CISC-102

Fall 2015

Lecture 1

Introduction

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- Goodwin Hall Room 532

- Office Hours:
  Wednesday 13:00- 15:00
- Course webpage:
  http://research.cs.queensu.ca/home/daver/102/2015Fall/

Introduction

- Class Hours

Tuesday,	14:30-15:30
Wednesday,	16:30-17:30
Friday,	15:30-16:30

- Class Location: Chernoff Hall Auditorium

Introduction

- Homework every week. Keep up to date or you risk falling behind.
- Homework will be solved in class on due date.

Introduction

- 4 quizzes 17% each
- 1 final 32%

Motivation

- According to a recent poll (33,000 CDN students interviewed in 2014) the preferred employer is Google.
- I have been given a communication from an applicant to Google with tips on how to conduct an interview.

  #1 tip Algorithm Complexity: You need to know Big-O. If you struggle with basic big-O complexity analysis, then you are almost guaranteed not to get hired.

Motivation

- Mastering Discrete Math is the direct pre-requisite to mastering algorithms and complexity.
  - Send me suggestions for applications you would like to know more about (for example, Google search, encryption, computer gaming…) and I will explain how some topic we study is related to that application

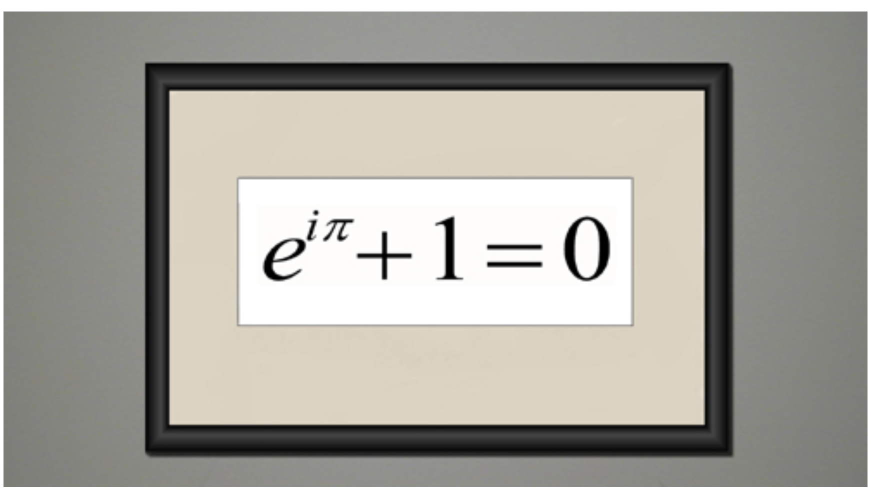
Motivation

- You should view this course as a language course. You will be learning the language of mathematics and computing!

Motivation

- Math can be fun.
- Math is beautiful!
- Math is a human invention just like music, painting, sculpture, poetry, hockey, basketball, soccer, fishing …

Motivation



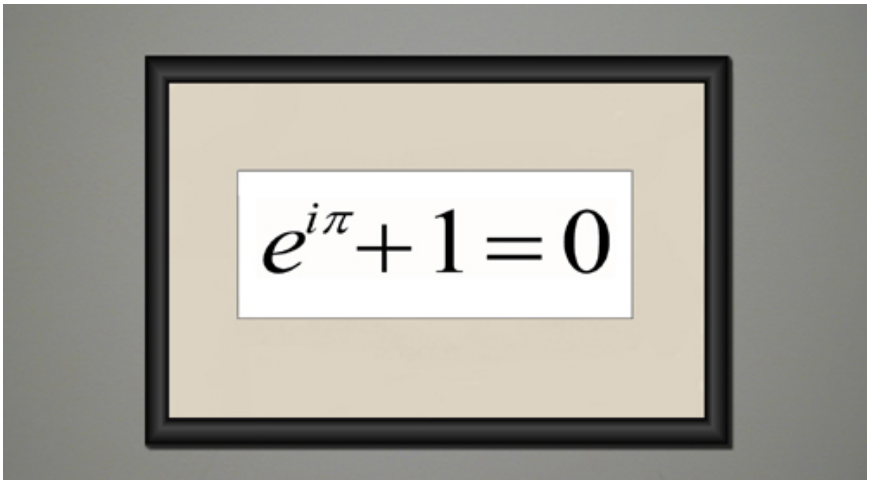
Motivation

- The picture on the previous slide is a work of art titled “beauty”. (Prints can be purchased on-line.)
- The equation $e^{i\pi} + 1 = 0$ consists of the most important numbers in mathematics 0,1 (integers) π (an irrational real number) i (a complex number), operations + X and exponentiation and the relation =.

Math is a language

A mathematical joke asks,
"How many mathematicians does it take to change a light bulb?"
and answers "$-e^{i\pi}$" .

Motivation



Hand Shakes

- Alice is having a birthday party at her house, and has invited Bob, Carl, Diane, Eve, Frank, and George.
- They all shake hands with each other
- Q: How many handshakes?

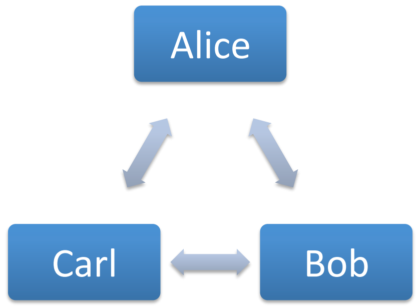
Hand Shakes

- How many handshakes?
  - Two people shaking hands with each other counts as one hand shake.
- Can you guess how many hand shakes with 7 people?
  - 7 people each shakes with 6 others. So 6*7 = 42?
  - This leads to a formula for n people we would get n*n-1 hand shakes.
- How about 2 people?
  - Easy: 1 handshake. But $2*1 \neq 1$?

Hand Shakes

- No? How about 2 people?
  - Easy: 1 handshake
- 3 people? 3*2=6. Correct answer is 3?
- It looks like the correct formula is 3*2/2 .

Hand Shakes



3*2 counts each handshake twice, so we divide by 2 to get the correct answer.

Hand Shakes

- How many handshakes?
  - Two people shaking hands with each other counts as one hand shake.
- Can you guess how many hand shakes with 7 people?
  - 7 people each shakes with 6 others.
  - So 7*6/2 = 21.
- In general we can say that for n people we have n(n-1)/2 hand shakes.

Hand Shakes

- The hand shake problem seems frivolous but it is actually a representation of an important mathematical concept.
- Computer Scientists need to study these concepts so that they can properly discuss the software that they develop (and use) in terms of correctness and efficiency.

Hand Shakes

- The hand shake problem seems frivolous but it is actually a representation of an important mathematical concept.
- For example if we wanted to know which handshake was the "best" we would have to compare n(n-1)/2 of them.
- Let n = 35, 000, 000 (the population of Canada) we would have to compare 612,499,982,500,000 or roughly 612 trillion hand shakes. (Too much!)

Hand Shakes

- Let n = 35, 000, 000 (the population of Canada) we would have to compare 612,499,982,500,000 or roughly 612 trillion hand shakes.
- If we test one handshake per second it would take roughly 31,688 Years, 269 Days, 1 Hour. (Too long!)

Hand Shakes

- Let’s convert the hand shake problem into an “official” math problem using proper notation.
- The basic building block will be the set.

Sets

- Let's convert the hand shake problem into an "official" math problem using proper notation.
- The basic building block will be the set. Examples:

A={1,3,5,7,9}
B={x|x is an even integer, x>0}
C={x:x is an odd integer, x>0}

Sets

A={1,3,5,7,9}
B={x|x is an even integer, x>0}
C={x:x is an odd integer, x>0}

examples

$A \subseteq C$ (A is a subset of C, or A is contained in C)

$C \supseteq A$ (C is a superset of A, or C contains A)

Sets

N = the set of *natural numbers*: 1, 2, 3, . . .
Z = the set of all integers: ...,−2,−1,0,1,2,…

Q = the set of rational numbers

R = the set of real numbers

C = the set of complex numbers

Observe that $\mathbf{N} \subseteq \mathbf{Z} \subseteq \mathbf{Q} \subseteq \mathbf{R} \subseteq \mathbf{C}$.

Sets

$\boldsymbol{U}$ **:** All sets under investigation in any application of set theory are assumed to belong to some fixed large set called the *universal set.*

$\varnothing$ **:** A set with no elements is called the *empty set* or *null set* .

For any set A, we have: $\varnothing \subseteq A \subseteq \boldsymbol{U}$

Sets

Let S = {a,b,c,d,e,f,g} denote the set of party goers.

A handshake can be represented as a two element subset of S, {a,b}.

Q. How many two element subsets are there of a set of *n* elements.

Sets

1.26 Which of the following sets are equal?

$A = \{x \mid x^2 - 4x + 3 = 0\}$,
$B = \{x \mid x^2 - 3x + 2 = 0\}$,
$C = \{x \mid x \in \mathbf{N}, x < 3\}$,
$D = \{x \mid x \in \mathbf{N}, x \text{ is odd}, x < 5\}$,
$E = \{1, 2\}$,
$F = \{1, 2, 1\}$,
$G = \{3, 1\}$,
$H = \{1, 1, 3\}$.

Sets

1.26 Which of the following sets are equal?
A = {x | $x^2 - 4x + 3 = 0$}, A = { x | (x-1)(x-3)=0}, **A={1,3}**
B={x|$x^2-3x+2=0$}, B = {x | (x-1)(x-2) = 0}, **B= {1,2}**
C = {x | x $\in$ **N**, x < 3}, **C = {1,2}**
D= {x| x $\in$ **N**, x is odd, x<5}, **D = {1,3}**
E = {1, 2},
F ={1,2,1}, **F= {1,2}** repetition does not change a set.
G = {3, 1}, Order does not change a set.
H ={1,1,3}. **H = {1,3}**

Sets

1.1 Which of the following sets are equal?
{x,y,z},{z,y,z,x},{y,x,y,z},{y,z,x,y}