

Analysis of Undergraduate Curriculum Toward Integration of Computational Science

The practical implementation of a computational science program for undergraduates often requires the addition of new courses as well as changes in existing courses so that disruption to the entire curriculum is minimized and the most efficient use is made of faculty and support personnel. This document provides a guide to structuring an undergraduate curriculum and then analyzing the current course structure at your institution preparatory to discussions with your colleagues on possible paths to implementation.

Competencies

Before we have you look at example programs, take some time to review the competencies assembled by an interdisciplinary group of educators. The competencies are intended to provide a model of the skills and knowledge that students should acquire about various aspects of computational science. There need not be a one-to-one correspondence between the competency groups and courses as some competencies can be embedded in one or more existing courses in your curriculum.

The first set of competencies are for an undergraduate minor in computational science for those that are majoring in a related engineering, science, or mathematics field. They are intended to represent a minimum set of skills that each graduating student should achieve through their coursework. Also note that not every student will meet every competency as the programs we will look at define a set of core courses and some electives that allow students to options depending upon their major and their interest.

The undergraduate competencies are found at:

<http://hpcuniversity.org/educators/undergradCompetencies/>

Take some time to look over at least the major categories in each of the seven areas of competency. Begin to think about your own curriculum and which of these competencies you would like your own students to achieve.

More recent curriculum developments have emerged around the idea of data analytics and data management. Those techniques can be applied to managing and interpreting a wide range of data from large-scale science and engineering datasets to business customer and transaction data to emerging video, sound, social media, and humanities data repositories.

Look at the basic competencies for data analytics:

<http://hpcuniversity.org/educators/basicCompetencies/>

Think about whether you would like your program to contain a portion of these skills as one possible track in your curriculum.

Model Curricula

Before you start to formulate a curriculum for your own institution, it may help to examine some example curricula from other institutions. We have selected several examples from different types of institutions to stimulate ideas about what you might implement. You can review those in the document *ExampleMinors*. We chose one large institution – The Ohio State University – because it has a large number of alternative courses across an array of disciplines. Only very large institutions could offer this many choices but some of the areas may have faculty experts at your institution.

We then chose two liberal arts colleges – Capital University and Wofford College. Capital has an extensive program even though it is a smaller institution but still offers fewer choices than at Ohio State. Wofford has an emphasis in computational science which is smaller in scope than the minor programs.

Finally, we provide one model of a minor in data sciences using the University of Mary Washington as an example. This program is different in scope, emphasizing more computer science database courses, data mining, and related business electives. However, it still overlaps with the computational science program by offering an introduction to modeling and simulation, visualization, and parallel computing courses.

If you still want to investigate the content of other programs, we have created a list of programs with pointers to their requirements. You can find this at (https://www.osc.edu/sites/osc.edu/files/staff_files/sgordon/Programs_final.csv). To use the document, download it and then import it to Excel or another spreadsheet program as a comma separated file.

Devising a Program for Your Institution

Now that you have reviewed both the competencies and several example programs, the rest of your homework involves a first draft of a program for your institution. You have several key questions to address:

- What will the overall scope of your program be? Will the starting point be an “emphasis” with a strong focus, a minor with a broader offering, or a minor with a very wide set of choices? You should make this decision in the context of the available faculty expertise and courses at your institution.
- With the overall scope in mind, you then need to identify the possible courses that will be a part of your program. The courses should be classified into three categories: new courses that will need to be designed and introduced on your campus; existing courses that already substantially address a portion of the competencies; and existing courses that will need significant modification to integrate the computational content associated with the competencies.
- For each of the courses you identify, you should also identify the faculty members that are most likely to be involved in course preparation and instruction.

Fill in the table with your initial program ideas. We will work more on the program at the workshop. If you have questions after the workshop or would like further assistance in working on your curriculum, please feel free to contact Steve Gordon by e-mail at sgordon@osc.edu.

Draft Program in Computational Science

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