Number Theory

Ikhan Choi

June 12, 2022

Contents

Part I

Algorithms

Chapter 1

Data structures

Chapter 2

Computational geometry

Part II

Chapter 3

Information theory

Chapter 4

Coding theory

Chapter 5

Cryptography

Part III

Numerical analysis

Chapter 6

Finite difference methods

6.1 Ordinary differential equations

interpolation, differentiation and integration runge-kutta, multi-step

6.2 Elliptic equations

6.1 (1D Poisson equation). Consider the following boundary value problem:

$$\begin{cases} -u''(x) = f(x), & \text{in } (0,1), \\ u(0) = u(1) = 0. \end{cases}$$

We discretize it by $(u_j)_{j=0}^N$ such that $hN = 1$ and

$$\begin{cases} -\dfrac{u_{j+1} - 2u_j + u_{j-1}}{h^2} = f_j, & \text{for } j = 1, \cdots, N-1, \\ \qquad u_0 = u_N = 0. \end{cases}$$

$$\frac{1}{h^2} \begin{pmatrix} 2 & -1 & & 0 \\ -1 & 2 & \ddots & \\ & \ddots & \ddots & -1 \\ 0 & & -1 & 2 \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \\ \vdots \\ u_{N-1} \end{pmatrix} = \begin{pmatrix} f_1 \\ f_2 \\ \vdots \\ f_{N-1} \end{pmatrix}$$

6.3 Parabolic equations

6.4 Hyperbolic equations

6.5 Computational fluid dynamics

Chapter 7

Finite element methods

Chapter 8

Optimization

8.1 Convex optimization

8.2 Dynamic programming

optimal control

Part IV

Mathematical statistics

Chapter 9

Statistical models

Chapter 10

Statistical inference

estimation, testing hypothesis, ranking, selection

Chapter 11