Proposal to add a Social Science Analytics specialization to the Data Analytics Major

The Data Analytics Major was approved by CAA in November of 2013 and by the Ohio Board of Regents in February 2014.

The Data Analytics Major is managed jointly by the Department of Statistics (College of Arts and Sciences) and the Department of Computer Science and Engineering (College of Engineering).

The Data Analytics Major is structured in three parts:
- Core fundamentals
- Area of specialization
- Integrated experiential education component

The Data Analytics major contains three specializations:
- Business Analytics specialization (14 credit hours in the specialization; 126 credit hours to complete the B.S.)
- Computational Analytics specialization (14 credit hours in the specialization; 128 credit hours to complete the B.S.)
- Biomedical Informatics specialization (21 credit hours in the specialization; 135 credit hours to complete the B.S.)

Each specialization is required to consist of a number of technical courses and a capstone experience that is optimized for the subject.

The Social Science Analytics Specialization (SSAS) contains the same GE requirements and the same set of core Data Analytics requirements as the other three specializations. It contains a minimum of 19 credit hours in the specialization and a minimum of 131 credit hours to complete the B.S. Similar in structure to the proceeding specializations, the SASS is comprised of:
- One course from the "overview of research methods" (3-4 credit hours)
- Three courses from electives listed under the "focused research methods" and "visualization and spatial analyses" areas (9-10 credit hours)
- Completion of an independent research project (enrollment in 4998 or 4999; 3 credit hours)
- Capstone in Data Analytics (CSE 5XXX/STAT 5XXX; 4 credit hours)
- Students will also be required to complete CITI Basic Human Research Course training (Social and Behavioral Research track; can be accessed on-line)

The SASS specialization will provide students with a degree and specialization that appears to have a growing area of employment availability. The credit hours required exceeds the 121 minimum for a B.S., but is in-line with the previously approved specializations and provides a well rounded/balanced set of skills for the market area.

Note: Focused Research Methods area does include two 7000-level courses

THE OHIO STATE UNIVERSITY

Data Analytics Major
College of Arts and Sciences

Department of Computer Science and Engineering
Department of Statistics

data-analytics.osu.edu
data-analytics@osu.edu

September 22, 2014

Vice Provost Randy W. Smith
Council on Academic Affairs
Office of Academic Affairs
203 Bricker Hall
190 North Oval Mall
Columbus, OH 43210

Dear Vice Provost Smith:

The College of Arts and Sciences requests that the Council on Academic Affairs approve a revision to the existing major in Data Analytics. The major is jointly administered by the Department of Statistics and the Department of Computer Science and Engineering and in its current form has three specializations: Biomedical Informatics, Business Analytics and Computational Analytics. We are proposing to add a fourth, Social Science Analytics Specialization to the major.

The proposed specialization was developed by faculty in the Division of Social and Behavioral Sciences (represented by Professor Kathleen McGraw, Associate Dean, Social and Behavioral Sciences) in consultation with the management and steering committees of the Data Analytics major, the memberships of which include faculty members from the College of Arts and Sciences, the College of Engineering, the College of Medicine and the Fisher College of Business. The proposed specialization has been reviewed and unanimously approved by these committees, and it has also been reviewed and approved by the faculty responsible for curricular matters in the Department of Statistics and the Department of Computer Science and Engineering.

Please feel free to contact us with any questions or concerns about this proposed revision to the major.

Sincerely,

Dr. Christopher Hans   Dr. Srinivasan Parthasarathy
Associate Professor, Statistics   Professor of Computer Science and Engineering
Co-director of the Data Analytics Major Co-director of the Data Analytics Major

Enclosures:
　　1.　Details of the proposed revision to the Data Analytics major.

General Information

The major in Data Analytics leads to the B.S. degree in the College of Arts and Sciences. The major was approved by the Council on Academic Affairs on November 6, 2013, and was approved by the Ohio Board of Regents on February 4, 2014. Students have been able to declare a major in Data Analytics since May 2014. Approximately 30 students are in the major as of September 2014.

The major is structured in three parts: core fundamentals, an area of specialization, and an integrative experiential education component. There are currently three specializations in the major: Biomedical Informatics, Business Analytics, and Computational Analytics. Each specialization is required to consist of a number of technical courses and a capstone experience that is optimized for the subject. The capstone experience serves as the integrative experiential component.

We are proposing to add a new **Social Science Analytics Specialization** (SSAS) to the major.

Rationale for the Proposed Specialization

The rationale for the proposed SSAS is given in the attached document "Overview of the Social Science Analytics Specialization."

Impact of the Proposed Revision on the Existing Major

The proposed revision to the major simply adds a fourth option for a specialization. All other aspects of the existing major remain intact. The proposed SSAS does *not* change the minimum number of credit hours for a student to major in Data Analytics.

Management of the Proposed Specialization

The Data Analytics major is a jointly managed program between the Department of Statistics (in the College of Arts and Sciences) and the Department of Computer Science and Engineering (in the College of Engineering). The Chair (or their designee(s)) of each department manage the program in conjunction with advising resources – together, the Chairs (or their designees) represent the Management Committee for the Data Analytics major. The Management Committee is aided by a Steering Committee, the membership of which includes one representative from each of the approved specializations in the Data Analytics major.

The proposed specialization is part of the Data Analytics major and, as such, will be managed by the above committees.

Upon approval of the SSAS by the Council on Academic Affairs, the Management Committee will work with the dean of the Division of Social and Behavioral Sciences to identify a faculty member from the Division to serve on the Steering Committee.

Learning Objectives

The Data Analytics major has five approved core program objectives. These core objectives are augmented with objectives associated with each specialization. The existing, approved major objectives (M.# notation) and the proposed objectives associated with the specialization (S.# notation) can be found in the curriculum map in the attachments.

Assessment

We are assembling an assessment plan as our first batch of students in the new major progress. The assessment plan will take into account both the major-specific learning outcomes as well as specialization-specific learning outcomes, and we anticipate working and coordinating with the specializations' representative on the steering committee and constituent units on campus for each of the specializations currently approved or in the approval process. We expect to begin collecting data on assessment as students progress through the core of the program and additional data for the assessment plan will be available after the first students have graduated. Then, further longitudinal tracking can occur to evaluate the effectiveness of our training regimen for the graduates from the new major. We also anticipate developing assessment strategies with the proposed external advisory board but have been advised at this point to wait for the creation of such an advisory board by the broader university collaborative on data analytics. As such we will try to put a plan in place but expect to execute this part of the plan in conjunction with relevant members of the external advisory board only when such a board is formally created. Like our steering committee, we expect such an advisory board to include not only members of industry and government but also academic leaders with experience in creating data science programs nationwide at the undergraduate and graduate level.

Implementation Issues

- How will the proposed revision of the major affect students, faculty, and staff outside the proposing units?

    All courses included in the curriculum for the SSAS already exist, and so no new courses have to be created due to the proposed revision to major. As described in the original proposal for the Data Analytics major, we have set a cap of 50 new students per year in the major for the first five years. As students in the major will be distributed among the specializations, we expect

any short-term extra demand for courses in the proposed specialization to be manageable.

- Advising support for the major from the College of Arts and Sciences

  The College of Arts and Sciences recently (September 2014) hired an Academic Planning Specialist to advise students in the major and provide support for program administration. This individual will provide advising support for students interested in the SSAS of the Data Analytics major.

ATTACHMENTS

1. Overview of the Social Science Analytics Specialization
2. Curricular information for the Social Science Analytics Specialization
3. Original Data Analytics major proposal (approved by the CAA in Nov. 2013)

Overview of the Social Science Analytics Specialization

The Social Science Analytics Specialization (SSAS) in the Data Analytics major will complement the computational, mathematical, and statistical skills attained from the core curriculum with an understanding of, and proficiency in, original social science research (including experiments, surveys, content analysis, and ethnographic research). The SSAS will provide students with an understanding of the fundamental concepts and issues involved in doing research (e.g., theory development and hypothesis testing, ethics, sampling, various types of validity, and measurement) and the skills necessary to design original research.

Social science research skills are critical components of "big data" analytics. For example, companies like Facebook and Google regularly conduct experiments for purposes of product testing, improving user experiences, and even basic social science; Google acknowledges running over 20,000 experiments a year (http://www.nytimes.com/2014/07/03/technology/personaltech/the-bright-side-of-facebooks-social-experiments-on-users.html). While new technologies have radically changed public opinion polling, the basic skills associated with survey research (e.g., sampling and measurement) remain elements of big data web panels and social media platforms. Cultural anthropologists and other ethnographic scholars are increasingly in demand to provide "thick" description and explanation to the results that emerge from big data platforms. (http://www.businessinsider.com/heres-why-companies-aredesperateto-hireanthropologists-2014-3). In short, it is expected that SSAS graduates will be attractive to employers in a wide range of industries, including technology and social media companies, marketing and consulting firms, and government agencies.

More concretely, the SSAS will provide students with two complementary sets of skills. First, they will have the ability to formulate specific hypotheses and research questions, and create analytic investigations designed to answer those questions, making use of existing large, complex data sets. Second, they will be proficient in designing original data collection project. These original research designs might be intended to guide the direction of large complex data collections. Alternately, these original research designs might be smaller projects designed to complement existing data collection efforts to provide deeper insights into when and why particular social patterns emerge. To achieve these outcomes, the SSAS has the following requirements (the details of the requirements are further spelled out below):

(1) **One general "overview of research methods" course**. There are four of these courses offered in Communication, Sociology, Psychology, and Political Science, respectively. These "overview" courses have some overlap, including coverage of: (1) fundamental principles of research design, such as the logic of hypothesis testing, sampling, measurement error, internal and external validity, and research ethics; (2) specific research methodologies, such as surveys, experiments, content analyses, and qualitative/ethnographic research; and (3) basic statistics. While these courses naturally

have different emphases given different disciplinary research norms, the overlap is substantial enough that only one of the four can count toward the specialization requirement.

(2) Three courses from a set of electives that **focus on specific research techniques, as well as visualization and spatial analyses.** Eighteen courses have been identified, offered by nearly the full range of social science disciplines (Anthropology, Communication, Economics, Geography, Political Science, Psychology, Sociology, and Statistics). These courses offer in-depth training in specific research methodologies, such as experiments, survey research, ethnography, network analysis, and GIS. It is possible, even likely, that this elective course list will be expanded, as the social science programs expand their research methods course offerings. ==There is no distribution requirement;== students can take any three of these courses to satisfy this requirement.

==There is no distribution requirement because the SSA specialization is intended to be interdisciplinary, in keeping with the nature of the major itself. Students will have the option to sample multiple social science disciplines, or focus on a single discipline (this flexibility is comparable to the Business Specialization in the Data Analytics major).==

==(3)== Completion of an **independent research project,** through enrollment in either a departmental 4998 (Undergraduate Research in XXX) or 4999 (Undergraduate Thesis Research). This requirement requires students to demonstrate that they can design and carry out an independent, data-based research project, as well as produce a written report describing the theoretical motivation, research design and empirical results. The project must have a data component, and it can draw on existing data sets or involve original data collection. This project must be approved in advance by the faculty member who will serve as the SSAS representative on the Data Analytics Steering Committee. ==The faculty member who supervises the research project will be responsible for approving, and submitting a grade for, the final project. The SSAS representative will also collect and review the final projects, not for purposes of evaluation but rather for subsequent program evaluation.==

==Students will have sufficient exposure to social science research topics to complete an independent research project. Students will received beginning-level exposure to social science theories and methods in prerequisites and GE courses, and this preparation is assumed to be sufficient to prepare students to move into the intermediate level courses. Virtually all of the courses in the specialization include a research component (most of them group-based projects), so students will have had several opportunities to conduct research projects on a wide array of social science topics prior to the independent research project. Thus, they will be in a position to==

make an informed choice about the topic of the independent research project, which might indeed build upon a project completed in an earlier course.

(4) Training in the ethics of human subjects research is incorporated in several of the specialization courses. Given the importance of research ethics in conducting social science research, students must also complete the Collaborative Institutional Training Initiative (CITI) web-based human research course (specifically, the Social and Behavioral Research track), available here http://orrp.osu.edu/irb/training-requirements/citi/. Many of the courses (in both the general "overview of research methods" and "specific research techniques" categories) require completion of the CITI training course. If the CITI training is not completed as part of a formal course requirement, it should be completed during the independent research project. Upon completing the training, students should print and retain a copy of the completion report so that fulfillment of this requirement can be verified by the SSAS faculty member on the Data Analytics Steering Committee.

(5) Students will also take part in the broader integrative experiential component of the major represented by the **Capstone Data Analytics course** being developed by CSE/STAT. It is anticipated that if the enrollments grow sufficiently in the future, an independent Social Science Capstone course would be developed to replace the CSE/STAT Capstone for SSAS students.

Specialization: Social Science Analytics

Outcomes from the Core Courses

M.1 Students will demonstrate an understanding of and ability to apply computer science principles relating to data representation, retrieval, programming and analysis.

M.2 Students will demonstrate an understanding of and ability to apply mathematical and statistical models and concepts to detect patterns in data, as well as draw inferences and conclusions supported by the data.

M.3 Students will demonstrate critical thinking skills associated with problem identification, problem solving and decision-making, assessing value propositions supported by data, and generating a logical synthesis of information from data.

M.4 Students will demonstrate the ability to apply knowledge gained from one area to problems and data in another.

M.5 Students will demonstrate the ability to communicate findings and their implications, and to apply them effectively in organizational settings.

Outcomes from the Technical Courses for the Specialization

S.1 Students demonstrate an understanding of methodologies used by social scientists in the conduct of research, including ethical issues.

S.2 Students demonstrate proficiency in critically evaluating social science research.

S.3 Students demonstrate proficiency in the design and implementation of original social science research.

Program outcomes *(B=beginner, I=intermediate, A=advanced)*

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2	S.3
Math 1151		B						
Math 1152		B						
Math 2568		I						
CSE 2221	B				B			
CSE 2231	I		B		B			
CSE 2321	I	B	B		B			
CSE 2421/2*xxx*	B		B		B			
CSE 3241	A		I		I			
STAT 3201		B			B			
STAT 3202		B	B		B			
ISE 3230		I	I		I			
STAT 3301	B	I	I	B	I			
STAT 3302	B	A	I	B	I			
STAT 3303		I	A	I	I			
STAT 4620	B	A	I	B	I			
CSE 5242	A		A	B	A			
CSE 5243	A	I	A	I	A			
CSE 5544 or ISE 5*xxx*	CSE: A ISE: I	ISE: I	A	I	A			

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2	S.3
Comm 3160		B	B		I	I	I	I
Soc 3487		B	B			I	I	B
Psych 2300		B	B			I	I	
PolSci 4781		I	B			I	I	
Anthro 5650			I		I	A	A	I
Comm 3163	B	B	B		I	I	I	I
Econ 4050		I	I		I	A	I	I
Econ 5420		A	A			I		
PolSci 7785		I	A		I	A	A	A
PolSci 7702		I	A		I	I	A	A
Psych 4511			I			I	I	
Soc 4650	I	I	I		I	I	I	A
Anthro 5651	I	I	I		I	I	I	A
Geog 5200	I		I		I	I	I	
Geog 5201	A		I		I			I
Geog 5210	I		I		I	I	I	
Geog 5212	A	I	I			I		I
Geog 5226	A	I	I		I	I	I	I
Geog 5222	A	I	I		I	I	I	I
Geog 5223	A	I	I			I		
Geog 5225	I	I	I		I	I		I
PolSci 3780	B	I	I		I	I	I	I
XXXX 4998		A	A		A	A	A	A
XXXX 4999		A	A		A	A	A	A
Capstone (CSE/STAT 5xxx)	A	A	A	A	A	A	A	A

B.S. Degree—Data Analytics Major   **The Ohio State University**
Specialization Requirements   College of Arts and Sciences

Social Science Analytics

Total credit hours: 19 hours minimum, to be satisfied as follows:

(1) One course from the "overview of research methods" courses listed below is required; only one of those four courses can count towards the specialization requirement. (3-4 credit hours)

(2) Three courses from the electives listed in the "focused research methods" and "visualization and spatial analyses" section. There is no distribution requirement; students may select any combination of these courses to satisfy this requirement. (9-10 credit hours)

(3) Completion of an independent research project, requiring enrollment in a departmental 4998 (Undergraduate Research in xxx) or 4999 (Undergraduate Thesis Research). (3 credit hours)

(4) Capstone in Data Analytics (CSE5xxx/STAT 5XXX). (4 credit hours)

In addition to completion of these formal course requirements, students are required to complete the CITI Basic Human Research Course training (the Social and Behavioral Research track). The CITI training may be completed as part of a requirement for one of the courses, or it may be completed independently by the student. The CITI Basic Human Research Course is accessed here:
http://orrp.osu.edu/irb/training-requirements/citi/. Upon completing the training, students should print and retain a copy of the completion report so that fulfillment of this requirement can be verified.

Electives	Title	Course #	CH	Pre-req
Overview of Research Methods	Communication Research Methods	Comm3160	4	Stat 1350 or 1450
	Research Methods in Sociology	Soc3487	3	
	Introduction to Research Methods	Psych 2300	3	Psych 1100
	Techniques of Political Analysis	PolSci4781	3	
Focused Research Methods	Research Design and Ethnographic Methods	Anthro5650	3	Anthro2202 or permission
	Communication Industry Research Methods	Comm 3163	4	Stat1350 or 1450
	Experimental Economics	Econ 4050	3	Econ2001 or equiv.
	Econometrics II	Econ 5420	3	Permission
	Experimental Design	PolSci7785	3	Permission of instructor and Grad School
	Survey and Questionnaire Design	PolSci7702	3	Permission of instructor and Grad School
	Psychological Testing	Psych4511	3	Psych2300
	Seminar in Social Networks	Soc 4650	3	
	Statistical Foundations of Survey Research	Stat 5510	3	Various stats or permission
Visualization and Spatial Analyses	Spatial Analysis for Anthropologists	Anthro5651	3	Geog 5210 or permission
	Cartography and Map Design	Geog 5200	3	

	GeoVisualization	Geog 5201	3	Geog 5200
	Fundamentals of GIS	Geog 5210	3	
	GIS Algorithms and Programming	Geog 5222	3	Geog 5210 or equiv or permission
	Design and Implementation of GIS	Geog 5223	3	Geog 5210 or equiv or permission
	Geographic Applications of Remote Sensing	Geog5225	3	Geog5100, Stat 2450 or permission
	Spatial Simulation and Modeling in GIS	Geog 5226		Geog 5210 or equiv or permission
	Data Literacy and Data Visualization	PolSci3780	3	
Required of all students	Undergraduate Research in XXX (independent study) or Undergraduate Thesis Research	XXXX4998 or XXXX4999	3	
Required of all students	Capstone in Data Analytics	CSE5XXX/ STAT5XXX	4	

B.S. Degree—Data Analytics Major
Advising Sheet

The Ohio State University
College of Arts and Sciences

Social Science Analytics Specialization
Suggested Curriculum

This should be used as a **guide** only. Semester offerings are subject to change.

Year	Autumn		Spring	
	Course	**Hrs.**	**Course**	**Hrs.**
1	ASC 1100.xx	1	Math 1152 (Calc II)	5
	Math 1151 (Calc I)	5	CSE 2221 (Software I)	4
	GE Phys. Sci. (lab)	4	GE Open Option*	3
	GE Foreign Language 1	4	GE Foreign Language 2	4
	GE Writing Level 1	3		
	Total:	**17**	**Total:**	**16**
2	CSE 2231 (Software II)	4	CSE 2421 or 2xxx (Systems I or Systems for Data Analytics)	4
	CSE 2321 (Foundations I)	3	Math 2568 (Linear Algebra)	3
	Stat 3201 (Prob. and Uncertainty)	3	Stat 3202 (Stat. Inference)	4
	GE Social Sciences I **	3	GE Writing Level 2	3
	GE Foreign Language 3	4	GE Social Sciences II **	3
	Total:	**17**	**Total:**	**17**
3	ISE 3230 (Optim. & System. Model.)	3	Stat 3302 (Modeling for Discovery II)	3
	CSE 3241 (Databases I)	3	CSE 5243 (Data Mining)	3
	Stat 3301 (Modeling for Discovery I)	3	GE Biological Sciences (lab)	4
	Social Science Analytics Elective	3-4	Social Science Analytics Elective	3-4
	Social Science Analytics Elective	3-4	CSE 5544 **or** ISE 5xxx (Visualization)	3
	Total:	**15-17**	**Total:**	**16-17**
4	Stat 4620 (Intr. Stat. Learning)	2	Stat 3303 (Statistical Dec. Making)	3
	CSE 5242 or CSE 5xxx (DB II or Adv. DB and Cloud Computing)	3	GE Historical Study	3
	Social Science Analytics Elective	3-4	Social Science Research Project****	3
	GE Natural Science	3	GE Cult. & Ideas or Hist. Study***	3
	GE Arts	3	CSE/Stat Capstone	4
	GE Literature	3		
	Total:	**17-18**	**Total:**	**16**

* Stat 2450 is a suggested, but not required, choice for the GE Open Option for students with no previous exposure to statistics.

** Psych 1100 (Introduction to Psychology) is a suggested choice for satisfying a GE Social Sciences requirement; Psych 1100 is required for the Psych 2300 (Introduction to Research Methods) Social Science Analytics elective.

*** Phil 1332 (Ethics in the Professions) is a suggested, but not required, choice for satisfying the GE Culture and Ideas requirement.

****Enrollment in a departmental 4998 (Undergraduate Research in xxx) or 4999 (Undergraduate Thesis Research) and completion of an independent research project. It is possible that the research project will require more than one semester to complete.

Geog 5210 (Fundamentals of GIS) is a prerequisite for Geog 5222, Geog 5223, and Geog 5226.

Total hours to complete the degree program = 131-135

Existing Data Analytics Major

Approved by CAA

November 6, 2013

Vice Provost W. Randy Smith
Council on Academic Affairs
Office of Academic Affairs
203 Bricker Hall
190 North Oval Mall
Columbus, OH 43210

The College of Arts and Sciences requests that the Council on Academic Affairs approve a new major entitled Data Analytics. The major will be jointly administered between the Department of Statistics and the Department of Computer Science and Engineering. The major has been vetted by and has approval of the College of Arts and Sciences, the College of Engineering, and the Fisher College of Business. If you have any questions about this new major, feel free to contact Chris Hadad (hadad.1@osu.edu) or David Tomasko (tomasko.1@osu.edu).

ATTACHMENTS

1. BS Data Analytics Major advising sheet - general
2. Business Analytics specialization
3. Computational Analytics specialization
4. Biomedical Informatics specialization

EXECUTIVE SUMMARY

As part of The Ohio State University's initiative to explore new ideas in STEM education, the College of Arts and Sciences and the College of Engineering have worked together to create a new major entitled Data Analytics. At the beginning of the 2013 spring semester, a small group met to develop a list of program objectives for this new major. Once the initial list was developed, the group expanded and eventually included faculty from the College of Arts and Sciences, the College of Engineering, the Fisher College of Business, and the College of Medicine. Starting in June 2013, the group met weekly to discuss how the new major would be structured and administered. In addition, meetings were held with interested businesses such as IBM, JPMorgan Chase, Nationwide Insurance and Battelle to gather their input on the major.

The major will be structured in three parts: core subject matter, discipline-specific specializations, and an integrative experiential education component. Each specialization will consist of a number of technical courses and a capstone experience that is ideally optimized for the subject. In the short term, as enrollments may be initially small, some specializations may combine their capstone experience as needed in order to have critical enrollments for offering the ideal pedagogical experience. Business, Computer Science and Engineering, and Biomedical Informatics have submitted specializations as part of this proposal, and as additional specializations are created, they will go through an approval process that is discussed in the proposal.

MAIN BODY

Rationale & Chronology

The Harvard Business Review has referred to data science and analytics as the "sexiest job in the twenty first century." The notion of "Big Data" has created a stir and promises to revolutionize all walks of human endeavor ranging from the financial industry to the health-care industry, from the social sciences (e.g., study of personalized and social interactions) to engineering (e.g., analyzing sensory data from the manufacturing process), and from scientific discovery to cyber-security. Increasingly one is seeing companies locally (e.g. Nationwide, JPMorgan Chase, IBM), nationally (e.g. Microsoft, IBM, Google), and even internationally (e.g. TATA Group, Infosys) looking for employees who have the skills to build and query large data sets but also understand how to ask the right questions and extract actionable knowledge. Data Analytics includes the set of skills necessary to identify how to manage, represent and manipulate large and complex data stores, how to abstract, model, and effectively analyze such data to facilitate the identification and evaluation of appropriate hypothesis and actionable patterns, and how to create quantitative visual cues to help explain and take informed decisions from those data. These skills draw heavily from traditional academic areas such as computer science, mathematics, operations research, and statistics. In fact, current departments of analytics in corporations are staffed largely with computer science, mathematics, statistics, and some social science majors who are being trained to develop a complete set of analytics and software skills required for the particular operation. Based on input from companies (see Consultative Process below), it appears that a critical need exists for graduates who have both quantitative computational and modeling skills along with behavioral psychology and critical thinking skills. This input from companies was specifically requested with respect to an *undergraduate* degree and was universally and enthusiastically positive.

A brief review of employment prospects shows universal agreement of the demand for employees with skills in in this area. As noted in a recent editorial in the New York Times: "*To meet demand from employers, the United States will need to increase the number of graduates with skills handling large amounts of data by as much as 60 percent, according to a report by McKinsey Global Institute. There will be almost half a million jobs in five years, and a shortage of up to 190,000 qualified data scientists, plus a need for 1.5 million executives and support staff who have an understanding of data.*"

A broad analysis of labor statistics, census data and economic indicators by McKinsey & Company shows that data analysis is now an integral business function and important factor for production in nearly every segment of the economy. Figure 1 is taken from that report and shows the projected demand for people with deep analytical skills outstripping supply by 140,000-190,000 by 2018. Table 1 shows a more local analysis based on the Occupational Outlook Handbook from the Bureau

of Labor Statistics. It shows strong growth expected for four job functions most closely related to Data Analytics (Data Analytics as a job function is not yet tracked): Database Administrators, Market Research Analysts, Statisticians and Management Analysts.
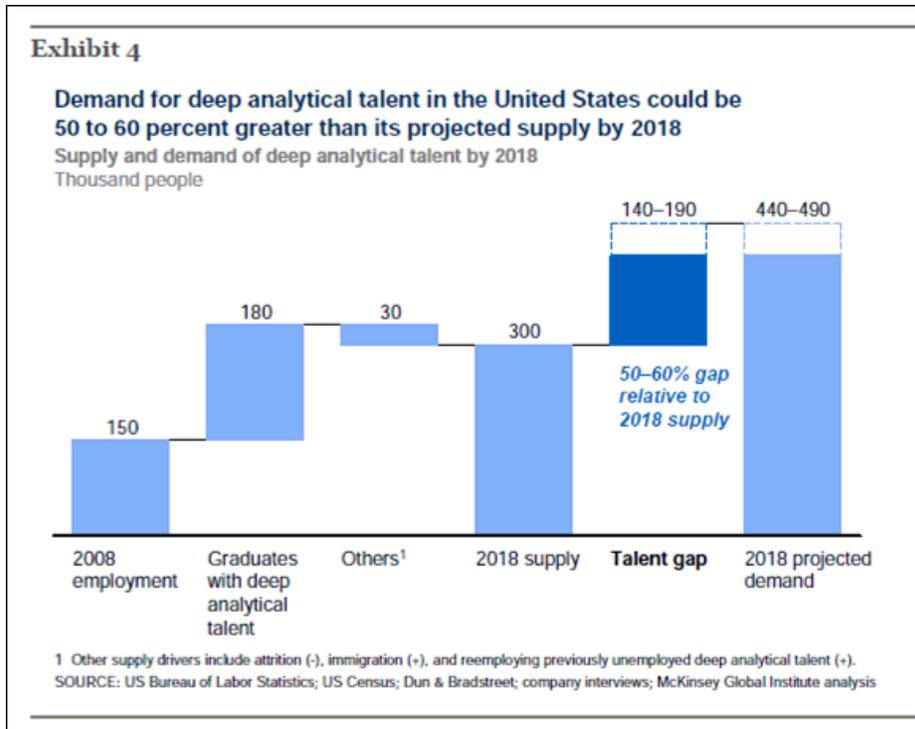
Figure 1: Demand for deep analytical talent. Numbers are in 1000's of persons or positions. Source: McKinsey Global Institute, "Big data: The next frontier for innovation, competition, and productivity" May 2011

Table 1: Excerpts from Bureau of Labor Statistics Occupational Outlook Handbook (2012-13 Ed.) for functions closely related to Data Analytics. National and Ohio information are shown.

Quick Facts	Database Administrators	Market Research Analysts	Statisticians	Management Analysts
2010 Median Pay	$73,490 per year $35.33 per hour	$60,570 per year $29.12 per hour	$72,830 per year $35.02 per hour	$78,160 per year $37.58 per hour
Entry-Level Education	Bachelor's degree	Bachelor's degree	Master's degree	Bachelor's degree
Work Experience in a Related Occupation	1 to 5 years	None	None	1 to 5 years
On-the-job Training	None	None	None	None
Number of Jobs, 2010	110,800	282,700	25,100	718,800
2010-20 projected growth rate	31% ([1]Much faster than average)	41% ([2]Much faster than	14% ([3]About as fast as average)	22% ([3]Faster than average)

		average)		
Ohio Outlook, 2010-20 > projected growth rate	26.6%	34.7%	17.5%	14.5%
Employment Change, 2010-20	33,900	116,600	3,500	157,200

[1]Rapid growth in data collection by businesses, as well as increased need for database security measures, will contribute to the growth of this occupation.
[2]Job prospects should be best for those with a master's degree.
[3]Job prospects will be very good.

Comparative Data on Similar Programs

To our knowledge, almost no universities in the U.S. offer an undergraduate degree in Data Analytics beyond a specialization out of computer science – the College of Charleston being the lone exception at the undergraduate level. Some programs, such as Bellevue College, appear to have a bachelor degree in Data Analytics in the approval process. The majority of programs in this are at the graduate level. A recent survey shows 26 Master's programs across the country (http://analytics.ncsu.edu/?page_id=4184).

Proposed Major in Data Analytics: Learning Objectives

Data Analytics is the application of fundamental scientific principles towards the analysis of large, complex data sets to answer questions, extract patterns, and predict behavior associated with those data sets. Data Analytics is also concerned with the use of such analysis to guide problem-solving and decision-making. The application of Data Analytics includes a wide range of fields including Business and Finance, Energy and the Environment, Healthcare, Logistics, and Transportation and Security. It encompasses:

- *Descriptive Analytics* that mines data to identify important behaviors and trends (data management; database design; data mining; visual analytics and sense-making)

- *Predictive Analytics* that predicts the future based on historical patterns (linear models; statistical learning; forecasting; system modeling and simulation)

- *Prescriptive Analytics* that enables smart decisions based on data (linear and nonlinear optimization; decision analysis; statistical decision making)

A student graduating with a Bachelor of Science in Data Analytics will have met the following learning objectives:

M.1 Students will demonstrate an understanding of and ability to apply computer science principles relating to data representation, retrieval, programming and analysis

M.2 Students will demonstrate an understanding of and ability to apply mathematical and statistical models and concepts to detect patterns in data, as well as draw inferences and conclusions supported by the data

M.3 Students will demonstrate critical thinking skills associated with problem identification, problem solving and decision making, assessing value propositions supported by data, and generating a logical synthesis of information from data

M.4 Students will demonstrate the ability to apply knowledge gained from one area to problems and data in another

M.5 Students will demonstrate the ability to communicate findings and their implications, and to apply them effectively in organizational settings.

These major objectives (M.# notation) will be augmented by objectives associated with each specialization (S.# notation), as appropriate. See the curriculum maps in the attachments for these objectives.

Structure of the Program

The major leading to the BS degree in the College of Arts and Sciences will be structured in three parts: core fundamentals, discipline-specific specializations, and an integrative experiential education component. Each specialization will consist of a number of technical courses and a capstone experience that is ideally optimized for the subject. Detailed curriculum sheets are attached as supporting documents.

Core fundamentals focus on:

- Mathematical Foundations (calculus; linear algebra; optimization)
- Statistical Foundations (probability; statistical learning; inference; model building)
- Computing Foundations (computer programming; database design; data mining; cloud computing)
- Critical thinking, translational and communication skills
- General Education as prescribed by the College of Arts and Sciences

Discipline-specific specializations include topical approaches to the application of data analytics offered via upper division courses. These specializations may focus on one or more of the following advanced areas of analytics:

- Visual Analytics and Sense-Making (visual analytics; visualization; critical thinking; abductive reasoning)

- System Modeling (systems thinking; social, biological and physical sciences; simulation; linear models; systems engineering)
- Pattern Recognition and Machine Learning (artificial intelligence; computer vision; scalable analytics)

The most popular specialization is expected to be Business Analytics, as this is the most fully-developed market segment for graduates. Other, more technically focused specializations include Biomedical Informatics and Computational Analytics.

Integrative Experiential Education is a common feature in engineering curricula where a capstone design project is offered via one or more courses at the end of a curriculum. The base offering in this major is proposed as a capstone course where projects offered by industry partners can be assigned to individuals or teams of students to integrate and apply the principles they have learned up to that point. In conversations with industry practitioners, the desire for an internship or cooperative education component was expressed so that students might gain exposure to the practical applications of the discipline earlier in their curriculum. It is envisioned that such an experience can be substituted for the capstone via an X191 course.

Management and Implementation

The Data Analytics effort for Ohio State University will occur as a jointly managed program between the Department of Statistics (in the College of Arts and Sciences) and the Department of Computer Science and Engineering (in the College of Engineering). The Chair (or their designee(s)) of each department will manage the program in conjunction with advising resources – together, the Chairs (or their designees) would represent the Management Committee for the Data Analytics major. Currently, the Department of Computer Science and Engineering manages the undergraduate degree programs for the Computer Science and Engineering undergraduate major program (in Engineering) and the Computer and Information Science undergraduate major program (in Arts and Sciences). The Management Committee will be aided by a Steering Committee with one representative from each of the approved specializations for the Data Analytics major. If a new specialization is being proposed, then the Management Committee will evaluate the proposal and then seek concurrence from the Steering Committee. Upon approval, by a majority decision of the Management and Steering Committees, then curriculum approval and concurrence will be sought from the College of Arts and Sciences and eventually the Office of Academic Affairs.

Further, we propose that an industrial advisory board be established for the major similar to those used in the Colleges of Engineering and Business. The purpose is to help ensure that the major is meeting its goal of producing graduates with requisite and desired skills to enter the workforce in this still emerging area. The board will be strictly advisory to the Steering Committee. The advisory board will be convened at the end of the first year of offering the major and annually after that.

One of the areas of focus for the board's input will be whether to seek accreditation for the major and if so, from whom.

Implementation Issues

- Approval of New Specializations:

  The Management Committee will work with the Steering Committee (as noted above) to manage the addition of new technical specializations to this major. New specializations will be expected to identify up to three learning objectives that supplement the existing learning objectives for the major.

- How will the proposal affect students, faculty, and staff outside the proposing units?

  Enrollment projections are uncertain, but it is likely that students in existing majors within the College of Arts and Sciences, such as mathematics, or in the College of Engineering, such as computer science and engineering, could opt to pursue this Data Analytics major rather than existing major programs. Many of the courses proposed in this new major program already exist and are taught on an ongoing basis. There are, however, a few new courses in the Department of Statistics, Computer Science, and Industrial and Systems Engineering that will need to be developed requiring additional instructional resources in order to offer these newly designed courses for Data Analytics. It is highly likely that this program will create additional demand on already over-subscribed lower division courses offered Computer Science and Engineering.

- Advising support for the major from the College of Arts and Science

  Advising of undergraduate students in the Computer and Information Science degree in the Arts and Sciences already occurs by coordination between advisors in the Arts and Sciences and the department of Computer Science and Engineering, in the College of Engineering. The Colleges have a long history of jointly managing undergraduate majors towards the best interests of the students. Administrative support will depend on the growth of the program, and the Management Committee will be able to solicit additional resources from the respective Colleges when justified by enrollment trends and other instructional demands.

- Ongoing assessment of the curriculum

  On a yearly basis, the Management Committee will prepare an assessment report for the major including a data-driven analysis with information collected from course rubrics, pre- and post-assessment tools, student focus groups, the industrial advisory board, and internship assessments. In consultation

with the Steering Committee, the Management Committee will make recommendations for the program going forward. As appropriate, the Arts and Sciences Curriculum Committee and the Office of Academic Affairs will be consulted. The Management Committee will submit a detailed Assessment Plan by June 2014.

Approvals and Concurrence

All units across campus were invited to participate and will still be able to propose specializations in the major. Statements of support and concurrence from Deans of those colleges involved in the proposal are included (Poon, Williams, Manderscheid, Lockwood).

Consultative Processes

To establish the desired learning goals for a major in Data Analytics, a group of local experts and practitioners was convened by Vice Provost Randy Smith on April 5, 2013 at OSU. The companies/attendees included:

- Nationwide Insurance:
    - Wes Hunt, VP, Corp. Marketing Info Mgmt.
    - Vijay Gopal, VP, Enterprise Chief Architect
- Information Control Corporation:
    - Jim Gallo, National Director of Business Analytics
- Huntington Bank:
    - Paul Heller, CIO
- Battelle:
    - Pam Hartford, Director, Data Analytics

In addition, on July 17, 2013, the group developing the major visited the IBM Client Center for Advanced Analytics in Dublin, Ohio to visit with additional professionals and learn more about analytics functions in business and industry.

Beyond these on-site/off-campus visits, the following individuals have also been consulted in relation to this program. They represent a broad cross-section of government and industrial practice experts working in the area of data analytics.

- TATA Consultancy Services
    - Gautam Shroff, VP of Research and Head Technology Innovation Laboratories,
- Infosys Technologies
    - Lokendra Shastri, Associate VP and General Manager, Research Wing (SET Labs)
- IBM TJ Watson Center
    - Chid Apte, Director of Analytics, Business Analytics and Mathematical Sciences,

- JPMorgan Chase
  - Raghav Madhavan, Managing Director, Cloud and Data Analytics,

Resource Impacts

This undergraduate teaching need complements the importance of hiring faculty to support graduate education and research in this area, as analytics is a cross-cutting theme that spans topics of central importance to many departments at OSU, as well as all three of the University Discovery Themes. The need to characterize and make sense of large data sets has become pervasive, and to meet requirements for associated graduate teaching and research, Ohio State also needs to make key hires in analytics.

- Enrollment Projections

While there is a clear job market demand for this major, it will require clear marketing and advising to generate student interest. Once made public, however, a high demand is anticipated. The proposing committee estimates that 50 students per year is a good projection for the purposes of resource allocation. In the initial year of offering (Spring of 2014), it is proposed to admit 50 freshmen to the major via an application process as well as up to 50 upperclassmen who already have the basic requirements outlined in the first year and are interested in switching into this major. The latter students would likely come from majors such as Computer and Information Science, Actuarial Science, or others. Table 2 shows an estimate of how enrollment would build over the first few years.

Table 2. Estimated enrollment projections in the DA major.

Yr in Curriculum	Year 1	Year 2	Year 3	Year 4	Year 5
Freshman	50	50	50	50+	50+
Sophomore	50*	50	50	50	50+
Junior		50*	50	50	50
Senior			50*	50	50
Totals	100	150	200	200+	200+

*It is possible that these 50 students will be spread among multiple upper classes and a few may graduate in fewer than 3 years.

- New faculty needed in core and specialization areas (Statistics, CSE, FCOB, and ISE, Health Sciences).

As enrollment demand in the newly proposed major is expected to be significant, additional resources for faculty instructors will be critical for success. For example, the Department of Statistics has seen consistent growth in undergraduate credit hours for much of the last decade. Computer Science and

Engineering has a similar trend line over the past 5+ years. For success in Data Analytics, University investment in tenure-track, and clinical, faculty will be critical for success. It will be essential to provide both a strong core of instruction in mathematics, statistics, and computer science as well as a practical appreciation of how data analytics is used by businesses and health care in technical specializations. Instructional investments will be needed in all of the units involved in these courses, and many of these investments are well aligned with the University's Discovery Themes, as outlined above in the rationale. Initial discussions have already begun with a number of the Deans associated with this new major as well as representatives from the Office of Academic Affairs. Enthusiasm is high from all sides, and a detailed resource request has been presented in August 2013, for discussion at OAA. Alignment of these needs with the three Discovery Themes will be critical. The Deans are aware that matching resources may be needed when the request for Discovery Theme proposals is announced.

A number of these courses are new. Furthermore, many of the courses that are already being offered are required of the students in those Departments and are consequently filled to capacity. Given the expected growth rate for this major, in order for the participating Departments and Colleges to offer these core and elective specialization courses, additional tenure-track and/or clinical faculty will be required. Given the current definition of this major and its associated specializations, this includes faculty in Statistics, Computer Science and Engineering, Business, the Health Sciences, and Integrated Systems Engineering.

In short, there is a compelling need to hire tenure-track and/or clinical faculty with expertise relevant to analytics in order to simultaneously meet the needs of Ohio State in undergraduate education, graduate education and research. A separate document outlining specific needs in each of the relevant units has been presented to the Deans of the participating Colleges.

ATTACHMENTS

1. BS Data Analytics Curricular Requirements
2. Business Analytics specialization
3. Computational Analytics specialization
4. Biomedical Informatics specialization

Curriculum map for the B.S. degree in Data Analytics

B.S. Degree—Data Analytics Major
Program Requirements

The Ohio State University
College of Arts and Sciences

The program requirements for the Bachelor of Science degree with a major in **Data Analytics** are given below. A minimum of 126 credit hours is required.

1. Data Analytics Core Requirements

Data Analytics Core Requirements	Course Number(s)	Credit Hours	Cr. Hrs. counted toward major*
Calculus I	Math 1151	5	0
Calculus II	Math 1152	5	0
Software I	CSE 2221	4	4
Software II	CSE 2231	4	4
Foundations I	CSE 2321	3	3
Systems I or Systems for Data Analytics	CSE 2421 or CSE 2xxx	4	4
Linear Algebra	Math 2568	3	3
Databases I	CSE 3241	3	3
Probability & Uncertainty	Stat 3201	3	3
Statistical Inference	Stat 3202	4	4
Optimization and Systems Modeling	ISE 3230	3	3
Modeling for Discovery I	Stat 3301	3	3
Modeling for Discovery II	Stat 3302	3	3
Statistical Decision Making	Stat 3303	3	3
Introduction to Statistical Learning	Stat 4620	2	2
Databases II or Adv DB and Cloud Computing	CSE 5242 or CSE 5xxx	3	3
Data Mining	CSE 5243	3	3
Visualization	CSE 5544 **or** ISE 5xxx	3	3
Total		61	**51**

* Math 1151 and Math 1152 are used in the Data Analytics Major Curriculum to fulfill General Education Requirements and so their credit hours do not count toward the major.

2. Data Analytics Specialization

Complete the requirements for one of the approved Data Analytics Specializations. The minimum number of credit hours for a specialization is **14**, which must include an approved capstone course or course sequence. The approved specializations are in the areas of **Business Analytics, Computational Analytics and Biomedical**

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Curriculum map for the B.S. degree in Data Analytics

Informatics. The requirements for each specialization are provided in Specialization Requirements sheets below. Note that some specializations require courses that may be used to fulfill requirements for particular General Education categories.

3. General Education Requirements

Satisfy the General Education requirements for the Bachelor of Science degree in the College of Arts and Sciences.

Note that Math 1151 and Math 1152 are required for the major core curriculum. It is suggested that students use these courses to satisfy the categories shown in the table below.

GE Category	Required Course	Min Course Hours	Min Category Hours
Writing			6
Quantitative and Logical Skills	Math 1151	5	5
Natural Science*	Physical Science (lab) Biological Science (lab)	4 4 3	11
Literature			3
Arts			3
Social Science	**		6
Historical Study			3
Culture and Ideas or Historical Study	***		3
Language			12
Open Option 1	Math 1152		5
Open Option 2	****		3
ACS/NMS Survey			1
Total			**61**

* Students choosing the Biomedical Informatics Specialization should use Chemistry 1110 or 1210, and Biology 1113 and 1114 to satisfy the GE Natural Science requirements. Others should consider Physics 1250 or Chemistry 1210 or Chemistry 1250 or any other eligible GE (BS) physical science lab course as the physical science component.

**Economics 2001.01 and 2002.01 are required courses for the Business Analytics specialization. Students choosing this specialization should use these courses to fulfill the GE requirements for the Social Sciences category.

***Students choosing to focus on Linguistics and Text Analysis in the Computational Analytics specialization should take Ling 2000 to fulfill the Culture and Ideas requirement.

****Stat 2450 is suggested, but not required, to fulfill the second Open Option requirement.

Curriculum map for the B.S. degree in Data Analytics

Specialization: Business Analytics

Outcomes from the Core Courses
M.1 Students will demonstrate an understanding of and ability to apply computer science principles relating to data representation, retrieval, programming and analysis.
M.2 Students will demonstrate an understanding of and ability to apply mathematical and statistical models and concepts to detect patterns in data, as well as draw inferences and conclusions supported by the data.
M.3 Students will demonstrate critical thinking skills associated with problem identification, problem solving and decision-making, assessing value propositions supported by data, and generating a logical synthesis of information from data.
M.4 Students will demonstrate the ability to apply knowledge gained from one area to problems and data in another.
M.5 Students will demonstrate the ability to communicate findings and their implications, and to apply them effectively in organizational settings.

Outcomes from the Technical Courses for the Specialization
S.1 Students demonstrate an understanding of how research and data analytics is done in business
S.2 Students demonstrate proficiency at designing and implementing analysis to carry out a firm's business objectives.
S.3 Students can identify and assess ethical issues surrounding business decisions

Program outcomes *(B=beginner, I=intermediate, A=advanced)*

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2	S.3
Math 1151		B						
Math 1152		B						
Math 2568		I						
CSE 2221	B				B			
CSE 2231	I		B		B			
CSE 2321	I	B	B		B			
CSE 2421/2*xxx*	B		B		B			
CSE 3241	A		I		I			
STAT 3201		B			B			
STAT 3202		B	B		B			
ISE 3230		I	I		I			
STAT 3301	B	I	I	B	I			
STAT 3302	B	A	I	B	I			
STAT 3303		I	A	I	I			
STAT 4620	B	A	I	B	I			
CSE 5242	A		A	B	A			
CSE 5243	A	I	A	I	A			
CSE 5544 or ISE 5*xxx*	CSE: A ISE: I	ISE: I	A	I	A			

Curriculum map for the B.S. degree in Data Analytics

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2	S.3
BUSFIN 3120 or 3220			I			B	B	B
BUSFIN 3222						I	I	
BUSFIN 3250						I	I	
BUSFIN 4201		A				A	A	
AMIS 2000 or 5000			B		I	B	B	B
AMIS 3600	B		I		B	I	I	B
AMIS 4210		B	A		A	A	I	
AMIS 4650	I	I	A		A	I	I	
AMIS 4310	B/I	A	A	B	A	A	A	B
AMIS 7350	B	A	A		A	A	A	A
BUSML 3150 or 3250			I		B	B		B
BUSML 4202	B	I				I	I	
BUSML 4210	A	A	A		A	A	A	I
BUSML 4211	A	A	A		I	A	A	
BUSML 4212	A	A	A		I	A	A	I
BUSML 3380	B		I			B		
BUSML 4382	A	A	A		A	A	A	
BUSML 4386	A	A	A		A	A	A	
BUSMGT 2321	B		I			B		B
BUSMGT 3230	I		I			I	I	
BUSMGT 4250	A	I	I			A	I	
BUSMGT 4251	A	I	A		A	A	A	
BUSADM 3630.05	I	I	I	I	I	I	I	I
BUSADM 3631.05	A	A	A	A	A	A	A	A

Curriculum map for the B.S. degree in Data Analytics

B.S. Degree—Data Analytics Major
Specialization Requirements

The Ohio State University
College of Arts and Sciences

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Business Analytics

Total credit hours: 14

1. Required Courses: BUSADM 3630.05 and 3631.05 (table below), and Economics 2001.01 and 2002.01. (A minimum GPA of 3.0 is required for a student to enroll in BUSADM 3630.05.) Students choosing this specialization should use the Economics courses to fulfill the General Education requirements in the Social Sciences category.

Required Core/ Capstone Sequence	Course Number	Credit Hours	Pre-req
Business Analytics: Principles & Concepts	BUSADM 3630.05	2	
Business Analytics: Applications & Experience	BUSADM 3631.05	3	

2. 9 credit hours of coursework from the elective list below. Courses are grouped to show possible focus areas but students may select any combination of courses (having met appropriate pre-requisites) to meet the 9 credit hours.

Elective Courses		Course Number	Credit Hours	Pre-req
Finance	Business Finance	BUSFIN 3120 or 3220	3	*
	Foundations of Investments	BUSFIN 3222	3	3120
	Foundations of International Finance	BUSFIN 3250	3	3120
	Financial Data	BUSFIN 4201	1.5	3120
AMIS	Foundations of Accounting	AMIS 2000 or 5000	3	*
	Accounting Information Systems	AMIS 3600	3	2000
	Financial Statement Analysis	AMIS 4210	3	2000
	Decision Support Systems	AMIS 4650	3	
	Topics in Managerial Acct	AMIS 4310	3	
	Fraudulent Financial Reporting	AMIS 7350	3	2000
Customer Insights	Foundations or Principles of Marketing	BUSML 3150 or 3250	3	*
	Marketing Research	BUSML 4202	1.5	3150
	Advanced Marketing Research	BUSML 4210	1.5	3150
	Market Analysis, Development & Forecasting	BUSML 4211	1.5	3150
	Customer Relationship Management	BUSML 4212	1.5	3150
Ops & Logistics	Business Analytics	BUSMGT 2321	3	
	Operations Mgt.	BUSMGT 3230	3	*
	Six Sigma Principles	BUSMGT 4250	3	3230
	Six Sigma Project	BUSMGT 4251	3	3230
	Logistics Management	BUSML 3380	1.5	*
	Logistics Analytics	BUSML 4382	3	3380
	Logistics Technology & Applications	BUSML 4386	1.5	3380

* Pre-requisite MA 1152 and CSE 2321

Curriculum map for the B.S. degree in Data Analytics

B.S. Degree—Data Analytics Major
Advising Sheet

The Ohio State University
College of Arts and Sciences

Business Analytics Specialization
Suggested Curriculum

This should be used as a **guide** only. Semester offerings are subject to change.

Year	Autumn		Spring	
	Course	**Hrs.**	**Course**	**Hrs.**
1	ASC 1100.xx	1	Math 1152 (Calc II)	5
	Math 1151 (Calc I)	5	CSE 2221 (Software I)	4
	GE Phys. Sci. (lab)	4	GE Open Option*	3
	GE Foreign Language 1	4	GE Foreign Language 2	4
	GE Writing Level 1	3		
	Total:	**17**	**Total:**	**16**
2	CSE 2231 (Software II)	4	CSE 2421 or 2xxx (Systems I or Systems for Data Analytics)	4
	CSE 2321 (Foundations I)	3	Math 2568 (Linear Algebra)	3
	Stat 3201 (Prob. and Uncertainty)	3	Stat 3202 (Stat. Inference)	4
	Econ 2001.01 (GE Social Sciences)	3	GE Writing Level 2	3
	GE Foreign Language 3	4	Econ 2002.01 (GE Social Sciences)	3
	Total:	**17**	**Total:**	**17**
3	ISE 3230 (Optim. & System. Model.)	3	Stat 3302 (Modeling for Discovery II)	3
	CSE 3241 (Databases I)	3	CSE 5243 (Data Mining)	3
	Stat 3301 (Modeling for Discovery I)	3		
	BUSADM 3630.05 (Business Analytics: Principles and Concepts)	2	BUSADM 3631.05 (Business Analytics: Applications & Experience)	3
			GE Biological Sciences (lab)	4
	Business Foundation	3	CSE 5544 **or** ISE 5xxx (Visualization)	3
	Total:	**14**	**Total:**	**16**
4	Stat 4620 (Intr. Stat. Learning)	2	Stat 3303 (Statistical Dec. Making)	3
	CSE 5242 or CSE 5xxx (DB II or Adv. DB and Cloud Computing)	3	GE Historical Study	3
	Business Analytics Elective	3	GE Natural Science	3
	Business Analytics Elective	3	GE Cult. & Ideas or Hist. Study	3
	GE Arts	3	GE Literature	3
	Total:	**14**	**Total:**	**15**

* Stat 2450 is a suggested, but not required, choice for the GE Open Option for students with no previous exposure to statistics.

Total hours to complete the degree program = 126

Curriculum map for the B.S. degree in Data Analytics

Specialization: Computational Analytics

Outcomes from the Core Courses
M.1   Students will demonstrate an understanding of and ability to apply computer science principles relating to data representation, retrieval, programming and analysis.
M.2   Students will demonstrate an understanding of and ability to apply mathematical and statistical models and concepts to detect patterns in data, as well as draw inferences and conclusions supported by the data.
M.3   Students will demonstrate critical thinking skills associated with problem identification, problem solving and decision-making, assessing value propositions supported by data, and generating a logical synthesis of information from data.
M.4   Students will demonstrate the ability to apply knowledge gained from one area to problems and data in another.
M.5   Students will demonstrate the ability to communicate findings and their implications, and to apply them effectively in organizational settings.

Outcomes from the Technical Courses for the Specialization
S.1   Students will demonstrate an understanding of the principles governing an advanced computational focus area (Cyber-security, Machine Intelligence, Systems/Theory, Linguistics and Text analytics).
S.2   Students will demonstrate an advanced understanding of and the ability to use analytic techniques in one or more focus areas.

Program outcomes *(B=beginner, I=intermediate, A=advanced)*

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2
Math 1151		B					
Math 1152		B					
Math 2568		I					
CSE 2221	B				B		
CSE 2231	I		B		B		
CSE 2321	I	B	B		B		
CSE 2421/2*xxx*	B		B		B		
CSE 3241	A		I		I		
STAT 3201		B			B		
STAT 3202		B	B		B		
ISE 3230		I	I		I		
STAT 3301	B	I	I	B	I		
STAT 3302	B	A	I	B	I		
STAT 3303		I	A	I	I		
STAT 4620	B	A	I	B	I		
CSE 5242	A		A	B	A		
CSE 5243	A	I	A	I	A		
CSE 5544 or ISE 5*xxx*	CSE: A ISE: I	ISE: I	A	I	A		
Cybersecurity Focus							

Curriculum map for the B.S. degree in Data Analytics

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2
CSE3461	A		I	B	I	B	B
CSE4471	A		I	I	A	I	I
CSE5472	A	I	A	I	A	A	A
Machine Intelligence Focus							
CSE2231	A	I	I	I	I	B	
CSE3521	A	B	I	I	A	I	B
CSE5524	A	B	A	I	A	A	I
CSE 5523	A	A	A	I	I	A	A
Systems/Theory Focus							
CSE2331 or	A	I	I	I	I	B	
CSE 2431	A	-	I	I	I	B	
CSE 390x	A		A	A	A	I	I
CSE 5425 or	A	I	A	A	A	A	A
CSE 5441	A	-	A	A	A	A	A
Linguistics and Text Focus							
Ling 2000 (GED)				B	B	B	
Ling Choice 4100,4200,4300,4400				I	I	I	B
Ling 5801	I		I	I	I	I	I
Ling 5802	I		I	I	I	A	I
CSE5525	A		A	I	A	A	A
Capstone (e.g., CSE 4*xxx*)	A	A	A	A	A	A	A

B.S. Degree—Data Analytics Major   **The Ohio State University**
Specialization Requirements   College of Arts and Sciences

Computational Analytics

Total credit hours: 14 hours minimum selected from the list below

Courses are grouped to show possible focus areas but students may select any combination of courses (having met appropriate pre-requisites) to meet the 14 credit hours.

Students choosing the Linguistics and Text Analytics focus should plan on taking Ling 2000 to satisfy the General Education requirements in the Culture and Ideas category.

Elective Courses		Course Number	Credit Hours	Pre-req
Cyber-security Focus	Computer Networking and Internet Tech.	CSE 3461	3	
	Information Security	CSE 4471	3	
	Information Security Projects or Introduction to Network Security	CSE 5472 or CSE 5473	3	
	Capstone in Data Analytics	CSE 59xx/Stat 5xxx	4	
Machine Intelligence Focus	Foundations II	CSE 2331	3	
	Introduction to AI	CSE 3521	3	
	Computer Vision for HCI	CSE 5524	3	
	Machine Learning and Stat. Pattern Rec. OR Introduction to Neural Networks	CSE 5523 or CSE 5526	3	
	Capstone in Data Analytics	CSE 59xx/Stat 5xxx	4	
Core (Systems or Theory) Focus	Foundations II or Systems II	CSE 2331 or CSE 2431	3	
	CSE Junior Project Choice	CSE 3901, 3902, 3903	4	
	Numerical Methods or Intro to Parallel Computing	CSE 5361 or CSE 5441	3	
	CSE Senior Capstone Choice	CSE 5901, 5902, 5903	4	
Linguistics and Text Analytics Focus	Intro to Languages and Humanities	Ling 2000	3	* GE
	Introduction to Computational Linguistics I	Ling 5801	3	
	Introduction to Computational Linguistics II	Ling 5802	3	
	Speech and Language Processing	CSE 5525	3	
	Linguistics Choice Elective -- Phonetics; Syntax; Phonology; or Linguistic Meaning	Ling 4100 or Ling 4200 or Ling 4300 or Ling 4400	3	
	CSE/Linguistics Capstone	CSE 59xx/Ling 5xxx	4	

B.S. Degree—Data Analytics Major
Advising Sheet

The Ohio State University
College of Arts and Sciences

Computational Analytics Specialization
Suggested Curriculum
with
Cybersecurity Focus

This should be used as a **guide** only. Semester offerings are subject to change.

Year	Autumn		Spring	
	Course	**Hrs.**	**Course**	**Hrs.**
1	ASC 1100.xx	1	Math 1152 (Calc II)	5
	Math 1151 (Calc I)	5	CSE 2221 (Software I)	4
	GE Phys. Sci. (lab)	4	GE Open Option*	3
	GE Foreign Language 1	4	GE Foreign Language 2	4
	Total:	**14**	**Total:**	**16**
2	CSE 2231 (Software II)	4	CSE 2421 or 2xxx (Systems I or Systems for Data Analytics)	4
	CSE 2321 (Foundations I)	3	Math 2568 (Linear Algebra)	3
	Stat 3201 (Prob. and Uncertainty)	3	Stat 3202 (Stat. Inference)	4
	GE Writing Level 1	3	GE Writing Level 2	3
	GE Foreign Language 3	4	CSE Elective	3
	Total:	**17**	**Total:**	**17**
3	ISE 3230 (Optim. & System. Model.)	3	Stat 3302 (Modeling for Discovery II)	3
	CSE 3241 (Databases I)	3	CSE 5243 (Data Mining)	3
	Stat 3301 (Modeling for Discovery I)	3	Econ 2002.01 (GE Social Sciences)	3
	CSE 5544 **or** ISE 5xxx (Visualization)	3	CSE 4471 (Information Security)	3
	CSE 3461 (Computer Networking and Internet Tech.)	3	GE Biological Sciences (lab)	4
	Econ 2001.01 (GE Social Sciences)	3		
	Total:	**18**	**Total:**	**16**
4	Stat 4620 (Intr. Stat. Learning)	2	Stat 3303 (Statistical Dec. Making)	3
	CSE 5242 or CSE 5xxx (DB II or Adv. DB and Cloud Computing)	3	CSE/Stat Capstone	4
	CSE 5472 (Information Security Projects)	3	GE Natural Science	3
	GE Historical Study	3	GE Cult. & Ideas or Hist. Study	3
	GE Arts	3	GE Literature	3
	Total:	**14**	**Total:**	**16**

* Stat 2450 is a suggested, but not required, choice for the GE Open Option for students with no previous exposure to statistics.

Total hours to complete the degree program = 128

Specialization: Biomedical Informatics

Outcomes from the Core Courses
M.1 Students will demonstrate an understanding of and ability to apply computer science principles relating to data representation, retrieval, programming and analysis.
M.2 Students will demonstrate an understanding of and ability to apply mathematical and statistical models and concepts to detect patterns in data, as well as draw inferences and conclusions supported by the data.
M.3 Students will demonstrate critical thinking skills associated with problem identification, problem solving and decision-making, assessing value propositions supported by data, and generating a logical synthesis of information from data.
M.4 Students will demonstrate the ability to apply knowledge gained from one area to problems and data in another.
M.5 Students will demonstrate the ability to communicate findings and their implications, and to apply them effectively in organizational settings.

Outcomes from the Technical Courses for the Specialization
S.1 Students will demonstrate an understanding of the core sub-disciplines of biomedical informatics that play a role in the design, implementation, and management of clinical, research, and translational information systems.
S.2 Students will demonstrate an understanding of the contributing theoretical frameworks that are conventionally used to inform the design and use of biological and medical information systems, and integrative data discovery and analysis tools.
S.3 Students will demonstrate critical evaluation skills that allow for the analysis of system design and or utilization of biomedical information systems and data.

Program outcomes *(B=beginner, I=intermediate, A=advanced)*

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2	S.3
Math 1151		B						
Math 1152		B						
Math 2568		I						
CSE 2221	B				B			
CSE 2231	I		B		B			
CSE 2321	I	B	B		B			
CSE 2421/2*xxx*	B		B		B			
CSE 3241	A		I		I			
STAT 3201		B			B			
STAT 3202		B	B		B			
ISE 3230		I	I		I			
STAT 3301	B	I	I	B	I			
STAT 3302	B	A	I	B	I			

Curriculum map for the B.S. degree in Data Analytics

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2	S.3
STAT 3303		I	A	I	I			
STAT 4620	B	A	I	B	I			
CSE 5242	A		A	B	A			
CSE 5243	A	I	A	I	A			
CSE 5544 or ISE 5*xxx*	CSE: A ISE: I	ISE: I	A	I	A			
BMI 5710	I	I	A	I	A	B	I	A
BMI 5720	I	I	I		A	I	I	A
BMI 5730	I	I	A	I	A	B	I	A
BMI 5740	A	I	A	I	A	A	A	A
Capstone (e.g., CSE 4*xxx*)	A	A	A	A	A	A	A	A

Biomedical Informatics

Total credit hours: 21

Although the official ASC requirement is stated as a minimum of 10 credit hours of GE natural science courses in physical science and biological science (each with one lab experience), students often take three GE natural science courses to meet this requirement. Students choosing this specialization are encouraged to take Chemistry 1110 or 1210 (5 credit hours), and Biology 1113 and 1114 (4 credit hours each) to meet the GE Natural Science requirements.

Course	Course Number	Credit Hours	Pre-req
Integrated Molecular and Cellular Biology for Non-Biologists	Mol Gen 5660	5	
Introduction to Biomedical Informatics	BMI 5710	3	
Imaging Informatics	BMI5720	3	
Introduction to Bioinformatics	BMI5730	3	
Introduction to Research in Bioinformatics	BMI 5740	3	
Capstone in Data Analytics	CSE 59xx/ Stat 5xxx	4	

Biomedical Informatics Specialization
Suggested Curriculum

This should be used as a **guide** only. Semester offerings are subject to change.

Year	Autumn		Spring	
	Course	**Hrs.**	**Course**	**Hrs.**
1	ASC 1100.xx	1	Math 1152 (Calc II)	5
	Math 1151 (Calc I)	5	CSE 2221 (Software I)	4
	Chem 1110 or 1210 (GE Phys. Sci. lab)*	5	GE Open Option**	3
	GE Foreign Language 1	4	GE Foreign Language 2	4
	GE Writing Level 1	3		
	Total:	**18**	**Total:**	**16**
2	CSE 2231 (Software II)	4	CSE 2421 or 2xxx (Systems I or Systems for Data Analytics)	4
	CSE 2321 (Foundations I)	3	Math 2568 (Linear Algebra)	3
	Stat 3201 (Prob. and Uncertainty)	3	Stat 3202 (Stat. Inference)	4
	Biology 1113 (GE Biol. Sci. lab)*	4	GE Writing Level 2	3
	GE Foreign Language 3	4	Biology 1114 (GE Natural Sci.)*	4
	Total:	**18**	**Total:**	**18**
3	ISE 3230 (Optim. & System. Model.)	3	Stat 3302 (Modeling for Discovery II)	3
	CSE 3241 (Databases I)	3	CSE 5243 (Data Mining)	3
	Stat 3301 (Modeling for Discovery I)	3	BMI 5710 (Intro. to Biomed. Inform.)	3
	CSE 5544 **or** ISE 5xxx (Visualization)	3	GE Social Sciences I	3
	Mol. Gen. 5660 (Integrated Molecular and Cellular Biol. for Non-Biologists)	5	GE Arts	3
			GE Historical Study	3
	Total:	**17**	**Total:**	**18**
4	Stat 3303 (Statistical Dec. Making)	3	Stat 4620 (Intr. Stat. Learning)	2
	CSE 5242 or CSE 5xxx (DB II or Adv. DB and Cloud Computing)	3	BMI 5740 (Introduction to Research in Bioinformatics)	3
	BMI 5720 (Imaging Informatics)	3	CSE/Stat Capstone	4
	BMI 5730 (Introduction to Bioinformatics)	3	GE Cult. & Ideas or Hist. Study	3
	GE Social Sciences II	3	GE Literature	3
	Total:	**15**	**Total:**	**15**

* Students choosing the Biomedical Informatics Specialization should use Chem 1110 or 1210, and Biology 1113 and 1114 to satisfy the GE Natural Science requirements.
** Stat 2450 is a suggested, but not required, choice for the GE Open Option for students with no previous exposure to statistics.

Total hours to complete the degree program = 135

Hi Steve,

The Glenn School's undergraduate curriculum committee has reviewed the social science data analytics specialization and is happy to concur. We're excited to see the major come together and think this will be a great specialization track for students.

The School plans to come forward with a public sector data analytics course soon. You'll see a description below. We intend to initially propose the course as a GE for the data analytics stream but also think that it could potentially fit in the proposed data analytics social science track.

PA 3020 : Data Sciences for the Public Sector
Student Learning Goals and Objectives

This course provides an orientation to the use of data for decision-making in the areas of public sector. The emphasis in the course is how to use data in context – when organizations require the analysis of sophisticated data in order to achieve goals or priorities. Topics in the class include; Background on data use in the public sector; Development of tools for decision-making; Use of visualization techniques; Policy Modeling tools; and, Applications to international organizations.

The objectives of the course include the following; 1) developing an understanding of importance of data for decision making, 2) knowledge of the decision making tools that agencies and government are using; 3) appreciation for the specific problems of conducing data analysis in government; and 4) exposure to the problems of working with data in international development contexts.

Best,

Trevor

THE OHIO STATE UNIVERSITY

Trevor Brown
Director
John Glenn School of Public Affairs
350C Page Hall | 1810 College Road, Columbus, OH 43210
glenn.osu.edu

Recently published: *Complex Contracting -- Government Purchasing in the Wake of the US Coast Guard's Deepwater Program* (Cambridge University Press). Pick up a copy

from [Cambridge](#) or [Amazon](#).

From: Fink, Steven
Sent: Tuesday, September 23, 2014 1:40 PM
To: Brown, Trevor; Hallihan, Kathleen
Subject: FW: Data analytics social science track

Thank you. And of course if you are able to reply sooner than the two week deadline we would appreciate it!—but take the time you need.

Steve

From: Hadad, Christopher
Sent: Tuesday, September 23, 2014 1:17 PM
To: Fink, Steven; McGraw, Kathleen
Subject: Fwd: Data analytics social science track

Steve and Kathleen M.,

FYI.

Christopher

Christopher M. Hadad
Dean, Natural and Mathematical Sciences
College of Arts and Sciences, Ohio State University
Phone: (614) 292-8908
http://hadad.group.chemistry.ohio-state.edu

Begin forwarded message:

From: "Vankeerbergen, Bernadette" <vankeerbergen.1@osu.edu>
Subject: RE: Data analytics social science track
Date: September 23, 2014 12:46:21 PM EDT
To: "Brown, Trevor" <brown.2296@osu.edu>, "Hallihan, Kathleen" <hallihan.3@osu.edu>
Cc: "Hadad, Christopher" <hadad.1@osu.edu>, "Greenbaum, Robert" <greenbaum.3@osu.edu>, "Haddad, Deborah" <haddad.2@osu.edu>, "Hans, Christopher" <hans@stat.osu.edu>, "Craigmile, Peter" <pfc@stat.osu.edu>

Dear Trevor and Kate,

Please see below the e-mail that Dean Hadad sent to Kate on Friday with the two attachments about the proposed Social Science Analytics Specialization in the Data Analytics BS. Could you please review the documents and provide concurrence/feedback within two weeks? Concurrence will be assumed after 2 weeks.

Please do not hesitate to contact us should you have any questions.

Many thanks,
Bernadette

Bernadette Vankeerbergen, Ph.D.
Program Manager, Curriculum and Assessment
Arts and Sciences
The Ohio State University
154D Denney Hall
164 W 17th Ave.
Columbus, OH 43210
Phone: 614-688-5679
Fax: 614-292-6303
http://asccas.osu.edu

From: Hadad, Christopher
Sent: Friday, September 19, 2014 4:51 PM
To: Vankeerbergen, Bernadette
Cc: Hallihan, Kathleen; Greenbaum, Robert
Subject: Re: Data analytics social science track

Kate,

Here is the original proposal from Kathleen McGraw to the Data Analytics committee for consideration.

Christopher

Christopher M. Hadad
Dean, Natural and Mathematical Sciences
College of Arts and Sciences, Ohio State University
Phone: (614) 292-8908
http://hadad.group.chemistry.ohio-state.edu

On Sep 18, 2014, at 7:56 PM, "Vankeerbergen, Bernadette" <Vankeerbergen.1@osu.edu> wrote:

Hi Kate,

I have not seen the proposal yet--has not filtered to my level yet. I am including Dean Hadad in the e-mail exchange since he indicated to me that the proposal will be coming very soon. I suppose that if JGS wishes to look at the proposal, this should happen before ASCC review (so that ASCC can look at the whole proposal with all the necessary concurrences). Christopher Hadad will know to whom your request should be forwarded (i.e., who is developing this track).

My best,
Bernadette

From: Hallihan, Kathleen
Sent: Thursday, September 18, 2014 6:20 PM
To: Vankeerbergen, Bernadette
Cc: Greenbaum, Robert
Subject: Data analytics social science track

Hello Bernadette,

Can you please send us the new data analytics social sciences track proposal Randy mentioned at CAA yesterday? We would like to look at it for concurrence purposes.

Thank you!
Kate

Kathleen M. Hallihan, Ph.D.

Director, Admissions and Student Services

The John Glenn School of Public Affairs

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410 Arps Hall
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Fax (614) 292-3906

April 27, 2015

Professor Meg Daly
Chair, Arts and Sciences Curriculum Committee

Re: Adding Social Science Analytics Specialization to Data Analytics

Dear Meg:

The SBS Panel on April 22, 2015 approved a proposal to add a Social Science Analytics specialization to the Data Analytics major.

The proposal is motivated by the need for a social science component in the Data Analytics program. Many "big data" analyses address social science issues. They also require social science research skills, particularly those related to survey research, such as sampling and measurement. The graduates of this specialization are likely attractive to a wide range of industries, including social media companies, marketing and consulting firms, and government agencies.

The panel agreed that the proposed specialization is worthwhile and it complements well the existing specializations in Biomedical Informatics, Business Analytics and Computational Analytics. The proposal was first reviewed by this panel on October 16, 2014. The panel questioned whether the electives and the training in ethics adequately prepare a student for the independent research project. The concerns have been addressed satisfactorily.

The panel's decision to approve the proposal was unanimous.

Sincerely,

Pok-sang Lam
Chair, ASCC SBS Panel