CSE215
Foundations of Computer Science
Course Information

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http://www.cs.stonybrook.edu/~hgupta/215
CSE 215

- CSE215 is NOT a course in computer programming.
- On formal concepts that form a basis of computer science in general (and programming too, in particular).
- Challenging!
- Prerequisites: AMS 151 or MAT 125 or MAT 131.
General Information

• Recitations:
  – Mostly, problem solving sessions.
• http://www.cs.sunysb.edu/~hgupta/215
• Some material may be posted on Blackboard.
Office Hours

• Name: Himanshu Gupta (hgupta@cs)
• Office: CS 335 (New Building)
• Hours: M 4pm and W 5pm, or by appointment.
  Open-ended hours, i.e., I’ll stay as long as needed.
  But, if no one is waiting, I may leave.
Grading

- Assignments: 40% (Tough; Groups of 2)
- Finals: 30%
- Two Midterms: 15% each
- Extra credit (for answering in-class questions).

- Cases of academic misconduct will be very strictly dealt with.
Textbook

• Discrete Mathematics: Introduction to Mathematical Reasoning (Brief Edition)
  Author: Susanna S. Epp
  First edition (February 7, 2011)
Motivation for CSE 215

• Formal concepts that we study in CSE 215, are essential to program effectively (among other things).

• Travelling Salesman Problem:
  – What is the smallest route that goes through all the 50 capital cities of USA?

• How would you write a program to solve the above?
Motivation for CSE 215 – II

- Possible TSP Algorithms:
  1. Enumerate all routes, and pick the best.
  2. Start from a city, and pick the next based on some “condition”.
  3. Solve the problem for all possible subsets of cities. Done “recursively”; also solving the problem for the full set.

- Concepts needed: counting, enumeration, conditions, sets, subsets, functions, variables, etc.

- Which of the above is optimal? Requires proof techniques.
CSE 215 Topics

• Overview of Topics.
• Logical conditions, statements.
• Proof Techniques
• Induction, Recursion
• Set Theory, Functions.
• Counting, Probability
Variables

• A variable is a name given to an entity whose value is unclear/unknown/not-fixed.
• E.g., How much it costs to drive 100 miles?
• Answer = 100 (gallon per mile)(price per gallon)
• Since, the (price/gallon) may change over time, and (gallon/mile) depends on the car, its best to express the answer as:
  = 100xy, where x and y are variables for (gallon per mile) and (price per gallon).
Logical Statements

• All men are crazy.
• Crazy people like each other.
• John is a man.
• Alex is crazy, but doesn’t like John.

Is Alex a man?
More Logical Statements

• For all numbers $r$, there exists a number $y$ such that $y > r$.

• Prime Test: A positive natural number is prime, if it is not divisible by any number less than it (except for 1).

  $x$ is prime if for all $1 < y < x$, $\text{ceiling}(x/y) \neq (x/y)$. 
Proofs

We’ll learn techniques to prove/disprove claims. Examples of claims.

• Any number greater than 1 is divisible by a prime number.

• For all numbers n, if n is even, then n or n+2 is divisible by 4.

• There exists a number n, such that \( n^2 - 3 \) is divisible by 7.
Sets

• Set = collection of elements.
  – Order of elements is irrelevant.

• Set-Roster Notation:
  – E.g., $A = \{1, 2, 3\}$, $B = \{3, 1, 2\}$.

• Set-Builder Notation:
  – E.g., $A = \{x \in \mathbb{R} \mid -2 < x < 5\}$

• “Belongs to” ($\in$) operator:
  – If $A = \{1, 2, 3\}$, then $1 \in A$. 

CSE 215: Introduction
Set Relationships and Operators

- Subset
- Proper Subset
- Superset
- Union, Intersection, Minus
- Cartesian Product
- Ordered pairs
Relations

• Relations define an “association/relationship” between elements of two sets.

• E.g., consider two sets “Drinkers” and “Beers”. Each drinkers “likes” a certain set of beers.
The “likes” relation can be specified as a set of ordered pairs:
{(John, Bud), (Jane, Miller), (John, Corona), …, …}

In general, a relation R from S1 to S2 is a subset of (S1 X S2).
Relations and Functions

- Each element of LHS is related to exactly one element of RHS.
- Such a relation is called a function.
Functions

- Each element of LHS is *still* related to exactly one element of RHS (even though, some elements of LHS are not related to anyone in the RHS).
- Still a **function**.
Functions – Concept.

• Function $f$ from $S_1$ to $S_2$.
• Notation. $f: S_1 \rightarrow S_2$.
• Concept:

  - Above $x \in S_1$, and $f(x) \in S_2$. 

CSE 215: Introduction
Function Examples

• Examples of $F: \mathbb{Z} \rightarrow \mathbb{Z}$ ($\mathbb{Z}$ is a set of integers).
  - $F(n) = n+1$
  - $F(n) = n-1$.

• Let $P$ be the set of all people.
  Examples of $F: P \rightarrow P$
  $F(p) =$ best friend of $p$.
  $F(p) =$ father of $p$.
  $F(p) =$ spouse of $p$.  (anything wrong?)
  $F(p) =$ friend of $p$.  (wrong; its a relation).