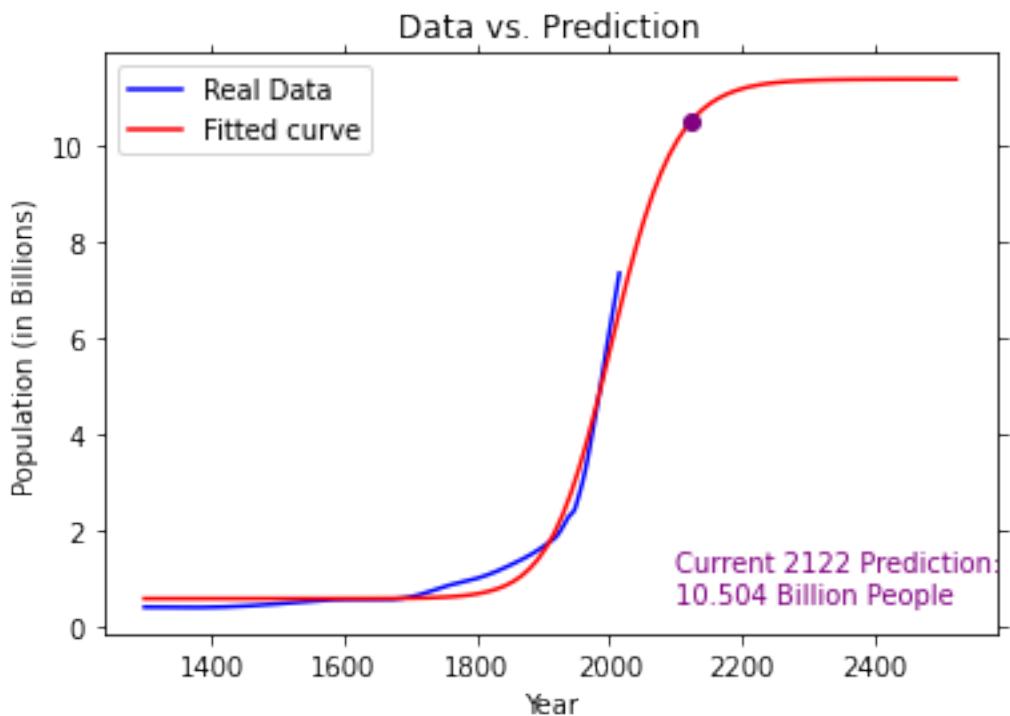
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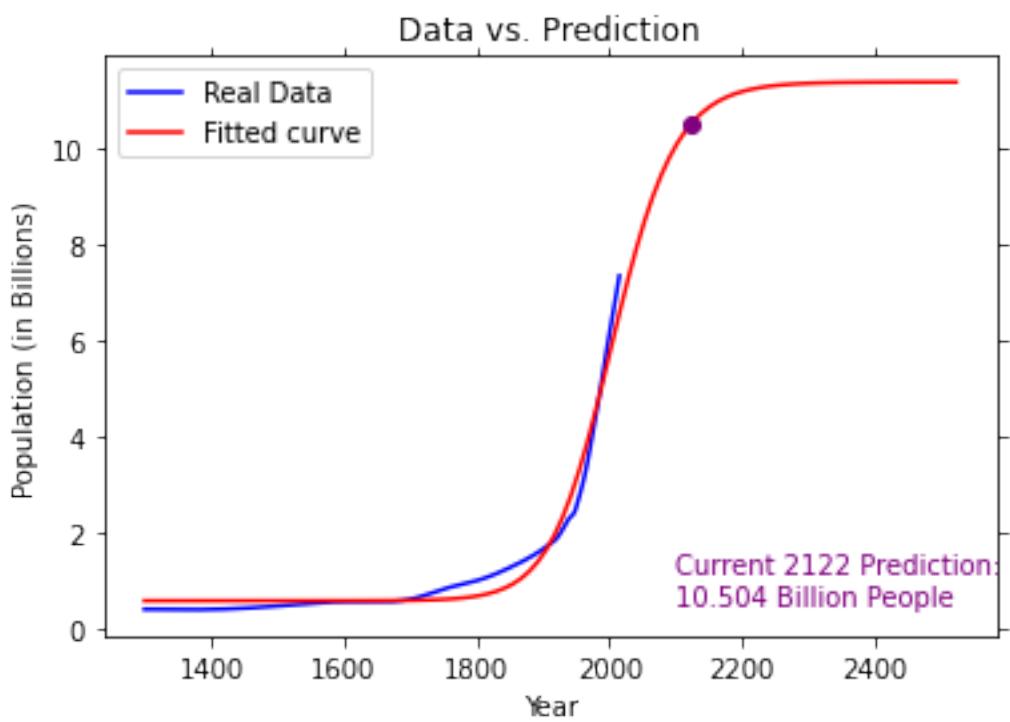
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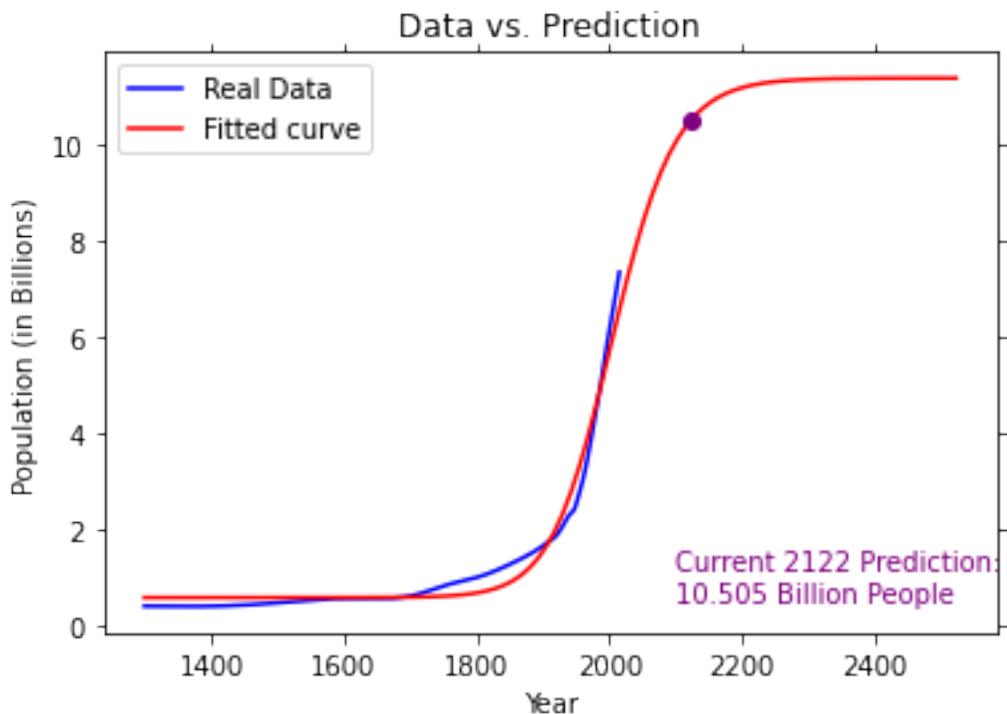
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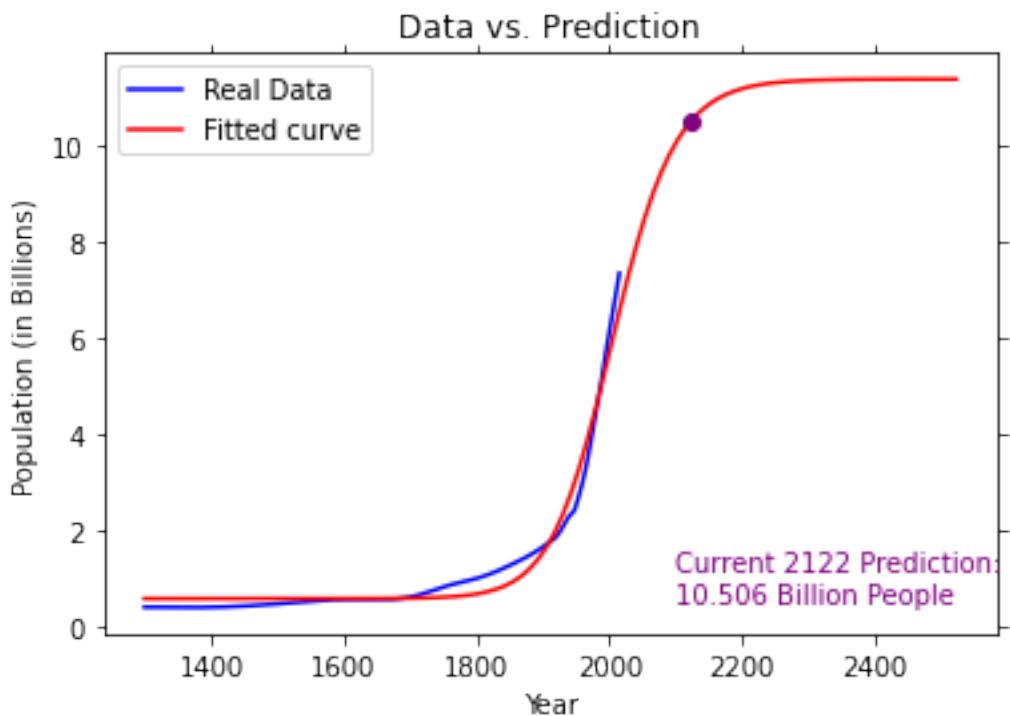
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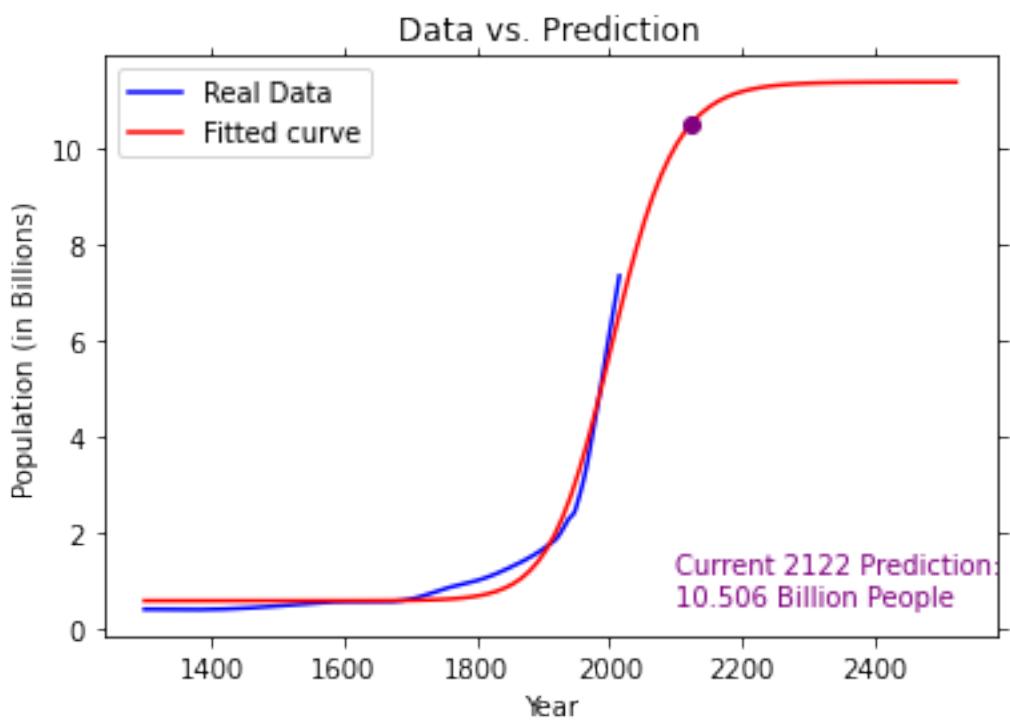
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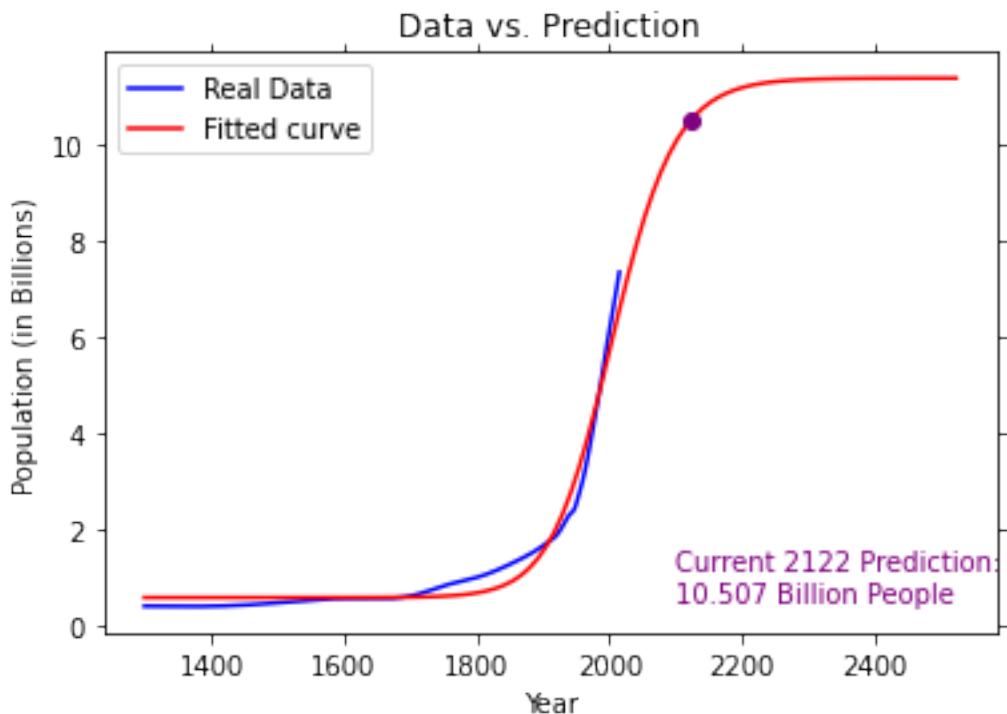
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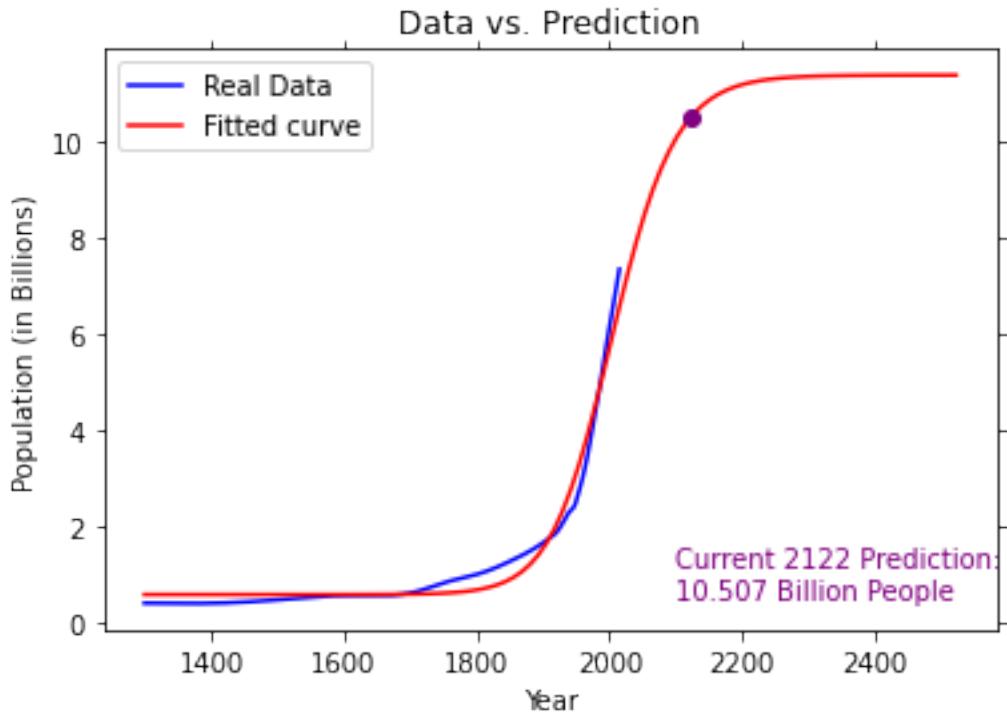
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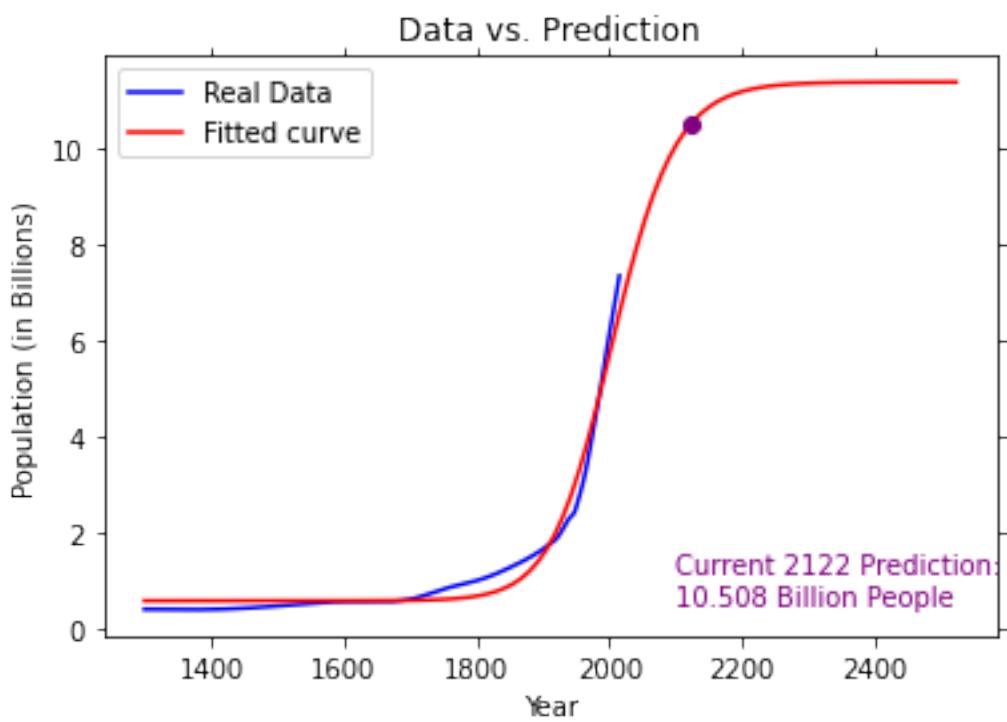
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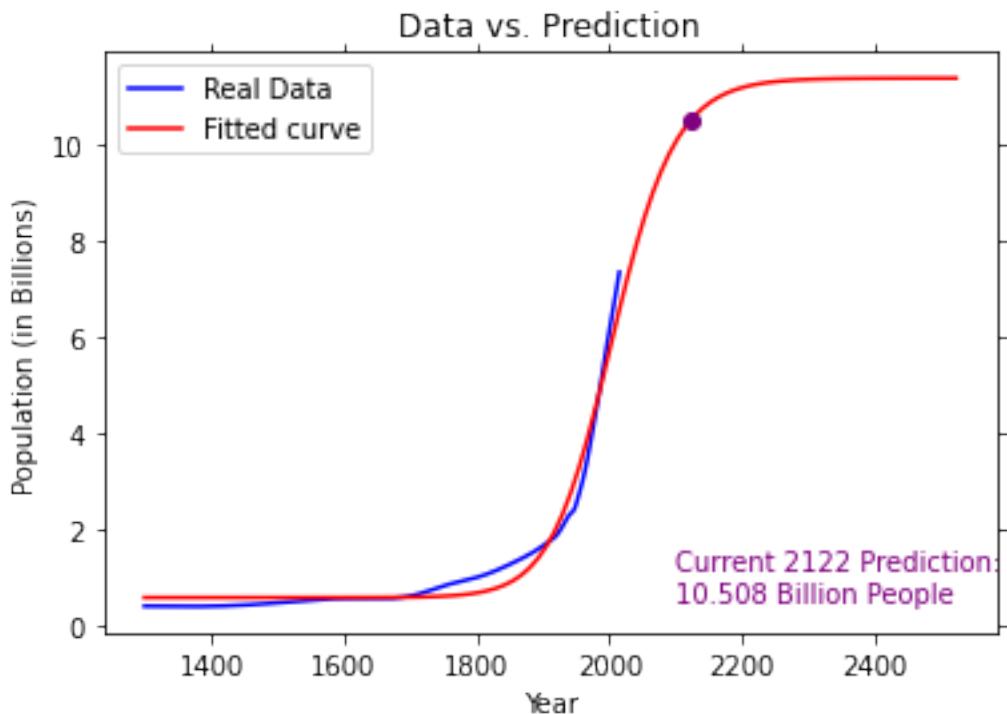
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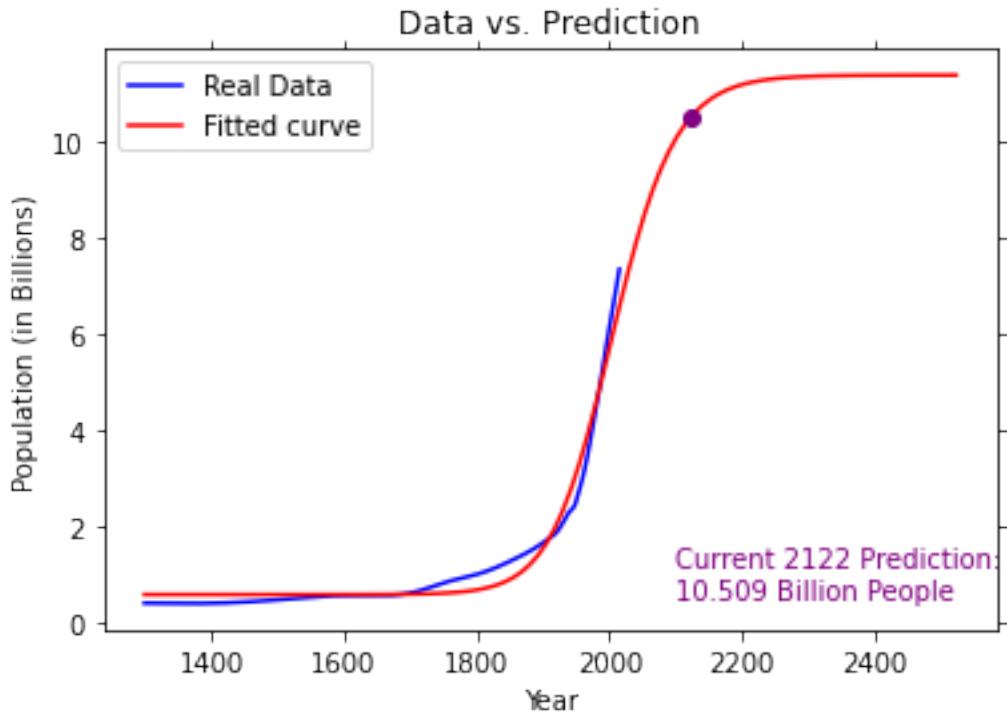
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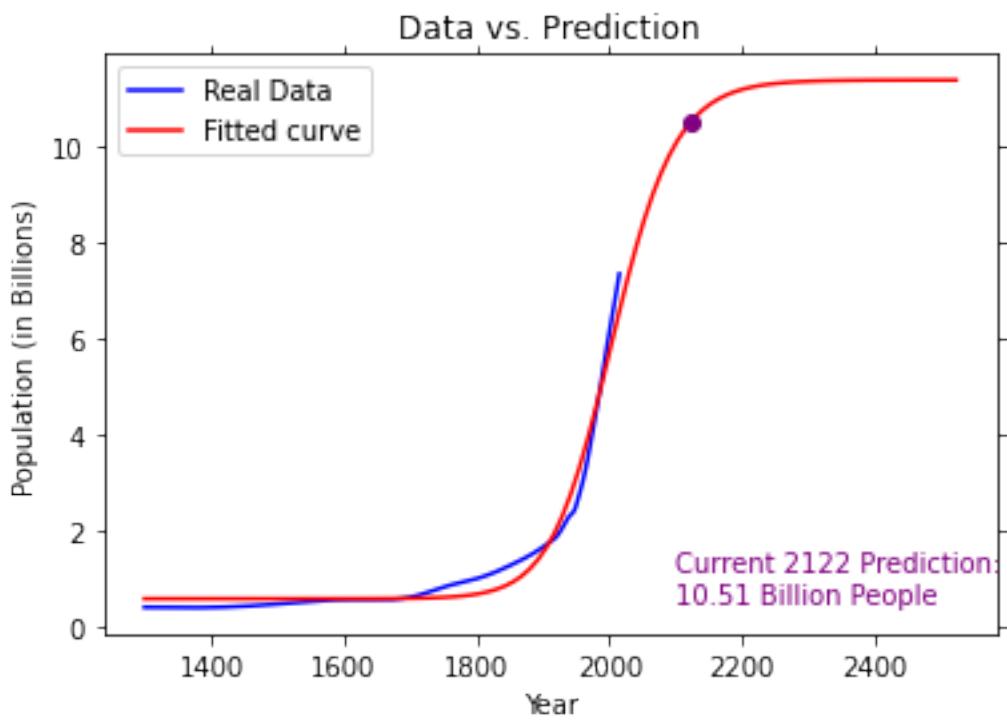
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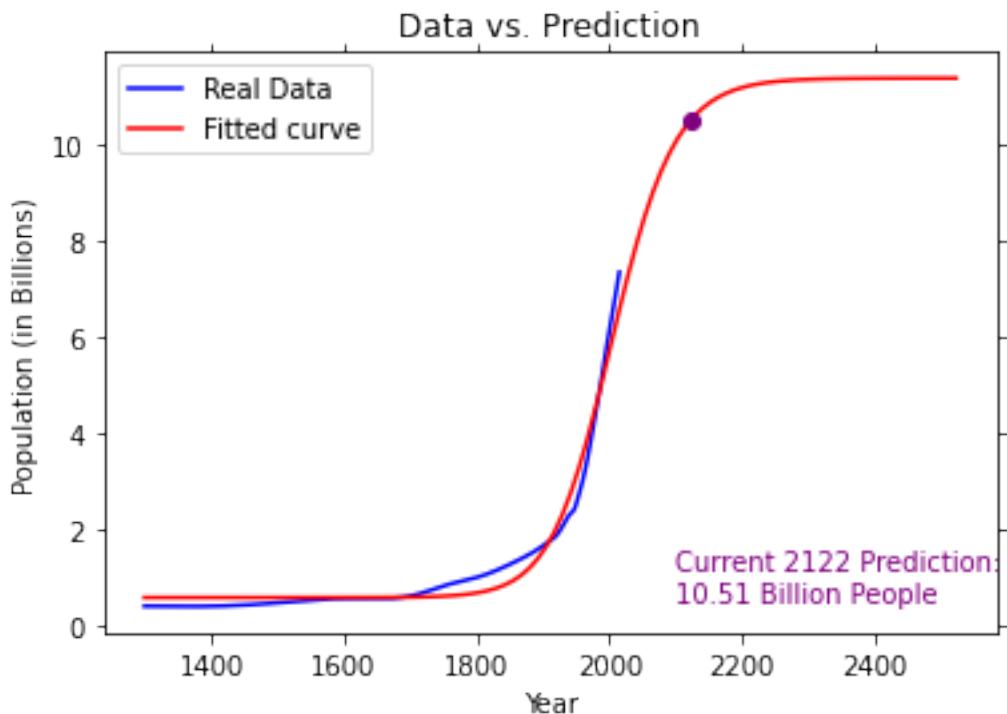
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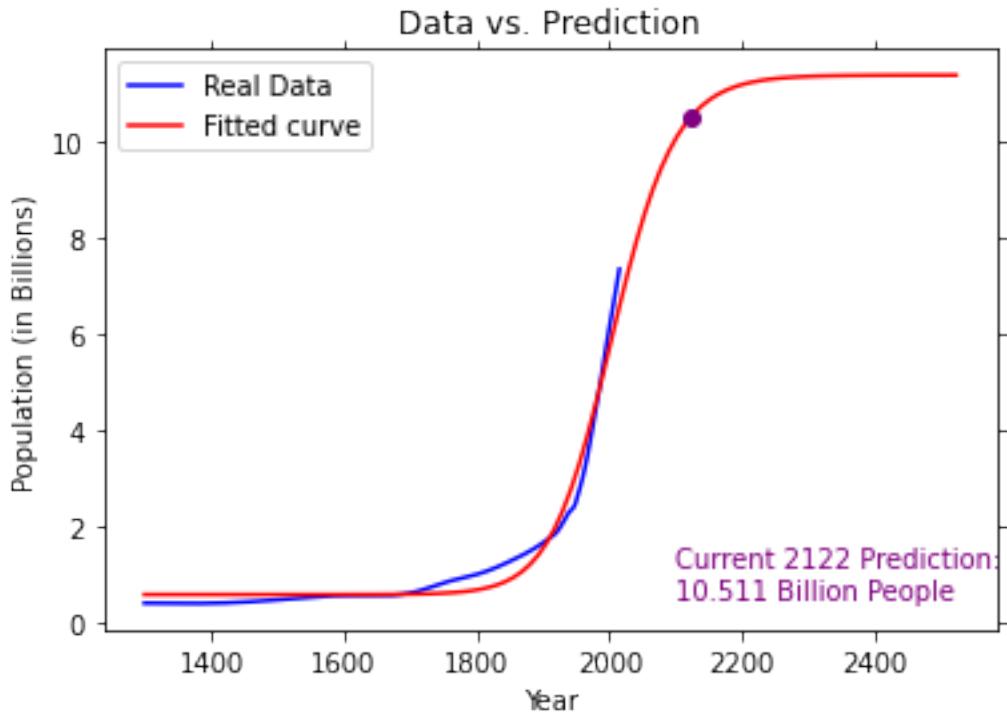
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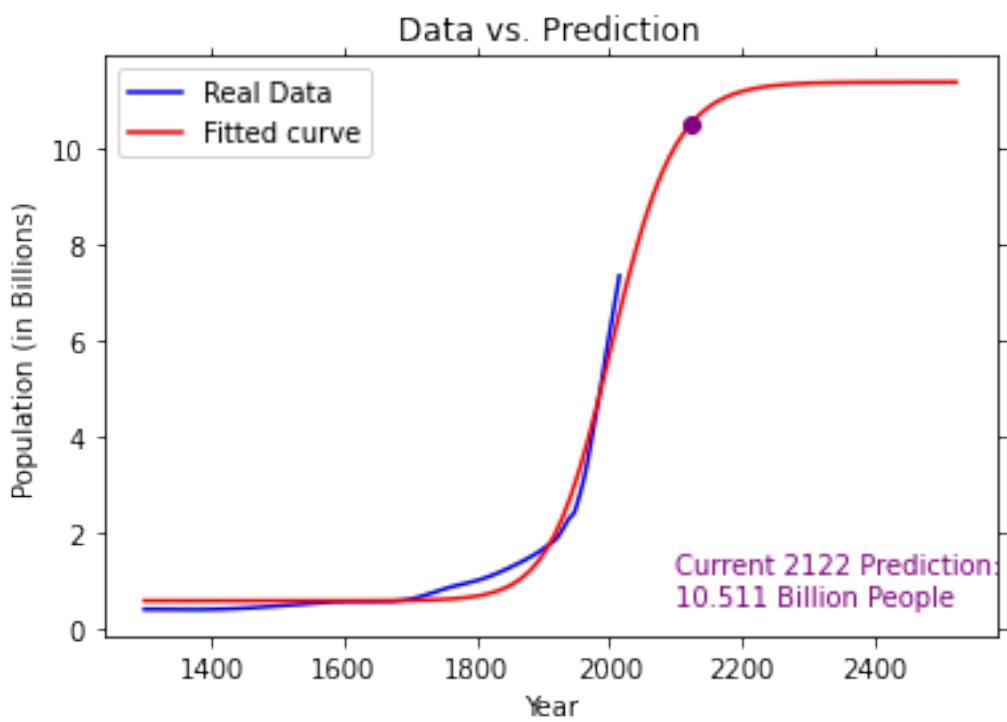
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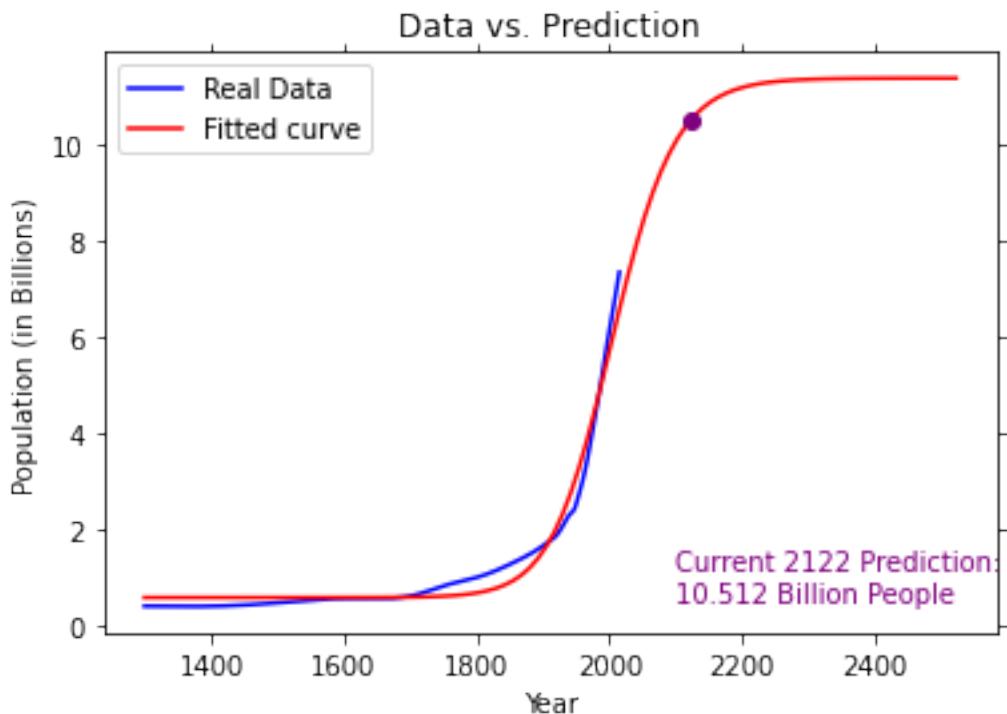
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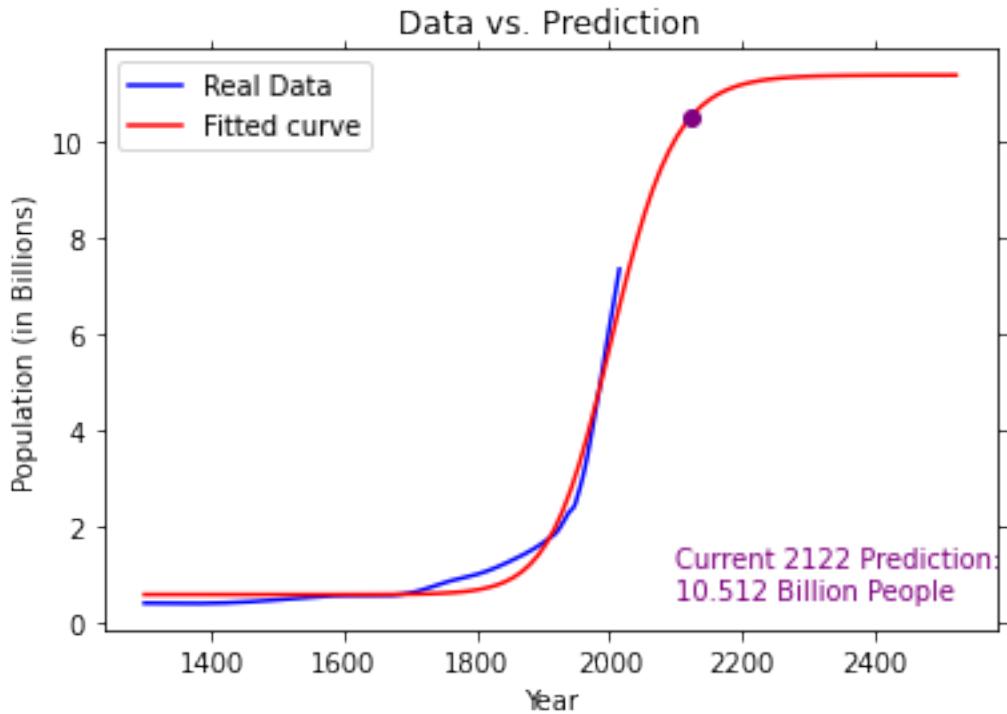
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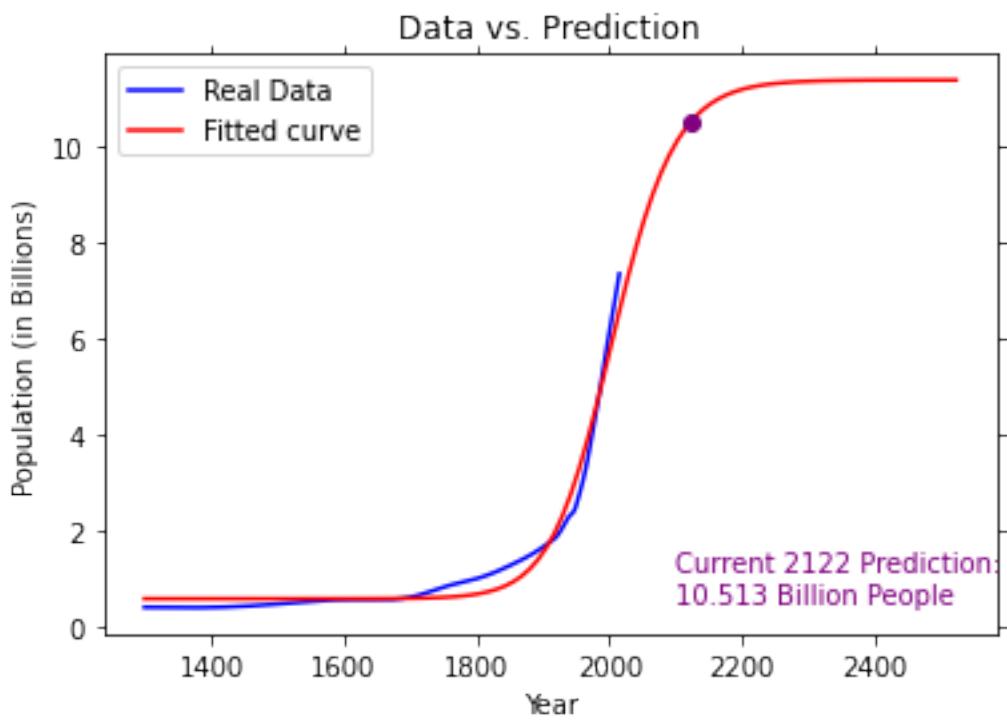
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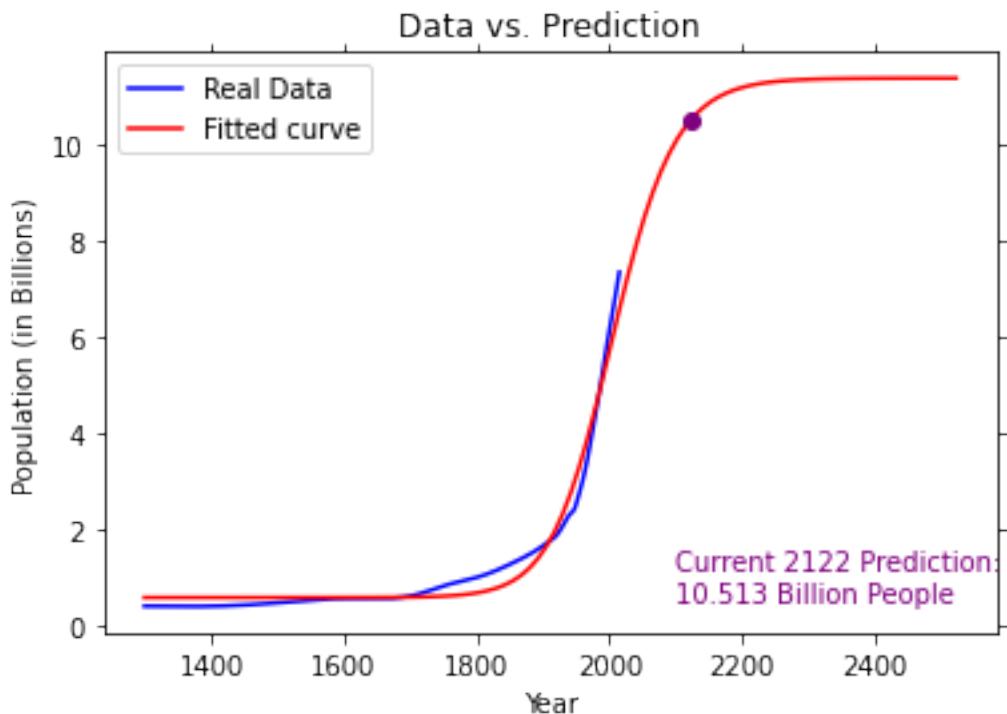
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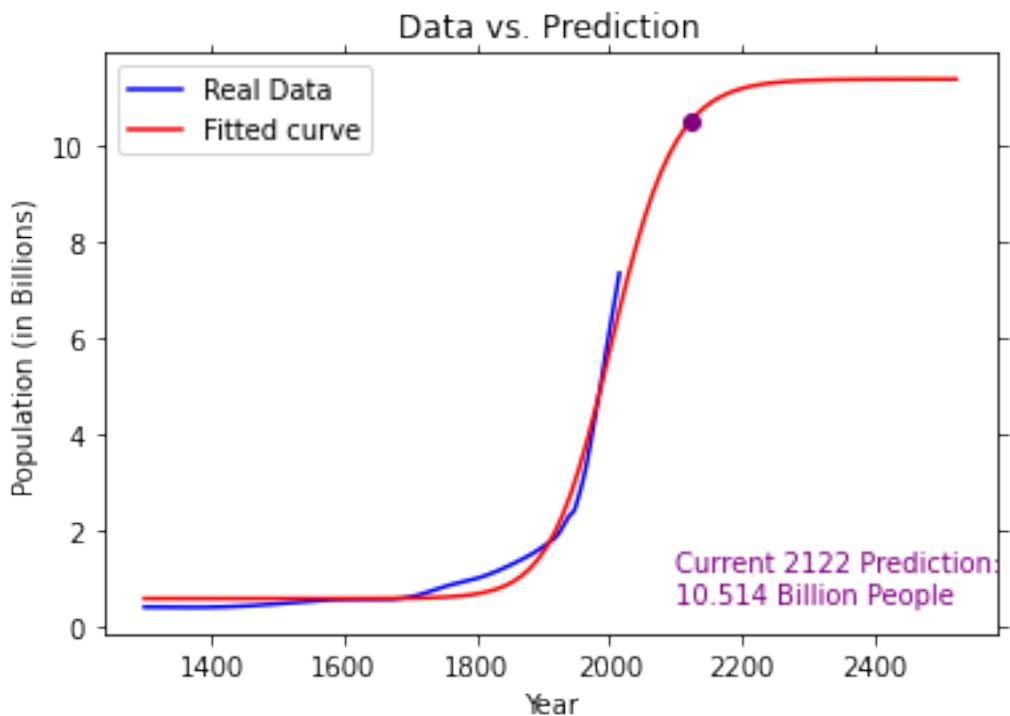
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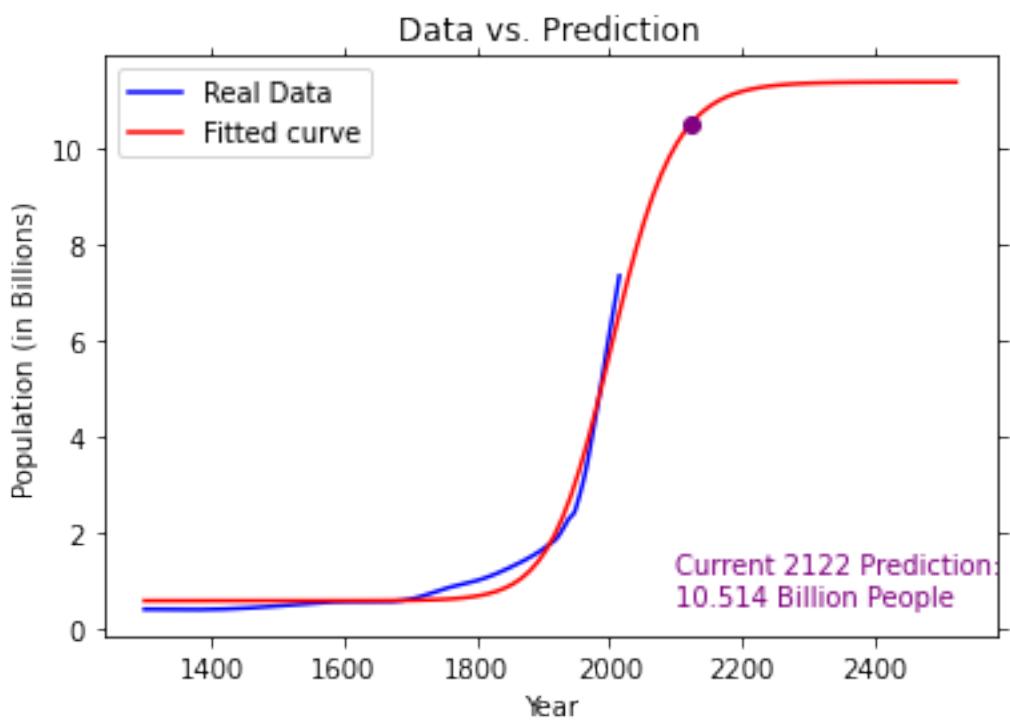
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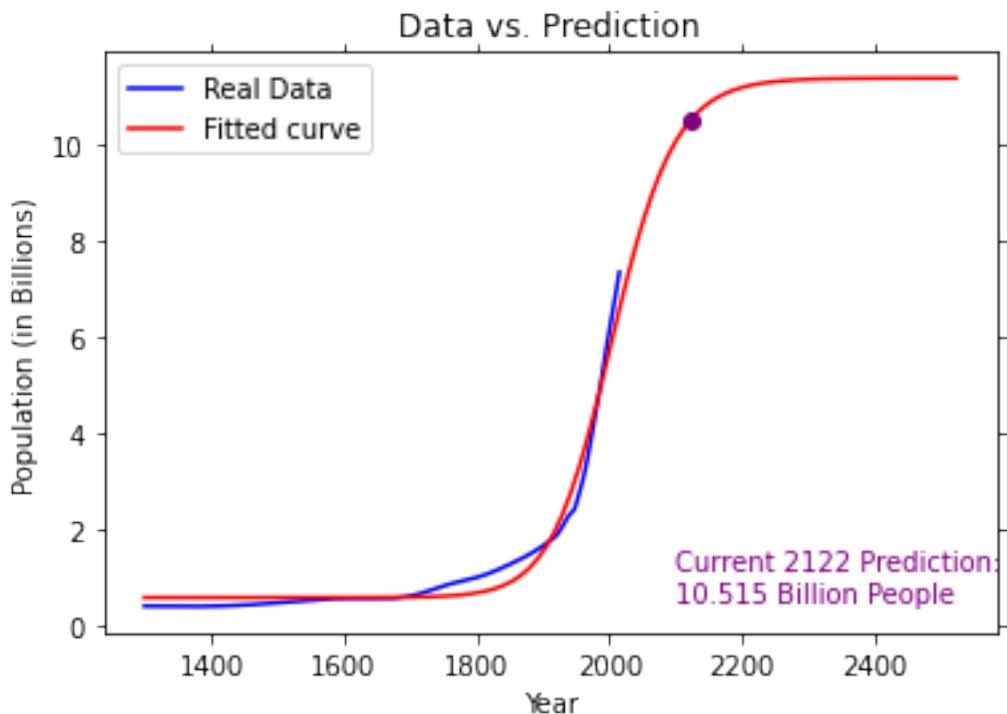
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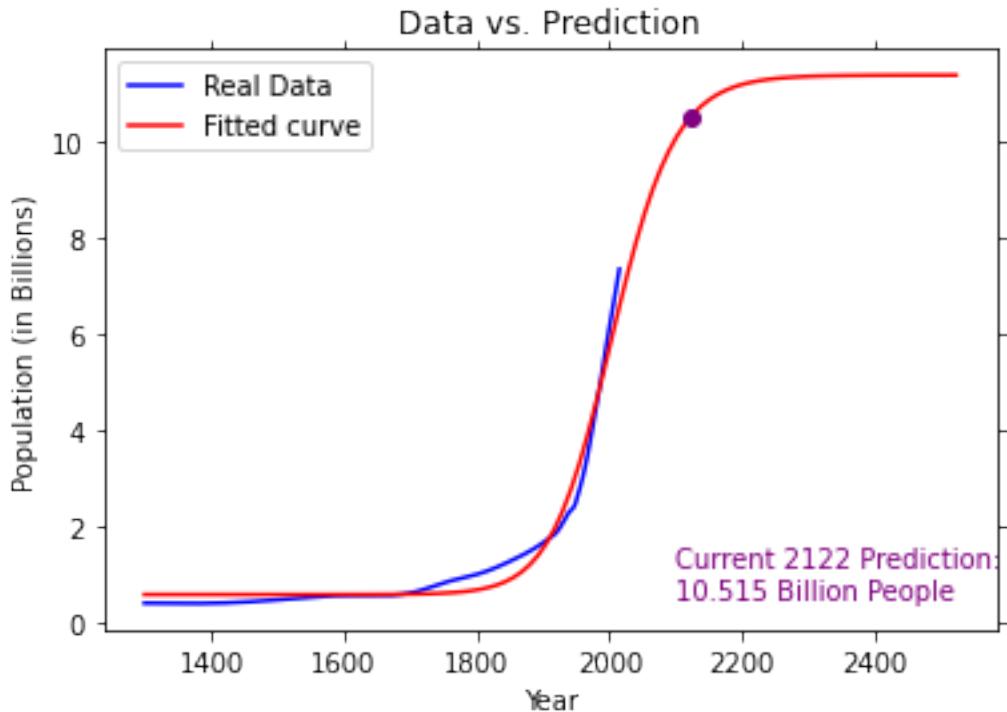
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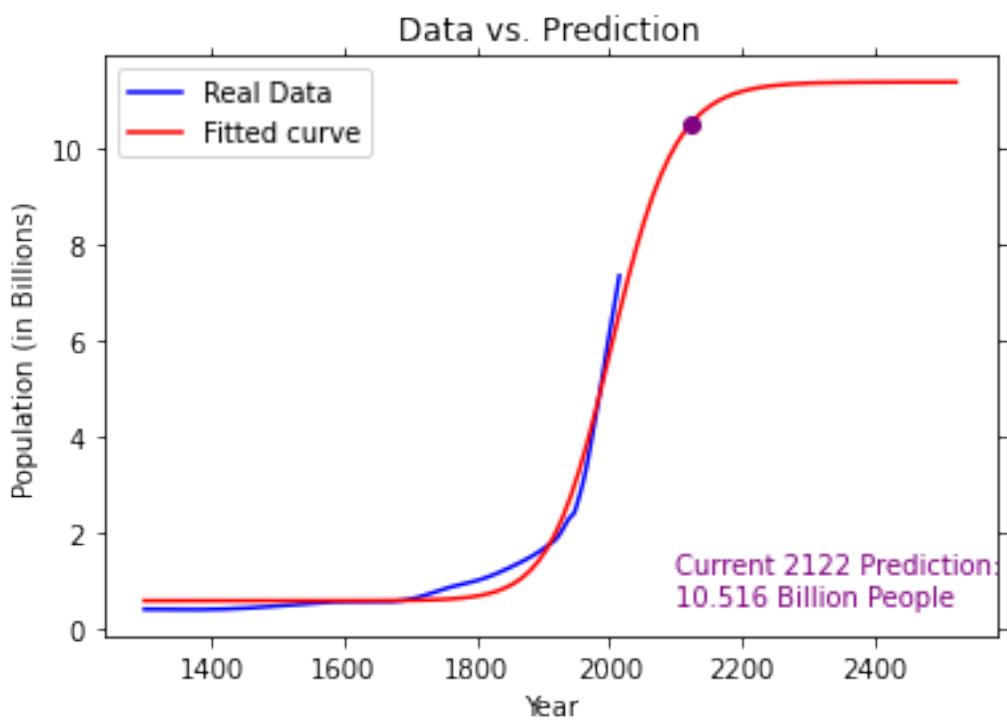
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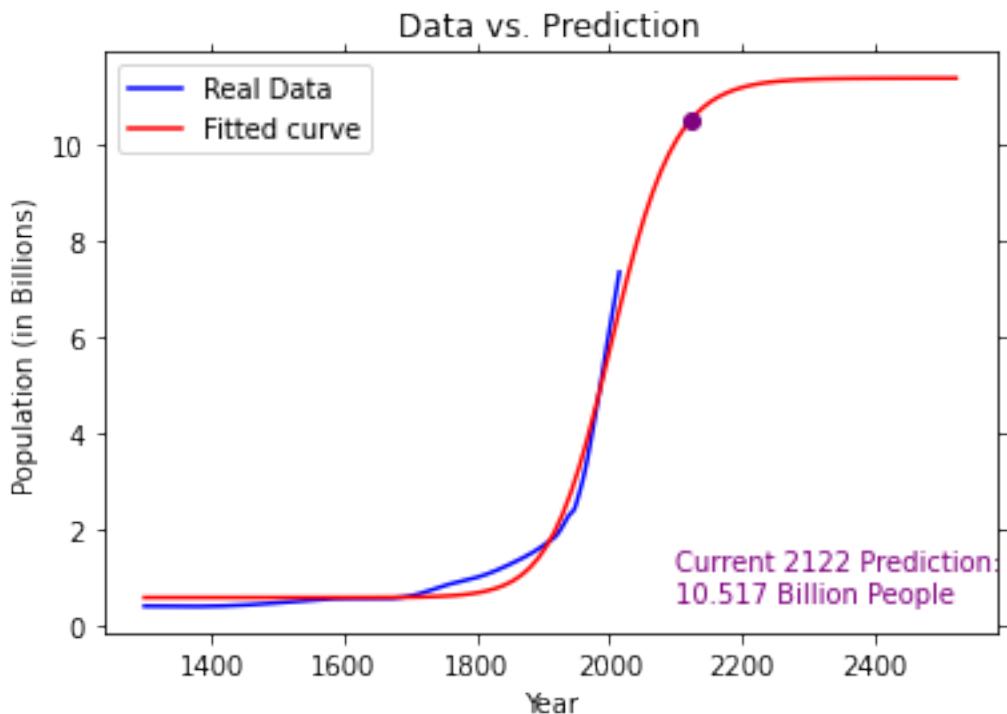
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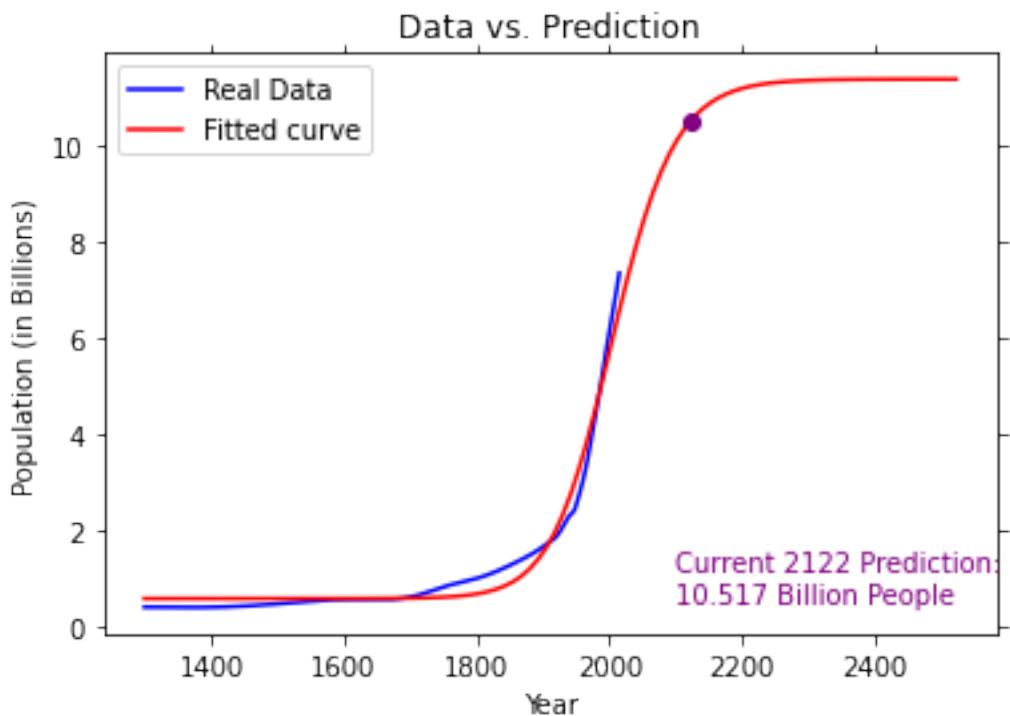
Iteration #14600, Loss: 0.054231028089566605



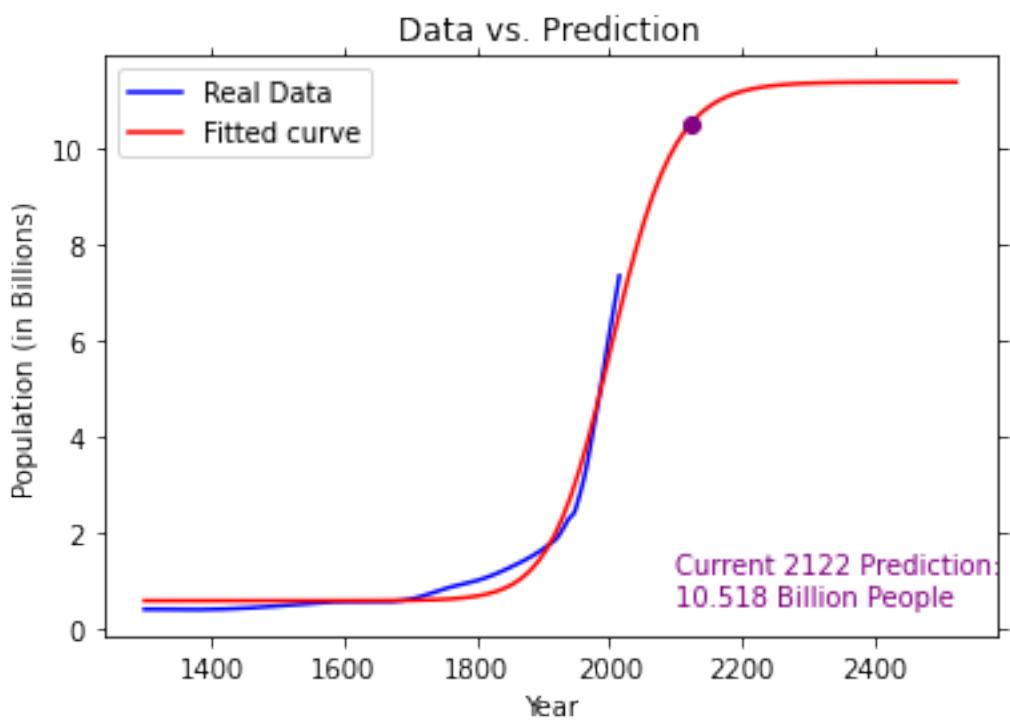
Iteration #14650, Loss: 0.054219149484578705



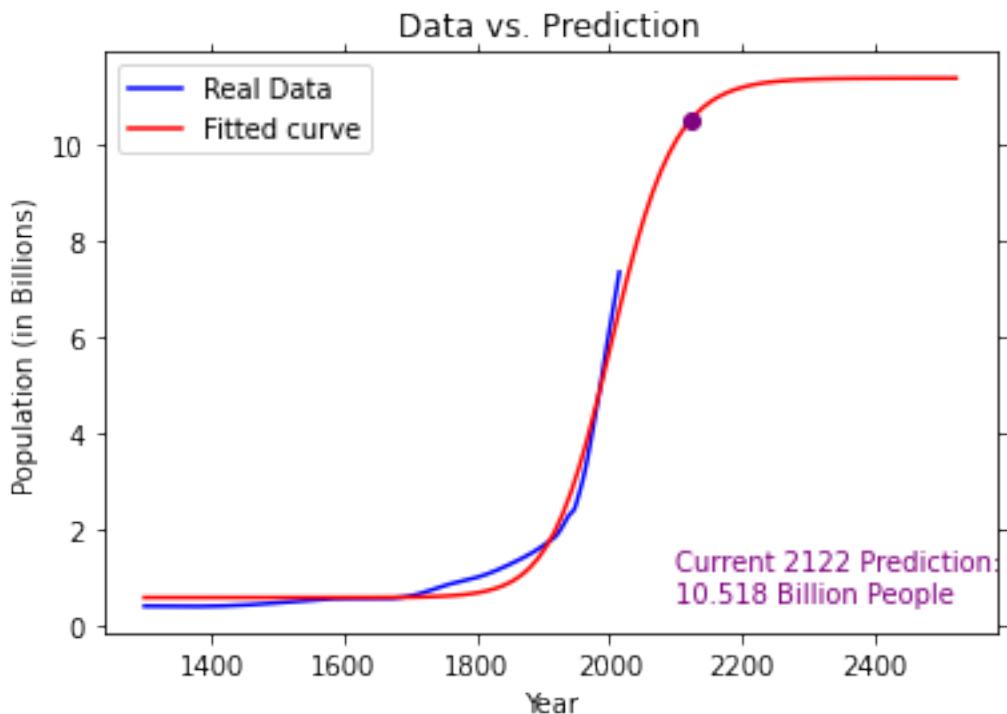
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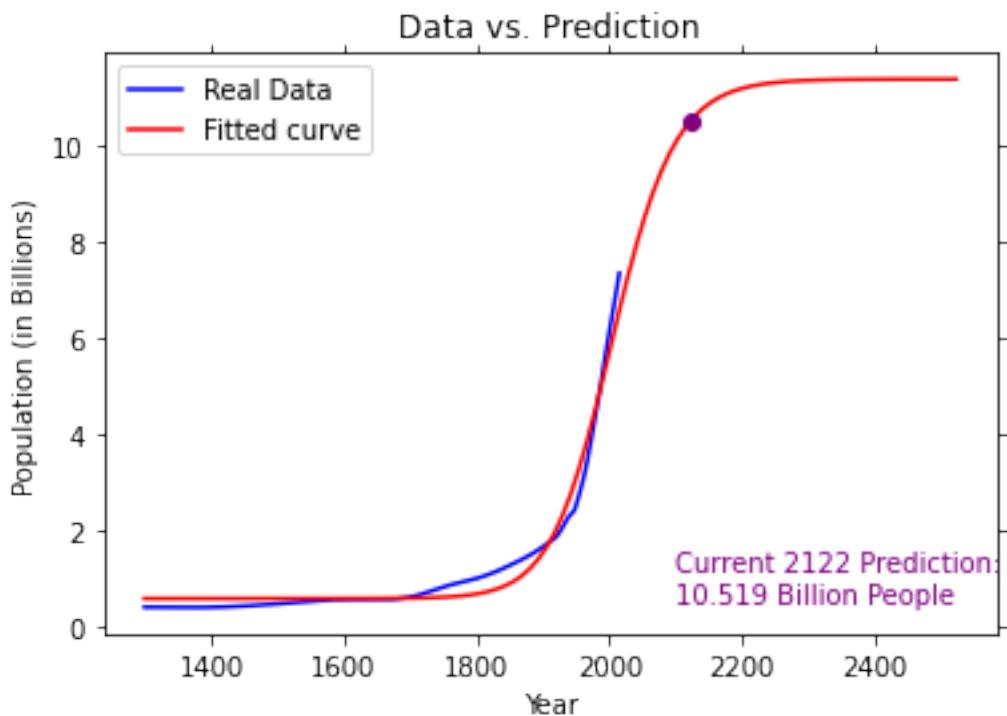
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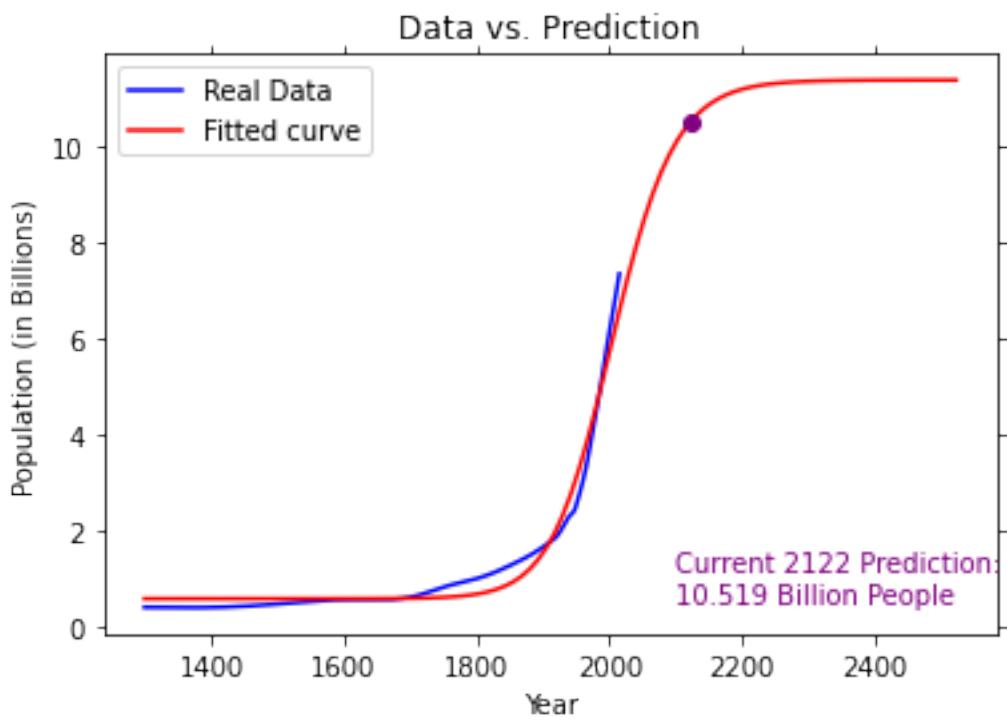
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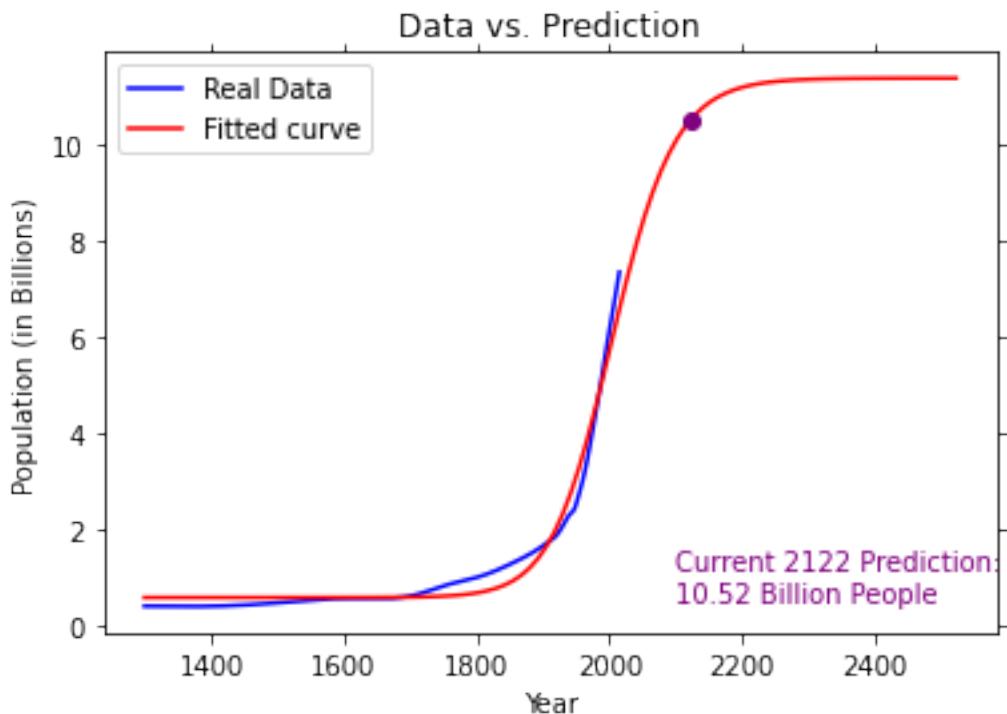
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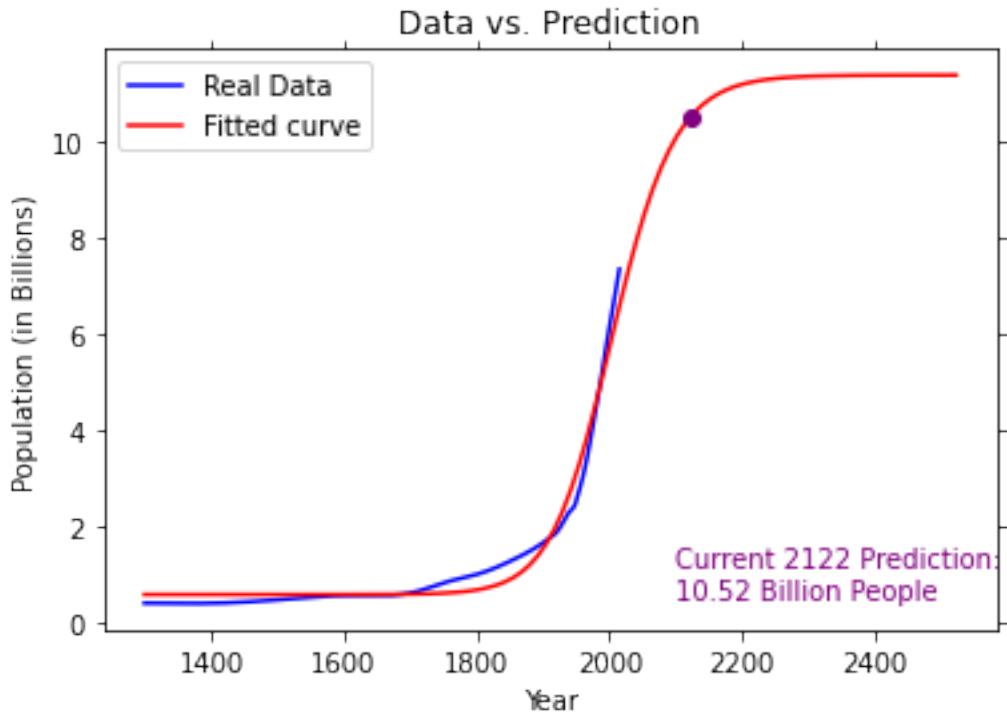
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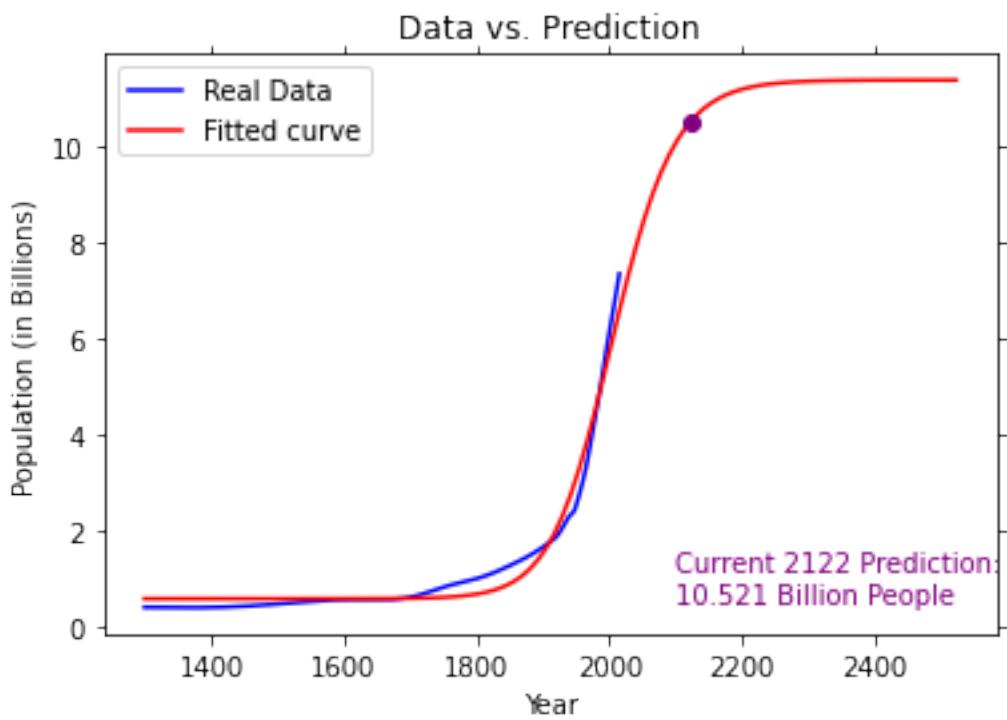
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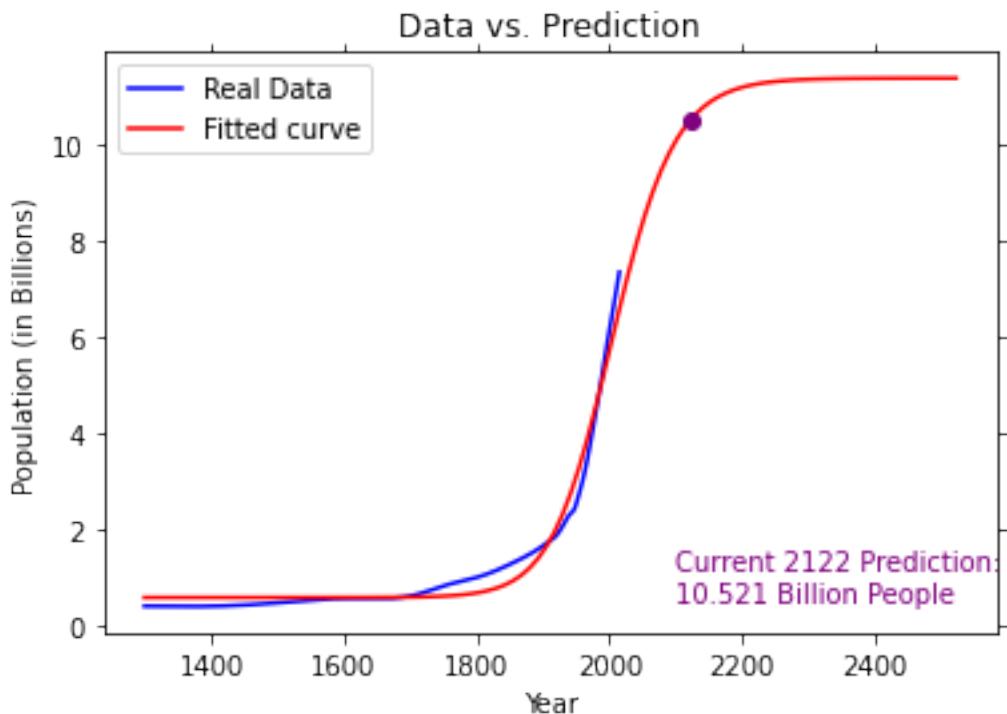
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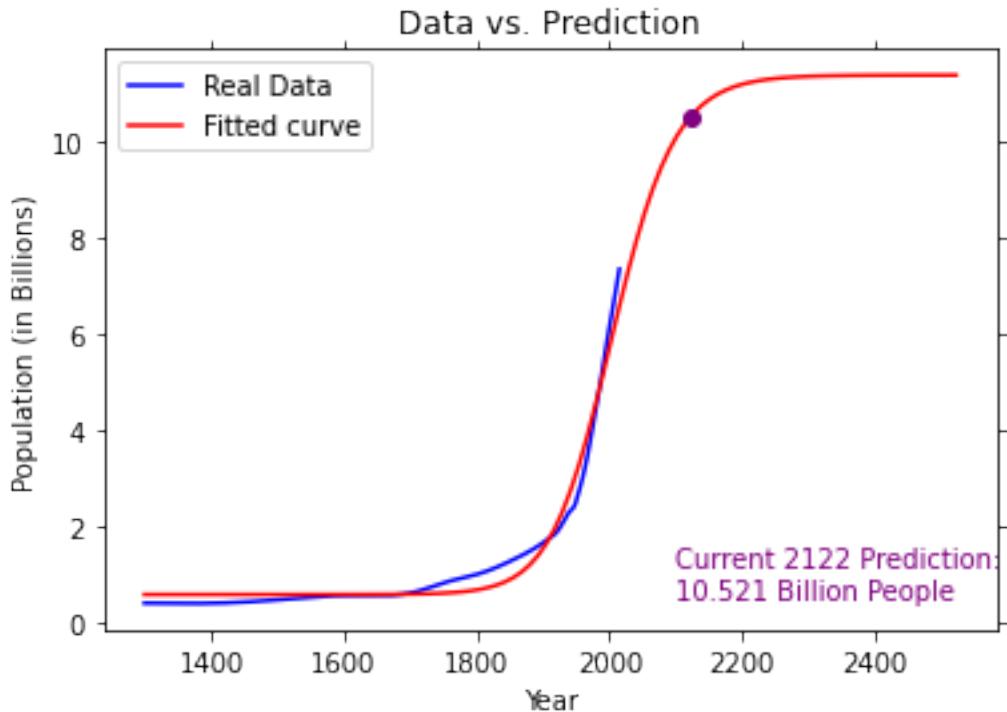
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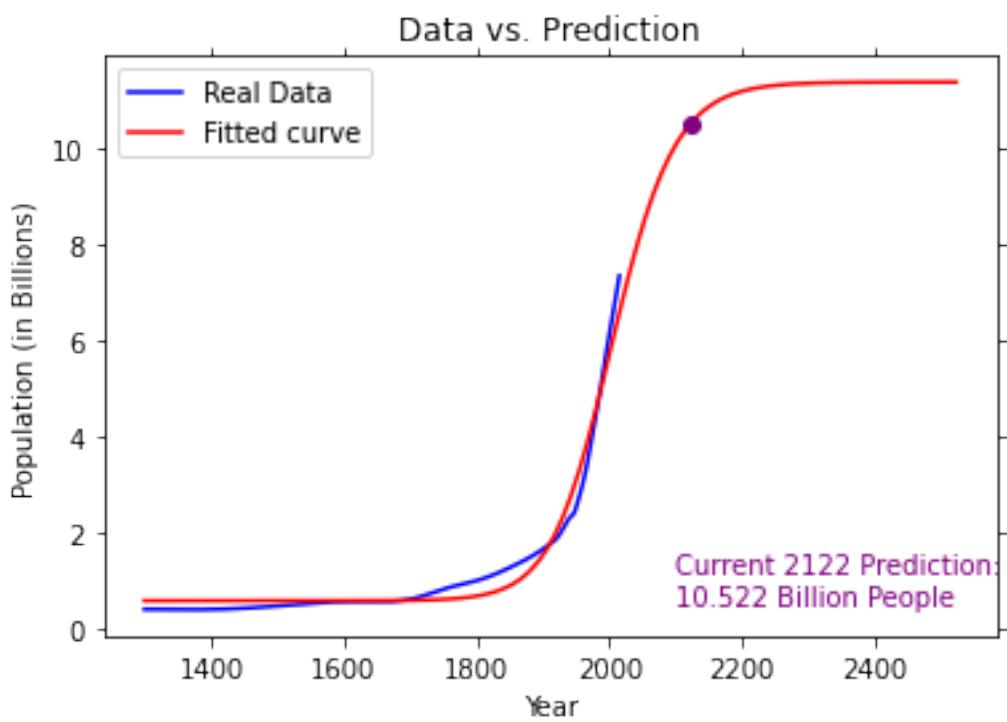
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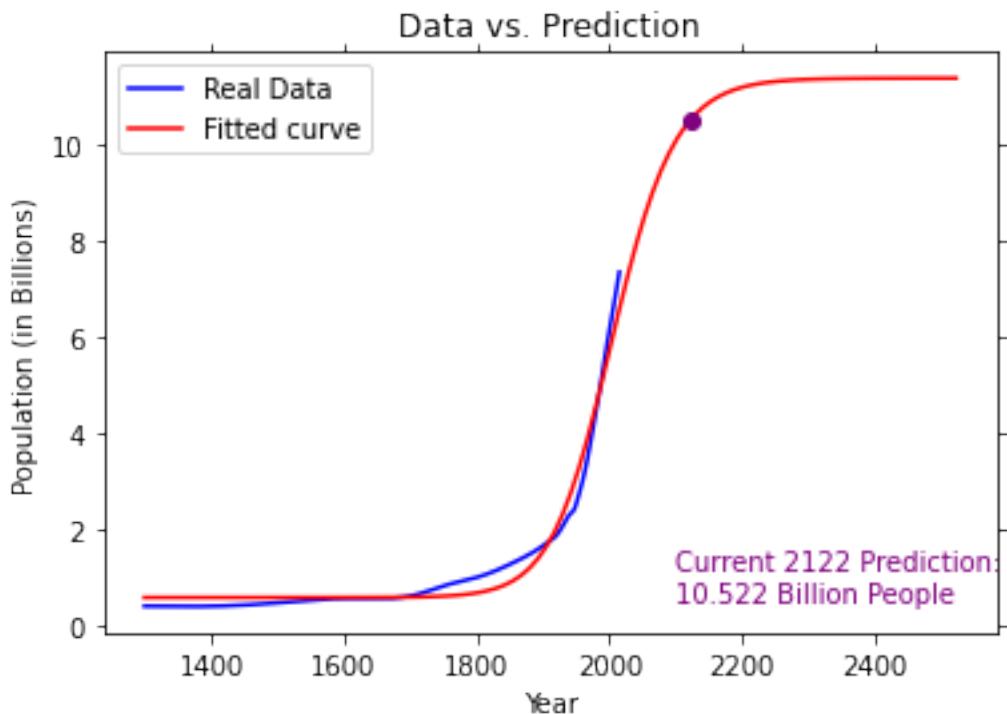
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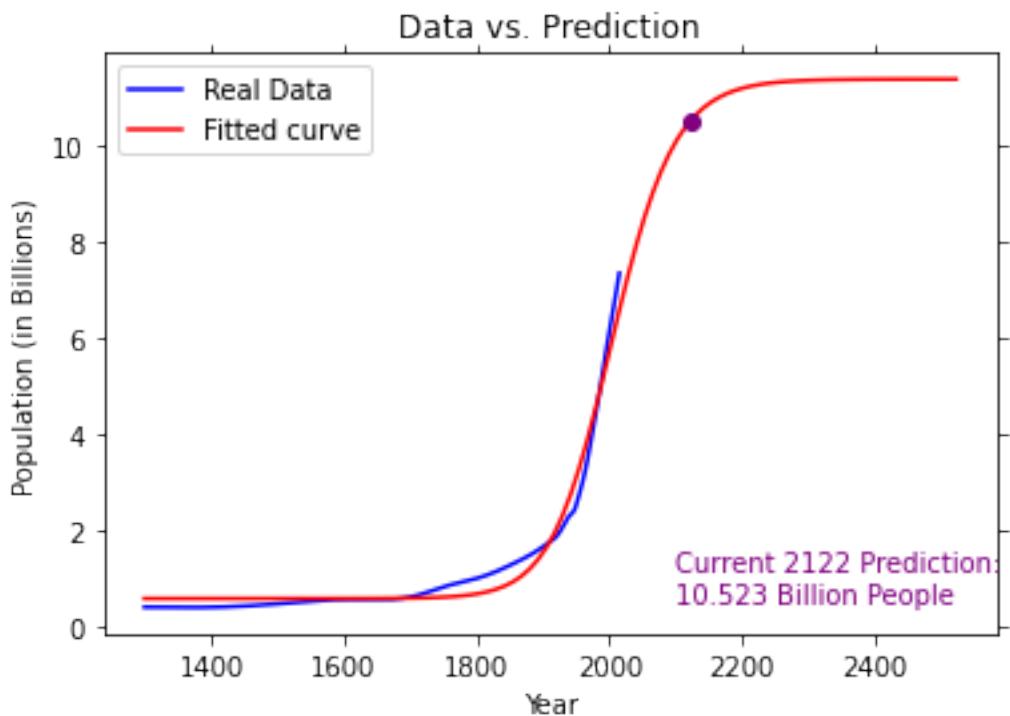
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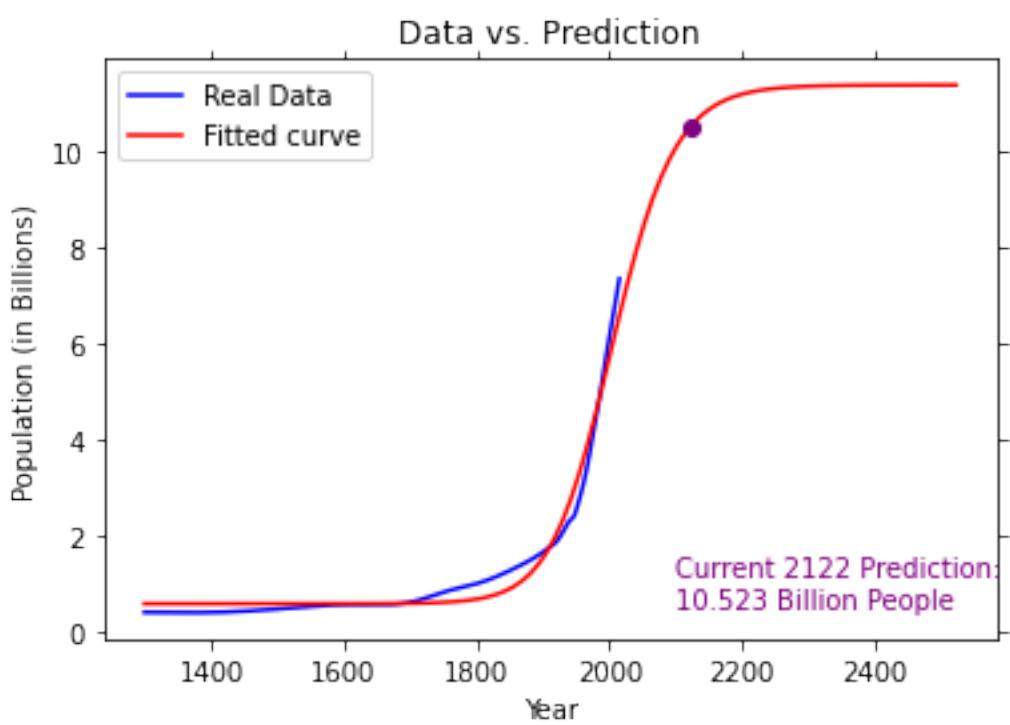
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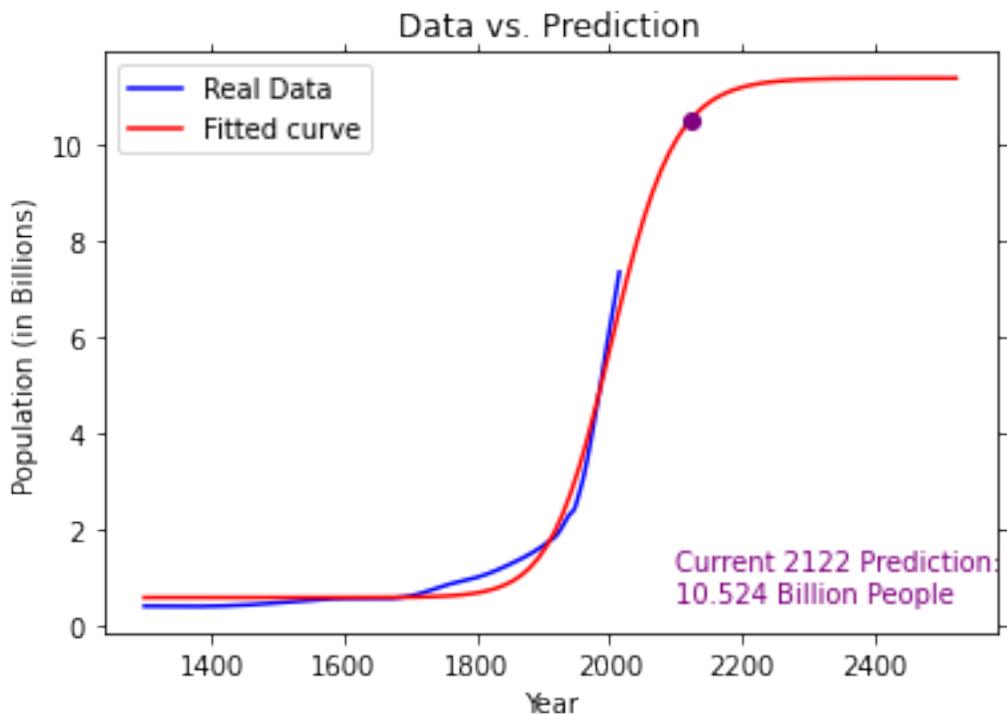
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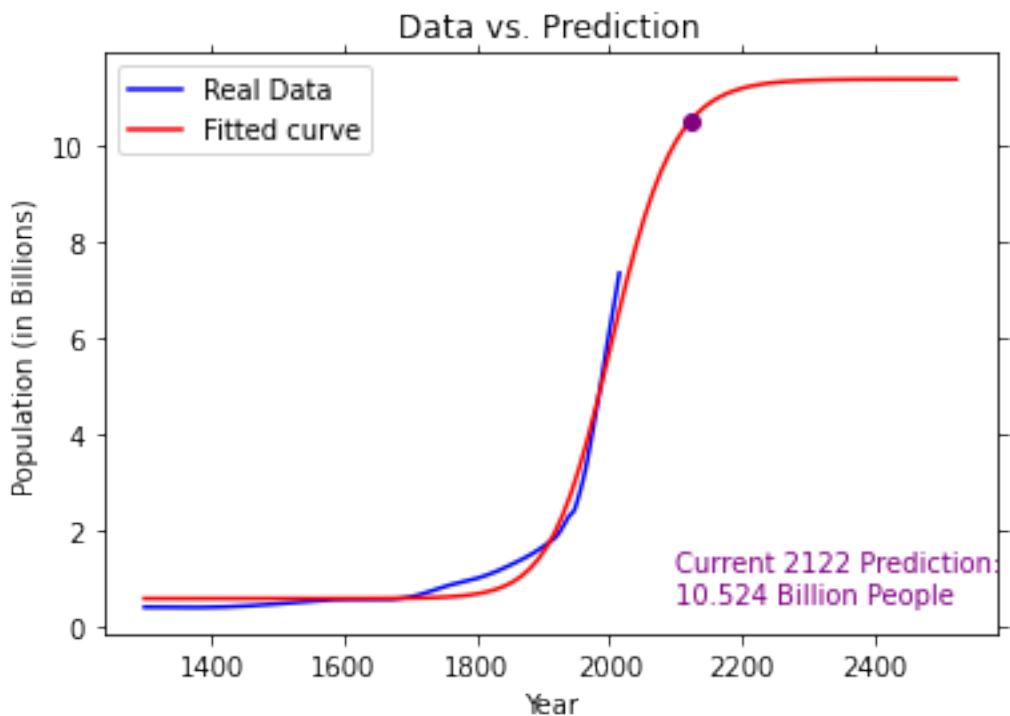
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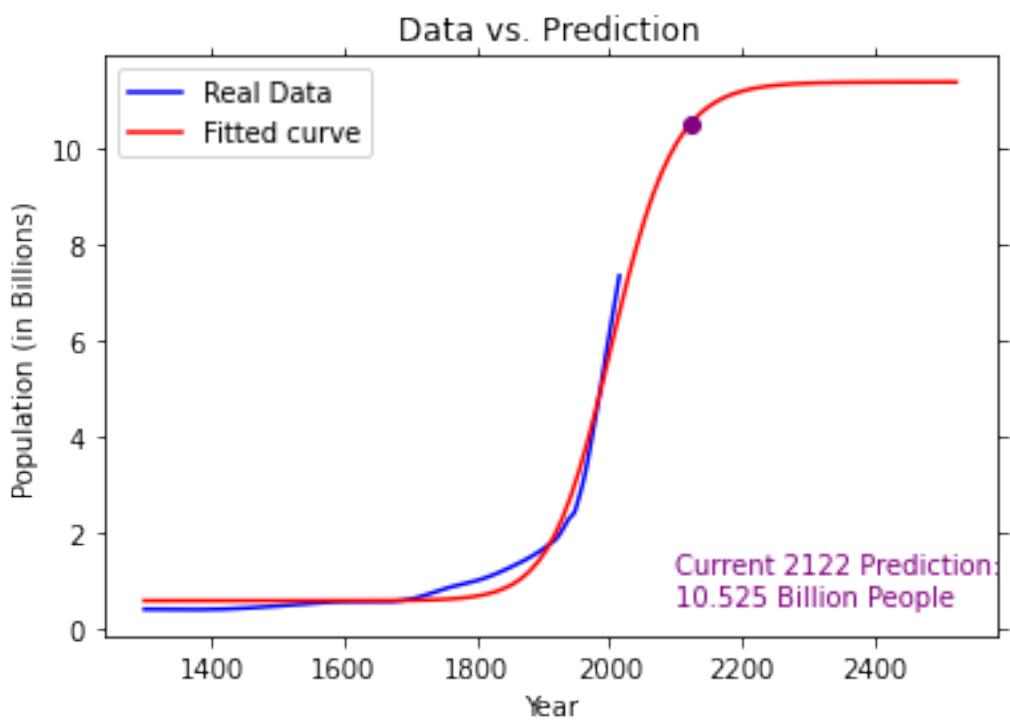
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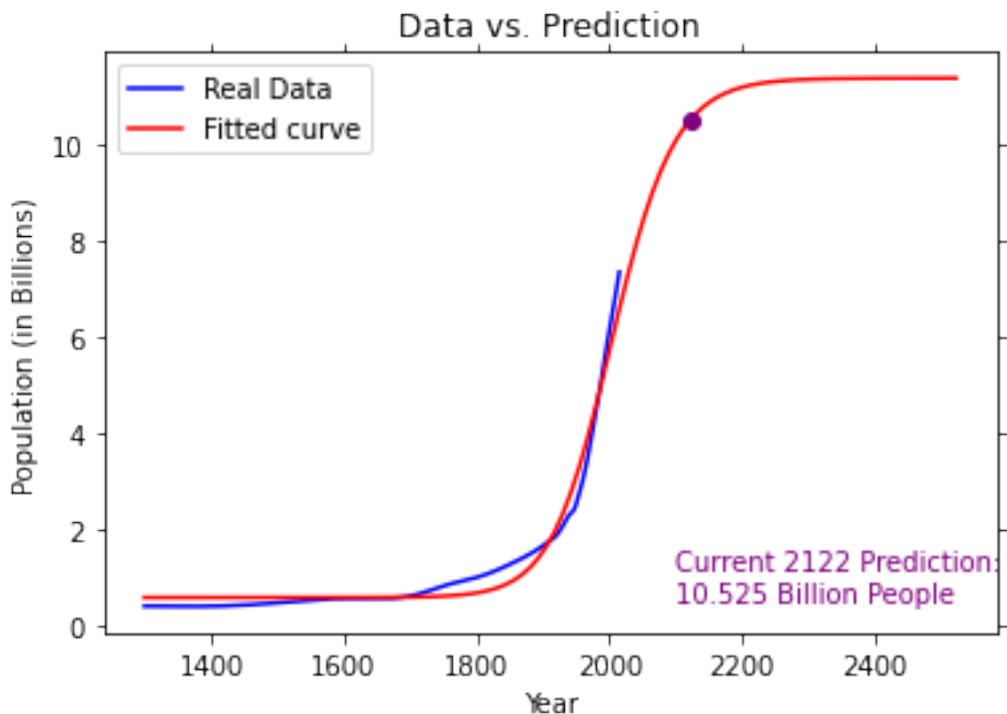
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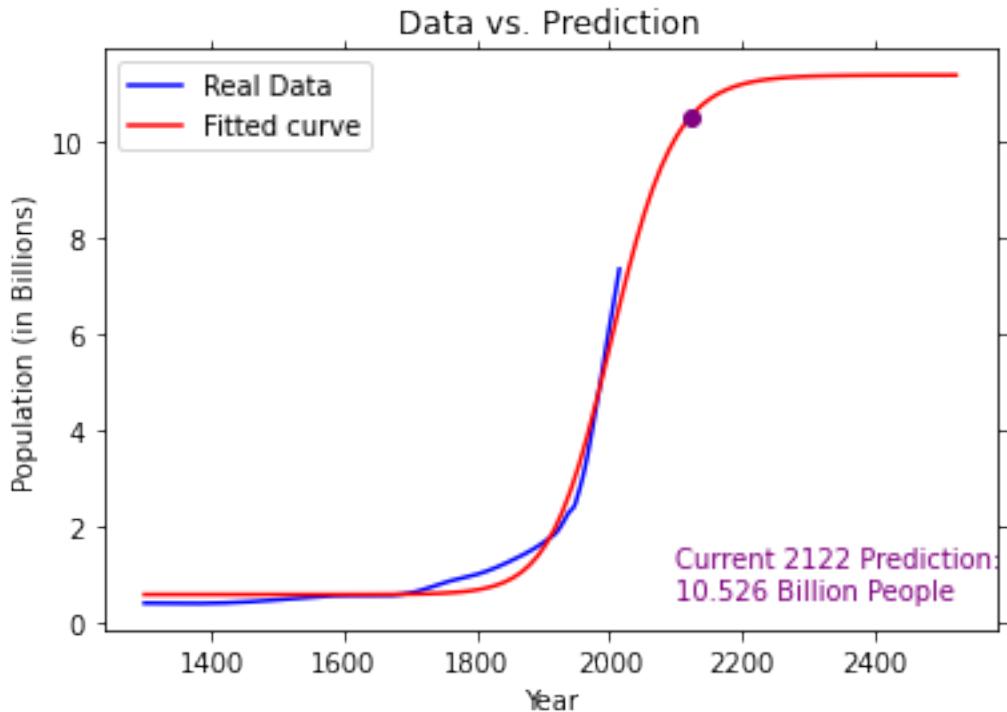
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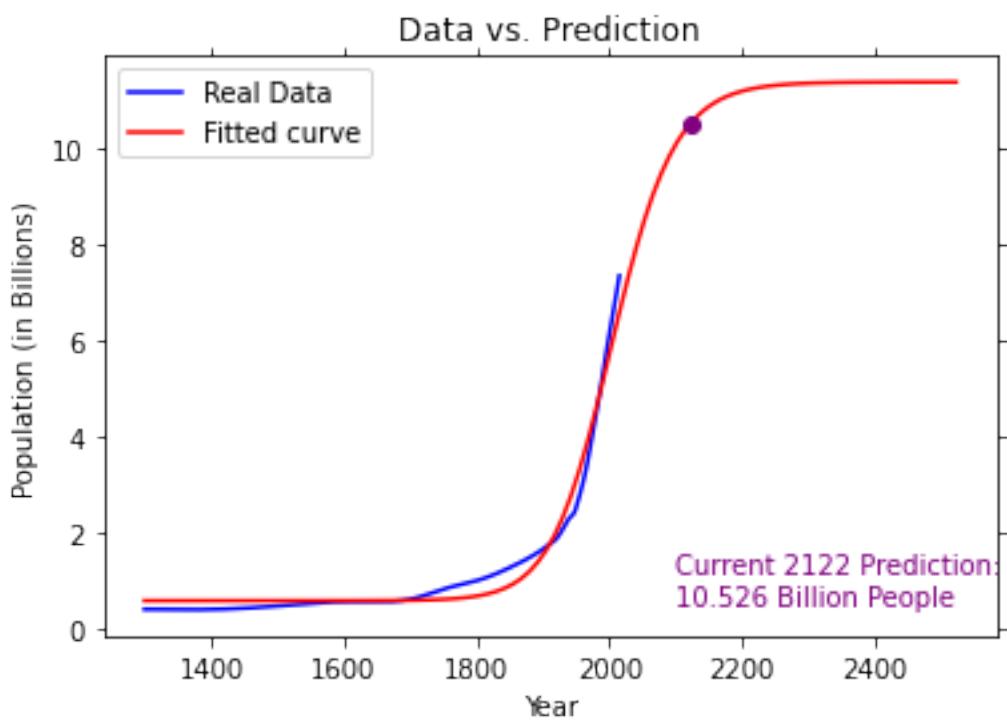
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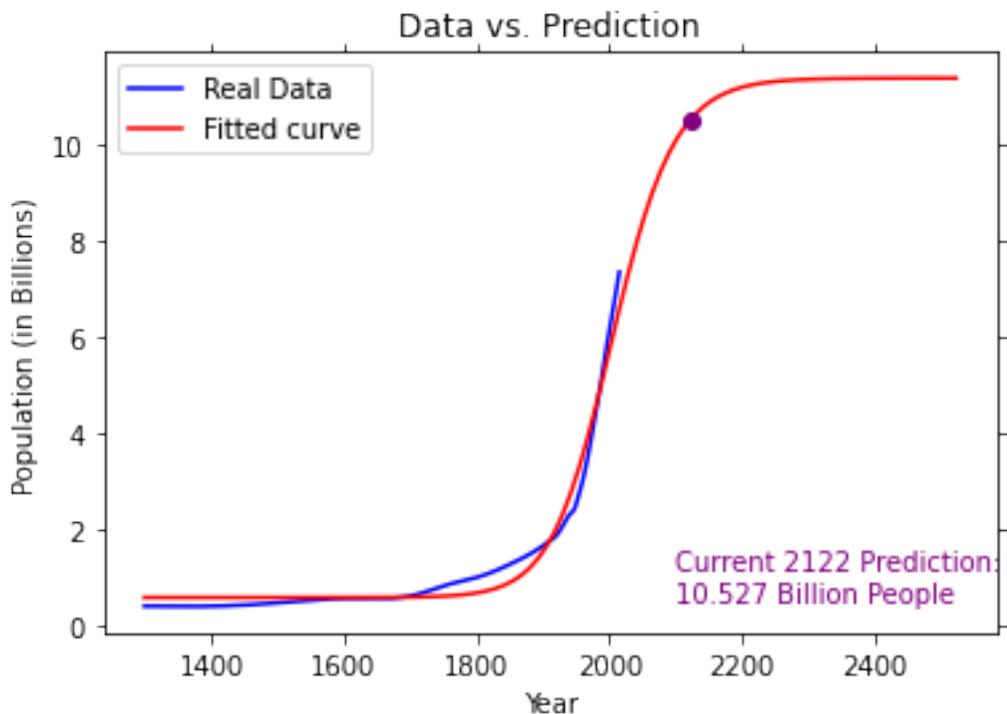
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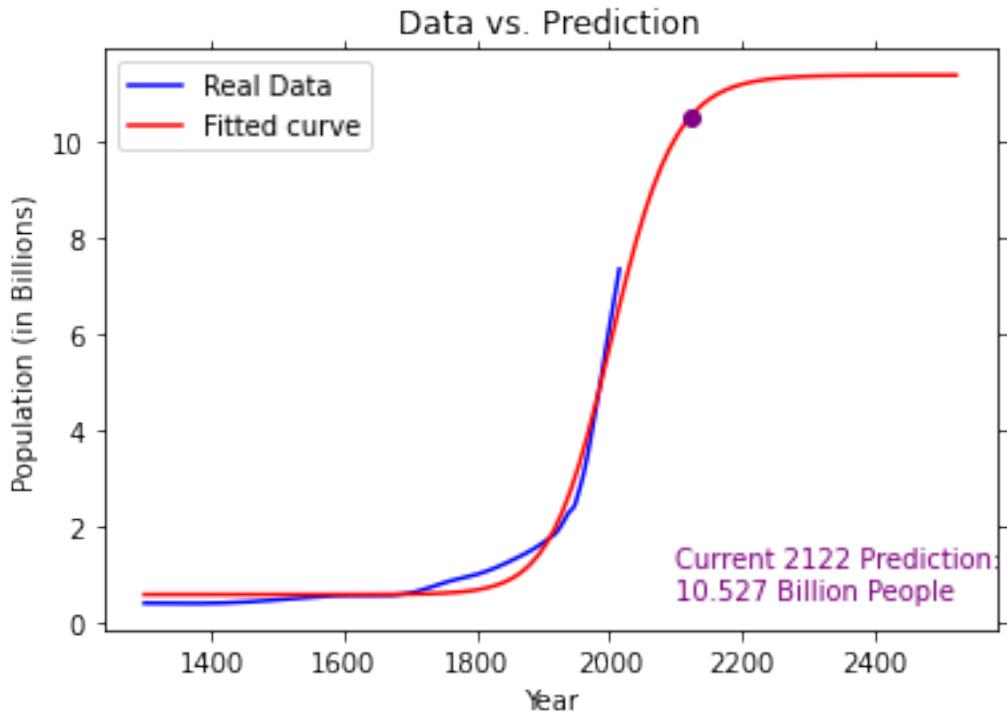
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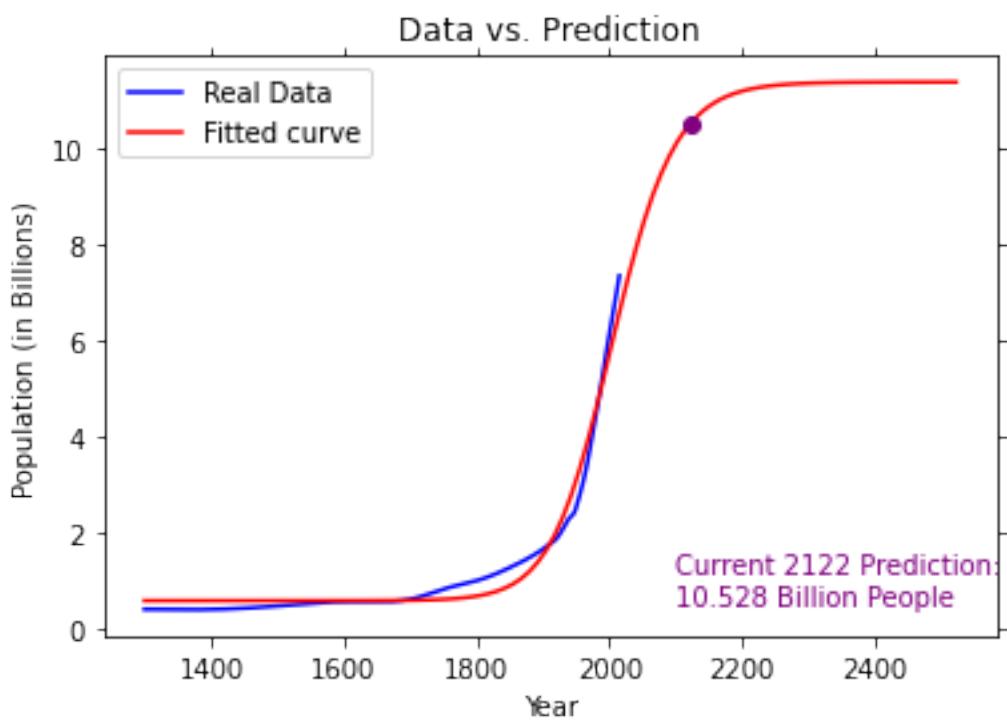
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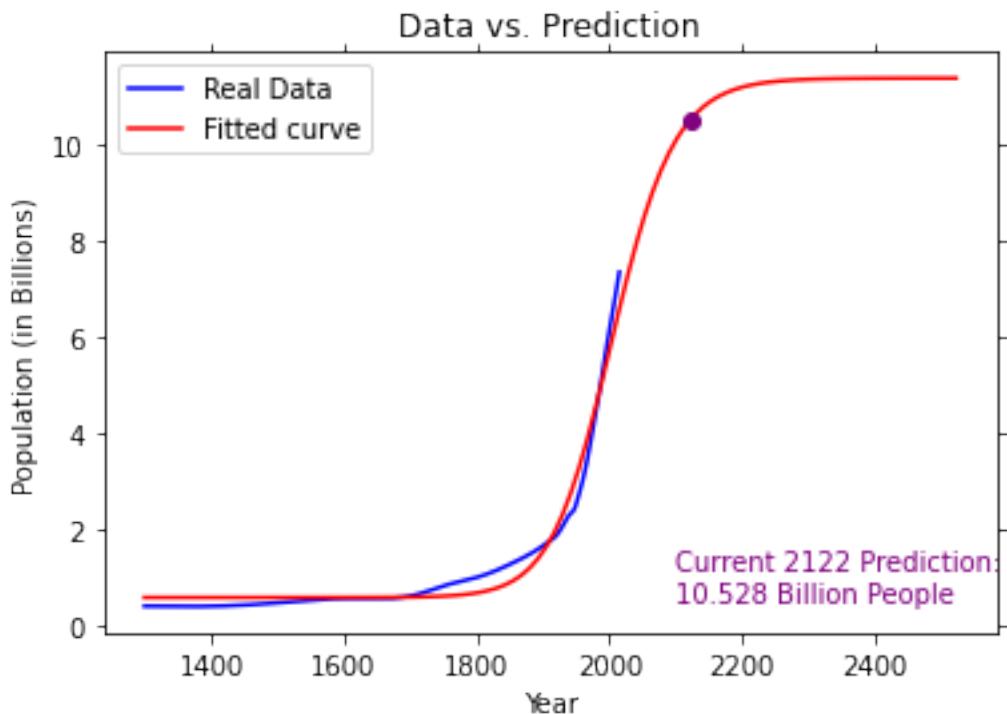
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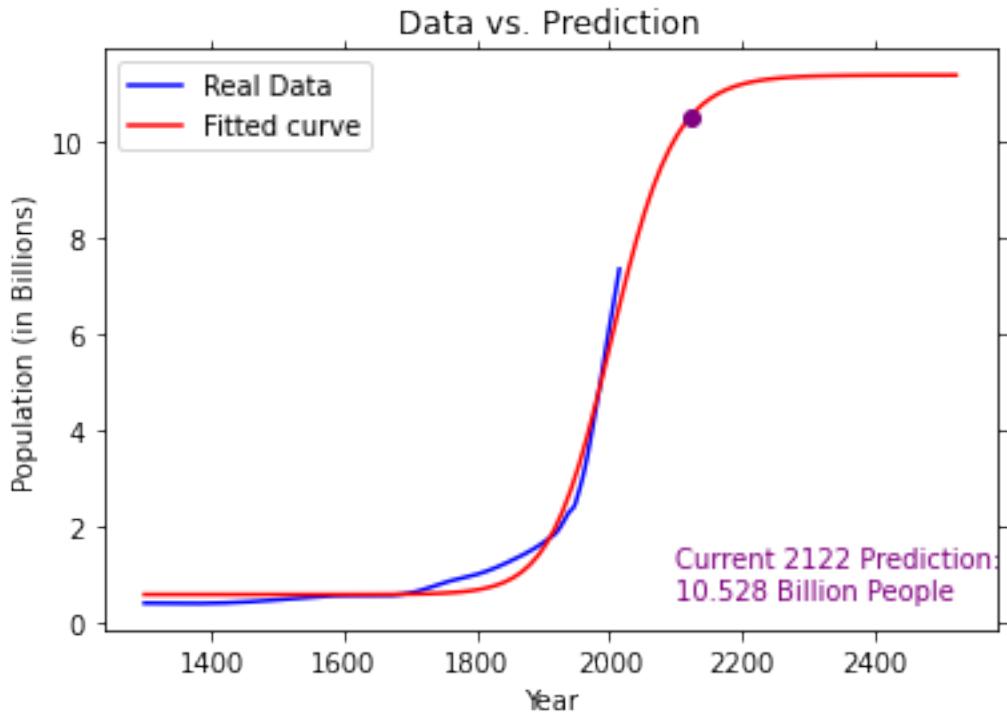
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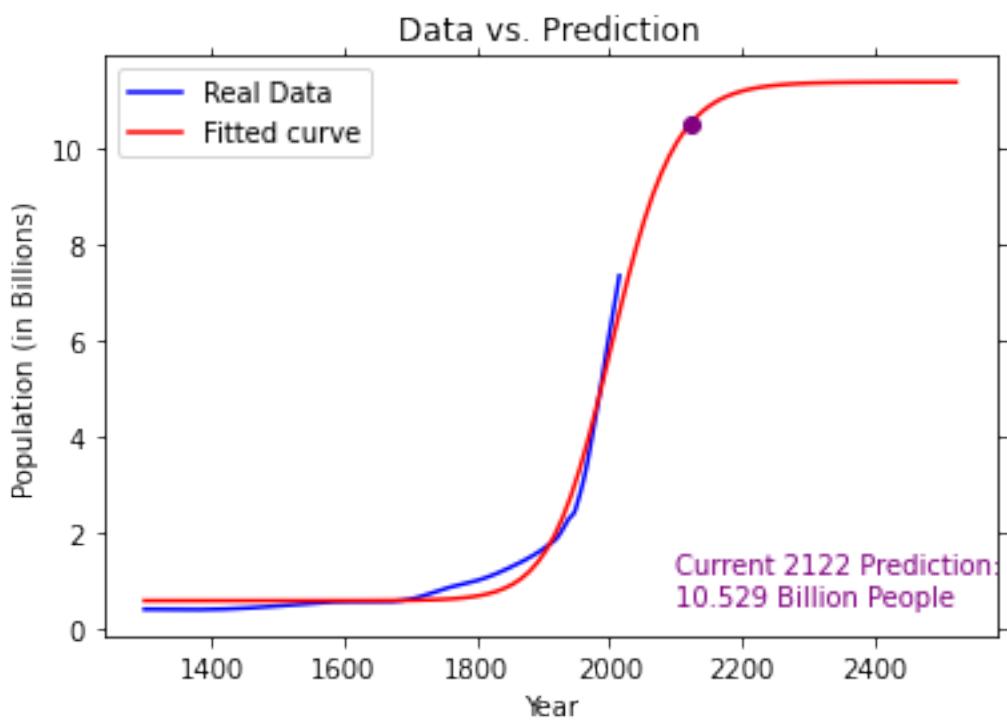
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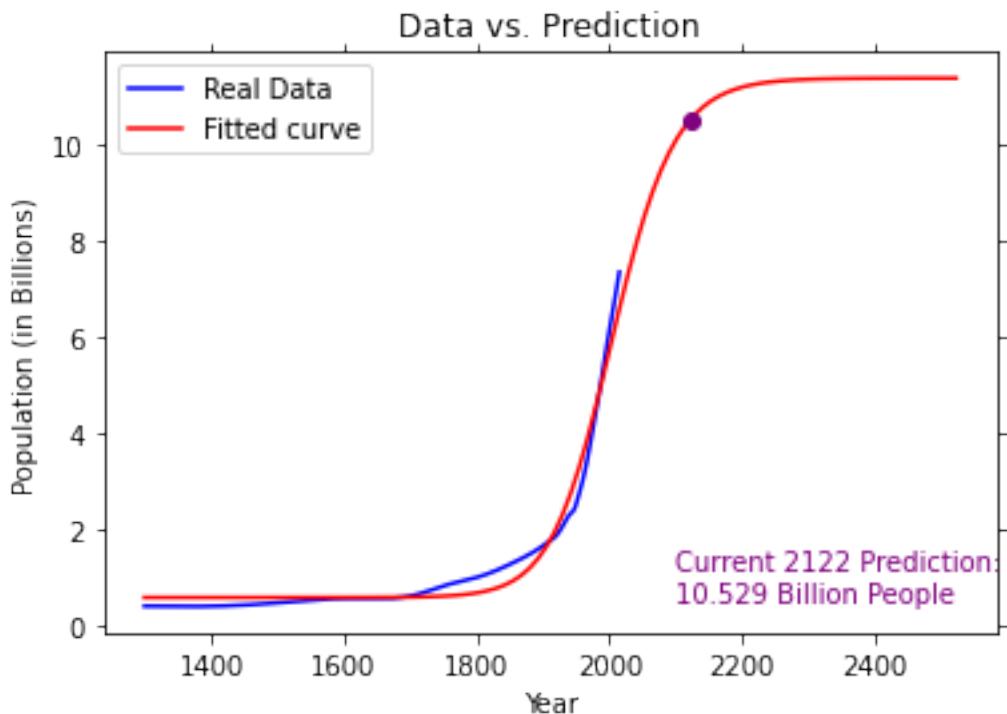
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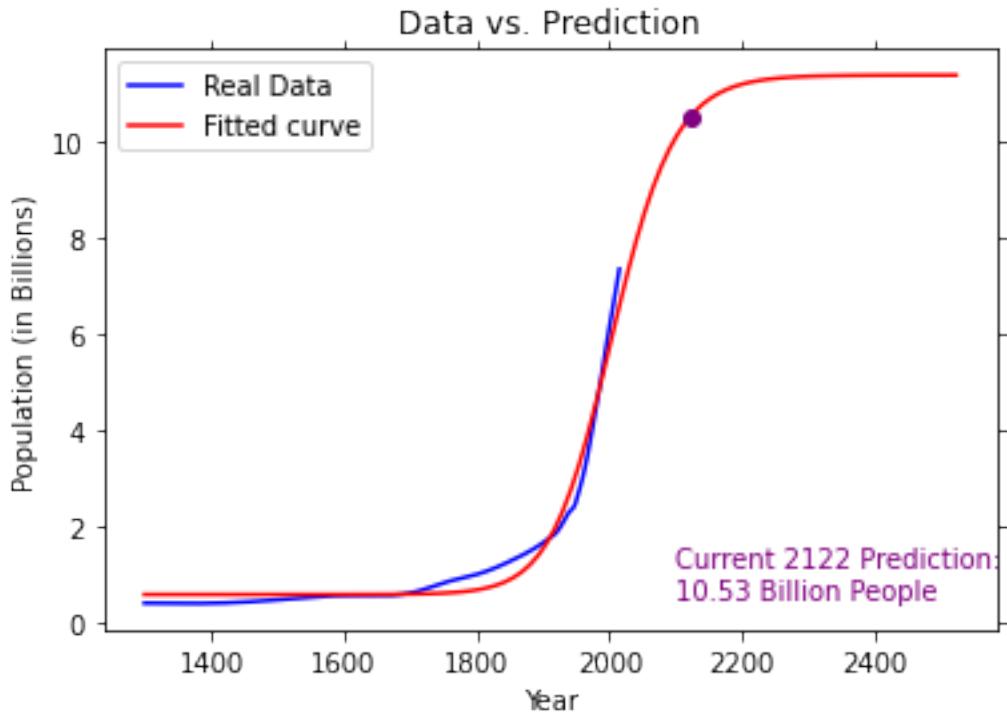
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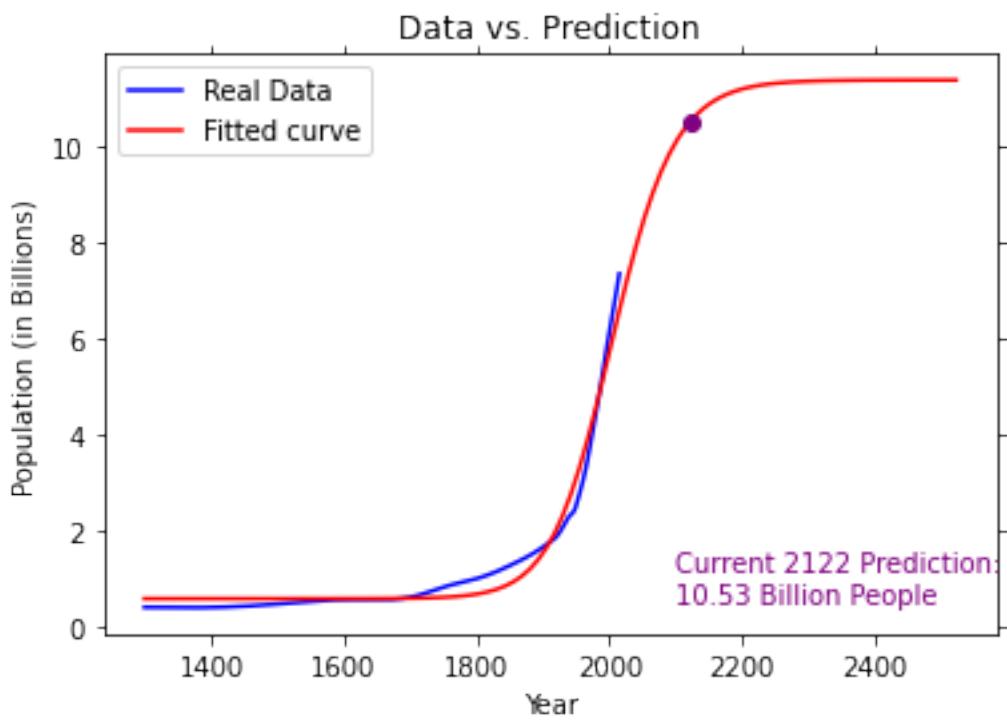
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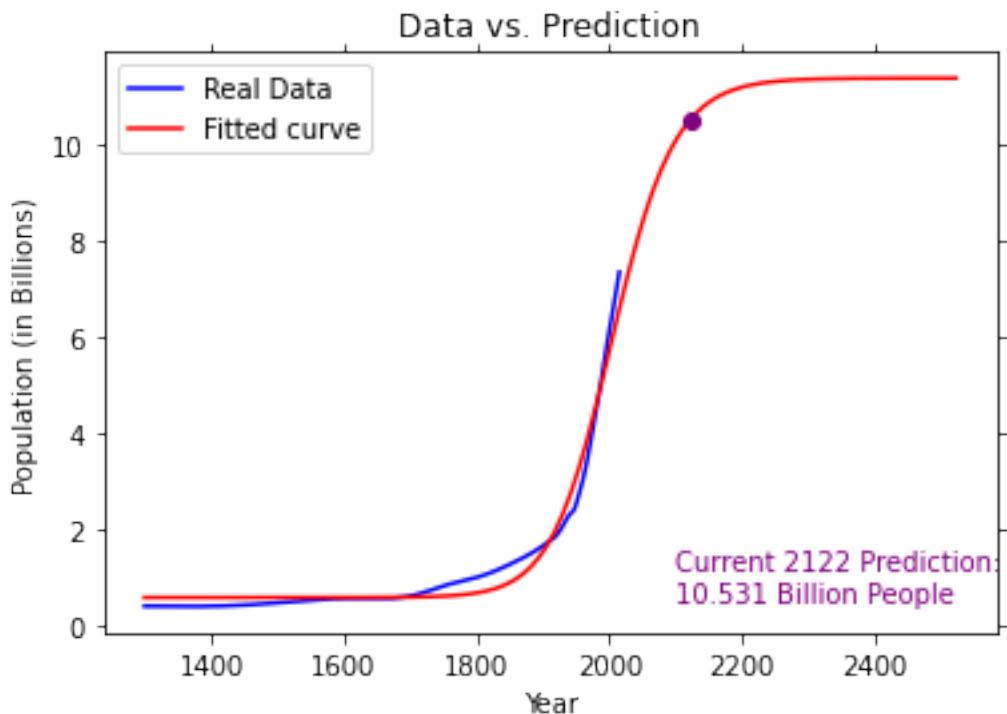
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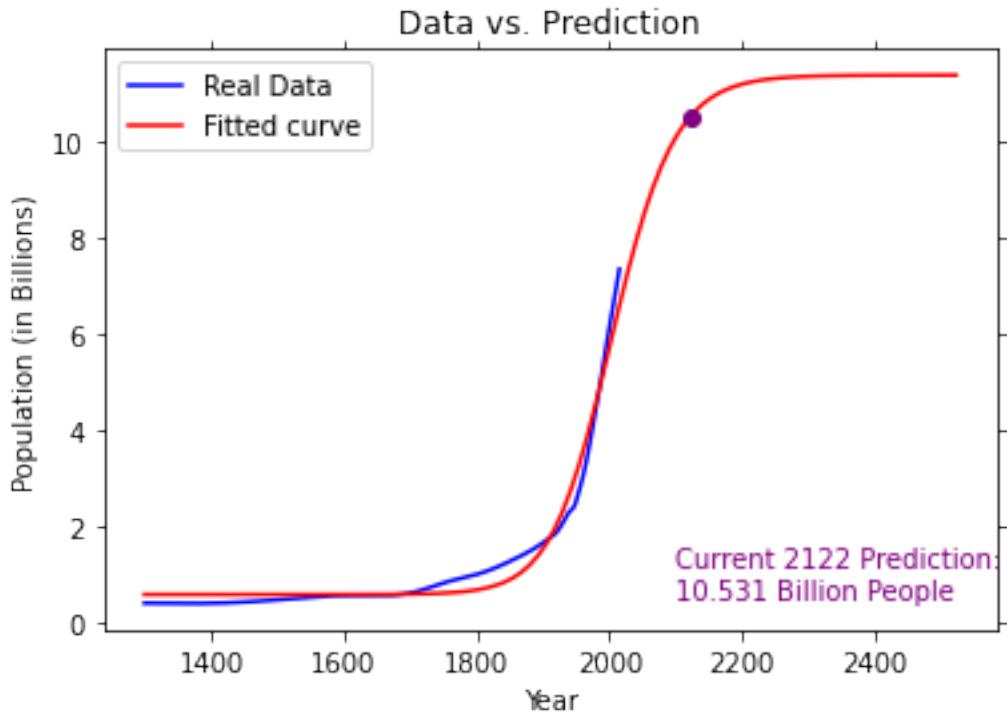
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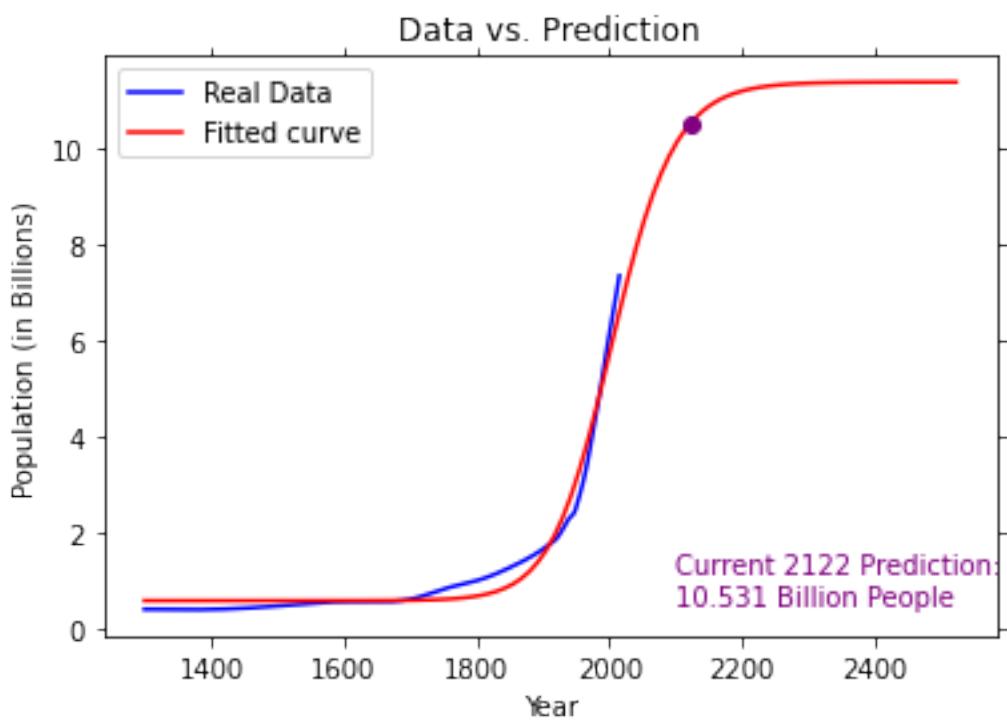
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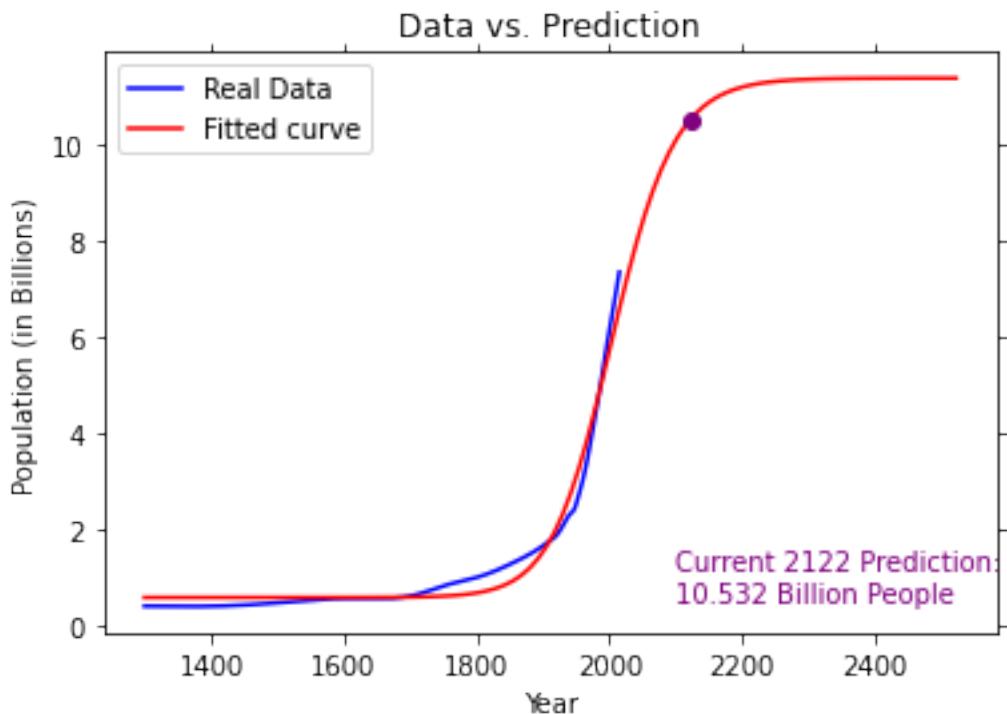
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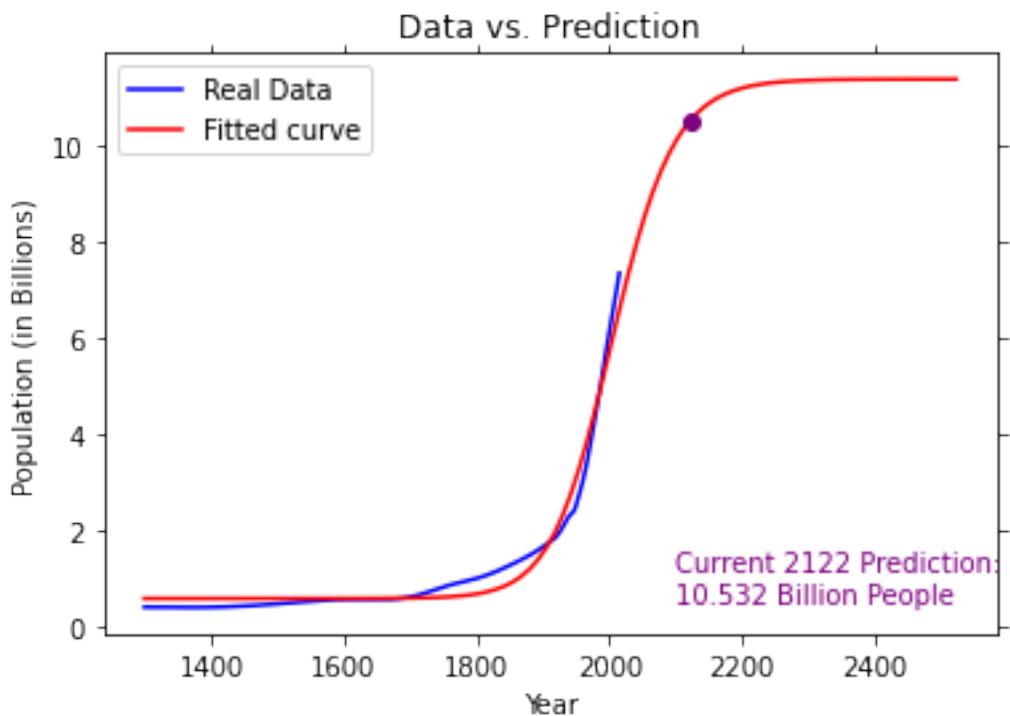
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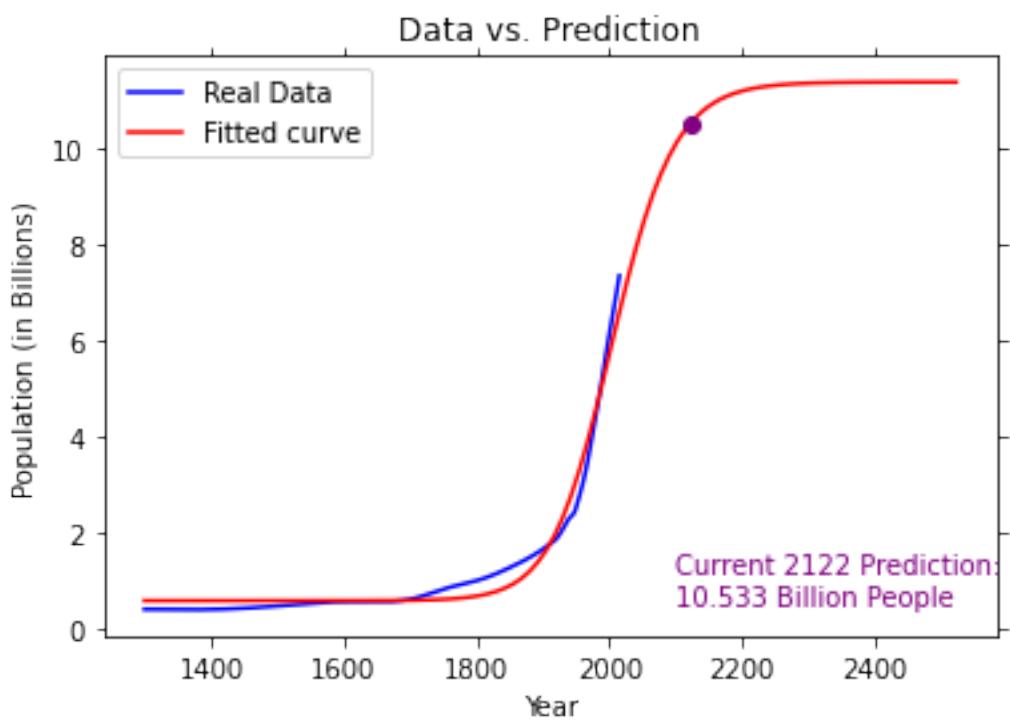
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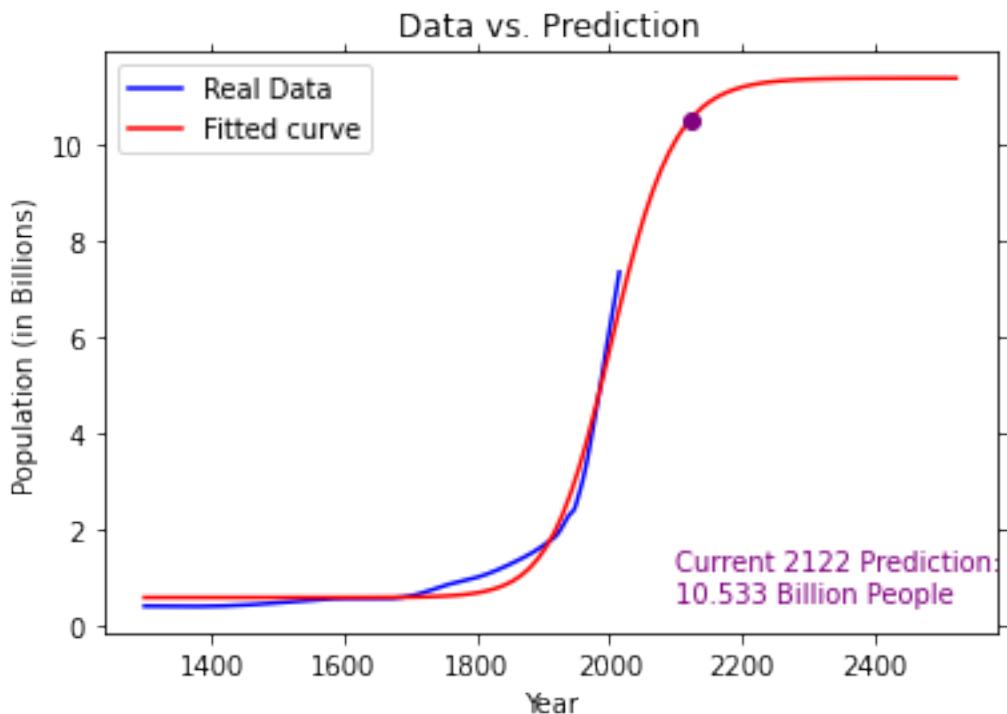
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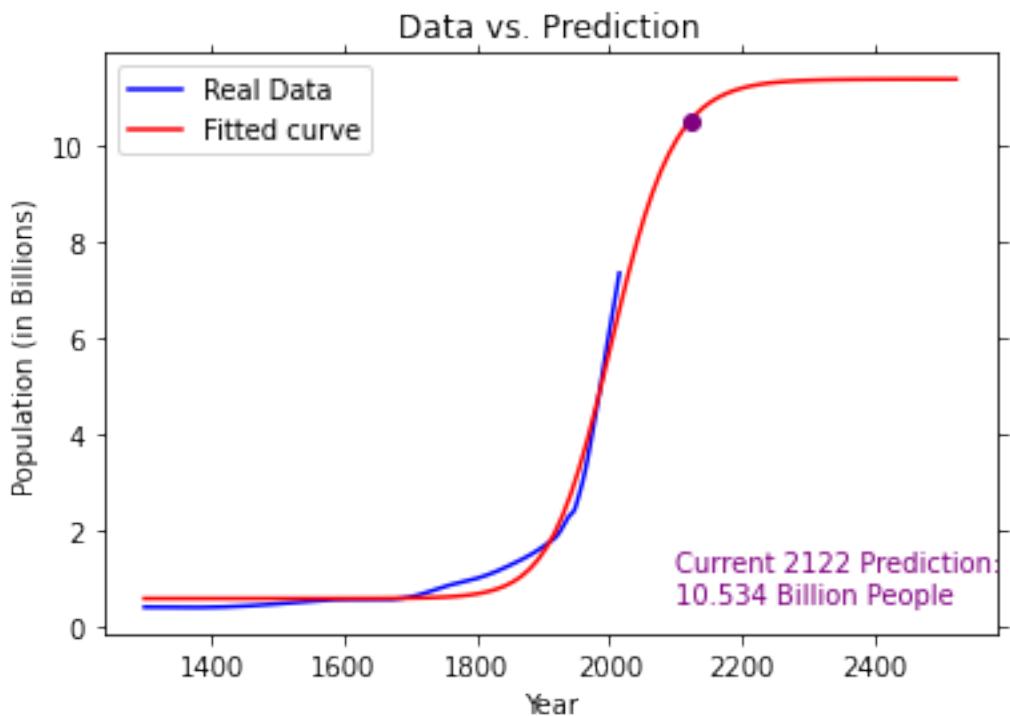
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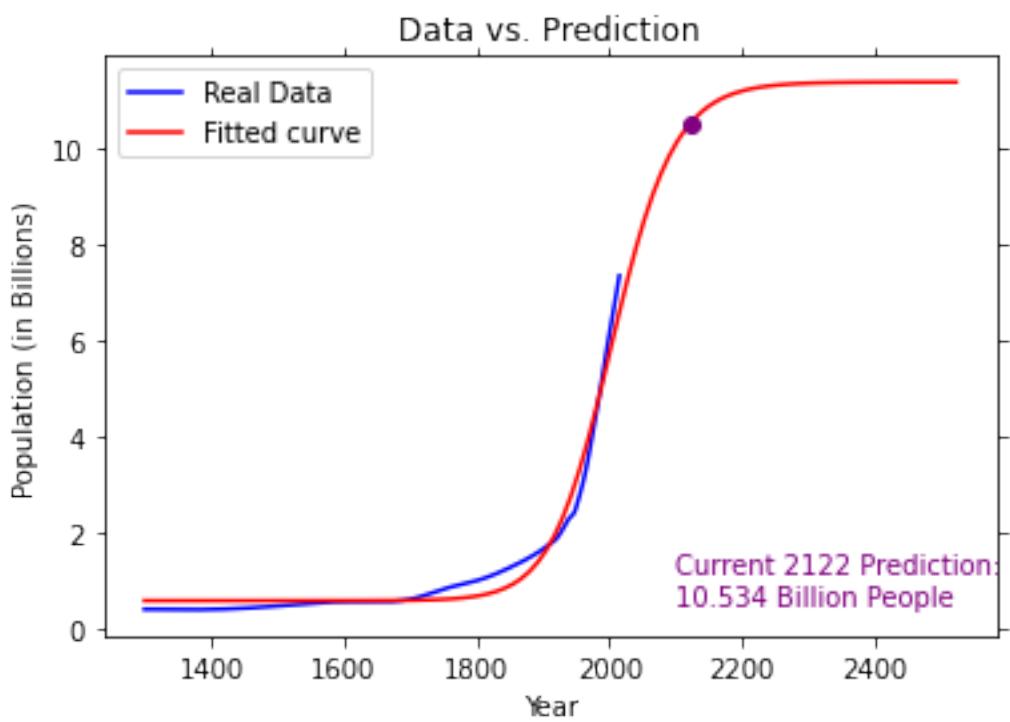
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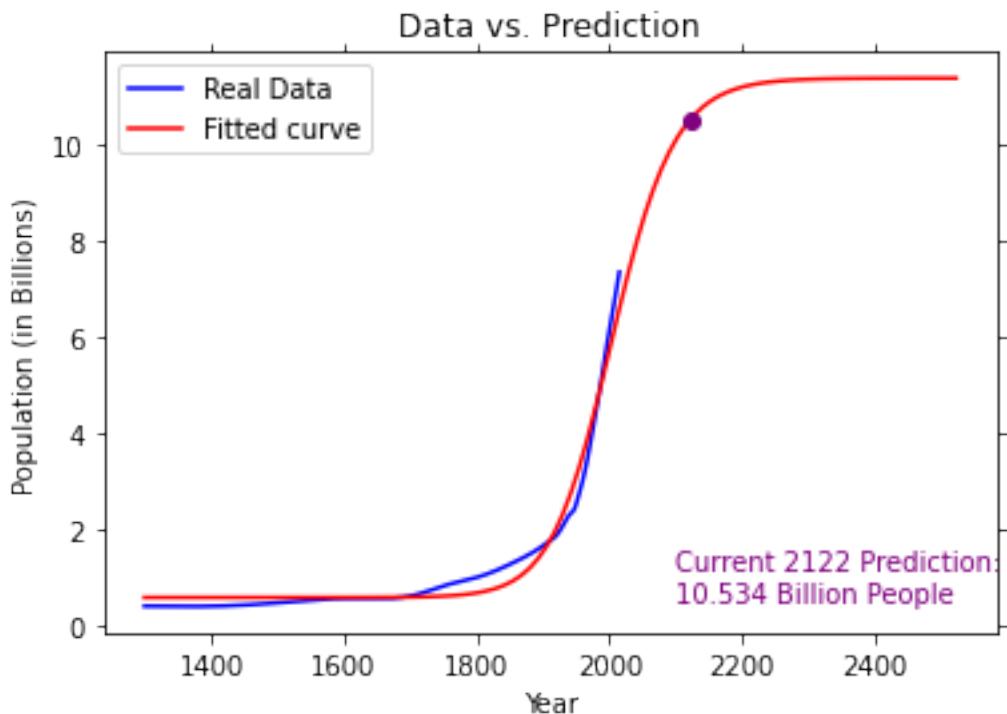
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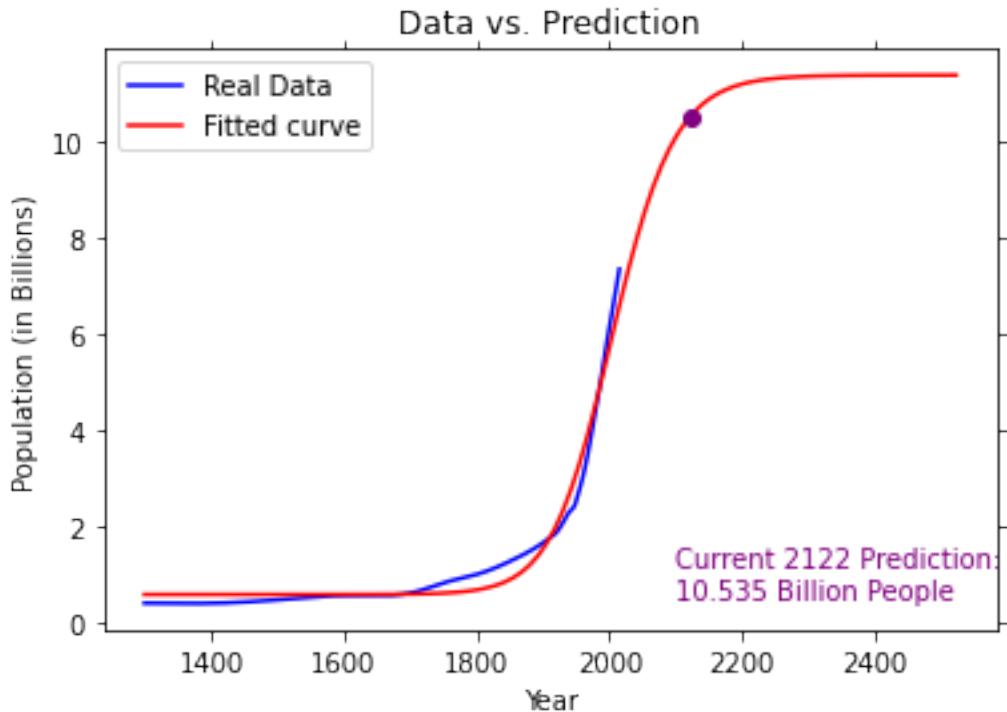
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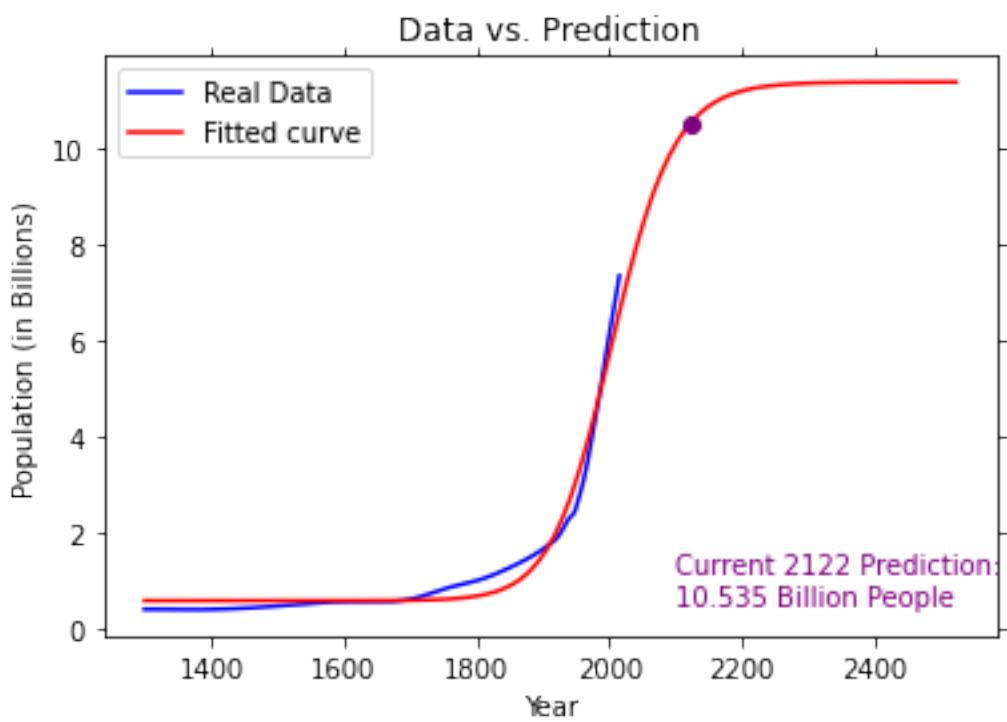
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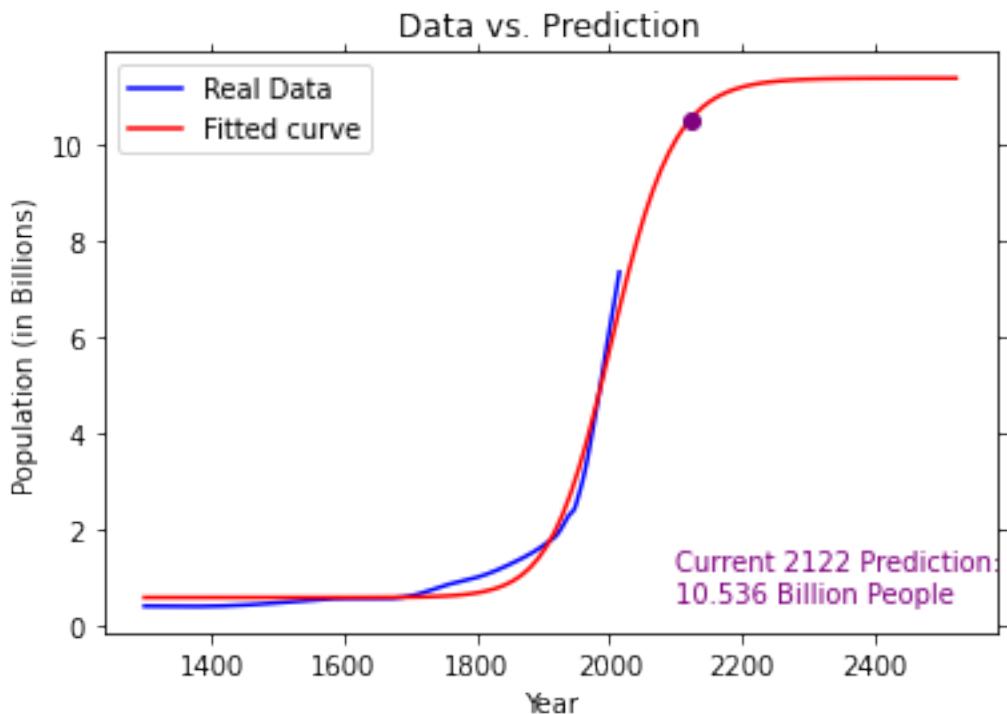
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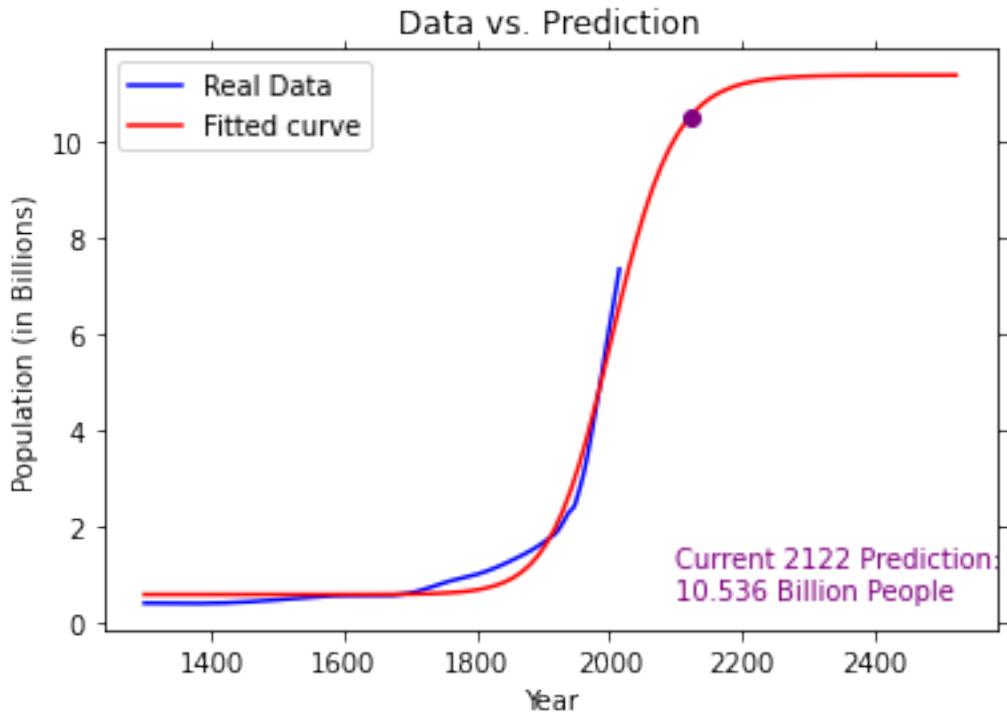
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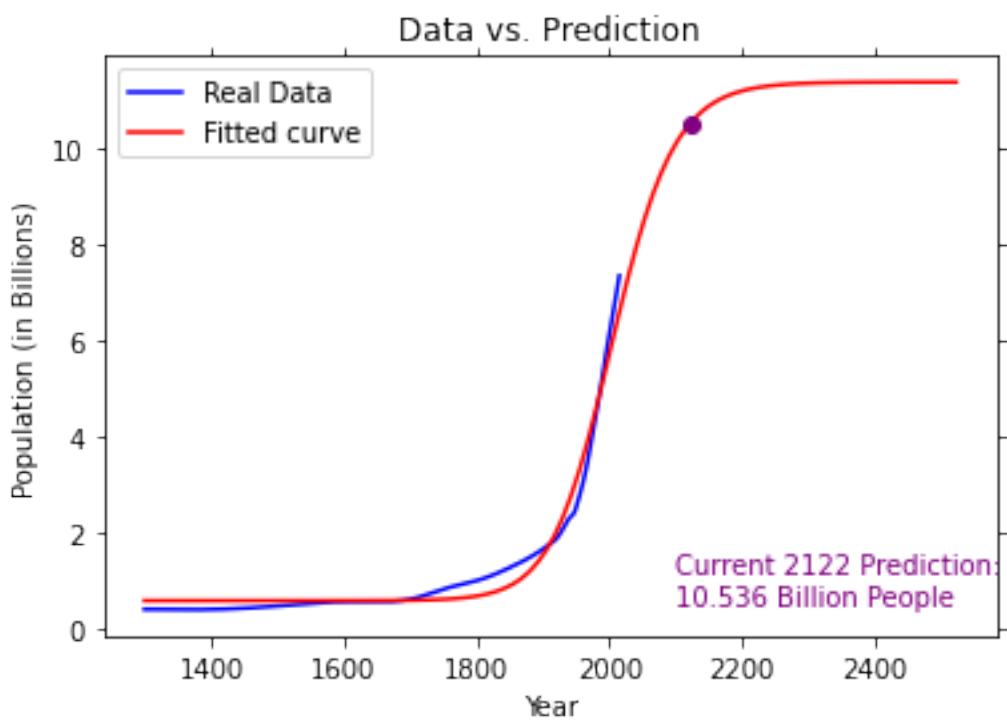
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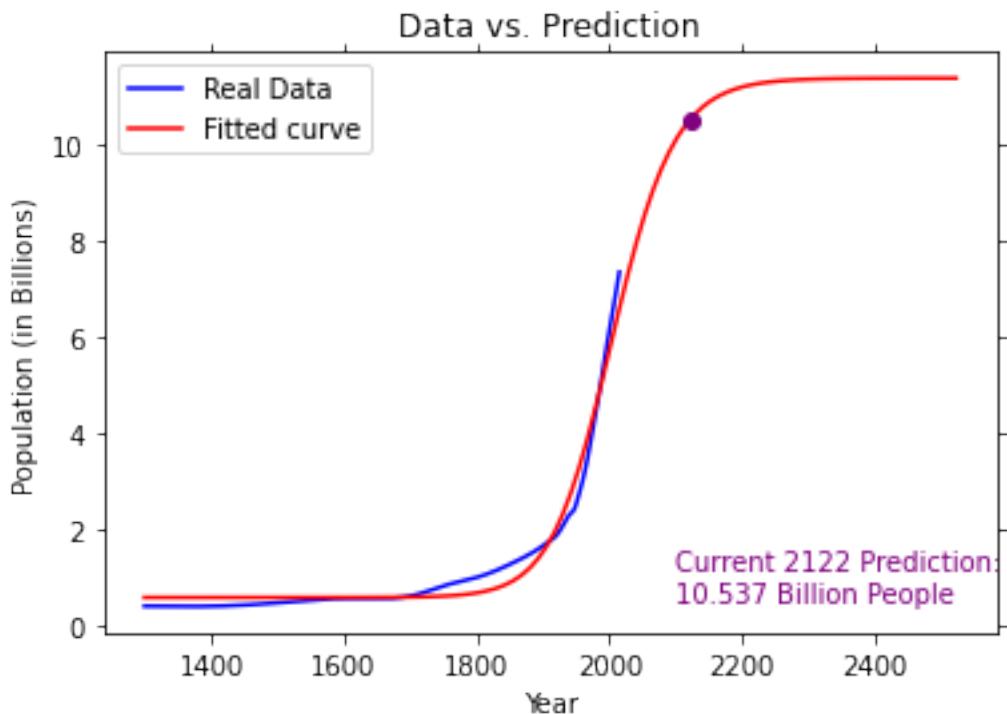
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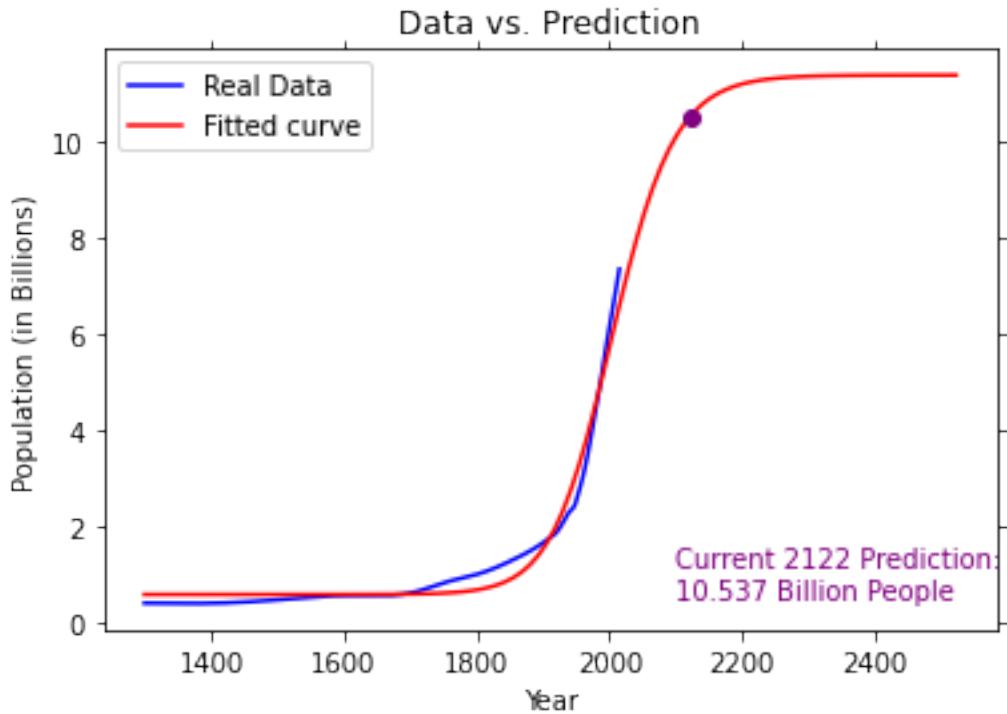
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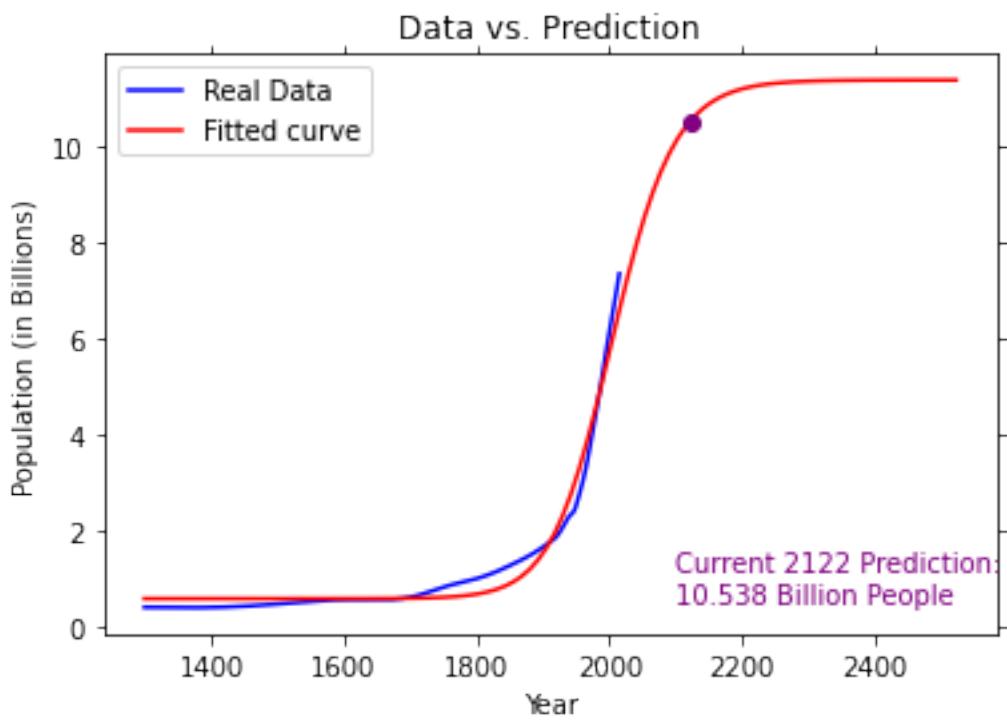
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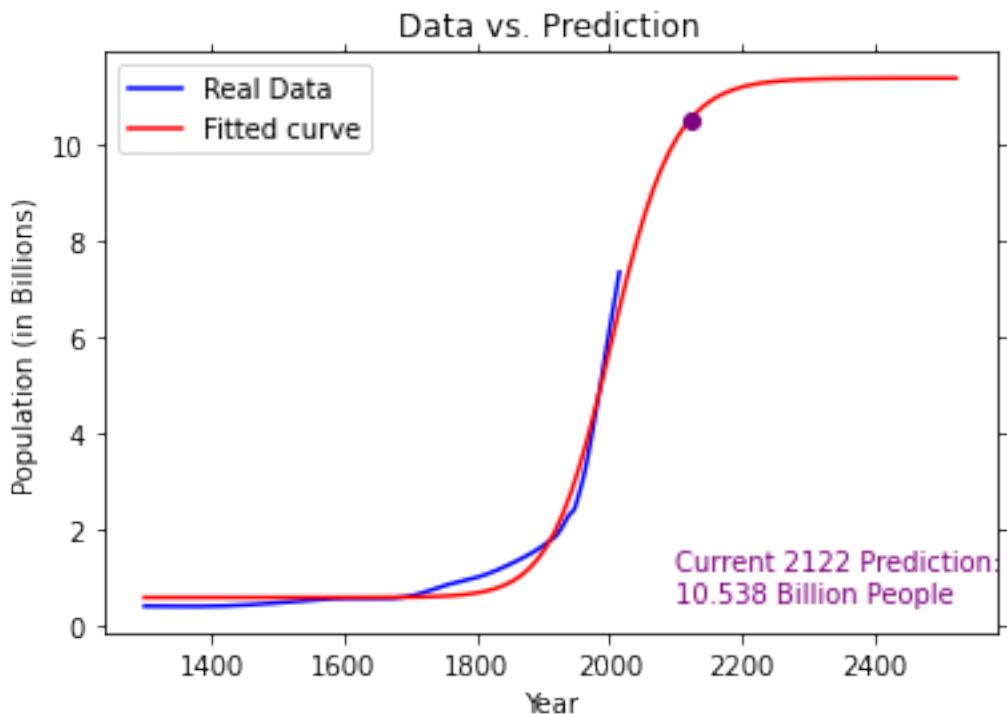
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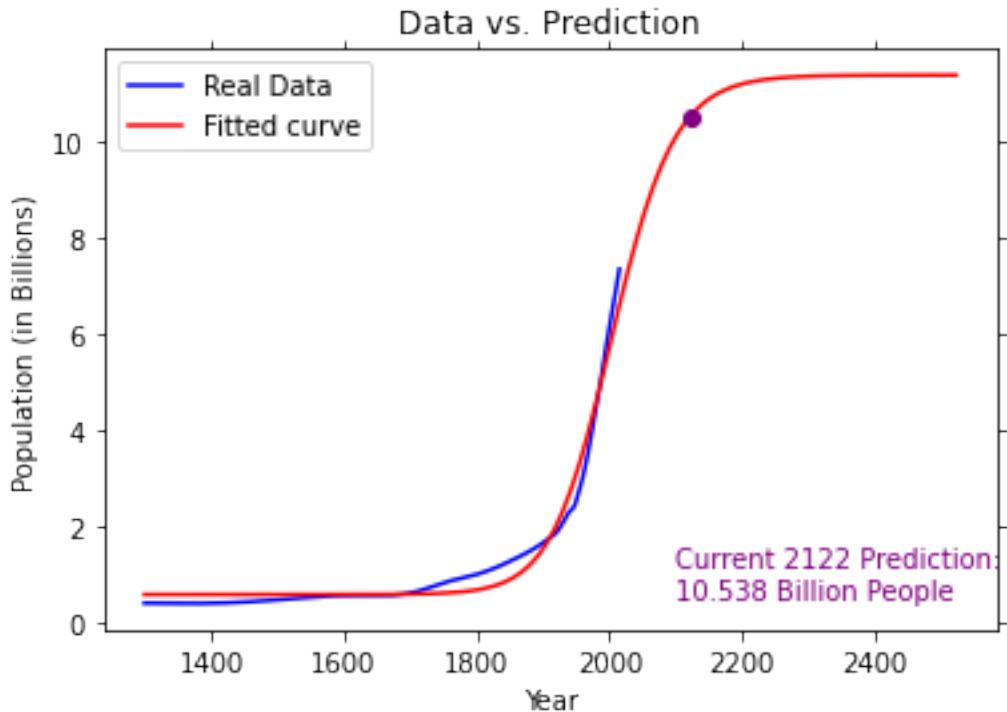
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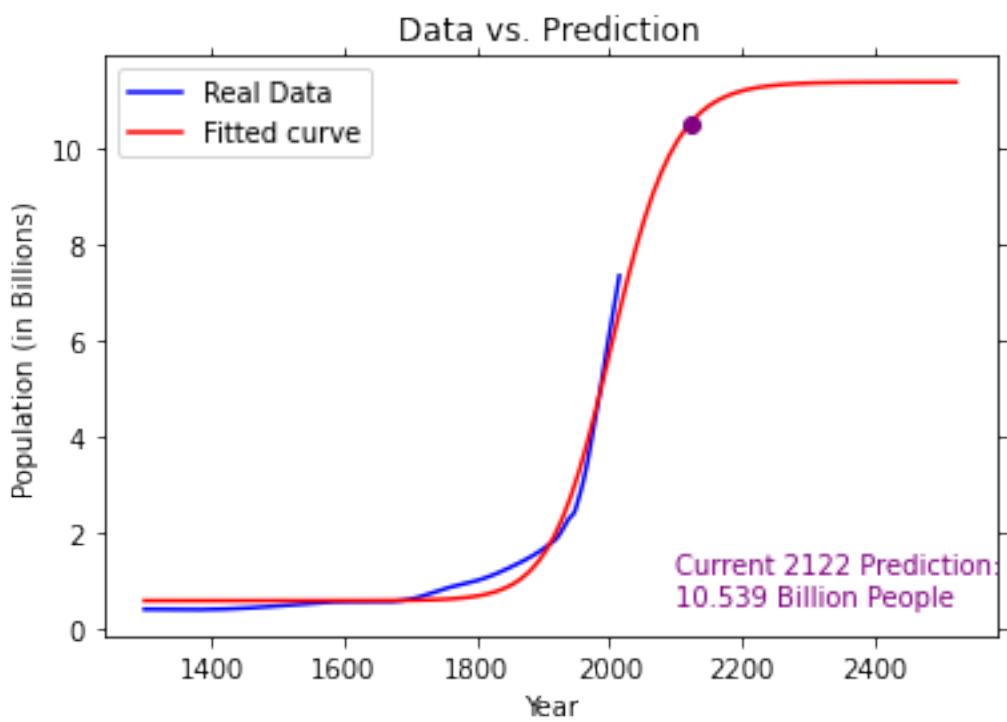
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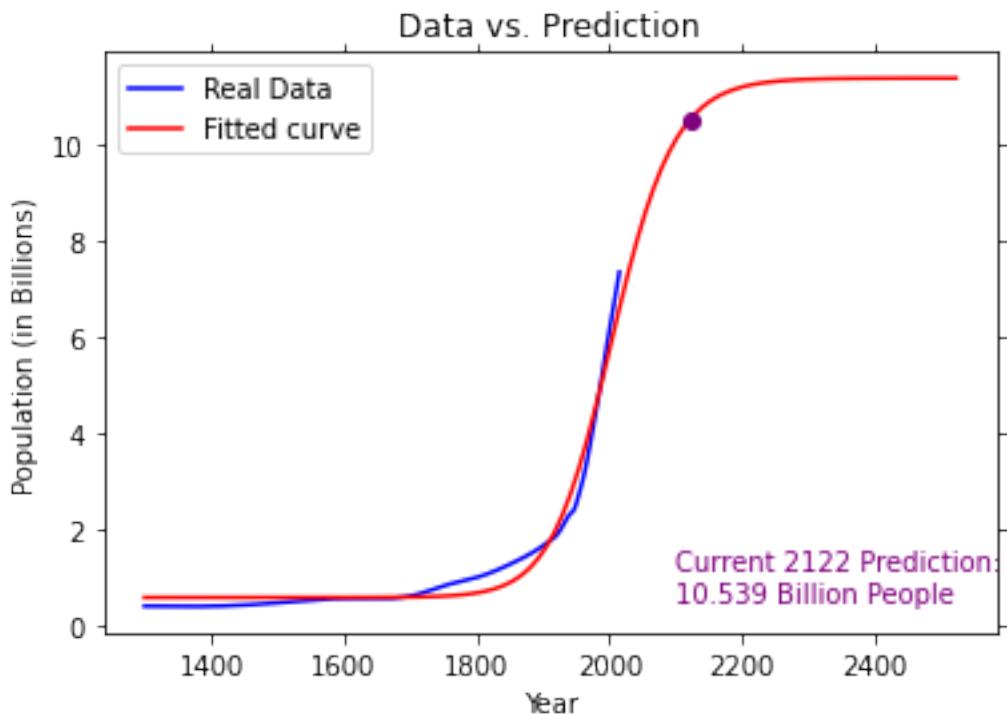
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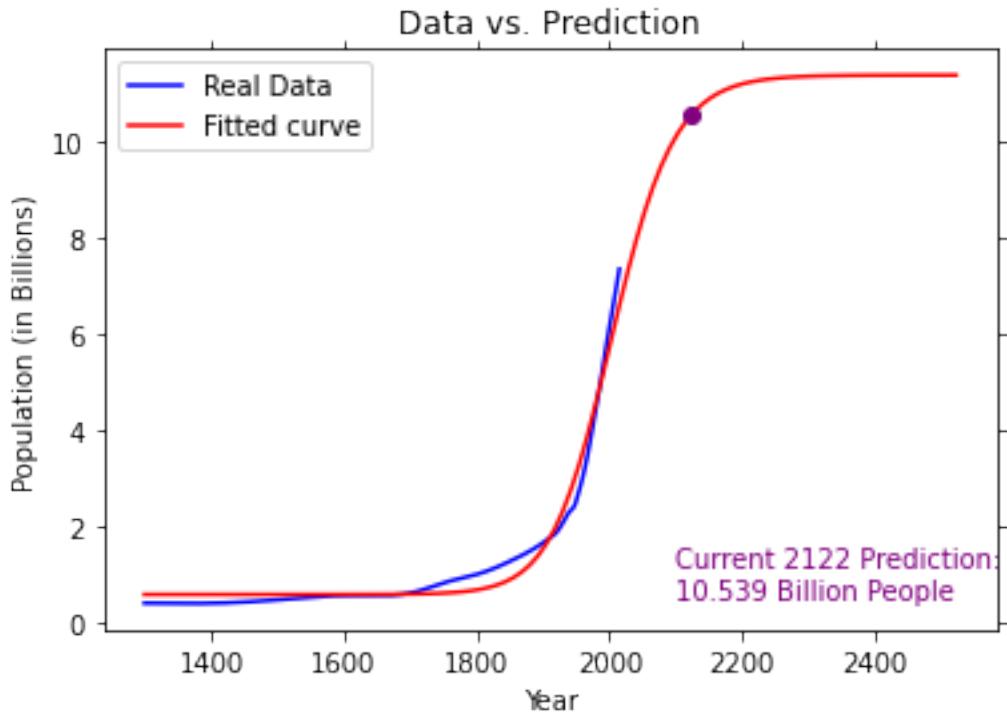
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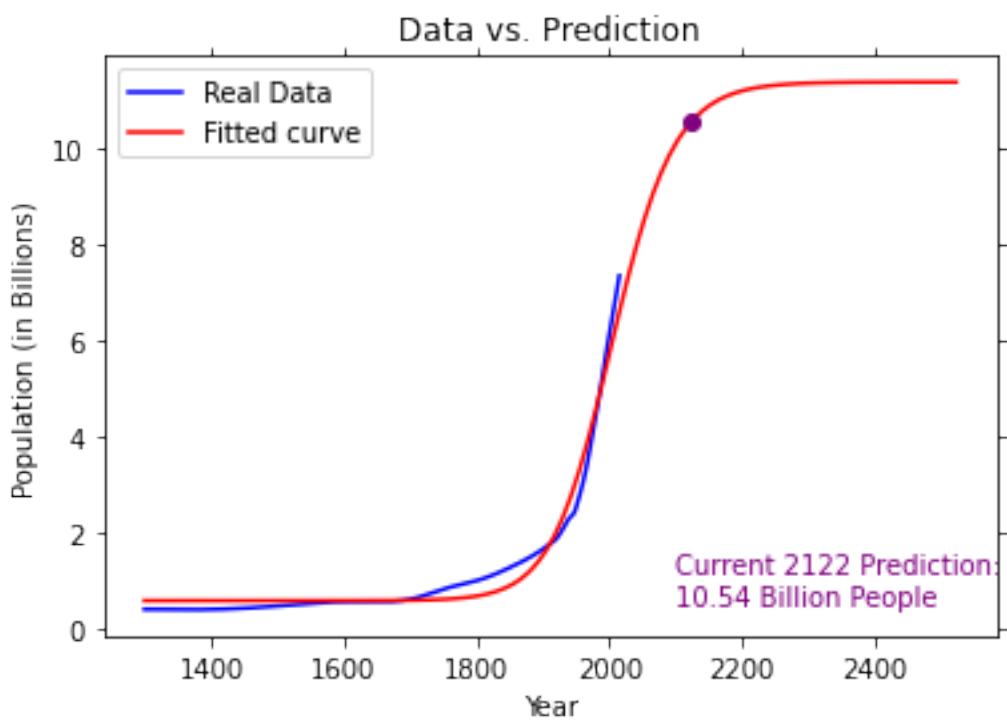
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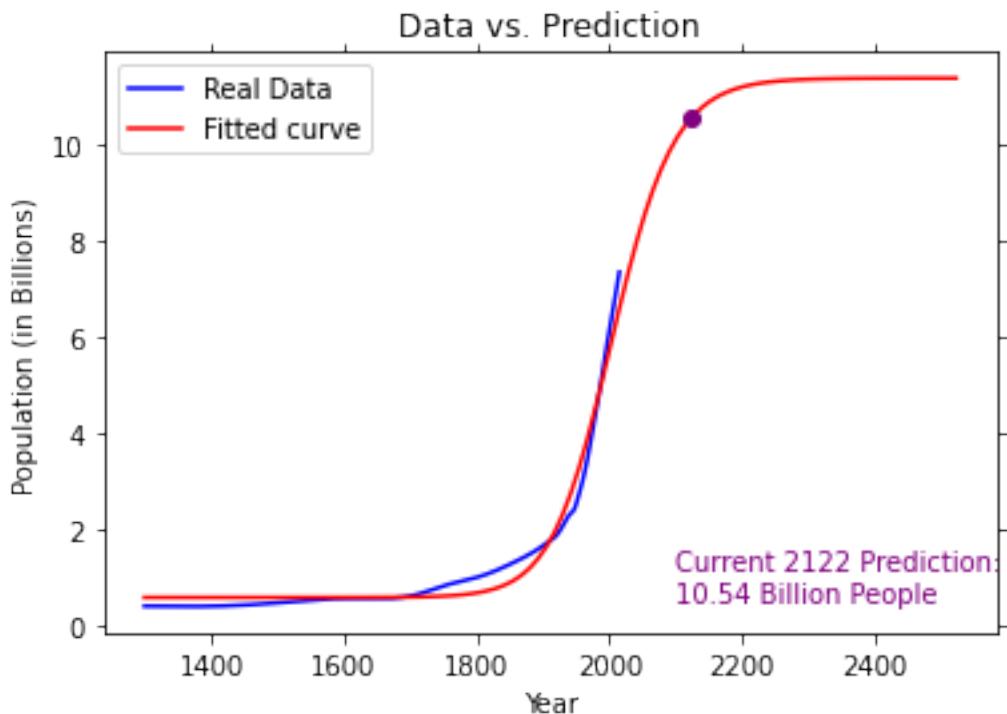
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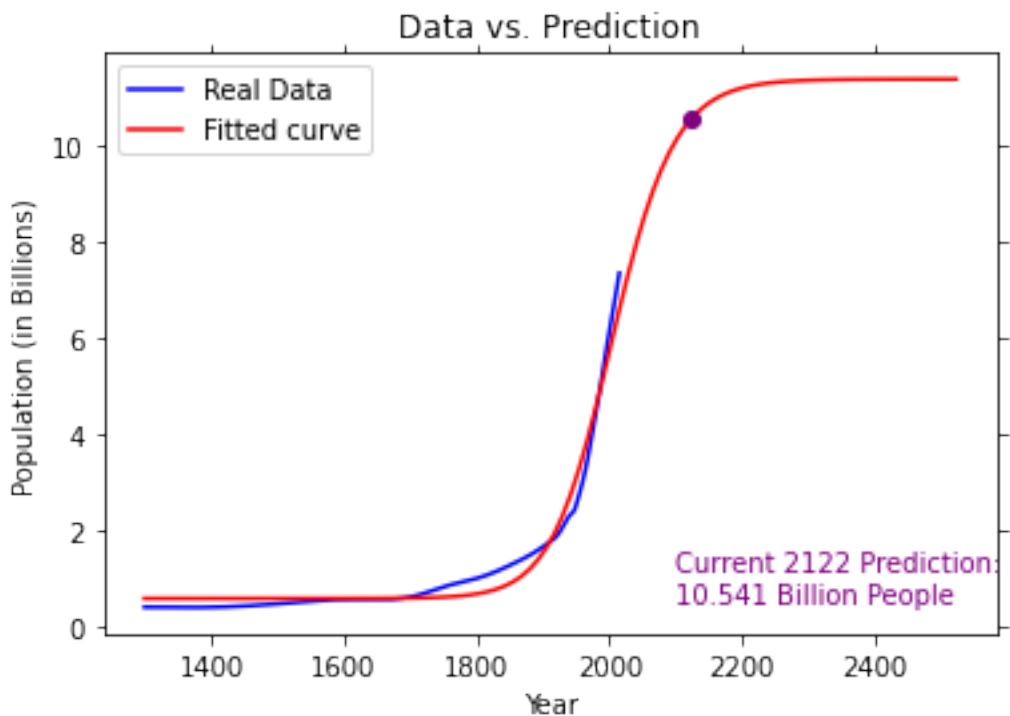
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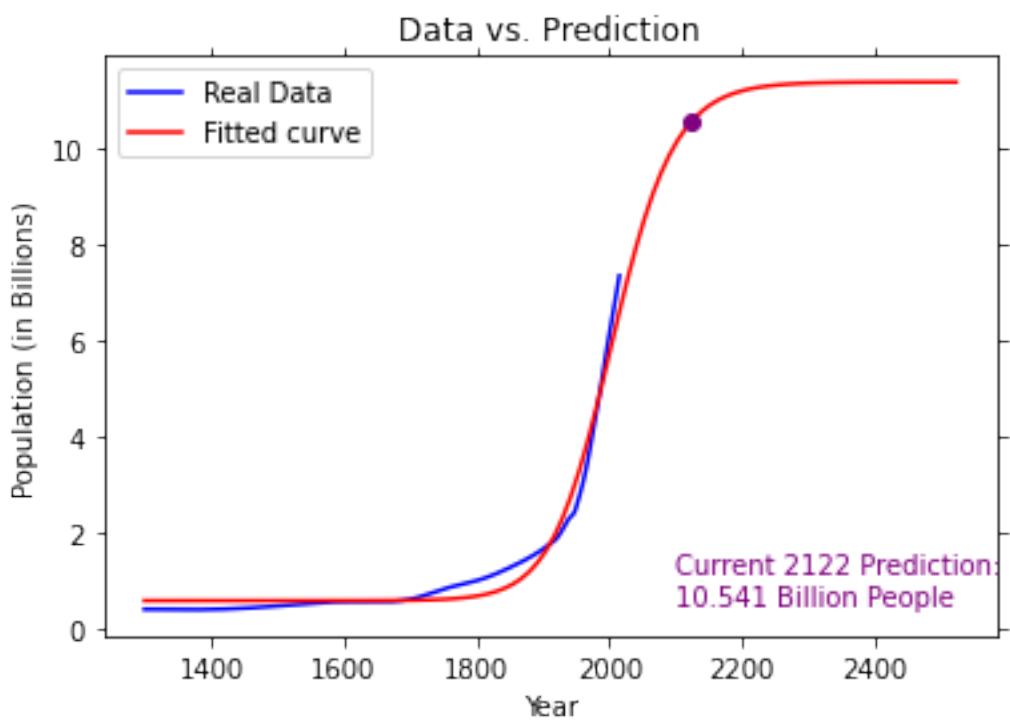
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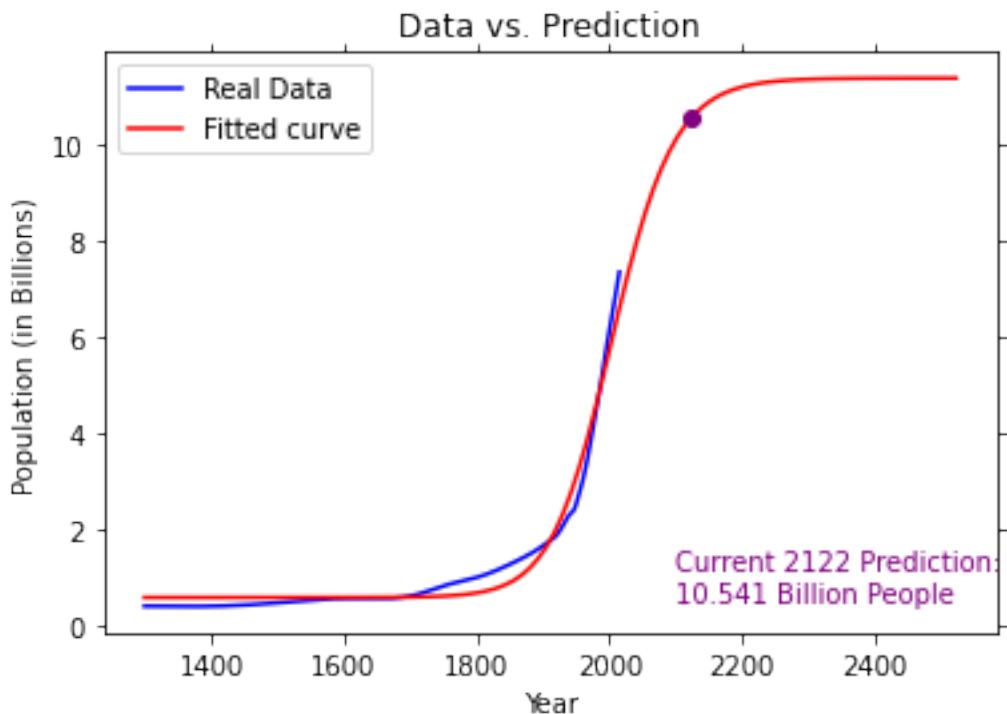
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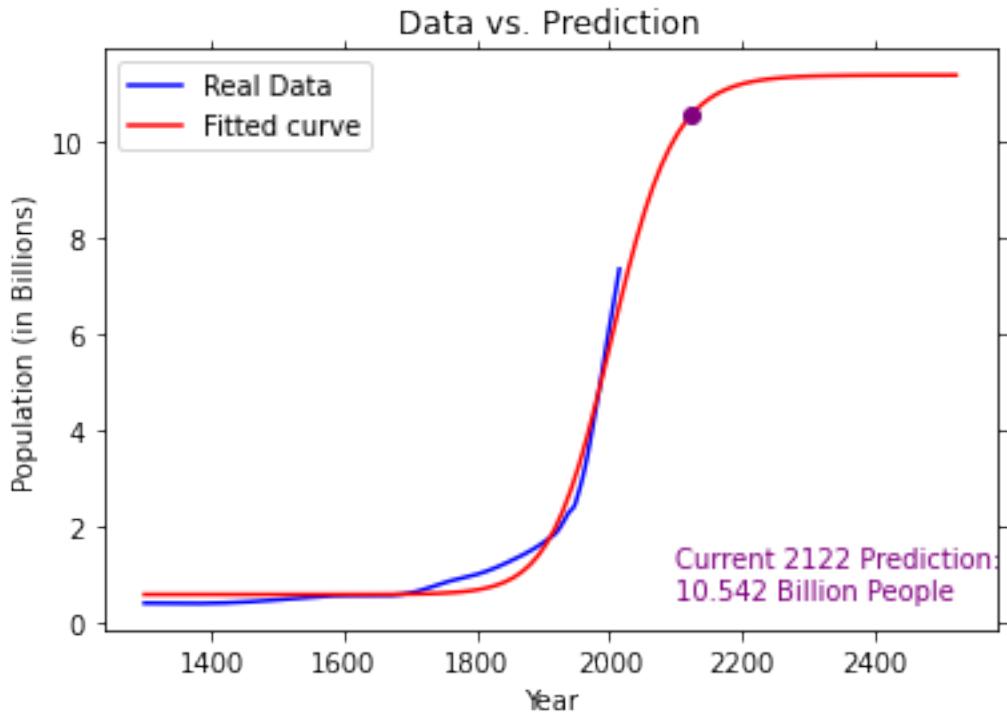
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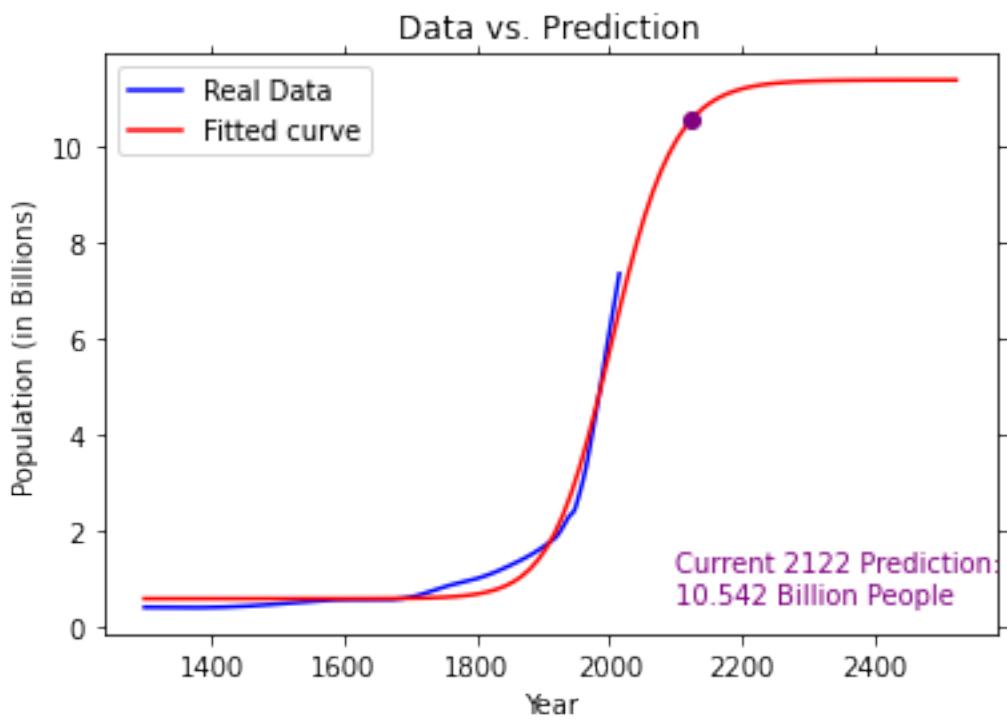
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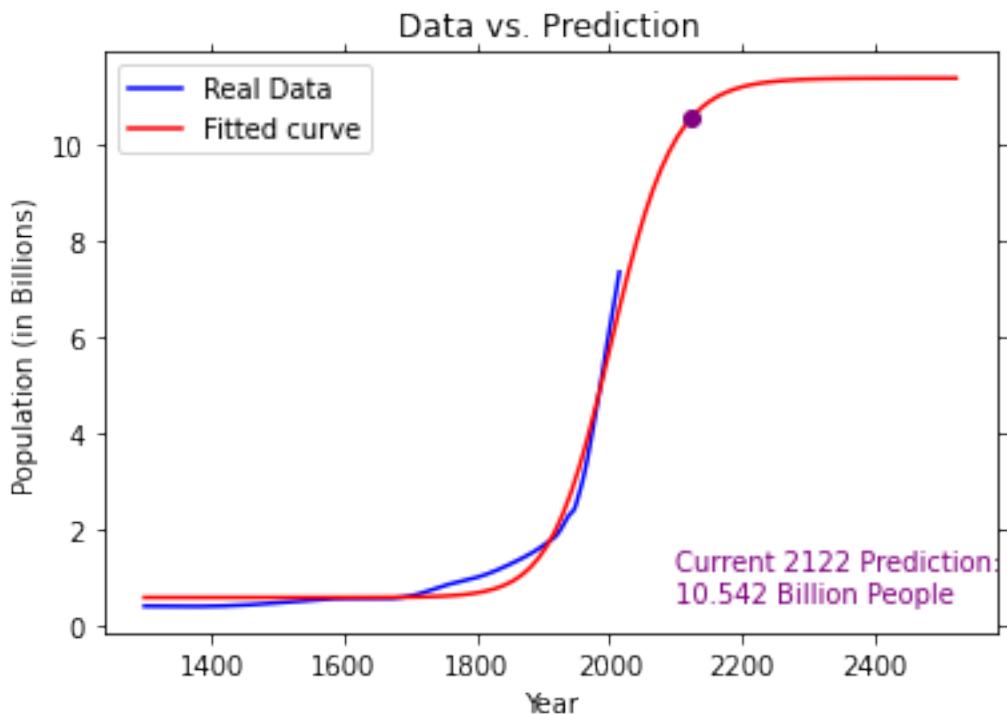
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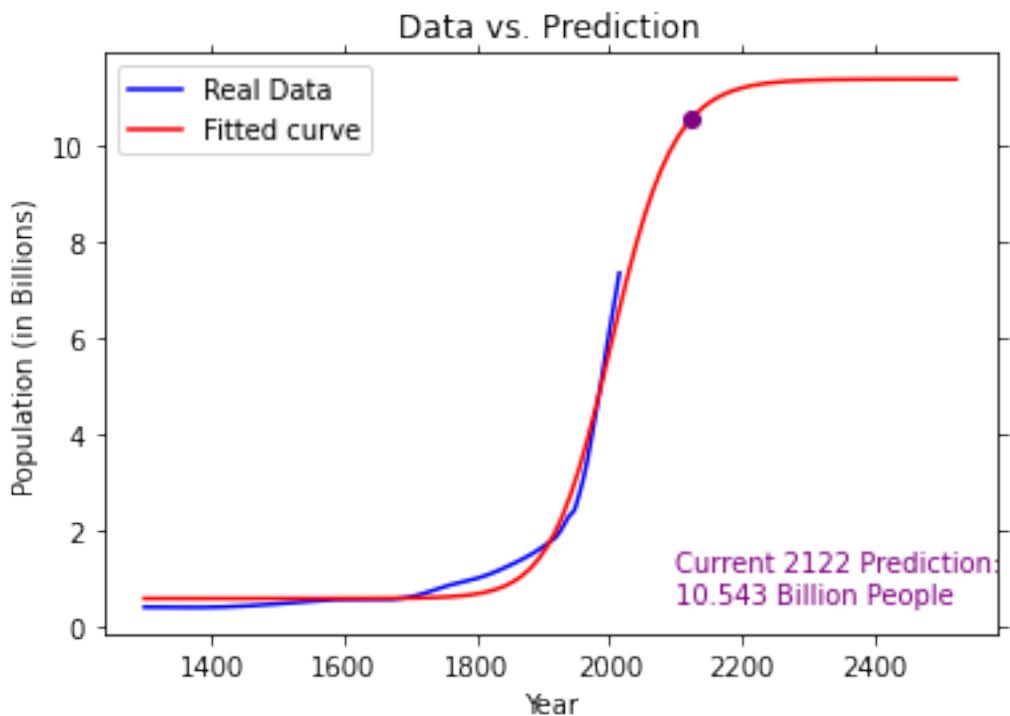
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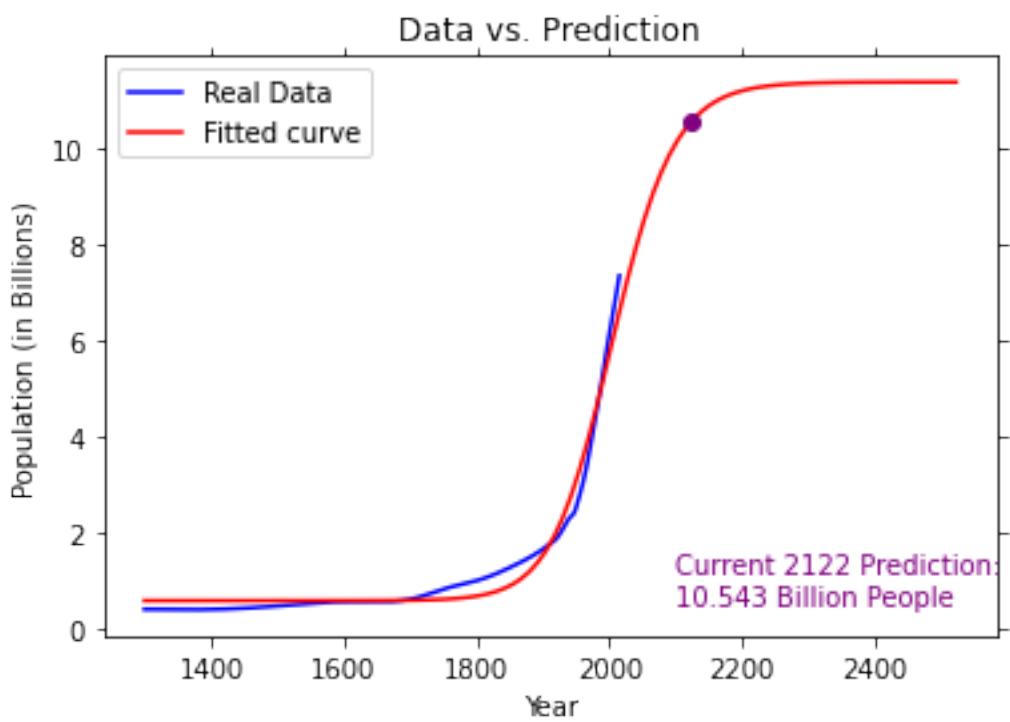
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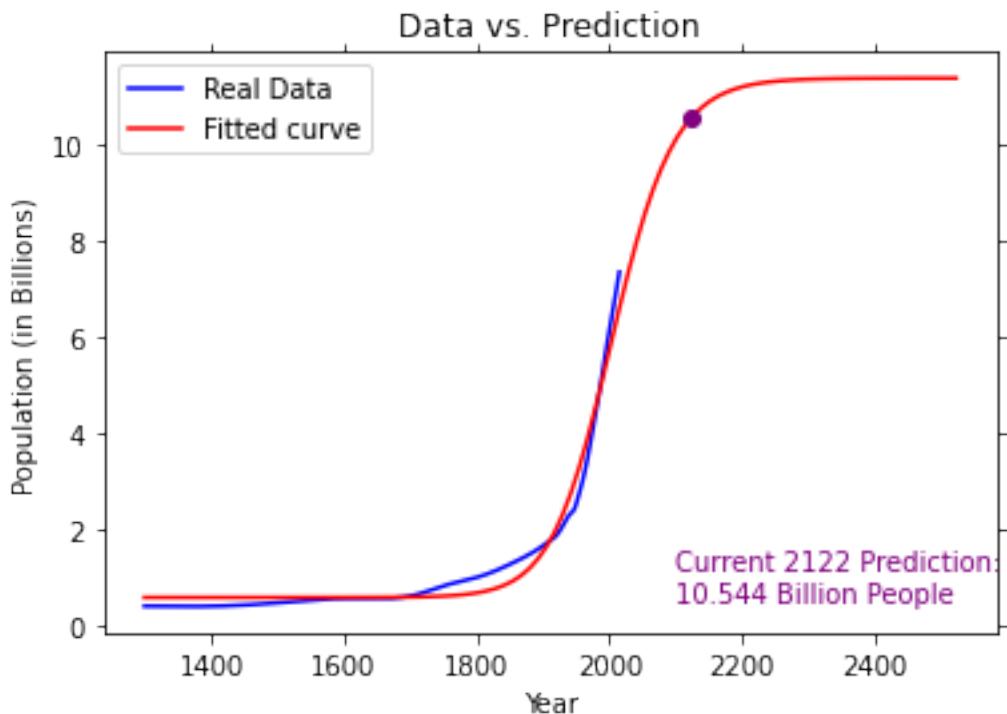
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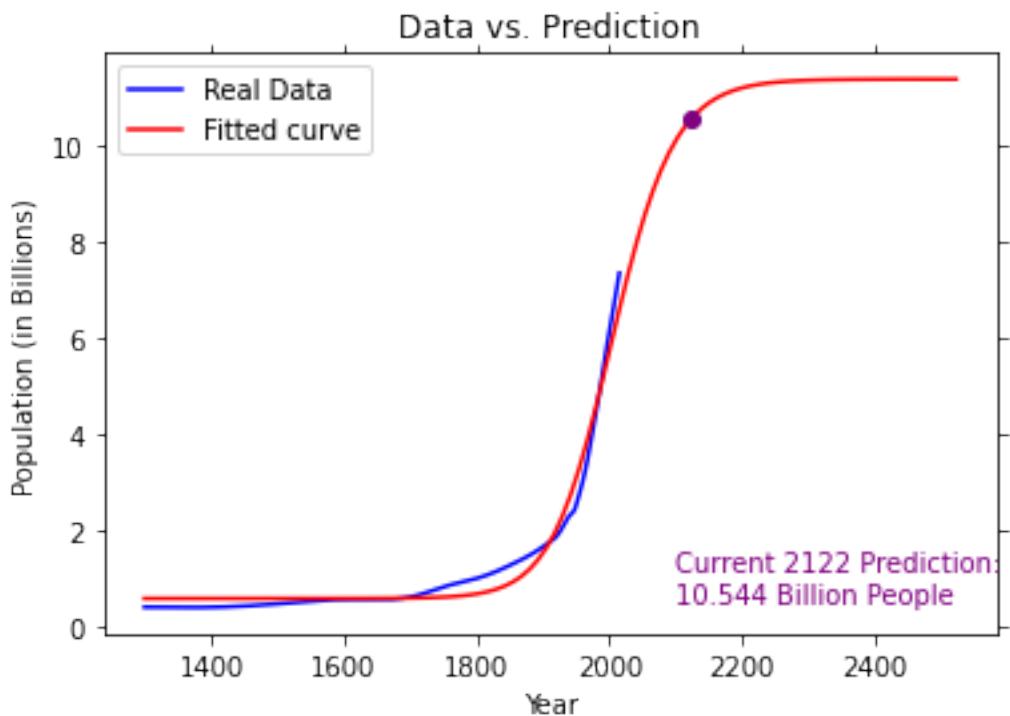
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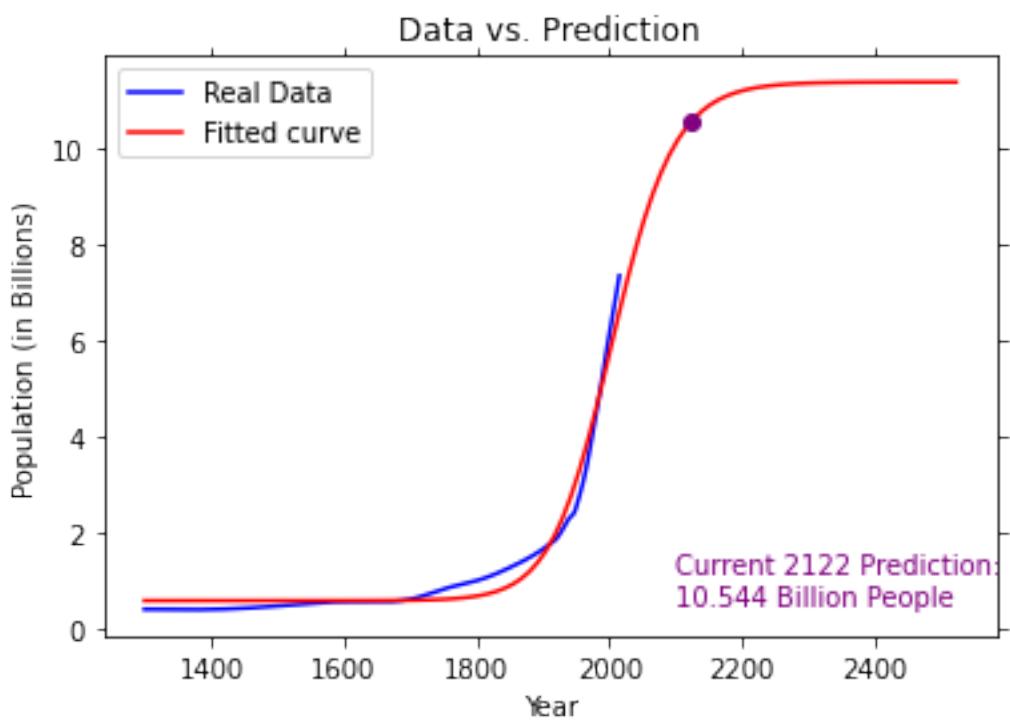
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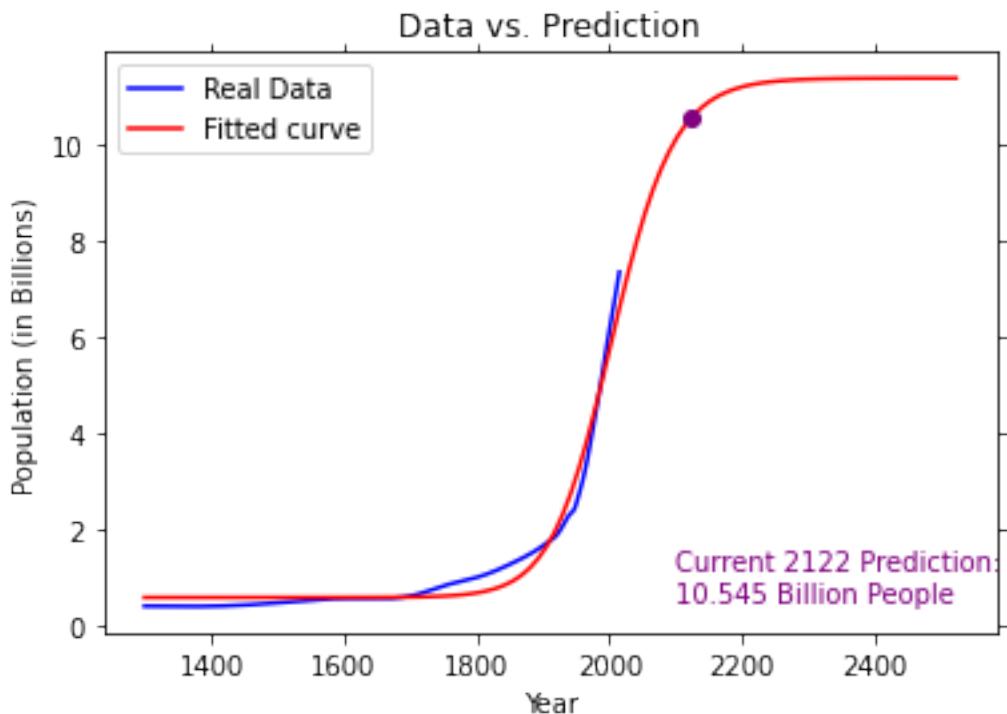
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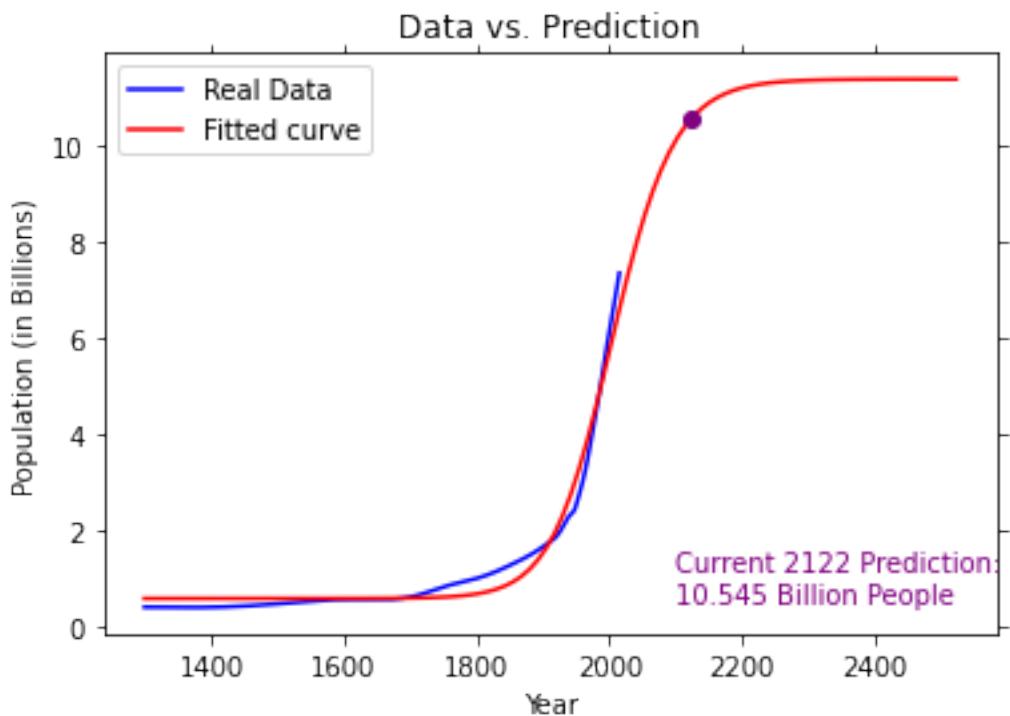
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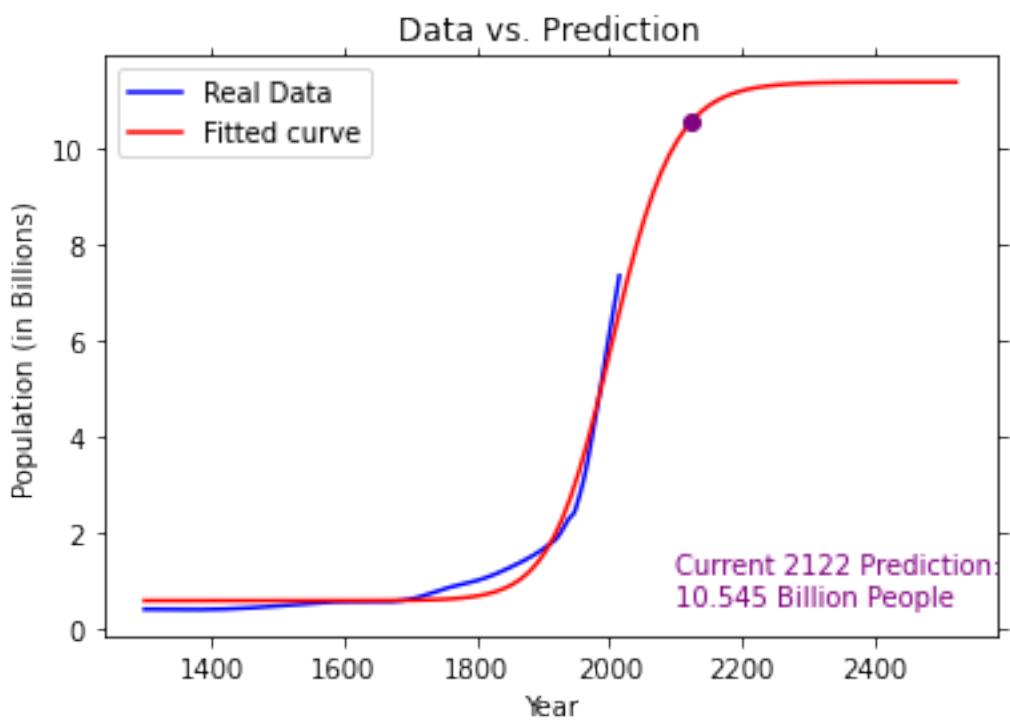
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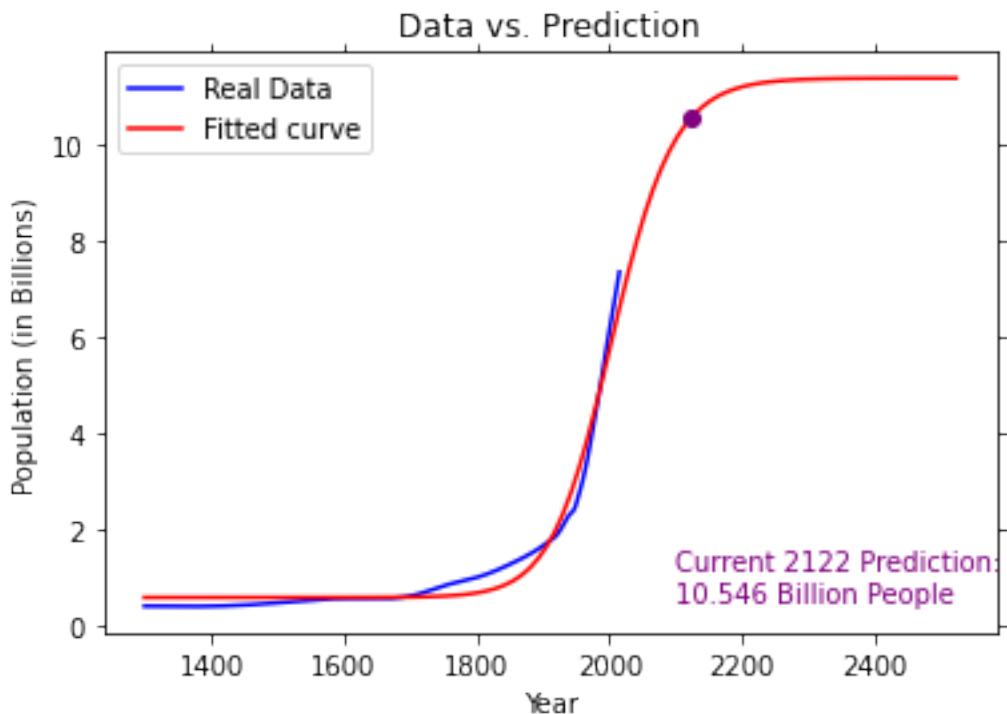
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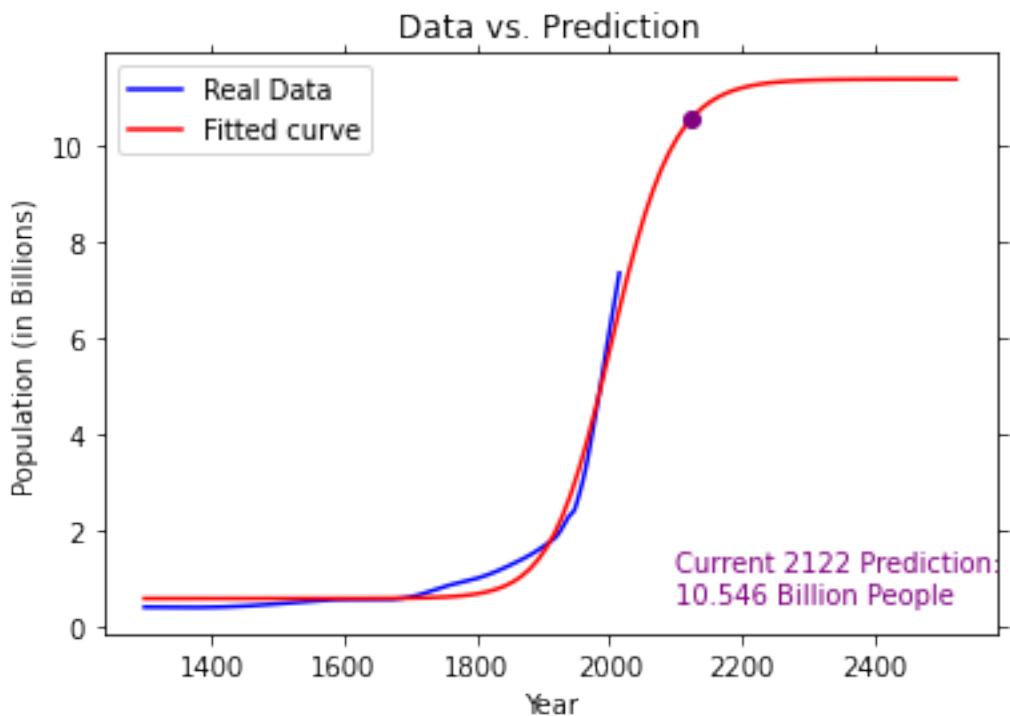
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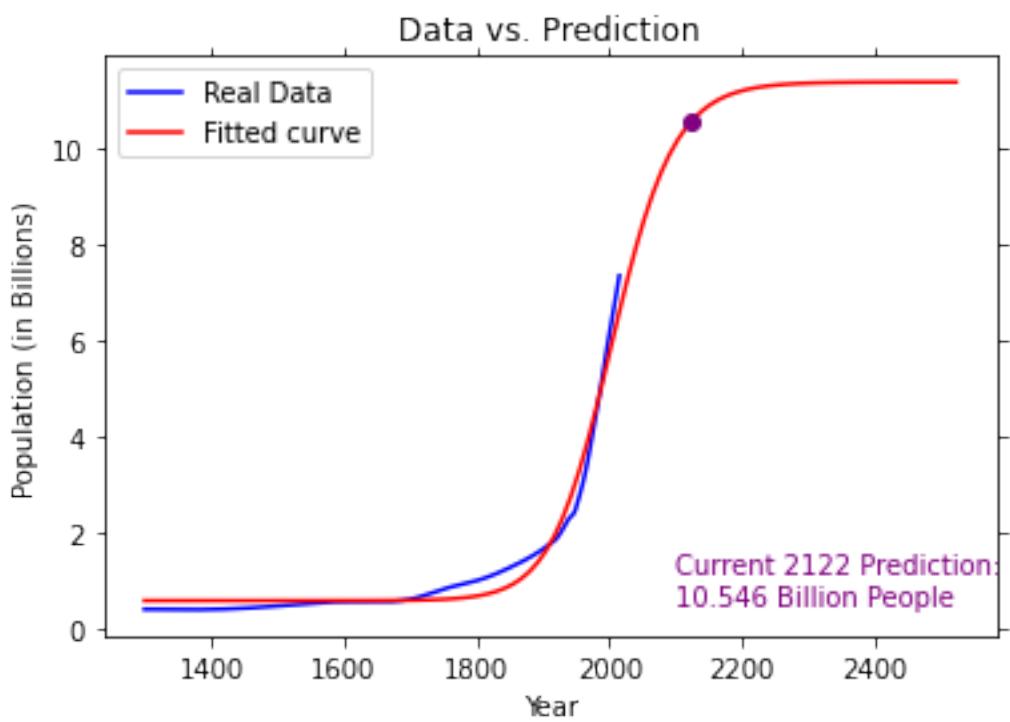
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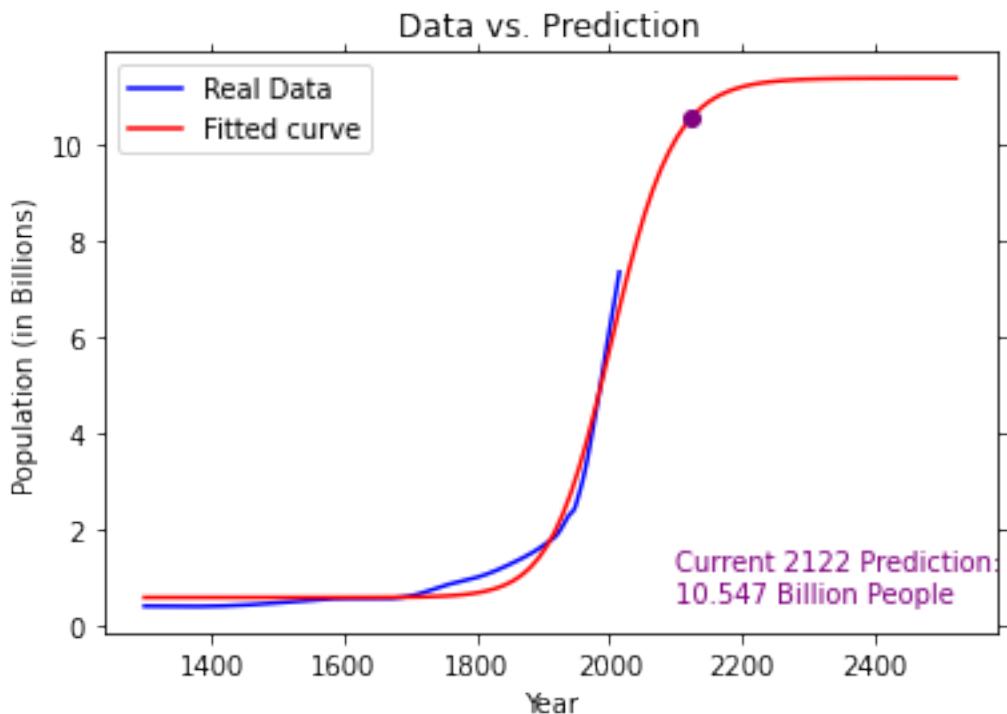
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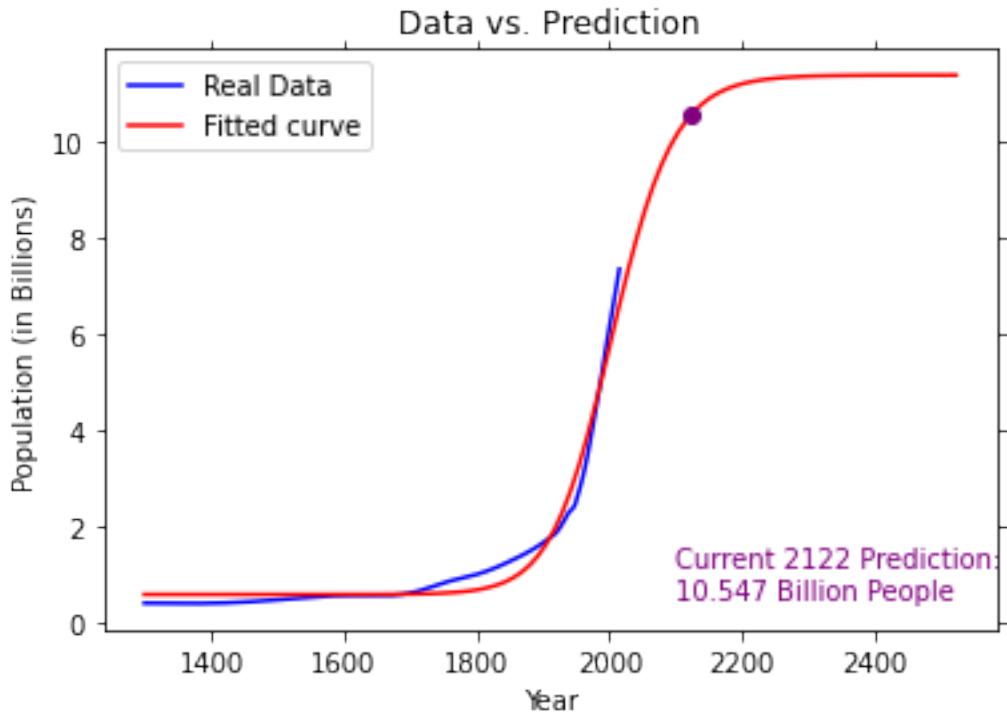
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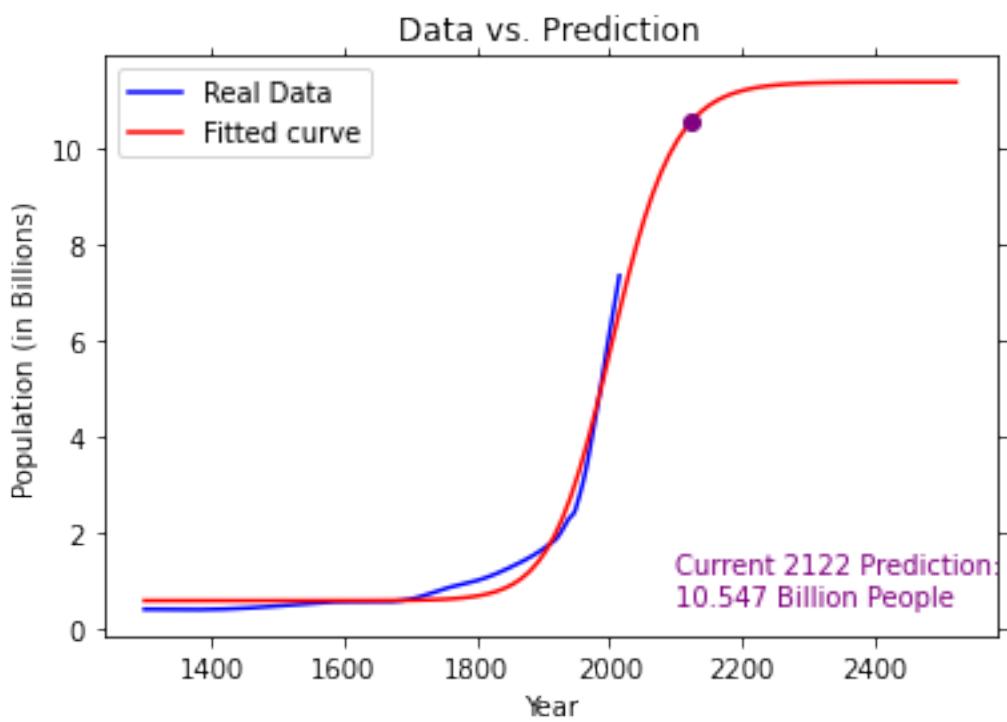
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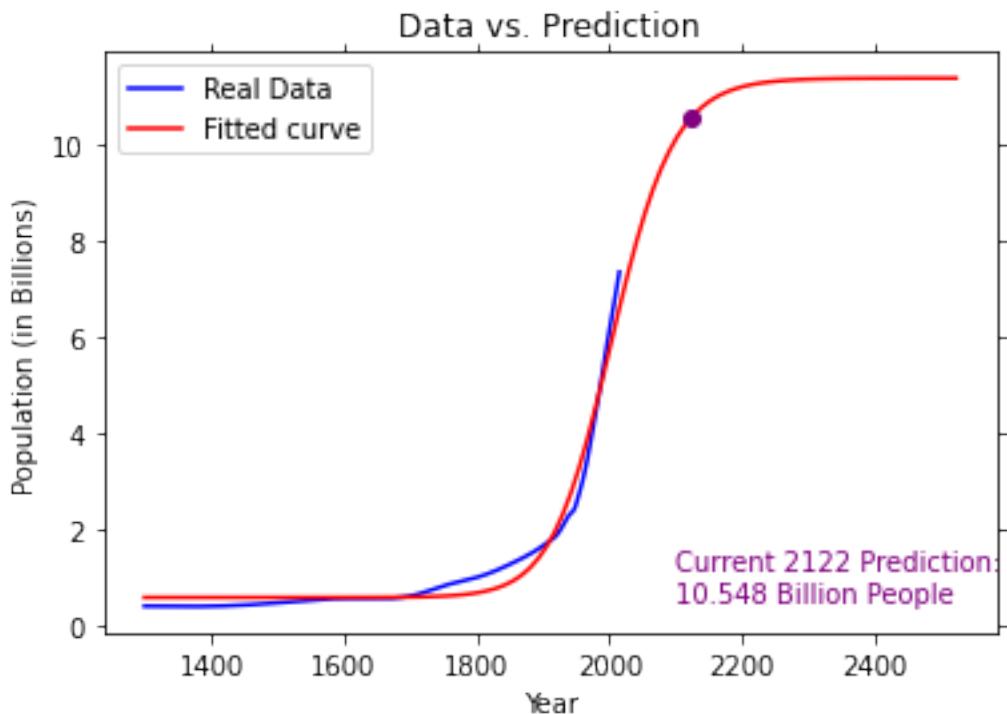
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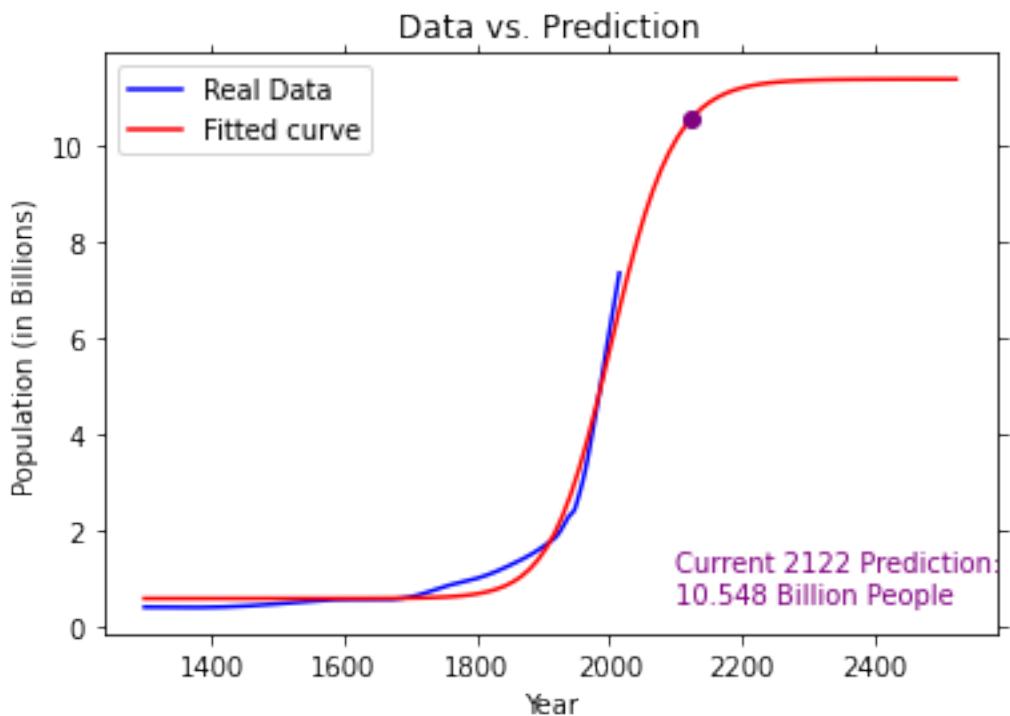
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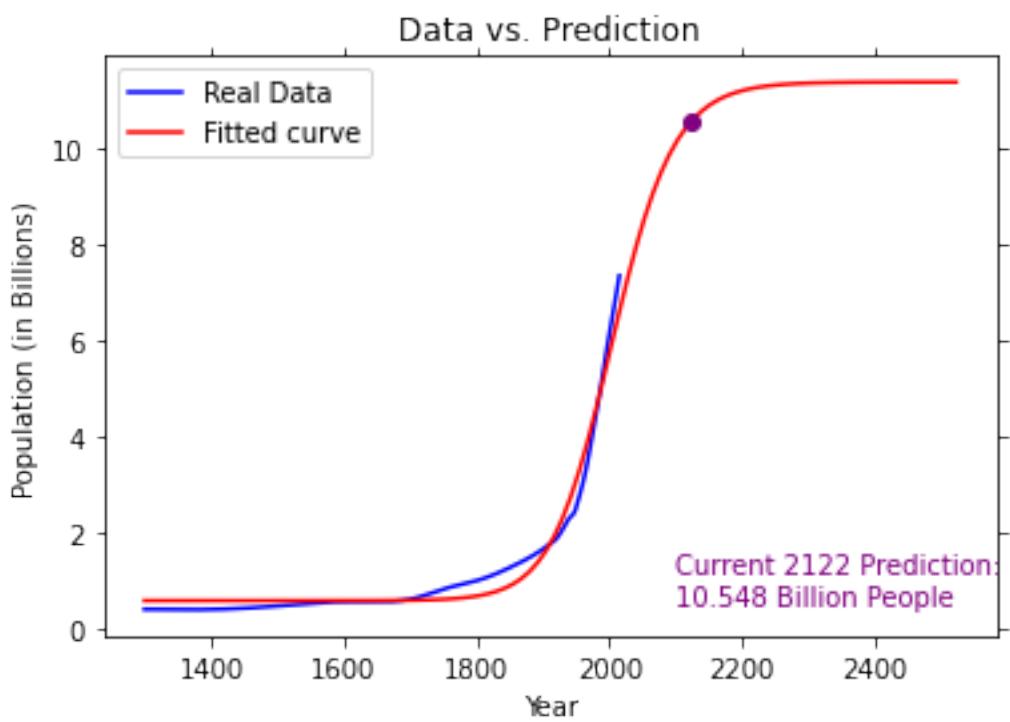
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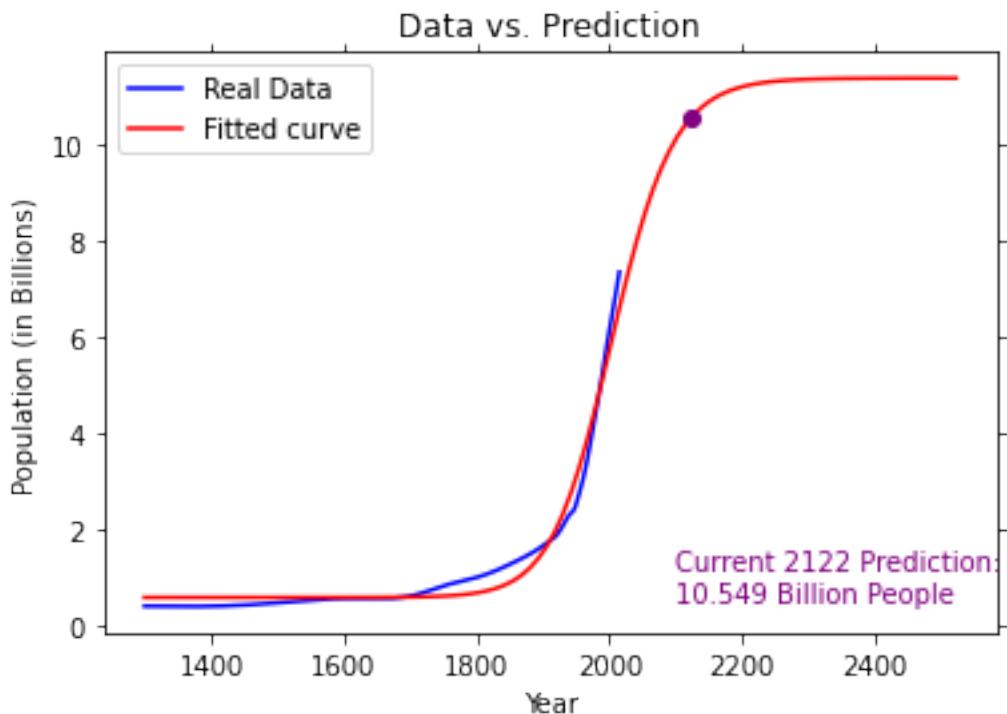
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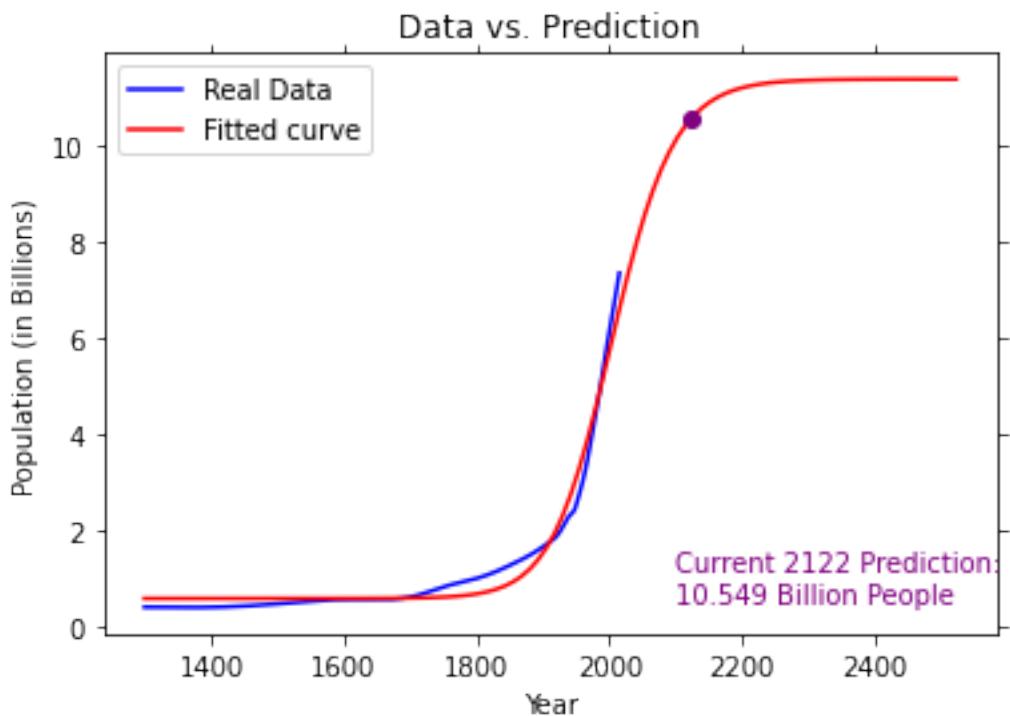
Iteration #18500, Loss: 0.05340290314145323



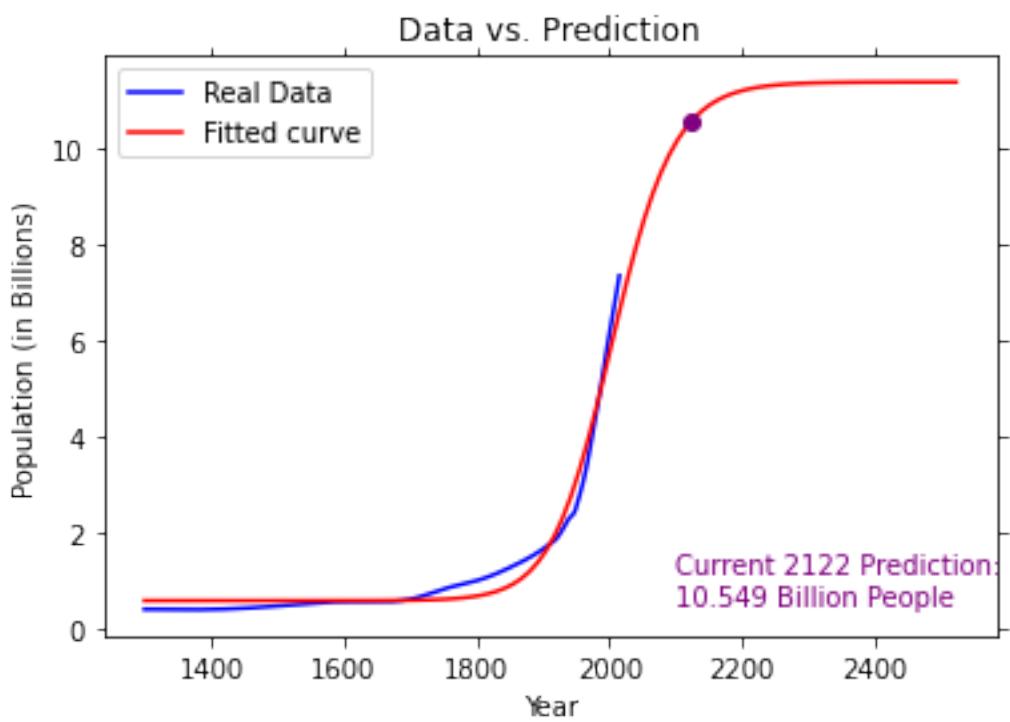
Iteration #18550, Loss: 0.05339328881950881



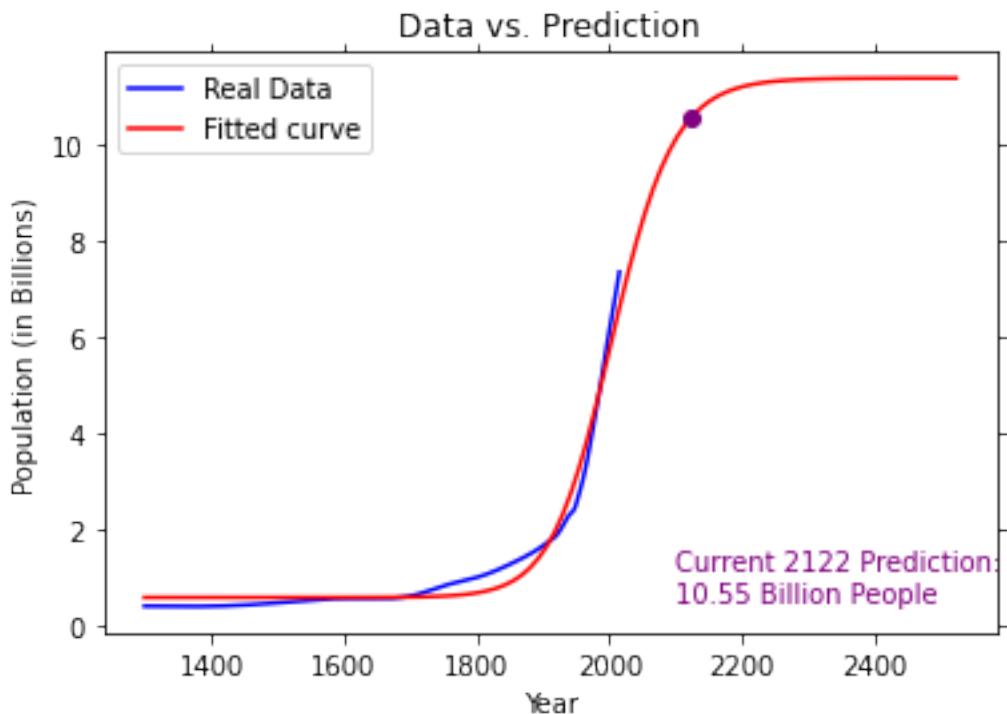
Iteration #18600, Loss: 0.05338369473099093



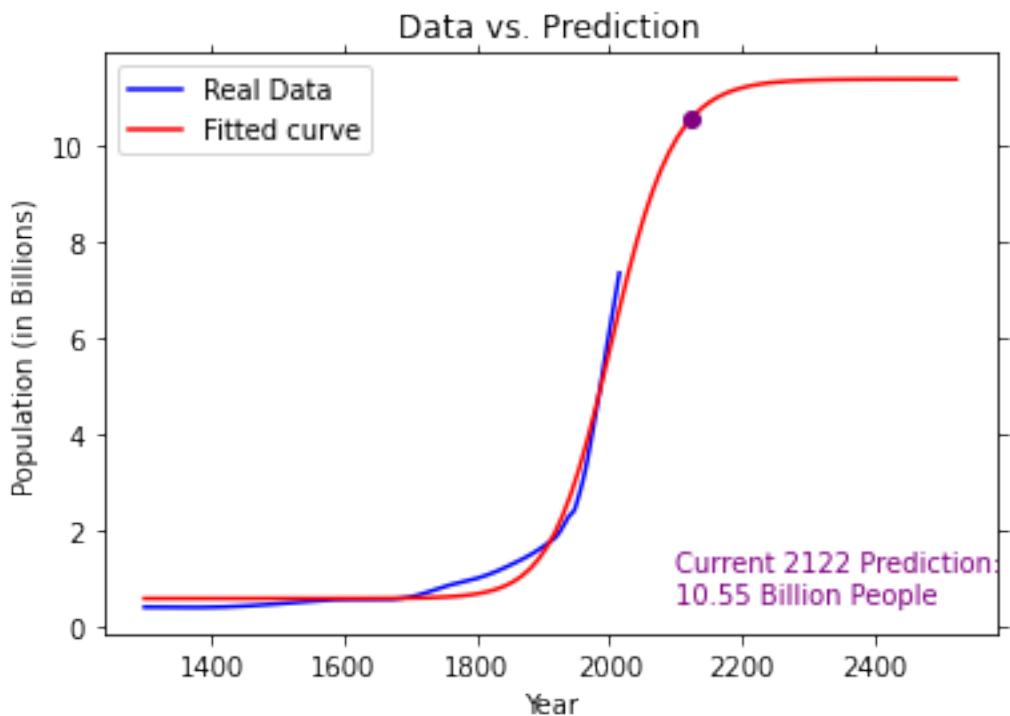
Iteration #18650, Loss: 0.05337412075072783



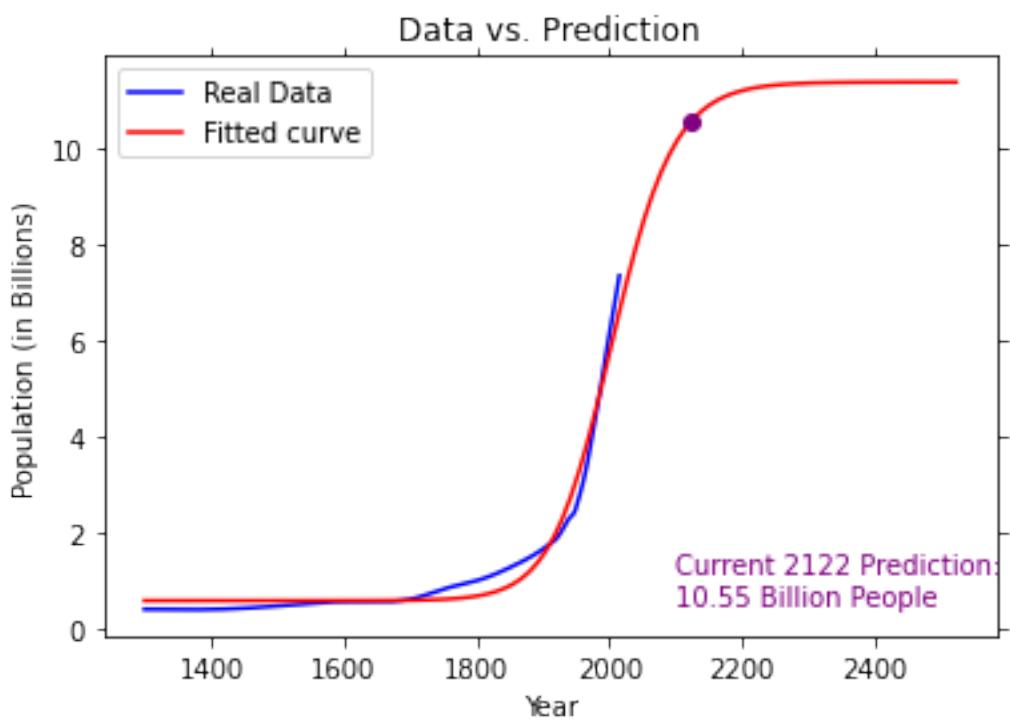
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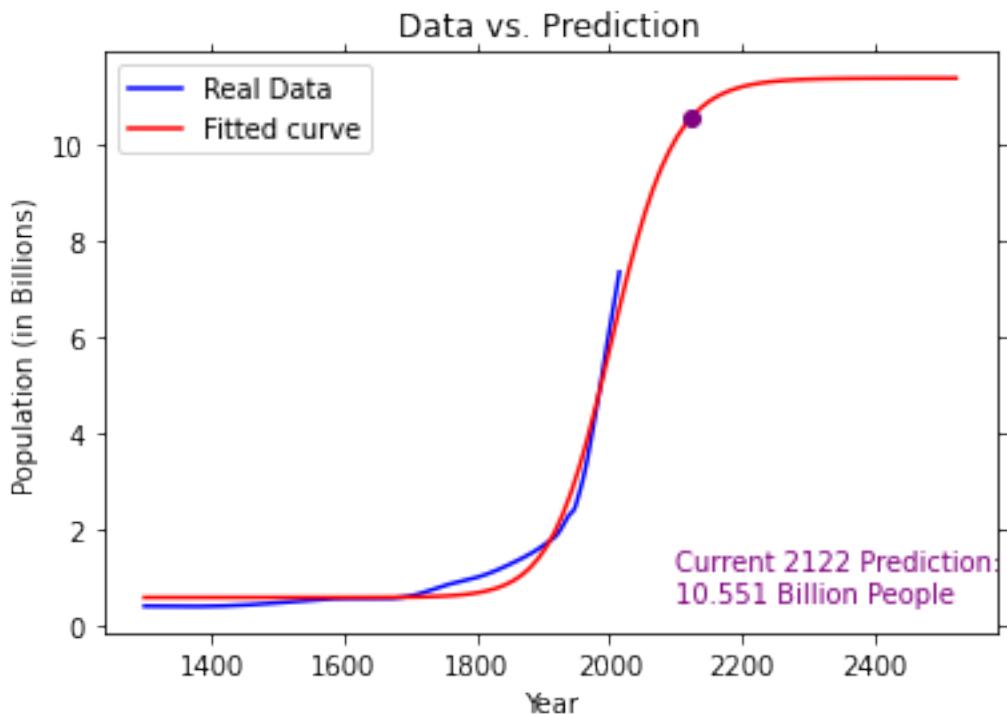
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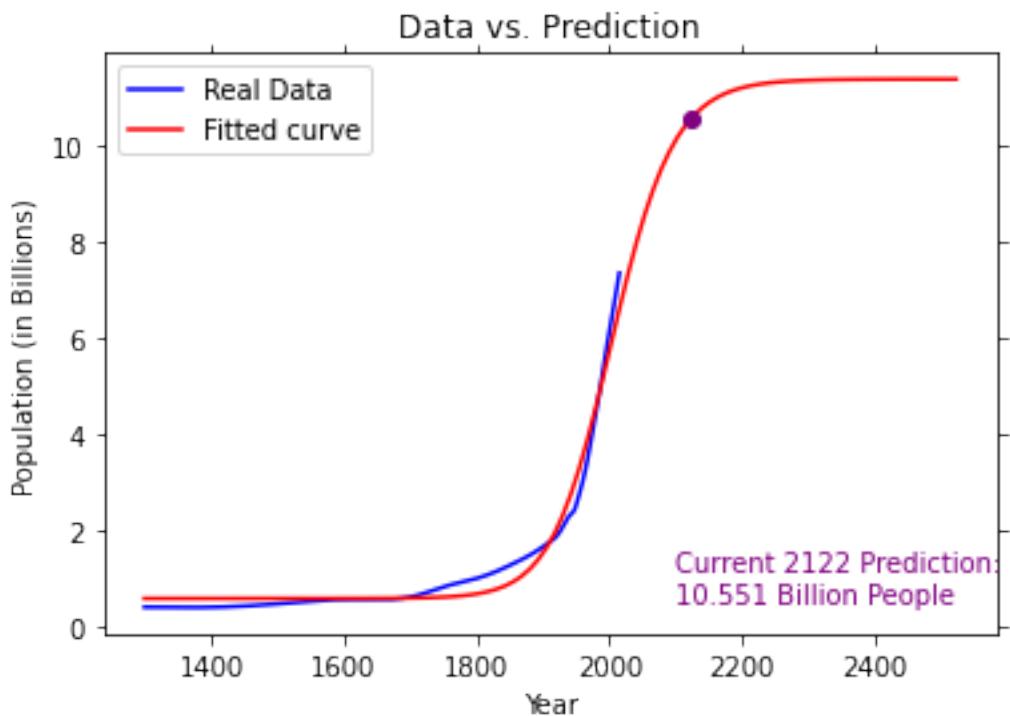
Iteration #18800, Loss: 0.053345518243387506



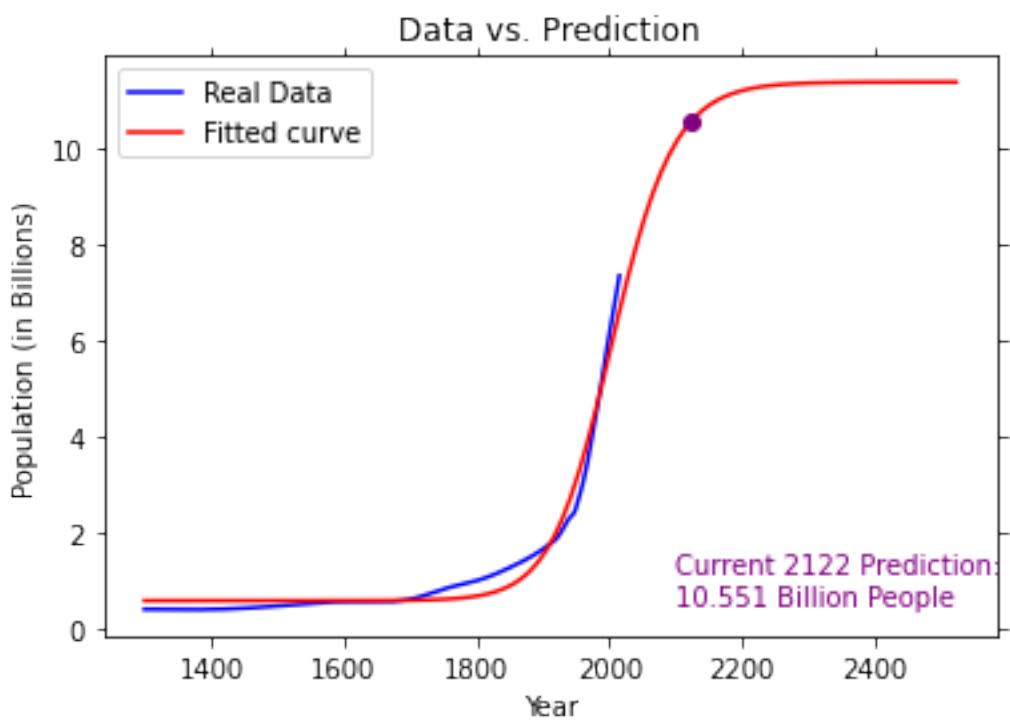
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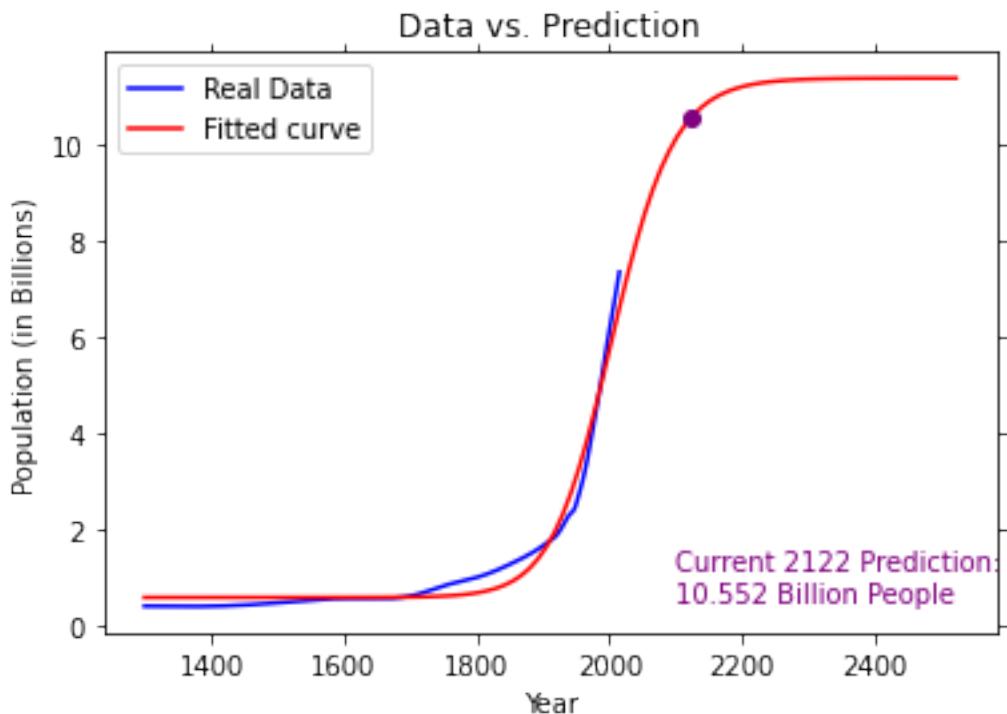
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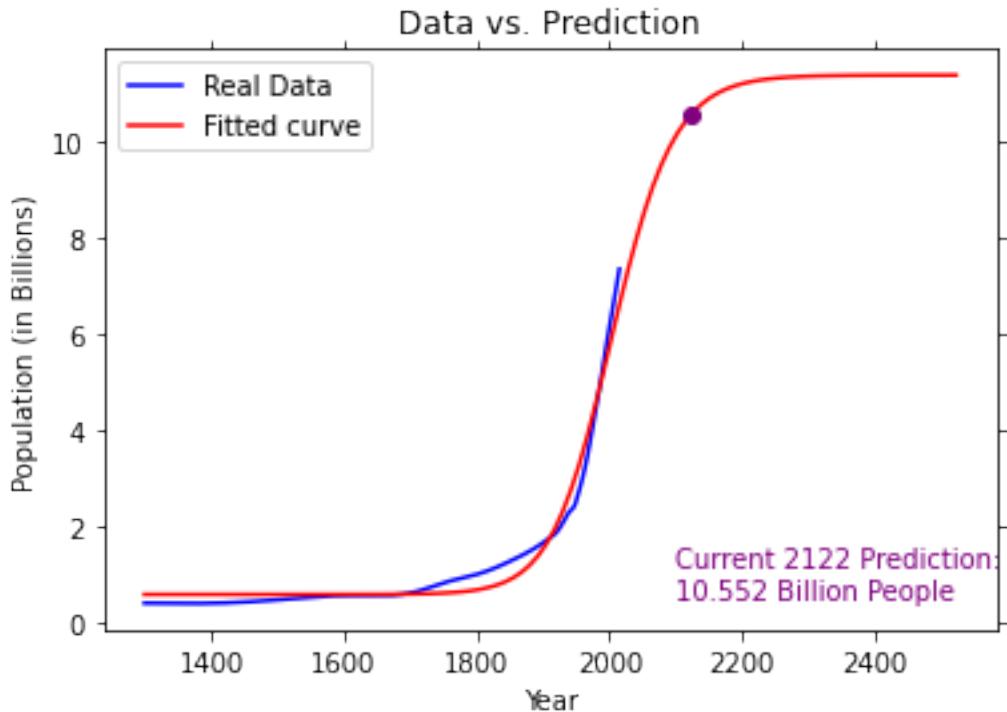
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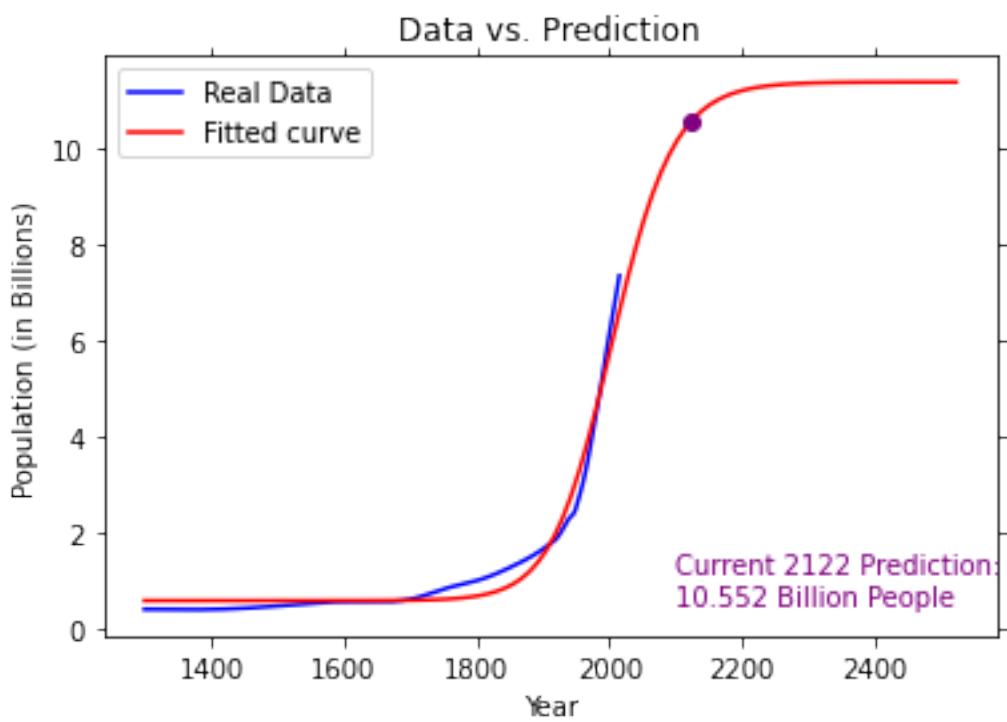
Iteration #19000, Loss: 0.05330765589736476



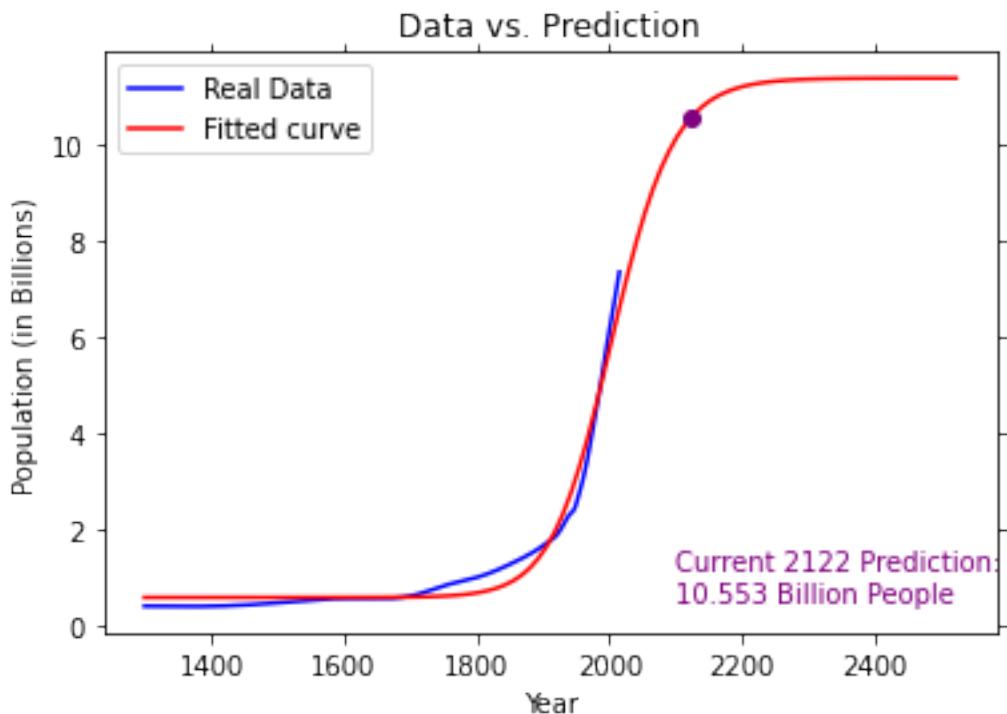
Iteration #19050, Loss: 0.053298238555197726



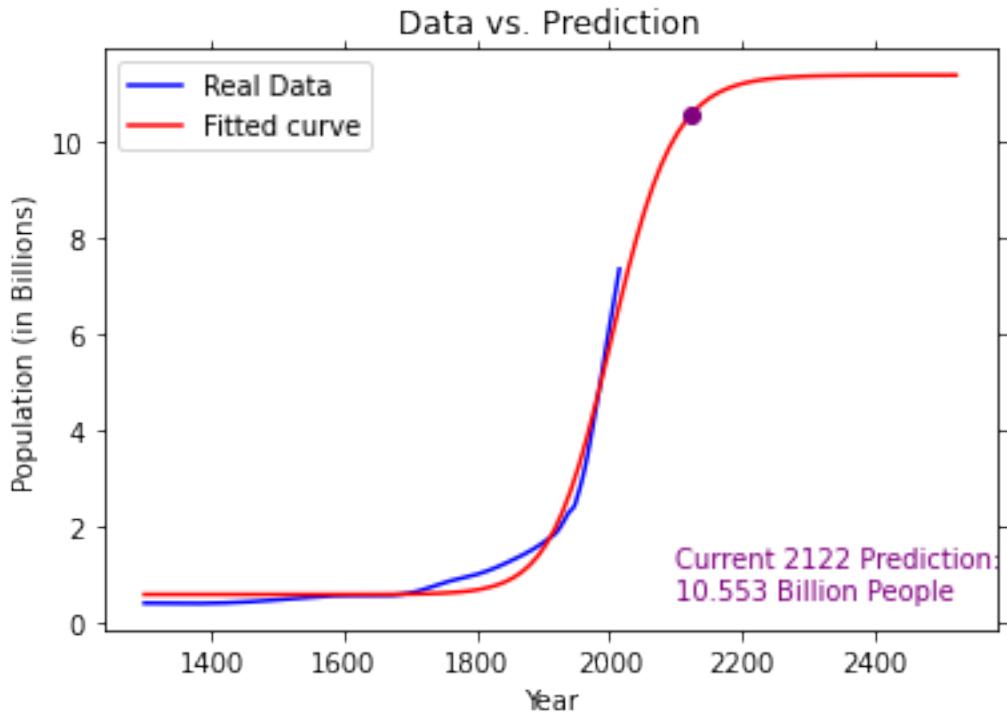
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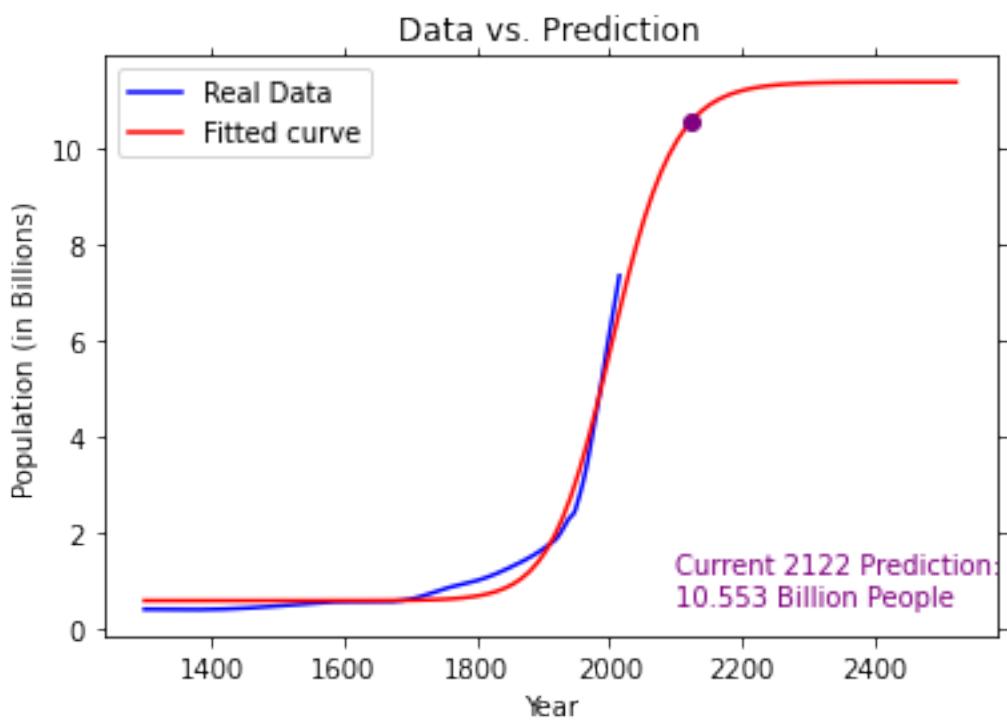
Iteration #19150, Loss: 0.05327946102078372



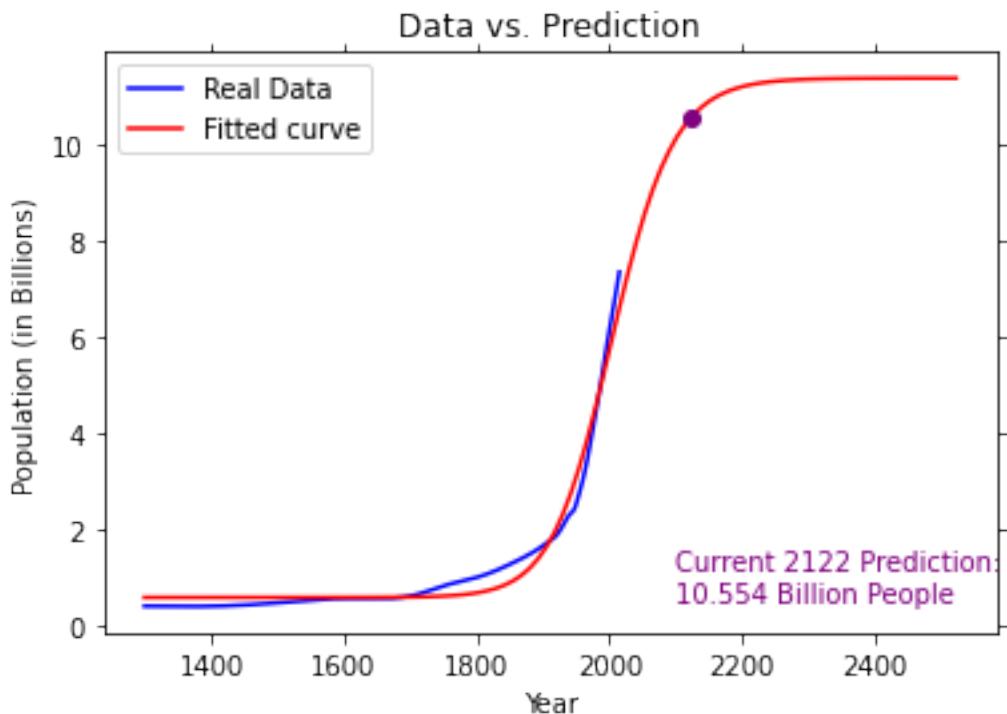
Iteration #19200, Loss: 0.05327010062431601



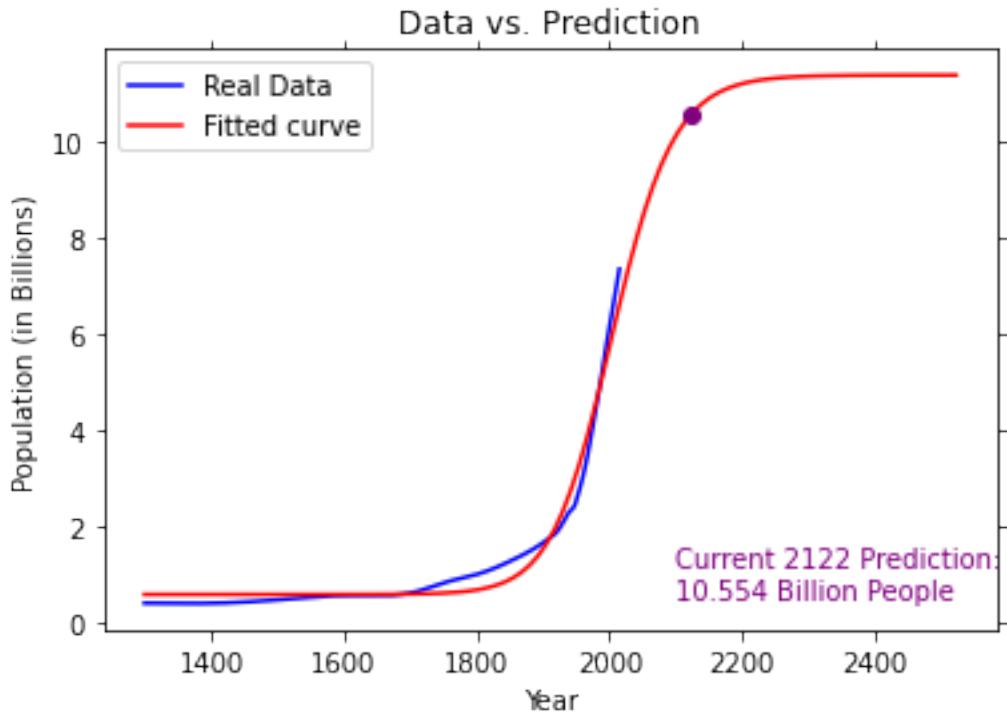
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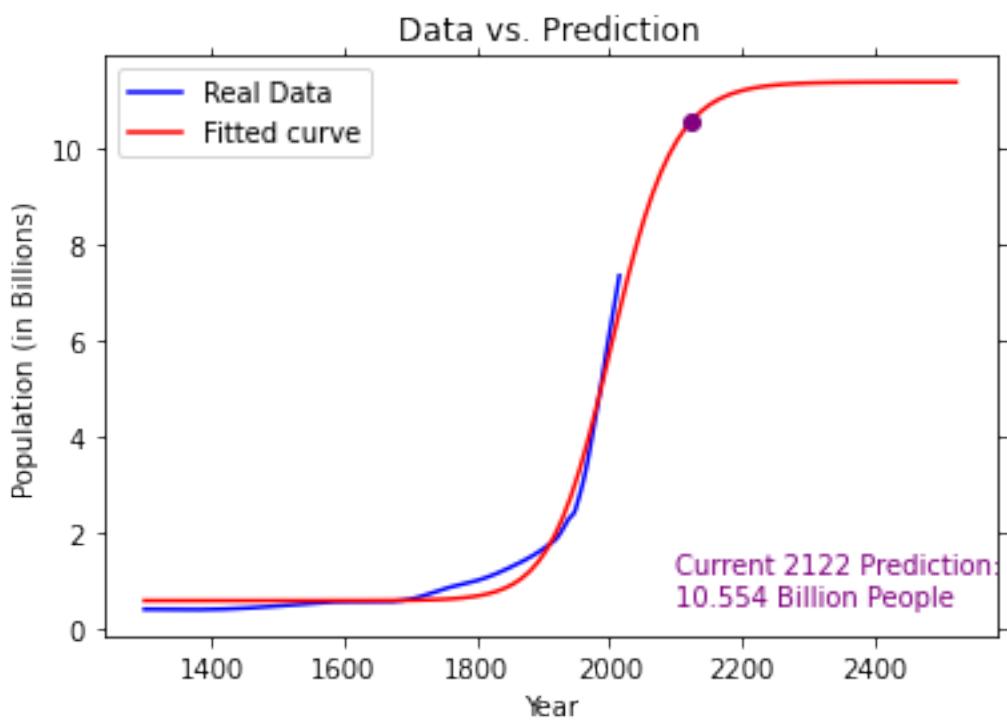
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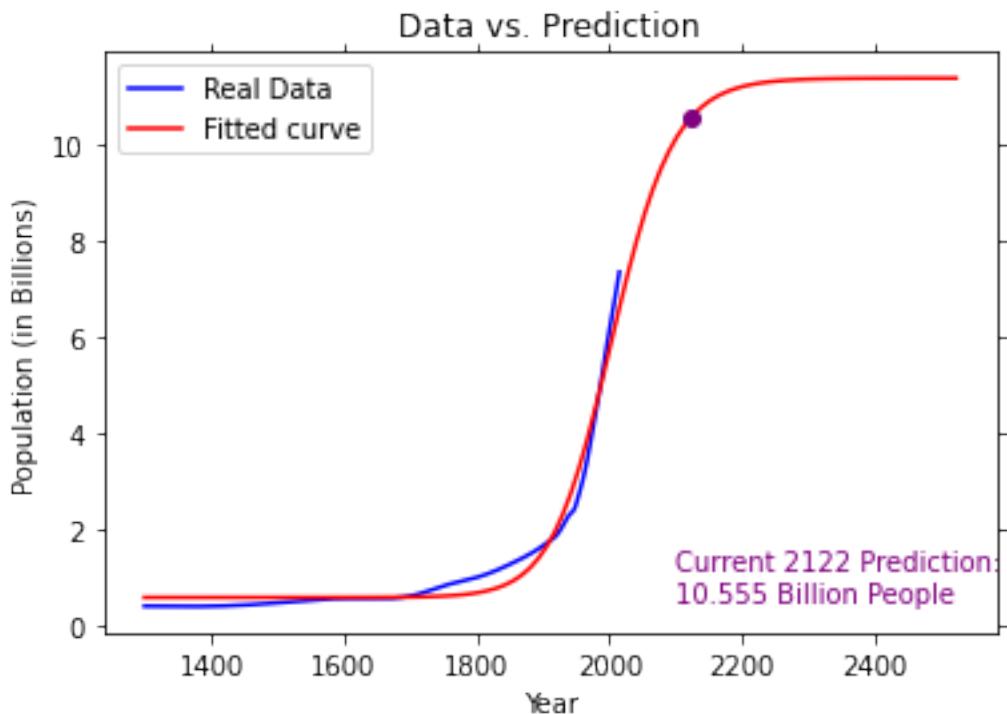
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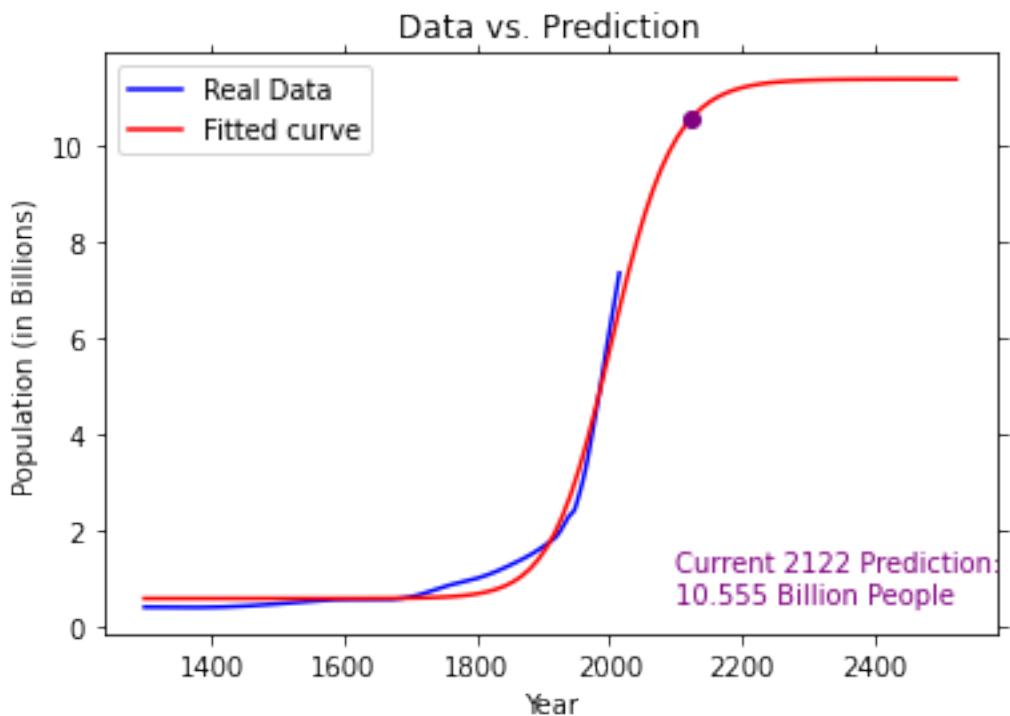
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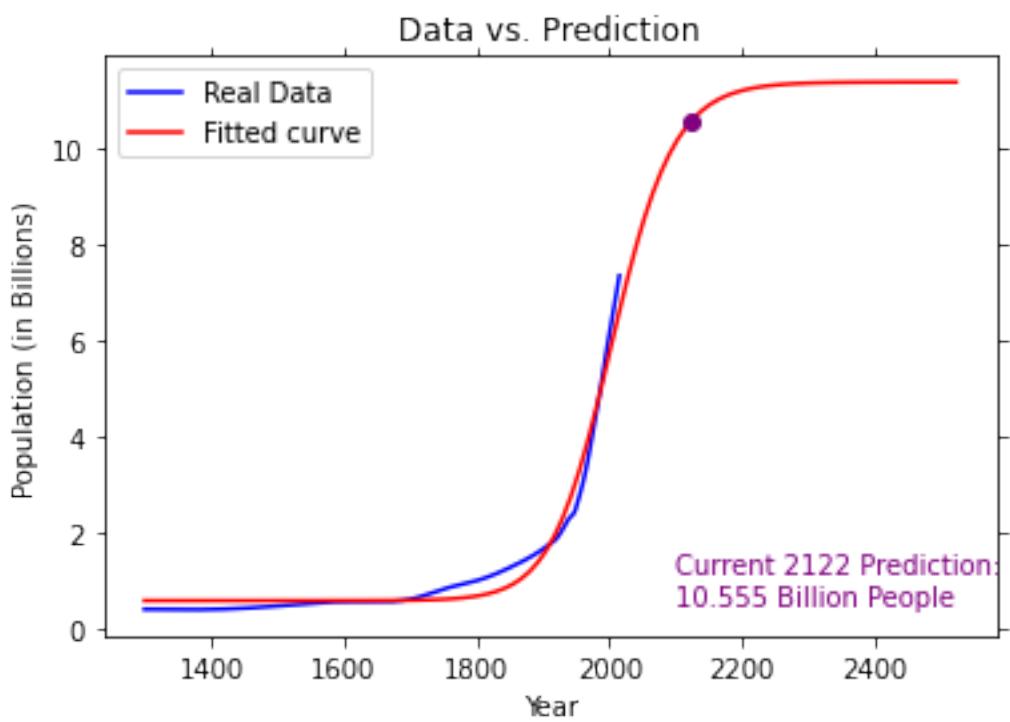
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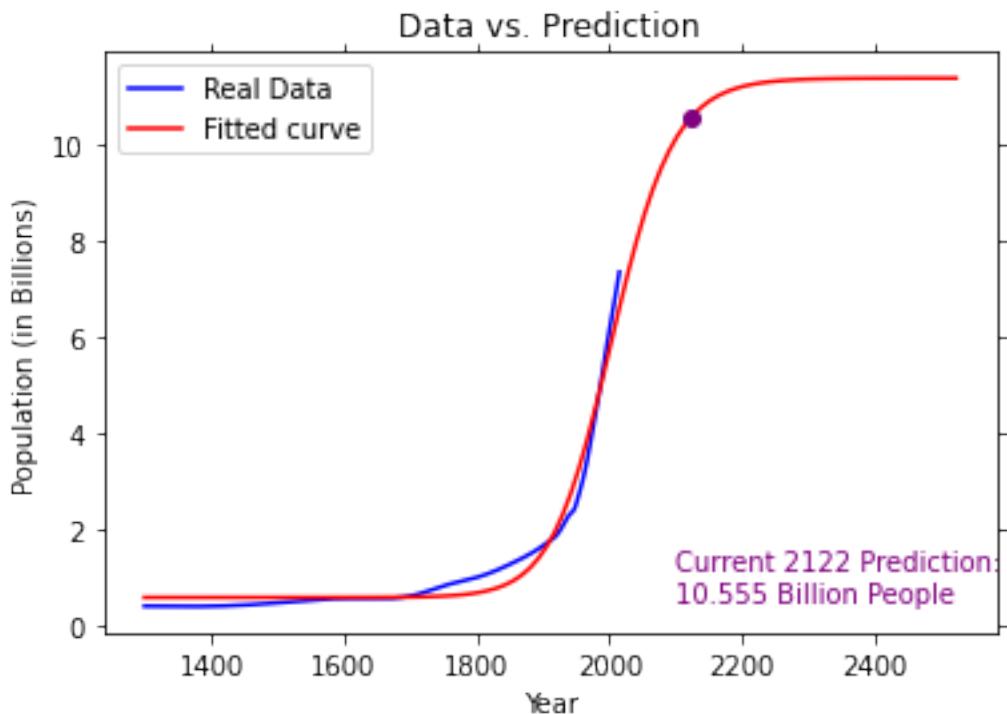
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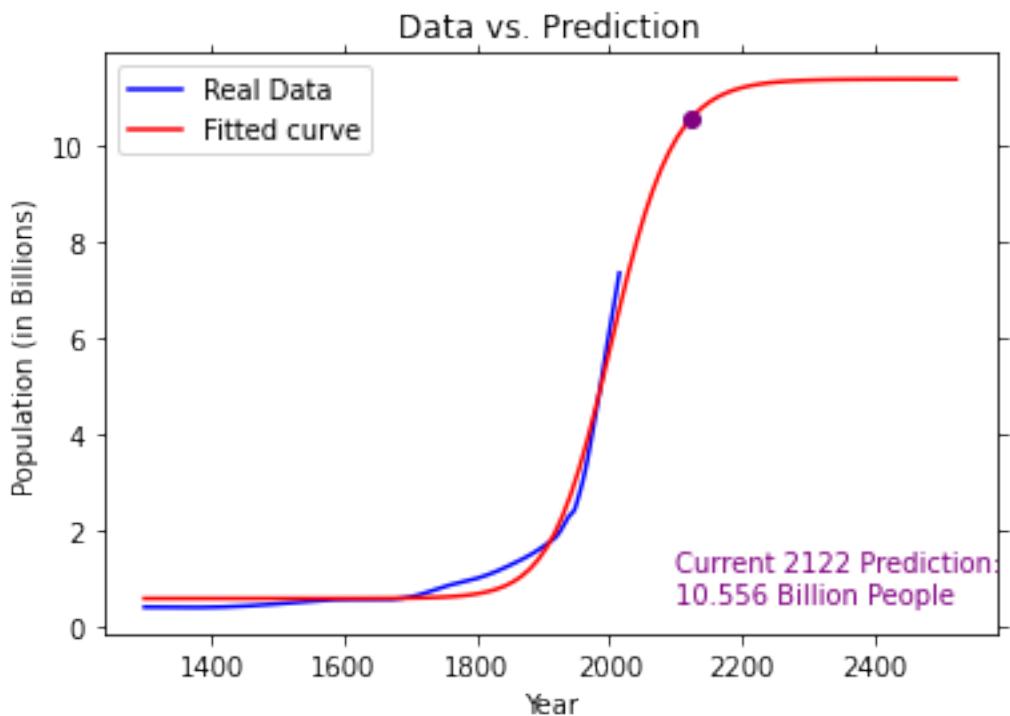
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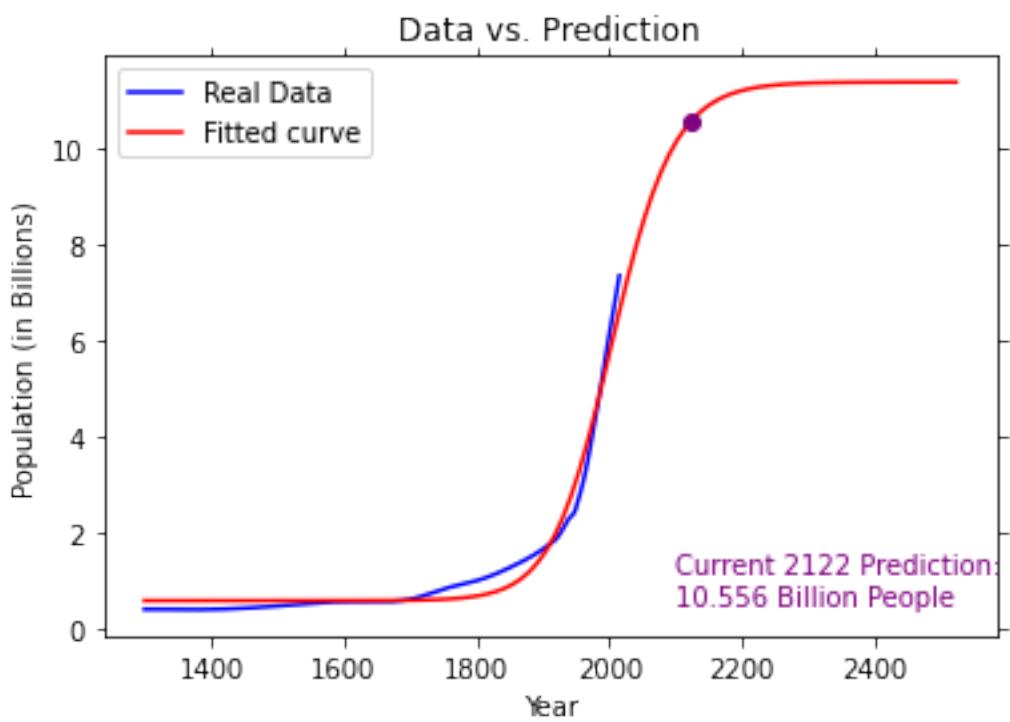
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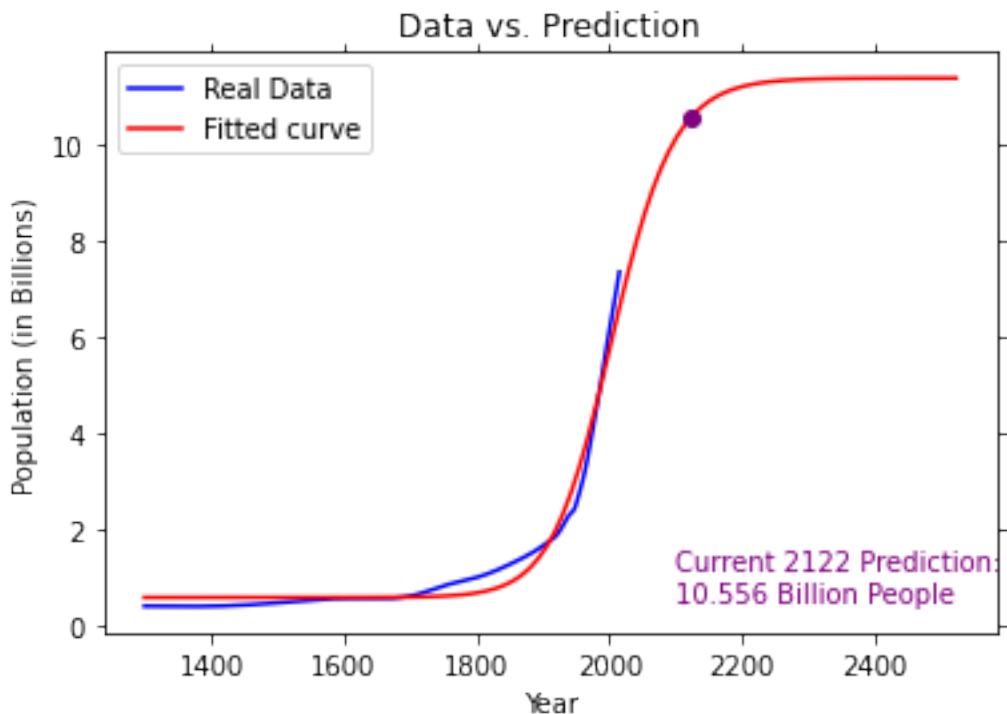
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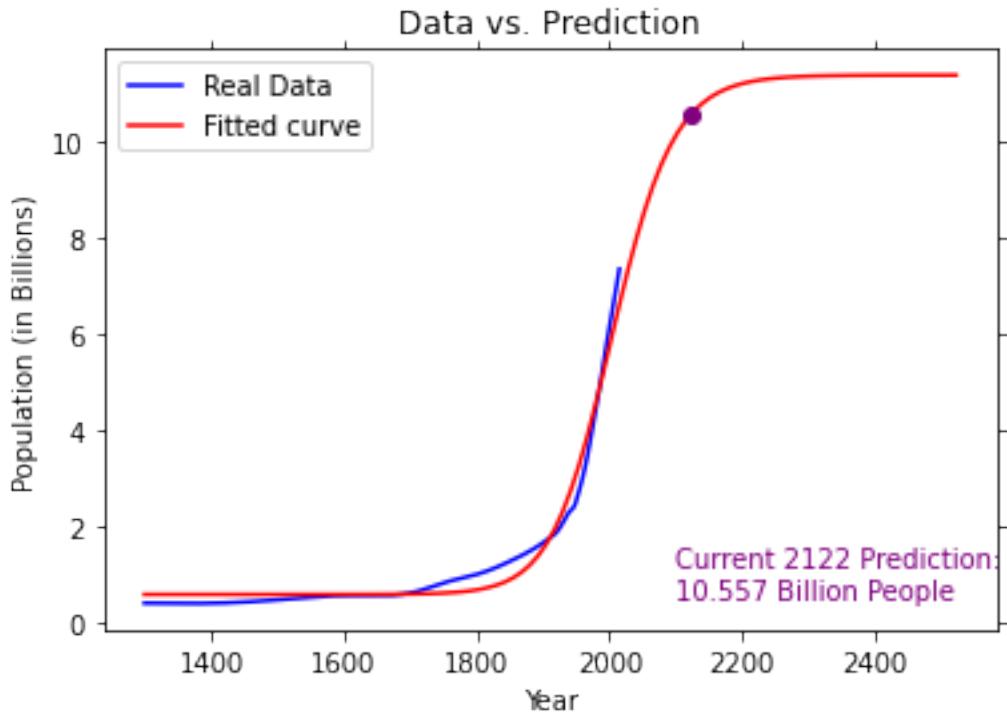
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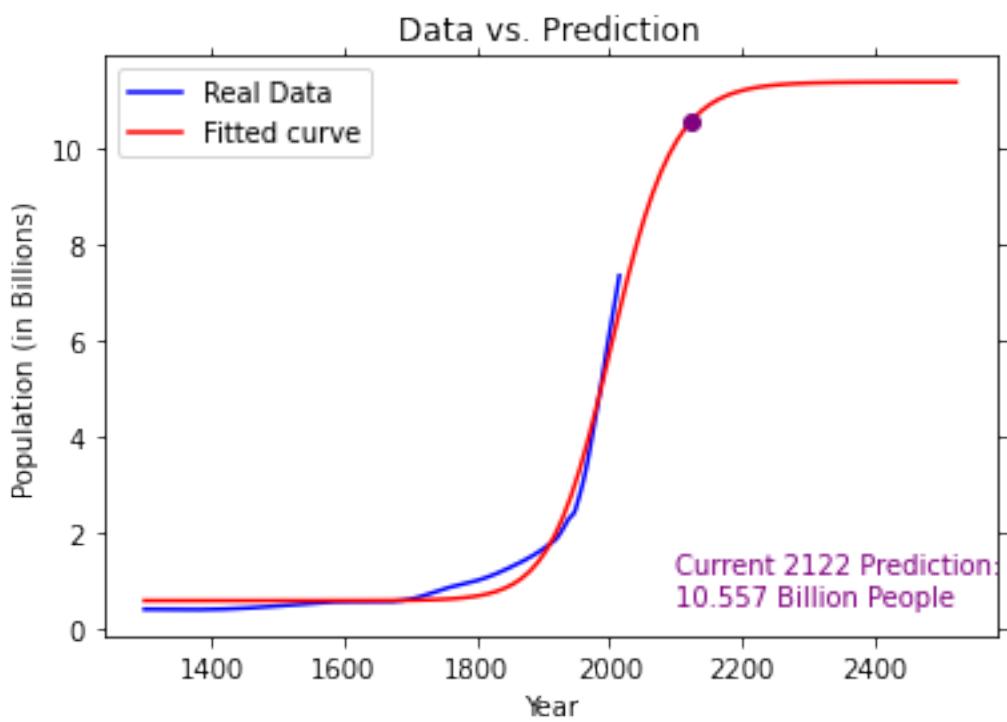
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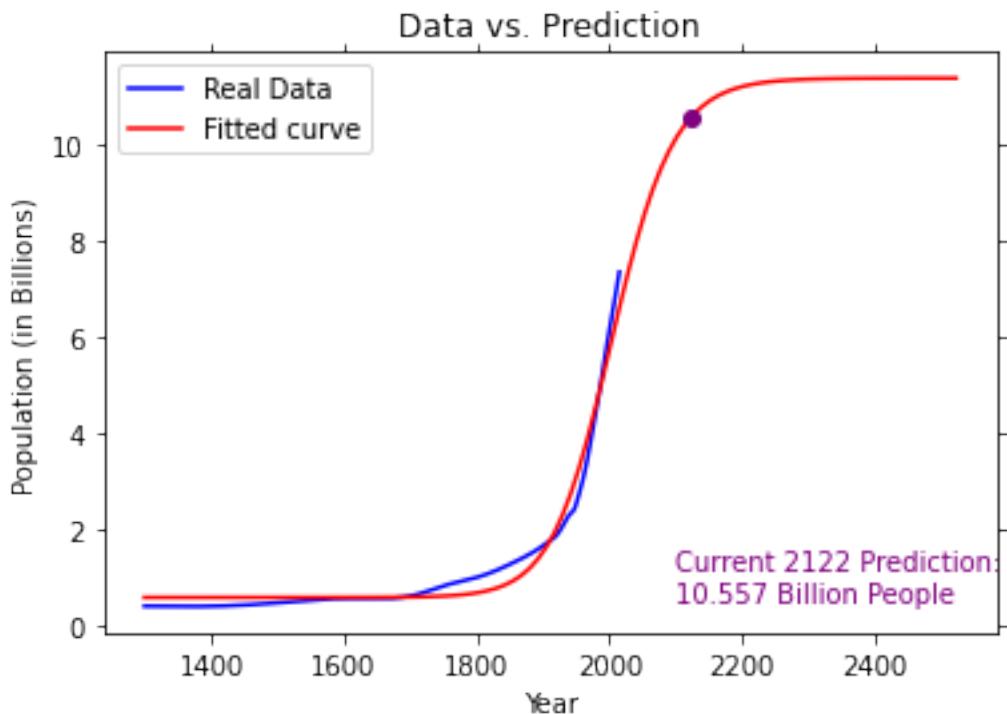
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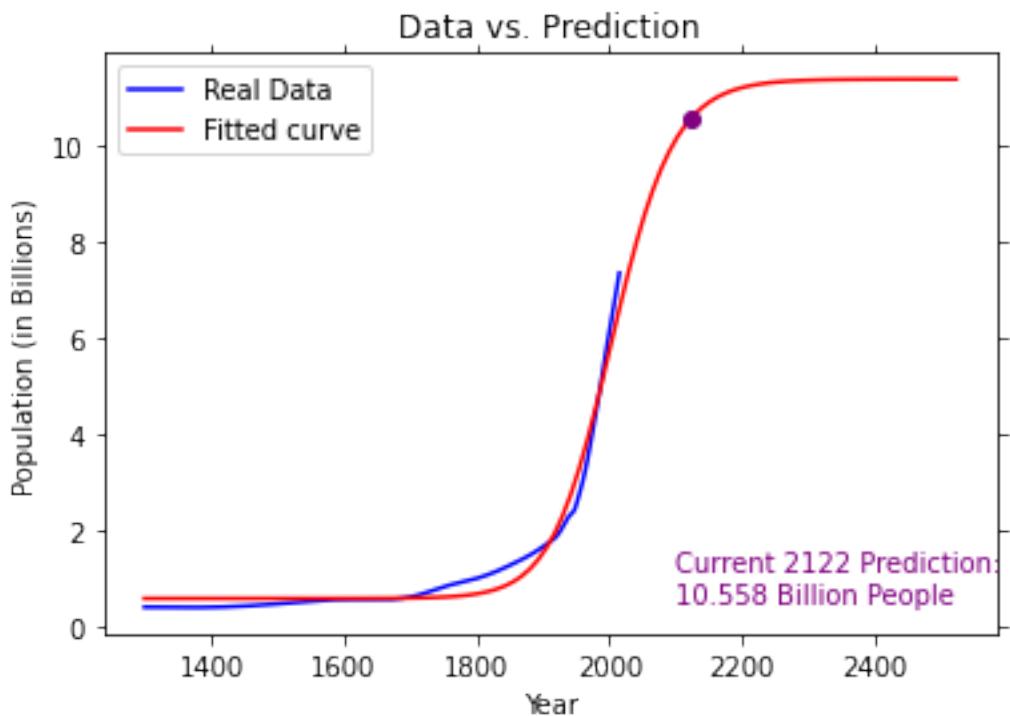
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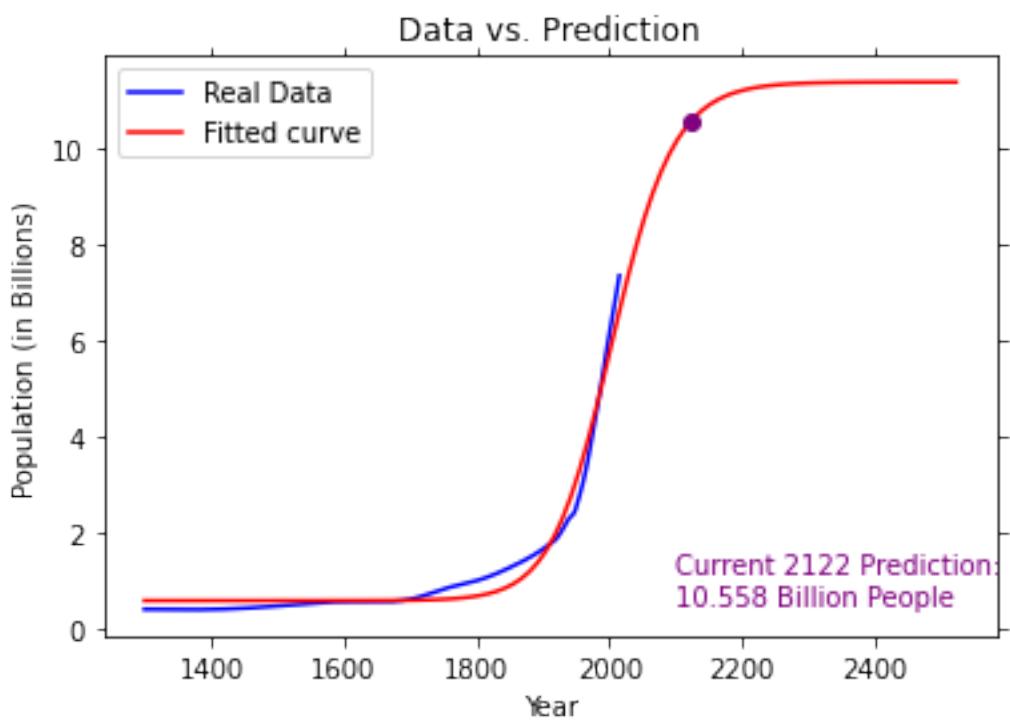
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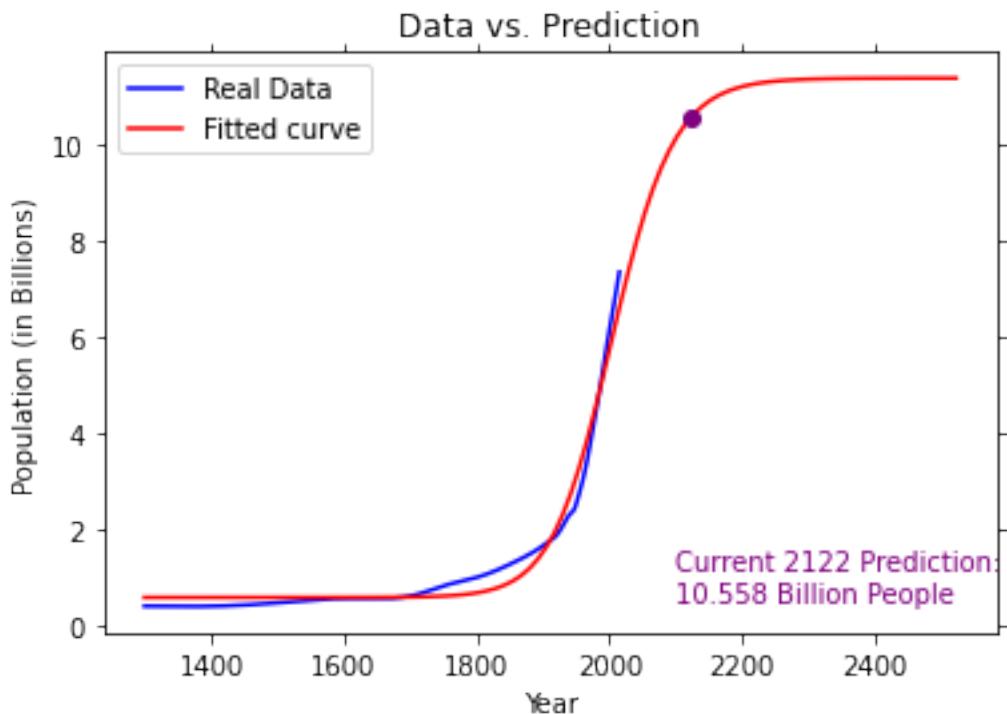
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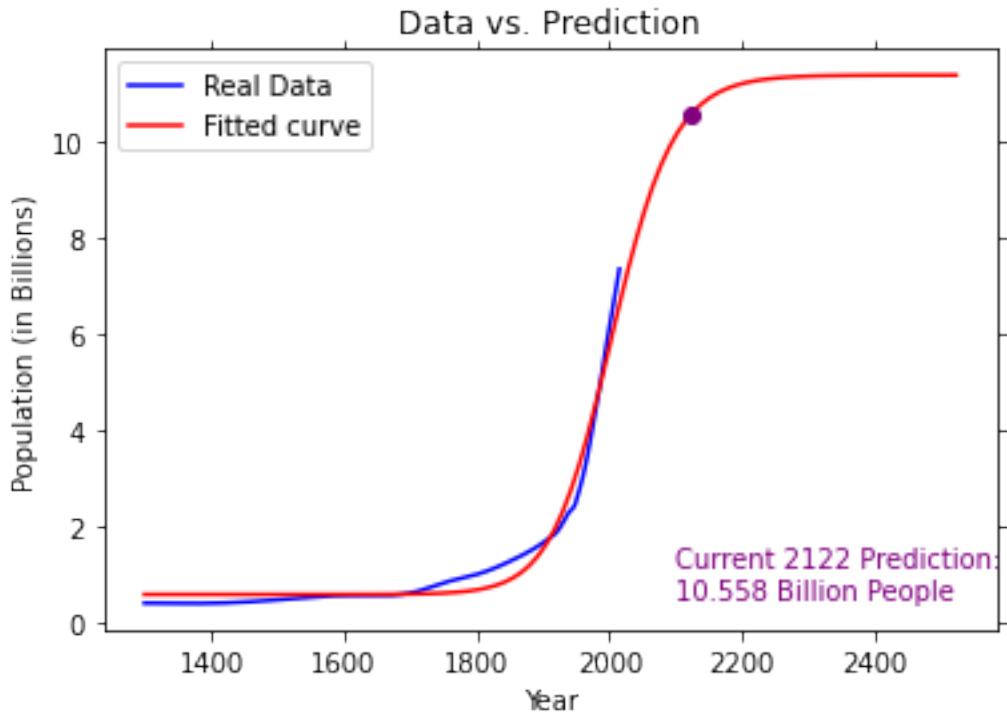
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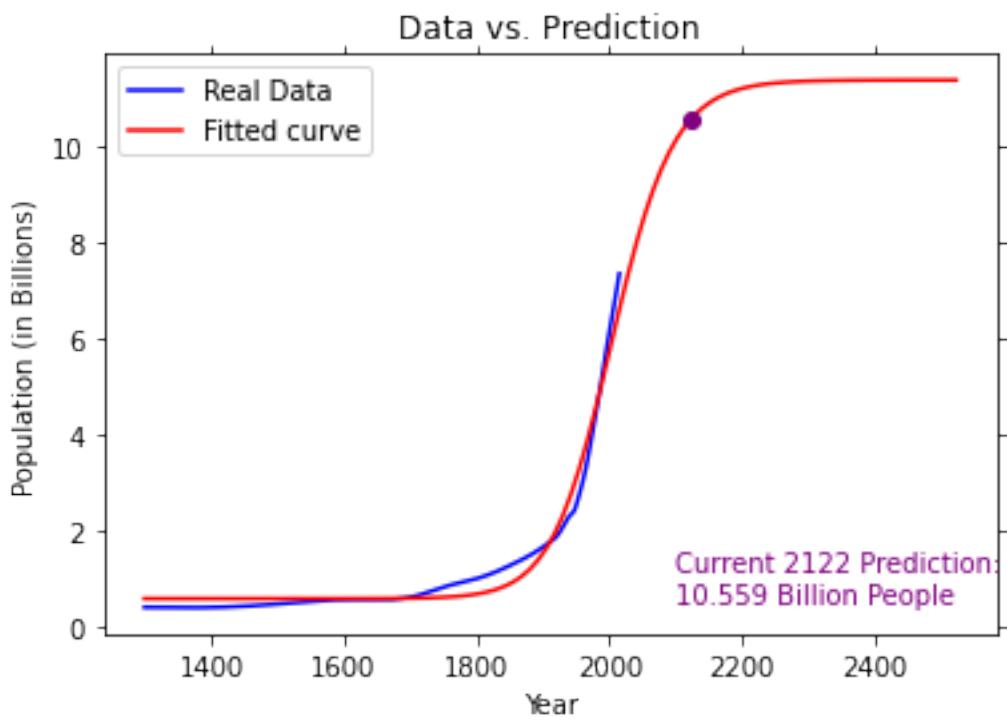
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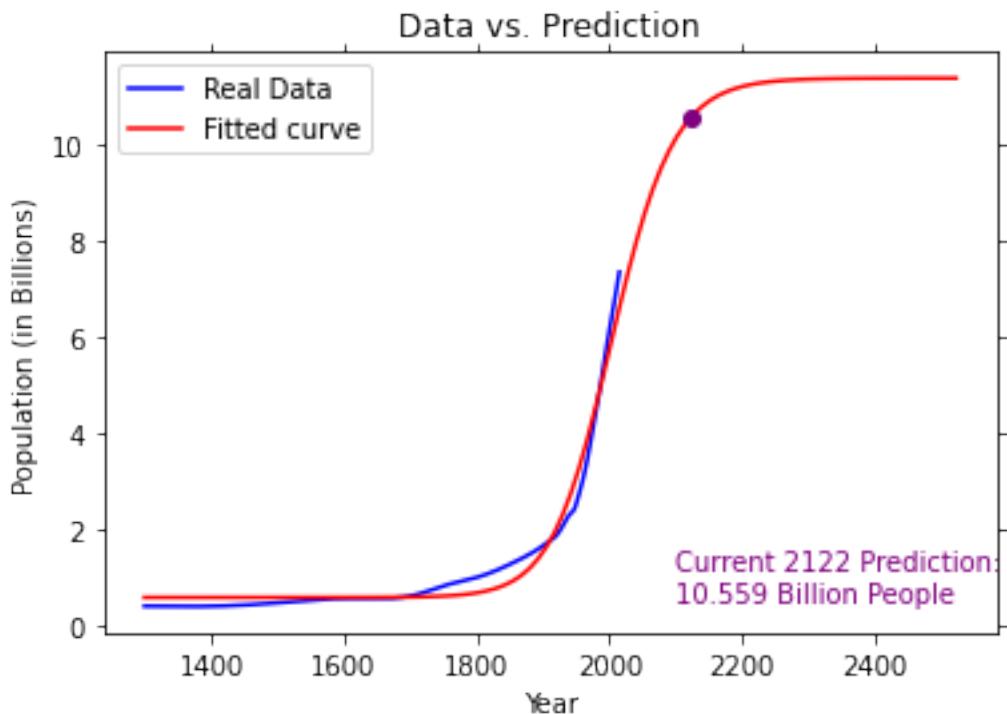
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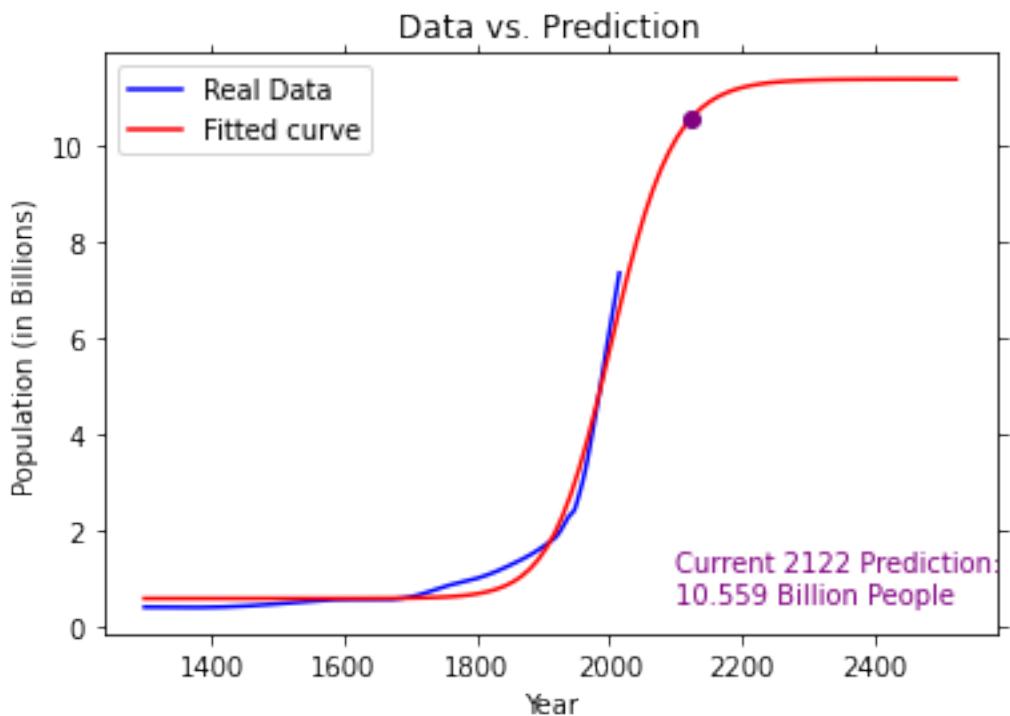
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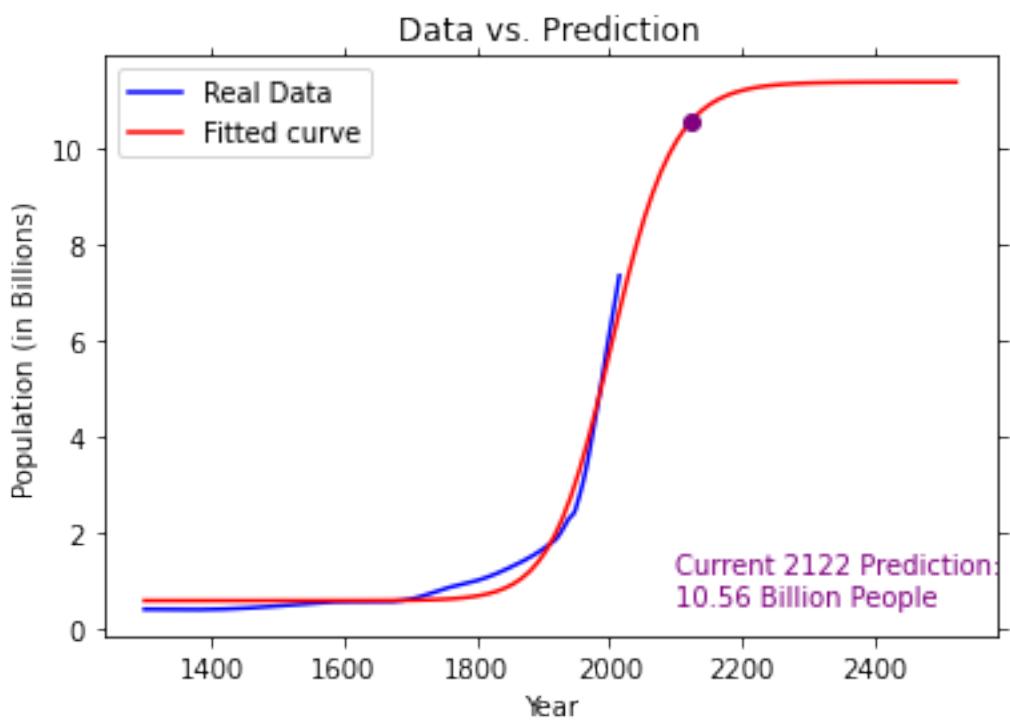
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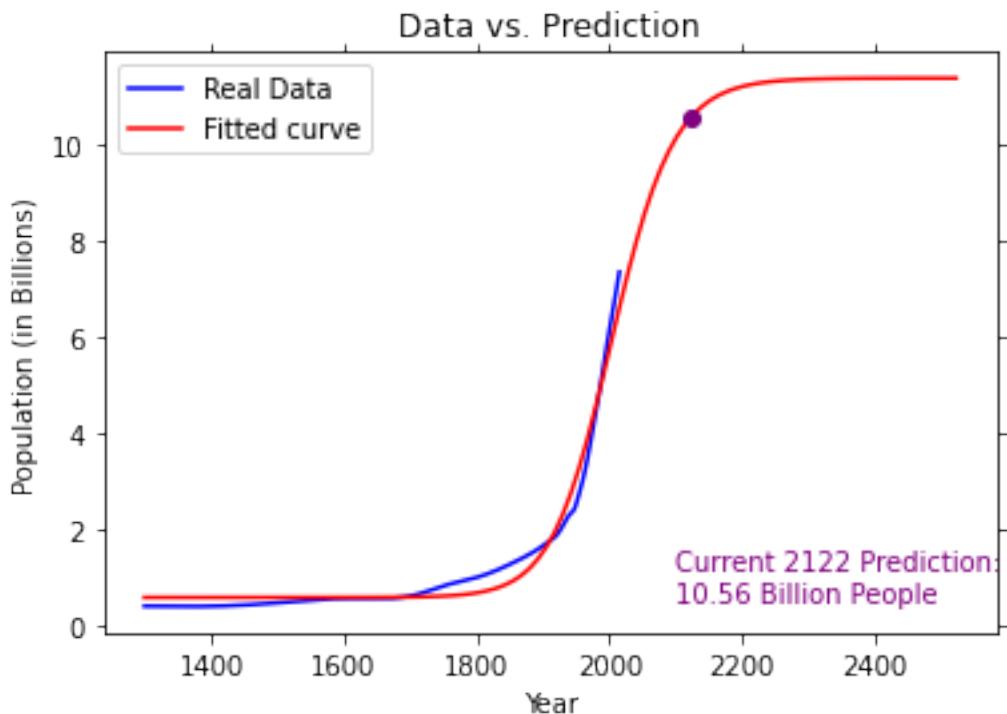
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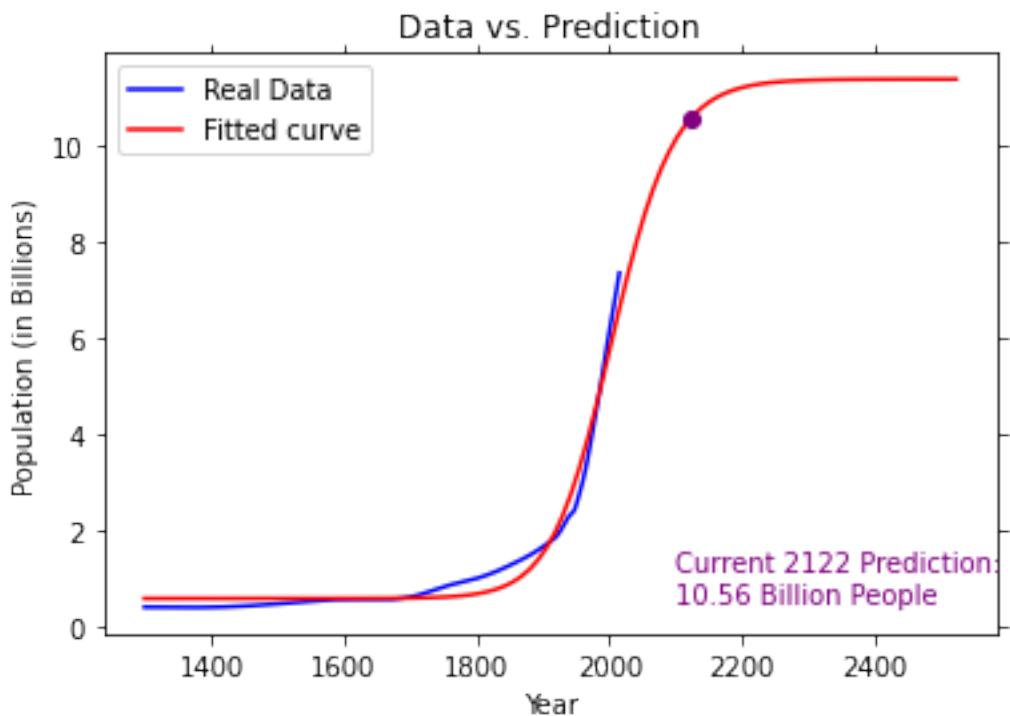
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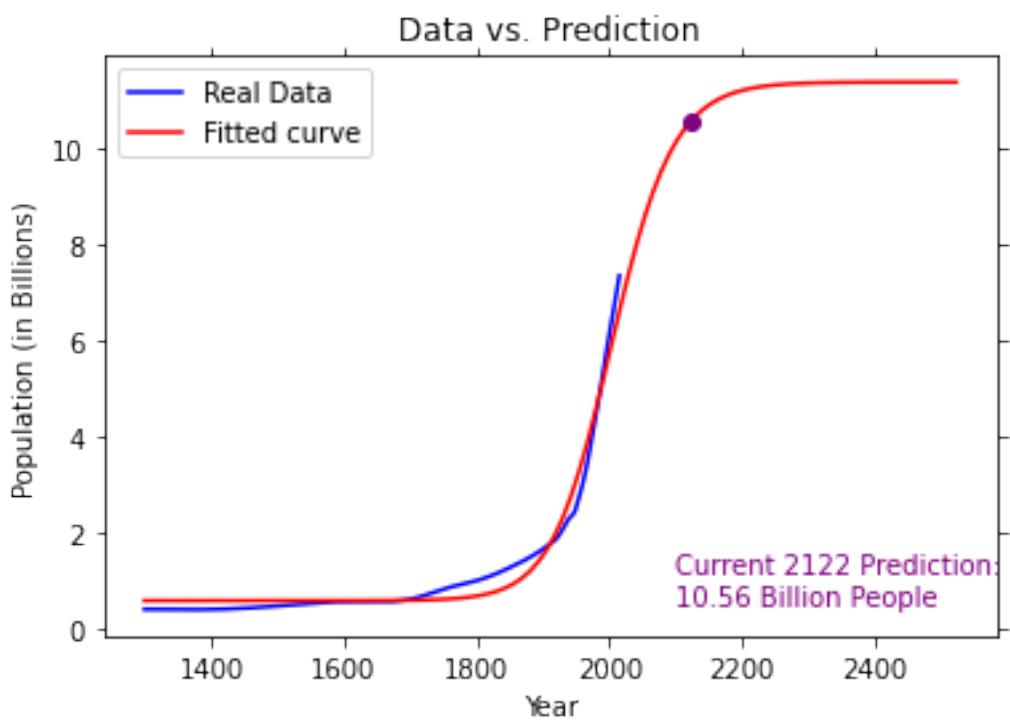
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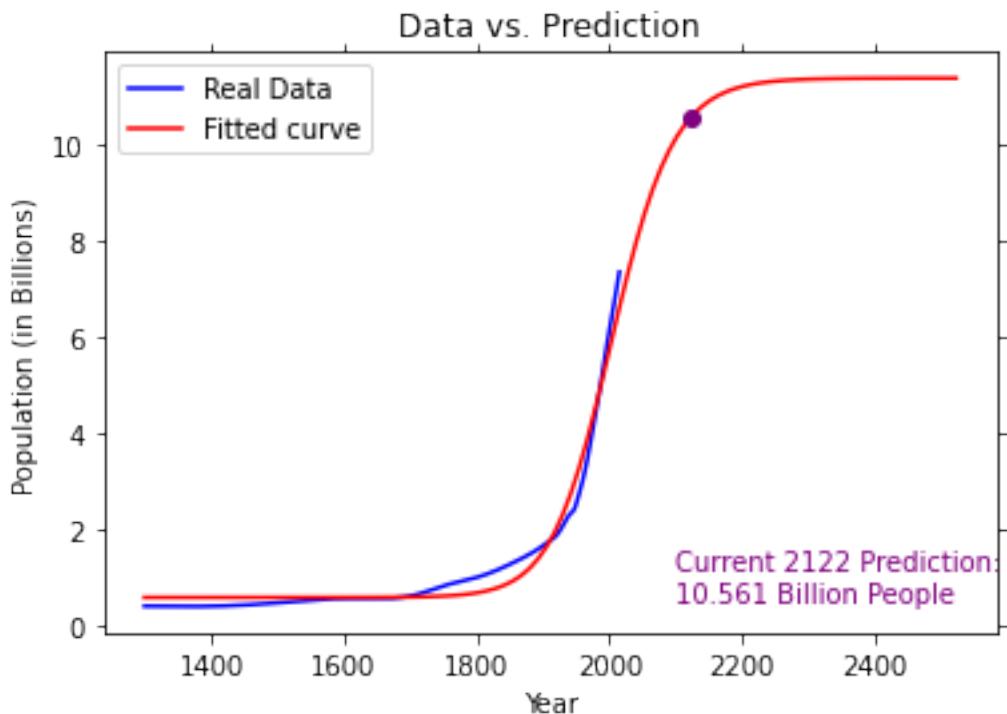
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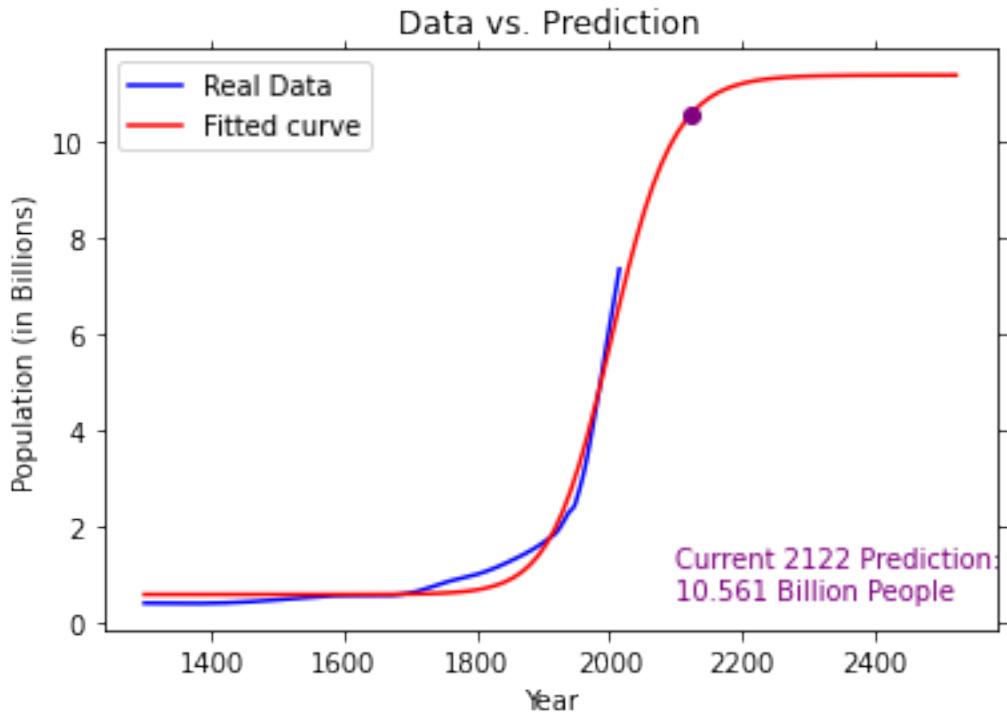
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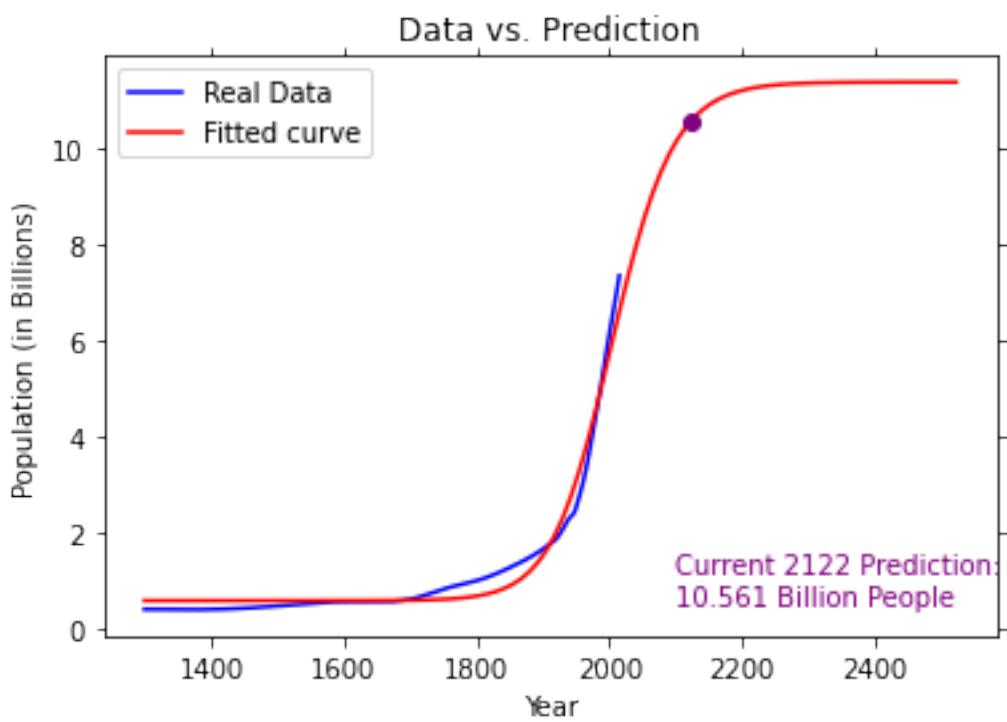
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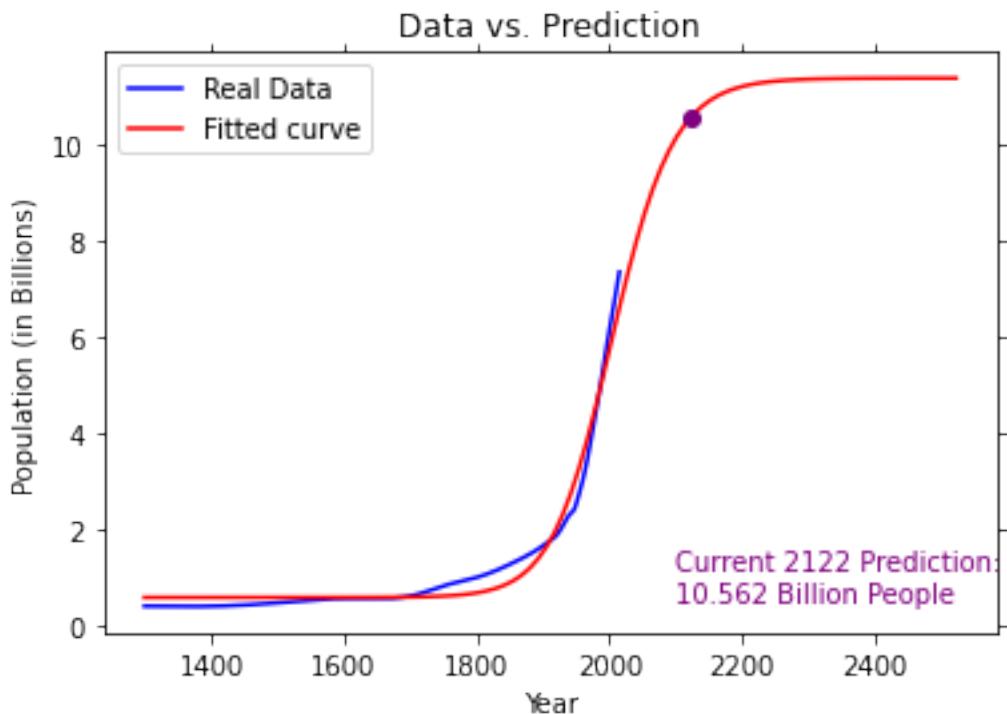
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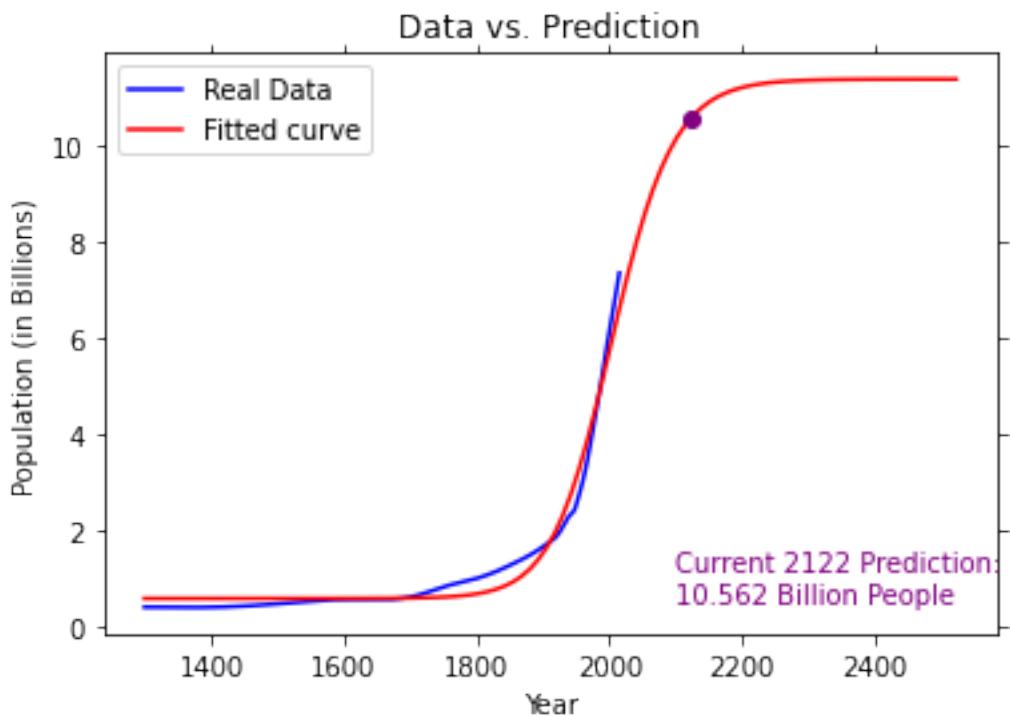
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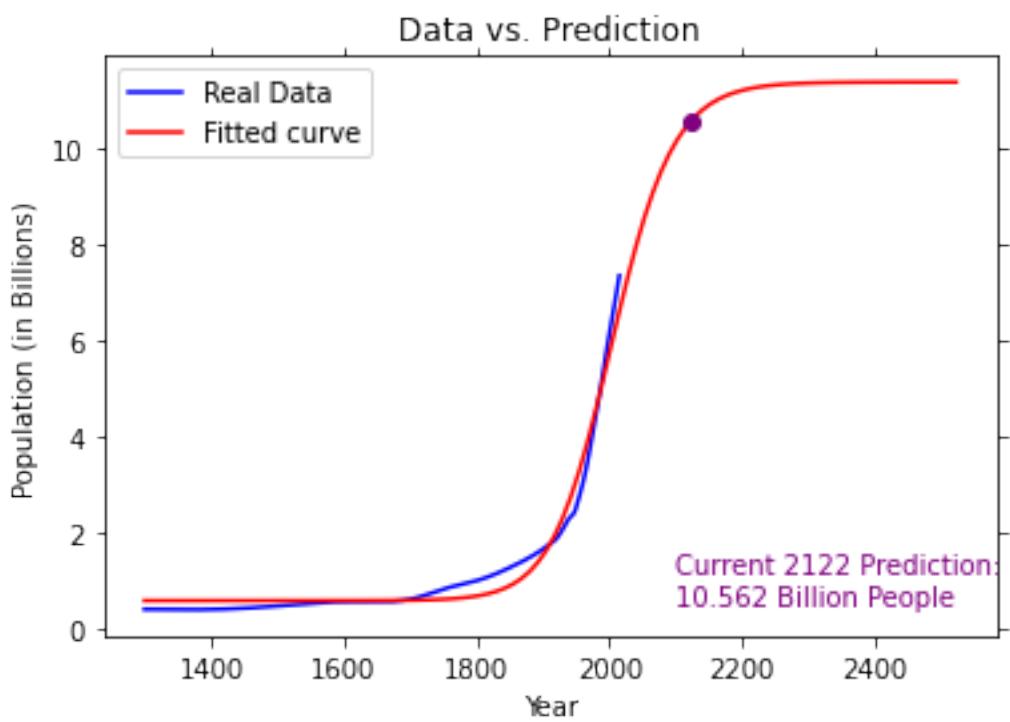
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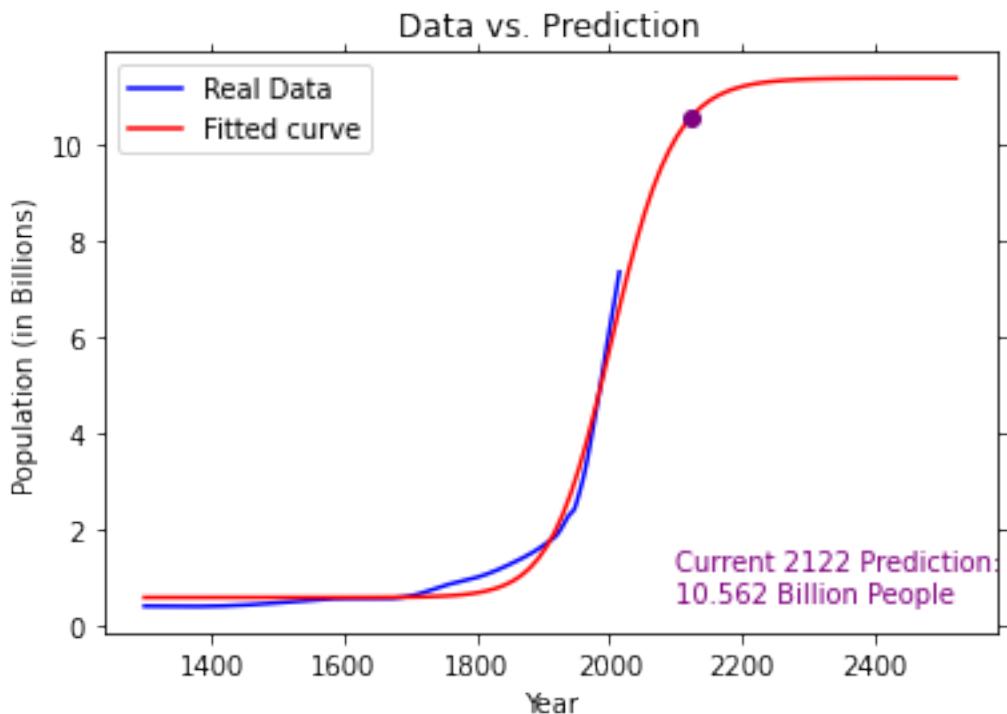
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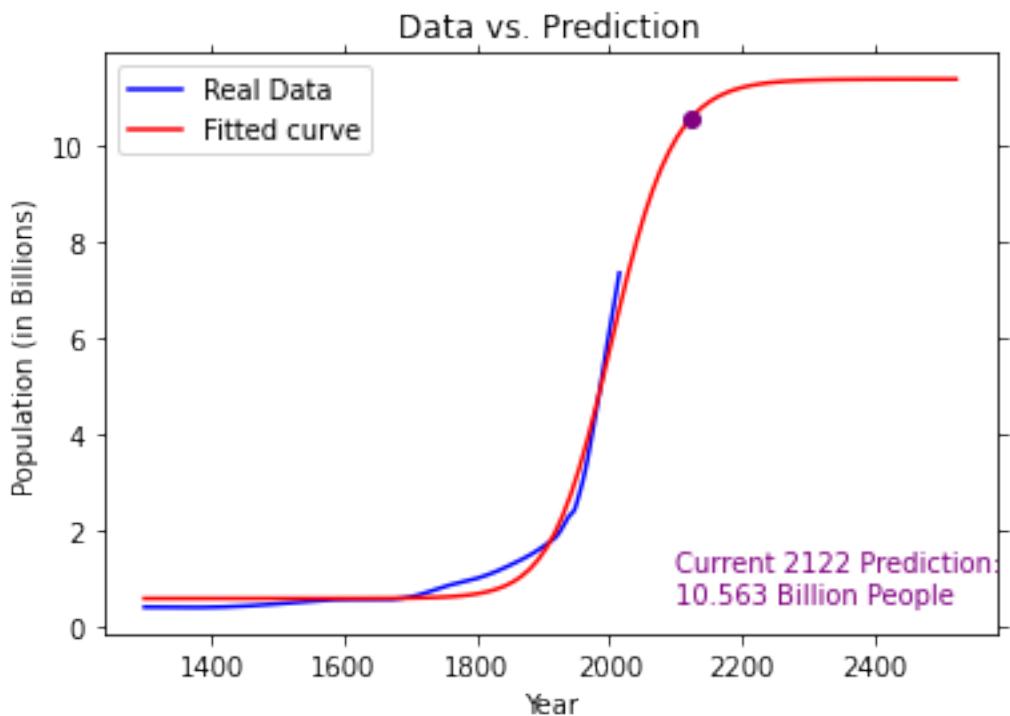
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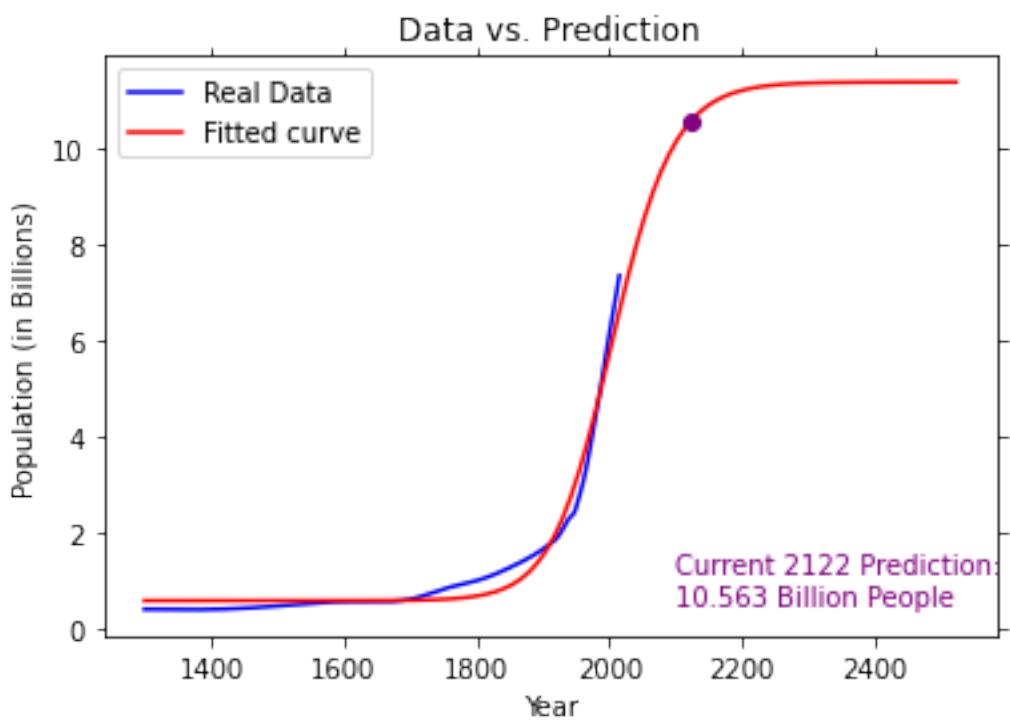
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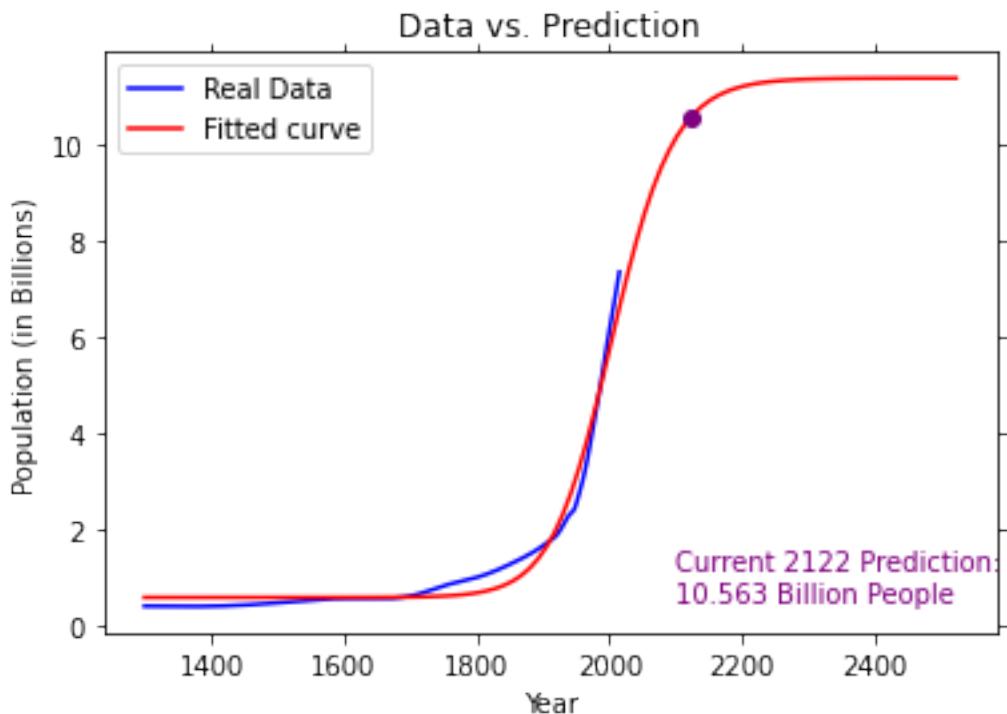
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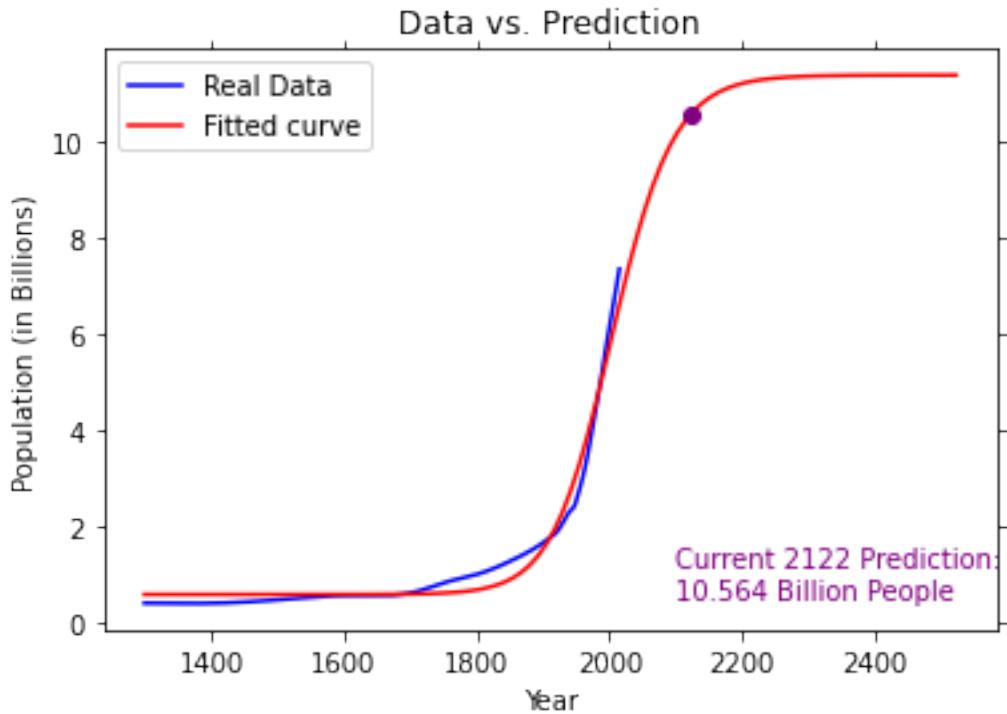
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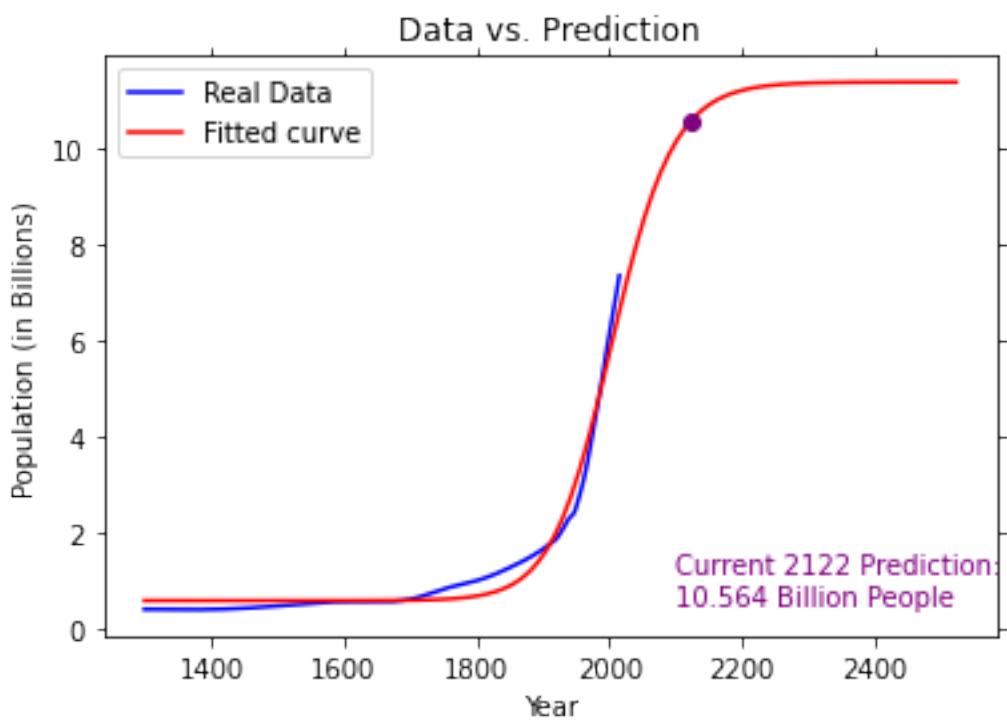
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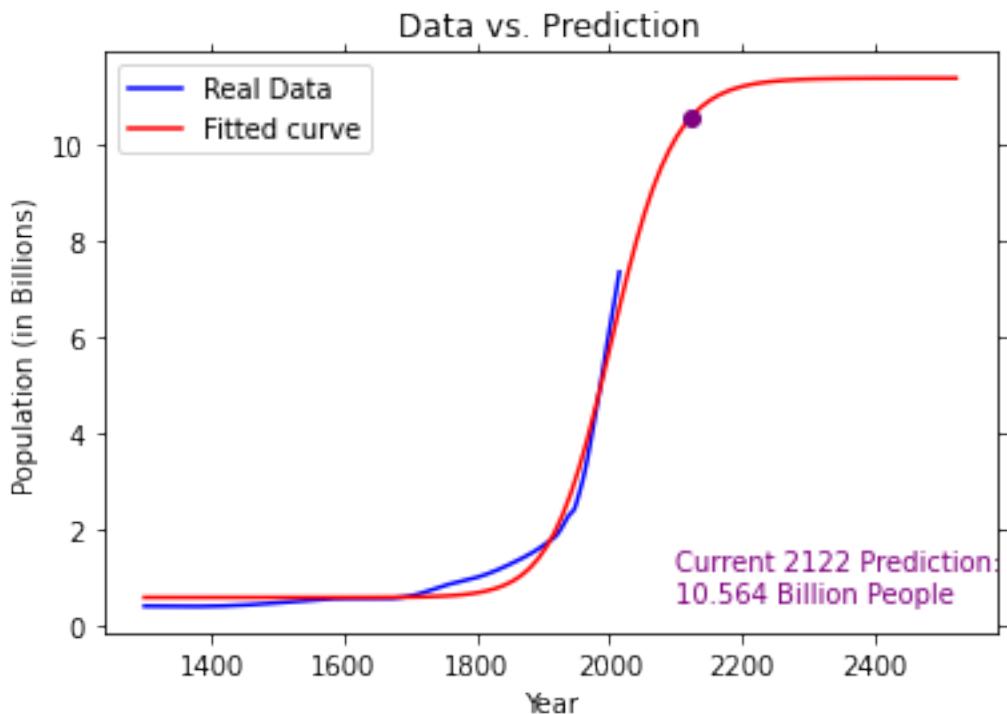
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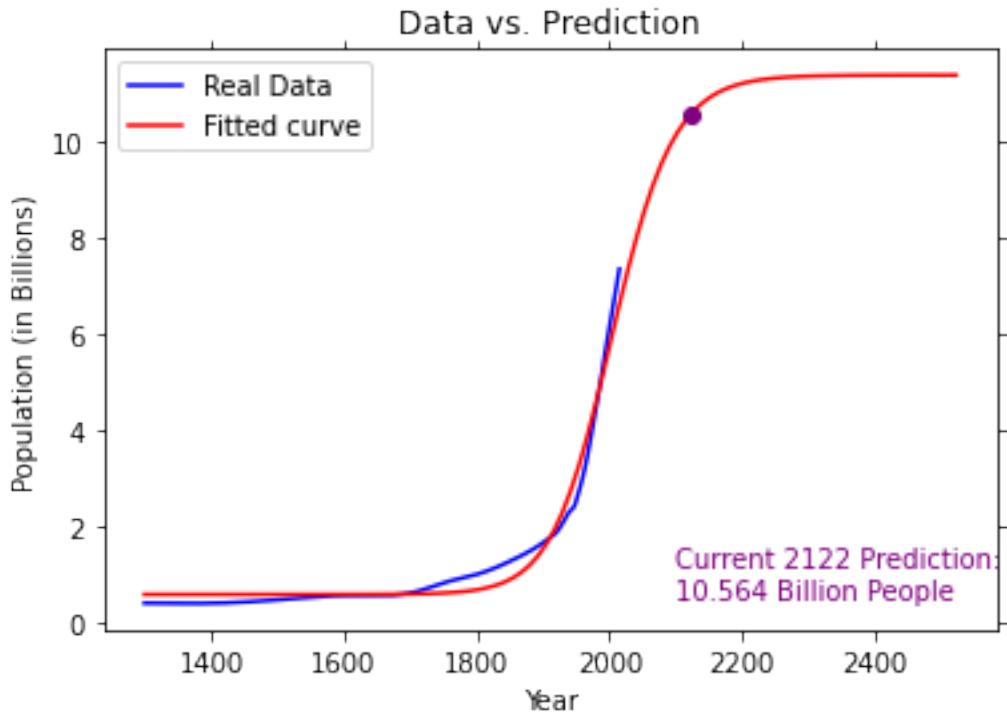
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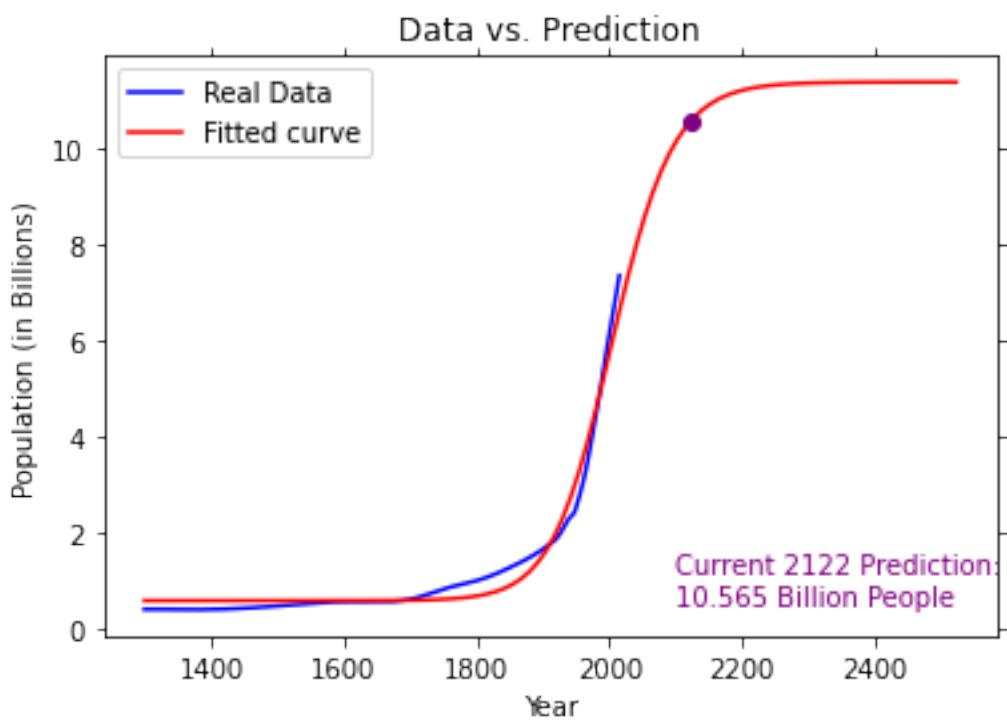
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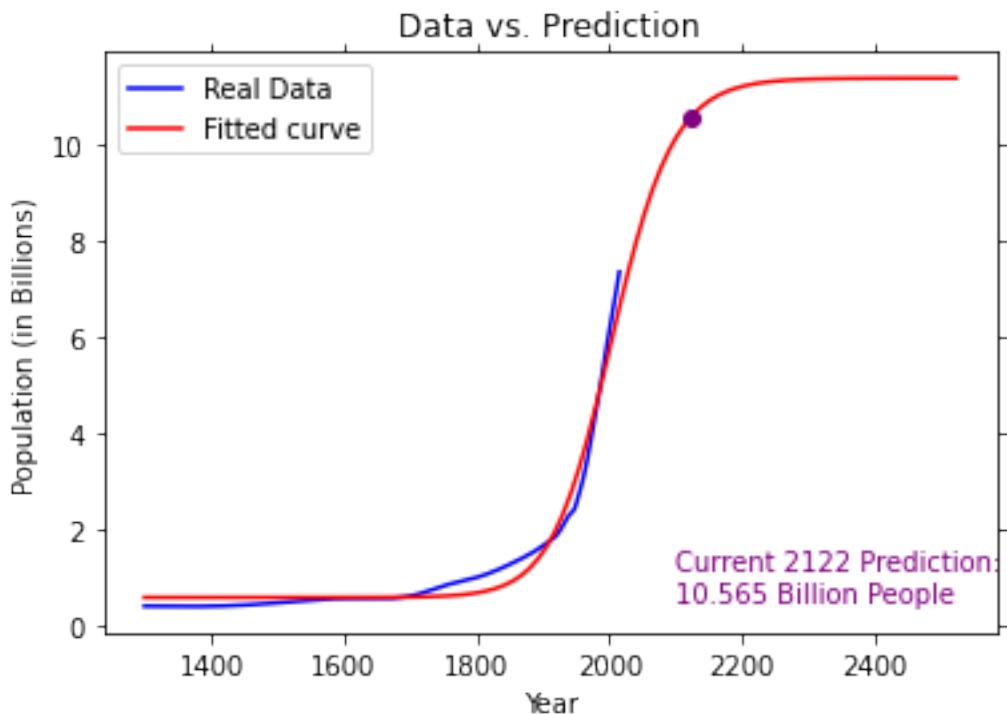
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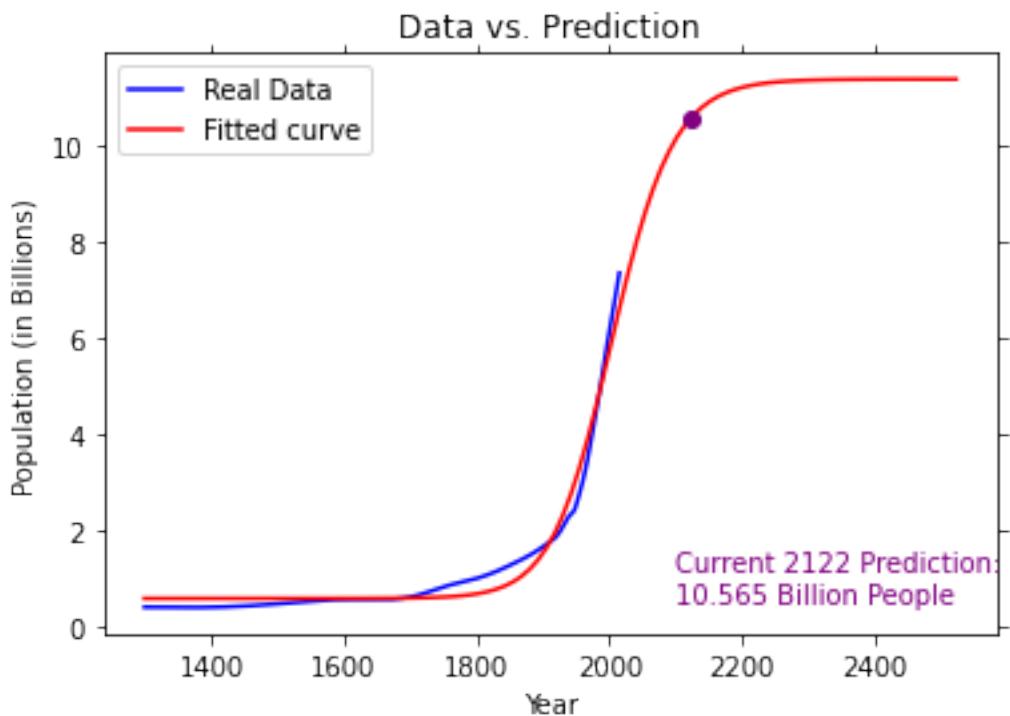
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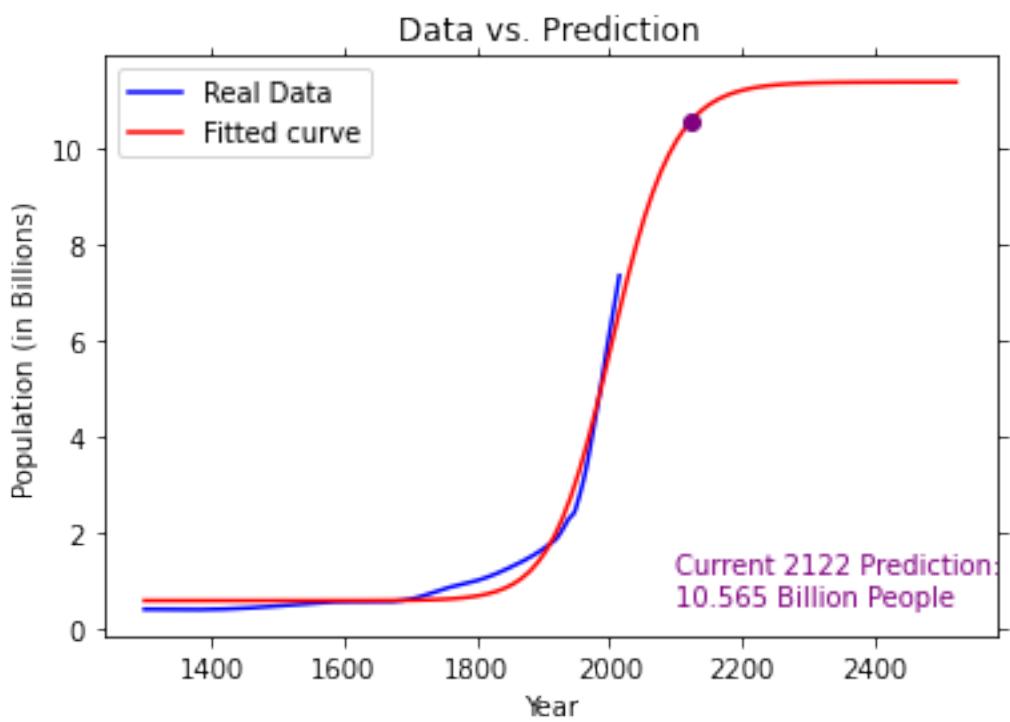
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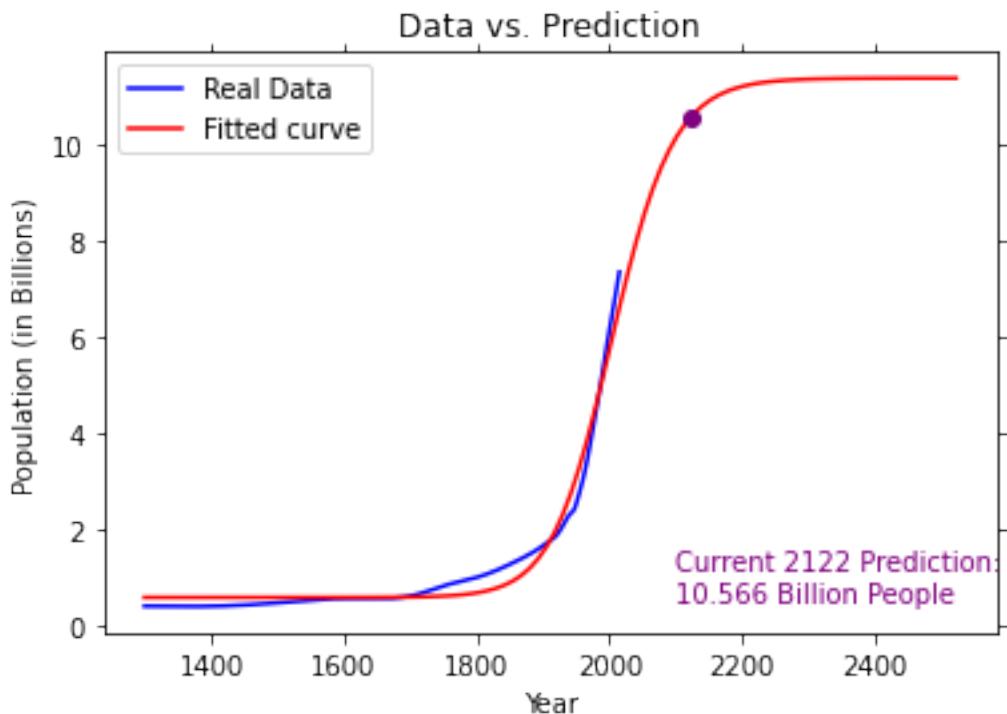
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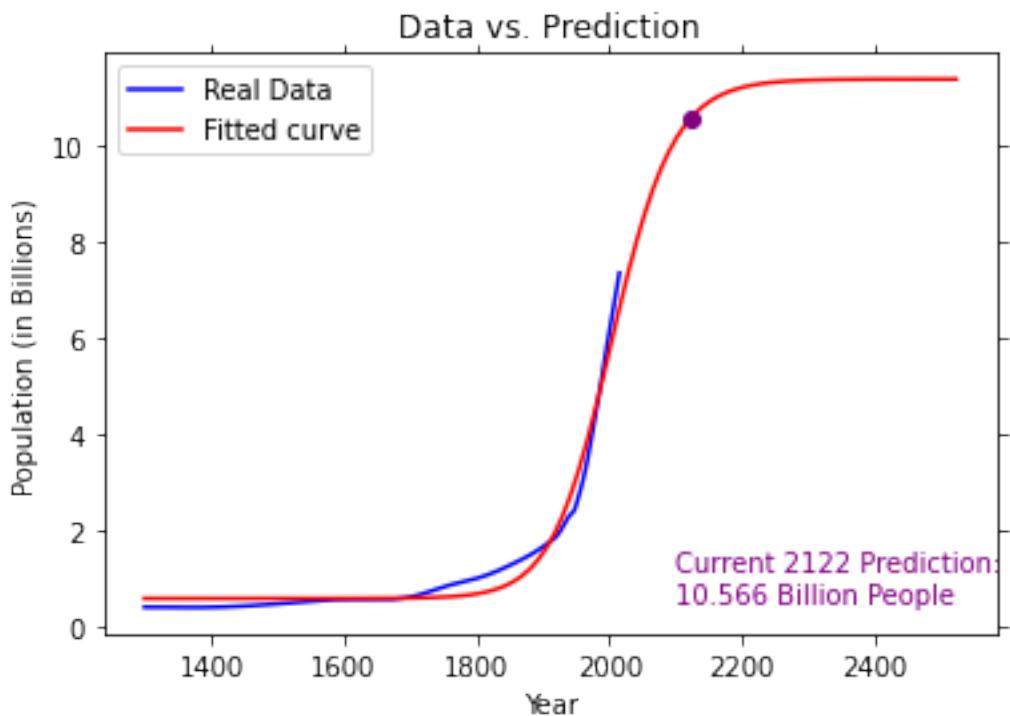
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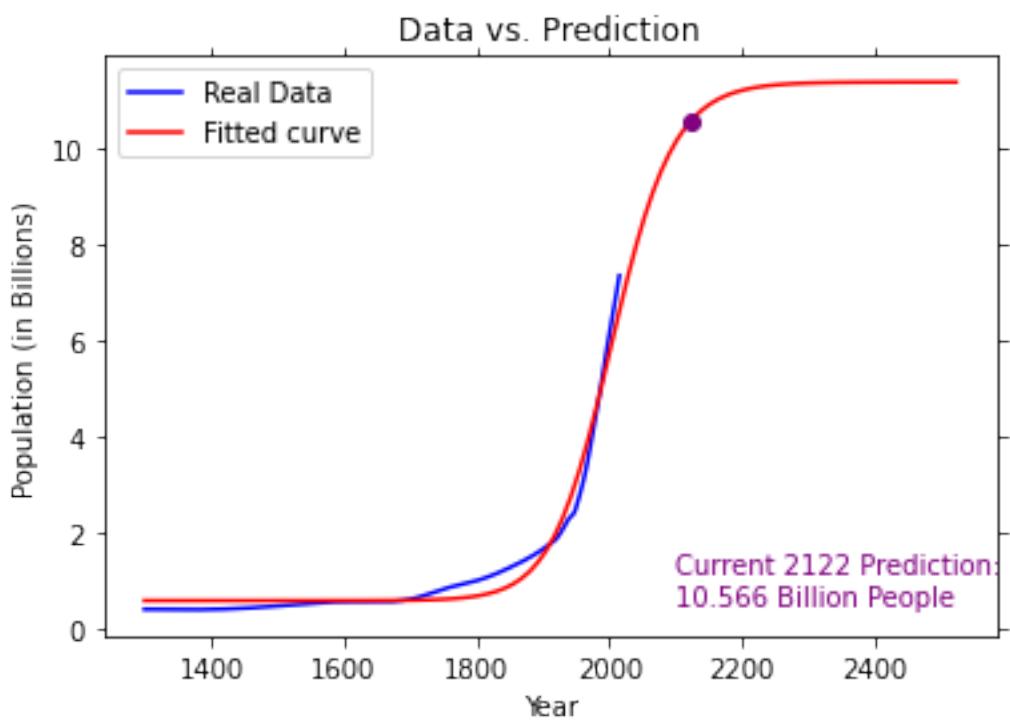
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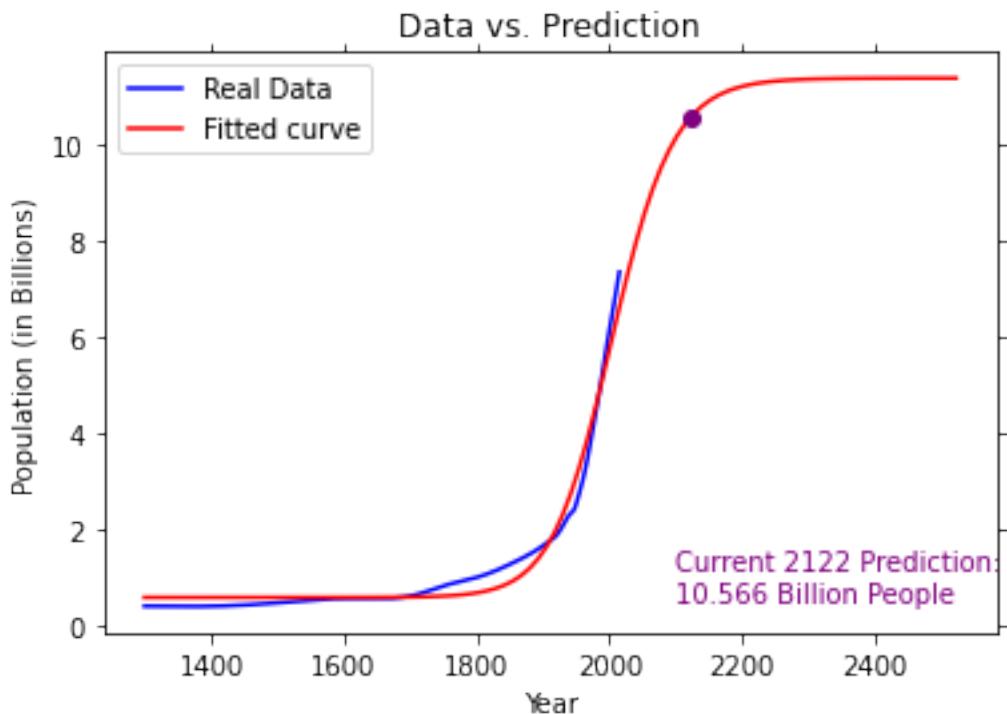
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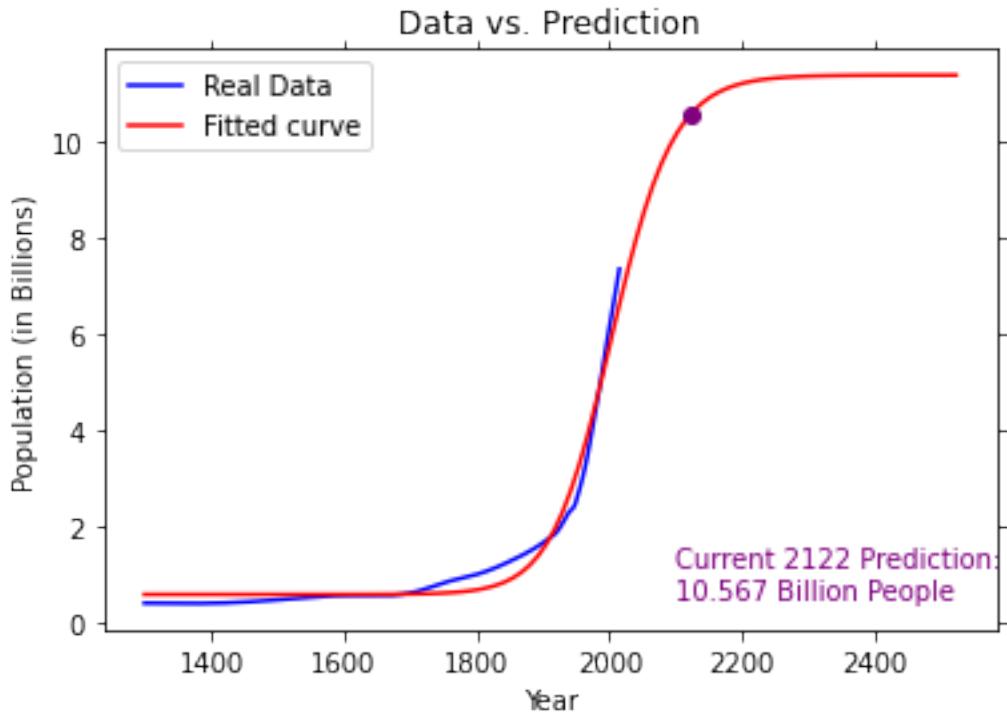
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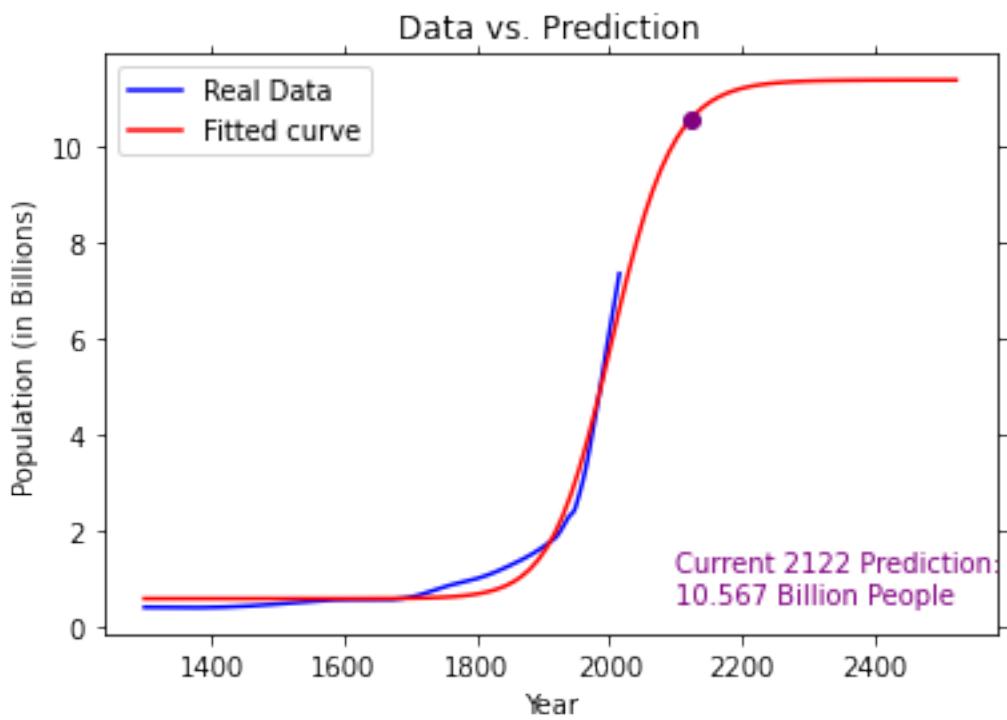
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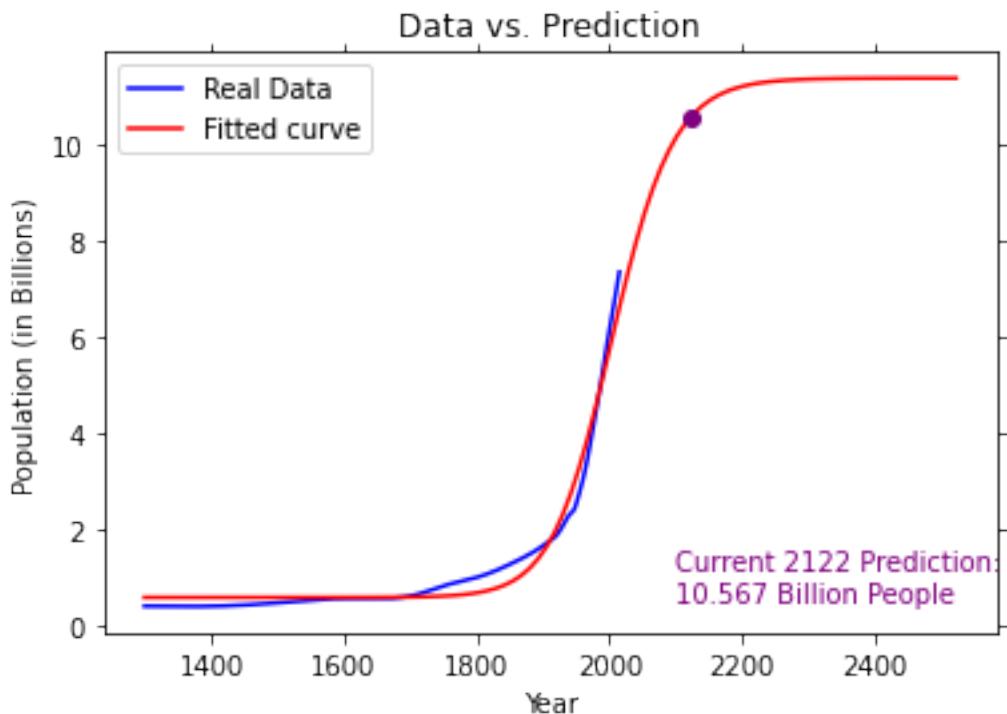
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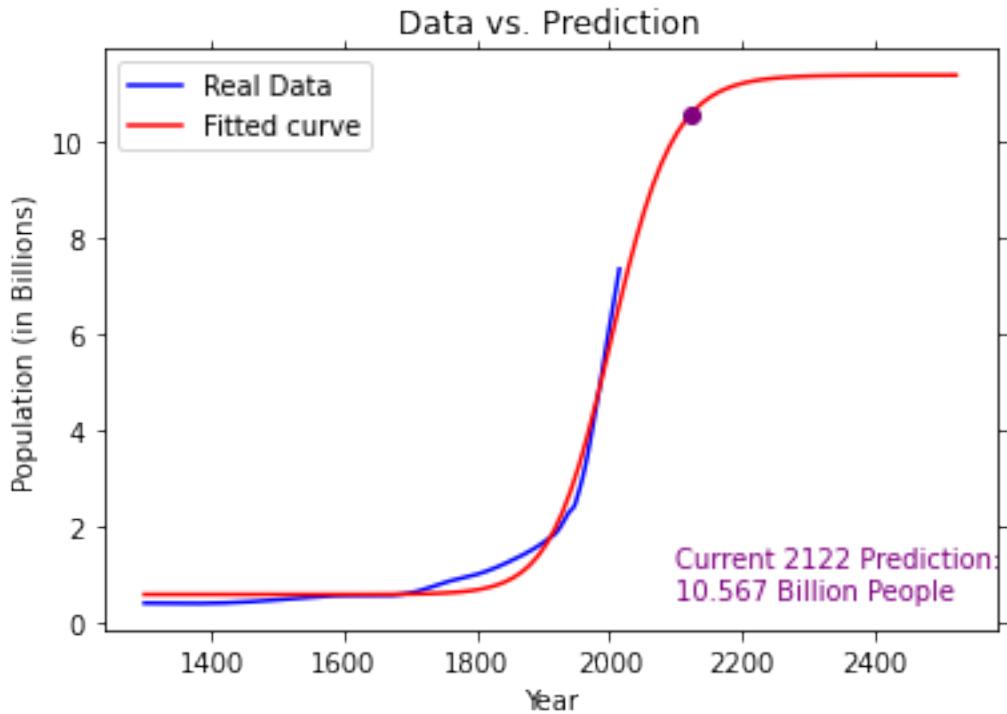
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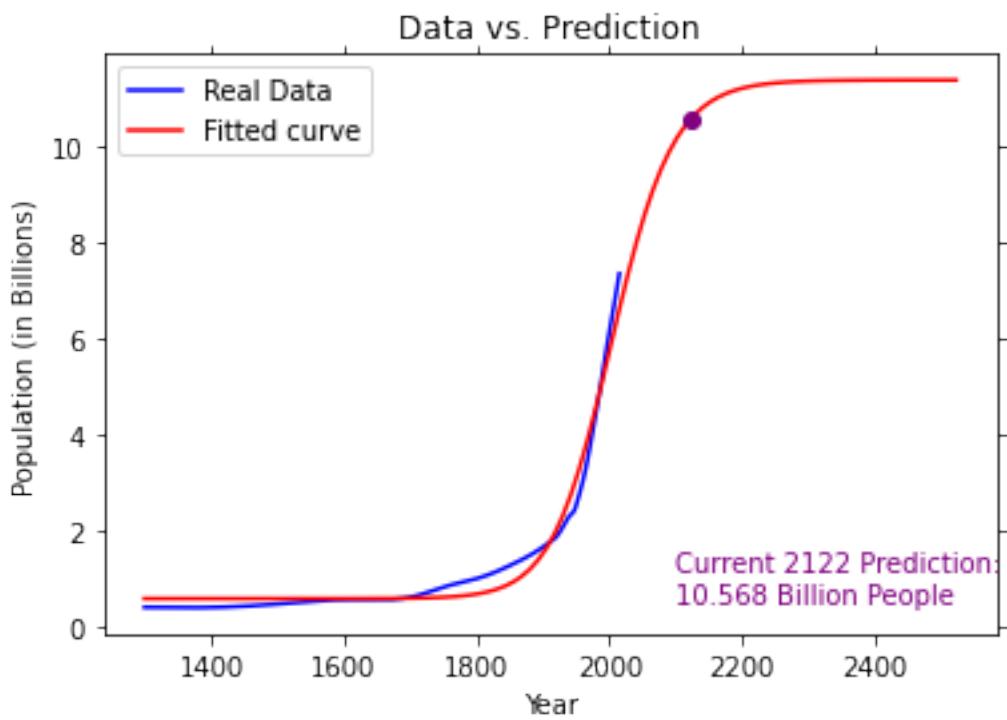
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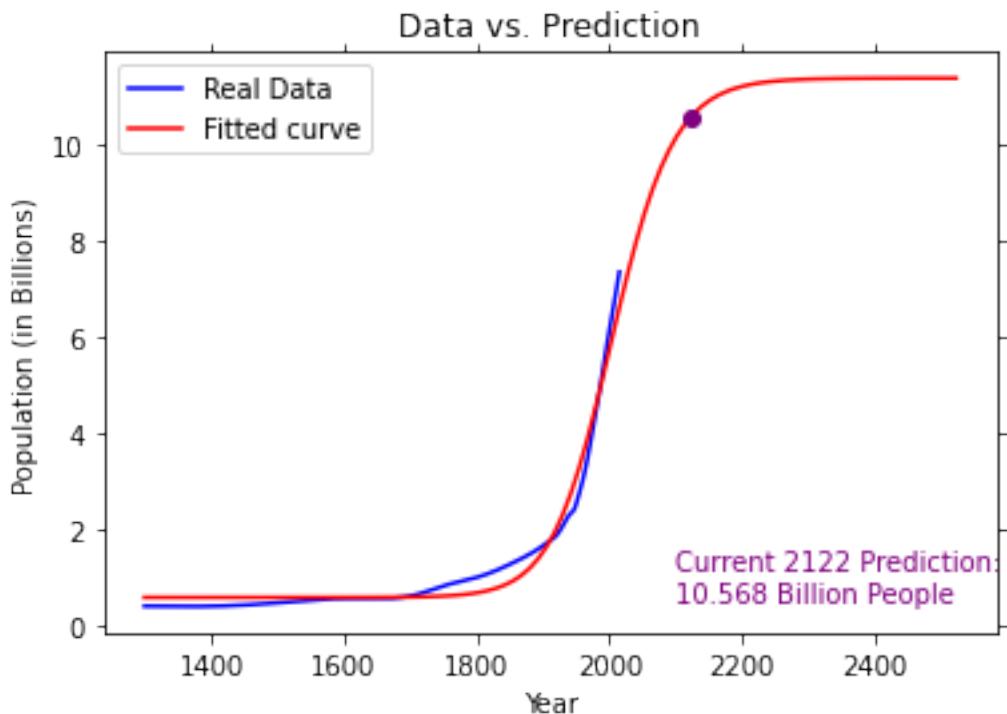
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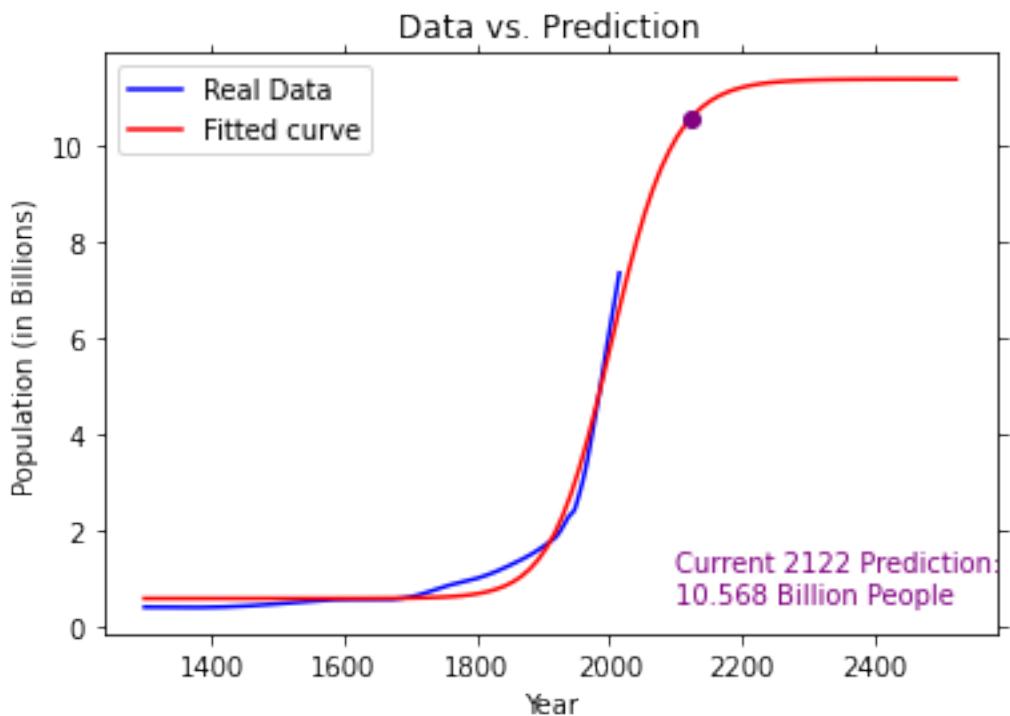
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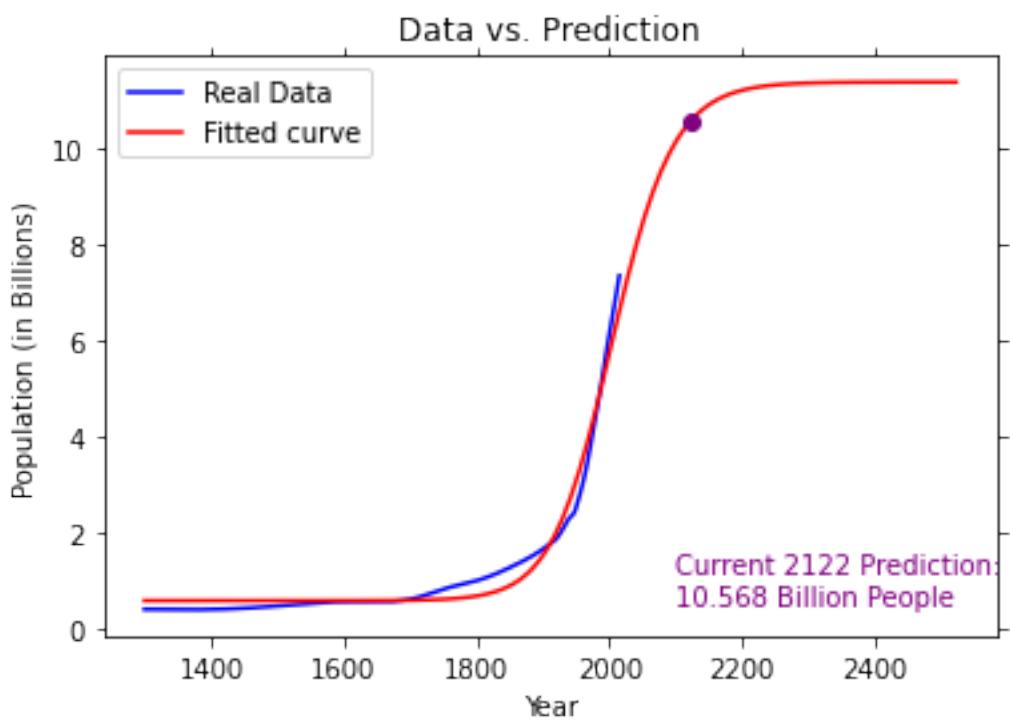
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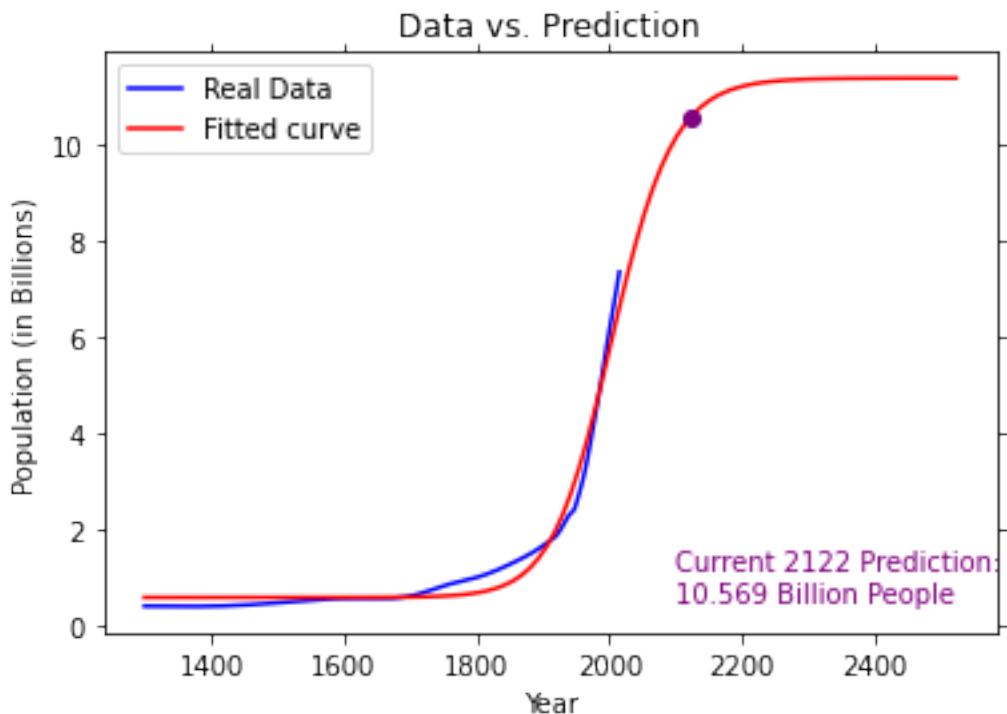
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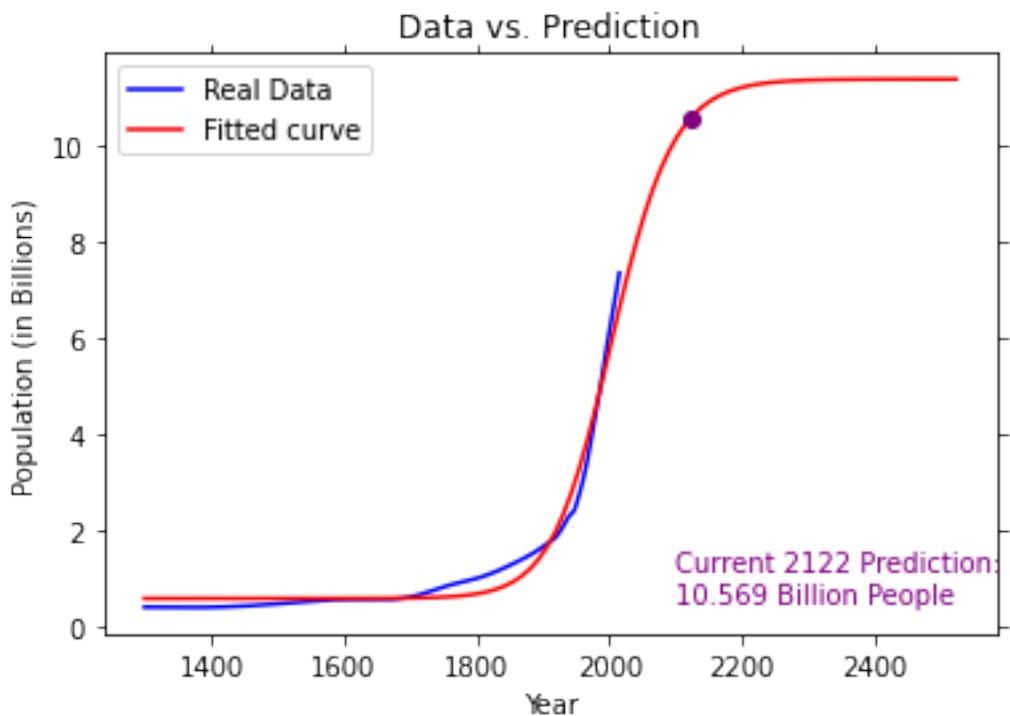
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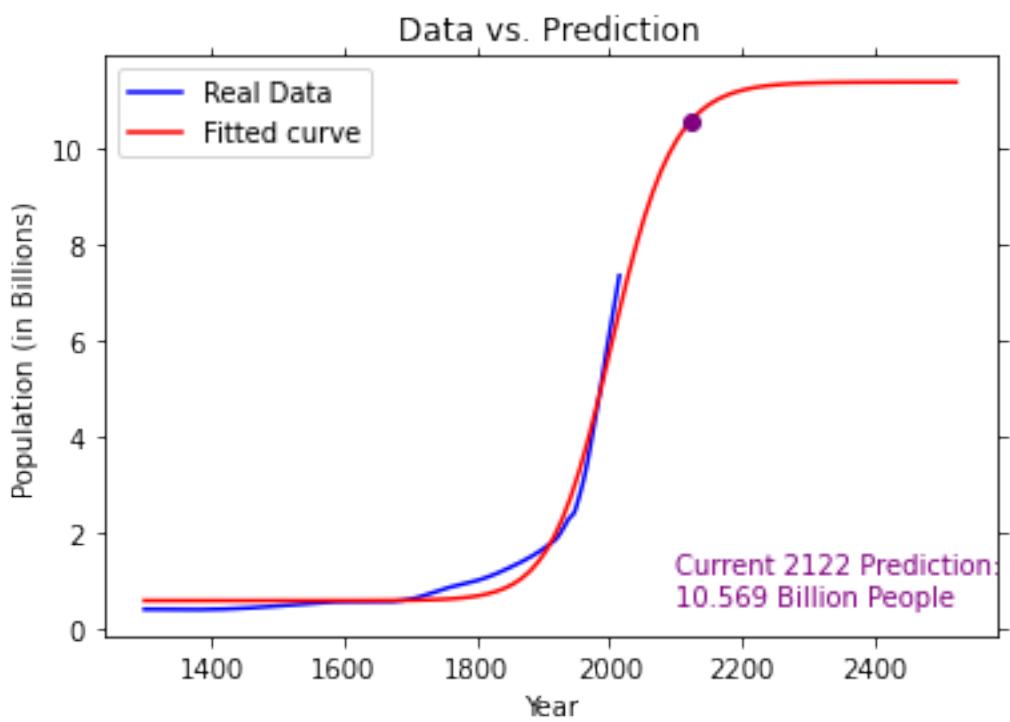
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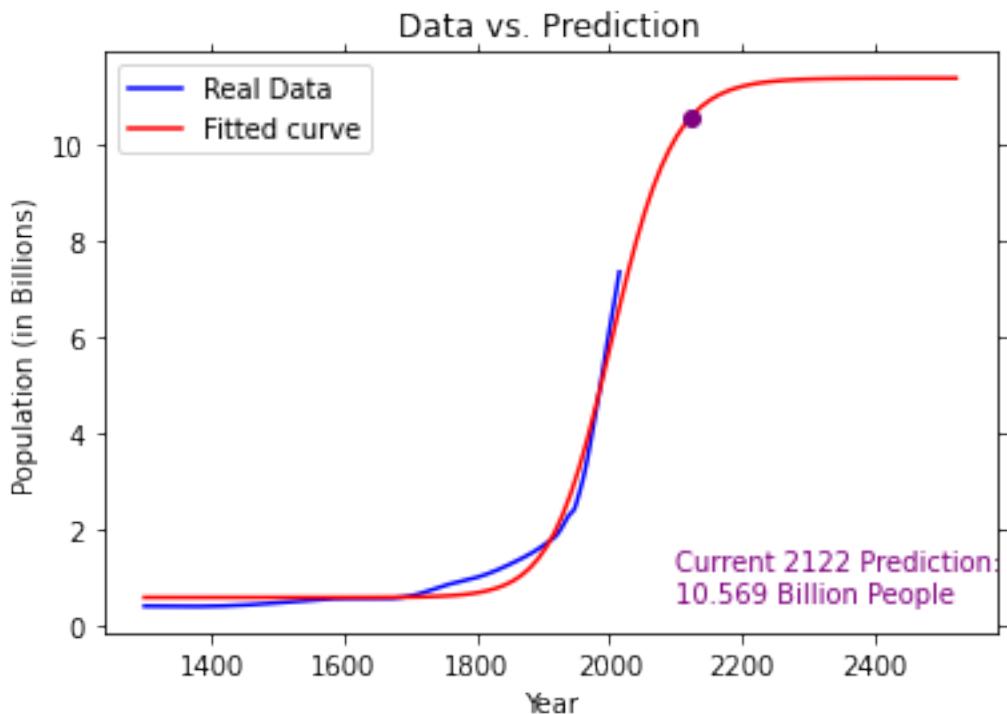
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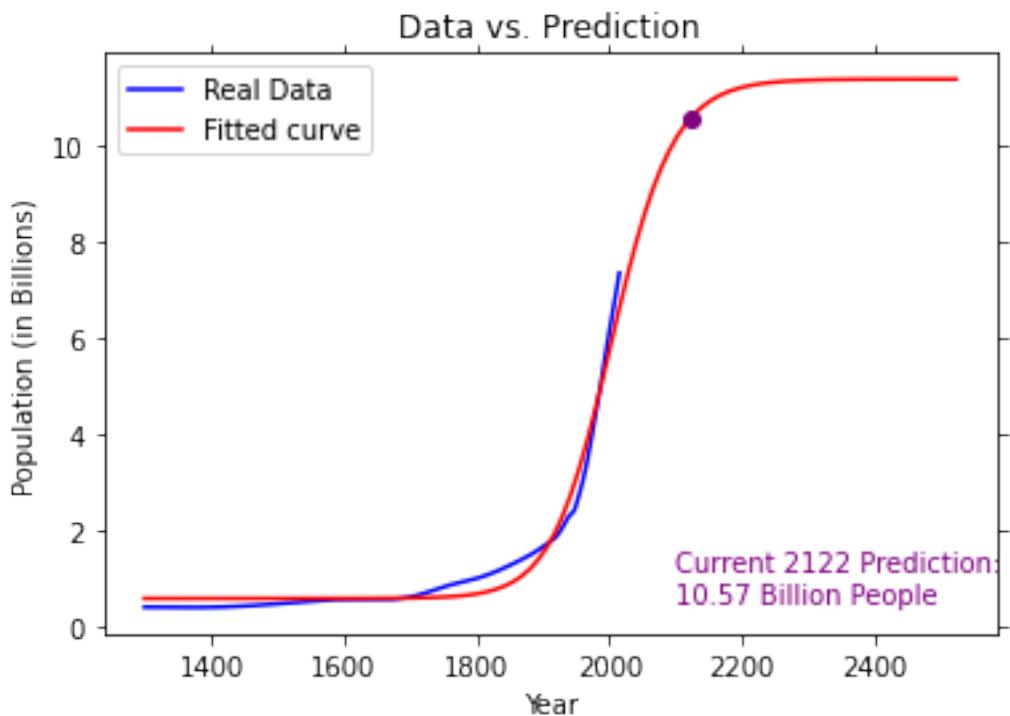
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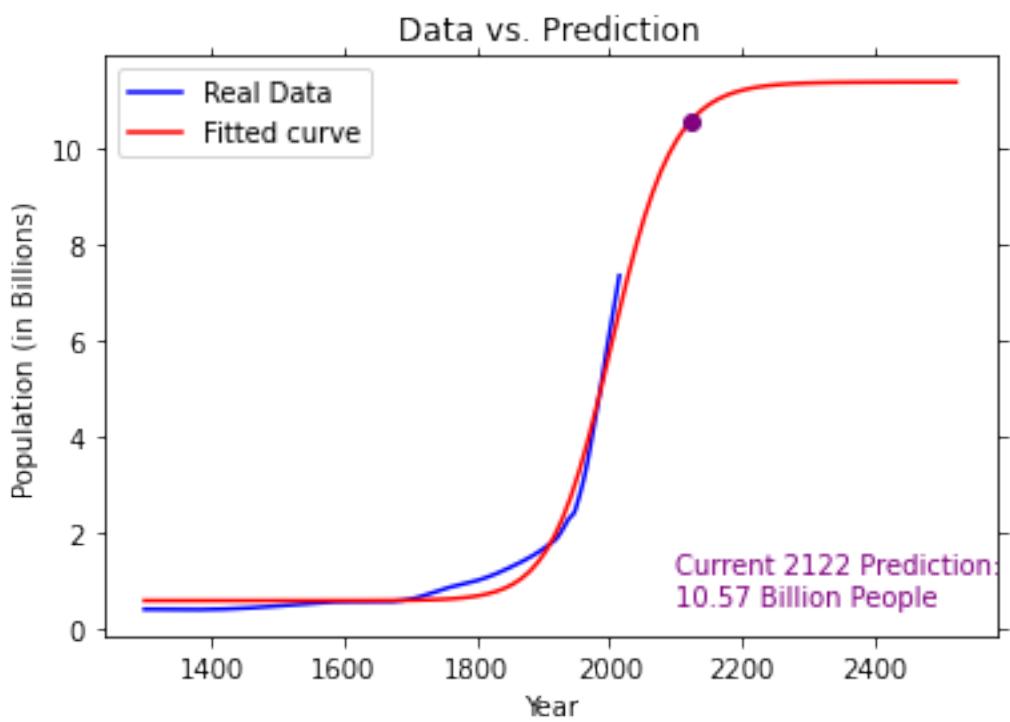
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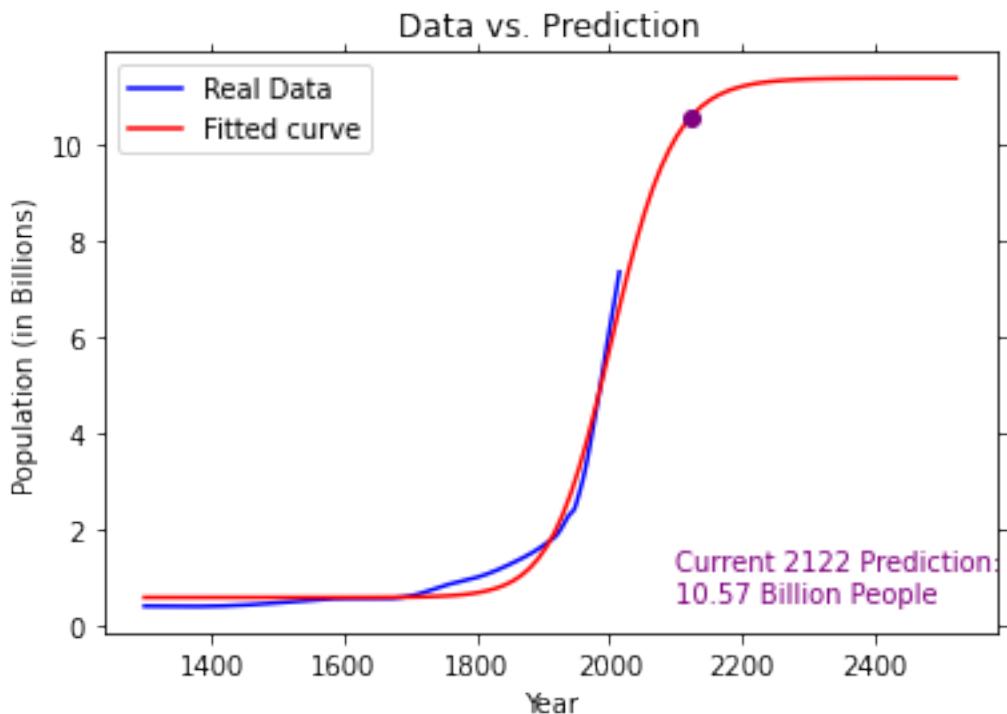
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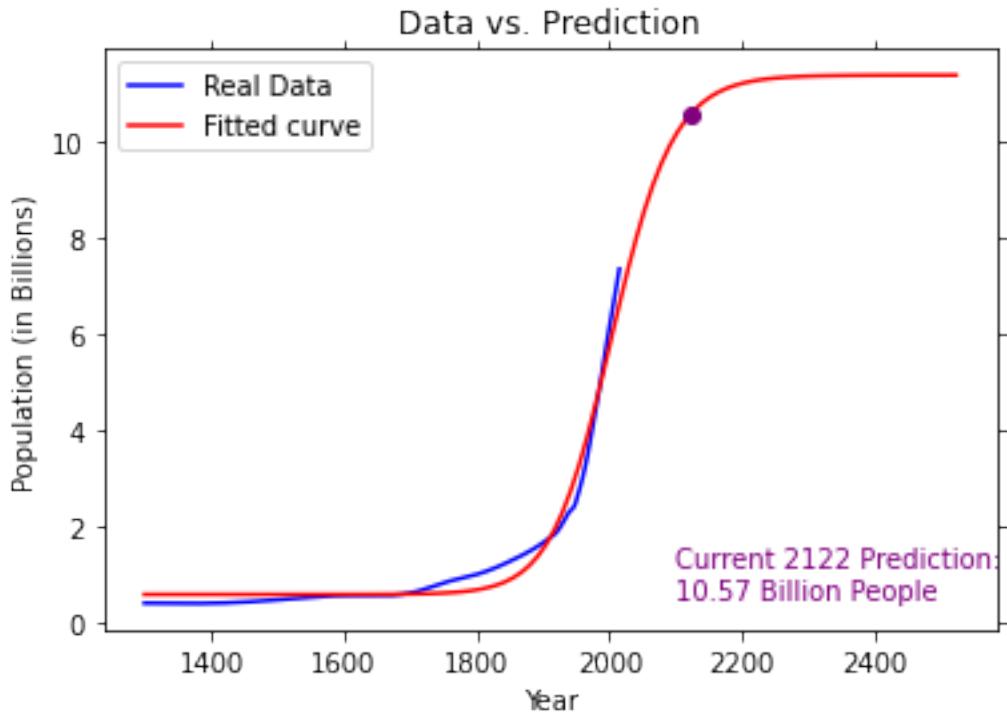
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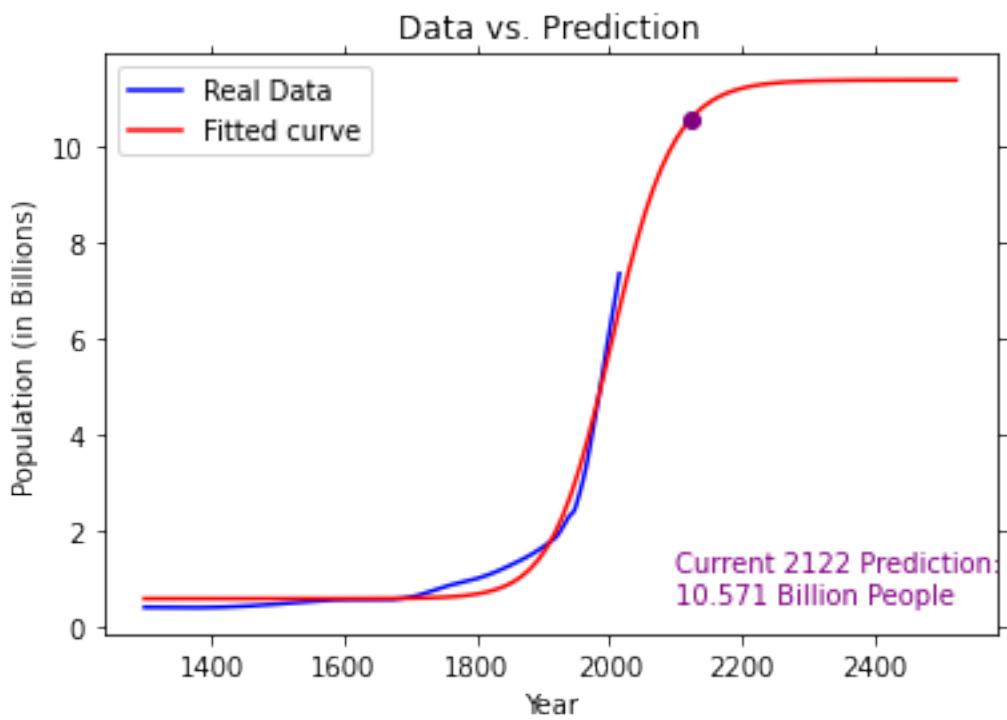
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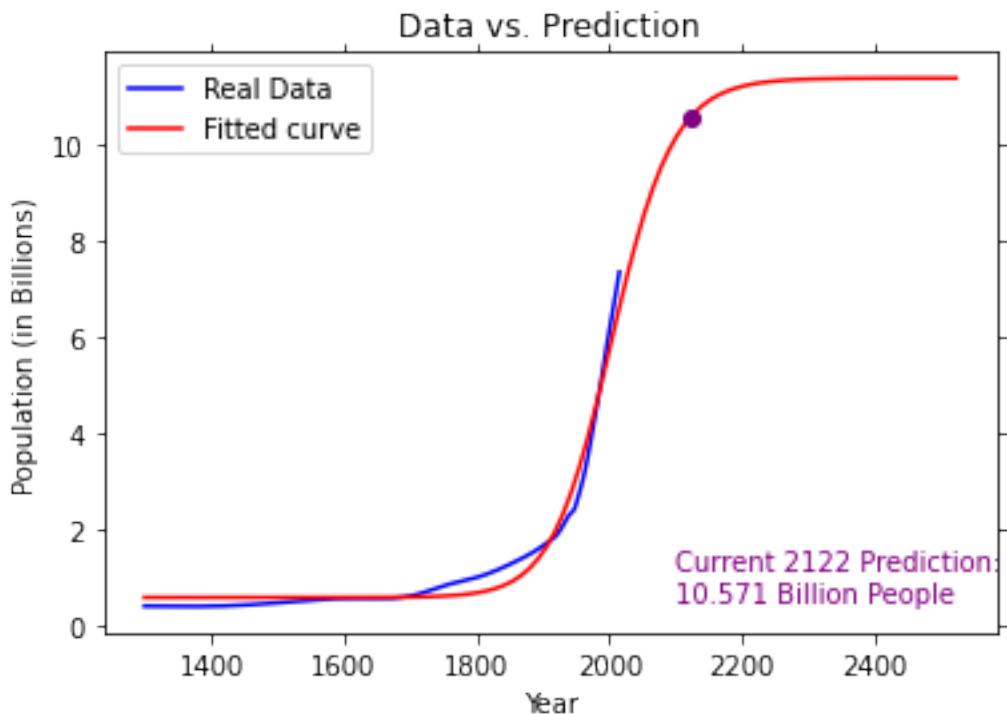
Iteration #22350, Loss: 0.05271518580055563



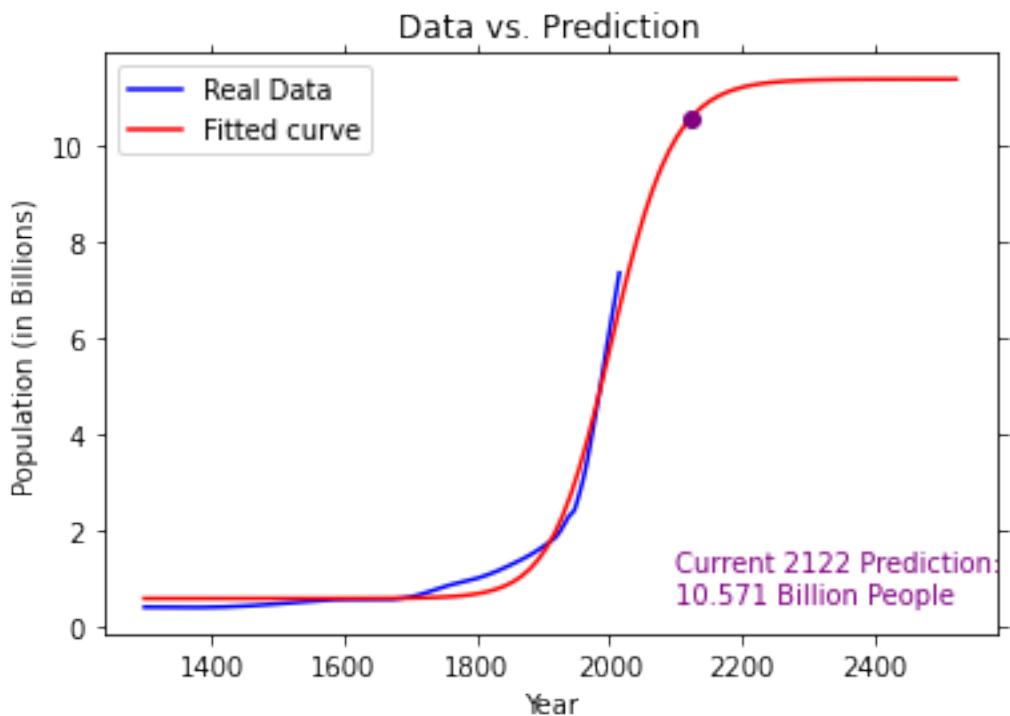
Iteration #22400, Loss: 0.05270689229926001



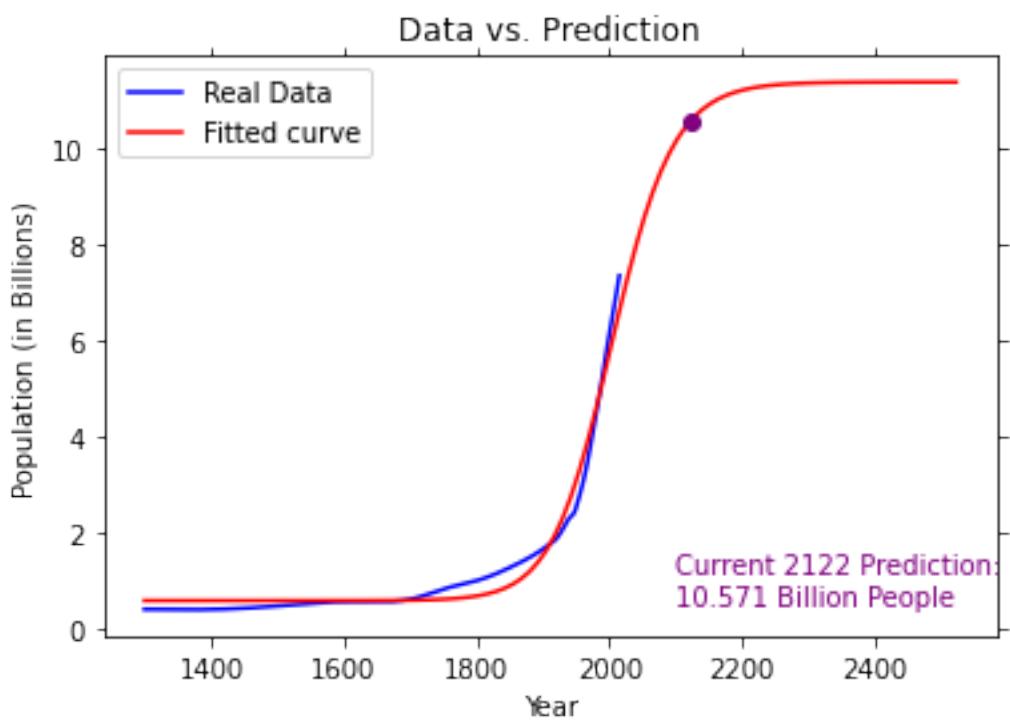
Iteration #22450, Loss: 0.05269861406101489



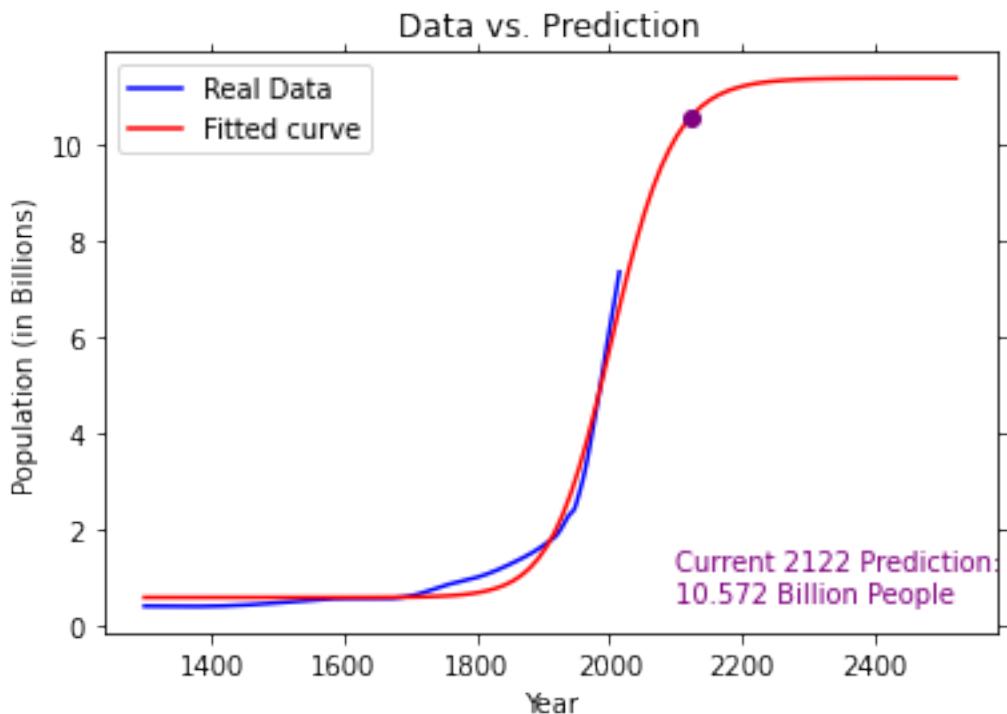
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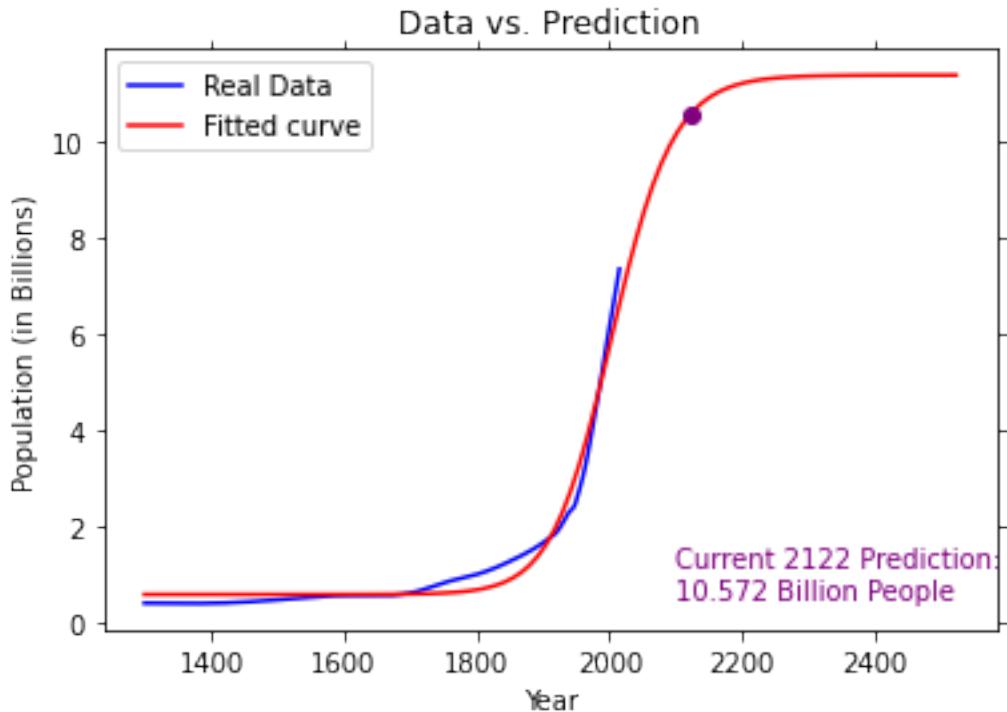
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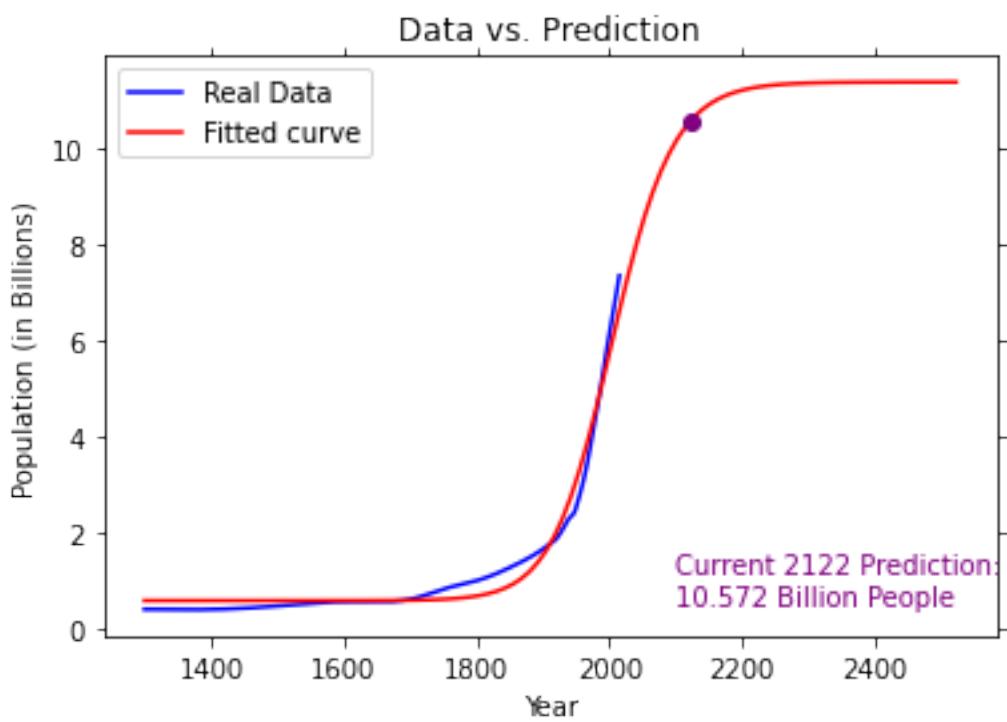
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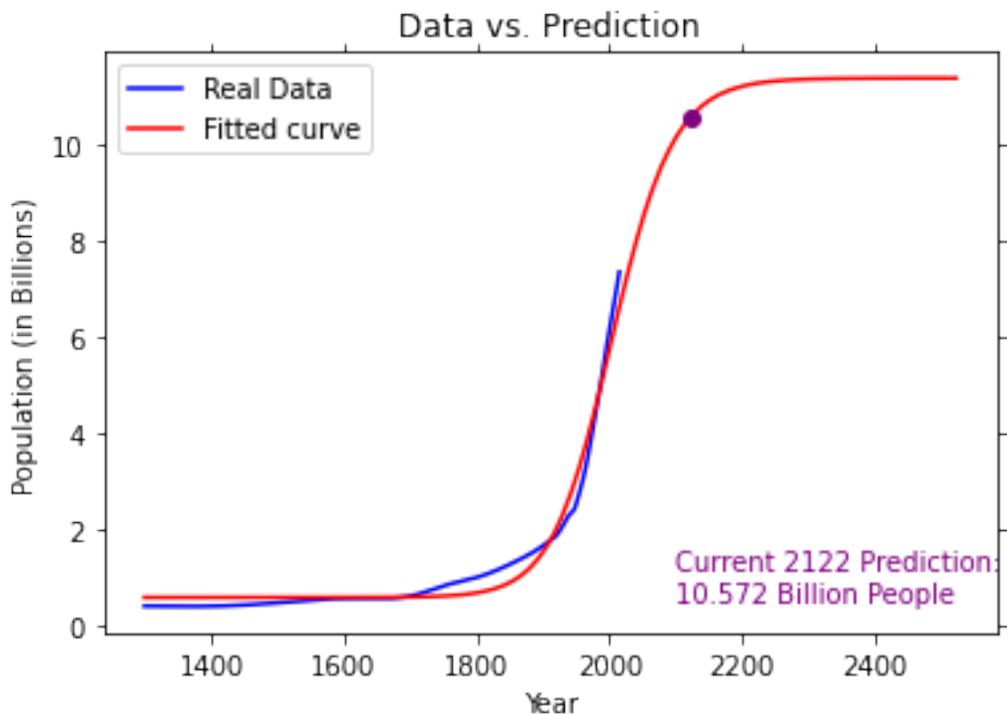
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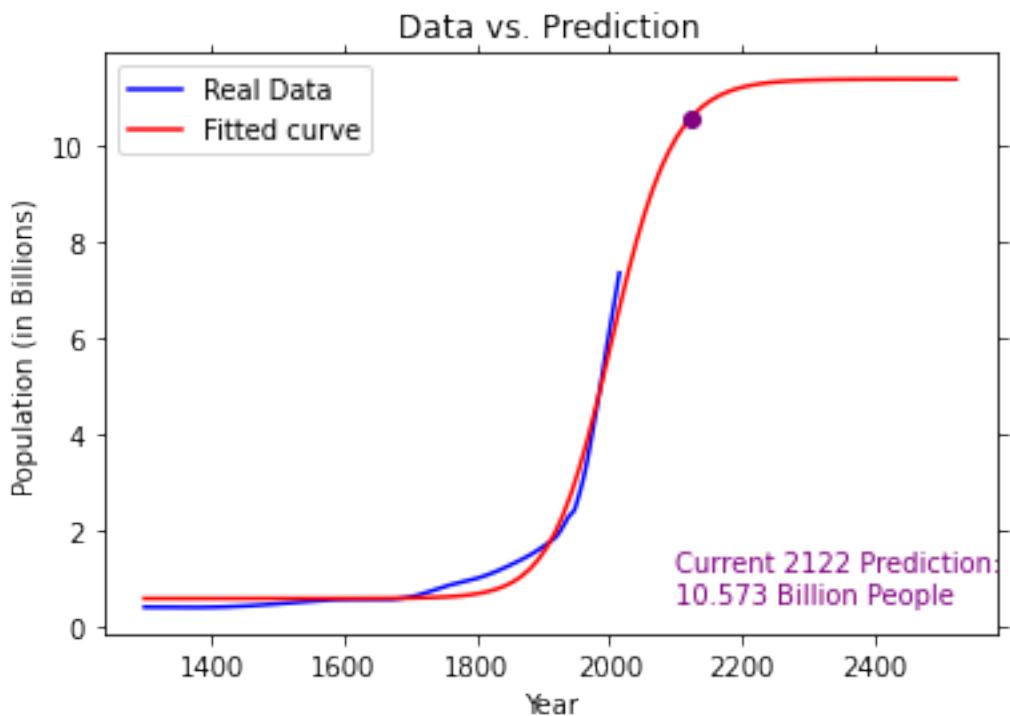
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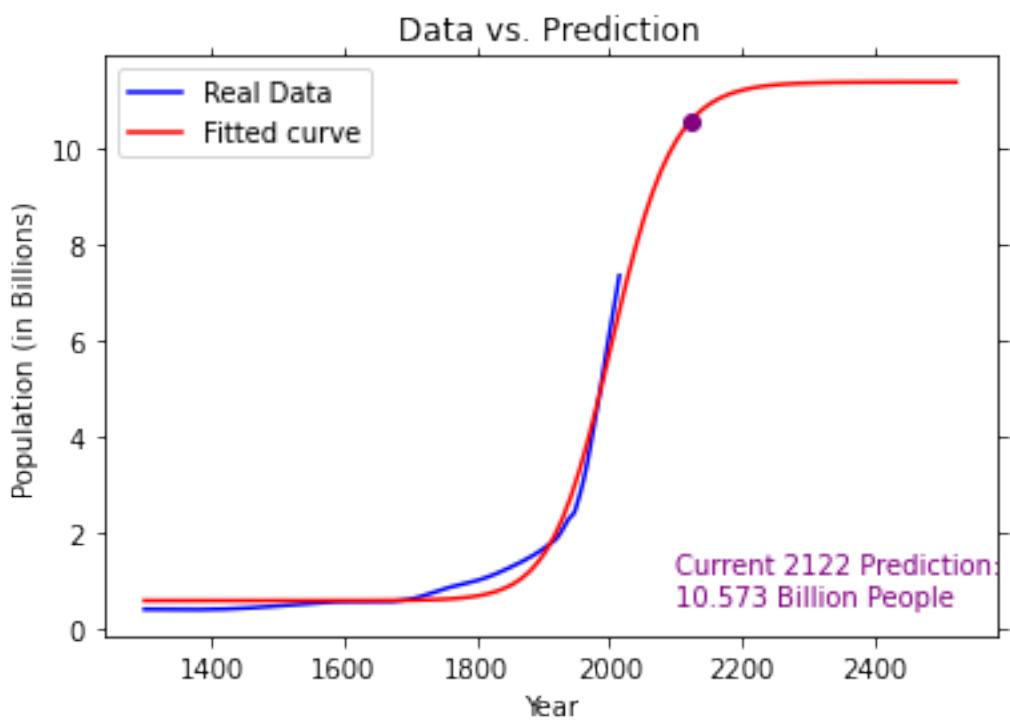
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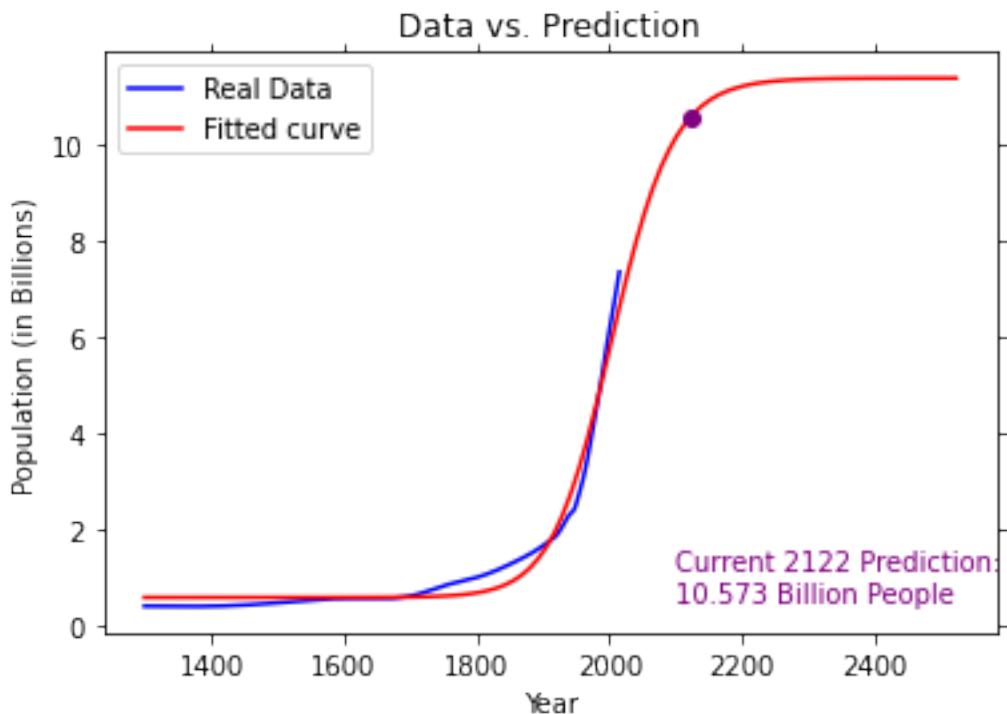
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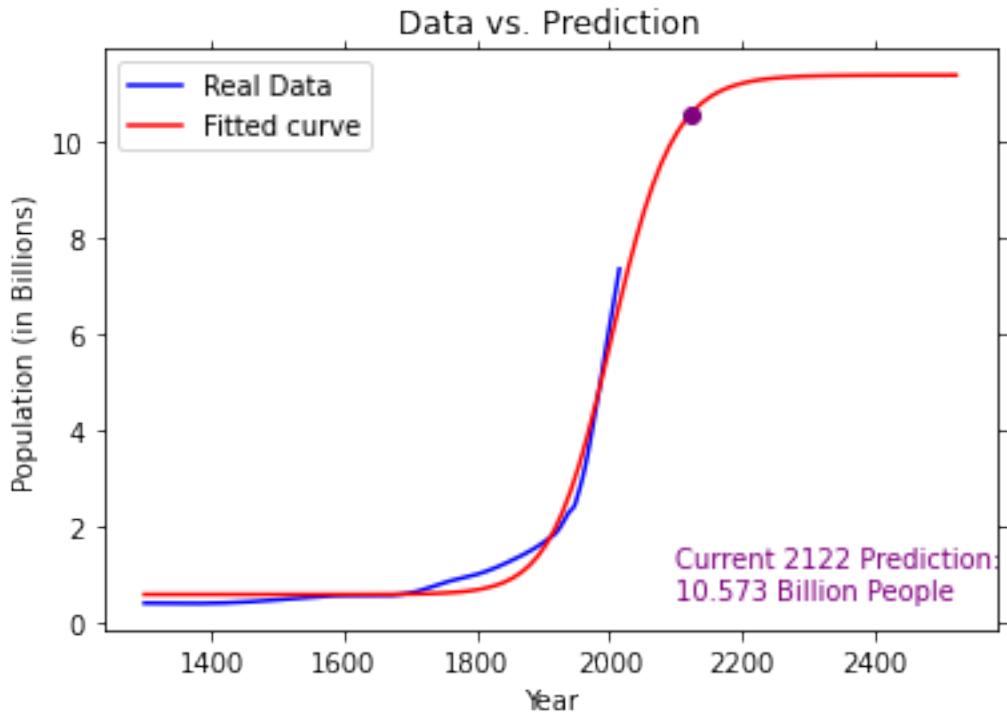
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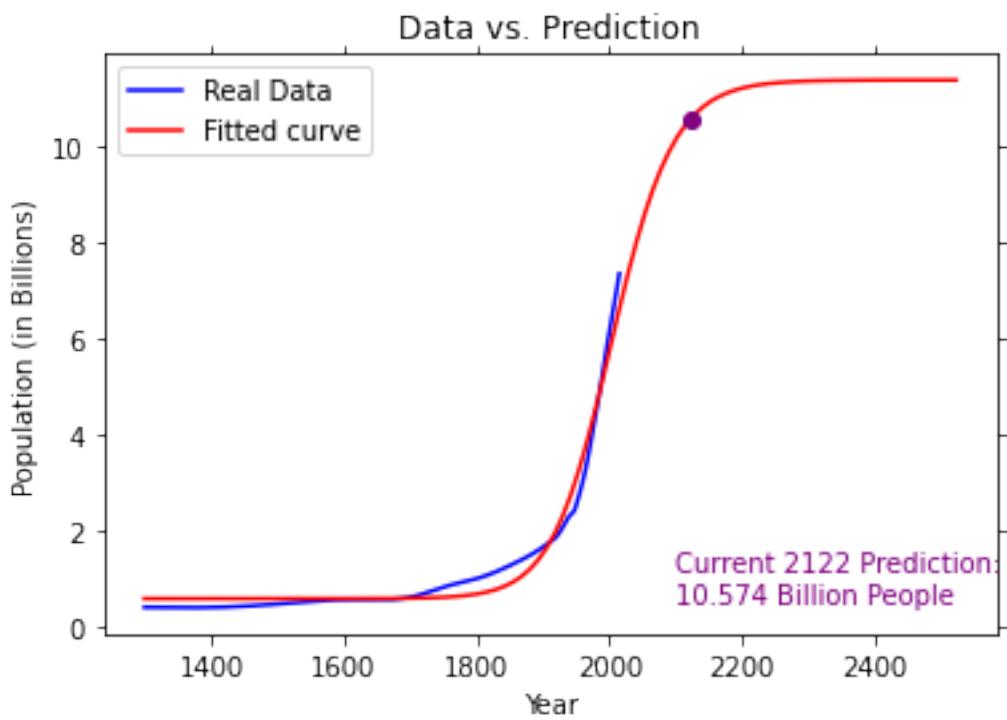
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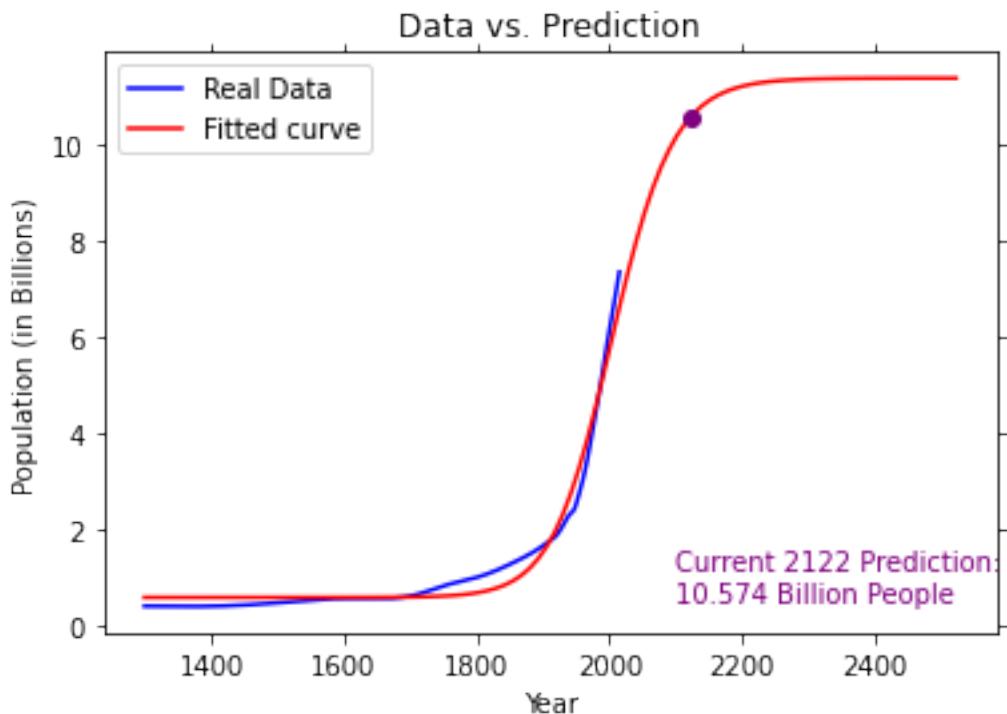
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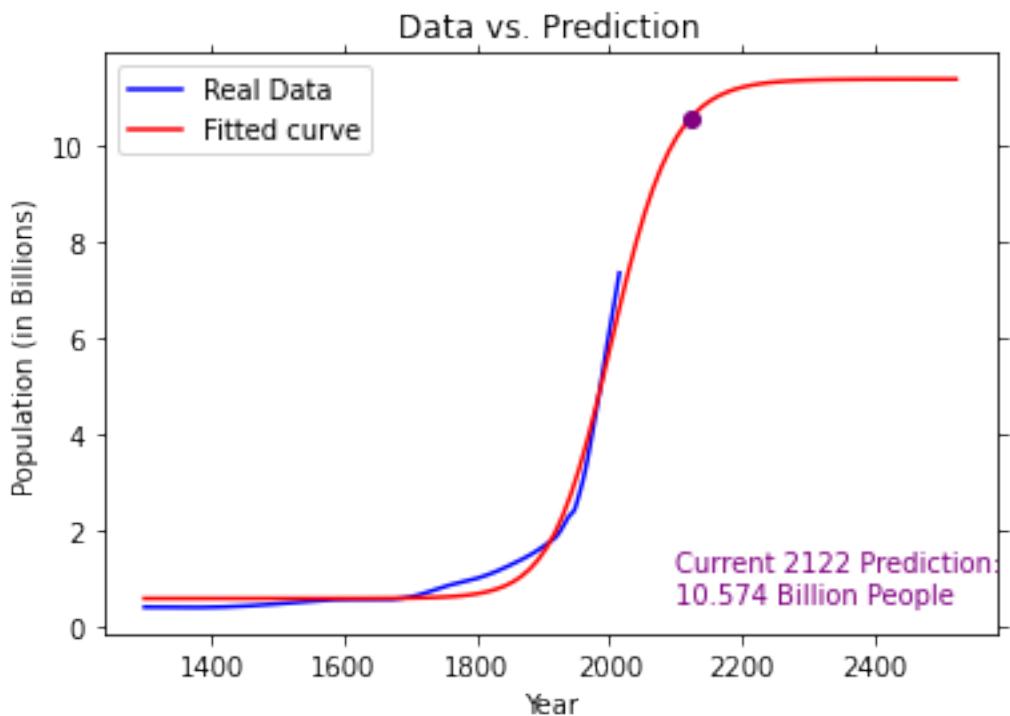
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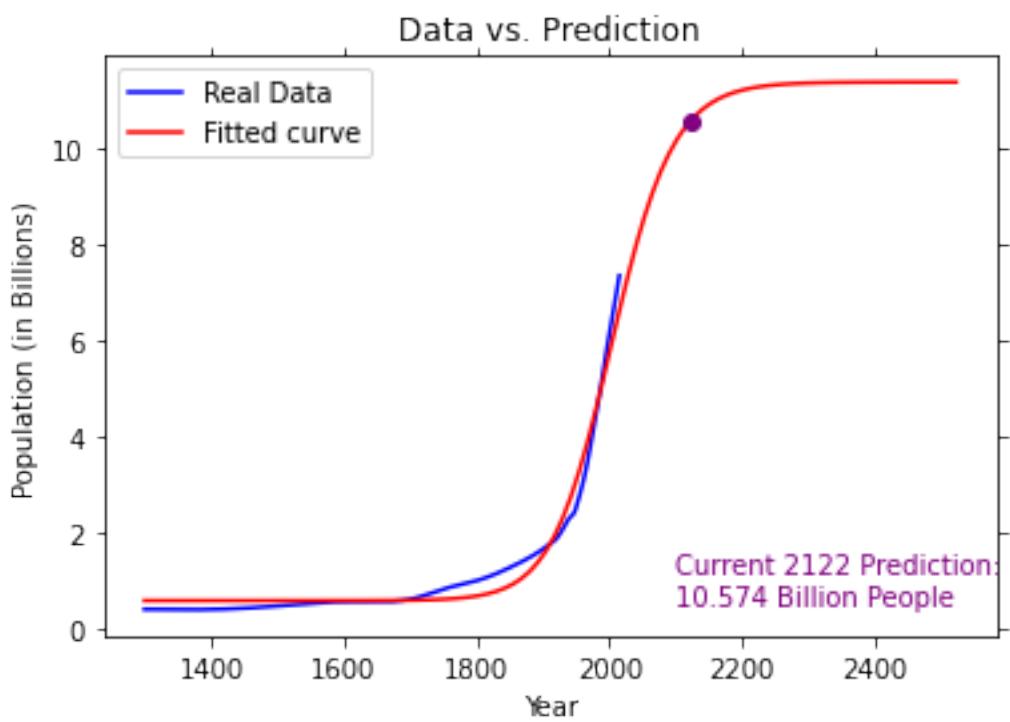
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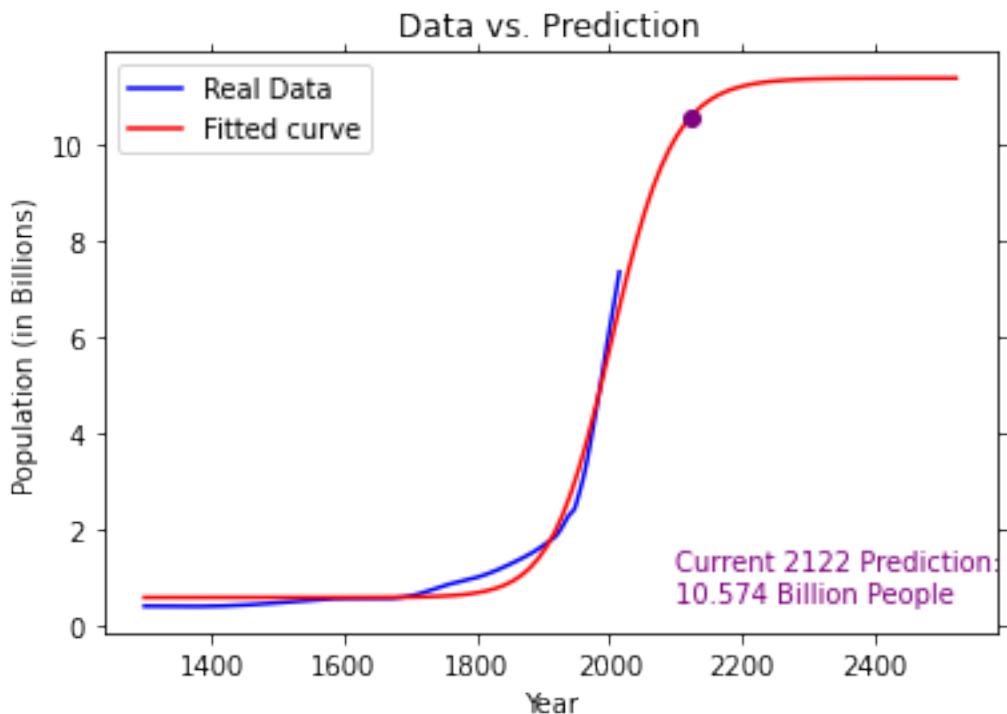
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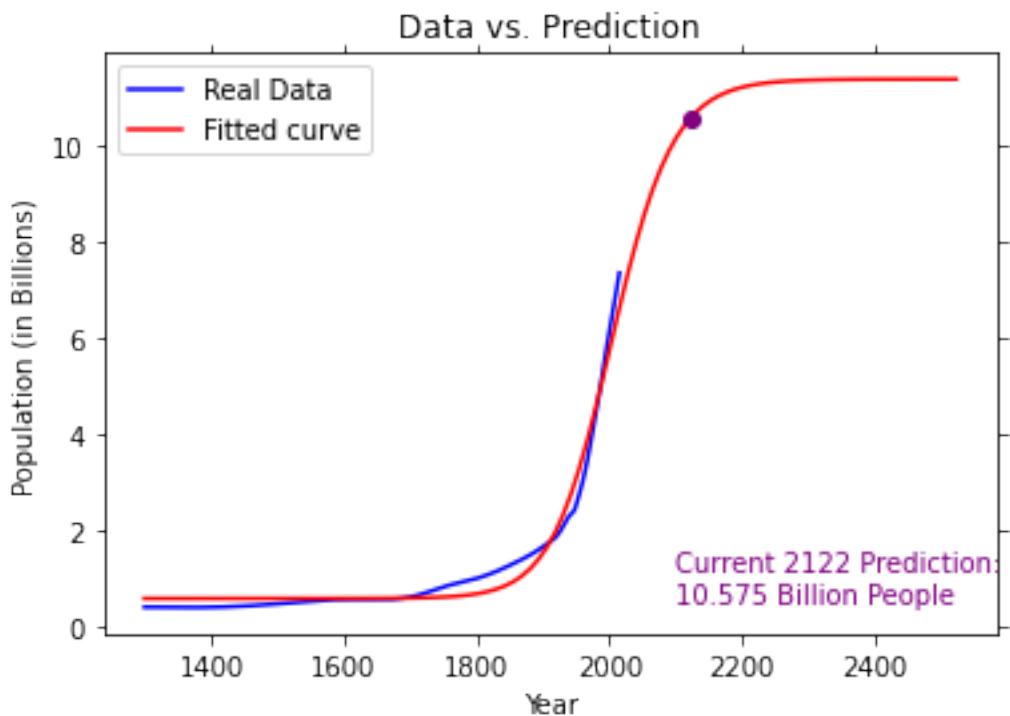
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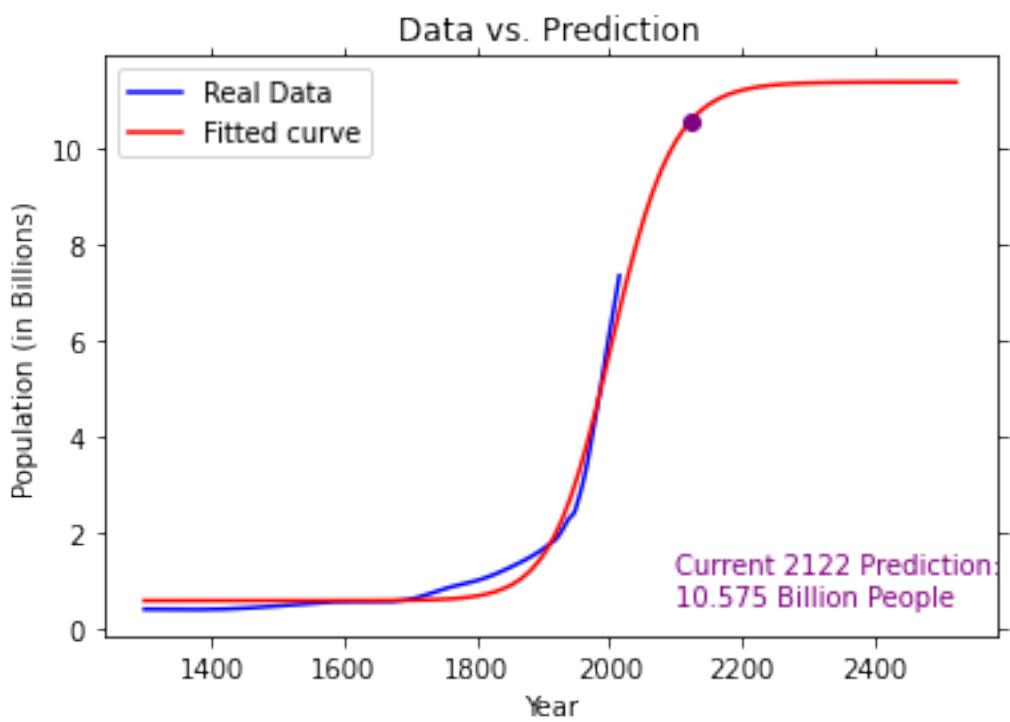
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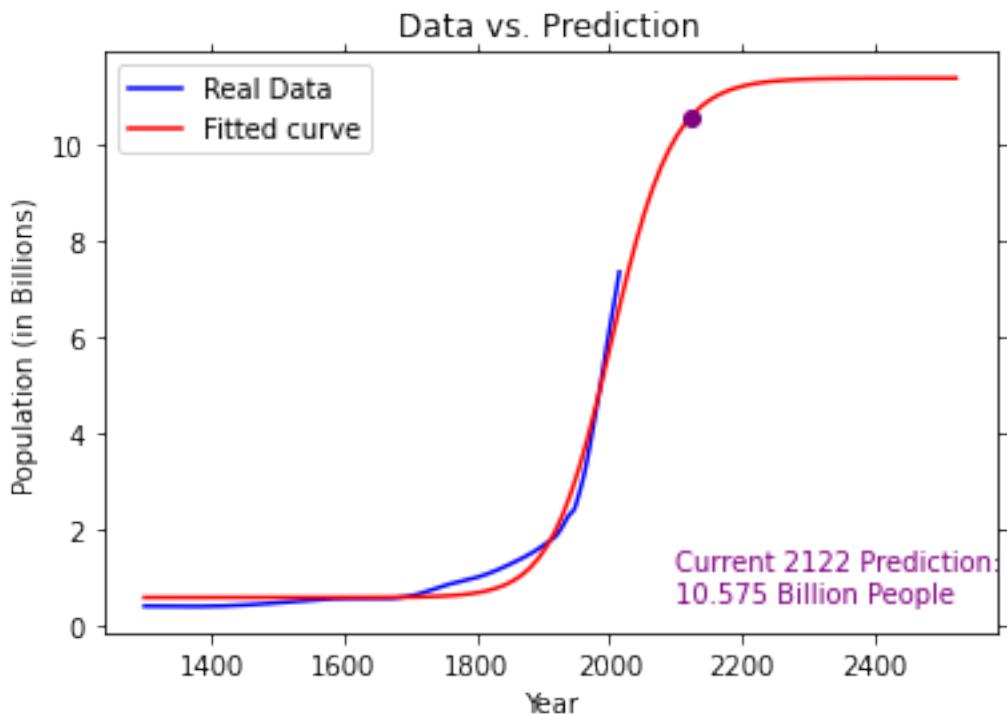
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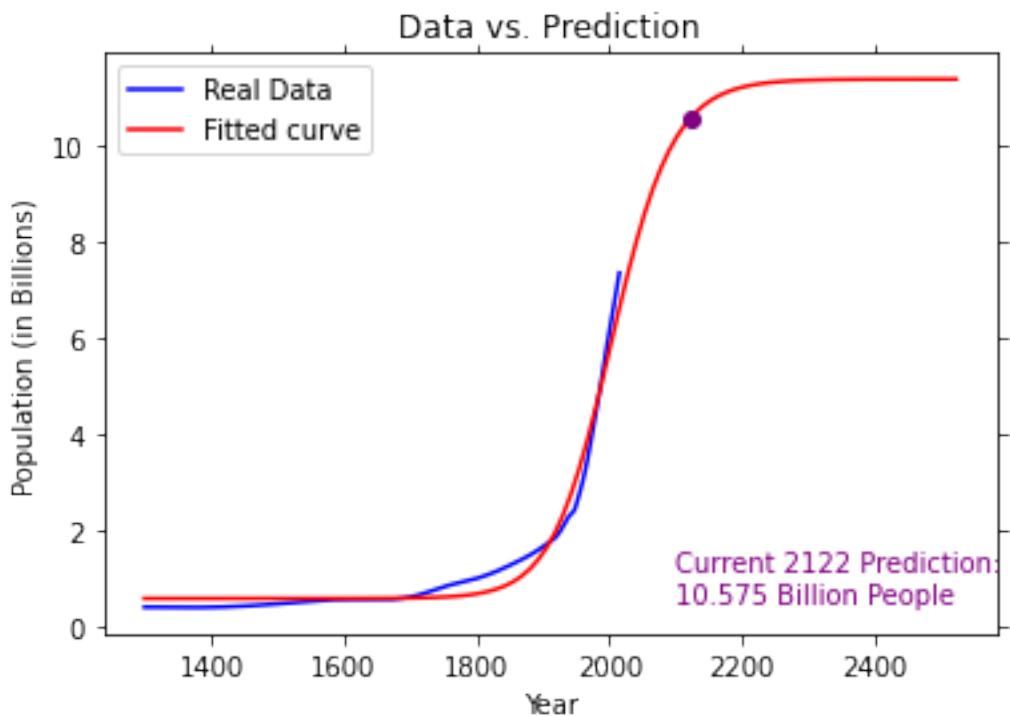
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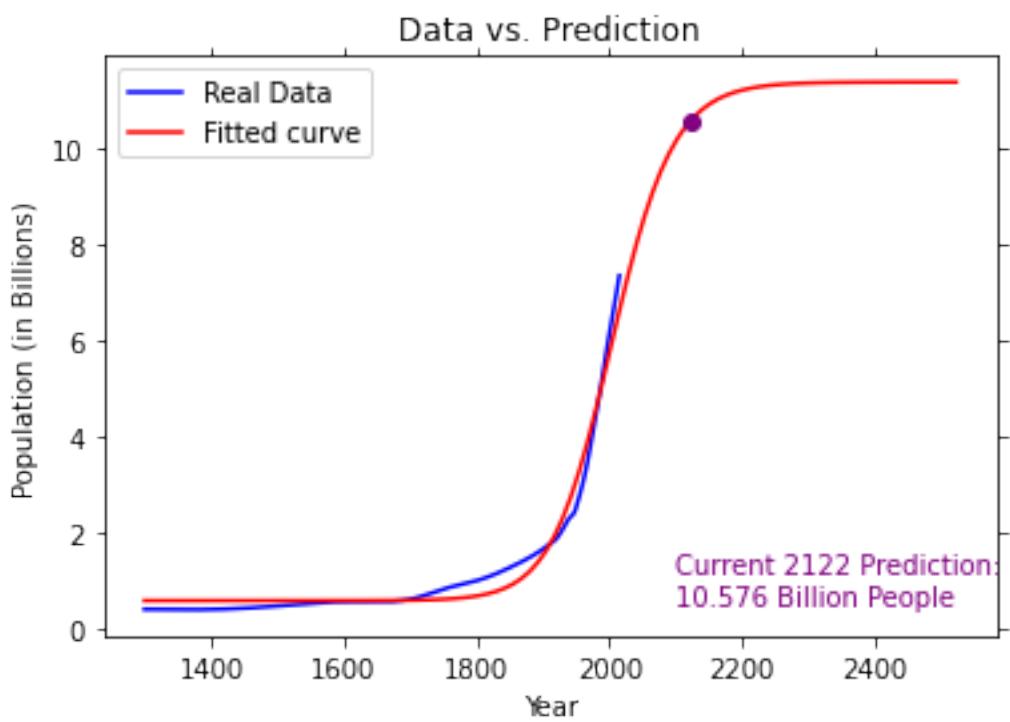
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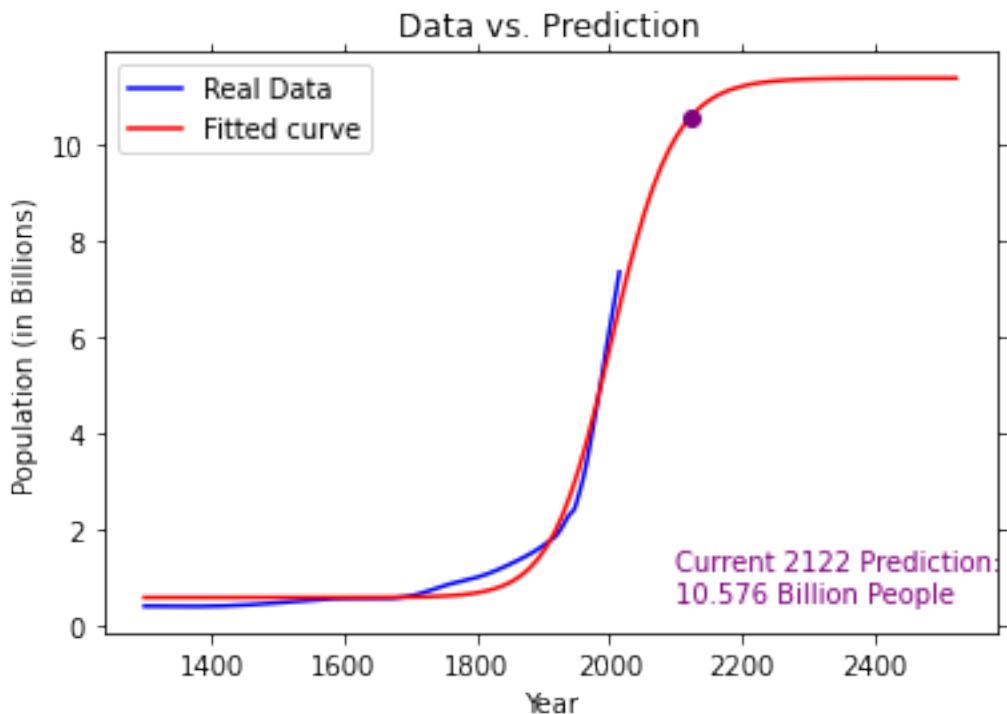
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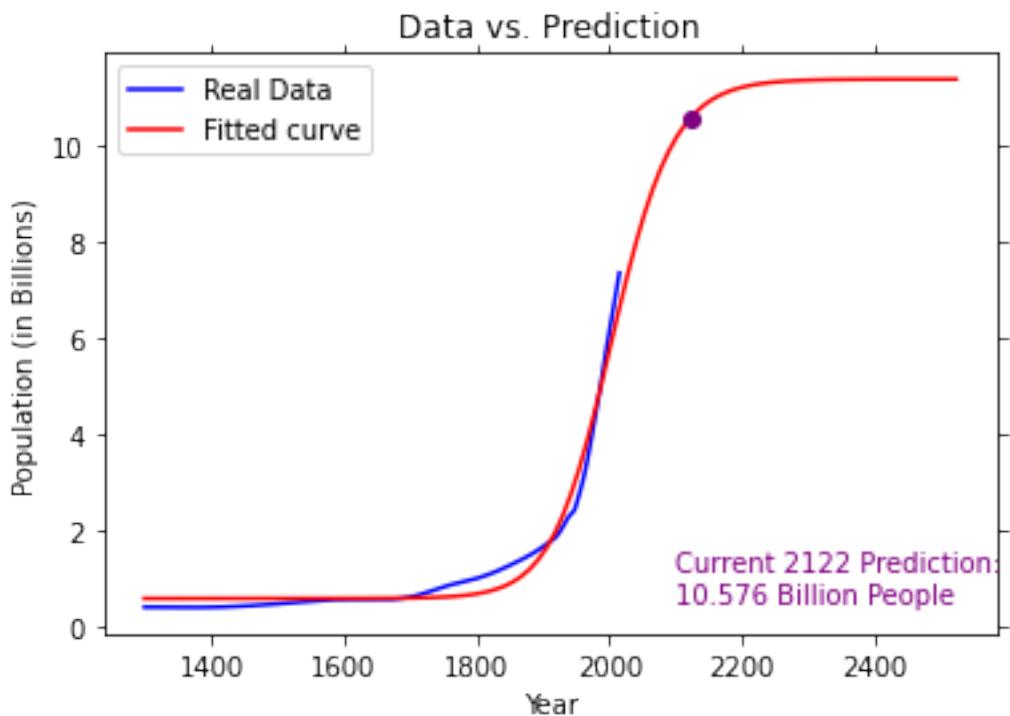
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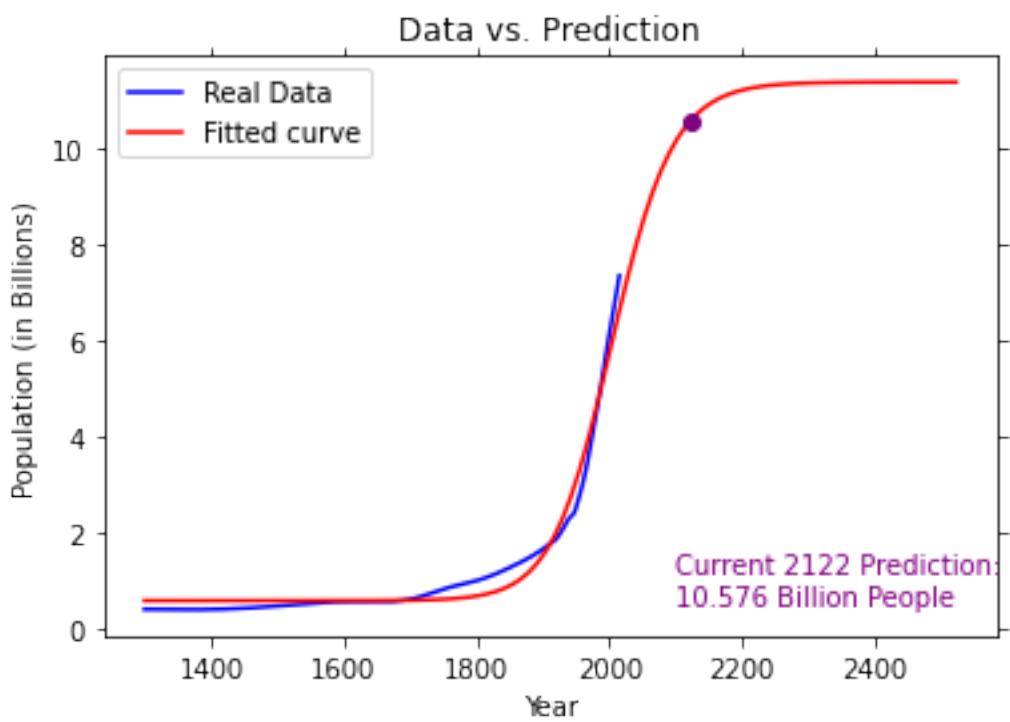
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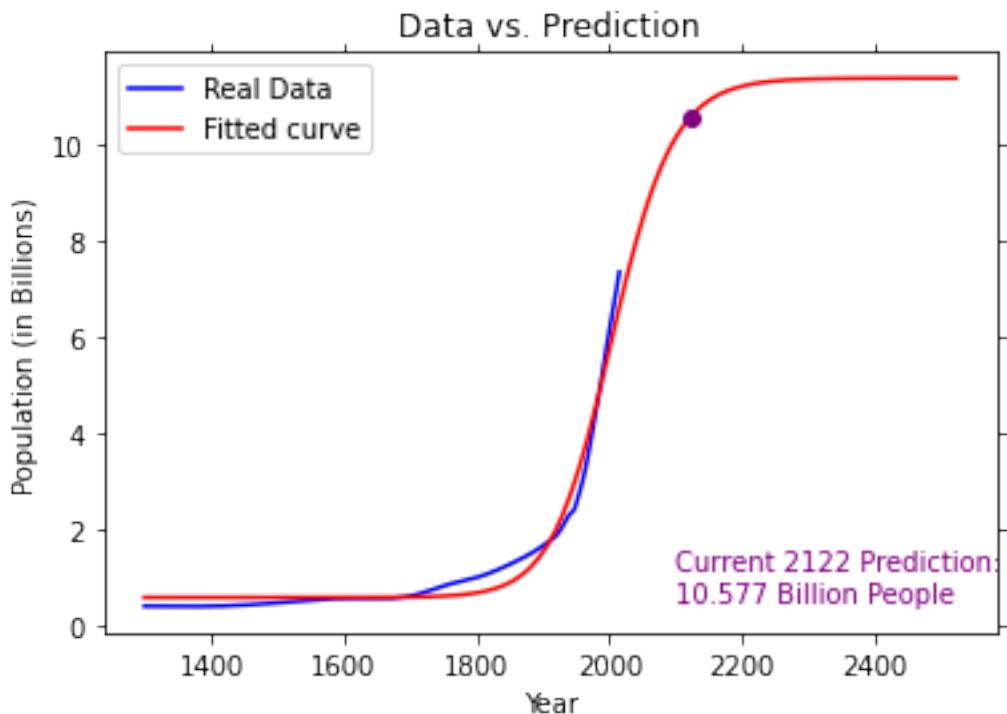
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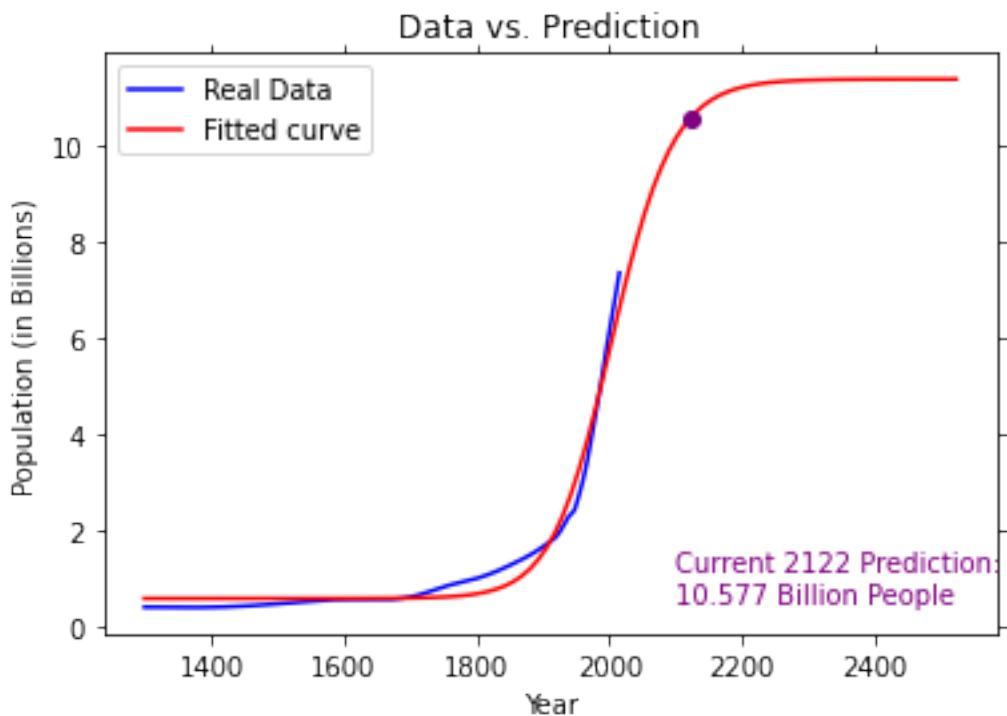
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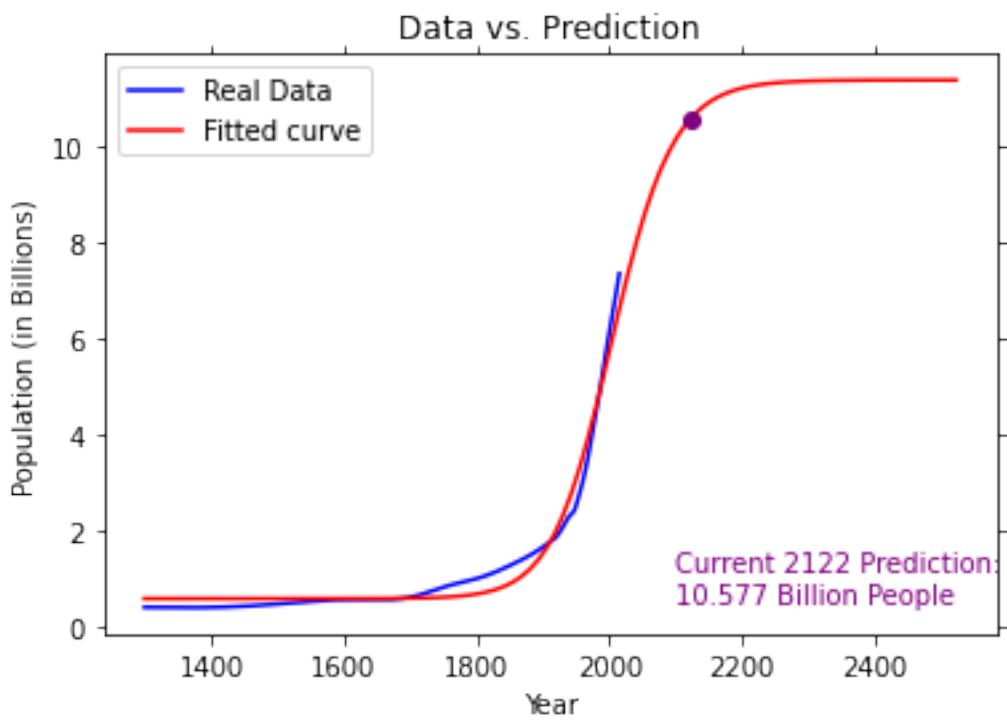
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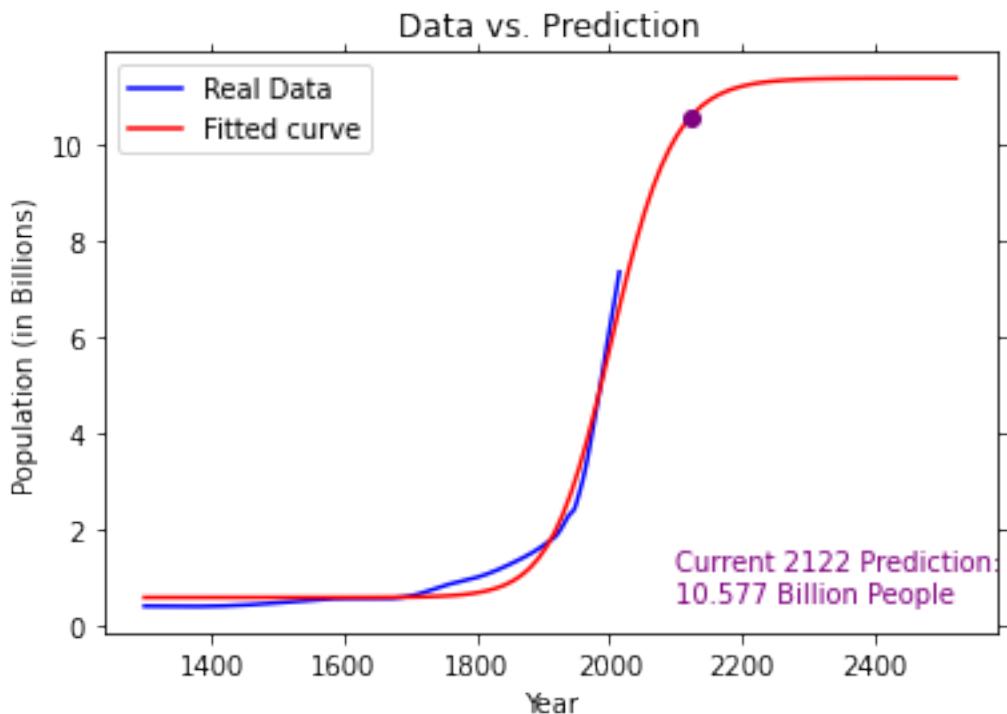
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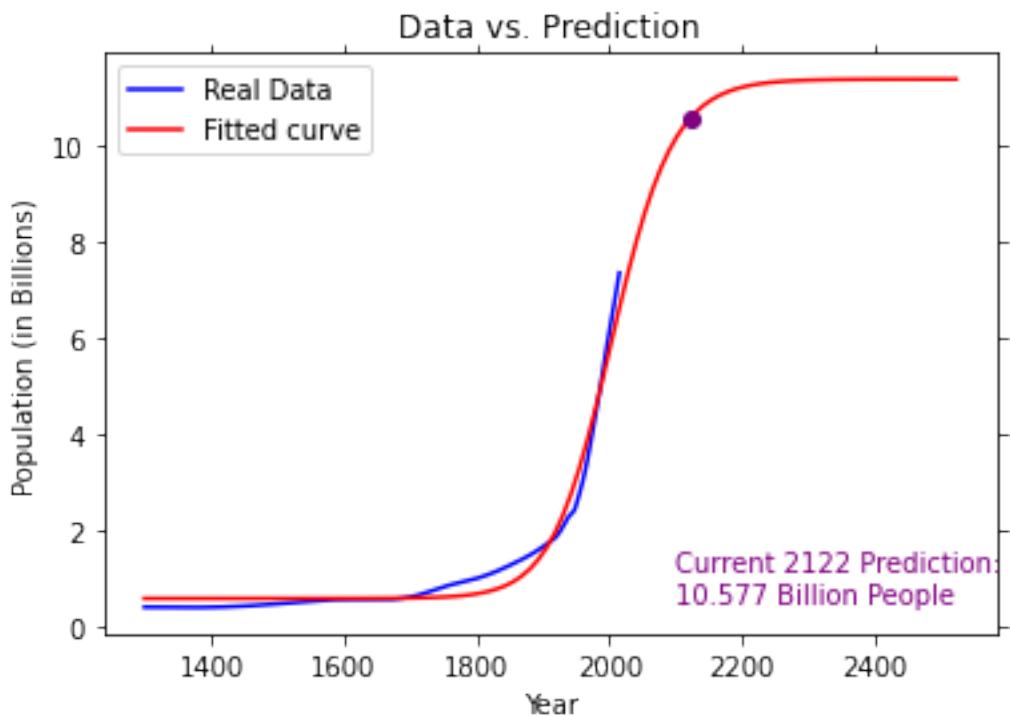
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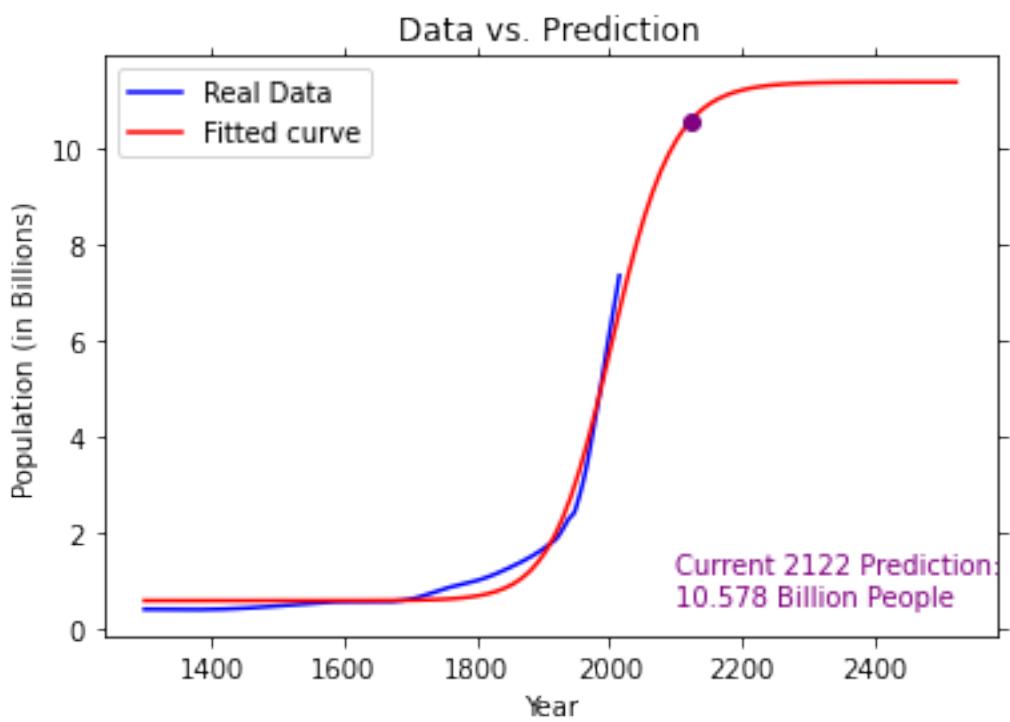
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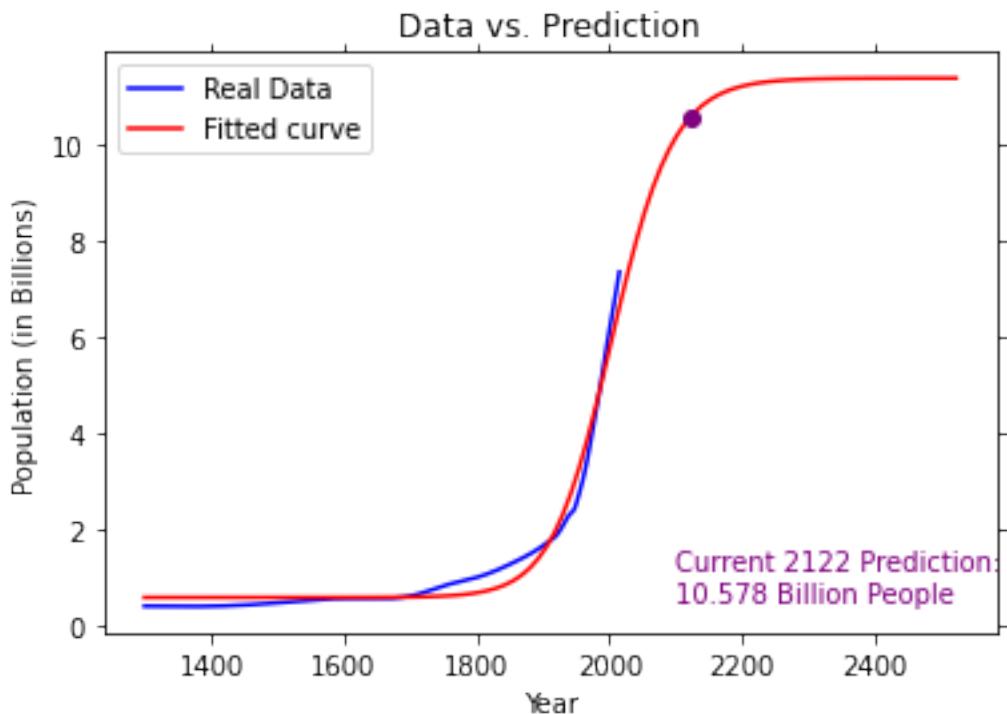
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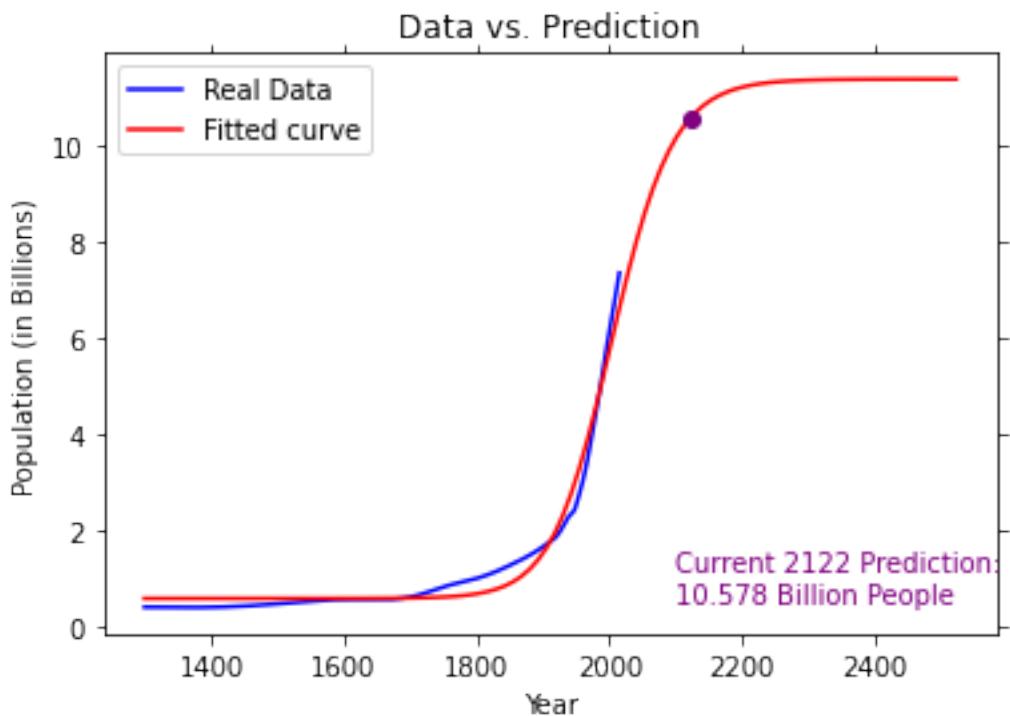
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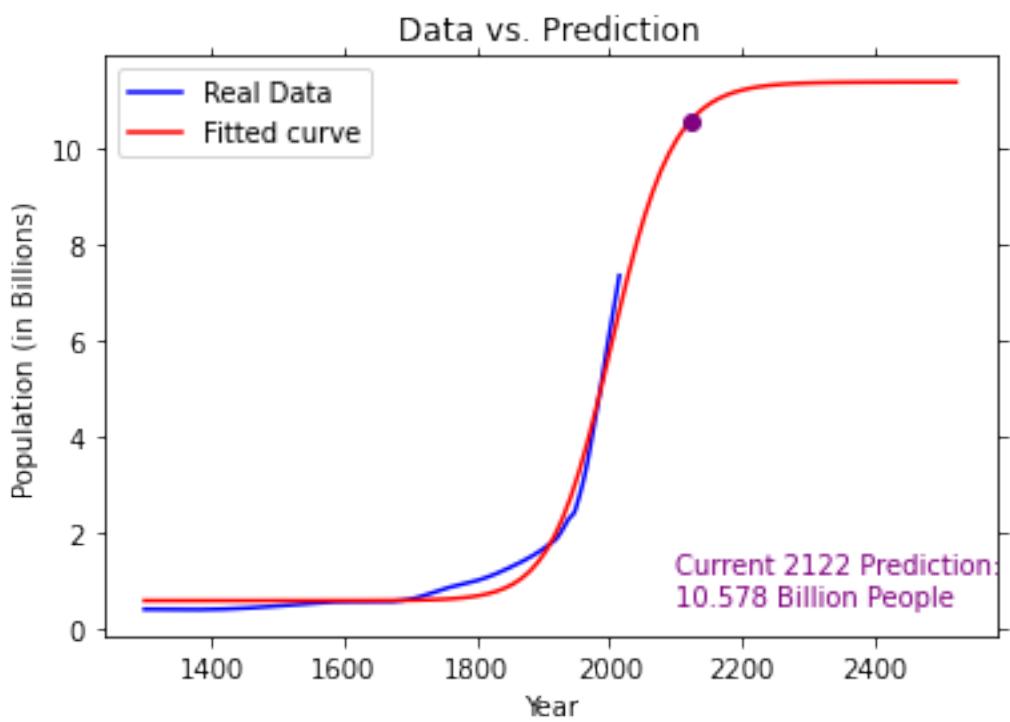
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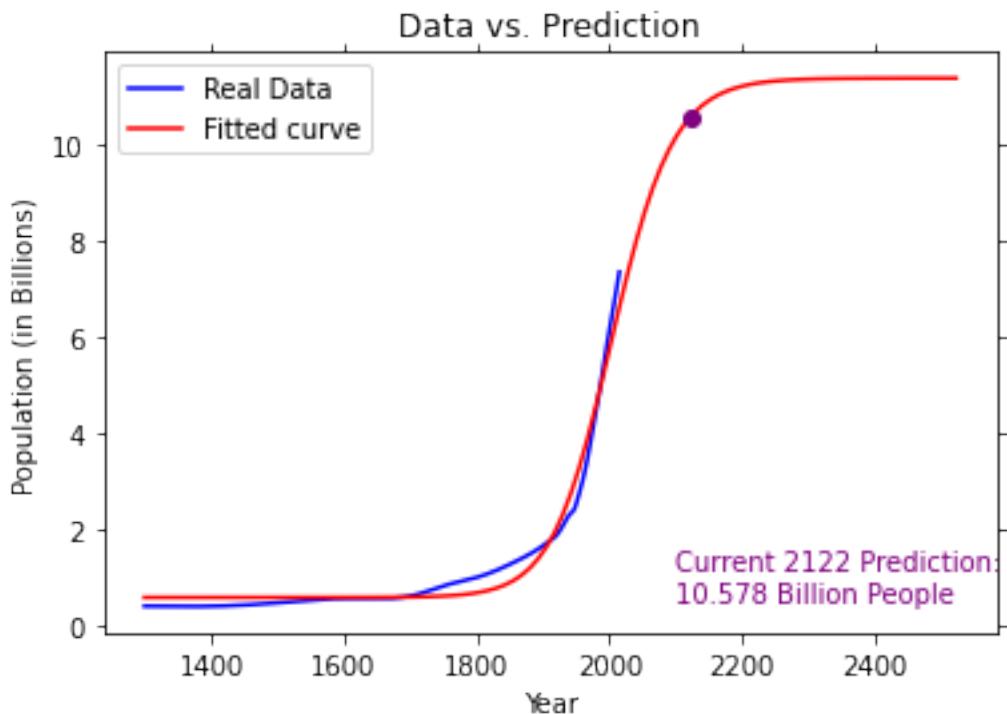
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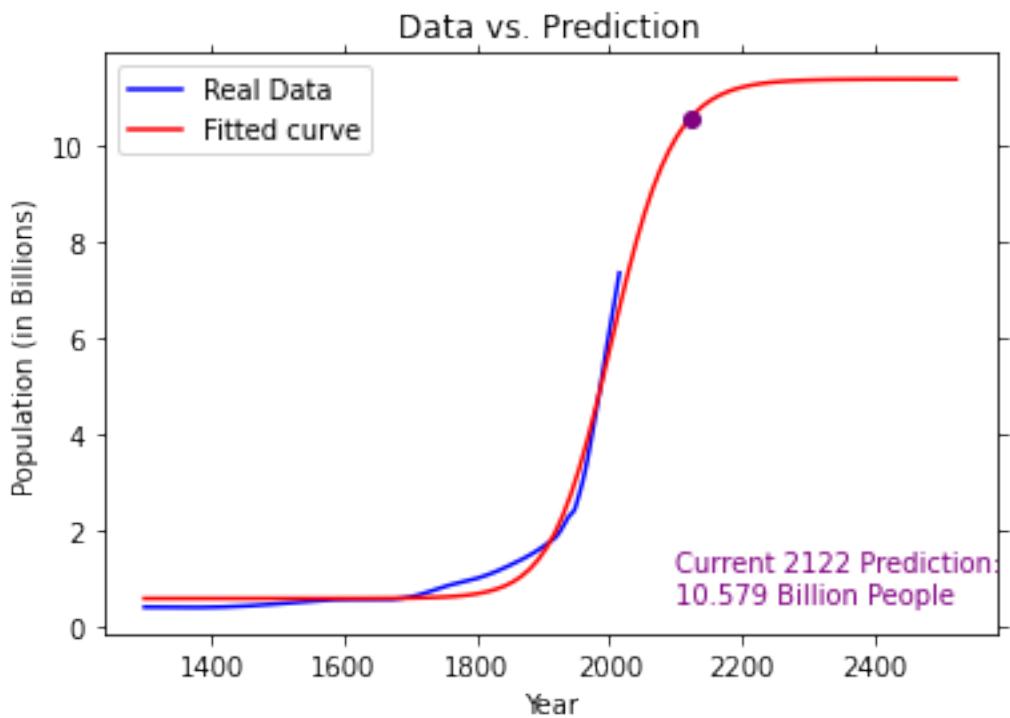
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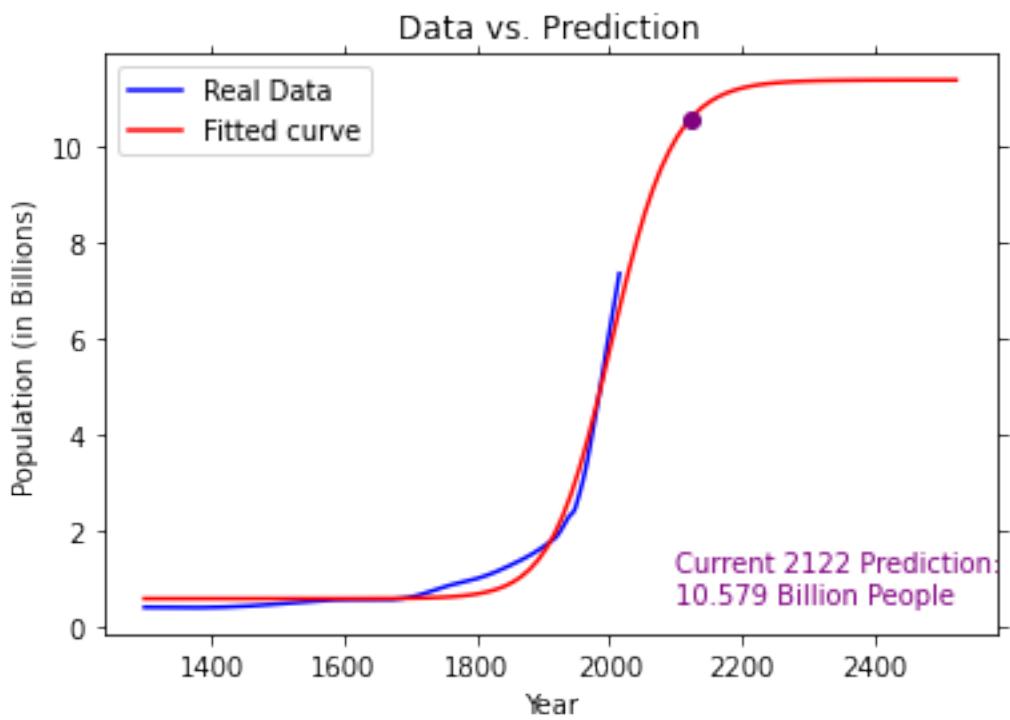
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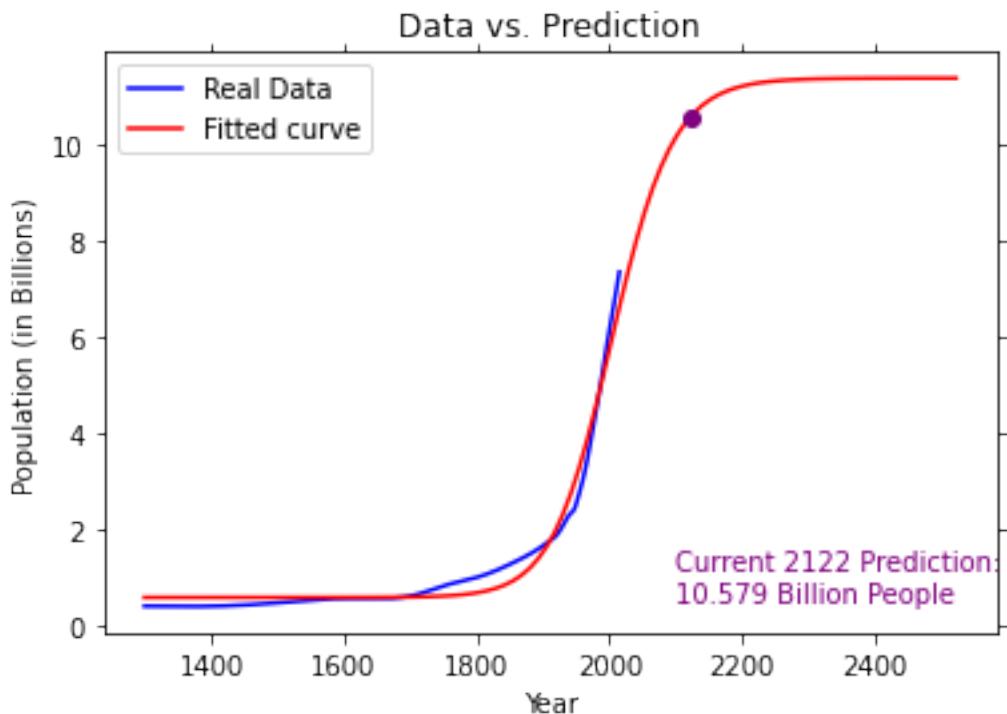
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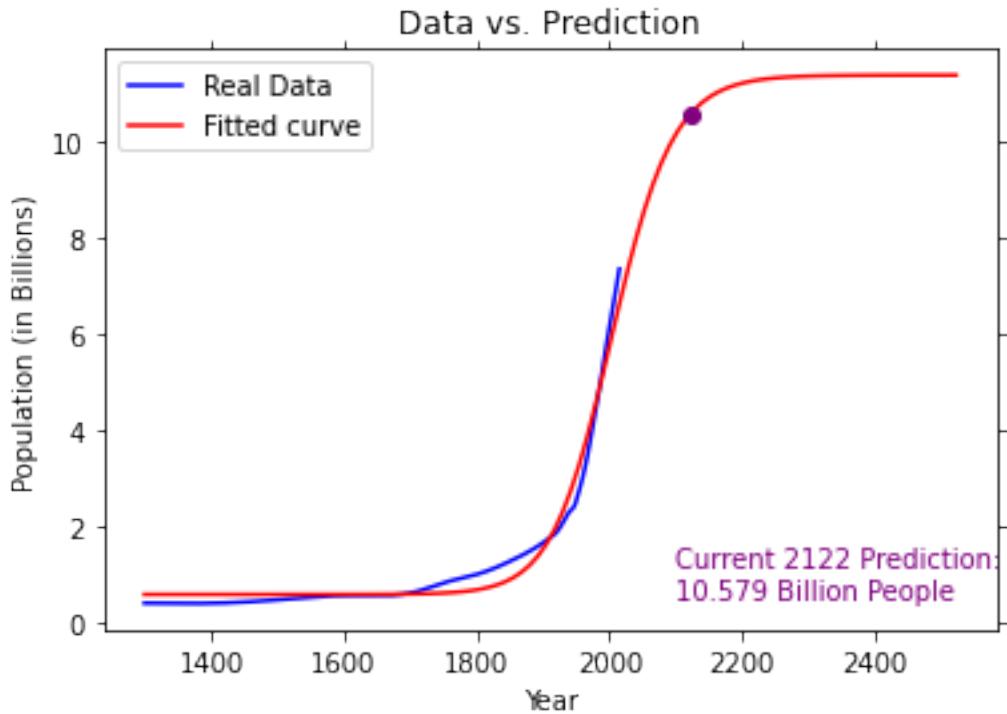
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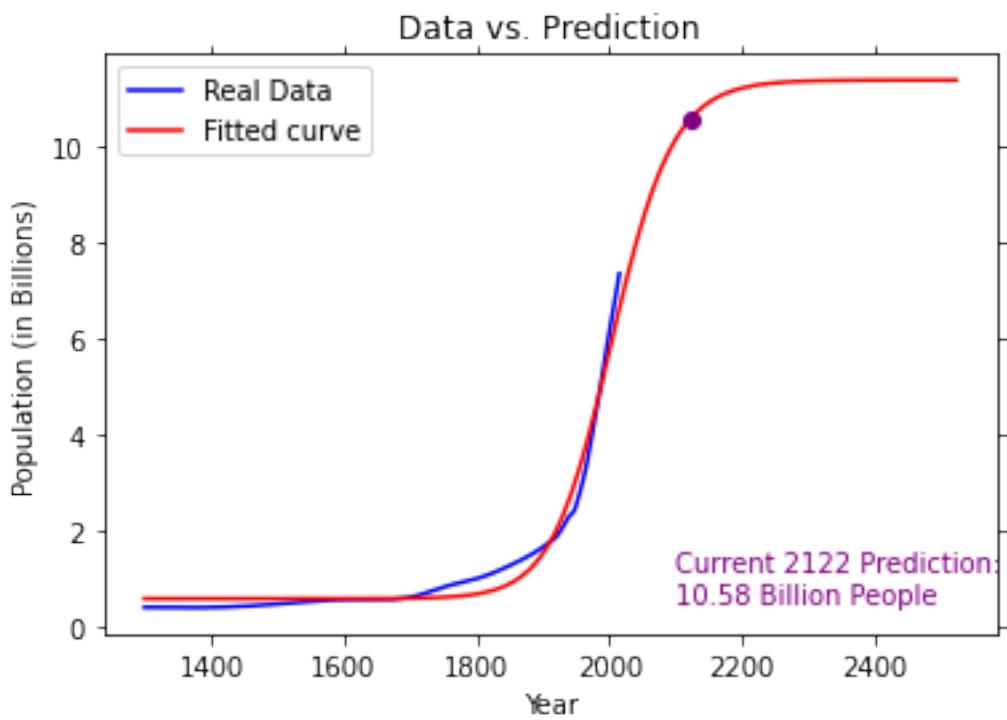
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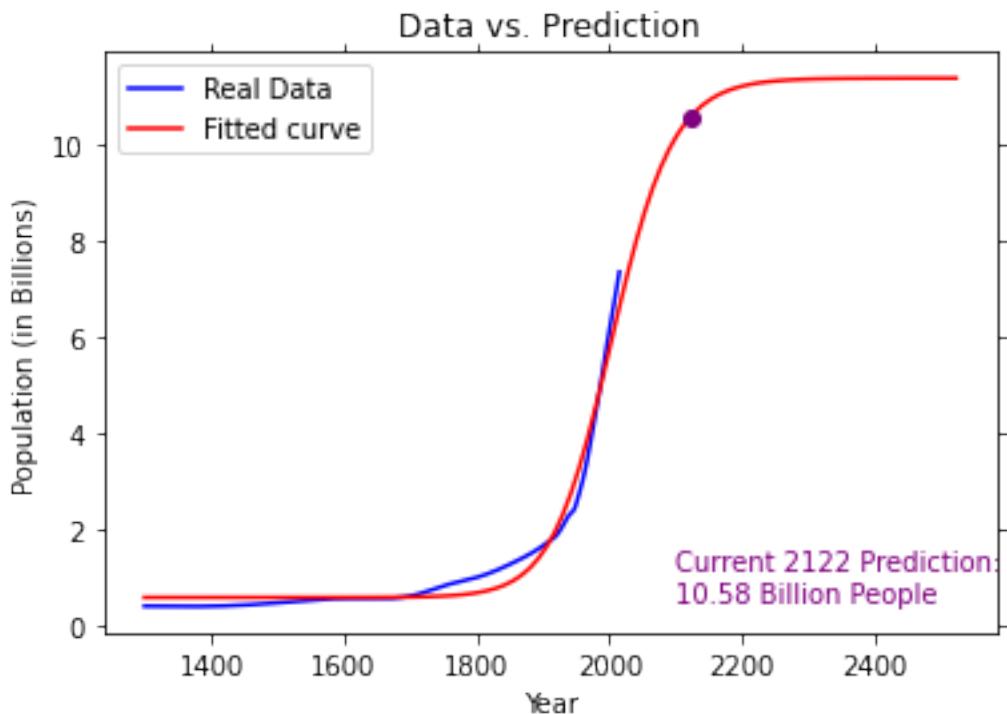
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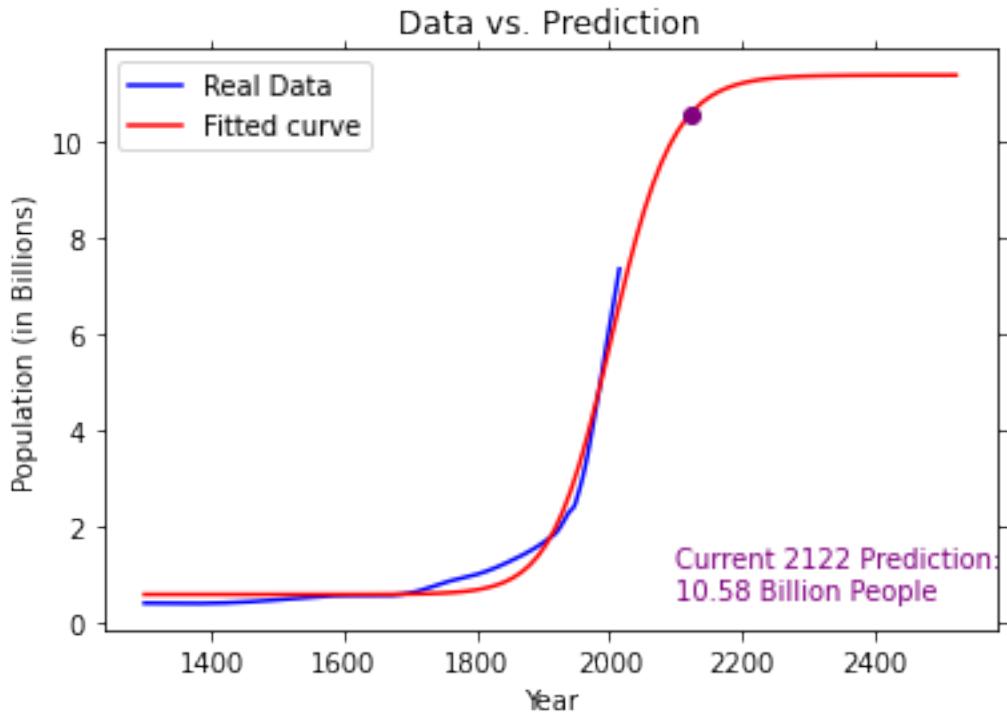
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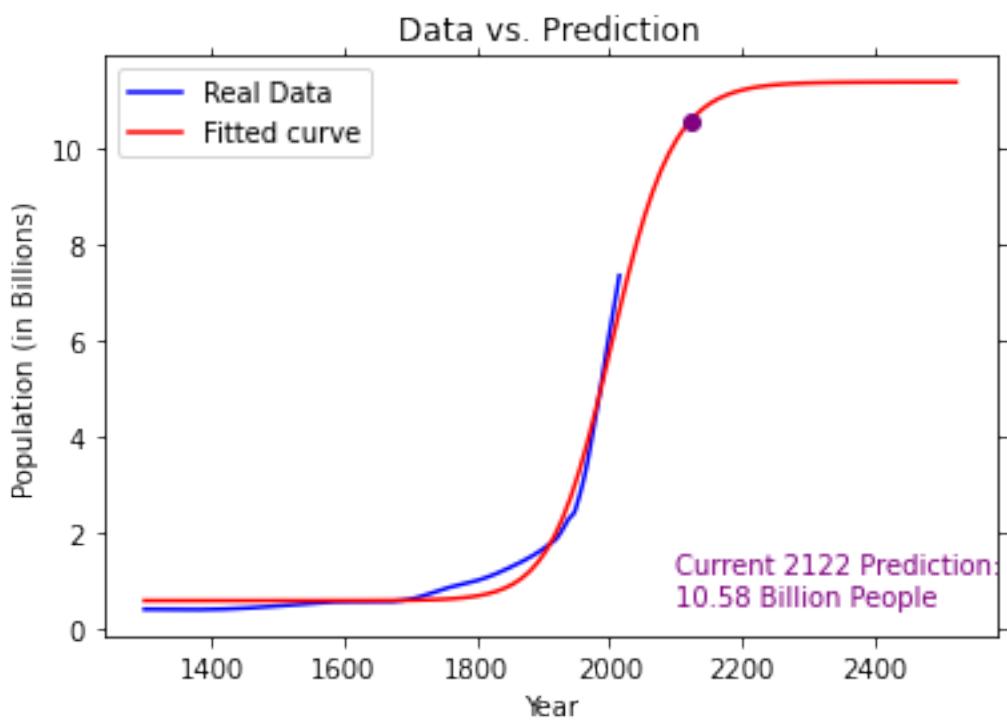
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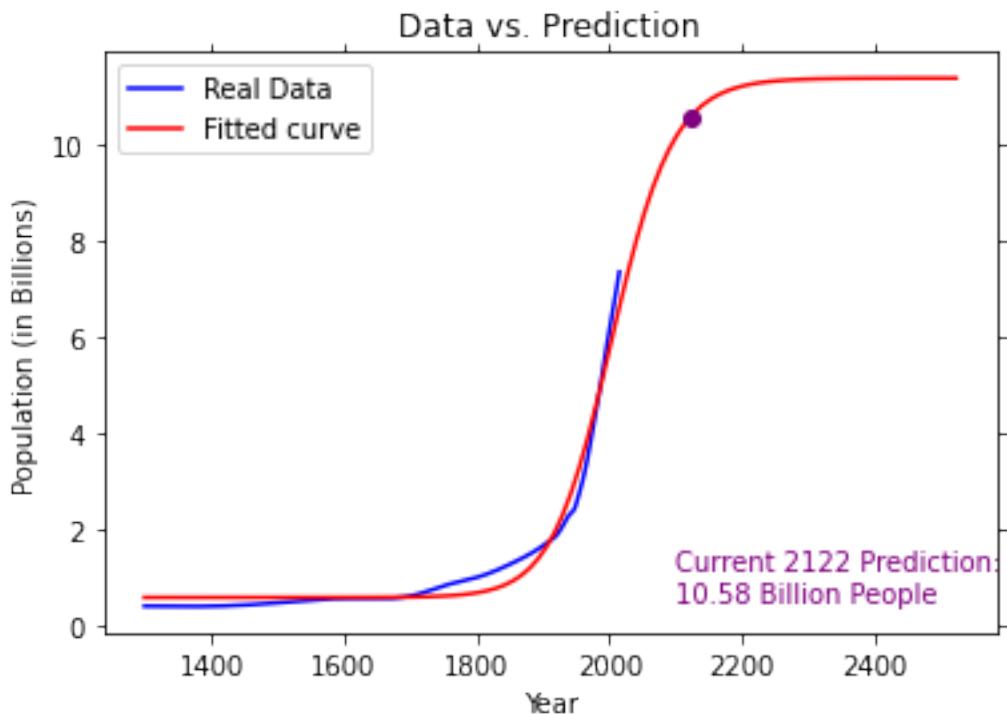
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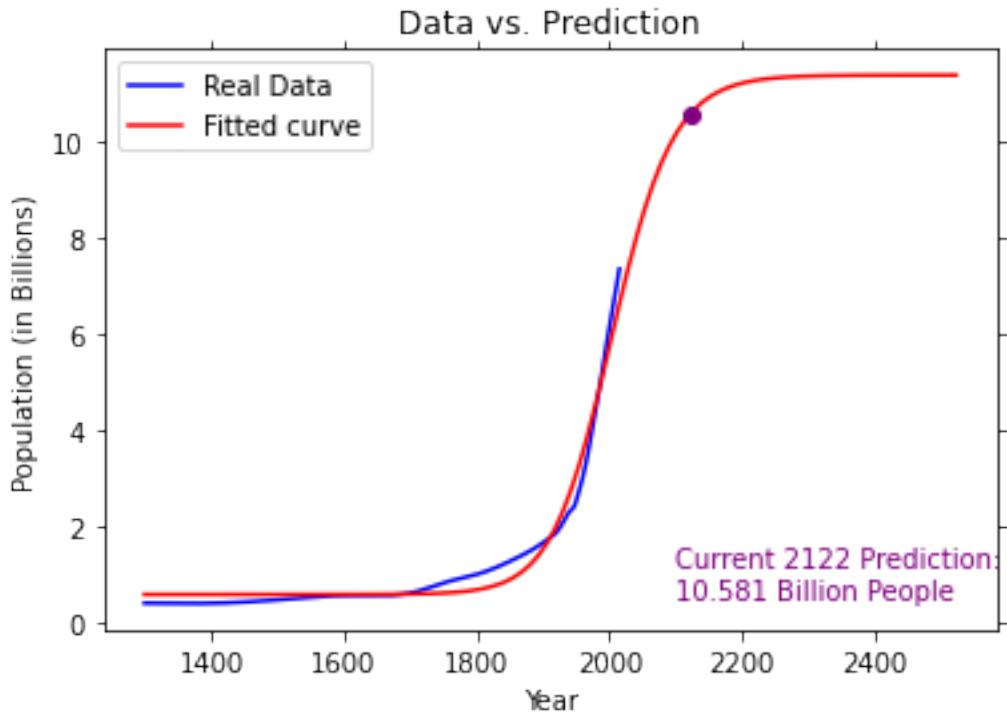
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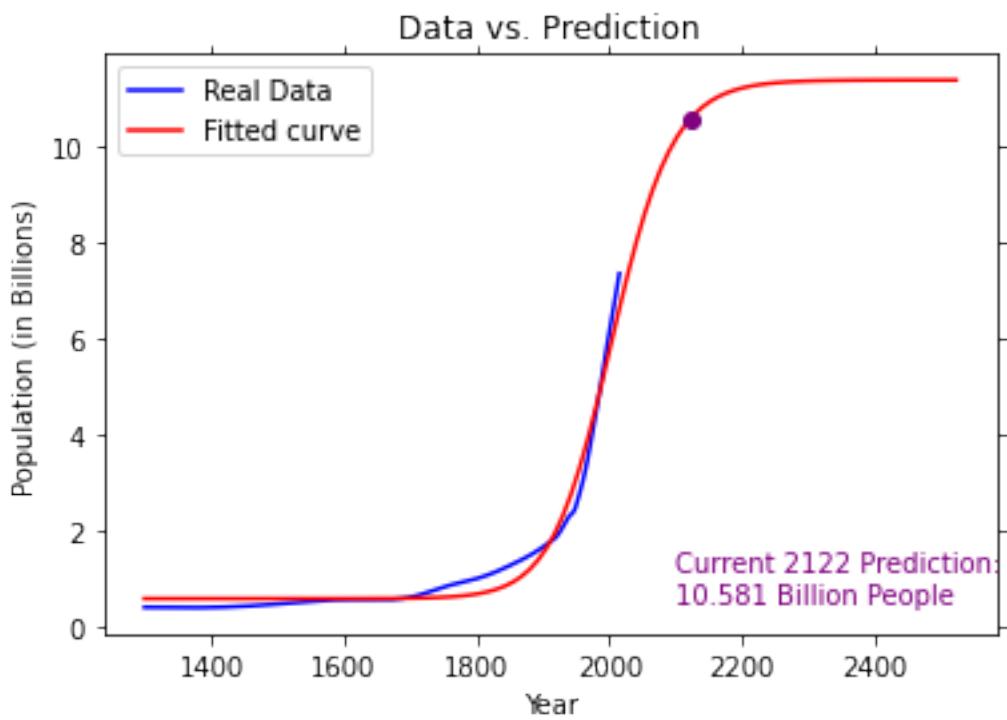
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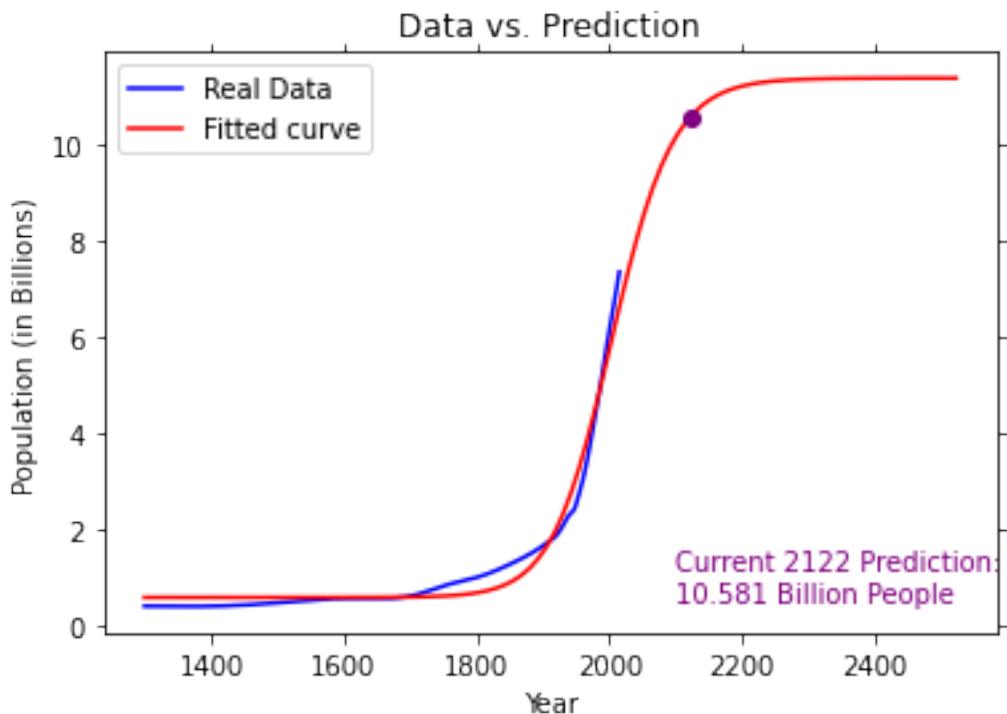
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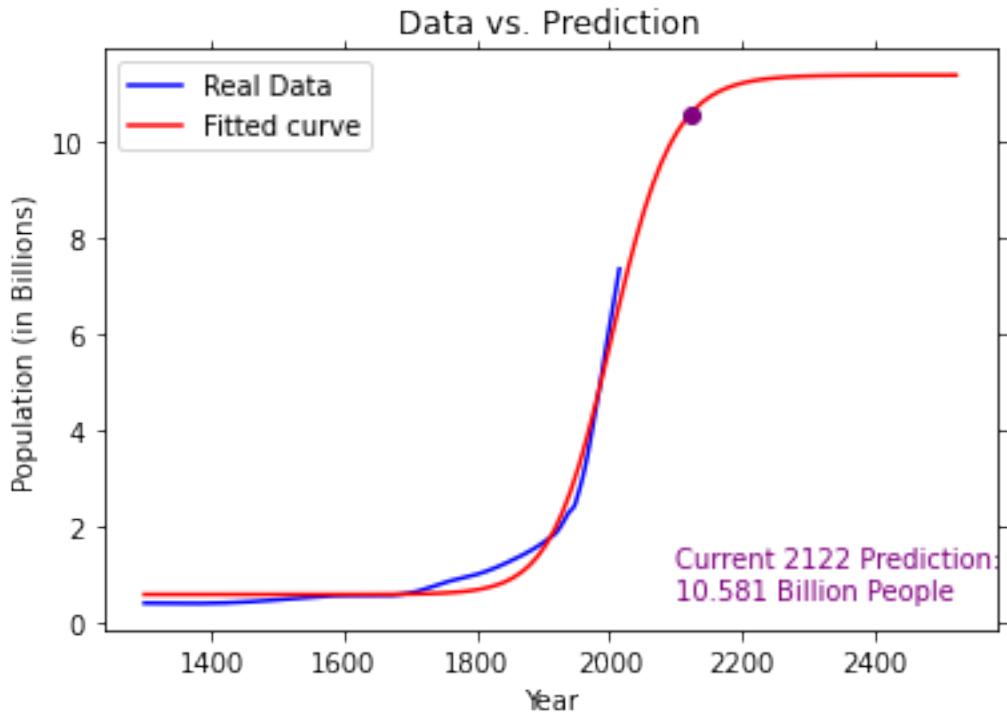
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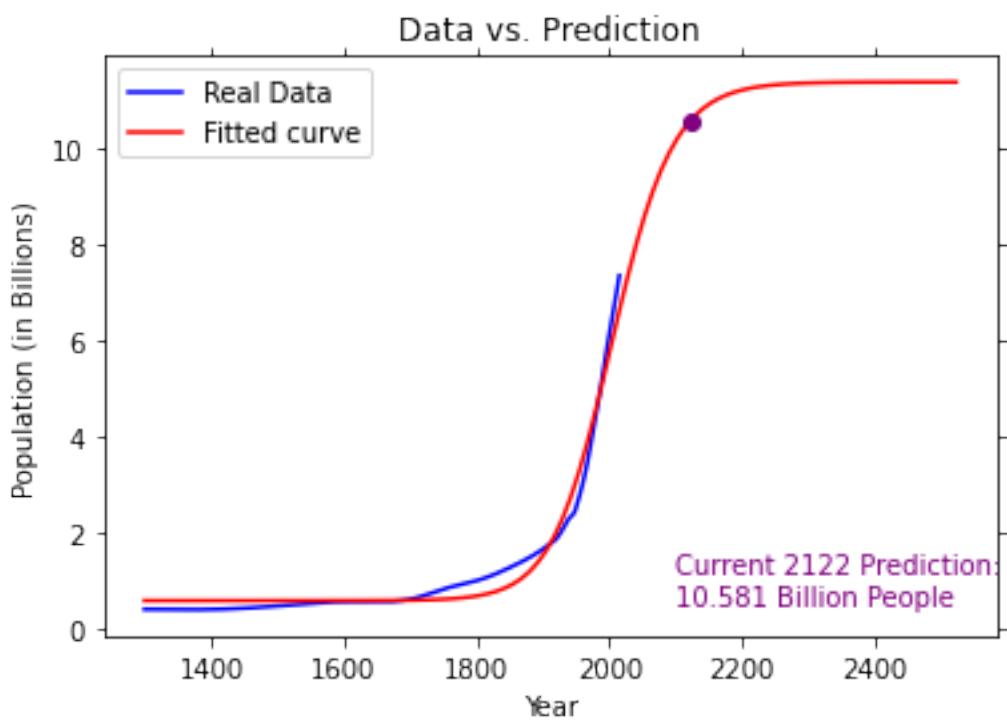
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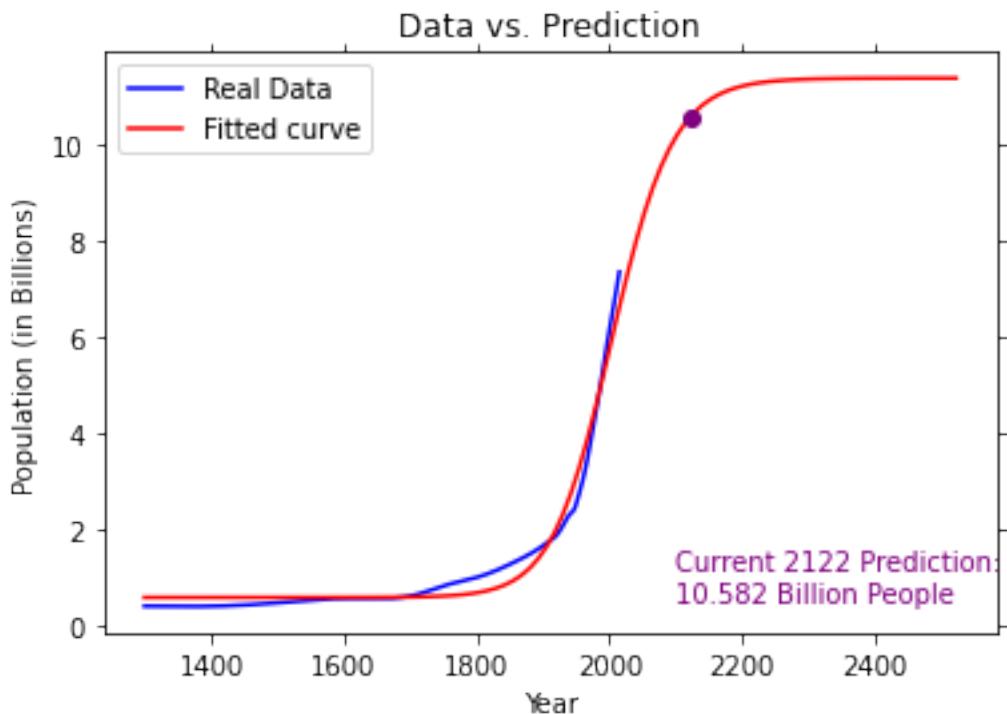
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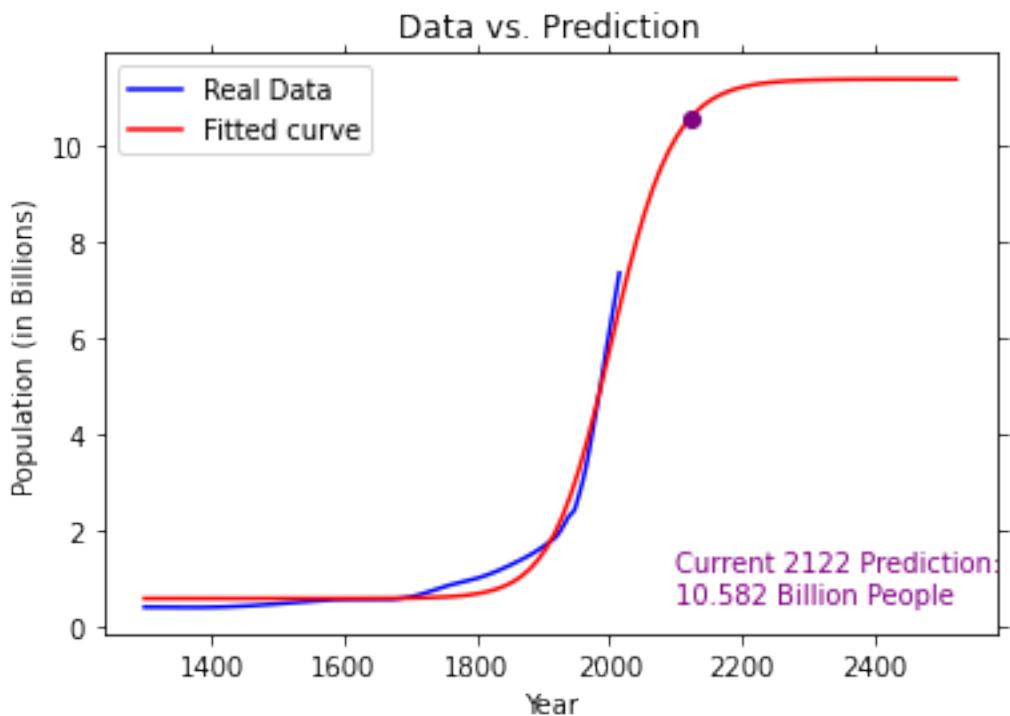
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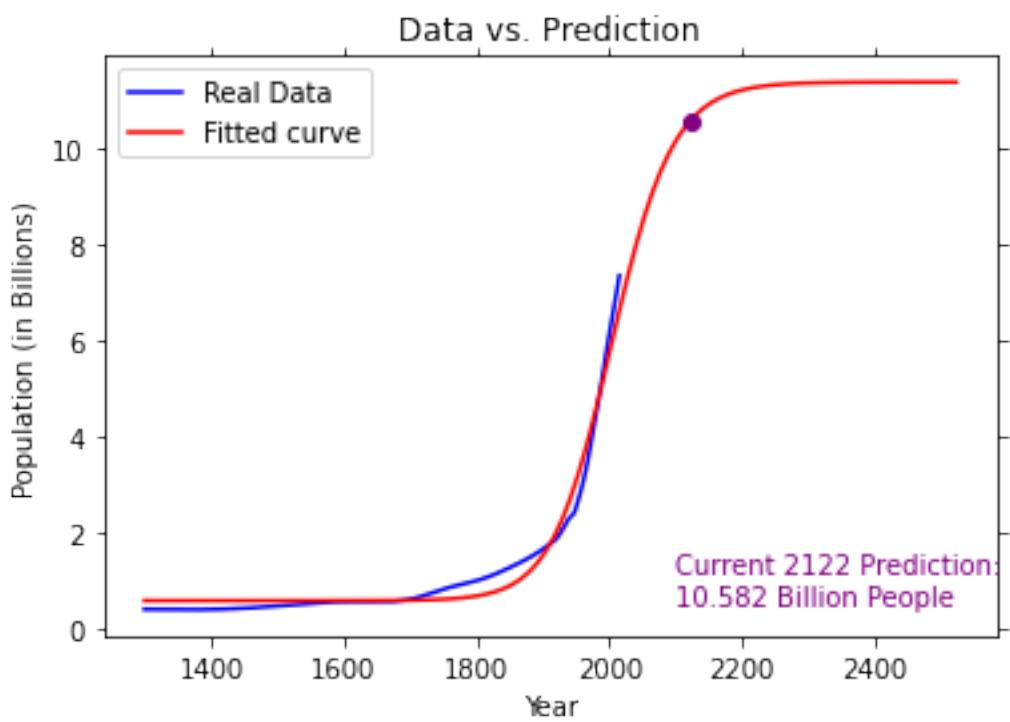
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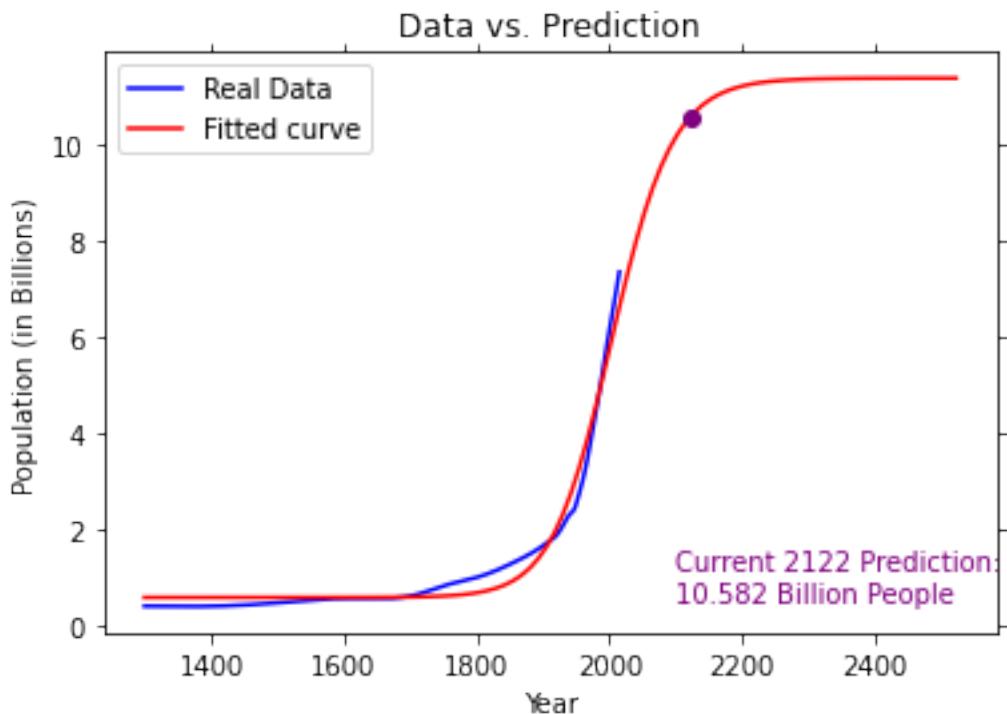
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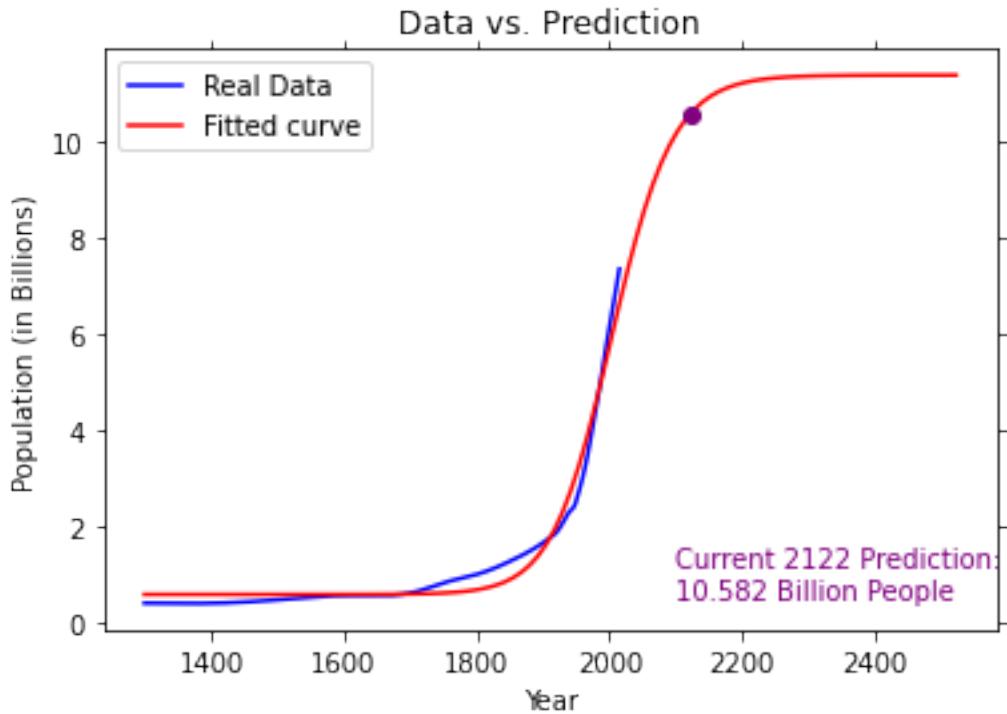
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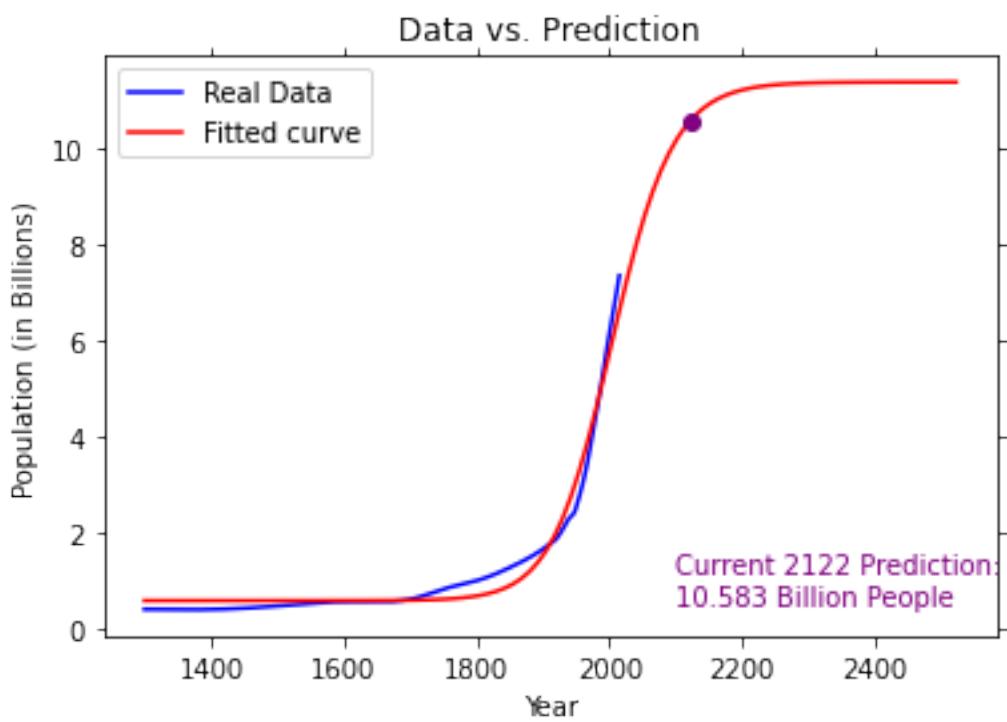
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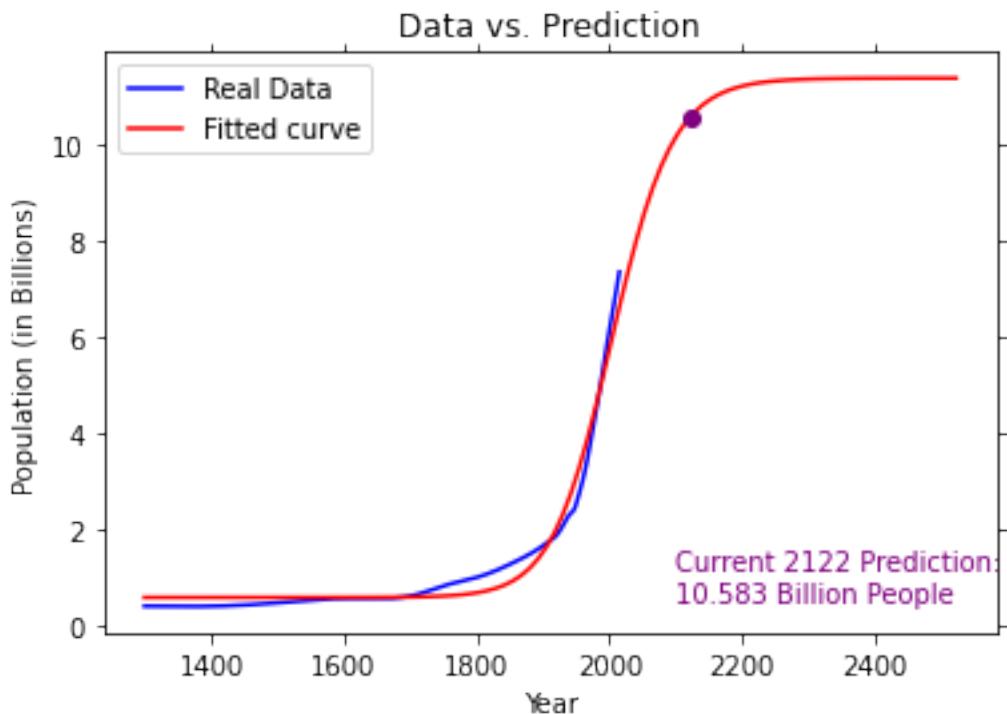
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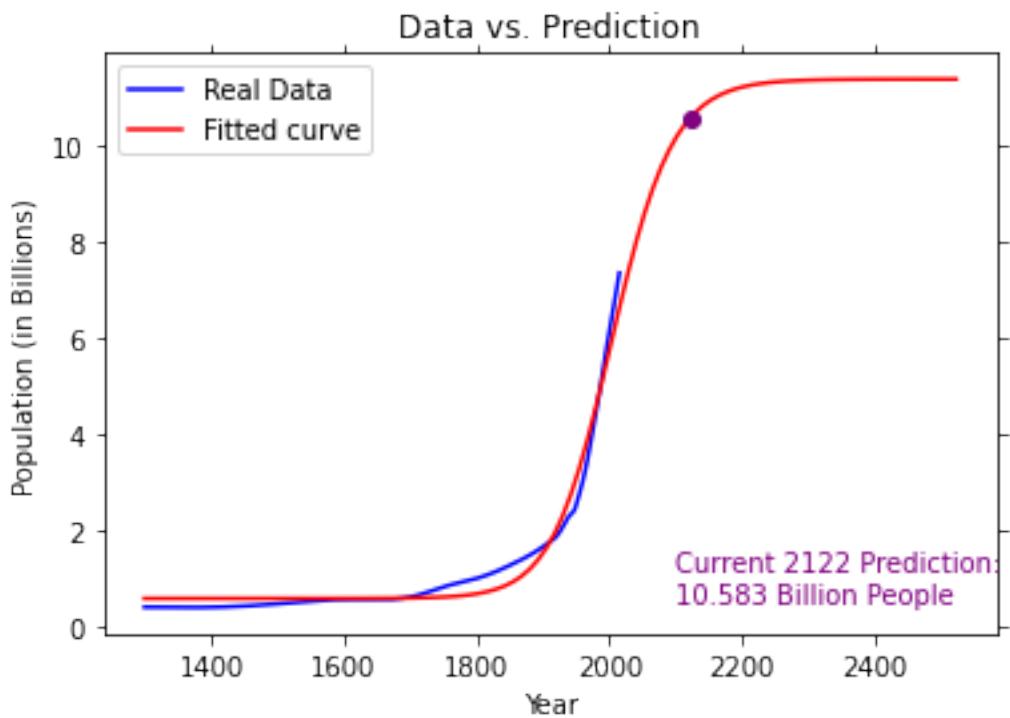
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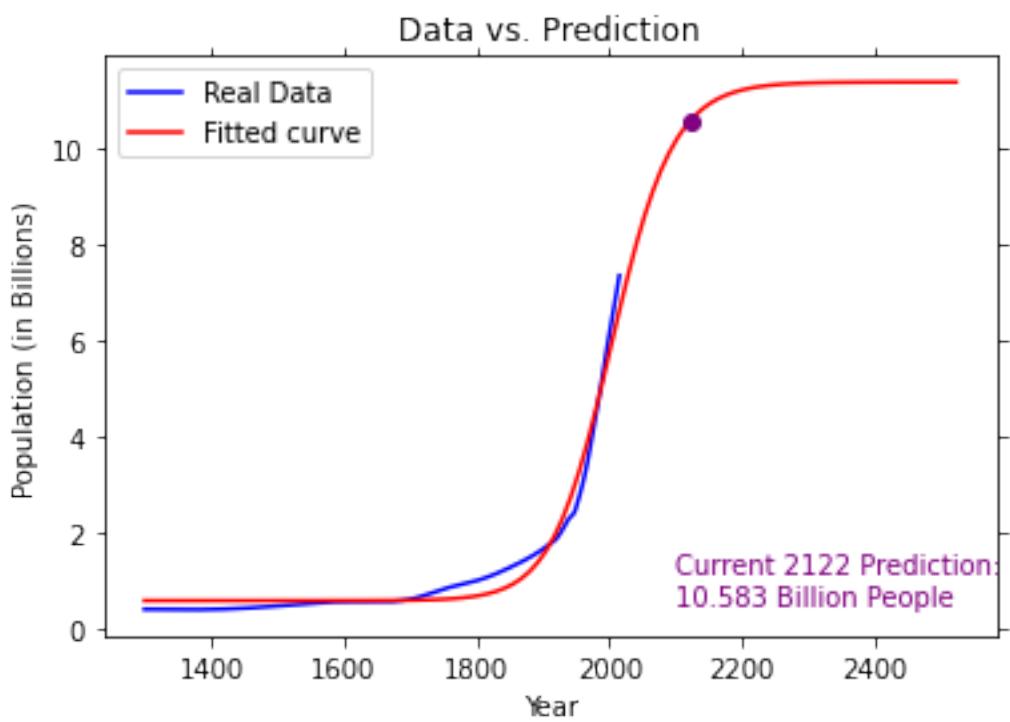
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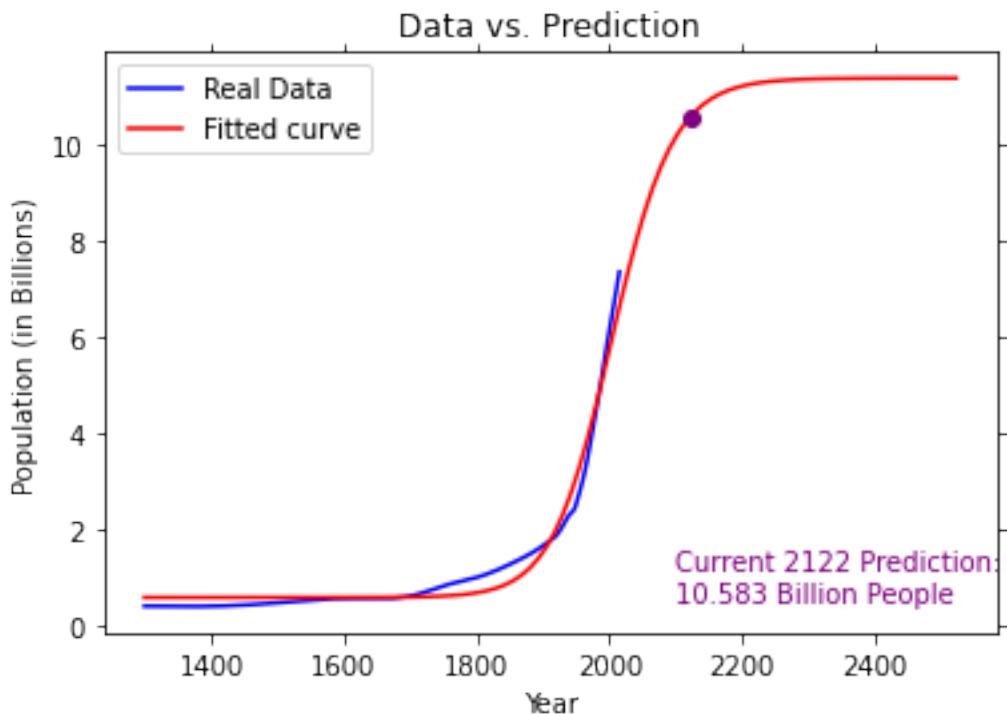
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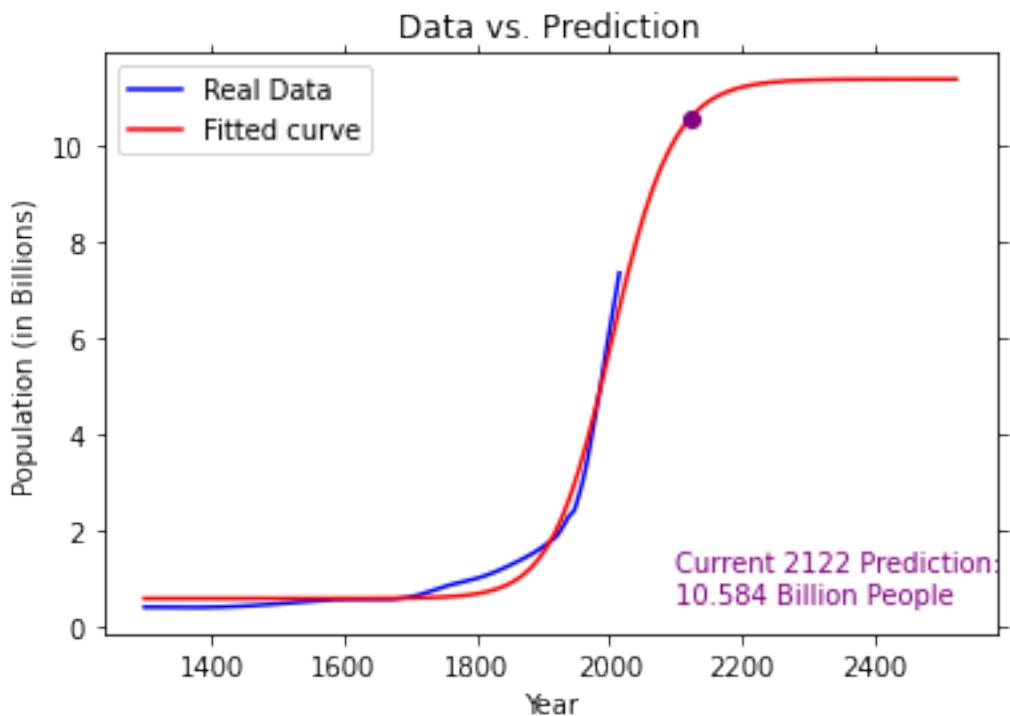
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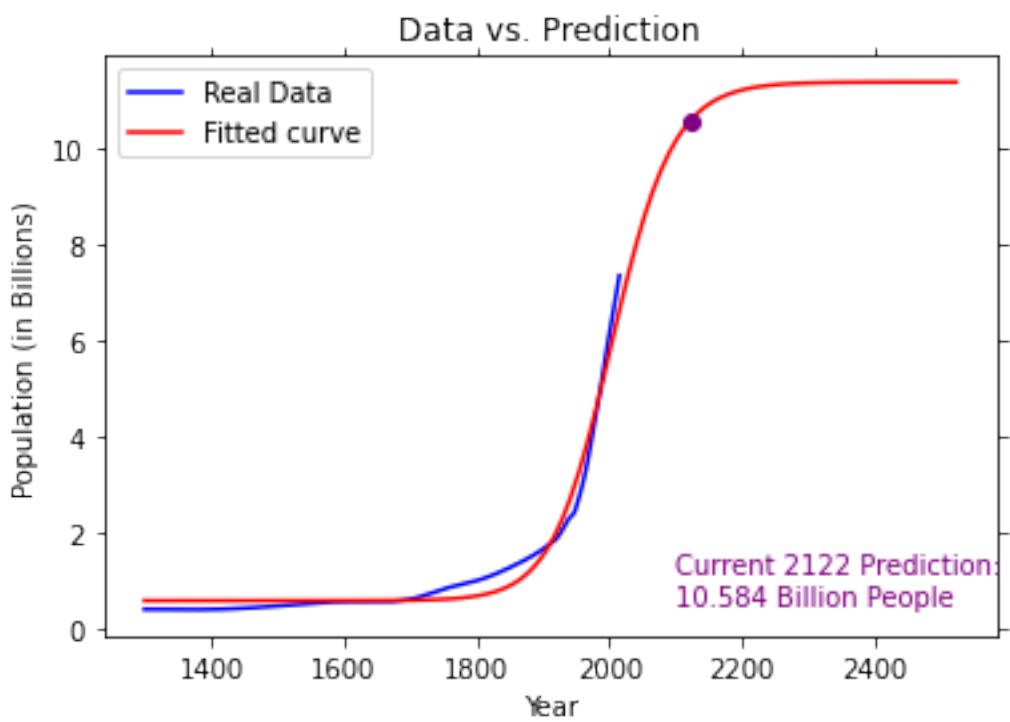
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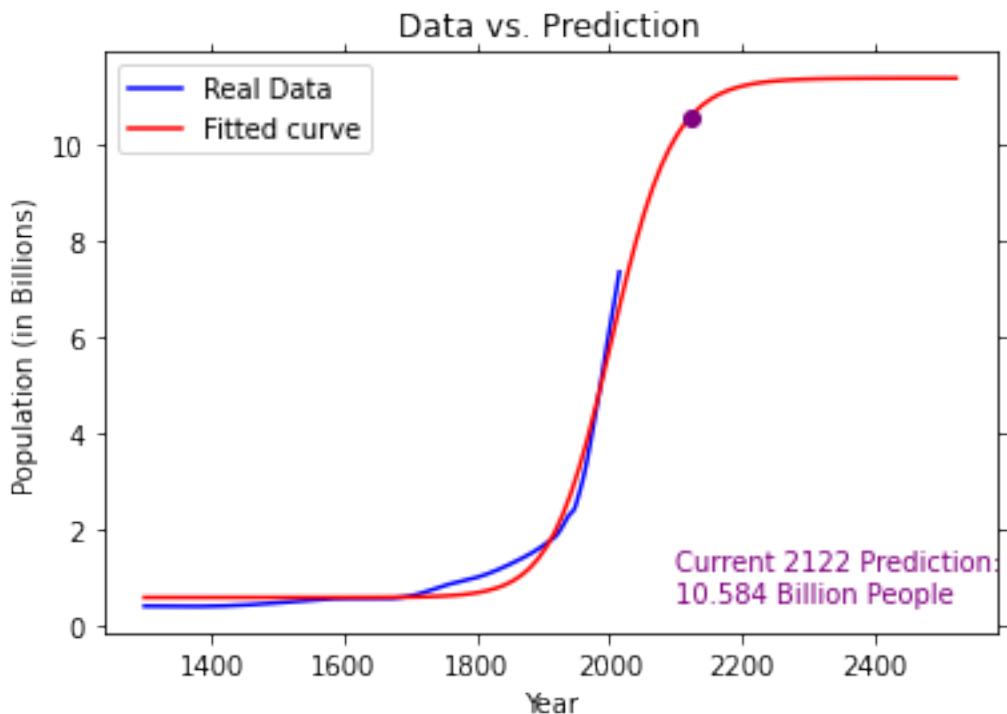
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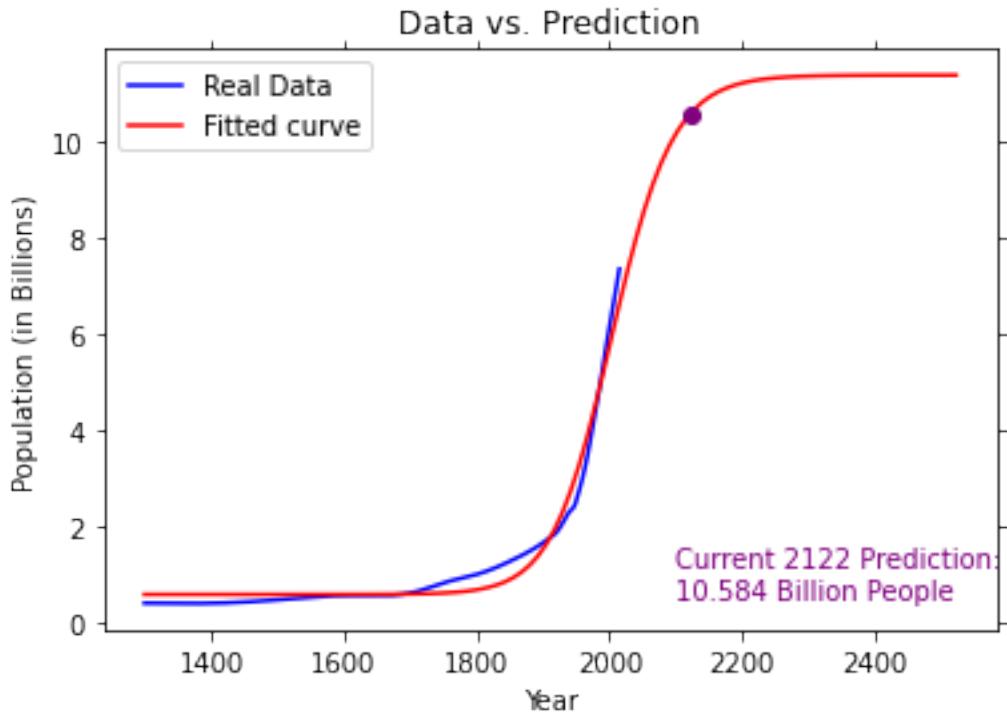
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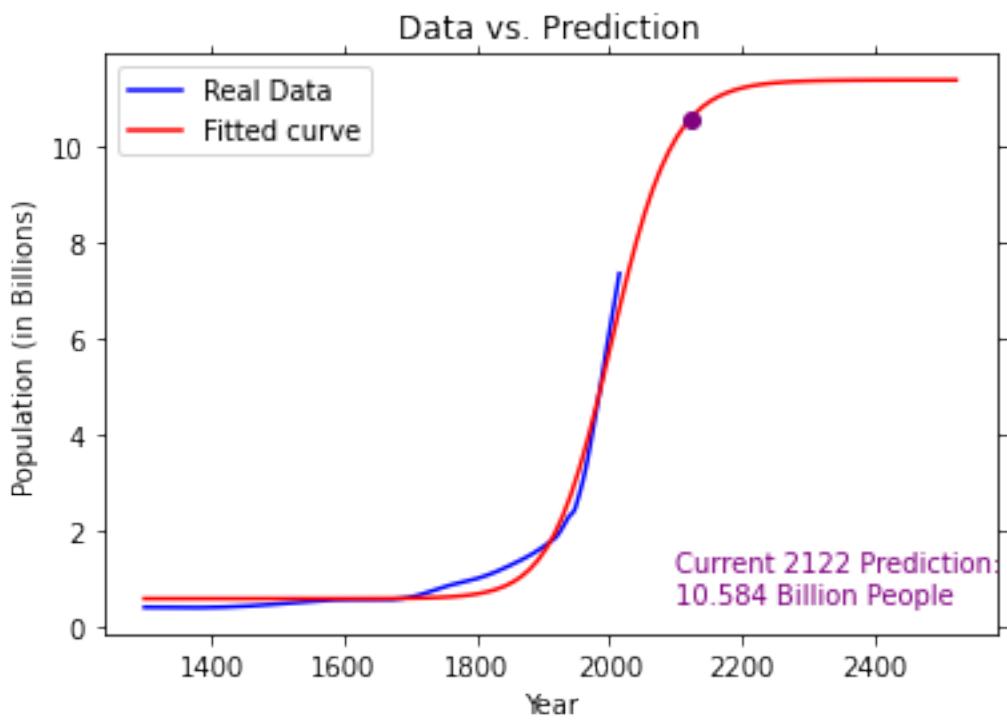
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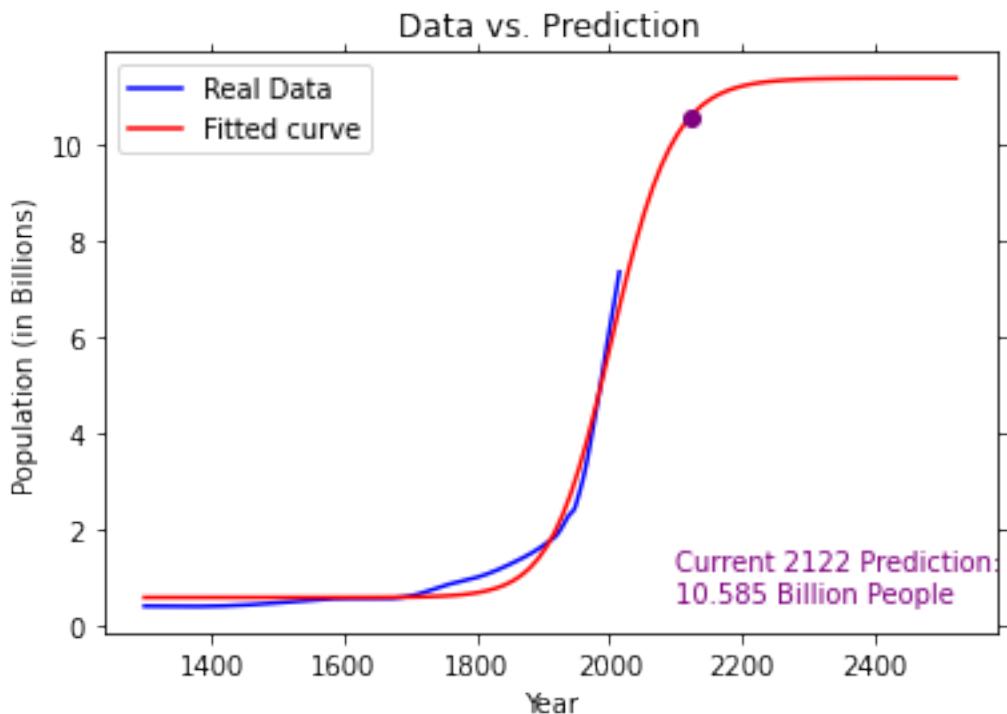
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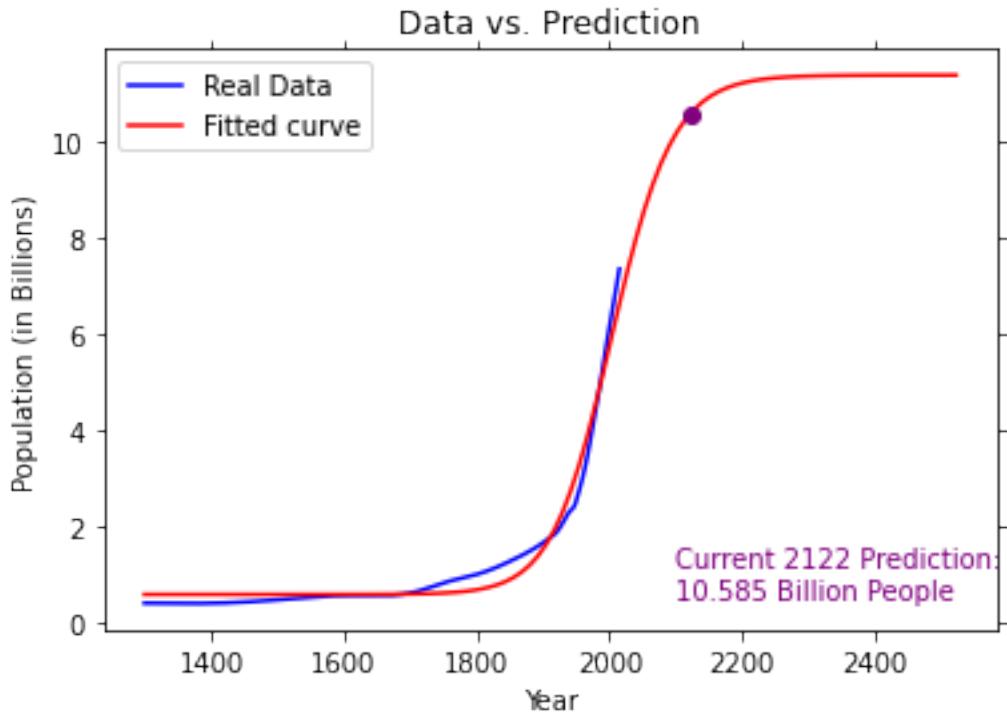
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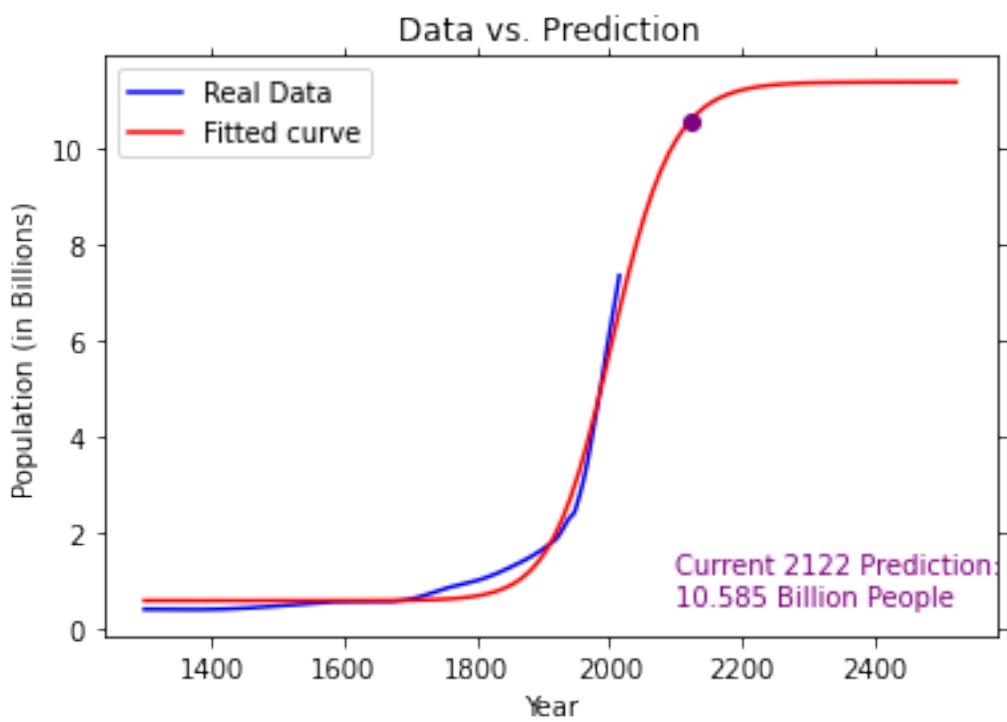
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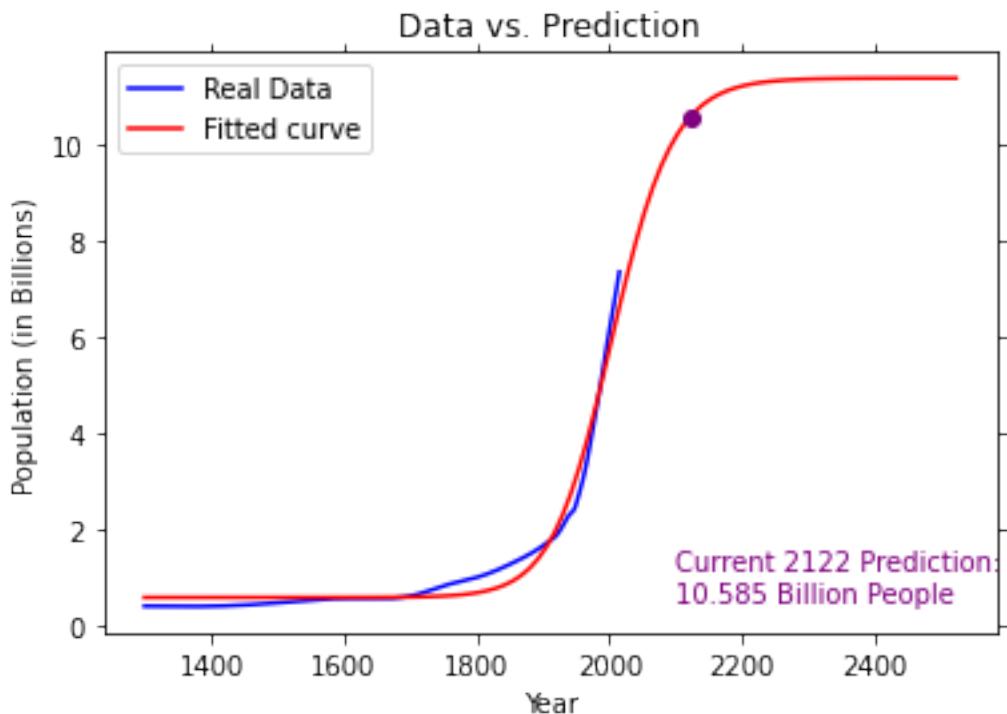
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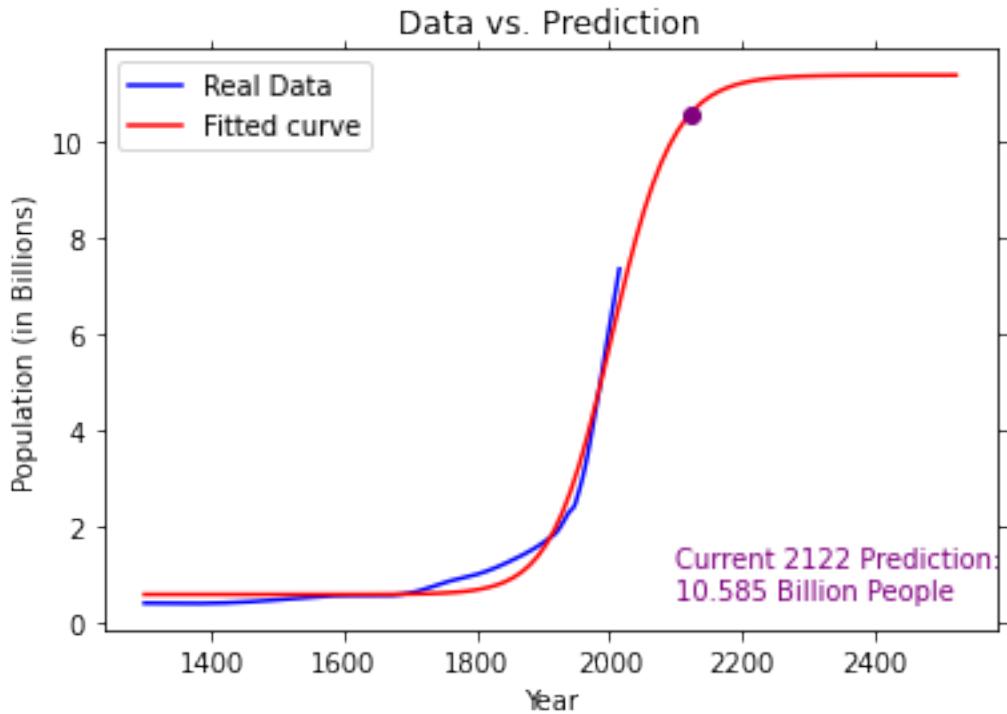
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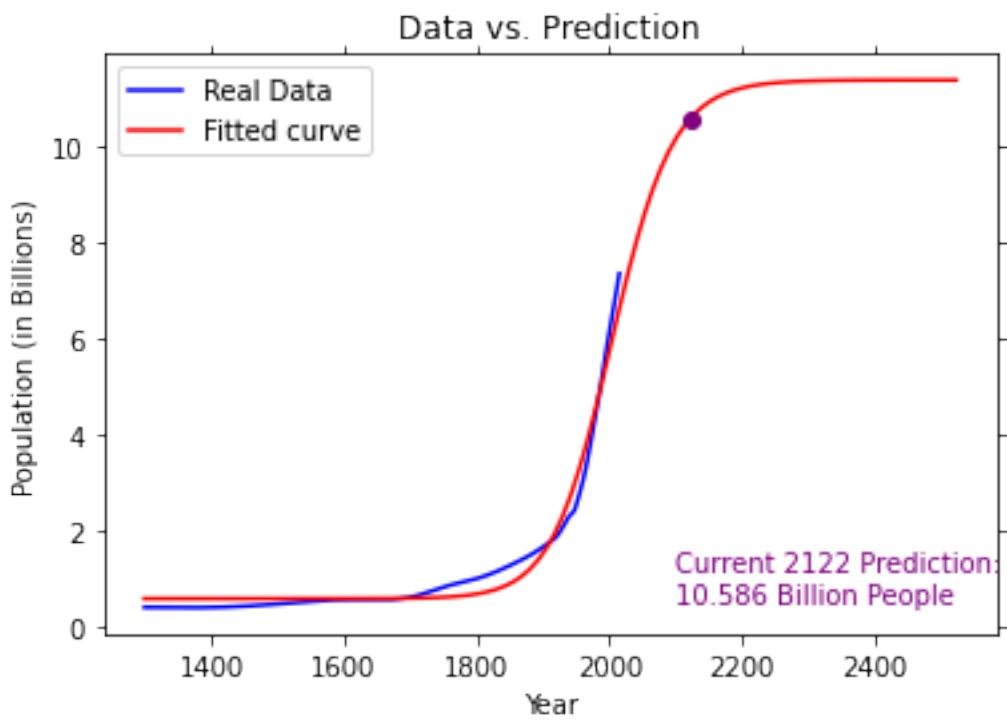
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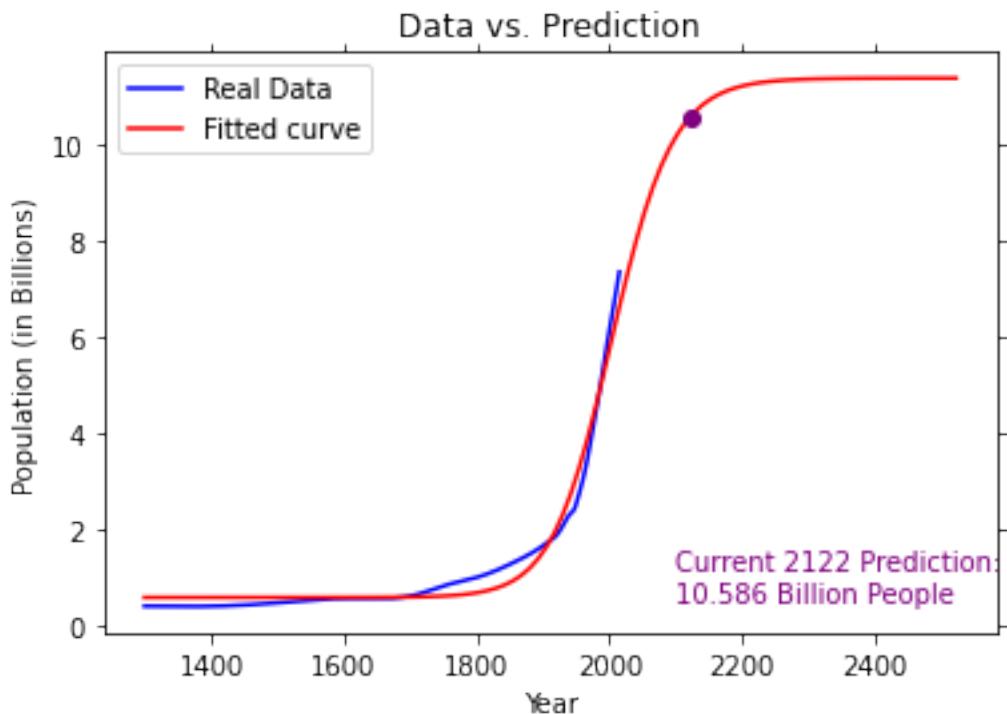
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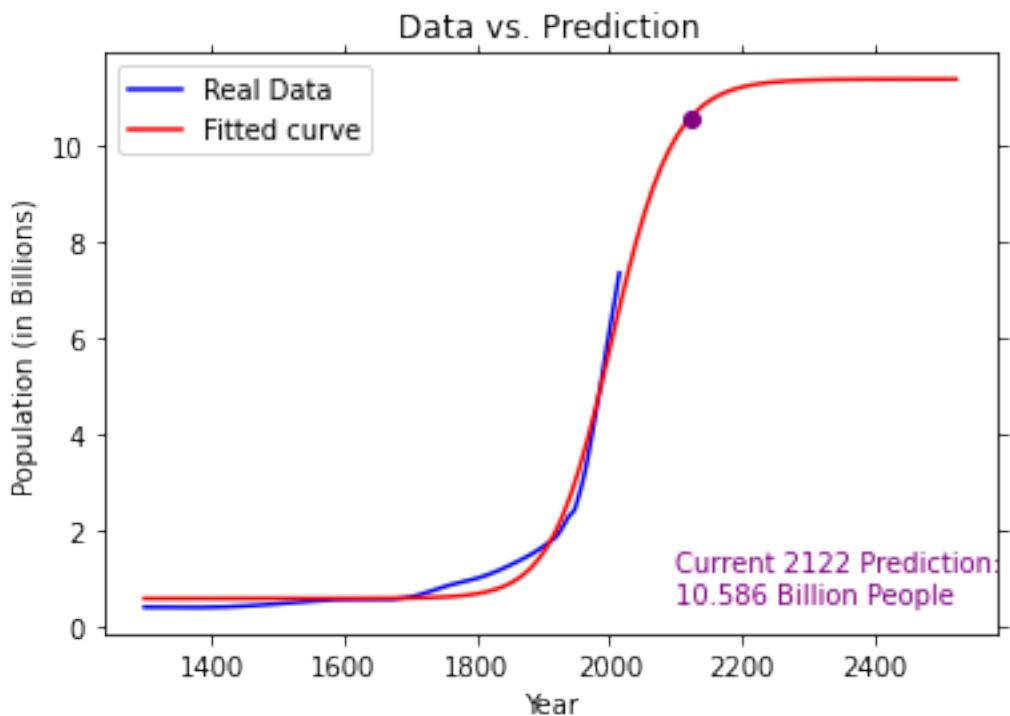
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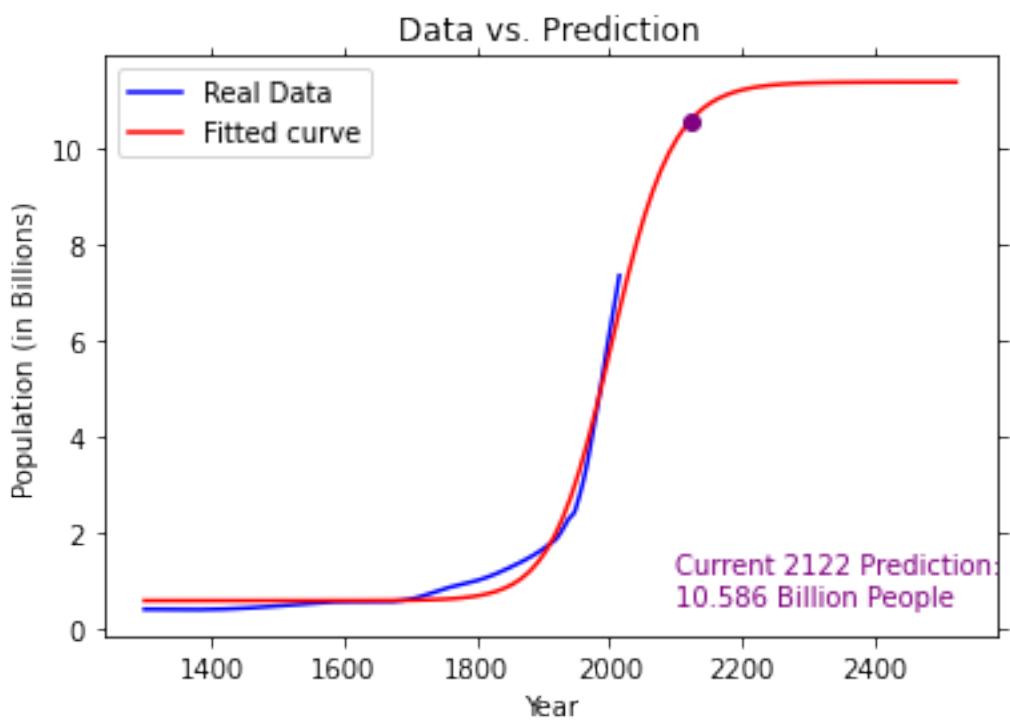
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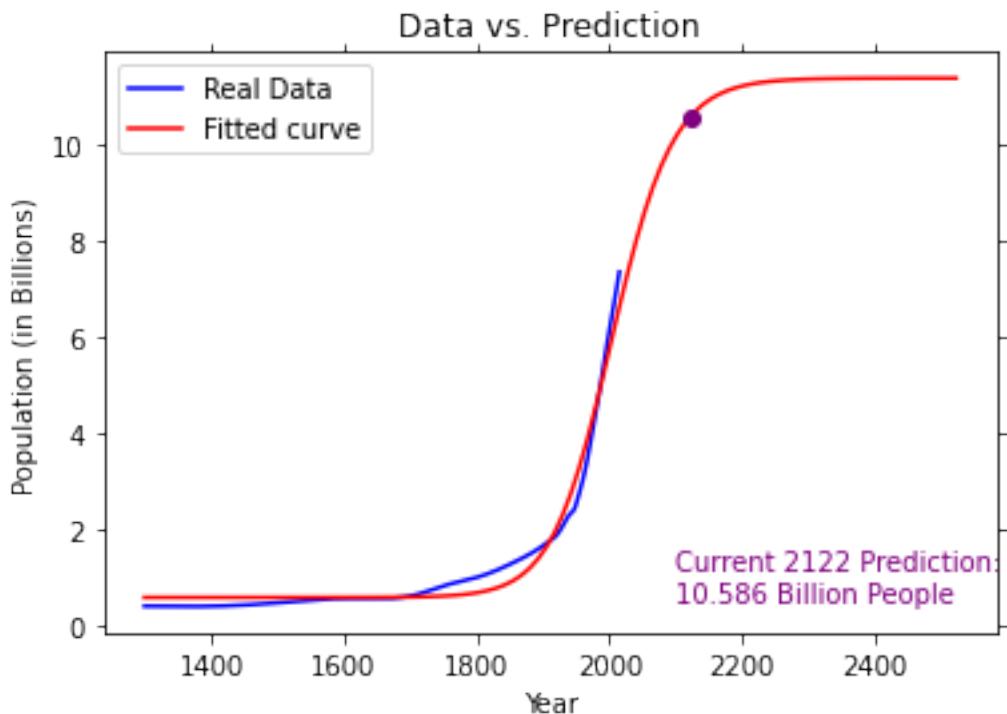
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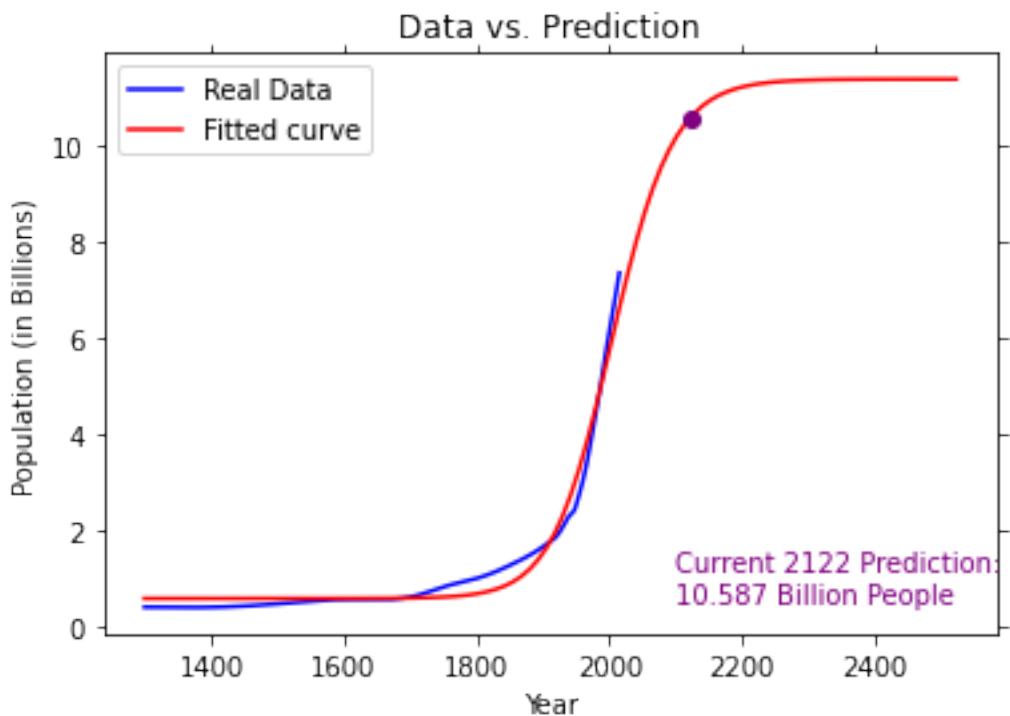
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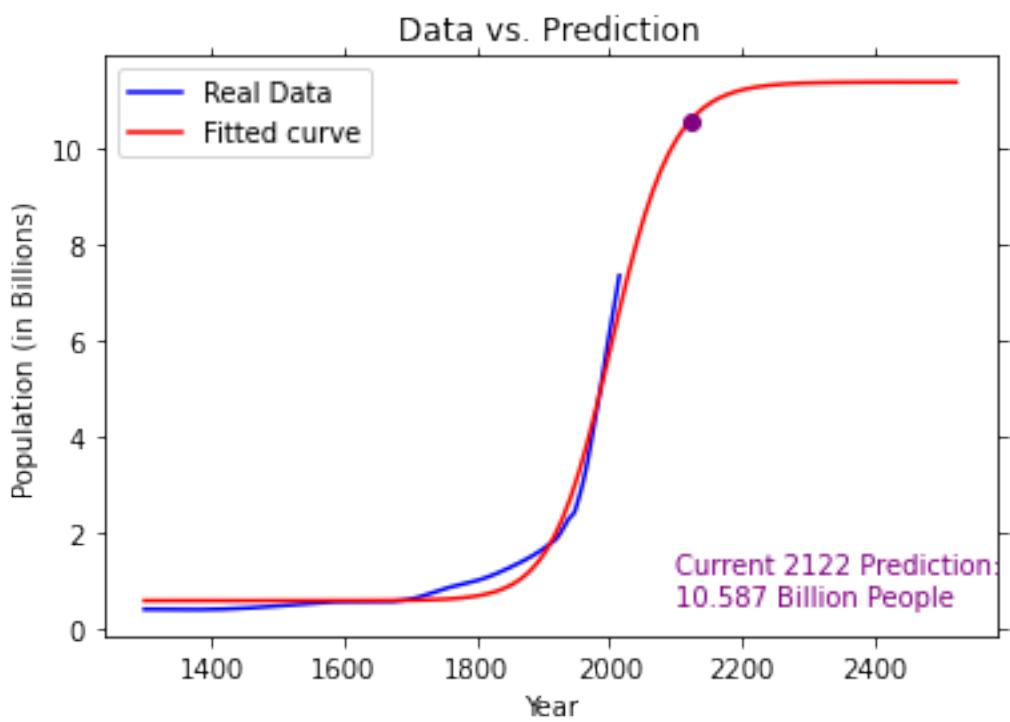
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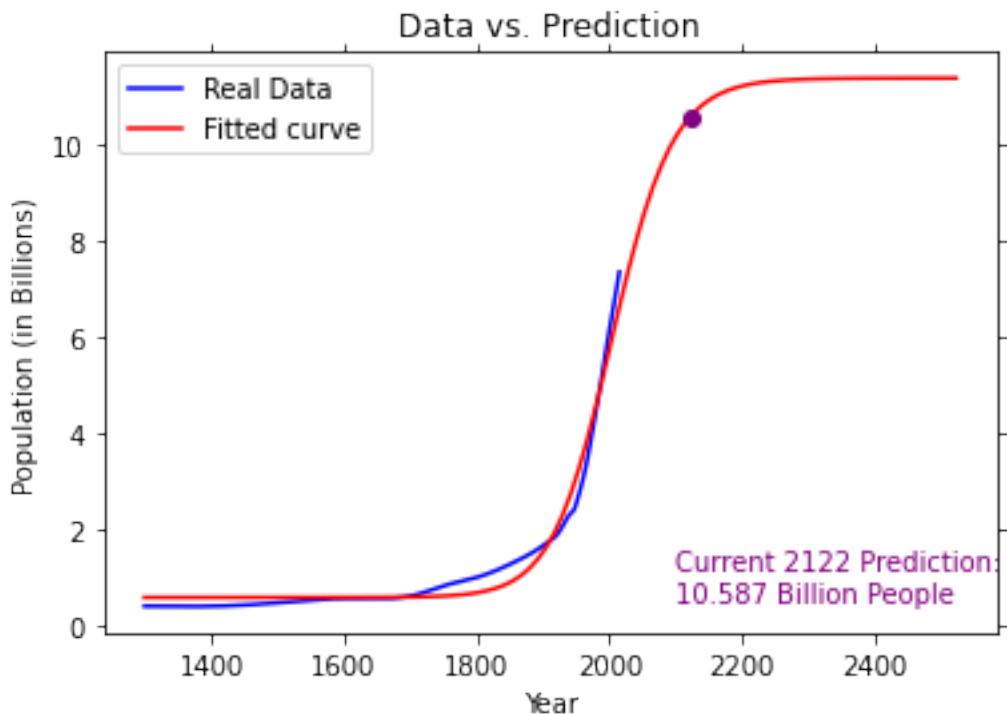
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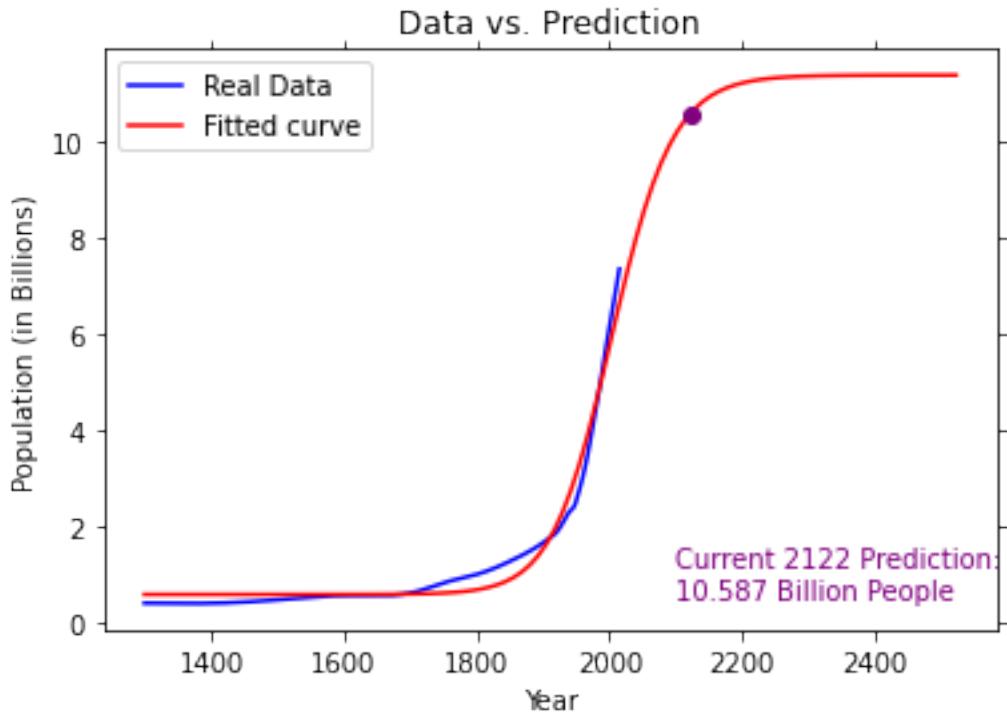
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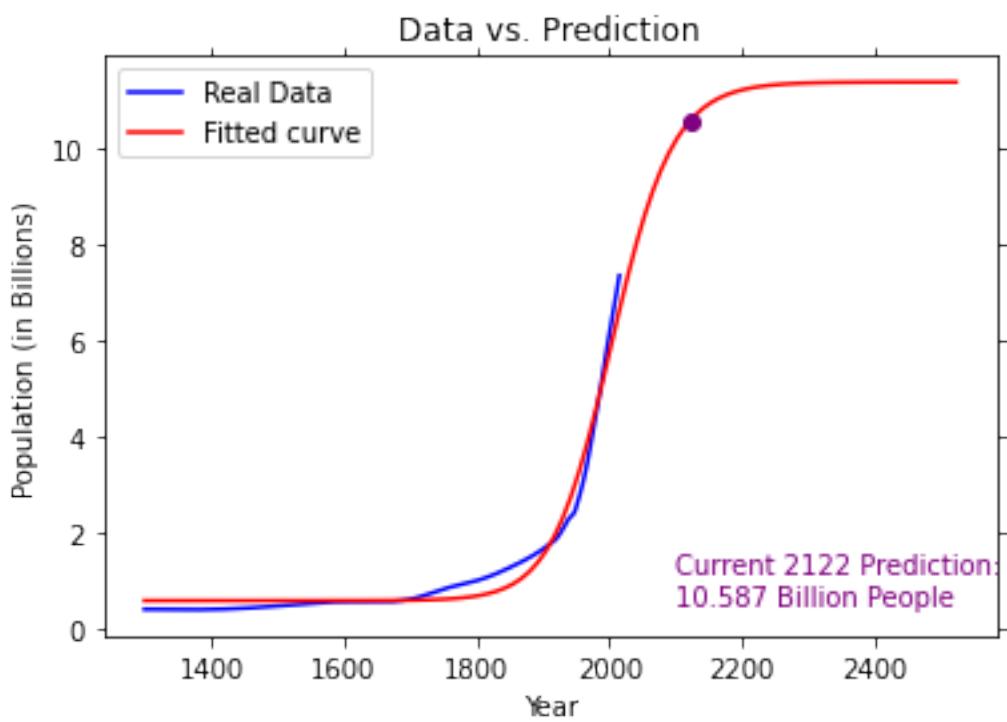
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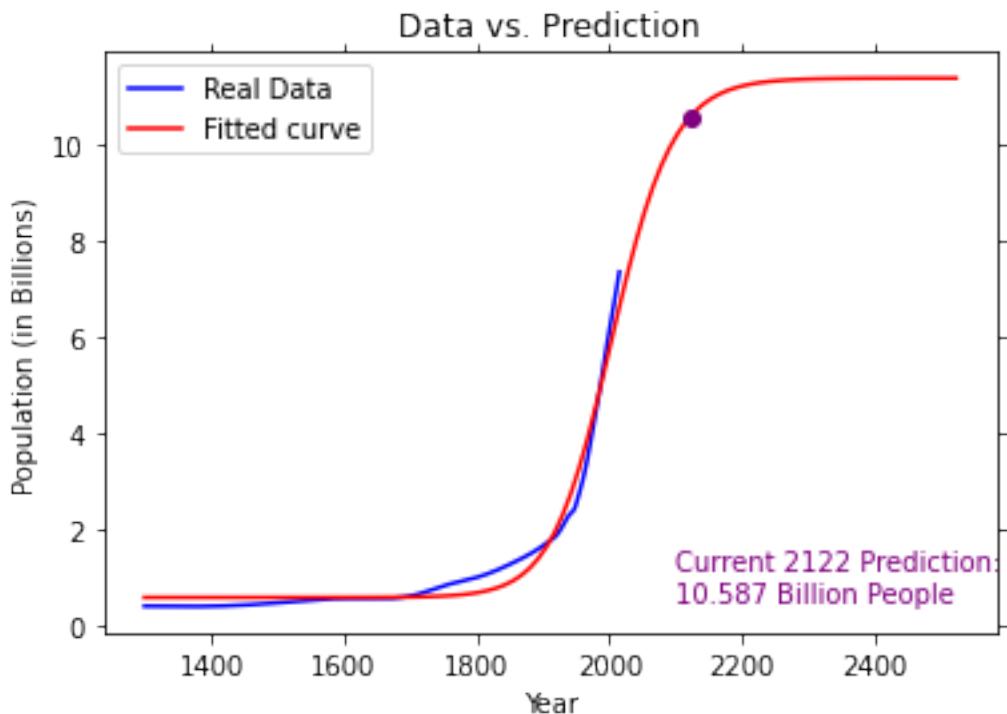
Iteration #26250, Loss: 0.052112870281289



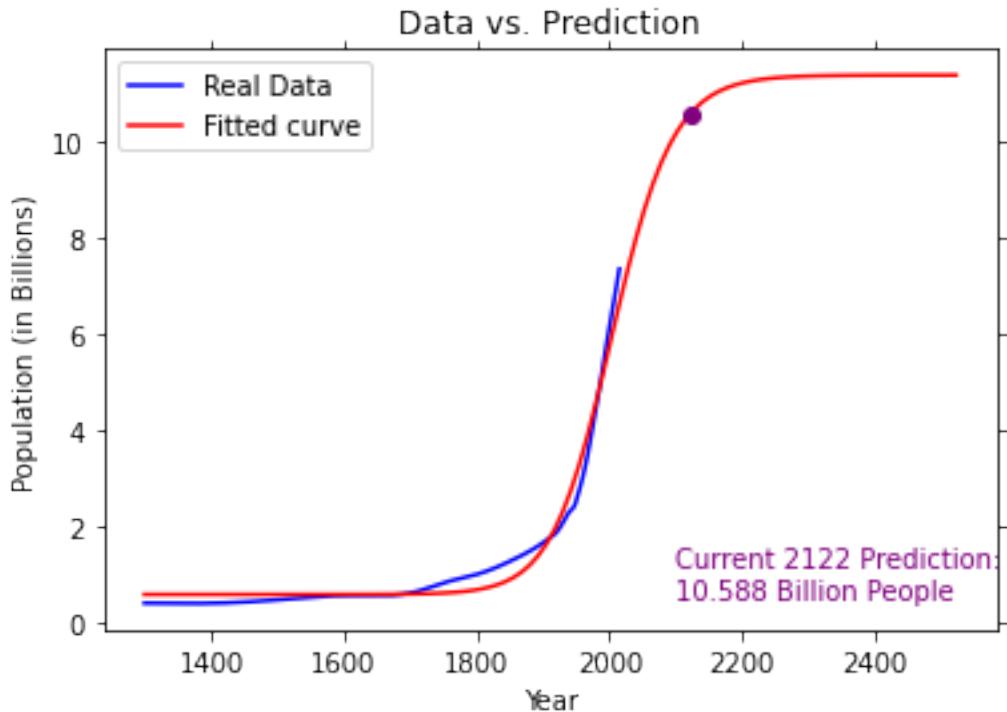
Iteration #26300, Loss: 0.05210572464221665



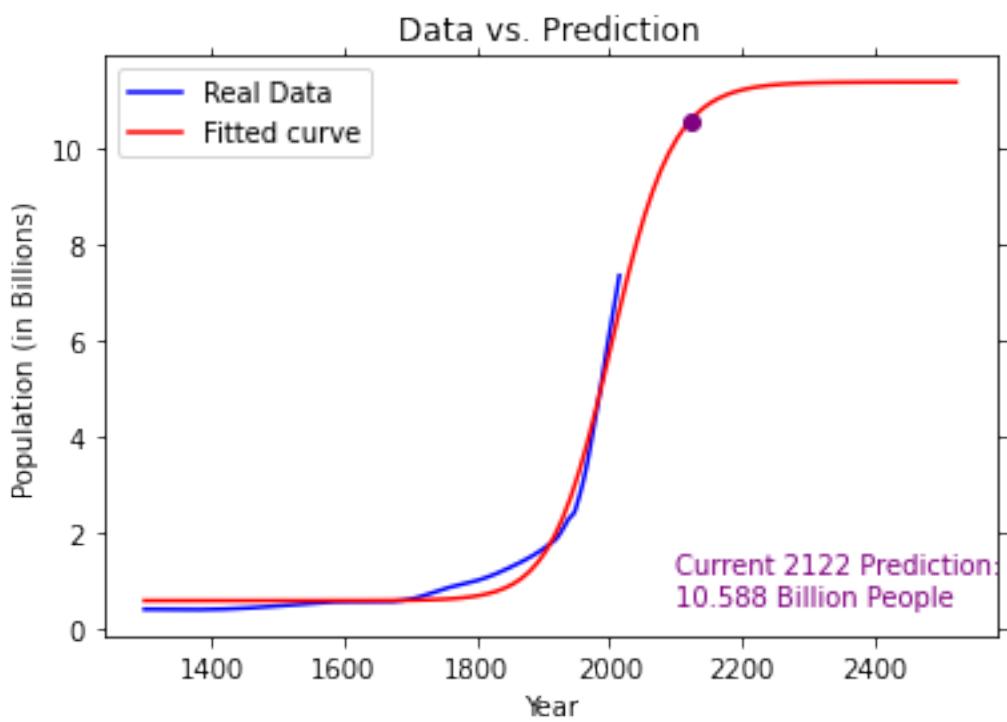
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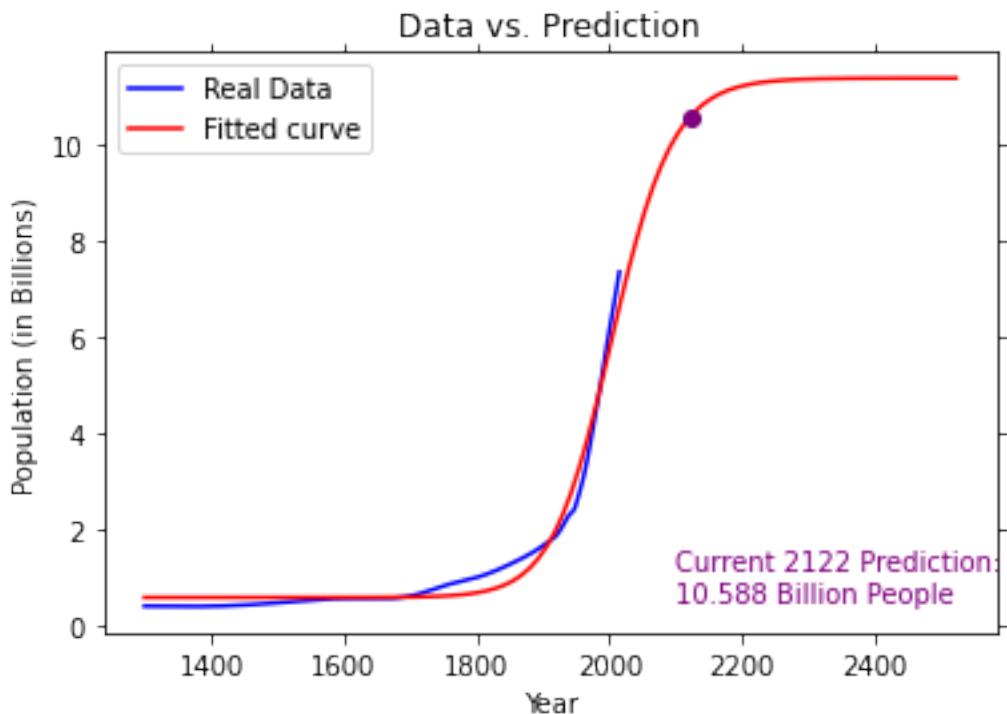
Iteration #26400, Loss: 0.05209147677423264



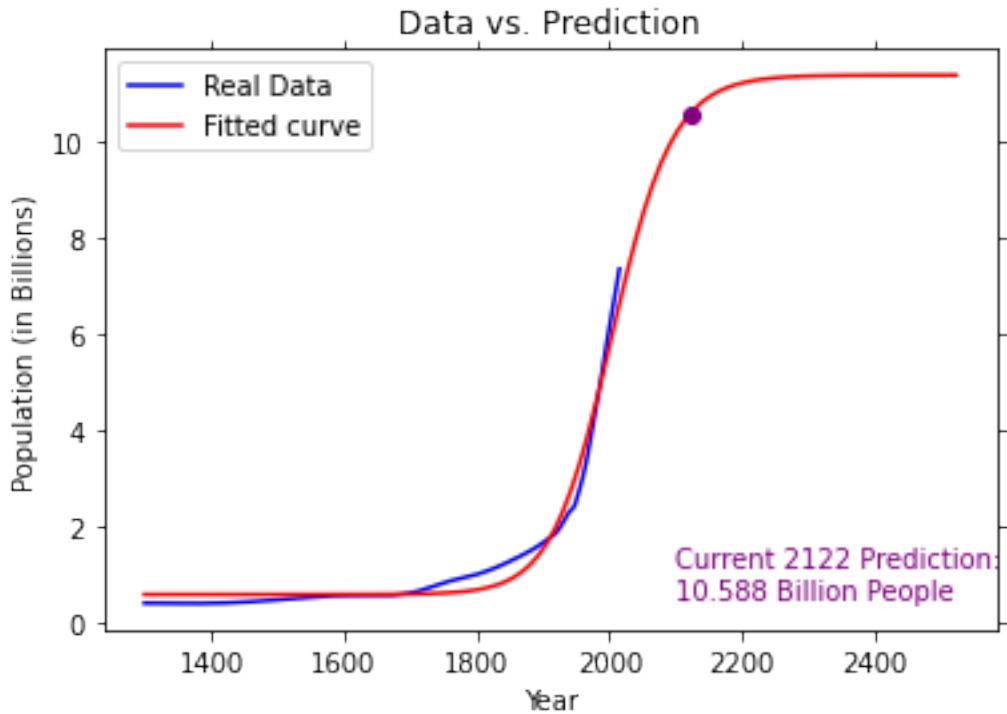
Iteration #26450, Loss: 0.05208437454407006



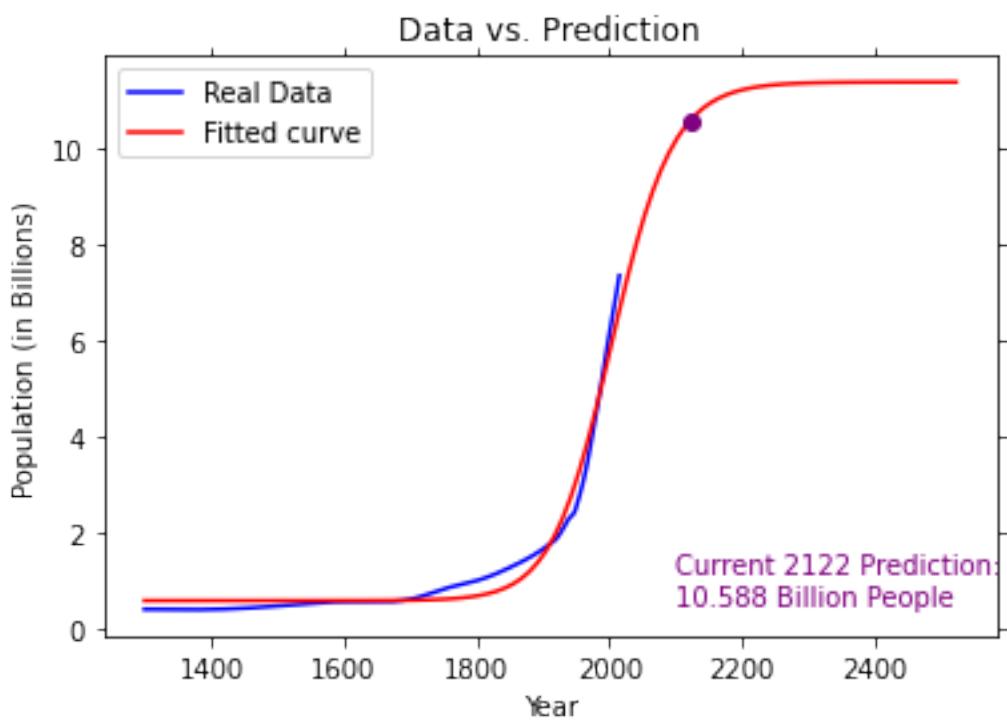
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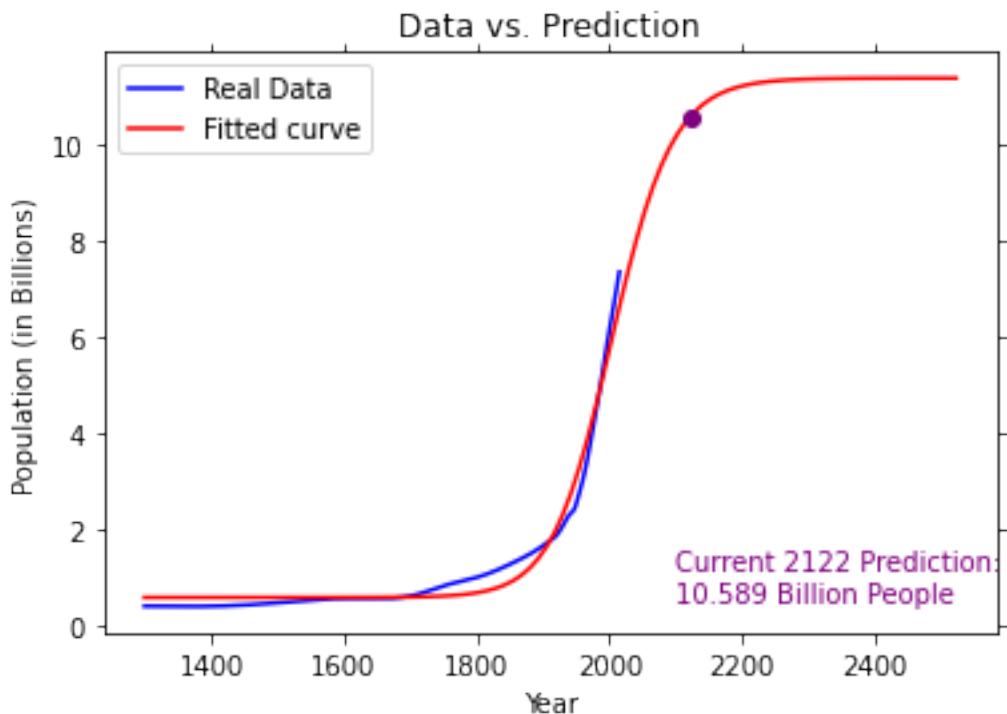
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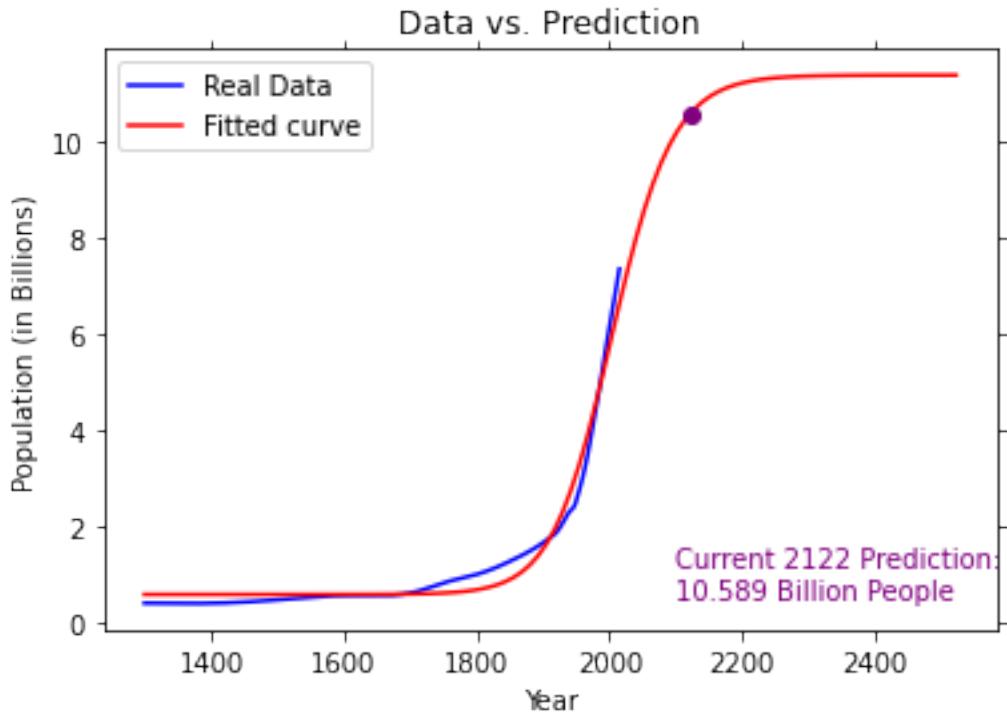
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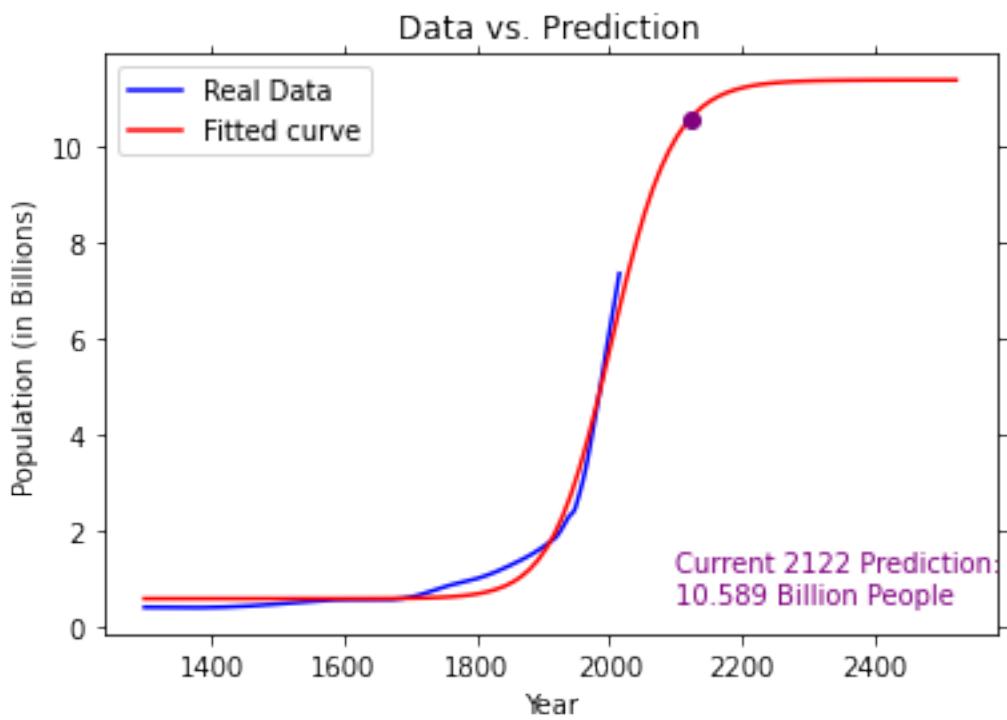
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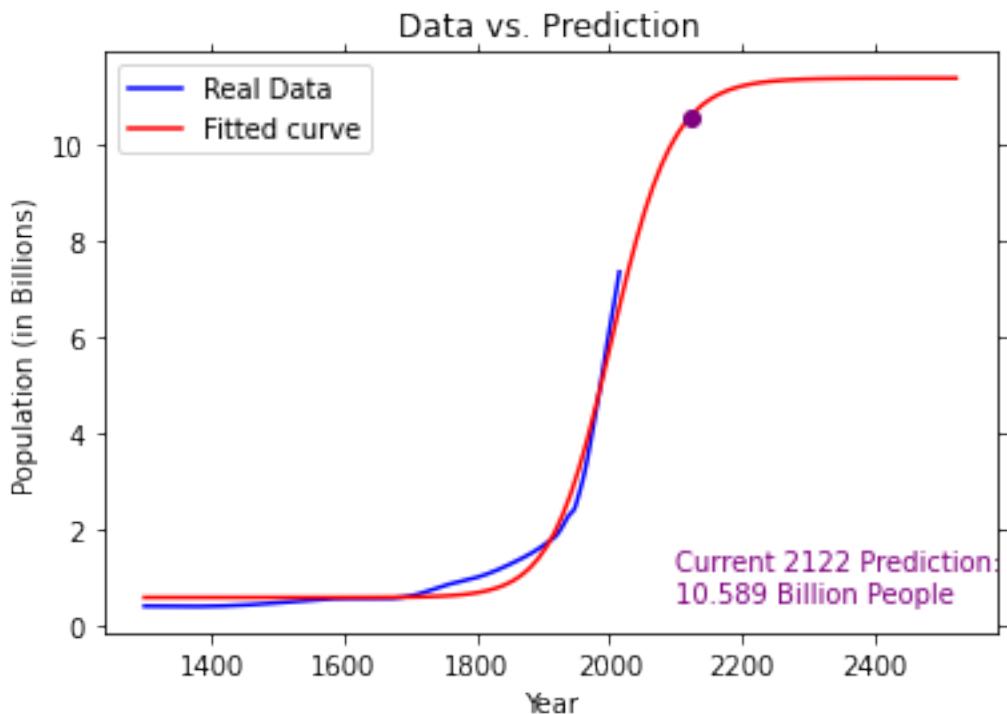
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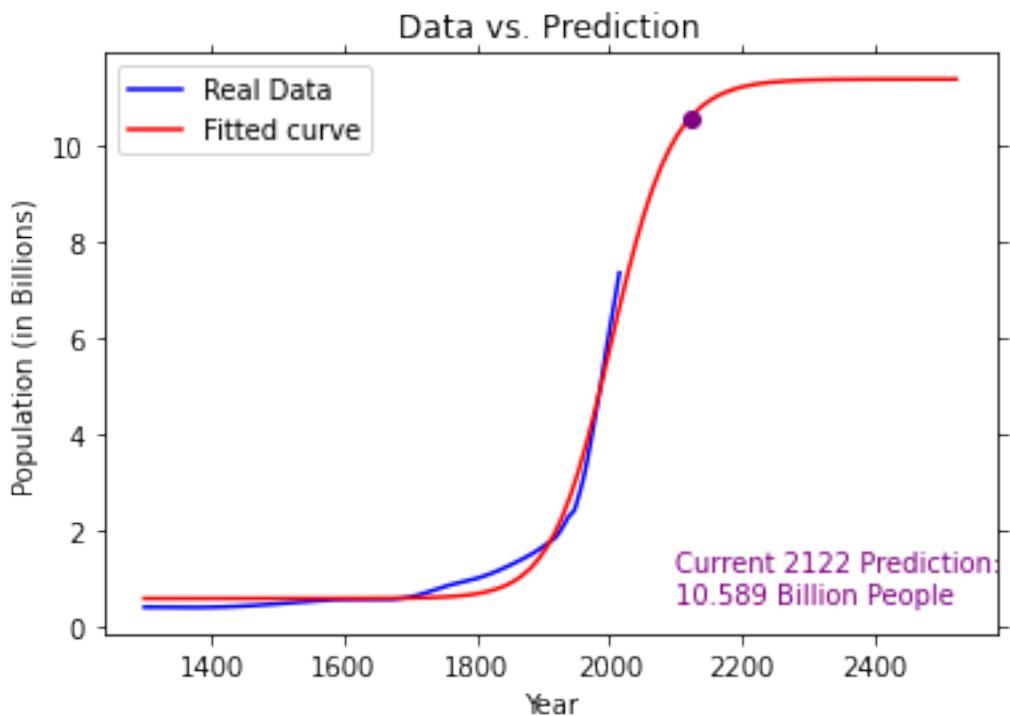
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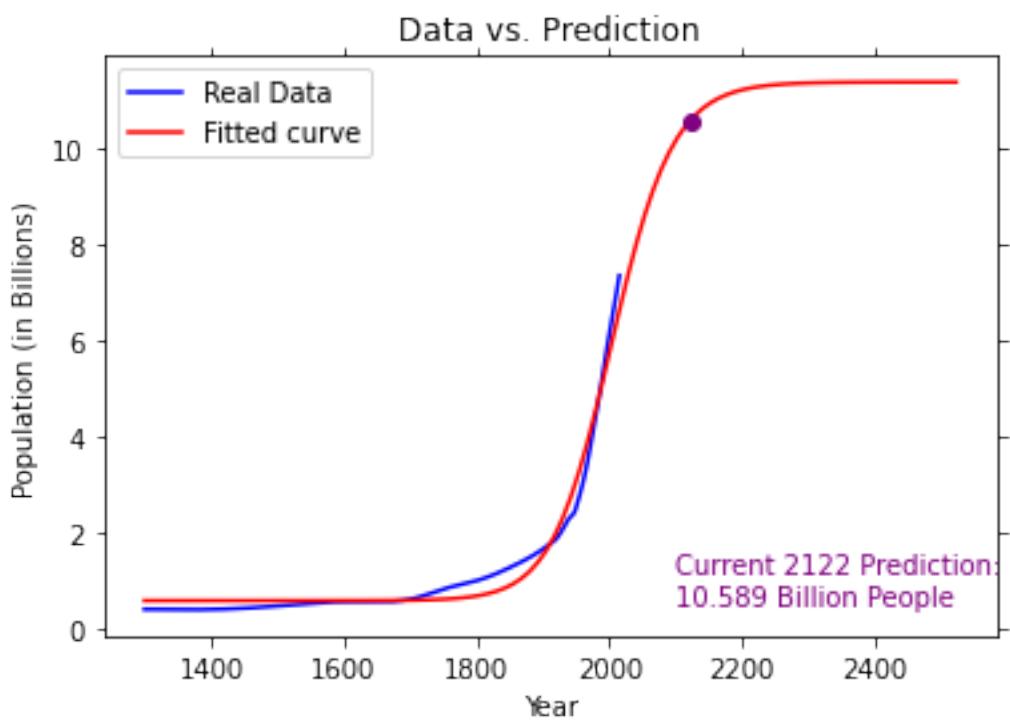
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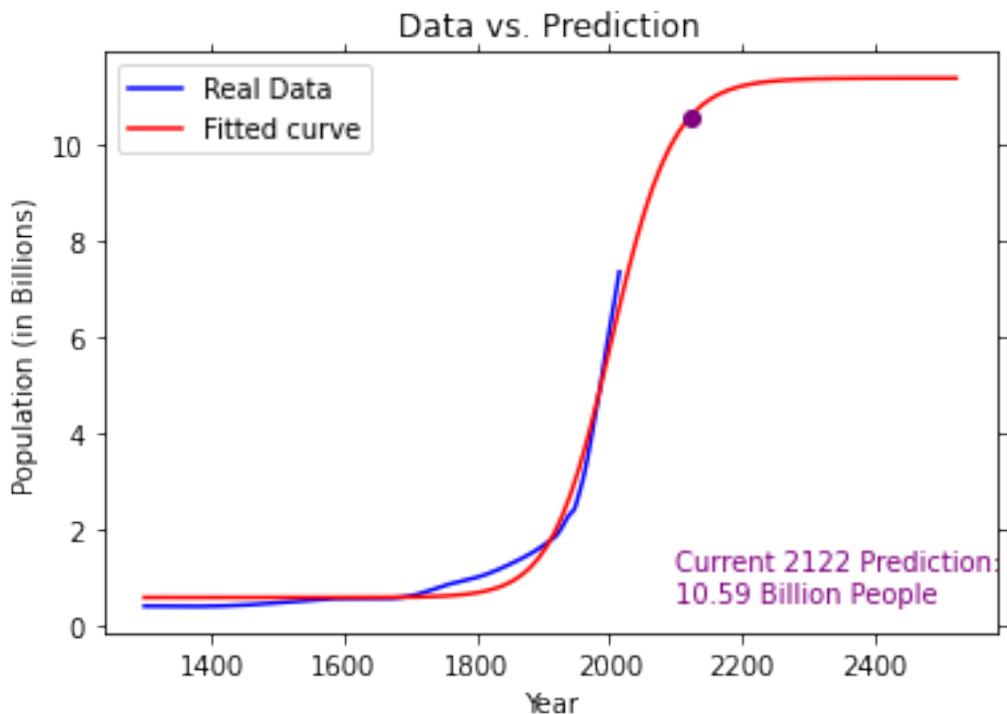
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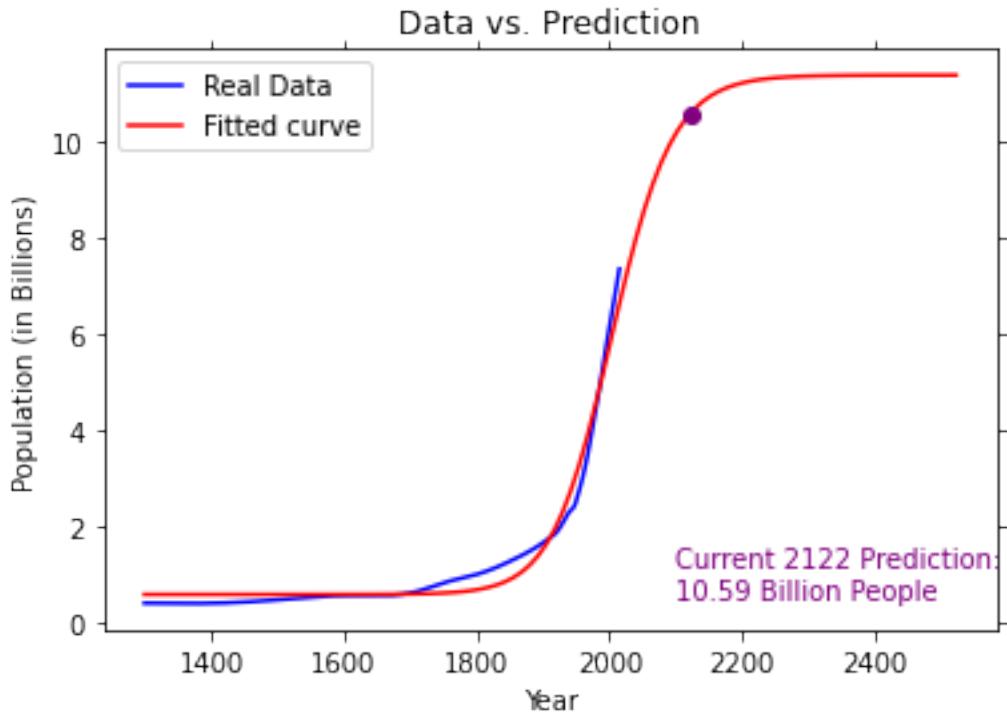
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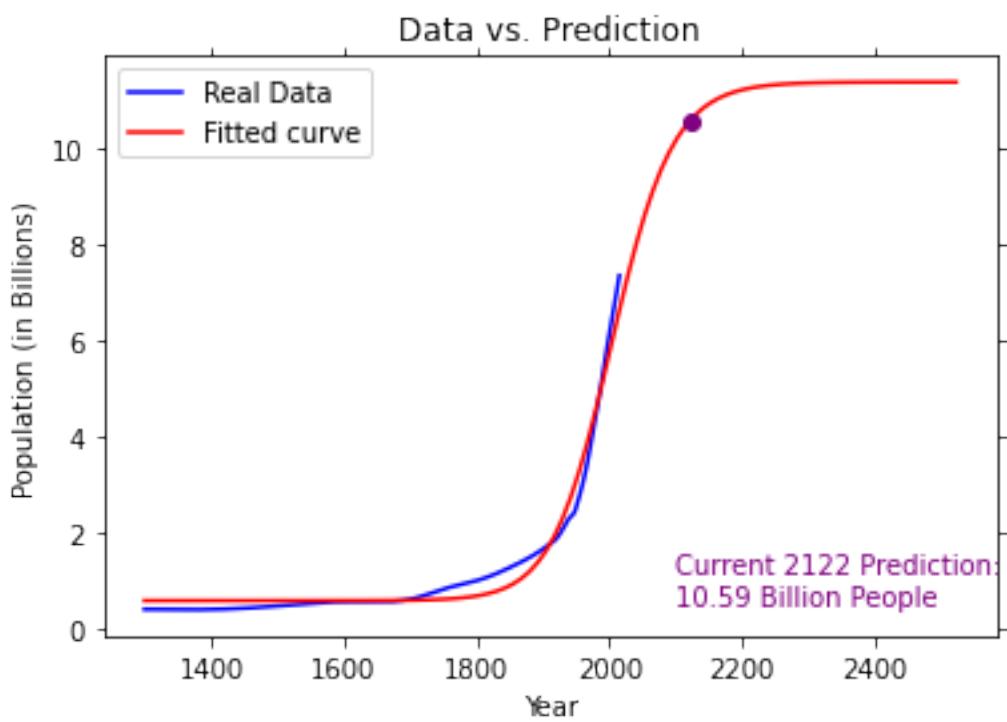
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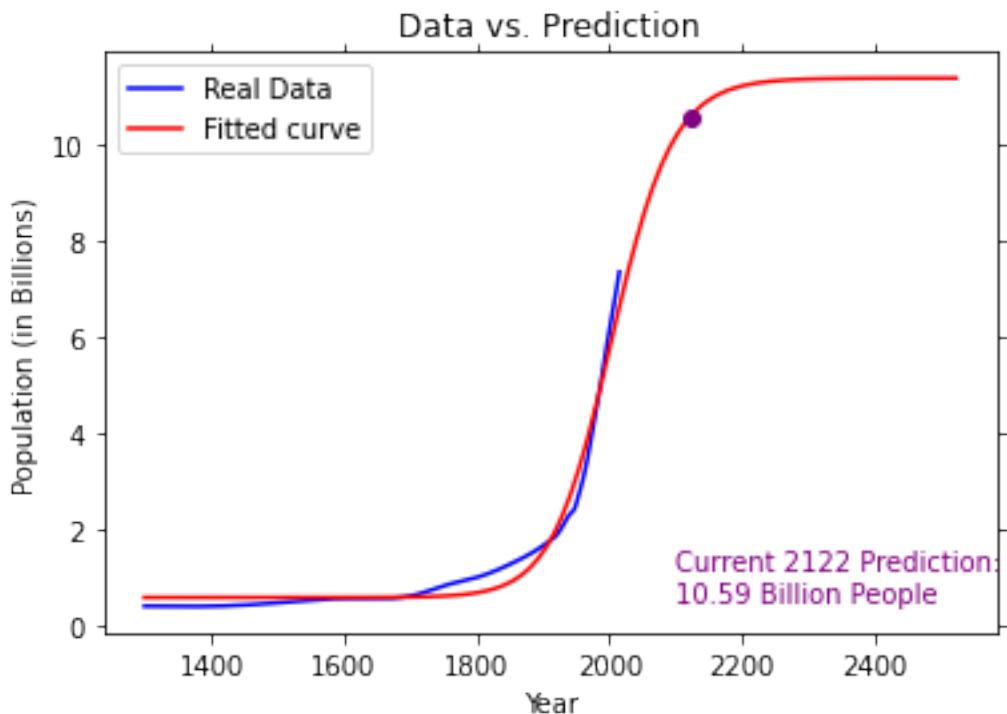
Iteration #27000, Loss: 0.052007204931248094



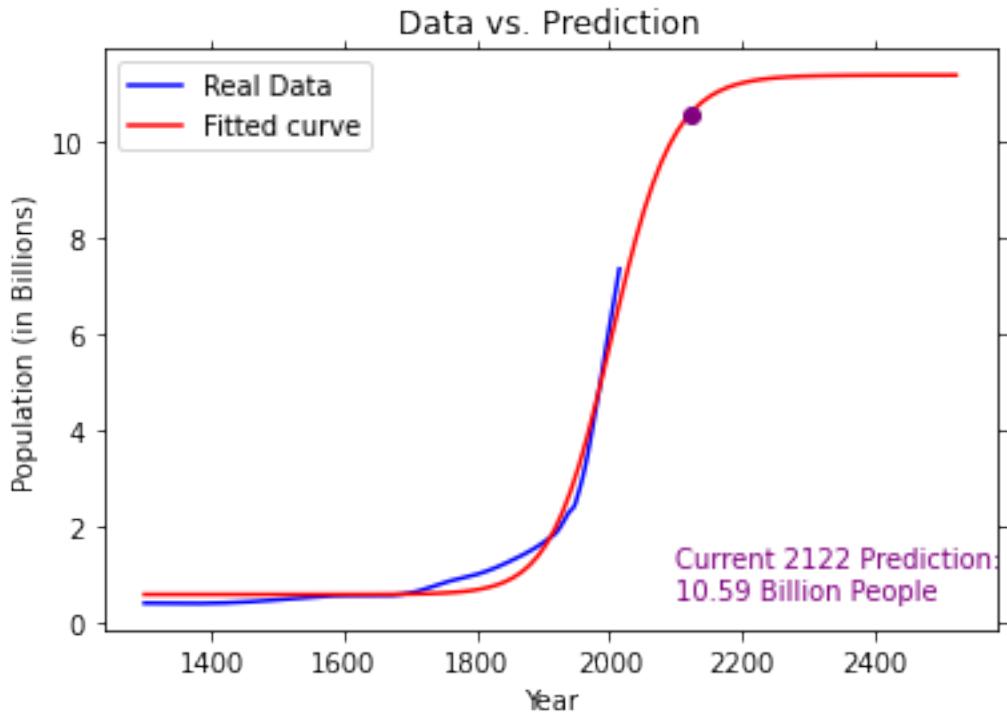
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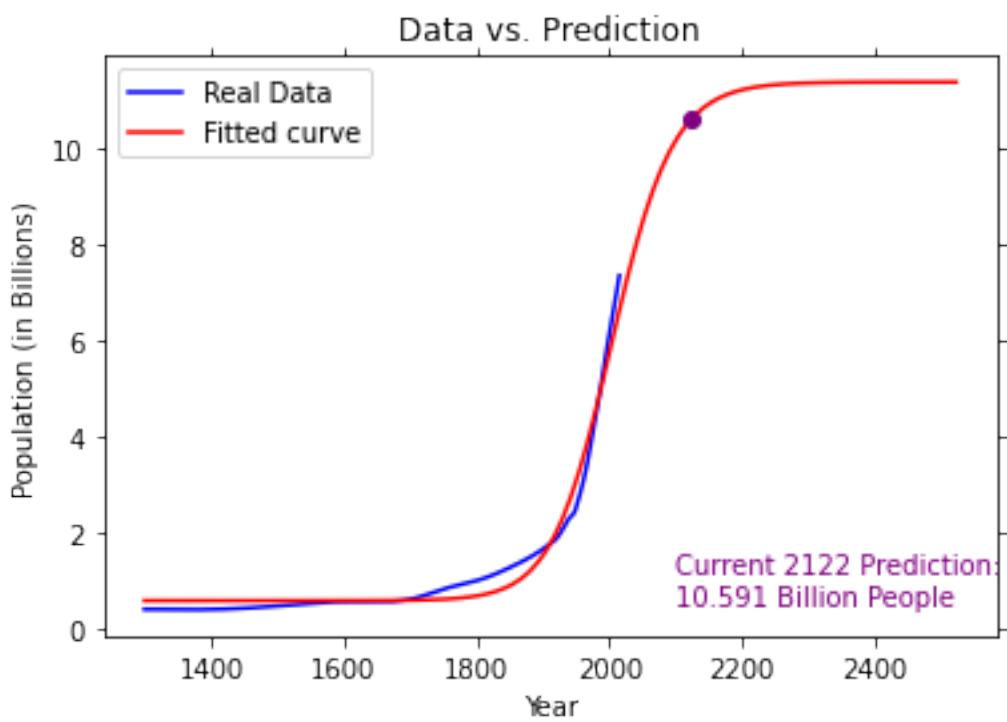
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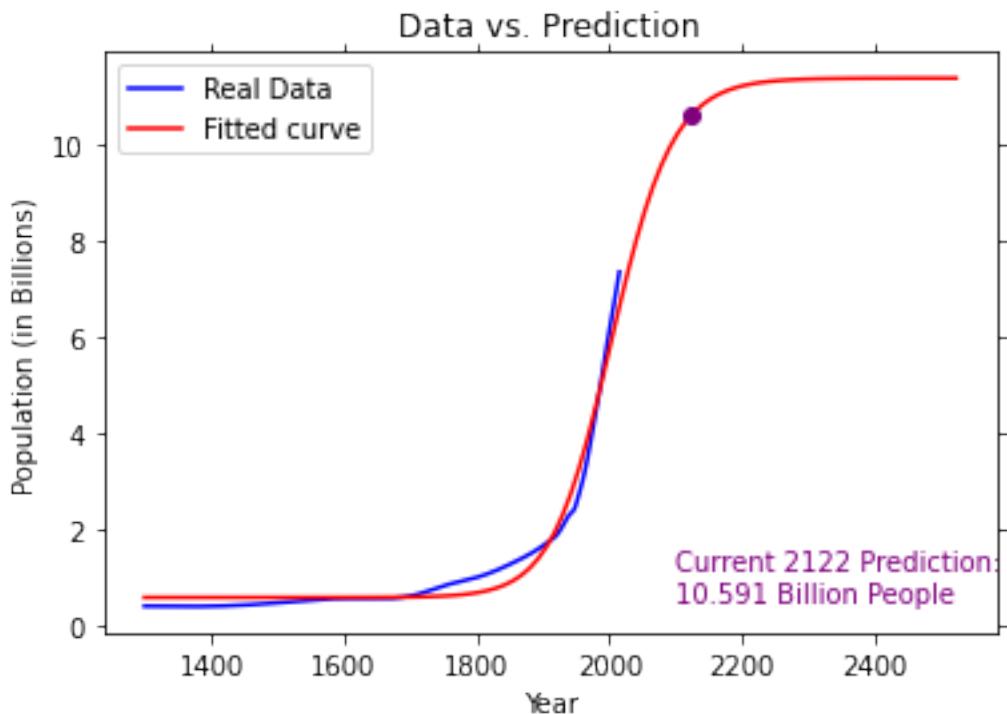
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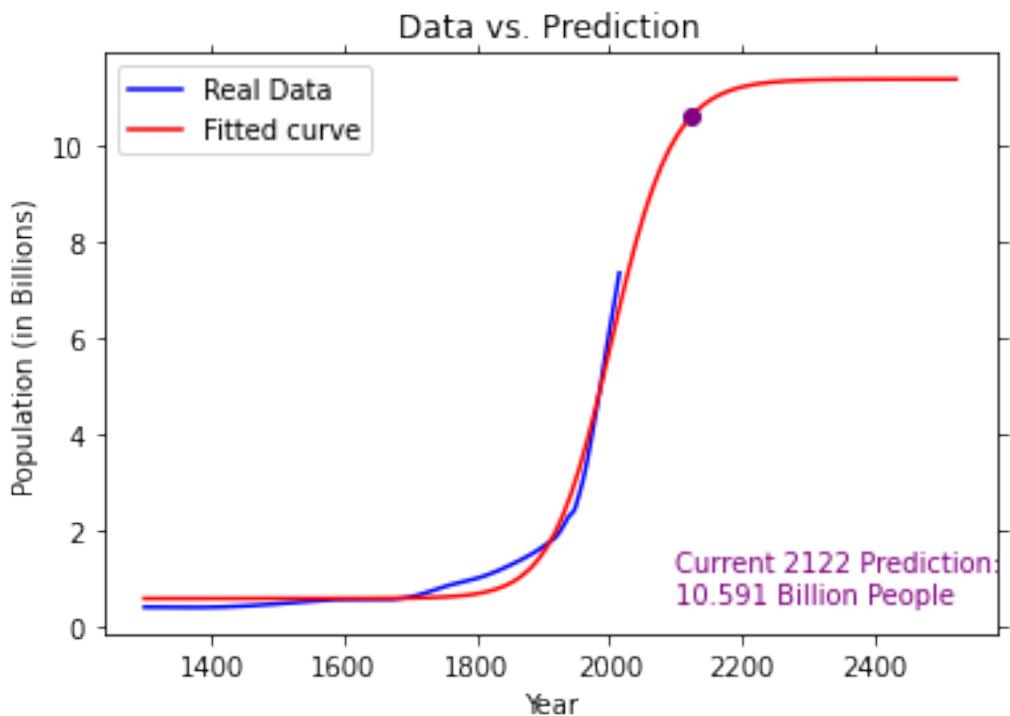
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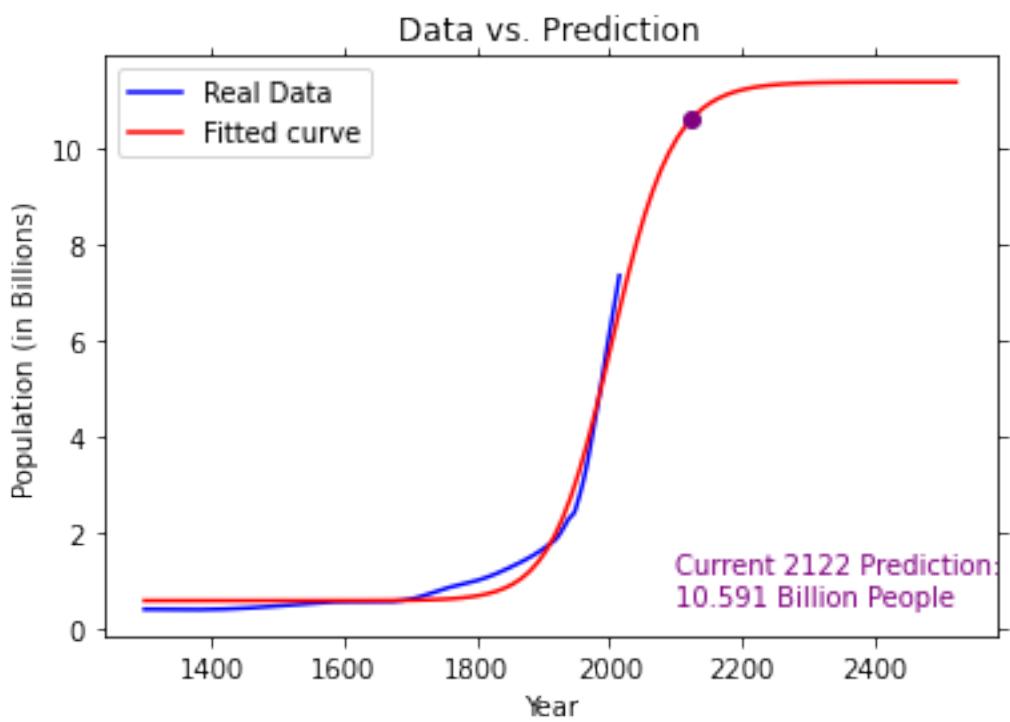
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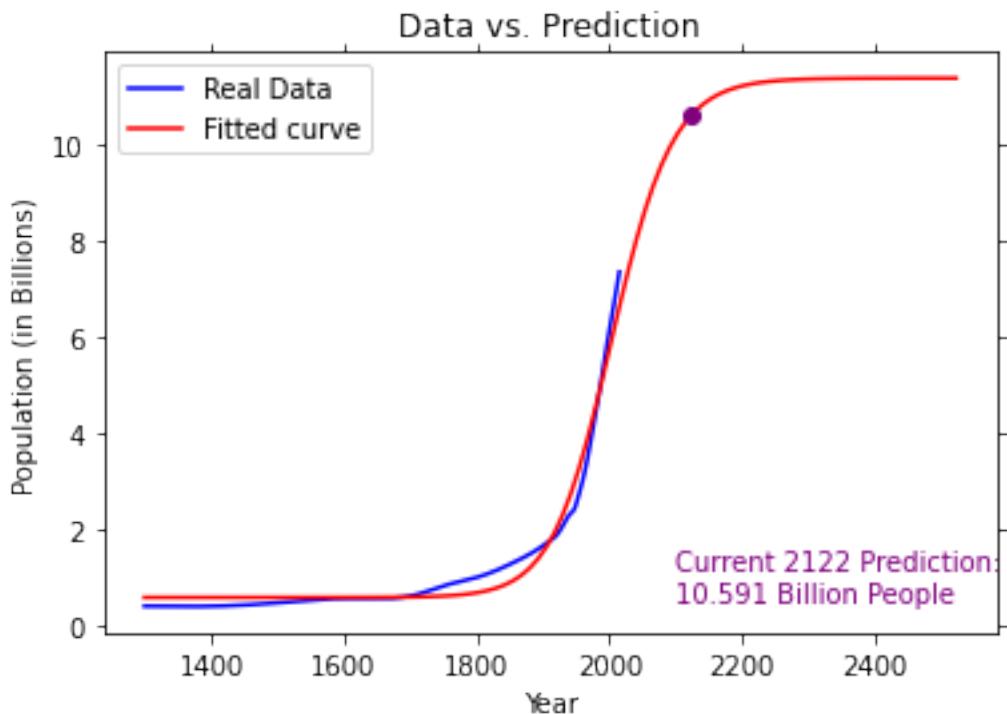
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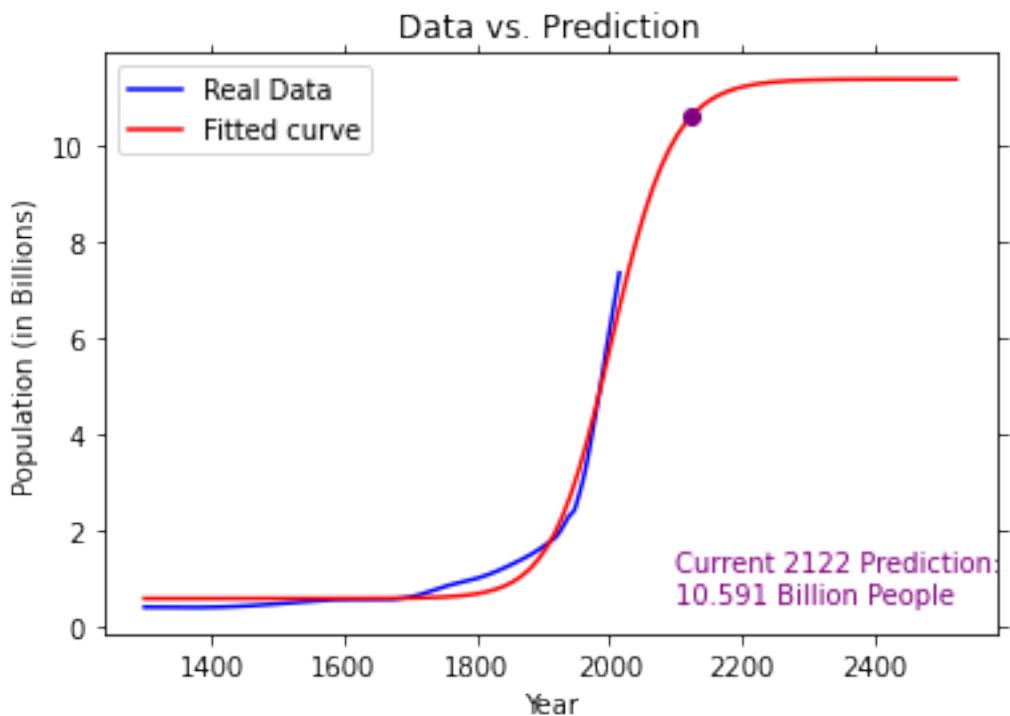
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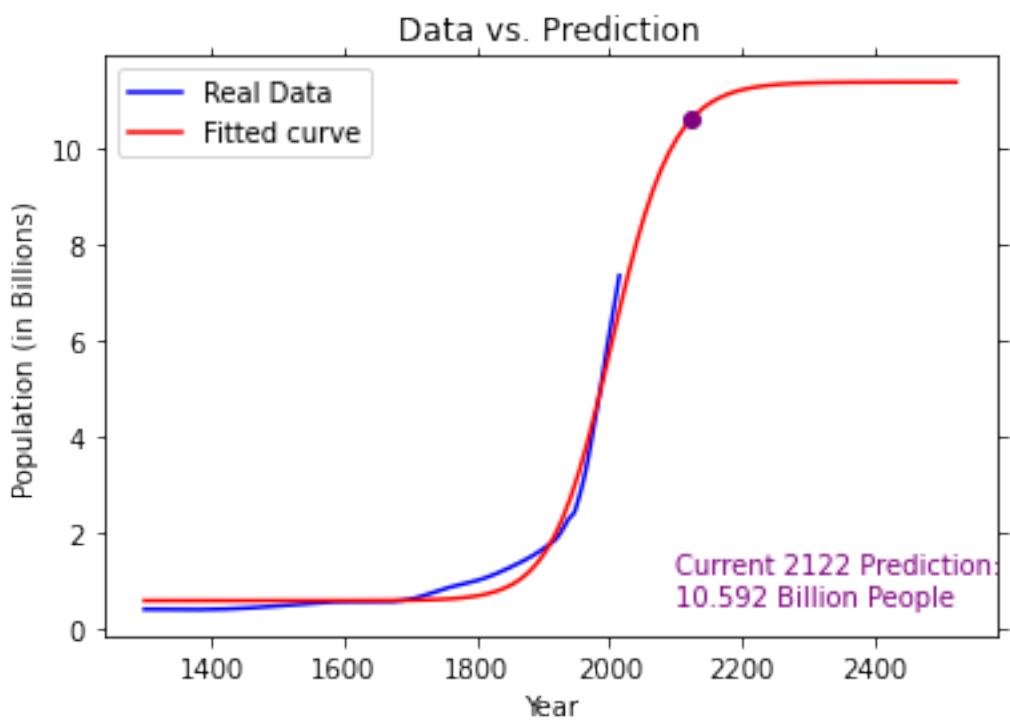
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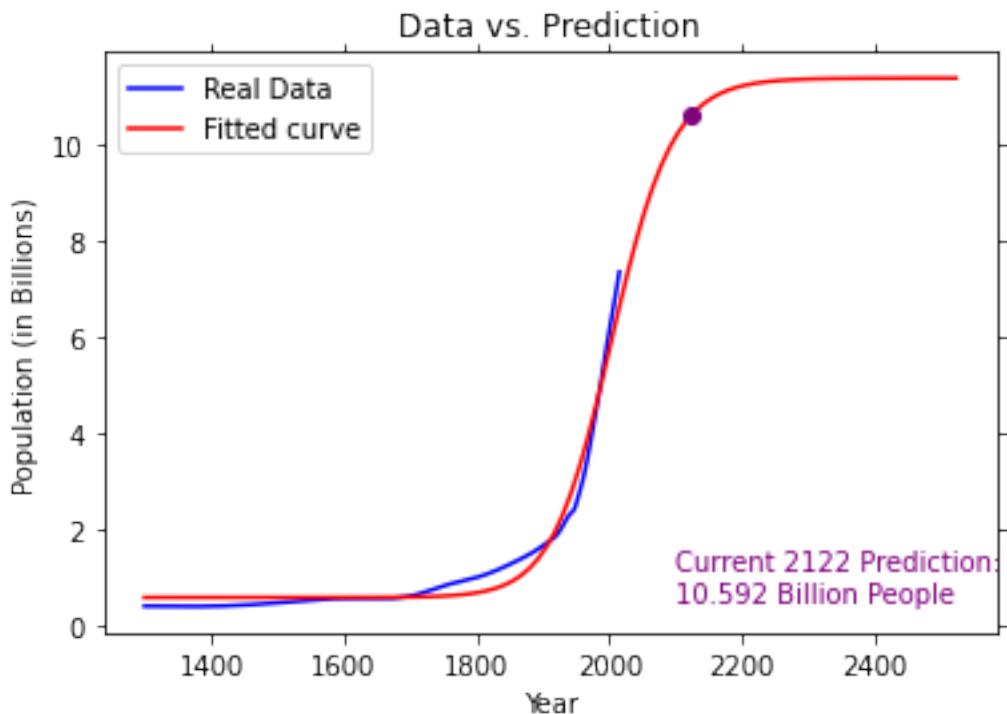
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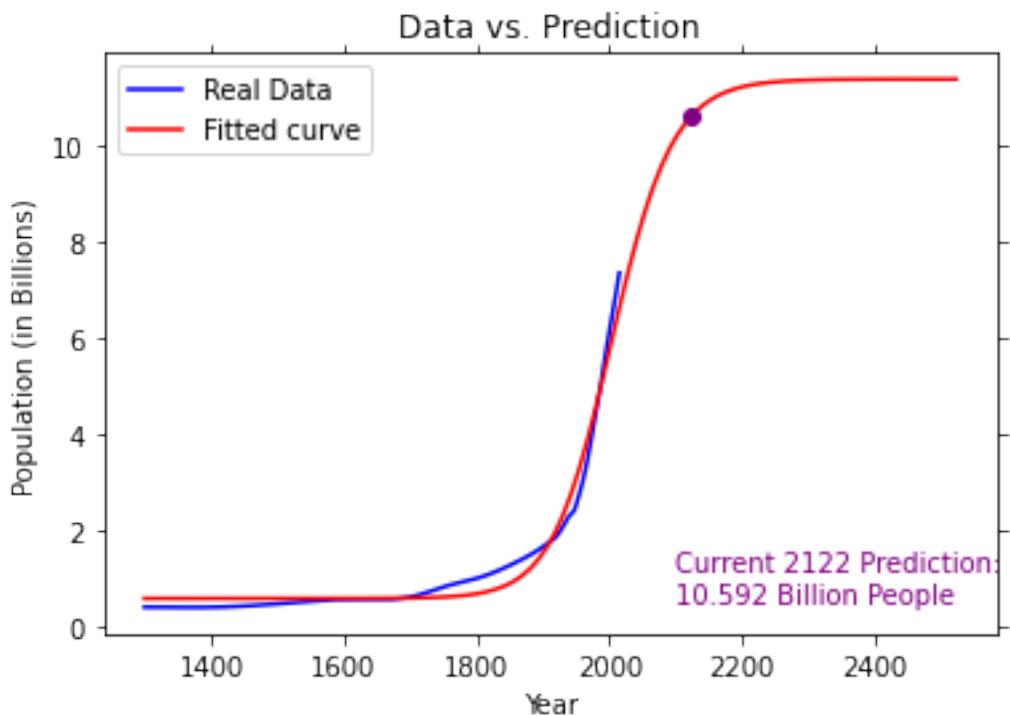
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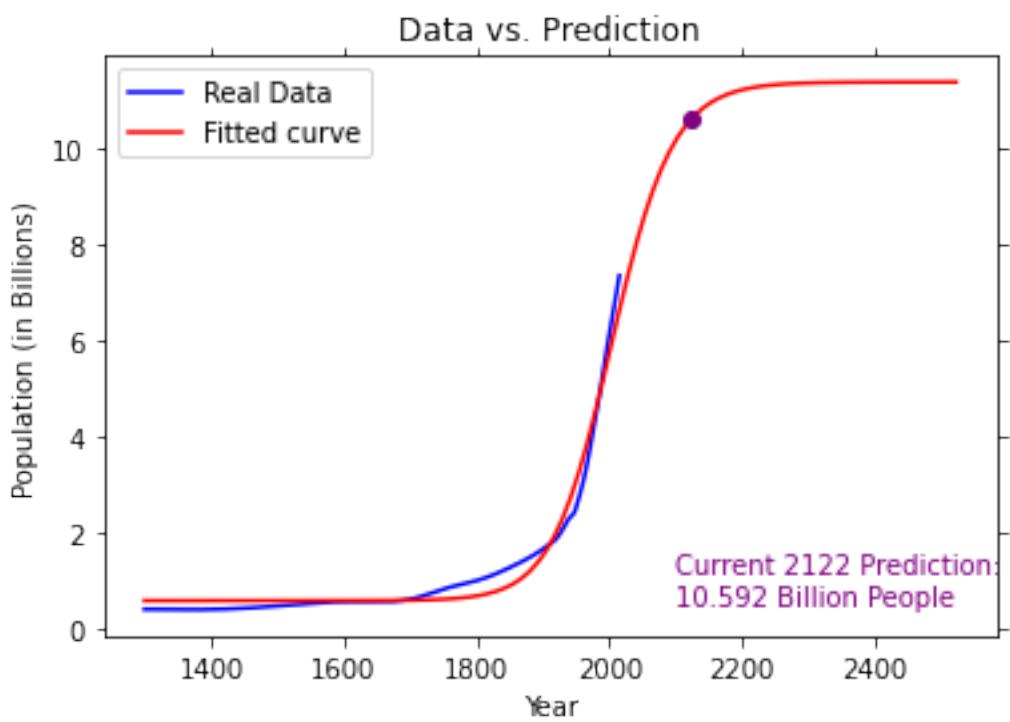
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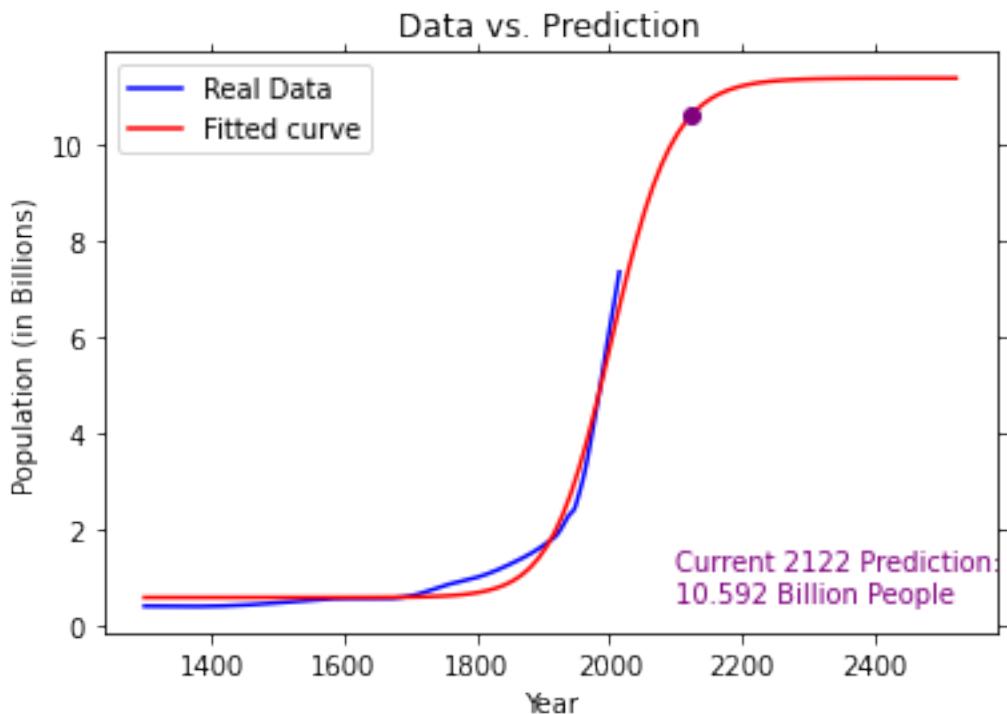
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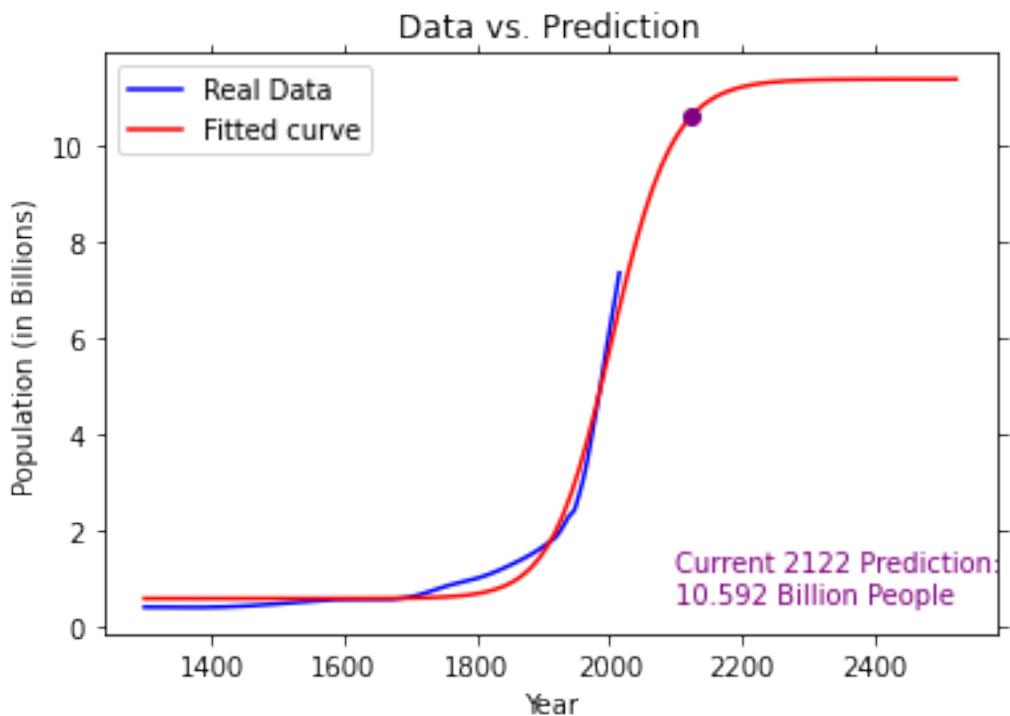
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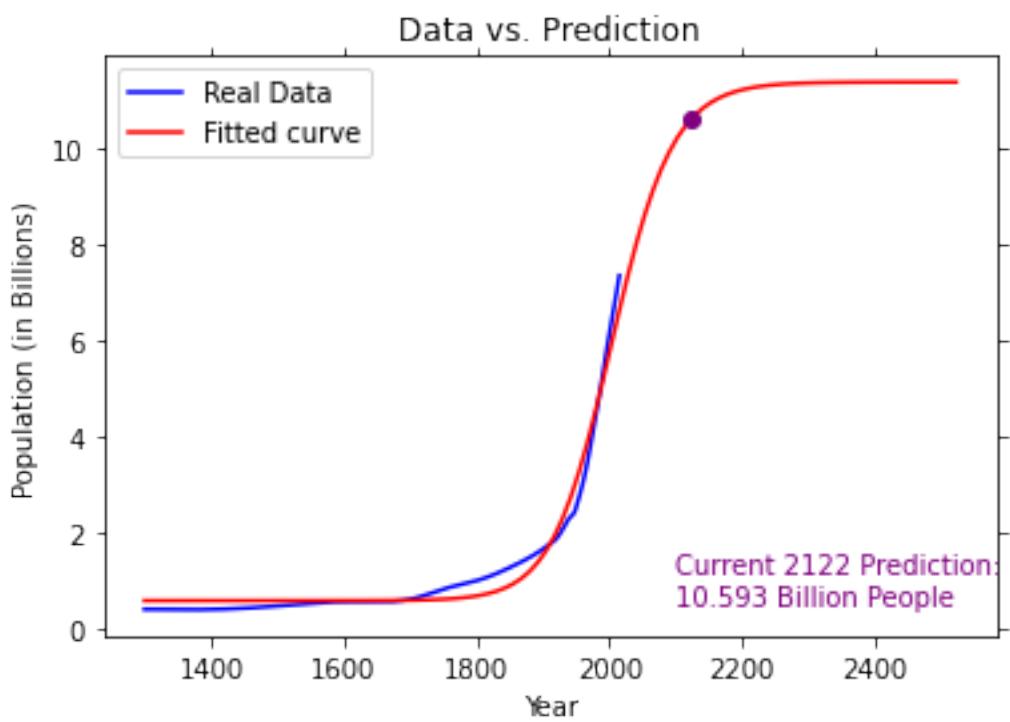
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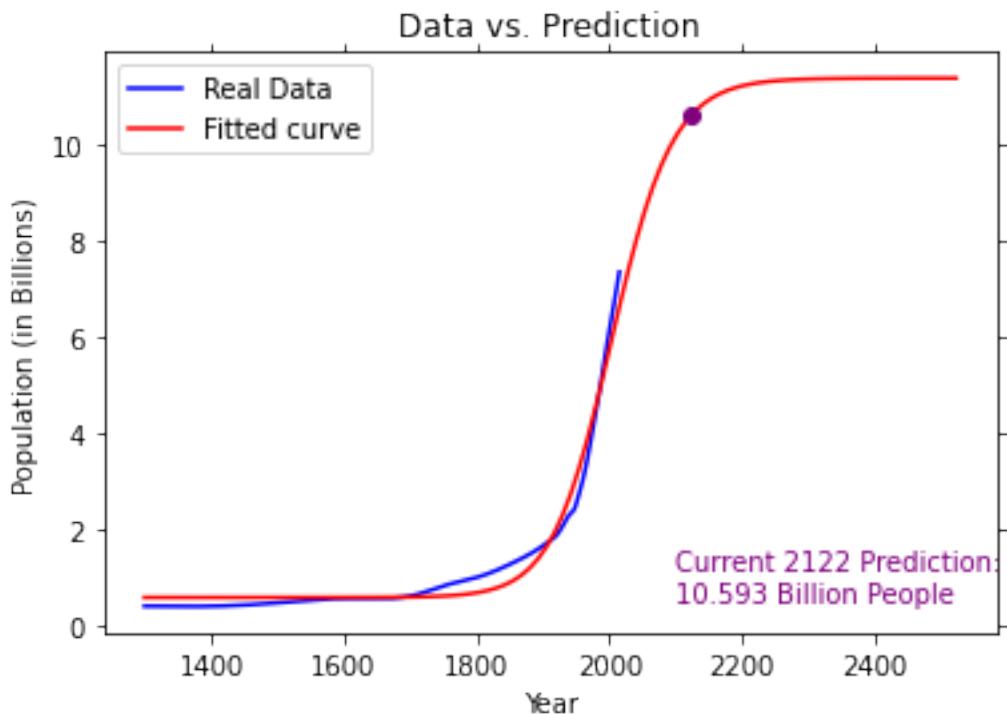
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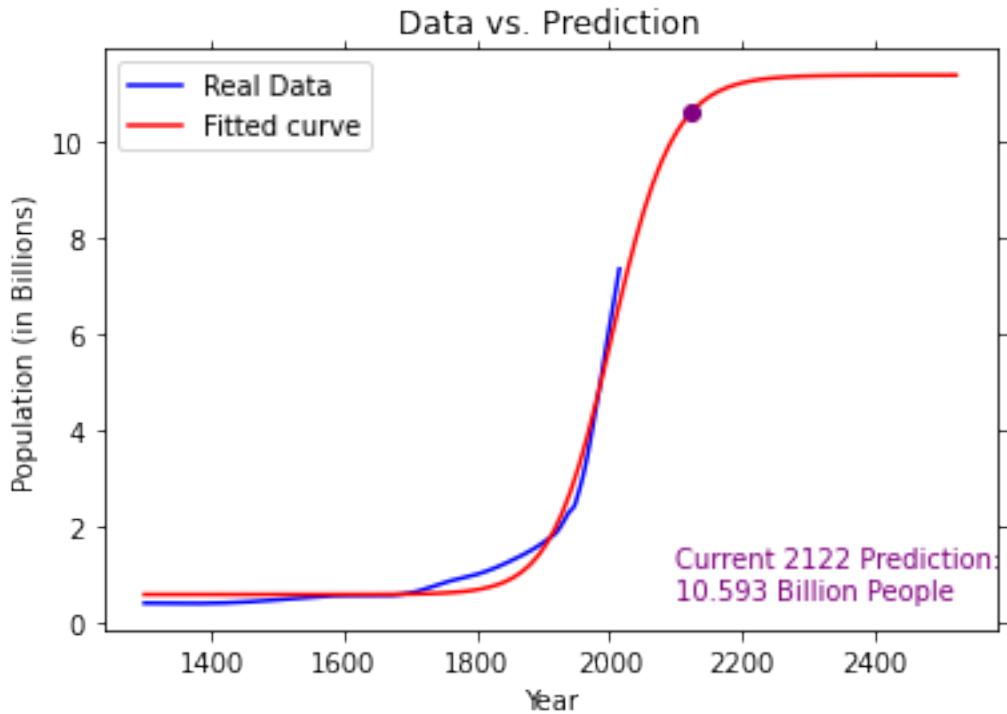
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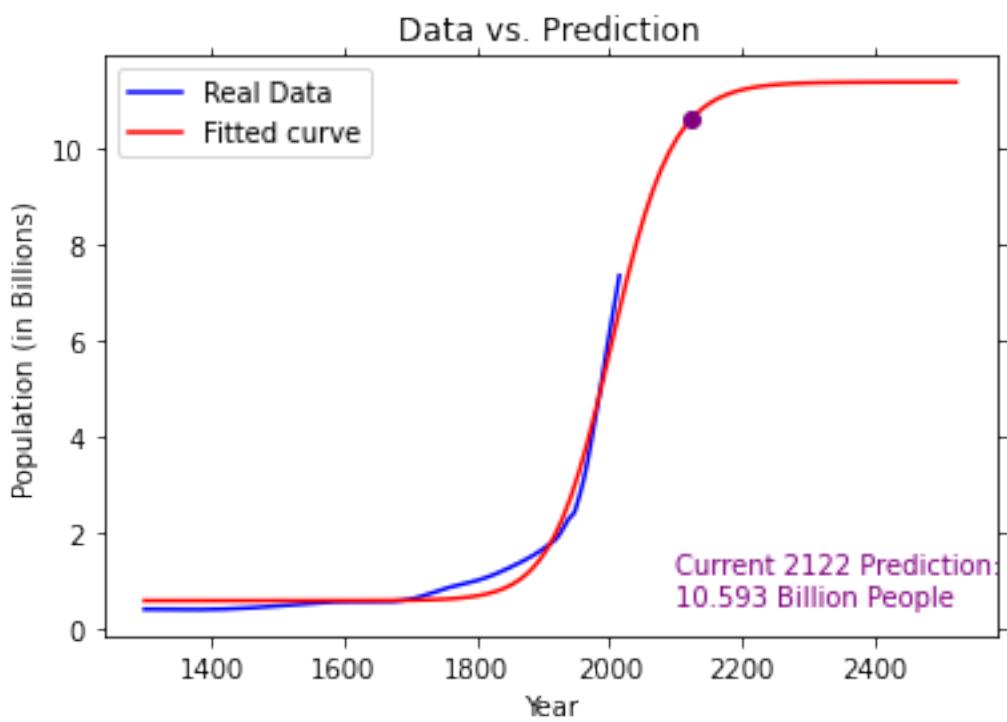
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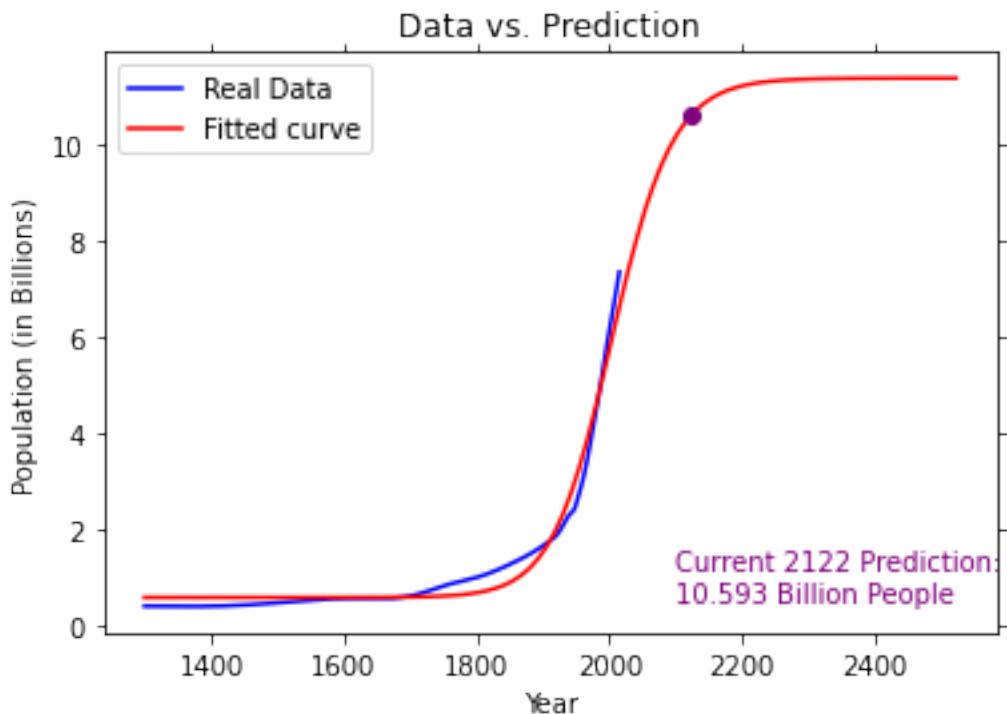
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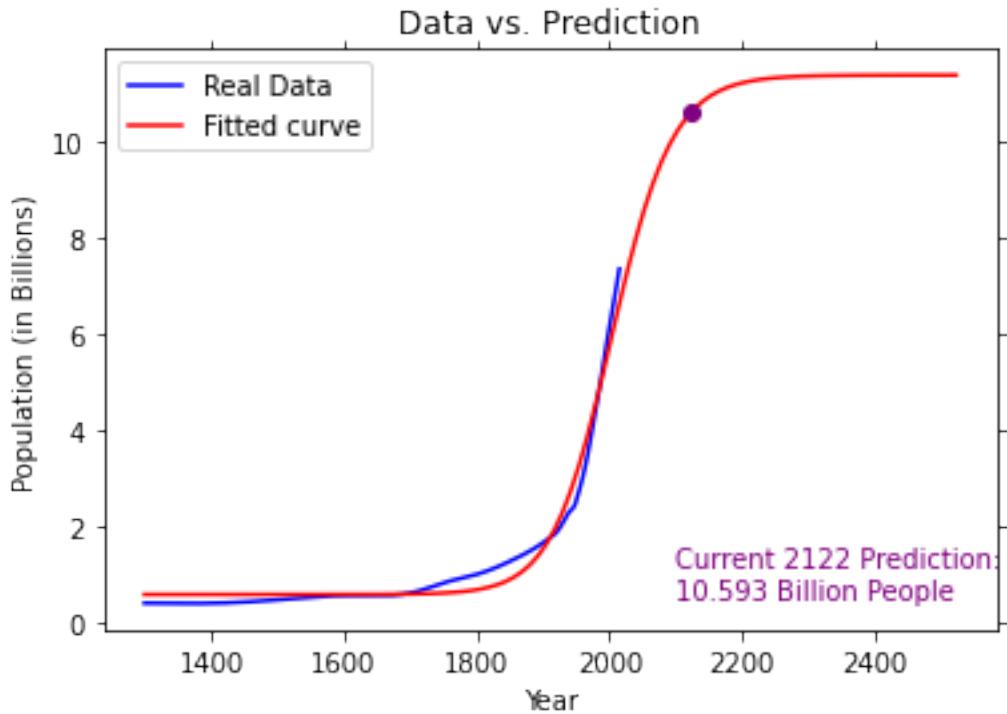
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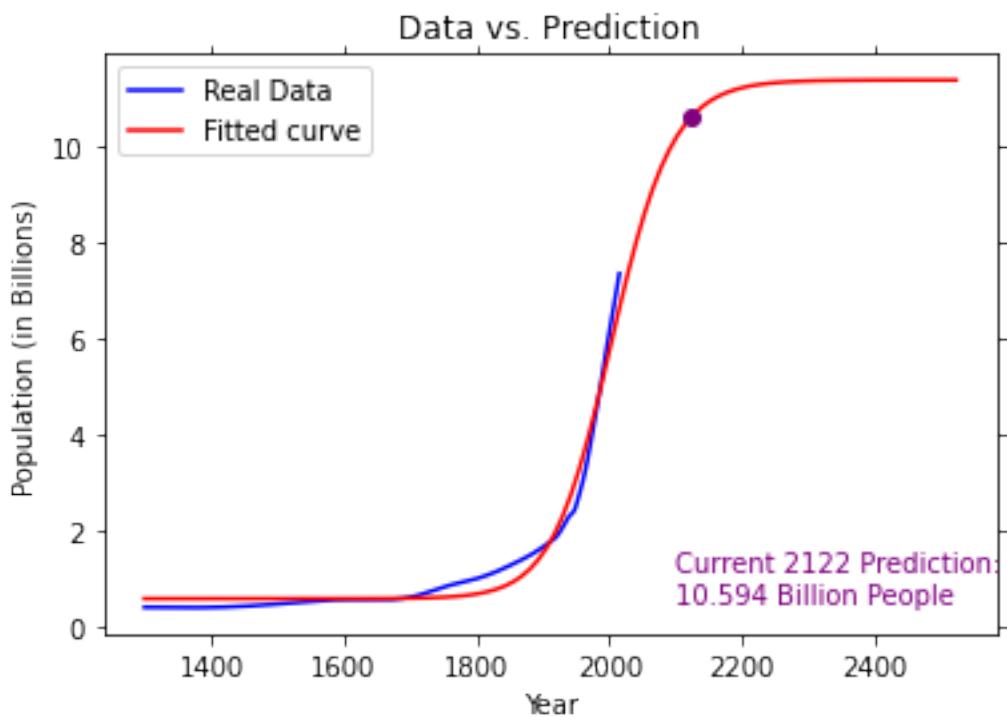
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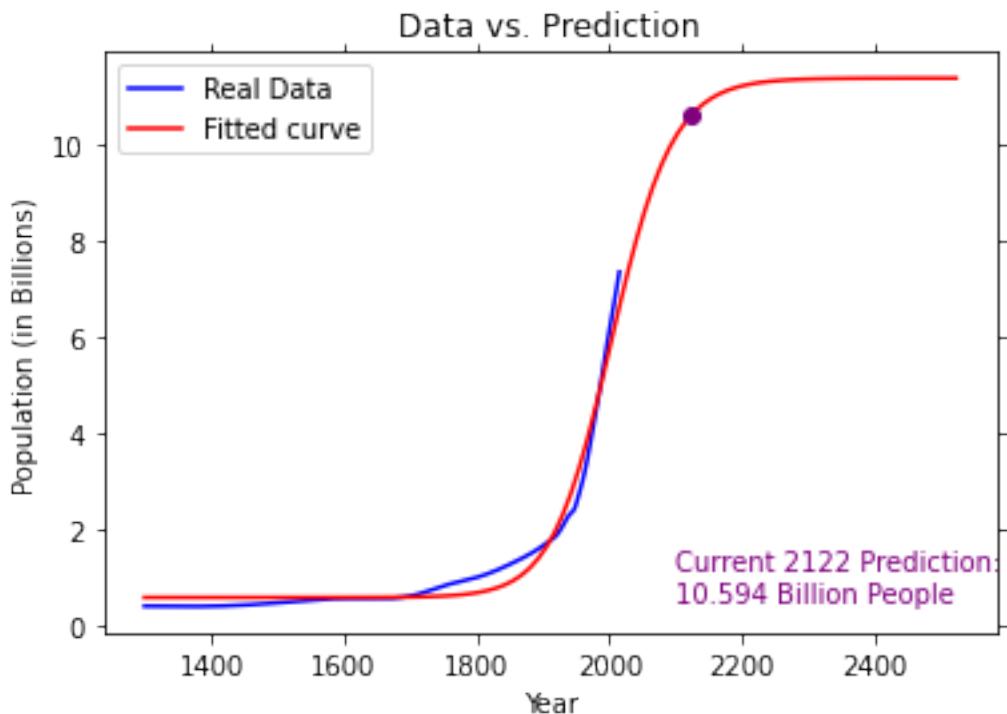
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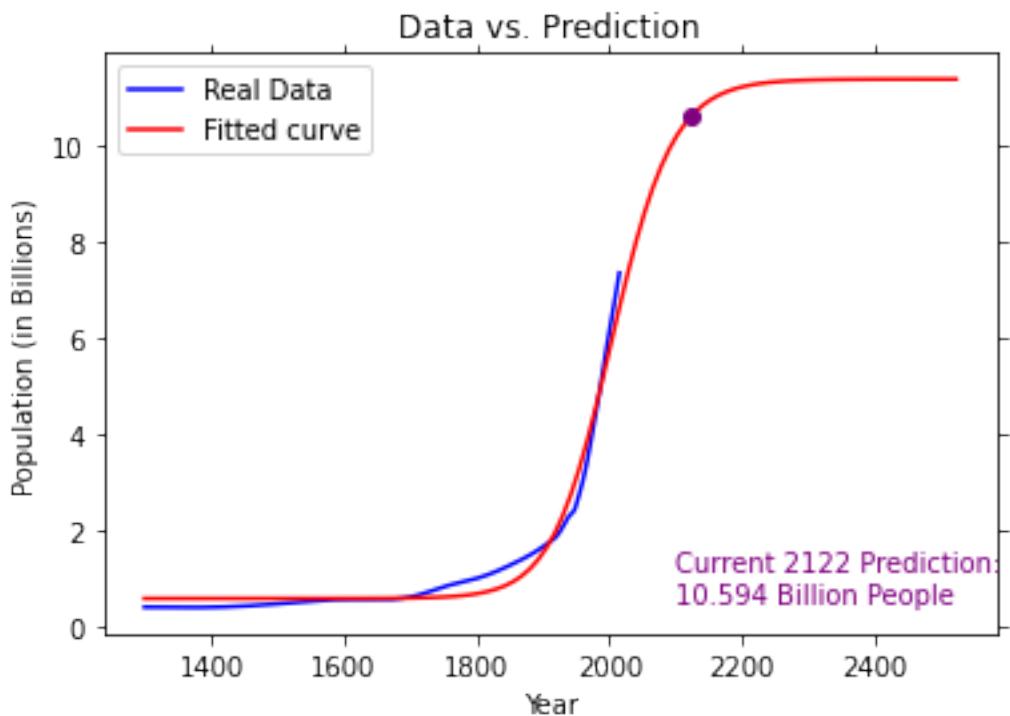
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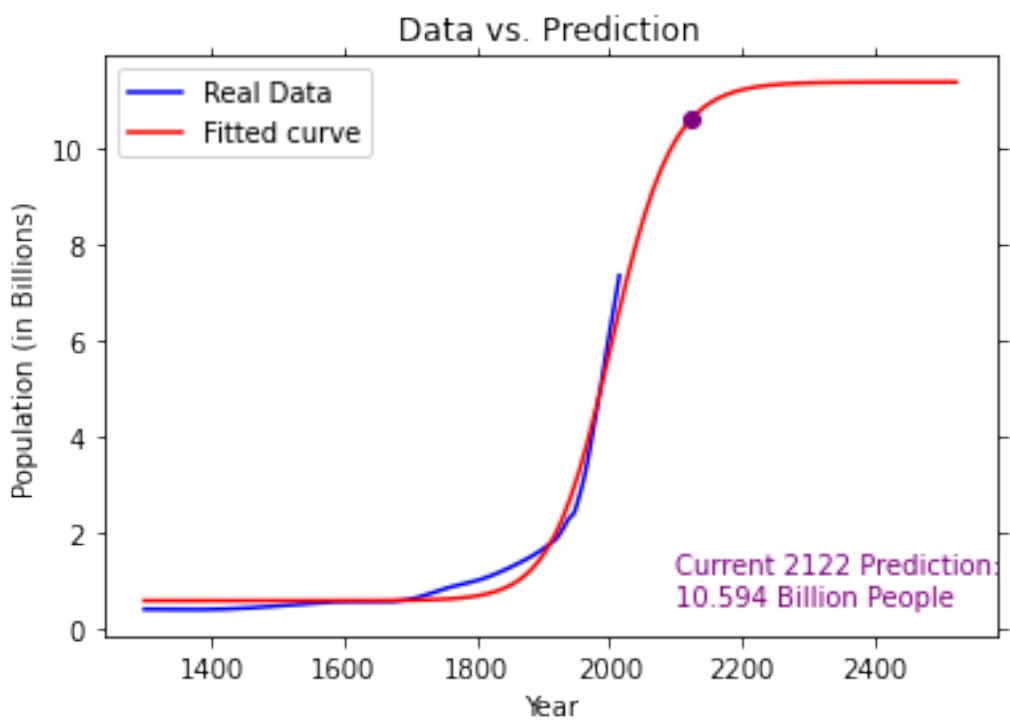
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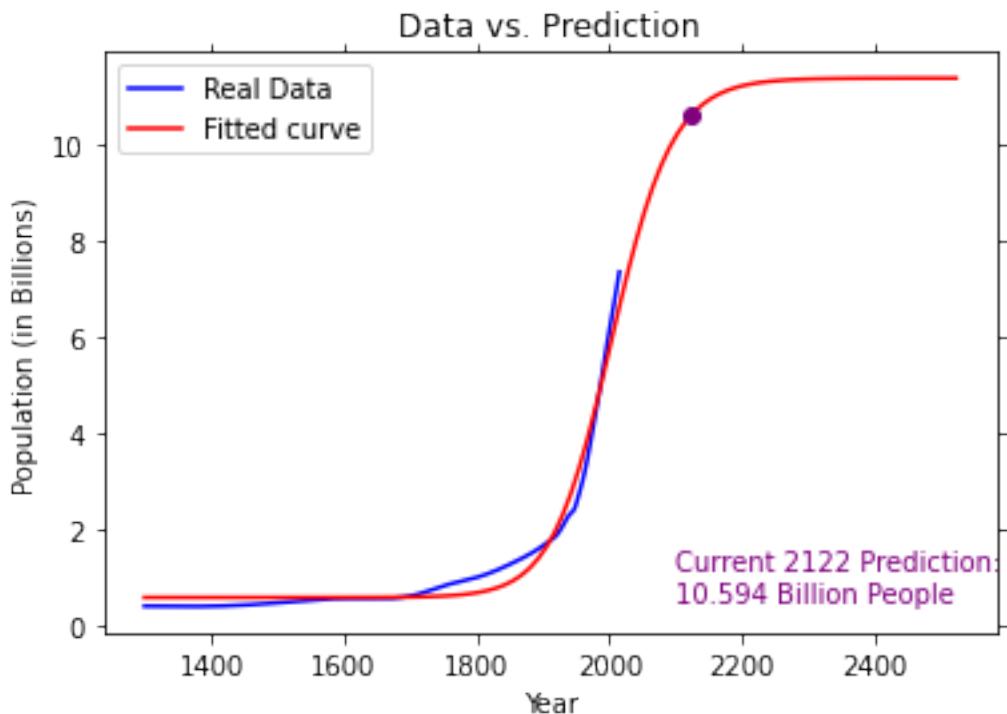
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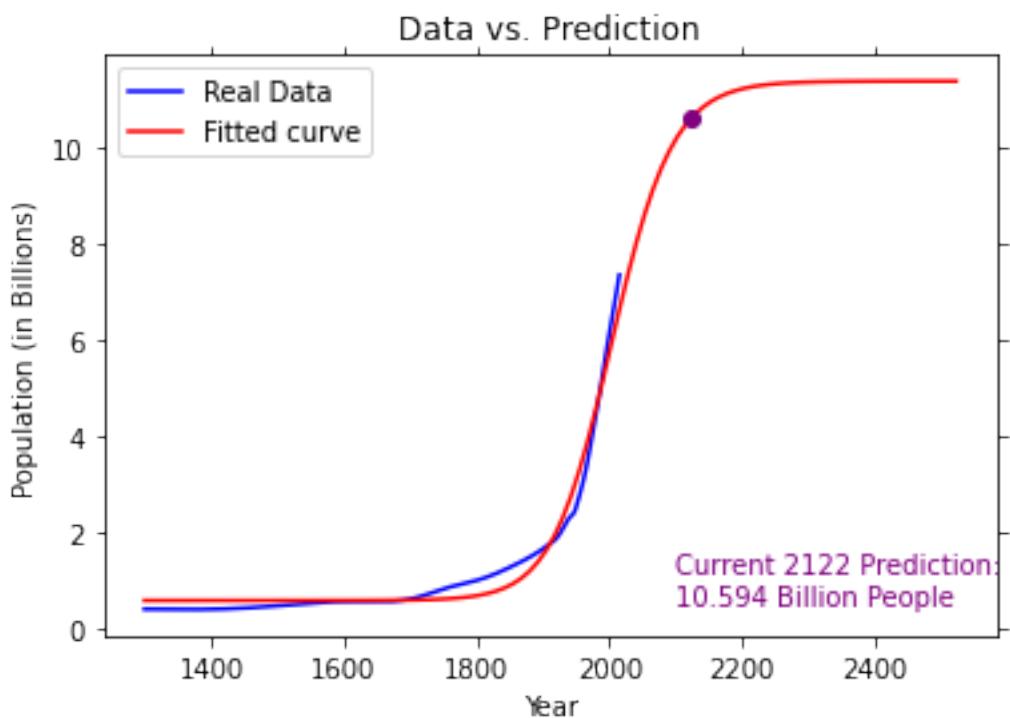
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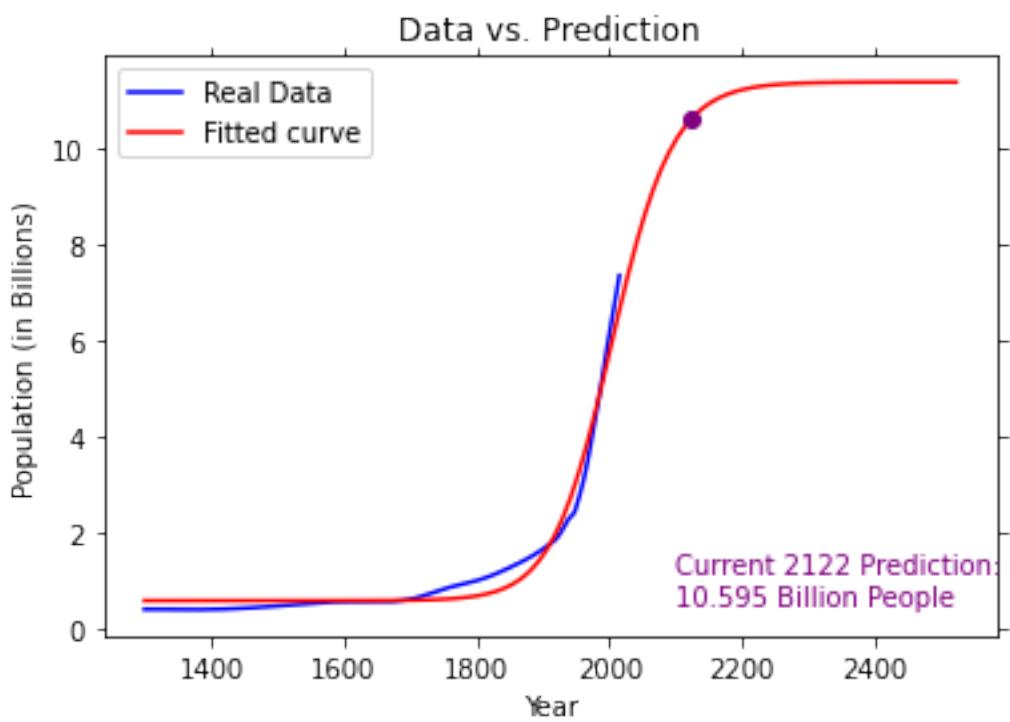
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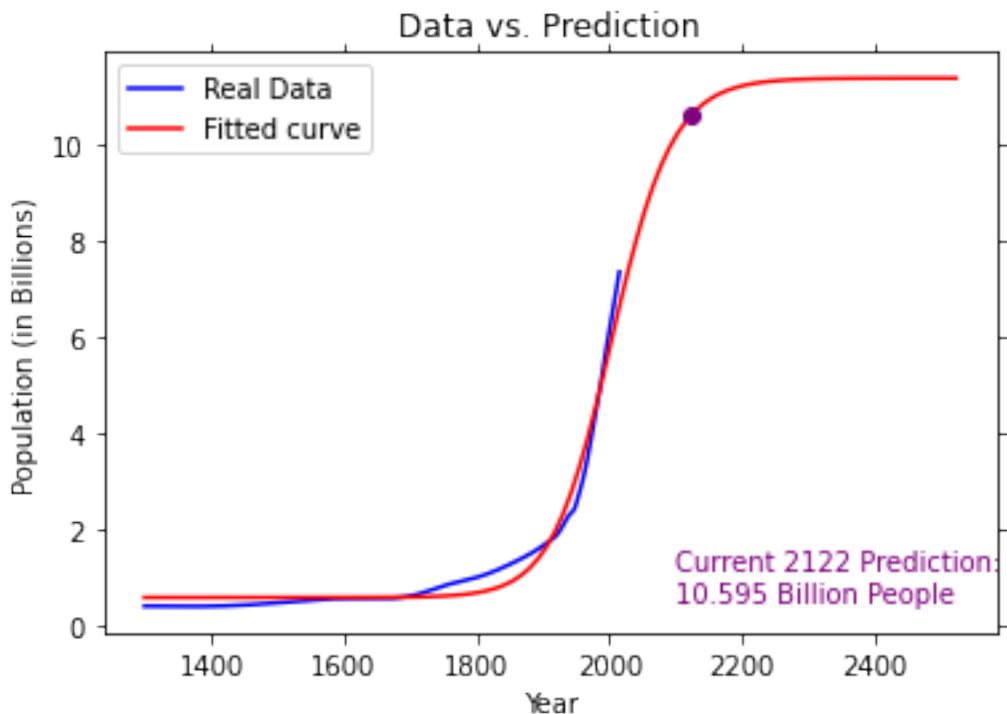
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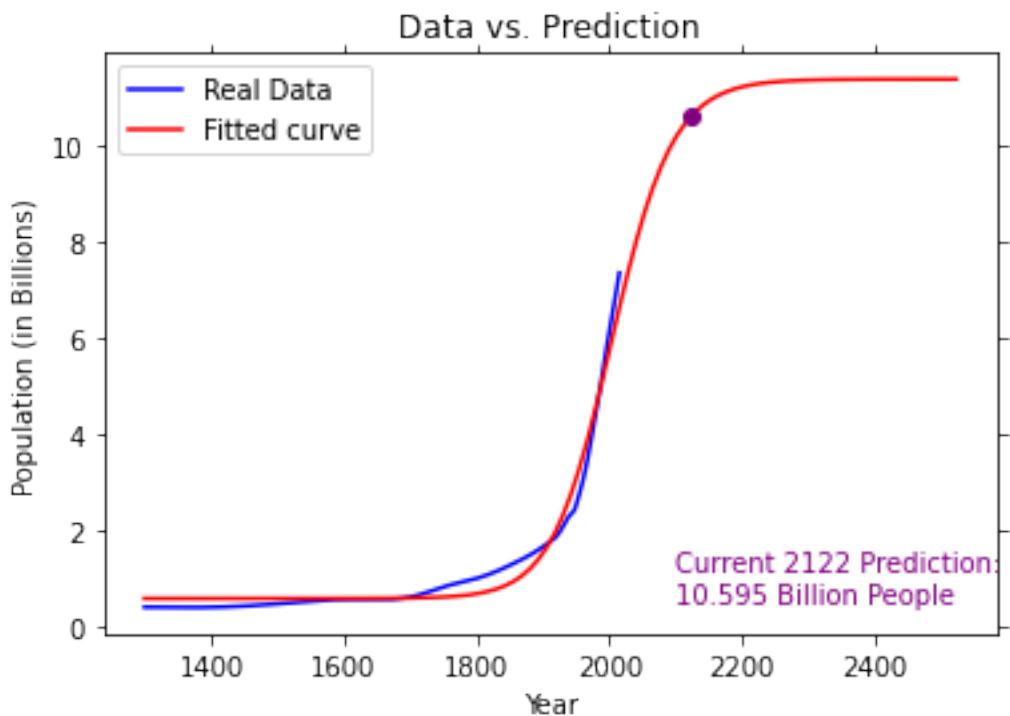
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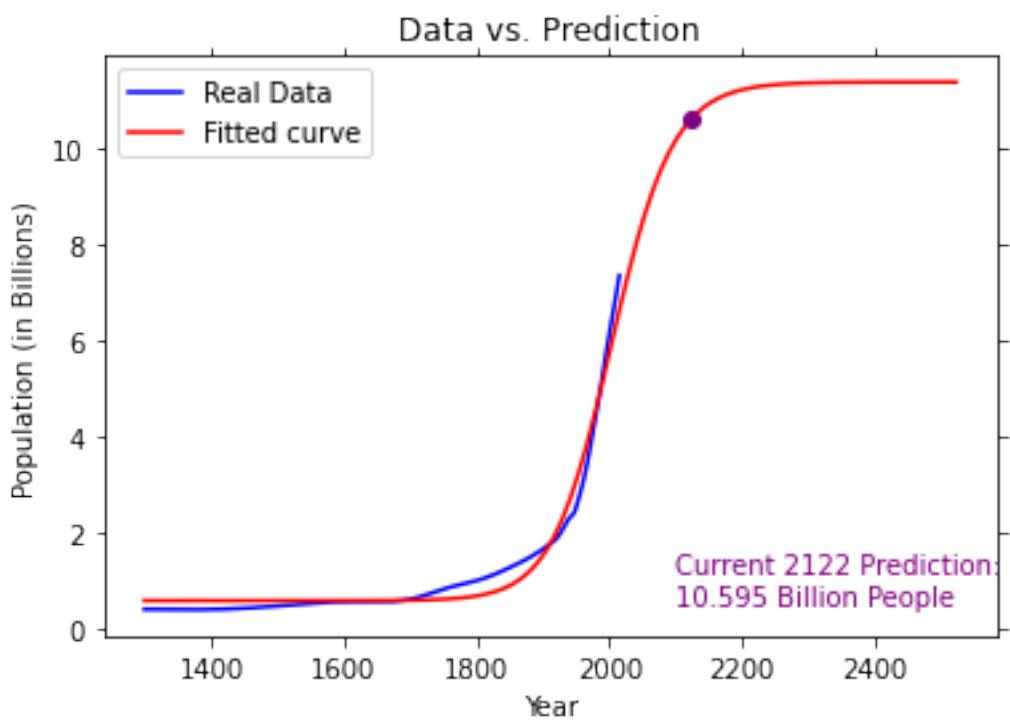
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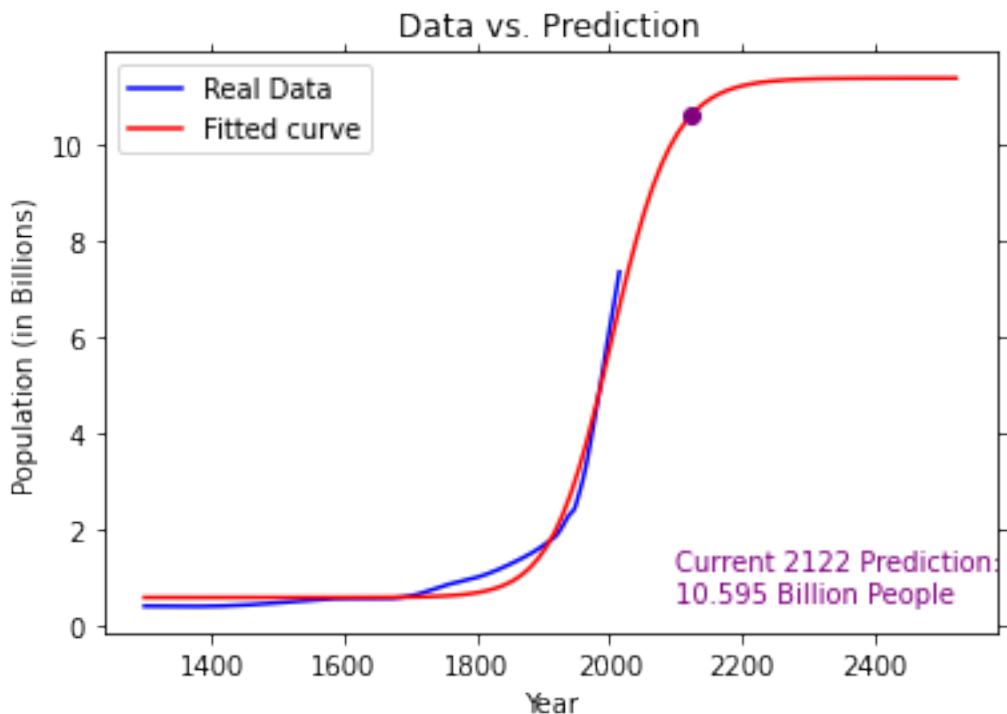
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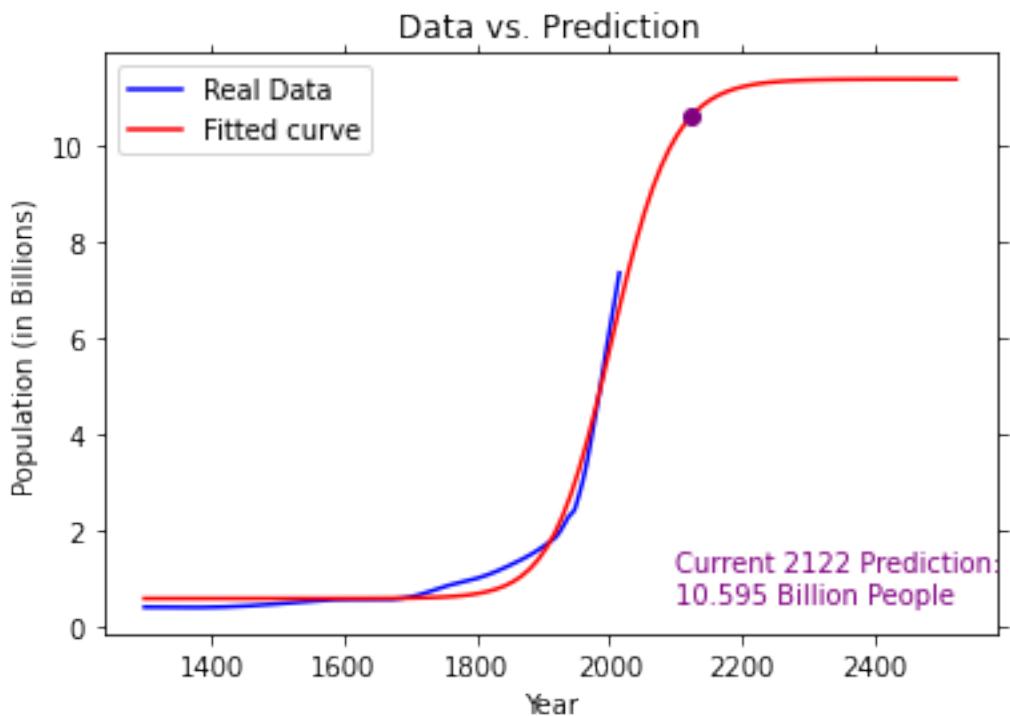
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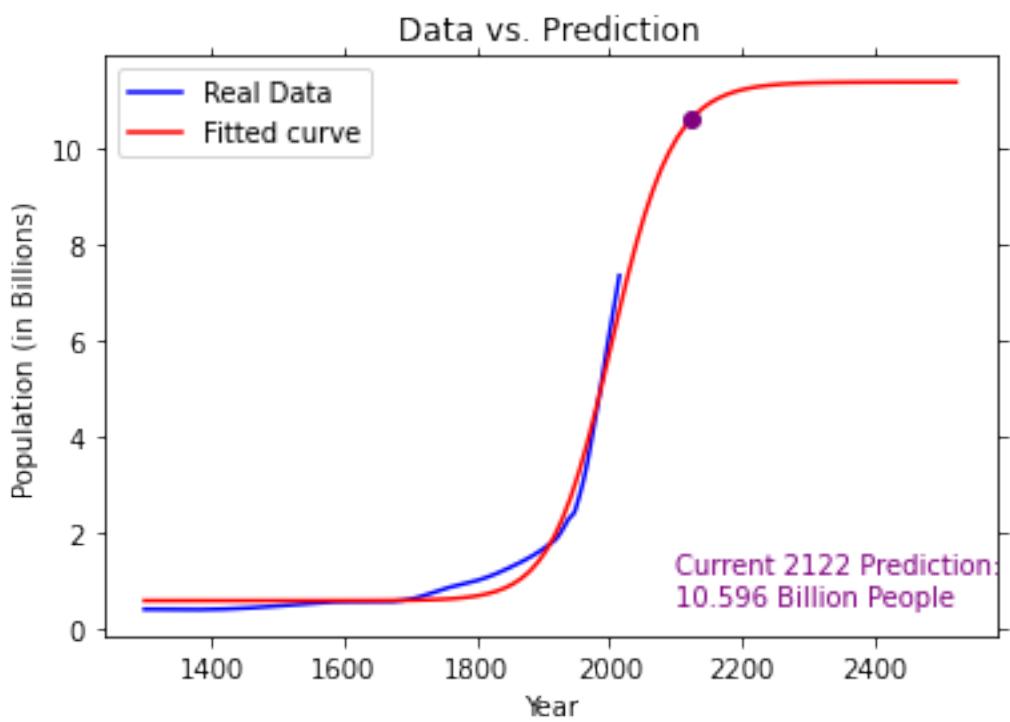
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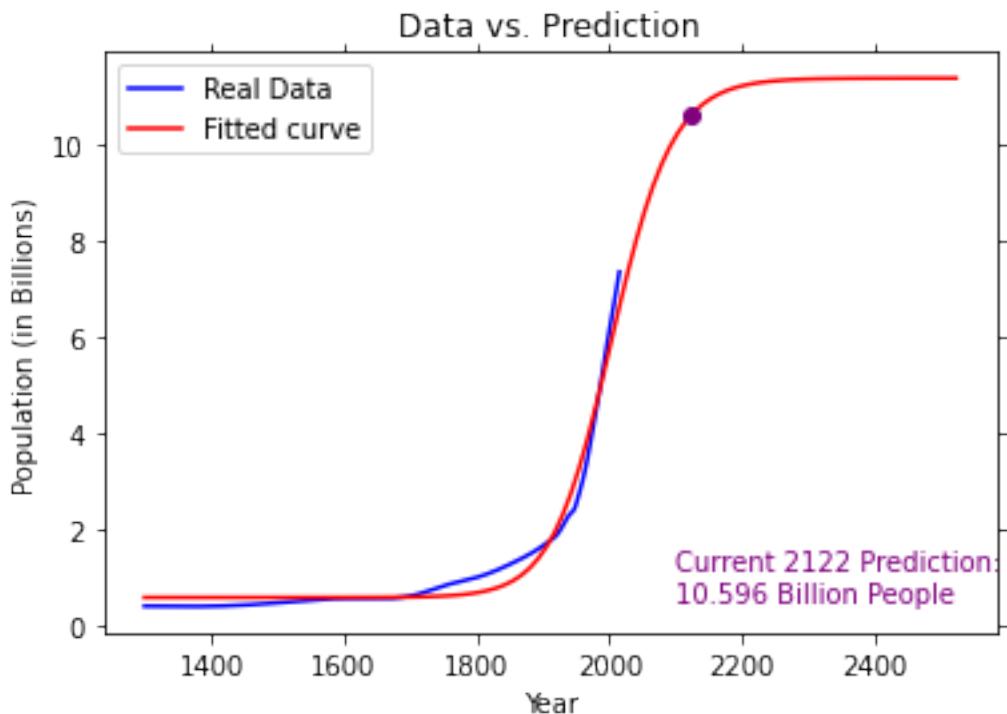
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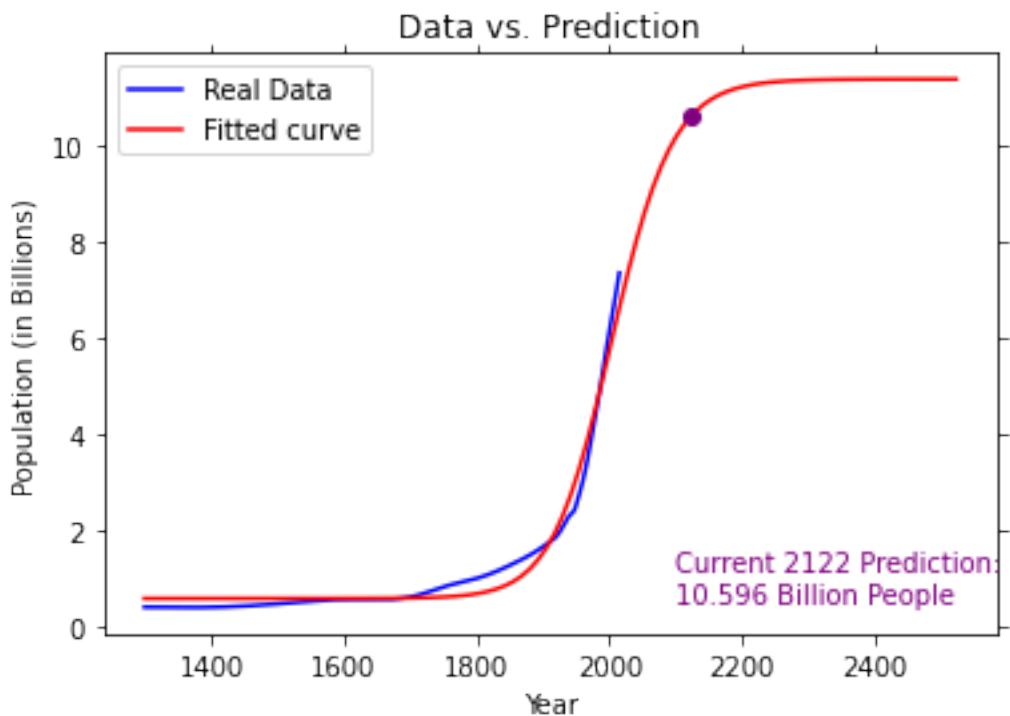
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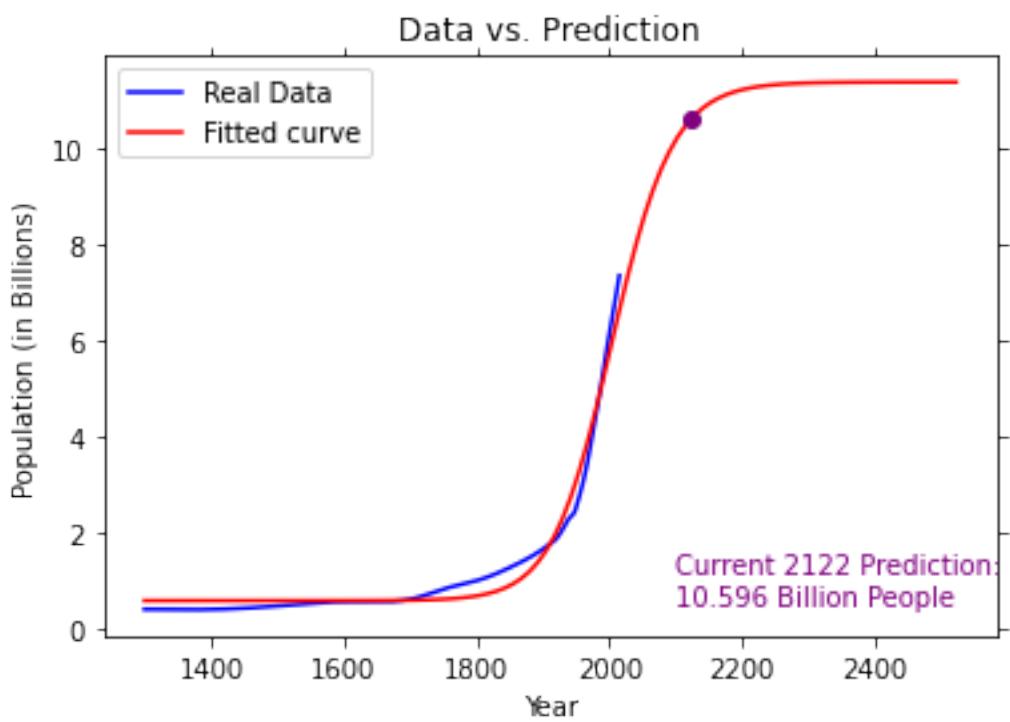
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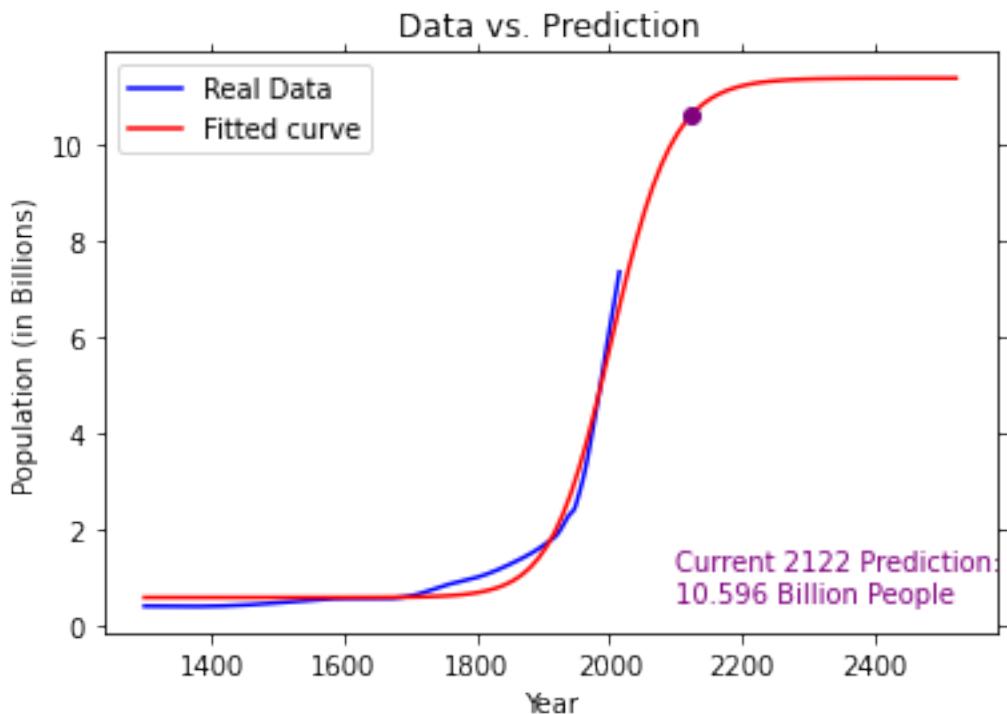
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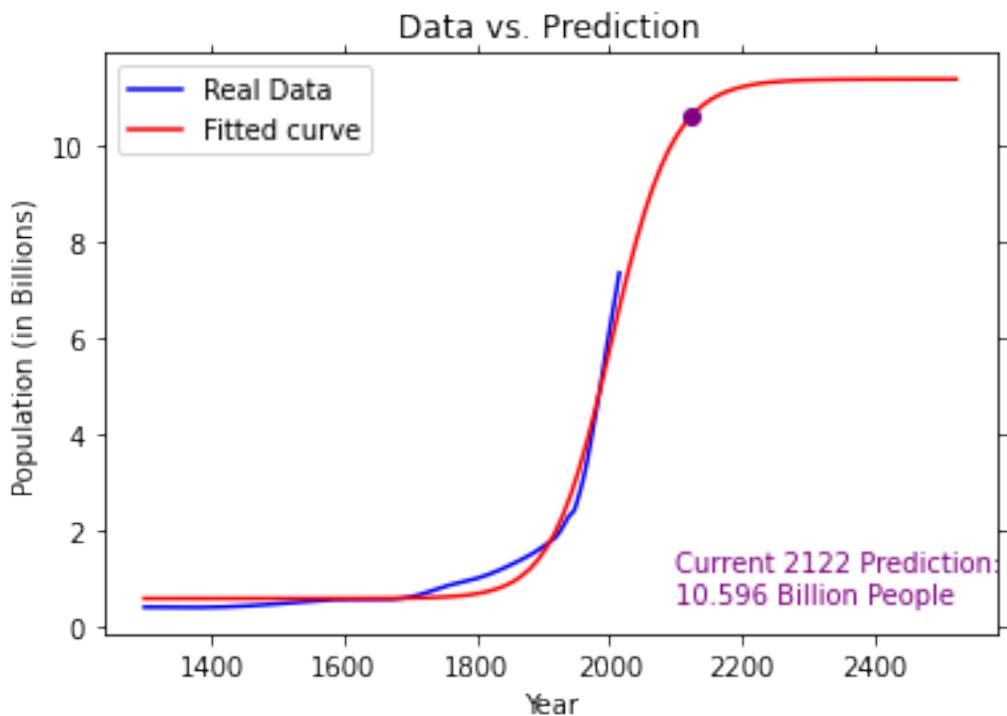
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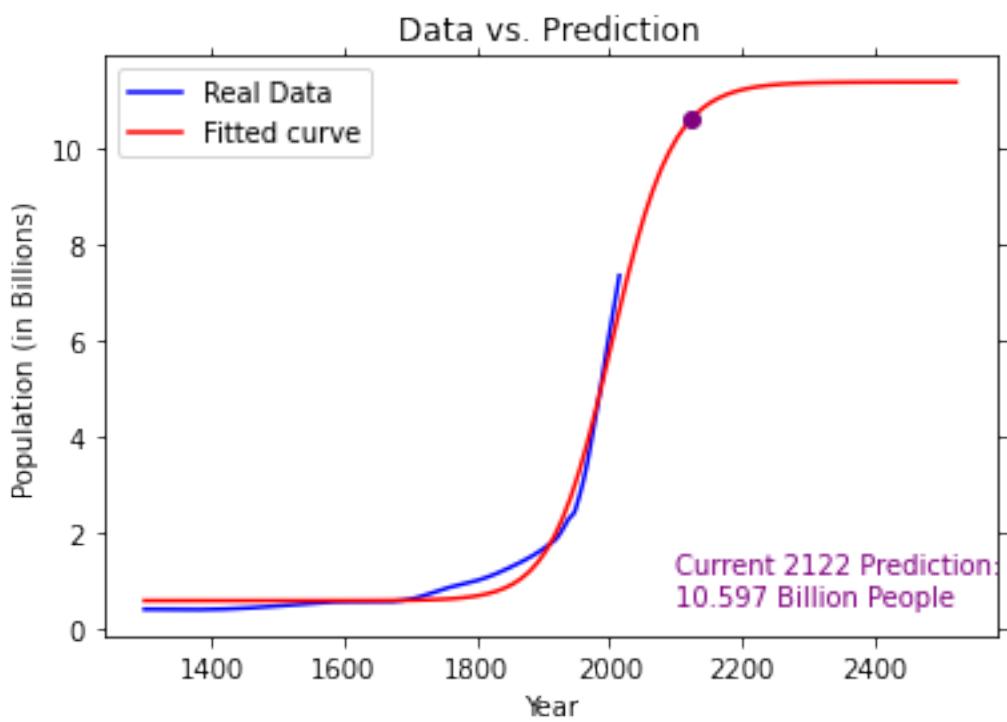
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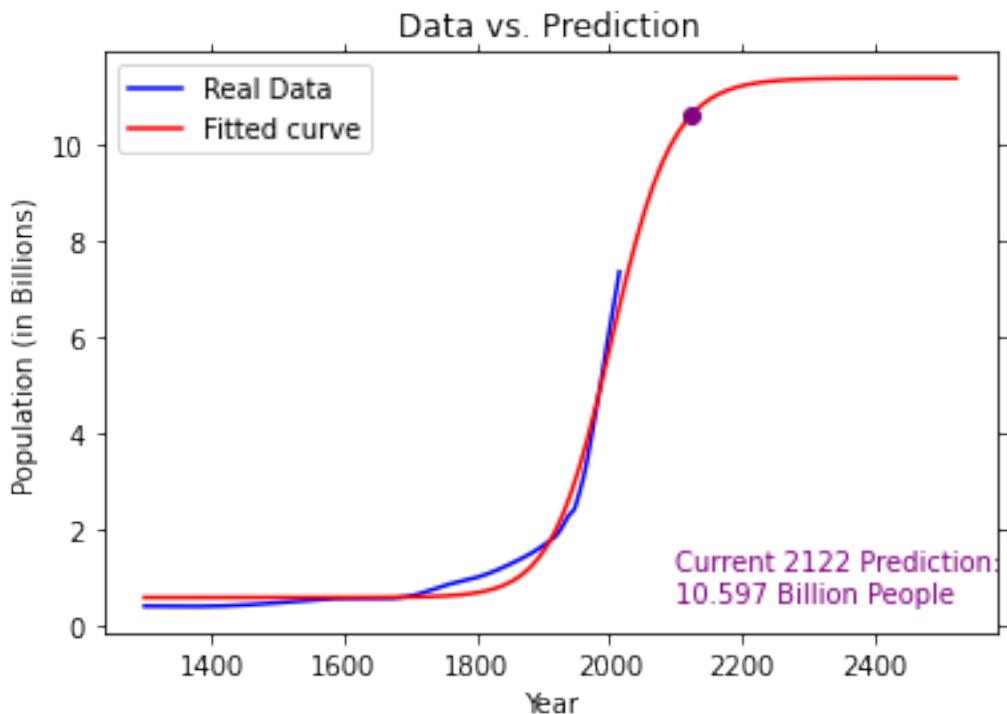
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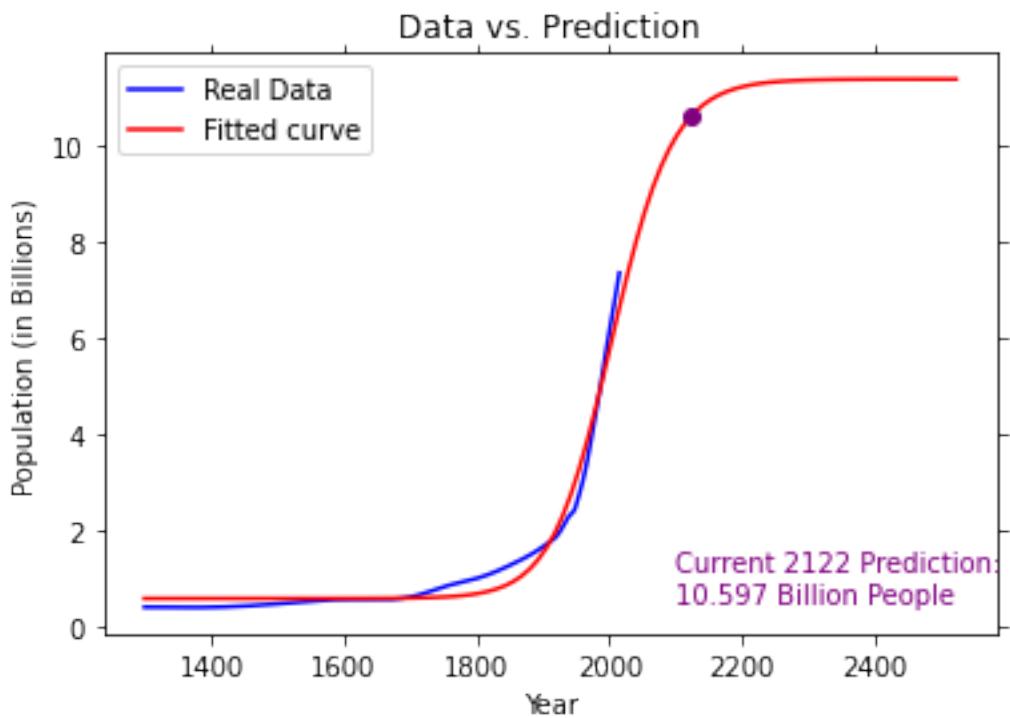
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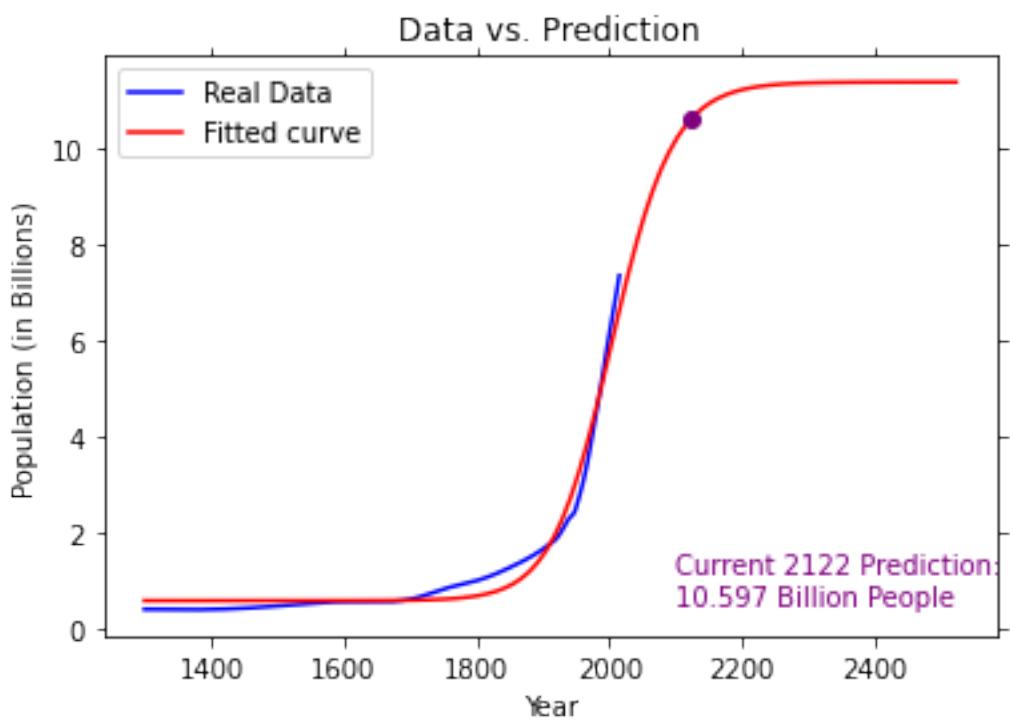
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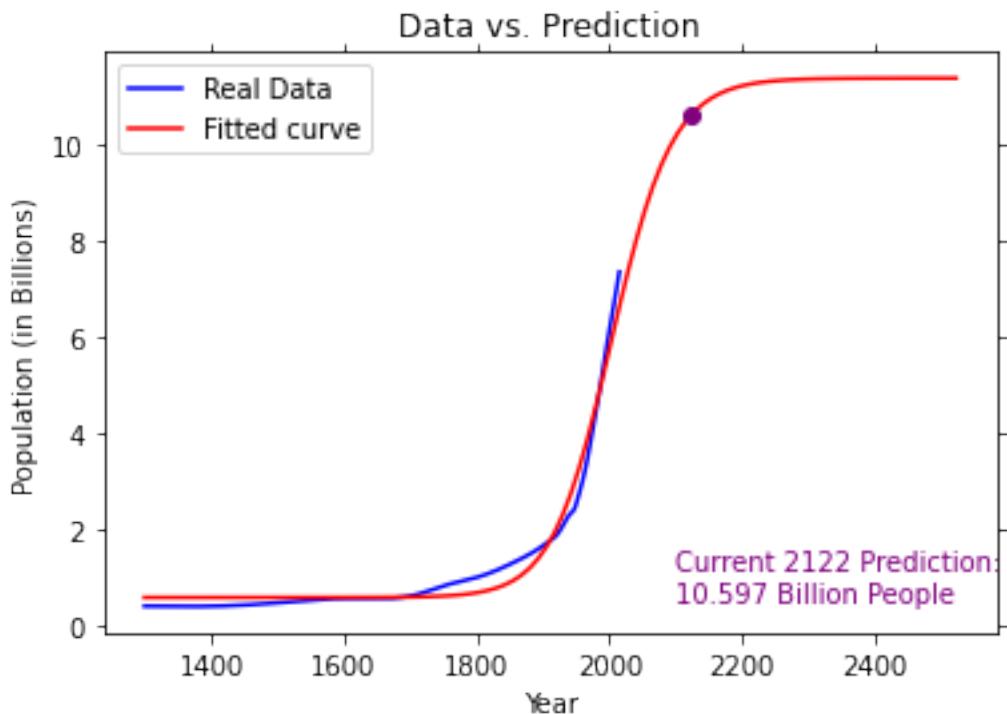
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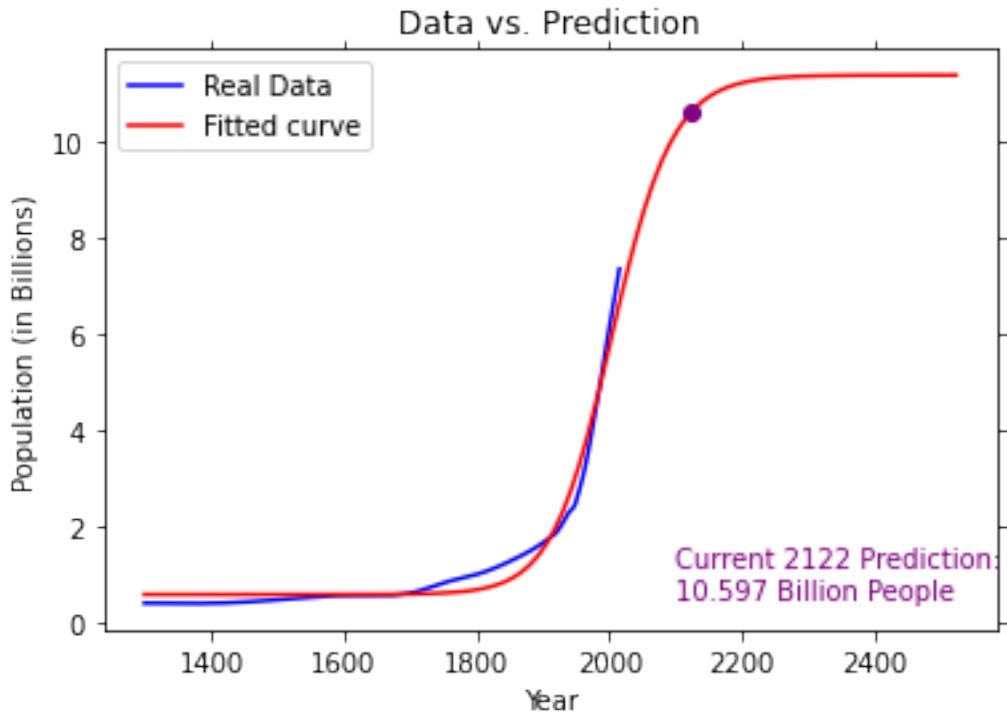
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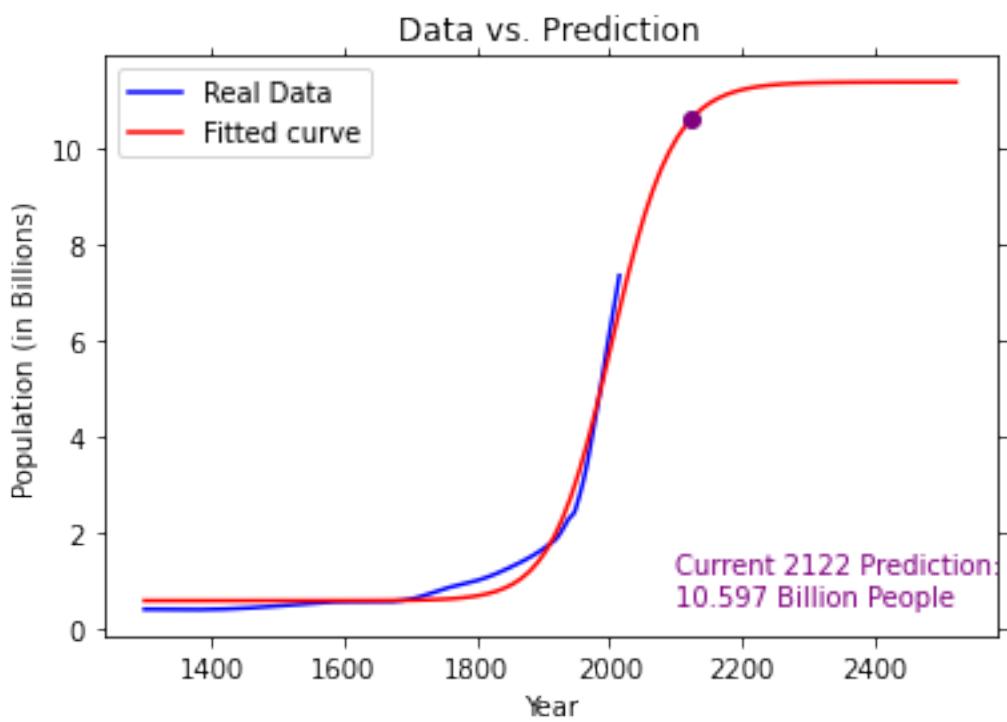
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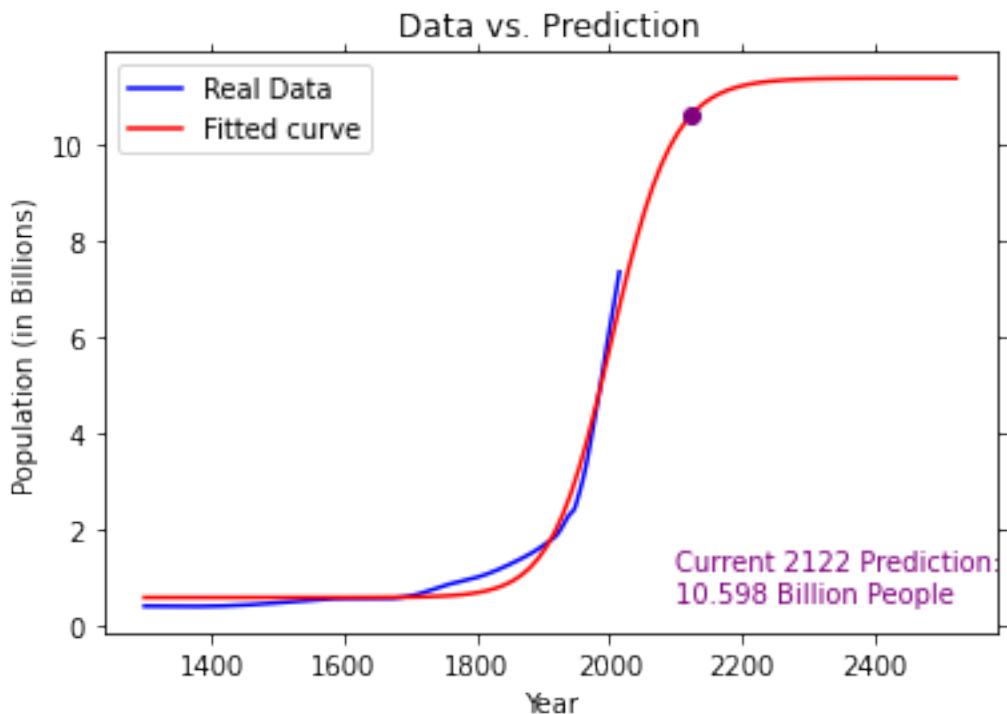
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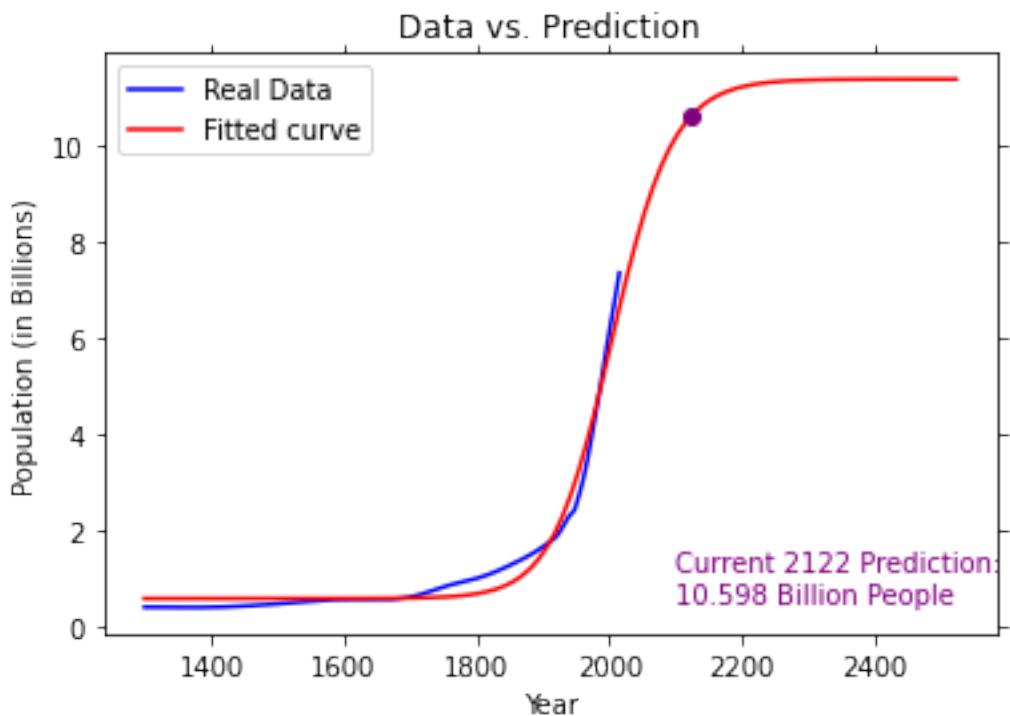
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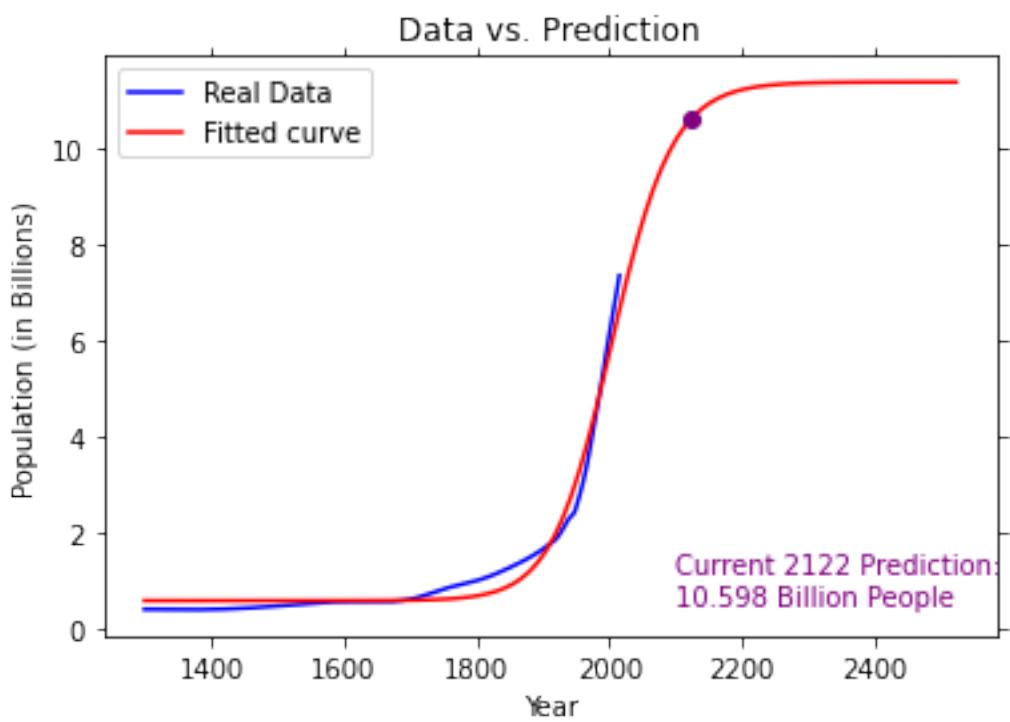
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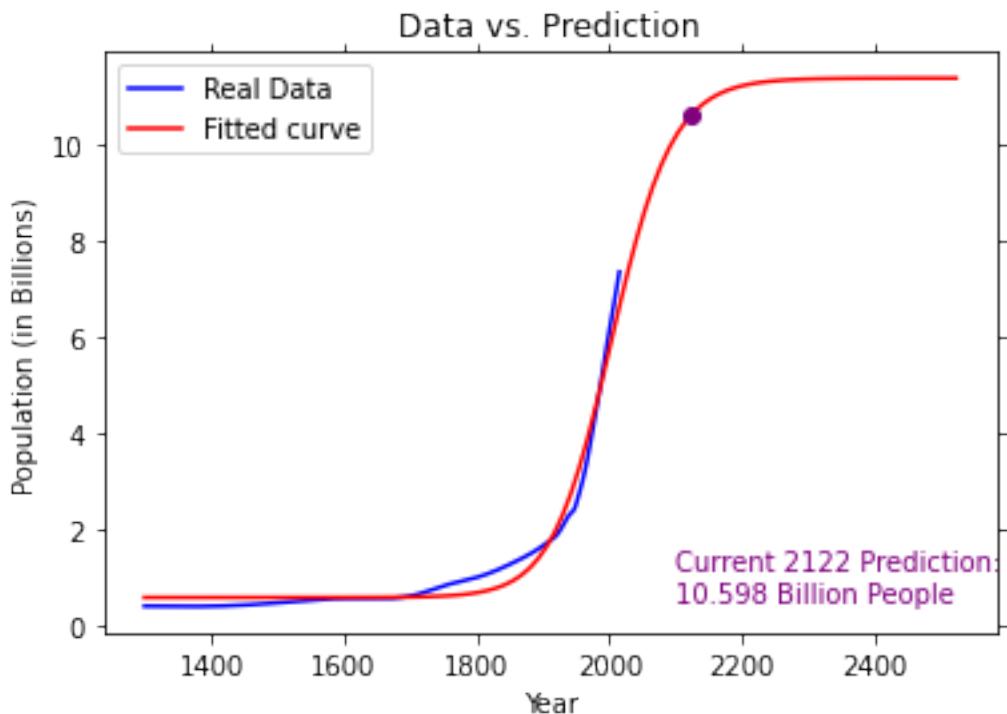
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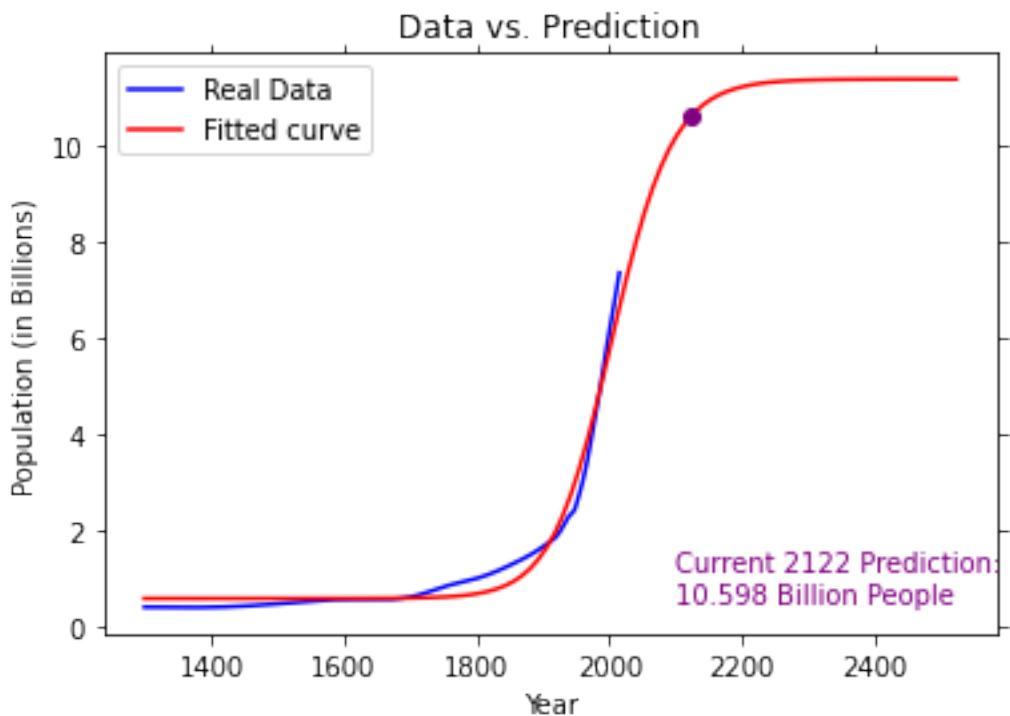
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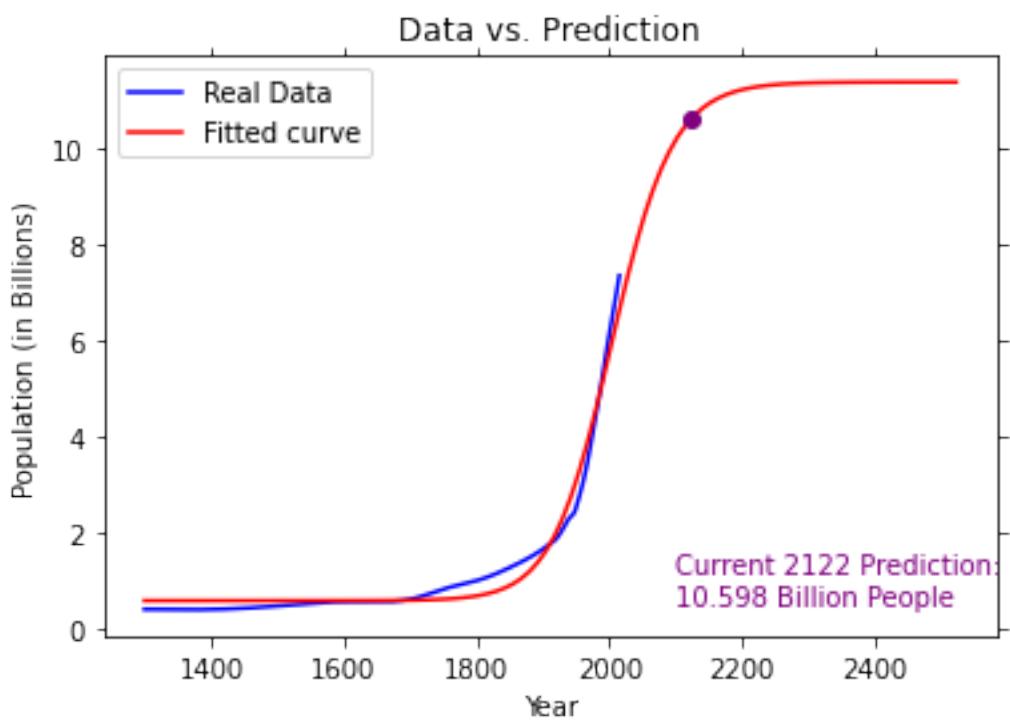
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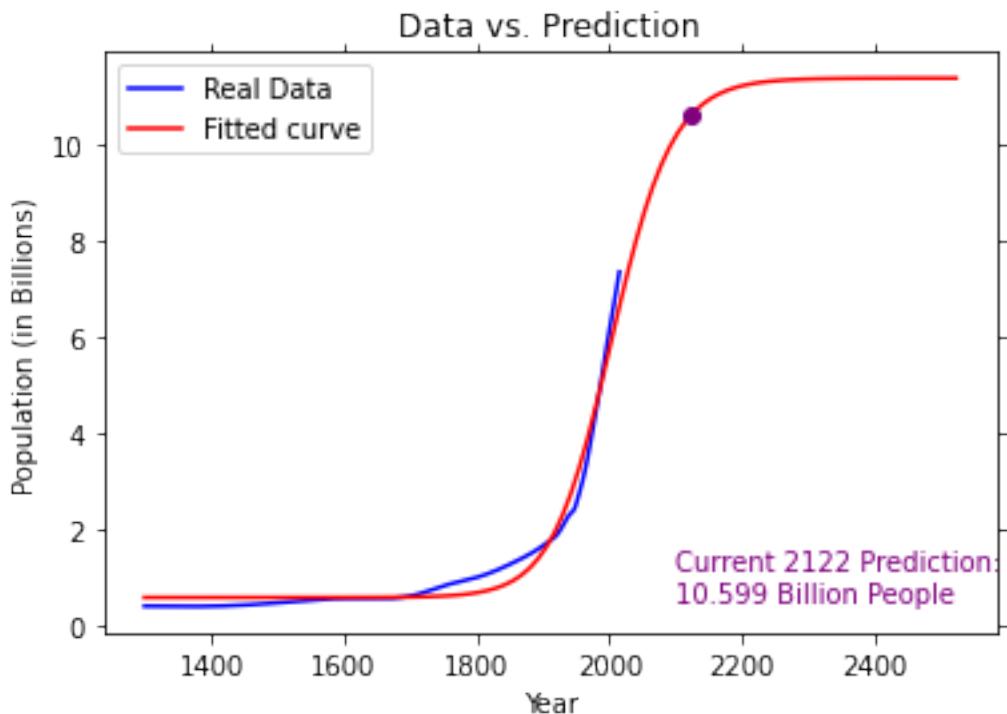
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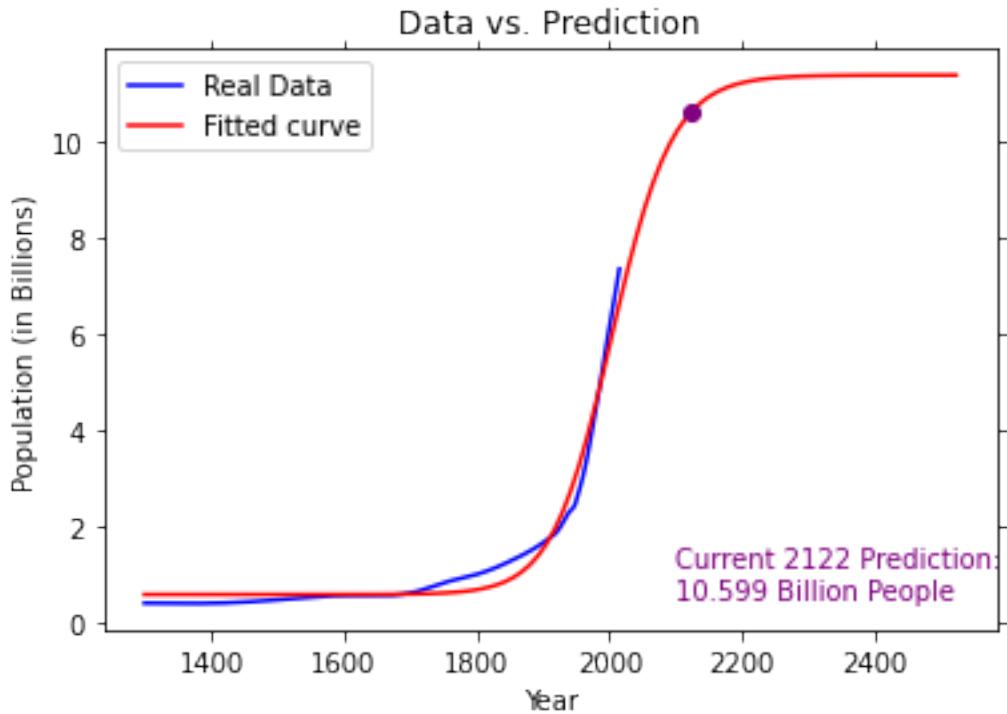
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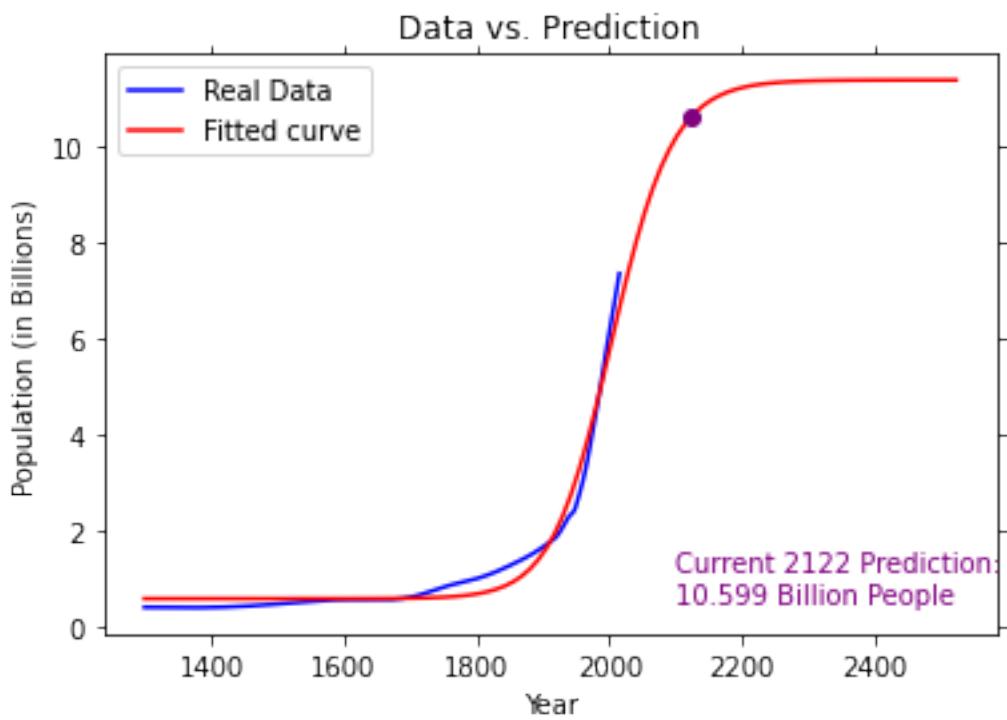
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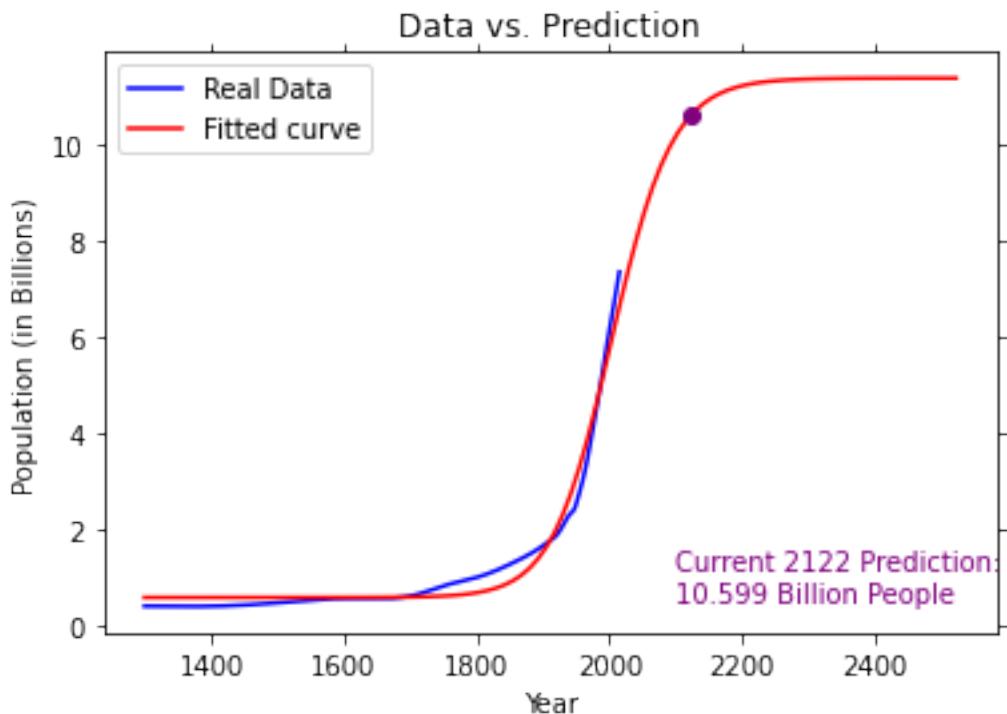
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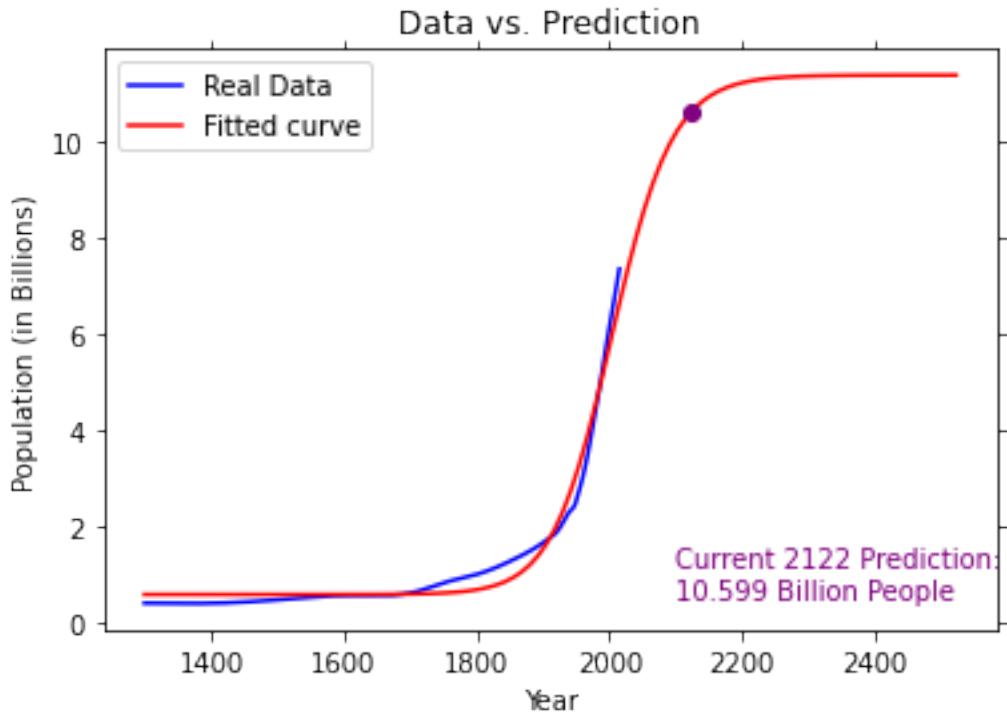
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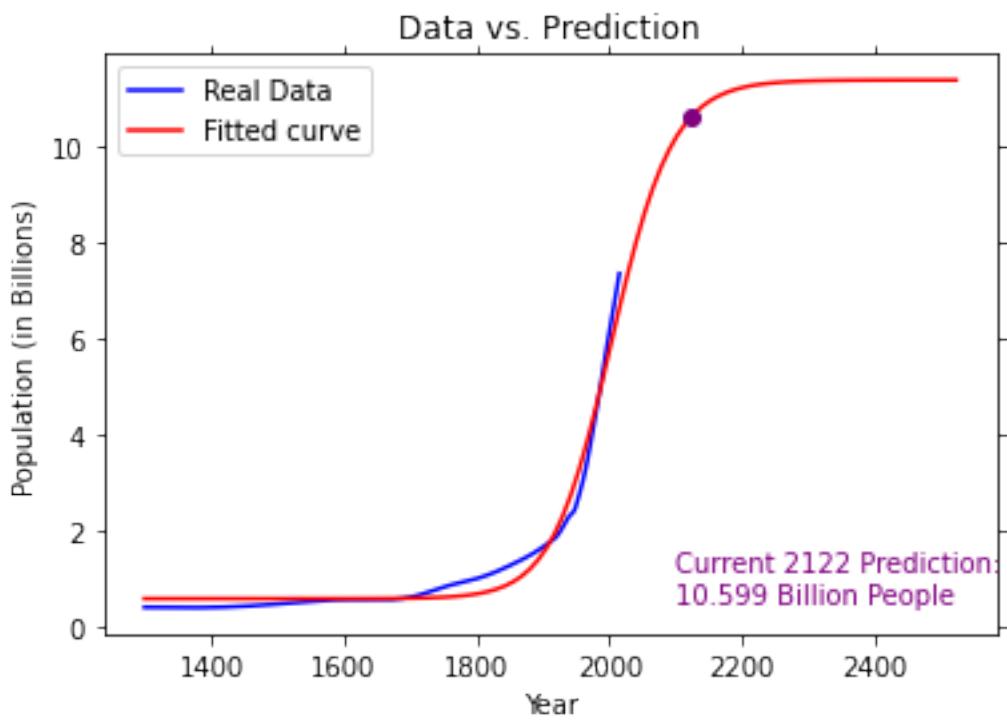
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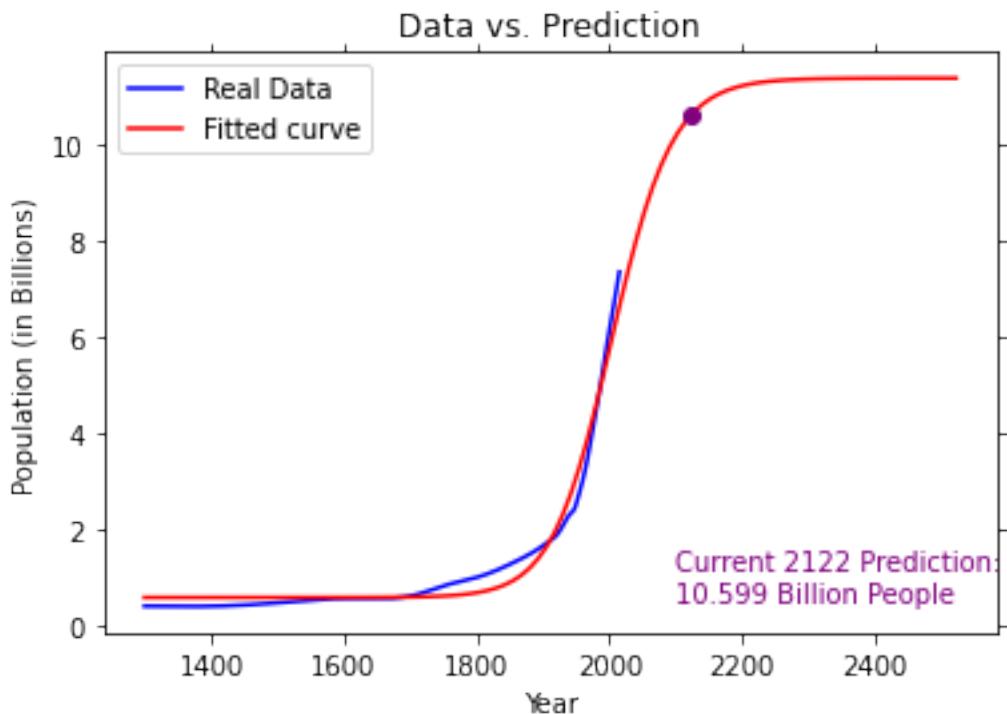
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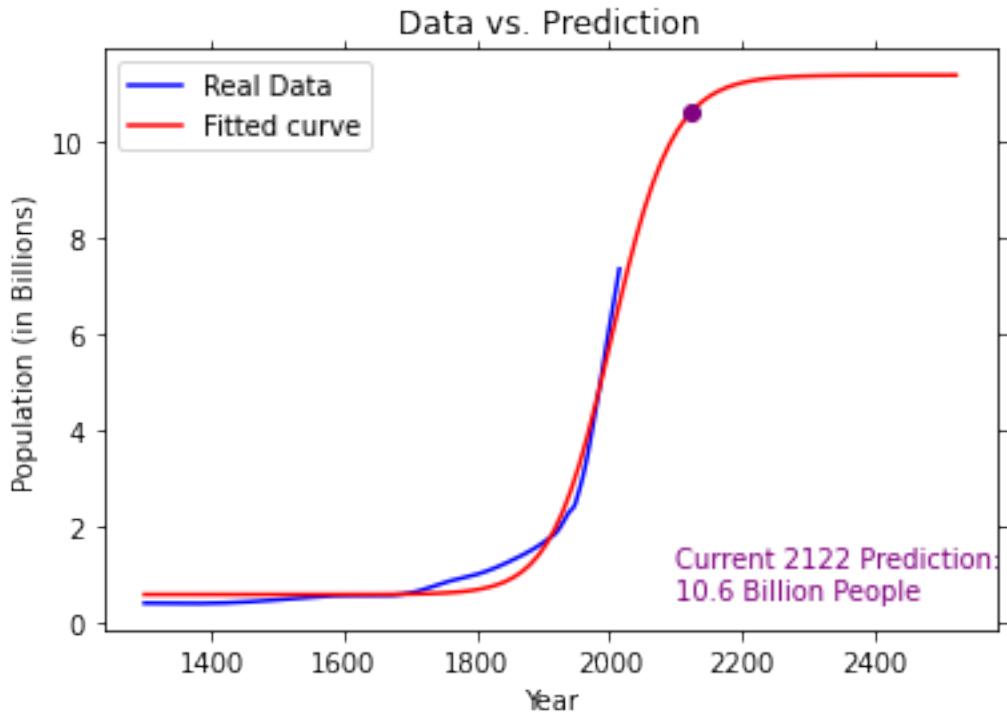
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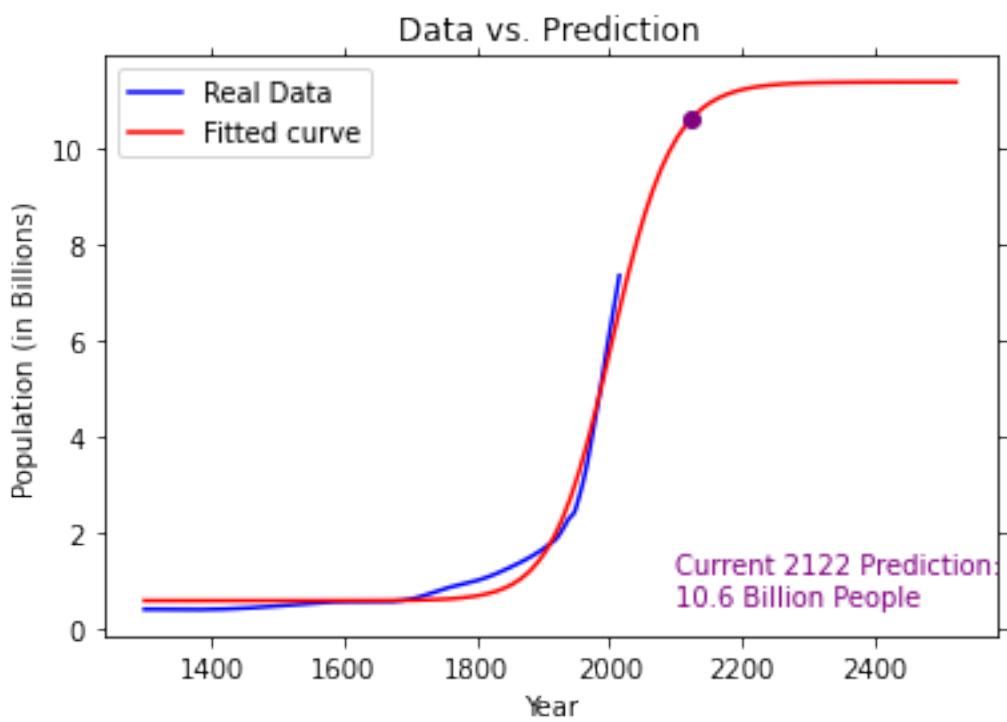
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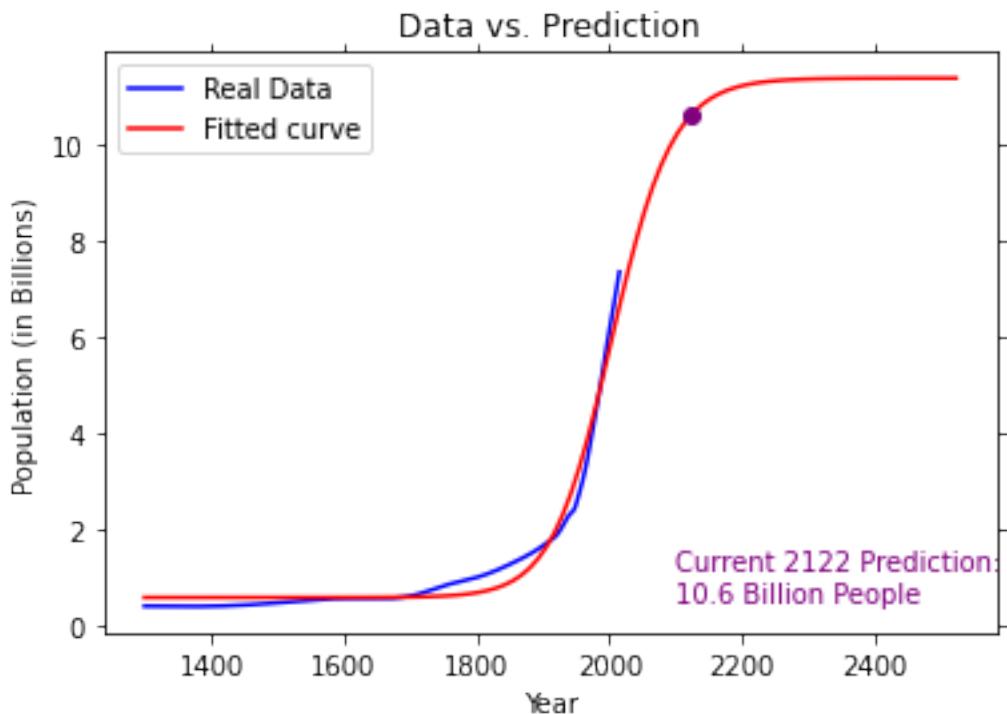
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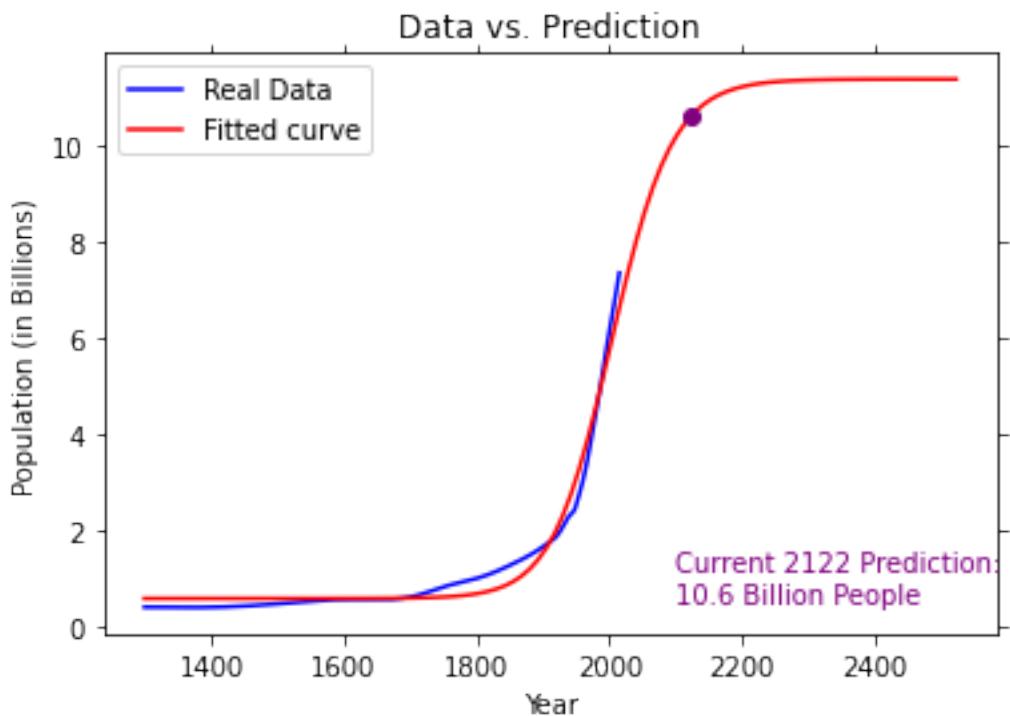
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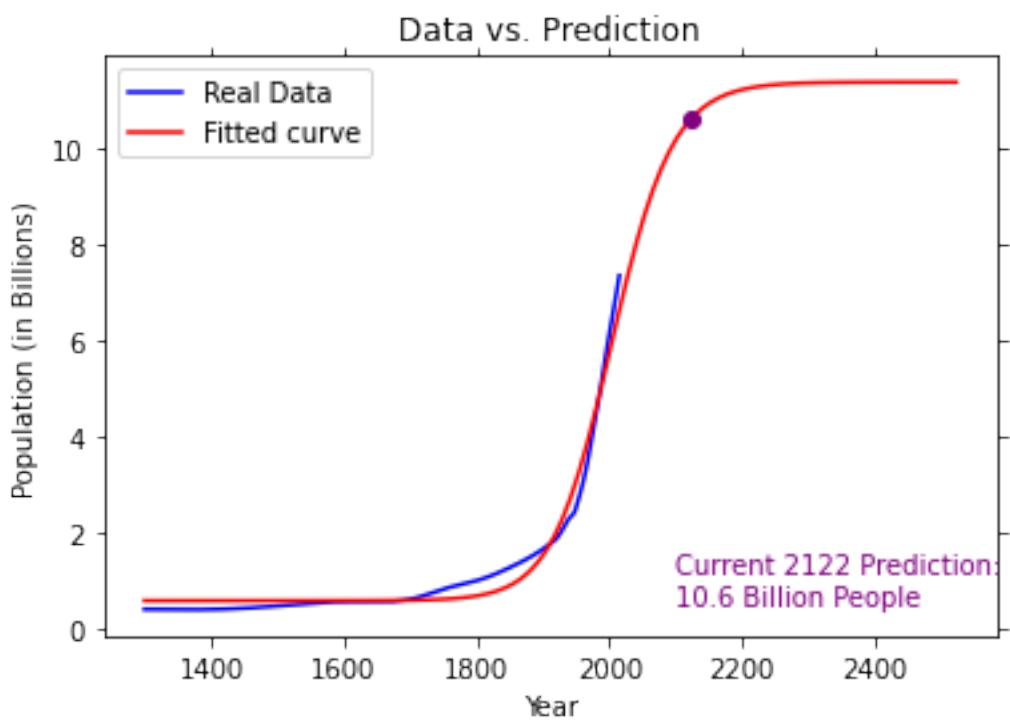
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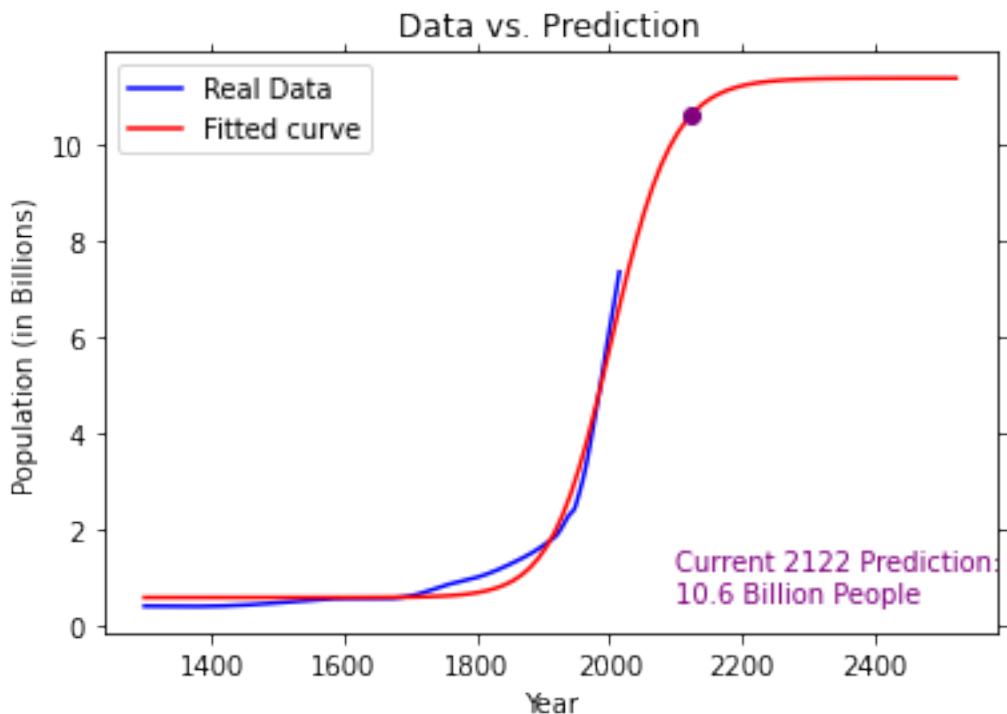
Iteration #30150, Loss: 0.051599050532622266



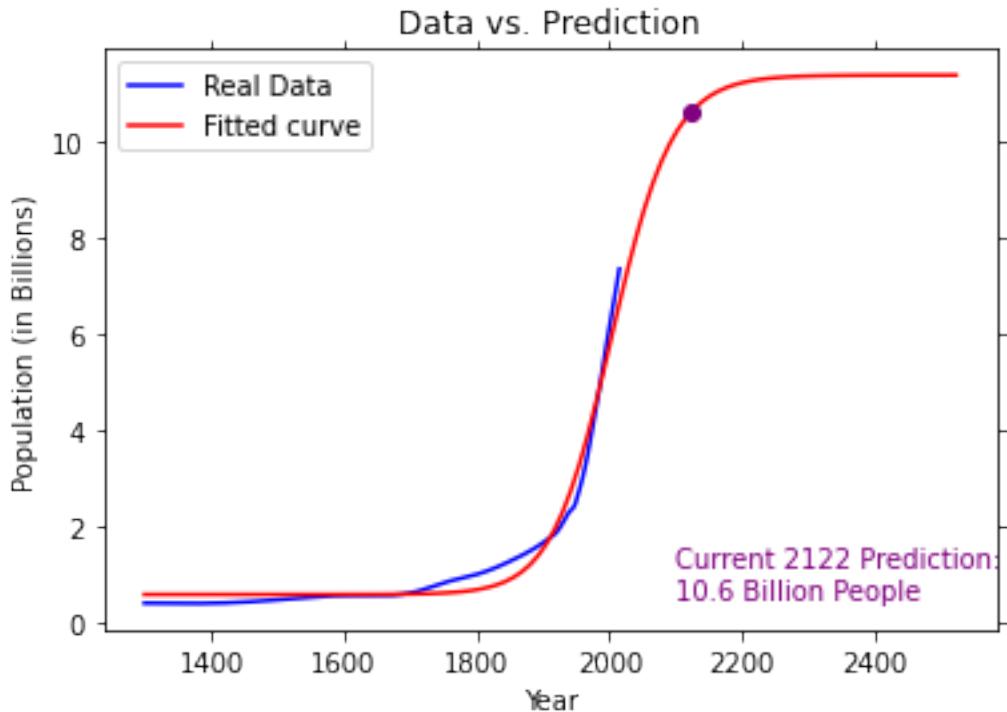
Iteration #30200, Loss: 0.05159303832162342



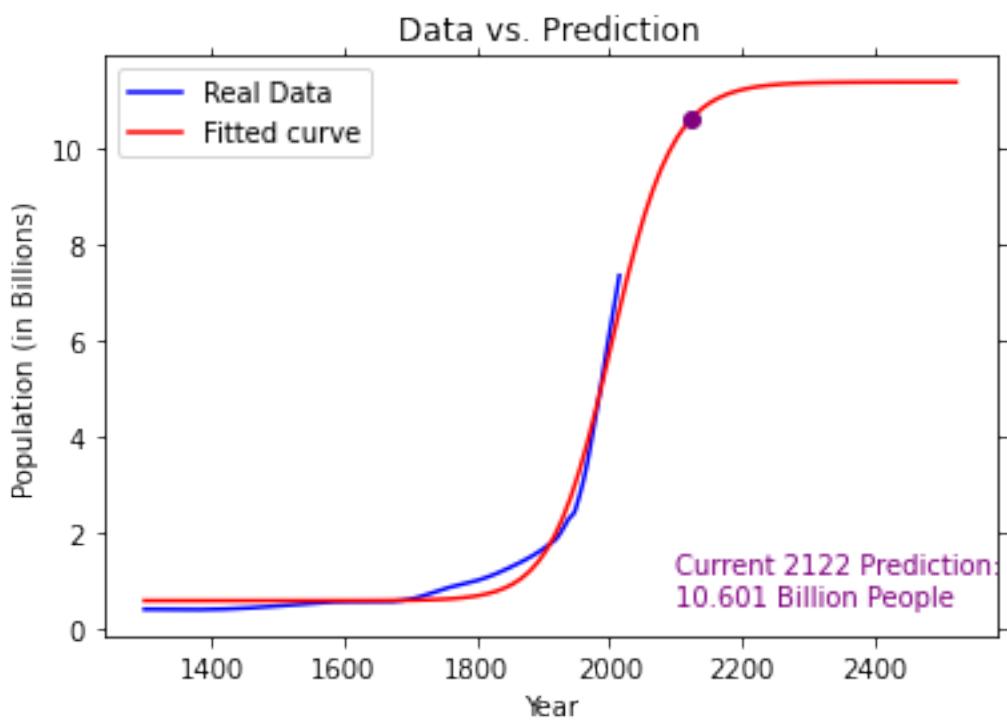
Iteration #30250, Loss: 0.05158704076239966



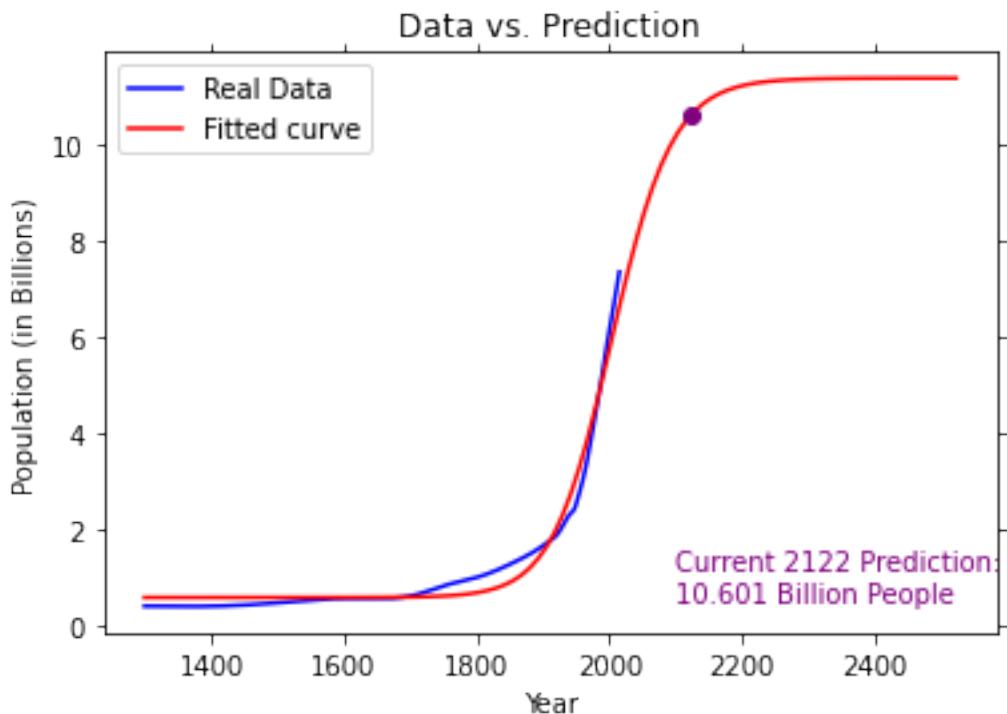
Iteration #30300, Loss: 0.051581057858829965



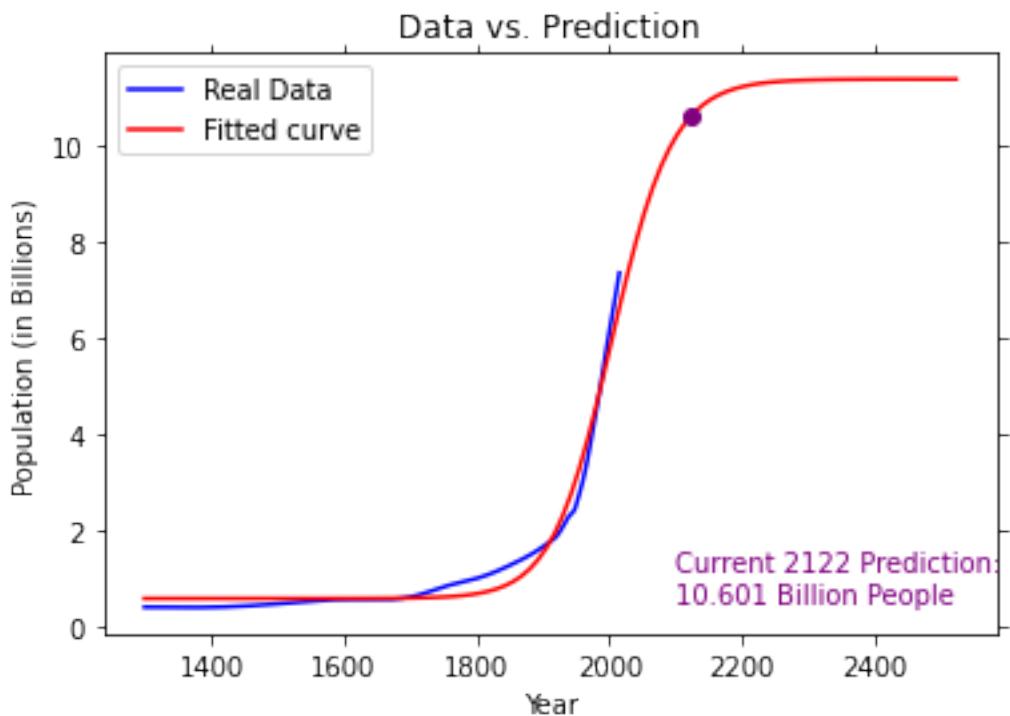
Iteration #30350, Loss: 0.051575089614804566



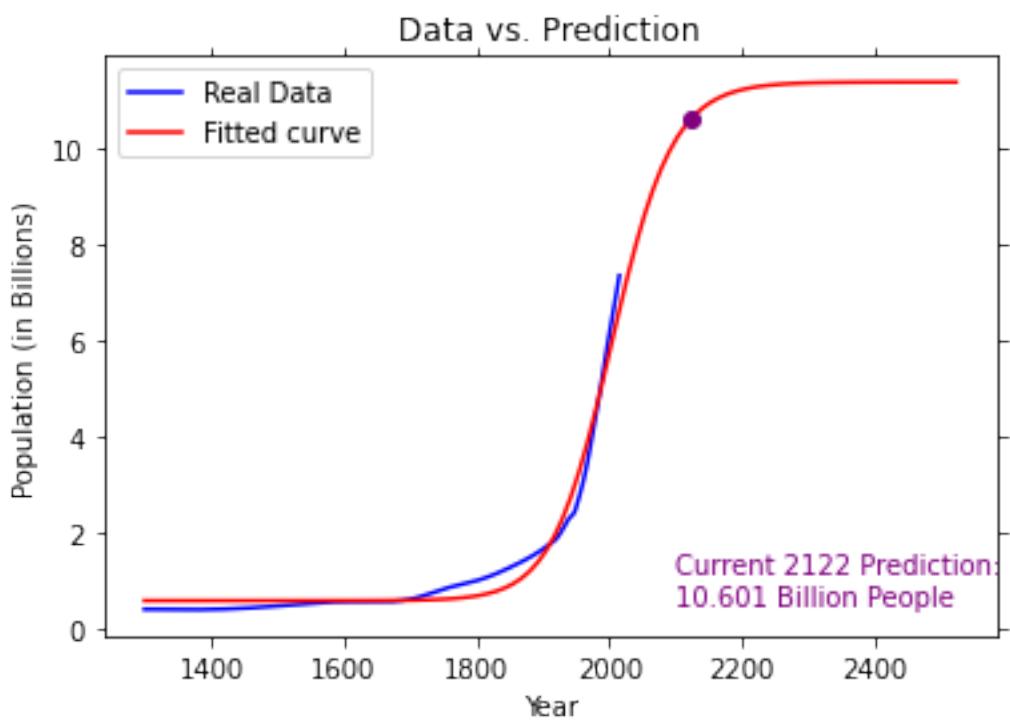
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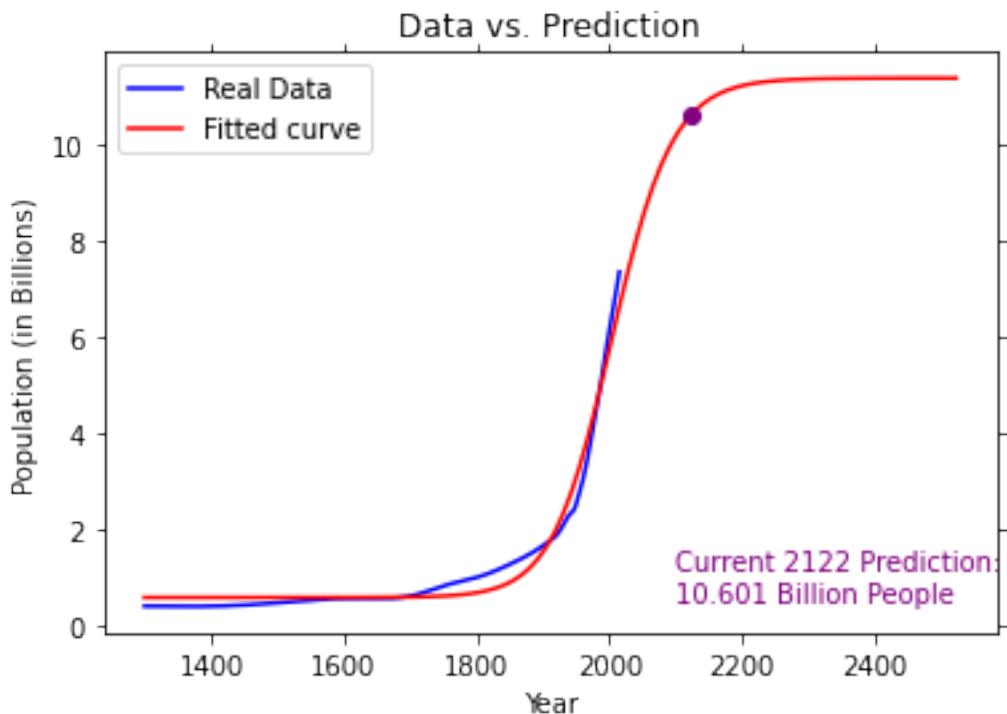
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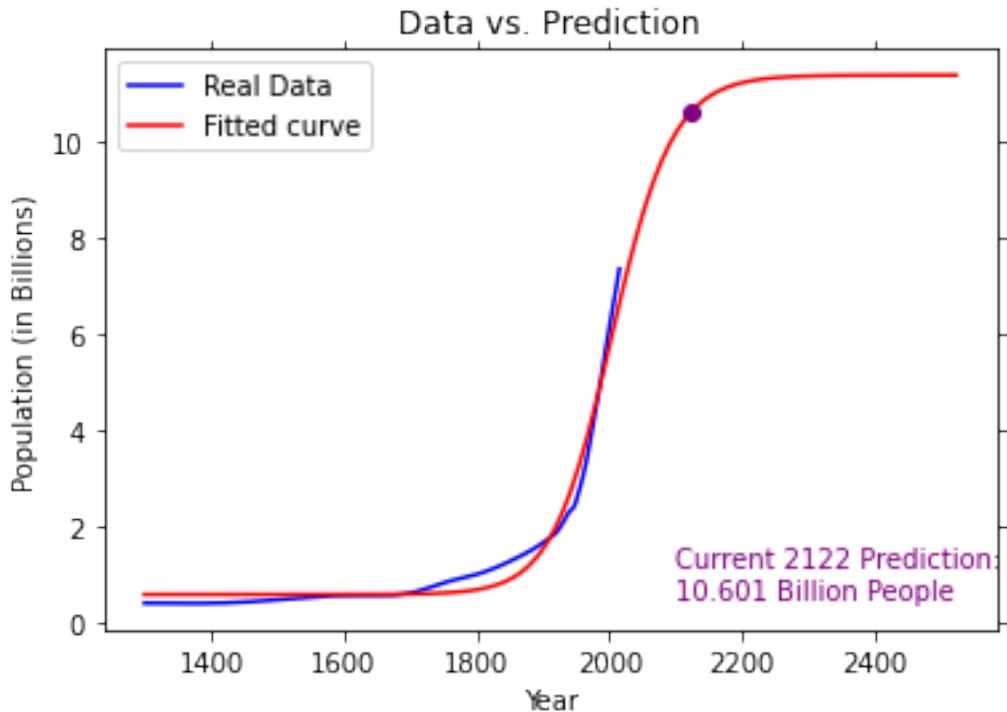
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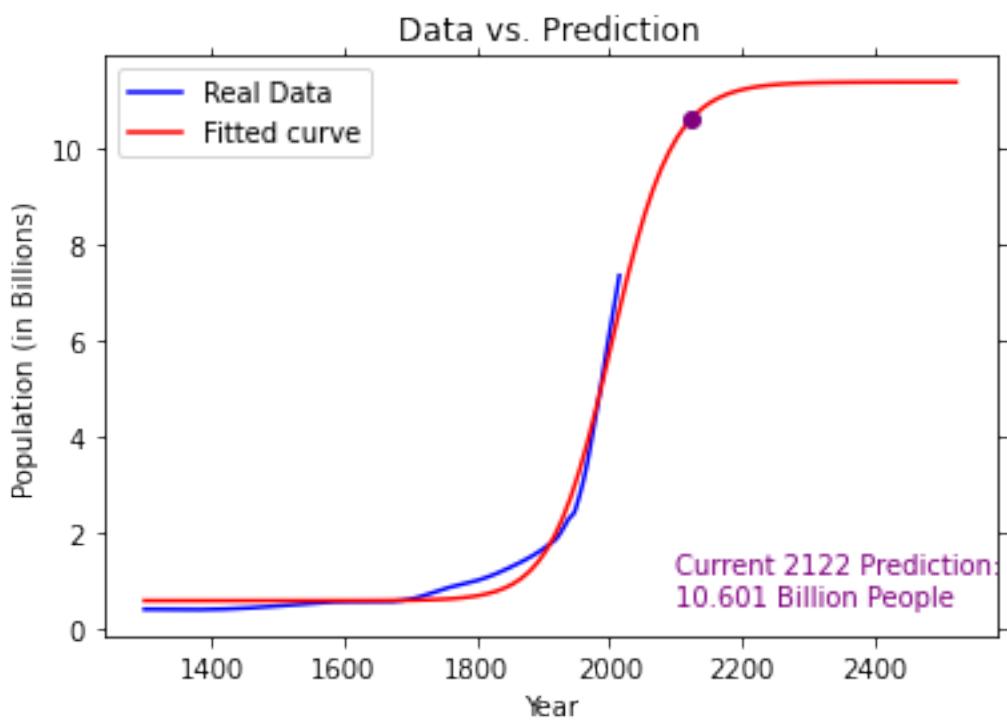
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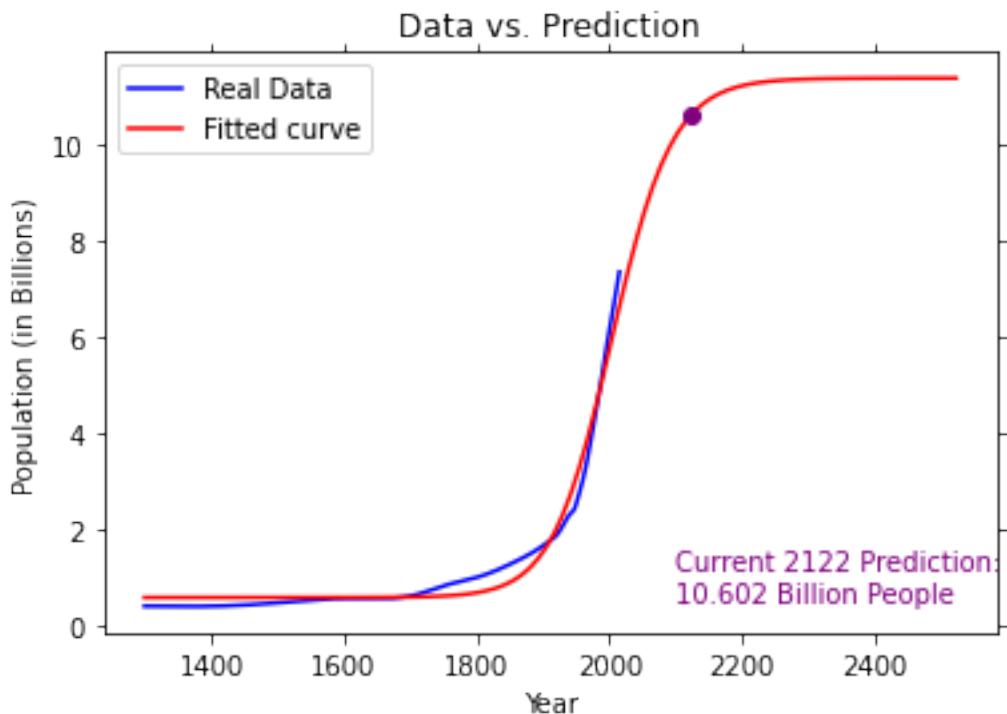
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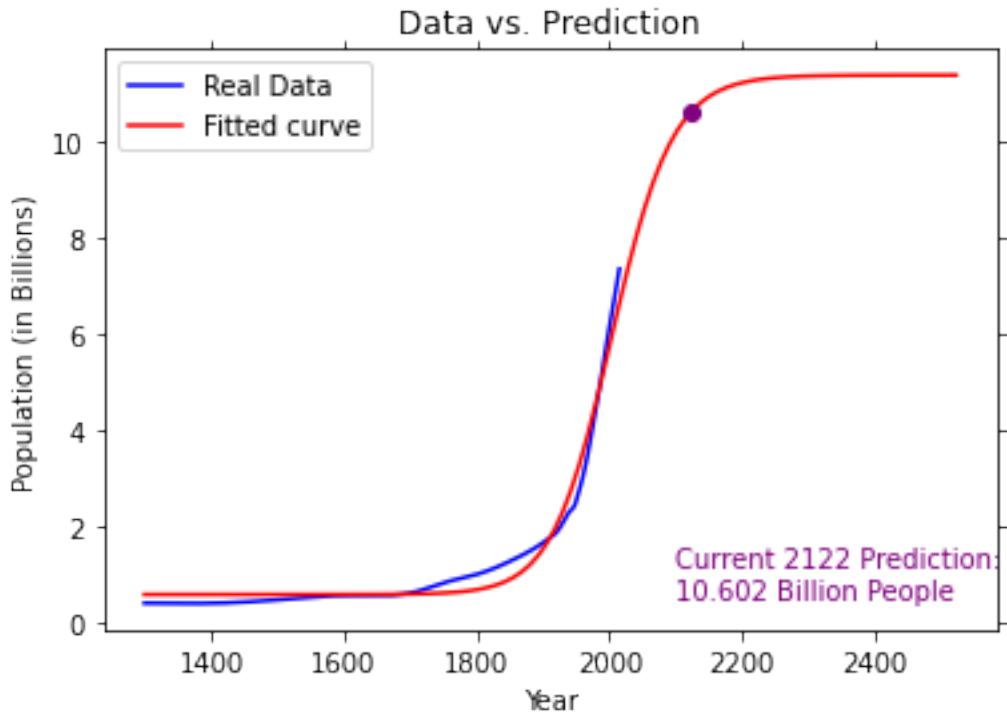
Iteration #30650, Loss: 0.05153958822019618



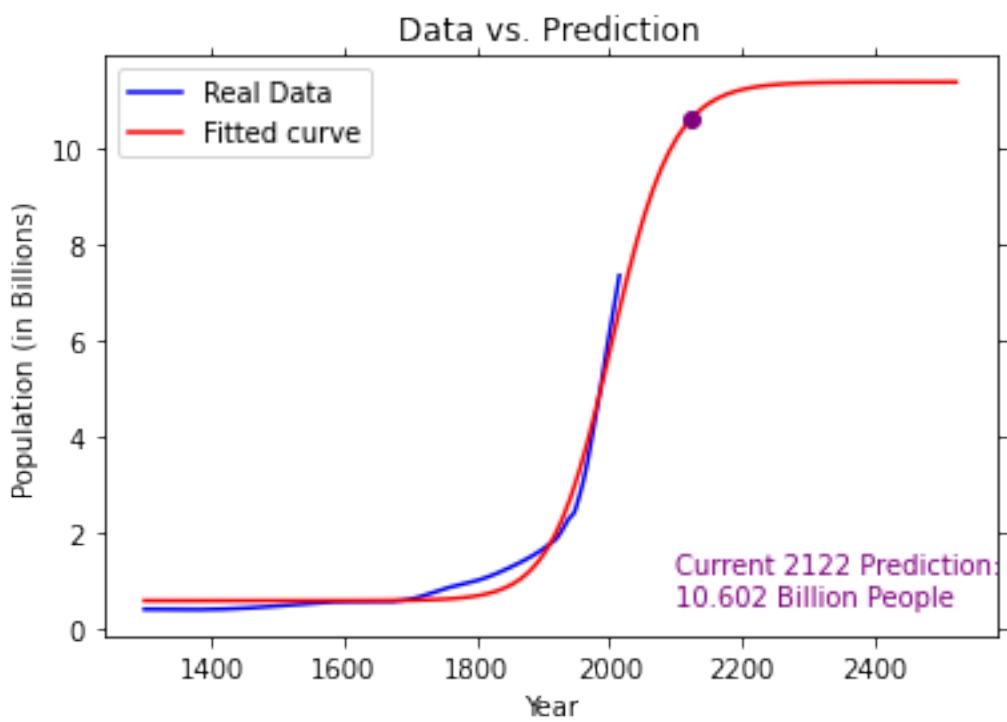
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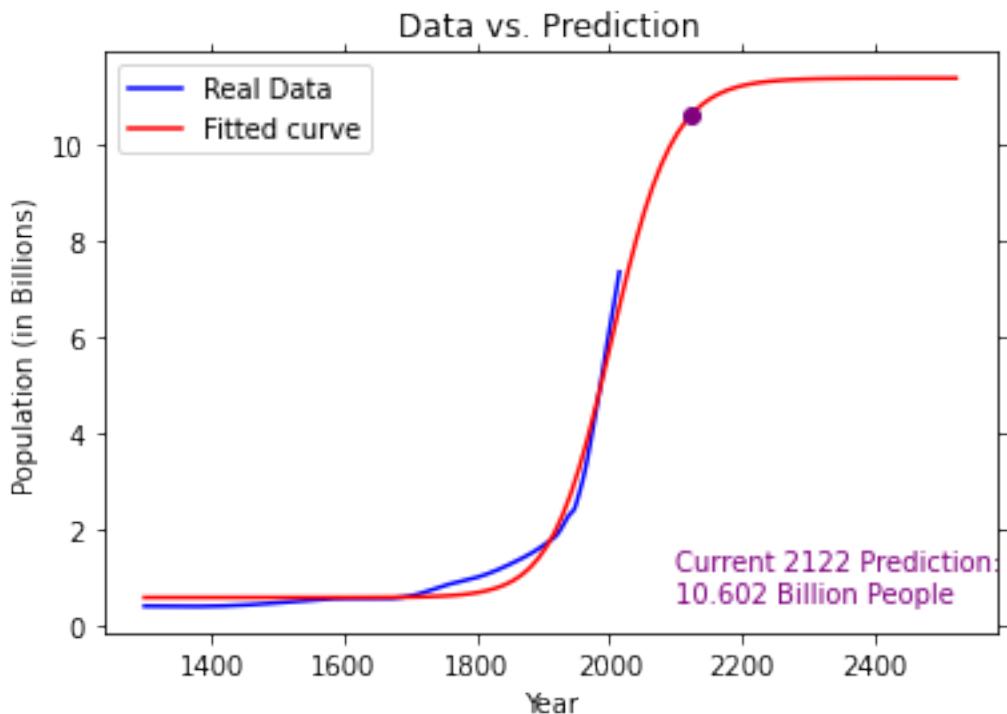
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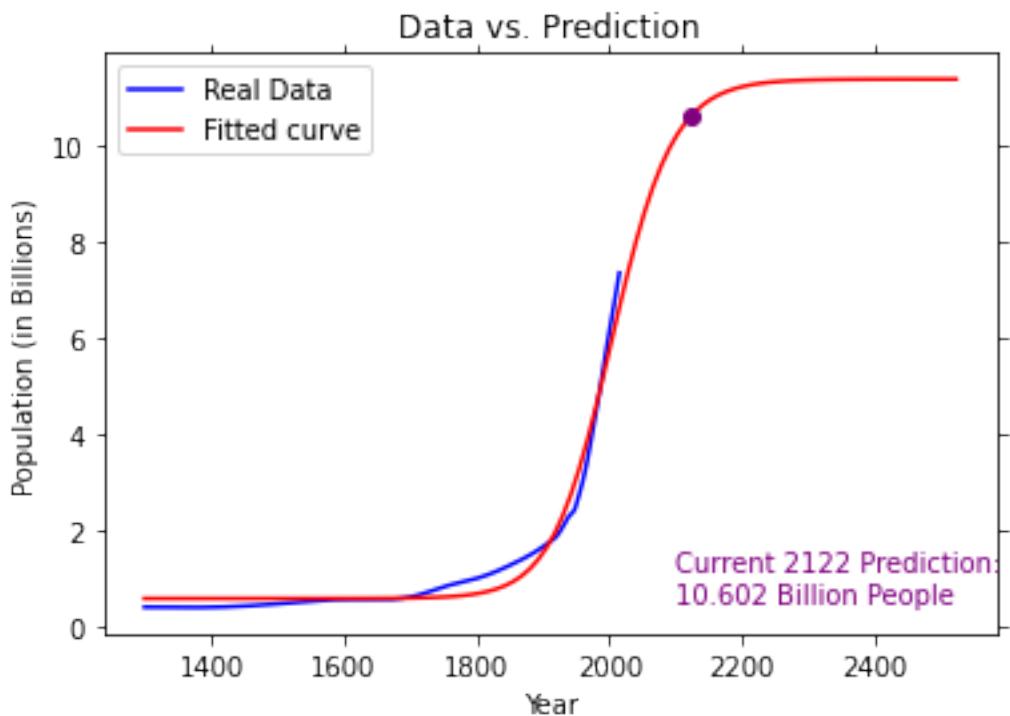
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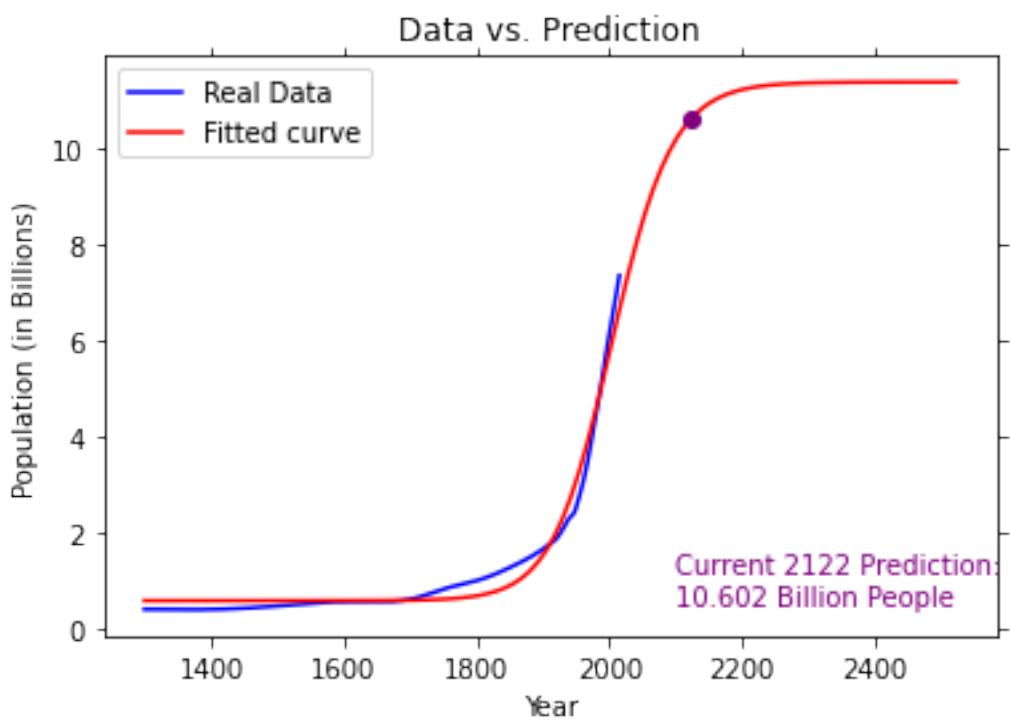
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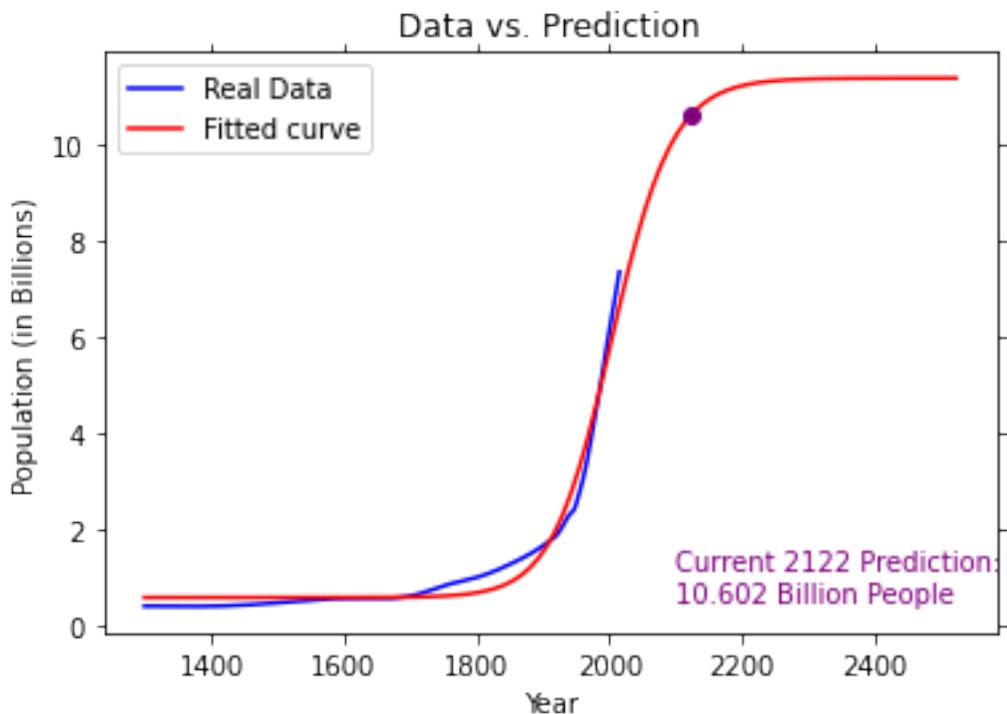
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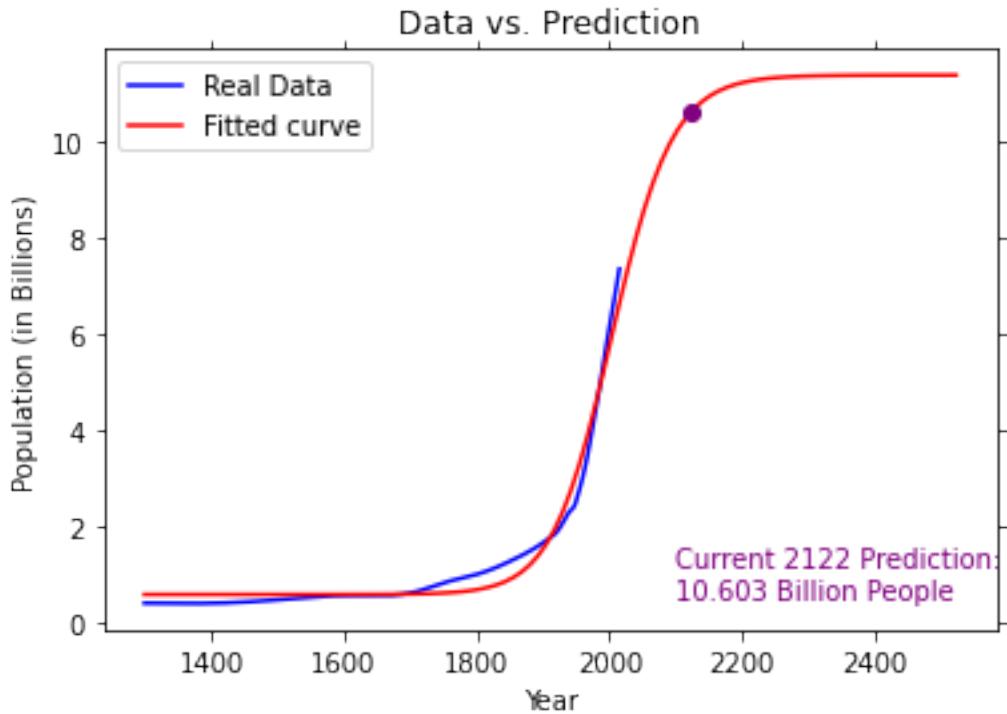
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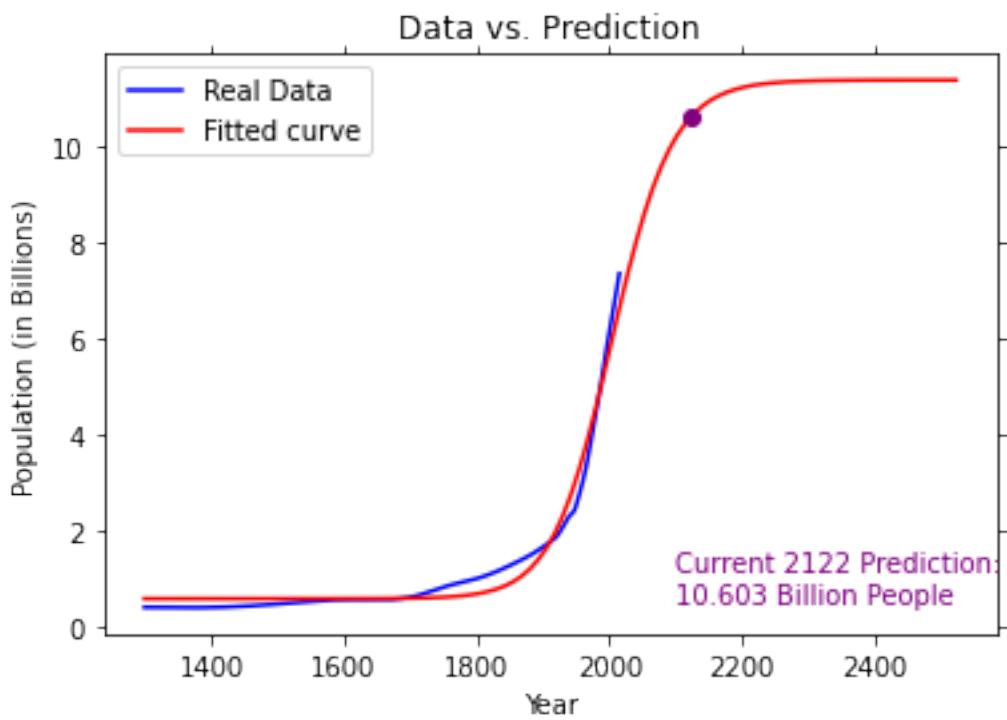
Iteration #31000, Loss: 0.05149883824758759



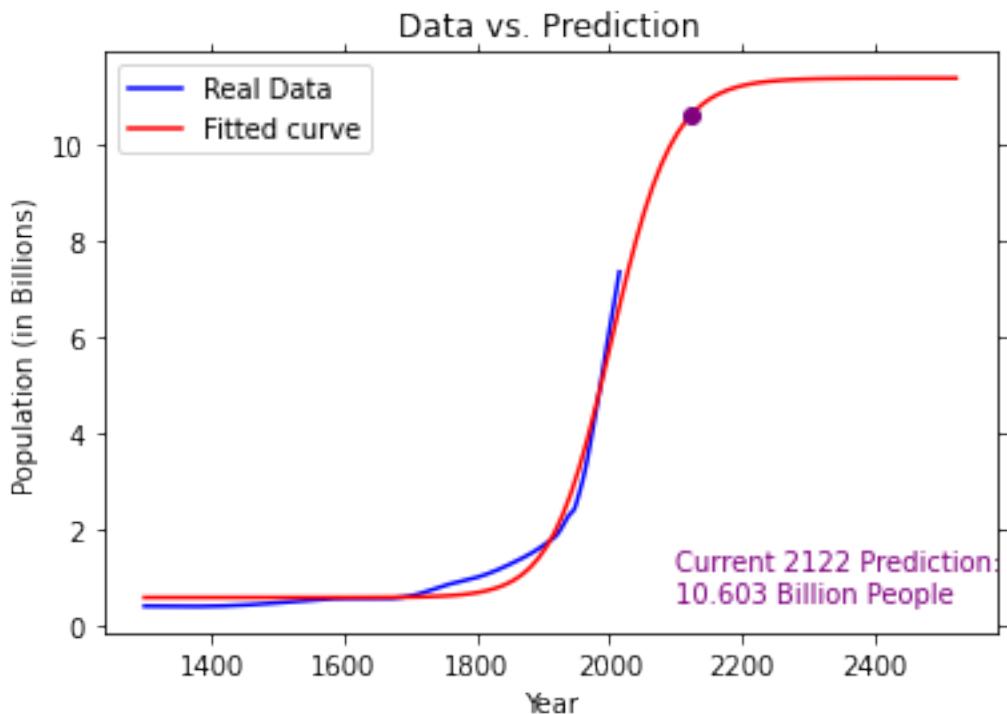
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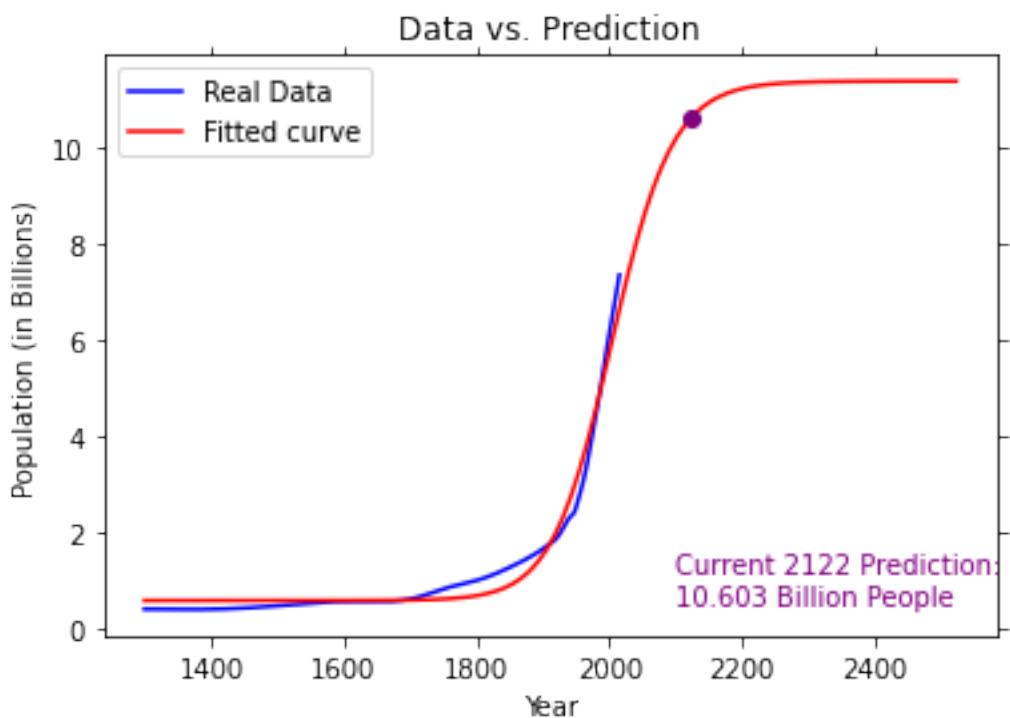
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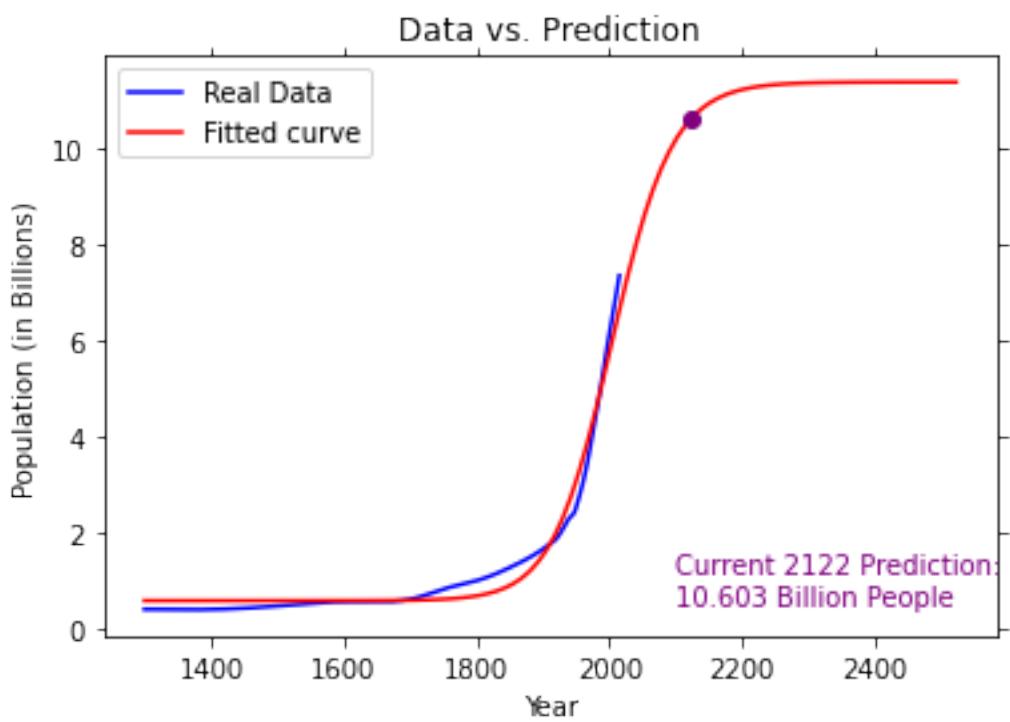
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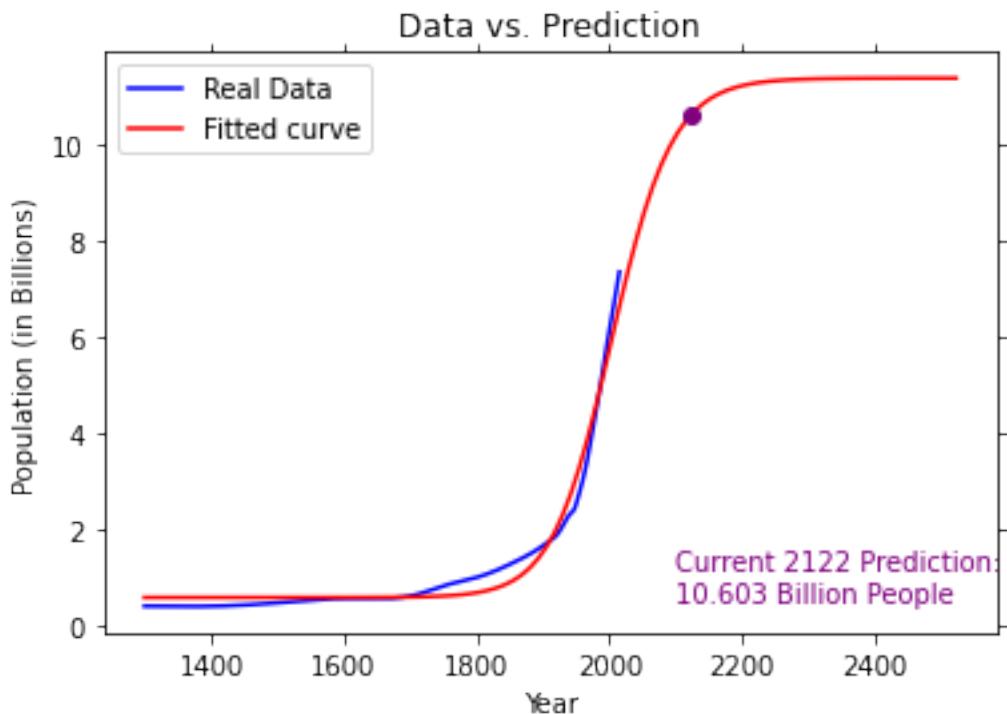
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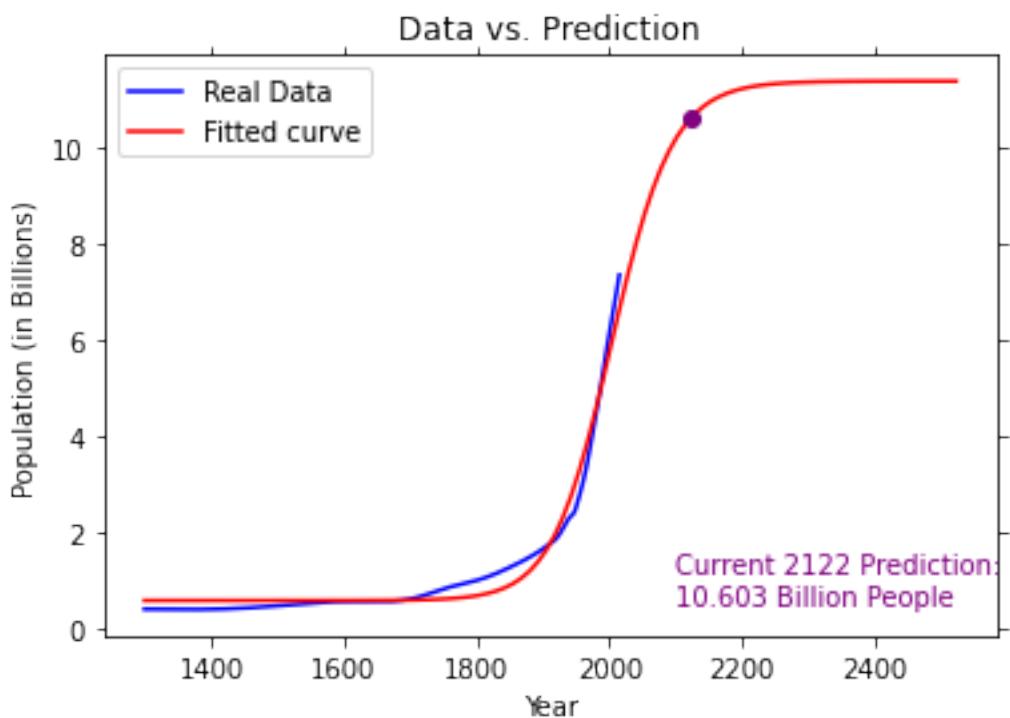
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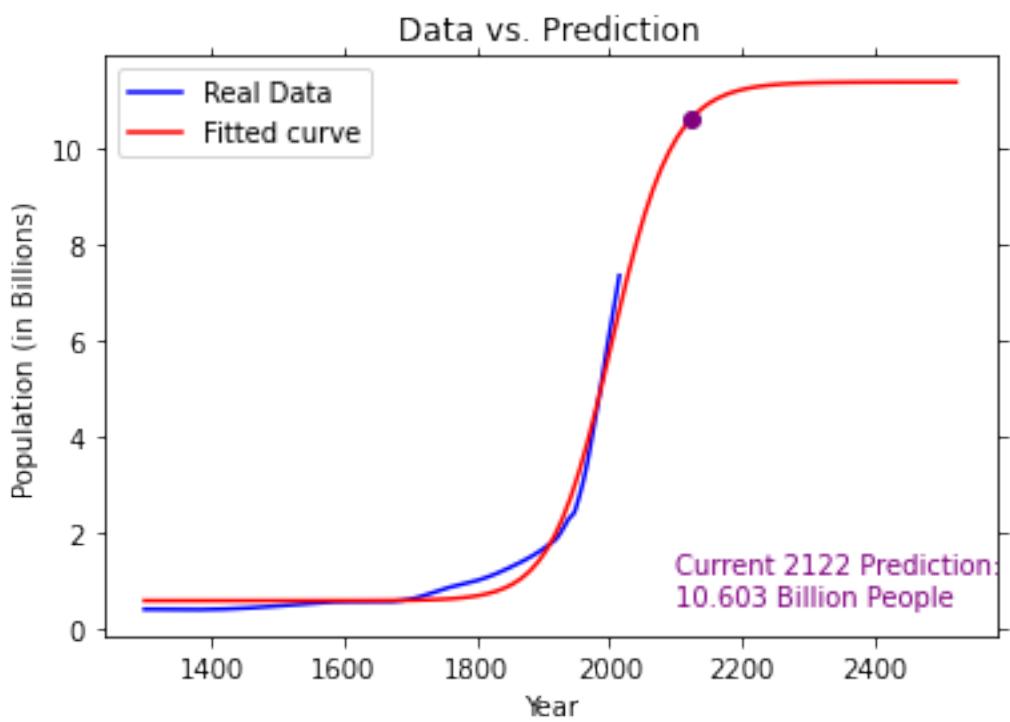
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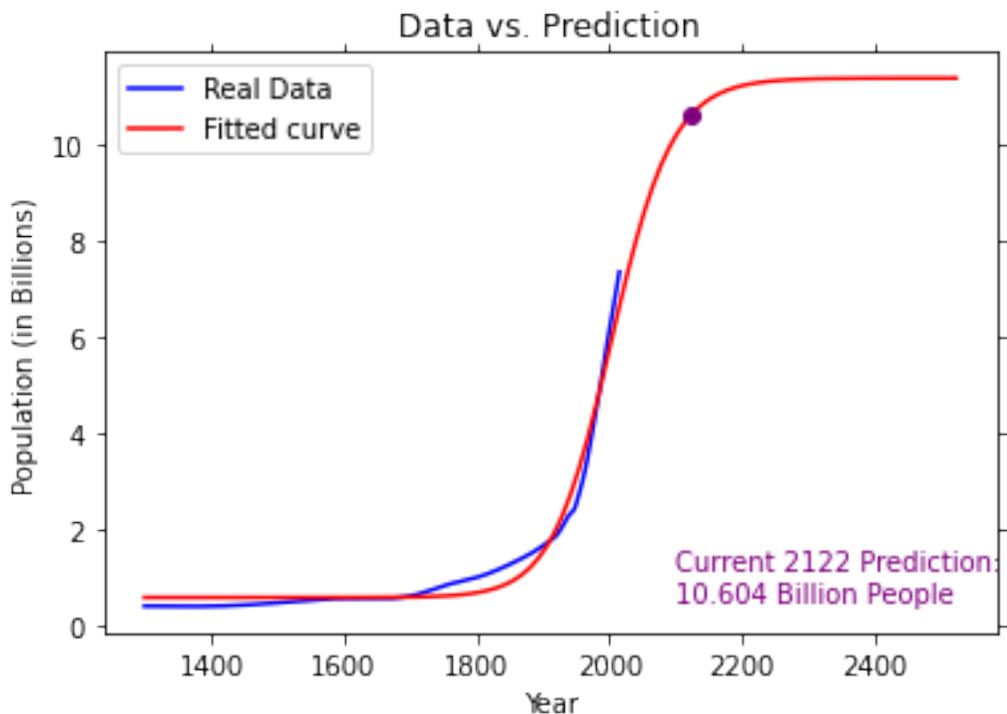
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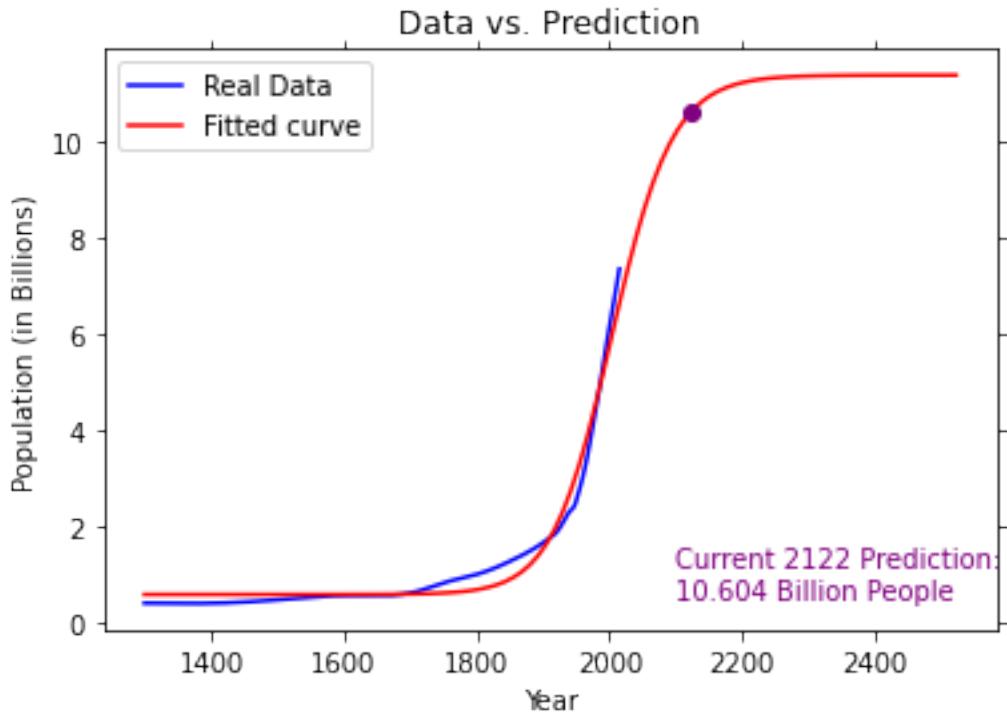
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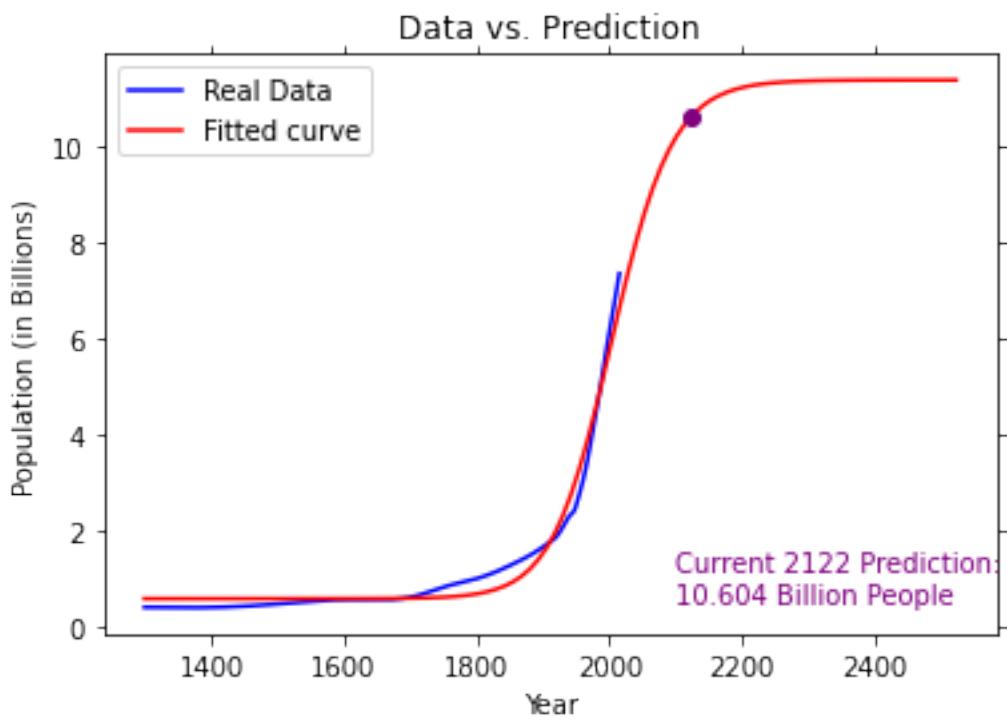
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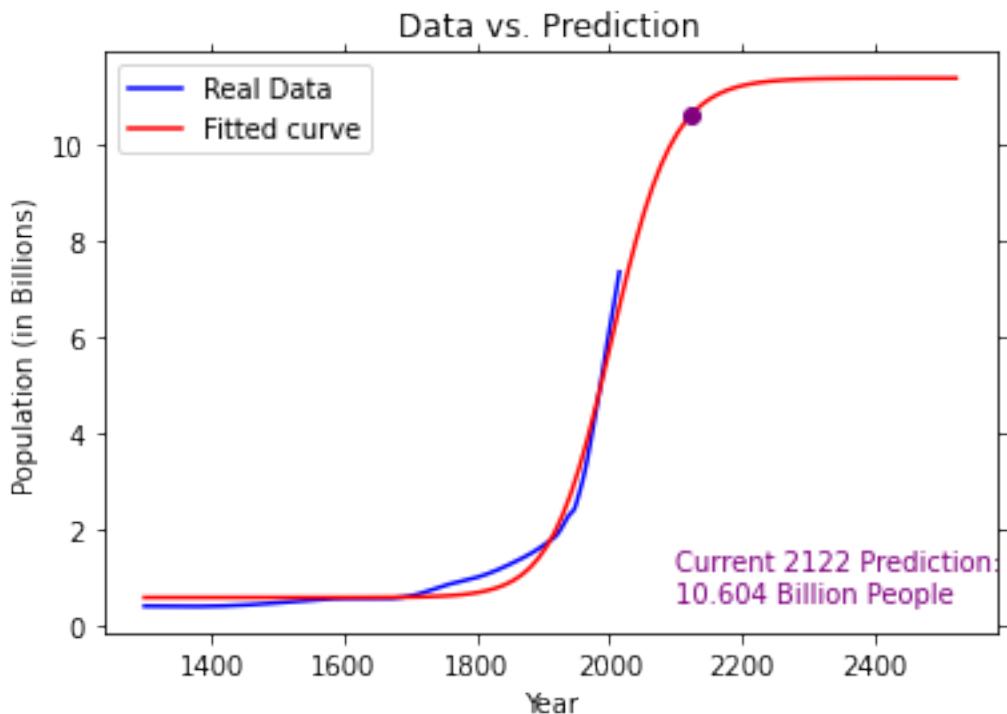
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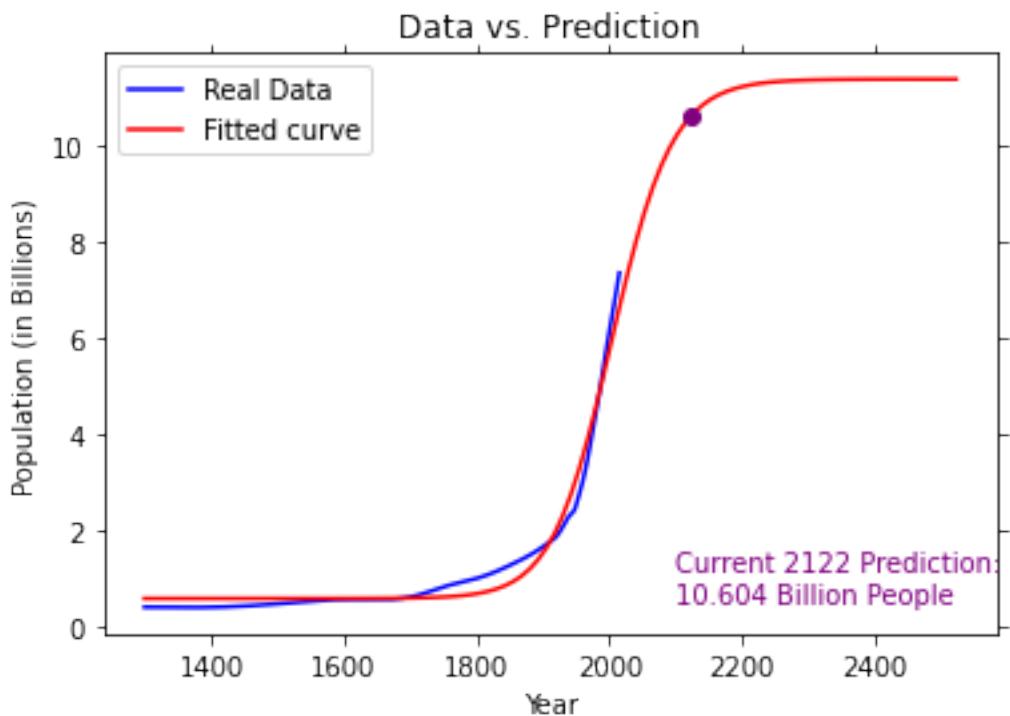
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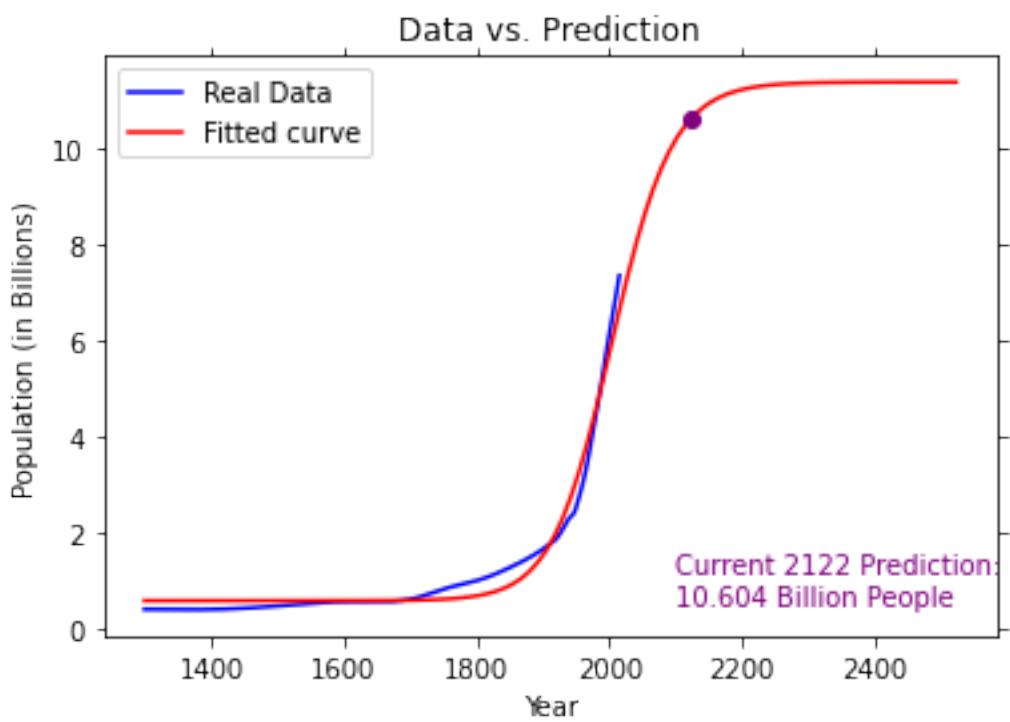
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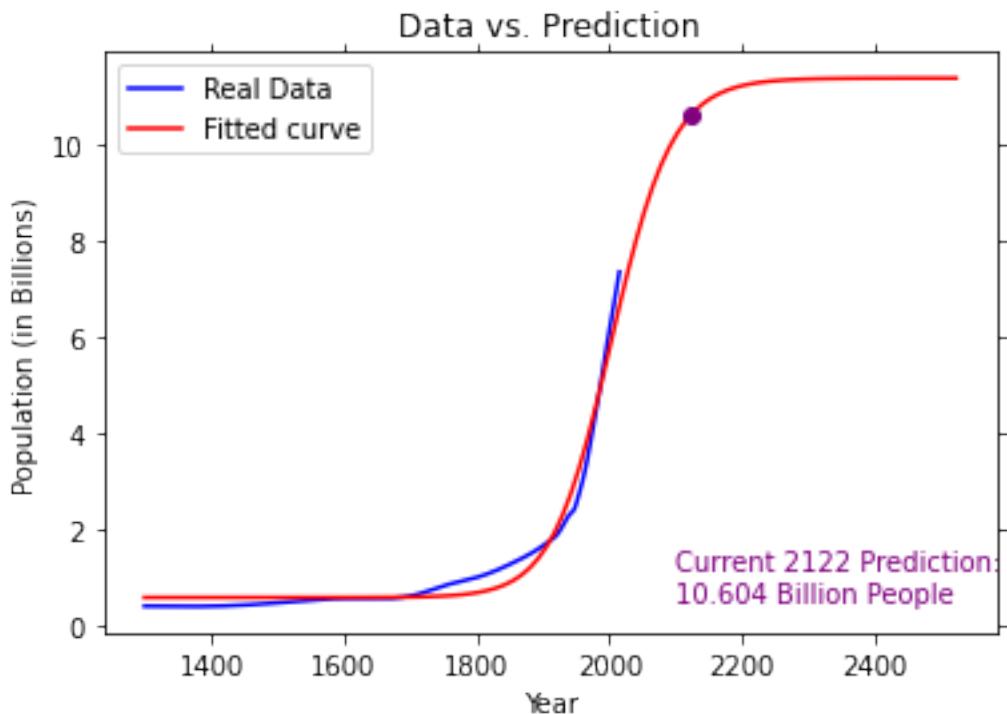
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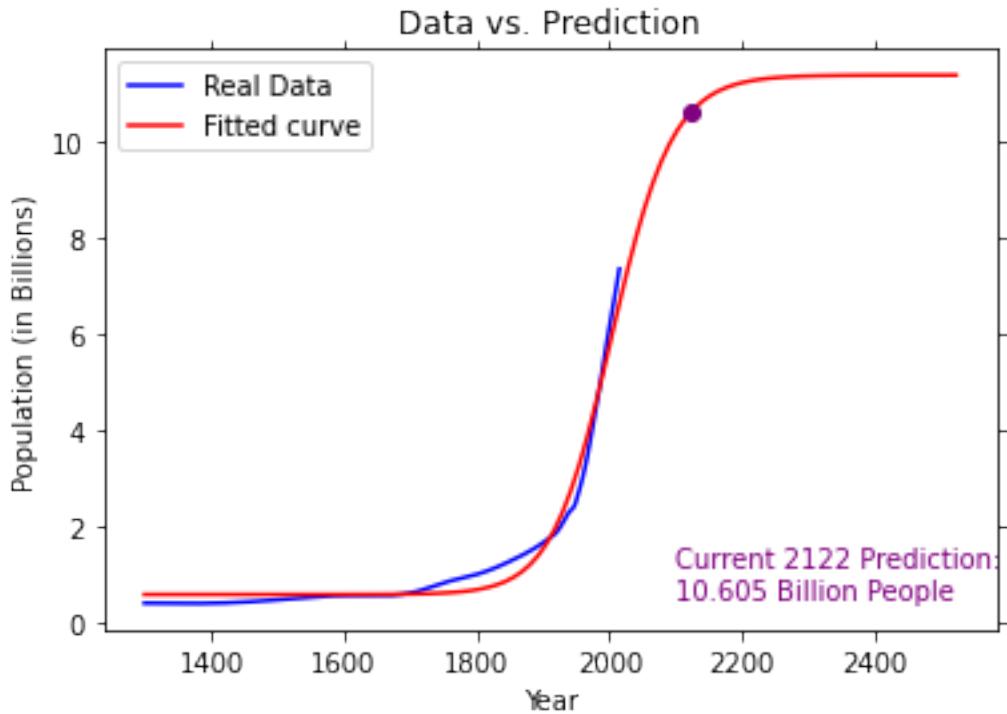
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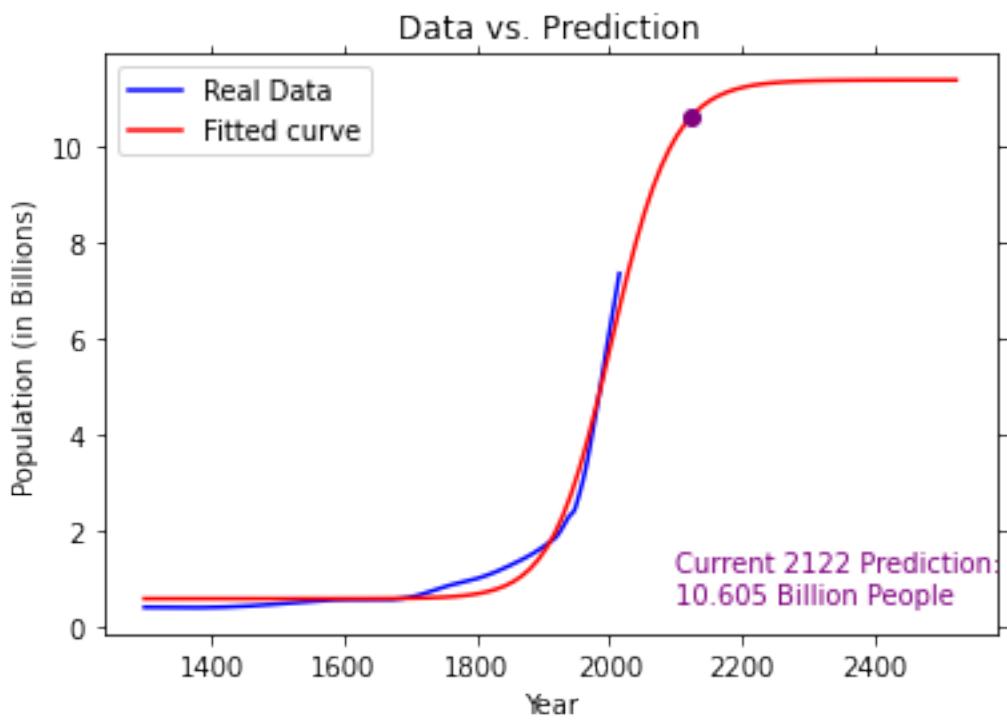
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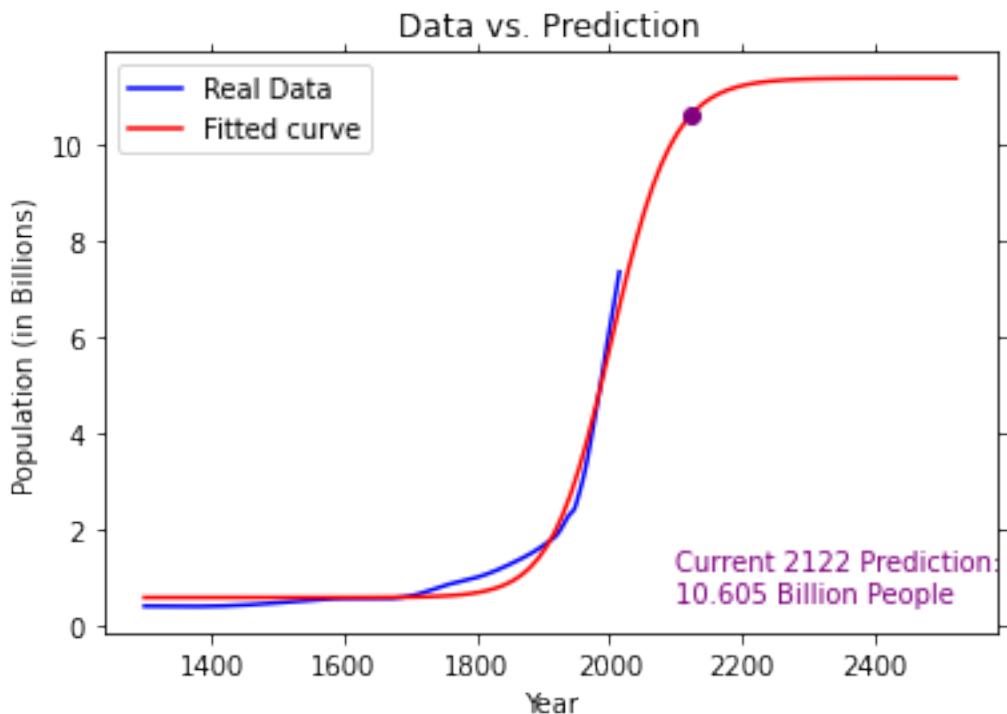
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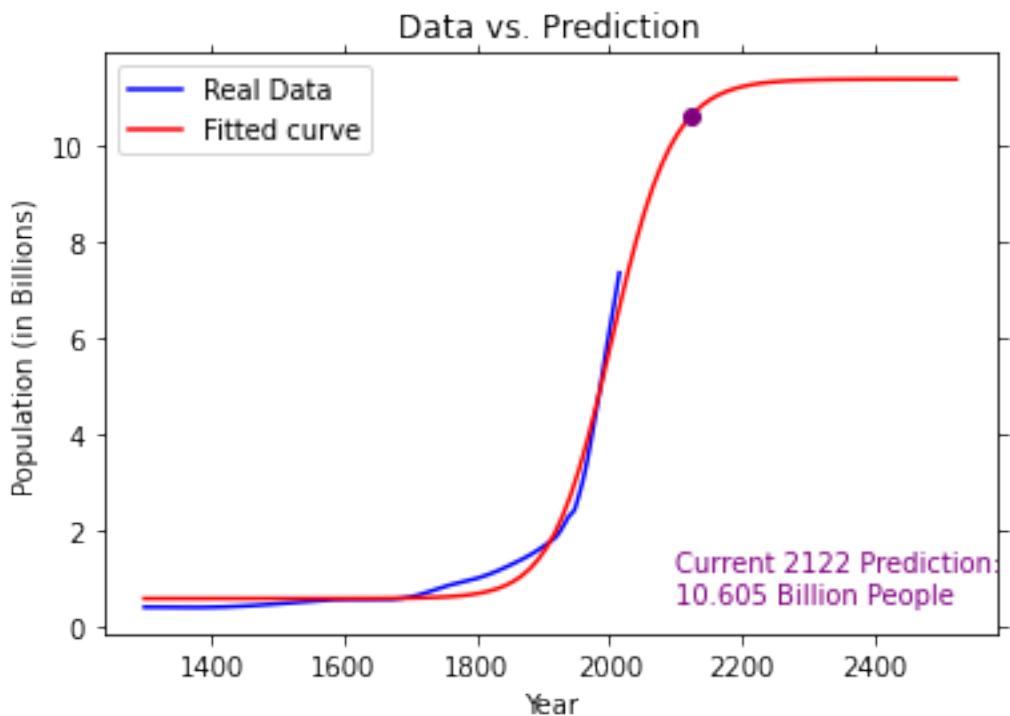
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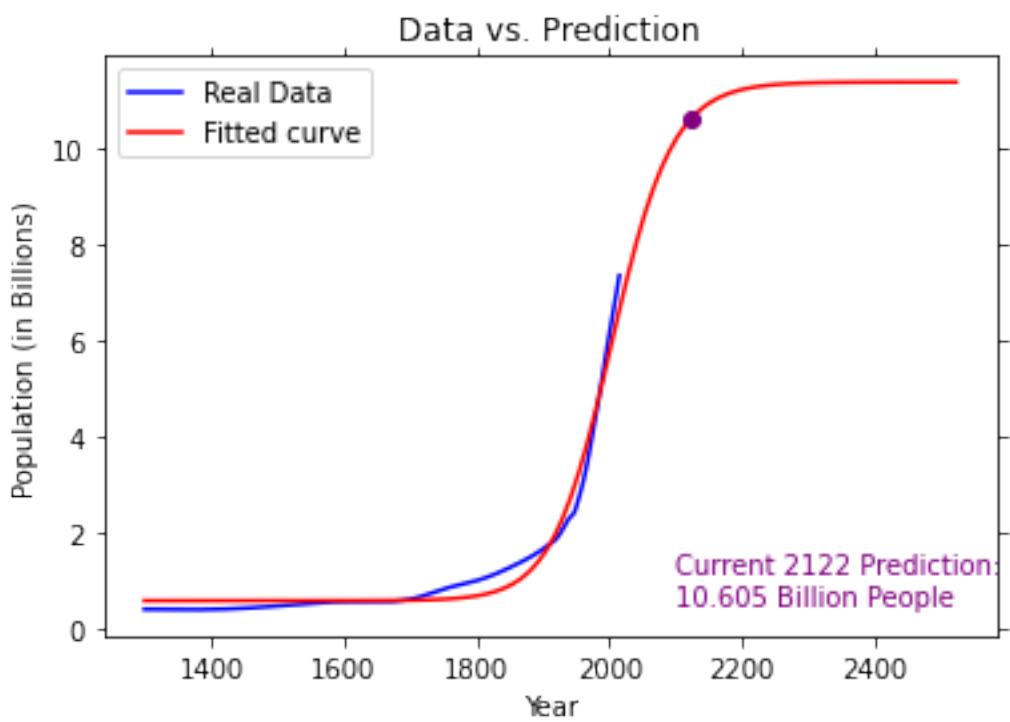
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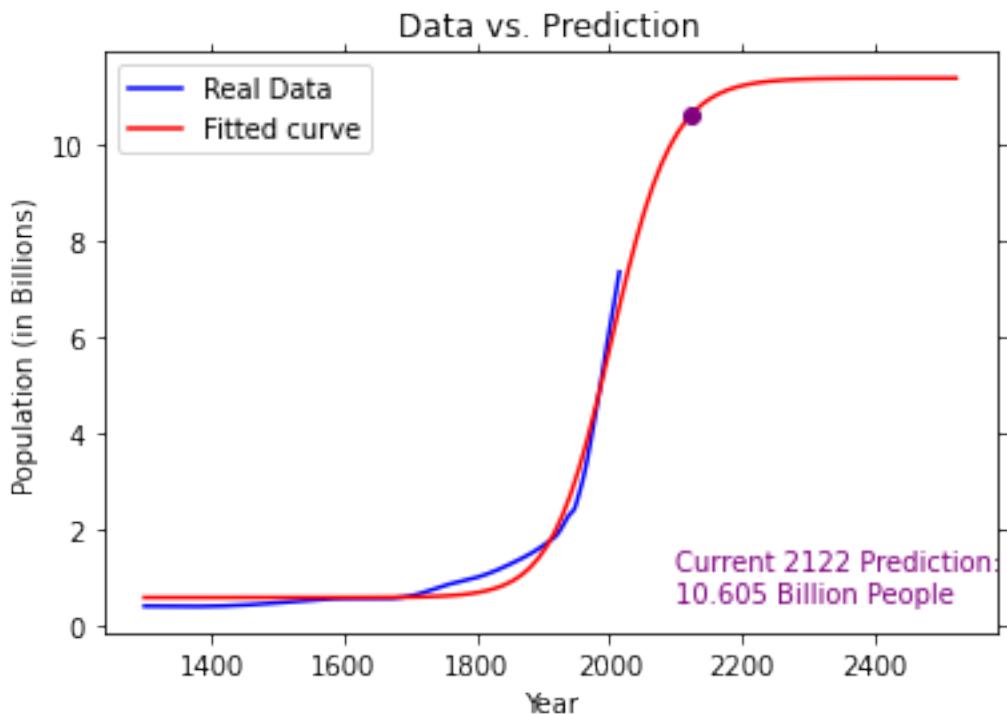
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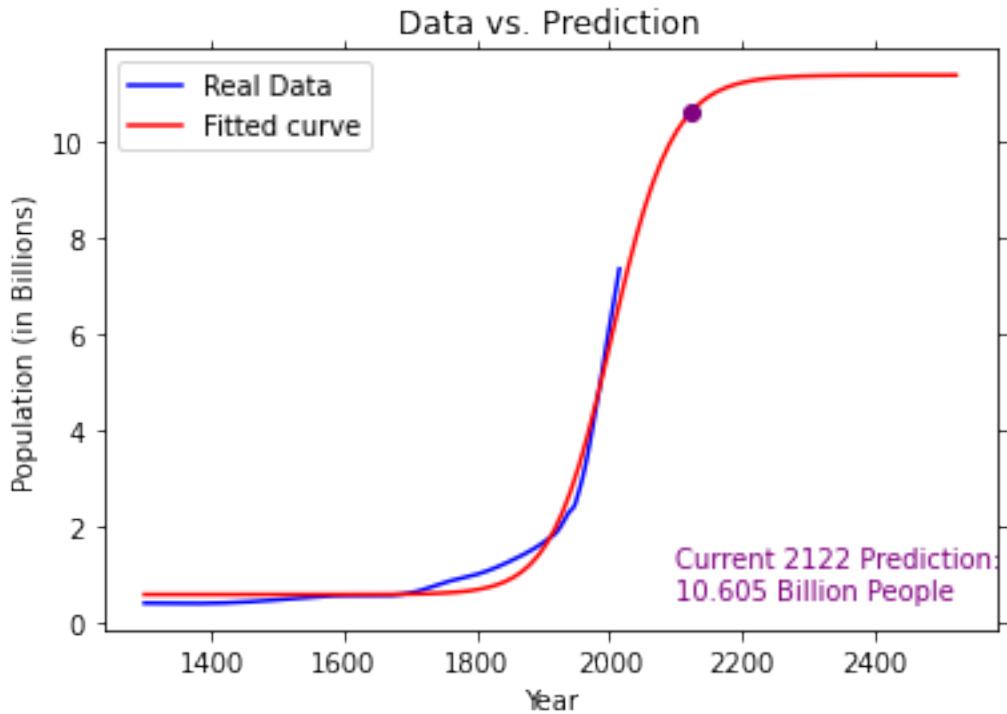
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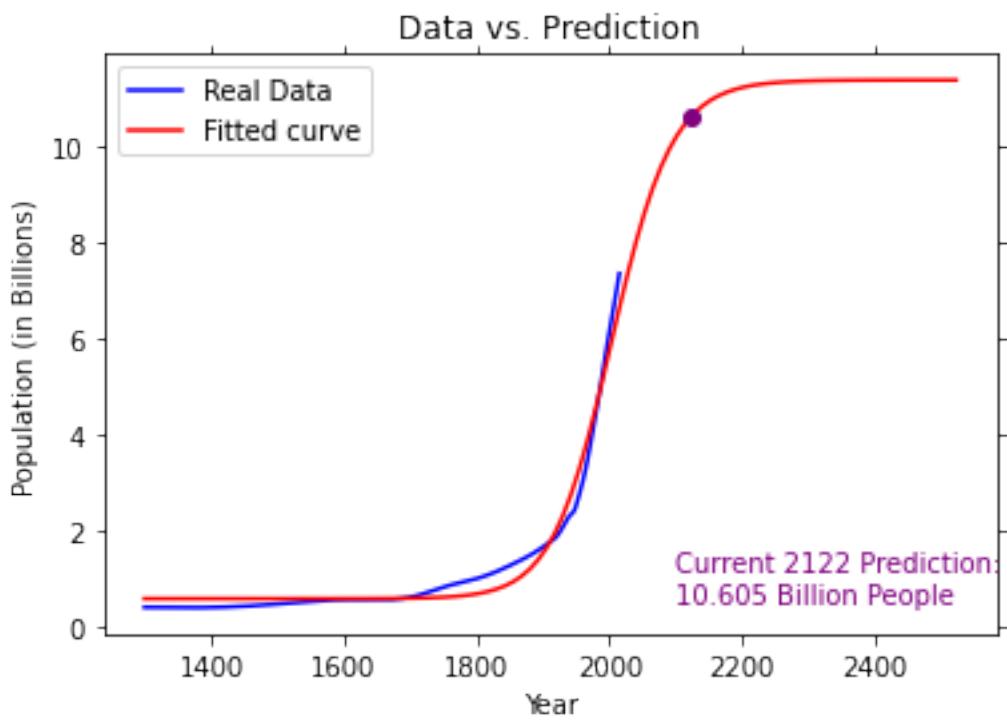
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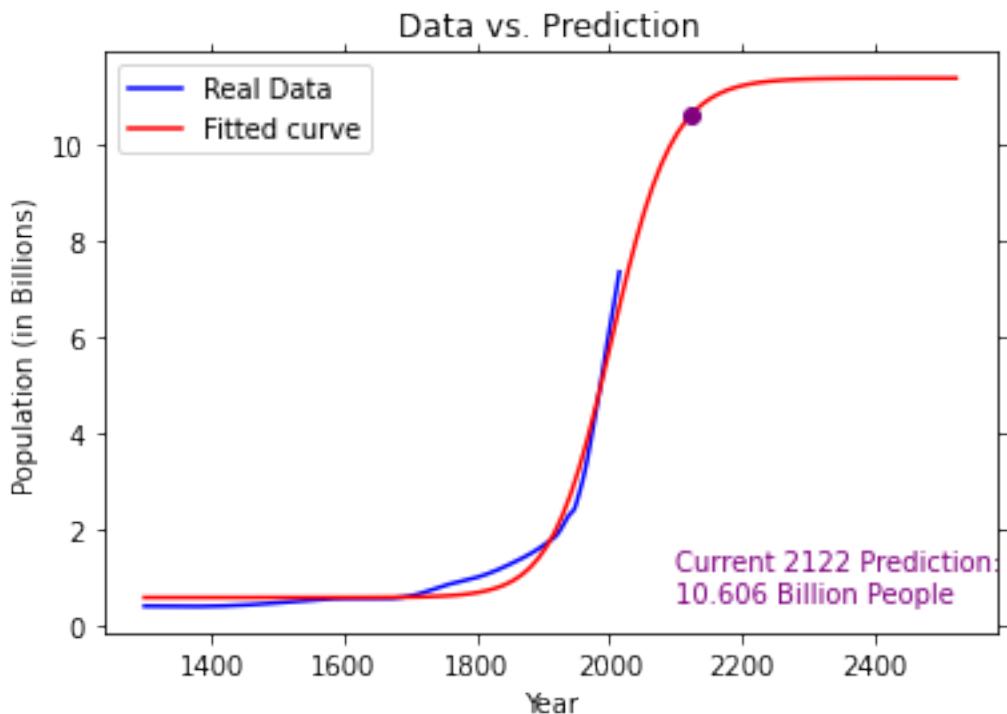
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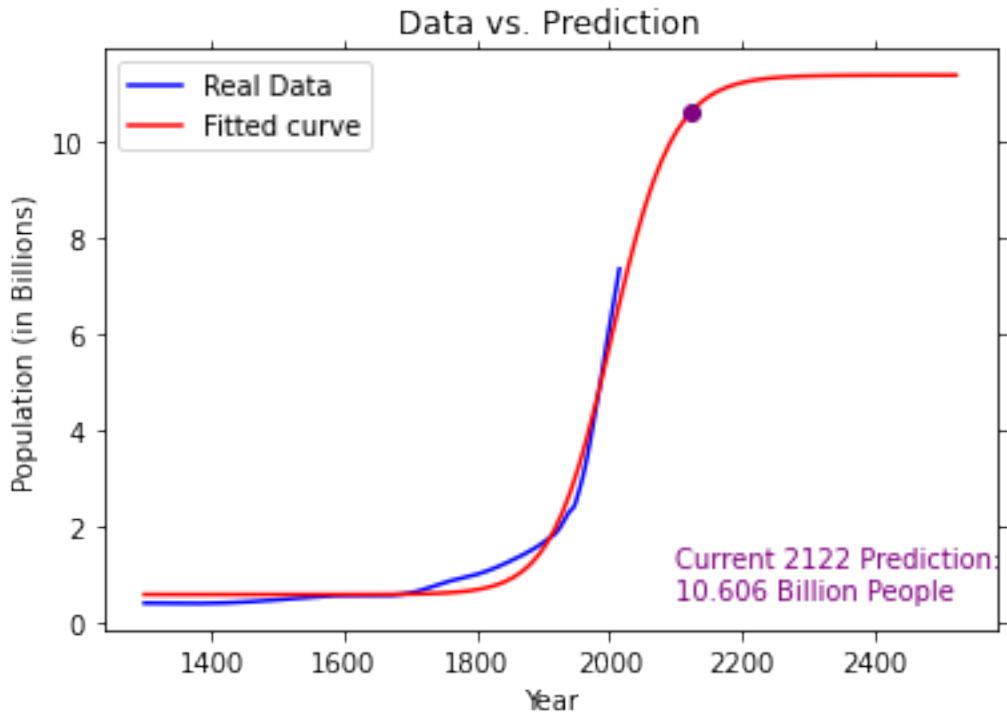
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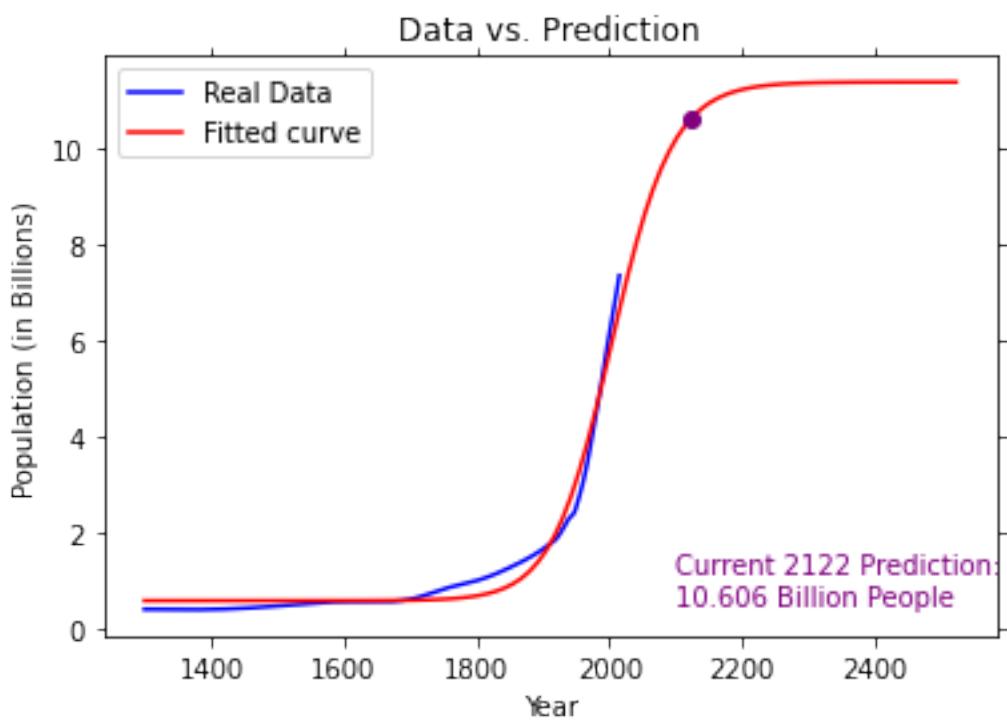
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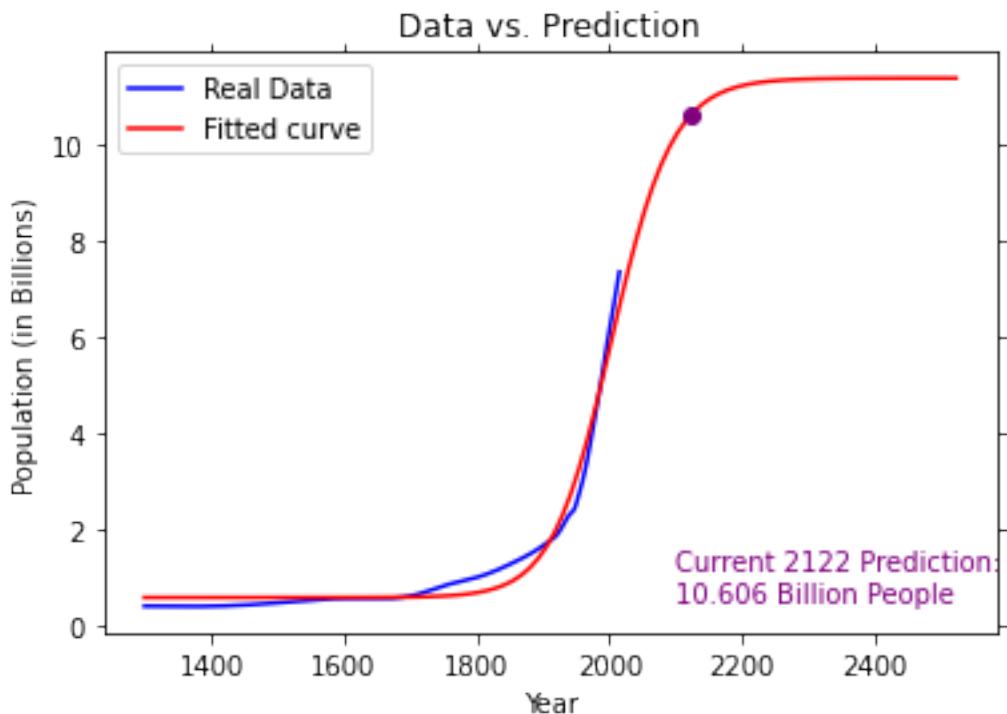
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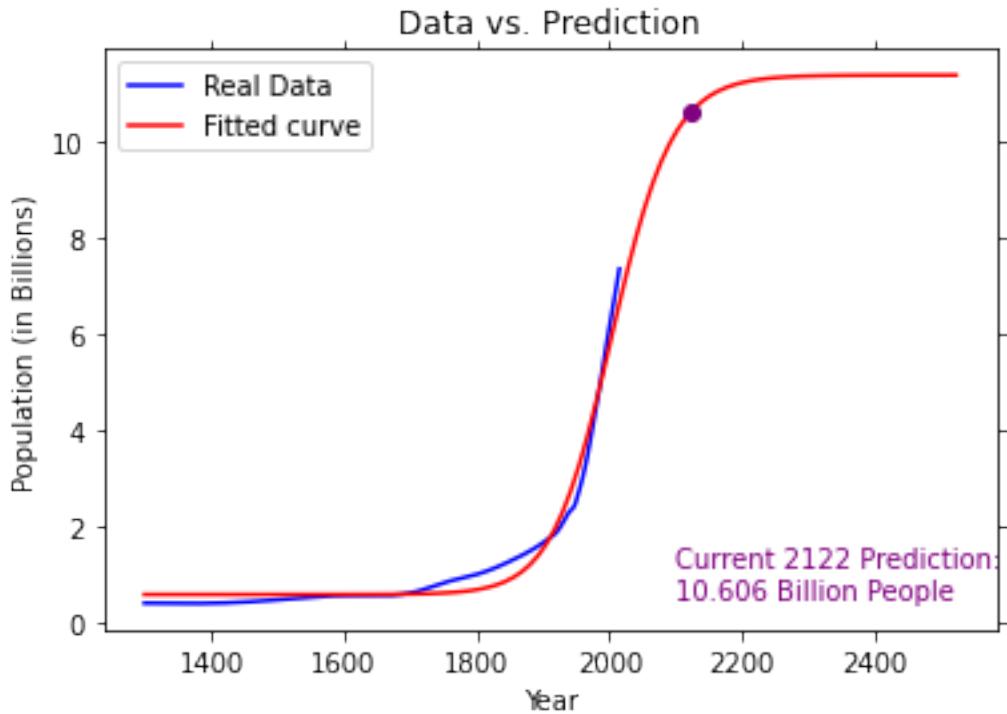
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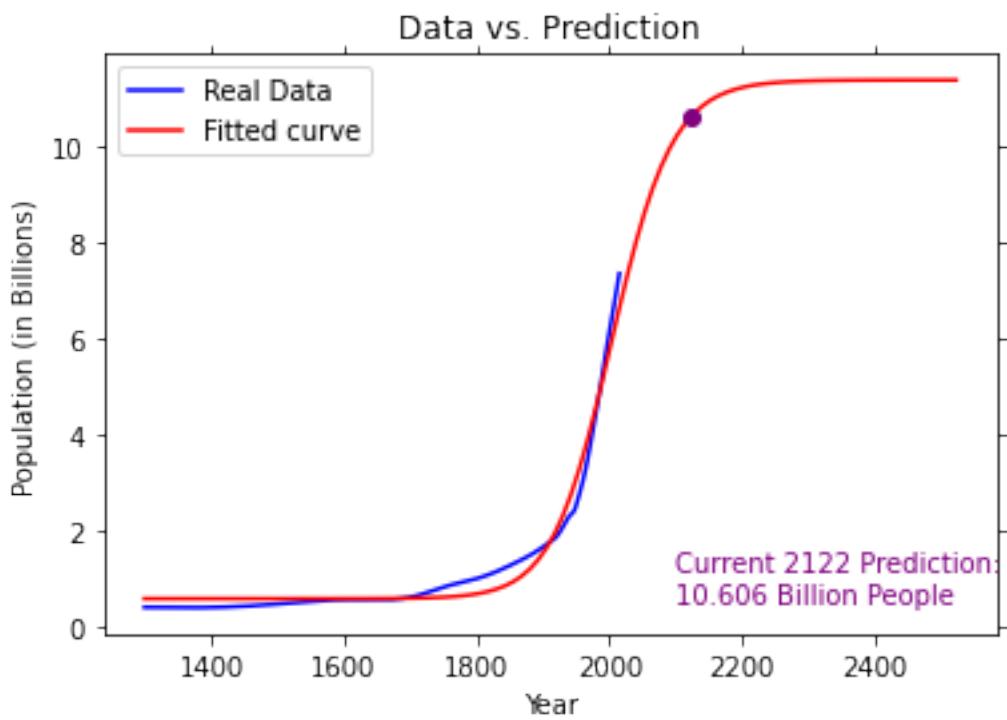
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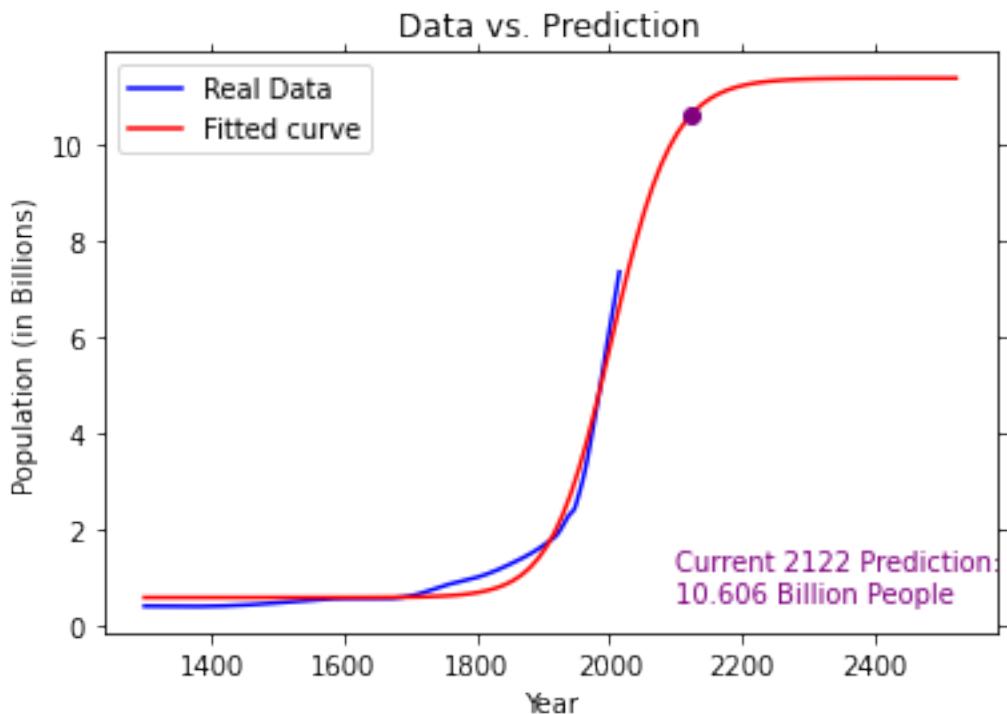
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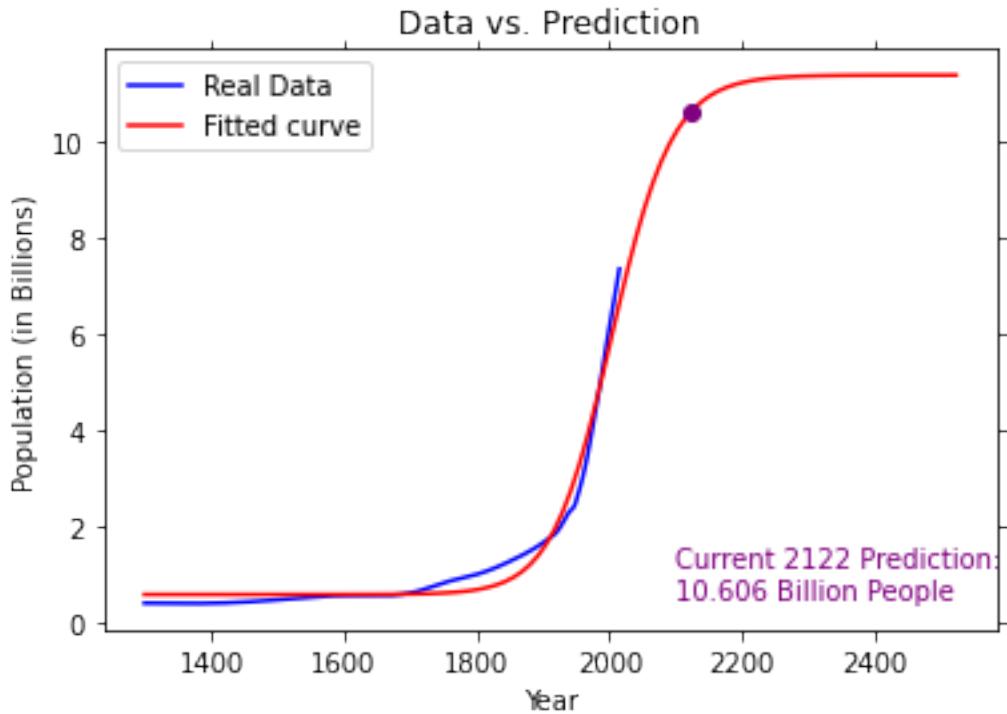
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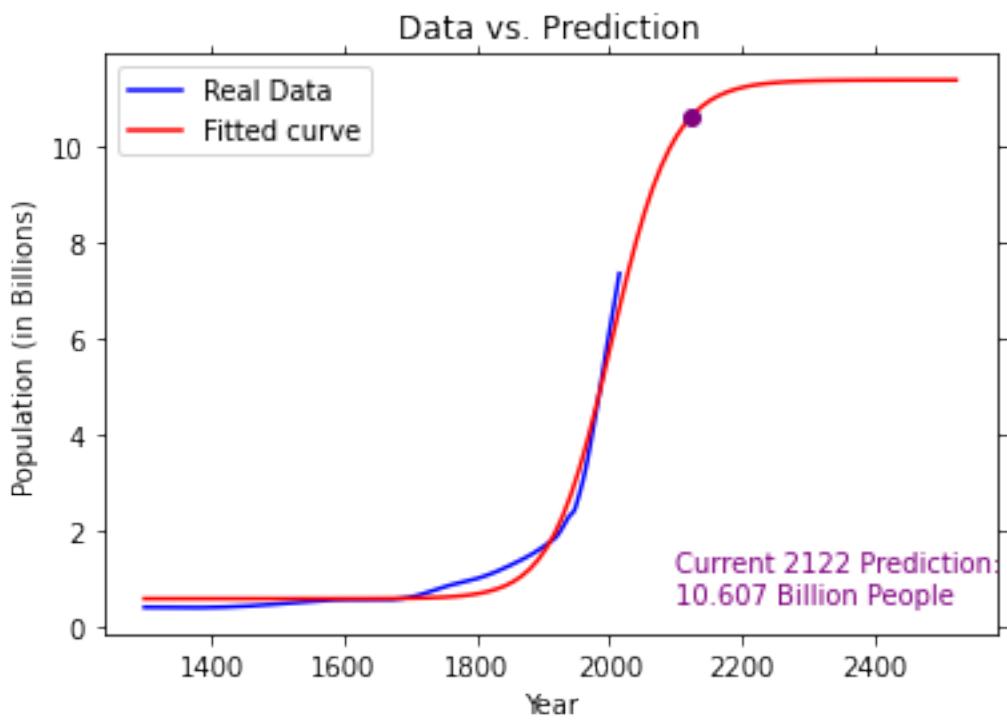
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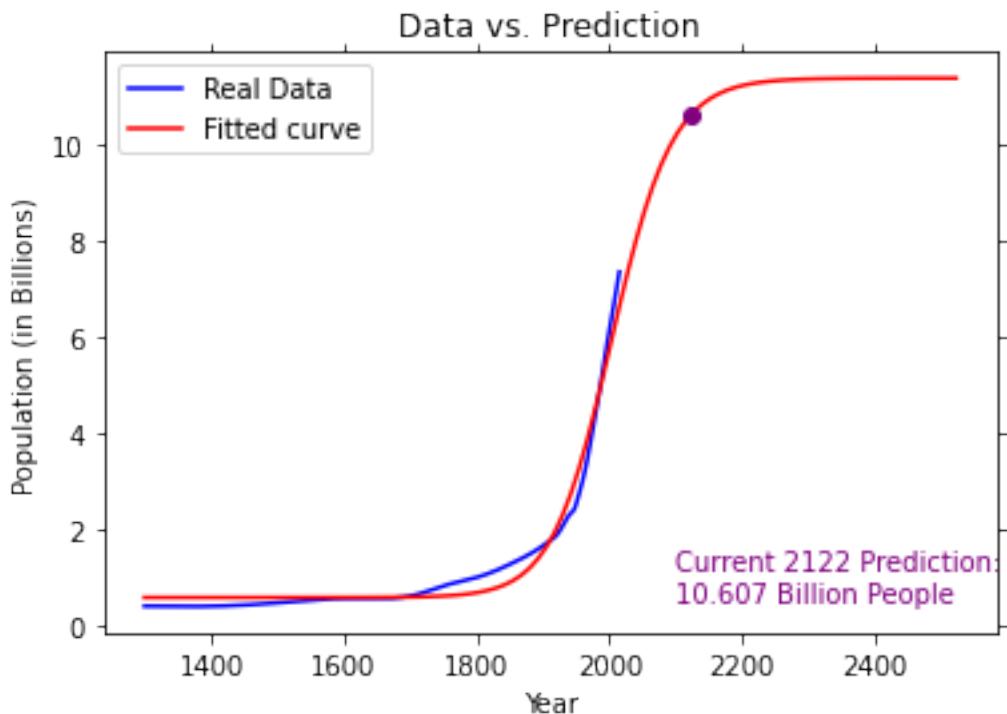
Iteration #32550, Loss: 0.0513270598628574



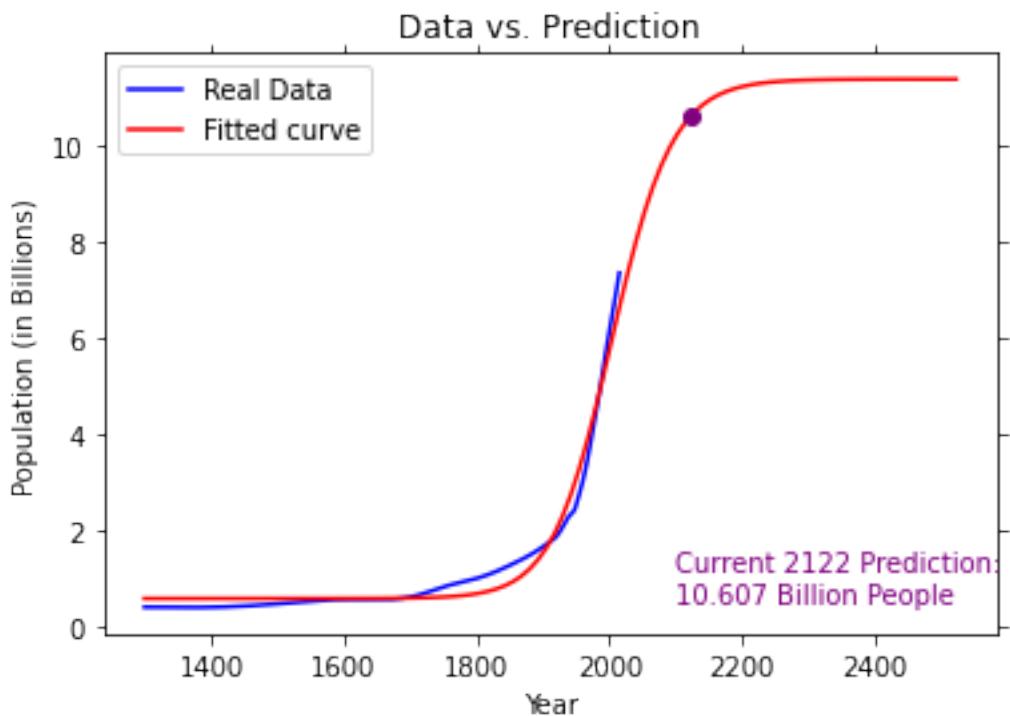
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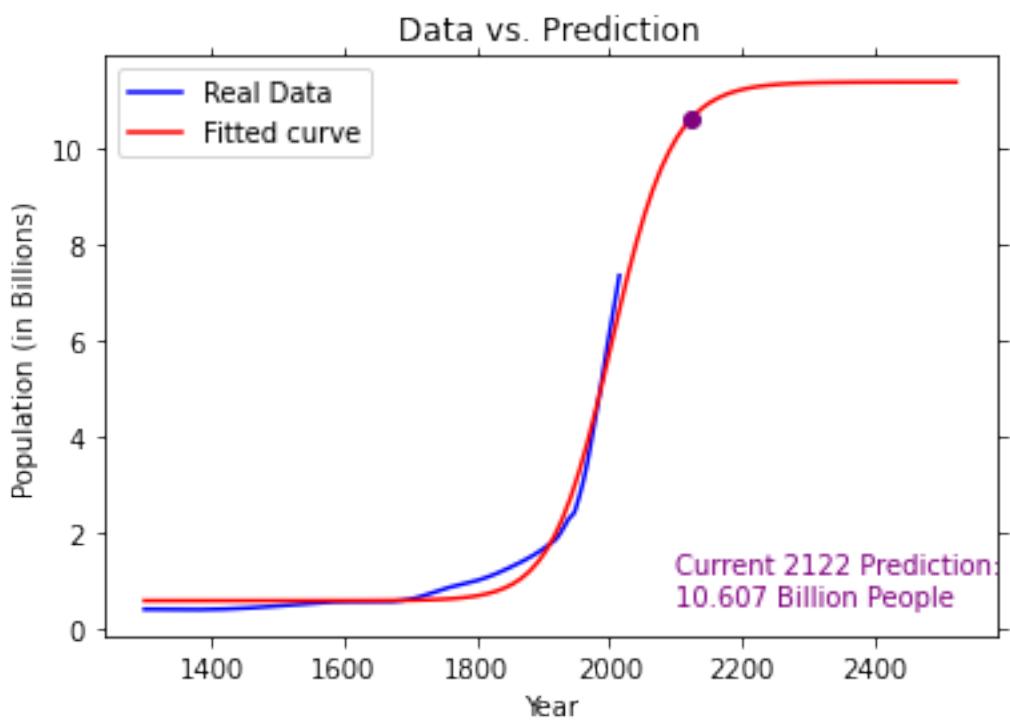
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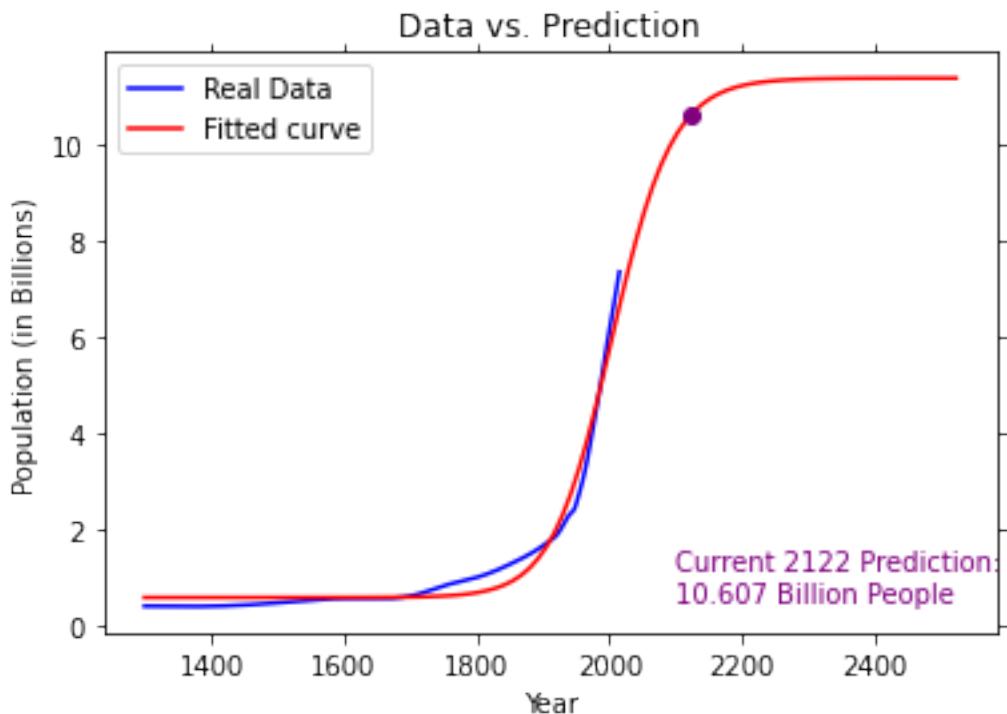
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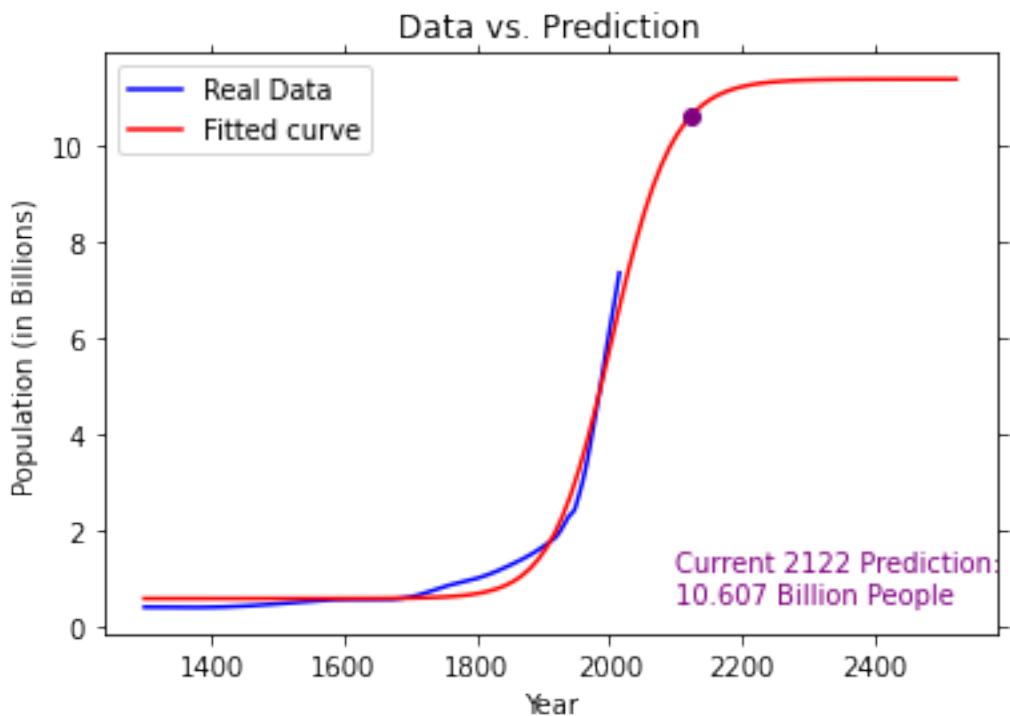
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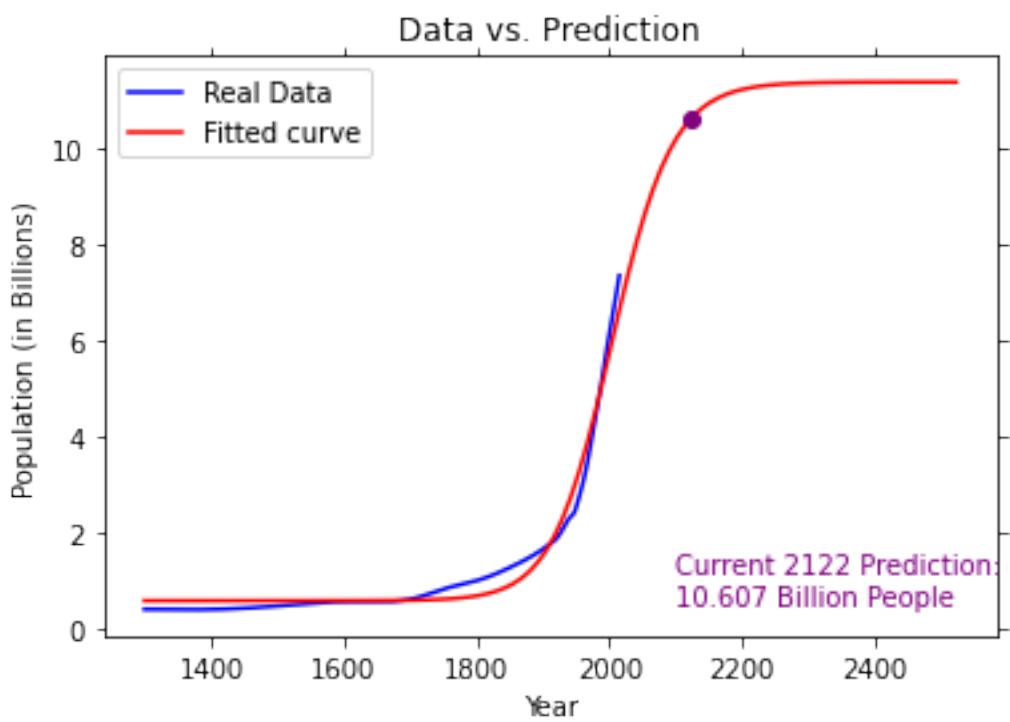
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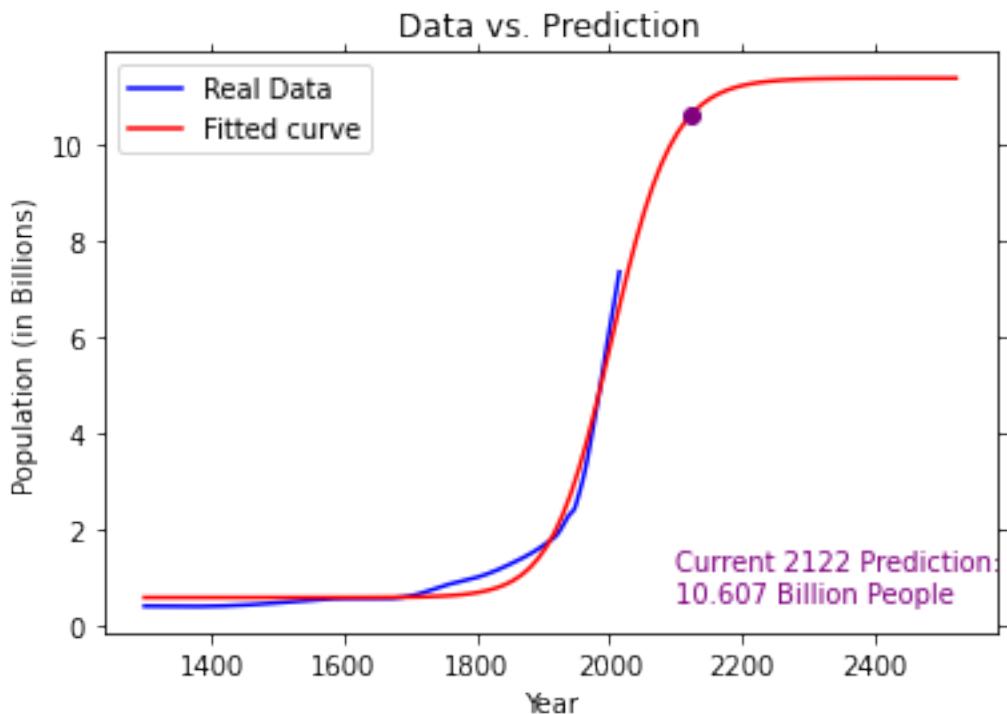
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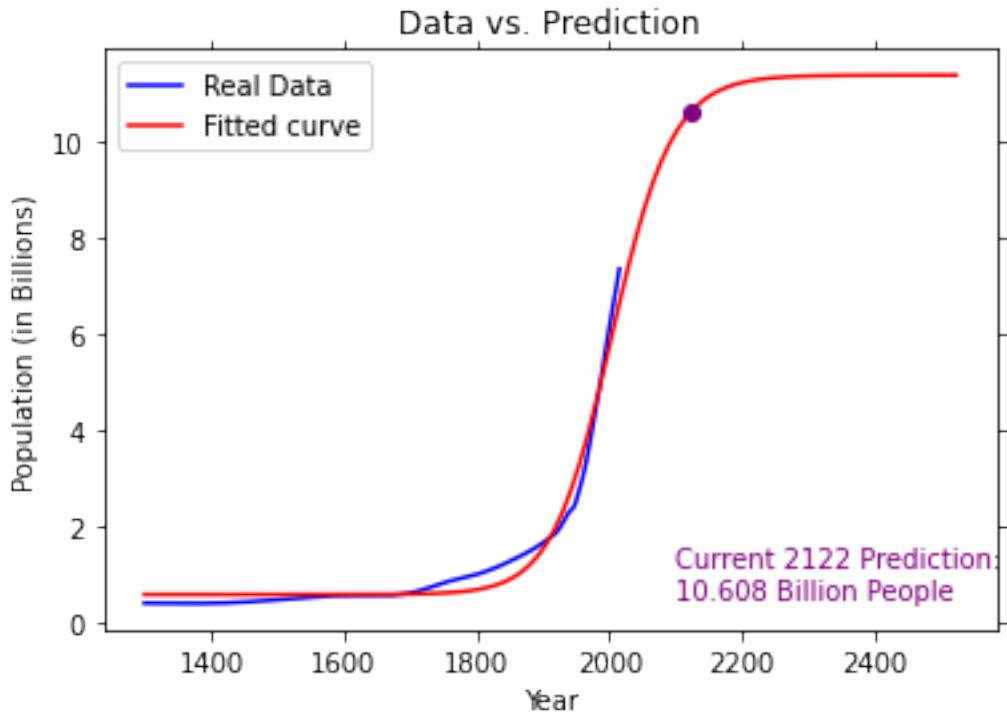
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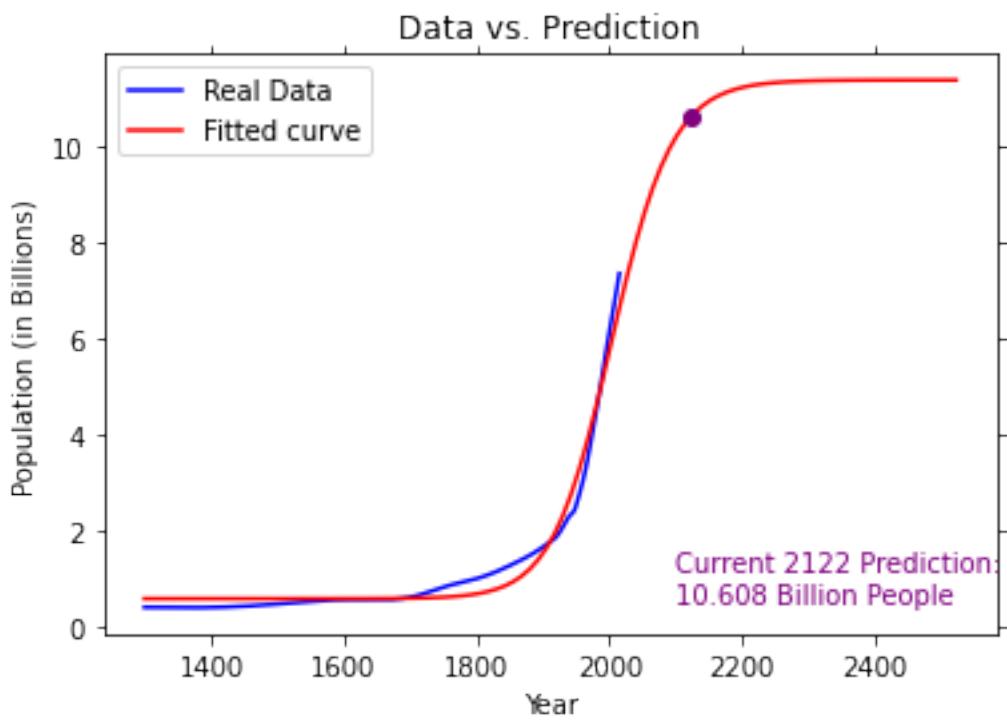
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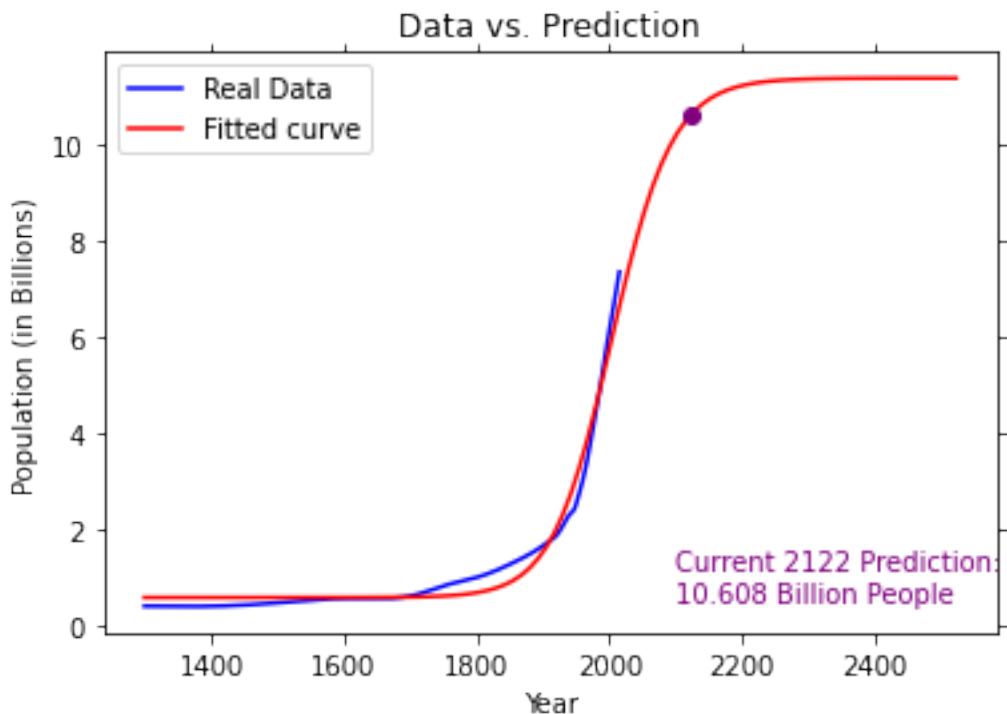
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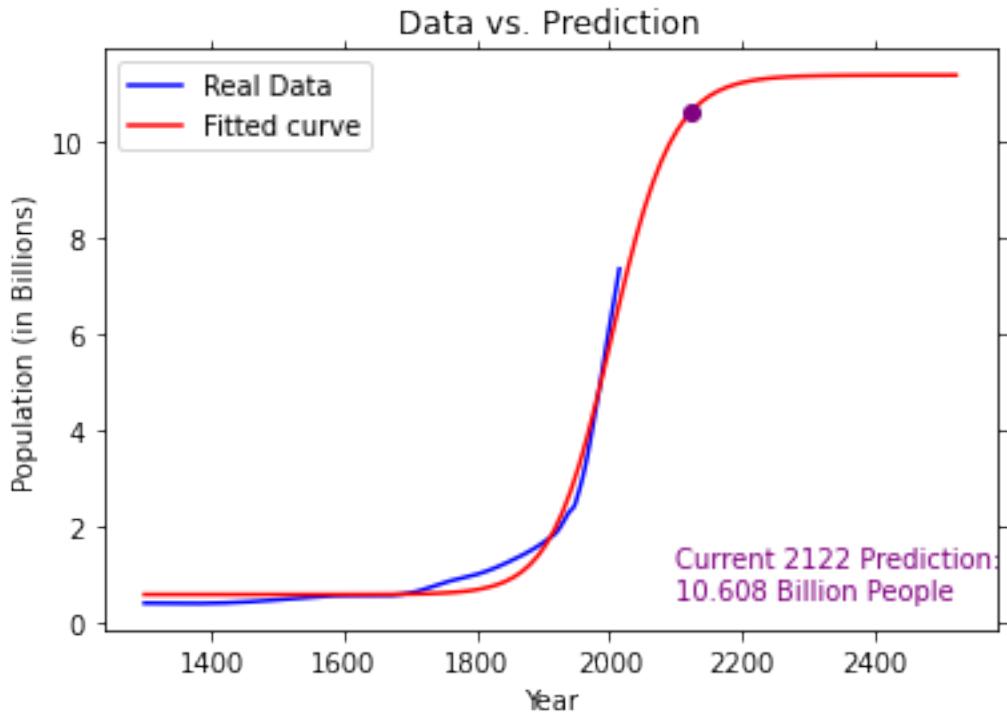
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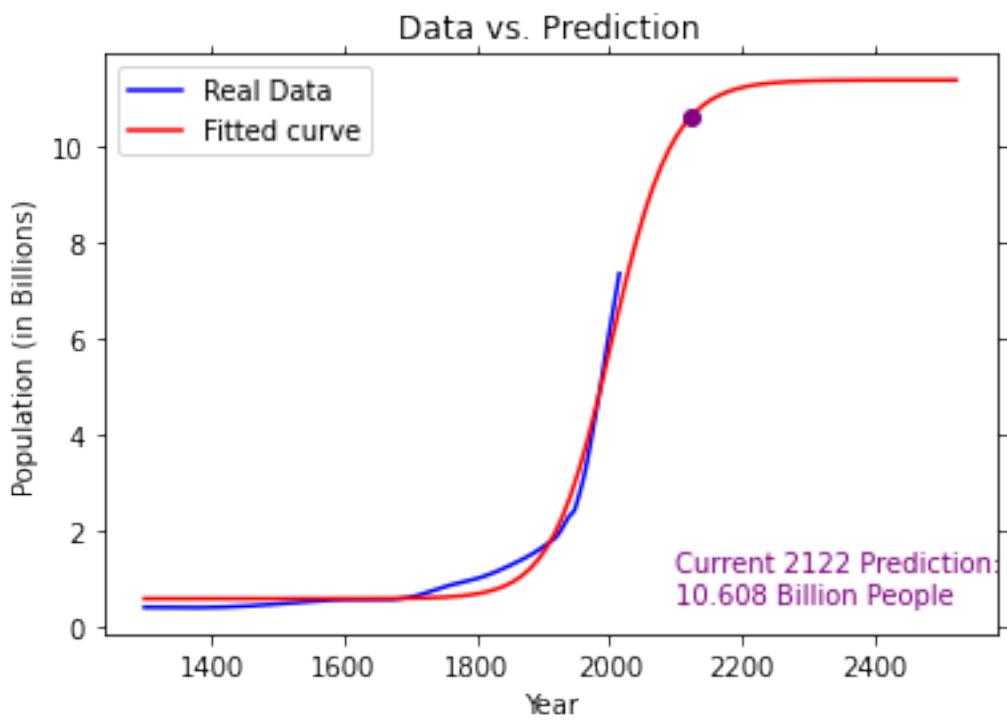
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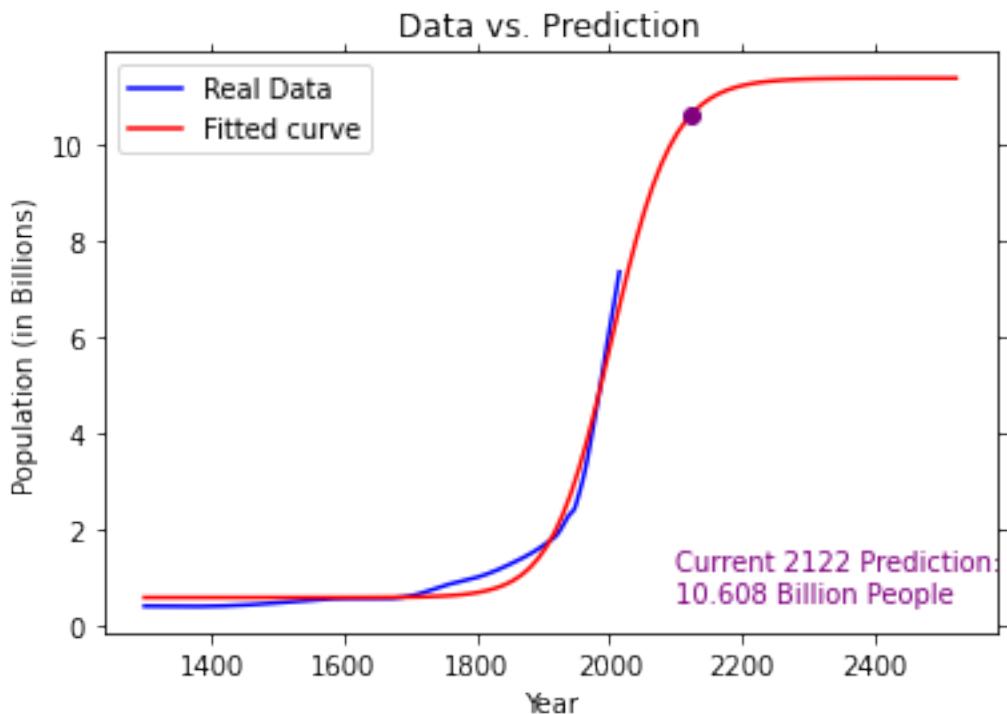
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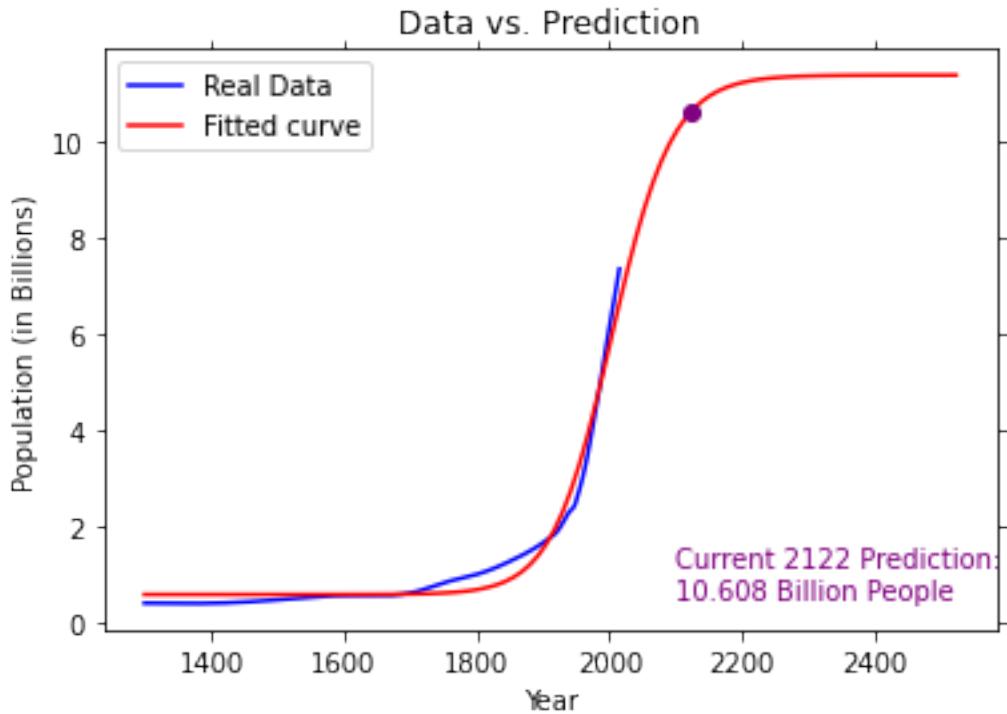
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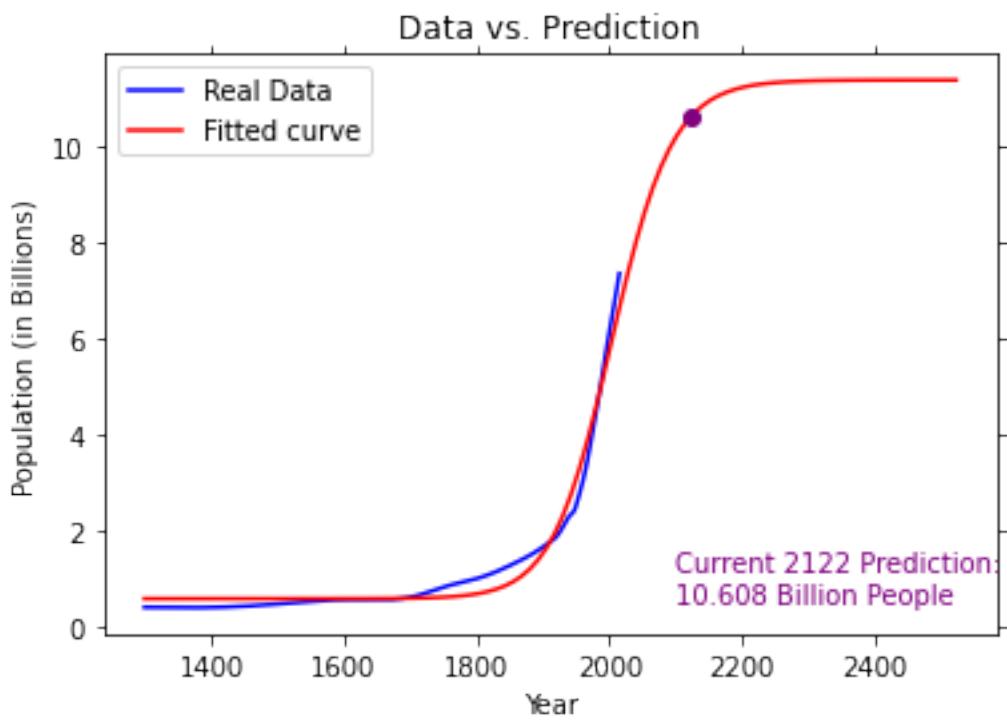
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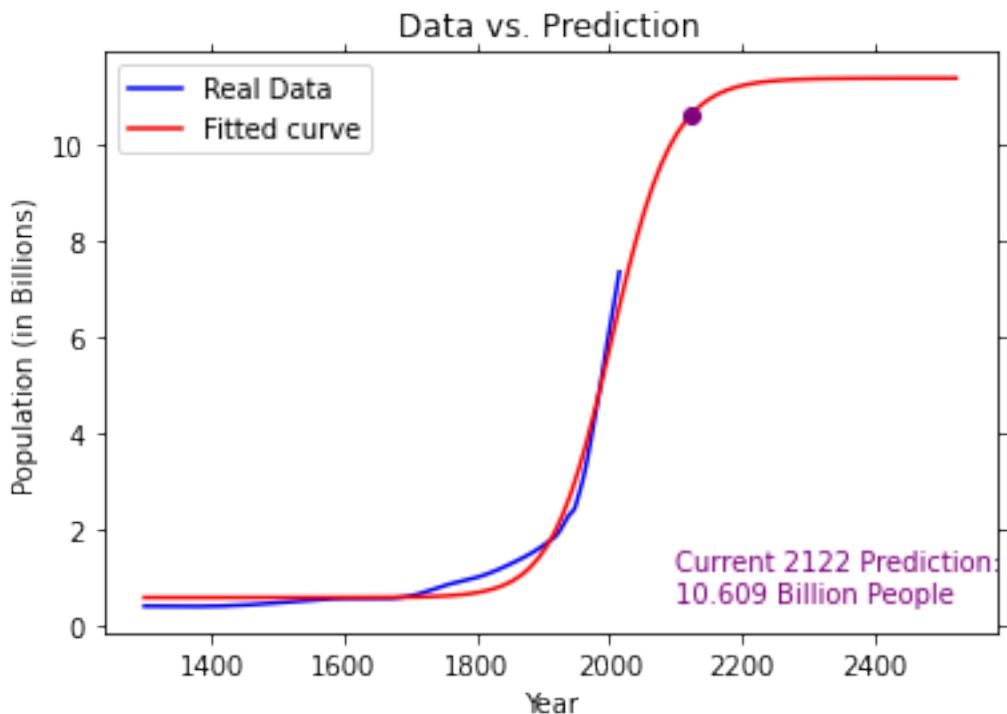
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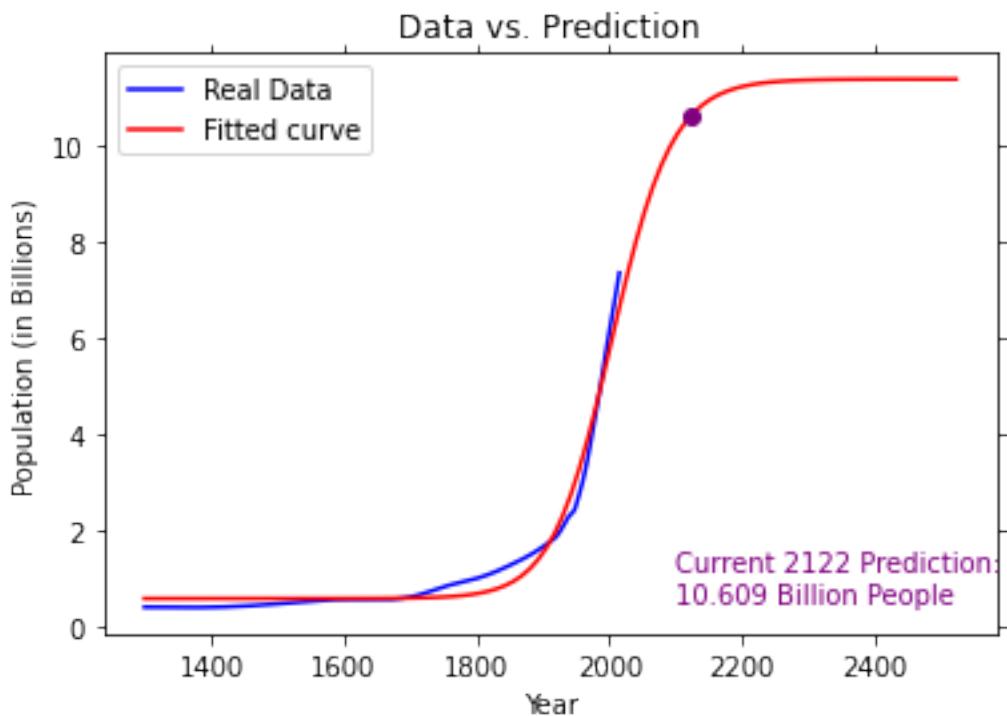
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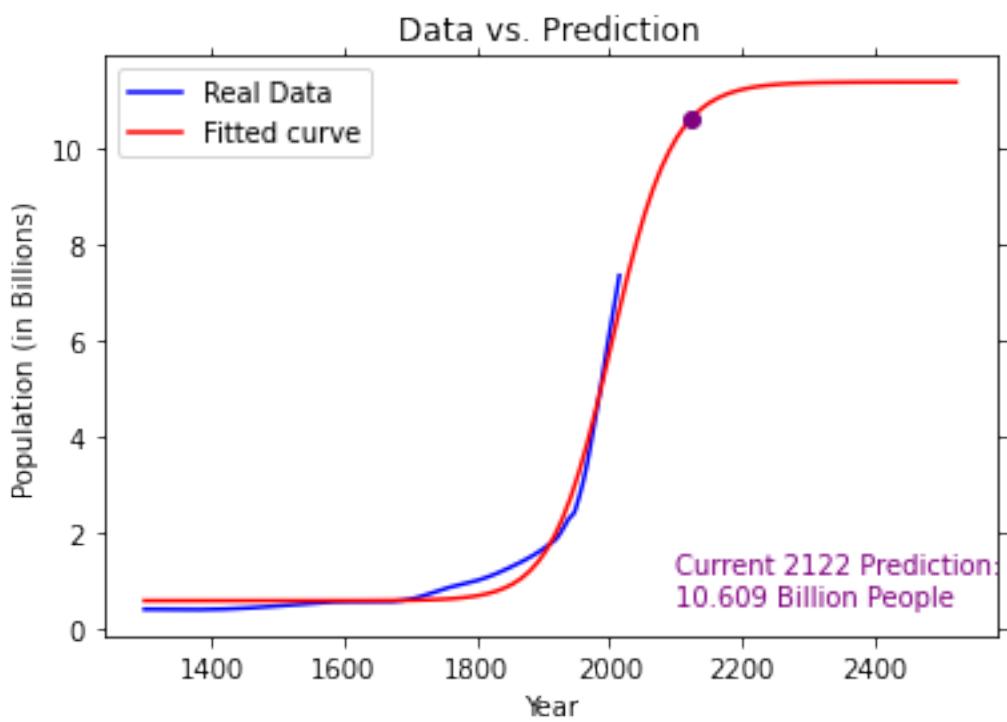
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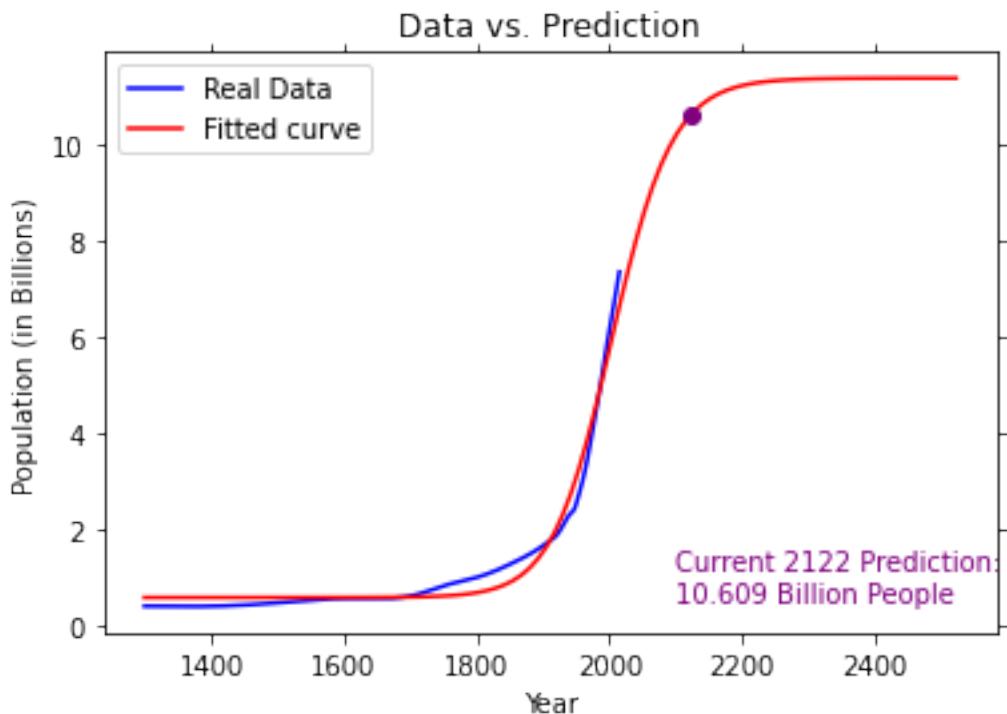
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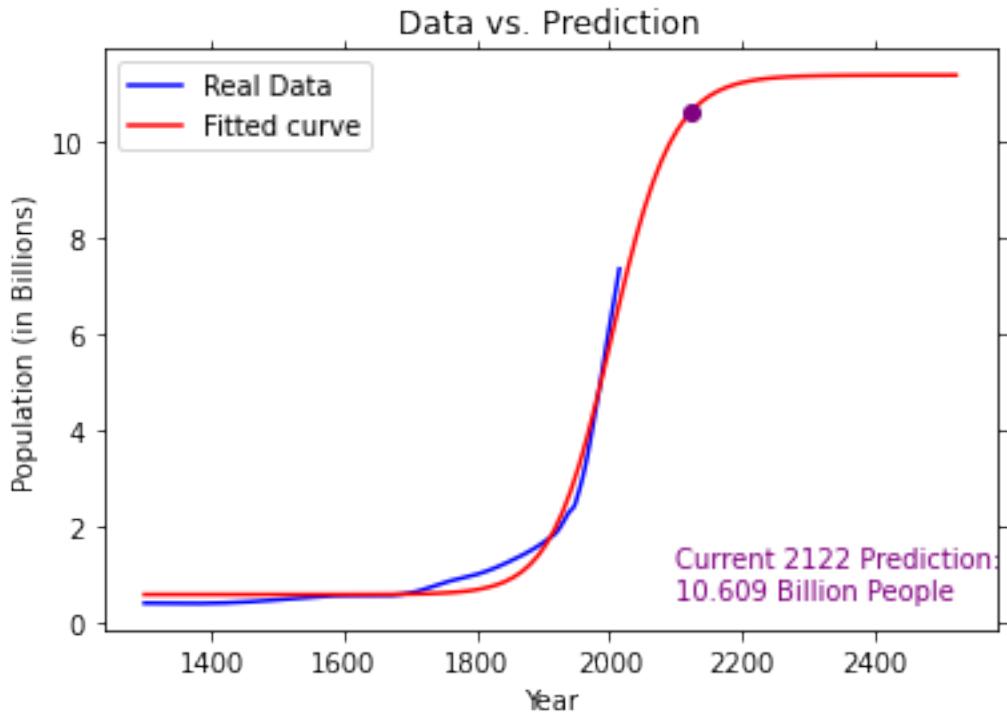
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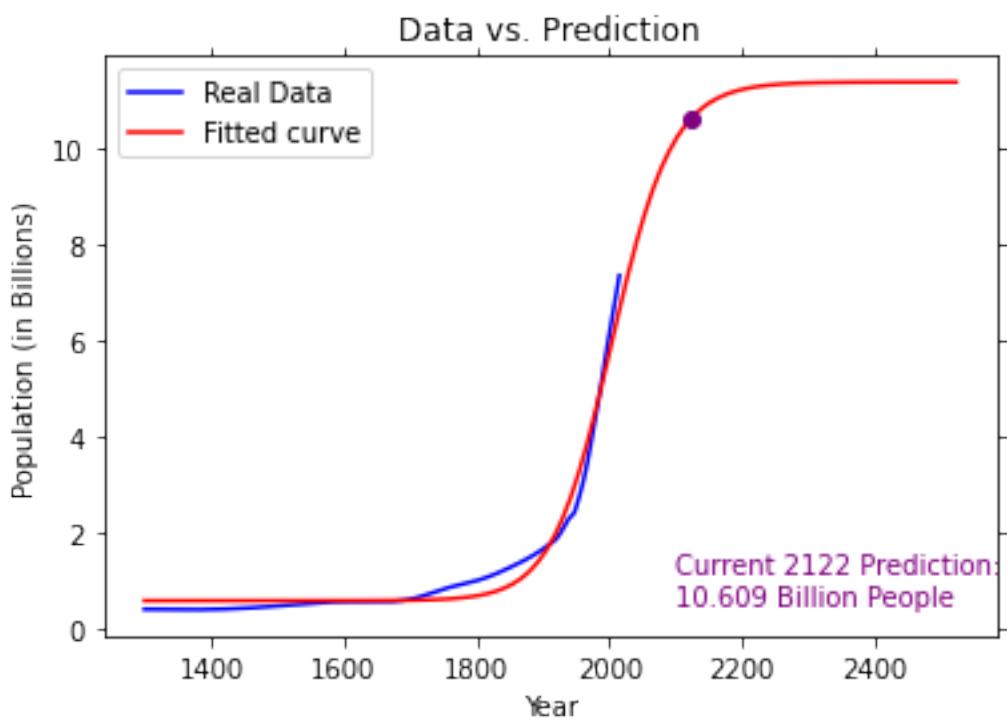
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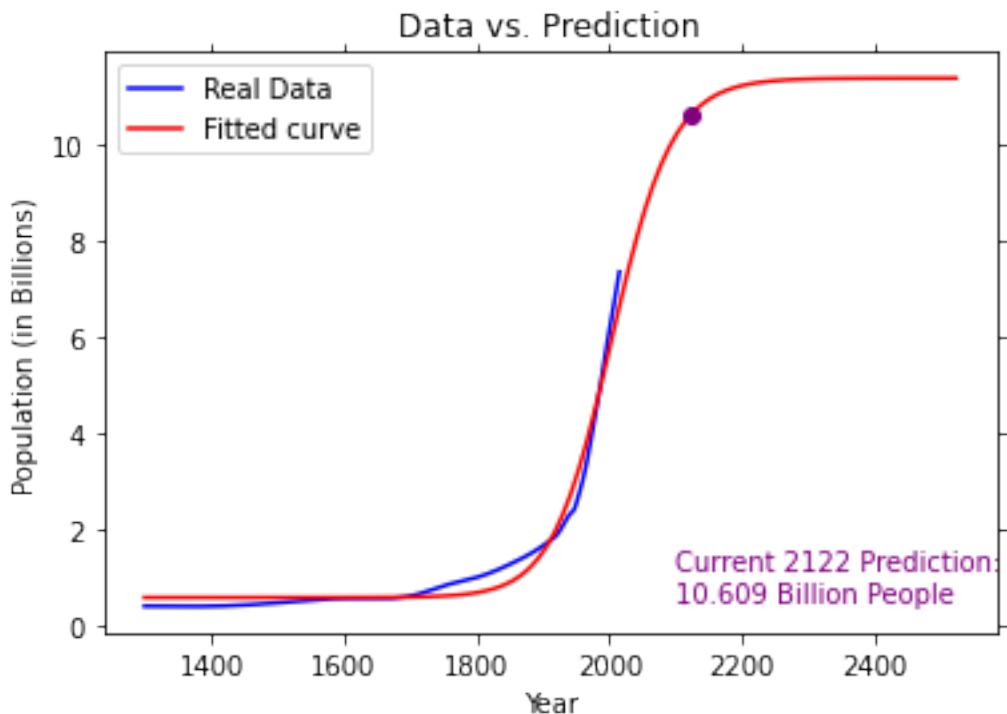
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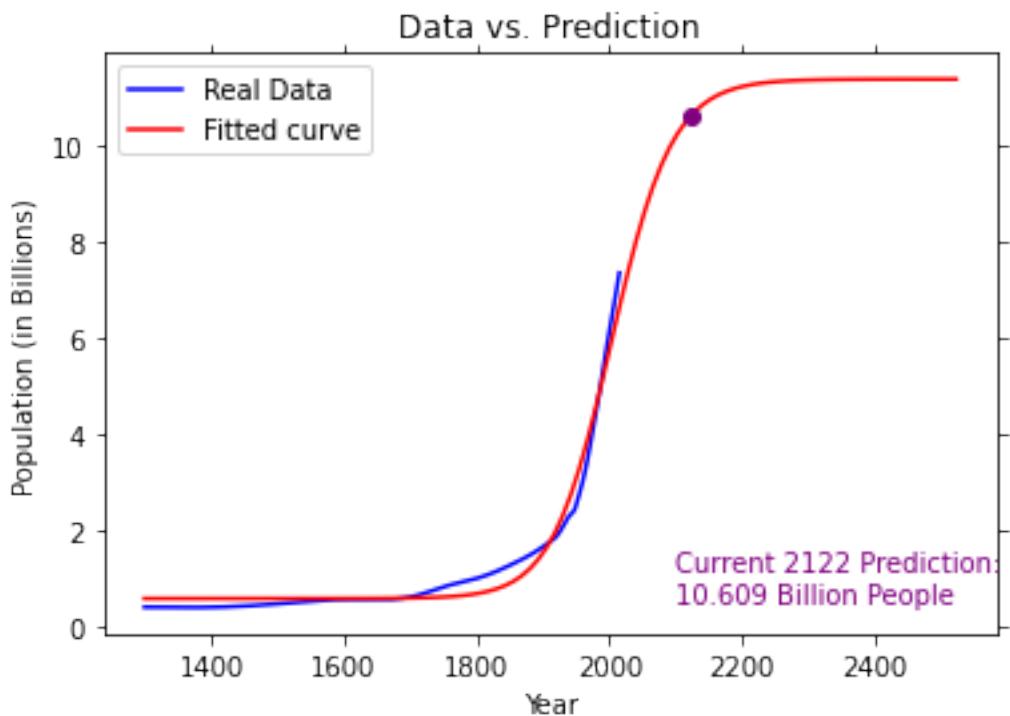
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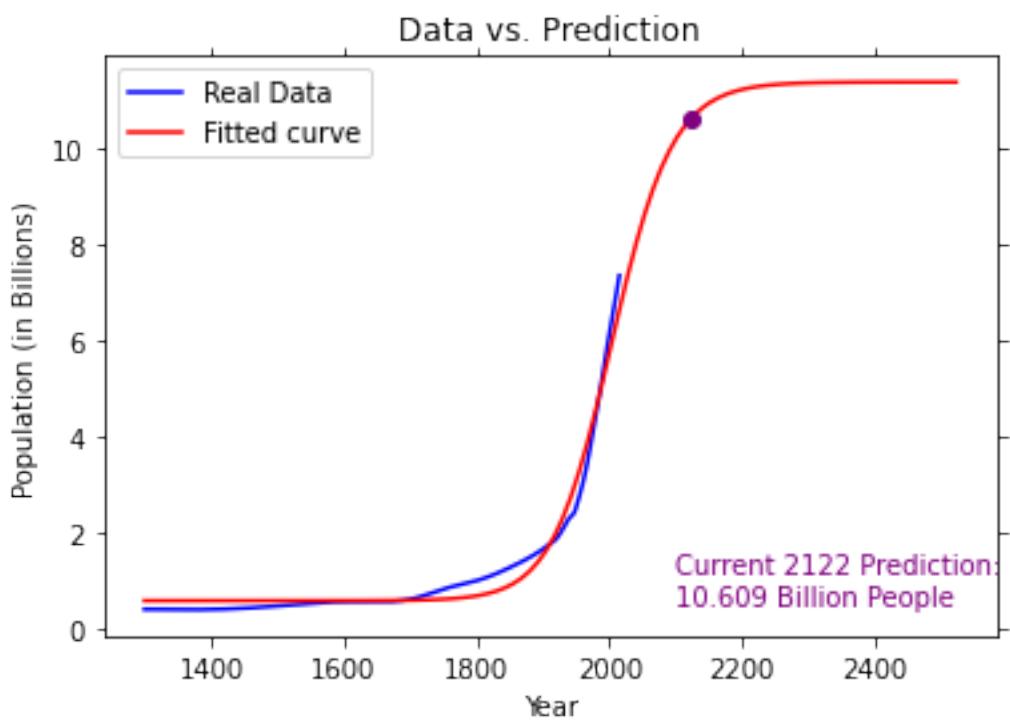
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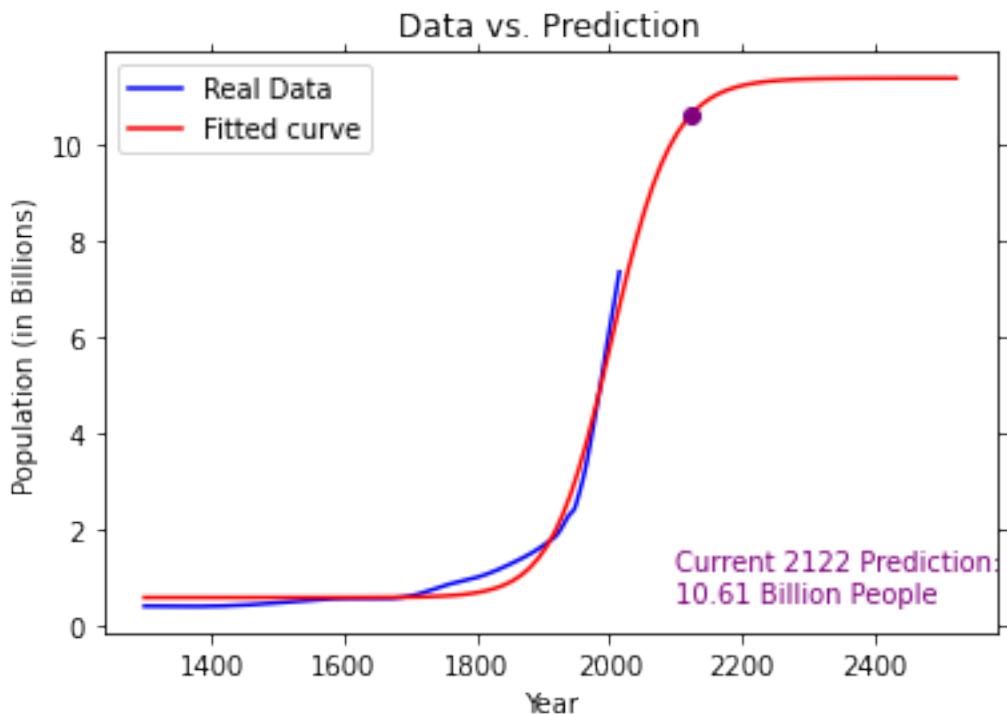
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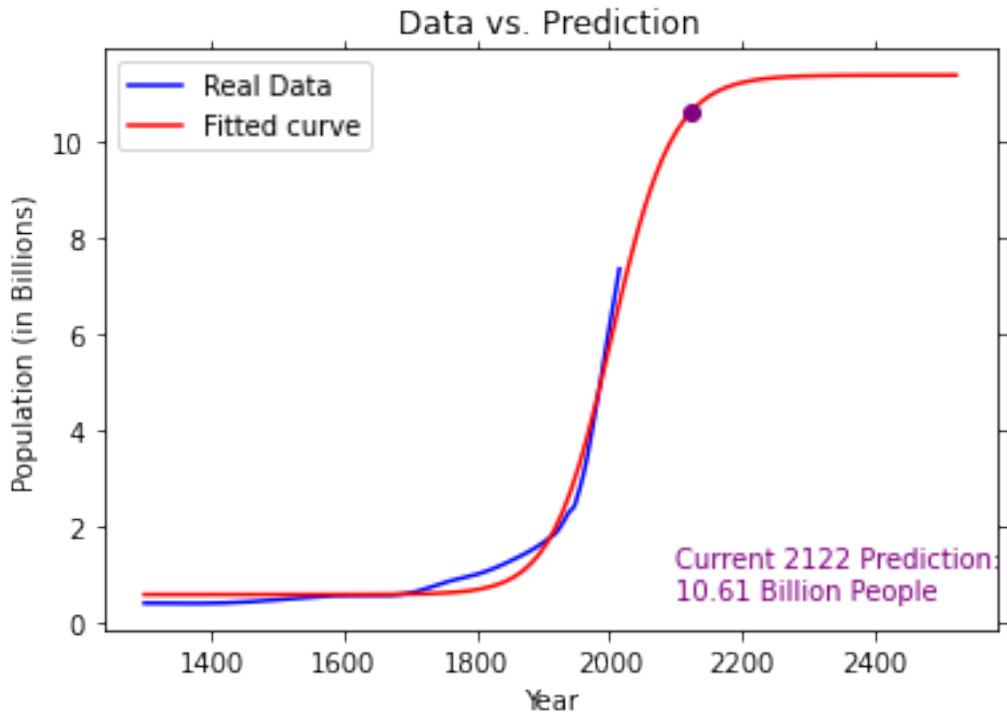
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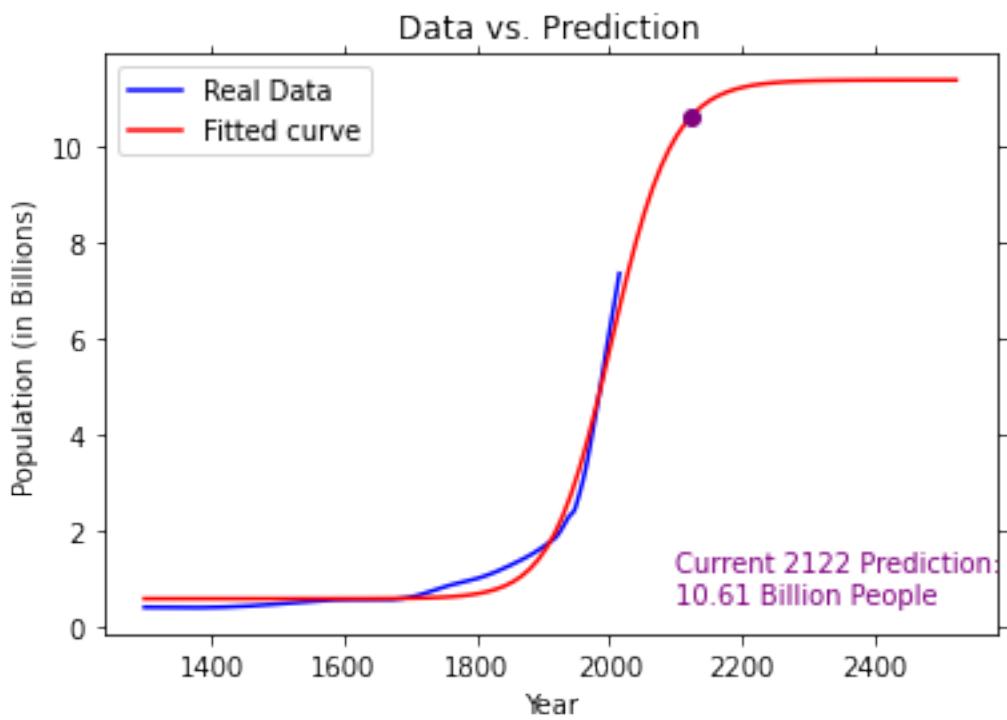
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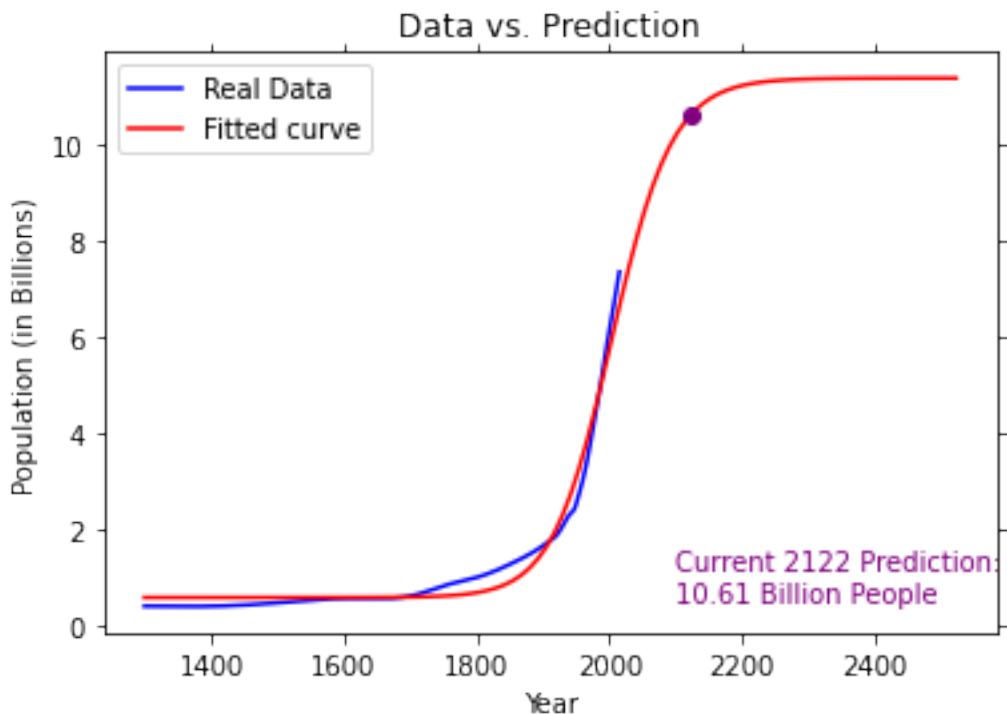
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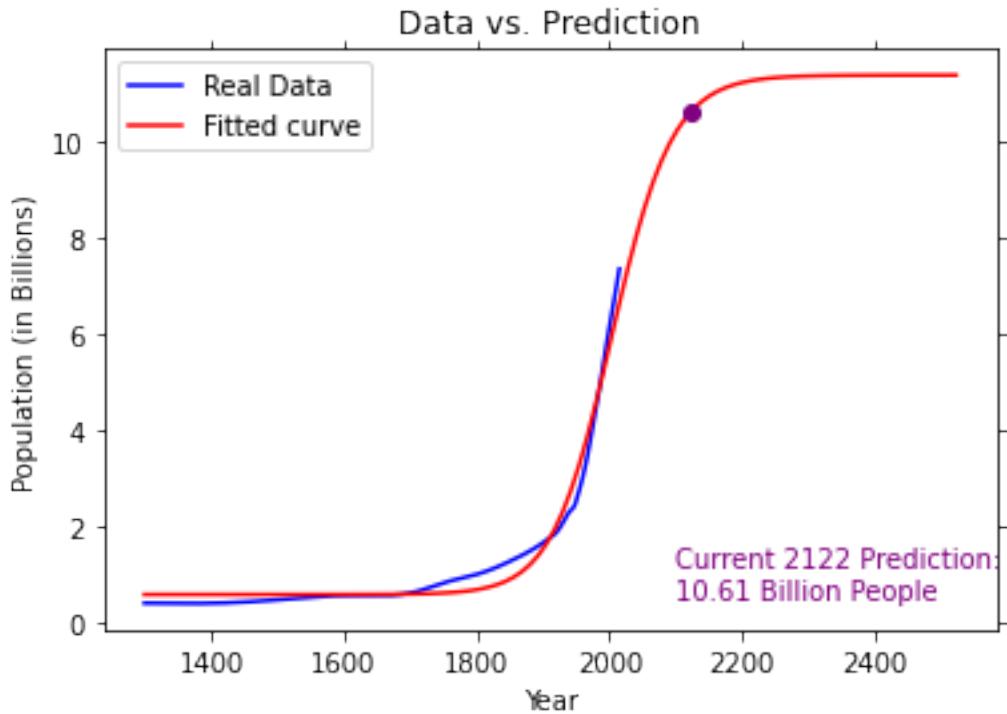
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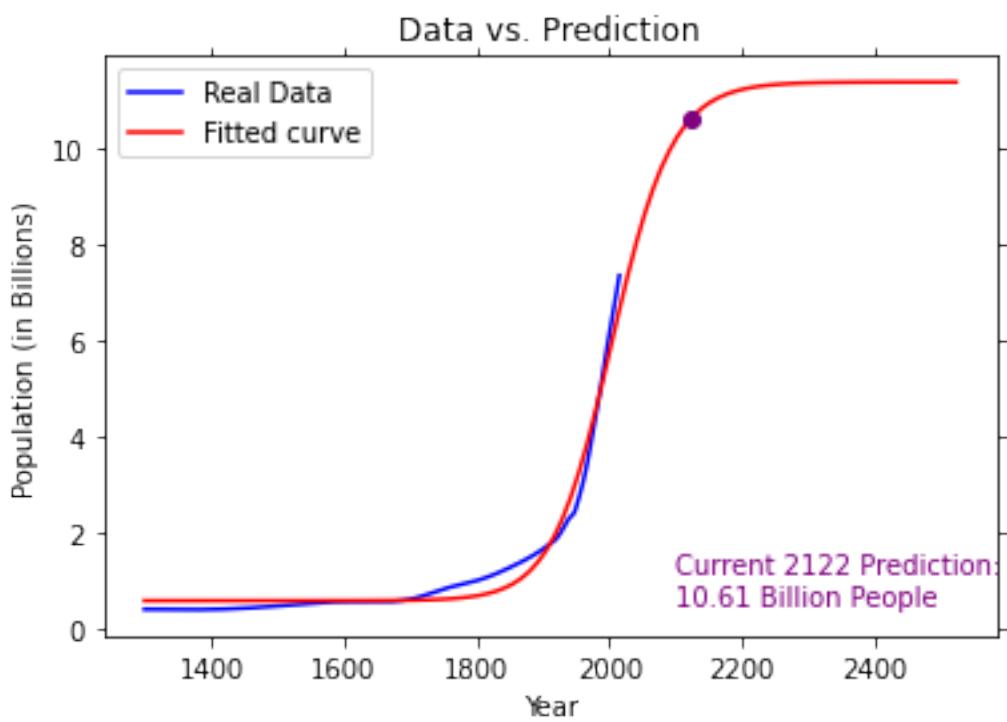
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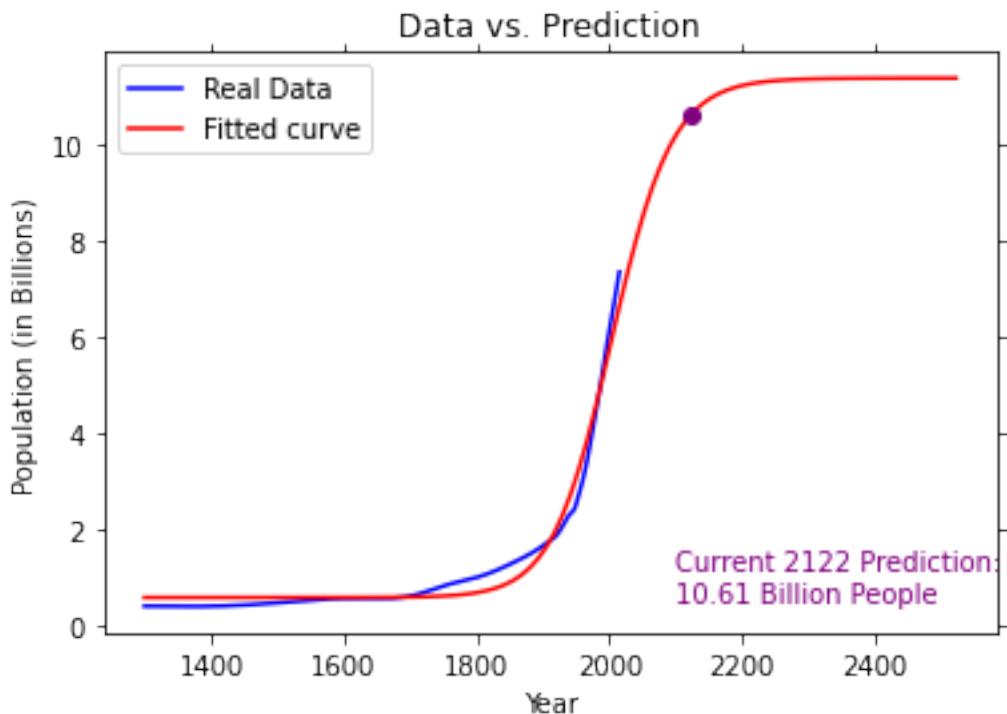
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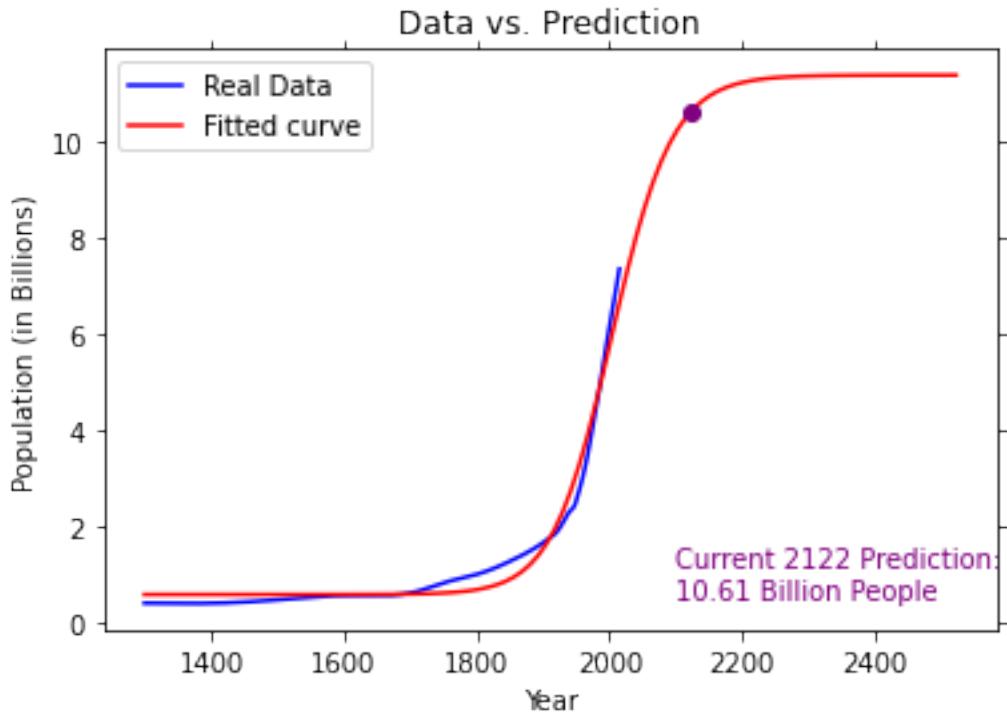
Iteration #34100, Loss: 0.051169539261600595



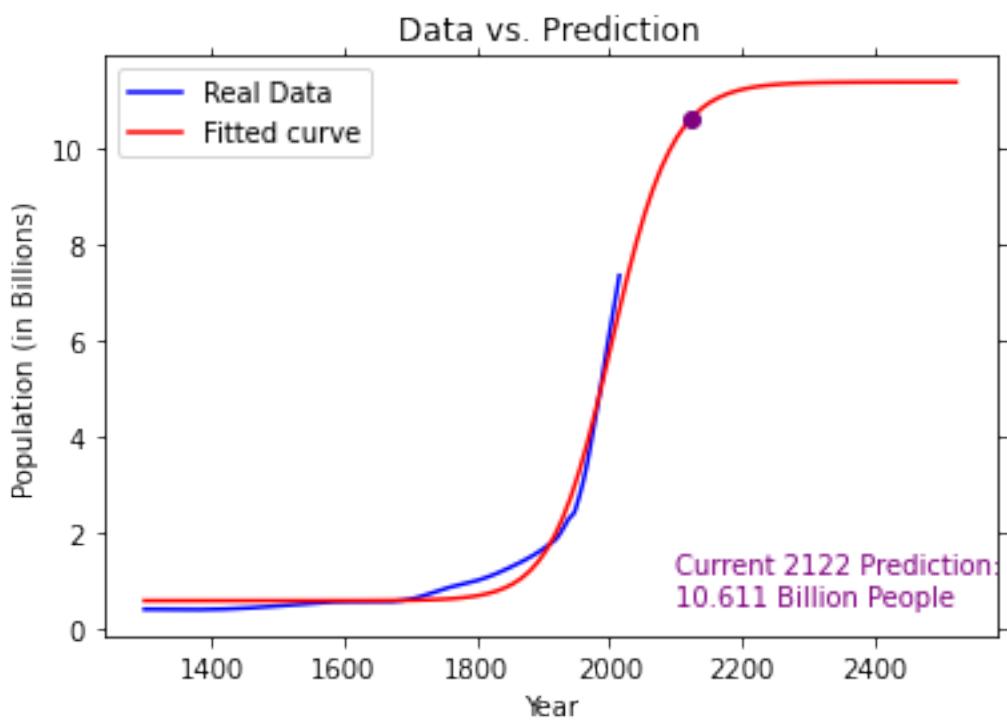
Iteration #34150, Loss: 0.051164696593550614



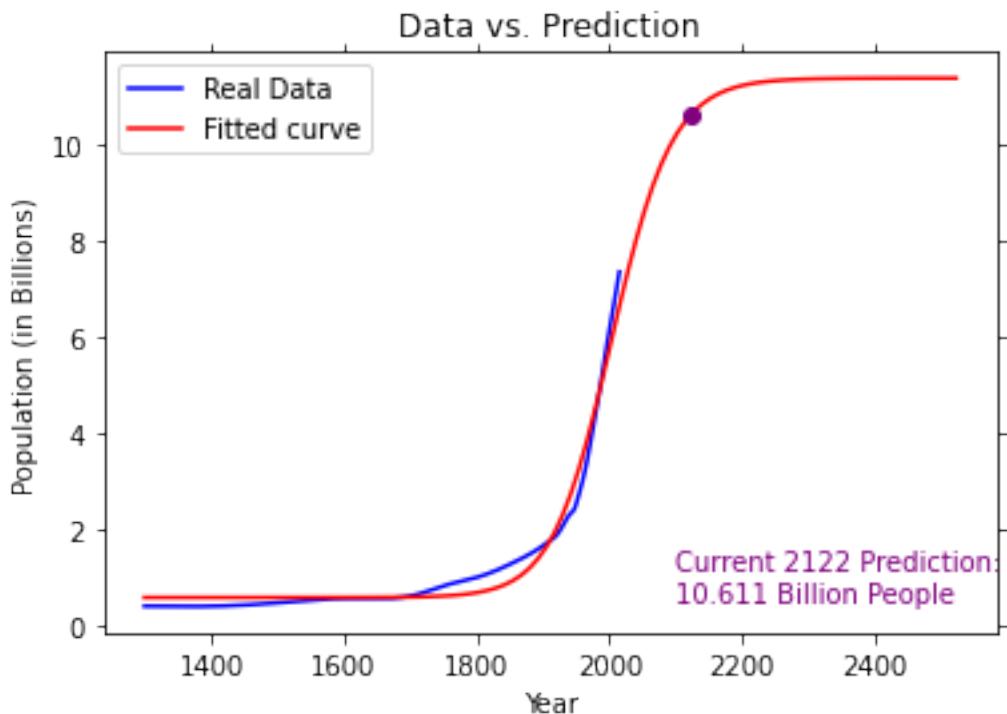
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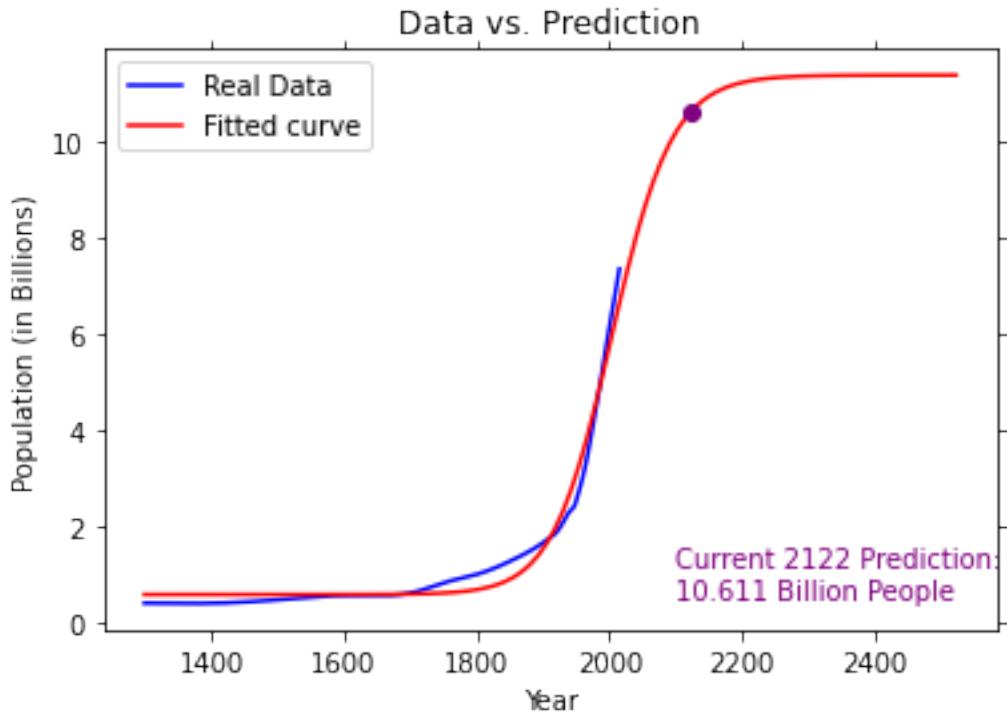
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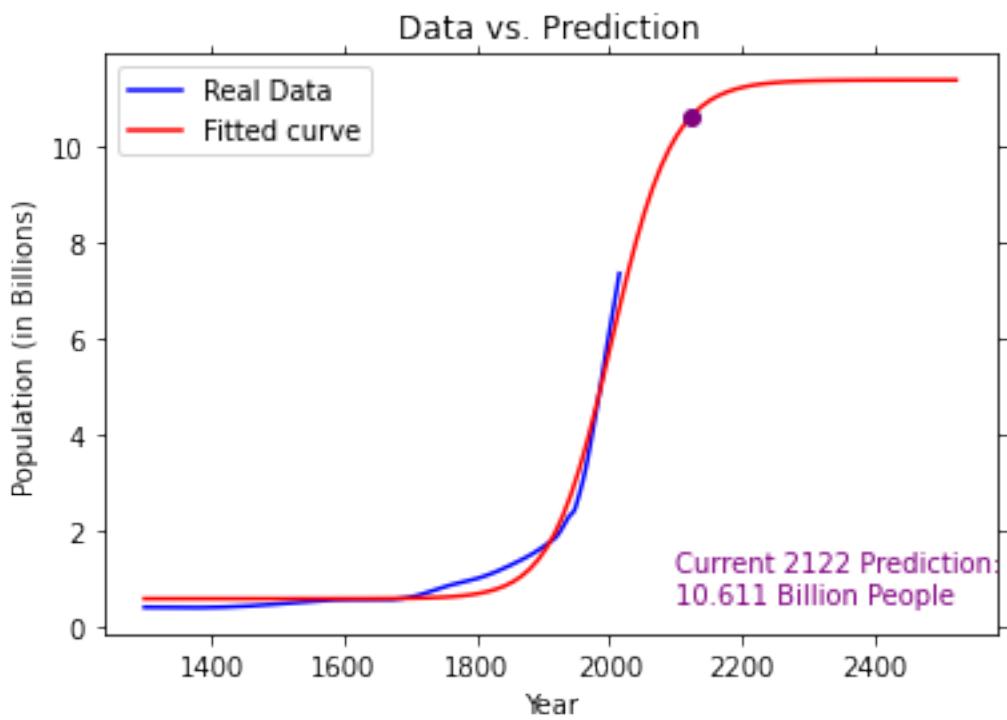
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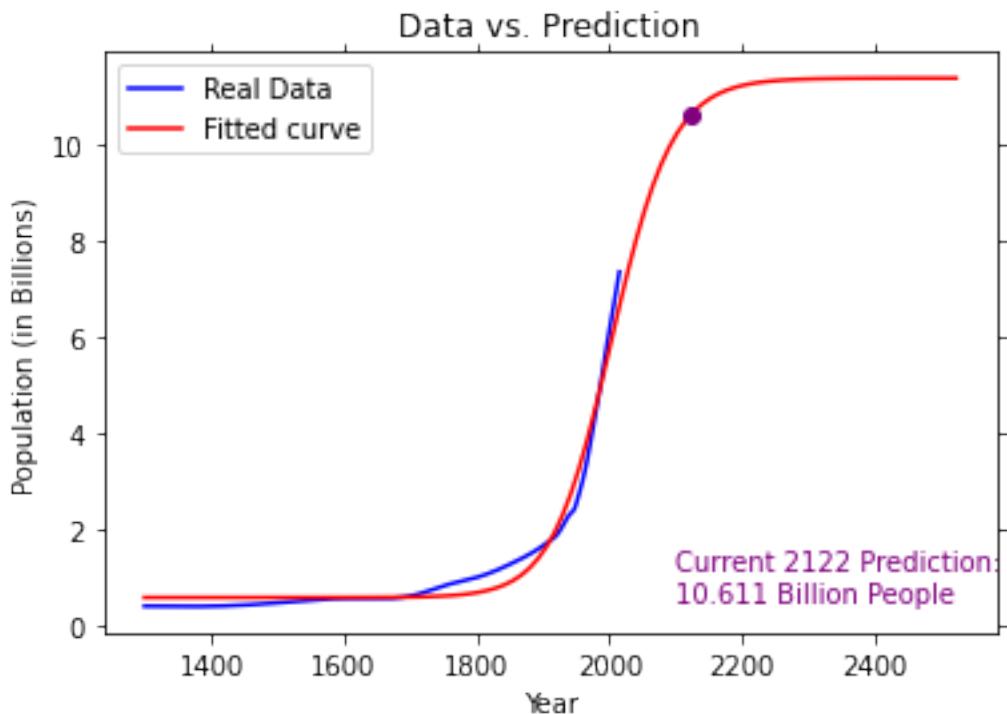
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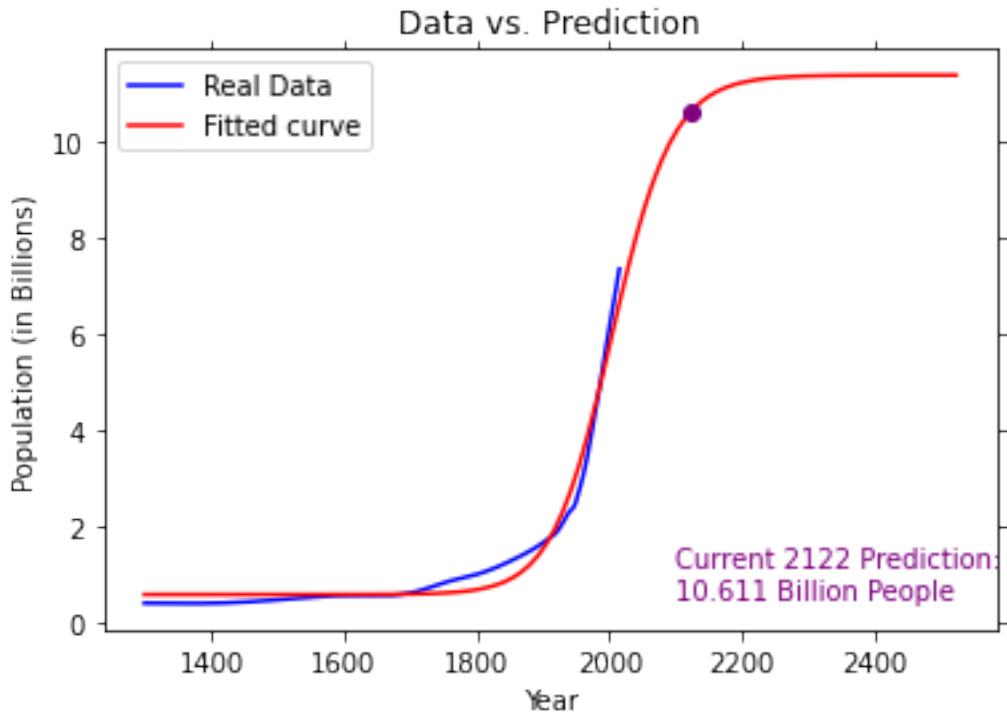
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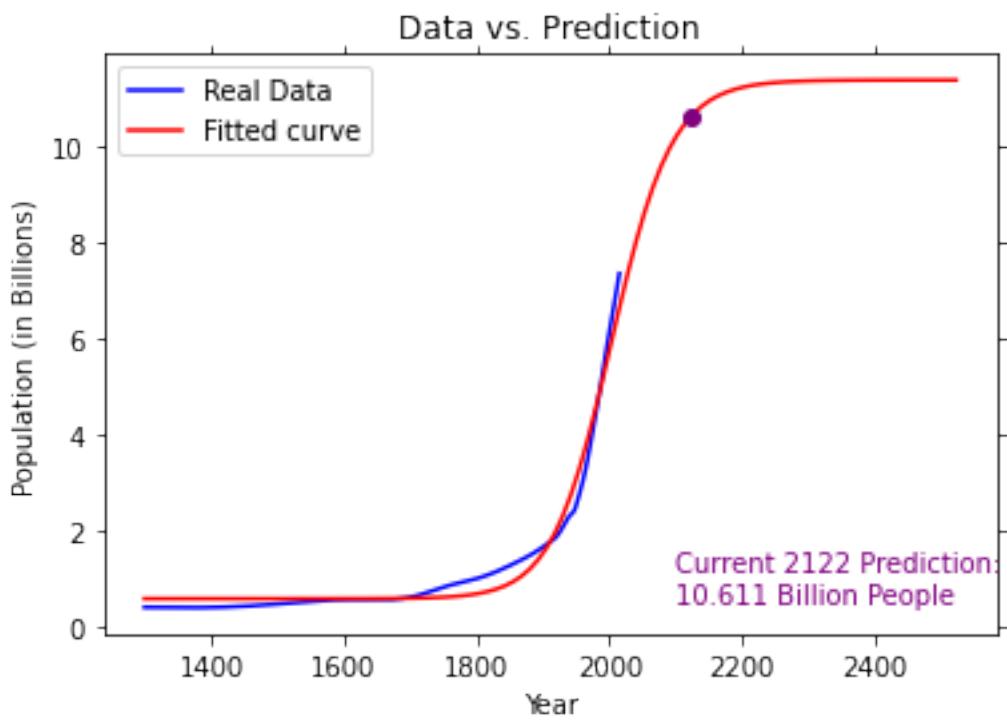
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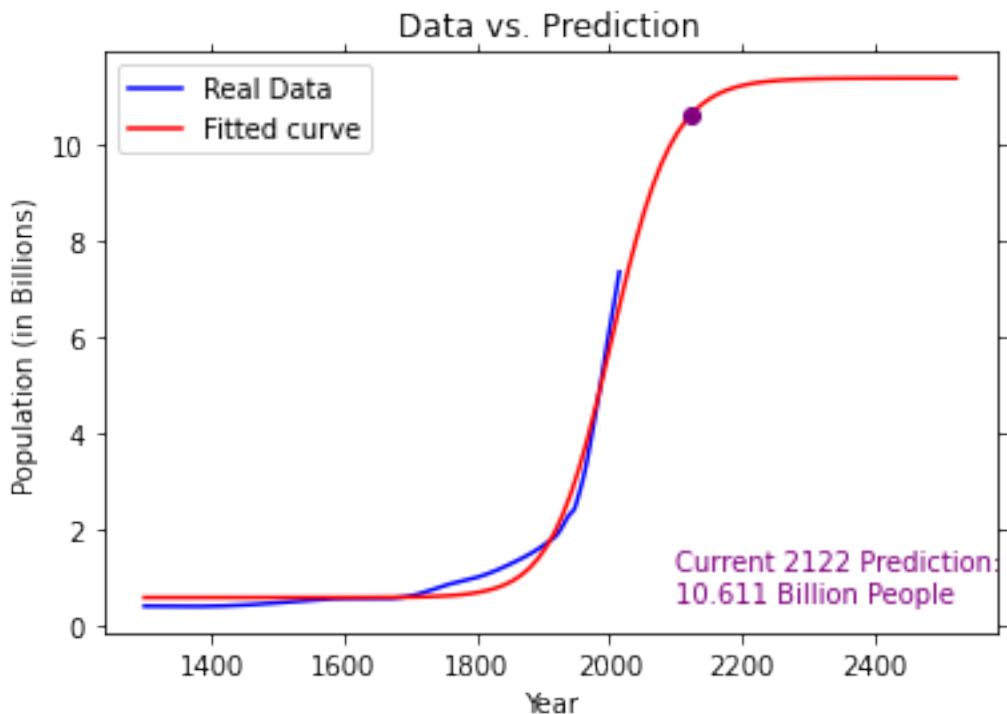
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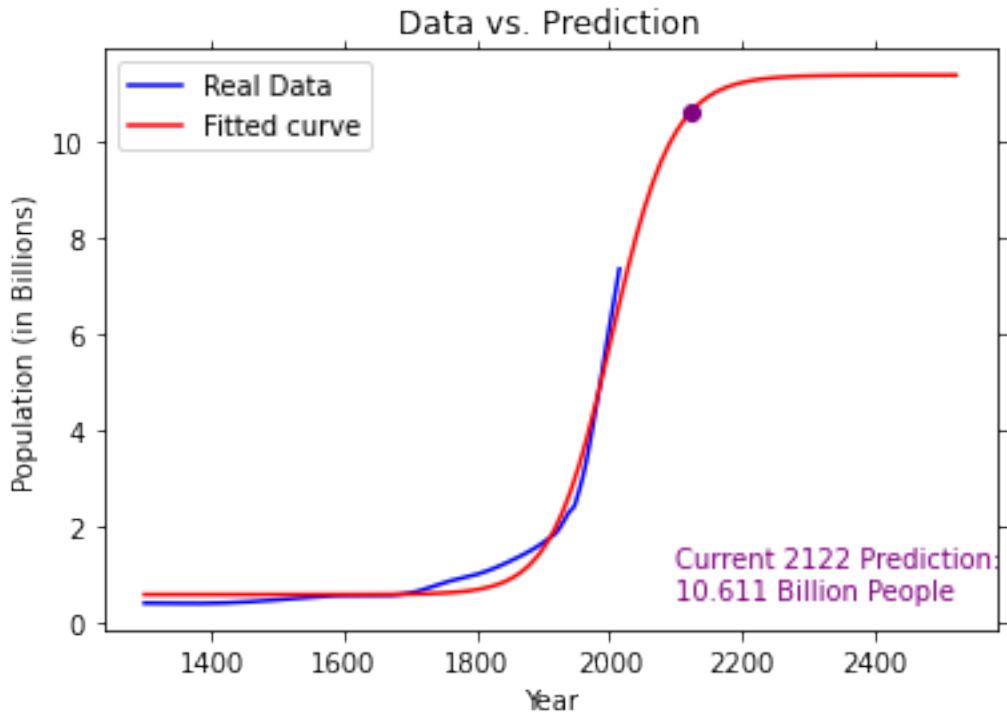
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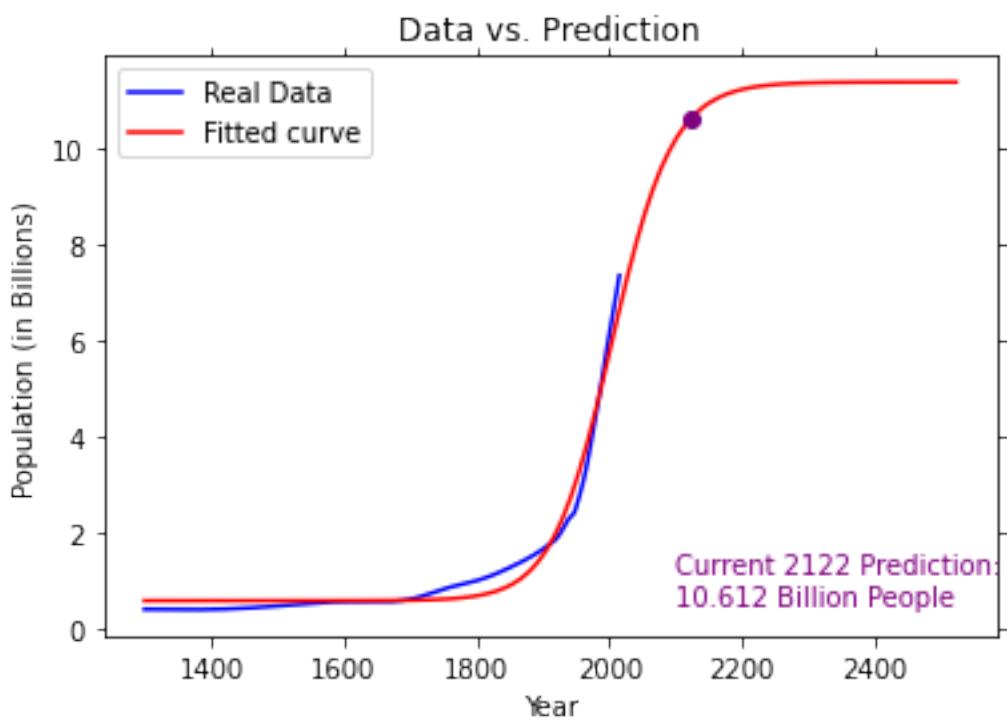
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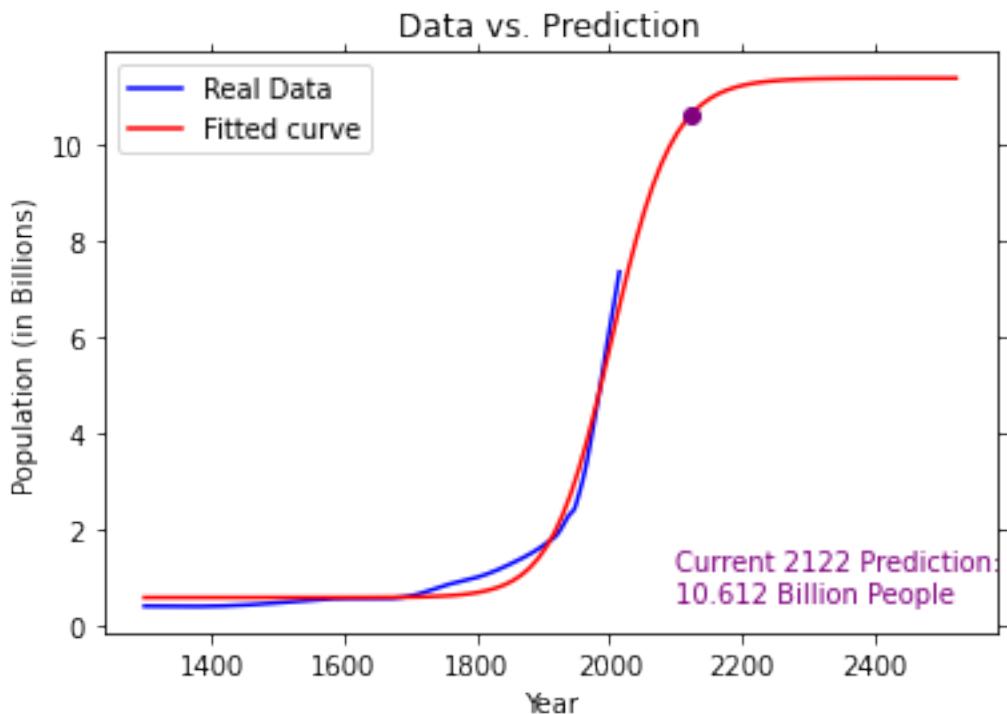
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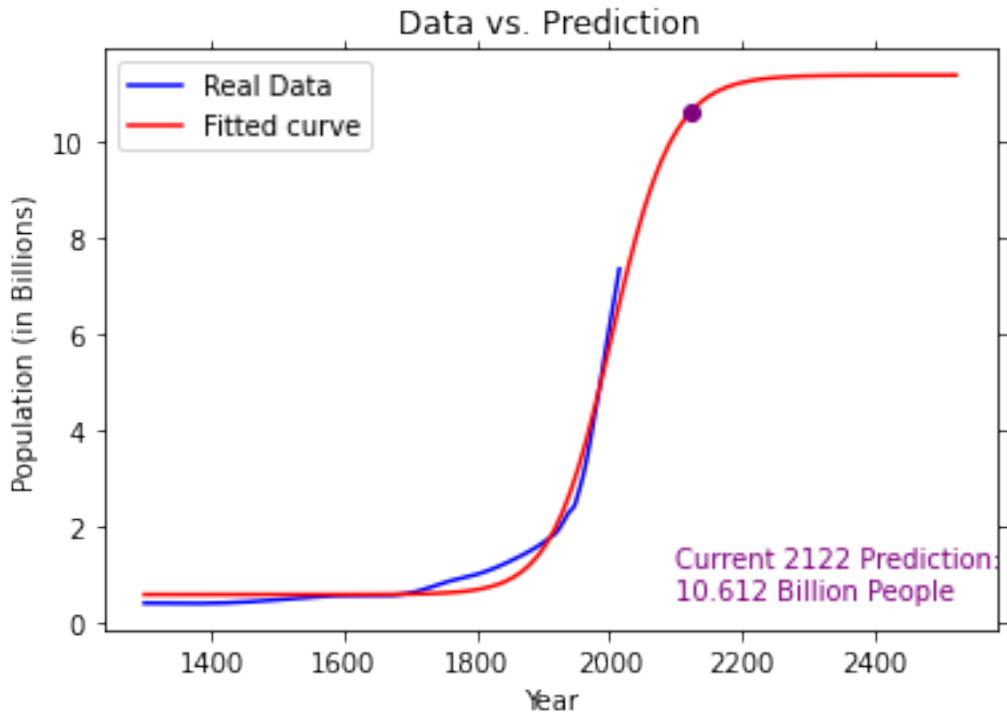
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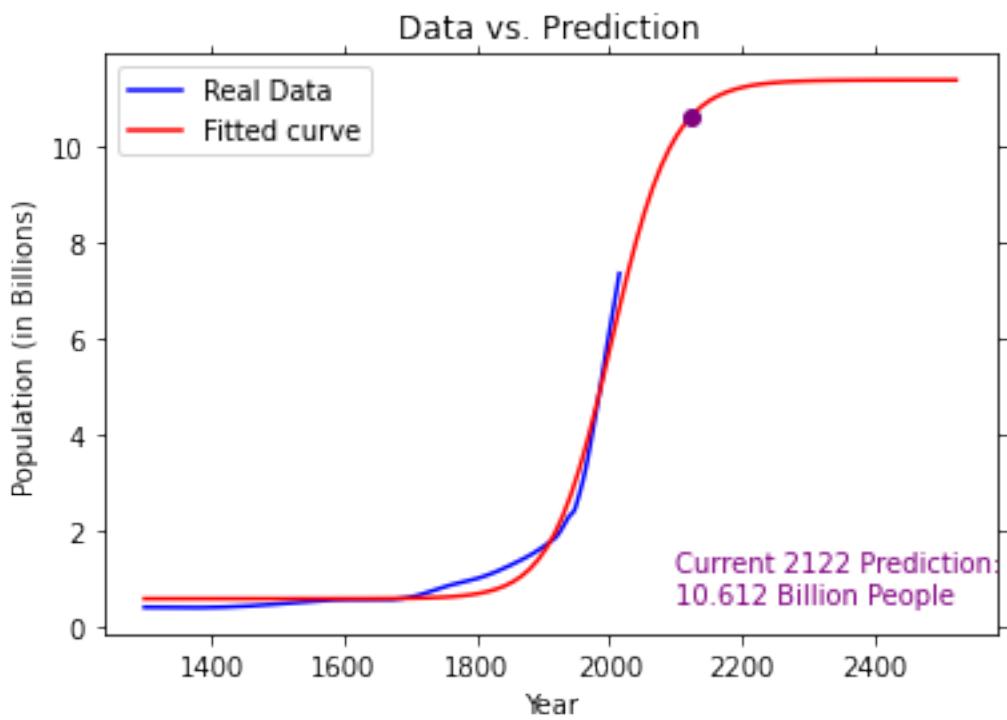
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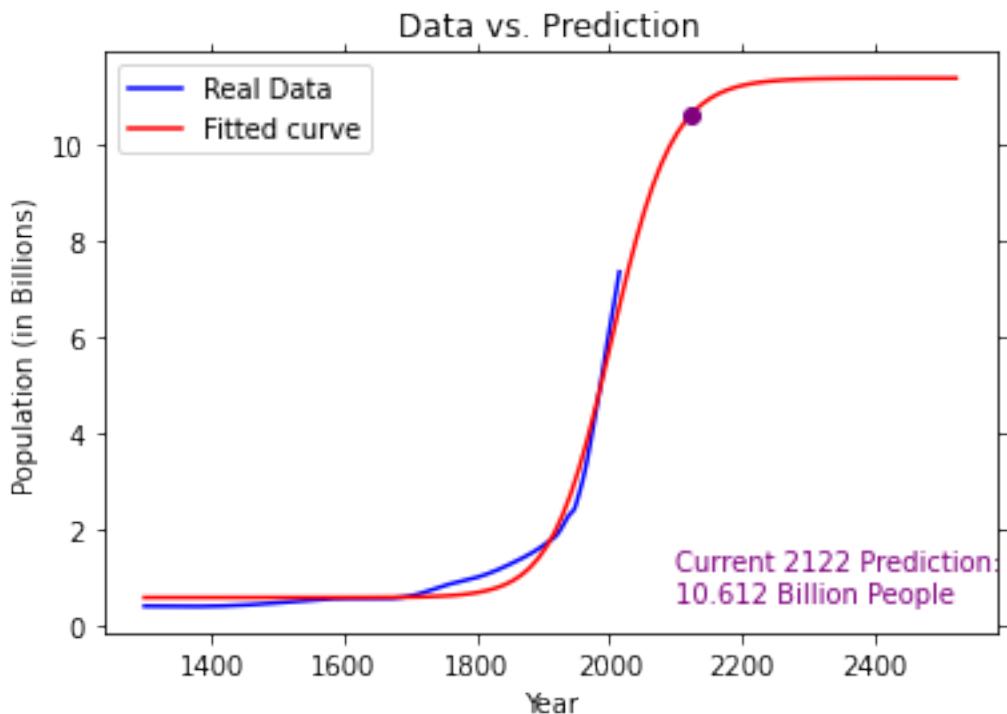
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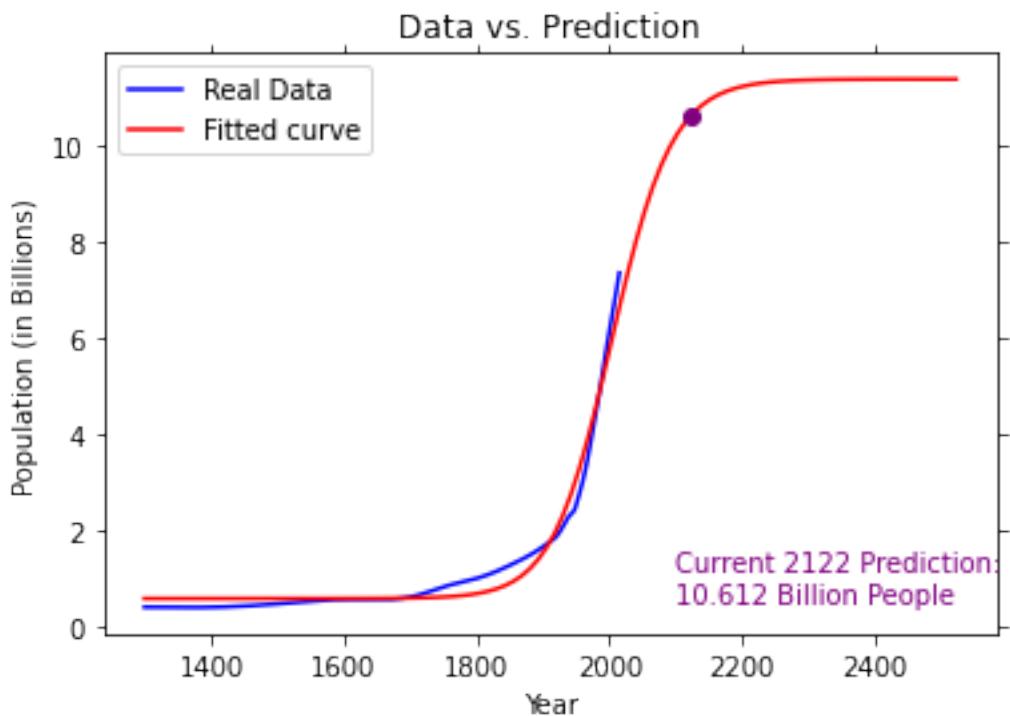
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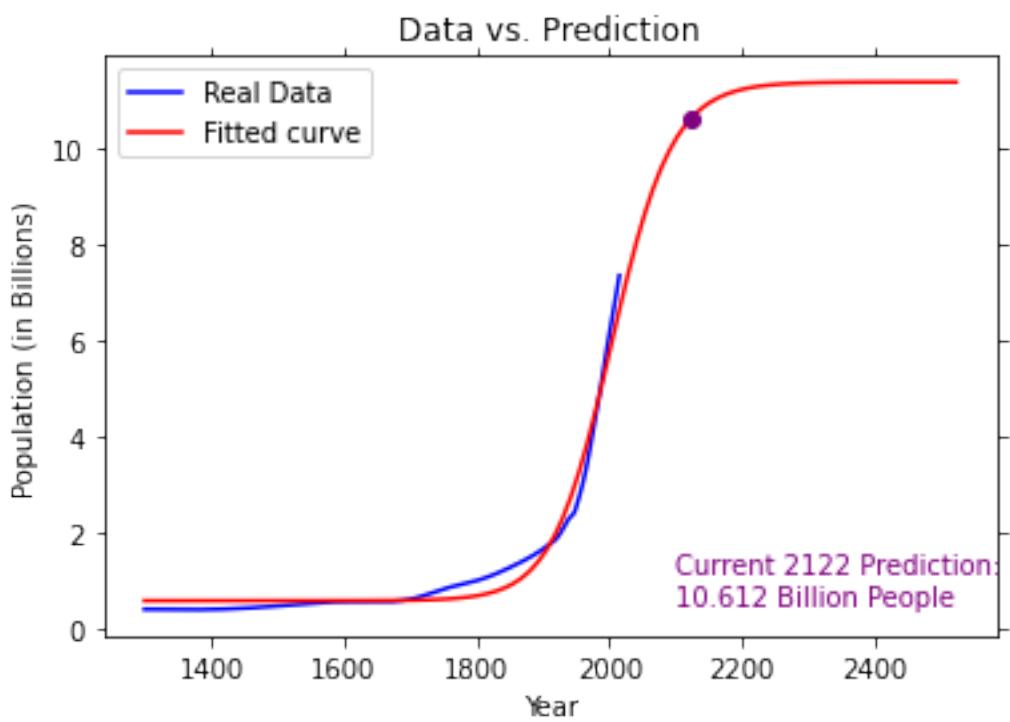
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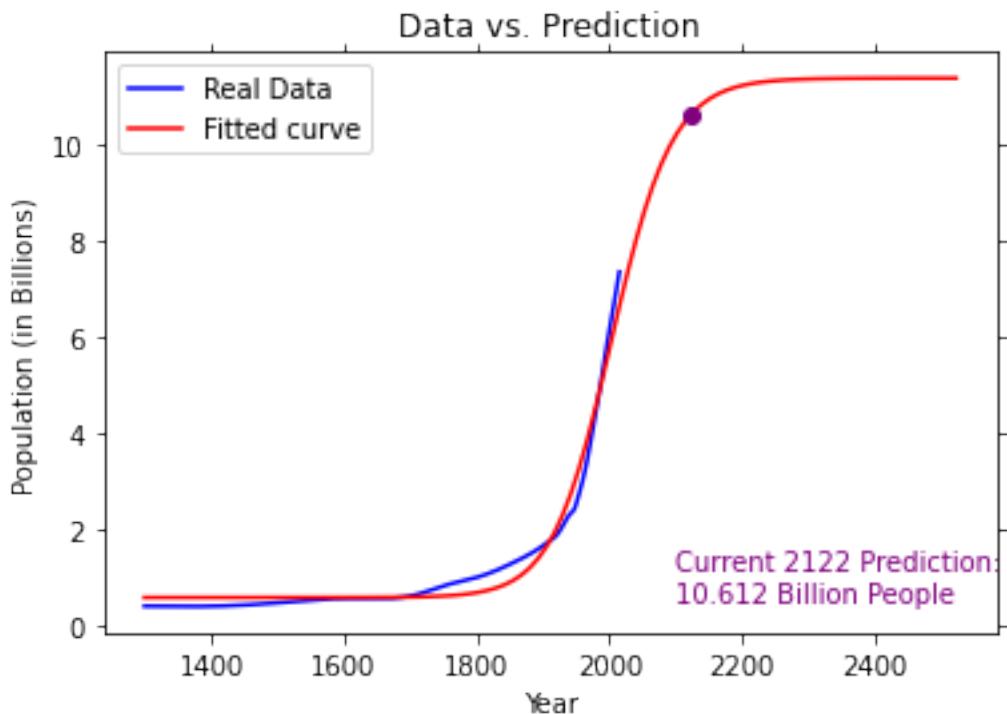
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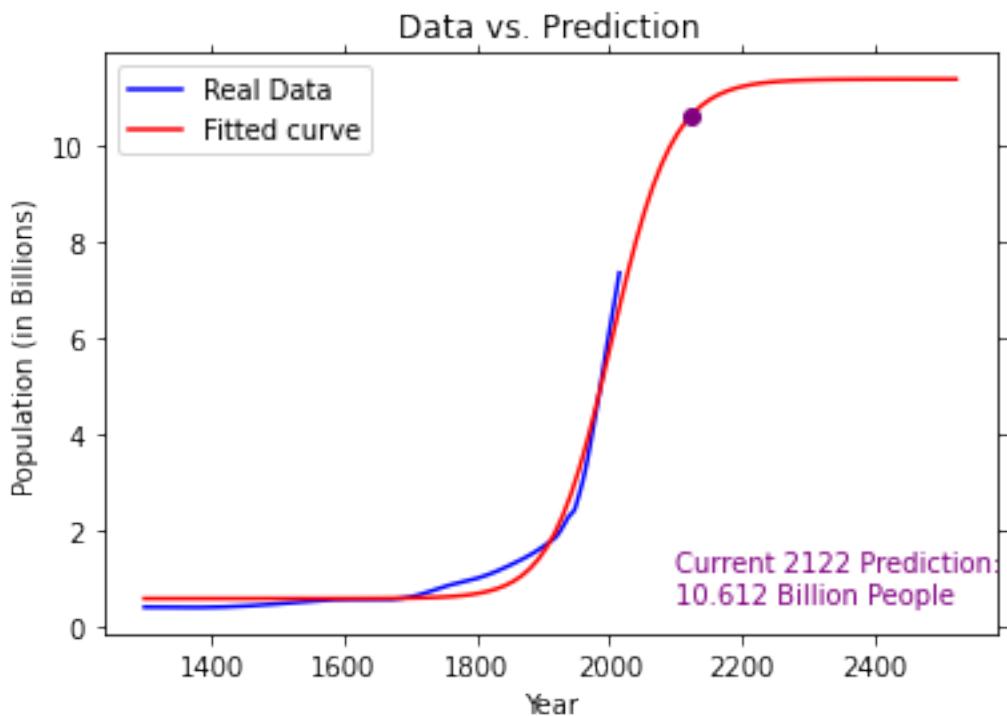
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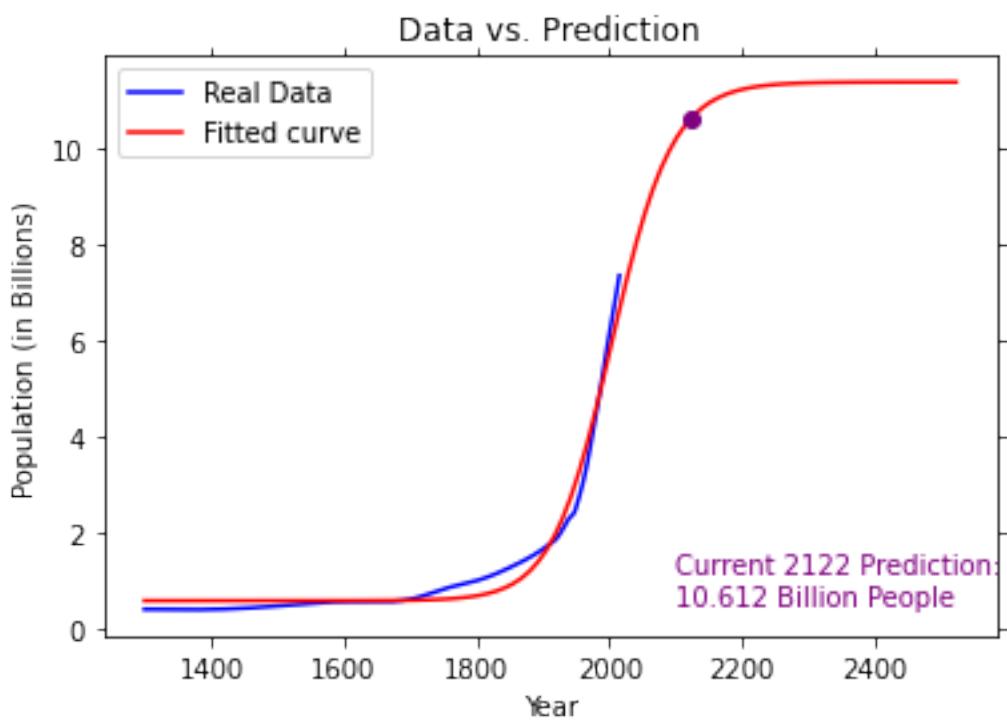
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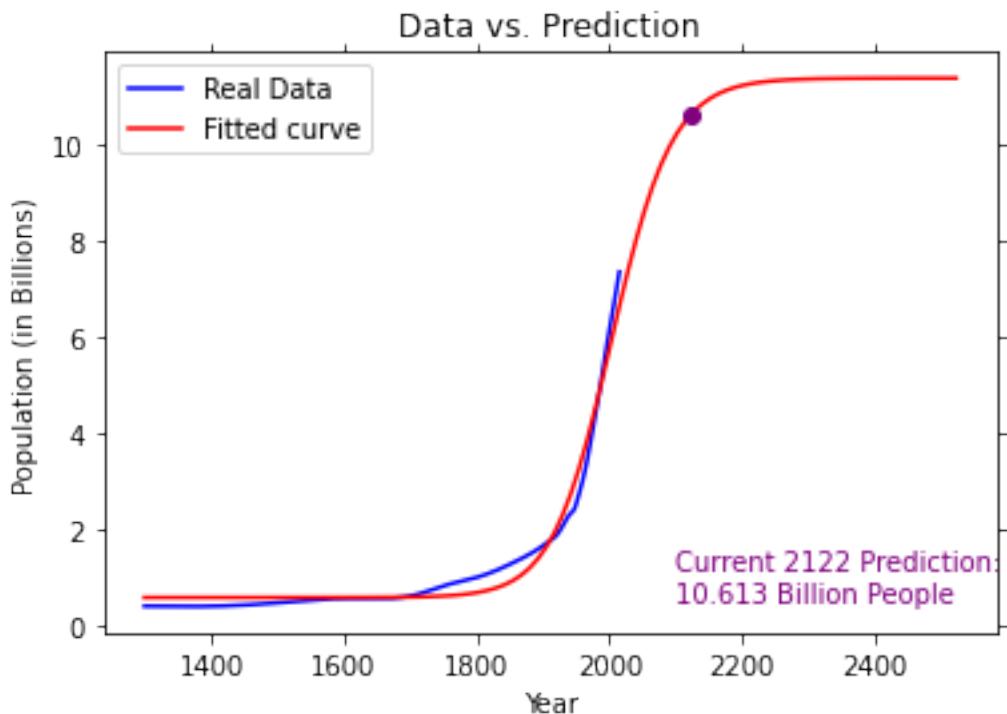
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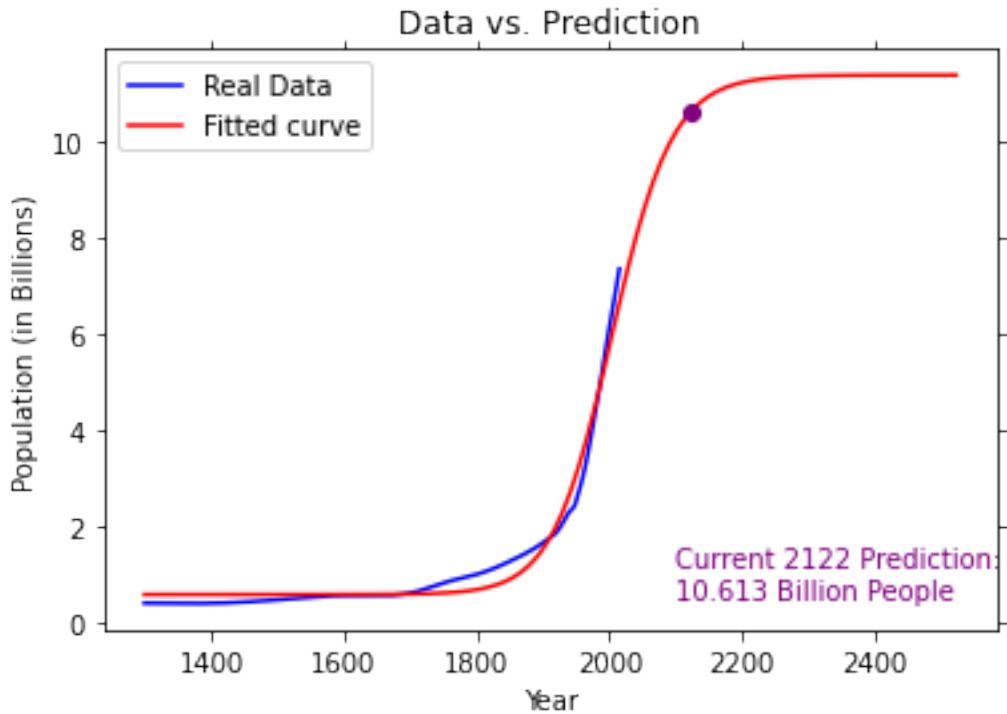
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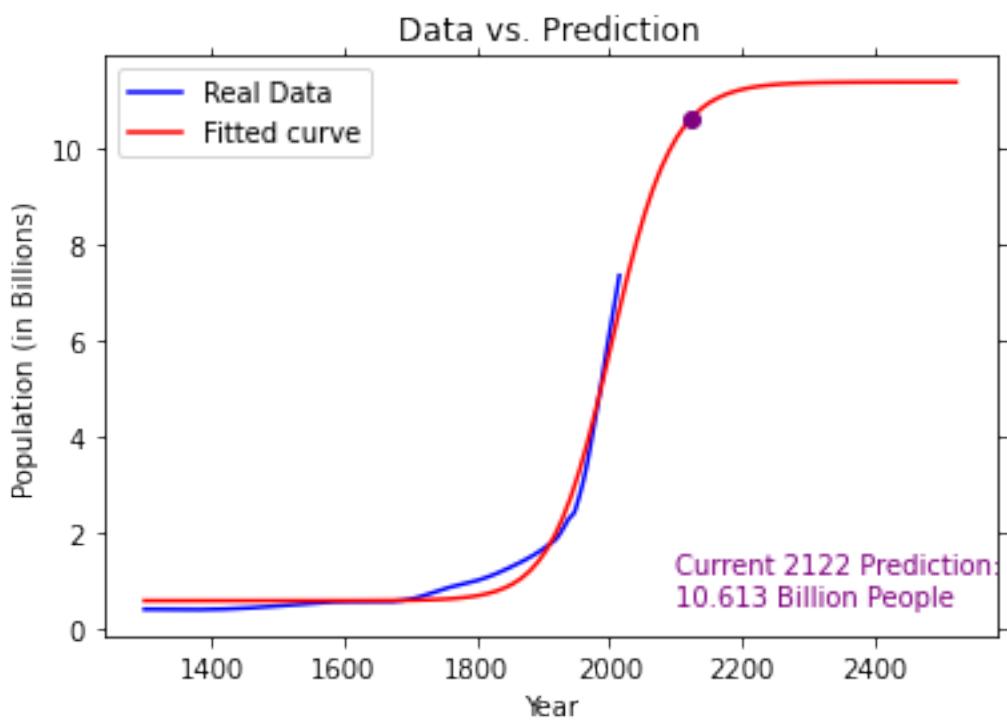
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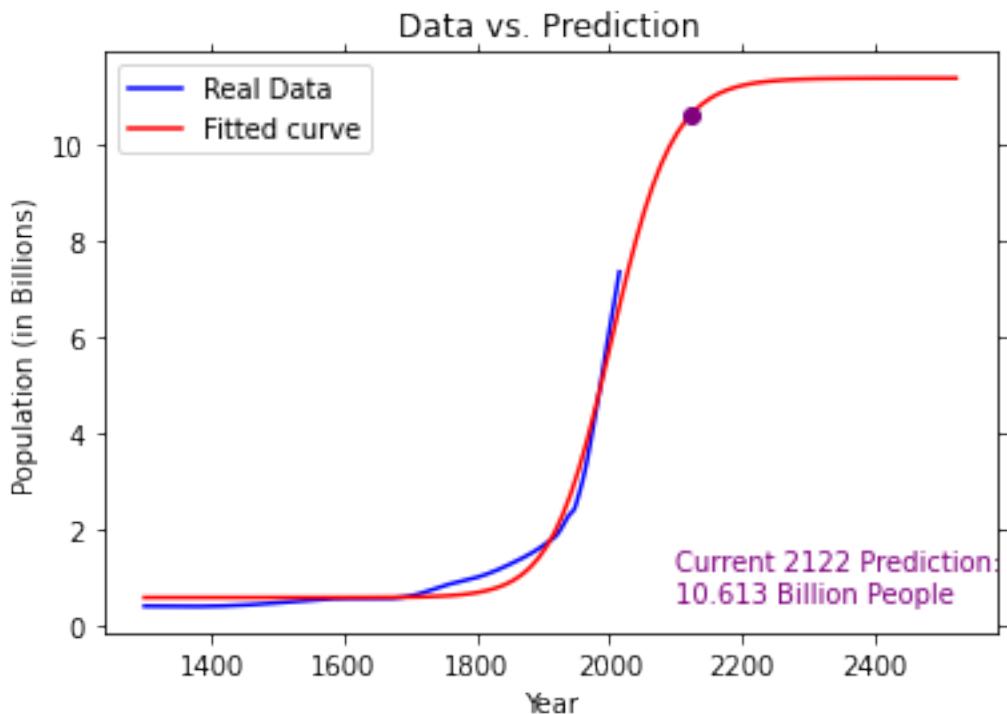
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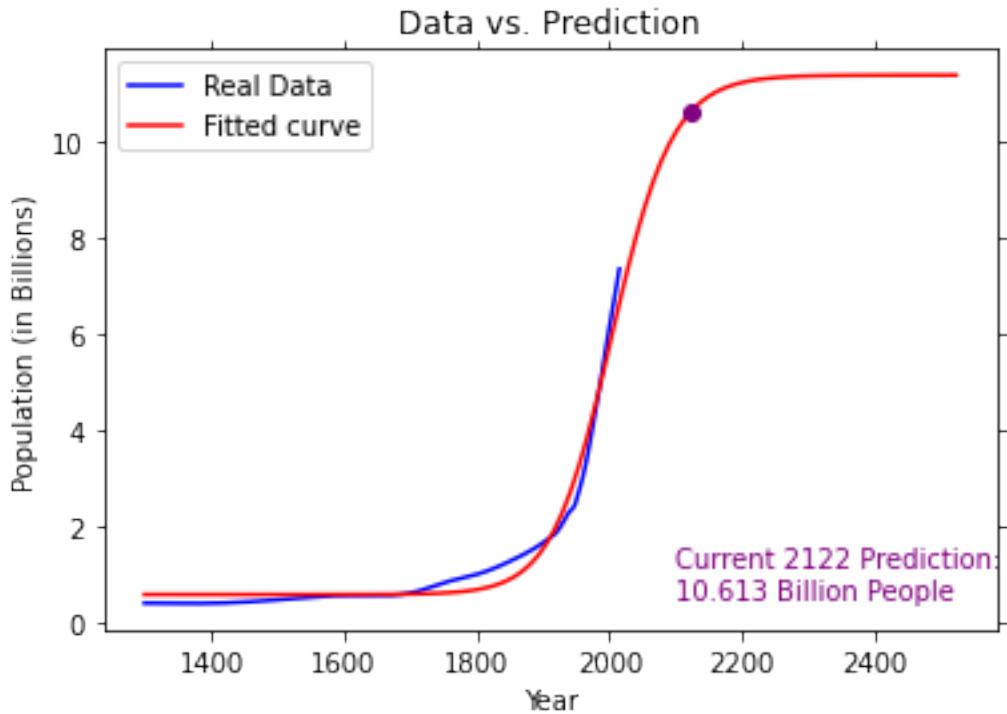
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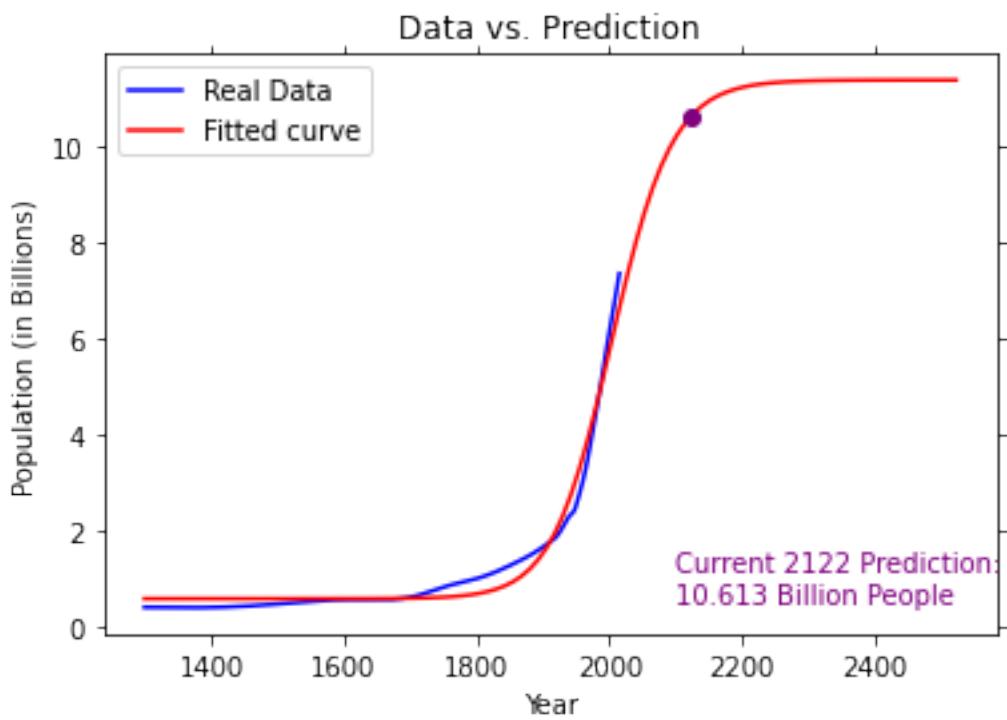
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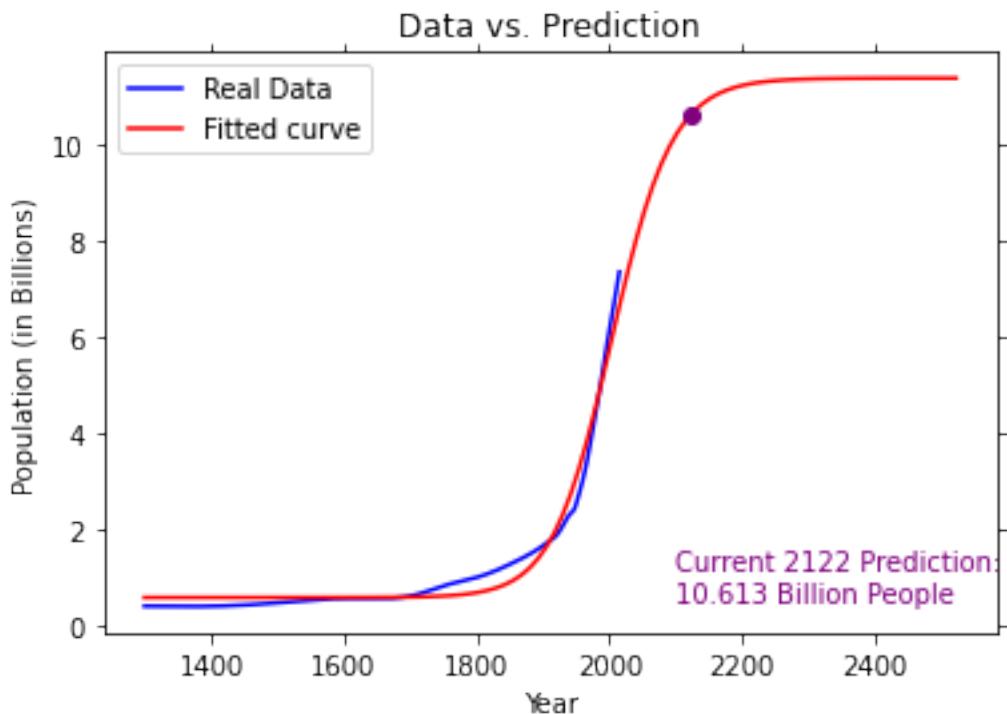
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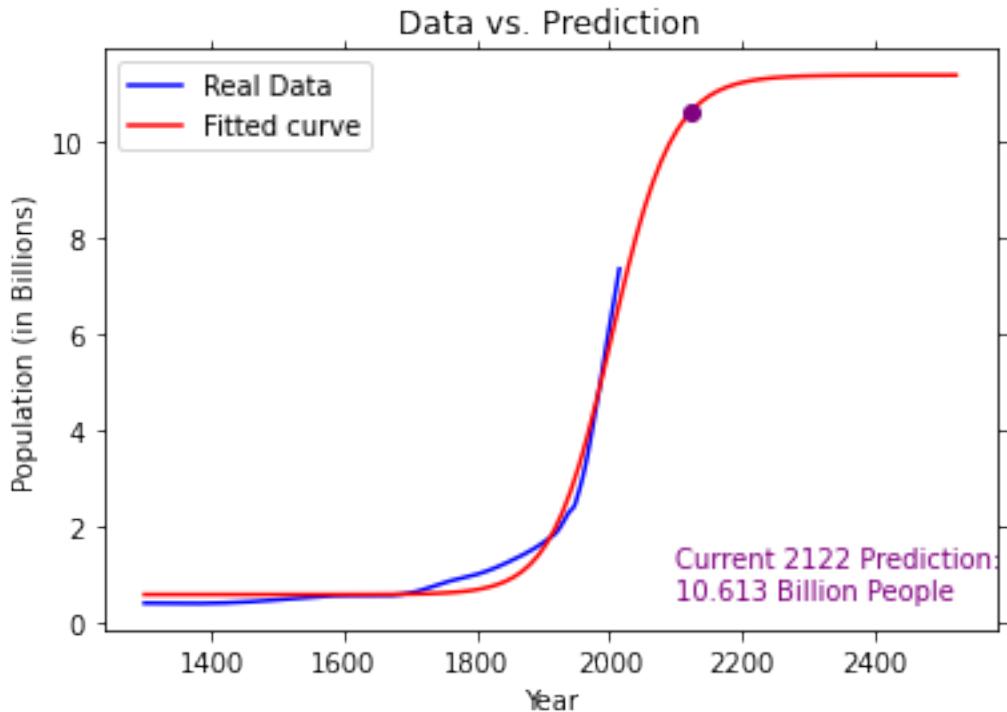
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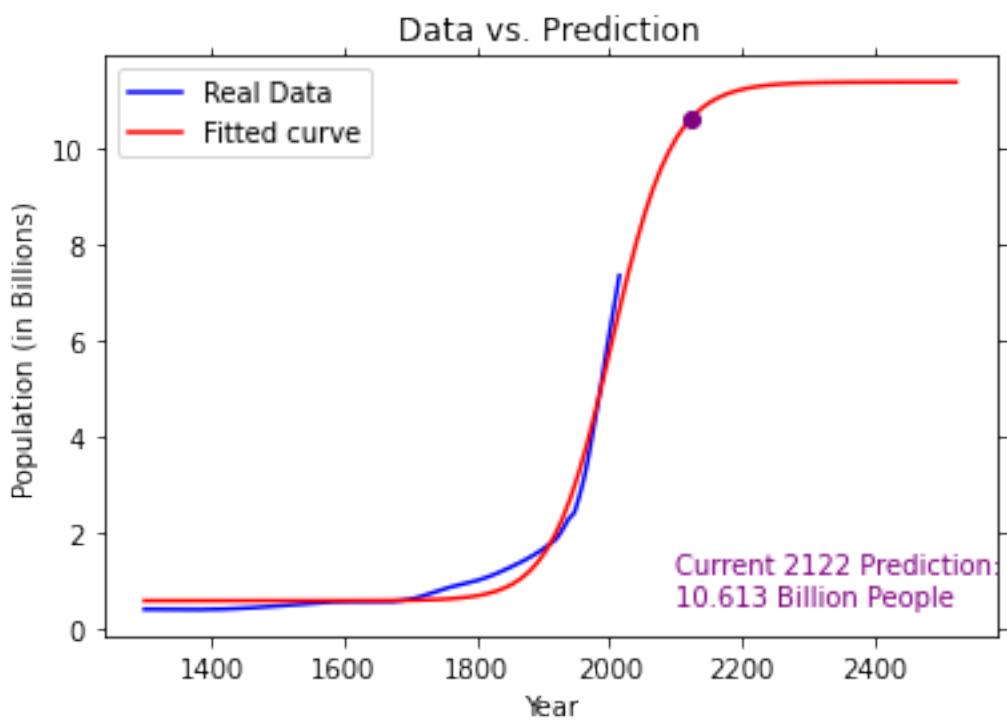
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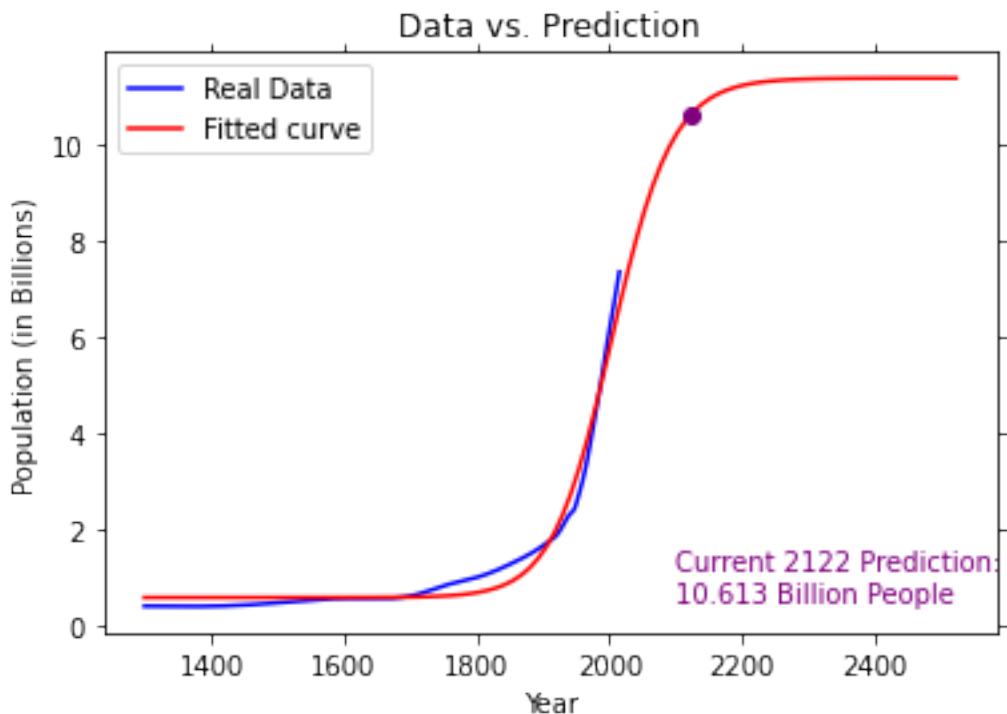
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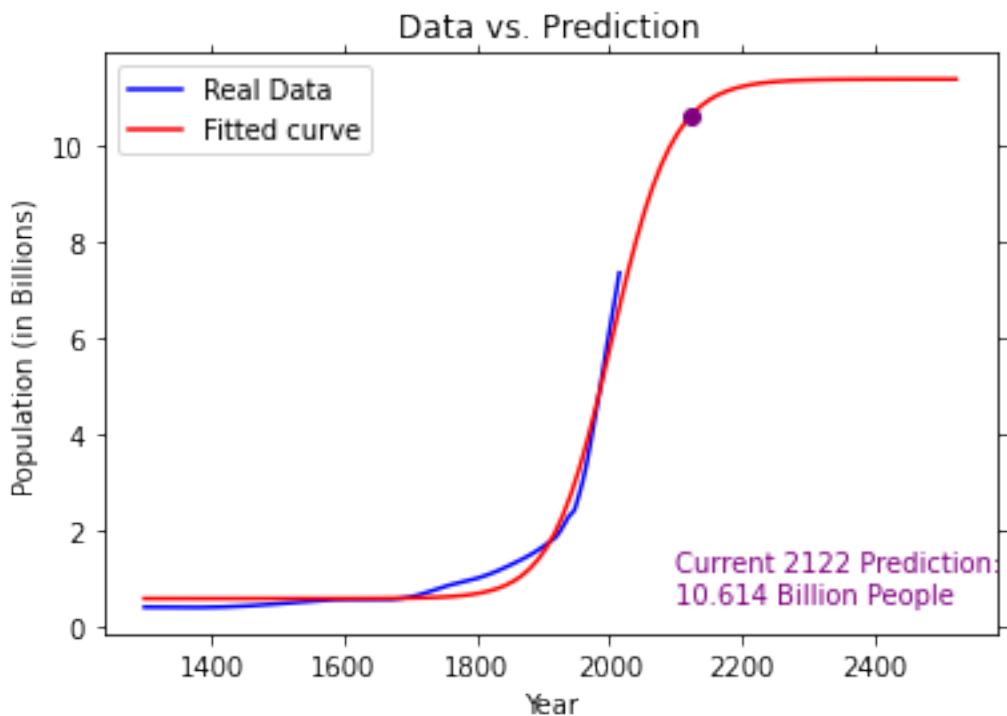
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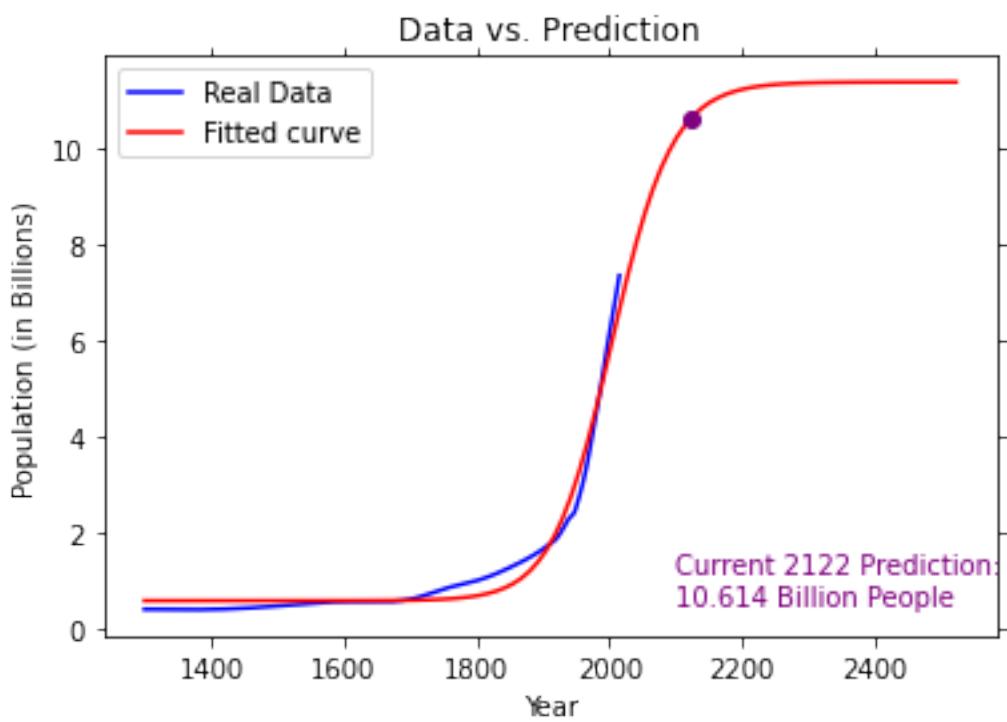
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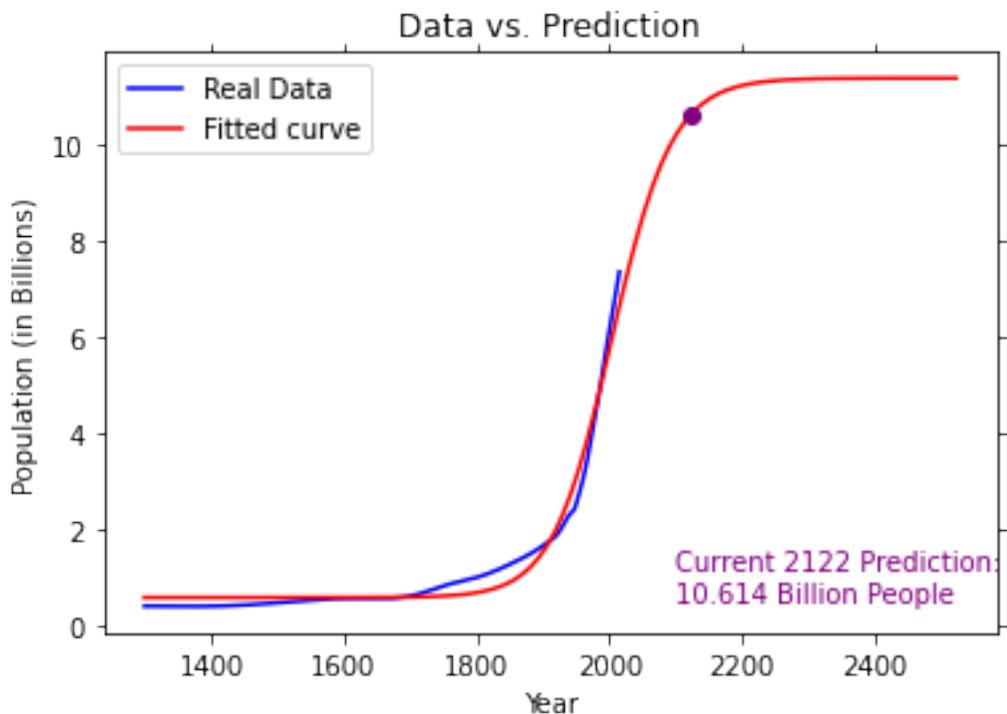
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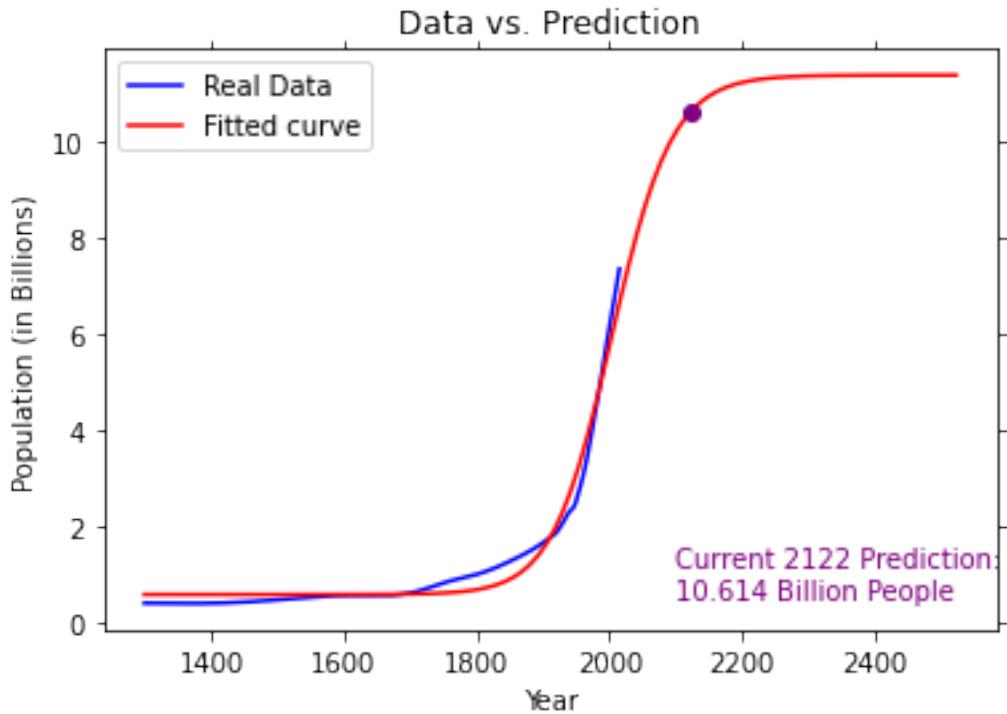
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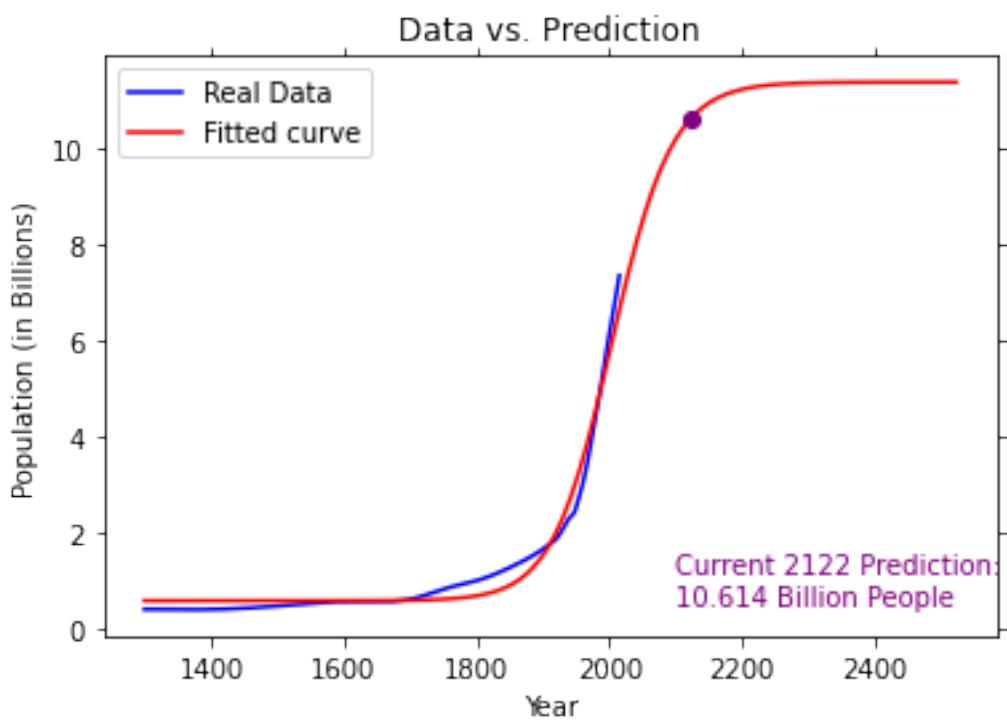
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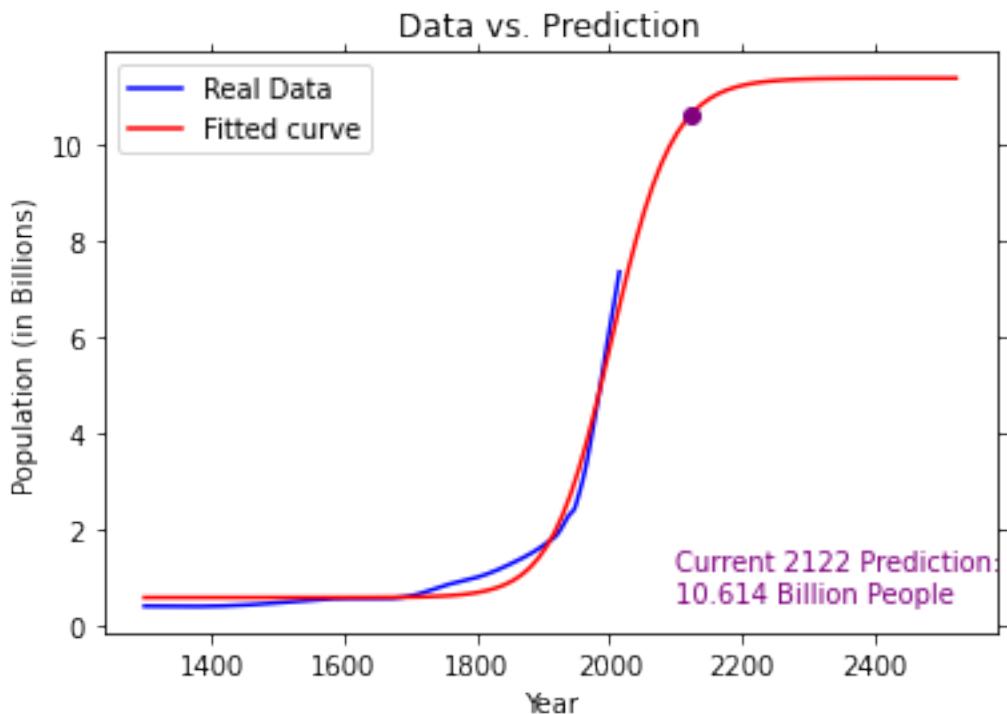
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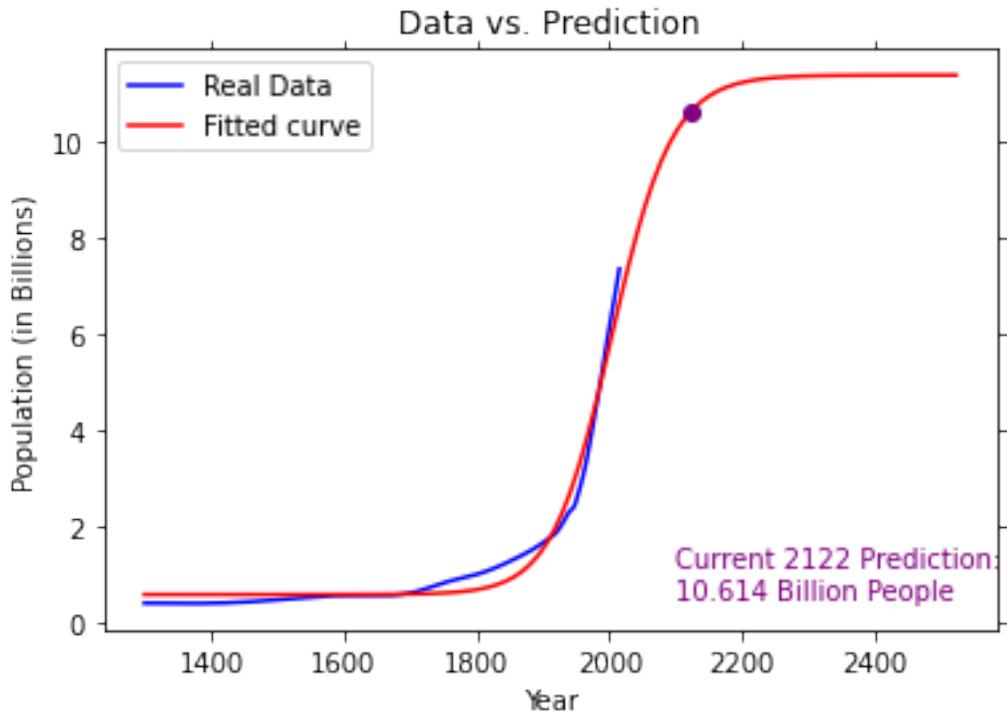
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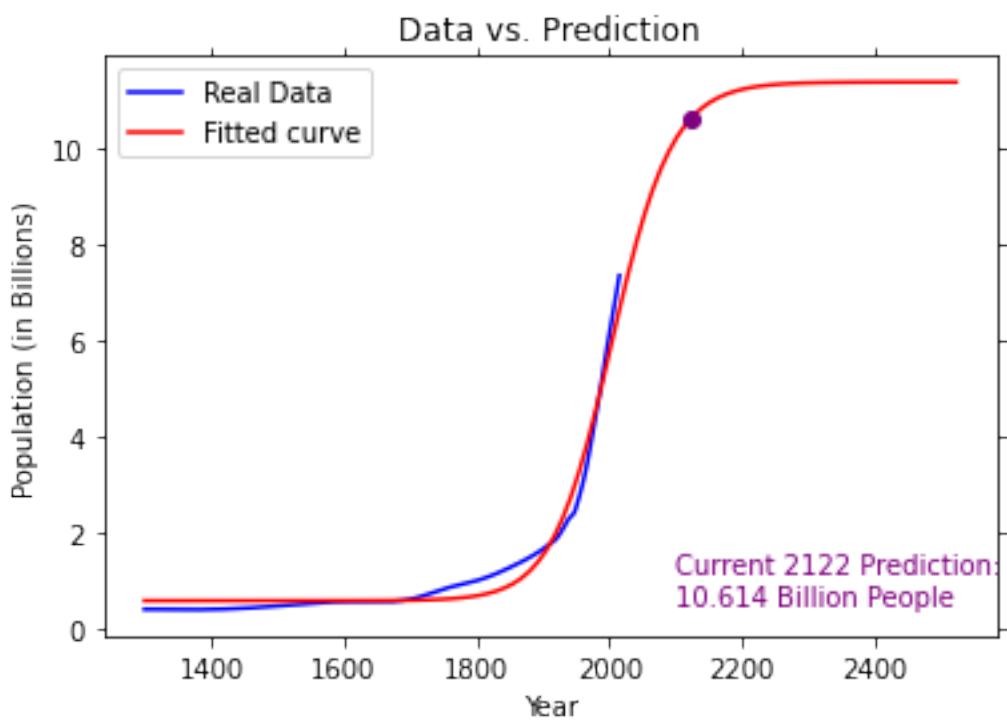
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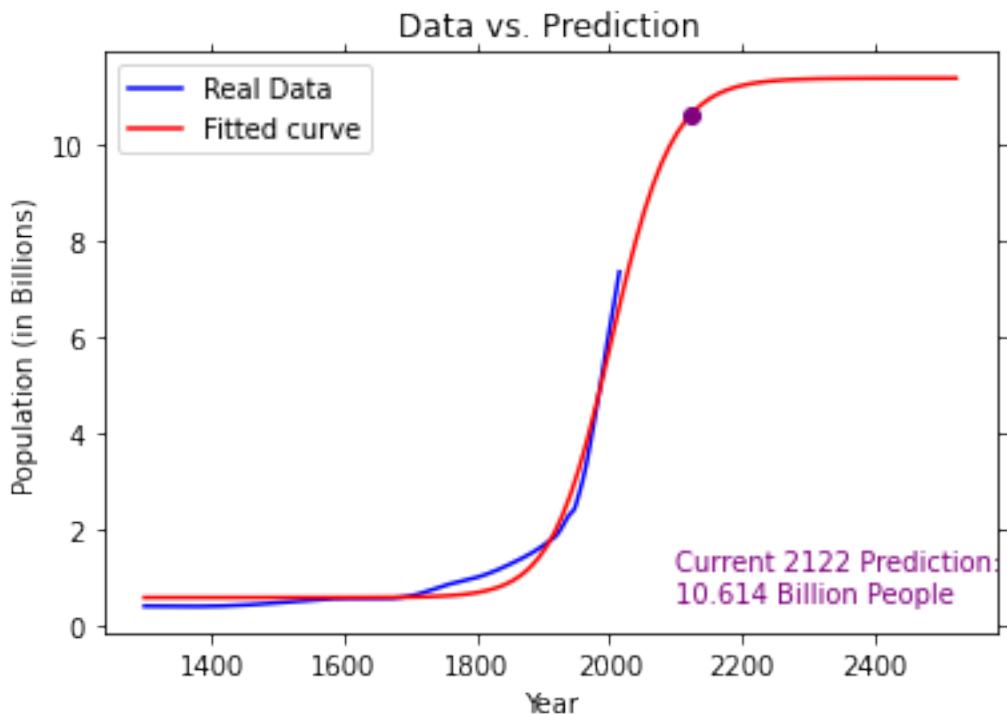
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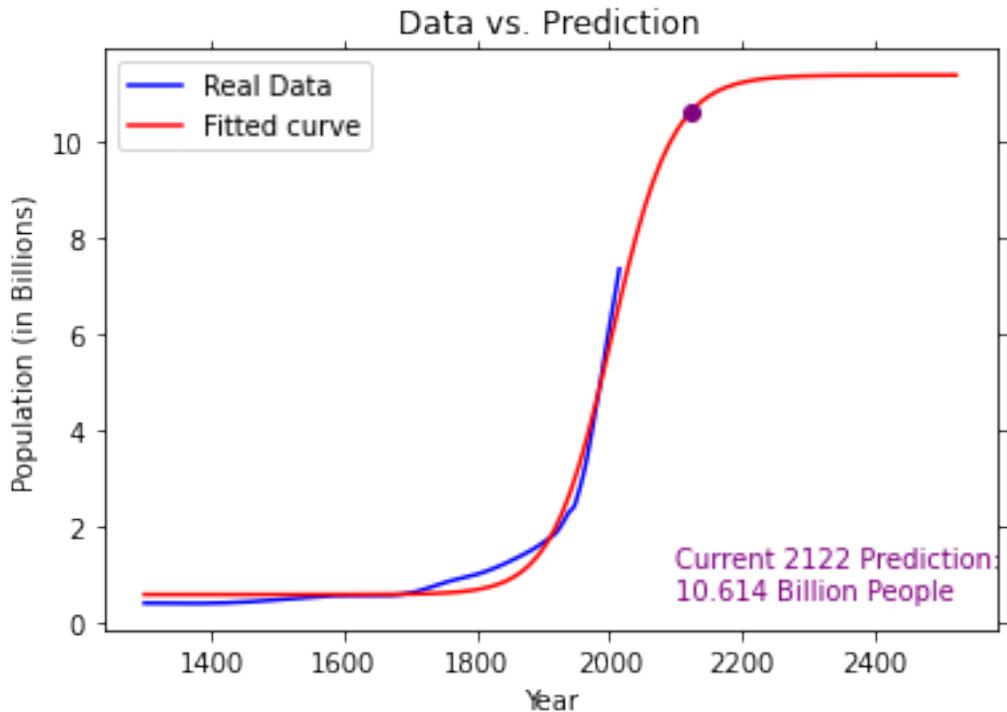
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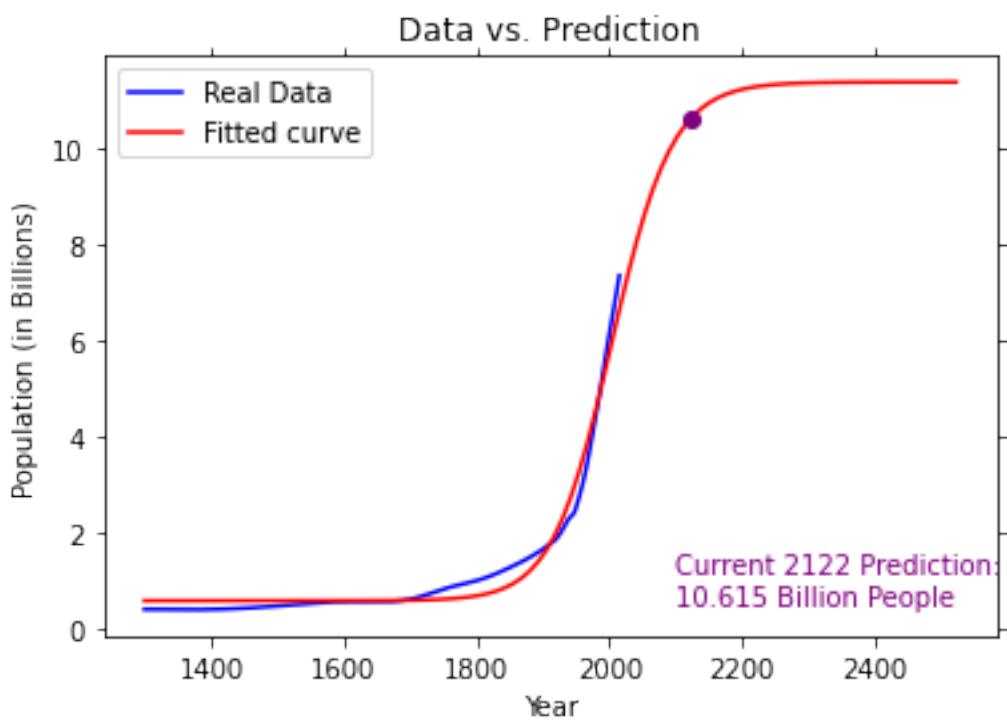
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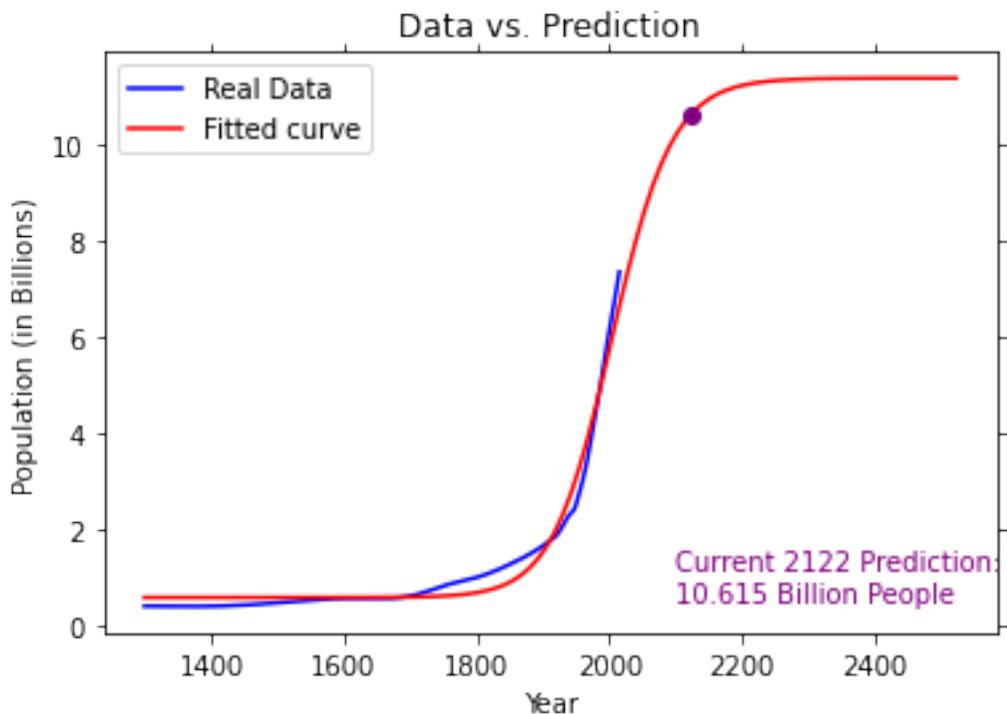
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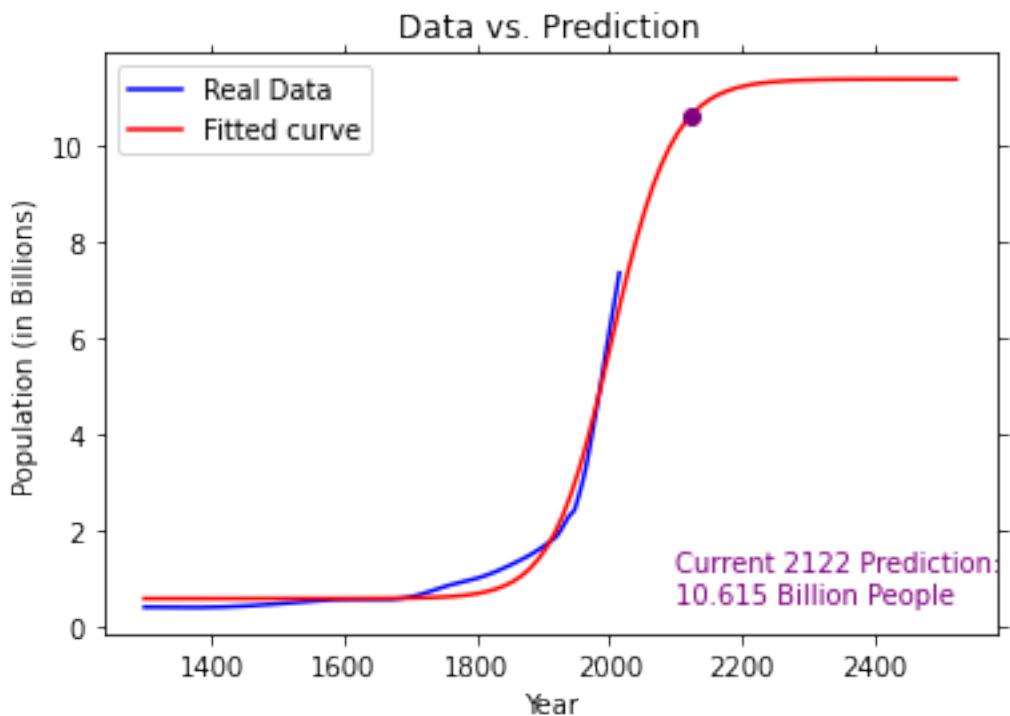
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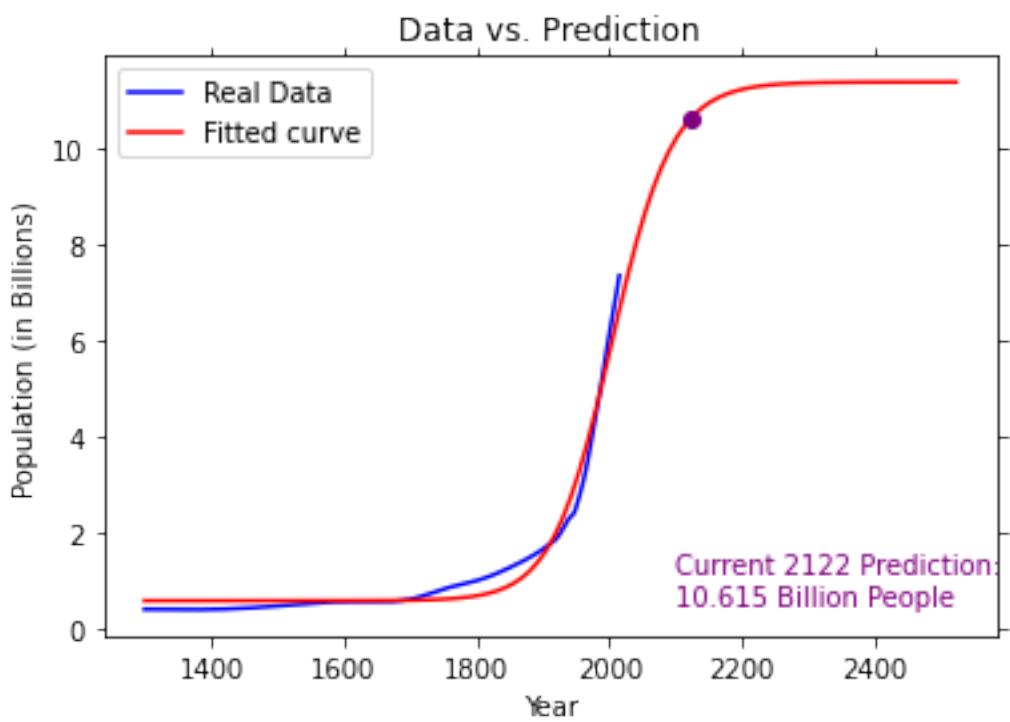
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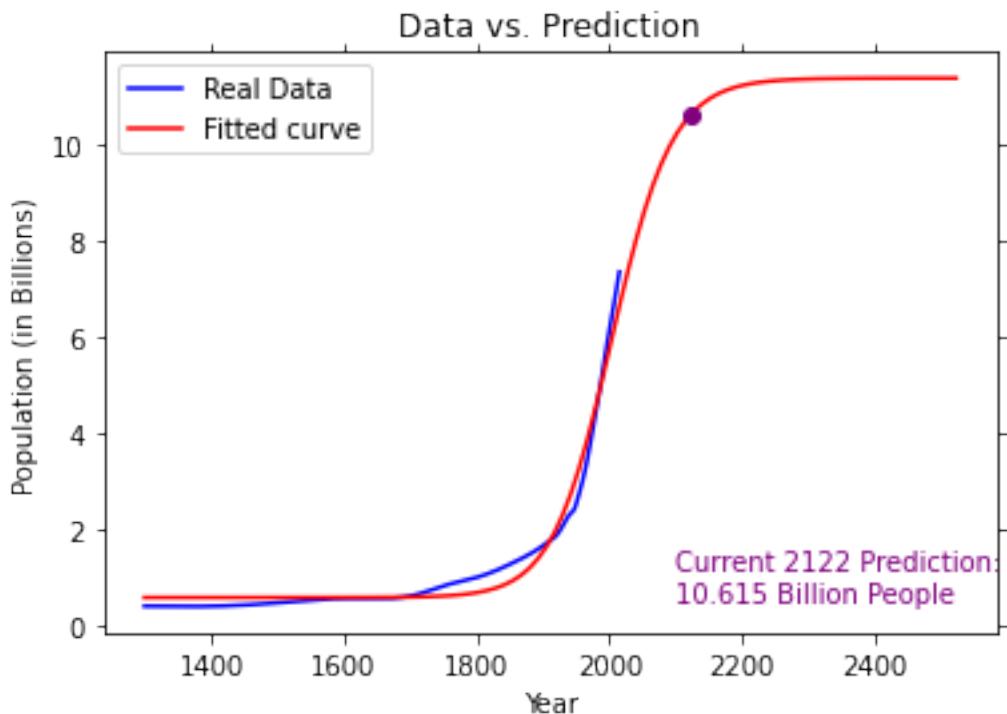
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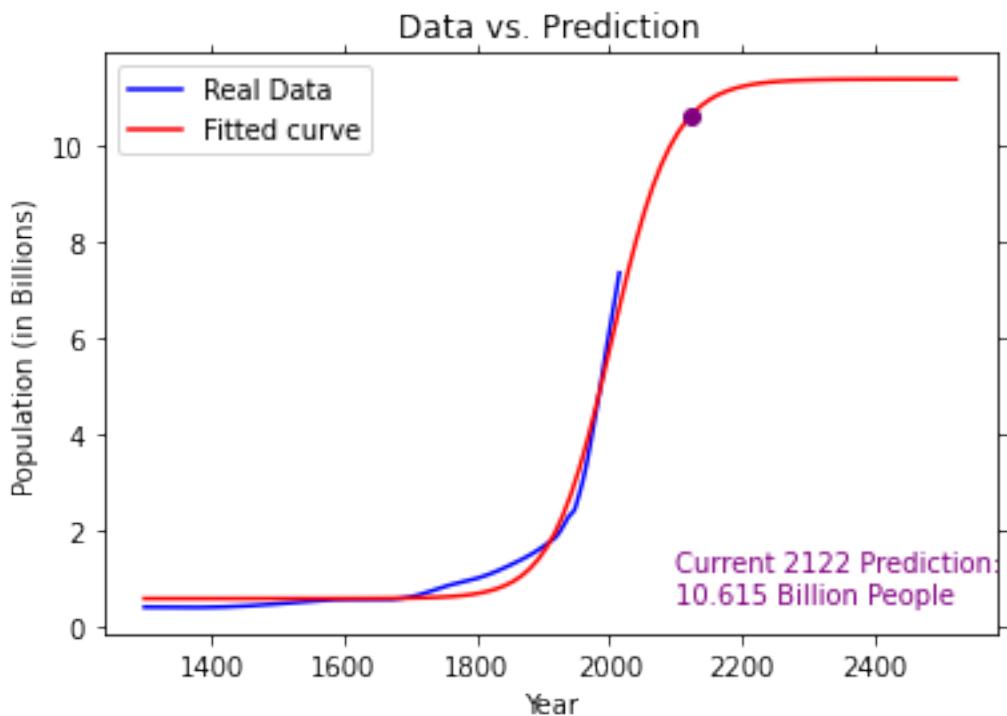
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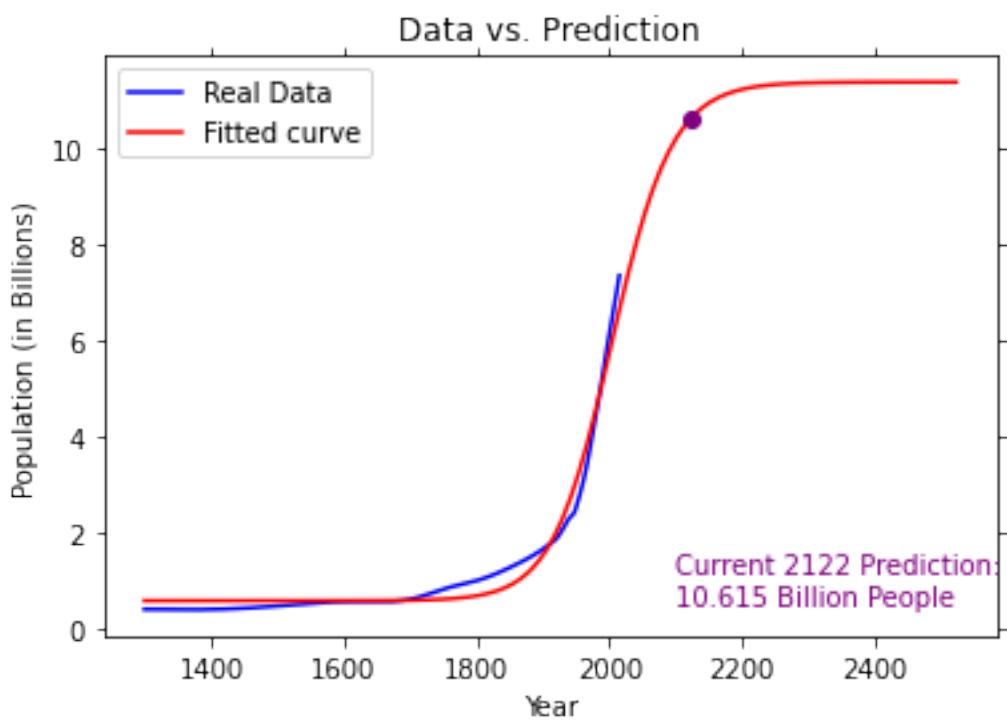
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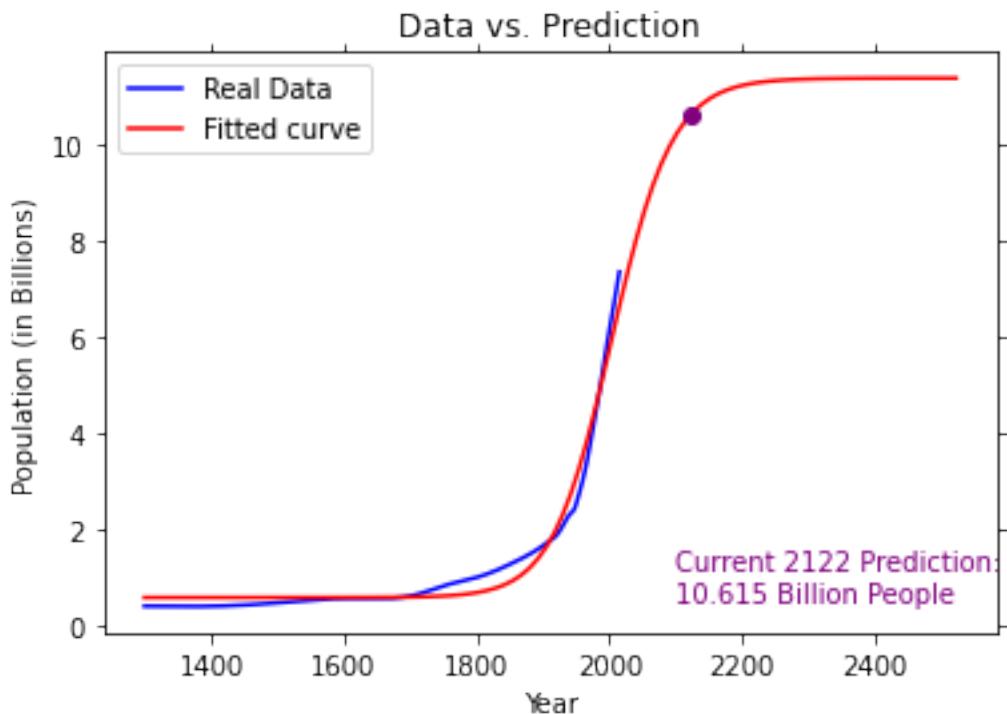
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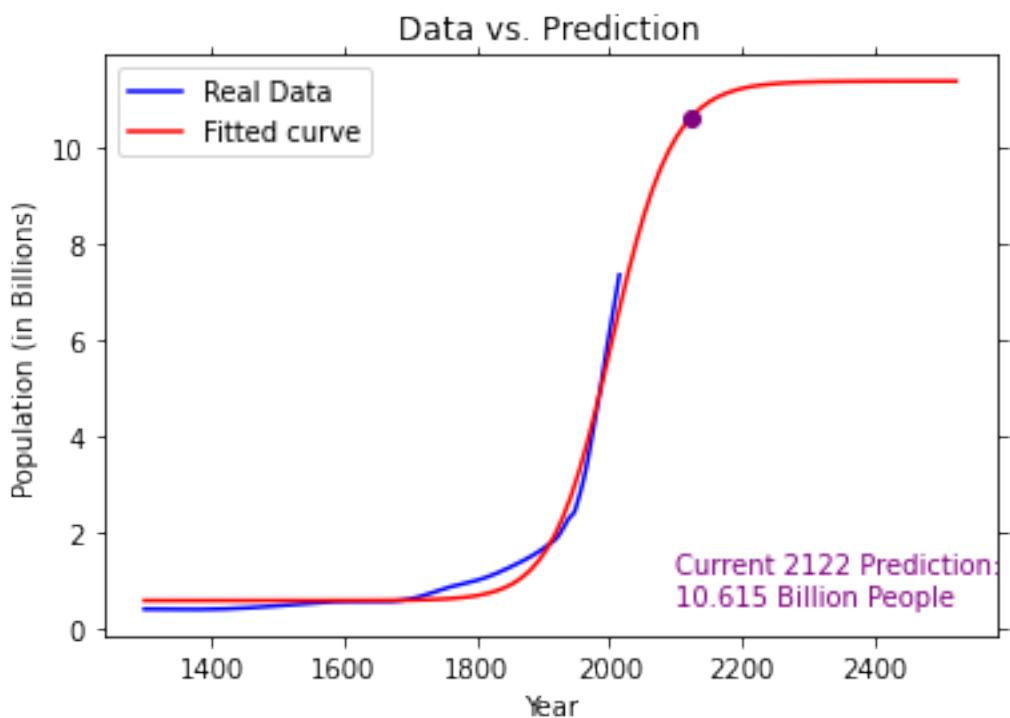
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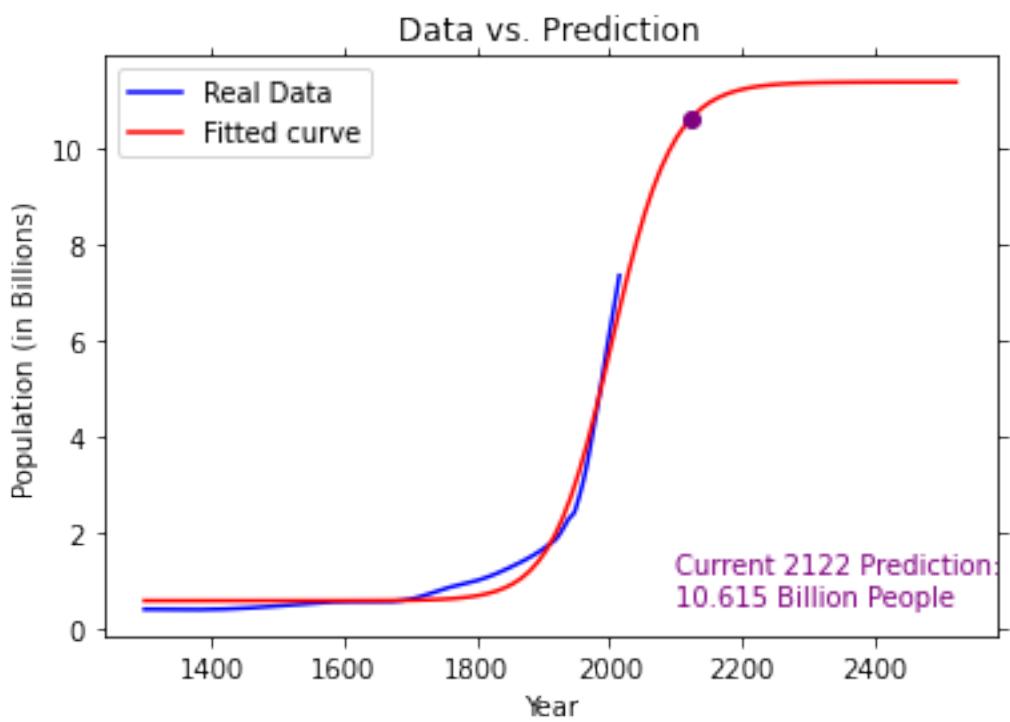
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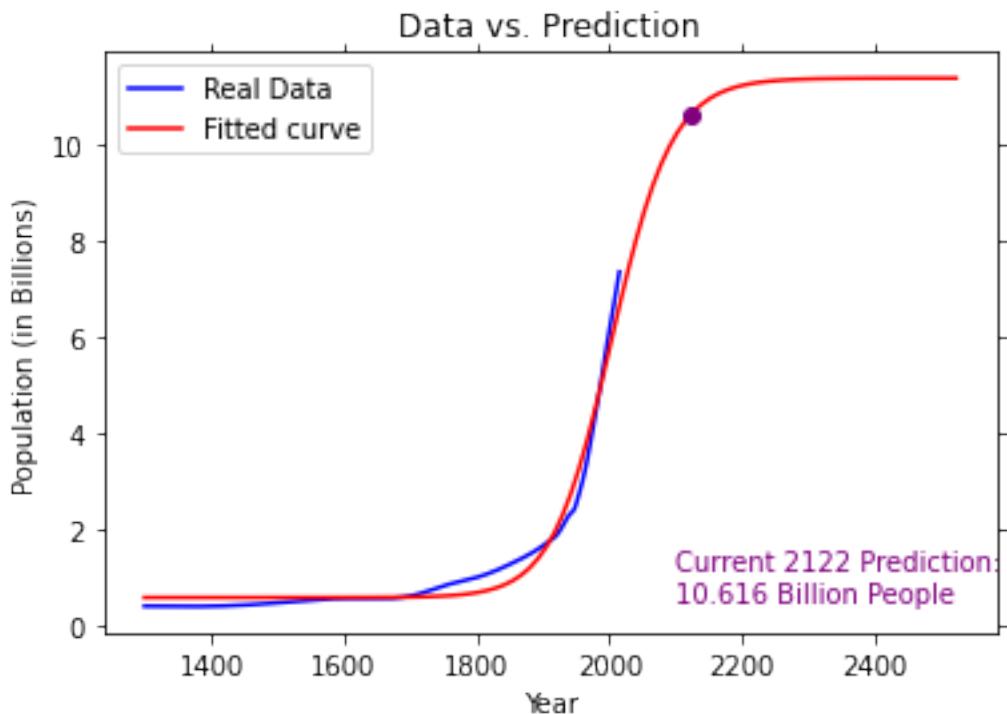
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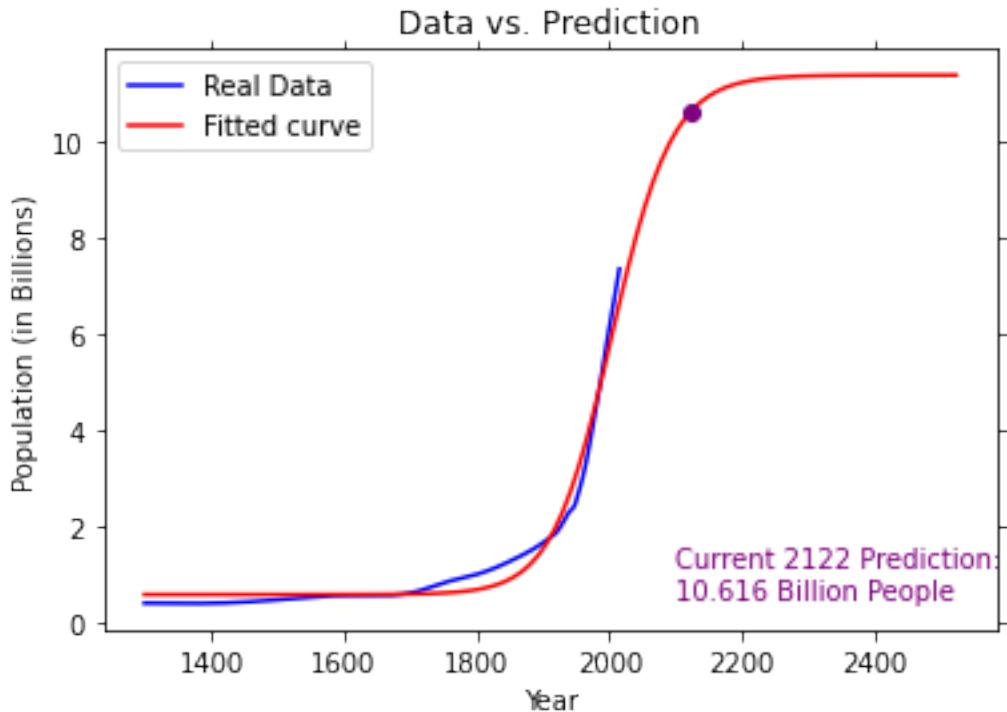
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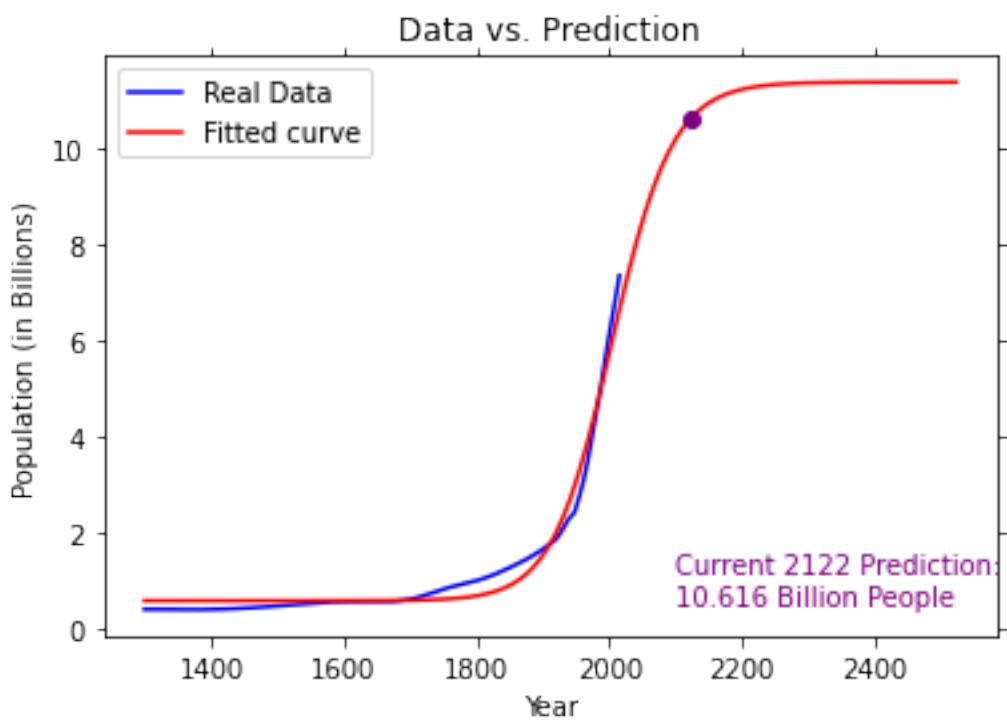
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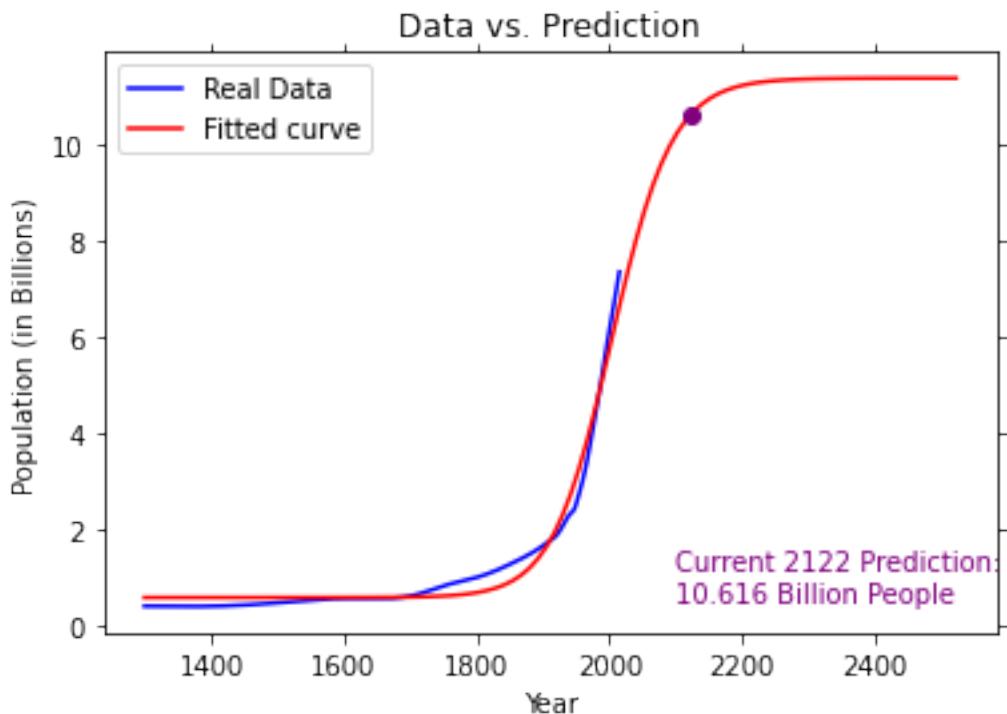
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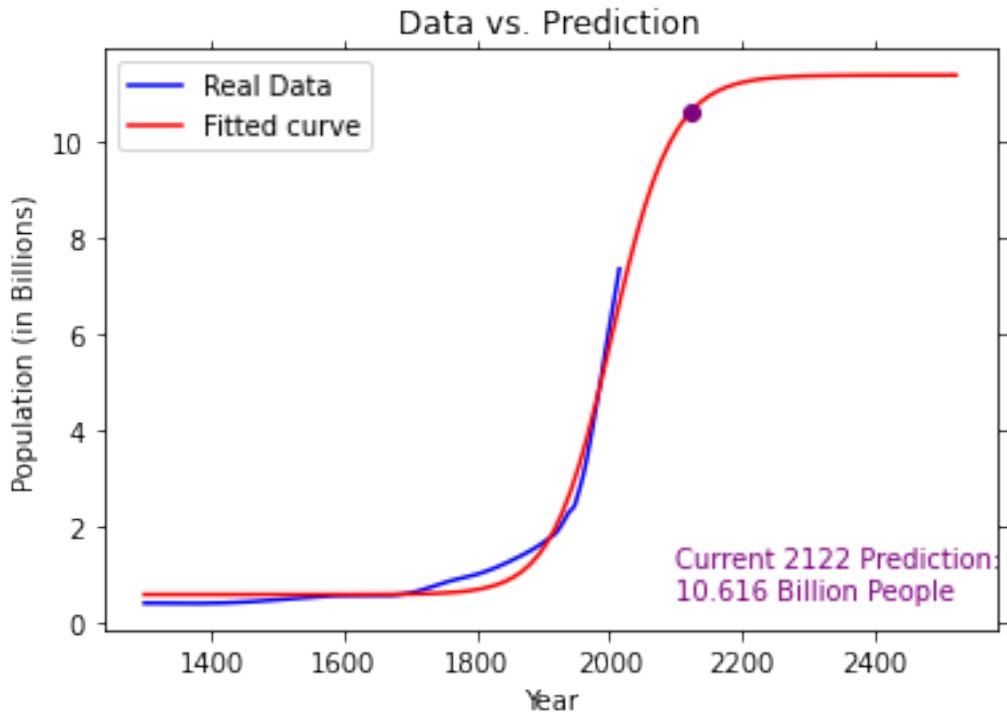
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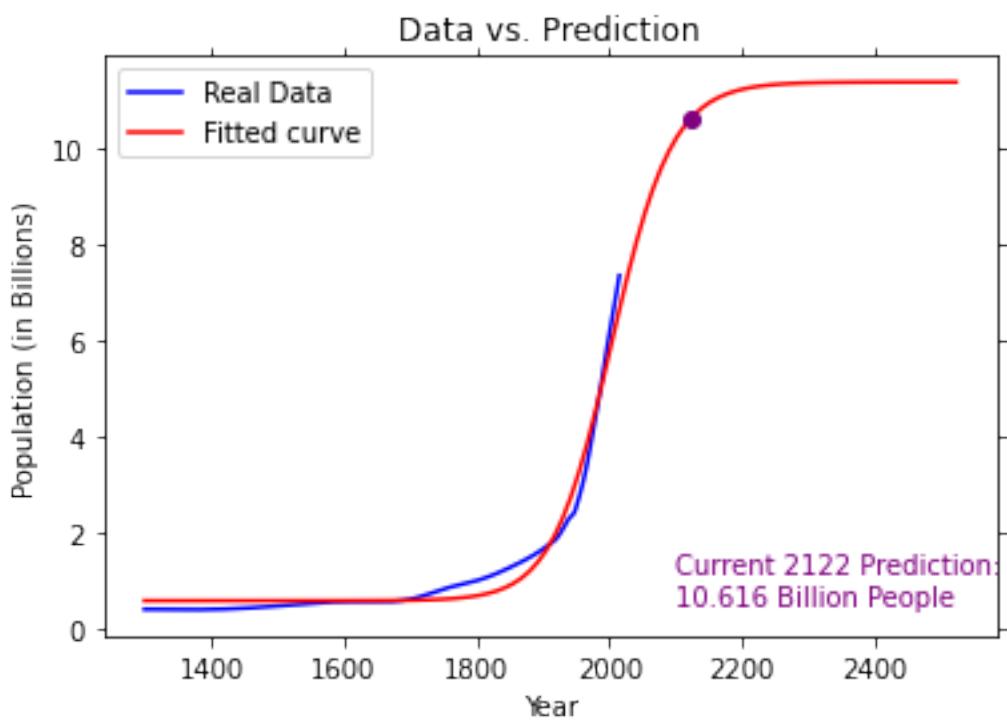
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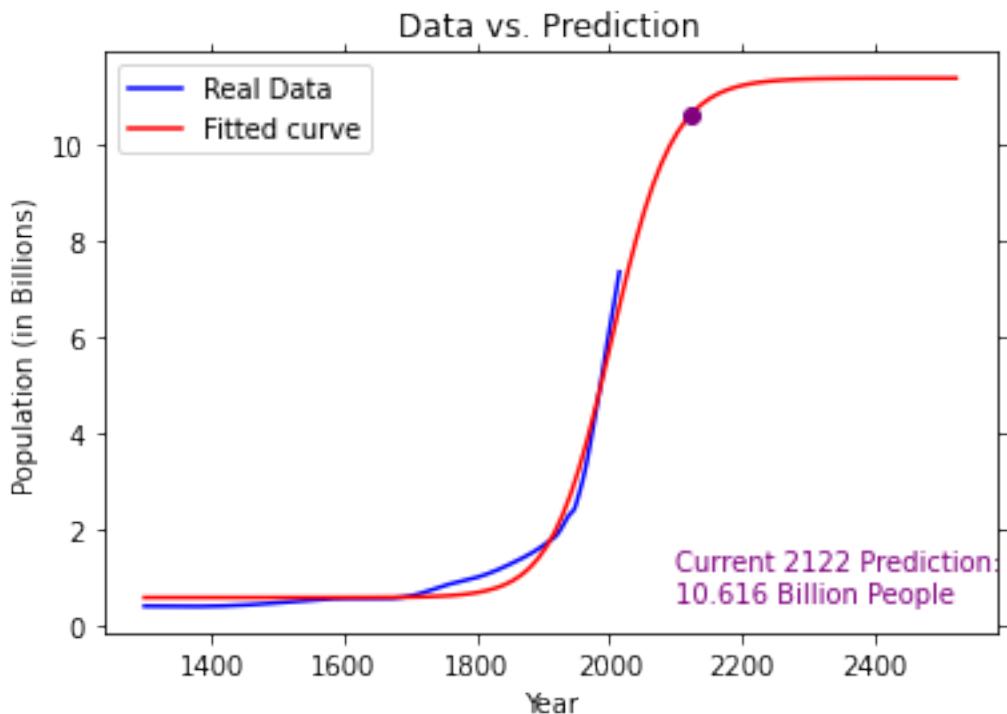
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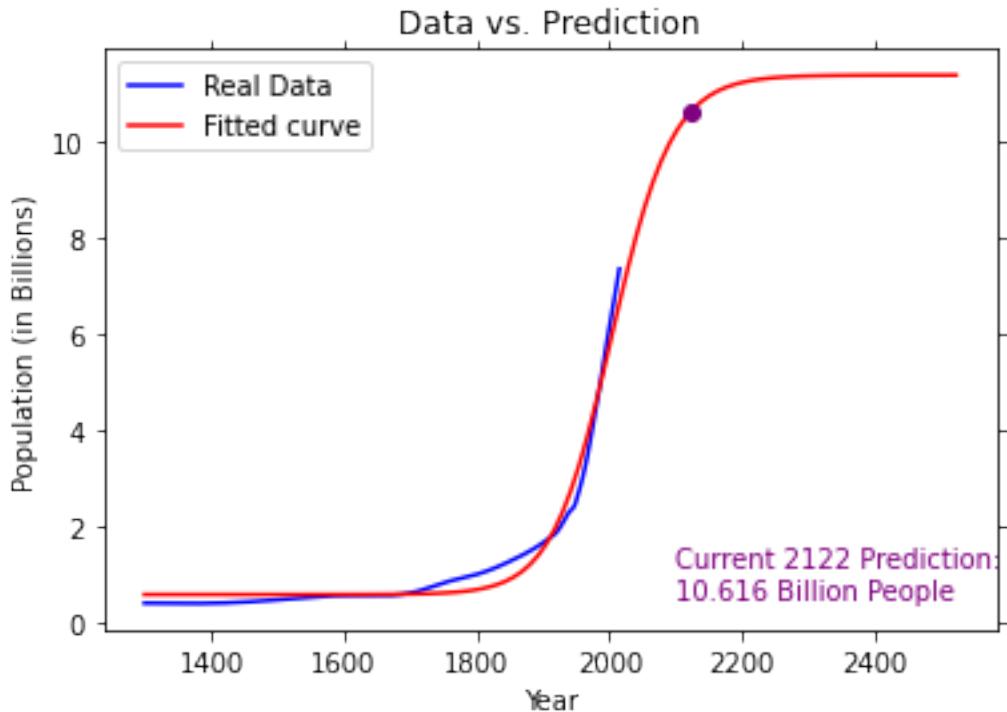
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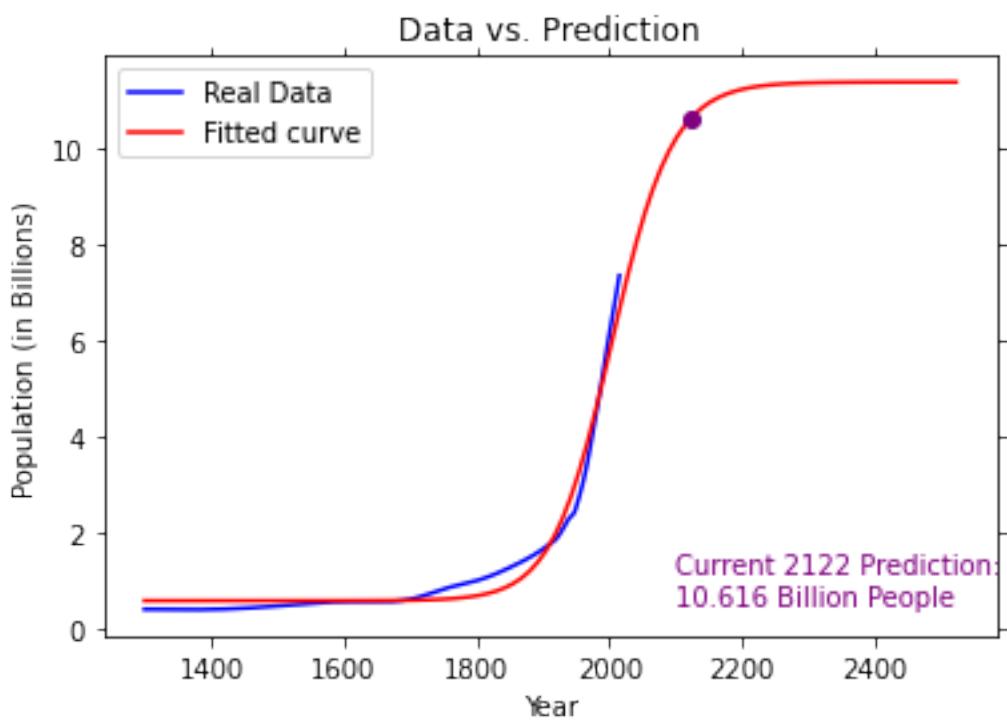
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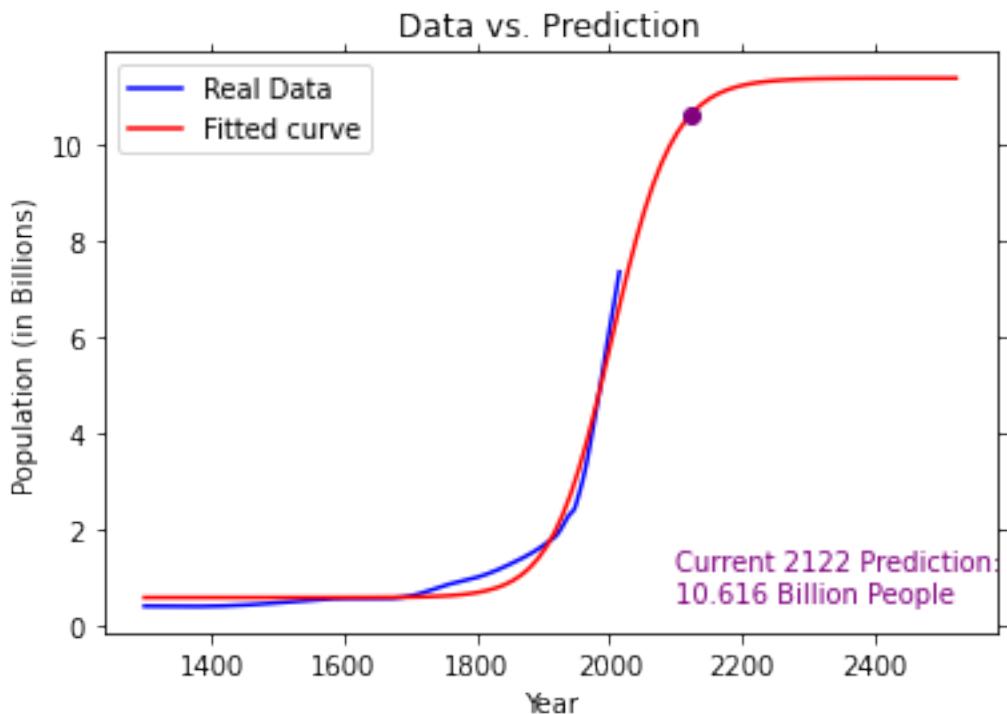
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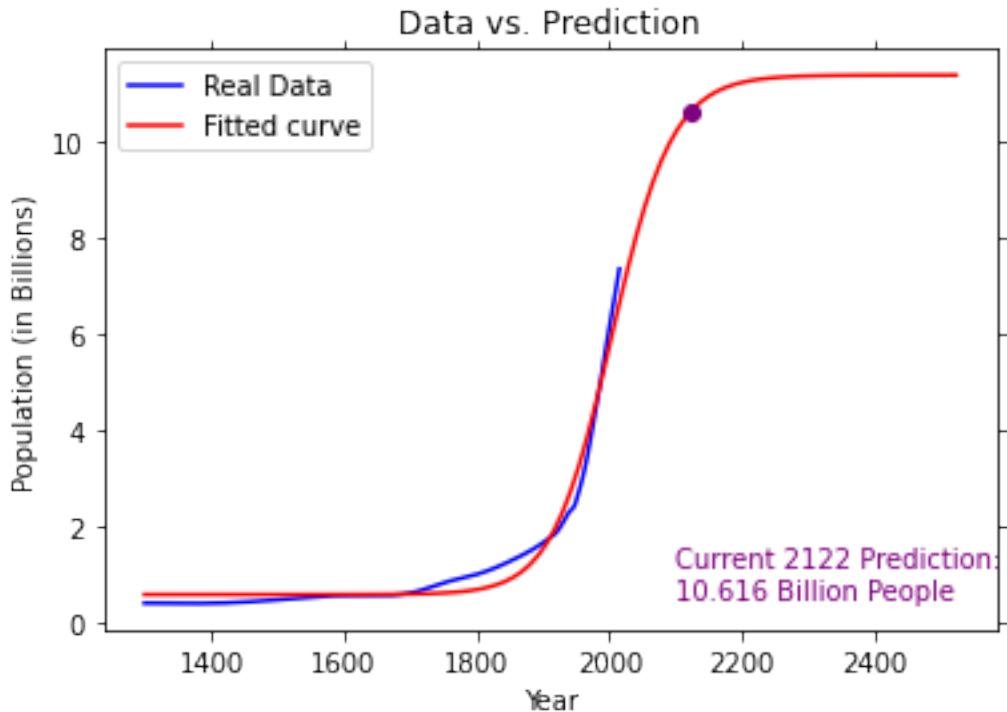
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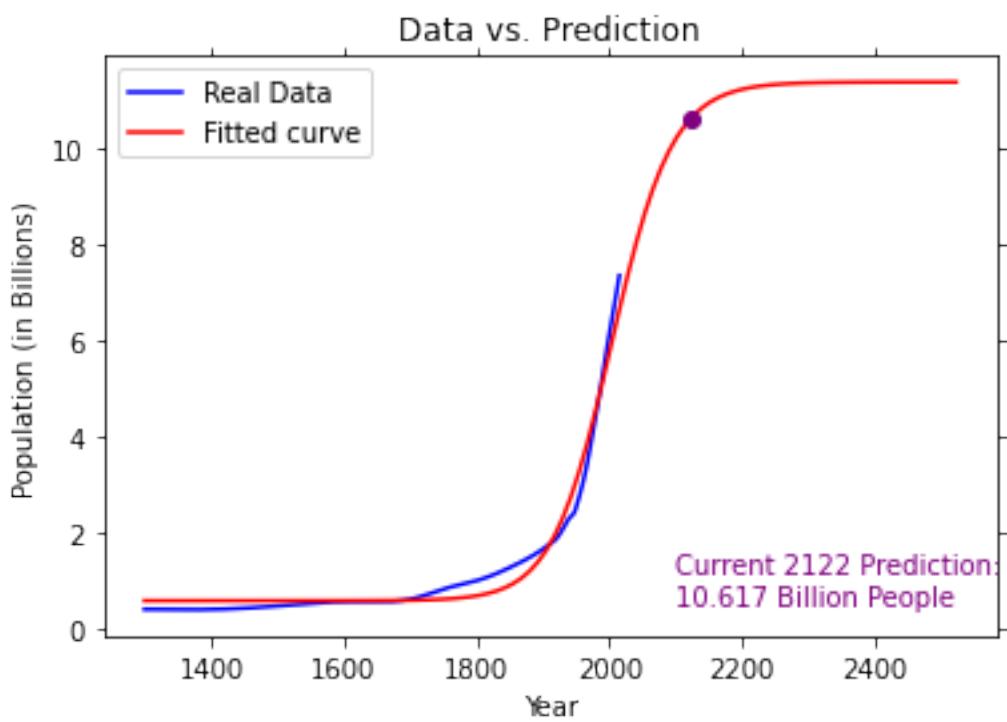
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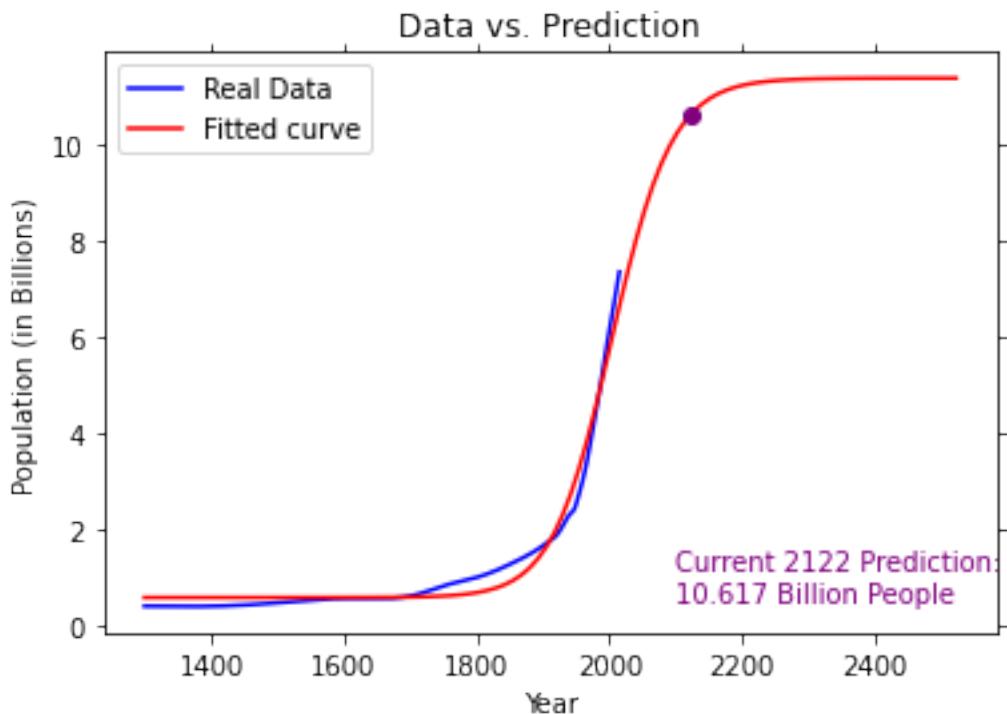
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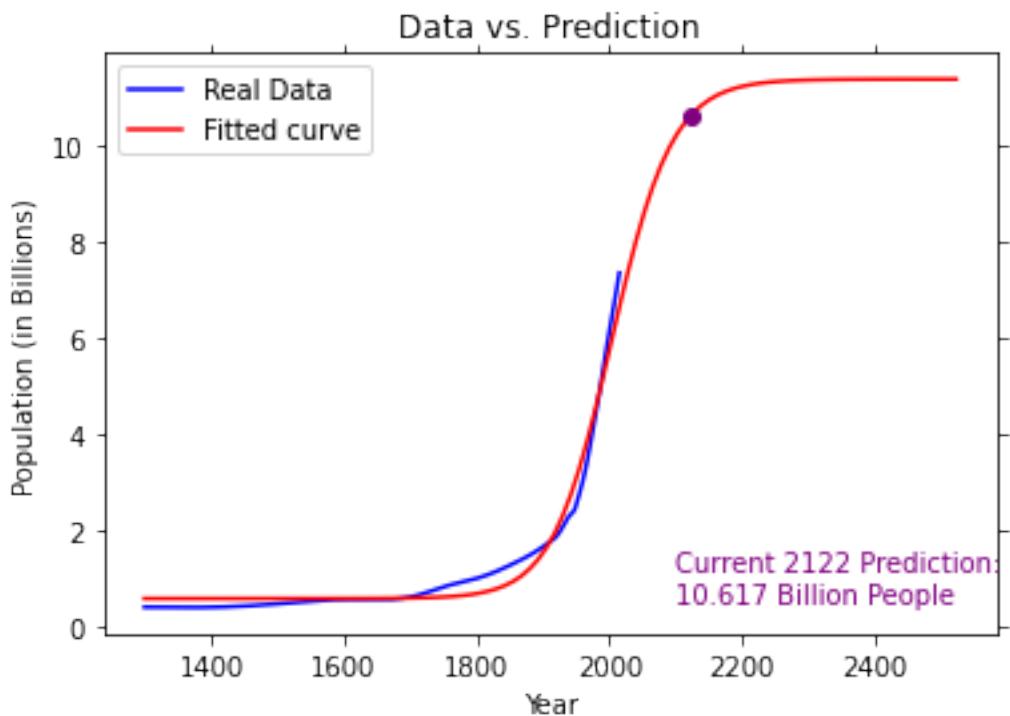
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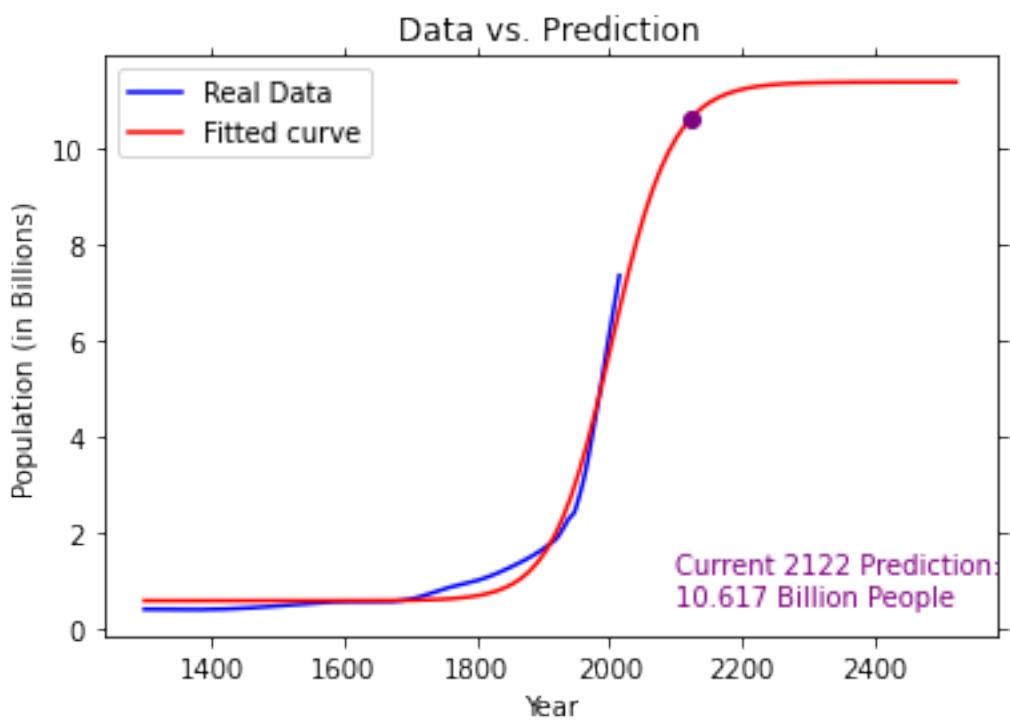
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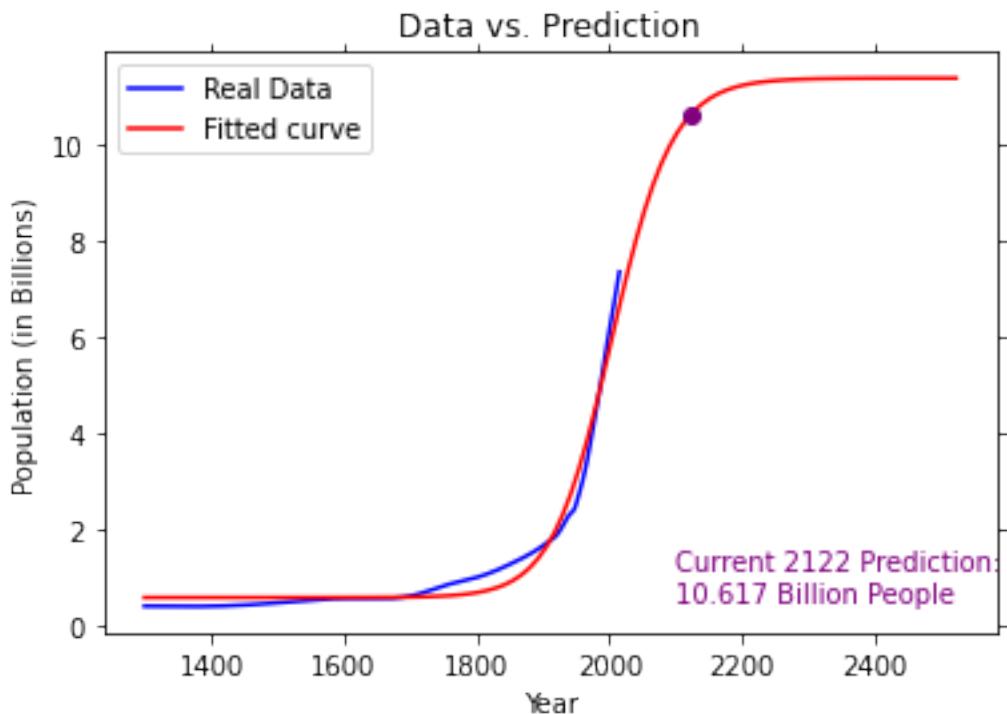
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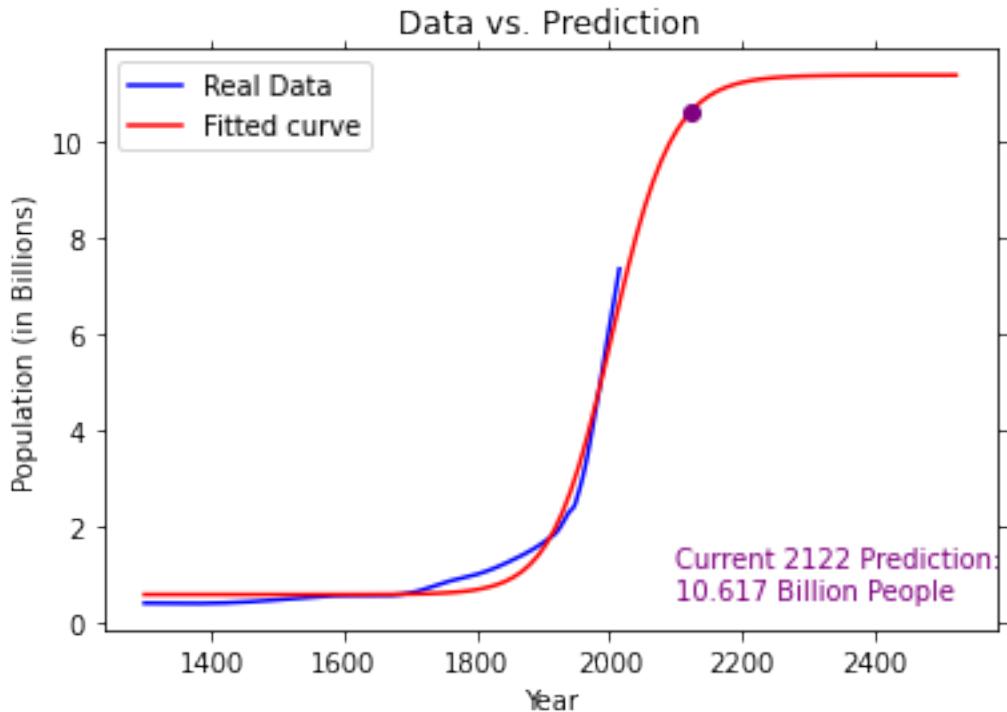
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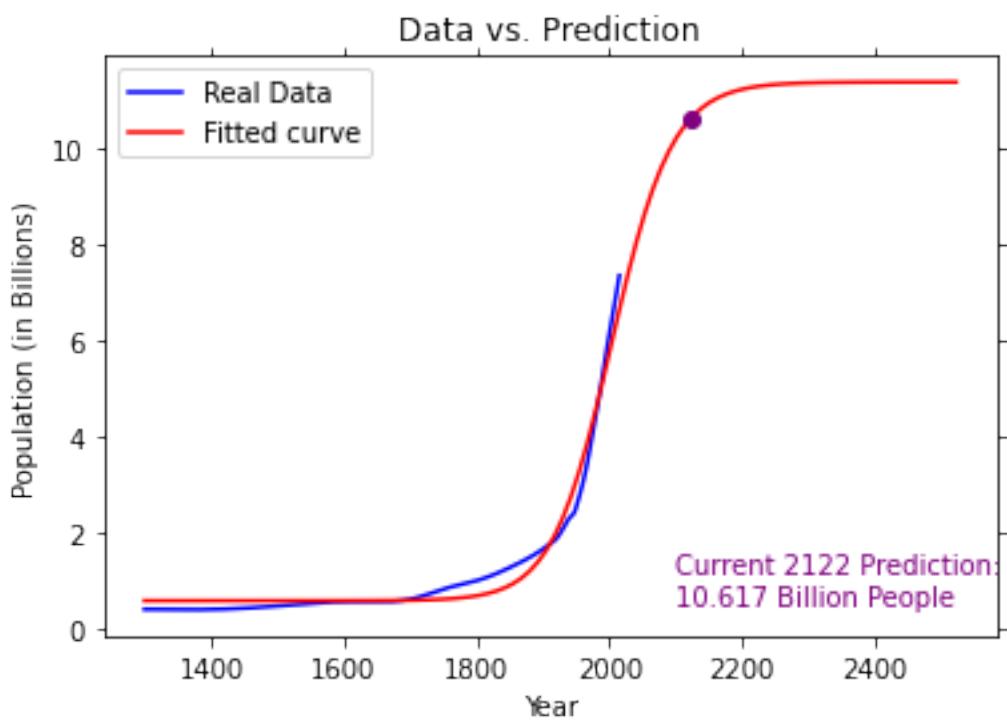
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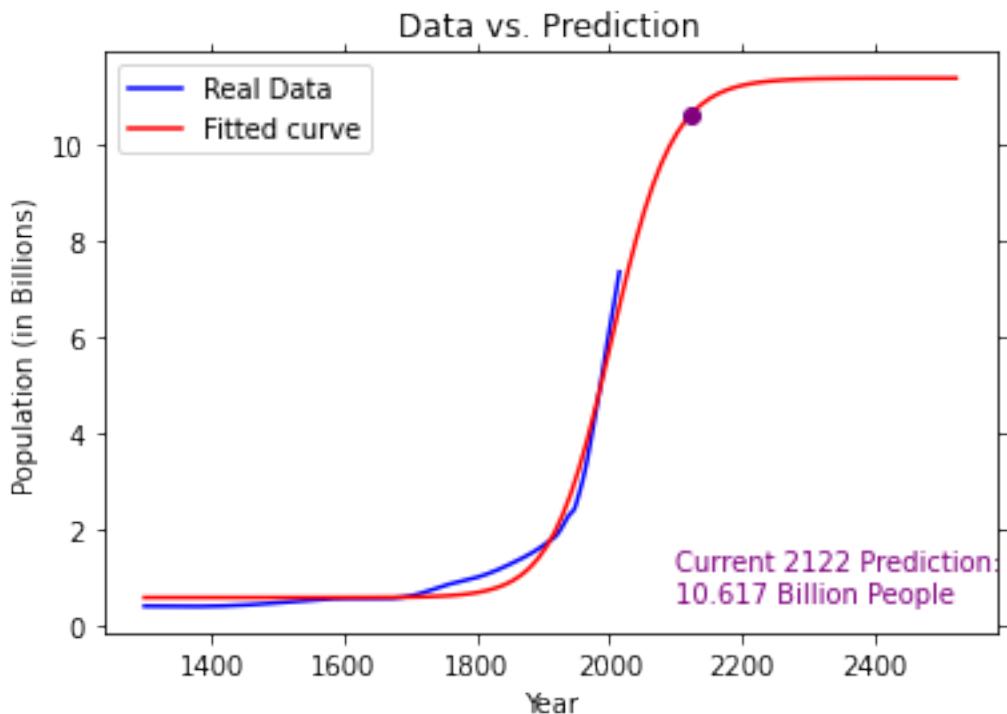
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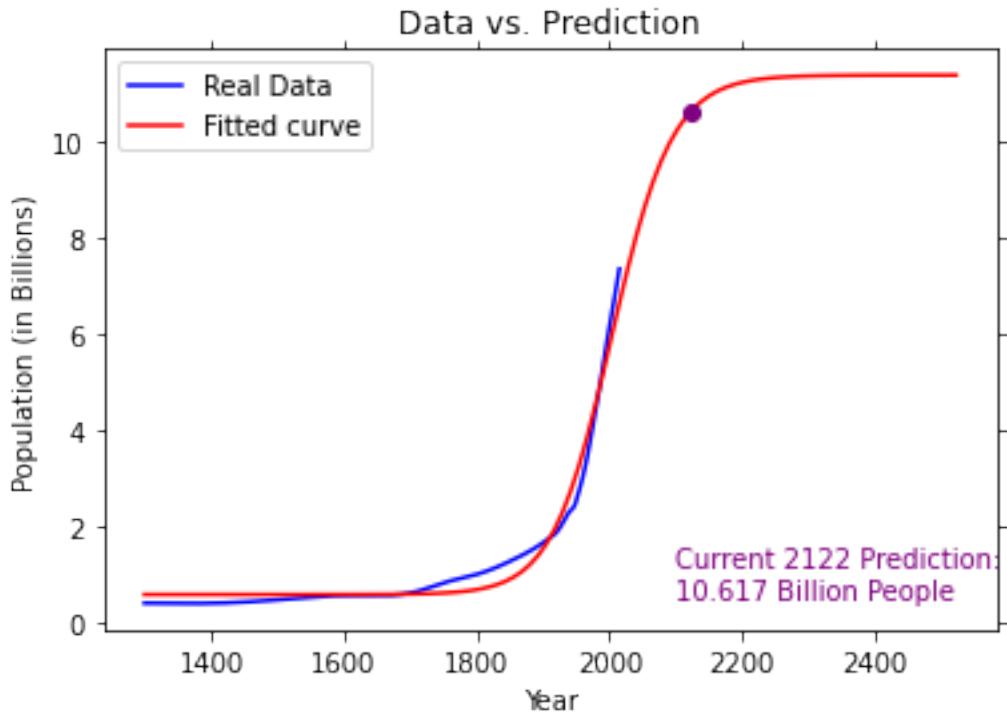
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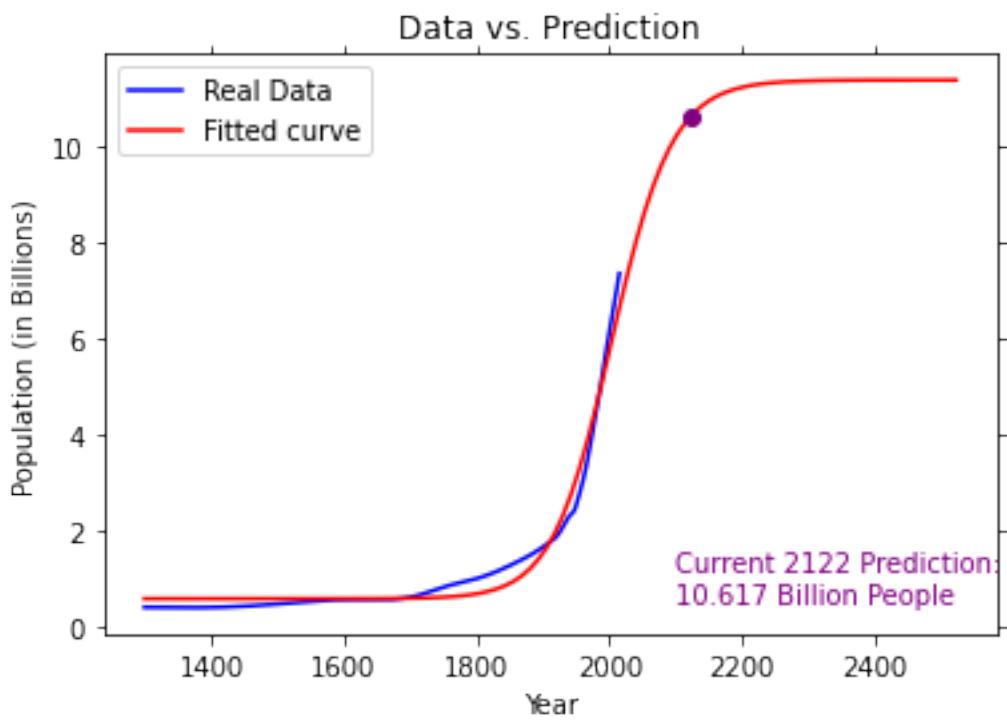
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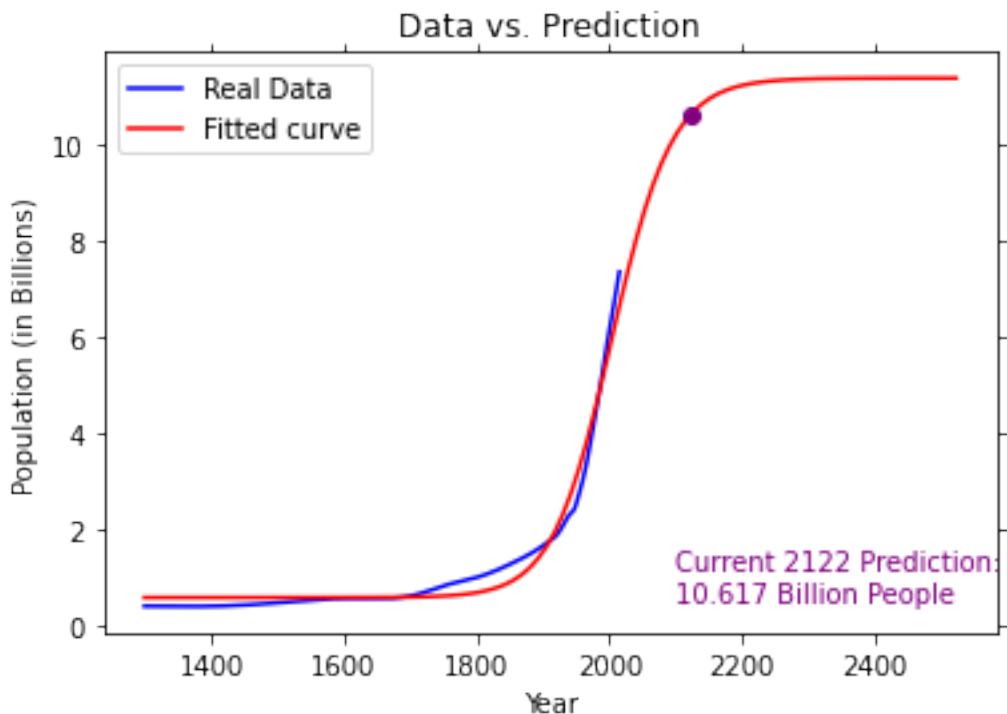
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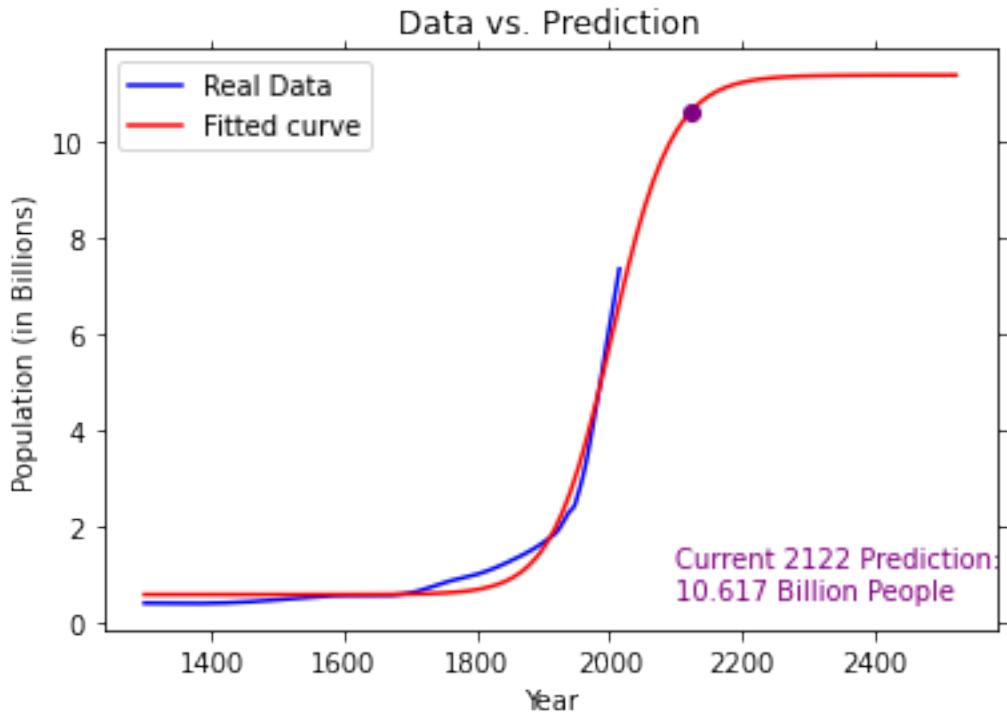
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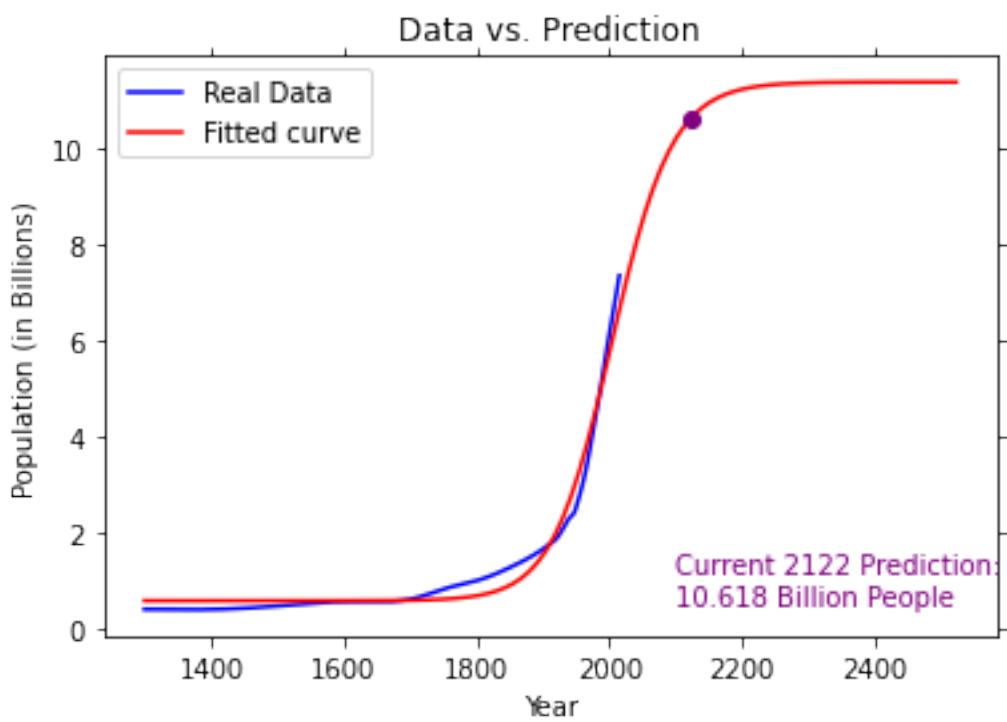
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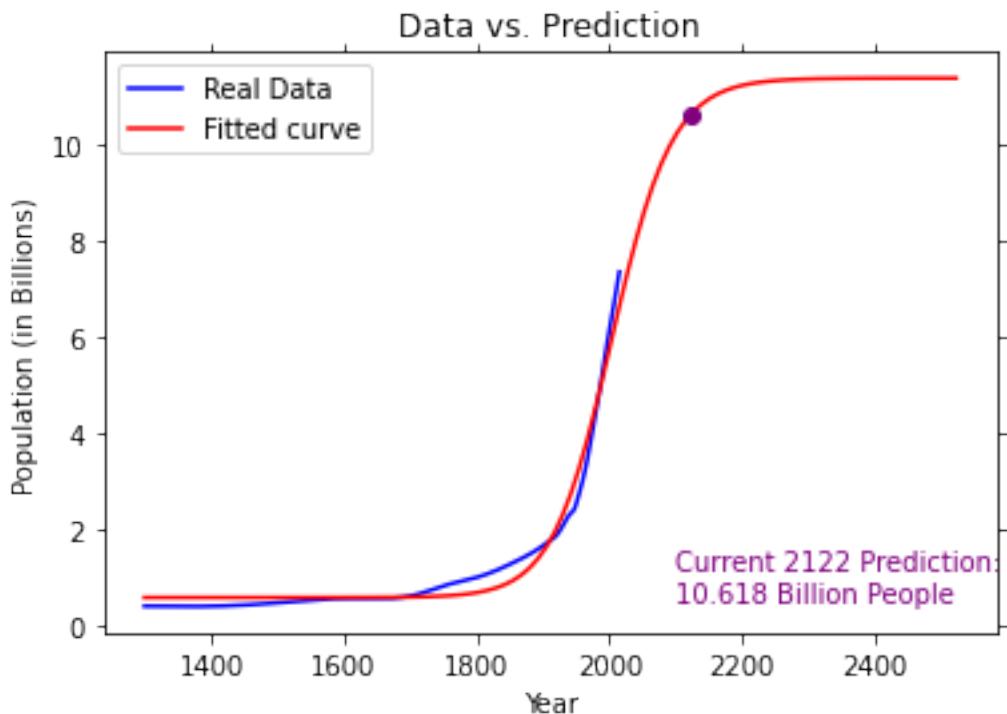
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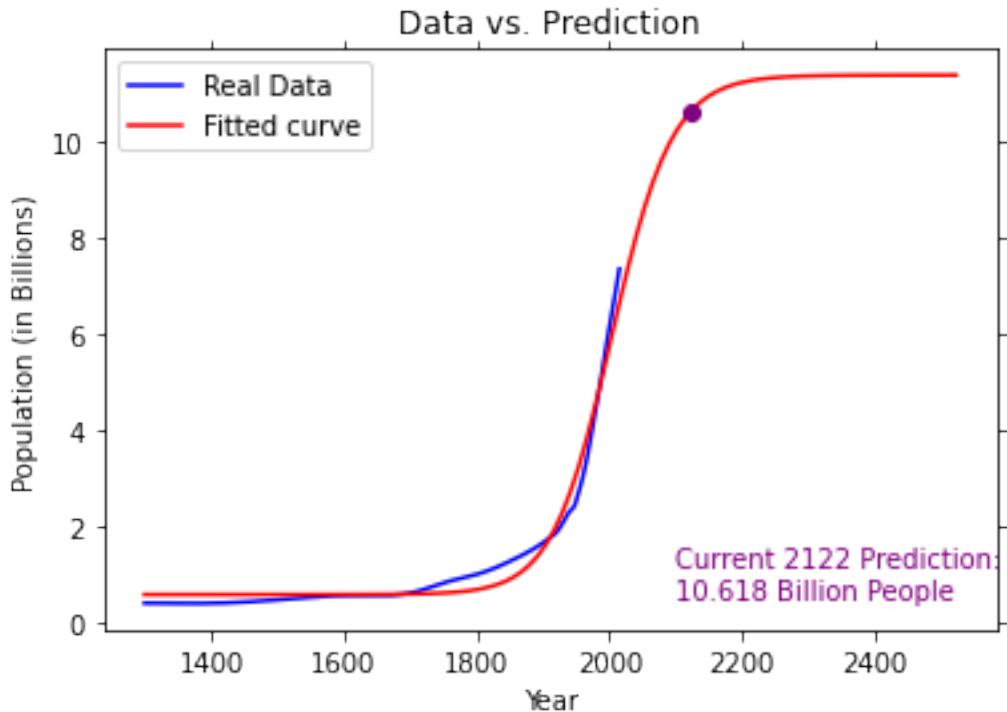
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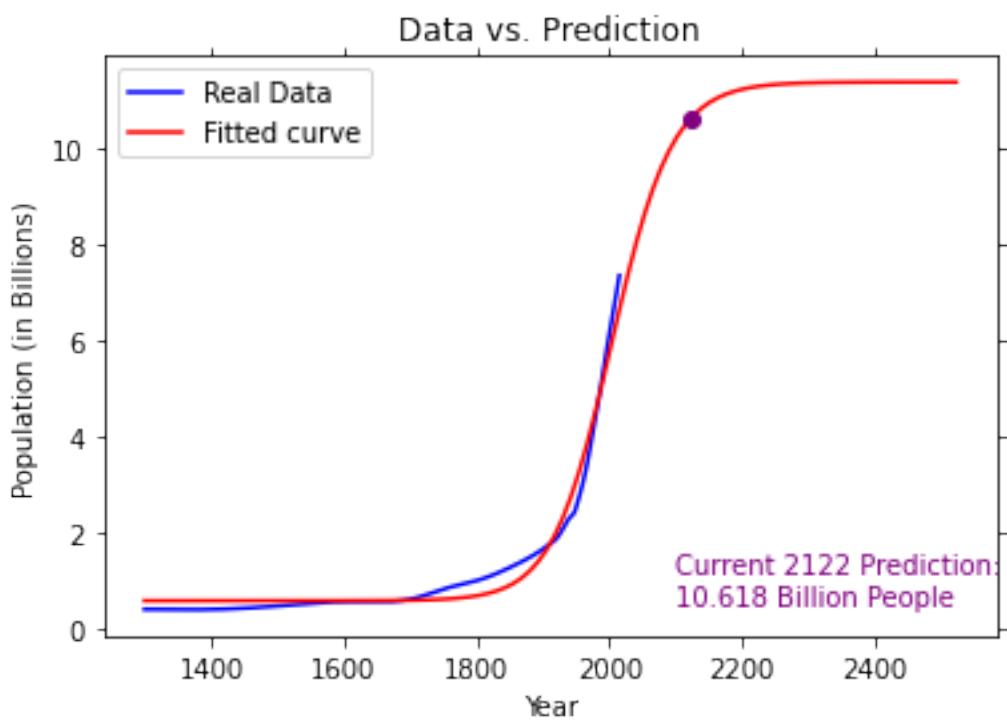
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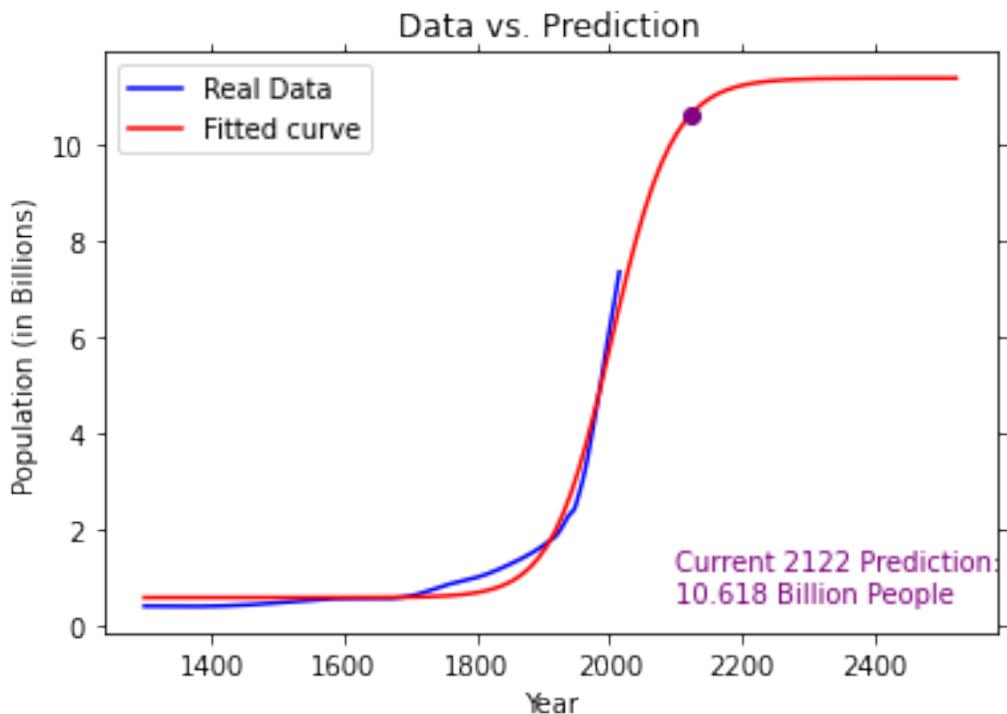
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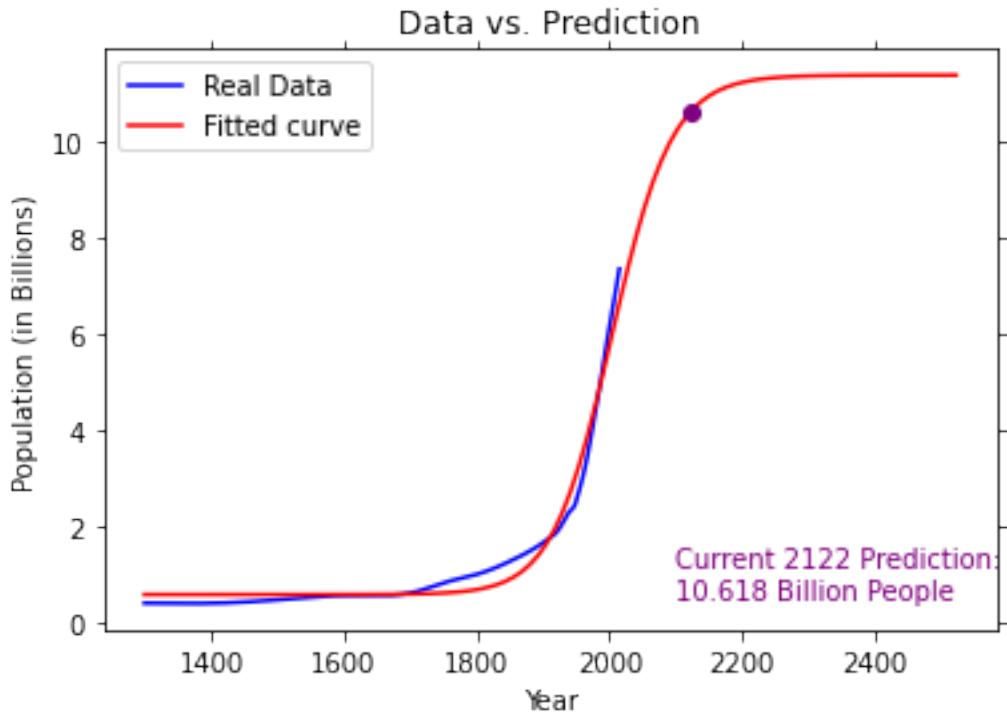
Iteration #38000, Loss: 0.050836955905748486



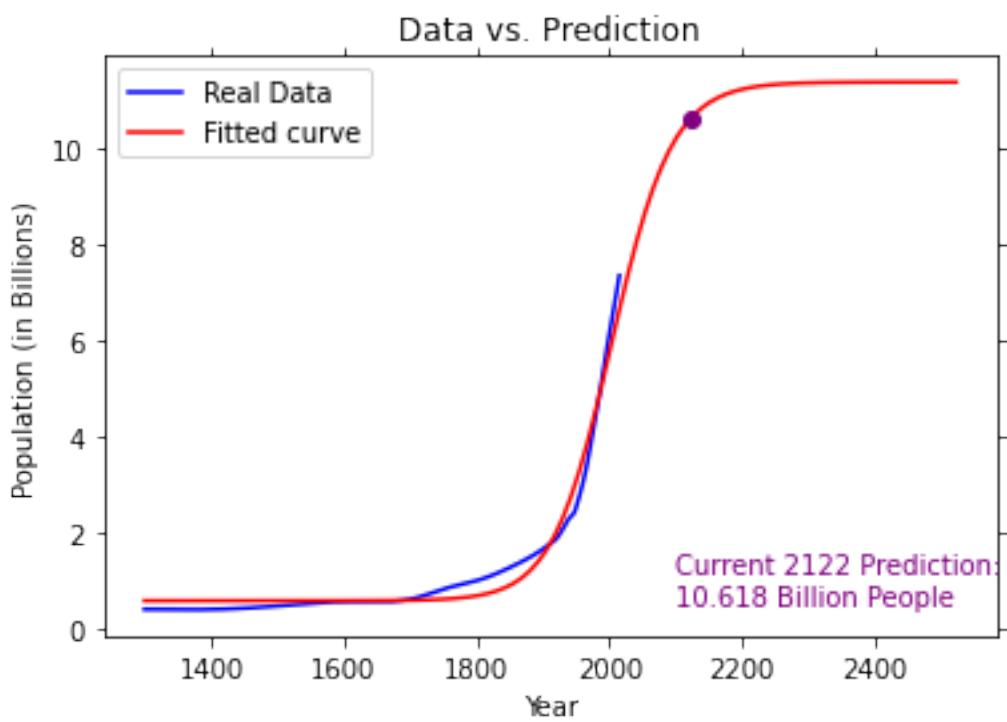
Iteration #38050, Loss: 0.050833288700367435



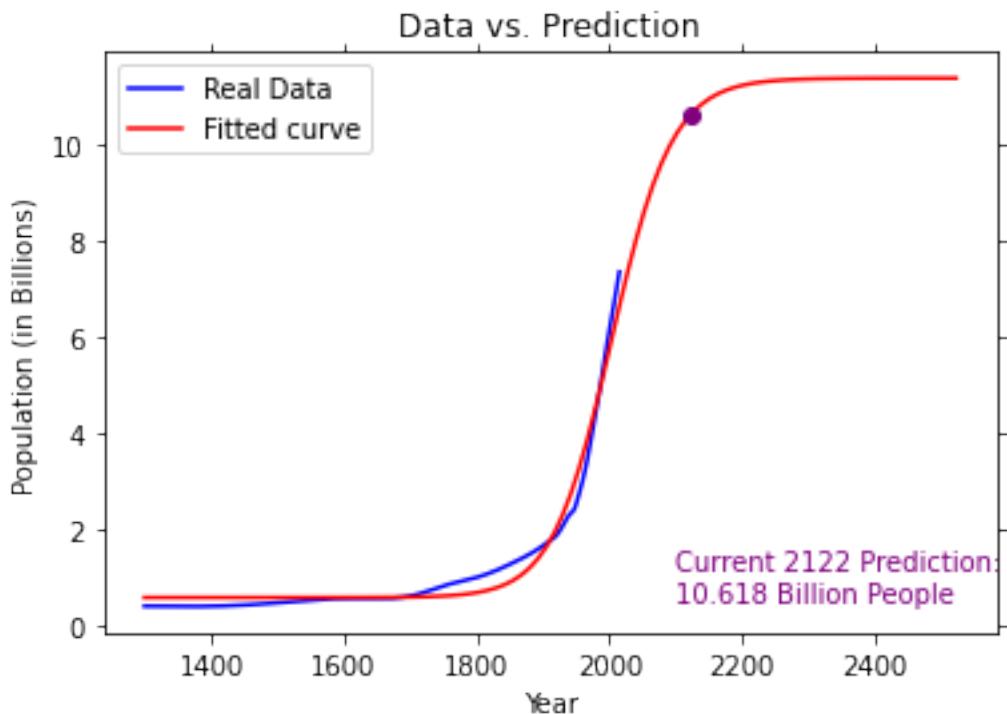
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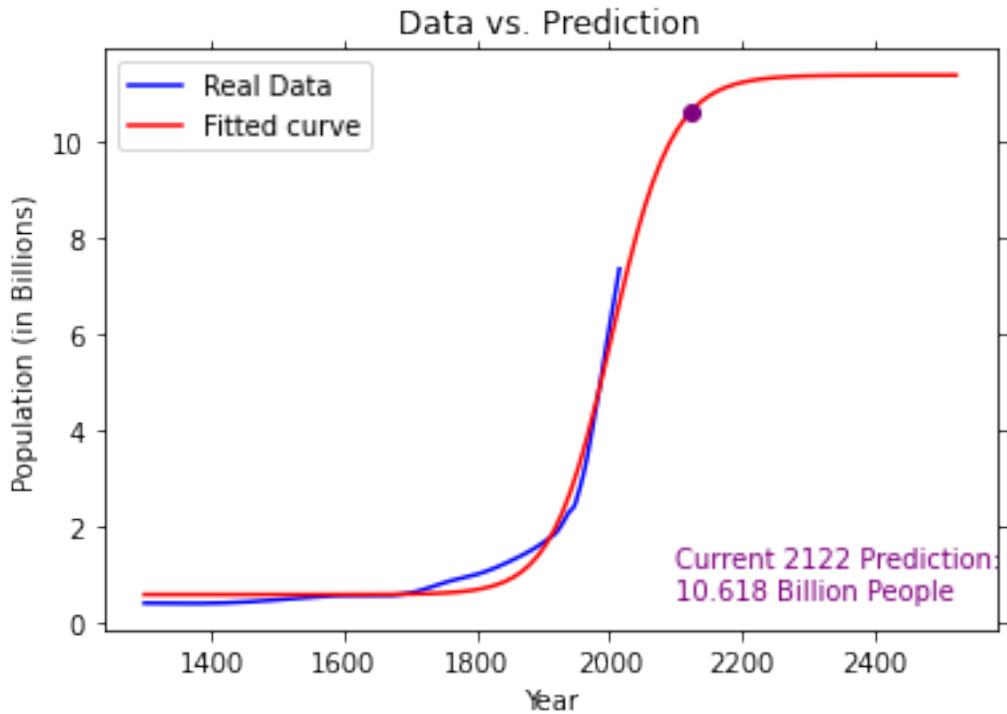
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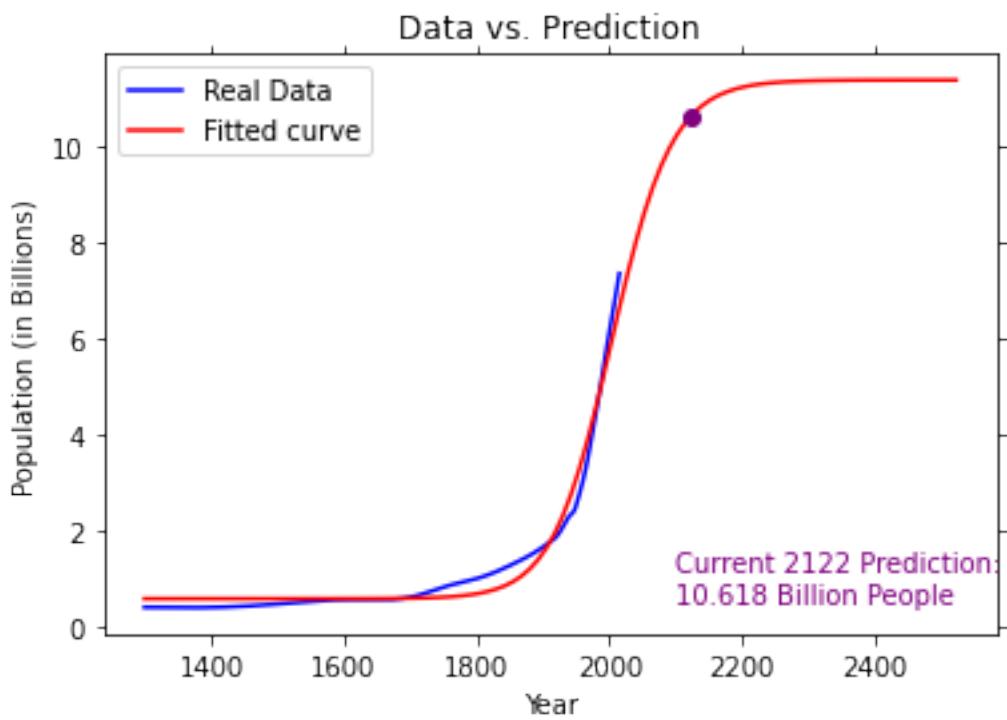
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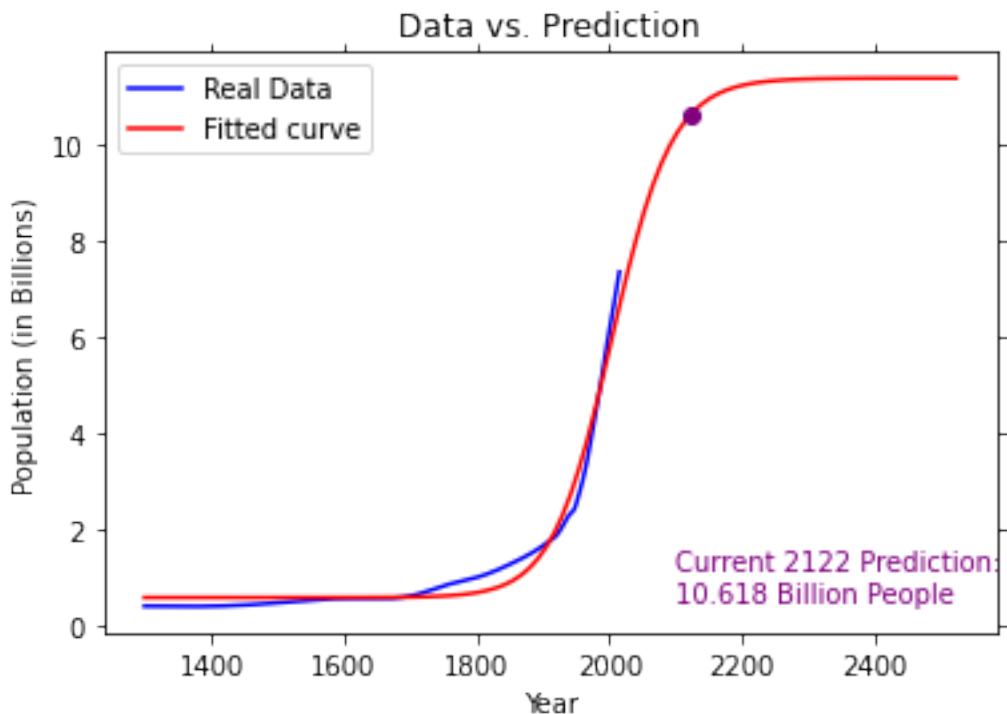
Iteration #38250, Loss: 0.05081877161587992



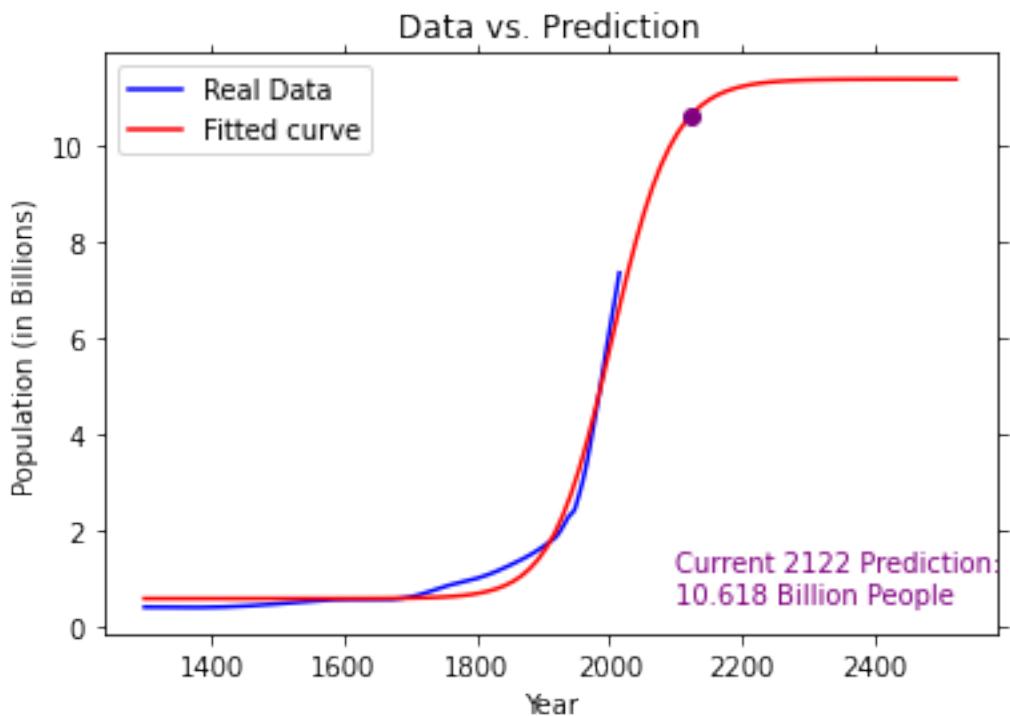
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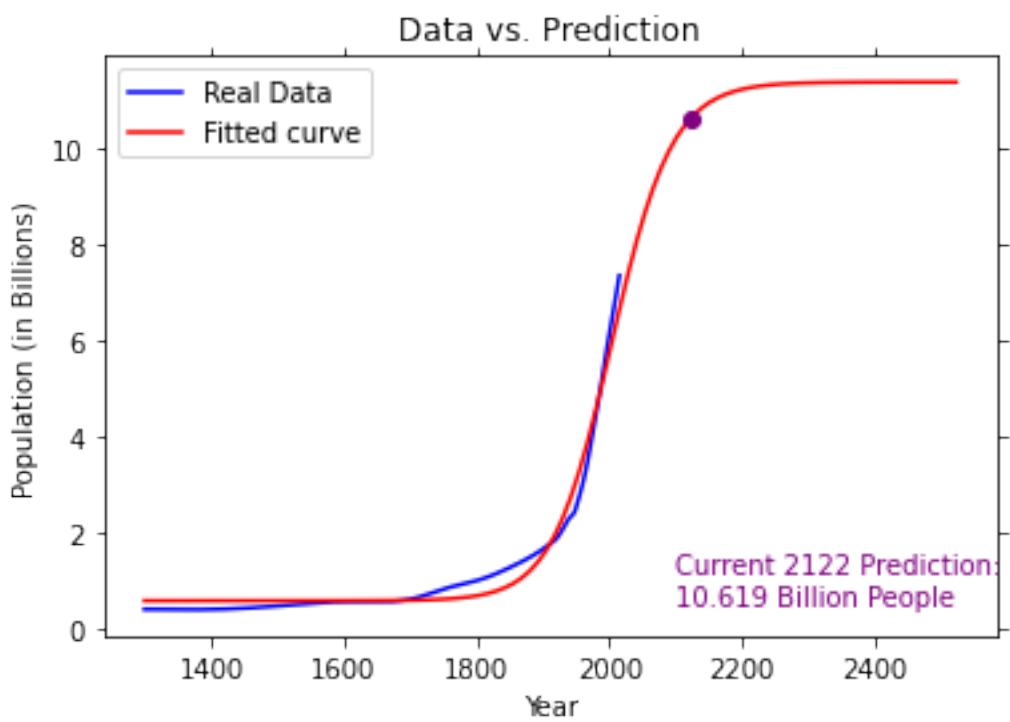
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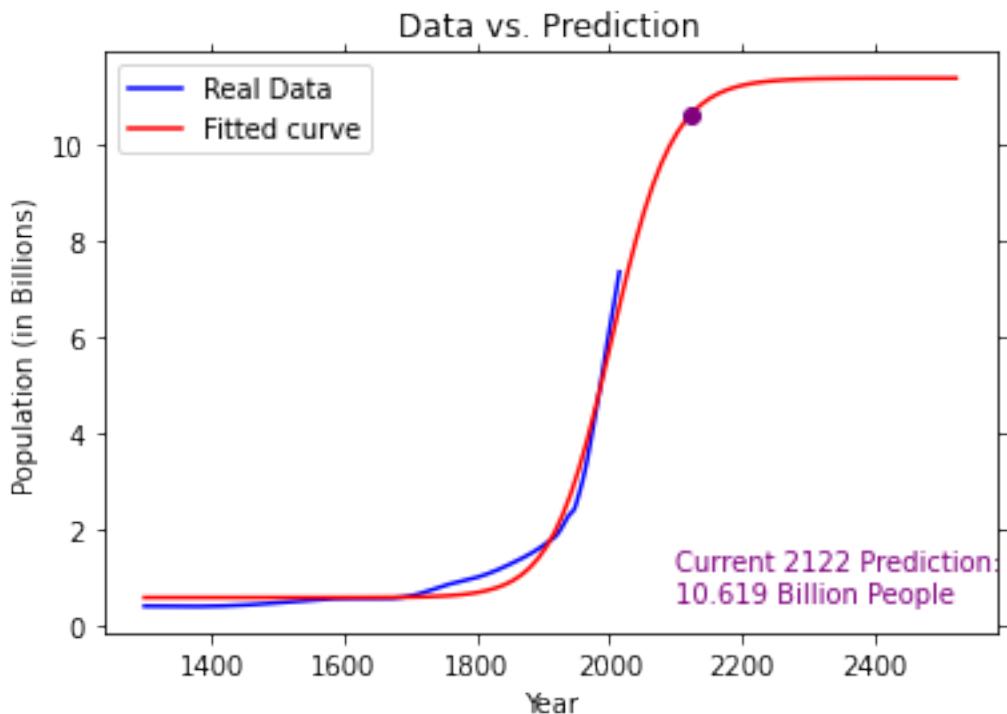
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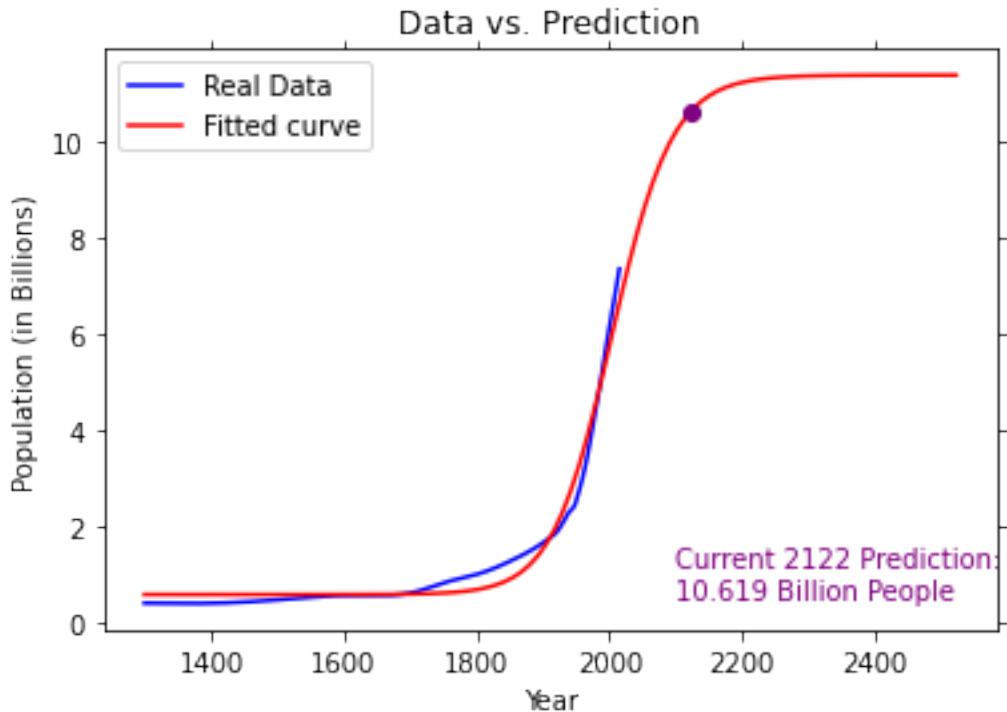
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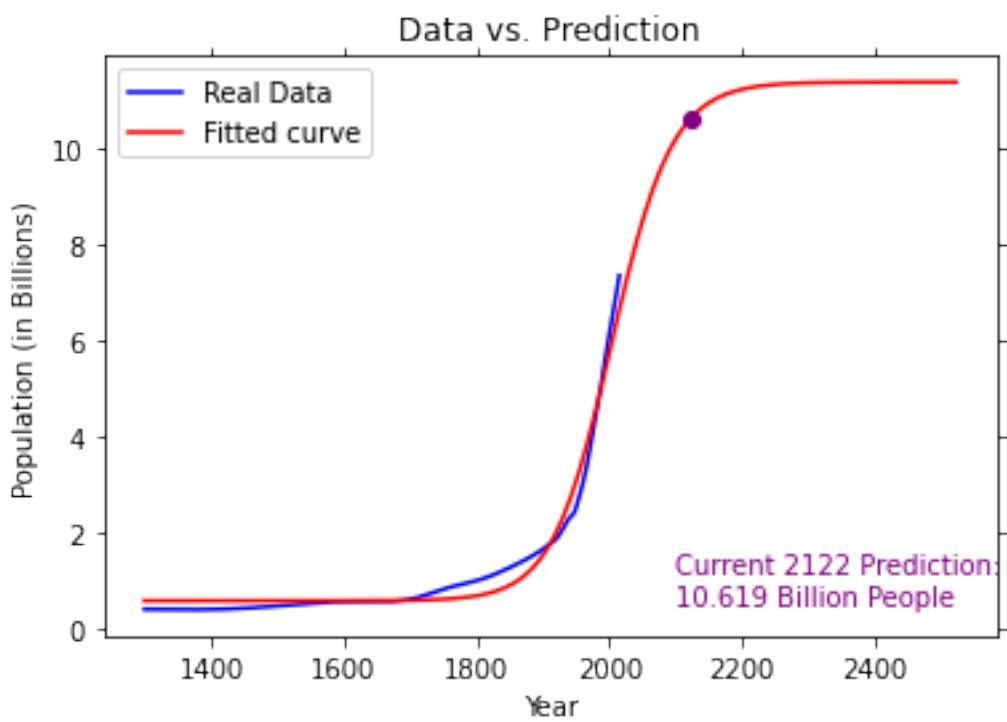
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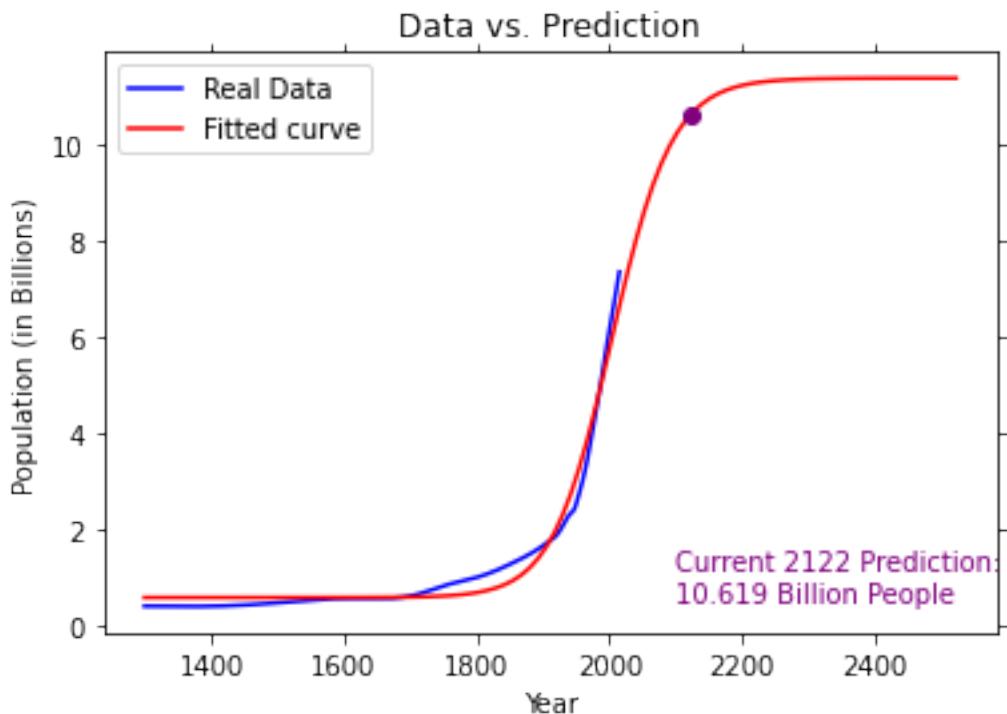
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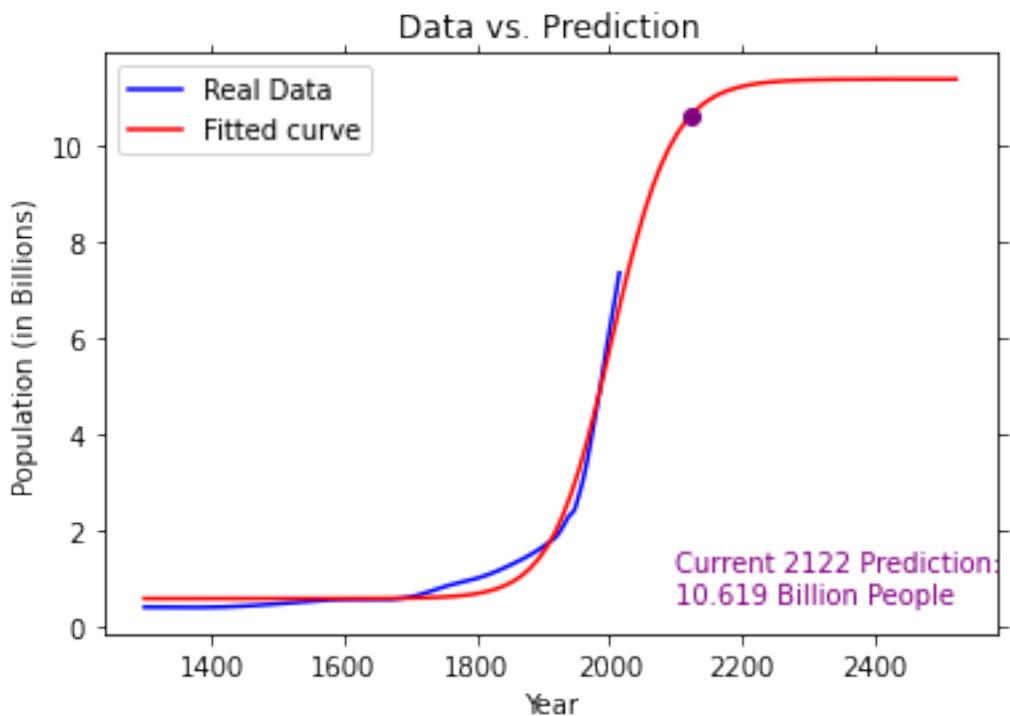
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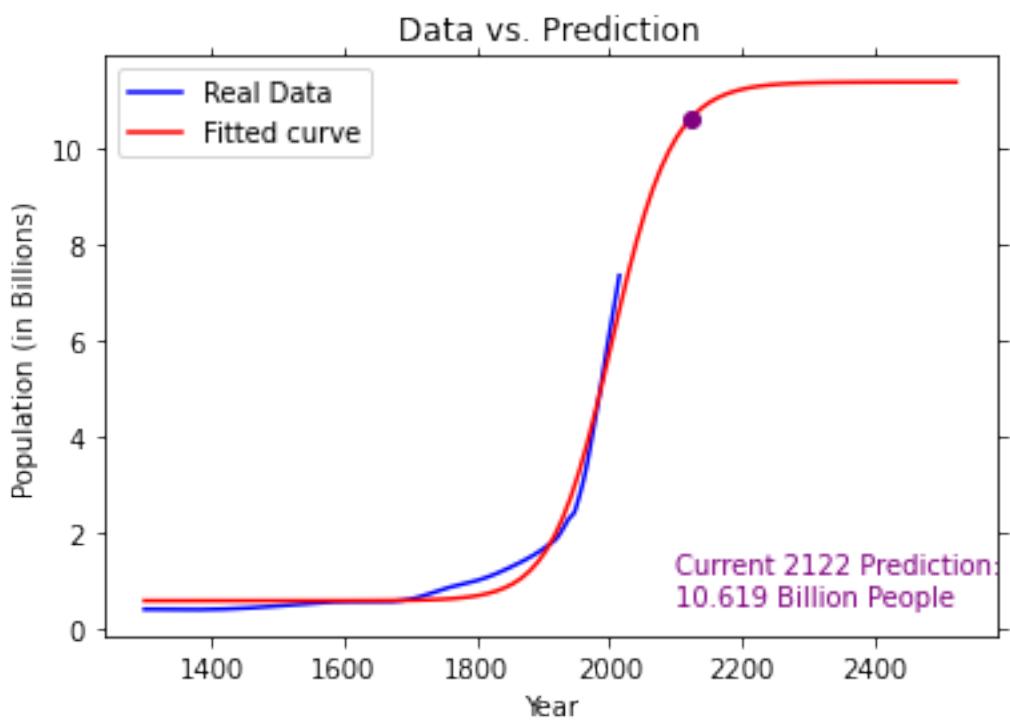
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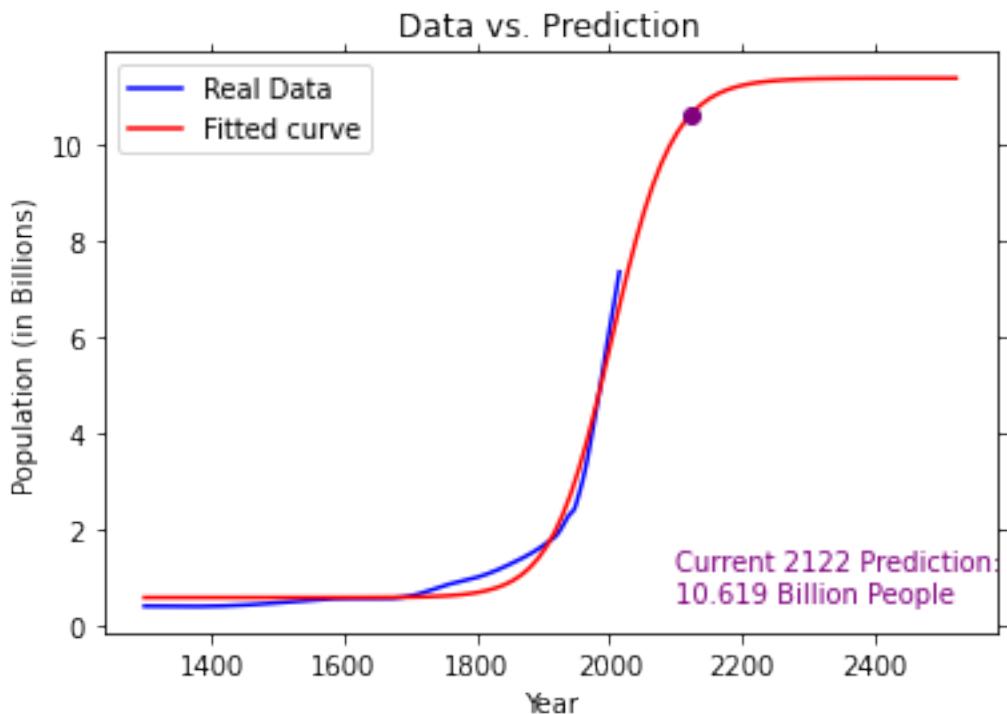
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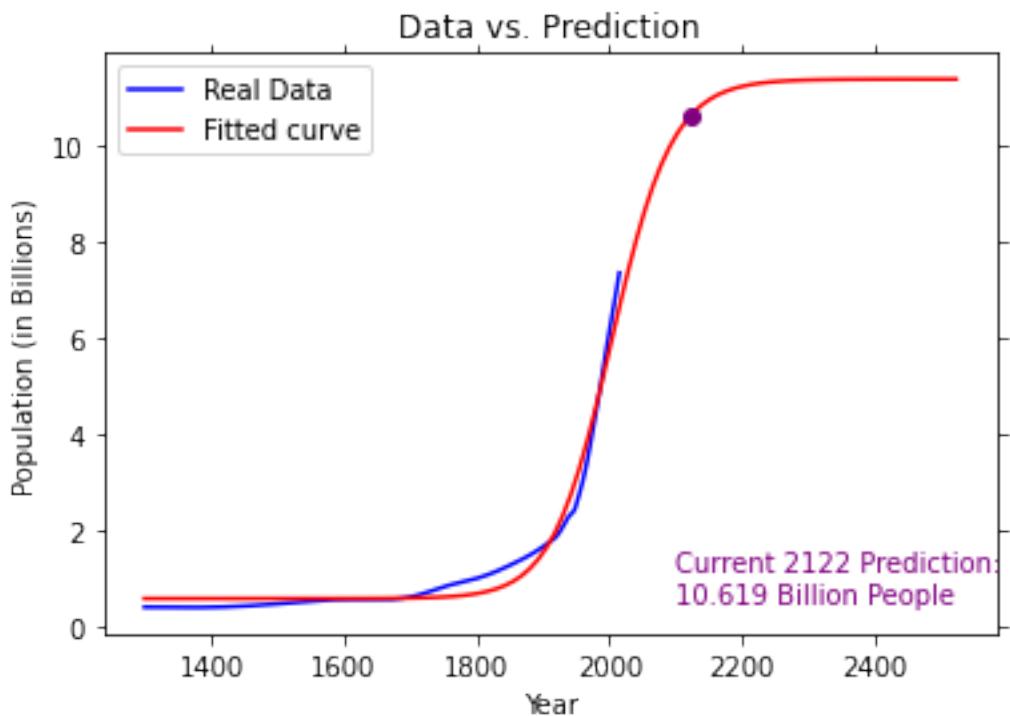
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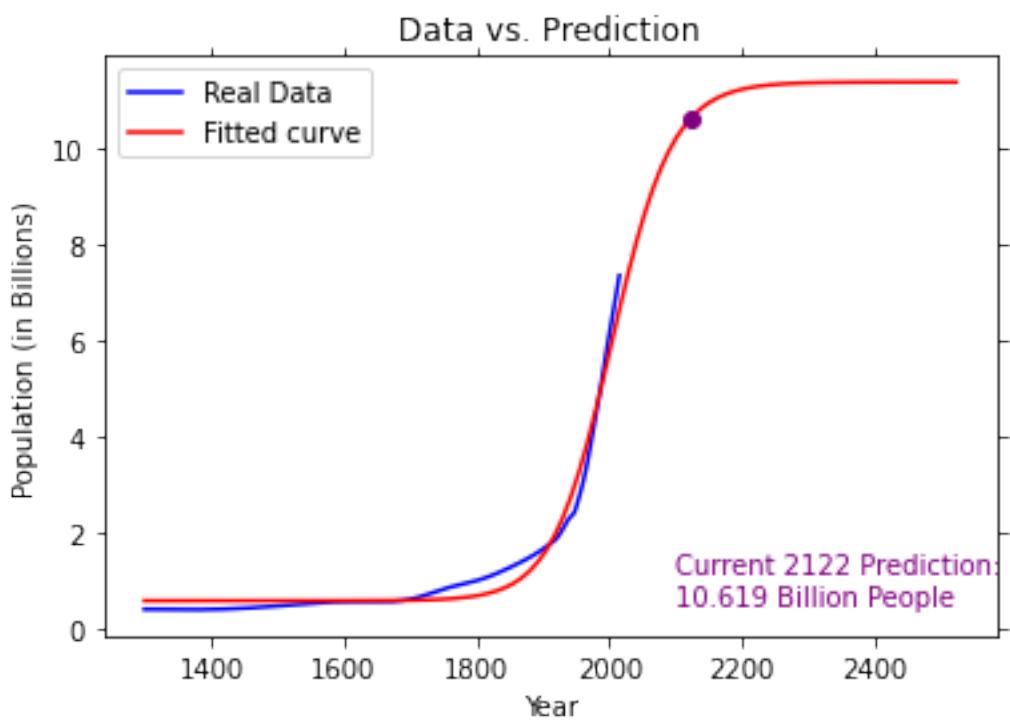
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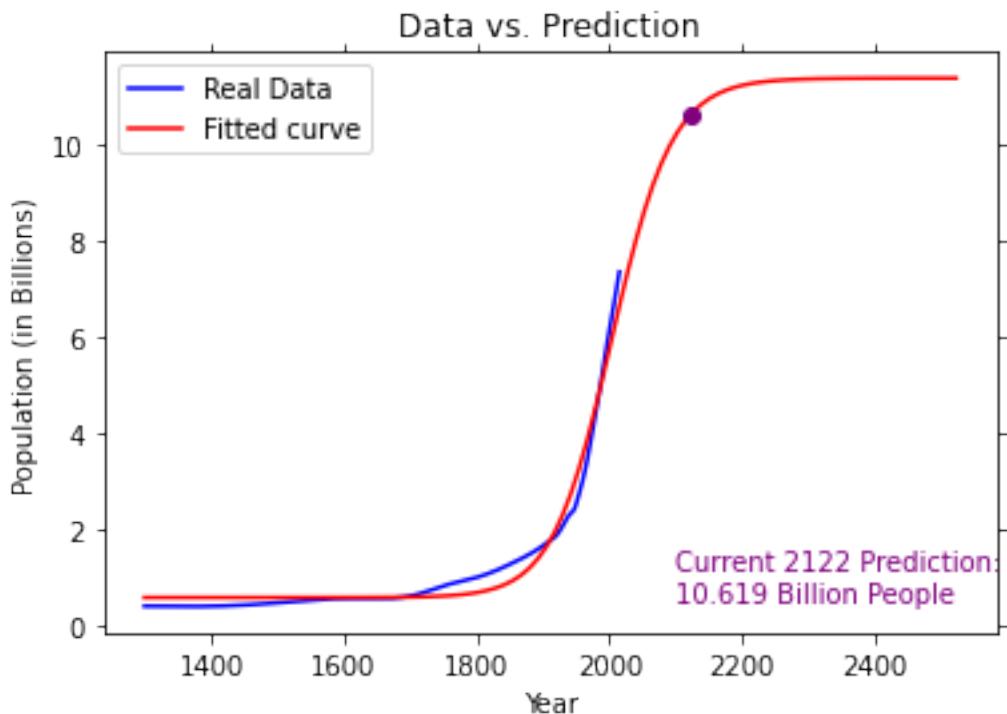
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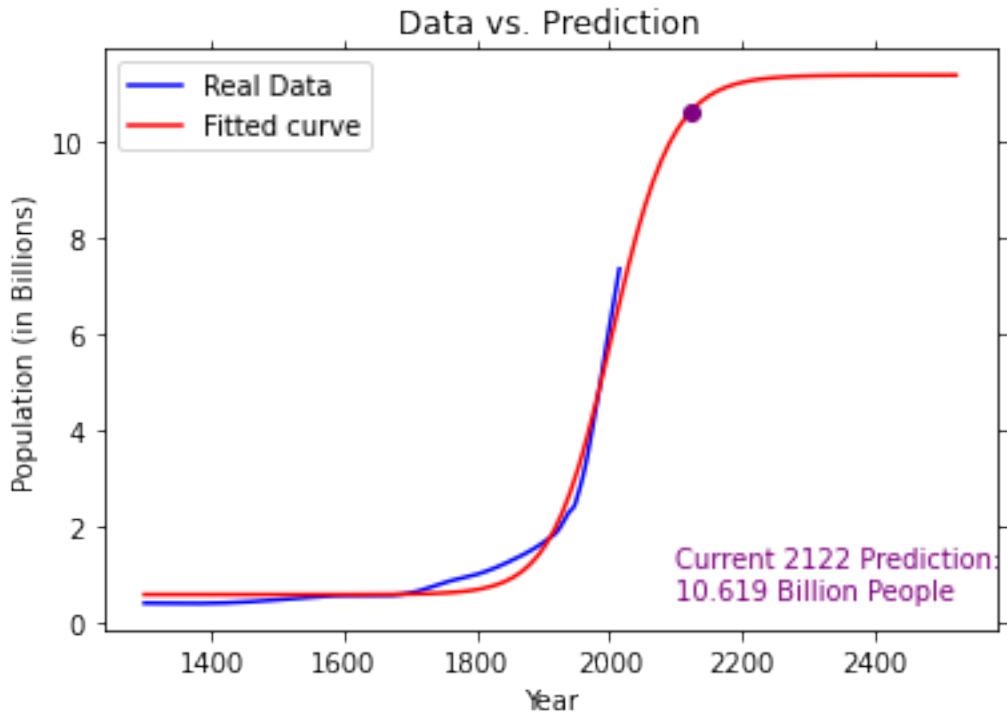
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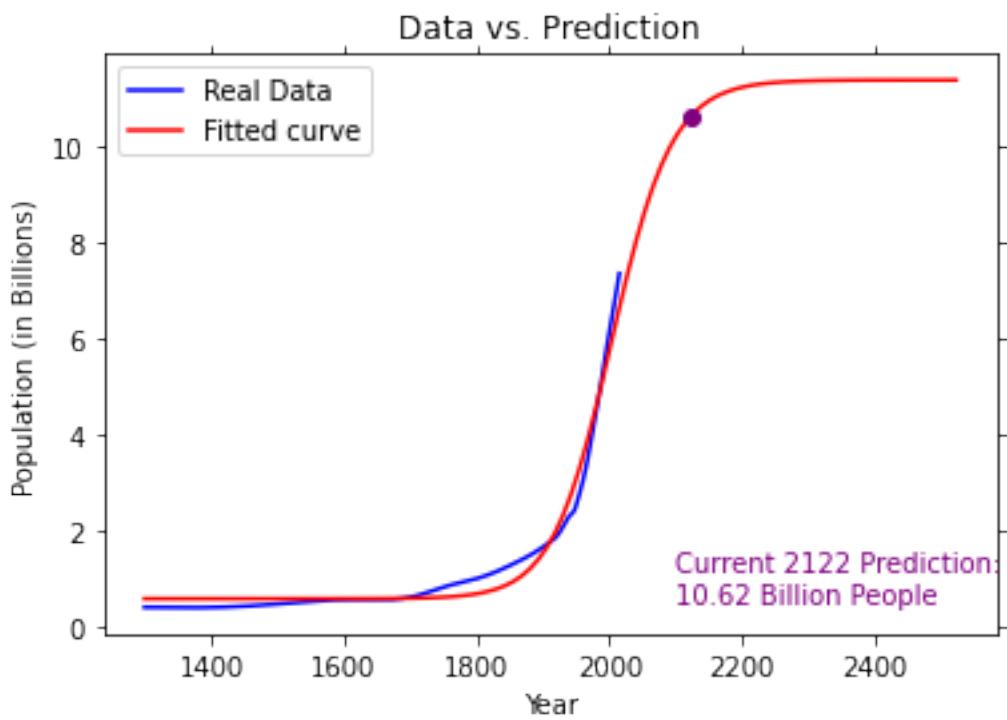
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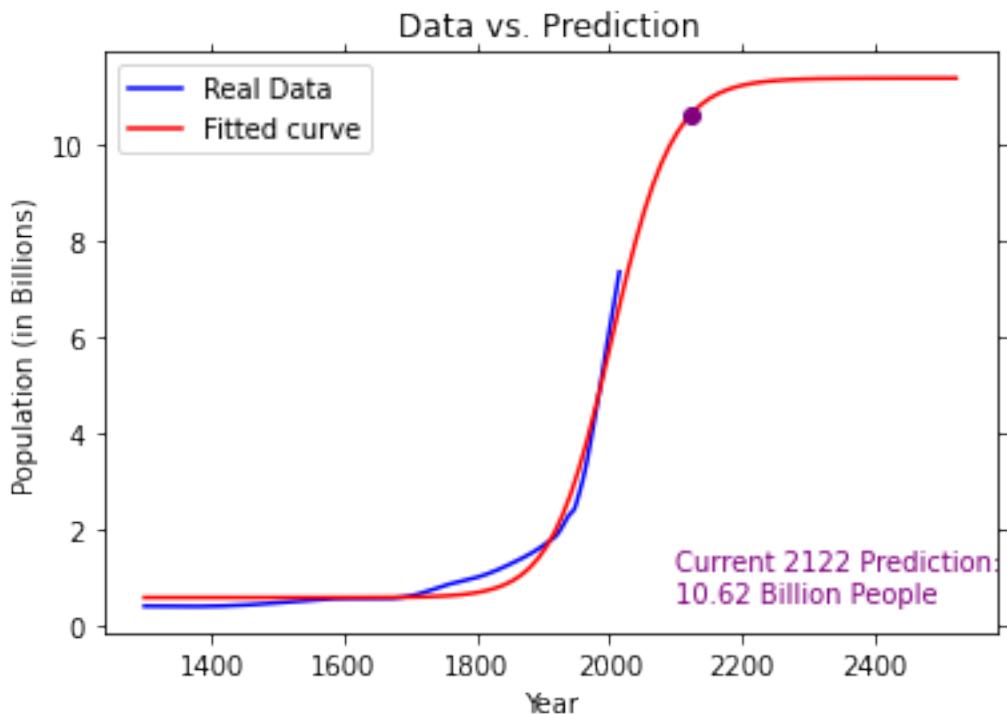
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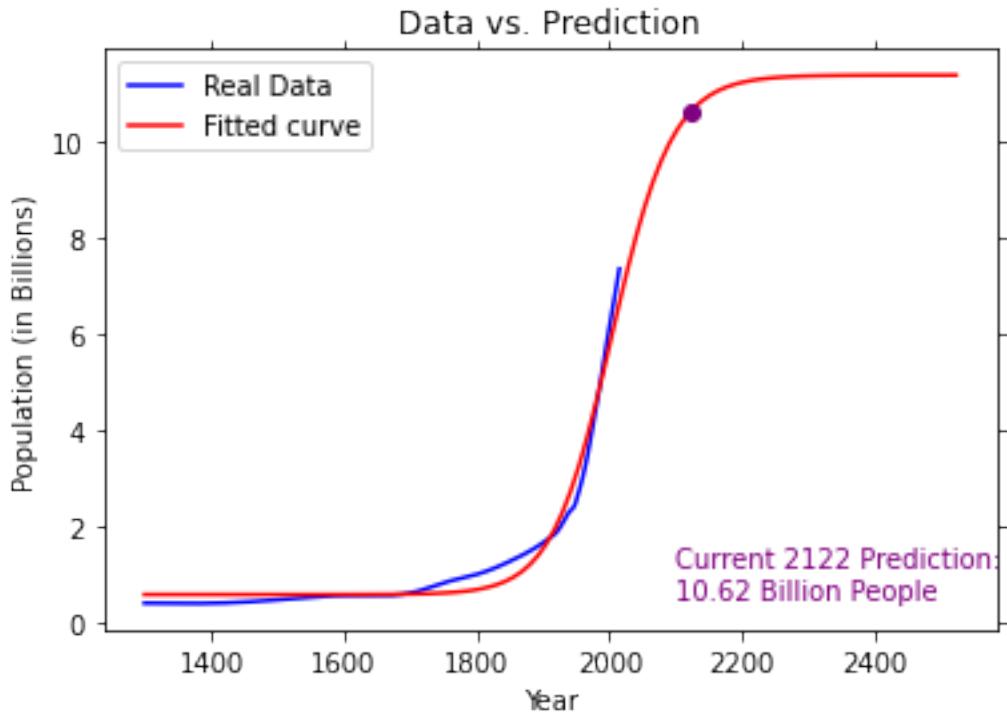
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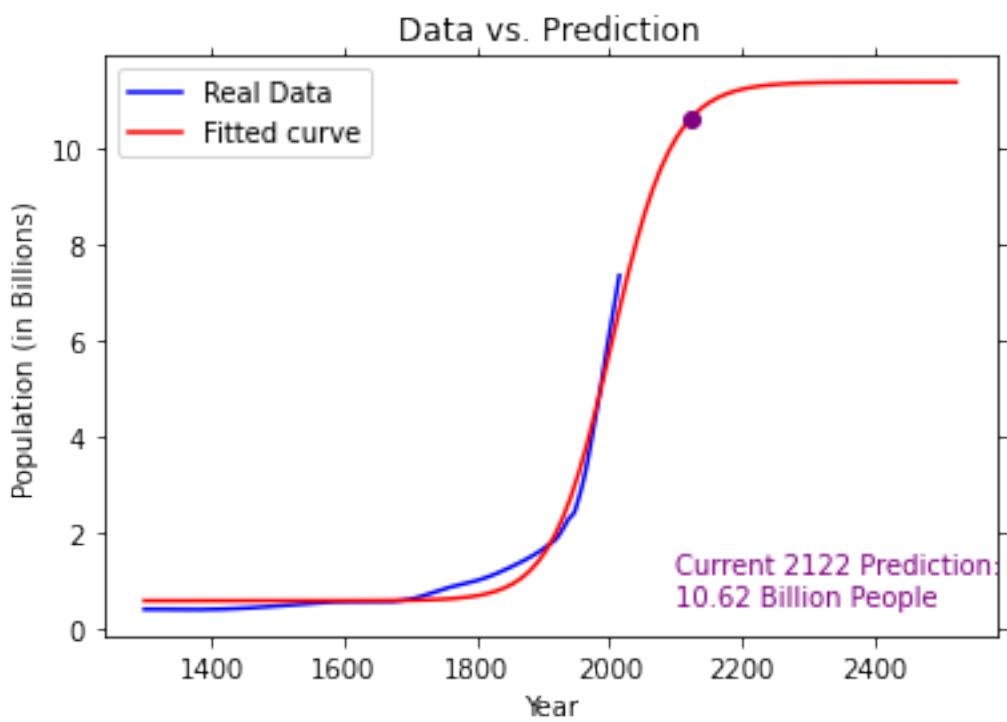
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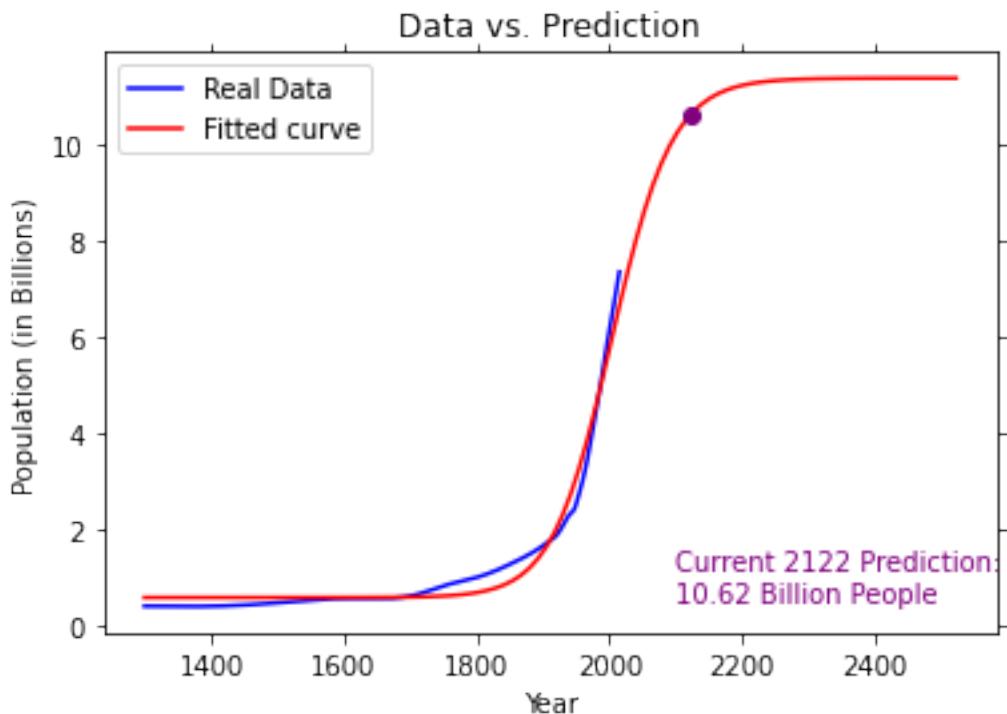
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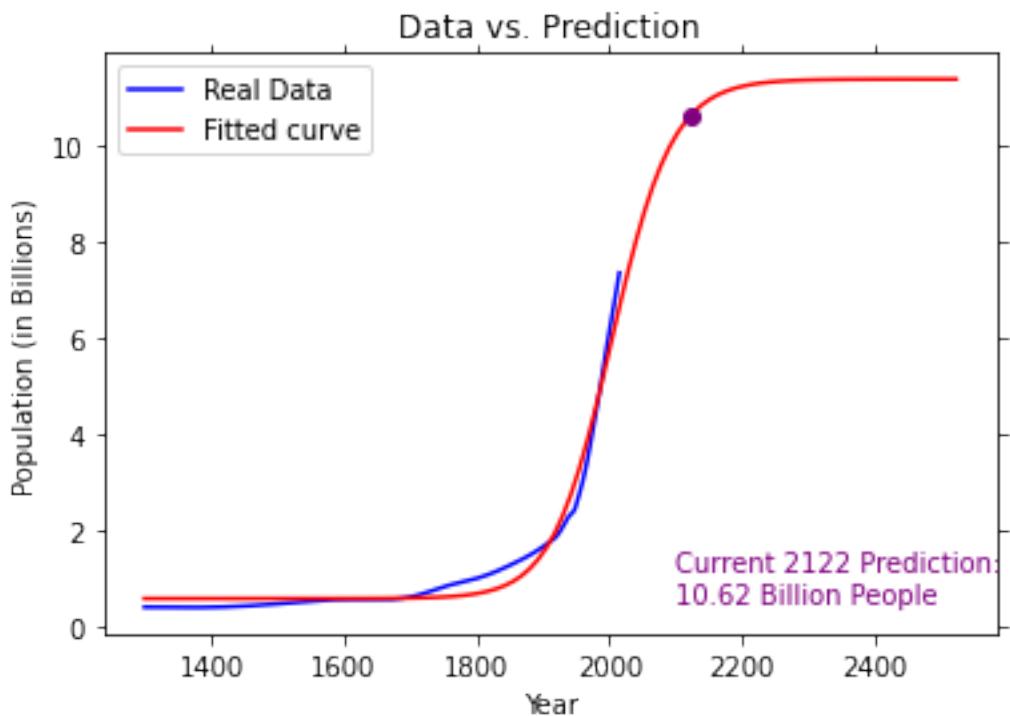
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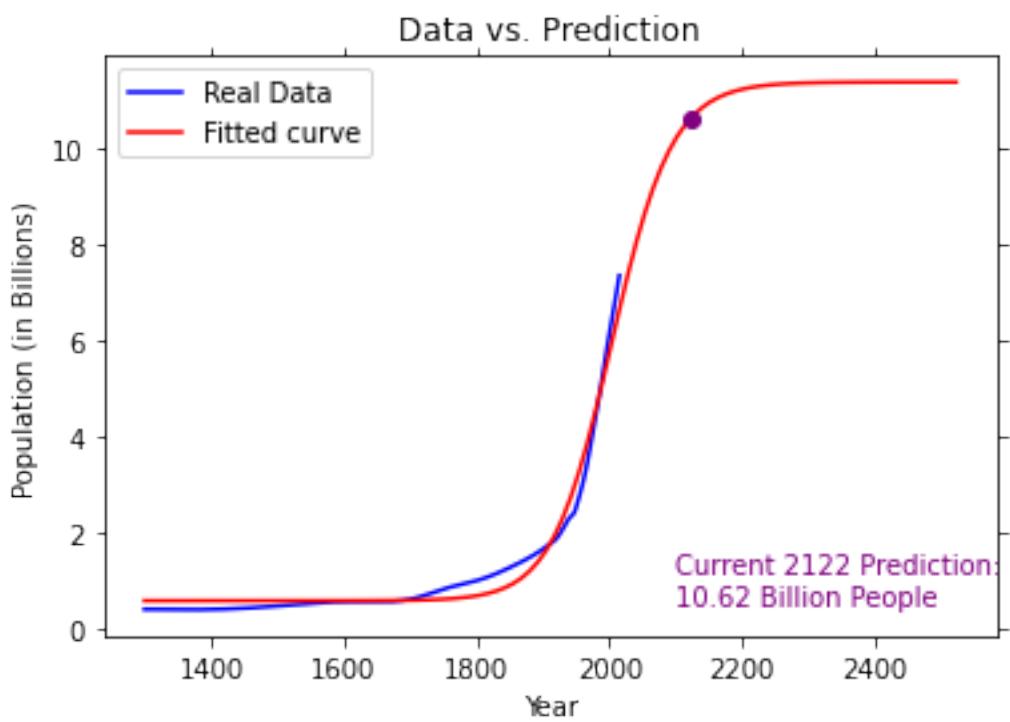
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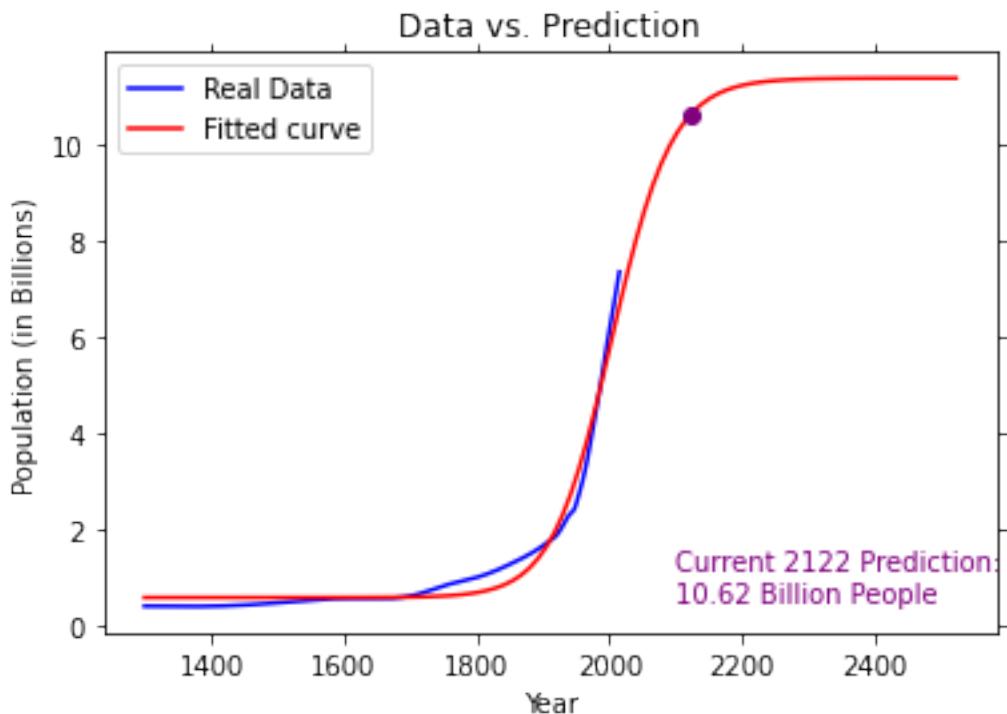
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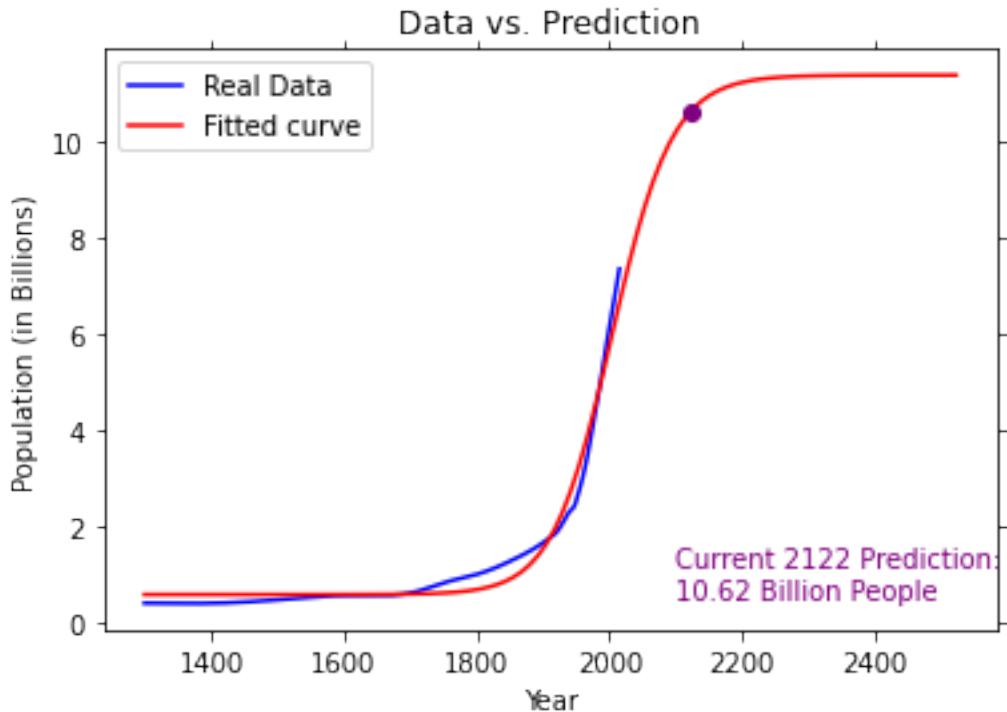
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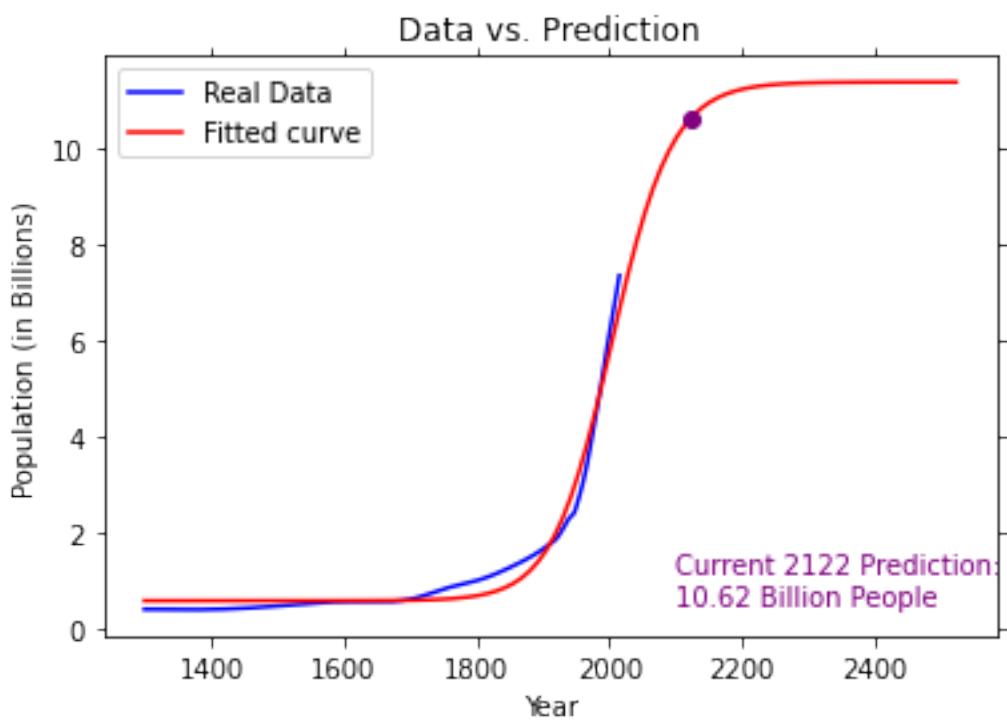
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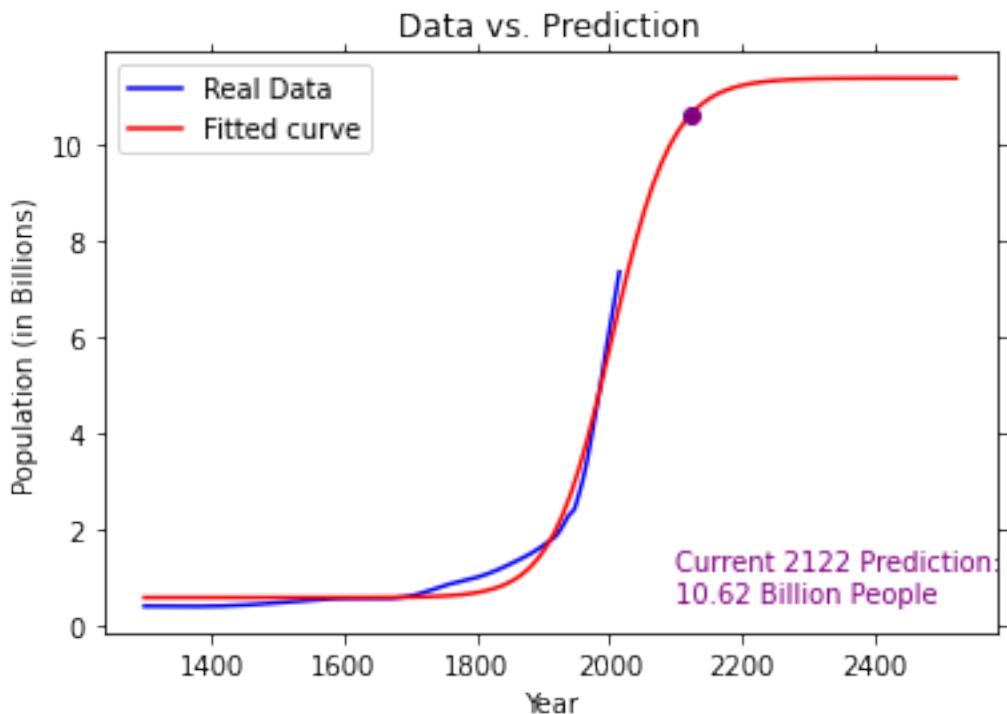
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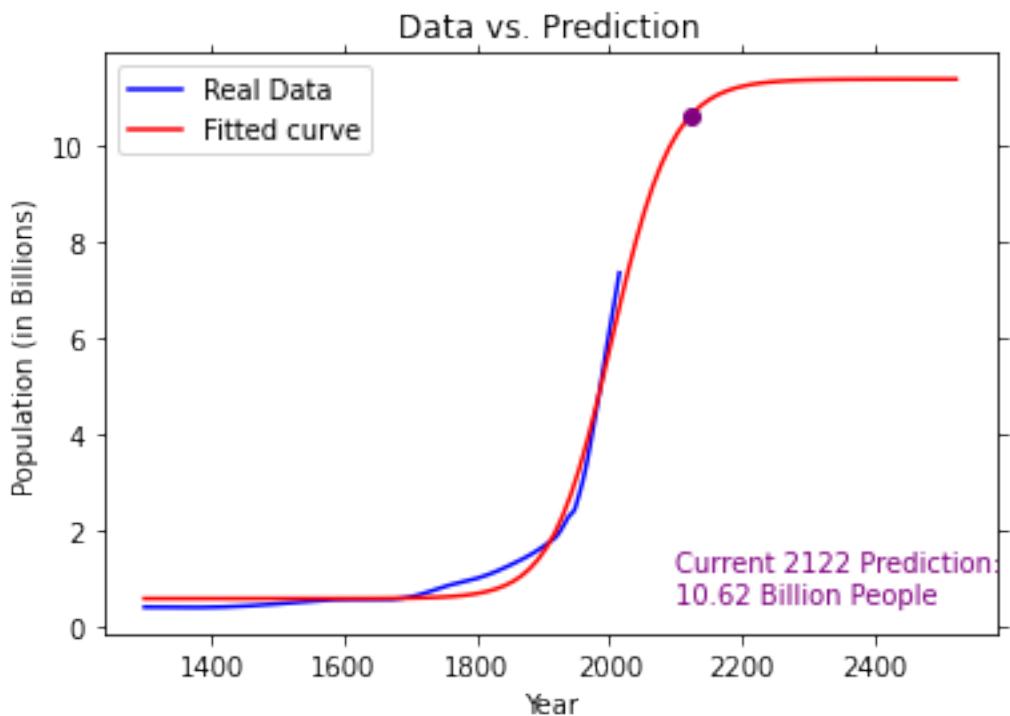
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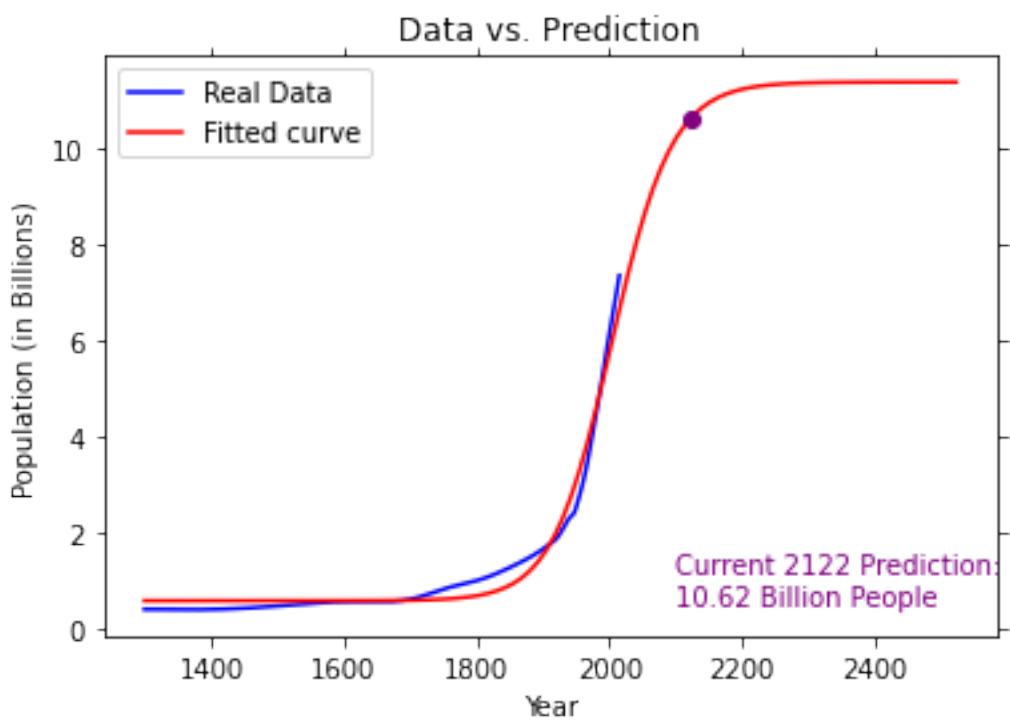
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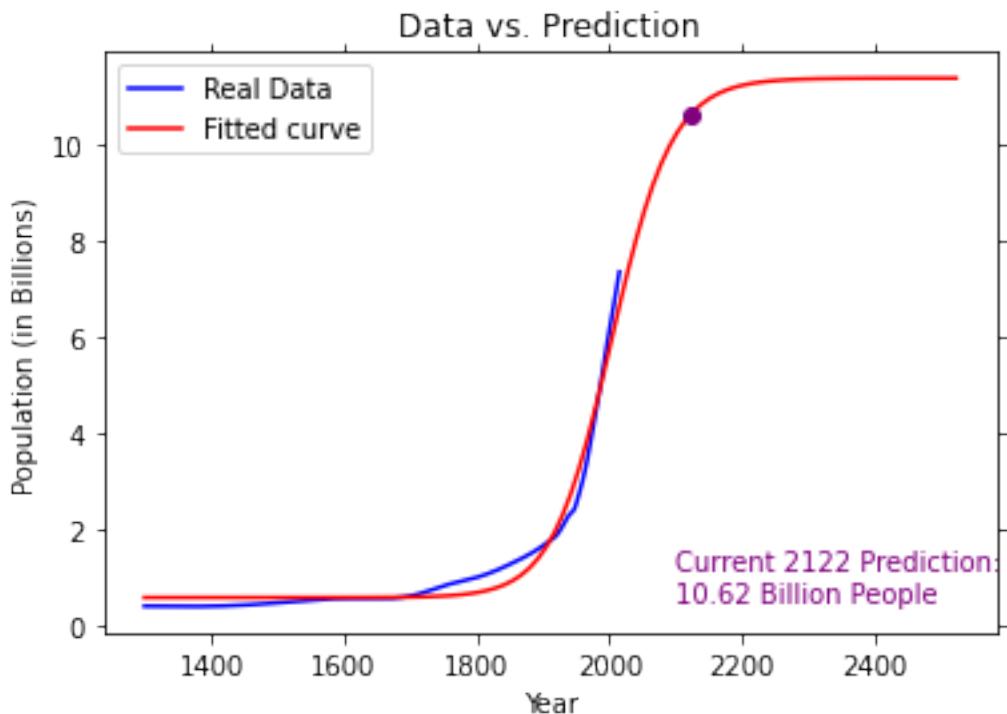
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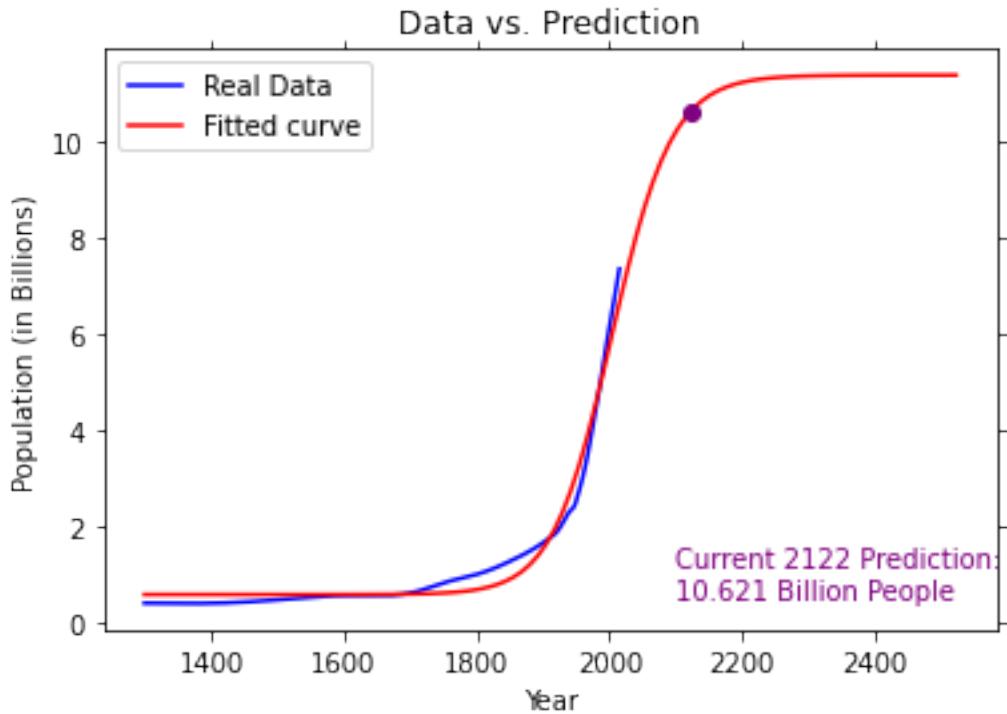
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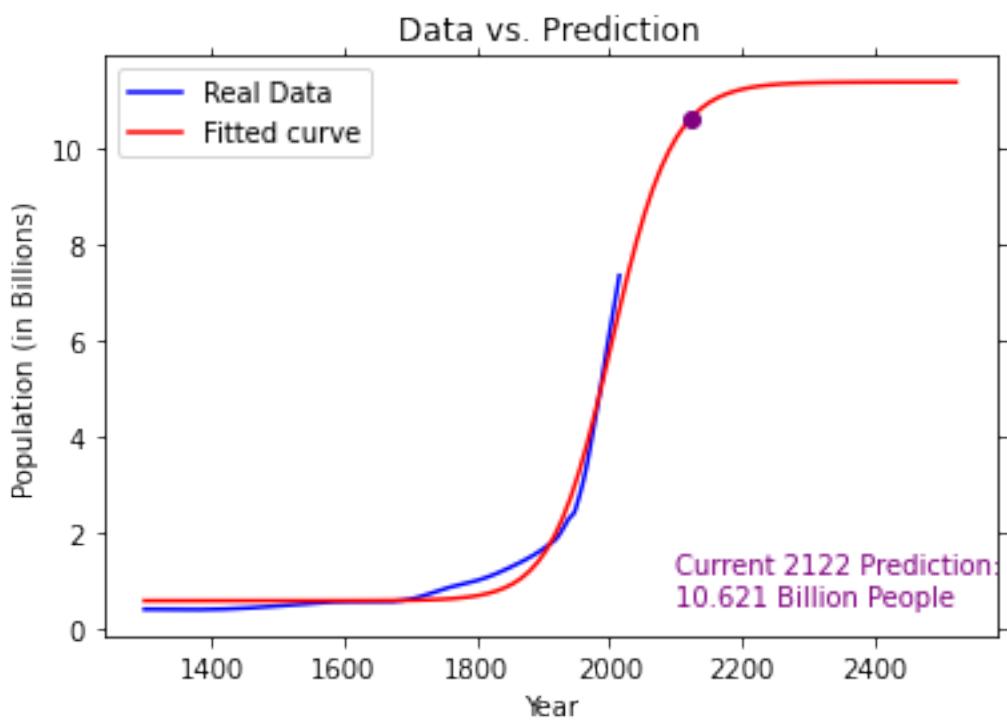
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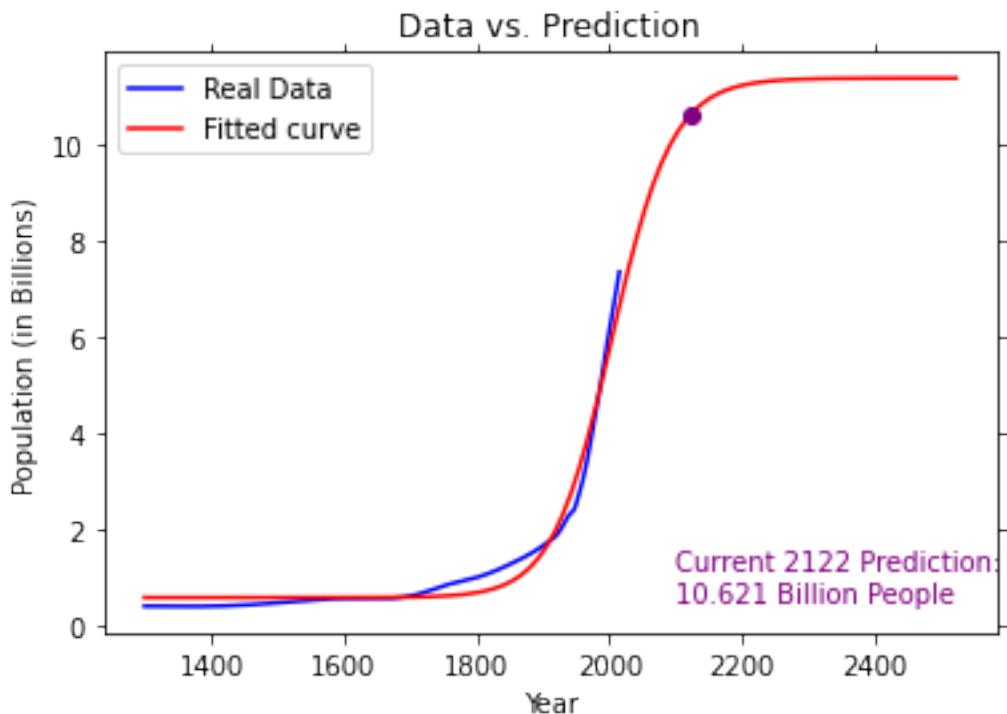
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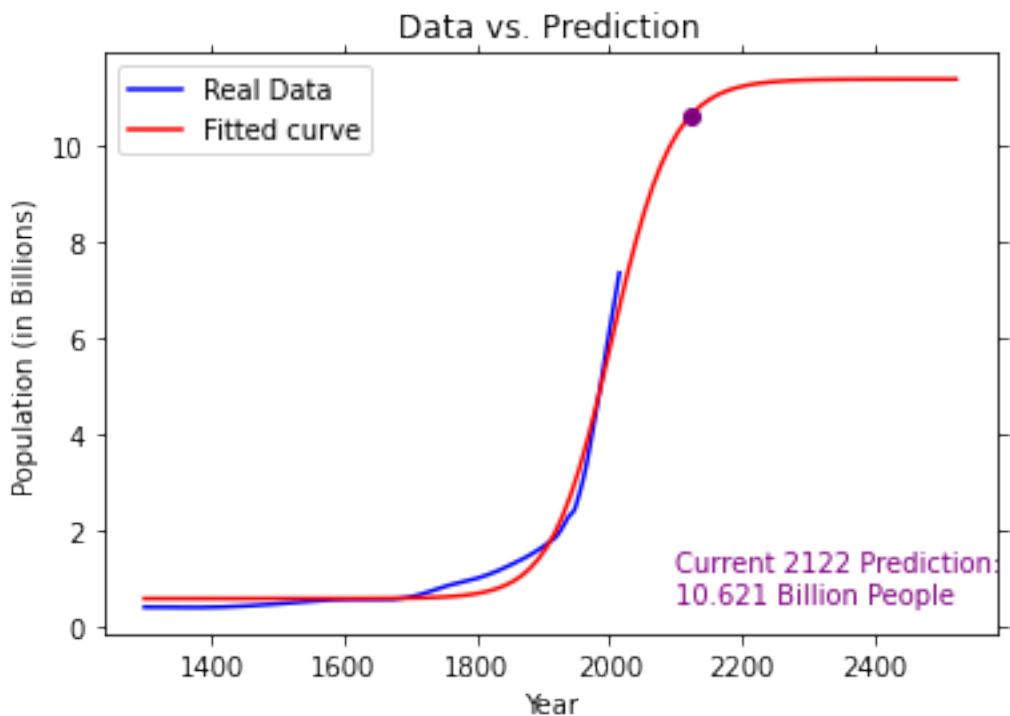
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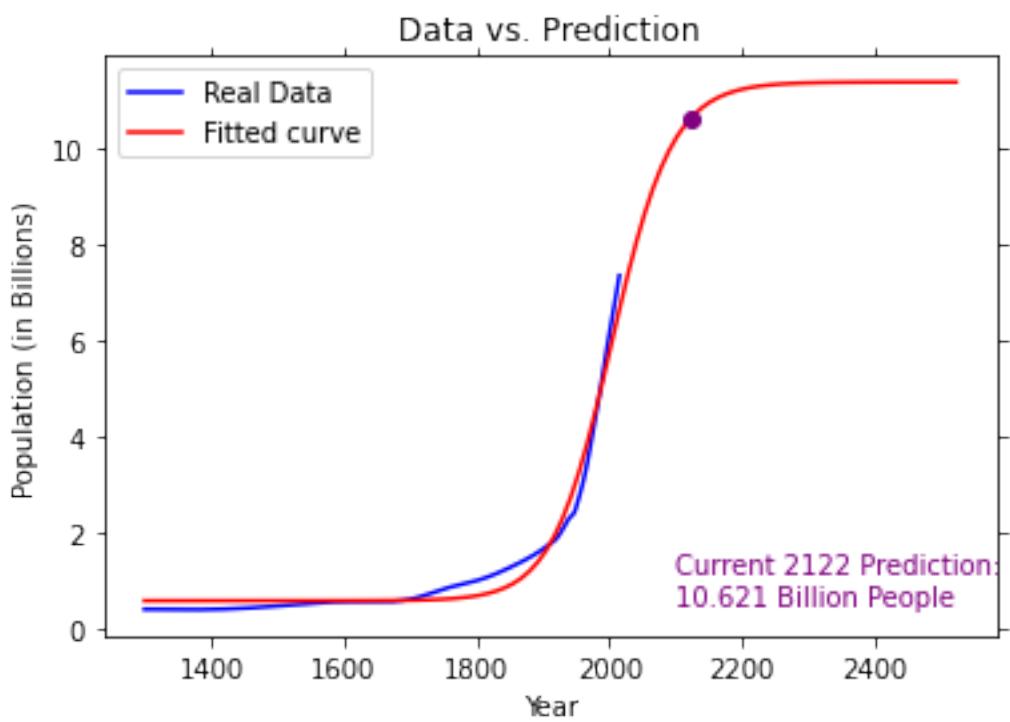
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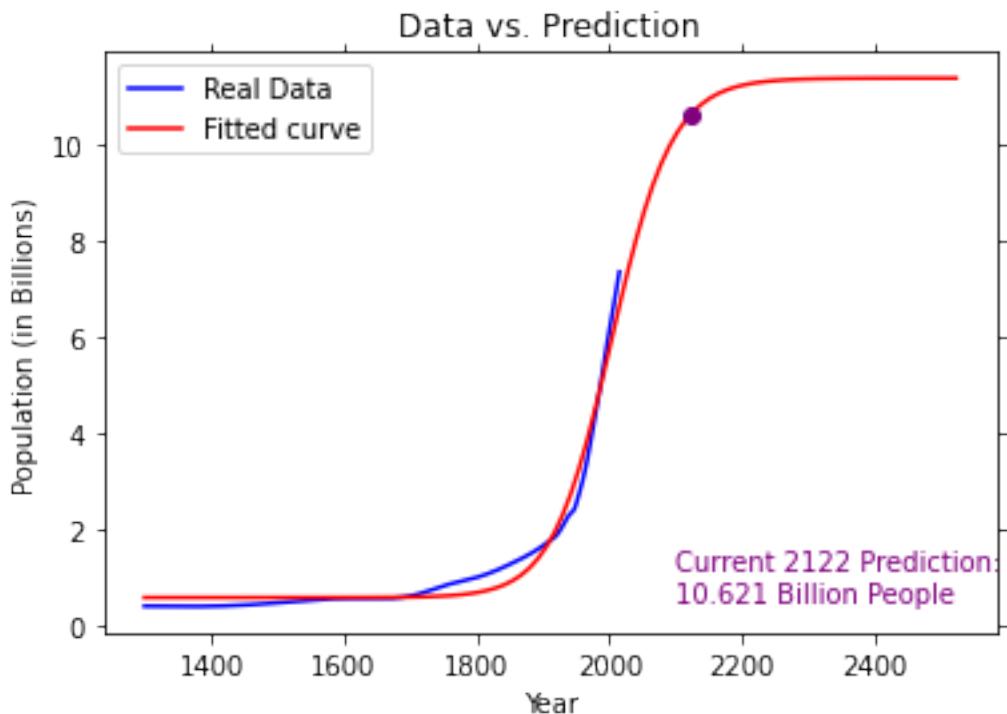
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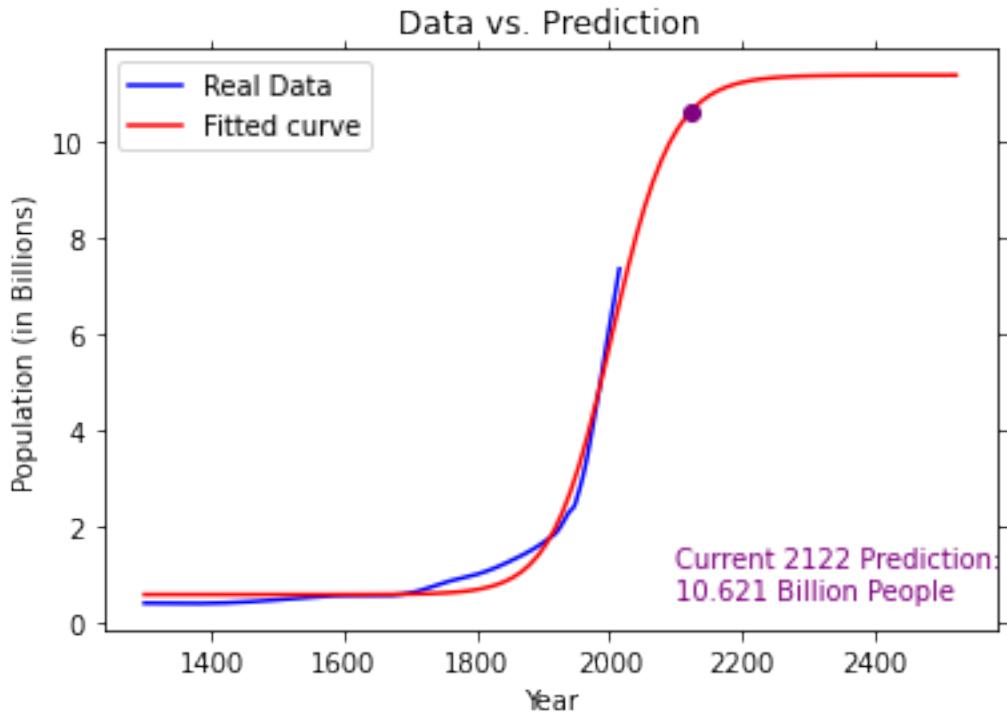
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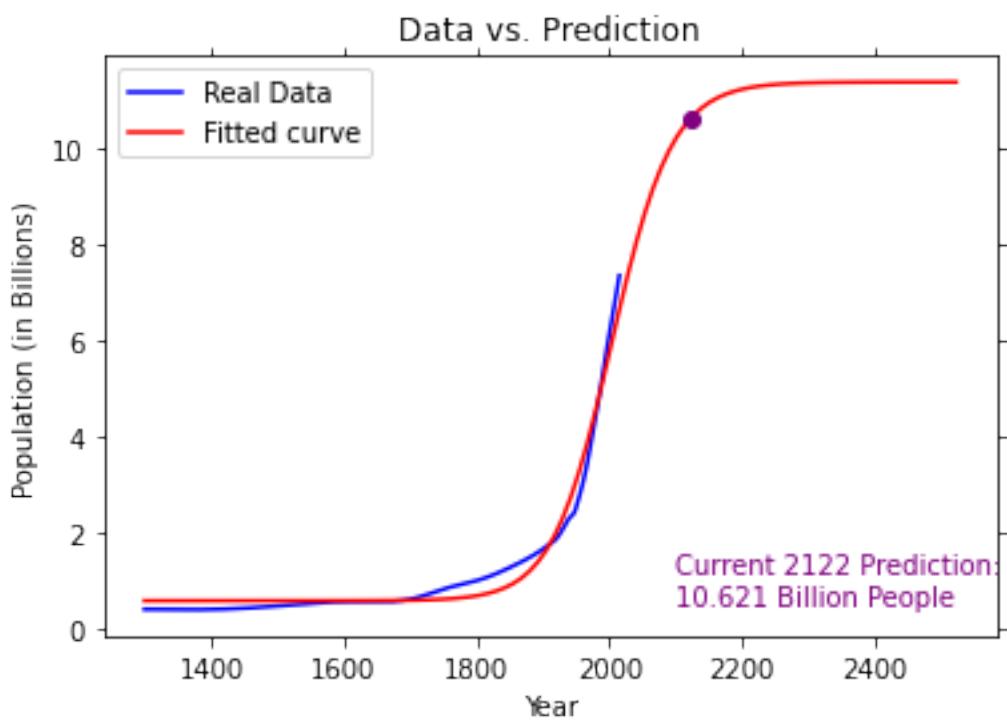
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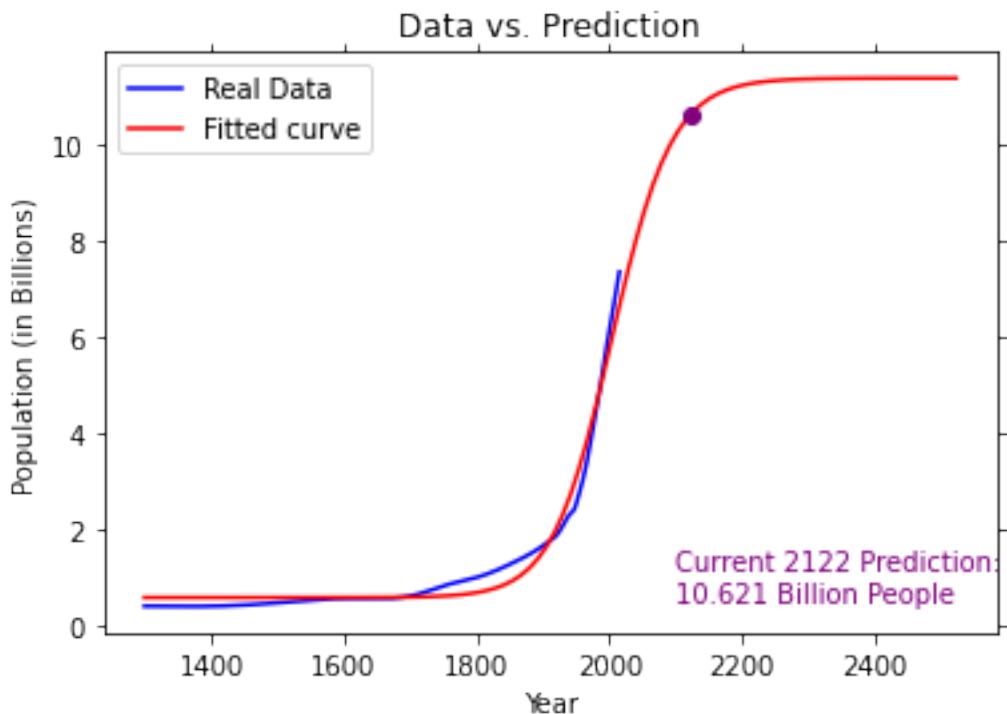
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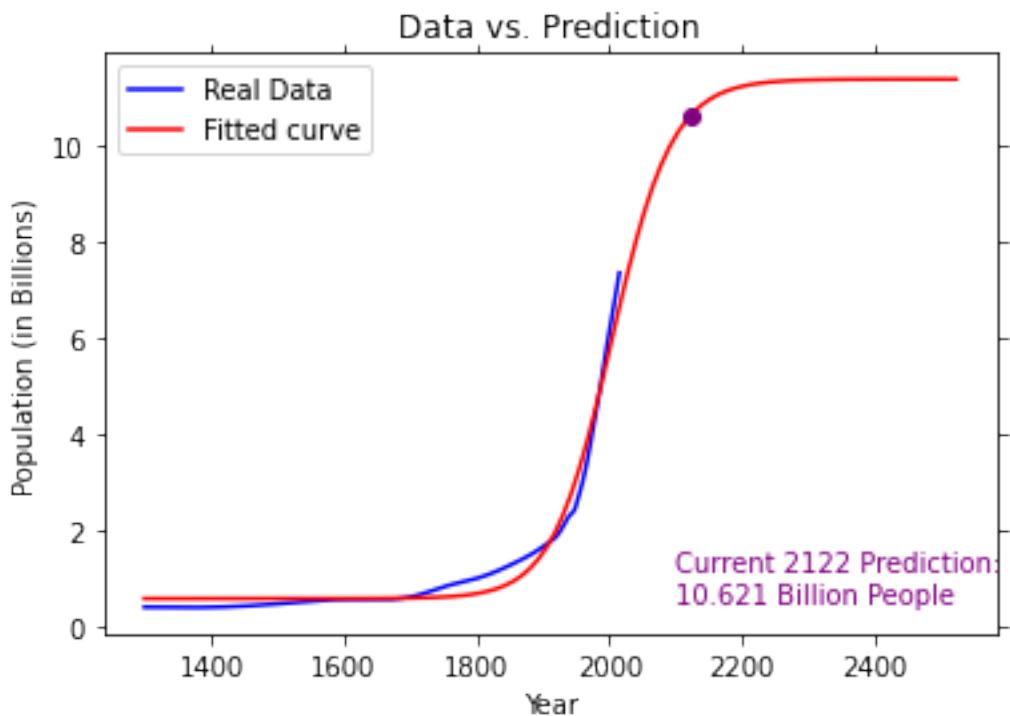
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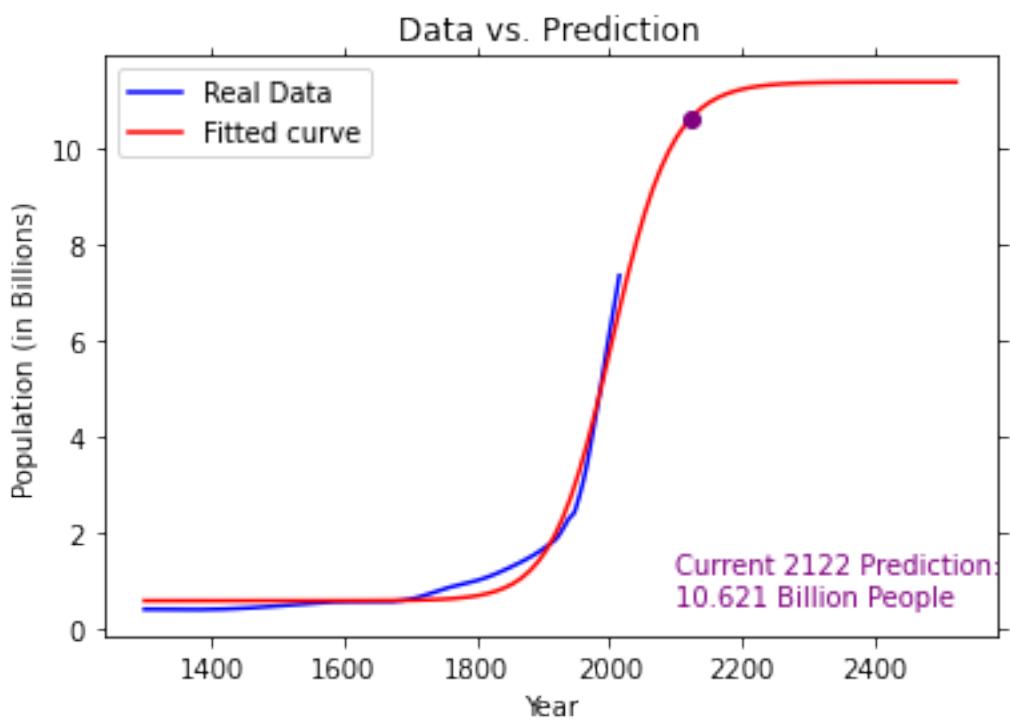
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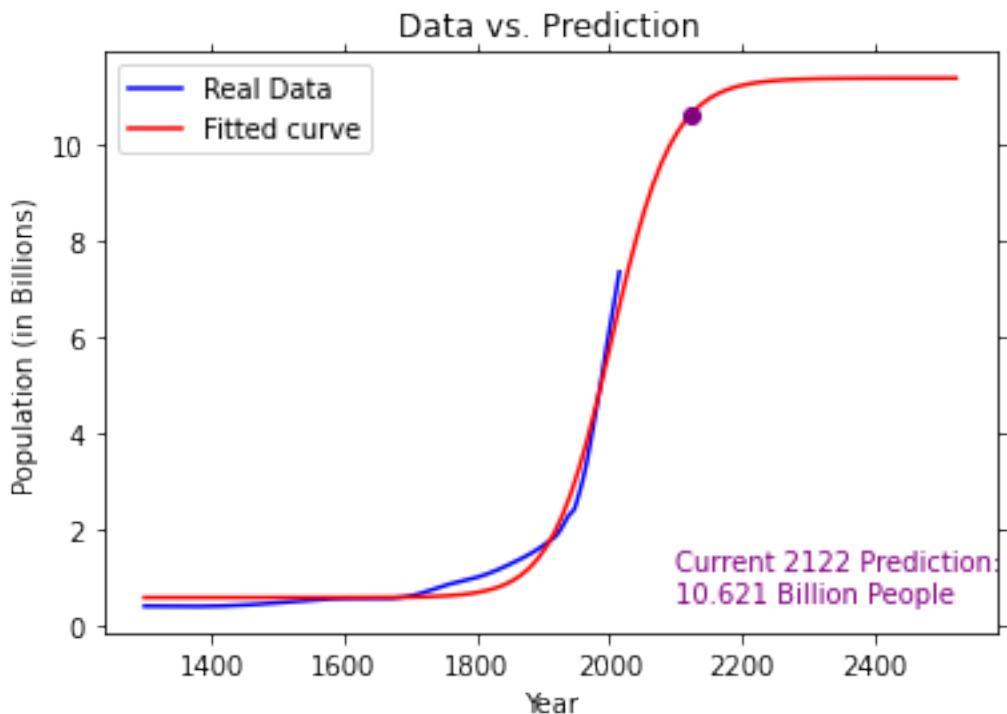
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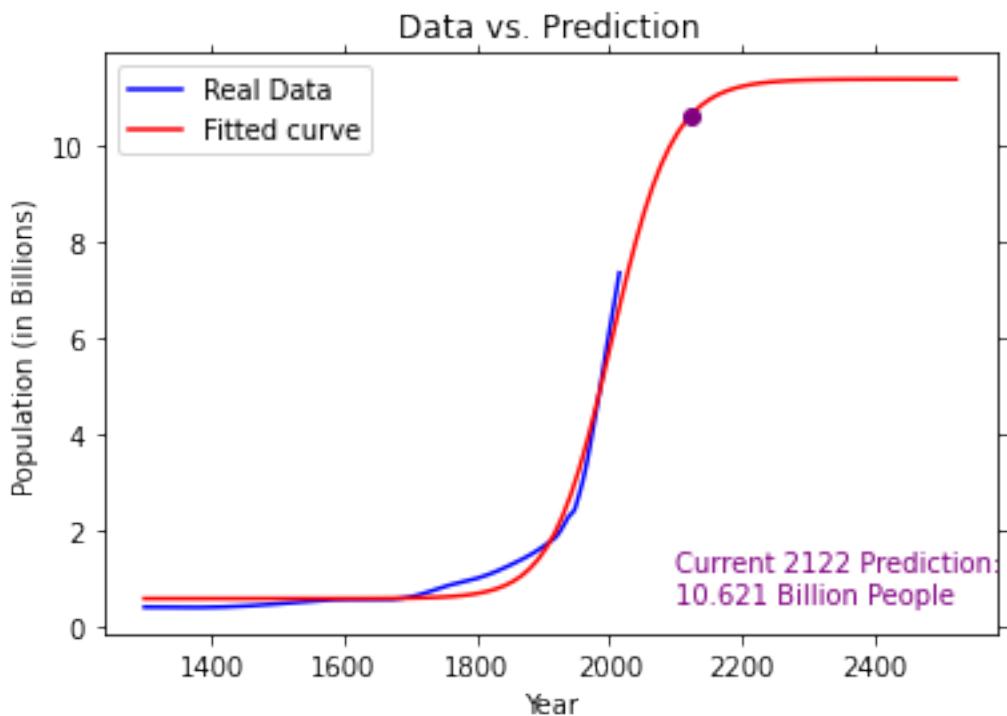
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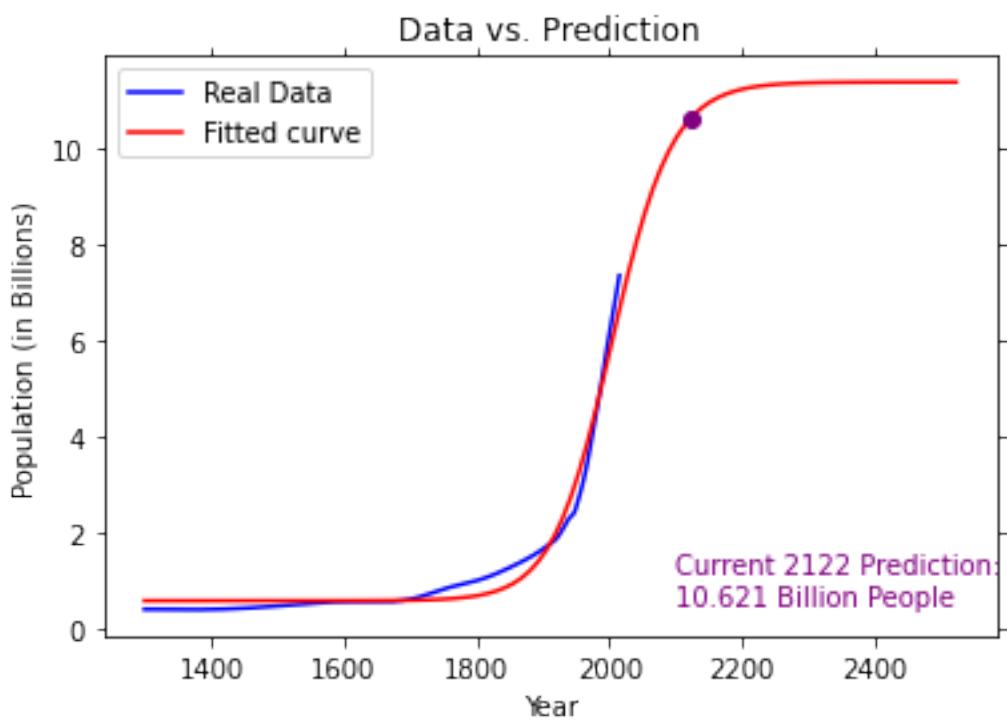
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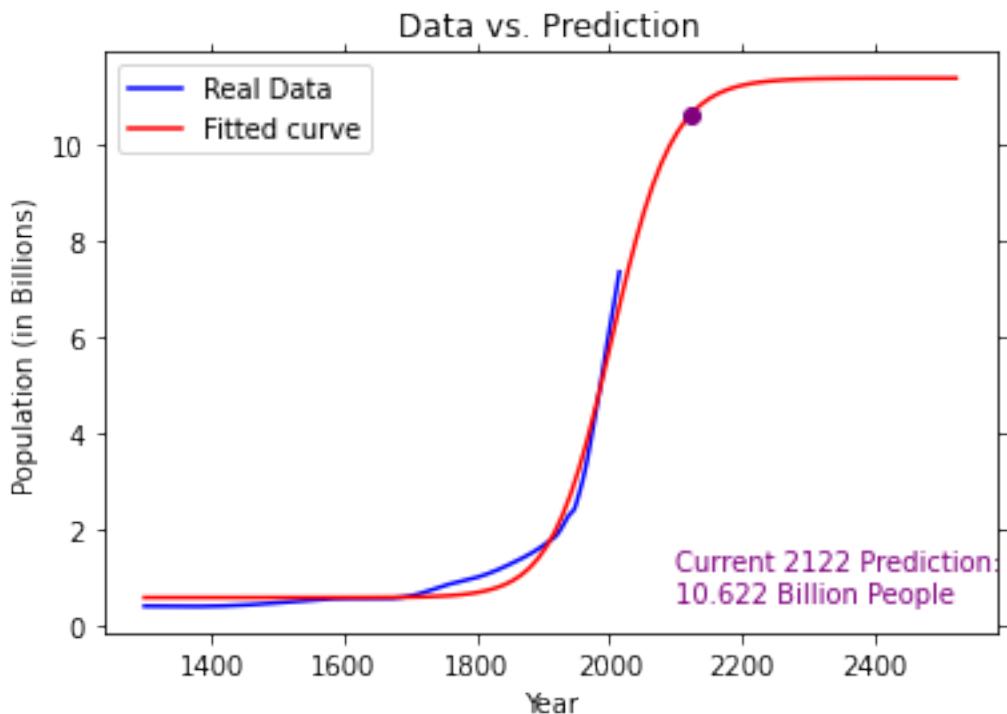
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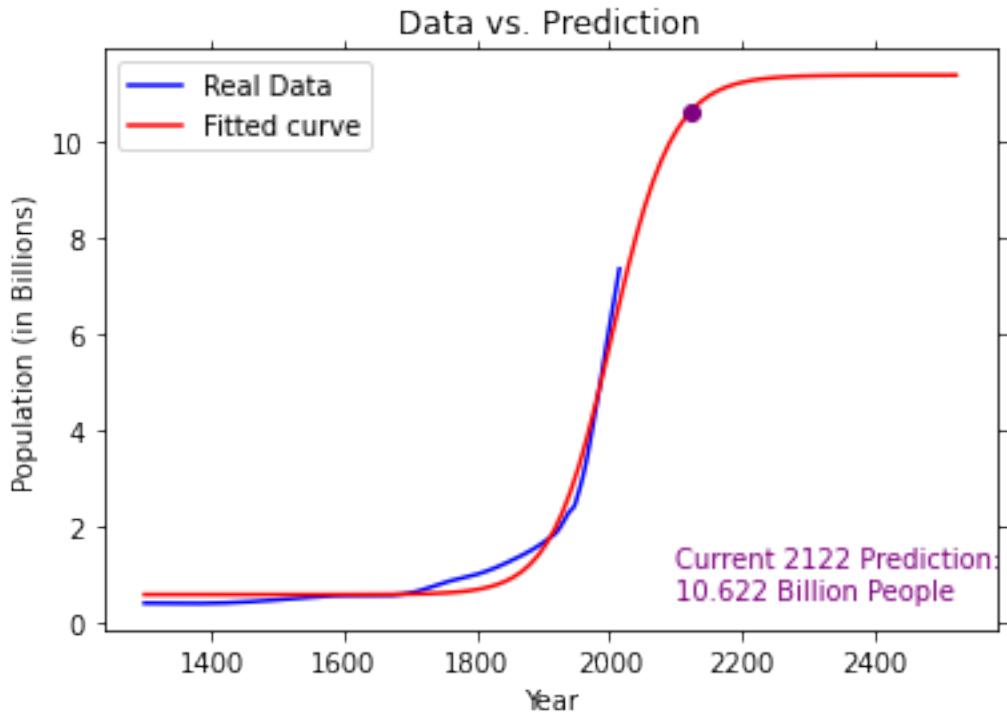
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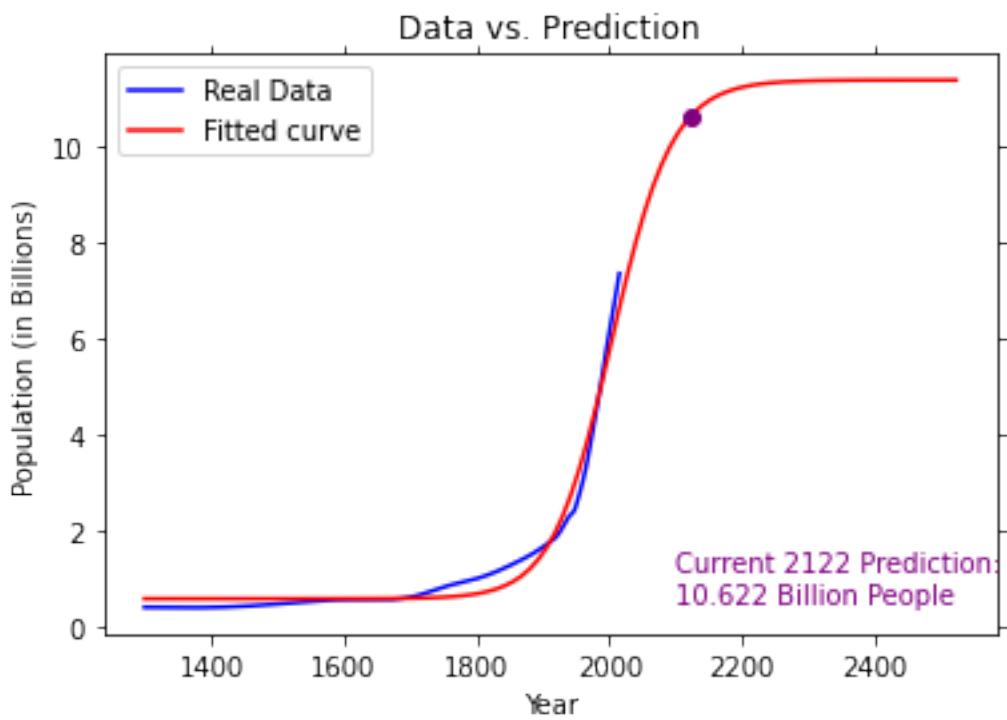
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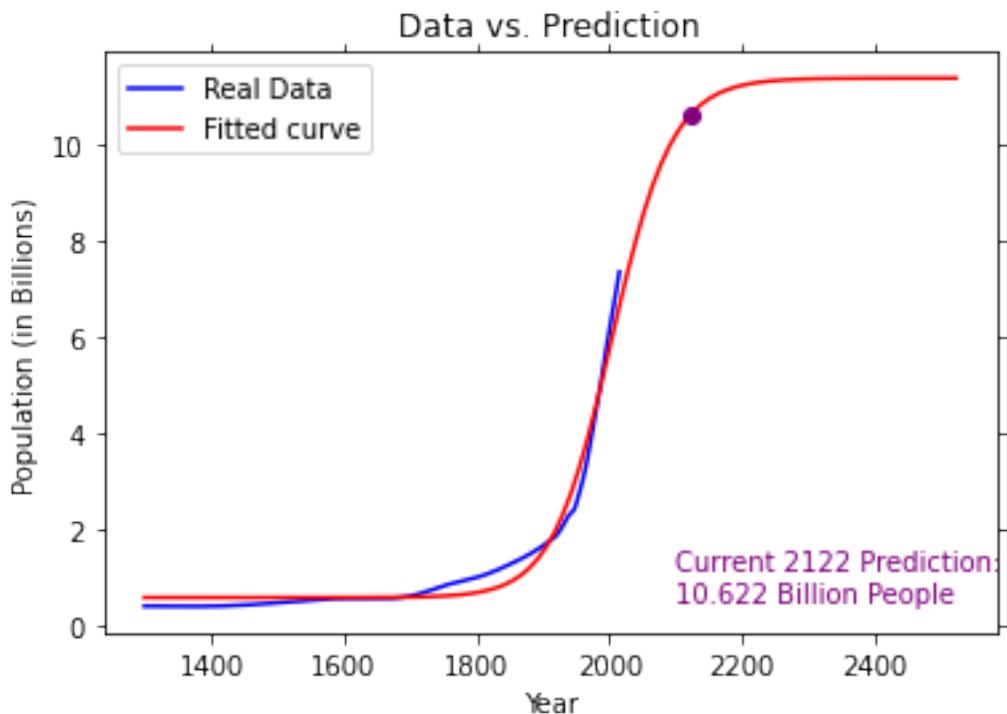
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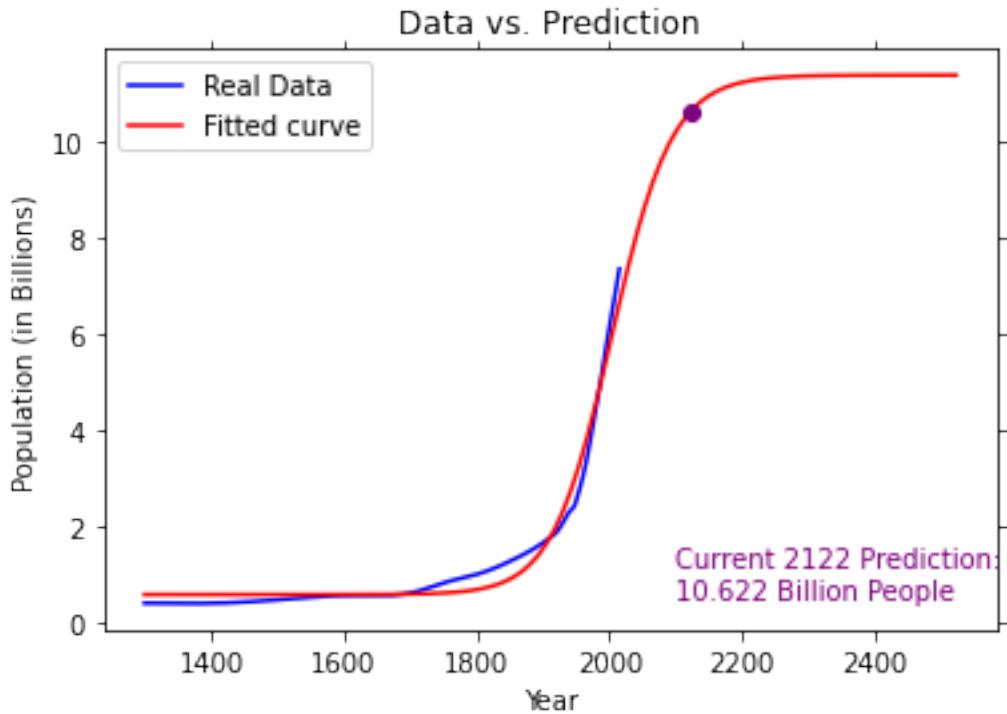
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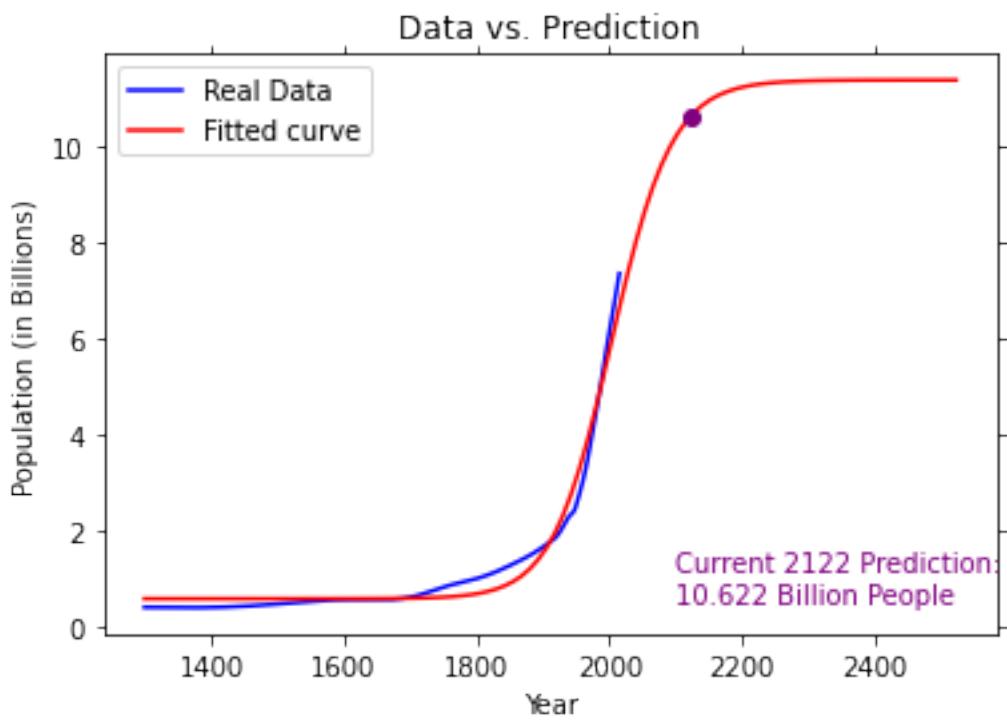
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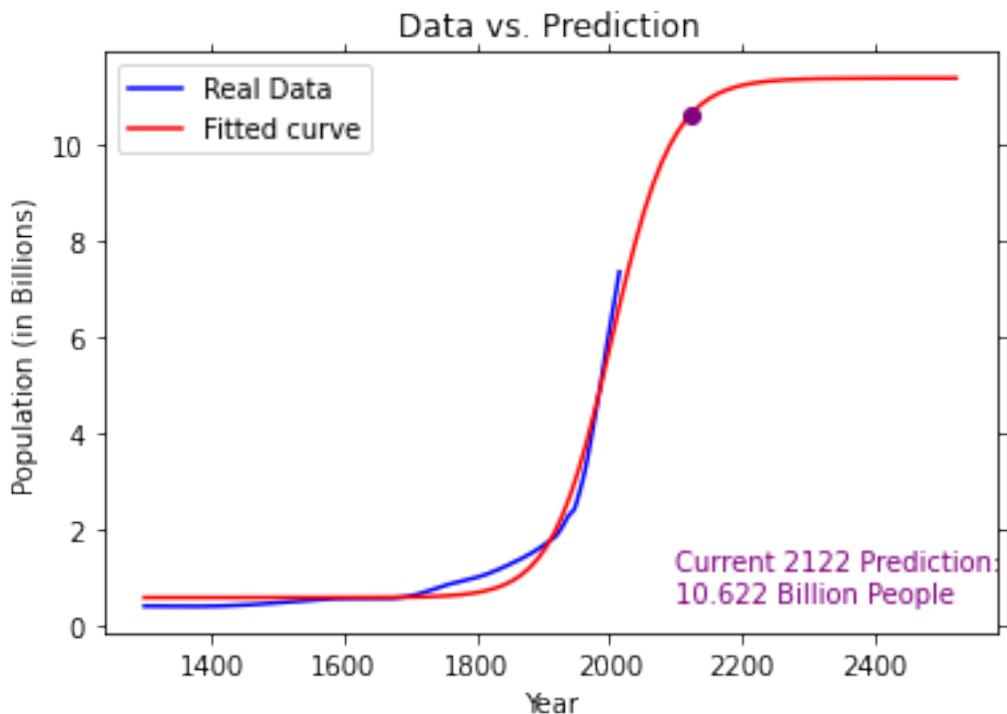
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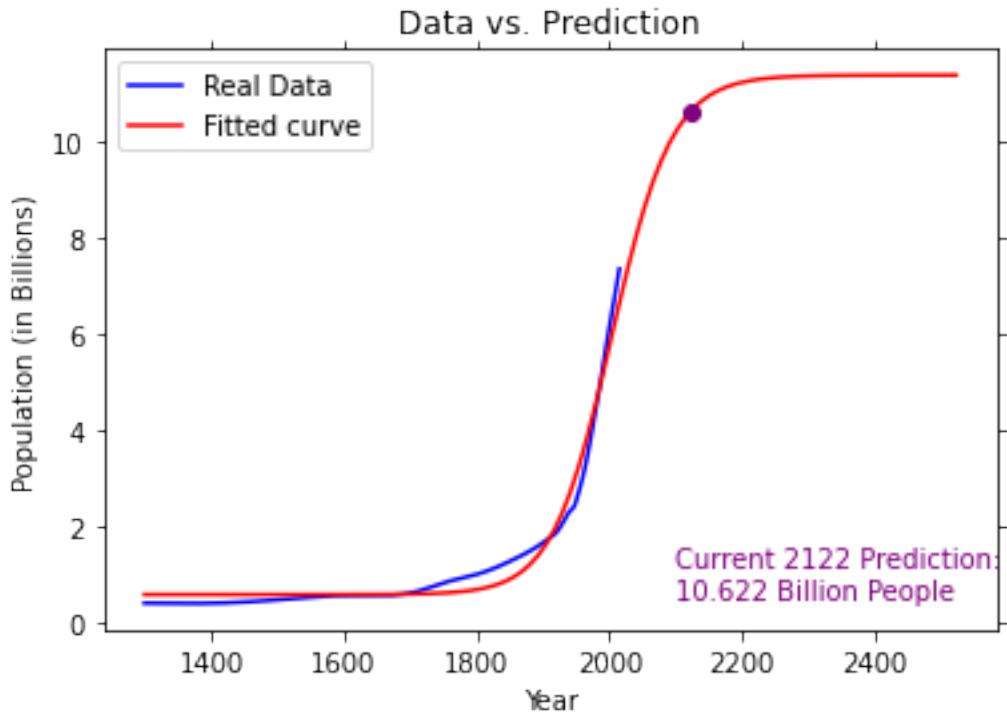
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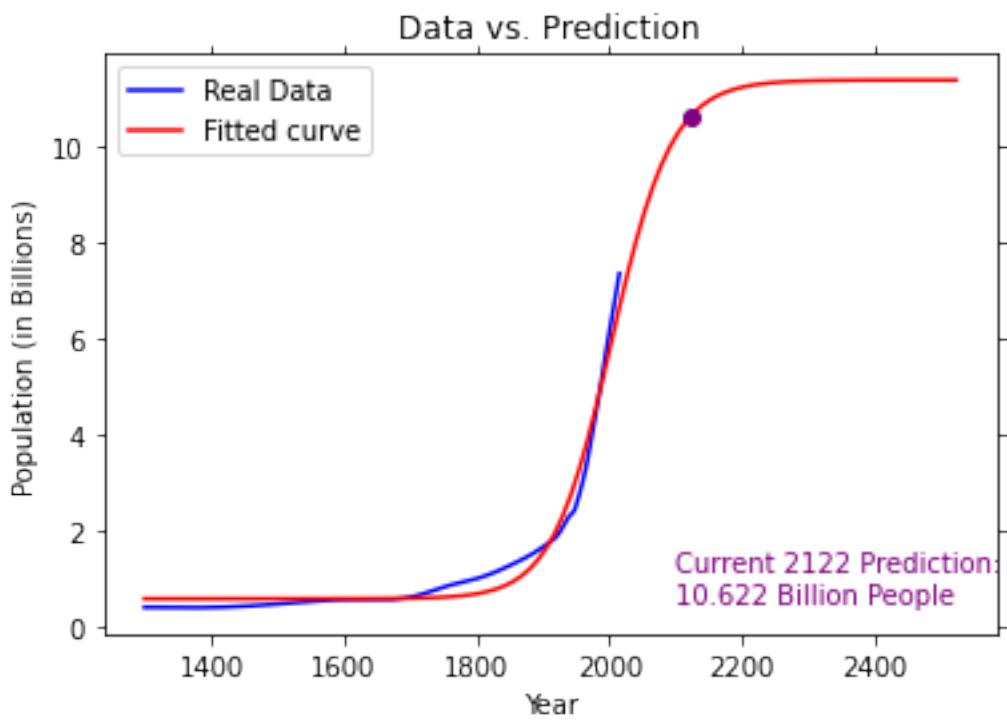
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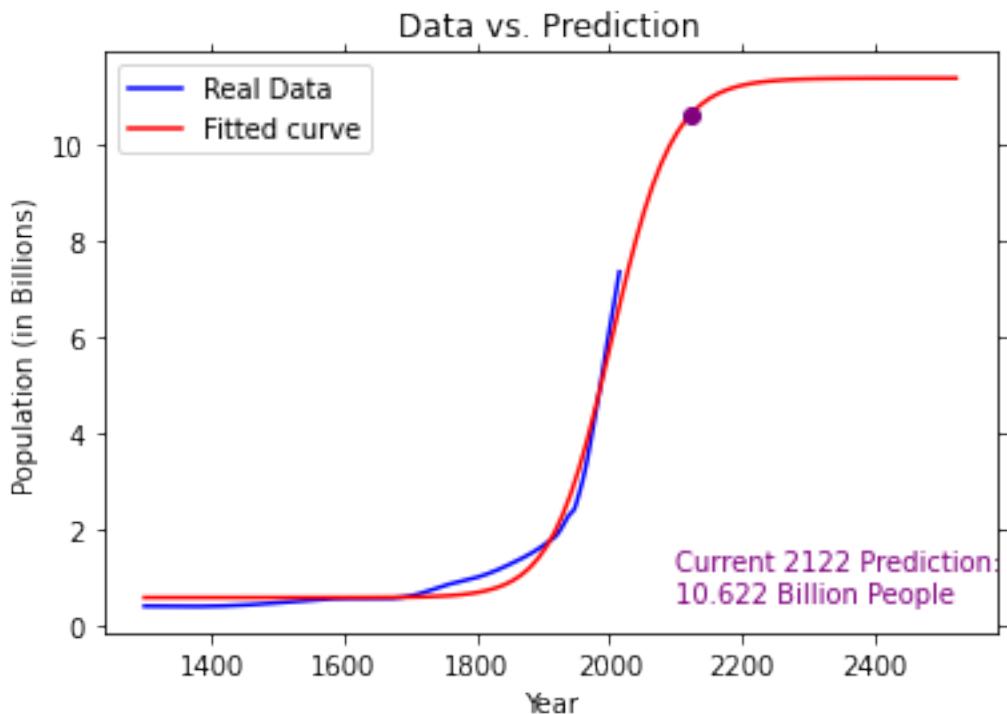
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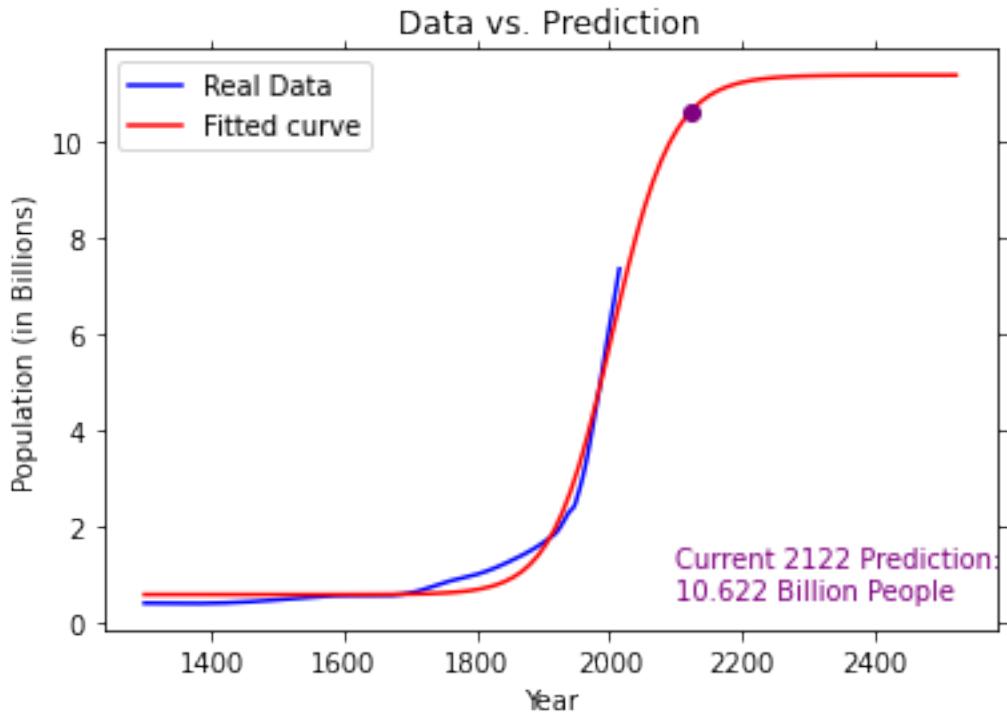
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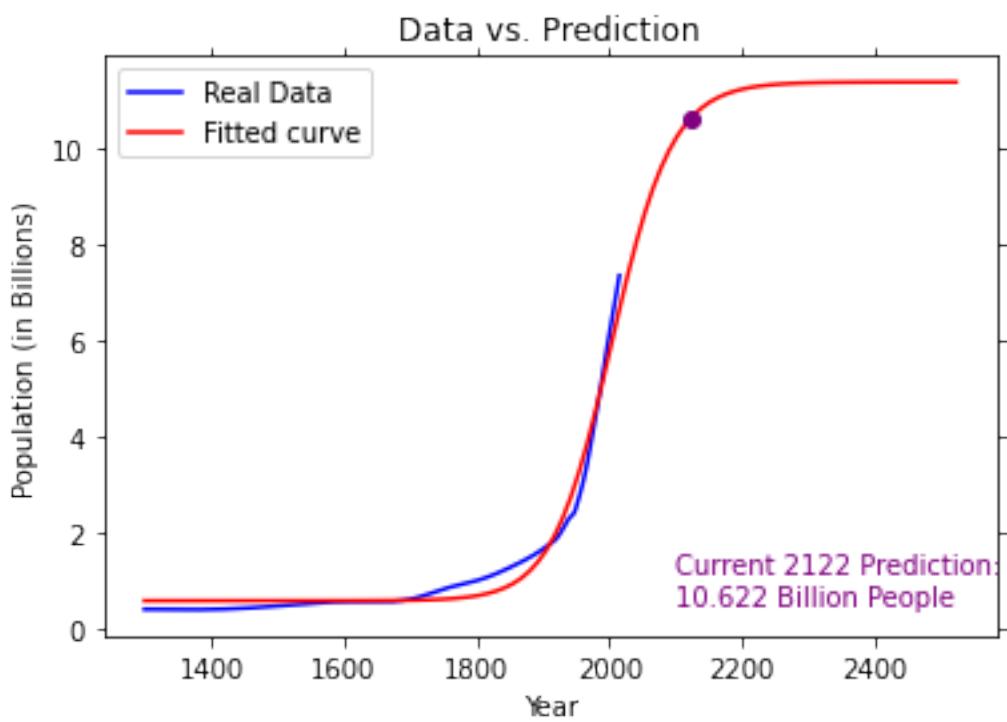
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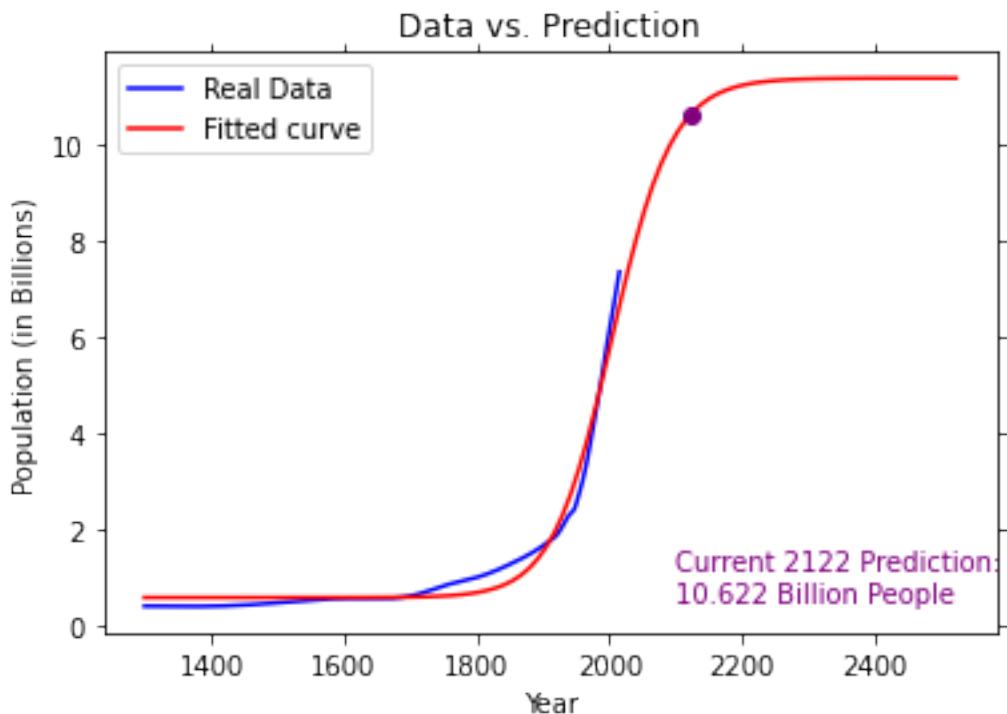
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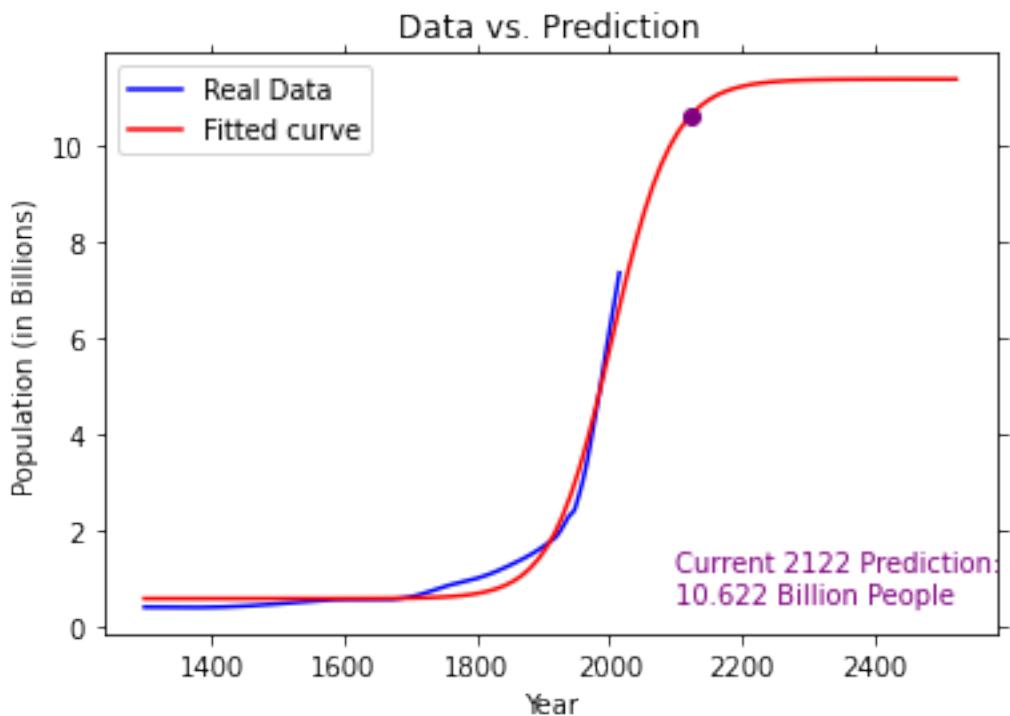
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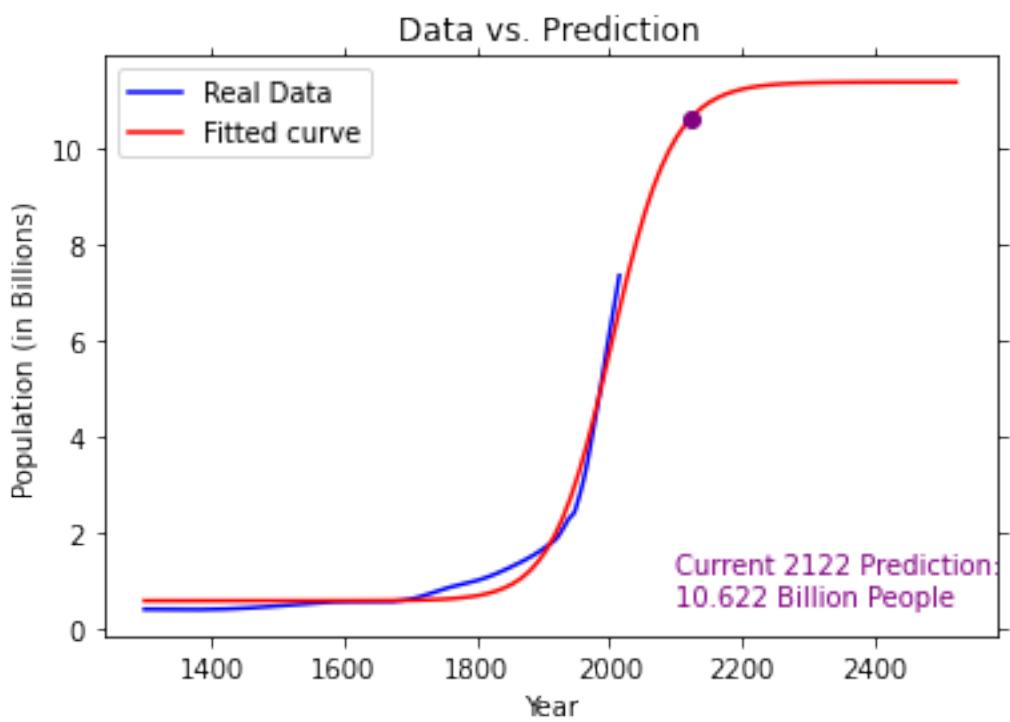
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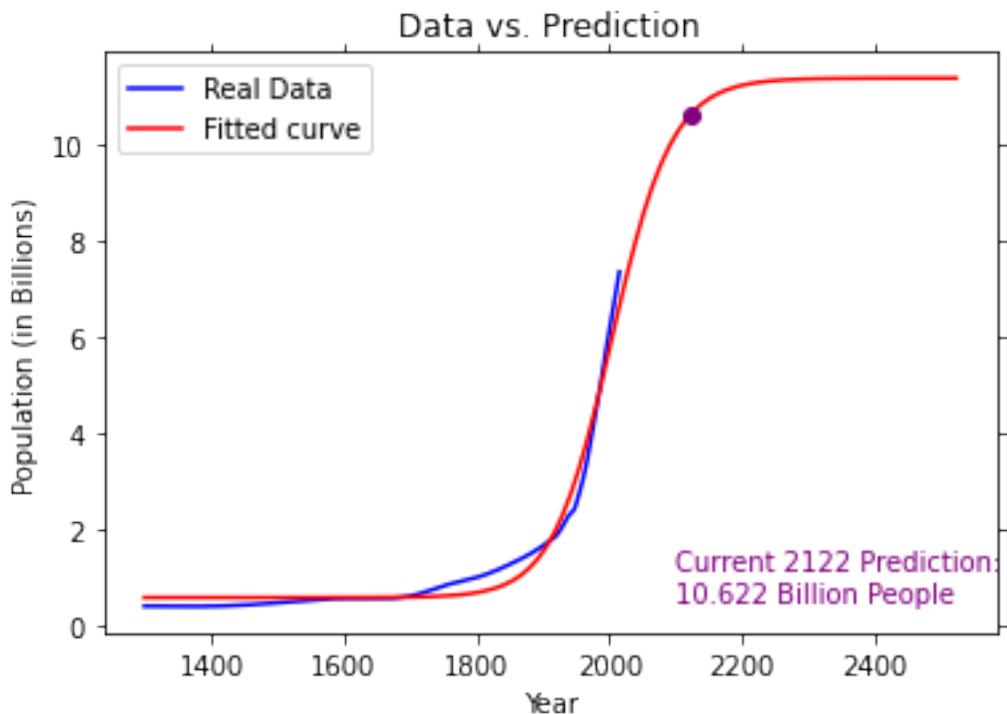
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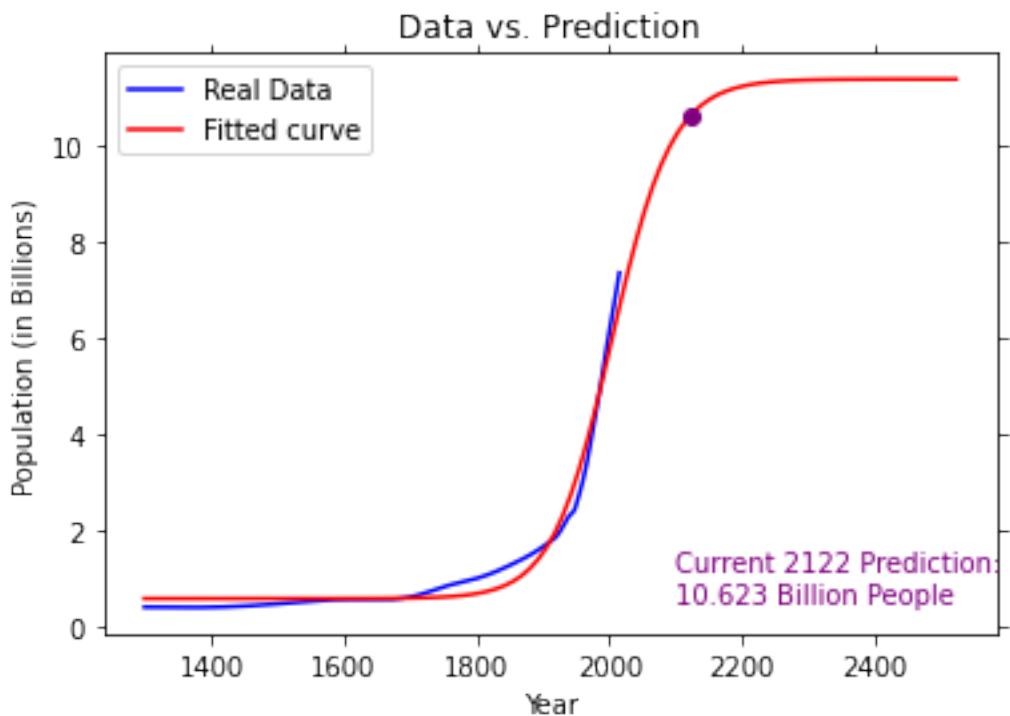
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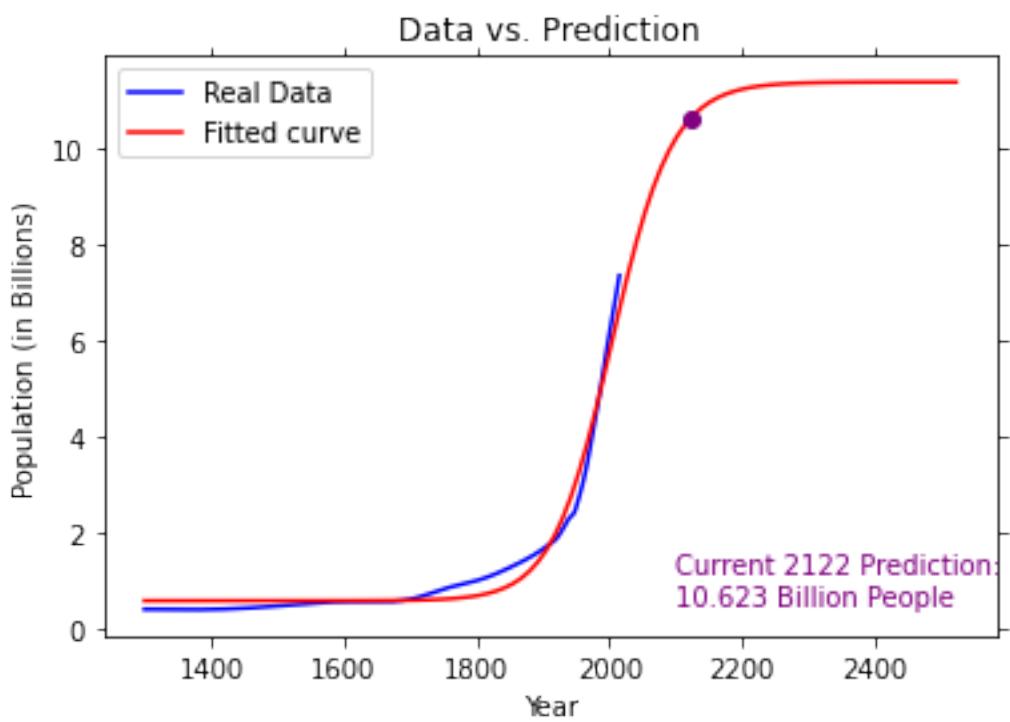
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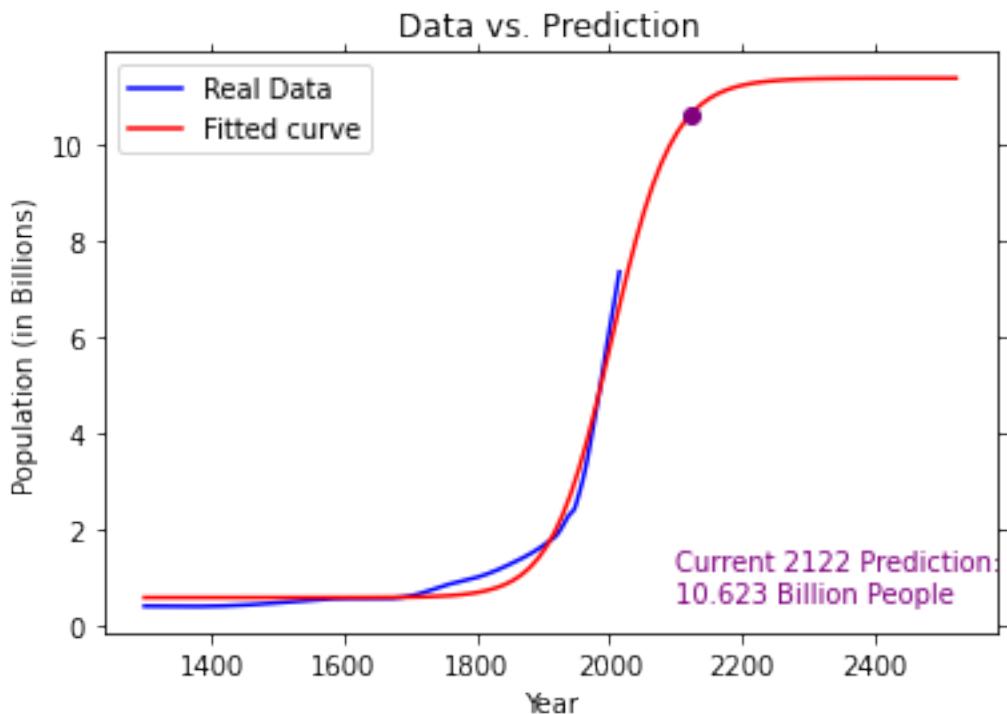
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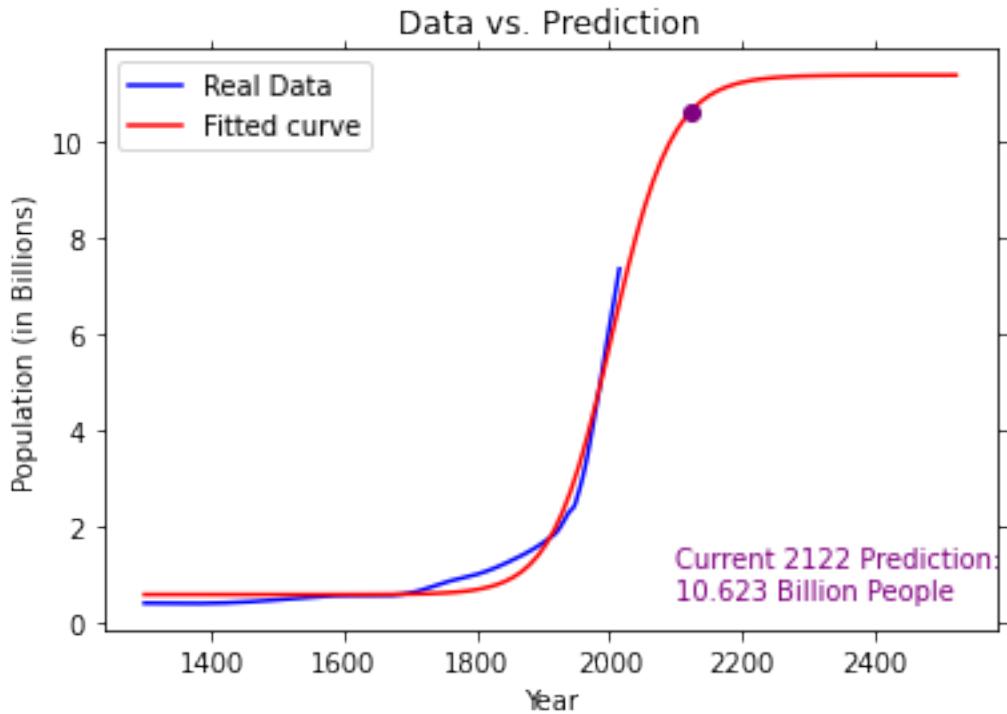
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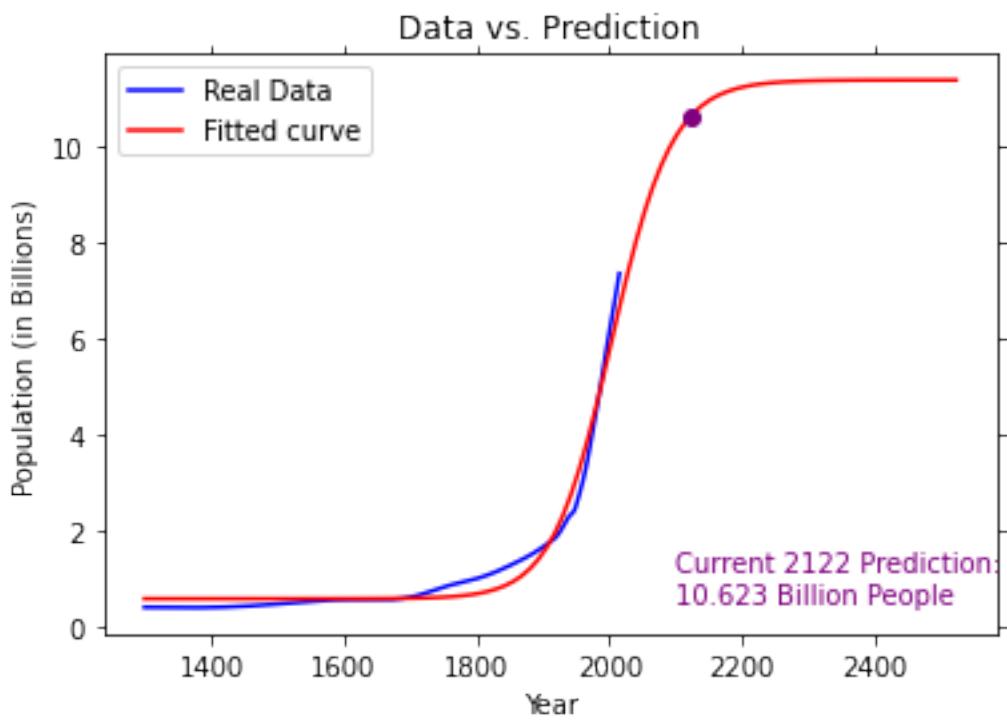
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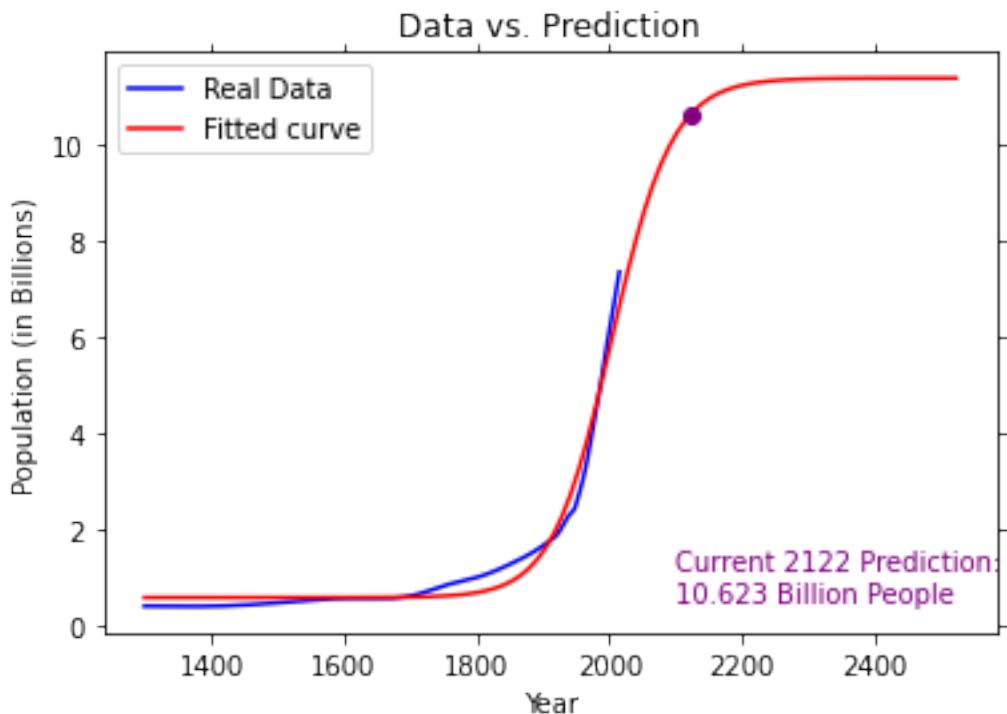
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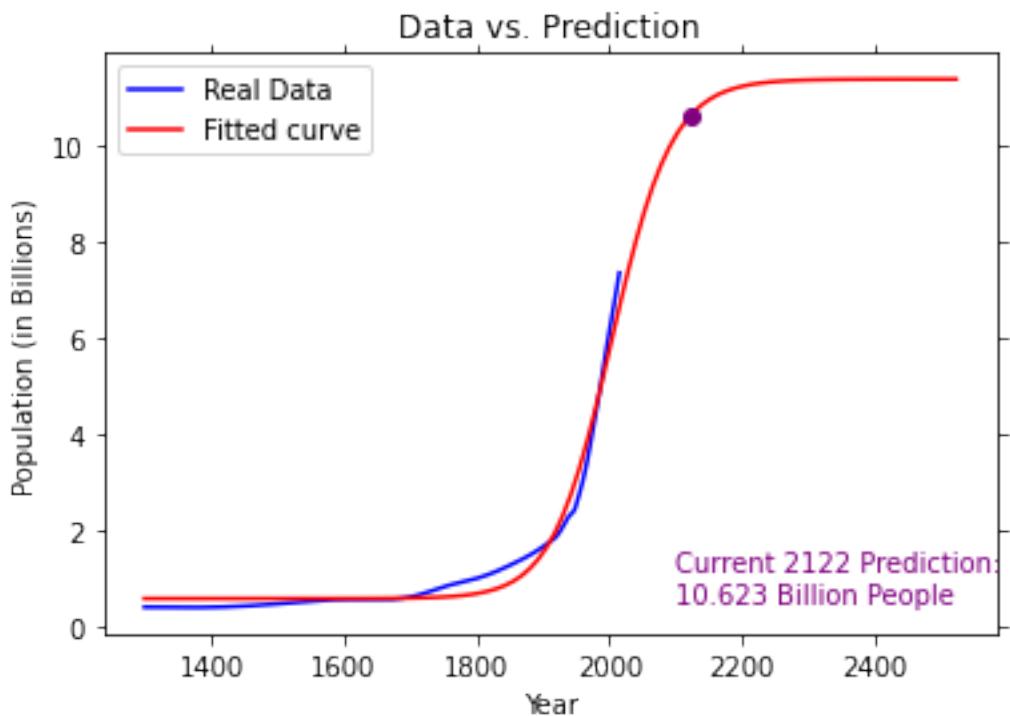
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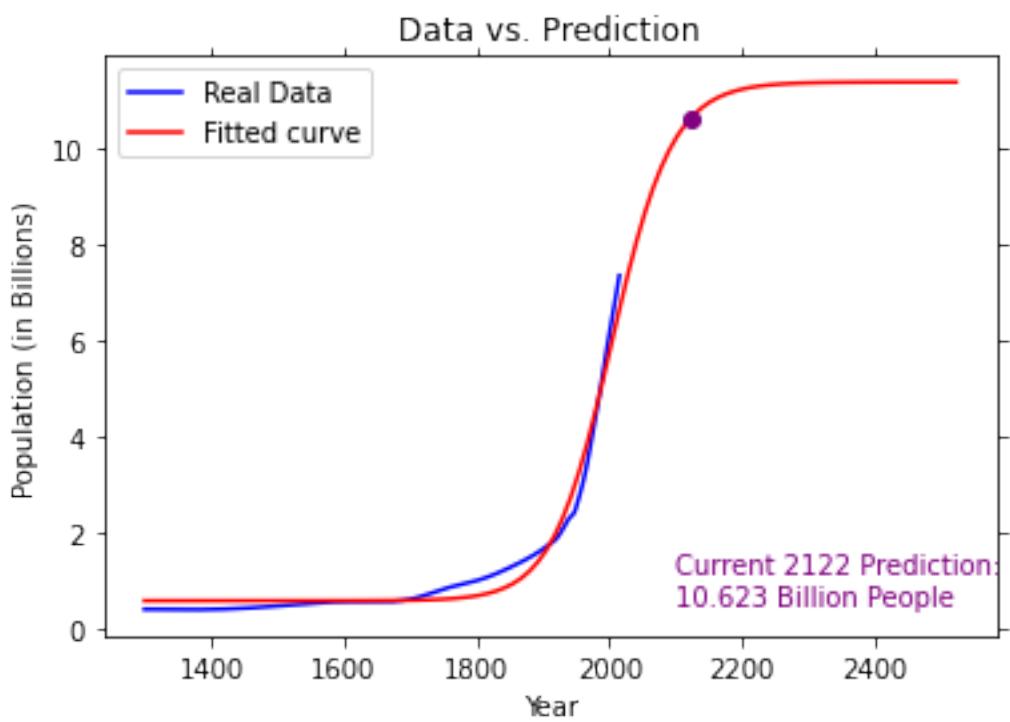
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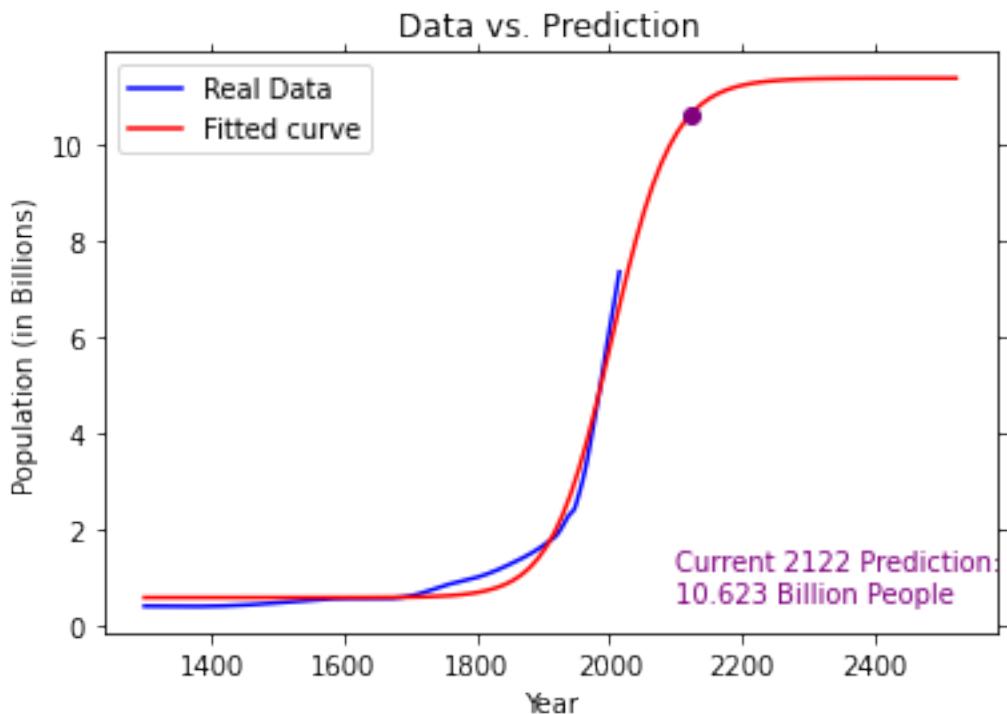
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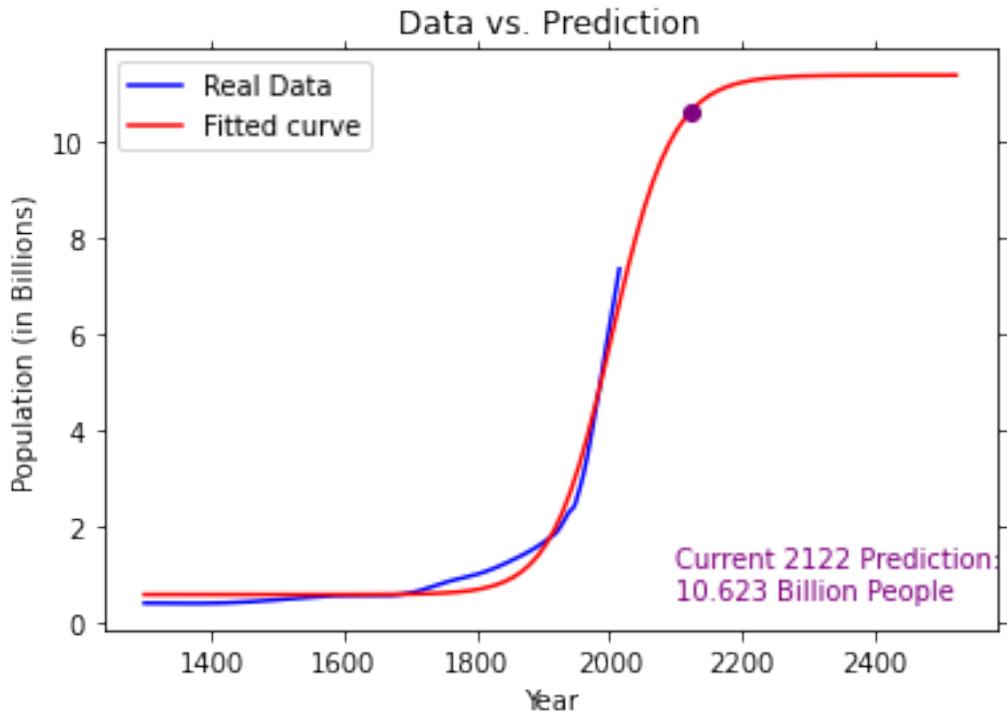
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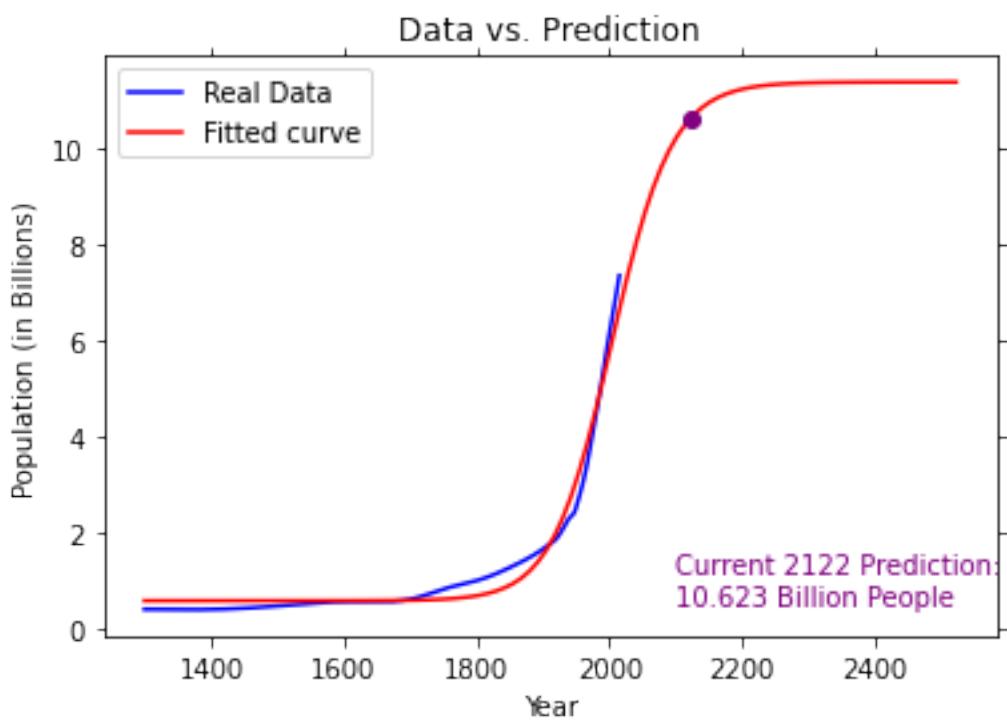
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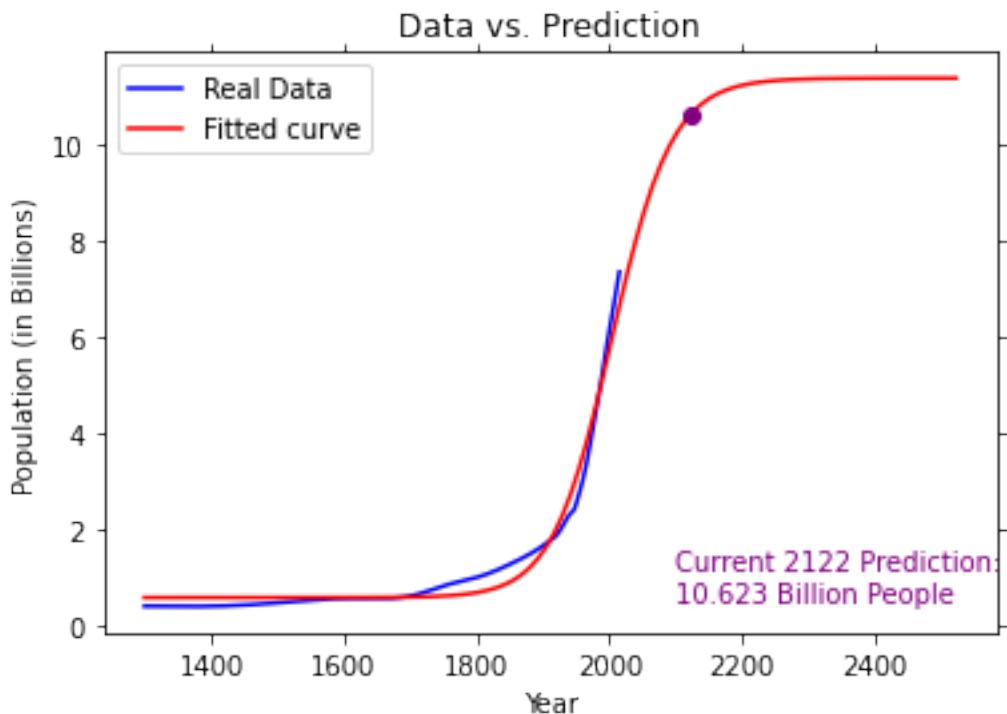
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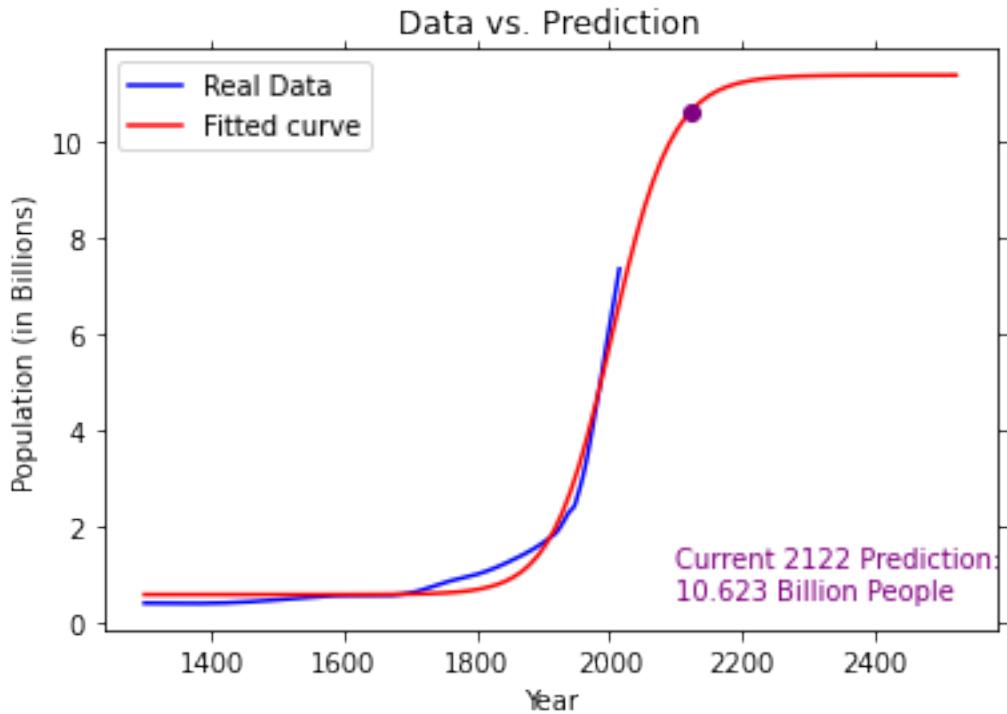
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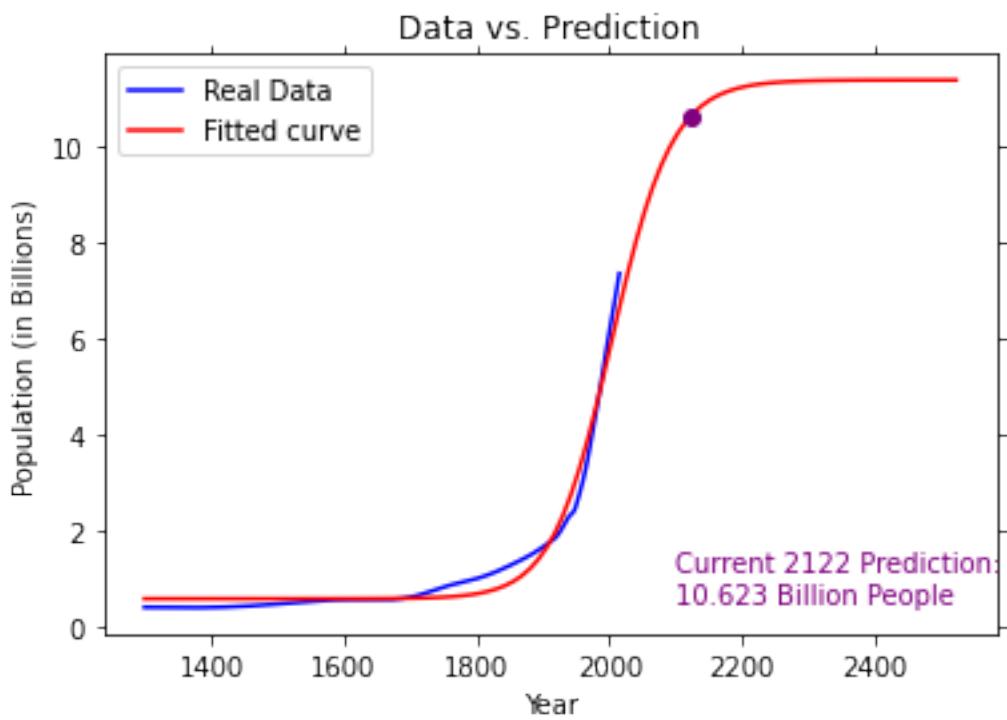
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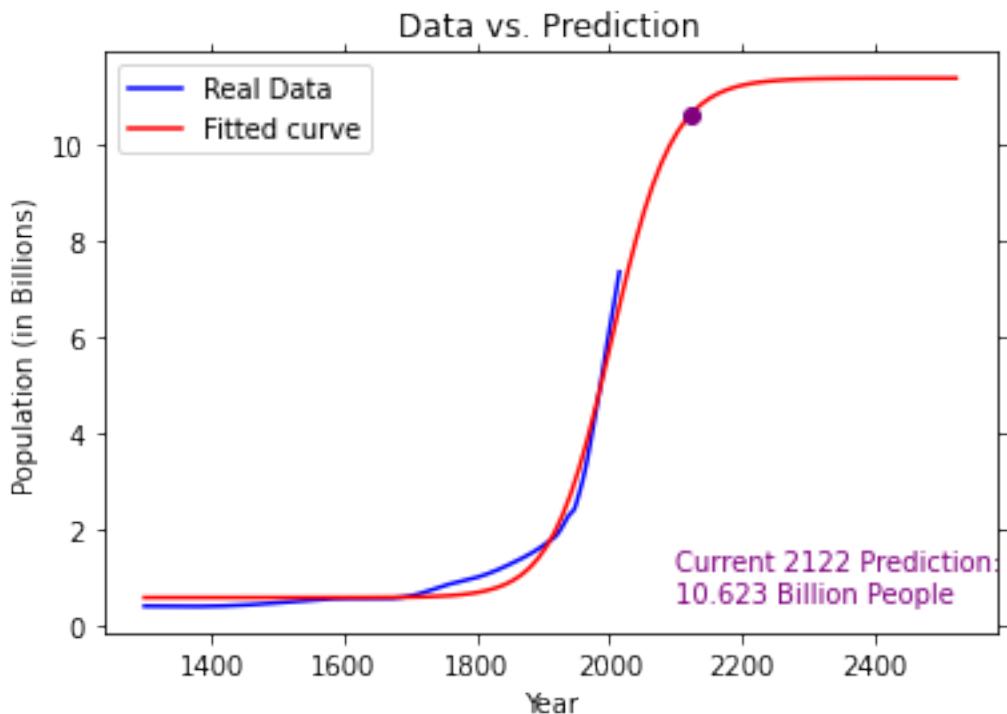
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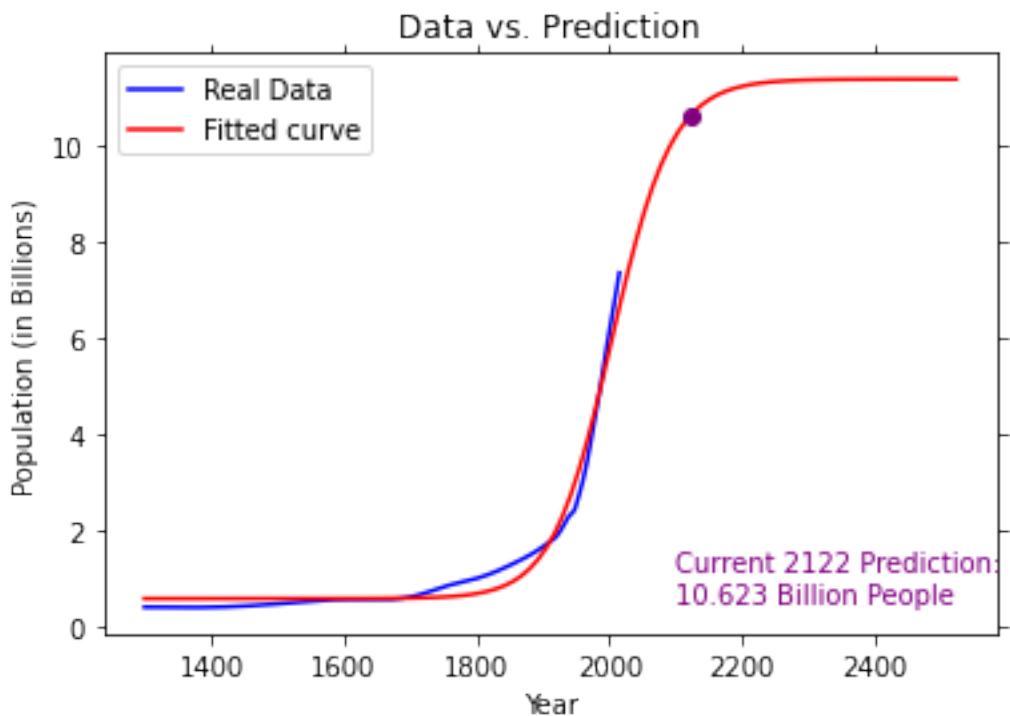
Iteration #41900, Loss: 0.05059661438272506



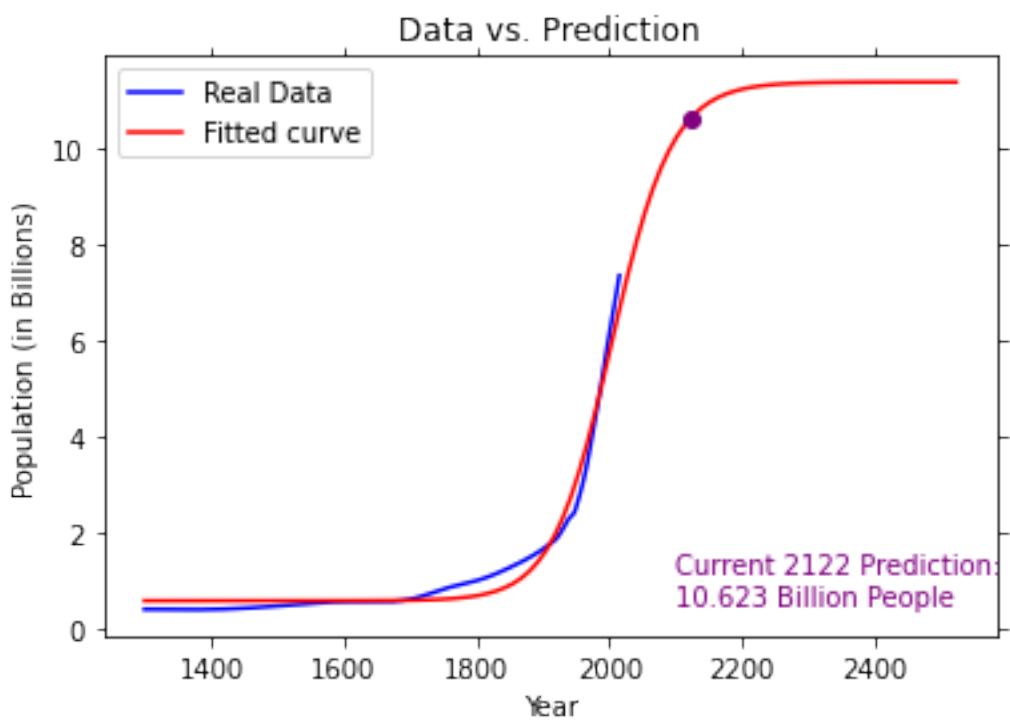
Iteration #41950, Loss: 0.050594135816996955



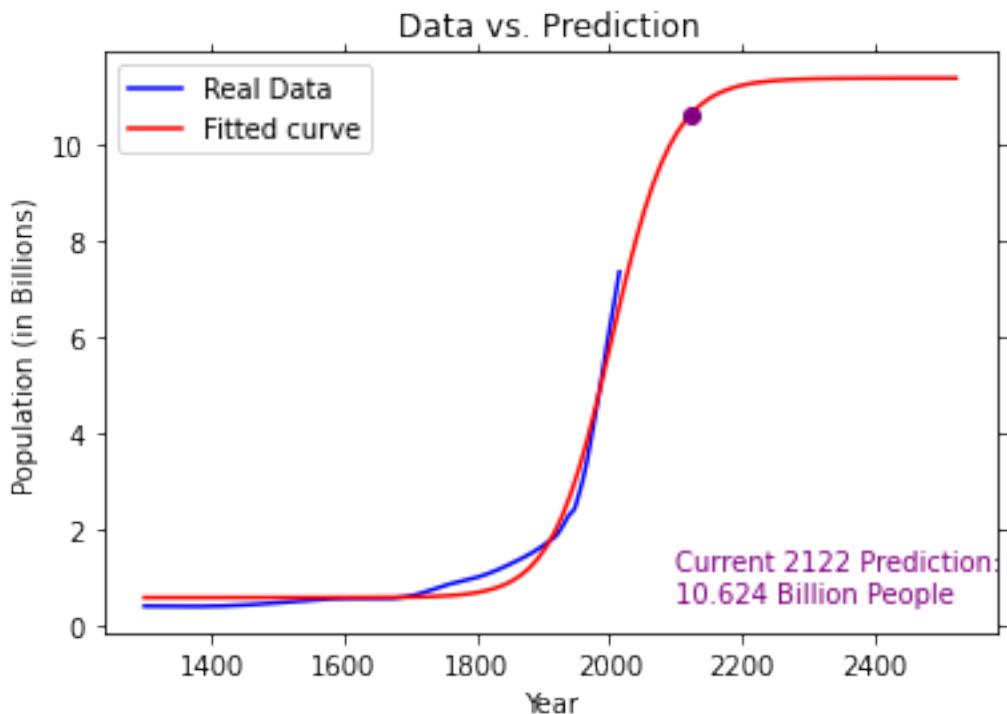
Iteration #42000, Loss: 0.050591672545426715



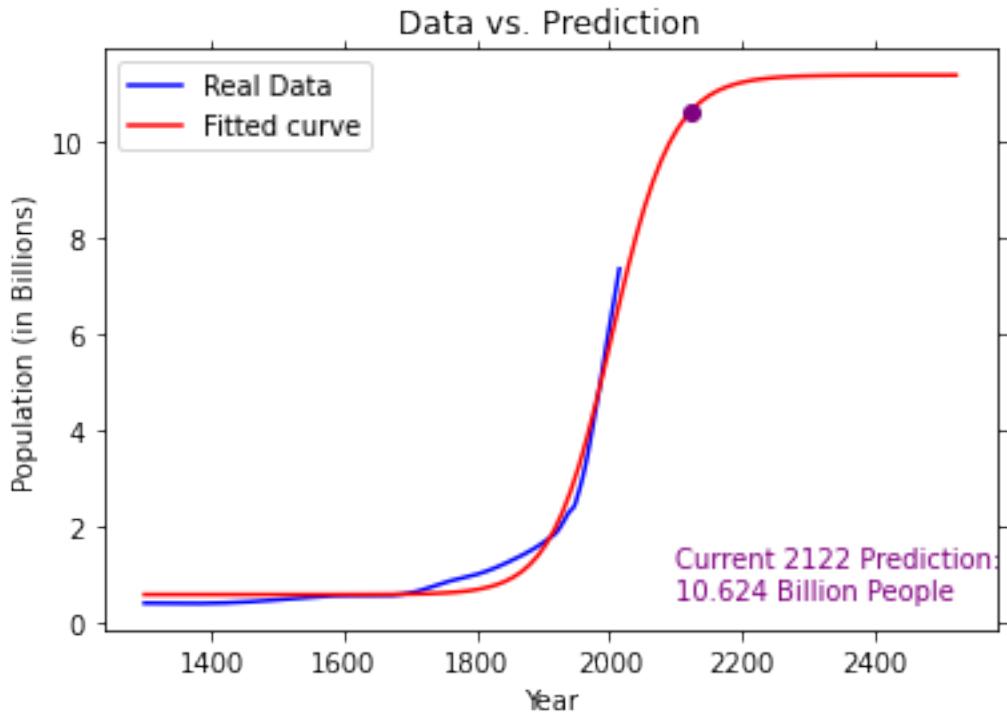
Iteration #42050, Loss: 0.05058922456908592



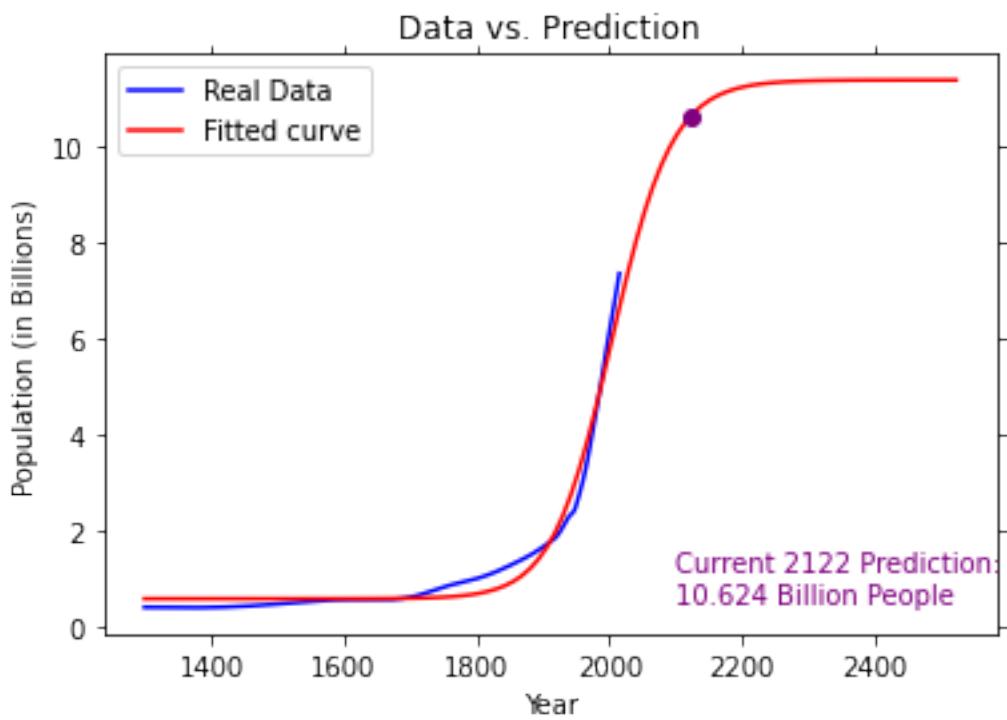
Iteration #42100, Loss: 0.05058679188903519



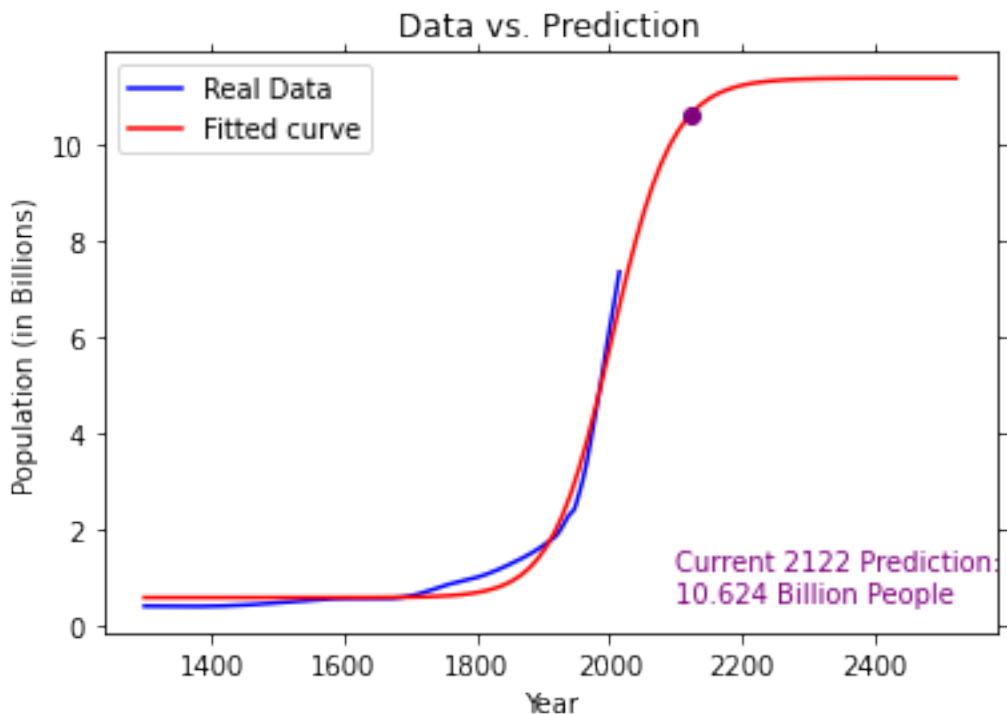
Iteration #42150, Loss: 0.050584374506324664



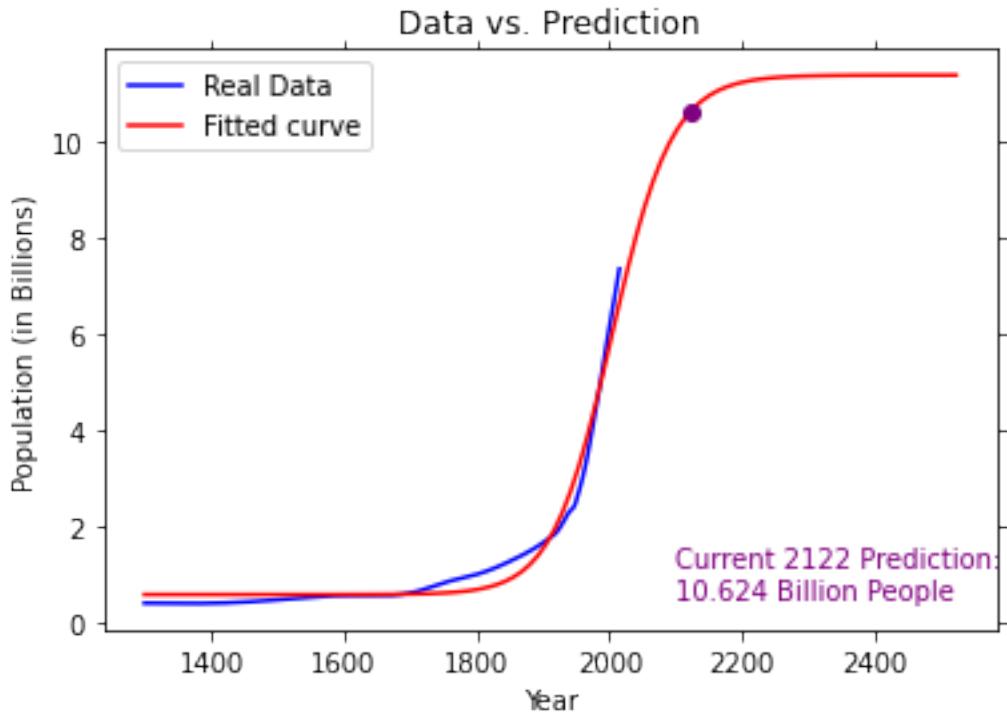
Iteration #42200, Loss: 0.050581972421993554



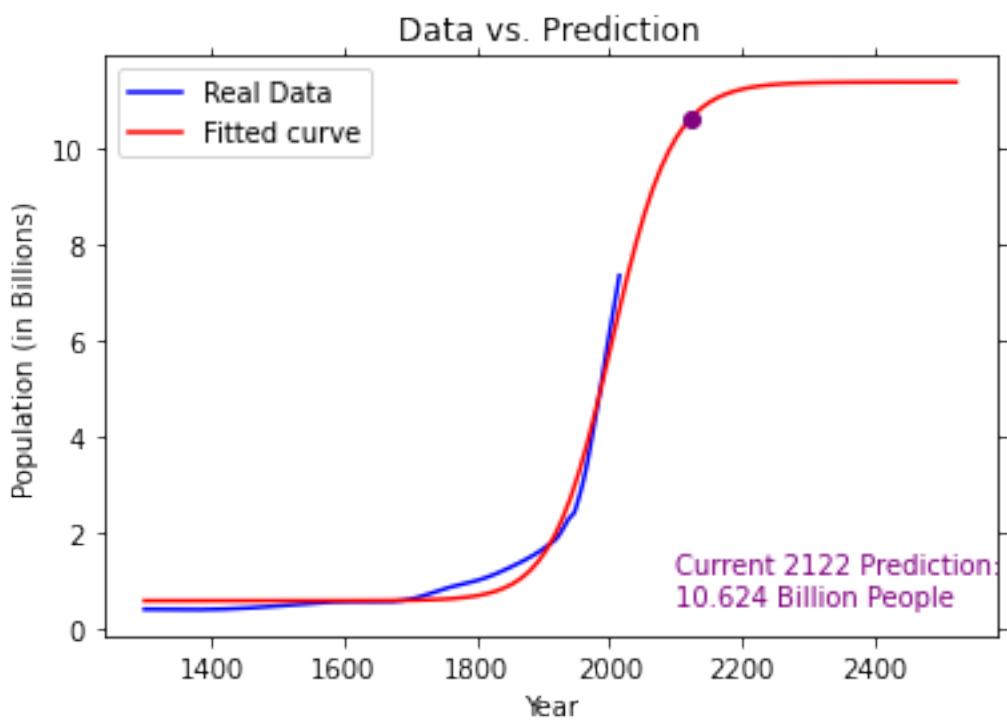
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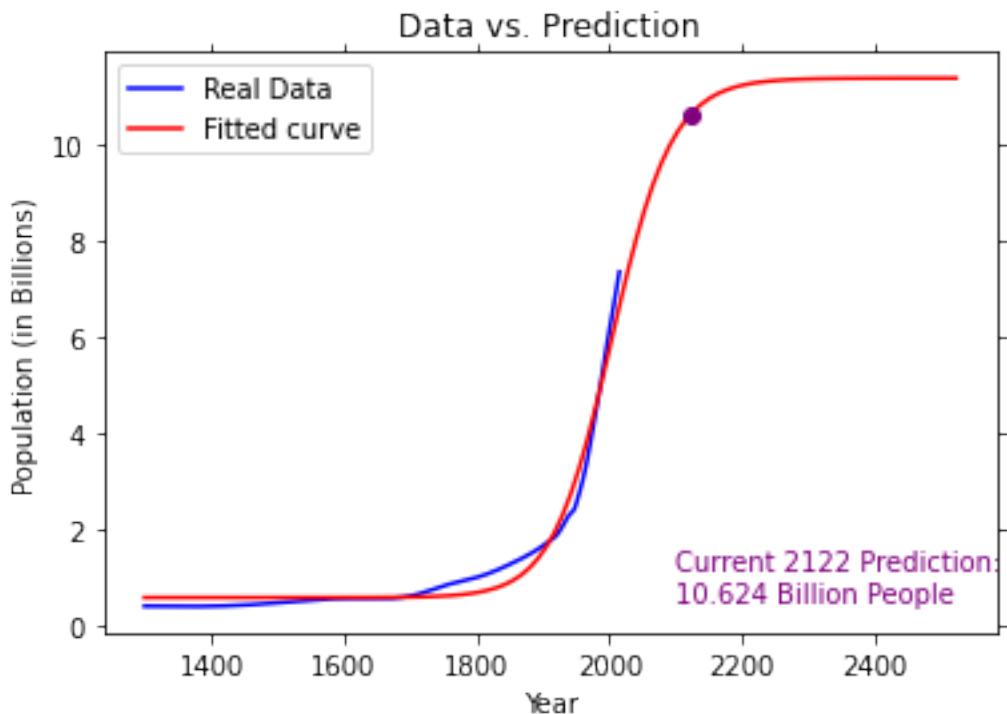
Iteration #42300, Loss: 0.05057721415257444



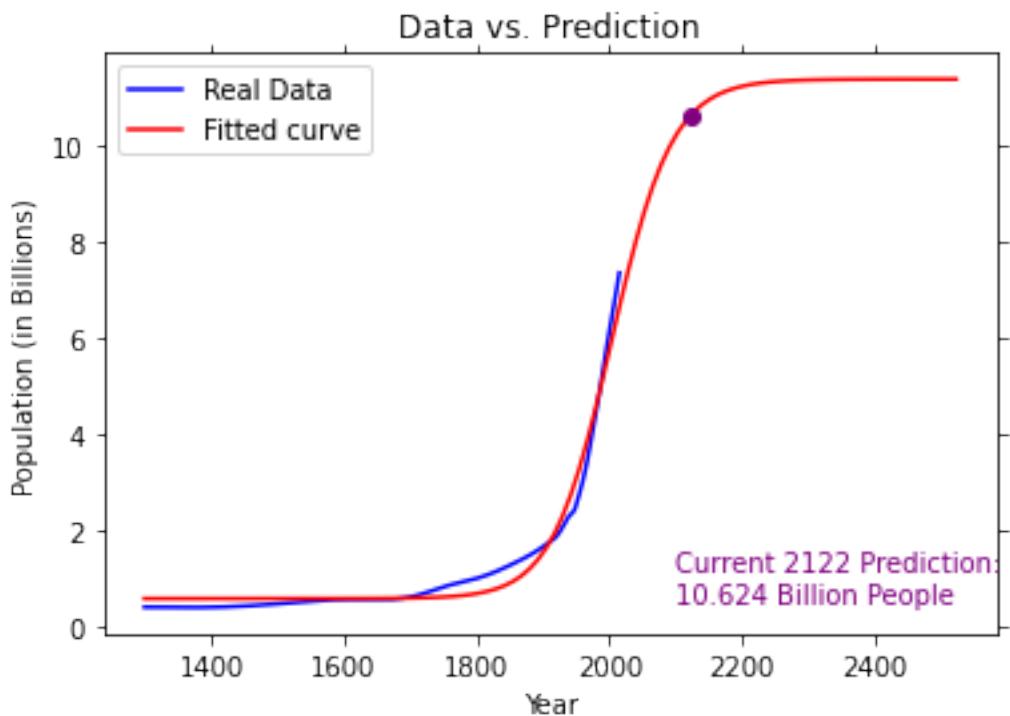
Iteration #42350, Loss: 0.05057485796951242



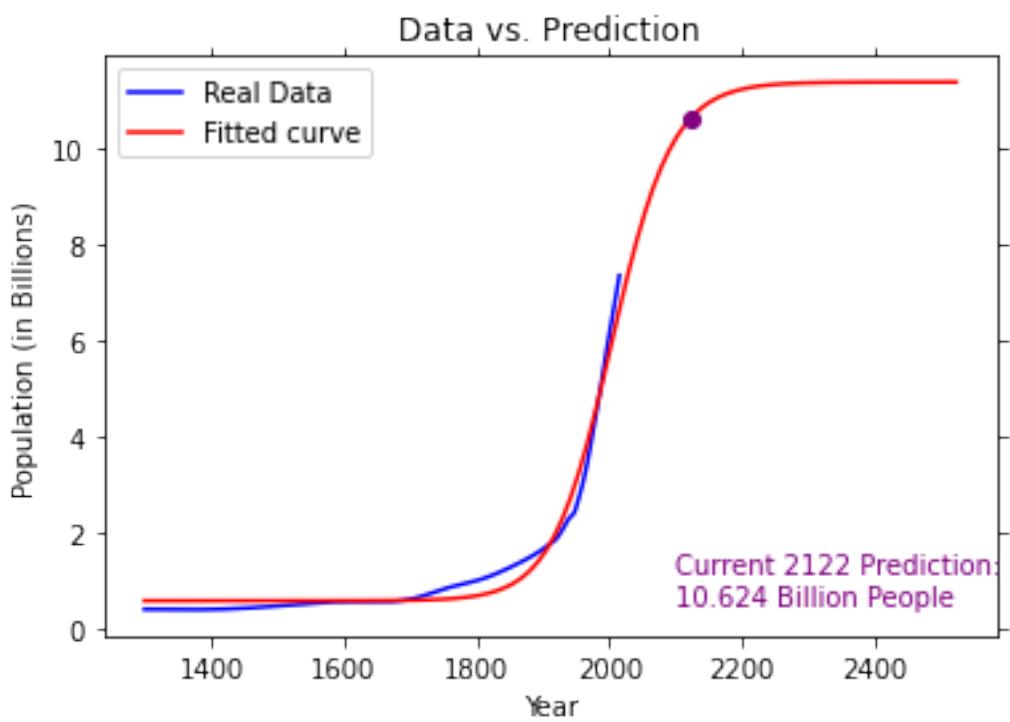
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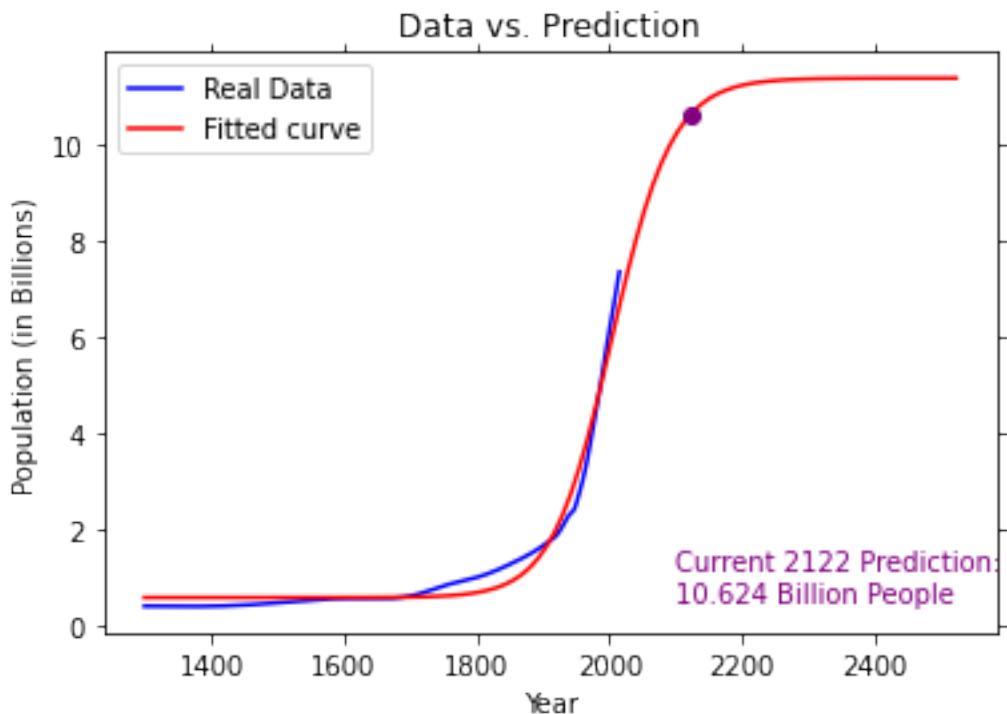
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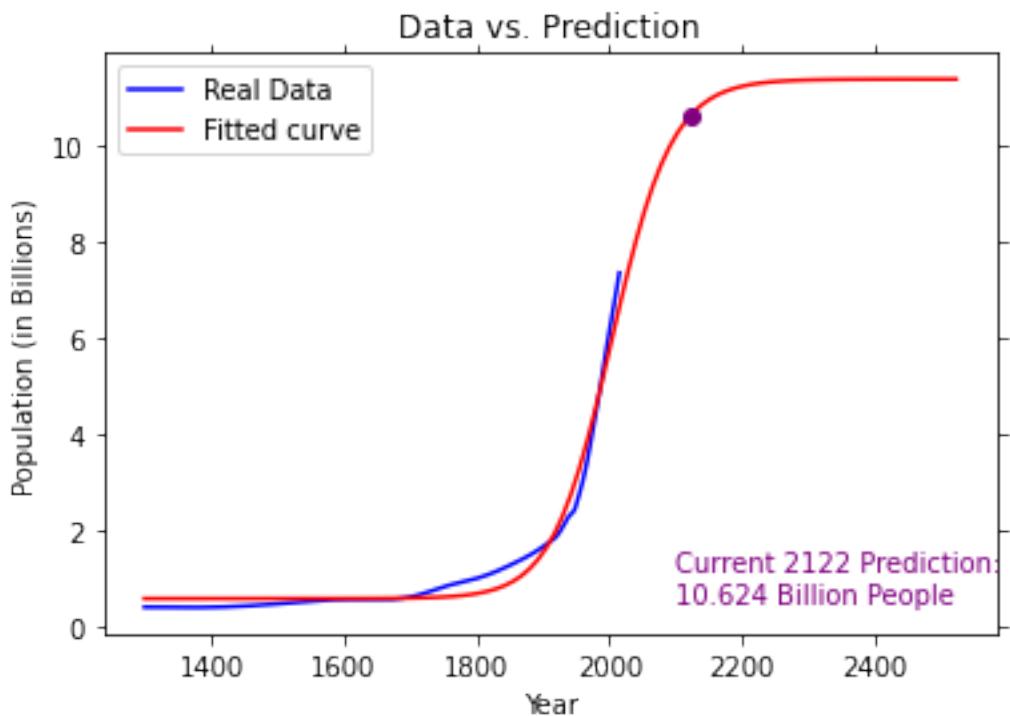
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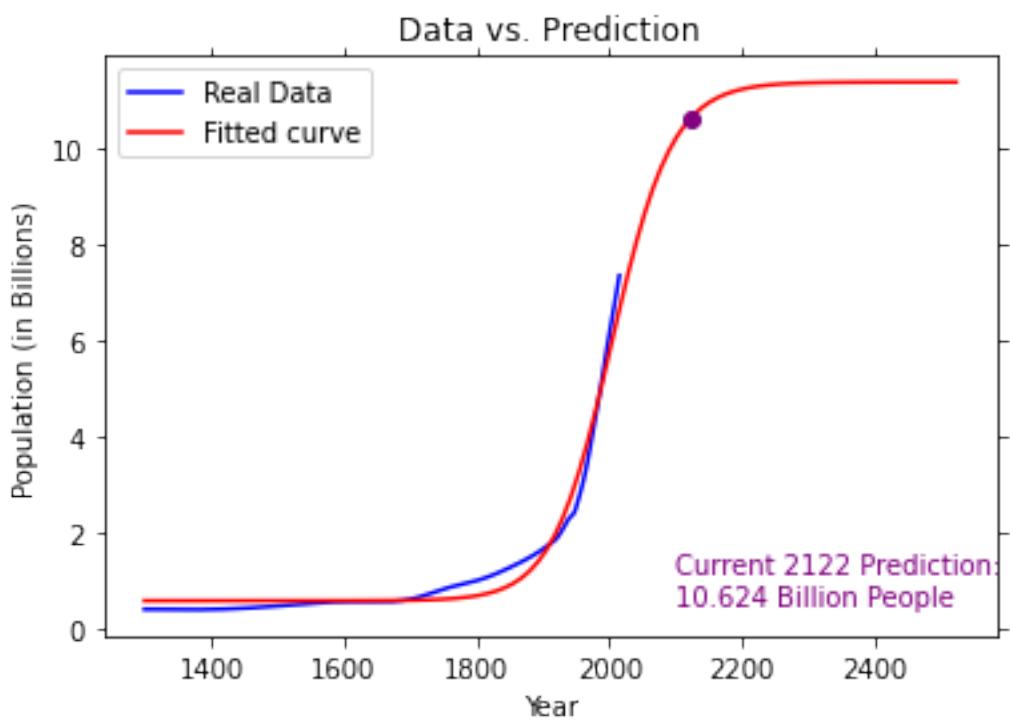
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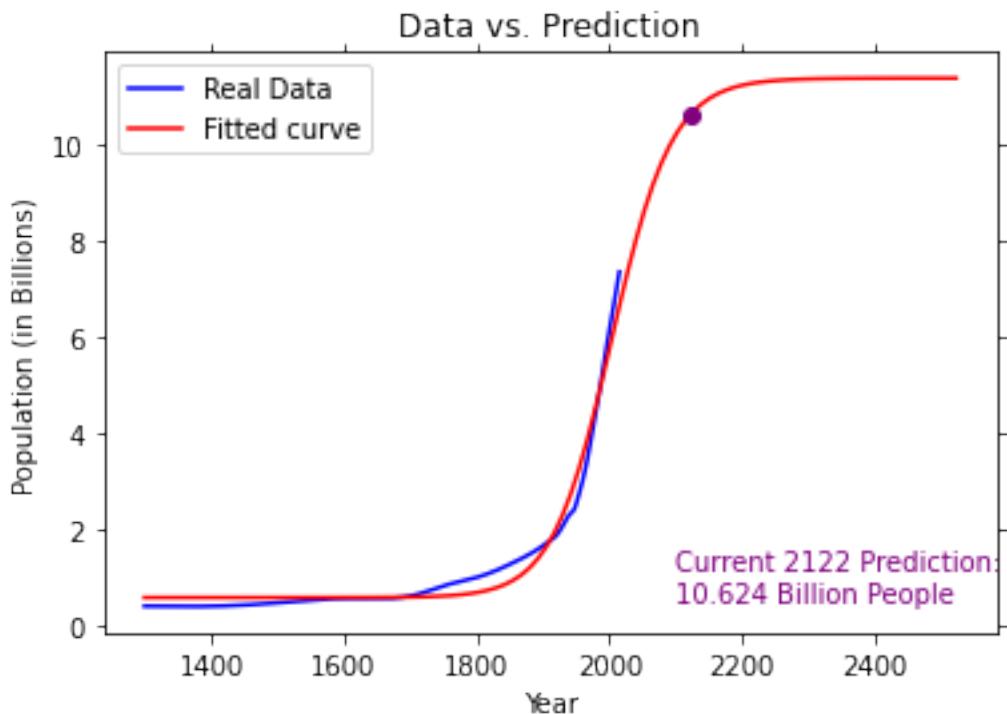
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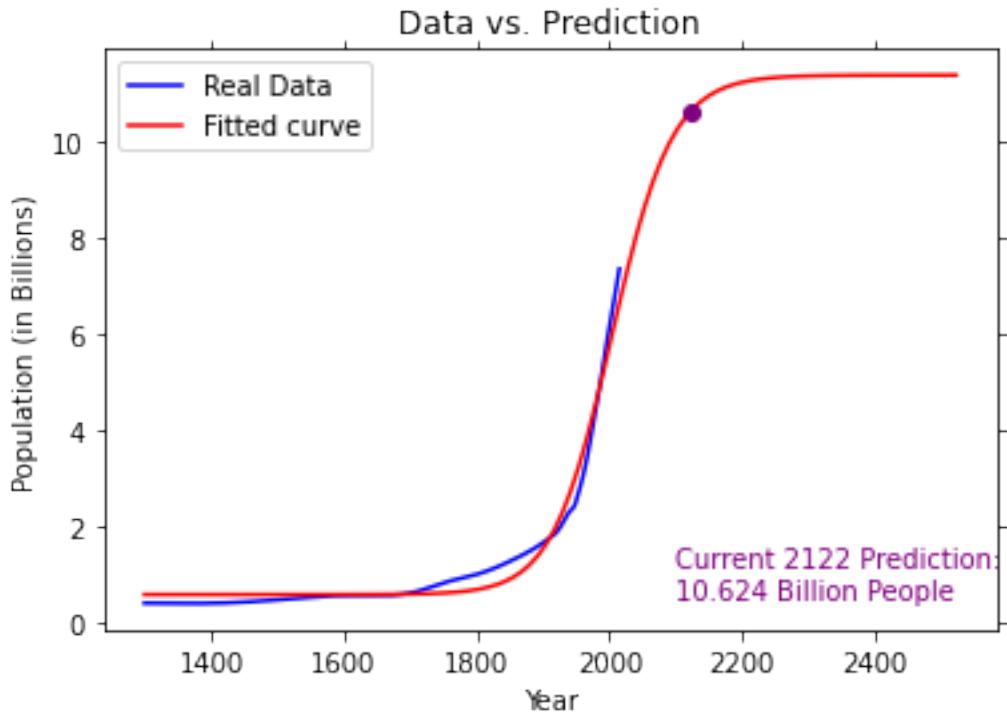
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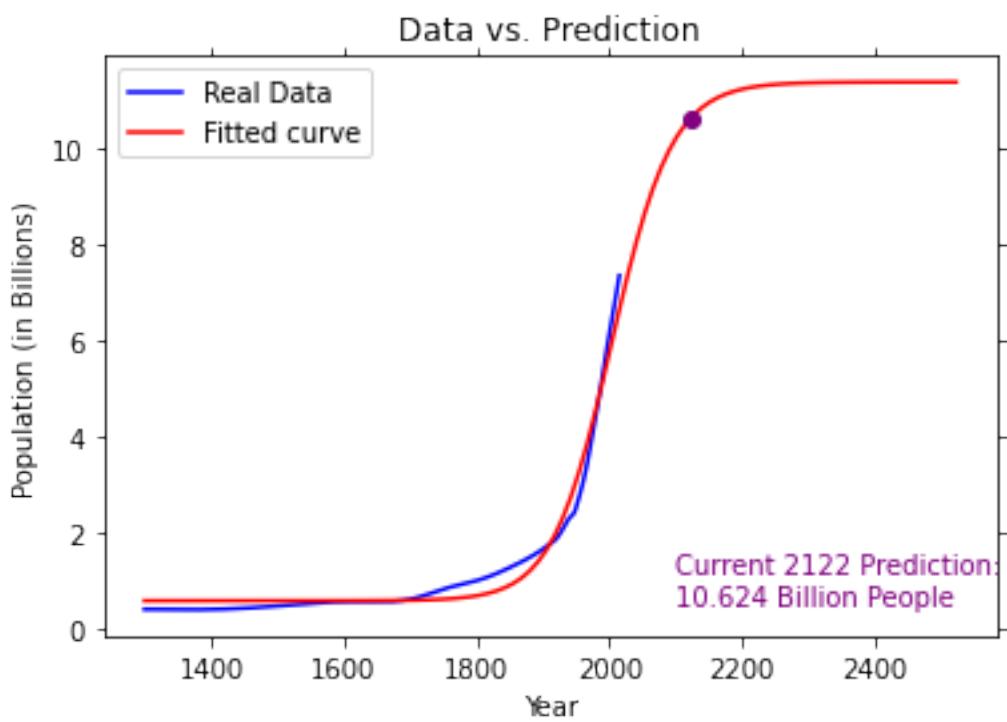
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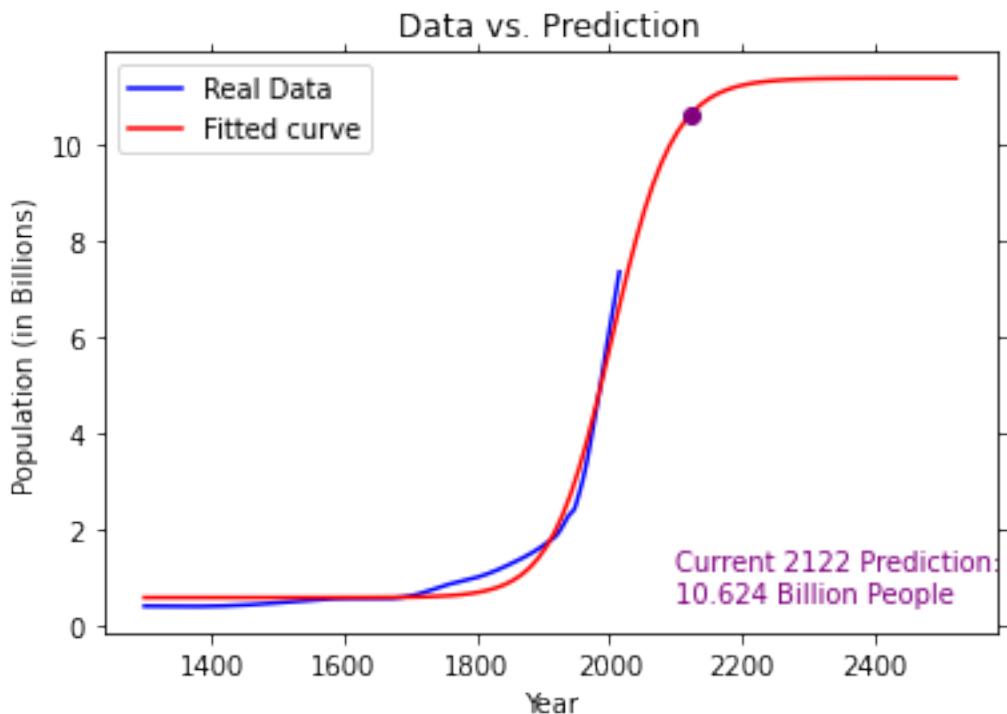
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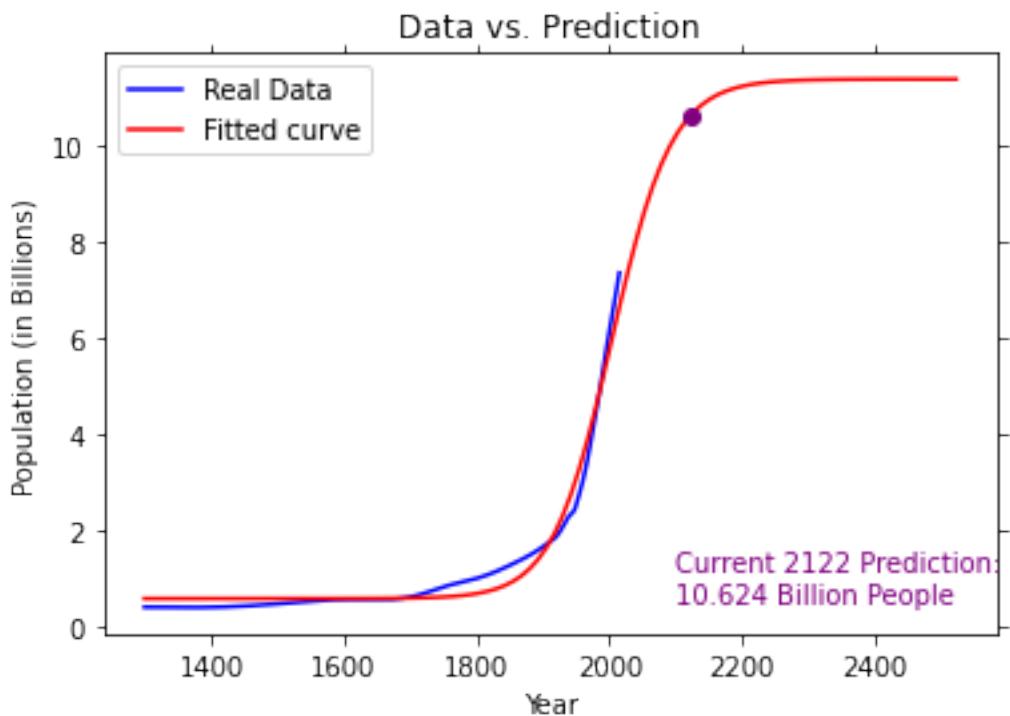
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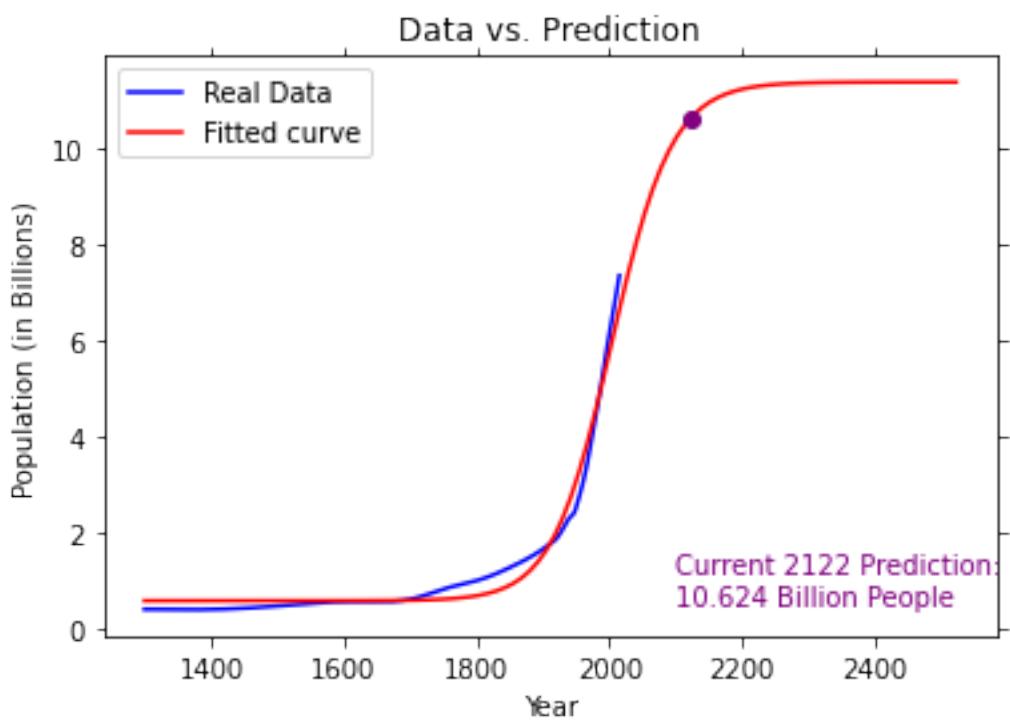
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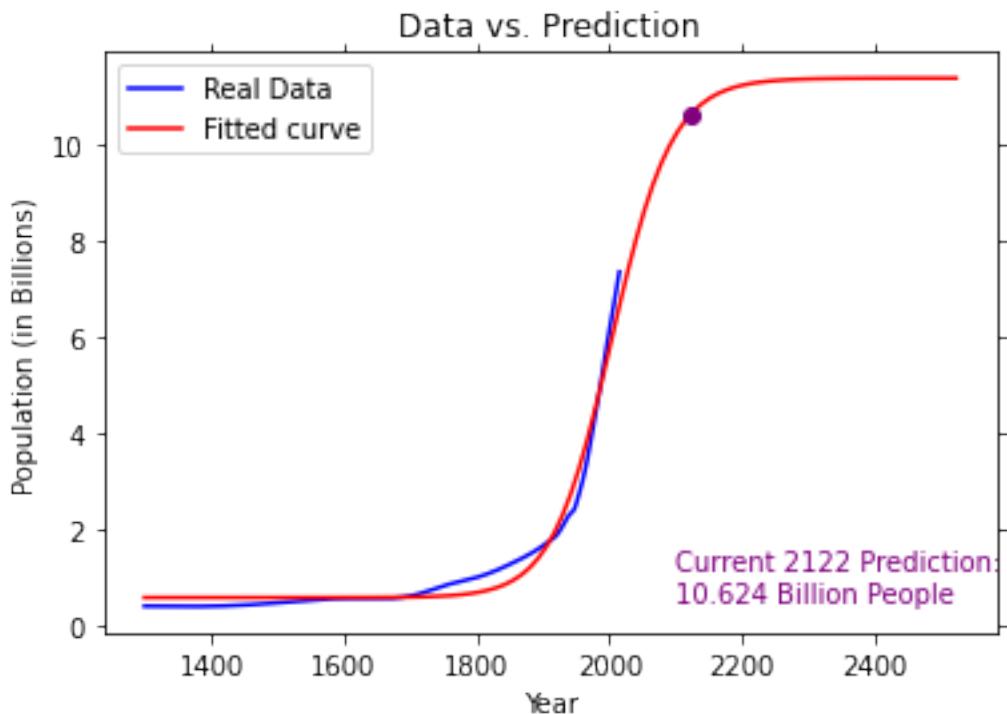
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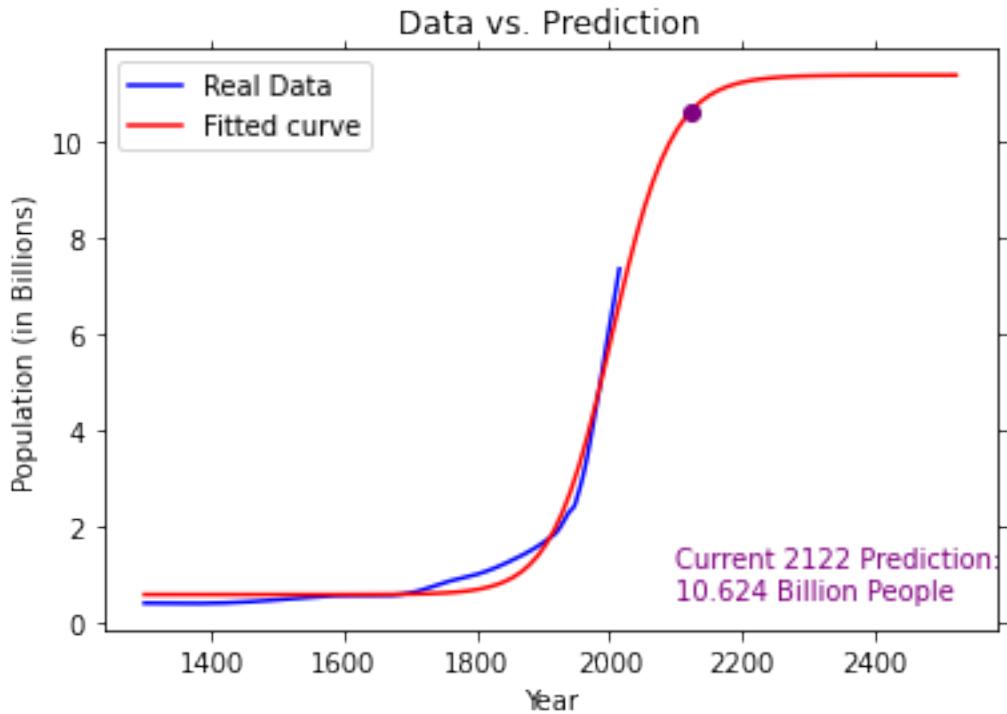
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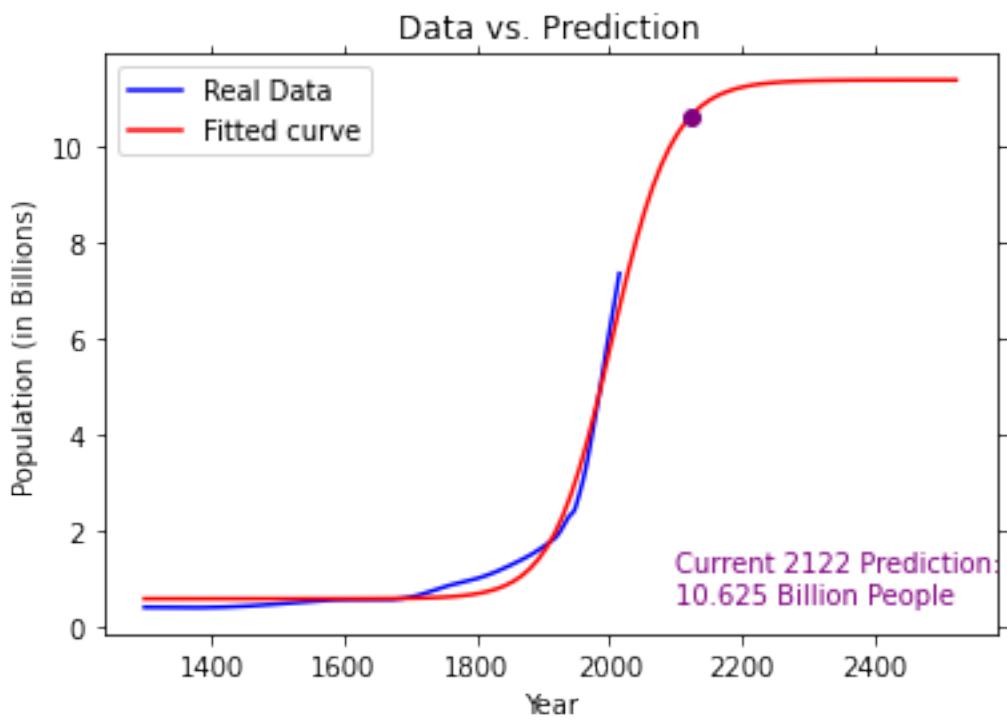
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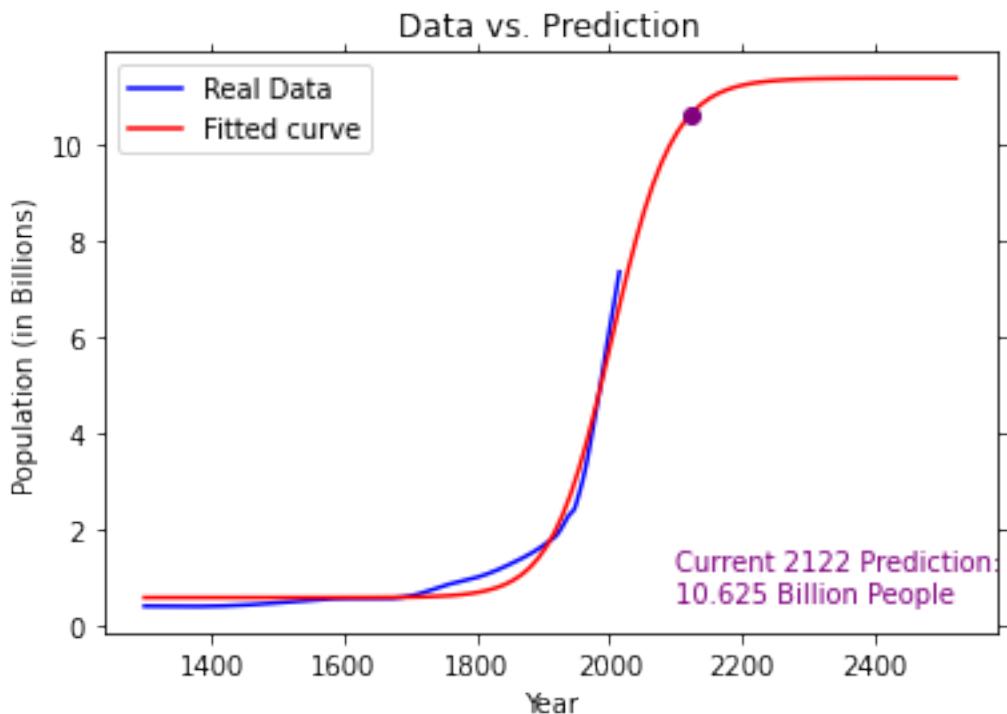
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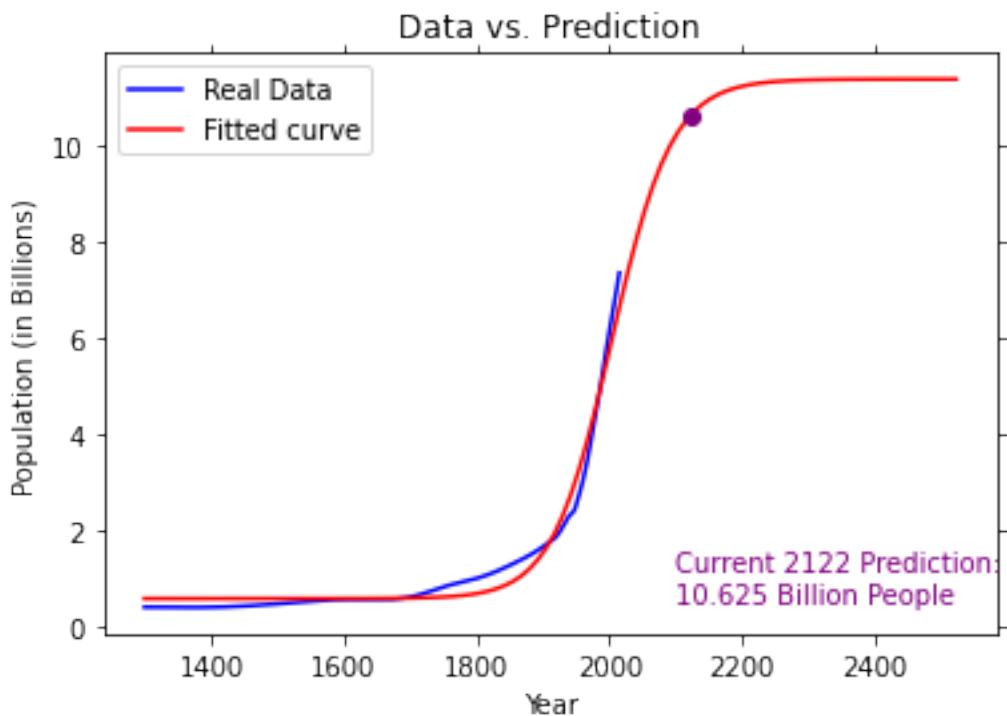
Iteration #43100, Loss: 0.050541352049867115



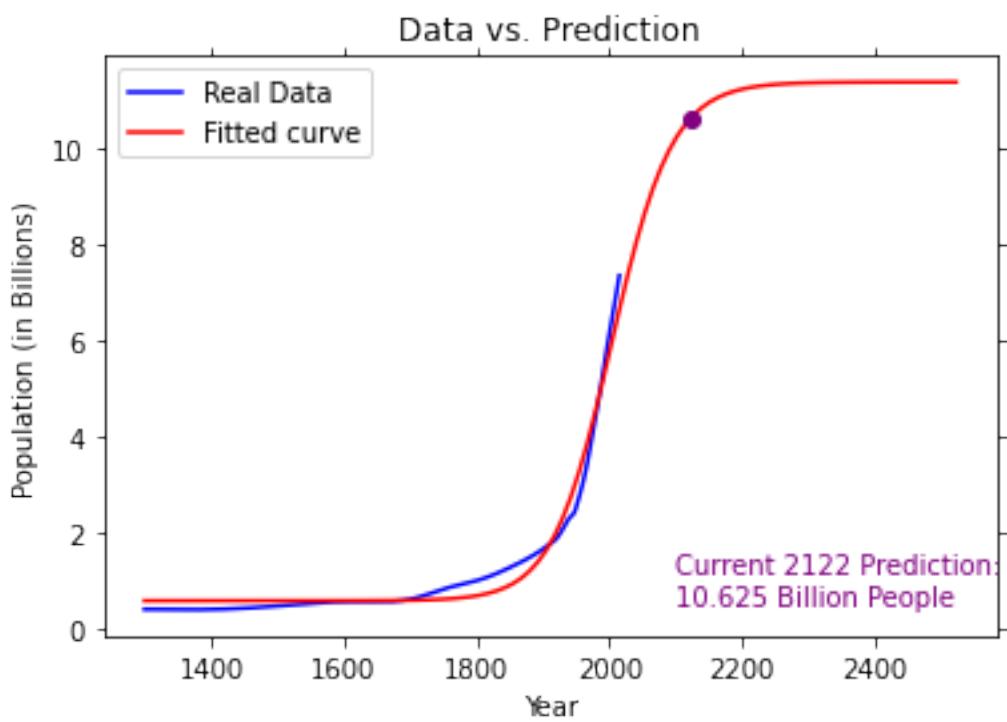
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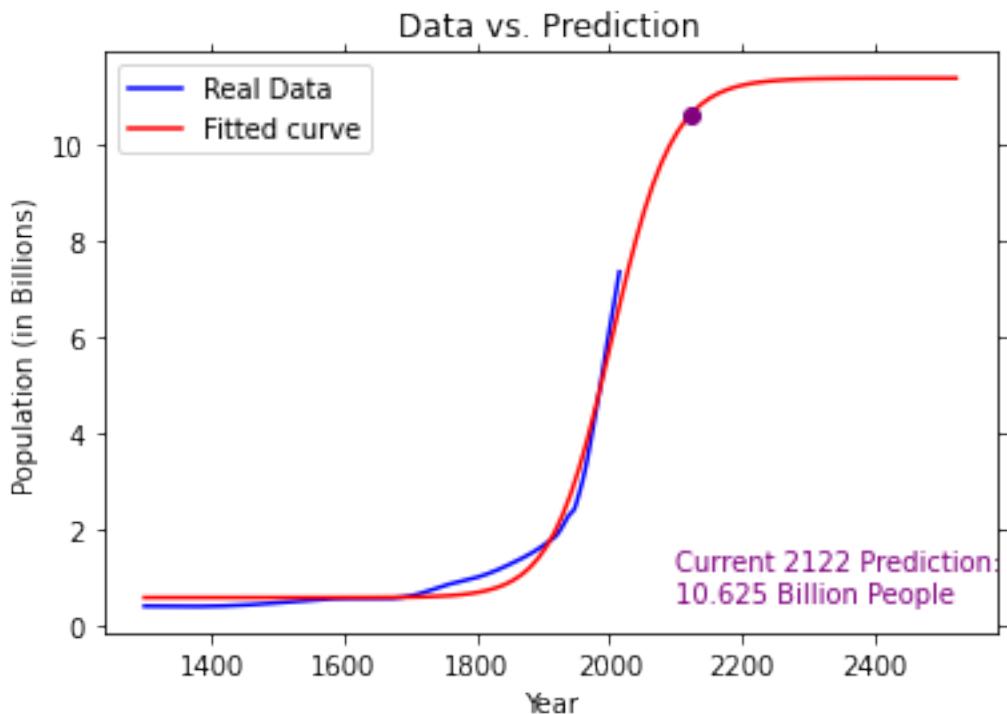
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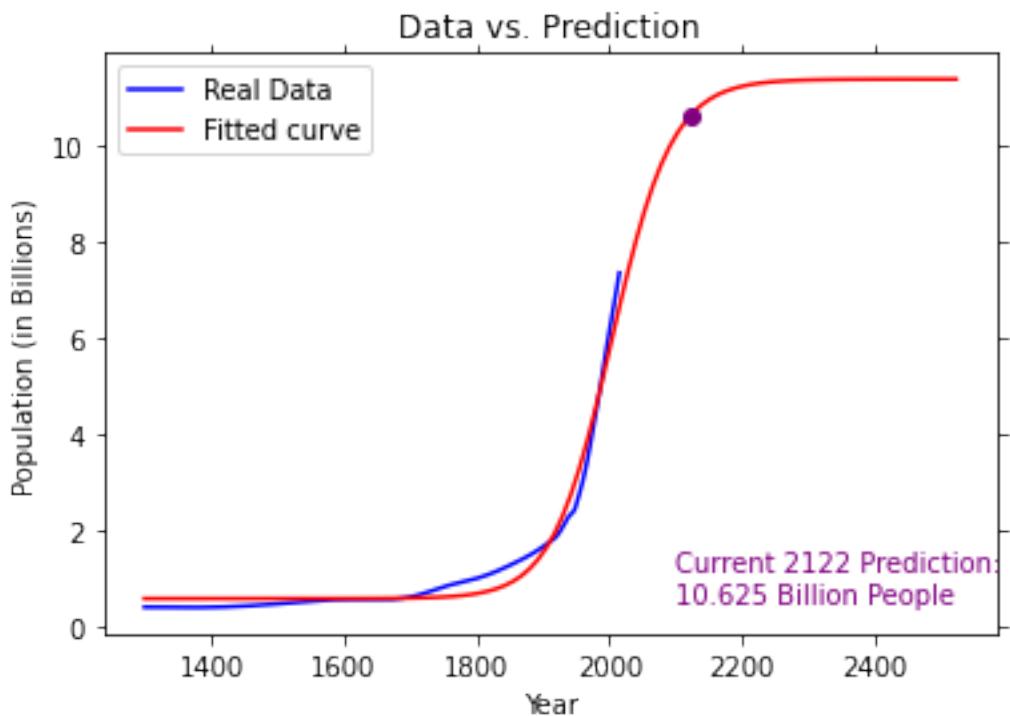
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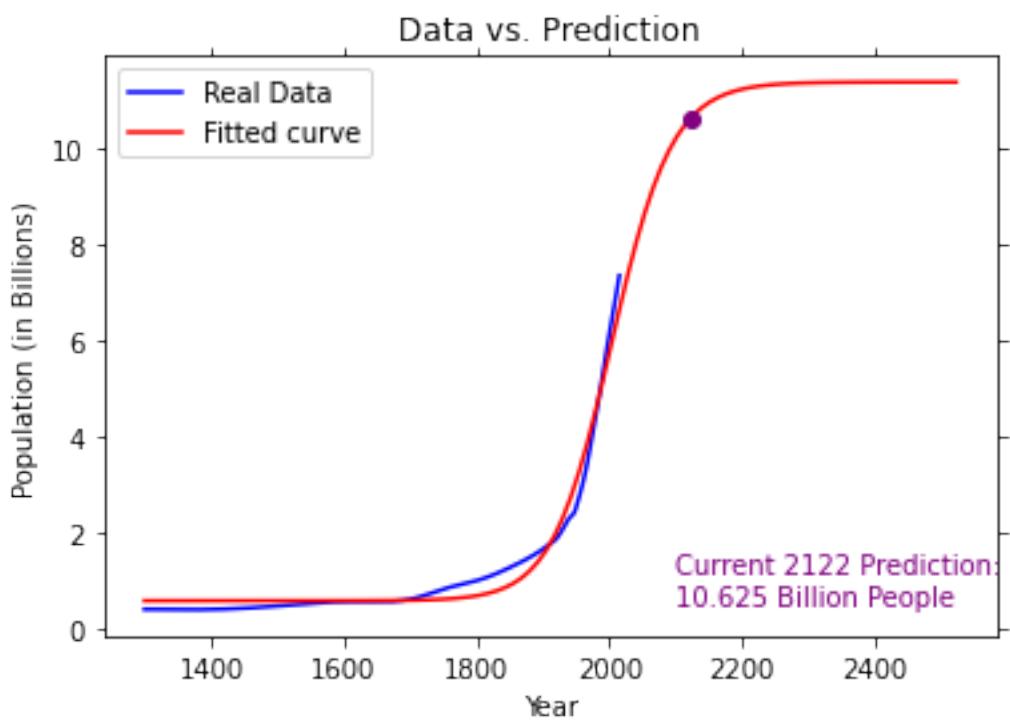
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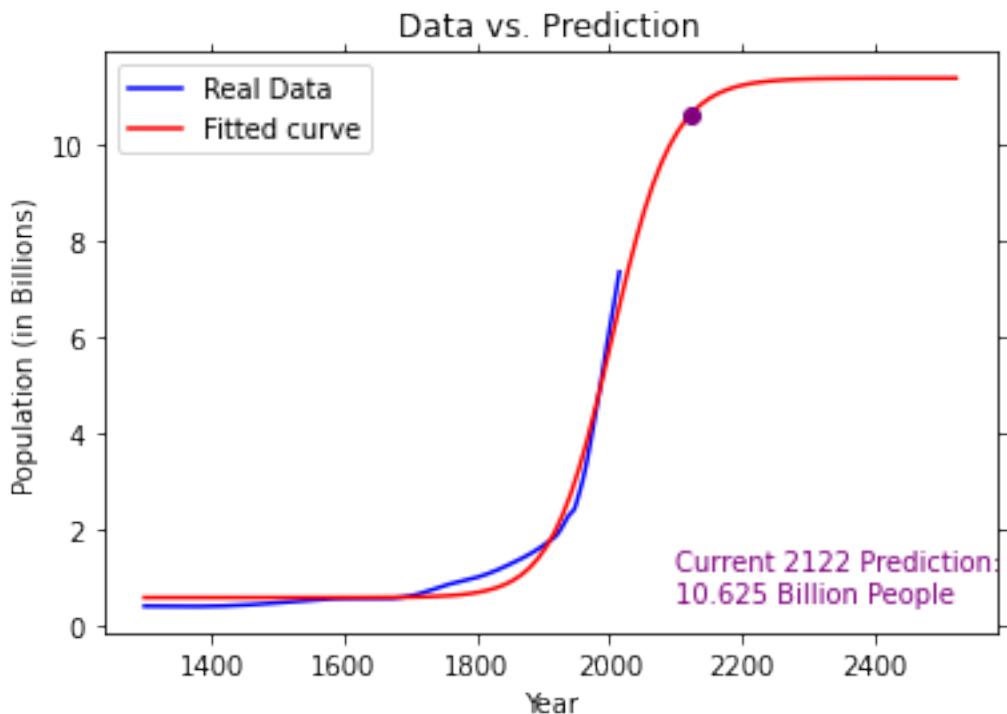
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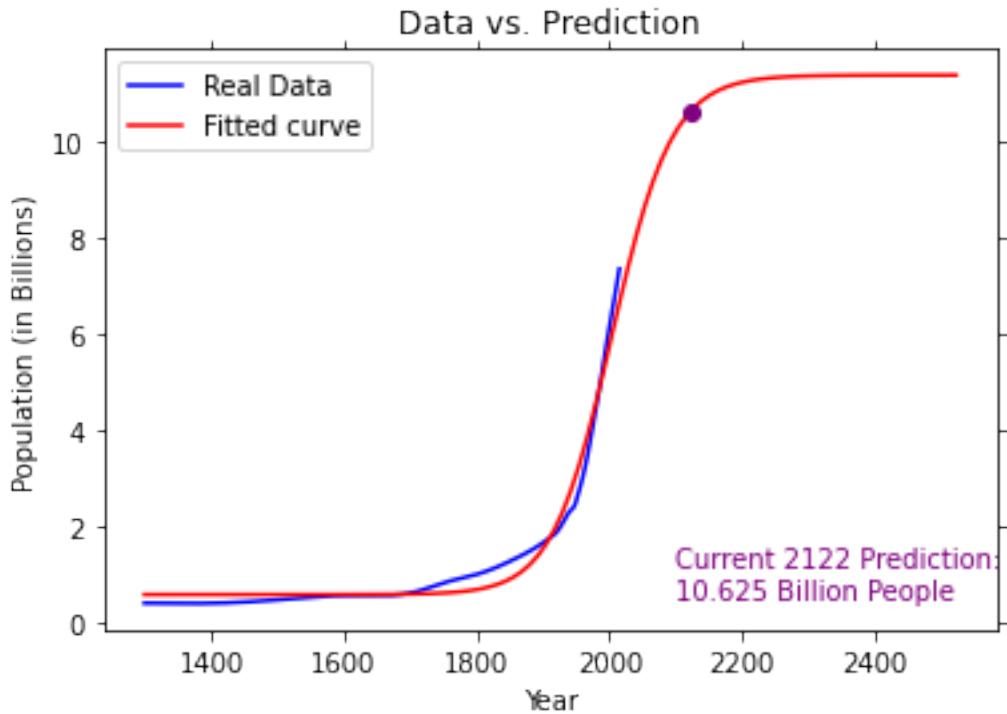
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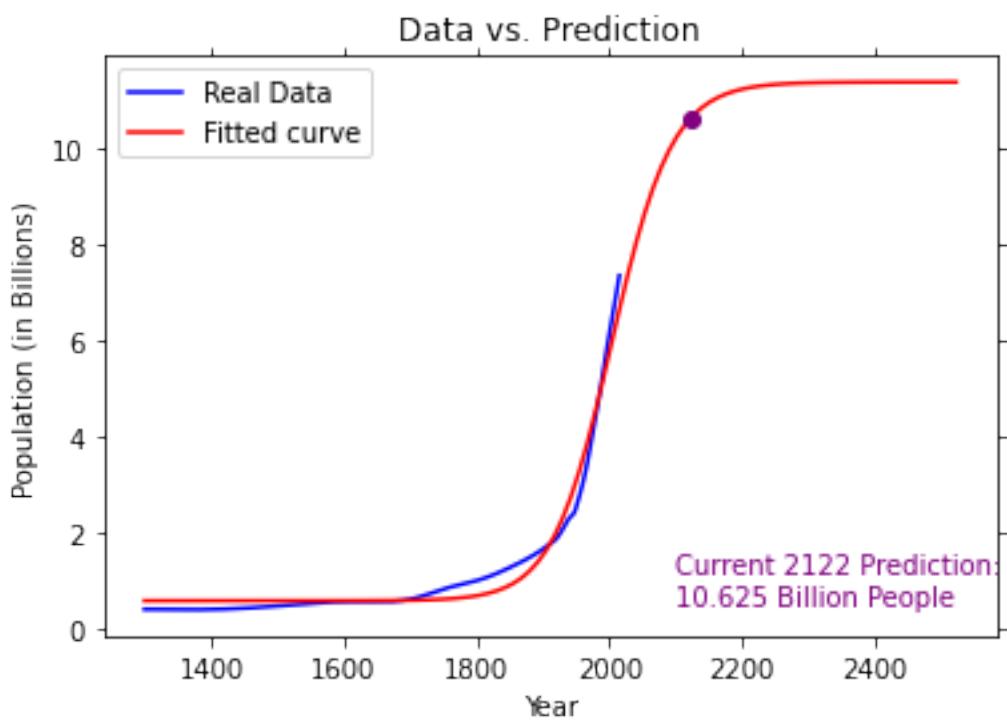
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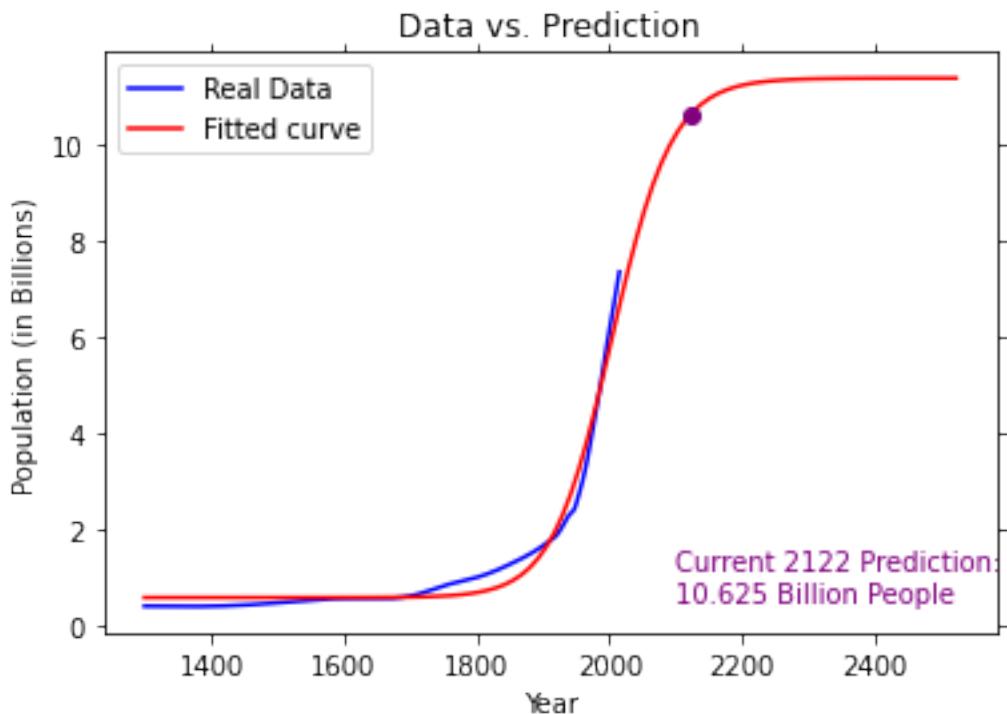
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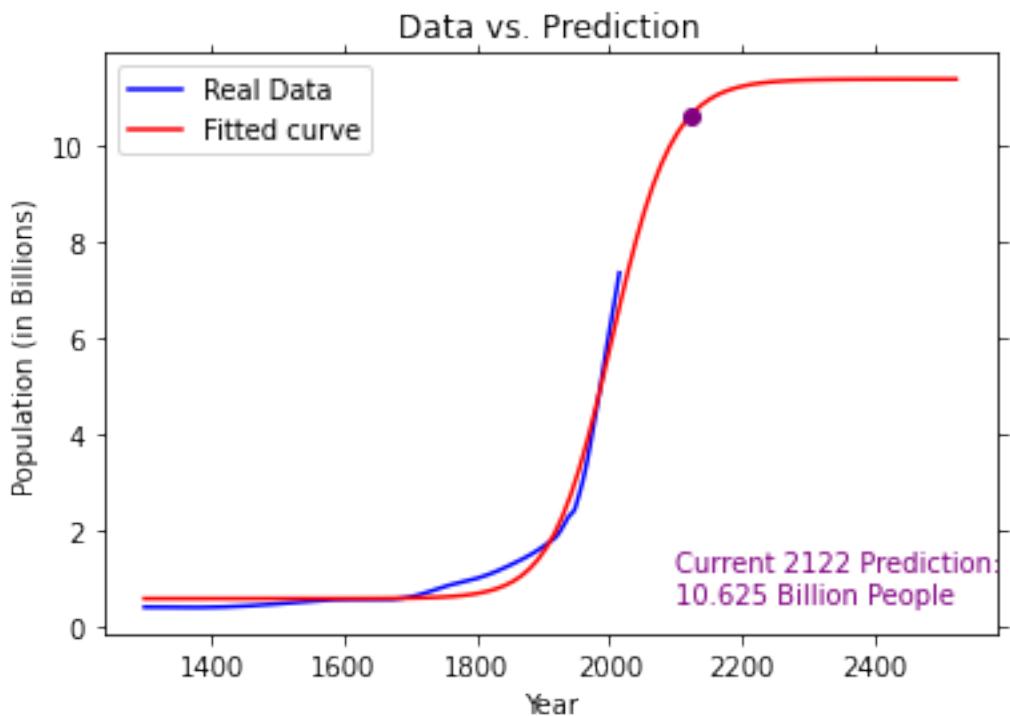
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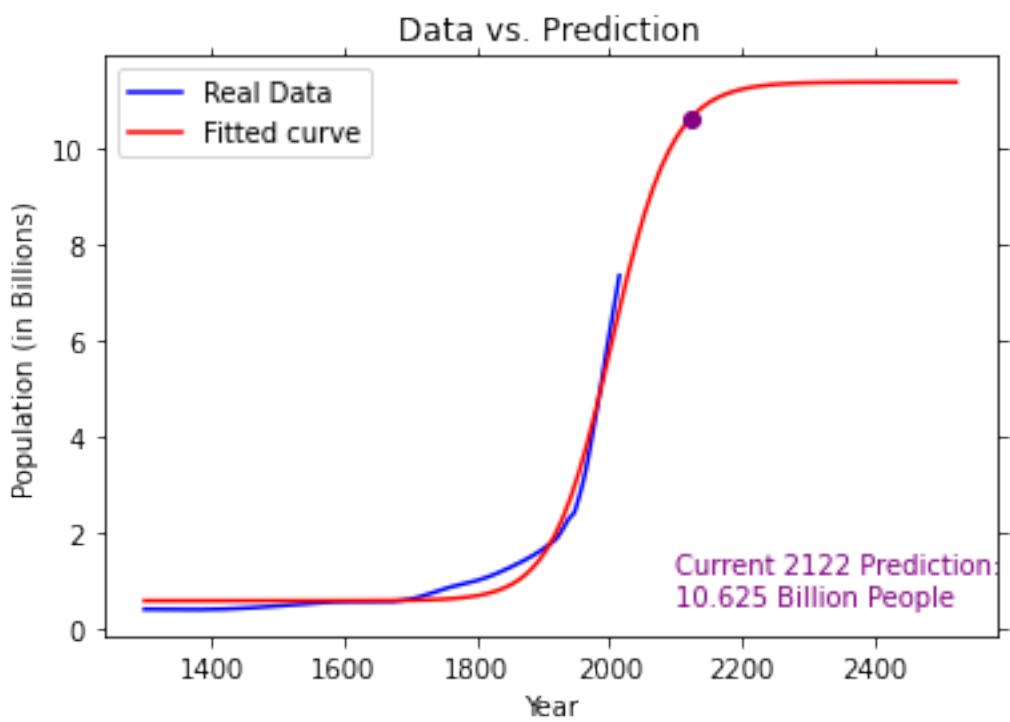
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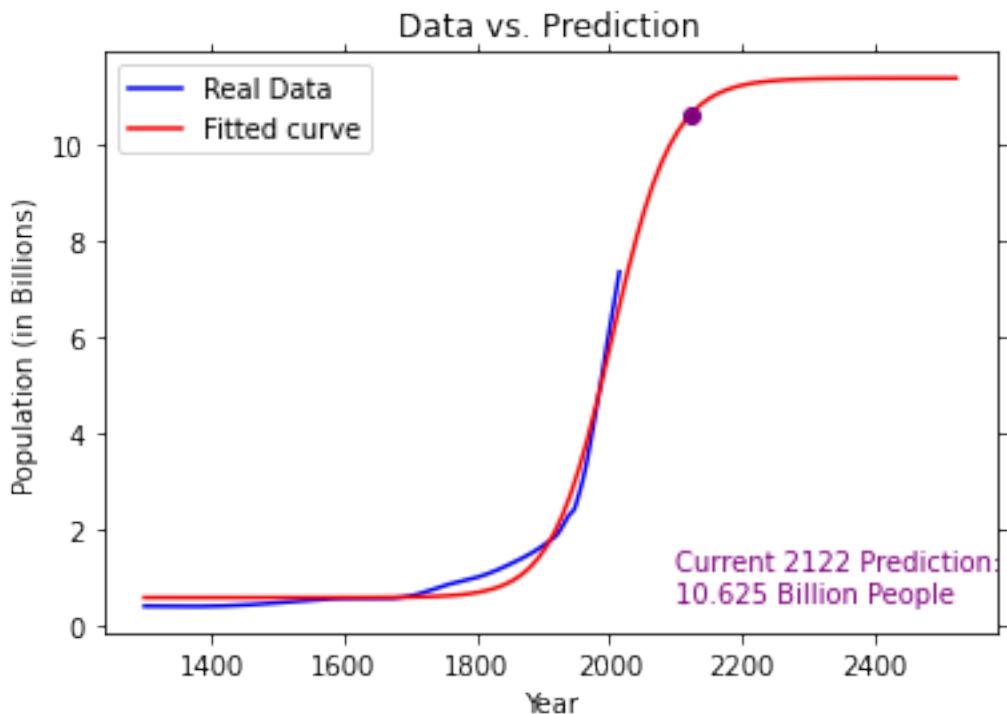
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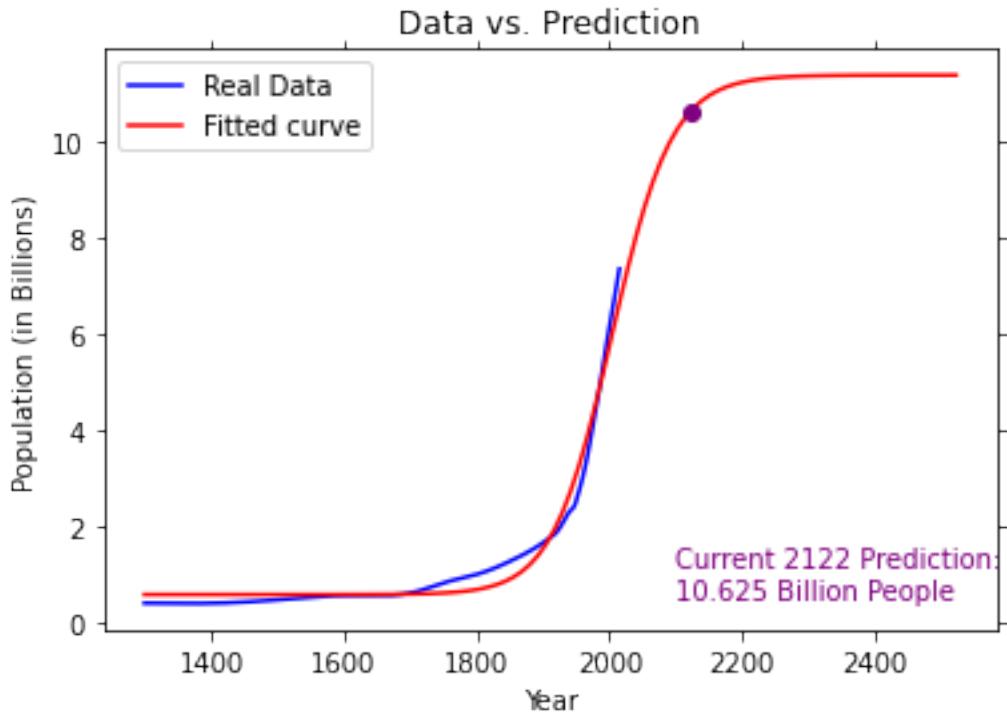
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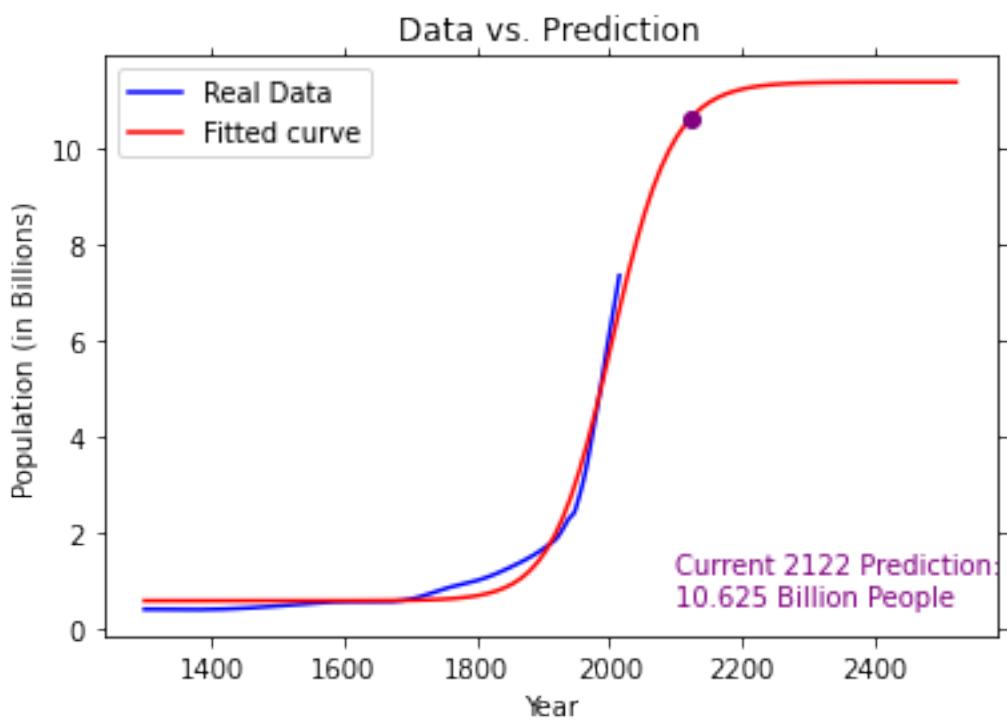
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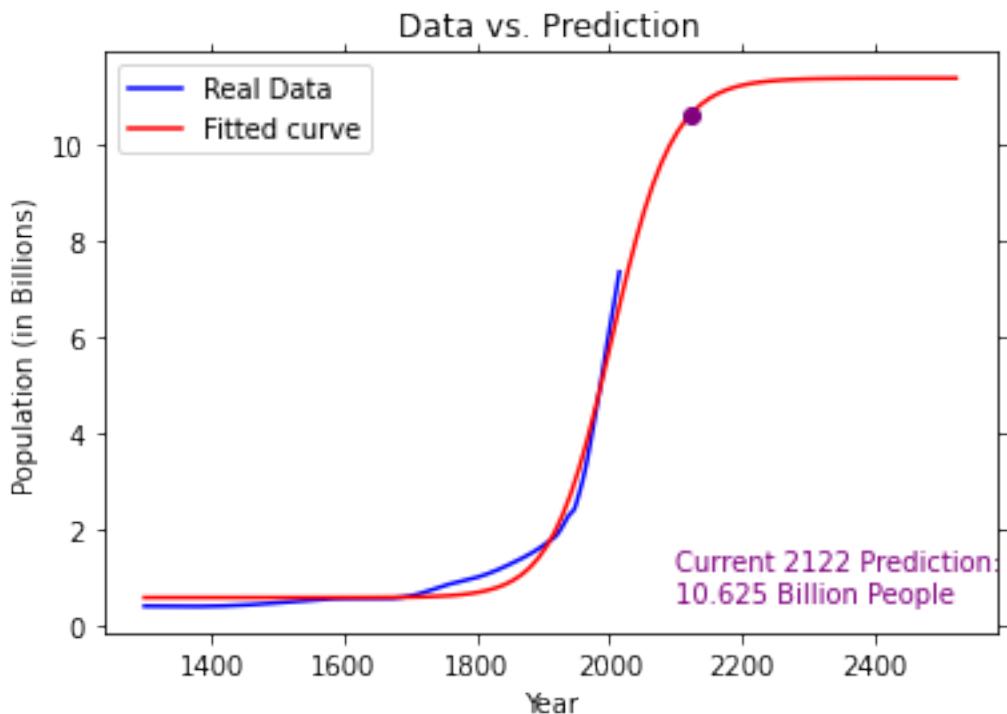
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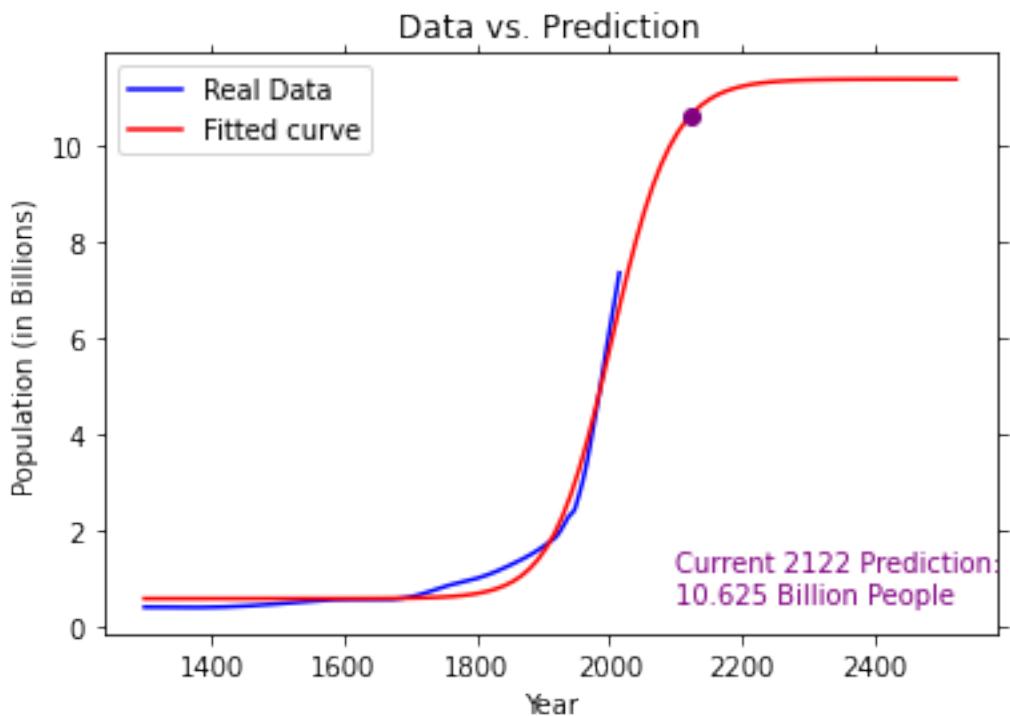
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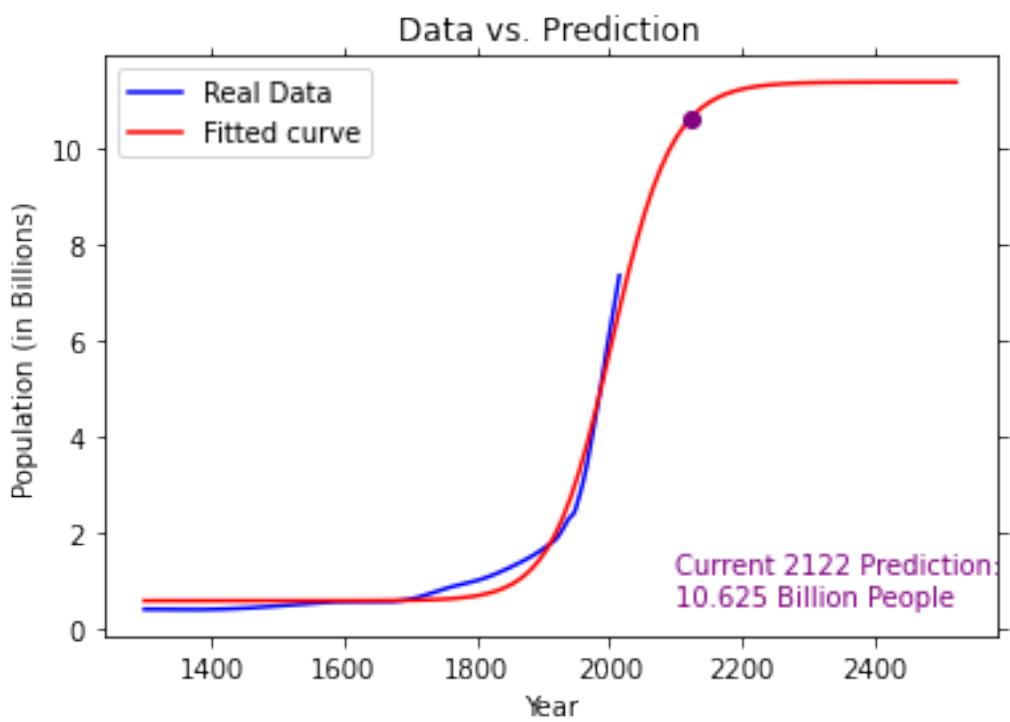
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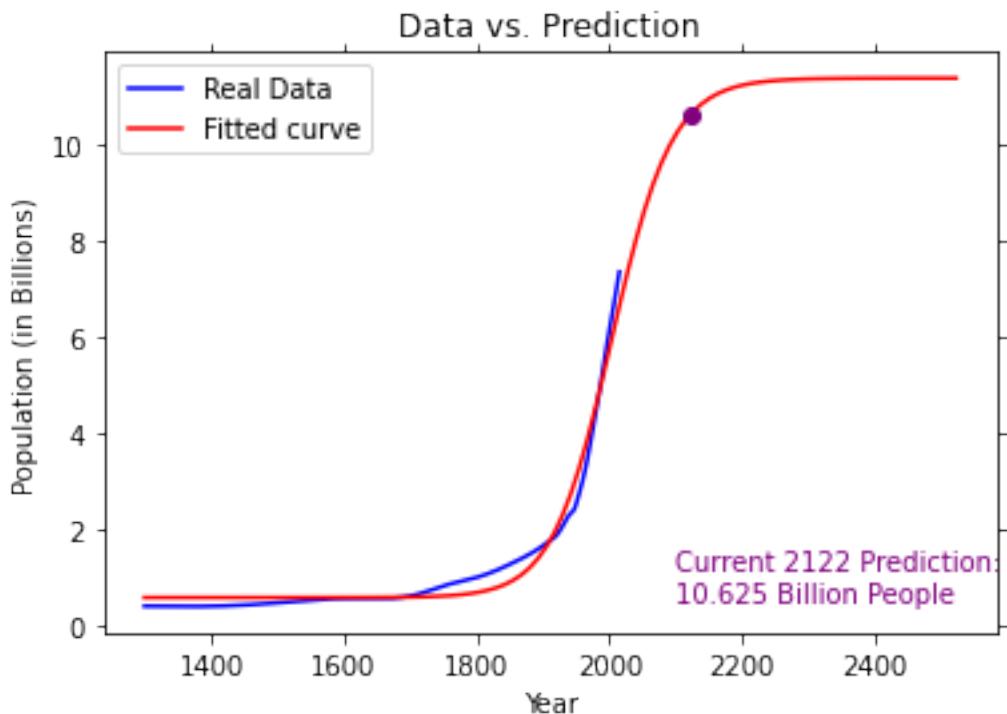
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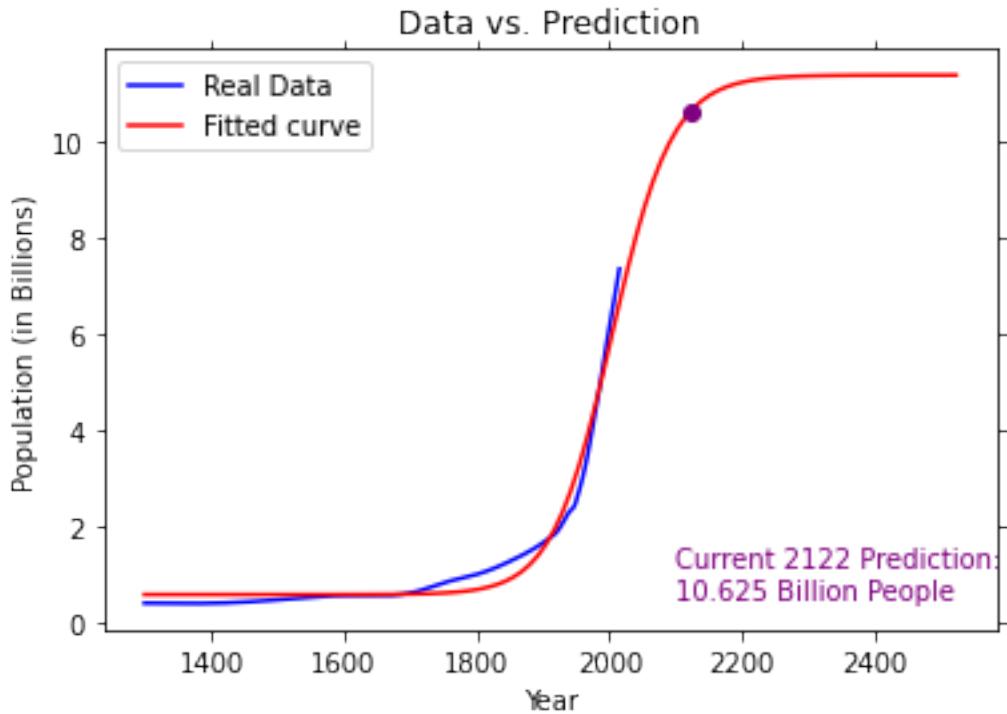
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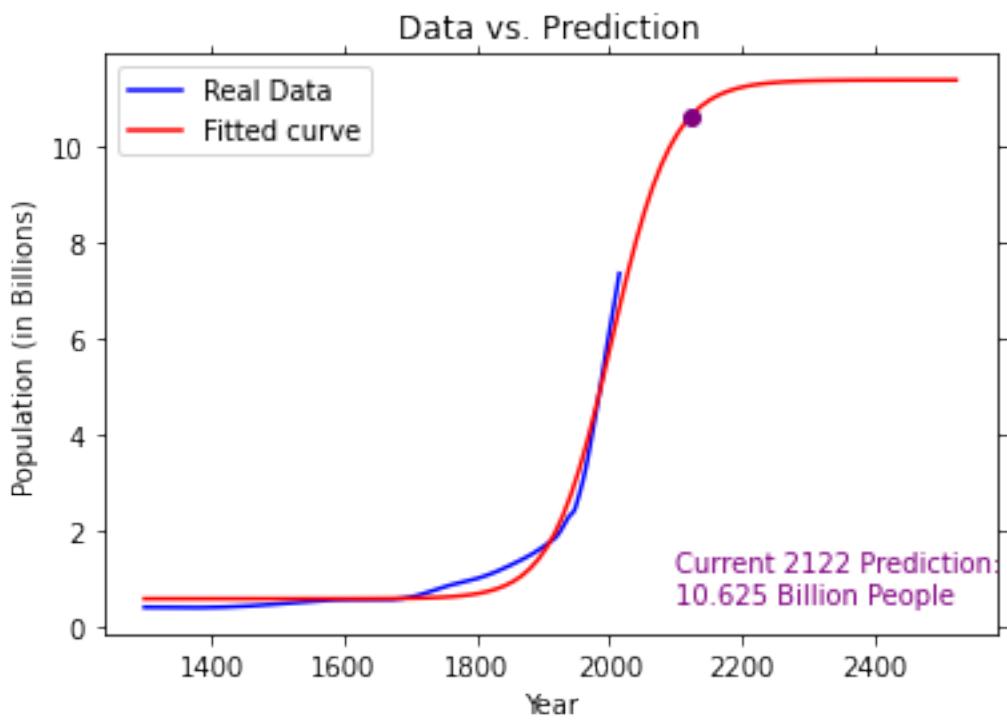
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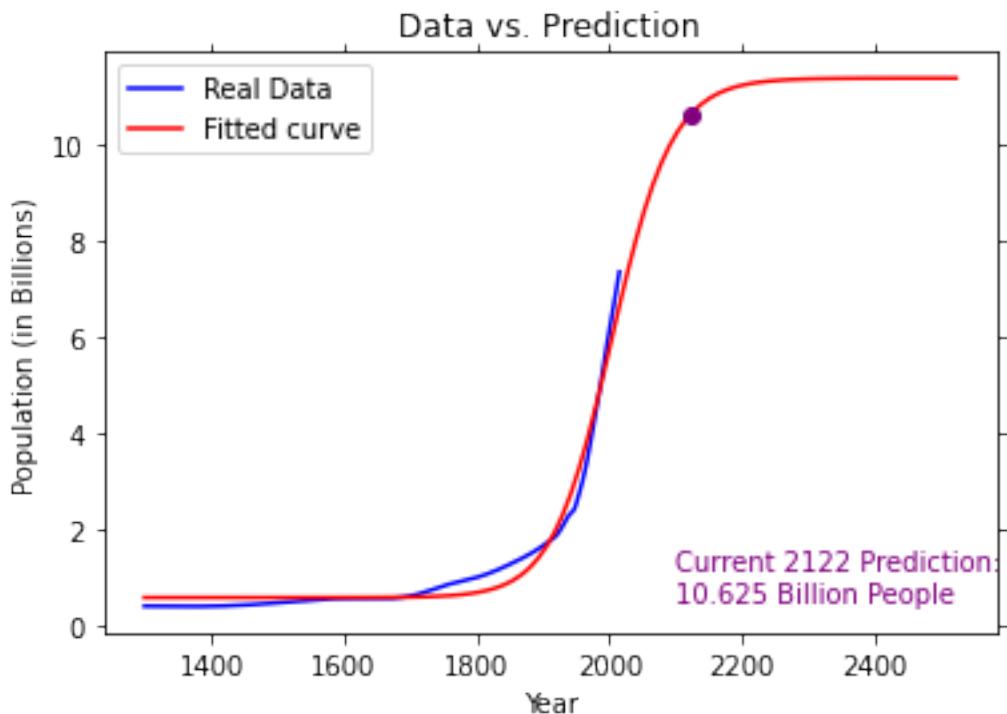
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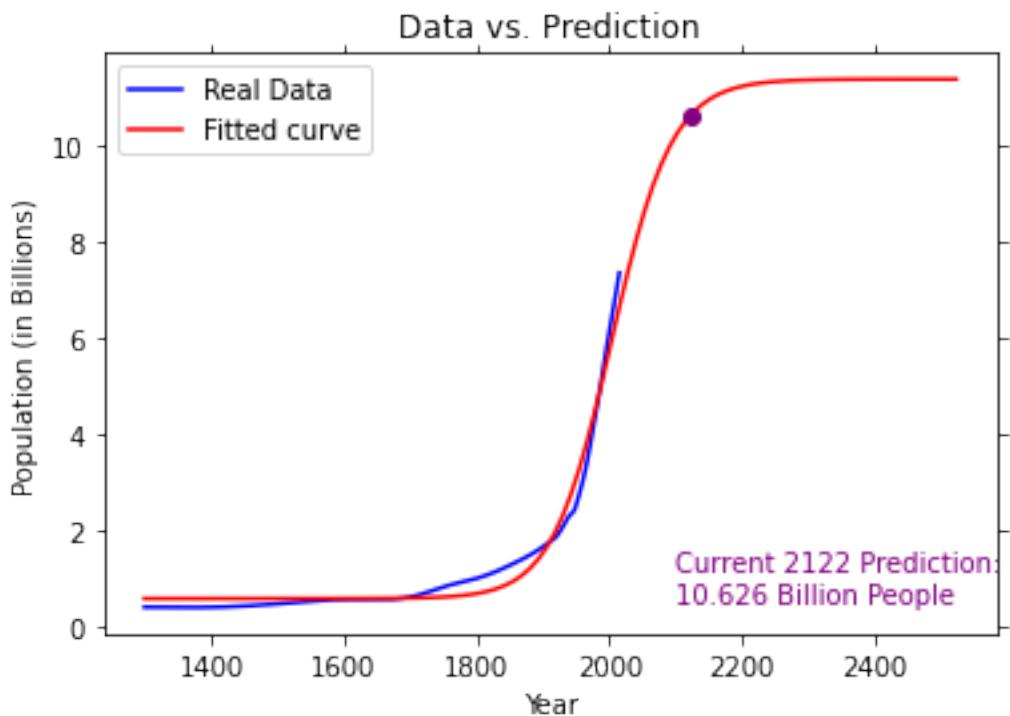
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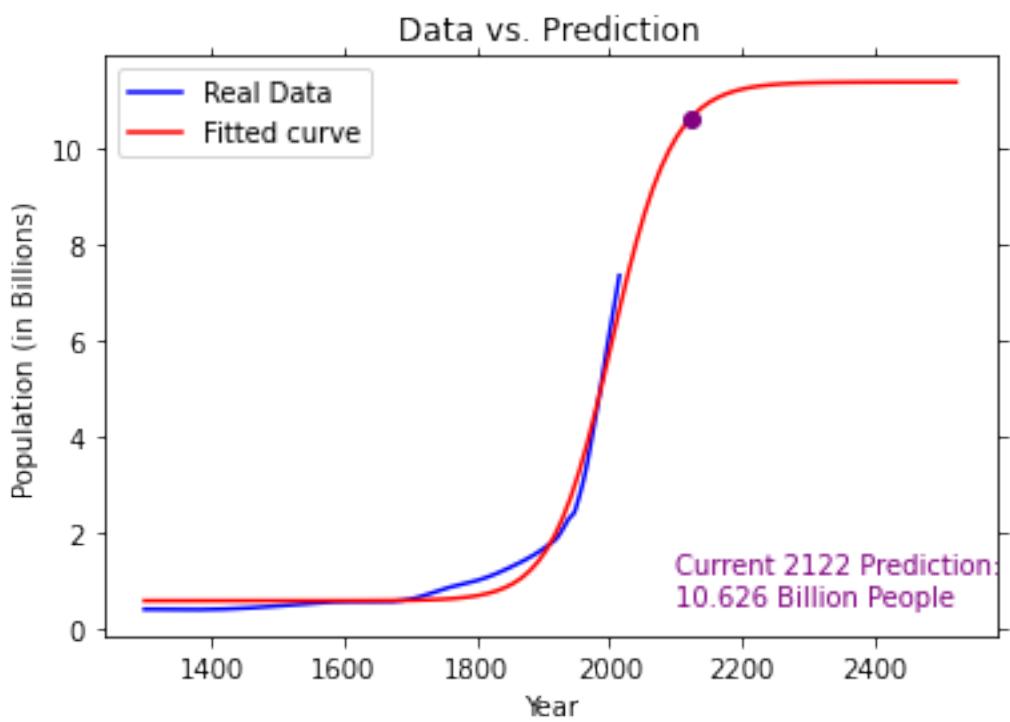
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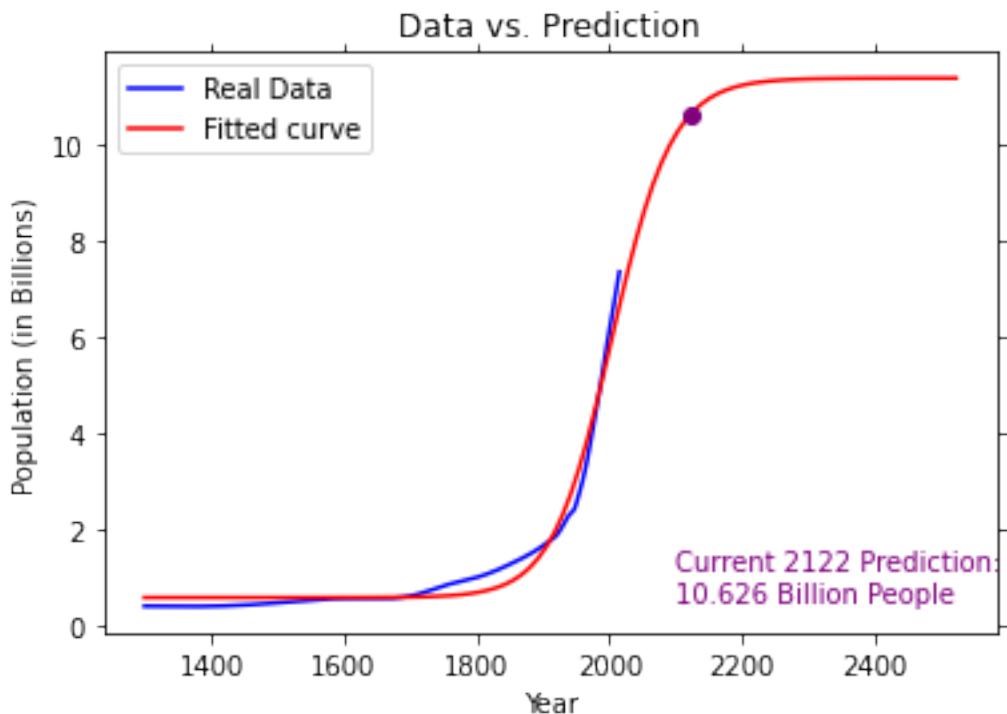
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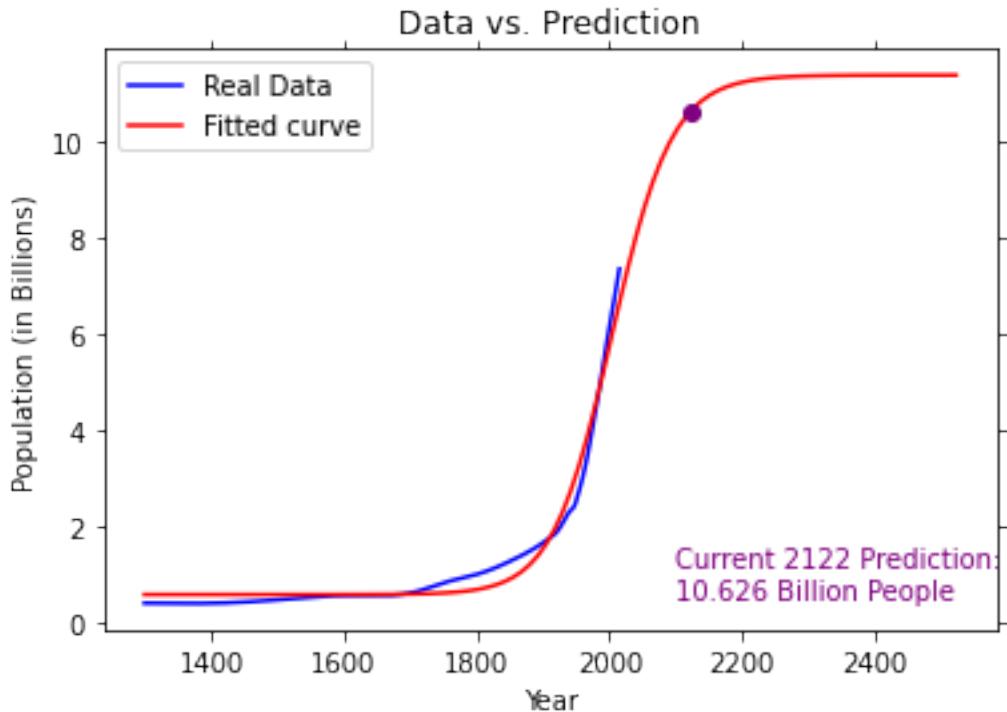
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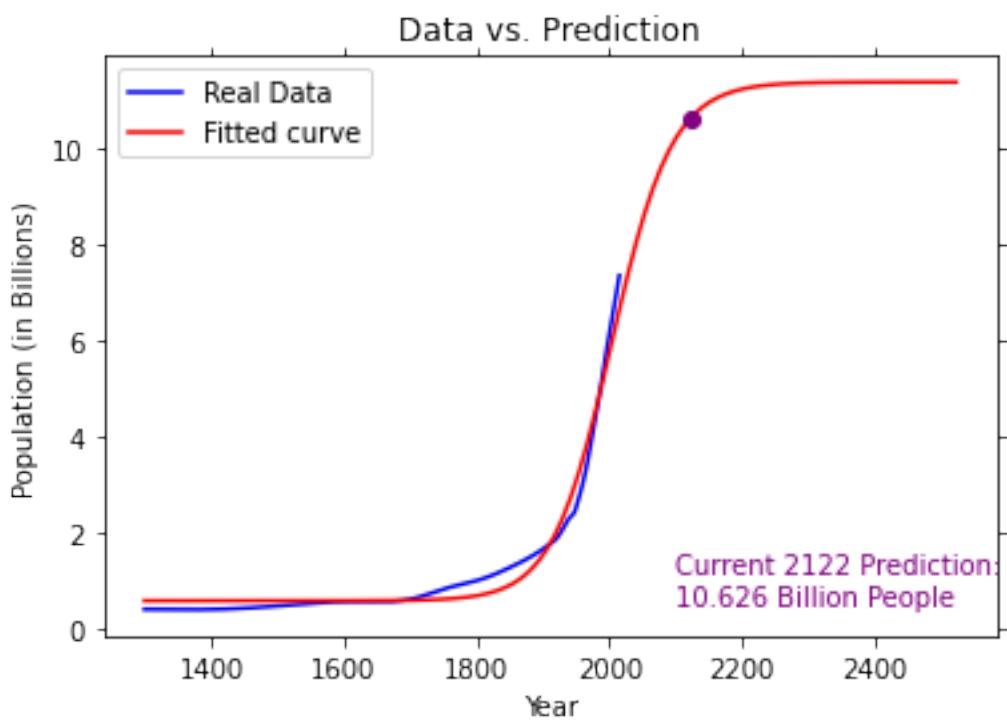
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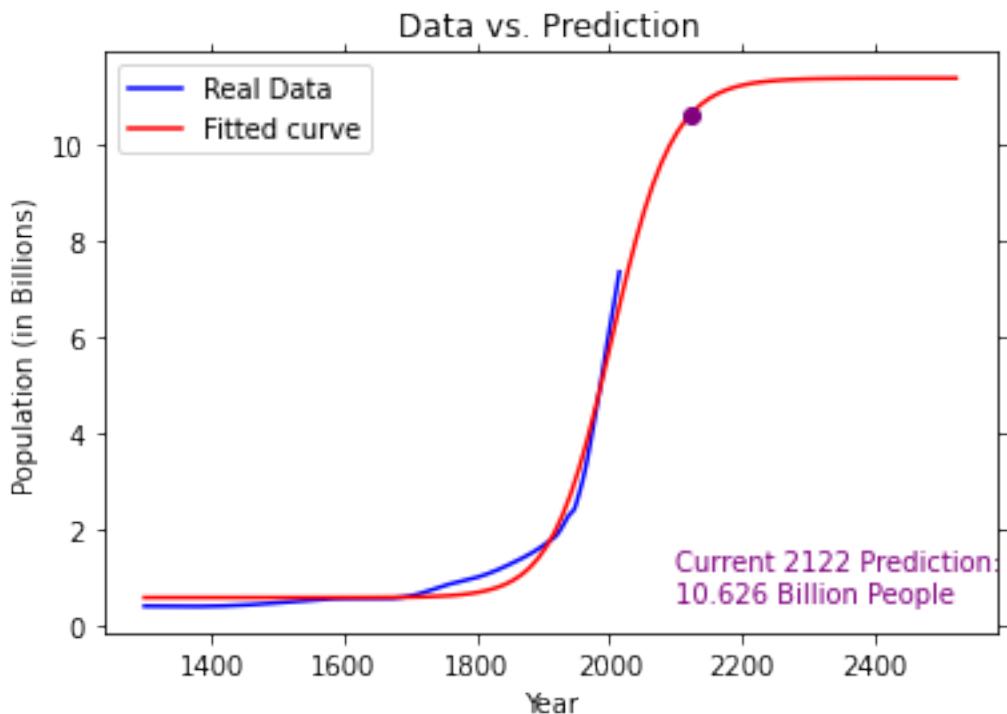
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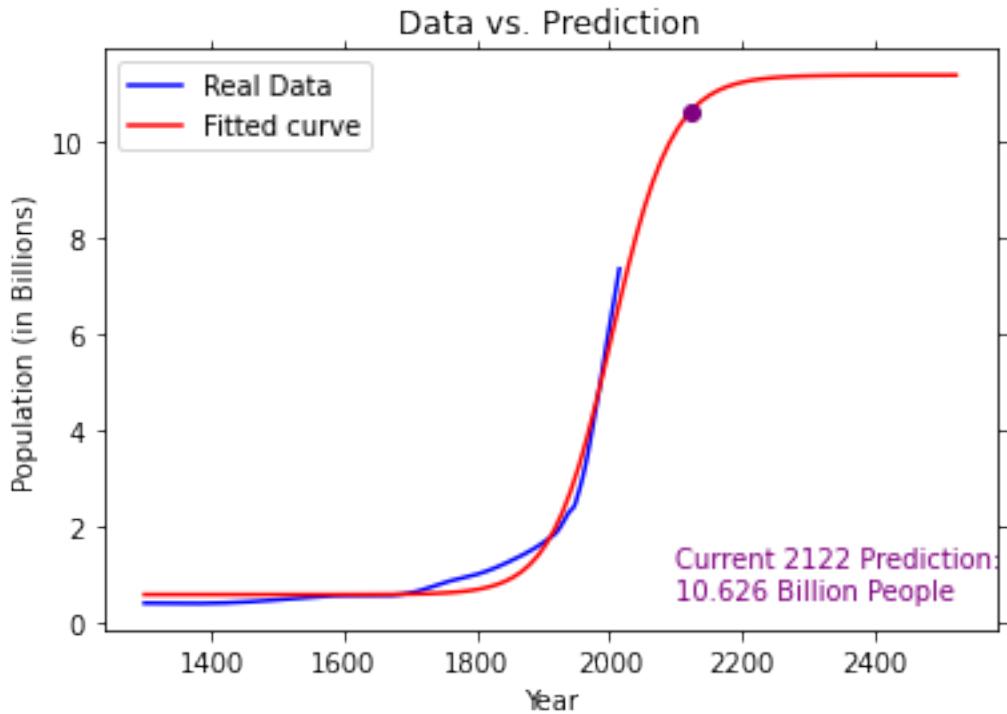
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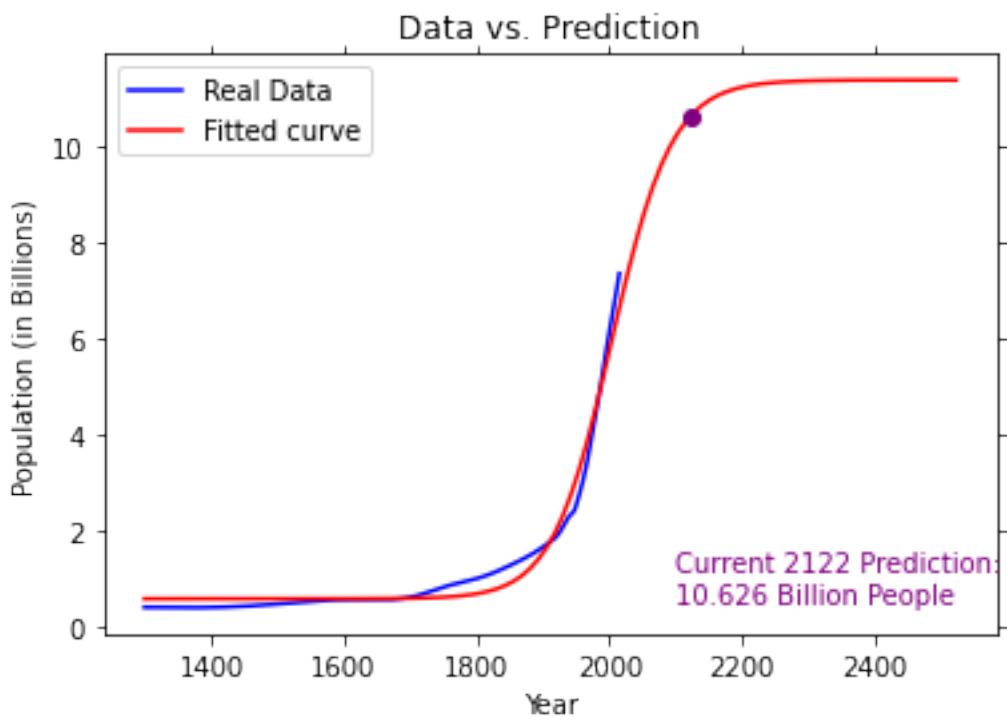
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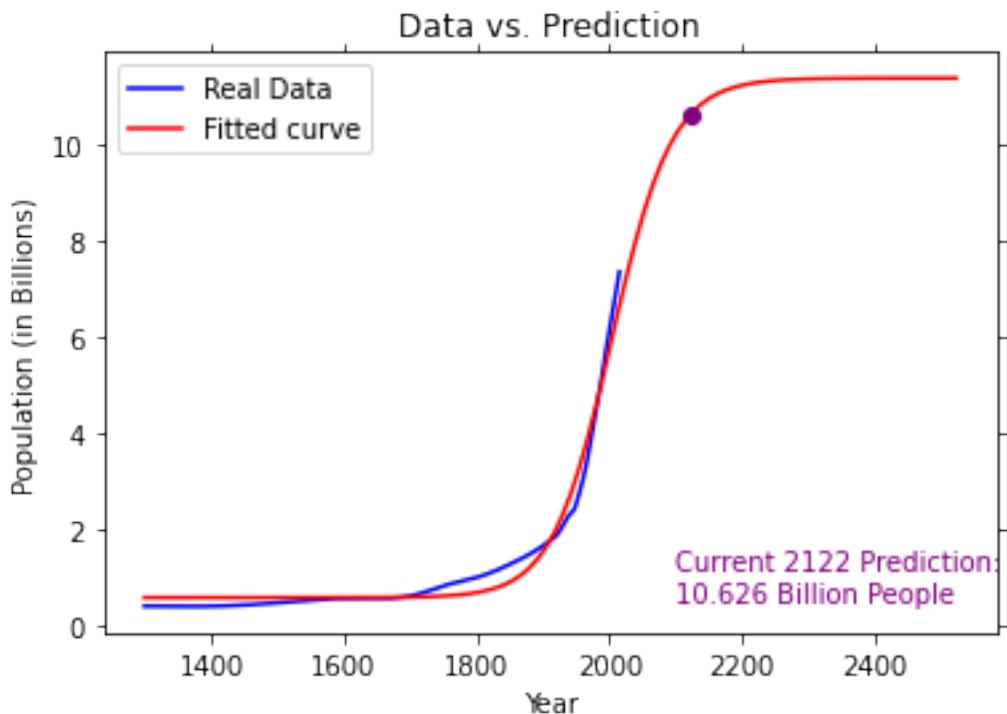
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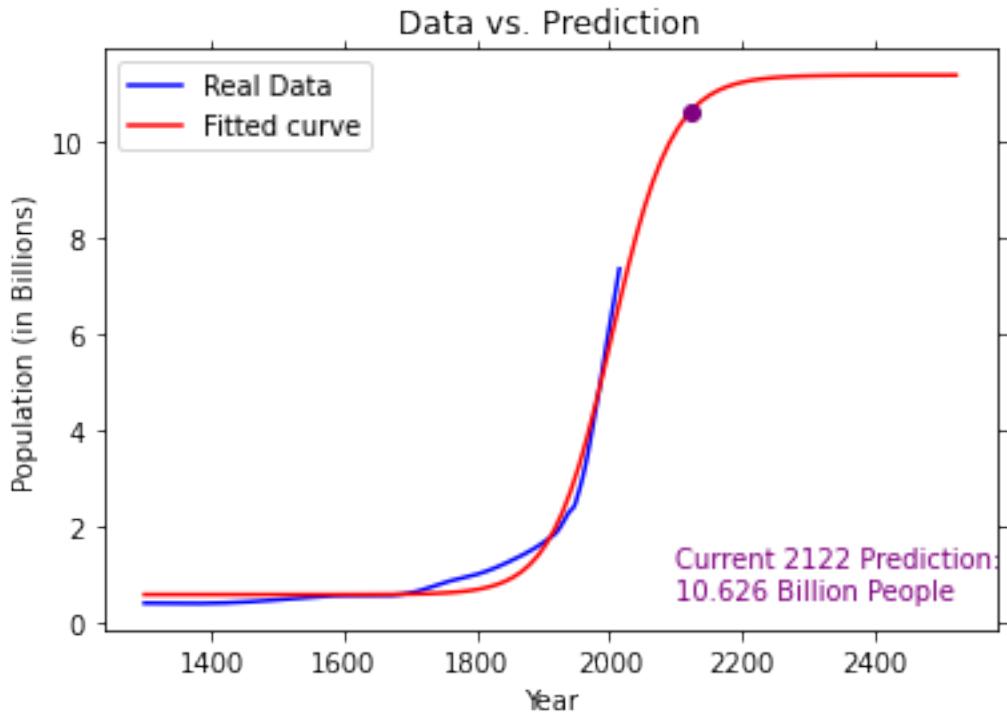
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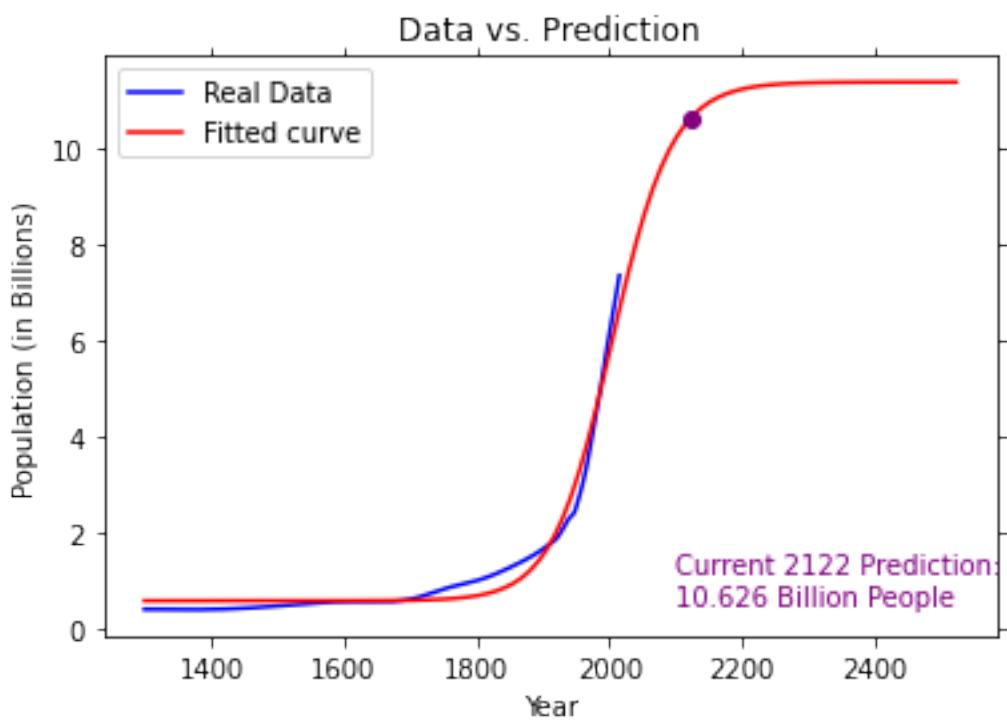
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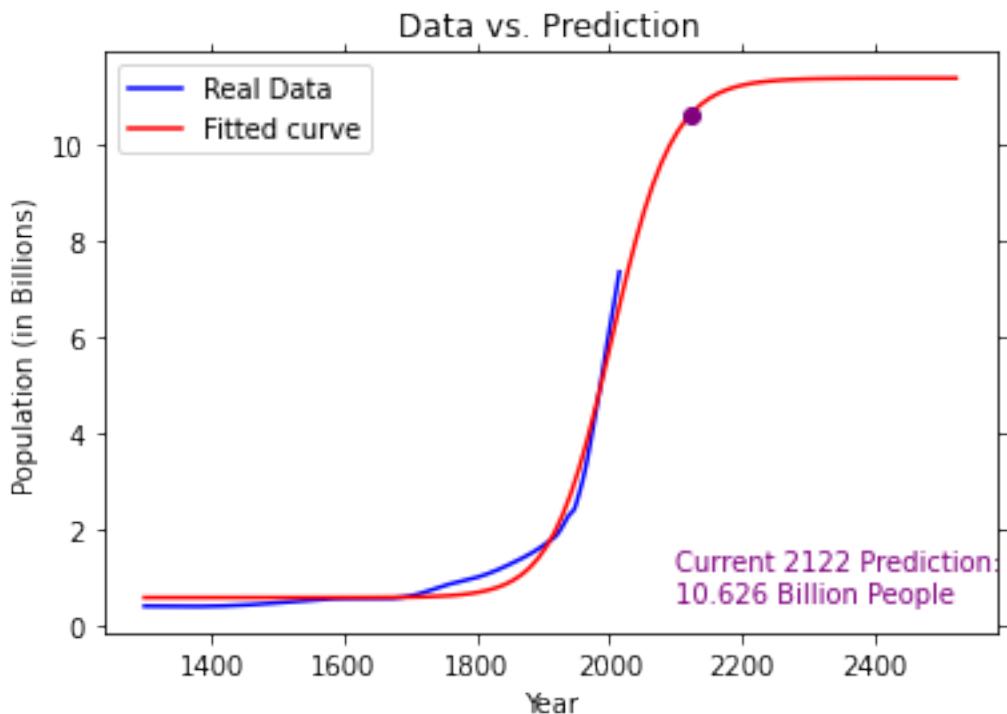
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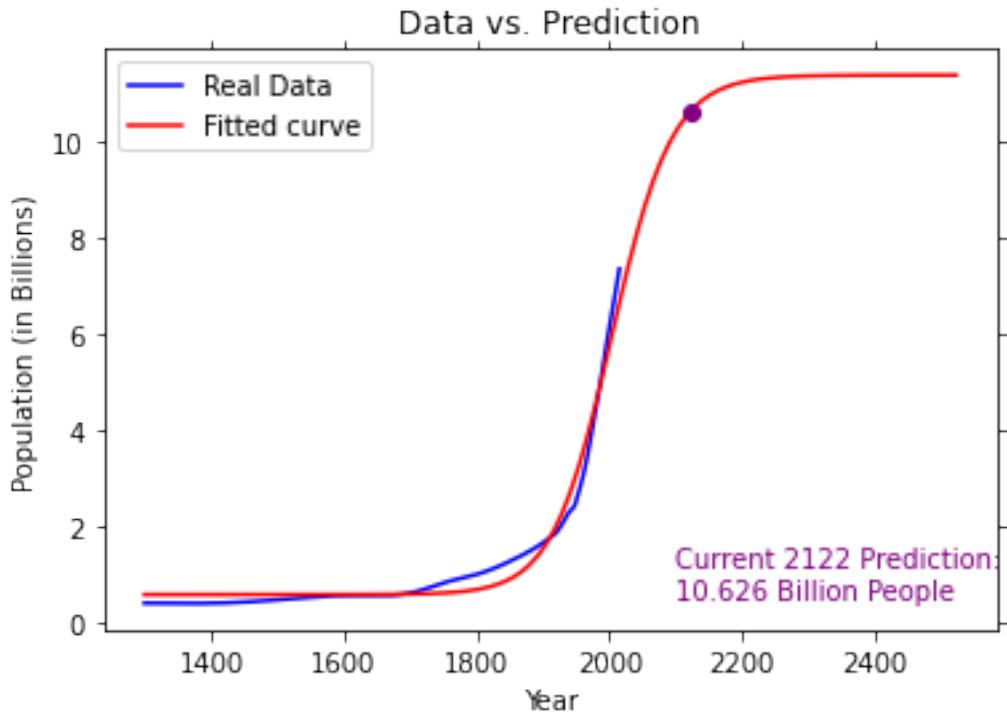
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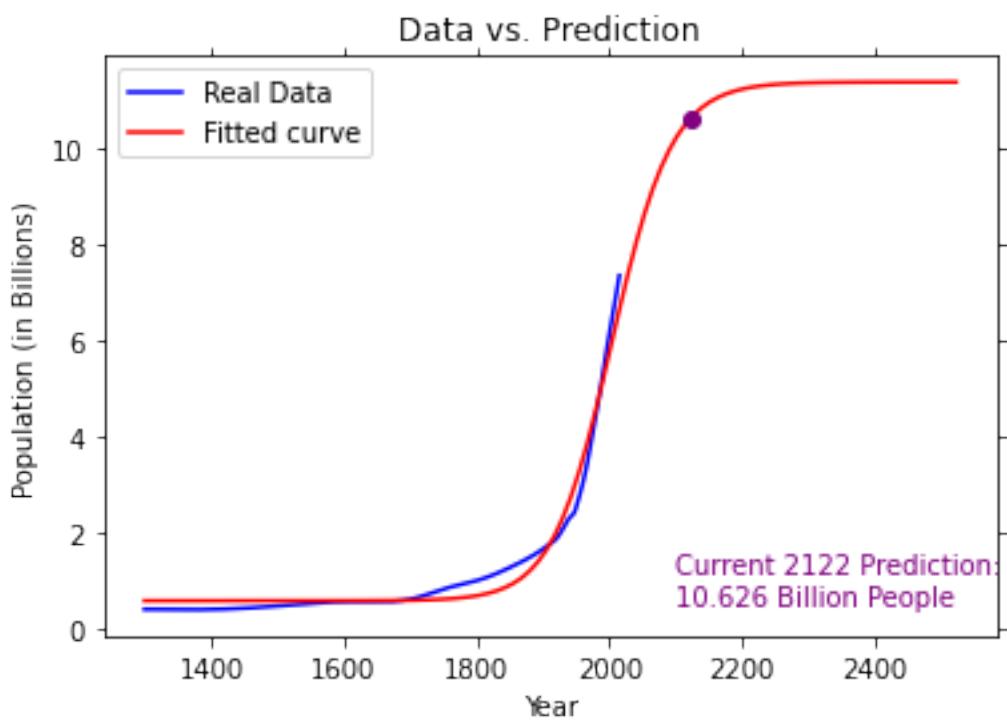
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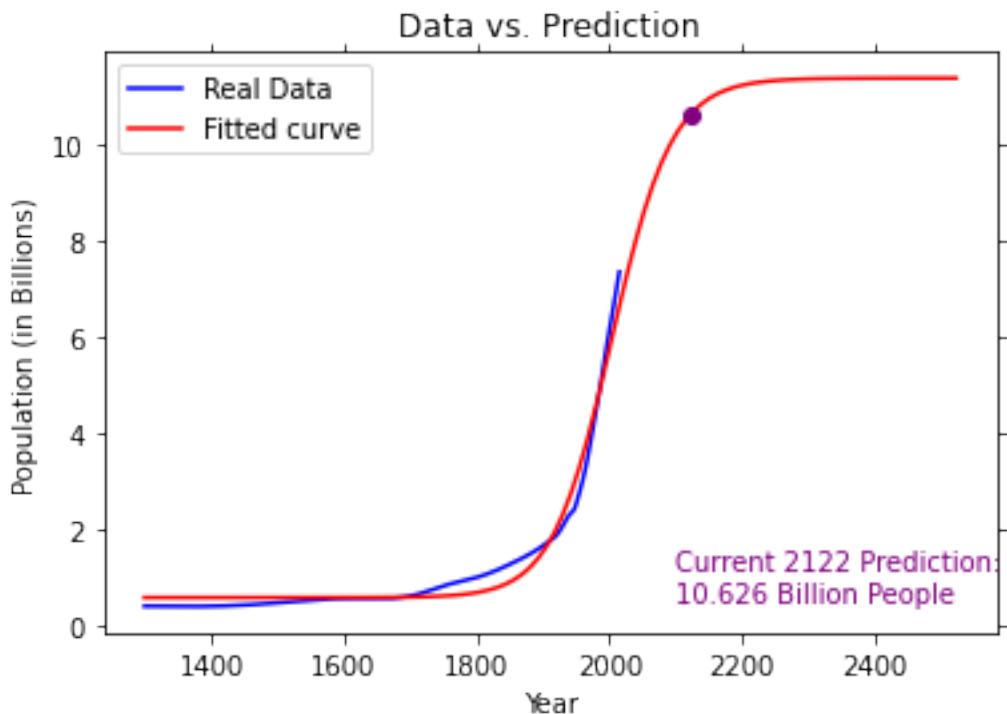
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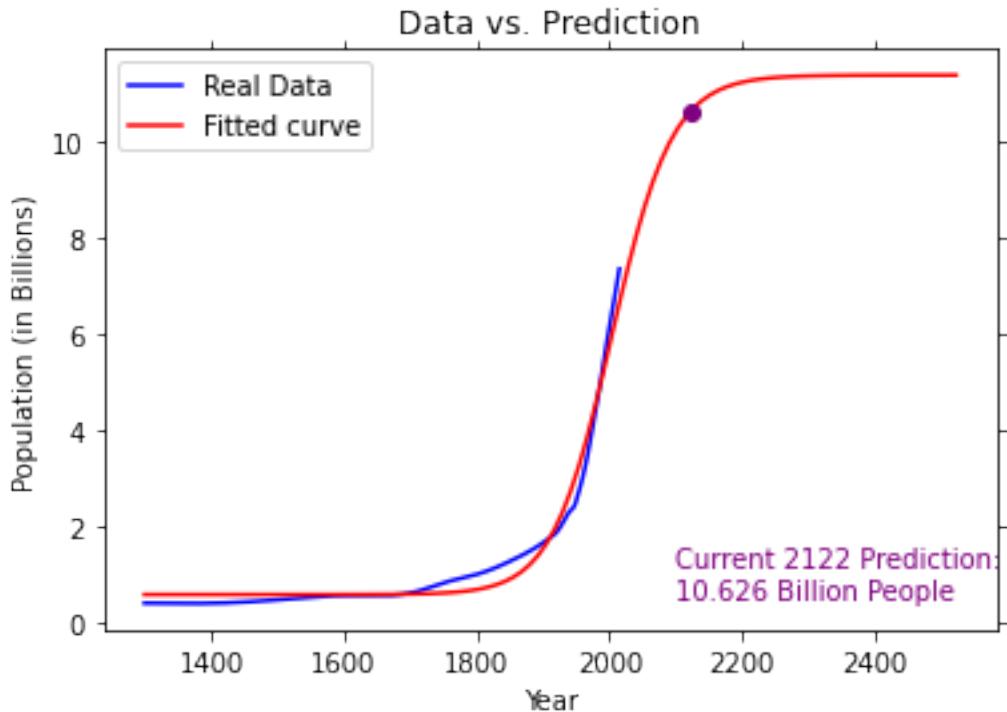
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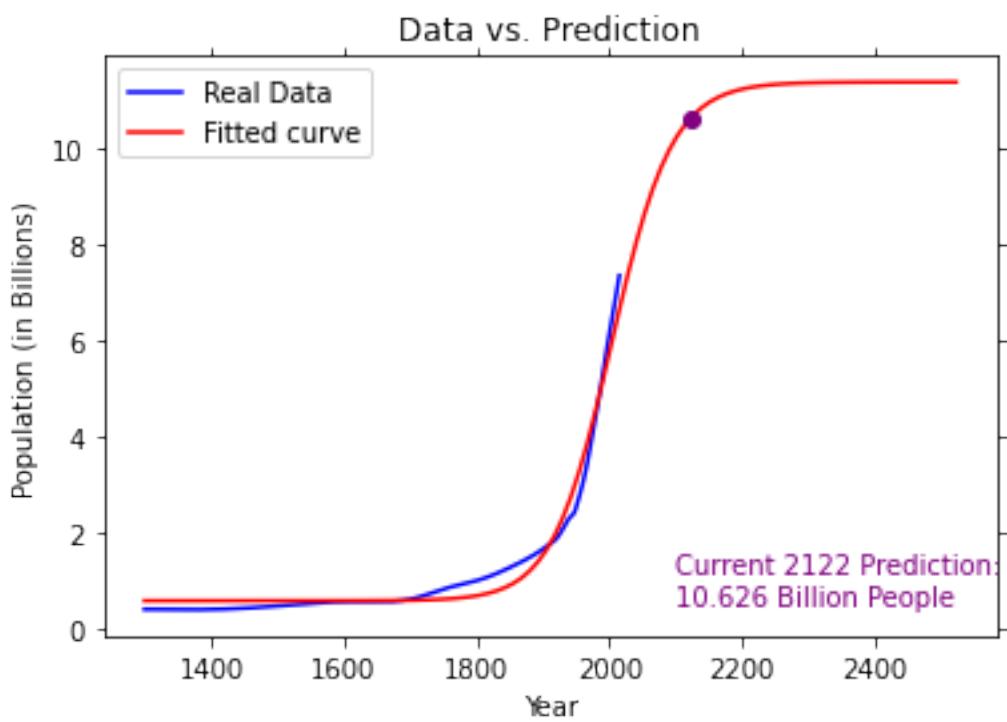
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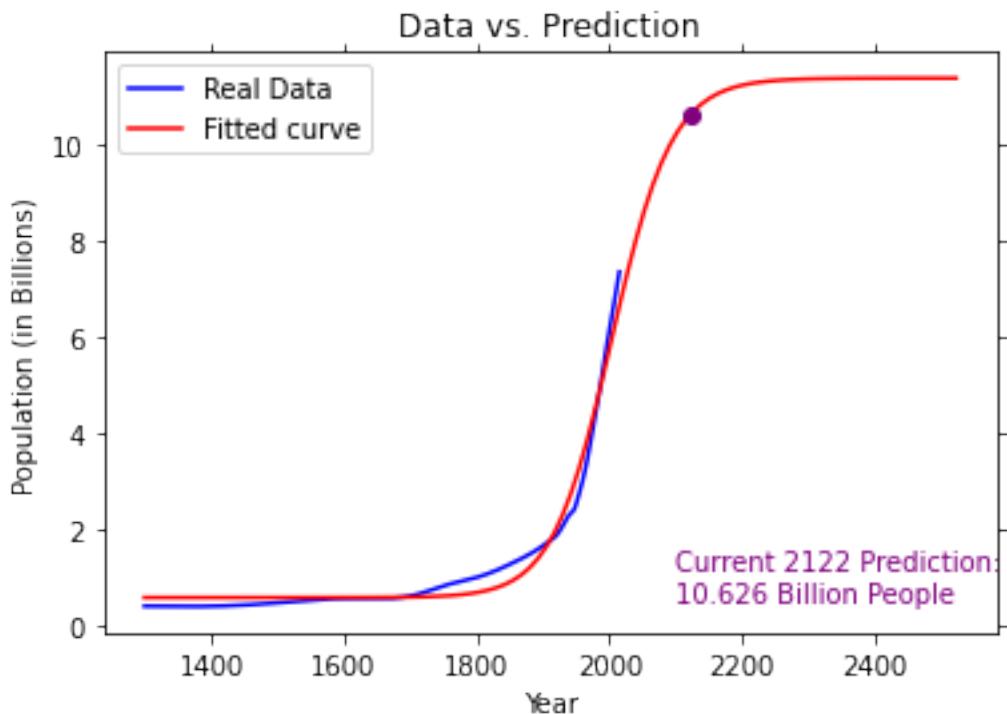
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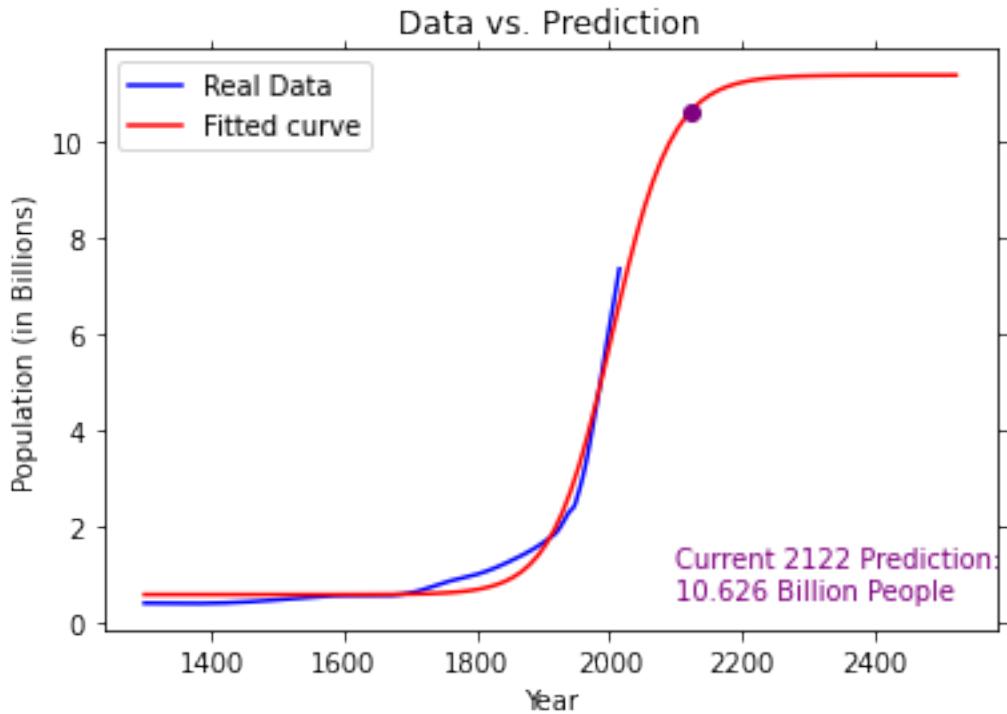
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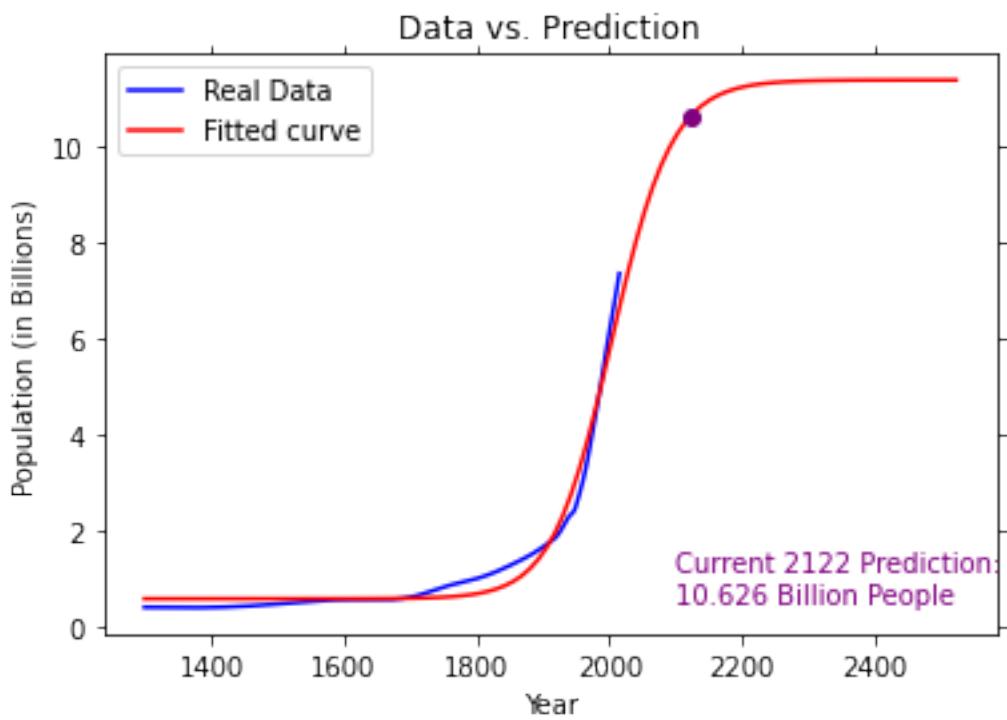
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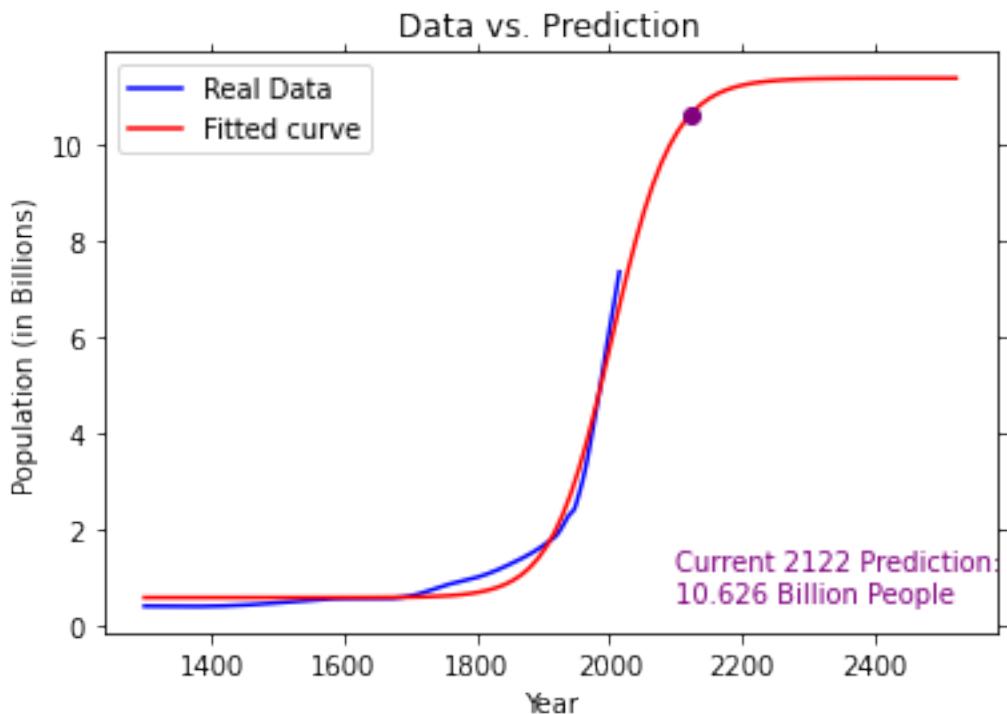
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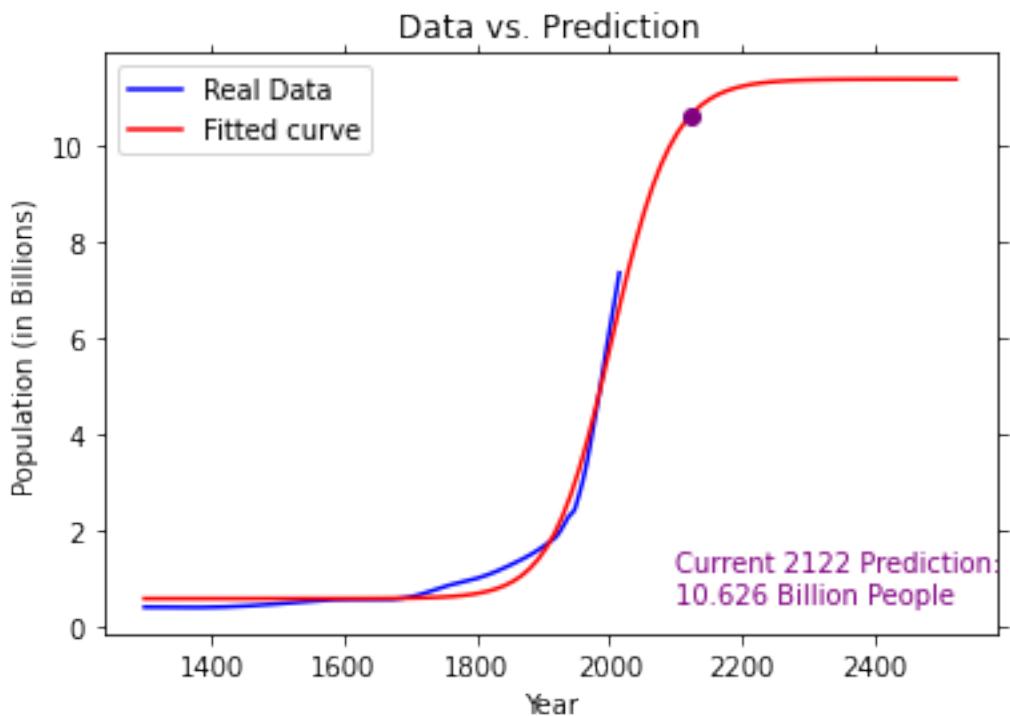
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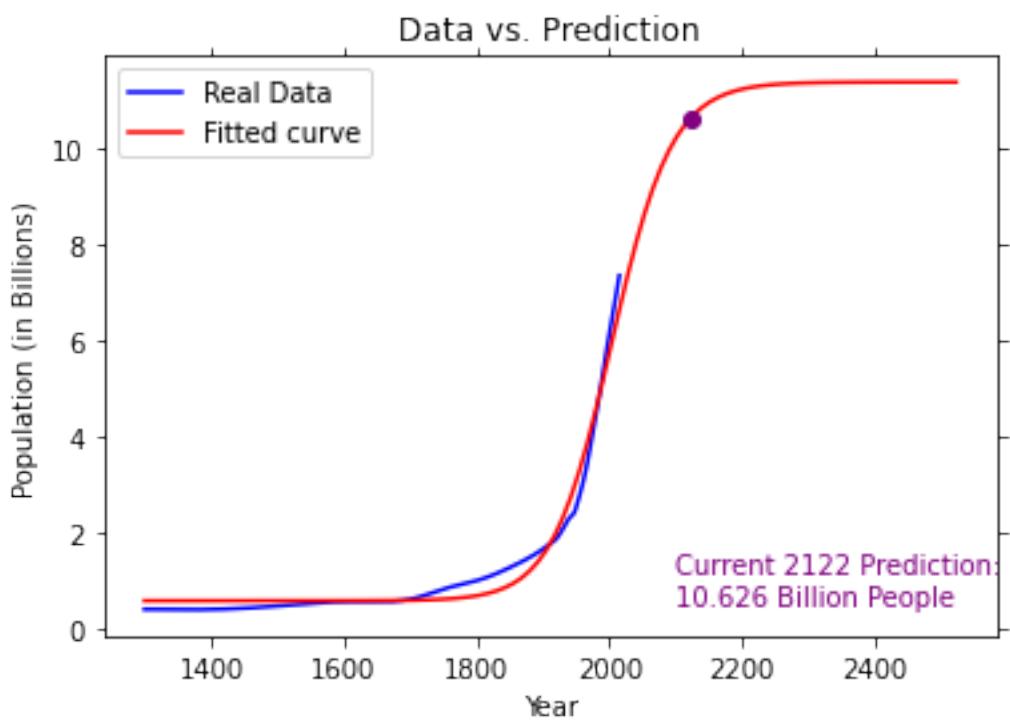
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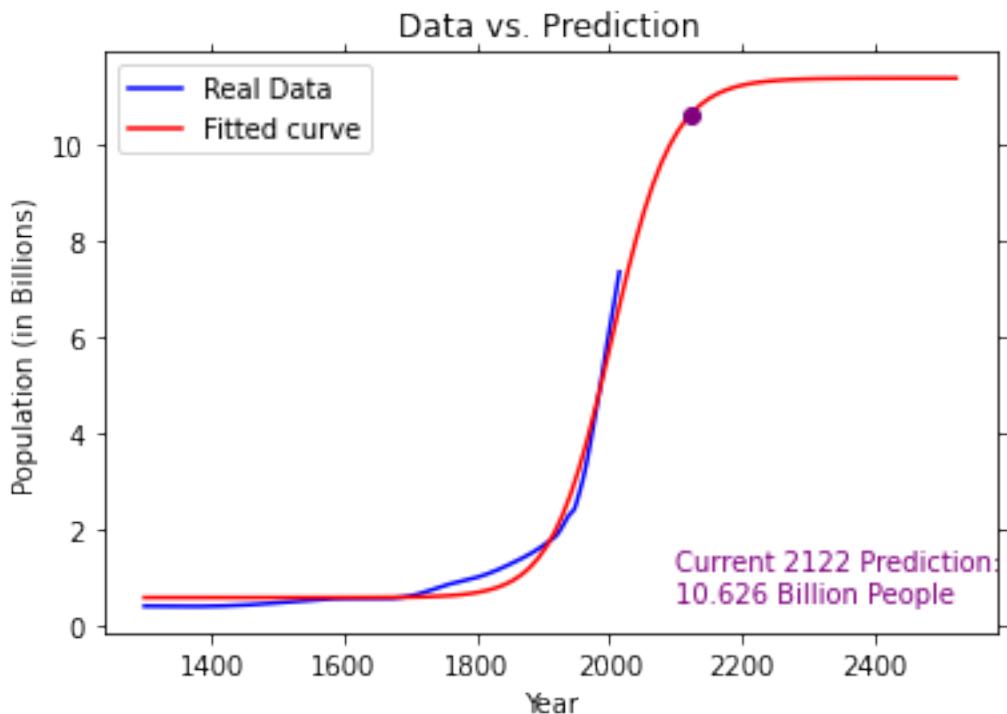
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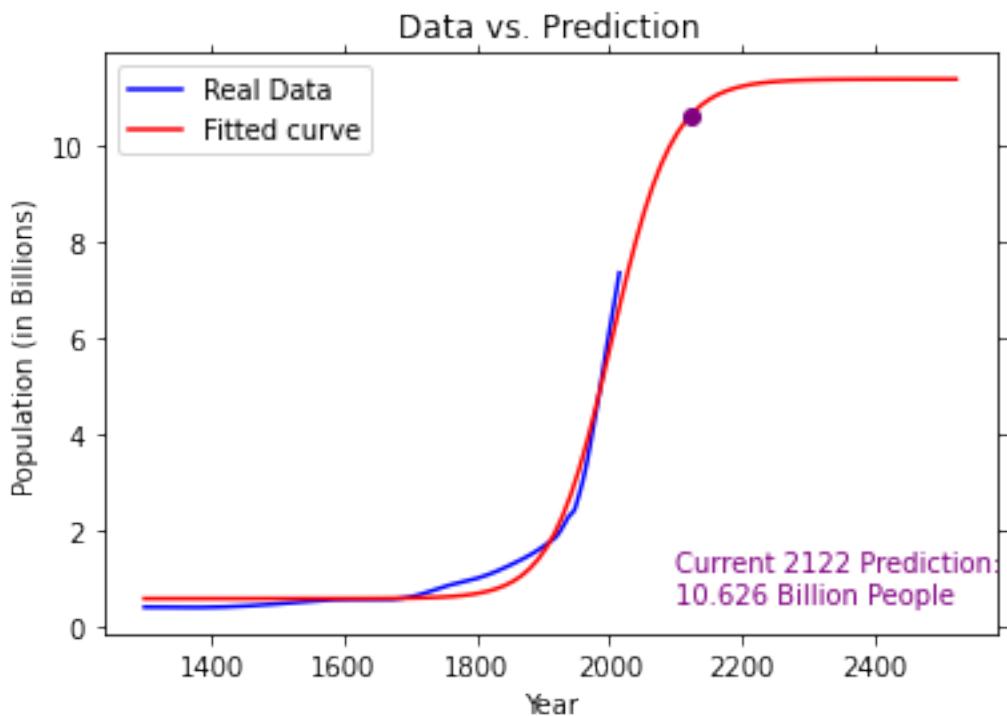
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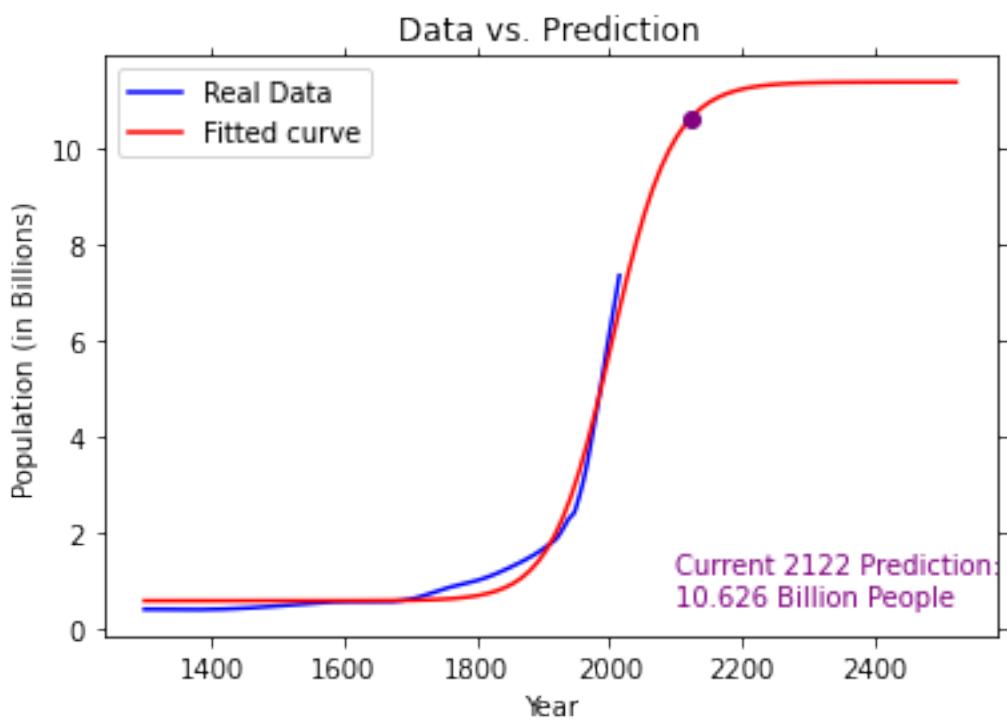
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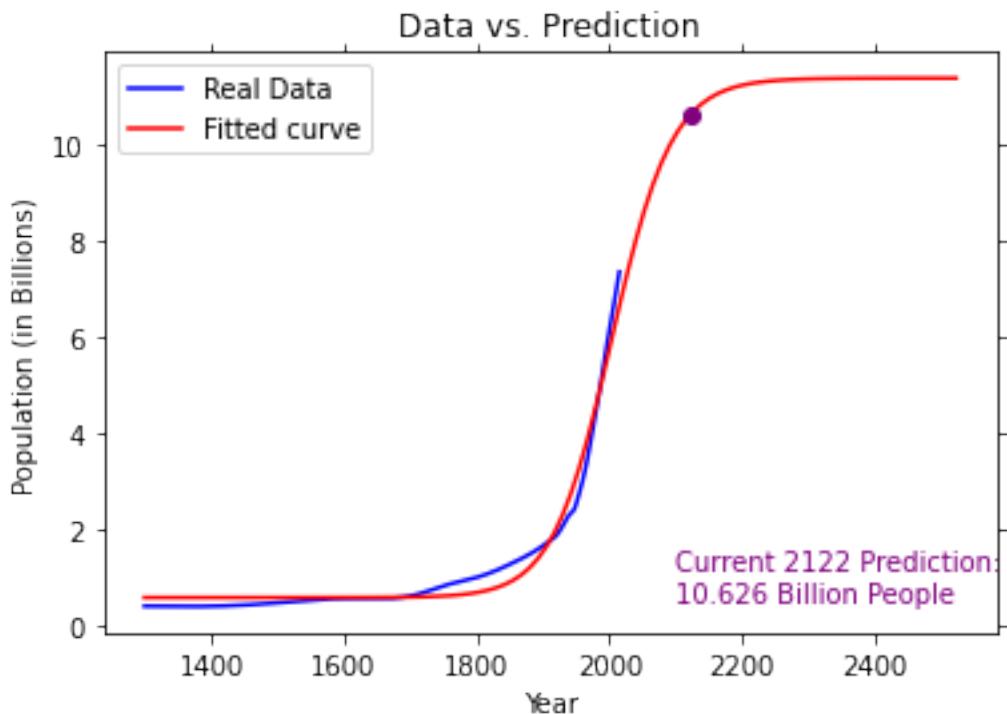
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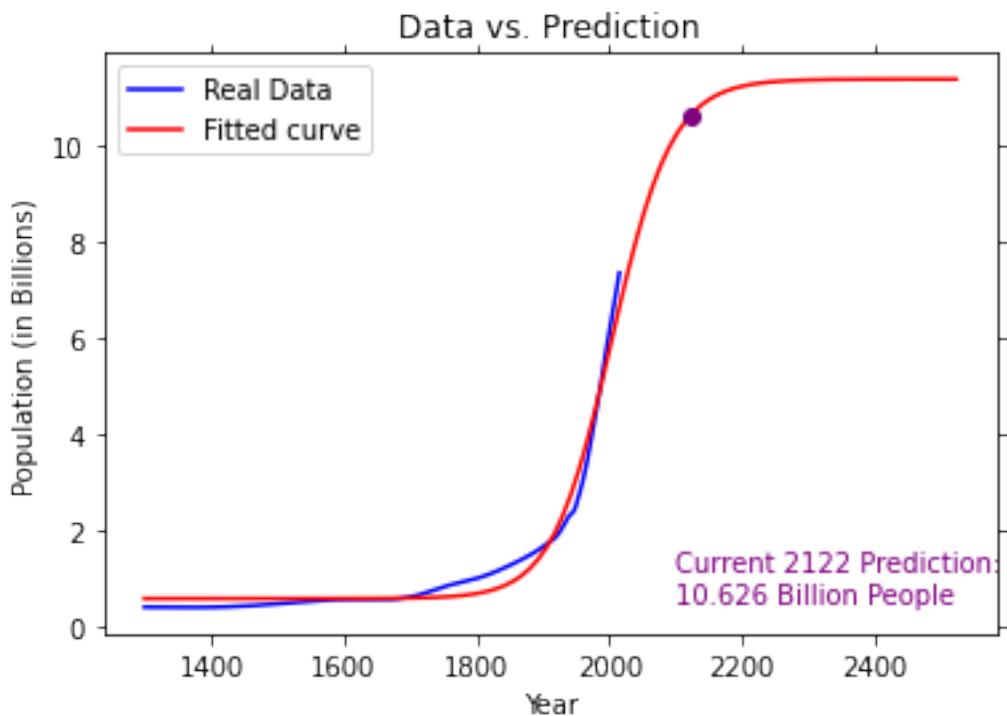
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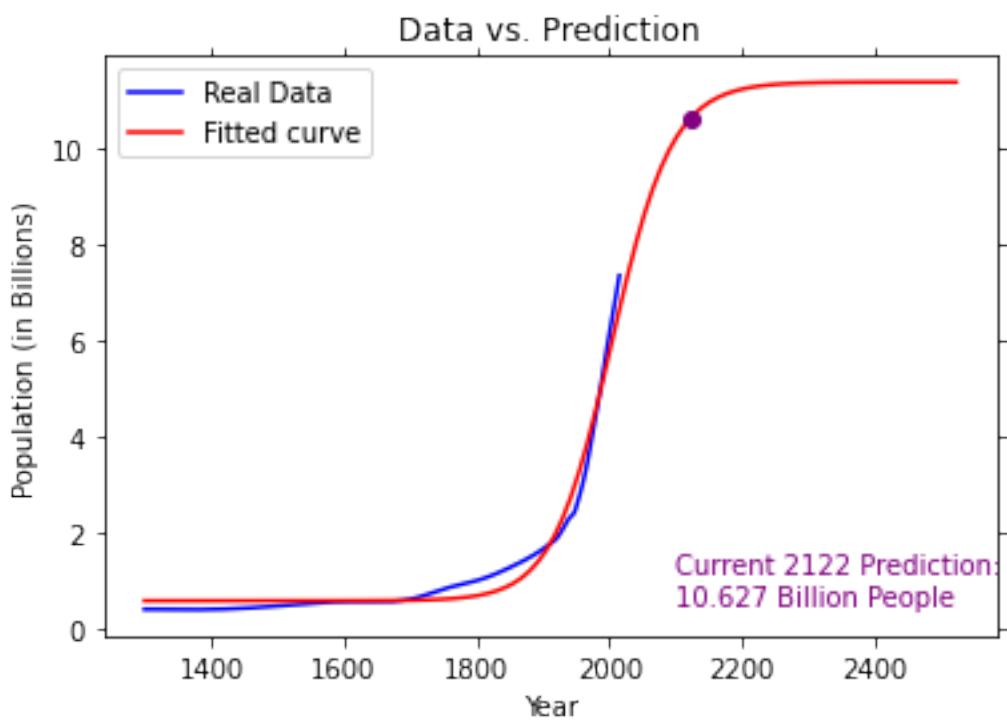
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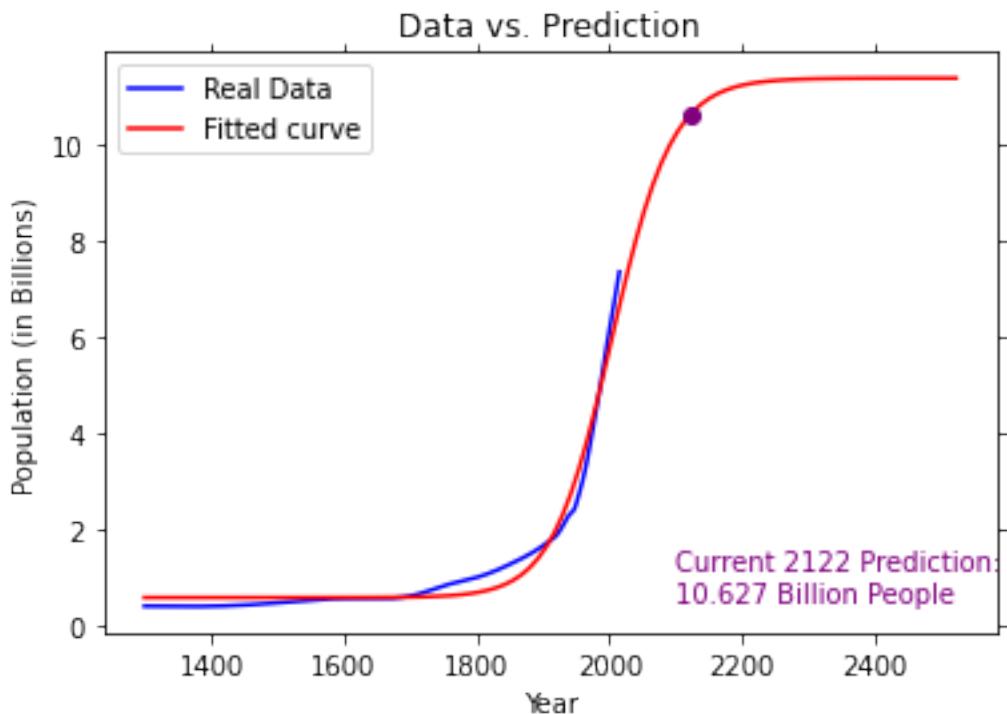
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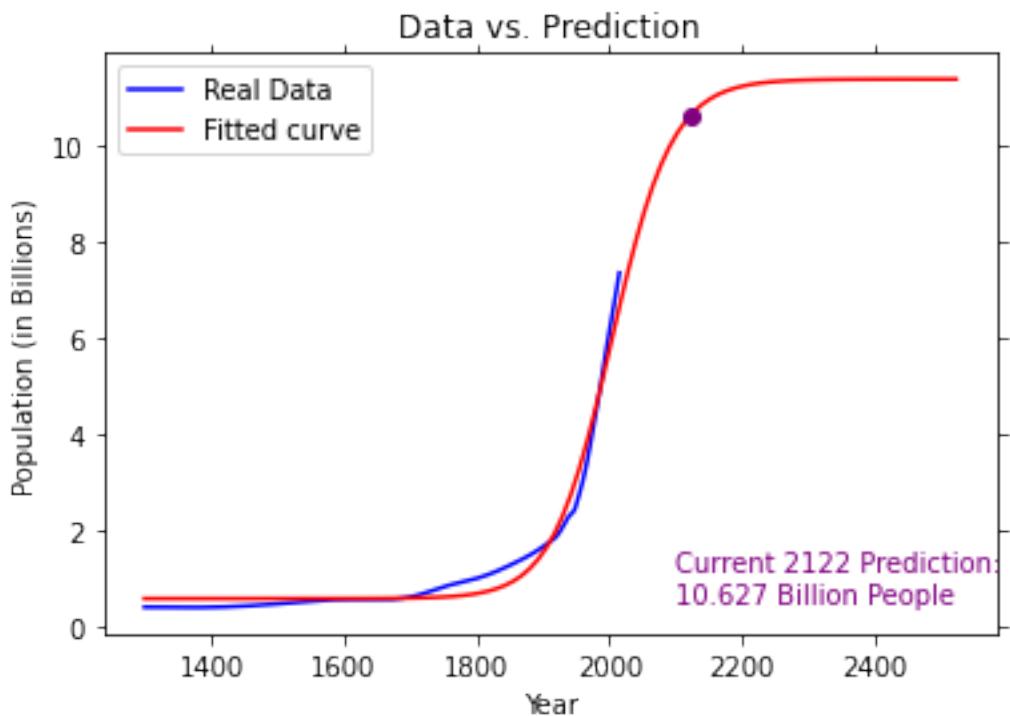
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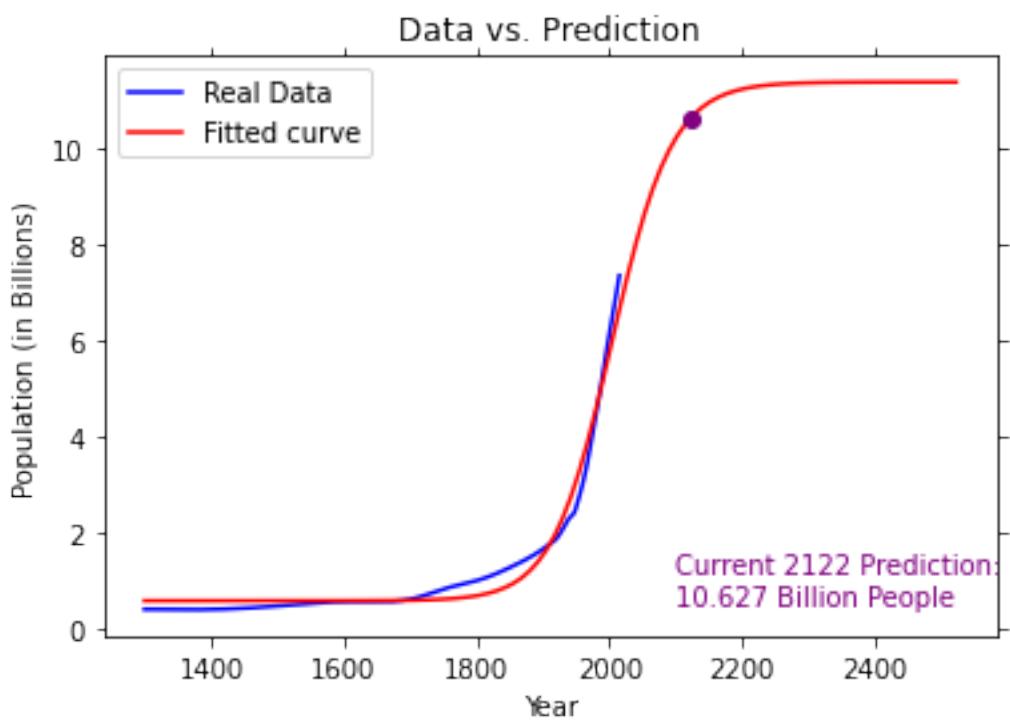
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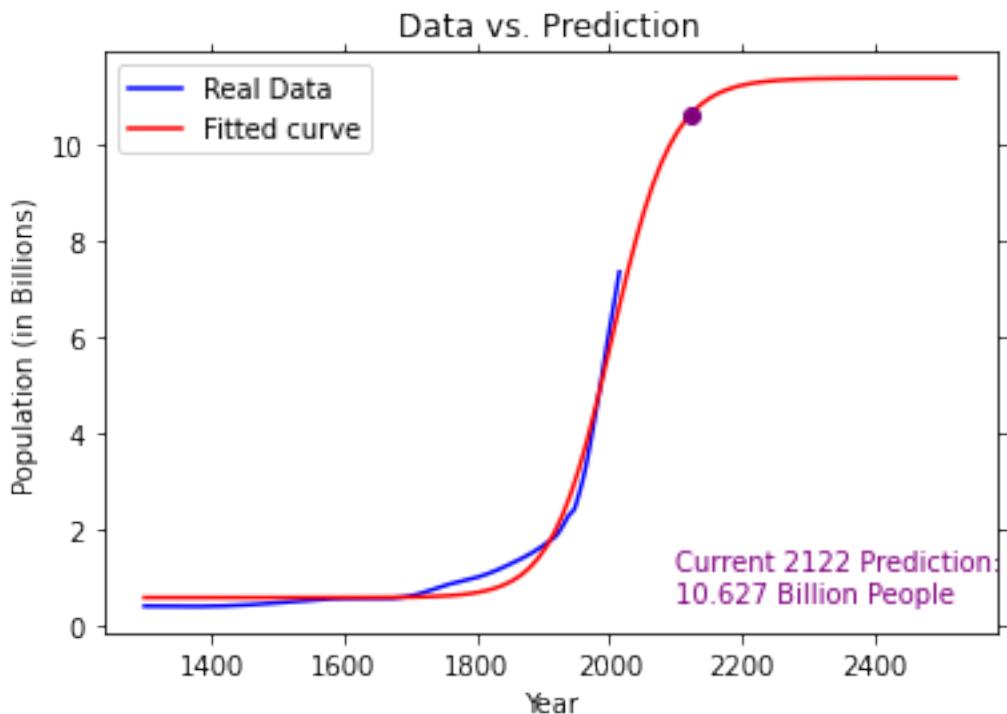
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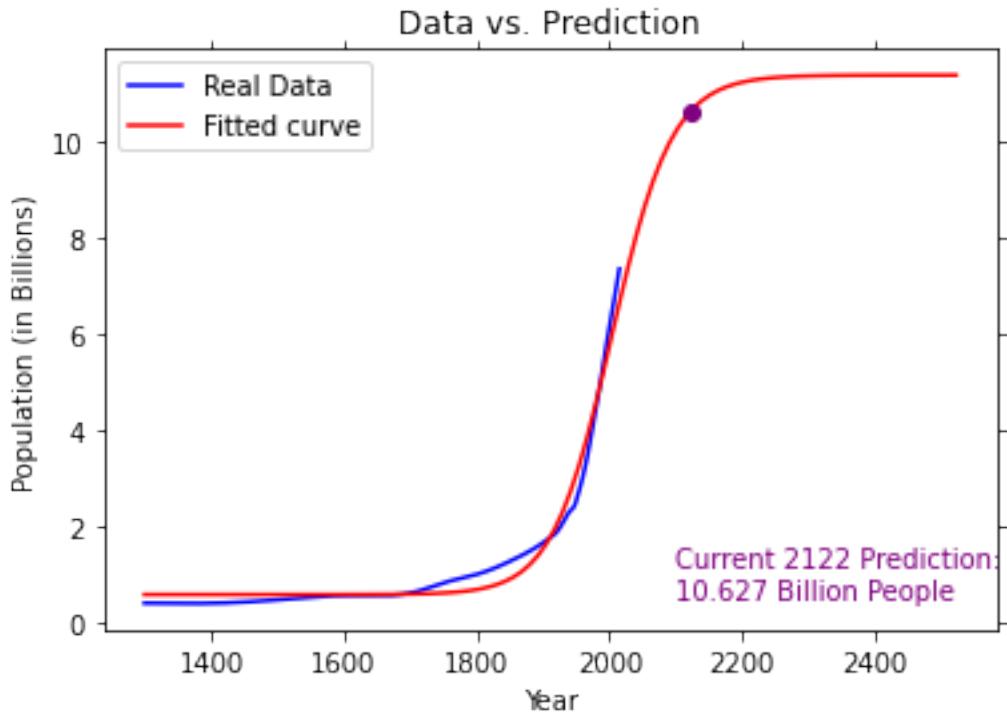
Iteration #45800, Loss: 0.050449282149742126



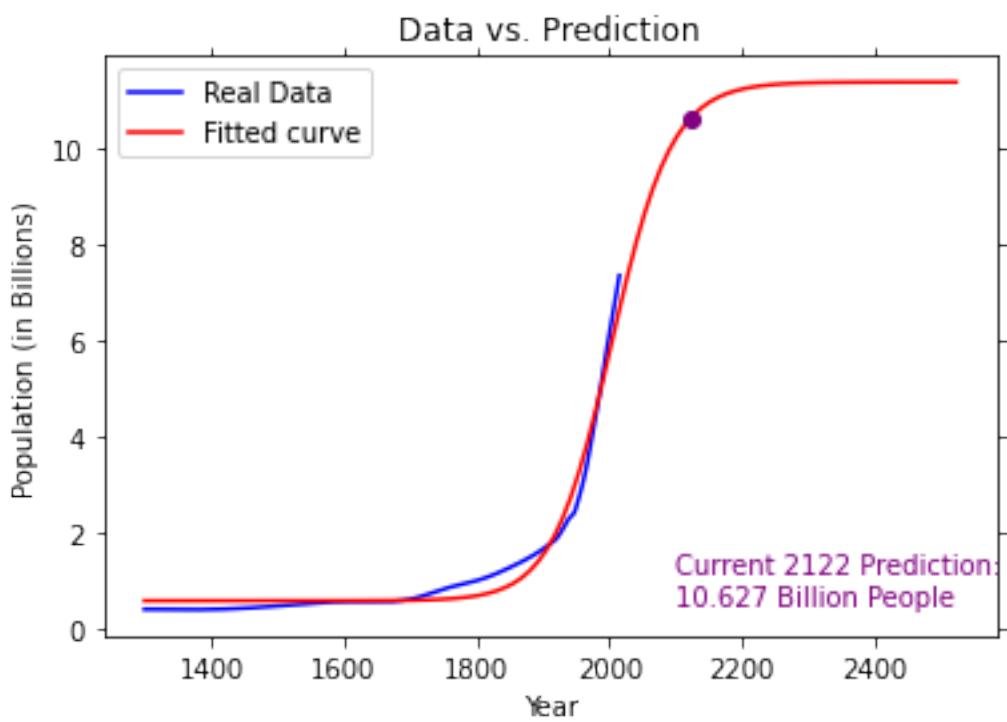
Iteration #45850, Loss: 0.050447999019553824



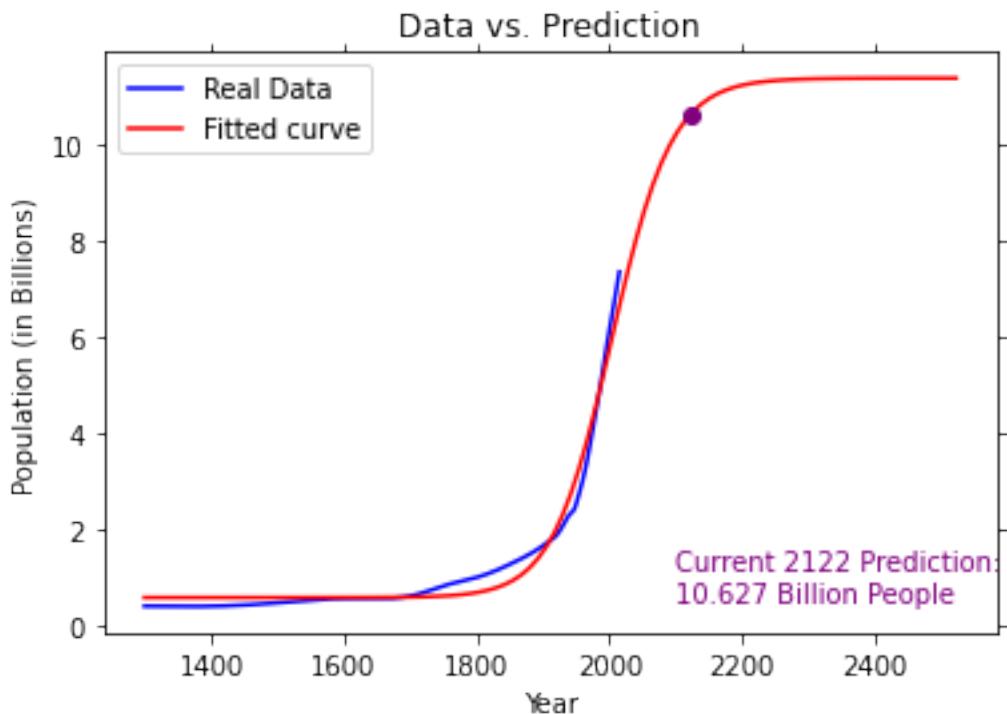
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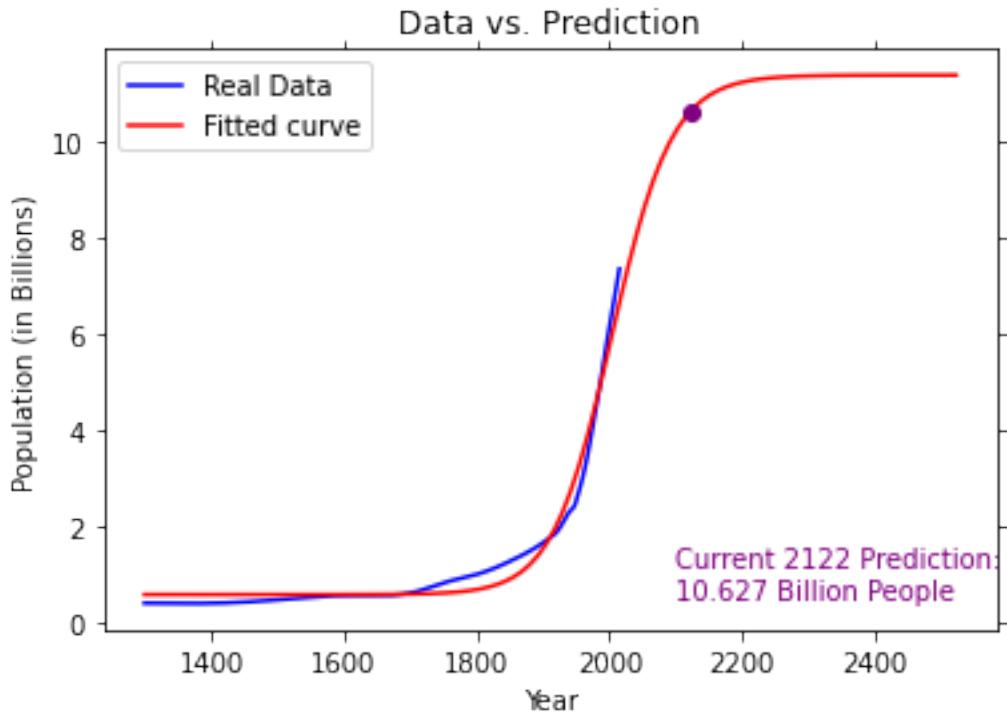
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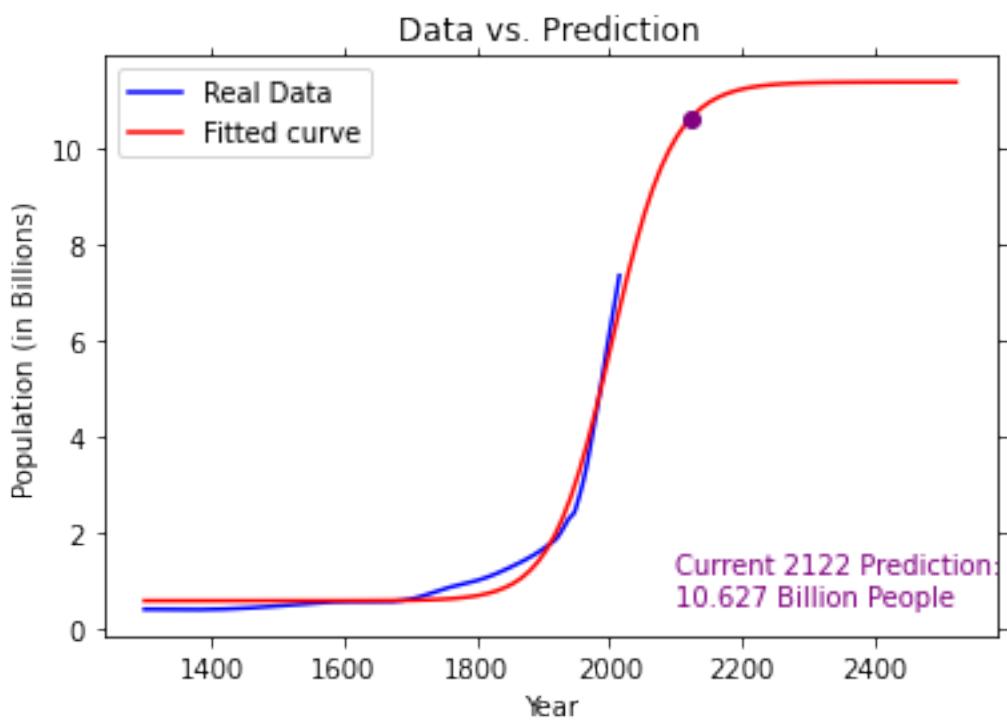
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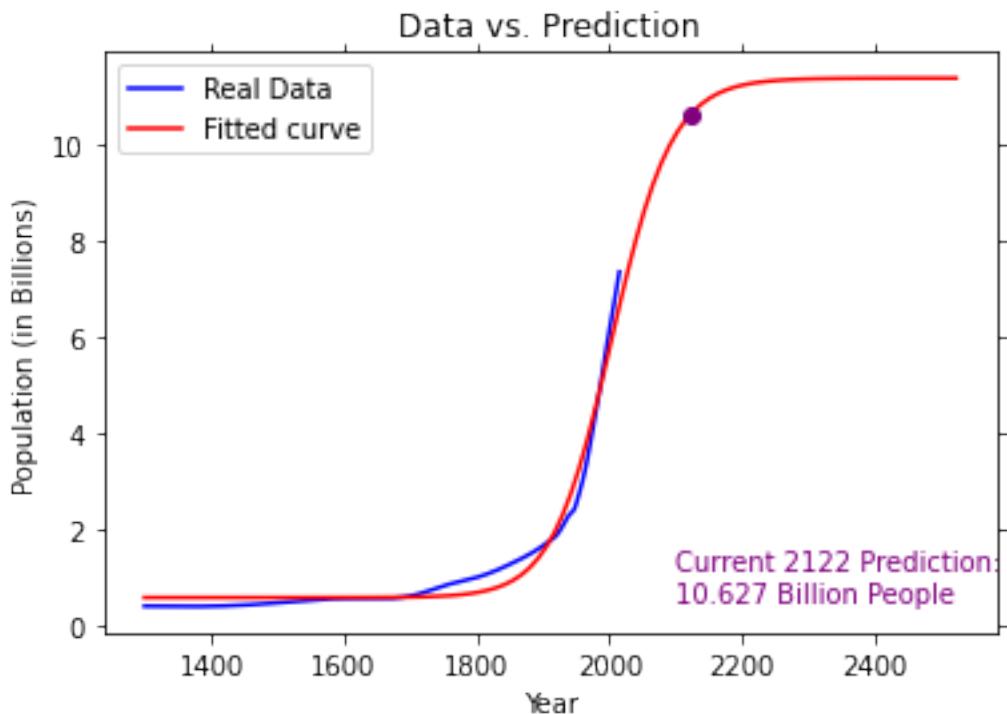
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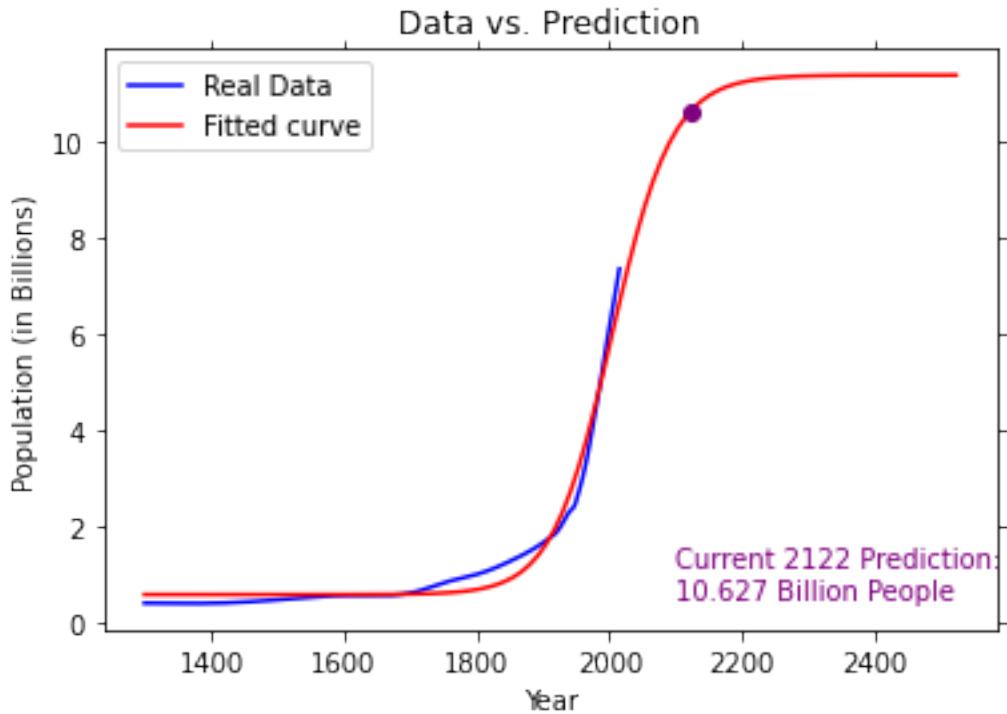
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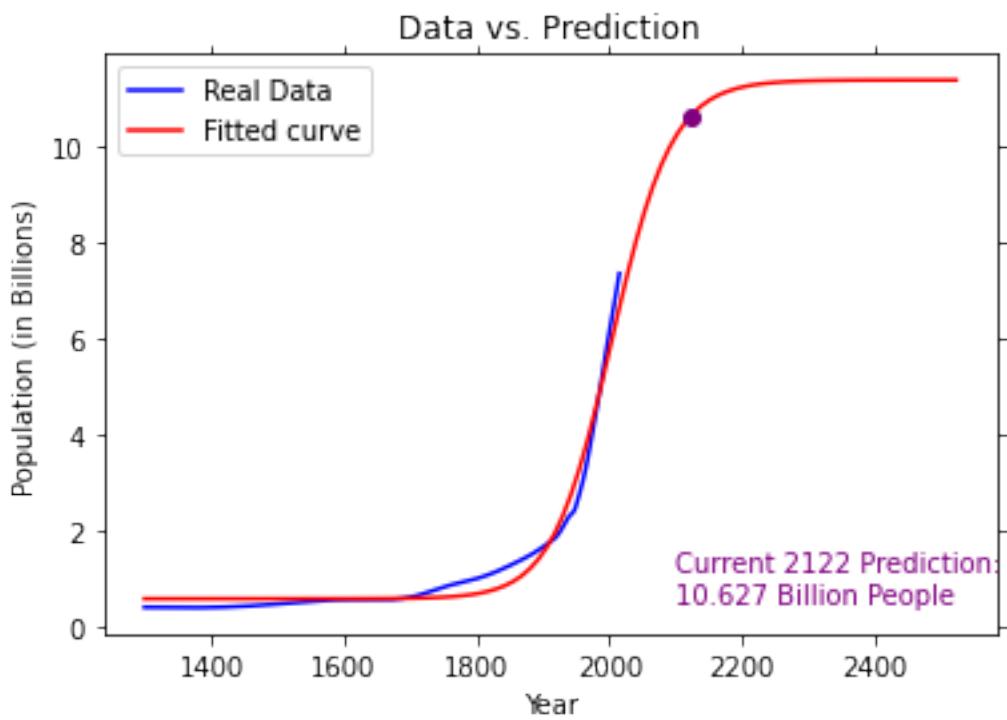
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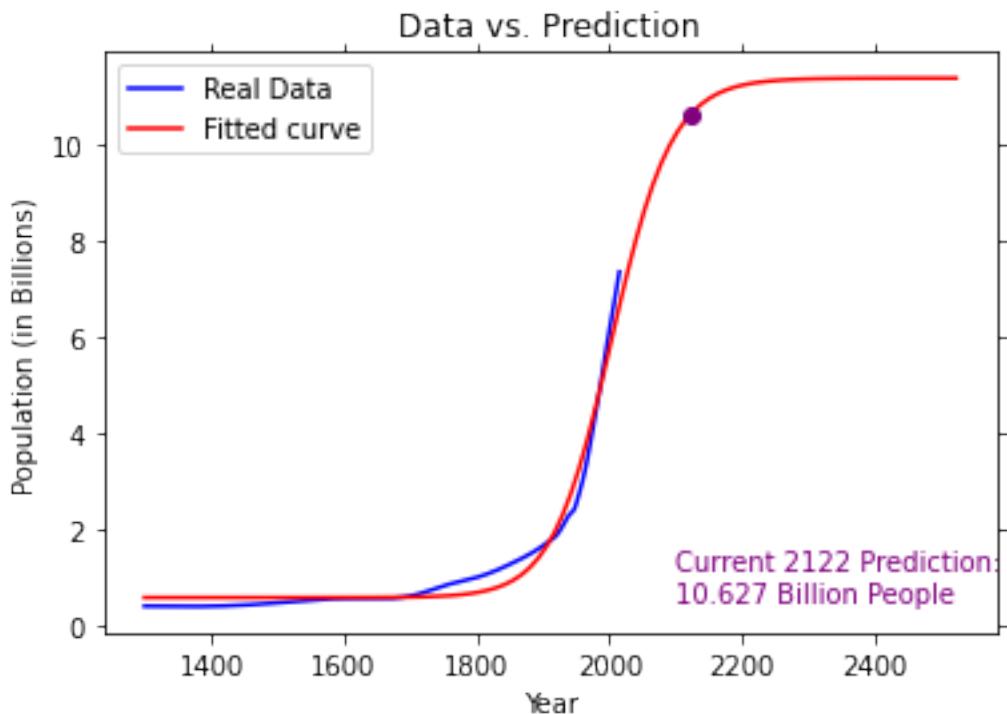
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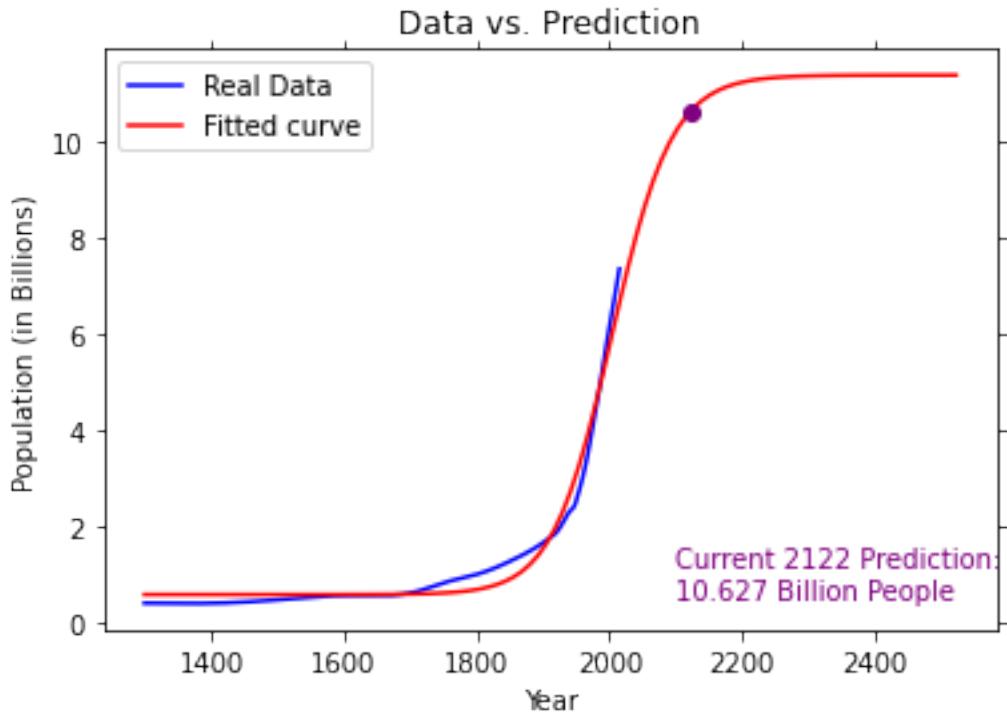
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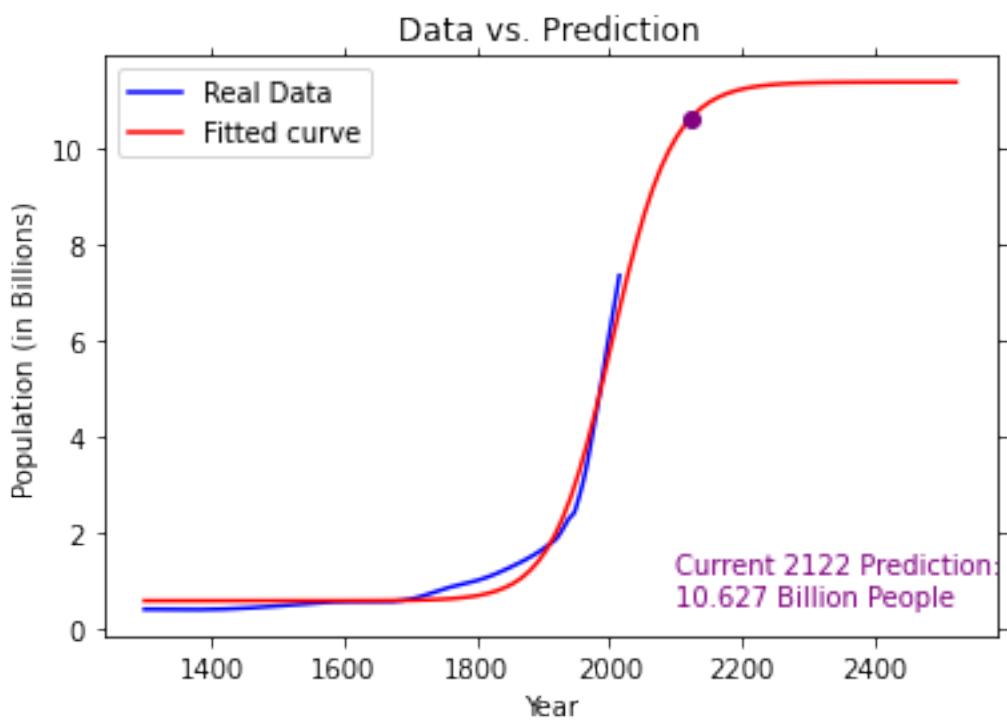
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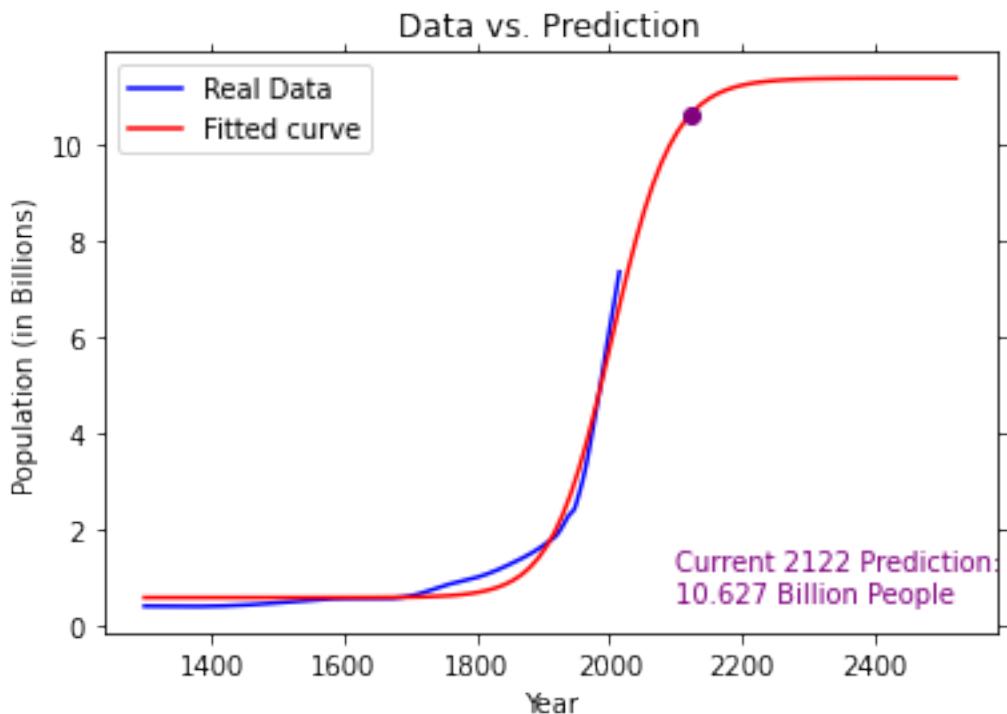
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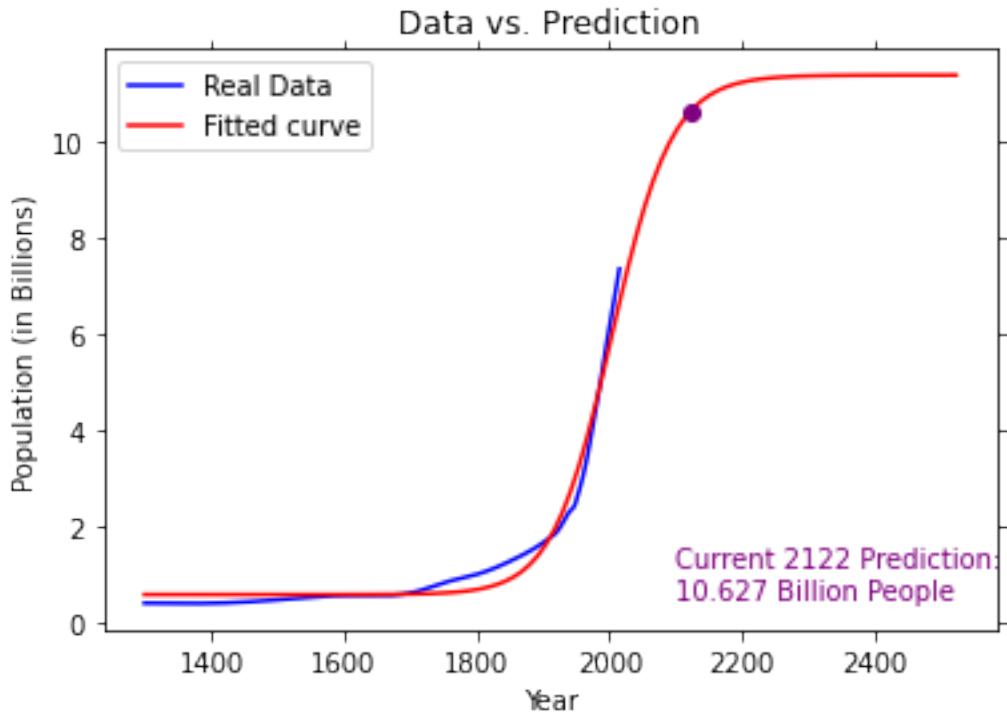
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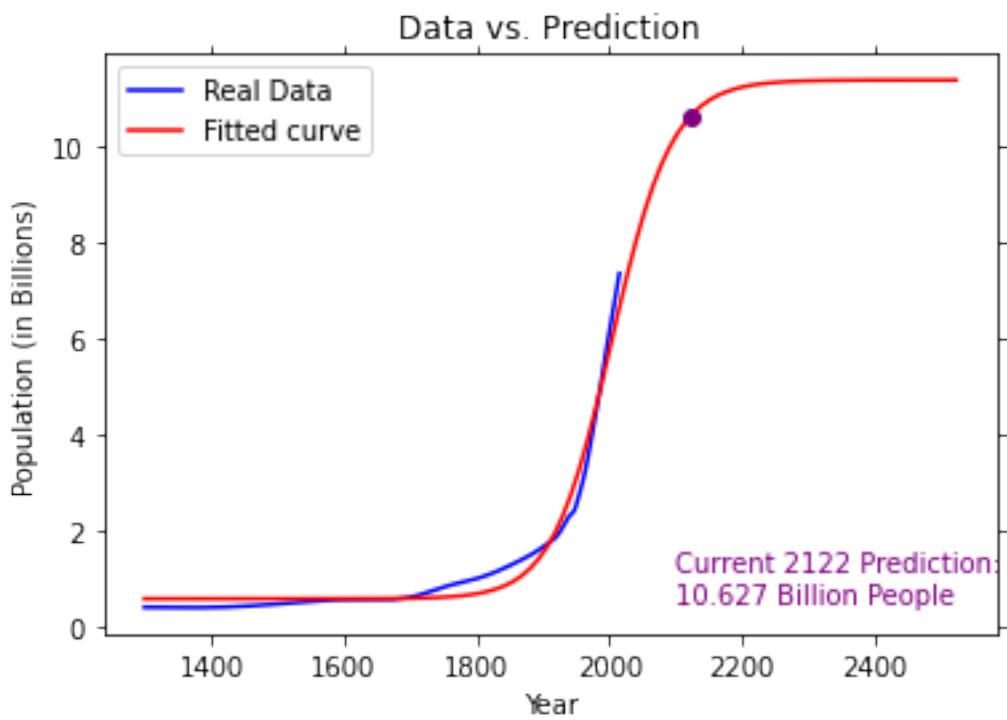
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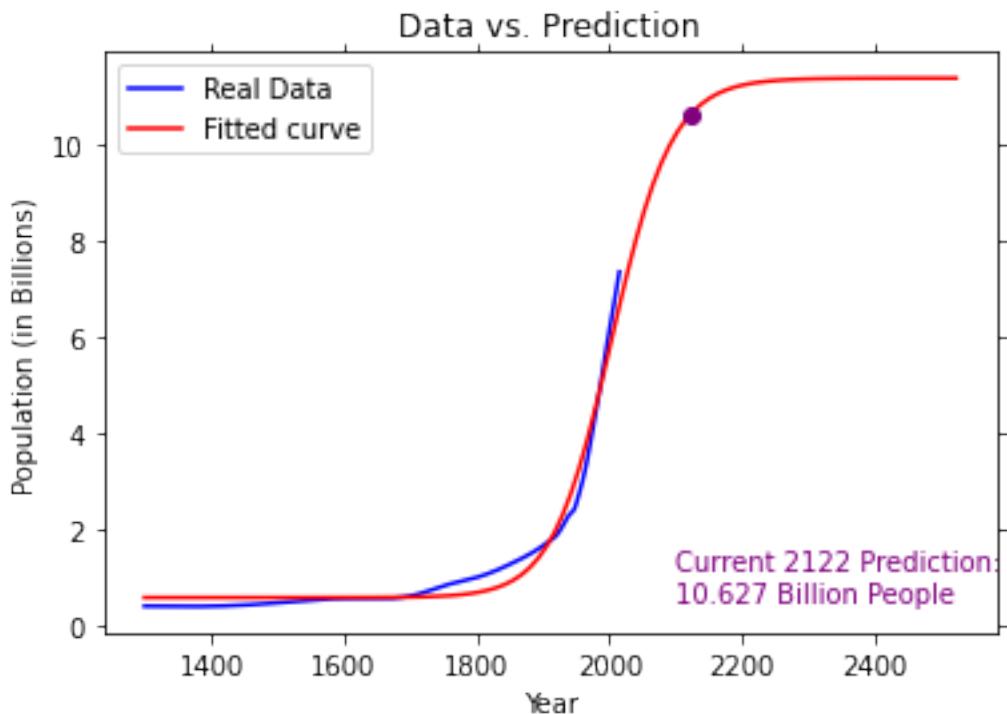
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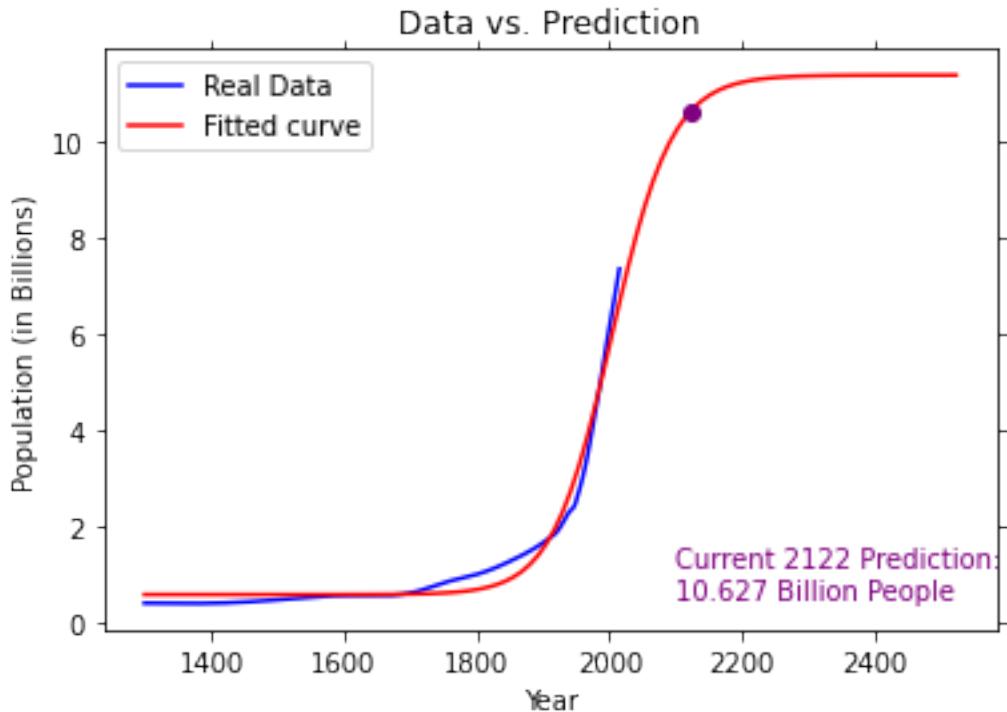
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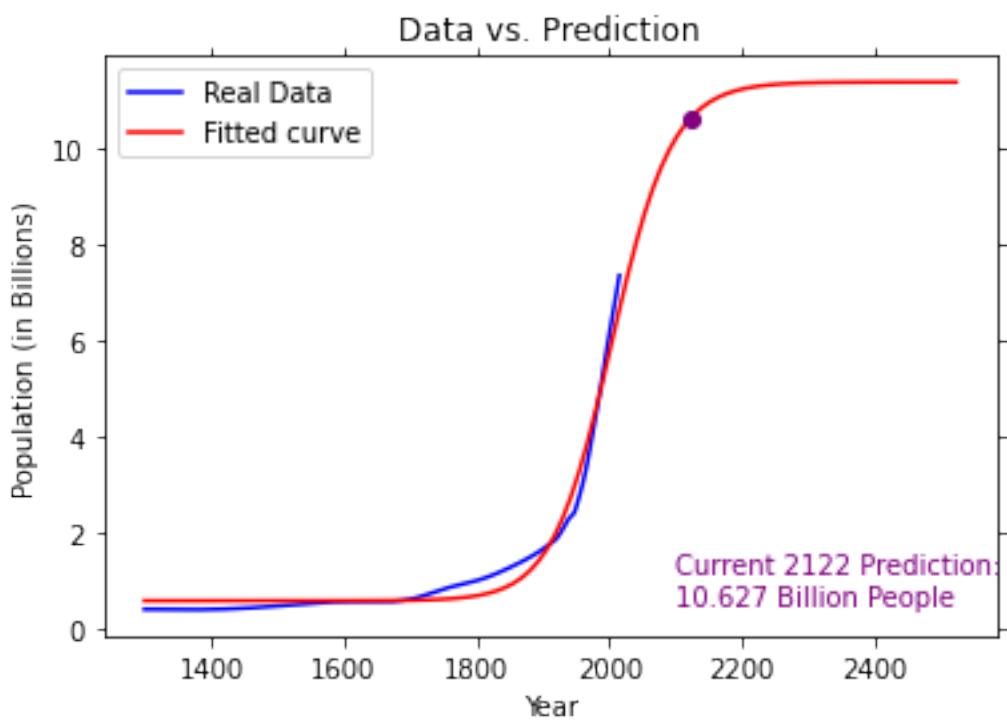
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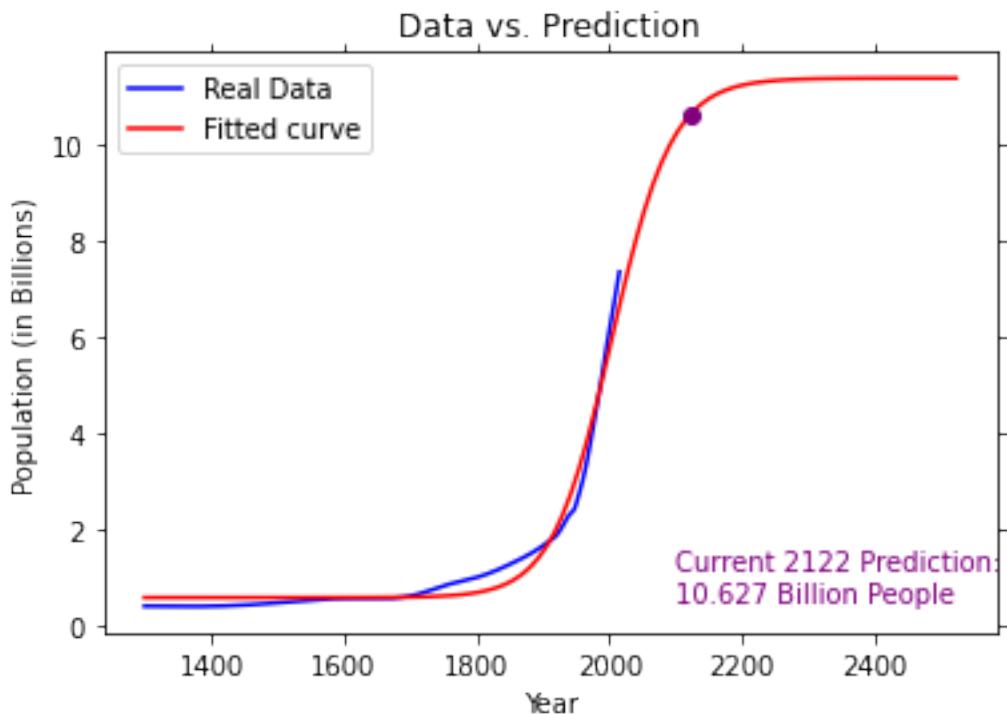
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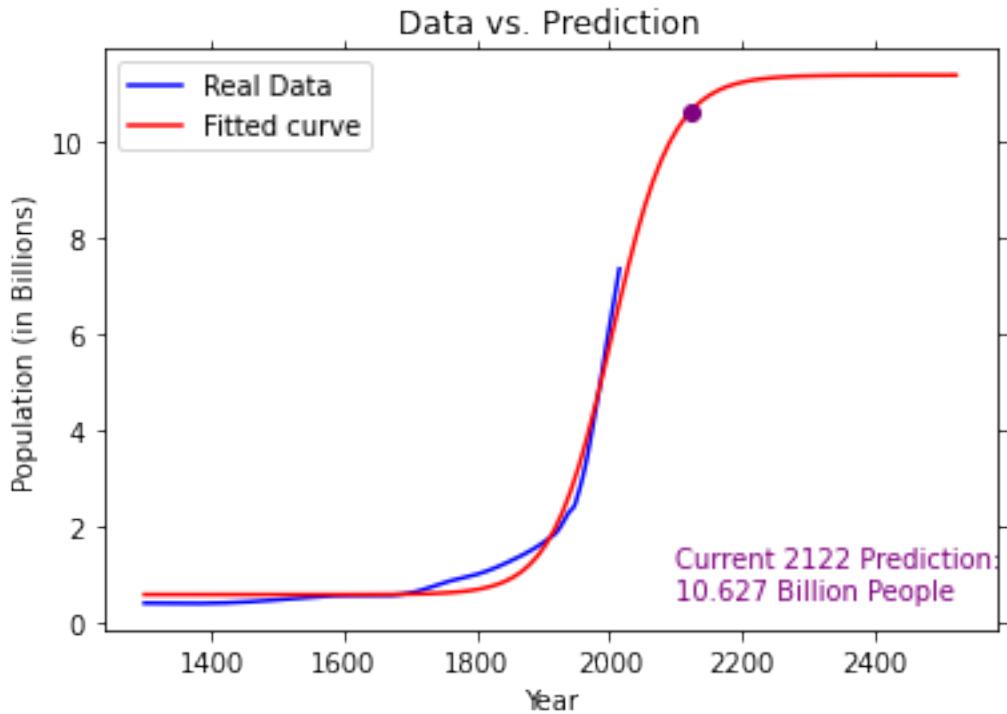
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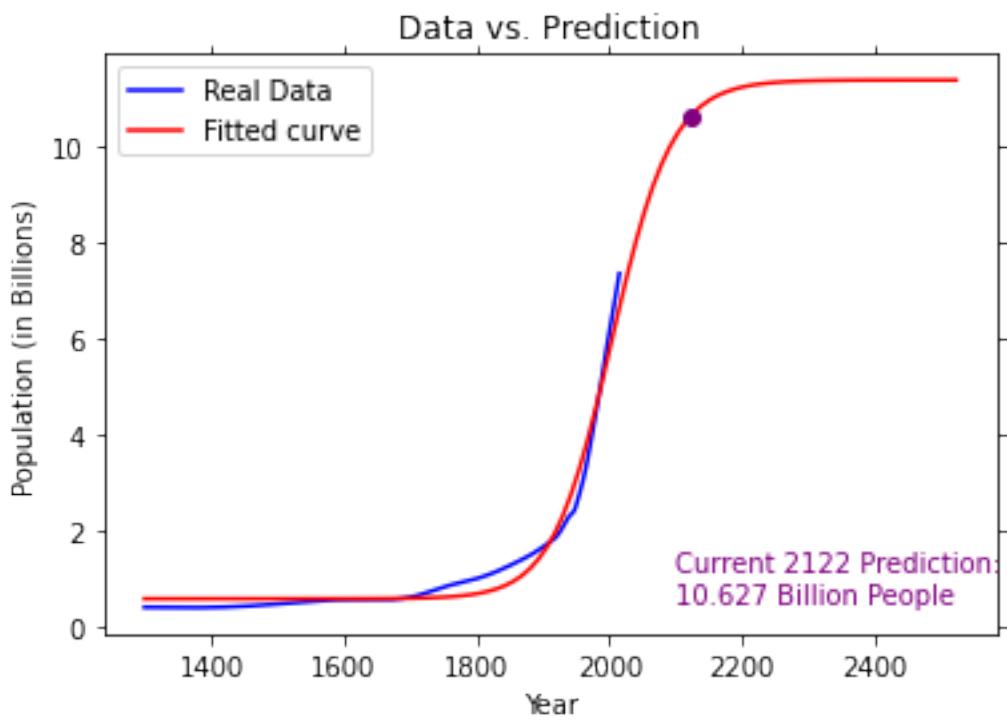
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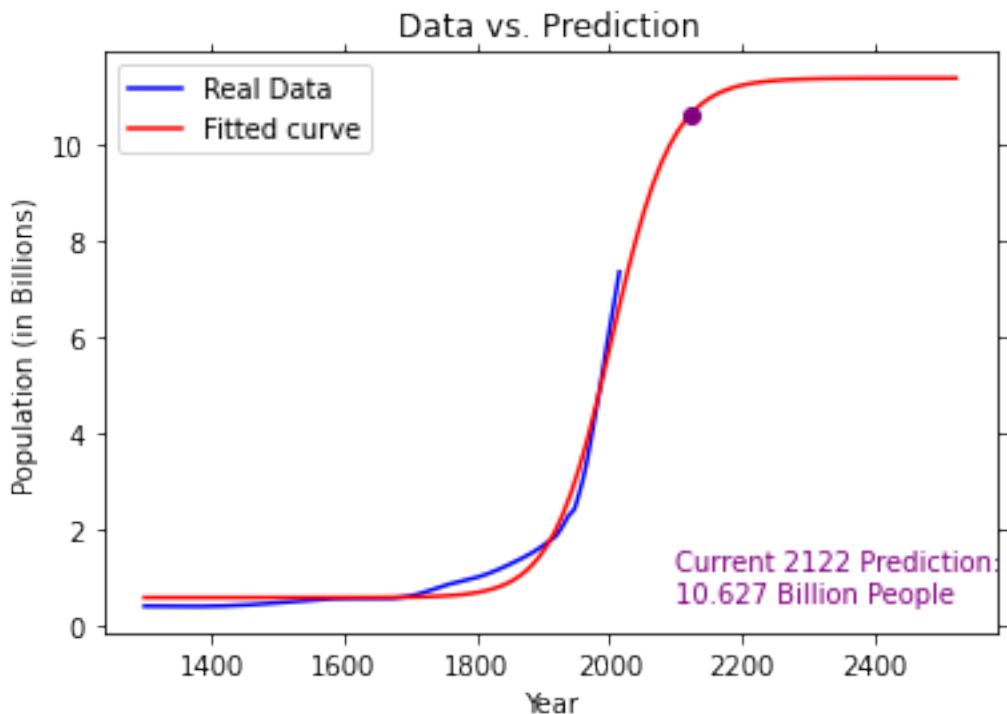
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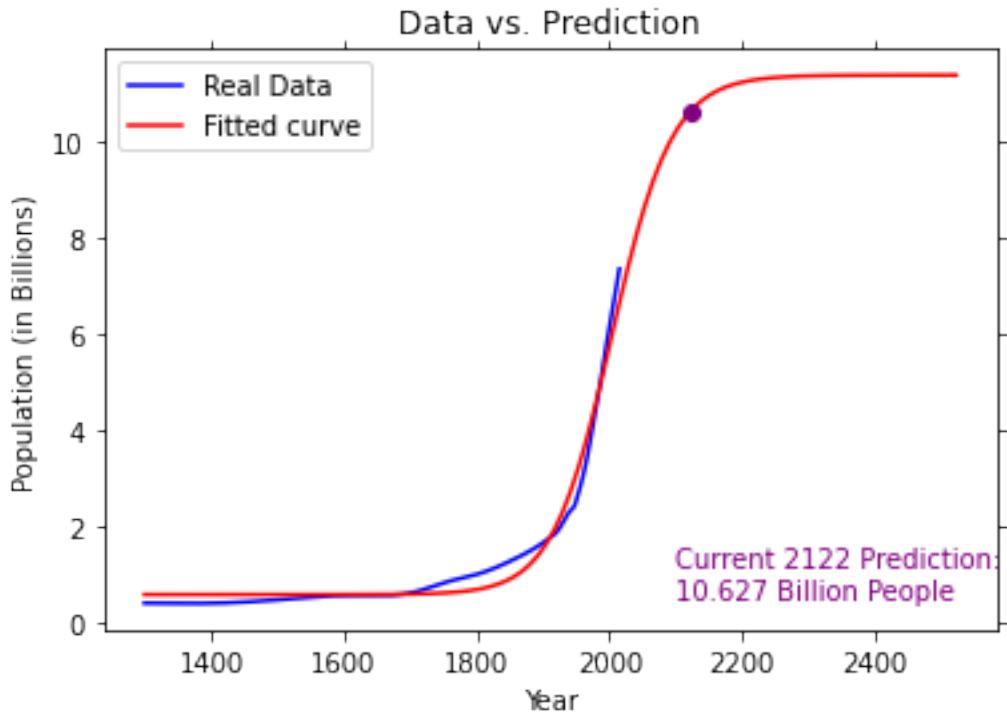
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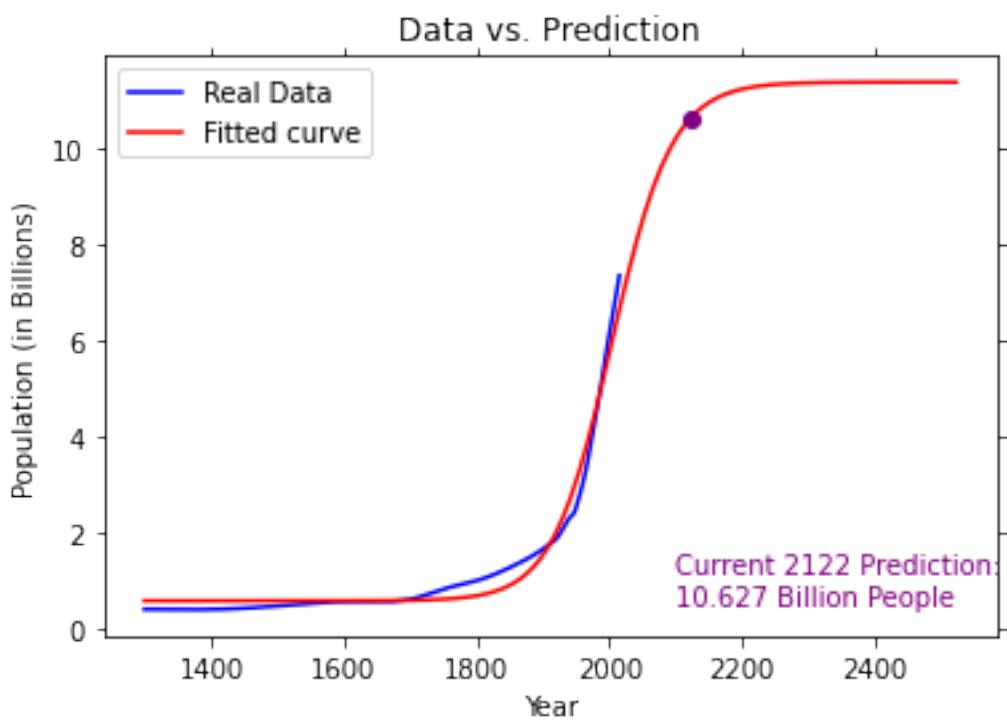
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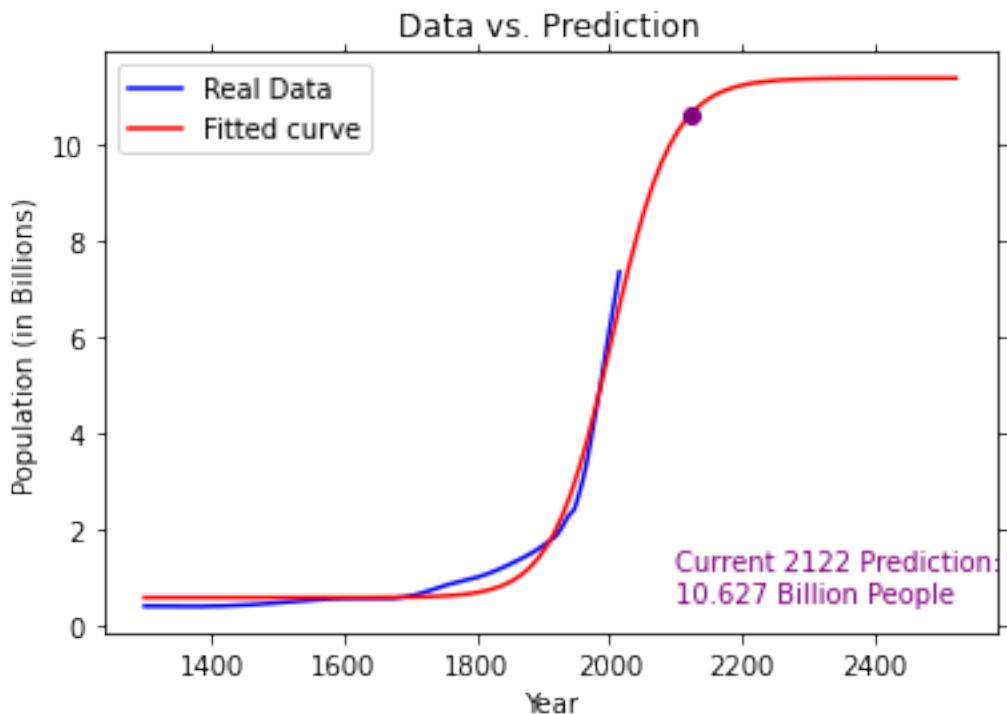
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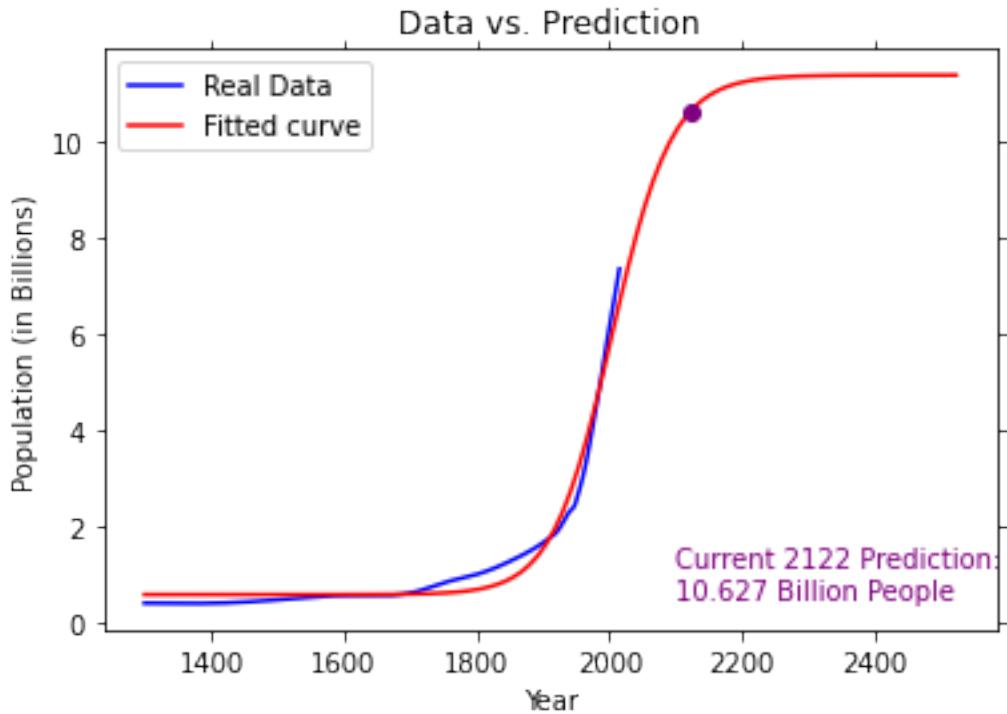
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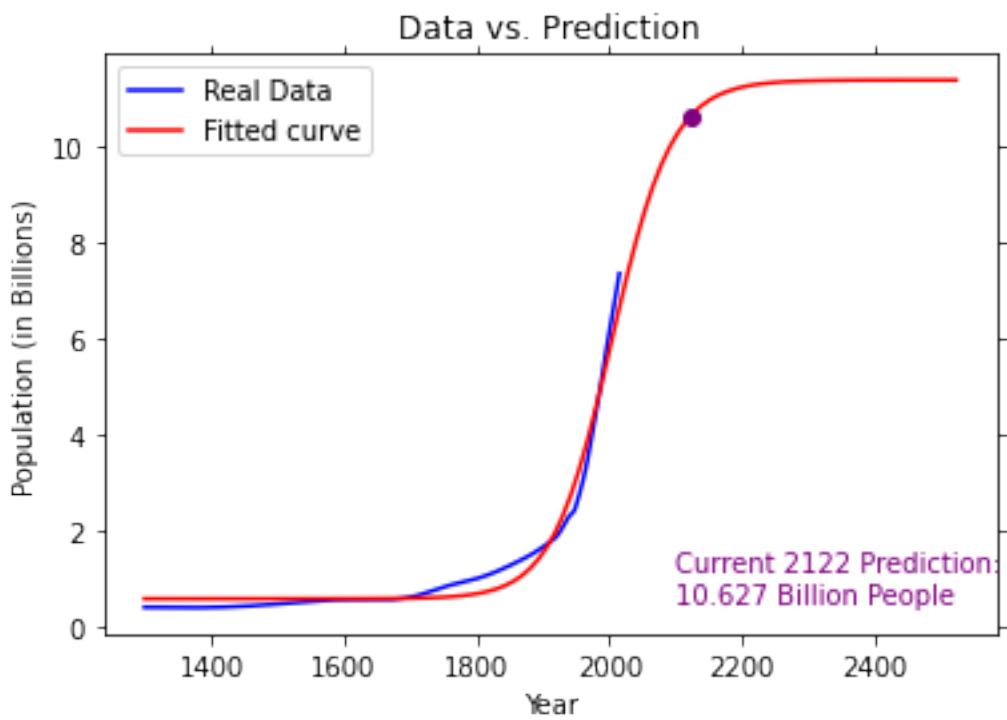
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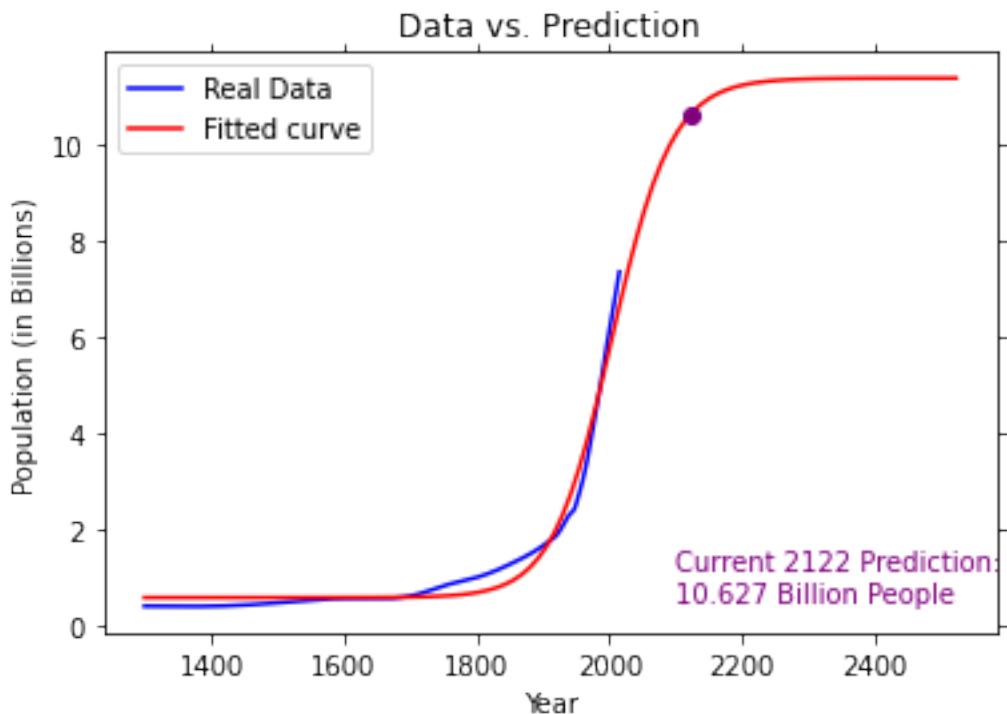
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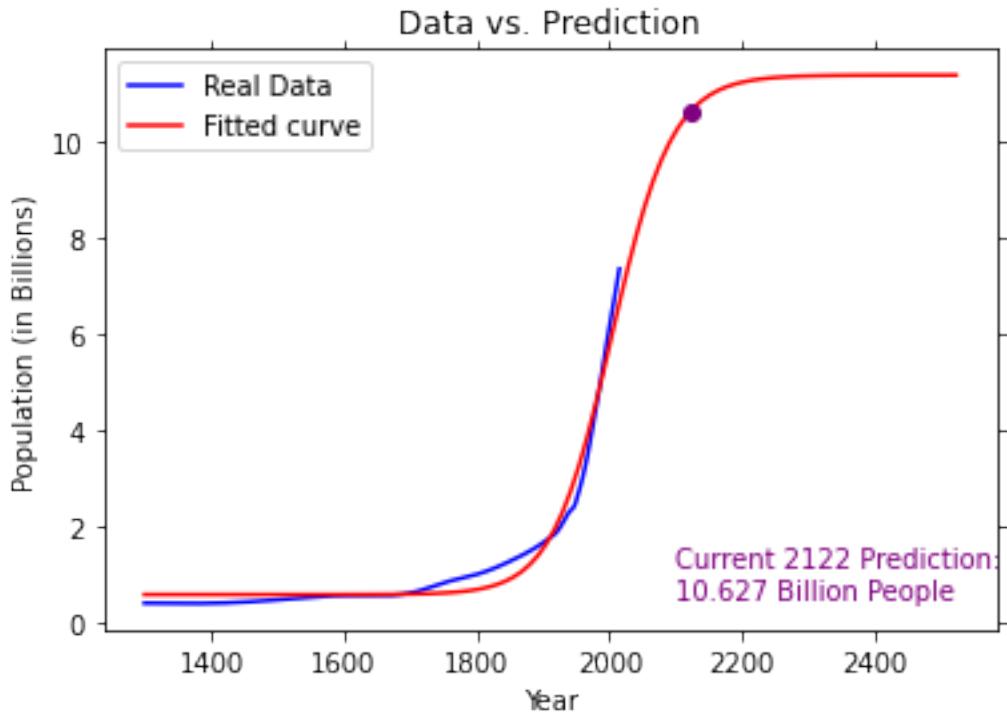
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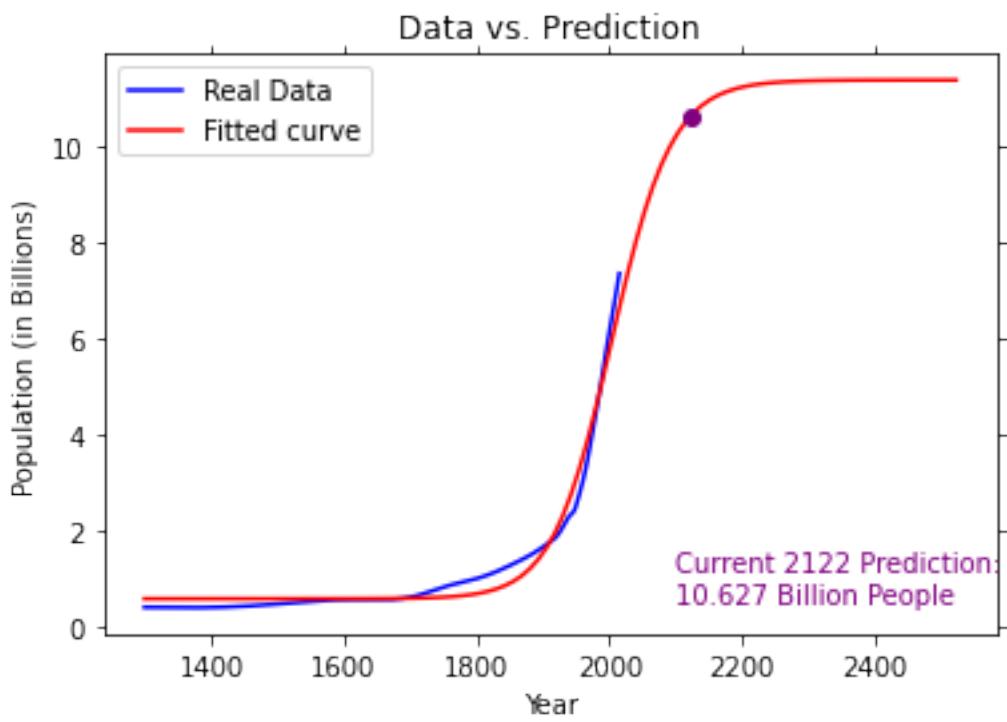
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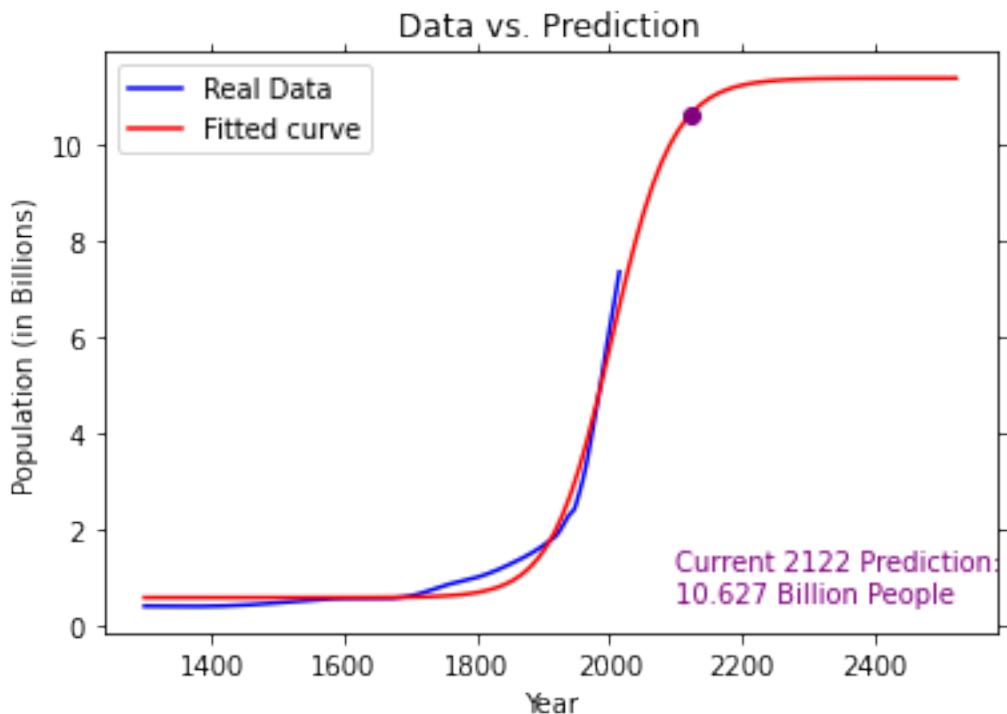
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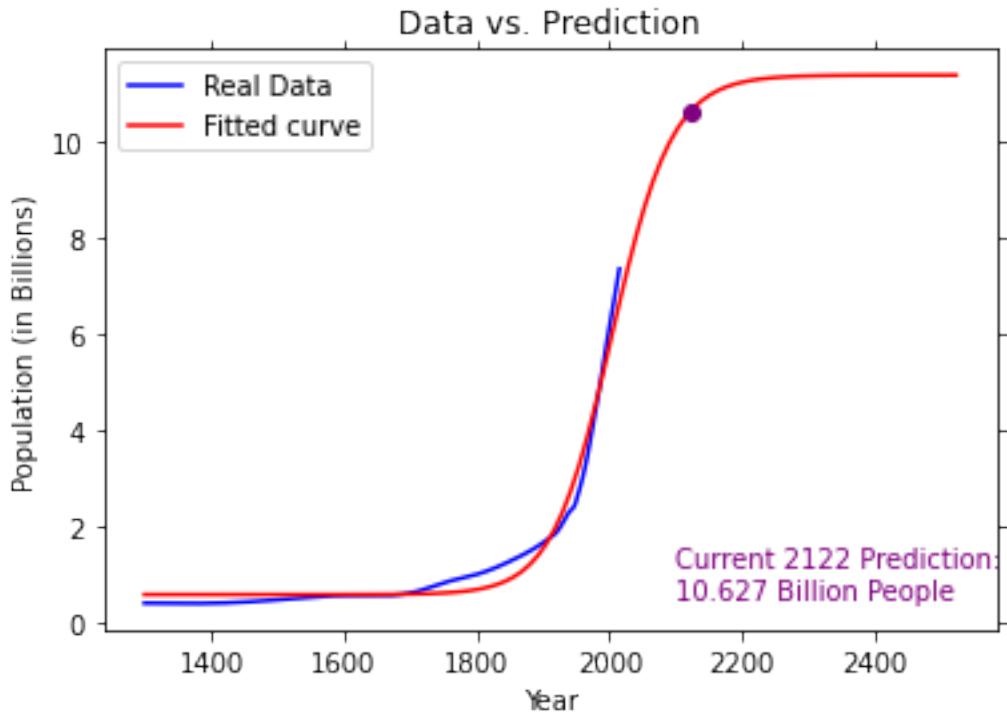
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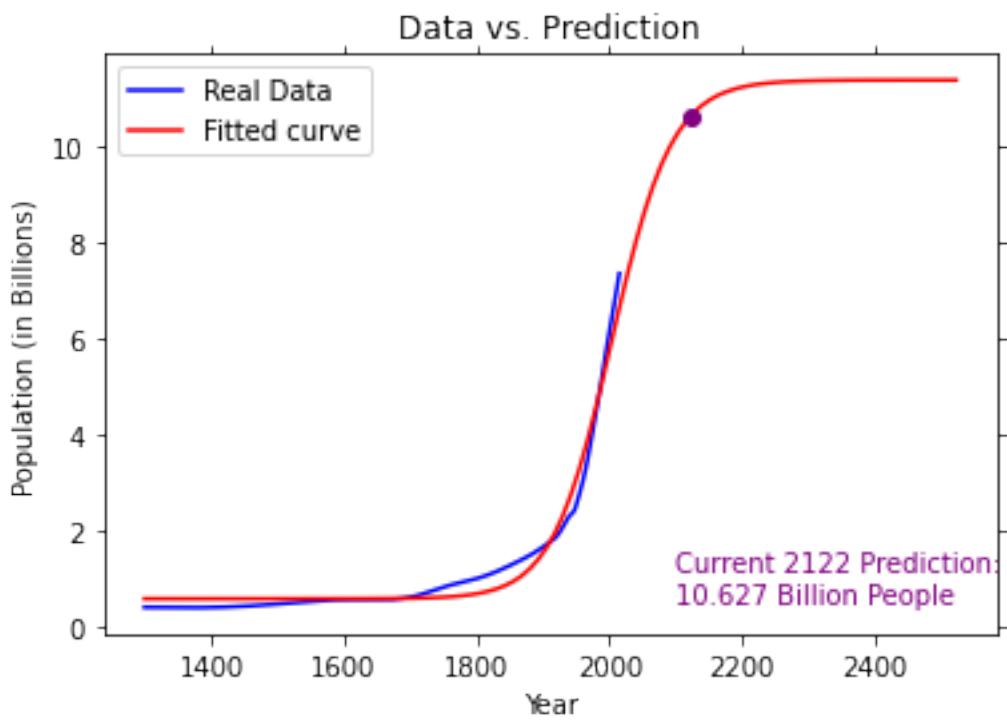
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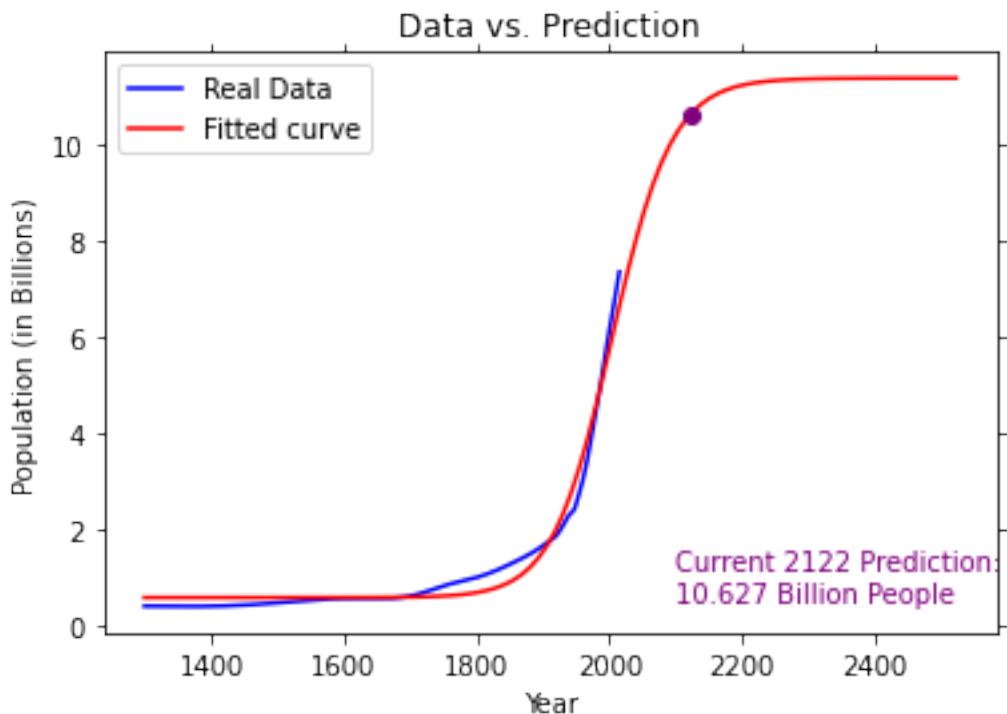
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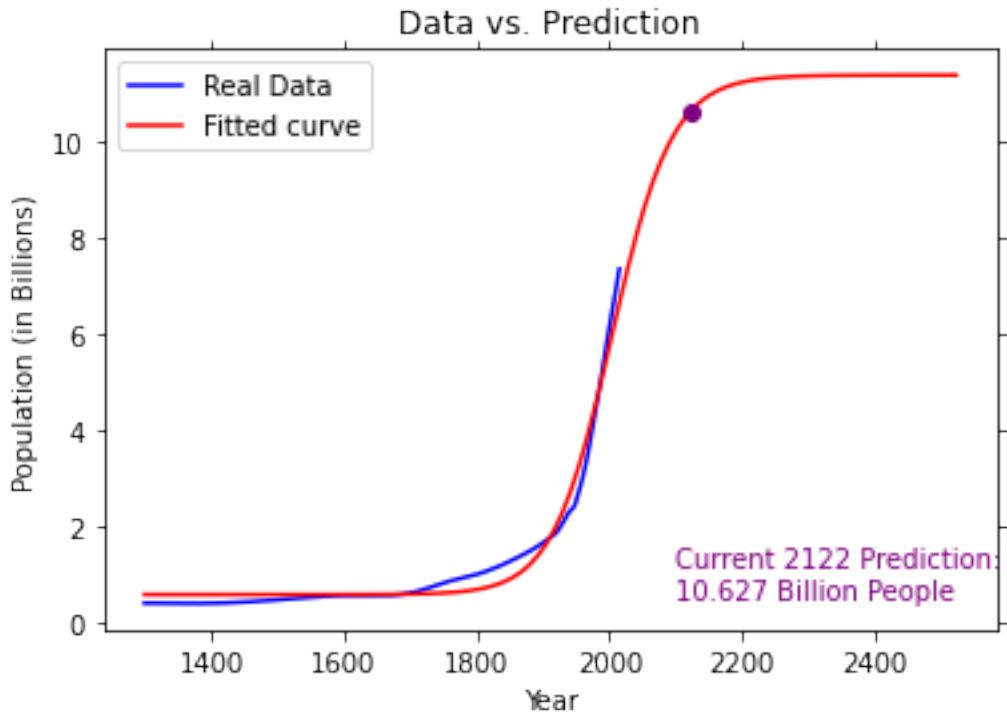
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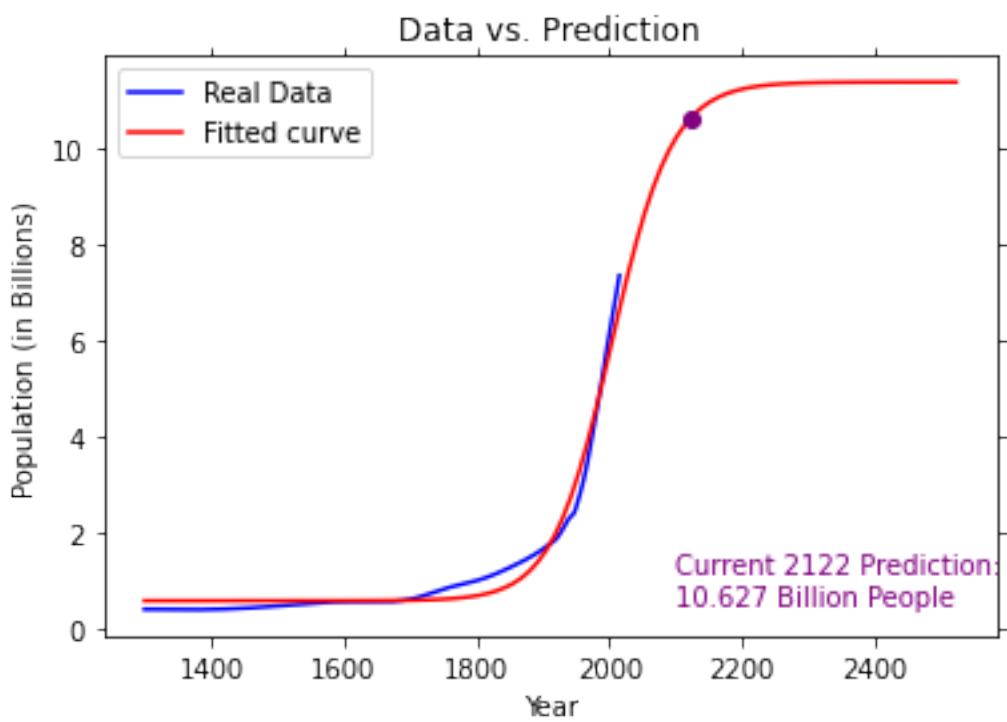
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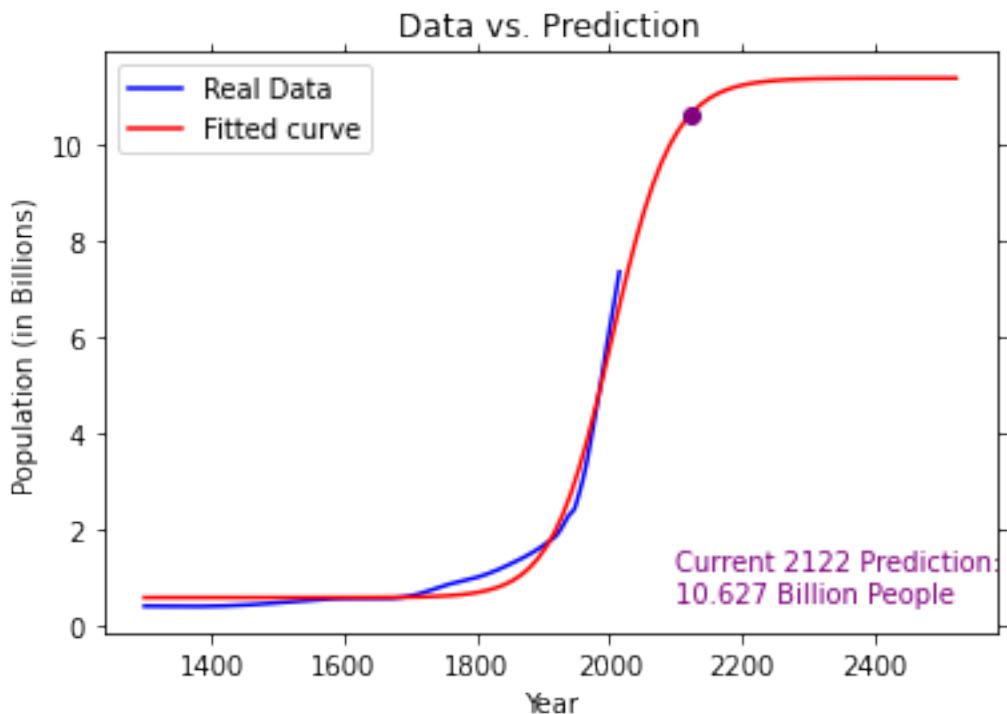
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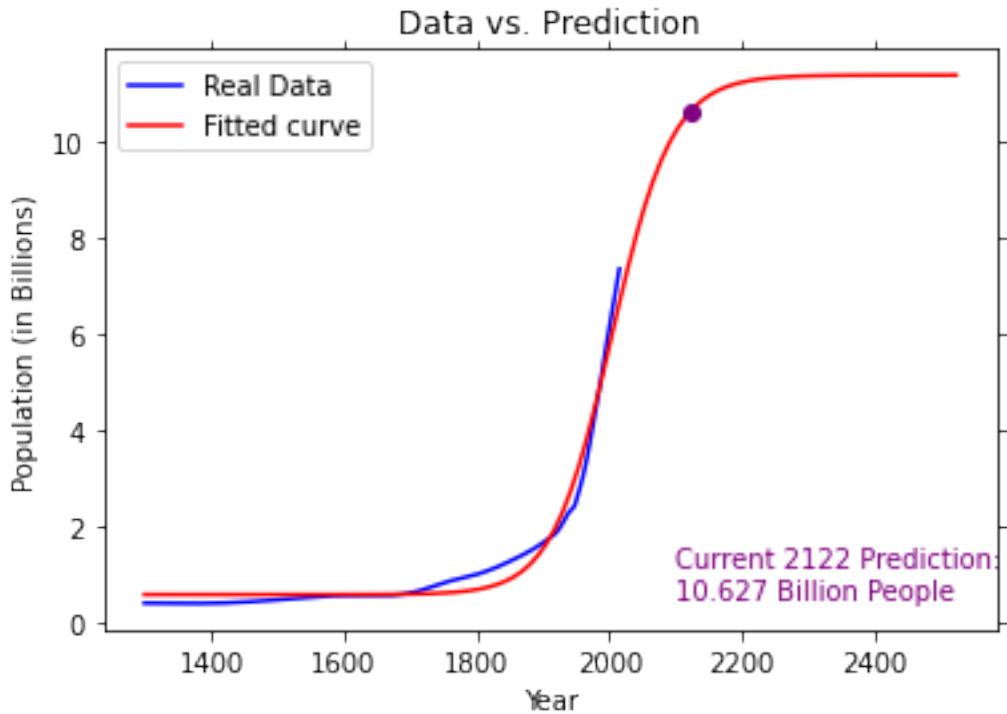
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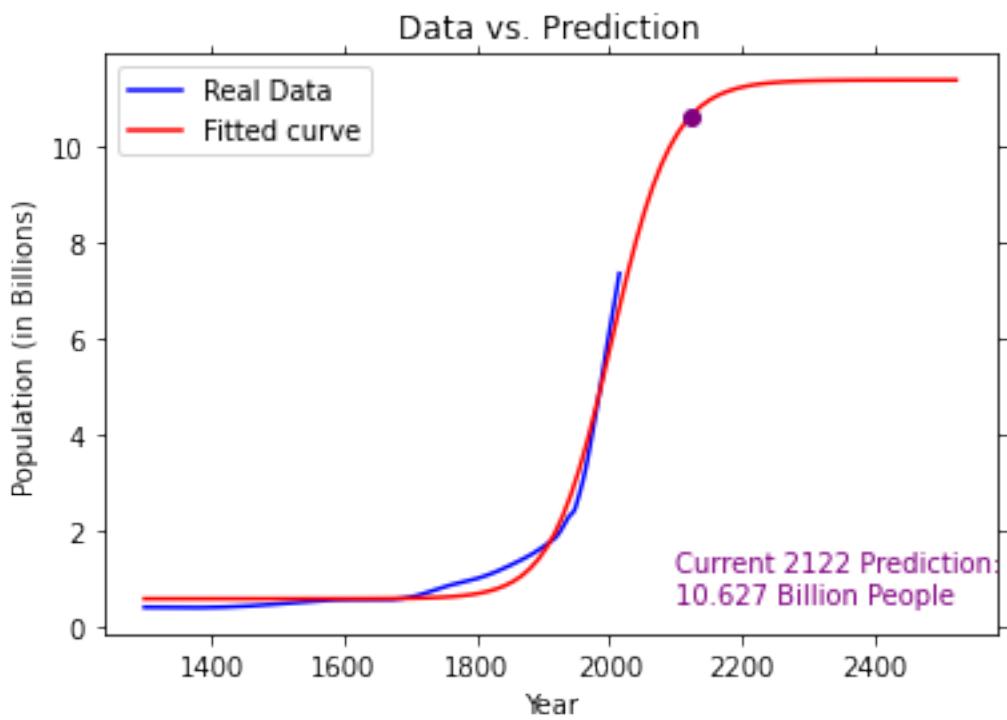
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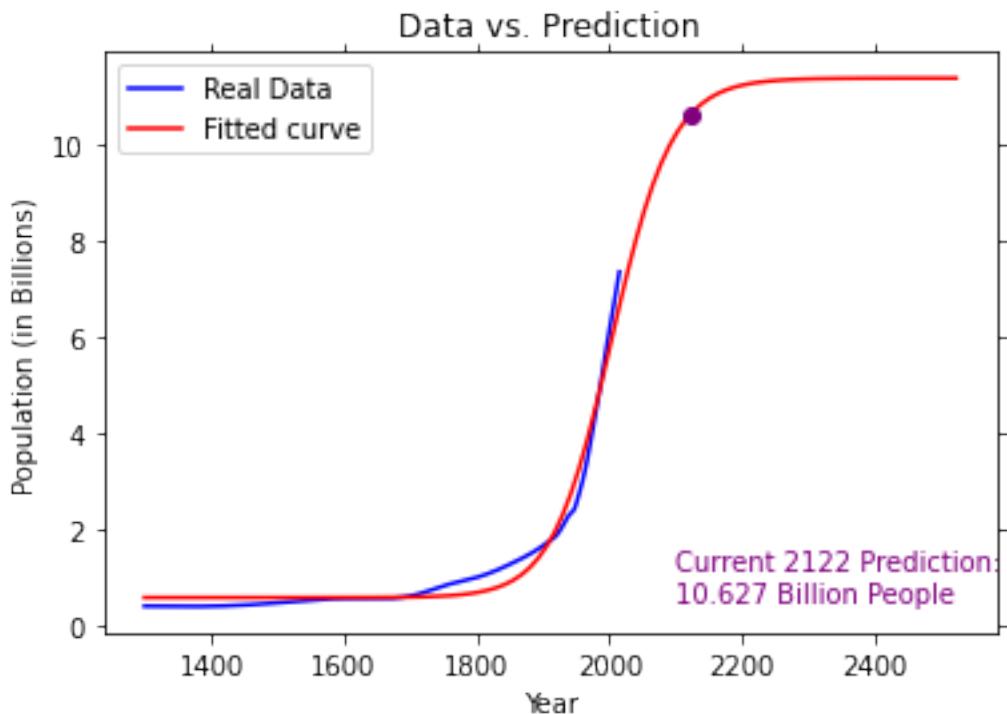
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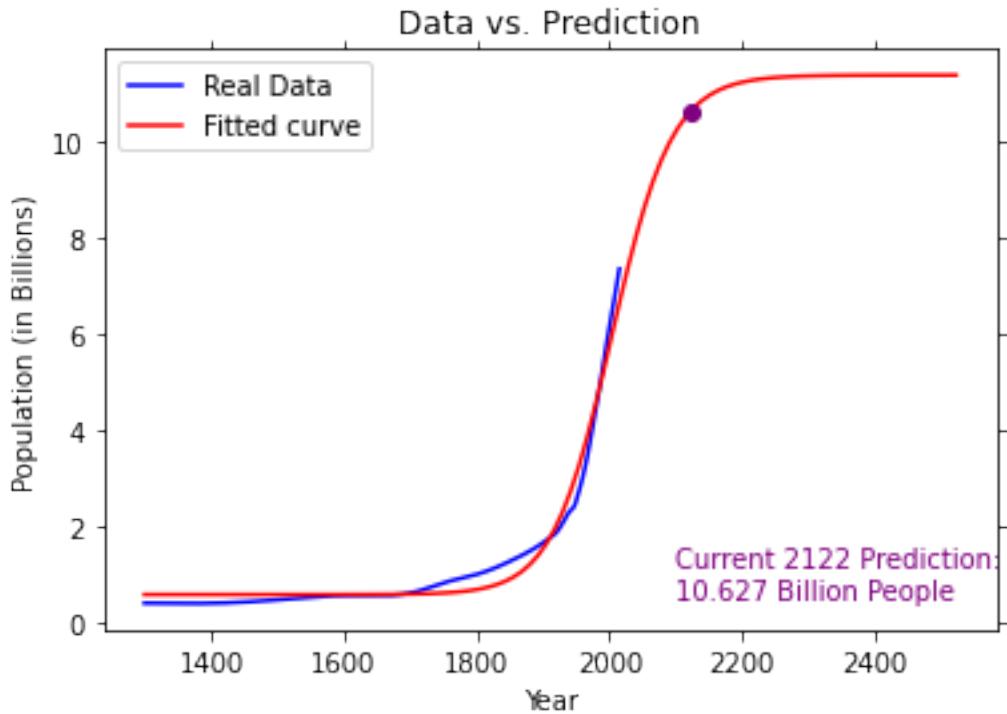
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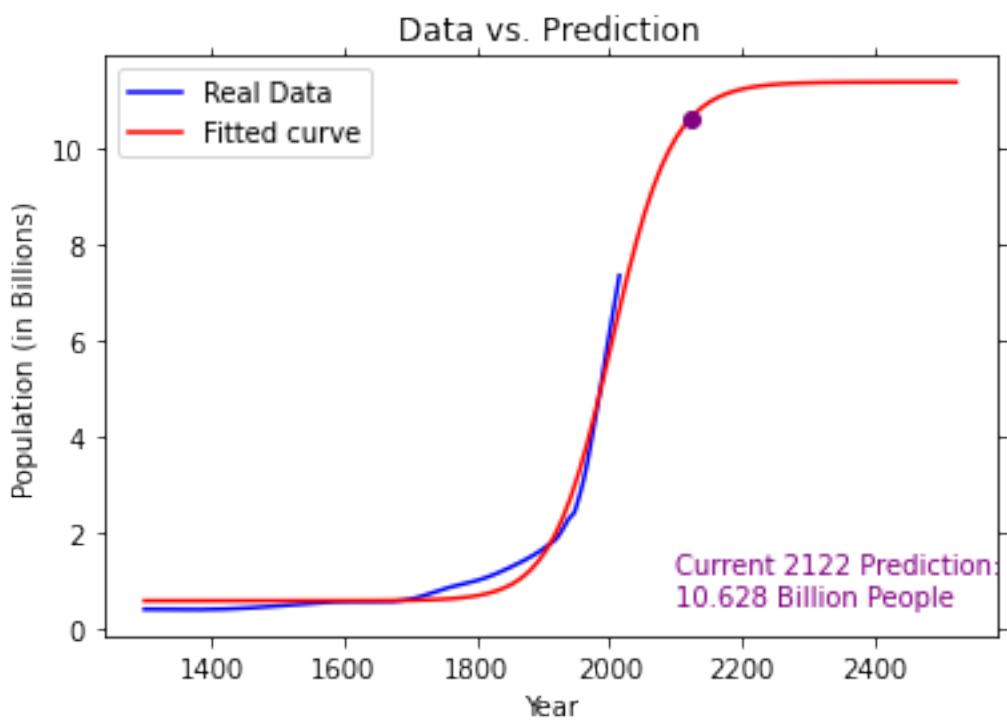
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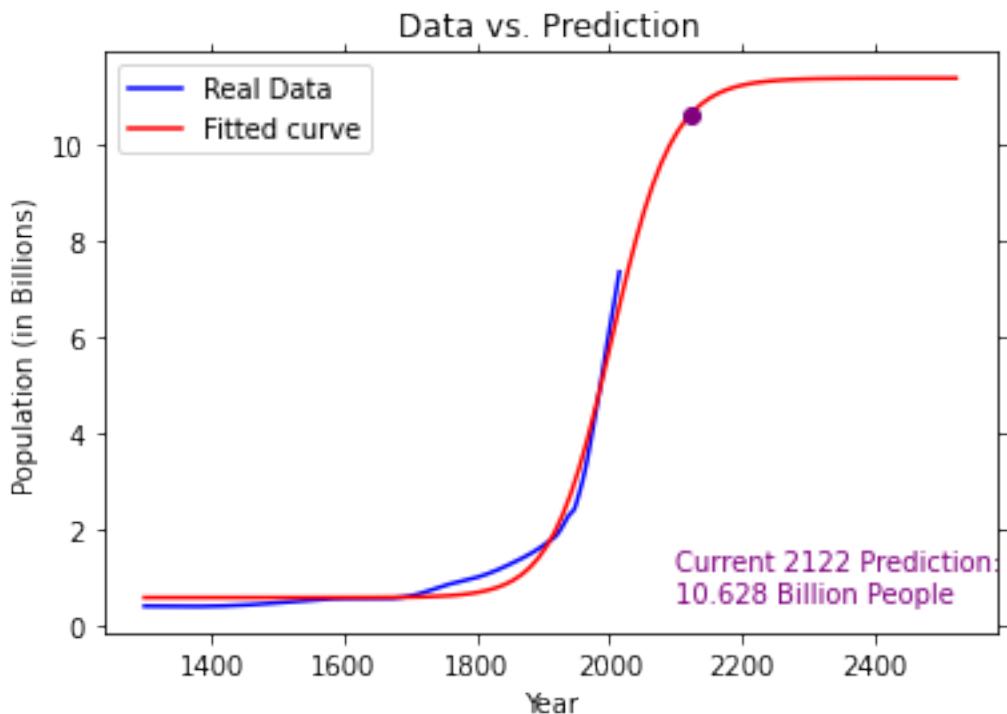
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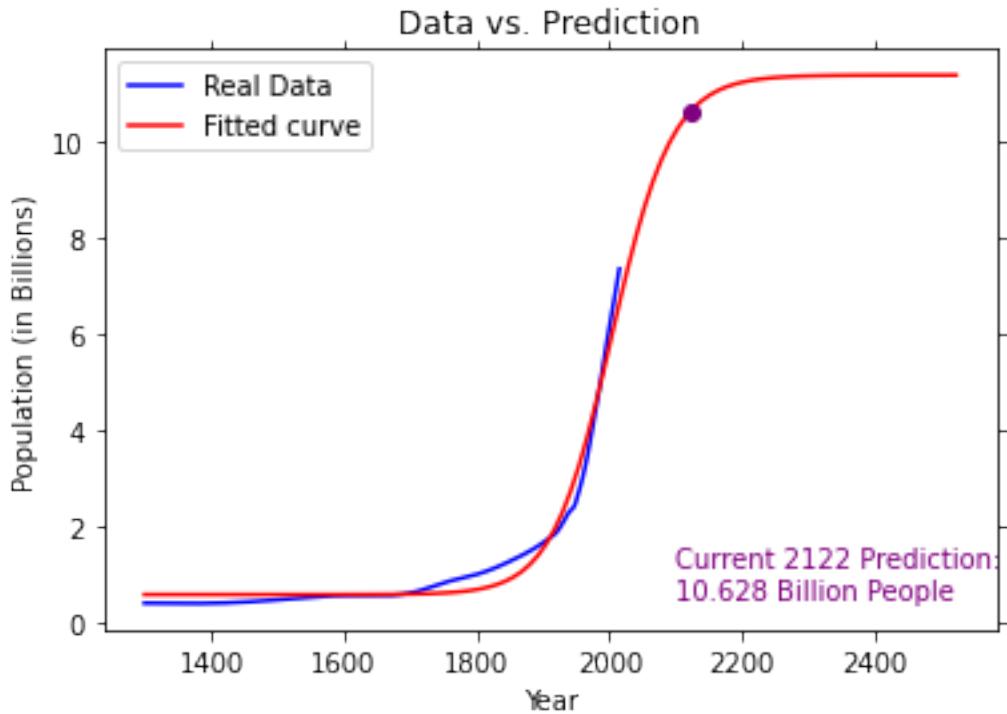
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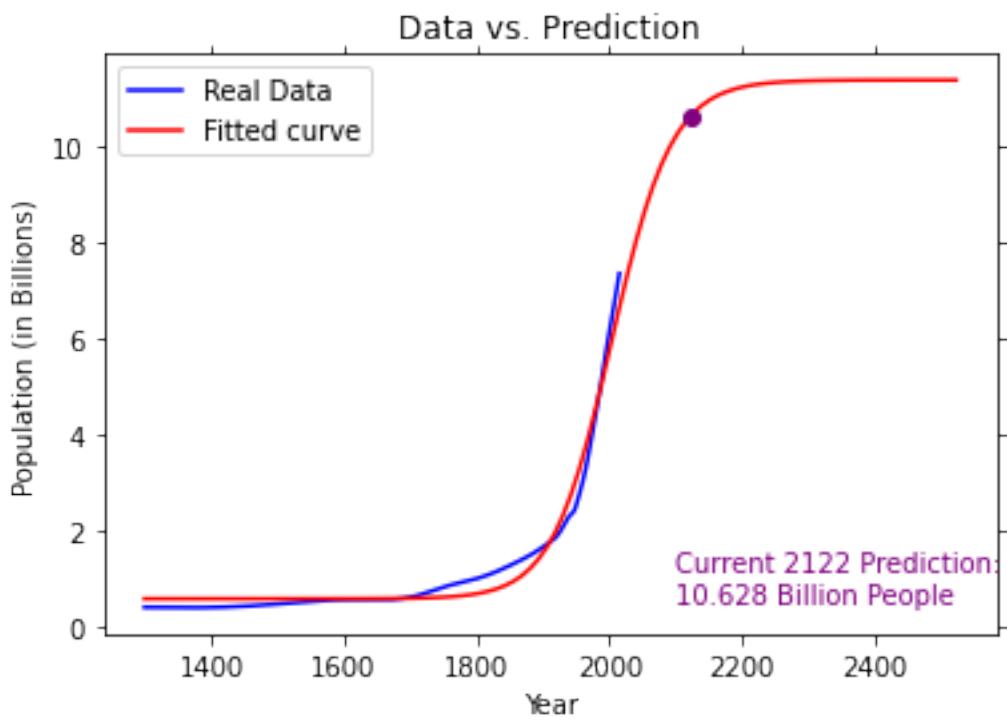
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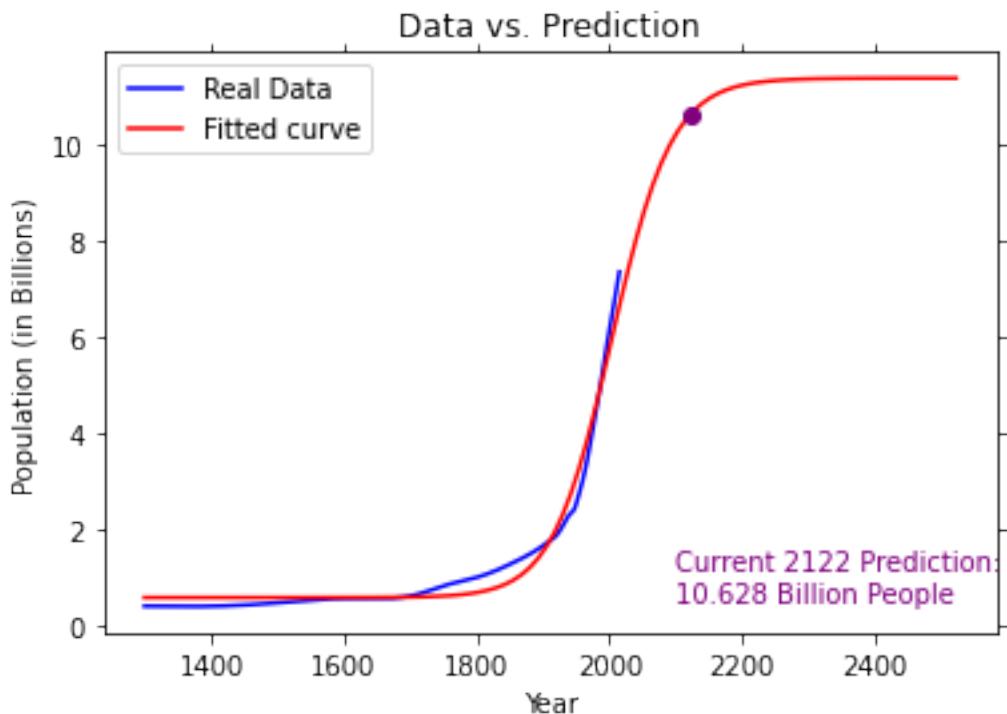
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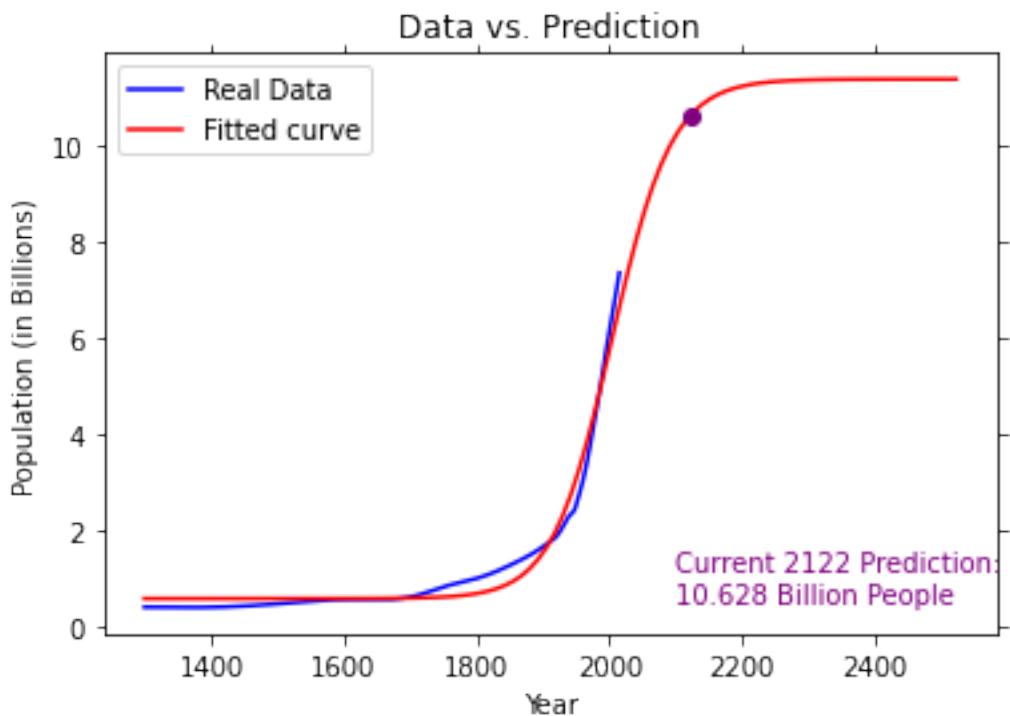
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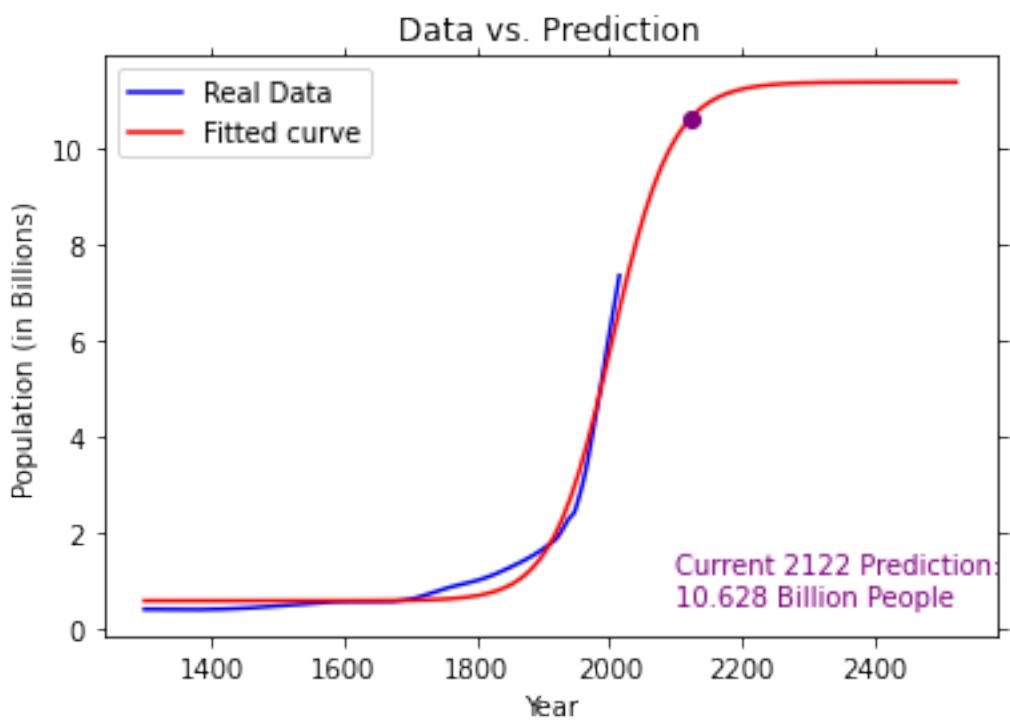
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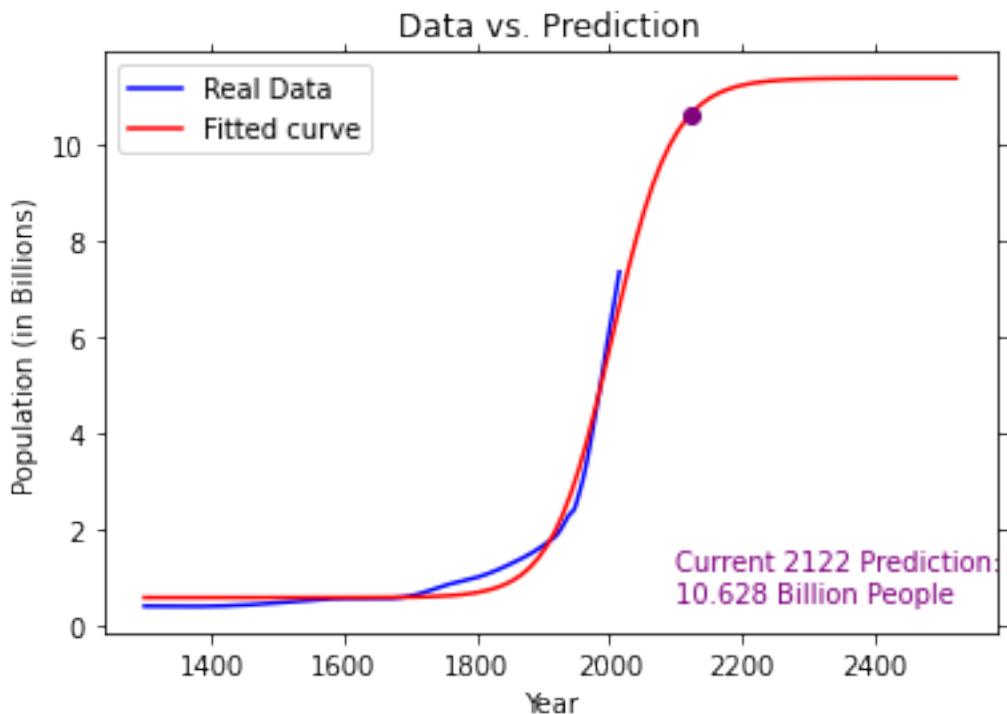
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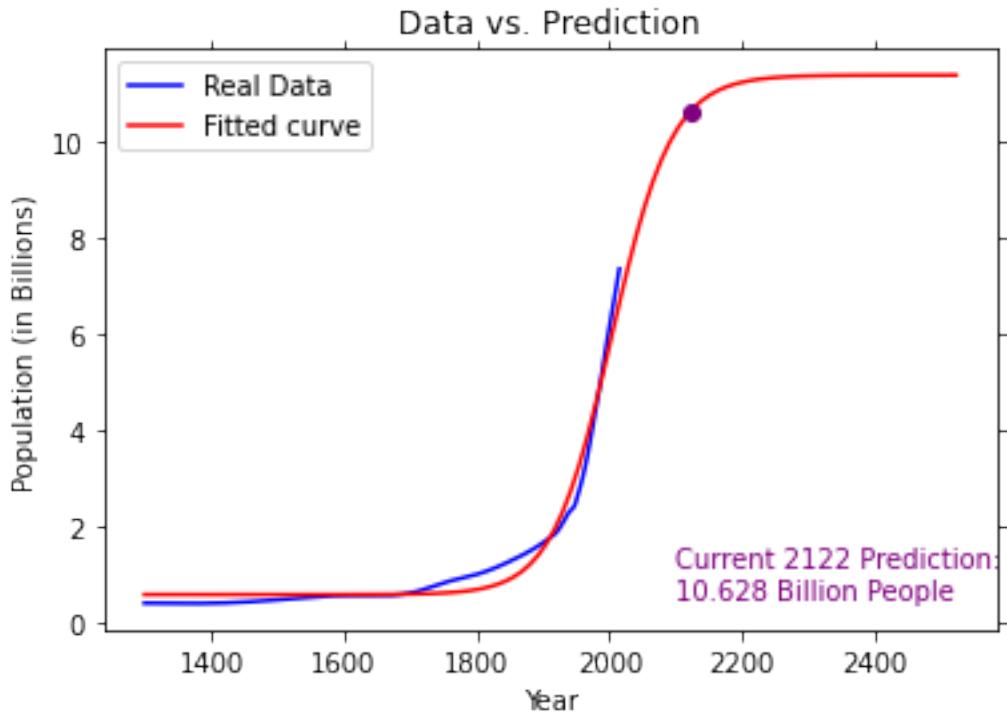
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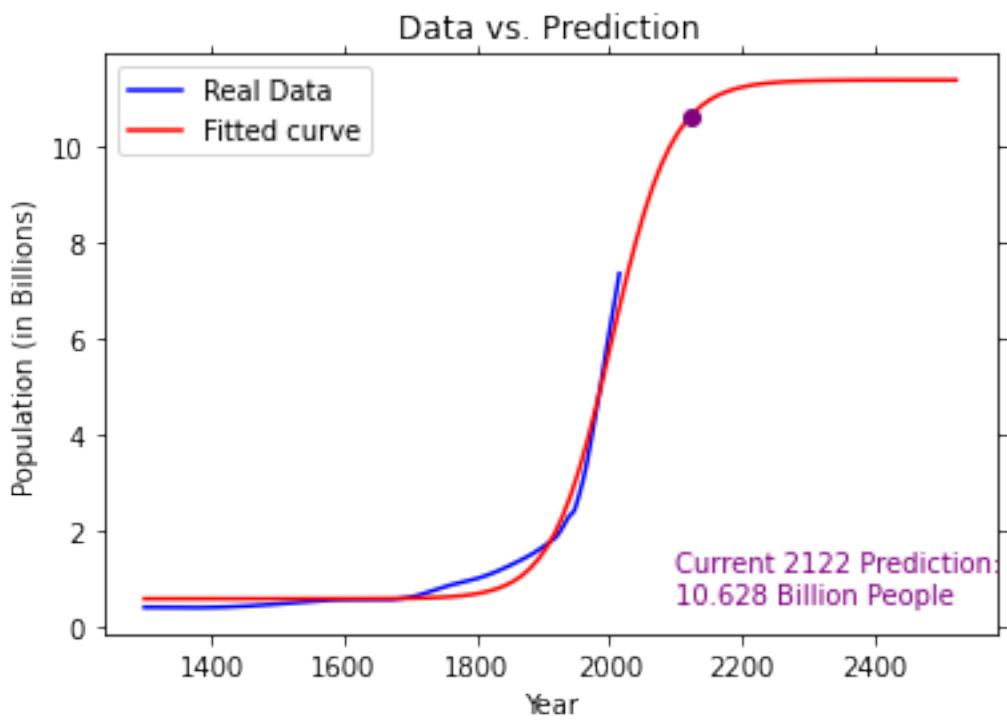
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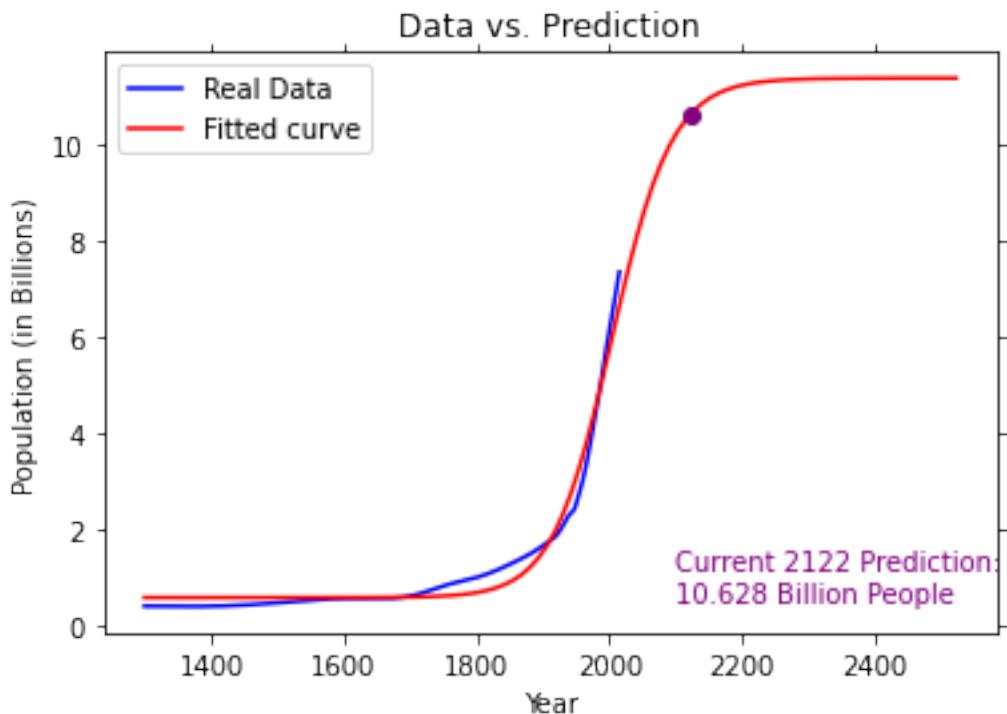
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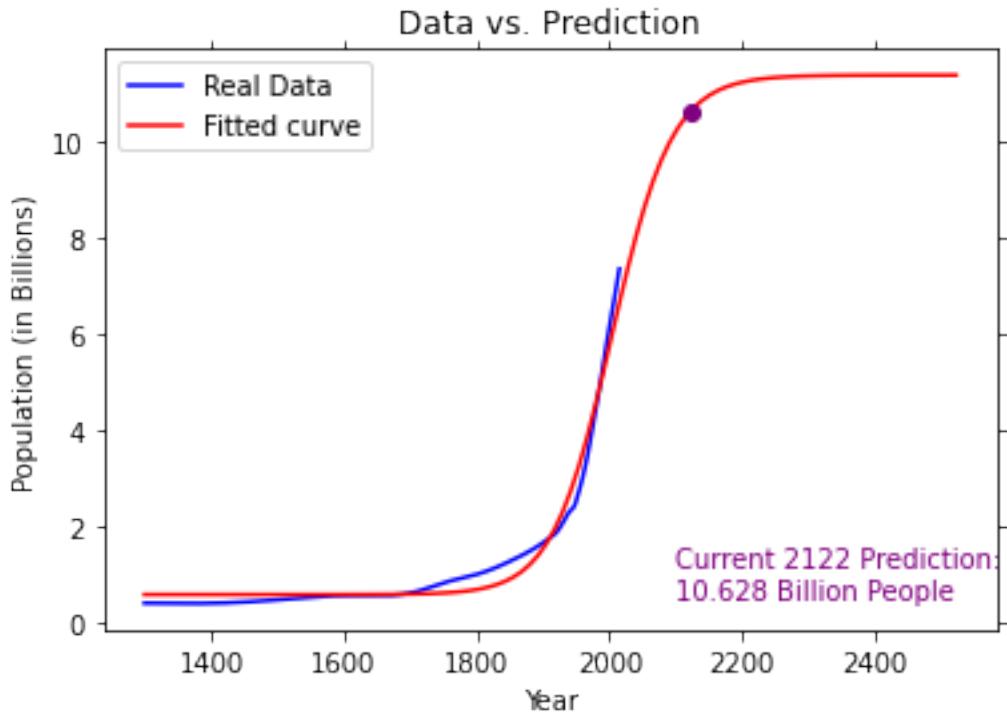
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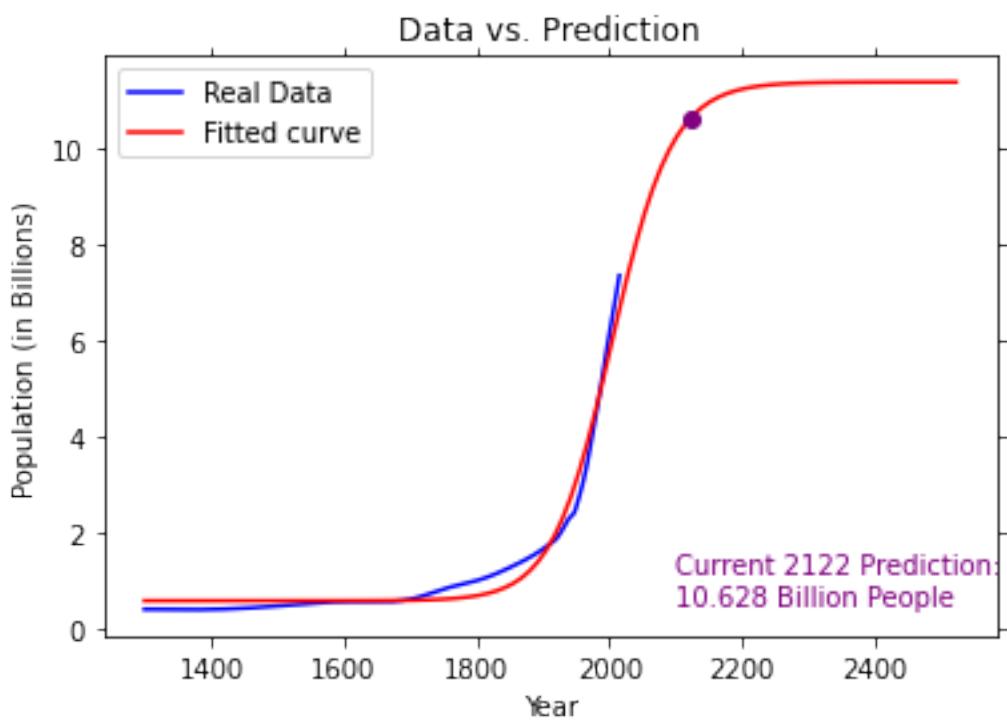
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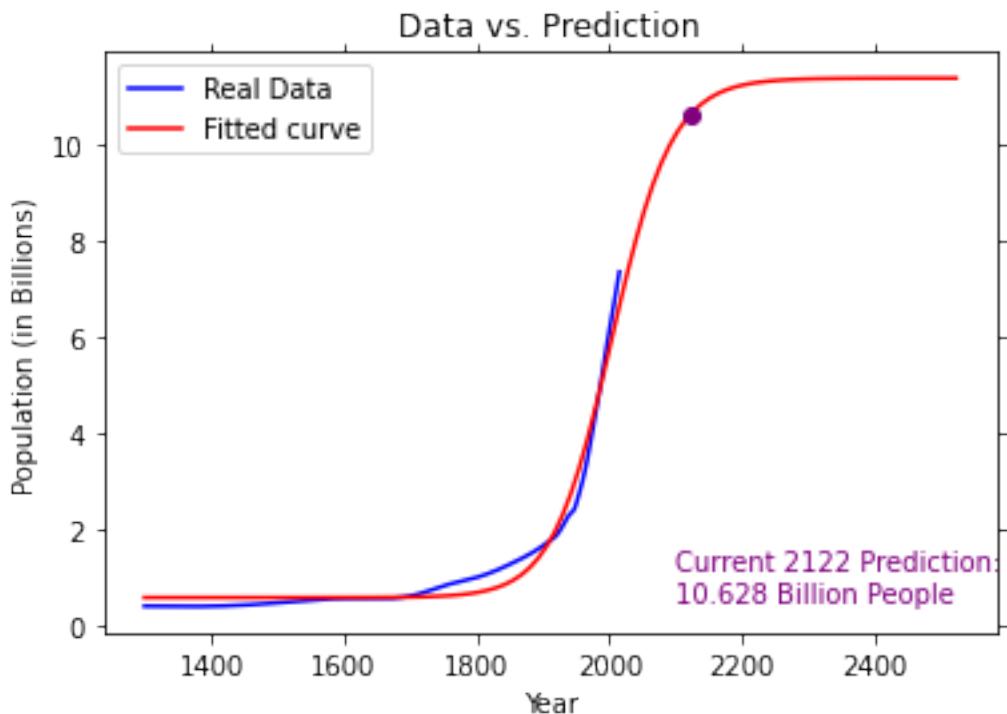
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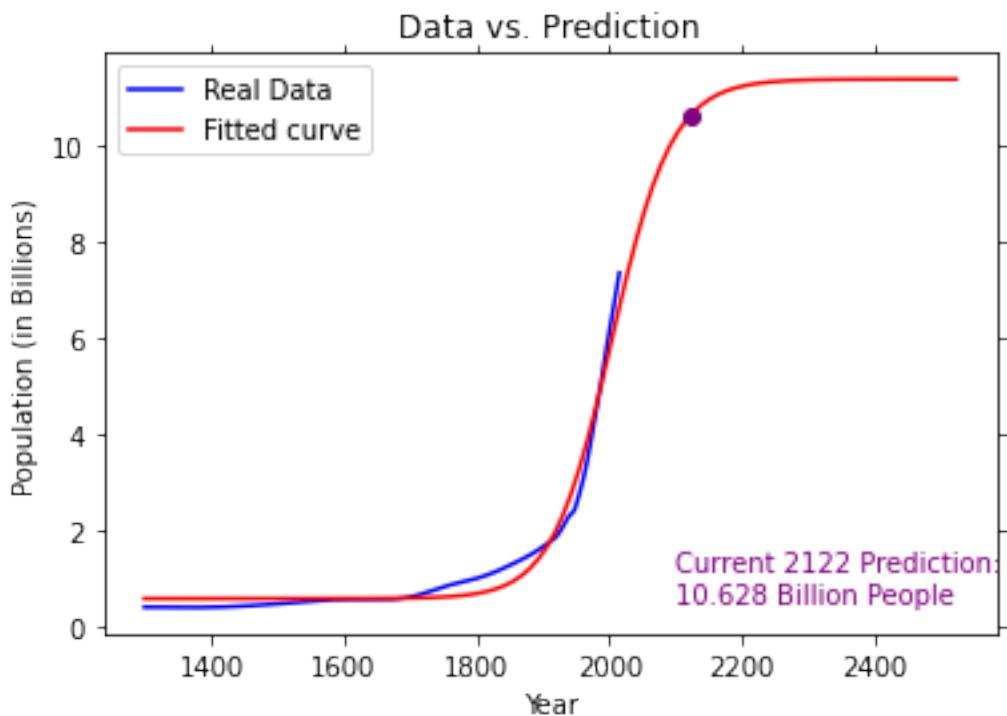
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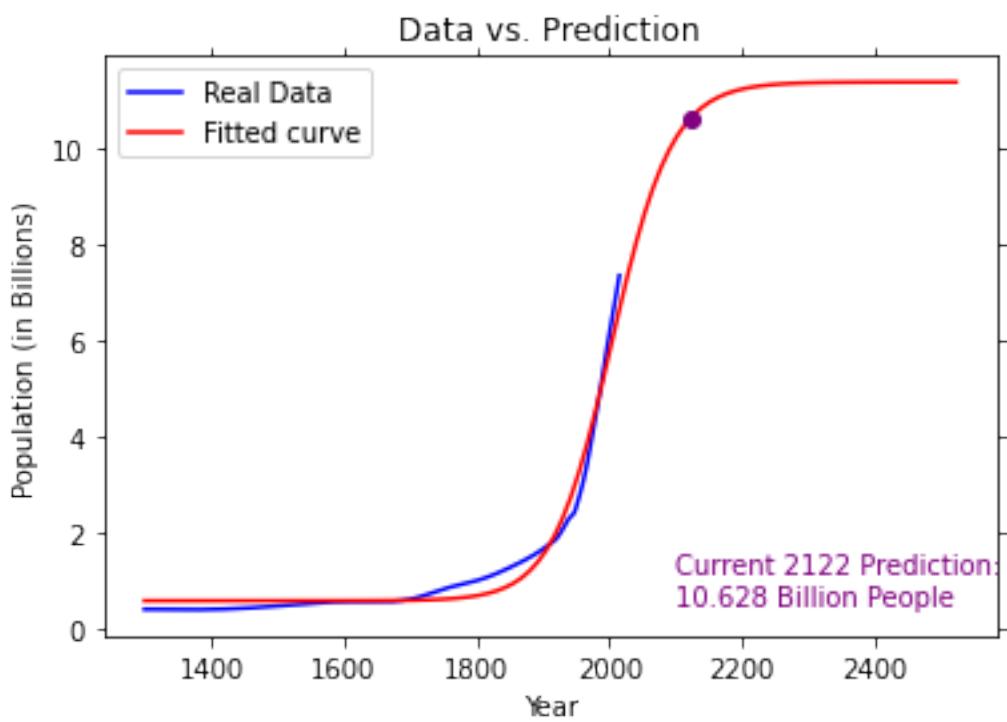
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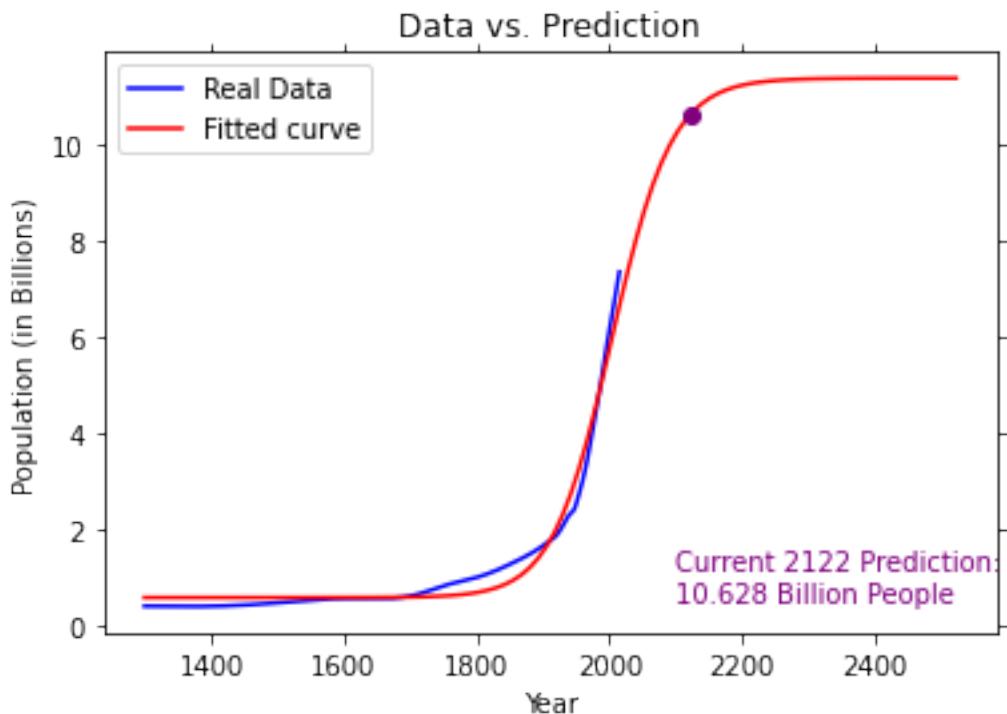
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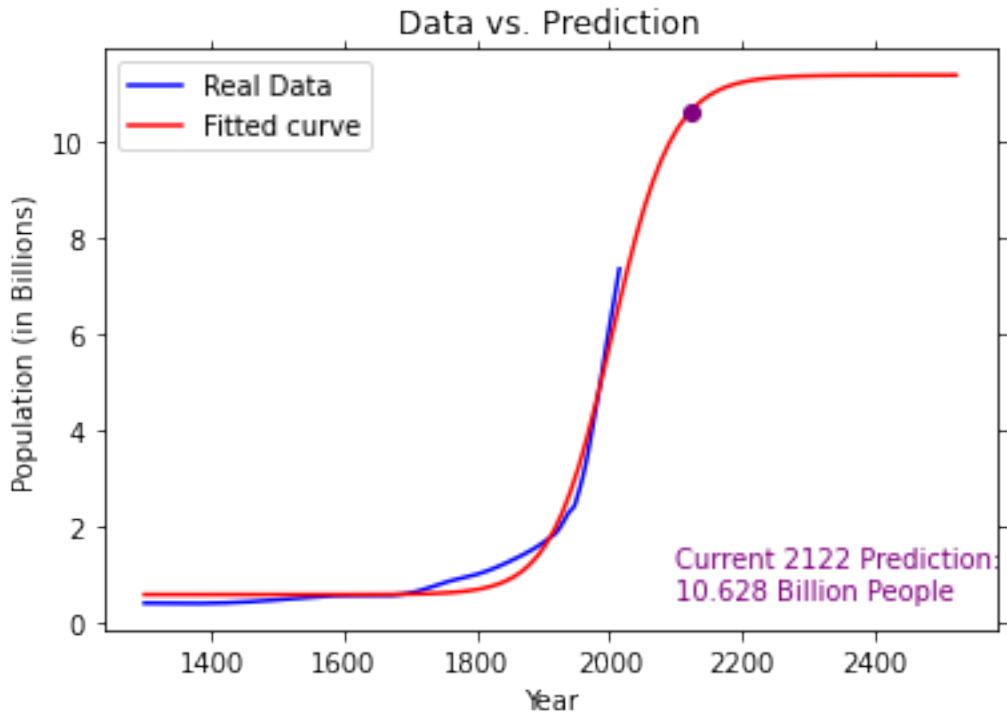
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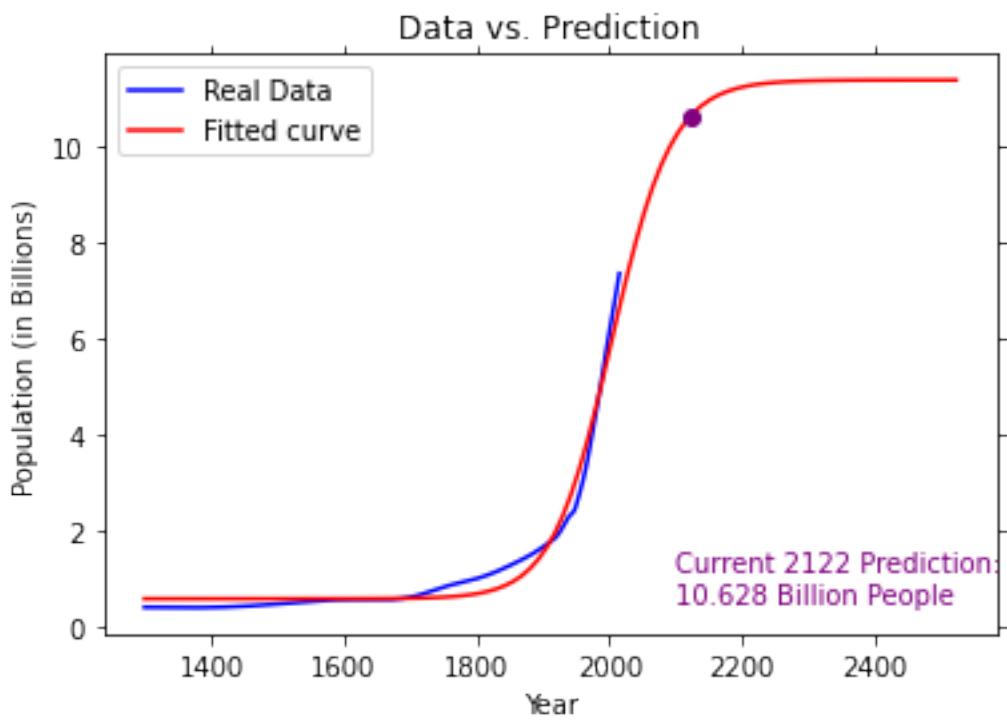
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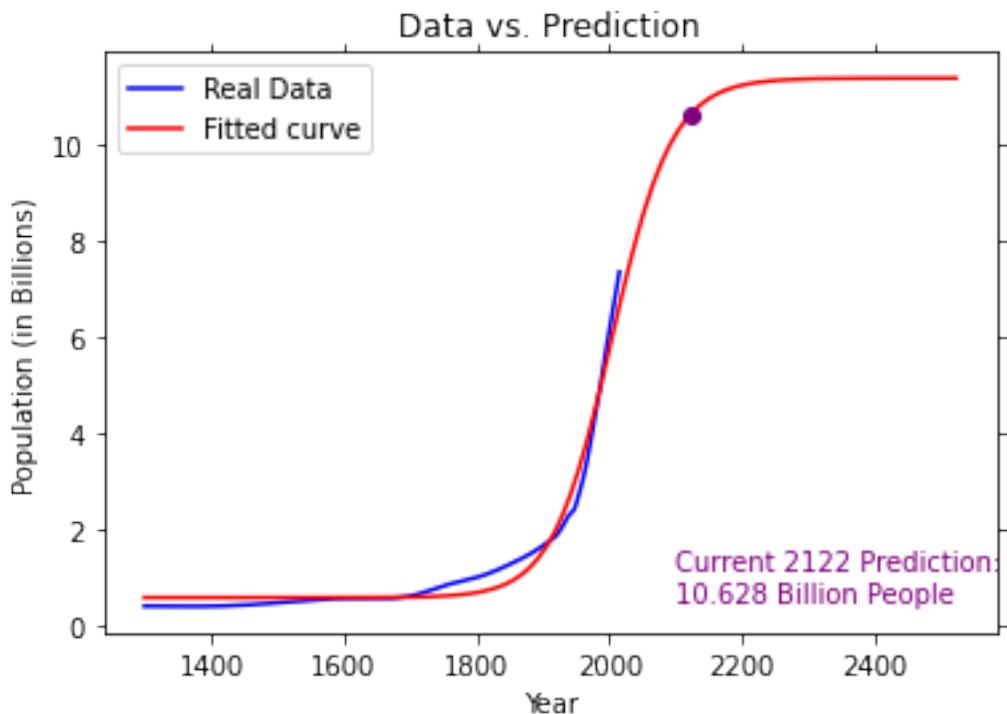
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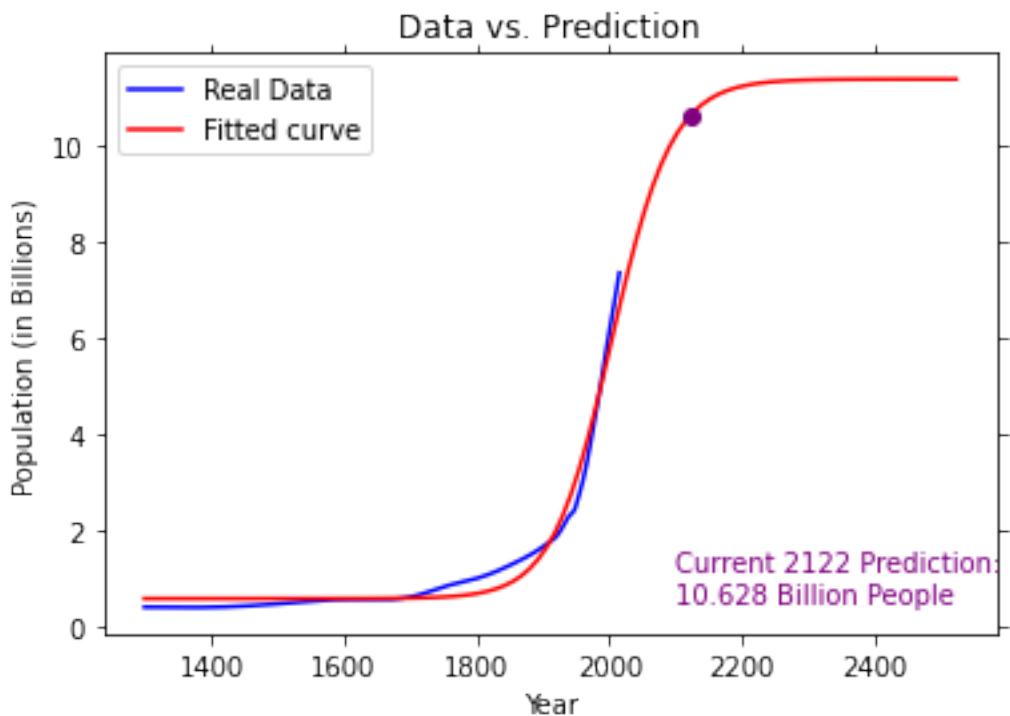
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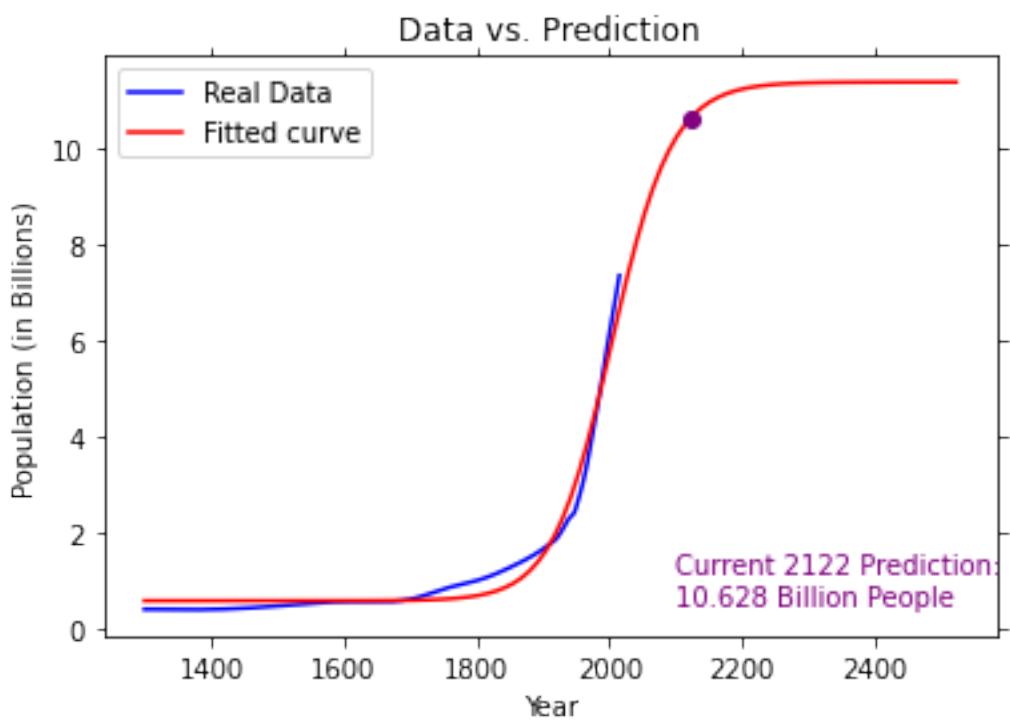
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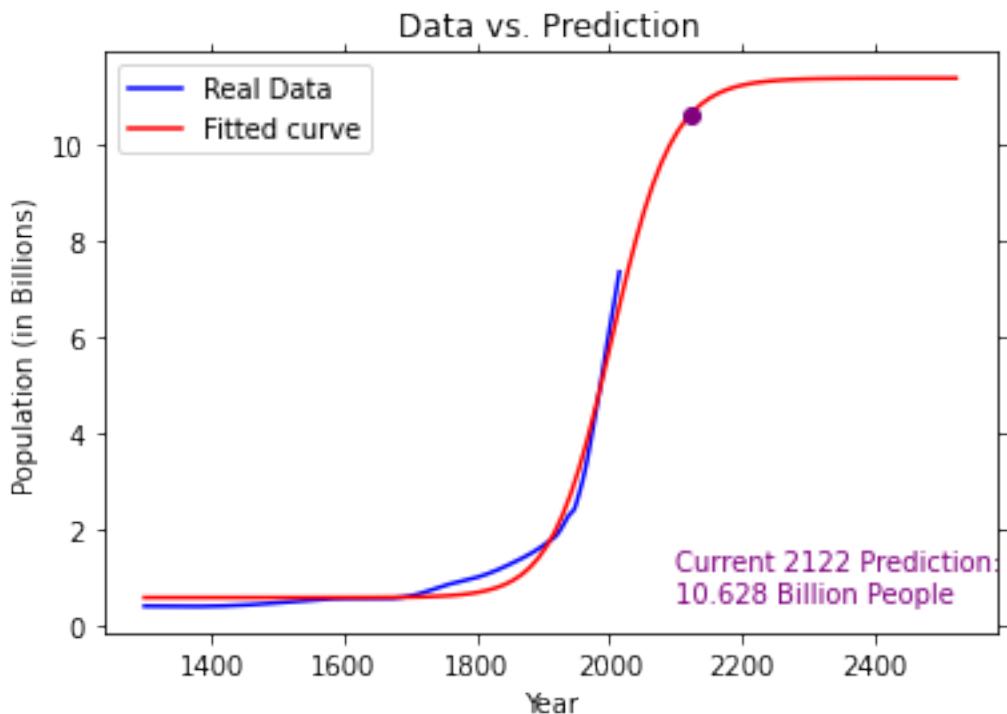
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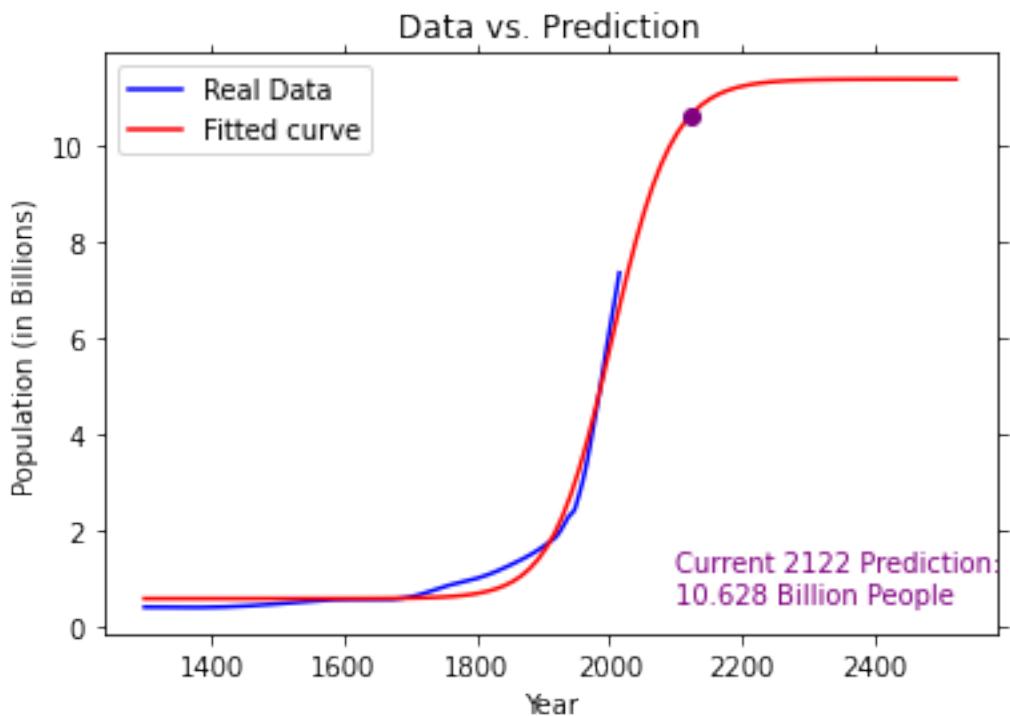
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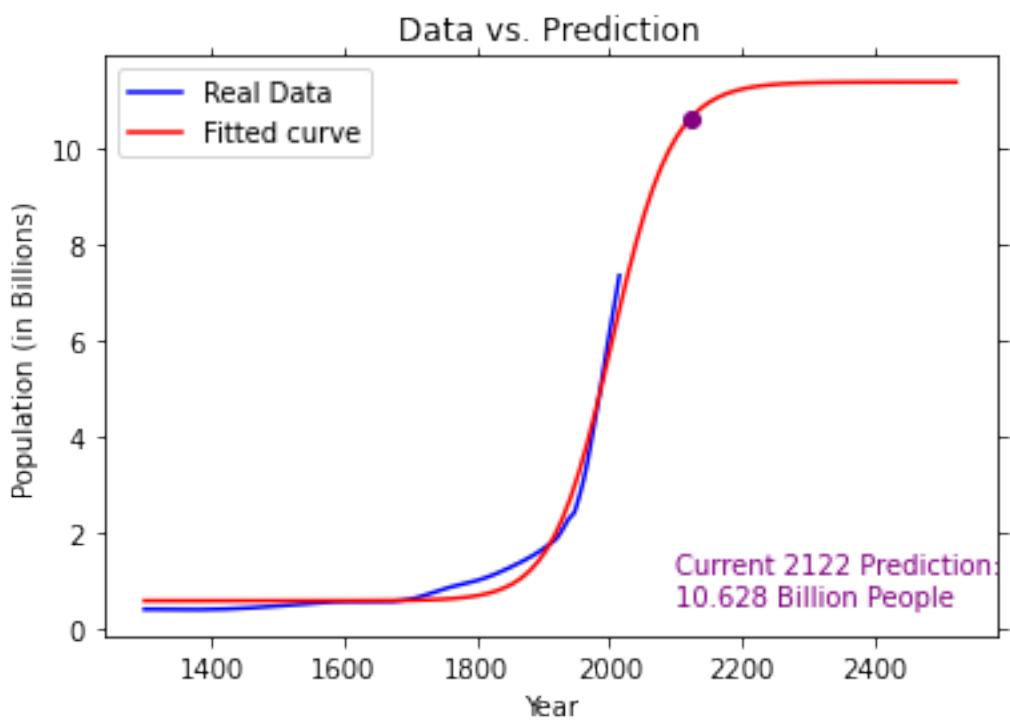
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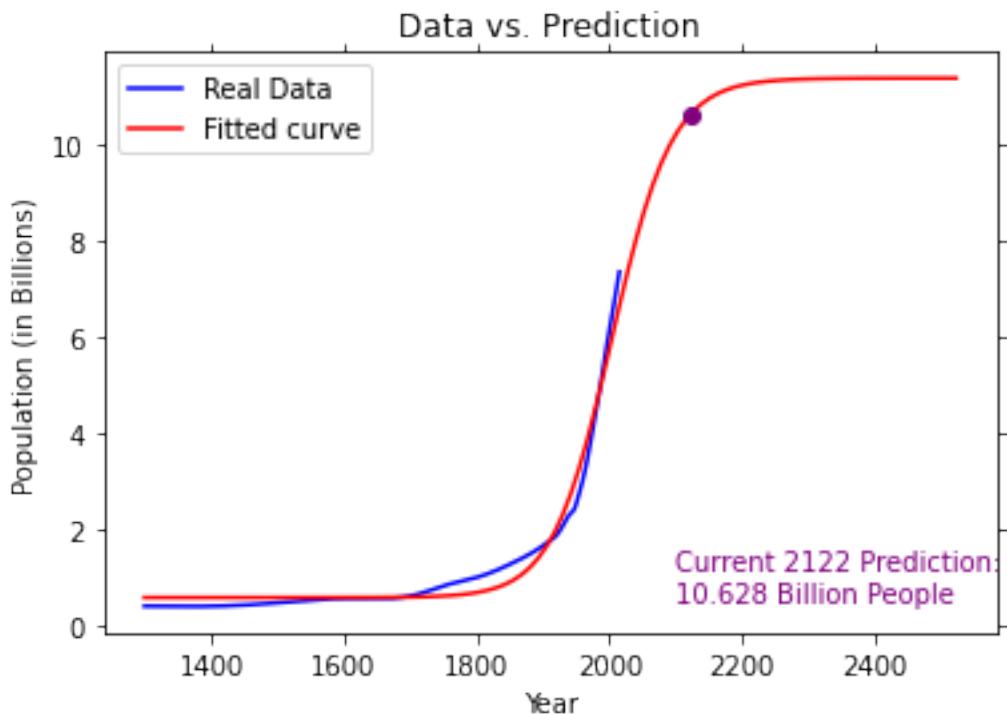
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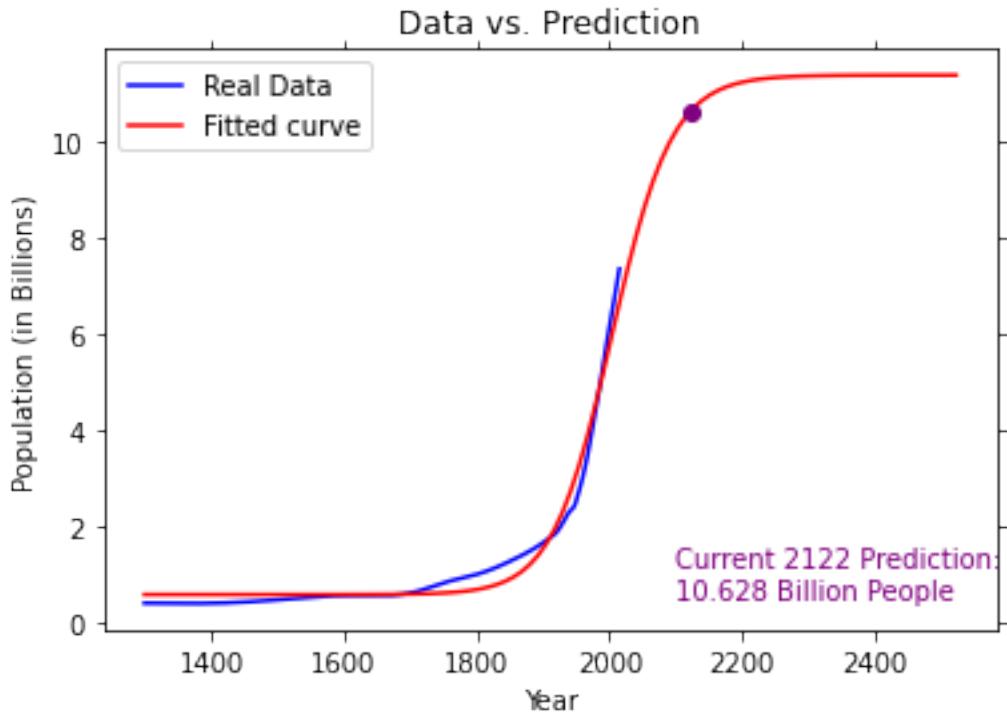
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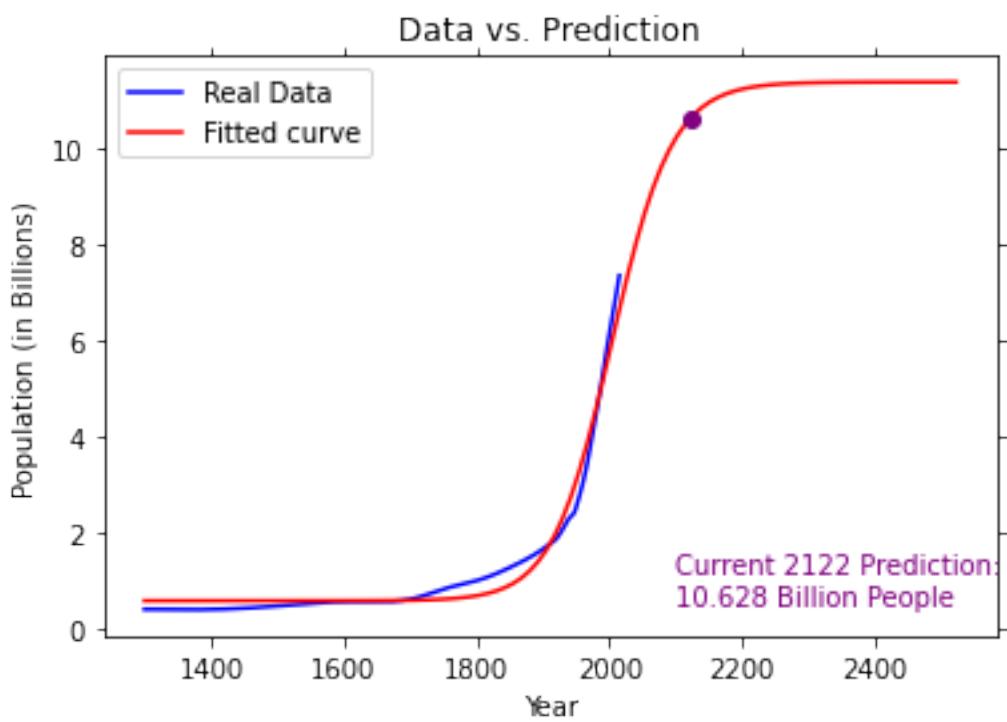
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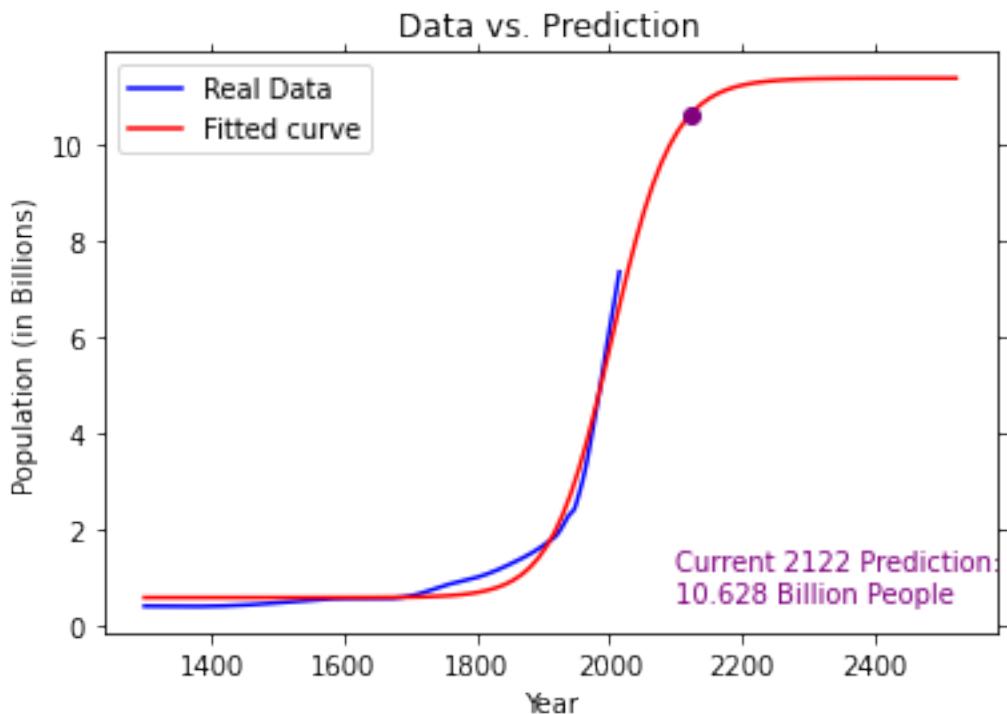
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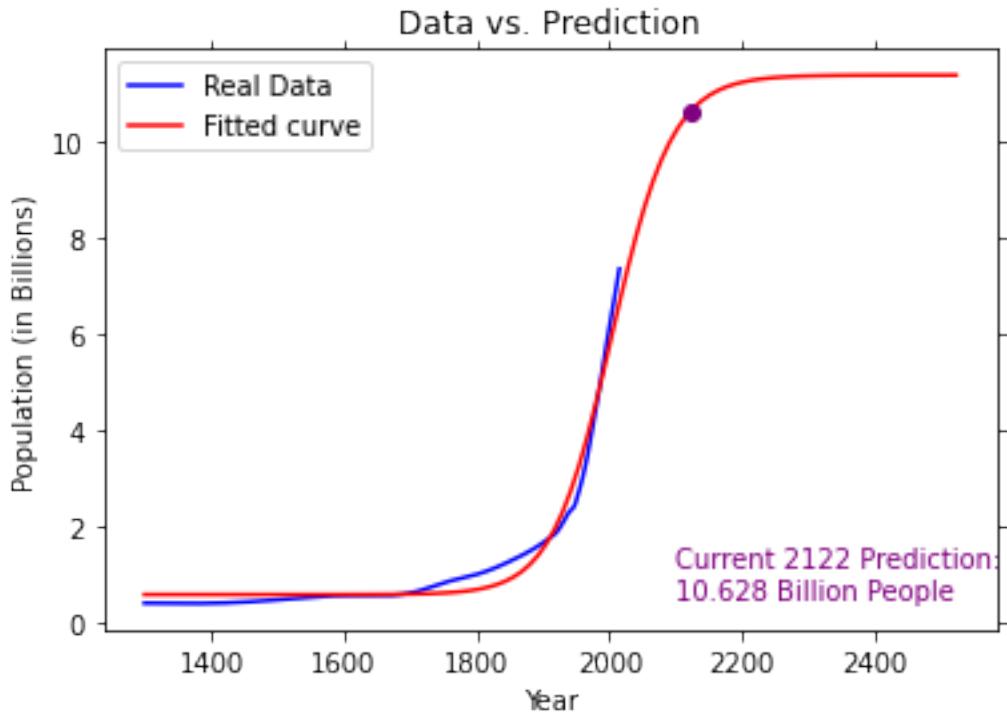
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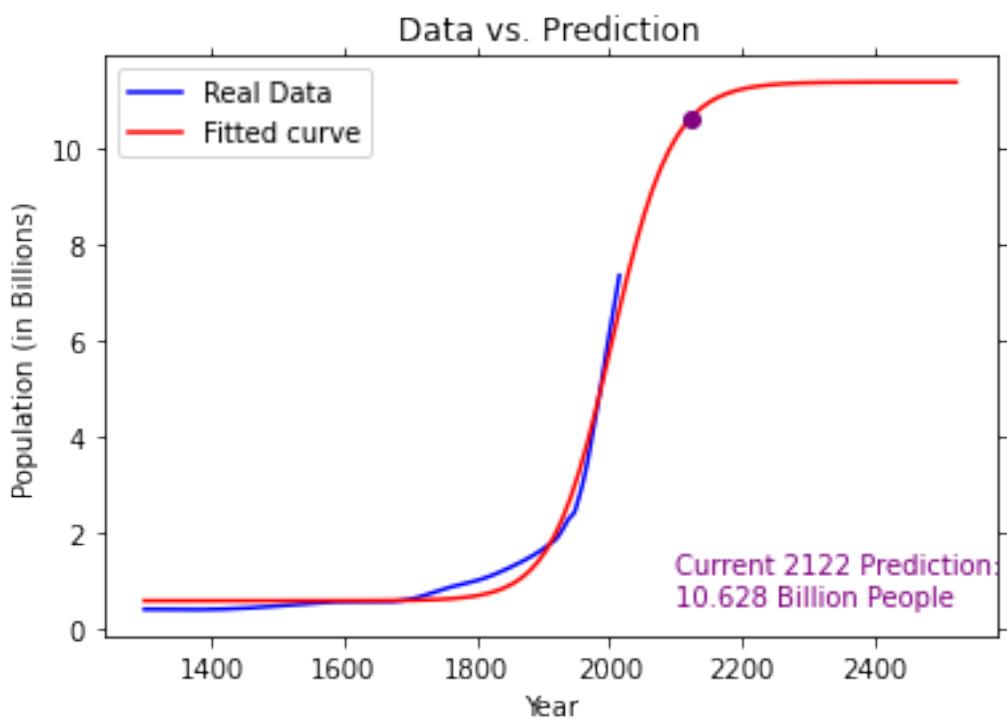
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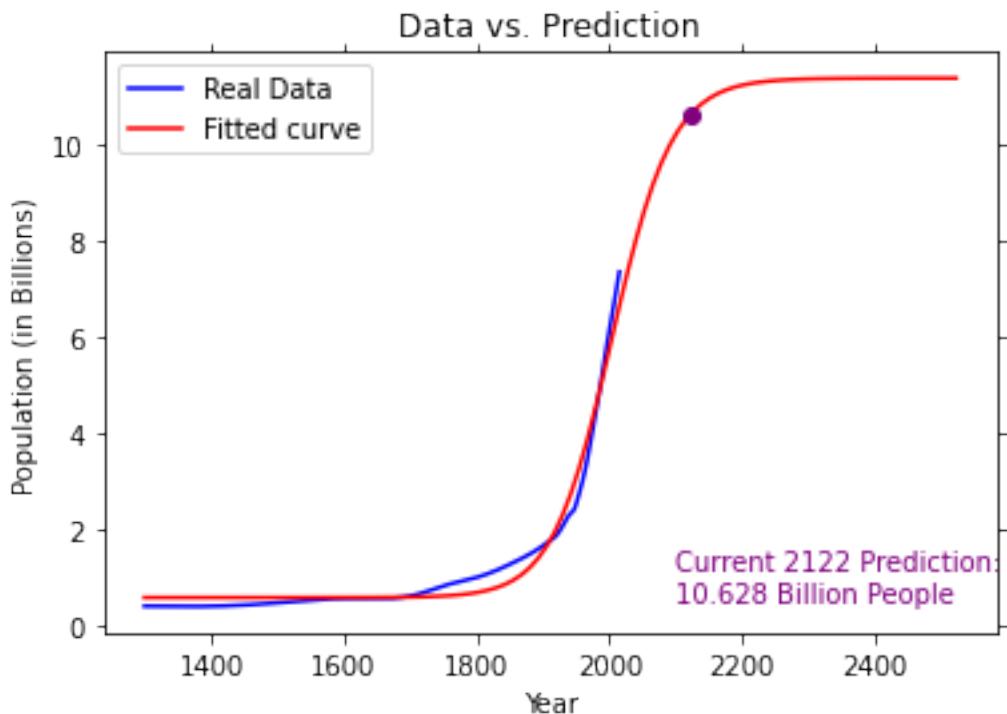
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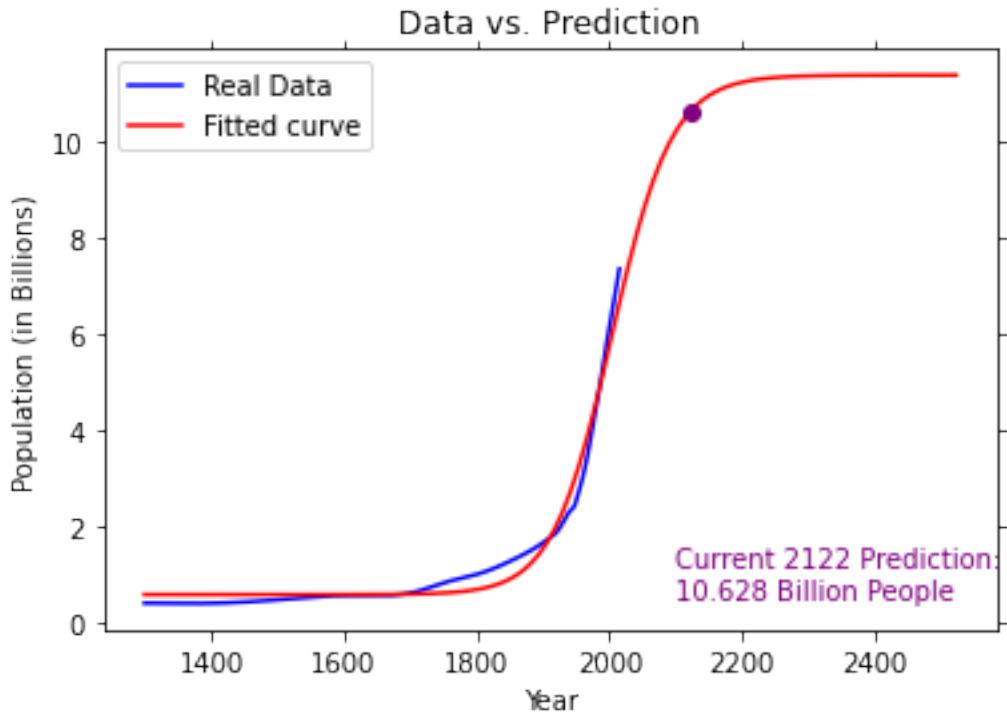
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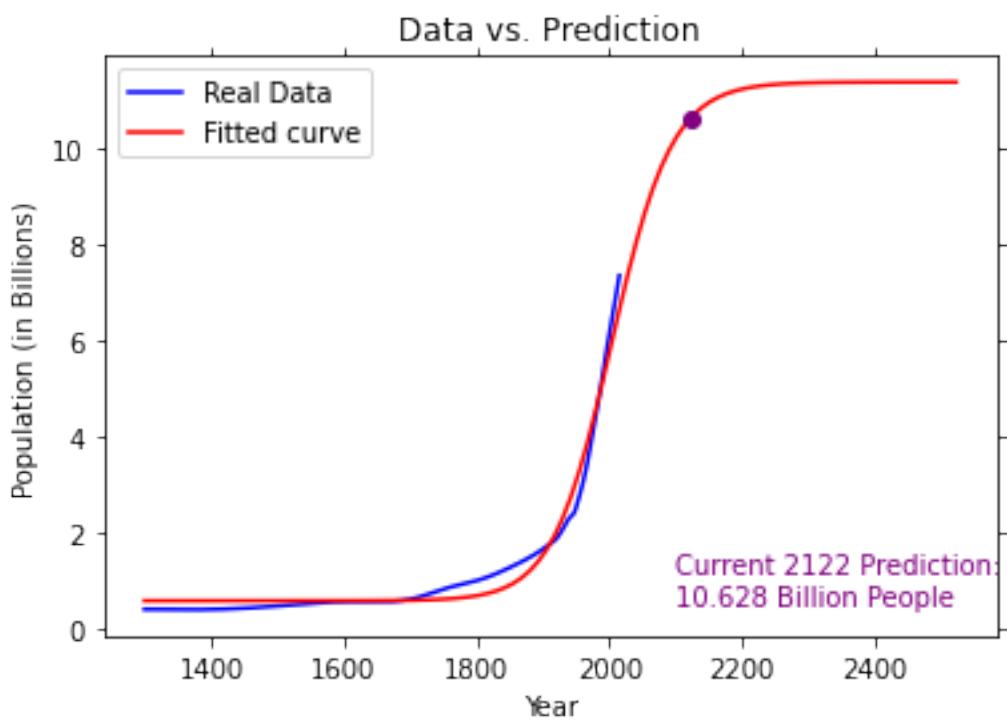
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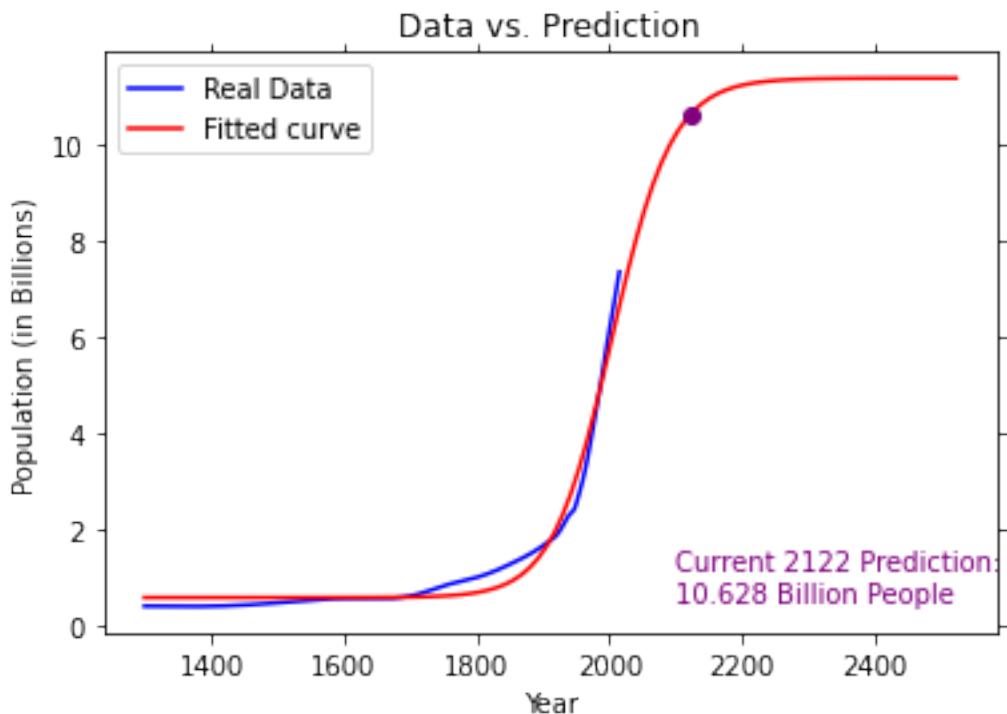
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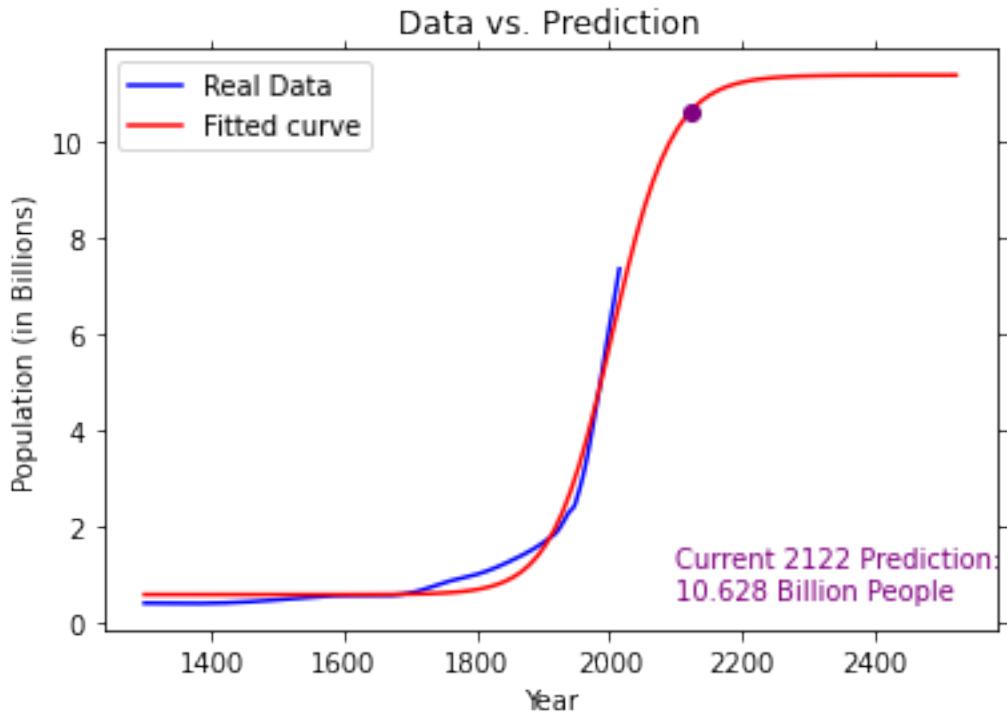
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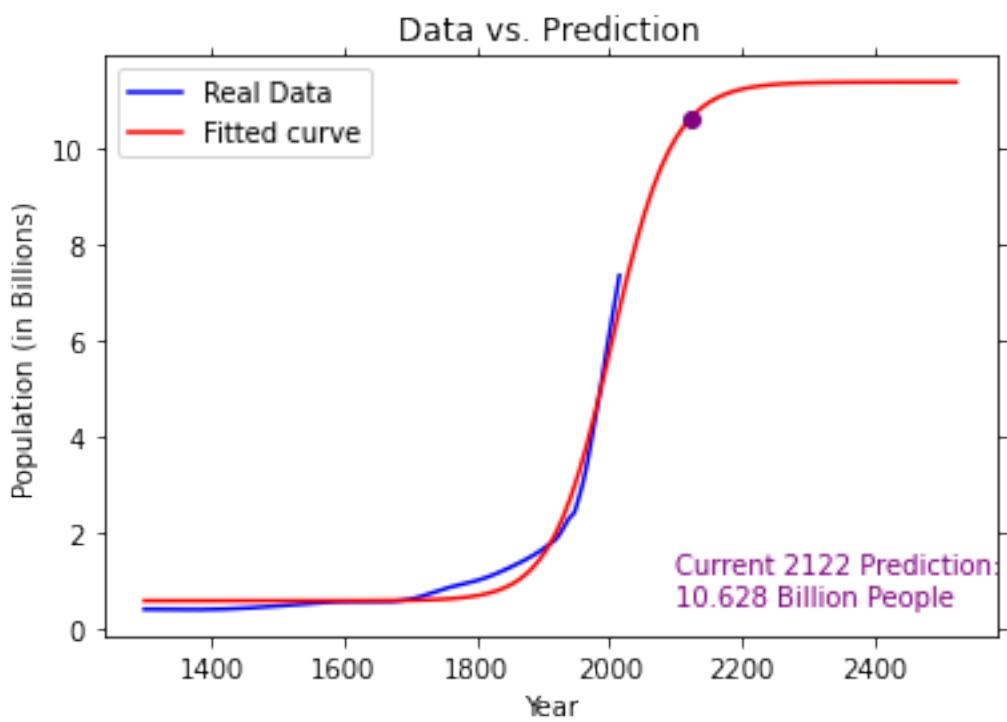
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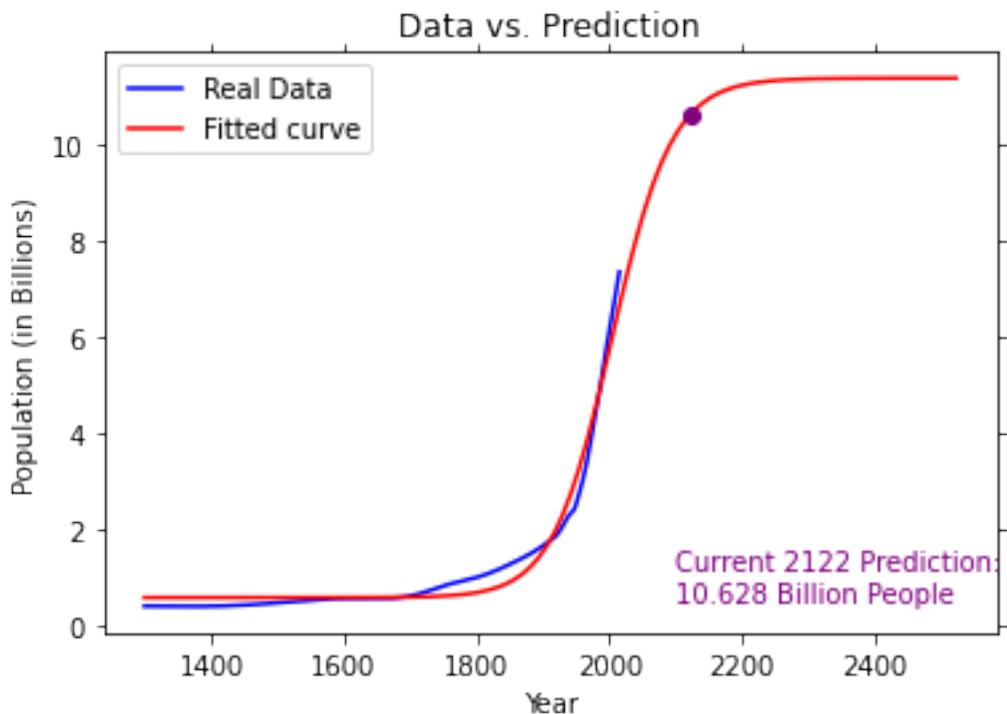
Iteration #49650, Loss: 0.050395418894163165



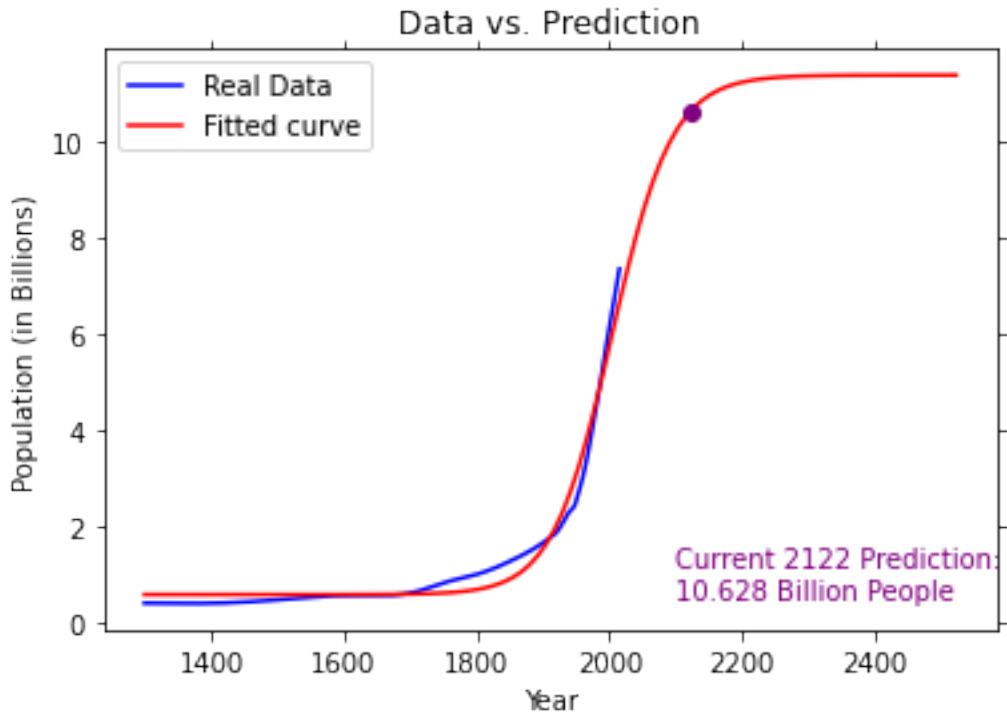
Iteration #49700, Loss: 0.050395318549718134



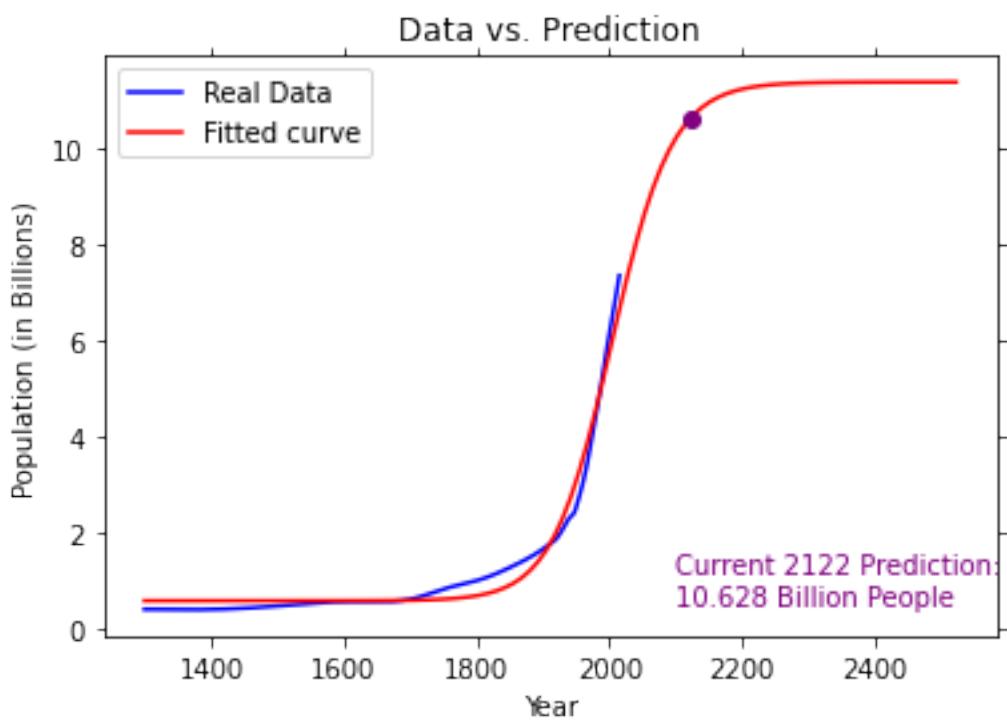
Iteration #49750, Loss: 0.050395233571907116



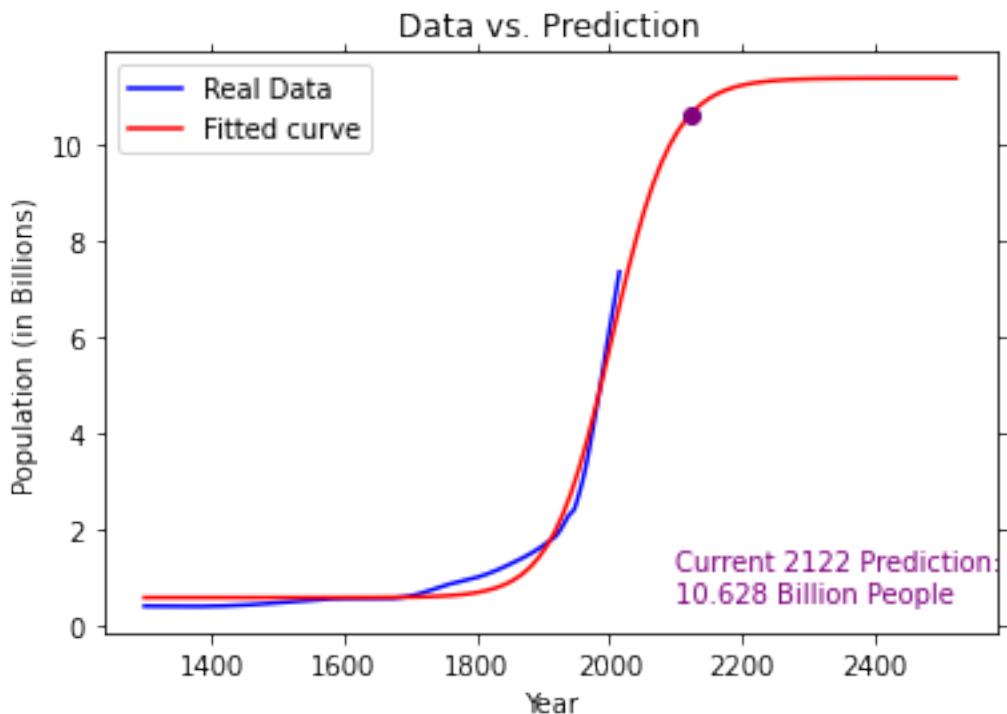
Iteration #49800, Loss: 0.05039516396075523



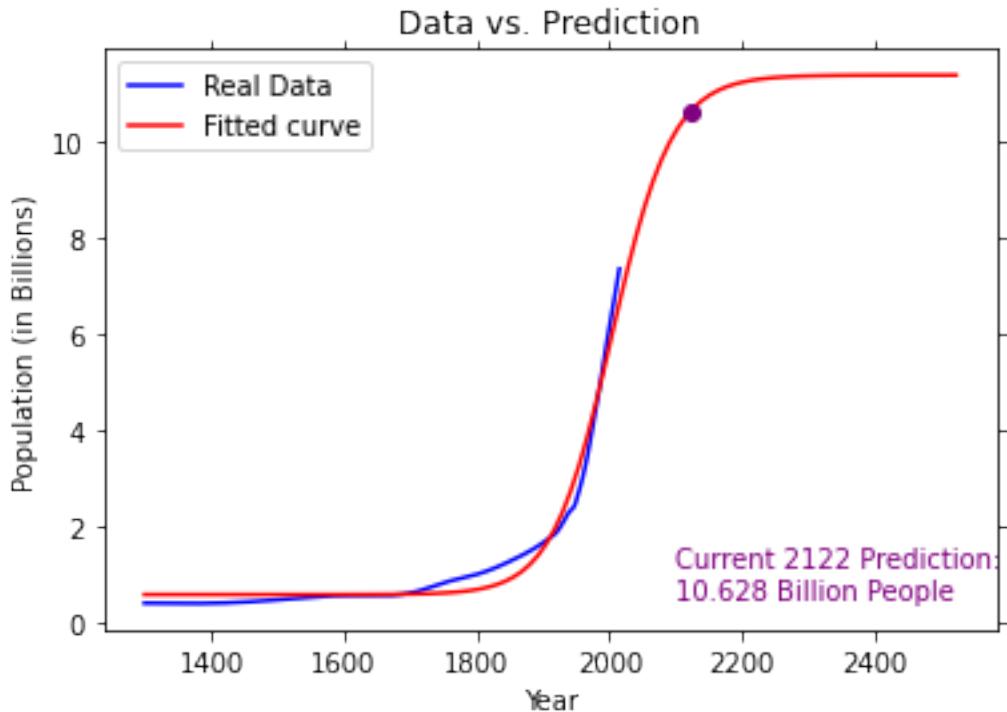
Iteration #49850, Loss: 0.05039510971628225



Iteration #49900, Loss: 0.050395070838504



Iteration #49950, Loss: 0.05039504732743204



Now let's get the parameters of the model when the model is done training

```
[12]: # Get the parameters of the model to save them
c1, c2, c3, c4, c5, c6, c7, c8 = m.getParams()
print(f"Parameters: c1={c1}, c2={c2}, c3={c3}, c4={c4}, c5={c5}, c6={c6}, c7={c7}, c8={c8}")
```

Parameters: c1=10.654135216823821, c2=0.9864140912245566, c3=1.0385540355655845, c4=1.9698143047910193, c5=1.104389410774113, c6=-22.060388036261674, c7=1.0657278995848072, c8=0.5712219176728186

Finally, we will make a prediction for 2122

```
[13]: # Make the prediction
print(f"Model prediction for 2122: {m(torch.tensor(21.22))} billion people")
```

Model prediction for 2122: 10.62781082708388 billion people

[]: