Bioinformatics is a specialisation within the Master’s degree programme in Computer Science. It focuses on the development of algorithms and models to interpret genomic data, in collaboration with biologists and biotechnologists. Bioinformatics offers a new approach to the formulation of hypotheses and the solution of problems in biology, based on the analysis of measurements on the presence or concentrations of all molecules of a particular type (DNA, RNA, proteins) in the cell.

Computational algorithms to interpret genomic data, in collaboration with biologists

We know that many diseases are controlled at the level of the gene: mutations in the DNA disrupt processes that take place in the cell. In order to understand the exact mechanisms of a disease or to propose an appropriate therapy, however, we need to know more about how genetic disorders progress. Genomics research has generated a wealth of information in the past decade, ranging from complete DNA sequences to detailed insight into molecular activities within the cell. By interpreting this information, we will eventually be able to reveal the mechanisms of major diseases within the cell. Due to the sheer volume of information that is currently being generated, however, biologists need smart software that can help them to interpret it all. Bioinformatics plays an important role in this regard.

Master’s programme

The Master of Science degree programme in Computer Science at TU Delft offers a track in Bioinformatics. This two-year track is designed for students who have completed a Bachelor’s degree in Computer Science. It is taught in English. Each year of the programme begins in September.
The Bioinformatics track is a joint programme operated by TU Delft and Leiden University. In the Bioinformatics track, you will learn how to design and develop computational algorithms to interpret genomic data. You will make use of concepts from mathematics and computer science, as well as from molecular biology and chemistry. The methodologies that you generate will have applications in a wide range of fields, from medicine and pharmacology to biotechnology for production of food, fuels and chemicals. They may also be applied in fundamental biological research.

The primary focus of the Delft-Leiden track in Bioinformatics is on data analysis and modelling. These are core aspects of techniques for data capturing, data warehousing, data mining and similar issues, which have been attracting considerable attention from researchers in biology, due to the explosive growth of quantitative data. Bioinformatics also contributes strongly to the identification of new computer-scientific principles and the development of new algorithms.

The programme begins with compulsory courses and a limited homologation programme (if needed), which allows students to follow courses in disciplines that were not included in their undergraduate programmes. Specialisation courses offer students the opportunity to broaden and deepen their knowledge in the areas of computer science, mathematics, biology and chemistry. During the Master's degree project, students collaborate with life scientists to work on one of the application domains.

Specialisation Courses

The Bioinformatics track does not offer specialisations, although it does allow students to select from a variety of the following specialisation courses:
- Advanced Bioinformatics
- Advanced Digital Image Processing
- Statistical Modelling for Classification and Prognosis
- Mathematical Biology, Virtual Cell
- Mathematical Biology, Metabolic Networks
- Multi-objective Optimisation in Bioinformatics and Chem-informatics
- Microscopy, Modelling and Visualisation
- Multimedia Information Retrieval
- Additional courses in computer science, mathematics, electrical engineering or life sciences in Delft or Leiden

Graduation projects

Some examples of recent graduation projects are:
- Detecting Down’s syndrome in utero by inspecting DNA in the blood of the mother
- A tumour-growth simulation model for the study of cancer-hallmark acquisition
- Reconstructing bacterial genomes using short-read DNA data
- Developing machine-learning algorithms for protein function prediction.

Professor Marcel Reinders

I am professor in Bioinformatics and I am fascinated by the interplay between computer science and life sciences. With the ability to decipher genomes, the role of computations is revolutionizing life science. This science of the 21st century will play a crucial role in solving the great challenges that humanity is facing. Already, important breakthroughs have been realized in understanding diseases, improvements in food production, or production of complex chemicals. These breakthroughs could be achieved only by virtue of automatic handling and interpretation of petabytes of life science data.

Within my research, I develop novel algorithms to analyse such data, by making use of machine learning methodologies, or graph-based algorithms. To do so, my lab has an excellent computing infrastructure with ultra-fast connections to the (inter)national high-performance computing environment. Our bioinformatics students work in inter-disciplinary teams. For example, a recent student closely collaborated with clinical geneticists. He developed new computational tools to detect trisonomies (three copies of a chromosome instead of two) in unborn children by testing maternal blood. The results are now being implemented as part of a novel and much safer screening technology for pregnant women.

Because of their strong technical background, and their ability to cooperate in complex settings, our students are very popular in the job market. The shortage of bioinformaticians makes them most welcome in research and industrial positions both in and outside the Netherlands. Come and join us in our endeavour of this new thrilling science!

Career prospects

Bioinformatics engineers are in great demand, both nationally and internationally. The track in Bioinformatics is a multi-disciplinary programme by nature. It accordingly offers considerable latitude in career choices across the primary disciplines that are integral to the programme. Opportunities are available in fields ranging from the medical sciences and biotechnology to chemistry and mathematics. For example, research groups in medical centres need bioinformatics support in order to interpret their results. Life-science support companies (which offer chemicals, tests and hardware) require
bioinformatics in order to process the output of their products. Large biotechnology firms (e.g. those involved in the production of fine chemicals, drugs or new crops) are increasingly relying on bioinformatics in order to identify new business opportunities.

Curriculum Bioinformatics

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<th>First Year</th>
<th>2nd Semester</th>
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<td>1st Semester</td>
<td>2nd Semester</td>
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<tr>
<td>Pattern Recognition</td>
<td>Methodology of Science and Engineering</td>
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<td>Databases and Data mining</td>
<td>Molecular Computational Biology</td>
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<td>Homologation Courses/Free electives (12 EC)</td>
<td>Functional Genomics and Systems Biology</td>
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<tr>
<td>Introduction to Life Science</td>
<td>BI Specialisation Courses (15 EC)</td>
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<td>Computer Science for Life Science</td>
<td>other Specialisation Courses (5 EC)</td>
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<th>Second Year</th>
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<td>1st Semester</td>
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<td>Specialisation Research Assignement (15 EC)</td>
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• EC = 28 hours of study, according to the European Credit Transfer System (ECTS) • Total number of credits in the MSc programme = 120 EC

For more information on all courses: www.studyguide.tudelft.nl.

Bioinformatics at TU Delft is a life experience

The reason I chose the MSc Track in Bioinformatics is that it allowed me to combine my knowledge of computer science with my love for biology. As a student with endless curiosity and a willingness to conduct further research, the field of bioinformatics offered an excellent environment for completing my Master’s degree and continuing to pursue a PhD. Given its reputation and the networks of its professors, TU Delft can help me to accomplish my goals. At TU Delft, the professors are truly willing to help us develop a critical mind concerning how to approach and address problems related to bioinformatics. I truly enjoy studying, trying to comprehend and complete this growing puzzle.

I chose to complete my Master’s degree programme abroad largely because TU Delft is able to enhance my choice to work in the area of research. In addition to the members of the TU Delft Bioinformatics team and its achievements, the multicultural environment trains my mind to be more flexible and capable of facing a variety of people, problems and circumstances every day. In summary, studying bioinformatics at the TU Delft is a life experience that has provided me with the essential elements that I need for my studies and for my future.
Admission requirements

The Bioinformatics track is an advanced programme, requiring thorough basic academic knowledge of computer science.

**BSc degree from a Dutch university**

Graduates with a BSc in Technical Informatics or Computer Science are eligible to enrol in the programme. Students with a Bachelor's degree in a related field are required to follow a customised bridging programme (maximum 30 ECTS). To determine whether your BSc degree makes you eligible for admission, please visit www.doorstroommatrix.nl.

**Degree from a Dutch university of applied sciences (Dutch HBO)**

Applicants holding a Bachelor's degree in Technical Informatics, Computer Science or another related relevant course of study are eligible to enrol in the programme after completing a bridging programme. Prospective students are advised to contact the Master's Coordinator before applying.

For additional details, go to www.hbodoorstroom.tudelft.nl.

The application procedure is conducted through Studielink: www.tudelft.studielink.nl.

**International applicants**

International applicants must meet the general admission requirements of TU Delft.

1. A BSc degree (or proof that you have nearly completed a BSc programme) in Computer Science or a field closely related to the MSc programme in Computer Science
2. A BSc Cumulative Grade Point Average (CGPA) of at least 75% of the scale maximum
3. Proof of English language proficiency: A score of at least 90 on the TOEFL or an overall Band score of at least 6.5 on the IELTS (academic version)

For international students, the application period starts in September and closes at April 1. To start a MSc application, complete the online application and pay the non-refundable application fee of € 50. Then send hard copies of the application documents to the TU Delft International Office. Please note that you should apply early if you wish to apply for a scholarship as well.

For more information about the application procedure and studying at TU Delft in general, go to www.admissions.tudelft.nl.

**Introduction week**

All international students will be welcomed with the award-winning introduction programme. The introduction consists of a variety of workshops and projects, during which you will get to know other international students, visit the highlights of Delft and learn the ins and outs of the TU Delft campus. After this very interesting and fun week, you will be introduced to the EEMCS faculty. During this three-day Master Kick Off, you will receive helpful information about the Dutch education system and meet the fellow students from your programme in a variety of social and educational activities.