```
 1 "C:\Program Files\Java\jdk-16\bin\java.exe" "-
   javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
   2020.3.3\lib\idea_rt.jar=55786:C:\Program Files\
   JetBrains\IntelliJ IDEA 2020.3.3\bin" -Dfile.encoding
   =UTF-8 -classpath C:\Users\cwhay\Documents\cs10\libs\
   opencv.jar;C:\Users\cwhay\Documents\cs10\libs\
   openblas-windows-x86_64.jar;C:\Users\cwhay\Documents\
   cs10\libs\javacv.jar;C:\Users\cwhay\Documents\cs10\
   libs\opencv-windows-x86_64.jar;C:\Users\cwhay\
   Documents\cs10\libs\json-simple-1.1.1.jar;C:\Users\
   cwhay\Documents\cs10\libs\net-datastructures-4-0.jar;
   C:\Users\cwhay\Documents\cs10\out\production\cs10
   POSTagTests
 2 Training...
 3     Training Sentence: I fish
 4     Corresponding Tags: PRO V
 5 Incrementing observations
 6     Incremented key: i to count: 1.0
 7     Incremented total: 1.0
 8 Incrementing transitions
 9     Incremented key: PRO to count: 1.0
10     Incremented total: 1.0
11 Incrementing observations
12     Incremented key: fish to count: 1.0
13     Incremented total: 1.0
14 Incrementing transitions
15     Incremented key: V to count: 1.0
16     Incremented total: 1.0
17 Training...
18     Training Sentence: Will eats the fish
19     Corresponding Tags: NP V DET N
20 Incrementing observations
21     Incremented key: will to count: 1.0
22     Incremented total: 1.0
23 Incrementing transitions
24     Incremented key: NP to count: 1.0
25     Incremented total: 2.0
26 Incrementing observations
27     Incremented key: eats to count: 1.0
28     Incremented total: 2.0
29 Incrementing transitions
30     Incremented key: V to count: 1.0
31     Incremented total: 1.0
32 Incrementing observations
```

```
33        Incremented key: the to count: 1.0
34        Incremented total: 1.0
35 Incrementing transitions
36        Incremented key: DET to count: 1.0
37        Incremented total: 1.0
38 Incrementing observations
39        Incremented key: fish to count: 1.0
40        Incremented total: 1.0
41 Incrementing transitions
42        Incremented key: N to count: 1.0
43        Incremented total: 1.0
44 Training...
45        Training Sentence: Will you cook the fish
46        Corresponding Tags: MOD PRO V DET N
47 Incrementing observations
48        Incremented key: will to count: 1.0
49        Incremented total: 1.0
50 Incrementing transitions
51        Incremented key: MOD to count: 1.0
52        Incremented total: 3.0
53 Incrementing observations
54        Incremented key: you to count: 1.0
55        Incremented total: 2.0
56 Incrementing transitions
57        Incremented key: PRO to count: 1.0
58        Incremented total: 1.0
59 Incrementing observations
60        Incremented key: cook to count: 1.0
61        Incremented total: 3.0
62 Incrementing transitions
63        Incremented key: V to count: 2.0
64        Incremented total: 2.0
65 Incrementing observations
66        Incremented key: the to count: 2.0
67        Incremented total: 2.0
68 Incrementing transitions
69        Incremented key: DET to count: 2.0
70        Incremented total: 2.0
71 Incrementing observations
72        Incremented key: fish to count: 2.0
73        Incremented total: 2.0
74 Incrementing transitions
75        Incremented key: N to count: 2.0
76        Incremented total: 2.0
```

```
 77 Training...
 78      Training Sentence: One cook uses a saw
 79      Corresponding Tags: DET N V DET N
 80 Incrementing observations
 81      Incremented key: one to count: 1.0
 82      Incremented total: 3.0
 83 Incrementing transitions
 84      Incremented key: DET to count: 1.0
 85      Incremented total: 4.0
 86 Incrementing observations
 87      Incremented key: cook to count: 1.0
 88      Incremented total: 3.0
 89 Incrementing transitions
 90      Incremented key: N to count: 3.0
 91      Incremented total: 3.0
 92 Incrementing observations
 93      Incremented key: uses to count: 1.0
 94      Incremented total: 4.0
 95 Incrementing transitions
 96      Incremented key: V to count: 1.0
 97      Incremented total: 1.0
 98 Incrementing observations
 99      Incremented key: a to count: 1.0
100      Incremented total: 4.0
101 Incrementing transitions
102      Incremented key: DET to count: 3.0
103      Incremented total: 3.0
104 Incrementing observations
105      Incremented key: saw to count: 1.0
106      Incremented total: 4.0
107 Incrementing transitions
108      Incremented key: N to count: 4.0
109      Incremented total: 4.0
110 Training...
111      Training Sentence: A saw has many uses
112      Corresponding Tags: DET N V DET N
113 Incrementing observations
114      Incremented key: a to count: 2.0
115      Incremented total: 5.0
116 Incrementing transitions
117      Incremented key: DET to count: 2.0
118      Incremented total: 5.0
119 Incrementing observations
120      Incremented key: saw to count: 2.0
```

```
121        Incremented total: 5.0
122 Incrementing transitions
123        Incremented key: N to count: 5.0
124        Incremented total: 5.0
125 Incrementing observations
126        Incremented key: has to count: 1.0
127        Incremented total: 5.0
128 Incrementing transitions
129        Incremented key: V to count: 2.0
130        Incremented total: 2.0
131 Incrementing observations
132        Incremented key: many to count: 1.0
133        Incremented total: 6.0
134 Incrementing transitions
135        Incremented key: DET to count: 4.0
136        Incremented total: 4.0
137 Incrementing observations
138        Incremented key: uses to count: 1.0
139        Incremented total: 6.0
140 Incrementing transitions
141        Incremented key: N to count: 6.0
142        Incremented total: 6.0
143 Training...
144        Training Sentence: You saw me color a fish
145        Corresponding Tags: PRO VD PRO V DET N
146 Incrementing observations
147        Incremented key: you to count: 2.0
148        Incremented total: 3.0
149 Incrementing transitions
150        Incremented key: PRO to count: 2.0
151        Incremented total: 6.0
152 Incrementing observations
153        Incremented key: saw to count: 1.0
154        Incremented total: 1.0
155 Incrementing transitions
156        Incremented key: VD to count: 1.0
157        Incremented total: 3.0
158 Incrementing observations
159        Incremented key: me to count: 1.0
160        Incremented total: 4.0
161 Incrementing transitions
162        Incremented key: PRO to count: 1.0
163        Incremented total: 1.0
164 Incrementing observations
```

```
165      Incremented key: color to count: 1.0
166      Incremented total: 6.0
167 Incrementing transitions
168      Incremented key: V to count: 3.0
169      Incremented total: 4.0
170 Incrementing observations
171      Incremented key: a to count: 3.0
172      Incremented total: 7.0
173 Incrementing transitions
174      Incremented key: DET to count: 5.0
175      Incremented total: 5.0
176 Incrementing observations
177      Incremented key: fish to count: 3.0
178      Incremented total: 7.0
179 Incrementing transitions
180      Incremented key: N to count: 7.0
181      Incremented total: 7.0
182 Training...
183      Training Sentence: Jobs wore one color
184      Corresponding Tags: NP VD DET N
185 Incrementing observations
186      Incremented key: jobs to count: 1.0
187      Incremented total: 2.0
188 Incrementing transitions
189      Incremented key: NP to count: 2.0
190      Incremented total: 7.0
191 Incrementing observations
192      Incremented key: wore to count: 1.0
193      Incremented total: 2.0
194 Incrementing transitions
195      Incremented key: VD to count: 1.0
196      Incremented total: 2.0
197 Incrementing observations
198      Incremented key: one to count: 2.0
199      Incremented total: 8.0
200 Incrementing transitions
201      Incremented key: DET to count: 1.0
202      Incremented total: 2.0
203 Incrementing observations
204      Incremented key: color to count: 1.0
205      Incremented total: 8.0
206 Incrementing transitions
207      Incremented key: N to count: 8.0
208      Incremented total: 8.0
```

```
209 Training...
210       Training Sentence: The jobs were mine
211       Corresponding Tags: DET N VD PRO
212 Incrementing observations
213       Incremented key: the to count: 3.0
214       Incremented total: 9.0
215 Incrementing transitions
216       Incremented key: DET to count: 3.0
217       Incremented total: 8.0
218 Incrementing observations
219       Incremented key: jobs to count: 1.0
220       Incremented total: 9.0
221 Incrementing transitions
222       Incremented key: N to count: 9.0
223       Incremented total: 9.0
224 Incrementing observations
225       Incremented key: were to count: 1.0
226       Incremented total: 3.0
227 Incrementing transitions
228       Incremented key: VD to count: 1.0
229       Incremented total: 3.0
230 Incrementing observations
231       Incremented key: mine to count: 1.0
232       Incremented total: 5.0
233 Incrementing transitions
234       Incremented key: PRO to count: 2.0
235       Incremented total: 3.0
236 Training...
237       Training Sentence: The mine has many fish
238       Corresponding Tags: DET N V DET N
239 Incrementing observations
240       Incremented key: the to count: 4.0
241       Incremented total: 10.0
242 Incrementing transitions
243       Incremented key: DET to count: 4.0
244       Incremented total: 9.0
245 Incrementing observations
246       Incremented key: mine to count: 1.0
247       Incremented total: 10.0
248 Incrementing transitions
249       Incremented key: N to count: 10.0
250       Incremented total: 10.0
251 Incrementing observations
252       Incremented key: has to count: 2.0
```

```
253        Incremented total: 7.0
254 Incrementing transitions
255        Incremented key: V to count: 3.0
256        Incremented total: 4.0
257 Incrementing observations
258        Incremented key: many to count: 2.0
259        Incremented total: 11.0
260 Incrementing transitions
261        Incremented key: DET to count: 6.0
262        Incremented total: 6.0
263 Incrementing observations
264        Incremented key: fish to count: 4.0
265        Incremented total: 11.0
266 Incrementing transitions
267        Incremented key: N to count: 11.0
268        Incremented total: 11.0
269 Training...
270        Training Sentence: You can cook many
271        Corresponding Tags: PRO MOD V PRO
272 Incrementing observations
273        Incremented key: you to count: 3.0
274        Incremented total: 6.0
275 Incrementing transitions
276        Incremented key: PRO to count: 3.0
277        Incremented total: 10.0
278 Incrementing observations
279        Incremented key: can to count: 1.0
280        Incremented total: 2.0
281 Incrementing transitions
282        Incremented key: MOD to count: 1.0
283        Incremented total: 5.0
284 Incrementing observations
285        Incremented key: cook to count: 2.0
286        Incremented total: 8.0
287 Incrementing transitions
288        Incremented key: V to count: 1.0
289        Incremented total: 2.0
290 Incrementing observations
291        Incremented key: many to count: 1.0
292        Incremented total: 7.0
293 Incrementing transitions
294        Incremented key: PRO to count: 1.0
295        Incremented total: 7.0
296 Counting Finished!
```

```
297
298 Observation Counts Map
299 {NP={will=1.0, countsTotal=2.0, jobs=1.0}, DET={the=
    4.0, a=3.0, countsTotal=11.0, one=2.0, many=2.0},
    MOD={can=1.0, will=1.0, countsTotal=2.0}, V={eats=1.
    0, color=1.0, countsTotal=8.0, cook=2.0, fish=1.0,
    uses=1.0, has=2.0}, PRO={mine=1.0, countsTotal=7.0,
    me=1.0, i=1.0, many=1.0, you=3.0}, N={mine=1.0,
    color=1.0, countsTotal=11.0, cook=1.0, fish=4.0,
    jobs=1.0, saw=2.0, uses=1.0}, VD={countsTotal=3.0,
    were=1.0, saw=1.0, wore=1.0}}
300 Transitions Counts Map
301 {NP={countsTotal=2.0, V=1.0, VD=1.0}, DET={
    countsTotal=11.0, N=11.0}, #={NP=2.0, DET=4.0, MOD=1
    .0, countsTotal=10.0, PRO=3.0}, MOD={countsTotal=2.0
    , V=1.0, PRO=1.0}, V={DET=6.0, countsTotal=7.0, PRO=
    1.0}, PRO={MOD=1.0, countsTotal=5.0, V=3.0, VD=1.0
    }, N={countsTotal=4.0, V=3.0, VD=1.0}, VD={DET=1.0,
    countsTotal=3.0, PRO=2.0}}
302 Turning raw counts into probabilities with natural
    log and normalization...
303 Processing counts to probabilities for tag: NP
304     Observations:
305     Raw Counts: {will=1.0, countsTotal=2.0, jobs=1.0
    }
306     Probabilities: {will=-0.6931471805599453, jobs=-
    0.6931471805599453}
307     Transitions:
308     Raw Counts: {countsTotal=2.0, V=1.0, VD=1.0}
309     Probabilities: {V=-0.6931471805599453, VD=-0.
    6931471805599453}
310 Processing counts to probabilities for tag: DET
311     Observations:
312     Raw Counts: {the=4.0, a=3.0, countsTotal=11.0,
    one=2.0, many=2.0}
313     Probabilities: {the=-1.0116009116784799, a=-1.
    2992829841302609, one=-1.7047480922384253, many=-1.
    7047480922384253}
314     Transitions:
315     Raw Counts: {countsTotal=11.0, N=11.0}
316     Probabilities: {N=0.0}
317 Processing counts to probabilities for tag: #
318     Transitions:
319     Raw Counts: {NP=2.0, DET=4.0, MOD=1.0,
```

```
319 countsTotal=10.0, PRO=3.0}
320     Probabilities: {NP=-1.6094379124341003, DET=-0.
    916290731874155, MOD=-2.3025850929940455, PRO=-1.
    2039728043259361}
321 Processing counts to probabilities for tag: MOD
322     Observations:
323     Raw Counts: {can=1.0, will=1.0, countsTotal=2.0}
324     Probabilities: {can=-0.6931471805599453, will=-0
    .6931471805599453}
325     Transitions:
326     Raw Counts: {countsTotal=2.0, V=1.0, PRO=1.0}
327     Probabilities: {V=-0.6931471805599453, PRO=-0.
    6931471805599453}
328 Processing counts to probabilities for tag: V
329     Observations:
330     Raw Counts: {eats=1.0, color=1.0, countsTotal=8.
    0, cook=2.0, fish=1.0, uses=1.0, has=2.0}
331     Probabilities: {eats=-2.0794415416798357, color
    =-2.0794415416798357, cook=-1.3862943611198906, fish
    =-2.0794415416798357, uses=-2.0794415416798357, has
    =-1.3862943611198906}
332     Transitions:
333     Raw Counts: {DET=6.0, countsTotal=7.0, PRO=1.0}
334     Probabilities: {DET=-0.15415067982725836, PRO=-1
    .9459101490553135}
335 Processing counts to probabilities for tag: PRO
336     Observations:
337     Raw Counts: {mine=1.0, countsTotal=7.0, me=1.0,
    i=1.0, many=1.0, you=3.0}
338     Probabilities: {mine=-1.9459101490553135, me=-1.
    9459101490553135, i=-1.9459101490553135, many=-1.
    9459101490553135, you=-0.8472978603872037}
339     Transitions:
340     Raw Counts: {MOD=1.0, countsTotal=5.0, V=3.0, VD
    =1.0}
341     Probabilities: {MOD=-1.6094379124341003, V=-0.
    5108256237659907, VD=-1.6094379124341003}
342 Processing counts to probabilities for tag: N
343     Observations:
344     Raw Counts: {mine=1.0, color=1.0, countsTotal=11
    .0, cook=1.0, fish=4.0, jobs=1.0, saw=2.0, uses=1.0}
345     Probabilities: {mine=-2.3978952727983707, color
    =-2.3978952727983707, cook=-2.3978952727983707, fish
    =-1.0116009116784799, jobs=-2.3978952727983707, saw
```

```
345 =-1.7047480922384253, uses=-2.3978952727983707}
346     Transitions:
347     Raw Counts: {countsTotal=4.0, V=3.0, VD=1.0}
348     Probabilities: {V=-0.2876820724517809, VD=-1.
    3862943611198906}
349 Processing counts to probabilities for tag: VD
350     Observations:
351     Raw Counts: {countsTotal=3.0, were=1.0, saw=1.0
    , wore=1.0}
352     Probabilities: {were=-1.0986122886681098, saw=-1
    .0986122886681098, wore=-1.0986122886681098}
353     Transitions:
354     Raw Counts: {DET=1.0, countsTotal=3.0, PRO=2.0}
355     Probabilities: {DET=-1.0986122886681098, PRO=-0.
    40546510810816444}
356 Training Finished!
357     Observation Probabilities Map
358     {NP={will=-0.6931471805599453, jobs=-0.
    6931471805599453}, DET={the=-1.0116009116784799, a=-
    1.2992829841302609, one=-1.7047480922384253, many=-1
    .7047480922384253}, MOD={can=-0.6931471805599453,
    will=-0.6931471805599453}, V={eats=-2.
    0794415416798357, color=-2.0794415416798357, cook=-1
    .3862943611198906, fish=-2.0794415416798357, uses=-2
    .0794415416798357, has=-1.3862943611198906}, PRO={
    mine=-1.9459101490553135, me=-1.9459101490553135, i
    =-1.9459101490553135, many=-1.9459101490553135, you
    =-0.8472978603872037}, N={mine=-2.3978952727983707,
    color=-2.3978952727983707, cook=-2.3978952727983707
    , fish=-1.0116009116784799, jobs=-2.3978952727983707
    , saw=-1.7047480922384253, uses=-2.3978952727983707
    }, VD={were=-1.0986122886681098, saw=-1.
    0986122886681098, wore=-1.0986122886681098}}
359
360     Transitions Probabilities Map
361     {NP={V=-0.6931471805599453, VD=-0.
    6931471805599453}, DET={N=0.0}, #={NP=-1.
    6094379124341003, DET=-0.916290731874155, MOD=-2.
    3025850929940455, PRO=-1.2039728043259361}, MOD={V=-
    0.6931471805599453, PRO=-0.6931471805599453}, V={DET
    =-0.15415067982725836, PRO=-1.9459101490553135}, PRO
    ={MOD=-1.6094379124341003, V=-0.5108256237659907, VD
    =-1.6094379124341003}, N={V=-0.2876820724517809, VD
    =-1.3862943611198906}, VD={DET=-1.0986122886681098,
```

```
361 PRO=-0.40546510810816444}}
362
363
364 Process finished with exit code 0
365
```