The scope of human knowledge has certainly changed over the last 3000 years. Daily, we manipulate electrons and beam electromagnetic signals to and fro. Large scale distribution networks move goods between highly specialized production centers. Information flows from one corner of the globe to another in a matter of seconds. Clearly, we live in an age of wonder. But interestingly, while what we have learned has increased over the centuries, the methods of inquiry into obtaining new knowledge really haven’t changed all that much; certainly what we know has changed greatly but not how we learn it.

Case in point, it the use of regression or recursion as a tool for understanding the world in a philosophical way. The applications of this approach are numerous due to the wide utility and the fruitful applications of it.

For example, [Aristotle argued for that Man must have a purpose](http://www.people.fas.harvard.edu/~korsgaar/AristotleFunction.pdf) by using a type of regression argument whose spirit, although not its explicit nature, goes something like this. Consider the bones of the hand; their function is to provide stiffness. Likewise, the ligaments, tendons, and muscles provide the articulation. The nerves provide the sense of touch and the flesh provides a means of touching, gripping, and holding as well as a unity and an encapsulation for the other parts. All of these pieces have a function to perform in the greater existence that is the hand. Likewise, one can find smaller parts serving limited roles within limbs, organs, and systems within the human body: the eye serves to see; the nose to smell and breath; the mouth to chew, taste, drink, eat, breathe, and talk; and so on. Since each piece contributes, through its function, to the greater function of the thing to which it is a part, isn’t reasonable to assume that the completed whole, the sum of all these individual parts within parts, also has a function or purpose? This argument, put forward approximately 2500 years ago, is still compelling and persuasive.

Saint Thomas Aquinas, one the great philosophers of the medieval world, put forward arguments greatly influenced and cast in the form of Aristotle’s arguments. In his Cosmos section of the *Summa Theologica*, [Aquinas offers five proofs for the existence of God](https://en.wikipedia.org/wiki/Five_Ways_(Aquinas)#The_Five_Ways) based on the concept of regression. In [outline form](http://web.mnstate.edu/gracyk/courses/web%20publishing/aquinasfiveways_argumentanalysis.htm) they are:

1. *Argument from Motion/Change*: changing things depend on their interaction with other things (a plant depends on sunlight which, in turn, depends on ongoing fusion, and so on). Since no change can start itself, things react when acted on by an external mover. The only way to avoid an infinite regression of things depending on yet more things (all operating simultaneously) is to assume that there is a prime or unmoved mover.
2. *Argument from Efficient Causes*: current effects are brought about by prior causes, which are, in turn, effects of causes one level more removed. The only way to avoid an infinite regression of things causing other things is to assume that there was a first cause not caused by anything else.
3. *Argument from Possibility and Necessity*: beings come and go into and out of existence; they are contingent – having a limited time during which they exist. Given infinite time in the past, there must have been a time where all things were absent implying nothing could exist now. Given the current state of existence, the only way to avoid this contradiction is to assume the existence of a non-contingent being.
4. *Argument from Gradation of Being*: natural objects are understood and ranked by quantities or qualities; this object is hotter than that one, this thing is better than another (better constructed, better conceived, and so on). Ranking requires a maximum (e.g. hottest object) from which all are measured. The only way to judge something as better is if there is a best that exists.
5. *Argument from Design*: natural objects seem to work towards a goal that they themselves don’t or can’t know and so are directed by a higher intelligence. The only way to avoid an infinite regression of greater intelligences directing lesser ones is to assume that there is a master intelligence that directs all.

In all of these arguments, Aquinas identifies the thing that prevents an infinite regress, that stops the chain of thinking at a well-defined point, as God.

These kinds of logical arguments are not limited to the purely metaphysical realm. One of the crowning achievements of mathematics is the development of set theory, which depends heavily on the type of arguments put forward above. The presence of a run-away regress, one that never stops, is a sign of issues within set theory. This typically, although not exclusively, happens when dealing with infinite collections or sets of things and leads to many paradoxes that must be resolved in order for mathematics to be put on a firm foundation.

Perhaps the most famous example is [Russell’s paradox](https://en.wikipedia.org/wiki/Russell's_paradox). The paradox is based on defining two types of sets:

* Ordinary sets – sets that do not contain themselves
* Extraordinary sets – sets that do contain themselves

It isn’t at all clear that extraordinary sets exist. If they do, they can’t be constructed using finite sets or the more familiar infinite sets like the integers or reals. But assuming that they do exist, one can ask the following question:

Does the set of all ordinary sets contain itself?

To see that this leads to a paradox, first suppose that this set, call it ***Q***, doesn’t contain itself. It is then an ordinary set by definition. Since it is ordinary, it should go in a listing of all ordinary sets – that is, it should contain itself. Thus, we conclude that ***Q*** is extraordinary (hence the need to define the term in the first place).

So far so good!

But the fly in the ointment comes when we look carefully at ***Q*** being extraordinary. The membership requirement to be in ***Q*** is that the element must be ordinary. But if ***Q*** is contained within ***Q***, it must be ordinary. And so, we arrive at an infinite loop where one condition implies the other and vice versa.

Oddly enough, even though the trappings are associated with present-day set theory, replete with fancy modern symbols, the structure is almost the same as the ancient [liars paradox](https://en.wikipedia.org/wiki/Liar_paradox). The main ingredients are self-reference and a requirement to end an infinite regression.

The solution of these paradox is a story for another post. The point here is that while the physical tools we use to manipulate the world have evolved dramatically over the centuries, the mental tools we use to grapple with logic remain largely unchanged.