# Normal IBM Model 1.

sentence 1 :    the house ||| la maison

sentence 2 :    house ||| maison

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## Draw Alignments:

Sentence 1 {

$a_1$:    the house    ;    $a_2$:    the    house

the — la, house — maison (straight lines) | crossed alignment

la    maison    ;    la    maison

sentence 2 {

$a_3$:    house

house — maison (straight line)

maison

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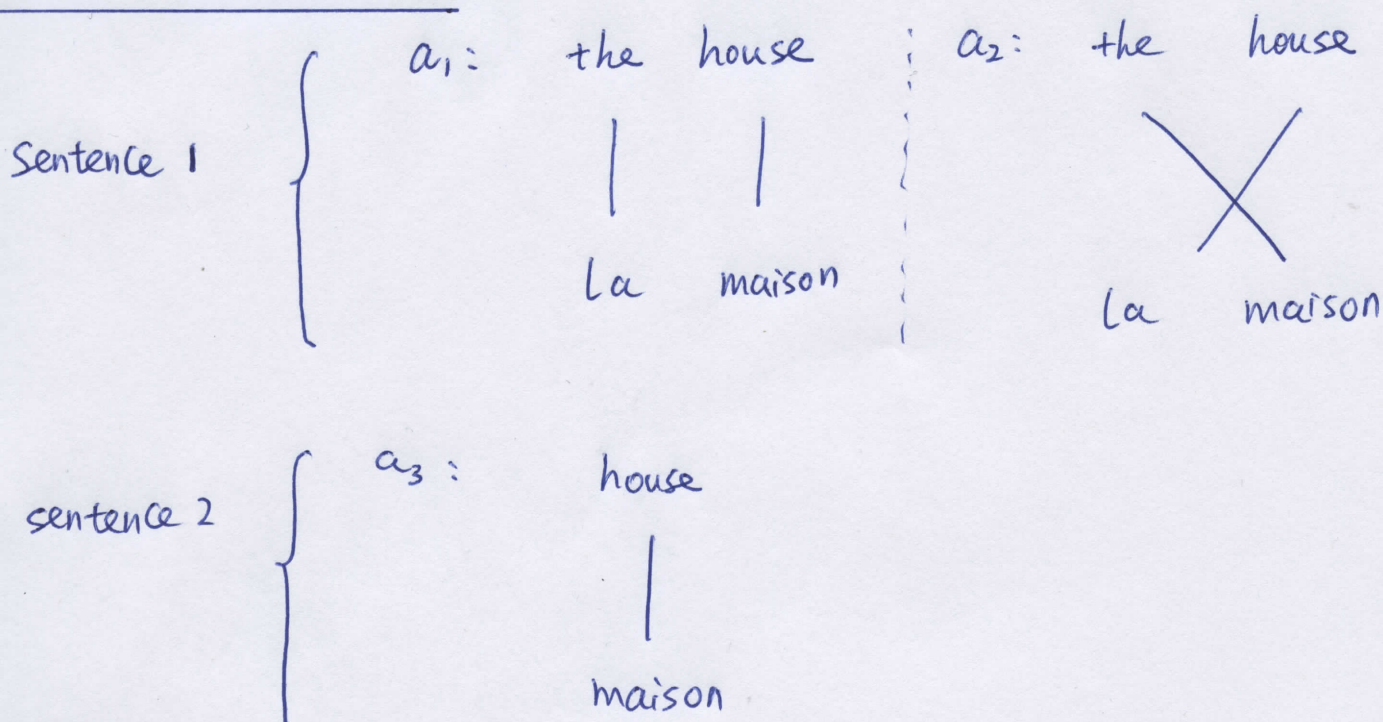
## Initialisation:

Source – side – vocabulary = { the , house }    size = 2

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

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

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

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

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## Iteration 1 – step 1 ( Expectation ): alignment probability

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

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

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

## Iteration 1 — step 1 (Expectation): Normalize alignment probability

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

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

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

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

## Iteration 1 — step 2 (max): collect counts

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

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

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

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

## Iteration 1 — step 2 (max): normalize

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

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

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

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