Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

DEPARTMENTOFINFORMATIONTECHNOLOGY

COURSECODE: DJ19ITL504 **DATE:6/12/22**
COURSENAME: Artificial Intelligence Laboratory **CLASS:TY-IT**

EXPERIMENTNO.10

CO/LO: Apply NLP techniques on domain specific problems.

AIM / OBJECTIVE: To implement Hidden Markov Model for tagging Parts of Speech.

DESCRIPTIONOFEXPERIMENT:

A Hidden Markov Model (HMM) is a statistical Markov model in which the system being modeled is assumed to be a Markov process with unobserved (hidden) states. In a regular Markov model (Markov Model (Ref: http://en.wikipedia.org/wiki/Markov_model)), the state is directly visible to the observer, and therefore the state transition probabilities are the only parameters. In a hidden Markov model, the state is not directly visible, but output, dependent on the state, is visible.

Hidden Markov Model has two important components-
1)Transition Probabilities: The one-step transition probability is the probability of transitioning from one state to another in a single step.
2)Emission Probabilities: The output probabilities for an observation from state. Emission probabilities B = { bi,k = bi(ok) = P(ok | qi) }, where ok is an Observation. Informally, B is the probability that the output is ok given that the current state is qi
For POS tagging, it is assumed that POS are generated as random process, and each process randomly generates a word. Hence, transition matrix denotes the transition probability from one POS to another and emission matrix denotes the probability that a given word can have a particular POS.

Objective:
1. Take a corpus
2. Calculate the emission and transmission probabilities.
3. Analyze the results for a valid and invalid sentence structure.
4. Analyze the results for a valid and invalid POS tagging.

Explanation/Solutions (Design):

```
import itertools as itr

s1="Mary Jane can see Will"   #dataset
s2="Spot will see Mary"
s3="Will Jane spot Mary"
s4="Mary will pat Spot"
```

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

```
s1=s1.lower()      #preprocessing
s2=s2.lower()
s3=s3.lower()
s4=s4.lower()

corpus=[s1,s2,s3,s4]      #corpus

s=set()
for i in s1.split():
    s.add(i)
for i in s2.split():
    s.add(i)
for i in s3.split():
    s.add(i)
for i in s4.split():
    s.add(i)
print("corpus : \n",corpus)
print("\n")

s1tags={"mary":"N","jane":"N","can":"M","see":"V","will":"N"}
s2tags={"spot":"N","will":"M","see":"V","mary":"N"}
s3tags={"will":"M","jane":"N","spot":"V","mary":"N"}
s4tags={"mary":"N","will":"M","pat":"V","spot":"N"}       #manual tagging


tp={}                                   #transmission probablity
for i in s:
    tp[i]=[0,0,0]
for i in s1tags.keys():
    if s1tags[i]=="N":
        tp[i][0]=tp[i][0]+1
    elif s1tags[i]=="M":
        tp[i][1]=tp[i][1]+1
    elif s1tags[i]=="V":
        tp[i][2]=tp[i][2]+1

for i in s2tags.keys():
    if s2tags[i]=="N":
        tp[i][0]=tp[i][0]+1
    elif s2tags[i]=="M":
        tp[i][1]=tp[i][1]+1
    elif s2tags[i]=="V":
        tp[i][2]=tp[i][2]+1

for i in s3tags.keys():
```

```
    if s3tags[i]=="N":
        tp[i][0]=tp[i][0]+1
    elif s3tags[i]=="M":
        tp[i][1]=tp[i][1]+1
    elif s3tags[i]=="V":
        tp[i][2]=tp[i][2]+1


for i in s4tags.keys():
    if s4tags[i]=="N":
        tp[i][0]=tp[i][0]+1
    elif s4tags[i]=="M":
        tp[i][1]=tp[i][1]+1
    elif s4tags[i]=="V":
        tp[i][2]=tp[i][2]+1
a=0
b=0
c=0
for i in tp.keys():
    a=tp[i][0]+a
    b=tp[i][1]+b
    c=tp[i][2]+c
#print(a,b,c)

for i in tp.keys():
    tp[i][0]=tp[i][0]/a
    tp[i][1]=tp[i][1]/b
    tp[i][2]=tp[i][2]/c

print("transmission probabilties : \n",tp)
print("\n")

s1="<s> " +s1 +" <e>"  #preprocessing
s2="<s> " +s2 +" <e>"
s3="<s> " +s3 +" <e>"
s4="<s> " +s4 +" <e>"

s1indxed=[]
s2indxed=[]
s3indxed=[]
s4indxed=[]
for i in s1.split():
    if i=="<s>" or i=="<e>":
        s1indxed.append(i)
    else:
```

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

```
        s1indxed.append(s1tags[i])

for i in s2.split():
    if i=="<s>" or i=="<e>":
        s2indxed.append(i)
    else:
        s2indxed.append(s2tags[i])

for i in s3.split():
    if i=="<s>" or i=="<e>":
        s3indxed.append(i)
    else:
        s3indxed.append(s3tags[i])

for i in s4.split():
    if i=="<s>" or i=="<e>":
        s4indxed.append(i)
    else:
        s4indxed.append(s4tags[i])

ep={}                                   #emission probablities
for i in range(1,len(s1indxed)):
    try:
        ep[s1indxed[i-1]+s1indxed[i]]=ep[s1indxed[i-1]+s1indxed[i]]+1
    except:
        ep[s1indxed[i-1]+s1indxed[i]]=1

for i in range(1,len(s2indxed)):
    try:
        ep[s2indxed[i-1]+s2indxed[i]]=ep[s2indxed[i-1]+s2indxed[i]]+1
    except:
        ep[s2indxed[i-1]+s2indxed[i]]=1

for i in range(1,len(s3indxed)):
    try:
        ep[s3indxed[i-1]+s3indxed[i]]=ep[s3indxed[i-1]+s3indxed[i]]+1
    except:
        ep[s3indxed[i-1]+s3indxed[i]]=1

for i in range(1,len(s4indxed)):
    try:
        ep[s4indxed[i-1]+s4indxed[i]]=ep[s4indxed[i-1]+s4indxed[i]]+1
    except:
        ep[s4indxed[i-1]+s4indxed[i]]=1
```

```
#print(ep)
s=0
n=0
m=0
v=0
for i in ep.keys():
    if i[0]=="N":
        n=n+ep[i]
    elif i[0]=="M":
        m=m+ep[i]
    elif i[0]=="V":
        v=v+ep[i]
    elif i[0]=="<":
        s=s+ep[i]
#print(n,m,v,s)
for i in ep.keys():
    if i[0]=="N":
        ep[i]=ep[i]/n
    elif i[0]=="M":
        ep[i]=ep[i]/m
    elif i[0]=="V":
        ep[i]=ep[i]/v
    elif i[0]=="<":
        ep[i]=ep[i]/s

print("emission probabilities : \n",ep)
print("\n")

sentence="Will can spot Mary"                    #testing
sentence=sentence.lower()                        #preprocessing

words=sentence.split()
possible=["N","M","V"]
ap=list(itr.product(possible,repeat=len(words)))  #all possible ways to tag the
sentence
#print(ap)
sol=[]
for i in ap:
    wtags=dict(zip(words,i))
    #w="<s> "+sentence +" <e>"
    blocks=list(wtags.values())
    blocks.append("<e>")
    blocks.insert(0,"<s>")
    #print(wtags)
    #calculate for assumed sequence :
```

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

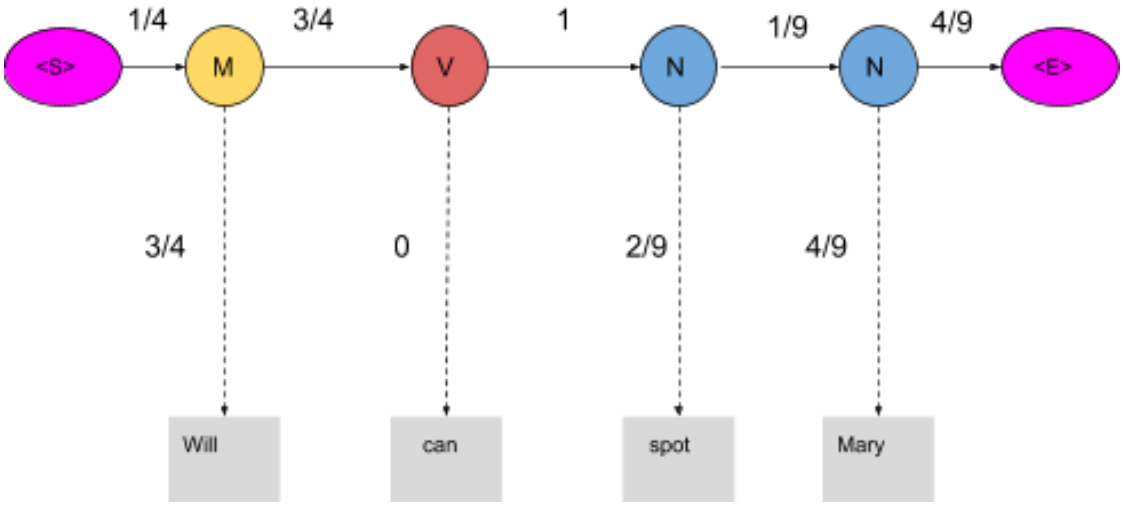
```
    prob=1
    for j in words:
        if wtags[j]=="N":
            col=0
        elif wtags[j]=="M":
            col=1
        elif wtags[j]=="V":
            col=2
        prob=prob*tp[j][col]     #multiply transmission probablities
    for z in range(1,len(blocks)):
        curr=blocks[z-1]+blocks[z]
        try:
            prob=prob*ep[curr]      #multiply emission probablities
        except:
            prob=prob*0

    sol.append(prob)           #keep track of all probablities

print("max probablity : ",max(sol))
print("tags are : ",ap[sol.index(max(sol))])
```

Output:

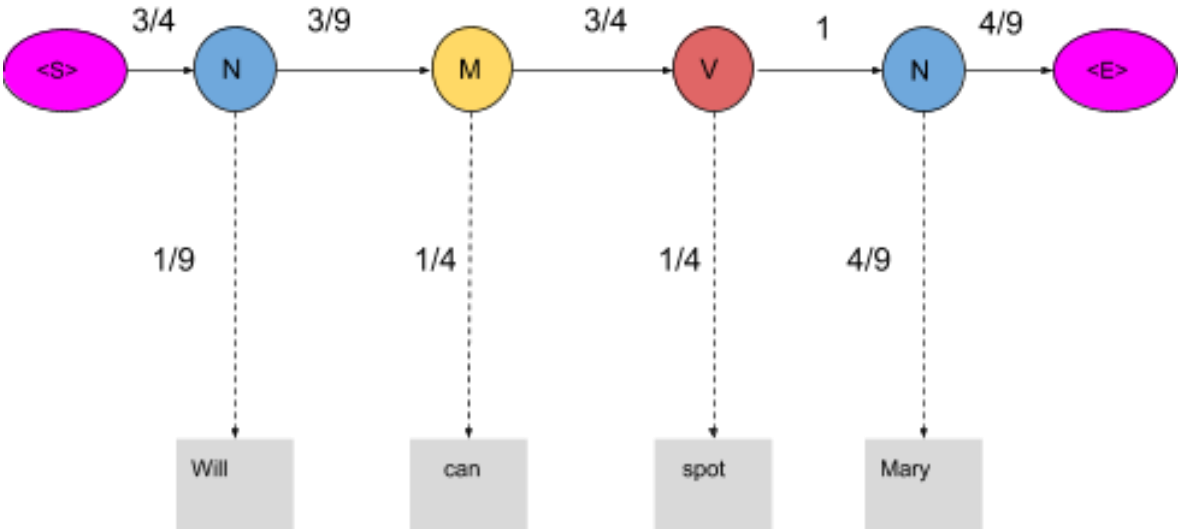
```
PS C:\Users\SHREE RAM\Desktop\ai> python -u "c:\Users\SHREE RAM\Desktop\ai\hmm.py"
corpus :
 ['mary jane can see will', 'spot will see mary', 'will jane spot mary', 'mary will pat spot']


transmission probabilties :
 {'pat': [0.0, 0.0, 0.25], 'can': [0.0, 0.25, 0.0], 'see': [0.0, 0.0, 0.5], 'jane': [0.2222222222222222, 0.0, 0.0
], 'spot': [0.2222222222222222, 0.0, 0.25], 'mary': [0.4444444444444444, 0.0, 0.0], 'will': [0.1111111111111111,
0.75, 0.0]}


emission probabilities :
 {'<s>N': 0.75, 'NN': 0.1111111111111111, 'NM': 0.3333333333333333, 'MV': 0.75, 'VN': 1.0, 'N<e>': 0.444444444444
4444, '<s>M': 0.25, 'MN': 0.25, 'NV': 0.1111111111111111}


max probablity :  0.00025720164609053495
tags are :  ('N', 'M', 'V', 'N')
PS C:\Users\SHREE RAM\Desktop\ai>
```

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

any arbitrary tags probability: **1/4*3/4*3/4*0*1*2/9*1/9*4/9*4/9=0**

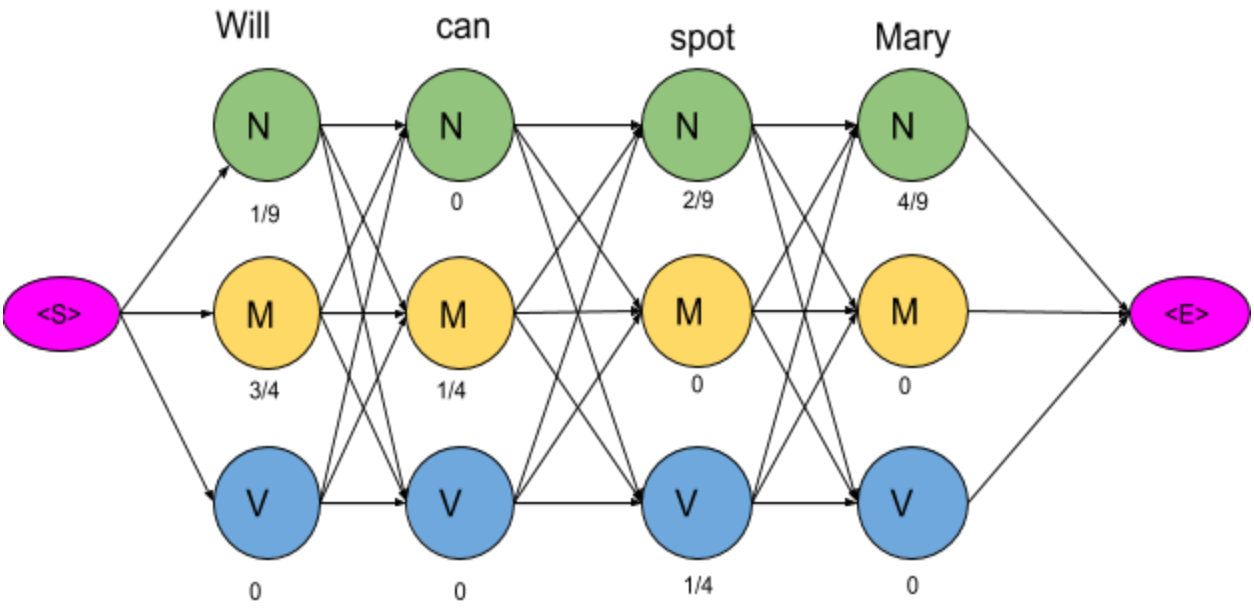


max tags probability: **3/4*1/9*3/9*1/4*3/4*1/4*1*4/9*4/9=0.00025720164**

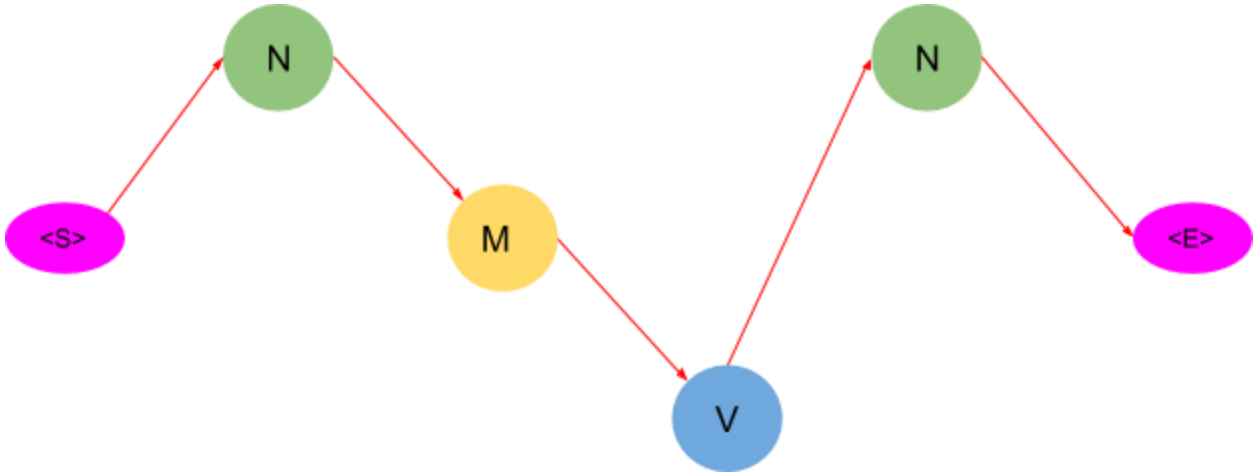


Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

HMM model:



Final Tags:



CONCLUSION:

Thus we have implemented parts of speech tagging on given corpus using hidden markov model

REFERENCES:

[1]: https://www.mygreatlearning.com/blog/pos-tagging/#:~:text=HMM%20(Hidden%20Markov%20Model)%20is,%2C%20partial%20discharges%2C%20and%20bioinformatics.