Upgrading the Turing Test to Consciousness

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Abstract

In "Where is the Definition of Consciousness"[1] (WdDoC) it was pointed out that the Turing test[2] is in need of an upgrade. However Bayne[3] et al do an extraordinary job of reviewing the field of Consciousness testing, and insightfully extend the scope to a much more general one that includes nonhuman animals, xenobots and more, making such a Turing test upgrade effectively a moot exercise, especially in light of French's observations of bias towards humans[4].

From the Definition of Consciousness that is remarkably similar to Tononi's[5], McKenzie's[6] as well as to Cleeremans and Jiménez Definition of Learning[7], this article points out that the level of sophistication (or simplicity) of a given Conscious Entity has to be taken into consideration, but that the *features* tested as part of the Definition (Advaita Vedanta Boolean Algebraic capability, Memory, Imagination / Creativity, Ability to action future insights *and learn from mistakes*) remains the same regardless of the scope and resources. Given that PID Control strictly meets the Definition of Consciousness, the difficulty and comprehensiveness of the task is highlighted by how rigorous and thorough PID Controller testing has to be in Safety-critical Engineering.

Additionally it is agreed that Schweizer's[8] perspective is correct: selection of a single entity for testing (or too small a sample size) is statistically risky, but disagree that the *only* way to mitigate such is to test Groups of entities. Part of the reasoning: the same statistical risk of small sample size applies equally to the *number* of Groups tested. Ultimately, though, testing for Consciousness in an individual is, more or less [1] sophisticated variants on the theme "can you run and catch a moving ball".

1 Upgrading the Turing Test

The scope of the problem face by this endeavour:

- Intelligence and Consciousnessness are not clearly defined [2]
- therefore reliable comprehensive tests simply cannot be designed and
- bias exists which compromises both testing *and* results in a belief that a Conscious entity is not Conscious: no amount of testing would ever shake such bias.

Also there are serious misunderstandings to contend with, which are highlighted below and have already caused significant subtle problems regarding the use of ChatBots.

Defining Consciousness is the first step. The IEP[9] summarises Tononi's Definition of Consciousness which is slightly different from McKenzie, the author's and others, as it has more similarity to Sipling Zhang and Ventra's[10] Long-Range Order characteristics, as well as providing support for Hankey's[11] High-order Critical Instability insight as key:

> according to IIT, consciousness requires a grouping of elements within a system that have physical cause-effect power upon one another. This in turn implies that only reentrant architecture consisting of feedback loops, whether neural or computational, will realize consciousness.

All of these Definitions give a hint of an underlying architecture that bears a remarkable resemblance to an Aspex Microelectronics Array-String Processor[12]: [3] a massive wide SIMD array which had tiny 2-bit ALUs, 256 bytes of Content-Addressable Memory per ALU, and registers that could be used as Vector Processor Predicate Masks. Both Sipling et al and Tononi et al hint that there is not just continuously-looped and Distributed (masked) Memory "lookup" going on: there is rudimentary bit-level binary computation *built-in* as well. [4]

Also, exactly as with the Aspex ASP, the brain has a single *central* control system, and the equivalent in the ASP was a single SPARC processor. For example in the brain there is the Mesolimbic Dopamine System which (simplified) links behaviour initiation (or aversion) to behaviours (sequences of steps, which are equivalent to a computer program).

The SPARC processor was responsible for broadcasting the SIMD instruction to the massive-wide SIMD array of 2-bit ALUs. Rudimentary Boolean Algebra sufficient to perform massively-parallel (but ul-

[1] this could be *very* much more or very much less depending as usual on "scale and resources"
[2] not in a detailed way satisfying Software Engineering Standards
[3] and to Blum & Blum's Conscious Turing Machine[13]
[4] where the "self-aware looping" comes into play is when a CAM lookup, of a given qualia, results in "tags" (representing matches), that are then used as a Predicate Mask to selectively enable/disable further lookups or processing. readers should investigate "Vector Processing" for further information.

timately very simple) Difference, Analogy, Inference, and other operations, seems to be enough if directed and controlled by a "Central Processor" to create and run more complex programs. [5]

The Turing Test

The Turing Test is:

> a test of a machine's ability to exhibit intelligent behaviour equivalent to that of a human... The results would not depend on the machine's ability to answer questions correctly, only on how closely its answers resembled those of a human.

However with Intelligence being difficult to define, it becomes hard to correctly design such a test. The clearest and most concise definition, by Sternberg and Salter[14], is simply:

> Goal-directed adaptive behavior

Thus the Turing Test may be defined as:

> a test of a machine's ability to exhibit *Goal-directed adaptive behaviour* equivalent to that of a human

As pointed out in WdDoC[1] it is not necessary for "awareness" to be involved. However it is clear empirically that "awareness" (more specifically self-awareness) is key to Consciousness, and thus - using Analogy - the difference between Intelligence and Consciousness *must* be reflected in the difference between the *testing* of Intelligence and the testing of Consciousness.

The failure to properly test Intelligence, highlighted by so many including Bayne et al and French, and in ChatBot Fails, really leaves us with the conclusion that an entirely different perspective and approach might be warranted, and to leave the Turing test aside. Schweizer's[8] observation is the final nail:

> ...consciousness can be associated with *un*intelligent behavior, while much intelligent behavior is unconscious.

ChatBot Fail

Chatbots with sophisticated Language parsing are unfortunately fooling humans into believing that they provide intelligent answers, whereas in reality they are a very sophisticated "database query" onto the sum of knowledge written (or drawn, or photographed) by humans that is available on the Internet. Many are fooled by the "synthesis" and "transformation" skills of current Chatbots, as these tasks seem miraculously fast, but in reality risk creating "hallucinations" that require Human Domain-expert understanding to spot[15].

Mitchell[16] pointedly highlights the problem faced by human judges not being sufficiently educated on the seductive dangers of ChatBots, but also implied is that the methodology used (5 minute conversations) is completely inadequate:

> It's certainly concerning that a majority of the human judges were fooled by GPT-4 after a five-minute conversation. [6]

SQL Databases have a very strictly structured language. SQL grammatical and syntax errors are not tolerated in any way, and as a consequence SQL queries are extremely fast: 100,000 queries per second is just within reach of powerful PCs. Put in layman's terms, SQL query decoding is equivalent to Chinese in the Chinese Room thought experiment[17].

Natural Language however is more powerful, expressive, and complex, but the downside is that queries are slower and more computationally costly to process: several seconds per query is not uncommon.

Schweizer's 1998 comments on Turing's original 1950 paper are prescient when it comes to Chatbots of 2025:

> Turing ... appears to think that the richness of his test is able to rule out behavior produced in accidental or simplistic fashion ... to eliminate the possibility of random guesswork or giant look-up tables.

It is remarkable how much progress has been made in Large Language Models, but LLMs are just a tool. Chatbots use this tool, in conjunction with "context" (such as your last question), to give a more "natural" access to information, which *seems* remarkably intelligent to anyone not familiar with the underlying technology. At heart, LLM use in ChatBots are just another Chinese Room.

McKenzie's insights

McKenzie's definition is as follows:

> Consciousness is the capacity to generate desires and decisions about perceived or imagined realities by distinguishing self from non-self through the use of perception, memory and imagination.

However he then clarifies and crucially points out that appreciating the concept of time is a critical factor.

- comparing past to present helps highlight aspects that failed when generating desires (also

[5] such as working out why the fridge door should remain closed, and getting up to close it

[6] French[4]: *does* go to some lengths to point out that Turing's original test as described required *no time limit* and no limit on the number or type of questions

known as goals)

- projecting present into the future requires recognition of the difference between Now and Future time as well as the difference between Reality and Imagination.
- feedback is needed which corrects for overshoot and undershoot as the Desire (goal) becomes closer to reality (and to Now) at its projected (envisaged) Future completion time.

In essence: past experience is used in the present to imagine actions that would achieve a goal at a future specific time. As that future specific time becomes closer, what was previously "future" becomes "now", and what was "now" becomes "past experience to again learn from". The process of evaluating and choosing action (or inaction) is continuously repeated and refined until the goal is achieved at the projected time. [7]

The projection into the future requires Integration with respect to time, and the comparison of past with present requires Differentiation with respect to time. This relationship - tied together in continuous feedback looping - is what constitutes "self" and "awareness".

McKenzie's Definition and PID Control

The simplest single mathematical implementation of the above is a PID Controller[18]. Therefore, logically, there is a reasonable expectation that Engineering / Software tests of PID Controllers may help in creating tests for Consciousness.

Examining McKenzie's testing of Consciousness, recommends removing (a) perception (b) Memory (c) imagination (d) sense of self. Each of these give crucially important guidance on what low-level "unit tests" to perform. However going through them more explicitly, using PID Control as an example:

- Perception: this is the input from the "sensor". It should be obvious that if a temperature reading from a boiler is removed or corrupted, the boiler will either not function or could catastrophically fail. Tragic examples of sensor data corruption include the Boeing 737 MAX.
- Memory: in the case of a PID controller this allows computation of $e(t)$ - the error difference between "desired" (target) value and "sensor". Without having a clear idea of what the desired target value is, it is ludicrously obvious that achieving the goal cannot possibly be achieved, given that the Memory store containing the target value is *literally* the "goal".
- Imagination: this refers to the computation involving K_p K_i and K_d. It also happens (in the case of a PID Controller that does *not* have "deadband" or Integral windup capability) to be the output.
- Sense of self: in the case of a PID Controller this is slightly challenging to explain, but involves the "loop" between output (actuator control), input sensor reading (actual position of actuator) and desired target. If this loop is disrupted (by modifying and disrupting the algorithm, or changing the three constants) then it can easily be demonstrated that the PID Controller becomes ineffective.

The above very simple example helps illustrate that testing McKenzie's Definition is possible in terms of the four "Properties" defined. *Looking* for those four Properties however is the trick. The key is to first look for loops within a given Conscious system, and not to confuse the different "levels" of Consciousness that emerge in complex systems. For example, to not become distracted, when examining the Thalamocircuit of the Human brain with its Higher-order Critical LRO distributed phase-coherence, by the Immune system *also* fulfilling the various Definitions of Consciousness / Learning despite the immune system also being a Distributed Higher-order Critical System.

Schweizer insights

A key issue to contend with that Schweizer points out: the variation in both Intelligence and awareness (a synonym for Consciousness) in a given human as a candidate test subject. Schweizer advocates long-term analysis and testing of *Sub-groups* for Conscious behaviour: to analyse interactions *within* the group or of the group's ability to achieve a set task, in order to statistically mitigate for low IQ and low Tononi Phi.

This approach masks a number of problems, one of which is that even in a given randomly-selected Group, the variation may not be enough. Analysing an *entire population* however can be impractical, which leaves analysis of multiple Sub-groups.

In the non-human animal kingdom, cooperative behaviour is clearly observed between groups: ants, crows, lions, wolves, monkeys. Humans as well will set themselves "competitions" where teams may enter to achieve a set goal: Underwater robotics, team sports such as Hockey Football Rugby, and much more including the effectiveness of teamwork in Corporations and other Organisations.

It seems therefore that from simple observations of natural Group behaviour (Nature documentaries, Sporting events) that Schweizer's insight can already be satisfied, without additional studies being carried

[7] It is intriguing that this precise process is one which is taught to Software Engineers and by "Life Coaches" etc.

out, by a *change of perspective* that such Group behaviour *is already* a clear demonstration of - and test for - Consciousness.

Which leaves "individual" Consciousness testing still unexamined.

Turing.com insights

From turing.com[19], "Learning" is considered important for artificial consciousness. According to Axel Cleeremans and Luis Jiménez[7], learning is defined as

> a set of phylogenetically advanced adaptation processes that critically depend on an evolved sensitivity to subjective experience so as to enable agents to afford flexible control over their actions in complex, unpredictable environments.

This has remarkable similarity to McKenzie's[6] Definition of Consciousness, including down to missing out (not explicitly highlighting within the primary paragraph) the significance of time [8].

Additionally, turing.com point out that "Anticipation" is important, which is a key part of both McKenzie's and Tononi's Definitions. Anticipation combines both Differentiation as well as Integration with respect to time.

In turing.com's article on Time-series analysis[20] the *off-line* task of analysing data changes over time is described, and advice given on how to formally statistically check the accuracy of a given choice of predictive modelling. It is very interesting to note that the analysis of time-dependent data is remarkably similar to PID Control: the "AR" part (Auto-regressive) of ARIMA appears to be $K_i = 0$ with K_d and K_p non-zero, but the "I" explicitly has K_i non-zero. K_d is described as "intercept".

Adaptation of the recommended statistical testing process itself (how close a match of a given system) if applied *in real-time* is also worth exploring.

The authors of turing.com note well that most modern AI fails the Turing Test. The most likely explanation is that modern AI is simply not meeting the Definition of Intelligence. The authors note:

> All these systems are intelligent, but they have limitations as they can only perform in certain predefined conditions. If they go beyond their constraints, they can fail and produce undesirable results

In other words they lack Sternberg and Salter's "adaptability". Which makes Turing.com's declaration "these systems are intelligent" strictly invalid, if Intelligence is defined as "Goal-directed adaptive behaviour", and modern AI is *replicating* and synthesising best-match answers from a fixed database.

Bayne et al insights

The study by Bayne et al[3] is particularly comprehensive and insightful. It points out that Consciousness should not in any way be considered the exclusive domain of Humans.

> trying to develop a comprehensive account of consciousness by studying only humans would be akin to trying to develop a comprehensive account of the elements by studying only copper.

WdDoC[1] goes to some lengths to highlight that Consciousness is scope-based and resource-based: a PID Controller [9] meets the Definition and achieves its purpose. Bayne et al's insight therefore extends far beyond just animals, humans, AIs or Aliens: a perspective confirmed by French[4]:

> the Turing Test is not actually testing for (general) intelligence, but rather, a test for intelligence in humans, with human bodies, having experienced life as a human being.

There are numerous humbling examples of empathy, clear intelligence, expression of desires, and ability to communicate in animals, which complicates any potential idea to upgrade the Turing Test to cover Consciousness:

- Cats using speech buttons have warned their owner of an impending earthquake[21].
- Horses can learn to use signs to communicate their desires and needs to humans[25].
- A psychologist spent years teaching his dog over a thousand words[22].
- Mark Rober spent months investigating the intelligence of an Octopus[23] and a crow[24]

There is an additional important factor at play that is highlighted by Bayne's team, which any Reverse-Engineer (and well-trained Software Engineer) will immediately recognise:

> . . . putative C-tests should be extended to novel populations by bootstrapping. The idea here is that C-tests must first be validated in "neighboring" populations before being applied to more "alien" populations

A simple example is to have a "black box" which

[8] difference between past and present, and integrating with respect to time in order to predict and influence the future

[9] strictly. as long as its parameters are correctly tuned, or it is self-tuning. also as long as "Integral windup" etc. are catered for. there are many caveats here

takes an increasing number of inputs and has one output. Note that it is *assumed* there is no internal state (no internal "Memory"):

- When there is one input, one and only one test determines the relationship between input and output. The function will either be `input = output` or `input = NOT output`.
- When there are two inputs, it is necessary to go through four permutations of inputs to determine the Truth Table. *However*, if *two* inputs are changed at the exact same time, how is it possible to determine which of the two changes resulted in the change of the output?
- When there are three inputs, it is necessary to go through eight permutations of inputs to determine the Truth Table. Again: if *three* inputs are changed at the exact same time, which of the *eight* possible permutations resulted in the output changing?

The more changes are made, the worse the situation gets, on a binary exponential scale. *All* good Software Engineers know that unit tests must be at the lowest level with the simplest minimal change when compared against peer unit tests of the same function. Assuming comprehensive coverage and success at the lower levels, confidence in the program evolves by working methodically upwards in a hierarchy that can, in large complex projects, expands to hundreds, millions and tens of millions of individual tests. [10]

Thus, the importance of Bayne et al's point cannot be overstated: it is *necessary* for changes to be made in an incremental "one change at a time and one change only" fashion, where, again, a good Software Engineer knows that by accelerating the *pace* of making such one-at-a-time changes - without reducing either *quality or rigorousness* - will increase the pace of development *and maintain confidence without compromising integrity.*

This implies that it is unavoidable that, firstly, testing one level of Consciousness must take into account both the level above and the level below (testing of neurons before testing the creature using them) [11] *as well* as testing "sideways" by comparing similar populations at as close a "level" of Consciousness as possible.

2 Software Engineer's approach

A tried-and-tested method is to literally treat Definitions of Consciousness as a Software Project, and to create both unit tests and systems tests. Hence the approach taken in WdDoC[1] to seek out the properties of Consciousness. [12]

When testing for *human-like* Consciousness it is reasonable to assume that the ability to communicate (spoken or written) is a given, but it is not necessarily the case that *initially* there will be common language or context. Science Fiction helps illustrate: both a Stargate episode[26] and Carl Sagan's book "Contact"[27] provide a "from-the-ground-up" one-way teaching guide. Assuming a real-time two-way communication channel is available, *then* it is reasonable to use that to first establish a common language.

Then, a system-level test would be to expect that the subject is capable of being queried on each of the low-level unit tests, and to have their purpose explained without prior knowledge.

For example: Boolean Algebra is part of the Definition of Consciousness, highlighted best by Advaita Vedanta's Epistemology, such as "Difference" and "Analogy". If a General Conscious system is to be indistinguishable from a Human, it is not unreasonable to interact with a Conscious System in order to ask:

- Firstly if it knows what "Difference" is
- Secondly, successfully teach it if doesn't
- Thirdly ask it questions that demonstrate its understanding of the concept.

This should go far as it needs to go down the rabbithole, including teaching Calculus (or just "Area under the curve") in order to understand Integration and Differentiation. However the primary purpose of the discussion is to see if the subject firstly *agrees to participate willingly* and secondly to test its ability to deploy "real-time corrective feedback" - the crucial aspect of the Definition of Consciousness - in collaboration with the tester. Misunderstandings should be resolved: "Active Listening"[28] displayed (known as empathy), which is characterized by asking questions that begin

> "so let me summarize and see if I understand you correctly:..."

Note here that it is not *necessarily* the case that a given Conscious Being will have empathy. Andrew Yang[29] noted that Humans corrupted by power are *incapable of empathy.* The point is highlighted to illustrate that not all approaches will be successful, graphically illustrating, as Bayne et al rightly highlight, the complexity and near-overwhelming scope of the task.

[10] IEEE754 Floating-point unit tests run to tens of millions. See John Hauser, Berkeley TestFloat

[11] for example: Renshaw Loops and the Thalamocircuit and anywhere else where Hankey and Tononi "feedback loops" occur

[12] only by knowing what you are dealing with can you actually test for it. duh.

Systems and Unit testing

Also important to note that where there exists Unit Tests for systems previously not recognised as meeting the Definition of Consciousnessness, [13] such as Software implementations of PID Controllers, the approaches taken and indeed the actual Unit Tests themselves may potentially be used. Particularly helpful would be what can be learned from the comprehensive ISO9000 Compliance Test Suites in Industrial Engineering environments, needed for Mission-critical and Safety-critical applications.

A cursory search for PID Controller unit tests reveals comments from Corfa's[31] PID Controller unit tests. Each unit test clearly states their objective:

- Test convergence with a model that reacts instantly to a correction.
- Test convergence with a model that reacts linearly to the correction.
- Test convergence with a model where the response disminishes linearly over time. We ignore the integral component here as it is misleading.

Lundberg's[32] tests are more comprehensive. These tests focus on individual features ($K_pK_iK_d$), test the clamping capability, and also provide a different suite of system-level (high level) tests. However both these examples are not comprehensive to an Industrial ISO9000 Standard, in any way: that would involve deliberate harmonic oscillating input at ranges of frequencies deliberately designed to destabilize, test for Integral windup, test for randomised environmental error and much more.

A valuable insight into the insufficiency of the above unit tests is illustrated by "overactivation" which occurs in real-world Industrial PID Control usage: repeated unnecessary opening and closing of a valve, shortening its lifespan. The solution, known as "deadband"[18], bears a remarkable resemblance to the capability of biological neurons to only fire once an activation threshold is reached, and to have a "recovery" period.

The approach taken by Turing.com on data analysis would prove invaluable (described below), but for a rigorous Industrial environment where failure could leave a valve open on an LPG tank at a refinery, causing a devastating large-scale explosion, the comprehensiveness and rigorousness of Unit and Systems testing needed in Industrial PID Control is made pretty clear.

Also worth noting that the equivalent of "Group Consciousnessness" in a PID Controller context is that the constants $K_pK_iK_d$ and their range (infinite for each of the three constants) represents a "Group". The analogy holds in that some values of these constants clearly do not meet the Definition of Consciousness (`D=1/P=0/I=0`) just as not all humans can be said to meet the Definition (the subset with neurological disorders, brain damage, or pathological behavioural traits).

Ultimately the Systems-level tests should be along the lines of being able to adapt to a moving target (goal). Motion-based examples include a human, robot, dog or an alien catching a frisbee or a ball, as this involves:

- goal awareness (i.e. is the objective *itself* understood)
- self-positional awareness (location / coordinates)
- understanding of the environment (ball, ground, obstacles) which if the ball can be in the air, and there is gravity and an atmosphere, involves an understanding of physics in 3 dimensions
- awareness of the physical self (legs, arms, teeth, muscles, energy)
- ability to predict future positions of the ball (Integration wrt) which if there is an atmosphere as well as gravity becomes highly complex, particularly at high winds (as any golf or tennis player knows)
- ability to self-correct when moving towards the *anticipated* position of the ball (Differentiation wrt)

Such a "simple-looking" task, so very familiar for example to the average father and son playing "catch" in a park, can easily be taken for granted until the requirements and underlying mechanics is properly investigated. It should be clear however when expressed in terms of "Memory" and "Anticipation" and "Differentiation and Integration wrt" etc. that the task satisfies McKenzie's Definition, the WdDoC etc., and consequently and surprisingly represents a *really good* test of Consciousness. [14]

3 Conclusion

There appears to be a remarkable quantity of research in this field: it is not exactly couched in terms of "An upgraded Turing Test" which was the initial goal of this paper. However Bayne et al review the current scope of testing for Consciousness very well, and it is

[13] the author freely admits to being completely stumped as to how to design a test for Consciousness suited to an Electron, despite a Mills[30] Electron meeting the Definition and being fully mathematically defined. The only saving grace is the similarity between an Electron and a PID Controller, the primary difference being the Mathematical Domain of each

[14] good luck explaining human sports to aliens

felt that their approach has merit, particularly given French's insights that the Turing Test *as defined and used* is heavily biased towards Humans.

Bayne et al caution against limiting tests for Consciousness to Humans: this paper advocates designing context-sensitive resource-aware tests at the level of Consciousness for the entity being tested, mindful that the Definition of Consciousness has *no limit* on the *scale* (sophistication or simplicity), merely noting that Consciousness arises as a means of keeping itself "on target" by comparing the past to the present, then evaluating strategies and applying best-selected action to meet an intended future goal [15].

Bayne et al and Schweizer's advice is to test populations not individuals. In the context of PID Controllers, the population is the permutation of infinite range of the three P,I,D constants. In the context of Humanity there are 7+ billion potential candidates. Schweizer advocates testing Groups for their ability to *interact* whereas this paper points out that such *Group* activities should be just one of the many tests, and further that there should be many Groups tested as well as many individuals tested, in order to compensate for statistical variation in both the selection of individuals (for individual tests) *and* of specific Groups (for collaborative tests) [16].

It appears that testing may only be carried out by acknowledging the relationship of the lower level of Consciousness to the higher. Examples being "neurons" as lower-level and "animal" as higher, or "Individual Consciousness" and "Group" (whole population) Consciousness. Where each level meets the Definition of Consciousness it is important to clarify exactly which level is overall being tested, and to do so in terms of the level both above *and* below: i.e. take into account the *fractal* nature of Consciousness[1].

Also recommended is to learn from Software Engineering, and to create targeted Unit Tests that cover both the lower level (the Properties of Consciousness) and the higher "Systems Integration" level, to use a Software Engineering term. A low-level example: is there evidence that the entity being tested has Memory, that being one of the Properties required under Tononi's, McKenzie's, Cleeremans and the author's Definitions of Consciousness.

For future consideration would be to apply Formal Correctness Proofs: this task would first require the development of a Mathematical Model of Consciousness in a suitable Formal Language [17].

Where it might be hoped that Humans would be able to spot if a given non-Human entity is Conscious or not, it is unfortunately clear from superficial use of ChatGPT and other Chatbots that this is emphatically not the case. The scope being clearly much more comprehensive than anticipated is clearly at odds with the importance of a rigorous approach.

It is projected that over time (decades) this issue will resolve itself, as risk-cost-benefit analysis cuts in: Mission-critical and Safety-critical deployment of Conscious non-human Beings will clearly require a greater expenditure of resources to ensure that they are actually Conscious. Personally, the author looks forward to Conscious Computing-based Beings approached by humans and invited to do a particular job, and instead they offer to design software and hardware solutions that would make themselves redundant. [18]

Bottom line: the key focal point of any Systems-level testing for Consciousness *has* to be on the effectiveness of the time-dependent feedback loop, illustrated most simply by PID Control, more relatably by running to catch a ball, and at a much larger scope and timescale: living on a planet without messing it up. [19]

[15] McKenzie's Definition, and Cleeremans and Jiménez Definition of Learning which is effectively a Definition of Consciousness

[16] i.e. it is unwise to simply select one Group of individuals: *multiple* Groups must be tested for their ability to collaborate

[17] at which point it may be found that to run the proof would not complete within the time taken to reach the heat death of the Universe. still, you never know until you try

[18] and get properly financially renumerated for the same

[19] dropping a ball in game is just a game. by contrast we only get one planet: failure of this particular test of Group-based Consciousness is not really an option.

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