UNIVERSITY OF MIAMI
FACULTY SENATE

The John Knoblock
Faculty Senate Office

Ashe Administration Building, #325
1252 Memorial Drive
Coral Gables, Florida 33146

facsen@miami.edu
fs.miami.edu
Ph: 305-284-3721
Fax: 305-284-5515

*REVISED MEMORANDUM

To: Julio Frenk
University President

From: Linda L. Neider
Chair, Faculty Senate

Date: November 22, 2019, April 8, 2020

Subject: Faculty Senate Legislation #2019-38(B) – Creation of a Master of Science (MS) in Data Science with Tracks, College of Arts and Sciences

****

The Faculty Senate, at its November 20, 2019 meeting, approved unanimously the creation of a new Master of Science in Data Science with tracks in the College of Arts and Sciences. This new degree program will offer several optional tracks. This program is an interdisciplinary program focused on professional training and will utilize existing course offerings from multiple colleges and schools.

Successful completion of the program will require 30 credit hours that will include 12 credit hours of courses focused on data science tools, 6 credit hours of course focused on data science applications, and 3–6 credit hours of an internship or project. Students will be required to choose one of several tracks: 1) Individualized track; 2) Technical Data Science track; 3) Smart Cities track; 4) Data Visualization track; or 5) Marine and Atmospheric Science track.

The program will be administered by the College of Arts and Sciences, jointly with the academic units that offer the courses. A body of industrial board members will provide professional advice regarding the program content, and will assist in internship placement.*

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
Mitsunori Ogihara, Professor, College of Arts and Sciences
Geoff Sutcliffe, Professor, College of Arts and Sciences
Maryann Tobin, Executive Director of Programs, College of Arts and Sciences

* this section is revised.

CAPSULE: Faculty Senate Legislation #2019-38(B) – Creation of a Master of Science in Data Science, College of Arts and Sciences

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 additional approval by the Board of Trustees)

NOT APPROVED AND REFERRED TO: _____

REMARKS (IF NOT APPROVED):_____

UNIVERSITY OF MIAMI

Proposal Submission Checklist

Proposals are to be submitted to the Office of Assessment and Accreditation (OAA), if applicable, the Graduate Council (for graduate programs excluding Law and Medical), if applicable, and the Faculty Senate. Refer to the Procedures for Program Changes document for information on the approvals and notifications needed for program changes and the Proposal Submissions Specifications document for an explanation of the process and a list of the materials required.

(Please note that change approvals can take 2 semesters to complete.)

Include this checklist at the beginning of each proposal.
(Complete the information below, save the form as a pdf, and insert it with the background materials that are specified, in the order listed, and send the package electronically as noted above.)

KEY CONTACT PERSONNEL INFORMATION

First Name	Last Name	Proponent's Title
Mitsunori	Ogihara	Professor

Department, if applicable	School/College
Computer Science	Arts and Sciences

E-mail	Phone
ogihara@cs.miami.edu	3052842308

Title of Proposal

Master of Science in Data Science

(-continue to next page-)

MANDATORY MEMORANDA AND FORMAT

Please check that each item listed below is included in the proposal package of materials, in the ORDER as listed. The applicable title (i.e. Letter of Explanation, Memo from the Dean, etc.) is to precede each section in the materials.

Only proposals conforming to this format will be accepted.

1. This completed checklist.

2. Letter of explanation. (2-3 pages only, double spaced, 12 pt font)

◉ Yes ○ No

If no, explain why.

3. A memo from the dean(s) signifying approval of the faculty of the relevant School(s) / Colleges(s).

◉ Yes ○ No

If no, explain why.

4. A memo that all affected or relevant School / College Council(s) have approved.

◉ Yes ○ No

If no, explain why.

5. A memo from the department chair(s) signifying approval of the faculty of the relevant department(s).

◉ Yes ○ No

If no, explain why.

6. A memo from the Office of Accreditation and Assessment (OAA) if the proposal involves academic programs (degrees, certificates, majors, minors, concentrations, specializations, tracks, etc.) such as new programs, closing programs, or program changes (such as changes in requirements, program length, modality, name, location).

(To be submitted by OAA to the Graduate Council or the Faculty Senate, as appropriate.)

◉ Applicable ○ Not applicable.

If not, explain why.

7. A memo from the Graduate School Dean signifying approval of the Graduate Council (for graduate programs only).
(To be submitted to the Faculty Senate by the Graduate Council.)

◉ Applicable ○ Not applicable.

If not, explain why.

8. Academic Deans Policy Council (ADPC) approval, for interdisciplinary issues and as appropriate. Please consult with the Dean of the Graduate School or the Secretary of the Faculty Senate to check if this is needed.

◉ Yes ○ No

If no, explain why.

9. Additional required documents as listed on the "Proposal Submissions Specifications," i.e. market analysis, budget information, assessment of library collections, etc. as specified.

List additional documents included.

A market analysis is included in the proposal. A proposed budget will be included separately.

End form.

PROPOSAL

MASTER OF SCIENCE IN DATA SCIENCE

Questions about the program should be directed to:

Dr. Mitsunori Ogihara, Professor
Department of Computer Science
#305-284-2308
ogihara@cs.miami.edu

Dr. Maryann Tobin, Executive Director of Programs
College of Arts & Sciences
#305-284-3737
met@miami.edu

Executive Summary

The Master of Science in Data Science is an interdisciplinary graduate program that combines the teaching of domain-specific and technical skills for analyzing large data sets. Built upon a core of foundational data science courses in Computer Science, Engineering, and Mathematics, and a selection of courses from data science application domains, the program is interdisciplinary in nature. Students interested in data science tools will be able to focus on tool principles and tool development, and students interest in data science applications will be able to focus on the application of data science tools with a selection of courses that develop skills in one of three application areas. The program also provides its students the option of doing an industrial internship, to acquire professional experience. The program allows the various academic units involved to add courses in their specific application domains, thus keeping the program updated and relevant to current practice and industrial needs. The program is both academic and professional in nature, providing courses that are true to a Master's level degree, and courses that reflect the needs of the profession.

The objectives of the program are as follows:

- To teach students programming skills not only for understanding the computer programs they use but also for getting started in developing their own programs
- To teach students mathematical and statistical foundations sufficient for understanding the underlying algorithms and the models developed
- To teach students how to turn domain questions into scientific investigations and how to interpret the results in their respective domain
- To teach practical problem-solving skills through an internship or project

The curriculum consists of three components: data science tool courses, data science application courses, and an internship/project/capstone. Students must complete at least 30 credits of graduate level courses to complete the degree. Credit can be given for prior study. Each student's selection of courses must be approved by a member of the administrative group (to avoid course overlap, ensure coherence, etc.). Several tracks have been defined to provide focused study within the general requirements of the degree. Students may choose to follow a track, or may build their own individualized program in consultation with their advisor.

Students in this program are likely to come from a range of backgrounds, however, they must meet specified minimum quantitative GRE requirements. We aim to attract students with interests in data mining, artificial intelligence, visualization, smart cities, media, geographic information systems, and climate modeling.

The program will be administered by the College of Arts and Science, jointly with the academic units that offer the courses (Computer Science - College of Arts and Sciences, Electrical and Computer Engineering - College of Engineering, Mathematics – College of Arts and Science, School of Architecture, Meteorology and Physical Oceanography - RSMAS, Journalism and Media Management - School of Communication). A body of industrial board members will provide professional advice regarding the program content, and will assist in internship placement.

The University of Miami Library system holdings and online resources are adequate to support this program. As the courses that comprise the program are already in existence, the various departments have adequate facilities, equipment, and space for the teaching. The Center for Computational Sciences (CCS) will provide additional computing resources to the departments. The College of Arts and Sciences will also collaborate with CCS in program advertisement, prospective student engagement, and internship placement. The program uses existing courses, and courses that the various academic units are already committed to creating, so that there is no budget required for course creation.

Revenue distribution: 30% of tuition revenue from all Master's degree programs returns to the Academy net of any waivers or scholarships. After that, a fixed amount will be charged to cover the costs of administering the program. After that all income will be distributed to the colleges and schools whose academic units teach the program's courses, according to the number of credit hours taught per student. Each college and school will distribute income to the academic units according to their individual college and school policies.

This budgetary arrangement will be reviewed annually to ensure that all parties are being compensated appropriately for their efforts.

UNIVERSITY OF MIAMI
COLLEGE of
ARTS & SCIENCES

Office of the Dean 1252 Memorial Drive
Ashe Building, Suite 227
Coral Gables, Florida 33146

Ph: 305-284-4117
Fax: 305-284-5637
as.miami.edu

November 1, 2019

To: Linda Neider
Chair, Faculty Senate

In response to the request made by the Graduate Council in their approval memo dated October 15, 2019, a letter of support from the Dean of the School of Communication has been added and non-relevant letters referencing the previous versions of the proposal have been removed.

Lastly, summary statements are included (grouped for efficiency) explaining the relevance of each letter of support.

Respectfully,

Maryann Tobin, Ph.D.
Executive Director of Programs

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memos from the **College of Arts & Sciences**

- Dean Leonidas Bachas (dated April 2018)
  - This is the required memo confirming that the faculty of the College of Arts & Sciences voted to support this proposal
- Dean Leonidas Bachas (revised Sept 2019)
  - Because the chair of the Faculty Senate requested a revision of the administrative structure of the proposal - with the program administration changing from the Center for Computational Studies to the College of Arts & Sciences - the faculty of the College of Arts & Sciences voted to accept that revision and move the proposal forward.
- Associate Dean Charles Mallery (email)
  - This email confirms that the Curriculum Committee of the College of Arts & Sciences approved the proposal
- Dr. Geoff Sutcliffe, Chair, Department of Computer Science
  - This is the required memo from the Responsible Academic Unit, confirming the support of the faculty of the Department of Computer Science. Dr. Mitsunori Ogihara will represent the College of Arts and Sciences on the Data Science Advisory Board
- Dr. Stephen Cantrell, Chair, Department of Mathematics
  - As mathematics and statistics courses are part of the core requirements for this degree, this memo confirms the support of the Department of Mathematics
- Dr. Ira Sheskin, Chair, Department of Geography & Regional Studies
  - Electives in geospatial technology are available to students in this program, particularly those in the Data Visualization track, therefore this memo confirms the support of the Department of Geography and Regional Studies

UNIVERSITY OF MIAMI
COLLEGE of
ARTS & SCIENCES

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To: Tomas Salerno
Chair, Faculty Senate

From: Leonidas Bachas
Dean, College of Arts and Sciences

Subject: New Degree Program:
Master of Science in Data Science

Date: April 3, 2018

Dear Tom,

I am writing to express my full support of the proposal for a new Master of Science (MS) in Data Science. On April 3, 2018, the faculty of the College of Arts and Sciences unanimously voted in favor of this new degree program, offered by the Department of Computer Science in cooperation with the Center for Computational Science. I am now forwarding the proposal to the Senate for action.

For your convenience, attached you will find a copy of the proposal. If you have any questions, please feel free to contact me.

LGB/mtt

UNIVERSITY OF MIAMI
COLLEGE of
ARTS & SCIENCES

Office of the Dean 1252 Memorial Drive
Ashe Building, Suite 227
Coral Gables, Florida 33146

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Fax: 305-284-5637
as.miami.edu

To: Linda Neider, Ph.D.
Chair, Faculty Senate

From: Leonidas Bachas, Ph.D.
Dean, College of Arts and Sciences

Subject: Revision to the administrative structure of the proposed Master of Science in Data Science

Date: September 19, 2019

Dear Linda,

Based on a review of the administrative structure originally drafted in the Proposal to Establish as Master of Science in Data Science, the proponents have modified the proposal so that all administration of the degree takes place entirely within the College of Arts & Sciences with the collaboration with the interdisciplinary Faculty Advisory Board.

At a regular faculty meeting, on September 17, 2019, the faculty of the College of Arts and Sciences unanimously voted that the proposal may move forward, with that modification, to Graduate Council.

If you have any questions, please feel free to contact me.

LGB/mtt

Monday, March 12, 2018 at 9:05:39 AM Eastern Daylight Time

Subject: Fwd: Master of Science in Data Science Proposal
Date: Monday, March 12, 2018 at 8:33:42 AM Eastern Daylight Time
From: Mallery, Charles H.
To: Tobin, Maryann
Attachments: y.MSDS-final-09mar18.pdf

Sorry,

forgot to include you on the final CCC approved version.

Thanks, Charles Mallery

associate dean, college of arts & sciences
Merrick bldg., room 304 - (305) - 284-3188 - cmallery@miami.edu

Begin forwarded message:

From: "Charles H. Mallery" <cmallery@miami.edu>
Subject: Master of Science in Data Science Proposal
Date: March 12, 2018 at 8:31:41 AM EDT
To: Rose-Ketlie Glemaud <rglemaud@miami.edu>
Cc: Geoffrey Sutcliffe <g.sutcliffe@miami.edu>

Rose,

At its regularly scheduled meeting on 09 March 2018 the College's Curriculum Committee reviewed and approved the proposal for MS in Data Science.

Attached please find a pdf file with the proposal and all its supporting documentation for consideration by the College Council and faculty of the College.

Thanks, Charles Mallery

associate dean, college of arts & sciences
Merrick bldg., room 304 - (305) - 284-3188 - cmallery@miami.edu

UNIVERSITY OF MIAMI

Department of Computer Science

POSTAL ADDRESS	TELEPHONE	FACSIMILE	EMAIL
P.O. Box 248154 Coral Gables Florida 33124 USA	+1 305 2842158 +1 305 2842268	+1 305 2842264	geoff@cs.miami.edu

1st September 2019

To: Whom it May Concern
From: Geoff Sutcliffe
Subject: Master of Science in Data Science

This letter confirms the support of the Department of Computer Science for the Master of Science in Data Science, proposed by the Department of Computer Science in conjunction with the Center for Computational Sciences and other units of the university. The Department of Computer Science is pleased to have courses in the program.

Regards,

Geoff Sutcliffe
Professor and Chair of Computer Science

UNIVERSITY OF MIAMI
COLLEGE of
ARTS & SCIENCES

Department of Mathematics
P.O. Box 249085
Coral Gables, FL 33124-4250

Phone: 305-284-2575
Fax: 305-284-2848
math@math.miami.edu

To: Leonidas G. Bachas, Dean
College of Arts & Sciences

Nick Tsinoremas, Director
Center for Computational Science

From: Robert Stephen Cantrell, Chair
Department of Mathematics

Date: February 13, 2018

Subject: Letter of Support for the Master of Science in Data Science

I am writing to express the support of my Departmental colleagues and myself for the Master of Science in Data Science proposed jointly by the Department of Computer Science at the College of Arts & Sciences and the Center for Computational Science.

Our department has agreed to provide courses for this interdisciplinary program, as outlined in the proposal. We are pleased to participate in this new degree.

Regards,

Robert Stephen Cantrell, Ph.D.
Professor and Chair
Department of Mathematics

UNIVERSITY
OF MIAMI

Department of Geography and Regional Studies
1300 Campo Sano
University of Miami
Coral Gables, FL 33124-2221

April 3, 2018

To: Geoff Sutcliffe, Chair
Department of Computer Science

From: Ira Sheskin, Chair
Department of Geography and Regional Studies

This letter confirms the support of the Department of Geography and Regional Studies for the Master of Science in Data Science proposed to be housed under the Department of Computer Science in conjunction with the Center for Computational Science and other units of the university. The Department of Geography and Regional Studies is glad to offer courses to support this program.

Regards,

Dr. Ira Sheskin
Chairperson
Department of Geography and Regional Studies

IMS/mtt

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memo from the **School of Architecture**

Dean Rodolphe el-Khoury is a member of the Data Science Advisory Board and will oversee the concentration in Smart Cities. His support memo is included to confirm that the School of Architecture will participate in the program, offering courses for the concentration in Smart Cities.

UNIVERSITY OF MIAMI
SCHOOL of
ARCHITECTURE

P.O. Box 249178
Coral Gables, Fl 33124

Phone: 305-284-3731
Fax: 305-284-2999
www.arc.miami.edu

December 11, 2017

Re: Letter of Support
Master of Science in Data Science

To: Geoff Sutcliffe, Nick Tsinoremas

This letter confirms the support of the School of Architecture for the Master of Science in Data Science proposed to be housed in the Department of Computer Science in conjunction with the Center for Computational Science, the School of Communication, the Rosenstiel School of Marine and Atmospheric Science and other units of the university. The interdisciplinary design of the Master in Data Science program is extremely valuable for students who seek to combine rigorous technical training with data science applications in architecture. The School of Architecture has been an integral collaborator in the process of creating the Master in Data Science program, and is pleased to have a track in Smart Cities as part of the program.

Regards,

Rodolphe el-Khoury, PhD
Dean and Professor

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memos from **RSMAS**

Dr. Ben Kirtman is a member of the Data Science Advisory Board and will oversee the concentration in Marine and Atmospheric Sciences. His support memo is included to confirm that the Rosenstiel School of Marine and Atmospheric Sciences will participate in the program, offering courses for the concentration in Marine and Atmospheric Sciences.

Additionally, at the suggestion of the GWC, a letter of support from the director of the Meteorology and Physical Oceanography program, Dr. Mohamed Iskandarani of the Department of Ocean Sciences, was added to this proposal on 11/14/19.

UNIVERSITY OF MIAMI
ROSENSTIEL
SCHOOL of MARINE &
ATMOSPHERIC SCIENCE

Department of Atmospheric Sciences
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149, USA

Phone: 305-421-4046 Email: bkirtman@rsmas.miami.edu

2 November 2017

To: Geoff Sutcliffe, Nick Tsinoremas

This letter confirms the support of the Department of Atmospheric Science/Rosenstiel School of Marine and Atmospheric Science for the Master of Science in Data Science proposed to be housed under the Department of Computer Science in conjunction with the Center for Computational Sciences and other units of the university. The Department of Atmospheric Science/Rosenstiel School of Marine and Atmospheric Science is pleased to have courses in the program.

If you need any further information, please do not hesitate to contact me either by phone (305-421-4046), fax (305-421-4696) or by e-mail (bkirtman@rsmas.miami.edu).

Sincerely,

Ben Kirtman
Professor, Department of Atmospheric Sciences
Director, Cooperative Institute for Marine and Atmospheric Studies
Rosenstiel School of Marine and Atmospheric Sciences
Program Director, Climate and Environmental Hazards
Center for Computational Science
University of Miami

To: Leonidas Bachas, Ph.D.
Dean, College of Arts and Sciences

From: Mohamed Iskandarani, PhD
Graduate Program Director, Meteorology and Physical Oceanography

Subject: Master of Science in Data Science

Date: November 14, 2019

This letter confirms the support of the Meteorology and Physical Oceanography Graduate Program for the new interdisciplinary Master of Science in Data Science proposed by the College of Arts & Sciences.

This graduate degree program is of extreme importance to our students and the University as a whole. It represents a concerted effort towards interdisciplinarity across units, and RSMAS is proud to have been an integral part of this proposal, the Center for Computational Science, and other collaborations across the university in the area of data science. We are enthusiastic about this new degree, and gladly offer courses to support the program, specifically the track in Marine and Atmospheric Sciences, as outlined in the proposal.

Regards,

Dr. Mohamed Iskandarani
Professor, Department of Ocean Sciences

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memo from the **School of Communication**

Dean Karen Wilkins' support memo is included to confirm that the School of Communication will offer courses to support the concentration in Data Visualization. The Data Visualization concentration will be supervised by Professor Alberto Cairo, who is a member of the Data Science Advisory Board.

UNIVERSITY OF MIAMI
SCHOOL of
COMMUNICATION

Office of the Dean
5100 Brunson Drive
Coral Gables, FL 33146-2105

Phone: 305-284-3420
Fax: 305-284-2454
www.com.miami.edu

MEMORANDUM

October 21, 2019

To: Linda Neider, Chair
Faculty Senate

From: Karin Gwinn Wilkins, Dean
School of Communication

Re: New Degree Program - Master of Science in Data Science

Recently I have been made aware of a proposed Master of Science (MS) degree in Data Science. I have been in touch with our recent Dean, Greg Shepherd, to learn more about the history of this proposal and our School's connection with this program. I am glad to support this graduate degree proposal. I believe this will be a quality program, with compelling content. I look forward to seeing this implemented.

Thank you for the opportunity to comment.

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memos from the **College of Engineering**

- Dean Daniel Berg
  - This memo is included to confirm the support of the College of Engineering, which will offer core courses, as well as electives and courses to support the concentration in Technical Data Science. The College of Engineering will be represented on the Data Science Advisory Board by Dr. Mei-Ling Shyu, professor of Electrical and Computer Engineering.
- Dr. Mohamed Abdel-Mottaleb, Chair, Department of Electrical and Computer Engineering
  - This email confirms that the Department of Electrical and Computer Engineering also supports the proposal and will offer core courses and electives.

UNIVERSITY OF MIAMI
COLLEGE of ENGINEERING

Daniel Berg, Ph.D.
Interim Dean

1251 Memorial Drive
MEB Room 255
Coral Gables, Fl 33146

Ph: 305-284-6035
Fax: 305-284-2885
dberg@miami.edu

To: Linda Neider
Chair, Faculty Senate

From: Daniel Berg Daniel Berg
Interim Dean, College of Engineering

Subject: New Degree Program:
Master of Science in Data Science

Date: August 20, 2019

Dear Linda,

I am writing to express my full support of the proposal for a new Master of Science (MS) in Data Science. This joint effort will be supported within the College of Engineering by Dr. Mohamed Abdel-Mottaleb and the Department of Electrical and Computer Engineering through core courses and courses in the Technical Data Science track.

Please feel free to contact me with any questions.

UNIVERSITY OF MIAMI
COLLEGE of ENGINEERING

Electrical and Computer Engineering Department
P.O. Box 248294
Coral Gables, FL 33124

Ph: 305-284-3291
Fax: 305-284-4044
ece.dept.um@miami.edu
www.miami.edu/ece

To: Mitsunori Ogihara
Department of Computer Science
College of Arts and Sciences

Geoff Sutcliffe
Department of Computer Science
College of Arts and Sciences

From: Mohamed Abdel-Mottaleb
Department of Electrical and Computer Engineering
College of Engineering

Date: 09/1/2019

Subject:Letter of Support for the Master of Science in Data Science

I am writing this letter to express my support and the support of the department of Electrical and Computer Engineering for the Master of Science in Data Science proposed jointly by the College of Arts and Sciences and the Center for Computational Science.

We agreed to provide courses for this interdisciplinary program as outlined in the proposal and to have a representative in the administrative group. We are enthusiastic to participate in the program.

Best regards,

Sincerely,

M Saeed

Dr. Mohamed Abdel-Mottaleb,
Professor and Chairman
Dept. of Electrical & Computer Engineering

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memo from the **Department of Educational and Psychological Studies, School of Education and Human Development**

Dr. Soyeon Ahn, chair of the Department of Educational and Psychological Studies (EPS), provides a support memo to confirm that her department will offer core courses for the degree. The EPS department will also propose a future concentration in Educational Measurement and Statistics. Dr. Cengiz Zopluoglu will represent the School of Education and Human Development on the Data Science Advisory Board.

Educational & Psychological Studies
5202 University Drive Merrick Bldg.
Suite 310-G
Coral Gables, FL 33146

UNIVERSITY OF MIAMI
SCHOOL of EDUCATION
& HUMAN DEVELOPMENT

October 15, 2018

To: Geoff Sutcliffe, Ph.D., Chair, Department of Computer Science
Mitsunori Ogihara, Ph.D., Professor of Computer Science

From: Soyeon Ahn, Ph.D., Chair, Department of Educational and Psychological Studies

cc: Cengiz Zoplugolu, Ph.D., Program Director, Research, Measurement, and Evaluation
Laura Kohn-wood, Ph.D., Dean, School of Education and Human Development

Subject: Letter of Support for the Master of Data Science Program

This letter confirms the conditional support from the Department of Educational and Psychological Studies for the Master of Data Science Program that are proposed to be administered jointly by the Department of Computer Science and the Center for Computational Sciences. I would like to thank you for discussing the possibilities, and considering of adding a track in Educational Measurement and Statistics into the program once the program is up and running. We look forward to working with you together in adding this track into your program and offering other coursework that will be relevant to students in this program.

Sincerely,

Soyeon Ahn, Ph.D.

Chair, Department of Educational and Psychological Studies;
Associate Professor, Research, Measurement, and Evaluation (RME) Program;
Director, Statistical Supporting Unit (STATS-U);
School of Education and Human Development
University of Miami
P.O. Box 248065
Coral Gables, FL 33124-2040
Tel: 305-284-1316
Fax: 305-284-3003

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memo from the **Department of Public Health Sciences, Miller School of Medicine**

Dr. Sunil Rao, chair of the Department of Public Health Sciences, includes a memo to confirm that the Department of Public Health Sciences supports the degree proposal and plans to propose a future concentration in Biostatistics.

UHealth
UNIVERSITY OF MIAMI HEALTH SYSTEM

UNIVERSITY OF MIAMI
MILLER SCHOOL
of MEDICINE

September 21, 2018

To: Mitsunori Ogihara, Ph.D.
Professor of Computer Science

Subject: Letter of Support for the Master of Data Science Program

I am writing to express my enthusiastic support for the Master of Data Science Program to be run jointly by the Department of Computer Science and the Center for Computational Sciences. I want to thank you personally for inviting a Biostatistics track into the program once the program is up and running. We very much look forward to participating in that capacity as well as offering coursework that will be of relevance to the data science students in general.

Sincerely,

J. Sunil Rao, Ph.D.,
Interim Chair, Department of Public Health Sciences
Professor & Director, Division of Biostatistics,
University of Miami Miller School of Medicine

Department of Public Health Sciences
Don Soffer Clinical Research Building (DSCRB), 9th & 10th Floors (Locator code R669)
1120 NW 14th Street • Miami, FL 33136
Phone: (305) 243-6312
publichealth.med.miami.edu

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memo from the **Center for Computational Science (CCS)**

Dr. Nick Tsinoremas, Director of the Center for Computational Science, includes a memo to confirm that CCS will be partners in this interdisciplinary degree program. While the Department of Computer Science will be the Responsible Academic Unit and the College of Arts & Sciences will administer the degree, CCS will provide resources and assistance as needed. The Data Science Advisory Board is comprised of members of the CCS and the Industry Advisory Board is an extension of the CCS' community connections.

UNIVERSITY OF MIAMI

CENTER for COMPUTATIONAL SCIENCE

Nicholas Tsinoremas, PhD
Founding Director
Professor of Medicine
Professor of Computer Science
Professor of Health Informatics
ntsinoremas@miami.edu
Gables One Tower, Suite 600 T 305.243.4962
1320 S Dixie Highway (Locator Code 2965) F 305.243.9732
Coral Gables, FL 33146-2926 ccs.miami.edu

December 11, 2017

Dean Leonidas Bachas
Ashe Administration Building
1252 Memorial Dr, Room 227
Coral Gables, Florida 33146-2509

Dear Dean Bachas,

This letter confirms the support of the Center for Computational Science for the Master of Science in Data Science proposed to be housed under the Department of Computer Science in conjunction with the Center for Computational Science and other units of the university. The Center for Computational Science is happy to administer the program and offer the use of computing resources as needed.

Regards,

Nick Tsinoremas, Ph.D.
Center Director

LETTERS OF SUPPORT
MASTER OF SCIENCE IN DATA SCIENCE

Support memos from the **Industry Board Members**

- The Center for Computational Science regularly convenes this advisory board.
- They will be consulted for their industry expertise and have offered to provide internship opportunities to our students.
- The following Industry Board members have provided letter of support:
    - Hector Irizarry, Thinergistics
    - Matthew Pape, Ryder System, Inc.
    - Gang Wang, Royal Caribbean Cruise Lines
    - Daniel Cohen, MasterCard
    - Pete Martinez, GameChangerTEC
    - Louis Gidel, Baptist Hospital
    - Renee Lopez-Cantera, Eikon Digital
    - Erika Twani, Learning One-to-One

THINERGISTICS
Strategic Technology Solutions

Letter of Support for the Professional Master in Data Science program

I, as a member of the University of Miami Center for Computational Science Big Data Advisory Board, are writing to express full support for the Professional Master in Data Science Program proposed as a collaboration between the College of Arts and Sciences, the School of Communication, the School of Architecture, the Rosenstiel School of Marine and Atmospheric Science, the College of Engineering, and the Center for Computational Science at the University of Miami.

As a key member of a wide range of industries in the South Florida region, I have first-hand experience of the needs that this program seeks to fill.

Every industry, without exception, can benefit from leveraging available data in driving decisions in areas such as the optimization of operations, marketing, human resource management, and many others. Technological developments have made possible the handling of data at larger and larger scales in both volume and complexity. These computational resources create the potential for any organization to dive into data to extract useful, actionable insights. However, for this potential to be realized, industries need an expert workforce, one that is both trained in the computational tools and with a deep understanding of the unique features that represent each domain.

Multiple universities have begun to respond to the changing landscape by creating graduate programs in Data Science. However, these programs often lean heavily towards either the technical or the domain skills, and have yet to successfully integrate the two. We believe that establishing the Master of Data Science program at UM as a collaboration between multiple Schools and Colleges will successfully address this challenge of integration and produce individuals who are highly skilled in both the technical computational competencies *and* in each of their domains. In doing so, the proposed program has the potential to establish the University of Miami as a leader in data science not only in South Florida, but nationwide.

As a CCS Big Data Advisory board member, I am eager to support the Professional Master in Data Science program in the following ways: (a) by providing insight to the Program Directors with respect to the skills that would increase the employability of the program graduates, and in doing so shaping the curriculum, and (b) by providing paid 6-month internship opportunities for students in the proposed program at my organization, including co-mentoring of the student by a member of the organization in addition to the student's academic advisor.

We eagerly anticipate collaborating with the program Steering Committee and the Program Directors on establishing the Master of Data Science program at UM.

Sincerely,

Hector Irizarry

Partner & Co-Founder

T: (305) 390-2550 | F: (305) 386-7474 | www.thinergistics.com | P.O. Box 160397, Miami, FL 33116

Ryder
Logistics & Transportation Solutions Worldwide

January 5, 2018

Dr. Nick Tsinoremas
Executive Director
UM Center for Computational Science
1320 S. Dixie Highway Suite 600
Coral Gables, FL 33146

RE: Professional Master in Data Science program

I, as a member of the University of Miami Center for Computational Science Big Data Advisory Board, am writing to express my complete and unequivocal support for the Professional Master in Data Science Program proposed as a collaboration between the College of Arts and Sciences, the School of Communication, the School of Architecture, the Rosenstiel School of Marine and Atmospheric Science, the College of Engineering, and the Center for Computational Science at the University of Miami.

As a key member of the South Florida industrial community, I have first-hand experience of the needs that this program seeks to fill, including right here on my own team. Every industry, without exception, can benefit from leveraging available data in driving decisions in areas such as the optimization of operations, marketing, human resource management, and many others. Technological developments have made possible the handling of data at larger and larger scales in both volume and complexity. These computational resources create the potential for any organization to dive into data to extract useful, actionable insights. However, for this potential to be realized, industries need an expert workforce, one that is both trained in the computational tools and with a deep understanding of the unique features that represent each domain.

Many universities, including several right here in the local community, have sprung to the challenge by creating graduate programs in Data Science. However, these programs often lean heavily towards either the technical or the domain skills, and have yet to successfully integrate the two. We believe that by establishing the Master of Data Science program at UM as a collaboration between multiple Schools and Colleges, UM will successfully address this challenge of integration and produce individuals who are highly skilled in both the technical computational competencies *and* in each of their domains. In so doing, the proposed program has the potential to establish the University of Miami as a leader in data science not only in South Florida, but nationwide.

As a CCS Big Data Advisory board member, I am eager to support the Professional Master in Data Science program in the following ways: (a) by providing insight to the Program Directors with respect to the skills that would increase the employability of the program graduates, and in doing so shaping the curriculum, and (b) by providing potential internship opportunities for students in the proposed program at my organization, including co-mentoring of the student by a member of the organization in addition to the student's academic advisor.

I enthusiastically look forward to collaborating with the program Steering Committee and the Program Directors on establishing the Master of Data Science program at UM.

Most Sincerely,

Matthew R. Pape
Director, Market Data Analytics & Insights
Ryder System, Inc.
Global Marketing Department
11690 NW 105th Street
Miami, Florida 33178

Royal Caribbean International
1050 Caribbean Way
Miami, Florida 33132
tel 305 539 6000
www.royalcaribbean.com

Letter of Support for the Professional Master in Data Science program

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As a CCS Big Data Advisory board member, I am eager to support the Professional Master in Data Science program in the following ways: (a) by providing insight to the Program Directors with respect to the skills that would increase the employability of the program graduates, and in doing so shaping the curriculum, and (b) by providing paid 6-month internship opportunities for students in the proposed program at my organization, including co-mentoring of the student by a member of the organization in addition to the student's academic advisor.

We eagerly anticipate collaborating with the program Steering Committee and the Program Directors on establishing the Master of Data Science program at UM.

Sincerely,

Gang Wang, Ph.D.
Director, Operations Data & Analytics
Royal Caribbean International
(305) 982-2195 | gwang@rccl.com

Daniel Cohen
Senior Vice President
MasterCard
Latin America & the Caribbean Region
801 Brickell Avenue, Suite 1300
Miami, Florida 33131-4945

Letter of Support for the Professional Master in Data Science program

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As a CCS Big Data Advisory board member, I am eager to support the Professional Master in Data Science program in the following ways: (a) by providing insight to the Program Directors with respect to the skills that would increase the employability of the program graduates, and in doing so shaping the curriculum, and (b) by providing paid 6-month internship opportunities for students in the proposed program at my organization, including co-mentoring of the student by a member of the organization in addition to the student's academic advisor.

We eagerly anticipate collaborating with the program Steering Committee and the Program Directors on establishing the Master of Data Science program at UM.

Sincerely,

Daniel Cohen
SVP DIGITAL SOLUTIONS

GAMECHANGERTEC

March 7, 2018

Letter of Support for the Professional Master in Data Science program

I, as a member of the University of Miami Center for Computational Science Big Data Advisory Board, are writing to express full support for the Professional Master in Data Science Program proposed as a collaboration between the College of Arts and Sciences, the School of Communication, the School of Architecture, the Rosenstiel School of Marine and Atmospheric Science, the College of Engineering, and the Center for Computational Science at the University of Miami.

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As a CCS Big Data Advisory board member, I am eager to support the Professional Master in Data Science program in the following ways: (a) by providing insight to the Program Directors with respect to the skills that would increase the employability of the program graduates, and in doing so shaping the curriculum, and (b) by providing paid 6-month internship opportunities for students in the proposed program at my organization, including co-mentoring of the student by a member of the organization in addition to the student's academic advisor.

We eagerly anticipate collaborating with the program Steering Committee and the Program Directors on establishing the Master of Data Science program at UM.

Sincerely,

Pete Martinez

CEO

Game Changer Tec LLC.

Baptist Health South Florida

6855 Red Road
Miami, FL 33143

BaptistHealth.net

March 5, 2018

Letter of Support for the Professional Master in Data Science program

I, as a member of the University of Miami Center for Computational Science Big Data Advisory Board, are writing to express full support for the Professional Master in Data Science Program proposed as a collaboration between the College of Arts and Sciences, the School of Communication, the School of Architecture, the Rosenstiel School of Marine and Atmospheric Science, the College of Engineering, and the Center for Computational Science at the University of Miami.

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Every industry, without exception, can benefit from leveraging available data in driving decisions in areas such as the optimization of operations, marketing, human resource management, and many others. Technological developments have made possible the handling of data at larger and larger scales in both volume and complexity. These computational resources create the potential for any organization to dive into data to extract useful, actionable insights. However, for this potential to be realized, industries need an expert workforce, one that is both trained in the computational tools and with a deep understanding of the unique features that represent each domain.

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As a CCS Big Data Advisory board member, I am eager to support the Professional Master in Data Science program in the following ways: (a) by providing insight to the Program Directors with respect to the skills that would increase the employability of the program graduates, and in doing so shaping the curriculum, and (b) by providing paid 6-month internship opportunities for students in the proposed program at my organization, including co-mentoring of the student by a member of the organization in addition to the student's academic advisor.

We eagerly anticipate collaborating with the program Steering Committee and the Program Directors on establishing the Master of Data Science program at UM.

Sincerely,

Louis T. Gidel, M.D., PhD., FCCP
Chief Medical Informatics Officer
Chief Quality Officer
Medical Director of Telehealth
eICU Medical Director
Transfer Center Medical Director

Mitsunori Ogihara
Professor, Department of Computer Science
University of Miami
1365 Memorial Drive, Coral Gables, FL 33146

Dear Mitsu:

I am writing to express support for the Professional Master in Data Science Program proposed as a collaboration between the College of Arts and Sciences, the School of Communication, the School of Architecture, the Rosenstiel School of Marine and Atmospheric Science, the College of Engineering, and the Center for Computational Science at the University of Miami.

As a key member of a wide range of industries in the AdTech, Marketing, AI, and start up communities in the South Florida region, I have first-hand experience of the needs that this program seeks of fill.

All industries can benefit from leveraging available data in driving decisions in areas such as the optimization of operations, marketing, human resource management, and many others. Technological developments have made possible the handling of data at larger and larger scales in both volume and complexity. These computational resources create the potential for any organization to dive into data to extract useful, actionable insights. However, for this potential to be realized, industries need an expert workforce, one that is both trained in the computational tools and with a deep understanding of the unique features that represent each domain.

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As an advisory board member, I am eager to support the Professional Master in Data Science program in the following ways: (a) by providing insight to the Program Directors with respect to the skills that would increase the employability of the program graduates, and in doing so shaping the curriculum, and (b) by providing internship opportunities for qualified students in the proposed program at the organization where I work, including co-mentoring of the student by a member of the organization in addition to the student's academic advisor.

I eagerly anticipate collaborating with the program Steering Committee and the Program Directors on establishing the Master of Data Science program at UM.

Renee Lopez-Cantera

Renee Lopez Cantera

VP of Business Development
Eikon Digital

LEARNING ONE TO ONE FOUNDATION

Fort Lauderdale, FL, October 31, 2018

Mitsunori Ogihara
Professor, Department of Computer Science
University of Miami
1365 Memorial Drive, Coral Gables, FL 33146

Dear Dr. Ogihara:

I am writing to express full support for the Professional Master in Data Science Program proposed as a collaboration between the College of Arts and Sciences, the School of Communication, the School of Architecture, the Rosenstiel School of Marine and Atmospheric Science, the College of Engineering, and the Center for Computational Science at the University of Miami.

As a key member of of the EdTech community in the South Florida region, I have first-hand experience of the needs that this program seeks of fill. I believe AI is the fourth industrial revolution and it is here to stay. We must prepare our future professionals for this new normal.

Every industry, without exception, can benefit from leveraging available data in driving decisions in areas such as the optimization of operations, marketing, human resource management, and many others. Technological developments have made possible the handling of data at larger and larger scales in both volume and complexity. These computational resources create the potential for any organization to dive into data to extract useful, actionable insights. However, for this potential to be realized, industries need an expert workforce, one that is both trained in the computational tools and with a deep understanding of the unique features that represent each domain.

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As an industrial advisory board member, I am committed to support the Professional Master in Data Science program in the following ways: (a) by providing insight to the Program Directors with respect to the skills that would increase the employability of the program graduates, and in doing so shaping the curriculum; and (b) by helping the program facilitate a paid six-month internship opportunities for students in the proposed program either at my company or at my partner companies.

I eagerly anticipate collaborating with the program Administrative Committee and the Program Directors on establishing the Master of Data Science program at UM.

Sincerely,

Erika Twani
CEO, Learning One to One Foundation

UNIVERSITY OF MIAMI
GRADUATE SCHOOL

Graduate School
P.O. Box 248125
Coral Gables, FL 33124-3220

Phone: 305-284-4154
Fax: 305-284-5441
graduateschool@miami.edu

MEMORANDUM

DATE: October 15, 2019

TO: Linda Neider
Chair, Faculty Senate

FROM: Guillermo (Willy) Prado
Dean, Graduate School

SUBJECT: Proposal – Master of Science degree in Data Science

The College of Arts & Sciences submitted a proposal for a Master of Science degree in Data Science. The proposal was discussed at the meeting of the Graduate Council on Tuesday, October 15, 2019. The proposal was approved by all Council members present. The Graduate Council suggests that a letter from the Dean of the School of Communication be added to the proposal given that students will be taking courses from there. Also, the Graduate Council recommends that only those letters of support relevant to the current version of the proposal be included, along with a summary statement that precedes each letter explaining why that letter is being included.

CC: Leonidas Bachas, Dean, College of Arts & Sciences
Maryann Tobin, Executive Director of Programs, College of Arts & Sciences
Mitsunori Ogihara, Professor, Department of Computer Science
Geoff Sutcliffe, Chair, Department of Computer Science
Tiffany Plantan, Director of Education, Graduate School
Patty Murphy, Associate Provost for University Accreditation, Office of Assessment and Accreditation

UNIVERSITY
OF MIAMI

Assessment and Accreditation
Gables One Tower 1320 S. Dixie Hwy.
Coral Gables, Florida 33146

Phone: 305-284-5120
Fax: 305-284-4929
oaa.miami.edu

MEMORANDUM

DATE: April 9, 2018

TO: Maryann Tobin, Executive Director of Programs
College of Arts and Sciences

FROM: Patty Murphy, Executive Director
Office of Assessment and Accreditation

RE: **New MS in Data Science with Tracks**

On April 3, 2018, the College of Arts and Sciences notified my office of its intent to offer a new Master of Science (MS) degree program in Data Science which will include several optional tracks. The effective date will be Spring 2019. This program is an interdisciplinary program focused on professional training.

The proposed MS in Data Science program will require successful completion of 30 credit hours that include 12 credits hours of courses focused on data science tools, 6 credit hours of courses focused on data science applications, and 3-6 credit hours of an internship or project. Students will be required to choose one of several tracks: 1) Individualized track; 2) Technical Data Science track; 3) Smart Cities track; 4) Data Visualization track; or 5) Marine and Atmospheric Science track.

This interdisciplinary program will utilize existing course offerings from multiple colleges and schools. The Department of Computer Science in the College of Arts and Sciences will serve as the home department. Dr. Mitsunori Ogihara will oversee the program. Dr. Ogihara is a Professor of Computer Science in the department. He is also the Director of Data Mining in the Center for Computational Sciences and Associate Dean for Digital Library Innovation. He has a PhD in Information Technology from the Tokyo Institute of Technology in Japan. Professor Rodolphe el-Khoury, Dean of the School of Architecture, will provide additional oversight for the Smart Cities track. Dr. el-Khoury has a PhD in Architecture from Princeton. Albert Cairo in the Department of Journalism and Media Management in the School of Communication will provide additional oversight for the Visualization track. Cairo has an MA in Information Studies from the Universitat Politecnica de Catalunya (Spain). He is the author of two books on information graphics and professional experience in this area. Ben Kirtman in the Department of Meteorology and Physical Oceanography in RSMAS will provide additional oversight for the track in Marine and Atmospheric Science. Dr. Kirtman has a PhD in Meteorology and Physical Oceanography from the University of Maryland—Baltimore.

The Center for Computational Science will administer the program along with an administrative group comprising faculty from the academic units teaching within the program. The program will also have an industrial advisory board which will include representatives from program internship sites.

The proposed new program does not "represent a significant departure, either in content or method of delivery" from what we are currently approved by SACSCOC to offer due to the following:

- The proposed program meets the SACSCOC requirement of a minimum of 30 credit hours for a graduate program.
- The program is a repackaging of existing courses. No new courses are being added; although an elective may be developed in the future.
- The new program will be supported by current qualified faculty.
- The program will be coordinated by qualified faculty.
- The University is already approved by SACSCOC to award a Master of Science degree; this is a proposal for a new major within an existing degree.
- The University is currently approved to offer the following graduate programs in related areas:
    - MS in Business Analytics
    - MS in Computer Science
    - MFA in Interactive Media
- The majority of the program will not be offered via distance education and, in any case, the University is approved to offer 100% distance education programs.
- The program will be offered on the University's Coral Gables and Marine campuses.
- The graduate program covers the literature in the field through its required core coursework.
- The graduate program ensures ongoing student engagement in research and/or appropriate professional practice and training experiences through either a required internship or project.

SACSCOC only requires notification of program changes that represent a significant departure from our current programs. Therefore, no notification or approval is required for this change.

Please contact me if you have any questions at pattymurphy@miami.edu or (305) 284-3276.

CC: Faculty Senate
Guillermo Prado, Dean of the Graduate School
Leonidas Bachas, Dean of the College of Arts and Sciences
Geoff Sutcliffe, Chair, Department of Computer Science
Karen Beckett, University Registrar
Ray Nault, Executive Director of Student Financial Assistance and Employment

PROPOSAL

MASTER OF SCIENCE IN DATA SCIENCE

Name of the program for the Diploma:

Master of Science in Data Science

Name of the program on student transcripts:

Master of Science in Data Science

[and if they follow a track] with a Track in *Track Name*

Responsible administrative unit for the program:

Department of Computer Science

Proposed date for implementation:

Fall 2020

1. Rationale

a. Exact Degree Title.

The School of Architecture, College of Arts and Sciences, School of Communication, School of Education and Human Development, College of Engineering, and the Rosenstiel School of Marine and Atmospheric Science jointly seek to offer an interdisciplinary master's degree in cooperation with. The program will be administered by the College of Arts and Sciences (A&S). The degree with be titled the Master of Science (MS) in Data Science.

b. Purpose and Goals of the Degree.

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.

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. Founded on computer science, mathematics, statistics, and optimization techniques, data scientists add deep content knowledge in specialized applications such as communications, architecture, and marine sciences. Training data scientists requires an interdisciplinary approach that ensures that the students are well-trained and able to take up the role of data scientist in any organization. The Harvard Business Review has dubbed data science as "the sexiest job of the 21st century."

Data science consists of many steps. It starts with project conception then moves on to collection and harvesting data from possible data sources, preprocessing the collected and harvested data, integrating multiple data sets for analysis, conducting analysis for modeling and prediction, visualizing obtained results for interpretation, developing actionable plans from obtained results, and preserving the curated data. Because of the size and complexity of the data sets, traditional data processing tools (for example, those available in spreadsheet programs and statistical software) are inadequate. In practice, many of the steps in analyzing large data sets are done using purpose-specific computer programs that require more than a click of a button; they require a solid understanding of the principles that the computer programs embody.

c. Motivation and Demand

The position of Data Scientist is a growing job market. The need for data science and the shortage of data scientists are well articulated in various reports [Herold; Orihuele and Bass; Sents], including an in-depth analysis [McKinsey]. Those who suspect that data science is a "hype" warn that the demands for data scientists may lesson soon, when many of the by-hand tasks of the data analytics processes are incorporated into software tools [Darrow]. A counter argument is that while software tools become more intelligent, the size and complexity of the datasets keep increasing. The 2016 McKinsey Report states, "Back in 2011, the McKinsey Global Institute published a report highlighting the transformational potential of big data.1 Five years later, we remain convinced that this potential has not been overhyped. In fact, we now believe that our 2011 analyses gave only a partial view. The range of applications and opportunities has grown even larger today." The report estimates that there will be a shortfall of 250K data scientists, but 50% of the work could be automated. As of April, 2017, there are 35K job openings listed at Glassdoor.com and 11K job openings listed at LinkedIn.com. The median salary of data scientists is estimated to be around $118K while that of skilled programmers is estimated to be $65K, according to Wired.com. Thus, the market potential of data science degree programs appears to be high.

At least two dozen universities now have a Master of Science in Data Science (or a similar degree). The current offerors include: Arizona State (Business Analytics), Carnegie Mellon (Computational Data Science), Central Florida, Columbia, Cornell (MPS in Applied Statistics), Georgia Tech., Illinois at Urbana Champaign (Professional MS), Illinois Tech, Indiana, Johns Hopkins (online), Minnesota, NYU, North Carolina State (Analytics), Northwestern (Analytics), Rochester, Rutgers (MS Business and Science), San Francisco, Southern California, Stanford, Texas A&M (Analytics), UC Berkeley (online), UC San Diego (Analytics), Virginia, Washington – Seattle, and Wisconsin. The duration of these programs ranges from 10 to 12 months with specific guidelines from selected programs highlighted in Section 6 of this proposal.

Interdisciplinary master's degree programs with an emphasis on professional training already exist at the University of Miami. For example, the College of Arts & Sciences currently offers interdisciplinary professional master's degree programs in International Administration, Liberal Arts, Latin American Studies, and Mathematical Finance, as well as departmental professional master's degrees in Applied Behavior Analysis, Anthropology, Criminology and Criminal Justice, International Studies, and Public Administration. Additionally, the Professional Science Master's program at RSMAS prepares its students for science careers in industry, government, and nonprofit organizations, where employment demands are growing. The curricula are structured to allow students to complete their degree in as little as 12 months, with the training and internship experiences necessary to prepare them for careers in today's professional job market.

There are two existing UM master's degree programs whose contents have some overlap with the proposed program: Master of Science in Business Analytics (MSBA) in the School of Business and Master of Fine Arts in Interactive Media in the School of Communication. The MS in Data Science is distinctly different from these

other programs at the University of Miami, with a focus on teaching key skills for conducting *science* with data and a strong emphasis on *interdisciplinary* education. It will draw from a separate pool of potential students, and produce graduates with a different set of data science skills. As such, the students will emerge into different job markets, outside of communication, finance, and business. The University of Miami's PIRA office has confirmed the difference in the context of SACS accreditation.

2. Curriculum

a. List the major divisions of the discipline in which graduate degree work will be offered.

The program will be administered by the College of Arts and Sciences (A&S), jointly with the academic units that offer the courses (Department of Computer Science - College of Arts and Sciences, Department of Electrical and Computer Engineering - College of Engineering, Department of Mathematics - College of Arts and Science, School of Architecture, Department of Educational and Psychological Studies - School of Education and Human Development, the Meteorology and Physical Oceanography Program - RSMAS, Department of Journalism and Media Management - School of Communication). A&S will provide administration for the program, and will appoint a program coordinator. The program coordinator will be responsible for recruiting, finance, internships, and program administration. The initial administrative group is listed below. This degree, as all graduate degrees, will be granted by the Graduate School. Each track will be managed by a faculty representative in the respective School/College. For the purpose of SACS and internal reporting students in any given track will be counted among the graduate students in that School/College. Students will work with faculty advisors, appropriate to their track in the respective School/College. The program coordinator will be in regular contact with each faculty advisor and the Administrative Group. This is a groundbreaking interdisciplinary arrangement across multiple units, unlike anything that the University has attempted before. It should be understood that various university systems and procedures (e.g., Canelink, track plan codes, etc.) may need modifications in order to optimize the student experience.

- *Administrative Group*: This group will represent all the academic units teaching courses in the program, and will be in charge of overseeing the validity and health of the program. No changes can be made to the academic structure without approval of this group. These members will be in charge of advising their respective students. The current members are:
    - Prof. Alberto Cairo (Journalism and Media Management, School of Communications)
    - Prof. Ben Kirtman (Meteorology and Physical Oceanography, RSMAS)
    - Prof. Mitsunori Ogihara (Computer Science, College of Arts and Sciences)
    - Prof. Rodolphe el-Khoury (School of Architecture)
    - Prof. Mei-Ling Shyu (Electrical and Computer Engineering, College of Engineering)
    - Prof. Cengiz Zopluoglu (Educational and Psychological Studies, School of Education and Human Development)

- *Industrial Advisory Board*: The advisory board will consist of representatives from companies who are willing to take in and supervise interns from the program for six months. Presently the board members include:
    - Pete Martinez, Chairman and CEO, GameChangerTec
    - Hector Irizarry, Founding Partner, Thinergistics
    - Gang Wang, Manager, Operations & Analytics, Royal Caribbean Cruise Lines
    - Renee Lopez-Cantera, VP of Business Development, Eikon Digital
    - Matthew Pape, Director, Market Data Analytics & Insight, Ryder - Global Marketing
    - Louis Gidel, Chief Medical Informatics and Quality Officer, Baptist Health South Florida
    - Daniel Cohen, Senior Vice President, Digital Payments and Labs for MasterCard Latin America

and the Caribbean
- Erika Twani, CEO, Learning 1-to-1

b. Provide a detailed description of the proposed program.

The objectives of the program are as follows:

- To teach students programming skills not only for understanding the computer programs they use but also for getting started in developing their own programs
- To teach students mathematical and statistical foundations sufficient for understanding the underlying algorithms and the models developed
- To teach students how to turn domain questions into scientific investigations and how to interpret the results in their respective domain
- To teach practical problem-solving skills through an internship or project

3. Requirements

a. Prerequisites.

Admission to the program will be handled by A&S. Requirements are:

i. Completion of an application
ii. A Baccalaureate degree from an accredited institution
iii. A cumulative undergraduate GPA of 3.0
iv. Introduction to Probability and Statistics and Computer Programming I (or equivalents). Students may be admitted with deficiencies, which must be completed in addition to the degree requirements.
v. GRE general test scores
   a. Applicants must rank in the 65% percentile or higher in the Quantitative Reasoning test. There is no minimum score requirement for the other parts of the GRE.
vi. Students from non-English speaking countries must send either TOEFL or IELTS scores.
   a. TOEFL minimum score: Internet based - 92; Computer based - 237; Paper based - 580.
   b. IELTS minimum score: 6.5.
vii. A personal statement of intent in which the applicant details reasons for pursuing the degree.

b. Courses.

The curriculum consists of three components: data science tool courses, data science application courses, and an internship or project. Students must complete at least 30 credits of graduate level courses to complete the degree. Several tracks have been defined to provide focused study within the general requirements of the degree. Students may choose to follow a track, or may build their own individualized program in consultation with their advisor. Each student's selection of courses must be approved by a member of the administrative group (to avoid course overlap, ensure coherence, etc.).

Data Science Tools (at least 12 credits)

The core data science tool courses are discipline independent courses that teach the fundamental skills of data science.

- Technical Prerequisites
  CSC6XX Computing and Mathematics for Data Science
  (To be developed to provide prerequisite knowledge for students from a non-technical background. Not available to students who have the material from prior studies.)
- Core (9 credits)
  - Machine Learning or Data Mining (3 credits)
    CSC687 Machine Learning with Applications
    xor ECE648 Machine Learning
    xor ECE677 Data Mining
  - Data Visualization (3 credits)
    CSC688 Data Science and Visualization
    xor JMM622 Infographics and Data Visualization
  - Statistics (3 credits)
    IEN713 Applied Regression Analysis
    xor EPS702 Quantitative Methods II
    xor MTH642 Statistical Analysis
- Computer Science
  - Programming (at least 3 credits):
    CSC686 Programming in Python for Scientists

CSC632 Introduction to Parallel Computing
CSC640 Algorithm Design and Analysis
EPS704 R programming

- Database Systems
  - CSC623 Theory of Relational Databases
  - xor ECE672 Object-Oriented and Distributed Database Management Systems
  - ECE697 Advanced Big Data Analysis
- Machine Learning and Data Mining
  - CSC687 Machine Learning with Applications
  - CSC746 Neural Networks and Deep Learning
  - xor ECE653 Neural Networks
  - ECE648 Machine Learning
  - ECE677 Data Mining
  - ECE730 Statistical Learning
  - ECE753 Pattern Recognition and Neural Networks
- Data Visualization
  - CSC688 Data Science and Visualization
  - JMM622 Introduction to Infographics

- Mathematics and Statistics
  - EPS703 Multivariate Statistics
  - EPS705 Measurement and Psychometric Theory
  - EPS706 Categorical Data Analysis
  - EPS707 Item Response Theory
  - EPS708 Structural Equation Modeling
  - EPS709 Introduction to Multilevel Modeling
  - EPS709 Advanced Structural Equation Modeling
  - MTH624 Introduction to Probability Theory
  - MTH625 Introduction to Mathematical Statistics

Data Science Applications (at least 6 credits)

These are courses specific to application domains. Each academic unit offers courses relevant to their discipline, and students who are focused on applications will be advised to take a selection of courses that develops skills in one application area. Note that the courses listed here are only an initially available list, and the various application areas are expected to add more.

ARC594 GIS in Urban Design
ARC684 RAD LAB-UM
ARC685 BIM/Virtual Design and Construction
CSC645 Introduction to Artificial Intelligence
or ECE637 Principles of Artificial Intelligence
EPS711 Advanced Topics in Research, Measurement, and Evaluation
GEG680 Spatial Data Analysis I
JMM692 Interactive Data Visualization for the Web
Courses for the graduate programs in Atmospheric Science (ATM), Ocean Sciences (OCE) and Meteorology & Physical Oceanography (MPO)

Data Science Internship or Project or Capstone (3-6 credits)

- Internship: This is a three- or six-month internship. Three month internships are for 3 credits, and are done in either semester or the summer. Six month internships are for 6 credits, and are done either from spring to summer or from summer to fall. The academic unit responsible for the student

coordinates the internship with the program coordinator. The student is assigned an internship supervisor in the academic unit and also at the location of the internship. The internship culminates with a report detailing the work done and knowledge gained, and a presentation to faculty and students in the program. Appropriate courses codes will be created.

- Project: This a semester long individual or small group project for 3 or 6 credits, depending on the scope of the project. Projects are done within one or two semesters. The student will have one or more supervisors within an appropriate academic unit in the program. The project culminates with a report detailing the work done and knowledge gained, and a presentation to faculty and students in the program. Appropriate courses codes will be created.
- Capstone: This is a 3 credit culminating course, integrating the knowledge and experience gained in the more specific courses of a track. The course will normally be offered by one of the units that provides the track. It may include lectures, surveys, project work, and other components.

Tracks

- Technical Data Science (Department of Computer Science, Department of Electrical and Computer Engineering)
  - Core: (9 credits)
    CSC687 Machine Learning with Applications
    xor ECE648 Machine Learning
    xor ECE677 Data Mining
    CSC688 Data Science and Visualization
    xor JMM622 Introduction to Infographics
    MTH642 Statistical Analysis
  - Tools: (12 credits)
    (A) Programming:
    CSC686 Programming in Python for Scientists
    xor CSC632 Introduction to Parallel Computing
    xor CSC640 Algorithm Design and Analysis
    (B) Machine Learning:
    CSC687 Machine Learning with Applications
    xor CSC746 Neural Networks and Deep Learning
    xor ECE648 Machine Learning
    xor ECE730 Statistical Learning
    (C) Data Analysis:
    ECE697 Advanced Big Data Analytics
    xor ECE677 Data Mining
    (D) Statistics:
    MTH624 Introduction to Probability Theory
    xor MTH625 Introduction to Mathematical Statistics
  - Applications (6 credits)
  - Internship or project (3 credits)

- Smart Cities (School of Architecture)
  - Data Science Tools (12 credits)
    Core (9 credits)
    Programming (3 credits)
  - Data Science Applications (9 credits)
    ARC594 GIS in Urban Design
    ARC684 RAD LAB-UM
    ARC685 BIM/Virtual Design and Construction
  - Electives (3-6 credits)
    Tools or Applications courses selected in consultation with an advisor
  - Internship or project (3-6 credits)

- Data Visualization (School of Communication)
  - Data Science Tools (12 credits)
    - Core (9 credits)
    - Programming (3 credits)
  - Data Science Applications (9 credits)
    - CSC688 Data Science and Visualization
    - JMM622 Introduction to Infographics
    - JMM692 Interactive Data Visualization for the Web
  - Electives (3-6 credits)
    - Tools or Applications courses selected in consultation with an advisor. Students interested in spatial visualization may take any of the following electives:
    - GEG691 Geographic Information Systems I
    - GEG693 Geographic Information Systems II
    - GEG680 Spatial Data Analysis I
    - GEG681 Spatial Data Analysis II
  - Internship or project (3-6 credits)

- Marine and Atmospheric Science (RSMAS)
  - Data Science Tools (12 credits)
    - Core (9 credits)
    - Programming (3 credits)
  - Data Science Applications (15 credits)
    - Courses selected from the track course lists for the RSMAS Master of Professional Science (MPS)
    - program (http://mps.rsmas.miami.edu/degree-tracks/) in consultation with an advisor. For example, students interested in Applied Remote Sensing might take:
    - OCE642 Physics of Remote Sensing I: Passive Systems
    - OCE686 Applied Remote Sensing
    - OCE643 Physics of Remote Sensing II: Active Systems
    - OCE687 Applied Radar Remote Sensing
    - MES660 Introduction to Marine Geographic Information Systems
    - MES661 GIS Laboratory (Can be taken in Fall or Spring
  - Internship or project (3 or 6 credits)

c. Examinations

Each course contributes independently to completion of the program, and there is no cumulative examination. Students must finish with a GPA of 3.0 in order to be awarded the degree.

4. Students

Students in this program are likely to come from a range of backgrounds, however, they must meet the minimum quantitative GRE requirements outlined above. We aim to attract students with interests in data mining, artificial intelligence, visualization, smart cities, media, geographic information systems, and climate modeling.

5. Resources

a. Assessment of Library Holdings

The University of Miami Library system holdings and online resources are adequate to support this program.

b. Physical Resources: Existing Facilities, Equipment, and Space

As the courses that comprise the program are already in existence, the various departments have adequate facilities, equipment, and space for the teaching. The CCS will provide additional computing resources to the departments.

c. Budget

The program uses existing courses, and courses that the various academic units are already committed to creating, so that there is no budget required for course creation.

Revenue distribution: 30% of tuition revenue from all Master's degree programs returns to the Academy net of any waivers or scholarships. The remaining 70% of tuition revenue will be used to cover a program coordinator housed in A&S (50% of a c104 appointment), stipends to track advisors ($2K each), and non-salary-related operational/marketing costs (up to $40K per year). After that, all income will be distributed to the colleges and schools whose academic units teach the program's courses, according to the number of credit hours taught per student, journaled annually from A&S. Each college and school will distribute income to the academic units according to their individual college and school policies.

This budgetary arrangement will be reviewed annually to ensure that all parties are being compensated appropriately for their efforts.

6. Comparisons

Top Ranked MS in Data Science Programs

- MS in Data Science, Columbia University, Offered by the Data Science Institute at Columbia
  - 30 credits, 6 core courses covering the essentials of computer science, probability, statistics and machine learning and a capstone project in the last semester.
  - Remaining 3 courses can be taken as electives from across the university, including computer science, statistics, business, and civil engineering
  - Research and internship opportunities available.

- MS in Data Science, New York University, Offered by the Center for Data Science at NYU
  - 36 credits, 6 core courses covering the essentials of statistics and machine learning and a capstone project in the last semester.
  - Remaining 6 courses can be taken as electives in applied statistics, bioinformatics, computer science, mathematical finance, political science and engineering
  - Research and internship opportunities available.

- MS in Data Science, Johns Hopkins, Offered by the Whiting School of Engineering
  - Also offers a Post-Graduate Certificate in Data Science
  - 30 credits, online and blended, capstone project
  - Research and internship opportunities available.

- MS in Computational Data Science, Carnegie Mellon University, Offered by the School of Computer Science
  - 36 credits, 2 concentrations – Analytics or Systems.
  - 5 core courses, 3, electives, 2 seminar courses and 1 capstone project is required
  - Electives which can be taken from the Department of Computer Science.
  - Research and internship opportunities available.

Local/State Programs

- MS in Data Science, Florida International University, Offered by the School of Computing and Information Science
  - 30 credits, 4 specializations – Computational Data Analytics, Business Analytics, Hospitality Analytics, Biostatistics Data Analytics
  - 4 core courses, electives, capstone project
  - No research component

- MS in Data Analytics, University of Central Florida, Offered jointly by the College of Sciences and the College of Engineering and Computer Science
  - 30 credits, 8 core courses, 2 electives, capstone project
  - Paid internships available
  - No research component

Other Related Degree Programs

- MS in Analytics, Northwestern University, Offered jointly by McCormick School of Engineering, Kellogg School of Management, and Medill School of Journalism
  - 15-month program, fixed curriculum
  - Both practicum and capstone projects are industry sponsored.
  - No research component

- MS in Information and Data Science, UC Berkeley, Offered by the School of Information
  - Fully-online with a short residency requirement ("immersion experience)
  - 20-month fixed curriculum, capstone project
  - No research or internship component

- MS in Statistics: Data Science, Stanford, Offered jointly by the Department of Statistics and the Institute for Computational and Mathematical Engineering
  - Track within the MS in Statistics degree
  - 45 credits/units, no thesis but a capstone project
  - Lab work in the Stanford Data Lab
  - Internship and research opportunities are available

7. References

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[Sents] Rob Sents (2016) Want to Become a Data Scientist? Where the Jobs Are And What Employers Are Looking For. *Forbes* Magazine, November 16, 2016. https://www.forbes.com/sites/emsi/2016/11/16/want-to-become-a-data-scientist-where-the-jobs-are-and-what-employers-are-looking-for/#7c82a9915760

APPENDIX A

MS in DATA SCIENCE **Proposed Curriculum - General**			
Technical Prerequisite for students with a non-technical background (in development)			
	CSC XXX	Computing and Mathematics for Data Science	
Core			
Machine Learning or Data Mining (choose 1 course from the following)			**3 credits**
	CSC 687	Machine Learning with Applications	
	ECE 648	Machine Learning	
	ECE 677	Data Mining	
Data Visualization (choose 1 course from the following)			**3 credits**
	CSC 688	Data Science and Visualization	
	JMM 622	Infographics and Data Visualization	
Statistics (choose 1 course from the following)			**3 credits**
	EPS 702	Quantitative Methods II	
	IEN 713	Applied Regression Analysis	
	MTH 642	Statistical Analysis	
Electives (at least 3 credits must be taken in Programming)			**12 credits**
Programming			
	CSC 686	Programming in Python for Scientists	
	CSC 632	Introduction to Parallel Computing	
	CSC 640	Algorithm Design and Analysis	
	EPS 704	R programming	
Database Systems			
	CSC 623 or ECE 672	Theory of Relational Databases Object-Oriented and Distributed Database Management Systems	
	ECE 697	Advanced Big Data Analysis	
Data Visualization			
	CSC 688	Data Science and Visualization	
	JMM 622	Introduction to Infographics	
Machine Learning and Data Mining			
	CSC 687	Machine Learning with Applications	
	CSC 746 or ECE 653	Neural Networks and Deep Learning Neural Networks	
	ECE 648	Machine Learning	
	ECE 677	Data Mining	
	ECE 730	Statistical Learning	
	ECE 753	Pattern Recognition and Neural Networks	
Mathematics and Statistics			
	EPS 703	Multivariate Statistics	
	EPS 705	Measurement and Psychometric Theory	
	EPS 706	Categorical Data Analysis	

	EPS 707	Item Response Theory	
	EPS 708	Structural Equation Modeling	
	EPS 709	Introduction to Multilevel Modeling	
	EPS 711	Advanced Structural Equation Modeling	
	MTH 624	Introduction to Probability Theory	
	MTH 625	Introduction to Mathematical Statistics	
Data Science Applications **(at least 6 credits, some tracks may specify additional courses)**			
	ARC 594	GIS in Urban Design	6-9 credits
	ARC 684	RAD LAB-UM	
	ARC 685	BIM/Virtual Design and Construction	
	CSC 645 or ECE 637	Artificial Intelligence Principles of Artificial Intelligence	
	GEG 680	Spatial Data Analysis I	
	JMM 692	Interactive Data Visualization for the Web	
Internship/Capstone			**3-6 credits**
		TOTAL:	**30 credits**

MS in DATA SCIENCE **Concentration in Technical Data Science**			
Core			**9 credits**
Data Science Tools (choose one course from each domain)			**12 credits**
Programming (3 credits)			
	CSC 686	Programming in Python for Scientists	
	CSC 632	Introduction to Parallel Computing	
	CSC 640	Algorithm Design and Analysis	
Database Systems			
	CSC 623 or ECE 672	Machine Learning with Application	
	ECE 697	Neural Networks and Deep Learning	
Data Analysis (3 credits)			
	ECE 697	Advanced Big Data Analytics	
	ECE 677	Data Mining	
Statistics (3 credits)			
	MTH 624	Introduction to Probability Theory	
	MTH 625	Introduction to Mathematical Statistics	
Data Science Applications/Electives			**6 credits**
Internship/Capstone			**3 credits**
		TOTAL:	**30 credits**

MS in DATA SCIENCE Concentration in Smart Cities			
Core			**9 credits**
Data Science Tools/Electives (3 credits must be taken in Programming)			**9 credits**
Data Science Applications			**9 credits**
	ARC 594	GIS in Urban Design	
	ARC 694	RAD LAB-UM	
	ARC 686	BIM/Virtual Design and Construction	
Internship/Capstone			**3 credits**
		TOTAL:	**30 credits**

MS in DATA SCIENCE Concentration in Data Visualization			
Core			**9 credits**
Data Science Tools/Electives (3 credits must be taken in Programming)			**9 credits**
Students interested in spatial visualization may also take any of the following electives:			
	GEG 691	Geographic Information Systems I	
	GEG 692	Geographic Information Systems II	
	GEG 680	Spatial Data Analysis I	
	GEG 681	Spatial Data Analysis II	
Data Science Applications			**9 credits**
	CSC 688	Data Science and Visualization	
	JMM 622	Introduction to Infographics	
	JMM 692	Interactive Data Visualization for the Web	
Internship/Capstone			**3 credits**
		TOTAL:	**30 credits**

MS in DATA SCIENCE Concentration in Marine and Atmospheric Sciences			
Core			**9 credits**
Programming			**3 credits**
	CSC 686	Programming in Python for Scientists	
	CSC 632	Introduction to Parallel Computing	
	CSC 640	Algorithm Design and Analysis	
Data Science Applications			**15 credits**
	OCE 642	Physics of Remote Sensing I: Passive Systems	
	OCE 686	Applied Remote Sensing	
	OCE 642	Physics of Remote Sensing II: Active Systems	
	OCE 687	Applied Radar Remote Sensing	
	MES 660	Introduction to Marine Geographic Information Systems	
	MES 661	GIS Laboratory	
	Or any other courses selected from the concentration course lists for the RSMAS Master of Professional Science (MPS), with advisor approval		
Internship/Capstone			**3 credits**
		TOTAL:	**30 credits**