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| For Academic Affairs and Research Use Only |
| CIP Code:  |  |
| Degree Code: |  |

**New Emphasis, Concentration or Option Proposal Form**

**[ ] Undergraduate Curriculum Council**

**[X] Graduate Council**

Signed paper copies of proposals submitted for consideration are no longer required. Please type approver name and enter date of approval.

Email completed proposals to curriculum@astate.edu for inclusion in curriculum committee agenda.

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| Edward Hammerand | 9/27/2017 |

**Department Curriculum Committee Chair** |

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**COPE Chair (if applicable)** |
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| Hung-Chi Su | 9/27/2017 |

**Department Chair:**  |

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**Head of Unitb (If applicable)**   |
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| David F. Gilmore | 10/6/2017 |

**College Curriculum Committee Chair** |

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**Undergraduate Curriculum Council Chair** |
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| Anne A. Grippo  | 10/6/2017 |

**College Dean** |

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**Graduate Curriculum Committee Chair** |
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**General Education Committee Chair (If applicable)**   |

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**Vice Chancellor for Academic Affairs** |

**i. Proposed Program Title**

Master of Science in Computer Science with Emphasis in Data Science

**ii. Contact Person** (Name, Email Address, Phone Number)

Dr. Hung-Chi Su, suh@astate.edu, 870-680-8119

**iii. Proposed Starting Date**

Spring 2018

**Bulletin Changes**

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| **Instructions**  |
| **Please visit** [**http://www.astate.edu/a/registrar/students/bulletins/index.dot**](http://www.astate.edu/a/registrar/students/bulletins/index.dot) **and select the most recent version of the bulletin. Copy and paste all bulletin pages this proposal affects below. Follow the following guidelines for indicating necessary changes.** **\*Please note: Courses are often listed in multiple sections of the bulletin. To ensure that all affected sections have been located, please search the bulletin (ctrl+F) for the appropriate courses before submission of this form.** - Deleted courses/credit hours should be marked with a red strike-through (~~red strikethrough~~)- New credit hours and text changes should be listed in blue using enlarged font (blue using enlarged font). - Any new courses should be listed in blue bold italics using enlarged font (***blue bold italics using enlarged font***)*You can easily apply any of these changes by selecting the example text in the instructions above, double-clicking the ‘format painter’ icon 🡪 , and selecting the text you would like to apply the change to.* *Please visit* [*https://youtu.be/yjdL2n4lZm4*](https://youtu.be/yjdL2n4lZm4) *for more detailed instructions.* |

Insert between page 262 and page 263 of 2017-18 Graduate Bulletin:

Computer Science

Master of Science

Emphasis in Data Science

University Requirements:

See Graduate School Degree Policies for additional information (p. 35)

Program Requirements:

Minimum of eighteen hours of 6000 level Computer Science and approved Mathematics and/or

Statistics coursework inclusive of thesis.

Sem. Hrs.

Theory: 3

CS 5133, Compiler

OR

CS 5723, Automata Theory

Systems (select one of the following): 3

CS 5313, Computer Networks

CS 6213, Parallel Processing

CS 6243, Distributed Systems

CS 6253, Heterogeneous Computing

Algorithms: 3

CS 5713, Analysis of Algorithms

Emphasis Area (Data Science):

CS 5543, Database Systems 3

CS 5623, Fundamentals of Data Science 3

CS 6523, Data Mining Techniques 3

Emphasis Elective (select one of the following): 3

CS 6443, Machine Learning

CS 6543, Advanced Database Systems

STAT 6433, Time Series Analysis

STAT 6643, Multivariate Analysis

STAT 6653, Data Analysis I: Regression Analysis

STAT 6663, Data Analysis II: Analysis of Variance

CS Electives 6

CS, MATH, and/or STAT Electives, 6

Subject to the prior approval of the Computer Science Curriculum Committee.

Sub-total 33

Total Required Hours: 33

**EMPHASIS ASSESSMENT**

**University Goals**

1. Please indicate the university-level student learning outcomes for which this new emphasis will contribute. Check all that apply.

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| * 1. **[ ]** Global Awareness
 | * 1. **[X]** Thinking Critically
 | * 1. **[X]** Information Literacy
 |

**Emphasis Goals**

2. Justification for the introduction of the new emphasis. Must include:

1. Academic rationale (how will this emphasis fit into the mission established by the department for the curriculum?)
 The emphasis addresses the department’s ongoing need to constantly revise the curriculum to reflect new concepts and technologies in computer science. The rapid growth in the data science area in recent years is bringing great attention and challenges to computer science academia, industry and government, placing high demands on professionals in this field.
2. List emphasis goals (faculty or curricular goals, specific to the emphasis.)
* Students will possess a strong foundational knowledge of the theory and application of data science algorithms and processes.
* Students will have the ability to identify and analyze data science problems and to implement solutions for them.

c. Student population served.

Graduate students

**Emphasis Student Learning Outcomes**

3. Please fill out the following table to develop a continuous improvement assessment process for this emphasis.

*For further assistance, please see the ‘Expanded Instructions’ document available on the UCC - Forms website for guidance, or contact the Office of Assessment at 870-972-2989.*

***Note: Best practices suggest an emphasis would have 1 to 3 outcomes.***

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| **Outcome 1** | A deeper understanding of the theory and application of data science algorithms and processes. |
| Assessment Procedure Criterion | Comprehensive examinations and employer surveys  |
| Which courses are responsible for this outcome? | CS 5543, Database Systems CS 5623, Fundamentals of Data ScienceCS 6523, Data Mining TechniquesCS 6443, Machine LearningCS 6543, Advanced Database Systems |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |

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| **Outcome 2** | The ability to apply data science analysis techniques to problem identification. |
| Assessment Procedure Criterion | Comprehensive examinations and employer surveys  |
| Which courses are responsible for this outcome? | CS 5543, Database Systems CS 5623, Fundamentals of Data ScienceCS 6523, Data Mining TechniquesCS 6443, Machine LearningCS 6543, Advanced Database SystemsSTAT 6433, Time Series Analysis STAT 6643, Multivariate AnalysisSTAT 6653, Data Analysis I: Regression AnalysisSTAT 6663, Data Analysis II: Analysis of Variance |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |

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| **Outcome 3** | The ability to apply data science implementation techniques to problem solution. |
| Assessment Procedure Criterion | Comprehensive examinations and employer surveys  |
| Which courses are responsible for this outcome? | CS 5543, Database Systems CS 5623, Fundamentals of Data Science CS 6523, Data Mining TechniquesCS 6443, Machine LearningCS 6543, Advanced Database Systems |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |

*Please repeat as necessary.*

**LETTER OF NOTIFICATION – 3
NEW OPTION, CONCENTRATION, EMPHASIS**(Maximum 18 semester credit hours of new theory courses and 6 credit hours of new practicum courses)

1. Institution submitting request:

Arkansas State University

2. Contact person/title:

 Dr. Hung-Chi Su, Chair of the Department of Computer Science

3. Phone number/e-mail address:

 870-680-8119, suh@astate.edu

4. Proposed effective date:

Spring 2018

5. Title of degree program: (Indicate if the degree listed above is approved for distance delivery)

Master of Science in Computer Science

6. CIP Code:

11.0101

7. Degree Code:

6180

8. Proposed name of new option/concentration/emphasis:

Data Science

9. Reason for proposed action:

There is a rising demand for students who have expertise in data science from corporations, nonprofit companies, agencies and educational institutions. A data science emphasis will complement the computer science degree program to prepare students with knowledge and skills to analyze and discover information and relationships from large-scale data sets in data-heavy careers.

10. New option/emphasis/concentration objective:

The emphasis will prepare students to have a set of data science theoretical and practical skills that can be used in a career to conduct research and/or to improve performance, add responsibilities, and earn promotions.

11. Provide the following:

* 1. Curriculum outline - List of courses in new option/concentration/emphasis – Underline required courses

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| CS 5543, Database Systems  |
| CS 5623, Fundamentals of Data Science |
| CS 6523, Data Mining Techniques |
| CS 6443, Machine Learning  |
| CS 6543, Adv. Database Systems |
| STAT 6433, Time Series Analysis  |
| STAT 6643, Multivariate Analysis |
| STAT 6653, Data Analysis I: Regression Analysis |
| STAT 6663, Data Analysis II: Analysis of Variance |

* 1. Provide degree plan that includes new option/emphasis/concentration

|  |  |  |
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| **Course Number** | **Course** **Name** | **Credit Hours** |
| CS 5713 | Analysis of Algorithms | 3 |
| Choose One of the Following: |
| CS 5133 | Compilers | 3 |
| CS 5723 | Automata Theory |
| Choose One of the Following: |
| CS 5313 | Computer Networks | 3 |
| CS 6213 | Parallel Processing |
| CS 6243 (pre fall 2017 #s were 6233 & 6823) | Distributed Systems |
| CS 6253 (pre fall 2017 #s were 6223 & 6823) | Heterogeneous Computing (pre fall 2017 name was High Performance Computing) |
| Data Science Emphasis: |
| CS 5543 | Database Systems  | 3 |
| CS 5623 | Fundamentals of Data Science  | 3 |
| CS 6523 | Data Mining Techniques | 3 |
| Choose One of the Following: |
| CS 6443  | Machine Learning  | 3 |
| CS 6543 | Advanced Database Systems |
| STAT 6433 | Time Series Analysis |
| STAT 6643  | Multivariate Analysis |
| STAT 6653 | Data Analysis I: Regression Analysis |
| STAT 6663 | Data Analysis II: Analysis of Variance  |
| Electives | Computer Science Electives | 6 |
| Electives | Computer Science, Math, or Stats Electives | 6 |
| Total |  | 33 |

* 1. Total semester credit hours required for option/emphasis/concentration

 (Option range: 9–24 semester credit hours)

 12

* 1. New courses and new course descriptions
* CS 5623, Fundamentals of Data Science
Study of the practices and techniques associated with data science, including programming for data analytics, modern technologies for data access in distributed and parallel systems, and an overview of machine learning models.
* CS 6523, Data Mining Techniques (*offered to date as a special topics subject, CS6823*)
Exploration of the algorithms and methodologies in knowledge discovery and data mining used to find information or knowledge of interest in large data sets efficiently.
* CS 6443, Machine Learning (*offered to date as a special topics subject, CS6823*)
The theory and practice of machine learning from a variety of perspectives. Topics include supervised learning (classification, regression); unsupervised learning (clustering, dimensionality reduction); reinforcement learning; and computational learning theory.
* CS 6543, Advanced Database Systems (*offered to date as a special topics subject, CS6823*)
A study of the internals of database systems as a basis for system implementation and performance tuning. Topics include database system architecture, transactions and serializability, recovery from errors, query optimization, and new technologies in database systems.
* STAT 6433, Time Series Analysis (*offered to date as a seminar subject, MATH 669V*)

Topics include stochastic processes, stationarity, autocovariance and autocorrelation, filtering and smoothing, ARMA processes, and spectral analysis.

* 1. Goals and objectives of program option
* Students will possess a strong foundational knowledge of the theory and application of data science algorithms and processes.
* Students will have the ability to identify and analyze data science problems and to implement their solutions.
	1. Expected student learning outcomes

Student will have:

* a deeper understanding of the theory and application of data science algorithms and processes.
* the ability to apply data science analysis techniques to problem identification.
* the ability to apply data science implementation techniques to problem solution.
	1. Documentation that program option meets employer needs

<https://www.forbes.com/sites/emsi/2016/11/16/want-to-become-a-data-scientist-where-the-jobs-are-and-what-employers-are-looking-for/#5b0628ce5760>

*There were on average 2900 unique job postings active per month for data scientists over the past nine months.*

<https://www.forbes.com/sites/louiscolumbus/2017/05/13/ibm-predicts-demand-for-data-scientists-will-soar-28-by-2020/#29aa079b7e3b>

*Annual demand for the fast-growing new roles of data scientist, data developers, and data engineers will reach nearly 700,000 openings by 2020.*

<http://www.computerscienceonline.org/degree-programs/data-science/>

*According to research from executive recruiting company Burtch Works, a majority of professional data scientists (92 percent) hold a graduate degree.*

* 1. Student demand (projected enrollment) for program option

 40

* 1. Name of institutions offering similar program or program option and the institution(s) used as a model to develop the proposed program option

 University of Georgia

 University of Colorado-Boulder

 University of Southern California

 Model used to develop program was the A-State M.S. in Computer Science program

12. Institutional curriculum committee review/approval date:

13. Will the new option/emphasis/concentration be offered via distance delivery? No

 If yes, indicate mode of distance delivery:

 Enter text...

14. Explain in detail the distance delivery procedures to be used:

 N/A

15. Specify the amount of additional costs required for program implementation, the source of funds, and how funds will be used.

 All but one of the courses involved are already being taught as special topics; the rotation will be revised to provide an opening for the one new course. Consequently, there will be no extra funds required.

16. Provide additional program information if requested by ADHE staff.

President/Chancellor Approval Date: Click here to enter a date.

Board of Trustees Notification Date: Click here to enter a date.

Chief Academic officer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: Enter date.

 Name (printed): Click here to enter text.