Assignment 3: Part of Speech Tagging – Viterbi

Task: Calculate $v_3(3)$

Resources Given:a

	NNP	MD	VB	JJ	NN	RB	DT
$<s>$	0.2767	0.0006	0.0031	0.0453	0.0449	0.0510	0.2026
NNP	0.3777	0.0110	0.0009	0.0084	0.0584	0.0090	0.0025
MD	0.0008	0.0002	0.7968	0.0005	0.0008	0.1698	0.0041
VB	0.0322	0.0005	0.0050	0.0837	0.0615	0.0514	0.2231
JJ	0.0366	0.0004	0.0001	0.0733	0.4509	0.0036	0.0036
NN	0.0096	0.0176	0.0014	0.0086	0.1216	0.0177	0.0068
RB	0.0068	0.0102	0.1011	0.1012	0.0120	0.0728	0.0479
DT	0.1147	0.0021	0.0002	0.2157	0.4744	0.0102	0.0017

Figure 1: Transition Probabilities computed from WSJ Corpus without Smoothing

	Janet	will	back	the	bill
NNP	0.000032	0	0	0.000048	0
MD	0	0.308431	0	0	0
VB	0	0.000028	0.000672	0	0.000028
JJ	0	0	0.000340	0	0
NN	0	0.000200	0.000223	0	0.002337
RB	0	0	0.010446	0	0
DT	0	0	0	0.506099	0

Figure 2: Observation likelihoods computed from WSJ Corpus without smoothing

Computation:

$v_3(3)$ requires first the computation of v_2 which requires the computation of v_1. The general equation $v_t(j) = V_{t-1}(i)\ \times P\left(x_i\right) \times P\left(x_j\right)$ is referred to as discussed in the lecture to calculate $v_3(3)$. Using the values given in Figure 1 and 2, we can compute the following:

$v_1(1) = P(start) \times P(NNP) = 0.2767 \times 0\ = 0.000009 v_1(2) = P(start) \times P(MD) = 0.2767 \times 0\ = 0 v_1(3) = P(st$

Now,

$v_2(j) = V_1(i)\ \times P\left(x_i\right) \times P\left(x_j\right) As\ V_1(i)\ \ =\ \ v_1(1) = \ 0.000009\ \&\ is\ only\ non\ -\ zero\ value\ for\ v_1(1) \ldots v_1(7) and,$

Using the values given in Figure 1 and 2, we can compute the following:

$$v_2(1) = 0.000009 \times P(NNP) \times\ P(NNP) = 0.000009\ \times\ 0.3777\ \times\ 0\ =\ 0$$

$$v_2(2) = 0.000009 \times P(NNP) \times\ P(MD) = 0.000009\ \times\ 0.0008\ \times\ 0\ =\ 3.05347 \cdot 10^{-8}$$

$$v_2(3) = 0.000009 \times P(NNP) \times P(VB) = 0.000009 \times 0.0009 \times 0.000028 = 2.286 \cdot 10^{-13}$$

$$v_2(4) = 0.000009 \times P(NNP) \times P(JJ) = 0.000009 \times 0.0084 \times 0 = 0$$

$$v_2(5) = 0.000009 \times P(NNP) \times P(NN) = 0.000009 \times 0.0584 \times 0.000200 = 1.0512 \cdot 10^{-10}$$

$$v_2(6) = 0.000009 \times P(NNP) \times P(RB) = 0.000009 \times 0.0090 \times 0 = 0$$

$$v_2(7) = 0.000009 \times P(NNP) \times P(DT) = 0.000009 * 0.0025 \times 0 = 0$$

Now,

$$v_3(j) = V_{3-1}(i) \times P\left(x_i\right) \times P\left(x_j\right)) As\ e_2 = back \therefore v_3(j) = V_2(i) \times P\left(x_i\right) \times P\left(x_j\right))$$

And we are interested in $v_3(3)$, $v_3(3) = V_2(i) \times P\left(x_i\right) \times P\left(x_3\right)$

To calculate $v_3(3)$, we must iterate through all non-zero values achieved in calculating v_2. This is achieved when $j = 2, 3, 5$. The rest can be skipped as they equate to zero i.e $v_3(j) = 0$ for $j = 1, 4, 6, 7$. See above for these equations.

$When\ i = 2,\ v_3(3) = v_2(2) \times P(MD) \times P(VB) = 3.05347 \cdot 10^{-8} \times 0.7968 \times 0.000672 = 1.634 \cdot 10^{-11} When\ i =$

As $1.634 \cdot 10^{-11} > 7.681 \cdot 10^{-19}\ and\ 1.634 \cdot 10^{-11} > 9.890 \cdot 10^{-17}$, $v_3(3) = 1.634 \cdot 10^{-11}$