Berkeley Mathematics and Science

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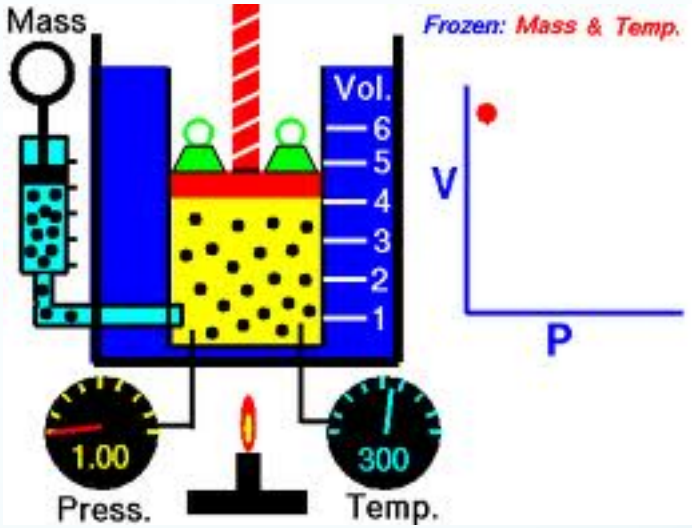
Ubiquity of Abstraction in Math and Science

- Laws of physical science and mathematics include inevitable uses of abstract terms
- *If...the perception that the same ideas will eternally have the same habitudes and relations is not a sufficient ground of knowledge, there could be no knowledge of general propositions in mathematics, for no mathematical demonstration would be any other than particular (IV.I.9, AW 388b).*

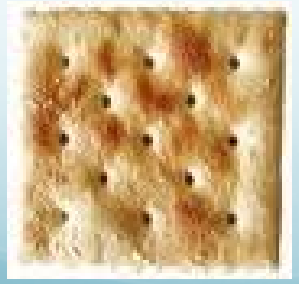
- Laws of Physics
  - Newton's three laws of motion
  - Gravity
  - Conservation of mass-energy
  - Thermodynamics
- Laws of Chemistry
  - Charles': V1T2=V2T1
  - Boyle's: P1V1=P2V2
  - **Ideal gas: pV=nRT**
    - **P? V?**
- Laws of Biology
  - Darwinian evolutionary theory

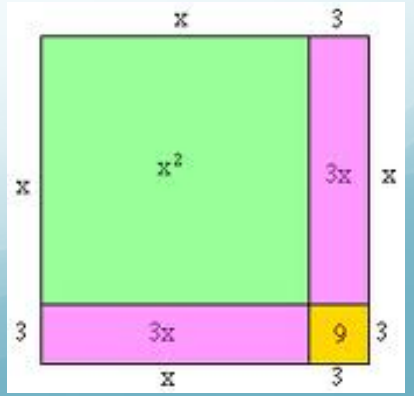


Review: Locke and Abstract Ideas

- Start with sense experience
- Notice common properties
- Assign a name to that possessing the common properties
- ex. abstract square-ness from the specific properties of squares





Review: Locke's Empirical Mathematics

- Locke's account of mathematics depends on this doctrine of abstraction
  - Sense the particulars of square objects in external world and generalize to form an individual abstract idea of a square
- Mathematical theorems pertain to our personal ideas
- Everyone's mathematical theorems concern their own mathematical ideas
- Follows that truth makers of mathematical theorems are *not* mathematical objects
- Math is certain, yet does not concern real things

Review: More Locke on Mathematics

- [The mathematician] is certain all his knowledge concerning such *ideas is real knowledge, because intending things no further than they agree with his ideas, he is sure what he knows concerning those figures, when they have barely an ideal existence in his mind, will hold true of them also when they have real existence in matter, his consideration being barely of those figures which are the same, wherever or however they exist (IV.IV.6, AW 404b).*

Skepticism and Atheism

- “invincible blindness to the *true* and *real* nature of things”
- Skepticism results because we can’t know if the perceived objects are like the unperceived objects.
- Atheism results because objects have internal causes driving them towards their essences (no room for God)
- Presupposes that external bodies have:
  - Existence without the mind
  - Essential impulses and internal forces which are beyond our comprehension
- Berkeley denies the existence of material causes
- No other efficient cause than spirit (God)

Berkeley's attack on Locke's conceptualism

- Berkeley's philosophy of mathematics rejects:
  - **Universal abstract ideas**
  - **Matter with an existence independent of mind**
- In mathematics, problem of abstraction is exacerbated
- *That the principles laid down by mathematicians are true, and their way of deduction from those principles clear and incontestible, we do not deny; but, we hold there may be certain erroneous maxims of greater extent than the object of mathematics, and for that reason not expressly mentioned, though tacitly supposed throughout the whole progress of that science; and that the ill effects of those secret unexamined errors are diffused through all the branches thereof. To be plain, we suspect the mathematicians are as well as other men concerned in the errors arising from the doctrine of abstract general ideas, and the existence of objects without the mind (Principles, §118).*

Berkeley on Mathematics

- **Berkeley rejects both contentions about mathematics:**
  - **It is based on Platonic or other abstract general ideas**
  - **It is about about sensible objects**
- Arithmetic and algebra as sciences about signs rather than objects
- But Berkeley wants definite physical referents for the whole numbers
- Numbers as relative and arbitrary "creatures of the mind”
  - An object can have an extension of 1, 10, or 100 according to its measurement in different units

Berkeley on Mathematics

- *“Arithmetic regards not the things but the signs, which nevertheless are not regarded for their own sake, but because they direct us how to act with relation to things, and dispose rightly of them"*
- Berkeley deviates from an empirical account of mathematics
- He denies that mathematical proofs have any real content
- So, mathematicians should reason without concern for the significance of the signs
- Berkeley does not deny the usefulness and convenience of mathematical theorems
- He wants us to avoid using them improperly

Berkeley and Calculus

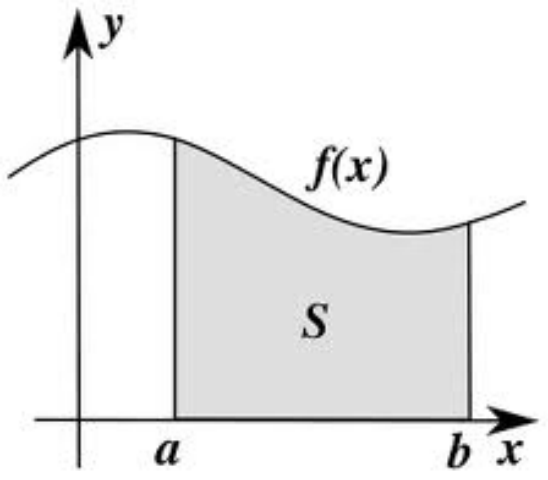
- Calculus is an important example of Berkeley’s issue with abstract mathematical ideas
- Skeptical of its foundations and methods
- Fundamental entities of the calculus: **Leibniz's infinitesimals** and **Newton's fluxions**
- Stand for no perceptible objects or ideas
- Hence have no geometrical legitimacy

Infinite Divisibility

- The *infinite divisibility of finite extension, though it is not expressly laid down either as an axiom or theorem in the elements of that science, yet is throughout the same everywhere supposed and thought to have so inseparable and essential a connexion with the principles and demonstrations in geometry, that mathematicians never admit it into doubt, or make the least question of it. And, as this notion is the source from whence do spring all those amusing geometrical paradoxes which have such a direct repugnancy to the plain common sense of mankind, and are admitted with so much reluctance into a mind not yet debauched by learning; so it is the principal occasion of all that nice and extreme subtilty which renders the study of mathematics so difficult and tedious. Hence, if we can make it appear that no finite extension contains innumerable parts, or is infinitely divisible, it follows that we shall at once clear the science of geometry from a great number of difficulties and contradictions which have ever been esteemed a reproach to human reason, and withal make the attainment thereof a business of much less time and pains than it hitherto has been (Principles §123).*

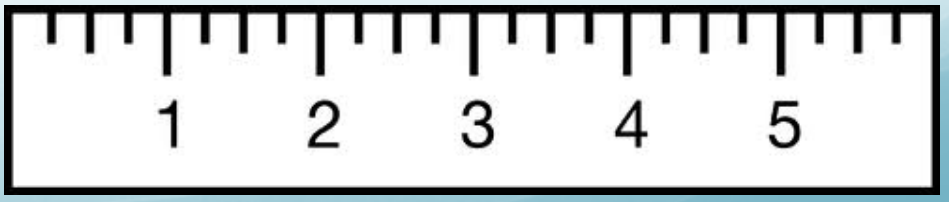
Paradox of Infinite Divisibility

- Calculus relies on extensions of infinitely small length
- Practical applications of calculus (to empirical science) seem to defend the phenomenon
- However, infinitesimals are incongruous with Berkeley's idealism and metaphysics
  - (things are just objects of perception)
- Berkeley's world (of ideas) is not infinitely divisible
  - Minimum sensibilia
  - Full moon=30 minimum sensibilia



Infinite Divisibility of finite segments

- There is no such thing as the ten-thousandth part of an *inch; but there is of a mile or diameter of the earth, which may be signified by that inch (Principles §127).*
- 10,000km vs. 1 inch on a map
- We cannot conceive of an inch itself as consisting of a thousand parts
- Berkeley argues that in order to use mathematics, it is *not necessary* to assume that there are infinite parts of finite lines or any quantities smaller than the smallest that can be sensed



Abstraction and Science

- Process of abstraction also gives rise to scientific laws
  - *Those who treat of mechanics employ certain abstract and general words, and imagine in bodies force, action, attraction, solicitation, etc., which are exceedingly useful for theories, enunciations, and computations concerning motion, although in actual truth and in bodies actually existing, they are sought in vain, as much as are those things imagined by mathematical abstraction* (*On Motion, §39, AW 506b).*

Berkeley and the Laws of Nature

- We learn [laws of nature] by experience, which teaches us that such and such ideas are attended with such and such other ideas in the ordinary course of things (*Principles §30, AW 453a).*
- Observe harmony and uniformity in nature from particular experience
- Explain these effects
- Reduce them to general and abstract rules
- Use them as foundational theorems and axioms
- Apply them broadly across nature
- Make conjectures and predictions about the world at a distance
  - Ex. All emeralds are green
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Berkeley and Gravity

- We perceive heavy bodies falling towards the center of the earth, nothing more as far as senses are concerned
- Reason suggests there must be a governing principle, call it gravity
- Force of gravity itself is not sensible
- Occult: abstract and obscure from view
- No clear or distinct meaning in words like gravity
- We don’t know if gravity is necessary or essential anywhere in the universe
- Cannot characterize gravity as an inherent quality of objects

Berkeley and Gravity

- Reason proves that there is some cause or principle of these phenomena, and this is generally called *gravity. Since, however, the cause of the fall of heavy bodies is dark and unknown, gravity in that sense cannot be called a sensible quality; consequently, it is an occult quality. But we can scarcely conceive - and indeed not even scarcely - what an occult quality is, and how any quality can act or effect anything.* ***It would be better then, if men would attend only to the sensible effects, putting the occult quality out of view****. Abstract words - however useful they are in discussion - should be discarded in meditation, and the mind should be fixed on particular and concrete things, that is, on the things themselves (On Motion, §4, AW 504b-505a).*

Berkeley and Science

- We find regularities and call them laws, but not all uniformities are laws (laws are predictive)
- Difference: presence of a *causal* relationship to explain the uniformity
- Recognition of a uniformity does not imply causality
  - Example: five people in a room
- Science can be used to:
  - Explain behavior of objects under particular circumstances
  - Newtonian equations: calculate observable phenomena
  - Scientific theories as predictive tools, neither true nor false
- Berkeley thinks scientific theories provide no *real* understanding

God and Science

- True cause of any phenomenon is a spirit, namely God
- God is original source of causation
- If we attentively consider the constant regularity, order, and concatenation of natural things, the surprising magnificence, beauty, and perfection of the larger, and the exquisite contrivance of the smaller parts of creation, together with the exact harmony and correspondence of the whole, but above all the never-enough-admired laws of pain and pleasure, and the instincts or natural inclinations, appetites, and passions of animals; I say if we consider all these things, and at the same time attend to the meaning and import of the attributes One, Eternal, Infinitely Wise, Good, and Perfect, we shall clearly perceive that they belong to the aforesaid spirit, *who works all in all, and by whom all things consist (Principles, §146).*

Berkeley and God

- Berkeley leaves room for miracles
- God is responsible for both the uniformity and the anomalies in nature
- We should further consider that the very blemishes and defects of nature are not without their use, in that they make an agreeable sort of variety, and augment the beauty of the rest of the creation, as shades in a picture serve to set off the brighter and more enlightened parts... It is plain that the splendid profusion of natural things should not be interpreted weakness or prodigality in the agent who produces them, but rather be looked on as an argument of the riches of His power (*Principles, §152).*

Inconsistency in Scientific Theory: neurodiversity

- For example, the case of Autism disorder
- Widespread abnormalities of social interactions and communication
- Spectrum disorder
- Error comes in presuming abstract underlying regularities where maybe none really exist

Berkeley's Essential Points

Berkeley's philosophy of mathematics rejects:

- **Universal abstract ideas**
- **Matter with an existence independent of mind**

- Mathematics is useful but…
- Mathematical terms are empty names
  - Physical universe fails to offer any particular examples of lines and numbers
- Thus, Berkeley denies *any* mathematical knowledge

Berkeley's philosophy of science:

- The human scientific mind seeks uniformities among particular experiences
- Berkeley denies that an understanding of the uniformities in nature leads to ascribing causal powers to any objects other than God

Discussion

- Can uniformity and irregularity both be attributed to God?
- Natural science has made much progress by assuming the existence of matter and mechanical motion…
- Does natural science have to presuppose a material world?