## Section 2: Gottfried Wilhelm Leibniz

**Reading**: http://www-history.mcs.st-and.ac.uk/Biographies/Leibniz.html

For many years, Isaac Newton was considered the father of the calculus and Leibniz was an afterthought. Through much research however, mathematicians have come to realize his importance in the development of this important field. The early claims that his work was not his own were dismissed almost as quickly as they arose, and his brilliant contributions to other fields furthered enhanced his credibility. Additionally, the notations he used in his version of the calculus were far superior to Newton's and many remain used to this day.

It was the mid 1670's when Leibniz developed his version of the calculus. In late 1675 (some sources claim October 29, other November 21), he first used an elongated S for his integral sign (derived from the first letter of the Latin word *summa* - sum) to indicate the sum of many infinitely small intervals. Within just a few weeks, he was using derivatives as we do today as well. His first paper on differential calculus appeared in 1684 and he used the $dx$ notation. Many of the elementary rules of differentiation were developed by Leibniz as well.

Leibniz was very sensitive to the importance of good notation in his work and worked hard to have a well-devised symbolism. His $dx$ notation proved to be significantly more flexible than Newton's $\dot{x}$. Due to the dispute between the two men regarding the true originator of the calculus, a deep rift formed between English mathematicians and those on continental Europe. We will discuss this in more detail in Section 1.3, but this friction led English mathematicians to cling to Newton's dot notation and his method of fluxions. This stubbornness lasted many years; in fact 200 years later when the Analytical Society was formed at Cambridge University, one of its founders Charles Babbage stated it was formed for the purpose of advocating "pure $d$ -ism as opposed to the *dot*-age of the university."

Leibniz was apparently a die-hard optimist. One of his life-long goals was the reunification of the Protestant and Catholic churches. When that seemed impossible, he set his sights on Christianizing all of China using another of his creations developed around 1679 (but not published until 1701): binary arithmetic. In this he saw the image of creation; since God may be represented by one and nothing by zero, he imagined God created everything from nothing just as in binary arithmetic everything is created from zero and one. The reigning emperor of China was particularly attracted to science, so Leibniz presented his ideas to the President of the Mathematical Board of China in the hopes of converting the emperor, and thence all of China, to Christianity.