Discrete Mathematics for Bioinformatics (P1)

Lecture & Tutorials (4 + 2)

Winter 2007/08, FU Berlin

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Web page at

http://www.math.fu-berlin.de/~gunnar/teaching/WS0708/P1.html

Organizational issues

Lecture and slides will be in English.

Credits. The slides are mostly taken from last year's lecture given by Prof. Alexander Bockmayr and Prof. Knut Reinert and include some slides by Prof. Daniel Huson (Tübingen)

Please note the following:

- You can download all slides (also in script form) typically the day after the lecture. It is not necessary to copy the slides.
- However, the slides are **not** a complete script. Please take notes and maybe copy things on the blackboard.
- Exercises will be held by Abdelhalim Larhlimi.
- **For all current information please check frequently** `http://www.math.fu-berlin.de/~gunnar/teaching/WS0708/P1.html`**.**

Lectures

Lectures take place

- Tuesdays from 10-12 am in SR 006 (Takustraße 9)
- Thursdays from 10-12 am in SR 032 (Arnimallee 6)

Exercises

The exercises are mandatory and will be counted as *active participation* in the new three column model of the FU Berlin.

Active participation = presence + reviews + some blackboard action.

There will also be some practical exercices (programming).

Reviews: 2×60 min (End November, Mid January)

Exercises (2)

Exercises will be held once weekly in room SR 119 (Fridays from 10-12 am).

First meeting: Friday, 26 Oct 2007

Office hours

Gunnar Klau: Thu, 16:30-17:30 + open door

Abdelhalim Larhlimi: open door

Content

The schedule is copied from last year. I will try to stick to this plan, but some changes may occur.

1. Linear Programming
   (a) (L1, 16 Oct) Optimization problems
   (b) (L2, 18 Oct) Polyhedra
   (c) (L3, 23 Oct) Simplex Algorithm
   (d) (L4, 25 Oct) Duality
2. Combinatorial Optimization
   (a) (L5, 30 Oct) Branch-and-Cut (Intro)
   (b) (L6, 1 Nov) B&C for sequence alignment (Modelling)
   (c) (L7, 6 Nov) B&C for sequence alignment (Algorithms)
   (d) (L8, 8 Nov) B&C for sequence alignment II

(e) (L9, 13 Nov) B&C for RNA alignment

(f) (L10, 15 Nov) Lagrangian Relaxation for RNA alignment

(g) (L11, 20 Nov) Constraint programming I

(h) (L12, 22 Nov) Constraint programming II

(i) (L13, 27 Nov) Local search and metaheuristics I

(j) (L14, 29 Nov) Local search and metaheuristics II

3. Graph algorithms

(a) (L15, 4 Dec) Overview and rehearsal (DFS, BFS, Dijsktra, Topsort, Spanning trees)

(b) (L16, 6 Dec) Shortest Path (A*,Floyd-Warshall)

(c) (L17, 11 Dec) Network flow

(d) (L18, 13 Dec) Bipartite Matching

4. Data structures and analysis methods

   (a) (L19, 18 Dec) Hashing

   (b) (L20, 20 Dec) Hashing II

   (c) (L21, 8 Jan) Random search trees/skiplists (KR)

   (d) (L22, 10 Jan) Randomized analysis, Chernoff bounds I (KR)

   (e) (L23, 15 Jan) Randomized analysis, Chernoff bounds II

   (f) (L24, 17 Jan) $\approx$ Review 2

   (g) (L25, 22 Jan) Locality sensitive hashing and applications

   (h) (L26, 24 Jan) Tree decompositions and applications I

   (i) (L27, 29 Jan) Tree decompositions and applications II

5. Complexity, Approximation, and Online-Algorithms

   (a) (L28, 31 Jan) Complexity I

   (b) (L29, 5 Feb) Complexity II

(c) (L30, 7 Feb) Approximation and online algorithms I

(d) (L31, 12 Feb) Approximation and online algorithms II (AB)

6. (L32, 15 Feb) Written examination

Discrete mathematics

What is *discrete mathematics*? (discrete, from lat. *discernere*, to discern, to separate)

From http://mathworld.wolfram.com:

> Discrete mathematics is the branch of mathematics dealing with objects that can assume only distinct, separated values. The term "discrete mathematics" is therefore used in contrast with "continuous mathematics", which is the branch of mathematics dealing with objects that can vary smoothly (and which includes, for example, calculus). Whereas discrete objects can often be characterized by integers, continuous objects require real numbers.
>
> The study of how discrete objects combine with one another and the probabilities of various outcomes is known as combinatorics. Other fields of mathematics that are considered to be part of discrete mathematics include graph theory and the theory of computation. Topics in number theory such as congruences and recurrence relations are also considered part of discrete mathematics.
>
> The study of topics in discrete mathematics usually includes the study of algorithms, their implementations, and efficiencies. Discrete mathematics is the mathematical language of computer science, and as such, its importance has increased dramatically in recent decades.

Why is it important in bioinformatics?

Questions?