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Adaptivity

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Abstract

This short paper gives an overview of my PhD thesis plans.

Goal of the project: to find out the properties and processes that make systems adaptive.

Project status: starting (1st year of my PhD studies).

1. What

According to WordNet dictionary (accessed through [1]) the verb "adapt" means *"make fit for, or change to suit a new purpose"* or *"conform oneself to new or different conditions"*. Adaptation in general is the process through which a system restores, maintains or increases its fitness when outer and inner environments change, or increases its fitness in a nonchanging environment. Adaptation can be observed at different levels: single individual (or object), a group (or a small number of objects), society (or a huge number of objects); at different time scales: short periods (compared to individual's lifetime), individual's lifetime, species' lifetime (if it can be determined, as species are usually in a constant change), and even longer periods; etc.

My thesis, in its currently very general formulation, is: "The properties and processes causing adaptivity in various systems are similar (when described at a suitable level of abstraction), or at least form a small number of different classes.".

Keywords related to the thesis: adaptivity, learning, flexibility, elasticity, plasticity, context-dependency/-dependence, context-awareness, self-organization, (self-)adjustability, (self-)reconfigurability, feedback, resilience, evolution, conformance, ...

2. Why

The phenomenon of adaptivity is obviously quite widely studied in various systems. However, I have not been able to find any good interdisciplinary, yet thorough, source giving a well-systematized overview of adaption in different kinds of systems and of underlying processes of adaptation in specific cases and in general. Possible reasons for not finding such a source:

1. I have not searched well enough? In that case this source must be quite hard to find and is likely to be missed by many other searchers, too, as I have already done at least medium level searches from databases of scientific papers, from amazon.com and from elsewhere in the web. I do continue searching, of course: if not to find THE source, then at least to find numerous existing works on adaptation in specific fields of study.

2. The generalizations are impossible to make? This is not very likely as at least some (maybe a bit limited) generalizations HAVE been made. For example the notion of evolution can be used to describe slow adaptation in biological species as well as, for example, in the ideas moving around in a society (as suggested by memetics theory). Also, cybernetics has pointed out a general process important for adaptation, namely the feedback. Of course, it can be wondered whether there would be any use for very broad generalizations at all, as Kenneth Boulding says [2]: *"... we always pay for generality by sacrificing content, and all we can say about practically everything is almost nothing."*. But he immediately continues: *"Somewhere however between the specific that has no meaning and the general that has no content there must be, for each purpose and at each level of abstraction, an optimum degree of generality."*. For the work on adaptation to have the biggest value, therefore, it should probably present in a systematic way the information characterizing adaptation at different levels of abstraction: starting from specific examples and going through various levels of abstraction up to the general notion of adaptivity.

3. Such an overview is just not written yet, though it would be possible, and very useful for understanding and creating adaptive systems? Considering the discussion in previous two paragraphs I find this the most probable reason for not finding the aforementioned thorough source. Therefore, creating a work analyzing and systematizing the adaptation processes of various systems seems to be, in my opinion, well justified.

3. How

Methods of doing my work will likely include:

* Studying many different kinds of adaptation by reading articles, books, web sources, talking with (knowledgeable) people, experimenting *in silico* and otherwise.

* Contacting specialists of different disciplines for finding out their views on the topic, what adaptation means in their field of work and asking for reading sug-

gestions. There is a very large number of potentially interesting fields. To name just a few: biology, ecology, psychology, anthropology, culturology, linguistics, urbanistics, art, marketing, cybernetics, artificial life, etc., etc., etc.

* Identifying the underlying causes of adaptation processes; systematizing and generalizing them onto different levels of abstraction.

* Suggesting applications for the results and possibly creating a few example applications myself.

4. Your Help Welcome!

If you have any comments or ideas about my work and about the topic in general, or any suggestions about what I should read (references to articles, books, web pages, etc.) or whom I might find interesting / useful to contact, then please let me know!

5. References

[1] Online dictionary http://www.webster-dictionary.org/ by Interapple, Inc PA USA.

[2] Boulding, K. E. "General Systems Theory: The Skeleton of Science," in *Management Science*, Vol. 2, No. 3, 1956, pp. 197-208. Reprint (with an introduction by Kurt A. Richardson) in *Emergence: Complexity and Organization*, Vol. 6, No 1-2, 2004, pp. 127-139.
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