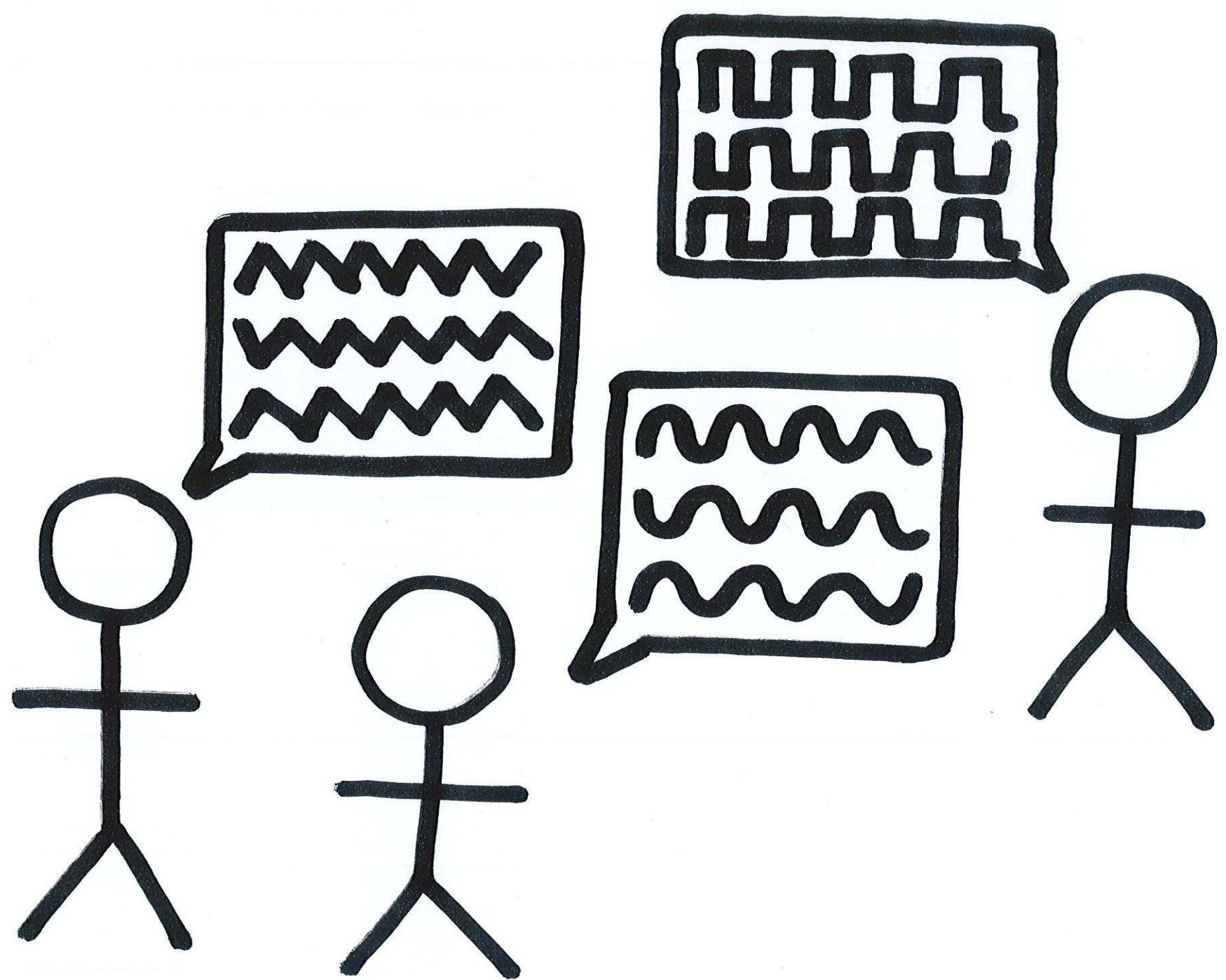
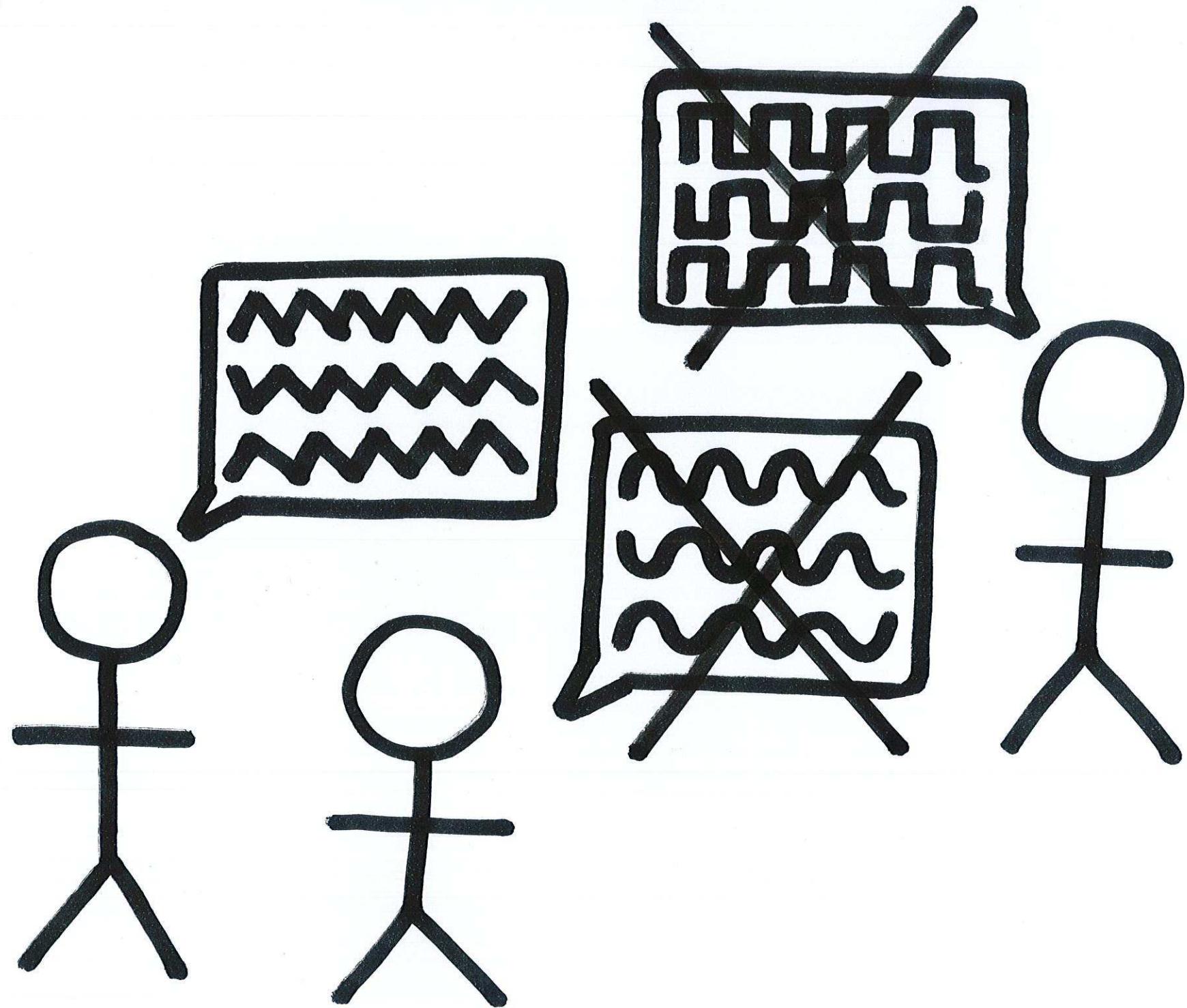


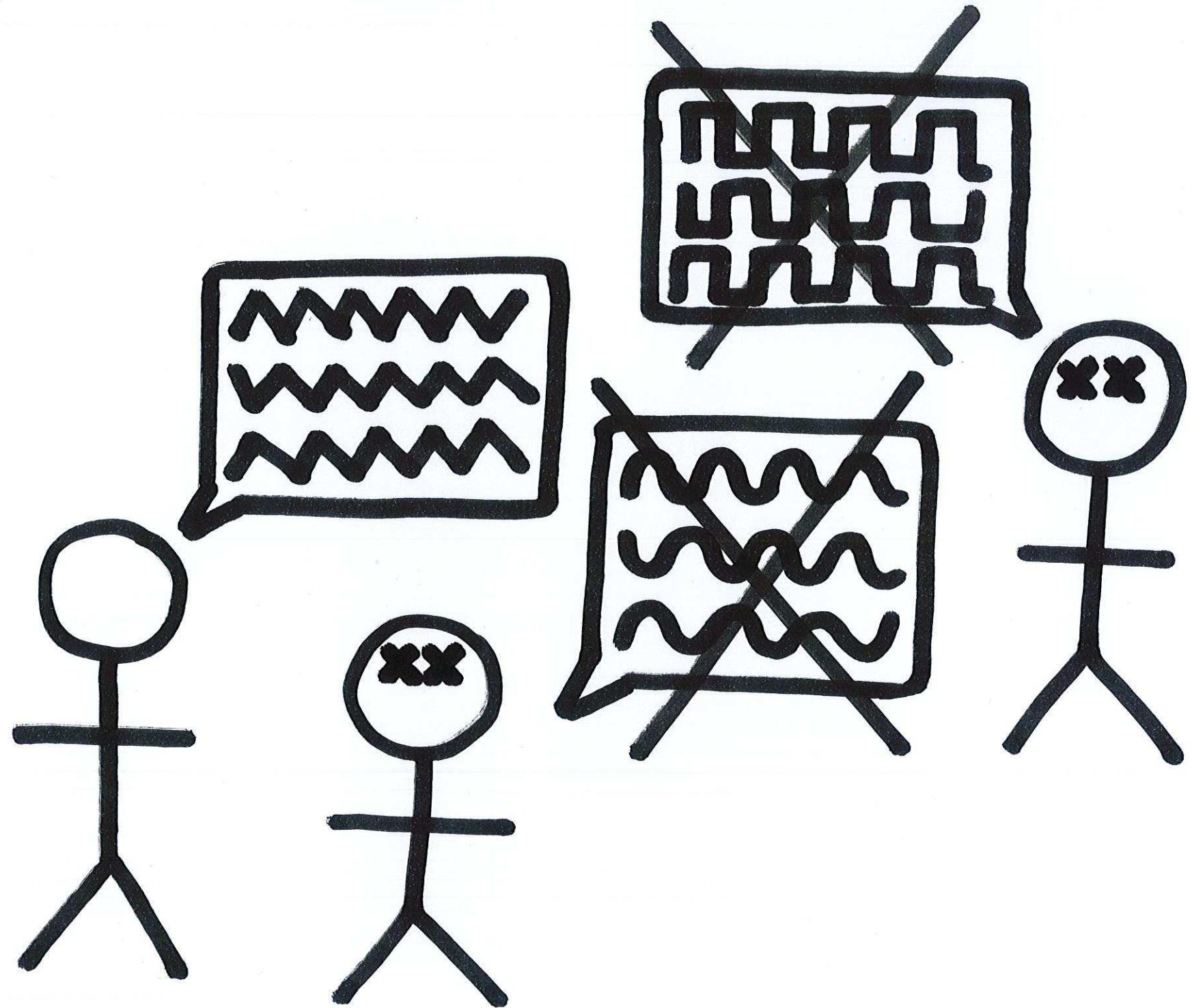
Learning a Lexicon and Translation Model from Phoneme Lattices

Oliver Adams ♠ ♥ Graham Neubig ♣ ♥
Trevor Cohn ♠ Steven Bird ♠
Quoc Truong Do ♥ Satoshi Nakamura ♥

♠ The University of Melbourne, Australia
♣ Carnegie Mellon University, Pittsburgh, USA
♥ Nara Institute of Science and Technology, Japan







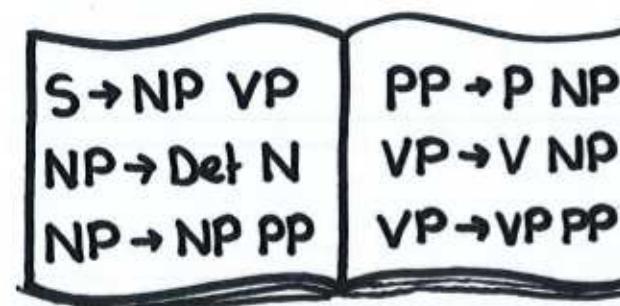
Phonemic
transcriptions

[hə'ləʊwɜːrl̩d]

Lexicons



Grammars



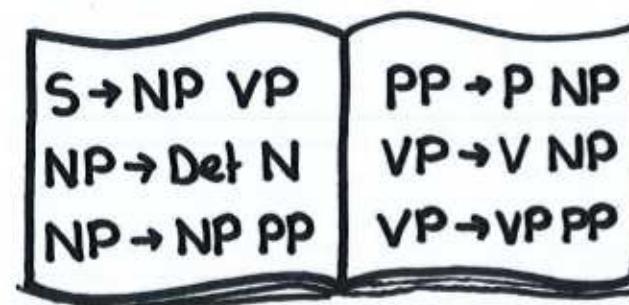
Phonemic
transcriptions

[hə'ləʊwɜːrl̩d]

Lexicons



Grammars



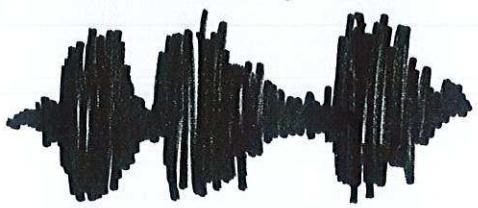




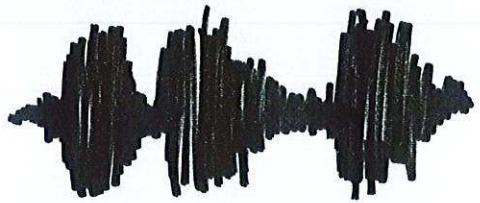




Source speech



Source speech



Hard

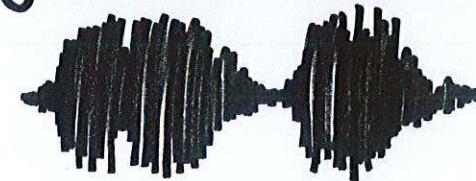
Phonemic
transcription

Source speech



Easier

Target translation



(large language)

Hard

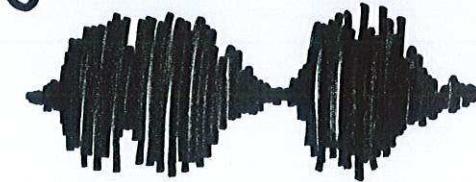
Phonemic
transcription

Source speech



Easier

Target translation



(large language)

Hard

Phonemic
transcription

Easier

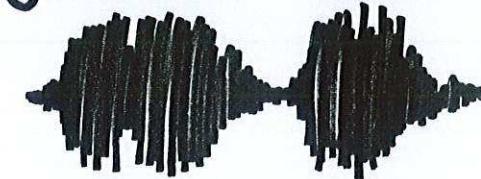
Orthographic
translation

Source speech



Easier

Target translation



(large language)

Hard

Phonemic
transcription

Easier

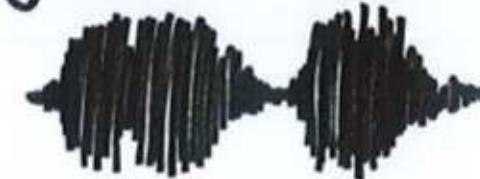
Orthographic
translation

Source speech



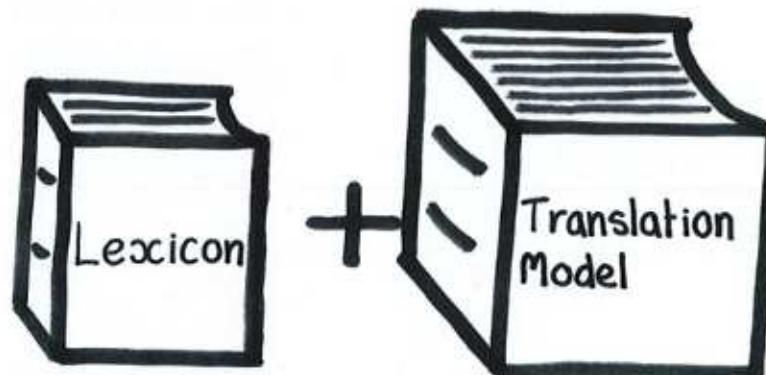
Easier

Target translation



(large language)

Hard



Easier

Phonemic
transcription

Orthographic
translation

Source speech



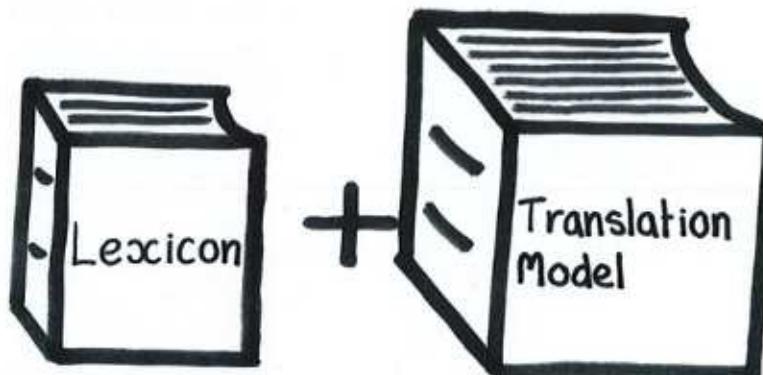
Easier

Target translation



(large language)

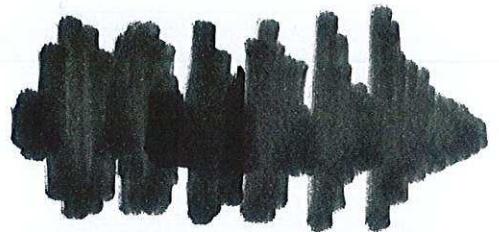
Hard



Easier

Phonemic transcription

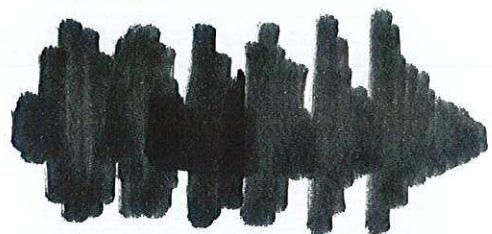
Orthographic translation



('das Ei')

+

'the egg'

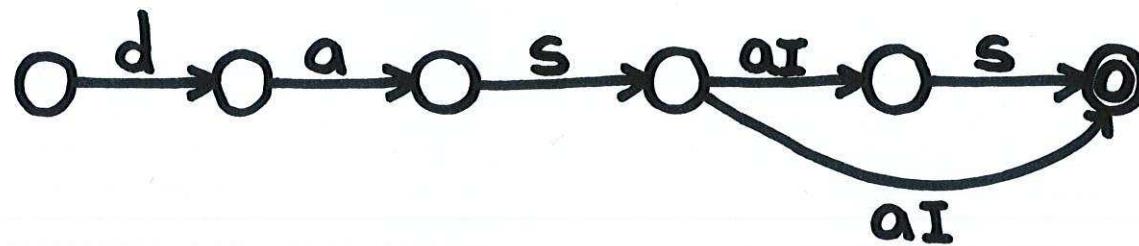


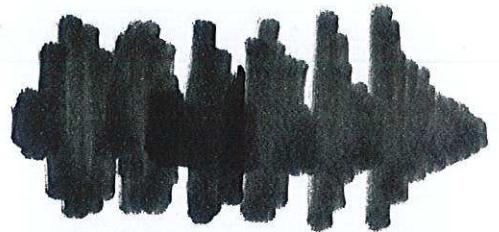
('das Ei')

+

'the egg'

acoustic
model



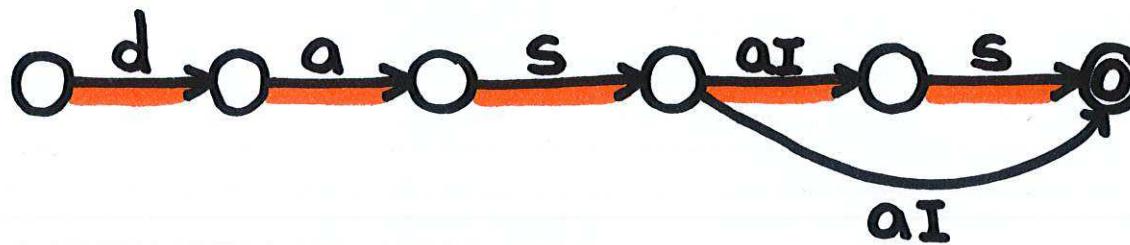


('das Ei')

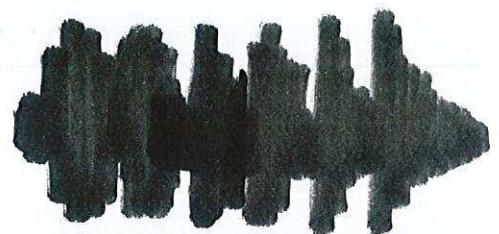
+

'the egg'

acoustic
model



'das Eis'
(the ice[cream])

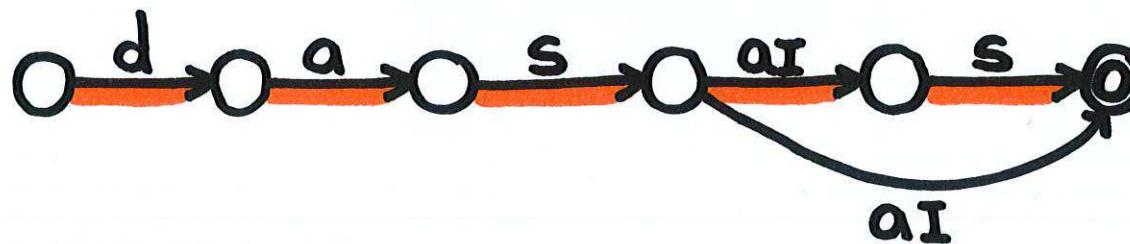


('das Ei')

+

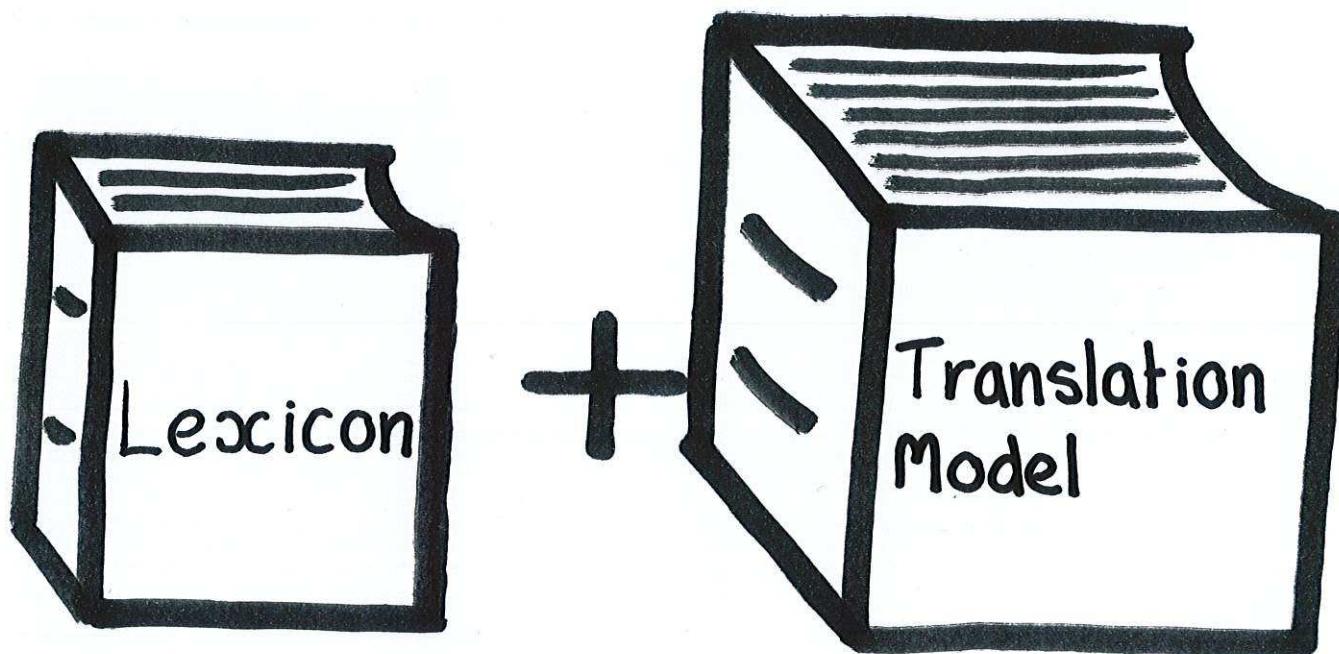
'the egg'

acoustic
model



'das Eis'
(the ice[cream])

Assume:

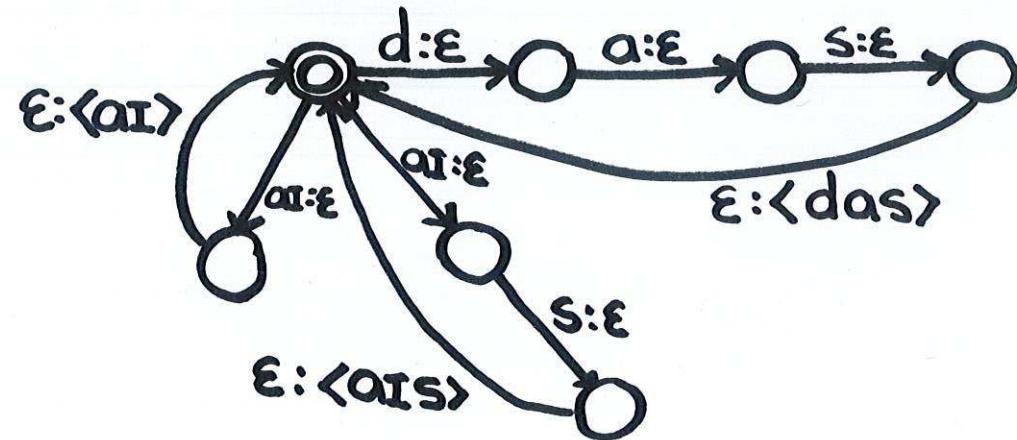


Phoneme lattice

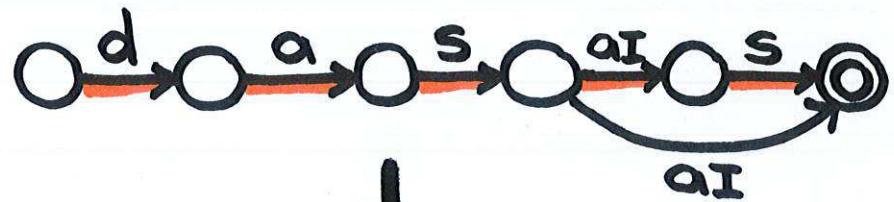


+

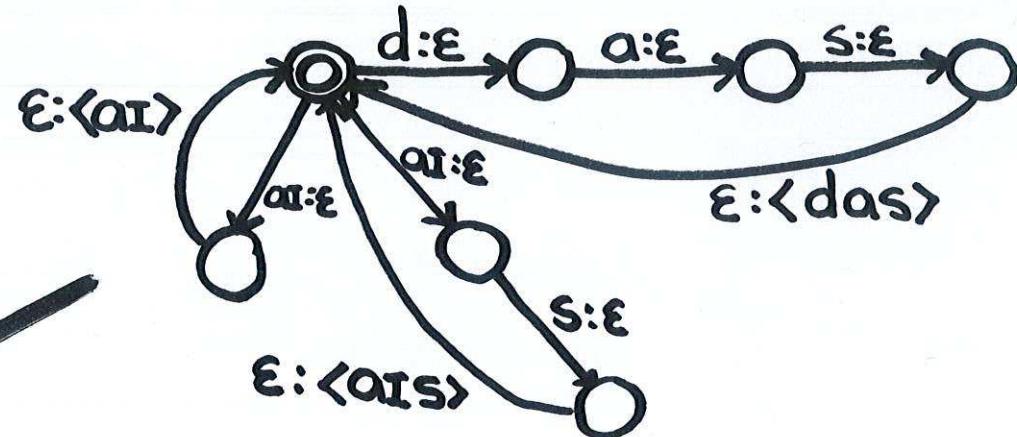
Lexicon



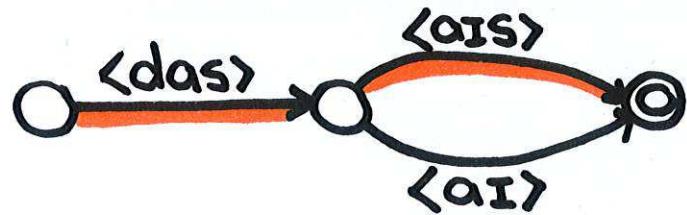
Phoneme lattice



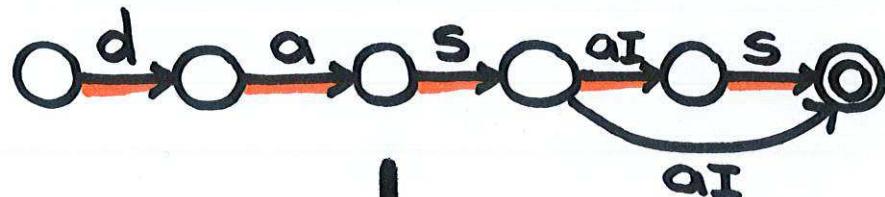
Lexicon



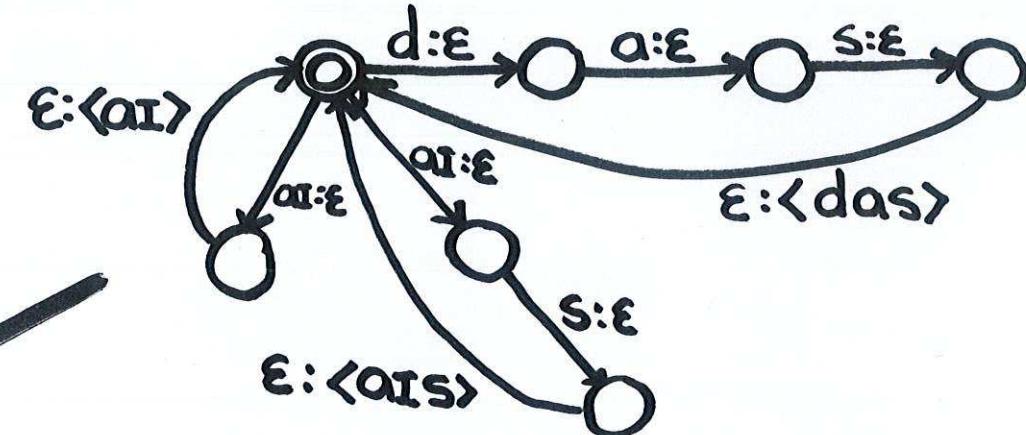
Word lattice



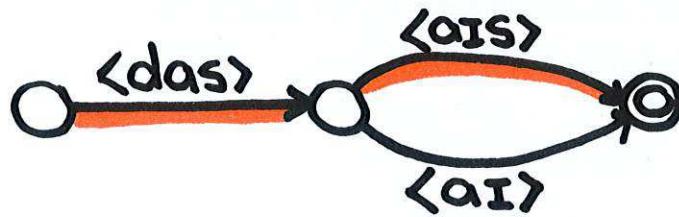
Phoneme lattice



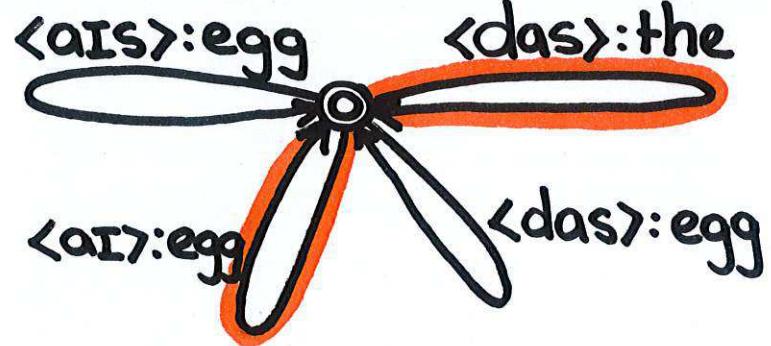
Lexicon



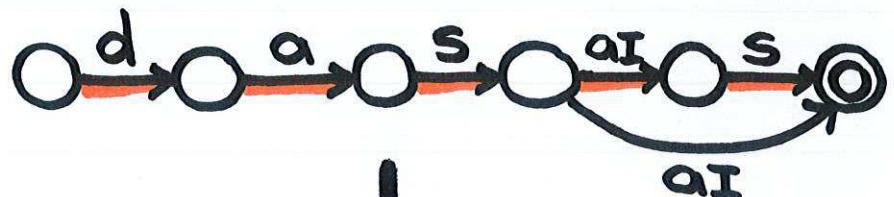
Word lattice



Translation model

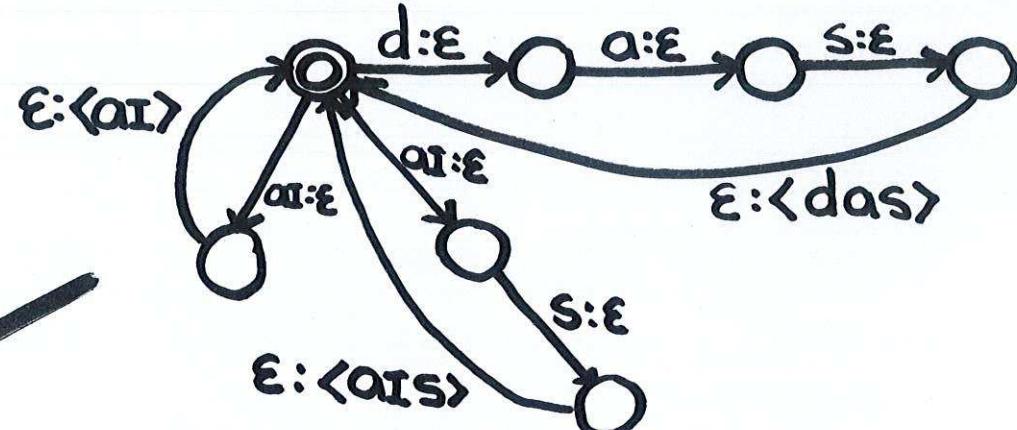


Phoneme lattice

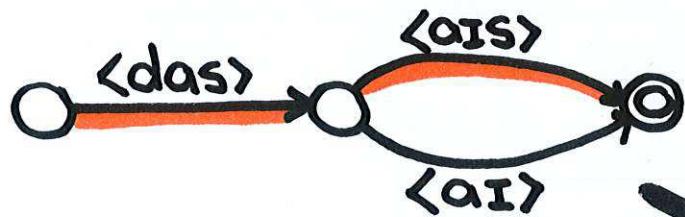


+

Lexicon

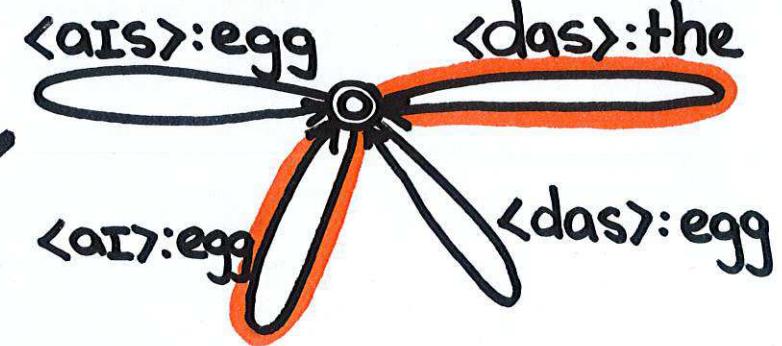


Word lattice

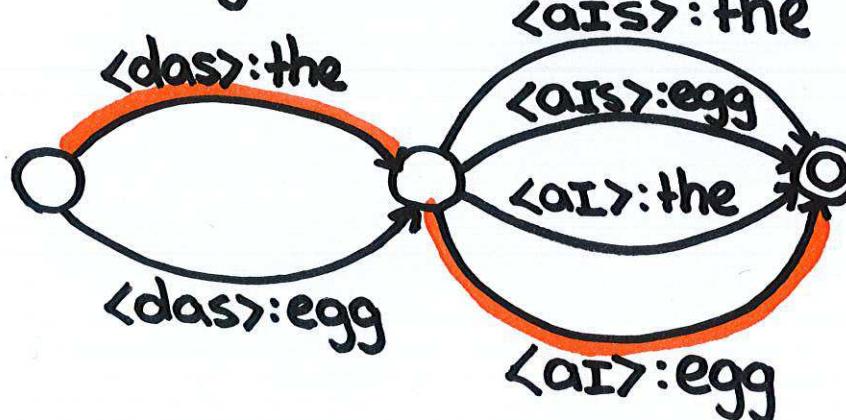


+

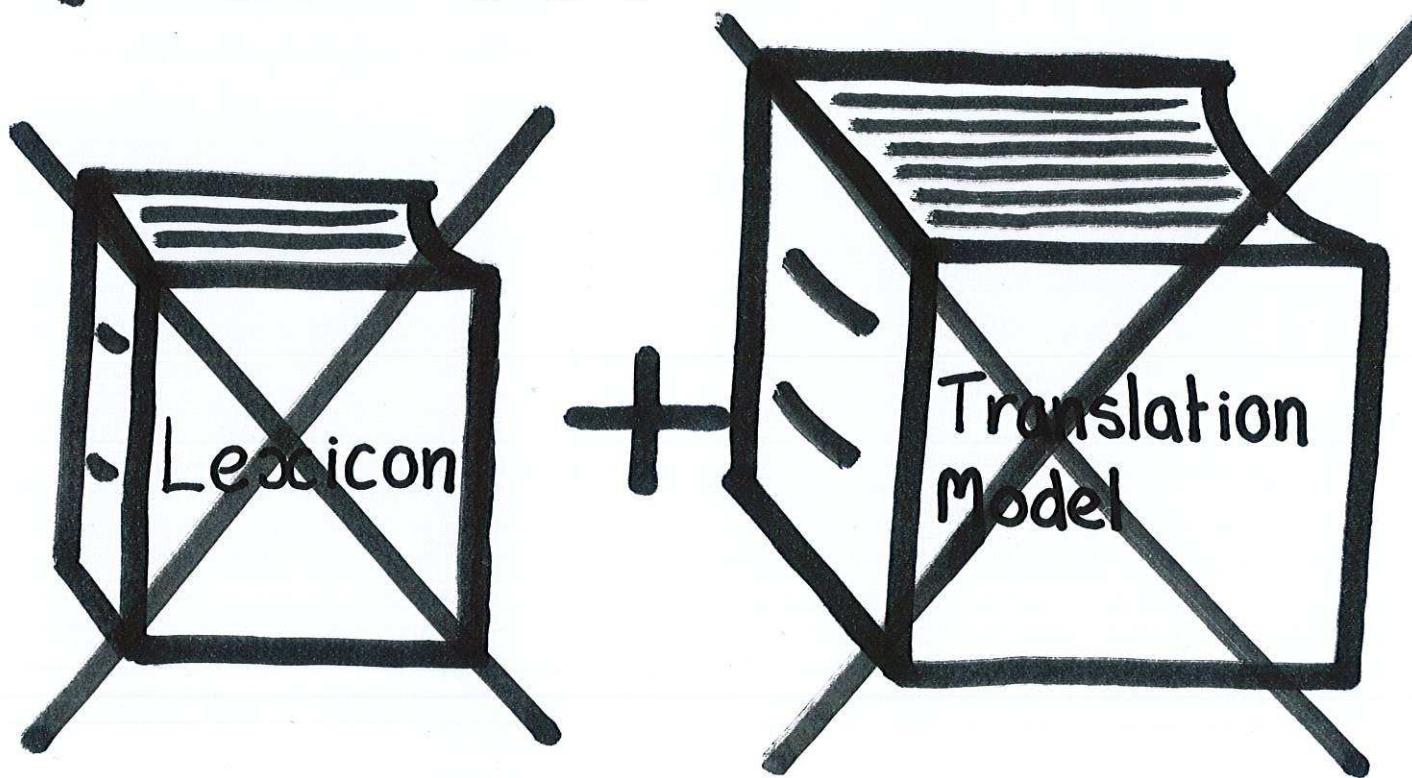
Translation model



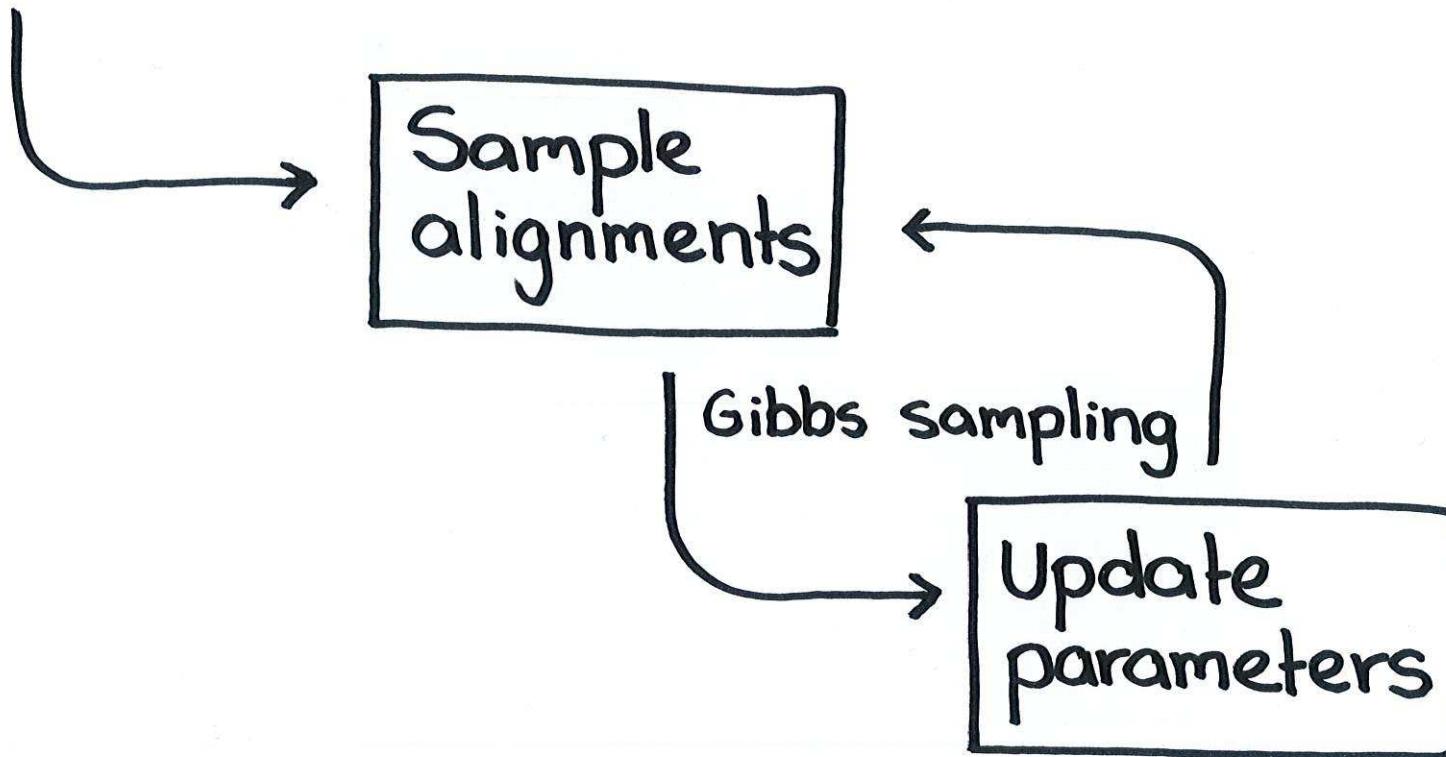
Alignment lattice



Assume:



Initialize
segmentation
prior



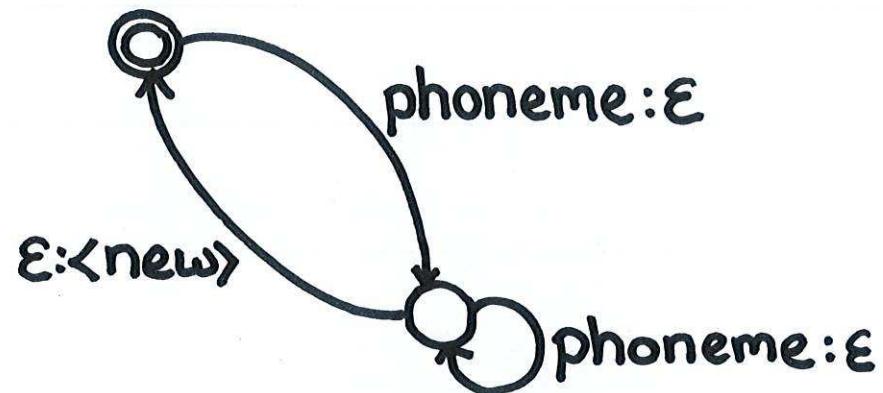
Lexicon



Translation model



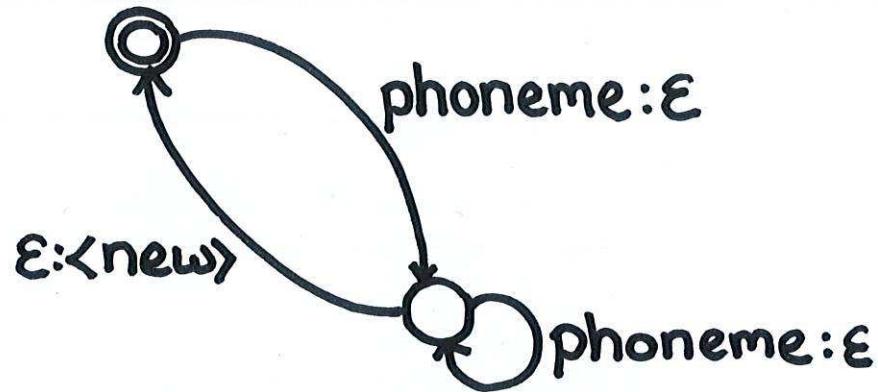
Lexicon



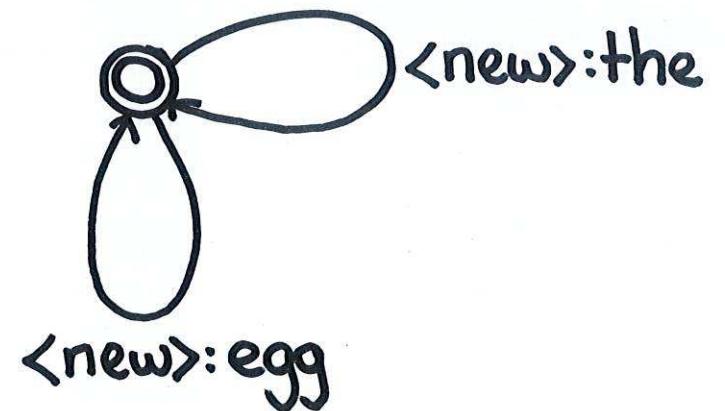
Translation model



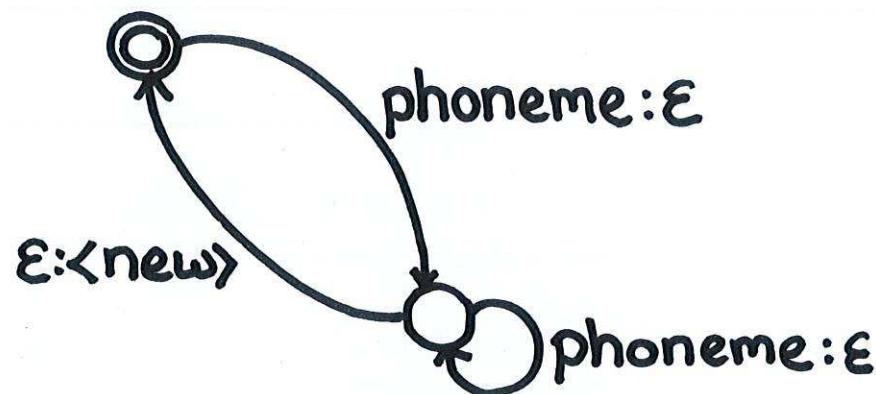
Lexicon



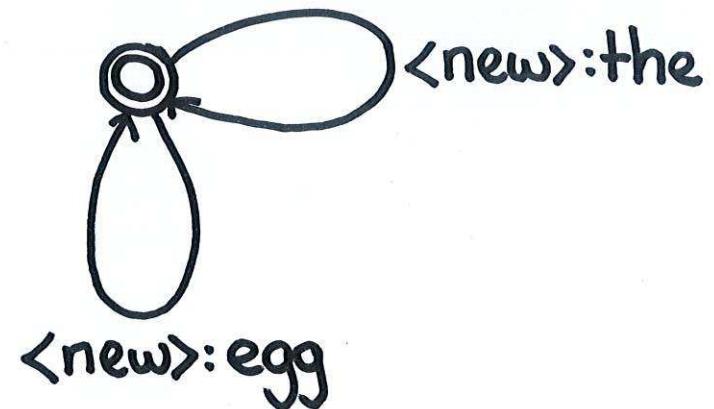
Translation model



Lexicon

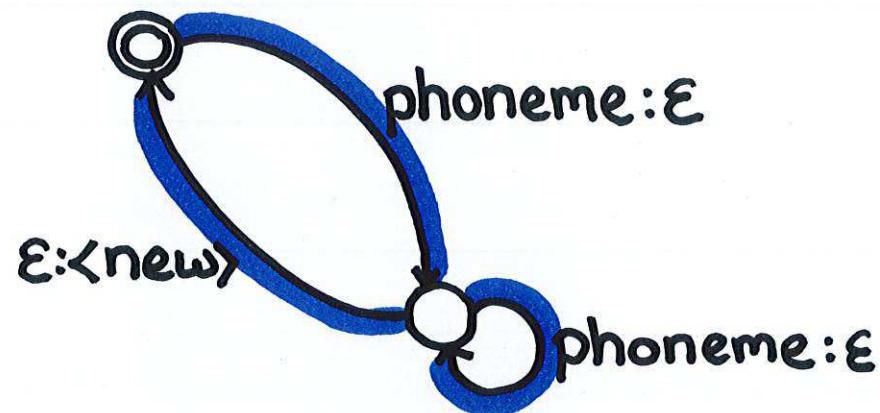


Translation model

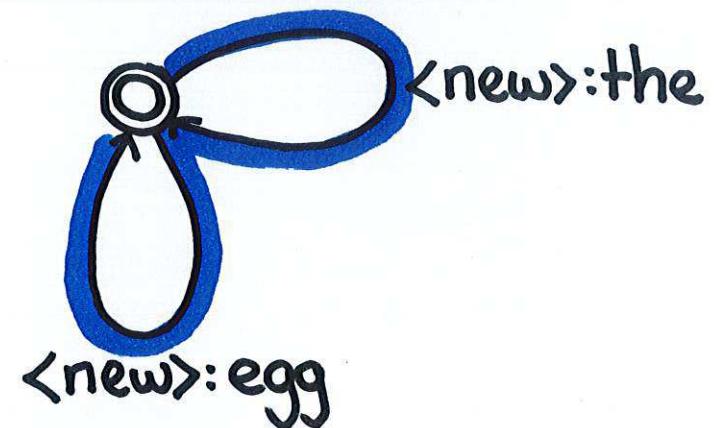


$$P(f|e) = \frac{\alpha P_0(f) + c(f,e)}{\alpha + c(e)}$$

Lexicon

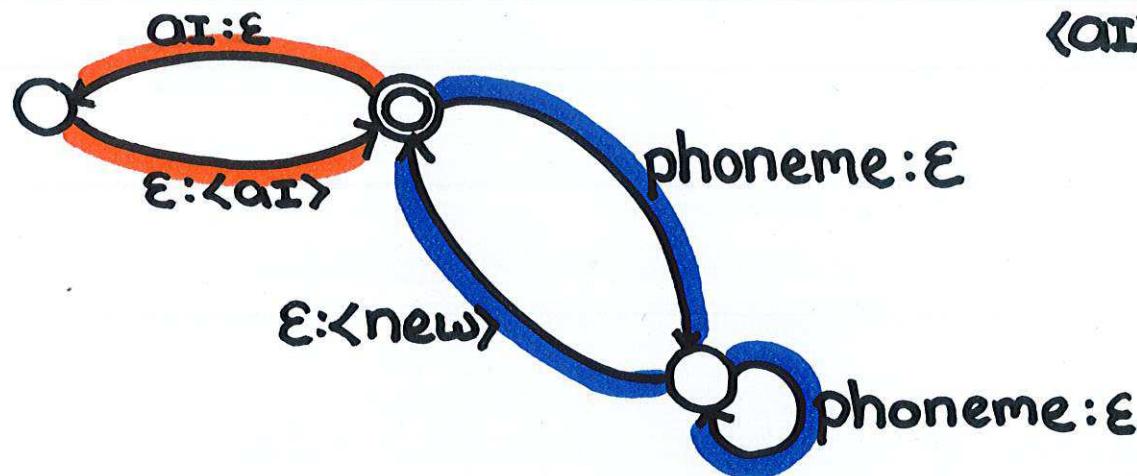


Translation model

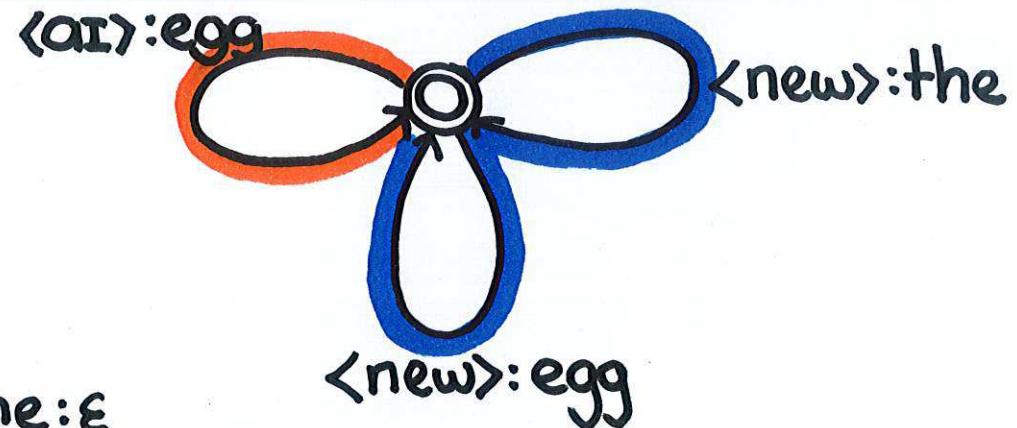


$$P(f|e) = \frac{\alpha P_0(f) + c(f,e)}{\alpha + c(e)}$$

Lexicon

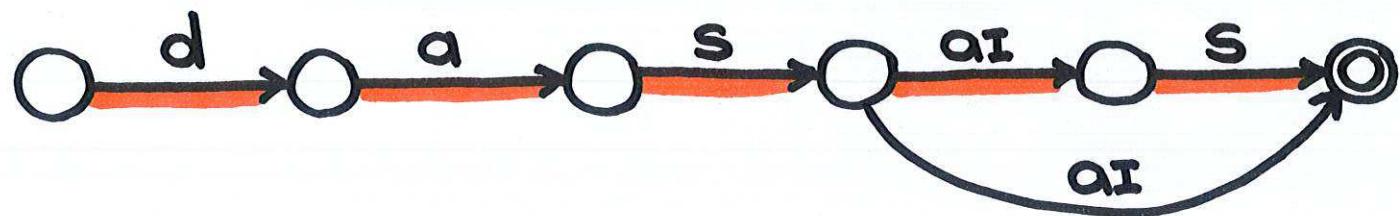


Translation model

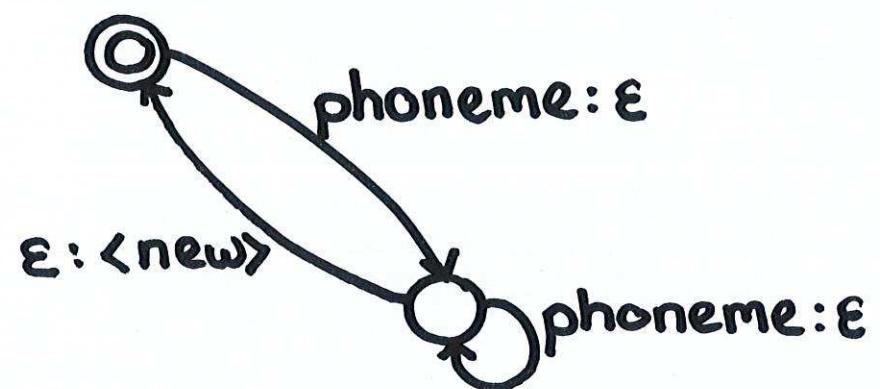


$$P(f|e) = \frac{\alpha P_0(f) + c(f,e)}{\alpha + c(e)}$$

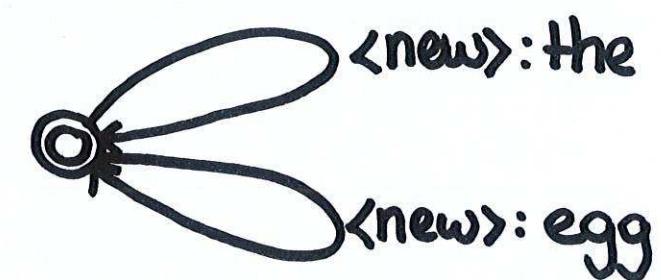
Phoneme lattice



Lexicon



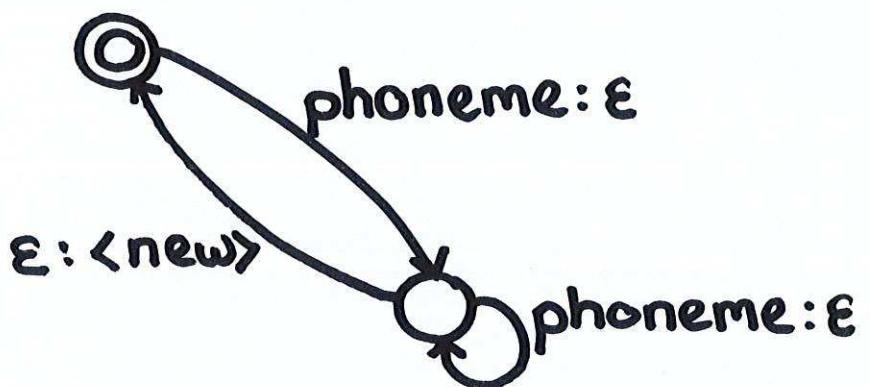
Translation model



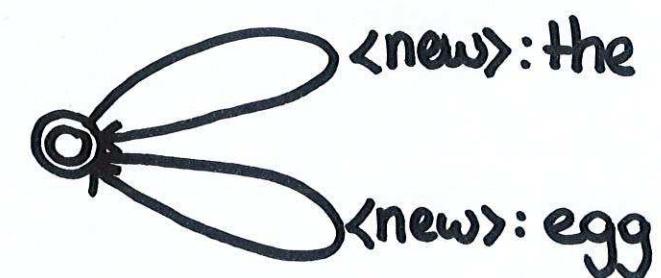
Phoneme lattice



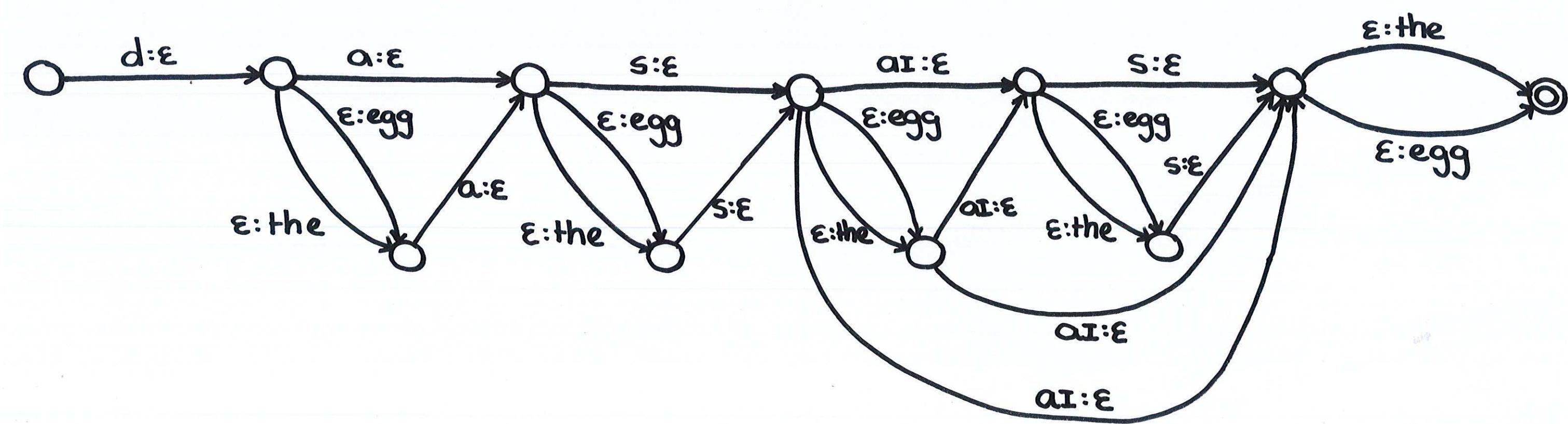
Lexicon



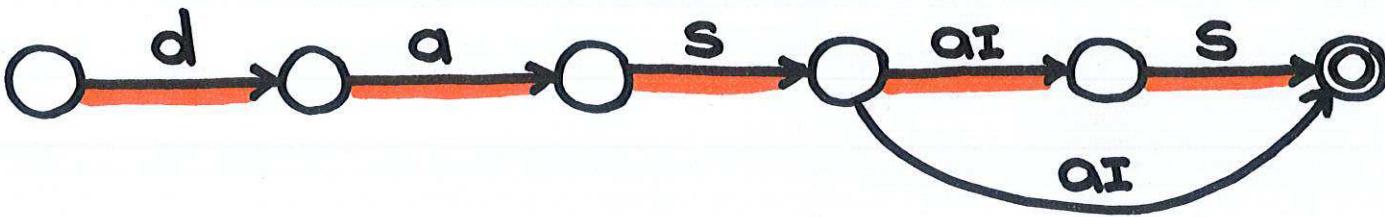
Translation model



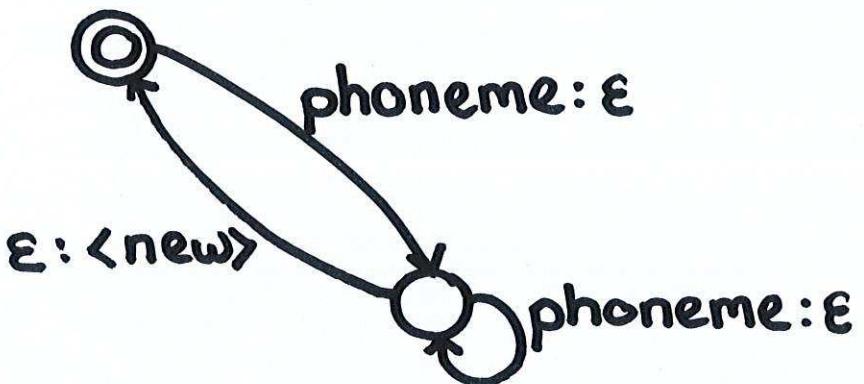
Alignment lattice



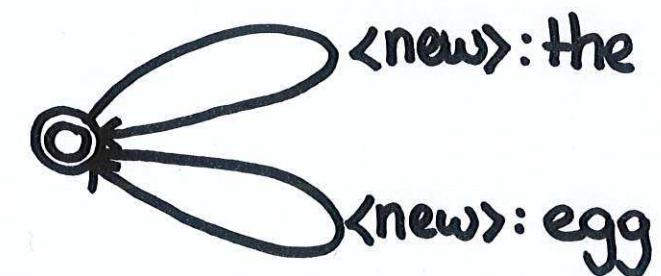
Phoneme lattice



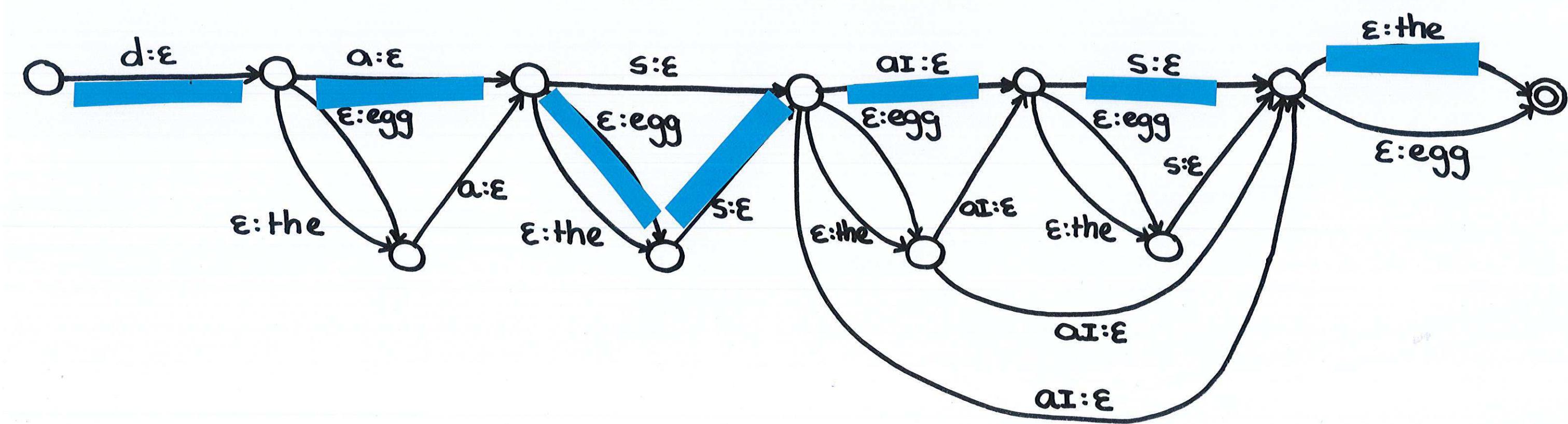
Lexicon



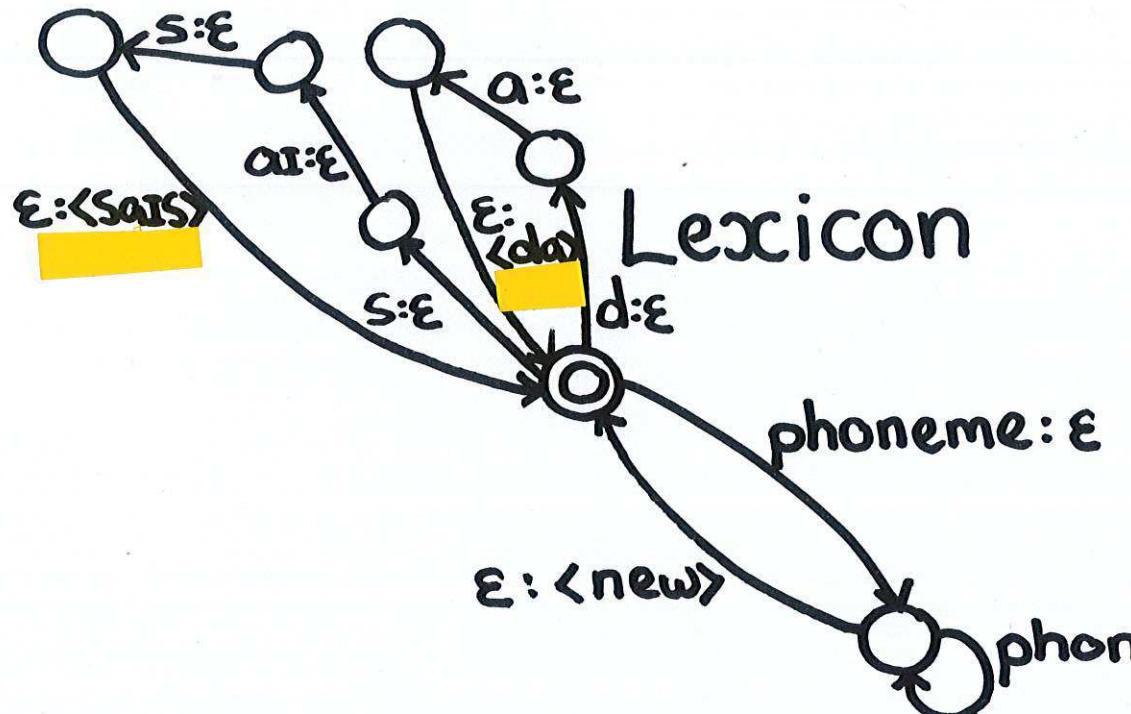
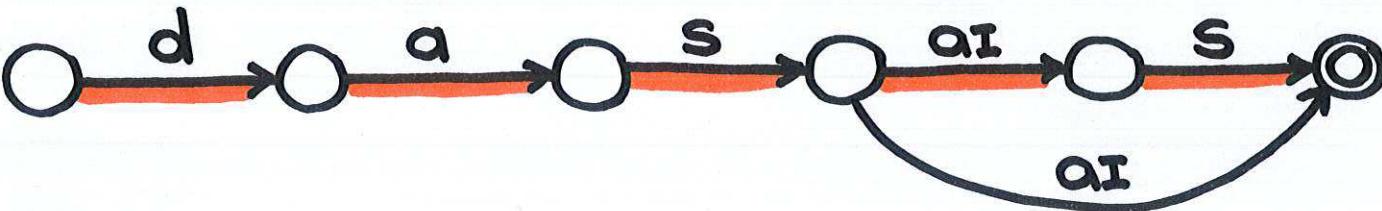
Translation model



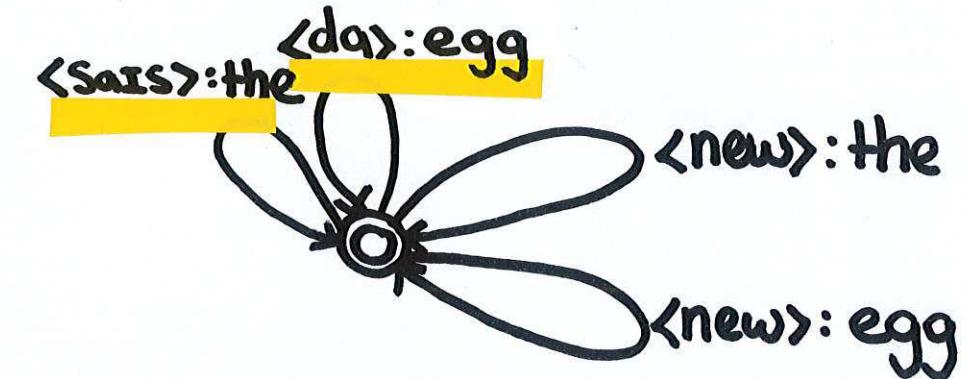
Alignment lattice



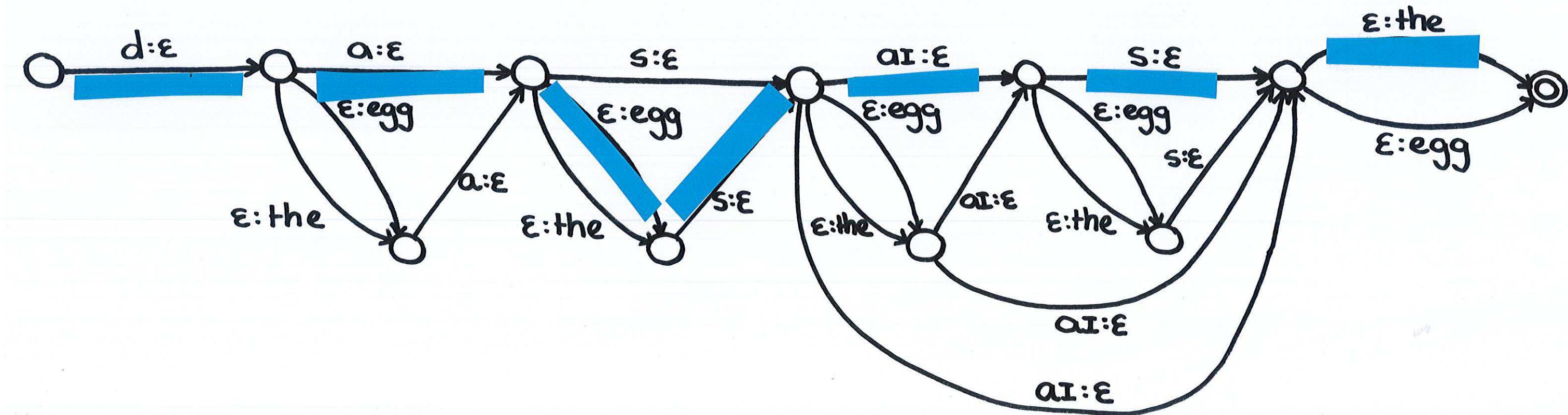
Phoneme lattice



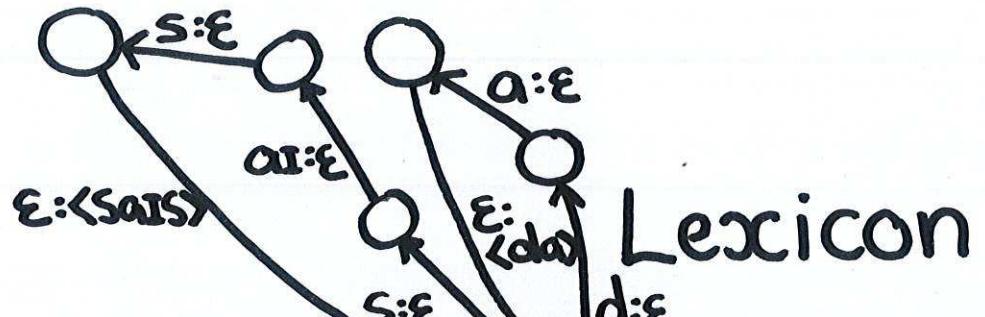
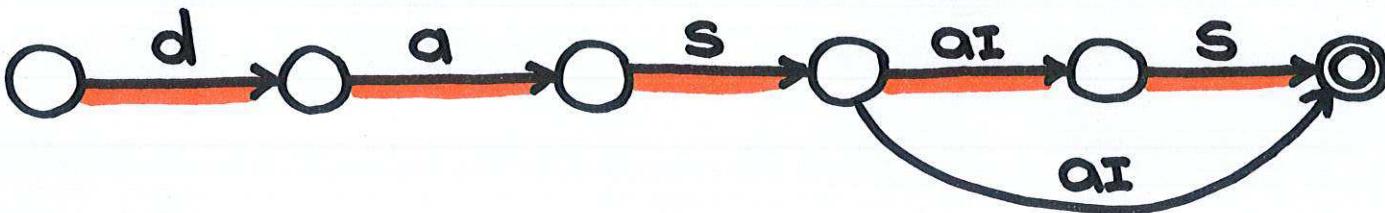
Translation model



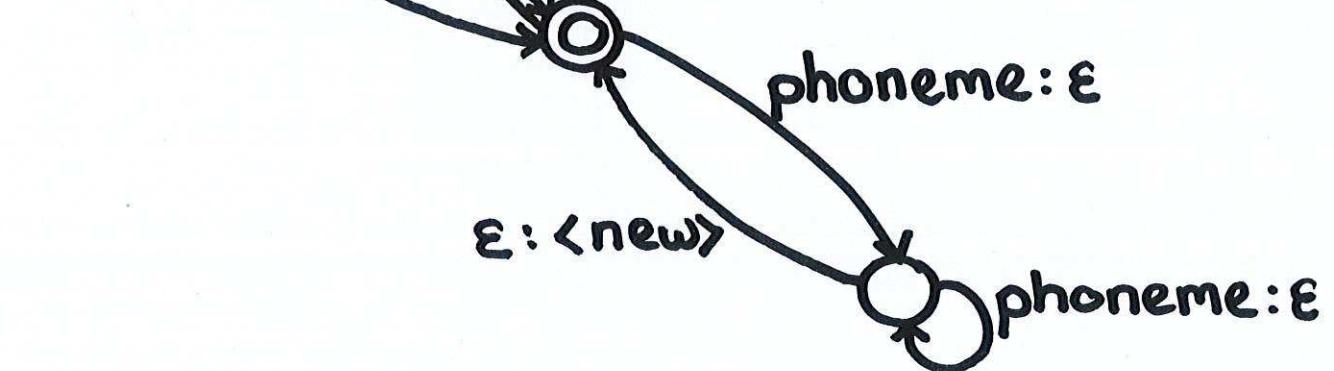
Alignment lattice



Phoneme lattice

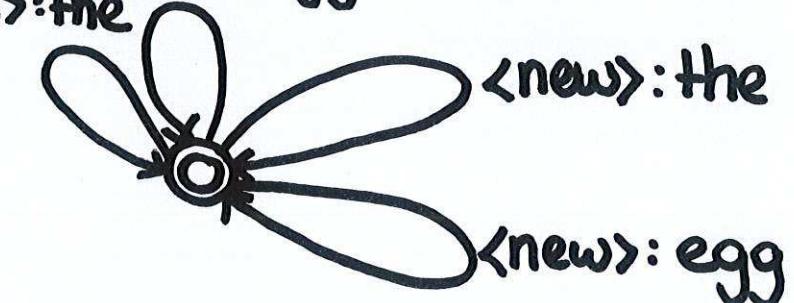


Lexicon

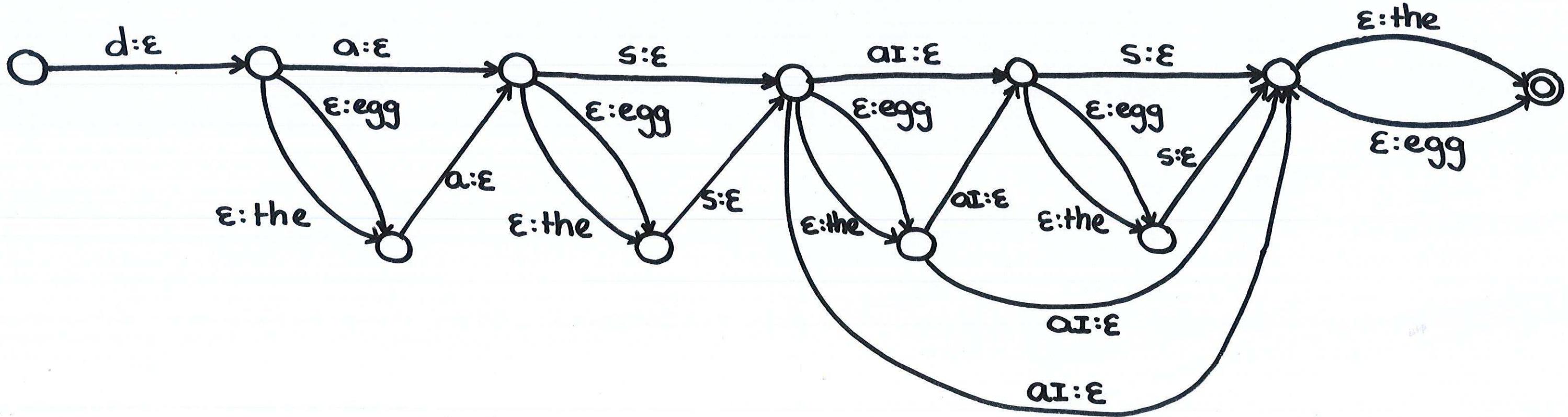


Translation model

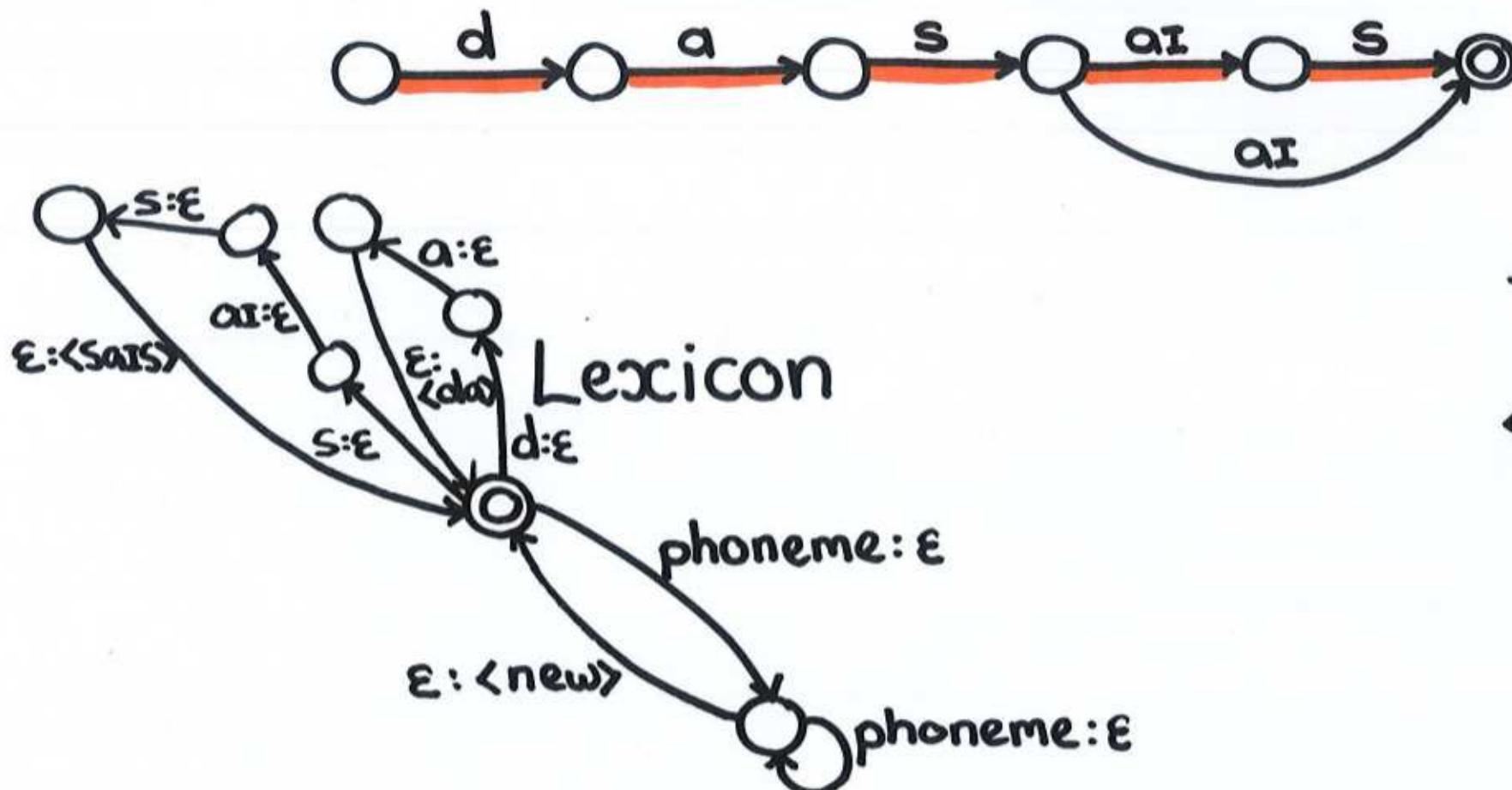
$\langle \text{sa} \rangle: \text{the}$ $\langle \text{da} \rangle: \text{egg}$



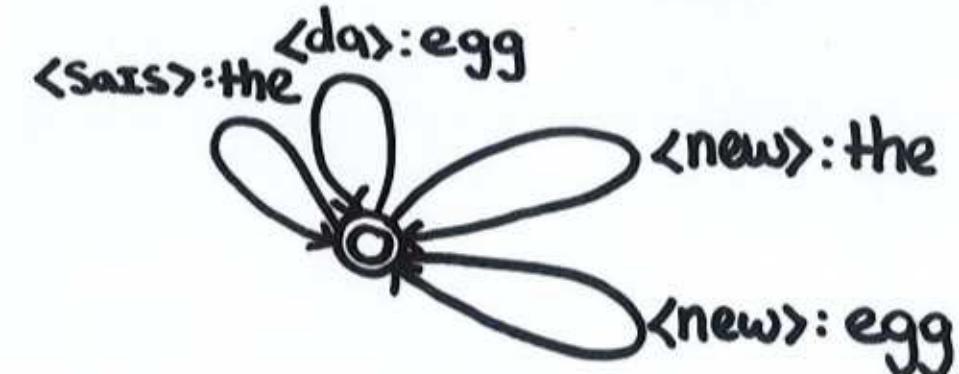
Alignment lattice



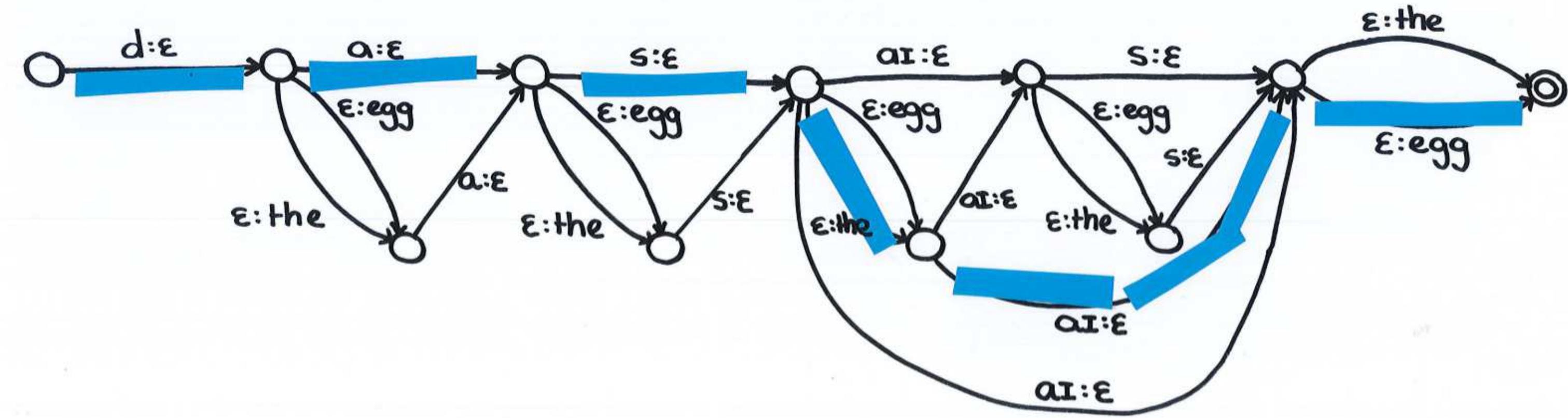
Phoneme lattice



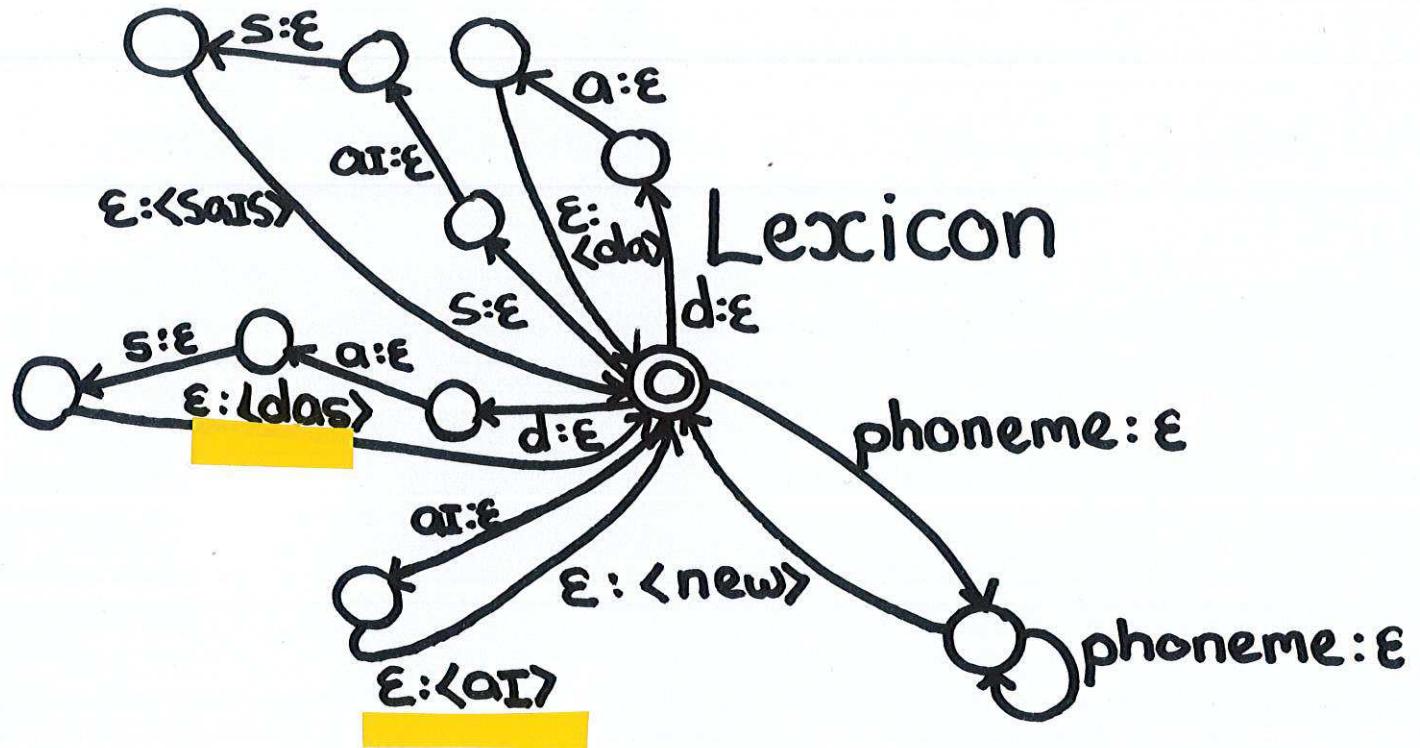
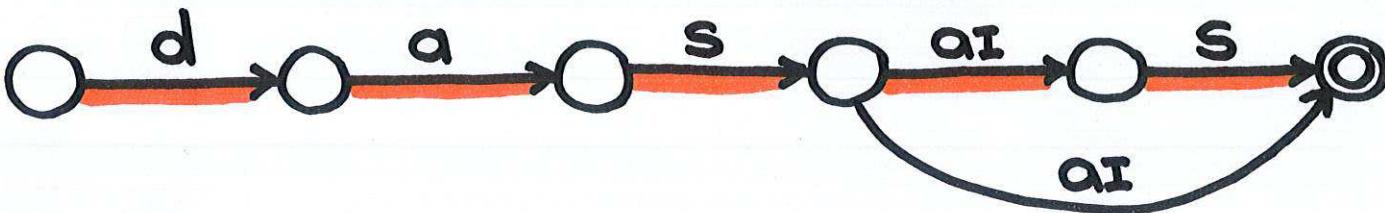
Translation model



Alignment lattice



Phoneme lattice

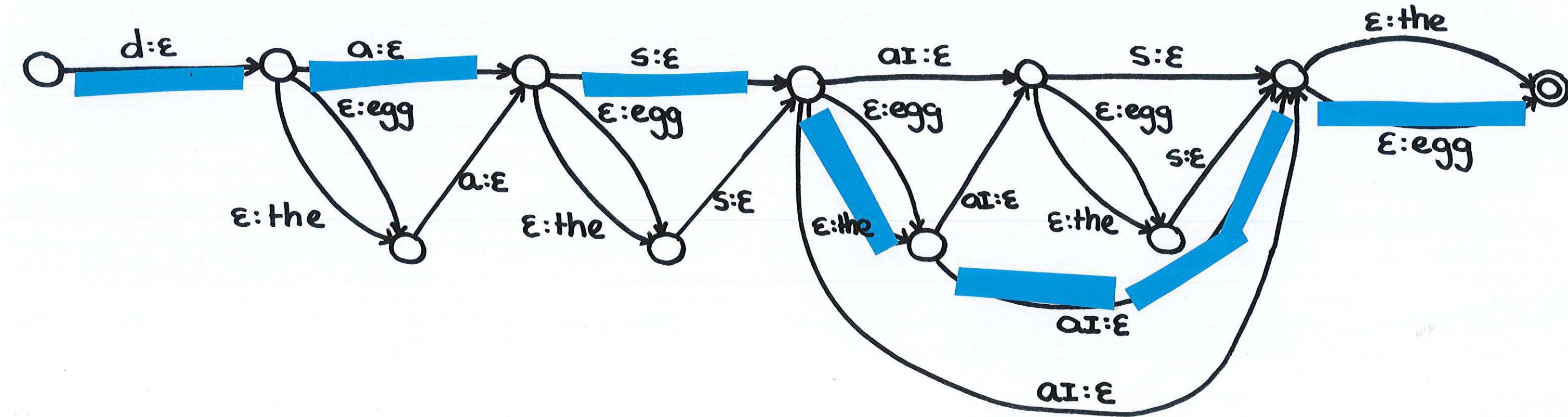


Translation model

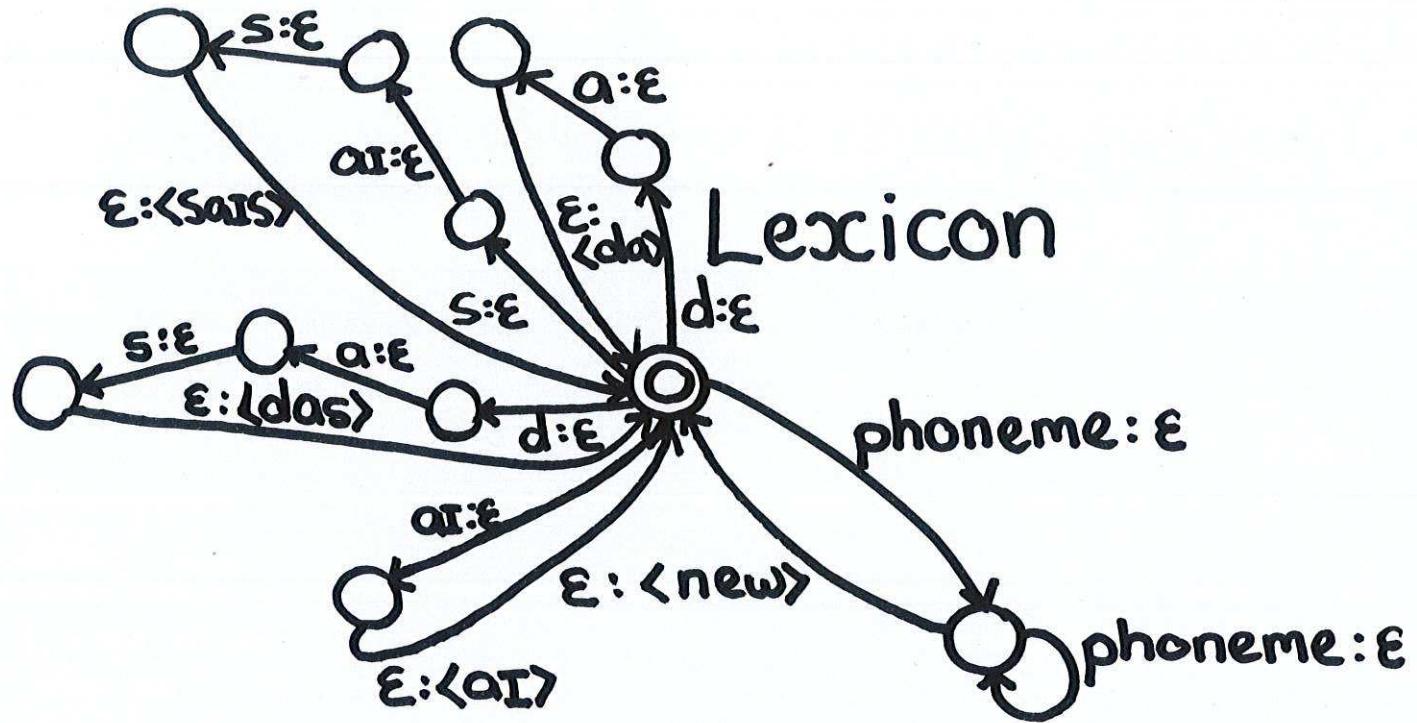
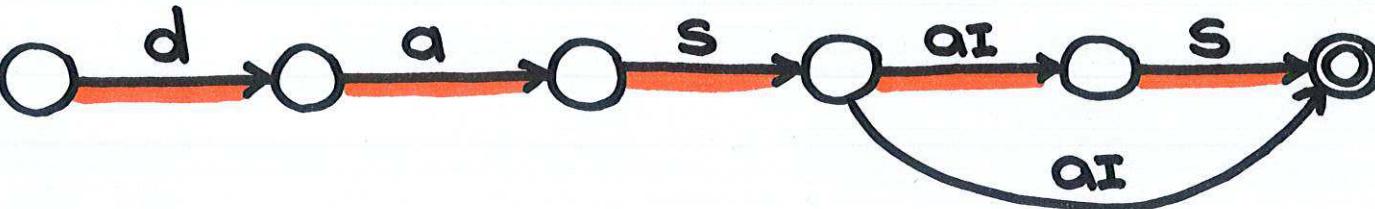
<saɪs>:the <das>:egg



Alignment lattice

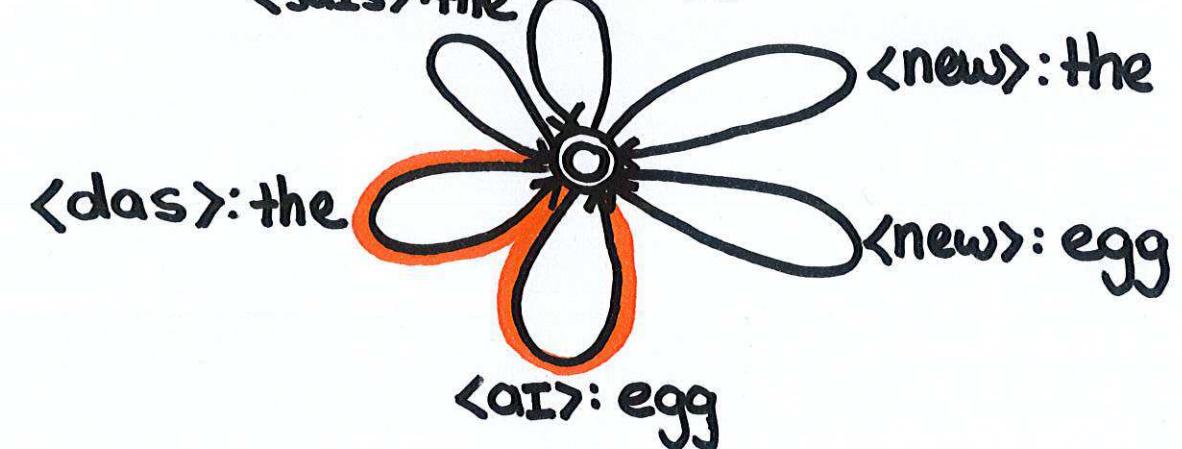


Phoneme lattice

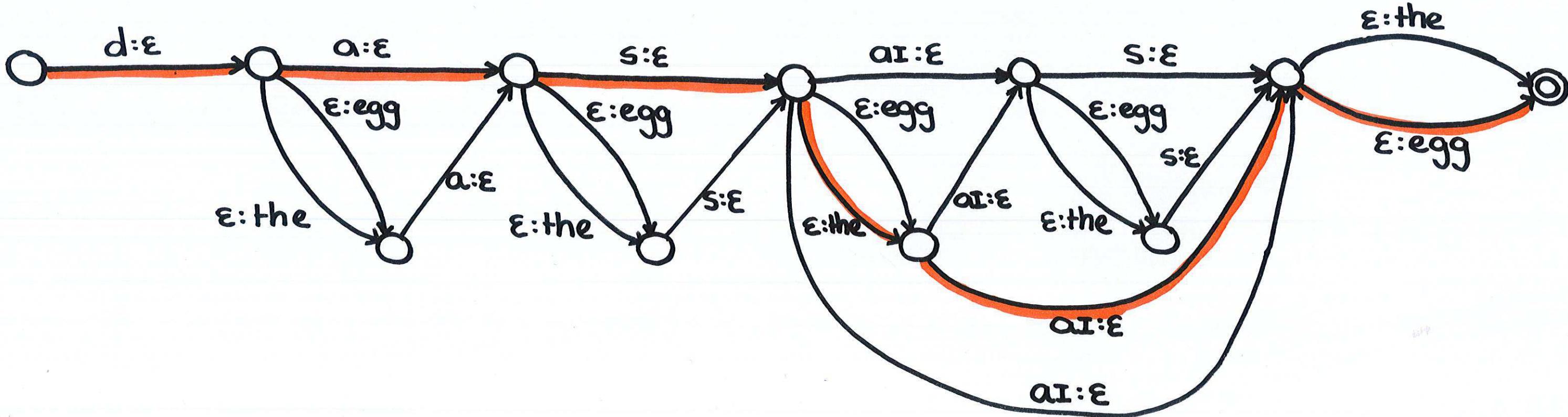


Translation model

<saɪs>:the <das>:egg



Alignment lattice



Experimental Setup

- Phoneme recognition.
- Japanese-English BTEC data:



What kind of cruises
are there on the river
Seine?

セーヌ川の クルーズには
どんな 種類のものか
ありますか。

- No prior lexicon, language model, or translation model.
- But we use Japanese and English acoustic models.

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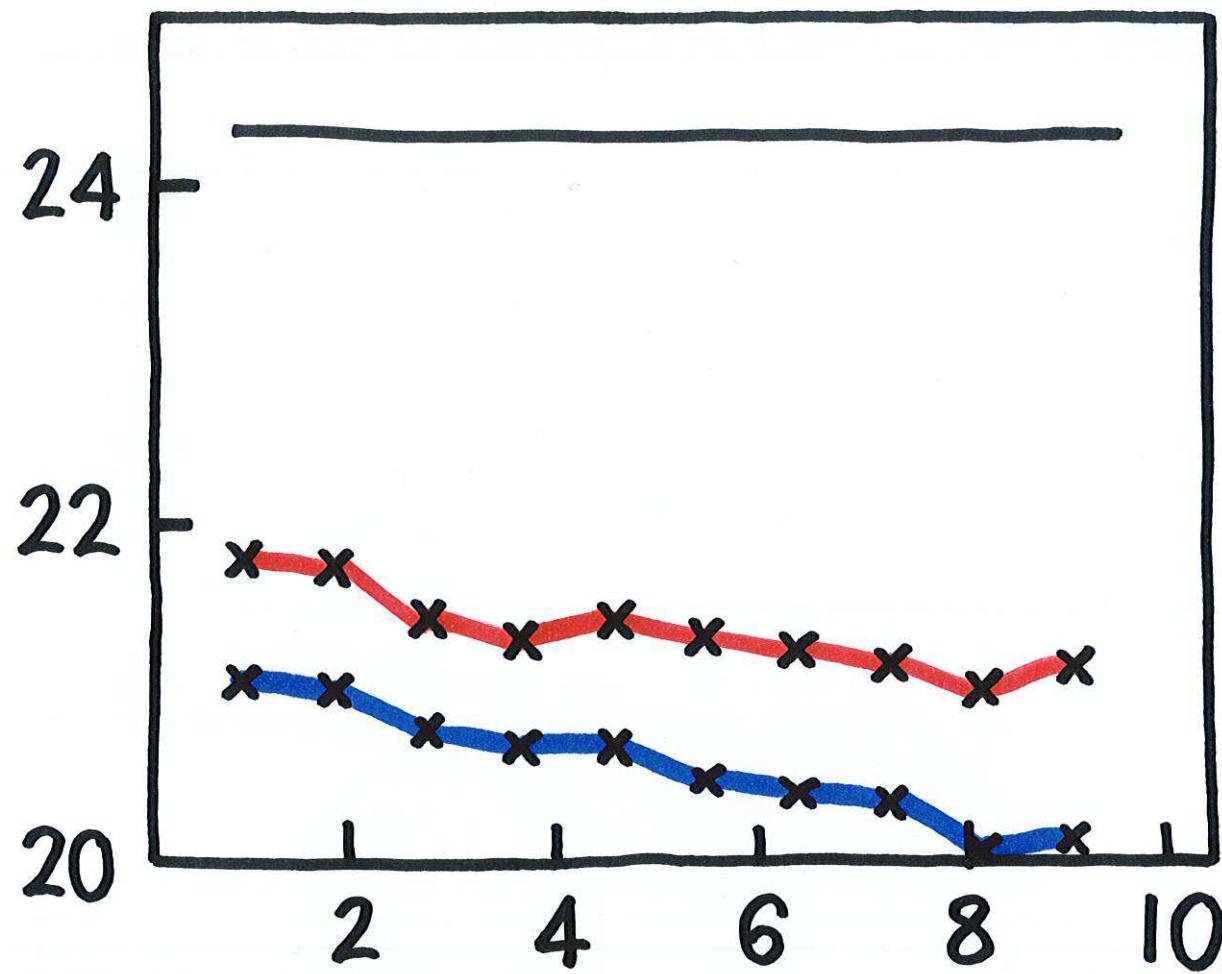
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Japanese phoneme error rates (per cent)



Training hours

— ASR — x — ja mono — x — ja-en

wʌn ↔ — (one)

-liːz ↔ <だ"さ_ (please)

wʌt ↔ 時 (what ↔ time)

iːŋ ↔ < (-ing ↔)

haʊmʌtʃ ↔ ()<5 (how much)

wʌn ↔ — (one) ✓

-liːz ↔ <だ"さ_ (please)

wʌt ↔ 時 (what ↔ time)

iːŋ ↔ < (-ing ↔)

haʊmʌts ↔ ()<5 (how much)

wʌn ↔ — (one) ✓

-liːz ↔ <だ"さ_ (please) ✗

wʌt ↔ 時 (what ↔ time)

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iːŋ ↔ < (-ing ↔) ✗

haʊmʌts ↔ ()<5 (how much)

wʌn ↔ — (one) ✓

-liːz ↔ <だ"さ_> (please) ✗

wʌt ↔ 時 (what ↔ time) ✗

iːŋ ↔ < (-ing ↔) ✗

haʊmʌts ↔ ()<5> (how much) ✗

wʌn ↔ —

(one)

✓

-liːz ↔ <だ"さ_

(please)

✗

wʌt ↔ 時

(what ↔ time) ✗

iːŋ ↔ <

(-ing ↔) ✗

haʊmʌts ↔ ()<5

(how much) ✗

Still useful information!

In conclusion...

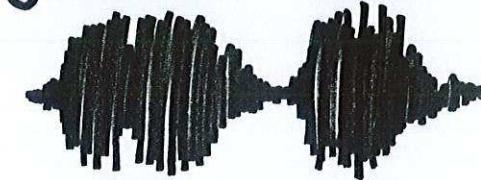


Source speech



Easier

Target translation



(large language)

Hard

Phonemic
transcription

Easier

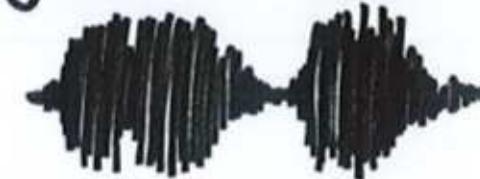
Orthographic
translation

Source speech



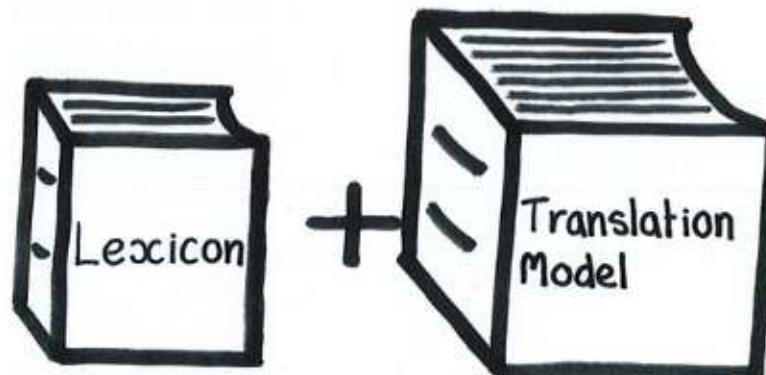
Easier

Target translation



(large language)

Hard



Easier

Phonemic
transcription

Orthographic
translation

Source speech



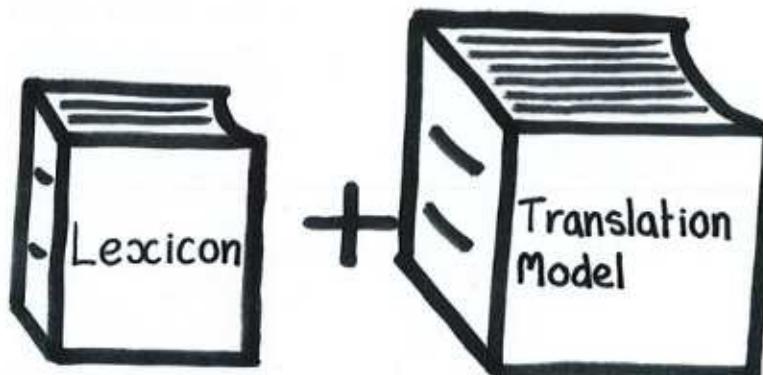
Easier

Target translation



(large language)

Hard



Easier

Phonemic transcription

Orthographic translation

Now for actual
low-resource
languages ...

Thank you. Questions?

Code <https://github.com/oadams/latticeM>

Contact oliver.adams@gmail.com

Thanks to support
from:

