



Committee for the Evaluation of Computer Science Study Programs

Weizmann Institute of Science
Mathematics and Computer Science Department
Evaluation Report

April 2014

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Chapter 1: Background

The Council for Higher Education (CHE) decided to evaluate study programs in the field of Computer Science during the academic year of 2012-2013.

Following the decision of the CHE, the Minister of Education, who serves ex officio as Chairperson of the CHE, appointed a Committee consisting of:

- Prof. Maurice Herlihy - Computer Science Department, Brown University, USA - Committee Chair
- Prof. Robert L. Constable - Computer Science Department ,Cornell University, USA¹
- Prof. David Dobkin - Department of Computer Science, Princeton University, USA²
- Prof. Sarit Kraus - Department of Computer Science, Bar Ilan University, Israel³
- Prof. Dmitry Feichtner-Kozlov - Department of Mathematics, Bremen University, Germany
- Prof. Joe Turner, Jr. - (Emeritus) - Department of Computer Science, Clemson University, USA - ABET Representative
- Prof. Moshe Vardi - Department of Computer Science, Rice University, USA

Ms. Maria Levinson-Or served as the Coordinator of the Committee on behalf of the CHE.

Within the framework of its activity, the Committee was requested to:⁴

¹ In accordance with the CHE's policy, Prof. Robert L. Constable did not participate in the evaluation of the Computer Science department at Ben Gurion University to prevent the appearance of a conflict of interests.

² Due to scheduling constraints, Prof. David Dobkin did not participate in the site visits to the Jerusalem College of Technology, Hadassah Academic College, Ariel University, the Weizmann Institute of Science, the College of Management Academic Studies, and the Holon Institute of Technology.

³ In accordance with the CHE's policy, Prof. Sarit Kraus did not participate in the evaluation of the Computer Science department at Bar Ilan University to prevent the appearance of a conflict of interests.

⁴ The Committee's letter of appointment is attached as **Appendix 1**.

1. Examine the self-evaluation reports, submitted by the institutions that provide study programs in Computer Science, and to conduct on-site visits at those institutions.
2. Submit to the CHE an individual report on each of the evaluated academic units and study programs, including the Committee's findings and recommendations.
3. Submit to the CHE a general report regarding the examined field of study within the Israeli system of higher education including recommendations for standards in the evaluated field of study.

The entire process was conducted in accordance with the CHE's Guidelines for Self-Evaluation of (October 2011).

Chapter 2: Committee Procedures

The Committee held its first meeting on May 21, 2013, during which it discussed fundamental issues concerning higher education in Israel, the quality assessment activity, as well as Computer Science Study programs in Israel.

In May - June 2013, the Committee held its first round of visits of evaluation, and visited the Hadassah Academic College, Jerusalem College of Technology, Ariel University, Tel Aviv University and Bar-Ilan University. In January 2014, the committee held its second round of visits of evaluation, and visited Ben-Gurion of the Negev, the Open University of Israel, the Interdisciplinary Center Herzliya, Tel-Aviv Yaffo Academic College, Netanya Academic College, the Weizmann Institute of Science, the College of Management Academic Studies, and the Holon Institute of Technology. During the visits, the Committee met with various stakeholders at the institutions, including management, faculty, staff, and students.

This report deals with the program of Computer Science at the Weizmann Institute of Science. The Committee's visit to the Institute took place on January 13, 2014.

The schedule of the visit is attached as **Appendix 2**.

As part of the evaluation process, the committee appraised the compliance of Computer Science departments to the CHE standards for studies in Computer Science, set in 2008. The CHE standards are attached as **Appendix 3**.

The Committee thanks the management of the Weizmann Institute of Science and the Department of Mathematics and Computer Science for their self-evaluation report and for their hospitality towards the committee during its visit at the institution.

Chapter 3: Evaluation of Computer Science Study Program at Weizmann Institute of Science

This Report relates to the situation current at the time of the visit to the institution, and does not take account of any subsequent changes. The Report records the conclusions reached by the Evaluation Committee based on the documentation provided by the institution, information gained through interviews, discussion and observation as well as other information available to the Committee.

1. Executive Summary

Computer science is central to the Israeli economy and even to its security. Among winners of the Turing Award (generally considered as the “Nobel Prize” for computer scientists), Israel has more recipients than all but one other country.

The Weizmann institute is unique, encompassing both a research institute and academic programs. The research programs are some of the best in the world, allowing researchers a high degree of freedom to pursue their research interests. The academic programs are impressive for the research quality of the students they produce at both the M.Sc. and Ph.D. levels.

The dual character of the institute’s mission presents the challenge of how to balance the research mission’s absence of teaching requirements with the educational mission’s need to provide a balanced offering of courses. In particular, the committee found that the selection of courses offered for the M.Sc. program too narrow to satisfy the CHE standards⁵ for a master’s program in computer science, and there is no policy in place to ensure that students are exposed to the range of basic knowledge required by such a program.

The selection mechanism ensures that admitted M.Sc. students are highly capable and highly motivated. However, existing advising mechanisms are not adequate to ensure that gaps in the students’ backgrounds will be filled.

⁵ As stated in the CHE standards for studies in Computer Science, attached as Appendix 3.

Overall, the institute did a good job addressing and implementing the previous committee's recommendations.

2. Organizational Structure

Observations and findings

The academic program does an excellent job of steering students into research groups, but sometimes at the cost of a balanced education.

3. Mission and Goals

Observations and findings

The mission and goals are appropriate for this institution.

4. Study Programs

Observations and findings

The master's program has no concrete requirements beyond completing a specific number of credits. However, the CHE standards for a master's program in computer science require "comprehensive theoretical and applied knowledge in a wide range of computer science topics"⁶.

The committee identified the following issues.

- a. The M.Sc. program has no breadth requirements⁷. While flexibility in curricular requirements is desirable, breadth requirements in master's programs are universally accepted as essential to a high-quality graduate education. A sound understanding of basic knowledge in the field is essential for long-term career success in both research and industry.
- b. The selection mechanism ensures that admitted M.Sc. students are highly capable and highly motivated. However, existing advising mechanisms

⁶ Ibid.

⁷ As can be seen in the list of offered M.Sc. courses, attached as Appendix 4.

are not adequate to ensure that gaps in the students' backgrounds will be filled.

- c. Because of the unique organizational structure of the institute, the course offerings are usually limited to the research interests of the individual researchers.

The committee sees several possible ways to address these issues in ways compatible with the institute's distinctive structure. Some of these are:

- a. Breadth requirements need not be rigid or onerous. They can be formulated in a way that balances intellectual rigor with flexibility, ensuring basic knowledge.
- b. The institute could recruit adjunct faculty, post-docs, or visitors to fill in gaps in the course offerings.
- c. The institute could make a systematic effort to identify and recommend courses at other Israeli academic institutions that fill in gaps.
- d. The institute could offer a qualifying exam or exams in lieu of courses.

Recommendations

Short term [~ within 1-2 year]:

- a) **Major recommendation:** The department must put into place a structure that ensures that the M.Sc. program provides students with an education that meets the CHE standard.
- b) The department must establish a systematic academic advising system for first-year master's students.

5. Human Resources / Faculty

Observations and findings

The committee was impressed with the quality of the faculty at all levels.

6. Students

Observations and findings

The committee was impressed with the quality of the students at all levels.

As noted above, the committee observed that first-year master's students are sometimes poorly served by the current advising structure.

Recommendation

Short term [~ within 1 year]:

As noted above, the Institute must establish a systematic academic advising system for first-year master's students.

7. Teaching and Learning Outcomes

Observations and findings

The teaching and learning outcomes stated are appropriate, but no systematic effort has been made to determine whether they have been achieved.

Recommendation

Short term [~ within 1 year]:

Within a year, the department should set in place a process to reflect on the attainment of outcomes in a planned, periodic manner.

8. Research

Observations and findings

The institute's runs a focused computer science research program of the highest quality.

9. Infrastructure

Observations and findings

The infrastructure appears to be adequate.

10. Self-Evaluation Process

Observations and findings

A complete response to the issues raised in the 2006 report was not included in the self-evaluation report, which created some initial misunderstandings. However, the committee did obtain a copy of the response during the visit, which addressed the previous recommendations.

Overall, the institute did a good job addressing and implementing the previous committee's recommendations.

Chapter 4: Summary of Recommendations and Timetable

Short term [~ within 1-2 year]:

- a) **Major recommendation:** The department must put into place a structure that ensures that the M.Sc. program provides students with an education that meets the CHE standard.
- b) The department must establish a systematic academic advising system for first-year master's students.
- c) Within a year, the department should set in place a process to reflect on the attainment of outcomes in a planned, periodic manner.

Signed by:



Prof. Maurice Herlihy
Committee Chair



Prof. Robert L. Constable



Prof. Dmitry Feichtner-Kozlov



Prof. Kraus Sarit



Prof. Joe Turner, Jr.



Prof. Moshe Vardi

Appendix 1: Letter of Appointment



הוועדה לתכנון ותקצוב | Planning & Budgeting Committee

12.5.2013
Jerusalem

Professor Maurice Herlihy
Computer Science Department
Brown University
USA

Dear Professor Herlihy,

The Israeli Council for Higher Education (CHE) strives to ensure the continuing excellence and quality of Israeli higher education through a systematic evaluation process. By engaging upon this mission, the CHE seeks to enhance and ensure the quality of academic studies, provide the public with information regarding the quality of study programs in institutions of higher education throughout Israel, as well as ensure the continued integration of the Israeli system of higher education in the international academic arena.

As part of this most important endeavor we reach out to world-renowned scientists to help us meet the critical challenges confronting Israeli higher education by extending our invitation to participate in an international evaluation committee. This process represents an opportunity to assess the current state of the field and plan for the future. This systematic process of quality assessment also establishes a framework for the interactive consultative process taking place between scientists around the globe regarding common academic dilemmas.

It is with great pleasure that I hereby appoint you to serve as chair of the Council for Higher Education's Committee for the Evaluation of Computer Science. The composition of the Committee will be as follows: Professor Maurice Herlihy, Committee Chair, Professor Moshe Vardi, Professor (Emeritus) Joe Turner Jr., Professor Robert L. Constable, Professor Sarit Kraus, Professor David Dobkin, and Professor Dmitry Feichtner-Kozlov.

Ms. Yael Herzstein will coordinate the Committee's activities.

In your capacity as Chair of the Evaluation Committee, you will be requested to function in accordance with the enclosed appendix.

I deeply appreciate your willingness to join us in this crucial enterprise.

I wish you much success in your role as the Chair of this most important committee.

Sincerely,


Dr. Avital Stein
Director General,
The Council for Higher Education

Enclosures: Appendix to the Appointment Letter of Evaluation Committees

cc: Ms. Michal Neumann, The Quality Assessment Division
Ms. Yael Herzstein, Committee Coordinator

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Appendix 2: Site Visit Schedule

Weizmann Institute of Science

Monday, January 13, 2014 All meetings will be held in room 261, Ziskind Building

09:00-09:30	Dean, Feinberg Graduate School Director, Feinberg Graduate School	Prof. Irit Sagi Dr. Ami Shalit
09:30-10:00	Dean, Mathematics and Computer Science Head, Department of Computer Science & Applied Mathematics Head, Department of Mathematics	Prof. David Peleg Prof. Uriel Feige Prof. Sergei Yakovenko
10:00-10:30	Chair, Board of Studies in Mathematics and Computer Science	Prof. Itai Benjamini
10:30-11:15	Senior Faculty Members	Prof. David Harel, Prof. Shimon Ullman, Prof. Zvi Artstein , Prof. Vered Rom-Kedar Prof. Retsef Levi (Adjunct)
11:15-12:00	Junior Faculty Members	Dr. Shahar Dobzinski, Dr. Rami Aizenbud, Dr. Yaron Lipman, Dr. Dmitry Gourevitch
12:00-12:45	Alumni	
12:45-13:45	Lunch (closed door meeting of the committee)	
13:45-14:30	Tour of the facilities	
14:30-15:15	MSc Students	
15:15-16:00	PhD Students	
16:00-16:15	Closed-door Working Meeting of the Committee	
16:15-16:45 Summary	Dean, Feinberg Graduate School Dean, Mathematics and Computer Science Chair, Board of Studies in Mathematics and Computer Science Director, Feinberg Graduate School	Prof. Irit Sagi Prof. David Peleg Prof. Itai Benjamini Dr. Ami Shalit

* The heads of the institution and academic unit or their representatives will not attend these meetings.

** The visit will be conducted in English with the exception of students who may speak in Hebrew and anyone else who feels unable to converse in English.

Appendix 3: CHE standards for studies in Computer Science

CHE decision of 17.7.08 regarding standards for Computer Science Studies

Bachelor's Degree Programs

A. Graduates

1. In determining these criteria, the committee felt that it would be beneficial to define the "final product", or the ideal graduate of a Computer Science bachelor's degree program:
2. A graduate has an in-depth understanding of Computer Science Theory, Computational Theory, Computational Mathematics, and staunch mathematical knowledge.
3. A graduate has broad knowledge in Computer Science applications (programming languages, software engineering, operations systems and computer design).
4. A graduate is capable of joining development teams in computer-related high-tech industries.
5. A graduate is able to carry out computer-based industrial projects.
6. A graduate is competent in applied analytics, and is capable of developing and integrating effective algorithms in software systems.
7. A graduate has independent study skills and can prepare Computer Science presentations.
8. A graduate is aware of the effects of computerization on individuals, organizations and on society, as well as its ethical, legislative and political ramifications.
9. Excellent graduates are capable of continuing their studies in master's degree programs.
10. To assure that their graduates attain these capabilities, bachelor's degree programs must adhere to the following criteria:

B. Curricula

Programs must include required courses as well as an adequate selection of elective courses.

1. Required (core) courses should include:
 - Advanced-level mathematics courses, taught by experienced Ph.D.-level mathematics professors. These should include: Discrete Mathematics, Calculus, Algebra and Introduction to Probability.
 - Courses in Computer Science Theory, including: Automata Theory (or a similar subject), Data Structure, Algorithmic Theory and Computational Theory.
 - At least one seminar and one applications project that includes accepted industry development processes.
 - Applied Computer Science courses in Programming Languages, Software Engineering, Operating Systems, Computer Design and Logical Content.
2. The program should offer as many elective courses as possible in Computer Science and related fields (Economics, Management, Mathematics), as well as Humanities courses, to provide a well-rounded education.
3. The programs should encourage independent study.

C. Students, Teaching and Learning

1. Institutions must adhere to the CHE admissions regulation requiring a matriculation certificate.
 2. Students who matriculated in mathematics at a 3-unit level will not be admitted unless they complete (passing a final exam) a preparatory course at the 4 or 5-unit level.
 3. "Conditional" admissions should not comprise more than 10% of all admissions.
 4. Departments will present detailed support programs for weak students admitted on special terms.
 5. Departments will determine rigorous requirements for continuing studies, and coherent diploma eligibility guidelines.
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6. Departments will maintain adequate teaching assistant staff, and present detailed programs for providing students with feedback and appropriate laboratory experience.
7. At least 80% of required courses will be taught by full-time faculty.

D. Faculty

1. New programs will require at least six senior Ph.D.-level faculty members; three at the program's inception and an additional two to three before the program start its third "cycle" of admissions and as a condition for final/permanent accreditation.
2. Programs will not get final/permanent accreditation if they lack the requisite number of full-time faculty members to teach at least 80% of the required courses.
3. The student-to-faculty ratio will not exceed 50:1 at colleges and 25:1 at research universities.

D. Infrastructure

The institutions must provide adequate facilities for all programs and faculty research – laboratories, appropriate computers, adequate technical support, up-to-date libraries, fully equipped classrooms, secretarial staff and adequate, fully-equipped faculty office space.

Master's Degree Programs

A. Graduates - General

1. Demonstrates good Self Study Abilities.
2. Has depth and systematic understanding of knowledge in academic discipline.
3. Has comprehensive theoretical and applied knowledge in a wide range of Computer Science topics.

B. Graduates – Research-based Master's Degree

1. Able to undertake independent research and present outcomes in writing.
2. Able to use full range of learning resources relevant to the research topic.
3. Has depth and systematic understanding of knowledge in academic discipline.
4. Excellent graduates should be able to continue their studies toward doctoral degrees.

C. Non-Research Master's Degrees

These programs will be offered predominantly at colleges, while universities will offer non-research master's degree programs only to students who can not complete their research projects, or to excellent students whose research results permit continuing directly to doctoral degree programs.

Non-research master's degree programs "produce" graduates with a broad knowledge base and a high level of applications experience, who are increasingly in demand in today's complex computer science market.

The committee found that the grade average in master's degree programs (research and non-research) at all of the universities is exceedingly high. To solve this problem, the committee recommends that at least 50% of required courses in master's degree programs should be advanced graduate-level courses.

The Council for Higher Education approved detailed requirements for accreditation of non-research master's degree programs (the decision taken on July 15, 2003 is attached). All these in addition to the following criteria:

1. Programs should include a major (year-long) applications project.
 2. Master's degree students will be required to submit a final paper and/or pass a qualifying exam, to cover all of the Computer Science subjects studied.
 3. At least 70% of the required courses in master's degree programs will be advanced graduate-level courses.
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D. Research-based Master's Degree Programs

The Council for Higher Education approved detailed requirements for accreditation of research-based master's degree programs at non-university institutions of higher education (the decision taken on October 10, 2004 is attached). All these in addition to the following criteria:

1. Research-based master's degree programs at academic institutions will not be approved unless the faculty includes, at colleges - at least ten full-time senior faculty members at Ph.D. level and involved in active research, and at universities, twenty faculty members with these qualifications.
2. Departments will establish academically acceptable approval procedures for research proposals, and follow-up and final approval procedures.
3. Thesis advisors will be Ph.D.-level faculty members at the rank of Lecturer at least.
4. The total number of advisees (master's and doctoral candidates) per faculty member will be limited to 5-7. Exceptional cases must be approved by special committee.
5. At least 70% of the required courses in master's degree programs will be advanced graduate-level courses.

Appendix 4: List of offered M.Sc. Courses

Here is the complete list of computer science courses offered in academic years 2011-2013:

- Advanced Algorithms
- Coping with NP-hardness
- Introduction to Statistical Machine Learning
- Theoretical Cryptography
- Computational Geometry
- Foundation of Privacy
- Introduction to Machine Vision
- Introduction Pseudorandomness and Derandomization
- Practical Cryptography
- Distributed Network Algorithms
- Introduction to Complexity - Reading Group
- Introduction to Complexity II - Reading Group
- Introduction to Machine Learning and Statistics
- Randomized Algorithms
- Topics in Circuit Lower Bounds
- Algorithmic Game Theory
- Information Theory and Applications