BACHELOR'S PROGRAMME COMPUTING SCIENCE

FACULTY OF SCIENCE

RADBOUD UNIVERSITEIT

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CONTENTS

REPORT ON THE BACHELOR'S PROGRAMME COMPUTING SCIENCE OF RADBOUD UNIVERSITY 5

ADMINISTRATIVE DATA REGARDING THE PROGRAMME 5

ADMINISTRATIVE DATA REGARDING THE INSTITUTION 5

COMPOSITION OF THE ASSESSMENT PANEL 5

WORKING METHOD OF THE ASSESSMENT PANEL 6

SUMMARY JUDGEMENT 9

DESCRIPTION OF THE STANDARDS FROM THE ASSESSMENT FRAMEWORK FOR LIMITED FRAMEWORK ASSESSMENTS 11

APPENDICES 23

APPENDIX 1: DOMAIN-SPECIFIC FRAMEWORK OF REFERENCE 25

APPENDIX 2: INTENDED LEARNING OUTCOMES 26

APPENDIX 3: OVERVIEW OF THE CURRICULUM 28

APPENDIX 4: PROGRAMME OF THE SITE VISIT 29

APPENDIX 5: THESES AND DOCUMENTS STUDIED BY THE PANEL 30

This report was finalised on 30 March 2020.

REPORT ON THE BACHELOR'S PROGRAMME COMPUTING SCIENCE OF RADBOUD UNIVERSITY

This report takes the NVAO's Assessment Framework for the Higher Education Accreditation System of the Netherlands for limited programme assessments as a starting point (September 2018).

ADMINISTRATIVE DATA REGARDING THE PROGRAMME

Bachelor's programme Computing Science

Name of the programme:	Computing Science
CROHO number:	59326
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specializations or tracks:	Cyber Security Software & Data Science
Location(s):	Nijmegen
Mode(s) of study:	full time
Educational minor:	applicable (second degree qualification)
Language of instruction:	English
Submission deadline NVAO:	01/05/2020

The visit of the assessment panel Computer Science to the Faculty of Science of Radboud University took place on 18 and 19 November 2019.

ADMINISTRATIVE DATA REGARDING THE INSTITUTION

Name of the institution:	Radboud University
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	positive

COMPOSITION OF THE ASSESSMENT PANEL

The NVAO has approved the composition of the panel on 15 April 2019. The panel that assessed the bachelor's programme Computing Science consisted of:

- Em. prof. dr. T. (Theo) D'Hondt, emeritus professor in Software Languages and Software Engineering at the Faculty of Sciences and Bioengineering Sciences of Vrije Universiteit Brussel (Belgium) [chair];
- Prof. dr. ir. W.E.A. (Wim) van Petegem, professor and policy coordinator Learning Technologies at the Faculty of Industrial Engineering Technology of KU Leuven (Belgium);
- Prof. dr. S. (Sjouke) Mauw, professor in Security and Trust of Software Systems at the Department of Computer Science of the University of Luxembourg (Luxembourg);
- Ir. E.A.P. (Ewine) Smits, Senior Manager in Advanced Analytics & Big Data at KPMG Nederland;
- M. (Martijn) Brehm, third-year bachelor student Computer Science at the University of Amsterdam [student member].

The panel was supported by M. (Mark) Delmartino MA, who acted as secretary.

WORKING METHOD OF THE ASSESSMENT PANEL

The site visit to the bachelor's programme Computing Science at the Faculty of Science of Radboud University was part of the cluster assessment Computer Science. Between June and December 2019 the panel assessed 29 programmes at 10 universities. The following universities participated in this cluster assessment: Leiden University, Delft University of Technology, University of Utrecht, Eindhoven University of Technology, Open University, University of Amsterdam, Vrije Universiteit Amsterdam, Radboud University, University of Groningen and University of Twente.

On behalf of the participating universities, quality assurance agency QANU was responsible for logistical support, panel guidance and the production of the reports. P.A. (Peter) Hildering MSc. was project coordinator for QANU. P.A. (Peter) Hildering MSc. and M. (Mark) Delmartino MA acted as secretary in the cluster assessment.

During the site visit at Radboud University the panel was supported by M. (Mark) Delmartino MA, a certified NVAO secretary.

Panel members of the cluster assessment Computer Science
The members of the assessment panel were selected based on their expertise, availability and independence. The panel consisted of the following members:

- Em. prof. dr. T. (Theo) D'Hondt, emeritus professor in Software Languages and Software Engineering at the Faculty of Sciences and Bioengineering Sciences of Vrije Universiteit Brussel (Belgium) [chair];
- Prof. dr. ir. W.E.A. (Wim) van Petegem, professor and policy coordinator Learning Technologies at the Faculty of Industrial Engineering Technology of KU Leuven (Belgium);
- Prof. dr. S. (Sjouke) Mauw, professor in Security and Trust of Software Systems at the Department of Computer Science of the University of Luxembourg (Luxembourg);
- Prof. dr. J.J. (John-Jules) Meyer, full professor Computer Science and Artificial Intelligence at the University of Utrecht;
- Drs. L. (Lennart) Herlaar, owner/director at Redbits.nl, a company specialized in software development and IT consultancy, and assistant professor Computer Science at the Faculty of Science of Utrecht University;
- T.A. (Tonny) Wildvank, owner/CEO at Wildvank, Management en Advies, specialized in IT-management and -consultancy;
- Prof. dr. J. (Jan) Aerts, full professor Visual Data Analysis at the University of Hasselt and associate professor Visual Data Analysis at the faculty of Engineering Science at KU Leuven (Belgium);
- Drs. H.C. (Jeroen) Borst, senior consultant Smart Cities at TNO;
- Prof. dr. P. (Petros) Koumoutsakos, full professor Computational Science at ETH Zürich (Switserland);
- Prof. dr. ir. J.M.W. (Joost) Visser, Chief Product Officer at Software Improvement Group (SIG) Nederland and professor Large-scale Software Systems at the Radboud University Nijmegen;
- Ir. E.A.P. (Ewine) Smits, Senior Manager in Advanced Analytics & Big Data at KPMG Nederland;
- Prof. dr. D.P. (Danilo) Mandic, full professor Signal Processing at the department of Electrical and Electronic Engineering of Imperial College London (United Kingdom);
- Dr. ir. J.C. (Job) Oostveen, Research Manager at the Department Monitoring and Control Services at TNO;
- Prof. dr. B.A.M. (Ben) Schouten, full professor Playful Interactions at Eindhoven University of Technology;
- Dr. ir. N. (Nico) Plat, owner/CEO at Thanos IT-consultancy and architecture.
- N. (Nienke) Wessel BSc, master's student Computing Science and bachelor's student Mathematics and Linguistics at Radboud University [student member];
- E. (Evi) Sijben BSc, master's student Computing Science in the specialisation track Data Science at Radboud University [student member];

- B. (Baran) Erdogan, third-year bachelor's student Computer Science at University of Amsterdam [student member];
- M. (Martijn) Brehm, third-year bachelor's student Computer Science at University of Amsterdam [student member].

Preparation
On 21 March 2019, the panel chair was briefed by QANU on his role, the assessment framework, the working method, and the planning of site visits and reports. A preparatory panel meeting was organised on 9 May 2019. During this meeting, the panel members received instruction on the use of the assessment framework. The panel also discussed their working method and the planning of the site visits and reports.

The project coordinator and secretary composed a schedule for the site visit in consultation with the Faculty. Prior to the site visit, the Faculty selected representative partners for the various interviews. See Appendix 4 for the final schedule.

Before the site visit to Radboud University, QANU received the self-evaluation reports of the programmes and sent these to the panel. A thesis selection was made by the panel's chair and secretary. The selection consisted of bachelor's theses, master' theses and their respective assessment forms, based on a provided list of graduates in the academic years 2016-2017, 2017-2018 and 2018-2019. A variety of topics and tracks and a diversity of examiners were included in the selection. The secretary and panel chair ensured that the distribution of grades in the selection matched the distribution of grades of all available projects and theses, and that all tracks of the programmes were covered in the selection. After studying the self-evaluation report, theses and assessment forms, the panel members formulated their preliminary findings. The secretary collected all initial findings and questions and distributed these amongst all panel members.

Site visit
The site visit to Radboud University took place on 18 and 19 November 2019. At the start of the visit, the panel discussed its initial findings, identified the key issues to be discussed during the sessions, and agreed on a division of tasks during the site visit. Before and during the site visit, the panel studied the additional documents provided by the programmes. An overview of these materials can be found in Appendix 5. The panel had a tour across the campus visiting programme-specific learning facilities and the study association, and conducted interviews with representatives of the programmes: students and staff members, programme management, alumni and representatives of the Board of Examiners. It also offered students and staff members an opportunity for confidential discussion during a consultation hour. One person made use of this opportunity. The panel used the final part of the site visit to discuss its findings in an internal meeting. Afterwards, the panel chair publicly presented the panel's preliminary findings and general observations.

The visit was concluded with a development conversation, in which the panel and the programmes discussed various development routes for the programmes. The result of this conversation is summarized in a separate report.

Consistency and calibration
In order to ensure the consistency of assessment within the cluster, following measures were taken: the panel composition ensured regular attendance of (key) panel members, including the chair, and the project coordinator was present at the panel discussion leading to the preliminary findings of each programme at all site visits.

Report
After the site visit, the secretary wrote a draft report based on the panel's findings and submitted it to the project coordinator for peer assessment. Subsequently, the secretary sent the report to the panel. After processing the panel members' feedback, the project coordinator sent the draft reports to the Faculty in order to have these checked for factual irregularities. The project coordinator

discussed the ensuing comments with the panel's chair and changes were implemented accordingly. The report was then finalised and sent to the Faculty and University Board.

Minor in Education
The Minor in Education leading to a second degree teaching qualification will be covered in-depth during the assessment of the academic teaching programmes (admission deadline:1 November 2021).

Definition of judgements standards
In accordance with the NVAO's Assessment framework for limited programme assessments, the panel used the following definitions for the assessment of the standards:

Generic quality
The quality that, from an international perspective, may reasonably be expected from a higher education Associate Degree, Bachelor's or Master's programme.

Meets the standard
The programme meets the generic quality standard.

Partially meets the standard
The programme meets the generic quality standard to a significant extent, but improvements are required in order to fully meet the standard.

Does not meet the standard
The programme does not meet the generic quality standard.

The panel used the following definitions for the assessment of the programme as a whole:

Positive
The programme meets all the standards.

Conditionally positive
The programme meets standard 1 and partially meets a maximum of two standards, with the imposition of conditions being recommended by the panel.

Negative
In the following situations:
- The programme fails to meet one or more standards;
- The programme partially meets standard 1;
- The programme partially meets one or two standards, without the imposition of conditions being recommended by the panel;
- The programme partially meets three or more standards.

SUMMARY JUDGEMENT

This evaluation concerns the bachelor's programme Computing Science, a three-year full-time 180 EC programme offered by the Institute for Computing and Information Sciences at the Radboud University in Nijmegen.

The bachelor's programme has an outspoken profile, which reflects the research priorities of the institute, the faculty and the university. The panel thinks highly of the way in which the vision on computing science interrelates with the priorities of the Institute and the programme specialisations on Cyber Security and Software & Data Science. Computing science in Nijmegen focuses on software products and emphasizes the role of theory and formal methods in its analysis, design, and manufacturing. The intended learning outcomes of the bachelor' programme are formulated clearly and reflect adequately the discipline, level and orientation of the programme. They do justice to the specialisations and to the explicit ambition to prepare bachelor students first and foremost for a follow-up master programme. According to the panel, the learning outcomes cover comprehensively both the European-wide Dublin Descriptors and the international ACM curriculum.

Overall, the teaching-learning environment of the bachelor programme is up to standard. Moreover, the panel is very positive about several aspects of the curriculum, the staff and the facilities that altogether allow students to successfully achieve the end terms of the bachelor programme. The curriculum is coherent and its contents are in full alignment with the programme profile, the intended learning outcomes and the international disciplinary requirements. Talented students attending the honours programme or enrolling for a second bachelor's degree appreciate these additional opportunities. The didactic concept is both clear and appropriate. Teaching staff is highly qualified in terms of both disciplinary know-how and didactics, and bachelor students are exposed in class to high quality researchers. The explicit attention to female staff is attracting female students and researchers. In addition to the teaching locations of the Faculty of Science, the Mercator 1 building contributes to the small-scale approachable education environment. The study association constitutes a value added for the students, the programme and the institute. In a number of cases, the panel found that a more explicit communication would enhance the overall quality of the programme even more: the entire range of academic skills components can be described more visibly, the study abroad options can be promoted more vigorously, and there is room for more exposure of bachelor students to industry. Furthermore, the panel understands the rationale for an English-language bachelor programme and considers that overall the transition to another language went smoothly. While acknowledging the positive effects in terms of attracting international students and staff, the panel is also concerned that the growing number of students is starting to affect some of the achievements and typical features of the Computing Science programme in Nijmegen, such as the small scale of the programme, the variety of teaching methods, the availability of teaching staff and the homey atmosphere in and capacity of the Mercator 1 building.

Student assessment is well organized in the Computing Science programme. The policy and principles underlying course assessments are up to standard and applied in the day-to-day reality of teaching and assessment. The panel thinks highly of the extensive overall programme test matrix and considers that course assessments are valid, reliable and transparent. Based on its own sample review, the panel considers that overall the assessment process of the thesis and the evaluation format are adequate and constitute a clear improvement compared to the previous accreditation visit. If used properly and completed fully, the evaluation form is very relevant. While several assessors complete the evaluation form in an insightful way, the panel encourages the programme to impose that all assessors provide qualitative feedback to motivate their scores. The Examination Board has appropriate expertise to safeguard the quality of both course and thesis assessments. Nonetheless, the panel thinks that the Examination Board can make better and more pro-active use of its expertise and independent position to insist that its findings and recommendations are implemented. In view of the growing student numbers, the programme may want to investigate further the opportunities of digital testing and sharpen the existing policy on fraud and plagiarism.

Bachelor students who graduate from the Computing Science programme are adequately prepared for a follow-up study. Having established that all bachelor theses meet at least the minimum requirements of what can be expected of a final project at bachelor level – and are often of higher quality – it is fair to state that the intended learning outcomes of the programme are achieved at the end of the bachelor curriculum. Graduates may well be fit for a position on the labour market, too, but there is no evidence for the moment confirming that students leave university with a bachelor's degree and pursue a professional career in industry. In this regard, the panel recommends the programme to follow-up more systematically the academic/professional careers of its bachelor graduates.

Across all standards, the panel noticed that the programme has done a great job in addressing the numerous recommendations of the previous accreditation committee. This results in a good quality programme and fewer specific points for improvement. Currently there is one major development – the growing number of students - that requires the attention of the programme. The panel noticed during the discussions that all stakeholders understand the concerns, are aware of the challenges and are working on the different elements but was surprised that they do not seem to consider the situation acute. The panel therefore calls on the management to take a more proactive stance in developing a strategy - and in implementing the resulting policies – on how to accommodate the growing student numbers while maintaining the level of good quality small scale education.

In sum, the panel concludes that the quality of the bachelor's programme Computing Science is up to standard on all accounts, hence its overall positive conclusion.

The panel assesses the standards from the *Assessment framework for limited programme assessments* in the following way:

Bachelor's programme Computing Science

Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard
General conclusion	positive

The chair, em. prof. dr. T. (Theo) D'Hondt, and the secretary, M. (Mark) Delmartino MA, of the panel hereby declare that all panel members have studied this report and that they agree with the judgements laid down in the report. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 30 March 2020

DESCRIPTION OF THE STANDARDS FROM THE ASSESSMENT FRAMEWORK FOR LIMITED FRAMEWORK ASSESSMENTS

Standard 1: Intended learning outcomes
The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings

Profile
The bachelor programme Computing Science is offered by the Institute for Computing and Information Sciences (ICIS). In the Faculty of Science of Radboud University (RU), ICIS is both an interdisciplinary thematic research institute and an educational institute: the educational institute is responsible for the bachelor's and master's programmes Computing Science and the master Information Sciences. The latter programme is not part of this cluster assessment. The bulk of its teaching staff are members of the research institute and the programme specialisations correspond with the core domains of the research institute. Since the previous accreditation visit in 2013-2014, the bachelor programme has changed in different ways: main differences are the two specialisations tracks - Cyber Security and Software & Data Science – and the fact that since September 2018 the bachelor programme is offered in English.

The panel gathered from the self-evaluation report and the discussions on site that the computing science programmes at RU have a clear profile within the Dutch higher education landscape. Computing science in Nijmegen focuses on software products and emphasizes the role of theory and formal methods in its analysis, design, and manufacturing. Moreover, it is viewed as a constructive science: researchers and students design, build and analyse products according to academic standards, using and developing knowledge about these products and the production process. In comparison to other bachelor's programmes in the Netherlands, computing science at RU covers extensively three major programming paradigms (imperative, object oriented, functional) and their associated styles of computational thinking and problem solving. Furthermore, the panel noticed that Nijmegen is well known – also among potential students - for its attention to Cyber Security, one of the ten leading research areas of RU and a prominent specialism in its computing science programmes.

The primary goal of the three-year full-time bachelor's programme Computing Science is to train students for a subsequent master's programme. Nonetheless, students who envisage entering the labour market upon graduation acquire both a theoretical and a practical foundation which enables them to embark on a professional career in computing science. In fact, Radboud students with a bachelor's degree in Computing Science are expected to have a solid foundation in the science of computing, will be specialised in Cyber Security or Software & Data Science, will have been outside the computing science 'bubble' via a minor and free electives programme, and should be able to apply their knowledge and skills in a team-based setting to real world problems.

Intended learning outcomes
The programme aims are reflected in the intended learning outcomes (ILOs), which are listed in Appendix 2 to this report. The panel noticed that the ILOs cover all Dublin descriptors at bachelor level. The programme's end terms are formulated adequately for a programme at bachelor's level and their description is detailed. ILOs common to all computing science students are organised in categories. For each category, the learning outcomes list what students are expected to achieve in a very concrete way, notably with regard to system development, research and reflection. The panel noticed that the research category is well covered in the ILOs and appreciates that all students are expected to acquire elements of law within a computing science context. In addition, students gain several additional competences that are specific to their specialisation: Cyber Security or Software &

Data Science. Furthermore, the panel acknowledges that all competences are pursued in the programme end terms: the ILOs in the categories system development, core and specialisations concentrate on the knowledge domains, while the skills and attitudes of the computing science students are covered in the categories general, research and reflection.

There is a common understanding among Dutch universities offering computer science programmes that the so-called ACM Computer Science Curricula 2013 serve as domain-specific framework of reference for undergraduate programmes. The panel gathered from the extensive and good quality analysis in the self-evaluation that this is also the case for the bachelor's programme Computing Science at RU, whose ILOs cover the eleven characteristics of computer scientists as formulated by the Association for Computer Machinery. These characteristics, as well as a link to the reference document, are provided in Appendix 1 to this report. Comparing the Computing Science programme to the domain-specific profile, the panel noticed that the differences are minor and reflect the focus of the RU programme on cyber security, software systems and data science.

Professional field
The ILOs of the bachelor's programme Computing Science include explicit reference to preparing students for a next career step and to reflecting on the roles and activities of computer scientists in a job context. The panel noticed that the relevance of the programme objectives and the curriculum contents are checked and discussed regularly with the professional advisory committee (*Commissie Afnemend Veld*). This was confirmed during the visit by members of the advisory committee, which has been active for quite some time and was unanimously positive of the programme developments.

Considerations
The panel considers that the bachelor's programme Computing Science has an outspoken profile, which reflects the research priorities of the institute, the faculty and the university. The panel thinks highly of the way in which the vision on computing science interrelates with the priorities of the Institute and the programme specialisations on Cyber Security and Software & Data Science. Given this well-grounded profile, Computing Science in Nijmegen takes up a position of its own within the Dutch higher education landscape of computer science programmes.

The panel appreciates the clear and specific way in which the end terms of the programme have been formulated: the intended learning outcomes reflect adequately the domain (computing science), the level (bachelor) and the orientation (academic) of the programme. The ILOs also do justice to the specialisations and to the explicit ambition to prepare bachelor's students first and foremost for a follow-up master's programme. According to the panel, the learning outcomes cover comprehensively both the European-wide Dublin Descriptors and the international domain-specific ACM curriculum.

The academic orientation of the programme does not prevent students from acquiring relevant competences to enter the labour market as academically trained professionals. In this regard, the panel welcomes the role of the professional advisory committee in ensuring that the programme objectives and the curriculum contents remain up-to-date in the rapidly evolving field of computing science.

Conclusion
Bachelor's programme Computing Science: the panel assesses Standard 1 as meets the standard. .

Standard 2: Teaching-learning environment
The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings

Curriculum
The bachelor's programme Computing Science amounts to 180 EC, which are spread equally over three years of four quarters each. The curriculum consists of core courses (129 EC), specialization courses (24 EC), a minor (15 EC) and free electives (12 EC). Appendix 3 to this report provides an overview of the curriculum. The panel gathered from the information materials that the curriculum is a balanced mixture of single quarter 3 EC courses and 6 EC semester courses; thematically related courses are organized in course series ('leerlijnen').

The panel obtained extensive information on the bachelor's programme and its curriculum in the self-evaluation report and the annexes. Studying the materials, the panel found that the curriculum is well-thought through and very coherent across the three years. The first year features several courses on mathematics and computing science theory, which allows students to reflect whether they have made the right choice, provides a good foundation for the remainder of the programme and supports students in making an informed choice about the specialization. In the second year students deepen the core knowledge and specialise in either Cyber Security or Software & Data Science. The third year includes core courses that require some level of maturity and encourages students to think about their future preferences when they personalise their curriculum through the minor period, free electives and the bachelor's thesis.

During the visit, the panel looked into several course materials and found these to be of good quality and at the proper level for an academic bachelor's programme. It gathered from the detailed bachelor assessment matrix, which relates the learning goals per course to the overall end terms of the programme, that altogether the courses cover the intended learning outcomes of the bachelor's programme Computing Science. Furthermore, the panel noticed that the bachelor's programme covers all 18 knowledge areas defined by the ACM Curricula 2013. In order to ensure that first-year students get a comprehensive overview of the discipline, 16 knowledge areas are addressed during the propaedeutic year. Comparing the Computing Science programme with the model ACM curriculum, the panel found that next to the many similarities, there are a few differences that align with the profile and priorities of the institute, faculty and university: there is more attention at RU for Information Management and for Algorithms and Complexity, while System Fundamentals, Software Development Fundamentals and Graphics and Visualization are covered to a lesser extent than envisaged in the ACM curriculum. Further to its considerations on the programme's end terms, the panel found that that the Computing Science curriculum is in full alignment with the programme profile, the ILOs and the international domain-specific requirements.

An important topic of discussion during the site visit was the attention in the curriculum to academic skills. According to the student chapter in the self-evaluation report, students struggle during the first two years with writing academic reports and giving presentations, as these skills are only covered sparsely before the fourth-semester course on research methods and the fifth-semester course on academic writing. The panel gathered from the staff – and students confirmed this during the visit, as well – that there are several opportunities to acquire knowledge on research methods and practice writing and presentation skills during the first part of the programme. It seems that there is a lot more attention to academic skills than what is covered in the dedicated '*leerlijn*'. The panel therefore suggests to make the entire 'package' of academic skills components more visible in the curriculum description.

Another topic of discussion was the involvement of industry in the programme and the preparation of bachelor's students for a professional career. The panel noticed in the self-evaluation that following a recommendation of the previous accreditation committee, the programme had undertaken several

steps to improve the link with the professional field: three courses – Requirements Engineering, R&D Project, and Software Engineering – have a direct link with the professional field; in the GiPHouse, a RU-based software company run by students, students operate in a project team to implement an IT solution for a real customer as part of the Software Engineering course; throughout the entire curriculum, students participate through the Reflection and Vocational Orientation course in different activities such as lunch lectures or industry excursions; students with a particular interest in the professional field can do a bachelor's thesis project in industry. The discussions on site, the review of course materials and the visit to the GiPHouse demonstrated according to the panel that the programme had taken at heart the recommendation, but that there was room for further improvement in the uptake of the initiatives. Overall, it seems that only a limited number of students effectively undertake a placement period in industry because the time available for such thesis-related internship is too limited and thus not interesting for companies. Moreover, the current set-up of the GiPHouse is such that bachelor students mainly work in-house as programmers while master students co-ordinate the work and the contacts with industry. A review of the Reflection and Vocational Orientation course materials showed that the activities can be sharpened in order to fully reach the learning goals. Whilst acknowledging the many positive steps taken in this regard, the panel found that both the involvement of industry and the preparation of students can be enhanced: the programme could invest more in its contacts with industry to ensure that bachelor students can do an internship while at the same time it could promote this opportunity more with students. Moreover, the panel thinks the GiPHouse is a very laudable initiative but considers that the role of bachelor's students in this endeavour can be enhanced.

Students who desire more challenges can combine the bachelor Computing Science with a bachelor's degree in Mathematics and obtain two bachelor's degrees in three years with a total study load of 225 EC. Students indicated to the panel that this option is widely communicated, also prior to enrolment. In fact, the panel noticed that on average 10 to 15 students per year start the combined programmes. One student emphasised that the existence - and facilitation - of this combination influenced her decision to enrol at RU. Students interested in education can opt for a 30 EC minor programme, leading to a second degree teaching qualification. Alternatively, the best performing students in the propaedeutic phase can enrol for an honours programme, either university-wide or faculty-specific. Two students were very enthusiastic about the latter variant, which focuses on multi-disciplinary work and in-depth research in small groups with biology, physics, mathematics and chemistry students. It challenges students to get out of their comfort zone through multidisciplinary work and master-level courses; moreover honours students develop particularly strong research skills. Asked what part of the studies had helped them most in their current job, one alumna referred to the honours programme.

Language of instruction
Since September 2018, the bachelor's programme is taught entirely in English. The transition to an English language programme was implemented to increase the intake of international students in order to offer students a multi-cultural teaching environment and to be able to attract the best teaching staff. Moreover, it matches the language of instruction in both the master's programme Computing Science and the bachelor's programme Artificial Intelligence. The panel discussed the language transition in several sessions during the visit because students had indicated in the Student Chapter that they were not convinced of the benefits of the switch and were concerned it would impact on the quality of education. The panel gathered during the interviews that the transition had happened gradually as several courses were already offered in English before 2018. Moreover, students mentioned that the initial concerns reported in the Student Chapter at the end of the first year of implementation, had been mitigated in the meantime: almost all students and all staff are competent in English and with the support of the study association Thalia international students blend in well with Dutch students. Moreover, the programme is monitoring adequately the diverse levels of prior knowledge of the international student intake. The panel understands the rationale behind the decision to switch to an English-taught bachelor programme and thinks that the programme has addressed adequately the teething problems that usually accompany such transition.

Educational concept
The bachelor's programme adopts a didactic concept that emphasizes a constructive approach. Students acquire understanding (knowledge and skills) in a solution-driven way: based on the available understanding, new understanding is acquired and integrated, strengthening the existing understanding. Students learn that acquiring knowledge is an iterative process: solving a problem may require solving sub-problems or applying known solutions to the problem. The didactic concept is applied in the programme right from the start by including open-ended assignments and projects. Both the complexity and the level of autonomy of tasks and assignments is increased gradually. The goal is to make students aware of their existing understanding, help them identify missing understanding and obtain the skills to acquire new understanding. According to the panel, the educational concept is well conceived and particularly suitable for the programme given Nijmegen's vision on computing science as a constructive science.

The panel observed furthermore that the programme courses feature a wide variety of teaching methods ranging from plenary lectures and lab sessions to self-study, team projects and discussions. Students indicated that they appreciate this variety, as well as the relatively high number of contact hours: on average students meet their teachers for 25 hours per week during the first two years.

The panel noticed that this attention to teacher and peer contact is part of a broader philosophy within the institute to offer Computing Science students an approachable education environment. Students indicated both in the report and during the visit that the relatively small scale of the study is a particularly strong point. Several students and alumni mentioned that this feature was an important element in their decision to enrol at RU and confirmed that in this regard the study lived up to the expectations: teachers know their students personally, know what they are up to and take time to help them.

At the time of the site visit, the programme was implementing for the second year the so-called 'onderwijsluwe week': following the decision of the Faculty Board, lecturing staff was to reduce the number of teaching weeks from 8 to 7 in each quarter in order to allow students more time to finish assignments and study for the exams. Students had indicated in the student chapter that the principle was fine but that the implementation left to be desired. During the visit, students clarified that several teachers had struggled with this approach during the first year of implementation, but had adjusted their teaching in the meantime. The panel understood furthermore that this organisational decision was imposed by the faculty. Its implementation encountered some teething problems which in the meantime are monitored attentively, formally and informally, and at different levels.

Intake
Since the previous accreditation visit, the number of incoming students has increased. The creation of the Cyber Security track and the termination of the Information Science bachelor's programme in 2012 resulted in a first big increase of the student numbers from 33 in 2012-2013 to 72 in 2013-2014. Afterwards the inflow grew modestly but systematically. Following the transition to a fully English taught language programme, the student number increased substantially – from 102 students in the last 'Dutch' programme year 2017-2018 to 162 and 176 respectively in 2018-2019 and 2019-2020. The programme has always attracted a handful of international students, mostly from Germany. The number and share of international students has boomed in the last two years: in September 2019, 50 international students enrolled in the Computing Science bachelor's programme, representing nearly 30% of the total intake.

The panel understood from the Self-Evaluation report that the growing number of students is impacting in several ways on the teaching and learning environment: it requires more teaching staff, different teaching and assessment methods, different facilities, etc. Moreover, it seems to jeopardise the small-scale, approachable character of the programme. The discussions on site revealed that all stakeholders understand the concerns and are aware of the challenges but do consider the situation to be acute. While the panel had expected a more pro-active attitude based on a concrete analysis and action plan on how to overcome or mitigate the consequences of the student growth, the

management indicated that they were looking into the situation and were working on the different elements. The panel suggests nonetheless that the programme takes a more proactive stance and formulates a policy / strategy on how to accommodate the growing student numbers while maintaining the level of good quality small-scale education.

Furthermore, the panel noticed that the share of female students is steadily increasing, but still very low: from 4% in 2013-2014 to 11% in 2016-2017 and 15% in 2017-2018. The increase of international students has positively impacted on the share of female students. The panel gathered from the information that the programme is actively looking into promoting computing science for both male and female students. It is supported in this endeavour by the Radboud Women of Computing Science, a committee founded in 2014-2015 by female staff and students who aim to attract female students into computing science and stimulate them to continue their career in this domain. The detailed breakdown of the respective student cohorts indicates that the share of female students is on the rise since 2015-2016.

Feasibility
The panel learned that since the previous accreditation, the programme has taken several initiatives to enhance the feasibility of the programme. In so far as the first year is concerned, the tutor is actively engaged in supporting students; because bachelor's students have different entry levels when they enrol in the programme, lecturers can ask the tutor to provide meetups for the students to overcome difficulties. As a result the share of students obtaining a positive Binding Study Advice has increased from 58% in 2012-2013 to 75% in 2017-2018.

Students indicated both in the information materials and during the site visit that the workload is high but corresponds to what can be expected of a programme with a full-time study load of 60 EC per year. As there are no specific courses that systematically hinder a smooth and timely realisation of the curriculum, students consider that the overall programme is feasible. This statement, however, seems to be contradicted by the overall success rate: less than a quarter of the students who enrol in year 2 graduate within the nominal period of three years, while just over half of the students do so in four years. The panel was informed that the programme recently surveyed students about their study investment and the potential hurdles in the curriculum: 40% of the respondents indicated they have a structural job next to their study and 22% deliberately choose not to study full-time. Students indicated that the workload is spread unevenly with the second year being more difficult than the third year. Moreover, students do encounter problems with individual courses: the survey identified four such courses (three of which in the second year); the programme management is now investigating how to improve their feasibility. While the third year is reportedly easier content-wise, it does require careful planning, individual choices and more individual work with fewer contact hours; in this regard the bachelor's thesis causes (further) study delay for almost half of the students. The panel appreciates the efforts of the programme to monitor the feasibility of the programme and to undertake action whenever this is required. It is aware that very often reasons for completing the study with a considerable delay are outside the scope of the programme.

Staff
The self-evaluation report provides an overview of the teaching personnel at ICIS. The education institute deploys education formation from the research institute, which means that teaching staff belongs to one of the three research sections of ICIS: Software Science, Data Science or Digital Security. The panel learned that courses are always coordinated by teaching staff with a research position, that every course features at least one expert as lecturer and that the Faculty of Science expects its (top) researchers to also teach first year bachelor's students. The panel appreciates this approach and policy.

The panel was informed that the institute, faculty and university are paying attention to attracting female staff who in turn serve as role models for attracting new students and PhD researchers. Currently, 20% of the ICIS teaching staff – five full professors and three assistant professors - is female. The panel welcomes this consistent effort, which seems to bear fruit.

Almost all lecturers have a basic or senior teaching qualification or are in the process of obtaining such educational qualification. The panel learned that teaching skills are considered important at RU and ICIS: the central Educational Support department offers several training schemes for lecturers, while the Education Board of the Institute organizes teacher days, issues teacher guidelines and informs staff during bi-monthly staff lunches. Following the decision to move to an English-taught programme, the English language proficiency of all staff teaching in the bachelor's programme was evaluated; while the central university service found that there was no need for additional training, some staff did follow a course to enhance their language skills. Students indicated in the student chapter and during the visit that they think highly of the domain-specific know-how and the didactic qualities of the staff; the teachers' level of English is invariably sufficient.

The panel noticed in the information materials that staff numbers relate to the entire institute and the three programmes it is responsible for. During the academic year 2018-2019, 39 scientific staff members – full/associate/assistant professors and appointed lecturers - were involved in teaching. The panel observed that over the past few years the number of students in the three programmes has increased significantly while there was hardly any increase in the institute's teaching staff: the staff-student ratio went up from 1:36 in 2015 to 1:53 in 2018. According to the programme management, this increase has been mitigated by hiring teaching assistants and will be further reduced when several vacancies are eventually filled. Students from their side indicated that the level of individual support they were used to receive from teachers is going down. The teachers are still very much willing to help but are reaching their limits in supporting an ever growing number of students. As already mentioned with regard to intake, the panel sees room for a more pro-active stance of the management to treat the high student intake as an acute issue.

Facilities
The computing science programmes are housed in the Mercator 1 building. While teaching locations are also located in other buildings of the Science faculty, the panel noticed during a guided tour that this building is really the home base of both staff and students: spread over three floors, there are offices for lecturers, study places for students and the board room of the study association Thalia. It also hosts the New Devices Lab and the student company GiPHouse. The panel acknowledges that the building contributes to creating a homey atmosphere and allows for frequent contacts between and among students and staff. However, its capacity is hardly sufficient for the current 'inhabitants', let alone for any further growth in staff and student numbers. After visiting the data security lab as one example of the lab facilities, the panel voiced its concern to the management about the limited space in the lab and the number of students and researchers it was expected to accommodate.

The panel noticed that Thalia, the study association of Computing Science in Nijmegen, plays an important role in building a community among and providing services to students: it is involved in the introduction week and organizes several activities throughout the year involving alumni and industry. The panel learned that Thalia offers introductory courses to students on supporting tools such as Linux, LaTeX and Git that are not covered in the regular curriculum. Another recent initiative is the co-organization of a bachelor's thesis market to inform students about thesis projects in industry. The institute considers the study association as a reliable partner and provides good support for their activities. According to the panel, the study association constitutes a value added for the programme and the institute.

Students play an important role in the quality system of the programme. They fill in course evaluations, are an active part of the programme committee and are represented on the education board meetings through a so-called institute assessor. Furthermore, they feel safe to share constructive criticism with the teaching staff. Students indicated to the panel that they appreciate the good contact with the programme management, that course evaluations are followed-up through the programme committee and by the teaching staff concerned.

Considerations
The panel considers that the teaching-learning environment of the bachelor's programme Computing Science is up to standard. In fact the panel thinks very highly about several components of the programme, and of the staff and facilities: the curriculum is coherent and its contents are in full alignment with the programme profile, the intended learning outcomes and the international disciplinary requirements; talented students attending the honours programme or enrolling for a second bachelor's degree appreciate these additional opportunities; the didactic concept underlying the programme is both clear and appropriate; the teaching staff is highly qualified in terms of both disciplinary know-how and didactics, and bachelor's students are exposed in class to high quality researchers; the explicit attention to female staff is in turn attracting female students and researchers; the Mercator building contributes to the small scale approachable education environment; and the study association constitutes a value added for the students, the programme and the institute.

Throughout the visit, the panel has come across a number of cases where a more explicit communication on the opportunities on offer would enhance the overall quality of the programme even more. In this regard it suggests the programme to make the entire range of academic skills components more visible in the curriculum description and to enhance the exposure of bachelor's students to industry in the curriculum, possibly but not exclusively through a more substantial role in the GiPHouse.

Furthermore, the panel understands the rationale for an English-language programme and considers that overall the transition to another language went smoothly. While it subscribes to the positive effects of this change in terms of attracting international students and staff, the panel is also concerned that the growing number of students is starting to affect some of the achievements and typical features of the Computing Science programme in Nijmegen, such as the small scale of the programme, the variety of teaching methods, the availability of teaching staff and the homey atmosphere in and capacity of the building. It therefore calls on the management to take a more active stance with regard to these challenges which are likely to become bigger rather than smaller in the near future.

Finally, the panel appreciates the efforts of the programme management to monitor the feasibility of the programme and to undertake action whenever this is required. It is aware that very often reasons for completing the study with a considerable delay are outside the scope of the programme.

Conclusion
Bachelor's programme Computing Science: the panel assesses Standard 2 as meets the standard. .

Standard 3: Student assessment
The programme has an adequate system of student assessment in place.

Findings

Assessment system
The panel noticed that the assessment system of the bachelor's programme Computing Science is based on the policy and procedures of the Science Faculty. Within the programme, there is a clear relation between the programme learning outcomes, the learning goals at course level and the test form to assess whether all learning goals have been achieved. Every course file consists of a course description, the learning goals and the exam(s) together with the correction prescription and a test matrix. By completing a test matrix, every course coordinator ensures that the different learning goals are tested and covered by the examination. Prior to the site visit, the panel studied the overall test matrix for the bachelor's programme, which lists the learning goals and test forms associated with each course.

The panel noticed in the overall test matrix that throughout the bachelor's programme, students are confronted with various test formats such as written exams, project exams, oral presentations, assignments, essays, (research) reports and peer review. During the first year most courses include a written exam and/or an assignment. Furthermore, every exam is created according to the four eyes principle: the course coordinator consults with a colleague to check that the exam tests what is required and whether the size, the formulation and the level of the exam are adequate.

The panel learned that in line with the provisions of the Science faculty, the Computing Science programmes are running a number of digital exams for programming courses using the campus-wide Cirrus system for digital testing. In view of the growing student numbers, the panel encourages the programme to further investigate the opportunities for digital testing.

The Computing Science programmes have a fraud policy, which is described in the Teaching and Exam Regulations and discussed extensively with students and among staff. Students confirmed to the panel that they are informed at several occasions about fraud and are well aware of the sanctions.

Course and thesis assessments
The panel noticed that the assessment principles underlying the bachelor's programme are sound and have been rigorously implemented in all courses. On site the panel looked into course files and their respective assessment forms and found these to be appropriate: the questions were valid and reliable. Students indicated during the visit that assessment is transparent: they know well in advance what they need to know for the exam and how they will be assessed.

As part of its thesis review, the panel studied a sample of 15 bachelor's theses and their respective assessment forms. Every thesis is assessed by the supervisor and a second reader using a similar but not identical evaluation form which they complete separately: the supervisor judges the product, process management, process content and presentation of the thesis, while the second reader only evaluates the product and the presentation. A short motivation is required when a dimension is marked insufficient or excellent or in case the assessor wants to change the proposed phrase of the rubric. The form also offers room for additional explanations. A third and final evaluation form is completed by the supervisor, second reader and the bachelor thesis coordinator: the supervisor and second reader propose a final grade, which is then validated by the thesis coordinator. The panel learned that this thesis evaluation format has been specifically developed following a recommendation of the previous accreditation committee. The panel thinks the evaluation form is good, provided it is completed properly. It acknowledges that the use of rubrics does contribute to a greater uniformity in the evaluation process of the bachelor's thesis. In almost all cases the panel agreed to the final score; however, the panel found that the form is not inviting for assessors to provide qualitative feedback and motivate their appreciation per dimension. In fact, the panel noticed that many supervisors / second readers only complete the motivation part in case of an outlier score. Those who do motivate their scores systematically, provide useful comments that help understand the final score. The panel welcomes the enhanced evaluation form and encourages the programme to monitor that all assessors add qualitative feedback to motivate each dimension that contributes to the final grade, not only the outlier categories.

The thesis evaluation is processed online through a faculty-wide system SPIB. Since the introduction of this system, which required an adaptation of the new evaluation form for online handling, there has been a problem with the retrieval / printed version of the evaluation form. The panel noticed that it was indeed very hard to read and review the thesis assessment form. According to the management and the Examination Board, the system is under review and should be optimized in the course of 2019-2020.

Examination Board
The Examination Board is responsible for safeguarding the quality of assessment and the realization of the intended learning outcomes in the Computing Science programmes. The panel gathered from the discussion with the Examination Board that the individual members have adequate expertise to

fulfil their quality assurance tasks. It welcomes the random checks the Examination board performs of the course files and the respective exams and test matrices. The panel learned that the Examination Board also checks that the bachelor's theses meet the requirements in terms of content, level and form. The panel subscribes to the statement of the Examination Board that the sample check did not raise concerns with regard to the quality of the theses and the allocated scores. The Examination Board agreed with the panel that the online evaluation form is not inviting for assessors to provide additional qualitative feedback. However, the panel thought the Examination Board could have spotted that the evaluation forms were not always completed in an insightful way because qualitative feedback motivating the score was missing, and could have undertaken action in this regard.

During the discussion, the Examination Board indicated to the panel that there are many ideas for change and improvement in the Computing Science programmes, but their implementation process is slowed down because the education centre reportedly has to serve several programmes and there is a tendency at faculty level to harmonise processes as much as possible across all programmes. Issues that are currently at stake include a workable retrieval of the thesis evaluation form, formulating explicit rules on what is fraud/plagiarism in coding assignments, checking plagiarism in exam products submitted for programming courses, and devising alternative (digital) testing formats. While it acknowledges the circumstances and appreciates the commitment of the Examination Board to its quality assurance tasks, the panel did find the Examination Board rather reactive in its approach and recommends it takes a more proactive stance insisting that its findings and recommendations are implemented.

Considerations
The panel considers that student assessment is well organized in the Computing Science programme. The policy and principles underlying course assessments are up to standard. The panel thinks highly of the extensive overall programme test matrix. Based on the discussions on site and the limited sample of individual assessments it reviewed, the panel considers that the course assessments are valid, reliable and transparent. Moreover, the panel appreciates that the programme is taking fraud seriously.

Based on its own sample review, the panel considers that overall the assessment process of the thesis and the evaluation format are adequate and constitute a clear improvement compared to the previous accreditation visit. The rubric allows for precise and harmonized final grades. If used properly and completed fully, the evaluation form is very relevant. While several assessors complete the evaluation form in an insightful way, the panel encourages the programme to impose – and the Examination Board to monitor systematically - that all assessors provide qualitative feedback to motivate their scores.

According to the panel, the Examination Board has appropriate expertise and uses this to quality control the course and thesis assessments. Nonetheless, the panel thinks that the committee can make better and more pro-active use of its expertise and independent position to insist that its findings and recommendations are implemented. In view of the growing student numbers, the panel recommends the programme to investigate in particular the opportunities of digital testing.

Conclusion
Bachelor's programme Computing Science: the panel assesses Standard 3 as meets the standard. .

Standard 4: Achieved learning outcomes
The programme demonstrates that the intended learning outcomes are achieved.

Findings

Thesis quality
In order to establish whether students achieve the intended learning outcomes, the panel has reviewed a sample of 15 bachelor's theses that were accepted in the academic year 2018-2019. The thesis is an individual research project and organized as a semester course. Following the recommendation of the previous accreditation committee, the bachelor's thesis has expanded from 9 EC tot 12 EC. The student chooses a supervisor among the ICIS staff members who belong to one of the three departments Software Science, Data Science or Digital Security. Students appreciate this freedom to choose a topic and a supervisor and indicated to the panel that they highly value the expertise and availability of their supervisors.

The panel found that each of the fifteen theses were of a quality that can be expected of a final project at bachelor's level. In several cases the quality of the work was high. The theses that according to the panel deserved a high score were quite complex, extensive, with a well-developed research component and written in a proper academic style. Those at the lower end of the continuum all deserved to pass but did less well on complexity, on developing the research question and in terms of academic writing.

In a previous section, the panel considered that through the individual courses, the curriculum allows students to acquire the programme's intended learning outcomes. Having reviewed a selection of bachelor's theses, the panel considers that students who successfully pass the thesis have indeed achieved all intended learning outcomes. Moreover, the panel considers that the thesis fits particularly well with the profile of the Computing Science programme and its attention to research skills.

Alumni
In addition to verifying the quality of the final deliverables, the academic and/or labour market performance of bachelor graduates is another way to establish whether students achieve the intended learning outcomes upon completion of the programme. Both the information materials and the discussions indicated that most bachelor graduates move on to a master's programme and very often do so at Radboud University. Nonetheless, many bachelor's students choose not to study full-time, hold a part-time job position in the domain of IT during their study and continue to do so during their master programme.

The panel noticed that the programme could only provide data on those bachelor graduates that continued studying at RU. While this group constitutes the majority of graduates, the panel thinks the programme would benefit from following-up more systematically the whereabouts of all graduates. According to the programme management, there are plans at faculty level to implement an alumni policy. The panel welcomes the initiative and recommends gathering and processing data on an individual programme level. This is all the more relevant in view of the growing number of students (30% in 2019, compared to 11% in 2016) who decided not to pursue their career at RU and may either have entered the labour market or enrolled for a master's degree elsewhere in the Netherlands or abroad.

Considerations
Based on its review of the final thesis projects and the discussions on site, the panel considers that bachelor's students who graduate from the Computing Science programme are adequately prepared for a follow-up study. Graduates may well be fit for a position on the labour market, too, but there is no evidence for the moment confirming that students leave university with a bachelor's degree and pursue a professional career in industry. In this regard, the panel recommends the programme to follow-up more systematically the academic/professional careers of its bachelor graduates.

Having established that each thesis in the sample meets at least the minimum requirements of what can be expected of a final project at bachelor level – and often is of higher quality – it is fair to state that the intended learning outcomes of the programme are eventually achieved at the end of the bachelor's curriculum.

Conclusion
Bachelor's programme Computing Science: the panel assesses Standard 4 as meets the standard. .

GENERAL CONCLUSION

In the previous sections, the panel has come to the conclusion that the BCS programme fulfils the quality requirements with regard to each of the four standards set by the NVAO's Assessment Framework for the higher Education Accreditation System of The Netherlands for limited programme assessments: intended learning outcomes, teaching-learning environment, student assessment, and achieved learning outcomes. Hence, the panel's overall assessment of the *bachelor's programme Computing Science* is positive.

APPENDICES

APPENDIX 1: DOMAIN-SPECIFIC FRAMEWORK OF REFERENCE

The bachelor's programme Computing Science uses the ACM Computer Science Curricula 2013 as domain-specific framework of reference. This curriculum framework is used by many programmes across the world and the Dutch computer science programmes have agreed to use it for bachelor's as well as master's programmes. The ACM framework is formulated for undergraduate programmes and available at: https://www.acm.org/binaries/content/assets/education/cs2013_web_final.pdf

The Association for Computing Machinery (ACM) is an internationally recognised institute that produces resources with the intention of helping computer science and similar fields advance scientifically as well as professionally. Besides giving detailed lists of subject matter to be covered in an undergraduate programme, it describes a computer science graduate in 11 characteristics.

At a broad level, the expected characteristics of computer science graduates include the following:

1. Technical understanding of computer science
2. Familiarity with common themes and principles
3. Appreciation of the interplay between theory and practice
4. System-level perspective
5. Problem solving skills
6. Project experience
7. Commitment to life-long learning
8. Commitment to professional responsibility
9. Communication and organizational skills
10. Awareness of the broad applicability of computing
11. Appreciation of domain-specific knowledge

For a more detailed coverage, please refer to chapter 3, page 23 on the above link.

APPENDIX 2: INTENDED LEARNING OUTCOMES

Bachelor's programme Computing Science

General end terms
The student has acquired knowledge and skills at the intended area (computing science), as well as:
a. the student has an academic attitude
b. the student is prepared for a next (study) career step

(System) development
The student can describe and select system development methods. The student can solve system development challenges at a basic level. The student can:
a. invent a suitable application for a given situation
b. assemble the system requirements
c. design an application and justify its design
d. implement an application in a team and / or individually
e. evaluate an application regarding functional correctness and usability
f. document the final product

Research
The student can describe and select appropriate (generic and discipline specific) research methods. The student can solve research problems at a basic level. The student can:
a. determine a relevant problem statement
b. formulate and justify a matching research question, hypothesis
c. describe and justify a matching theoretic context and research method
d. perform the research
e. report and present the results
f. invent and justify a(n innovative) scientific solution to a problem

Communication
The student can present and document computing science related material at a basic level in a clear manner to her peers. The student has fulfilled several roles in project teams.

Reflection
Given a problem at basic level, the student can identify relevant computing science domains and their contributions, in particular with respect to the skills mentioned below:
a. reflect on her role as junior academic
b. participate in discussions concerning the impact in society of computing science developments
c. identify characteristic functions, roles, activities, and competences of computer scientists in a job context
d. make a well informed decision concerning a specific subsequent (master) study or otherwise

Core
The student can perform the above-mentioned activities in, and using knowledge from, the following computing science domains:
a. algorithms and theory
b. programming
c. computer systems and security
d. information and knowledge systems
e. mathematics
f. law

Specialisation: Cyber Security
The student can also:
a. analyse security problems and their causes

b. describe and apply security -techniques, -cryptography, -guidelines, and -principles
c. make a well-informed decision concerning not only technical aspects, but also personal and societal aspects, such as privacy and implementation in organisations

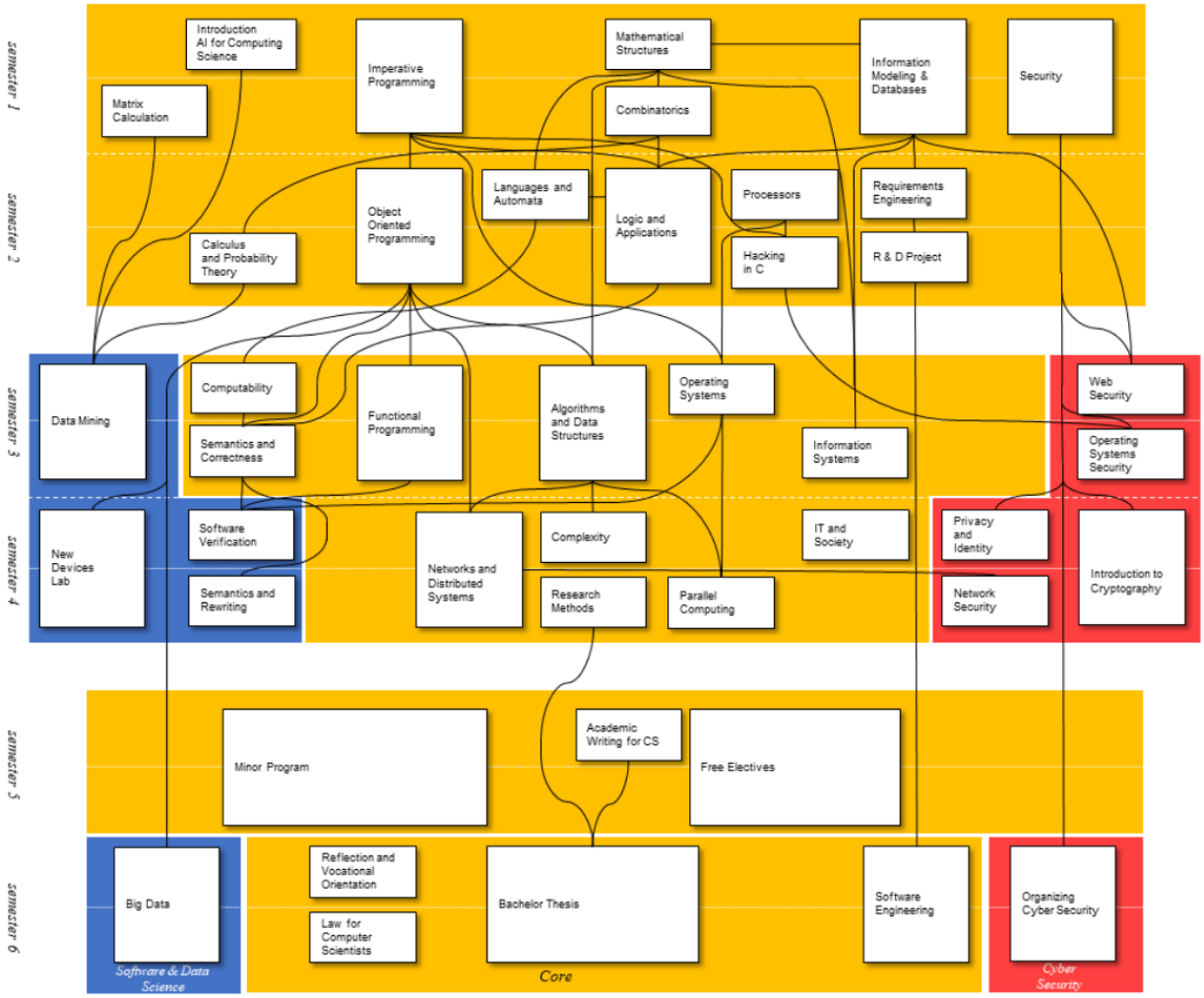
Specialisation: Software & Data science
The student can also:
a. implement platform specific applications for embedded computers
b. describe the semantics of programming languages in suitable formalisms
c. analyse the behaviour of programs using computational models and tools
d. identify techniques for extracting relevant information out of big data
e. identify fundamental search techniques, explain their differences, select and implement them.

Double bachelor Mathematics & Computing Science
a. more comprehensive mathematics and logic
b. in case of the specialization Cyber Security: describe and apply security –techniques, -cryptography, -guidelines, and -principles
c. in case of the specialization Software & Data Science:
    i. describe the semantics of programming languages in suitable formalisms
    ii. analyse the behaviour of programs using computational models and tools
    iii. identify fundamental search techniques, explain their differences, select and implement them.

APPENDIX 3: OVERVIEW OF THE CURRICULUM

Bachelor's programme Computing Science

This overview shows the entire bachelor programme, consisting of a core (gold) and two specialisations: Software & Data Science (blue) and Cyber Security (red).



APPENDIX 4: PROGRAMME OF THE SITE VISIT

Venue: RU Nijmegen, campus Toernooiveld, Huygens building, room 01.060

Programme site visit Computing Science, Radboud University		
Date: 18-11-2019	**Activity**	**Language**
10.30 h. - 10.45 h.	Arrival of panel	
10.45 h. - 13.00 h.	Preparation panel (closed session), including lunch	
13.00 h. - 14.00 h.	**Round 1:** Programme management	Dutch
14.15 h. -15.15 h.	**Round 2:** Examination board (and admissions officer)	Dutch
15.15 h. - 16.15 h.	Guided tour panel - visit Mercator, GIP/LEGO/New Devices Lab etc.	
16.15 h. - 17.00 h.	**Round 3:** Alumni, employers and professional advisory board	Dutch
17.00 h. - 18.00 h.	Walk-in session	
18.00 h. - 18.30 h.	Deliberations panel (closed session)	
Date: 19-11-2019	**Activity**	**Language**
08.45 h. - 09.00 h.	Arrival of panel	
09.00 h. - 09.45 h.	**Round 4:** Students (Bachelor)	English
10.00 h. - 10.45 h.	**Round 5:** Students (Master)	English
11.00 h. - 12.00 h.	**Round 6:** Lecturers (Bachelor and Master)	English
12.00 h. - 13.15 h.	Lunch and preparation final feedback (closed session)	
13.15 h. - 14.00 h.	**Round 7:** Programme management (final consultation)	Dutch
14.00 h. - 16.15 h.	Panel deliberations (closed session)	
16.15 h. - 16.30 h.	**Plenary feedback of main findings by panel chair in HG 00.071**	English
16.45 h. - 17.30 h.	**Development dialogue (closed session)**	Dutch
17.30 h.	Drinks and snacks in Mercator 1 (ground floor)	

APPENDIX 5: THESES AND DOCUMENTS STUDIED BY THE PANEL

Bachelor's Programme Computing Science, Self-evaluation report, September 2019.

Prior to the site visit, the panel studied 15 theses of the bachelor's programme Computing Science. Information on the selected theses is available from QANU upon request.

Following materials were made available by the Educational Institute for Computing and Information Sciences before or during the site visit, either as hard copy or in digital format through the QANU document site or the faculty's electronic learning environment Brightspace:

Overview of student intake

Toetsmatrix bachelor programme

Annual Reports: Jaarverslagen van het Onderwijsinstituut Informatica en Informatiekunde (jaren 2013-2014 t/m 2017-2018)
Verslagen van vergadergremia

a. Verslagen en rapportages van de Examencommissie
b. Verslagen van de Opleidingscommissie
c. Verslagen van de Onderwijsdirectie

Course materials: Cursusmateriaal, bestaande uit literatuur (indien als hard-copy aanwezig) en samenvatting van cursusdossiers. Hierbij was opgenomen de cursusbeschrijving, practicumopdrachten (voor zover aanwezig), (deel)tentamen(s) en correctievoorschrift(en), toetsmatrix, student-evaluaties, docentevaluatie en oordeel van de opleidingscommissie.
Tevens is digitaal cursusmateriaal beschikbaar gemaakt via Brightspace.

- NWI-IPC023 Requirements Engineering
- NWI-IPC026 Web Security
- NWI-IPC031 Imperative Programming
- NWI-IBC022 Network Security
- NWI-IBC027 Algorithms and Data Structures
- NWI-IBI008 Data Mining
- NWI-I00041 Information Retrieval
- NWI-IMC039 Cryptographic Engineering

Het materiaal van de cursus NWI-IBI010 Reflection and Vocational Orientation is digitaal beschikbaar gesteld via Brightspace, en tevens is een overzicht van requirements beschikbaar gesteld.

Enkele *Thabloid*s – blaadje van studievereniging Thalia

Keuzegids Hoger Onderwijs (Universiteiten + Masteropleidingen)

Strategisch plan 2016-2020 van de faculteit Science