THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Advanced Computing Center for the Arts and Design

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December 12, 2016

Dear Curriculum Committees,

We are proposing to add a fifth specialization in Visualization to the existing undergraduate major in Data Analytics. The proposed specialization was developed by faculty in the Department of Design, the Department of Computer Science and Engineering and the Advanced Computing Center for the Arts and Design 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 specialization to the major.

Sincerely,

Maria Palazzi
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Cc: Dr. Mary Anne Beecher, Dr. Raghu Machiraju

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 details of the requirements are further spelled out below:

(1) **DSN 5505: Information Design; ACCAD 5141: Interactive Arts Media; ACCAD 5XXX: Emerging Trends in Data Visualization;** 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.

(2) **CSE 5544: Introduction to Data Visualization;** 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 course 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.

(3) **ACCAD 5XXX: Data Visualization Co-op Capstone*;** Participation on a multi-disciplinary **team-based sponsored project** in which students 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.

*We anticipate that there will not be enough critical mass for this course for the first 1-2 years of the Specialization. To compensate for this issue we will substitute the Computer Science and Engineering/Statistics Capstone

course currently under development. A course number will be provided as soon as it is available.

Data Visualization Specialization Educational Objectives

In addition to the core objectives, a student graduating with a B.S. 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						I	B	B	
ACCAD 5141						I		B	
CSE 5544	A			A	A	B	B	A	N/A
ACCAD 5XXX							I	I	B
ACCAD 5XXX (Capstone*)						I	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 Specialization

Total credit hours: 15, to be satisfied with five required courses as follows:

(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 5XXX: Emerging Trends in Data Visualization (3 credit hours): Considers how existing and emerging technologies can and will engage and inform the meaning of big data for the end user. This includes exploration of interactive, immersive or augmented experiences of visualization.

(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 **The Ohio State University**
Advising Sheet **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 (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
	ISE 5760 (Core Visualization Req.)	3	ACCAD 5141 Interact. Arts Media (DVS)	3
	Design 5505 Info. Design (DVS)	3	CSE 5544 Intro to Data Vis (DVS)	3
	Total:	**15**	**Total:**	**16**
4	Stat 4620 (Intr. Stat. Learning) CSE 5242 or CSE 5xxx (DB II or Adv. DB and Cloud Computing)	2 3	Stat 3303 (Statistical Dec. Making)	3
			GE Historical Study	3
	ACCAD 5xxx Emerging Trends in Data Vis (DVS)	3	GE Natural Science	3
			GE Cult. & Ideas or Hist. Study	3
	GE Natural Science	3	ACCAD 5xxx Data Vis Capstone (DVS)	3
	GE Literature	3		
	GE Arts	3		
		17	**Total:**	**15**

Total hours to complete the degree program = 130