

Smartfin: Mathworks Symposium

Cal State Kalman Filter

Our test case consisted of recreating a pendulum motion with a sampling rate of 100Hz. You can see the graphs and outputs below:

```
clc;
clear all; %%File reading
filename = 'cleaned_data/lm_positive_fast_time.csv';
num = csvread(filename,1);
disp(num)
```

0	0	0.0190	-0.4844	0.8750
1.0000	0.0100	0.0173	-0.4861	0.8828
2.0000	0.0200	0.0259	-0.4890	0.8845
3.0000	0.0300	0.0239	-0.4810	0.8870
4.0000	0.0400	0.0283	-0.4783	0.8845
5.0000	0.0500	0.0237	-0.4890	0.8850
6.0000	0.0600	0.0256	-0.4954	0.8884
7.0000	0.0700	0.0291	-0.4946	0.8838
8.0000	0.0800	0.0227	-0.4939	0.8848
9.0000	0.0900	0.0227	-0.4929	0.8862
10.0000	0.1000	0.0229	-0.4851	0.8870
11.0000	0.1100	0.0239	-0.4827	0.8926
12.0000	0.1200	0.0183	-0.4829	0.8867
13.0000	0.1300	0.0200	-0.4849	0.8867
14.0000	0.1400	0.0271	-0.4900	0.8821
15.0000	0.1500	0.0232	-0.4875	0.8831
16.0000	0.1600	0.0225	-0.4924	0.8901
17.0000	0.1700	0.0247	-0.4941	0.8875
18.0000	0.1800	0.0225	-0.4900	0.8875
19.0000	0.1900	0.0251	-0.4797	0.8867
20.0000	0.2000	0.0300	-0.4700	0.8840
21.0000	0.2100	0.0334	-0.4751	0.8823
22.0000	0.2200	0.0347	-0.4734	0.8875
23.0000	0.2300	0.0300	-0.4775	0.8853
24.0000	0.2400	0.0308	-0.4888	0.8862
25.0000	0.2500	0.0227	-0.4912	0.8911
26.0000	0.2600	0.0254	-0.4966	0.8896
27.0000	0.2700	0.0300	-0.4888	0.8938
28.0000	0.2800	0.0254	-0.4695	0.8896
29.0000	0.2900	0.0356	-0.4702	0.8970
30.0000	0.3000	0.0293	-0.4861	0.9001
31.0000	0.3100	0.0403	-0.4688	0.9224
32.0000	0.3200	0.0095	-0.4487	0.9285
33.0000	0.3300	0.0344	-0.4939	0.7827
34.0000	0.3400	0.0132	-0.3997	0.8279
35.0000	0.3500	0.0034	-0.4072	0.9204
36.0000	0.3600	0.0491	-0.3101	0.9219
37.0000	0.3700	0.0466	-0.2825	0.8667
38.0000	0.3800	-0.0076	-0.1670	0.8533
39.0000	0.3900	-0.0757	-0.1372	1.1399
40.0000	0.4010	-0.0205	-0.3809	1.0293
41.0000	0.4110	-0.0327	-0.2244	0.8894
42.0000	0.4210	-0.0657	0.4524	0.7676
43.0000	0.4310	-0.0591	0.1438	0.2432

44.0000	0.4410	-0.0474	-0.1582	1.1150
45.0000	0.4510	-0.0479	-0.1238	1.1724
46.0000	0.4610	-0.1428	-0.1646	0.8157
47.0000	0.4710	-0.0881	-0.0339	0.9387
48.0000	0.4810	-0.0679	0.0930	0.9431
49.0000	0.4910	-0.0852	0.0911	0.8789
50.0000	0.5010	-0.0566	0.1453	1.0349
51.0000	0.5110	-0.0811	-0.0725	1.0667
52.0000	0.5210	-0.0889	-0.2170	1.0420
53.0000	0.5310	-0.0657	-0.1245	1.0369
54.0000	0.5410	-0.0688	0.0161	1.0696
55.0000	0.5510	-0.0750	0.0850	1.0815
56.0000	0.5610	0.0024	0.0479	1.0696
57.0000	0.5710	-0.0332	-0.0420	1.0862
58.0000	0.5810	-0.1035	-0.1040	1.1887
59.0000	0.5910	-0.0488	-0.0713	1.3110
60.0000	0.6010	0.0049	-0.0403	0.9221
61.0000	0.6110	-0.0059	0.0984	0.9763
62.0000	0.6210	-0.0188	0.1687	1.0520
63.0000	0.6310	-0.0710	-0.0403	1.1970
64.0000	0.6410	-0.0151	-0.1675	1.1917
65.0000	0.6510	-0.0208	-0.0298	1.2456
66.0000	0.6610	-0.0654	0.0337	1.2759
67.0000	0.6710	-0.0378	0.0654	1.2749
68.0000	0.6810	-0.0332	0.0020	1.2859
69.0000	0.6910	-0.0581	-0.0190	1.3022
70.0000	0.7010	-0.0740	-0.0828	1.2688
71.0000	0.7110	-0.0483	-0.0527	1.2175
72.0000	0.7210	-0.0352	0.0127	1.2297
73.0000	0.7310	-0.0513	0.0667	1.2588
74.0000	0.7410	-0.0652	0.0300	1.2405
75.0000	0.7510	-0.0718	-0.0288	1.2214
76.0000	0.7610	-0.0754	-0.0647	1.2251
77.0000	0.7710	-0.0938	-0.0276	1.1873
78.0000	0.7810	-0.0874	0.0376	1.2151
79.0000	0.7910	-0.0991	0.0615	1.2144
80.0000	0.8010	-0.1021	0.0112	1.1772
81.0000	0.8110	-0.1030	-0.0364	1.1575
82.0000	0.8210	-0.1189	-0.0444	1.1465
83.0000	0.8310	-0.1201	-0.0110	1.1270
84.0000	0.8410	-0.1091	0.0188	1.1118
85.0000	0.8510	-0.1191	0.0254	1.0947
86.0000	0.8610	-0.1240	0.0215	1.0735
87.0000	0.8710	-0.1292	-0.0110	1.0613
88.0000	0.8810	-0.1235	-0.0247	1.0488
89.0000	0.8910	-0.1165	-0.0117	1.0332
90.0000	0.9010	-0.1118	0.0234	1.0120
91.0000	0.9110	-0.1040	0.0405	0.9900
92.0000	0.9210	-0.0991	0.0208	0.9875
93.0000	0.9310	-0.0962	0.0029	0.9780
94.0000	0.9410	-0.0803	0	0.9587
95.0000	0.9510	-0.0786	-0.0027	0.9299
96.0000	0.9610	-0.0681	0.0125	0.9263
97.0000	0.9710	-0.0691	0.0251	0.8984
98.0000	0.9810	-0.0684	0.0381	0.8677
99.0000	0.9910	-0.0569	0.0310	0.8943
100.0000	1.0010	-0.0505	0.0139	0.9019
101.0000	1.0110	-0.0474	0.0122	0.8972
102.0000	1.0210	-0.0520	0.0222	0.8923
103.0000	1.0310	-0.0447	0.0227	0.8845
104.0000	1.0410	-0.0435	0.0251	0.8853
105.0000	1.0510	-0.0432	0.0295	0.8945
106.0000	1.0610	-0.0435	0.0300	0.8948
107.0000	1.0710	-0.0447	0.0325	0.9072

108.0000	1.0810	-0.0503	0.0327	0.9207
109.0000	1.0910	-0.0464	0.0225	0.9285
110.0000	1.1010	-0.0544	0.0166	0.9194
111.0000	1.1110	-0.0637	0.0222	0.9507
112.0000	1.1210	-0.0679	0.0208	0.9541
113.0000	1.1310	-0.0671	0.0264	0.9700
114.0000	1.1410	-0.0774	0.0232	0.9883
115.0000	1.1510	-0.0730	0.0225	0.9980
116.0000	1.1610	-0.0759	0.0208	1.0032
117.0000	1.1710	-0.0813	0.0115	1.0298
118.0000	1.1810	-0.0701	0.0112	1.0437
119.0000	1.1910	-0.0654	0.0151	1.0632
120.0000	1.2010	-0.0720	0.0117	1.0869
121.0000	1.2110	-0.0723	0.0129	1.0928
122.0000	1.2210	-0.0630	0.0115	1.1101
123.0000	1.2310	-0.0684	0.0125	1.1265
124.0000	1.2410	-0.0608	0.0183	1.1543
125.0000	1.2510	-0.0615	0.0188	1.1609
126.0000	1.2610	-0.0605	0.0073	1.1687
127.0000	1.2710	-0.0520	0.0222	1.2144
128.0000	1.2810	-0.0667	0.0227	1.2217
129.0000	1.2910	-0.0637	0.0112	1.2346
130.0000	1.3010	-0.0566	-0.0110	1.1890
131.0000	1.3110	-0.0527	0.0127	1.2385
132.0000	1.3210	-0.0620	0.0259	1.2512
133.0000	1.3310	-0.0632	0.0112	1.2517
134.0000	1.3410	-0.0640	0.0063	1.2437
135.0000	1.3510	-0.0569	-0.0039	1.2424
136.0000	1.3610	-0.0635	0.0037	1.2424
137.0000	1.3710	-0.0662	0.0042	1.2537
138.0000	1.3810	-0.0620	0.0103	1.2361
139.0000	1.3910	-0.0637	0.0063	1.2393
140.0000	1.4020	-0.0688	0.0046	1.2258
141.0000	1.4120	-0.0603	0.0044	1.2158
142.0000	1.4220	-0.0632	-0.0017	1.2087
143.0000	1.4320	-0.0591	0.0056	1.2126
144.0000	1.4420	-0.0647	0.0127	1.1899
145.0000	1.4520	-0.0605	-0.0046	1.1877
146.0000	1.4620	-0.0635	-0.0046	1.1465
147.0000	1.4720	-0.0676	0.0034	1.1497
148.0000	1.4820	-0.0618	0.0054	1.1321
149.0000	1.4920	-0.0625	0.0100	1.1238
150.0000	1.5020	-0.0605	0.0059	1.0933
151.0000	1.5120	-0.0659	-0.0042	1.0762
152.0000	1.5220	-0.0645	-0.0100	1.0647
153.0000	1.5320	-0.0684	0.0212	1.1411
154.0000	1.5420	-0.0698	0.0164	1.0662
155.0000	1.5520	-0.0618	-0.0073	0.9729
156.0000	1.5620	-0.0684	-0.0088	0.9924
157.0000	1.5720	-0.0664	-0.0115	0.9731
158.0000	1.5820	-0.0649	0.0002	0.9617
159.0000	1.5920	-0.0625	-0.0078	0.9495
160.0000	1.6020	-0.0635	-0.0068	0.9312
161.0000	1.6120	-0.0579	-0.0144	0.9216
162.0000	1.6220	-0.0684	-0.0105	0.9126
163.0000	1.6320	-0.0623	-0.0149	0.9014
164.0000	1.6420	-0.0588	0.0046	0.8962
165.0000	1.6520	-0.0627	0.0015	0.9146
166.0000	1.6620	-0.0603	-0.0203	0.9258
167.0000	1.6720	-0.0557	-0.0276	0.8787
168.0000	1.6820	-0.0522	-0.0132	0.8743
169.0000	1.6920	-0.0410	-0.0088	0.8892
170.0000	1.7020	-0.0425	-0.0269	0.8972
171.0000	1.7120	-0.0452	-0.0295	0.8711

172.0000	1.7220	-0.0410	-0.0259	0.8933
173.0000	1.7320	-0.0356	-0.0176	0.9106
174.0000	1.7420	-0.0369	-0.0244	0.9155
175.0000	1.7520	-0.0320	-0.0259	0.9231
176.0000	1.7620	-0.0288	-0.0186	0.9314
177.0000	1.7720	-0.0327	-0.0222	0.9414
178.0000	1.7820	-0.0322	-0.0254	0.9622
179.0000	1.7920	-0.0281	-0.0220	0.9729
180.0000	1.8020	-0.0266	-0.0237	0.9839
181.0000	1.8120	-0.0349	-0.0247	1.0073
182.0000	1.8220	-0.0371	-0.0244	1.0166
183.0000	1.8320	-0.0366	-0.0259	1.0352
184.0000	1.8420	-0.0391	-0.0271	1.0515
185.0000	1.8520	-0.0386	-0.0139	1.0703
186.0000	1.8620	-0.0400	-0.0132	1.0818
187.0000	1.8720	-0.0369	-0.0168	1.0979
188.0000	1.8820	-0.0437	-0.0247	1.1218
189.0000	1.8920	-0.0525	-0.0149	1.1311
190.0000	1.9020	-0.0522	-0.0139	1.1423
191.0000	1.9120	-0.0522	-0.0125	1.1587
192.0000	1.9220	-0.0522	-0.0044	1.1753
193.0000	1.9320	-0.0579	-0.0032	1.1702
194.0000	1.9420	-0.0635	-0.0017	1.2039
195.0000	1.9520	-0.0618	-0.0122	1.2034
196.0000	1.9620	-0.0703	-0.0115	1.2175
197.0000	1.9720	-0.0732	-0.0007	1.2300
198.0000	1.9820	-0.0674	-0.0061	1.2253
199.0000	1.9920	-0.0701	0.0007	1.2292
200.0000	2.0020	-0.0801	0.0132	1.2427
201.0000	2.0120	-0.0825	-0.0066	1.2288
202.0000	2.0220	-0.0830	0.0010	1.2749
203.0000	2.0320	-0.0823	0.0054	1.2356
204.0000	2.0420	-0.0867	0.0161	1.2239
205.0000	2.0520	-0.0886	-0.0022	1.2236
206.0000	2.0620	-0.0859	-0.0017	1.2209
207.0000	2.0720	-0.0867	0.0085	1.2117
208.0000	2.0820	-0.0933	0.0063	1.2012
209.0000	2.0920	-0.0925	0.0046	1.1899
210.0000	2.1020	-0.0908	0.0085	1.1858
211.0000	2.1120	-0.0908	0.0190	1.1624
212.0000	2.1220	-0.0842	0.0073	1.1467
213.0000	2.1320	-0.0815	0.0093	1.1355
214.0000	2.1420	-0.0815	0.0032	1.1228
215.0000	2.1520	-0.0837	0.0156	1.1125
216.0000	2.1620	-0.0789	0.0164	1.0876
217.0000	2.1720	-0.0771	0.0173	1.0752
218.0000	2.1820	-0.0759	0.0210	1.0535
219.0000	2.1920	-0.0698	0.0188	1.0408
220.0000	2.2020	-0.0713	0.0142	1.0239
221.0000	2.2120	-0.0659	0.0112	1.0044
222.0000	2.2220	-0.0737	0.0190	0.9968
223.0000	2.2320	-0.0688	0.0266	0.9866
224.0000	2.2420	-0.0635	0.0220	0.9636
225.0000	2.2520	-0.0603	0.0193	0.9546
226.0000	2.2620	-0.0591	0.0225	0.9451
227.0000	2.2720	-0.0557	0.0122	0.9351
228.0000	2.2820	-0.0547	0.0190	0.9243
229.0000	2.2920	-0.0510	0.0288	0.9119
230.0000	2.3020	-0.0474	0.0205	0.9021
231.0000	2.3120	-0.0588	0.0261	0.9016
232.0000	2.3220	-0.0471	0.0271	0.9270
233.0000	2.3320	-0.0444	0.0164	0.8940
234.0000	2.3420	-0.0461	0.0193	0.8982
235.0000	2.3520	-0.0488	0.0208	0.9026

236.0000	2.3620	-0.0457	0.0232	0.9082
237.0000	2.3720	-0.0410	0.0312	0.9006
238.0000	2.3820	-0.0439	0.0278	0.9131
239.0000	2.3920	-0.0498	0.0256	0.9172
240.0000	2.4020	-0.0471	0.0127	0.9280
241.0000	2.4120	-0.0488	0.0190	0.9316
242.0000	2.4220	-0.0491	0.0288	0.9487
243.0000	2.4320	-0.0471	0.0310	0.9670
244.0000	2.4420	-0.0522	0.0083	0.9810
245.0000	2.4520	-0.0459	0.0264	0.9951
246.0000	2.4620	-0.0459	0.0312	0.9895
247.0000	2.4720	-0.0513	0.0208	1.0139
248.0000	2.4820	-0.0510	0.0081	1.0315
249.0000	2.4920	-0.0549	0.0200	1.0542
250.0000	2.5020	-0.0562	0.0225	1.0681
251.0000	2.5120	-0.0618	0.0212	1.0791
252.0000	2.5220	-0.0596	0.0249	1.0950
253.0000	2.5320	-0.0667	0.0303	1.1096
254.0000	2.5420	-0.0642	0.0259	1.1240
255.0000	2.5520	-0.0674	0.0264	1.1423
256.0000	2.5620	-0.0649	0.0127	1.1624
257.0000	2.5720	-0.0708	0.0132	1.1716
258.0000	2.5820	-0.0720	0.0210	1.1843
259.0000	2.5920	-0.0774	0.0176	1.1904
260.0000	2.6020	-0.0801	0.0242	1.2053
261.0000	2.6120	-0.0813	0.0247	1.2124
262.0000	2.6220	-0.0771	0.0112	1.2263
263.0000	2.6320	-0.0862	0.0056	1.2185
264.0000	2.6420	-0.0879	0.0159	1.2241
265.0000	2.6520	-0.0925	0.0164	1.2319
266.0000	2.6620	-0.0879	0.0242	1.2444
267.0000	2.6720	-0.0933	0.0120	1.2283
268.0000	2.6820	-0.0996	0.0076	1.2322
269.0000	2.6920	-0.0962	0.0139	1.2368
270.0000	2.7020	-0.0952	0.0095	1.2329
271.0000	2.7120	-0.0952	0.0054	1.2178
272.0000	2.7220	-0.0969	0.0085	1.2126
273.0000	2.7320	-0.0977	0.0029	1.1919
274.0000	2.7420	-0.1006	0.0063	1.1863
275.0000	2.7520	-0.1033	-0.0051	1.1724
276.0000	2.7620	-0.0991	-0.0063	1.1658
277.0000	2.7720	-0.1077	-0.0032	1.1592
278.0000	2.7820	-0.1064	-0.0059	1.1292
279.0000	2.7920	-0.0979	-0.0002	1.1155
280.0000	2.8020	-0.0947	-0.0088	1.0876
281.0000	2.8120	-0.0991	-0.0100	1.0793
282.0000	2.8220	-0.0938	-0.0232	1.0676
283.0000	2.8320	-0.0820	-0.0176	1.0559
284.0000	2.8420	-0.0872	-0.0168	1.0430
285.0000	2.8520	-0.0759	-0.0139	1.0127
286.0000	2.8620	-0.0762	-0.0149	0.9941
287.0000	2.8720	-0.0688	-0.0142	0.9963
288.0000	2.8820	-0.0684	-0.0151	0.9897
289.0000	2.8920	-0.0549	-0.0154	0.9556
290.0000	2.9020	-0.0586	-0.0222	0.9446
291.0000	2.9120	-0.0566	-0.0142	0.9321
292.0000	2.9220	-0.0527	-0.0215	0.9390
293.0000	2.9320	-0.0432	-0.0193	0.9182
294.0000	2.9420	-0.0349	-0.0137	0.9094
295.0000	2.9520	-0.0327	-0.0237	0.8987
296.0000	2.9620	-0.0374	-0.0164	0.9062
297.0000	2.9720	-0.0315	-0.0151	0.9033
298.0000	2.9820	-0.0315	-0.0220	0.8945
299.0000	2.9920	-0.0288	-0.0137	0.8950

300.0000	3.0020	-0.0312	-0.0188	0.8933
301.0000	3.0120	-0.0278	-0.0229	0.8982
302.0000	3.0220	-0.0349	-0.0208	0.9023
303.0000	3.0320	-0.0254	-0.0198	0.9080
304.0000	3.0420	-0.0337	-0.0200	0.9131
305.0000	3.0520	-0.0310	-0.0208	0.9185
306.0000	3.0620	-0.0374	-0.0144	0.9268
307.0000	3.0720	-0.0337	-0.0212	0.9351
308.0000	3.0820	-0.0364	-0.0193	0.9512
309.0000	3.0920	-0.0408	-0.0198	0.9617
310.0000	3.1020	-0.0327	-0.0156	0.9844
311.0000	3.1120	-0.0403	-0.0220	0.9866
312.0000	3.1220	-0.0469	-0.0088	0.9929
313.0000	3.1320	-0.0520	-0.0059	1.0269
314.0000	3.1420	-0.0425	-0.0085	1.0415
315.0000	3.1520	-0.0461	-0.0105	1.0493
316.0000	3.1620	-0.0469	-0.0144	1.0605
317.0000	3.1720	-0.0520	-0.0100	1.0847
318.0000	3.1820	-0.0488	-0.0071	1.1033
319.0000	3.1920	-0.0459	-0.0066	1.1108
320.0000	3.2020	-0.0488	-0.0044	1.1165
321.0000	3.2120	-0.0520	-0.0085	1.1296
322.0000	3.2220	-0.0457	-0.0078	1.1492
323.0000	3.2320	-0.0437	-0.0034	1.1655
324.0000	3.2420	-0.0530	0.0005	1.1812
325.0000	3.2520	-0.0503	0.0051	1.1899
326.0000	3.2620	-0.0569	-0.0117	1.1963
327.0000	3.2720	-0.0464	-0.0005	1.2029
328.0000	3.2820	-0.0537	0.0061	1.2170
329.0000	3.2920	-0.0569	-0.0024	1.2207
330.0000	3.3020	-0.0574	-0.0024	1.2234
331.0000	3.3120	-0.0559	0.0012	1.2275
332.0000	3.3220	-0.0613	-0.0010	1.2222
333.0000	3.3320	-0.0635	0.0037	1.2307
334.0000	3.3420	-0.0603	0.0017	1.2273
335.0000	3.3520	-0.0625	0.0012	1.2180
336.0000	3.3620	-0.0708	-0.0002	1.2073
337.0000	3.3720	-0.0710	0.0039	1.2019
338.0000	3.3820	-0.0732	0.0042	1.1919
339.0000	3.3920	-0.0728	0.0027	1.1807
340.0000	3.4020	-0.0718	0.0081	1.1838
341.0000	3.4120	-0.0781	0.0085	1.1589
342.0000	3.4220	-0.0703	0.0071	1.1360
343.0000	3.4320	-0.0779	0.0139	1.1431
344.0000	3.4420	-0.0747	0.0127	1.1355
345.0000	3.4520	-0.0706	0.0178	1.1155
346.0000	3.4620	-0.0669	0.0137	1.0862
347.0000	3.4720	-0.0737	0.0068	1.0762
348.0000	3.4820	-0.0742	0.0132	1.0728
349.0000	3.4920	-0.0679	0.0232	1.0564
350.0000	3.5020	-0.0657	0.0173	1.0374
351.0000	3.5120	-0.0664	0.0181	1.0251
352.0000	3.5220	-0.0669	0.0237	1.0073
353.0000	3.5320	-0.0598	0.0215	0.9937
354.0000	3.5420	-0.0615	0.0210	0.9783
355.0000	3.5520	-0.0615	0.0225	0.9653
356.0000	3.5620	-0.0588	0.0239	0.9563
357.0000	3.5720	-0.0586	0.0200	0.9438
358.0000	3.5820	-0.0510	0.0161	0.9363
359.0000	3.5920	-0.0562	0.0264	0.9290
360.0000	3.6020	-0.0596	0.0332	0.9226
361.0000	3.6120	-0.0547	0.0247	0.9165
362.0000	3.6220	-0.0500	0.0281	0.9082
363.0000	3.6320	-0.0503	0.0225	0.8992

364.0000	3.6420	-0.0562	0.0239	0.9084
365.0000	3.6520	-0.0461	0.0210	0.9026
366.0000	3.6620	-0.0469	0.0227	0.9060
367.0000	3.6720	-0.0518	0.0315	0.9099
368.0000	3.6820	-0.0579	0.0339	0.9185
369.0000	3.6920	-0.0471	0.0315	0.9158
370.0000	3.7020	-0.0420	0.0164	0.9231
371.0000	3.7120	-0.0476	0.0232	0.9319
372.0000	3.7220	-0.0515	0.0251	0.9446
373.0000	3.7320	-0.0457	0.0200	0.9500
374.0000	3.7420	-0.0479	0.0259	0.9570
375.0000	3.7520	-0.0469	0.0286	0.9780
376.0000	3.7620	-0.0503	0.0256	0.9880
377.0000	3.7720	-0.0486	0.0215	1.0044
378.0000	3.7820	-0.0525	0.0149	1.0132
379.0000	3.7920	-0.0623	0.0161	1.0269
380.0000	3.8050	-0.0576	0.0264	1.0518
381.0000	3.8150	-0.0586	0.0291	1.0703
382.0000	3.8250	-0.0615	0.0273	1.0786
383.0000	3.8350	-0.0684	0.0193	1.0869
384.0000	3.8450	-0.0664	0.0208	1.1018
385.0000	3.8590	-0.0713	0.0234	1.1392
386.0000	3.8690	-0.0776	0.0168	1.1401
387.0000	3.8790	-0.0852	0.0149	1.1450
388.0000	3.8890	-0.0906	0.0173	1.1653
389.0000	3.8990	-0.0891	0.0254	1.1848
390.0000	3.9120	-0.0891	0.0149	1.2007
391.0000	3.9220	-0.0935	0.0139	1.1995
392.0000	3.9320	-0.1050	0.0034	1.2031
393.0000	3.9420	-0.0962	0.0093	1.2129
394.0000	3.9520	-0.0969	0.0144	1.2278
395.0000	3.9660	-0.0972	0.0103	1.2227
396.0000	3.9760	-0.1028	-0.0005	1.2161
397.0000	3.9860	-0.1028	0.0029	1.2175
398.0000	3.9960	-0.0945	0.0017	1.2300
399.0000	4.0060	-0.0979	-0.0017	1.2168
400.0000	4.0160	-0.0957	0.0022	1.2085
401.0000	4.0300	-0.0918	0.0046	1.2063
402.0000	4.0400	-0.0959	0.0049	1.1970
403.0000	4.0500	-0.0869	0.0002	1.1780
404.0000	4.0600	-0.0886	-0.0073	1.1724
405.0000	4.0700	-0.0867	-0.0002	1.1584
406.0000	4.0840	-0.0796	-0.0085	1.1497
407.0000	4.0940	-0.0754	-0.0059	1.1157
408.0000	4.1040	-0.0715	-0.0068	1.1094
409.0000	4.1140	-0.0769	-0.0051	1.0930
410.0000	4.1240	-0.0659	-0.0054	1.0925
411.0000	4.1340	-0.0659	-0.0088	1.0535
412.0000	4.1480	-0.0605	-0.0168	1.0444
413.0000	4.1580	-0.0608	-0.0083	1.0317
414.0000	4.1680	-0.0562	-0.0073	1.0208
415.0000	4.1780	-0.0549	-0.0090	0.9961
416.0000	4.1880	-0.0488	-0.0100	0.9822
417.0000	4.2020	-0.0481	-0.0164	0.9651
418.0000	4.2120	-0.0391	-0.0164	0.9561
419.0000	4.2220	-0.0464	-0.0164	0.9492
420.0000	4.2320	-0.0430	-0.0195	0.9294
421.0000	4.2420	-0.0486	-0.0117	0.9187
422.0000	4.2520	-0.0408	-0.0161	0.9229
423.0000	4.2680	-0.0388	-0.0151	0.9058
424.0000	4.2780	-0.0427	-0.0220	0.8984
425.0000	4.2880	-0.0398	-0.0161	0.9009
426.0000	4.2980	-0.0308	-0.0100	0.8997
427.0000	4.3080	-0.0337	-0.0122	0.8960

428.0000	4.3180	-0.0320	-0.0181	0.8975
429.0000	4.3280	-0.0293	-0.0117	0.9016
430.0000	4.3380	-0.0281	-0.0081	0.9060
431.0000	4.3480	-0.0291	-0.0208	0.9126
432.0000	4.3580	-0.0347	-0.0178	0.9138
433.0000	4.3680	-0.0325	-0.0110	0.9253
434.0000	4.3780	-0.0305	-0.0098	0.9365
435.0000	4.3880	-0.0266	-0.0078	0.9460
436.0000	4.3990	-0.0239	-0.0149	0.9563
437.0000	4.4090	-0.0315	-0.0037	0.9788
438.0000	4.4190	-0.0232	-0.0142	0.9819
439.0000	4.4290	-0.0225	-0.0134	0.9990
440.0000	4.4390	-0.0247	-0.0173	1.0117
441.0000	4.4490	-0.0281	-0.0083	1.0210
442.0000	4.4590	-0.0332	-0.0071	1.0415
443.0000	4.4690	-0.0249	-0.0098	1.0471
444.0000	4.4790	-0.0337	-0.0085	1.0610
445.0000	4.4890	-0.0315	-0.0198	1.0759
446.0000	4.4990	-0.0405	-0.0098	1.1057
447.0000	4.5090	-0.0317	-0.0061	1.1099
448.0000	4.5190	-0.0305	-0.0056	1.1277
449.0000	4.5290	-0.0422	-0.0071	1.1401
450.0000	4.5390	-0.0391	-0.0061	1.1511
451.0000	4.5490	-0.0439	-0.0037	1.1621
452.0000	4.5590	-0.0488	-0.0073	1.1755
453.0000	4.5690	-0.0520	-0.0073	1.1816
454.0000	4.5790	-0.0544	-0.0095	1.1853
455.0000	4.5890	-0.0549	-0.0024	1.1848
456.0000	4.5990	-0.0596	-0.0059	1.2026
457.0000	4.6090	-0.0579	-0.0100	1.2058
458.0000	4.6190	-0.0620	-0.0012	1.2153
459.0000	4.6290	-0.0664	0.0005	1.2131
460.0000	4.6390	-0.0693	-0.0054	1.2083
461.0000	4.6490	-0.0703	0.0024	1.2119
462.0000	4.6590	-0.0803	0.0010	1.2136
463.0000	4.6690	-0.0791	0.0020	1.2063
464.0000	4.6790	-0.0793	0.0015	1.1946
465.0000	4.6890	-0.0815	0.0027	1.1995
466.0000	4.6990	-0.0840	0.0037	1.1860
467.0000	4.7090	-0.0840	-0.0017	1.1748
468.0000	4.7190	-0.0913	0.0049	1.1658
469.0000	4.7290	-0.0940	0.0068	1.1526
470.0000	4.7390	-0.0925	0.0088	1.1479
471.0000	4.7490	-0.0947	0.0085	1.1384
472.0000	4.7590	-0.0920	0.0066	1.1135
473.0000	4.7690	-0.0945	0.0105	1.0991
474.0000	4.7790	-0.1003	0.0066	1.0859
475.0000	4.7890	-0.0913	0.0137	1.0798
476.0000	4.7990	-0.0916	0.0156	1.0591
477.0000	4.8090	-0.0906	0.0166	1.0403
478.0000	4.8190	-0.0884	0.0073	1.0225
479.0000	4.8290	-0.0830	0.0176	1.0176
480.0000	4.8390	-0.0820	0.0122	1.0049
481.0000	4.8490	-0.0818	0.0186	0.9817
482.0000	4.8590	-0.0781	0.0181	0.9717
483.0000	4.8690	-0.0774	0.0178	0.9629
484.0000	4.8790	-0.0715	0.0225	0.9575
485.0000	4.8890	-0.0647	0.0200	0.9441
486.0000	4.8990	-0.0667	0.0164	0.9312
487.0000	4.9090	-0.0669	0.0227	0.9297
488.0000	4.9190	-0.0664	0.0278	0.9277
489.0000	4.9290	-0.0610	0.0242	0.9138
490.0000	4.9390	-0.0520	0.0166	0.9119
491.0000	4.9490	-0.0574	0.0200	0.9062

492.0000	4.9590	-0.0601	0.0276	0.9106
493.0000	4.9690	-0.0525	0.0205	0.9048
494.0000	4.9790	-0.0508	0.0208	0.9224
495.0000	4.9890	-0.0547	0.0181	0.9282
496.0000	4.9990	-0.0532	0.0198	0.9197
497.0000	5.0090	-0.0569	0.0278	0.9250
498.0000	5.0190	-0.0576	0.0215	0.9385
499.0000	5.0290	-0.0613	0.0200	0.9529
500.0000	5.0390	-0.0569	0.0242	0.9536
501.0000	5.0490	-0.0569	0.0229	0.9585
502.0000	5.0590	-0.0635	0.0227	0.9688
503.0000	5.0690	-0.0540	0.0276	0.9893
504.0000	5.0790	-0.0586	0.0244	1.0017
505.0000	5.0890	-0.0596	0.0237	1.0139
506.0000	5.0990	-0.0652	0.0210	1.0198
507.0000	5.1090	-0.0645	0.0161	1.0359
508.0000	5.1190	-0.0659	0.0186	1.0623
509.0000	5.1290	-0.0662	0.0244	1.0696
510.0000	5.1390	-0.0686	0.0225	1.0886
511.0000	5.1490	-0.0752	0.0181	1.0981
512.0000	5.1590	-0.0664	0.0208	1.1152
513.0000	5.1690	-0.0698	0.0222	1.1272
514.0000	5.1790	-0.0698	0.0151	1.1392
515.0000	5.1890	-0.0732	0.0127	1.1472
516.0000	5.1990	-0.0791	0.0093	1.1477
517.0000	5.2090	-0.0784	0.0110	1.1677
518.0000	5.2190	-0.0759	0.0137	1.1711
519.0000	5.2290	-0.0813	0.0178	1.1895
520.0000	5.2390	-0.0818	0.0173	1.1912
521.0000	5.2490	-0.0837	0.0046	1.2095
522.0000	5.2600	-0.0830	0.0093	1.1995
523.0000	5.2690	-0.0891	0.0015	1.2009
524.0000	5.2790	-0.0884	0.0103	1.2019
525.0000	5.2890	-0.0806	0.0125	1.2185
526.0000	5.2990	-0.0874	0.0076	1.2053
527.0000	5.3090	-0.0857	0.0103	1.2063
528.0000	5.3190	-0.0869	0.0071	1.2048
529.0000	5.3290	-0.0835	0.0098	1.1941
530.0000	5.3390	-0.0857	0.0056	1.1936
531.0000	5.3490	-0.0835	0.0022	1.1853
532.0000	5.3590	-0.0837	0.0054	1.1726
533.0000	5.3690	-0.0811	0.0044	1.1550
534.0000	5.3790	-0.0781	-0.0027	1.1506
535.0000	5.3890	-0.0718	-0.0027	1.1504
536.0000	5.4000	-0.0730	-0.0032	1.1211
537.0000	5.4100	-0.0757	-0.0012	1.1047
538.0000	5.4200	-0.0728	-0.0061	1.0906
539.0000	5.4300	-0.0713	-0.0010	1.0837
540.0000	5.4400	-0.0706	-0.0044	1.0669
541.0000	5.4500	-0.0752	-0.0098	1.0552
542.0000	5.4600	-0.0662	-0.0105	1.0396
543.0000	5.4700	-0.0632	-0.0134	1.0198
544.0000	5.4800	-0.0598	-0.0110	0.9915
545.0000	5.4900	-0.0586	-0.0093	0.9907
546.0000	5.5000	-0.0562	-0.0088	0.9790
547.0000	5.5100	-0.0544	-0.0132	0.9688
548.0000	5.5200	-0.0481	-0.0139	0.9607
549.0000	5.5300	-0.0454	-0.0134	0.9463
550.0000	5.5400	-0.0464	-0.0137	0.9294
551.0000	5.5500	-0.0386	-0.0061	0.9326
552.0000	5.5600	-0.0388	-0.0110	0.9248
553.0000	5.5700	-0.0332	-0.0212	0.9207
554.0000	5.5800	-0.0291	-0.0134	0.9087
555.0000	5.5900	-0.0298	-0.0142	0.9080

556.0000	5.6000	-0.0269	-0.0146	0.9067
557.0000	5.6100	-0.0225	-0.0156	0.9116
558.0000	5.6200	-0.0215	-0.0181	0.9170
559.0000	5.6300	-0.0234	-0.0098	0.9131
560.0000	5.6400	-0.0190	-0.0186	0.9082
561.0000	5.6500	-0.0171	-0.0098	0.9172
562.0000	5.6600	-0.0142	-0.0168	0.9219
563.0000	5.6700	-0.0193	-0.0181	0.9272
564.0000	5.6800	-0.0186	-0.0176	0.9351
565.0000	5.6900	-0.0122	-0.0125	0.9404
566.0000	5.7000	-0.0178	-0.0178	0.9519
567.0000	5.7100	-0.0168	-0.0195	0.9597
568.0000	5.7200	-0.0193	-0.0168	0.9753
569.0000	5.7300	-0.0203	-0.0122	0.9871
570.0000	5.7400	-0.0264	-0.0154	0.9934
571.0000	5.7500	-0.0303	-0.0095	1.0083
572.0000	5.7600	-0.0364	-0.0142	1.0256
573.0000	5.7700	-0.0334	-0.0120	1.0454
574.0000	5.7800	-0.0369	-0.0215	1.0513
575.0000	5.7900	-0.0366	-0.0115	1.0703
576.0000	5.8000	-0.0400	-0.0149	1.0793
577.0000	5.8100	-0.0530	-0.0066	1.0986
578.0000	5.8200	-0.0522	-0.0134	1.1143
579.0000	5.8300	-0.0500	-0.0200	1.1216
580.0000	5.8400	-0.0618	-0.0085	1.1277
581.0000	5.8500	-0.0608	-0.0161	1.1431
582.0000	5.8600	-0.0708	-0.0046	1.1560
583.0000	5.8700	-0.0745	-0.0132	1.1675
584.0000	5.8800	-0.0776	-0.0144	1.1638
585.0000	5.8900	-0.0815	-0.0083	1.1907
586.0000	5.9000	-0.0840	0.0012	1.1997
587.0000	5.9100	-0.0916	-0.0071	1.2026
588.0000	5.9200	-0.0962	0.0017	1.2000
589.0000	5.9300	-0.0923	-0.0044	1.1985
590.0000	5.9400	-0.1013	-0.0054	1.2036
591.0000	5.9500	-0.1033	-0.0085	1.2014
592.0000	5.9600	-0.1003	-0.0103	1.1970
593.0000	5.9700	-0.1082	-0.0017	1.1907
594.0000	5.9800	-0.1079	0.0051	1.2000
595.0000	5.9900	-0.1096	0.0034	1.1943
596.0000	6.0000	-0.1069	0.0034	1.1802
597.0000	6.0100	-0.1106	-0.0005	1.1733
598.0000	6.0200	-0.1125	-0.0017	1.1672
599.0000	6.0300	-0.1086	0.0056	1.1543
600.0000	6.0400	-0.1055	0.0120	1.1426
601.0000	6.0500	-0.1104	0.0044	1.1292
602.0000	6.0600	-0.1067	0.0149	1.1157
603.0000	6.0700	-0.1028	0.0054	1.1033
604.0000	6.0800	-0.1001	0.0151	1.0959
605.0000	6.0900	-0.0977	0.0042	1.0684
606.0000	6.1000	-0.0911	0.0056	1.0625
607.0000	6.1100	-0.0938	0.0188	1.0479
608.0000	6.1200	-0.0808	0.0181	1.0308
609.0000	6.1300	-0.0823	0.0173	1.0149
610.0000	6.1400	-0.0752	0.0122	1.0007
611.0000	6.1500	-0.0664	0.0188	0.9934
612.0000	6.1600	-0.0649	0.0278	0.9819
613.0000	6.1700	-0.0649	0.0125	0.9692
614.0000	6.1800	-0.0632	0.0278	0.9626
615.0000	6.1900	-0.0598	0.0288	0.9436
616.0000	6.2000	-0.0632	0.0107	0.9426
617.0000	6.2100	-0.0552	0.0229	0.9395
618.0000	6.2200	-0.0486	0.0251	0.9375
619.0000	6.2300	-0.0486	0.0271	0.9243

620.0000	6.2400	-0.0498	0.0239	0.9233
621.0000	6.2500	-0.0425	0.0286	0.9211
622.0000	6.2610	-0.0403	0.0251	0.9133
623.0000	6.2710	-0.0410	0.0261	0.9182
624.0000	6.2790	-0.0386	0.0256	0.9204
625.0000	6.2890	-0.0422	0.0288	0.9236
626.0000	6.2990	-0.0386	0.0234	0.9287
627.0000	6.3090	-0.0393	0.0288	0.9280
628.0000	6.3190	-0.0457	0.0369	0.9329
629.0000	6.3290	-0.0430	0.0300	0.9478
630.0000	6.3390	-0.0359	0.0298	0.9482
631.0000	6.3490	-0.0349	0.0247	0.9595
632.0000	6.3590	-0.0410	0.0264	0.9673
633.0000	6.3690	-0.0303	0.0325	0.9812
634.0000	6.3790	-0.0339	0.0291	0.9939
635.0000	6.3890	-0.0369	0.0317	1.0061
636.0000	6.4000	-0.0364	0.0244	1.0210
637.0000	6.4100	-0.0364	0.0247	1.0283
638.0000	6.4200	-0.0383	0.0291	1.0378
639.0000	6.4300	-0.0427	0.0359	1.0569
640.0000	6.4400	-0.0364	0.0344	1.0735
641.0000	6.4500	-0.0354	0.0361	1.0825
642.0000	6.4600	-0.0359	0.0237	1.0801
643.0000	6.4700	-0.0393	0.0122	1.0823
644.0000	6.4800	-0.0491	0.0225	1.1001
645.0000	6.4900	-0.0437	0.0330	1.1189
646.0000	6.5000	-0.0439	0.0293	1.1382
647.0000	6.5100	-0.0476	0.0269	1.1528
648.0000	6.5200	-0.0510	0.0293	1.1597
649.0000	6.5300	-0.0569	0.0308	1.1650
650.0000	6.5400	-0.0537	0.0190	1.1755
651.0000	6.5500	-0.0588	0.0266	1.1743
652.0000	6.5600	-0.0601	0.0193	1.1719
653.0000	6.5700	-0.0635	0.0176	1.1750
654.0000	6.5800	-0.0645	0.0352	1.1909
655.0000	6.5900	-0.0693	0.0347	1.1973
656.0000	6.6000	-0.0667	0.0210	1.1858
657.0000	6.6100	-0.0757	0.0200	1.1763
658.0000	6.6200	-0.0713	0.0120	1.1804
659.0000	6.6300	-0.0710	0.0144	1.1865
660.0000	6.6400	-0.0710	0.0168	1.1819
661.0000	6.6500	-0.0737	0.0122	1.1768
662.0000	6.6600	-0.0732	0.0093	1.1570
663.0000	6.6700	-0.0713	0.0154	1.1499
664.0000	6.6800	-0.0754	0.0093	1.1433
665.0000	6.6900	-0.0720	0.0054	1.1436
666.0000	6.7000	-0.0684	0.0027	1.1064
667.0000	6.7100	-0.0698	0.0061	1.0967
668.0000	6.7200	-0.0649	0.0039	1.1042
669.0000	6.7300	-0.0605	0.0056	1.0776
670.0000	6.7400	-0.0623	0.0032	1.0515
671.0000	6.7500	-0.0591	0.0020	1.0518
672.0000	6.7600	-0.0544	0.0002	1.0505
673.0000	6.7700	-0.0549	-0.0012	1.0386
674.0000	6.7800	-0.0493	-0.0029	1.0195
675.0000	6.7900	-0.0491	-0.0007	1.0142
676.0000	6.8000	-0.0442	-0.0020	1.0098
677.0000	6.8100	-0.0371	-0.0056	0.9912
678.0000	6.8200	-0.0391	0.0017	0.9851
679.0000	6.8300	-0.0337	-0.0090	0.9639
680.0000	6.8400	-0.0298	-0.0142	0.9531
681.0000	6.8500	-0.0229	-0.0078	0.9619
682.0000	6.8600	-0.0269	-0.0002	0.9495
683.0000	6.8700	-0.0183	-0.0095	0.9426

684.0000	6.8800	-0.0146	-0.0059	0.9255
685.0000	6.8900	-0.0095	-0.0112	0.9285
686.0000	6.9000	-0.0122	-0.0076	0.9280
687.0000	6.9100	-0.0093	-0.0095	0.9253
688.0000	6.9200	-0.0103	-0.0129	0.9099
689.0000	6.9300	-0.0117	-0.0132	0.9121
690.0000	6.9400	-0.0115	-0.0051	0.9207
691.0000	6.9500	-0.0027	-0.0071	0.9241
692.0000	6.9600	0.0010	-0.0115	0.9185
693.0000	6.9700	-0.0103	-0.0132	0.9189
694.0000	6.9800	-0.0012	-0.0066	0.9458
695.0000	6.9900	-0.0042	-0.0134	0.9500
696.0000	7.0000	-0.0020	-0.0110	0.9412
697.0000	7.0100	-0.0105	-0.0122	0.9580
698.0000	7.0200	-0.0112	-0.0071	0.9707
699.0000	7.0300	-0.0122	-0.0061	0.9736
700.0000	7.0400	-0.0122	-0.0076	0.9883
701.0000	7.0500	-0.0190	-0.0022	0.9897
702.0000	7.0600	-0.0234	-0.0073	1.0134
703.0000	7.0700	-0.0237	-0.0081	1.0210
704.0000	7.0800	-0.0195	-0.0010	1.0400
705.0000	7.0900	-0.0303	0.0005	1.0376
706.0000	7.1000	-0.0300	0.0010	1.0503
707.0000	7.1100	-0.0347	0.0024	1.0615
708.0000	7.1200	-0.0295	-0.0042	1.0754
709.0000	7.1300	-0.0378	-0.0002	1.0959
710.0000	7.1400	-0.0337	0.0022	1.0994
711.0000	7.1500	-0.0386	0.0039	1.1060
712.0000	7.1600	-0.0344	0.0059	1.1162
713.0000	7.1700	-0.0383	-0.0027	1.1194
714.0000	7.1800	-0.0371	0.0044	1.1433
715.0000	7.1900	-0.0459	0.0073	1.1472
716.0000	7.2000	-0.0400	0.0105	1.1755
717.0000	7.2100	-0.0383	-0.0063	1.1536
718.0000	7.2200	-0.0396	0.0083	1.1594
719.0000	7.2300	-0.0449	0.0117	1.1636
720.0000	7.2400	-0.0398	0.0056	1.1677
721.0000	7.2500	-0.0378	0.0085	1.1719
722.0000	7.2610	-0.0347	0.0110	1.1729
723.0000	7.2710	-0.0413	0.0032	1.1611
724.0000	7.2800	-0.0386	0.0017	1.1604
725.0000	7.2900	-0.0308	0.0171	1.1653
726.0000	7.3000	-0.0405	0.0134	1.1589
727.0000	7.3100	-0.0415	0.0154	1.1553
728.0000	7.3200	-0.0437	0.0105	1.1541
729.0000	7.3300	-0.0447	0.0093	1.1521
730.0000	7.3400	-0.0481	0.0144	1.1350
731.0000	7.3500	-0.0493	0.0100	1.1279
732.0000	7.3600	-0.0500	0.0178	1.1252
733.0000	7.3700	-0.0479	0.0193	1.1086
734.0000	7.3800	-0.0559	0.0112	1.0933
735.0000	7.3900	-0.0469	0.0132	1.0891
736.0000	7.4010	-0.0459	0.0178	1.0754
737.0000	7.4110	-0.0562	0.0266	1.0625
738.0000	7.4210	-0.0481	0.0244	1.0461
739.0000	7.4310	-0.0498	0.0251	1.0469
740.0000	7.4410	-0.0486	0.0173	1.0378
741.0000	7.4510	-0.0527	0.0198	1.0212
742.0000	7.4610	-0.0518	0.0171	1.0098
743.0000	7.4710	-0.0491	0.0229	0.9944
744.0000	7.4810	-0.0442	0.0283	0.9905
745.0000	7.4910	-0.0425	0.0298	0.9817
746.0000	7.5010	-0.0515	0.0266	0.9673
747.0000	7.5110	-0.0471	0.0242	0.9626

748.0000	7.5210	-0.0486	0.0208	0.9431
749.0000	7.5310	-0.0447	0.0205	0.9502
750.0000	7.5410	-0.0408	0.0354	0.9463
751.0000	7.5510	-0.0430	0.0217	0.9348
752.0000	7.5610	-0.0425	0.0264	0.9272
753.0000	7.5710	-0.0354	0.0266	0.9292
754.0000	7.5810	-0.0354	0.0281	0.9360
755.0000	7.5910	-0.0322	0.0247	0.9336
756.0000	7.6010	-0.0320	0.0203	0.9333
757.0000	7.6110	-0.0298	0.0266	0.9351
758.0000	7.6210	-0.0330	0.0303	0.9399
759.0000	7.6310	-0.0254	0.0203	0.9421
760.0000	7.6410	-0.0210	0.0259	0.9441
761.0000	7.6510	-0.0242	0.0247	0.9475
762.0000	7.6610	-0.0254	0.0312	0.9607
763.0000	7.6710	-0.0232	0.0281	0.9658
764.0000	7.6810	-0.0149	0.0332	0.9758
765.0000	7.6910	-0.0173	0.0369	0.9832
766.0000	7.7010	-0.0151	0.0271	0.9956
767.0000	7.7110	-0.0105	0.0295	1.0007
768.0000	7.7210	-0.0117	0.0222	1.0156
769.0000	7.7310	-0.0115	0.0298	1.0208
770.0000	7.7410	-0.0085	0.0315	1.0312
771.0000	7.7510	-0.0051	0.0369	1.0396
772.0000	7.7610	-0.0051	0.0317	1.0530
773.0000	7.7710	-0.0056	0.0332	1.0625
774.0000	7.7810	-0.0039	0.0273	1.0745
775.0000	7.7910	-0.0022	0.0366	1.0854
776.0000	7.8010	-0.0066	0.0283	1.0920
777.0000	7.8110	-0.0142	0.0303	1.0955
778.0000	7.8210	-0.0112	0.0327	1.1150
779.0000	7.8310	-0.0115	0.0325	1.1174
780.0000	7.8410	-0.0125	0.0376	1.1279
781.0000	7.8510	-0.0139	0.0288	1.1279
782.0000	7.8610	-0.0237	0.0322	1.1338
783.0000	7.8710	-0.0195	0.0315	1.1421
784.0000	7.8810	-0.0266	0.0339	1.1431
785.0000	7.8910	-0.0266	0.0356	1.1440
786.0000	7.9010	-0.0283	0.0320	1.1494
787.0000	7.9110	-0.0308	0.0247	1.1497
788.0000	7.9210	-0.0332	0.0229	1.1487
789.0000	7.9310	-0.0291	0.0261	1.1470
790.0000	7.9410	-0.0391	0.0168	1.1489
791.0000	7.9510	-0.0354	0.0144	1.1484
792.0000	7.9610	-0.0378	0.0183	1.1421
793.0000	7.9710	-0.0396	0.0151	1.1387
794.0000	7.9810	-0.0454	0.0134	1.1331
795.0000	7.9910	-0.0515	0.0144	1.1260
796.0000	8.0010	-0.0498	0.0146	1.1228
797.0000	8.0110	-0.0522	0.0117	1.1167
798.0000	8.0210	-0.0520	0.0120	1.1042
799.0000	8.0310	-0.0522	0.0066	1.0957
800.0000	8.0410	-0.0559	0.0081	1.0852
801.0000	8.0510	-0.0547	0.0076	1.0820
802.0000	8.0610	-0.0618	0.0056	1.0706
803.0000	8.0710	-0.0576	0.0039	1.0532
804.0000	8.0810	-0.0535	0.0020	1.0439
805.0000	8.0910	-0.0574	0.0029	1.0405
806.0000	8.1010	-0.0608	0.0027	1.0325
807.0000	8.1110	-0.0596	0.0015	1.0208
808.0000	8.1210	-0.0569	0.0017	1.0122
809.0000	8.1310	-0.0532	0.0022	0.9990
810.0000	8.1410	-0.0510	-0.0061	0.9919
811.0000	8.1510	-0.0544	-0.0007	0.9856

812.0000	8.1610	-0.0537	-0.0095	0.9766
813.0000	8.1710	-0.0444	-0.0088	0.9688
814.0000	8.1810	-0.0474	-0.0078	0.9714
815.0000	8.1910	-0.0447	-0.0093	0.9490
816.0000	8.2010	-0.0410	-0.0059	0.9502
817.0000	8.2110	-0.0369	-0.0081	0.9580
818.0000	8.2210	-0.0344	-0.0117	0.9482
819.0000	8.2310	-0.0327	-0.0044	0.9534
820.0000	8.2410	-0.0330	-0.0015	0.9512
821.0000	8.2510	-0.0249	-0.0056	0.9399
822.0000	8.2620	-0.0244	-0.0056	0.9431
823.0000	8.2720	-0.0286	-0.0046	0.9404
824.0000	8.2810	-0.0183	-0.0139	0.9456
825.0000	8.2910	-0.0132	-0.0029	0.9458
826.0000	8.3010	-0.0215	-0.0056	0.9543
827.0000	8.3110	-0.0222	-0.0034	0.9546
828.0000	8.3210	-0.0198	-0.0071	0.9656
829.0000	8.3310	-0.0154	-0.0017	0.9712
830.0000	8.3410	-0.0249	0.0020	0.9749
831.0000	8.3510	-0.0178	-0.0027	0.9824
832.0000	8.3610	-0.0142	-0.0049	0.9875
833.0000	8.3710	-0.0217	0.0002	0.9932
834.0000	8.3810	-0.0166	-0.0105	1.0117
835.0000	8.3910	-0.0190	-0.0049	1.0186
836.0000	8.4020	-0.0166	-0.0105	1.0151
837.0000	8.4120	-0.0164	-0.0005	1.0312
838.0000	8.4220	-0.0212	0.0015	1.0398
839.0000	8.4320	-0.0288	-0.0007	1.0513
840.0000	8.4420	-0.0229	-0.0017	1.0522
841.0000	8.4520	-0.0215	-0.0027	1.0703
842.0000	8.4620	-0.0181	0	1.0740
843.0000	8.4720	-0.0237	-0.0007	1.0845
844.0000	8.4820	-0.0181	-0.0063	1.0911
845.0000	8.4920	-0.0186	0.0054	1.1001
846.0000	8.5020	-0.0168	-0.0073	1.1062
847.0000	8.5120	-0.0173	0.0046	1.1094
848.0000	8.5220	-0.0159	0.0063	1.1162
849.0000	8.5320	-0.0090	0.0054	1.1179
850.0000	8.5420	-0.0125	0.0054	1.1262
851.0000	8.5520	-0.0173	0.0034	1.1323
852.0000	8.5620	-0.0195	0.0039	1.1262
853.0000	8.5720	-0.0156	0.0134	1.1262
854.0000	8.5820	-0.0254	0.0139	1.1230
855.0000	8.5920	-0.0195	0.0063	1.1355
856.0000	8.6020	-0.0356	0.0034	1.1304
857.0000	8.6120	-0.0271	0.0103	1.1274
858.0000	8.6220	-0.0305	0.0110	1.1238
859.0000	8.6320	-0.0293	0.0120	1.1179
860.0000	8.6420	-0.0322	0.0071	1.1177
861.0000	8.6520	-0.0393	0.0081	1.1077
862.0000	8.6620	-0.0400	0.0142	1.0986
863.0000	8.6720	-0.0454	0.0054	1.1045
864.0000	8.6820	-0.0312	0.0117	1.0938
865.0000	8.6920	-0.0403	0.0127	1.0874
866.0000	8.7020	-0.0371	0.0105	1.0796
867.0000	8.7120	-0.0303	0.0120	1.0740
868.0000	8.7220	-0.0364	0.0212	1.0652
869.0000	8.7320	-0.0337	0.0229	1.0530
870.0000	8.7420	-0.0364	0.0161	1.0435
871.0000	8.7520	-0.0356	0.0190	1.0388
872.0000	8.7620	-0.0334	0.0181	1.0315
873.0000	8.7720	-0.0342	0.0188	1.0229
874.0000	8.7820	-0.0386	0.0232	1.0134
875.0000	8.7920	-0.0359	0.0168	1.0105

876.0000	8.8020	-0.0295	0.0227	0.9956
877.0000	8.8120	-0.0344	0.0220	0.9902
878.0000	8.8220	-0.0383	0.0200	0.9878
879.0000	8.8320	-0.0293	0.0183	0.9797
880.0000	8.8420	-0.0349	0.0234	0.9739
881.0000	8.8520	-0.0396	0.0271	0.9658
882.0000	8.8620	-0.0391	0.0229	0.9666
883.0000	8.8720	-0.0420	0.0208	0.9631
884.0000	8.8820	-0.0430	0.0234	0.9622
885.0000	8.8920	-0.0447	0.0173	0.9561
886.0000	8.9020	-0.0469	0.0149	0.9551
887.0000	8.9120	-0.0449	0.0225	0.9495
888.0000	8.9220	-0.0457	0.0247	0.9585
889.0000	8.9320	-0.0420	0.0259	0.9573
890.0000	8.9420	-0.0508	0.0234	0.9551
891.0000	8.9510	-0.0481	0.0151	0.9626
892.0000	8.9610	-0.0476	0.0244	0.9619
893.0000	8.9710	-0.0464	0.0190	0.9695
894.0000	8.9800	-0.0481	0.0176	0.9753
895.0000	8.9890	-0.0483	0.0164	0.9739
896.0000	8.9980	-0.0500	0.0237	0.9829
897.0000	9.0070	-0.0449	0.0251	0.9883
898.0000	9.0160	-0.0498	0.0220	0.9956
899.0000	9.0250	-0.0459	0.0178	1.0024
900.0000	9.0340	-0.0530	0.0151	1.0037
901.0000	9.0430	-0.0498	0.0168	1.0168
902.0000	9.0520	-0.0498	0.0144	1.0203
903.0000	9.0610	-0.0518	0.0154	1.0256
904.0000	9.0700	-0.0483	0.0176	1.0359
905.0000	9.0790	-0.0476	0.0212	1.0457
906.0000	9.0880	-0.0559	0.0171	1.0518
907.0000	9.0970	-0.0483	0.0190	1.0540
908.0000	9.1060	-0.0574	0.0195	1.0698
909.0000	9.1150	-0.0527	0.0176	1.0706
910.0000	9.1240	-0.0491	0.0107	1.0764
911.0000	9.1330	-0.0623	0.0107	1.0823
912.0000	9.1420	-0.0581	0.0146	1.0869
913.0000	9.1510	-0.0637	0.0117	1.0947
914.0000	9.1600	-0.0564	0.0098	1.0986
915.0000	9.1690	-0.0591	0.0122	1.1040
916.0000	9.1780	-0.0623	0.0122	1.1116
917.0000	9.1870	-0.0608	0.0078	1.1140
918.0000	9.1960	-0.0579	0.0122	1.1138
919.0000	9.2050	-0.0601	0.0081	1.1150
920.0000	9.2140	-0.0581	0.0068	1.1243
921.0000	9.2230	-0.0596	0.0010	1.1233
922.0000	9.2320	-0.0583	0.0083	1.1238
923.0000	9.2410	-0.0552	0.0061	1.1248
924.0000	9.2500	-0.0632	0.0093	1.1257
925.0000	9.2600	-0.0608	0.0049	1.1233
926.0000	9.2700	-0.0542	0.0059	1.1184
927.0000	9.2800	-0.0537	0.0081	1.1265
928.0000	9.2880	-0.0535	0.0083	1.1179
929.0000	9.2970	-0.0525	0.0076	1.1074
930.0000	9.3060	-0.0586	-0.0002	1.1077
931.0000	9.3150	-0.0586	0.0063	1.1021
932.0000	9.3240	-0.0520	0.0076	1.0947
933.0000	9.3330	-0.0505	0.0032	1.0962
934.0000	9.3420	-0.0493	0.0022	1.0903
935.0000	9.3510	-0.0515	-0.0024	1.0798
936.0000	9.3600	-0.0513	0.0049	1.0764
937.0000	9.3690	-0.0498	0.0022	1.0701
938.0000	9.3800	-0.0496	0.0042	1.0596
939.0000	9.3900	-0.0498	0.0024	1.0439

940.0000	9.4000	-0.0479	-0.0049	1.0381
941.0000	9.4110	-0.0459	-0.0039	1.0305
942.0000	9.4210	-0.0454	-0.0063	1.0298
943.0000	9.4310	-0.0425	-0.0002	1.0159
944.0000	9.4410	-0.0376	-0.0007	1.0051
945.0000	9.4510	-0.0422	-0.0017	0.9973
946.0000	9.4610	-0.0339	-0.0039	0.9998
947.0000	9.4710	-0.0391	0.0027	0.9919
948.0000	9.4810	-0.0334	-0.0063	0.9741
949.0000	9.4910	-0.0371	-0.0085	0.9722
950.0000	9.5010	-0.0356	-0.0037	0.9688
951.0000	9.5110	-0.0300	-0.0020	0.9692
952.0000	9.5210	-0.0266	-0.0037	0.9583
953.0000	9.5310	-0.0334	-0.0051	0.9573
954.0000	9.5410	-0.0305	-0.0042	0.9563
955.0000	9.5510	-0.0286	-0.0005	0.9529
956.0000	9.5610	-0.0266	-0.0005	0.9478
957.0000	9.5710	-0.0327	-0.0027	0.9426
958.0000	9.5810	-0.0288	-0.0015	0.9446
959.0000	9.5910	-0.0303	-0.0029	0.9509
960.0000	9.6010	-0.0244	-0.0083	0.9534
961.0000	9.6110	-0.0222	-0.0046	0.9565
962.0000	9.6210	-0.0288	-0.0073	0.9585
963.0000	9.6310	-0.0254	-0.0032	0.9666
964.0000	9.6410	-0.0281	-0.0032	0.9692
965.0000	9.6510	-0.0291	-0.0061	0.9724
966.0000	9.6610	-0.0300	-0.0005	0.9788
967.0000	9.6710	-0.0256	0.0002	0.9819
968.0000	9.6810	-0.0249	-0.0037	1.0039
969.0000	9.6910	-0.0266	-0.0012	1.0012
970.0000	9.7010	-0.0305	-0.0056	1.0037
971.0000	9.7110	-0.0242	-0.0005	1.0181

```
time=[]; u=[]; k=[];
u1x=[]; u2x=[]; u3x=[];
u1y=[]; u2y=[]; u3y=[];
u1z=[]; u2z=[]; u3z=[];
```

X - Direction

```
n = 972;
disp(num(2, 2))
```

0.0100

```
for i = 1:1:n
    time(i) = num(i, 2);
    %disp("time: " + num(i))
    u1x(i) = 9.8 * num(i, 3);           % x direction only
    %disp("u1: " + num(i+n))
    u2x(i) = 9.8 * num(i, 4);
    %disp("u2: " + num(i+(2*n)))
    u3x(i) = 9.8 * num(i, 5);
    %disp("u3: " + num(i+(3*n)))
end
time = time'; u1x = u1x'; u2x = u2x'; u3x = u3x';
```


Y - Direction

```
n = 972;  
disp(num(2, 2))
```

0.0100

```
for i = 1:1:n  
    time(i) = num(i, 2);  
    %disp("time: " + num(i))  
    u1y(i) = 9.8 * num(i, 4);           % y direction only  
    %disp("u1: " + num(i+n))  
    u2y(i) = 9.8 * num(i, 5);  
    %disp("u2: " + num(i+(2*n)))  
    u3y(i) = 9.8 * num(i, 3);  
    %disp("u3: " + num(i+(3*n)))  
end  
time = time'; u1y = u1y'; u2y = u2y'; u3y = u3y';
```

Z - Direction

```
n = 972;  
disp(num(2, 2))
```

0.0100

```
for i = 1:1:n  
    time(i) = num(i, 2);  
    %disp("time: " + num(i))  
    u1z(i) = 9.8 * num(i, 5);           % z direction only  
    %disp("u1: " + num(i+n))  
    u2z(i) = 9.8 * num(i, 3);  
    %disp("u2: " + num(i+(2*n)))  
    u3z(i) = 9.8 * num(i, 4);  
    %disp("u3: " + num(i+(3*n)))  
end  
time = time'; u1z = u1z'; u2z = u2z'; u3z = u3z';
```

define our meta - variables

```
duration = size(time); %how long the simulation is  
dt = 0.039;           %10 Hz continuously looking for measurement %0.039
```

define update equations

```
A = [1 dt dt^2/2; 0 1 dt; 0 0 1]; %transition matrix  
B = 0;  
H = [1 0 0; 0 1 0; 0 0 1];       %genral form matrices ; measurement matrix
```

define main variables

```
ux=0; uy = 0; uz = 0;
k1x = [u1x u2x u3x];           %control vector ; acceleration matrix
k1y = [u1y u2y u3y];           %control vector ; acceleration matrix
k1z = [u1z u2z u3z];           %control vector ; acceleration matrix
Q= [0; 0; 0];                   %initized state ; [position velocity]
Q_estimate_x = Q;
Q_estimate_y = Q;
Q_estimate_z = Q;
P = eye(3);                     % q --> estimated process error covariance.
Ex = eye(3);                    %estimate of initial object position
R = [1 0 0 ;0 1 0;0 0 1];
```

Initialize result variables

```
Z_p_x = [];    Z_v_x = [];    Z_a_x = [];
Z_p_y = [];    Z_v_y = [];    Z_a_y = [];
Z_p_z = [];    Z_v_z = [];    Z_a_z = [];
```

Variables for X Direction

```
x_estimate_az_x = []; y_estimate_az_x = []; z_estimate_az_x =[];
%estimate of the object path using Kalman filter
u3_bias_x=[];    u3_perfect_x =[];
ll_x = mean(u3x);
%taking the mean of u3 will give the value and it is subtracted from
%each u3 to find bias and u3_perfect is calculated.

for t = 1:1:duration
    u3_bias_x(t) = u3x(t)-ll_x;
    u3_perfect_x(t) = u3x(t)-u3_bias_x(t);
end
```

Variables for Y Direction

```
x_estimate_az_y = []; y_estimate_az_y = []; z_estimate_az_y =[];
%estimate of the object path using Kalman filter
u3_bias_y=[];    u3_perfect_y =[];
ll_y = mean(u3y);
%taking the mean of u3 will give the value and it is subtracted from
%each u3 to find bias and u3_perfect is calculated.

for t = 1:1:duration
    u3_bias_y(t) = u3y(t)-ll_y;
    u3_perfect_y(t) = u3y(t)-u3_bias_y(t);
end
```

Variables for Z Direction

```

x_estimate_az_z = []; y_estimate_az_z = []; z_estimate_az_z =[];
%estimate of the object path using Kalman filter
u3_bias_z=[]; u3_perfect_z =[];
ll_z = mean(u3z);
%taking the mean of u3 will give the value and it is subtracted from
%each u3 to find bias and u3_perfect is calculated.

for t = 1:1:duration
    u3_bias_z(t) = u3z(t)-ll_z;
    u3_perfect_z(t) = u3z(t)-u3_bias_z(t);
end

```

Kalman Filter for X

```

Q_estimate_x= [0; 0; 0];
for t = 1:1:duration
    % Predict
    % Predicted State
    Q_estimate_curr = A * Q_estimate_x + B * ux; %-----1
    Z_p_x = [Z_p_x; Q_estimate_curr(1)];
    Z_v_x = [Z_v_x; Q_estimate_curr(2)];
    Z_a_x = [Z_a_x; Q_estimate_curr(3)];
    %predicted next covariance
    P = A * P * A' + Ex; %-----2
    % Update
    %Kalman Gain
    K = P*H'*inv(H*P*H'+R); %-----3

    % Update the state estimate.
    y = [Q_estimate_curr(1);Q_estimate_curr(2);u3x(t)];
    Q_estimate_x = Q_estimate_curr + K * (y - H * Q_estimate_curr); %--4

    % update covariance estimation.
    P = (eye(3)-K*H)*P; %-----5
    % Store for Plotting
    x_estimate_az_x = [x_estimate_az_x; Q_estimate_x(1)];
    y_estimate_az_x = [y_estimate_az_x; Q_estimate_x(2)];
    z_estimate_az_x = [z_estimate_az_x; Q_estimate_x(3)];
end

```

Kalman Filter for Y

```

Q_estimate_y= [0; 0; 0];
for t = 1:1:duration
    % Predict
    % Predicted State
    Q_estimate_curr = A * Q_estimate_y + B * uy; %-----1
    Z_p_y = [Z_p_y; Q_estimate_curr(1)];
    Z_v_y = [Z_v_y; Q_estimate_curr(2)];

```

```

Z_a_y = [Z_a_y; Q_estimate_curr(3)];
%predicted next covariance
P = A * P * A' + Ex; %-----2
% Update
%Kalman Gain
K = P*H'*inv(H*P*H'+R); %-----3

% Update the state estimate.
y = [Q_estimate_curr(1);Q_estimate_curr(2);u3y(t)];
Q_estimate_y = Q_estimate_curr + K * (y - H * Q_estimate_curr); %--4

% update covariance estimation.
P = (eye(3)-K*H)*P; %-----5
% Store for Plotting
x_estimate_az_y = [x_estimate_az_y; Q_estimate_y(1)];
y_estimate_az_y = [y_estimate_az_y; Q_estimate_y(2)];
z_estimate_az_y = [z_estimate_az_y; Q_estimate_y(3)];
end

```

Kalman Filter for Z

```

Q_estimate_z= [0; 0; 0];
for t = 1:1:duration
    % Predict
    % Predicted State
    Q_estimate_curr = A * Q_estimate_z + B * uz; %-----1
    Z_p_z = [Z_p_z; Q_estimate_curr(1)];
    Z_v_z = [Z_v_z; Q_estimate_curr(2)];
    Z_a_z = [Z_a_z; Q_estimate_curr(3)];
    %predicted next covariance
    P = A * P * A' + Ex; %-----2
    % Update
    %Kalman Gain
    K = P*H'*inv(H*P*H'+R); %-----3

    % Update the state estimate.
    y = [Q_estimate_curr(1);Q_estimate_curr(2);u3z(t)];
    Q_estimate_z = Q_estimate_curr + K * (y - H * Q_estimate_curr); %--4

    % update covariance estimation.
    P = (eye(3)-K*H)*P; %-----5
    % Store for Plotting
    x_estimate_az_z = [x_estimate_az_z; Q_estimate_z(1)];
    y_estimate_az_z = [y_estimate_az_z; Q_estimate_z(2)];
    z_estimate_az_z = [z_estimate_az_z; Q_estimate_z(3)];
end

```

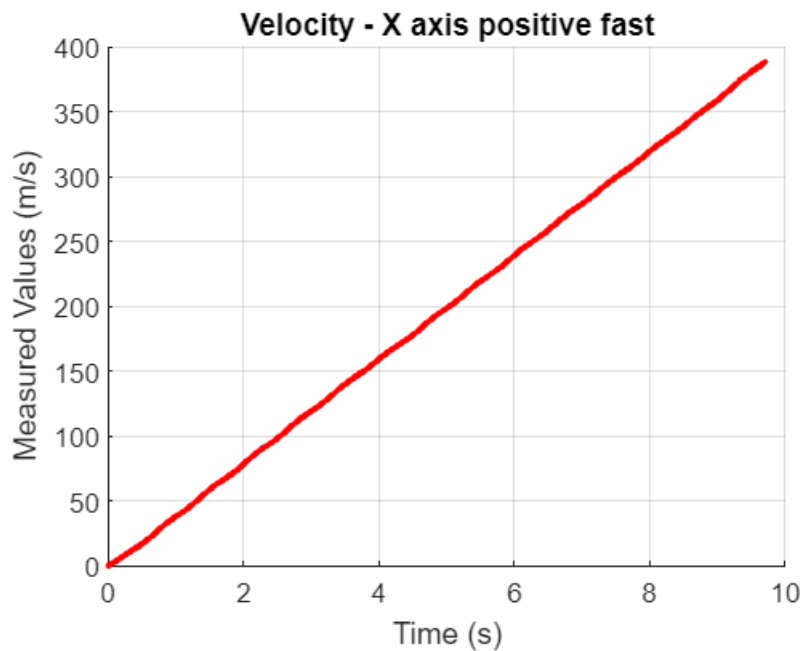
Plotting for X

```

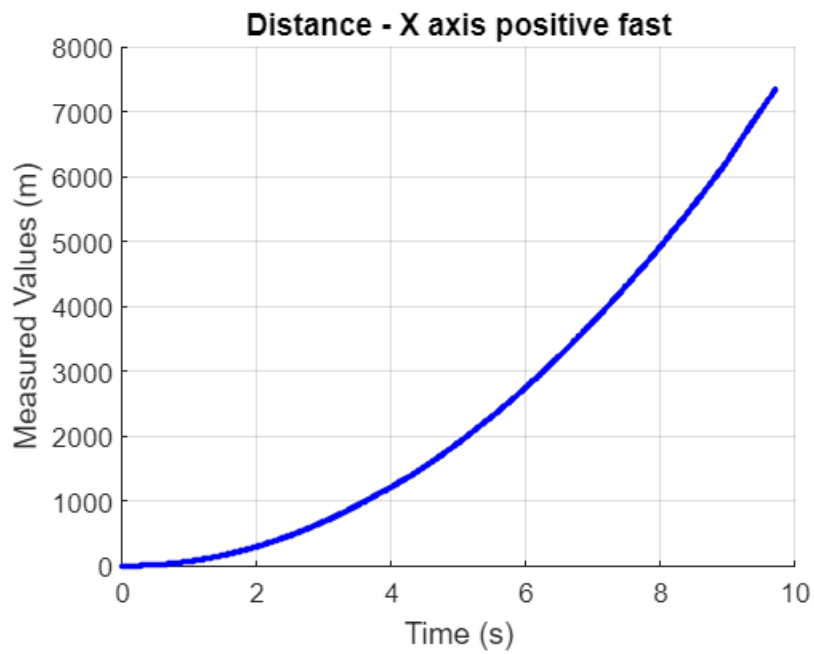
tt = 1:1:size(Z_v_x);

```

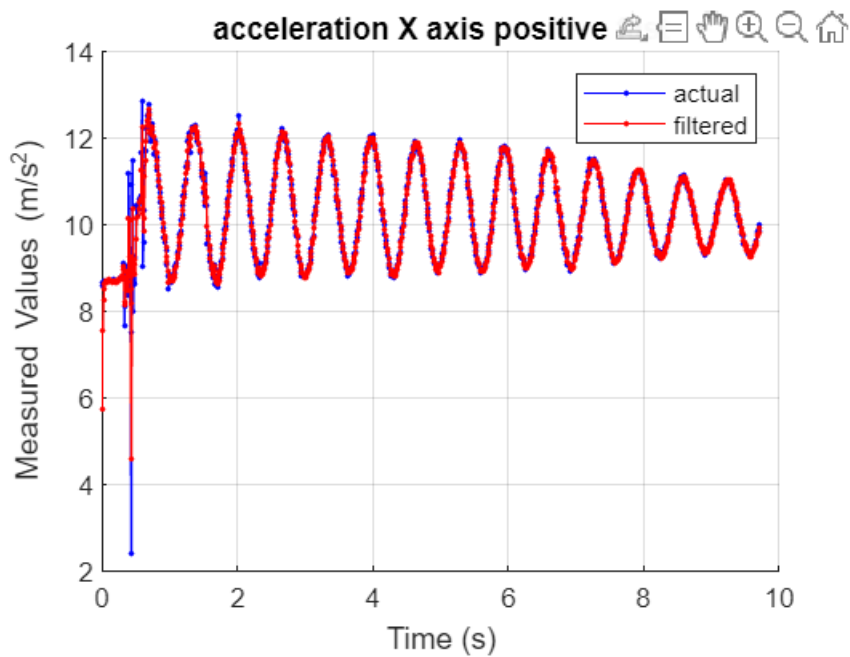
```
%x
figure;
hold on
grid on
plot(time(tt),Z_v_x,'-b. ');
plot(time(tt),y_estimate_az_x,'-r. ');
title('Velocity - X axis positive fast');
xlabel('Time (s)');
ylabel('Measured Values (m/s)');
hold off
```



```
figure;
hold on
grid on
plot(time(tt),Z_p_x,'-r. ');
plot(time(tt),x_estimate_az_x,'-b. ');
title('Distance - X axis positive fast');
xlabel('Time (s)');
ylabel('Measured Values (m)');
hold off
```



```
figure;
hold on
grid on
plot(time(tt),u3x(tt),'-b.');
plot(time(tt),z_estimate_az_x,'-r.');
title('acceleration X axis positive fast');
legend('actual', 'filtered')
xlabel('Time (s)');
ylabel('Measured Values (m/s^2)');
hold off
```



Plotting for Y

```
tt = 1:1:size(Z_v_y);  
%x  
figure;  
hold on  
grid on  
plot(time(tt),Z_v_y,'-b.');
```

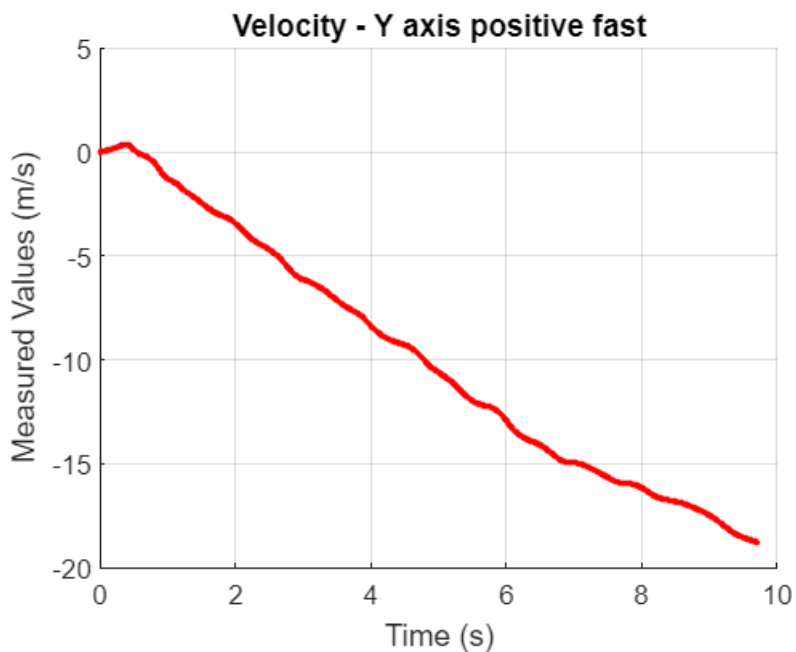
plot(time(tt),y_estimate_az_y,'-r.');

title('Velocity - Y axis positive fast');

xlabel('Time (s)');

ylabel ('Measured Values (m/s)');

hold off



```
figure;  
hold on  
grid on  
plot(time(tt),Z_p_y,'-r.');
```

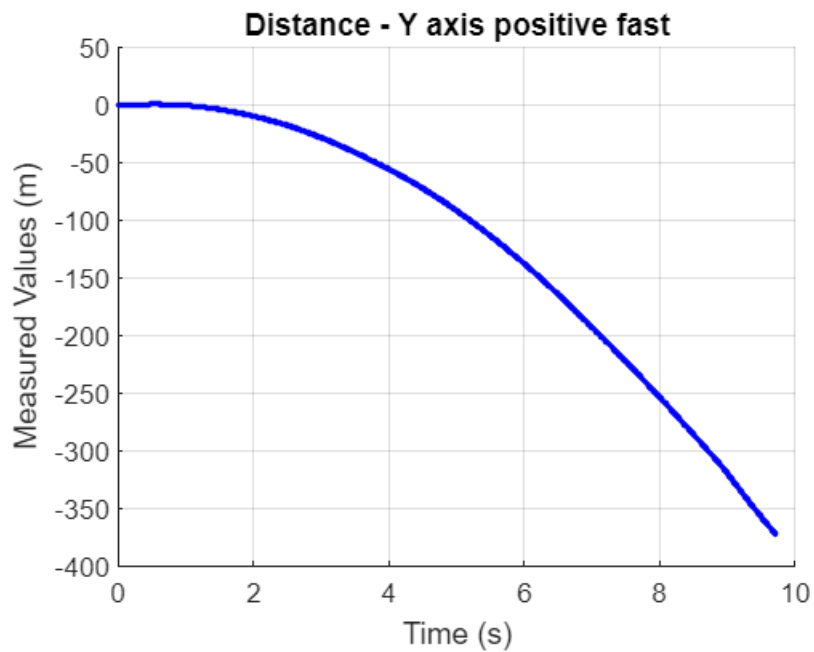
plot(time(tt),x_estimate_az_y,'-b.');

title('Distance - Y axis positive fast');

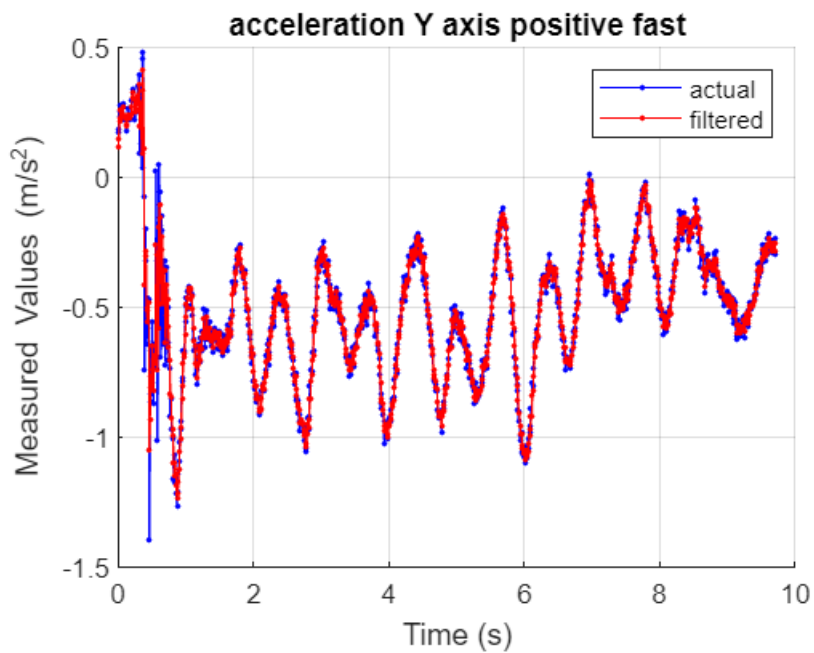
xlabel('Time (s)');

ylabel ('Measured Values (m)');

hold off



```
figure;
hold on
grid on
plot(time(tt),u3y(tt),'-b. ');
plot(time(tt),z_estimate_az_y,'-r. ');
title('acceleration Y axis positive fast');
legend('actual', 'filtered')
xlabel('Time (s)');
ylabel('Measured Values (m/s^2)');
hold off
```



Plotting for Z

```
tt = 1:1:size(Z_v_z);  
%x  
figure;  
hold on  
grid on  
plot(time(tt),Z_v_z,'-b.');
```

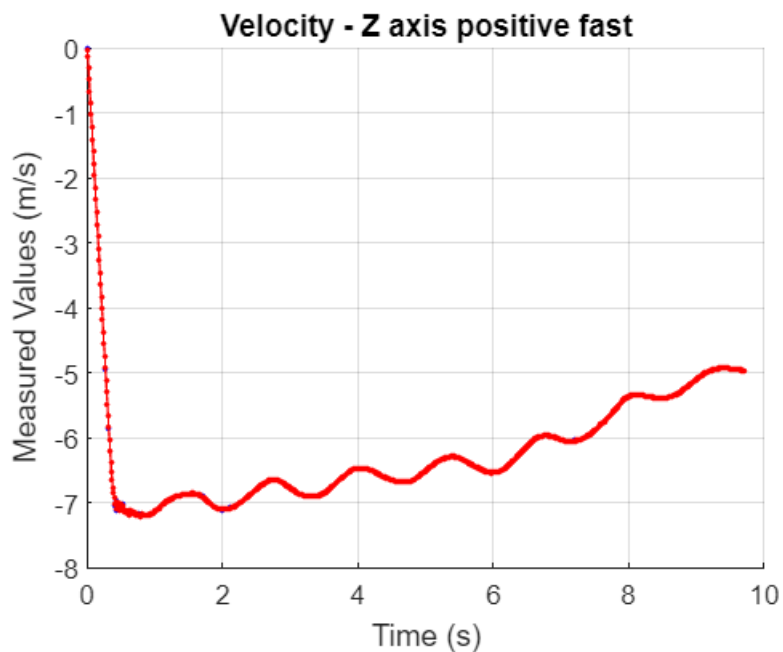
plot(time(tt),y_estimate_az_z,'-r.');

title('Velocity - Z axis positive fast');

xlabel('Time (s)');

ylabel ('Measured Values (m/s)');

hold off



```
figure;  
hold on  
grid on  
plot(time(tt),Z_p_z,'-r.');
```

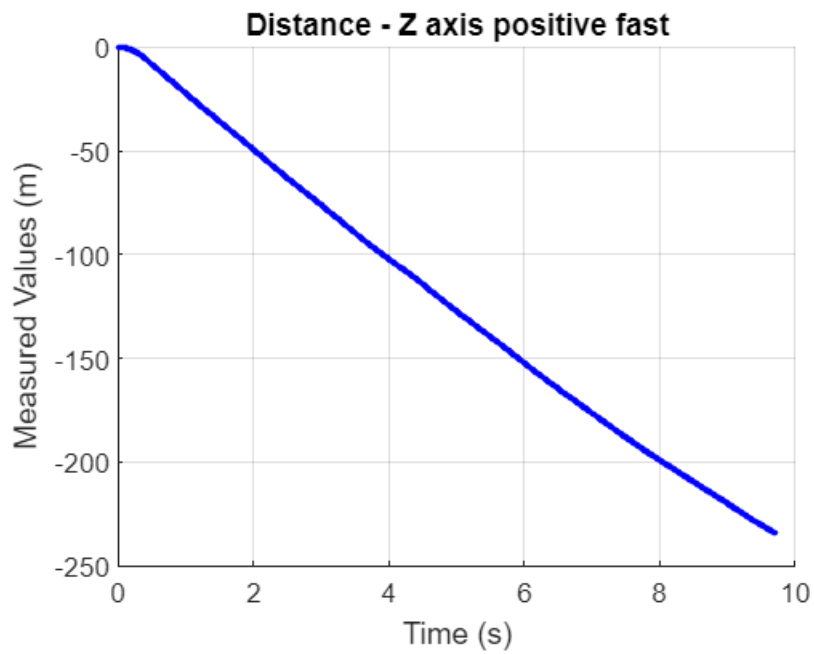
plot(time(tt),x_estimate_az_z,'-b.');

title('Distance - Z axis positive fast');

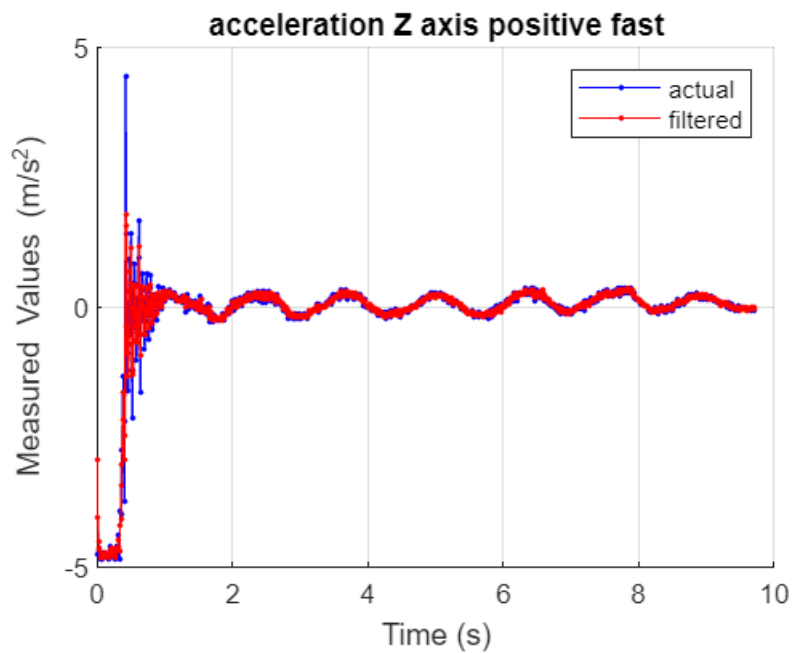
xlabel('Time (s)');

ylabel ('Measured Values (m)');

hold off



```
figure;
hold on
grid on
plot(time(tt),u3z(tt),'-b. ');
plot(time(tt),z_estimate_az_z,'-r. ');
title('acceleration Z axis positive fast');
legend('actual', 'filtered')
xlabel('Time (s)');
ylabel('Measured Values (m/s^2)');
hold off
```



imufilter: Estimate Orientation from IMU data

Load the IMU data which contains recorded accelerometer, gyroscope sensor data from a device oscillating in pitch (around y-axis), then yaw (around z-axis), and then roll (around x-axis). The sampling rate of this is 100 Hz.

```
filename_acc = 'cleaned_data/acc_values_vector_nav_45.csv';  
filename_gyr = 'cleaned_data/gyr_values_vector_nav_45.csv';  
filename_ypr = 'cleaned_data/ypr_values_vector_nav_45.csv';  
filename_quat = 'cleaned_data/quat_values_vector_nav_45.csv';
```

```
Fs = 400;
```

```
acc = csvread(filename_acc,1, 1);  
gyr = csvread(filename_gyr,1, 1);  
ypr = csvread(filename_ypr,1, 1);  
quat = csvread(filename_quat,1, 1);
```

```
accelerometerReadings = acc(1:7218,:)
```

```
accelerometerReadings = 7218x3  
    0.0112    -0.0106    -9.1792  
    0.0664     0.0127    -9.1577  
    0.0325     0.0239    -9.1589  
    0.0094    -0.0111    -9.1587  
    0.0701     0.0053    -9.1590  
    0.0384     0.0237    -9.1638  
   -0.0110    -0.0149    -9.1513  
    0.0537     0.0094    -9.1626  
    0.0305     0.0227    -9.1525  
   -0.0100    -0.0064    -9.1470  
      :  
      :
```

```
disp(accelerometerReadings)
```

```
    0.0112    -0.0106    -9.1792  
    0.0664     0.0127    -9.1577  
    0.0325     0.0239    -9.1589  
    0.0094    -0.0111    -9.1587  
    0.0701     0.0053    -9.1590  
    0.0384     0.0237    -9.1638  
   -0.0110    -0.0149    -9.1513  
    0.0537     0.0094    -9.1626  
    0.0305     0.0227    -9.1525  
   -0.0100    -0.0064    -9.1470  
    0.0584     0.0044    -9.1776  
    0.0407     0.0023    -9.1826  
   -0.0191    -0.0295    -9.1476  
    0.0605    -0.0122    -9.1301  
    0.0761     0.0206    -9.1588  
    0.0070    -0.0180    -9.1539  
    0.0679    -0.0270    -9.1246  
    0.0783     0.0079    -9.1403
```

-0.0055	0.0003	-9.1504
0.0327	0.0063	-9.1621
0.0680	0.0146	-9.1592
0.0101	-0.0092	-9.1432
0.0415	-0.0095	-9.1456
0.0779	0.0042	-9.1363
0.0086	-0.0092	-9.1344
0.0275	0.0005	-9.1289
0.0831	0.0302	-9.1233
0.0333	0.0089	-9.1533
0.0345	-0.0063	-9.1839
0.0721	0.0047	-9.1789
0.0126	-0.0118	-9.1541
0.0100	-0.0077	-9.1602
0.0829	0.0262	-9.1634
0.0278	0.0148	-9.1385
0.0081	-0.0172	-9.1469
0.0742	-0.0015	-9.1497
0.0173	0.0037	-9.1573
-0.0153	-0.0120	-9.1760
0.0618	0.0121	-9.1761
0.0504	0.0070	-9.1847
0.0048	-0.0164	-9.1913
0.0636	0.0090	-9.2041
0.0566	-0.0033	-9.1685
-0.0022	-0.0420	-9.1271
0.0586	-0.0101	-9.1527
0.0596	0.0246	-9.1703
-0.0003	0.0026	-9.1686
0.0618	0.0083	-9.1677
0.0674	0.0161	-9.1509
-0.0159	-0.0262	-9.1479
0.0395	-0.0336	-9.1596
0.0719	-0.0032	-9.1462
-0.0038	-0.0181	-9.1551
0.0453	-0.0109	-9.1685
0.0867	0.0228	-9.1638
-0.0144	0.0036	-9.1600
-0.0040	-0.0035	-9.1431
0.0644	0.0228	-9.1528
0.0070	-0.0078	-9.1526
0.0205	-0.0141	-9.1308
0.0833	0.0268	-9.1327
0.0264	0.0129	-9.1650
0.0167	-0.0144	-9.1776
0.0784	0.0091	-9.1456
0.0219	0.0191	-9.1271
0.0038	0.0072	-9.1422
0.0821	0.0324	-9.1641
0.0559	0.0179	-9.1670
0.0227	-0.0198	-9.1573
0.0806	0.0076	-9.1587
0.0592	0.0297	-9.1602
0.0190	0.0025	-9.1529
0.0663	0.0163	-9.1629
0.0429	0.0271	-9.1847
-0.0090	-0.0074	-9.1963
0.0588	-0.0010	-9.1849
0.0767	0.0284	-9.1704
0.0037	-0.0076	-9.1761
0.0673	-0.0068	-9.1862
0.0830	0.0269	-9.1878
0.0106	0.0005	-9.1719
0.0651	0.0121	-9.1565

0.0843	0.0276	-9.1689
0.0157	-0.0002	-9.1791
0.0462	0.0040	-9.1884
0.0755	0.0079	-9.1851
-0.0114	-0.0149	-9.1405
0.0152	0.0017	-9.1203
0.0849	0.0224	-9.1502
0.0174	-0.0214	-9.1655
0.0094	-0.0195	-9.1791
0.0563	0.0094	-9.1930
-0.0050	-0.0001	-9.1852
-0.0101	0.0139	-9.1747
0.0685	0.0219	-9.1748
0.0125	-0.0109	-9.1990
0.0037	-0.0238	-9.2022
0.0845	0.0060	-9.1737
0.0322	0.0064	-9.1642
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0.0165	-0.0276	-9.1818
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0.0816	0.0051	-9.1595
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0.0182	-0.0017	-9.1691
0.0271	0	-9.1644
0.0762	0.0021	-9.1708
0.0258	-0.0163	-9.1729
0.0381	0.0033	-9.1784
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0.0191	-0.0075	-9.1459
0.0984	0.0165	-9.1471
0.0469	-0.0052	-9.1697
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0.0473	0.0278	-9.1516
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0.0804	0.0266	-9.1796
0.0478	0.0041	-9.1806
0.0047	-0.0231	-9.1573
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0.0454	0.0224	-9.1404
0.0223	-0.0033	-9.1391
0.0970	0.0091	-9.1725
0.0865	0.0055	-9.1899
0.0177	-0.0141	-9.1893
0.0673	0.0221	-9.1670
0.0801	0.0500	-9.1631
0.0128	0.0103	-9.1715
0.0551	0.0073	-9.1717
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0.0191	-0.0014	-9.1795
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0.0592	-0.0059	-9.1762
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0.0236	0.0022	-9.2180
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0.1041	0.0224	-9.1864
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0.0399	0.0034	-9.1629
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0.0244	-0.0048	-9.1607
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0.0092	0.0236	-9.1330
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0.0607	0.0146	-9.1778
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0.0559	-0.0005	-9.1599
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0.1003	0.0161	-9.1838
0.0156	0.0192	-9.1717
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0.0168	-0.0049	-9.1972
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0.0058	-0.0259	-9.1470
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0.0206	-0.0270	-9.1780
0.0772	0.0085	-9.1555
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0.0575	0.0115	-9.1792

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0.0391	-0.0203	-9.1619
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1.1222	0.1182	-9.0354
1.1669	0.1485	-9.0876
1.1049	0.1195	-9.0927
1.1364	0.0631	-9.0905
1.2195	0.0688	-9.0949
1.1427	0.0630	-9.1255
1.1416	0.0610	-9.1718
1.2191	0.1624	-9.2032
1.1654	0.2471	-9.2226
1.1563	0.2497	-9.2638
1.2228	0.2180	-9.2888
1.2074	0.1271	-9.2932
1.2031	0.0487	-9.2752
1.2588	0.0680	-9.2513
1.2327	0.1111	-9.2302
1.2719	0.1650	-9.1807
1.3499	0.2818	-9.1253
1.2283	0.2905	-9.0958
1.1627	0.2293	-9.0875
1.2796	0.2563	-9.0637
1.2911	0.2480	-9.0053
1.2144	0.2089	-8.9428
1.2698	0.2478	-8.9312
1.2972	0.2633	-8.9274

1.2382	0.2172	-8.9244
1.2813	0.1755	-8.9448
1.3090	0.1161	-8.9660
1.2265	0.0657	-8.9670
1.2615	0.0678	-8.9592
1.3128	0.1067	-8.9421
1.2116	0.1007	-8.8948
1.2364	0.0971	-8.8868
1.3407	0.1657	-8.9322
1.3013	0.2155	-8.9635
1.3255	0.2470	-8.9728
1.4125	0.3080	-8.9833
1.3825	0.3428	-8.9813
1.4029	0.3490	-9.0027
1.4695	0.3842	-9.0536
1.3674	0.3585	-9.0891
1.3322	0.2735	-9.1260
1.4204	0.2778	-9.1840
1.3789	0.2924	-9.2252
1.3653	0.2677	-9.2553
1.4585	0.2828	-9.2816
1.4170	0.3145	-9.2604
1.3837	0.3471	-9.2212
1.4650	0.3966	-9.2373
1.4385	0.3617	-9.2359
1.4158	0.2933	-9.1936
1.4817	0.3339	-9.1880
1.4485	0.3469	-9.1617
1.3941	0.3034	-9.1136
1.4626	0.2969	-9.0525
1.4636	0.3095	-8.9737
1.4084	0.3156	-8.9395
1.4743	0.3074	-8.9767
1.4987	0.2872	-9.0194
1.4242	0.2622	-9.0446
1.4592	0.2749	-9.0564
1.4851	0.2537	-9.0349
1.4327	0.1895	-9.0323
1.5044	0.2426	-9.0130
1.5645	0.3624	-8.9334
1.5220	0.4650	-8.8383
1.5573	0.5644	-8.8068
1.6088	0.5991	-8.8531
1.5707	0.5404	-8.9516
1.5595	0.4485	-9.0271
1.6060	0.3923	-9.0851
1.5650	0.3671	-9.1382
1.5624	0.3986	-9.1502
1.6604	0.4889	-9.1844
1.6330	0.5334	-9.1693
1.6237	0.5291	-9.1358
1.6898	0.5433	-9.1230
1.6262	0.5114	-9.0643
1.5720	0.4499	-9.0698
1.6476	0.4494	-9.0971
1.6491	0.4627	-9.0701
1.6287	0.5094	-9.0452
1.6877	0.6131	-9.0098
1.6808	0.6550	-8.9558
1.6560	0.6345	-8.9354
1.7114	0.6408	-8.9509
1.7009	0.6005	-8.9462
1.6425	0.5160	-8.9395
1.7037	0.4873	-8.9298

1.7263	0.4818	-8.9165
1.6568	0.4575	-8.8788
1.6831	0.4596	-8.8430
1.7176	0.4604	-8.8587
1.7022	0.4590	-8.8526
1.7586	0.5250	-8.8236
1.7641	0.5852	-8.8509
1.7103	0.5629	-8.8868
1.7526	0.5162	-8.9044
1.8026	0.5109	-8.9560
1.7290	0.5179	-9.0025
1.7324	0.5404	-9.0273
1.7984	0.5718	-9.0744
1.7359	0.5544	-9.1047
1.7495	0.5588	-9.0916
1.8421	0.6091	-9.0799
1.8009	0.6087	-9.0640
1.8064	0.6129	-9.0437
1.8817	0.6520	-9.0268
1.8104	0.6276	-9.0027
1.7526	0.5790	-8.9797
1.8196	0.5900	-9.0020
1.8025	0.6097	-9.0235
1.7823	0.6026	-8.9727
1.8861	0.6101	-8.9550
1.8732	0.6449	-8.9596
1.8093	0.6477	-8.9211
1.8841	0.6189	-8.9170
1.8885	0.5966	-8.9517
1.8178	0.5667	-8.9555
1.8683	0.5470	-8.9381
1.8900	0.5685	-8.9229
1.8545	0.6171	-8.8773
1.9291	0.6831	-8.8412
1.9539	0.7393	-8.8179
1.8675	0.7190	-8.8000
1.8995	0.6734	-8.8126
1.9561	0.6970	-8.8384
1.8962	0.7281	-8.8630
1.9289	0.7093	-8.8593
1.9772	0.7012	-8.8960
1.9055	0.7029	-8.9478
1.9450	0.7038	-8.9983
1.9850	0.7074	-9.0250
1.9056	0.7042	-8.9965
1.9390	0.7236	-9.0033
1.9974	0.7620	-8.9789
1.9255	0.7433	-8.9165
1.9399	0.7091	-8.8852
2.0129	0.7253	-8.8756
1.9347	0.7081	-8.8806
1.8994	0.6832	-8.8789
1.9838	0.6861	-8.8862
1.9657	0.6891	-8.8815
1.9515	0.7239	-8.8483
2.0262	0.7793	-8.8531
2.0020	0.7841	-8.8321
1.9623	0.7476	-8.8190
2.0155	0.7525	-8.8460
2.0051	0.7363	-8.8443
1.9538	0.6980	-8.8282
2.0216	0.7153	-8.8382
2.0158	0.7291	-8.8486
1.9460	0.7219	-8.8322

2.0119	0.7434	-8.8537
2.0288	0.7580	-8.8816
1.9881	0.7315	-8.8910
2.0412	0.7416	-8.9300
2.0531	0.7772	-8.9466
1.9888	0.7338	-8.9408
2.0316	0.7398	-8.9511
2.0737	0.7801	-8.9504
2.0101	0.7629	-8.9385
2.0353	0.7880	-8.9158
2.0660	0.8230	-8.9277
2.0120	0.8127	-8.9665
2.0434	0.7922	-8.9496
2.0914	0.7943	-8.9263
2.0266	0.7799	-8.9267
2.0331	0.8061	-8.9302
2.1032	0.8880	-8.9472
2.0478	0.8719	-8.9349
2.0567	0.8415	-8.8736
2.1117	0.8771	-8.8496
2.0380	0.8309	-8.8621
2.0073	0.7422	-8.8579
2.0557	0.6958	-8.8817
2.0286	0.6700	-8.9023
2.0044	0.6671	-8.9011
2.0889	0.7100	-8.8843
2.0960	0.7759	-8.8876
2.0441	0.7706	-8.9128
2.0927	0.7619	-8.9298
2.0806	0.7876	-8.9708
2.0269	0.7647	-9.0291
2.0740	0.7609	-9.0636
2.0657	0.7551	-9.0707
2.0217	0.7395	-9.0784
2.0997	0.7670	-9.0832
2.1174	0.7857	-9.0687
2.0337	0.7708	-9.0514
2.0846	0.7631	-9.0435
2.1187	0.7415	-9.0106
2.0461	0.7112	-9.0031
2.0910	0.7292	-8.9970
2.1257	0.7331	-8.9679
2.0521	0.6965	-8.9661
2.0863	0.6943	-8.9672
2.1232	0.7193	-8.9529
2.0487	0.7156	-8.9611
2.0800	0.7411	-8.9970
2.1494	0.7750	-9.0112
2.0989	0.7480	-8.9864
2.0979	0.7180	-8.9750
2.1558	0.7499	-8.9974
2.1195	0.8152	-9.0087
2.1238	0.8724	-8.9844
2.2082	0.8907	-8.9583
2.1815	0.8461	-8.9502
2.1495	0.8034	-8.9380
2.2118	0.8197	-8.9632
2.1769	0.8211	-8.9668
2.1590	0.8437	-8.9349
2.2560	0.9569	-8.8896
2.2403	1.0023	-8.8855
2.2022	0.9732	-8.9268
2.2757	0.9770	-8.9490
2.2581	0.9439	-8.9774

2.1896	0.8911	-8.9674
2.2493	0.8970	-8.9167
2.2584	0.8804	-8.8990
2.1823	0.8188	-8.9060
2.2285	0.7924	-8.8915
2.2469	0.7985	-8.8809
2.1904	0.8044	-8.8743
2.2456	0.8426	-8.8665
2.2856	0.8835	-8.8714
1.8710	0.9921	-8.9016
2.1482	1.2022	-8.8005
2.6575	1.0474	-8.5848
2.3418	0.6779	-8.8823
2.2098	0.6524	-9.0247
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2.2724	0.7949	-8.9113
2.2875	0.8351	-8.9836
2.3462	0.8985	-9.0186
2.2926	0.9055	-8.9586
2.3180	0.9140	-8.8636
2.4114	0.9934	-8.8164
2.3843	1.0520	-8.7896
2.3593	1.0629	-8.7675
2.4415	1.0520	-8.7088
2.3999	1.0123	-8.6339
2.3254	0.9606	-8.5780
2.3889	0.9496	-8.5398
2.3748	0.9408	-8.5422
2.3490	0.9027	-8.4808
2.4269	0.9433	-8.4227
2.3949	0.9903	-8.4402
2.3558	0.9892	-8.5030
2.4388	1.0230	-8.5798
2.4319	1.0173	-8.6255
2.3799	0.9824	-8.6456
2.4276	1.0058	-8.6555
2.4110	1.0260	-8.6770
2.3554	1.0352	-8.6988
2.4295	1.1098	-8.7270
2.4739	1.1793	-8.7450
2.4214	1.1696	-8.7141
2.4597	1.1572	-8.7025
2.4775	1.1454	-8.7537
2.3994	1.0890	-8.8196
2.4256	1.0391	-8.8691
2.4519	1.0152	-8.9251
2.3840	0.9696	-8.9740
2.4118	0.9286	-9.0283
2.4551	0.9095	-9.0867
2.3688	0.8842	-9.0715
2.3661	0.8986	-9.0391
2.4381	0.9623	-9.0087
2.4044	0.9807	-8.9557
2.4160	1.0004	-8.9140
2.4901	1.0499	-8.9277
2.4474	1.0711	-9.0191
2.4282	1.0588	-9.1296
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2.4660	0.9763	-9.2826
2.4131	0.9224	-9.3325
2.4706	0.9081	-9.3706
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2.4197	0.8652	-9.3091
2.4994	0.9052	-9.2092

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2.5364	1.0019	-8.5771
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2.5328	1.1542	-8.4678
2.5991	1.1593	-8.4872
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2.6084	1.2047	-8.3349
2.6049	1.2144	-8.3734
2.6590	1.2394	-8.4146
2.7215	1.3209	-8.5066
2.6974	1.3387	-8.5650
2.7464	1.2548	-8.5389
2.8022	1.1144	-8.5595
2.6784	0.9471	-8.5396
2.6204	0.8563	-8.5018
2.6626	0.8708	-8.5802
2.6022	0.8456	-8.7421
2.5804	0.7702	-8.8780
2.6514	0.7532	-8.8249
2.6342	0.7801	-8.7113
2.6057	0.8228	-8.7298
2.7101	0.8965	-8.6989
2.7381	0.9646	-8.5513
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2.7054	1.0765	-8.3741
2.7308	1.1019	-8.3330
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2.7342	0.9520	-8.6540
2.6394	0.9111	-8.6662
2.6696	0.9037	-8.6278
2.7192	0.9056	-8.6263
2.6706	0.9435	-8.6662
2.7418	1.0665	-8.7178
2.8327	1.2383	-8.7429
2.7922	1.3188	-8.7840
2.8098	1.3311	-8.8637
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2.7562	1.1426	-9.0718
2.7475	1.0028	-9.2034
2.7825	0.9634	-9.2229
2.7025	0.9513	-9.1475
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2.8033	0.9894	-8.9947
2.7552	1.0162	-8.9072
2.7414	1.0688	-8.8114
2.8280	1.1577	-8.7065
2.8031	1.1743	-8.6095
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2.8567	0.9462	-8.7345
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2.8065	0.8725	-8.7387
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3.2640	0.9919	-8.2442
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3.2271	0.9428	-8.1527
3.2674	0.9038	-8.1947
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3.2327	0.9348	-8.2306
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3.2924	0.9244	-8.2097
3.2373	0.8932	-8.2257
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3.2523	0.8783	-8.5215
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3.3082	0.8998	-8.5268
3.2872	0.8750	-8.5473
3.3599	0.8805	-8.5776
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3.3600	0.8825	-8.5882
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3.3067	0.9511	-8.6043
3.3400	0.9476	-8.5905
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3.3975	0.9967	-8.5452
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3.4458	0.9761	-8.5195
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3.4337	0.8063	-8.4840
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3.3524	0.8386	-8.4551
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3.4601	0.9098	-8.4706
3.4019	0.9068	-8.4706
3.4485	0.9249	-8.4847
3.4490	0.9425	-8.5041
3.3715	0.9240	-8.5251
3.4279	0.9312	-8.5396
3.4708	0.9324	-8.5521
3.4008	0.9201	-8.5608
3.4380	0.9298	-8.5735
3.4711	0.9193	-8.5933
3.3956	0.8918	-8.6008
3.4191	0.8613	-8.5977
3.4689	0.8611	-8.6032
3.3847	0.8209	-8.6209
3.3884	0.7887	-8.6217
3.4590	0.8180	-8.5967
3.4129	0.8099	-8.6052
3.4129	0.8210	-8.6108
3.4816	0.8789	-8.6136
3.4544	0.8971	-8.5778
3.4414	0.8775	-8.4823
3.5008	0.9040	-8.4131
3.4575	0.9161	-8.3881
3.4258	0.8885	-8.4128
3.4996	0.8893	-8.4465
3.4689	0.8780	-8.4709
3.4422	0.8705	-8.4657
3.5256	0.9198	-8.4462
3.5013	0.9631	-8.4695
3.4391	0.9617	-8.5113
3.5238	0.9762	-8.5660
3.5488	0.9426	-8.5935
3.4691	0.8564	-8.5891
3.5233	0.8546	-8.5963
3.5428	0.8865	-8.6443
3.4710	0.8869	-8.6719
3.5345	0.9114	-8.6755
3.5646	0.9314	-8.7087
3.4918	0.8889	-8.7190
3.5116	0.8248	-8.7052
3.5329	0.7923	-8.6739
3.4763	0.7667	-8.6603
3.5150	0.7895	-8.6310
3.5826	0.8314	-8.6224
3.5500	0.8079	-8.6185
3.5760	0.7939	-8.5695
3.6110	0.7943	-8.5596
3.5277	0.7610	-8.5666
3.5210	0.7659	-8.5465
3.5801	0.7903	-8.5155
3.5262	0.7794	-8.4856
3.5301	0.7736	-8.4756
3.6202	0.8125	-8.4786
3.5821	0.8376	-8.4522
3.5527	0.8204	-8.3926

3.6457	0.8314	-8.3573
3.6221	0.8350	-8.3599
3.5955	0.8481	-8.3241
3.6933	0.8985	-8.2704
3.6781	0.9311	-8.2534
3.6422	0.9411	-8.2525
3.7200	0.9481	-8.2679
3.7110	0.9418	-8.2536
3.6440	0.9136	-8.2090
3.6935	0.9238	-8.2421
3.7009	0.9331	-8.2854
3.6527	0.9057	-8.3418
3.7188	0.9153	-8.4049
3.7274	0.9054	-8.4229
3.6515	0.8565	-8.3964
3.7095	0.8671	-8.3476
3.7377	0.8880	-8.3971
3.6608	0.8839	-8.4411
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3.7439	0.8810	-8.4213
3.6868	0.8413	-8.4454
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3.7430	0.8722	-8.4320
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3.7413	0.8656	-8.3995
3.6820	0.8458	-8.3666
3.6800	0.8205	-8.3122
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3.7398	0.8793	-8.2988
3.8119	0.9315	-8.2932
3.7569	0.9369	-8.2794
3.7446	0.9333	-8.2671
3.8376	0.9708	-8.2350
3.8052	0.9780	-8.2326
3.7685	0.9440	-8.2626
3.8506	0.9472	-8.2861
3.8238	0.9504	-8.3183
3.7611	0.9269	-8.3506
3.8128	0.9362	-8.3386
3.8056	0.9487	-8.3050
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3.8798	1.0018	-8.3553
3.9428	1.0539	-8.3351
3.8716	1.0502	-8.2913
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3.9500	0.9868	-8.2332
3.9255	1.0402	-8.1783
4.0018	1.0834	-8.1065
3.9966	1.0594	-8.1212
3.9409	0.9809	-8.1887
3.9832	0.9551	-8.2428
4.0018	0.9678	-8.2658
3.9523	0.9513	-8.3374
3.9735	0.9768	-8.4284
3.9839	1.0203	-8.4763
3.9136	1.0138	-8.4580
3.9538	1.0210	-8.4193
3.9893	1.0133	-8.4243
3.9370	0.9694	-8.4142
3.9667	0.9850	-8.4003
4.0168	1.0321	-8.3963
3.9785	1.0460	-8.3714
4.0156	1.0807	-8.3229
4.0981	1.1598	-8.2907
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4.1290	1.2927	-8.0955
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4.0579	1.1750	-8.1362
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4.0787	1.2039	-8.1766
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4.2043	1.2259	-8.2499
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4.1938	1.0350	-8.2394
4.1197	1.0114	-8.2152
4.0917	0.9708	-8.1811
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4.2627	1.2292	-8.2052
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4.1980	1.1369	-8.3159
4.1385	1.0256	-8.2948
4.1833	0.9375	-8.2789
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4.1960	1.1404	-8.0075
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4.1968	0.9443	-7.9486
4.2479	0.9796	-7.9283
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4.1262	0.9373	-7.9687
4.1812	0.8845	-8.0616
4.1593	0.8194	-8.1185
4.1053	0.7444	-8.1297
4.1596	0.7155	-8.1650
4.1430	0.7102	-8.2140
4.0899	0.6794	-8.2229
4.1669	0.6834	-8.2273
4.1722	0.7021	-8.2653
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4.1852	0.7577	-8.3391
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4.3368	0.9848	-7.9246
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4.2318	0.7361	-8.2826
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4.0899	0.3399	-8.3252
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4.1174	0.5346	-8.1229
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4.0881	0.5043	-8.1820
4.1326	0.5158	-8.1884
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4.1053	0.5162	-8.2050
4.0763	0.4364	-8.2074
4.1073	0.3666	-8.2181
4.0347	0.2798	-8.2535
4.0272	0.2418	-8.3024
4.0864	0.2561	-8.3200
4.0262	0.2440	-8.2860
4.0284	0.2682	-8.2850
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4.2777	0.3327	-8.2642
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4.2385	0.5287	-8.1751
4.3063	0.5246	-8.2300
4.2606	0.4582	-8.2958
4.2187	0.4026	-8.3392
4.2734	0.4080	-8.3749
4.2550	0.3967	-8.3816
4.2126	0.4045	-8.3496
4.2871	0.4577	-8.3014
4.2898	0.4946	-8.2361
4.2190	0.4952	-8.2120
4.2693	0.5026	-8.2385
4.2747	0.5217	-8.2388
4.2148	0.4959	-8.2242
4.2712	0.4908	-8.2153
4.2870	0.5028	-8.1685
4.2203	0.4907	-8.1207
4.2595	0.4973	-8.1294
4.2958	0.4898	-8.1294
4.2152	0.4562	-8.1057
4.2045	0.4619	-8.1166
4.2404	0.4806	-8.1837
4.2037	0.4652	-8.2393

4.2287	0.4585	-8.2669
4.2659	0.4812	-8.2761
4.1887	0.4947	-8.2601
4.1952	0.5147	-8.2647
4.2777	0.5345	-8.2669
4.2313	0.4993	-8.2731
4.2318	0.4985	-8.2965
4.3157	0.5506	-8.3321
4.2844	0.5852	-8.3300
4.2680	0.6298	-8.2533
4.3356	0.6624	-8.1814
4.2766	0.6243	-8.1361
4.2295	0.5831	-8.1090
4.2986	0.5701	-8.1183
4.2635	0.5236	-8.1133
4.2082	0.4964	-8.0958
4.2579	0.5121	-8.0981
4.2471	0.5245	-8.1035
4.2078	0.5422	-8.1171
4.2829	0.5976	-8.1284
4.2991	0.6478	-8.1276
4.2476	0.6472	-8.1476
4.2992	0.6499	-8.1782
4.2849	0.6134	-8.2002
4.2035	0.5093	-8.2177
4.2300	0.4507	-8.2113
4.2285	0.4294	-8.1940
4.1657	0.4192	-8.2004
4.2267	0.4668	-8.2219
4.2725	0.5262	-8.2145
4.2159	0.5374	-8.1637
4.2642	0.5434	-8.1529
4.3075	0.5515	-8.1652
4.2368	0.5496	-8.1484
4.2471	0.5678	-8.0985
4.2856	0.5841	-8.0938
4.2181	0.5632	-8.1297
4.2223	0.5073	-8.1191
4.2664	0.4938	-8.1835
4.1916	0.4820	-8.2610
4.1805	0.4583	-8.2705
4.2609	0.4775	-8.2716
4.2292	0.4770	-8.2931
4.2124	0.4713	-8.3006
4.2789	0.5007	-8.2818
4.2429	0.5037	-8.2868
4.2148	0.4793	-8.2939
4.2708	0.4869	-8.3145
4.2329	0.4720	-8.3514
4.2188	0.4391	-8.3592
4.3038	0.4578	-8.3361
4.2663	0.4764	-8.3237
4.1935	0.4760	-8.2887
4.2435	0.5175	-8.2451
4.2477	0.5543	-8.2532
4.1985	0.5354	-8.2567
4.2497	0.5276	-8.2015
4.2660	0.5411	-8.1614
4.2001	0.5479	-8.1300
4.2407	0.5786	-8.0690
4.2797	0.5850	-8.0645
4.2262	0.5386	-8.1000
4.2579	0.5263	-8.1156
4.2689	0.5104	-8.1262

4.1786	0.4438	-8.1876
4.2040	0.4064	-8.2615
4.2611	0.3895	-8.2962
4.1855	0.3720	-8.2907
4.1902	0.3899	-8.2770
4.2655	0.4291	-8.2823
4.2239	0.4388	-8.2841
4.2407	0.4550	-8.2402
4.3170	0.5124	-8.1716
4.2654	0.5323	-8.1295
4.2426	0.5418	-8.1048
4.3057	0.5743	-8.0887
4.2483	0.5411	-8.0899
4.1995	0.4704	-8.1367
4.2691	0.4735	-8.1752
4.2536	0.4782	-8.2106
4.2199	0.4515	-8.2339
4.2819	0.4656	-8.2518
4.2572	0.4386	-8.3132
4.1980	0.3871	-8.3359
4.2674	0.4006	-8.3311
4.2773	0.4346	-8.3148
4.2219	0.4499	-8.2743
4.2784	0.4969	-8.2414
4.2849	0.5464	-8.2441
4.2268	0.5545	-8.2285
4.2751	0.5902	-8.2062
4.3143	0.6303	-8.2017
4.2732	0.6208	-8.1670
4.3210	0.6323	-8.1544
4.3532	0.6309	-8.1558
4.2736	0.5706	-8.1603
4.3019	0.5671	-8.1557
4.3390	0.5649	-8.1495
4.2521	0.4954	-8.1342
4.2552	0.4546	-8.1436
4.3002	0.4557	-8.1906
4.2218	0.4367	-8.2404
4.2238	0.4260	-8.2767
4.2932	0.4345	-8.2458
4.2585	0.4080	-8.2203
4.2549	0.3853	-8.2234
4.3066	0.4239	-8.1856
4.2545	0.4366	-8.1663
4.2651	0.4209	-8.1956
4.3520	0.4723	-8.1816
4.2918	0.5086	-8.1455
4.2455	0.4810	-8.1247
4.3199	0.4793	-8.1191
4.3094	0.4727	-8.1204
4.2616	0.4343	-8.0886
4.3033	0.4444	-8.0629
4.2880	0.4777	-8.0619
4.2531	0.4799	-8.0776
4.3316	0.4906	-8.0946
4.3305	0.4961	-8.0874
4.2776	0.5025	-8.0813
4.3535	0.5473	-8.1102
4.3686	0.5490	-8.1353
4.3113	0.5016	-8.1387
4.3530	0.4999	-8.1510
4.3514	0.5025	-8.1577
4.2774	0.4554	-8.1704
4.3201	0.4363	-8.1672

4.3549	0.4317	-8.1623
4.2837	0.3988	-8.1609
4.2979	0.3898	-8.1511
4.3503	0.4243	-8.1663
4.2984	0.4516	-8.1768
4.3196	0.4826	-8.1835
4.3896	0.5232	-8.2141
4.3258	0.5280	-8.1824
4.3071	0.5483	-8.1379
4.3742	0.5516	-8.1452
4.3214	0.4852	-8.1587
4.2941	0.4367	-8.1765
4.3482	0.4364	-8.1942
4.3017	0.4018	-8.2057
4.2903	0.3626	-8.2213
4.3708	0.4071	-8.2358
4.3410	0.4507	-8.2294
4.3138	0.4848	-8.2199
4.4084	0.5539	-8.1878
4.3910	0.5864	-8.1554
4.3220	0.5756	-8.0950
4.3918	0.5560	-8.0436
4.3708	0.5392	-8.0628
4.2848	0.5064	-8.0557
4.3539	0.5088	-8.0377
4.3610	0.5249	-8.0416
4.2837	0.4949	-8.0288
4.3398	0.4899	-8.0292
4.3900	0.4865	-8.0511
4.3467	0.4626	-8.0824
4.3770	0.4943	-8.0861
4.4009	0.5317	-8.0529
4.3226	0.5188	-8.0265
4.3412	0.5006	-8.0494
4.3997	0.4703	-8.1215
4.3407	0.4204	-8.1846
4.3702	0.4093	-8.2252
4.4206	0.4381	-8.2513
4.3194	0.4028	-8.2282
4.3150	0.3798	-8.2002
4.3882	0.4375	-8.1785
4.3390	0.4736	-8.1795
4.3507	0.4897	-8.1749
4.4362	0.5172	-8.1358
4.3821	0.5309	-8.0978
4.3619	0.5513	-8.0570
4.4380	0.5637	-8.0502
4.3855	0.5367	-8.0654
4.3319	0.4866	-8.0313
4.3971	0.4390	-7.9911
4.3641	0.4020	-8.0218
4.3102	0.3456	-8.0665
4.3562	0.3181	-8.0664
4.3108	0.3033	-8.0210
4.2679	0.3188	-8.0681
4.3757	0.4379	-8.1483
4.4064	0.5085	-8.1881
4.3397	0.4844	-8.2143
4.4027	0.4936	-8.2393
4.4417	0.5080	-8.2532
4.3812	0.4996	-8.2419
4.4232	0.5145	-8.2331
4.4137	0.4838	-8.2127
4.3278	0.3876	-8.2137

4.3857	0.3676	-8.2049
4.4199	0.4054	-8.1614
4.3506	0.4235	-8.1193
4.3918	0.4820	-8.1021
4.4465	0.5490	-8.0897
4.3719	0.5334	-8.0741
4.3695	0.5035	-8.0609
4.4271	0.5107	-8.0471
4.3578	0.4957	-8.0431
4.3514	0.4793	-8.0370
4.4196	0.4714	-8.0468
4.3693	0.4499	-8.0438
4.3595	0.4511	-8.0172
4.4210	0.4739	-8.0272
4.3691	0.4703	-8.0188
4.3331	0.4648	-7.9795
4.4004	0.4767	-7.9705
4.3624	0.4469	-8.0095
4.3375	0.4024	-8.0652
4.4246	0.3891	-8.0871
4.3940	0.3867	-8.0773
4.3209	0.3873	-8.0636
4.3921	0.4294	-8.0197
4.3903	0.4788	-7.9564
4.3374	0.4805	-7.9326
4.4085	0.4927	-7.9495
4.3998	0.4735	-7.9750
4.3211	0.4095	-7.9843
4.3633	0.3893	-7.9994
4.3884	0.3791	-8.0232
4.3377	0.3534	-8.0375
4.3780	0.3911	-8.0572
4.4067	0.4120	-8.0920
4.3378	0.3644	-8.1247
4.3524	0.3554	-8.1610
4.3902	0.3762	-8.2003
4.3135	0.3776	-8.2276
4.3553	0.4250	-8.2331
4.4309	0.4840	-8.2521
4.3347	0.4320	-8.2465
4.3132	0.3348	-8.2315
4.3700	0.3017	-8.2753
4.3094	0.3211	-8.2743
4.3212	0.3860	-8.2470
4.4207	0.4676	-8.2259
4.3646	0.4997	-8.1825
4.3322	0.4738	-8.1410
4.3939	0.4404	-8.1496
4.3426	0.4222	-8.1700
4.3282	0.4192	-8.1549
4.4141	0.4612	-8.1538
4.3912	0.4737	-8.1578
4.3434	0.4637	-8.1521
4.3752	0.4858	-8.1626
4.3271	0.4576	-8.1988
4.2815	0.4063	-8.2249
4.3594	0.4228	-8.2041
4.3626	0.4801	-8.1456
4.3219	0.5339	-8.0951
4.3967	0.5705	-8.1026
4.4044	0.5659	-8.1559
4.3338	0.5340	-8.1555
4.3789	0.5309	-8.1217
4.3826	0.5580	-8.0868

4.3162	0.5619	-8.0951
4.3712	0.5549	-8.1365
4.4100	0.5651	-8.1333
4.3306	0.5581	-8.1259
4.3397	0.5459	-8.0953
4.3805	0.5425	-8.0536
4.3196	0.5028	-8.0600
4.3436	0.4822	-8.0903
4.4007	0.5085	-8.1101
4.3227	0.5118	-8.1254
4.2983	0.4873	-8.1378
4.3521	0.4558	-8.1687
4.3111	0.3840	-8.2249
4.2855	0.3568	-8.2605
4.3504	0.3933	-8.2524
4.3502	0.4212	-8.2517
4.3316	0.4580	-8.2486
4.3854	0.4928	-8.1996
4.3396	0.4798	-8.1449
4.3041	0.4455	-8.1301
4.3781	0.4584	-8.1389
4.3396	0.4598	-8.1371
4.2907	0.4503	-8.1314
4.3623	0.4602	-8.1552
4.3538	0.4542	-8.1900
4.2879	0.4344	-8.1900
4.3414	0.4340	-8.1584
4.3291	0.4547	-8.1272
4.2618	0.4510	-8.1120
4.3411	0.4622	-8.1153
4.3578	0.4931	-8.1013
4.2812	0.4998	-8.0798
4.3343	0.5224	-8.0915
4.3703	0.5558	-8.0987
4.3082	0.5573	-8.0782
4.3469	0.5689	-8.0495
4.3952	0.5887	-8.0512
4.3351	0.5493	-8.0529
4.3542	0.5211	-8.0282
4.3777	0.5172	-8.0339
4.2816	0.4833	-8.0597
4.3024	0.4692	-8.1190
4.3659	0.4690	-8.1680
4.2924	0.4466	-8.1608
4.2892	0.4296	-8.1588
4.3542	0.4292	-8.1592
4.2907	0.4141	-8.1817
4.2712	0.4041	-8.2377
4.3576	0.4405	-8.2270
4.3053	0.4456	-8.2085
4.2526	0.4385	-8.2042
4.3394	0.4731	-8.1838
4.3332	0.4808	-8.1781
4.2935	0.4810	-8.1423
4.3557	0.5411	-8.1057
4.3382	0.5876	-8.0984
4.2944	0.5989	-8.0831
4.3688	0.6474	-8.0599
4.3632	0.6541	-8.0545
4.3012	0.6046	-8.0896
4.3706	0.6174	-8.1467
4.3739	0.6039	-8.1419
4.2755	0.5351	-8.1307
4.3109	0.5027	-8.1885

4.3387	0.4922	-8.2470
4.2866	0.4937	-8.2832
4.3412	0.5164	-8.2613
4.3839	0.5660	-8.2163
4.3231	0.5683	-8.2208
4.3569	0.5602	-8.2532
4.3882	0.5718	-8.2771
4.2817	0.5059	-8.2596
4.2836	0.4364	-8.2560
4.3436	0.4307	-8.2798
4.2739	0.4169	-8.2764
4.2780	0.3897	-8.2661
4.3313	0.3897	-8.2739
4.2733	0.4003	-8.2833
4.2800	0.4464	-8.2627
4.3551	0.5415	-8.2022
4.3057	0.5715	-8.1417
4.2774	0.5425	-8.1159
4.3335	0.5361	-8.1204
4.2817	0.4990	-8.1293
4.2585	0.4701	-8.1158
4.3429	0.5273	-8.0897
4.3263	0.5677	-8.0932
4.2950	0.5559	-8.0639
4.3742	0.5858	-8.0263
4.3558	0.6173	-8.0449
4.2855	0.5879	-8.0503
4.3493	0.5766	-8.0517
4.3562	0.5709	-8.0518
4.2938	0.5676	-8.0473
4.3495	0.5973	-8.0732
4.3603	0.6068	-8.1029
4.2953	0.5945	-8.1261
4.3462	0.6064	-8.1309
4.3565	0.6363	-8.1106
4.2666	0.5928	-8.1259
4.3051	0.5503	-8.1687
4.3510	0.5622	-8.2192
4.2829	0.5335	-8.2340
4.3047	0.5134	-8.2410
4.3514	0.5160	-8.2841
4.2786	0.5013	-8.2702
4.3114	0.5007	-8.2531
4.3866	0.5304	-8.2625
4.3100	0.5586	-8.2565
4.3117	0.5957	-8.2374
4.3900	0.6420	-8.1956
4.3240	0.6309	-8.1346
4.2983	0.6206	-8.0972
4.3651	0.6369	-8.0979
4.3179	0.6161	-8.1003
4.2862	0.6143	-8.0878
4.3618	0.6695	-8.0782
4.3483	0.6976	-8.0517
4.3036	0.6854	-8.0426
4.3618	0.7224	-8.0766
4.3580	0.7506	-8.0552
4.3307	0.7219	-8.0513
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4.2727	0.5501	-8.1872
4.3031	0...	

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gyroscopeReadings = gyr(1:7218, :);
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disp(gyroscopeReadings)
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-0.0007   -0.0003    0.0001
-0.0007   -0.0006   -0.0003
-0.0003   -0.0003    0.0003
-0.0004    0.0000   -0.0005
 0.0002   -0.0004   -0.0006
 0.0009    0.0001    0.0012
 0.0010    0.0007    0.0014
 0.0004    0.0003    0.0004
-0.0001   -0.0001   -0.0008
-0.0005    0.0001   -0.0007
-0.0007    0.0009    0.0001
 0.0005    0.0007   -0.0003
 0.0001    0.0001    0.0005
-0.0009    0.0006    0.0012
-0.0005    0.0001    0.0012
-0.0009   -0.0015    0.0006
-0.0004   -0.0011   -0.0004
-0.0001   -0.0004   -0.0003
-0.0008   -0.0004   -0.0007
 0.0000   -0.0001   -0.0002
 0.0004   -0.0002    0.0006
-0.0003   -0.0003   -0.0004
-0.0008   -0.0004   -0.0016
-0.0008    0.0002   -0.0014
-0.0006    0.0010    0.0003
 0.0000    0.0001    0.0003
-0.0001   -0.0009   -0.0005
-0.0004   -0.0009   -0.0006
 0.0002   -0.0010   -0.0004
 0.0009   -0.0005    0.0001
 0.0008    0.0007    0.0003
 0.0002    0.0005    0.0003
-0.0007   -0.0003   -0.0003
-0.0016   -0.0008   -0.0000
-0.0002    0.0000    0.0005
 0.0012    0.0002    0.0004
 0.0012   -0.0007   -0.0002
 0.0004   -0.0001   -0.0010
-0.0002    0.0009   -0.0009
 0.0000    0.0011   -0.0008
-0.0001    0.0001   -0.0005
 0.0002   -0.0011   -0.0002
 0.0005   -0.0015   -0.0001
-0.0002   -0.0011   -0.0000
-0.0001   -0.0008   -0.0004
-0.0004   -0.0010    0.0004
-0.0013   -0.0005    0.0010
-0.0010   -0.0006    0.0007
-0.0007   -0.0001    0.0002
 0.0000    0.0007   -0.0001
 0.0013    0.0002   -0.0000
 0.0004   -0.0002   -0.0000
-0.0000    0.0004   -0.0004
 0.0001    0.0004    0.0002
-0.0002   -0.0003    0.0002
-0.0006   -0.0005   -0.0007
-0.0007    0.0002   -0.0005
-0.0005   -0.0001    0.0000
-0.0005   -0.0010    0.0003
-0.0007   -0.0003    0.0011
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-0.0000	-0.0001	0.0012
0.0007	0.0006	0.0003
0.0000	0.0009	0.0002
-0.0006	0.0002	0.0007
-0.0004	0.0007	0.0008
0.0001	0.0001	-0.0002
0.0005	-0.0005	-0.0004
0.0006	0.0005	0.0004
0.0003	0.0009	0.0000
0.0007	0.0007	0.0001
0.0008	0.0006	0.0001
0.0005	0.0001	-0.0004
0.0004	-0.0004	-0.0003
0.0005	0.0003	-0.0002
-0.0002	0.0002	-0.0000
-0.0002	-0.0002	-0.0000
0.0007	-0.0005	-0.0002
-0.0003	-0.0010	-0.0002
-0.0002	-0.0010	0.0003
0.0010	-0.0010	-0.0005
0.0008	-0.0008	-0.0016
-0.0004	-0.0010	-0.0011
-0.0005	-0.0003	-0.0008
0.0001	0.0009	-0.0011
-0.0001	0.0008	-0.0004
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0.0018	0.0014	0.0023
0.0011	0.0016	0.0000
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0.0001	0.0014	-0.0009
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0.0006	0.0024	0.0005
0.0002	0.0028	0.0004
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-0.0003	0.0404	-0.0011
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0.0020	0.0478	-0.0025
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0.0008	0.0623	-0.0017
0.0003	0.0636	-0.0015
0.0007	0.0640	-0.0018
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-0.0000	0.0638	-0.0018
-0.0001	0.0625	-0.0029
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0.0009	0.0738	-0.0220
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-0.0008	0.0517	0.0056
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-0.0001	0.0543	0.0009
-0.0001	0.0604	-0.0026
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0.0013	0.2147	0.0071
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0.0005	0.2451	-0.0038

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-0.0011	0.2406	-0.0214
-0.0003	0.2516	-0.0265
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-0.0018	0.2706	-0.0303
-0.0015	0.2799	-0.0323
-0.0014	0.2907	-0.0338
-0.0008	0.3033	-0.0417
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0.0023	0.3710	-0.0562
0.0034	0.3837	-0.0550
0.0036	0.3972	-0.0540
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0.0089	0.4218	-0.0502
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-0.0033	0.4337	0.0054
-0.0033	0.4230	-0.0001
-0.0031	0.4118	-0.0040
-0.0027	0.3990	-0.0068
-0.0023	0.3832	-0.0070
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0.0017	0.2843	-0.0118
0.0013	0.2759	-0.0153
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-0.0011	0.1247	-0.0013
-0.0012	0.1222	-0.0004

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-0.0011	0.1179	0.0062
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-0.0015	0.1184	0.0046
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-0.0015	0.1323	-0.0010
-0.0020	0.1417	-0.0006
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-0.1675	0.2350	0.0169
-0.1835	0.2518	0.0187
-0.2005	0.2681	0.0224
-0.2156	0.2830	0.0250
-0.2284	0.2992	0.0256
-0.2395	0.3125	0.0266
-0.2490	0.3214	0.0272
-0.2563	0.3275	0.0275
-0.2596	0.3288	0.0258
-0.2592	0.3271	0.0238
-0.2558	0.3215	0.0225
-0.2505	0.3139	0.0196
-0.2465	0.3098	0.0148
-0.2463	0.3079	0.0083
-0.2481	0.3091	0.0025
-0.2490	0.3116	-0.0042
-0.2491	0.3109	-0.0144
-0.2475	0.3072	-0.0221
-0.2399	0.2986	-0.0240
-0.2257	0.2849	-0.0212
-0.2098	0.2692	-0.0130
-0.1965	0.2528	-0.0015
-0.1887	0.2423	0.0057

-0.1857	0.2392	0.0079
-0.1873	0.2427	0.0066
-0.1956	0.2515	0.0035
-0.2056	0.2624	0.0027
-0.2153	0.2728	0.0044
-0.2249	0.2837	0.0093
-0.2332	0.2941	0.0154
-0.2410	0.3016	0.0197
-0.2509	0.3064	0.0225
-0.2588	0.3099	0.0222
-0.2616	0.3129	0.0190
-0.2640	0.3135	0.0164
-0.2639	0.3128	0.0182
-0.2630	0.3114	0.0245
-0.2620	0.3084	0.0311
-0.2585	0.3040	0.0383
-0.2537	0.2985	0.0451
-0.2489	0.2931	0.0488
-0.2434	0.2882	0.0495
-0.2359	0.2812	0.0461
-0.2277	0.2734	0.0410
-0.2198	0.2650	0.0373
-0.2097	0.2537	0.0324
-0.1982	0.2423	0.0256
-0.1874	0.2312	0.0209
-0.1757	0.2202	0.0206
-0.1656	0.2102	0.0204
-0.1569	0.2006	0.0203
-0.1498	0.1923	0.0197
-0.1444	0.1882	0.0153
-0.1431	0.1896	0.0112
-0.1468	0.1935	0.0089
-0.1534	0.2004	0.0071
-0.1620	0.2085	0.0049
-0.1709	0.2171	0.0018
-0.1786	0.2260	0.0005
-0.1834	0.2321	0.0006
-0.1853	0.2378	-0.0000
-0.1858	0.2420	0.0015
-0.1868	0.2440	0.0021
-0.1883	0.2475	-0.0020
-0.1902	0.2508	-0.0059
-0.1921	0.2531	-0.0079
-0.1939	0.2560	-0.0084
-0.1928	0.2585	-0.0101
-0.1913	0.2576	-0.0124
-0.1898	0.2556	-0.0108
-0.1855	0.2532	-0.0115
-0.1817	0.2511	-0.0162
-0.1794	0.2504	-0.0201
-0.1759	0.2484	-0.0254
-0.1714	0.2452	-0.0320
-0.1668	0.2406	-0.0355
-0.1593	0.2361	-0.0357
-0.1496	0.2301	-0.0329
-0.1376	0.2208	-0.0306
-0.1240	0.2105	-0.0322
-0.1142	0.2021	-0.0351
-0.1080	0.1962	-0.0356
-0.1018	0.1899	-0.0341
-0.0970	0.1847	-0.0326
-0.0947	0.1831	-0.0310
-0.0955	0.1838	-0.0295
-0.0980	0.1871	-0.0292

-0.1012	0.1899	-0.0296
-0.1040	0.1931	-0.0291
-0.1066	0.1959	-0.0292
-0.1082	0.1943	-0.0289
-0.1064	0.1893	-0.0295
-0.1022	0.1830	-0.0302
-0.0969	0.1766	-0.0292
-0.0937	0.1686	-0.0302
-0.0907	0.1599	-0.0332
-0.0854	0.1541	-0.0365
-0.0794	0.1482	-0.0370
-0.0715	0.1396	-0.0349
-0.0624	0.1309	-0.0323
-0.0528	0.1229	-0.0303
-0.0431	0.1169	-0.0294
-0.0346	0.1115	-0.0304
-0.0263	0.1056	-0.0334
-0.0181	0.0987	-0.0359
-0.0107	0.0924	-0.0382
-0.0037	0.0866	-0.0386
0.0017	0.0812	-0.0376
0.0052	0.0767	-0.0378
0.0074	0.0744	-0.0387
0.0061	0.0733	-0.0400
0.0052	0.0726	-0.0409
0.0048	0.0738	-0.0408
0.0019	0.0739	-0.0390
-0.0015	0.0736	-0.0355
-0.0026	0.0743	-0.0320
-0.0013	0.0746	-0.0287
-0.0018	0.0752	-0.0251
-0.0041	0.0746	-0.0223
-0.0060	0.0734	-0.0193
-0.0073	0.0720	-0.0168
-0.0102	0.0714	-0.0132
-0.0136	0.0723	-0.0085
-0.0153	0.0712	-0.0035
-0.0134	0.0693	0.0025
-0.0082	0.0678	0.0062
-0.0027	0.0633	0.0114
0.0014	0.0576	0.0167
0.0044	0.0537	0.0172
0.0078	0.0492	0.0135
0.0122	0.0456	0.0076
0.0146	0.0428	0.0031
0.0162	0.0403	0.0010
0.0164	0.0392	0.0023
0.0152	0.0399	0.0054
0.0113	0.0425	0.0077
0.0041	0.0490	0.0092
-0.0053	0.0599	0.0105
-0.0180	0.0730	0.0098
-0.0328	0.0861	0.0074
-0.0481	0.1000	0.0066
-0.0615	0.1153	0.0055
-0.0731	0.1271	0.0056
-0.0831	0.1364	0.0066
-0.0926	0.1453	0.0055
-0.1004	0.1520	0.0032
-0.1070	0.1590	0.0010
-0.1126	0.1656	-0.0018
-0.1187	0.1704	-0.0054
-0.1253	0.1742	-0.0093
-0.1291	0.1785	-0.0133

-0.1319	0.1841	-0.0187
-0.1362	0.1885	-0.0223
-0.1416	0.1917	-0.0238
-0.1465	0.1965	-0.0259
-0.1516	0.2022	-0.0276
-0.1575	0.2084	-0.0308
-0.1652	0.2163	-0.0356
-0.1739	0.2250	-0.0380
-0.1817	0.2321	-0.0353
-0.1880	0.2378	-0.0309
-0.1930	0.2432	-0.0291
-0.1965	0.2479	-0.0304
-0.1998	0.2525	-0.0326
-0.2035	0.2567	-0.0343
-0.2079	0.2598	-0.0339
-0.2121	0.2612	-0.0281
-0.2155	0.2637	-0.0203
-0.2214	0.2671	-0.0126
-0.2291	0.2721	-0.0046
-0.2377	0.2807	-0.0000
-0.2474	0.2878	0.0018
-0.2545	0.2907	0.0032
-0.2577	0.2914	0.0028
-0.2579	0.2911	0.0001
-0.2556	0.2906	-0.0036
-0.2539	0.2916	-0.0089
-0.2535	0.2928	-0.0145
-0.2528	0.2913	-0.0177
-0.2490	0.2882	-0.0212
-0.2245	0.2968	-0.0628
-0.1522	0.3141	-0.1300
-0.1950	0.2861	-0.1143
-0.2516	0.2709	-0.0715
-0.2224	0.2856	-0.0755
-0.2320	0.2776	-0.0743
-0.2294	0.2736	-0.0710
-0.2068	0.2732	-0.0705
-0.1748	0.2757	-0.0693
-0.1575	0.2759	-0.0689
-0.1496	0.2738	-0.0677
-0.1439	0.2727	-0.0640
-0.1472	0.2714	-0.0565
-0.1540	0.2683	-0.0491
-0.1537	0.2623	-0.0438
-0.1498	0.2510	-0.0407
-0.1451	0.2337	-0.0410
-0.1316	0.2142	-0.0435
-0.1118	0.1908	-0.0469
-0.0907	0.1652	-0.0495
-0.0719	0.1399	-0.0503
-0.0598	0.1153	-0.0511
-0.0493	0.0947	-0.0516
-0.0381	0.0780	-0.0498
-0.0259	0.0626	-0.0471
-0.0118	0.0483	-0.0464
-0.0038	0.0375	-0.0461
-0.0034	0.0288	-0.0460
-0.0022	0.0223	-0.0446
-0.0010	0.0172	-0.0387
-0.0018	0.0114	-0.0311
-0.0063	0.0058	-0.0219
-0.0127	0.0012	-0.0128
-0.0169	-0.0009	-0.0057
-0.0206	0.0000	-0.0010

-0.0231	0.0042	-0.0003
-0.0237	0.0116	-0.0019
-0.0243	0.0216	-0.0051
-0.0236	0.0336	-0.0099
-0.0225	0.0484	-0.0169
-0.0220	0.0648	-0.0260
-0.0210	0.0785	-0.0336
-0.0221	0.0903	-0.0391
-0.0257	0.1031	-0.0433
-0.0333	0.1165	-0.0454
-0.0469	0.1326	-0.0445
-0.0625	0.1511	-0.0434
-0.0769	0.1744	-0.0430
-0.0907	0.2045	-0.0440
-0.1052	0.2372	-0.0483
-0.1192	0.2726	-0.0557
-0.1286	0.3099	-0.0663
-0.1331	0.3443	-0.0782
-0.1354	0.3762	-0.0899
-0.1399	0.4065	-0.1003
-0.1461	0.4319	-0.1077
-0.1488	0.4525	-0.1128
-0.1452	0.4695	-0.1156
-0.1344	0.4832	-0.1183
-0.1211	0.4917	-0.1263
-0.1076	0.4945	-0.1395
-0.0862	0.4903	-0.1537
-0.0525	0.4798	-0.1645
-0.0199	0.4636	-0.1692
0.0063	0.4422	-0.1683
0.0320	0.4200	-0.1658
0.0658	0.3985	-0.1627
0.1040	0.3765	-0.1592
0.1330	0.3515	-0.1577
0.1661	0.3321	-0.1763
0.2312	0.3175	-0.2030
0.2715	0.2794	-0.1773
0.2491	0.2490	-0.1457
0.2172	0.2353	-0.1426
0.2080	0.2090	-0.1268
0.2197	0.1853	-0.1069
0.2422	0.1673	-0.0923
0.2687	0.1536	-0.0803
0.2805	0.1424	-0.0657
0.2738	0.1346	-0.0554
0.2465	0.1329	-0.0576
0.1995	0.1321	-0.0691
0.1553	0.1285	-0.0818
0.1393	0.1254	-0.0930
0.1561	0.1254	-0.1026
0.1706	0.1251	-0.1100
0.1651	0.1230	-0.1163
0.1661	0.1191	-0.1211
0.1763	0.1102	-0.1236
0.1806	0.0969	-0.1233
0.1755	0.0817	-0.1206
0.1604	0.0646	-0.1152
0.1357	0.0460	-0.1089
0.1154	0.0278	-0.1029
0.1195	0.0115	-0.1003
0.1417	-0.0028	-0.1008
0.1585	-0.0133	-0.1013
0.1622	-0.0203	-0.1036
0.1632	-0.0261	-0.1070

0.1657	-0.0287	-0.1075
0.1587	-0.0267	-0.1001
0.1373	-0.0185	-0.0864
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0.0601	0.0186	-0.0483
0.0146	0.0443	-0.0330
-0.0192	0.0723	-0.0235
-0.0352	0.1014	-0.0203
-0.0397	0.1288	-0.0210
-0.0427	0.1513	-0.0231
-0.0472	0.1691	-0.0244
-0.0501	0.1831	-0.0234
-0.0482	0.1920	-0.0200
-0.0423	0.1951	-0.0138
-0.0390	0.1949	-0.0055
-0.0412	0.1901	0.0046
-0.0430	0.1819	0.0132
-0.0388	0.1739	0.0175
-0.0253	0.1646	0.0160
-0.0100	0.1555	0.0096
0.0023	0.1474	0.0049
0.0147	0.1402	0.0042
0.0243	0.1328	0.0062
0.0278	0.1262	0.0115
0.0266	0.1227	0.0178
0.0226	0.1190	0.0232
0.0165	0.1151	0.0311
0.0123	0.1117	0.0400
0.0077	0.1098	0.0461
0.0036	0.1112	0.0500
0.0015	0.1126	0.0521
-0.0033	0.1167	0.0524
-0.0147	0.1243	0.0515
-0.0265	0.1325	0.0500
-0.0307	0.1409	0.0476
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-0.0317	0.1503	0.0449
-0.0343	0.1510	0.0466
-0.0323	0.1491	0.0512
-0.0314	0.1459	0.0565
-0.0391	0.1431	0.0593
-0.0458	0.1426	0.0593
-0.0440	0.1431	0.0577
-0.0449	0.1429	0.0544
-0.0458	0.1430	0.0487
-0.0388	0.1443	0.0434
-0.0304	0.1475	0.0407
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-0.0001	0.1443	0.0408
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-0.0188	0.1456	0.0603
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-0.0488	0.1645	0.0640
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-0.0825	0.1967	0.0616
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-0.0041	0.4426	-0.0263
-0.0066	0.4525	-0.0289
-0.0043	0.4584	-0.0317
0.0036	0.4607	-0.0315
0.0126	0.4599	-0.0299
0.0192	0.4575	-0.0265
0.0223	0.4509	-0.0215
0.0279	0.4445	-0.0155
0.0403	0.4402	-0.0109
0.0552	0.4380	-0.0104
0.0716	0.4410	-0.0125
0.0905	0.4438	-0.0151
0.1071	0.4403	-0.0139
0.1208	0.4360	-0.0100
0.1306	0.4340	-0.0081
0.1353	0.4309	-0.0094
0.1372	0.4300	-0.0117
0.1409	0.4303	-0.0135
0.1470	0.4296	-0.0154
0.1506	0.4300	-0.0167
0.1504	0.4286	-0.0208
0.1488	0.4240	-0.0269
0.1484	0.4172	-0.0329
0.1494	0.4100	-0.0403
0.1527	0.4035	-0.0493
0.1569	0.3975	-0.0591
0.1543	0.3896	-0.0637
0.1441	0.3778	-0.0606
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0.1205	0.3447	-0.0474
0.1108	0.3262	-0.0401
0.1039	0.3043	-0.0344
0.0973	0.2809	-0.0301
0.0887	0.2596	-0.0283
0.0832	0.2405	-0.0278
0.0768	0.2222	-0.0289
0.0694	0.2051	-0.0297
0.0643	0.1882	-0.0288
0.0610	0.1695	-0.0256
0.0557	0.1509	-0.0230
0.0482	0.1336	-0.0220
0.0387	0.1172	-0.0212
0.0276	0.1041	-0.0227
0.0189	0.0932	-0.0227
0.0127	0.0834	-0.0237
0.0060	0.0754	-0.0270
0.0000	0.0691	-0.0296
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0.0010	0.0612	-0.0319
-0.0005	0.0588	-0.0330
-0.0017	0.0582	-0.0337
-0.0004	0.0604	-0.0342
0.0026	0.0639	-0.0340
0.0101	0.0669	-0.0350
0.0236	0.0692	-0.0397
0.0397	0.0705	-0.0444
0.0551	0.0718	-0.0522
0.0694	0.0723	-0.0624
0.0838	0.0725	-0.0700
0.0965	0.0741	-0.0749
0.1062	0.0764	-0.0786

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0.1138	0.0823	-0.0806
0.1155	0.0843	-0.0804
0.1180	0.0855	-0.0778
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0.1263	0.0870	-0.0713
0.1316	0.0868	-0.0662
0.1335	0.0850	-0.0612
0.1320	0.0858	-0.0557
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0.1228	0.0901	-0.0454
0.1221	0.0900	-0.0404
0.1199	0.0896	-0.0338
0.1177	0.0880	-0.0298
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0.1024	0.0832	-0.0192
0.0917	0.0828	-0.0177
0.0838	0.0833	-0.0165
0.0786	0.0828	-0.0170
0.0766	0.0838	-0.0189
0.0767	0.0853	-0.0205
0.0729	0.0849	-0.0226
0.0639	0.0828	-0.0256
0.0564	0.0810	-0.0294
0.0532	0.0806	-0.0328
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0.0458	0.0762	-0.0354
0.0395	0.0759	-0.0363
0.0328	0.0761	-0.0346
0.0258	0.0754	-0.0320
0.0185	0.0761	-0.0281
0.0112	0.0783	-0.0232
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-0.0005	0.0828	-0.0148
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-0.0417	0.1073	0.0012
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-0.0496	0.1203	0.0028
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-0.0501	0.1505	-0.0133
-0.0499	0.1549	-0.0135
-0.0499	0.1578	-0.0141
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-0.0492	0.1426	-0.0078
-0.0481	0.1385	-0.0062
-0.0468	0.1357	-0.0056
-0.0455	0.1343	-0.0053
-0.0438	0.1341	-0.0024
-0.0444	0.1348	0.0023
-0.0449	0.1364	0.0078
-0.0406	0.1395	0.0129
-0.0344	0.1439	0.0168
-0.0288	0.1492	0.0178
-0.0262	0.1555	0.0175
-0.0269	0.1633	0.0179

-0.0265	0.1724	0.0189
-0.0258	0.1851	0.0216
-0.0253	0.1998	0.0253
-0.0257	0.2135	0.0281
-0.0276	0.2257	0.0269
-0.0292	0.2370	0.0218
-0.0335	0.2489	0.0161
-0.0366	0.2581	0.0105
-0.0330	0.2661	0.0079
-0.0273	0.2738	0.0058
-0.0256	0.2794	0.0018
-0.0247	0.2841	-0.0031
-0.0202	0.2881	-0.0092
-0.0150	0.2912	-0.0154
-0.0085	0.2947	-0.0218
-0.0023	0.2969	-0.0286
0.0023	0.2965	-0.0349
0.0076	0.2956	-0.0395
0.0129	0.2933	-0.0433
0.0175	0.2888	-0.0472
0.0224	0.2832	-0.0519
0.0262	0.2776	-0.0546
0.0251	0.2727	-0.0549
0.0206	0.2678	-0.0552
0.0172	0.2611	-0.0543
0.0144	0.2539	-0.0510
0.0104	0.2453	-0.0462
0.0028	0.2366	-0.0423
-0.0072	0.2305	-0.0407
-0.0153	0.2256	-0.0389
-0.0196	0.2196	-0.0370
-0.0214	0.2148	-0.0356
-0.0225	0.2133	-0.0344
-0.0220	0.2146	-0.0345
-0.0268	0.2167	-0.0347
-0.0389	0.2199	-0.0369
-0.0499	0.2231	-0.0395
-0.0529	0.2240	-0.0419
-0.0498	0.2251	-0.0444
-0.0492	0.2266	-0.0458
-0.0518	0.2277	-0.0474
-0.0514	0.2286	-0.0509
-0.0499	0.2297	-0.0557
-0.0513	0.2298	-0.0596
-0.0532	0.2283	-0.0635
-0.0537	0.2272	-0.0669
-0.0514	0.2250	-0.0707
-0.0496	0.2235	-0.0756
-0.0513	0.2227	-0.0799
-0.0535	0.2187	-0.0837
-0.0537	0.2127	-0.0859
-0.0505	0.2060	-0.0868
-0.0441	0.1976	-0.0859
-0.0378	0.1889	-0.0838
-0.0355	0.1812	-0.0830
-0.0367	0.1770	-0.0821
-0.0391	0.1758	-0.0818
-0.0406	0.1738	-0.0818
-0.0376	0.1730	-0.0811
-0.0330	0.1719	-0.0804
-0.0291	0.1686	-0.0804
-0.0260	0.1654	-0.0803
-0.0237	0.1634	-0.0808
-0.0211	0.1638	-0.0809

-0.0173	0.1645	-0.0811
-0.0141	0.1660	-0.0812
-0.0147	0.1687	-0.0817
-0.0177	0.1724	-0.0842
-0.0204	0.1787	-0.0889
-0.0217	0.1878	-0.0940
-0.0210	0.1986	-0.0985
-0.0203	0.2077	-0.1023
-0.0241	0.2157	-0.1034
-0.0306	0.2254	-0.1036
-0.0387	0.2332	-0.1020
-0.0457	0.2374	-0.0986
-0.0487	0.2379	-0.0947
-0.0504	0.2354	-0.0895
-0.0517	0.2330	-0.0829
-0.0551	0.2291	-0.0737
-0.0634	0.2230	-0.0628
-0.0713	0.2151	-0.0510
-0.0774	0.2057	-0.0399
-0.0828	0.1955	-0.0325
-0.0882	0.1870	-0.0298
-0.0949	0.1819	-0.0304
-0.1055	0.1778	-0.0316
-0.1186	0.1748	-0.0363
-0.1306	0.1723	-0.0454
-0.1383	0.1707	-0.0548
-0.1398	0.1706	-0.0631
-0.1413	0.1694	-0.0687
-0.1450	0.1677	-0.0700
-0.1499	0.1652	-0.0680
-0.1597	0.1616	-0.0647
-0.1701	0.1549	-0.0629
-0.1688	0.1474	-0.0640
-0.1565	0.1453	-0.0705
-0.1414	0.1487	-0.0762
-0.1388	0.1529	-0.0784
-0.1462	0.1605	-0.0820
-0.1549	0.1718	-0.0847
-0.1679	0.1836	-0.0857
-0.1798	0.1951	-0.0876
-0.1895	0.2029	-0.0904
-0.1948	0.2099	-0.0936
-0.1930	0.2155	-0.0987
-0.1875	0.2192	-0.1021
-0.1793	0.2212	-0.1036
-0.1701	0.2215	-0.1030
-0.1622	0.2218	-0.0998
-0.1535	0.2213	-0.0948
-0.1457	0.2160	-0.0869
-0.1411	0.2065	-0.0759
-0.1372	0.1952	-0.0627
-0.1295	0.1818	-0.0499
-0.1178	0.1706	-0.0399
-0.1045	0.1603	-0.0329
-0.0892	0.1501	-0.0283
-0.0740	0.1405	-0.0245
-0.0615	0.1308	-0.0210
-0.0500	0.1229	-0.0195
-0.0406	0.1171	-0.0189
-0.0343	0.1151	-0.0194
-0.0286	0.1130	-0.0210
-0.0209	0.1103	-0.0206
-0.0124	0.1067	-0.0196
-0.0086	0.1008	-0.0153

-0.0084	0.0942	-0.0100
-0.0119	0.0885	-0.0049
-0.0193	0.0848	0.0023
-0.0259	0.0808	0.0090
-0.0310	0.0784	0.0143
-0.0366	0.0764	0.0175
-0.0426	0.0745	0.0189
-0.0461	0.0753	0.0185
-0.0462	0.0753	0.0158
-0.0431	0.0752	0.0126
-0.0371	0.0737	0.0090
-0.0299	0.0696	0.0055
-0.0222	0.0643	0.0009
-0.0160	0.0594	-0.0047
-0.0109	0.0560	-0.0089
-0.0090	0.0539	-0.0116
-0.0114	0.0541	-0.0120
-0.0146	0.0547	-0.0112
-0.0161	0.0553	-0.0083
-0.0163	0.0544	-0.0026
-0.0167	0.0531	0.0043
-0.0159	0.0526	0.0097
-0.0133	0.0512	0.0153
-0.0101	0.0497	0.0214
-0.0072	0.0485	0.0272
-0.0073	0.0487	0.0330
-0.0063	0.0523	0.0390
-0.0014	0.0571	0.0454
0.0030	0.0625	0.0509
0.0068	0.0710	0.0565
0.0127	0.0795	0.0608
0.0252	0.0873	0.0621
0.0419	0.0956	0.0608
0.0564	0.1042	0.0570
0.0672	0.1132	0.0546
0.0749	0.1209	0.0534
0.0797	0.1264	0.0524
0.0838	0.1297	0.0533
0.0887	0.1288	0.0553
0.0931	0.1246	0.0559
0.0948	0.1171	0.0541
0.0953	0.1060	0.0486
0.0945	0.0949	0.0416
0.0903	0.0830	0.0370
0.0871	0.0694	0.0346
0.0870	0.0577	0.0256
0.0762	0.0489	0.0152
0.0700	0.0332	0.0270
0.0998	0.0254	0.0389
0.1178	0.0341	0.0332
0.1015	0.0407	0.0254
0.0954	0.0445	0.0201
0.1013	0.0482	0.0174
0.1023	0.0529	0.0143
0.0987	0.0562	0.0090
0.0969	0.0559	0.0018
0.0961	0.0544	-0.0037
0.0943	0.0526	-0.0068
0.0925	0.0497	-0.0093
0.0916	0.0455	-0.0092
0.0909	0.0418	-0.0077
0.0948	0.0395	-0.0082
0.1031	0.0374	-0.0089
0.1109	0.0366	-0.0106

0.1198	0.0366	-0.0142
0.1326	0.0370	-0.0193
0.1491	0.0378	-0.0273
0.1701	0.0393	-0.0344
0.1887	0.0407	-0.0406
0.1966	0.0414	-0.0464
0.1950	0.0430	-0.0475
0.1918	0.0443	-0.0429
0.1933	0.0454	-0.0332
0.2020	0.0444	-0.0216
0.2170	0.0440	-0.0133
0.2302	0.0482	-0.0100
0.2352	0.0527	-0.0089
0.2407	0.0554	-0.0091
0.2522	0.0585	-0.0095
0.2616	0.0622	-0.0077
0.2635	0.0658	-0.0036
0.2593	0.0694	0.0049
0.2520	0.0707	0.0176
0.2439	0.0692	0.0305
0.2370	0.0653	0.0430
0.2321	0.0590	0.0531
0.2306	0.0507	0.0589
0.2341	0.0405	0.0621
0.2451	0.0269	0.0647
0.2599	0.0101	0.0685
0.2691	-0.0061	0.0721
0.2715	-0.0202	0.0742
0.2750	-0.0321	0.0736
0.2815	-0.0409	0.0703
0.2863	-0.0473	0.0638
0.2883	-0.0513	0.0529
0.2897	-0.0521	0.0395
0.2909	-0.0514	0.0267
0.2905	-0.0494	0.0146
0.2909	-0.0472	0.0019
0.2956	-0.0454	-0.0092
0.3023	-0.0424	-0.0177
0.3073	-0.0385	-0.0250
0.3084	-0.0344	-0.0302
0.3055	-0.0284	-0.0319
0.2984	-0.0214	-0.0316
0.2857	-0.0168	-0.0270
0.2711	-0.0177	-0.0155
0.2535	-0.0243	-0.0014
0.2330	-0.0339	0.0069
0.2245	-0.0441	0.0076
0.2357	-0.0518	0.0041
0.2571	-0.0549	-0.0043
0.2792	-0.0525	-0.0174
0.3000	-0.0440	-0.0327
0.3164	-0.0310	-0.0468
0.3250	-0.0193	-0.0552
0.3276	-0.0108	-0.0585
0.3289	-0.0054	-0.0568
0.3325	-0.0052	-0.0491
0.3394	-0.0099	-0.0402
0.3446	-0.0202	-0.0274
0.3466	-0.0344	-0.0112
0.3470	-0.0494	0.0062
0.3438	-0.0633	0.0259
0.3355	-0.0776	0.0463
0.3238	-0.0916	0.0675
0.3146	-0.1046	0.0911

0.3098	-0.1175	0.1159
0.3047	-0.1276	0.1387
0.2962	-0.1334	0.1575
0.2840	-0.1398	0.1719
0.2725	-0.1489	0.1805
0.2648	-0.1567	0.1849
0.2595	-0.1624	0.1861
0.2497	-0.1603	0.1851
0.2256	-0.1463	0.1892
0.2017	-0.1279	0.1988
0.1876	-0.1136	0.2093
0.1685	-0.1030	0.2174
0.1524	-0.0944	0.2239
0.1514	-0.0886	0.2278
0.1555	-0.0842	0.2250
0.1563	-0.0814	0.2159
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0.1389	-0.0707	0.1777
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0.1217	-0.0642	0.1624
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0.1112	-0.0705	0.1594
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0.1177	-0.0864	0.1535
0.1252	-0.0848	0.1509
0.1351	-0.0820	0.1509
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0.0424	-0.0248	0.1445
0.0325	-0.0265	0.1385
0.0275	-0.0278	0.1308
0.0270	-0.0279	0.1216
0.0249	-0.0266	0.1103
0.0192	-0.0253	0.1017
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-0.0888	-0.0381	0.1177
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-0.0956	-0.0230	0.1179
-0.1000	-0.0158	0.1173
-0.1018	-0.0085	0.1170
-0.1021	-0.0035	0.1137
-0.0998	0.0019	0.1078
-0.0955	0.0086	0.1016
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-0.0956	0.0223	0.0833
-0.0950	0.0264	0.0735
-0.0942	0.0314	0.0649
-0.0939	0.0332	0.0583
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-0.0961	0.0373	0.0546
-0.1017	0.0435	0.0579
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-0.1182	0.2049	0.0038
-0.1295	0.2070	0.0045
-0.1402	0.2092	0.0048
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-0.1383	0.2080	0.0031
-0.1289	0.2052	0.0012
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-0.1135	0.1929	-0.0080
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0.0050	-0.0327	-0.0073
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0.0076	-0.0295	-0.0100
0.0089	-0.0282	-0.0107
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0.0163	-0.0343	-0.0142
0.0216	-0.0391	-0.0169
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0.0096	-0.0068	-0.0402
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0.0149	0.0007	-0.0221
0.0144	-0.0012	-0.0165
0.0163	-0.0044	-0.0144
0.0217	-0.0096	-0.0131
0.0262	-0.0154	-0.0121
0.0285	-0.0202	-0.0130
0.0306	-0.0248	-0.0151
0.0315	-0.0270	-0.0164
0.0296	-0.0282	-0.0152
0.0235	-0.0285	-0.0112
0.0151	-0.0271	-0.0044
0.0069	-0.0254	0.0039
0.0009	-0.0229	0.0111
-0.0009	-0.0210	0.0160
-0.0000	-0.0190	0.0179
0.0030	-0.0171	0.0159
0.0051	-0.0144	0.0095
0.0041	-0.0108	0.0036
0.0032	-0.0094	0.0016
0.0055	-0.0101	0.0019
0.0096	-0.0120	0.0035
0.0130	-0.0145	0.0062
0.0155	-0.0185	0.0084
0.0167	-0.0223	0.0107
0.0165	-0.0261	0.0148
0.0189	-0.0306	0.0194
0.0247	-0.0350	0.0225
0.0281	-0.0388	0.0232
0.0275	-0.0403	0.0223
0.0265	-0.0398	0.0210
0.0230	-0.0365	0.0201
0.0174	-0.0315	0.0180
0.0145	-0.0267	0.0151
0.0120	-0.0214	0.0143

0.0089	-0.0161	0.0143
0.0076	-0.0124	0.0146
0.0081	-0.0086	0.0139
0.0076	-0.0047	0.0121
0.0053	0.0007	0.0097
0.0047	0.0082	0.0073
0.0069	0.0143	0.0049
0.0087	0.0187	0.0038
0.0110	0.0229	0.0030
0.0143	0.0264	0.0023
0.0165	0.0282	0.0041
0.0191	0.0287	0.0060
0.0216	0.0273	0.0071
0.0226	0.0254	0.0084
0.0234	0.0235	0.0110
0.0253	0.0189	0.0156
0.0276	0.0131	0.0200
0.0286	0.0077	0.0228
0.0301	0.0046	0.0228
0.0305	0.0037	0.0216
0.0282	0.0045	0.0184
0.0246	0.0081	0.0114
0.0232	0.0139	0.0036
0.0235	0.0199	-0.0031
0.0245	0.0246	-0.0082
0.0250	0.0276	-0.0112
0.0246	0.0298	-0.0136
0.0243	0.0322	-0.0152
0.0217	0.0334	-0.0150
0.0191	0.0322	-0.0143
0.0191	0.0280	-0.0118
0.0219	0.0239	-0.0071
0.0245	0.0204	-0.0025
0.0236	0.0178	-0.0025
0.0202	0.0191	-0.0055
0.0167	0.0233	-0.0066
0.0147	0.0273	-0.0079
0.0140	0.0307	-0.0105
0.0119	0.0361	-0.0138
0.0096	0.0436	-0.0177
0.0079	0.0513	-0.0227
0.0049	0.0579	-0.0260
0.0011	0.0635	-0.0272
-0.0018	0.0687	-0.0263
-0.0040	0.0712	-0.0243
-0.0079	0.0734	-0.0208
-0.0125	0.0767	-0.0137
-0.0178	0.0789	-0.0071
-0.0237	0.0816	0.0007
-0.0295	0.0838	0.0097
-0.0346	0.0842	0.0154
-0.0376	0.0843	0.0212
-0.0368	0.0832	0.0274
-0.0320	0.0801	0.0309
-0.0264	0.0778	0.0330
-0.0210	0.0765	0.0327
-0.0172	0.0755	0.0304
-0.0130	0.0766	0.0291
-0.0065	0.0790	0.0264
-0.0009	0.0819	0.0216
0.0015	0.0840	0.0188
0.0029	0.0861	0.0149
0.0049	0.0899	0.0103
0.0064	0.0921	0.0053

0.0087	0.0938	0.0010
0.0130	0.0941	-0.0009
0.0180	0.0919	-0.0016
0.0226	0.0894	-0.0017
0.0274	0.0851	-0.0024
0.0333	0.0800	-0.0043
0.0393	0.0759	-0.0086
0.0434	0.0708	-0.0119
0.0440	0.0675	-0.0130
0.0438	0.0657	-0.0145
0.0431	0.0623	-0.0160
0.0413	0.0580	-0.0165
0.0363	0.0539	-0.0148
0.0285	0.0521	-0.0125
0.0212	0.0515	-0.0098
0.0139	0.0504	-0.0062
0.0067	0.0503	-0.0040
0.0009	0.0515	-0.0042
-0.0007	0.0526	-0.0060
0.0002	0.0525	-0.0080
0.0011	0.0523	-0.0103
0.0019	0.0530	-0.0148
0.0023	0.0535	-0.0179
0.0027	0.0535	-0.0205
0.0015	0.0541	-0.0231
-0.0004	0.0550	-0.0225
-0.0003	0.0564	-0.0208
0.0029	0.0568	-0.0188
0.0084	0.0554	-0.0149
0.0117	0.0552	-0.0120
0.0150	0.0559	-0.0124
0.0232	0.0569	-0.0143
0.0332	0.0584	-0.0165
0.0389	0.0608	-0.0197
0.0431	0.0640	-0.0252
0.0494	0.0666	-0.0302
0.0530	0.0694	-0.0327
0.0512	0.0723	-0.0326
0.0476	0.0744	-0.0305
0.0456	0.0734	-0.0271
0.0457	0.0711	-0.0228
0.0459	0.0678	-0.0191
0.0452	0.0628	-0.0164
0.0448	0.0572	-0.0151
0.0450	0.0514	-0.0144
0.0440	0.0463	-0.0138
0.0410	0.0421	-0.0137
0.0378	0.0397	-0.0154
0.0341	0.0378	-0.0151
0.0308	0.0340	-0.0136
0.0284	0.0293	-0.0122
0.0260	0.0255	-0.0101
0.0240	0.0226	-0.0082
0.0215	0.0195	-0.0061
0.0177	0.0190	-0.0060
0.0158	0.0207	-0.0070
0.0184	0.0228	-0.0083
0.0220	0.0270	-0.0099
0.0231	0.0317	-0.0118
0.0220	0.0368	-0.0151
0.0217	0.0418	-0.0181
0.0218	0.0458	-0.0190
0.0192	0.0479	-0.0182
0.0174	0.0484	-0.0157

0.0184	0.0478	-0.0113
0.0194	0.0445	-0.0067
0.0204	0.0413	-0.0024
0.0210	0.0400	0.0010
0.0189	0.0377	0.0021
0.0125	0.0334	-0.0001
0.0059	0.0285	-0.0040
0.0072	0.0239	-0.0077
0.0148	0.0187	-0.0144
0.0224	0.0130	-0.0245
0.0273	0.0108	-0.0326
0.0317	0.0106	-0.0357
0.0358	0.0119	-0.0336
0.0355	0.0163	-0.0306
0.0324	0.0221	-0.0286
0.0327	0.0281	-0.0254
0.0407	0.0322	-0.0218
0.0518	0.0329	-0.0184
0.0630	0.0319	-0.0181
0.0775	0.0322	-0.0214
0.0887	0.0341	-0.0261
0.0915	0.0348	-0.0305
0.0917	0.0348	-0.0322
0.0920	0.0356	-0.0311
0.0913	0.0365	-0.0279
0.0882	0.0367	-0.0253
0.0834	0.0348	-0.0241
0.0789	0.0308	-0.0210
0.0753	0.0270	-0.0190
0.0726	0.0236	-0.0187
0.0704	0.0210	-0.0181
0.0664	0.0176	-0.0183
0.0598	0.0129	-0.0178
0.0541	0.0082	-0.0158
0.0485	0.0034	-0.0133
0.0423	-0.0020	-0.0099
0.0379	-0.0097	-0.0079
0.0347	-0.0168	-0.0079
0.0331	-0.0207	-0.0090
0.0321	-0.0222	-0.0112
0.0301	-0.0240	-0.0129
0.0270	-0.0271	-0.0144
0.0236	-0.0310	-0.0149
0.0193	-0.0369	-0.0131
0.0164	-0.0442	-0.0106
0.0186	-0.0518	-0.0079
0.0232	-0.0604	-0.0057
0.0269	-0.0699	-0.0069
0.0292	-0.0767	-0.0091
0.0310	-0.0816	-0.0127
0.0337	-0.0857	-0.0174
0.0353	-0.0896	-0.0197
0.0335	-0.0927	-0.0216
0.0301	-0.0927	-0.0246
0.0258	-0.0896	-0.0296
0.0185	-0.0852	-0.0345
0.0112	-0.0803	-0.0379
0.0105	-0.0759	-0.0394
0.0140	-0.0740	-0.0370
0.0173	-0.0712	-0.0369
0.0188	-0.0664	-0.0408
0.0171	-0.0595	-0.0468
0.0143	-0.0503	-0.0538
0.0100	-0.0427	-0.0571

0.0068	-0.0369	-0.0568
0.0060	-0.0328	-0.0550
0.0025	-0.0315	-0.0526
-0.0031	-0.0302	-0.0516
-0.0070	-0.0291	-0.0515
-0.0107	-0.0289	-0.0507
-0.0150	-0.0280	-0.0495
-0.0201	-0.0272	-0.0470
-0.0271	-0.0267	-0.0433
-0.0341	-0.0246	-0.0407
-0.0374	-0.0209	-0.0397
-0.0407	-0.0163	-0.0400
-0.0461	-0.0112	-0.0408
-0.0534	-0.0076	-0.0380
-0.0633	-0.0057	-0.0312
-0.0719	-0.0036	-0.0221
-0.0796	-0.0026	-0.0144
-0.0871	-0.0010	-0.0080
-0.0929	0.0010	-0.0017
-0.0982	0.0010	0.0039
-0.1042	0.0011	0.0095
-0.1092	0.0003	0.0154
-0.1075	-0.0022	0.0210
-0.1015	-0.0055	0.0264
-0.0987	-0.0112	0.0324
-0.0986	-0.0165	0.0365
-0.0982	-0.0208	0.0399
-0.0961	-0.0234	0.0434
-0.0918	-0.0240	0.0444
-0.0870	-0.0248	0.0460
-0.0818	-0.0255	0.0476
-0.0765	-0.0252	0.0445
-0.0679	-0.0222	0.0385
-0.0573	-0.0165	0.0323
-0.0511	-0.0105	0.0273
-0.0448	-0.0061	0.0244
-0.0360	-0.0027	0.0241
-0.0318	0.0002	0.0247
-0.0325	0.0017	0.0243
-0.0337	0.0031	0.0213
-0.0365	0.0052	0.0175
-0.0410	0.0066	0.0165
-0.0452	0.0073	0.0151
-0.0473	0.0080	0.0129
-0.0488	0.0091	0.0113
-0.0515	0.0107	0.0093
-0.0530	0.0125	0.0051
-0.0514	0.0132	0.0024
-0.0473	0.0118	0.0016
-0.0445	0.0089	-0.0003
-0.0435	0.0059	-0.0023
-0.0421	0.0039	-0.0032
-0.0408	0.0005	-0.0034
-0.0412	-0.0046	-0.0016
-0.0426	-0.0093	0.0014
-0.0442	-0.0139	0.0045
-0.0442	-0.0198	0.0087
-0.0428	-0.0254	0.0128
-0.0429	-0.0295	0.0144
-0.0444	-0.0338	0.0146
-0.0460	-0.0386	0.0139
-0.0441	-0.0419	0.0111
-0.0395	-0.0430	0.0071
-0.0347	-0.0431	0.0036

-0.0305	-0.0428	-0.0002
-0.0301	-0.0431	-0.0053
-0.0308	-0.0411	-0.0108
-0.0291	-0.0388	-0.0160
-0.0272	-0.0364	-0.0214
-0.0287	-0.0324	-0.0266
-0.0319	-0.0316	-0.0304
-0.0333	-0.0304	-0.0332
-0.0361	-0.0281	-0.0354
-0.0412	-0.0264	-0.0360
-0.0464	-0.0272	-0.0347
-0.0529	-0.0310	-0.0327
-0.0586	-0.0330	-0.0277
-0.0630	-0.0343	-0.0215
-0.0677	-0.0361	-0.0169
-0.0714	-0.0377	-0.0105
-0.0720	-0.0380	-0.0051
-0.0708	-0.0359	-0.0025
-0.0713	-0.0340	-0.0020
-0.0714	-0.0334	-0.0021
-0.0703	-0.0302	-0.0026
-0.0672	-0.0241	-0.0029
-0.0632	-0.0191	-0.0032
-0.0608	-0.0158	-0.0021
-0.0554	-0.0129	0.0030
-0.0491	-0.0093	0.0080
-0.0457	-0.0053	0.0093
-0.0431	-0.0018	0.0084
-0.0394	0.0014	0.0052
-0.0344	0.0050	0.0006
-0.0292	0.0087	-0.0070
-0.0253	0.0141	-0.0161
-0.0233	0.0198	-0.0226
-0.0225	0.0245	-0.0290
-0.0211	0.0288	-0.0338
-0.0187	0.0315	-0.0351
-0.0193	0.0313	-0.0350
-0.0205	0.0292	-0.0352
-0.0193	0.0278	-0.0359
-0.0187	0.0262	-0.0377
-0.0202	0.0242	-0.0408
-0.0236	0.0235	-0.0431
-0.0263	0.0223	-0.0444
-0.0258	0.0192	-0.0447
-0.0244	0.0133	-0.0420
-0.0226	0.0055	-0.0380
-0.0205	-0.0013	-0.0349
-0.0208	-0.0074	-0.0328
-0.0231	-0.0132	-0.0313
-0.0271	-0.0175	-0.0311
-0.0311	-0.0196	-0.0305
-0.0345	-0.0201	-0.0276
-0.0370	-0.0202	-0.0257
-0.0384	-0.0198	-0.0237
-0.0423	-0.0198	-0.0198
-0.0460	-0.0212	-0.0173
-0.0427	-0.0218	-0.0170
-0.0350	-0.0199	-0.0176
-0.0301	-0.0167	-0.0195
-0.0261	-0.0129	-0.0224
-0.0227	-0.0070	-0.0258
-0.0210	-0.0006	-0.0301
-0.0200	0.0056	-0.0333
-0.0193	0.0104	-0.0356

```

-0.0183    0.0137   -0.0362
-0.0191    0.0175   -0.0345
-0.0210    0.0190   -0.0311
-0.0229    0.0183   -0.0268
-0.0244    0.0160   -0.0234
-0.0257    0.0134   -0.0206
-0.0255    0.0099   -0.0184
-0.0238    0.0048   -0.0162
-0.0241    0.0004   -0.0115
-0.0269   -0.0052   -0.0065
-0.0288   -0.0108    0.0002
-0.0297   -0.0156    0.0086
-0.0313   -0.0202    0.0167
-0.0330   -0.0239    0.0253
-0.0316   -0.0256    0.0320
-0.0285   -0.0268    0.0355
-0.0260   -0.0269    0.0341
-0.0238   -0...

```

The test case we are testing here is a 45 degree rotation about the pitch or y-axis. We will plot the actual orientation values below:

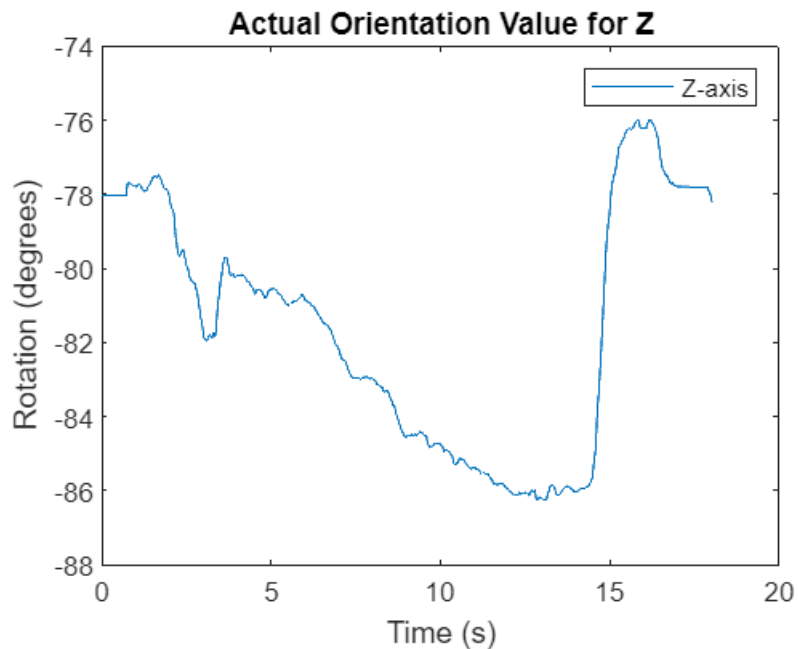
```
time = [1:size(ypr)]/Fs'
```

```
time = 1x7219
    0.0025    0.0050    0.0075    0.0100    0.0125    0.0150    0.0175    0.0200 ...
```

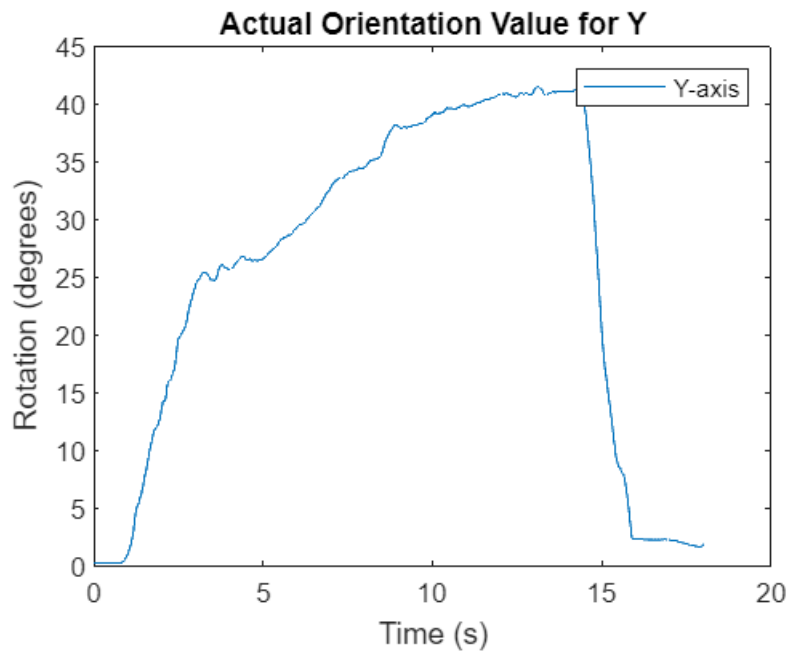
```

plot(time,ypr(:, 1))
title('Actual Orientation Value for Z')
legend('Z-axis')
xlabel('Time (s)')
ylabel('Rotation (degrees)')

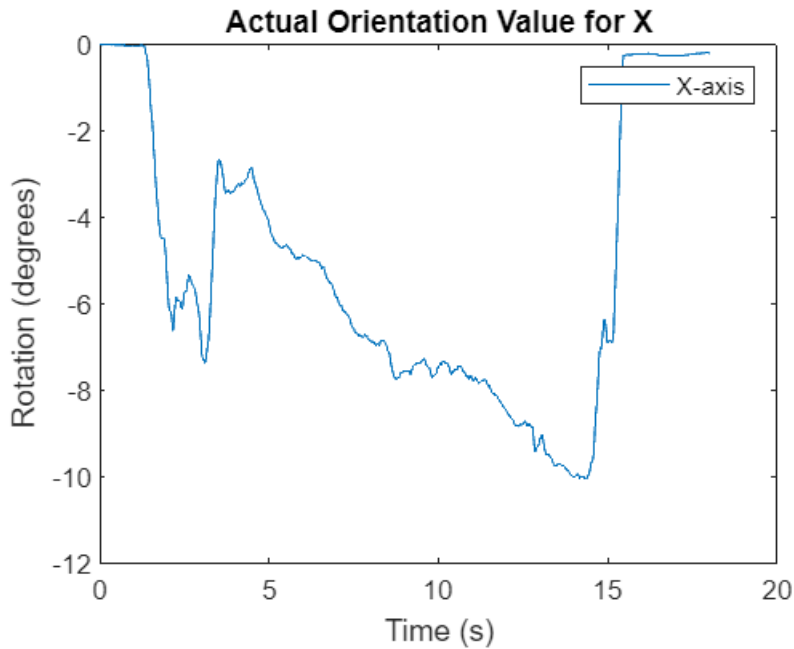
```




```
plot(time,ypr(:, 2))
title('Actual Orientation Value for Y')
legend('Y-axis')
xlabel('Time (s)')
ylabel('Rotation (degrees)')
```



```
plot(time,ypr(:, 3))
title('Actual Orientation Value for X')
legend('X-axis')
xlabel('Time (s)')
ylabel('Rotation (degrees)')
```



Create an `imufilter` System object™ with sample rate set to the sample rate of the sensor data. Specify a decimation factor of two to reduce the computational cost of the algorithm.

```
decim = 2;
fuse = imufilter('SampleRate',Fs,'DecimationFactor',decim);
```

Pass the accelerometer readings and gyroscope readings to the `imufilter` object, `fuse`, to output an estimate of the sensor body orientation over time. By default, the orientation is output as a vector of quaternions.

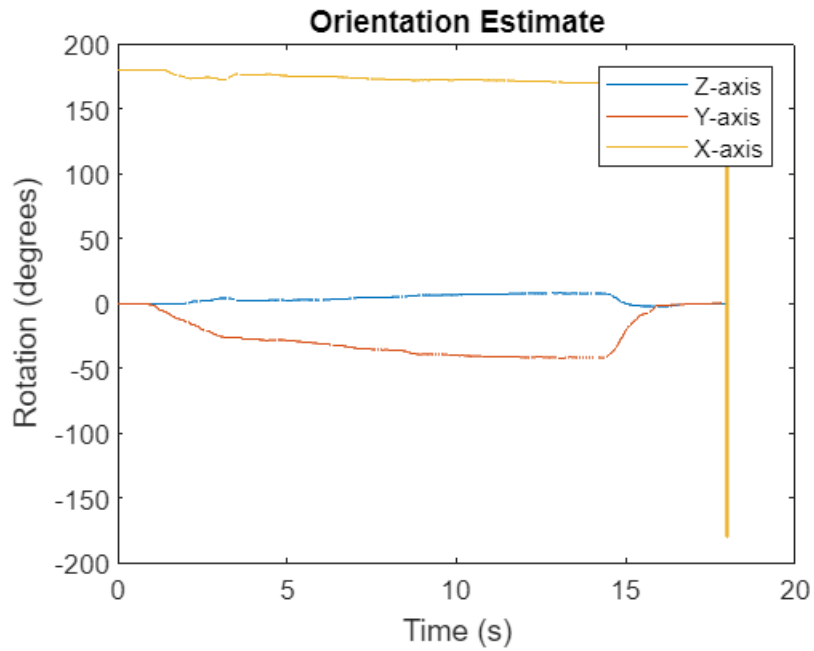
```
q = fuse(accelerometerReadings,gyroscopeReadings);
```

Orientation is defined by the angular displacement required to rotate a parent coordinate system to a child coordinate system. Plot the orientation in Euler angles in degrees over time.

`imufilter` fusion correctly estimates the change in orientation from an assumed north-facing initial orientation. However, the device's x-axis was pointing southward when recorded. To correctly estimate the orientation relative to the true initial orientation or relative to NED, use `ahrsfilter`.

```
time = (0:decim:size(accelerometerReadings,1)-1)/Fs;

plot(time,eulerd(q,'ZYX','frame'))
title('Orientation Estimate')
legend('Z-axis', 'Y-axis', 'X-axis')
xlabel('Time (s)')
ylabel('Rotation (degrees)')
```

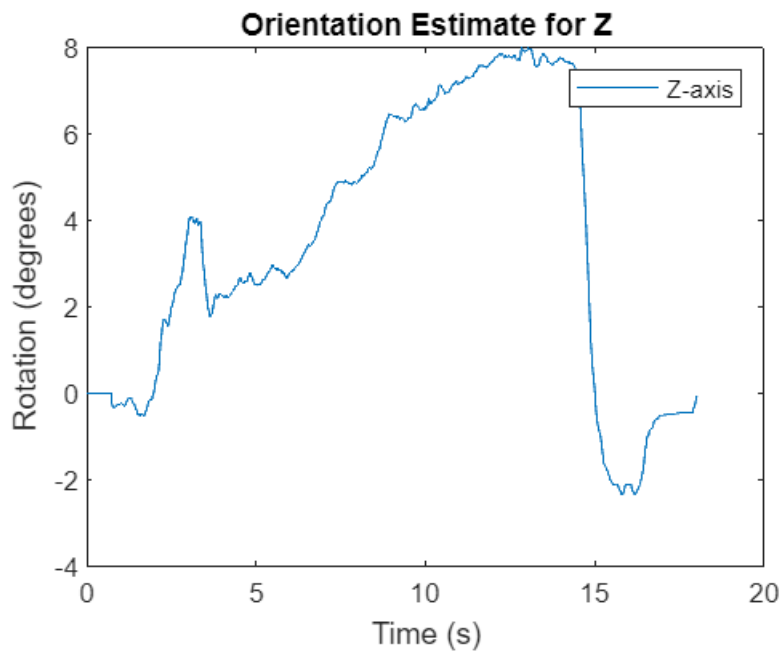


```
m = (eulerd(q, ['ZYX'], 'frame'))
```

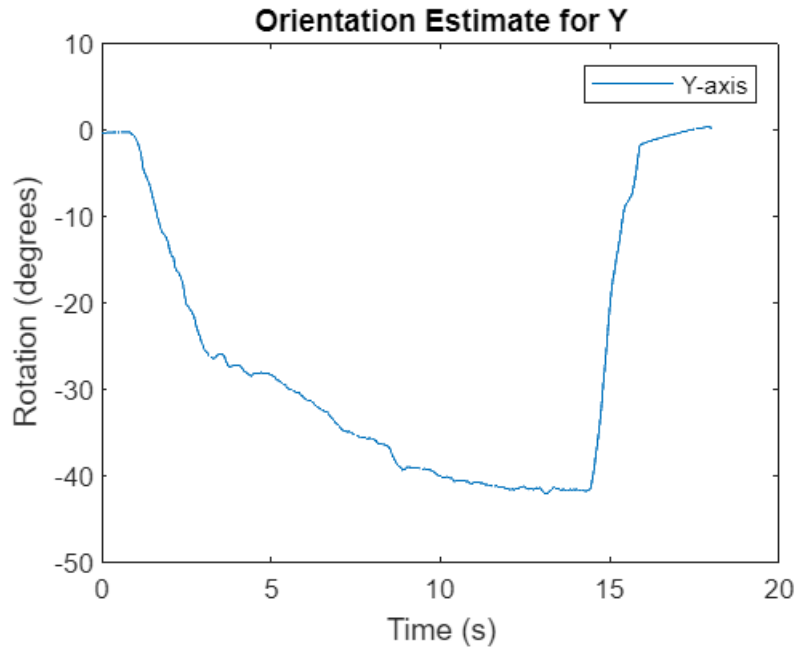
```
m = 3609x3
    0.0001    -0.4156    179.9203
    0.0001    -0.4065    179.9238
    0.0001    -0.4046    179.9211
    0.0000    -0.4045    179.9219
   -0.0002    -0.3946    179.9248
   -0.0000    -0.3943    179.9254
   -0.0000    -0.3957    179.9282
   -0.0003    -0.3886    179.9311
   -0.0005    -0.3926    179.9301
   -0.0004    -0.3884    179.9303
      ⋮
```

```
writematrix(m, 'Orientation_vector_nav_results.csv')
```

```
plot(time,m(:, 1))
title('Orientation Estimate for Z')
legend('Z-axis')
xlabel('Time (s)')
ylabel('Rotation (degrees)')
```



```
plot(time,m(:, 2))
title('Orientation Estimate for Y')
legend('Y-axis')
xlabel('Time (s)')
ylabel('Rotation (degrees)')
```



```
plot(time,m(:, 3))
title('Orientation Estimate for X')
legend('X-axis')
xlabel('Time (s)')
```

```
ylabel('Rotation (degrees)')
```

