THE MASTER of SCIENCE
in
COMPUTER SCIENCE

GRADUATE PROGRAM BROCHURE
--

UNIVERSITY OF MINNESOTA DULUTH
DULUTH, MINNESOTA 55812

2019-2020

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The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation.

In adhering to this policy, the University abides by the Minnesota Human Rights Act, Minnesota Statute Ch. 363, by the Federal Civil Rights Act, 420 S.C. 2000E; by the requirements of Title IX of the Education Amendments of 1972; by Sections 503 and 504 of the Rehabilitation Act of 1973; by Executive Order 11246, as amended; 38 U.S. 2012, the Vietnam Era Veterans Readjustment Assistance Act of 1972, as amended; and by other applicable statutes and regulations relating to equality of opportunity.

University of Minnesota Graduate School Commitment to Diversity

The Graduate School embraces the University of Minnesota's position that promoting and supporting diversity among the student body is central to the academic mission of the University. We define diversity to encompass many characteristics including economic disadvantage, special talents, evidence of leadership qualities, race or ethnicity, a strong work record, and disability. A diverse student body enriches graduate education by providing a multiplicity of views and perspectives that enhance research, teaching, and the development of new knowledge. A diverse mix of students promotes respect for, and opportunities to learn from, others with the broad range of backgrounds and experiences that constitute modern society. Higher education trains the next generation of leaders of academia and society in general, and such opportunities for leadership should be accessible to all members of society. The Graduate School and its constituent graduate programs are therefore committed to providing equal access to educational opportunities through recruitment, admission, and support programs that promote diversity, foster successful academic experiences, and cultivate the leaders of the next generation.

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1. The Department of Computer Science

Computer Science is a discipline that requires understanding the design of computers and computational processes. The discipline ranges from the theoretical study of algorithms to the design and implementation of software at the systems and applications levels. The Department of Computer Science offers programs leading to both the B.S. and M.S. degrees in Computer Science. The M.S. is a two-year program that depends upon a solid foundation in mathematics and statistics, computational problem solving, software design and analysis, programming languages, algorithms, data structures, and computer organization and architecture. The Master's program builds upon this foundation to provide depth in specified areas of computer science, with a focus on research and research methods. It provides the necessary foundational studies for graduates planning to pursue either a Ph.D. in computer science or a career as a computer scientist in business or industry.

The department currently consists of thirteen full-time faculty members with Ph.D.s in computer science or a closely related field. On an annual basis, the department confers approximately forty bachelor's degrees. The Master's program, begun in 1987, serves a student body of approximately twenty students per year.

The Computer Science Department is part of the Swenson College of Science and Engineering at the University of Minnesota Duluth, a campus of the University of Minnesota system. The University provides a comprehensive set of high quality programs in the areas of undergraduate, graduate and professional education to a population of some 11,000 students. Duluth is located on the shores of Lake Superior in one of the most beautiful areas of the country with numerous opportunities for outdoor activities The metropolitan area, with a population of approximately 100,000, offers many cultural events and excellent educational, recreational, and medical facilities.

The faculty is committed to excellence in both teaching and research. Research is focused in the following areas:

Computer Security	Artificial Intelligence
Parallel/Distributed Computing	Logic Programming
Natural Language Processing	Machine Learning
Environment Simulation	Energy Efficiency
Computer Security	Health informatics
User Interface Design	Data Mining
Operating Systems	Computer Networks
Network Traffic/Performance/Quality	Reinforcement Learning
Virtual Environments	Real-time Systems
Applied Perception in Graphics	Knowledge Representation
Visualization	Computational Linguistics

1.1 Computing Facilities

UMD students have access to a variety of computing facilities.

Computer Science Computing Facilities.

Each Research and Teaching Assistant affiliated with the department is provided with a workstation for his/her own use. Each workstation is on the UMD network and has access to a printer.

The Department maintains six departmental laboratories, described below. Along with its description is included the primary use of the lab, its location, and, where applicable, the faculty member who maintains it.

1. The CS Software Development Lab. 17 Alienware X51 workstations. 2 Dell Precision T5500 w/ NVIDIA Tesla cards. 3 iMacs. 1 HP All-in-one for windows consulting. [Heller Hall 314].

2. The CS Networking and Hardware Lab. 22 Dell workstations with removable hard drives. This lab has magnetic keycard access and is available to students registered in networking and system-related classes 24 hours a day. The lab also contains dedicated network switches and routers to provide a network testbed for exploration and investigation of network connectivity and communication protocols. [Marshall W. Alworth Hall (MWAH)187]

3. LARS Lab - The Laboratory for Advanced Research in Systems (LARS) is a lab dedicated to cutting-edge research into the security and efficiency of modern devices and their operating systems. Founded in 2015, the lab is currently under construction, but will feature a publicly-available testbed for hardware and software testing and energy measurement. The testbed will provide full hardware access and energy measurement for a variety of device types to researchers at UMD and beyond. LARS will also have a workstation for building devices and adding energy measurement instrumentation to existing hardware, such as smart phones, laptops and tablets. LARS has a strong commitment to education and outreach; in addition to hosting UMD's Ubuntu Linux mirror and developing security exercises for university students, we will be hosting a competitive cyber-tank programming league for regional high school students. [334 Heller Hall; Peterson]

4. Research at Distributed Systems and Networking Lab (DSNL) in UMD concentrates on designing highly scalable and efficient networking infrastructures, by combining optimization, economics, and computer science. Besides network optimization, projects at DSNL also address application specific issues in cloud computing, peer-to-peer (P2P) and multimedia systems. For example, our study on cloud computing aims to mitigate the performance

as well as the energy issues in the existing visualization environments. Our students will be able to test and explore different real-world cloud systems (e.g., cloud gaming/synchronization apps) in our lab. [MWAH 187; Wang]

5. Simulation and Interaction in Virtual Environments (SIVE) Lab. The SIVE Lab specializes in interactive simulations that use GPU-based resources, or benefit from interactive, immersive visualization capabilities. The lab consists of a 21ft x 33ft space containing a OptiTrack Motion Tracker system. The tracker system is primarily used to track the movements of users potentially wearing head-mounted displays (such as the NVIS nVisor SX Head Mounted Display or several Oculus Rift displays). The lab also contains a specialized L-shaped stereo projection display system. The L-shaped display is part of a haptic terrain system that allows users to feel what they virtually step on through the use of a special, robotic Smart-shoe. Two projectors provide forward and floor stereo projection for the user. This equipment allows us to provide an interactive, immersive experience in which people are able to walk around using their own locomotive abilities in a simulated 3D space. The lab also contains several Linux and Mac workstations to support the computation associated with visualization and interaction in these virtual environments. The lab is used for research, as well as teaching classes on human-centered computing (HCC) in virtual environments. Both undergraduates and graduate students work in the lab on a regular basis. Access to the lab is scheduled by the instructor. [Marshall W. Alworth Hall (MWAH) 143; Willemsen]

6. Motion and Media Across Disciplines (MMAD) Lab. The MMAD lab is supported by an interdisciplinary group of researchers (Morris Levy, Biomechanics-HPER; Joellyn Rock, Art + Design; Thomas Isbell, Theater; Robert Feyen, Mechanical and Industrial Engineering; Peter Willemsen, Computer Science, with assistance from Lisa Fitzpatrick). The lab is funded through an Infrastructure Investment Initiative (I3) award from the University of Minnesota.

   The MMAD Lab is a 3D motion capture and high definition video production studio. It is equipped with a multiple camera shooting space, cyclorama and backdrops, studio lighting and sound booth, and a Vicon motion tracking system. The high definition video production and motion capture studio fosters faculty collaboration and research in biomechanics, ergonomics, animation, performing arts and computer generated virtual environments research. Access to the lab is scheduled by the instructor. [Bohannon Hall 24a; Willemsen]

In addition to these resources, the Computer Science Department maintains two compute servers. The Dell PowerEdge R820 has 10 8-core processors and 512GB of memory. The Dell PowerEdge R815 compute server has 4 8-Core processors and 192 GB of memory. Both run Ubuntu Linux. These computers are often used in advanced classes for extremely large jobs and for undergraduate research. The Department also

maintains a file server. This file server is a virtual computer running on ITSS's servers, and has about 5TB of storage for people in Computer Science.

U.M.D. Computing Facilities
UMD's Information Technology Systems and Services (ITSS) provides a wide range of computing services including networking, computing labs (using a variety of hardware/software platforms) and a wide range of application software. To learn more about the resources available to students, visit the ITSS website.

1.2 The Faculty

A listing of departmental graduate faculty, along with a brief description of teaching and research interests and a recent publication, follows:

Arshia Khan, Ph.D., Associate Professor of Computer Science

Teaching and Research Interests: Technological solutions to improve healthcare with an emphasis in mobile technology and avant-garde teaching pedagogies.

Publication:
Khan, A., Bahra, R. Bipolar Depression Druid: Wireless Technology Framework to Predict Bipolar Depression. Proceedings of the International Conference on Health Informatics and Medical Systems, Las Vegas, 2016; http://worldcomp-proceedings.com/proc/p2016/HIMS16_Contents.html; ISBN: 1-60132-437-5, CSREA Press

Khan, A., Reuter, M., Phung, N. (2016) "Wireless Solution to Prevent Decubitus Ulcers: Preventive Weight Shifting Guide, Monitor, and Tracker App for Wheel Chair Users with Spinal Cord Injuries (Phase II), Proceedings of the e-Health Networking, Applications and Services (Healthcom), 2016 IEEE 18th International Conference on (pp. 1-6). IEEE.

Khan, A. Imtiaz, D., Seelye, A. (2017). Happy Times: A Mobile Multimedia Reminiscence Therapy Application to Reduce Behavioral and Psychological Symptoms in Persons with Alzheimer's -Phase 1. Journal of Healthcare Engineering

Khan, A. Hassan, A., Seelye, A. (2017). Framework to Predict, Identify, and Track Wandering behavior in Individuals with Alzheimer's Dementia using Various Physiological and Other Sensors, and Kinects. EURASIP Journal on Advances in Signal Processing.

Research Description: My research sits under the umbrella of biomedical and health informatics where wireless sensor based mobile assistive technology and robotics are used to enhance the delivery of care. In the recent months, my research interests have evolved into robotic assistive technology where we are employing new and innovative

assistive robotic technologies to help patients recover after open heart surgery. In addition, we are also exploring the use of robots in identifying and predicting wandering behavior among individuals with dementia. I am fortunate to be able to contribute to the growth of this new and emerging field of medical and health informatics. In this interdisciplinary work, I am collaborating with experts such as cardiothoracic surgeon from St. Luke's, neuropsychologists from the VA, roboticist from University of Minnesota TC campus, psychologist from Cadence Hospital, physical therapist and Essentia Health systems, dietician, nurse and occupational therapist.

Assistive technology plays an important role in offering individuals opportunities to track and monitor any personal health problems. There is a big need for tools that can increase individual access to applications that can be used to their benefit. In particular, mobile and robotic assistive technology has been recognized to have a great potential in advancing the delivery of care in chronically ill individuals.

Wireless sensors integrated with mobile platforms offer cost efficient solutions that have the potential to address, track and monitor chronic illnesses in real time by remote monitoring, patient data tracking, increased accessibility to patient clinical data and wellness apps.

In the area of sensor based mobile technology my projects utilize sensors for tracking heart rate, blood pressure, body surface temperature, oxygen saturation, accelerometer, and pressure sensors to monitor and track various physiological conditions that play a role in prevention of pressure ulcers, tracking, monitoring and management of bipolar disorder, and detection of wandering in patients affected with dementia.

Eleazar Leal, Ph.D., Assistant Professor of Computer Science

Teaching and research interests: Database Management, Data Mining/Machine Learning, Parallel Algorithms for GPUs and Multicore CPUs.

Publication: Eleazar Leal, Le Gruenwald, Jianting Zhang, Simin You. Parallel Processing of Top-K Trajectory Similarity Queries with GPGPUs. *International Journal of Big Data*, Vol. 3, Issue 2, 2017.

Research Description: My research interests lie in the intersection of data mining/machine learning, database management, and parallel algorithms. My research goal consists in designing parallel algorithms for GPUs and multicore CPUs that: use data mining to solve database management problems, or that use database management techniques to solve data mining challenges. Some more concrete areas where I have worked are: spatial databases, data stream management, and spatio-temporal mining.

Richard Maclin, Ph.D., Professor of Computer Science

Teaching and research interests: data mining, machine learning, bioinformatics, database management systems, artificial intelligence, robotic learning.

Publication: Advice Refinement for Knowledge-Based Support Vector Machines. *Proceedings of the Twenty-Fifth Conference on Neural Information Processing Systems (NIPS 2011)* (with G. Kunapuli and J. Shavlik)

Ted Pedersen, Ph.D., Professor of Computer Science

Teaching and research interests: natural language processing, computational linguistics.

Publication: Offspring from Reproduction Problems: What Replication Failure Teaches Us. *Proceedings of the 51st Annual Meeting of the Association for Computational Linguistics, August 4-9, 2013, pp. 1691-1701, Sofia, Bulgaria.* (Fokkens, van Erp, Postma, Pedersen, Vossen, and Freire)

Research Description: I develop methods that enable computers to understand and use human language. I am especially interested in automatically organizing words and concepts based on their meaning since this is often at the core of solving a wide range of problems in human language. I'm a great believer in open science, and put a high priority on making software and data freely available so that experimental results can be easily reproduced by other researchers.

Peter Peterson, Ph.D., Assistant Professor of Computer Science

Teaching and research interests: Computer Security, Operating Systems, Energy Efficiency, CS Education

Publication: Datacomp: Locally Independent Adaptive Compression for Real-World Systems. Peter A. H. Peterson and Peter L. Reiher. In the Proceedings of the International Conference on Distributed Computing Systems (ICDCS), 2016.

Research Description: My primary research focuses on computer security and efficiency -- and on the intersection of the two. Security generally costs more resources than insecurity, and efficiency efforts can hurt security. I look at how to improve security while reducing the efficiency impact, or how to improve efficiency without meaningfully harming security. I also perform research and development in the area of computer security education.

Andrew Sutton, Ph.D., Assistant Professor of Computer Science

Teaching and research interests: theory of randomized search heuristics, theory of evolutionary computation, parameterized complexity, randomized algorithms.

Publication: B. Doerr, F. Neumann, and A. M. Sutton. Time Complexity Analysis of Evolutionary Algorithms on Random Satisfiable k-CNF Formulas.
Algorithmica, 78:2 (2017), pp. 561-586. [Article Link]

Research Description: My research takes an algorithmic approach to studying search and optimization heuristics that come from the domain of artificial intelligence. These techniques are sometimes inspired by natural processes and are popular because they are easy to deploy in situations where problem-specific knowledge is incomplete due to domain complexity or resource scarcity. Despite their industrial use and practical success, the development and application of these approaches is still very much an art, often driven by trial and error. The broad goal of my research is to develop a sound and mathematically rigorous understanding of the influence of problem structure on the behavior of these kinds of search and optimization algorithms.

Hudson Turner, Ph.D., Associate Professor of Computer Science and Head

Teaching and research interests: knowledge representation, automated planning and reasoning about action, declarative logic programming.

Publication: Nonmonotonic Causal Logic, *Handbook of Knowledge Representation*, Elsevier, edited by Frank von Hermelen, Vladimir Lifschitz, and Bruce Porter, 759-776 (2008).

Research Description: A logical formalism is called "nonmonotonic" if adding new axioms to a theory (expressed in the logic) can sometimes eliminate conclusions entailed by the theory. (Classical logic is monotonic.) Nonmonotonic logics are useful for expressing "default assumptions". For instance, in reasoning about the effects of actions on the state of the world, it is generally convenient to assume that, roughly speaking, things don't change (unless there's a cause). I have studied how to formalize this commonsense default assumption, and how to use such formalizations for automated planning.

Haiyang (Henry) Wang, Ph.D., Assistant Professor of Computer Science

Teaching and research interests: computer networking, in particular, cloud computing, social networking, peer-to-peer networking, multimedia communications, IP routing and QoS

Publication: H. Wang, F. Wang, J. Liu, D. Wang and J. Groen, Enabling Customer-Provided Resources for Cloud Computing: Potentials, Challenges, and Implementation, IEEE Transactions on Parallel and Distributed Systems (TPDS), 2014.

Research Description: Dr. Wang's research concentrates on designing highly scalable and efficient networking infrastructures, by combining optimization, economics, and computer science. For example, his research on cloud computing aims to mitigate the performance as well as the energy issues in such existing virtualization environments as Xen and KVM.

Peter Willemsen, Ph.D., Professor of Computer Science

Teaching and Research Interests: computer graphics, perception in graphics, simulation and human-centered computing in immersive virtual environments.

Publication: A Rapid and Scalable Radiation Transfer Model for Complex Urban Domains, Urban Climate, vol 15, pp. 25-44 (2015) Elsevier (with M. Overby, B. Bailey, S. Halverson, and E.R. Pardyjak)

Retired Emeritus Faculty

Douglas Dunham, Ph.D., Professor of Computer Science

Teaching and research interests: computer graphics, visualization, 3D rendering, hyperbolic geometry, user interface design.

Publication: Creating Regular Repeating Hyperbolic Patterns, *5th Mathematics & Design International Conference Proceedings* (2007).

2. Admission Information

All applications to the Computer Science Graduate Program are now handled electronically through https://choose.umn.edu/apply/. General information on the application process is found on the UMD Graduate School Office web page at http://www.d.umn.edu/grad/ along with access to the automated application interface.

Applicants are encouraged to submit applications early in the year, which allows time to resubmit material that may be missing and enables the department to consider requests for financial aid in a timely fashion. See Section 2.2 (below) for deadlines.

The Computer Science Department requires as a part of the application packet an official report of the scores received by the applicant on the Graduate Record Examination (GRE) General Test. Specify university code 6873 for UMD so that your official score may be retrieved from ETS.

2.1 Departmental Information

Some applicants may be interested in the following information:

The GRE Subject Test:
The Department does not require that applicants take the GRE Subject Test in Computer Science. However, an applicant seeking to support his/her application may wish to submit an official report of his/her scores, especially if the undergraduate degree is in a related field.

If your native language is not English:
Each applicant whose native language is not English must submit a record of the scores received on either the TOEFL (Test of English as a Foreign Language) or IELTS (International English Language Testing System).

For TOEFL: Specify the University of Minnesota Duluth, code number 6873, for reporting purposes. The Graduate School requires a score of 550 on the written test, 213 on the computer-based test and 79 or above with the Internet-based test. The department gives preference for financial support to those with minimum scores of 650 (written test), 280 (computer-based) and 110 (Internet-based). Additionally, TOEFL sub-scores in the Speaking Proficiency

For IELTS: The Graduate School will accept scores from the IELTS in lieu of the TOEFL. See www.d.umn.edu/grad/ or http://www.deii.org for details. The minimum acceptable score on the IELTS is 6.5. Individual IELTS scores must also be at the 6.5 level or above.

Foreign Applicants:
Each foreign applicant must submit an International Financial Certification Statement before a visa will be issued. See the UMD Graduate School Office web page for information.

Financial Aid:
Any applicant seeking financial aid should supply additional information as indicated in Section 3. The Application for Graduate Assistantship is available at https://scse.d.umn.edu/sites/scse.d.umn.edu/files/application-graduate-assistantship.pdf. The Application for Assistantship form and the required recommendations should be submitted with online application.

Fall Admissions Policy:
Under normal circumstances, the Computer Science Graduate Program restricts its admissions to once a year. All applicants are evaluated in the spring for admission the following fall semester.

2.2 Application Deadlines

The department processes applications as they are received. Thus it is in the applicant's best interests to submit his/her application early in the cycle (i.e., by **January 15th** if possible). Early application enhances the opportunity for financial aid.

February 1- March 15, 2019 -- Initial Round of Financial Aid Decisions

The decisions on admissions and financial aid for the next academic year are made during this period. To be considered in the first round, an applicant must have submitted an admissions application by March 15.

March 15 - April 15, 2019 -- Notification of Financial Aid

The department makes its offers of financial aid as early as possible in the spring of the year. Although we attempt to make all offers by April 15th, for various reasons during a particular year this may not be possible. In this case, offers may be made as late as April 30th. If you are awarded financial aid, you will be notified by email no later than April 30th.

Due to the large number of applications received, the department is unable to inform you personally if you have not been awarded aid. However, funding may become available later in the year, so if you are interested in this possibility, please notify the department via email and your name will be kept on file. You will then be considered for any financial aid that subsequently becomes available for the next academic year.

April 15, 2019 -- Council of Graduate Schools Deadline

Note that the University of Minnesota Duluth subscribes to the Resolution of the Council of Graduate Schools in the United States, and every offer of financial aid in the form of a Teaching or Research Assistantship is subject to this Resolution as a term of employment (see Section 7.2). This resolution specifies that acceptance of an offer of financial aid is an agreement that both student and graduate school are expected to honor. To quote:

> "*Acceptance of an offer of financial support (such as a graduate scholarship, fellowship, traineeship, or assistantship) for the next academic year by a prospective or enrolled graduate student completes an agreement that both student and graduate school expect to honor. In that context, the conditions affecting such offers and their acceptance must be defined carefully and understood by all parties.*
>
> *Students are under no obligation to respond to offers of financial support prior to April 15; earlier deadlines for acceptance of such offers violate the intent of*

> *this Resolution. In those instances in which a student accepts an offer before April 15, and subsequently desires to withdraw that acceptance, the student may submit in writing a resignation of the appointment at any time through April 15. However, an acceptance given or left in force after April 15 commits the student not to accept another offer without first obtaining a written release from the institution to which a commitment has been made. Similarly, an offer by an institution after April 15 is conditional on presentation by the student of the written release from any previously accepted offer. It is further agreed by the institutions and organizations subscribing to the above Resolution that a copy of this Resolution or a link to the URL should accompany every scholarship, fellowship, traineeship, and assistantship offer.*"

This Resolution was renewed October 2009.

Please note that any student who accepts a Teaching or Research Assistantship from the department, fails to submit a written resignation prior to April 15, and enters the country on our form I-20 will be strictly held to the conditions of employment to which s/he has agreed. Under no circumstances will such a student be given a written release since at this point it is then too late to fill the position.

The department regrets that it is unable to answer email or telephone inquiries about the status of an application. However, email inquiries may be directed to the department at cs@d.umn.edu and we will reply as time permits.

July 15, 2019 -- Deadline for Fall 2019 Admission

2.3 Entrance Requirements

The program is designed for those with undergraduate degrees in Computer Science. These students should be able to enroll immediately in 8000-level computer science courses at UMD. All such students should have completed the following courses or their equivalents: CS 3512 (Computer Science Theory), CS 5621 (Architecture) or CS 5651 (Computer Networks), and CS 5631 (Operating Systems) prior to enrollment.

Students with other backgrounds may be considered if they have completed the following courses or their equivalents: CS 1511 and 1521 (Computer Science I and II), CS 2511 (Software Analysis and Design), CS 2521 (Computer Organization), CS 3512 (Computer Science Theory) or both CS 5511 (Theory of Computation) and CS 5521 (Advanced Data Structures), CS 5621 (Computer Architecture) or CS 5651 (Computer Networks), and CS 5631 (Operating Systems). The appropriate math prerequisites, namely, Math 1296 and 1297 (Calculus I and II), and Statistics 3611 (Probability and Statistics) are also required. Students who lack only a small subset of these required courses may be admitted at the discretion of the DGS based on the recommendation

of the Graduate Committee. The GRE General Test is required of all applicants; the TOEFL (or IELTS) is also required of international students.

2.4 Ethical Considerations

The Department of Computer Science adheres to the tenets of the ACM Code of Ethics and Professional Conduct. Any student found to be in violation of this code or the UMD Code of Student Conduct will be subject to immediate dismissal. Such violations include plagiarism and the inappropriate access of computing resources (e.g., attempts to violate system security, access files belonging to others, forge/falsify email, download inappropriate or copyrighted files, etc. using university equipment). See Section 7.3, Policy on the Appropriate Use of Information Technology for details.

3. Financial Aid

Half-time Teaching and Research Assistantships are available to qualified students. These currently pay $15,967 per academic year. Research assistantships funded by the National Science Foundation or other agencies may be available. All half-time (50%) assistantships and fellowships carry a tuition waiver. Applicants for Teaching Assistantships are expected to know C, C++, Java, and Visual Basic.

Financial aid in the form of teaching assistantships is available through the department. The number of assistantships available is limited, however, and once a student has committed him/herself to accept an assistantship, any subsequent failure to meet that commitment seriously and negatively impacts the department and its operation. Namely, (1) the department is left shorthanded in meeting the demand for its services during the next academic year, and (2) another deserving applicant is unable to attend graduate school because it is too late to offer the support to another student. ***With this in mind, we ask that you carefully evaluate your position before accepting a teaching assistantship with us. Should you for some reason be unable to fulfill the stipulations set forth in the offer letter, please notify the department at once so that another student may be offered the funding.***

When applying for financial aid please specify a **fax number**, **telephone number**, and an **email address** where you may be reached ***at any time*** during the year ***(including summer*)**.

Summer support may be available from one's advisor through research funding. If the advisor is unable to provide it, support may be available for summer research from the DGS through the Quality Metrics Allocation/Chancellor's Graduate Fellowship funding. These funds, when available, are targeted at Plan A students, namely, second year students who are completing their theses and first year students working with their advisors on continuing research initiatives. Additionally, to qualify for these funds, Plan A students must have satisfied the department's Progress Milestones.

Should you accept financial support from the department in the form of a Teaching or Research Assistantship, please note that additional information is due in our office by these deadlines:

June 15, 2019: Verification of Visa

A copy of the official verification from the consulate that you have been granted a visa to enter the U.S., i.e., a copy of the page in your passport with the sticker applied by the U.S. consulate. Fax this copy to us at 218-726-8240 or email to llucia@d.umn.edu

August 1, 2019: Verification of Travel Arrangements

Your travel arrangements (i.e., flight numbers and dates, including date of arrival) must be emailed to Ms. Lucia in our office by this date. Arrangements will be made for someone affiliated with the department to meet you when you arrive.

3.1 Financial Aid Application

When applying for a departmental teaching or research assistantship, each applicant must complete a financial aid application (see below), which is separate from the admission application.

The deadline for initial consideration for financial aid is March 15. Later applications will be considered until all appointments are filled. The following materials are required to process an application for financial aid:

1. An application for financial assistance which may be found at https://scse.d.umn.edu/sites/scse.d.umn.edu/files/application-graduate-assistantship.pdf

2. The completed application, sent by the applicant to the Graduate School using https://choose.umn.edu/apply/.

3. Three letters of recommendation, submitted through the online application. These letters should address in particular any teaching experience you have had and how successful it was, along with direct comments on your ability to understand, write and speak English. (The department reserves the right to process, at its discretion, applications with fewer than three letters of recommendation.)

4. Any additional material that the applicant believes may enhance his/her application for financial aid (such as an official report of the scores received on the GRE Subject Test in Computer Science).

3.2 Costs

The information in this section is current as of Fall 2019.

Resident tuition for a full-time student is $8,532 per semester. Non-resident tuition is $13,206 per semester. All full-time students are assessed approximately $1,000 per semester in non-waivable fees. A late registration fee will be assessed for any initial registration which occurs on or after the first day of classes: $50 during the first or second week, and $100 thereafter. A student with a half-time assistantship receives a tuition waiver equivalent to $8,532.00 each semester; federal income tax is payable on the value of the tuition benefit. Any student fees, tuition costs over 14 credits and/or late fees are the responsibility of the student.

No one is allowed to register without proof of hospitalization insurance. Any student who registers for at least 6 credits and is without medical insurance is offered an inexpensive student-only policy for $1,116.00 per semester. Anyone eligible for the student-only policy may insure a spouse (at $1,680.00 per semester) and children (at $1,242.00 per semester for one child and $1,776.00 per semester for more than one child).

Housing in Duluth can be relatively inexpensive compared to many parts of the country. The department does not make housing arrangements for incoming students. The University residence hall information can be obtained by emailing housing@d.umn.edu
or by writing UMD Housing Office, 149 Lake Superior Hall, 10 University Drive, Duluth, MN 55812-2496, phone 218-726-8178. Most graduate students live off campus. One of the resources for International students is Anna Gilmore (anaug0026@d.umn.edu) in the International Student Adviser office. Another resource is Laura Young (lyoung@d.umn.edu) in the Kirby Student Center. This office lists off-campus housing available in the Duluth area.

4. Requirements for a M.S. Degree in Computer Science

The Master of Science in Computer Science is offered under two plans. Most students will undertake Plan A, which involves writing a thesis. Plan B involves additional course work and a project in lieu of the thesis.

The requirements for the completion of the M.S. in Computer Science are listed below.

4.1 Residency

The normal time frame for completion of the coursework and research required for a Master's degree in Computer Science is four semesters. (This timeline may be adjusted for part-time students.) All students who receive financial aid in the form of a Teaching Assistantship should understand that such assistantships are given only for a

full, one-year period (two semesters) and are renewed (subject to satisfactory performance and progress toward the degree during the first year) for a second year. Students accepting Teaching Assistantships should plan to spend two years in residence. Support beyond the normal two-year period is not available from the department.

4.2 Performance

Satisfactory performance is judged on the basis of one's academic progress and ability to carry out departmental responsibilities in the areas of teaching (for TAs) and research (all graduate students). Satisfactory performance for a teaching assistant is also based on his/her ability to communicate effectively in English, both on an individual basis and in a classroom environment. Should a teaching assistant fail to meet this requirement during his/her first year, the assistantship will not be renewed for a second year. In addition, each graduate student must progress satisfactorily in his/her own research program. This requires each student to (1) complete the three departmental Milestones for Degree Completion, and (2) maintain active student status by following registration guidelines for fall and spring semesters. A minimum GPA of 3.000 is required for graduation by the Department of Computer Science. The department does not count S/N credits toward graduation.

The Graduate School Constitution requires a written annual progress evaluation for all Masters students. The review annotates the student's progress toward his/her research goals during the semester and concludes with a finding of either satisfactory or unsatisfactory progress. The review is shared with the student and becomes part of his/her permanent file. Any finding of unsatisfactory progress must be discussed by the advisor with both the student and the DGS prior to the beginning of the next semester. The student may request a subsequent discussion with the DGS if desired.

Satisfactory progress toward the degree, maintained on a semester basis, is required in order for a graduate student to receive or retain financial assistance from the department. *Satisfactory progress* entails (1) maintaining a minimal grade point average of 3.00, and (2) completion of the required coursework for the semester (i.e., a minimum of 8 graduate credits, including one 8000-level CS course, Graduate Seminar, and one additional course of 3 or more credits during the first semester; a minimum of 7 graduate credits, including one 8000-level CS course and one additional course of 3 or more credits during the second semester; one 8000-level CS course plus thesis credits or additional coursework as required by the Plan A during the third semester; and one 8000-level CS course plus thesis credits or additional coursework as required by the Plan A during the fourth semester. Any graduate student currently receiving financial aid who fails to meet these standards will not have his/her aid renewed.

The successful completion of a research program requires an ability to express one's thoughts and work in written form. The Graduate Program in Computer Science

expects each of its students to produce a written document (e.g., thesis or project report) detailing his/her research project in accepted manuscript style (i.e., CBE). Students showing deficits in this area may be asked to take remedial work.

The Graduate School has established a five-year time limit for completing master's degrees, but provides a process for requesting individual extensions. Virtually all Computer Science graduate students finish within two years.

4.3 Courses

On the semester system, a minimum of 34 credits is required (based on University of Minnesota Graduate School Policy, no graduate Plan A and Plan B program can require more than 36 credits):

1. 16 credits from 8000-level courses in Computer Science (as approved by the Director of Graduate Studies [DGS]).

2. 2 credits of CS 8993, Graduate Seminar (1 credit taken during first semester, 1 credit taken during third semester).

3. 6 credits from a specified set of courses either from computer science courses or courses outside of computer science (minor or related field, see below).

4. Additional credits, as required for your Plan option (see below).

Minor or related field: The purpose of this requirement is to provide coursework from another department which will support your degree program *without duplicating or overlapping* courses available within the CS curriculum. Such courses may be chosen from the mathematics and/or statistics courses subject to approval of the DGS.

Graduate students may take additional courses either from within the department or outside it. However, all courses used to fulfill the minor or related field requirement must first be approved by the DGS. The Graduate Program does not allow the use of S/N credits for courses contributing toward the degree. Up to 12 credits of graduate coursework may be transferred in as part of a student's degree program, subject to the discretion of the DGS. Transfer credits do not reduce the departmental requirement of 16 credits at the 8000-level. University guidelines impose a 5-year limit on the completion of requirements for the Master's degree.

The department reserves the right to determine which option (thesis or project) is taken by the student. In particular, we expect that all students with strong computer science backgrounds (i.e., those with undergraduate degrees in Computer Science or a closely related field such as Computer Engineering) will take the thesis option. Some students

with undergraduate degrees in other disciplines may be allowed to choose the project option.

4.4 Additional Requirements for Plan A (Thesis Option)

Total credits for the Plan A include the 24 credits summarized above in Section 4.3 with the following credits and requirements:

1. 10 credits of CS 8777 (Thesis).

2. Departmental or college colloquium session, during which the student presents his/her research results.

3. The satisfactory completion of an oral examination focusing on the thesis and supporting area(s).

4.5 Additional Requirements for Plan B (Project Option)

Total credits for the Plan B include the 24 credits described above in Section 4.3 with the following requirements:

1. 10 additional credits from courses in Computer Science at the 5000 level or above, as approved by the DGS.

2. Completion of an approved Plan B project (usually a significant programming project).

3. A departmental or college colloquium based on the project, presenting the results of that work.

4. The successful completion of an oral examination covering the project, supporting area(s), and graduate-level computer science courses.

4.6 Departmental Progress Milestones (Plan A and Plan B)

The department tracks thesis (and project) progress through a series of milestones. These milestones represent the department's minimum level of expectation for progress. The milestones are meant to promote consistent and successful progress on thesis work for degree completion.

1. Milestone 1: Draft of Background/Related Work Chapter + Abstract

During the first semester, students will be assigned an advisor. Through working with the advisor, students will work to understand their thesis research question by reading several research papers in their thesis area. Students will then assemble a draft of their thesis abstract along with an initial pass at the background/related work chapter of their thesis document. Students will work with the DGS in the Graduate Seminar (CS 8993) to understand the components of thesis documents and how to write them. Student writing will be evaluated at the end of the 1st semester and remedial work may be required to improve writing skills.

DUE Date: End of 1st Semester

2. Milestone 2: Continued Drafting of Background/Related Work Chapter + Implementation Chapter Draft + Refined Abstract

   The second milestone is aimed at helping students better understand what they will be doing for their thesis work. At the end of the second semester, students are expected to turn in to both the DGS and their advisor a refined Abstract, a refined and lengthened Background/Related Work Chapter, and a first pass at the Implementation Chapter.

   DUE Date: End of 2nd Semester

3. Milestone 3: Poster presentation of Thesis Work, Improved Thesis Draft

   The third milestone will be a Departmental/College-wide Research Poster session or colloquium. By the end of the 3rd semester, students should be able to maintain a conversation about their research work and be able to describe their work to others, namely (1) the problem they are investigating, (2) why it is worth investigating, (3) how they are going about doing it, and (4) what they currently expect of their results. Graduate students will be required to create a poster of their thesis research and present it at the end of semester colloquium.

   DUE Date: End of 3rd Semester

4. Milestone 4: Full Thesis Draft

   The fourth milestone is a draft of the entire thesis. By the end of their 4th semester, students will have progressed through nearly all of their thesis work. It is expected that a draft of all the components of the thesis will be completed by the end of this last semester. Students may still need to complete some results, but overall, much of the writing and implementation will be completed by this phase of the thesis or project tracks.

DUE Date: End of 4th Semester

Failure to Complete Milestones

Failure to complete any of the milestones will result in both first and second year students being ineligible from receiving summer research funding through our Quality Metrics Allocation funds. Moreover, faculty advisors will not sign OPT forms until the 3rd Milestone is met because OPT requires sufficient progress to completion; completion of Milestone 3 indicates the student is making sufficient progress. The graduate students will be responsible for completing these milestones. Graduate faculty advisors will be responsible for working with their students and helping them through these milestones.

If Milestone 1 and 2 are not met at the end of their respective semesters, students can still make up for these missed deadlines by completing these milestones later in order to qualify for summer funding opportunities. However, failure to meet the poster session in Milestone 3 could result in a failure of Milestone 3 and thus, students would lose out on funding later in the fourth semester. If students do not complete the poster session, they can make it up later by presenting a 30 minute colloquium to the department on their research, covering the same content as the poster session.

Milestones and Eligibility for Summer QMA Funding Opportunities

Students who complete all Milestones (1-4) will receive higher priority for receiving summer QMA funds at the end of their second year. Students who have only completed Milestones 1-3 can still qualify for summer funding but will receive lower priority in the award process.

4.7 Degree Papers and the Thesis/Project Proposal

Degree Papers: All graduate students in the Computer Science Department are assigned an advisor when they arrive on campus and are required to complete either a thesis or project under direction of the advisor. After completing a specified number of hours of graduate work, the student is required by the Graduate School to complete his/her *degree papers* (otherwise a *hold* is placed on the student's record preventing registration for the next semester). Degree papers include (1) the graduate degree plan listing the courses the student will take to complete the graduate program; (2) the committee request form (submitted electronically), which specifies the student's committee (requesting a member of the computer science faculty, and a faculty member from the student's related field), the Executive Secretary will submit your adviser information electronically to the graduate school prior to your requesting your other committee members. You can find the forms and additional information at: http://www.d.umn.edu/grad/current-students-forms-documents.php. The student's advisor must sign item 1 above. It is the advisor's responsibility to verify, prior to the student's exam and colloquium, that the student's transcript is in agreement with

his/her degree program form. All paperwork is examined for compliance by the Graduate School prior to the student's exam and colloquium using their degree clearance procedures.

A change of advisor may be occasioned by the dissatisfaction of advisee and/or advisor with either one's work or the advisor/advisee relationship. The DGS will work with all parties to reach a satisfactory resolution of the problem in the best interests of the student and department.

Thesis Proposal: The thesis/project proposal is represented by Milestone 1 (described previously). It represents the student's initial work towards their thesis/project. The advisor and student indicate their agreement (with respect to the thesis/project tasks to be done and the dates by which each task is to be accomplished) by signing the Milestone completion sheet.

Milestones completion sheets will be submitted at the end of each semester upon successful completion of each Milestone. These forms need to be signed by the student and the advisor and submitted to the DGS, or executive secretary.

Once approved by the DGS, these documents are maintained in the student's file.

4.8 Colloquium and Oral Exam

The colloquium is a one-hour presentation by the student of his/her research. It is immediately followed by a one-hour oral exam, which is directed by the advisor with input from the other members of the student's committee. The colloquium has a specific format: (1) introduction (statement of the problem); (2) background; (3) description of the research itself; (4) the results of this research; and (5) conclusions and suggestions for future work. In no case should items (1) and (2) consume more than 20 minutes of the presentation.

4.9 Records and Departmental Policies

Each graduate student has a graduate academic record file that is kept in the department. This file contains the student's application to the Computer Science Graduate Program, transcript(s), immigration documents, social security information, semester-based progress reports from the advisor, verification of required inoculations (i.e., TB), and any record of disciplinary action associated with the student. Faculty and staff have access to this file on a need-to-know basis as per FERPA regulations. The student may have access, per written request to the DGS, to any information in the file to which s/he has not waived viewing rights.

The Department Chair is the chief administrative officer of the department. The Chair is responsible for making TA assignments, handling disciplinary matters relating to work issues, and determining whether TA (work) performance meets the qualifications for

continued funding. The Director of Graduate Studies is the advisor of record for all graduate students. S/he directs the program and advises graduate students on all matters which do not directly relate to the student's research topic. The DGS, working with the Graduate Committee, evaluates applicants and hires RAs and TAs. S/he monitors the progress of students, works with students and faculty to resolve any problems which arise, supervises the evaluation of thesis proposals, and communicates regularly with students on matters which affect them. The department's executive secretary provides much needed support with respect to employment contracts and related issues, budgetary matters, and maintenance of records.

Each UM student has an email account which serves as the University's official method of communication. Graduate students have access to telephones for local calls. Each graduate student employed by the university has his/her own mailbox in the department to facilitate communication with faculty, staff, and other students. TAs and RAs may also utilize copy machines in the department as directed by office staff.

Travel funds are available to graduate students from various sources. These may include the student's advisor, the offices of the collegiate and/or graduate Dean, and particular funds designated for this purpose by the University of Minnesota Graduate School. Partial funding is available from the offices of both the Graduate and CSE Deans for students presenting papers at conferences. Other funding may be available; it is the student's responsibility to investigate and identify potential funding sources.

4.10 Career Fair and Other External Off-Campus Attendance Policy

There will be many opportunities for career fairs and other job searching activities. When you are able, we do encourage students to attend these events. However, Teaching Assistants (TA) are all employed by the University and the Department with important jobs for helping students during office hours, grading, proctoring exams, or teaching labs. As such, the following policy is in place to maintain normal operations in the department during the semester.

Policy for TAs asking to be excused from office hours or lab to attend a career fair

1) If you can find a substitute TA who is currently a TA for the course in question, you may attend the career fair. You MUST advise the instructor beforehand, and ideally a week before if possible but no later than 2-3 days before the event.

2) If you can find a substitute TA who is not currently teaching the course in question, you must secure instructor approval BEFORE the career fair. You MUST alert the instructor about this 1 week prior to attending the career fair to allow the instructor time to prepare the alternate TA.

3) If you cannot find a replacement through (1) and (2) above, you cannot attend the career fair.

4) Requests from second-year TAs will be considered before requests from first-year TAs.

4.11 2019-20 Schedule with Important Dates

Work Schedule: All Graduate Assistants are employed by the department and hence subject to the university calendar. Official university holidays are specified in the calendar; these are the dates on which the university will be closed and UMD employees may legitimately be absent from campus. Graduate Assistants are paid 39 weeks during the academic year and must be on campus during this time, except for *official university holidays*. This work period *includes the week preceding the start of classes and the week of and immediately following final exams.* The official university holidays are Labor Day and Thanksgiving (for Fall semester), Christmas, New Year's holiday and Martin Luther King Day (during Semester Break).

At the end of classes each semester, Graduate Teaching Assistants are expected to be available to assist the faculty in grading student work and determining grades. Also, during the work period between fall and spring semesters, teaching assistants are expected to assist the faculty in preparing handouts and materials for the next semester. Assistants should not plan on being absent from the campus between semesters except for the official school holidays. Similar work rules apply to Graduate Research Assistants: GRAs are expected to be present to conduct research and to work with their faculty supervisors during any regularly scheduled workday. *The only periods during which a Graduate Teaching or Research Assistant may be absent from campus without the explicit permission of the department head is during an official university holiday* (as listed above).

To reiterate: **Graduate Assistants are to be present on campus for the entire academic year—from the fall starting date to the spring terminal date of employment—except for official university holidays.** Dates for the 2018-19 academic year are given below.

Fall Semester Starting Date: August 19, 2019 [All TAs must be present on campus]
Labor Day Holiday: September 2, 2019 [official university holiday]
Thanksgiving Holiday: November 28-29, 2018 [official university holiday]
Final Exams: December 9-13, 2019
Christmas Holidays: December 23--25, 2019 [official university holiday]
New Year's Holidays: December 31, 2019-January 1, 2020[official university holiday]
Spring Semester Starting Date: January 15, 2020
Martin Luther King Day: January 20, 2020 [official university holiday]
Final Exams: May 4-8, 2020
Graduate Commencement: May 9, 2020
Spring Semester Terminal Date: May 17, 2020
Graduate Offices Vacated: August 15, 2020 [all labs/offices closed for maintenance]

NOTE: Graduate Assistants who are absent from campus in violation of the stated policy are subject to the following penalties: deduction from paycheck in the amount of time missed; loss of tuition benefit covering time in question (the student must then pay this amount from his/her own funds); and a written reprimand inserted in his/her file. Any recommendations made by the faculty with respect to the student in question may be affected as a result.

4.12 Graduate Student Deadline Checklist

For All First Year Students: Additional Dates of Importance

1. **Milestone 1 Deadline**: The thesis/project proposal, or Milestone 1, signed by both advisor and student, must be completed by the end of the first semester. Follow the guidelines provided in the Graduate Brochure (see Section 4.6).
2. **Registration for the Next Academic Year:** All first year graduate students must complete their registrations for the upcoming Fall semester by May 1, 2019. This registration must agree with the courses listed on the Degree Program. All TA assignments for the next academic year are made based on this registration.
3. **Milestone 2 Deadline**: Students must complete Milestone 2 (as described in Section 4.6) and submit the Milestone completion form signed by both the student and the advisor.

For All Second Year Students: Additional Dates of Importance

1. **Milestone 3 Deadline:** Students must complete Milestone 3 which includes a poster colloquium presentation at the end of the 3rd semester.
2. **Degree Program**: The deadline for completion of the Degree Program is the 4th of January, 2019. Graduate School approval of program must be granted by the 12th of February. See the Degree Application[1] at the Grad School web page for more information.
3. **Application for Degree**: Information regarding the graduation process and requirements can be found at the Graduate Schools Grad Packet webpage.[2]
4. **Milestone 4 Deadline**: Completion of Milestone 4 will ensure students receive higher priority for summer funding opportunities. Milestone 4 should be submitted with the application for summer funding that is due near the end of the last semester.
5. **Commencement Ceremony**: The department requires that all of its graduating (i.e., second year) students participate in the Graduate Commencement Ceremony. This is a reflection of the contribution of the Computer Science Graduate Program to the University and of the research and professional

[1] http://www.grad.umn.edu/current-students-graduate-student-services-progress/application-degree
[2] www.d.umn.edu/grad/current-students-gradpacket.php

accomplishments of its students and faculty. The Spring 2019 commencement will be held Saturday, May 11, 2019.

5. Selected Course Descriptions

Only credits from courses numbered 5000 and above can be applied toward a master's degree in computer science.

Students who need undergraduate courses to satisfy the prerequisites of our 5000-level courses are encouraged to complete course equivalents before coming to UMD.

CS 5511. THEORY OF COMPUTATION (4.0 cr.; prereq 3512, Math 3326 or #, a grade of C- or better is required in all prerequisite courses

Mathematical theory of computation and complexity. Deterministic and non deterministic Turing machines, Church-Turing Thesis, recursive and recursively enumerable languages. Undecidable problems, Rice's Theorem. Time and space complexity,reducibility, completeness for complexity classes, Cook's Theorem, P versus NP, Savitch's Theorem, complexity hierarchy.

CS 5521. ADVANCED DATA STRUCTURES (4.0 cr.; prereq 2511, 3512, Math 3326 or #, a grade of C- or better is required in all prerequisite courses

Survey of advanced data structures and algorithms such as heaps and heapsort, quicksort, red-black trees, B-trees, hash tables, graph algorithms, divide and conquer algorithms, dynamic programming, and greedy algorithms. Methods for proving correctness and asymptotic analysis.

CS 5541. ARTIFICIAL INTELLIGENCE (4.0 cr.; prereq 2511, 3512 or #, a grade of C- or better is required in all prerequisite courses)

Principles and programming methods of artificial intelligence. Knowledge representation methods, state space search strategies, and use of logic for problem solving. Applications chosen from among expert systems, planning,natural language understanding, uncertainty reasoning, machine learning, and robotics.Lectures and labs will utilize suitable high-level languages (e.g., Python or Lisp).

CS 5551. USER INTERFACE DESIGN (4.0 cr.; prereq 2511, Math 2326 or 3326 or 4326 or #, a grade of C- or better is required in all prerequisite courses)

Design and layout of interactive programs using components, containers, events, menus,and dialogs. The use of graphics primitives,color and images; giving user feedback and help. Rapid prototyping and interface management systems. Design for accessibility and usability.

CS 5621. COMPUTER ARCHITECTURE (4.0 cr.; prereq 2521 or #, a grade of C- or better is required in all prerequisite courses)

Advanced concepts in processor and computer system organization and their impact on performance. Exploitation of parallelism, multilevel memory organization, system interconnection, and input-output organization.

CS 5631. OPERATING SYSTEMS CS 5631. Operating Systems. (4.0 cr.; prereq 2511, 2521 or # a grade of C- or better is required in all prerequisite courses)

Operating system as resource manager. Processor management and scheduling, deadlocks, concurrency, memory management and protection and security as applied in modern operating systems. Concepts are illustrated via laboratory assignments which heavily emphasize concurrency.

CS 5641. COMPILER DESIGN (4.0 cr.; prereq 2511, 2521, 3512 or # a grade of C- or better is required in all prerequisite courses)

A selection from the following topics: finite-state grammars, lexical analysis, and implementation of symbol tables. Context-free languages and parsing techniques. Syntax-directed translation. Run-time storage allocation. Intermediate languages. Code generation methods. Local and global optimization techniques.

CS 5651. COMPUTER NETWORKS (4.0 cr.; prereq 2511, 2521 or #, a grade of C- or better is required in all prerequisite courses)

Introduction to computer networking, network programming, networking hardware and associated network protocols. Layered network architecture, network services, and implementation of computer networking software.

CS 5721. COMPUTER GRAPHICS (4.0 cr.; prereq 2511, Math 2326 or 3326 or 4326 or #, a grade of C- or better is required in all prerequisite courses)

Mathematics for computer graphics, basic raster algorithms, 2D and 3D transformations,viewing and shading. The graphics pipeline including visible surface determination, shading, ray-tracing, texture mapping, and clipping. Data structures including triangle meshes, scene graphs, bounding volume hierarchies. Real-time graphics applications using software systems such as Op.

CS 5741. OBJECT-ORIENTED DESIGN (4.0 cr.;prereq 2511, 3512 or #, a grade of C- or better is required in all prerequisite courses)

Overview of software design and design methods, focusing on object-oriented design.Impact of object and class organization on software maintenance and reusability. Implementation of a significant project using object-oriented methods and tools.

CS 5751. INTRODUCTION TO MACHINE LEARNING (4.0 cr.; prereq 2511, 3512, Stat 3611, Math 2326 or 3326 or 4326 or #; a grade of C- or better is required in all prerequisite courses)

Survey of methods in machine learning including supervised and unsupervised methods. Topics covered may include clustering, decision trees, neural networks,support vector machines, genetic algorithms and reinforcement learning. Theoretical concepts associated with machine learning.

CS 5761. INTRODUCTION TO NATURAL LANGUAGE PROCESSING (4.0 cr.; prereq 2511, 3512 or #; a grade of C-or better is required in all prerequisite courses)

Techniques for creating computer programs that analyze, generate, and understand natural human language. Topics include syntactic analysis, semantic interpretation, and discourse processing. Applications selected from speech recognition, conversational agents,machine translation, and language generation.Substantial programming project required.

CS 5991. Independent Study (1.0-4.0 cr.[max 8.0 cr.]; prereq #)

Directed study of special interest topics not available in the standard curriculum. Must be arranged with the instructor in advance of registration. May include readings, research, or special projects.

CS 5994. ADVANCED TOPICS IN COMPUTER SCIENCE (Various Titles to be Assigned). (4 cr; prereq CS grad or #)

Research-oriented study of topics of current academic or industrial interest, such as parallel algorithms, VLSI design, computational geometry, logic programming languages, program correctness, information retrieval systems, and decision support systems.

CS 8561. HUMAN COMPUTER INTERACTION (4.0cr.; prereq 5551 or 5721)

Introduction to the software algorithms,hardware components, and concepts for building and evaluating virtual environments for effective human-computer interaction

(visual, auditory, haptic, and mechanical aspects). Includes the perceptual components for constructing effective human-computer interaction with a virtual environment.

CS 8621. ADVANCED COMPUTER ARCHITECTURE (4.0 cr.; prereq 5621, 5631 or #)

Algorithmically-specialized functional units.Principles of advanced memory subsystem organization, including virtual memory and caches. Novel hardware technologies. Foundations of parallel architectures: from supercomputers to cluster environments. Advanced hardware/software performance analysis.

CS 8631. ADVANCED SYSTEMS PROGRAMMING (4.0 cr.;prereq 5631, 5641 or #)

Overview of systems programs with emphasis on unifying themes common to major application areas, such as compiler construction, operating systems, and networks. Advanced study of practical aspects of one of these systems, including a substantive software development project.

CS 8721. ADVANCED COMPUTER GRAPHICS (4.0 cr.; prereq 5721 or #)

Contemporary computer graphics techniques. Focus on advanced graphics algorithms and programming, curve and surface representations, physically based rendering,visible surface determination, illumination, texturing, and real time rendering.

CS 8751. ADVANCED MACHINE LEARNING (4.0 cr.; prereq 5751 or #)

Survey of emerging research topics in machine learning and data mining plus the relation of machine learning to fields such as bioinformatics. Topics drawn from emerging techniques such as support vector machines,ensemble methods and Bayesian networks.

CS 8761. NATURAL LANGUAGE PROCESSING (4.0 cr.; prereq 5761 or #; CS grad student)

Techniques to analyze, generate, and understand human language via computational techniques. This course focuses on empirical approaches to lexical and syntactic analysis,semantic interpretation, and discourse processing. Applications include part-of-speech tagging, parsing, lexical acquisition,and machine translation.

CS 8771. ADVANCED COMPUTATIONAL LOGIC (4.0 cr.; prereq 4511 or #; CS grad student)

Mathematically sound reintroduction to classical logic. Syntax, semantics, and proof theory for propositional and first-order logic. Soundness and completeness. Incompleteness. Additional topic(s)from among: automated theorem proving,

second-order logic, nonmonotonic logics and knowledge representation, logic programming.

CS 8777. THESIS CREDITS. MASTERS (1.0-24.0 cr. [max 50.0 cr.]; prereq Max 18 cr per semester or summer; 10 cr total required (Plan A only)

Thesis research and development.

CS 8821. ADVANCED COMPUTER SECURITY (4.0 Cr,; prereq Graduate student or CS 4821 and #)

Broad, active, hands-on and implementation-based approach to computer security. Fundamental cryptographic theory, advanced techniques and application. Complexity, cryptanalysis, and impact of technological change. Core security theory; confidentiality, integrity, availability. Security models. Risk assessment and decision-making. Issues for general -purpose, trusted and "cloud" operating system security including hardware requirements, authentication, access control, information flow and assurance. Program and network security fundamentals and best practices including coding principles, firewalls and network design. Exploits, defenses and remediation for multiple issues pertaining to software, hardware, databases and networks. Political, social and engineering issues relating to security and privacy.

CS 8993. SEMINAR (1.0 cr. [max 3.0 cr.]; prereq CS GRAD or #)

Presentation and discussion of basic ethical theories, case studies dealing with ethical issues facing the computing professional in his/her life as a practitioner, and the development of research proposal which meets the requirements and standards of the department and serves as the foundation of and guideline for the development of the graduate research project (i.e., thesis).

CS 8995. SPECIAL TOPICS: (Various Titles to be Assigned) (1.0-4.0 cr. [max 8.0 prereq CS Grad student and #)

Topics not available in standard curriculum.Topic announced in [Class Schedule].

6. GRADUATES

As of September 2018, 271 students have graduated from UMD as Masters of Computer Science. Their names, project or thesis titles, graduation dates, and research advisers are listed below.

Clyde Rogers, "Enhancements to Ziv-Lempel Data Compression," Plan A, May 1989. Adviser: Clark Thomborson.

Chi-Cheng Lin, “Showing Profile Curves and Hidden-Line Removal Algorithms,” Plan B, May 1989. Adviser: Doug Dunham.

Hui-Liang Low, “Matrix-Multiplication Problem Using Parallel Processing,” Plan B, June 1989. Adviser: Keith Pierce.

Bridget Rogers, “Modifying CAP to Provide Unix File Serving on a LAN of Mixed Macintoshes and DOS PCs,” Plan A, July 1989. Adviser: Mark Luker.

Glenn Andreas, “Visual Navigation of the Search Process in a Clustered Document Space,” Plan A, November 1989. Adviser: Donald Crouch.

Krishna Mohan Nareddy, “A Connectionist Model for Information Retrieval,” Plan A, August 1990. Adviser: Donald Crouch.

Paul Durrant, “The Distributed Appointment Manager,” Plan A, August, 1990. Adviser: Mark Luker.

Jeanne Dezell, “Clustering and Partitioning Techniques for Creating Rectilinear Steiner Trees,” Plan A, October 1990. Adviser: Linda Deneen.

Ningjian Wang, “The Intelligent and Visual Modeling of Linear Programming,” Plan A, October 1990. Adviser: Donald Crouch.

Ching Tsui, “A Gamma-Backward Defeasible Reasoning System,” Plan A, March 1991. Adviser: Timothy Colburn.

James Fenno, “Heuristic Control of Constraint-Based Scheduling,” Plan B, June 1991. Adviser: Timothy Colburn.

Renato Milanesi, “Optimal Look-Ahead Adders,” Plan A, July 1991. Adviser: Clark Thomborson.

I-Chang Wen, “A Study in Software Engineering - Maintenance, Restructuring and Interfacing,” Plan B, August 1991. Advisor: Douglas Dunham.

Sree Rama Peyyety, “A Proposal for Measurement Study of Ethernet Traffic,” Plan B, August 1991. Adviser: Clark Thomborson.

Bokyung Yang-Stephens, “Automatic Query Extension in Information Retrieval,” Plan A, September 1991. Adviser: Donald Crouch.

Yanzhang Lu, “Solving Combinatorial Optimization Problems by Simulated Annealing, Genetic Algorithms, and Neural Networks,” Plan A, September 1991. Adviser: Clark Thomborson.

Sudhamsa Gottipati, “An Improved Algorithm for Drawing Grid Surfaces,” Plan B, October 1991. Adviser: Douglas Dunham.

Amitabh Singhal, “Relevance Feedback as a Tool in Information Retrieval,” Plan A, March 1992. Adviser: Donald Crouch.

Peter Tsai, “Rendering Objects in 3-Dimensional Hyperbolic Design Program,” Plan B, May 1992. Adviser: Douglas Dunham.

Gary Anderson, “Maintenance and Interface Design for a Hyperbolic Design Program,” Plan B, May 1992. Adviser: Douglas Dunham.

Xun Zhao, “An Interface for Transforming Information from TimberWolf to RanTer,” Plan B, May 1992. Adviser: Clark Thomborson.

Shashikant Joshi, “Treasures in an Art Gallery,” Plan A, June 1992. Adviser: Linda Deneen.

Li Wei, “Displaying Three Dimensional Graphics with Contours and Hidden-Line Removal,” Plan B, August 1992. Adviser: Douglas Dunham.

Kanaiya Vasani, “A Network Management Tool Based on a Simple Network Management Protocol,” Plan B, March 1993. Adviser: Donald Crouch.

Srikanth Varanasi, “Surface Determination in 3-D Using Volume Rendering,” Plan B, April 1993. Adviser: Douglas Dunham.

Paul D. Kopecky, “Parallel Programming Using RPC,” Plan A, May 1993. Adviser: Gary Shute.

David D. Winslow, “A Neural Network Approach to the Prediction of S.E.C. Indictments,” Plan B, May 1993. Adviser: Timothy Colburn.

Yi Sun, “Delay Optimization of Carry Lookahead Adders Using Dynamic Programming,” Plan B, August 1993. Adviser: Clark Thomborson.

Craig Zwicky, “Restoring Files from the VMS/VAX,” Plan B, February 1994. Adviser: Mark Luker.

Parul Jain, “Visible Surface Determination using Ray Tracing and Transparency,” Plan B, June 1994. Adviser: Douglas Dunham.

Ravishanker Nandiwada, “A Tuning Algorithm for Fuzzy Modeling,” Plan A, July 1994. Adviser: Marian Stachowicz.

Manjari Yalavarthy, "Distributed Fractal Generation Using Remote Procedure Calls," Plan B, July 1994. Adviser: Gary Shute.

Chaohui Yang, "A Fuzzy Neural Integrated System and Its Applications in Modeling and Control," Plan A, July 1994. Adviser: Marian Stachowicz.

Rajinder Singh, "Document Modification in a Connectionist Retrieval Model," Plan A, September 1994. Adviser: Donald Crouch.

Randy Peterson, "Enhanced Associative Retrieval in a Connectionist Environment," Plan A, December 1994. Adviser: Carolyn Crouch.

Harvinder Bhela, "Monitoring Network Traffic Using SNMP Queries," Plan B, April 1995. Adviser: Gary Shute.

Xiangsheng Xia, "Rectilinear Steiner Minimum Tree Problem," Plan A, July 1995. Adviser: Gary Shute.

David Axtell, "Neural Networks and Quantitative Structure-Activity Relationships," Plan A, July 1995. Adviser: Timothy Colburn.

Harry Gehring, "An Interactive Tool to Support the Teaching of Compiler Construction," Plan B, August 1995. Adviser: Donald Crouch.

Nanbo Li, "A Computer Program to Generate Semi-regular Hyberbolic Tessellations," Plan B. September 1995. Adviser: Douglas Dunham.

James Donohoe, "An OSDF/Motif Implementation of a Computer Graphic Program for Generating Repeating Patterns on the Hyperbolic Plane," Plan B, September 1995. Co-advisers: Marian Stachowicz and Douglas Dunham.

Jingwen Wang, "A Hyperbolic Design Program Using the Motif/X11 Interface," Plan B, November 1995. Adviser: Douglas Dunham.

Shiaoling Peng, "Studies of Parallel Programming," Plan B, February 1996. Adviser: Donald B. Crouch.

Pankaj Agrawal, "Non-Uniform Image Processing: Feature Based Image Compression and Sub-Pixel Image Interpolation," Plan A, March 1996. Adviser: Donald B. Crouch.

Haichou Fan, "Adaptive Marching Cubes: A Fast 3D Surface Construction Algorithm," Plan A, April 1996. Adviser: Douglas Dunham.

Amit Jain, “Adaptive Marching Cubes,” Plan B, April 1996. Adviser: Douglas Dunham.

Rahul Bora, “Information Retrieval and the TREC Database,” Plan B, August 1996. Adviser: Carolyn J. Crouch.

Prathibha Gunaseelan, “Software Tools for a Compiler Project,” Plan B, September, 1996. Adviser: Donald Crouch.

N. R. Vaidyanathan, “Re-engineering MPI for a Multi-Homed Switched Network of Workstations,” Plan B, January 1997. Adviser: Gary Shute.

William Reichelt, “Feature Selection in Neural Networks: An Examination of Three Algorithms,'' Plan B, February 1997. Co-Advisers: Tim Colburn and David Opitz.

Ravi Potluri, “Machine Learning Techniques For Automated Information Filtering,” Plan B, March 1997. Adviser: David Opitz.

Tong Chen, “Using Smart for TREC Research,” Plan B, May 1997. Adviser: Carolyn Crouch.

Ewa Kusmierek, “Synchronization of Java Threads,” Plan A, May 30, 1997. Adviser: Gary Shute.

Yunjiang Luo, “Query Reformulation in TREC,” Plan A, June 1997. Adviser: Carolyn Crouch.

Lei Chen, “Generating Kaleidoscope Patterns in the Hyperbolic Plane,” Plan B, July 1997. Adviser: Douglas Dunham.

Bei Tang, “Decision-Theoretic Algorithms for Clustering Data,” Plan B, September 1997. Adviser: Marion Stachowicz.

Xi (Cissy) Zhang, “A Comparison of Information Retrieval Methods with Machine Learning Approaches,” Plan A, November 1997. Co-advisers: Carolyn Crouch and Richard Maclin.

Xing Li, “Generating Objects in the Hyperbolic Plane,” Plan B, December 1997. Adviser: Douglas Dunham.

Vinod John, “Geometric Transformation of Motifs of Repeating Hyperbolic Patterns,” Plan A, May 1998. Adviser: Douglas Dunham.

Sameer Pradhan, “A Generalized Approach to Computer Science Distance Learning,” Plan B, May 1998. Adviser: Donald Crouch.

Xiong Wang, "Experiment on Generating Improved Queries for the World Wide Web," Plan A, July 1998. Adviser: Carolyn Crouch.

Ramji Pilapakam, "Reinforcement Learning in a Multi-Agent Environment," Plan A, July 1998. Adviser: Richard Maclin.

Zhiyu (Sonny) Zhan, "Fuzzy Mathematical Approach to Color Recognition," Plan A, August 1998. Adviser: Marian Stachowicz.

Rahul Naik, "Creating Classification Features for Biological Images," Plan A, September 1998. Adviser: Richard Maclin.

Norman Will, "Using the Web for Interactive Data Acquisition, Presentation and Analysis," Plan B, October 1998. Adviser: Carolyn Crouch.

Gang Wu, "Polygon Area Decomposition with Near-Minimal Perimeter," Plan A, June 1999. Adviser: Donald Crouch

Christopher Buck, "Applying Persistence to Priority Search Trees to Facilitate Multi-Dimensional Range Queries," Plan A, July 1999. Adviser: Gary Shute

Shakila Xavier, "Learning from Training Samples," Plan A, July 1999. Adviser: Richard Maclin

Dheeraj Reddy, "The Generation of Semi-Regular Tilings in the Hyperbolic Plane Using Complete Polygons," Plan A, July 1999. Adviser: Douglas Dunham

Guoqiang Zang, "From Concurrent STRIPS to Logic Programming," Plan A, August 1999. Adviser: Hudson Turner

Qingyan Chen, "Improving the Retrieval Effectiveness of Very Short Queries," Plan A, September 1999. Adviser: Carolyn Crouch

Ravi Terala, "Streaming Audio Player in Java," Plan B, January 2000. Adviser: Gary Shute

Purushottam Kulkarni, "Some Methods for Parallelizing Decision Tree Learning," Plan A, May 2000. Adviser: Richard Maclin

Jayaraman Manni, "A Study of Object Oriented Design Patterns in the Development of a Framework," Plan A, May 2000. Adviser: Gary Shute

Karthik Ramakrishnan, "Building a Piece-Wise Ensemble of Decision Tree Classifiers," Plan A, May 2000. Adviser: Richard Maclin

Vishwas Raman, "A High Throughput Computing System with User-Initiated Checkpointing," Plan A, May 2000. Adviser: Richard Maclin

Ramesh Kizhappali, "Valkyrie: A Distributed System for Graph Visualization," Plan A, June 2000. Adviser: Douglas Dunham

Vidyasagar Krishnamoorthy, "Object Oriented Graph Framework with Searcher," Plan A, September 2000. Adviser: Gary Shute

Haseen Alam, "Multi-channel Image Segmentation," Plan A, December 2000. Adviser: Donald B. Crouch

Hariprasad Bommaganti, "Feature Boosting: A Novel Feature Subset Selection Approach," Plan A, May 2001. Adviser: Richard Maclin

Gan Chen, "Providing Dynamic Network Information to Distributed Applications," Plan A, May 2001. Adviser: Maria Sosonkina

Xiaochun (Shirley) Liu, "Deterministic Conformant Planning with the Causal Calculator," Plan A, May 2001. Adviser: C. Hudson Turner

Kiranmayee Nakka, "Object-Oriented Graph Framework," Plan A, May 2001. Adviser: Gary Shute

Anand Nagarajan, "Distributed Graph Coloring Algorithms in Linear Systems," Plan A, June 2001. Adviser: Maria Sosonkina

Milton Luoma, "A Realistic Bayes Net for Predicting Type 2 Diabetes," Plan B, June 2001. Adviser: Carolyn Crouch

Steven Holtz, "Further Experiments in Improving Very Short Queries," Plan A, July 2001. Adviser: Carolyn Crouch

Shardul Vikram, "Some Experiments with Reinforcement Learning on Real World Robots," Plan A, September 2001. Adviser: Richard Maclin

Alark Joshi, "Interactive Visualization of Models of Hyperbolic Geometry," Plan A, October 2001. Adviser: Douglas Dunham

Aditi Paluskar, "User-Level Control of Scheduling in a Micro Kernel Operating System," Plan B, December 2001. Adviser: Theodore Pedersen

Kiranmai Kodukula, "Using Artificial Neural Networks to Predict Properties of Polypropylene Film," Plan B, June 2002. Adviser: Timothy Colburn

Amit Lath, “Approximate Hyperbolic Splines and Their Transformations,” Plan A, June 2002. Adviser: Douglas Dunham

Kristy VanHornweder, “Applying the Partial Order Bounding to Game Tree Search,” Plan A, June 2002. Adviser: Timothy Colburn

Devdatta Kulkarni, “Using Dynamic Network Information to Improve the Runtime Performance of a Distributed Sparse Linear System Solution,” Plan A, July 2002. Adviser: Masha Sosonkina

Srinivas Vadrevu, “Efficient Neural Network Training Using Subsets of Very Large Datasets,” Plan A, August 2002. Adviser: Richard Maclin

Inderjit Singh, “The Impact of Phrases on the Retrieval Effectiveness of Very Short Queries,” Plan A, September 2002. Adviser: Carolyn Crouch

Zhuo Chen, “Determinizing in Conformant Planning,” Plan A, October 2002. Adviser: C. Hudson Turner

Satanjeev Banerjee, “Adapting the Lesk Algorithm for Word Sense Disambiguation to WordNet,” Plan A, December 2002. Adviser: Ted Pedersen

Abhijit Parsekar, “ A Unified Data Representation and Visualization of Patterns Based on Regular Tessellations in the Three “Classical” Geometries,” Plan A, December 2002. Adviser: Douglas Dunham

Nitin Varma, “Identifying Word Translations in Parallel Corpora Using Measures of Association,” Plan A, December 2002. Adviser: Ted Pedersen

Deepa Krishnamoorthy, “An Approach to Inclusion of Parallel Independent Sets in PARMS,” Plan A, March 2003. Adviser: Masha Sosonkina

Nirish Dhruv, “Design of Large Scale Data Archival and Retrieval System for Transportation Sensor (Write-Once-Ready-Many Type) Data,” Plan A, April 2003. Adviser: Donald B. Crouch

Krishna Kotnana, “Conformant Planning as QBF Satisfiability,” Plan A, July 2003. Adviser: C. Hudson Turner

Sameer Apte, “Using the Extended Vector Space Model for Content-Oriented XML Retrieval,” Plan A, August 2003. Adviser: Carolyn J. Crouch

Harsh Bapat, “Adapting the Extended Vector Space Model for Structured XML Retrieval,” Plan A, August 2003. Adviser: Carolyn J. Crouch

Saif Mohammad, "Combining Lexical and Syntactic Features for Supervised Word Sense Disambiguation," Plan A, August 2003. Adviser: Ted Pedersen

Siddharth Patwardhan, "Incorporating Dictionary and Corpus Information into a Context Vector Measure of Semantic Relatedness," Plan A, August 2003. Adviser: Ted Pedersen

Sweta Sinha, "A Finite Domain Satisfiability Solver," Plan A, August 2003. Adviser: C. Hudson Turner

Jayanta Nath, "Modeling Behavior Programming Language Design in a Rat Maze Simulator," Plan B, September 2003. Adviser: Christopher Prince

Oleksandr Kosolapov, "The Effects of Category Information on Association Learning Tasks in Neural Network Models," Plan A, October 2003. Adviser: Christopher Prince

Srikanth Varanasi, "Modeling and Simulating Scenarios for Testing the Effects of Information Technology in the Reduction of Medical Errors," Plan A, November 2003. Adviser: Piotr Windyga

Krishna Chengavalli, "Wearable Computing in the Reduction of Medical Errors Committed by Registered Nurses in the Intensive Care Unit," Plan A, December 2003. Adviser: Piotr Windyga

Anand Sivaraman, "Improving the Efficiency of a Color-Based Image Retrieval System," Plan A, December 2003. Adviser: Donald B. Crouch

Kiran Vuppla, "Evaluation and Documentation of Two Synchrony Detection Implementations," Plan A, April 2004. Adviser: Christopher Prince

Samuel Storie, "Aspects of Communication Subsystem Analysis for Distributed Scientific Applications," Plan A, May 2004. Adviser: Masha Sosonkina

Navdeep Kaur, "Empirical Analysis of Two Learning Techniques for Image Retrieval," Plan A, June 2004. Adviser: Donald B. Crouch

Deodatta Bhoite, "A Traffic Data Warehouse and Visualization Scheme," Plan A, July 2004. Adviser: Richard Maclin

Ruinan Lu, "Parallel Algebraic Recursive Multilevel Solver to Tackle Difficult Sparse Linear Systems of Equations," Plan B, July 2004. Adviser: Masha Sosonkina

Nan Zhang, "Duluth Entertainment Convention Center (DECC) Special Events Traffic Flow Study," Plan A, July 2004. Adviser: Douglas Dunham

Nitin Agarwal, "Extending the Stream Concept," Plan A, August 2004. Adviser: Gary Shute

Rashmi Kankaria, "A Tool for Constructing and Visualizing Tree Augmented Bayesian Networks for Survey Data," Plan A, August 2004. Adviser: Richard Maclin

Yanhua Li, "Hyperbolic Spline Curves Using a Weighted Average," Plan A, August 2004. Adviser: Douglas Dunham

Ashutosh Nagle, "A Finite Domain Satisfiability Solver with Negation," Plan A, August 2004. Adviser: C. Hudson Turner

Amruta Purandare, "Unsupervised Word Sense Discrimination by Clustering Similar Contexts," Plan A, August 2004. Adviser: Ted Pedersen

Prashant Rathi, "Development of Customizable Analytical Model of the Prostrate Anatomy for Training in Cryosurgical Related Procedures and Design of the Virtual Simulator," Plan A, August 2004. Adviser: Douglas Dunham

Anand Takale, "Constructing Predictive Models to Assess the Importance of Variables in Epidemiological Data Using a Genetic Algorithm System Employing Decision Trees," Plan A, August 2004. Adviser: Richard Maclin

Kailash Aurangabadkar, "Generating Subnets for Polyhedra," Plan A, September 2004. Adviser: Douglas Dunham

Archana Bellamkonda, "Automation of Content and Structure (or CAS) Query Processing," Plan A, September 2004. Adviser: Carolyn Crouch

Aniruddha Mahajan, "Flexible Retrieval in a Structured Environment," Plan A, September 2004. Adviser: Carolyn Crouch

Sachin Sharma, "Object Retrieval Based on Color Composition," Plan A, October 2004. Adviser: Donald B. Crouch

Suchitra Goopy, "Improving Usability of the Parallel Algebraic Recursive Multilevel Solver," Plan B, December 2004. Adviser: Masha Sosonkina

Anushri Parsekar, "Blind Deconvolution of Vehicle Inductive Signatures for Travel Time Estimation," Plan A, December 2004. Adviser: Donald B. Crouch

Bridget Thomson-McInnes, "Extending the Log Likelihood Measure to Improve Collocation Identification," Plan A, December 2004. Adviser: Ted Pedersen

Paul Gordon, "Using NICAN for the Monitoring and Reporting of Environmental Conditions on Multiple Nodes during the Execution of the Parallel Program GAMESS," Plan B, May 2005. Adviser: Masha Sosonkina

Sumalatha Kuthadi, "Detection of Objects from High-Resolution Satellite Images," Plan A, May 2005. Adviser: Douglas Dunham

Archna Yadav, "A State Space Approach to Arterial Travel Time Prediction," Plan B, May 2005. Adviser: Carolyn Crouch

Ajit Datar, "Generating Hyperbolic Patterns for Regular and Non-Regular P-Gons," Plan A, July 2005. Adviser: Douglas Dunham

Jason Michelizzi, "Semantic Relatedness Applied to All Words Sense Disambiguation," Plan A, July 2005. Adviser: Ted Pedersen

Pratheepan Raveendranathan, "Identifying Sets of Related Words from the World Wide Web," Plan A, July 2005. Adviser: Ted Pedersen

Nagendra Doddapaneni, "Effective Structured Query Processing," Plan A, August 2005. Adviser: Donald B. Crouch

Varsha Kodali, "Characterization of Proteomics Maps Using Graph-Theoretical Methods," Plan B, August 2005. Adviser: Gary Shute

Hemal Lal, "A Finite Domain Satisfiability Solver with Clause Leaning and Non-Chronological Backtracking," Plan A, August 2005. Adviser: C. Hudson Turner

Sampanna Salunke, "Comparing Synchrony Detection Algorithms for Robotic Self-other Discrimination," Plan A, August 2005. Adviser: Christopher Prince

Ravindra Bharadia, "A Program to Display Semi-Regular Tessellations of Hyperbolic Plane," Plan B, September 2005. Adviser: Douglas Dunham

Tarun Kapoor, "Generating Repeating Hyperbolic Patterns Based on {p,∞}," Plan A, September 2005. Adviser: Douglas Dunham

Sudip Khanna, "Design and Implementation of a Flexible Retrieval System," Plan A, September 2005. Adviser: Carolyn J. Crouch

Poorva Potnis, "Relevance Feedback in Flexible Retrieval System," Plan A, September 2005. Adviser: Carolyn J. Crouch

Anoop Parlapalli Reddy, "Analysis of Synchronous and Asynchronous Video Using the SenseStream Program," Plan B, March 2006. Adviser: Christopher Prince

David Wicklund, "Making the Most of SQL Views," Plan B, May 2006. Adviser: Carolyn J. Crouch

Sameer Atar, "Generating Repeating Patterns on Subnets of Polyhedra," Plan A, July 2006. Adviser: Douglas Dunham

Saiyam Kohli, "Introducing an Object Oriented Design to the Ngram Statistics Package," Plan B, July 2006. Adviser: Ted Pedersen

Anagha Kulkarni, "Unsupervised Context Discrimination and Automatic Cluster Stopping," Plan A, July 2006. Adviser: Ted Pedersen

Aditya Polumetla, "Machine Learning Methods for the Detection of RWIS Sensor Malfunctions," Plan A, July 2006. Adviser: Richard Maclin

Kai Xu, "Deciding Strong Equivalence of Causal Theories," Plan B, July 2006. Adviser: C. Hudson Turner

Vishal Bakshi, "Flexible Retrieval for the Semi-Structured Documents," Plan A, August 2006. Adviser: Carolyn J. Crouch

Satyanarayana Murthy Ganapathibhotla, "Query Processing in a Flexible Retrieval Environment," Plan A, August 2006. Adviser: Carolyn J. Crouch

Mahesh Joshi, "Kernel Methods for Word Sense Disambiguation and Abbreviation Expansion in the Medical Domain," Plan A, August 2006. Adviser: Richard Maclin

Apurva Padhye, "Comparing Supervised and Unsupervised Classification of Messages in the Enron Email Corpus," Plan A, August 2006. Adviser: Ted Pedersen

Kedar Bhumkar, "Interactive Visualization of Hyperbolic Geometry using the Weierstrass Model," Plan A, September 2006. Adviser: Douglas Dunham

Lalit Nookala, "Weather Impact on Traffic Conditions and Travel Time Prediction," Plan A, November 2006. Adviser: Donald B. Crouch

Umesh Maitipe, "Using Programmable Graphics Hardware for Real Time Tree Animation with Simulated Wind Patterns," Plan A, July 2007. Adviser: Pete Willemsen

Aditya Mone, "Dynamic Element Retrieval for the Semi-Structured Documents," Plan A, July 2007. Adviser: Carolyn J. Crouch

Neeraj Vohra, "An Investigation: Using Lemur to Feed Flex," Plan B, July 2007. Adviser: Carolyn J. Crouch

Nachiket Kamat, "Impact of Untagged Text in Dynamic Element Retrieval," Plan A, August 2007. Adviser: Donald B. Crouch

Vikram Malik, "Impact of Terminal Node Processing on Element Retrieval," Plan A, August 2007. Adviser: Carolyn J. Crouch

Ajit Marathe, "Incorporating Points at Infinity in a Hyperbolic Drawing Program," Plan A, August 2007. Adviser: Douglas Dunham

Vinayak Patil, "Tile Coding Reinforcement Learning for RoboCup Soccer," Plan B, August 2007. Adviser: Richard Maclin

Amine Abou-Rjeili, "Solving Conformant Planning Using Chen's Determinizing Method," Plan A, May 2008. Adviser: C. Hudson Turner

Anagha Dharasurkar, "Further Evaluation of the Gogate el al Synchrony Measurement Algorithm," Plan B, June 2008. Adviser: Christopher Prince

Andrew Norgren, "GPU Based Particle Dispersion Modeling with Interactive Visualization Support for Real-time Simulation," Plan A, June 2008. Adviser: Peter Willemsen

Salil Bapat, "Improving Results for Focused and Relevance-in-Context Tasks," Plan A, August 2008. Adviser: Donald B. Crouch.

Prafulla Bhalekar, "A Web-Based System to Assist in Detecting RWIS Sensor Malfunctions," Plan A, August 2008. Adviser: Richard Maclin

Sarika Mehta, "Finding the Best Entry Point," Plan A, August 2008. Adviser: Carolyn J. Crouch

Aneerudh Naik, "Impact of Slope and Pivot Values on Dynamic Element Retrieval," Plan B, August 2008. Adviser: Carolyn J. Crouch

Ankur Nepalia, "Creating Repeating Patterns on Polyhedra," Plan A, August 2008. Adviser: Douglas Dunham

Shruti Pandey, "Methods for Approximating Forward Selection of Features in Information Retrieval Problems Using Machine Learning Methods," Plan A, August 2008. Adviser: Richard Maclin

Darshan Paranjape, "Improving Focused Retrieval," Plan A, August 2008. Adviser: Donald B. Crouch

Premchand Bellamkonda, "Rapid Simulation of the Great Depression 1929-1932," Plan B, September 2008. Adviser: Donald B. Crouch

Anurag Jain, "Watched Literals in a Finite Domain SAT Solver," Plan A, September 2008. Adviser: C. Hudson Turner

Vishnu Pedireddi, "Large Scale Traffic Simulation on Graphics Hardware," Plan A, September 2008. Adviser: Pete Willemsen

Bin Lan, "Grounder for Finite Domain SAT," Plan B, June 2009. Adviser: Hudson Turner

Prasad Kulkarni, "Simulating Wing-Sensors on a Sailplane Airfoil to Evaluate Usefulness for Pilot Feedback," Plan A, July 2009. Adviser: Christopher Prince

Varun Sudhakar, "Improving Results for the Best in Context Task," Plan B, July 2009. Adviser: Donald B. Crouch

Dinesh Bhirud, "Focused Retrieval Using Upper Bound Methodology," Plan A, August 2009. Adviser: Carolyn J. Crouch

Siddharth Deokar, "Real-Time Snow Rendering," Plan A, August 2009. Adviser: Peter Willemsen

Varada Kolhatkar, "An Extended Analysis of a Method of AllWords Sense Disambiguation," Plan A, August 2009. Adviser: Ted Pedersen

Atul Kulkarni, "A Nearest Neighbor Approach Using Clustering on the Netflix Prize Data," Plan B, August 2009. Adviser: Richard Maclin

Andrew Larson, "DVPDS: An Open Source Data Analysis and Visual Programming Tool for Database Statistics," Plan A, August 2009. Co-Advisers: Richard Maclin and Peter Willemsen

Chaitanya Polumetla, "Improving Results for the Relevant in Context Task," Plan A, August 2009. Adviser: Carolyn J. Crouch

Pavan Poluri, "Focused Retrieval Using Exact Methodology," Plan A, August 2009. Adviser: Donald B. Crouch

Md Ashraful Alam, "Experimenting with Various Web Services Toolkit and Their Support for Backward Computability," Plan B, January 2010. Adviser: Douglas Dunham

Sathavahana Bhogapathi, "My Experiences with MPI," Plan B, August 2010. Adviser: Pete Willemsen

Ramakrishna Cherukuri, "Significance Testing for INEX 2008-09 Ad Hoc Track," Plan A, August 2010. Adviser: Carolyn Crouch

Vivek Kasireddy, "A Biclustering Method for Extracting Keyphases to Describe Groups of Yeast Genes," Plan A, August 2010. Adviser: Richard Maclin

Abhijeet Mahule, "Improving Results for the INEX Thorough Task," Plan A, August 2010. Adviser: Carolyn Crouch

Michael Neilsen, "AIRS An Architecture for Interactive Real-time Systems," Plan A, August 2010. Adviser: Pete Willemsen

Dipesh Pandey, "Re-Engineering a Repeated Hyperbolic Pattern Program to Include Color Symmetry," Plan B, August 2010. Adviser: Douglas Dunham

Sridhar Uppala, "Experiments with Weighting Schemes in SMART," Plan B, August 2010. Adviser: Donald B. Crouch

Sandeep Vadlamudi, "Producing Improved Results for the INEX Focused and Relevant in Context Tasks," Plan A, August 2010. Adviser: Donald B. Crouch

Sunil Vejandla, "Branch Prediction," Plan B, August 2010. Adviser: Gary Shute

Anand Janjal, "Register Renaming," Plan B, September 2010. Adviser: Gary Shute

Chandana Nagalla, "Rewards and Recognition System," Plan B, February 2011. Adviser: Peter Willemsen

Natasha Deepak Acquilla, "Improving Results for the 2009 and 2010 INEX Focused Tasks," Plan A, August 2011. Adviser: Carolyn J. Crouch

Radhika A. Banhatti, "Improving Results for the INEX 2009 Thorough and 2010 Efficiency Tasks," Plan A, August 2011. Adviser: Donald B. Crouch

Bhagyashri Abhijeet Mahule, "A User Guide for Flex," Plan A, August 2011. Adviser: Carolyn J. Crouch

Reena Rachel Narendravarapu, "Improving Results for the INEX 2009 and 2010 Relevant in Context Tasks," Plan A, August 2011. Adviser: Donald B. Crouch

Dnyaneshwari Chandarana, "Designing an Algorithm That Transforms Each Pixel Back to Motif in a Fundamental Region," Plan A, September 2011. Adviser: Douglas Dunham

Lakshmi Ramya Pathi, "Covering Polyhedra by Motifs with Triangular Fundamental Regions," Plan A, September 2011. Adviser: Douglas Dunham

Joshua Clark, "A Fast and Efficient Simulation Framework for Modeling Heat Transport," Plan A, January 2012. Adviser: Peter Willemsen

Michele Clark, "A Study of Real-Time Lighting Effects," Plan A, January 2012. Adviser: Peter Willemsen

Bharat Siginam, "Adaptive Tile Coding Methods for the Generalization of Value Functions in the RL State Space," Plan A, March 2012. Adviser: Richard Maclin

Scot Halverson, "Energy Transfer Ray Tracing with OptiX," Plan A, June 2012. Adviser: Peter Willemsen

Srivishnu Kaushik Satyavolu, "Self-Avatars and IR-Based Position Tracking in Virtual Environments Using Microsoft Kinects," Plan A, June 2012. Adviser: Peter Willemsen

Christopher Becker, "Creating Repeating Hyperbolic Patterns Based on Regular Tessellations," Plan A, July 2012. Adviser: Douglas Dunham

Mugdha Choudhari, "Extending the Hirst and St-Onge Measure of Semantic Relatedness for the Unified Medical Language System," Plan A, August 2012. Adviser: Ted Pedersen

Kiran Kura, "A Novel Data Set for Semantic Parsing using SQL as a Formal Language," Plan A, September 2012. Adviser: Richard Maclin

Sai Subramanyam Chittilla, "Parsing the Wiki Collection and Snippet Generation," Plan A, April 2013. Adviser: Donald B. Crouch

Supraja Nagalla, "From Focused Elements to Snippets," Plan A, April 2013. Adviser: Carolyn J. Crouch

Sameer Kulkarni, "Experimetns in Non-Factoid Question Answering," Plan A, August 2013. Adviser: Carolyn J.Crouch

Swapnil Nawale, "A Non-Factoid Question Answering System for Tweet Contextualization," Plan A, August 2013. Adviser: Donald B.Crouch

Aditya Vegesna, "Optimizing Urban Environmental Simulations using Boinc," Plan A, August 2013. Adviser: Peter Willemsen

Kiran Kumar Bushireddy, "Generating a Reference Set," Plan A, September 2013. Adviser: Carolyn J. Crouch

Aishwarya Ashok, “A Java Application to Draw Repeating Euclidean Patterns,” Plan B, November 2013. Adviser: Douglas Dunham

Siva Sravani Gurram, “Analyzing the Computations of Ray Tracing Using NVIDIA OptiX,” Plan B, December 2013. Adviser: Peter Willemsen

Maneesha Vejendla, “Generating Repeating Hyperbolic Patterns Based on Regular Tessellations Using an Applet,” Plan A, December 2013. Adviser: Douglas Dunham

Anand Jha, “An Approach to Improve Cluster Labeling and Evaluation,” Plan A, February 2014. Adviser: Donald B. Crouch

Henry Helgen, “Human Computer Collaboration in Ranking Images,” Plan B, April 2014. Adviser: Douglas Dunham

Rajesh Tripurneni, “Semantic Parsing for Automatic Generation of SQL Queries Using Adaptive Boosting,” Plan A, May 2014. Adviser: Richard Maclin

Ramakanth Vanga, “Hyperbolic Spline Curves Using a Weighted Average,” Plan B, June 2014. Adviser: Douglas Dunham

Mihir Atmakuri, “A View of Snippet Retrieval,” Plan B, August 2014. Adviser: Carolyn J. Crouch

Praveen Katta, “Visualization of Algorithms with the Implementation of Sprites,” Plan B, August 2014. Adviser: Gary Shute

Venkataravikiran Ravva, “Personalized Book Retrieval System Usint the Amazon-LibraryThing Collection,” Plan A, August 2014. Adviser: Carolyn Crouch

Lakshmi Lavanya Singampalli, “Social Book Search: A Methodology that Combines Both Retrieval and Recommendation,” Plan A, August 2014. Adviser: Carolyn Crouch

Vamshi Thotempudi, “A Recommender System for Social Book Search,” Plan A, August 2014. Adviser: Carolyn Crouch

Matthew Overby, “A High Performance Framework for Coupled Urban Microclimate Models,” Plan A, November 2014. Adviser: Peter Willemsen

Mounika Alla, “An Interactive Java Program for Creating Regular Repeating Hyperbolic Patterns,” Plan B, June 2015. Adviser: Douglas Dunham

Sai Charan Raj Chitirala, "Comparing the Effectiveness of Automated Test Generation Tools "EVOSUITE" and "Tpalus," Plan A, July 2015. Adviser: Andrew Brooks

Shiva Kumar Chittamuru, "An Interactive Java Program to Generate Hyperbolic Repeating Patterns Based on Regular Tessellations Including Hyperbolic Circles and Horocycles," Plan A, July 2015. Adviser: Douglas Dunham

Sakethram Karumuri, "An Interactive Java Program to Generate Hyperbolic Repeating Patterns Based on Regular Tessellations Including Hyperbolic Lines and Equidistant Curves," Plan A, July 2015. Adviser: Douglas Dunham

Venkata Subhash Movva, "Automatic Test Suite Generation for Scientific MATLAB Code," Plan A, July 2015. Adviser: Andrew Brooks

Viswanadh Vuggumudi, "A MPI-based Distributed Computation for Supporting Optimization of Urban Designs with QUIC EnvSim," Plan A, July 2015. Adviser: Peter Willemsen

Vidya Attivilli, "An Automatic Tutoring System to Teach Microsoft Excel," Plan A, August 2015. Adviser: Richard Maclin

Akshay Reddy Koppula, "Conducting Inductive Logic Programming in Database Management Systems," Plan A, August 2015. Adviser: Richard Maclin

Ranga Reddy Pallelra, "Measurement and Enhancement of Peer-to-Peer Based File Synchronization with Cloud Assistance," Plan A, August 2015. Adviser: Haiyang Wang

Ravikanth Repaka, "Efficiently Storing and Discovering Knowledge in Databases via Inductive Logic Programming Implemented Directly in Databases," Plan A, August 2015. Adviser: Richard Maclin

Sarmad Ahsan Siddiqui, "A Ray-Traced Sampling Framework for Visualizing and Improving Material Detail in Urban Energy Simulations with QUIC EnvSim," Plan A, August 2015. Adviser: Peter Willemsen

Mounika Chillamcherla, "On High Performance Cloud Based File Synchronization with User Collaboration," Plan A, July 2016. Adviser: Haiyang Wang

Preethi Chimerla, "Investigating Distance Perception in Virtual Reality," Plan B, July 2016. Adviser: Peter Willemsen

Anicia Dcosta, "Utilizing the Redirected Walking Algorithm to Avoid User-Obstacle Collisions," Plan A, July 2016. Adviser: Peter Willemsen

Vamsidhar Reddy Kasireddy, "Establishing the Connection Between a Triply Periodic Polyhedron and its Hyperbolic Covering Tessellation," Plan A, July 2016. Adviser: Douglas Dunham
Nirav Vinod Kumar Sharda, "Modelling the Relationship Between a Hperbolic Tessellation and a Corresponding Triply Periodic Polyhedron," Plan A, July 2016. Adviser: Douglas Dunham

Yan Bai, "Power Consumption of Virtual Machines in Cloud Computing Measurement and Enhancement," Plan A, August 2016. Adviser: Haiyant Wang

Bharath Kumar Bommana, "Towards Reliable User Collaboration over Cloud-based File Synchronization System: Ddropbox as a Case Study," Plan A, August 2016. Adviser: Haiyang Wang

Swetha Naidu, "Transforming Euclidean Object Files to Hyperbolic Data Files," Plan A, October 2016. Adviser: Peter Willemsen

Priyankana Basak, "A GUI for Defining Inductive Logic Programming Tasks For Novice Users," Plan A, March 2017. Adviser: Rich Maclin

Puja Davande, "Implementation of Breadth-First Search Method Based on a Randomly Chosen Bottom Clause for Inductive Logic Programming Method," Plan A, March 2017. Adviser: Rich Maclin

Jonathan Rusert, "Language Evolves, so should WordNet - Automatically Extending WordNet with the Senses of Out of Vocabulary Lemmas," Plan A, May 2017. Adviser: Ted Pedersen

Sandeep Vuppula, "From Scenarios to Optimally Allocated Timed Automata," Plan A, June 2017. Adviser: Neda Saeedloei

Penghuan Ni, "Urban Design Using Genetic Algorithm and Active Learning," Plan B, July 2017. Adviser: Rich Maclin

Brandon Paulsen, "debreach: Selective Dictionary Compression to Prevent BREACH and CRIME," Plan A, July 2017. Adviser: Peter Peterson

Manoj Naik Prakash, "Tiling Euclidean Polygons Mapped From Their Hyperbolic Equivalent," Plan A, July 2017. Co-Advisers: Douglas Dunham and Pete Willemsen

Sai Ram Kowshik Vattipally, "Measurement and Enhancement of Cloud-based Online Gaming Systems," Plan A, July 2017. Adviser: Haiyang Wang

Rushmeet Bahra, "Monitoring Bipolar Disorder using Heart Rate, Sleep, and Mood Changes," Plan A, August 2017. Adviser: Arshia Khan

Xue Gao, “User Intent Using Gaze and Gesture Data with Neural Networks,” Plan B, May 2018. Adviser: Peter Willemsen
Vaclav Hasenohrl, “On the Runtime Dynamics of the Univariate Marginal Distribution Algorithm on Jump Functions,” Plan A, May 2018. Adviser: Andrew Sutton

Dennis Asamoah Owusu, “Modeling Outputs of Efficient Compressibility Estimator,” Plan A, June 2018. Adviser: Peter A.H. Peterson

Jonathan Beaulieu, “Adaptive Filesystem Compression for General Purpose Systems,” Plan A, June 2018. Adviser: Peter A.H. Peterson

Arshia Zernab Hassan, “Wandering Behavior Management Systems for Individuals with Dementia,” Plan A, July 2018. Adviser: Arshia Khan

Noah Miller, “Comparing Interface Affordances for Controlling a Push Broom in VR,” Plan A, July 2018. Adviser: Peter Willemsen

Manikya Swathi Vallabhajosyula, “Hypernym Discovery over WordNet and English Corpora - using Hearst Patterns and Word Embeddings,” Plan A, July 2018. Adviser: Ted Pedersen

Sai Praneeth Cheedella, “Adaptive Impedance Control for Physical Rehabilitation Robot,” Plan A, August 2018. Adviser: Arshia Khan

Kushagra Kumar, “Analyzing Commercial Peer-to-Peer File Synchronization via Distributed Active Measurement,” Plan A, September 2018. Adviser: Haiyang Wang

7. RELATED POLICIES AND INFORMATION

7.1 Mutual Responsibilities in Graduate Education at the University of Minnesota

Preamble

A major purpose of graduate education at the University of Minnesota is to instill in each student an understanding of and capacity for scholarship, independent judgment, academic rigor, and intellectual honesty. Graduate education is an opportunity for the student to develop into a professional scholar. Graduate research and teaching assistantships offer an "apprenticeship" experience in the academic profession as well as financial support. It is the joint responsibility of faculty and graduate students to work together to foster these ends through relationships that encourage freedom of inquiry, demonstrate personal and professional integrity, and foster mutual respect. This shared responsibility with faculty extends to all of the endeavors of graduate students, as students, employee, and members of the larger academic community.

High quality graduate education depends on the professional and ethical conduct of the participants. Faculty and graduate students have complementary responsibilities in the maintenance of academic standards and the creation of high quality graduate programs. Excellence in graduate education is achieved when both faculty and students are highly motivated, possess the academic and professional backgrounds necessary to perform at the highest level, and are sincere in their desire to see each other succeed.

The following principles illustrate what students should expect from their programs and what programs should expect from their students, to help achieve this excellence.

Principle 1: Information about Policies and Procedures.

The Graduate School and graduate programs are responsible for providing students and prospective student with access to information about their graduate program, areas of specialization, degree requirements, and average time to completion of degrees. Graduate programs are responsible for providing access to information about graduate student financial support in the program, such as the prospects for fellowships, assistantships or other financial support and the proportion of students receiving financial support. In addition, graduate programs should provide students and applicants with information about career experiences of graduates of the program. All such information should be presented in a format that does not violate the privacy of individual students. Programs are encouraged to provide relevant information in their handbooks, websites or other readily accessible formats.

Students are responsible for keeping themselves informed about current policies of their program and the Graduate School that affect graduate students. Students and

alumni also have a responsibility to respond to program inquiries about their career development.

Principle 2: Communication about Academic Status

The Graduate School and graduate programs are responsible for providing students with information about their individual academic status: who in the Graduate School and in their graduate program is responsible for communicating to them about admission issues and progress through the degree program, how the communication will take place, and the possibility for appeal to a third party for assistance in solving disputed issues.

Students are responsible for communicating with the Graduate School and their graduate program about changes in their circumstances that affect their status and progress toward the degree.

Principle 3: Research Contributions

Individual faculty as research directors are responsible for providing students with appropriate recognition for their contributions at conferences, in professional publications, or in applications for patents. It is the faculty member's responsibility to clarify the principles for determining authorship and recognition at the beginning of any project.

Students are responsible for discussing their expectations regarding acknowledgment of research contributions or intellectual property rights with the appropriate person(s) in the research team, preferably early in the project.

Principle 4: University Governance

Departments and graduate programs are responsible for defining specific opportunities for student participation on committees as they deem appropriate. The University recognizes that graduate students make important contributions to governance and decision making at the program, department, college, Graduate School and University level; specific roles for participation are defined at each level by the relevant governing bodies. For example, University Senate policy requires student membership on faculty search committees.

Students are responsible for participating in University governance and decision making that enriches the campus community.

Principle 5: Respectful Employment Conditions

University faculty and staff are responsible for assuring that graduate students are able to conduct their work, as students or students/employees, in a manner consistent with

professional conduct and integrity, free of intimidation or coercion. Students who are employees also have the protection of all University employment policies and laws. Graduate programs are responsible for providing clear communication to students about the possibility for appeal to a third party for assistance in resolving disputed issues.

Students are responsible for reporting unprofessional conduct to the appropriate body or person, as defined in the academic or employment grievance policy; they should be able to do so without fear of reprisal. Students are responsible for acting in a respectful and fair manner toward other students, faculty, or staff in the conduct of their academic work or work they may do in connection with an assistantship.

Principle 6: Conditions of Employment

The University (through its departments, research projects or other employing units) is responsible for providing to prospective graduate assistants a written offer of financial support before a response to the offer is required. Such communication must indicate their salary and the terms and conditions of their appointment, including the general nature of the work they will be performing, duration of employment, and whether and how this employment is tied to their academic progress. The details of specific teaching or research assignments may need to await later written clarification.

Students are responsible for accepting the conditions of employment only if they believe they are qualified and able to complete the tasks assigned. Students have a responsibility for communicating in writing any changes in their circumstances that affect their ability to fulfill the terms and conditions of their employment.

Principle 7: Safe Working Environment

Supervisors are responsible for providing a safe working environment for graduate students, and for developing and publicizing safety policies and training programs to achieve that goal.

Graduate students are responsible for helping to maintain a safe working environment, for adhering to safety policies, for participating in training programs and for reporting safety violations to the proper authority.

7.2 Resolution of the Council of Graduate Schools in the United States

Acceptance of an offer of financial support *(such as a graduate scholarship, fellowship, traineeship, or assistantship) for the next academic year by a prospective or enrolled graduate student completes an agreement that both student and graduate school expect to honor. In that context, the conditions affecting such offers and their acceptance must be defined carefully and understood by all parties.

Students are under no obligation to respond to offers of financial support prior to April 15; earlier deadlines for acceptance of such offers violate the intent of this Resolution. In those instances in which a student accepts an offer before April 15, and subsequently desires to withdraw that acceptance, the student may submit in writing a resignation of the appointment at any time through April 15. However, an acceptance given or left in force after April 15 commits the student not to accept another offer without first obtaining a written release from the institution to which a commitment has been made. Similarly, an offer by an institution after April 15 is conditional on presentation by the student of the written release from any previously accepted offer. It is further agreed by the institutions and organizations subscribing to the above Resolution that a copy of this Resolution or a link to the URL should accompany every scholarship, fellowship, traineeship, and assistantship offer.

This Resolution was renewed October 2009.

7.3 Other University Documents may provide information and guidance relevant to the graduate education experience:

* Board of Regents, Code of Conduct, adopted 7/12/96
[www.regents.umn.edu/policies/academic/Conduct.pdf]
* Board of Regents, Academic Freedom and Responsibility, adopted 9/8/95
[www.regents.umn.edu/policies/academic/AcademicFreedom.pdf]
* Graduate Assistant Office, Handbook for Graduate Assistants
[www.umn.edu/OHR/GAO/]
* Policy on the Appropriate Use of Information Technology
(www.d.umn.edu/itss/policies/appuse.html)
* University Senate, minutes, April 19, 1990, Student Conduct Code
[Gopher: U of M Campus Information/ Information for Students/Student Conduct Code]
* Standards of Student Conduct Enforceable by University Agencies
[www.sja.umn.edu/conduct.html]
* Expectations of Graduate Students in Research, Scholarship, and Professional Education
[www.grad.umn.edu/Ethics/ethics_brochure.html]
* Research Involving Human Subjects
[www.research.umn.edu/subjects]
* Research Involving Animal Subjects
[www.reseach.umn.edu/subjects
* Work-Related Policies (inquires directed to Graduate Assistantship Office and/or Human Resources)
[www1.umn.edu/ohr/gao]