UNIVERSITY OF MIAMI
FACULTY SENATE

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# MEMORANDUM

**To:** Julio Frenk
University President

**From:** Linda L. Neider
Chair, Faculty Senate

**Date:** April 27, 2020

**Subject:** Faculty Senate Legislation #2019-75(B) – Adding a Data Science Track to the Bachelor's in Science (BS) in Computer Science Program Major – College of Arts and Science

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The Faculty Senate, at its April 22, 2020 meeting, had no objections to the approval of the College of Arts and Sciences proposal for an addition of a data science track to the computer science major. The proposed track is a repackaging of existing courses.

The proposal is enclosed for your reference.

This legislation is now forwarded to you for your action.

LLN/ss/rh

cc: Jeffrey Duerk, Executive Vice President and Provost
Leonidas Bachas, Dean, College of Arts and Sciences
Geoff Sutcliffe, Chair, Computer Science Department, College of Arts and Science

**CAPSULE:** Faculty Senate Legislation #2019-75(B) – Adding a Data Science Track to the Bachelor's in Science (BS) in Computer Science Program Major – College of Arts and Science

**PRESIDENT'S RESPONSE**

APPROVED: ________________________ DATE: 5/20/20
(President's Signature)

OFFICE OR INDIVIDUAL TO IMPLEMENT: Dean Leonidas Bachas, College of Arts & Sciences

EFFECTIVE DATE OF LEGISLATION: _______IMMEDIATELY__________
(Pending any further Board of Trustees approval.)

NOT APPROVED AND REFERRED TO: ______________________________

REMARKS (IF NOT APPROVED):____________________________________

# Program Change Request

Date Submitted: 12/17/19 2:08 pm

## In Workflow

1. **PG CSC UG Director**
2. **PG CSC Chair**
3. **PG AS Sr Admin I**
4. **PG AS Dean**
5. **PG Assessment and Accreditation**
6. **PG FS Office for UCC**
7. **PG University Curriculum Committee**
8. **PG FS Office for GWC**
9. PG FS GWC
10. PG Faculty Senate
11. PG FS Office for President
12. PG Registrar

## Approval Path

1. 12/17/19 2:44 pm Victor Milenkovic (vmilenkovic): Approved for PG CSC UG Director
2. 12/17/19 2:46 pm Geoff Sutcliffe (gsutcliffe): Approved for PG CSC Chair
3. 01/15/20 2:27 pm Patty Murphy (pxm491): Rollback to PG CSC Chair for PG AS Sr Admin I
4. 01/15/20 2:32 pm Geoff Sutcliffe (gsutcliffe): Approved for PG CSC Chair
5. 01/31/20 8:42 am Charles Mallery (cmallery): Rollback to PG CSC Chair for PG AS Sr Admin I
6. 01/31/20 8:50 am Geoff Sutcliffe (gsutcliffe): Approved for PG CSC Chair
7. 01/31/20 8:56 am Charles Mallery (cmallery): Approved for PG AS Sr Admin I
8. 03/16/20 1:22 pm Leonidas Bachas

Viewing:

(l.bachas): Approved for PG AS Dean

9. 03/16/20 2:45 pm Patty Murphy (pxm491): Rollback to PG AS Dean for PG Assessment and Accreditation
10. 03/20/20 1:24 pm Leonidas Bachas (l.bachas): Approved for PG AS Dean
11. 03/20/20 3:07 pm Patty Murphy (pxm491): Approved for PG Assessment and Accreditation
12. 03/20/20 3:08 pm Patty Murphy (pxm491): Approved for PG FS Office for UCC
13. 03/27/20 11:53 am David Chin (dchin1): Approved for PG University Curriculum Committee

### History

1. Dec 3, 2019 by Jenny Vargas (j.zwanziger)

# COMP_BS,COMP1_BS,COMP1_BS_P,COMP2_BS,COMP3_BS,COMP4_BS,COMP6_BS,COMP : B.S. in Computer Science

Last approved: 12/03/19 3:41 pm

Last edit: 03/16/20 2:44 pm

Changes proposed by: Geoff Sutcliffe (gsutcliffe)

| | |
|---|---|
| Catalog Pages Using this Program | B.S. in Computer Science |

*Please list the authors of this proposal including name, rank/title, program/department, and school.*

| | |
|---|---|
| Proposer(s) Name | Geoff Sutcliffe, Professor, Department of Computer Science |
| Change Type | All Other Changes |
| Provide a brief summary of the change | Adding a new Data Science track |
| Career | Undergraduate |
| Academic Structure | |

| School/ College | Department |
|---|---|
| College of Arts and Sciences | Computer Science |

Plan Type Major and/or Degree

Who can take this program? **Any Student at University of Miami**

Degree Type Bachelor's

Degree Name B.S.

Proposed Plan Code COMP7_BS and COMP7_AS_A

Plan Name B.S. in Computer Science

Will there be any subcomponents within the program such as concentrations, specializations, thesis/non-thesis options, or tracks?

Yes

Subcomponents

| Subcomponent Type | Subcomponent Name |
|---|---|
| Track | Comprehensive Track |
| Track | Flexible Track |
| Track | Computational Science Track |
| Track | Cryptography and Security Track |
| Track | Graphics and Games Track |
| **Track** | **Data Science Track** |

Effective Term Fall 2020

First Term Valid Fall 2020

Program Instruction Mode In Person

Where is the program offered?

| Location | Please provide the % of instruction at each location. |
|---|---|
| Coral Gables Campus | 100 |

Program Length (Years) 4

Total Credits 120

Areas of Knowledge

STEM

### To Be Published in the Academic Bulletin

Program Overview

## Overview

**The major in Computer Science for BS students consists of a core of 23 credits of Computer Science courses, 17 credits of Mathematics courses (which may apply towards a mathematics minor), 17 credits from a chosen track, and 12-14 credits of required science and ethics courses.**

~~Overview~~

Program Mission Statement

## Mission

The Department's mission is to educate and perform scholarly activities in the discipline of Computer Science, in order to meet national and international demand for trained computer scientists who are capable of building the robust computation structures upon which society is becoming increasingly dependent.

Program Goals

## Goals

Students will acquire understanding and capability for the structure and developmental processes of software systems, from the translation of domain problems to forms amenable to software solution, through the production of efficient and robust computer programs, to the supporting systems and hardware components.
Students will acquire these abilities through a combination of classroom instruction, laboratory work, independent project work, and group project work.
Graduates will be prepared to work in industries that are directly involved in the development of fundamental computing resources (e.g., Microsoft, Apple, IBM, Intel, etc.), and in industries that rely on computation in support of their core businesses (e.g., banking, transport, manufacturing, medical, etc.).
Faculty and students will engage in activities that support and achieve the development of new techniques and software that can contribute to the science, and where appropriate contribute to the teaching objectives. Examples of such activities include academic research, development of novel techniques and software products, consulting and internship activities in local industries, and maintaining awareness of cutting edge approaches to Computer Science.

Student Learning Outcomes

## Student Learning Outcomes

Students must be able to translate domain problems to forms amenable to software solution.
Students must be able to produce efficient and robust computer programs.
Students must be able to build and deploy a completed, integrated, and documented (Advanced Writing and Communication Skills) software solution to a domain problem.
Students must have understanding and competence in the mathematical foundations of Computer Science.

Curriculum Requirements

## Curriculum Requirements for B.S. in Computer Science and for Additional Major in Computer Science with Tracks

Course List

| Code | Title | Credit Hours |
|---|---|---|
| Core Computer Science Courses | | |
| CSC 120 | Computer Programming I | 4 |
| CSC 220 | Computer Programming II | 4 |
| CSC 314 | Computer Organization and Architecture | 3 |
| CSC 317 | Data Structures and Algorithm Analysis | 3 |
| CSC 322 | System Programming | 3 |
| CSC 427 | Theory of Computing | 3 |
| CSC 431 | Introduction to Software Engineering | 3 |
| Core Mathematics Courses 1 | | |
| MTH 161 | Calculus I (or equivalent - MTH 140 and MTH 141, MTH 151, or MTH 171) | 4 |
| MTH 162 | Calculus II (or equivalent - MTH 172) | 4 |
| MTH 210 | Introduction to Linear Algebra | 3 |
| MTH 224 | Introduction to Probability and Statistics | 3 |
| MTH 309 | Discrete Mathematics I | 3 |
| Tracks | | |
| Select one of the following Tracks: | | 17 |
| Comprehensive Track: 2,3 | | |
| CSC 419 | Programming Languages | |
| or CSC 546 | Introduction to Machine Learning with Applications | |
| CSC 421 | Principles of Computer Operating Systems | |
| CSC 423 | Database Systems | |
| CSC 424 | Computer Networks | |
| Select a minimum of 5 credit hours of approved electives | | |
| Flexible Track: 2 | | |
| Select a minimum of 17 credit hours of approved electives | | |
| Computational Science Track: 4 | | |
| CSC 210 | Computing for Scientists | |
| CSC 528 | Introduction to Parallel Computing | |
| CSC 547 | Computational Geometry | |

| Code | Title | Credit Hours |
|---|---|---|
| CSC 548 | Bioinformatics Algorithms | |
| CSC 410 | Computer Science Project Planning | |
| or CSC 411 | Computer Science Project Implementation | |
| MTH 320 | Introduction to Numerical Analysis | |
| or MTH 520 | Numerical Linear Algebra | |
| BIL 150 | General Biology 5 | |
| BIL 151 | General Biology Laboratory 5 | |
| Cryptography and Security Track: 4 | | |
| CSC 421 | Principles of Computer Operating Systems | |
| CSC 424 | Computer Networks | |
| CSC 507 | Data Security and Cryptography | |
| CSC 410 | Computer Science Project Planning | |
| or CSC 411 | Computer Science Project Implementation | |
| MTH 461 | Survey of Modern Algebra | |
| or MTH 505 | Theory of Numbers | |
| or MTH 561 | Abstract Algebra I | |
| Select a minimum of 2 credit hours of approved electives | | |
| Graphics and Games Track: 4 | | |
| CSC 329 | Introduction to Game Programming | |
| CSC 529 | Introduction to Computer Graphics | |
| CSC 545 | Introduction to Artificial Intelligence | |
| CSC 410 | Computer Science Project Planning | |
| or CSC 411 | Computer Science Project Implementation | |
| Select a minimum of 5 credit hours of approved electives 5 | | |
| PHY 201 | University Physics I for the Sciences 6 | |
| or PHY 221 | University Physics I | |
| **Data Science Track: 4** | | |
| **CSC 315** | **Introduction to Python for Scientists** | |
| MTH 542 | Statistical Analysis | |
| **CSC 546** | **Introduction to Machine Learning with Applications** | |
| **CSC 410** | **Computer Science Project Planning** | |
| **CSC 411** | **Computer Science Project Implementation** | |
| **Select a minimum of 6 credit hours of approved electives** | | |
| Science & Ethics Requirement | | |
| An approved two semester sequence of courses with laboratory in Biology, Chemistry, Physics, or Geological Sciences | | 8-11 |
| PHI 115 | Social and Ethical Issues in Computing | 3 |
| Approved Electives | | |
| Any CSC 2XX, CSC 3XX, CSC 4XX, CSC 5XX 7, 8 | | |
| BTE 535 | Information Security | |
| BTE 565 | Mobile to Cloud: Developing Distributed Applications | |
| ECE 414 | Computer Organization and Design | |
| ECE 514 | Computer Architecture | |
| ECE 548 | Machine Learning | |
| ECE 553 | Neural Networks | |
| ECE 570 | Network Client-Server Programming | |
| ECE 572 | Object-Oriented and Distributed Database Management Systems | |
| ECE 574 | Agent Technology | |
| ECE 576 | Internet and Intranet Security | |
| ECE 577 | Data Mining | |
| ECE 481 | Senior Project I 9 | |
| ECE 482 | Senior Project II 9 | |
| MTH 320 | Introduction to Numerical Analysis | |
| MTH 505 | Theory of Numbers | |
| MTH 520 | Numerical Linear Algebra | |
| MTH 521 | Numerical Methods in Differential Equations | |
| MTH 524 | Introduction to Probability | |
| MTH 525 | Introduction to Mathematical Statistics | |
| **MTH 542** | **Statistical Analysis** | |
| Additional Requirements for the B.S. 10 | | |
| ENG 105 | English Composition I | 3 |
| ENG 106 | English Composition II | 3 |
| Language Requirement | | 3-9 |

| Code | Title | Credit Hours |
|---|---|---|
| Arts and Humanities Cognate | | 9 |
| People and Society Cognate | | 9 |
| Electives | | 25-16 |
| Total Credit Hours | | 120 |

1 These mathematics courses can also fulfill the requirements for a Minor in Mathematics (see here for details).
2 Available to all students.
3 The Comprehensive Track provides coverage of the topics in Computer Science prescribed by the Association of Computing Machinery curriculum and the ABET Computing Accreditation Commission.
4 Requires permission of the Director of Undergraduate Studies.
5 In addition to the generally approved electives, CIM 423, CIM 433, MMI 504, and MMI 505 are approved for the Graphics and Games track.
6 In addition to the generally approved electives, JMM 429 is approved for the Data Science track.
7 This course may also be applied towards the Science requirement.
8 CSC 40X - Computer Science Practicum must be taken at the same time as host course.
9 Maximally 6 credit hours from CSC 481 - Computer Science Teaching Assistant.
10 ECE 481 and ECE 482 may be used to replace any requirement for CSC 410 and CSC411.
**11 For the Additional Major in Computer Science, with Tracks, students not in the College of Arts and Sciences should use the requirements of their school or college's degree in place of the additional requirements listed here.**

Plan of Study

## Suggested Plan of Study

Plan of Study Grid

| | | |
|---|---|---|
| Year One | | |
| Fall | | Credit Hours |
| CSC 120 | Computer Programming I | 4 |
| MTH 161 | Calculus I | 4 |
| ENG 105 | English Composition I | 3 |
| Language Course | | 3 |
| Elective | | 3 |
| | Credit Hours | 17 |
| Spring | | |
| CSC 220 | Computer Programming II | 4 |
| MTH 162 | Calculus II | 4 |
| ENG 106 | English Composition II | 3 |
| Language Course | | 3 |
| Elective | | 3 |
| | Credit Hours | 17 |
| Year Two | | |
| Fall | | |
| CSC 314 | Computer Organization and Architecture | 3 |
| MTH 309 | Discrete Mathematics I | 3 |
| BIL or CHM or PHY Course I | | 4 |
| BIL or CHM or PHY Associated Lab I | | 1 |
| Language Course | | 3 |
| | Credit Hours | 14 |
| Spring | | |
| CSC 322 | System Programming | 3 |
| MTH 210 | Introduction to Linear Algebra | 3 |
| BIL or CHM or PHY Course II | | 4 |
| BIL or CHM or PHY Associated Lab Course II | | 1 |
| PHI 115 | Social and Ethical Issues in Computing | 3 |
| | Credit Hours | 14 |
| Year Three | | |
| Fall | | |
| CSC 317 | Data Structures and Algorithm Analysis | 3 |
| CSC 401 | Computer Science Practicum I | 1 |
| CSC 423 | Database Systems | 3 |
| MTH 224 | Introduction to Probability and Statistics | 3 |
| People and Society Cognate Course | | 3 |

| | |
|---|---|
| Writing Intensive Course | 3 |
| Credit Hours | 16 |
| Spring | |
| CSC 424 Computer Networks | 3 |
| CSC 427 Theory of Computing | 3 |
| ENG 233 Advanced Writing for STEM | 3 |
| Arts and Humanities Cognate Course | 3 |
| People and Society Cognate Course | 3 |
| Credit Hours | 15 |
| Year Four | |
| Fall | |
| CSC 421 Principles of Computer Operating Systems | 3 |
| Computer Science Elective | 3 |
| CSC 405 Computer Science Seminars | 1 |
| Arts and Humanities Cognate Course | 3 |
| People and Society Cognate Course | 3 |
| Credit Hours | 13 |
| Spring | |
| CSC 419 Programming Languages | 3 |
| CSC 431 Introduction to Software Engineering | 3 |
| Arts and Humanities Cognate Course | 3 |
| Elective | 3 |
| Elective | 3 |
| Credit Hours | 15 |
| Total Credit Hours | 121 |

## Rationale

Rationale

Data Science is a broad term referring to scientific investigations through analysis of datasets that are large in size, heterogeneous in nature, in multiple formats, coming from disparate data sources. Analysis of data sets can find new correlations, revealing emerging business trends and opportunities, and leading to new scientific discoveries. Professionals in many parts of society, including scientists, business executives, practitioners of media and advertising, and government analysts, regularly have difficulties with large data sets in areas such as internet search, finance, healthcare, and business. The ability to analyze large and complex data sets accurately for modeling and prediction leads to more confident decision-making, and better decisions can mean greater operational efficiency, cost reduction, and reduced risk.
The new track in Data Science will serve students who wish to use computing techniques to analyze large amounts of data. The track will include 11 credits of core skill courses, and 6 credits of data science application courses.

Market Demand

Many large companies today have data science departments. Data scientists who can not only perform various data analysis techniques but also are able to interpret the results by drawing on their domain knowledge into actionable items are in high demand, as executives seek talented individuals capable of unlocking the hidden value in big data to garner strategic insights and business results. The challenges of modern data science require data scientists to possess strong training in both data analysis technologies and also domain specific issues. The Harvard Business Review has dubbed data science as “the sexiest job of the 21st century.”

Relationship to Other Programs

The track in Data Science will naturally feed into our recently approved MS in Data Science.

Library Resources Available and Needed to Support the Program

No new resources required.

Laboratory Facilities, Equipment, and Space Available and Needed to Support the Program

The Department of Computer Science has the necessary space and equipment to support the track.

Other Resources Available or Needed to Support the Program

No further resources required.

## Curriculum

Program Curriculum

Upload Syllabi for Any New Courses

Proposed Schedule of Course Offerings for the First Three Years

## CIP Code

Proposed CIP Code

## Faculty

Program Directors

Upload CV(s)

Program Faculty

## Students

Applicant Pool

Enrollment Projections

## Administration

Program Administration

## Comparison

Peer Comparisons

## Documents

Attach Supporting Documentation BSDSTrack.pdf

Reviewer Comments **Geoff Sutcliffe (gsutcliffe) (12/17/19 2:46 pm):** Approved by a vote of the faculty of the Department of Computer Science.

**Charles Mallery (cmallery) (01/31/20 8:42 am):** Rollback: CIM shows CSC546 as not found.. could be typo... please correct and resubmit
**Geoff Sutcliffe (gsutcliffe) (01/31/20 8:50 am):** Fixed. Found CSC546 in the system now. It was approved by CCC on 2020/01/17.
**Patty Murphy (pxm491) (03/18/20 4:58 pm):** The proposed track is just a repackaging of existing courses. It does not require notification to or approval from SACSCOC.
**Leonidas Bachas (l.bachas) (03/20/20 1:24 pm):** The Arts and Sciences faculty voted to approve this proposal on February 18, 2020. I support the proposed program change
**David Chin (dchin1) (03/27/20 11:53 am):** On 3/25/20 the University Curriculum Committee voted to support this proposal as submitted.

Key: 445

iThis document shows the prerequisites in []s, and the electives for the DS track

Required (11 credits)
CSC315 - Python for Scientists - 3 credits. [CSC2XX, MTH161/MTH210, MTH224]
   NOTE: Can be taken split as CSC125 (1 credit) and CSC498 (2 credits)
CSC546 - Machine Learning [MTH210, MTH224]
      or ECE548 - Machine Learning [ECE218 or MTH309 or CSC220]
MTH542 - Statistical Analysis [MTH210, MTH224]
      or IEN312 - Applied Statistical Methods [IEN310 or IEN311]
CSC410 - Computer Science Project Planning (1 credit)
CSC411 - Computer Science Project Implementation (1 credit)

Electives (6 credits)
CSC210 - Computing for Scientists [MTH161]
ECE572 - NoSQL Database Management Systems [TBA]
CSC528 - Introduction to Parallel Computing [CSC317]
CSC545 - Introduction to Artificial Intelligence [CSC317, MTH224]
      or ECE537 - Principles of Artificial Intelligence [ECE218 or CSC220]
CSC546 - Deep Learning [CSC317, MTH210, MTH224]
CSC549 - Biomedical Data Science [CSC120 or BIL150]
CSC550 - Computational Neuroscience [CSC120, CSC210, MTH224]
CSC595 - GPU Programming [??]
CSC5XX - Data Mining [CSC317] (Mitsu's new course)
      or ECE577 - Data Mining [ECE467 or CSC423]
JMM429 - Interactive Data Visualization
MAS432 - Data Analysis [IEN312 or MAS202 or MAS 312. MTH224 is not enough]