**Annual Departmental Assessment Report**

**Department or Program: Computer and Information Science**

**Academic Year of Report: 2017**

**Department Contact Person for Assessment: J Sventek**

**Section 1: Learning Objectives Assessed for this Report**

The complete list of learning outcomes for the **CIS** and **MACS** degrees are listed below, with those outcomes being evaluated for the 2017 academic year highlighted.

***CIS***

LO1 - have demonstrated technical mastery of the main areas of computer science, including theoretical foundations, computer systems, programming languages, and software development;

LO2 - be able to draw on a broad knowledge of computer science to design, implement, and test software solutions to significant problems in a variety of areas;

LO3 – have an awareness of the broad applicability of computing; be proficient in one or more subareas of computer science or applied computer science;

LO4 – be able to adapt and extend fundamental knowledge and skills to new problem domains and emerging technologies;

LO5 – be able to communicate and collaborate with others as part of a project team, and express ideas orally and in writing.

***MACS***

LO1 – have demonstrated proficiency in the main areas of computer science, including data structures and algorithms, computer systems, programming languages, and software development;

LO2 – be able to draw on broad knowledge of computer science to design, implement, and test software solutions to problems in a variety of areas;

LO3 – have demonstrated in-depth understanding of some area of computer science (theoretical foundations, computer systems, software development);

LO4 – have demonstrated proficiency with the calculational techniques and applications of calculus and linear algebra;

LO5 – be able to read and write mathematical proofs, producing arguments that are logically and syntactically correct;

LO6 – have demonstrated an in-depth understanding of some area of mathematics;

LO7 – be able to communicate and collaborate with others, and express ideas orally and in writing.

**Section 2: Assessment Activities**

***CIS/LO1***

CIS/LO1 actually consists of 4 sub-learning objectives. In this assessment, we have evaluated technical mastery of theoretical foundations. The description of this assessment in the assessment plan is “At the conclusion of CIS 212, a student should be able to distinguish between a linear-time algorithms and an algorithm of higher complexity, although their reasoning will be informal. At the conclusion of CIS 313, a student will be able to reason formally about the asymptotic performance of algorithms involving standard data structures (lists, queues, heaps, etc.). At the conclusion of CIS 315 a student will be able to select and reason formally about performance properties of advanced algorithms, and will be able to use knowledge of algorithmic strategies (such as dynamic programming) to devise and analyze algorithms suited to a given problem. These proficiencies will be assessed through performance on final examination questions.”

As this is the first time that we have assessed this learning outcome, we focus on a relevant question from the Winter 2018 offering of CIS 313. Question 3 of the final for that course made ten different asymptotic complexity assertions in terms of $Ο\left( \right), Ω\left( \right), and Θ\left( \right).$ Students were asked to determine if the assertion was True or False, and describe how they determined their answers; thus, a perfect score on this question was 20.

The class consisted of 78 students (61 CIS, 4 MACS, 13 OTHER); the statistics for Question 3 were mean = 14.90, standard deviation = 4.30, median = 16, minimum = 2, maximum = 20. Mastery is exhibited by achieving a score > 12 on this question – i.e., getting 2/3 of the questions right. 54 students achieved this level, or 69% of the cohort. If we relax the measure of mastery to >10 (i.e. more than 1/2 right), this yields 81% of the cohort having mastered this concept.

***CIS/LO2***

The description of this assessment in the assessment plan is “The two primary courses where students demonstrate their ability to solve large problems using a variety of techniques are CIS 330 and CIS 415; in both cases, the ability to achieve 75% or greater on the assessed programming projects is an indication that students have met this particular learning outcome; two sections, of approximately equal size, of each course are taught each year; we will sample the results of student performance in one section of each, CIS 330 and CIS 415 in the Spring quarter, guaranteeing that we are not assessing any students twice (CIS 330 is a pre-requisite for CIS 415.”

*CIS/LO2/330*

In CIS 330, the students embark on a series of building projects. Project "3H" is the culmination of this effort. In the preceding projects, the students build a data flow network-based system for image processing, including file readers, writers, and filters that manipulate the image. In "3H" their projects are run against a variety of stress tests. The tests are generated by the students and also include some "greatest hits" tests from previous years. There are 111 (as of S18, only 48 in S17) tests for the students to pass. The students are given the tests ahead of time and allowed to correct their code before the tests are executed by the graduate TA.

The scoring rubric is:
0 incorrect: 11 points
1-5 incorrect: 9 points
6-10 incorrect: 7 points
11-half correct: 6 points
<half correct: 5 points
no submission: 0 points

Any student scoring 7, 9 or 11 points is achieving this learning outcome. We also argue that most of the students scoring 6 points also are achieving this learning outcome, since the code being tested is ~1000 lines of C++ and has been constructed incrementally over the quarter.

The scores for the 56 students in the Spring 2018 cohort are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Score | 0 | 5 | 6 | 7 | 9 | 11 |
| # students | 4 | 5 | 6 | 2 | 17 | 22 |

Thus, 83.9% of the students achieve this learning outcome.

For historical comparison, 83.6% of the Spring 2017 cohort achieved this learning outcome.

*CIS/LO2/415*

In CIS 415, the students must complete 3 x 3-week projects that emphasize the following concepts: P0 requires that they build a sophisticated program using abstract data types in the C programming language; P1 requires that by use Linux system calls to build a combination command processor and round-robin process scheduler; and P2 requires that they build a limited context driver in which they use multi-threading to cope with speed mismatches between clients and pseudo-device. Each project is marked on 100 points, with a mark of 75 points indicating reasonable mastery of the material.

Each of these projects require the students to master several new concepts. The projects do not build upon each other. Students achieving 75% or greater on all three projects have exhibited complete mastery, on two of the projects have exhibited mastery, and on 1 of the projects have exhibited mastery for one of the projects with respect to this learning outcome. We will count all three of these equivalence classes as having achieved the learning outcome.

The results for the 59 students in the Spring 2018 cohort are:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # projects >= 75% | 3 | 2 | 1 | 0 |
| # students | 20 | 16 | 13 | 10 |

Thus, 83.0% have achieved this learning outcome.

For historical comparison, 93.9% of the Spring 2017 cohort achieved this learning outcome. The Sp2017 cohort was distinctly stronger in terms of system programming.

***MACS/LO1***

MACS/LO1 actually consists of 4 sub-learning objectives. In this assessment, we have evaluated technical mastery of data structures and algorithms. The description of this assessment in the assessment plan is “At the conclusion of CIS 212, a student should be able to distinguish between a linear-time algorithms and an algorithm of higher complexity, although their reasoning will be informal. At the conclusion of CIS 313, a student will be able to reason formally about the asymptotic performance of algorithms involving standard data structures (lists, queues, heaps, etc.). At the conclusion of CIS 315 a student will be able to select and reason formally about performance properties of advanced algorithms, and will be able to use knowledge of algorithmic strategies (such as dynamic programming) to devise and analyze algorithms suited to a given problem. These proficiencies will be assessed through performance on final examination questions.”

As this is the first time that we have assessed this learning outcome, we focus on a relevant question from the Winter 2018 offering of CIS 313. Question 3 of the final for that course made ten different asymptotic complexity assertions in terms of $Ο\left( \right), Ω\left( \right), and Θ\left( \right).$ Students were asked to determine if the assertion was True or False, and describe how they determined their answers; thus, a perfect score on this question was 20.

The class consisted of 78 students (61 CIS, 4 MACS, 13 OTHER); the statistics for Question 3 were mean = 14.90, standard deviation = 4.30, median = 16, minimum = 2, maximum = 20. Mastery is exhibited by achieving a score > 12 on this question – i.e., getting 2/3 of the questions right. 54 students achieved this level, or 69% of the cohort. If we relax the measure of mastery to >10 (i.e. more than 1/2 right), this yields 81% of the cohort having mastered this concept.

***MACS/LO2***

The description of this assessment in the assessment plan is “The primary course where students demonstrate their ability to solve large problems using a variety of techniques is CIS 212; we will evaluate student performance on programming projects in CIS 212; the ability to achieve 75% or greater on the assessed programming projects is an indication that students have met this particular learning outcome; two sections, of approximately equal size, are taught each year; we will sample the results of student performance in one section of CIS 212 in the Spring quarter.”

The new syllabus for 212 described in Section 4 below was taught for the first time in Fall 2018. Thus, for this analysis we have assessed the programming assignments in CIS 313 for Winter 2018.

The students were assigned 5 programming assignments through the quarter, and they were able to drop their lowest score. Each of these projects require the students to build and exploit one or more data structures. Students achieving 75% or greater on three or four projects have exhibited complete mastery, on two of the projects have exhibited mastery, and on 1 of the projects have exhibited mastery for one of the projects with respect to this learning outcome. We will count students who have achieved 75% on two or more projects as having achieved the learning outcome.

The results for the 78 students in the Winter 2018 cohort are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # projects >= 75% | 4 | 3 | 2 | 1 | 0 |
| # students | 9 | 15 | 25 | 22 | 7 |

Thus, 62.8% have achieved this learning outcome.

***MACS/LO3***

The description of this assessment in the assessment plan is “Students have a choice of MATH 316, 347, and 391, where this learning outcome is developed. We will audit selected problems from the final exams in these courses, grading them by an independent committee to see whether the students leaving the courses have actually developed the desired proof skills.”

A question was chosen from the final exam for MATH 316, 347, and 391, and an independent committee graded the answers according to the following scale:

1. No progress toward a solution
2. Some small amount of progress towards a solution.
3. Mostly incorrect, but some nontrivial amount of progress.
4. Significant errors, but mostly correct.
5. One or two very minor errors.
6. Perfect.

The committee noted that for the MATH 316 problem, the distinction between a score of 2 and a score of 3 hinged on very minor considerations, as many solutions were close to half correct. We will count students who have achieved scores of 3-5 as having achieved the learning outcome.

The measured results for these courses were:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Grade: | 0 | 1 | 2 | 3 | 4 | 5 |
| MATH 316 | 0 | 2 | 4 | 14 | 5 | 1 |
| MATH 347 | 0 | 1 | 1 | 0 | 5 | 21 |
| MATH 391 | 1 | 1 | 1 | 6 | 10 | 3 |
|  | 1 | 5 | 8 | 23 | 24 | 30 |

Thus, we conclude that 84.6% of the students achieved this learning outcome.

**Section 3: Actions Taken Based on Assessment Analysis**

***CIS/LO1***

With the syllabus change for CIS 212 described below, we expect CIS 313 students to demonstrate much better mastery of algorithmic complexity. The next time we assess this sub-learning outcome, we should see significantly better results.

***CIS/LO2***

With the syllabus change for CIS 212 described below, we expect CIS 330 and CIS 415 students to demonstrate much better mastery of design, implementation, and testing of solutions to significant programming problems. The next time we assess this learning outcome, we should see much better results.

***MACS/LO1***

With the syllabus change for CIS 212 described below, we expect CIS 313 students to demonstrate much better mastery of algorithmic complexity. The next time we assess this sub-learning outcome, we should see significantly better results.

***MACS/LO2***

With the syllabus change for CIS 212 described below, we expect CIS 212 students to demonstrate much better mastery of design, implementation, and testing of solutions to problems in a variety of areas. The next time we assess this learning outcome, we should see much better results.

***MACS/LO3***

Normally a question from MATH 392 would have been used in the assessment. Since the final exam was replaced by a project and final quiz, and students could choose which problems in the quiz to solve, the committee selected a question from MATH 391, instead. Since MACS students are not required to take MATH 392, if the Math department chooses 392 in the future, these will be eliminated from the assessment in the future.

Because of the change in courses being assessed, variation in graders, and the variation of problems across courses, it is not clear what conclusion can be drawn from the data provided above. To help reach more useful findings in the future, the committee recommends:

1. Maintaining a library of previously-assessed problems, so that the committee can try to grade consistently with previous graders.
2. Auditing the same classes for the next several years, and attempting to audit similar problems to these, to allow longitudinal comparisons.

**Section 4: Other Efforts to Improve the Student Educational Experience**

In academic 2018 we have introduced a changed syllabus for CIS 212, the 3rd quarter course for our 1st year major sequence. The course introduces students to another programming language and basic data structures in that language; the previous syllabus focused on Java as the language, and the data structure aspect of the course was primarily to introduce students to data structures in the Java Collection Classes – i.e., students did not learn how to create data structures, simply how to use them.

The new syllabus teaches students the C programming language, how to program in the Linux environment, and spends fully 5 weeks on the implementation and exploitation of basic data structures. This course has been taught for the first time in Fall 2018, with the 2nd section of the course offered in Spring 2019.

This new syllabus introduces students to concepts that are important to both of the learning outcomes that we have assessed in Academic 2017 – the students learn about *O()* notation for describing the worst-case complexity of an algorithm, thus initiating their understanding of asymptotic complexity; additionally, by having the students program in the C language, we are initiating their understanding of programming large-scale solutions to problems.

**Section 5: Plans for Next Year**

The assessment plans for the two majors call for the following assessments in Academic 2018.

***CIS***

LO1 - have demonstrated technical mastery of the main areas of computer science, including theoretical foundations, computer systems, programming languages, and software development;

LO3 – have an awareness of the broad applicability of computing; be proficient in one or more subareas of computer science or applied computer science;

***MACS***

LO1 – have demonstrated proficiency in the main areas of computer science, including data structures and algorithms, computer systems, programming languages, and software development;

LO3 – have demonstrated in-depth understanding of some areas of computer science (theoretical foundations, computer systems, software development);

LO6 – have demonstrated an in-depth understanding of some area of mathematics;

For CIS/LO1, we will perform the same assessment we did this year, although we will also look at mastery in CIS 212 and CIS 315, in addition to CIS 313. We will also assess the second sub-outcome with respect to computer systems. At the conclusion of CIS 314, students will understand modern computer organization including pipelining and caches. This will be assessed by projects and by exam questions. At the conclusion of CIS 415, students will be able to design, implement, and reason about a component of a modern operating system, such as a device driver or virtual memory page replacement algorithm. This will be assessed through successful completion of projects and by exam questions that test ability to reason about the consequences of computer system design decisions.

For CIS/LO3, each CIS student must specialize in a particular track with their elective courses. We are in the process of determining from the faculty in charge of each track how best to assess student performance in each track. We intend to complete this determination by the middle of Winter 2019, so that we may apply the resulting assessments to students graduating in June 2019.

For MACS/LO1, we will perform the same assessment we did this year, although we will also look at mastery in CIS 212. We will also assess the second sub-outcome with respect to computer systems. At the conclusion of CIS 314, students will understand modern computer organization including pipelining and caches. This will be assessed by projects and by exam questions.

For MACS/LO3, each MACS student must choose their elective courses from CIS 322, CIS 422, CIS 330, and CIS 420. We are in the process of determining how best to assess student performance for this learning outcome. We intend to complete this determination by the middle of Winter 2019, so that we may apply the resulting assessments to students graduating in June 2019.

For MACS/LO6, each MACS student must demonstrate an in-depth understanding of some area of mathematics. The Math department are in the process of determining how best to assess this outcome. We intend to complete this determination by the middle of Winter 2019, so that we may apply the resulting assessments to students graduating in June 2019.