Göteborg 2005-11-14

To

Chalmers University of Technology

This Document is to be completed in some details, and then sent in also to Faculty of Science at Göteborg University

Bioinformatics and Systems Biology – Masters Programme proposal

The discussions about the future of the current International Master's Programme in Bioinformatics from 2007 and onwards have resulted in a proposal from GRUL at Chalmers that we should try to join forces with the recently started programme in Systems Biology at GU.

After a relative short time of discussions with Stefan Hohmann responsible for the latter programme and Jöran Berg from the faculty board, we have the following suggestion.

From autumn 2007 we wish to admit 50-60 students to a joint Chalmers-GU Programme with the name "Bioinformatics and Systems Biology". The programme should be fully integrated with the students admitted in a single application procedure in which:

1. All students with a GU-background will stay at GU and get their degree at GU and similar for Chalmers students. In general, all admitted students will be placed at GU or Chalmers according to their study background and the degree title will be as Master of Engineering (Chalmers) and Master of Science (GU).

2. The bioinformatics and systems biology profiles will be shaped by strong recommendations of key bioinformatics and systems biology courses, respectively. Both the directions aim for a mix of students from different backgrounds in the core courses, and allow for theoretical specialisation as well as measurement technique directed, and more applied biological specialisations. Students' opportunities to follow courses in the other profile are facilitated by the flexible project timing and size in year 2.

3. The first semester and part of the second semester will contain a mix of background specific obligatory courses (alternative obligatory), giving both crossover training in molecular biology, wet lab techniques and computational sciences, as well as introductory knowledge in bioinformatics and mathematical and computational modelling. This will help the students in their future work and in their individual curriculum decisions. At Chalmers, students from Kb, IT, D and other programmes fit very well into this design. On the GU side molecular biology, computational, biochemical and statistical backgrounds fit very well.

4. We wish to adopt the Chalmers model in the first quarters with two parallel courses of 5 cu in order to get needed flexibility.

5. We choose to make the Master's Thesis part flexible in length between 20 and 30 cu. The length will be decided before project start, at the latest in the second quarter of the second year. Moreover, the actual proportion of the project work in different quarters in the last year will be flexible.

Background

The genomic revolution in life sciences has lead to a dramatic change in the way molecular life scientist's work. As a consequence, the labor market, especially in research (academic and industrial) for cross-discipline well trained scientists in bioinformatics, computational biology and systems biology have developed fast in the last decade. Chalmers at its start of its bioinitiative in 1999/2000 initiated a research programme in bioinformatics in close collaboration with GU and in connection to this also an international master's programme in bioinformatics (see original application for this programme from Mathematical Sciences 16 May 2005 for more details). This programme has been a great success, as we can clearly see from our ongoing survey among the around 90 students studying in the programmes starting 2000-2003. The main key to this success has been our unconventional mixing of students with different scientific backgrounds, and the course designs with a mix of practical and theoretical aspects of virtually all the topics under study. Another profile has been the academic research orientation in many of the master's projects so far.

The experience of this programme and discussion with our research and master's programme partners at GU lead to the start of a related programme on the university side in systems biology, where focus will be more on genomic experimental techniques, and mathematical, computational and statistical modeling of cellular processes and biological systems on a detailed level. The programme has started this year with a quite small group of dedicated students, and is expected to grow next year. Systems biology is currently an exploding research area where the international competition on the research side is quite tough, but not so much master's level education is offered in Europe (and in fact not even in US).

We strongly believe that the possibility to repeat the success with the bioinformatics programme is greater if we join forces and carefully construct two twinned organizationally joint programme profiles as a joint GU-Chalmers project, to be named <u>Bioinformatics and Systems Biology.</u>

Recruitment and labor market

See the application document from Mathematical Sciences 16 May 2005 for recruitment statistics. As stated in this document we strive for changing from historical and current domination of third world students to a larger fraction of local, Swedish, Nordic and other EU-students. This profile change is planned in the light of explicit plans from central university agencies to introduce student fees for the former category. However we expect that the labor market will continue to be essentially international, and it would be a great mistake to focus our planning taking only Göteborg region, and even only Sweden into account.

Aim of the programme

We will foster modern applied and theoretical molecular and genomic bio-scientists that will be the next generation of researchers and bio-technicians in academic and bio-industrial laboratories, and we will profile theoretical scientists in the direction of computational modeling and analysis in genomic data. In doing so we wish to help the biologists and medical researchers to make the structural changes necessary for the future of Swedish and European life science health care, pharma industry etc.

Goal with the programme

The key for research focused master's programmes are extremely well motivated and talented students. In the two fields of the programme many such students will probably have to internationally recruited, and we will under all circumstances adapt the student number in the programme so that quality is kept high!

Both in bioinformatics/bioscience research our bioinformatics students so far have been extremely successful competitors for PhD studies (well over 50% so far have continued with graduate studies all over Europe). We wish to continue to train with an advanced research career in focus.

Students should be allowed and even encouraged to profile themselves within the two directions to become or less theoretical, and they should be encouraged to strengthen their original skills.

We also wish to teach the students that hard work is essential.

We wish to continue the collaboration with applied biomedical research, locally and elsewhere, by promoting applied biomedical problem oriented master's projects of high relevance and high quality, on an individually designed level.

Comparisons with other schools

The number of programmes in bioinformatics is growing both nationally and internationally, and we have a very competitive programme and record in this area. In contrast, there are relatively few programmes in systems biology on this level. It is our ambition to be at the forefront of Master education in this area.

Economy

We do not have any detailed suggestions at this moment for the collaboration on the economic level between GU and Chalmers. But we have been thinking a lot about the size. We think that it is realistic to recruit 50-60 students in total already from start 2007. This will be achieved by a joint engagement between two existing programmes already in the current recruitment of students starting 2006 and a carefully planned campaign next autumn. We plan to engage one of our recent PhD's to help us (Olle Nerman and Stefan Hohmann) with practicalities of doing this..

Tentative curriculum

Due to heavy duties in his international engagement, Stefan Hohmann has not yet got the opportunity to discuss details of the system biology oriented courses in the curriculum presented below, and we wish to get back in short with a more precise study plan.

It is non-trivial to get all courses in and get a natural order, especially we feel that the programme has too little computer science in the first year at the moment, and this is likely to change in the final study plan version. Observe also that courses marked BINF and SYS are thought to be essential for the two directions.

First year

Quarter 1
Obligatory: Introduction to Bioinformatics and Systems Biology, 5 cu.
Obligatory: Introduction to Programming, 5 cu, or Basics in Biology, 5 cu. Biotechnology and biology students read the first, while D and IT students read the latter.

Quarter 2
Obligatory: Mathematical Modelling and Computational Tools, 5 cu. Both course and examination take care of the various backgrounds of the students appropriately. Contains a project work of 2 cu to be done in group.
Obligatory: A technique-oriented biology-course, 5 cu. Obligatory for all but Kb students that may read a course from third semester instead?

Quarter 3
Obligatory: Statistical Inference Theory and Experimental Planning, 5 cu.
Sequence Bioinformatics, 5 cu. BINF
Systems Biology I, 5 cu. SYS (to be detailed)

Quarter 4
Obligatory: Large Scale genomics techniques, their analysis and experimental modelling, 5 cu.
Structural Bioinformatics, 5 cu. BINF
Metabolomics, 5 cu? SYS

Second year

All courses in the second year are elective. Most courses are expected to exist also on other programmes. Project work of flexible length, 20-30 cu.

Quarter 1
Population Genetics, 5 cu.
Statistical Genetics, 5 cu.
Systems Biology II, 5 -10 cu.(to be detailed)
Molecular Biology, 10 cu.
Biochemistry 2, 10 cu.
Algorithms 5 cu

Start of Project work, 0-10 cu.

Quarter 2
Databases, 5 cu
Systems Biology III, 5 -10 cu (to be detailed)
Drug development, 5 cu.
Molecular microbiology, 10 cu.
Genetics, 10 cu.

Project work 5-10 cu.

Quarter 3
Statistical Imaging, 5 cu.
Machine Learning, 5 cu.
Immunology, 10 cu.
Sequence Bioinformatics, 5 cu (from year 1 quarter 3)
Systems Biology I (from year 1 quarter 3)

Project work, 5-10 cu.

Quarter 4
Structure Bioinformatics, 5 cu. (from year 1, quarter 4)
Metabolomics, 5 cu? (from year 1, quarter 4)
Databases, 5 cu.
Advanced course in mathematical modelling, 5 cu.
Proteomics, 5 cu.?
Algorithms 5 cu

Project work 0-10 cu.

Göteborg 2005-11-14

För Matematiska Vetenskaper

Bo Johansson   Olle nerman