B1. Methodology and Scientific Reasoning
Reasoning without language or logic

Ivan Gazeau
ivan.gazeau@polytechnique.edu
Ecole Polytechnique, France

Short abstract:

This talk proposes an explanation on how reasoning may work on an intuitive level (as it may be the case for superior animals) before the use of language and logic. We exhibit some processes that allow for the acquisition of mental representations of our environment. Our main contribution is: unlike proofs where hypothesis and goals have the same nature, actions and intentions are not comparable but have mirror properties. This might explain how our mind can select and refine "pertinent" notions so that solving a problem is as straightforward as possible.

We would like to propose in this talk some processes that may appear in our instinctive reasoning before we use language or logic. For instance, bears are able to solve mazes. And when we are trying to solve a puzzle, we do not especially have words in mind. In these cases, reasoning is just about modeling the world and forecasting the solution from our mental representation. But, most often, in the situation of understanding what the solution may be, we do not try all possible choices until we find a good one. Indeed, in some situations, we are not able to look over every choice (for example, with puzzles made up of pieces of wood and strings we may discover actions we did not think possible at the beginning). Moreover, after some unsuccessful tries, we will be able to feel whether what we are trying is promising or not. Here, we would like to begin an explanation on how this feeling appears and helps us to find the solution without trying all possibilities. But first, we will explore some properties of our material representation of the world.

When we represent ourselves manipulating an object, there is no small object residing in our mind that supports this simulation. When we are thinking about an object, we assemble experiences about it that may come from completely different domains. For instance, we can imagine ourselves cutting with a knife weighting ten kilograms, one centimeter long and made of plastic. Such an object cannot exist but it is not a problem for our mind. Indeed, we grab three distinct experiences: to manipulate a heavy object, to have a tool too small and to cut with a plastic knife.
Our representation of an object is not something we get all at one time. First, in a new environment, we do not have a good mental representation. When people use a computer for the first time, they can think what happens is due to one of their actions when it is not the case, or quite the opposite, think that the computer crashing cannot be the result of something they did, so that helping them is quite hard. So, acquiring our environment is done little by little: we grab experiences to simulate some actions while some behaviors may remain undefined in our mind. Then, when our environment grows more familiar, our representation becomes more like Newton's theory: we have basic objects (like atoms) and we have rules to make them interact from any initial position. Then we can define some assemblage as a cluster of smaller objects (a forest is somewhere where there are a lot of trees).

Now, we will introduce our idea. From an evolutionary point of view, superior animals need to represent their environment to find how to climb a tree but they also need information on how threatening their environment is. This latter information is instinctive judgment: without forecasting anything, some process will generate our intention for the situation. For example, instinctive judgments are what a blitz chess player feels when considering his next move and being instantaneously informed whether the move is good or bad, or if more turns should be examined. So instinctive judgments are not part of the forecasting reasoning but are processed in parallel. We might say that establishing instinctive judgments is the art to transform something that happens locally in a very distant future (the king's capture) to something present for the whole duration (of the game) and concerning the environment as a whole (all the pieces). Notice that to represent our environment, we do the opposite. For instance, we may enter a room and see a big mess, then we will distinguish big elements, like tables, then smaller objects (it is the same when discovering a computer: the registry key is not the first thing we deal with).

Furthermore, we believe that instinctive judgments - which we will call intentional representation - and material representations are mirror processes in our mind. Processes explained for material representations apply with mirror changes to intentional representations. Whereas material representation helps acting successfully (ex: to climb a tree), instinctive judgments move us to desirable intentions (ex: to stay or to leave a place). Material representations proceed "from small to big": Newton's laws define the interactions between two particles for an infinitesimal duration, then you can compute a long evolution and relative positions of numerous particles at equilibrium. Intentional representations proceed "from big to small": you know what you want to have in the end, you know the relationship between intentions (if one concrete intention is helpful or not for a more general one) then you try to find which sort of basic goal should be attempted to get what you want. This reasoning is finalised when you find a way to diplomatically explain something: there is no time progression but a refinement progression from the main ideas to the right words.

The interaction between these two representations allows us to establish useful notions. When we think about something, we have both representations in mind. For instance, to congratulate someone is associated with the actions that are effectively done to congratulate and with the fact that it encourages people to keep the same intentions. Because of this link, what we consider to be part of the material definition may be improved. For instance, we may think at first that congratulations need to be accompanied with a superficial smile, then, after discovering that it does not help with the encouragements, we will remove this element from our definition. So our concepts are not arbitrary definitions so much as they are points where material and intentional representations are strongly correlated. These changes can also influence the most basic objects of our representations, making us able to completely transform them.

We have taken everyday life examples to illustrate our proposal but these mechanisms may apply to the determination of mathematical demonstrations as well. Intentional representations contain high level concepts and explain how likely to solve some high level problem a method is. Material representations would be things you actually have the right to write while theorems would be the points making the correlation between both representations. To solve a problem, a mathematician would need to start by recognizing an "intention" from the problem like what properties " resist" to be proven, then refine the problem with intentional reasoning, then try to fill in the gaps using material reasoning.

Thus, what we have presented here is a possible model for our mental representation of the world. We have not checked if this model really occurs in our mind, but the construction, because it gives a way to create and improve notions, looks in itself promising.