Randomized Algorithms - Course Structure

K. Subramani\textsuperscript{1}

\textsuperscript{1}Lane Department of Computer Science and Electrical Engineering
West Virginia University

17 January, 2012
Outline

1. Motivation
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2. Course Structure
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1 Motivation
2 Course Structure
3 Prerequisites
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3. Prerequisites
4. Expectations
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1. Motivation
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3. Prerequisites
4. Expectations
5. Syllabus
   - General Information
   - Topics to be covered
   - Social Justice Statement
Motivation

Why Randomized Algorithms

(i) What is an algorithm?
(ii) What resources do we analyze?
(iii) What is a randomized algorithm?
(iv) What do we analyze?
(v) Why are randomized algorithms preferred over deterministic ones?
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Course Structure

Flow

(i) Fundamentals and Applications.
(ii) High Probability Analysis.
(iii) Advanced Analysis Tools.
(iv) Advanced Applications (Seminar).
Flow

(i) Fundamentals and Applications.
Course Structure

Flow

(i) Fundamentals and Applications.
(ii) High Probability Analysis.
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Flow

(i) Fundamentals and Applications.
(ii) High Probability Analysis.
(iii) Advanced Analysis Tools.
(iv) Advanced Applications (Seminar).
Prerequisites

Topics

(i) Discrete mathematics, including mathematical induction and counting.
(ii) Probability fundamentals, including measures of aggregation and dispersion.
(iii) Design and analysis of algorithms for combinatorial problems.
Topics

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Expectations

Guidelines
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Guidelines

1. Attendance.
Expectations

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1. Attendance.
2. Inquisitiveness.
Expectations

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1. Attendance.
2. Inquisitiveness.
3. Systematic hard work.
Expectations

Guidelines

1. Attendance.
2. Inquisitiveness.
3. Systematic hard work.
4. Perseverance.
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General Information

Logistics

2. Meeting Times: Tu-Th, 09:30 am - 10:45 am.
   Location: 355 ESB-E.
3. Contact Information: 749 ESB, ksmani@csee.wvu.edu.
4. Office Hours: By appointment.
5. Prerequisites: Exposure to probability and algorithm design.
6. Textbook - [MU05] is the main text, although [MR95] and [Ros00] are strongly
   recommended for supplementary reading.
7. URL -
Homeworks (3) - There will be three homework assignments; each assignment is worth 20% of your grade. Table (1) details the homework schedule.

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<thead>
<tr>
<th>Assignment Date</th>
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Table: Homework Schedule

Presentation (1) - You will be required to present one topic which will be decided through discussions with the instructor. The presentation is worth 20 points.

Research - You are expected to engage in independent research on a problem of your choosing, related to the topics of this course. This research is to be summarized in a report, to be handed in on the last day of class and is worth 20 points. Alternatively, you will be handed a fourth homework assignment, on May 1, which you will need to turn in by May 8.

Final - There will be no final exam.
General Information (contd.)

Assessment

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A maximum of 5 bonus points will be awarded for class performance.

Grade Boundaries:

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Grading policy - If you have any questions about the grading, you must contact the instructor within two days of your paper being returned.

Makeup Policy - If for some reason, you are unable to attend a test or an exam, please meet me at the earliest and I will set an alternate date.
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(a) Introducing the fundamentals of probabilistic analysis.
(b) Analyzing algorithms in the probabilistic framework.
(c) Introducing high probability analysis.
(d) Introducing the Monte Carlo method.
(e) Introducing Randomized Complexity classes.

Learning Outcomes

(a) Appreciate the fundamentals of randomized algorithm design.
(b) Develop randomized algorithms for variants of problems in P.
(c) Apply high probability analysis to selected randomized algorithms.
(d) Apply the Probabilistic Method for establishing the existence of properties in combinatorial structures.
(e) Understand the fundamentals of Markov chains and the Monte Carlo method.
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Topics to be covered

- Probability Fundamentals
  - Sample Space, Events, Assigning probabilities to events, Conditional probability, Independent events, Useful identities, Random Variables, Linearity of Expectation.

- A sampling of Randomized Techniques
  - Verifying polynomial identities, verifying matrix multiplication, A min-cut algorithm, The coupon collector's problem, Quicksort.

- Moments and Deviations

- The Chernoff Bound
  - Moment Generating Functions, Deriving and Applying Chernoff bounds, Special cases, Applications.
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Moments and Deviations
Markov’s inequality, Moments of a Random Variable, Chebyshev’s inequality, Applications.
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Topics to be covered (contd.)

**Balls, Bins and Random Graphs**

Topics to be covered (contd.)

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**The Probabilistic Method**

Topics to be covered (contd.)

**Balls, Bins and Random Graphs**

**The Probabilistic Method**

**Markov Chains and Random Walks**
Definitions and Representations, Classification of states, Stationary distributions, Random walks on undirected graphs, Parrondo’s paradox.
Topics to be covered (contd.)

The Monte Carlo Method
- The Monte Carlo Methods
- The DNF counting problem
- From Approximate sampling to Approximate counting
- The Markov Chain Monte Carlo Method

Martingales
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- Stopping Times
- Wald's Equation
- Tail Inequalities for Martingales
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Topics to be covered (contd.)

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Social Justice

West Virginia University is committed to social justice. I concur with that commitment and expect to foster a nurturing learning environment, based upon open communication, mutual respect and non-discrimination. Our University does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color or national origin. Any suggestions to further such a positive and open environment in this class will be appreciated and given serious consideration. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me of the same and make appropriate arrangements with Disability Services (293-6700).

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