#### AGI 的一些基本概念

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## Talk summary

- ① 什么是 inductive bias ?「没有免费午餐」
- ② 神经网络 的 力量 来自什么?
- ③ Turing 机 与 逻辑 的 宇宙性
- 经典逻辑 AI 系统 的 基本结构

# 什么是 inductive bias ?「没有 免费午餐」

# 机器学习 的 目的

- 机器学习的目的,是在某些「学习机器」的空间中,搜寻符合要求的某些机器
- 例如在所有给定大小的神经网络中,搜寻符合 目标函数 的那些神经网络的weights

#### Al Winter

- 一般来说, AI 的 樽颈问题 就是 搜寻空间 太大, 导致 学习 太慢
- 历史上「AI 寒冬」出现的原因,是因为 基於逻辑 的学习方法,导致 搜寻空间 的 组合数量爆炸,而没有很好的 heuristic (算法窍门)

# Inductive bias (归纳偏好)

• 每种学习方法都有它的 归纳偏好

### 一粒神经元

● 一粒神经元 就是 一个 dot product 接著 一个 非线性函数:

$$\bigcirc\langle x, w \rangle$$
 (1)

• 这非线性函数 可以有很多种, 例如:

$$O(\xi) = \frac{1}{1 + e^{-\xi}}$$
 (2)

#### 一层神经元

一层神经元 是 一个 matrix multiplication:

$$\mathcal{O}(W \cdot \boldsymbol{x}) \tag{3}$$

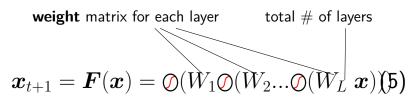
#### 一个神经网络

• 一个神经网络 是很多 层 的函数 composition  $f \circ f$ :

$$[\mathcal{O}W]^L x$$
 (4)

#### Neural network

 A neural network is a generic function with a large number of parameters called weights:



• *(*) is the **sigmoid** function applied *component-wise* to the vector *x*:

# "Unreasonable" effectiveness of neural networks

 If ① is replaced by polynomial, degree of the composite function increases
exponentially as # layers increase

# Optimization over logic formulas

 For example, the logic rule "'love and not loved back ⇒ unhappy" performs the rewriting of the following sub-graph:

$$\rightarrow$$
 (7)

• This is the **state transition**  $\vec{u}: \vec{x} \mapsto \vec{x}'$ , which can also be regarded as the **logical inference**  $\vec{u} : \vec{v} \vdash \vec{x}'$ , where  $\vec{u}$  is the

rewriting function or logic rule

# The problem with predicate logic

$$\forall x, y, z. \; \mathsf{father}(x, y) \land \mathsf{father}(y, z) \to \mathsf{grandfather}(x)$$
 (8)

 This involves variable substitutions which are troublesome to handle with neural networks.

(The difficulty seems to come from the cylindric-algebraic structure of predicate

ic if a formula have variables

#### Relation algebra

#### Given that:

Father 
$$\circ$$
 Father = Grandfather (9)

we can deduce:

john Father paul(10)paul Father pete(11)
$$\Rightarrow$$
 john Father  $\circ$  Father pete(12) $\Rightarrow$  john Grandfather pete(13)

via direct substitution of equal terms.

We're looking for developers to implement a prototype.

### Thank you