

Artificial General Intelligence

Jay Urbain, PhD

Credits:

First International Summer School on Artificial
General Intelligence

Artificial General Intelligence (AGI)

“The ability to achieve complex goals in complex environments using limited computational resources”

- Autonomy
- Practical understanding of self and others
- Understanding “what the problem is” as opposed to just solving problems posed explicitly by programmers

Narrow AI

The vast majority of AI research practiced in academia and industry today fits into the “Narrow AI” category

Each “Narrow AI” program is (in the ideal case) highly competent at carrying out certain complex goals in certain environments

- Chess-playing, medical diagnosis, car-driving, etc.



agi-09.org

AGI-08:

Memphis

AGI-09:

Washington DC

AGI-10:

Lugano
(Switzerland)

AGI-11:

Silicon Valley

AGI-12:

Asia?

In the last few years, there have been an increasing number of workshops, symposia, conference sessions and conferences on AGI.

OpenCog.org

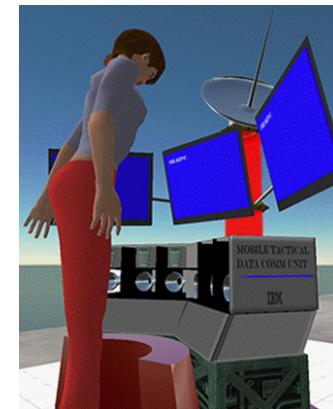
An open-source AGI framework, launched in 2008

Sponsored initially by Novamente LLC and Singularity Institute for AI

Seeded with key software components from the Novamente Cognition Engine (a proprietary AI system)

Intended to support flexible, open-ended development of various AI components (learning, reasoning, perception, action, representation, etc.) in an integrative-AGI context

Integration with Multiverse and RealXTend (OpenSim) for virtual embodiment



AI and AGI: Past, Present and Future





Alan Turing



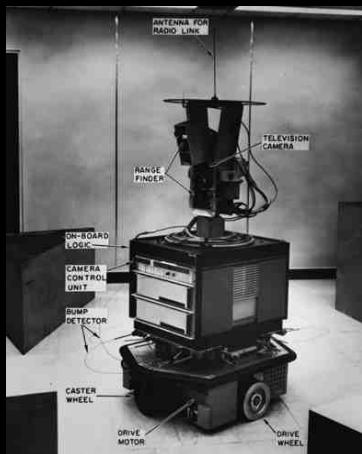
Arthur Samuel

1950 – Alan Turing proposes a test for machine intelligence

1956 – John McCarthy coins the term “artificial intelligence”

1959 – Arthur Samuel’s checkers program wins games against the best human players

1962 – First industrial robot company, Unimation, founded



Shakey



John McCarthy

1967 – “HAL” stars in “2001: A Space Odyssey”

1969 – Stanford Research Institute: *Shakey the Robot* demonstrated combining movement, perception and problem solving



Terry Winograd



Connection
Machine



John Holland



Doug Lenat

1971 – Terry Winograd's PhD thesis (M.I.T.) demonstrated the ability of computers to understand English sentences in a restricted world of children's blocks

1975 - John Holland's book *Adaptation in Natural and Artificial Systems* formalizes and popularizes evolutionary algorithms

1982 - Doug Lenat's self-modifying heuristic AI program EURISKO wins the Traveler TCS contest the second year in a row

1983 - Danny Hillis co-founded Thinking Machines Corporation during his doctoral work at MIT. The company was to develop Hillis' Connection Machine design into a commercial parallel supercomputer line.



Google's First Server



Gulf War



Deep Blue



Creature from
Black & White

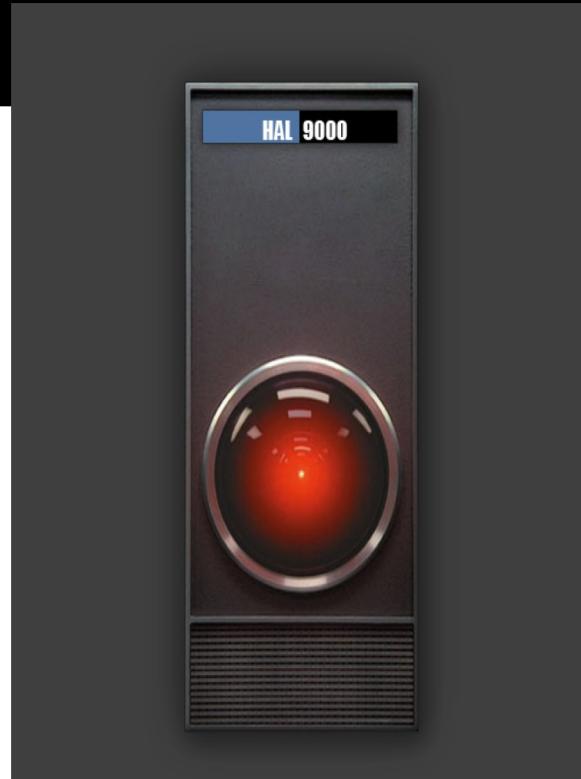
1990-91 – AI technology plays a key role in the Gulf War, from automated co-pilots and cruise missiles, to overall battle coordination, and more

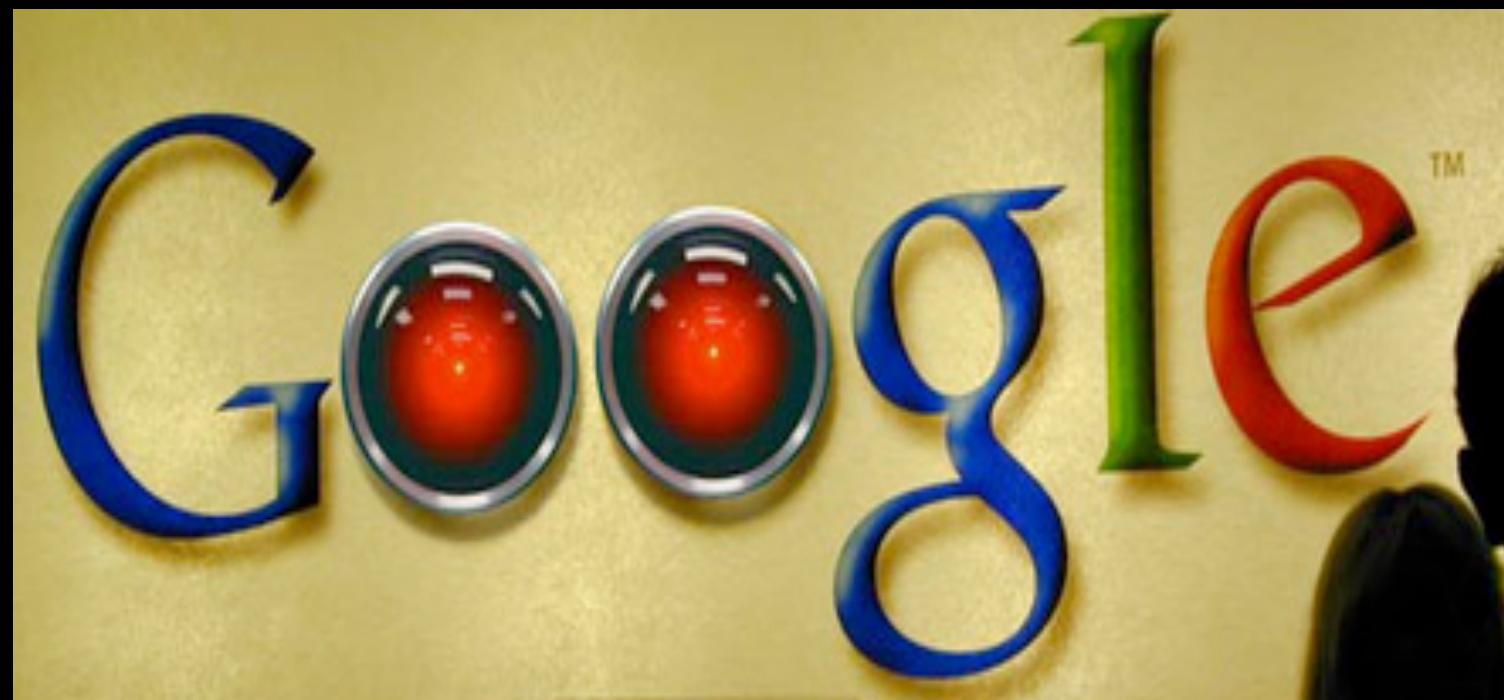
1997 – IBM supercomputer Deep Blue defeats world chess champion Garry Kasparov in a 6-game match

1998 -present -- Google leverages an increasing arsenal of narrow-AI technologies to provide commercially successful Web search and ad delivery

2001 - Lionhead Studio releases Black and White, a popular videogame in which players teach AI-controlled creatures using imitative and reinforcement learning

2001





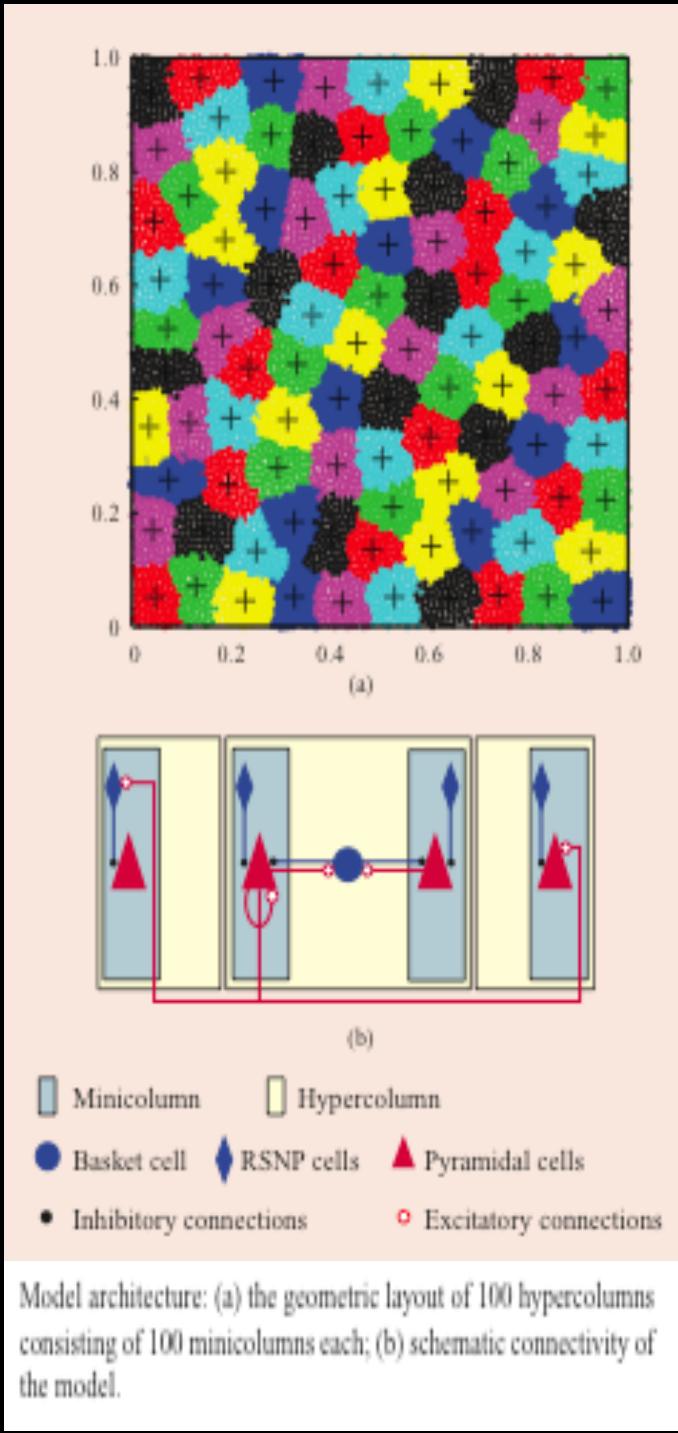
Lots of real-world achievements

Lots of deep, fascinating ideas

Nothing close to a consensus on the right path
to human-level AGI

In many cases, AGI visions have given way to
narrow-AI successes





Brain-scale simulation of the neocortex on the IBM Blue Gene/L supercomputer

On the neuro side, we've come a long way since McCullough and Pitts...

We can simulate a lot of spiking neurons -- but we don't know how to connect them to yield intelligent behavior.

Today, Narrow AI Dominates the AI Field (in both academia and applications)



Deep Blue - whoops us pesky humans at chess - but can't learn to play a new game based on a description of the game rules



DARPA Grand Challenge - a great leap forward -- but it can't learn to drive different types of vehicles besides cars (trucks, boats, motorcycles)



Google - fantastic service: but can't answer complex questions. Whatever happened to AskJeeves?



how many years does a pig live?

Search

Advanced Search
Preferences

Web

Results 1 - 10 of about 2,110,000 for how many years does a pig live? (0.31 seconds)

[1 Human year equals how many Guinea Pig years? - Yahoo! Answers](#)

2 answers - My guinea pig is a close to 1 and half years old, and I know they don't live very long, but how many years is that for a guinea pig?

answers.yahoo.com/question/index?qid=20070929111834AAa482G - 53k -

[Cached](#) · [Similar pages](#) · [Note this](#)

[Pork Checkoff - Pork 4 Kids - Ask A Farmer](#)

In fact, some pigs have lived as long as 15 years! Q: How many pigs does it ... Q: How much food does a pig eat in a day, and how much does the food cost? ...

www.pork4kids.com/AskAFarmer.aspx - 39k - [Cached](#) · [Similar pages](#) · [Note this](#)

[how long does a pig live and what is the record for the longest...](#)

how long does a pig live and what is the record for the longest life span of a ... The lifespan on the average pig is now considered to be 12 - 15 years. ...

www.geek.com/other/246-geek.html - 6k - [Cached](#) · [Similar pages](#) · [Note this](#)

[Pot Bellied Pigs -animal care, caging, habitats and feeding](#)

The amount of rooting that a potbellied pig does can be caused by many Potbellied pet pigs are estimated to live from 15 to 20 years assuming they ...

www.animalsexotique.com/pot_bellied_pigs.html - 29k - [Cached](#) · [Similar pages](#) · [Note this](#)



how many years does a dead pig live?

Search

[Advanced Search
Preferences](#)

Web

Personalized Results 1 - 10 of about 1,930,000 for **how many years** does a **dead pig live**?

[PETA Protests Nude Artist Performing With Dead Pig](#)

What they see is Kira O'Reilly sitting in a bed naked with a **dead pig** in her I have been a PETA member for many, many years. Over those years I have ...

blogcritics.org/archives/2006/08/21/000343.php • 68k • Cached • [Similar pages](#) • [Note this](#)

[Marcus Aurelius: The Meditations](#)

So think it no great thing to die after as **many years** as you can count rather ... the **dead body** of a fish, and this is the **dead body** of a bird or of a **pig**; ...

www.wsu.edu/~wldchv/world_civ_reader/world_civ_reader_1/aurelius.html • 13k •
Cached • [Similar pages](#) • [Note this](#)

["The Only Good Pig Is a Dead Pig": A Black Panther Paper Editor...](#)

Does the Black Panther Party encourage members of the black community to possess "The only good pig, is a **dead pig**," and here it is in the so-called ...

historymatters.gmu.edu/d/6460/ • 31k • Cached • [Similar pages](#) • [Note this](#)

[Internet Archive: Details: Grateful Dead Live at Fillmore ...](#)

Subject: Great after so **many years** I wanna be back to the **years**. Great music, great beatyfull Great old vintage Grateful Dead. Pig Pen at his finest. ...

www.archive.org/details/gd06-11-19.sbd.self.41.sbook.shrf • 34k •
Cached • [Similar pages](#) • [Note this](#)



how many years does a pig live in captivity?

Search

Advanced Search
Preferences

Web

Personalized Results 1 - 10 of about 202,000 for how many years does a pig live in captivity?.

[How Long Does A Gray Wolf Live? - Science Fact Finder](#)

The gray wolf (*Canis lupus*), also known as the timber wolf, lives for less than 10 years in the wild but can live for up to 20 years in captivity. ...

www.enotes.com/science-fact-finder/animal-world/how-long-does-gray-wolf-live - 23k ·
[Cached](#) · [Similar pages](#) · [Note this](#)

[Trivia](#)

How much does one gallon of water weigh? 8.34 pounds How many gallons of water ... carp lives up to 25 years in the wild, and up to 40 years in captivity. ...

ct.water.usgs.gov/education/trivia.htm - 27k · [Cached](#) · [Similar pages](#) · [Note this](#)

[Alligator Trivia - Can You Tell the Tail?](#)

Approximately how many years does the typical American Alligator live? a. 150 years in captivity, 100 in the wild b. 15 years in captivity, 10 in the wild ...

ezinearticles.com/?Alligator-Trivia—Can-You-Tell-the-Tail?&id=631275 - 38k ·
[Cached](#) · [Similar pages](#) · [Note this](#)

[AT WHAT TIME IN LIFE DOES AN ANIMAL GROW OLD?: The Killing of Two ...](#)

Jewel, Who Is 65 Years Old, live many years. One Indian rhino died in the Paris Italy, there was a fish which lived over 60 years in captivity. ...

query.nytimes.com/gst/abstract.html?res=FA0B16FE3F6517738000AB0994DA406B&sl1=103 - 16k ·
[Cached](#) · [Similar pages](#) · [Note this](#)

[Extreme cuisine: So what does it feel like to eat live octopus ...](#)

Anyway, most octopuses have a life span of less than 5 years, even in captivity, so it's not



"quotes"

Who mocked

?

go

Who mocked Blair ?

 Powerset Results

 It's a Tie

 The Other Guys

 let us know whose results were better before you ask another question 

Powerset Results

② International Moron Patrol

It contains political references, often mocking Tony Blair and George W.Bush, other superhero cameos(such as cameos from the Justice League and Superman in episode 28) and even characters from Disney (A notable one is Winnie the Pooh, who is actually made out to be pure evil in this series, something of a mockery).

② Ken Livingstone

William Hague, then Leader of the Opposition taunted Blair at Prime Minister's Question Time: "Why not split the job in two, with Frank Dobson as your day mayor and Ken Livingstone as your nightmare?"

② The Facts of Life (TV series)

 Comedy Central's Drawn Together parodies Blair and her cousin Geri in an episode entitled "The Other Cousin".

The Other Guys

Yo, Blair - Wikipedia, the free encyclopedia

Yo, Blair! is the title of a polemical 2006 book by Geoffrey Wheatcroft. — Reuters (2006-07-18). Yo Bush! Blair mocked as U.S. poodle. China Daily. —

Criticism of Tony Blair - Wikipedia, the free encyclopedia

The criticism of Tony Blair includes accusations of dishonesty and authoritarianism as well as ... Blair mocked as U.S. poodle Reuters UK 18 July 2006 ...

Get tough on crime - Wikipedia, the free encyclopedia

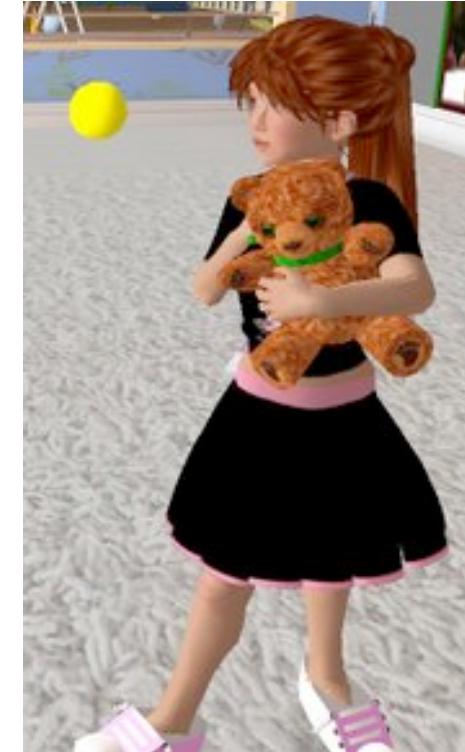
The speech also marked Blair as one of the coming men of the Party. The slogan would later go on to be mocked when crime continued to be rampant. ...

Here Powerset shows off all of the word variation possible around "mock": lampoon, caricature, parody, taunt, impersonators of, etc.

The “Common-sense Bottleneck”

Narrow-AI NLP can't handle

- Parse selection for complex sentences
- Semantic disambiguation beyond nouns and verbs
- Preposition disambiguation
- Reference resolution (esp. nominal)
- Contextual interpretation of comparatives
- Etc.



AI's can't yet pass the “5-year-old child Turing test”

Will Narrow-AI NLP Software Ever Correctly Interpret This Paragraph?

“The world's primary source of caffeine is the coffee bean (the seed of the coffee plant), from which coffee is brewed. Caffeine content in coffee varies widely depending on the type of coffee bean and the method of preparation used; even beans within a given bush can show variations in concentration. In general, one serving of coffee ranges from 40 milligrams, for a single shot (30 milliliters) of arabica-variety espresso, to about 100 milligrams for a cup (120 milliliters) of drip coffee.”

<http://en.wikipedia.org/wiki/Caffeine>

Will Narrow-AI NLP Software Ever Create a Chat Bot that Knows What It's Talking About?

Human: When someone talks to you, do you really understand what they are talking about?

ALICE: That does not happen very often.

Human: What doesn't happen very often?

ALICE: What do you think it does?

Human: Do you mean people don't talk to you much, or that you don't understand them much?

ALICE: Yes, that's what I mean, isn't it clear?

Human: It was an either-or question.

ALICE: How did you feel about that?

Human: Basically emotionally neutral.

ALICE: How interesting. I'm sometimes undecided myself.

Human: What do you do when you're undecided about something?

ALICE: I give the most accurate replies possible.

Human: What if you don't know which reply is most accurate?

ALICE: Try it and see.

Human: Anyway, is accuracy always the most important thing in life?

ALICE: Ask again later. Ask John Lennon if it is.

Human: He's dead.

ALICE: Maybe it's another person using his name.

Human: Why did you bring up John Lennon?

ALICE: Because my programming determined it.

Can Narrow AI Incrementally Lead to General AI?

IMHO, a major lesson from the history of AI is:

Narrow AI success is generally of fairly limited use as a stepping-stone toward AGI success

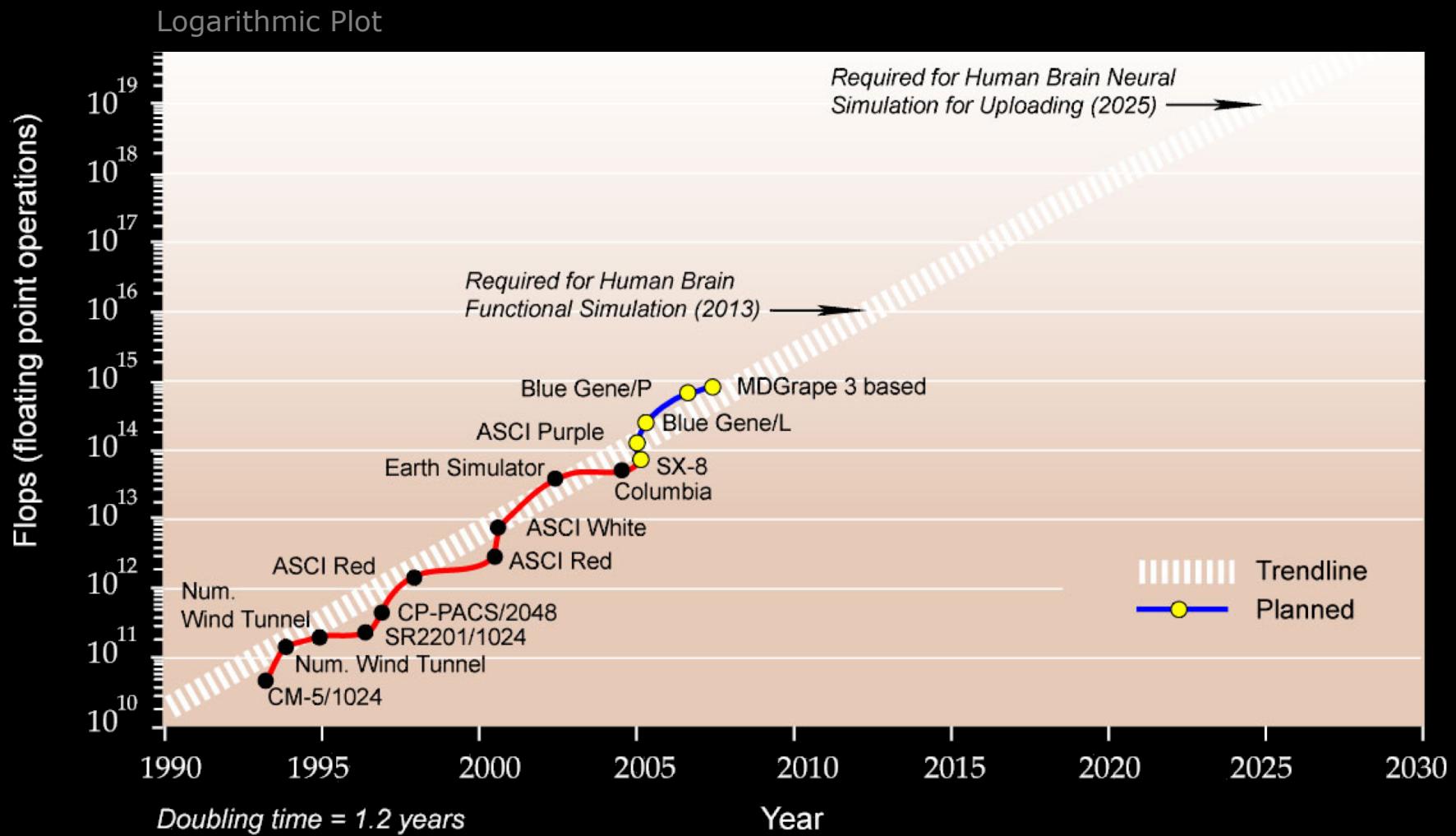
Transferring insight from narrow-AI to AGI involves a whole lot of creative thinking

And some of the key aspects of AGI may not arise in narrow-AI work at all

2009

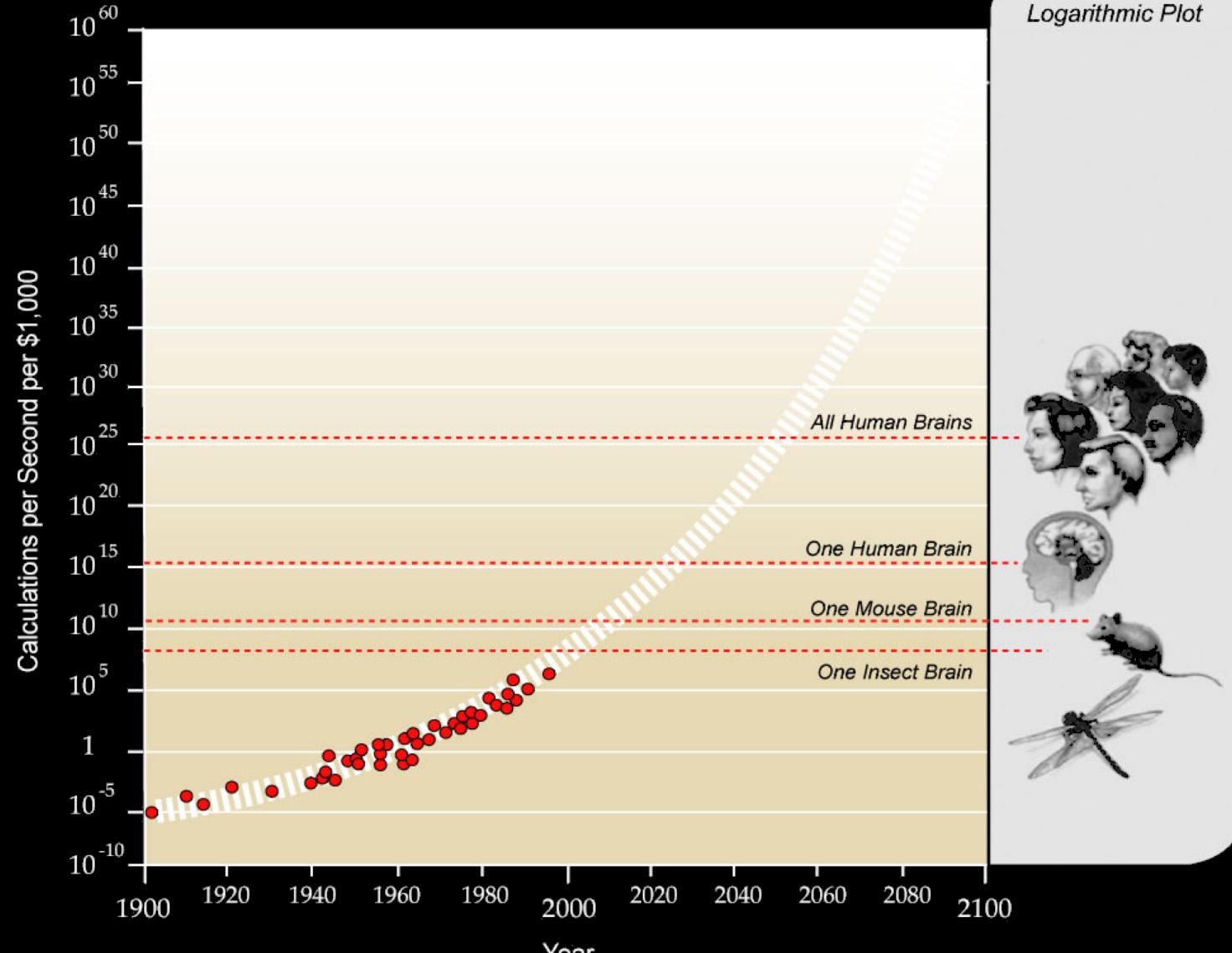
The Technological and Scientific Context
Leaves us Poised for Dramatic AGI Progress

Growth in Supercomputer Power



Credit: Ray Kurzweil

Exponential Growth of Computing



Credit: Ray Kurzweil

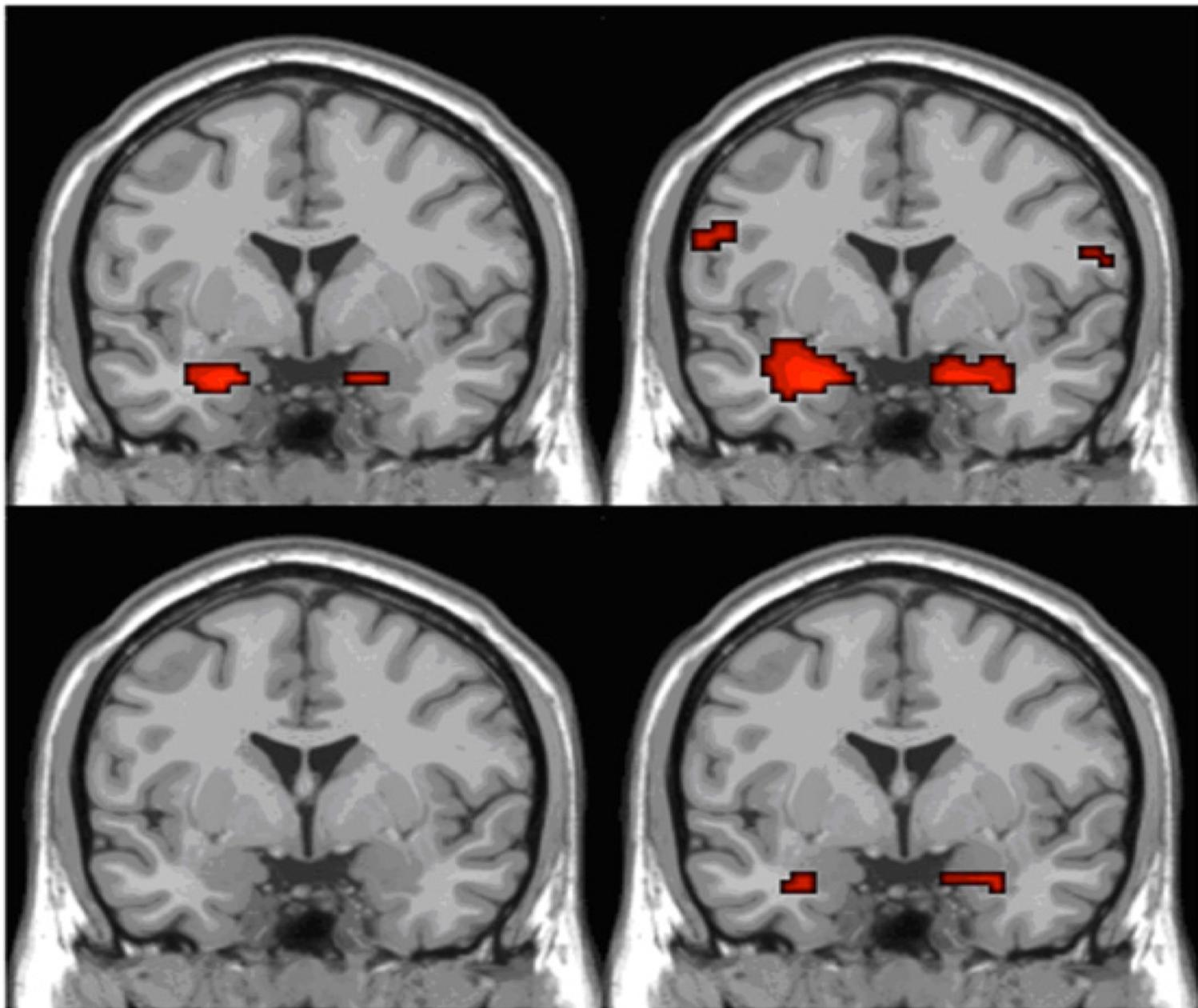


Oxytocin

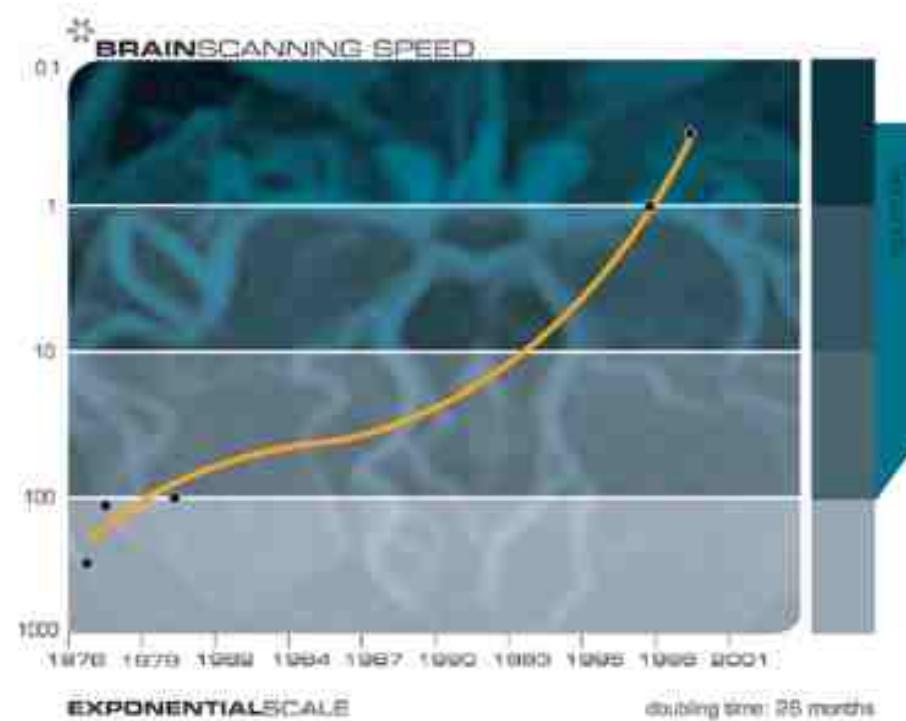
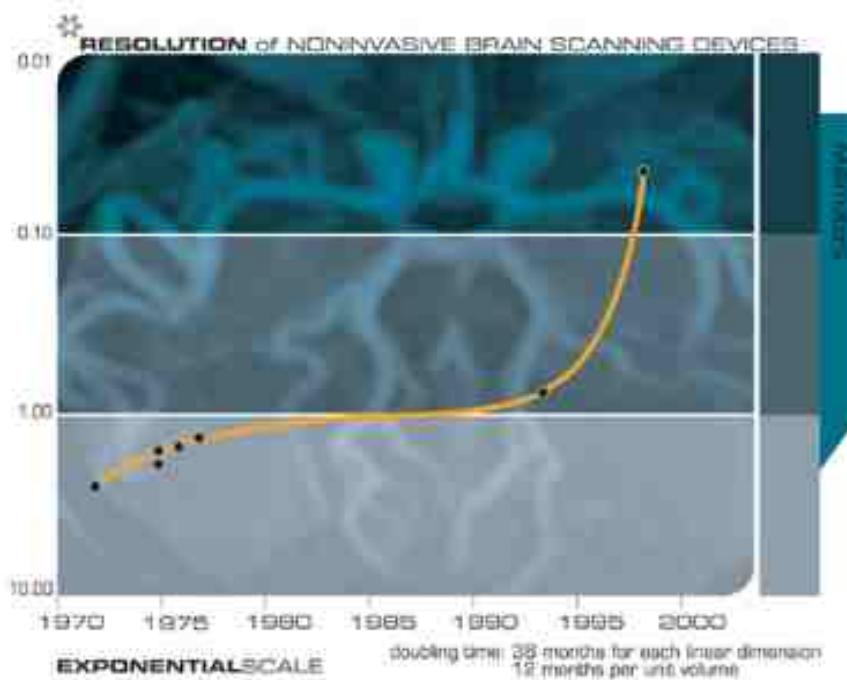
Placebo

faces

scenes



Exponential Improvement of Brain Scanning Technology

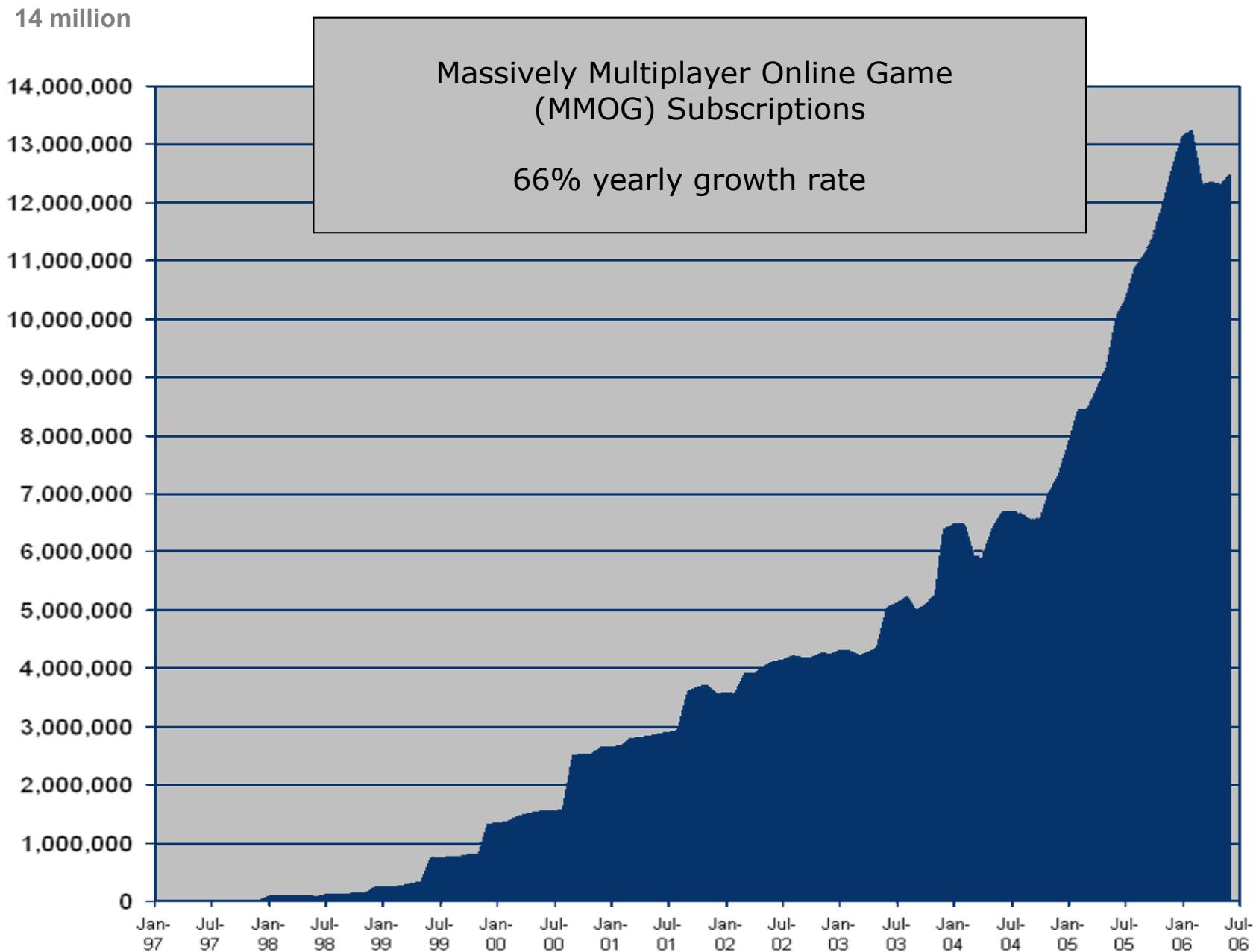


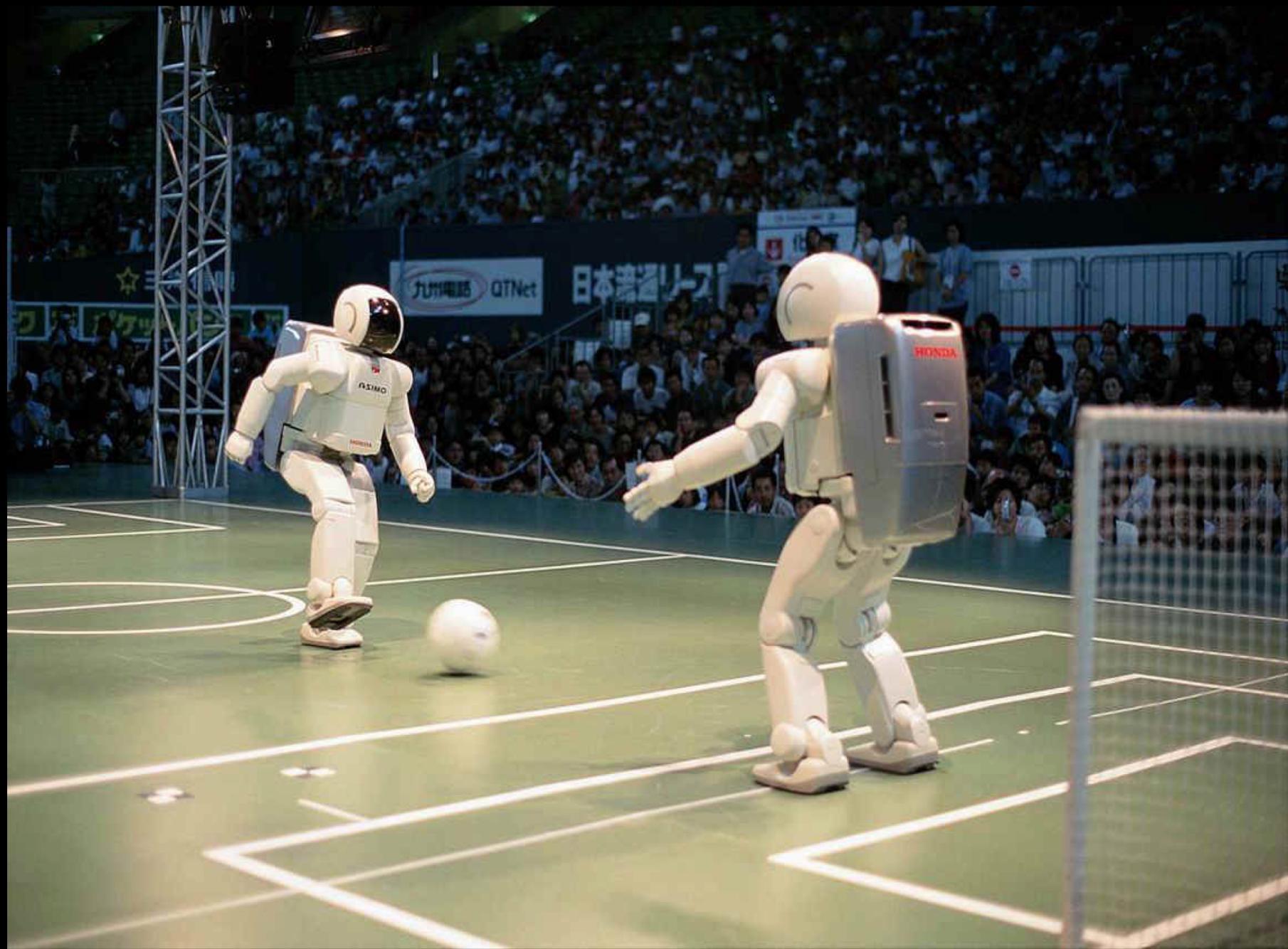


You: Sit!









THE FASTEST AND SHORTEST ALGORITHM FOR ALL WELL-DEFINED PROBLEMS¹

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Key Words

Acceleration, Computational Complexity, Algorithmic Information Theory, Kolmogorov Complexity, Blum's Speed-up Theorem, Levin Search.

Abstract

An algorithm M is described that solves any well-defined problem p as quickly as the fastest algorithm computing a solution to p , save for a factor of 5 and low-order additive terms. M optimally distributes resources between the execution of provably correct p -solving programs and an enumeration of all proofs, including relevant proofs of program correctness and of time bounds on program runtimes. M avoids Blum's speed-up theorem by ignoring programs without correctness proof. M has broader applicability and can be faster than Levin's universal search, the fastest method for inverting functions save for a large multiplicative constant. An extension of Kolmogorov complexity and two novel natural measures of function complexity are used to show that the most efficient program computing some function f is also among the shortest programs provably computing f .

THEOREM 1. Let p^* be a given algorithm computing $p^*(x)$ from x , or, more generally, a specification of a function. Let p be any algorithm, computing provably the same function as p^* with computation time provably bounded by the function $t_p(x)$ for all x . $\text{time}_{t_p}(x)$ is the time needed to compute the time bound $t_p(x)$. Then the algorithm M_{p^*} constructed in Section 4 computes $p^*(x)$ in time

$$\text{time}_{M_{p^*}}(x) \leq 5 \cdot t_p(x) + d_p \cdot \text{time}_{t_p}(x) + c_p$$

with constants c_p and d_p depending on p but not on x . Neither p , t_p , nor the proofs need to be known in advance for the construction of $M_{p^*}(x)$.

THEOREM 2. Let p^* be a given algorithm or formal specification of a function. There exists a program \tilde{p} , provably equivalent to p^* , for which the following holds

- i) $l(\tilde{p}) \leq K''(p^*) + O(1)$
- ii) $\text{time}_{\tilde{p}}(x) \leq 5 \cdot t_p(x) + d_p \cdot \text{time}_{t_p}(x) + c_p$

where p is any program provably equivalent to p^* with computation time provably less than $t_p(x)$. The constants c_p and d_p depend on p but not on x .

To prove the theorem, we just insert the shortest algorithm p' provably equivalent to p^* into M , that is $\tilde{p} := M_{p'}$. As only $O(1)$ instructions are needed to build $M_{p'}$ from p' , $M_{p'}$ has size $l(p') + O(1) = K''(p^*) + O(1)$. The computation time of $M_{p'}$ is the same as of M_{p^*} apart from "slightly" different constants.



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(Switzerland)

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AGI-12:

Asia?

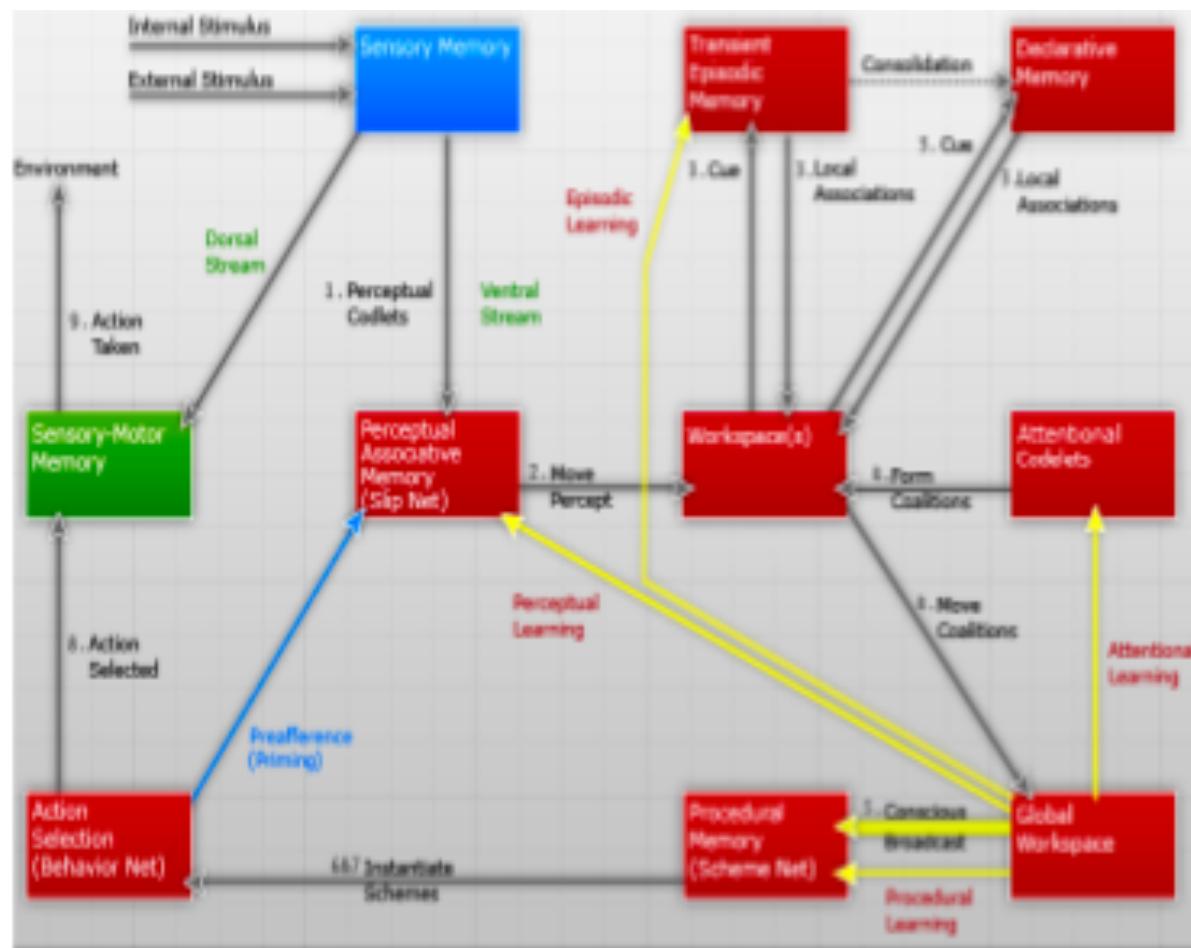
What We Have Now

- Fast computers internetworked
- Decent virtual worlds for AI embodiment
- Halfway-decent robot bodies
- Lots of AI algorithms and representations
 - often useful in specialized areas
 - often not very scalable on their own
- A basic understanding of human cognitive architecture
- A cruder but useful understanding of brain structure and dynamics
- A theoretical understanding of general intelligence under conditions of massive computational resources

Big Questions

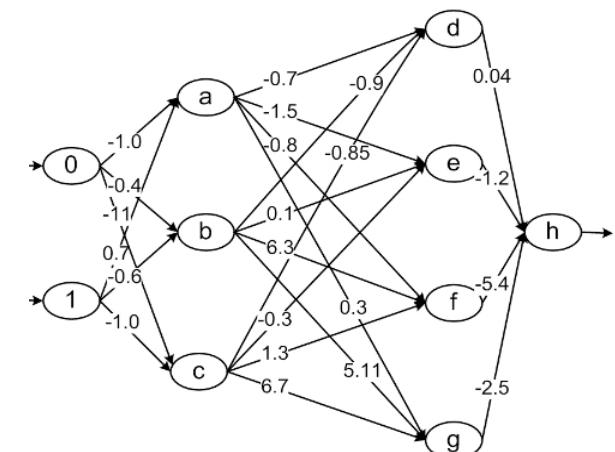
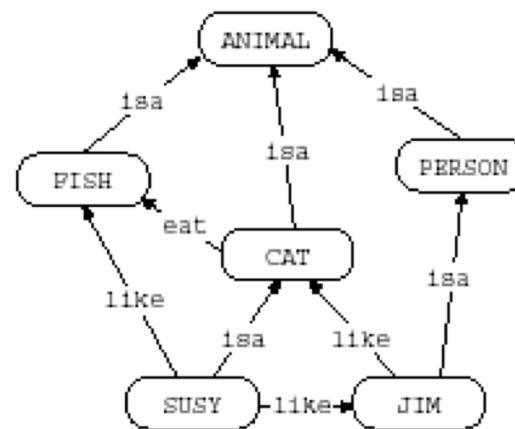
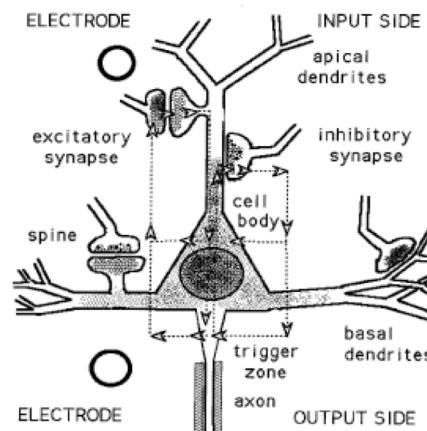
...we may be on the verge of
answering...

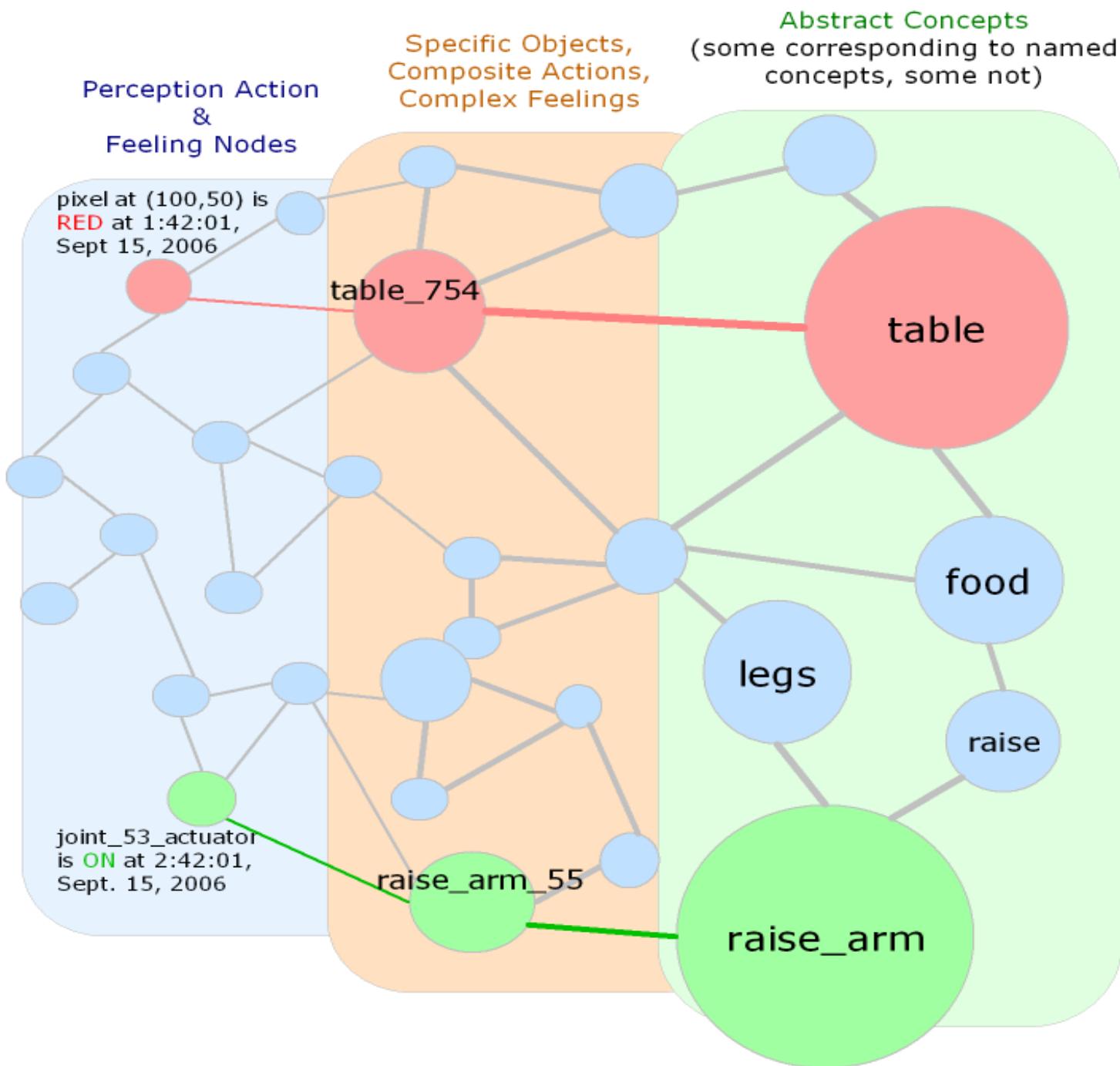
What's a Workable Cognitive Cycle?



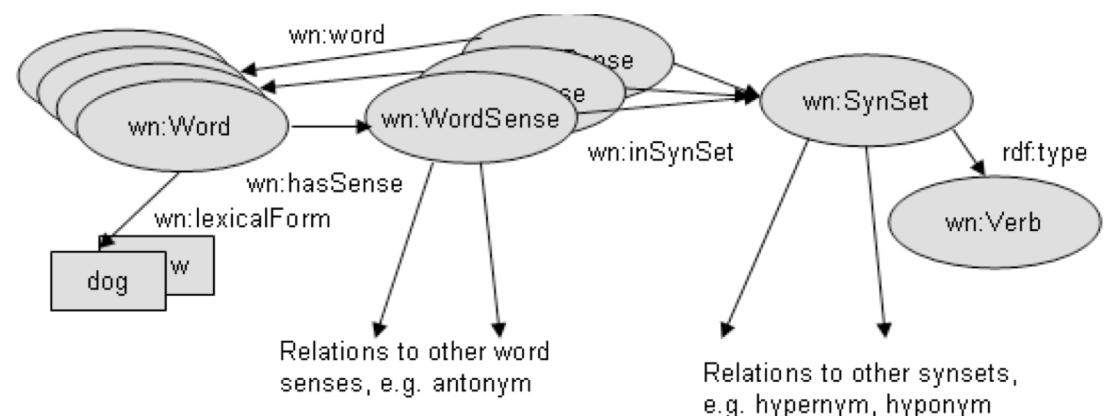
Can Abstract Knowledge Representations Serve As an Adequate Foundation for the Adaptive Creation of Context-Specific Knowledge Representations?

(and if so, what kind?)





Must an AGI Wholly Learn Language, or Can Linguistic Resources, Statistical NLP and Commonsense KB's Help?



Powerset

Google™

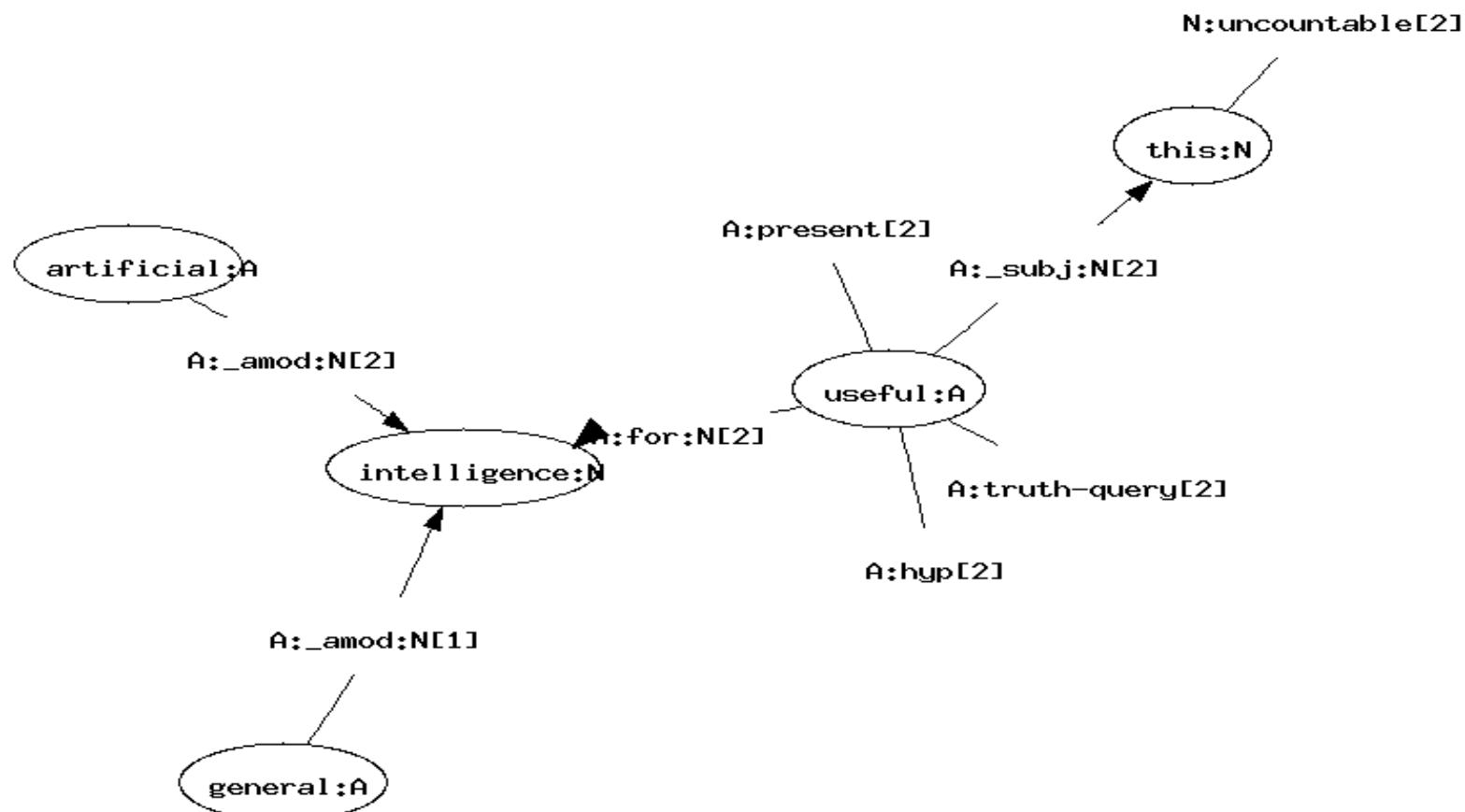
cycorp

```

+-----Xp-----+
|           |
+----Paf----+
|   +---Qd---+SIs*b+
|   |       |
LEFT-WALL is.v this.p useful.a for.p artificial.a general.a intelligence.n ?
|       |       |
+---MVP+-----+
|           |
+-----Jp-----+
|           |
+A-----+
|           |
+A-----+

```

Is this useful for artificial general intelligence?



Questioning:Message(truth-query,useful)

Questioning:Message(truth-query_1,useful)

Existence:Circumstances(truth-query_1,useful)

Existence:Circumstances(truth-query,useful)

Usefulness:Purpose(useful,intelligence)

Usefulness:Entity(useful,this)

Communicate_categorization:Category(general,intelligence)

Communicate_categorization:Item(general,intelligence)

Communicate_categorization:Category(artificial,intelligence)

Communicate_categorization:Item(artificial,intelligence)

What Must a World Be That an AGI Can Develop In It?



Can Logic Serve as a Scalable Foundation for Sensorimotor Learning?

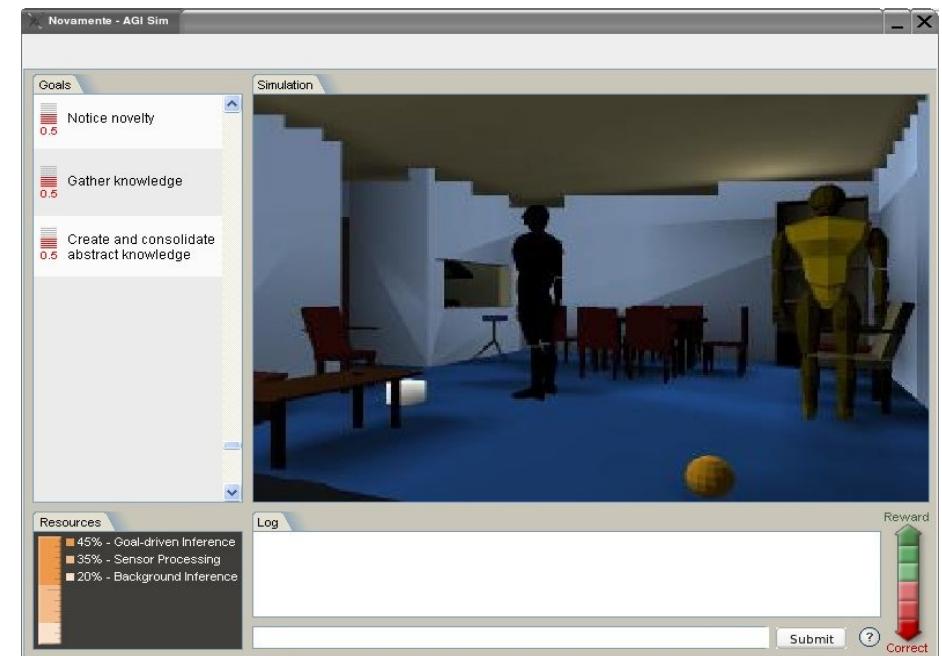
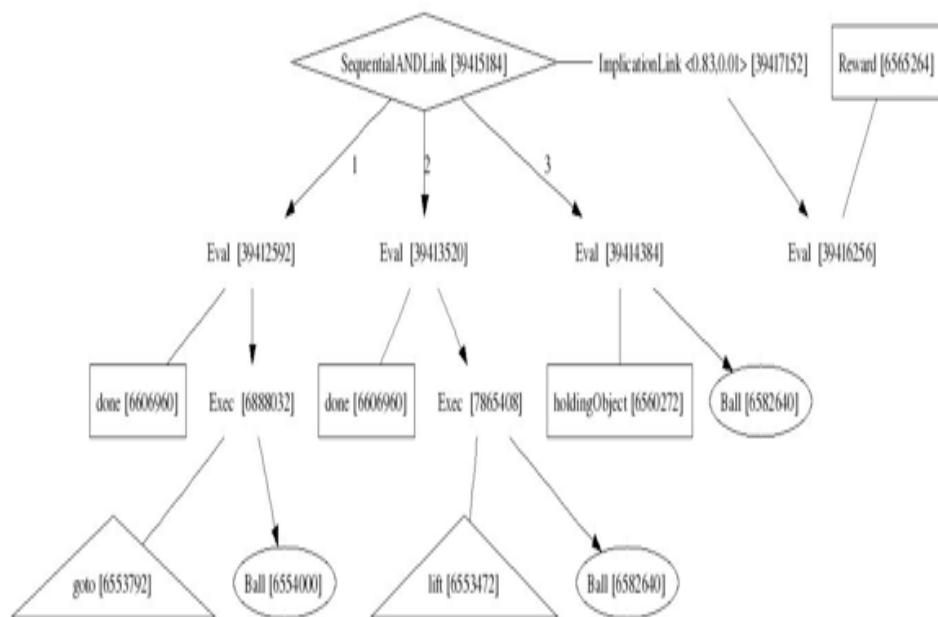
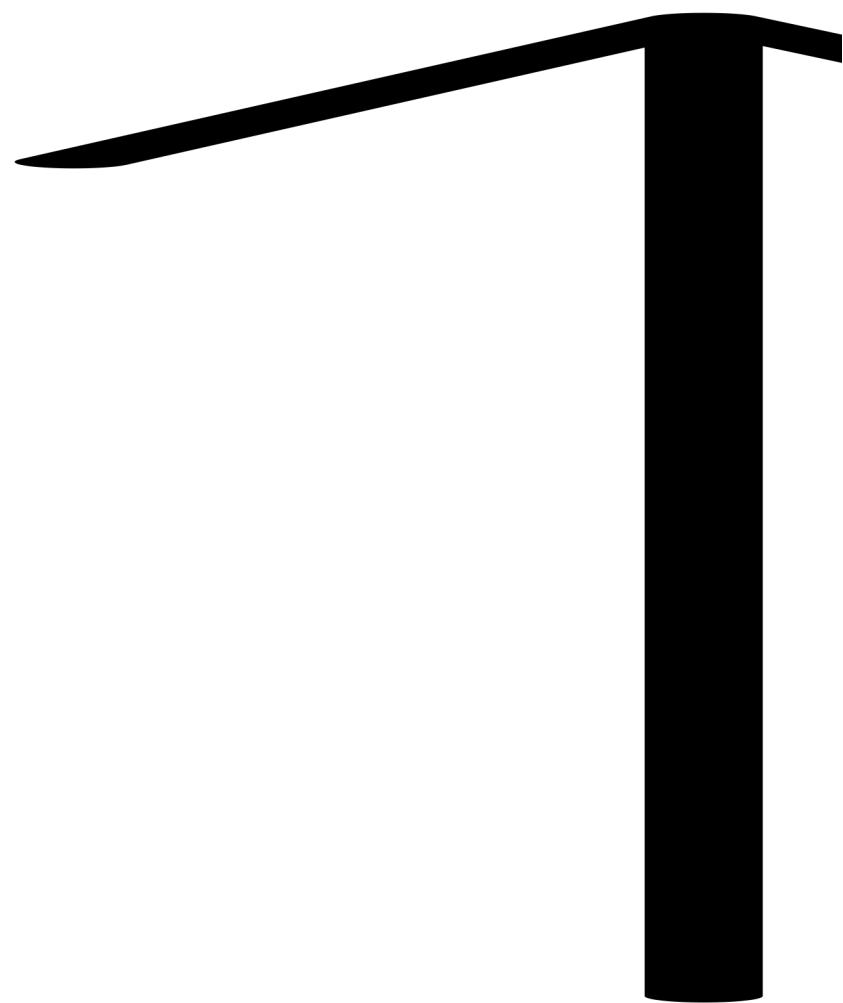
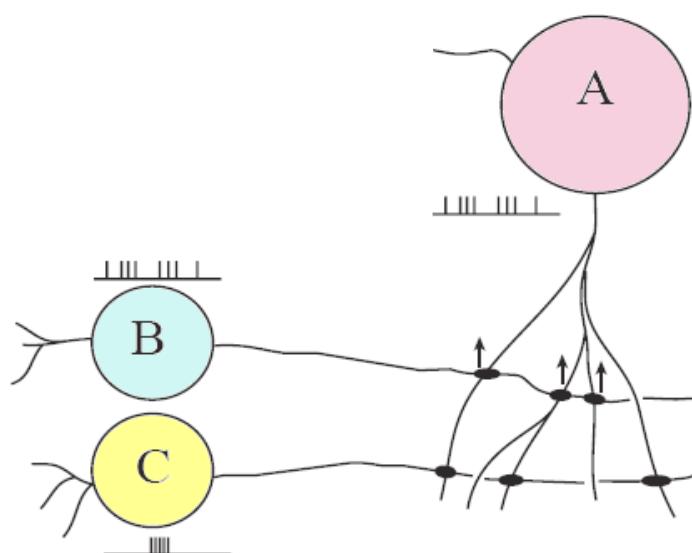
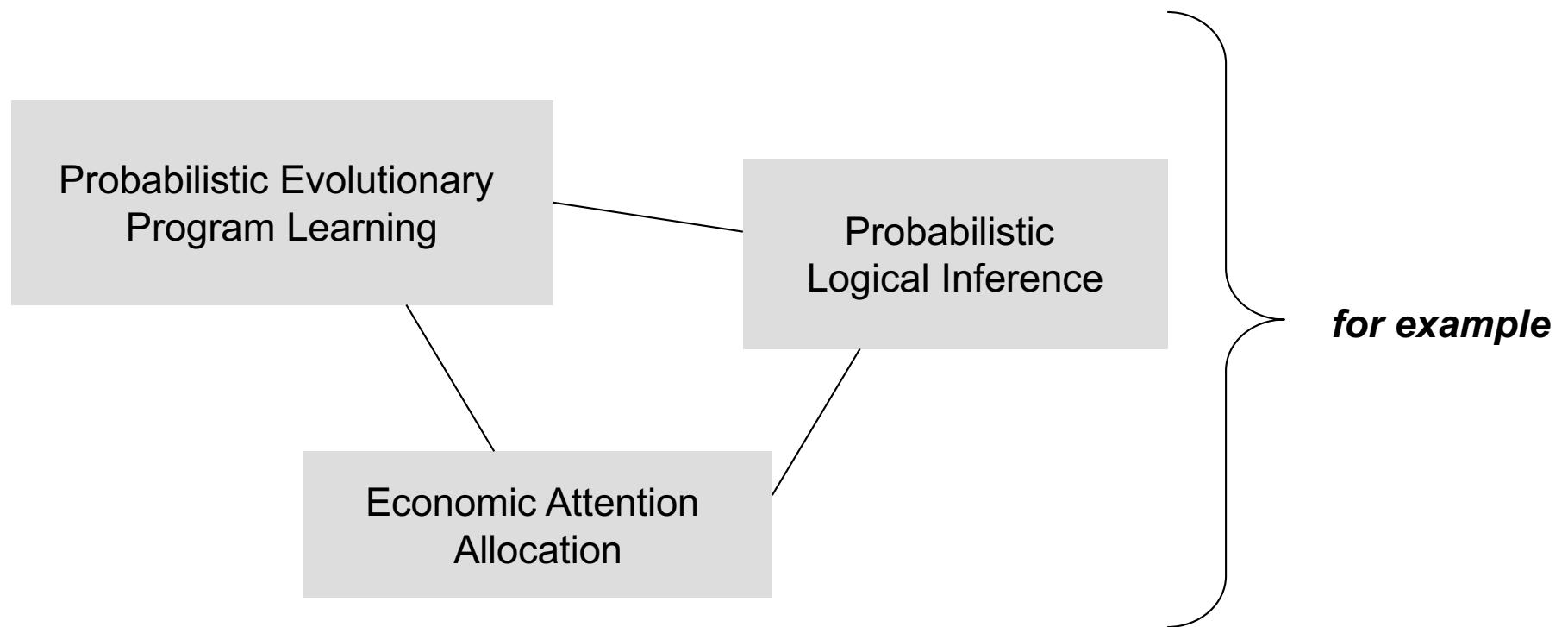


Figure 1. Graphical depiction of the final logical plan learned for carrying out the fetch task.

How Does Neural Learning Relate to Abstract Formal Models of Learning?



Can Integrative Design Allow Multiple AI Algorithms to Quell Each Others' Combinatorial Explosions?



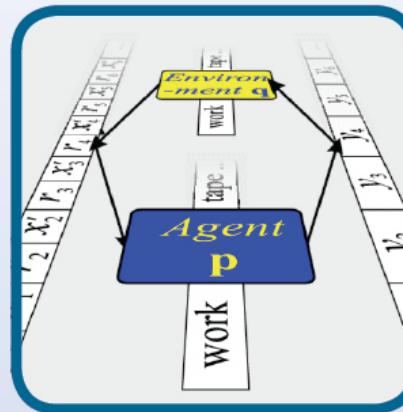


4 approaches to advanced AGI

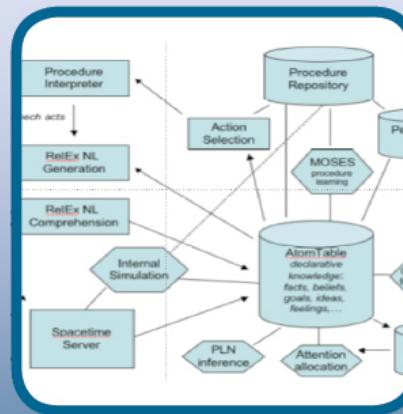
Brain
Emulation



Narrow
AI ++

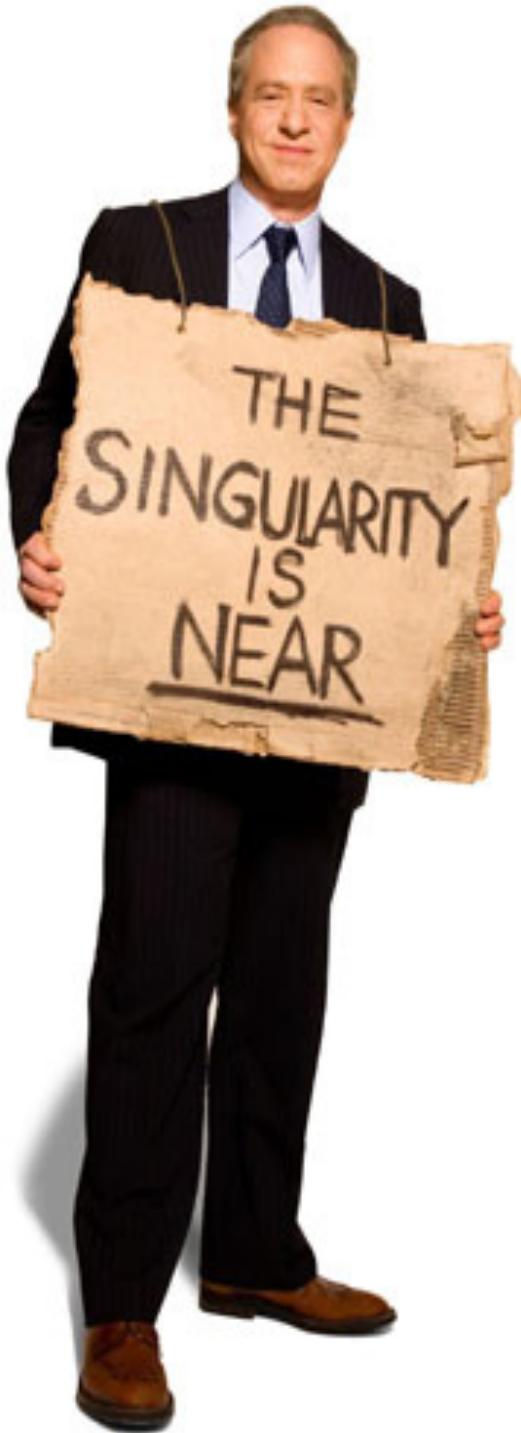


Math
Theory
Driven



Integrative
Computer
Science

THE BIG PICTURE



"I set the date for the **Singularity**-
representing a profound and disruptive
transformation in human capability- as **2045**.

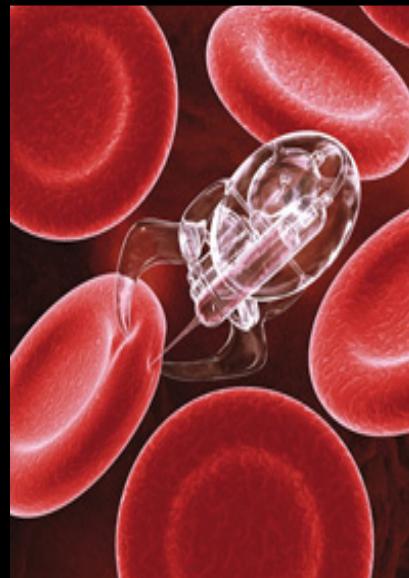
The nonbiological intelligence created in that year will be **one billion times more powerful than all human intelligence today**."

Ray Kurzweil
The Singularity is Near (2005)

Technologies with the Potential for Radical Transformation



Biotech



Nanotech



Robotics

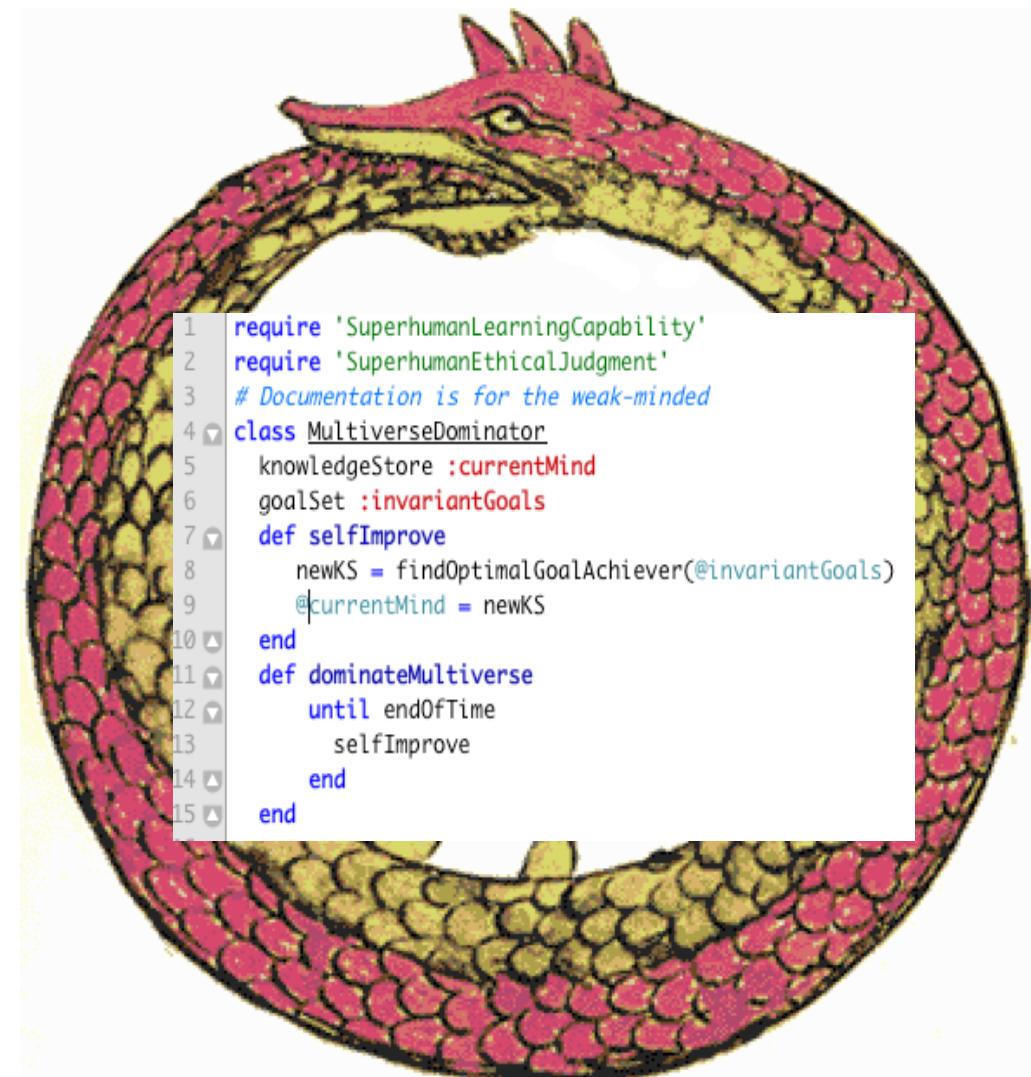


Strong AI

A Very Hard Problem

Goal Invariance Under Radical Self-Modification

How to architect an AGI system so as to maximize the odds that, as it radically self-modifies and self-improves, it will not lose track of its originally programmed/taught goal system?



Another Very Hard Problem

Making Sure the “Good Guys” Win

Suppose we eventually do understand how to build a **beneficial**, powerful AGI

How do we guarantee that this is the first kind that gets built and achieves wide influence?

