About the Course

Lecture 0: Sep 2
Plan

- Course Information and Arrangement
- Course Requirement
- Topics and objectives of this course
Basic Information

- **Course homepage:** [http://www.cse.cuhk.edu.hk/~chi/csc2110/](http://www.cse.cuhk.edu.hk/~chi/csc2110/)
- **Instructor:** Lau, Lap Chi
- **Office hour:** Tuesday, Wednesday, 10am-12pm (SHB 911)
- **Lectures:** M7-8, 2:30-4:15 (ERB LT), H5 12:30-1:15 (NAH 115)
- **Tutors:** Poon, Chun Yeung
  - Sham, Yik Hin
  - Zhou, Hong
- **Tutorials:** W5 (ERB 803) or W10 (LSB C2) or H6 (LSB C2)
  (Only attend one tutorial session.)
Course Material

- **Textbook:** Discrete Mathematics with Applications
  
  Author: Susanna S. Epp
  
  Publisher: Brooks/Cole

- **Notes:** Course notes from “mathematics for computer science”
  
  http://courses.csail.mit.edu/6.042/spring07/

  (available to be downloaded in the course homepage)
Course Requirements

- Homework, 25%
  (6 assignments, count the best 5)

- Midterm, 25%
  Midterm: Oct 15 (Tuesday), 7pm

- Final Exam, 50%
Mathematics

Computer Science: use computer technology to solve problems.

Many courses in our curriculum will talk about computer technology.

This course will provide the mathematical foundation to solve problems,
e.g. to design a security system, to design a fast searching algorithm,
to analyze algorithms rigorously (e.g. pagerank and linear algebra), etc.

\[
R = \begin{bmatrix}
    (1 - d)/N \\
    (1 - d)/N \\
    \vdots \\
    (1 - d)/N
\end{bmatrix}
\begin{bmatrix}
    \ell(p_1, p_1) & \ell(p_1, p_2) & \cdots & \ell(p_1, p_N) \\
    \ell(p_2, p_1) & \cdots & & \\
    \vdots & & \cdots & \\
    \ell(p_N, p_1) & \cdots & & \ell(p_N, p_N)
\end{bmatrix}
R
\]

(pictures from wiki)
What is discrete mathematics?

<table>
<thead>
<tr>
<th>discrete mathematics</th>
<th>continuous mathematics</th>
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</thead>
<tbody>
<tr>
<td>integers</td>
<td>real numbers</td>
</tr>
<tr>
<td>graphs</td>
<td>geometric space</td>
</tr>
<tr>
<td>induction</td>
<td>calculus</td>
</tr>
<tr>
<td>logic</td>
<td></td>
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</tbody>
</table>

These two areas are not disjoint, e.g. calculus can be used to solve discrete problems (generating functions).
Why discrete mathematics?

In computer science we usually deal with finite, discrete objects. For example,

- we cannot store a real number (infinite precision) in a computer but can only store bits (finite precisions).

- we often model a computer network as a graph, and use the knowledge and techniques in dealing with graphs to solve problems in networks.

The problems and the techniques are often different (e.g. induction, recursion).
Topic 1: Logic and Proofs

How do computers (and humans) think?

Logic: propositional logic, first order logic

Proof: induction, contradiction

$\forall x \exists y, z \ x = y + z$

$\frac{x_1 + x_2 + \ldots + x_n}{n} \geq \sqrt[n]{x_1 \cdot x_2 \cdots x_n}$

Applications: artificial intelligence, database, circuit, algorithms

Objective: to reason rigorously and learn basic proof techniques (e.g. induction)
Topic 2: Graph Theory

- Graphs
- Degree sequence, Eulerian graphs, isomorphism
- Trees
- Matching
- Coloring

Applications: Computer networks, circuit design, data structures
Topic 2: Graph Theory

How to color a map?
How to schedule exams?

How to send data efficiently?

Objective: to model problems and learn basic concepts and knowledge
Topic 3: Counting

- Sets and Functions
- Combinations, Permutations, inclusion-exclusion
- Counting by mapping, pigeonhole principle
- Recursions, generating functions

Applications: probability, data structures, algorithms

Objective: to learn basic concepts (set, functions) and fundamental techniques.
Topic 3: Counting

How many steps are needed to sort $n$ numbers?

Algorithm 1 (Bubble Sort):
Every iteration moves the $i$-th smallest number to the $i$-th position

Algorithm 2 (Merge Sort):

Which algorithm runs faster?
## Tentative Course Schedule

<table>
<thead>
<tr>
<th>Monday</th>
<th>Thursday</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep 2</td>
<td>Sep 5</td>
<td>introduction, propositional logic</td>
</tr>
<tr>
<td>Sep 9</td>
<td>Sep 12</td>
<td>first order logic, methods of proofs</td>
</tr>
<tr>
<td>Sep 16</td>
<td>Sep 19</td>
<td>methods of proofs, induction</td>
</tr>
<tr>
<td>Sep 23</td>
<td>Oct 26</td>
<td>mathematical induction</td>
</tr>
<tr>
<td>Sep 30</td>
<td>Oct 3</td>
<td>graph, tree</td>
</tr>
<tr>
<td>Oct 7</td>
<td>Oct 10</td>
<td>graph matching</td>
</tr>
<tr>
<td>Oct 14 (holiday)</td>
<td>Oct 17</td>
<td>graph coloring</td>
</tr>
<tr>
<td>Oct 21</td>
<td>Oct 24</td>
<td>planar graph</td>
</tr>
<tr>
<td>Oct 28</td>
<td>Oct 31</td>
<td>sets, basic counting</td>
</tr>
<tr>
<td>Nov 4</td>
<td>Nov 7</td>
<td>binomial coefficients, inclusion-exclusion</td>
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<tr>
<td>Nov 11</td>
<td>Nov 14</td>
<td>functions, counting by mapping</td>
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<tr>
<td>Nov 18</td>
<td>Nov 21</td>
<td>counting by mapping, number sequences</td>
</tr>
<tr>
<td>Nov 25</td>
<td>Nov 28</td>
<td>recursion</td>
</tr>
</tbody>
</table>
Objectives of This Course

• To learn basic mathematical concepts, e.g. sets, functions, graphs
• To be familiar with formal mathematical reasoning, e.g. logic, proofs
• To improve problem solving skills, e.g. induction, recursion
• To see the connections between discrete mathematics and computer science

Knowledge will be used in future courses:
CSC 2100, ERG 2040, CSC 3130, CSC 3160
CUHK staff student expectations on teaching and learning
http://www.cse.cuhk.edu.hk/~chi/csc2110/notes/expectation.doc

No electronic devices in class, including phones, laptops, iPads, etc.

No talking please.
Academic Honesty

http://www.cuhk.edu.hk/policy/academichonesty/

Definition: see booklet and http://www.cuhk.edu.hk/policy/academichonesty/p01.htm

Examples: see booklet and http://www.cuhk.edu.hk/policy/academichonesty/p02.htm

Procedure: see booklet and http://www.cuhk.edu.hk/policy/academichonesty/p06.htm

• Computer programs checking plagiarism

• Discussions of ideas may be allowed, in any case need to write your own solutions.

• State the source and let the marker make the adjustments.

Academic Honesty in the Faculty of Engineering: http://www.cse.cuhk.edu.hk/~chi/honesty.p