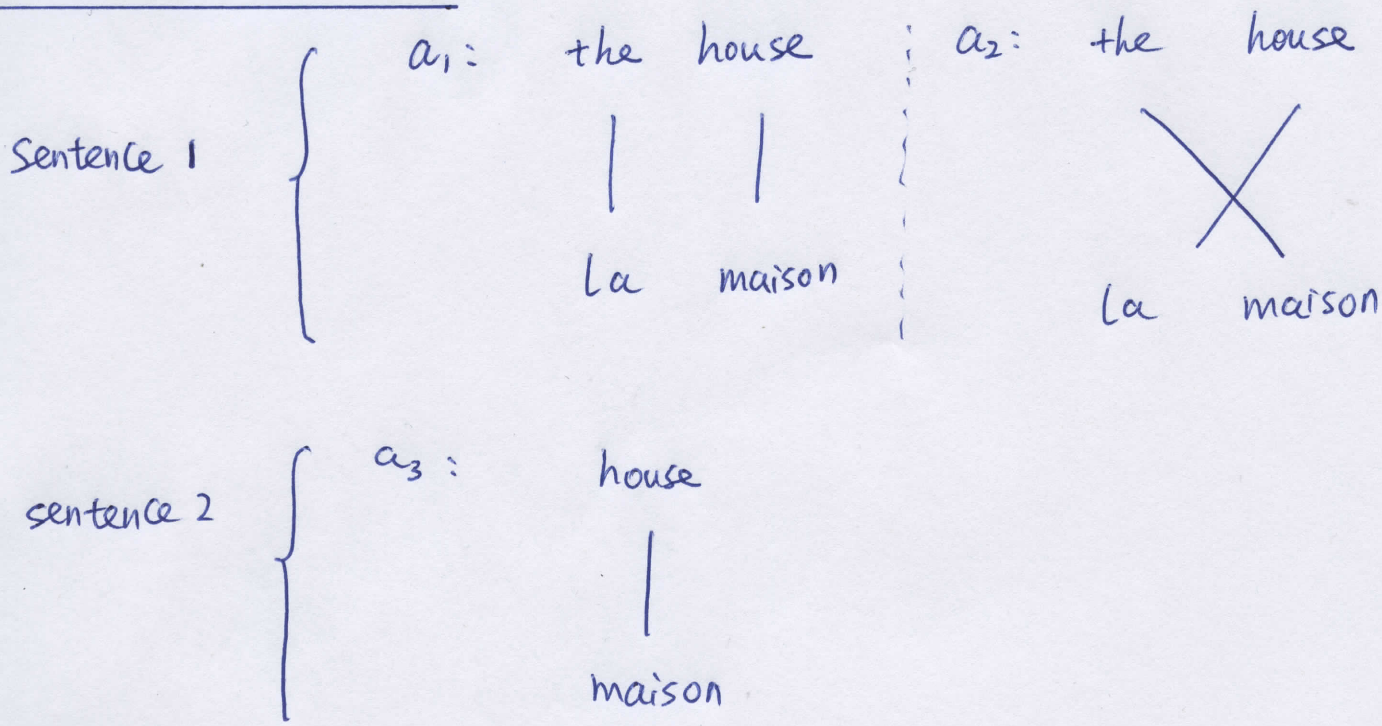
Normal IBM Model 1.

sentence 1 : the house ||| la maison

sentence 2 : house ||| maison

Draw Alignments:



Initialisation :

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source_side_vocabulary = { the , house }   size = 2

$$t(la \mid the) = \frac{1}{size} = \frac{1}{2}$$

$$t(maison \mid the) = \ldots = \frac{1}{2}$$

$$t(la \mid house) = \ldots = \frac{1}{2}$$

$$t(maison \mid house) = \ldots = \frac{1}{2}$$

Iteration 1 – step 1 (Expectation): alignment probability

$$P(e, a_1 \mid f) = t(la \mid the) \times t(maison \mid house) = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$P(e, a_2 \mid f) = t(maison \mid the) \times t(la \mid house) = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$P(e, a_3 \mid f) = t(maison \mid house) = \frac{1}{2}$$

Iteration1 – step1 (Expectation): Normalize alignment probability

$$P(a_1|E,F) = \frac{P(e,a_1|f)}{\sum_a P(E,a|F)} = \frac{P(e,a_1|f)}{P(e,a_1|f)+P(e,a_2|f)}$$

$$= \frac{1/4}{1/4+1/4} = \frac{1}{2}$$

$$P(a_2|E,F) = \frac{P(e,a_2|f)}{\sum_a P(E,a|F)} = \frac{P(e,a_2|f)}{P(e,a_1|f)+P(e,a_2|f)} = \frac{1/4}{1/4+1/4} = \frac{1}{2}$$

$$P(a_3|E,F) = \frac{P(e,a_3|f)}{\sum_a P(E,a|F)} = \frac{P(e,a_3|f)}{P(e,a_3|f)} = 1$$

Iteration1 – step2 (max): collect counts

$$C(la|the) = P(a_1|E,F) \times Count(la|the) = \frac{1}{2} \times 1 = \frac{1}{2}$$

$$C(maison|the) = P(a_2|E,F) \times Count(maison|the) = \frac{1}{2} \times 1 = \frac{1}{2}$$

$$C(la|house) = P(a_2|E,F) \times Count(la|house) = \frac{1}{2} \times 1 = \frac{1}{2}$$

$$C(maison|house) = P(a_1|E,F) \times Count(maison|house) + P(a_3|E,F) \times Count(maison|house) = \frac{1}{2} \times 1 + 1 \times 1 = \frac{3}{2}$$

Iteration1 – step2 (max): normalize

$$t(la|the) = \frac{C(la|the)}{\sum_* C(*|the)} = \frac{C(la|the)}{C(la|the)+C(maison|the)} = \frac{\frac{1}{2}}{\frac{1}{2}+1/2} = \frac{1}{2}$$

$$t(maison|the) = \frac{C(maison|the)}{\sum_* C(*|the)} = \frac{C(la|the)}{C(la|the)+C(maison|the)} = \frac{1/2}{1/2+1/2} = \frac{1}{2}$$

$$t(la|house) = \frac{1/2}{1/2+3/2} = \frac{1}{4}$$

$$t(maison|house) = \frac{3/2}{1/2+3/2} = \frac{3}{4}$$

Iteration 2 - Step 1 (EXP): alignment probability

$$p(e, a_1 | f) = \frac{1}{2} \times \frac{3}{4} = \frac{3}{8}$$

$$p(e, a_2 | f) = \frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$$

$$p(e, a_3 | f) = \frac{3}{4}$$

Iteration 2 - Step 1 (EXP): Normalize alignment probability

$$p(a_1 | E, F) = \frac{3/8}{3/8 + 1/8} = \frac{3}{4}$$

$$p(a_2 | E, F) = \frac{1/8}{3/8 + 1/8} = \frac{1}{4}$$

$$p(a_3 | E, F) = \frac{3/4}{3/4} = 1$$

Iteration 2 - step 2 (Max): Collect counts

$$c(la | the) = \frac{3}{4} \times 1 = \frac{3}{4}$$

$$c(masion | the) = \frac{1}{4} \times 1 = \frac{1}{4}$$

$$c(la | house) = \frac{1}{4} \times 1 = \frac{1}{4}$$

$$c(maison | house) = \frac{3}{4} \times 1 + 1 \times 1 = \frac{7}{4}$$

Iteration 2 - step 2 (Max): Normalize

$$t(la | the) = \frac{\frac{3}{4}}{3/4 + 1/4} = \frac{3}{4}$$

$$t(maison | the) = \frac{\frac{1}{4}}{3/4 + 1/4} = \frac{1}{4}$$

$$t(la | house) = \frac{\frac{1}{4}}{\frac{1}{4} + \frac{7}{4}} = \frac{1}{8}$$

$$t(masion | house) = \frac{\frac{7}{4}}{\frac{1}{4} + \frac{7}{4}} = \frac{7}{8}$$