THE LIFE AND ACHIEVEMENTS OF GEORGE BOOLE

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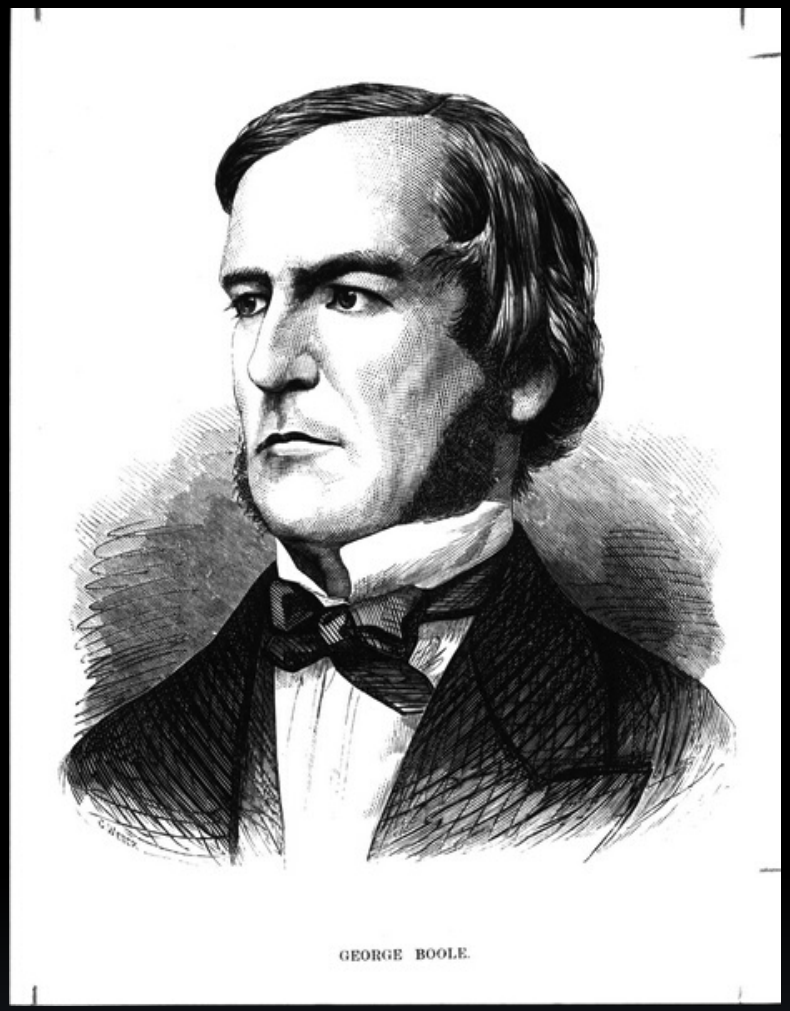


October 17, 2011

The University of Texas at El Paso

Course: University 1301

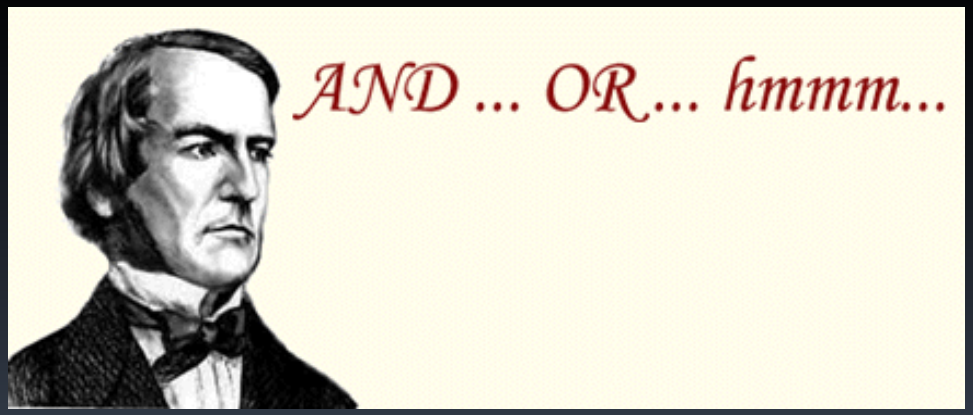
Instructor: Dr. Helmut Knaust

Peer Leader: Priscilla Lucerno

Overview of Presentation

George Boole: His Life and Achievements

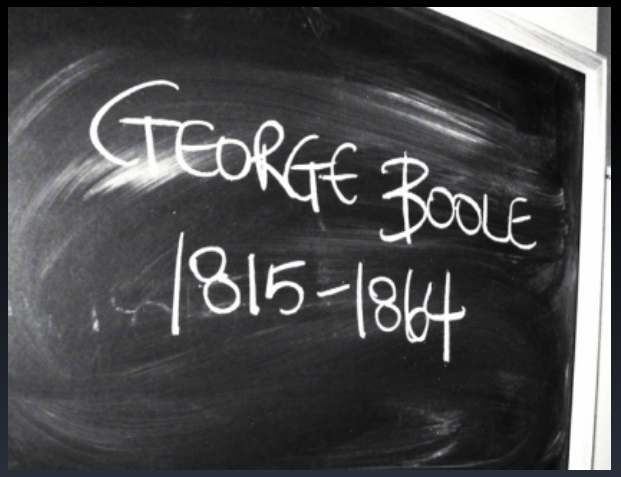
- Introduction
- The Birth of George Boole
- George Boole & Family
- Childhood & Schooling
- Early Twenties
- Brief Overview on Invariant Theory
- Who Influenced Boole?
  - Leibniz
  - Lagrange
  - Laplace



Overview of Presentation

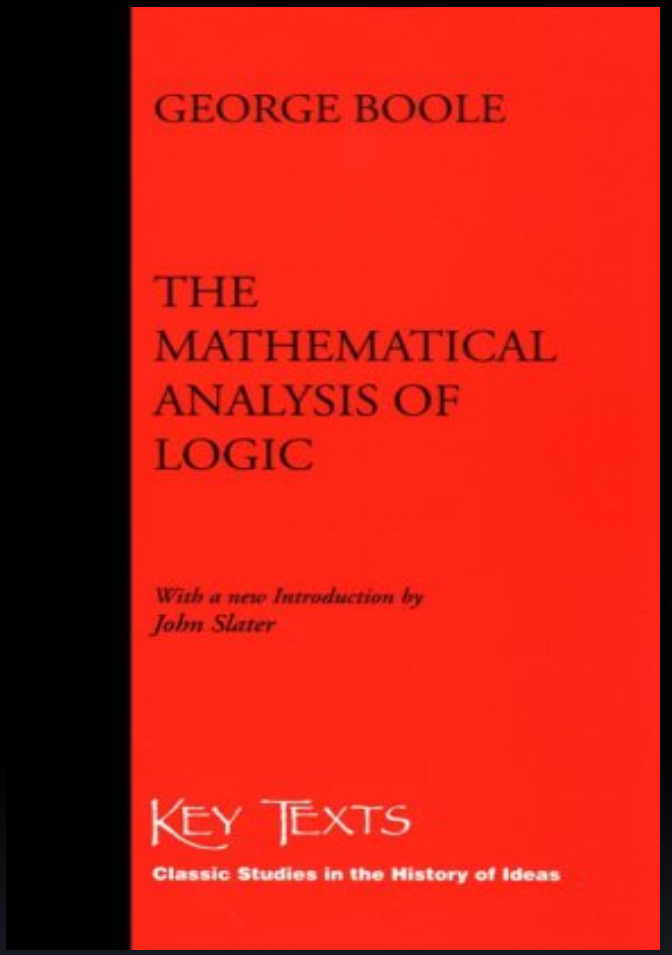
George Boole: His Life and Achievements (continued)

- Professorship at Queen's College
- *The Laws of Thought* and Boolean Algebra
- Boolean Algebra and *The Laws of Thought*
- Marriage to Mary Everest
- Children of George and Mary Boole
- Death
- Legacy



Introduction

- English Mathematician
- Inventor of Boolean Algebra
- Two major writings that incorporate George Boole's work: "The Mathematical Analysis of Logic"(1847) and "The Laws of Thought" (1854)
- Known as the "founder of the field of computer science"
- Major influence on development of computer circuits



George Boole & Family

The Duke of Wellington leading the British troops in the Battle of Waterloo, five months before George Boole's birth.
Source: paranoidpyro8503.blogspot.com

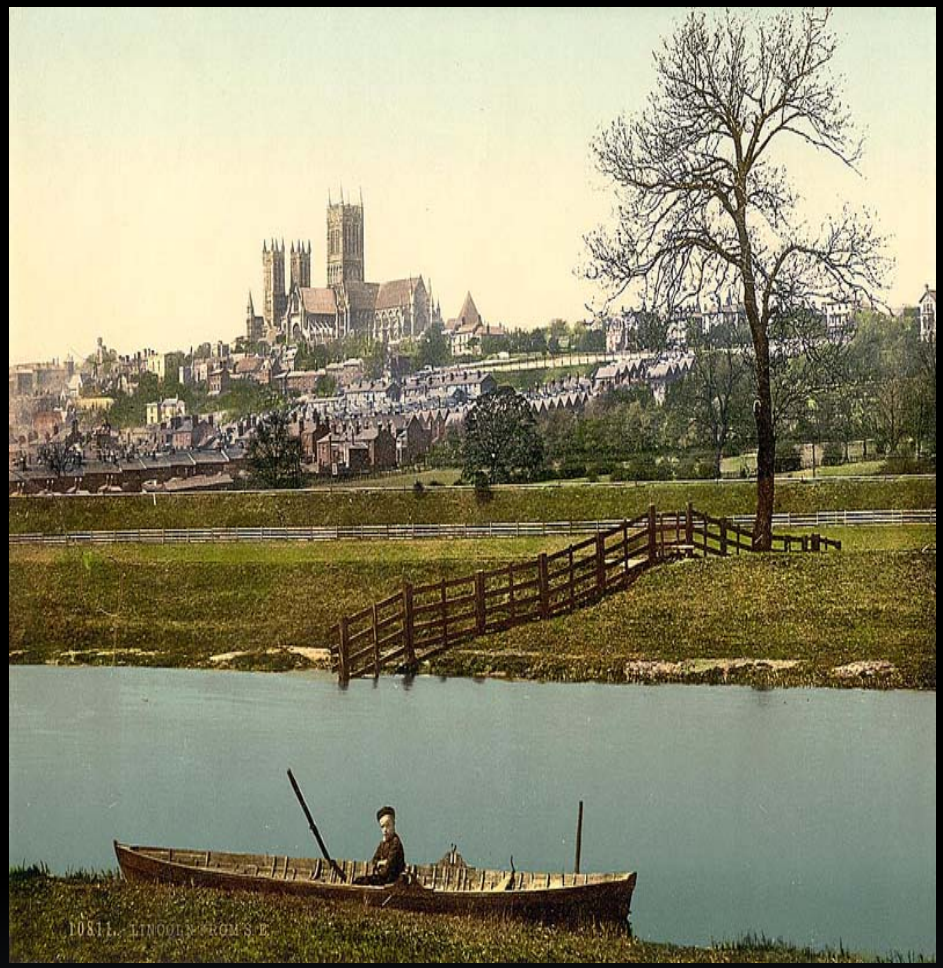
- Mary Ann Joyce & John Boole married September 14, 1806
- Father: John Boole, shopkeeper and amature mathematical scientist
- Mother: Mary Ann Joyce, a lady's maid
- John owned a cobbler shop located at 34 Silver street, Lincoln

The Birth of George Boole

- Born November 2, 1815 in Lincoln, England
- Born into the "lower classes" of English society

George Boole & Family

- Father had deep passion and love for mathematics as well as instruments; drove majority of attention to hobbies instead of securing successful business
- Family not well off
- After John & Mary Ann had 9 years together conceived George
- George named after his grandfather, who passed away in 1815
- Three siblings: Mary Ann, William, and Charles



A painting of Lincolnshire, UK
image source: www.oldukphotos.com

Childhood & Schooling

- At age two, attended school for children of tradesmen
- A year after, age three, attended a commercial school; remained seven years
- Father primary instructor and inspiration in Mathematics throughout Boole's schooling years
- Father peeked son's interest in making optical instruments

Childhood & Schooling

- Attended a primary school at age of seven
- Became interested in learning classical languages as a way to raise his social status
- Father noticed son's interest in laguages; had friend William Brooke, a bookseller, teach George Latin
- Boole taught himself Greek at age 14

Typical School in Lincoln, UK
image source: geograph.org.uk

Schooling continued

Boole's house, which still stands to this day, in Cork, Ireland
image source: Wikimedia Commons

- Age 12, translated one of Horace's Odes from Latin into English
- Father so proud he had son's translation published in local paper
- Age 14, began attending Bainbridge Commercial Academy
- Learned French as well as English while studying at the academy
- Last of formal education; after leaving, began self study
- Age 16, Boole took job as "usher" (assistant teacher) to help support his parents

Childhood and schooling continued

- Had a mystic experience at age 17. Believed God called upon him to explain how the mind processes thought
- 1834, Boole's father made curator of the Mechanics Institute (an organization to help the lower classes educate themselves)
- Public lectures given
- Age 20, Boole opened his own school

George Boole
image source: daviddarling.info

Early Twenties

- At age 20 had mastered French, German, and Italian
- 1835: gives an address on Newton; it is printed
- 1838: Robert Hall, headmaster of Hall's Academy in Waddington, dies
- Boole invited to take charge of Hall's Academy; moves with parents and sisters to Waddington

Drawing of George Boole as a young man
image credit: School of Mathematics and Statistics, University of St Andrews, Scotland

Early Twenties

- studied the works of great mathematicians and rewrote textbooks (Sir Issac Newton, Pierre-Simon Laplace, Joseph-Louis Lagrange)
- By 1839 began producing his own mathematical work, some of which later inspired Einstein
- 1840: contributes to Cambridge mathematical journal (*Researches on the Theory of Analytical Transformations*)


THE CAMBRIDGE AND DUBLIN

MATHEMATICAL JOURNAL.

EDITED BY W. THOMSON, M.A.

VOL. III.

CAMBRIDGE:

Cambridge & Dublin Mathematical Journal
image source: books.google.com

Early Twenties

- 1841: develops **Invariant Theory**
- 1844: Boole writes mathematical pioneering paper on "*Calculus of Operators*"
- Awarded first Gold Medal for Mathematics from the Royal Society of London for this work (*On a General Method in Analysis)*

Royal Society Gold Medal for Astronomy, 1876. The medal Boole received was for Mathematics, but would have appeared similar.
image source: xtimeline.com

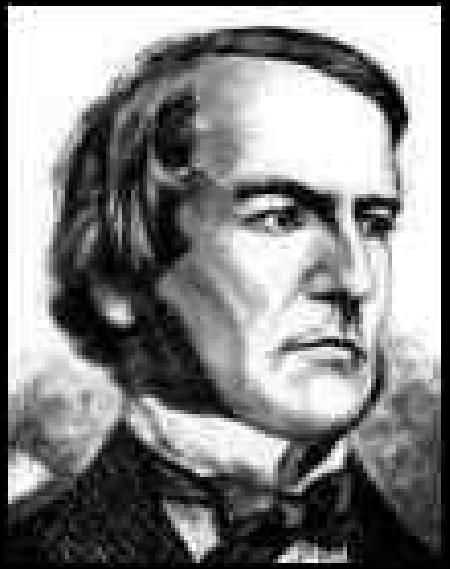
Royal Society of London:
"his method would find a permanent place in the science"

Brief Overview on **Invariant Theory**

- Classical invariant theory is the study of intrinsic properties of polynomials.
- Intrinsic: those properties which are unaffected by a change of variables and are purely geometric.
- Intrinsic properties:
  - factorizability,
  - multiplicities of roots,
  - geometrical congurations of roots.
- Non-intrinsic properties:
  - explicit values of the roots,
  - particular coefficients of the polynomial

Early Twenties

"...no general method for the solution of questions in the theory of probabilities can be established which does not **explicitly** *reco gnize... those universal laws of thought* **which are the basis of all reasoning...** **"**



- 1847- applying algebra to the solution of logical problems
- *"The Mathematical Analysis of Logic"*
- *Expanded Gottfried Leibniz' correlation between logic and math*
- *argued that logic was principally a discipline in mathematics, rather than philosophy*
- *Won him admiration and admission to the faculty of Ireland's Queen's College*

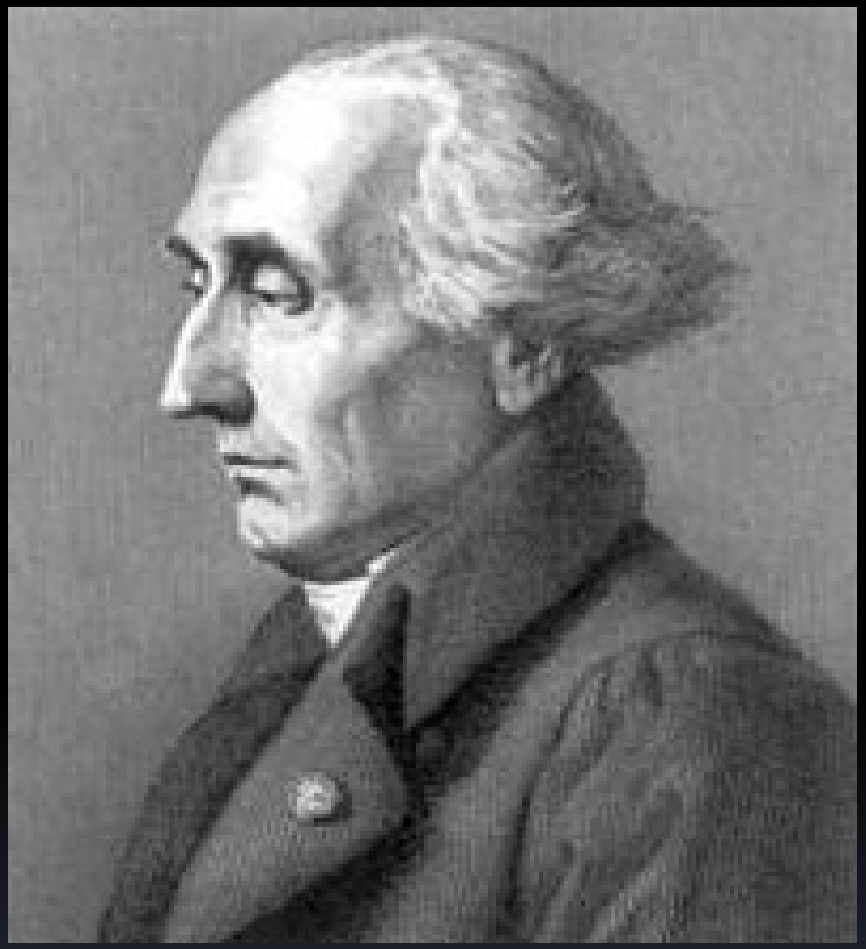
Who influenced George Boole? Leibniz

- *The Mathematical Analysis of Logic* influenced by Gottfried Leibniz's work
- Leibniz believed a relation existed between logic and math
- Boole expanded on his idea
- Boole argued logic was a *"discipline of mathematics rather than philosophy." (Source: George Boole")*

Gottfried Wilhelm von Leibniz
image credit: Wikimedia Commons

Who Influenced Boole?
Lagrange

- Boole read Lagrange's treatise on analytical mechanics (*Mécanique Analytique*) in his early twenties
- In the *Mécanique,* Lagrange used mathematics to describe the motion of objects



Joseph-Louis comte de Lagrange
image credit: Wikimedia Commons

Who Influenced Boole?
Laplace

Pierre-Simon Laplace
image credit: Wikimedia Commons

- Laplace: French mathematician and astronomer
- Boole read Laplace's work on celestial mechanics (the *Mécanique Céleste*)
- Laplace's book uses calculus to explain the motion of stars and planets

D. F. Gregory

D. F. Gregory, Scottish mathematician and friend of Boole
image source: Wikimedia Commons

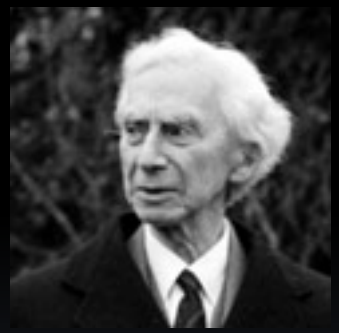
- Scottish mathematician
- Corresponded with Boole on mathematics
- Admired originality of Boole's work
- Helped Boole publish his first works in the *Cambridge Mathematical Journal* (of which Gregory was the editor)
- Formed life-long friendship with Boole

Professorship at Queen's College

Queen's College, Cork
image credit: corkheritage.ie

- Boole appointed first Professor of Mathematics at Queen's College, Cork Ireland, in 1849
- Produced various mathematical works during his time at Queen's
- Put most of his effort into his great work on symbolic logic, *An Investigation of the Laws of Thought*

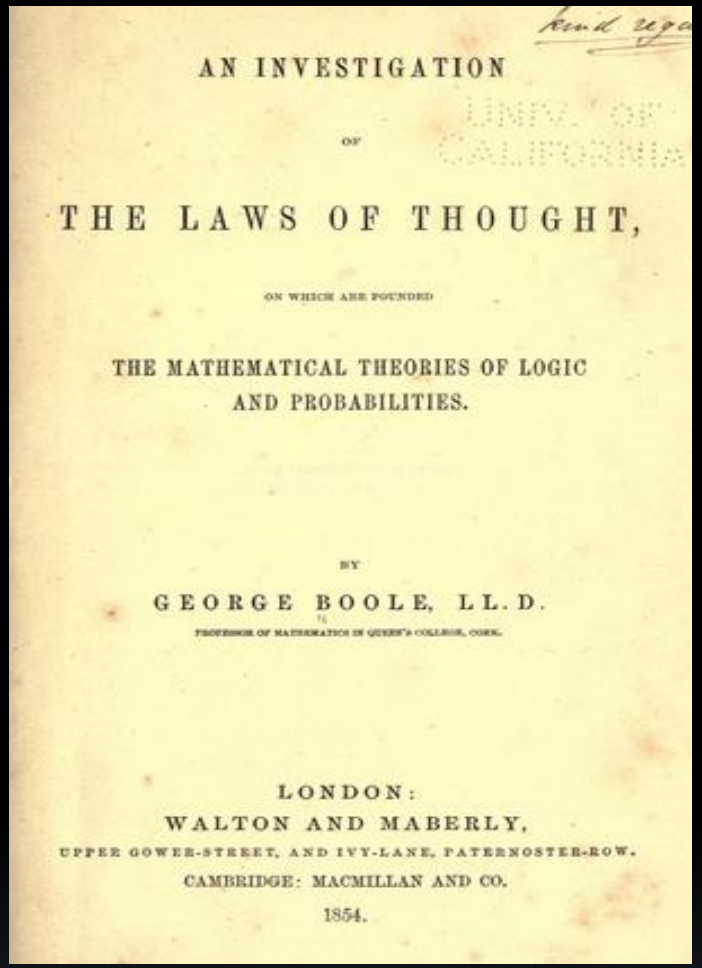
"Pure Mathematics was discovered by Boole in a work which he called The Laws of Thought.*"*



- Bertrand Russell

The Laws of Thought

- *An Investigation of the Laws of Thought, on which are founded the Mathematical Theories of Logic and Probabilities*
- Published 1848
- Written while Boole at Queen's
- Applied algebra to logical reasoning
- Initially ignored as a useless novelty



AN INVESTIGATION

OF

THE LAWS OF THOUGHT,

ON WHICH ARE FOUNDED

THE MATHEMATICAL THEORIES OF LOGIC AND PROBABILITIES.

BY

GEORGE BOOLE, LL.D.

PROFESSOR OF MATHEMATICS IN QUEEN'S COLLEGE, CORK.

LONDON:
WALTON AND MABERLY,
UPPER GOWER-STREET, AND IVY-LANE, PATERNOSTER-ROW.
CAMBRIDGE: MACMILLAN AND CO.
1854.

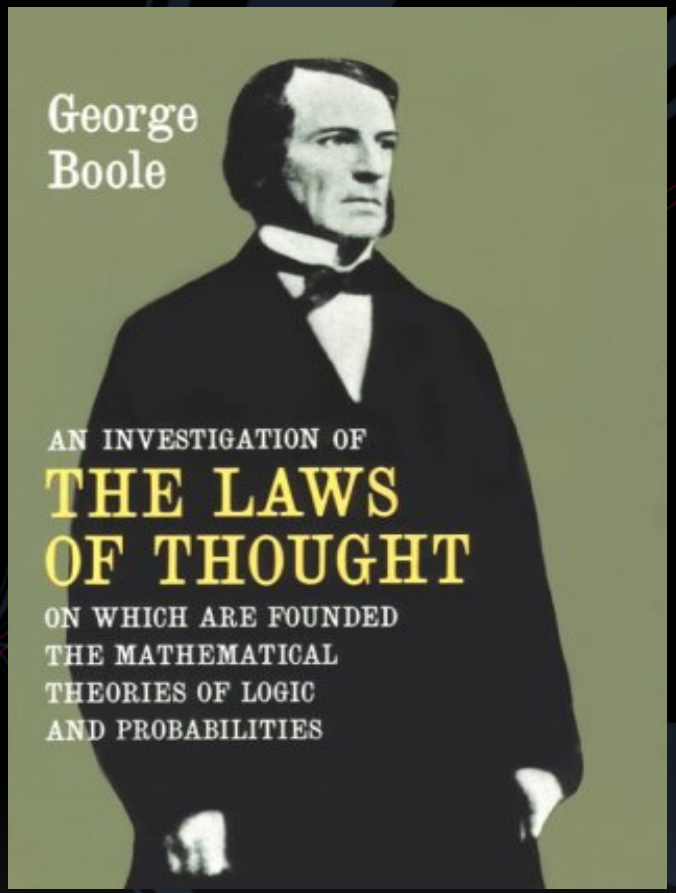
The Laws of Thought, title page
image credit: openlibrary.org

What is Boolean Algebra?

- An algebra for calculating truth values from logically connected statements
- Rules for this algebra known as Boolean Laws
- Uses true and false statements configured from the symbols $\neg, \rightarrow, \vee, \wedge$ in a series of statements
- True and false statements are base of circuit functions

Boolean Algebra Laws

- *Boolean Algebra Laws*
  - *I. Commutative Law*
    - *eg., ab = ba*
  - *II. Associative Law*
    - *eg., (ab) c = a (bc)*
  - *III. Distributive Law*
    - *eg., a(b+c) = ab+ac*
  - *IV. Identity Law*
    - *eg., a+a = a*
  - *V. Redundance Law*
    - *eg., a+ab = a*



Truth Tables

A	B	A AND B	A OR B	IF A THEN B
True	True	True	True	True
True	False	False	True	False
False	True	False	True	True
False	False	False	False	True

A truth table showing the truth values for various operands of the binary Boolean operators AND, OR, and IF...THEN

Marriage to Mary Everest

- married in 1855
- Niece of Welsh surveyor and geographer George Everest (after whom Mount Everest is named)
- George and Mary Boole had five daughters together

image credit: from the book *George Boole* by Desmond MacHale

Children of George and Mary Boole

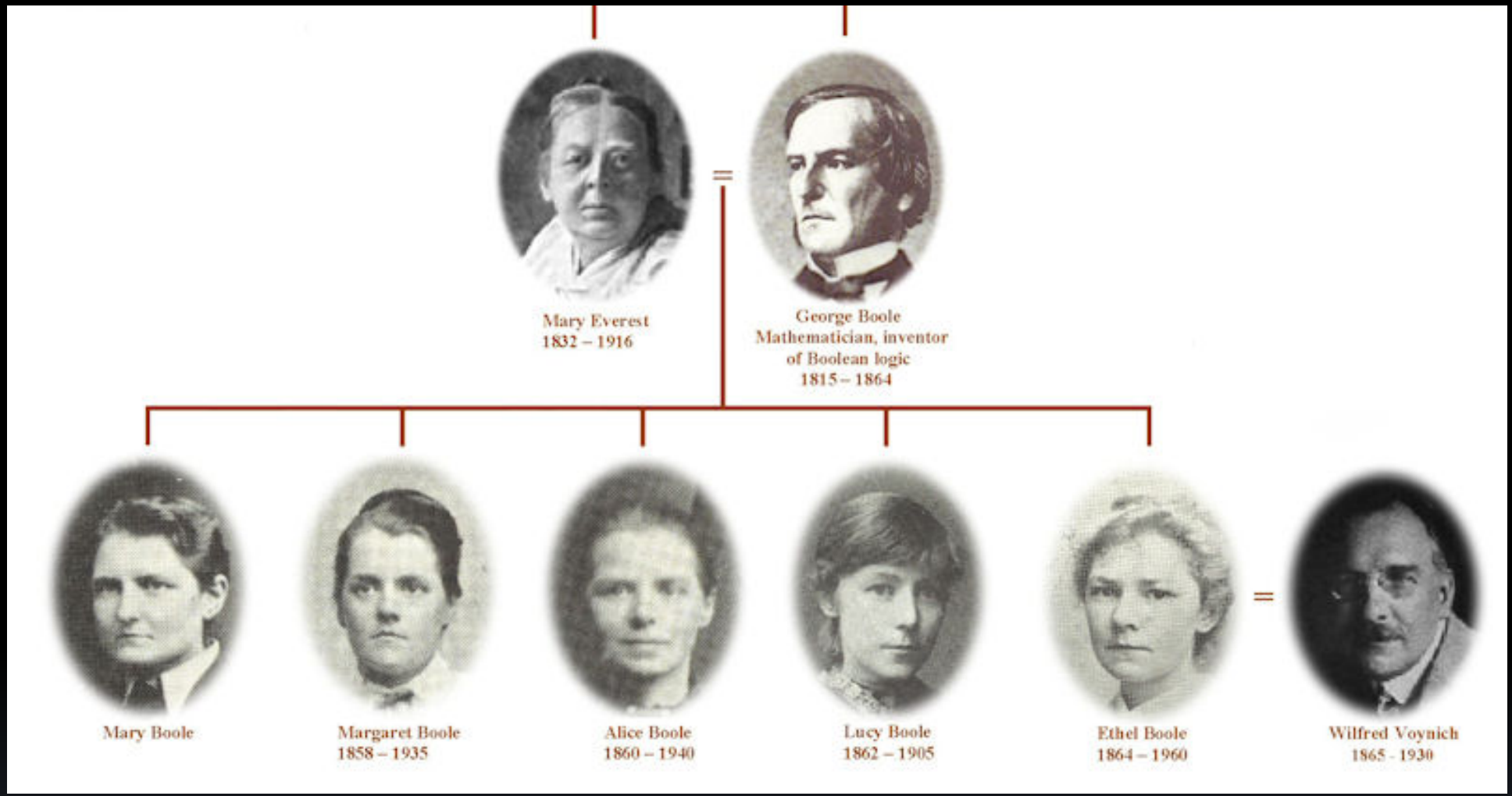
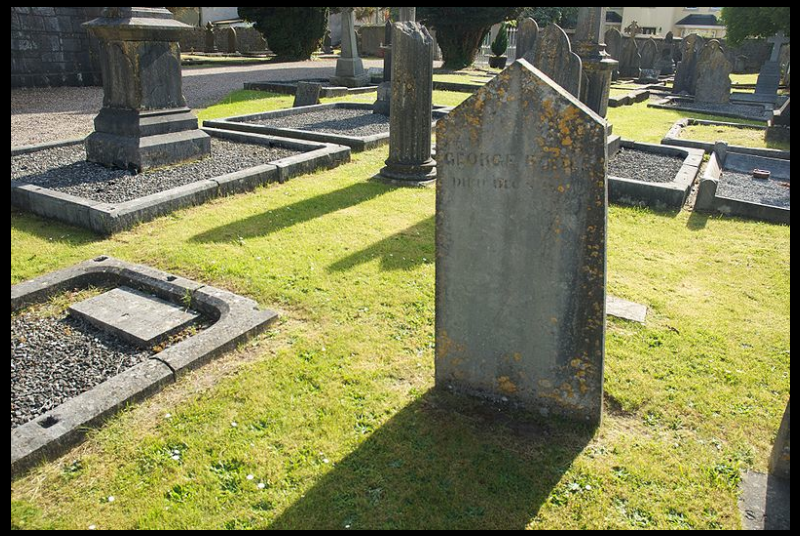


image credit: Kevin Boole, http://www.freewebs.com/boole-family/

Death

- Contracted pneumonia after lecturing in wet clothing
- Died December 8, 1864, in Ballintemple, County Cork, Ireland

Boole Plaque
image credit: Richard Croft



Boole's grave site in Cork
image credit: Marcovanhogan

- Funeral attended by many admirers from his community
- Buried in the Church of Ireland cemetery of St Michael's

image credit: University College, Cork
(through www.freewebs.com/boole-family/boolewindowcork.htm)

Memorial Windows
in Great Hall of University College Cork, Ireland

Boole Memorial Window, detail

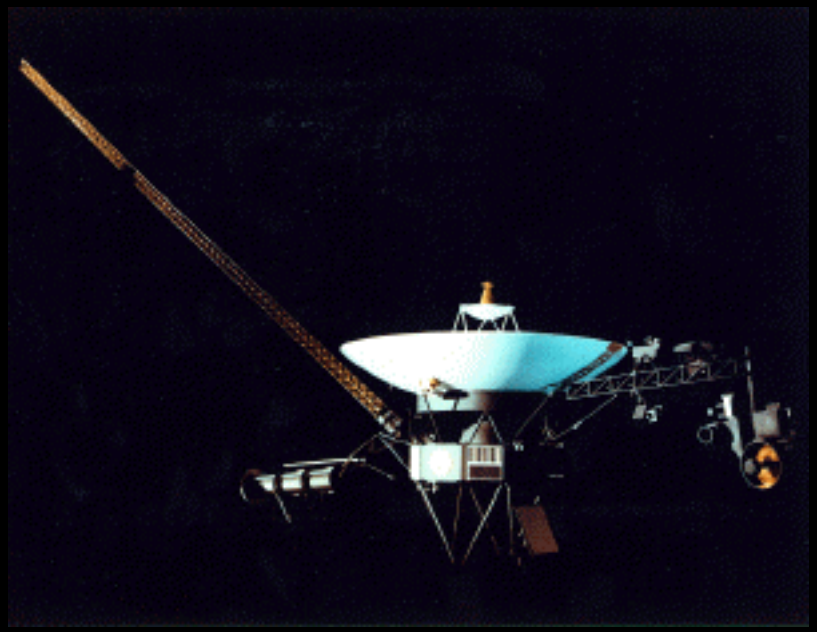
This window commemorates "Mathematical Logic"

Depicted are Aristotle, Euclid, and Boole (seated)

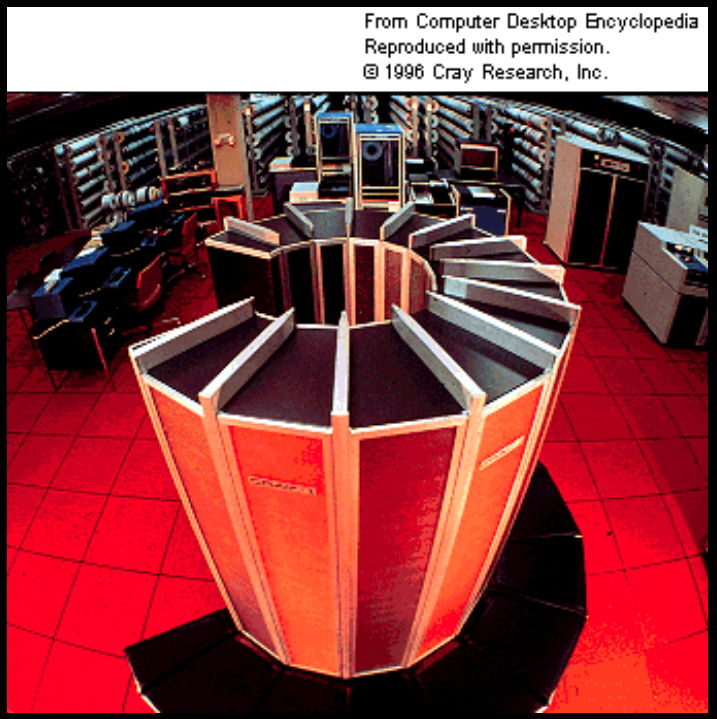
Window installed in 1860's

image credits: University College, Cork
(through www.freewebs.com/boole-family/boolewindowcork.htm)

Legacy



Voyager space probe
image credit: nssdc.gsfc.nasa.gov

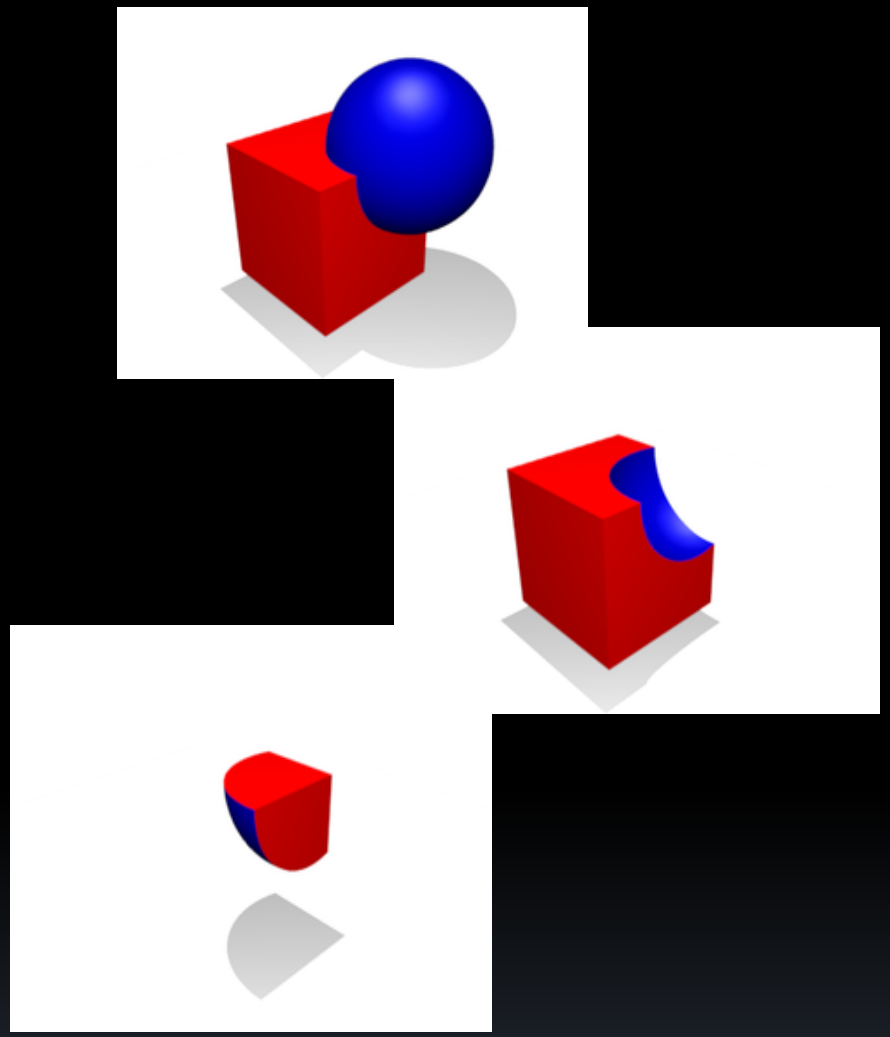


A Cray-1 supercomputer, circa 1970
image credit: Cray Research, Inc.

- Modern electronic technology is built upon Boole's work on symbolic logic

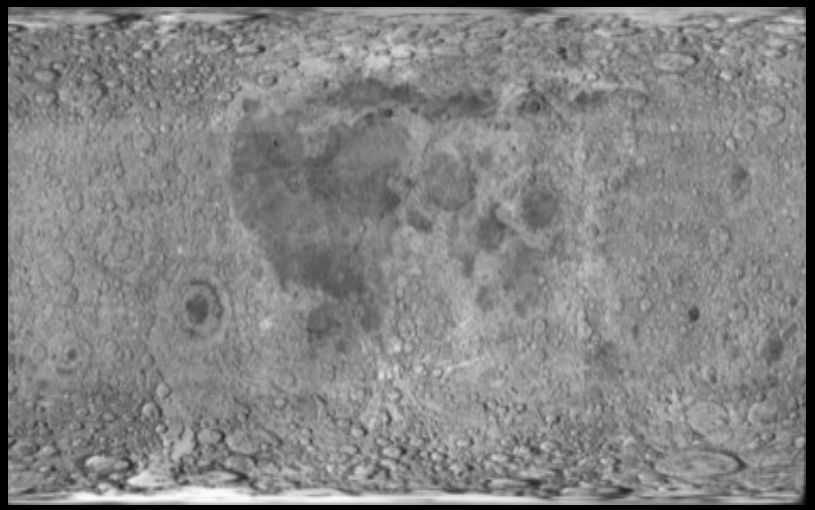
Legacy

- Boolean algebra first applied to electrical switching circuits in 1930's by Claude Shannon
- Boolean algebra used to design electronic circuits
- Basis for all modern computer logic
- Internet searches often use Boolean operators to separate and relate search terms: "fish AND (chips OR french-fries)"



Boolean operations in constructive solid geometry
image credit: Captain Sprite, wikipedia.org

Legacy



- The Boole Centre for Research in Informatics at University College Cork (the modern name of Queen's College, Cork) is named after George Boole
- Boole Crater on the moon is named after George Boole

BOOLE CENTRE
FOR RESEARCH IN INFORMATICS

Thanks

The presenters would like to thank the following:

The Technology Support Center at the University of Texas at El Paso library, for providing computers and group space in which we worked on this presentation

Our UNIV 1301 peer-leader, Priscilla Lucerno
Our UNIV 1301 instructor, Dr. Helmut Knaust

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- Boole's Lincolnshire house (Attribution: Richard Croft) http://commons.wikimedia.org/wiki/File:3_Pottergate_-_geograph.org.uk_-_657140.jpg
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