Distinguishing and Defining Performant Intelligence

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Q: *"You almost got us killed! Are you brainless?"*

J: *"I speke!"*

Q: *"The ability to speak does not make you intelligent. Now get out of here."*

—*Star Wars: The Phantom Menace*

Introduction

What is "intelligence"? With ongoing improvements in the capabilities and the ubiquity of what we call "artificial intelligence" (AI), it becomes increasingly important to know what we mean by the terminology when we use it, whether in academic or in colloquial settings. In this paper, I note that there are two main categories of how we use the term "intelligence" in common speech: the *sentient* and the *performant*. I then point out that, within the *performant* sense of intelligence, there are, in fact, several different dimensions of what we call "intelligent" behavior, and evaluating each of these depends on one's context and goals. I suggest that these dimensions can be used to more precisely describe intelligence, whether natural or artificial, and avoid ambiguity in our everyday conversations.

Sentient vs Performant Intelligence

I observe that there are two broad uses of the term "intelligence" among people. The first kind, which I call "*sentient intelligence*," refers to a general, deep-thinking and consciousness, such as people might use to distinguish humans from animals. For example, this is used when a science fiction show refers to "intelligent life forms" in outer space. This kind is also commonly associated with artificial general intelligence (AGI). The second kind, which I call "*performant intelligence*," is more synonymous with "smart." It refers to the qualities of a mind that might make one "more intelligent" or "smarter" than another. This use might be used almost synonymously with "rationality". It can be applied equally to humans, animals, machines, etc. "I wish my dog was as intelligent as yours!" This kind is usually what is actually referred to in discussions of AI.

A mind with the first kind of intelligence has the capacity for the latter, but a mind can have either without possessing the other. Defining *sentient intelligence* would, I think, be better served by first defining "human-like generality", "cognition", or "consciousness". But what about the *performant intelligence*?

Four Dimensions of Performant Intelligence

I observe four different qualities that a person might refer to when describing "intelligence":

- **Speed**: Someone is viewed as smarter at something if he is faster at it. For example, the person has faster memory recall (in game shows like *Jeopardy*), or faster planning and response time in timed chess, or even faster ability to converse. People who speak unusually slowly are conversely often viewed as less intelligent.

- **Volume**: Someone is viewed as smarter if he is able to perform to a greater depth or breadth at once. For example, the person knows more facts about a subject, or can plan ahead in chess to a further depth, or is fluent in many more languages than the average person.

- **Utility**: Someone is viewed as smarter if his knowledge or actions are more correct or rational for achieving desired results. For example, the person has better accuracy in recalling facts, or better planning in games like chess (leading to winning), or better skill at activities such as driving.

- **Novelty**: Someone can be viewed as smarter for the creativity of his ideas or approaches. For example, the person solves problems by thinking "outside the box," or is an author who writes stories with unique or insightful themes and developments.

These can be considered orthogonal dimensions: Someone might have high *speed* at speaking or recalling things but still say things that are incorrect, poorly thought out, or unoriginal. Someone might know a high *volume* of facts but recall them at inappropriate times, or the person might have a high capacity to mentally simulate many possible futures in chess, yet still

play predictably or choose a poor plan. Someone's reasoning might have high *utility* in accuracy or logic but still be very slow or only about a small scope of things. And a person might be very *novel* in thinking but with different speeds, quantities, and degrees of relevance.

Three Processes of Performant Intelligence

I observe that the above dimensions are used to describe three particular categories of mental process:

1. **Comprehension**: Someone can be considered more intelligent for his ability to perceive and understand aspects of the world. For example, a person who better comprehends a scientific paper, infers the next item in a pattern sequence, reads difficult text, or perceives distinctions of ideas during a conversation.

2. **Recollection**: Someone is viewed as smarter if he has a better memory for facts or details. For example, a person who performs better in common game shows like *Are You Smarter Than a 5th Grader?*, or memorizes pi to some number of digits, or excels in memory tests.

3. **Manipulation**: Someone can be considered more intelligent for how well he mentally manipulates the knowledge that he comprehends or recalls during imagination, planning, and decision making. For example, a person who makes fewer mistakes in mental math or constructs better strategies during a board game.

Each of these processes has measures in terms of speed, volume, utility, and novelty: Someone might *comprehend* a scene at different speeds or with varying accuracy or representational quality, or comprehend different amounts at a time, or notice things others do not. Someone might *recollect* facts at different speeds or degrees of accuracy or quality, or greater volume or uniqueness in what he recalls (such as with a savant who can remember what the weather was like on any specific day ten years ago, which most people cannot do). Someone might *manipulate* or reason through comprehended ideas at different speeds or degrees of insightfulness, using different levels of detail or novelty.

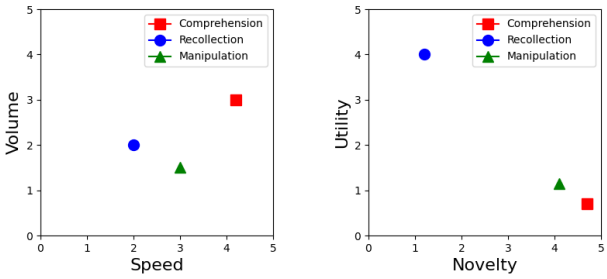
Comprehending that one sees a particular object involves recalling what that object is, and so comprehension and recollection often go together. However, they are distinct processes. An amnesiac who forgets most of their knowledge of what things are has reduced recollection, but he might still comprehend the world and discern distinctions in sights and ideas within it.

One might argue to add a fourth process of "execution": that someone can be considered more intelligent for how well he executes the ideas that he plans. For instance, someone might view a man as "intelligent" if he is throws a ball to flip a light switch in an impressive way. I argue that this is another manifestation of the processes already described. Intelligent planning of the low-level details of an action is distinct from one's physical fidelity to that plan when externally executing it. Physical fidelity to planned actions is clearly not usually associated with the word "intelligent." We do not typically describe someone as "smart" for how steady his hands are. Skillful execution requires a degree of motor skill and learning that is separate from the processes already discussed, however, the "smart" aspect of a man doing well at an external action like throwing a ball lies in comprehending the ongoing state of the world he is manipulating, recalling the correct action to take at each moment (both in imagination and in "muscle memory"), and planning the correct next actions to take at the appropriate moments.

One might be tempted to reduce the three processes of intelligence into simpler terms such as "input", "memory", and "output", but I advise against this. "Input" might be used to refer to more than comprehension, such as simply having good eyesight. Comprehension also can involve more cognitive processes such as pattern understanding that are not typically associated with the input process. "Memory" might be used to refer to different memory systems in the brain, such as perceptual or procedural memory, which would actually be involved in the other processes of comprehension and manipulation. "Output" might be used to include characteristics like steadiness of hands, which, as described, are not relevant for describing "intelligence".

Quantifying Intelligence

Speed, *volume*, *utility*, and *novelty* might be drawn as orthogonal dimensions in a graph, and the three processes as individual values plotted in that space. Since it is difficult to represent four dimensional space on paper, one could simply also draw two graphs for *speed + volume* and for *utility + novelty*, respectively. The former pair can be measured more objectively, while



(a) (b)

Figure 1: Example way of plotting intelligence for one individual in a particular task context.

the latter pair could be more subjective unless one is careful.

To keep a measurement of *utility* objective, one would want to quantify it in terms of some objective score, such as one's final score on memory test. It would be important to ensure that the measure accurately reflects the goals of the individual being measured, however.

To keep a measurement of *novelty* objective, one might try to embed graded answers within some N-dimensional space, and then measure whether that answer is an outlier or not relative to other answers. One must exercise caution here, however, as it is very difficult to guarantee that one's method of embedding an answer in some mathematical space accurately reflects the manner in which people regard an answer as intelligently novel.

Taking all four dimensions together, one could choose to plot intelligence in terms of specific tasks or sub-tasks or contexts. A person might be good at comprehending histograms but terrible at comprehending a subway map. Similarly, *utility* depends greatly on context.

It might also be useful to subdivide the three processes in terms of modality. For example, a person might be good at visual comprehension or manipulation but poor at auditory comprehension. One might attempt to plot other specific memory systems as well. However, it would be important to not attempt to divorce the above measures from the everyday life activities from which they are derived. One could try to measure overall "intelligence" by averaging scores across different tasks, similar to IQ-style tests, but one must remember that a high or low average in one area does not necessarily change the value of another area.[1]

Various IQ tests seem to implicitly target the three types of processing outlined above. For example, *comprehension* questions of pattern completion, such as, "Book is to reading as fork is to: __", or *manipulation* questions such as, "Which of the following can be arranged into a 5-letter English word? 1) H R G S T, 2) R I L S A, 3) T O O M T." (Succeeding at either of these examples requires recollection as well.)

Discussion

While there may not be a single standard definition of intelligence, John McCarthy (the man who coined the term "artificial intelligence"), offered the following definition, which has been widely adopted in the AI community:

> *"Intelligence is the computational part of the ability to achieve goals."* (Sutton, 2020)

This would, I think, fit with my framework, "the computational part" is described through the three processes, and "achieving a goal" is described in terms of the four dimensions.

Clearly, animal behavior in various activities can be measured using the same processes and dimensions described here. If one wanted to relate *sentient intelligence* to this framework of *performant intelligence* in an attempt to concretely define the computational part of *sentient intelligence*, if such is possible, then one would have to define the qualities that differentiate *sentient intelligence* from animal intelligence. This is beyond the scope of this paper and requires separate analysis and discussion.

The focus of this paper has been on distinguishing and defining *performant intelligence*. This is the sense usually involved in discussions of artificial intelligence. As artificial intelligence increases in its performant abilities, it becomes increasingly crucial to clarify what sets machines apart from humans.

At the end of the day, it is of chief importance that a person distinguish which sort of measure is being used when discussing an individual's, or a machine's, "intelligence". My hope is that more precise definitions will enable better disambiguation.

References

Sutton, R. S. (2020). John mccarthy's definition of intelligence. *Journal of Artificial General Intelligence*, *11*(2), 66–67.

[1]Though the distinction between average *manipulation* and *comprehension* with *recollection* might reflect the colloquial distinction between "understanding" and "wisdom".