

CS 130

Discrete Structures

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Purpose of the Class

By Reputation

- “It’s just a weeder class”
- “I’m never going to use it”
- “There’s a lot of memorization”

In Actuality

- Ever notice the “science” part of “computer science”?
- You’ll use it as much as you want to
- There are a lot of new concepts

Content of the Class

By Definition

discrete (dis-'krēt) *adj*

1. constituting a separate entity; individually distinct
2.
 - a. consisting of distinct or unconnected elements; noncontinuous
 - b. taking on or having a finite or countably infinite number of values

structure ('stræk-chər) *noun, pl* structures

1. a cohesive whole built up of distinct parts
2. the overall form or organization of something
3. a set of rules defining behavior
4. (*computing*) several pieces of data treated as a unit
5. (*logic*) a set along with a collection of finitary functions and relations

Content of the Class

By Comparison

When we think of this class, we like to think of the logic. . .

MAT 310 Basic Set Theory and Logic

PHL 218 Logic and Computing

PHL 390 Predicate Logic

A lot of other topics can be called “discrete mathematics”

Number Theory MAT 325

Graph Theory MAT 370, MAT 570

Modern Algebra MAT 417, MAT 418

Combinatorics MAT 470

Content of the Class

Math and Philosophy

Math is many things. . .

- The study of measurements and quantities
 - Arithmetic, combinatorics, number theory, etc.
- The study of shapes and space
 - Geometry, topology, trigonometry, etc.
- The study of abstract structures and relationships
 - Group theory, category theory, set theory, etc.

Underlying all of these is the need to **prove** the truth and validity of results in a way that's convincing to other mathematicians

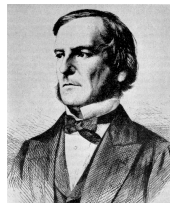
What is truth?



George Boole (1815–1864)

The design of the following treatise is to investigate the fundamental laws of those operations of the mind by which reasoning is performed; to give expression to them in the symbolical language of a Calculus, and upon this foundation to establish the science of Logic and construct its method

—The Laws of Thought (1854)



The Foundational Crisis of Mathematics (1903–1930)



David Hilbert
1862–1943



L.E.J. Brouwer
1881–1966

- Formalism

- Reduce all mathematics to axiomatic form
- Define in terms of **language**
- Prove by applying rewrite rules to axioms

- Intuitionism

- Mathematics is a creation of the human mind
- Truth is **constructed** internally
- Proofs simulate the construction of truth

The Foundational Crisis of Mathematics (1903–1930)

Problems

Intuitionism

- Classical notions turned upside-down (e.g., double-negation)

Formalism

- What are the proper axioms? Can they themselves be verified?



Kurt Gödel
1906–1978

Logicism

- In the meantime, the debate has settled down
- Intuitionism never gained much ground
- Axiomatic systems can still be used for the bulk of mathematics
 - Symbolic logic
 - Set theory
 - Zermelo-Fraenkel set theory
- Internal inconsistencies & paradoxes can typically be avoided

Claude Shannon (1916–2001)



- Dual-major in electrical engineering and math
- *A Symbolic Analysis of Relay and Switching Circuits* (1937)
- Realized George Boole's algebra in electromechanical relays used in telephone routing switches
- Possible to arrange relays to solve Boolean algebra problems

In the Trenches

To do your best in CS 130

- Come to class
- Do your homework—it's practice
- Come to office hours—it's practice
- Don't procrastinate
- **Practice!**

More Information

- The Laws of Thought
 - <http://www.gutenberg.org/ebooks/15114>
- The Foundational Crisis
 - <http://plato.stanford.edu/entries/hilbert-program/>
 - <http://plato.stanford.edu/entries/intuitionism/>
- The Foundations of Mathematics
 - http://en.wikipedia.org/wiki/Foundations_of_mathematics
 - MAT 450