Dear Randy and Katie,

Please find attached a proposal to add a new specialization in Data Visualization to the BS Data Analytics. The proposal was fully approved by the ASC Curriculum Committee (ASCC) on Friday, September 29, 2017.

We are now advancing the proposal for review by CAA. The attached documents are: (1) cover letter, (2) proposal, and (3) Natural and Mathematical Sciences Panel cover letter to ASCC.

Please use this email as a cover letter indicating that the proposal has been duly reviewed and approved by the appropriate ASC curricular bodies.

Please let me know if you have any questions.

Best regards,
Bernadette

THE OHIO STATE UNIVERSITY

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September 25, 2017
To: Chair of ASCC
From: Charles J. Daniels, Chair ASCC Natural and Mathematical Sciences Panel

Dear colleagues,

The Natural and Mathematical Sciences (NMS) Panel has reviewed and approved (June 30, 2017) the proposal for the Data Visualization Specialization (DVS) in the Data Analytics major.

The proposed DVS program is the fifth specialization in the Data Analytics major, joining the active specializations in Biomedical Informatics, Business Analytics, Computational Analytics and Social Sciences Analytics. The DVS is a relevant addition to the Data Analytics major and provides students with two complementary skills: students will develop the skills to "visualize data for the purpose of seeing and exploring what is contained within it" and to acquire the ability to make both static and dynamic visuals as a means of "telling the stories found in the analysis of data". A growing number of job postings in this area support the need for high-level skills in this area.

The NMS panel first considered the DVS proposal on January 31st, 2017; at this time several issues were raised that required further clarification and/or corrections and the proposal was returned for revision without a vote (described below). A revised proposal was reviewed by the NMS panel on April 25th, 2017, and approved with minor contingencies. In response, an updated document was received in June and the proposal was approved in its final form on June 30, 2017.

We had two primary concerns in the initial review:

- The requirements for the specialization were five (3 hour) courses at the 5000-level. The committee was concerned that the focus on higher-level courses might deter students, especially since some of the courses didn't have prerequisites.

- Of the five required courses, two had not been submitted for approval: ACCAD 5150, "Emerging Trends in Data Visualization" and an ACCAD capstone course.

The remaining questions were less critical and concerned clarifications of learning outcomes and the four-year plan.

These concerns were addressed in the intervening revisions and we formally approved the proposal on June 30th, 2017.

Respectfully,

Charles J. Daniels

Charles J. Daniels, Ph.D.

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December 21, 2016

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 four specializations: Biomedical Informatics, Business Analytics, Social Science Analytics and Computational Analytics. We are proposing to add a fifth, Data Visualization Specialization, to the major.

The proposed specialization was developed by faculty in the Division of the Arts and Humanities (represented by Professor Mary Anne Beecher, Chair of the Department of Design, and Professor Maria Palazzi, Director of ACCAD) and faculty in the College of Engineering (represented by Raghu Machiraju, Professor of Computer Science and Interim Director of TDA) 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 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
Associate Professor, Statistics
Co-director of the Data Analytics Major

Dr. Srinivasan Parthasarathy
Professor of Computer Science and Engineering
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. As of September 2016, 172 students are in the major or pre-major.

The major is structured in three parts: core fundamentals, an area of specialization, and an integrative experiential education component. There are currently four specializations in the major: Biomedical Informatics, Business Analytics, Computational Analytics and Social Sciences 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 **Data Visualization Specialization** (DVS) to the major.

Rationale for the Proposed Specialization

The rationale for the proposed DVS is given in the attached document "Overview of the Data Visualization Specialization."

Impact of the Proposed Revision on the Existing Major

The proposed revision to the major adds a fifth option for a specialization. All other aspects of the existing major remain intact. The proposed DVS 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 Chairs (or their designees) of the two departments 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 DVS by the Council on Academic Affairs, the Management Committee will work with the dean of the Division of the Arts and Humanities 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

After establishing an initial assessment plan at the major's inception, we have been updating the plan yearly as our first batch of students has progressed through the major. The assessment plan takes into account both the major-specific learning outcomes as well as specialization-specific learning outcomes. Details for how the Data Visualization Specialization will be assessed are provided in the attached documents.

Implementation Issues

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

    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

    Advising for all students in the Data Analytics major is handled by the Academic Planning Specialist who is housed in the Department of Statistics in the College of Arts and Sciences. This individual will provide advising support for students interested in the DVS of the Data Analytics major.

Overview of the Data Visualization Specialization

The 15 credit hour Data Visualization Specialization (DVS) 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 the use of analog and digital tools and methods to analyze and represent quantitative and qualitative data as pictorial representation of data that may take the form of an animation, an interactive visual interface, an immersive environment, a cloud, a map, a chart, or a simple picture.

Students choosing this specialization will take both of the DA core options for visualization (ISE 5760 and CSE 5544). The ISE course will thus be taken to fulfill the core visualization requirement and the CSE course joins Design and ACCAD courses in visual and experiential design to construct the Data Visualization Specialization.

What the Specialization Provides:
This DVS will provide students with an understanding of the **human-centered approach** to the design of static and interactive visual and experiential materials. Students will learn basic visualization design techniques and theories to produce their own visual stories that address visualization methodologies. They will also learn how to use computational media to reveal insights and will analyze and interpret complex information. All of these learning experiences together expand students' approaches to theory development, hypothesis testing and their ability to synthesize.

Data visualization skills are critical components of "big data" analytics. Just as students with skills in conducting research and performing statistical analyses are attractive to employers in a wide range of industries that include technology and social media companies, marketing and consulting firms, and government agencies, students with the ability to use visualization strategies to interrogate data and communicate its meaning are in high demand in these same types of industries. At any one time, one can find significant numbers of job postings that require or desire data visualization experience from corporations such as Nationwide Insurance, Moody Corporation, the NBA, Capital One, Tableau, the Ford Motor Company, and Amazon.

More concretely, the **DVS will provide students with two complementary sets of skills.**

- First, students will have the ability to visualize data for the purpose of seeing and exploring what is contained within it. While the use of visualization to inform analysis is common practice in the arts, it is the intent of the DVS to provide DA students with opportunities to develop visualization strategies to support their ability to make sense of data.

- Second, students will acquire the ability to make visuals—both static and dynamic—as a means of telling the stories found in the analysis of data. By creating compelling visuals using human-centered design principles and practices, students will enhance their ability to engage audiences and provide them with efficient and effective access to knowledge.

DVS Requirements
To achieve these outcomes, the DVS has the following requirements (the details of the requirements are further spelled out below):

(1) One computer science course in data visualization that links programing skills to the creation of visual interfaces and visuals that use measurements and calculations from a range of social and scientific disciplines. The specified course (CSE 5544) provides students with opportunities to **explore tool building** through modern programming languages and systems in order to explore the opportunities and limits of existing software and the need to tailor tools for statistical and data-type-contextual analysis to the questions being probed and for data explorations to embark on.

(2) Three courses that focus on **specific approaches to visualization.** One visualization course in the Department of Design provides knowledge of the elements and principles of visual design and composition and opportunities to practice their application in the development of a range of ways to visualize information. Two visualization courses offered at ACCAD enable students to understand the implications of user experience and user interface design in the development of dynamic visual applications and to experience the potential impact of state-of-the-art emerging technologies on the ability to explore and present the meaning of data.

(3) Participation on a **team-based sponsored project** in the Data Visualization Capstone course (still to be proposed and approved). Here, students will demonstrate their ability to work with others to interpret and represent the meaning of existing complex data sets that are connected to data-driven analytical problems found in real-world scenarios. The collaborative work conducted in the capstone course is designed to provide opportunities for university researchers and off-campus entities such as non-profit organizations and industry sponsors to benefit from student-provided enhancements to their visualization strategies. Projects produced can be cataloged and featured on the TDA web site and used as tools in recruitment and assessment.

Data Visualization Specialization Educational Objectives

In addition to the core objectives, a student graduating with a Bachelor of Science degree with a major in Data Analytics with a specialization in Visualization will be able to:

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** Apply visual design principles to simple and complex models that tell the stories found in data.
- **S.2** Merge approaches to visualization with design principles to reveal patterns in data and present information from a human-centered perspective.
- **S.3** Use a range of analog and digital tools and techniques to translate the meaning of data into comprehensible visual or experiential content.
- **S.4** Understand ways in which interaction and immersive experiences can encourage the generation and exploration of data-based hypotheses, today and in the future.

Table 1: Data Visualization Specialization Outcomes

Course	M.1	M.2	M.3	M.4	M.5	S.1	S.2	S.3	S.4
DSN 5505		B	I	I		I	B	B	
ACCAD 5141			I		I	I		B	
CSE 5544	A			A	A	B	B	A	N/A
ACCAD 5150		I		B	I		I	I	B
ACCAD 5XXX (Capstone)	I	I	A	A	I	A	A	I	B

Key: B= beginner I=intermediate A = advanced

Assessment

For the Data Visualization Specialization, all learning outcomes will be measured within a 3-year period. The assessment means/methods that will be used include a combination of the following:

- Direct assessment of student projects or other assignments as appropriate by faculty members teaching specialization courses using rubrics mapped to the learning outcomes.
- Direct assessment of student performance on embedded test questions that map to learning outcomes
- Indirect assessment of student perception of their competency mapped to specific learning outcomes measured using a discursive course evaluation tool
- Indirect assessment of graduated and/or current student competency via industry sponsor surveys

The assessment process for assuring that successful learners and graduates meet the desired competencies include objective and subjective quizzes and examinations, research papers, project portfolios, culminating projects, and student/graduate surveys.

Upon approval of the specialization, the Specialization proposers (Beecher, Machiraju, and Palazzi) will meet with faculty teaching the Specialization courses from their programs to map assessment via specific assignments in the five courses.

Using mapping from *Table 1: Data Visualization Specialization Outcomes*, a plan for covering all the outcomes will be developed (i.e. rubrics, surveys, score charts) and evaluation criteria will be determined. This data will be analyzed at the end of each academic year by Beecher, Machiraju and Palazzi with faculty teaching those courses. A summary of the findings and recommendations to improve student learning and specialization effectiveness will be reported to the Data Analytics undergraduate studies committee. Implementation of any changes based on findings will be overseen by contributing programs (ACCAD, CSE, Design) and will be assessed in turn.

Data Visualization

Total credit hours: 15, to be satisfied as follows:

Five required courses:

(1) DSN 5505: Information Design (3 credit hours): Influence of design principles, layout, typography, and choice of tool/medium on ability to structure and communicate visual messages.

(2) ACCAD 5141: Interactive Arts Media (3 credit hours): Practice in methods for designing and crafting user experiences (UX) and user interfaces (UI) that provide a cohesive, subjectively satisfying experience that in turn motivates the user to repeatedly utilize the application.

(3) CSE 5544: Introduction to Data Visualization (3 credit hours): Principles and methods for visualizing data from measurements and calculations in physical and life sciences, and transactional and social disciplines; information visualization; scientific visualization.

(4) ACCAD 5150: Emerging Trends in Data Visualization (3 credit hours): This course enables students to explore new and emerging visualization approaches, topics and trends in visualization research and their applications. Students will research, write about, experience, propose, and prototype trends and possibilities for visualization.

[ACCAD plans to offer this course 1x/year. In addition to DA students, the course is expected to attract advanced undergraduates and graduate students in Art, Design, and CSE. It will also be included in the to-be proposed Visualization Undergraduate Minor and Visualization Graduate Interdisciplinary Specialization.]

(5) ACCAD 5XXX: Data Visualization Capstone (3 credit hours): Students will work on team-based sponsored projects using visualization practices to analyze and translate data to provide a unique and critical perspective.

B.S. Degree—Data Analytics Major
Advising Sheet

The Ohio State University
College of Arts and Sciences

Data Visualization 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	5
	Math 1151	5	CSE 2221	4
	CSE 1223	3	GE Foreign Language II	4
	GE Foreign Language I	4	GE Phys. Science (lab)	4
	GE Writing Level 1	3		
		------		------
	Total 16		**Total 17**	
2	CSE 2231	4	CSE 2421 or 3430	4
	CSE 2321	3	Math 2568	3
	Stat 3201	3	Stat 3202	4
	GE Social Science	3	GE Writing Level II	3
	GE Foreign Language III	4	GE Social Science	3
		------		------
	Total 17		**Total 17**	
3	ISE 3230	3	Stat 3302	3
	CSE 3241	3	CSE 5243	3
	Stat 3301	3	GE Bio. Science (lab)	4
	ISE 5760 (Core Visualization Req.)	3	**ACCAD 5141 Int. Arts Media: UI/UX**	3
	DSN 5505 Information Design	3	**CSE 5544 Intro to Data Vis**	3
		------		------
	Total 15		**Total 16**	
4	Stat 4620	2	Stat 3303	3
	CSE 5242	3	GE Historical Study	3
	ACCAD 5150 Emerg. Trends Data Vis	3	GE Natural Science	3
	GE Literature	3	GE Cult. & Ideas or Hist. Study	3
	GE Visual & Performing Arts	3	**ACCAD 5xxxx Data Vis Capstone***	3
	GE Open Option	3		
		-------		------
	Total 17		**Total 15**	

*For the beginning offering of the Specialization, the existing Data Analytics capstone
(CSE 59xx/Stat 5xxx Capstone) will be used for these credits. Once there is evidence of a
large enough cohort in this specialization, the Data Visualization capstone will be
submitted for approval and will become the final course in the Specialization.

Total hours to complete the Data Analytics degree program = 130