Reinterpreting The Cortical Circuit

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Whole Brain Architecture Initiative

The Whole Brain Architecture Initiative, a specified non-profit organization

http://wba-initiative.org/

Uniformity of the neocortex is the basis for human versatility





c.f. : http://bio1152.nicerweb.com/Locked/media/ ch48/48_27HumanCerebralCortex.jpg

Various functions are realized on an anatomically uniform structure







<u>Importance</u>:

The versatility of human intelligence comes from the uniform local circuit of the neocortex.

• Feasibility:

Recent progress in neuroscience and machine learning is making this reinterpretation more likely

• <u>Aim:</u>

To suggest a domain model that machine learning experts can understand and invite them to contribute to AGI research.



Can brain functions be implemented on ANNs?



- (1) Canonical cortical circuits are gradually being unveiled (2) Some cognitive functions are being implemented on artificial neural networks (ANNs)
- (1) & (2) can be combined 3)



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A rough sketch of the entire brain architecture







Reinterpretation of the cortical circuits







Bottom-up direct paths used by CNN





Major pathways

- bottom-up direct path ← already described
- bottom-up indirect path

- top-down direct path #1
- top-down direct path #2
- top-down direct path #3



Defining the canonical cortical circuit framework

- ((j))
- Standard I / O semantics of neocortical local circuits
 - Integrate neuroscientific findings
 - Output is organized by layer
 - Input is organized from the nature of source
 - Semantics understandable by machine learning specialists



- Function of neocortical local circuits
 - Functions of intelligent agents to be carried out by neocortex
 - Functions suffered by damage of neocortex
 - Functions that cannot bear by other brain organs
 - To be consistent with existing neocortical computational models
 - E.g. visual object recognition



Referred models and descriptions







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				Neuroscientific knowledge			Various artificial neural network models							
		I / O semantics / functions	Ideal NMA	AGI.io	Bayesian filter hypothesi s	Cognitive consillienc e	PredNet	НТМ	BESOM	Stacked Auto Encoder	Ladder Net	CNN	Frontal cortex for PBWM	
I/0s		Hierarchy	~	~	~	N/A	~	TBI	~	~	~	~	N/A	
	Input1	Control	~	~	~	~	-	-	-	-	-	-	~	
	Input2	Hidden state output control	~	~	-	~	-	-	-	-	-	-	~	
	Input3	State (top down)	~	~	-	~	~	~	~	~	~	-		
	Input4	State (bottom up)	~	>	~	~	~	~	~	~	~	~	~	
	Input5	Hidden state (bottom up)	<	~	~	 ✓ 	-	~	-	-	-	-	_	
	Output1	Control	~	~	~	~	-	-	_	-	-	-	-	
	Output2	Hidden state	~	~	~	~	-	~	_	-	-	-	~	
	Output3	Control	~	~	-	 ✓ 	~	~	~	~	~	~	-	
Functions	Unsuper vised learning	Time series prediction	~	- N/A	N/A	N/A	~	~	_	-	-	-	- N/A	
		Disentangle / Orthogonalizat	~				-	-	~	-	D/J	-		
		Categorization	~				_	D/J	~	~	-	_		
		Dimension reduction	~				~	-	~	~	~	~		
		Sparse representation	~				~	~	~	D/J	~	-		
		Maintain simple state	~				~	-	-	-	-	-		
	Internal state	Finite state machine	~				~	~	_	-	-	-		
		Pushdown automaton	~				D/J	_	_	_	_	_		
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- Project AGI [Kowadlo 15, Kowadlo 16] was a relatively comprehensive description
 - It was consistent with many other models
 - We had to adjust the input from the thalamus slightly
- The Bayesian filter has low coverage but conservative
- In Kawaguchi hypothesis, the description of L5 was detailed and consistent with others

There exist feed-back loops between L2 / 3 and L5

• Most of these were consistent with the neuroscience findings of Cognitive consilience





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		Hierarchy	~	~	~	N/A	~	TBI	~	~	 ✓ 	~	N/A	
	Input1	Control	~	~	~	~	-	-	-	-	-	-	~	
	Input2	Hidden state output control	~	~	-	~	-	-	-	-	-	-	~	
S	Input3	State (top down)	~	~	-	~	~	~	~	~	~	-	_	
$\overline{0}$	Input4	State (bottom up)	~	~	~	~	~	~	~	~	~	>	~	
Ĥ	Input5	Hidden state (bottom up)	~	~	~	~	-	~	-	-	-	-	-	
	Output1	Control	~	~	~	~	-	-	-	-	-	-	-	
	Output2	Hidden state	~	~	~	~	-	~	_	-	-	_	~	
	Output3	Control	~	~	-	~	~	~	~	~	~	~	-	
	Unsuper vised learning	Time series prediction	~	N/A	N/A	N/A	~	~	-	-	_	_	- N/A	
		Disentangle / Orthogonalizat	~				-	-	~	-	D/J	-		
ns		Categorization	~				-	D/J	~	~	_	_		
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Ц	Internal state	Maintain simple state	~				~	-	-	-	_	_		
		Finite state machine	~				~	~	-	-	_	_		
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							TBI	To be imple	emented					



Whole Brain Architecture approach @ WBAI 📖 🍕

'to create a human-like AGI by learning from the architecture of the entire brain'



To reach AGI, we start from mimicking highlevel architectures of the brain, and gradually introduce details as needed



Open platform strategy @ WBAI mpo





Integration : A brain-inspired architecture platform for integrating machine learning modules

<u>Catch-up:</u>

An open technician community that can implement the cutting-edge machine leanings in a short term





Open Platform Strategy @WBAI mpo



Let's build a brain, together



To "harmonize AGI with human beings" by democratizing AI technologies

(c.f. "Common goods": Asiloma AI Principle 23)



Standardization trend in progress



One Model To Learn Them All (Google, 16 Jun 2017)

TASKS:

- (1) WSJ speech corpus
- (2) ImageNet dataset
- (3) COCO image captioning dataset
- (4) WSJ parsing dataset
- (5) WMT English-German translation corpus
- (6) The reverse of the above: German-English translation.
- (7) WMT English-French translation corpus
- (8) The reverse of the above: German–French translation.

KEY: (1) Convolutions. (2) Attention (3) Sparsely-gated mixture-of-experts





Our message



- ✓ Definition and implementation of the canonical neocortical circuit is an important landmark for brain-inspired AGI.
- ✓ We proposed a framework that can be understandable by ML experts while maintaining neurobiological accuracy.
- We believe that the brain-inspired approach will harmonize AGI with mankind, and established a non-profit organization to develop an open-platform for co-creation of brain-inspired AGI.
- If you are interested in our research and activities, please contact us.
 Positions available: Posdocs/Students





We promote open co-creation of AGI on Brain



