LING5702: Lecture Notes 5
A Model of Complex Ideas in Associative Memory

We have seen how interconnected neurons can define mental states and cued associations.

This lecture will describe how mental states and cued associations can define complex ideas.

Contents

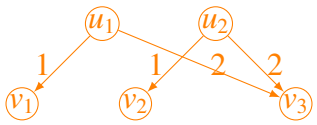
5.1 Previously: mental states and cued associations

Recall neural activation patterns and potentiated connection weights:

target v_1	cue u_1		target v_2	cue u_2		associations M_1
.71			.0			.0 .41 .0 .41 .41
.0			.58			.0 .0 .41 .41 .0
.71	.0 .58 .0 .58 .58	+	.58	.0 .0 .71 .71 .0	=	.0 .41 .41 .82 .41
.0			.0			.0 .0 .0 .0 .0
.0			.58			.0 .0 .41 .41 .0

target v_3	cue u_1		target v_3	cue u_2		associations M_2
.58			.58			.0 .33 .74 .41 .33
.58			.58			.0 .33 .74 .41 .33
.0	.0 .58 .58 .0 .58	+	.0	.0 .0 .71 .71 .0	=	.0 .0 .0 .0 .0
.58			.58			.0 .33 .74 .41 .33
.0			.0			.0 .0 .0 .0 .0

define coordinates of points (mental states) in mental space, linked by cued associations:



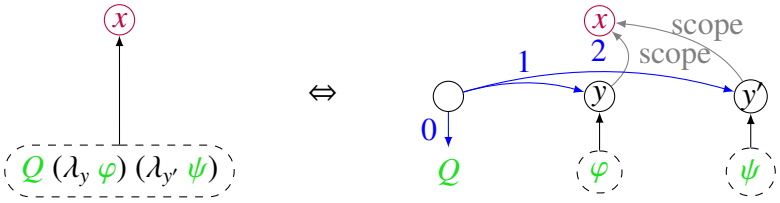
5.2 Cued associations represent lambda calculus (Schuler & Wheeler, 2014)

Mental states mostly correspond to lambda calculus variables, and directly cue the following:

1. **function arguments**: cued associations from function to argument, numbered by position
2. scope: association from a quantifier's argument variables to its immediate outscoper

We can use cued associations to build complex ideas, equivalent to lambda calculus expressions (define cued associations via recursive mappings, in context of a most recently bound variable x):

1. **generalized quantifications** (unlabeled circles) cue restrictor and nuclear scope variables:

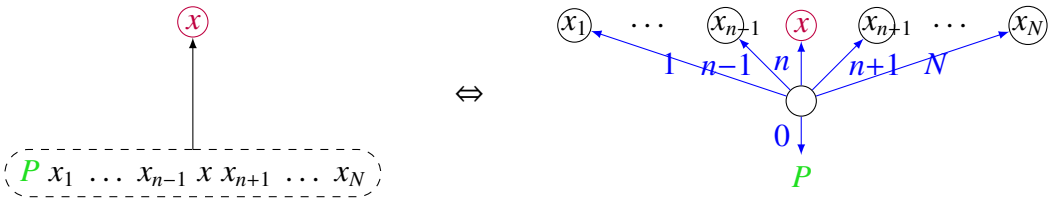


   A 'scope' association cues the most recently bound variable as immediately outscoping.

2. **intensions** of generalized quantifiers use the most recently bound variable as quantification:

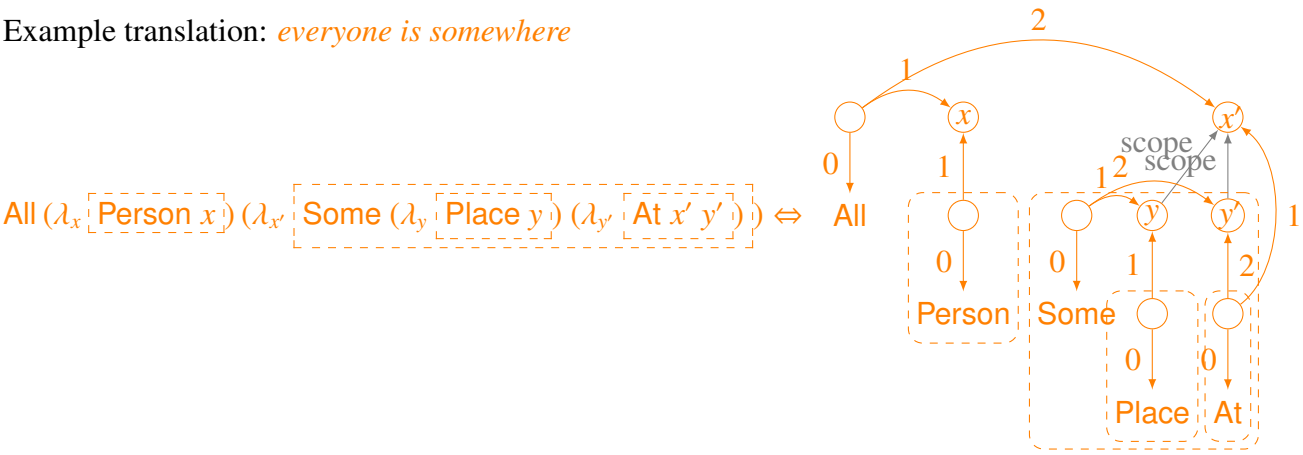
3. **conjunctions** are represented as independent graphs sharing a most recently bound variable:

4. **predications** (unlabeled circles) directly cue a predicate type and arguments:



   Note that the most recently bound variable is typically one of the arguments.

Example translation: *everyone is somewhere*



In this manner, any complex idea may be stored as cued associations in associative memory.

(Here, unlike other possible representations, all variables are unique, so may be cued by content.)

We'll assume a representation like this is formed incrementally during sentence comprehension.

Similar: Mel'čuk (1988); Baldridge & Kruijff (2002); Koller (2004); Copestake et al. (2005); Banarescu et al. (2013).

These are graphical, but don't guarantee unique cueing without interference (superposition).

5.3 How are complex ideas experienced?

In this model a complex idea is a collection of cued associations in associative memory.

The entire idea is not all active at the same time.

How is such an idea experienced?

Just as we apprehend visual scenes by saccading from one physical fixation point to another, in this model we apprehend complex ideas by **transitioning** from one referential state to another, via cued associations.

So, as we think about people and places, there is always a 'you-are-here pointer' in the graph.

References

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Banarescu, L., Bonial, C., Cai, S., Georgescu, M., Griffitt, K., Hermjakob, U., Knight, K., Koehn, P., Palmer, M., & Schneider, N. (2013). Abstract meaning representation for sembanking. In *Proceedings of the 7th Linguistic Annotation Workshop and Interoperability with Discourse* (pp. 178–186). Sofia, Bulgaria: Association for Computational Linguistics.

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