

Perceptron

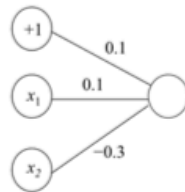
2. Let the following be a training set, $\{(\mathbf{x}, t)\}$

$((0,0), 0)$

$((0,1), 1)$

$((1,1), 1)$

Let $\mathbf{w} = \{w_0, w_1, w_2\} = \{0.1, 0.1, -0.3\}$



Perceptron learning rule:

$$w_i \leftarrow w_i + \Delta w_i$$

where

$$\Delta w_i = \eta (t^k - y^k) x_i^k$$

(a) What is the accuracy of the perceptron on the training data before training?

Example	Target	Output
0,0	0	1
0,1	1	0
1,1	1	0

Accuracy: 0

Output = 1 if $y > 0$

Output = 0 if $y \leq 0$

$$y = w_1 x_1 + w_2 x_2 + w_0$$

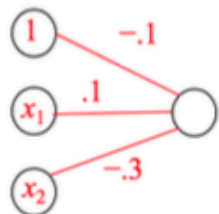
Perceptron

(b). Using the Perceptron learning rule, train the perceptron for one epoch, setting $\eta = 0.2$.

What are the weights after training for one epochs?

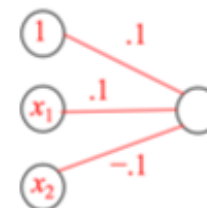
Example	Target	Output
0,0	0	1
$\Delta w_0 = (.2)(-1)(1) = -.2$		
$w_0 = -.1$		
$\Delta w_1 = (.2)(-1)(0) = 0$		
$w_1 = .1$		
$\Delta w_2 = (.2)(-1)(0) = 0$		
$w_2 = -.3$		

New perceptron:



Example	Target	Output
0,1	1	0
$\Delta w_0 = (.2)(1)(1) = .2$		$w_0 = .1$
$\Delta w_1 = (.2)(1)(0) = 0$		$w_1 = .1$
$\Delta w_2 = (.2)(1)(1) = .2$		$w_2 = -.1$

New perceptron:



Example	Target	Output
1,1	1	1

Weights don't change.

Perceptron

(c) What is the accuracy of the perceptron on the training data after training for one epoch? Did the accuracy improve?

Example	Target	Output
0,0	0	1
0,1	1	0
1,1	1	1

Accuracy: 1/3 Yes, it improved.

Viterbi

Apply the Viterbi algorithm to find the student's sleeping history from the following observations:

- day: 1 : no red eye and not sleeping in class
- day: 2 : no red eye and sleeping in class
- day: 3 : red eye and sleeping in class

R= Red eye
!R= No red Eye
C = Sleeping in class
!C = Not sleeping in class

S = Had enough Sleep
!S = Did not have enough Sleep

Observations: (!R, !C) (!R, C) (R,C)

Classes: S, !S

Viterbi

Apply the Viterbi algorithm to find the student's sleeping history from the following observations:

- day: 1 : no red eye and not sleeping in class
- day: 2 : no red eye and sleeping in class
- day: 3 : red eye and sleeping in class

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

R= Red eye
 !R= No red Eye
 C = Sleeping in class
 !C = Not sleeping in class

S = Had enough Sleep
 !S = Did not have enough Sleep

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(\{R, C\} S) = 0.02$	$P(\{R, C\} !S) = 0.28$
$P(\{R, !C\} S) = 0.08$	$P(\{R, !C\} !S) = 0.42$
$P(\{!R, C\} S) = 0.18$	$P(\{!R, C\} !S) = 0.12$
$P(\{!R, !C\} S) = 0.72$	$P(\{!R, !C\} !S) = 0.18$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
Classes: S, !S

$P(\{R, C\} S) = 0.02$	$P(\{R, C\} !S) = 0.28$
$P(\{R, !C\} S) = 0.08$	$P(\{R, !C\} !S) = 0.42$
$P(\{!R, C\} S) = 0.18$	$P(\{!R, C\} !S) = 0.12$
$P(\{!R, !C\} S) = 0.72$	$P(\{!R, !C\} !S) = 0.18$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

$P(S|S) = 0.9$

$P(!S|S) = 0.1$

$P(S|!S) = 0.2$

$P(!S|!S) = 0.8$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$

$P(!S|S) = 0.1$

$P(S | !S) = 0.2$

$P(!S | !S) = 0.8$

$P(S|q_0) = 0.6$

$P(!S|q_0) = 0.4$

!S			
S			
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S			
S			
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, !C\}|S) = P(\{!R, !C\}|S) * P(S|q_0) = 0.012$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S			
S	0.432 (q_0)		
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, !C\}|S) = P(\{!R, !C\}|S) * P(S|q_0) = 0.432$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q ₀)		
S	0.432 (q ₀)		
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, !C\} | !S) = P(\{!R, !C\} | !S) * P(!S|q_0) = 0.072$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q_0)		
S	0.432 (q_0)		
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, C\} | S) = P(\{!R, C\} | S) * P(S|S)$$

$$P(\{!R, C\} | S) = P(\{!R, C\} | S) * P(S|!S)$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$

$P(!S|S) = 0.1$

$P(S|!S) = 0.2$

$P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q ₀)		
S	0.432 (q ₀)		
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, C\} | S) = P(\{!R, C\} | S) * P(S|S) = 0.18 * 0.9 = 0.162$$

$$P(\{!R, C\} | S) = P(\{!R, C\} | S) * P(S|!S)$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$

$P(!S|S) = 0.1$

$P(S | !S) = 0.2$

$P(!S | !S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q ₀)		
S	0.432 (q ₀)		
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, C\} | S) = P(\{!R, C\} | S) * P(S|S) = 0.18 * 0.9 = 0.162$$

$$P(\{!R, C\} | S) = P(\{!R, C\} | S) * P(S|!S) = 0.18 * 0.2 = 0.036$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q ₀)		
S	0.432 (q ₀)	0.162 (S)	
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, C\} | S) = P(\{!R, C\} | S) * P(S|S) = 0.18 * 0.9 = 0.162$$

$$P(\{!R, C\} | S) = P(\{!R, C\} | S) * P(S|!S) = 0.18 * 0.2 = 0.036$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q ₀)	→	
S	0.432 (q ₀)	↗	0.162 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, C\} | !S) = P(\{!R, C\} | !S) * P(!S|S)$$

$$P(\{!R, C\} | !S) = P(\{!R, C\} | !S) * P(!S|!S)$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q ₀)	→	
S	0.432 (q ₀)	↗	0.162 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, C\} | !S) = P(\{!R, C\} | !S) * P(!S|S) = 0.012$$

$$P(\{!R, C\} | !S) = P(\{!R, C\} | !S) * P(!S|!S) = 0.096$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q ₀)	0.096 (!S)	
S	0.432 (q ₀)	0.162 (S)	
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{!R, C\} | !S) = P(\{!R, C\} | !S) * P(!S|S) = 0.012$$

$$P(\{!R, C\} | !S) = P(\{!R, C\} | !S) * P(!S|!S) = 0.096$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q_0)	0.096 (!S)	
S	0.432 (q_0)	0.162 (S)	
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{R, C\} | S) = P(\{R, C\} | S) * P(S|S)$$

$$P(\{R, C\} | S) = P(\{R, C\} | S) * P(S|!S)$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q_0)	0.096 (!S)	
S	0.432 (q_0)	0.162 (S)	
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{R, C\} | S) = P(\{R, C\} | S) * P(S|S) = 0.018$$

$$P(\{R, C\} | S) = P(\{R, C\} | S) * P(S|!S)$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$

$P(!S|S) = 0.1$

$P(S|!S) = 0.2$

$P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q_0)	0.096 (!S)	
S	0.432 (q_0)	0.162 (S)	
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{R, C\} | S) = P(\{R, C\} | S) * P(S|S) = 0.018$$

$$P(\{R, C\} | S) = P(\{R, C\} | S) * P(S|!S) = 0.004$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$

$P(!S|S) = 0.1$

$P(S | !S) = 0.2$

$P(!S | !S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q_0)	0.096 (!S)	
S	0.432 (q_0)	0.162 (S)	0.018 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{R, C\} | S) = P(\{R, C\} | S) * P(S|S) = 0.018$$

$$P(\{R, C\} | S) = P(\{R, C\} | S) * P(S|!S) = 0.004$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$
 $P(\{R, !C\} | S) = 0.08$
 $P(\{!R, C\} | S) = 0.18$
 $P(\{!R, !C\} | S) = 0.72$

$P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$

$P(!S|S) = 0.1$

$P(S|!S) = 0.2$

$P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q_0)	0.096 (!S)	
S	0.432 (q_0)	0.162 (S)	0.018 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{R, C\} | !S) = P(\{R, C\} | !S) * P(!S|S) = 0.028$$

$$P(\{R, C\} | !S) = P(\{R, C\} | !S) * P(!S|!S)$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$
 $P(\{R, !C\} | S) = 0.08$
 $P(\{!R, C\} | S) = 0.18$
 $P(\{!R, !C\} | S) = 0.72$

$P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | !S) = 0.18$

$P(S|S) = 0.9$
 $P(!S|S) = 0.1$
 $P(S|!S) = 0.2$
 $P(!S|!S) = 0.8$

$P(S|q_0) = 0.6$
 $P(!S|q_0) = 0.4$

!S	0.072 (q ₀)	0.096 (!S) →	
S	0.432 (q ₀)	0.162 (S) ↗	0.018 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{R, C\} | !S) = P(\{R, C\} | !S) * P(!S|S) = 0.028$$

$$P(\{R, C\} | !S) = P(\{R, C\} | !S) * P(!S|!S) = 0.224$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

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!S	0.072 (q_0)	0.096 (!S) \longrightarrow	0.224 (!S)
S	0.432 (q_0)	0.162 (S)	0.018 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

$$P(\{R, C\} | !S) = P(\{R, C\} | !S) * P(!S|S) = 0.028$$

$$P(\{R, C\} | !S) = P(\{R, C\} | !S) * P(!S|!S) = 0.224$$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
 $P(\{R, !C\} | S) = 0.08$ $P(\{R, !C\} | !S) = 0.42$
 $P(\{!R, C\} | S) = 0.18$ $P(\{!R, C\} | !S) = 0.12$
 $P(\{!R, !C\} | S) = 0.72$ $P(\{!R, !C\} | !S) = 0.18$

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$P(!S|S) = 0.1$

$P(S | !S) = 0.2$

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			!S
!S	0.072 (q_0)	0.096 (!S)	0.224 (!S)
S	0.432 (q_0)	0.162 (S)	0.018 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

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		!S	!S
!S	0.072 (q_0)	0.096 (!S)	0.224 (!S)
S	0.432 (q_0)	0.162 (S)	0.018 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$

Viterbi

Observations: $\{!R, !C\}$ $\{!R, C\}$ $\{R, C\}$
 Classes: S, !S

$P(\{R, C\} | S) = 0.02$ $P(\{R, C\} | !S) = 0.28$
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	!S	!S	!S
!S	0.072 (q_0)	0.096 (!S)	0.224 (!S)
S	0.432 (q_0)	0.162 (S)	0.018 (S)
Input	$\{!R, !C\}$	$\{!R, C\}$	$\{R, C\}$