

Blueprint for an ASERC

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Abstract

In the dawning era of peta-scale computing—multi-disciplinary research teams, parallel machines with tens or even hundreds of thousands of processors, and large capital investments for software and hardware—what is the rationale for informally-structured, in-house algorithmic science and engineering research centers (ASERCs) at the *opposite* end of the computing spectrum? The foregoing question is considered in this short appendix to a recent commentary article, Nazareth [6].

Computational science and engineering—the mode of investigation whereby challenging, often very large-scale, problems of science and engineering are tackled through computation—is undergirded by computer science and scientific computing, as depicted in Figure 1. We note that the former is closely allied with electrical engineering (EECS) and the latter also embraces engineering and mathematical computing.

Computer science relies, first and foremost, on combinatorial, or discrete, algorithms (see [3]); scientific computing on real-number algorithms that arise, in particular, within numerical analysis and optimization (see [4]). Discrete algorithms, in turn, are premised on the classical Turing model, real-number algorithms on more recent models of computation, see [2], [9]. And the “pillar” depicted in the figure rests, implicitly, on a foundation of computational mathematics (see [8]).

Algorithmic science and engineering (AS&E) encompasses the lower, right-hand parts of Figure 1, as described in detail in [6]. This emerging discipline emphasizes the study of real-number algorithms and associated computational models that underpin scientific computing, although *not* to the exclusion of their left-hand counterparts emphasized in computer science. Note that important problems of scientific computing involve a synergy—a hybridizing of models and algorithms—between the two halves of the figure, as highlighted by the \Leftrightarrow

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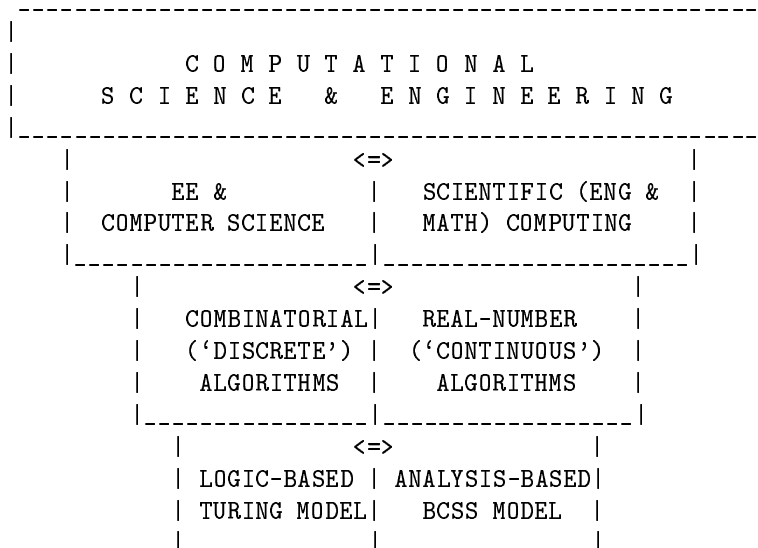


Figure 1: Supporting “Pillar” of Computational S&E

symbol. Figure 1 captures only the extremes. Its primary purpose here is to portray the *vertical hierarchy of support* for computational science & engineering and thereby to motivate the “blueprint” below.

Informally-structured AS&E research centers, organized in-house on a small scale, would be a useful way to encourage *interaction* among algorithm-oriented researchers from diverse areas and facilitate the exploration of algorithmic issues *at a root level*. An ASERC could find a home within any one of a number of existing university departments—mathematics, applied mathematics, mathematical sciences, IE&OR, computer science, EECS—where *integrative* activities along the following lines can be pursued.

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- Provide an *intellectual staging-ground* that brings together algorithm-oriented researchers from optimization and numerical analysis, as well as from other scientific and engineering disciplines where algorithms play a prominent role. An ASERC can also encourage participation of graduate research students and research-oriented undergraduates.
- Organize a *regular seminar*—options are monthly, biweekly, or weekly meetings, as determined by need—where local and outside speakers could create a useful forum for the periodic discussion of research into real-number algorithms and their applications.
- Conduct (occasional, not-for-credit) *courses*, ranging from introductory minicourses aimed at a broad audience to advanced seminar-type courses suitable for graduate research students.
- Provide a *repository of information about root-level experimentation* with real-number algorithms and an environment within which specific case studies could be pursued; for example, see the recent study reported in [5].
- Organize *meetings* akin to the pioneering Pacific-West Algorithmic Science Meeting [7]; see also the proceedings of its antecedent research conference [1].
- Create a local ASERC *website* and distribute a *newsletter* to participants via the internet.
- In cooperation with other ASERCs, spearhead the creation of an AS&E *research journal* to foster the discipline.
- Explore opportunities for raising the *modest level of funding* needed to support the foregoing activities from a governmental agency, a private foundation, or a computer-related company.

The foregoing activities would require only a relatively minor commitment of resources, both physical space and other infrastructure and administrative support, and the organizational effort itself could be kept to a minimum. ASERC computational needs could be satisfied by small-scale, in-house systems already in place (networked PCs, Beowulf clusters), because computer programming activities would be typically along lines described by Trefethen [10]. In contrast, highly-organized, peta-scale computation centers lie at the opposite end of the computing spectrum and serve the high-end needs of Computational S&E, in the uppermost portion of Figure 1. They would derive considerable sustenance from the activities outlined above that informally-organized ASERCs can better pursue.

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