

# Grammar

- NP => Det N 0.6
- NP => Det N N 0.4
- N => N N 0.4
- N => train 0.1
- N => conductor 0.2
- N => training 0.3
- Det => the 1.0

Substitute NP=>Det N N 0.4 by

NP=>Det N\_N 0.4

N\_N=> N N 1.0

Inside

	1	2	3	4
1				
2				
3				
4				
	the	train	conductor	training

	1	2	3	4
1	$\beta(\text{Det})= 1.0$			
2		$\beta(\text{N})=0.1$		
3			$\beta(\text{N})=0.2$	
4				$\beta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\beta(\text{Det})= 1.0$	$\beta(\text{NP})=0.6*1.0*0.1$ $=0.06$		
2		$\beta(\text{N})=0.1$	$\beta(\text{N})=0.4*0.1*0.2$ $=0.008$  $\beta(\text{N\_N})=1.0*0.1*0.2$ $=0.02$	
3			$\beta(\text{N})=0.2$	$\beta(\text{N})=0.4*0.2*0.3$ $=0.024$  $\beta(\text{N\_N})=1.0*0.2*0.3$ $=0.06$
4				$\beta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\beta(\text{Det})= 1.0$	$\beta(\text{NP})=0.6*1.0*0.1$ $=0.06$	$\beta(\text{NP})=0.6*1.0*0.008$ $=0.0048$  $+ 0.4*1.0*0.02$ $=0.008$ $= 0.0128$	
2		$\beta(\text{N})=0.1$	$\beta(\text{N})=0.4*0.1*0.2$ $=0.008$  $\beta(\text{N\_N})=1.0*0.1*0.2$ $=0.02$	$\beta(\text{N})= (0.4*0.1*0.024 =0.00096)$ $+ (0.4*0.008*0.3 =0.00096)$ $=0.00192$  $\beta(\text{N\_N})=(1.0*0.1*0.024=0.0024)$ $+ (1.0*0.008*0.3=0.0024)$ $=0.0048$
3			$\beta(\text{N})=0.2$	$\beta(\text{N})=0.4*0.2*0.3$ $=0.024$  $\beta(\text{N\_N})=1.0*0.2*0.3$ $=0.06$
4				$\beta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\beta(\text{Det})= 1.0$	$\beta(\text{NP})=0.6*1.0*0.1$ $=0.06$	$\beta(\text{NP})=0.6*1.0*0.008$ $=0.0048$  $+ 0.4*1.0*0.02$ $=0.008$ $= 0.0128$	$\beta(\text{NP})=(0.6*1.0*0.00192=0.001152)$ $+ (0.4*1.0*0.0048=0.00192)$  $= 0.003072$
2		$\beta(\text{N})=0.1$	$\beta(\text{N})=0.4*0.1*0.2$ $=0.008$  $\beta(\text{N\_N})=1.0*0.1*0.2$ $=0.02$	$\beta(\text{N})= (0.4*0.1*0.024 =0.00096)$ $+ (0.4*0.008*0.3 =0.00096)$ $=0.00192$  $\beta(\text{N\_N})=(1.0*0.1*0.024=0.0024)$ $+ (1.0*0.008*0.3=0.0024)$ $=0.0048$
3			$\beta(\text{N})=0.2$	$\beta(\text{N})=0.4*0.2*0.3$ $=0.024$  $\beta(\text{N\_N})=1.0*0.2*0.3$ $=0.06$
4				$\beta(\text{N})=0.3$
	the	train	conductor	training

Viterbi

	1	2	3	4
1				
2				
3				
4				
	the	train	conductor	training

	1	2	3	4
1	$\delta(\text{Det})= 1.0$			
2		$\delta(\text{N})=0.1$		
3			$\delta(\text{N})=0.2$	
4				$\delta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\delta(\text{Det})= 1.0$	$\delta(\text{NP})=0.6*1.0*0.1$ =0.06 $\Psi(\text{NP})=\text{DetN},1$		
2		$\delta(\text{N})=0.1$	$\delta(\text{N})=0.4*0.1*0.2$ =0.008 $\Psi(\text{N})=\text{NN},2$  $\delta(\text{N\_N})=1.0*0.1*0.2$ =0.02 $\Psi(\text{N\_N})=\text{NN},2$	
3			$\delta(\text{N})=0.2$	$\delta(\text{N})=0.4*0.2*0.3$ =0.024 $\Psi(\text{N})=\text{NN},3$  $\delta(\text{N\_N})=1.0*0.2*0.3$ =0.06 $\Psi(\text{N\_N})=\text{NN},3$
4				$\delta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\delta(\text{Det})= 1.0$	$\delta(\text{NP})=0.6*1.0*0.1$ $=0.06$ $\Psi(\text{NP})=\text{DetN},1$	$\delta(\text{NP})=$ $\max($ $(0.6*1.0*0.008=0.0048),$ $(0.4*1.0*0.02=0.008)$ $)$ $= 0.008$ $\Psi(\text{NP})=\text{DetN\_N},1$	
2		$\delta(\text{N})=0.1$	$\delta(\text{N})=0.4*0.1*0.2$ $=0.008$ $\Psi(\text{N})=\text{NN},2$  $\delta(\text{N\_N})=1.0*0.1*0.2$ $=0.02$ $\Psi(\text{N\_N})=\text{NN},2$	$\delta(\text{N})= \max($ $(0.4*0.1*0.24 =0.00096),$ $(0.4*0.008*0.3 =0.00096)$ $=0.00096$ $\Psi(\text{N})=\text{NN},2$ $\delta(\text{N\_N})= \max($ $(1.0*0.1*0.024=0.0024),$ $(1.0*0.008*0.3=0.0024))$ $=0.0024$ $\Psi(\text{N\_N})=\text{NN},2$
3			$\delta(\text{N})=0.2$	$\delta(\text{N})=0.4*0.2*0.3$ $=0.024$ $\Psi(\text{N})=\text{NN},3$  $\delta(\text{N\_N})=1.0*0.2*0.3$ $=0.06$ $\Psi(\text{N\_N})=\text{NN},3$
4				$\delta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\delta(\text{Det})= 1.0$	$\delta(\text{NP})=0.6*1.0*0.1$ $=0.06$ $\Psi(\text{NP})=\text{DetN},1$	$\delta(\text{NP})=$ $\max($ $(0.6*1.0*0.008=0.0048),$ $(0.4*1.0*0.02=0.008)$ $)$ $= 0.008$ $\Psi(\text{NP})=\text{DetN}_N,1$	$\delta(\text{NP})=\max($ $(0.6*1.0*0.00096=0.000576),$ $(0.4*1.0*0.0024=0.00096)$  $= 0.00096$ $\Psi(\text{NP})=\text{DetN}_N,1$
2		$\delta(\text{N})=0.1$	$\delta(\text{N})=0.4*0.1*0.2$ $=0.008$ $\Psi(\text{N})=\text{NN},2$  $\delta(\text{N}_N)=1.0*0.1*0.2$ $=0.02$ $\Psi(\text{N}_N)=\text{NN},2$	$\delta(\text{N})= \max($ $(0.4*0.1*0.24 =0.00096),$ $(0.4*0.008*0.3 =0.00096)$  $=0.00096$ $\Psi(\text{N})=\text{NN},2$ $\delta(\text{N}_N)= \max($ $(1.0*0.1*0.024=0.0024),$ $(1.0*0.008*0.3=0.0024))$  $=0.0024$ $\Psi(\text{N}_N)=\text{NN},2$
3			$\delta(\text{N})=0.2$	$\delta(\text{N})=0.4*0.2*0.3$ $=0.024$ $\Psi(\text{N})=\text{NN},3$  $\delta(\text{N}_N)=1.0*0.2*0.3$ $=0.06$ $\Psi(\text{N}_N)=\text{NN},3$
4				$\delta(\text{N})=0.3$
	the	train	conductor	training

Outside

	1	2	3	4
1	$\beta(\text{Det})= 1.0$	$\beta(\text{NP})=0.6*1.0*0.1$ $=0.06$	$\beta(\text{NP})=0.6*1.0*0.008$ $=0.0048$  $+ 0.4*1.0*0.02$ $=0.008$ $= 0.0128$	$\beta(\text{NP})=(0.6*1.0*0.00192=0.001152)$ $+ (0.4*1.0*0.0048=0.00192)$  $= 0.003072$
2		$\beta(\text{N})=0.1$	$\beta(\text{N})=0.4*0.1*0.2$ $=0.008$  $\beta(\text{N\_N})=1.0*0.1*0.2$ $=0.02$	$\beta(\text{N})= (0.4*0.1*0.024 =0.00096)$ $+ (0.4*0.008*0.3 =0.00096)$ $=0.00192$  $\beta(\text{N\_N})=(1.0*0.1*0.024=0.0024)$ $+ (1.0*0.008*0.3=0.0024)$ $=0.0048$
3			$\beta(\text{N})=0.2$	$\beta(\text{N})=0.4*0.2*0.3$ $=0.024$  $\beta(\text{N\_N})=1.0*0.2*0.3$ $=0.06$
4				$\beta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\beta(\text{Det})= 1.0$	$\alpha(\text{NP})=0$	$\alpha(\text{NP})=0$	$\alpha(\text{NP})=1.0$
2		$\beta(\text{N})=0.1$	$\beta(\text{N})=0.4*0.1*0.2$ $=0.008$  $\beta(\text{N\_N})=1.0*0.1*0.2$ $=0.02$	$\beta(\text{N})= (0.4*0.1*0.24 =0.00096)$ $+ (0.4*0.008*0.3 =0.00096)$ $=0.00192$  $\beta(\text{N\_N}) =(1.0*0.1*0.024=0.0024)$ $+ (1.0*0.008*0.3=0.0024)$ $=0.0048$
3			$\beta(\text{N})=0.2$	$\beta(\text{N})=0.4*0.2*0.3$ $=0.024$  $\beta(\text{N\_N})=1.0*0.2*0.3$ $=0.06$
4				$\beta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\beta(\text{Det})= 1.0$	$\alpha(\text{NP})=0$	$\alpha(\text{NP})=0$	$\alpha(\text{NP})=1.0$
2		$\beta(\text{N})=0.1$	$\beta(\text{N})=0.4*0.1*0.2$ $=0.008$  $\beta(\text{N\_N})=1.0*0.1*0.2$ $=0.02$	$\alpha(\text{N})= 0.6*\alpha(\text{NP})*\beta(\text{Det})$ $=0.6*1.0*1.0$ $=0.6$ $\alpha(\text{N\_N})= 0.4*\alpha(\text{NP})*\beta(\text{Det})$ $=0.4*1.0*1.0$ $=0.4$
3			$\beta(\text{N})=0.2$	$\beta(\text{N})=0.4*0.2*0.3$ $=0.024$  $\beta(\text{N\_N})=1.0*0.2*0.3$ $=0.06$
4				$\beta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\beta(\text{Det})= 1.0$	$\alpha(\text{NP})=0$	$\alpha(\text{NP})=0$	$\alpha(\text{NP})=1.0$
2		$\beta(\text{N})=0.1$	$\alpha(\text{N})=(0.4*\alpha(\text{N})*\beta(\text{N})$ $=0.4*0.6*0.3=0.072)$ $+ (1.0*\alpha(\text{N\_N})*\beta(\text{N})$ $=1.0*0.4*0.3=0.12)$ $=0.192$	$\alpha(\text{N})= 0.6*\alpha(\text{NP})*\beta(\text{Det})$ $=0.6*1.0*1.0$ $=0.6$ $\alpha(\text{N\_N})= 0.4*\alpha(\text{NP})*\beta(\text{Det})$ $=0.4*1.0*1.0$ $=0.4$
3			$\beta(\text{N})=0.2$	$\alpha(\text{N})=(0.4*\alpha(\text{N})*\beta(\text{N})$ $=0.4*0.6*0.1=0.024)$ $+ (1.0*\alpha(\text{N\_N})*\beta(\text{N})$ $=1.0*0.4*0.1=0.04)$ $=0.064$
4				$\beta(\text{N})=0.3$
	the	train	conductor	training

	1	2	3	4
1	$\alpha(\text{Det})=(0.6*\alpha(\text{NP})*\beta(\text{N}))$ $=0.6*1.0*0.00192$ $=0.001152)$ $+ (0.4*\alpha(\text{NP})*\beta(\text{N\_N}))$ $=0.4*1.0*0.0048$ $=0.00192)$ $=0.003072$	$\alpha(\text{NP})=0$	$\alpha(\text{NP})=0$	$\alpha(\text{NP})=1.0$
2		$\alpha(\text{N})=(0.4*\alpha(\text{N})*\beta(\text{N}))$ $=0.4*0.192*0.2$ $=0.01536)$ $+ (0.4*\alpha(\text{N})*\beta(\text{N}))$ $=0.4*0.6*0.024$ $=0.00576)$ $+ (1.0*\alpha(\text{N\_N})*\beta(\text{N}))$ $=1.0*0.4*0.024$ $=0.0096$ $=0.03072$	$\alpha(\text{N})=(0.4*\alpha(\text{N})*\beta(\text{N}))$ $=0.4*0.6*0.3=0.072)$ $+ (1.0*\alpha(\text{N\_N})*\beta(\text{N}))$ $=1.0*0.4*0.3=0.12)$ $=0.192$	$\alpha(\text{N})= 0.6*\alpha(\text{NP})*\beta(\text{Det})$ $=0.6*1.0*1.0$ $=0.6$ $\alpha(\text{N\_N})= 0.4*\alpha(\text{NP})*\beta(\text{Det})$ $=0.4*1.0*1.0$ $=0.4$
3			$\alpha(\text{N})=(0.4*\alpha(\text{N})*\beta(\text{N}))$ $=0.4*0.192*0.1$ $=0.00768)$ $+ (0.4*\alpha(\text{N})*\beta(\text{N}))$ $=0.4*0.064*0.3$ $=0.00768)$ $=0.01536$	$\alpha(\text{N})=(0.4*\alpha(\text{N})*\beta(\text{N}))$ $=0.4*0.6*0.1=0.024)$ $+ (1.0*\alpha(\text{N\_N})*\beta(\text{N}))$ $=1.0*0.4*0.1=0.04)$ $=0.064$
4				$\alpha(\text{N})=(0.4*\alpha(\text{N})*\beta(\text{N}))$ $=0.4*0.064*0.2=0.00512)$ $+ (0.4*\alpha(\text{N})*\beta(\text{N}))$ $=0.4*0.6*0.008 =0.00192)$ $+ (1.0*\alpha(\text{N\_N})*\beta(\text{N}))$ $=1.0*0.4*0.008 =0.0032)$ $=0.01024$
	the	train	conductor	training