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clear

NOTE:

The way we plot is by selecting parsed data 1 by 1 and just hitting run. This helps us adjust the parameters between different sets of data for testing purposes. We can also use this to isolate different segments and plot individually. This design choice for code was purposeful

```
coviddata = load("COVIDdata.mat"); % TO SPECIFY
% The following line creates an 'anonymous' function that will return the cost
% (i.e., the model fitting error) given a set
% of parameters. There are some technical reasons for setting this up in this
% way.
% Feel free to peruse the MATLAB help at
% https://www.mathworks.com/help/optim/ug/fmincon.html
% and see the section on 'passing extra arguments'
% Basically, 'sirafun' is being set as the function siroutput (which you
% will be designing) but with t and coviddata specified.
pop = coviddata.STLmetroPop*1e5;
t = length(coviddata.COVID_STLmetro.cases); % TO SPECIFY
% t = 318 for mask mandate
coviddata = coviddata.COVID_STLmetro;
```

Data parsing to fit for different waves

```
coviddata2 = coviddata(1:134,:); % 07-18-2020
coviddata3 = coviddata(134:237,:); %10-29-2020
coviddata4 = coviddata(237:318,:); %01 - 18-2021
coviddata5 = coviddata(318:508,:);%07-27-2021
coviddata6 = coviddata(508:655,:);%12-21-2021
coviddata7 = coviddata(655:end,:);%05-13-2022

coviddata8 = coviddata(421:605,:); % Data for 5/1/21 - 11/1/21

t2 = length(coviddata2.date);
t3 = length(coviddata3.date);
t4 = length(coviddata4.date);
t5 = length(coviddata5.date);
t6 = length(coviddata6.date);
```

```
t7 = length(coviddata7.date);
t8 = length(coviddata8.date); % Corresponding time for delta variant
```

Input data periods to plot here

%Note: Input data here for accurate plots

```
Inputtime = t;           %Input time here
InputData = coviddata; %Input data here

Policy = false; %Set to true to implement policy

sirafun= @(x)siroutput(x,Inputtime,InputData);
```

set up rate and initial condition constraints

Set A and b to impose a parameter inequality constraint of the form $A*x < b$ Note that this is imposed element-wise If you don't want such a constraint, keep these matrices empty.

```
A = [0 0 1 0 0 0 0 0 0 0];
b = [1];
```

set up some fixed constraints

Set Af and bf to impose a parameter constraint of the form $Af*x = bf$ Hint: For example, the sum of the initial conditions should be constrained If you don't want such a constraint, keep these matrices empty.

```
Af = ([0,0,0,1,1,1,1,0,0,0]);
bf = 1;
```

set up upper and lower bound constraints

Set upper and lower bounds on the parameters $lb < x < ub$ here, the inequality is imposed element-wise If you don't want such a constraint, keep these matrices empty.

```
ub = [0.5 1 1 1 1 1 0 1 1 1];
lb = [0 0 0 0 0 0 0 0 0 0];
```

```
% Specify some initial parameters for the optimizer to start from
x0 = [0.0001    0.0000    0.0010    1.0000    0.000    0.000    0.001
      0.4643    0.4643    0.4643];
```

```
x = fmincon(sirafun,x0,A,b,Af,bf,lb,ub);
```

```
if Policy
x(1) = 0.75*(x(1));%First policy trial: Reduce infection rate by 25%
x(3) = 1.05*(x(3));%Increased recovery rate due to reduced workloads at
    hospitals
end
```

```
Y_fit = siroutput_full(x,Inputtime);
```

```

hold on
Simcases = pop - Y_fit(:,1)*pop; %Simulation cases
Simdeaths = Y_fit(:,4).*pop;      %Simulation deaths

```

```

% Make some plots that illustrate your findings.

```

```

plot(InputData.date,InputData.deaths,'b');
hold on
plot(InputData.date,Simdeaths,'r','LineWidth',1);
legend('Deaths data', 'Simulated deaths')
title("")
xlabel('date')
ylabel('Number of deaths to date')

```

Local minimum found that satisfies the constraints.

Optimization completed because the objective function is non-decreasing in feasible directions, to within the value of the optimality tolerance, and constraints are satisfied to within the value of the constraint tolerance.

$f =$

1.0000	0.0000	0.0000	0
0.9997	0.0003	0.0000	0.0000
0.9994	0.0006	0.0000	0.0000
0.9991	0.0009	0.0000	0.0000
0.9988	0.0012	0.0000	0.0000
0.9985	0.0015	0.0000	0.0000
0.9982	0.0017	0.0001	0.0000
0.9979	0.0020	0.0001	0.0000
0.9976	0.0023	0.0001	0.0000
0.9973	0.0025	0.0001	0.0000
0.9970	0.0028	0.0002	0.0000
0.9967	0.0031	0.0002	0.0000
0.9964	0.0033	0.0003	0.0000
0.9961	0.0036	0.0003	0.0000
0.9958	0.0038	0.0004	0.0000
0.9955	0.0041	0.0004	0.0000
0.9952	0.0043	0.0005	0.0000
0.9949	0.0045	0.0005	0.0000
0.9946	0.0048	0.0006	0.0000
0.9943	0.0050	0.0007	0.0000
0.9940	0.0052	0.0007	0.0000
0.9937	0.0054	0.0008	0.0000
0.9934	0.0057	0.0009	0.0000
0.9931	0.0059	0.0010	0.0000
0.9928	0.0061	0.0011	0.0000
0.9925	0.0063	0.0011	0.0000
0.9922	0.0065	0.0012	0.0000
0.9919	0.0067	0.0013	0.0000

0.9916	0.0069	0.0014	0.0000
0.9913	0.0071	0.0015	0.0000
0.9911	0.0073	0.0016	0.0000
0.9908	0.0075	0.0017	0.0000
0.9905	0.0077	0.0018	0.0000
0.9902	0.0079	0.0019	0.0000
0.9899	0.0080	0.0021	0.0000
0.9896	0.0082	0.0022	0.0000
0.9893	0.0084	0.0023	0.0000
0.9890	0.0086	0.0024	0.0000
0.9887	0.0087	0.0025	0.0000
0.9884	0.0089	0.0027	0.0000
0.9881	0.0091	0.0028	0.0000
0.9878	0.0092	0.0029	0.0000
0.9875	0.0094	0.0030	0.0000
0.9872	0.0096	0.0032	0.0001
0.9869	0.0097	0.0033	0.0001
0.9866	0.0099	0.0035	0.0001
0.9863	0.0100	0.0036	0.0001
0.9860	0.0102	0.0037	0.0001
0.9857	0.0103	0.0039	0.0001
0.9854	0.0105	0.0040	0.0001
0.9851	0.0106	0.0042	0.0001
0.9848	0.0108	0.0043	0.0001
0.9845	0.0109	0.0045	0.0001
0.9842	0.0110	0.0046	0.0001
0.9840	0.0112	0.0048	0.0001
0.9837	0.0113	0.0050	0.0001
0.9834	0.0114	0.0051	0.0001
0.9831	0.0116	0.0053	0.0001
0.9828	0.0117	0.0055	0.0001
0.9825	0.0118	0.0056	0.0001
0.9822	0.0119	0.0058	0.0001
0.9819	0.0121	0.0060	0.0001
0.9816	0.0122	0.0061	0.0001
0.9813	0.0123	0.0063	0.0001
0.9810	0.0124	0.0065	0.0001
0.9807	0.0125	0.0067	0.0001
0.9804	0.0126	0.0068	0.0001
0.9801	0.0127	0.0070	0.0001
0.9798	0.0129	0.0072	0.0001
0.9795	0.0130	0.0074	0.0001
0.9792	0.0131	0.0076	0.0001
0.9790	0.0132	0.0078	0.0001
0.9787	0.0133	0.0079	0.0001
0.9784	0.0134	0.0081	0.0001
0.9781	0.0135	0.0083	0.0001
0.9778	0.0136	0.0085	0.0001
0.9775	0.0137	0.0087	0.0001
0.9772	0.0138	0.0089	0.0001
0.9769	0.0139	0.0091	0.0001
0.9766	0.0139	0.0093	0.0001
0.9763	0.0140	0.0095	0.0002
0.9760	0.0141	0.0097	0.0002

0.9757	0.0142	0.0099	0.0002
0.9754	0.0143	0.0101	0.0002
0.9751	0.0144	0.0103	0.0002
0.9749	0.0145	0.0105	0.0002
0.9746	0.0145	0.0107	0.0002
0.9743	0.0146	0.0109	0.0002
0.9740	0.0147	0.0111	0.0002
0.9737	0.0148	0.0113	0.0002
0.9734	0.0149	0.0116	0.0002
0.9731	0.0149	0.0118	0.0002
0.9728	0.0150	0.0120	0.0002
0.9725	0.0151	0.0122	0.0002
0.9722	0.0152	0.0124	0.0002
0.9719	0.0152	0.0126	0.0002
0.9716	0.0153	0.0128	0.0002
0.9714	0.0154	0.0131	0.0002
0.9711	0.0154	0.0133	0.0002
0.9708	0.0155	0.0135	0.0002
0.9705	0.0156	0.0137	0.0002
0.9702	0.0156	0.0140	0.0002
0.9699	0.0157	0.0142	0.0002
0.9696	0.0158	0.0144	0.0002
0.9693	0.0158	0.0146	0.0002
0.9690	0.0159	0.0149	0.0002
0.9687	0.0159	0.0151	0.0002
0.9685	0.0160	0.0153	0.0002
0.9682	0.0161	0.0155	0.0002
0.9679	0.0161	0.0158	0.0002
0.9676	0.0162	0.0160	0.0003
0.9673	0.0162	0.0162	0.0003
0.9670	0.0163	0.0165	0.0003
0.9667	0.0163	0.0167	0.0003
0.9664	0.0164	0.0169	0.0003
0.9661	0.0164	0.0172	0.0003
0.9658	0.0165	0.0174	0.0003
0.9656	0.0165	0.0176	0.0003
0.9653	0.0166	0.0179	0.0003
0.9650	0.0166	0.0181	0.0003
0.9647	0.0167	0.0183	0.0003
0.9644	0.0167	0.0186	0.0003
0.9641	0.0168	0.0188	0.0003
0.9638	0.0168	0.0191	0.0003
0.9635	0.0169	0.0193	0.0003
0.9632	0.0169	0.0195	0.0003
0.9630	0.0170	0.0198	0.0003
0.9627	0.0170	0.0200	0.0003
0.9624	0.0170	0.0203	0.0003
0.9621	0.0171	0.0205	0.0003
0.9618	0.0171	0.0208	0.0003
0.9615	0.0172	0.0210	0.0003
0.9612	0.0172	0.0212	0.0003
0.9609	0.0172	0.0215	0.0003
0.9606	0.0173	0.0217	0.0003
0.9604	0.0173	0.0220	0.0003

0.9601	0.0173	0.0222	0.0004
0.9598	0.0174	0.0225	0.0004
0.9595	0.0174	0.0227	0.0004
0.9592	0.0175	0.0230	0.0004
0.9589	0.0175	0.0232	0.0004
0.9586	0.0175	0.0235	0.0004
0.9583	0.0176	0.0237	0.0004
0.9581	0.0176	0.0240	0.0004
0.9578	0.0176	0.0242	0.0004
0.9575	0.0176	0.0245	0.0004
0.9572	0.0177	0.0247	0.0004
0.9569	0.0177	0.0250	0.0004
0.9566	0.0177	0.0252	0.0004
0.9563	0.0178	0.0255	0.0004
0.9561	0.0178	0.0257	0.0004
0.9558	0.0178	0.0260	0.0004
0.9555	0.0179	0.0262	0.0004
0.9552	0.0179	0.0265	0.0004
0.9549	0.0179	0.0268	0.0004
0.9546	0.0179	0.0270	0.0004
0.9543	0.0180	0.0273	0.0004
0.9541	0.0180	0.0275	0.0004
0.9538	0.0180	0.0278	0.0004
0.9535	0.0180	0.0280	0.0004
0.9532	0.0181	0.0283	0.0004
0.9529	0.0181	0.0286	0.0005
0.9526	0.0181	0.0288	0.0005
0.9523	0.0181	0.0291	0.0005
0.9521	0.0181	0.0293	0.0005
0.9518	0.0182	0.0296	0.0005
0.9515	0.0182	0.0299	0.0005
0.9512	0.0182	0.0301	0.0005
0.9509	0.0182	0.0304	0.0005
0.9506	0.0183	0.0306	0.0005
0.9503	0.0183	0.0309	0.0005
0.9501	0.0183	0.0312	0.0005
0.9498	0.0183	0.0314	0.0005
0.9495	0.0183	0.0317	0.0005
0.9492	0.0183	0.0319	0.0005
0.9489	0.0184	0.0322	0.0005
0.9486	0.0184	0.0325	0.0005
0.9484	0.0184	0.0327	0.0005
0.9481	0.0184	0.0330	0.0005
0.9478	0.0184	0.0333	0.0005
0.9475	0.0185	0.0335	0.0005
0.9472	0.0185	0.0338	0.0005
0.9469	0.0185	0.0340	0.0005
0.9466	0.0185	0.0343	0.0005
0.9464	0.0185	0.0346	0.0005
0.9461	0.0185	0.0348	0.0006
0.9458	0.0185	0.0351	0.0006
0.9455	0.0186	0.0354	0.0006
0.9452	0.0186	0.0356	0.0006
0.9449	0.0186	0.0359	0.0006

0.9447	0.0186	0.0362	0.0006
0.9444	0.0186	0.0364	0.0006
0.9441	0.0186	0.0367	0.0006
0.9438	0.0186	0.0370	0.0006
0.9435	0.0186	0.0372	0.0006
0.9433	0.0187	0.0375	0.0006
0.9430	0.0187	0.0378	0.0006
0.9427	0.0187	0.0380	0.0006
0.9424	0.0187	0.0383	0.0006
0.9421	0.0187	0.0386	0.0006
0.9418	0.0187	0.0388	0.0006
0.9416	0.0187	0.0391	0.0006
0.9413	0.0187	0.0394	0.0006
0.9410	0.0187	0.0396	0.0006
0.9407	0.0188	0.0399	0.0006
0.9404	0.0188	0.0402	0.0006
0.9401	0.0188	0.0404	0.0006
0.9399	0.0188	0.0407	0.0006
0.9396	0.0188	0.0410	0.0006
0.9393	0.0188	0.0412	0.0007
0.9390	0.0188	0.0415	0.0007
0.9387	0.0188	0.0418	0.0007
0.9385	0.0188	0.0420	0.0007
0.9382	0.0188	0.0423	0.0007
0.9379	0.0188	0.0426	0.0007
0.9376	0.0189	0.0429	0.0007
0.9373	0.0189	0.0431	0.0007
0.9371	0.0189	0.0434	0.0007
0.9368	0.0189	0.0437	0.0007
0.9365	0.0189	0.0439	0.0007
0.9362	0.0189	0.0442	0.0007
0.9359	0.0189	0.0445	0.0007
0.9357	0.0189	0.0447	0.0007
0.9354	0.0189	0.0450	0.0007
0.9351	0.0189	0.0453	0.0007
0.9348	0.0189	0.0456	0.0007
0.9345	0.0189	0.0458	0.0007
0.9343	0.0189	0.0461	0.0007
0.9340	0.0189	0.0464	0.0007
0.9337	0.0189	0.0466	0.0007
0.9334	0.0189	0.0469	0.0007
0.9331	0.0189	0.0472	0.0007
0.9329	0.0190	0.0474	0.0008
0.9326	0.0190	0.0477	0.0008
0.9323	0.0190	0.0480	0.0008
0.9320	0.0190	0.0483	0.0008
0.9317	0.0190	0.0485	0.0008
0.9315	0.0190	0.0488	0.0008
0.9312	0.0190	0.0491	0.0008
0.9309	0.0190	0.0493	0.0008
0.9306	0.0190	0.0496	0.0008
0.9303	0.0190	0.0499	0.0008
0.9301	0.0190	0.0502	0.0008
0.9298	0.0190	0.0504	0.0008

0.9295	0.0190	0.0507	0.0008
0.9292	0.0190	0.0510	0.0008
0.9289	0.0190	0.0512	0.0008
0.9287	0.0190	0.0515	0.0008
0.9284	0.0190	0.0518	0.0008
0.9281	0.0190	0.0521	0.0008
0.9278	0.0190	0.0523	0.0008
0.9276	0.0190	0.0526	0.0008
0.9273	0.0190	0.0529	0.0008
0.9270	0.0190	0.0531	0.0008
0.9267	0.0190	0.0534	0.0008
0.9264	0.0190	0.0537	0.0008
0.9262	0.0190	0.0540	0.0009
0.9259	0.0190	0.0542	0.0009
0.9256	0.0190	0.0545	0.0009
0.9253	0.0190	0.0548	0.0009
0.9251	0.0190	0.0550	0.0009
0.9248	0.0190	0.0553	0.0009
0.9245	0.0190	0.0556	0.0009
0.9242	0.0190	0.0559	0.0009
0.9240	0.0190	0.0561	0.0009
0.9237	0.0190	0.0564	0.0009
0.9234	0.0190	0.0567	0.0009
0.9231	0.0190	0.0569	0.0009
0.9228	0.0190	0.0572	0.0009
0.9226	0.0190	0.0575	0.0009
0.9223	0.0190	0.0578	0.0009
0.9220	0.0190	0.0580	0.0009
0.9217	0.0190	0.0583	0.0009
0.9215	0.0190	0.0586	0.0009
0.9212	0.0190	0.0588	0.0009
0.9209	0.0190	0.0591	0.0009
0.9206	0.0190	0.0594	0.0009
0.9204	0.0190	0.0597	0.0009
0.9201	0.0190	0.0599	0.0009
0.9198	0.0190	0.0602	0.0010
0.9195	0.0190	0.0605	0.0010
0.9193	0.0190	0.0608	0.0010
0.9190	0.0190	0.0610	0.0010
0.9187	0.0190	0.0613	0.0010
0.9184	0.0190	0.0616	0.0010
0.9182	0.0190	0.0618	0.0010
0.9179	0.0190	0.0621	0.0010
0.9176	0.0190	0.0624	0.0010
0.9173	0.0190	0.0627	0.0010
0.9171	0.0190	0.0629	0.0010
0.9168	0.0190	0.0632	0.0010
0.9165	0.0190	0.0635	0.0010
0.9162	0.0190	0.0637	0.0010
0.9160	0.0190	0.0640	0.0010
0.9157	0.0190	0.0643	0.0010
0.9154	0.0190	0.0646	0.0010
0.9151	0.0190	0.0648	0.0010
0.9149	0.0190	0.0651	0.0010

0.9146	0.0190	0.0654	0.0010
0.9143	0.0190	0.0656	0.0010
0.9140	0.0190	0.0659	0.0010
0.9138	0.0190	0.0662	0.0010
0.9135	0.0190	0.0665	0.0011
0.9132	0.0190	0.0667	0.0011
0.9129	0.0190	0.0670	0.0011
0.9127	0.0190	0.0673	0.0011
0.9124	0.0190	0.0675	0.0011
0.9121	0.0190	0.0678	0.0011
0.9119	0.0190	0.0681	0.0011
0.9116	0.0190	0.0684	0.0011
0.9113	0.0190	0.0686	0.0011
0.9110	0.0190	0.0689	0.0011
0.9108	0.0190	0.0692	0.0011
0.9105	0.0190	0.0694	0.0011
0.9102	0.0190	0.0697	0.0011
0.9099	0.0190	0.0700	0.0011
0.9097	0.0190	0.0703	0.0011
0.9094	0.0190	0.0705	0.0011
0.9091	0.0190	0.0708	0.0011
0.9089	0.0190	0.0711	0.0011
0.9086	0.0190	0.0713	0.0011
0.9083	0.0189	0.0716	0.0011
0.9080	0.0189	0.0719	0.0011
0.9078	0.0189	0.0721	0.0011
0.9075	0.0189	0.0724	0.0011
0.9072	0.0189	0.0727	0.0012
0.9069	0.0189	0.0730	0.0012
0.9067	0.0189	0.0732	0.0012
0.9064	0.0189	0.0735	0.0012
0.9061	0.0189	0.0738	0.0012
0.9059	0.0189	0.0740	0.0012
0.9056	0.0189	0.0743	0.0012
0.9053	0.0189	0.0746	0.0012
0.9050	0.0189	0.0749	0.0012
0.9048	0.0189	0.0751	0.0012
0.9045	0.0189	0.0754	0.0012
0.9042	0.0189	0.0757	0.0012
0.9040	0.0189	0.0759	0.0012
0.9037	0.0189	0.0762	0.0012
0.9034	0.0189	0.0765	0.0012
0.9032	0.0189	0.0767	0.0012
0.9029	0.0189	0.0770	0.0012
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0.9023	0.0189	0.0776	0.0012
0.9021	0.0189	0.0778	0.0012
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0.9015	0.0189	0.0784	0.0012
0.9013	0.0189	0.0786	0.0012
0.9010	0.0189	0.0789	0.0012
0.9007	0.0189	0.0792	0.0013
0.9005	0.0189	0.0794	0.0013
0.9002	0.0188	0.0797	0.0013

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0.8996	0.0188	0.0802	0.0013
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0.8619	0.0182	0.1181	0.0019
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0.8614	0.0181	0.1186	0.0019
0.8611	0.0181	0.1188	0.0019
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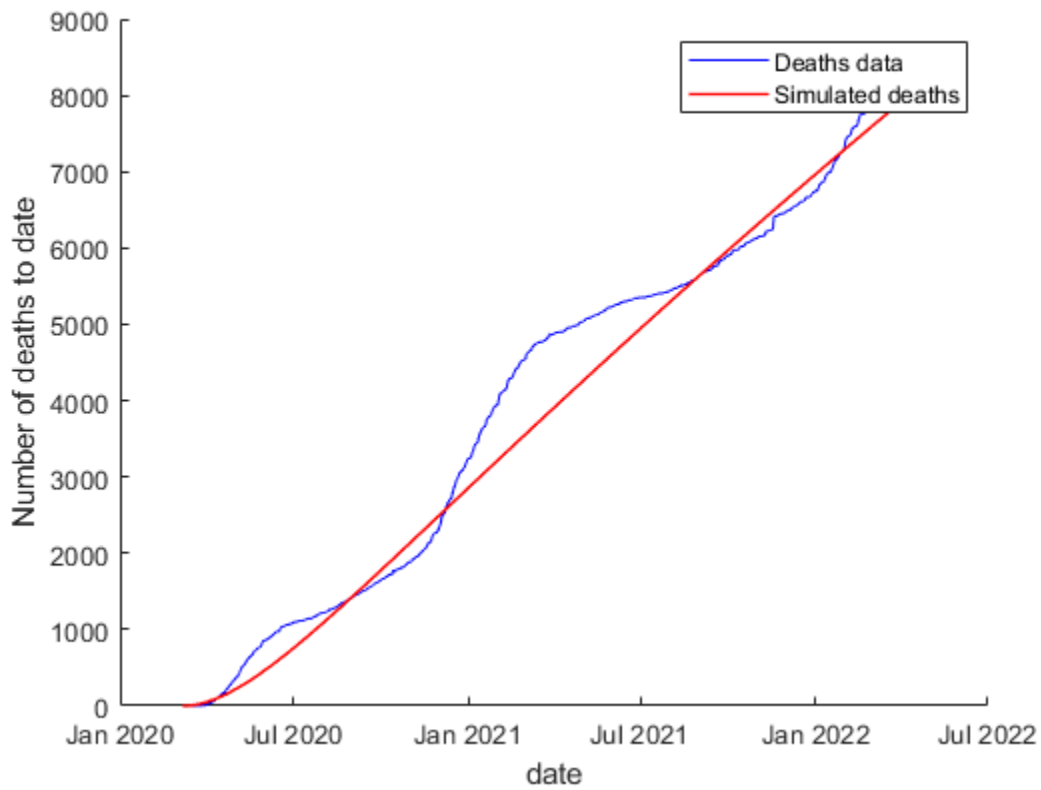
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0.8410	0.0177	0.1391	0.0022
0.8407	0.0177	0.1393	0.0022
0.8405	0.0177	0.1396	0.0022
0.8402	0.0177	0.1398	0.0022
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0.8004	0.0169	0.1798	0.0028
0.8002	0.0169	0.1801	0.0029
0.8000	0.0169	0.1803	0.0029
0.7997	0.0169	0.1806	0.0029
0.7995	0.0168	0.1808	0.0029
0.7992	0.0168	0.1811	0.0029
0.7990	0.0168	0.1813	0.0029
0.7988	0.0168	0.1815	0.0029
0.7985	0.0168	0.1818	0.0029
0.7983	0.0168	0.1820	0.0029
0.7980	0.0168	0.1823	0.0029
0.7978	0.0168	0.1825	0.0029
0.7976	0.0168	0.1827	0.0029
0.7973	0.0168	0.1830	0.0029
0.7971	0.0168	0.1832	0.0029
0.7968	0.0168	0.1835	0.0029
0.7966	0.0168	0.1837	0.0029
0.7964	0.0168	0.1839	0.0029
0.7961	0.0168	0.1842	0.0029
0.7959	0.0168	0.1844	0.0029
0.7957	0.0168	0.1847	0.0029
0.7954	0.0168	0.1849	0.0029
0.7952	0.0168	0.1851	0.0029
0.7949	0.0168	0.1854	0.0029
0.7947	0.0167	0.1856	0.0029
0.7945	0.0167	0.1859	0.0029
0.7942	0.0167	0.1861	0.0029
0.7940	0.0167	0.1863	0.0029
0.7937	0.0167	0.1866	0.0030
0.7935	0.0167	0.1868	0.0030
0.7933	0.0167	0.1870	0.0030
0.7930	0.0167	0.1873	0.0030
0.7928	0.0167	0.1875	0.0030
0.7926	0.0167	0.1878	0.0030
0.7923	0.0167	0.1880	0.0030
0.7921	0.0167	0.1882	0.0030
0.7918	0.0167	0.1885	0.0030
0.7916	0.0167	0.1887	0.0030
0.7914	0.0167	0.1890	0.0030
0.7911	0.0167	0.1892	0.0030
0.7909	0.0167	0.1894	0.0030

0.7907	0.0167	0.1897	0.0030
0.7904	0.0167	0.1899	0.0030
0.7902	0.0167	0.1901	0.0030
0.7900	0.0166	0.1904	0.0030
0.7897	0.0166	0.1906	0.0030
0.7895	0.0166	0.1909	0.0030
0.7892	0.0166	0.1911	0.0030
0.7890	0.0166	0.1913	0.0030
0.7888	0.0166	0.1916	0.0030
0.7885	0.0166	0.1918	0.0030
0.7883	0.0166	0.1920	0.0030
0.7881	0.0166	0.1923	0.0030
0.7878	0.0166	0.1925	0.0030
0.7876	0.0166	0.1928	0.0031



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