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1 01.14.21

1.1 Automaton (automata)

- Self running machine requiring a continuous power source
 - Historically used power sources include water, steam, and electricity
- Course revolves around defining the mathematics powering machines

1.2 The Mathematics of Automata

1.2.1 Mathematicians & History

- Cantor defines sets as collections of objects
- Cantor also argues that infinities can be of different magnitudes - there are infinitely more real numbers than natural numbers
- Goedel eventually derives his incompleteness theorem
 - No logical system that contains the natural numbers can prove its own soundness
 - Every sound logical system containing the natural numbers contains valid statements that cannot be proved or disproved
- In 1936, Turing proves The Halting Problem is not decidable, it is impossible

- The Halting Problem is an algorithm that can analyze any other algorithm and determine whether or not it goes into an infinite loop
- Turing creates the turing machine as an object consisting of sets and processes wherein the object can use any finite process to complete an action.
- Turing machine sets the basis for a computer, which leads to a series of important questions:
 - What can & can't a machine do?
 - What does it mean for a problem to be harder than another?
 - What does it mean for a machine to be more powerful than another?

1.2.2 Sequential Logic

- Sentential Logic- based on boolean results
 - Predicated on AND, OR, NOT
 - XOR, XAND, etc. can be derived using the above

1.3 Necessary Review

- Textbook Ch. 0
- Logic Statements
- Set Theory
- Functions

1.4 Functions

- Functions - something that maps objects from one set to another
- Given $f: a \rightarrow b$;
 - Everything in a is mapped to something in b
 - * For every x , such that x is an element of a , there exists a y , such that y is an element of b

- No one point in the domain can be mapped to two different points in the codomain
 - * Logically, you can't have a function that takes in one input and returns two different outputs
 - * If f maps x to y_1 and to y_2 , $y_1 = y_2$
- $\neg_{1,y_2}[f(x)=y_1 \wedge f(x)=y_2 \rightarrow y_1 = y_2]$

1.5 TODO Types of Functions - Definition & Logical Statement

- Injective Functions
- Surjective Functions
- Proof by Induction (\rightarrow)
- Proof by Contradiction (\neg)

1.6 Finite Automaton (Finite State Machine)

- States are logical configurations
- States are generally based upon input
- Purpose of a state machine is to make a yes/no decision