Genifer — white paper

YKY 甄景贤

Independent researcher, Hong Kong

generic.intelligence@gmail.com

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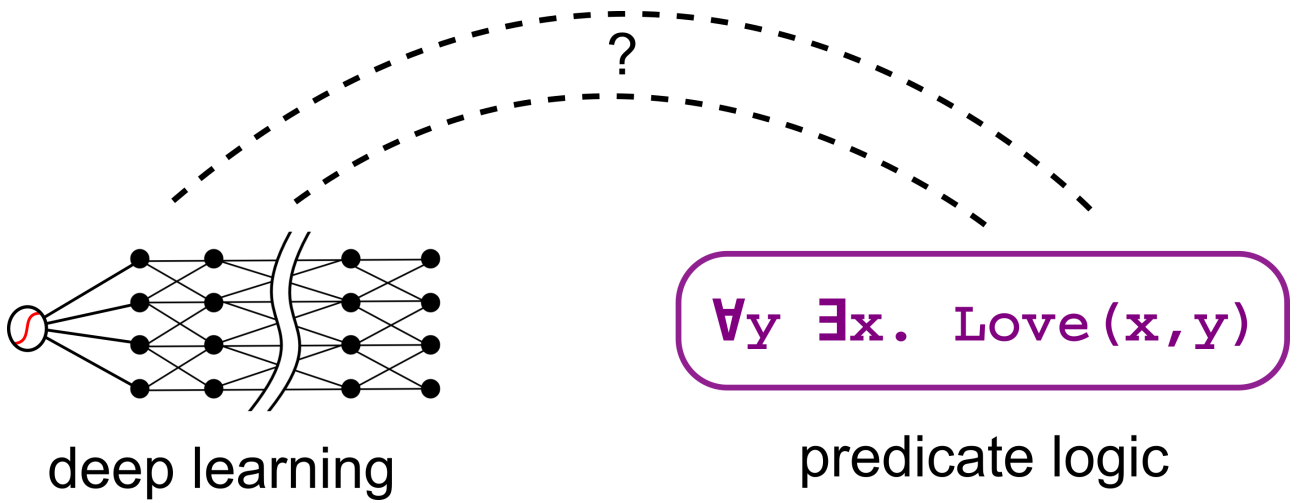
The missing link in strong AI

- Classical (predicate) logic captures human intelligence, but its learning algorithm (inductive logic programming, based on discrete, combinatorial search) is *too slow*.
- Deep learning is fast but we don't know how to design *neural representations*.



(1)

The problem with predicate logic

$$\forall x, y, z.\ \text{father}(x, y) \wedge \text{father}(y, z) \rightarrow \text{grandfather}(x, z) \tag{2}$$

- This involves **variable substitutions** which are troublesome to handle with neural networks.
  (The difficulty seems to come from the cylindric-algebraic structure of predicate logic: if a formula have variables $x_1, x_2, x_3, ...$, we would need to consider the domain $D \times D \times D \times ...$ where $D \ni x_i$)

Relation algebra

Given that:

$$\text{Father} \circ \text{Father} = \text{Grandfather} \tag{3}$$

we can deduce:

$$\text{john Father paul} \tag{4}$$

$$\text{paul Father pete} \tag{5}$$

$$\Rightarrow \text{john Father} \circ \text{Father pete} \tag{6}$$

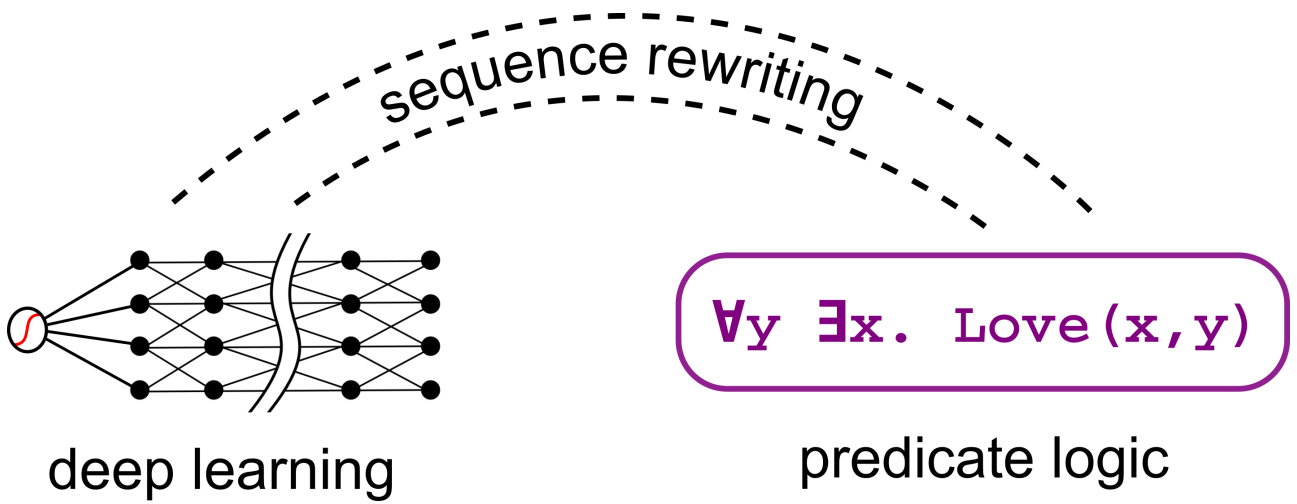
$$\Rightarrow \text{john Grandfather pete} \tag{7}$$

via *direct* substitution of equal terms.

- Relation algebra appears very *natural* and similar to human thinking

The solution: term rewriting systems

- The essence of relation algebra seems to be **sequence-rewriting** (though relation algebra has other operations)
- I believe sequence-rewriting is the missing link between "neural" and logic.



(8)

Sequence to sequence

Sequence to sequence:

$$\boxed{A}\boxed{B}\boxed{C}\boxed{D} \rightarrow \boxed{X}\boxed{Y}\boxed{Z} \tag{9}$$

Sequence-of-sequences to sequence:

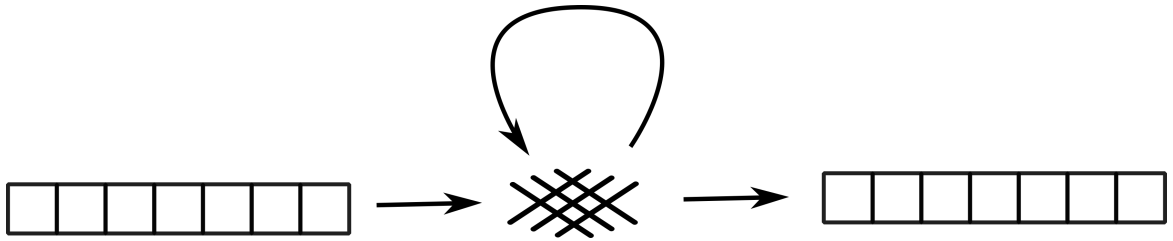
$$\boxed{A}\boxed{B}\boxed{C}\boxed{D} \wedge \boxed{E}\boxed{F}\boxed{G} \rightarrow \boxed{X}\boxed{Y}\boxed{Z} \tag{10}$$

Note the similarity between (10) and *logical reasoning*.

- We already know that RNN is good at sequence-to-sequence processing
- How to design RNN to do sequence-of-sequences-to-sequence?

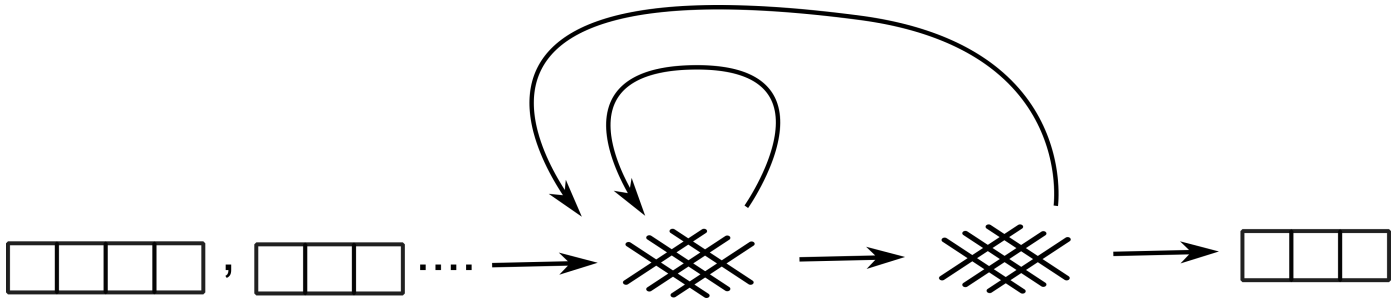
RNN for seq-of-seqs-2-seq

I'm not 100% sure if it would work, but this is one idea:
Sequence to sequence:



(11)

Sequence-of-sequences to sequence:



(12)

It may look simple, but I think the RNN architecture (12) is sufficient for AGI. We're looking for Tensorflow developers to implement a prototype.

Thank you