Remote Learning Module for 1 April 2020

Lecture Notes: Leibniz, Physics & Theory of Perception

Last time we took stock of Leibniz's life and times. It will be important for us today to remember that Leibniz's early work focused on physics and mathematics, which, along with his later ontological argument, featuring the principle of sufficient reason, he brought to bear against both Cartesian and Newtonian mechanics.

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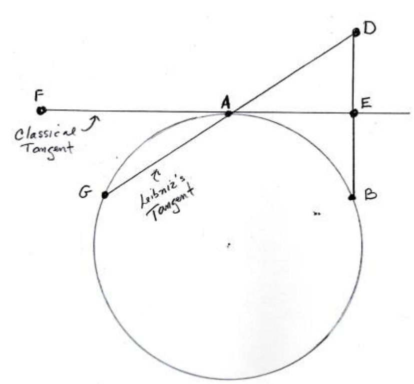
(1) The Problem of Planetary Motion.

One of the primary problems for mathematical physics in Leibniz's day was that of modelling and measuring the motion of the planets, especially that of the Copernican Earth, whose annual revolution around the sun was still understood as circular or roughly circular—until Newton finally demonstrated, in 1687, that Kepler's laws, where the planets trace elliptical orbits, were mathematically demonstrable from Newton's new law of universal gravitation, $F=(m_1 \times m_2)/r^2$, alone. Consider the scale of the problem. With a radius of roughly 4,000 miles, and therefore a circumference of approximately 25,000 miles, the rotational speed of the Earth is about 1,000 miles per hour. The Copernican sun was thought to be a mere 4.6 million miles away from the Earth (travelling at 3,200 miles per hour). On the Copernican model, if the Earth's path around the sun was indeed circular, then, at 93 million some odd miles away, the Earth would be travelling at 69,000 miles per hour. Empirical observation needed a general theory in order to arrive at reliable predictions and accurate models.

(2) The General Problem of Motion along a Curve.

Using his new differential calculus, Leibniz broke the curve up intro many little straight lines, creating a *polygon curve*. As the number of sides increases, the polygon curve increasingly approximates the *rigorous curve* more closely. Leibniz defined the tangent at any point on the curve as the extension of the side of the polygon whose vertex is at that point. This, however, appeared to generate a paradox, as evident in the following illustration.



Centripetal force is the force needed to return a point mass from the tangent to the curve; it is proportional to the distance: EB on the rigorous curve, and DB on the Leibnizian curve. At the limit, FAE will coincide with GAD. But, paradoxically, DB will always equals 2 x EB.

Leibniz proposed to solve this problem by introducing a new law for the conservation of momentum. Descartes' law required that conservation is only maintained if motion in opposite directions are subtracted; it says that momentum is the product of mass and velocity (mv). In its place Leibniz proposed mv^2. The force required to propel an object is, he said, a living force, or *vis viva*. According to Leibniz, *vis viva* is absolute; it is *in* the object. For Descartes, Newton after him, a force only exists *between* objects. Leibniz's view was favored, incidentally, by the Italian physicist, Giovanni Poleni, because the latter found that balls of unequal mass but the same size will make the same impressions in clay *only if* they are dropped from a greater height (and, yes, Poleni actually did drop balls from the Leaning Tower of Pisa), and, by Galileo's law, where the relative heights are proportional to v^2 at impact.

With his new physics in hand, Leibniz took up his obsession with refuting both Cartesian substance dualism and Spinoza's substance monism in one fell swoop.

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(3) Leibniz's Reduction of *Res Extensa* to *Res Cogitans*.

(i) Leibniz utilizes two sorts of argument to reject the plenum physics on which both Descartes' substance dualism and Spinoza's property dualism depend. The first argument reflects a 'bottom-up' strategy and consists mainly in a reinvention of the mathematical foundations of physics; the second argument reflects a 'top-down' strategy and consists mainly in a metaphysical analysis that reduces the concept of extended substance to absurdity.

(ii) *New Foundations:* Leibniz proposes to replace the basic units of physical reference (bits of matter/extension in motion) with what he calls "ratios of force" (energy). He thus rejects the following two postulates of Cartesian, Spinozist, and Hobbesian physics:

> (A) The *plenum* is composed of discreta;
>
> (B) The fundamental law of mechanics is the *Conservation of Momentum.*
> [The overall quantity of motion in the universe remains constant over time: when something speeds up or increases in mass, something else slows down or decreases in mass.]

Leibniz proposes instead:

> (C) The *plenum* is composed of continua;
>
> (D) The fundamental law of mechanics is the *Conservation of Kinetic Action.*

(iii) Leibniz argues that the old physics fails to predict phenomena correctly; it implies that all motion is circular and instantaneous, when, in fact, observation records rectilinear, continuous motion. His point is that if bodies are the fundamental units of physical science and bodies are definable as discrete regions of space, then motion is the passage of a body through a definite number of intermediate places. But accelerated motion cannot be so described, since the velocity is continuously increasing at a given time, so motion doesn't happen in leaps, but continuously. "Body in motion" is just a derivative concept--the primary concept is *continuum of energy.* The units of physics are, then, infinitely small quanta of force: each unit is therefore a simple (not composite)--what Leibniz calls a *monad.*

(iv) *Substance:* Leibniz also argues, on metaphysical grounds, that substance must by simple: since no physical things are simple, no physical things are substances. In a letter to Arnauld, Leibniz offers the following analogy. Is an army a substance? One might think so; but in fact it is simply a number of soldiers interrelated in certain ways--the whole truth about the army can be expressed without residue in sentences of the form: $F(a_1, a_2, \ldots, a_n)$. In general, true assertions about aggregates are similarly reduced to assertions about constituent parts. Concerning extension, Leibniz argues that anything with parts is an aggregate and that extended objects are, by definition, *pars ex partes*, and therefore aggregate: in Jonathan Bennett's phrase: "a diamond is on a par with a flock of sheep, but to scatter it, you have to bark louder." Extension must reduce, then, to simples.

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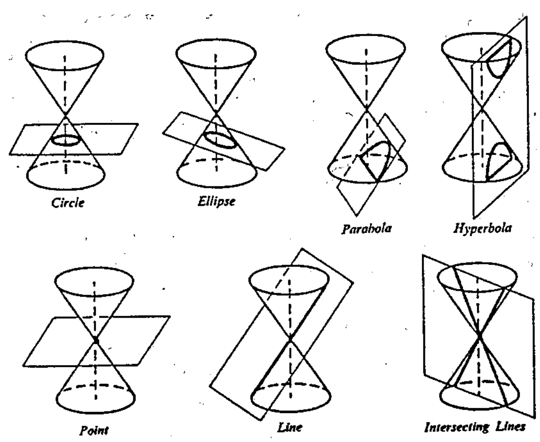
(4) Theory of Perception in Leibniz.

(i) Leibniz's phenomenalism (or immaterialist metaphysics) connects theory of substance, theory of perception and dynamics under a general theory of monads. Thus, for Leibniz, substance and its states, as well as bodies and their forces, are to be understood in terms of the mind and its perceptions. Accordingly, it is crucial to sort out the lineaments of the theory of perception through which Leibniz provides the unification of his metaphysics.

(ii) Two preliminaries: (a) not all substances are minds, nor are they all aware of their surroundings (the theory of substance would remain intact even if no human knowers existed); and (b) the theory of perception is a *metaphysical* but not an *epistemological* theory ("perception" does not account, as in the empiricists, for how we come to know the world--it accounts for what the world is).

(iii) Leibniz worked out the central features of his theory of perception at least as early as 1687; he writes to Arnauld: "A perception is the expression or representation of the many in the one or the composite in the simple." Arnauld replied: "You say our soul expresses even the whole universe. . . but if you mean some thought or item of knowledge, I cannot agree. . . but if not, I do not know what it [a perception] is" (28 August 1687). Leibniz replies: "One thing *expresses* another when there exists a constant, fixed relationship between what can be said of one and of the other. This is the way that a perspectival projection expresses its ground plan" (9 October 1687). But the core idea--perspectival projection--was already developed some nine years earlier (in the fragment, *What is an Idea?*). Here Leibniz provides a list of examples: a model expresses a machine, a map expresses a geographical area, a projective drawing in a plane expresses a solid, a whole effect expresses a whole cause, an algebraic equation expresses a geometrical figure, characters express numbers, and the world, expresses God. What impressed Leibniz about all these examples was that we can pass from a consideration of the relations in the expression to a knowledge of the relations in thing expressed. His favorite example, however, was perspectival projection: he used it, for example, against Locke's differentiation of qualities into primary and secondary and as an articulation of the Principle of Harmony.

(iv) Locke had supposed that while our ideas of the primary qualities resemble real qualities of objects, our ideas of the secondary qualities do not. Leibniz argues against this view that the secondary qualities exhibit an incomplete but *expressive* resemblance. In the *Theodicy*, for instance, he writes: "It is true that the same thing may be represented in different ways: the projections in perspective of the conic sections of the circle show that one and the same circle may be represented by an ellipse, parabola, hyperbola, another circle, straight line, even a point. Nothing appears so different nor so dissimilar as these figures; and yet there is an exact relation between each point and every other point. Thus one must allow that each soul represents the universe to itself according to its point of view, and through a relation which is peculiar to it; but a perfect harmony always subsists therein" (*Theodicy,* §357). Thus:



(v) Expression, then, is the genus of which perception, animal sensation, and intellectual knowledge are species.

(vi) Consequently, for Leibniz, a soul expresses the particular states of its own body, but through its body it expresses the states of the rest of the universe, no part of which can fail to have some effect on it through the propagation to infinity of motion in a mechanically operating universe. He writes to Sophia: "The universe being in a way fluid, all of one piece, and like a limitless ocean, all motions are conserved and propagated to infinity. . . this communication of motion means that each thing acts on and is affected by every other thing" (to Electress Sophia, 9 February 1706).

(vii) In order to hold this theory over against Arnauld's worries (Arnauld does not find in his own mind anything even remotely like an awareness of the whole universe), Leibniz invents a distinction between conscious and unconscious perception. He does this by differentiating *distinct* and *confused* perceptions in such a manner so as to allow one and the same perception to be both distinct *and* confused. A perception is distinct in terms of its *external* relations to other perceptions from which it is distinguished, while a perception will be confused in terms of the infinitude of *petite perceptions* of which it is composed. Leibniz has two favorite examples: (a) the roar of the surf is *distinct* from, say, the roar of a lion, but the roar of the surf is a *confused* aggregate of all the waves we must be perceiving below the threshold of apperception (conscious awareness); and (b) the color green is *distinct* from, say, the color purple, but the color green is a *confused* aggregate of perceptions of the colors blue and yellow, neither of which we apperceive when examining green objects.

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On Friday, we'll turn our attention to Leibniz's metaphysics in the *Monadology*. Be well everyone, and remember: social distancing saves lives, which is presumably why we are still not in JUB 202 presently.