Homework 3

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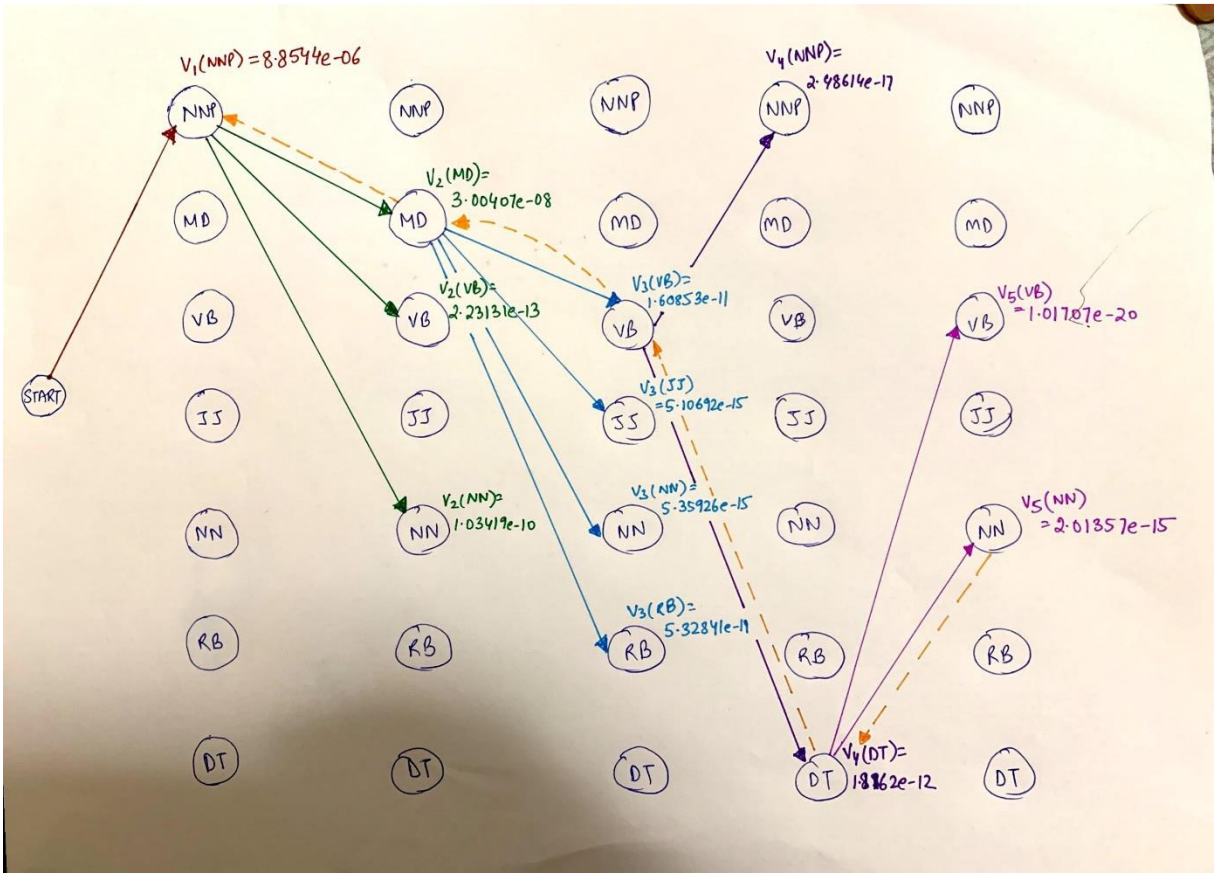
1. Regular Expressions (50 points)

a) Trellis is added below. Calculations for each state follow.



The calculations shown are for the max obtained at each state for every observation state. B_ij indicates the backtracking state for the state j at observation i

Obs_State (START) → State (Janet)

$P(NNP \mid START) = 0.2767$
$P(Janet \mid NNP) = 0.000032$

$V_1^{(NNP)} = 0.2767 \times 0.000032 = 8.8544e-06$
$B_1^{(NNP)} = 0$

Obs_State (Janet) → State (will)

$P(MD \mid NNP) = 0.011$
$P(will \mid MD) = 0.308431$

$P(VB \mid NNP) = 0.0009$
$P(will \mid VB) = 0.000028$

$P(NN \mid NNP) = 0.0584$
$P(will \mid NN) = 0.0002$

~~$V_1(NNP) \times P(MD \mid NNP) \times P(will \mid MD) = 9.73984e-08$~~
~~$V_1(NNP) \times P(VB \mid NNP) \times P(will \mid VB) = 7.96896e-09$~~
~~$V_1(NNP) \times P(NN \mid NNP) \times P(will \mid NN) = 5.17097e-07$~~

$V_1(NNP) \times P(MD \mid NNP) \times P(will \mid MD) = 3.00407e-08$
$V_1(NNP) \times P(VB \mid NNP) \times P(will \mid VB) = 2.23131e-13$
$V_1(NNP) \times P(NN \mid NNP) \times P(will \mid NN) = 1.03419e-10$

$V_2(MD) = 3.00407e-08$ $B_2(MD) = NNP$
$V_2(VB) = 2.23131e-13$ $B_2(VB) = NNP$
$V_2(NN) = 1.03419e-10$ $B_2(NN) = NNP$

Obs_State (will) → State (back)

$P(VB|MD) = 0.7968$
$P(back|VB) = 0.000672$

$P(JJ|MD) = 0.0005$
$P(back|JJ) = 0.00034$

$P(NN|MD) = 0.0008$
$P(back|NN) = 0.000923$

$P(RB|MD) = 0.1698$
$P(back|RB) = 0.010446$

$V_2(MD) \times P(VB|MD) \times P(back|VB) = 1.60853e-11$
$V_2(MD) \times P(JJ|MD) \times P(back|JJ) = 5.10692e-15$
$V_2(MD) \times P(NN|MD) \times P(back|NN) = 5.35926e-15$
$V_2(MD) \times P(RB|MD) \times P(back|RB) = 5.32841e-11$

$V_3(VB) = 1.60853e-11$ $B_3(VB) = MD$
$V_3(JJ) = 5.10692e-15$ $B_3(JJ) = MD$
$V_3(NN) = 5.35926e-15$ $B_3(NN) = MD$
$V_3(RB) = 5.32841e-11$ $B_3(RB) = MD$

Obs_State (back) → State (the)

$P(NNP|VB) = 0.0322$
$P(the|NNP) = 0.000048$

$P(DT|VB) = 0.2231$
$P(the|VB) = 0.506099$

$V_3(VB) \times P(NNP|VB) \times P(the|NNP) = 2.48614e-17$
$V_3(VB) \times P(DT|VB) \times P(the|\cancel{VB}\ DT) = 1.8162e-12$

$V_4(NNP) = 2.48614e-17 \quad B_4(NNP) = VB$
$V_4(DT) = 1.8162e-12 \quad B_4(DT) = VB$

Obs. state (the) → state (bill)

$P(VB|DT) = 0.0002$
$P(\cancel{VB}\ bill|VB) = 0.000028$

$P(NN|DT) = 0.4744$
$P(bill|NN) = 0.002337$

$V_4(DT) \times P(VB|DT) \times P(bill|VB) = 1.01707e-20$
$V_4(DT) \times P(NN|DT) \times P(bill|NN) = 2.01357e-15$

$V_5(VB) = 1.01707e-20 \quad B_5(VB) = DT$
$V_5(NN) = 2.01357e-15 \quad B_5(NN) = DT$

max value at final state (bill) = 2.01357e-15
Tag for 'bill' = NN

backtracking :
$B_5(NN) = DT \quad \therefore Tag(the) = DT$
$B_4(DT) = VB \quad \therefore Tag(back) = VB$
$B_3(VB) = MD \quad \therefore Tag(will) = MD$
$B_2(MD) = NNP \quad \therefore Tag(Janet) = NNP$

Ans: Janet will back the bill
NNP MD VB DT NN

b) The code along with instructions and output file is attached.

2. Telephone Number (50 points)

a) Secretariat/NNP is/VBZ expected/VBN to/TO race/?? tomorrow/NN
For NN|race, features satisfied are f1, f6
For VB|race, features satisfied are f2, f4, f5

$$P(NN|race) = \frac{e^{0.3}e^{-0.2}}{(e^{0.3}e^{-0.2} + e^{0.75}e^{0.10}e^{0.15})}$$

$$P(NN|race) = 0.2891$$

Also,

$$P(VB|race) = \frac{e^{0.75}e^{0.10}e^{0.15}}{(e^{0.3}e^{-0.2} + e^{0.75}e^{0.10}e^{0.15})}$$

$$P(VB|race) = 0.711$$

Thus, we choose VB as the POS Tag for race.

b) the/DT race/?? for/IN outer/JJ space/NN
For NN|race, features satisfied are f1, f3
For VB|race, features satisfied are f4, f5

$$P(NN|race) = \frac{e^{0.3}e^{0.9}}{(e^{0.3}e^{0.9} + e^{0.1}e^{0.15})}$$

$$P(NN|race) = 0.7211$$

Also,

$$P(VB|race) = \frac{e^{0.1}e^{0.15}}{(e^{0.3}e^{0.9} + e^{0.1}e^{0.15})}$$

$$P(VB|race) = 0.2789$$

Thus, we choose NN as the POS Tag for race.