BCB 444/544X Introduction to Bioinformatics

Syllabus – Fall 2005

BCB 444/544X Introduction to Bioinformatics. (3-2) Cr. 4.

Broad overview of bioinformatics with a significant problem-solving component, including hands-on practice using computational tools to solve a variety of biological problems. Topics include: database searching, sequence alignment, gene prediction, RNA and protein structure prediction, construction of phylogenetic trees, comparative and functional genomics.

Prereq: Math 165 or Stat 401 or equiv.
Co-listings: BCB/Biol/ComS/CprE/Gen 444X / BCB/ComS/CprE/GDCB 544X

Website: http://www.cs.iastate.edu/~cs544

Instructors:

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Class Meetings:

Lectures:	MWF	10:00 – 10:50 AM
Lab:	Th	1:10 – 3:00 PM

Textbook: *Bioinformatics: Sequence & Genome Analysis, 2nd edition*
David W. Mount
Cold Spring Harbor Press, 2004

Course Goals:

To convey the importance of bioinformatic approaches in solving problems in modern biological research and provide hands on experience using software, critically evaluating results, and interpreting their biological significance.

Students will understand:

- the *fundamental biological questions* and how to apply appropriate computational tools
- the *basic principles underlying the computational approaches*, the limitations of available tools and how to critically interpret results

Required Reading:

BCB 444: Assigned chapters in the text and supplemental materials provided in class or on the website.

BCB 544: Same as 444. In addition, reading assignments from primary literature and a term research project will be assigned during the semester. Students will be required to answer discussion questions for each reading assignment. A written summary and an oral presentation on the term project will be required.

Exams: There will be two in-class midterm exams and a final exam. The final will be cumulative with emphasis on the most recent material and general concepts from earlier material. In addition, there will be frequent take-home assignments based on material covered in the lectures and laboratory.

Grading:

BCB 444:
Midterm Exams = 100 points each
Take-home assignments = 150 points
Final Exam = 150 points
Total 500 points

BCB 544:
Midterm Exams = 125 points each*
Take-home assignments = 150 points
Final Exam = 200 points
Discussion questions/projects = 200 points total
Total 800 points

*544 students will be required to answer extra questions on each exam. These questions will emphasize experimental interpretation and design or concepts related to the journal readings.

Intended Learning Outcomes

Students are expected to gain an understanding of the importance of bioinformatic approaches in modern biological research. For each of the topics covered, they will understand the fundamental biological questions and be able to apply appropriate computational tools. They will understand the basic principles underlying the computational approaches, realize the limitations of available tools and be able to critically interpret results.

Students with Disabilities

If you have a disability and require accommodations, please contact one of the instructors early in the semester so that your learning needs may be appropriately met. You will need to provide documentation of your disability to the Disability Resources (DR) office, located on the main floor of the Student Services Building, Room 1076, 515-294-6624.

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Tentative Lecture Schedule

#	Date	Topic	Reading	Instructor
1	Aug 22 M	*Course Overview; What is bioinformatics?*	Mount, Ch 1	DD
2	Aug 24 W	*Alignment of pairs of sequences: Overview of methods*	Mount, Ch 3	DFB
3	Aug 26 F	*Alignment of pairs of sequences: Dynamic programming*	Mount, Ch 3	DFB
4	Aug 29 M	*Alignment of pairs of sequences: Substitution matrices and parameter choice*	Mount, Ch 3	DFB
5	Aug 31 W	*Statistical analysis of alignments: Overview of statistical issues*	Mount, Ch 4	DFB
6	Sep 2 F	*Statistical analysis of alignments: Assessing significance*	Mount, Ch 4	DFB
-	Sep 5 M	**NO CLASS – University Holiday**		
7	Sep 7 W	*Statistical analysis of alignments: Bayesian methods*	Mount, Ch 4+	DFB
8	Sep 9 F	*Multiple sequence alignment: Definitions, global vs. local*	Mount, Ch 5	DFB
9	Sep 12 M	*Multiple sequence alignment: Dynamic programming and progressive methods*	Mount, Ch 5	DFB
10	Sep 14 W	*Multiple sequence alignment: Hidden Markov models, position-specific scoring*	Mount, Ch 5	DFB
11	Sep 16 F	*Database searching: Overview of FASTA and BLAST*	Mount, Ch 6	DFB
12	Sep 19 M	*Database searching: Dynamic programming, Bayesian methods*	Mount, Ch 6	DFB
13	Sep 21 W	*Database searching: Scoring issues*	Mount, Ch 6	DFB
14	Sep 23 F	**MIDTERM EXAM #1**		
15	Sep 26 M	*PERL*	Mount, Ch 12	MT
16	Sep 28 W	*PERL*	Mount, Ch 12	MT
17	Sep 30 F	*Phylogenetic prediction: Definitions and basic concepts, overview of methods*	Mount, Ch 7+	DFB
18	Oct 3 M	*Phylogenetic prediction: Compatibility and parsimony*	Mount, Ch 7+	DFB
19	Oct 5 W	*Phylogenetic prediction: Distance-based methods*	Mount, Ch 7+	DFB
20	Oct 7 F	*Phylogenetic prediction: Maximum likelihood*	Mount, Ch 7+	DFB
21	Oct 10 M	*Phylogenetic prediction: Accuracy of methods*	Mount, Ch 7+	DFB
22	Oct 12 W	*Gene prediction: Methods & programs*	Mount, Ch 9	DFB/DD
23	Oct 14 F	*Gene prediction: Prokaryotes vs eukaryotes*	Mount, Ch 9	DD
24	Oct 17 M	*Gene regulation; Predicting promoters,regulatory regions*	Mount, Ch 9	DD
25	Oct 19 W	*Predicting miRNA genes & targets*	Mount, Ch 9+	DD
26	Oct 21 F	*RNA structure: RNA functional classes & structural features*	Mount Ch 8	DD
27	Oct 24 M	*Predicting RNA secondary structure*	Mount, Ch 8+	DD/DFB
28	Oct 26 W	*Predicting RNA tertiary structure*	Mount, Ch 8+	DD
29	Oct 28 F	**MIDTERM EXAM #2**		
30	Oct 31 M	*Protein structure: Protein structural features, structure classification, databases,& visualization tools*	Mount, Ch 10	DD
31	Nov 2 W	*Protein structure: Structural alignment methods*	Mount, Ch 10	DD
32	Nov 4 F	*Predicting protein secondary structure*	Mount, Ch 10	DD
33	Nov 7 M	*Predicting protein tertiary structure*	Mount, Ch 10+	DD
34	Nov 9 W	*Protein structural modeling & protein-ligand docking*		DD
35	Nov 11 F	*Genome analysis: Genomic sequence assembly*	Mount, Ch 11	DD
36	Nov 14 M	*Genome analysis: Comparative genomics*	Mount, Ch 11	DD
37	Nov 16 W	*Microarrays: Experimental methods, design & analysis*	Mount, Ch 13+	DD
38	Nov 18 F	*Proteomics: Experimental methods, design & analysis*	Mount, Ch 13+	DD
-	**Nov 21-25**	**NO CLASS – Thanksgiving Break**		
39	Nov 28 M	*Machine learning algorithms*		V Honavar
40	Nov 30 W	*Modeling networks: Pathway & interaction databases; genetic regulatory & metabolic network modeling*		DD/VH
41	Dec 2 F	*Prediction protein function*		DD

42	**Dec 5 M**	**Student Project Presentations (2 X 20')**		DFB/DD
43	**Dec 7 W**	**Student Project Presentations (2 X 20')**		DFB/DD
44	**Dec 9 F**	**Student Project Presentations (2 X 20')**		DFB/DD
45	**Dec ?**	**FINAL EXAM**		

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Tentative Lab Schedule

#	Date (Th)	Topic	Reading	Instructor
1	Aug 25	*Sequences & databases*	Mount, Ch 2	MT
2	Sep 1	*Sequence alignment*	Mount, Ch 3	MT
3	Sep 8	*Sequence alignment*	Mount, Ch 4	MT
6	Sep 15	*Sequence alignment*	Mount, Ch 5	MT
7	Sep 22	*Database searching*	Mount, Ch 6	MT
8	Sep 29	*PERL*	Mount, Ch 12	MT
9	Oct 6	*Phylogenetic prediction*	Mount, Ch 7+	MT
10	Oct 13	*Phylogenetic prediction*	Mount, Ch 7+	MT
11	Oct 20	*Gene prediction*	Mount, Ch 9	MT
12	Oct 27	*RNA structure prediction*	Mount, Ch 8+	MT
13	Nov 3	*Protein structure prediction*	Mount, Ch 10+	MT
14	Nov 10	*Docking*		MT
15	Nov 17	*Genome analysis, Microarrays*	Mount, Ch 11 & 13	MT
-	Nov 24	**NO LAB – Thanksgiving Break**		
17	Dec 1	*Protein function prediction*		MT
18	**Dec 8**	**Student Project Presentations (4 X 20')**		DFB/DD
-	Dec 15	**NO LAB – Finals Week**		