

ReadMe:
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CSE532 HW4

I am using Docker to do the assignment since both HDP Sandbox and Cloudera are too heavy for my Mac laptop.

Task 1.

The arguments are the same as indicated in the assignment page.

“InputFilePath worldFlagBoolean OutputDirectoryPath”

When flag is set to true: all data will be displayed.

When flag is set to false: International and World data will be ignored.

When flag is set to something else: default to false.

Task 2.

The arguments are the same as indicated in the assignment page.

“InputFilePath startDate endDate OutputDirectoryPath”

Both startDate and endDate use the **yyyy-mm-dd** format.

The result includes world and international counts.

Task 3.

The arguments are the same as indicated in the assignment page.

“InputFilePath populationFilePathWithHDFS OutputDirectoryPath”

For example:

VM: **“/cse532/input/covid19_full_data.csv hdfs://localhost:9000/cse532/cache/populations.csv /cse532/output/”**

Docker: **“/cse532/input/covid19_full_data.csv hdfs://9ae81bae0044:9000/cse532/cache/populations.csv /cse532/output/”**

I followed the lecture slide and used a HashTable to store data for population.csv in reducer. So the file will only be accessed once (by the setup method) and the HashTable will only be accessed once by every different key (country).

The result ignores “Bonaire, Saint Eustatius and Saba” and locations with no population.

I used AWS EMR for the Spark Extra Credit part of the HW.

Task 4. Extra Credit 1:

The arguments are the same as indicated in the assignment page.

`“spark-submit --class className Filename.jar HDFSInputFilePath startDate endDate
HDFSOutputDirectoryPath”`

For example:

```
spark-submit --class SparkCovid19_1 SparkCovid19_1.jar hdfs://ip-172-31-35-  
46.ec2.internal:8020/cse532/input/covid19_full_data.csv 2020-01-01 2020-03-31 hdfs://ip-172-31-35-  
46.ec2.internal:8020/cse532/output/
```

Task 5. Extra Credit 2:

The arguments are the same as indicated in the assignment page.

`“spark-submit --class className Filename.jar HDFSInputFilePath HDFSPopulationFilePath
HDFSOutputDirectoryPath”`

For example:

```
spark-submit --class SparkCovid19_2 SparkCovid19_2.jar hdfs://ip-172-31-35-  
46.ec2.internal:8020/cse532/input/covid19_full_data.csv hdfs://ip-172-31-35-  
46.ec2.internal:8020/cse532/input/populations.csv hdfs://ip-172-31-35-46.ec2.internal:8020/cse532/output/
```

On Piazza, the TA mentioned that we are using Broadcast Variable for DistributedCache. I read and parse the population.csv file once before calling mapper or reducer and store the data in a HashTable. Then I store this HashTable as a Broadcast Variable since I am reading it multiple times later on and I don't need to modify any data in the HashTable. I read data from HashTable and does calculation after the reducer part.

Task 6. Extra Credit 3:

See performance.pdf

Outputs:

Task 1: /cse532/input/covid19_full_data.csv true /cse532/output/

Afghanistan	367	Costa Rica	483	Indonesia	2738
Albania	383	Cote d'Ivoire	349	International	696
Algeria	1468	Croatia	1282	Iran	62589
Andorra	545	Cuba	396	Iraq	1031
Angola	17	Curacao	13	Ireland	5709
Anguilla	3	Cyprus	494	Isle of Man	150
Antigua and Barbuda	15	Czech Republic	5017	Israel	9248
Argentina	1715	Democratic Republic of Congo		Italy	135586
Armenia	853		180	Jamaica	63
Aruba	74	Denmark	5071	Japan	3906
Australia	5956	Djibouti	121	Jersey	170
Austria	12640	Dominica	15	Jordan	349
Azerbaijan	717	Dominican Republic	1956	Kazakhstan	704
Bahamas	36	Ecuador	3995	Kenya	172
Bahrain	811	Egypt	1322	Kosovo	184
Bangladesh	164	El Salvador	78	Kuwait	743
Barbados	63	Equatorial Guinea	16	Kyrgyzstan	270
Belarus	861	Eritrea	31	Laos	12
Belgium	22194	Estonia	1149	Latvia	548
Belize	7	Ethiopia	52	Lebanon	548
Benin	26	Faeroe Islands	184	Liberia	14
Bermuda	39	Falkland Islands	5	Libya	19
Bhutan	5	Fiji	15	Liechtenstein	78
Bolivia	210	Finland	2308	Lithuania	880
Bonaire Sint Eustatius and Saba	2	France	78167	Luxembourg	2970
Bosnia and Herzegovina	781	French Polynesia	47	Macedonia	599
Botswana	7	Gabon	30	Madagascar	85
Brazil	13717	Gambia	4	Malawi	8
British Virgin Islands	3	Georgia	196	Malaysia	3963
Brunei	135	Germany	103228	Maldives	19
Bulgaria	577	Ghana	287	Mali	56
Burkina Faso	384	Gibraltar	113	Malta	293
Burundi	3	Greece	1832	Mauritania	6
Cambodia	117	Greenland	11	Mauritius	268
Cameroon	685	Grenada	12	Mexico	2785
Canada	17883	Guam	121	Moldova	1056
Cape Verde	7	Guatemala	80	Monaco	79
Cayman Islands	45	Guernsey	166	Mongolia	15
Central African Republic	9	Guinea	144	Montenegro	241
Chad	9	Guinea-Bissau	33	Montserrat	6
Chile	5116	Guyana	33	Morocco	1184
China	82757	Haiti	25	Mozambique	10
Colombia	1780	Honduras	312	Myanmar	22
Congo	45	Hungary	895	Namibia	16
		Iceland	1586	Nepal	9
		India	5194	Netherlands	19580

New Caledonia	18	Saint Vincent and the	Taiwan	376
New Zealand	969	Grenadines	Tanzania	24
Nicaragua	6	San Marino	Thailand	2369
Niger	278	Saudi Arabia	Timor	1
Nigeria	254	Senegal	Togo	65
Northern Mariana Islands	8	Serbia	Trinidad and Tobago	107
Norway	5863	Seychelles	Tunisia	596
Oman	419	Sierra Leone	Turkey	34109
Pakistan	4072	Singapore	Turks and Caicos Islands	8
Palestine	260	Sint Maarten (Dutch part)	Uganda	52
Panama	2249	Slovakia	Ukraine	1462
Papua New Guinea	2	Slovenia	United Arab Emirates	2359
Paraguay	115	Somalia	United Kingdom	55242
Peru	2954	South Africa	United States	398809
Philippines	3764	South Korea	United States Virgin Islands	45
Poland	4848	South Sudan	Uruguay	424
Portugal	12442	Spain	Uzbekistan	504
Puerto Rico	573	Sri Lanka	Vatican	7
Qatar	2057	Sudan	Venezuela	166
Romania	4417	Suriname	Vietnam	251
Russia	7497	Swaziland	World	1391863
Rwanda	105	Sweden	Zambia	39
Saint Kitts and Nevis	11	Switzerland	Zimbabwe	10
Saint Lucia	14	Syria		

Task 2: `/cse532/input/covid19_full_data.csv 2020-01-01 2020-03-31 /cse532/output/`

Afghanistan	4	Belize	0	China	3309
Albania	12	Benin	0	Colombia	14
Algeria	31	Bermuda	0	Congo	0
Andorra	8	Bhutan	0	Costa Rica	2
Angola	2	Bolivia	6	Cote d'Ivoire	1
Anguilla	0	Bosnia and Herzegovina	8	Croatia	6
Antigua and Barbuda	0	Brazil	159	Cuba	4
Argentina	24	British Virgin Islands	0	Curacao	1
Armenia	3	Brunei	1	Cyprus	7
Aruba	0	Bulgaria	8	Czech Republic	24
Australia	19	Burkina Faso	12	Democratic Republic of Congo	8
Austria	108	Cambodia	0		
Azerbaijan	4	Cameroon	2	Denmark	77
Bahamas	0	Canada	89	Djibouti	0
Bahrain	4	Cape Verde	1	Dominica	0
Bangladesh	5	Cayman Islands	1	Dominican Republic	42
Barbados	0	Central African Republic	0	Ecuador	62
Belarus	0	Chad	0	Egypt	40
Belgium	513	Chile	8	El Salvador	0

Equatorial Guinea	0	Lebanon	11	Saint Kitts and Nevis	0
Eritrea	0	Liberia	0	Saint Lucia	0
Estonia	3	Libya	0	Saint Vincent and the	
Ethiopia	0	Liechtenstein	0	Grenadines	0
Faeroe Islands	0	Lithuania	7	San Marino	25
Fiji	0	Luxembourg	22	Saudi Arabia	8
Finland	13	Macedonia	7	Senegal	0
France	3024	Madagascar	0	Serbia	13
French Polynesia	0	Malaysia	37	Seychelles	0
Gabon	1	Maldives	0	Singapore	3
Gambia	1	Mali	0	Sint Maarten (Dutch part)	0
Georgia	0	Malta	0	Slovakia	0
Germany	583	Mauritania	0	Slovenia	11
Ghana	5	Mauritius	3	Somalia	0
Gibraltar	0	Mexico	28	South Africa	3
Greece	43	Moldova	2	South Korea	163
Greenland	0	Monaco	0	Spain	7340
Grenada	0	Mongolia	0	Sri Lanka	1
Guam	1	Montenegro	1	Sudan	2
Guatemala	1	Montserrat	0	Suriname	0
Guernsey	0	Morocco	33	Swaziland	0
Guinea	0	Mozambique	0	Sweden	146
Guinea-Bissau	0	Myanmar	0	Switzerland	295
Guyana	1	Namibia	0	Syria	2
Haiti	0	Nepal	0	Taiwan	5
Honduras	7	Netherlands	864	Tanzania	1
Hungary	16	New Caledonia	0	Thailand	10
Iceland	2	New Zealand	1	Timor	0
India	32	Nicaragua	1	Togo	1
Indonesia	122	Niger	3	Trinidad and Tobago	3
International	7	Nigeria	2	Tunisia	8
Iran	2757	Northern Mariana Islands	0	Turkey	168
Iraq	46	Norway	26	Turks and Caicos Islands	0
Ireland	54	Oman	0	Uganda	0
Isle of Man	0	Pakistan	18	Ukraine	11
Israel	17	Palestine	1	United Arab Emirates	5
Italy	11591	Panama	26	United Kingdom	1408
Jamaica	1	Papua New Guinea	0	United States	3170
Japan	56	Paraguay	3	United States Virgin Islands	0
Jersey	2	Peru	24	Uruguay	1
Jordan	5	Philippines	88	Uzbekistan	2
Kazakhstan	1	Poland	31	Vatican	0
Kenya	1	Portugal	140	Venezuela	3
Kosovo	1	Puerto Rico	6	Vietnam	0
Kuwait	0	Qatar	1	World	37272
Kyrgyzstan	0	Romania	44	Zambia	0
Laos	0	Russia	10	Zimbabwe	1
Latvia	0	Rwanda	0		

Task 3: /cse532/input/covid19_full_data.csv

hdfs://9ae81bae0044:9000/cse532/cache/populations.csv /cse532/output/

Afghanistan	9	Cuba	34	Israel	1068
Albania	133	Curacao	79	Italy	2242
Algeria	33	Cyprus	409	Jamaica	21
Andorra	7053	Czech Republic	468	Japan	30
Angola	0	Democratic Republic of Congo		Jordan	34
Anguilla	199		2	Kazakhstan	37
Antigua and Barbuda	153	Denmark	875	Kenya	3
Argentina	37	Djibouti	122	Kosovo	95
Armenia	287	Dominica	208	Kuwait	173
Aruba	693	Dominican Republic	180	Kyrgyzstan	41
Australia	233	Ecuador	226	Laos	1
Austria	1403	Egypt	12	Latvia	290
Azerbaijan	70	El Salvador	12	Lebanon	80
Bahamas	91	Equatorial Guinea	11	Liberia	2
Bahrain	476	Eritrea	8	Libya	2
Bangladesh	0	Estonia	866	Liechtenstein	2045
Barbados	219	Ethiopia	0	Lithuania	323
Belarus	91	Faeroe Islands	3765	Luxembourg	4744
Belgium	1914	Falkland Islands	1435	Macedonia	287
Belize	17	Fiji	16	Madagascar	3
Benin	2	Finland	416	Malawi	0
Bermuda	626	France	1197	Malaysia	122
Bhutan	6	French Polynesia	167	Maldives	35
Bolivia	17	Gabon	13	Mali	2
Bosnia and Herzegovina		Gambia	1	Malta	663
	238	Georgia	49	Mauritania	1
Botswana	2	Germany	1232	Mauritius	210
Brazil	64	Ghana	9	Mexico	21
British Virgin Islands	99	Gibraltar	3354	Moldova	261
Brunei	308	Greece	175	Monaco	2013
Bulgaria	83	Greenland	193	Mongolia	4
Burkina Faso	18	Grenada	106	Montenegro	383
Burundi	0	Guam	716	Montserrat	1200
Cambodia	6	Guatemala	4	Morocco	32
Cameroon	25	Guinea	10	Mozambique	0
Canada	473	Guinea-Bissau	16	Myanmar	0
Cape Verde	12	Guyana	41	Namibia	6
Cayman Islands	684	Haiti	2	Nepal	0
Central African Republic	1	Honduras	31	Netherlands	1142
Chad	0	Hungary	92	New Caledonia	63
Chile	267	Iceland	4647	New Zealand	200
China	57	India	3	Nicaragua	0
Colombia	34	Indonesia	10	Niger	11
Congo	8	Iran	745	Nigeria	1
Costa Rica	94	Iraq	25	Northern Mariana Islands	
Cote d'Ivoire	13	Ireland	1156		138
Croatia	312	Isle of Man	1764	Norway	1081

Oman	82	Serbia	359	Thailand	33
Pakistan	18	Seychelles	111	Timor	0
Palestine	50	Sierra Leone	0	Togo	7
Panama	521	Singapore	253	Trinidad and Tobago	76
Papua New Guinea	0	Sint Maarten (Dutch part)		Tunisia	50
Paraguay	16		932	Turkey	404
Peru	89	Slovakia	106	Turks and Caicos Islands	
Philippines	34	Slovenia	507		206
Poland	128	Somalia	0	Uganda	1
Portugal	1220	South Africa	29	Ukraine	33
Puerto Rico	200	South Korea	202	United Arab Emirates	238
Qatar	713	South Sudan	0	United Kingdom	813
Romania	229	Spain	3005	United States	1204
Russia	51	Sri Lanka	8	United States Virgin Islands	
Rwanda	8	Sudan	0		430
Saint Kitts and Nevis	206	Suriname	17	Uruguay	122
Saint Lucia	76	Swaziland	8	Uzbekistan	15
Saint Vincent and the		Sweden	761	Vatican	8652
Grenadines	72	Switzerland	2560	Venezuela	5
San Marino	8220	Syria	1	Vietnam	2
Saudi Arabia	80	Taiwan	15	Zambia	2
Senegal	14	Tanzania	0	Zimbabwe	0

Task 4: `spark-submit --class SparkCovid19_1 SparkCovid19_1.jar hdfs://ip-172-31-35-46.ec2.internal:8020/cse532/input/covid19_full_data.csv 2020-01-01 2020-03-31 hdfs://ip-172-31-35-46.ec2.internal:8020/cse532/output/`

(Australia,19)	(Angola,2)	(Liberia,0)
(Brazil,159)	(Denmark,77)	(Bermuda,0)
(Uzbekistan,2)	(Saudi Arabia,8)	(Democratic Republic of
(Papua New Guinea,0)	(Paraguay,3)	Congo,8)
(Greenland,0)	(Curacao,1)	(Poland,31)
(Finland,13)	(Isle of Man,0)	(Afghanistan,4)
(Peru,24)	(Suriname,0)	(Israel,17)
(Guernsey,0)	(New Caledonia,0)	(Saint Vincent and the
(Djibouti,0)	(Iceland,2)	Grenadines,0)
(Montenegro,1)	(Netherlands,864)	(Jersey,2)
(Uruguay,1)	(French Polynesia,0)	(Canada,89)
(Gibraltar,0)	(Vatican,0)	(Barbados,0)
(United States Virgin Islands,0)	(Mongolia,0)	(Japan,56)
(Sweden,146)	(Kazakhstan,1)	(San Marino,25)
(Vietnam,0)	(Fiji,0)	(Equatorial Guinea,0)
(Serbia,13)	(Indonesia,122)	(Cyprus,7)
(Iran,2757)	(Eritrea,0)	(Singapore,3)
(Slovakia,0)	(Somalia,0)	(Benin,0)
(Madagascar,0)	(Norway,26)	(Turks and Caicos Islands,0)

(Moldova,2)	(South Korea,163)	(Niger,3)
(Colombia,14)	(Myanmar,0)	(Belgium,513)
(Cote d'Ivoire,1)	(Germany,583)	(Guyana,1)
(Dominica,0)	(Cayman Islands,1)	(Nicaragua,1)
(Mozambique,0)	(Northern Mariana Islands,0)	(China,3309)
(Tanzania,1)	(Macedonia,7)	(Zimbabwe,1)
(Taiwan,5)	(Cuba,4)	(Algeria,31)
(Cameroon,2)	(Cape Verde,1)	(Seychelles,0)
(Luxembourg,22)	(Kosovo,1)	(Sri Lanka,1)
(Turkey,168)	(Bahrain,4)	(United Arab Emirates,5)
(Congo,0)	(El Salvador,0)	(Costa Rica,2)
(International,7)	(Oman,0)	(Bulgaria,8)
(Panama,26)	(Bangladesh,5)	(Aruba,0)
(Chad,0)	(Libya,0)	(Mauritius,3)
(Hungary,16)	(Ghana,5)	(Haiti,0)
(Portugal,140)	(Venezuela,3)	(New Zealand,1)
(United Kingdom,1408)	(Senegal,0)	(Palestine,1)
(Bolivia,6)	(Saint Lucia,0)	(Philippines,88)
(Guam,1)	(Sudan,2)	(India,32)
(Jamaica,1)	(Iraq,46)	(Austria,108)
(Sint Maarten (Dutch part),0)	(Gambia,1)	(Lebanon,11)
(Georgia,0)	(Namibia,0)	(Argentina,24)
(Honduras,7)	(Greece,43)	(Croatia,6)
(Dominican Republic,42)	(Italy,11591)	(Estonia,3)
(Kyrgyzstan,0)	(Slovenia,11)	(Lithuania,7)
(Faeroe Islands,0)	(Mauritania,0)	(Ecuador,62)
(Morocco,33)	(Maldives,0)	(Laos,0)
(Zambia,0)	(Kuwait,0)	(Belize,0)
(Belarus,0)	(Spain,7340)	(Guinea-Bissau,0)
(Cambodia,0)	(Liechtenstein,0)	(Switzerland,295)
(Nepal,0)	(Montserrat,0)	(Bosnia and Herzegovina,8)
(World,37272)	(Malaysia,37)	(Swaziland,0)
(Kenya,1)	(Ukraine,11)	(Tunisia,8)
(Saint Kitts and Nevis,0)	(Malta,0)	(Mali,0)
(Bhutan,0)	(Romania,44)	(Qatar,1)
(Syria,2)	(Egypt,40)	(Ireland,54)
(Uganda,0)	(Latvia,0)	(United States,3170)
(Albania,12)	(Rwanda,0)	(South Africa,3)
(British Virgin Islands,0)	(Timor,0)	(Azerbaijan,4)
(Puerto Rico,6)	(Antigua and Barbuda,0)	(Central African Republic,0)
(Jordan,5)	(Armenia,3)	(Nigeria,2)
(Trinidad and Tobago,3)	(Monaco,0)	(Guatemala,1)
(Grenada,0)	(Thailand,10)	(Russia,10)
(Brunei,1)	(Togo,1)	(Gabon,1)
(Guinea,0)	(Pakistan,18)	(Andorra,8)
(Mexico,28)	(Ethiopia,0)	(Bahamas,0)
(Anguilla,0)	(Burkina Faso,12)	(Czech Republic,24)
(France,3024)	(Chile,8)	

Task 5: `--class SparkCovid19_2 SparkCovid19_2.jar hdfs://ip-172-31-35-46.ec2.internal:8020/cse532/input/covid19_full_data.csv hdfs://ip-172-31-35-46.ec2.internal:8020/cse532/input/populations.csv hdfs://ip-172-31-35-46.ec2.internal:8020/cse532/output/`

(Australia,233)	(Saint Vincent and the	(Uganda,1)
(Brazil,64)	Grenadines,72)	(Albania,133)
(Uzbekistan,15)	(Canada,473)	(British Virgin Islands,99)
(Papua New Guinea,0)	(Barbados,219)	(Puerto Rico,200)
(Greenland,193)	(Japan,30)	(Jordan,34)
(Finland,416)	(San Marino,8220)	(Trinidad and Tobago,76)
(Peru,89)	(Equatorial Guinea,11)	(Grenada,106)
(Djibouti,122)	(South Sudan,0)	(Brunei,308)
(Montenegro,383)	(Cyprus,409)	(Guinea,10)
(Uruguay,122)	(Singapore,253)	(Mexico,21)
(Gibraltar,3354)	(Benin,2)	(Anguilla,199)
(United States Virgin	(Turks and Caicos Islands,206)	(France,1197)
Islands,430)	(Moldova,261)	(South Korea,202)
(Sweden,761)	(Colombia,34)	(Myanmar,0)
(Vietnam,2)	(Cote d'Ivoire,13)	(Germany,1232)
(Serbia,359)	(Dominica,208)	(Cayman Islands,684)
(Iran,745)	(Mozambique,0)	(Northern Mariana Islands,138)
(Slovakia,106)	(Tanzania,0)	(Macedonia,287)
(Madagascar,3)	(Taiwan,15)	(Cuba,34)
(Angola,0)	(Cameroon,25)	(Cape Verde,12)
(Denmark,875)	(Luxembourg,4744)	(Kosovo,95)
(Saudi Arabia,80)	(Turkey,404)	(Bahrain,476)
(Paraguay,16)	(Congo,8)	(El Salvador,12)
(Curacao,79)	(Panama,521)	(Oman,82)
(Isle of Man,1764)	(Chad,0)	(Bangladesh,0)
(Suriname,17)	(Hungary,92)	(Libya,2)
(New Caledonia,63)	(Portugal,1220)	(Ghana,9)
(Iceland,4647)	(United Kingdom,813)	(Venezuela,5)
(Netherlands,1142)	(Bolivia,17)	(Senegal,14)
(French Polynesia,167)	(Guam,716)	(Falkland Islands,1435)
(Vatican,8652)	(Jamaica,21)	(Saint Lucia,76)
(Mongolia,4)	(Sint Maarten (Dutch part),932)	(Sudan,0)
(Kazakhstan,37)	(Georgia,49)	(Iraq,25)
(Fiji,16)	(Honduras,31)	(Gambia,1)
(Indonesia,10)	(Dominican Republic,180)	(Botswana,2)
(Eritrea,8)	(Kyrgyzstan,41)	(Namibia,6)
(Somalia,0)	(Faeroe Islands,3765)	(Greece,175)
(Norway,1081)	(Morocco,32)	(Italy,2242)
(Liberia,2)	(Zambia,2)	(Slovenia,507)
(Bermuda,626)	(Belarus,91)	(Mauritania,1)
(Democratic Republic of	(Cambodia,6)	(Maldives,35)
Congo,2)	(Nepal,0)	(Kuwait,173)
(Poland,128)	(Kenya,3)	(Spain,3005)
(Afghanistan,9)	(Saint Kitts and Nevis,206)	(Liechtenstein,2045)
(Israel,1068)	(Bhutan,6)	(Montserrat,1200)
	(Syria,1)	(Malaysia,122)

(Ukraine,33)
(Malta,663)
(Romania,229)
(Egypt,12)
(Latvia,290)
(Rwanda,8)
(Timor,0)
(Antigua and Barbuda,153)
(Armenia,287)
(Monaco,2013)
(Burundi,0)
(Thailand,33)
(Togo,7)
(Pakistan,18)
(Ethiopia,0)
(Burkina Faso,18)
(Chile,267)
(Belgium,1914)
(Niger,11)
(Guyana,41)
(Nicaragua,0)
(China,57)

(Zimbabwe,0)
(Algeria,33)
(Seychelles,111)
(Sri Lanka,8)
(United Arab Emirates,238)
(Costa Rica,94)
(Bulgaria,83)
(Aruba,693)
(Mauritius,210)
(Haiti,2)
(Sierra Leone,0)
(New Zealand,200)
(Palestine,50)
(Philippines,34)
(India,3)
(Austria,1403)
(Lebanon,80)
(Argentina,37)
(Croatia,312)
(Estonia,866)
(Lithuania,323)
(Ecuador,226)

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