THE UNIVERSITY OF MEMPHIS

BIOINFORMATICS

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STUDENT HANDBOOK

2009-2010

About The Bioinformatics Program

Bioinformatics is an emerging interdisciplinary field which combines mathematical and computer sciences with biology and/or medicine. With the recent advancements in biotechnology, biologists are frequently overloaded with large datasets which need to be stored and analyzed in automated ways. Bioinformatics provides the tools to understand complex biological systems ranging from entire ecological systems, to specific human diseases, to cellular and molecular networks.

Currently the Bioinformatics Program at the University of Memphis includes over 15 faculty members from 5 different departments: Computer Science, Mathematics, Biology, Chemistry, and Electrical and Computer Engineering. In addition, the Program includes 7 affiliated faculty from various departments at University of Tennessee Health Science center in Memphis.

Research Assistantships

The Bioinformatics Program does not award Teaching Assistantships. A select number of students **(~75% of current students**) receive Research Assistantships (RA), which are renewable each semester on a competitive basis. Research Assistantships begin at $3,000 per semester and include a full tuition waiver. All students receiving RA stipends must: 1) enroll in 12 credit hours each semester; 2) enroll in 3 credit hours of research with supervising faculty member; 3) conduct research in addition to their coursework (approx. 20 hrs per week); 4) complete a BINF Master's Thesis project. Depending on the performance and quality of the research, stipend may be raised to $6,000 per semester, usually during the second year in the program. It is important to note that students may loose their RA if their performance is not satisfactory as judged by the research mentor.

Students receiving an RA will be asked to submit a brief (one paragraph) research report to both the research advisor and the Bioinformatics Program mid-semester. A reminder email will be sent out each semester and will advise the deadline for the report.

Students receiving an RA are also required to submit a research progress report to their faculty supervisor 3 weeks before the end of each semester. The report should be brief (~2 pages) and contain the following:

1. Brief intro and objectives/aims of your project
2. General methodology and approach taken
3. Major Conclusions
4. Future plan (for next semester's research)

A copy of this report should be turned in to the Bioinformatics Program office and will become a part of your permanent student record.

Registration & Advising

Before a student can register for the semester using the **MyMemphis** online system at https://my.memphis.edu/cp/home/displaylogin, an advisory hold must be lifted by the Bioinformatics Program, which requires that your course schedule is approved by the Director. The Bioinformatics degree plan is specified in an Excel worksheet (as demonstrated on page 5) which can be obtained from Ms Campbell or Dr. Homayouni. The student is responsible for adhering to this degree plan and making choices for the sequence of courses according to their specific backgrounds. Each semester, the student must submit via email an updated degree plan to the Bioinformatics Program, before an advisory hold will be lifted. In addition, the student must propose their class schedule for approval.

If you or your research advisor prefer to substitute a course that might be better suited for your studies, then a substitution form must be filled out and submitted to the Director for approval. The substitution forms will be kept in the student file and will be submitted at the time of graduation along with the graduation candidacy form (see below).

Once your proposed coursework is approved by the Director, the advisory hold will be cleared and you will be able to register within a few days. If permits are required for classes, you must contact the department offering the course to get a permit issued.

Appointments with the Director

Prior to the beginning of each registration period, students will be advised via email to set appointments with Dr. Homayouni. Please remember his schedule fills up a week or two in advance so when you are notified there is time available you should contact the office (678-3132) as soon as possible.

Graduation Responsibilities

Each student is responsible for understanding and meeting all graduation requirements imposed by the University of Memphis Graduate School. The following websites contain important information for graduation. Please check for updated information every semester.

Bioinformatics Program: http://www.memphis.edu/binf/

Graduate School: http://memphis.edu/gradschool/

PLEASE NOTE: No extension is allowed if you miss the deadline to file the intent to graduate form.

Non-Thesis Option

Students may choose a non-thesis option for obtaining a Master's Degree in Bioinformatics. This option requires that the student successfully completes a BINF project class under the supervision of a primary research advisor. The student must choose a project supervisor well in advance of registering for the class. Within the first 2 weeks of class, the student must submit a 2 page proposal to the primary research advisor and the Program Director for approval. A full research paper (generally >20 pages) should be submitted 3 weeks before the end of the semester to the primary advisor and a public presentation of the project must be given at least one week before the last day of class in a semester. The presentation time and place must be coordinated with Ms Campbell several weeks in advance and a title and abstract for the presentation must be given to Ms Campbell for dissemination one week prior to the presentation. A satisfactory grade in this class is required for graduation.

2009-2010 Dates & Deadlines for Project or Thesis Planning

		Fall 2009	Spring 2010
Defended Thesis due in Graduate School Office		Nov 20	April 9
Comprehensive Exam Certification due	*	Dec 4	April 23
Final Corrected Thesis Copy for binding		Dec 4	April 23
Last Day of Class		Dec 9	April 28
Commencement		Dec 19	May 8

*This form is issued by Bioinformatics at the time of your Project presentation or Thesis defense, and must be signed by your committee members. Final corrected Thesis copy to be used for binding must be submitted to the Graduate School Office by this deadline also.

Master's Thesis Procedure

Master's Thesis research must begin at the end of the first year in the Program, and preferably will be initiated during the summer break. Therefore, students are responsible for interacting with various faculty and research groups during their first year in order to determine their research advisors and Thesis projects. Student must establish a Thesis committee, comprised of 3 graduate faculty members, and submit a Master's Thesis proposal during their 3rd semester in the Program. During their final semester, the student is expected to turn in a complete and fully-edited Thesis draft to the committee members at least 2 weeks before the scheduled defense date. The defense will include a one-hour public presentation, followed by a private oral examination from the committee. At this point, the committee will judge the quality of the work and suggest modifications to the Thesis. The committee approved Thesis must be submitted to the graduate office before the deadline for each semester, which is usually three to four weeks before the last day of class for that semester. The graduate office will review the thesis and contact you when your thesis is ready to be picked up and printed. The completed Thesis is due in the graduate office five to seven days before the end of the semester. In addition, students must be enrolled in BINF Thesis class in the semester that they plan to graduate.

Name:	ID: U	Advisor:			
Began: Grad:	Bioinformatics MS Degree Plan			updated:	
2009 Curriculum per Graduate Catalog	**Course Status**	**Credits Required**	**Sem. Taken**	**Credits Taken**	**Grade**
a. Major Field Core (13 hrs required)		**13 hrs**			
BINF 7980 Research Seminar in Bioinformatics *					
***Suggested for every semester (4 credit hours total)**					
COMP 6030 Introduction to Algorithms					
OR COMP 7712 Algorithms Problem Solving					
COMP 7295 Introduction to Bioinformatics					
MATH 6635 Introduction to Probability Theory					
MATH 7221 Stat Meth for Analyzing Gene Expression Data					
b. Biology: 6 credit hours chosen from:		**6 hrs**			
BIOL 7131 Cell and Molecular Biology					
BIOL 7470 Advanced Bacterial Genetics					
BINF 7701 Intro to Genomics & Bioinformatics (also listed as BIOL 7008)					
BIOL 7703 Molecular Biology of Cancer					
BIOM 7004 Life Sciences 1					
c. Electives: 9-15 credit hours chosen from:		**9 hrs**			
BIOL 6480 Cellular and Molecular Pharmacology					
CHEM 6415 Computational Chemistry					
COMP 6081 Software Development					
COMP 6262 Programming in Unix					
COMP 6601 Models of Computation					
MATH 6607 Introduction to SAS Programming					
CHEM 7711 Approximate Chemical Modeling Methods					
COMP 7115 Database Systems					
COMP 7116 Advanced Database Systems					
COMP 7117 Topics in Database Management Systems					
COMP 7118 Data Mining					
COMP 7282 Evolutionary Computations					
COMP 7290 Molecular Computing					
COMP 7717 Topics in Algorithm					
COMP 7740 Neural Networks					
MATH 7641 Analysis of Variance					
MATH 7642 Design of Experiments					
MATH 7643 Regression Analysis					
MATH 7647 Nonparametric Methods					
MATH 7657 Multivariate Methods					
MATH 7660 Applied Time Series Analysis					
MATH 7680 Bayesian Inference					
MATH 7685 Statistical Computing and Simulation					
MATH 7695 Bootstrap and Other Resampling Methods					
d. Thesis 3 hrs Required (6 hrs Maximum for Thesis)		**3 to 6**			
BINF 7996 Bioinformatics Thesis					
or BINF 7992 Bioinformatics Project					
	Min. Hours =	37		0	0
**NOTE: 26 credits must be from 7/8000 level classes					>7000

SAMPLE DEGREE PLAN

A SPREADSHEET WILL BE SENT TO YOU AS AN EMAIL ATTACHMENT

BIOINFORMATICS DEGREE PLAN—2009-2010

1. Candidates must satisfactorily complete 37 credit hours of graduate course work (27 of which must be 7000 level or higher) as approved by the Program Advisor and distributed as follows:

A. Major Field Core (13 credit hours):

BINF 7980 Research Seminar in Bioinformatics
COMP 6030 Introduction to Algorithms or
COMP 7712 Algorithms Implementation and Problem Solving
COMP 7295 Introduction to Bioinformatics
MATH 6635 Introduction to Probability Theory
MATH 7221 Statistical Methods for Analyzing Gene Expression Data

B. Biology: 6 credit hours chosen from:

BIOL 7131 Cell and Molecular Biology
BIOL 7470 Advanced Bacterial Genetics
BINF 7701 Introduction to Genomics & Bioinformatics (cross-listed as BIOL 7008)
BIOL 7703 Molecular Biology of Cancer
BIOM 7004 Life Sciences for Biomedical Engineering I

C. Electives: 9 credit hours chosen from:

BIOL 6480 Cellular and Molecular Pharmacology
CHEM 6415 Computational Chemistry
CHEM 7711 Approximate Chemical Modeling Methods
COMP 6081 Software Development
COMP 6262 Programming in UNIX
COMP 6601 Models of Computation
COMP 7115 Database Systems
COMP 7116 Advanced Database Systems
COMP 7117 Topics in Database Management Systems
COMP 7118 Data Mining
COMP 7282 Evolutionary Computations
COMP 7290 Molecular Computing
COMP 7717 Topics in Algorithm
COMP 7740 Neural Networks
MATH 6607 Introduction to SAS Programming
MATH 7641 Analysis of Variance
MATH 7642 Design of Experiments
MATH 7643 Regression Analysis
MATH 7647 Nonparametric Methods
MATH 7657 Multivariate Methods
MATH 7660 Applied Time Series Analysis
MATH 7680 Bayesian Inference
MATH 7685 Statistical Computing and Simulation
MATH 7695 Bootstrap and Other Resampling Methods

D. Thesis: 3 credit hours

BINF 7996 Thesis or BINF 7992 Bioinformatics Project

Source: Graduate Catalog— http://www.memphis.edu/gradcatalog/degreeprog/cas/binf.php

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BIOINFORMATICS (BINF)

7701. Introduction to Genomics & Bioinformatics. (3) Accelerated introduction to molecular and genomic sciences, covering basic concepts of gene and protein structure/ function, genome sequencing and annotation, single nucleotide polymorphism, genetic variation, gene expression, and functional genomics and proteomics. PREREQUISITE: Permission of Instructor. Cross listed with BIOL 7008.

7980. Research Seminar in Bioinformatics. (1). Current research topics in Bioinformatics.

†7991. Bioinformatics Internship. (1-3). Supervised practical experience conducted in industrial, academic research or clinical research organizations. The project must be approved by the program director and may be supervised by any faculty in the program. A written report is required. May be repeated for a total of 12 semester hours. **NOTE: Credit is not applicable toward Bioinformatics Master's Degree.**

†7992. Bioinformatics Project. (3). Research project conducted in lieu of a Master's Thesis under the supervision of a faculty advisor. The project must be approved by the program director and may be supervised by any faculty in the program. A written report and an oral presentation are required for satisfactory completion of the course.

†7996. Bioinformatics Thesis. (1-3). Supervised research in preparation for advanced degree thesis. May be repeated for up to 6 hours.

†Grades of S, U, or IP will be given.

BIOLOGY (BIOL)

6480. Cellular and Molecular Pharmacology. (3). Provides basic understanding of mechanisms by which therapeutic agents regulate physiological function of cells comprising organ systems such as the heart and central nervous system; drug action (pharmacodynamics) addressed at the melocular, cellular, and organ level, as well as common diseases affecting a system. PREREQUISITES: CHEM 1120 and BIOL 3130.

7008. Introduction to Genomics & Bioinformatics. (3) See BINF 7701

7131. Cell and Molecular Biology. (4). Introduction to principles of molecular biology as they apply to eukaryotic cells including transcription, translation, regulation of protein function, DNA replication, membrane biogenesis, secretion, hormone action, signal transduction, and ligand receptor interaction. *Four lecture hours per week.*

7470 - Adv Bacterial Genetics (3) (MMCS 7470-8470). Advanced studies in the molecular basis of bacterial genetics; including mutation and bacterial repair systems, complementation analysis, recombination, gene transfer mechanisms, gene conversion and marker effects, insertional elements, phase variation, and bacteriophage genetics. PREREQUISITE: BIOL 6470 or equivalent.

7700-40–8700-40. Special Topics in Biology. (1-4). Current topics of special interest in biology. PREREQUISITE: Permission of instructor. **BIOL 7703: Molecular Biology of Cancer**

BIOMEDICAL ENGINEERING (BIOM)

NOTE: Students taking Engineering courses will be charged an additional $25 per credit hour.

7004. Life Sciences for Biomedical Engineering I. (3). This introduction and application to aspects of the entire body provides engineers and physical scientists with an understanding of aspects of the chemical, physical, and mechanical basis of cell shape, function, and motility; integrated treatment of topics in cellular biochemistry, protein synthesis, energy releasing pathways, and membrane biophysics.

CHEMISTRY (CHEM)

6415. Computational Chemistry. (3). Application of computers to problems in organic and inorganic chemistry; use of quantum chemistry codes to solve problems related to electronic, molecular, and vibrational structure.

7711. Approximate Chemical Modeling Methods. (3). Development of approximate classical and quantum mechanical techniques for modeling chemical systems, molecular mechanics, semiempirical quantum mechanics. PREREQUISITE: CHEM 7411 or permission of instructor.

COMPUTER SCIENCE (COMP)

6030. Introduction to Algorithms. (3). Asymptotic behavior of programs; basic paradigms in algorithm design: greedy, divide-and-conquer, dynamic programming; analysis of efficiency, and optimality of representative algorithms, including graph, pattern matching, numerical, randomized, and approximation algorithms; approaches to lower bound analysis; basic parallel algorithms. NOTE: Computer Science majors may not use this course to fulfill degree requirements. PREREQUISITE: COMP 3160.

6081. Software Development. (3-6). Advanced programming methods: testing, generic libraries, documentation methods; program analysis and design methodologies such as object-oriented, life cycles, metrics, process improvement strategies, personal software process; software quality. NOTE: Computer Science majors may not use this course to fulfill degree requirements. PREREQUSITE: COMP 3160, or permission of instructor.

6262. Programming in UNIX. (3). Fundamentals of UNIX system and environment including: file system, shell concepts and programming, editors (VI and EMACS), filters (SED, AWK, GREP, SORT), utilities (MAKE, YACC, LEX), mail facility, communication software, C programming and its UNIX interface, X window system. NOTE: Computer Science majors may not use this course to fulfill degree requirements. PREREQUISITE: COMP 2150 or permission of instructor.

6601. Models of Computation. (3). Computer models as a basis of the understanding and analysis of programming: computation and complexity: machine models (finite-state, stack and Turing machines), linguistic models (grammars, lambda calculus, and predicate calculi); biologically-inspired models (e.g.: neural nets or genetic algorithms); unsolvability, universality, decidability, and feasibility. NOTE: Computer Science majors may not use this course to fulfill degree requirements. PREREQUISITE: COMP 2150, MATH 2701.

7115. Database Systems. (3). Review of the relational model; query processing and optimization; physical database design and tuning; transaction processing; concurrency control; crash recovery; database buffer management; database security. PREREQUISITE: COMP 6115 or permission of instructor.

7116. Advanced Database Systems. (3). Advanced data modeling; object-oriented and object-relational databases; indexing of complex data; advanced transaction processing; on-line analytical processing and data warehousing; distributed database processing. PREREQUISITE: COMP 7115 or permission of instructor.

7117. Topics in Database Management Systems. (3). Advanced current research topics in database and information management, with emphasis on nontraditional data and applications. PREREQUISITE: COMP 7116 or permission of instructor.

7118. Topics in Data Mining. (3). Approaches to data mining and knowledge discovery (graphical, statistical, combinatorial, heuristic); classification and clustering; time series analysis; spatial data mining; data mining applications. PREREQUISITE: COMP 3160 or permission of instructor.

COMPUTER SCIENCE (COMP)

7282. Evolutionary Computation. (3). Computational implementation of biological analogies, such as genetic algorithms, genetic programming, embryonics, evolutionary engineering; representation, fitness functions, fitness landscapes, automatically defined functions; applications to optimization, machine learning, software development. PREREQUISITE: COMP 6601 or permission of instructor.

7290. Molecular Computing. (3). Basics of cell biology and genetics (DNA structure and enzymes, replication and translation); feasible DNA-based solution of hard computational problems; issues in the design of molecular computers; foundations of nanotechnology. PREREQUISITE: COMP 7712 or permission of instructor.

7295. Introduction to Bioinformatics. (3). Algorithms for problems arising in molecular biology, such as sequence matching, alignment, gene finding, sequence assembly, phylogeny, and structure prediction; internet resources; statistical analysis of DNA, RNA, and protein sequences. PREREQUISITE: COMP 6030 or permission of instructor.

7712. Algorithms Implementation and Problem Solving. (3). Covers algorithms problems, techniques, and design emphasizing problem solving and implementation skills; topics include advanced data structures, graph algorithms, string matching, network flow, dynamic programming, and randomized algorithms. PREREQUISITE: COMP 3160 or permission of instructor.

7717. Topics in Algorithms. (3). Recent developments and practical issues in algorithms and data structures. PREREQUISITE: COMP 7713 or permission of instructor.

7740. Neural Networks. (3). Learning algorithms for multilayer perceptrons, least-mean squares, backpropagation and its variants, cascade-correlation, other supervised learning algorithms; unsupervised methods, including Hebbian, competitive, and reinforcement learning; applications to associative memories, combinatorial optimization, component analysis, function approximation, pattern classification; theory of neurodynamics, including equilibrium, stability, and computational power. PREREQUISITE: COMP 4030 or permission of instructor.

MATHEMATICS (MATH)

6607. Introduction to SAS Programming. (3). SAS program statement syntax and flow control; selecting and summarizing observations; combining, dividing, and updating SAS dataset; input tailoring and output customization; SAS built-in functions; SAS Macro Language Programming; other SAS packages like SAS/GRAPH and SAS/IML. NOTE: Introductory statistical courses are recommended.

6635. Introduction to Probability Theory. (3). Basic probability theory, random variables, discrete and continuous probability distributions, functions of one or more random variables, multivariate distributions including multinomial and bivariate normal distributions. NOTE: Students may not receive credit for both MATH 6635 and MATH 6614. PREREQUISITE: MATH 1920.

7221. Statistical Methods for Analyzing Gene Expression Data. (3). Design of microarray experiements; normalization procedures for Oligonucleotide and cDNA microarrays; clustering procedures: hierarchical clustering, principal compenents and analysis, discriminant analysis, eigenvalue decomposition discriminant analysis and nonparametric clustering methods; controlling error rates in multiple testing through resampling methods, false discovery rates, Bayesian and empirical Bayes techniques, Support Vector Machines. PREREQUISITE: MATH 7643.

MATHEMATICS (MATH)

7641. Analysis of Variance. (3). Basic concepts of ANOVA, partitioning of the sums of squares, fixed effects models, t- and F-tests, multiple comparison procedures, random effect models, variance component models, analysis of covariance and introduction to MANOVA (SAS or comparable statistical packages used extensively to analyze different types of designs). PREREQUISITE: MATH 7643 or MATH 6636.

7642. Experimental Design. (3). Fundamental concepts in designing experiments, justification of linear models, randomization, principle of blocking, use of concomitant observations, principle of confounding, fractional replication, composite designs, incomplete block designs. PREREQUISITE: MATH 7641 or 7643.

7643. Least Squares and Regression Analysis. (3). Basic concepts of hypothesis testing and confidence intervals; simple and multiple regression analyses, model selection, Mallow's Cp, examination of residuals, Box-Cox transformation, influence diagnostics, multicolinearity, ridge-regression, probit, logit, and log-linear analyses; intensive use of SAS or other statistical packages. PREREQUISITE: MATH 6635.

7647. Nonparametric Statistical Methods. (3). Use of distribution-free statistics for estimation, hypothesis testing, and correlation measures in designing and analyzing experiments. PREREQUISITE: MATH 6635; COREQUISITE: MATH 6636.

7657. Multivariate Statistical Methods. (3). Basic contents: multivariate normal distributions; Wishart distribution, Hotelling-T2, Matric-t and Beta distributions; generalized regression models and growth curve models; multivariate analysis of variance; principal component analysis; discriminant analysis; factor analysis; curve fitting procedures in multivariate cases. All topics will be illustrated by practical examples. PREREQUISITE: MATH 6636 or permission of the instructor.

7660. Applied Time Series Analysis. (3). Basic concepts and examples of stationary and nonstationary time series; random harmonic analysis; spectral density functions, model building procedures for time series models; model identification; diagnostic checking, smooth, forecasting and control; Box-Jenkin approach of time series analysis; some seasonal models. PREREQUISITE: MATH 6636.

7680. Bayesian Inference. (3). Nature of Bayesian inference; formulation and choice of prior distributions; advantages and disadvantages of Bayesian approach; applications of Bayesian approach to Behren-Fisher problems, to regression analysis, and to the analysis of random effect models; applications of Bayesian approach to the assessment of statistical assumptions; Bayesian prediction procedures. PREREQUISITE: MATH 6636.

7685. Statistical Simulation and Computing. (3). Uniform random number generation and testing, generation of non-uniform random variables, approximating tail probabilities and percentage points in common distributions, computational methods for multiple regression analysis. PREREQUISITE: MATH 6636 and knowledge of FORTRAN.

7695. Bootstrap and Other Resampling Methods. (3). Empirical distribution and plug-in principle; bias reduction; bootstrapping regression models; the jackknife; balanced repeated replication; bootstrap confidence intervals; parametric bootstrap; permutation tests. PREREQUISITE: MATH 7645 and MATH 7647

Students Planning a PhD in Computer Science

A Bioinformatics Master of Science degree may count towards a PhD in Computer Science at the University of Memphis if the student fulfills the core requirements, which include the following four courses:

COMP 7012-8012. Foundations of Software Engineering. (3). (Same as EECE 7012-8012). Covers project management; Unified Process; software disciplines (requirements, analysis, design, implementation, testing); Unified Modeling Language; design patterns, mapping designs to code. Students work in teams to develop a significant software system. PREREQUISITE: COMP 3160 or permission of instructor.

COMP 7212-8212. Operating and Distributed Systems. (3). Overview of operating system architecture for centralized and distributed systems; storage device and file systems; process management, scheduling, synchronization, interprocess communications and security; case studies of selected operating systems. PREREQUISITES: COMP 3160 or permission of instructor.

COMP 7612-8612. Foundations of Computing. (3). Review of basic models of computation and complexity; measures and modes of complexity analyses, both logical and experimental; average case analysis of algorithms; information complexity and its applications to coding; deterministic and stochastic methods for data analysis and compaction, hypothesis testing, and estimation. PREREQUISITE: COMP 4030 or permission of instructor.

The courses listed above should be taken as electives.

COMP 7712. Algorithms Implementation and Problem Solving. (3). See page 9 for description Note: As indicated in Degree Plan shown on page 5 and 6 of this handbook, this course can be substituted for the Bioinformatics core class COMP 6030.

NOTES