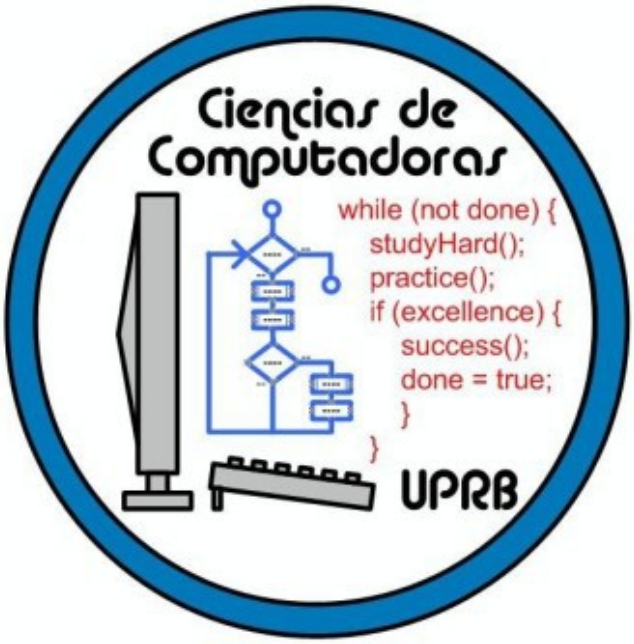
University of Puerto Rico at Bayamón

Computer Science Department



Assessment Plan

Computer Science Program

Information Systems Program

Accreditation and Assessment Committee
Revised in August 2012

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Purpose

The purpose of this plan is to outline the assessment processes for the Department's program. We want to answer questions such as *What is to be measured?, Who will it be measured on?, How?, When?, Where?, How often?, How is the data evaluated?, and How is it used to continuously improve the program?*

The Accreditation and Assessment Committee started this plan by drafting the Program Educational Objectives and the Student Outcomes according to ABET's definitions:

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.[1]

Student Outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in the matriculation through the program.[1]

The program Educational Objectives and the Student Outcomes were drafted during the second semester of 2010-2011, considering the Computer Science Departments, the University of Puerto Rico at Bayamon's and the University of Puerto Rico's mission statements. These drafts were then presented to the Faculty for discussion, with the resulting suggestions being incorporated into the document. During the next semester, these draft documents were presented to the Department's External Advisory Board. [1]

[1] **ABET's 2010-2011 Criteria for Accrediting Computing Programs**

Institutional Objectives
a) Promote the development of effective thinking with emphasis on reflection, identification, definition, categorization and solution of problems, and decision-making.
b) Promote creative expression within the learning process.
c) Promote the development of solidarity with democratic values.
d) Promote the integration of knowledge through research.
e) Promote the development of effective thinking with emphasis on reflection, identification, definition, categorization and solution of problems, and decision-making.
f) Promote creative expression within the learning process.
g) Promote appreciation for and integration of ethical and aesthetic values.
h) Promote the development of the ability to adapt to changes and interpret them as new challenges.
i) Ensure the development of a scientific culture that allows for the application of scientific thinking, the ability to make judgments and make responsible decisions on issues related to health, and the use and conservation of the environment.
j) Ensure the development of diverse knowledge that allows for understanding their own culture and how it interrelates with other cultures.
k) Ensure the development and application of technological knowledge.
l) Ensure the development of skills related to the identification, management and effective use of information (information literacy.)

Educational Objectives
1. Our graduates will have the professional competences that will add value to their careers in Computer Science and/or Information Systems
2. Our graduates will apply mathematical tools, problem solving skills, and essential knowledge in the process of developing a computational solution in the practice of Computer Science, Information Systems and/or related application areas.
3. Our graduates will demonstrate a sense of societal, human, and ethical responsibility in their professional endeavors.
4. Our graduates will engage in professional development or post-graduate education amid future technological changes as well as to the needs of society.
5. Our graduates will communicate effectively in English and Spanish.
6. Our graduates will perform efficiently in team environments either as members or leaders.

Scope of the Assessment Process

According to ABET's Criteria, a program seeking accreditation should measure the achievement level for each of the Program Educational Objectives and the Student Outcomes. Program Educational Objectives, being long-term in nature, should be reflected by the program's alumni. The Accreditation and Assessment Committee decided, in order to effectively measure alumni achievement of the Educational Objectives, these should also be measured through employers, preferably direct supervisors. Student Outcomes, on the other hand, should be achieved by students at the moment of graduation. For each outcome, the corresponding performance indicators were classified as cognitive or affective. The decision was made to spread the measurements throughout the program, with some measurements taken early on in the program and compared to measurements taken later on. Other measurements would be taken only once throughout the program. This would ease things for everyone involved.

To have continuous improvement, the assessment data should be evaluated and used to make decisions that improve the program. This three-stage process –data gathering, evaluation and improvement– must to be repeated periodically. In the Computer Science Department this cycle is completed every two years (4 semesters), with the first two semesters dedicated to data gathering, and the evaluation and improvement stages taking place during the last two semesters.

Student Outcomes and Corresponding Performance Indicators Computer Science Program
1. An ability to apply knowledge of computing and mathematics appropriate to the discipline.
(a) Select the appropriate algorithm for a specific situation (Cog-Knowledge).
(b) Analyze the asymptotic running time of simple algorithms using big-O notation (Cog-Analysis)
(c) Apply mathematical concepts in the solution of a given problem (Cog-Application)
2. An ability to analyze a problem, identify and define the computing requirements appropriate to its solution.
(a) Analyze a problem (Cog-Analysis)
(b) Identify and define the computational requirements needed in a real situation (Cog-Synthesis).
(c) Choose the appropriate software and/or hardware tools to meet the desired goals (Cog-Evaluation).
3. An ability to design, implement, and evaluate a computer-based system, process, component or program to meet desired needs.
(a) Design a solution for a given problem using the structured approach (Cog-Synthesis).
(b) Design a solution for a given problem using the object-oriented approach (Cog-Synthesis).
(c) Implement an algorithm using the appropriate programming language (Cog-Application).
(d) Implement abstract solutions using pseudo code, flowchart or natural language (Cog-Synthesis).
(e) Perform both unit and systems testing (Cog-Evaluation).
4. An ability to function effectively on teams to accomplish a common goal.
(a) Evaluate a given problem within a team environment (Cog-Evaluation).
(b) Perform the tasks assigned when working on a team (Affective-Responding).
(c) Assist its team mates when needed (Affective-Responding).
(d) Complete its duties assigned within a team environment (Affective-Valuing).
5. An understanding of professional, ethical, legal, security and social issues and responsibilities.

(a) Evaluate the ethical implications of an issue in the computing discipline (Cog-Evaluation).

(b) Evaluate the social impact of a given computing technology (Cog-Evaluation).

(c) Recognize the responsibilities inherent to the profession of computing (Cog-Knowledge).

6. An ability to communicate effectively with a range of audiences.

(a) Present different topics both orally and in writing (Affective-Responding).

(b) Explain technical concepts using the correct terminology (Affective-Valuing).

(c) Display knowledge of technical report writing skills (Cog-Knowledge)

7. An ability to analyze the local and global impact of computing on individuals, organizations, and society.

(a) Identify the contribution of computing and other related professionals to society (Cog-Knowledge).

(b) Understand computational or technological advances and their impact to the profession (Cog-Comprehension).

8. Recognition of the need for and an ability to engage in continuing professional development.

(a) Recognize options of continuing studies after degree completion (Cog-Knowledge).

(b) Use diverse information resources when performing assigned duties (Cog-Application).

9. An ability to use current techniques, skills, and tools necessary for computing practices.

(a) Use hardware and software tools currently available (Cog-Application).

(b) Recognize emerging technologies and their implication to the practice of the profession (Cog-Knowledge).

10. An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.

(a) Solve problems using the principles from discrete and continuous mathematics (Cog-Application).

(b) Perform basic algorithmic analysis using big-O notation (Cog-Analysis)

(c) Determine the most appropriate data structure needed to solve a given problem (Cog-Evaluation)
(d) Demonstrates basic knowledge of scientific computing using numerical analysis (Cog-Comprehension).
(e) Appraise whether a given problem has a computational solution (Cog-Evaluation).
(f) Determine the most appropriate programming paradigm needed to solve a problem (Cog-Evaluation).
11. An ability to apply design and development principles in the construction of software systems of varying complexity.
(a) Determine the feasibility of a proposed software system (Cog-Evaluation).
(b) Perform object oriented and structure analysis and design of software systems (Cog-Application).
(c) Analyze and evaluate alternatives for acquiring or developing a software system (Cog-Evaluation).
(d) Construct a complete software system (Cog-Synthesis).

Student Outcomes and Corresponding Performance Indicators Information Systems Program
1. An ability to apply knowledge of computing and mathematics appropriate to the discipline.
(a) Select the appropriate algorithm for a specific situation (Cog-Knowledge).
(b) Analyze the asymptotic running time of simple algorithms using big-O notation (Cog-Analysis)
(c) Apply mathematical concepts in the solution of a given problem (Cog-Application)
2. An ability to analyze a problem, identify and define the computing requirements appropriate to its solution.
(a) Analyze a problem (Cog-Analysis)
(b) Identify and define the computational requirements needed in a real situation (Cog-Synthesis).
(c) Choose the appropriate software and/or hardware tools to meet the desired goals (Cog-Evaluation).
3. An ability to design, implement, and evaluate a computer-based system, process, component or program to meet desired needs.
(a) Design a solution for a given problem using the structured approach (Cog-Synthesis).
(b) Design a solution for a given problem using the object-oriented approach (Cog-Synthesis).
(c) Implement an algorithm using the appropriate programming language (Cog-Application).
(d) Implement abstract solutions using pseudo code, flowchart or natural language (Cog-Synthesis).
(e) Perform both unit and systems testing (Cog-Evaluation).
4. An ability to function effectively on teams to accomplish a common goal.
(a) Evaluate a given problem within a team environment (Cog-Evaluation).
(b) Perform the tasks assigned when working on a team (Affective-Responding).
(c) Assist its team mates when needed (Affective-Responding).
(d) Complete its duties assigned within a team environment (Affective-Valuing).

5. An understanding of professional, ethical, legal, security and social issues and responsibilities.

(a) Evaluate the ethical implications of an issue in the computing discipline (Cog-Evaluation).

(b) Evaluate the social impact of a given computing technology (Cog-Evaluation).

(c) Recognize the responsibilities inherent to the profession of computing (Cog-Knowledge).

6. An ability to communicate effectively with a range of audiences.

(a) Present different topics both orally and in writing (Affective-Responding).

(b) Explain technical concepts using the correct terminology (Affective-Valuing).

(c) Display knowledge of technical report writing skills (Cog-Knowledge)

7. An ability to analyze the local and global impact of computing on individuals, organizations, and society.

(a) Identify the contribution of computing and other related professionals to society (Cog-Knowledge).

(b) Understand computational or technological advances and their impact to the profession (Cog-Comprehension).

8. Recognition of the need for and an ability to engage in continuing professional development.

(a) Recognize options of continuing studies after degree completion (Cog-Knowledge).

(b) Use diverse information resources when performing assigned duties (Cog-Application).

9. An ability to use current techniques, skills, and tools necessary for computing practices.

(a) Use hardware and software tools currently available (Cog-Application).

(b) Recognize emerging technologies and their implication to the practice of the profession (Cog-Knowledge).

12. An understanding of processes that support the delivery and management of information systems within a specific application environment.

(a) Display basic knowledge of accounting and management principles (Cog-Comprehension).
(b) Analyze the information flow in an organization (Cog-Analysis).
(c) Understand the process operations within an organization (Cog-Comprehension).
(d) An ability to discern between a transactional, management of information and decision support system (Cog-Evaluation).
(e) Recommends viable solutions using computer systems as main solution (Cog-Evaluation).
(f) Construct an Information System (Cog-Synthesis).

The Assessment Process

This section describes in detail de assessment process of the program.

Methods

To measure the achievement levels of Program Educational Objectives, surveys to alumni and their employers should be used. The data collected through the surveys are then grouped according to the category of the respondent. Graphs and/or tables are prepared in terms of percentage of responses for each answer. Then they are analyzed together to identify any trends. Those trends that reflect unsatisfactory or inconsistent results are then deeply analyzed again. Focus groups are used as needed so that triangulation could be achieved, and the performance of the assessment process could be increased.

To measure the achievement levels for the Student Outcomes through the established Performance Indicators, different assessment methods should be used. The particular assessment method should be chosen depending on its suitability. An exam should be developed to measure those performance indicators of cognitive nature. Performance indicators reflecting affective learning, behaviors or attitudes, should be measured throughout the courses by means of observations. The results of these observations would be evaluated using rubrics.

To measure students' perceptions of their own individual levels of achievement, the department should conduct a graduating student survey. A different survey should be used on those that have graduated from the program in the past. It should be noted that the Institutional Planning Office conducts a survey to all graduates from the University of Puerto Rico at Bayamon. This survey is segregated by program and we have those results available.

These methods should provide direct measurements of the level of achievement of the corresponding performance indicators. Collectively, these methods represent both direct and indirect measurement.

Exam to measure cognitive Performance Indicators

As stated in the previous section, an exam should be developed to directly measure most performance indicators and, in turn, most student outcomes. The idea is to be able to measure those indicators that could be effectively evaluated by a written exam. The exam should have approximately 40 questions, 25 of them should be common to both emphasis areas.

Details Regarding Behavioral Observations

Rubrics should be designed for each course were behavioral observations should be conducted. A rubric for a specific course may include several performance indicators from different outcomes. Each of the rubric's rows should contain a single performance criterion and single method of assessment. Special rubrics for evaluating oral presentations and written reports should be developed.

Table 1 – Performance Indicators measured through assessment exam

Computer Science Program

Outcome	Performance Indicator	Question Id	Question
1	a	O1A_P1	For which of the following situations, it is recommended to use nested loops?
1	a	O1A_P2	Which of the following is the recommended algorithm to find a value in a sorted array of integers?
1	b	O1B_P1	What is the time complexity of the following piece of code?
1	b	O1B_P2	What is the time complexity of the following piece of code?
1	c	O1C_P1	According to the theory of waiting lines (queues), how do multiple servers must be organized to be more effective?
1	c	O1C_P2	Suppose that you have a rectangular lot containing a square house and a circular pool. If S is the area of lot, P is the pool area, C is the area of the house, how could you determine the total time in seconds that will take to cut the grass of the lot if you cut at a rate of 2 square feet per second?
2	a	O2A_P1	Suppose that you have a rectangular lot containing a square house and a circular pool. You want determine the total time in seconds that will take to cut the grass of the lot if you cut at a rate of 2 square feet per second. Which of the following is not an input value?
2	a	O2A_P2	Which of the following statements describes a typical Web application?
2	b	O2B_P1	Where should the database reside on a client / server environment?
2	b	O2B_P2	Which of the following would not be a functional requirement of a payroll system?
2	c	O2C_P1	Which of the following tools are used to query relational databases?
2	c	O2C_P2	Where should data be stored if you need to access them efficiently?
2	c	O2C_P3	Which of the following technologies meet the requirement for a remote system to process critical transactions at the highest speed?
3	a	O3A_P1	If a task must be performed several times in a program, which practice of the structured approach to program design should be used?
3	a	O3A_P2	In object-oriented design, which is recommended for good design of the fields and methods in a class?
3	b	O3B_P1	In object-oriented design, how do you call the relationship between two classes in which a class is created as an extension of another?
3	d	O3D_P1	Which of the following should be used to replace <initial value> and <condition> so that the pseudocode shows the sum of the values from 1 to m, where m > = 1?

5	a	O5A_P1	In a corporate environment , you have noticed that your group leader has deceived the chief development regarding to the progress of a project. What would be the most ethically correct action?
5	a	O5A_P2	Why is software piracy unethical?
5	a	O5A_P3	What is the best practice for the acquisition of proprietary tools for developing a software system?
7	b	O7B_P1	Suppose that a blind person asks for a recommendation that allows him or her to use a newly purchased computer. What can we say?
9	b	O9B_P1	What is the base operating system used by the leading smart mobile devices (smartphones / tablets)?
9	b	O9B_P2	Which of the following is not a Web 2.0 technology?
9	b	O9B_P3	Which of the following defines what a Web 2.0 technology is?
10	a	O10A_P1	Which of the following strings is generated by the grammar S → SaSbS | ε ? A researcher is preparing a questionnaire with six questions to be answered with "Yes", "Maybe" and "No". The researcher wants to know how many people respond to a particular combination of responses. A developer is designing a data structure to collate the responses to this questionnaire. The programmer decides to use a base structure with 6 memory slots, one for each question. Each item will contain a 2 for "Yes", 1 for "Maybe" and 0 for "No". Responses a person might look like this: 1,2,2,1,0,1.
10	a	O10A_P2	The programmer declares an array with one position for every possible combination of responses. What will be the number of entries in the array be?
10	c	O10C_P1	What is the most appropriate data structure to implement a collection of values in which the items are added at one end but are removed at the other end, and there is no limit to the number of values in the collection?
10	c	O10C_P2	What is the most appropriate data structure for evaluating a postfix expression?
10	d	O10D_P1	Which of the following methods are used to solve a system of n x n linear equations?
10	d	O10D_P2	How do you call the method for finding the roots of non-linear equations in which each iteration discards half of the search interval?
10	e	O10E_P1	Which of the following problems can not be solved computationally?
10	f	O10F_P1	You want to develop a game that contains different types of military vehicles (aircraft and ships). There are three types of aircraft and two types of boats. Each vehicle contains a set of parts and can be turned on, off, accelerate or stop. What paradigm is recommended to solve this problem?
10	f	O10F_P2	Which of the following programming paradigms uses recursion as the only mechanism of repetition?

Table 2 – Performance Indicators measured through behavioral observations

Computer Science Program

Assessment Data Collection and Analysis Matrix

Outcome	Course	Assessment Instrument	2011-12		2012-13	
			First Semester Collecting Group A	Second Semester Collecting Group B	First Semester Analyzing Groups A & B	Second Semester Recommendations
3 c	COTI-3101	Midterm Final	X		X	X
	COTI-3102	Midterm Final Project		X	X	X
	SICI-4036	Quizzes Assignments		X	X	X
	COTI-4150	Quizzes Assignments	X		X	X
	SICI-3039	Quizzes Assignments	X		X	X
3 d	COTI-3101	Midterm Final	X		X	X
	COTI-3102	Midterm Final Project		X	X	X
4 a, b, c, d	SICI-4037	Class/Home Work	X		X	X
	COTI-4430	Group Project	X		X	X
	COTI-4210	Final Project		X	X	X
	SICI-4029	Peers Assignments	X		X	X
6 a, b, c	SICI-4037	Discussion Question Test	X		X	X
	SICI-3015	Final Presentation	X		X	X
	COTI-4430	Final Presentation	X		X	X
	SICI-	Monograph		X	X	X

Assessment Data Collection and Analysis Matrix

Outcome	Course	Assessment Instrument	2011-12		2012-13	
			First Semester Collecting Group A	Second Semester Collecting Group B	First Semester Analyzing Groups A & B	Second Semester Recommendations
	4019					
	SICI-4038	Term Project		X	X	X
11 b	SICI-3015	Final Project	X		X	X
	COTI-3102			X	X	X
	SICI-4038	Term Project		X	X	X
11 d	SICI-4038	Term Project		X	X	X
12 e, f	SICI-4038	Term Project		X	X	X

Table 1 – Performance Indicators measured through assessment exam

Information Systems Program

Outcome	Performance Indicator	Question Id	Question
1	a	O1A_P1	For which of the following situations, it is recommended to use nested loops?
1	a	O1A_P2	Which of the following is the recommended algorithm to find a value in a sorted array of integers?
1	b	O1B_P1	What is the time complexity of the following piece of code?
1	b	O1B_P2	What is the time complexity of the following piece of code?
1	c	O1C_P1	According to the theory of waiting lines (queues), how do multiple servers must be organized to be more effective?
1	c	O1C_P2	Suppose that you have a rectangular lot containing a square house and a circular pool. If S is the area of lot, P is the pool area, C is the area of the house, how could you determine the total time in seconds that will take to cut the grass of the lot if you cut at a rate of 2 square feet per second?
2	a	O2A_P1	Suppose that you have a rectangular lot containing a square house and a circular pool. You want determine the total time in seconds that will take to cut the grass of the lot if you cut at a rate of 2 square feet per second. Which of the following is not an input value?
2	a	O2A_P2	Which of the following statements describes a typical Web application?
2	b	O2B_P1	Where should the database reside on a client / server environment?
2	b	O2B_P2	Which of the following would not be a functional requirement of a payroll system?
2	c	O2C_P1	Which of the following tools are used to query relational databases?
2	c	O2C_P2	Where should data be stored if you need to access them efficiently?
2	c	O2C_P3	Which of the following technologies meet the requirement for a remote system to process critical transactions at the highest speed?
3	a	O3A_P1	If a task must be performed several times in a program, which practice of the structured approach to program design should be used?

3	a	O3A_P2	In object-oriented design, which is recommended for good design of the fields and methods in a class?
3	b	O3B_P1	In object-oriented design, how do you call the relationship between two classes in which a class is created as an extension of another?
3	d	O3D_P1	Which of the following should be used to replace <initial value> and <condition> so that the pseudocode shows the sum of the values from 1 to m, where m > = 1?
5	a	O5A_P1	In a corporate environment , you have noticed that your group leader has deceived the chief development regarding to the progress of a project. What would be the most ethically correct action?
5	a	O5A_P2	Why is software piracy unethical?
5	a	O5A_P3	What is the best practice for the acquisition of proprietary tools for developing a software system?
7	b	O7B_P1	Suppose that a blind person asks for a recommendation that allows him or her to use a newly purchased computer. What can we say?
9	b	O9B_P1	What is the base operating system used by the leading smart mobile devices (smartphones / tablets)?
9	b	O9B_P2	Which of the following is not a Web 2.0 technology?
9	b	O9B_P3	Which of the following defines what a Web 2.0 technology is?
12	a	O12A_P1	What is a deliverable in an information system development project? A graduate of the Computer Science or the Information program of the University of Puerto Rico at Bayamón has received job offers from four companies. He or she has decided to evaluate the offers according to the expected salary for five years. What should he or she do?
12	a	O12A_P2	A company wants to lease offices to provide services in systems. The performance of each office depends on future demand for services. Assume that the company understands that future demand is reduced to three possibilities (low, moderate, high) and can estimate the gain or loss according to the combination of office size / future demand from the table: Determine the best company for the student using the maximax criteria.

			A company wants to lease offices to provide services in systems. The performance of each office depends on future demand for services. Assume that the company understands that future demand is reduced to three possibilities (low, moderate, high) and can estimate the gain or loss according to the combination of office size / future demand from the table:
12	a	O12A_P3	A pessimistic or conservative manager (maximin criterion) would choose office::
12	b	O12B_P1	Which of the following is discussed in more detail in a DFD model (Data Flow Diagrams)?
12	b	O12B_P2	According to the model shown below, indicate what business process is being exposed in the DFD?
12	b	O12B_P3	What level of abstraction is represented in the following DFD (Data Flow Diagram)?
12	c	O12C_P1	Which of the following is a diagram of UML (Unified Modeling Language) that allows us to document the processes of an organization?
12	d	O12D_P1	What type of information system is a purchase order processing system?

Table 2 – Performance Indicators measured through behavioral observations

Information Systems Program

Assessment Data Collection and Analysis Matrix

Outcome	Course	Assessment Instrument	2011-12 First Semester Collecting Group A	2011-12 Second Semester Collecting Group B	2012-13 First Semester Analyzing Groups A & B	2012-13 Second Semester Recommendations
3 c	COTI-3101	Midterm Final	X		X	X
	COTI-3102	Midterm Final Project		X	X	X
	SICI-4036	Quizzes Assignments		X	X	X
	COTI-4150	Quizzes Assignments	X		X	X

Assessment Data Collection and Analysis Matrix

Outcome	Course	Assessment Instrument	2011-12		2012-13	
			First Semester Collecting Group A	Second Semester Collecting Group B	First Semester Analyzing Groups A & B	Second Semester Recommendations
	SICI-3039	Quizzes Assignments	X		X	X
3 d	COTI-3101	Midterm Final	X		X	X
	COTI-3102	Midterm Final Project		X	X	X
4 a, b, c, d	SICI-4037	Class/Home Work	X		X	X
	COTI-4430	Group Project	X		X	X
	COTI-4210	Final Project		X	X	X
	SICI-4029	Peers Assignments	X		X	X
6 a, b, c	SICI-4037	Discussion Question Test	X		X	X
	SICI-3015	Final Presentation	X		X	X
	COTI-4430	Final Presentation	X		X	X
	SICI-4019	Monograph		X	X	X
	SICI-4038	Term Project		X	X	X
11 b	SICI-3015	Final Project	X		X	X
	COTI-3102			X	X	X
	SICI-4038	Term Project		X	X	X
11 d	SICI-4038	Term Project		X	X	X
12 e, f	SICI-4038	Term Project		X	X	X

Evaluation Phase

The Accreditation and Assessment Committee is responsible for evaluating the data and reporting to the Faculty and the Department's committees. The data pertaining to Program Educational Objectives and the Student Outcomes should be considered separately. As stated previously, the assessment of the Educational Objectives should consist of surveys for alumni and employers. The answers for these questions should be analyzed using a scale of *exemplary, satisfactory, developing, unsatisfactory* or *does not apply*.

Surveys should be analyzed according to respondent: one group for alumni and another for employers. For each group, the amount of responses for each achievement level should be determined by question. Graph and/or tables for all parts of each Education Objective should be created. The parts should then be arranged by question, side by side, in respondent type pairs. This would allow for comparison between the collective responses and could be evaluated individually.

Relationships between pairs of responses should be sought. Generally, the occurrence of similar responses would indicate an agreement. Very different patterns, extremes in particular levels of achievement or variability, between both groups should be considered as contradicting or inconclusive. They would require further study[2] to determine those causes for discrepancy and deal with them. If the combined number of *exemplary* and *satisfactory* answers is high as compared to the other levels, that part of the Educational Objective should be considered as being met. After each Educational Objective's parts have been analyzed, they should be considered together to determine the overall level of achievement for the Educational Objective and draw conclusions.

For evaluating each Outcome's Performance Indicators a similar procedure should be used. All the Performance Indicators related an Outcome should be graphed together, as stated before. Each performance indicator should be measured using at least two different methods, such as coursework and the exit exam. The data for all Performance Indicators should be then examined as a whole. After all Performance Indicators for a given outcome have been analyzed individually, they should be considered collectively so that the level of achievement for the particular outcome could be determined.

According to the analyses for the Educational Objectives and the Outcomes, recommendations to the appropriate channels should be made. Issues related to the measurement of Educational Objectives and Outcomes should then be evaluated and approved by the Accreditation and Assessment Committee. Issues related to courses and curricula should be referred to the Curriculum Committee. Other issues should then be referred to the Department's Chairman.

[2] For example, focus groups

Improvements Phase

The Accreditation and Assessment Committee is responsible of submitting recommendations for modification to the Educational Objectives and/or Outcomes. They should then present these recommendations to the Department's External Advisory Board and to the Faculty for evaluation and ratification. In case of recommendations that would require minor changes to the curriculum of the program, the Department Head would submit a request to the Dean of Academic Affairs. This request would then need to be also approved by the UPR Vice-President of Academic Affairs.

If the required changes are major, the request would be submitted to the Dean of Academic Affairs, who in turn, would have look for approval by the Academic Senate, by the Chancellor and by the Vice-President of Academic Affairs. Since a program's Educational Objectives and Outcomes constitute part of the program's philosophical frame, the Vice-President's Office is required to report them to Puerto Rico Education Council, the state licensing entity.

Curricular changes should be the responsibility of the program's Curriculum Committee. The replacement or addition of courses should be approved at the Office of the Dean of Academic Affairs after consulting with the VPAA. Changes to the description of a course, the number of credits, or pre-requisites are approved at the VPAA level. The VPAA oversees whether curricular changes are compatible with the corresponding licenses, institutional accreditation, policies or certifications by the UPR Board of Trustees.

Changes to the assessment process should be approved by the Accreditation and Assessment Committee, whereas changes to the curricula should be evaluated and approved by the program's Curriculum Committee.

Process Cycle

The cycle for achieving continuous improvement of the program should consist of two school years (four semesters). The basic cycle should run as follows:

	First Semester	Second Semester	Third Semester	Fourth Semester
	Data gathering Course Group A	Data gathering Course Group B	Analysis of Data Course Group A	Recommendations
		Alumni Survey Employers Survey	Analysis of Data Course Group B	
	Post-Test	Post-Test	Post-Test & Analysis of Data	Post-Test
		Graduating Students' Survey	Focus Group*	Graduating Students' Survey

*When needed

As the previous table shows, the data gathering stage should consist of the first two semesters, and the courses should be classified in two groups (A and B). During the first semester, the data of the courses in group A should be gathered. During the second semester, surveys should be sent to alumni, employers and graduating students and the data of the courses in group B should be gathered. The third semester of the cycle should be used to analyze the data gathered in the previous academic year and focus groups should be used if needed. The the Accreditation and Assessment Committee should be responsible for this task. During the fourth semester, recommendations for modifications to the program should be made. The Accreditation and Assessment Committee should seek input from the External Advisory Board before taking the final recommendations to the Department's Head. It is important to note that a post-test should be administered to the students taking the capstone course (SICI 4038) each semester. The post-test and the graduating students' survey that are administered during the fourth and final semester of the cycle should be used as part of the data gathering stage of the next cycle.

Group A	Group B
First Semester	**Second Semester**
First year	**First year**
COTI 3101 – Algorithms & Program Development I	COTI 3102 - Algorithms & Program Development II
Second year	**Second year**
COTI 3205 – Computer Organization	SICI 4019 – Computer Architecture
SICI 3015 – Information Systems Analysis & Design	SICI 4036 – Data Structure
Third year	**Third Year**
SICI 4029 – Fundamentals of Operating Systems	SICI 4009 – Introduction to Numerical Analysis
SICI 3039 – Computer Programming Languages	SICI 4030 – Database Programming
COTI 4150 – Information Systems Programming	COTI 4210 – Web Applications Programming
Fourth year	**Fourth year**
SICI 4037 – Data Communications	SICI 4038 – Research Workshop
SICI 4028 – Operations Research	
COTI 4250 – Introduction to Theory of Computation	
COTI 4430 – Project Management	