New Program Proposal: Graduate Degree Program

Form 2B
Version 2016-10-13

This form should be used to seek SUNY's approval and New York State Education Department's (SED) registration of a proposed new academic program leading to master's or doctoral degree. Approval and registration are both required before a proposed program can be promoted or advertised, or can enroll students. The campus Chief Executive or Chief Academic Officer should send a signed cover letter and this completed form (unless a different form applies[1]), which should include appended items that may be required for Sections 1 through 6, 9 and 10 and MPA-1 of this form, to the SUNY Provost at *program.review@suny.edu*. The completed form and appended items should be sent as a single, continuously paginated document.[2] If Sections 7 and 8 of this form apply, External Evaluation Reports and a single Institutional Response should also be sent, but in a separate electronic document. Guidance on academic program planning is available here.

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[1]Use a different form if the proposed new program will lead to a graduate degree or any credit-bearing certificate; be a combination of existing registered programs (i.e. for a multi-award or multi-institution program); be a breakout of a registered track or option in an existing registered program; or **lead to certification as a classroom teacher, school or district leader, or pupil personnel services professional** (e.g., school counselor).

[2]This email address limits attachments to 25 MB. If a file with the proposal and appended materials exceeds that limit, it should be emailed in parts.

Section 1. General Information

<table>
<tr><td>a)
Institutional
Information</td><td style="text-align:right">Date of Proposal:</td><td></td></tr>
<tr><td></td><td style="text-align:right">Institution's 6-digit SED Code:</td><td>211000</td></tr>
<tr><td></td><td style="text-align:right">Institution's Name:</td><td>Binghamton University</td></tr>
<tr><td></td><td style="text-align:right">Address:</td><td>4400 Vestal Parkway, Binghamton, NY 13902</td></tr>
<tr><td></td><td style="text-align:right">Dept of Labor/Regent's Region:</td><td></td></tr>
</table>

b) Program Locations	List each campus where the entire program will be offered (with each institutional or branch campus 6-digit SED Code): 211000
	List the name and address of off-campus locations (i.e., extension sites or extension centers) where courses will offered, **or check here [ ] if not applicable**:

<table>
<tr><td rowspan="7">c) Proposed Program Information</td><td style="text-align:right">Program Title:</td><td>Data Analytics</td></tr>
<tr><td style="text-align:right">Award(s) (e.g., M.A., Ph.D.):</td><td>M.S.</td></tr>
<tr><td style="text-align:right">Number of Required Credits:</td><td>Minimum [30]   If tracks or options, largest minimum [   ]</td></tr>
<tr><td style="text-align:right">Proposed HEGIS Code:</td><td>#0702</td></tr>
<tr><td style="text-align:right">Proposed 6-digit CIP 2010 Code:</td><td>#11.0401</td></tr>
<tr><td colspan="2">If the program will be accredited, list the accrediting agency and expected date of accreditation:</td></tr>
<tr><td colspan="2">If applicable, list the SED professional licensure title(s)[3] to which the program leads:</td></tr>
</table>

d) Campus Contact	Name and title: Telephone: E-mail:

e) Chief Executive or Chief Academic Officer Approval	**Signature affirms that the proposal has met all applicable campus administrative and shared governance procedures for consultation, and the institution's commitment to support the proposed program.** *E-signatures are acceptable.* Name and title: Signature and date:
	If the program will be registered jointly[4] with one or more other institutions, provide the following information for each institution:
	Partner institution's name and 6-digit SED Code: Name, title, and signature of partner institution's CEO (or **append** a signed letter indicating approval of this proposal):

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[3] If the proposed program leads to a professional license, a specialized form for the specific profession may need to accompany this proposal.

[4] If the partner institution is non-degree-granting, see SED's CEO Memo 94-04.

Attestation and Assurances

On behalf of the institution, I hereby attest to the following:

That all educational activities offered as part of this proposed curriculum are aligned with the institutions' goals and objectives and meet all statutory and regulatory requirements, including but not limited to Parts 50, 52, 53 and 54 of the Rules of the Board of Regents and the following specific requirements:

That credit for study in the proposed program will be granted consistent with the requirements in §50.1(o).

That, consistent with §52.1(b)(3), a reviewing system has been devised to estimate the success of students and faculty in achieving the goals and objectives of the program, including the use of data to inform program improvements.[5]

That, consistent with §52.2(a), the institution possesses the financial resources necessary to accomplish its mission and the purposes of each registered program, provides classrooms and other necessary facilities and equipment as described in §52.2(a)(2) and (3), sufficient for the programs dependent on their use, and provides libraries and library resources and maintains collections sufficient to support the institution and each registered curriculum as provided in §52.2(a)(4), including for the program proposed in this application.

That, consistent with 52.2(b), the information provided in this application demonstrates that the institution is in compliance with the requirements of §52.2(b), relating to faculty.

That all curriculum and courses are offered and all credits are awarded, consistent with the requirements of §52.2(c).

That admissions decisions are made consistent with the requirements of §52.2(d)(1) and (2) of the Regulations of the Commissioner of Education.

That, consistent with §52.2(e) of the Regulations of the Commissioner of Education: overall educational policy and its implementation are the responsibility of the institution's faculty and academic officers, that the institution establishes, publishes and enforces explicit policies as required by §52.2(e)(3), that academic policies applicable to each course as required by §52.2(e)(4), including learning objectives and methods of assessing student achievement, are made explicit by the instructor at the beginning of each term; that the institution provides academic advice to students as required by §52.2(e)(5), that the institution maintains and provides student records as required by §52.2(e)(6).

That, consistent with §52.2(f)(2) of the Regulations of the Commissioner of Education, the institution provides adequate academic support services and that all educational activities offered as part of a registered curriculum meet the requirements established by state, the Rules of the Board of Regents and Part 52 of the Commissioner's regulations.

CHIEF ADMINISTRATIVE or ACADEMIC OFFICER/ PROVOST	
Signature	Date
Type or print the name and title of signatory	Phone Number

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[5] The NY State Education Department reserves the right to request this data at any time and to use such data as part of its evaluation of future program registration applications submitted by the institution.

Section 2. Program Information

2.1. Program Format

Check all SED-defined formats, mode and other program features that apply to the **entire program**.

a) **Format(s):** [X]Day [X]Evening [X]Weekend [ ]Evening/Weekend [ ]Not Full-Time

b) **Modes**: [X]Standard [ ]Independent Study [ ]External [ ]Accelerated [X]Distance Education
NOTE: If the program is designed to enable students to complete 50% or more of the course requirements through distance education, check Distance Education, see Section 10, and append a Distance Education Format Proposal.

c) **Other**: [ ] Bilingual [ ] Language Other Than English [ ] Upper Division [ ] Cooperative [ ] 4.5 year [ ] 5 year

2.2. Related Degree Program

NOTE: This section is not applicable to a program leading to a graduate degree.

2.3. Program Description, Purposes and Planning

a) What is the description of the program as it will appear in the institution's catalog?

The M.S. in Data Analytics curriculum builds a foundation for the methods and techniques of data analytics with a practicum component involving real-world applications and tools to prepare students for the growing need of analytics and intelligence in the business world. This program also develops the team-work and communication skills necessary in the real business world. The program aims to prepare students for successful careers making more informed decisions through analytics in the data driven business world. The program is trans-disciplinary and is rooted on foundations in mathematical sciences, business and industrial practices and computer science.

Through a unique and innovative collaboration between the School of Management, the Department of Mathematical Sciences, the Department of Computer Science and the Department of Systems Science and Industrial Engineering, the program is designed to prepare students with diverse backgrounds with balanced business intelligence, leadership, quantitative, and technical skills and abilities. Given the highly quantitative nature of the program, it qualifies as a STEM degree. The program will be offered both on campus and as an online distance program.

b) What are the program's educational and, if appropriate, career objectives, and the program's primary student learning outcomes (SLOs)? ***NOTE: SLOs are defined by the Middle States Commission on Higher Education in the Characteristics of Excellence in Higher Education (2006) as "clearly articulated written statements, expressed in observable terms, of key learning outcomes: the knowledge, skills and competencies that students are expected to exhibit upon completion of the program."***

Successful graduates of the program will be able to:

- Demonstrate knowledge of appropriate analytics techniques, tools and software, including those in the big data regime and data visualization tools to communicate results of data analysis
- Recognize the data structures, storage, retrieval and other technical needs in order to implement the analytical solutions and make the results available throughout organizations.
- Develop and apply predictive models using statistical, data mining and machine learning techniques to solve real world business and decision problems.
- Apply different analytics and methods to solve important business and non-business (e.g., healthcare) problems.
- Work both independently and in a team with diverse educational backgrounds to solve complex real data analytics problems provided by corporate and organizational partners
- Present and communicate the findings to business leaders and policymakers of client organizations

c) How does the program relate to the institution's and SUNY's mission and strategic goals and priorities? What is the program's importance to the institution, and its relationship to existing and/or projected programs and its expected impact on them? As applicable, how does the program reflect diversity and/or international perspectives? For doctoral programs, what is this program's potential to achieve national and/or international prominence and distinction?

Binghamton University's mission combines academic excellence and public service. As our Road Map strategic plan explains, "Binghamton University is a premier public university dedicated to enriching the lives of people in the region, state, nation and world through discovery and education and to being enriched by partnerships with those communities." The proposed program will advance our mission in academic excellence and community partnership by adding advanced study of the large data sets that shape the world: national hospital readmissions related to age and disease states, for example, or population density studies related to potential mass transit developments. The program aligns with the Data Science Initiative, one of the four strategic initiatives announced in the Strategic Plan Road Map Renewal in August 2017. While governments and businesses have always depended on data to make good decisions, they now depend on Big Data; the graduates of our program will not only analyze large data, but also understand how to relate their results to real life decisions.

The program is unique, even among data analytics programs, for its combination of foundations and coursework from three different fields; it will place students in front of tomorrow's broadly transdisciplinary questions and problems. Binghamton's signature academic focus on Transdisciplinary Areas of Excellence, called "TAEs," has generated intensive collaboration across disciplinary lines. This campus climate has enabled the conversations across schools and disciplines that led faculty to this proposal for a complex approach to data analytics. The program, and the faculty who collaborate in offering it, have clear potential interests in and contributions to two of the five TAEs, Smart Energy and Health Sciences.

Our plan to increase graduate enrollments has been approved by SUNY system administration and the governor's office. This new program will constitute part of that growth, while creating a vital new resource for graduate students who want to explore data analytics; it will help employers who need advanced analytics of big groups of unsorted information. Because it combines strengths in computer science, mathematical and statistical analysis, and business modeling, this program will prepare students with unique combinations of highly advanced transdisciplinary analytical understanding.

d) How were faculty involved in the program's design? Describe input by external partners, if any (e.g., employers and institutions offering further education?

Faculty members from School of Management, the Department of Mathematical Sciences in Harpur College of Arts and Sciences, and the Departments of Computer Science and Systems Science and Industrial Engineering in the Watson School of Engineering & Applied Science met regularly between December 2014 and February 2018 to discuss the program and its components in detail.

e) How did input, if any, from external partners (e.g., educational institutions and employers) or standards influence the program's design? If the program is designed to meet specialized accreditation or other external standards, such as the educational requirements in Commissioner's Regulations for the profession, append a side-by-side chart to show how the program's components meet those external standards. If SED's Office of the Professions requires a specialized form for the profession to which the proposed program leads, append a completed form at the end of this document.

The need for a program of this trans-disciplinary nature was articulated by the industrial advisory boards and alumni of the participating departments. These include, for example, the School of Management Metro Advisory Board, and several of the large Financial and Management Consulting firms in New York city. For example KPMG discussed their needs for students to have both accounting and data analytics knowledge to help them in auditing. All their client firms are having increasing needs to help them apply data analytics techniques in their respective businesses, and KPMG want to hire students with those critical thinking and analytical skills. Ernst and Young expressed a similar sentiment. PWC, as well, needs students with the analytical skill set. Members of the SOM Metro Advisory Board have expressed similar needs in their organizations when our Dean has presented the analytics proposal to them.

f) Enter anticipated enrollments for Years 1 through 5 in the table below. How were they determined, and what assumptions were used? What contingencies exist if anticipated enrollments are not achieved?

Year	Anticipated Headcount Enrollment			Estimated FTE
	Full-time	Part-time	Total	
1	25		25	
2	30		30	
3	40	15	55	
4	50	20	70	
5	60	25	85	

Our vision is to make this a truly hybrid online / on campus program. We plan to initially start with an on-campus class, and then from Year 3 extend the program to an online presence.
Here is a more detailed look at the numbers.

	Year 1	Year 2	Year 3	Year 4	Year 5
On Campus Students - Domestic	25	25	35	42	50
On Campus Students - Intl/Out of State		5	5	8	10
No of students Online			15	20	25
Total Students	25	30	55	70	85

As can be seen, from Year 3 we start to add an online cohort. We plan to offer some of the classes in the evenings, so that online students can also attend them live. Some classes will be archived and lectures will be available to the online classes in asynchronous manner. Our initial vision is to recruit students for the online program in the broader New York City Region, so that these students could meet physically on some selected weekends either in NYC or in Binghamton. This will differentiate the program from fully 100% online programs, and provide a much better "on-campus" like experience.

We plan to advertise the program both on campus and off campus, and we plan to assign a Director of the program in advance of the first class. We feel confident that we can obtain a class of 25 students in the first year, given the huge need for students with both analytics and business background. There is tremendous amount of interest in data science on campus – a voluntary group of students has an email list of 300. We expect that some of the students in the program will come from students finishing their undergraduate degrees on campus. A marketing campaign using search engine marketing, meet-ups in NYC and other towns as well as targeted emails will help us recruit.

Since there is a large need, there is also very good potential for currently working professionals who want to get trained in data analytics. These students will form our target market for the online program.

Contingencies:

If the on-campus program does not grow at the anticipated rate, we will grow our on-line offering to meet the targeted growth. This will be possible, as we expect the program to be attractive to professionals in the larger metropolitan areas who already have a full-time job, particularly in NYC and other nearby areas. If the overall program does not grow at the expected rate, staffing will be adjusted commensurately. In the worst-case, the courses developed can be adapted as specialized courses in the respective departments who are engaged in this program.

g) Outline all curricular requirements for the proposed program, including prerequisite, core, specialization (track, concentration), internship, capstone, and any other relevant component requirements, but do not list each General Education course.

Course Title	Credits	Course Title	Credits
MDSA 500: Introduction to Analytics (Road Map) – New course	3		
MSDA 501: Data Science I (Regression) – New Course	3		
MSDA 502: Data Science II (Data Mining) – New Course	3		
MSDA 504: Database and Large Data Repositories – New Course	3		
MSDA 510: Analytics Practicum I – New Course	3		
Elective 1	3		
MSDA 503: Data Science III (Modeling) – New Course	3		
MSDA 511: Analytics Practicum II – New Course	3		
Elective 2	3		
Elective 3			
Total required credits: 30			

Prerequisites: undergraduate or graduate degree in mathematics, statistics, or an applied science such as economics, business, management science, computer science, system science or industrial engineering

Core Courses: MSDA 500, 501, 502, 503, 504.

Specialization: The three elective courses will be chosen by the student, in conjunction with an academic/ faculty advisor, based on their proposed field of interest, e.g. Management, Computer Science and Mathematical Statistics. Other existing on campus courses could also qualify as electives. Students can petition the program director / committee to accept other elective courses.

Practicum I and II: MSDA 510 and MSDA 511 are required of all students and will involve teams of students working on real data analytics projects obtained from organizations.

Termination Project: MSDA 511 will serve as the termination project for the degree program.

h) Program Impact on SUNY and New York State

h)(1) *Need:* What is the need for the proposed program in terms of the clientele it will serve and the educational and/or economic needs of the area and New York State? How was need determined? Why are similar programs, if any, not meeting the need?

In 2011, McKinsey Global Institute projected a shortage of 140,000 to 190,000 analysts with advanced skills, and as many as 1,500,000 managers and analysts who can analyze big data and use the findings to make informed decisions. While the United States graduates the largest number of students with deep analytical training, about 25,000 per year, the growth in demand is rapidly outpacing the supply. According to a 2012 Accenture Report, US demand will create 44% of the new jobs in analytics, but only about 23% of the supply—leaving a large unfilled gap. A recent report by IBM (The Quant Crunch:: How the demand for Data Science skills is disrupting the job market, 2017) projects that by 2020, the number of position for data analytics talent in the US will increase by 364,000 to 2,720,000 in 2020.

The needs evolving in the job market are for people with three different skills: technical skills in statistics and machine learning; the ability to analyze big data sets and to find information for business; and the educated insight to pose the right managerial questions and to use the results of data analysis for informed business and policy decisions. The shortage of qualified people is certain to be felt in all sectors of the economy, from Wall Street to manufacturing to health care and education.

The US Bureau of Labor Statistics predicts that jobs in this area will increase faster than the national average between 2012 and 2022. The demand for master's-prepared mathematicians will increase by 23%; for operations research analysts will increase by 27%; for statisticians will increase by 27%; for financial analysts will increase by 16%; for management analysts will increase by 19%; and for market research analysts will increase by 32%.

New York State will have similar shortages in the main industries creating employment; according to the New York State Department of Labor, these include agriculture, manufacturing, health care, and financial services. Jobs for graduates of a program in large data analytics will expand in all of these industries. More specific data for New York from the NYS Department of Labor shows that jobs will increase faster than average between 2012 and 2022 in fields specifically related to data analytics: the demand for management analysts will increase by 14.7%; for market research analysts will increase by 20%; and for computer systems analysts will increase by 32%.

There are existing, related master's programs in each of the fields that join together in the proposal both on campus, and off campus. None of these programs offers separately what the proposed program will achieve through the combination of approaches united in the proposed Data Analytics program. The proposed program has the following differentiating features:

- Data Analytics is rapidly becoming a very powerful application tool, and the research area permeates many academic disciplines such as computer science, mathematics, statistics, marketing, operations research, industrial engineering and health systems. Similarly, the application domain now includes finance, marketing, manufacturing and healthcare. The data analytics program envisioned at BU is an interdisciplinary one, both in terms of students and active involvement of academic departments..
- Five core courses will be newly developed with the core faculty jointly working out the content, resulting in a true multidisciplinary course content. The course content will focus more on applied problems.
- Machine learning is increasingly disrupting businesses. The program includes machine learning methods that will allow the students to understand its potential as well as pitfalls. Hands on experience will be provided.
- Course work is designed to provide hands on skills in programming (R, Python, SQL), and standardized data analytic packages (SPSS, SAS) as well as data visualization software (Tableau).
- The students will be able to take electives in their areas of interest in other approved university courses and obtain deeper expertise, such as Marketing, Operations, Health Care, Computer Science etc.., providing a more customized education.
- The practicum project courses with have students working on real problems which will be identified in conjunction with our business and organizational partners. The problems will be worked on in teams composed of individuals with complementary strengths, and they will present the solutions to the sponsoring organizations, resulting in potential jobs.
- The project teams will be multifunctional with students with backgrounds in management, science, liberal arts and engineering. This will make the learning of the students and demonstrated ability to work with multifunctional teams attractive to employers.
- The online program is a hybrid program wherein the online classes will be in the evenings and delivered synchronously. On campus students will be taking the same class. This will allow teams to have both online and on-campus students, allowing them to work in virtual teams.

Current programs are generally housed in one department (e.g. management, operations research, mathematics and statistics). Faculty in these do not have the same breadth of knowledge that a truly multifunctional program can provide.

The proposed program is expected to attract new students with a broader set of educational backgrounds and a different set of intellectual interests than the existing programs. We anticipate that the program will draw students with applied and practical interests and a greater range of skills than the discipline-specific programs.

h)(2) *Employment:* For programs designed to prepare graduates for immediate employment, use the table below to list potential employers of graduates that have requested establishment of the program and state their specific number of positions needed. If letters from employers support the program, they may be **appended** at the end of this form.

Employer	Need: Projected positions	
	In initial year	In fifth year
KPMG, 345 Park Avenue, New York, NY		
Ernst & Young LLP, 5 Times Square, New York, NY		
PWC LLP, 300 Madison Avenue, New York, NY		
Travelers, One Tower Square, Hartford, CT		

Several firms have expressed strong desire in hiring/recruiting the students with the kinds of skill sets the proposed Data Analytics program will teach. Please see the attached letters in Appendix 4.

h)(3) *Similar Programs:* Use the table below to list similar programs at other institutions, public and independent, in the service area, region and state, as appropriate. Expand the table as needed. ***NOTE: Detailed program-level information for SUNY institutions is available in the*** Academic Program Enterprise System *(APES) or* Academic Program Dashboards. *Institutional research and information security officers at your campus should be able to help provide access to these password-protected sites. For non-SUNY programs, program titles and degree information – but no enrollment data – is available from* SED's Inventory of Registered Programs.

Academic Program Name	Campus Name	NYSED.GOV Program Code	Current Enrollment
MS in Data Science	University of Rochester	0799	35
MS in Data Analytics - online	CUNY School of Professional Studies	34715	
MS in Business Analytics	Fordham University	35294	
MS in Data Science	NYU	35896	61
MS in Business Analytics	Lally School, RPI	35971	36
MS Enterprise Analytics	Pace University	36949	
MS in Data Mining and Predictive Analytics	St. Johns University	37493	
MS in Data Analytics – Residential + Online	Clarkson University	37923	Max 20 residential, max 15 online

h)(4) **C**ollaboration: Did this program's design benefit from consultation with other SUNY campuses? If so, what was that consultation and its result?

Other SUNY campuses were not consulted in this process. However, a LOI was circulated to all SUNY campuses for the required 30 day period, announcing BU's intention to develop this degree program. Approval for the development of this program was established by Binghamton University's Provost in consultation with the deans from School of Management, Watson School of Engineering & Applied Science or Harpur College of Arts and Sciences.

h)(5) *Concerns or Objections:* If concerns and/or objections were raised by other SUNY campuses, how were they

resolved?

No concerns or objections have been communicated to the School of Management, Watson School of Engineering & Applied Science or Harpur College of Arts and Sciences.

a) What are all admission requirements for students in this program? Please note those that differ from the institution's minimum admissions requirements and explain why they differ.

Applicants to this program must hold either a baccalaureate or a graduate degree in mathematics, statistics, or an applied science such as economics, business, management science, computer science, system science, or industrial engineering. Those who have at least 2 years' working experience in the business and industrial setting will be preferred. Some of these major requirements may be substituted by relevant work experience in the related field.

All students applying to the program submit their application materials through the Graduate School. A completed online application, academic transcript(s), two letters of recommendation, current resume, and a personal statement are the minimum requirements to apply. GRE/GMAT scores are strongly preferred but may not be required in all cases, such as a student who has completed high performance in a reputed graduate program. Students are expected to have a GPA of 3.0 or above. International applicants must also submit results from either TOEFL (minimum score of 100) or IELTS (minimum score in Band Seven).

Because the faculty contributing to this program come from several different departments and schools, an admissions committee consisting of 3 faculty from different departments who teach in the program will be created, with members serving for terms of 2 or 3 years. Faculty membership on the admissions committee will rotate among the faculty teaching in the program to involve faculty members teaching different courses. Working with the faculty committee, the program director will make admissions decisions.

In setting the standards for admission, the faculty committee will strive for both academic excellence and diversity (of race/ethnicity, gender, undergraduate major, field of professional interest, etc. No standards will be applied that differ from Binghamton University's minimum admissions requirement.

b) What is the process for evaluating exceptions to those requirements?
   No exceptions will be made.

c) How will the institution encourage enrollment in this program by persons from groups historically underrepresented in the institution, discipline or occupation?

   The Graduate School currently recruits applicants to all programs from historically underrepresented groups by attending recruitment fairs dedicated to minority students, by visiting colleges and universities where underrepresented students attend in large numbers, and by emphasizing the affordability of a Binghamton education and the availability of scholarships for historically underrepresented students. At the same time, 36% of our undergraduate students come from historically underrepresented groups, and we anticipate a high level of interest in this program from our own graduates.
   Recruiting for the MSDA program will involve both Graduate School staff recruiters and an Administrative Assistant dedicated to the program. We will also seek help from Division of Diversity, Equity and Inclusion. Targeted visits for MSDA recruiting will be made to colleges and universities and to recruiting fairs focused on minority students.

d) What is the expected student body in terms of geographic origins (i.e., same county, same Regents Region, New York State, and out-of-state); academic origins; proportions of women and minority group members; and students for whom English is a second language?

   We anticipate that most students will be from the core areas where Binghamton University gets its students – viz. New York State. Since a large number of alumni as well as potential firms that need the graduates are in the greater New York area, we anticipate our students will come from that area. The online component of the program may be attractive to students in NY state, as well as throughout the US.

2.5. Academic and Other Support Services

a) Summarize the academic advising and support services available to help students succeed in the program.

Students enrolled in the program will be assigned an academic advisor from the faculty teaching in the program. Students will be required to meet with their faculty advisors each semester to review their progress in courses, field placements, and discuss their short- and long-term academic and career goals. A student progress evaluation form will be developed to track their progress each semester. The Director will also meet with each student once a semester to monitor their progress. Online students not resident in the geographic area will have the option to consult with their faculty advisors online via for example Skype or GoTO Meeting.

The program will incorporate efforts to support distance students in their utilization of the virtual learning environment. Orientation to online learning through B-online (Binghamton University's tutorial for students taking online courses), community building activities at the onset of each course, and video conferencing for academic advising and office hours will be provided to students to foster a personally engaging and supporting environment.

All students enrolled may access Services for Students with Disabilities (SSD) and other student support services.

b) Describe types, amounts and sources of student financial support anticipated. Indicate the proportion of the student body receiving each type of support, including those receiving no support.

Student financial support may be available based on need from the Office of Financial Aid. We anticipate receiving some modest scholarships from firms that may potentially employ our graduates.

2.6. Prior Learning Assessment

If this program will grant credit based on Prior Learning Assessment, describe the methods of evaluating the learning and the maximum number of credits allowed, **or check here [X] if not applicable**.

2.7. Program Assessment and Improvement

Describe how this program's achievement of its objectives will be assessed, in accordance with *SUNY policy*, including the date of the program's initial assessment and the length (in years) of the assessment cycle. Explain plans for assessing achievement of students learning outcomes during the program and success after completion of the program. **Append** at the end of this form, **a plan or curriculum map** showing the courses in which the program's educational and, if appropriate, career objectives – from Item 2.3(b) of this form – will be taught and assessed. *NOTE: The University Faculty Senate's Guide for the Evaluation of Undergraduate Programs is a helpful reference.*

Program assessment will include the following components.
- Each course will be assessed by students using the Binghamton University (or a variant) SOOT form. This form assesses the course and faculty on ten items. There is also a place for extensive comments. The form will be administered through our Learning Management System, MyCourses. These assessments will be shared with the program director.
- A program outcome survey of all graduating students will be administered. This survey will be given to the students before they graduate, and will ask them to respond to program level feedback – program content, its co-ordination across courses, program management, placement services, technology etc.
- Program learning goal outcome will be assessed in courses as outlined in the curricular map. The proportion of students who are at, below and above expectations will be documented. Faculty evaluation committee will meet annually to assess the measures and take steps in various courses to improve the performance.
- Informal feedback from employers after placement of students will be done about one year after the completion of the program.

In the spirit of Total Quality Management, the director and the faculty review committee will review all feedback annually and take corrective actions to improve the program. The findings of these assessments will be shared with the deans and the

program faculty.

Section 3. Program Schedule and Curriculum

Complete the **SUNY Graduate Program Schedule** to show how a typical student may progress through the program. This is the registered curriculum, so please be precise. Enter required courses where applicable, and enter generic course types for electives or options. Either complete the blank Schedule that appears in this section, or complete an Excel equivalent that computes all sums for you, found here. Rows for terms that are not required can be deleted.

*NOTES: The **Graduate Schedule** must include all curriculum requirements and demonstrate that expectations from in Regulation 52.2 http://www.highered.nysed.gov/ocue/lrp/rules.htm are met.*

Special Cases for the Program Schedules:
- *For a program with multiple tracks, or with multiple schedule options (such as full-time and part-time options), use one Program Schedule for each track or schedule option. Note that licensure qualifying and non-licensure qualifying options cannot be tracks; they must be separate programs.*
- *When this form is used for a multi-award and/or multi-institution program that is <u>not</u> based entirely on existing programs, use the schedule to show how a sample student can complete the proposed program. **NOTE:** Form 3A, Changes to an Existing Program, should be used for new multi-award and/or multi-institution programs that are based entirely on existing programs. SUNY policy governs the awarding of two degrees at the same level.*

a) If the program will be offered through a nontraditional schedule (i.e., not on a semester calendar), what is the schedule and how does it impact financial aid eligibility? *NOTE: Consult with your campus financial aid administrator for information about nontraditional schedules and financial aid eligibility.*

b) For each existing course that is part of the proposed graduate program, **append** a catalog description at the end of this document.

The courses we have included as potential electives are as of the current state of knowledge. As the data analytics field is very dynamic, new courses that qualify as electives will be added as needed. The courses will be approved by the Director of the program in consultation with the program faculty committee.

c) For each new course in the graduate program, **append** a syllabus at the end of this document. *NOTE: Syllabi for all courses should be available upon request. Each syllabus should show that all work for credit is graduate level and of the appropriate rigor. Syllabi generally include a course description, prerequisites and corequisites, the number of lecture and/or other contact hours per week, credits allocated (consistent with SUNY policy on credit/contact hours), general course requirements, and expected student learning outcomes.*

d) If the program requires external instruction, such as clinical or field experience, agency placement, an internship, fieldwork, or cooperative education, **append** a completed External Instruction form at the end of this document

SUNY Graduate Program Schedule (*OPTION: You can insert an Excel version of this schedule AFTER this line, and delete the rest of this page.*)
Program/Track Title and Award:_____

a) Indicate **academic calendar** type: [X] Semester [ ] Quarter [ ] Trimester [ ] Other (describe):
b) **Label each term in sequence**, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)
c) Use the table to show **how a typical student may progress through the program**; copy/expand the table as needed.
d) Complete the last row to show program totals and comprehensive, culminating elements. **Complete all columns that apply to a course.**

On Campus Student (11 months)

Course Title	Credits	Term	New	Co/Prerequisites
MDSA 500: Introduction to Analytics (Road Map)	3	Summer 2	X	None
MSDA 501: Data Science I (Regression)	3	Summer 2	X	MSDA 500
MSDA 502: Data Science II (Data Mining)	3	Fall	X	MSDA 500
MSDA 504: Database and Large Data Repositories	3	Fall	X	MSDA 500
MSDA 510: Analytics Practicum I	3	Fall	X	MSDA500,501
Elective 1	3	Fall		
MSDA 503: Data Science III (Modeling)	3	Spring	X	MSDA502, 504
MSDA 511: Analytics Practicum II	3	Spring	X	MSDA 503
Elective 2	3	Spring		
Elective 3	3	Spring		
Total required credits	30			

Distance Student (2 years)

Course Title	Credits	Year	Term	New	Co/Prerequisites
MDSA 500: Introduction to Analytics (Road Map)	3	1	Summer 2	X	None
MSDA 501: Data Science I (Regression)	3	1	Summer 2	X	MSDA 500
MSDA 502: Data Science II (Data Mining)	3	1	Fall	X	MSDA 500
MSDA 504: Database and Large Data Repositories	3	1	Fall	X	MSDA 500
MSDA 503: Data Science III (Modeling)	3	1	Spring	X	MSDA502, 504
Elective 1	3	1	Spring		
MSDA 510: Analytics Practicum I	3	2	Fall	X	MSDA500,501
Elective 2	3	2	Fall		
MSDA 511: Analytics Practicum II	3	2	Spring	X	MSDA 503
Elective 3	3	2	Spring		
Total required credits	30				

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Section 4. Faculty

a) Complete the **SUNY Faculty Table** on the next page to describe current faculty and to-be-hired (TBH) faculty.

b) **Append** at the end of this document position descriptions or announcements for each to-be-hired faculty member.

NOTE: CVs for all faculty should be available upon request. Faculty CVs should include rank and employment status, educational and employment background, professional affiliations and activities, important awards and recognition, publications (noting refereed journal articles), and brief descriptions of research and other externally funded projects. New York State's requirements for faculty qualifications are in in Regulation 52.2 http://www.highered.nysed.gov/ocue/lrp/rules.htm

c) What is the institution's definition of "full-time" faculty?

Faculty are full time when they have full-time commitments to a department, division, or school. Their full-time obligations in teaching, research, and service are defined by the dean and chair of the unit in which they are employed.

SUNY Faculty Table

Provide information on current and prospective faculty members (identifying those at off-campus locations) who will be expected to teach any course in the graduate program. Expand the table as needed. Use a separate Faculty Table for each institution if the program is a multi-institution program.

(a) Faculty Member Name and Title/Rank (Include and identify Program Director with an asterisk)	(b) % of Time Dedicated to This Program	(c) Program Courses Which May Be Taught (Number and Title)	(d) Highest and Other Applicable Earned Degrees (include College or University)	(e) Discipline(s) of Highest and Other Applicable Earned Degrees	(f) Additional Qualifications: List related certifications, licenses and professional experience in field
PART 1. Full-Time Faculty					
Manoj Agarwal	10%	MSDA500, 501, Electives	Ph.D., SUNY Buffalo	Management (Marketing)	Expertise in modelling customer behavior and customer analytics.
Sal Agnihothri	10%	MSDA 500, Electives	Ph.D., University of Rochester	Management (Operations)	Expertise in optimization of supply chains using EXCEL
Ali Yayla	10%	MSDA 504, Electives	Ph.D., Florida Atlantic University	Management (MIS)	Expertise in IT security and databases
Weiyi Meng	10%	MSDA 504, Electives	Ph.D., University of Illinois	Computer Science	Expertise in metasearch engines, Web Database Integration, Information Retrieval
Zhongfei (Mark) Zhang	10%	MSDA 502. Electives	Ph.D., University of Massachusetts	Computer Science	Expertise in data mining, medical imaging and bioinformatics
Arti Ramesh	10%	Electives	Ph.D. University of Maryland	Computer Science	Expertise in machine learning, natural language processing, social network analysis
Yu Liu	10%	MSDA502, Electives	Ph.D. Johns Hopkins University	Computer Science	Expertise in programming languages, software engineering, machine learning
Xingye Qiao	10%	MSDA501, Electives	Ph.D., University of North Carolina at Chapel Hill	Statistics	Expertise in statistical machine learning, subsampling of high dimensional data sets

Name	Load	Courses	Degree	Field	Expertise
Nagen Nagarur	10%	MSDA503, Electives	Ph.D., Virginia Polytechnic Institute	System Science and Industrial Engineering	Expertise in quality control, supply chain modeling, reliability
Sanjeena Dang	10%	Electives	Ph.D. University of Guelph	Statistics	Expertise in computational statistics, clustering and classification
Ganggang Xu	10%	MSDA503, Electives,	Ph.D. Texas A&M	Statistics	Expertise in model selection, quantile regression, spatial statistics
Aleksey Polunchenko	10%	Electives	Ph. D. University of Southern California	Applied Mathematics	Expertise in change point detection, cyber security
Chang Hee Park	10%	MSDA501	Ph. D. Cornell University	Management (Marketing)	Expertise in modeling individual customer behavior
Part 2. Part-Time Faculty					
Part 3. Faculty To-Be-Hired (List as TBH1, TBH2, etc., and provide title/rank and expected hiring					

In the first two years, as the program gets on its feet, the various departments will provide faculty on load, or to receive extra service compensation. Once students arrive and the program starts to generate revenue, some faculty may be hired for the program, but resident in one of the departments. .

List of Potential Faculty to teach the courses

Course Title	Potential Faculty
MDSA 500: Introduction to Analytics (Road Map)	Manoj Agarwal, Xingye Qiao, Mark Zhang, Nagen Nagarur
MSDA 501: Data Science I (Regression)	Ganggang Xu, Chang Hee Park
MSDA 502: Data Science II (Data Mining)	Mark Zhang, Yu Liu
MSDA 504: Database and Large Data Repositories	Ali Yayla, Weiyi Meng
MSDA 510: Analytics Practicum I	Any of the program faculty
Elective 1	Weiyi Meng, Arti Ramesh, Nagen Nagarur, Aleksey Polanchenko, Manoj Agarwal, Ali Yayla
MSDA 503: Data Science III (Modeling)	Sal Agnihothri, Nagen Nagarur
MSDA 511: Analytics Practicum II	Any Program Faculty

Elective 2	Weiyi Meng, Arti Ramesh, Nagen Nagarur, Aleksey Polanchenko, Manoj Agarwal, Ali Yayla, Chang Hee Park
Elective 3	Weiyi Meng, Arti Ramesh, Nagen Nagarur, Aleksey Polanchenko, Manoj Agarwal, Ali Yayla, Chang Hee Park

Section 5. Financial Resources and Instructional Facilities

a) What is the resource plan for ensuring the success of the proposed program over time? Summarize the instructional facilities and equipment committed to ensure the success of the program. Please explain new and/or reallocated resources over the first five years for operations, including faculty and other personnel, the library, equipment, laboratories, and supplies. Also include resources for capital projects and other expenses.

Program faculty will be provided by the three schools for the first two years until the enrollments stabilize. Based on growth, additional faculty for the MSDA program may be hired.

The current collection of Binghamton University Libraries includes approximately 2.4 million volumes (including print volumes, government documents, and electronic books); over 80,000 journal holdings, including current subscriptions and backfiles; 121 electronic databases; and 6000 audio-visual materials. A successful history of implementing advances in technology has allowed the Libraries to offer access to many citation and full-text databases in the areas of mathematics, statistics, management, computer science and systems science.

As one of SUNY's four research centers, Binghamton University's technological resources and services are well-established and will be readily available to students and faculty in the proposed program. Information Technology Services (ITS) provides central computing support for the academic and research endeavors of students, faculty and staff across the University. Existing computer laboratory resources will be initially utilized. A separate computer lab will also be established.

b) Complete the five-year SUNY Program Expenses Table, below, consistent with the resource plan summary. Enter the anticipated <u>academic years</u> in the top row of this table. List all resources that will be engaged specifically as a result of the proposed program (e.g., a new faculty position or additional library resources). If they represent a continuing cost, new resources for a given year should be included in the subsequent year(s), with adjustments for inflation or negotiated compensation. Include explanatory notes as needed.

SUNY Program Expenses Table
(OPTION: You can paste an Excel version of this schedule AFTER this sentence, and delete the table below.)

Program Expense Categories	Expenses (in Dollars)					
	Before Start	Academic Year 1:	Academic Year 1:	Academic Year 3:	Academic Year 4:	Academic Year 5:
a) Personnel (including faculty and all others)	$172,000	$358,360	$320,860	$393,280	$402,760	$589,640
(b) Library						
(c) Equipment						
(d) Laboratories	$60,000					
(e) Supplies (Software)	$15,000	$15,000	$15,000	$10,000	$5,000	$5,000
(f) Capital Expenses						
(g) Other (Specify)						
Marketing	$100,000	$40,000	$30,000	$30,000	$30,000	$30,000
(h) Sum of Rows Above	$347,000	$413,360	$365,860	$433,280	$437,760	$624,640
Before start we assume the costs of 1 director ($150,000) and reducing to 0.75 in tyear 1 and 0.5 year 2 onwards and 0.5 administrative assistant ($22,000)						

a) Summarize the analysis of library collection resources and needs *for this program* by the collection librarian and program faculty. Include an assessment of existing library resources and accessibility to those resources for students enrolled in the program in all formats, including the institution's implementation of SUNY Connect, the SUNY-wide electronic library program.

The Libraries has a current collection of data analysis related journals, databases and eBooks, as well as Data Analysis Databases and eBooks as well as collections of large datasets that will help support this program. Here are a list of some of the databases that will be of use for the M.S. in Data Analytics curriculum. These resources will be accessible to both on-campus and online students.

• ACM Digital Library: Full-text access to all articles published in ACM magazines, journals and some conference proceedings

• IEEExplore Digital Library: Full-text access to IEEE journals, magazines, conference proceedings and standards

• ScienceDirect: Full-text access to Elsevier journals subscribed to by SUNY institutions

• Inspec: Indexed database of citations and abstracts in several scientific fields, including computer science, engineering, and information technology

• Business Source Complete: Journals in all disciplines of business. Includes industry reports, market research, and SWOT analysis.

• Computer Source: Covers information on computers, telecommunications, electronics, and the Internet

• Scopus: Scopus is the largest abstract and citation database of peer-reviewed literature and quality web sources with smart tools to track, analyze and visualize research. Includes over 38 million references in science and social science.

• Statistical Insight: Indexes and abstracts statistical publications from the U.S. government from 1973, state and private sources from 1980, and documents from international organizations from 1983.

The Libraries also subscribes or makes annual purchases of eBook collections that will help support the curriculum:

• Synthesis Digital Library of Engineering and Computer Science: contains books on various related topics such as computer science, data management and data mining and knowledge discovery

• Safari eBooks: selected, full-text titles on Information Technology and Computer Science from O'Reilly, Sams and other publishers

• Springer Computer Science Collection: includes the "Lecture Notes in Computer Science" conference proceedings book series

The libraries also maintain current subscriptions to several data analytics related journals, or provide access to open access titles:
• Data Mining and Knowledge Discovery
• Statistical analysis and data mining

- Intelligent Data Analysis (12 month embargo)
- Data Science and Engineering (Open Access)
- International Journal of Artificial Intelligence and Knowledge Discovery (Open Access)
- Data Science Journal (Open Access)
- Journal of Data Science (Open Access)

Finally, students and faculty will be able to work with several data sets made available by through the Libraries:

- Bloomberg--Major global provider of financial news and information, including real-time and historic price data, financials data, trading news, analysts' coverage, emerging market data, etc. One terminal in Libraries--multiple terminals in School of Management.

- Datastream--Historical coverage of worldwide markets, in addition to emerging markets and new instruments. Includes equity, index, commodity, currency and economic data. One terminal in Libraries.

- Cross National Time Series Data Archive--Longitudinal data series covering over 200 countries and 200 variables.

- ICPSR (Inter-university Consortium for Political and Social Research) Vast archive of social science data.

- PolicyMap--Online GIS mapping tool with over 15,000 data indicators.

b) Describe the institution's response to identified collection needs and its plan for library development.

As the program develops, the library resources will be enhanced. Additional journals and books will be added. Currently we have identified the following journals based on comparison with peer universities.

- Big Data
- Big Data and Information Analytics
- Journal on Data Semantics
- Journal of Data Processing
- International Journal of Data Warehousing and Mining

The library also plans to add about 40 eBooks and print books as identified by the faculty. There will also be a need in the future for a digital librarian.

Section 7. External Evaluation

SUNY and SED require external evaluation of all proposed graduate degree programs. List below all SUNY-approved evaluators who conducted evaluations (adding rows as needed), and **append at the end of this document** each original, signed *External Evaluation Report.* ***NOTE:*** *To select external evaluators, a campus sends 3-5 proposed evaluators' names, titles and CVs to the assigned SUNY Program Reviewer, expresses its preferences and requests approval.*

Evaluator #1
Name: Dr. Rabikar Chatterjee
Title: Associate Dean for Masters and
    Executive Programs, Gulf Oil
    Foundation Professor of Business
Institution: Katz Graduate School of Business
    University of Pittsburgh

Evaluator #2
Name: Dr. Simon Sheather
Title: Professor of Statistics, Interim Director of Texas
    A&M Data Science Institute, Academic Director
    Of MS (Analytics) and Online Programs
Institution: Texas A&M University

Reports are available in Appendix 5.

Section 8. Institutional Response to External Evaluator Reports

Append at the end of this document a single *Institutional Response* to all *External Evaluation Reports.*

Report is available in Appendix 6.

Section 9. SUNY Undergraduate Transfer

NOTE: *SUNY Undergraduate Transfer policy does not apply to graduate programs.*

Section 10. Application for Distance Education

a) Does the program's design enable students to complete 50% or more of the course requirements through distance education? [ ] No   [X] Yes. If yes, **append** a completed *SUNY Distance Education Format Proposal* at the end of this proposal to apply for the program to be registered for the distance education format.

Form available in Appendix 7.

b) Does the program's design enable students to complete 100% of the course requirements through distance education? [X] No   [ ] Yes

Section MPA-1. Need for Master Plan Amendment and/or Degree Authorization

a) Based on guidance on Master Plan Amendments, please indicate if this proposal requires a Master Plan Amendment.
[ ] No   [ ] Yes, a completed *Master Plan Amendment Form* is **appended** at the end of this proposal.

b) Based on *SUNY Guidance on Degree Authorizations* (below), please indicate if this proposal requires degree authorization.

[ ] No   [ ] Yes, once the program is approved by the SUNY Provost, the campus will work with its

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Campus Reviewer to draft a resolution that the SUNY Chancellor will recommend to the SUNY Board of Trustees.

SUNY Guidance on Degree Authorization. *Degree authorization is required when a proposed program will lead to a [new degree](#) (e.g., B.F.A., M.P.H.) at an existing level of study (i.e., associate, baccalaureate, first-professional, master's, and doctoral) in an existing disciplinary area at an institution. Disciplinary areas are defined by the [New York State Taxonomy of Academic Programs](#). Degree authorization requires approval by the SUNY Provost, the SUNY Board of Trustees and the Board of Regents.*

Appended Items: Materials required in selected items in Sections 1 through 10 and MPA-1 of this form should be appended after this page, with continued pagination. In the first column of the chart below, please number the appended items, and append them in number order.

Number	Appended Items	Reference Items
	For multi-institution programs, a letter of approval from partner institution(s)	Section 1, Item (e)
	For programs leading to professional licensure, a side-by-side chart showing how the program's components meet the requirements of specialized accreditation, Commissioner's Regulations for the Profession, or other applicable external standards	Section 2.3, Item (e)
	For programs leading to licensure in selected professions for which the SED Office of Professions (OP) requires a specialized form, a completed version of that form	Section 2.3, Item (e)
4	*OPTIONAL: For programs leading directly to employment*, letters of support from employers, if available	Section 2, Item 2.3 (h)(2)
1	*For all programs*, a plan or curriculum map showing the courses in which the program's educational and (if appropriate) career objectives will be taught and assessed	Section 2, Item 7
2	*For all programs*, a catalog description for each existing course that is part of the proposed graduate major program	Section 3, Item (b)
3	*For all programs with new courses,* syllabi for all new courses in a proposed graduate program	Section 3, Item (c)
	For programs requiring external instruction, a completed *External Instruction Form* and documentation required on that form	Section 3, Item (d)
	For programs that will depend on new faculty, position descriptions or announcements for faculty to-be-hired	Section 4, Item (b)
5	*For all programs*, original, signed External Evaluation Reports from SUNY-approved evaluators	Section 7
6	*For all programs*, a single Institutional Response to External Evaluators' Reports	Section 8
7	*For programs designed to enable students to complete at least 50% of the course requirements at a distance*, a *Distance Education Format Proposal*	Section 10
	For programs requiring an MPA, a *Master Plan Amendment form*	Section MPA-1

Appendix 1: Curricular Map

Program Learning Objective	Courses Covering Learning Goal	Assessed in
Demonstrate knowledge of appropriate analytics techniques, tools and software, including those in the big data regime and data visualization tools to communicate results of data analysis	MSDA 500, 501, 502, 503	MSDA 501, 503
Recognize the data structures, storage, retrieval and other technical needs in order to implement the analytical solutions and make the results available throughout organizations.	MSDA 504	MSDA 504
Develop and apply predictive models using statistical, data mining and machine learning techniques to solve real world business and decision problems	MSDA 500, 510, 511	MSDA 510, 511
Apply different analytic and methods to solve important business and non-business (e.g., healthcare) problems.	MSDA 500, 501, 502, 503	MSDA 502
Work both independently and in a team to carry out large data analysis projects.	MSDA 510, 511	MSDA 510, 511
Present and communicate the findings to business leaders and policymakers	MSDA 510, 511	MSDA 510, 511

Appendix 2: Catalog Description of Existing Courses for Electives

These courses can form part of the Elective Offerings.

MKTG 581D: Customer Analytics
Studies of selected areas of marketing knowledge and thought. Specific topics vary each semester depending on particular interests of instructor. 2 or 4 credits. Pre-requisite. MGMT 506. Offered as needed.

SCM 560: Decision Modeling and Risk Analysis
This course uses problems and cases, primarily from general management, finance, marketing, and operations and spreadsheet-based analytical tools to improve your decision-making ability in an uncertain and complex environment. Students learn techniques widely used to estimate the impact of a decision on performance measures of interest, assess and manage risk, structure problems and determine the optimal decision. The course has three segments: Spreadsheet Modeling, Decision Making under Uncertainty (using Decision Trees and Simulation), Decision Making under Certainty (using Linear, Integer and Nonlinear Programming). Microsoft Excel and Excel add-ins are used throughout the course. All classes will be held in a computer lab. Pre-requisite: MGMT 503. Offered as needed.

MATH 535: Statistical Learning and Data Mining
Regression and Logistic Regression, Lasso and Related Methods, Support Vector Machines and Large Margin Classifiers, Kernel Methodology, Principal Components (SVD) and Variations, Multidimensional Scaling and Isomap, Nonnegative Matrix Factorization, Boosting, Random Forests and Ensemble Methods, Bagging, Graphical Models, Cross-Validation, Bootstrap. Co/Prerequisite: Math 531 or 555. 4 cr.

MATH 559: Time Series Analysis
Trend analysis and smoothing. Estimation, testing, modeling and forecasting for ARMA and ARIMA models. Prerequisite: MATH 555. 4 cr. Every three years.

CS 533: Information Retrieval
Course Topics: Indexing and data structures for storing and searching the index. Boolean, statistical, inference nets and knowledge-based models. Thesaurus construction. Query expansion. Natural language and linguistic techniques. Evaluation. Distributed information retrieval. Information integration and fusion. Dissemination of information. Summaries, themes and reading tours. Hypertext. Internet tools. Intelligent agents. Digital libraries

CS 538: Introduction to Multimedia Database Systems
Introduction to the organization of multimedia database systems. Review of conventional database systems, including design principles and typical architectures. Organization of multimedia content. Advanced data structures for image, text, video, audio and combined databases. Other topics include physical storage and retrieval, multimedia presentations and network issues.

Prerequisite: CS 432 or 532 or equivalent.

CS 58X: Machine Learning
This course provides a broad introduction to machine learning and its applications. Major topics include: supervised learning (generative/discriminative learning, parametric/non-parametric learning, support vector machines); computational learning theory (bias/variance tradeoffs, VC theory, large margins); unsupervised learning; semi-supervised learning; reinforcement learning. The course will give students the basic ideas and intuition behind

different techniques as well as a more formal understanding of how and why they work. The course will also discuss recent applications of machine learning, such as to data mining, bioinformatics, and information retrieval.

Prerequisites: CS 375 and MATH 327 or equivalent

CS 634: Web Data Management
Advanced topics in Web data management. New techniques for retrieving documents from search engines, including the use of links and user-behavior knowledge. Meta-search engine techniques, including resource discovery and result fusion. Database approaches for Web data management. Semi-structured data management, including data models, query languages and XML. Topics may vary when offered in different years.

Prerequisite: CS 432 or 532 or Equivalent.

SSIE 519: Applied Soft Computing
Covers relatively new approaches to machine intelligence known collectively as soft computing. Introduces various types of fuzzy inference systems, neural networks and genetic algorithms, along with several synergistic approaches for combining them as hybrid intelligent systems. Emphasis is on applications, including modeling, prediction, design, control, databases and data mining. The undergraduate students are not required to do projects on the same level as the graduate students, and are not required to place the degree of emphasis on hybrids.

Prerequisites: basic knowledge of calculus and discrete mathematics, and competence in at least one programming language, or consent of the instructor.

SSIE 616: Advanced Topics Applied Soft Computing
Course is designed to follow a currently offered course, SSIE 519: Applied Soft Computing. Both courses are designed to cover relatively new approaches to machine intelligence and systems analysis known collectively as soft computing. The 519 course already introduces various types of fuzzy inference systems, neural networks, and genetic algorithms, along with several synergistic approaches for combining them, including "neuro and fuzzy" techniques, neuro-fuzzy models, the use of neural models in fuzzy systems design, genetic auto-tuning techniques, genetic training of neural nets, fuzzified neural nets, and neural genetic fuzzy models. Naturally, with so many new approaches developing in this field, it is possible in an entry-level graduate course only to cover the main topics in depth and to offer only a general overview on the more advanced hybrid approaches. The purpose of SSIE 616 is to allow students to pursue these advanced approaches to a much greater depth. The emphasis will be on applications, including modeling, prediction, design, control, databases, and data mining, just as is already the case in the 519 course.

Prerequisite: SSIE 519 or Equivalent

SSIE 617: Fuzzy Sets, Fuzzy Logic & Fuzzy Systems
Course consists of two parts. The first part covers fundamentals of fuzzy set theory and the associated fuzzy logic. The second part is devoted to applications of the theory. Topics of the theoretical part include basic concepts of fuzzy set theory and fuzzy logic; representations of fuzzy sets; extension principle that facilitates fuzzifications of classical mathematical concepts; aggregation operations on fuzzy sets; the concept of a fuzzy number and arithmetic operations on fuzzy numbers; fuzzy relations;

fuzzy relation equations; basic ideas of fuzzy logic; possibility theory based on fuzzy sets; and information aspects of fuzzy sets. In the application part, methods of constructing fuzzy sets in various application contexts are

overviewed and representative applications of fuzzy sets and fuzzy logic are examined. The application areas covered include systems science; approximate reasoning in expert systems; database and information retrieval systems; pattern recognition and image processing; decision making; medicine; economics; psychology; and various areas of engineering.

Prerequisites: SSIE 505 or equivalent and calculus and discrete mathematics, or consent of instructor.

Appendix 3: Syllabi for New Courses

MSDA 500: Introduction to Analytics (Road Map)

Course Description: The course provides an overall introduction to the field of Data Analytics. Since data analytics involves concepts in analytic methods, programming tools, data retrieval and management, and applications in various domains, the course will provide concepts in these areas along with assignments that will allow students to learn how to make data-driven decisions.

Topics to be covered
- Introduction to enterprises and their analytical needs for decision making.
- Introduction to relational databases & SQL, data access and management, data cleaning and preparation.
- Introduction to statistical programming: R or Python
- Data summarization and visualization using R or Python
- Using R / Python / Excel to perform
  - Regression (linear and nonlinear)
  - Classification
  - Clustering Analysis
- Ethical issues in Data Analytics

Course requirements:

Class Participation (10%)
Since this course incorporates a collaborative learning experience, attendance and active participation in class discussions is required. Students will be required to come to class prepared to discuss the assignments and readings.

Exams (20%)

Projects and Assignments (50%)
- 5 assignments each dealing with the five broad topic areas

Final Project (20%)

Potential Texts:
An Introduction to Data Science by Saltz and Stanton (ISBN-13: 978-1506377537) (Uses R)

Python Data Science Handbook: Essential Tools for Working with Data by Jake VanderPlas, ISBN-13: 978-1491912058 (Uses IPython)

Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking by Foster Provost and Tom Fawcett ISBN: 978-1449361327

Data Visualization and Presentation with Microsoft Office Valerie by Sue and Matthew Griffin 2015, ISBN-13: 978-1483365152

Potential Software:
Microsoft Excel, including PowerBI add-ins
Microsoft Power BI Desktop
Microsoft SQL Server Management Studio
R Studio
Ipython / Python

Tableau

Credits: 3
Contact hours/week: 3

Student Learning Outcomes: At the end of the course, students will:
- Understand what business and data analytics are and why organizations are actively adopting this orientation for strategic advantage.
- Understand key information technology/system concepts that will allow provide the necessary data retrieval and preparation for analytics.
- Learn necessary data analytics tools and concepts so that they can participate in and lead analytics-based projects.
- Learn core and necessary programming skills either in R or Python so that they understand how to work with data sets and apply the appropriate tools and techniques to answer strategic managerial questions.
- Be able to analyze & evaluate output from data analytics procedures and draw correct conclusions from it.
- Be able to communicate the results of data analysis to management by writing a detailed report.
- Understand the special ethical issues that arises when utilizing data analytics tools and techniques and to behave ethically in the professional communities.

Course outline developed by Manoj Agarwal (SOM), Xingye Qiao (Mathematics), Mark Zhang (Computer Science), Nagen Nagarur (SSIE).

MSDA 501: Data Science 1: Regression

Course Description: With the emergence of big data, data-driven decision-making abilities have become increasingly important to professionals and practitioners across various industries. This course aims to provide students with an in-depth understanding of multiple linear regression analysis, a simple but powerful modeling tool for data and decision analytics.

Course topics include the theoretical background and formulation of linear regression models, the estimation methods, the diagnostics procedures, and the interpretation of model results. Emphasis will be placed on the application of the models to real world problems. Topics will include:

- Multiple Regression
- Diagnostics
  - Residual Plots, R squared, Scatter Plots
  - Outlier detection, influential points,
  - Heteroscedasticity, serially correlated errors
- Transformations of Variables
- Model Selections
  - Traditional, forward, backward, stepwise, AIC, BIC, cross validation
  - High dimensional data, Lasso and sparsity
- Non-linear regression
- Logistic regression
- ANOVA
- Software: SAS, SPSS and/or R will be used for applied problems

Course Requirements:

Class participation (5%)

Because this course incorporates a collaborative learning experience, attendance and active participation in class discussions is required. Students are expected to be prepared to discuss the readings assigned for each topic and exchange ideas on statistical modeling and its implementation.

Homework assignments (20%)

Homework assignments will be given weekly. Students are expected to perform statistical analysis on the assigned problems and write detailed reports of their analyses and results. Homework assignments must be completed individually while discussions are encouraged.

Exams (40%)

There will be two exams: mid-term exam (20%) and final exam (20%). The exams can be in-class or take-home and will cover all the materials (lectures, readings, and assignments) discussed prior to the exam date.

Team project (35%)

Students will be required to work together with 1-2 other students as a team to conduct a joint project by analyzing a real world data set that is either found online or collected by themselves. Each team will write an initial proposal (5%), give a 30-minute presentation (10%), and submit a 20-30 page final report (20%).

Potential Texts:

Faraway, Julian J. (2014), Linear Models with R, 2nd edition, Chapman & Hall/CRC Texts in Statistical Science

Sheather, Simon J. (2009), A Modern Approach to Regression with R, Springer Texts in Statistics

Credits: 3

Contact hours/week: 3

Student Learning Outcomes

1. To understand basic theories of linear regression models: estimation, statistical inference, prediction, model diagnosis, model selection, etc.
2. To learn how to apply linear regression models to solve real world problems in a scientifically organized way.
3. To obtain proficient programming skills and knowledge of statistical software for the implementation of linear regression models.
4. To develop an ability to effectively communicate the procedures and results of regression analysis in both written and verbal forms.

Course outline developed by Profs. Chang Hee Park (SOM) , Ganggang Xu (Mathematics)

MSDA 502: Data Science 2: Data Mining

Course Description: With advances in modern technology, such as the widespread use of electronic records or the internet, the sheer volume of data that is collected is staggering. The challenge is to distill this data into useful information that has relevance for managerial decisions. Data mining is a subfield of statistics that gives us a wide array of tools to tackle these questions. To illustrate, some recent applications of data mining include (i) models to predict consumer preferences, e.g. Netflix recommendation system and (ii) models to detect fraudulent credit card transactions, (iii) prediction of diseases in the medical diagnosis field.

Learning Objectives: On the completion of the course, students will:
   • Have knowledge of basic concepts, algorithms, and techniques of data mining.
   • Understand the differences between the various data mining techniques and which ones are appropriate for different problems
   • Be able to use data mining tools, in particular with R software.
   • Be able to apply data mining tools to real business problems

Credits: 3.
Contact hoursper week: 3.

Potential Textbook: "An Introduction to Statistical Learning With Applications in R," by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani.

Homework: Homework will be assigned weekly and be graded based on correctness. All assignments are quantitatively oriented and will require the use of R. Submit your R script as well as an accompanying write-up in Word or PDF format for every homework.

Participation: Part of the grade will be based on class participation, as active participation leads to better learning and understanding. A key skill is to concisely articulate ideas. In a business environment this is crucial since most managers spend little time reading and writing reports and so most of their interactions will be oral. Students will not be graded on class participation. However students should be prepared, have a view on the discussion questions, and be willing to share it. Regularly missing lecture or failing to contribute to class discussion will result in a lower participation grade.

Exam: There will be a midterm and final exam. The format of both exams will be take home, open note, open book, open computer.

Project: There will be a semester long data analysis project performed in groups of 3 to 5 people. Each group will formulate a research question and answer it by using the tools we learn in class. Your deliverables will be:

(i) a short research proposal presentation due midway through the semester,

(ii) a final presentation and write-up summarizing your findings due at the end of the semester. The grade will be based on (i) the quality of the analysis, (ii) the novelty or importance of the research question.

Grading: Your grade will be calculated by a weighted average with the following weights:

25% midterm exam,

25% final exam,

20% homework,

20% project,

- **List of topics**:
    - Week 1. Review of regression: multiple regression, logistic regression, transformations, model selection.
    - Week 2. Classification: logistic regression.
    - Week 3. Classification: linear discriminant analysis, quadratic discriminant analysis.
    - Week 4. Resampling methods: cross-validation, bootstrapping.
    - Week 5. Tree-based methods: decision trees.
    - Week 6. Tree-based methods: bagging, random forests, boosting.
    - Week 7,8. Support vector machines: the maximal margin classifier, the support vector classification
    - Week 9,10. Neural networks, deep learning.
    - Week 11. Unsupervised learning: principal components analysis.
    - Week 12. Unsupervised learning: k-means clustering, hierarchical clustering.
    - Week 13. Text mining.

10% class participation.

Honor code: Please follow the honor code outlined in the student handbook. All violations will be reported to administration, with no exceptions.

Developed by Leon Cui, SOM and Yu Lei, Computer Science

MSDA 503: Data Science 3: Modelling

Course description

Analytics is defined as the scientific process of transforming data into insights for making better decisions. Analytical models are key to understanding data, gaining insights into systems, generating predictions, and making decisions. Three major parts of analytical modeling are descriptive analytics (describe what happened), predictive analytics (predict what will happen), and prescriptive analytics (prescribe what should happen). In this course, we will discuss some modeling techniques for predictive and prescriptive analytics.

Managers constantly make decisions, under complex situations, and rarely with full information. This course introduces the students to the art of mathematical modeling of business and social systems for making practical, data-driven decisions. The methods covered include deterministic and stochastic optimization techniques and simulation modeling techniques to discover and analyze the risk and uncertainty.

Topics to be covered
- Introduction to Optimization Modeling
- Linear Programming Models
- Network Models

- Optimization Models with Integer Variables
- Nonlinear Optimization Models
- Decision Making Under Uncertainty
- Simulation Models
- Queueing Models

# of Credits: 3
Contact Hours per week: 3
Prerequisites / Corequisites: MSDA 500, 501, 502
Course grades:
- Homework and case assignments: 25%
- Exams (3): 75%

Potential Texts:
- Winston, W.L. and Albright, S.C. *Practical Management Science*; Fifth Edition (2016); ISBN-13: 9781305250901; Publisher: South-Western, Cengage Learning
- S. G. Powell and K. R. Baker*, Management Science: The art of Modeling with Spreadsheets*, Fourth Edition (2014), ISBN-13: 978-1118582695; Publisher: John Wiley.
- C. T. Ragsdale, *Spreadsheet Modeling and Decision Analysis: A Practical Introduction to Business Analytics*, Eighth Edition (2017), ISBN-13: 978-1305947412; Publisher: Cengage Learning (latest edition is 2015).

Potential Software:
- Microsoft Excel
- Decision Tools Suite, including *@RISK, Precision Tree, StatTools, TopRank, NeuralTools, Evolver,* and *BigPicture*; by Palisades Corporation.

Student Learning Outcomes
Students will:
- Learn analytical problem-solving methods.
- Be able to create a mathematical model. This helps them think clearly and precisely.
- Understand the importance of modeling for decision making.
- Apply optimization techniques to make decisions in a deterministic environment.
- Learn how uncertainty complicates decision-making process and learn to apply techniques useful in assessing risk and making decisions under uncertainty.
- Be able to conduct what-if analysis
- Be proficient in using Excel and Excel Add-ins to create appropriate models for helping in decision making.

Developed by Sal Agnihothri (SOM), Nagen Nagarur (SSIE)

MSDA 504: Database and Large Data Repositories

Course Description: The focus of this course will be on understanding information systems and infrastructure used in Data Analytics. The course will provide an introduction to elements of database design and database query languages. Students will also gain technical understanding of and hands-on experience with the information technology infrastructure required for data analytics.

The course content is in twofold. The first part of the course focuses on traditional databases and structured data. It covers association between data elements and data models (including entity-relationship and relational models), relational database design techniques, database query languages. Students will be exposed to the basics in query processing, transaction management, and concurrency control.

The second part of the course covers non-relational databases and big data infrastructure. Students compare and contrast as well as have hands-on experience with various non-relational databases including document, graph, and column databases. Students will also be exposed to Hadoop environment and basic services available in this environment, including MapReduce, distributed file systems, storage, and processing.

Course Objectives: This course is designed to provide a solid foundation and background in traditional database systems and large data repositories. Students will be exposed to data storage and retrieval as well as data management practices in the course.

> **Credits:** 3.
> **Contact hoursper week:**3.

Learning Goals: Upon successful completion of this course, students will be able to:

- Demonstrate an understanding of the relational data model and the entity-relationship model,
- Demonstrate an understanding of the database design process and theory as well as the ability to perform database design. This process includes conceptual design (E-R diagram), logical design based on the relational model, table normalization, and internal design,
- Demonstrate an understanding of basic relational database operations and the ability to use SQL at expert level,
- Understand the fundamental concepts, terminology, and principles of information technology infrastructure necessary for business analytics,
- Be able to store, process, and access data for the purpose of business analytics,
- Have hands-on experience with variety of non-relational databases to be able to perform basic functions,
- Be able to make sense of data using visualization.

Course Grading: Grading points will be based on 2 exams (50%), 6 assignments (30%), and 1 project (20%).

Potential Software: Students will be exposed to the following software: Oracle, Hadoop, SAP HANA, MongoDB, Neo4j, and Hive.

Potential Texts: Following textbooks can be used as reference books:

- *Database Systems* by M. Kifer, A. Bernstein, and P. M. Lewis, second edition
- *Hadoop: The Definitive Guide* by Tom White, third edition
- *Programming Hive: Data Warehouse and Query Language for Hadoop* by Edward Capriolo, first edition
- *Designing Data-Intensive Applications* by Martin Kleppmann, first edition

Developed by Profs. Ali Yayla, SOM and Weiyi Meng, Computer Science

MSDA 510 and MSDA 511: Analytics Practicum 1 & 2

Course Description:
This course teaches data analytics under a problem-solving framework. In doing so, students are provided a unique opportunity to apply the analytical tools and concepts taught in the MSDA program in a practical manner. Students will work on live projects from various organizations.

Each project will have three to five students assembled as a team. Each project involves a single "client" organization, which may be a profit, non-profit, or governmental organization. Each client provides its assigned study team with a project of current interest and an executive dedicated to working with the team. A faculty advisor is assigned to each team. Several faculty advisors might participate, depending on the expertise needed. Students schedule their own time, dovetailing with client schedules and that of their faculty advisor. Students (in consultation with the client and faculty advisor) will be responsible for project scope, understanding the issues and analytic needs, identifying appropriate analytical methods, analyzing the data, drawing conclusions and/or making recommendations for decision-making, writing a report, and presenting conclusions/recommendations to the clients, and the advisor / instructor.

Topics to be covered
- Initial orientation and meeting with the faculty advisor/ course instructor.
- Meeting with the client to discuss decision problems and the expected deliverables
- Development of a "Memorandum of Understanding" outlining the background of the problem, problem statement, final client deliverables, schedules, interim deliverables, team and individual responsibilities, and budgets
- Report writing and developing presentations

Course requirements:
Since this is a hands-on projects course, there are no scheduled class times. An initial organizing session with the faculty advisor and possibly the client will be required. Student teams will be required to meet with the faculty advisor <u>weekly</u> to ensure progress and meeting the interim project goals and timelines.

Potential Texts:
Contemporary Business Reports, by Shirley Kuiper and Dorinda Clippinger ISBN-13: 978-1111820855

Beyond Bullet Points: Using Microsoft PowerPoint to Create Presentations That Inform, Motivate, and Inspire, by Cliff Atkinson (3rd Edition) ISBN-13: 978-0735627352

Potential Software:
Microsoft Excel, including PowerBI add-ins
Microsoft Power BI Desktop
Microsoft SQL Server Management Studio
R Studio
Ipython
Tableau
Credits: 3

Contact hours/week: 3

Course Grades:
There will be no exams. Course grades will be based on quality of the project report evaluated by the client, faculty advisor, as well as the peer evaluations of the group members.

Student Learning Outcomes
Students will:
- o Learn to identify appropriate analytical tools and techniques to help in decision making
- o Learn to retrieve, clean, and massage data to get it ready for analysis
- o Learn to apply the appropriate techniques for solving real-world problems
- o Work in teams to write a comprehensive report
- o Learn to present their conclusions/recommendations to the client, including suggestions for implementation.

Course outline developed by Manoj Agarwal (SOM), Xingye Qiao (Mathematics), Mark Zhang (Computer Science), Nagen Nagarur (SSIE).

Optional Courses not required of all students

MSDA 599: Optional Boot Camp Course (for students with weak background)
Course Description: This course will bring students up to date with the basic requirements that will be used in the courses in the program. Students will refresh their knowledge in databases, programming, calculus and probability and statistics.
Prerequisites / Corequisites: None
Contact Hours per week: 35
# of Credits: 3
Student Learning Outcomes: The students will be able to:
- Understand how databases are structured and how to retrieve needed data
- Write a program to perform an analytics task
- Be able to differentiate and maximize functions
- Understand elements of linear algebra
- Formulate and perform hypotheses testing.

Course Topics will include:
- Database Overview
- Programming Overview
- Calculus Review
- Linear Algebra Review
- Review of Probability and Statistics
  - o Descriptive Statistics
  - o Distribution Families
  - o Estimation
  - o Hypothesis Testing

Course Assignments and Grades: Five assignments (80%) will be used to assess each of the learning goals. The assignments will be a mix of homework and mini projects. One exam (20%) will also be given.
The course grade will be composed of the weighted average of the assignment grades and exams.

MSDA 520: Independent Study in Advanced Data Analytics

Course Description: This course will allow to pursue interest in selected topics based on interests of students and expertise of faculty.

Prerequisites / Corequisites: MSDA 500, 501, 502

Contact Hours per week: 1 hour per credit hour

# of Credits: Variable (between 1 and 3)

Student Learning Outcomes: Students will get a much more in depth knowledge of particular data analytics methods and techniques.

General Course Requirements: An initial memorandum of understanding will be written up discussing the objectives of the course, learning goals, number of credits, meeting frequency between instructor and student, deliverables, grading and evaluation methods. This MOU will need approval of the Director of the Program.

MSDA 521: Internship in Data Analytics

Course Description: This course will allow students to work in an organization to help them in analytical projects.

Prerequisites / Corequisites: MSDA 500, 501, 502

Contact Hours per week: 1 hour per credit hour

# of Credits: Variable (between 1 and 3)

Student Learning Outcomes: Students will:
- Get a much more in depth knowledge of data analytics methods and techniques in the industry with which they do internships.

General Course Requirements: Since this is a hands-on projects course, there are no scheduled class times. An initial organizing session with the faculty advisor and possibly the client will be required. Student teams will be required to meet with the faculty advisor on an agreed frequency to ensure progress and meeting the internship goals and timelines. An memorandum of understanding will be written up discussing the objectives of the internship, learning goals, number of credits, meeting frequency between instructor and student, deliverables, grading and evaluation methods. This MOU will need approval of the Director of the Program.

Appendix 4: Letters of Support from Potential Employers

KPMG

KPMG

KPMG LLP
345 Park Avenue
New York, NY 10154-0102

Telephone +1 212 758 9700
Fax +1 212 758 9819
kpmg.com

April 7, 2017

Mr. Upinder S. Dhillon
Dean and Koffman Scholar of Finance
Binghamton University
School of Management
DEH Development Office, AD248
4400 Vestal Parkway East
Vestal, NY 13850

Dear Upinder:

KPMG is very excited about the prospect of a *Master's Degree in Data Analytics* at Binghamton University. We are extremely supportive of such a program and believe there is tremendous value in producing graduates with this skillset. Programs like this are disrupting the education experience for the audit profession by integrating courses in accounting and auditing with the real-world application of technologies and advanced D&A capabilities to develop auditors for an era of machine learning, artificial intelligence and other digital advances.

Data and analytics is changing the way that KPMG and the public accounting profession provide services. Beyond a deep knowledge of accounting, our audit professionals often need to be D&A-savvy and possess the analytical skills and critical thinking to improve the quality of certain audit procedures and deliver insights to our clients. The focus of D&A in academia is not primarily aimed at our profession, and new talent will benefit from more preparation in order to work on today's data-driven audits. The new technologies must be matched with people who know how to use them effectively.

The quality of information new D&A technologies and tools are able to handle, and the speed with which they are able to do so, is unprecedented. Audit committees, management and stakeholders expect their auditors to keep pace, improve audit quality, and provide deeper insight into the audit based on the new capabilities and data volumes. Addressing this new reality is critical to our profession's focus on quality.

While it is difficult to put an exact count on the students we would hire from such a program, KPMG has hired close to 100 full time students across all functions over the last three years. Such an offering would only enhance our already strong hiring numbers. KPMG has a critical need for talented people with a desire to learn and who can cope with the change brought on by D&A. As a firm, we are investing heavily to change how we attract, train and deploy students to have an immediate and lasting impact on our business.

As always, KPMG values our relationship with Binghamton University and looks forward to seeing this new offering come to fruition.

Very truly yours,

David J. Kaplan
Partner

Ernst and Young (EY)

EY
Building a better
working world

Ernst & Young LP
5 Times Square
New York, NY 10036-6530

Tel +1 212 773 3300
Fax +1 212 773 6350

Upinder Dhillon
Dean – School of Management
Binghamton University
Academic A Building
PO Box 6000
Binghamton, NY 13902-6000

Dean Dhillon:

EY has seen and will continue to see an increased use of analytics in all of our service lines. It is becoming a reality that everyone in business will confront large amounts of data that may be unstructured, in motion, uncleansed or untrusted and that means that we all need an additional set of tools. More and more, EY expects people to come to the firm with an analytical mindset. Additionally, we will need to hire people in all parts of the business who are more expert and experienced with these tools and processes. As a result, EY supports the School of Management's proposed new Master's Degree in Data Analytics.

Please let me know if you require additional information or have any questions.

Regards,

Marc Dieli
EY Campus Recruiting Coordinating Partner

Price Waterhouse Cooper (PWC)

pwc

Dear Dean Upinder Dhillon:

As a leading professional services firm, PwC is committed to our clients and addressing their needs in the most effective and efficient way possible. As our world changes at an unprecedented rate, our clients are being impacted by five major forces of macroeconomic change: rapid demographic changes, economic shifts, increasing resource scarcity, urbanization, and technology breakthroughs. In order to address these impending forces and better serve our clients, we are searching for new talent with the correct skillsets and technical foundations to adapt to this new reality. At PwC, we firmly believe that data analytics and related technical skills are the future of our firm, our industry, and the rapidly changing business environment.

Binghamton University's School of Management is one of our largest strategic sources for campus recruitment and entry level hiring. As such, it is imperative that the students joining PwC out of these programs have the necessary skills to succeed and become leaders in our firm. We are very excited about the School of Management's proposal for a graduate program focusing on Data Analytics and we strongly believe a Master's Degree in this field will be a differentiator for students and the university alike. The accounting, tax, and consulting professions - the core of our business - are entrenched in the explosion of data across our clients' industries. We need talent with the capacity to turn "big data" into meaningful insights and strategic decision making - and, we need it now.

A Master's in Data Analytics would equip students with skills in basic programming, data visualization tools, statistical analytics, and ultimately, data analytics practicum - the solving of real business issues using data analytics. All of these skills will be instrumental to the future of PwC as we work to achieve better insight and greater efficiency through the use of data. As a firm, we have committed our time and resources to educating students and faculty on the importance of data analytics and how it is shaping our industry. This degree program has the potential to build a well-qualified and competitive candidate pipeline for our business needs at PwC. PwC's campus hiring from the School of Management would likely increase as a result of this program and the skill set it would afford to those who enroll.

We are confident technology and data will continue to disrupt and reshape our current business environment. As employers and educators, it is our responsibility to ensure that students and our incoming talent are well prepared to adapt and drive innovation. We do not underestimate the time and investment it takes to develop a new curriculum, however, we believe in this program and the opportunities it would create.

Sincerely,

Matthew Singer

Matthew Singer
PwC Financial Services Partner

PricewaterhouseCoopers LLP, 300 Madison Avenue, New York, NY 10017
www.pwc.com/us

Travelers

TRAVELERS

Jay S. Benet
Vice Chairman and
Chief Financial Officer
One Tower Square, 2MS
Hartford, CT 06183
860.277.7680 TEL
860.277.8136 FAX

January 10, 2018

Donald G. Nieman
Executive Vice President for Academic Affairs and Provost
Professor of History
Binghamton University
PO Box 6000
Binghamton, New York 13902-6000

Dear Don:

This letter is being provided in support of your efforts to obtain approval from SUNY and the NY State Department of Education for the data analytics master's degree program that is currently under development at Binghamton University. As you know, my wife and I have personally supported this effort by committing to fund a fellowship for a faculty member involved in this program. We did this in recognition of the important role that data and analytics now plays in enabling companies to successfully compete in today's business world. This is especially true in my industry, property casualty insurance. My company, Travelers, currently employs approximately 1,200 data and analytics specialists who help us evaluate risk and price and manage our products, among other important functions. We look forward to Binghamton University serving as a source of future data and analytics employees.

Sincerely yours,

Jay S. Benet

Appendix 5: External Evaluation Reports from SUNY- approved evaluators

Professor Rabikar Chatterjee

Associate Dean for Masters and Executive Programs, and Gulf Oil Foundation Professor of Business, Katz Graduate School of Business, University of Pittsburgh

External Evaluation Report

The External Evaluation Report is an important component of a new academic program proposal. The external evaluator's task is to examine the program proposal and related materials, visit the campus to discuss the proposal with faculty and review related instructional resources and facilities, respond to the questions in this Report form, and submit to the institution a signed report that speaks to the quality of, and need for, the proposed program. The report should aim for completeness, accuracy and objectivity.

The institution is expected to review each External Evaluation Report it receives, prepare a single institutional response to all reports, and, as appropriate, make changes to its program proposal and plan. Each separate External Evaluation Report and the Institutional Response become part of the full program proposal that the institution submits to SUNY for approval. If an external evaluation of the proposed program is required by the New York State Education Department (SED), SUNY includes the External Evaluation Reports and Institutional Response in the full proposal that it submits to SED for registration.

Institution: Binghamton University (SED Code: 211000)

Evaluator Name (Please print.): RABIKAR CHATTERJEE

Evaluator Title and Institution: Associate Dean for Masters and Executive Programs, and Gulf Oil Foundation Professor of Business, Katz Graduate School of Business, University of Pittsburgh

Evaluator Signature:

45

Proposed Program Title: Data Analytics

Degree: M.S.

Date of evaluation: September 11-13, 2017

I. Program

  1. Assess the program's **purpose, structure, and requirements** as well as formal mechanisms for program **administration and evaluation.** Address the program's academic rigor and intellectual coherence.

  Purpose. The program aims to prepare students for successful careers making more informed decisions through analytics in the data driven economy. See also Section 2.3 (a) and (b) (page 5) of the proposal.

  Structure. There are two versions of the program. The on-campus version is a 30-credit, 11 month, program offered over Summer-2 (6 credits), Fall (12 credits), and Spring (12 credits). For the online distance version, the 30 credit, 2 year program is offered over 5 terms – Summer-2, Fall, and Spring (Year 1) and Fall and Spring (Year 2), with 6 credits in each term.

Requirements. Curricular and admissions requirements are described in the proposal (in Sections 2.3 (g) (page 8) and 2.4 (a) (page 11) respectively). The description and details in the proposal and subsequent on-site discussions confirm that these are appropriate.

Administration. The proposal identifies a Director as the principal administrator of the program, along with support staff. See also Section 2.5 (a) of the proposal (page 12) for more detail. Although not explicitly mentioned in the proposal, the core group of faculty members from different units will also need to be involved in managing this program, especially in the early years.

Evaluation. Section 2.7 (page 12) and Appendix 7 Part B.3 (pages 43 and 44) of the proposal describe the proposed evaluation process for the on-campus and distance learning versions respectively. These evaluation and continuous improvement processes are reasonable and satisfactory.

Academic rigor and intellectual coherence. Based on the details of the program and the courses provided in the proposal, and strongly reinforced by face-to-face meetings with key faculty and administrators, I have full confidence that the program will be academically rigorous and intellectually coherent. (This issue is also discussed more fully later in this report.)

2. Comment on the **special focus** of this program, if any, as it relates to the discipline.

The program focuses on methods and techniques of data analytics that provide a set of highly valuable skills that apply across disciplines. Its transdisciplinary focus involves collaboration across four departments in three schools. In my view, the focus of the program is very effectively articulated in the proposal.

3. Comment on the plans and expectations for **self-assessment and continuous improvement**.

The proposal describes the plans for program, assessment and continuous improvement in Section 2.7 (page 12) and in Part B.3 (pages 43 and 44) of the proposal. These plans were also discussed during the visit. On this basis, I believe that the plans are feasible and meet the need for continuous quality monitoring and improvement.

4. Discuss **the relationship** of this program to other programs of the institution and collaboration with other institutions, and assess available support from related programs.

This is a unique cross-disciplinary program that relates to other programs in at two significant ways:

- It is an attractive post-graduate option for students graduating from several baccalaureate programs on campus
- It involves close collaboration among three units on campus – the School of Management, the Harpur College of Arts and Sciences (Department of Mathematical Sciences), and the Watson School of Engineering & Applied Science (Departments of Computer Science and Systems Science, and Industrial Engineering)

Based on the proposals and discussions during the visit, I fully believe that this program will receive the support they need from the participating units and programs.

5. What is the evidence of **need** and **demand** for the program locally, in the State, and in the field at large? What is the extent of occupational demand for graduates? What is the evidence that demand will continue?

The need for a transdisciplinary program in data analytics has been articulated by the industry advisory boards and alumni of participating departments. Section 2.3(h)(1) (pages 8-9) provides extensive evidence of demand for graduates with the skills that this program is designed to impart. The need for data analysts will continue to grow in the foreseeable future. It is clear to me that this is not a fad, but based on systemic long term needs in the economy.

II. Faculty

6. **Evaluate the faculty**, individually and collectively, with regard to training, experience, research and publication, professional service, and recognition in the field.

During my campus visit, I had the opportunity to assess the credentials of the faculty who will be directly involved with the development and execution in the program, and subsequently teaching the courses that comprise the program. I believe that the faculty has the expertise and experience to make this a very successful program.

7. **Assess the faculty in terms of number and qualifications** and **plans for future staffing**. Evaluate **faculty responsibilities** for the proposed program, taking into account their other institutional and programmatic commitments. Evaluate faculty **activity in generating funds** for research, training, facilities, equipment, etc. Discuss any **critical gaps and plans for addressing them**.

The plan calls for existing faculty across the schools/departments to carry the teaching burden, at least initially. The core group of faculty appear to be committed to the success of this program, and willing to take on the additional work load that this program will entail. The deans of the respective schools are also committed in their support, including possible reassignment of faculty to ensure that the courses in this program are covered. (This may require the use of adjunct faculty to teach the courses that faculty so reassigned currently teach.)

In particular, this program calls for a high level of coordination across schools, involving in particular the core group of faculty and administrators, including the deans. This transdisciplinary aspect is a great strength of the program, but it will involve significant commitment of time on the part of this group of faculty. Notwithstanding the stated willingness of the core faculty to be so involved, there is a need to have a more detailed and formal plan in the next steps of development. This includes future faculty needs. Presumably, the increased number of students generated by this new graduate program will open up a few tenure stream faculty lines.

Faculty involvement will be necessary in generating projects for the practicum. These projects are a key component of the program, and an important point of differentiation. I must admit that after reading the proposal prior to the visit, I was concerned about the program's ability to generate these projects. However, after discussions with key faculty, I believe that the resources and industry contacts are in place to be able to generate the projects.

8. Evaluate credentials and involvement of **adjunct faculty** and **support personnel**.

There is insufficient information to ascertain if (and when) adjunct faculty will be used to teach in this program. At least in the early years, the plan calls for courses to be taught by full time faculty. In my view, the courses in this type of "flagship" graduate-level programs must be taught by full time faculty.

Among support personnel (staff), the program, has identified a capable person who may potentially serve as the administrative head (director) of the program. That will be caliber of person needed for the position.

III. Students

9. Comment on the **student population the program seeks to serve**, and assess plans and projections for student recruitment and enrollment.

As described in Section 2.4(d) of the proposal (page 11), it is anticipated that most students will be from the core areas where Binghamton University gets its students – viz. New York State. Since a large of alumni as well as potential firms that need the graduates are in the greater New York area, the students are likely come from that area. The online version of the program may be attractive to students in NY state who are unable to be part of the residential (on-campus) version, but can cover a wider areas outside NY state as well, especially neighboring states.

Given the attractiveness of the program, I fully expect that the projected enrollment can be met, with the specified admissions standards. However, as discussed below, it may be prudent to delay the start of the part-time online version by one year (to Year 3) to ensure a successful launch for that version of the program, using Year 2 as a pilot to test one course (or some limited number of courses), since the distance learning version will have its own unique challenges.

10. What are the prospects that recruitment efforts and admissions criteria will supply **a sufficient pool of highly qualified applicants and enrollees**?

Given the strong market need for the program and the institution's ability to draw students from the NY City area, I feel confident that there will be a sufficiently large pool of qualified applicants and enrollees.

11. Comment on provisions for encouraging participation of **persons from underrepresented groups**. Is there adequate attention to the needs of part-time, minority, or disadvantaged students?

The online version is designed especially for part-time students. The attention to the needs of minority and disadvantaged students should be no different from other master's level programs on campus and consistent with the guidelines and expectations of the institution and the SUNY system. All students enrolled may access Services for Students with Disabilities (SSD) and other student support services.

12. Assess the system for monitoring **students' progress and performance** and for **advising students** regarding academic and career matters.

As described in Section 2.5 (page 11) of the proposal, students enrolled in the program will be assigned an academic advisor from the faculty teaching in the program. Students will be required to meet with their faculty advisors each semester to review their progress in courses, field placements, and discuss their short- and long-term academic and career goals. The Program Director will also meet with each student once a semester to monitor their progress.

The program will incorporate efforts to support distance students in their utilization of the virtual learning environment. Orientation to online learning through B-online (Binghamton University's tutorial for students taking online courses), community building activities at the onset of each course, and video conferencing for academic advising and office hours will be provided to students to foster a personally engaging and supportive environment.

13. Discuss prospects for graduates' post-completion success, whether **employment, job advancement, future study, or other outcomes related to the program's goals.**

Given the very strong and growing demand in the market for the skills that this program is designed to impart, prospects for employment or job advancement are excellent.

IV. Resources

14. Comment on the adequacy of physical **resources** and **facilities**, e.g., library, computer, and laboratory facilities; practica and internship sites or other experiential learning opportunities, such as co-ops or service learning; and support services for the program, including use of resources outside the institution.

Based on an inspection of the physical resources and facilities during the campus visit, these are judged to be adequate for the requirements of the program.

15. What is the **institution's commitment** to the program as demonstrated by the operating budget, faculty salaries, the number of faculty lines relative to student numbers and workload, and discussions about administrative support with faculty and administrators?

The core team of faculty working on developing this program is totally committed to the program, as are the deans of the schools/colleges involved (the Graduate School, the Schools of Management and Engineering & Applied Science, and the College of Arts and Sciences). The dean of the Business School, in particular, is enthusiastic in his support of the program, and a key driver of this initiative.

The budget projections will need to be fleshed out more fully, as was discussed by the external reviewers during the visit, including recognizing the up-front start-up costs and the workloads of the core faculty team involved. Nevertheless, it is my impression that the senior administration, including the Provost, is supportive of the program, and recognizes the potential contribution to the institution in terms of growing the graduate student population, generating net revenues, and enhancing the institution's reputation.

V. Summary Comments and Additional Observations

16. Summarize the **major strengths and weaknesses** of the program as proposed with particular attention to feasibility of implementation and appropriateness of objectives for the degree offered.

Strengths:

- The skills imparted to students by the program in data analytics are in high (and growing) demand across a wide variety of sectors of the economy.
- The institution can draw from a large and strong pool of potential applicants in-state, particularly from around the NY city area. The distance learning version further expands the potential market, by adding part-time students and enlarging the geographical catchment area.
- The program should contribute significantly to the number of graduate students (in this case, tuition-paying professional students), consistent with the institution's strategic objectives.
- The objectives of the program and its overall design are well thought through – the framework is in place for a successful program for the institution.
- There are two key aspects of its design that are its particular strengths: its transdisciplinary structure and the practicum requirement. While both would generally pose significant resource and coordination challenges, I believe, after interviewing the key players involved, that there is the commitment and institutional experience to deliver successfully on both counts.
- The key physical resources and core faculty are in place.

Weaknesses:

- Several similar programs offering master's degrees in data analytics already exist in NY state and elsewhere, which puts this program (at least potentially) at a competitive disadvantage.

- There is a need for a more formal arrangement among the schools/departments laying out the responsibilities and scope of work, and also revenue and cost sharing formulas. The core group of faculty from across the units may be committed to a high level of interdepartmental cooperation, but the model will not be sustainable without such a formal arrangement.

- The plan to launch the distance learning version in Year 2 is too ambitious. Instead, Year 2 should be used at most for a small-scale trial before scaling up in subsequent years.

- A more detailed plan and budget will be necessary, that will more fully recognize the timing and magnitude of resources required, including marketing of the program (in both versions – the distance learning version in particular would likely required the stronger marketing effort).

However, I would emphasize that all of these weaknesses can be addressed. The market for data analytics graduates is large enough and expanding so that this program will not suffer from a lack of applicants. Further, its unique design (discussed under strengths) will make it attractive relative to several of the competing programs. As to the other three weaknesses, I believe that the institution and the team developing the program are fully capable of addressing them in a timely fashion.

17. If applicable, particularly for graduate programs, comment on the ways that this program will make a **unique contribution** to the field, and its likelihood of achieving State, regional and/or national **prominence**.

This is not a research-oriented program, but one designed to train graduates for jobs in an already large and rapidly growing area (data analytics). Its unique interdisciplinary design will help propel the program to prominence at the state level and beyond, especially with its distance learning version.

18. Include any **further observations** important to the evaluation of this program proposal and provide any **recommendations** for the proposed program.

I was impressed during my visit to note the level of commitment and the ability of the core faculty group working on the program, as well as the strength of support of the deans. In particular, I believe that the dean of the School of Management can play an extremely affective role as a senior-level product champion. These observations during my visit addressed my concerns prior to the visit (after reading the proposal) about the institution's ability to tackle a very ambitious project.

As an external reviewer, I would strongly recommend that the program be approved, with the following specific issues in particular to be addressed:

- The development of more detailed plan and budget that recognizes specific resources required up front to develop and successfully launch the program.

- A formal, written memorandum of understanding among the participating units that clearly outlines responsibilities and how revenues and costs will be split across the units.

- A full launch of the distance learning version be postponed by at least a year to focus fully to the on-campus version initially, learn from that experience to improve the program and inform the design of the distance version. A pilot of the distance program (with one or two courses and a few distance students willing to participate in the test) can be launched in Year 2. Delivering a successful distance learning program will have its own set of challenges, and it would make sense to develop and test it carefully before a full launch.

External Reviewer Conflict of Interest Statement

I am providing an external review of the application submitted to the State University of New York by:

Binghamton University (SED Code: 211000)
<div align="center">(Name of Institution or Applicant)</div>

The application is for (circle A **or** B below)
  A) New Degree Authority

(B) Registration of a new academic program by an existing institution of higher education:

Master of Science in Data Analytics

(Title of Proposed Program)

I affirm that I:

(1.) am not a present or former employee, student, member of the governing board, owner or shareholder of, or consultant to the institution that is seeking approval for the proposed program or the entity seeking approval for new degree authority, and that I did not consult on, or help to develop, the application;

(2.) am not a spouse, parent, child, or sibling of any of the individuals listed above;

(3.) am not seeking or being sought for employment or other relationship with the institution/entity submitting the application?

(4.) do not have now, nor have had in the past, a relationship with the institution/entity submitting the application that might compromise my objectivity.

Name of External Reviewer (please print): RABIKAR

CHATTERJEE

Signature:

Professor Simon Sheather

Professor of Statistics, Interim Director of the Texas A&M Data Science Institute, Academic Director of MS (Analytics) and Online Programs, Texas A&M University

External Evaluation Report

Form 2D

The External Evaluation Report is an important component of a new academic program proposal. The external evaluator's task is to examine the program proposal and related materials, visit the campus to discuss the proposal with faculty and review related instructional resources and facilities, respond to the questions in this Report form, and submit to the institution a signed report that speaks to the quality of, and need for, the proposed program. The report should aim for completeness, accuracy and objectivity.

The institution is expected to review each External Evaluation Report it receives, prepare a single institutional response to all reports, and, as appropriate, make changes to its program proposal and plan. Each separate External Evaluation Report and the Institutional Response become part of the full program proposal that the institution submits to SUNY for approval. If an external evaluation of the proposed program is required by the New York State Education Department (SED), SUNY includes the External Evaluation Reports and Institutional Response in the full proposal that it submits to SED for registration.

Institution: Binghamton University (SED Code: 211000)

Evaluator Name (Please print.): Simon Sheather

Evaluator Title and Institution: Professor of Statistics, Interim Director of the Texas A&M Data Science Institute, Academic Director of MS (Analytics) and Online Programs, Texas A&M University

Evaluator Signature: *Simon Sheather*

Proposed Program Title: Data Analytics

Degree: M.S.

Date of evaluation: September 11-13, 2017

I.   Program

1. Assess the program's **purpose, structure, and requirements** as well as formal mechanisms for

program
administration and evaluation. Address the program's academic rigor and intellectual coherence.

Purpose. According to the proposal, "the (M.S. in Data Analytics) program is designed to prepare students with balanced business intelligence, leadership, quantitative, and technical skills and abilities. … The program aims to prepare students for successful careers making more informed decisions through analytics in the data driven business world."

Structure. The program consists of 30 credits, made up of ten 3 credit courses. Five of these courses are core courses, two courses form an Analytics Practicum. The five core courses will be newly developed, based around an interdisciplinary focus, with each course involving multiple faculty members. The three elective courses are to be chosen by each student, based on their proposed field of interest. The program will be offered both on campus and in an online distance format. The only difference between the two program formats is the duration of the program.

Requirements. Curricular requirements for the proposed program are described in detail in Section 2.3(g) of the proposal.

Administration. A crucial feature of the administration of the program is "to assign a Director of the program in advance of the first class". This person will have the important role of bringing together faculty from the School of Management, the Department of Mathematical Sciences in Harpur College of Arts and Sciences, and the Departments of Computer Science and Systems Science and Industrial Engineering in the Watson School of Engineering & Applied Science. In addition, the program director will perform the usual duties, such as, making admissions decisions. The roles of two support staff are also described in the proposal.

Evaluation. Program assessment is described in detail in the proposal in Section 2.7.

Academic rigor and intellectual coherence. The program has been well thought out. The relatively novel approach of having interdisciplinary core courses focus, involving multiple faculty members will ensure intellectual coherence. The details of the curriculum demonstrate both the breadth and depth of the proposed program and hence its academic rigor.

2. Comment on the **special focus** of this program, if any, as it relates to the discipline.

The special focus of the program is Data Analytics, an important field that brings together skills from computer science, engineering, management and statistics. In terms of delivery, the focus of this program that sets it apart from many other programs is its truly interdisciplinary delivery of the core courses.

3. Comment on the plans and expectations for **self-assessment and continuous improvement**.

These are described in detail in Section 2.7 of the proposal. It was evident during the site visit that there is a strong focus on self-assessment and continuous improvement for all degree programs at SUNY Binghamton.

4. Discuss **the relationship** of this program to other programs of the institution and collaboration with other institutions, and assess available support from related programs.

The proposed program in Data Analytics will draw on faculty expertise in computer science, engineering, management and statistics. Based on the site visit, I am very confident that the program will receive the necessary support from the relevant Department Heads, Deans right up to the Provost.

5. What is the evidence of **need** and **demand** for the program locally, in the State, and in the field at large? What is the extent of occupational demand for graduates? What is the evidence that demand will continue?

The September-October Issue of the *Harvard Business Review* includes an article entitled "Careers – How data science is disrupting the job market". According to the article, "Data scientist, data engineer and Director of Analytics are the fastest-growing and hardest-to-fill positions (with high costs to hire)." This article also provides the following statistics:
- By 2020 the demand for data scientists and data engineers is expected to grow by 39%
- 364,000 additional job listings are expected by 2020
-

    II.   Faculty

6. **Evaluate the faculty**, individually and collectively, with regard to training, experience, research and publication, professional service, and recognition in the field.

Faculty from the School of Management, the Department of Mathematical Sciences in Harpur College of Arts and Sciences, and the Departments of Computer Science and Systems Science and Industrial Engineering in the Watson School of Engineering & Applied Science will be involved in the program. Each of the faculty that we met during the campus visit is well credentialed and has the experience and expertise to make the program a success.

7. **Assess the faculty in terms of number and qualifications** and **plans for future staffing**. Evaluate **faculty responsibilities** for the proposed program, taking into account their other institutional and programmatic commitments. Evaluate faculty **activity in generating funds** for research, training, facilities, equipment, etc. Discuss any **critical gaps and plans for addressing them**.

Given the truly interdisciplinary nature of the core courses, this program calls for a high level of coordination at all levels. First, the faculty from the four departments will need to work together to produce and deliver the new courses. Secondly, the Deans of the School of Management, the Harpur College of Arts and Sciences and the Watson School of Engineering & Applied Science along with the Dean of the Graduate School will

need to work together with the Provost to decide the sharing rules for the funds generated by the program. The long term success of the new MS program is critically dependent on the success of this co-ordination.

8. Evaluate credentials and involvement of **adjunct faculty** and **support personnel**.

Adjunct faculty will be needed both to generate industry projects for the Practicum and to help supervise the students undertaking them. There is no concern here, since a long track record of success, in both of these activities, exists in the Watson School of Engineering & Applied Science.

Support personnel (including teaching assistants) will be crucial to success of the program, especially so, the distance version of the program. Based on my experience with Distance Education, which dates back to 1989, the following types of support personnel will be needed for the distance based program:
- A relatively senior IT professional, who can operate autonomously to ensure the effective delivery of the distance program
- A program manager responsible for overseeing the day-to-day delivery of the distance program
- Teaching assistants (TAs), who can assistant both the faculty teaching the distance courses, as well as the students taking the courses. A particular challenge will be that qualified TAs may be hard to find for the core courses, given their interdisciplinary nature.
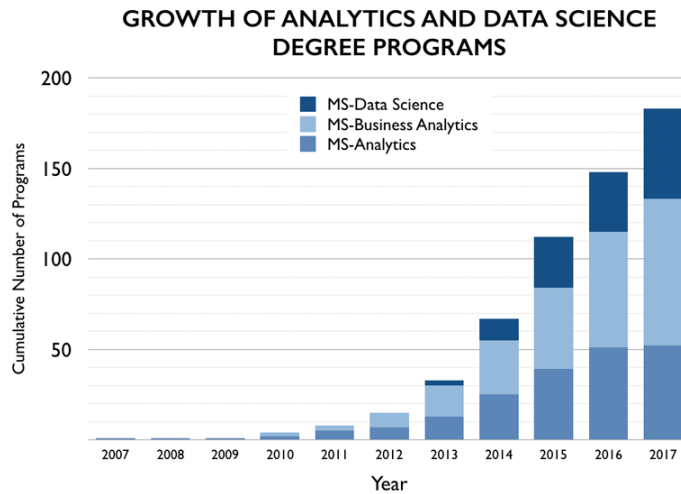
III. Students

9. Comment on the **student population the program seeks to serve**, and assess plans and projections for student recruitment and enrollment.

The proposal states that "most students will be from the core areas where Binghamton University gets its students – viz. New York State. Since a large of alumni as well as potential firms that need the graduates are in the greater New York area, we anticipate our students will come from that area. The online component of the program may be attractive to students in NY state, as well as throughout the US." The projections for student recruitment and enrollment appear to be reasonable.

10. What are the prospects that recruitment efforts and admissions criteria will supply **a sufficient pool of highly qualified applicants and enrollees**?

The chart below demonstrates that the proposed program is late to the market and that there are more than 180 competing programs already in existence. On the other hand, the proposed program has a unique selling proposition, namely, that the five core courses will be newly developed, based around an interdisciplinary focus, with each course involving multiple faculty members. I believe that if this unique selling proposition is communicated to potential students then there will be a sufficient pool of highly qualified applicants and enrollees for the program.

GROWTH OF ANALYTICS AND DATA SCIENCE DEGREE PROGRAMS

Source: http://analytics.ncsu.edu/?page_id=4184

11. Comment on provisions for encouraging participation of **persons from underrepresented groups**. Is there adequate attention to the needs of part-time, minority, or disadvantaged students?

Yes. According to the proposal:
"The Graduate School currently recruits applicants to all programs from historically underrepresented groups by attending recruitment fairs dedicated to minority students, by visiting colleges and universities where underrepresented students attend in large numbers, and by emphasizing the affordability of a Binghamton education and the availability of scholarships for historically underrepresented students. At the same time, 36% of our undergraduate students come from historically underrepresented groups, and we anticipate a high level of interest in this program from our own graduates."

12. Assess the system for monitoring **students' progress and performance** and for **advising students** regarding academic and career matters.

An effective system for monitoring and advising students will be in place. According to the proposal:
"Students enrolled in the program will be assigned an academic advisor from the faculty teaching in the program. Students will be required to meet with their faculty advisors each semester to review their progress in courses, field placements, and discuss their short- and long-term academic and career goals. The Director will also meet with each student once a semester to monitor their progress.

The program will incorporate efforts to support distance students in their utilization of the virtual learning environment. Orientation to online learning through B-online (Binghamton University's tutorial for students taking online courses), community building activities at the onset of each course, and video conferencing for

academic advising and office hours will be provided to students to foster a personally engaging and supporting environment."

13. Discuss prospects for graduates' post-completion success, whether **employment, job advancement, future study, or other outcomes related to the program's goals.**

As described in Section I.5, students with in Analytics and Data Science are in ever growing demand. Thus, the prospects for employment, job advancement for the graduates of the proposed program are indeed excellent.

IV.   Resources

14. Comment on the adequacy of physical **resources** and **facilities**, e.g., library, computer, and laboratory facilities; practica and internship sites or other experiential learning opportunities, such as co-ops or service learning; and support services for the program, including use of resources outside the institution.

During the site visit, the reviewers were shown examples of the physical resources and facilities that will be available for the program. There are no concerns here.

15. What is the **institution's commitment** to the program as demonstrated by the operating budget, faculty salaries, the number of faculty lines relative to student numbers and workload, and discussions about administrative support with faculty and administrators?

There is a great deal of interest in and good will for the proposed program beginning at the top with the Provost, including the relevant deans and department heads and going through to the faculty who will design and teach the new core courses. In this sense, there is a great deal of the institutional commitment to the program.

It will be necessary to develop a more detailed budget for the program, which explicitly lists startup activities and their associated costs, as well as ongoing activities and their steady state costs.

V.   Summary Comments and Additional Observations

16. Summarize the **major strengths and weaknesses** of the program as proposed with particular attention to feasibility of implementation and appropriateness of objectives for the degree offered.

Major strengths:

- In a very crowded marketplace, the proposed program has a unique selling proposition, namely, that the five core courses will be newly developed, based around an interdisciplinary focus, with each course involving multiple faculty members.

- The program is both innovative and well designed, including core courses, electives and a practicum.
- The key faculty to teach the interdisciplinary core courses are already in place.
- A strong leader has been identified to fill the crucial role of Program Director.

Major weaknesses:

- In a very crowded marketplace, the proposed program is late to the market.
- An explicit agreement is needed that spells out the sharing rules for the funds generated by the program.
- More planning is needed with respect to the distance learning version of the program. Valuable experience on a small scale is needed before the program is rolled out in distance format to a wider audience.

17. If applicable, particularly for graduate programs, comment on the ways that this program will make a **unique contribution** to the field, and its likelihood of achieving State, regional and/or national **prominence**.

The program has the potential to achieve State, regional and even national prominence on the basis of its truly interdisciplinary focus. While a number of analytics programs exist that involve two colleges at an institution, very few exist that involve 4 departments across 3 colleges.

18. Include any **further observations** important to the evaluation of this program proposal and provide any **recommendations** for the proposed program.

I strongly recommend that the proposed MS Data Analytics degree be approved.

External Reviewer Conflict of Interest Statement

I am providing an external review of the application submitted to the State University of New York by:

Binghamton University (SED Code: 211000) .,

_____

(Name of Institution or Applicant)

The application is for (circle A **or** B below)

A) New Degree Authority

B) Registration of a new academic program by an existing institution of higher education:

Master of Science in Data Analytics

(Title of Proposed Program)

I affirm that I:

1. am not a present or former employee, student, member of the governing board, owner or shareholder of, or consultant to the institution that is seeking approval for the proposed program or the entity seeking approval for new degree authority, and that I did not consult on, or help to develop, the application;

2. am not a spouse, parent, child, or sibling of any of the individuals listed above;

3. am not seeking or being sought for employment or other relationship with the institution/entity submitting the application?

4. do not have now, nor have had in the past, a relationship with the institution/entity submitting the application that might compromise my objectivity.

Name of External Reviewer (please print): Simon

_____Sheather_____

Signature:

_____Simon Sheather_____

60

Appendix 6: Institutional Response to External Evaluation Reports

Overall, both the reviewers are very positive and support the program structure, focus, self-assessment and continuous improvement, need and demand for the program, as well as the faculty and their qualifications, among other things. They both strongly recommend approval of the program.

There are several issues on which they wanted further clarifications.

- A more detailed budget projection, including up-front startup costs like marketing.
  - We have researched the upfront cost for marketing similar programs, and have added a Year 0 initial costs. Total costs including Director salary are close to $350,000. These investments will be provided by the participating schools.
- A more formal arrangement among the schools / departments laying out the revenue and cost sharing formulas.
  - The deans and department chairs have met and have an informal agreement about revenue sharing. More details will be worked out once the program is formally approved by NY State Education Department and SUNY.
- Delay the launch of the online program.
  - We have now moved the launch date of the online program from Year 2 to Year 3.
- Get some experience on a small scale before launching the online program.
  - In year 3, we will only target to get 15 online students. This number will allow us to learn and debug any issues. At maximum strength, we only plan to have 25 students in Year 5.

Appendix 7: Distance Education Format Proposal Form 4

Distance Education Format Proposal

For A Proposed or Registered Program

When a new or existing program is designed for a distance education format, a campus Chief Executive Officer or Chief Academic Officer should submit a signed cover letter and this completed form to the SUNY Provost at *program.review@suny.edu*. According to MSCHE, the 50% standard includes only courses offered in their entirety via distance education, not courses utilizing mixed delivery methods. Also, MSCHE requires that the first two programs for which 50% or more is offered through distance education be submitted for Commission review and prior approval of a substantive change.

- All campuses must complete the following sections: Sections 1 - 3, and Part B: Program Specific Issues.
- Part A must be completed if the proposing campus has not previously submitted this form with a completed Part A: Institution-wide Issues, or has made significant changes to its institution-wide distance education operations since last completing Part A. This applies even if the institution has programs registered to be delivered at a distance.

Section 1. General Information		
a) **Institutional** **Information**	Institution's 6-digit SED Code:	**211000**
	Institution's Name:	Binghamton University
	Address:	*4400 Vestal Parkway, Binghamton, NY 13902-6000*
b) **Registered or Proposed Program**	Program Title:	MS in Data Analytics
	SED Prog30ram Code	
	Award(s) (e.g., A.A., B.S.):	M.S.
	Number of Required Credits:	Minimum [30] If tracks or options, largest minimum [ ]
	HEGIS Code: 62	#0702

	CIP 2010 Code:	#11.0401
c) **Distance Education Contact**	Name and title: Telephone: E-mail:	
d) **Chief Executive or Chief Academic** **Officer Approval**	**Signature affirms that the proposal has met all applicable campus administrative and shared governance procedures for consultation, and the institution's commitment to support the proposed program. *E-signatures are acceptable.*** Name and title: Signature and date:	
	If the program will be registered jointly[1] with one or more other institutions, provide the following information for each institution:	
	Partner institution's name and 6-digit SED Code: Name, title, and signature of partner institution's CEO (or **append** a signed letter indicating approval of this proposal):	

Section 2: Enrollment

Year	Anticipated Headcount Enrollment			Estimated FTE
	Full-time	**Part-time**	**Total**	
1		0	0	
2		0	0	
3		15	15	
4		20	20	
5		25	25	

Section 3: Program Information

a) ***Term length*** (in weeks) for the distance program: 15

---

[1] If the partner institution is non-degree-granting, see SED's CEO Memo 94-04.

b) Is this the same as term length for classroom program? [ ] No [X] Yes

c) How much "*instructional time*" is required per week per credit for a distance course in this program? (Do not include time spent on activities that would be done outside "class time," such as research, writing assignments, or chat rooms.)   ***NOTE:*** *See SUNY policy on credit/contact hours and SED guidance.*

One hour per week per credit

d) What proportion or percentage of the program will be offered in Distance Education format? Will students be able to complete 100 percent of the program online? If not, what proportion will be able to be completed online?

50% will be offered in Distance Education Format. Students will be able to complete 90% of program online. A one-week residency on campus will be required while taking the MSDA 500 Introduction to Analytics course. Other group meetings will be enabled either physically or using technology.

e) What is the maximum number of students who would be enrolled in an online course section?
30

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Part A: Institution-wide Issues: Submit Part A only for the **first** Distance Education program proposed by your institution using this form. SUNY and the State Education Department will keep this in a master file so that your institution will not need to resubmit it for each new proposed online program, **unless there are significant changes, such as a new platform**.

</div>

Part A is already on file. This part was submitted as part of a proposal titled "Advanced Certificate for Social Work in Health Care" dated February 1, 2015.

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Part B: Program-Specific Issues: Submit Part B for each new request to add Distance Education Format to a proposed or registered program.

</div>

<div style="border:1px solid #000; background:#bcd">

Part B.1. Learning Design

</div>

a) How does your institution ensure that the ***same academic standards and requirements*** are applied to the program on campus and through distance learning? If the curriculum in the Distance Education program differs from that of the on-ground program, please identify the differences.

The main required courses MSDA 500, 501,502, 503 and 504 will be taught synchronously. While on-campus students will be taking 4 courses a semester, we anticipate that the online students will take 2 courses. We plan to offer half of these required courses in the evening hours, so that online students can attend classes synchronously. In addition, lectures will be taped and available online, in case online students (or on campus students) are not able to attend. Online students may also be part of the teams working on projects. Thus we expect the academic standards and requirements to be identical to the on-campus program.

The elective courses are going to be archived at the time they are taught. The online students will then access them asynchronously, with special office hours set up for them for interacting with the professors. The professors will use the same set of standards as the on-campus version.

b) The practicum courses (MSDA 510 and 511) will be done by the students who will be included in the on-campus teams. Using distance education and IT tools, the in-class and on-campus students will work together in teams on their project works. The System Science and Industrial Engineering (SSIE) department of the Watson School has many on-line students in their on-campus program and has been successfully including them in on-campus teams for any required work, report writing, and project presentations, for more than a decade. Are the courses that make up the distance learning program offered in a sequence or configuration that allows ***timely completion of requirements***?

Below we attach the proposed schedule for both the on-campus and distance courses. We require distance students to attend a one week on campus course MSDA 500. This course will be taught intensively, and will allow the distance students to get to know their fellow students.

In year 1, The MSDA501 will be taught in the evenings in the summer, so the distance students can take the course. In Fall, MSDA502 and 504 will be taught in the evenings, while in Spring MSDA 503 will be in the evening. Elective 1 will be archived and available asynchronously to distance students.

In year 2, students will take MSDA510 and Elective 2, and in spring MSDA511 and Elective 3.

		On Campus	Distance Students	
		Students	Yr 1	Yr 2
MDSA 500: Introduction to Analytics (Road Map)	3	Summer One Week Intensive	X On Campus	
MSDA 501: Data Science I (Regression)	3	Summer 4 Weeks	X	
MSDA 502: Data Science II (Data Mining)	3	Fall	X	
MSDA 504:Database and Large Data Repositories	3	Fall	X	

MSDA 510: Analytics Practicum I	3	Fall		X
Elective 1	3	Fall		Elective 2
MSDA 503: Data Science III (Modelling)	3	Spring	X	
MSDA 511: Analytics Practicum II	3	Spring		X
Elective 2	3	Spring	Elective 1	
Elective 3	3	Spring		Elective 3

c) How do faculty and others ensure that ***the technological tools*** used in the program are appropriate for the content and intended learning outcomes?

The program works closely with the University's Center for Learning and Teaching (CLT) which includes Educational Communications and the University Center for Training and Development. Our partnership with these campus units allows us to review and select software platforms to optimize student learning outcomes and which integrate with our existing Learning Management System (LMS).

The program uses a design team comprised of instructional designers, a student disability specialist, librarian, and social work faculty. The team identified priorities related to accessibility for students and pedagogy. The team selected software that (1) optimizes accessibility for students; (2) provides a means for demonstrating new practice behaviors (3) provides opportunities for students to demonstrate assessment and intervention skills; and (4) provides timely and meaningful feedback to learners. The University's LMS (BlackBoard Collaborate) provides appropriate means to deliver educational content asynchronously and synchronously, and has integrated video conferencing software to facilitate synchronous discussions, demonstrations and exercises.

The software needed for the courses like SAS, SPSS etc. is available to students to install on their laptops. Students can also log in into the remote desktop versions of these programs. Software like R is available free to students to install on their laptops.

d) How does the program provide for appropriate and flexible interaction between faculty and students, and among students?

The program will use several strategies to promote student connectivity and engagement order to foster a sense of community. All distance students are required to attend a one week intense on campus course MSDA 500. This will be first step in building a sense of community, getting to know the professors and other students,

Academic advisement and office hours will be facilitated through video conferencing (e.g., Blackboard Collaborate). Synchronous class sessions will be held in four required courses (MSDA 501,502,503,504) to foster live interaction among faculty, students and guest presenters. Asynchronous methods of communicating – email, voice threads, discussion boards, and chat rooms – will be use allow flexibility among personal schedules to dialogue with faculty and other students. assignments where students are required to provide feedback to one another, software which allows asynchronous video recordings or discussion threads will be utilized.

e) How do faculty teaching online courses verify that the student who registers in a distance education course or program is the same student who participates in and completes the course or program and receives the academic credit?

Currently, each student is assigned a unique sign-in and password for access to our LMS. The Center for Learning & Teaching (CLT) vetted a series of online verification software packages for the university. These measures would be in addition to the university's standard authentication processes. Individual programs and/or instructors may select which verification software are best for their courses. In addition, since students will be working in teams on projects in every class, it will be hard for non-registered students to fake their identity. Webcams will be used for small group projects, and this personal nature of interaction will ensure that only the actual students are participating.

Part B.2. Outcomes and Assessment

a) Distance learning programs are expected to produce the *same learning outcomes* as comparable classroom-based programs. How are these learning outcomes identified – in terms of knowledge, skills, or credentials – in course and program materials?

All the courses will involve students working in teams with on-campus students. In addition at least six of the 10 classes are taken jointly with on-campus students. This ensures that the same learning outcomes will be achieved between the on campus and distance students. We understand the distance learning students may have a different profile than the on campus students and may learn at a different speed. We are budgeting extra tutorial hours for these students to bring them to the same learning level.

b) Describe how the *means chosen for assessing student learning* in this program are appropriate to the content, learning design, technologies, and characteristics of the learners.

Since the same means are being used for both on-campus and distance students, we expect they are appropriate for both audiences.

Part B.3. Program Evaluation

a) What process is in place to monitor and *evaluate the effectiveness* of this particular distance education program on a regular basis?

We will be using several tools to assess the effectiveness of the classes and the program.

- Learning objectives will be assessed through the evaluation measures used in the class like exams, projects, reports, presentations etc.
- A capstone project is required in the last semester. The capstone project evaluation will allow us to assess overall learning from the program.
- Student Opinion of Teaching (SOOT) survey is administered for all courses through MyCourses- the university learning management system. This quantitative survey uses a Likert Scale to assess students' perception of the quality of course preparation and teaching, instructor's knowledge in the specified topic area, and usefulness of instructional materials and assignments. There is also a place for extensive comments.
- Students will complete a mid-term and final anonymous, qualitative survey to evaluate the effectiveness of the learning environment in relation to specified competencies and practice behaviors. These surveys are administered by the course instructor.
- Students completing the program will be included in the Graduate School's established post-graduation program evaluations.
- We will also conduct focus groups with students both at the end of year 1 and year 2 to assess strengths and weaknesses of the program and places for improvement.

b) How will the evaluation results will be used for ***continuous program improvement***?

The Program Director will review all results of the program evaluation with the Faculty Advisory Committee as well as the Deans for School of Management, Watson School of Engineering and Harpur College.

Recommendations from the various groups will be compiled and integrated into the curriculum. Furthermore, given the regular advances in data analytics methods and technology, faculty will be responsible for updating course content on an annual basis. The Faculty Advisory committee will meet with the Director once a semester while the Dean will meet with the Director once a year.

c) How will the evaluation process assure that the ***program results in learning outcomes appropriate to the rigor and breadth*** of the college degree or certificate awarded?

We will track placements and job market outcomes of all students. We will also conduct Informal surveys of employers after placement of students, and will be done about one year after the completion of the program. We also plan to do an informal monitoring of other graduate programs in data analytics, and ensure that our course content and rigor is being maintained at appropriate levels.

Part B.4. Students Residing Outside New York State

SUNY programs must comply with all "authorization to operate" regulations that are in place in other U.S. states where the institution has enrolled students or is otherwise active, based on each state's definitions.

a) What processes are in place to monitor the U.S. state of residency of students enrolled in any distance education course in this program while residing in their home state?

Residency status of each student is initially established based on admissions data. If the applicant is a US citizen or permanent resident, attended at least two years of high school and graduated in New York, and applied for undergraduate admission within five years of their graduation date, we usually treat them as a NY resident for tuition billing purposes. All others are deemed nonresident unless they can prove that they are a resident.

Technically, the university's data storage resource, ODS, and report creation program, Hyperion, provides the university with the means to create a list of non-resident distance learning students and their home state of residence.

b) Federal regulations require institutions delivering courses by distance education to provide students or prospective students with contact information for filing complaints with the state approval or licensing entity in the student's state of residency and any other relevant state official or agency that would appropriately handle a student's complaint. What is the URL on your institution's website where contact information for filing complaints for students in this program is posted?   ***NOTE:*** *Links to information for other states can be found at* [*here*](#)*.*

For summer session students: http://www.binghamton.edu/clt/summer-session/academic-information.html

For winter session students: [http://www.binghamton.edu/clt/winter-session/academic- information.html](http://www.binghamton.edu/clt/winter-session/academic-%20information.html)

For all students, the university Ombudsman: http://www.binghamton.edu/ombudsman/index.html