Coherence from Incomplete Sequences
Fuzzy Logic in Taxonomy & Evolution

The arguments against pre-historical processes such as Evolution and Emergences frequently rest on the incompleteness of the record and the consequent evidential gaps in any postulated development process, as well as missing steps in the theories themselves. Concrete evidence of most detail in such theories is NOT available, and the trajectories are usually informed speculation rather than concretely established fact.

And this is especially true in the cases of Emergence. And yet, the successes of Geology, Palaeontology and archaeology in piecing together commanding pictures of the past from very partial evidence must be brought in to counter such cynicism.

In addition, I must also bring in the results of some research which I carried out many years ago into what was then termed Fuzzy Logic. I was providing a dichotomous tree structure for a colleague, who was doing crucial original work on the taxonomy of Tardigrades (Water Bears), and his problem was that as soon as a new species was brought to his attention, his whole scheme had to be revised. Local areas of it were fine, but he frequently had to move these bodily from one part of the structure to another, and it was driving him mad. Such revisions as he was doing THE initial work in this area, were inevitable, and so he asked me to write him a program to facilitate such changes.

Now, several things came out of my research in order to produce this facility. We were dealing with a process that was much more general that his particular task. The problem beset the whole problem of scientific categorisation. Whenever elements needed to be related to one another, my colleague's problems would certainly be replicated. We were dealing with the trajectory of classification generally - A very important task.

In addition, crucial questions could not always be answered.

In a dichotomous tree, the classification structure is made up of a series of questions of physical structure of the organism in question, to which the answer is either "YES" or "NO". And each answer then directed the user to an appropriate branch of the tree, where the next question would be asked.

Incompleteness of the specimen under study (or its age or damage), meant that certain questions could only be answered with "I **don't know**" and the problem was then, "what do I do next? Which branch must I take? Do I have to take BOTH branches in parallel?" And to this last question, I'm afraid the answer is "Yes!" So, our tree structure had to accommodate three answers – YES, NO, and I **don't know** and organise the subsequent traversing consequences. Without this modification, and having successfully entered the appropriate YES or NO answers throughout, such a tree could deliver the name of the species being processes.

What would happen with a few "**don't know**"s ?

This had to change the way the questions were asked and subsequently processed. Instead of a single simple route change as with a YES or a NO, a **don't know** necessitated that both the YES and the NO routes be taken further, answering questions at every following node, in case they were relevant.

Now, how we did this was crucial. If we designed it badly the user would get confused. After all we now had TWO routes to investigate, and if further **don't know**s arose the number of routes would increase. How could we keep these alternatives simple and obvious? We decided whenever we encountered a **don't know** to take the YES branch first and carry it through to a termination. This would give (without any further **don't know**s) the first possible species. Our program would then back track to the question where a **don't know** answer was given, and the NO branch would be followed. Once again, without further **don't know** answers we would finally terminate on a different species name. So, instead of a single solution we were given TWO to choose from. Now, of course, other things could also happen. We could find other **don't know** answers. But, this was no problems for the program. It merely did exactly the same process – taking first the YES, and then the NO branches onward. The user didn't have to understand the intricacies of the routes, he was simply provided with the next appropriate question to be answered. Now, this produced the following interesting result.

For every **don't know** encountered, an extra solution could be added to the results, and the final finish of the process was delivered as *series of answers*. By traversing these answers in a particular way we caused them to be delivered as a step-by-step continuous sequence of possibilities. The expert in the field (my colleague) could most times position his looked-for specimen perfectly in this spectrum of answers.

Surprisingly, another situation also frequently occurred.

We invariably hit a series of questions which proved we were on the **wrong path** through the tree, and we could immediately terminate it without a final species diagnosis. That branch would be discarded, and we could confidently use only the other route from the original question with a **don't know** answer. Such premature terminations meant that in spite of one or more **don't know** answers, we often still ended up with a *single species name*.

This work proved that you do NOT have to fill every single gap in a system to arrive at dependable conclusions. The built-in relationships as a whole would throe away obviously wrong turnings and enable a return to correct path through the material.

My colleague was the first person to establish a sound taxonomy of Water Bears. He was 22 years old.

Years later, when I was writing a series of papers on the Processes and Productions of Abstraction, I had to deal with the vital subject of categorization, and it turned out to be very sophisticated. Though it appeared first, at a very early stage in the necessary sequence of processes, it was invariably erroneous to some degree, and later processes and their productions brought the current categorization into question. There was then nothing to it but to return to this early step and correct it in the light of evidence from higher up the structure. Such changes then rippled through the above superstructure changing many relationships as they went. The categorization/revision loop became an essential, ever-present process. Now what was even more surprising was how dependable were many of the superstructure productions in spite of errors close to the foundation of the edifice. The "wall" of truth was sound in spite of a few "duff" bricks. All these discoveries showed that the unattainable(?) Absolute Truth is built out of a multitude of Relative Truths, and even the WRONG relative truths have sufficient *objective content* (truthful form) to maintain the structure. Repair and improvement doesn't usually require rebuilding the whole wall.

(1,152 words)