



STUDIJŲ KOKYBĖS VERTINIMO CENTRAS

VILNIAUS UNIVERSITETO
BIOINFORMATIKOS STUDIJŲ PROGRAMOS
(612I52001)
VERTINIMO IŠVADOS

EVALUATION REPORT
OF *BIOINFORMATICS* (612I52001)
STUDY PROGRAMME
at VILNIUS UNIVERSITY

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Išvados parengtos anglų kalba
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2013

DUOMENYS APIE ĮVERTINTĄ PROGRAMĄ

Studijų programos pavadinimas	<i>Bioinformatika</i>
Valstybinis kodas	612I52001
Studijų sritis	Fizinių mokslų studijų sritis
Studijų kryptis	Sveikatos informatika
Studijų programos rūšis	Universitetinės studijos
Studijų pakopa	Pirmoji
Studijų forma (trukmė metais)	Nuolatinė (4 m.)
Studijų programos apimtis kreditais	240 ECTS
Suteikiamas laipsnis ir (ar) profesinė kvalifikacija	Bioinformatikos bakalauras
Studijų programos įregistravimo data	Lietuvos Respublikos švietimo ir mokslo ministro 2005 m. birželio 3 d. įsakymu.

INFORMATION ON EVALUATED STUDY PROGRAMME

Title of the study programme	<i>Bioinformatics</i>
State code	612I52001
Study area	Physical Sciences
Study field	Health Informatics
Kind of the study programme	University Studies
Study cycle	First
Study mode (length in years)	Full-time (4 years)
Volume of the study programme in credits	240 ECTS
Degree and (or) professional qualifications awarded	Bachelor of Bioinformatics
Date of registration of the study programme	3 of May 2005, under the order of the Minister of the Ministry of Education and Science of the Republic of Lithuania

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The Centre for Quality Assessment in Higher Education

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I. INTRODUCTION

The subject of this evaluation is the undergraduate (Bachelor) programme in Bioinformatics taught by the lecturers of the following departments of the Faculty of Mathematics and Informatics: Computer Science, Software Engineering, Mathematical Computer Science, Mathematical Analysis, as well as by the lectures of Faculty of Natural Sciences and scientists from the Institute of Biotechnology and Institute of Applied Sciences. The students obtain the right to enter the Master programmes in the field of Informatics at the Faculty of Mathematics and Informatics.

The programme is for a full time study of 4 years with 240 credit points. The degree awarded is “*Bachelor of Bioinformatics*”. The curriculum covers mathematical and algorithmic subjects, fundamental knowledge in biology and life science and specific topics in bioinformatics. The Vilnius University prepared the Self Evaluation Report (SER). The programme was evaluated by an Review Panel formed by: Prof. Jukka Paakki (head of the team), Prof. Rolf Backofen, Prof. Jerzy Marcinkowski, Vida Juozapavičienė (social partner) and Lukas Jokūbas Jakubauskas (student member).

II. PROGRAMME ANALYSIS

1. Programme aims and learning outcomes

The programme aims and learning outcomes are well defined. It aims at training highly qualified specialists who are able to do Bioinformatics work in the life science area. The students should also acquire enough skills and knowledge in computers science to be able to work in IT-related jobs.

The information on the programme is publicly available on the following web site: <http://mif.vu.lt/lt2/struktura/matinf>.

The programme aims are clearly based on academic and professional requirements. Besides, good training in biology and computer science, one important point is to be able to perform interdisciplinary work. This is required by the labor market and clearly achieved by the programme. This is also shown by the fact that graduates from the programme work in both computer sciences related environments as well as in life science laboratories. The programme aims and learning outcomes are consistent with a bachelor level in Bioinformatics. The name is clearly appropriate according to the curriculum and the subjects taught. The social partners also expressed that the programme meets the labor market needs, and this is also acknowledged by the Ministry of Health. As the Review Panel has been informed, this is the only programme in bioinformatics in Lithuania. Since it is not a large programme (14 students were admitted in 2013), the Review Panel expects that all graduates will be needed by academia or by the labor market. The number of students applying has been dropping over the years (from 310 in 2005 to 81 in 2012 (SER, table 8)).

Providing a clear roadmap for a future career (i.e., having a suitable Masters programme) would definitely help to attract more students to the programme. The number of study places (state funded) has also been adapted to 30 to compensate for overestimation of employment in bioinformatics (SER page 25, par. 115).

2. Curriculum design

The curriculum design meets the legal requirements since the scope of the entire programme is 240 credits, 30 credits per term and 60 credits per study year. The workload in hours in the programme is 800 per semester, in accordance with the legal requirements. The amount of contact time is 37.11% and thus above fraction of 35% contact time as required by the Vilnius study programme regulations, albeit exceeding it only marginally. Also, the core Bioinformatics programme has 165 credits and thus exactly meets the requirements of Vilnius study programme regulation. For an interdisciplinary programme this is suitable. For the bachelor thesis 12 credit points are allocated, which fits again with the Vilnius university regulation (at least 12 credit points).

There is a good balance between the disciplines; the students do get a good education at bachelor level in computer science and also in natural sciences, especially if those students study also the minor in genetics or molecular biology. The study subjects are spread evenly and their themes are not repetitive. The students also report that there are many different subjects to learn, which also indicates that there is not much repetition.

The subjects and contents are appropriate for a Bachelor degree in Bioinformatics. The students study basic life science topics like *general biology*, *biochemistry* and *molecular biology*, as well as many courses from a bachelors programme in computer science. The later is also verified by the observation that students can easily continue with a Master programme in computer science.

The contents of the modules fit to a bachelors programme in bioinformatics. For such a programme, it is also important to have specialized courses in Bioinformatics, since interdisciplinarity is only taught directly in such specialized courses. The programme contains 4 courses in Bioinformatics, and the topics taught are suitable to ensure the learning outcomes. Concerning teaching methods used in the bioinformatics courses, students reported that practical work (i.e., working with real bioinformatics data) is somewhat underrepresented. This can also partially be seen in the list of learning goals (Self Evaluation Report (hereafter SER), Table 1). The syllabus of the Bioinformatics courses has already been adapted in the past as a reaction to the participation in the EU-funded BIOTEFA-A project (*„Improvement of the education of highly qualified professionals*

for biotechnology and biopharmacy sector“). The Review Panel recommends to continue with this process and to include more practical work in the Bioinformatics courses.

Since the start of the programme 6 years ago, several changes in the curriculum have been made. For example, from the Faculty of Natural Sciences a course on ecological systems has been replaced by systems biology, taught by a teacher graduated from the Bioinformatics programme. For the Faculty of Mathematics and Informatics, also changes and adaptations have been made to individual courses. Furthermore, the Review Panel got the impression that the study programme has been changed on recommendation. For example, students report that *biochemistry* should be taught later and *physical chemistry* earlier, since some of the requirements of *biochemistry* are given in *physical chemistry*. In the study plan presented to the panel, *physical chemistry* is now taught in the first semester, and *biochemistry* in the second. As another example, there have been reports that Linear Algebra and Geometry, albeit useful, might be taught a bit too early. The students also report that studying the 7 subjects with a broad coverage is quite labor intensive.

The Review Panel assessed also bachelor theses; the subject titles provided in English are appropriate for a Bachelor degree in bioinformatics. A positive aspect found by the panel was that there have been several examples of cooperation between the two faculties in a bachelor thesis.

The content of the programme does reflect current achievements in the field of bioinformatics, especially in the specialized bioinformatics courses. This includes topics like sequence alignment, current databases like PDB, or hidden markov model. Furthermore, recently a course in systems biology was added, which represents latest trends in bioinformatics. The subjects in computer science as well as in natural science are as one would expect in a modern bioinformatics programme, albeit a bit more mathematical than in a typical programme.

In addition, one member of the study programme committee is a researcher of the Institute of Biotechnology. He is actively using bioinformatics for his own research in protein three-dimensional structure analysis. The Review Panel got the impression that he influences the study programme positively. He also gives an up-to-date course in bioinformatics. This arrangement ensures that latest achievements in the field are taught in the programme.

3. Staff

The list of staff for the programme meets the legal requirements, and the number of staff is more than adequate for a Bioinformatics programme. The list of teaching staff (SER, Annex-2) contains 35 persons. From this, only five persons are lecturers that do not have a PhD degree. This meets the legal requirements that no less than half of study field subjects must be taught by scientists.

It can be positively remarked that three teachers of the Bioinformatics study programme have been elected as the best teachers of the Faculty of Mathematics and Informatics in the recent years. The competence of the mathematical computer science staff seems to fit to the programme, albeit it would be appreciated if more staff actually did research in bioinformatics.

Concerning teaching staff turnover, there has been constant adaptations of the programme, which has involved additional teachers. In the last 3 years, the teachers of 10 lectures had changed. Furthermore, there are very active researchers involved in the programme. Examples are Edita Sužiedielienė (Faculty of Natural Sciences) and Saulius Gražulis (Institute of Biotechnology), who is also member of the study programme committee. There are also graduates that participate in a Ph.D. programme and have been involved in teaching. As we have noticed during the visit, these graduates are working on current research topics, which also influence the subjects they teach. Thus, the staff turnover does ensure the quality of the programme.

The faculty has provided several opportunities for the professional development of the teaching staff especially with respect to bioinformatics. As an example, lecturer I. Grinis has attended an international bioinformatics workshop, and several lectures from the Faculty of Natural Sciences have attended several workshops or used Erasmus studies (SER, par. 90) to improve their qualifications.

Professors have the minimal teaching load of 90 contact hours per year. These positions are given to teachers with a research profile. Other teachers have much more teaching duties, and as much as up to 20 hours of actual lecturing per week have been reported. Teachers can be promoted to associate or full professorship if they satisfy the quality requirements. There is a competition to fill these positions. There are different requirements for first time promotion, and for a position to be extended. Furthermore, the number of positions to be filled is not fixed. A professor must have 5 papers (ISI Web of Science) in the last 5 years to extend his position, and 8 papers in 10 years for filling a professorship for the first time. These are the minimal requirements as given by governmental regulations.

The programme involves active researchers from both the Faculty of Natural Sciences as well as the Institute of Biotechnology, some of them being also members of the study programme committee. The Institute of Biotechnology existed till 2011 as an independent state institute for fundamental research and is now integrated in the university. The institute is more research oriented, but one member of this institute gives a specialized bioinformatics course in the programme. In addition, the institute trains Ph.D. students. Concerning teaching, the institute has its own courses but does not provide its own study programme. The Review Panel considers the involvement of the Institute of Biotechnology as a positive aspect of the programme. The Institute of Biotechnology is very active

in research with a good publication track, and the Review Panel considers this as a good possibility to get the students involved in research very early.

4. Facilities and learning resources

The buildings provided by the faculty for the programme are adequate. Renovations have been done in one building, and a new building is planned for the near future.

The faculty is well equipped with computing resources. It has recently (2 years ago) bought a supercomputer with 2000 cores and 600 TB of disk space. This is currently the largest supercomputer in Lithuania. We were informed that up to 40% of computing power is sold to companies, which implies that 60% is left for university projects. This computing resource is important especially for study programmes like bioinformatics, where scientific computing involves solving complex computational problems. The faculty invests 200.000 Litas for replacement of equipment every year. The buildings are also well equipped with wireless communication. Furthermore, the students have access to computing services from the faculty. 250MB space seems to be appropriate for each student. Also on the positive side the renovation of several computer rooms (8 new computer classes and 3 to be renovated soon) can be mentioned. As mentioned in the SER (page 25, paragraph 114), the facilities for disabled people should be improved if possible.

The department has two locations with two buildings next to each other in Naugarduko Str. 24 and Šaltinių Str. 1a, and another location in Didlaukio Str. 47. The two locations are reachable by public transport, which however takes some time. The Review Panel estimates this to be roughly 30-40 minutes. However, it can be stated positively that the timetable is organized such that students mostly do not need to travel between the locations on the same day. The same is true for teachers: if they have a course in one location, they will not have lectures in the other locations. The students re-assured the Review Panel that there is no problem with the timetable. The Review Panel, however, could envision more problems if more additional optional courses are provided, since this would complicate the association of teachers and students to the different locations.

The faculty invests between 17.000 and 28.000 Litas per year for the library. The library is well equipped with current computer science literature, albeit there also seems to be some concentration on books written by the lecturers, at least for some subjects. For example, some books written by lecturers from the faculty are found up to 270 times in the library (SER, page 24, table 7). It can also be positively remarked that the library has access to ACM/IEEE digital library, which gives the students the possibility to read many current computer science papers and journals online. Students report that most of the material they need are accessible online. The Review Panel, however, suggests to buy a few copies (1-2) of recent bioinformatics books for the library.

The Review Panel had no visit to wet lab facilities. This was not necessary as there is currently not much lab work contained in the curriculum. However, if additional wet lab is included in the curriculum, appropriate facilities for that have to be provided.

5. Study process and student assessment

The University organizes admission in accordance with the Lithuanian legal requirements as stated in the Law No. V-2486 of the Ministry of Education and Science.

The programme involves many stakeholders from different faculties. This could generate problems for generating the timetable, but the administration seems to be efficiently solving these problems. Concerning the process of curriculum improvements, the contents of specialized courses have been improved recently. For the general courses, due to the number of students, the courses in mathematics and computer science are taught together with the informatics students, which is common in bioinformatics programmes. In order to capture appropriate contents, standard courses have also been re-ordered and combined in order to cope with the requirements of bioinformatics. An example is *Linear Algebra and Geometry*, which has been especially designed for the bioinformatics programme.

The communication between the faculties is mostly channeled through few persons and deemed functional. Scientific supervisors from the biological laboratories are submitting their problems and recommendations to the study programme. Teachers from the Faculty of Natural Sciences report that this process is effective and efficient.

The students mentioned a high workload to the Review Panel. Albeit this is somewhat unavoidable in interdisciplinary studies like bioinformatics, the Review Panel recommends continuing with the adaption of the study plan in the future such that the workload of the students is more appropriate. Furthermore, students report that the study plan contains a lot of theoretical work, and some more practical work would be welcomed. This is also true for the natural sciences, where more experience in the wet lab would be appropriate. Similarly, students miss real bioinformatics applications.

The strong participation of the Faculty of Natural Sciences and also especially the Institute of Biotechnology encourages students to participate in research. This can be seen also from the fact that a comparable high number of graduates from the programme (3 students) are continuing with Ph.D. studies.

The faculties provide enough possibilities for students to participate in mobility programmes since they have signed 76 Erasmus cooperation agreements. Since 2008, 13 students have been participating in the Erasmus exchange, which is a high number given the low number of students in the programme.

Concerning the academic and social support, the university provides the following social support options for the students: incentive scholarship for particularly good study results, social scholarship for students from the needy families or living alone, persons receiving social allowance; students with 45% and lower level of disability; or those below 25 years of age who were granted care or both parents (or one of the parents) are dead. One-time social scholarships are given to students in cases of death of a family member, natural or other disaster, disease or similar case, and also one-time target scholarship is granted to the students who have achieved good results in sports, cultural and research / public activity.

Disabled students can receive social allowance, and they can study according to individual plans (SER, page 31, paragraph 138). All the students have a right to get accommodation in Students' Residence. Student Representation Office is involved in numerous activities and invites students to take part in cultural and sports programmes.

Furthermore, on the academic side, it can be seen that currently most students do their practical work in companies that are more related to general IT technology. For that reason, the curriculum is chosen broader to provide better employment options for the students.

Concerning the assessment of students' performance, the students report that there is an online system where they can access their marks and also information about the overall performance of students of that course. Furthermore, the students can ask the lecturers about details of their assessment, both online or via direct communications. There were no complaints about the assessment system from the students side.

Some graduates work in the natural science area, which meets the programme providers' expectation. Other graduates continue with a Master programme in Informatics or work in IT-related areas. The same is true for several students concerning their professional work in the study programme. As stated by the faculty and also by the social partners, one reason is that the number of bioinformatics positions has been overestimated when launching the programme. A possible explanation is that there is not yet enough bioinformatics educated personnel in order to provide associated services in companies. This is in agreement with the expectations of the social partners, including the Ministry of Health. They also stressed the need for specialists who are able to combine knowledge in computer science and biology for different areas such as biotechnology and

health care in Lithuania. Other study programmes in Lithuania do not satisfy these needs since they do not provide enough interdisciplinary knowledge.

6. Programme management

Concerning the organization of the study process, the faculty has different departments in computer science that are related to different research areas. A study programme is usually run by one department, with a nearly one-to-one match between teachers of the departments and the study programmes. The evaluation of the quality of a study programme is regulated by the Vilnius University study programme regulations and supervised by the study programme committee. In the case of the Bachelor programme in Bioinformatics, members of the Institute of Biotechnology with professional bioinformatics expertise are also part of the study programme committee. In agreement with this, students report that the Faculty of Natural Sciences has had more influence in recent time, and that part of the curriculum was adopted to meet their requirements.

The Review Panel considers this contribution of the natural sciences in the study programme design as very fruitful and important.

Teachers from the Faculty of Mathematics and Informatics (namely R. Eidukevičius, S. Gražulis, I. Grinis and doctor student K. Kvedaravičiūtė) were part of the EU-funded BIOTEFA-A project („*Improvement of the education of highly qualified professionals for biotechnology and biopharmacy sector*“), which led to several improvements to the courses *Biometrics*, *Bioinformatics II*, *III* and *VI*. The Faculty of Natural Sciences also participated in the BIOTEFA-A project, improving the courses for life sciences. The Review Panel appreciates this involvement of computer science teachers in biotechnology related projects and also the fact that research has driven improvement in the course syllabus.

It can be positively remarked that the student opinions are taken into account in the study programme design. To give an example, the study order of some courses (e.g. Neuroinformatics) was changed according to students' comments in 2013.

The order of subjects taught was also re-ordered to adapt to the requirements from the natural sciences, which is a positive aspect. However, more optional bioinformatics courses would be welcomed, especially since many students of the programme will defend a Ph.D. in near future and might be able to help in the curriculum.

Some courses have been removed according to comments from the students. Alumni wanted also to have more natural science courses, as they didn't have the possibility to study a minor in natural sciences. This is now possible, and 7 students from the bioinformatics programme have chosen the minor in genetics and molecular biology, which the Review Panel considers as positive. Some

alumni report that they have been consulted. Machine learning is currently not offered in the programme but considered to be important by the alumni. The current study programme now contains a course in data mining, which covers some current topics in machine learning such as k-means clustering and nearest neighbor's classifier. However, an additional course would improve the situation.

The faculty is aware of the fact that the programme has currently only few students, but is willing to support the programme in a longer run. The faculty considers this as an investment in the future because of a rising biotechnology market. They are discussing with the social partners and adapting the curriculum accordingly.

The Review Panel got the impression that there is constant improvement of the study programme and found several proofs for actual improvements. This indicates that the quality assurance measures are effective.

III. RECOMMENDATIONS

1. Currently, a Master programme in bioinformatics is missing, so students starting the Bachelor programme have no clear roadmap for their future career. For that reason, the review panel recommends considering all possibilities for a clearer career roadmap for the bachelor students of bioinformatics. This could be a separate Master programme in bioinformatics, or a specialization in other programmes like the Master in computer modeling or a Master in genetics/molecular biology.
2. The Expert Team recommends adding another course in machine learning, at least as an optional one.
3. If possible, the study programme should include more practical work, especially some wet lab courses. There is a short wet lab course (some hours), but it would be good if bioinformatics students have more experience with experimental work. Similarly, the panel recommends that students work more with actual bioinformatics data.
4. The study programme committee should continue with revising the programme and the syllabi for computer science courses, especially for the more theoretical ones. Courses like information and coding, operating systems, chaos theory, methods of computer program construction, to give some examples, seemed to be a bit too specialized for bioinformatics.
5. For promoting teachers in computer science, currently only the number of papers from venues listed in ISI Web of Science is used. This excludes some well-established conference proceedings in computer science. Thus, the panel recommends adapting this norm better for computer science. At the time of this evaluation, it is recommended to use the service of Microsoft Academic Search to evaluate the quality of publications in computer science journals and conference proceedings.
6. The review panel recommends attracting young teachers with a research profile in bioinformatics, in order to have more specialized courses in bioinformatics.
7. The review panel suggests buying a few copies of recent bioinformatics books for the library.
8. In general, students wish more exchange between companies and the university concerning teachers. The university should be more actively looking for more teachers from companies, and vice versa.

IV. SUMMARY

The aims and learning outcomes of the Bachelor programme in Bioinformatics are well defined, clear and publicly available. The students get a good knowledge in computer science as well as in natural sciences, which is required for such an interdisciplinary programme. This can be seen from the fact that graduates of the programme could work both in natural science related areas, as well as in computer science. The programme also benefits from up-to-date computer equipment, both for lectures as well as for specific applications. The Faculty of Mathematics and Informatics is equipped with a supercomputer with 2000 cores and 600 TB of disk space, which is currently the largest supercomputer in Lithuania. This is especially important for advanced bioinformatics applications that either require to analyze large amounts of data (such as high-throughput sequencing), or need to solve complex computational problems (such as the analysis of protein structure).

The programme aims are clearly based on academic and professional requirements. For graduates working in bioinformatics, a very important skill is being able to perform interdisciplinary work, and to be able to communicate with both disciplines. These are special skills that many graduates of classical study programmes do not have. This is also required by the labor market and clearly achieved by the programme since the curriculum contains basic biological topics like *biochemistry* and *molecular biology*, as well as standard mathematical and computer science topics to be expected in a computer science bachelor programme. A positive aspect of the programme is also the inclusion of four specialized courses in bioinformatics. This is important for students since they need this special training. In addition, it allows them to develop a professional identity as bioinformaticians.

The curriculum is constantly being improved, either in order to adapt to the requirements of natural sciences, or due to additional qualifications of the staff. For example, in previous years there have been problems with biochemistry since pupils from the high school often do not have sufficient training in chemistry. This is now solved in the new timetable, where the course in physical chemistry is taught before biochemistry. In addition, the subjects of various bioinformatics courses have been adapted after teachers did receive some training. The study programme committee is composed of both faculties. This committee is very actively improving the curriculum, and both the Faculty of Natural Sciences and the Faculty of Mathematics and Informatics are active in the committee.

The programme greatly benefits from the strong involvement of researchers in the programme such as Edita Sužiedielienė (Faculty of Natural Sciences) and Saulius Gražulis (Institute of Biotechnology), who is also member of the study programme committee. Saulius Gražulis is

affiliated at the Institute of Biotechnology, a research institute that is now part of the university. This strong research component is important to improve the syllabi of the specialized courses in bioinformatics, but also for practical work and bachelor theses. This can also be seen from the fact that there are three graduates who continue now in a Ph.D. programme, albeit this programme is relatively small in comparison. The review panel considers both the strong contribution of the Faculty of Natural Sciences and the research orientation as very positive aspects of the programme. Albeit the programme is already in a good shape, the study programme committee should continue with its efforts in improving the curriculum. Studying partly biology and partly computer science requires more efforts than studying one single subject. For that reason, the Faculty of Mathematics and Informatics should consider to reduce some of the more theoretically oriented topics in order to integrate more specialized bioinformatics courses, or computer science courses more appropriate for bioinformatics, such as machine learning. This could also be used to reduce the workload of the students. Partially this is already done by integrating data mining and combining linear algebra and geometry in one course, but the study programme committee should actively check the syllabi and try to reduce some topics. In addition, this would allow adding wet lab work, which is requested by the students and recommended by the review panel.

There are two important aspects of the programme that require some attention from the study programme committee in the future. First, there is no Master programme in bioinformatics. This implies that there is no clear career roadmap for students starting in the programme, which is clearly unfortunate. The study programme committee is advised to think in any possible way to improve this situation. The current solution, namely that students continue in the Master programme in Informatics, is clearly unsatisfactory. One possible solution would be a Master programme in bioinformatics, which might be too small given the current number of bachelor students. Other solutions are specializations in other Master programmes like computer modeling, which could fit since it is also related to the analysis of large data and to scientific computing. Yet another possibility would be specialization in one of the Master programmes in the Faculty of Natural Sciences.

The other aspect, which is possibly related to the previous one, is the dropping number of students. Providing a clear roadmap for a future career would definitely help to attract more students to the programme. On the other hand, employment in bioinformatics has been clearly overestimated when the programme started. The number of study places has been adapted to 30, which the Review Panel considers as appropriate. This view is agreed on by the social partners of the programme, who indicated a clear need for bioinformaticians in the labour market.

V. GENERAL ASSESSMENT

The study programme *Bioinformatics* (state code – 612I52001) at Vilnius University is given **positive** evaluation.

Study programme assessment in points by evaluation areas.

No.	Evaluation Area	Evaluation Area in Points*
1.	Programme aims and learning outcomes	3
2.	Curriculum design	3
3.	Staff	4
4.	Material resources	4
5.	Study process and assessment (student admission, study process student support, achievement assessment)	3
6.	Programme management (programme administration, internal quality assurance)	3
	Total:	20

*1 (unsatisfactory) - there are essential shortcomings that must be eliminated;

2 (satisfactory) - meets the established minimum requirements, needs improvement;

3 (good) - the field develops systematically, has distinctive features;

4 (very good) - the field is exceptionally good.

Grupės vadovas:

Team leader:

Prof. Jukka Paakki

Grupės nariai:

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Prof. Rolf Backofen

Prof. Jerzy Marcinkowski

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**VILNIAUS UNIVERSITETO PIRMOSIOS PAKOPOS STUDIJŲ PROGRAMOS
BIOINFORMATIKA (VALSTYBINIS KODAS – 612I52001) 2014-03-21 EKSPERTINIO
VERTINIMO IŠVADŲ NR. SV4-95 IŠRAŠAS**

<...>

V. APIBENDRINAMASIS ĮVERTINIMAS

Vilniaus universiteto studijų programa *Bioinformatika* (valstybinis kodas – 612I52001) vertinama **teigiamai**.

Eil. Nr.	Vertinimo sritis	Srities įvertinimas, balais*
1.	Programos tikslai ir numatomi studijų rezultatai	3
2.	Programos sandara	3
3.	Personalas	4
4.	Materialieji ištekliai	4
5.	Studijų eiga ir jos vertinimas	3
6.	Programos vadyba	3
	Iš viso:	20

* 1 - Nepatenkinamai (yra esminių trūkumų, kuriuos būtina pašalinti)

2 - Patenkinamai (tenkina minimalius reikalavimus, reikia tobulinti)

3 - Gerai (sistemiškai plėtojama sritis, turi savitų bruožų)

4 - Labai gerai (sritis yra išskirtinė)

<...>

IV. SANTRAUKA

Bioinformatikos bakalauro studijų programos tikslai ir studijų rezultatai yra aiškiai apibrėžti, aiškūs ir viešai prieinami. Studentai gauna išsamių žinių apie kompiuterijos mokslą, taip pat kaip ir apie gamtos mokslus, kas tokiai tarpdisciplininei programai, kaip ši, yra reikalinga. Tai įrodo faktas, kad programos absolventai gali dirbti tiek su gamtos mokslais susijusiose srityse, tiek kompiuterių mokslo srityje. Programos privalumas taip pat yra moderni kompiuterinė įranga, naudojama ir paskaitų metu, ir specifinėms reikmėms. Matematikos ir informatikos fakultete yra superkompiuteris, turintis 2000 branduolių ir 600 TB duomenų saugyklą, kas šiuo metu yra

didžiausias superkompiuteris Lietuvoje. Toks kompiuteris itin svarbus pažangiosioms bioinformatikos programoms, kurioms reikia arba analizuoti didelius duomenų kiekius (pavyzdžiui, didelio našumo sekas), arba spręsti sudėtingus skaičiavimo uždavinius (pavyzdžiui, baltymo struktūros analizė).

Programos tikslai aiškiai paremti akademiniais ir profesiniais reikalavimais. Bioinformatikos srityje dirbantiems absolventams labai svarbu gebėti atlikti tarpdisciplininį darbą ir gebėti suprasti abi disciplinas. Tai specialieji įgūdžiai, kurių daugelis klasikinių studijų programų absolventų neturi. To taip pat reikalaujama darbo rinkoje ir visiškai pasiekama studijuojant šią programą, kai į studijų planą yra įtrauktos pagrindinės biologijos temos, tokios kaip *biochemija* ir *molekulinė biologija*, taip pat ir standartinės matematikos ir kompiuterių mokslų temos, kurios dažniausiai būna kompiuterinių mokslų bakalauro programoje. Programos teigiamas bruožas yra tas, kad joje siūlomi keturi specializuoti bioinformatikos dalykai. Studentams tai svarbu, nes jiems būtent reikia šio specialaus mokymo. Be to, tai suteikia jiems galimybę tobulėti profesiniu požiūriu kaip bioinformatikams.

Studijų turinys yra nuolat gerinamas, kad atitiktų gamtos mokslų reikalavimus ar prisitaikant prie papildomos personalo kvalifikacijos. Pavyzdžiui, ankstesniais metais kilo nesklandumų dėl biochemijos, kai mokyklų mokiniai dažnai neturi pakankamai chemijos žinių. Ši problema dabar išspręsta, nes pagal naująjį studijų programos planą fizikinė chemija yra dėstoma prieš biochemiją. Taip pat po kelių mokymų dėstytojams buvo atnaujintas įvairių bioinformatikos dalykų turinys. Studijų programos komitetą sudaro abiejų fakultetų nariai. Šis komitetas yra itin aktyvus tobulinant studijų turinį ir abu fakultetai (tiek Gamtos mokslų, tiek Matematikos ir informatikos) yra vienodai aktyvūs.

Programą labai praturtina aktyvus mokslininkų įsitraukimas, tokių kaip Edita Sužiedielienė (Gamtos mokslų fakultetas) ir Saulius Gražulis (Biotechnologijos institutas), kuris taip pat yra ir studijų programos komiteto narys. Saulius Gražulis yra Biotechnologijos instituto (Mokslinių tyrimų instituto, kuris dabar priklauso Universitetui) narys. Šis stiprus mokslinių tyrimų indėlis yra svarbus tobulinant specializuotų bioinformatikos dalykų turinį, taip pat ir praktiniams darbams bei bakalauro baigiamiesiems darbams. Tai taip pat įrodo faktas, kad trys absolventai, palyginti iš nedidelės programos, dabar tęsia mokslus doktorantūros studijose. Ekspertų grupės nuomone, tiek svarus Gamtos mokslų fakulteto indėlis, tiek orientacija į mokslinius tyrimus yra programos pranašumai.

Nors programa yra gera, studijų programos komitetas turėtų toliau stengtis gerinti studijų turinį. Norint studijuoti iš dalies biologiją ir iš dalies kompiuterijos mokslus, reikia didesnių pastangų nei mokantis tik vieną dalyką. Dėl šios priežasties, Matematikos ir informatikos fakultetas turėtų apsvarstyti galimybę sumažinti kai kurių, labiau į teoriją orientuotų, temų skaičių, kad galėtų

integuoti labiau specializuotus bioinformatikos dalykus arba kompiuterių mokslo dalykus, tinkamesnius bioinformatikai, tokius kaip mašinų mokymasis. Tai taip pat gali padėti sumažinti studentų darbo krūvį. Iš dalies, tai jau daroma integruojant duomenų gavybą ir sujungiant tiesinę algebrą ir geometriją į vieną dalyką. Tačiau studijų programos komitetas turėtų aktyviai tikrinti turinį ir stengtis kai kurias temas mažinti. Be to, tai leistų įtraukti darbą tradicinėje chemijos laboratorijoje, kurio pageidauja studentai ir taip pat rekomenduoja ekspertų grupė.

Studijų programos komitetas ateityje turėtų atkreipti dėmesį į du svarbius studijų programos aspektus. Pirma tai, kad nėra Bioinformatikos magistro programos. Tai reiškia, kad studentai, pradėdantys studijuoti šią programą, neturi aiškios būsimos profesinės veiklos gairių, dėl to labai gaila. Studijų programos komitetui patariama apmąstyti visus galimus būdus šiai situacijai spręsti. Dabar galiojantis sprendimas, būtent, kad studentai tęsia magistro studijas Informatikos programoje, neabejotinai yra nepatenkinama. Vienas iš galimų sprendimų galėtų būti Bioinformatikos magistro studijų programa, kuri, atsižvelgiant į dabartinį bakalauro studentų skaičių, gali būti per maža. Kiti sprendimai: magistro programų, pavyzdžiui, Kompiuterinio modeliavimo, specializacija, kas turėtų tiktai, atsižvelgiant į tai, kad ji yra susijusi su dideliu kiekiu duomenų analizavimu ir moksliniais skaičiavimais. Dar viena galimybė – specializacija vienoje iš Gamtos mokslų fakultete teikiamų magistro programų.

Kitas aspektas, kuris tikriausiai susijęs su pirmiau minėtu, yra mažėjantis studentų skaičius. Aiškios būsimos profesinės veiklos gairės tikrai padėtų pritraukti daugiau studentų į studijų programą. Kita vertus, pradėjus vykdyti programą, įdarbinimo galimybės bioinformatikos srityje buvo akivaizdžiai pervertintos. Studijų vietų skaičius buvo pritaikytas trisdešimčiai, o tai, ekspertų grupės nuomone, yra tinkama. Su šia nuomone sutinka ir programos socialiniai partneriai, kurie aiškiai nurodė, jog darbo rinkoje yra bioinformatikų paklausa.

III. REKOMENDACIJOS

1. Šiuo metu nėra Bioinformatikos magistro studijų programos, todėl pradėdami studijuoti bakalauro programą studentai neturi aiškių būsimos profesinės veiklos gairių. Dėl to ekspertų grupė rekomenduoja apsvarstyti visas galimybes Bioinformatikos bakalauro studijų studentams sudaryti aiškesnes profesinės veiklos gaires. Tai galėtų būti atskira Bioinformatikos magistro studijų programa arba kitos programos specializacija, pavyzdžiui, Kompiuterinio modeliavimo magistras arba Genetikos/Molekulinės biologijos magistras.
2. Ekspertų grupė rekomenduoja įtraukti dar vieną dalyką apie mašinų mokymąsi, bent kaip pasirenkamąjį.

3. Jei įmanoma, studijų programoje turėtų būti daugiau praktinio darbo, ypač susijusio su darbu tradicinėje chemijos laboratorijoje (angl. *wet lab*). Yra joje trumpai (keletas valandų) dėstomas dalykas, tačiau būtų gerai, jei bioinformatikos studentai turėtų daugiau patirties atliekant eksperimentinį darbą. Taip pat, ekspertai rekomenduoja studentams daugiau dirbti su realiais bioinformatikos duomenimis.
4. Studijų programos komitetas turėtų tęsti programos ir kompiuterijos mokslo dalykų medžiagos, ypač teorinių, atnaujinimą. Kai kurie dalykai, pavyzdžiui, Informacija ir kodavimas, Operacinės sistemos, Chaoso teorija, Kompiuterinių programų kūrimo metodai, pasirodė Bioinformatikos programai šiek tiek per specifiniai.
5. Siekiant skatinti dėstytojus tobulintis kompiuterijos mokslo srityje, šiuo metu naudojami tik tie moksliniai darbai, kurie skelbiami „ISI Web of Science“ platformoje. Kai kurių labai svarbių konferencijų medžiaga apie kompiuterijos mokslą yra neįtraukta. Todėl ekspertų grupė geriau rekomenduoja šį faktorių pritaikyti kompiuterijos mokslui. Šitokio vertinimo metu, įvertinti publikacijų kompiuterijos mokslo žurnaluose ir konferencijų medžiagos kokybę, rekomenduojama naudotis „Microsoft Academic Search“ paslaugomis.
6. Ekspertų grupė rekomenduoja pritraukti jaunos bioinformatikos dėstytojus, mokslininkus, kad būtų galima pasiūlyti itin specializuotus bioinformatikos dalykus.
7. Ekspertų grupė bibliotekai siūlo įsigyti keletą egzempliorių naujausių bioinformatikos knygų.
8. Apskritai, kalbant apie dėstytojus, studentai norėtų aktyvesnių mainų tarp universiteto ir įmonių. Universitetas turėtų aktyviau ieškoti dėstytojų, dirbančių įmonėse, ir atvirkščiai.

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Paslaugos teikėja patvirtina, jog yra susipažinusi su Lietuvos Respublikos baudžiamojo kodekso¹ 235 straipsnio, numatančio atsakomybę už melagingą ar žinomai neteisingai atliktą vertimą, reikalavimais.

¹ Žin., 2002, Nr.37-1341.