

Evaluation Report
Master in Computational Science
University of Oslo

1 Generalities

- Website of the master program:
<https://www.uio.no/english/studies/programmes/computational-science-master/>
- The process of establishing this master program started in 2015, involving 7 out of 8 departments. Announcements and structure with web pages started in 2017, but information online might be outdated.
- What should be evaluated:
 1. Adequacy of admission requirements
 2. Is the program structure good/interesting? Does it serve its purpose?
 3. How each specialization is administrated by the different departments? How is the workload distributed?
 4. Multidisciplinary and scope?
 5. Associated costs to students/staff?
 6. How are the job opportunities for the students approaching the end of their studies or just after it?
- The evaluation committee is composed by:
 - Celine Marie Solberg, master student in "Elektronikk, informatikk og teknologi, retningen Signalbehandling og avbildning" (<https://www.linkedin.com/in/celine-marie-solberg-23523a167/>).
 - Sebastian Winther-Larsen, Data Scientist at Menon Economics (<https://www.menon.no/staff/sebastian-gregorius-winther-larsen/?lang=en>).
 - Pedro Lind (leader), professor at OsloMet (<https://www.oslomet.no/en/about/employee-pedrolin/>).

Note: Till 2024.05.15, the committee included Lillian Smestad, data scientist at Inmeta (<https://www.linkedin.com/in/lillian-smestad/?originalSubdomain=no>), and previous master student and PhD candidate at UiO. Due to personal (external) reasons, Lillian Smestad had to decline continuing in the committee and was substituted by Sebastian Winther-Larsen.

Programme options

CS: Applied Mathematics and Risk Analysis →	CS: Astrophysics →	CS: Bioinformatics →
CS: Bioscience →	CS: Chemistry →	CS: Geoscience →
CS: Imaging and Biomedical Computing →	CS: Materials Science →	CS: Mechanics →
CS: Physics →		

Figure 1: Specializations of the Master Program in Computational Science at UiO (2024). Information available at https://www.studiebarometeret.no/no/student/studieprogram/1110_mnm2-cs/.

- The evaluation report was based in the following:
 - Documentation provided by the head of the program (Morten Hjorth-Jensen) and the administrative coordinator (Espen Murtnes).
 - One meeting with the head of the program and the administrative coordinator.
 - One online meeting with students finishing the master in 2024.
 - Correspondence through email exchange.

2 Main feedback

2.1 Documentation and feedback from staff

The Master Program in Computational Science (CS) is an interdisciplinary master's program with now 10 specializations (cf. Figure 1). The program comprises four semesters, including a thesis, and it is shared among seven departments, namely Mathematics, Astrophysics, Informatics, Bio-sciences, Chemistry, Geosciences, and Physics. Each specialization is administrated by one of such departments, and the Department of Physics has the overall coordination of the program. The program started to be planned in 2015 and has been active since 2018. Typically, 30 to 40 students enroll each year. The number of students in each specialization varies broadly. As of October 2023, 104 students had completed the program. Minimum requirements to enroll: maths (linear algebra) and computer science (coding).

The program consists of a master's thesis of 60 credits and of subjects (total of 60 credits) mainly chosen by the students themselves, in collaboration with the supervisor, under the constraint of

(mandatory) selecting two of the following subjects: *Applied data analysis and machine learning* (FYS-STK4155), *Introduction to numerical analysis* (MAT4110) and *High-Performance Computing and Numerical Projects* (IN4200). The specialization in Mechanics also offers a short-thesis possibility, composed of 30 credits for the thesis and then 90 credits in other courses. According to the coordinator and the staff, the purpose of this program is to "meet the future," aiming at transferring nowadays' computer and scientific skills in computational sciences, intersecting the different areas of science. Focus is given to natural sciences.

The students apply for a field of study, which have different admission requirements and different number of vacancies. The program is aimed at students with a solid mathematical background who can program and who want to work with numerical methods. The admission requirements for the courses belonging to the Department of Mathematics and the Department of Informatics differ from the admission requirements for the other courses. These two specializations require applicants to have some subjects specific subjects covered (or equivalent). The other six specializations have more flexible admission requirements, which can be met by most people who have taken mathematics-heavy science subjects such as physics, chemistry, mathematics, or engineering courses at other educational institutions.

Almost half of the students on the program are co-supervised by researchers and experts from other institutions, namely SIMULA, Sintef, Meteorological Institute, IFE, and FFI. Moreover, the teachers involved in the program are researchers with collaborations worldwide, including universities in Canada and in the USA, in Asia and in Europe as well as leading National Laboratories in the USA. These networking opportunities are transferred into exchange possibilities for the students. Namely, visits and internships at other institutions are planned, with a recommendation from the administration and coordination of the program to have them after the first semester. In particular, in the period 2018-2024, three students have stayed at UNIS in Svalbard, two in the USA, one in Poland, and one in the Netherlands. Three students from outside the EU/EEA have been admitted to the program in this period, from Brazil, Iran and the United States. There has been no separate internationalization initiative under the auspices of the program.

According to the official statistics, since 2018, two thirds or more seem to complete the degree, and half of these in the normal time. The "Studiebarometeret" evaluation, with a ranking from 1 (worst) to 5 (best), has always been above 4, with the exception of the Corona period. Moreover, the typical average evaluation of the students in this program stays above the overall average in Norway (cf. Figure 2). However, some of the questions in the "Studiebarometeret" related to working life possibilities are very negatively evaluated, probably addressing aspects related to a lack of connection between academic studies (in the program) and the business world during the studies within the program.

A few changes in the program and curriculum are planned. Specifically, it has been decided to change the current specialization, "Materials Science" to a specialization called "Quantum Information Science and Technologies". The new specialization will be run by the Department of Physics.

2.2 What should be kept

In the enumeration, "S" means Students, "T" means Teacher, and "O" means Other.

S Very free to choose subjects/thesis. Students can really build their profile and portfolio of

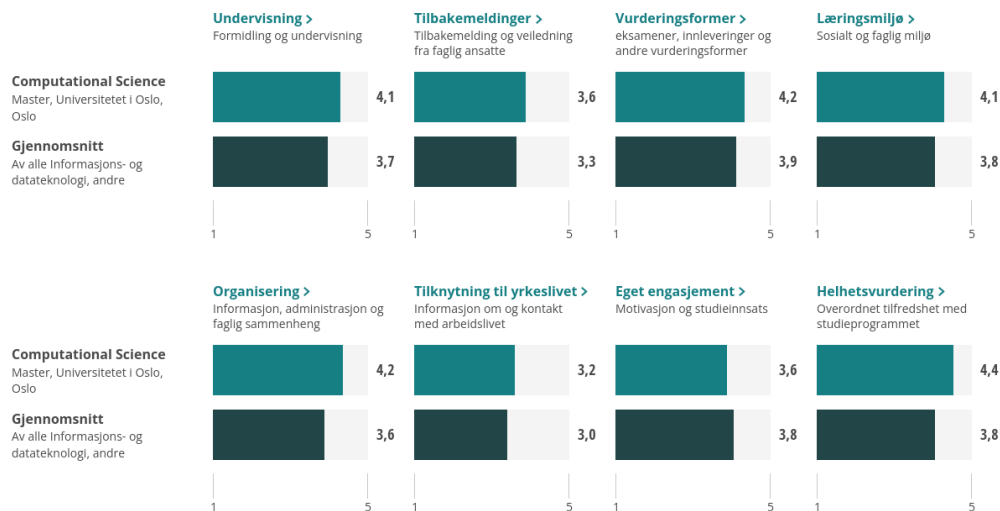


Figure 2: Evaluation of the CS Master Program at UiO in comparison with the average of all similar programs in Norway ("Studiebarometeret"). Information available at https://www.studiebarometeret.no/no/student/studieprogram/1110_mmm2-cs/.

expertise.

- S The interdisciplinary character of the program is very good (at least in CS-Physics, with less information from other specializations), particularly because of the "project-based course".
- S There are some mandatory courses for all specializations, which enables opportunities to bring all students (all specializations) together.
- S For Maths and Physics, there is a good balance between mandatory courses and freedom of choice (of other courses).
- S The ordering of the courses composing the curriculum seems to be ok.
- S The presentation of the coordinator (Morten?) at the beginning of the master's is very helpful in understanding the connections between the different courses.
- T Students with A/B get offers one year ahead of completion.

2.3 What should change

In the enumeration "+" means it should be "done more", "-" means it should be "done less".

- + While the inclusion of international students is good within the student community of this program, the students seem to feel a lack of internalization, i.e., more international students.

- + The gender balance is very bad both among students as well as among teachers. More females would contribute to a better gender balance.
- Before starting the master's, when applying for admission, applicants do not have a clear enough idea of what courses are mandatory and what profile/skills they should have.
- + Some courses should state in a clearer way the background needed for the course. Namely, "QM", "Advanced ML". This sometimes makes the audience (students who selected the course) too broad in their profiles, which also harms the group work needed in some of these courses.
- + There should be more updates on the web pages, particularly in the English version, which seems to have a significant lack of content compared with the Norwegian version.
- + There seems to be a lack of information about the space where the students can gather and work.
- + More "neutral" spaces that students from different specializations can use together. There are some spaces but within specific departments, running specific specializations of this master program.
- + More events for all CS students could be organized. Note that some specializations are just a few students. There was a meeting at the beginning of the semester, organized by Morten Hjorth-Jensen (head of the master program), but this seems to have stopped. E.g., in 2023-2024, students reported that there was no meeting with companies. There are also some monthly or bimonthly meetings, but they end up being only gatherings of students and alumni. Those events could be more topic-based and organized e.g. biweekly. To note that, till now, gatherings seem to be mostly arranged by students volunteering to arrange them. Moreover, such events are very important for the students to know what exists outside of academia and getting a job.
- + Students also report a lack of information about the topics in each course and the contact persons responsible for specific tasks and/or entities (in research). For example, there is an important center recently established at UiO (Integrate); there could be better coordination between the Program Coordination and Administration and other academics/researchers at UiO to advertise seminars, events, and meetings which could be of interest to the students enrolled in the master program.
- + There seems to be a lack of information enabling distinguishing between programs. According to students, this could be a "side-effect" for enabling more freedom in choosing courses. However, more information about the different programs/specialization seems to be a need, since the committee noted a very broad freedom in planning and selecting the courses. As an example: it is possible, theoretically, to finish the master degree in the specialization of Physics with no course in Physics.

2.4 Further suggestions

From the documentation and meetings with students and staff, the committee also points out the following suggestions which, independently of the overall evaluation (next section), can contribute to further improvement or solve specific shortcomings:

- The project-based course in CS-Physics seems to boost interdisciplinarity in the formation of the students in this program. Perhaps the course could be extended to other specializations?
- There is no student association within the program, and it seems students miss that. Implementing a student association seems to be feasible, and it could contribute to boosting engagement and interaction among students. Student associations can get subsidies for both academic and social purposes from various organizations (see <https://www.sio.no/foreninger/stotteordninger>).
- Some specific courses seem to have points for improvement from the perspective of the students. While there are procedures for evaluating each course individually, in the end of each semester, such evaluation is a responsibility of each department separately. There is no standardization (coordination) of such evaluation within the umbrella of the master program across the different departments. In particular, HPC seems to have lack of assistance and midterms are perhaps too important for the final assignment; MET/MEK (numerical methods for PDE) was discontinued but is now revised.
- To improve the information to students concerning events, spaces to meet, etc, perhaps a Mattermost platform or similar could be a solution.
- Some more meetings/events could facilitate and promote interaction between and engagement from the students' community. Similarly, a "Buddy-week" could also be something that helps the information to and between students. These meeting could also involve alumni students - particularly already enrolled in the job market and/or academic career.
- Some of the websites are outdated. Students, staff, and others (e.g., external supervision) could profit from updated websites about the program.
- More connection between academic studies (in the program) and the business world during the studies within the program. Perhaps through workshops or open-door days to gather students and industry/business stakeholders together.
- AS it stands the programs enables to finish the master degree in, e.g., physics specialization with very little background in physics courses. It is understandable that being a master in Computational Science, that specific background in the specialization is not necessary. Still, it should be properly advertised to candidates to the program, that the choice of one specific specialization does not mean a deep formation in that field (physics, bioinformatics, mechanics, etc).

3 Overview and conclusions

- The success rate of the program is good, with approximately 50% finishing within the planned time (4 semesters) and 30%-40% other finishing with 1 or 2 extra semesters.
- Students are overall very impressed and satisfied with the formation they get in the program. Some remarks for improvement can be pointed out (see above).
- The structure of the program seems to promote broad freedom to the students in what concerns building up their curriculum. Even within the three mandatory courses (see above), two of them are project-based (FYS-STK4155 and IN4200).
- Internationalization is a major strength of this program. The teachers and researchers involved are very well connected with research hubs worldwide. The students seem to be very much aware of it and appreciate the strength of the program.
- Many involved institutes with shared responsibility: The program has ten areas spread over seven institutes, and each institute administers its own directions. This means that it is difficult for the students to get a sense of belonging to the program. They tend to maintain a feeling of belonging to the sublevel department. Moreover, the sharing of responsibility can sometimes promote a lack of understanding about "who does what" / "who is responsible for what." This has led to students sometimes to a lack of information or getting the wrong information. Perhaps this might not be true for all specializations, and therefore, it would be recommendable to inspect (i) to what extent this lack of "program identity" is happening within the students and (ii) to which specializations it applies. The same applies to the program coordinator. A possible solution would be to collect online questionnaires from students and staff at three different levels: individual courses, each specialization/department, and the overall program. At each level, one could collect feedback about (i) what should be kept, (ii) what should be done more, and (iii) what should be done less. After collecting the results, the program teachers, student representatives, and coordinator could meet and discuss possible points to change.
- The inclusion of a new specialization in "Quantum Information Technology" (QIT) seems to be very timely. Picking the appropriate courses and thesis topic in Physics or Materials Science specialisation would be a *de facto* QIT specialisation. Due to the fast pace of change in the fields crossing new AI topics of research, a general recommendation in keeping frequent revisions of course syllabus might maintain the high interest of students as well as their good opportunities in the job market. Contents intersecting topics such as LLMs, Big Data, and Unconventional Computing could perhaps be further addressed by the teachers.

All in all, approaching the main points to be evaluated:

1. Adequacy of admission requirements

Answer: It is very difficult to match prerequisite knowledge with what the students will end up doing for their MSc. Generally I find that the admissions are done appropriately. Maybe add more information: update webpages, specific course content/requirement etc. as already mentioned.

2. Is the program structure good/interesting? Does it serve its purpose?

Answer: In general, yes. The program structure seems to be well adapted to the universe of students attending the program, who also show a general interest in it. Enabling a strong interdisciplinary across different fields (covered by the different departments), it also serves its main purpose, namely to "meet the future" (see above), and to transfer nowadays' computer and scientific skills in computational sciences to the next generation of computer scientists.

3. How each specialization is administrated by the different departments? How is the work load distributed?

Answer: Each specialization is administrated by one of the involved departments, and mainly separately from the other departments, i.e. following the internal rules and procedures establish by each department (e.g. the evaluation processes of the courses).

Since the overall coordination of the program belongs to the physics department, the workload seems to be more concentrated in that department as well. Since, one main focus of the master program and one of the main reasons for involving several departments is the interdisciplinarity of computer science as a field, it would be beneficial to have a more coordinated work load and procedures across the departments.

4. Multidisciplinary and scope?

Answer: From the scientific and academic point of view, the multidisciplinary structure is well established. However, the course recommendations should be better highlighted to avoid a course selection which can lead to a lack of focus in the specialization one students selects. From the administrative point of view, there are some procedures - e.g. evaluation of the courses - which could be better coordinated across the departments, to better evaluate the multidisciplinary character of this master program.

5. Associated costs to students/staff?

Answer: The student's fee seems to have increased considerably for students outside the EU (~ 270 kNOK); although this is an aspect beyond the decision power of the program administration and coordination, it should be noticed that it is harming the competitiveness of this Norwegian program in the long run in comparison with other international programs worldwide.

6. How are the job opportunities for the students approaching the end of their studies or just after it?

Answer: Close to 50% of the students get job offers before the last months of their studies in this program, which is a very high rate of success in the job market. In the future, we recommend to advertise this quantitative measures.