

MACCSKeyBits, *MACCSKeyCount*. Default value: *MACCSKeyBits*.

For *MACCSKeyBits* value of -m, --mode option, a fingerprint bit-vector string containing zeros and ones is generated and for *MACCSKeyCount* value, a fingerprint vector string corresponding to number of MACCS keys is generated.

MACCSKeyBits / *MACCSKeyCount* values for -m, --mode option along with two possible 166 / 322 values of -s, --size supports generation of four different types of MACCS keys fingerprint: *MACCS166KeyBits*, *MACCS166KeyCount*, *MACCS322KeyBits*, *MACCS322KeyCount*.

Definition of MACCS keys uses the following atom and bond symbols to define atom and bond environments:

Atom symbols for 166 keys [Ref 47]:

A : Any valid periodic table element symbol
 Q : Hetro atoms; any non-C or non-H atom
 X : Halogens; F, Cl, Br, I
 Z : Others; other than H, C, N, O, Si, P, S, F, Cl, Br, I

Atom symbols for 322 keys [Ref 46]:

A : Any valid periodic table element symbol
 Q : Hetro atoms; any non-C or non-H atom
 X : Others; other than H, C, N, O, Si, P, S, F, Cl, Br, I
 Z is neither defined nor used

Bond types:

- : Single
 = : Double
 T : Triple
 # : Triple
 ~ : Single or double query bond
 % : An aromatic query bond

None : Any bond type; no explicit bond specified

\$: Ring bond; \$ before a bond type specifies ring bond
 ! : Chain or non-ring bond; ! before a bond type specifies chain bond

@ : A ring linkage and the number following it specifies the atoms position in the line, thus @1 means linked back to the first atom in the list.

Aromatic: Kekule or Arom5

Kekule: Bonds in 6-membered rings with alternate single/double bonds or perimeter bonds

Arom5: Bonds in 5-membered rings with two double bonds and a hetro atom at the apex of the ring.

MACCS 166 keys [Ref 45-47] are defined as follows:

Key Description

1 ISOTOPE
 2 103 < ATOMIC NO. < 256
 3 GROUP IVA,VA,VIA PERIODS 4-6 (Ge...)
 4 ACTINIDE
 5 GROUP IIIB,IVB (Sc...)
 6 LANTHANIDE
 7 GROUP VB,VIB,VIIB (V...)
 8 QAAA@1
 9 GROUP VIII (Fe...)
 10 GROUP IIA (ALKALINE EARTH)
 11 4M RING
 12 GROUP IB,IIB (Cu...)
 13 ON(C)C
 14 S-S
 15 OC(O)O
 16 QAA@1
 17 CTC
 18 GROUP IIIA (B...)
 19 7M RING
 20 SI
 21 C=C(Q)Q
 22 3M RING
 23 NC(O)O
 24 N-O
 25 NC(N)N
 26 C\$=C(\$A)\$A
 27 I

28 QCH2Q
29 P
30 CQ(C)(C)A
31 QX
32 CSN
33 NS
34 CH2=A
35 GROUP IA (ALKALI METAL)
36 S HETEROCYCLE
37 NC(O)N
38 NC(C)N
39 OS(O)O
40 S-O
41 CTN
42 F
43 QHAQH
44 OTHER
45 C=CN
46 BR
47 SAN
48 OQ(O)O
49 CHARGE
50 C=C(C)C
51 CSO
52 NN
53 QHAAAQH
54 QHAAQH
55 OSO
56 ON(O)C
57 O HETEROCYCLE
58 QSQ
59 Snot%A%A
60 S=O
61 AS(A)A
62 A\$A!A\$A
63 N=O
64 A\$A!S
65 C%N
66 CC(C)(C)A
67 QS
68 QHQH (&...)
69 QQH
70 QNQ
71 NO
72 OAAO
73 S=A
74 CH3ACH3
75 A!N\$A
76 C=C(A)A
77 NAN
78 C=N
79 NAAN
80 NAAAN
81 SA(A)A
82 ACH2QH
83 QAAAA@1
84 NH2
85 CN(C)C
86 CH2QCH2
87 X!A\$A
88 S
89 OAAAO
90 QHAACH2A
91 QHAAACH2A
92 OC(N)C
93 QCH3
94 QN
95 NAAO
96 5M RING
97 NAAAO
98 QAAAAA@1
99 C=C
100 ACH2N
101 8M RING
102 QO
103 CL
104 QHACH2A
105 A\$A(\$A)\$A

```

106 QA(Q)Q
107 XA(A)A
108 CH3AAACH2A
109 ACH2O
110 NCO
111 NACH2A
112 AA(A)(A)A
113 Onot%A%A
114 CH3CH2A
115 CH3ACH2A
116 CH3AACH2A
117 NAO
118 ACH2CH2A > 1
119 N=A
120 HETEROCYCLIC ATOM > 1 (&...)
121 N HETEROCYCLE
122 AN(A)A
123 OCO
124 QQ
125 AROMATIC RING > 1
126 A!O!A
127 A$A!O > 1 (&...)
128 ACH2AAACH2A
129 ACH2AACH2A
130 QQ > 1 (&...)
131 QH > 1
132 OACH2A
133 A$A!N
134 X (HALOGEN)
135 Nnot%A%A
136 O=A > 1
137 HETEROCYCLE
138 QCH2A > 1 (&...)
139 OH
140 O > 3 (&...)
141 CH3 > 2 (&...)
142 N > 1
143 A$A!O
144 Anot%A%Anot%A
145 6M RING > 1
146 O > 2
147 ACH2CH2A
148 AQ(A)A
149 CH3 > 1
150 A!A$A!A
151 NH
152 OC(C)C
153 QCH2A
154 C=O
155 A!CH2!A
156 NA(A)A
157 C-O
158 C-N
159 O > 1
160 CH3
161 N
162 AROMATIC
163 6M RING
164 O
165 RING
166 FRAGMENTS

```

MACCS 322 keys set as defined in tables 1, 2 and 3 [Ref 46] include:

- . 26 atom properties of type P, as listed in Table 1
- . 32 one-atom environments, as listed in Table 3
- . 264 atom-bond-atom combinations listed in Table 4

Total number of keys in three tables is : 322

Atom symbol, X, used for 322 keys [Ref 46] doesn't refer to Halogens as it does for 166 keys. In order to keep the definition of 322 keys consistent with the published definitions, the symbol X is used to imply "others" atoms, but it's internally mapped to symbol X as defined for 166 keys during the generation of key values.

Atom properties-based keys (26):

| Key | Description |
|-----|--|
| 1 | A(AAA) or AA(A)A - atom with at least three neighbors |
| 2 | Q - heteroatom |
| 3 | Anot%not-A - atom involved in one or more multiple bonds, not aromatic |

| | |
|----|---|
| 4 | A(AAAA) or AA(A)(A)A - atom with at least four neighbors |
| 5 | A(QQ) or QA(Q) - atom with at least two heteroatom neighbors |
| 6 | A(QQQ) or QA(Q)Q - atom with at least three heteroatom neighbors |
| 7 | QH - heteroatom with at least one hydrogen attached |
| 8 | CH2(AA) or ACH2A - carbon with at least two single bonds and at least two hydrogens attached |
| 9 | CH3(A) or ACH3 - carbon with at least one single bond and at least three hydrogens attached |
| 10 | Halogen |
| 11 | A(-A-A-A) or A-A(-A)-A - atom has at least three single bonds |
| 12 | AAAAAA@1 > 2 - atom is in at least two different six-membered rings |
| 13 | A(\$A\$A\$A) or A\$A(\$A)\$A - atom has more than two ring bonds |
| 14 | A\$A!A\$A - atom is at a ring/chain boundary. When a comparison is done with another atom the path passes through the chain bond. |
| 15 | Anot%A%Anot%A - atom is at an aromatic/nonaromatic boundary. When a comparison is done with another atom the path passes through the aromatic bond. |
| 16 | A!A!A - atom with more than one chain bond |
| 17 | A!A\$A!A - atom is at a ring/chain boundary. When a comparison is done with another atom the path passes through the ring bond. |
| 18 | A%Anot%A%A - atom is at an aromatic/nonaromatic boundary. When a comparison is done with another atom the path passes through the nonaromatic bond. |
| 19 | HETEROCYCLE - atom is a heteroatom in a ring. |
| 20 | rare properties: atom with five or more neighbors, atom in four or more rings, or atom types other than H, C, N, O, S, F, Cl, Br, or I |
| 21 | rare properties: atom has a charge, is an isotope, has two or more multiple bonds, or has a triple bond. |
| 22 | N - nitrogen |
| 23 | S - sulfur |
| 24 | O - oxygen |
| 25 | A(AA)A(A)A(AA) - atom has two neighbors, each with three or more neighbors (including the central atom). |
| 26 | CHACH2 - atom has two hydrocarbon (CH2) neighbors |

Atomic environments properties-based keys (32):

| Key | Description |
|-----|-------------|
| 27 | C(CC) |
| 28 | C(CCC) |
| 29 | C(CN) |
| 30 | C(CCN) |
| 31 | C(NN) |
| 32 | C(NNC) |
| 33 | C(NNN) |
| 34 | C(CO) |
| 35 | C(CCO) |
| 36 | C(NO) |
| 37 | C(NCO) |
| 38 | C(NNO) |
| 39 | C(OO) |
| 40 | C(COO) |
| 41 | C(NOO) |
| 42 | C(OOO) |
| 43 | Q(CC) |
| 44 | Q(CCC) |
| 45 | Q(CN) |
| 46 | Q(CCN) |
| 47 | Q(NN) |
| 48 | Q(CNN) |
| 49 | Q(NNN) |
| 50 | Q(CO) |
| 51 | Q(CCO) |
| 52 | Q(NO) |
| 53 | Q(CNO) |
| 54 | Q(NNO) |
| 55 | Q(OO) |
| 56 | Q(COO) |
| 57 | Q(NOO) |
| 58 | Q(OOO) |

Note: The first symbol is the central atom, with atoms bonded to the central atom listed in parentheses. Q is any non-C, non-H atom. If only two atoms are in parentheses, there is no implication concerning the other atoms bonded to the central atom.

Atom-Bond-Atom properties-based keys: (264)

| Key | Description |
|-----|-------------|
|-----|-------------|

| | |
|-----|-------|
| 59 | C-C |
| 60 | C-N |
| 61 | C-O |
| 62 | C-S |
| 63 | C-Cl |
| 64 | C-P |
| 65 | C-F |
| 66 | C-Br |
| 67 | C-Si |
| 68 | C-I |
| 69 | C-X |
| 70 | N-N |
| 71 | N-O |
| 72 | N-S |
| 73 | N-Cl |
| 74 | N-P |
| 75 | N-F |
| 76 | N-Br |
| 77 | N-Si |
| 78 | N-I |
| 79 | N-X |
| 80 | O-O |
| 81 | O-S |
| 82 | O-Cl |
| 83 | O-P |
| 84 | O-F |
| 85 | O-Br |
| 86 | O-Si |
| 87 | O-I |
| 88 | O-X |
| 89 | S-S |
| 90 | S-Cl |
| 91 | S-P |
| 92 | S-F |
| 93 | S-Br |
| 94 | S-Si |
| 95 | S-I |
| 96 | S-X |
| 97 | Cl-Cl |
| 98 | Cl-P |
| 99 | Cl-F |
| 100 | Cl-Br |
| 101 | Cl-Si |
| 102 | Cl-I |
| 103 | Cl-X |
| 104 | P-P |
| 105 | P-F |
| 106 | P-Br |
| 107 | P-Si |
| 108 | P-I |
| 109 | P-X |
| 110 | F-F |
| 111 | F-Br |
| 112 | F-Si |
| 113 | F-I |
| 114 | F-X |
| 115 | Br-Br |
| 116 | Br-Si |
| 117 | Br-I |
| 118 | Br-X |
| 119 | Si-Si |
| 120 | Si-I |
| 121 | Si-X |
| 122 | I-I |
| 123 | I-X |
| 124 | X-X |
| 125 | C=C |
| 126 | C=N |
| 127 | C=O |
| 128 | C=S |
| 129 | C=Cl |
| 130 | C=P |
| 131 | C=F |
| 132 | C=Br |
| 133 | C=Si |
| 134 | C=I |
| 135 | C=X |
| 136 | N=N |

137 N=O
138 N=S
139 N=Cl
140 N=P
141 N=F
142 N=Br
143 N=Si
144 N=I
145 N=X
146 O=O
147 O=S
148 O=Cl
149 O=P
150 O=F
151 O=Br
152 O=Si
153 O=I
154 O=X
155 S=S
156 S=Cl
157 S=P
158 S=F
159 S=Br
160 S=Si
161 S=I
162 S=X
163 Cl=Cl
164 Cl=P
165 Cl=F
166 Cl=Br
167 Cl=Si
168 Cl=I
169 Cl=X
170 P=P
171 P=F
172 P=Br
173 P=Si
174 P=I
175 P=X
176 F=F
177 F=Br
178 F=Si
179 F=I
180 F=X
181 Br=Br
182 Br=Si
183 Br=I
184 Br=X
185 Si=Si
186 Si=I
187 Si=X
188 I=I
189 I=X
190 X=X
191 C#C
192 C#N
193 C#O
194 C#S
195 C#Cl
196 C#P
197 C#F
198 C#Br
199 C#Si
200 C#I
201 C#X
202 N#N
203 N#O
204 N#S
205 N#Cl
206 N#P
207 N#F
208 N#Br
209 N#Si
210 N#I
211 N#X
212 O#O
213 O#S
214 O#Cl

215 O#P
216 O#F
217 O#Br
218 O#Si
219 O#I
220 O#X
221 S#S
222 S#Cl
223 S#P
224 S#F
225 S#Br
226 S#Si
227 S#I
228 S#X
229 Cl#Cl
230 Cl#P
231 Cl#F
232 Cl#Br
233 Cl#Si
234 Cl#I
235 Cl#X
236 P#P
237 P#F
238 P#Br
239 P#Si
240 P#I
241 P#X
242 F#F
243 F#Br
244 F#Si
245 F#I
246 F#X
247 Br#Br
248 Br#Si
249 Br#I
250 Br#X
251 Si#Si
252 Si#I
253 Si#X
254 I#I
255 I#X
256 X#X
257 C\$C
258 C\$N
259 C\$O
260 C\$S
261 C\$Cl
262 C\$P
263 C\$F
264 C\$Br
265 C\$Si
266 C\$I
267 C\$X
268 N\$N
269 N\$O
270 N\$S
271 N\$Cl
272 N\$P
273 N\$F
274 N\$Br
275 N\$Si
276 N\$I
277 N\$X
278 O\$O
279 O\$S
280 O\$Cl
281 O\$P
282 O\$F
283 O\$Br
284 O\$Si
285 O\$I
286 O\$X
287 S\$S
288 S\$Cl
289 S\$P
290 S\$F
291 S\$Br
292 S\$Si

EXAMPLES

To generate MACCS keys fingerprints of size 166 in binary bit-vector string format and create a SampleMACCS166FPBin.csv file containing sequential compound IDs along with fingerprints bit-vector strings data, type:

```
% MACCSKeysFingerprints.pl -r SampleMACCS166FPBin -o Sample.sdf
```

To generate MACCS keys fingerprints of size 166 in binary bit-vector string format and create SampleMACCS166FPBin.sdf, SampleMACCS166FPBin.csv and SampleMACCS166FPBin.csv files containing sequential compound IDs in CSV file along with fingerprints bit-vector strings data, type:

```
% MACCSKeysFingerprints.pl --output all -r SampleMACCS166FPBin
-o Sample.sdf
```

To generate MACCS keys fingerprints of size 322 in binary bit-vector string format and create a SampleMACCS322FPBin.csv file containing sequential compound IDs along with fingerprints bit-vector strings data, type:

```
% MACCSKeysFingerprints.pl -size 322 -r SampleMACCS322FPBin -o Sample.sdf
```

To generate MACCS keys fingerprints of size 166 corresponding to count of keys in ValuesString format and create a SampleMACCS166FPCount.csv file containing sequential compound IDs along with fingerprints vector strings data, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyCount -r SampleMACCS166FPCount
-o Sample.sdf
```

To generate MACCS keys fingerprints of size 322 corresponding to count of keys in ValuesString format and create a SampleMACCS322FPCount.csv file containing sequential compound IDs along with fingerprints vector strings data, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyCount -size 322
-r SampleMACCS322FPCount -o Sample.sdf
```

To generate MACCS keys fingerprints of size 166 in hexadecimal bit-vector string format with ascending bits order and create a SampleMACCS166FPHex.csv file containing compound IDs from MolName along with fingerprints bit-vector strings data, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyBits --size 166 --BitStringFormat
HexadecimalString --BitsOrder Ascending --DataFieldsMode CompoundID
--CompoundIDMode MolName -r SampleMACCS166FPBin -o Sample.sdf
```

To generate MACCS keys fingerprints of size 166 corresponding to count of keys in IDsAndValuesString format and create a SampleMACCS166FPCount.csv file containing compound IDs from MolName line along with fingerprints vector strings data, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyCount --size 166
--VectorStringFormat IDsAndValuesString --DataFieldsMode CompoundID
--CompoundIDMode MolName -r SampleMACCS166FPCount -o Sample.sdf
```

To generate MACCS keys fingerprints of size 166 corresponding to count of keys in IDsAndValuesString format and create a SampleMACCS166FPCount.csv file containing compound IDs using specified data field along with fingerprints vector strings data, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyCount --size 166
--VectorStringFormat IDsAndValuesString --DataFieldsMode CompoundID
--CompoundIDMode DataField --CompoundID Mol_ID -r
SampleMACCS166FPCount -o Sample.sdf
```

To generate MACCS keys fingerprints of size 322 corresponding to count of keys in ValuesString format and create a SampleMACCS322FPCount.tsv file containing compound IDs derived from combination of molecule name line and an explicit compound prefix along with fingerprints vector strings data in a column labels MACCSKeyCountFP, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyCount -size 322 --DataFieldsMode
CompoundID --CompoundIDMode MolnameOrLabelPrefix --CompoundID Cmpd
--CompoundIDLabel MolID --FingerprintsLabel MACCSKeyCountFP --OutDelim
Tab -r SampleMACCS322FPCount -o Sample.sdf
```

To generate MACCS keys fingerprints of size 166 corresponding to count of keys in ValuesString format and create a SampleMACCS166FPCount.csv file containing specific data fields columns along with fingerprints vector strings data, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyCount --size 166
--VectorStringFormat ValuesString --DataFieldsMode Specify --DataFields
Mol_ID -r SampleMACCS166FPCount -o Sample.sdf
```

To generate MACCS keys fingerprints of size 322 corresponding to count of keys in ValuesString format and create a SampleMACCS322FPCount.csv file containing common data fields columns along with fingerprints vector strings data, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyCount --size 322
--VectorStringFormat ValuesString --DataFieldsMode Common -r
```

```
SampleMACCS322FPCount -o Sample.sdf
```

To generate MACCS keys fingerprints of size 166 corresponding to count of keys in ValuesString format and create SampleMACCS166FPCount.sdf, SampleMACCS166FPCount.fpf and SampleMACCS166FPCount.csv files containing all data fields columns in CSV file along with fingerprints vector strings data, type:

```
% MACCSKeysFingerprints.pl -m MACCSKeyCount --size 166 --output all  
--VectorStringFormat ValuesString --DataFieldsMode All -r  
SampleMACCS166FPCount -o Sample.sdf
```

AUTHOR

Manish Sud <msud@san.rr.com>

SEE ALSO

InfoFingerprintsFiles.pl, SimilarityMatricesFingerprints.pl, AtomNeighborhoodsFingerprints.pl, ExtendedConnectivityFingerprints.pl, PathLengthFingerprints.pl, TopologicalAtomPairsFingerprints.pl, TopologicalAtomTorsionsFingerprints.pl, TopologicalPharmacophoreAtomPairsFingerprints.pl, TopologicalPharmacophoreAtomTripletsFingerprints.pl

COPYRIGHT

Copyright (C) 2004-2012 Manish Sud. All rights reserved.

This file is part of MayaChemTools.

MayaChemTools is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 3 of the License, or (at your option) any later version.