Swedish e-Science Education Mission statement 2019-2020

eScience

Most modern scientific problems are highly complex and often not tractable using traditional analytical methods. These problems are inherently multi-dimensional, multi-scale, nonlinear and data intensive, and therefore, require extensive data analysis and numerical simulations of complex systems.

eScience refers to topics related to data management, data analysis, visualization of high dimensional and large amount of data, high performance computing and numerical simulations of complex natural and artificial systems. Education in these topics has rapidly become essential to understand not only some of the classical unsolved problems but also to address new emerging problems associated with the highly networked and digitalized societies.

The graduate school Swedish e-Science Education (SeSE)

The graduate school Swedish e-Science Education (SeSE) is a swedish initiative to provide e-Science education at the PhD level. SeSE was created by the joint efforts of Swedish e-Science Research Center (**SeRC**) and The e-Science Collaboration (**eSSENCE**): two national e-Science research environments funded by the Swedish government. The SeSE was created with a motivation to form a coherent education program aligned with the research focus of the two e-science research environments and educate the next generation of e-Science researchers.

SeSE offers both core and specialized courses (see below) in e-Science. SeSE courses are open, for free, to anyone registered as a PhD student at a nordic university. SeSE courses can also be offered to employees at companies (private sector) as well as non-academic government bodies, via separate agreements.

SeSe provides funding and necessary infrastructure to develop and deliver the courses. The actual task of grading and evaluating students is upto the teachers and the concerned universities.

Organization

SeSE activities are jointly coordinated by representatives from SeRC and eSSENCE who act as a director and vice director of SeSE. The directors work together with a Steering Committee composed of members from both eSSENCE and SeRC.

The SeSE directors are responsible for:

1. determining the course curriculum and the budget
2. contacting with the course responsible teachers
3. announcing the courses
4. compiling information about e-Science courses provided by Swedish actors
5. identifying the need for courses and initiating development of new courses
6. promoting SeSE courses both in Sweden and within the Nordic countries.

The role of the Steering Committee is to promote the activities within SeSE among the Swedish e-Science research community and to give recommendations to the Executive Group.

Objectives

There are three primary objectives of SeSE:

1. To provide education in fields where the use of **e-Science** is emerging
2. Identify areas where courses within **e-Science** are needed
3. To provide a meeting place for graduate students using **e-Science** tools and techniques

Framework for teaching and learning

SeSE aims to make it as easy as possible for the teachers to offer high quality education at a national level, mostly through the online system, which involves

- Announcement of courses
- Registration of courses
- Course evaluations
- Online learning management system (under investigation)

Course structure

Most of the courses offered by SeSE are worth 3 ECTS points. The standard course format is divided in three parts:

- Part 1 (At the home university of the student): Students do preparatory work or reading before the course
- Part 2 (At the home university of the teacher): Students spend one week at the university campus attending lectures and tutorials
- Part 3 (At the home university of the student): After the formal teaching is over, students work on a project or home assignments, necessary to complete course.

The course is evaluated by the course responsible teachers who are also responsible for submitting the grade to Ladok.

Besides this standard format, SeSE, on specific occasions, can also support international summer schools and workshops provided there are sufficient number of SeRC and eSSENCE student participants. The number of ECTS points for the workshop/summer school are determined by the organizers.

SeSE curriculum

At a coarse level SeSE course can be divided into two classes: core e-Science courses and specialized e-Science courses.

Core e-Science courses:

As the name indicates, the core e-Science courses provide education in topics that are essential for e-Science, irrespective of the specific application of e-Science tools. The topics covered by the core e-Science courses include four categories.

- Scientific computing
- Software tools
- Visualization
- Computational data science

Specialized e-Science courses:

SeSE also offer courses in specialized fields with high e-Science elements. Some of the specialized course offered by SeSE are:

- Climate modeling
- Matrix computations for statistics and applications
- Introduction to high performance computing
- Uncertainty quantification for partial differential equations
- Numerical solution of initial boundary value problems
- Winter school in multiscale modeling
- Topics in computational fluid dynamics
- Potential energy surfaces and dynamics

Course funding

In the standard model, SeSE provides 80K SEK to develop a course. Another 80K SEK are provided for deliveriing the course. That is, new courses receive up to 160K SEK from SeSE while old course receive only 80K SEK.

Course selection

SeSE directors choose the courses based on the discussion and suggestions from the SeSE coordination group. A typical course must fulfill the following criteria:

- The course contents are consistent with the SeSE mandate and provides education in e-Science
- There is a need for the course
- The course may not be offered at a Swedish university as a standard II/III cycle course
- The course should attract 10 or more students

Usually SeSE directors approach possible course gives in an ad hoc basis. However, since 2019 SeSE has also decided to make open calls for courses from SeRC and eSSENCE Universities to expand the spectrum of courses offered with in SeSE.

Strategy to develop of future course curriculum

Over the years a number of e-Science courses have become available as II/III cycle courses at various universities. In particular, some of the core e-Science courses are offered routinely at universities. Moreover, students and faculty members have expressed desires for courses in new emerging domains of e-Science such as brain science, astrophysics, etc. Therefore, in future such course may not be offered by SeSE and we need to expand the spectrum of courses to include new emerging application domain of e-Science. SeSE has taken following steps:

1. SeSE now makes open call for course in specific domain e.g. machine learning, neuronal networks, biological image analysis
2. SeRC research is structured in five different (but complementary) multidisciplinary collaborative projects (MCPs). It has been proposed that each of these will offer at least one course
3. Similar efforts will be made to align the SeSE courses with research within in eSSENCE
4. SeSE has also started to collect information on II/III cycle e-Science course to better organize its own curriculum
5. SeSE also plans to collaborate with e-science education within other large-scale research collaboration networks e.g. WASP

Thus, over the next few semesters we will observe a revamping of SeSE course curriculum.

Financing

SeSE is co-funded by SeRC and eSSENCE. The details of how funding has been provided and used have varied over the years. Since 2018 funding is being used for the following activities:

1. Financing of course development and delivery of 6-10 e-Science courses every year
    a. SeRC finances advanced course delivered by teachers from SeRC affiliated universities. The decision to fund is taken on course-by-course basis
    b. eSSENCE provides a fixed amount of money every year and the course selection is left to the discretion of the SeSE directors. All the core courses are funded from eSSENCE funds
2. Every year upto 60K SEK are used to provide travel grants to students to facilitate their participation
3. Partial financing of the position of SeSE Director Dr. Pavlin Mitev (by eSSENCE)
4. Partial financing of the position of SeSE Vice Director Dr. Arvind Kumar (by SeRC)
5. SeRC finances courses indirectly by requiring that SeRC-communities which have received direct financing also offer courses. These courses should generally be provided through SeSE