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Are Al's Key Challenges Solved?

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Artificial Intelligence in 2023

ChatGPT Large-Language Model. Trained on text from WWW. Answers questions effectively across many topics.

Turing Test Informal claims that ChatGPT passes the Turing Test (or the Imitation Game) from Alan Turing's 1950 paper.

Unsolved Challenge Can AI systems invent or discover novel entities and relationships which explain new observed phenomena in Science, Engineering and Mathematics?

Founders of Artificial Intelligence



Alan Turing 1912-1954



John McCarthy 1927-2011 Turing (Mind, 1950) Section 7 - Learning Machines The challenge of "Supercriticality" in Al

Supercriticality - analogy nuclear chain reaction One could say that a man can "inject" an idea into the machine, and that it will respond to a certain extent and then drop into quiescence, like a piano string struck by a hammer. .. An idea presented to a subcritical mind will on average give rise to less than one idea in reply. A smallish proportion are supercritical. An idea presented to such a mind may give rise to a whole "theory" consisting of secondary, tertiary and more remote ideas. Animals' minds seem to be very definitely subcritical. Adhering to this analogy we ask, "Can a machine be made to be supercritical?"

McCarthy (ILP06, 2006) Appearance and Reality

Machine discovery Some scientific discoveries like Galileo's $s = \frac{1}{2} gt^2$ involve discovering the relations between known entities. Patrick Langley's Bacon program did that. John Dalton's postulation of atoms and molecules made up of fixed numbers of atoms of two or more kinds was much more creative and will be harder to make computers do. .. Reality is usually more stable than appearance, i.e. changes more slowly. .. Geologists, oil companies, and astronomers are faced with inverse problems. Their solution is intellectually difficult and computationally intensive. Human-level AI systems will also have to be able to infer reality from appearances related to them in complex ways.

Science: McCarthy's Discovery Challenge

Entities Atom, Electron, Nucleus, Neutrino, Radio Wave, Planet, Crater, Galaxy, Dark matter, Gene, Species, Tectonic plate, Geological Layer, Ionosphere.

Relations Force, Pressure, Voltage, Distance, Speed, Acceleration, Genetic inheritance, Predation, Electromagnetic induction.

Engineering: McCarthy's Discovery Challenge

Entities Bridge, Canal, Steam engine, Aeroplane, Turbine, Computer, Information

Relations Support, Traction, Relative efficiency, Relative safety, Relative information Electromagnetic induction.

Mathematics: McCarthy's Discovery Challenge

Entities Number, Set, Group, Function, Line, Polygon, Matrix, Lattice, Graph

Relations Square-root, Ordering, Homomorphism, Subset, Equivalence

Towards Turing's Supercriticality? DeepLog (ProcRoySocA, 2023) Reverse Uppercase

	Concept	Input Example	Bac	Background Concepts		
	rvup	$\langle a,I,i,c,e angle ightarrow \langle E,C,I,L,A angle$	Lib	orary 63 primitives		
Οι	utput Hypot	hesis H [5]	Evaluation			
rvı	up(X,Y) :- c	all1(X,Z), $rvup_1(Z,Y)$.	Time = 0.21s/0.65s			
rvı	up_1(X,Y) :-	$pop(X,Z), rvup_1_1(Z,Y).$	$g(H) = \frac{1}{7740} \approx 0.0001$			
rvup_1_1(X,Y) :- upc(X,Z), rvup_1_1(Z,Y).						
rvı	up_1_1_1(X,	Y) :- push(X,Z), return1(Z	$-ln \ p(H E) = 24.01$			
rvup_1_1_1(X,Y) :- push(X,Z), rvup_1(Z,Y).				EA(H) > 99.94%		

Towards	McCarthy's	Challenge -	Regular	Grammar
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Concept	Input Example	Background Concepts	
abc4	$\langle a,b,c,d,e,f,c,d,e,f,g,h angle ightarrow \langle angle$	Library 63 primitives	
Output Hyp	othesis H [7]	Evaluation	
abc4(X,Y)	- a(X,Z), abc4_1(Z,Y).	Time = 0.15s/0.56s	
abc4_1(X,Y	′) :- b(X,Z), abc4_1_1(Z,Y).		
abc4_1_1(X	(,Y) :- g(X,Z), h(Z,Y).	$g(H) = \frac{1}{1080} \approx 0.0009$	
abc4_1_1(X	(,Y) :- cdef(X,Z), abc4_1_1(Z,Y)		
Introduced	Auxiliaries [3]	$-ln \ p(H E) = 17.97$	
cdef(X,Y) :-	-cd(X,Z), ef(Z,Y).		
cd(X,Y) :- c	d(X,Z), d(Z,Y).	EA(H) > 99.57%	
ef(X,Y) :- e	(X,Z), f(Z,Y).		

Conclusions

Turing Supercriticality Challenge

McCarthy Appearance and Reality Challenge

Relevant Areas Fundamental Concepts in Science, Engineering and Mathematics

Discoveries Thousands of hidden entities and relationsips discovered over last 200 years. All by human beings.

Automated Discoveries in ongoing Science, Engineering and Maths

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