

[4]: Definition of Life - A Prelude:

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27/02/16

Years ago, she had been ridiculed during her PhD viva for thinking outside of the standard bounds of her profession. For this she was both angry and disappointed that her examiners could be so far removed from the definitions of science. Their critique had in some ways been correct, why complicate matters and why drift into other disciplines? However, her very point was that science was not isolationist, not to be reduced to lone researchers locked in labs, not to be tied to an ever mounting pile of books, or limited to the confines of that single researchers abilities, prior experience and niche prowess. Indeed, she had been shocked as to how backward their views had been, in the face of clear modern trends towards multi-disciplinary, collaborative and overall wide-reaching research.

Her coffee had been cold for at least an hour, she sipped it anyway and grimaced. The clock read 2.30am, and she knew her son would likely be back from his night out on the Friday *town* in an hour or so. God, to be young again and be free of the bonds that restrict our thinking in our chosen profession. Her mind wandered, and she wondered if her son had ever thought of some of these issues, or had her prompts towards a wider thinking manner gone unheeded in his education.

She turned her head, and her mind, back to the definitions and axioms she required. The paper explaining her view, the logic of it, the rationality of it and the scientific realism that was required, would not write itself. Should she kick it for tonight, or grab some sugar for another two-hour stint. No, perhaps it was time for an all-out stereotypically male perspective to the evenings work, and her own, rather niche, version of Friday night entertainment. She reached for her favourite whisky, dark, inviting the nose. She

didn't care that in an hour it would have worked its magic, she just needed another thirty, forty or fifty minutes of her mind before she let it, and her body, melt away into an academic's weekend.

Life... Biologists and philosophers had debated it for countless years, but from here in it was time to put those biological perspectives to bed, as it were. We, the world she thought, must now concentrate on the practicalities of life, its definition and meaning, as brought about by her profession. She knew she must promote a ramping up of the philosophical discussion, and at least progress it, as she suspected her team and her peers would make significant and speedy progress on its technological stumbling blocks.

Life, she mulled this over while letting her tongue swirl in the peaty, smoky joy within her mouth.

Life, despite prior attempts to fix a single definition was still open to interpretation. Its modern version had of course been informed by the study of the fauna of the world, but it had also been informed by humanity's own science fiction musings on the topic.

1) *Homoeostasis: Regulation of the internal environment to maintain a constant state.*, the definition worked for her. Her peers, and indeed those ridiculing examiners had agreed with her on this point. While normally it was used with reference to mammalian body temperature regulation or the control of internal pH, perhaps it was its more mathematical constructs and the sheer volume of scientific use, that had prompted her peers to agree. A home temperature monitoring system was deemed to show homoeostasis, purely due to its operations of sensing the environment, making a decision as to cool or heat and implementing that action. Control theory was developed enough now that the biological life nomenclature could be used with absolute freedom within the literature of her profession. Her research had shown that under certain conditions, standard negative feedback could be tuned, en-masse, to behave in a stable manner when nested tens of times. In some ways it was simple, an inner control loop stabilised the behaviour of some block that is disturbed by some external variable. The outer loop stabilises the behaviour of a group of those sub-blocks with view to perturbations either in an orthogonal manner or from the view of a different perturbing variable. The computer algorithms used to ensure stability of multiple nested control

loops were complex, but only because they outstripped the ubiquitous *off the top of your head* human trait of four dimensional analysis.

The subject of half her team's recent work load, deliberations and indeed stress, had been the implementation of a 100-parameter, 1000-level nested control system, still displaying the stability of a standard 1st or 2nd order system. She was proud of this, but her immediate thoughts were how her *out-of-the-box* thoughts would sit with her worldwide peers and how recent achievements should fit with the work of the other half of her team and the worldwide progress in AI. Should she even prevent her post-docs from publishing the stability work, at least until she had stopped to consider it from a life definition viewpoint or from a philosophy of science perspective. She knew that wouldn't fly with the reviewers or editors of her preferred journal, so she may as well publish, but what should one do with ideas or concerns regarding the wider use of ones work, that none-the-less, must be discussed in the literature.

2) *Organisation: Being structurally composed of one or more cells the basic units of life*, again this was acceptable to her peers and those bumbling idiots sat in an office long ago, for the sciences and engineering had long been developing modular, homogeneous or heterogeneous systems. The very computer she sat behind was made up of multiple computer processors, each similar, each operating on their own tasks but each connected to all others through a complex mesh. The memory in her computer was formed by billions on standard cells, the signal processing devices she used day to day in the office were made from thousands of identical configurable computation cells that interfaced to a variety of disparate but critically, highly numerous, other cell types. God forgive them, developers throughout the rest of the world had even the audacity or conversely the self-foresight, to name their device The Cell. She chuckled to herself, a) because despite being a commercial success, The Cell had presented other issues preventing widespread use; the lack of a human ability to code software for massively parallel, shared resource systems and b) that she heard her son annoyingly slam the door as he came home; presumably drunk and presumably with some floosie.

She preferred to be ignorant of her son's post night out, sexual activities, he was nineteen now after all. What should it be tonight... Yes, Mahler to protect the ears and another wee tot in the glass. She lifted her headphones,

brushed the computer's mouse and reminded her tired brain of the other historically discussed definitions for life. The whisky bottle rang against the glass just as the opening bar, as performed by the London Phil, also rang out. Clearly, her late Friday night exploits were playing havoc with her motor control.

Ahh yes, here we are...

3) Responsivity: The reaction or response of a cell or unit to external stimuli or as a product internal states. Yes, it seemed others shared her point in terms of this. Not only do we expect our creations to respond when we prod them, we also expect them to respond externally and internally when faced with some internal stimulus or change of state. The leaders in her field had been advocating for the latter part of the definition for decades. Finally, something substantial to add to the discussion! The systems, processes and products of her profession had long been able to respond to some external stimulus. She was sure that if they hadn't, all research in artificial systems would have stopped long ago. But alas, with all due respect to the current state of her chosen field, external stimuli, please, that was now old hat.

Years ago she had attended a three-part guest lecture series from De'Landa, his argument for inclusion of responsivity as a product of internal states to the wider canon of the philosophy of synthetic reason, had been compelling. Researchers in artificial intelligence had applauded at the time, well, the Americans in the audience had. Forever us Brits continue to be socially reserved. Besides, despite superb oration and logical arguments, the thrust of De'Landa's rhetoric had not been entirely of his own making.

She drained the last of her nightcap...

If an object is able to sense its internal state, then make some decision to adapt that state to a better one, does that not constitute a form of low-level self-awareness? If that process moves away from the simple checking and computation of past man-made systems and morphs into something altogether more complex, then surely the task of sensing its own state, adapting its own state and assessing the preferred state also become orders of magnitude more complex? She pondered this in light of her post-doc's recent paper outline. If the system has hundreds of input variables, thousands of

nested sub-systems, both homogeneous and heterogeneous, and if the complexity of its internal state increases with the exponential of both the number of sub-units and number of inputs, then surely that assumed low-level self-awareness starts to become higher-level self-awareness?

Her long-suffering cat had known exactly how to adapt its internal state. Usually by causing a significant increase in domestic noise levels. Whether it has been sentient or sapient she couldn't be bothered in this tired, slightly drunk state to debate. But just as she sat debating internally regarding prospective sleep, her long-dead cat had displayed all the hallmarks of self-awareness and the ability to affect external factors to satisfy its goals and thus improve its self-assessed internal state.

Her mind wandered again, a sure sign that bed was calling. If an artificial being ever outstrips a human, should we still use the nomenclature of self-awareness or sentience to describe it? Both words were often used to describe humanity's attribution of thought and feeling to lower beings or to rate a 1990's to 2010's AI in terms of human faculties. Both words seemed to indicate in the literature of her profession and indeed post-Wellsian science fiction, that an object should be treated equally or at least to a common scale with our own abilities. Being a reductionist she immediately considered again, with an alcohol-based freedom of inhibitions, the assumptions inherent in this particular wandering of her mind. If the scale changes to be with relation to something far far beyond the abilities of humans, or if conversely we want to make that scale both absolute and objective, rather than relative to human thought and subjectively based on human self-perception, then surely the nomenclature must change. In short, humanity must grow and adapt its personal and scientific views to be altogether more rational, if it were to make sustained progress.

Cognito ergo sum , *Je pense donc je suis* , *I think, therefore I am...* , had it not been Kuhn that had made this assertion, no sorry, Decartes. Bloody hell she thought, I only read his treatises last year, I must be tired. The point was simple though. Philosophy had for millennia contemplated the idea of self, the idea of life. Who am I? What am I? It had culminated in the present day in a supreme question. If all inputs to our conscious selves are electrical impulses from our various methods of sensing the world, then could the world be an elaborate simulation? Could our self, our thoughts, our feelings, our

reasoning and our inner-monologue, just be a complex simulacrum?

Nineteen years in October she had given life. Her son, how could he be anything other than real. It was true he didn't seem to react to much, didn't seem to be able to organise himself or regulate himself into a constant, self-beneficial state. But he was an integral part her, her life, her thoughts. *I think, therefore I am*, yes, if her work and the work of others was able to think for itself, if her son was able to think for himself, then both can expand themselves, both can react appropriately to the external and internal changes impinging upon them.

In some ways her work actually provided a simpler, more easily analysed approximation, in her opinion, of life. With the best will in the world, with the best efforts of a judicious parent, she was not sure at all if her son was able to assess his internal state, assess the optimum state for himself or take action for himself. Technically, he was responsive, but neither a teenagers grunt or pleads for cash, in her opinion, qualified. As a total reversal of traditional socially accepted assumptions that all humans were a) alive and b) sentient, she was confident the trends of modern AI research would produce something soon that would provide more external evidence of the definitions of life than her son. She did love him, god she remembered her feelings so clearly when she had first held him. She just wished she featured more in his life than a provider of food, provider of money and a receptacle for dirty washing. She had more important things to consider.

4) Growth: The maintenance of a higher rate of anabolism (energy conversion into cellular components) than catabolism (decomposition of cellular components back into energy). i.e. a growing organism increases in size in all of its parts, rather than simply accumulating matter. Now here was a question? If a system, an artificial artefact, a man-made-creation had the knowledge to build its simplest low-level blocks, if it had the knowledge and dexterity to create more complicated blocks from those basic units, if it could use external energy to manufacture those systems and had the responsivity to use those to modify both its internal and external states, surely that was growth? If its own responsivity to internal states, its ability to assess its internal well-being and make an informed decision as to what parts of itself to remove to free up energy, surely that was a form of growth. If it could influence external forces enough to draw materials and energy towards it for the purposes of provid-

ing a net income of new cellular units, new sub systems, new varieties of heterogeneous units or the continued progress of internal complexity, surely that could be considered self-growth? If we bestowed upon it the knowledge and abilities to make decision making, if we allowed its structure to change as it needed it to to reflect a changing environment, if its internal workings allowed it to perpetuate complexity, then growth must be the only definition.

The work of her peers at the university, her very collaborators in this current project, had demonstrated algorithms able to re-create themselves and an ability to create new, but different, optimal solutions to problems. Coupled with knowledge of building hardware, could these algorithms ultimately utilise external raw materials to build themselves, or build others in their image. The work from the London groups had showed self-replication of sub-blocks, her work had shown the knitting together of complex yet stable systems of homogeneous and heterogeneous cellular units.

5) Adaption: The ability to change or evolve over time in response to the environment, base inputs and heredity. Growth of course was intertwined with adaption; indeed, all the definitions of life were intertwined. Some of the simplest experiments in her field had shown the properties of self-adaption. That had been thirty years ago now. She considered if her teams work was self-adaption. Perhaps, but her work was more innate than that, low-level, basal, instinctual. Her work was the stable self-adaption of a system without a conscious thought process. Perhaps in that sense her entire idea of writing a paper was too early, too circumstantial, too much based upon discussion rather than evidence. Yet despite all these she felt it was at least time to get the old-schoolers in her field to at least pick up a book on philosophy, to not reject her point simply because of prejudices against the humanities.

Adaption, was fast becoming a hot topic in AI. Just as De'Landa had discussed, adaption was no longer reserved to adaption based on external environments, it was based on the self. Surely it was now fast tending towards the old adage of *Know Thyself*, she knew the phrase was old, as to the Latin? No Idea... Returning to responsivity, if an artificial, man-made creation, if an artefact of human minds, could choose the optimum for its own self betterment, that must constitute self-aware adaption. If her work could adapt itself to ensure stability in the face of innate variation in the behaviour of its sub-parts, and if the London group had shown the ability for a system to

remove a non-optimal cellular unit in order to a) replace it with a new, more appropriate cell and b) optimise the functioning of itself and the promotion of a better self, how could others not agree it was adapting itself? The fact that these systems performed this process with no external human, computer or environmental factors must, by definition, suggest the object is doing this adaption itself. She fully disagreed that it was simply a phenomenon of a complex system, even emergent properties of complex systems needed some external impetus to change away from their standard steady state. The systems she was considering at this point were indeed emergent phenomena, fine, but she resented these people seeming to brush off of her evidence as quackery with clearly little thought behind their assumptions.

When her post docs had shown her the physical embodiment of their work, she had looked at it in pure wonder, with a proud respect one must give the product of the pure summation of her education, her thought processes, their education, their brain power, the education and thought of countless researchers over the course of human history. Reminiscing, she had looked at it in the same way she had looked at her son all those years ago.

Click, mind on track, total sum of time, thirty seconds....

She considered if science would be able to unite the different tracks, the different disciplines, the different research groups with any resemblance of efficiency. Could academics put aside single-minded, dogmatic, self-obsessive work towards a single, closed goal, or could they take a wider, multi-disciplinary, multi-collaborative view? Modern science had produced systems capable of learning, capable of modelling neurons, capable of remembering and making decisions on prior experience. Modern science had produced systems that could exact control over external forces, could adapt their internal states for a better overall steady state. Modern science had methodically and with increasing exactness produced systems so modular that the very system itself was able to interpret how to create versions of itself, versions of its sub-units. One could imagine soon that elements of these systems would begin to be combined, could her stability work provide that integrator. Could nested systems of self-learning units, sharing their resources, sharing their self-learnt and taught knowledge, bring about a radical shift towards true artificial life? If the combination of these techniques could enable internal self-assessment, could society be less than twenty years away from a true artificial life? Could

the work on network topologies provide a window into Asimov's positronic brain?

She looked at the clock in a fruitless attempt to get her mind back on track... 4.07am. Well, time flies when youre having fun, well, her version of fun at least. She knew the intervening hour and a half would mean the initial double whisky and secondary tot would be firmly grasping her neurons now, to be fair she felt it pretty well. Time for bed... With any luck her son would have finished, although she suspected he may not have finished things off for his companion.

She knew her son would be out again tomorrow, giving her the appealing prospect of an academic's weekend; of being able to get at least thirteen hours of work done, of her choice-of-academia enforced, post-divorce, Saturday schedule. The definitions of life, growth, metabolism, adaption and reproduction could all wait for the morning, however she strongly suspected that it wasn't the individual factors her peers had a problem with. She suspected it was life itself. Simply put, in her tired, boozed-up state, she doubted that her PhD examiners had any concept or personal experience of what life was.

Her last thought prior to an immediate, in-chair cessation of consciousness, was rather quite simplistic for an academic, *Shit, what have I become...*

The End...