Theoretical Computer Science CS 310

Chadd Williams

Office Hours:

Mon 2-4pm

Wed 2-4pm

Thur 2-4pm

and by appointment

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202 Strain

http://zeus.cs.pacificu.edu/chadd/cs310f14/

Syllabus

http://zeus.cs.pacificu.edu/chadd/cs310f14/syllabus.html

- *Introduction to the Theory of Computation* by Michael Sipser, (**Second Edition**)
  - I will assign problems out of this book
  - I expect you to do the readings

Policies:

- Class starts promptly at 4:45pm
- Assignments are due at the **beginning of class**. Late assignments will not be accepted.
- Programs that do not compile lose 70% (JFLAP)
- The cheating policy is defined in the Pacific Catalog
- Silence all electronic devices
- Participation can raise/lower your grade
  - much board work

Syllabus

Grade Distribution

Homework	20%
Unannounced Quizzes	5%
Exam 1	25%
Exam 2	25%
Final	25%

Percent Breakdown

			92-100	A		90-92	A-
88-90	B+		82-88	B		80-82	B-
78-80	C+		72-78	C		70-72	C-
68-70	D+		60-68	D			
0-60	F						

Tentative Dates:

- Midterm 1, Mon, Sept 29, 2014
- Midterm 2, Fri, November 7, 2014
- Final, Friday Dec 5 (3-5:30pm)

Today

- Overview of class
- Mathematical Notation
- Proof by Induction

Who are we?

- Is Computer Science a science?
  - Is it a *natural* science?

- What do we study?

Overview

- What are the fundamental capabilities and limitations of computers?
- How does theory related to programming?
- Complexity Theory
- Computability Theory
- Automata Theory

Mathematical Notation (Chap. 0)

- Basic notations we will use in this class
  - Page 16 of your book has a partial list (no symbols!)
- Set
- Subset
- Proper Subset

Sets

- Shorthand for describing a set

  { n | rule about n}

Set Operations

- What can we do with sets?
- Union
- Intersection
- Complement

Sets

- Power Set

  { 0, 1 }

- Cartesian Product (Cross Product)

  { 0, 1 } X { a, b }

Sequences/Tuples

- Sequence

- Tuple

  K-tuple

Functions

- Object that takes input, produces output

  $f\ (a) = b$

- Domain and Range

  $f : D \rightarrow R$

- Onto

Functions

- $f : A_1 \times A_2 \times \ldots \times A_k \to R$

  $(a_1, a_2, \ldots, a_k)$

  k-ary

  arity

  unary (k=1) binary (k=2)

- Notation

  Infix notation: a + b

  Prefix notation: add(a,b)

Relations

- Predicate (property)

  $f : D \rightarrow \{\text{TRUE, FALSE}\}$

- Relation

  $f : A_1 \times A_2 \times \ldots \times A_n \rightarrow \{\text{TRUE, FALSE}\}$

- Notation

  table

  Set

Equivalence Relations

binary relation

shows that two objects are equal

must satisfy 3 conditions:

1. R is ***reflexive*** if for every x, xRx;
2. R is ***symmetric*** if for every x and y,
   xRy if and only if yRx;
3. R is ***transitive*** if for every x, y, and z,
   xRy and yRz implies xRz

Proof by Contradiction

- Assume the concept is false
- Show this leads to a false consequence
  - tricky to pick exactly the false consequence

- Prove $\sqrt{2}$ is irrational
  - Assume it is rational: $\sqrt{2} = m/n$

Proof by Induction

- Basis

  Prove P(1) is true

- Induction Step

  Prove that for each i≥1, if P(i) is true,

  then so is P(i+1); *assume P(i) is true*

- Basis + Induction Step

  P(1) is true, i = 1

  P((i+1)) is true

  P((i+1) +1) is true …

Proof by Induction

- Prove: $1 + 2 + \ldots + n = n(n+1) / 2$

  for $n \geq 1$

  Basis:

  Induction:

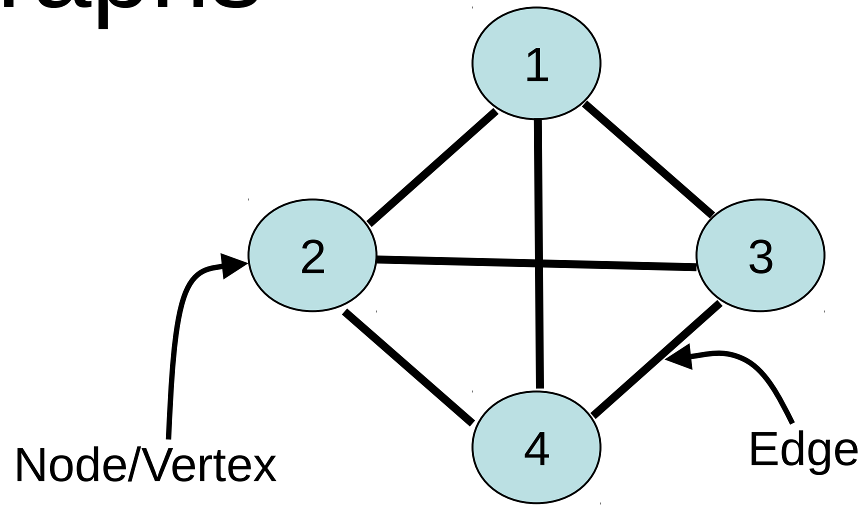
Prove by Induction

- $n^2 >= 3n$, $n>=3$

- F_n is the *n*th Fibonacci number, $n>=1$.
  - $F_n = F_{n-1} + F_{n-2}$
  - $F_1=1$; $F_2=1$

- F_{3n} is even, $n>=1$
- F_{4n} is evenly divisible by 3, $n>=1$

Graphs



- Graph

  Collection of nodes

  and edges

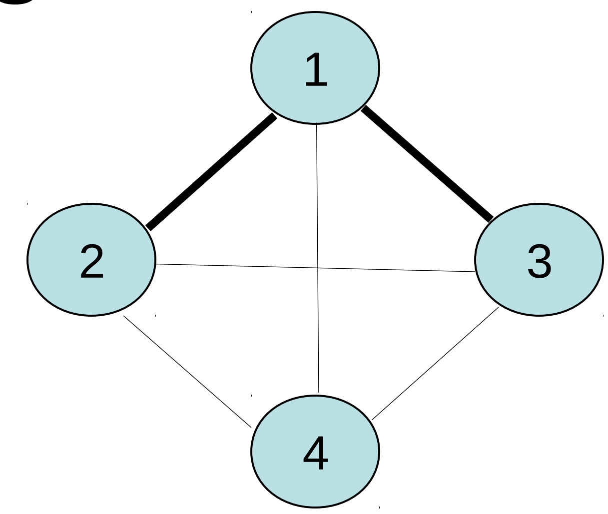
  G = (V,E)

  E =

  undirected

- Degree of a node

Graphs



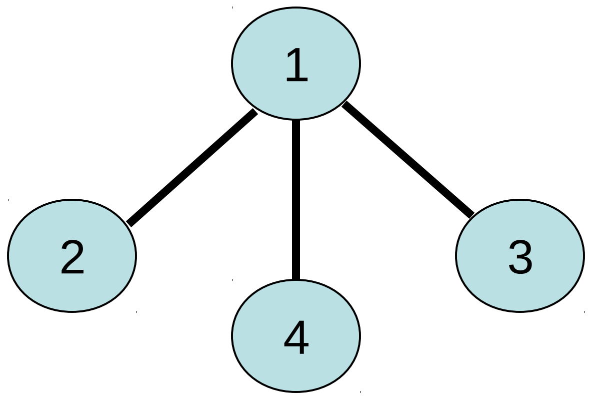
- Subgraph
- Path

  Connected graph

- Cycle

Trees

- Connected graph with no simple cycles
- Leaves
- Root



Directed Graph

- Arrows denote which way an edge goes

  outdegree/indegree

  G=(V,E)

  V=

  E=

  Directed path

  Strongly connected