Cognitive and Information Sciences Ph.D. Program Requirements

October 17th, 2011

The CIS Ph.D. program requirements were originally codified in the CIS proposal submitted to UC Merced's Graduate and Research Council, and to the UC-wide Coordinating Committee on Graduate Affairs. The purpose of this document is to summarize, elaborate upon, and update the CIS program requirements as needed. The program is outlined below, followed by relevant sections of the CIS proposal. All updates, elaborations, and changes in the outline (i.e. information not in the original proposal) are colored in red. These updates override the original proposal excerpts.

CIS Graduate Program Faculty: There are *core* and *affiliate* faculty members, listed below (* = core member). Core faculty may be primary advisors to CIS graduate groups, whereas Affiliate faculty may only serve on advisory committees. New core and affiliate members may join by a majority vote of the core CIS faculty.

Ardell
Carreira-Perpiñán
Carpin
Chen
Dale*
Heit*
Kallmann
Kello*
Maglio*
Matlock*
Newsam
Nicholson
Noelle*
Spivey*
Vanderschraaf
Yoshimi*
Warlaumont*
Westerling

Program Committees: There are four possible standing committees for administering the program—the Executive, Educational Policy, Graduate Advising, and Admissions committees. Currently, only the Executive Committee is constituted, with the duties of the other committees carried by the Executive Committee. The Executive Committee consists of the Graduate Group Chair and two core CIS faculty members. The Chair is appointed by the Graduate Division, and the non-chair members are elected to one year, renewable, terms by the core CIS faculty. Current members are Chris Kello (Chair), Evan Heit, and Rick Dale. Terms are one year, renewable.

Graduate Student Committees: Each student must have a faculty advisory committee at all times while enrolled in the program. The first advisory committee is formed by the end of the first semester of the first year. It consists of the student's primary advisor plus two other faculty members who agree to serve. The advisory committee becomes the candidacy exam committee when the exam is taken. The student may optionally initiate a change in the committee membership prior to the exam. After passing the exam, the advisory committee becomes the student's dissertation committee.

Coursework: CIS students must satisfy the following course requirements for their Ph.D. degrees. When necessary, students may consult with their advisors and advisory committee to identify particular courses that satisfy the requirements. All of the courses below must be at least 3 units. These requirements override those from the original proposal (see below), allowing for more flexibility. Where necessary, students work with their advisory committee to choose courses that satisfy these requirements.

- *Cognitive Science Foundations I & II* courses (COGS 201 & 202)
- During each semester in residence at UCM, enroll in *Cogsci Graduate Seminar* (COGS 250)
- One graduate level course in methods, statistics, or data analysis
- One graduate level course in computational modeling
- Two elective graduate level courses

Annual Progress Report. Students must submit a brief report at the end of each year that catalogs the achievements of the year, and comments on progress and any obstacles to progress, as well as plans for the upcoming year. Progress reports will be reviewed collectively by the CIS faculty, and each student will receive a memo that comments on their progress. Progress reports are due at the end of Spring semester (unless specified otherwise), and students will receive their memos no later than the beginning of the following Fall semester.

1st and 2nd Year Research Projects: Each student must give a talk on a research project they are working on at the end of their first year, and at the end of their second year. Unless otherwise arranged, first and second year talks will occur on the same day near the end of the semester, such as the 2nd Friday of May, in a mini-conference format attended by CIS members. Students must also write a research report each year (no less than 10 pages). All 1st year reports will be due shortly after the day of presentations (e.g. last Friday of May, to allow time for revision based on feedback), and all 2nd year reports will be due shortly beforehand (e.g. first Friday of May, to give faculty advisors time to review it before talks). Advisory committees will evaluate reports and presentations in terms of progress towards professional academic work in one or more areas of cognitive science. 1st year reports will be given a grade of Pass, Conditional Pass, or Fail, whereas 2nd year reports alternatively may be given Revise and Resubmit as a grade, allowing for rounds of revision. Faculty must provide the first round of feedback by one month from submission of their respective reports, and the final grade by three months from submission.

Present an open *Technical Seminar* at least once prior to graduation. The seminar may be given in any scholarly public venue that is approved by the student's advisory committee at the time. At least one CIS faculty member must be present at the seminar.

Complete the equivalent of at least 2 semesters of TA appointment, where each is a "full" TA (50% appointment). 25% appointments may be aggregated to form the equivalent of two semesters at 50% in order to satisfy this requirement.

Integrative Review Papers. Students must receive passing grades on two integrative review papers (no less than 20 pages each, ~30 references each) submitted to their advisory committee, normatively at the end of 3rd year in residence. Each must cover three of six topics identified in the proposal sections

included below, and all six topics must be covered across the two papers. The advisory committees use the same evaluation process as for 2nd year projects.

Ph.D. Candidacy Examination. Students must pass a candidacy exam, typically in the third or fourth year, in order to begin work on their dissertation. The exam consists of a written dissertation proposal (about 30 pages in length) and an oral defense of the proposal, which takes place privately with the student's advisory committee. The oral defense may also include general questions about topics in cognitive science covered in the student's integrative review papers.

Ph.D. Dissertation. Students must successfully complete a written doctoral dissertation containing an original contribution to scientific knowledge in some domain within cognitive and information sciences. The dissertation should contain material of a quality that is worthy of scholarly publication, and must be formatted according to campus guidelines for dissertation manuscripts. The student must also give an oral presentation of the dissertation that is open to the campus community, and the presentation is followed by a private session of questions and discussion with the advisory committee.

CIS CCGA Proposal Excerpts Relevant to Program Requirements

1.7 Program Administration

The UCM Graduate and Research Council oversees the graduate programs on campus, and it will be asked to review this proposal and, when satisfied, provide a letter of support. The CIS program bylaws (see Appendix E) establish program oversight and resource allocation by an academic Dean. The Dean of SSHA (currently Mark Aldenderfer) will serve this role. The academic program and admissions process is administered by UCM Graduate Division (headed by the Dean of Graduate Studies, currently Sam Traina). The SSHA Graduate Coordinator (currently Mitch Ylarregui) helps graduate students with academic administrative matters as well as with GRS and TA paperwork. The Coordinator also assists the CIS Admissions Committee with the admission process and recruiting.

Program Learning Outcomes

1. Understanding foundational concepts in cognitive and information sciences. Introductory understanding is assessed by student performance in required foundation courses. More advanced understanding is demonstrated in the literature reviews contained in each student's First Year Research Report and Second Year Research Report. Mastery is assessed in the two required Integrative Review Papers.
2. Skillful use of foundational methods in cognitive and information sciences. Introductory understanding is evaluated in the computational and experimental methods employed in the First Year Research Report and the Second Year Research Report. More advanced understanding and mastery is assessed during the Candidacy Examination and evaluation of the Thesis Proposal.
3. Scientific communication skills. Introductory written skills are demonstrated in the First Year Research Report and the Second Year Research Report. More advanced writing skills are assessed in the clarity of the Integrative Review Papers and Thesis Proposal. Mastery is demonstrated in the Dissertation. With regard to oral communication, introductory level skills are demonstrated in the First Year Research Presentation and the Second Year Research Presentation. More advanced skills are demonstrated during the oral Thesis Proposal presentation, and mastery is assessed in the required technical seminar and Thesis Defense.
4. Ability to integrate knowledge across the disciplines that compose cognitive and information sciences. Interdisciplinary thinking is initially assessed in the Integrative Review Papers. More advanced interdisciplinary thinking is assessed in the Candidacy Examination, including the literature review and methods portions of the Thesis Proposal. Mastery is demonstrated in review portions of the Dissertation and Thesis Defense.
5. Expertise in a specific scientific domain. Expertise in the student's chosen specific field of study is initially assessed, at an introductory level, through the Integrative Review Papers. More advanced expertise is assessed in the Thesis Proposal and performance on the Candidacy Examination. Mastery is necessary for successful completion of the Dissertation and Thesis Defense.

2.2 Overview of Requirements for the CIS Doctor of Philosophy Degree

To be awarded the degree of *Doctor of Philosophy in Cognitive and Information Sciences*, students must meet a range of requirements designed to ensure their mastery of this interdisciplinary field. These requirements include a period of residency, the successful completion of coursework, exhibitions of ability to present research results, and competent performance on an extensive Candidacy Examination. The Doctor of Philosophy degree is not granted by the University of California merely for the fulfillment of technical requirements, such as residence or the completion of fundamental courses, however. In general, the recipient of a Ph.D. degree is understood to possess thorough knowledge of a broad field of learning and to have demonstrated evidence of distinguished accomplishment in that field; the degree is warrant of critical ability and powers of imaginative synthesis. The degree also signifies that the recipient has presented a doctoral dissertation containing an original contribution to knowledge in his or her chosen field of study. Ultimately, the quality of the dissertation and the qualifications of the candidate for the Ph.D. in CIS are determined by a faculty committee convened to provide such an evaluation to the Dean of Graduate Studies.

In general, students seeking a Ph.D. degree in CIS must satisfy all of the requirements for a Ph.D. degree specified by the Graduate Division of the University of California, Merced. These include residency requirements and scholarship requirements, including a minimum grade-point average (GPA). These requirements are described in detail in the *Graduate Advisors Handbook*, available from the Graduate Division. In addition to these general requirements, students must satisfy a range of program-specific requirements in order to be awarded a Ph.D. in CIS. These additional requirements are described in the sections that follow.

2.2 Faculty Guidance and Oversight of Student Progress

Each student pursuing a Ph.D. degree in CIS receives regular guidance and evaluative feedback from a Primary Research Adviser and a faculty oversight committee. While students typically work with a single Primary Research Adviser throughout their graduate studies, the composition and role of the faculty oversight committee changes as the student advances through the program.

Incoming students typically identify a Primary Research Adviser upon commencement of their studies, with the process of negotiating this working relationship often taking place prior to enrollment in the program. The appointment of a faculty member as a student's Primary Research Adviser must be approved by the student, by the faculty member in question, and by the program's Admissions Committee. In the unusual situation in which a student begins studies without a Primary Research Adviser, the Admissions Committee will appoint a faculty member to play this role in an interim fashion, though faculty members may decline such appointments. The Admissions Committee communicates the establishment of adviser-student relationships to the program's Graduate Advising Committee.

Either the student or the Primary Research Adviser may unilaterally terminate the adviser-student relationship at any time by formally communicating such an intention to the Graduate Advising Committee. Such a separation is to be avoided, however, as any student without a Primary Research Adviser cannot meet any of the formal program requirements (other than the completion of course

work) and is generally considered to be in poor standing. Students may switch to a new Primary Research Adviser, however, with the approval of the student, the new faculty adviser, and the Graduate Advising Committee.

Early in a student's program of study, faculty guidance is available from the student's Faculty Advisory Committee. Each Faculty Advisory Committee consists of the student's Primary Research Adviser and two additional faculty members associated with the CIS graduate group. Members of this committee are to be determined through informal negotiations during the student's first semester in residence, with approval required from the student, the student's Primary Research Adviser, the nominated committee members, and the program's Graduate Advising Committee. A student's Faculty Advisory Committee may be reconstituted at any time, upon approval by the Graduate Advising Committee. Each Faculty Advisory Committee is charged to provide guidance to the student related to the meeting of program requirements and general professional development. This committee also evaluates student progress on a regular basis, as described in the following sections of this document.

When a student begins preparations for her or his Candidacy Examination, an Examination Committee must be established for the student. Like the Faculty Advisory Committee, this committee must consist of the Primary Research Adviser and two other program faculty members, though additional faculty may be invited to join the Examination Committee beyond these minimal requirements. While it is not required, it is generally desirable for the Examination Committee to be identical in membership to the later constituted Dissertation Committee, described below, and members should be selected with this goal in mind. The members of the Examination Committee must be approved by the student, the Primary Research Adviser, the nominated committee members, the program's Graduate Advising Committee, and, additionally, by the Dean of Graduate Studies. The primary charge of the Examination Committee is to evaluate student performance on the Candidacy Examination. This faculty group also acts as the student's Faculty Advisory Committee from the time it is constituted until a Dissertation Committee is established.

Once a student advances to candidacy, a formal Dissertation Committee should be constituted, providing oversight through the remainder of the student's graduate education. The Dissertation Committee must minimally consist of the Primary Research Adviser, at least two additional faculty members associated with the CIS program, and at least one faculty member *not* formally associated with the CIS graduate group. This last "outside member" may be a UCM faculty member unaffiliated with CIS, or, more commonly, may be a researcher from another institution. Such outside members are expected to possess a Ph.D. degree, or equivalent, in a relevant field. The membership of the Dissertation Committee must meet the approval of the student, the Primary Research Adviser, the nominated members, the program's Graduate Advising Committee, and the Dean of Graduate Studies. In addition to officiating at the student's Thesis Defense, the Dissertation Committee acts as the student's Faculty Advisory Committee once it is constituted. A student's Dissertation Committee may be reconstituted if appropriate cause can be documented (e.g., a faculty member has moved, changed positions, or is otherwise unavailable for guidance), with the approval of the program's Graduate Advising Committee and the Dean of Graduate Studies.

In summary, once an initial Faculty Advisory Committee is established during the first semester in residence, each student should persistently have access to a committee consisting of at least three CIS program faculty members to provide guidance and oversight for the full duration of the student's graduate education.

2.3 Overview of Program-Specific Requirements & Evaluation of Student Progress

In addition to general University requirements, each student enrolled in this program must satisfy the following requirements in order to be awarded the Ph.D. degree in CIS:

• Complete at least six semesters of full-time academic residence at UCM.

• Complete the *Cognitive Science Foundations I & II* courses (COGS 201 & 202), earning a letter grade no lower than "B" in each course.

• During each semester in residence at UCM, enroll in the *Cognitive Science Graduate Seminar* (COGS 250), which includes participation in the *Mind, Technology, & Society Seminar Series*, earning a passing grade during each enrolled semester.

• Complete a graduate level course in statistics or data analysis (e.g. *Advanced Psychological Statistics*, PSY 202A), earning a letter grade no lower than "B" in the course.

• Complete COGS 206, *Computational Modeling Foundations*, earning a letter grade no lower than "B" in the course.

• Complete at least two additional graduate level courses, with each course offering a minimum of 3 units, earning a letter grade no lower than "B" in each course.

• Complete at least two semesters as a full-time teaching assistant.

• Successfully produce a written *First Year Research Report* and deliver a *First Year Research Presentation* before the end of the first year in academic residence at UCM.

• Successfully produce a written *Second Year Research Report* and deliver a *Second Year Research Presentation* before the end of the second year in academic residence at UCM.

• Successfully deliver a full *technical seminar*, open to the UCM community, at least once while in residence at UCM.

• Successfully complete a pair of *Integrative Review Papers* before the end of the third year in academic residence at UCM.

• Pass the Ph.D. *Candidacy Examination*, which includes the successful defense of a formal proposal of research to be completed for the doctoral dissertation.

• Produce, present, and successfully defend a doctoral dissertation containing an original contribution to scientific knowledge in some domain within cognitive and information sciences.

Specific criteria for satisfaction exist for each of these requirements, as described in more detail in the following sections. In addition to these evaluative criteria, general student progress is regularly assessed by means of an Annual Progress Report, submitted by the student. The progress report is a written narrative that summarizes all of the student's activities, accomplishments, and evaluations (e.g. grades, journal reviews, grant reviews, etc.) for the immediate preceding year. Each student submits the progress report to his or her Faculty Advisory Committee on September 1st of each year, covering the prior 12 month period from July 1 to June 30. The committee reviews the report and summarizes their feedback to the student in a written Annual Review Memo, which is provided to the student and to the program's Graduate Advising Committee. The student's Faculty Advisory Committee may also meet with the student to discuss the Progress Report, at the committee's discretion. Annual Review Memos should be disseminated by October 1st of each year.

In general, satisfactory progress is defined relative to meeting the requirements outlined above in the normative time frame outlined in Sections 2.12 and 2.13 below. The Annual Review Memo should clearly communicate whether student progress is or is not satisfactory relative to these requirements and normative time frame expectations. If a student does not demonstrate satisfactory progress, the memo should clearly state the actions that the student must take to achieve satisfactory progress. The following year's Annual Progress Report and Annual Review Memo should, then, address whether the prescribed actions were or were not taken, and whether they resulted in satisfactory progress.

The program requirements listed above apply to all students pursuing a Ph.D. in CIS, but some exceptional circumstances may warrant an adjustment to these requirements for specific students. Any modifications to these requirements for individual students may be requested by petition, with such petitions requiring approval by the student's Faculty Advisory Committee (or, if constituted, the student's Examination Committee or Dissertation Committee), as well as the program's Graduate Advising Committee.

2.4 Residency Requirements

The minimum residency requirement for the Ph.D. degree in CIS is six semesters. In addition, before advancing to candidacy, Ph.D. students must be registered in University courses as a full-time student for at least four semesters. Residency is established by satisfactory completion of at least one upper division or graduate course of four units or more per term.

2.5 Coursework Requirements

Students enrolled in this Ph.D. program are expected to acquire and demonstrate broad knowledge of core theories and methods from the full range of disciplines that contribute to cognitive and information sciences. Graduate courses are delivered in order to assist with this learning process. While some courses are mandatory for all students, there is a considerable amount of flexibility in the coursework requirements of the program. Each student is expected to assume responsibility for the design of a personal curriculum that will develop graduate-level competency in both a focal area of research and in the area of CIS, broadly construed. Faculty advisers should be regularly consulted as this personal curriculum is shaped.

Every student enrolled in the Cognitive Science Ph.D. program must complete the following courses: *Cognitive Science Foundations I* (COGS 201, *Cognitive Science Foundations II* (COGS 202), *Advanced Psychological Statistics* (PSY 202A or equivalent), and *Computational Modeling Foundations* (COGS 206, course under development). Each of these courses must be taken for a letter grade, and a grade no lower than "B" must be earned in each course in order to satisfy this requirement. In addition, every student is expected to complete at least two additional graduate level courses (with each course granting no fewer than 3 units), enrolling in the courses for a letter grade and earning a grade no lower than "B" in each. These two additional courses must be "regular courses" listed in the UCM General Catalog and not courses offering "independent study", "guided research", "talk series", "reading group", or the like. For example, topics classes, like COGS 269 or 285, may be used to satisfy this requirement. However, one may not use seminars like COGS 250, and research courses like COGS 295, COGS 298, and COGS 299. Importantly, graduate level courses offered outside of the CIS program, but in a related field, may be used to satisfy this requirement. For example, students might partially fulfill this requirement with a course in *Developmental Psychology* (PSY 230) or with a course in *Machine Learning* (EECS 276).

In addition to these course requirements, every CIS Ph.D. student must enroll in the *Cognitive Science Graduate Seminar* (COGS 250) during every semester of academic residency. This course, which includes the *Mind, Technology, & Society Seminar Series*, is seen as a central component of the CIS Ph.D. program. The reason is that it exposes students to a broad range of contemporary CIS research topics and provides interdisciplinary education.

2.6 Teaching Requirements

To receive a Ph.D. in CIS from UCM, students must complete at least two semesters employed as a full-time teaching assistant (as with other requirements, a student's Dissertation Committee may waive or replace this requirement if, e.g. the student has a 4 or 5 year fellowship, or assistantships are unavailable). Students enrolled in this program typically act as teaching assistants for undergraduate Cognitive Science courses offered by the School of Social Sciences, Humanities, & Arts (SSHA). Each student is responsible for actively pursuing the required teaching assistant appointments through interactions with faculty advisers and appropriate administrative staff in the CIS group as well as in SSHA. Work as a UCM teaching assistant in another area related to CIS may also be applied to this requirement. This includes areas administered inside of SSHA, such as management or philosophy, as well as areas administered outside of SSHA, such as biology or computer science. In the context of this requirement, a "full-time" teaching assistantship is an appointment involving the maximum allowed hours for an enrolled Ph.D. student (e.g., 49.9% time).

2.7 Research Report Requirements

Students enrolled in the CIS Ph.D. program must submit two written research progress reports in their first two years in residence. Specifically, a *First Year Research Report* must be produced by the end of the second semester in residence, and a *Second Year Research Report* must be produced by the end of the fourth semester in residence. Each of these reports should describe the central research activities of the student since beginning the CIS Ph.D.program. Typically, the *First Year Research Report* will describe

results from initial original experiments associated with a broader research program, or, at a minimum, provide a detailed plan for the execution of such experiments. The *Second Year Research Report* is expected to include original experimental results relevant to the student's line of research.

Each report is to be formatted in a manner consistent with submission for academic publication. The papers are to be double-spaced, with margins no larger than 1.5 inches, in a font no smaller than 12 point, and no less than 10 pages in length. Each student is responsible for delivering copies of their reports to each member of his or her Faculty Advisory Committee by the last day of instruction (i.e., prior to finals week) of the appropriate spring semester. Thus, the *First Year Research Report* must be delivered by the last day of instruction of the student's second semester in residence, and the *Second Year Research Report* must be delivered by the last day of instruction of the student's fourth semester in residence. First and second year research reports are expected to serve as the bases for conference proceedings submissions (e.g. to the Annual Meeting of the Cognitive Science Society) or journal articles.

The members of a student's Faculty Advisory Committee will confer to evaluate each research report. Typically, this evaluation is performed after the student has had an opportunity to present her or his work orally, as described in the next section of this document. The Faculty Advisory Committee may score a research report as satisfactory for meeting requirements or as unsatisfactory. Committee members are strongly encouraged to deliberate until a unanimous decision with regard to this score is reached, but, in the case of an impasse, the opinion of the simple majority of committee members will determine the assigned score. If a report is found to be unsatisfactory, the Faculty Advisory Committee has the option of allowing a single resubmission of the research report, with the resubmission delivered to the committee prior to the onset of the subsequent semester (i.e., the third semester in residence for the *First Year Research Report* and the fifth semester in residence for the *Second Year Research Report*). Only a single resubmission is allowed, and this resubmission is at the discretion of the committee. While the full membership of the Faculty Advisory Committee is responsible for evaluating any resubmitted report, the committee may delegate this responsibility to the Primary Research Advisor if specific concrete criteria for improvement over the initial submission can be specified. The final evaluation of the committee will be recorded and taken into account when the student is considered for advancement to candidacy. The evaluation of the committee, along with any detailed comments on the research report, will be communicated to the student no later than the end of the first week after the official end of the spring semester in which the report was submitted, or, in the case of resubmissions, no later than the end of the second week of instruction of the subsequent semester.

2.8 Research Presentation Requirements

To be awarded the CIS Ph.D. degree, students must successfully deliver three oral presentations communicating their own research progress, in addition to the presentations incorporated into other program examinations, such as the *Candidacy Examination* and the *Thesis Defense*. These three presentations are the *First Year Research Presentation*, the *Second Year Research Presentation*, and a later *Technical Seminar*.

The *First Year Research Presentation* involves a short (e.g., 20 minute) oral description of the primary

research work conducted by the student during the first year of academic residence at UCM. This presentation should report the results of initial experiments associated with a broader research program or, at a minimum, provide a detailed plan for the execution of such initial experiments. In most cases, the work reported should be coextensive with that appearing in the student's written *First Year Research Report*, described in the previous section. This presentation must take place prior to the completion of the first full year in academic residence at UCM, but it is typically performed during a day, late in the spring term, specifically scheduled for graduate student presentations. Thus, students are typically expected to deliver this presentation before the end of their second semester in academic residence. Presentations of this kind are typically open to the UCM CIS community, but a minimum of three CIS program faculty members must be present in order to satisfy this requirement.

The *Second Year Research Presentation* involves a longer (e.g., 45-50 minute) oral description of the student's research activities during the first two years of academic residence at UCM. This presentation is expected to include the results of initial experiments associated with a broader research program, and the work reported should generally be coextensive with that appearing in the student's written *Second Year Research Report*. This presentation must take place prior to the completion of the second full year in academic residence at UCM. Presentations of this type are generally scheduled for late in the spring term, however, so students are typically expected to deliver this presentation before the end of their fourth semester in academic residence. These presentations are typically open to the UCM CIS community, but a minimum of three CIS program faculty members must be present in order to satisfy this requirement.

In addition to these two research presentations, and in addition to presentations incorporated into the Candidacy Examination and the Dissertation Defense, each student is required to deliver at least one *technical seminar* that is open to the full UCM community. This seminar is expected to fill most of an hour (e.g., 45-50 minutes), and it is expected to be accessible to a broad CIS audience. Typically, this seminar should report original research findings arising from the student's own research activities. Alternatively, the presentation may involve a detailed review of existing work in some area of interest to cognitive scientists. Presentations of this kind are often delivered as part of the regular *Mind, Technology, & Society Seminar Series*. A minimum of three CIS program faculty members must be present in order to satisfy this requirement.

The topics and general content of all three of these presentations are to be determined in negotiation between the student and the members of the student's Faculty Advisory Committee. The scheduling of presentations is to arise from negotiations between the student, the members of the student's Faculty Advisory Committee, and other faculty members of the CIS program, as appropriate. For example, the program faculty may select a date late in the spring term during which all *First Year Research Presentations* for that year are to be delivered. As another example, the faculty member organizing the *Mind, Technology, & Society Seminar Series* for a given semester must approve of any student-led *technical seminars* to be included in that series during that semester. Ideally, all members of a student's Faculty Advisory Committee would attend any required presentation made by the student, but this is not always feasible. Instead, a minimum of three CIS program faculty members must attend a presentation in order for the presentation to satisfy a program requirement.

2.9 Integrative Review Paper Requirements

Graduates of the Ph.D. program in CIS are expected to possess a broad understanding of the full range of theories and methods employed in this interdisciplinary field. In order to assess the breadth of student knowledge, and in order to encourage an integrated view of the varied contributions that different disciplines make to cognitive and information sciences, each student must compose two *integrative review papers*. Each of these papers is to take the form of either a "review-and-synthesis" report or a formal research proposal. Each paper is normally required to substantially incorporate theories and/or methods from at least three of the following six disciplines, with all six disciplines playing a role across the two papers:

- Computational Modeling
- Cognitive Engineering
- Linguistic Analyses
- Behavioral Science
- Neuroscience
- Philosophical Methods

Thus, all six disciplines will be significantly represented in at least one of each student's integrative review papers, allowing for an assessment of the student's breadth of knowledge. Also, each paper will involve the integration of at least three of these disciplines, encouraging students to develop a truly interdisciplinary perspective of cognition. (Under exceptional circumstances, with the unanimous approval of the student's Faculty Advisory Committee, a student may opt to cover a total of only five out of the six disciplines.) The specific topics to be addressed in each paper are to be determined by the student in concert with the members of the student's Faculty Advisory Committee.

Each paper is to be formatted in a manner consistent with submission for academic publication. The papers are to be double-spaced, with margins no larger than 1.5 inches, in a font no smaller than 12 point, and no less than 20 pages in length. Each paper should reference at least 30 previous publications or other informational sources. Each paper is to reflect the individual understanding and solitary effort of its student author. While members of the student's Faculty Advisory Committee may be consulted for guidance, and other researchers may act as sources of information, the content of each submitted paper is to be composed by the student, alone. Students are expected to strive to produce documents of the highest quality, both in terms of scholarship and in terms of presentation. It is anticipated that at least one of these two papers will be revised and expanded by the student in order to produce a publishable manuscript, allowing this requirement to act both as a program milestone and a means for strengthening the student's academic credentials.

The topics of both *Integrative Review Papers* are to be determined at the beginning of the student's fifth semester of academic residency at UCM. Specifically, by the end of the first week of instruction of the fall semester of the student's third year of residency, the student is required to submit a brief description of proposed topics to the members of her or his Faculty Advisory Committee. The Faculty Advisory Committee, in turn, is to respond with assigned topics for the papers, guided by the student's suggestions. These topics are to be delivered to the student no later than the end of the second week of

instruction of the fall semester. Students are expected to spend a substantial portion of their fifth semester in residence producing these two documents. The final drafts of these papers must be delivered to the members of the student's Faculty Advisory Committee by the last day of instruction (i.e., prior to finals week) of the fall semester. It is the student's responsibility to ensure that these documents are delivered in a timely fashion. By the end of the first week of instruction of the subsequent spring semester, the student's Faculty Advisory Committee is expected to deliver detailed comments on both papers to the student, along with a clear indication if the submissions are seen as meeting expectations for this requirement. While the committee is to strive to reach a unanimous decision with regard to this evaluation, the opinion of a simple majority of committee members is sufficient to determine if the submitted papers satisfy this requirement.

At the discretion of the committee, students may be allowed to resubmit one or both of their *Integrative Review Papers*, if the initial submissions fail to meet expectations. Resubmissions must be delivered to the student's Faculty Advisory Committee prior to the beginning of the Spring Recess of the student's sixth semester of residence, and the members of the committee are expected to provide feedback and a reevaluation of the student's performance no later than two weeks after the delivery of the resubmitted papers. While the full membership of the Faculty Advisory Committee is responsible for evaluating any resubmitted paper, the committee may delegate this responsibility to the Primary Research Advisor if specific concrete criteria for improvement over the initial submission can be specified. The final evaluations of the Faculty Advisory Committee, along with specific comments provided to the student, are recorded for review when the student is considered for advancement to candidacy.

2.10 Ph.D. Candidacy Examination

All students in the CIS Ph.D. program are required to pass a Candidacy Examination prior to advancement to candidacy for the Ph.D. degree. The Candidacy Examination is normally taken after the completion of a majority of formal coursework, as well as after the successful delivery of both *Integrative Review Papers*. It is expected that students will complete the Candidacy Examination prior to the beginning of their seventh semester in academic residence (excluding summer semesters) at UCM. The Candidacy Examination has three basic purposes. First, it is intended as a test of the breadth of knowledge of the student, providing a forum for interactive challenges to the student's mastery of core cognitive science concepts and methods. Second, it determines if the student possesses the knowledge and skills needed to successfully complete a dissertation research project in their chosen area of interest. Third, and lastly, it provides a means for providing constructive criticism of the student's plan for his or her dissertation research. In pursuit of these three goals, the Candidacy Examination includes both a written component and an oral component. The written component involves the composition of a formal dissertation research proposal, including a review of the relevant literatures. The oral component includes an interactive test of the student's knowledge, in both breadth and depth, and a constructive critique of the student's research proposal. The examination is officiated by the student's Examination Committee, which determines, based both on examination performance and previous academic record, whether or not to recommend the student for advancement to candidacy.

2.10.1 Dissertation Research Proposal. Each student must prepare a document proposing a specific plan for her or his dissertation research. This document is expected to make a convincing case that the proposed research is likely to make an original contribution to human knowledge, is of sufficient interest to be worthy of pursuit, and is feasible given the student's skills, time constraints, and available resources. In order to defend the novelty of the research, as well as explain its significance, this document should include a substantial review of the literatures that are directly relevant to the proposed dissertation project. In order to justify the feasibility of the proposal, the document should include an overview of progress to date, as well as a detailed description of the research yet to be completed, along with an estimated schedule for the component tasks. Depending on the scope of the proposed dissertation project, the proposal document need not be long (e.g., typically about 30 double-spaced pages), but it should make a clear case for the program of work. The document should be double-spaced, with margins no larger than 1.5 inches, and in a font no smaller than 12 point. The topic of the dissertation research proposal is to be determined by the student in negotiation with his or her Primary Research Adviser. The document must be approved by the Primary Research Adviser before it is delivered to the other members of the Dissertation Committee. Informal feedback on this document may be provided by Dissertation Committee members prior to the oral component of the Candidacy Examination, but the primary forum for feedback is to be the oral defense of the proposal. Thus, the negotiated date of the oral component of the Candidacy Examination must allow at least two weeks for the Dissertation Committee to evaluate the dissertation research proposal document.

2.10.2 Oral Candidacy Examination. In order to advance to candidacy, each student in the CIS Ph.D. program must pass an oral Candidacy Examination, including an oral defense of his or her written dissertation research proposal. The oral component of the Candidacy Examination is to be scheduled by consensus of the student and the members of the student's Examination Committee. The examination meeting must not take place earlier than two weeks after the dissertation research proposal has been delivered to the members of the Examination Committee, however. Also, this meeting must be held before the beginning of the student's seventh semester in residency at UCM (excluding summer semesters). All members of the Examination Committee must either be physically present at the Candidacy Examination meeting, or must be able to robustly interact with physically present participants through the use of sufficiently high bandwidth telecommunication technologies. (The central participants, including both the members of the Examination Committee and the student being examined, must be unanimous in their acceptance of any telecommunication surrogate for physical presence.) The format of the oral Candidacy Examination is to be determined by the Examination Committee. For example, it may include a presentation by the student, but it need not. If the student is to prepare a presentation, or any other specific material, for this examination, the Examination Committee must communicate these expectations to the student no later than one week prior to the examination date. The meeting may be made open to the UCM CIS community, or to the broader University community, in full or in part, upon unanimous consent of the members of the Examination Committee. At minimum, students should expect to be questioned by members of the Examination Committee on the following topics:

- general knowledge of CIS concepts and methods

- contents of coursework completed by the student
- material related to the two *Integrative Review Papers* prepared by the student
- material related to the written dissertation research proposal submitted by the student

The oral Candidacy Examination is to last no more than three hours, including deliberations. Once all members of the Examination Committee are satisfied with the questions that have been presented, the Examination Committee must meet in private in order to deliberate and determine the results of the examination. The results of these deliberations should be communicated to the student being examined as soon as possible, usually immediately upon their completion. The conclusions of the Examination Committee should be communicated to the Dean of Graduate Studies, using the forms provided by the Graduate Division.

2.10.3 Candidacy Examination Outcomes. In private deliberations, the Examination Committee must determine the outcome of the Candidacy Examination, and it must determine if the student is qualified to advance to candidacy. There are three possible outcomes for the Candidacy Examination: Pass, Conditional Pass, and Fail.

An outcome of "Pass" is unconditional. The student cannot be required to satisfy any other conditions before obtaining the benefits of passing this examination. A "Conditional Pass" is treated as a "Pass" outcome as soon as the student satisfies certain specific conditions detailed by the Examination Committee at the time of the assignment of the "Conditional Pass" outcome. Acceptable conditions include the successful completion of prescribed courses and the rewriting of the dissertation research proposal. A student who receives a "Fail" outcome may repeat the Candidacy Examination after a preparation time of no less than three months. Typically, a new dissertation research proposal is prepared for the repeated examination, but the original document may be used with the unanimous consent of the members of the Examination Committee. The repeated examination must be officiated by the same Examination Committee, though members of this committee may be replaced, with the approval of the Primary Research Adviser, if cause, such as extended absence from campus, is demonstrated and documented. Failure to pass the examination upon a second attempt disqualifies the student from further study toward the doctoral degree. The Examination Committee must reach a unanimous decision with regard to the outcome of this examination.

If the exam is passed, the Examination Committee immediately extends its deliberations to determine if the student should be advanced to candidacy, as described in the next section. If the exam is initially failed, the result (as always) is immediately communicated to the student, and planning should begin for a repeated examination. If the exam is then failed again, the result is immediately communicated to the student, as well as to the Dean of Graduate Studies. If the exam is passed conditionally, a document detailing the conditions to be met by the student should be provided to the student within one week of the examination. Once these conditions are met, the Examination Committee confers to determine if the conditions have been satisfied and if the student should be advanced to candidacy, as described in the next section.

2.10.4 Advancement to Candidacy. Once a student is awarded a "Pass" outcome on the Candidacy

Examination, she or he should be promptly considered for advancement to candidacy. In order to advance to candidacy, each student must satisfy the following requirements:

- Complete at least four semesters of academic residency at UCM.
- Complete the *Cognitive Science Foundations I & II* courses (COGS 201 & 202), earning a letter grade no lower than "B" in each course.
- Complete a graduate level course in *Advanced Psychological Statistics* (PSY 202A), earning a letter grade no lower than "B" in the course.
- Complete at least two additional graduate level courses, with each course offering a minimum of 3 units, earning a letter grade no lower than "B" in each course.
- Receive a "Pass" outcome on the Candidacy Examination.

These criteria are generally unambiguous, though the final requirement demands a comprehensive evaluation by the members of the Examination Committee prior to the Candidacy Examination. Committee members should evaluate the relevant portions of the student's academic record, the quality of the written and oral research reports delivered by the student during her or his first two years of academic residency, the student's performance on the *Integrative Review Papers*, and an overall assessment of the student's potential for scholarly research. The Examination Committee should strive to reach a unanimous decision concerning advancement to candidacy. If it is not possible for the members of the committee to resolve their differences, a vote shall be taken, with a simple majority of the committee members determining the outcome. If such a vote is divided, committee members may provide a written minority report to be included in the *Application for Advancement to Candidacy* delivered to the Dean of Graduate Studies.

If the Examination Committee decides to recommend advancement to candidacy, the student must take and pass the Candidacy Examination, which is then also evaluated by the Examination Committee as above. If the Examination is passed, committee members must sign an *Application for Advancement to Candidacy* prepared by the student under consideration. This form must also be signed by the Chair of the CIS Graduate Group before being submitted to the Dean of Graduate Studies for approval.

Once a student has advanced to candidacy, the student's Dissertation Committee is charged to guide the student in research and in the preparation of his or her dissertation.

Students enrolled in the CIS Ph.D. program must advance to candidacy before the beginning of their ninth semester in academic residence at UCM.

2.11 Ph.D. Dissertation & Thesis Defense

The final and central requirement for awarding the CIS Ph.D. degree is the completion of a substantial and original independent research project. The successful completion of this requirement is demonstrated through the production of a dissertation document, describing the research project and its results, and the defense of the project from challenges offered by the members of the student's faculty Dissertation Committee. The quality of the dissertation and the defense of its thesis are evaluated by the Dissertation Committee in order to determine if the student has successfully completed this final requirement for the Ph.D. degree in CIS.

2.11.1 Dissertation Document

The Ph.D. dissertation must be a creative and independent work that can stand the test of peer review. The research described in this document must be original and defensible. The expectation is that the dissertation will serve as the basis for at least one publication in a peer-reviewed journal. The reported work and the written composition must be the student's own, though the student is encouraged to discuss both the substance and the preparation of the dissertation with the members of her or his Dissertation Committee well in advance of its final defense.

While the dissertation document is expected to provide a complete and comprehensive characterization of the student's Ph.D. research project, there are no universal requirements concerning the format of this document. Each student's Primary Research Adviser is responsible for providing structuring and formatting guidelines for the dissertation document.

Once the dissertation document is complete in the opinion of the student and the student's Primary Research Adviser, the student must provide a copy of the dissertation to each member of her or his Dissertation Committee. Each committee member must be given at least two weeks to read the dissertation and provide informal comments on it before a date may be scheduled for the thesis defense. Also, if one or more committee members find that there are significant errors or shortcomings in the dissertation, or that the scope or nature of the work is not adequate, the student must address these shortcomings before scheduling the defense. Once all of the committee members agree that the dissertation is ready to be defended (though minor errors or matters of controversy may still exist), the defense date may be scheduled.

2.11.2 Thesis Defense

The Ph.D. thesis defense consists of an open seminar on the dissertation work followed by a closed examination conducted by the Dissertation Committee. During the examination, the student is expected to explain the significance of the dissertation research, justify the methods employed, and defend the conclusions reached.

The thesis defense cannot be scheduled until all members of the Dissertation Committee have read the dissertation and agreed that it is ready to be defended. Once such an agreement has been reached, the student is expected to negotiate with the members of the Dissertation Committee in order to schedule a date and time for the defense. All members of the Dissertation Committee must attend the thesis defense, either through physical presence or through the use of a high-bandwidth telecommunications technology that is unanimously accepted by the student and all members of the Dissertation Committee. The thesis defense cannot extend beyond three hours, but a block of time of that size should be reserved for this event in every case. Once the date of the thesis defense is determined, this information must be reported to the Dean of Graduate Studies, and one copy of the dissertation must be filed with the Division of Graduate Studies no later than two weeks before the scheduled date of the thesis defense.

Immediately following the closed examination of the student by the Dissertation Committee, the

members of the Dissertation Committee shall meet in private in order to discuss the student's performance. At the conclusion of these deliberations, the committee shall vote on the question of whether both the written dissertation and the student's performance during the defense are of sufficient quality to warrant the awarding of a Ph.D. degree from the University of California. A simple majority is required to pass. Members of the committee may vote to make conferral of the degree contingent on corrections and/or revisions to the dissertation, however. In this case, the committee will select one member, normally the Primary Research Adviser, to be responsible for approving the final version of the dissertation that is submitted to Division of Graduate Studies. All members of the Dissertation Committee who voted to award the degree must sign the final dissertation.

2.12 Nominal Times to Ph.D. Degree

Students completing this Ph.D. program will be equipped for careers in research, teaching, and industry. The nominal time for completion of the Ph.D. degree for a student entering the program with a Master's degree in a relevant field is approximately 4 years. Students entering the program without a Master's degree typically will require an additional year of study. In some instances, a student may need to withdraw from the Ph.D. program for reasons unrelated to academic performance. If the student has satisfied all of her or his requirements except for completion of the dissertation, she or he may be considered for a Candidacy Degree in CIS (see below), at the discretion of the members of the student's Examination Committee.

2.13 Example Ph.D. in CIS Curriculum

The following is an example sequence of courses and activities, itemized semester-by-semester, that a graduate student might complete in pursuit of a Ph.D. degree in CIS.

YEAR 1

Fall Semester

COGS 201: Cognitive Science Foundations I [4 credits]
COGS 250: Cognitive Science Graduate Seminar [4 credits]
PSY 202A: Advanced Psychological Statistics [4 credits]
COGS 295: Graduate Research [4 credits]

Teaching Assistant for COGS 101: Minds, Brains, and Computation

Student discusses research topics with multiple potential faculty advisers.
Student begins progress on first-year research project.
Student submits application for an NSF Graduate Research Fellowship.

Spring Semester

COGS 202: Cognitive Science Foundations II [4 credits]
COGS 203: Introduction to Neural Networks in Cognitive Science [4 credits]
COGS 250: Cognitive Science Graduate Seminar [4 credits]
COGS 295: Graduate Research [4 credits]

Teaching Assistant for COGS 140: Perception

Student finalizes choice of Primary Research Adviser and establishes Faculty Advisory Committee.
Student prepares and delivers *First Year Research Report*.
Student prepares and delivers *First Year Research Presentation*.

YEAR 2

Fall Semester

COGS 250: Cognitive Science Graduate Seminar [4 credits]
COGS 269: Topics in Cognitive Science [4 credits]
COGS 295: Graduate Research [4 credits]

Teaching Assistant for COGS 105: Research Methods for Cognitive Scientists

Student continues research, perhaps including side projects.
With the help of the Primary Research Adviser, student rewrites *First Year Research Report* for submission to the annual meeting of the *Cognitive Science Society*.

Spring Semester

COGS 223: Computational Cognitive Neuroscience [4 credits]
COGS 250: Cognitive Science Graduate Seminar [4 credits]
COGS 295: Graduate Research [4 credits]

Teaching Assistant for COGS 103: Introduction to Neural Networks in Cognitive Science

Student prepares and delivers *Second Year Research Report*.
Student prepares and delivers *Second Year Research Presentation*.
Student begins to outline dissertation research project.
Student prepares topics for integrative review papers.
Student attends the annual meeting of the *Cognitive Science Society* during the summer.

YEAR 3

Fall Semester

COGS 250: Cognitive Science Graduate Seminar [4 credits]
COGS 295: Graduate Research [8 credits]

Teaching Assistant for COGS 123: Computational Cognitive Neuroscience

With the help of the Primary Research Adviser, student rewrites *Second Year Research Report* for submission to a scientific journal.

Student prepares two *Integrative Review Papers*.

Spring Semester

COGS 250: Cognitive Science Graduate Seminar [4 credits]
COGS 295: Graduate Research [8 credits]

Teaching Assistant for COGS 153: Judgment and Decision Making

Student prepares dissertation research proposal.
Student formally constitutes Dissertation Committee.
Student passes *Candidacy Examination* and advances to candidacy.
Student makes revisions to *Second Year Research Report* journal submission.
Student attends the annual meeting of the *Cognitive Science Society* during the summer.

YEAR 4

Fall Semester

COGS 250: Cognitive Science Graduate Seminar [4 credits]
COGS 295: Graduate Research [8 credits]

Graduate Research Assistant funded by Primary Research Advisor

With the help of the Primary Research Adviser, student rewrites an *Integrative Review Paper* for submission to a scientific journal or edited volume.
With the help of the Primary Research Adviser, student writes up intermediate research results for submission to the annual meeting of the *Cognitive Science Society*.
Student presents intermediate research results as a *technical seminar* for COGS 250.
Student conducts dissertation research.

Spring Semester

COGS 250: Cognitive Science Graduate Seminar [4 credits]
COGS 295: Graduate Research [8 credits]

Graduate Research Assistant funded by Primary Research Advisor.

Student makes revisions to *Integrative Review Paper* journal submission.
Student completes the dissertation during the first half of the semester.
With the help of the Primary Research Advisor, student writes up dissertation research results for submission to a scientific journal.
Student interviews for subsequent positions.
Student successfully defends thesis by the end of the semester.
Student attends the annual meeting of the *Cognitive Science Society* during the summer.