Analysis

Hidden Markov Models (HMMs) are statistical models used in natural language processing for tasks like part-of-speech tagging. They operate on the principle of transition probabilities between states. In the context of POS tagging, each word in a sentence is treated as a sequence of states, where each state represents a possible part-of-speech tag. The HMM calculates the probability of transitioning from one state (POS tag) to another based on the observed word sequence. By analyzing a large corpus of text, the HMM learns these transition probabilities, allowing it to predict the most likely sequence of POS tags for a given sentence.

Conditional Random Fields (CRFs) are probabilistic models used for sequence labeling tasks, including POS tagging. Unlike HMMs, which model the transition probabilities between states, CRFs directly model the conditional probability of a label sequence given an input sequence. In POS tagging, the input sequence is the sequence of words in a sentence, and the label sequence is the sequence of POS tags assigned to each word. CRFs consider various features of the input sequence, such as word identities, prefixes, suffixes, and context words, to calculate the likelihood of different label sequences. They use this information to determine the most probable sequence of POS tags for the input sentence.

HMM

English

Precision: 0.591713452574835
Recall: 0.43890675241157556
F1 Score: 0.3811332012839551
Confusion matrix:

```
        CC   CD   DM    DT    JJ  NEG    NN   NNP   PR  PRP  PRQ   PSP
PU  PUNC   QT  QTC  QTO   RB  RBR    RP   TO  VAUX  VBZ    VM  WRB
CC    11.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  1.0  0.0   0.0  0.0   0.0  0.0   2.0  0.0
CD     0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  8.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   1.0  0.0
DM     0.0  0.0  0.0   1.0   0.0  0.0   0.0   0.0  6.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  1.0  0.0   0.0  0.0   0.0  0.0   4.0  0.0
DT     0.0  0.0  0.0  43.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  1.0  0.0   0.0  0.0   0.0  0.0  36.0  0.0
JJ     0.0  0.0  0.0   0.0  18.0  0.0   2.0   0.0  0.0  0.0  0.0   1.0
0.0   0.0  0.0  0.0  0.0  3.0  0.0   0.0  0.0   0.0  0.0  31.0  0.0
NEG    0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   3.0  0.0   0.0  0.0   0.0  0.0
NN     0.0  0.0  0.0   0.0   1.0  0.0  46.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0  78.0  0.0
NNP    0.0  0.0  0.0   0.0   0.0  0.0   0.0  11.0  0.0  0.0  0.0   0.0
0.0   0.0  8.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0  46.0  0.0
PR     0.0  0.0  0.0   0.0   1.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
```

PROF

```
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0
PRP    0.0  0.0  0.0   1.0   1.0  0.0   0.0   0.0  3.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   3.0  0.0
PRQ    0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  1.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0
PSP    0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0  25.0
0.0   0.0  0.0  0.0  0.0  2.0  0.0  11.0  0.0   0.0  0.0   6.0  0.0
PU     0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   1.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0
PUNC   0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0  51.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   2.0  0.0
QT     0.0  0.0  0.0   0.0   1.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0
QTC    0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  5.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   3.0  0.0
QTO    0.0  0.0  0.0   0.0   3.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0
RB     0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  9.0  0.0   0.0  0.0   0.0  0.0   3.0  0.0
RBR    0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  1.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0
RP     0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  3.0  0.0   0.0  0.0   0.0  0.0   0.0  0.0
TO     0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   1.0  0.0   0.0  0.0   0.0  0.0
VAUX   0.0  0.0  0.0   0.0   0.0  0.0   1.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0  23.0  0.0  18.0  0.0
VBZ    0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0   1.0  0.0
VM     0.0  0.0  0.0   0.0   0.0  0.0   9.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0  36.0  0.0
WRB    0.0  0.0  0.0   0.0   0.0  0.0   0.0   0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  1.0  0.0   0.0  0.0   0.0  0.0   1.0  0.0
```

PROF

Time taken in seconds: 8.01795506477356\

Hindi

Precision: 0.40750128008192527
Recall: 0.24423963133640553
F1 Score: 0.2511683401084323
Confusion matrix:

```
       CC  CCD  CCS  INTF   JJ  NEG   NN  NNP  PRL  PRP  PRQ   PSP  PUNC
QT  QTC  QTO    RB  RPD  SYM  UNK   UT  VAUX   VM  VNF   WQ
CC    3.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
CCD   1.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
CCS   3.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
```

```
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
INTF  0.0  0.0  0.0   0.0  1.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   1.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
JJ    0.0  0.0  0.0   0.0  8.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
3.0  0.0  0.0   4.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
NEG   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
NN    0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   5.0   0.0
0.0  0.0  0.0  26.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
NNP   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0  14.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
PRL   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
PRP   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
1.0  0.0  0.0   1.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
PRQ   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   1.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
PSP   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  86.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
PUNC  0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   1.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
QT    0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
8.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
QTC   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
4.0  0.0  0.0   6.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
QTO   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
1.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
RB    0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   1.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
RPD   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   2.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
SYM   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
UNK   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   2.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
UT    0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
VAUX  0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
VM    0.0  0.0  0.0   0.0  3.0  0.0  0.0  0.0  0.0  0.0  0.0   1.0   0.0
0.0  0.0  0.0   6.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
VNF   0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
WQ    0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0
0.0  0.0  0.0   0.0  0.0  0.0  0.0  0.0   0.0  0.0  0.0  0.0
```

PROF

Time taken in seconds: 22.796072483062744

CRF

English

Precision: 0.6428057313975908
Recall: 0.635048231511254
F1 Score: 0.6206271298439481\

```
        CC   CD   DM    DT    JJ  NEG     NN  NNP   PR  PRP  PRQ   PSP
PUNC    QT  QTC  QTO   RB  RBR   RP   TO  VAUX  VBZ    VM  WRB
CC    11.0  0.0  0.0   0.0   0.0  0.0    0.0  0.0  1.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  1.0  0.0  0.0  0.0   0.0  0.0   2.0  0.0
CD     0.0  0.0  0.0   0.0   0.0  0.0    2.0  1.0  0.0  0.0  0.0   0.0
0.0   6.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
DM     0.0  0.0  0.0   6.0   0.0  0.0    1.0  0.0  6.0  0.0  0.0   0.0
3.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
DT     0.0  0.0  0.0  67.0   2.0  0.0    0.0  1.0  0.0  0.0  0.0   0.0
8.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   2.0  0.0
JJ     2.0  0.0  0.0   1.0  32.0  0.0   12.0  3.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  3.0  0.0  1.0  0.0   0.0  0.0   1.0  0.0
NEG    0.0  0.0  0.0   0.0   0.0  0.0    0.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  3.0  0.0   0.0  0.0   0.0  0.0
NN     5.0  0.0  0.0   0.0   7.0  0.0  102.0  1.0  0.0  0.0  0.0   1.0
1.0   1.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   7.0  0.0
NNP    3.0  0.0  0.0   0.0  17.0  0.0   16.0  9.0  0.0  0.0  0.0   0.0
1.0  10.0  0.0  0.0  1.0  0.0  3.0  0.0   0.0  0.0   2.0  0.0
PR     0.0  0.0  0.0   0.0   0.0  0.0    1.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
PRP    0.0  0.0  0.0   1.0   2.0  0.0    1.0  1.0  3.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
PRQ    0.0  0.0  0.0   0.0   0.0  0.0    0.0  0.0  1.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
PSP    0.0  0.0  0.0   0.0   0.0  0.0    2.0  0.0  0.0  0.0  0.0  57.0
0.0   0.0  0.0  0.0  0.0  0.0  7.0  0.0   0.0  0.0   3.0  0.0
PUNC   0.0  0.0  0.0   0.0   1.0  0.0    0.0  0.0  0.0  0.0  0.0   0.0
52.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   1.0  0.0
QT     0.0  0.0  0.0   0.0   1.0  0.0    0.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
QTC    0.0  0.0  0.0   0.0   0.0  0.0    1.0  1.0  0.0  0.0  0.0   0.0
1.0   4.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   1.0  0.0
QTO    0.0  0.0  0.0   0.0   3.0  0.0    0.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
RB     2.0  0.0  0.0   0.0   0.0  0.0    0.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  7.0  0.0  0.0  0.0   0.0  0.0   3.0  0.0
RBR    0.0  0.0  0.0   0.0   0.0  0.0    0.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  1.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
RP     0.0  0.0  0.0   0.0   0.0  0.0    0.0  0.0  0.0  0.0  0.0   1.0
0.0   0.0  0.0  0.0  1.0  0.0  0.0  0.0   0.0  0.0   1.0  0.0
TO     0.0  0.0  0.0   0.0   0.0  0.0    0.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  1.0  0.0   0.0  0.0   0.0  0.0
VAUX   2.0  0.0  0.0   0.0   0.0  0.0    3.0  0.0  1.0  0.0  0.0   1.0
0.0   0.0  0.0  0.0  1.0  0.0  2.0  0.0  27.0  0.0   5.0  0.0
VBZ    0.0  0.0  0.0   0.0   0.0  0.0    0.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0   1.0  0.0
VM     1.0  0.0  0.0   0.0   2.0  0.0    9.0  1.0  0.0  0.0  0.0   0.0
```

PROF

```
1.0   0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0  0.0  31.0  0.0
WRB    0.0  0.0  0.0   0.0   0.0  0.0    1.0  0.0  0.0  0.0  0.0   0.0
0.0   0.0  0.0  0.0  1.0  0.0  0.0  0.0   0.0  0.0   0.0  0.0
```

Hindi

Precision: 0.6881771240205123
Recall: 0.7027649769585254
F1 Score: 0.6863571656255918
Confusion matrix:

```
       CC  CCD  CCS  INTF   JJ  NEG    NN   NNP  PRL   PRP  PRQ   PSP
PUNC   QT  QTC  QTO   RB  RPD  SYM  UNK   UT  VAUX    VM  VNF   WQ
CC    0.0  2.0  3.0   0.0  0.0  0.0   0.0   0.0  1.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
CCD   0.0  1.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
CCS   0.0  1.0  3.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
INTF  0.0  0.0  0.0   0.0  1.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  1.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
JJ    0.0  0.0  0.0   0.0  9.0  0.0   4.0   0.0  0.0   0.0  0.0   2.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
NEG   0.0  0.0  0.0   0.0  0.0  4.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
NN    0.0  0.0  0.0   0.0  0.0  0.0  87.0   5.0  0.0   0.0  0.0   4.0
0.0  0.0  1.0  0.0  0.0  1.0  0.0  0.0  0.0   0.0   3.0  0.0  0.0
NNP   0.0  0.0  0.0   0.0  2.0  0.0   8.0  12.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
PRL   0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  3.0   1.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
PRP   0.0  0.0  0.0   0.0  0.0  0.0   1.0   1.0  2.0  11.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  1.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
PRQ   0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  1.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
PSP   0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   1.0  0.0  86.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
PUNC  0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
23.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
QT    0.0  0.0  0.0   1.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  6.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
QTC   0.0  0.0  0.0   0.0  0.0  0.0   4.0   2.0  0.0   0.0  0.0   0.0
0.0  0.0  4.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   1.0  0.0  0.0
QTO   0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  1.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
RB    0.0  0.0  0.0   0.0  1.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
RPD   0.0  0.0  0.0   0.0  0.0  0.0   1.0   0.0  0.0   1.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  1.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
SYM   0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
```

```
13.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
UNK   0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   2.0  0.0  0.0
UT    0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
2.0  0.0  0.0  0.0  0.0  0.0  1.0  0.0  0.0   0.0   0.0  0.0  0.0
VAUX  0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  30.0  10.0  0.0  0.0
VM    0.0  0.0  0.0   0.0  4.0  0.0   4.0   0.0  0.0   0.0  0.0   1.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   3.0  30.0  0.0  0.0
VNF   0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  0.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   2.0  0.0  0.0
WQ    0.0  0.0  0.0   0.0  0.0  0.0   0.0   0.0  1.0   0.0  0.0   0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   0.0   0.0  0.0  0.0
```

Observations

1. The CRF model performs better than the HMM model in both languages.
2. The CRF model performs better in Hindi than in English.
3. The HMM model performs better in English than in Hindi.

(1) is because the CRF model is able to take into account the context of the words and the features of the words, which the HMM model is not able to do. The CRF model is able to learn the features of the words and the context in which they appear, which helps it in making better predictions. The HMM model, on the other hand, is not able to learn the features of the words and the context in which they appear, which makes it less accurate in making predictions.