$$P(x_1, x_2, \ldots, x_n, y_1, \ldots, y_n) = p(y_1) * p(y_2|y_1) \cdots * p(y_n|y_{n-1}, y_{n-2}, \ldots y_1) * p(x_1|y_n, y_{n-1}, \ldots y_1) * p(x_n|x_{n-1}, \ldots, x_1, y_n, y_{n-1}, \ldots y_1)$$

$$\prod_{i=1}^{n} q(y_i|y_{i-2}, y_{i-1})$$

equivalente a una LM de trigramas sobres las etiquetas,

Es la probabilidad Prior de nuestras etiquetas

$$\prod_{i=1}^{n} e(x_i|y_i)$$

$e(\text{the}|\text{DT})$

Probailidad de observar la palabra "the" dado que la etiqueta es "DT"

$$\mathcal{V} = \{\text{the,dog,cat,a,barks}, ..\}$$

$$\mathcal{S} = \{\text{DT,NN,VB,P,ADV}, ..\}$$

Sequence Classification -> Input (El perro ladra), output (mascotas)
Sequence Labeling or Tagging -> Input(El perro ladra), output(DET, NOUN, VERB)

Sequence to Squence -> Input (El perro ladra mucho), out(The dog barks a lot)

Forma de la HMM

$$p(x_1 \ldots x_n, y_1 \ldots y_{n+1}) = \prod_{i=1}^{n+1} q(y_i | y_{i-2}, y_{i-1}) \prod_{i=1}^{n} e(x_i | y_i)$$

$$y_{n+1} = \text{STOP}$$

Problem: for an input $x_1 \ldots x_n$, find

$$\arg \max_{y_1 \cdots y_{n+1}} p(x_1 \ldots x_n, y_1 \ldots y_{n+1})$$

Because of the Limited Horizon of the HMM, we don't need to keep a complete record of how we arrived at a certain state.

$S = \{D, N, P, V\}$

		The	man	saw	the	dog	with	the	telescope
*	*	1	2	3	4	5	6	7	8
		D	D	D	D	D	P	D	
		N	N	N	N	N			
		V	V	V	V	V			
		P	P	P	P	P			

There are many possible sequeces of tags.
Each of these will have a probability calculated from parameters q and e.

$\Pi(7, P, D) =$ This is the maxmimum probability of any of those tag sequences ending in P D at position 7, the path represents the sequence with the maximum probability.

				D			
				$\boxed{\text{N}}$			
				V			
				P	P	D	
The	man	saw	the	dog	with	the	telescope
1	2	3	4	5	6	7	8

$$\mathcal{S}_5 = \mathcal{S} = \{D, N, V, P\}$$

$$\Pi(7, P, D) = \max_{w \in \mathcal{S}_5} \left(\Pi(6, w, P) \times q(D|w, P) \times e(\text{the}|D)\right)$$

If we think in any tag sequence ending in tags P and D in position 7, it has to include some tag at position 5.
We are basically searching the tag tha maximizes the probability at position 5.