main

March 30, 2023

1 Extract male bias genes on the X chromosome

```
[1]: import session_info
     import pandas as pd
     from pyhere import here
[2]: def get_deg():
         fn = here("differential_expression/tissue_comparison/summary_table",
                   "_m/differential_expression_analysis_4features_sex.txt.gz")
         df = pd.read_csv(fn, sep='\t').loc[:, ["Tissue", "Feature", "ensemblID", __
      \hookrightarrow "Symbol",
                                                  "seqnames", "Type", "t",⊔

¬"Chrom_Type", "adj.P.Val"]]

         return df[(df["Type"] == "Gene") & (df["adj.P.Val"] < 0.05)].copy()</pre>
[3]: df = get_deg()
[4]: xci = pd.read_csv("../../_h/xci_status_hg19.txt", sep='\t')
     xci["ensemblID"] = xci["Gene ID"].str.replace("\\..*", "", regex=True)
     xci.head(2)
[4]:
      Gene name
                            Gene ID Chr
                                          Start position End position \
     0
          PLCXD1 ENSG00000182378.8
                                                  192989
                                                                 220023
                                                                 230886
          GTPBP6 ENSG00000178605.8
                                                  220025
       Transcript type Combined XCI status
                                                   ensemblID
                                    escape ENSG00000182378
     0 protein_coding
     1 protein_coding
                                     escape
                                             ENSG00000178605
[5]: xci.groupby("Combined XCI status").size()
[5]: Combined XCI status
     escape
                  99
     inactive
                 431
     variable
                 101
     dtype: int64
```

```
tt[(tt['t'] > 0)]
[6]:
               Tissue
                                             Feature
                                                              ensemblID
                                                                             Symbol
                                                                                     \
                                                                               CD99
     26
              Caudate
                            CD99 | ENSG00000002586.20
                                                       ENSG00000002586
                DLPFC
                            CD99 | ENSG00000002586.20
                                                                               CD99
     27
                                                       ENSG00000002586
     28
         Hippocampus
                                                                               CD99
                            CD99 | ENSG00000002586.20
                                                       ENSG00000002586
     34
             Caudate
                           ZBED1 | ENSG00000214717.12
                                                       ENSG00000214717
                                                                              ZBED1
     35
                DLPFC
                           ZBED1 | ENSG00000214717.12
                                                       ENSG00000214717
                                                                              ZBED1
     36
         Hippocampus
                           ZBED1 | ENSG00000214717.12
                                                       ENSG00000214717
                                                                              ZBED1
     37
              Caudate
                           DHRSX | ENSG00000169084.15
                                                       ENSG00000169084
                                                                              DHRSX
     38
                DLPFC
                           DHRSX | ENSG00000169084.15
                                                       ENSG00000169084
                                                                              DHRSX
                           DHRSX | ENSG00000169084.15
     39
         Hippocampus
                                                       ENSG00000169084
                                                                              DHRSX
     46
             Caudate
                          PLCXD1 | ENSG00000182378.15
                                                       ENSG00000182378
                                                                             PLCXD1
     47
                DLPFC
                          PLCXD1 | ENSG00000182378.15
                                                       ENSG00000182378
                                                                             PLCXD1
     48
         Hippocampus
                          PLCXD1 | ENSG00000182378.15
                                                       ENSG00000182378
                                                                             PLCXD1
     54
             Caudate
                          GTPBP6 | ENSG00000178605.14
                                                       ENSG00000178605
                                                                             GTPBP6
     55
                          GTPBP6 | ENSG00000178605.14
                DLPFC
                                                       ENSG00000178605
                                                                             GTPBP6
     56
         Hippocampus
                          GTPBP6 | ENSG00000178605.14
                                                       ENSG00000178605
                                                                             GTPBP6
     61
             Caudate
                           ASMTL | ENSG00000169093.16
                                                       ENSG00000169093
                                                                              ASMTL
     62
                DLPFC
                           ASMTL | ENSG00000169093.16
                                                       ENSG00000169093
                                                                              ASMTL
     63
         Hippocampus
                           ASMTL | ENSG00000169093.16
                                                       ENSG00000169093
                                                                              ASMTL
     64
             Caudate
                        PPP2R3B | ENSG00000167393.18
                                                       ENSG00000167393
                                                                            PPP2R3B
     65
                DLPFC
                        PPP2R3B | ENSG00000167393.18
                                                       ENSG00000167393
                                                                            PPP2R3B
     66
         Hippocampus
                        PPP2R3B | ENSG00000167393.18
                                                       ENSG00000167393
                                                                            PPP2R3B
     69
              Caudate
                           CD99P1 | ENSG00000223773.9
                                                       ENSG00000223773
                                                                             CD99P1
                DLPFC
     70
                           CD99P1 | ENSG00000223773.9
                                                       ENSG00000223773
                                                                             CD99P1
     71
         Hippocampus
                           CD99P1 | ENSG00000223773.9
                                                       ENSG00000223773
                                                                             CD99P1
     79
             Caudate
                           IL3RA | ENSG00000185291.12
                                                       ENSG00000185291
                                                                              IL3RA
     82
              Caudate
                       ASMTL-AS1 | ENSG00000236017.8
                                                       ENSG00000236017
                                                                          ASMTL-AS1
     85
                       LINCO0106 | ENSG00000236871.7
              Caudate
                                                       ENSG00000236871
                                                                         LINC00106
                         AKAP17A | ENSG00000197976.12
                                                       ENSG00000197976
                                                                            AKAP17A
         Hippocampus
        seqnames
                   Type
                                  t Chrom_Type
                                                     adj.P.Val
                                                                 Gene name
     26
             chrX
                   Gene
                          20.718194
                                       Allosome
                                                  9.927600e-62
                                                                      CD99
                   Gene
                                       Allosome
     27
             chrX
                          10.690853
                                                  1.487166e-20
                                                                      CD99
     28
             chrX
                   Gene
                          10.917016
                                       Allosome
                                                  1.493665e-21
                                                                      CD99
     34
             chrX
                   Gene
                          14.600959
                                       Allosome
                                                  4.860361e-36
                                                                     ZBED1
     35
             chrX
                   Gene
                           6.980985
                                       Allosome
                                                  5.207188e-09
                                                                     ZBED1
     36
             chrX
                   Gene
                          13.595283
                                       Allosome
                                                  1.234819e-31
                                                                     ZBED1
     37
             chrX
                   Gene
                          13.689327
                                       Allosome
                                                  2.277083e-32
                                                                     DHRSX
     38
             chrX
                   Gene
                           7.063517
                                                  3.144477e-09
                                                                     DHRSX
                                       Allosome
     39
             chrX
                   Gene
                          10.147705
                                       Allosome
                                                  7.500811e-19
                                                                     DHRSX
     46
             chrX
                   Gene
                          11.285881
                                                  4.067496e-23
                                       Allosome
                                                                    PLCXD1
     47
             chrX
                   Gene
                           8.640379
                                                  8.799965e-14
                                                                    PLCXD1
                                       Allosome
     48
             chrX
                   Gene
                           8.739616
                                       Allosome
                                                  3.292915e-14
                                                                    PLCXD1
     54
             chrX
                   Gene
                          10.387204
                                       Allosome
                                                  6.926781e-20
                                                                    GTPBP6
```

[6]: tt = df.merge(xci[(xci["Combined XCI status"] == "escape")], on="ensemblID")

55	chrX	Gene	7.267410	Allosome	9.077018e-10	GTPBP6
56	chrX	Gene	8.947148	Allosome	7.560856e-15	GTPBP6
61	chrX	Gene	7.896321	Allosome	9.027584e-12	ASMTL
62	chrX	Gene	8.213591	Allosome	1.762084e-12	ASMTL
63	chrX	Gene	9.253175	Allosome	7.723961e-16	ASMTL
64	chrX	Gene	7.727152	Allosome	2.781165e-11	PPP2R3B
65	chrX	Gene	4.258662	Allosome	5.423498e-03	PPP2R3B
66	chrX	Gene	8.034230	Allosome	4.626593e-12	PPP2R3B
69	chrX	Gene	6.853646	Allosome	7.729268e-09	CD99P1
70	chrX	Gene	6.564555	Allosome	6.221642e-08	CD99P1
71	chrX	Gene	7.829146	Allosome	1.868196e-11	CD99P1
79	chrX	Gene	4.012975	Allosome	6.880722e-03	IL3RA
82	chrX	Gene	3.413658	Allosome	3.552684e-02	ASMTL-AS1
85	chrX	Gene	3.300754	Allosome	4.480663e-02	LINCO0106
87	chrX	Gene	4.214142	Allosome	6.764315e-03	AKAP17A

	Gene ID	Chr	Start position	End position	Transcript type
26	ENSG00000002586.13	Х	2609220	2659350	<pre>protein_coding</pre>
27	ENSG00000002586.13	X	2609220	2659350	<pre>protein_coding</pre>
28	ENSG00000002586.13	X	2609220	2659350	<pre>protein_coding</pre>
34	ENSG00000214717.5	X	2404455	2419008	<pre>protein_coding</pre>
35	ENSG00000214717.5	Х	2404455	2419008	<pre>protein_coding</pre>
36	ENSG00000214717.5	X	2404455	2419008	<pre>protein_coding</pre>
37	ENSG00000169084.8	X	2137557	2420846	<pre>protein_coding</pre>
38	ENSG00000169084.8	X	2137557	2420846	<pre>protein_coding</pre>
39	ENSG00000169084.8	X	2137557	2420846	<pre>protein_coding</pre>
46	ENSG00000182378.8	X	192989	220023	<pre>protein_coding</pre>
47	ENSG00000182378.8	X	192989	220023	<pre>protein_coding</pre>
48	ENSG00000182378.8	X	192989	220023	<pre>protein_coding</pre>
54	ENSG00000178605.8	X	220025	230886	<pre>protein_coding</pre>
55	ENSG00000178605.8	X	220025	230886	<pre>protein_coding</pre>
56	ENSG00000178605.8	X	220025	230886	<pre>protein_coding</pre>
61	ENSG00000169093.10	X	1522032	1572655	<pre>protein_coding</pre>
62	ENSG00000169093.10	X	1522032	1572655	<pre>protein_coding</pre>
63	ENSG00000169093.10	X	1522032	1572655	<pre>protein_coding</pre>
64	ENSG00000167393.12	X	294698	347690	<pre>protein_coding</pre>
65	ENSG00000167393.12	X	294698	347690	<pre>protein_coding</pre>
66	ENSG00000167393.12	X	294698	347690	<pre>protein_coding</pre>
69	ENSG00000223773.2	X	2527389	2575270	pseudogene
70	ENSG00000223773.2	Х	2527389	2575270	pseudogene
71	ENSG00000223773.2	X	2527389	2575270	pseudogene
79	ENSG00000185291.6	X	1455509	1501578	<pre>protein_coding</pre>
82	ENSG00000236017.3	X	1520662	1532921	antisense
85	ENSG00000236871.2	X	1515320	1518295	${\tt lincRNA}$
87	ENSG00000197976.6	Х	1710486	1721407	<pre>protein_coding</pre>

Combined XCI status

```
27
                      escape
     28
                      escape
     34
                      escape
     35
                      escape
     36
                      escape
     37
                      escape
     38
                      escape
     39
                      escape
     46
                      escape
     47
                      escape
     48
                      escape
     54
                      escape
     55
                      escape
     56
                      escape
     61
                      escape
     62
                      escape
     63
                      escape
     64
                      escape
     65
                      escape
     66
                      escape
     69
                      escape
     70
                      escape
     71
                      escape
     79
                      escape
     82
                      escape
     85
                      escape
     87
                      escape
    Escaped genes are also located on the PAR regions of the Y chromosome.
[7]: xlinked = df[(df['seqnames'] == 'chrX')].copy()
     xx_male = df[(df['seqnames'].isin(["chrX", "chrY"])) & (df["t"] > 0)].copy()
     xlinked_male = xlinked[(xlinked["t"] > 0)].copy()
     xlinked_female = xlinked[(xlinked["t"] < 0)].copy()</pre>
[8]: xlinked.groupby("Tissue").size()
[8]: Tissue
     Caudate
                     72
     DLPFC
                     36
     Hippocampus
                     44
     dtype: int64
[9]: xlinked_male.groupby("Tissue").size()
[9]: Tissue
     Caudate
                     22
```

26

escape

DLPFC 14 Hippocampus 13 dtype: int64

[10]: xlinked_female.groupby("Tissue").size()

[10]: Tissue

Caudate 50 DLPFC 22 Hippocampus 31 dtype: int64

[11]: xlinked_male

[11]:		Tissue	Feature	ensemblID	\
	53	Caudate	CD99 ENSG00000002586.20	ENSG00000002586	
	56	Caudate	PRKCIP1 ENSG00000237682.2	ENSG00000237682	
	62	Caudate	ZBED1 ENSG00000214717.12	ENSG00000214717	
	65	Caudate	DHRSX ENSG00000169084.15	ENSG00000169084	
	66	Caudate	ENSG00000289007 ENSG00000289007.2	ENSG00000289007	
	72	Caudate	PLCXD1 ENSG00000182378.15	ENSG00000182378	
	77	Caudate	GTPBP6 ENSG00000178605.14	ENSG00000178605	
	91	Caudate	ASMTL ENSG00000169093.16	ENSG00000169093	
	94	Caudate	PPP2R3B ENSG00000167393.18	ENSG00000167393	
	100	Caudate	CD99P1 ENSG00000223773.9	ENSG00000223773	
	107	Caudate	LINC00685 ENSG00000226179.6	ENSG00000226179	
	140	Caudate	CACNA1F ENSG00000102001.13	ENSG00000102001	
	167	Caudate	FIRRE ENSG00000213468.7	ENSG00000213468	
	176	Caudate	MAGEE2 ENSG00000186675.7	ENSG00000186675	
	281	Caudate	IL3RA ENSG00000185291.12	ENSG00000185291	
	434	Caudate	REPS2 ENSG00000169891.18	ENSG00000169891	
	457	Caudate	ENSG00000235189 ENSG00000235189.2	ENSG00000235189	
	529	Caudate	MCTS1 ENSG00000232119.8	ENSG00000232119	
	536	Caudate	ASMTL-AS1 ENSG00000236017.8	ENSG00000236017	
	557	Caudate	ENSG00000286085 ENSG00000286085.1	ENSG00000286085	
	614	Caudate	ARHGEF9 ENSG00000131089.17	ENSG00000131089	
	632	Caudate	LINC00106 ENSG00000236871.7	ENSG00000236871	
	681463	DLPFC	PRKCIP1 ENSG00000237682.2	ENSG00000237682	
	681470	DLPFC	ENSG00000289007 ENSG00000289007.2	ENSG00000289007	
	681473	DLPFC	CD99 ENSG00000002586.20	ENSG00000002586	
	681483	DLPFC	PLCXD1 ENSG00000182378.15	ENSG00000182378	
	681485	DLPFC	ASMTL ENSG00000169093.16	ENSG00000169093	
	681492	DLPFC	GTPBP6 ENSG00000178605.14	ENSG00000178605	
	681496	DLPFC	DHRSX ENSG00000169084.15	ENSG00000169084	
	681497	DLPFC	ZBED1 ENSG00000214717.12	ENSG00000214717	
	681502	DLPFC	CD99P1 ENSG00000223773.9	ENSG00000223773	
	681551	DLPFC	PPP2R3B ENSG00000167393.18	ENSG00000167393	

681558 DLPFC	CO1 E E O	DI DEG	I TNOO	COELEM	gg000000061	70 6	EMGGO	0000006170
Selection	681558	DLPFC						
Selection								
1333417								
1333434								
1333435								
1333437								
Name								
1333450 Hippocampus PPP2R3B ENSGOO000167393 .18 ENSGOO000223773 .9 ENSGOO000223773 .9 1333488 Hippocampus LINCO0685 ENSGO0000226179 .6 ENSGOO000197976 .12 ENSGOO000197976 .12 ENSGOO000197976 .13 1333498 Hippocampus AKAP17A ENSGO000147124 .13 ENSGOO00197976 .12 ENSGOO00197976 .13 1333516 Hippocampus ZNF41 ENSGO000147124 .13 ENSGOO00197976 .12 ENSGOO000197976 .12 53 CD99 chrX Gene 20.718194 All Some 9.927600-62 9.927600-62 56 PRKCFPI ChrX Gene 17.897618 All Some 9.027108-30 9.027600-62 62 ZBED1 ChrX Gene 17.897618 All Some 9.027108-30 9.027600-62 65 DHRSX ChrX Gene 13.689327 All Some 9.027108-32 66 ENSGO000289007 ChrX Gene 11.285881 All Some 6.926781-20 1.978779-29 72 PLCXD1 ChrX Gene 11.285881 All Some 6.926781-20 91 ASMTL ChrX Gene 10.387204 All Some 6.926781-20 91 ASMTL ChrX Gene 6.853646 All Some 6.926781-20 91 ASMTL ChrX Gene 6.853646 All Some 7.729268-09 7.729268-09 11.00 CACNA1F ChrX Gene 6.853646 All Some 3.99273-05 167 FIRRE ChrX								
1333451								
1333488 Hippocampus LINCO∪685 IENSU0000226179.6 ENSG∪00026179 ENSG∪000197976 1333499 Hippocampus AKAP17 I ENSU0000147124.13 ENSG∪000197976 12 ENSG∪000197976 1333516 Hippocampus ZNF41 IENSU0000147124.13 ENSG∪000147124 12 53 CD99 chrX Gene 20.718194 All Jone 9.927600e-62 56 PRKCTP1 chrX Gene 17.897618 All Jone 9.9242191e-50 62 ZBED1 chrX Gene 13.689327 All Jone 9.042191e-50 65 DHRSX chrX Gene 12.947296 All Jone 1.978779e-29 72 PLCXD1 chrX Gene 11.285881 All Jone 1.978779e-29 72 PLCXD1 chrX Gene 11.285881 All Jone 4.067496e-23 77 GTPBF6 chrX Gene 7.896321 All Jone 6.926781e-20 91 ASMTL chrX Gene 7.896321 All Jone 6.92678								
Symbol seqnames								
Symbol seqnames Type t Chrom_Type adj.P.Val 53 CD99 chrX Gene 20.718194 Allosome 9.927600e-62 56 PRKCIP1 chrX Gene 17.897618 Allosome 9.042191e-50 62 ZBED1 chrX Gene 14.600959 Allosome 9.042191e-50 65 DHRSX chrX Gene 13.689327 Allosome 2.277083e-32 66 ENSG00000289007 chrX Gene 11.285881 Allosome 1.978779e-29 72 PLCXD1 chrX Gene 10.387204 Allosome 4.067496e-23 77 GTPBP6 chrX Gene 7.896321 Allosome 6.926781e-20 91 ASMTL chrX Gene 7.727152 Allosome 2.781165e-11 100 CD99P1 chrX Gene 6.853646 Allosome 7.722968e-09 107 LINC00685 chrX Gene 6.393728 Allosome 7.722968e-09 <tr< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr<>								
53 CD99 chrX Gene 20.718194 Allosome 9.927600e-62 56 PRKCIP1 chrX Gene 17.897618 Allosome 9.042191e-50 62 ZBED1 chrX Gene 14.600959 Allosome 4.860361e-36 65 DHRSX chrX Gene 13.689327 Allosome 2.277083e-32 66 ENSG0000289007 chrX Gene 11.285881 Allosome 1.978779e-29 72 PLCXD1 chrX Gene 10.387204 Allosome 4.067496e-23 77 GTPBP6 chrX Gene 1.38581 Allosome 6.926781e-20 91 ASMTL chrX Gene 1.386321 Allosome 6.926781e-20 91 ASMTL chrX Gene 7.727152 Allosome 9.027584e-12 94 PPP2R3B chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 5.287079 Alloso	1333310	Hippocampus	71/1.	41 LEND	G0000014712	4.13	ENDGO	0000147124
53 CD99 chrX Gene 20.718194 Allosome 9.927600e-62 56 PRKCIP1 chrX Gene 17.897618 Allosome 9.042191e-50 62 ZBED1 chrX Gene 14.600959 Allosome 4.860361e-36 65 DHRSX chrX Gene 13.689327 Allosome 2.277083e-32 66 ENSG00000289007 chrX Gene 12.947296 Allosome 1.978779e-29 72 PLCXD1 chrX Gene 10.387204 Allosome 4.067496e-23 77 GTPBP6 chrX Gene 1.385831 Allosome 6.926781e-20 91 ASMTL chrX Gene 1.386321 Allosome 6.926781e-20 91 ASMTL chrX Gene 7.727152 Allosome 9.027584e-12 94 PPP2R3B chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 5.287079 Allo		Symbol	segnames	Type	t	Chrom	Type	adj.P.Val
62 ZBED1 chrX Gene 14.600959 Allosome 4.860361e-36 65 DHRSX chrX Gene 13.689327 Allosome 2.277083e-32 66 ENSG00000289007 chrX Gene 12.947296 Allosome 1.978779e-29 72 PLCXD1 chrX Gene 11.285881 Allosome 4.067496e-23 77 GTPBP6 chrX Gene 10.387204 Allosome 6.926781e-20 91 ASMTL chrX Gene 7.727152 Allosome 9.027584e-12 94 PPP2R3B chrX Gene 6.853646 Allosome 2.781165e-11 100 CD9PP1 chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 5.287079 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.617251 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.012975 A	53		_					•
65 DHRSX chrX Gene 13.689327 Allosome 2.277083e-32 66 ENSG00000289007 chrX Gene 12.947296 Allosome 1.978779e-29 72 PLCXD1 chrX Gene 11.285881 Allosome 4.067496e-23 77 GTPBP6 chrX Gene 10.387204 Allosome 6.926781e-20 91 ASMTL chrX Gene 7.896321 Allosome 9.027584e-12 94 PPP2R3B chrX Gene 6.853646 Allosome 2.781165e-11 100 CD99P1 chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 6.393728 Allosome 7.729268e-09 140 CACNA1F chrX Gene 5.287079 Allosome 1.178363e-07 140 CACNA1F chrX Gene 4.617251 Allosome 2.963626e-04 176 MAGE2 chrX Gene 3.56066 <td< td=""><td>56</td><td>PRKCIP1</td><td>chrX</td><td>Gene</td><td>17.897618</td><td>Allo</td><td>some</td><td>9.042191e-50</td></td<>	56	PRKCIP1	chrX	Gene	17.897618	Allo	some	9.042191e-50
66 ENSG00000289007 chrX Gene 12.947296 Allosome 1.978779e-29 72 PLCXD1 chrX Gene 11.285881 Allosome 4.067496e-23 77 GTPBP6 chrX Gene 10.387204 Allosome 6.926781e-20 91 ASMTL chrX Gene 7.896321 Allosome 9.027584e-12 94 PPP2R3B chrX Gene 7.727152 Allosome 2.781165e-11 100 CD99P1 chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 6.393728 Allosome 7.729268e-09 140 CACNA1F chrX Gene 5.287079 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.617251 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.012975 Allosome 8.083446e-04 281 ILSAGO0000235189 chrX Gene 3.519369	62	ZBED1	chrX	Gene	14.600959	Allo	some	4.860361e-36
72 PLCXD1 chrX Gene 11.285881 Allosome 4.067496e-23 77 GTPBP6 chrX Gene 10.387204 Allosome 6.926781e-20 91 ASMTL chrX Gene 7.896321 Allosome 9.027584e-12 94 PPP2R3B chrX Gene 6.853646 Allosome 2.781165e-11 100 CD99P1 chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 6.393728 Allosome 1.178363e-07 140 CACNA1F chrX Gene 4.844137 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.617251 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.012975 Allosome 8.083446e-04 281 IL3RA chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.418956 <td< td=""><td>65</td><td>DHRSX</td><td>chrX</td><td>Gene</td><td>13.689327</td><td>Allo</td><td>some</td><td>2.277083e-32</td></td<>	65	DHRSX	chrX	Gene	13.689327	Allo	some	2.277083e-32
77 GTPBP6 chrX Gene 10.387204 Allosome 6.926781e-20 91 ASMTL chrX Gene 7.896321 Allosome 9.027584e-12 94 PPP2R3B chrX Gene 7.727152 Allosome 2.781165e-11 100 CD99P1 chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 6.393728 Allosome 1.178363e-07 140 CACNA1F chrX Gene 5.287079 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.617251 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.012975 Allosome 8.083446e-04 281 IL3RA chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.418956 Allosome 3.532313e-02 529 MCTS1 chrX Gene 3.413658	66	ENSG00000289007	chrX	Gene	12.947296	Allo	some	1.978779e-29
91 ASMTL chrX Gene 7.896321 Allosome 9.027584e-12 94 PPP2R3B chrX Gene 7.727152 Allosome 2.781165e-11 100 CD99P1 chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 6.393728 Allosome 1.178363e-07 140 CACNA1F chrX Gene 5.287079 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.844137 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.617251 Allosome 8.083446e-04 281 IL3RA chrX Gene 4.012975 Allosome 6.880722e-03 434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG0000235189 chrX Gene 3.418956 Allosome 3.532313e-02 529 MCTS1 chrX Gene 3.418956 Al	72	PLCXD1	chrX	Gene	11.285881	Allo	some	4.067496e-23
94 PPP2R3B chrX Gene 7.727152 Allosome 2.781165e-11 100 CD99P1 chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 6.393728 Allosome 1.178363e-07 140 CACNA1F chrX Gene 5.287079 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.844137 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.617251 Allosome 8.083446e-04 281 IL3RA chrX Gene 4.012975 Allosome 6.880722e-03 434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG0000235189 chrX Gene 3.418956 Allosome 3.532313e-02 529 MCTS1 chrX Gene 3.413658 Allosome 3.552684e-02 557 ENSG00000286085 chrX Gene 3.383794	77	GTPBP6	chrX	Gene	10.387204	Allo	some	6.926781e-20
100 CD99P1 chrX Gene 6.853646 Allosome 7.729268e-09 107 LINC00685 chrX Gene 6.393728 Allosome 1.178363e-07 140 CACNA1F chrX Gene 5.287079 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.844137 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.617251 Allosome 8.083446e-04 281 IL3RA chrX Gene 4.012975 Allosome 6.880722e-03 434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.519369 Allosome 2.835066e-02 529 MCTS1 chrX Gene 3.418956 Allosome 3.532313e-02 557 ENSG00000286085 chrX Gene 3.333794 Allosome 4.259924e-02 632 LINC00106 chrX Gene 3.300754	91	ASMTL	chrX	Gene	7.896321	Allo	some	9.027584e-12
107 LINC00685 chrX Gene 6.393728 Allosome 1.178363e-07 140 CACNA1F chrX Gene 5.287079 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.844137 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.617251 Allosome 8.083446e-04 281 IL3RA chrX Gene 4.012975 Allosome 6.880722e-03 434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.519369 Allosome 2.835066e-02 529 MCTS1 chrX Gene 3.418956 Allosome 3.532313e-02 536 ASMTL-AS1 chrX Gene 3.413658 Allosome 3.788879e-02 614 ARHGEF9 chrX Gene 3.323602 Allosome 4.259924e-02 632 LINCO0106 chrX Gene 3.300754	94	PPP2R3B	chrX	Gene	7.727152	Allo	some	2.781165e-11
140 CACNA1F chrX Gene 5.287079 Allosome 3.998273e-05 167 FIRRE chrX Gene 4.844137 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.617251 Allosome 8.083446e-04 281 IL3RA chrX Gene 4.012975 Allosome 6.880722e-03 434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.519369 Allosome 2.835066e-02 529 MCTS1 chrX Gene 3.418956 Allosome 3.532313e-02 536 ASMTL-AS1 chrX Gene 3.3413658 Allosome 3.552684e-02 557 ENSG00000286085 chrX Gene 3.323602 Allosome 4.259924e-02 632 LINC00106 chrX Gene 3.300754 Allosome 4.480663e-02 681463 PRKCIP1 chrX Gene 10.86684	100	CD99P1	chrX	Gene	6.853646	Allo	some	7.729268e-09
167 FIRRE chrX Gene 4.844137 Allosome 2.963626e-04 176 MAGEE2 chrX Gene 4.617251 Allosome 8.083446e-04 281 IL3RA chrX Gene 4.012975 Allosome 6.880722e-03 434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.519369 Allosome 2.835066e-02 529 MCTS1 chrX Gene 3.418956 Allosome 3.532313e-02 536 ASMTL-AS1 chrX Gene 3.413658 Allosome 3.552684e-02 557 ENSG00000286085 chrX Gene 3.383794 Allosome 3.788879e-02 614 ARHGEF9 chrX Gene 3.300754 Allosome 4.259924e-02 681463 PRKCIP1 chrX Gene 23.144727 Allosome 1.157617e-69 681470 ENSG00000289007 chrX Gene <td< td=""><td>107</td><td>LINCO0685</td><td>chrX</td><td>Gene</td><td>6.393728</td><td>Allo</td><td>some</td><td>1.178363e-07</td></td<>	107	LINCO0685	chrX	Gene	6.393728	Allo	some	1.178363e-07
176 MAGEE2 chrX Gene 4.617251 Allosome 8.083446e-04 281 IL3RA chrX Gene 4.012975 Allosome 6.880722e-03 434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.519369 Allosome 2.835066e-02 529 MCTS1 chrX Gene 3.418956 Allosome 3.532313e-02 536 ASMTL-AS1 chrX Gene 3.413658 Allosome 3.552684e-02 557 ENSG00000286085 chrX Gene 3.383794 Allosome 3.788879e-02 614 ARHGEF9 chrX Gene 3.300754 Allosome 4.259924e-02 632 LINC00106 chrX Gene 23.144727 Allosome 1.157617e-69 681463 PRKCIP1 chrX Gene 10.866842 Allosome 3.758222e-21 681470 ENSG00000289007 chrX Gene	140	CACNA1F	chrX	Gene	5.287079	Allo	some	3.998273e-05
281 IL3RA chrX Gene 4.012975 Allosome 6.880722e-03 434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.519369 Allosome 2.835066e-02 529 MCTS1 chrX Gene 3.418956 Allosome 3.532313e-02 536 ASMTL-AS1 chrX Gene 3.413658 Allosome 3.552684e-02 557 ENSG00000286085 chrX Gene 3.383794 Allosome 3.788879e-02 614 ARHGEF9 chrX Gene 3.323602 Allosome 4.259924e-02 632 LINC00106 chrX Gene 3.300754 Allosome 4.480663e-02 681463 PRKCIP1 chrX Gene 23.144727 Allosome 3.758222e-21 681470 ENSG00000289007 chrX Gene 10.690853 Allosome 1.487166e-20 681483 PLCXD1 chrX Gene	167	FIRRE	chrX	Gene	4.844137	Allo	some	2.963626e-04
434 REPS2 chrX Gene 3.566068 Allosome 2.524039e-02 457 ENSG00000235189 chrX Gene 3.519369 Allosome 2.835066e-02 529 MCTS1 chrX Gene 3.418956 Allosome 3.532313e-02 536 ASMTL-AS1 chrX Gene 3.413658 Allosome 3.552684e-02 557 ENSG00000286085 chrX Gene 3.383794 Allosome 3.788879e-02 614 ARHGEF9 chrX Gene 3.303602 Allosome 4.259924e-02 632 LINC00106 chrX Gene 3.300754 Allosome 4.480663e-02 681463 PRKCIP1 chrX Gene 23.144727 Allosome 1.157617e-69 681470 ENSG00000289007 chrX Gene 10.866842 Allosome 3.758222e-21 681483 PLCXD1 chrX Gene 8.640379 Allosome 8.799965e-14 681485 ASMTL chrX Gene	176	MAGEE2	chrX	Gene	4.617251	Allo	some	8.083446e-04
457ENSG00000235189chrXGene3.519369Allosome2.835066e-02529MCTS1chrXGene3.418956Allosome3.532313e-02536ASMTL-AS1chrXGene3.413658Allosome3.552684e-02557ENSG00000286085chrXGene3.383794Allosome3.788879e-02614ARHGEF9chrXGene3.323602Allosome4.259924e-02632LINC00106chrXGene3.300754Allosome4.480663e-02681463PRKCIP1chrXGene23.144727Allosome1.157617e-69681470ENSG00000289007chrXGene10.866842Allosome3.758222e-21681473CD99chrXGene10.690853Allosome1.487166e-20681483PLCXD1chrXGene8.640379Allosome8.799965e-14681485ASMTLchrXGene8.213591Allosome1.762084e-12	281	IL3RA	chrX	Gene	4.012975	Allo	some	6.880722e-03
529 MCTS1 chrX Gene 3.418956 Allosome 3.532313e-02 536 ASMTL-AS1 chrX Gene 3.413658 Allosome 3.552684e-02 557 ENSG00000286085 chrX Gene 3.383794 Allosome 3.788879e-02 614 ARHGEF9 chrX Gene 3.323602 Allosome 4.259924e-02 632 LINC00106 chrX Gene 3.300754 Allosome 4.480663e-02 681463 PRKCIP1 chrX Gene 23.144727 Allosome 1.157617e-69 681470 ENSG00000289007 chrX Gene 10.866842 Allosome 3.758222e-21 681473 CD99 chrX Gene 10.690853 Allosome 1.487166e-20 681483 PLCXD1 chrX Gene 8.640379 Allosome 8.799965e-14 681485 ASMTL chrX Gene 8.213591 Allosome 1.762084e-12	434	REPS2	chrX	Gene	3.566068	Allo	some	2.524039e-02
536 ASMTL-AS1 chrX Gene 3.413658 Allosome 3.552684e-02 557 ENSG00000286085 chrX Gene 3.383794 Allosome 3.788879e-02 614 ARHGEF9 chrX Gene 3.323602 Allosome 4.259924e-02 632 LINC00106 chrX Gene 3.300754 Allosome 4.480663e-02 681463 PRKCIP1 chrX Gene 23.144727 Allosome 1.157617e-69 681470 ENSG00000289007 chrX Gene 10.866842 Allosome 3.758222e-21 681473 CD99 chrX Gene 10.690853 Allosome 1.487166e-20 681483 PLCXD1 chrX Gene 8.640379 Allosome 8.799965e-14 681485 ASMTL chrX Gene 8.213591 Allosome 1.762084e-12	457	ENSG00000235189	chrX	Gene	3.519369	Allo	some	2.835066e-02
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614 ARHGEF9 chrX Gene 3.323602 Allosome 4.259924e-02 632 LINC00106 chrX Gene 3.300754 Allosome 4.480663e-02 681463 PRKCIP1 chrX Gene 23.144727 Allosome 1.157617e-69 681470 ENSG00000289007 chrX Gene 10.866842 Allosome 3.758222e-21 681473 CD99 chrX Gene 10.690853 Allosome 1.487166e-20 681483 PLCXD1 chrX Gene 8.640379 Allosome 8.799965e-14 681485 ASMTL chrX Gene 8.213591 Allosome 1.762084e-12	536	ASMTL-AS1	chrX	Gene	3.413658	Allo	some	3.552684e-02
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681463 PRKCIP1 chrX Gene 23.144727 Allosome 1.157617e-69 681470 ENSG00000289007 chrX Gene 10.866842 Allosome 3.758222e-21 681473 CD99 chrX Gene 10.690853 Allosome 1.487166e-20 681483 PLCXD1 chrX Gene 8.640379 Allosome 8.799965e-14 681485 ASMTL chrX Gene 8.213591 Allosome 1.762084e-12	614	ARHGEF9	chrX	Gene	3.323602	Allo	some	4.259924e-02
681470 ENSG00000289007 chrX Gene 10.866842 Allosome 3.758222e-21 681473 CD99 chrX Gene 10.690853 Allosome 1.487166e-20 681483 PLCXD1 chrX Gene 8.640379 Allosome 8.799965e-14 681485 ASMTL chrX Gene 8.213591 Allosome 1.762084e-12	632	LINCO0106	chrX	Gene	3.300754	Allo	some	4.480663e-02
681473 CD99 chrX Gene 10.690853 Allosome 1.487166e-20 681483 PLCXD1 chrX Gene 8.640379 Allosome 8.799965e-14 681485 ASMTL chrX Gene 8.213591 Allosome 1.762084e-12	681463	PRKCIP1	chrX	Gene	23.144727	Allo	some	1.157617e-69
681483 PLCXD1 chrX Gene 8.640379 Allosome 8.799965e-14 681485 ASMTL chrX Gene 8.213591 Allosome 1.762084e-12	681470	ENSG00000289007	chrX	Gene	10.866842	Allo	some	3.758222e-21
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                                                          Allosome
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[12]: xlinked_male.merge(xci[["ensemblID", "Combined XCI status"]], on="ensemblID", uhow="left").fillna("unknown")

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Caudate	ZBED1 ENSG00000214717.12	ENSG00000214717	
Caudate	DHRSX ENSG00000169084.15	ENSG00000169084	
Caudate	ENSG00000289007 ENSG00000289007.2	ENSG00000289007	
Caudate	PLCXD1 ENSG00000182378.15	ENSG00000182378	
S Caudate	GTPBP6 ENSG00000178605.14	ENSG00000178605	
' Caudate	ASMTL ENSG00000169093.16	ENSG00000169093	
Caudate	PPP2R3B ENSG00000167393.18	ENSG00000167393	
Caudate	CD99P1 ENSG00000223773.9	ENSG00000223773	
.0 Caudate	LINC00685 ENSG00000226179.6	ENSG00000226179	
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.2 Caudate	FIRRE ENSG00000213468.7	ENSG00000213468	
.3 Caudate	MAGEE2 ENSG00000186675.7	ENSG00000186675	
.4 Caudate	IL3RA ENSG00000185291.12	ENSG00000185291	
.5 Caudate	REPS2 ENSG00000169891.18	ENSG00000169891	
.6 Caudate	ENSG00000235189 ENSG00000235189.2	ENSG00000235189	
.7 Caudate	MCTS1 ENSG00000232119.8	ENSG00000232119	
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                            CD99P1 | ENSG00000223773.9
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31
          DLPFC
                          PPP2R3B | ENSG00000167393.18
                                                        ENSG00000167393
32
          DLPFC
                         LINCO0685 | ENSG00000226179.6
                                                        ENSG00000226179
33
          DLPFC
                           NLRP3P1 | ENSG00000277883.1
                                                        ENSG00000277883
34
          DLPFC
                  ENSG00000236064 | ENSG00000236064.3
                                                        ENSG00000236064
35
          DLPFC
                          CHMP1B2P|ENSG00000278530.5
                                                        ENSG00000278530
36
    Hippocampus
                           PRKCIP1 | ENSG00000237682.2
                                                        ENSG00000237682
37
    Hippocampus
                            ZBED1 | ENSG00000214717.12
                                                        ENSG00000214717
38
    Hippocampus
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                                                        ENSG00000002586
39
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                  ENSG00000289007 | ENSG00000289007.2
                                                        ENSG00000289007
40
    Hippocampus
                            DHRSX | ENSG00000169084.15
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41
    Hippocampus
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42
    Hippocampus
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43
    Hippocampus
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                                                        ENSG00000223773
46
    Hippocampus
                         LINCO0685 | ENSG00000226179.6
                                                        ENSG00000226179
    Hippocampus
47
                          AKAP17A | ENSG00000197976.12
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48
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                          chrX
                                Gene
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                                                    Allosome
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8
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14
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                                Gene
                                                    Allosome
15
               REPS2
                          chrX
                                Gene
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16
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                          chrX
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                                                    Allosome
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LINCO0106 | ENSG00000236871.7

ENSG00000236871

21

Caudate

17	MCTS1	chrX	Gene	3.418956	Allosome	3.532313e-02
18	ASMTL-AS1	chrX	Gene	3.413658	Allosome	3.552684e-02
19	ENSG00000286085	chrX	Gene	3.383794	Allosome	3.788879e-02
20	ARHGEF9	chrX	Gene	3.323602	Allosome	4.259924e-02
21	LINCO0106	chrX	Gene	3.300754	Allosome	4.480663e-02
22	PRKCIP1	chrX	Gene	23.144727	Allosome	1.157617e-69
23	ENSG00000289007	chrX	Gene	10.866842	Allosome	3.758222e-21
24	CD99	chrX	Gene	10.690853	Allosome	1.487166e-20
25	PLCXD1	chrX	Gene	8.640379	Allosome	8.799965e-14
26	ASMTL	chrX	Gene	8.213591	Allosome	1.762084e-12
27	GTPBP6	chrX	Gene	7.267410	Allosome	9.077018e-10
28	DHRSX	chrX	Gene	7.063517	Allosome	3.144477e-09
29	ZBED1	chrX	Gene	6.980985	Allosome	5.207188e-09
30	CD99P1	chrX	Gene	6.564555	Allosome	6.221642e-08
31	PPP2R3B	chrX	Gene	4.258662	Allosome	5.423498e-03
32	LINCO0685	chrX	Gene	4.176934	Allosome	7.264379e-03
33	NLRP3P1	chrX	Gene	4.016033	Allosome	1.287122e-02
34	ENSG00000236064	chrX	Gene	3.745985	Allosome	2.961044e-02
35	CHMP1B2P	chrX	Gene	3.607484	Allosome	4.049366e-02
36	PRKCIP1	chrX	Gene	21.036757	Allosome	3.995345e-62
37	ZBED1	chrX	Gene	13.595283	Allosome	1.234819e-31
38	CD99	chrX	Gene	10.917016	Allosome	1.493665e-21
39	ENSG00000289007	chrX	Gene	10.581601	Allosome	2.325250e-20
40	DHRSX	chrX	Gene	10.147705	Allosome	7.500811e-19
41	ASMTL	chrX	Gene	9.253175	Allosome	7.723961e-16
42	GTPBP6	chrX	Gene	8.947148	Allosome	7.560856e-15
43	PLCXD1	chrX	Gene	8.739616	Allosome	3.292915e-14
44	PPP2R3B	chrX	Gene	8.034230	Allosome	4.626593e-12
45	CD99P1	chrX	Gene	7.829146	Allosome	1.868196e-11
46	LINCO0685	chrX	Gene	4.800975	Allosome	5.409422e-04
47	AKAP17A	chrX	Gene	4.214142	Allosome	6.764315e-03
48	ZNF41	chrX	Gene	3.850933	Allosome	2.614981e-02

Combined XCI status

escape
unknown
escape
escape
unknown
escape
unknown
inactive
variable

```
14
                      escape
      15
                    inactive
      16
                     unknown
      17
                    inactive
      18
                      escape
      19
                     unknown
      20
                    inactive
      21
                      escape
      22
                     unknown
      23
                     unknown
      24
                      escape
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      26
                      escape
      27
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      28
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      29
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      30
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      31
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      34
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      35
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      36
      37
                      escape
      38
                      escape
                     unknown
      39
      40
                      escape
      41
                      escape
      42
                      escape
      43
                      escape
      44
                      escape
      45
                      escape
      46
                     unknown
      47
                       escape
      48
                    inactive
[13]: dx = xlinked_male.merge(xci[["ensemblID", "Combined XCI status"]],
       ⇔on="ensemblID", how="left").fillna("unknown")
      dx = dx[(dx["Combined XCI status"] == "unknown")].copy()
[14]: pd.concat([xx_male.merge(xci[["ensemblID", "Combined XCI status"]],
       ⇔on="ensemblID"), dx], axis=0)\
        .sort_values(["Tissue", "Combined XCI status", "seqnames"], ascending=True)\
        .to_csv("BrainSeq_male_biased_genes_XCI_status.tsv", sep='\t', index=False)
```

13

unknown

1.1 Session information

```
[15]: session_info.show()
```

[15]: <IPython.core.display.HTML object>