

Critique of “From Alan Turing to Modern AI: Practical Solution and an Implicit Epistemic Stance”

Luger presents a rather distinctive approach to classify and summarize the research work that has happened until now with a philosophical perspective of Ontology, Epistemology and Methodology.

Before diving into criticizing his critiques on the events of moving towards AI, it would be justified if I explain these confusing philosophical terms.

Ontology – It is study of being or the nature of reality.

Epistemology – It is a branch of philosophy concerned with the theory of knowledge. In other words, the nature of knowledge, knowledge acquisition etc.



Figure 1: A comparative difference between Ontology and Epistemology

Methodology – The next step after an epistemological study is methodology, where in different types of frameworks/methods that can be used for knowledge acquisition is studied.

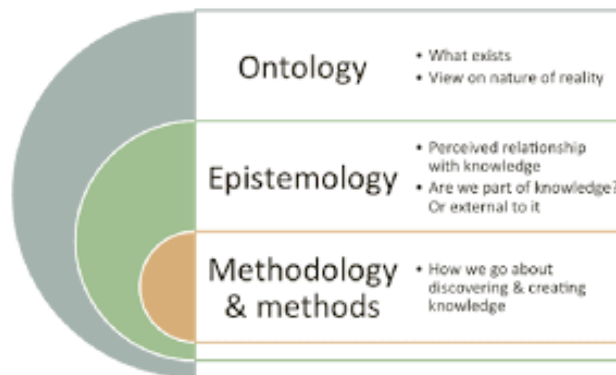


Figure 2: A comparison of Ontology, Epistemology and Methodology

This paper has conceived all the work accomplished till now in the field of AI in philosophical terms. Hence, we will need to understand a few other concepts that the author mentions along with the relevant AI work in terms of rationalism, empiricism, pragmatism and lastly Luger's constructivist bias. While I do try to explain these terms, they might be restricted to field of AI and largely dependent on this paper for categorization of an algorithm with any of the above stances.

Rationalist – Rationalists are those who believe in acknowledging/describing reality without the use of senses. In a form of logical sense based on deductions. They also assume to not have a priori (knowledge without experience). A popular such system was the expert/rule-based system. A cognitive plausibility was given by Newell and Simon with production system encoding long term human memory in the form of 50,000 rules of if/else constructs that exhibit expertise in Chess etc. The production system is considered to be an embodiment of the "physical symbol system hypothesis". Early robotic systems which rely on states are also considered to belong to the rationalistic approach.

Empiricist – This category of people believes that all knowledge in an abstraction or a symbolic representation of the reality and everything else is a manipulation of these symbols. Another characteristic is the creation of associations (correlation etc.) between symbols. One very good example is the conversion of audio and video input signals into bit strings. These bit strings are then manipulated to form associations. Some of the typical examples include semantic networks, Neural Networks, and Genetic algorithms and Artificial life all belong to such ideology. In robotics the Subsumption Architecture proposed by Rodney Brooks appears to be of empiricist ideology due to his strong criticism over Large Memory based system like the expert systems. However, ascertaining that Brooks is a pragmatist!

Pragmatist – He who believes in the practical application of concepts or the relevance of a research work in terms of applicability in the real world. Typical examples can be the Voice Assistants like Apple's Siri, IBM's Watson, chatbots etc., which understand the context of conversation.

Luger proposes that with Brooks, Dreyfus, Merleau-Ponty et. al. epistemic concern over traditional AI having explicit representations for expressing a behaviour and their limitations to adapt and acquire knowledge from the environments could be solved using DBNs and form a bridge between pragmatists and constructivists.

Constructivist - Those who believe that there is know one reality and the truth perception and varies with perception and situation. Hence, believe that the system must be adaptable to the environment in terms of the already existing conception. This was largely an ideology of Jean Piaget which can be related to a quote: *“People actively build their perception of the world and interpret actions and events that surround them in terms of what they already know”*. According to constructivists there is no single valid methodology in science, but rather a diversity of useful methods. This ideology highly opposes rationalist and empiricist ideology but bridges the gap between pragmatism and adaptability to a dynamic and variable environment.

Luger proposes that Dynamic Belief Networks (DBNs) can be a key solution for adapting to dynamic environments. The base is a Bayesian probabilistic model:

$$p(h_i/E) = \frac{p(E/H_i) \cdot p(h_i)}{\sum_k p(E/H_k) \cdot p(h_k)}$$

Where $p(h_i/E)$ is the probability that a particular hypothesis h_i is true, given evidence E .

$p(h_i)$ is the probability that h_i is true overall, i.e., how likely h_i is to occur.

$p(E/H_i)$ is the probability of observing evidence E when hypothesis h_i is true.

n is the number of possible hypotheses.

From this we can eliminate the denominator as it is the same for all the hypothesis. Next, we can find the most likelihood of hypothesis for a given a particular state. The helicopter rotor example has been extensively used to illustrate the same. A modified form i.e., *auto-regressive Hidden Markov Model (ARHMM)* which converts the raw sensory signal to Frequency domain using FFT and the state is analysed to provide the most likely cause of an error in the rotor system is predicted. It must be noted that each state variable is considered to be independent given the parent state or variable reducing a lot of computation.

A solution can also be arrived using RL algorithms which also implicitly utilize a probabilistic model and are able to gather knowledge from the surroundings dynamically. The author unfortunately does not mention this?!

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