# COMP90042 Web search and text analysis

Workshop Week 12

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https://github.com/HanXudong/COMP90042\_Workshops

## What aspects of human language make automatic translation difficult?

- 南京市 长江大桥
   Nanjing Yangtze River Bridge
- 南京 市长 江大桥
   Daqiao Jiang, the major of Nanjing City.
- Not just simple word for word translation
  - structural changes
  - multiple word translations
  - inflections for gender
  - missing information

#### Representation:

$$E = e_1 ... e_l = F = f_1 ... f_l = A = a_1 ... a_l = B_1 ... a_l = B_2 ... a_l = B_3 ... a_l = B_$$

And the program has been implemented  $F = f_1 \dots f_1 = Le \ programme \ a \ ete \ mis \ en \ application$ 2, 3, 4, 5, 6, 6, 6.

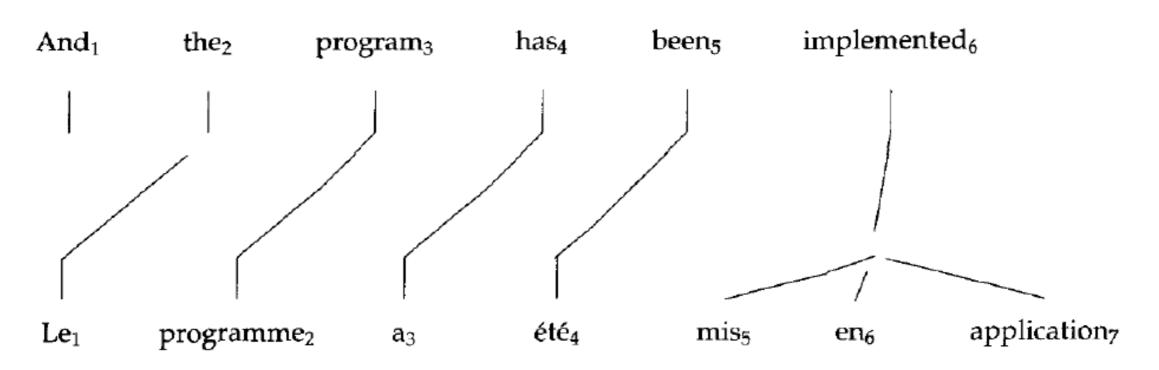


Figure from Brown, Della Pietra, Della Pietra, Mercer, 1993

Two components:

Translation Model (TM)

$$\hat{e} = \operatorname{argmax}_{e} P(e) P(f|e)$$
 Language Model (LM)

- Responsible for:
  - P(f|e) rewards good translations, but permissive of disfluent e
  - P(e) rewards e which look like fluent English, and helps put words in the correct order

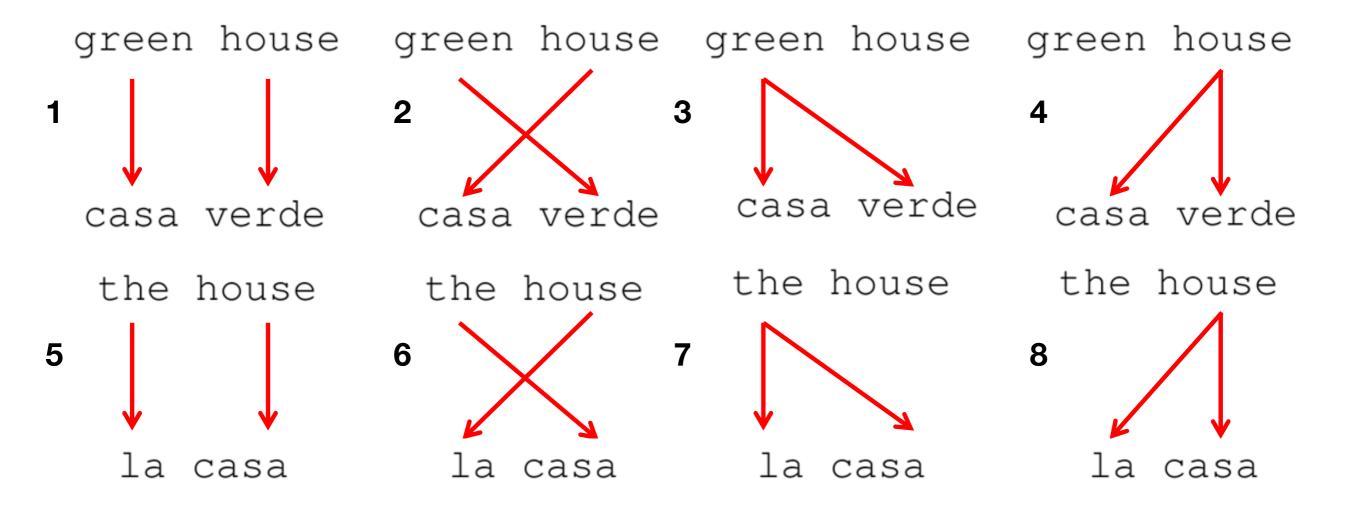
### Translate B -> A

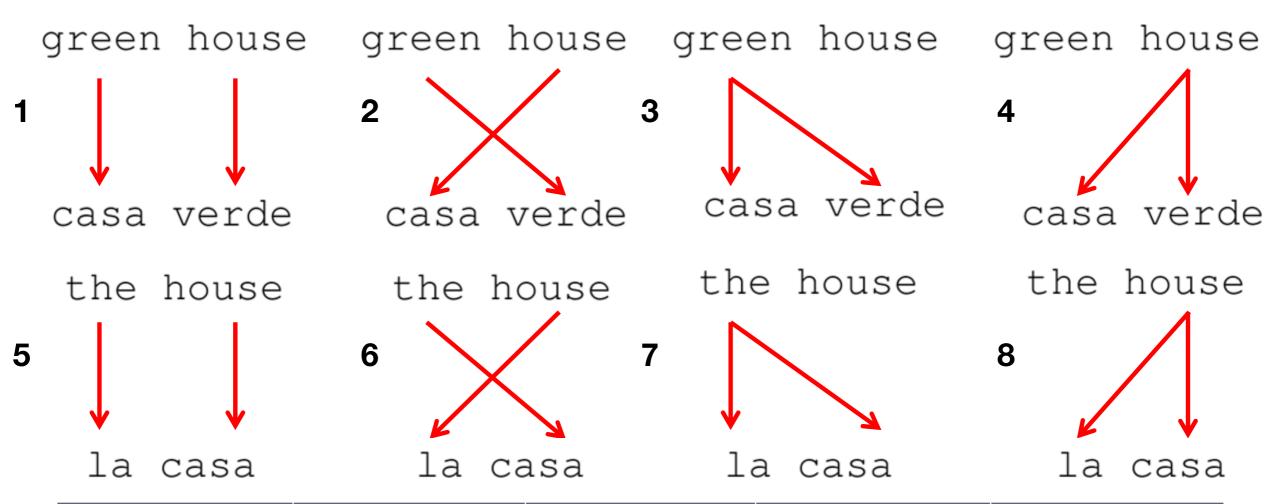
Language A	Language B
green house	casa verde
the house	la casa

t(B A)	casa	la	verde	Total
green	1/3	1/3	1/3	1
house	1/3	1/3	1/3	1
the	1/3	1/3	1/3	1

Need to calculate expected alignments under the model

(step 2) 
$$P(\mathbf{a}|\mathbf{e},\mathbf{f}) = \frac{P(\mathbf{f},\mathbf{a},\mathbf{e})}{P(\mathbf{f},\mathbf{e})} = \frac{P(\mathbf{f},\mathbf{a}|\mathbf{e})}{P(\mathbf{f}|\mathbf{e})}$$





t(B A)	casa	la	verde	Total
green	1/3	1/3	1/3	1
house	1/3	1/3	1/3	1
the	1/3	1/3	1/3	1

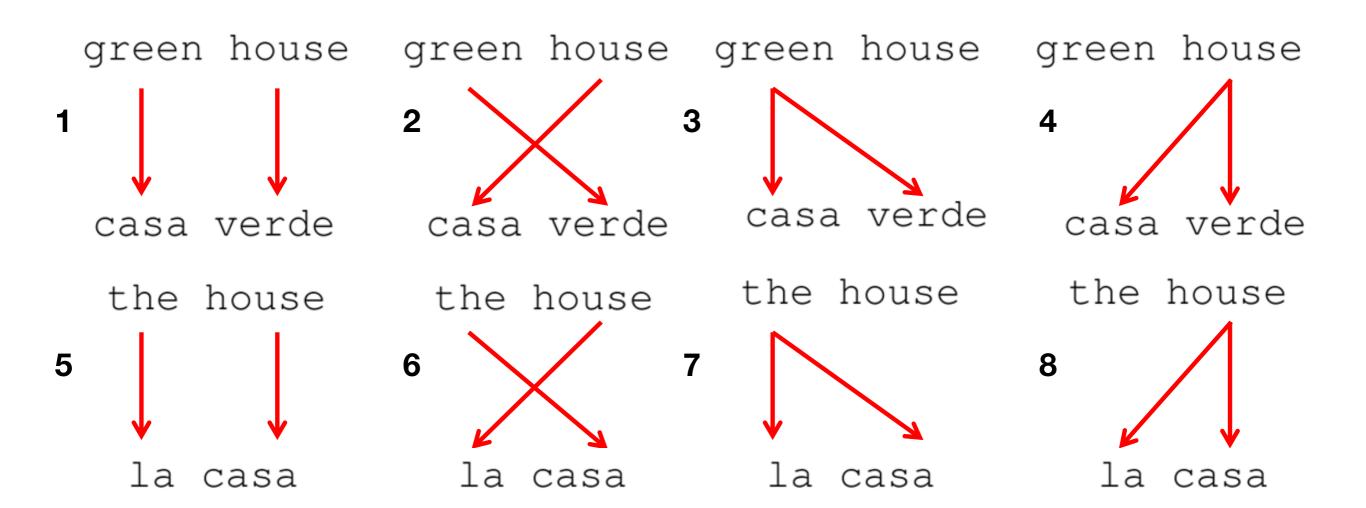
P(a1)	1/9	P(a2)	1/9	P(a3)	1/9	P(a4)	1/9
P(a5)	1/9	P(a6)	1/9	P(a7)	1/9	P(a8)	1/9

$$\begin{array}{lcl} \hat{P}(F,A|E) &=& \frac{\epsilon}{(I+1)^J} t(\text{casa}|\text{green}) t(\text{verde}|\text{house}) \\ &=& \frac{\epsilon}{(2+1)^2} (\frac{1}{3}) (\frac{1}{3}) = \frac{\epsilon}{9} \frac{1}{9} \end{array}$$

### (ignoring the $\epsilon$ term):

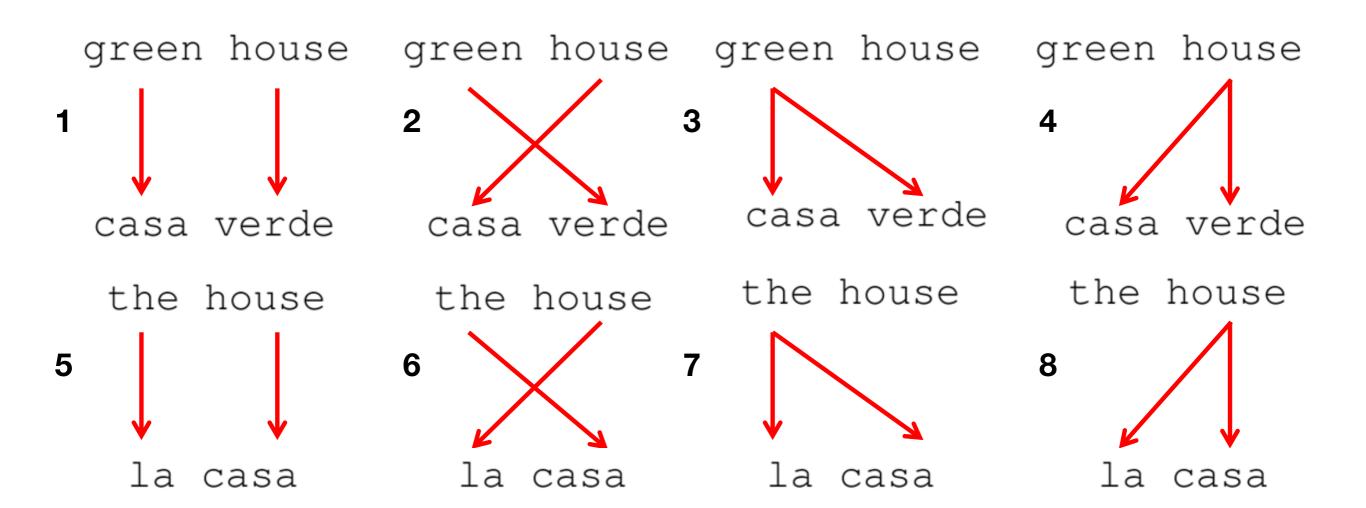
t(B A)	casa	la	verde	Total
green	1/9 * 2	0	1/9 * 2	4/9
house	1/9 * 4	1/9 * 2	1/9 * 2	8/9
the	1/9 * 2	1/9 * 2	0	4/9





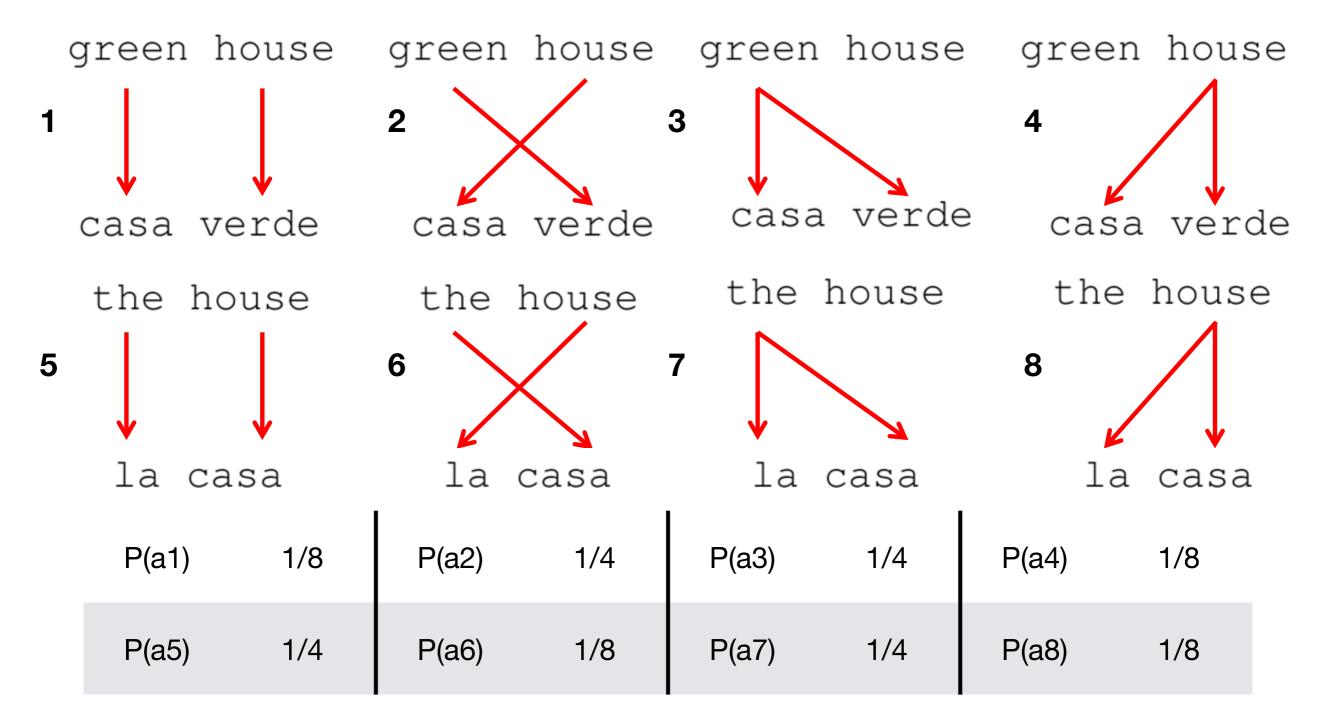
t(B A)	casa	la	verde	Total
green	1/2	0	1/2	1
house	1/2	1/4	1/4	1
the	1/2	1/2	0	1

P(a1)	P(a2)	P(a3)	P(a4)
P(a5)	P(a6)	P(a7)	P(a8)



t(B A)	casa	la	verde	Total
green	1/2	0	1/2	1
house	1/2	1/4	1/4	1
the	1/2	1/2	0	1

P(a1)	1/8	P(a2)	1/4	P(a3)	1/4	P(a4)	1/8
P(a5)	1/4	P(a6)	1/8	P(a7)	1/4	P(a8)	1/8



t(B A)	casa	la	verde	Total
green	1/8 + 1/4	0	1/4 + 1/4	7/8
house	1/4 + 1/8 + 1/4 + 1/8	1/8 + 1/8	1/8 + 1/8	10/8
the	1/8 + 1/4	1/4 + 1/4	0	7/8