Academic Program Review
Self-Study Report

Computer Science Department
Georgia State University

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Note: The peer computer science programs for both the undergraduate and graduate program comparisons are those at George Mason University, Wayne State University, and the University of Texas at Dallas.
1. Where We Are Now

The Department of Computer Science at Georgia State is at a crossroads with booming enrollments at both the undergraduate and graduate levels, shortage of faculty, inadequate instructional as well as research laboratory space, and strong research programs in focused areas such as big data analytics, bioinformatics, parallel and distributed systems, and cyber-physical systems.

Undergraduate enrollment has continuously grown from a low of 327 majors in Fall 2007 to 1404 in Fall 2016, and expected to continue growing. Graduate enrollments are at an all-time high of 177 in Fall 2016. With no significant faculty additions until Fall 2016, when 4 new tenure track faculty and 3 new Lecturers were hired, we are still relying heavily on Ph.D. students and part time instructors to teach approximately 20 sections each semester. The department has been successful in obtaining two next generation faculty program awards in 2016 and hopes to hire 3 additional tenure track faculty in 2017-18. One additional tenure track faculty to assist with our new Computational Data Analytics concentration in the M.S. Analytics program has been authorized and we hope to hire this faculty in 2017. We are also searching for a replacement hire for one faculty who left for the University of Georgia in 2016.

The department has just one dedicated 30-seat computer laboratory for all its undergraduate and graduate classes. This is clearly inadequate to provide the hands-on training that is essential for student learning. Our near absence of lab space is unheard of as compared to any other Computer Science department in the country.

Research productivity in terms of external funding is at an all-time high for the department with over 2.1 million in funding in FY 2016 and an average of over 1.5 million during the past 3 years.

1.a. Undergraduate Education

Since 2007, the Computer Science Department has seen unprecedented and continuous growth in enrollments following national trends. This growth is expected to continue in the coming years based on the societal dependence on technology, especially with the prevalence of impactful new technologies such as Mobile and Ubiquitous Computing, Internet of Things, and Big Data. The plethora of jobs in computing, as well as the rapid evolution and expansion of the field, is spurring the enrollment growth.

At the undergraduate level, the Computer Science Department offers a Bachelor of Science in Computer Science with the requirement of choosing from one of six concentrations. We also offer several dual degrees in Computer Science, some of which partner with the Georgia State University’s Robinson College of Business.

In FY 2015 Computer Science conferred 110 B.S. degrees. Additionally, the Computer Science major has grown rapidly over the last three fiscal years (Appendix 4). The number of majors increased from 704 in Fall 2013 to 1227 in Fall 2015.

1.a.1 Quality of Undergraduate Students

Appendix 1 provides averages for high school GPA, Freshman Index, SAT, and ACT of Freshman Computer Science majors. By these measures, the quality of entering Computer Science majors has not changed significantly over the past three years and is on par with the university-wide Freshman Index.
During this time, however, we have had an increase in the number of Honors students that are Computer Science majors. Fall 2016 marked the first time that Computer Science had the highest number of majors for the incoming class of Honors students.

1.a.2 Scholarship Support

Currently, the Department of Computer Science does not offer scholarship support for its undergraduate majors.

1.a.3 Student Success and Satisfaction

1.a.3.1 Learning Outcomes

Student Learning. The department submitted an Assessment Plan that was approved in July 2004. Assessment of learning outcomes were focused on six areas that are central to the field: 1) algorithm design and analysis, 2) discrete mathematics, 3) computer systems development, 4) programming skills, 5) hardware systems, and 6) computer organization and programming.

Through the assessment procedure, the department recognized that many of our students were not becoming proficient programmers. It is not as effective for students to learn to program passively. Instead it is imperative that they have ample opportunity to work on coding while having access to ask questions in a supervised setting. Thus, we have modified the structure of our introductory courses to include a weekly lab component.

1.a.3.2 Recruitment Rates

The Computer Science major has grown rapidly over the last three fiscal years (see the table below). The number of majors increased from 879 in Fall 2013 to over 1200 in Fall 2015. With our most popular concentration being Computer Software Systems.

<table>
<thead>
<tr>
<th>Program</th>
<th>Major</th>
<th>Concentration</th>
<th>Fall 2012</th>
<th>Fall 2013</th>
<th>Fall 2014</th>
<th>Fall 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS</td>
<td>CSC</td>
<td>CWS</td>
<td>57</td>
<td>77</td>
<td>97</td>
<td>132</td>
</tr>
<tr>
<td>BS</td>
<td>CSC</td>
<td>DKS</td>
<td>21</td>
<td>35</td>
<td>43</td>
<td>56</td>
</tr>
<tr>
<td>BS</td>
<td>CSC</td>
<td>GHI</td>
<td>25</td>
<td>37</td>
<td>45</td>
<td>64</td>
</tr>
<tr>
<td>BS</td>
<td>CSC</td>
<td>HDS</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>BS</td>
<td>CSC</td>
<td>NPD</td>
<td>17</td>
<td>22</td>
<td>29</td>
<td>35</td>
</tr>
<tr>
<td>BS</td>
<td>CSC</td>
<td>NA</td>
<td>579</td>
<td>704</td>
<td>856</td>
<td>934</td>
</tr>
<tr>
<td>BS</td>
<td>CSC</td>
<td>RSC</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>#majors</td>
<td></td>
<td></td>
<td>704</td>
<td>879</td>
<td>1,075</td>
<td>1,227</td>
</tr>
</tbody>
</table>

While the undergraduate enrollments have been on a steady increase of 15-20% each year, our faculty size has not increased over this time. With 19 faculty in Fall 2015, our student to faculty ratio was at 64.6:1, well above GSU’s overall ratio of 21:1. Using the GSU ratio, our undergraduate student population should have been roughly 400. This is clearly showing that our faculty resources have been significantly inadequate for our majors. With an expected continuing growth, this will only get worse, despite new faculty hires in 2016.

1.a.3.3 Retention Rates and Graduation Rates

The retention and graduation rates for Computer Science majors by cohort is shown below. We show 3-year retention data for three cohorts and graduation data for three earlier cohorts. Retention rates are slightly increasing over the three years for the recent cohorts. The graduation rates have been increasing with the increase in enrollment as shown in the table and figure below, but there is still much room for improvement. One reason for the delays in
progression and graduation is that students have had difficulty getting seats for their classes. The unmet demand is being monitored closely to alleviate this problem.

### First-time, Full-time Freshmen Retention Data

<table>
<thead>
<tr>
<th>Cohort Year</th>
<th>Total Freshman</th>
<th>1-Yr ENR</th>
<th>2-Yr ENR</th>
<th>3-Yr ENR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2010 Cohort</td>
<td>108</td>
<td>85</td>
<td>70</td>
<td>62</td>
</tr>
<tr>
<td>Fall 2011 Cohort</td>
<td>110</td>
<td>94</td>
<td>72</td>
<td>67</td>
</tr>
<tr>
<td>Fall 2012 Cohort</td>
<td>172</td>
<td>143</td>
<td>113</td>
<td>96</td>
</tr>
</tbody>
</table>

### First-time, Full-time Freshmen Graduation Data

<table>
<thead>
<tr>
<th>Cohort Year</th>
<th>Total Freshman</th>
<th>4-Yr Grad_by</th>
<th>5-Yr Grad_by</th>
<th>6-Yr Grad_by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2007 Cohort</td>
<td>64</td>
<td>7</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Fall 2008 Cohort</td>
<td>92</td>
<td>17</td>
<td>33</td>
<td>41</td>
</tr>
<tr>
<td>Fall 2009 Cohort</td>
<td>72</td>
<td>11</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

Graduation numbers for all CSc degree programs over the past 8 Academic Years
1.3.4 Placement and Acceptance into Advanced Degree Programs

The Computer Science Department does not currently track data on placement of students into graduate programs. The university survey data, however, is informative in showing that many of our undergraduates choose to attend graduate school.

Alumni in this survey indicated that they are attending Georgia State University, Georgia Institute of Technology, and Colorado State University. (See Appendix 5)

1.3.5 Enrollment by program, gender, and race

The ethnic and gender composition of the Computer Science major is provided in Appendix 6. Computer Science majors have been consistently split at approximately 17% female and 83% male. The department has increased its enrollment of female undergraduates slightly over the three-year period. The ethnic composition of our majors has also stayed consistent year-to-year with a consistent enrollment of black students and a decrease in white student enrollment.

1.3.6 Level of Financial Need

Financial unmet need for Computer Science majors is substantial but has decreased slightly in the last year of reporting Fall 2014. (Appendix 7).

1.3.7 Student Surveys

Surveys were administered to currently enrolled undergraduate students and undergraduate alumni by the Office of Institutional Research in March 2016. The response rate for current undergraduates was 17%, with 190 undergraduate students completing the survey. The university response rate is 21%, with 1,965 students participating in the survey.

In Section 1, devoted to General Learning Outcomes, CSC undergraduate majors responded favorably in the areas of integrating new information with past knowledge and analyzing problems from various points of view, with over 42% of respondents either agreeing or strongly agreeing.

Undergraduate responses for the question stating that class sizes are too large, with 50% of the respondents either agree or strongly agree. For the question stating that the undergraduate program is academically challenging, over 62% of the respondents agreed or strongly agreed with this statement. Half of our students either agreed or strongly agreed that faculty members in the department are interested in students’ academic development, as well as that faculty in the department are appropriately prepared for their courses, and that degree requirements are clear.

However, respondents suggested a need for improvement in the areas of writing and speaking clearly and effectively with response ratings at or above a 3.06 average rating. However, our department did receive higher ratings in the areas of integrating new information with past knowledge, analyzing problems from various points of view and developing original ideas.

Students also responded favorably in their responses to questions centered on academic preparation and fostering an academically challenging environment with response rates near or above 4.00 out 5. Students also indicated that they are being prepared for career and future educational goals with a mean response of 3.96 which is lower than the university’s mean response of 4.89 (see Undergraduate Student Survey Comparisons section for CS). A contributing factor to this lower rating by Computer Science students is that they are not given ample hands-on experience through their classes, which is critical to developing the necessary skill set required to be successful in the work field.

Our department received high ratings in the areas of faculty response rates to students (average rating of 3.99) as well as faculty preparation for subject content (average rating of 3.78) but there are two areas in which improvement could be made: currently undergraduate majors do not have ample opportunities to conduct undergraduate research, which is reflected in the low
student response average of 3.29 and the average response was 2.97 for access to emerging technologies. Our department will continue to advocate for additional space and resources for our undergraduates to provide access to emerging technologies and for research opportunities.

The departments’ use of technology received a mean rating of 2.85 and this rating was also reiterated in the student comment section. We believe, as a department, it is essential to add additional tutoring lab resources for our undergraduate majors. Students also requested that labs be taught in a uniform manner and we have addressed this concern with the recent launch of our new Undergraduate Teaching Assistant program this past fall 2016. The goal of this new pilot program is to provide a uniformed approach to tutoring students in lower division courses such as Principals of Computer Science I & II as well as Theoretical Foundations of Computer Science.

In closing, the question that drew the lowest average response rating of 2.38 was whether the department’s reputation was a significant factor in the decision to attend. As a department, this response should be situated in relation to the extraordinarily high demand for our courses as well as our rising major count, which hovers around 1,400 students. Indeed, while undergraduate majors may not choose the CSC major based on national reputation, they are certainly deciding to pursue the degree based on employment prospects, graduate school acceptance and industry demand.

1.a.3.8 Curriculum Quality

Requirements for the B.S. in Computer Science can be divided into four groups of courses that are specific to the major and are beyond the undergraduate core curriculum areas as stated by the university. A minimum of 120 semester hours must be completed.

1. **Courses appropriate to the major field:** Phys 2211K, Phys 2212K, Math 1112, Math 2211, Math 2212, and Math 3030.

2. **Computer Science requirements:** CSc 1301, CSc 1302, CSc 2720, CSc 3210, CSc 3320, CSc 4210, CSc 4330, CSc 4350, and CSc 4520.

3. **Concentration courses:** Students are to select an area of concentration from 1) Computer Software Systems, 2) Databases and Knowledge-Based Systems, 3) Graphics and Human-Computer Interaction, 4) Hardware Systems, 5) Networks and Parallel and Distributed Computing, and 6) Theoretical Computer Science. For a total of 12 hours, students select three courses from within their concentration and exactly two additional courses from outside their concentrations.

4. **General Electives:** Students select 12 hours of 2000-level or above. This can be used to work towards a minor or towards the graduate credit hours for one of the dual degree options.

**Major changes during the program review period:** Some of the math and physics course requirements were removed. These classes made the degree extra challenging for our students. Only 25 credit hours of computer science courses (rather than 28) are now required. The number of concentration hours was reduced from 20 to 12. We included 12 hours of general electives that enabled students to earn a minor or work towards a dual degree.

Due to recent merger between Georgia State University and Georgia Perimeter College, many course prefixes have been changes to align curricula. We also increased the number of credit hours for our two introductory courses, CSc 1301 and 1302 from 3 to 4 hours. This allows for an increase in the meeting time for the lab sessions.

There has also been updates and changes to our major requirements in Areas F & G. The department has added the following courses: 18 hours in Area F: CSc 2920, ASTR 1010K,

48 hours in Area G: PHYS 2212K Principles of Physics II (4) (Unless already taken in Area D). Also, to complete 48 semester hours in Area G, select one course from the list below that was not used in Area D or F: ASTR 1010K (4), ASTR 1020K (4), BIOL 1103K (4), BIOL 1104K (4), BIOL 2107K (4), BIOL 2108K (4), CHEM 1211K (4), CHEM 1212K (4), CSC 2301K (3), CSC 3330K (3), GEOL 1121K (4), GEOL 1122K (4), PHYS 2211K (4), PHYS 2212K (4)

1.a.3.8.a Syllabi, Degree Requirements, and Advisement Procedures

Syllabi for our three core courses (CSc 3320 System-Level Programming, CSc 3210 Comp. Organization and Programming, CSc 4520 Analysis of Algorithms) in the Computer Science B.S. degree can be found in Appendix 9. Degree requirements for a B.S. in Computer Science, the 6 concentrations and provided in Appendix 12. Both core and elective course descriptions are in Appendix 10. Our department strongly encourages students to meet with the Undergraduate Coordinator or the Director of Undergraduate Studies for guidance regarding the major.

1.a.3.8.b List of Courses

Descriptions of all Computer Science courses appear in Appendix 10. Data about enrollments in these courses is shown in Appendix 11 for FY 2013, 2014, and 2015. The growth trends are easily seen in the table with increasing #heads, hours, and #sections.

1.a.3.9 Contribution to the Core Curriculum and General Education Outcomes

The Computer Science Department contributes only one course (CSC 1010 Computers & Applications) to the Core Curriculum and General Education Outcomes. This course is an option to fulfill the Area D (Natural & Computational Sciences) section. See Appendix 12.

1.a.4 Signature Experiences

The Department of Computer Science participates in the university wide Cooperative Education program. Over the past four years, we have had a small number of undergraduate majors participate in full-time, paid, rotational, field-based experiences.

1.a.4.3 Internships

Our department has had a successful internship program, which has provided field experience opportunities to our students. Please see Appendix 13 for enrollment details. For our students to be marketable upon graduation, it is imperative that they gain work experience while pursuing their degree. Many of our students seek out internships from local companies and are then offered a job once they receive their degree.

1.a.5. Honors College

1.a.5.1 Honors courses taught by faculty

The following faculty members have taught honors courses in the last three years: Xiaojun Cao (CSc 4220 Computer Networks), Rafal Anryk (CSc 4710 Database Systems) and Michael C. Weeks (CSc 4870 Honors Thesis Research). Raj Sunderraman served as the Honors Thesis supervisor for one of our Honors students. (See Appendix 14)

1.a.5.3 Honors theses produced by students in the major

We have had one student complete an honors thesis within the past three years and it is listed in Appendix 15.

1.a.5.4 Student participating in the GSU Undergraduate Research Conference

The Computer Science Department has had four participants in the GSURC through poster and oral presentations. In 2016, our department had two students present on exploring machine learning procedures via Game Design and five students present on helio-physics events
knowledgebase (HEK). A detailed description of the students who participated in the GSURC in the past three years is shown in Appendix 16.

1.a.6 Undergraduate programs within the GSU context

1.a.6.1 Programs undertaken jointly with other units at GSU, list of cross-listed courses

The Computer Science program offers courses jointly taught with other departments at GSU for our Computer Science majors. Specifically, our department has cross-listed courses with the Mathematics and Physics Departments. A list of cross-listed courses is shown in Appendix 17.

1.a.6.2 Areas of substantial overlap/redundancy with other units at GSU

The Computer Science Department offers numerous courses jointly taught with other STEM departments at GSU for our CSC majors. A list of cross-listed courses is shown in Appendix 18.

1.a.7 Number of students enrolled in fully online and hybrid courses

Currently, the Computer Science Department does not offer online or hybrid courses. However, such courses are in discussion.

1.b. Graduate Education

At the graduate level, the Computer Science Department offers MS and PhD degrees in Computer Science. Our programs are strong and stable with increasing enrollments from around the globe.

1.b.1 Quality of graduate students attracted to the unit’s programs (Average scores on entrance exams - GRE)

The average GRE scores during the years of 2012-2014 are as following table. More information about the admitted students can be found in Appendix 19.

<table>
<thead>
<tr>
<th>Term</th>
<th>V%</th>
<th>Q%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2012</td>
<td>58</td>
<td>82</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>35</td>
<td>77</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>34</td>
<td>74</td>
</tr>
<tr>
<td>Fall 2015</td>
<td>34</td>
<td>74</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>40.25%</strong></td>
<td><strong>76.75%</strong></td>
</tr>
</tbody>
</table>

1.b.2 Expanding Support for Graduate Programs

Over the past ten years, the department has received several increases in its graduate budget to account for the growth in both the MS and the PhD program.

1.b.2.1 Total numbers of graduate students by year, degree program, and concentration in the period of the Self-Study

The enrollments of our graduate programs are listed in the following table (Appendix 20).

<table>
<thead>
<tr>
<th>Program</th>
<th>Fall 2012</th>
<th>SP 2013</th>
<th>SU 2013</th>
<th>FA 2013</th>
<th>SP 2014</th>
<th>SU 2014</th>
<th>Fall 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHD</td>
<td>66</td>
<td>69</td>
<td>62</td>
<td>76</td>
<td>63</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>MS</td>
<td>62</td>
<td>71</td>
<td>36</td>
<td>78</td>
<td>77</td>
<td>27</td>
<td>86</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>128</strong></td>
<td><strong>140</strong></td>
<td><strong>98</strong></td>
<td><strong>154</strong></td>
<td><strong>153</strong></td>
<td><strong>90</strong></td>
<td><strong>155</strong></td>
</tr>
</tbody>
</table>

1.b.2.2 Percentage of graduate students compared to total number of students in the Department
As the following table shows, the percentage of graduate students drops slightly year by year, due to the faster growth in undergraduate enrollment.

<table>
<thead>
<tr>
<th>Year</th>
<th>Undergraduate Enrollment</th>
<th>Undergraduate %</th>
<th>Graduate Enrollment</th>
<th>Graduate %</th>
<th>Total Enrollment</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2012</td>
<td>704</td>
<td>85</td>
<td>129</td>
<td>15</td>
<td>833</td>
<td>100</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>879</td>
<td>85</td>
<td>154</td>
<td>15</td>
<td>1,075</td>
<td>87</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>1,075</td>
<td>87</td>
<td>162</td>
<td>13</td>
<td>1,237</td>
<td>100</td>
</tr>
<tr>
<td>Fall 2015</td>
<td>1,227</td>
<td>88.8</td>
<td>155</td>
<td>11.2</td>
<td>1,383</td>
<td>100</td>
</tr>
</tbody>
</table>

1.b.2.3 Graduate student financial support by type GTA, GRA, etc.

The numbers of Graduate Research Assistant (GRA), Graduate Laboratory Assistant (GLA) and Graduate Teaching assistant (GTA) hired by the department are listed in the following table.

<table>
<thead>
<tr>
<th>TERM</th>
<th>GRA</th>
<th>GLA</th>
<th>GTA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2012</td>
<td>32</td>
<td>26</td>
<td>26</td>
<td>84</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>27</td>
<td>45</td>
<td>11</td>
<td>83</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>37</td>
<td>58</td>
<td>0</td>
<td>95</td>
</tr>
<tr>
<td>Fall 2015</td>
<td>39</td>
<td>45</td>
<td>18</td>
<td>102</td>
</tr>
</tbody>
</table>

1.b.2.4 Ratio of graduate students to TT faculty

From 2012 to 2015, the average ratio of graduate students to TT faculty is 8.6:1.

<table>
<thead>
<tr>
<th>Term</th>
<th>Faculty</th>
<th>Graduate</th>
<th>Student/Faculty Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2012</td>
<td>18</td>
<td>129</td>
<td>7.2</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>17</td>
<td>154</td>
<td>9.1</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>17</td>
<td>162</td>
<td>9.5</td>
</tr>
<tr>
<td>Fall 2015</td>
<td>18</td>
<td>155</td>
<td>8.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Term</th>
<th>Faculty</th>
<th>Degree Level</th>
<th>Graduate</th>
<th>Student/Faculty Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA 2012</td>
<td>18</td>
<td>Doctorate</td>
<td>66</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Masters</td>
<td>61</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Term Total:</td>
<td>127</td>
<td>7.1</td>
</tr>
<tr>
<td>FA 2013</td>
<td>17</td>
<td>Doctorate</td>
<td>76</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Masters</td>
<td>78</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Term Total:</td>
<td>154</td>
<td>9.1</td>
</tr>
<tr>
<td>FA 2014</td>
<td>17</td>
<td>Doctorate</td>
<td>78</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Masters</td>
<td>84</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Term Total:</td>
<td>162</td>
<td>9.5</td>
</tr>
<tr>
<td>FA 2015</td>
<td>18</td>
<td>Doctorate</td>
<td>69</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Masters</td>
<td>86</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Term Total:</td>
<td>155</td>
<td>8.6</td>
</tr>
</tbody>
</table>
1.b.2.5 Internships, service learning programs, research practicum, field placements, etc.

We encourage our graduate students to seek industry internships. There is an internship course to facilitate students taking internships. During past two years, over 60% of the MS student’s conducted internships and most the interns led to full time working positions.

1.b.3 National Reputation in Professional Degree Programs

The Ph.D. program is nationally competitive and ranks among the best in the Southeast, per National Research Council data. The program also has a high rank in several categories at the PhDs.org website (Appendix 21).

1.b.3.1 Number of graduate students in professional degree programs by year, with % growth

N/A

1.b.3.2 Pass rates on national credentialing examinations

N/A

1.b.4 Student Success and Satisfaction

The survey from our alumni and current graduate students shows that our graduate students are well prepared in the program and are positioned to be successful in making contributions to the industry and academia. As shown in Appendix 26, the survey shows our students score CS graduate program with an average of 4.69 (out of 5) when responding their satisfaction on CS graduate program. Over 90% of our graduate students secure one or more job offers upon graduation.

1.b.4.1.a Learning outcomes

The primary learning outcomes/objectives of the graduate program include:

1. Students should be able to describe the principles and methods of (a) discrete mathematics, (b) best-practices programming paradigms, (c) algorithm analysis, (d) computer hardware systems development, and (e) advanced network-oriented software engineering.

2. Students should be able to formulate corresponding optimization problems and develop models

3. Students should be able to apply (a) discrete structures for solving problems in computer science, (b) algorithmic techniques to solve problems, (c) high-level programming languages to implement the programming paradigms, and (d) advanced software engineering and modeling techniques for computer systems and implementing the phases of hardware development.

In our Ph.D assessment procedure, we are using the graduation rate as a measure to evaluate the desired results. On average, we graduate 8 Ph.D. students each year over the past eight years. Our retention rate is over 80%. The dropouts are due to reasons such as failure in qualifying exam, difficulties in conducting research, or transferring to other Ph.D. programs for personal reasons, and the lucrative job markets where these students earn high salaries.

1.b.4.1.b Courses taught

Refer to Appendix 22 for a list of course taught by CSC core faculty in 2012-2014.

1.b.4.2 Recruitment rates, admission requirements and procedures and advisement

Our target students include national and international students. From 2012 to 2015, 1150 students have applied, and 364 (32%) were accepted into our program and 145 (40%) enrolled (Appendix 21). The admission requirements are as follows:

Applicants for the M.S. program must satisfy the general requirements of the College of Arts and Sciences which includes TOEFL (for non-English speaking International students). The Department of Computer Science has the following additional requirements:
1. A baccalaureate degree in computer science, or equivalent. While we welcome capable students with non-computer-science degrees, they may need some foundation courses.
2. A supplemental application for computer science.
3. A statement of background and goals.
4. Three letters of recommendations from individuals who can evaluate the applicant’s potential for graduate work in computer science.
5. GRE (General) score.
6. Minimum GPA 3.0/4.0. (PhD students only)

All newly enrolled students must attend a mandatory new student orientation before classes begin in the Fall. The Director of Graduate Studies and his assistant (staff position) advised students on course selections and available funding opportunities. Most PhD students enter the program with a chosen faculty advisor so that they can begin research immediately. Otherwise, the student has one year to decide on a faculty advisor.

1.b.4.3 Retention rates, graduation rates, and output quality metrics (Appendix 23)

There are extensive interests in our MS program and more resources may enable the program to expand accordingly. As shown in the following table, issues with our retention, progression and graduation rates are practically nonexistent. Almost all our graduated students receive employment.

<table>
<thead>
<tr>
<th>Degree Major</th>
<th>Cohort FA 2012</th>
<th>YR 1 ENRL FA 2013</th>
<th>YR 2 ENRL FA 2014</th>
<th>YR 3 ENRL FA 2015</th>
<th>YR 3 GRAD FA 2015</th>
<th>YR 3 RETD FA 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS Computer Science (CSC)</td>
<td>14</td>
<td>13</td>
<td>6</td>
<td>3</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>PHD Computer Science (CSC)</td>
<td>13</td>
<td>13</td>
<td>11</td>
<td>11</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Year Total</td>
<td>27</td>
<td>26</td>
<td>17</td>
<td>14</td>
<td>10</td>
<td>24</td>
</tr>
</tbody>
</table>

1.b.4.4 Placement rates

All our graduate students (both MS and PhD) secured positions shortly after graduation in industry and academia. We now have graduates at Google, Microsoft, Oracle, Amazon, Facebook, eBay, and PayPal to name a few.

1.b.4.5 Enrollment by program, gender, and race

As shown in Appendix 24, the enrollment of our PhD program includes diverse populations, with more than 33% female and 5% African-American students.

1.b.4.6 Level of financial need

Most our full-time PhD students need and applied full financial support from the department. Many of our MS students seek partial support and tuition waivers from the department and other on-campus units (see Appendix 25).

1.b.4.7 Student surveys

The comprehensive survey results are in Appendix 26. The survey was administered to graduate students and alumni by the Office of Institutional Research in the spring of 2016. The following table shows the number of participants of the survey.

<table>
<thead>
<tr>
<th>Survey type</th>
<th>CSC response rate</th>
<th>CSC #respondents</th>
<th>Univ. response rate</th>
<th>Univ. #respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Student</td>
<td>30%</td>
<td>48</td>
<td>43%</td>
<td>961</td>
</tr>
<tr>
<td>Alumni</td>
<td>13%</td>
<td>13</td>
<td>27%</td>
<td>410</td>
</tr>
</tbody>
</table>
Some highlights of the survey results are listed below.

In the general learning outcomes, the CS graduate students had an overall positive response, with the mean scores in the range of 4.25 and above, but this response is lower than the university with the means scores in the range of 4.73 and above for all subsections.

In the program preparation/challenge, the CS graduate students had an overall positive response, with the mean scores in the range of 4.53 and above and this response is higher than the university with the means scores in the range of 4.40 and higher for all subsections.

In the faculty interaction section of table 4, the CS graduate students had an overall positive response with mean scores in the range of 4.6 and above.

There were four questions submitted by the department concerning graduate office space, stipends, travel support, research areas, adequate availability of faculty advisors, and the departmental reputation. The mean scores in this section range from 3.28 to 3.83, which is a bit poor and deserves improvements. As shown in the chart listed below, the lowest mean score is the travel support and stipends section, respectively.

<table>
<thead>
<tr>
<th>Graduate Office Space</th>
<th>Avg = 3.83</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stipends</td>
<td>Avg = 3.77</td>
</tr>
<tr>
<td>Travel Support</td>
<td>Avg = 3.28</td>
</tr>
<tr>
<td>A wide variety of research areas</td>
<td>Avg = 3.79</td>
</tr>
</tbody>
</table>

In the employment section of table 4, the general areas of employment for our graduate alumni are as follows.

<table>
<thead>
<tr>
<th>Area</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business/Finance</td>
<td>16.7</td>
</tr>
<tr>
<td>College Faculty/Admin</td>
<td>8.3</td>
</tr>
<tr>
<td>Other</td>
<td>75.0</td>
</tr>
</tbody>
</table>

In the employment section, the respondents confirmed the fact that is good to have good communication skills, ability to analyze problems from different perspectives and ability to interpret data. Per the data, these skills sets are the most important in the job market.

1.b.4.8 Student publications and presentations

All our PhD students publish their research and present their work in respective professional conferences. Some MS students convert their project/thesis into publications. The number of publications are listed in Appendix 27.

1.b.4.9 Student accomplishments: exams, theses, dissertations, projects, grants, prizes, and awards

Our students have won prizes, awards, and grants nationwide, which include Departmental Outstanding Senior Award, Student Hackathon Award, Departmental Outstanding Teaching Award, M2Women travel award, MSU College of Engineering’s Benjamin Fellowship, Student Travel Grant, Dissertation Grant, 2CI fellowships, 2nd Place Award in Charleston Defense Contractors Association, 3rd place in the 2013 AT&T Coding Challenge and so on. The list of the prizes and awards won by students are listed in Appendix 28.

1.b.4.10 Doctoral student time-to-degree

For doctoral students, the average time-to-degree is 5 years (Appendix 29).
1.b.4.11 Student outcomes after graduation: admission into further graduate education, postdoctoral fellowships, employment

The majority (over 90%) of our graduate students (both MS and PhD) secured positions shortly after graduation in industry and academia. We now have graduates at Google, Microsoft, Oracle, Amazon, Facebook, eBay, and PayPal to name a few. (Appendix 30)

1.b.5 Graduate Programs within the GSU Context

The collaboration of CS department and other departments now offers several interdisciplinary graduate programs, which include: M.S. in Analytics with Concentration in Computational Data Analytics (collaborated with Robinson College) and M.S./Ph.D. with Bioinformatics Concentration (collaborated with Biology, Chemistry and Math departments). Given more resources in terms of tenure-track position and space, the department will be positioned to develop more programs to meet the demand from the emerging industries and offer more interdisciplinary education opportunities to GSU students.

1.b.5.1 Programs undertaken jointly with other GSU units, list of cross-listed courses

The list of cross-listed courses is in Appendix 31.

1.b.5.2 Areas of overlap/redundancy with other GSU units

N/A

1.b.6 Number of students enrolled in fully online and hybrid courses

Currently, we do not have any students enrolled in online or hybrid courses.

1.b.7 Graduate degrees conferred by fiscal year

The following table shows the degree conferred in past three years.

<table>
<thead>
<tr>
<th>Degree</th>
<th>Major</th>
<th>Concentration</th>
<th>FY 2013</th>
<th>FY 2014</th>
<th>FY 2015</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>Computer Science</td>
<td>Bioinformatics</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Computer Science</td>
<td></td>
<td>33</td>
<td>38</td>
<td>48</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>FY Total (MS)</td>
<td></td>
<td>35</td>
<td>42</td>
<td>49</td>
<td>42</td>
</tr>
<tr>
<td>PHD</td>
<td>Computer Science</td>
<td></td>
<td>7</td>
<td>8</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>FY Total (PHD)</td>
<td></td>
<td>7</td>
<td>8</td>
<td>13</td>
<td>9.3</td>
</tr>
<tr>
<td></td>
<td>Department FY Total</td>
<td></td>
<td>42</td>
<td>50</td>
<td>62</td>
<td>51.3</td>
</tr>
</tbody>
</table>

1.c. Research

1.c.1 Success of the Unit’s Research Culture

The department had taken big strides in expanding its research activities during the past 10 years. The number of publications, grants, and recognitions have consistently been increasing since the previous Academic Program Review.

1.c.1.1 2CI hires, Regents Professors, Alumni Distinguished Professors, eminent scholars, and endowed professors

The Computer Science Department has hired one 2CI faculty in AstroInformatics: Rafal Angryk in 2014. The department also includes one Regents Professor: Yi Pan, and two Distinguished University Professors: Yi Pan and Alex Zelikovskiy.

1.c.1.2a Levels of external and internal funding: grants, fellowships, and awards

The CS department at GSU has received substantial amounts of external research funding. Appendices 32 and 33 show the CS department has been awarded a total of $4,311,411 in grant money from 2013 to 2015. Among these awarded grants, most which ($3,949,859) are funded
through federal agencies, and most which ($3,892,131) are for basic research. Appendix 34 shows the external grants CS faculty participated (as PI, Co-PI, or Senior Personnel) from 2012 to 2015, including all grants started or ended within this period. During this period, CS faculty were involved in a total of 62 external grants with total amount of $36,475,610.

1.c.1.2b Ratio of grants submitted to grants awarded

Per the APR Dashboard database, the percentage of proposals receiving funding was 20% in 2013, 26.32% in 2014 and 6.45% in 2015. (Appendix 35)

1.c.1.3 National/international rankings of the unit (e.g., by the National Research Council, US News and World Report, professional associations)

Based on the most recent data, the US News and World Report ranked the GSU CS department 112th in the US; Phds.org ranked the GSU CS department 35th in the US; and the National Research Council ranked the GSU CS department 55th in the US. (Appendix 36)

1.c.1.4 Research productivity that furthers the strategic goals of the university

1.c.1.4.a Quantity and quality of disseminated research—incl. qualitative assessment of venues in which faculty have published, and impact factors where available

Most tenured and tenure-track faculty in the CS department have active research programs. Appendix 37 shows the research publications of CS faculty from 2013 to 2015. During these three years, the CS faculty had 456 publications in total, among which 195 were peer reviewed journal papers and 261 were peer reviewed conference proceedings papers. See Appendix 38.

Appendix 39 shows the journals in which CS faculty have published papers from 2013 to 2015 and the impact factors of these journals. As can be seen, the main venues for journal publication are IEEE Transactions, ACM Transactions, and journals on Bioinformatics and Wireless or Sensor Networks. These reflect the main strength of CS faculty’s research areas. The impact factors for these journals range from 0.4 to 6.7.

1.c.1.4.b Impact of research on relevant disciplines, including analyses of citations of the work of individual faculty members

Research from the GSU CS department faculty has a significant impact on the literature. Based on data from Google Scholar (Appendix 40) the h indexes of faculty members ranging from 10 to 45 with average h index being 22. The average h-index citation for the past 5 years is 17. The average number of citations for faculty is 2530, with the average citation for past 5 years being 1472.

1.c.1.5 Success in recruitment and retention of top faculty in the field

The CS has been successful in hiring one 2CI faculty in Astronomy Informatics: Rafal Angryk in 2014.

1.c.1.6.a Number of faculty promoted and/or tenured since the last self-study

Since the last self-study in 2006, the CS has tenured 8 faculty and promoted 11 faculty either from assistant professor to associate professor or from associate professor to full professor. (Appendix 41)

1.c.1.6.b Average time in rank, recruiting/hiring history

By fiscal year 2015, the CS department has total 18 faculty with the following faculty composition: 7 full professors, 8 associate professors, 1 assistant professor, and 2 non-tenure track instructors.

1.c.1.7 Faculty participating in exchanges, where applicable to the Unit

N/A
1.c.1.8 Faculty Surveys

A survey was administered to faculty by the Office of Institutional Research in the spring of 2016 (see Appendix 42). The response rate was 67%, with 14 faculty completing the survey. The university response rate average is 80%.

On the University/Department Engagement category, the CS faculty overall had a positive response, with department mean scores in the range of 4.0 and above, and higher than the university mean scores for all sub-questions except the question “I am proud of my department's standing in the national academic community”. The same positive response is seen for the categories of Career Goals, Department Climate, and Mentoring, where CS faculty responded favorably with high mean scores. Note that for the specific question of “Do you have someone in the department who mentors you?”, only 22.2% CS faculty answered Yes. This compares to the university average 38.7%. On the Research category, the CS faculty responded favorably for most of the statements. The outlier is the statement “I have adequate resources (e.g., library, labs, technology) to do my research.”, for which CS faculty has a mean score 3.62, which is significantly lower than the university mean score 4.53. This indicates a dissatisfaction of resources from CS faculty. On the Program category, Computer Science faculty did not have a favorable rate for the quality of the department’s program, with department mean scores all lower than the university mean scores. For example, for the question “How would you rate the academic quality of undergraduate student majors in your department?”, the CS department mean score is 3.36, which is lower than the university mean score 4.10.

The average scores from faculty surveys (see Appendix 42) are given in the two following tables (1: Strongly Disagree, 5: Strongly Agree).

<table>
<thead>
<tr>
<th>Office Space</th>
<th>Research Labs</th>
<th>Teaching Labs</th>
<th>Salary</th>
<th>Travel Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.07</td>
<td>1.71</td>
<td>1.43</td>
<td>2.43</td>
<td>2.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current Enrollment</th>
<th>Growth in current research areas</th>
<th>Growth in new research areas</th>
<th>Graduate students</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.57</td>
<td>4.29</td>
<td>4.36</td>
<td>3.38</td>
</tr>
</tbody>
</table>

Clearly, Department of Computer Science needs more space (teaching labs, research labs and offices), and more travel supports for faculty members to attend conferences and seek research collaborations for external grants and projects from NSF, NIH, and industry. Faculty members need higher salary.

In addition, the current enrollment is excellent. Faculty members support that more growth in current research areas and more growth new research areas as well. A current graduate program is very good, but it needs more improvement in terms of quality.

1.c.2 Faculty Partnerships and Professional Service

1.c.2.1 Faculty Participation (direction, affiliation) in research centers and clusters at the Georgia State University

Our faculty members participated in research centers such as Neuroscience Institute and MBD (more details are shown in Appendix 43).

1.c.2.2 National and international research collaborations/partnerships

Our faculty members conducted multidisciplinary research projects with faculty members in U.S. and other faculty members in other countries. For example, Dr. Katharine Reeves, from the Harvard-Smithsonian Center for Astrophysics, Rafal Angryk (PI) and Dr. Martens from GSU
working on an awarded NSF project (2014-2017). WenZhan Song (PI) works on an award NSF project (2015-2019) with Fan-Chi Lin (University of Utah), Dr. Yao Xie (GaTech). More examples of the multidisciplinary research are provided in Appendix 44.

1.c.2.3 Evidence of Interdisciplinary Research

Our faculty members did multidisciplinary research projects with faculty member in Biology, Chemistry, Education, Mathematics and Statistics, Neuroscience, Physics and Astronomy, and Psychology. For example, Dr. Angryk (PI) in computer science and Dr. Martens in physics and astronomy at GSU are working on an awarded NSF project (2015-2019). Dr. Baro (PI) in Biology, Dr. Sunderraman (Co-PI) and Dr. Y.-Q. Zhang (Co-PI) in computer science are working on an awarded NSF project (2015-2019). More examples of the multidisciplinary research are provided in Appendix 45.

1.c.2.4 Significant Professional Service

Our faculty members did outstanding professional national and international services including many major journals’ editorial boards, chairs of international conferences and workshops, grant review panels, and as officers of professional organizations. For example, Dr. Cao was Vice Chair of the IEEE Optical Networking Technical Committee in 2015. Dr. Pan is Editor-in-Chief of International Journal of Bioinformatics Research and Applications (IJBRA), and International Journal of Cloud Computing (IJCC). Details are shown in Appendix 46.

1.c.3 Recognition of Scholarly Excellence

1.c.3.1 Recipients of GSU Faculty Fellowship and other internal awards

Our faculty have received numerous internal awards. These include Distinguished University Professorships for Dr. Yi Pan and Dr. Alex Zelikovsky, Regents Professorship for Dr. Yi Pan, 2013 Faculty Instructional Innovation Award for Dr. Zhu, and GSU Research Program Enhancement grants for Dr. Rob Harrison, Dr. Yi Pan, and Dr. Yanqing Zhang. A full list is provided in Appendix 47.

1.c.3.2 External awards, honors, prizes, and fellowships

The department faculty have received numerous awards, honors, and prizes from external societies, companies, and conferences. These include “Certificate of Appreciation for Outstanding Service, IEEE ICCABS 2015” (Dr. Pan), “2012 and 2013 IBM Faculty Award” (Dr. Pan), “2014 IEEE Computer Society Outstanding Contributions Award” (Dr. Prasad), “2013 ACM Distinguished Scientist” (Dr. Prasad), “2012 IEEE-CS TCPP Outstanding Service Award” (Dr. Prasad), “2015 IEEE Computer Society Golden Core Member” (Dr. Prasad), and “2015 J. Tinsley Oden Faculty Fellowship, UT Austin” (Dr. Song). In addition, the faculty have given scores of Keynote and Invited Talks at major international conferences and workshops. A full list is available in Appendix 48.

1.c.4 Unit Infrastructure for Supporting Research

1.c.4.1 Unit-level research and travel grants

CS Department provides each faculty member $1,200 each year for professional development (travel to a conference, etc.). CS graduate students who are Brains & Behavior fellows or MBD fellows receive $500 for a conference registration. Faculty can apply for a Brains & Behavior seed grant up to $30,000 once every other year. In addition, Faculty members can apply for internal grants such as a Scholarly Support Grant, Research Initiation Grants, etc.

1.c.4.2 Grant support: writing, administration

University Research Services and Administration (URSA) provides various proposal preparation services such as automatic grant warnings, grant-writing workshops (such as NSF CAREER), and careful proposal review for error corrections before final submission. URSA also emails grant chances to relevant departments.
1.c.4.3 Facilities, equipment, technical support and other administrative support
CS Department has one systems administrator for all departmental computing facilities. CS faculty have access to various facilities as shown in detail in Appendix 49.

1.c.4.4 Research information resources
GSU library provides ACM Digital Library, IEEE Xplore and other e-publications.

1.c.5 Contributions to Science and Health/Medical Education
Anu Bourgeois (Co-PI) worked on an NSF project “Catalyzing Transformative Change in the STEM Disciplines at Georgia State University”.
Ying Zhu (PI) works on National Science Foundation Project (2013 – 2016) “Courseware for improving undergraduate students’ debugging skill in GPU programming” (Co-PI: Scott Owen).

CS Department hosted the NSF REU Site: Summer Research for Undergraduates in high performance data mining from 2012 to 2014. The 8-week program has 10 students whose research projects focus on high performance data mining techniques and their applications in bioinformatics and security. 30 REU students from GSU and other colleges did 27 research projects. Most REU students are underrepresented students (especially minority and women) from small colleges with limited research resources.

1.d. Contribution to Cities

1.d.1 Activities with the Council for the Progress of Cities
N/A.

1.d.2 Contribution of the Arts and Media
1.d.2.1 Speakers’ series
CS Department hosts ACM speaker series as shown in detail in Appendix 50.

1.d.2.a. Art Exhibits
N/A.

1.d.2.4 Performances
N/A.

1.d.2.5 Radio and Television Broadcasts, Webcasts, and Films
Dr. Rafal Angryk was invited to the White House to Discuss preparedness for space weather events. Dr. Yi Pan appeared in various television broadcasts and Dr. Xiaolin Hu’s article was published by Research Media Limited, a British company. Details are shown in Appendix 51.

1.d.3 Field-specific contributions to cities (e.g., city planning, land use, transportation, the environment, etc.)
N/A.

1.e. Globalizing the University

1.e.1 Critical issues for global cities: partnerships with other universities on challenges facing cities
N/A.

1.e.2 Funded Research on Challenges Facing Emerging Nations
N/A.

1.e.3 Establishment of GSU as an International Center
N/A.

1.e.3.1 Faculty international exchanges, speakers, cultural events, visiting scholars
Appendix 52 shows the list of visiting scholars from 2012 to 2015. Appendix 53 shows international related activities from 2012 to 2015.

1.e.3.2 International forums
N/A.

1.e.3.3 Programs for foreign students
N/A.

1.e.3.4 Programs coordinated with the university's international initiatives
N/A.

1.e.4 Enhancement of Global Competency

1.e.4.1 Contribution to international studies
N/A.

1.e.4.2 Number of students enrolled in study abroad programs
Appendix 54 shows the list of students enrolled in study abroad programs from 2013 to 2015.

1.e.4.3 Global leadership certificate programs for undergraduates
N/A.

1.e.4.4 Language programs with learning outcomes and success measures
N/A.

1.e.4.5 Courses/programs with learning outcomes and success measures
N/A.

1.e.4.6 Contribution of global/multicultural perspectives to Core and other major courses
N/A.

1.e.4.7 Contribution to global competency for staff
N/A.

1.e.4.8 Success in recruiting top international faculty and students
N/A.

1.f. Overall assessment of the unit

The Department of Computer Science has made tremendous progress since the last Academic Program Review in 2006.

Research productivity in terms of grants is at an all-time high with over 2.1M in grants in FY 2016 and the faculty continue to publish in leading IEEE and ACM journals and conferences. The department is building its strengths in Big Data, Bioinformatics, and Cyber-Physical Systems and has initiated several interdisciplinary research projects in recent years.

The graduate programs are popular and growing in strength with all time high enrollments and excellent job placements for all MS and PhD graduates. The department graduates approximately 40 MS and 8 PhD students each year and in May 2016, we had the 100th PhD graduate. A new concentration in Computational Data Analytics in the M.S. Analytics program was added and plans are underway to add innovative M.S. programs to increase graduate enrollments.

Undergraduate enrollments are also continuously grow to an all-time high of 1404 majors in Fall 2016. The curriculum was revamped in 2010 and in recent years many new courses on cutting-edge technologies and techniques have been introduced. The quality of undergraduates is also improving with over 120 honors students in the program.

During all this growth, the department did not see any significant increases in resources in terms of new faculty positions until Fall 2016, when 4 tenure track and 3 lecturers were hired.
These new hires are a relief, but still fall short in terms of keeping up with the enrollment growths. The retention, progression, and graduation (RPG) rates have not kept up with the growth and the department plans to work hard during the next 10 years to improve RPG numbers.

The department has also lobbied for additional instructional as well as research laboratory space for its growing student population, but has not had any success. The department has only one dedicated instructional lab for all its undergraduate and graduate students. Acquiring laboratory space will be top priority for the department during the next 10 years so that the students can benefit from the hands-on experiential learning that is essential in CS.

2 How Adequate Are Your Unit’s Resources?

2.a. Faculty Resources

2.a.1 Faculty Composition

The unprecedented and continuous growth in enrollments in Computer Science since 2007 has put tremendous stress in the offering of classes to our students. The undergraduate enrollments have grown from 327 in Fall 2007 to over 1400 in Fall 2016. At the same time, the graduate program has increased from 117 to 176.

Unfortunately, during most of this growth in enrollments, faculty size has remained constant ranging from 16 to 19 until 2015. After urgent discussions in 2015, numerous faculty lines have finally been authorized and we added 5 new faculty in Fall 2016 and are scheduled to hire 2 more Lecturers in January 2017. We are also beneficiary of two Next Generation Faculty Program awards that will add 3 new TT lines to the department in the next 2 years. With all these additions and the loss of one Professor, we expect to reach a 30 faculty in the coming few years.

<table>
<thead>
<tr>
<th>Faculty Type</th>
<th>FA 2012</th>
<th>FA 2013</th>
<th>FA 2014</th>
<th>FA 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Full Time Faculty (FT)</td>
<td>17</td>
<td>18</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>20 Part Time Instructor (PT)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>30 Grad Teaching Assistants (GTA)</td>
<td>21</td>
<td>15</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>34</td>
<td>37</td>
<td>41</td>
</tr>
</tbody>
</table>

2.a.2 Student/faculty ratio data

During Fall 2015, the department had 1228 undergraduate majors and a full-time faculty of 19 (16 TT and 3 NTT) resulting in a student to faculty ratio of 64.6:1. for undergraduates. This ratio is among the highest at GSU and is three times the GSU’s student to faculty ratio of 21:1. In Fall 2016, we added 5 new faculty and lost one professor, however we added 178 new majors thereby improving the ratio to 61:1, not changing the fact that this ratio is still amongst the worst at GSU.

<table>
<thead>
<tr>
<th>Term</th>
<th>TT Faculty</th>
<th>TT+NTT Faculty</th>
<th>#Undergrad</th>
<th>Undergrad Student:Faculty Ratio</th>
<th>#Grad</th>
<th>Grad Student:Faculty Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA 2012</td>
<td>15</td>
<td>17</td>
<td>704</td>
<td>41.4</td>
<td>129</td>
<td>8.6</td>
</tr>
<tr>
<td>FA 2013</td>
<td>16</td>
<td>18</td>
<td>879</td>
<td>48.8</td>
<td>154</td>
<td>9.6</td>
</tr>
<tr>
<td>FA 2014</td>
<td>16</td>
<td>18</td>
<td>1,075</td>
<td>59.7</td>
<td>162</td>
<td>10.1</td>
</tr>
<tr>
<td>FA 2015</td>
<td>16</td>
<td>19</td>
<td>1,228</td>
<td>64.6</td>
<td>155</td>
<td>9.6</td>
</tr>
</tbody>
</table>
2.a.3 Credit hour generation data, by faculty by fiscal year

The number of credit hours taught by the faculty has increased from 18,609 in FY14, to 21,221 in FY15, to 22,938 in FY16. This represents a 22% increase during the two-year period from FY14 to FY16. During this time, the number of faculty has increased by 1, from 18 to 19, a 5.5% increase. Thus, the # credit hours taught per faculty member has increased by 16% from FY14 to FY16.

<table>
<thead>
<tr>
<th>Faculty Type</th>
<th>FY2014</th>
<th>FY2015</th>
<th>FY2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Full Time Faculty (FT)</td>
<td>13,708</td>
<td>14,785</td>
<td>14,785</td>
</tr>
<tr>
<td>20 Part Time Instructor (PT)</td>
<td>688</td>
<td>955</td>
<td>2,213</td>
</tr>
<tr>
<td>30 Grad Teaching Asst (GTA)</td>
<td>4,213</td>
<td>5,481</td>
<td>5,804</td>
</tr>
<tr>
<td>FY Total</td>
<td>18,609</td>
<td>21,221</td>
<td>22,938</td>
</tr>
</tbody>
</table>

2.b. Administrative Resources

The Department of Computer Science has six full-time staff members, including a business manager, a technology administrator, an academic administrative specialist, a senior administrative coordinator, and two administrative coordinators. All staff members are in the department’s main office on the 7th floor of 25 Park Place. Our department has grown considerably since 2006, but our staff has increased only by one position. With 25 faculty and over 1,600 students presently and with the possibility of continued growth in both faculty and students in coming years, we would need additional staff to handle the complexities of the fastest growing department in an effective manner.

2.b.1 Staff support per FTE faculty member

In the fall of 2016, there are 6 full-time staff members for 25 full-time TT and NTT faculty resulting in a ratio of 1 staff member per 4.16 faculty.

2.c. Technological Resources

Computer Science (CS) faculty in our department have access to a minimum of one office workstation in their office. Each system is customized to the specifications of that faculty member, including additional hardware and accessories if available. Some faculty have multiple computers e.g., a PC for office-related tasks and a Unix workstation for research work. Many faculty members prefer to work in a Unix environment.

Office computers are wired into the campus network. Portable devices have wireless connectivity through the university’s wireless network. This works well for most wireless devices, such as laptops, smart phones, tablets, and smart devices, but not well for research devices that do not confirm the university’s authentication system. For example, some wireless devices used in research may not be WPA2 capable and are unable to authenticate with the wireless network. This is a hardware limitation of these devices; wireless connectivity is deliberately simplified and cannot take advantage of these advanced security protocols.

Graduate students have access to workstations, some of them shared, which creates problems when students are assigned to the same workstation at the same time. Many students choose to use their personal laptops to perform their university work as it suits their workflow, and thus run into many licensing issues with software they are required to have access to to
perform their work. For example, some students may need access to the Adobe Creative Suite of software (such as Illustrator, Acrobat Pro, and Photo Shop) which is not currently provided for students, but is provided for faculty. Personal laptops also pose a problem connecting to some shared resources, such as printers.

Faculty, staff, and graduate students have access to many shared department resources, such as two fully equipped conference rooms for faculty meetings and presentations, access to research computing clusters, access to departmental systems such as web servers and network shares, and several network printers. Additional hardware is also provided on an as-needed basis. This includes projectors, laptops, audio-visual equipment, and networking equipment. The department also provides in-house professional-quality poster printing for research conference presentations.

Computer Science (CS) faculty, staff, and students are served by the department's technical environment comprising managed hardware, software, services, and support. Data storage and backup protection are provided by individually managed file servers housed in the university's climate controlled data center. Technology for the department is spread across 3 separate locations in 3 separate buildings.

User support ranges from hardware and software installation, desktop application assistance, advanced troubleshooting, maintenance and repair, to assistance with the purchase, configuration and maintenance of new high performance computing, and maintaining the infrastructure for all department systems. The technical staff includes a single highly skilled Network Systems Administrator assisted by several computer technicians with limited experience in the IT field and corporate environment.

This computer and technical support team has engineered solutions such as redesigning the centralized backup and storage infrastructure, rebuilding a virtualization cluster for departmental services, research, and classroom instruction, as well as the implementation of several spaces for student research and tutoring.

2.d. Space Resources

The main offices of the Department of Computer Science are on the 7th floor of 25 Park Place, with additional offices for graduate students in about 30% space on the 6th floor. With the sudden hiring of 7 new faculty members in FY2017 and increased enrollments in the graduate program (currently at 176 students), the department has been allocated temporary space in the 9th floor of Langdale Hall, where 4 lecturers, 2 instructors, 2 part-time instructors, and 10 graduate students are located.

On the 7th floor of 25 Park Place, full-time faculty and staff members have a private office each and 25 PhD students share 8 rooms. On the 6th floor, 22 PhD students occupy 7 rooms, 29 PhD students are seated in cubicles, and numerous cubicles are set aside for our M.S. graduate assistants as shareable space. We also have between 5 and 10 visiting scholars and post-docs seated in cubicles in the 6th floor. Graduate student space is limited and not all graduate students are assigned office space. Priority is given first to Ph.D. students and then to full-time M.S. students on assistantships. Students are often crammed into offices designed to hold fewer people. In some cases, students are assigned to the same carrel, forcing them to “time-share” the space. Because of the tiny spaces they are assigned, graduate teaching assistants and laboratory assistants have no suitable place to meet with their students.

The department has two conference rooms used for department and committee meetings, research meetings, and colloquium talks.
The department currently occupies approximately 8,000 square feet on the 7th floor of 25 Park Place, approximately 2100 square feet on the 6th floor of 25 Park Place, and approximately 1700 square feet in Langdale Hall. In addition, the department controls a laboratory with 1078 square feet in Classroom South.

2.e. Laboratory Resources (both research and non-instructional laboratory space)

The department has one computer laboratory, used primarily for teaching purposes. This lab, located in room 400 of the Classroom South building, occupies 1078 square feet. It contains seating for 30 students with a computer for each student, and one instructor workstation.

A study and tutoring lab, located in room 976 of Langdale Hall, contains 8 workstations and seating for 12 students. This room needs renovation as both the technical equipment and the physical workspace is insufficient. A Student Tech Fee award was recently received by the department to do this renovation.

2.f. GSU Foundation Resources and other gifts the unit has received

The Department of Computer Science has a foundation account which receives donations from alumni and well-wishers of the department. In recent years, annual donations approximate $4000 per year. Recently, an alum donated $25,000 which was matched by his company, to be used for equipping/furnishing instructional laboratories or student lounges. Since no space has been identified yet for this purpose, the donation is kept unspent for the time being.

2.g. Library Resources

The University Library report is in Appendix G2. Internet access to journals and conference proceedings is critical for our research, more so than physical access. Our library provides online access to IEEE Xplore and the ACM Digital Library. These resources are more than enough to rate our library as adequate. It should be noted that these online resources are not guaranteed. They are expensive, but it is very important to us that they remain available.

Our department has the luxury of accessing Georgia Tech’s library for any books, journals, or conference proceedings that our library does not have. Their campus is only a 15-minute drive from ours.

3. Where Does the Computer Science Department Want to Go?

3.a. Sustaining and disruptive innovations

3.a.1 Maintain and enhance our internationally recognized faculty and productive research programs in focused areas of research.

We plan to continue to build on our existing strengths in the areas of Data Analytics and Big Data, Cyber-Physical Systems and Internet of Things, Parallel and Distributed High Performance Computing, and Bioinformatics and Computational Biology. In addition, we plan to consolidate and expand our expertise in Privacy and Security aspects of Computing.

Data Analytics and Big Data: In recent years, we have hired a new 2CI faculty (Angryk) who is an expert of data analytics, data mining, and machine learning and their applications in astrophysics. He has formed a successful cluster and has been successful in obtaining large external grants in the short time he has been at GSU. He also successfully won a Next Generation Faculty award to expand the cluster with additional faculty to be hired in the next two years. The department added a new assistant professor with expertise in Big Data (Wu) in Fall 2016 and is expected to hire an additional assistant professor in Fall 2017 to support our Computational Data Analytics concentration in the MS Analytics program. In collaboration with
the Robinson College of Business, the department won a second Next Generation Faculty award in Unstructured Data Analytics for Business and is expected to hire an additional assistant professor in Fall 2017. In addition to all these new additions, the department has several other research active faculty with expertise in data mining, machine learning, and big data. The expectation is for this core group of faculty to work in interdisciplinary projects with the rest of the university community on big data projects and increase the level of funding in coming years.

*Cyber-Physical Systems and Internet of Things:* Several of the department’s existing faculty work in this emerging area of research and importance (Bourgeois, Cao, Li). We recently lost an expert in CPS/IoT to University of Georgia (Song), but have hired a new assistant professor (Ashok) who has expertise in CPS. We hope to replace Song by another assistant professor in this area. This group of faculty will reach out to industry and local government as well as to federal funding agencies to initiate projects dealing with smart cities, smart homes, and smart infrastructures.

*Parallel and Distributed High Performance Computing:* This area has been traditionally strong in the department with several faculty (Bourgeois, Li, Pan, Prasad) making a mark nationally and internationally. The department is submitting a Next Generation Faculty proposal in collaboration with the Astronomy department in which high performance computing plays a vital role. If funded, this will bring in 2 additional faculty to the department.

*Bioinformatics and Computational Biology:* Back in early 2000s, the department hired its first bioinformatics professor (Harrison) and has since expanded this area of research with several other faculty (including Pan, Zhang, Zelikovsky) conducting bioinformatics research. The department recently hired an assistant professor (Skums) in Bioinformatics and Computational Biology. Computer Science has been an integral part of the Molecular Basis for Diseases (MBD) program since its inception and have graduated over 30 PhDs in this area. The department has also participated in the Brains and Behavior program (B&B) and has successfully completed several interdisciplinary projects in neuro-informatics. The department is submitting a Next Generation Faculty proposal to further strengthen this area of research.

*Cybersecurity:* The department also plans to strengthen its expertise in Cybersecurity. Currently, several of the faculty work in data and network security. A recent assistant professor hire works in privacy and security aware computing, and a new Lecturer has expertise in Software Security. The department has submitted a Next Generation Faculty proposal in collaboration with the Robinson College of Business and the Andrew Young School of Policy Studies in Cybersecurity in FinTech. The department has also made a proposal for a Cybersecurity concentration in its M.S. program and hopes to strengthen this area of research.

All the focus areas listed above have excellent potential for interdisciplinary collaboration and the faculty will reach out to domain experts in various fields such as life sciences, geoscience, astronomy, business, public health, and education and initiate collaborative projects. The hope is to increase the level of external funding with these collaborations.

### 3.a.2 Maintain and Enhance Quality of Undergraduate Program

The focus for the undergraduate program is to enhance the quality of our graduates and make our program nationally recognizable and sought after. The following will enable us to achieve this goal.

*Pre-major:* We will implement a pre-major classification for our program as soon as possible. In this way, students will be required to successfully complete three introductory course (Principles of CS I, Discrete Math, and first Pre-Calculus/Calculus) in their freshman year,
before they can declare Computer Science as their major. These courses are predictive of success in the major.

**Gender Diversity:** Nationwide there is a gender gap in Computing with roughly 20% females. At GSU it is currently at 17%. We intend to take measures to improve this disparity.

**Curriculum Updates:** With the fast changing and ever evolving field, it is imperative that our curriculum keeps pace with the current technologies and concepts. We will continue to introduce new courses and provide the necessary environment for hands on learning.

**Honors and Undergraduate Research:** With over 120 honors CS students, there is an increasing demand to provide smaller honors sections and research opportunities. Beyond the honors students there is also a growing number of high achieving students requesting research opportunities. We shall make efforts to satisfy these demands.

**Signature Experiences:** To reach a nationally recognizable status, it is imperative for the department to provide signature experiences in the form of internships, co-op, hackathons, and specialized training outside of the class. This includes connecting with local industry to form a “Friends of CS” symbiotic working group where experts from these companies will host regular workshops focused on specialized training and job hunting skills. This will enhance the learning opportunities for our students and provide pathways to internships, co-ops, and full-time employment. We envision these companies to participate in and sponsor our hackathons and similar activities.

**Undergraduate Teaching Assistants:** The department recently launched the UTA program in which 16 of our brightest undergraduates were chosen as TAs for lower level classes. The UTAs not only helped in grading but also devoted several hours a week in the tutoring room assisting students with difficulties in early programming and concepts classes. The feedback has been excellent and we plan to expand the program.

3.a.3 *Maintain, Enhance, and Expand Graduate Programs*

With demand for computer science being at an all-time high, we are seeing large number of applications for our graduate programs, especially for the M.S. program. The department plans to expand the offerings at the M.S. level and improve the quality of our Ph.D. program.

**Innovative Master’s Programs:** The department has already introduced a Computational Data Analytics concentration in the M.S. in Analytics program offered through the Robinson College of Business. We are currently proposing a concentration in Cybersecurity in the M.S. in Computer Science program and hope to have it launched in the coming year or two. Several other areas where M.S. concentrations can be introduced soon include Game Design, Computer Engineering, and the Internet of Things. Currently the department has approximately 100 students enrolled in the M.S. program and with the new concentrations, we can grow our graduate enrollments, which is a key part of GSU’s strategic plans. Of course, additional resources are needed to implement these new concentrations and programs.

**PhD Program Quality:** The department’s PhD program was introduced in 1999 and it produced its first graduate in December 2004. Since then, the program has grown in stature, ranking in the top 50 in several categories in the 2010 National Research Council’s rankings. The program produced its 100th graduate in May 2016 and currently has 78 enrolled students. The department plans to focus on improving its quality further during the next 10 years by increasing its recruiting efforts by advertising and reaching out to potential applicants. The department will also work towards higher stipends by increasing grant support for Ph.D. students. The department will also make applications for training grants and encourage eligible students to apply for external fellowships from DOD, DOE, NIH, and NSF.
3.a.4 *Expand Training and Outreach Activities*

Computer Science plays a pervasive role in our lives today, requiring an increasingly educated and technologically literate citizenry, for even those outside of the computer science discipline. Thus, there has been increasing requests for our department to provide training activities to a variety of groups in the community.

*Non-CSc GSU students:* To succeed in the current digital information age and with the proliferation of big data, students in various fields of study require some level of computing skills. We intend to offer certificates in areas of Introductory Programming, Data Management, Big Data Analytics, Gaming and Web Design, and Web/Mobile Application Programming.

*Industry:* Many local companies are in need for additional training to learn the latest in information security, database management, and data analytics. We plan on connecting with local industry and offering workshops to train their employees.

*Local community:* There is a large population of young adults that either do not complete high school or go on to college. This youth is lacking is often lacking in a skill set to become a productive member of the workforce. There are jobs that do not require the background of a complete four-year computer science degree. Rather, there are entry level positions that someone with some basic computing knowledge could be successful with. We plan on implementing a certificate training program as an outreach to the local community. This includes a coding camp, gaming certificate, and database management certificate.

4. What Do We Need to Do or Change to Get There?

4.a. A list of Objectives for each Goal in the coming cycle, including a description of identified strategic initiatives or changes the unit will undertake to improve program quality and align the unit with the strategic plan

**GOAL 1: STRENGTHEN UNDERGRADUATE PROGRAM**

**Objective 1:** Obtain 3 new teaching laboratories equipped with modern software and hardware

*Rationale:* An integral part of the Computer Science learning experience is the availability of dedicated laboratory space for instructor-led sessions as well as for open access time to work on individual or group projects. Computer Science is a rapidly changing field and it is critical for students to be exposed to state-of-the-art technologies and facilities throughout their learning experience. Hands-on lab time engages students in active and discovery learning. Almost all universities provide dedicated lab spaces for Computer Science students as part of their learning experience. Unfortunately, at Georgia State University, we have not been able to do so in an effective manner. The only dedicated space we have is a 1078 square feet room (Classroom South 400) that was recently re-modeled with Student Tech Fee monies and has 30 seats. However, all our 4000-level classes have a capacity of at least 50 students. We currently use this dedicated lab for some of the break-out lab sessions associated with our programming courses (CSc 1301, CSc 1302, and CSc 2720). There is urgent need for additional dedicated labs both for more break-out sessions in the lower level programming courses as well as for advanced 4000-level courses, such as CSc 4110/6110 Embedded Systems, CSc 4220/6220 Computer Networks, CSc 4222/6222 Information Security, and CSc 4750 Mobile App Development.
The most common concern students addressed in the surveys centered on the lack of laboratory space, with 26% of respondents stressing the importance of adding additional lab spaces to stay current with other CS departments. One representative comment was “Have more computer labs that are accessible to CSC students that we could use to learn about new technologies hands on.”

It is common place for Computer Science Departments, regardless of their size or quality, to have dedicated instructional labs. For example, the Department of Computer Science at Wayne State University has 8 instruction labs with 7,680 square feet for an undergraduate student population of 522 (See Appendix 55) compared to 1400 at GSU. The Department of Computer Science at University of Texas at Dallas has a 150,000-square-foot building with modern classrooms and leading edge laboratories, and approximately 1,600 bachelor’s-degree students (See Appendix 56).

Objective 2: Improve undergraduate retention, progression, and graduation rates
Rationale: In spite of increased enrollments, our graduation rates are not rising proportionally. One contributing factor is the lack of faculty resources leading to significant unmet demand. We have recently hired new faculty (4 TT and 3 NTT) to address this growth, however this is not sufficient for our current enrollment of 1400 students. National trends indicate a continued growth for the next several years in computer science enrollments making the unmet demand problem even greater. Without enough seats in the classes, our students will not make progress towards their degree completion.

GOAL 2: STRENGTHEN AND EXPAND GRADUATE PROGRAMS
Objective 1: Establish 2 new graduate teaching labs with modern software and hardware
Rationale: It is common place for Computer Science Departments to have dedicated instructional laboratories for specialized courses that require hands on experience. Many of the graduate courses require access to specialized equipment such as sensors, robots, flying drones, network switch/router racks, game consoles, virus-infected computers/networks, etc. Currently, the department does not have any laboratories for this purpose. Our students are missing the hands-on experiential learning that is so vital in computer science. Responding to the surveys, many of our graduate students responded with comments such as “The Computer Science department needs its own computer labs, server equipment, network equipment, and software. It's really hard to conduct research when I have to scrounge for what I need or just use my own equipment.” And “it's clear that more faculty, labs, and opportunity are needed in order for GSU's CS department to grow its reputation”.

Objective 2: Introduce innovative M.S. programs
Rationale: In response to the needs from the industry and research community, the Computer Science department recently started a new MSA concentration in computational data analytics. We plan to offer a cybersecurity concentration in the coming year. There are also other similar demands in areas such as computer engineering, game design and so on.

Objective 3: Improve quality of Ph.D. students
Rationale: The quality of Ph.D. students is tightly tied with the research profiles in the department. During the past years, we have made plenty of progress in admitting students with better background. However, many students with outstanding background chose to enroll somewhere else. The starting stipend of $19K that we offer our PhD students is not competitive enough to attract the best students.
GOAL 3: ENHANCE RESEARCH PROGRAMS

Objective 1: Secure 3 departmental research labs and adequate faculty research space

Rationale: Adequate research space for faculty and graduate students are critical and necessary for productive research. However, at CS department, there only 12 small research rooms that can seat two students; and only 5 research rooms that can seat 4 students. Currently, there are 19 research groups in the department and will be 5 more once we finish the hiring during fall 2017. Thus, some senior faculty are significantly in short of research spaces, while 3 faculty hired in 2016 and 4 incoming faculty (to be hired in fall 2017) have no research space. Our research is significantly limited or handicapped by the lack of research space.

The average scores from faculty surveys are 2.07 for faculty research space and 1.71 for graduate research labs (1: Strongly Disagree, 5: Strongly Agree). Sample comments from faculty members include “No dedicated labs for many computer science, either instructional or research.”, “Teaching labs, research labs.”, “However, the department is way short of spaces for faculty/PhD students.”, “Creating dedicated labs for research and instructions.”, “The department needs new resources, space being the most important one. Research space is very minimal at this point and to enable high quality research growth research labs are crucial. Instructional spaces such as dedicated labs are also essential and it is a shame that the department does not have much to show for in this area. With the growth in student population, this is essential to increase the quality of instruction.”

It is important for Computer Science Departments in research universities to have dedicated faculty research spaces and departmental research labs. For example, Department of Computer Science at Wayne State University has 13 graduate research labs (a total of 7,550 square feet), and 23 faculty research office rooms (a total of 6,825 square feet).

Objective 2: Acquire additional financial support for faculty development, graduate students and supplies

Rationale: Attending various major computer science oriented international conferences such as IEEE conferences and ACM conferences is critical and beneficial for faculty and graduate students to learn latest computing techniques for real applications, and contact other experts to seek various collaborations such as joint external grant applications, joint projects with companies, joint research projects and joint education activities, etc. However, these international conferences’ registration fees have been increasing greatly (average is around $800) in recent years. Current faculty development support ($1,200) is not enough to cover costs for travel and registration. In addition, no special student travel fund is for graduate students to attend a conference or a workshop. Sample comments from faculty members include “summer support.”, “high performance computers and mobile devices for research labs and teaching labs. powerful GPU server. latest software systems related to current real applications”, “more travel support.”, “More travel fund, more fund for grad students, sabbatical leave, better support for grant management.”, “Additional travel support for faculty and graduate students.” The average score from faculty surveys is 2.14 for travel support (1: Strongly Disagree, 5: Strongly Agree).

Objective 3: Increase the number of faculty

Rationale: The computer science research is constantly evolving to reflect new computing paradigms and to address new computing challenges such as cyber security and big data. It is critical for the department to recruit new faculty to stay competitive on emerging research topics. Increasing the number of faculty will also strengthen the faculty body for better collaboration among faculty to produce higher quality research results. Department of Computer Science at
George Mason University has a much lower ratio of undergraduate students to faculty (993/39=25.5) (See Appendix 57) than our department at GSU that has (1,227/18=68.2) in 2015.

Objective 4: Obtain more external funding
Rationale: External funding is essential for hiring graduate students and post-docs to carry out research activities. The level of external funding is also a major factor to promote ranking of the department and to attract faculty and students.

Objective 5: Enhance interdisciplinary research in bioinformatics and big data via interdepartmental, national and international collaborations
Rationale: Interdisciplinary research collaborations among different departments (Biology, Chemistry, Physics and Astronomy, etc.), and other national and international universities are important and useful to apply for external grants successfully and make effective progress in research and education in big data, bioinformatics, cybersecurity, and networks, and other complex computing applications.

GOAL 4: EXPAND COMMUNITY OUTREACH
Objective 1: Develop connections with local high schools
Rationale: Targeting High school/middle school students and informing them about the benefits of getting the right computer science education is one of the goals of making Computer Science education available to everyone as promised by president Obamas’ initiative; “computer science for all.”

Objective 2: Develop connections with local industry
Rationale: Establishing connection with local industry is a key to getting to know the needs of local industry and develop collaboration to target certain demands and fulfill them.

GOAL 5: ENRICH INTERNATIONAL INITIATIVES
Objective 1: Expand international research collaborations
Rationale: Expanding new international research programs can be beneficial for increasing our research profile. This also gives our faculty opportunity to compete for targeted international external grants at NSF such as NSF PIRE.

Objective 2: Develop international education programs
Rationale: Developing new international education programs can be beneficial for sending our students out to other countries to learn new knowledge and recruiting more international students to Georgia State. Since many international students pay out state tuitions, GSU can get more income to grow and improve global education.

4.b. A List of Any Identified New Resources, where necessary, that will be required to achieve each goal
To achieve the five goals, the following new resources are needed:
1. Laboratory space for 5 new teaching labs (2,000 square feet for 50 seats each) and 3 new research labs (Bioinformatics Research Lab, Data Science Research Lab, and Cyber Physical Systems Research Lab) (over 1,000 square feet each), and offices for new faculty, staff, and graduate students.
2. One new Information Technology staff to handle the labs and computing infrastructure.
3. Three new NTT Lecturers to teach required and elective classes resulting from enrollment growths.
4. Additional tenure-track positions to teach the new and innovative M.S. programs.
5. Increased funding for Undergraduate Teaching Assistants.
6. Increases in the departmental supplies budget to account for the growth.

4.c. An Implementation Plan for achieving each goal by the next scheduled self-study

GOAL 1: STRENGTHEN UNDERGRADUATE PROGRAM

Objective 1: Obtain 3 new teaching laboratories equipped with modern software and hardware

Implementation Plan: We have been awarded a tech fee for enough computers for two instructional labs. However, we have not been able to secure rooms to house these. We will solicit donations from alumni and industry in the area to help fund equipment for the specialized labs. However, we will still need dedicated space to set up our much needed 3 new teaching labs (2,000 square feet for 50 seats each) with modern software and hardware. One will be the “Programming Lab” for exclusive use by CSc 1301 students (16 break out labs of 90 minutes each and open lab time). The second will be the “Computing Lab” for exclusive use by CSc 1302 and 2720 students (12 break out labs and open lab time). The third will be the “Systems Lab” for exclusive use by CSc 3210 and CSc 3320 students. The Systems Lab will hold break out lab sessions, open lab times and house specialized hardware such as Raspberry Pis, Arduinos and related devices for use by the students in these classes. Resources needed: Dedicated lab space, possibly in the basement of 25 Park Place. A new IT staff person to manage the new labs and computing infrastructure.

Objective 2: Improve undergraduate retention, progression, and graduation rates

Implementation Plan: To solve the unmet demand, it is critical that we hire several more NTT Lecturers over the next 2 to 3 years. This will increase our section offering by 9 each semester or between 400 and 500 seats.

Another means of tacking the RPG problem is to utilize our newly hired undergraduate academic coordinator to closely monitor the degree program of CS majors to pinpoint problematic areas. Possible items to address will be: bottleneck courses preventing graduation, enrollment issues related to those bottleneck courses as well as focusing on designing a pre-major program for students interested in the CS major. The goal with the pre-major program is to assist students (and academic advisors) in determining if they have the appropriate foundation in mathematics to academically succeed in their later coursework. We are currently modeling our pre-major program after peer and aspirational institutions.

We have launched an inaugural program to use high achieving undergraduate students as teaching assistants (UTA program) that is modeled after other peer or aspirational institutions. This program has allowed for the placement of 12 tutors in the Computer Science Tutoring Lab to provide tutoring for our foundational courses such as CSc 1301, CSc 1302, and CSc 2510. We have received amazing feedback from our UTAs on the success of the program and many have expressed an interest in returning in their roles. Securing instructional labs and specialized labs will also help to increase RPG rates. Resources needed: 3 new NTT Lecturers; Increased funds for UTAs.
GOAL 2: STRENGTHEN AND EXPAND GRADUATE PROGRAMS
Objective 1: Establish 2 new graduate teaching labs with modern software and hardware
Implementation Plan: The graduate courses that need access to specialized equipment and computers for experiential learning can be served by the introduction of two instructional labs with seating capacity of 40 each: Internet of Things (IoT) Lab and an Informatics Lab. The IoT lab will house sensors, robots, network switch/router, and desktops/laptops and will cater to the graduate courses that are more systems and hardware oriented including Sensor Networks, Sensor Web Architectures, Internet of Things, Computer Vision, and Computer Networks. The Informatics lab will house workstations that are connected to powerful servers maintained in the server space of the department. These servers will host database systems such as Oracle, MySQL, and NoSQL systems and will also have storage capabilities for big data. This lab will cater to our data analytics courses such as database systems, data mining, big data programming, and machine learning. We shall apply for Student Tech Fee monies to acquire the servers and specialized equipment. Resources needed: 2 dedicated lab space, preferably in the basement of 25 Park Place.

Objective 2: Introduce innovative M.S. programs
Implementation Plan: When enough resources such as faculty and space are identified, we will start to develop more concentrations and convert some existing concentrations to standalone M.S. programs. Resources needed: New faculty lines in emerging areas and dedicated lab space (Cybersecurity labs), preferably in the basement of 25 Park Place.

Objective 3: Improve quality of Ph.D. students
Implementation Plan: Targeted advertising is needed to attract more and better applicants. We also need to keep improving the departmental research profiles by hiring outstanding faculty, securing new research grants, and encouraging more interdisciplinary collaborations in areas such as big data, cybersecurity, bioinformatics, and Internet of Things. Resources needed: More financial support for higher PhD stipends and funds for brochures and advertising support.

GOAL 3: ENHANCE RESEARCH PROGRAMS
Objective 1: Secure 3 departmental research labs and adequate research space
Implementation Plan: We will establish new research space as follows: (i) 7 faculty research rooms that can seat 3-5 students to accommodate the faculty hired in 2016/2017; and (ii) 3 departmental research labs: Bioinformatics Research Lab, Data Science Research Lab, and Cyber Physical Systems Research Lab. Each of the three departmental research labs will be about 1000 square feet, which can host the large sponsored projects and encourage cutting-edge research collaborations. Resources needed: Dedicated faculty research spaces possibly in the basement of 25 Park Place.

Objective 2: Acquire additional financial support for faculty development, graduate students and supplies
Implementation Plan: Our department will raise funds for student travel awards, and seek industry donations. College will give more financial support for supplies. Resources needed: Increases in supply budget to support conference registration fees.

Objective 3: Increase the number of faculty
Implementation Plan: The department will actively participate in the Next Generation Faculty Program proposals within the department and together with other departments to secure new lines of faculty. We will also request lines for new faculty for emerging research topics. Resources needed: none.
Objective 4: Obtain more external funding
Implementation Plan: The department will encourage more collaborations among faculty within the department and between CS and other departments for grant submission. Besides actively submitting grant proposals to federal funding agencies such as NSF, NIH, and DoD, the department will also encourage faculty to secure funding from other sources such as industry and government. Resources needed: none.

Objective 5: Enhance interdisciplinary research in bioinformatics and big data via interdepartmental, national and international collaborations
Implementation Plan: faculty and Ph.D. students constantly seek various opportunities such as external grants (NSF, NIH, industry, etc.), industrial projects, international collaborations, etc. Faculty will apply for internal grants such as DEEP and FITE for international research collaborations. Faculty attend conferences and workshops to seek national and international research collaborations with other experts. Resources needed: none.

GOAL 4: EXPAND COMMUNITY OUTREACH
Objective 1: Develop connections with local high schools
Implementation Plan: Arrange for visits by the students to our department as well as visits by our faculty to schools to inform the students about computer science education. Resources needed: none.

Objective 2: Develop connections with local industry
Implementation Plan: Set up an IAB from major local industry companies. Arrange activities that involve our students. Seek advice from the board members on establishing new programs or certificates. Resources needed: none.

GOAL 5: ENRICH INTERNATIONAL INITIATIVES
Objective 1: Expand international research collaborations
Implementation Plan: The faculty will make more efforts to contact relevant international experts and seek various international collaborations in terms of external grants such as NSF PIRE. The faculty will also engage in joint international research projects and joint international conferences and workshops. Resources needed: none.

Objective 2: Develop international education programs
Implementation Plan: Work with the Office of International Initiatives to contacting interested international universities and create international education programs agreements with them. Resources needed: none.