Artificial Intelligence

Faculty of Sciences,
Vrije Universiteit Amsterdam

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This report was finalized on 6 December 2013.

Report on the bachelor's programme Lifestyle Informatics and the master's programme Artificial Intelligence of the Vrije Universiteit Amsterdam

This report takes the NVAO's Assessment framework for limited programme assessments as a starting point.

Administrative data regarding the programmes

Bachelor's programme Lifestyle Informatics

Name of the programme:	Lifestyle Informatics
CROHO number:	56983
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specializations or tracks:	-
Location(s):	Amsterdam
Mode(s) of study:	full time
Expiration of accreditation:	31-12-2014

Master's programme Artificial Intelligence

Name of the programme:	Artificial Intelligence
CROHO number:	66981
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	Intelligent Systems Design Web Science Human Ambience Cognitive Science
Location(s):	Amsterdam
Mode(s) of study:	full time
Expiration of accreditation:	31-12-2014

The visit of the assessment committee Artificial Intelligence to the Faculty of Sciences of the Vrije Universiteit Amsterdam took place on 10th and 11th June 2013.

Administrative data regarding the institution

Name of the institution:	Vrije Universiteit Amsterdam
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	applied (pending)

Quantitative data regarding the programmes

The required quantitative data regarding the programmes are included in Appendix 5.

Composition of the assessment committee

The assessment of the bachelor's programme Artificial Intelligence was part of an assessment cluster. In total, the committee assessed 14 Artificial Intelligence programmes. The committee that assessed all of these programmes consisted of eight members:

- Prof. drs.dr. L.J.M. (Leon) Rothkrantz (chairman), Associate Professor at Delft University of Technology and Professor of Intelligent Sensor-Systems at the Netherlands Defense Academy;
- Prof. dr. ir. D.K.J. (Dirk) Heylen, Professor of Socially Intelligent Computing, Department of Computer Science at the University of Twente;
- Prof. dr. T. J. (Tim) Grant, Emeritus Professor of Operational ICT & Communications within the Faculty of Military Sciences at the Netherlands Defence Academy (NLDA) and founder/director Retired But Active Researchers (R-BAR);
- Dr. J. (Jimmy) Troost, Director of Thales Research & Technology, Delft;
- Drs. M.J. den Uyl, owner of SMRGroup, Senior Researcher and CEO of VicarVision, Sentient and Parabots;
- Prof. dr. L. (Luc) De Raedt, Research Professor at the Lab for Declarative Languages and Artificial Intelligence at the Department of Computer Science of the KU Leuven;
- Prof. dr. P. (Patrick) de Causmaecker, Professor of Computer Science at KU Leuven, Kortrijk Campus, Belgium, guest professor at KaHo St.-Lieven, Ghent, Belgium, and Head of the CODes research group, coordinator of the interdisciplinary research team itec at KU Leuven, Kortrijk Campus;
- R.H.M. (Rik) Claessens, BSc, student of the master's programme Artificial Intelligence of Maastricht University;
- Y. (Yfke) Dulek, student of the bachelor's programme Artificial Intelligence of Utrecht University.

For each site visit a subcommittee was set up, taking into account any potential conflict of interests, expertise and availability. To ensure consistency within the cluster the chairman, prof. drs. dr. Leon Rothkranz, attended all visits.

The coordinator of the cluster visits for Artificial Intelligence was drs. Hans Wilbrink, QANU staff member. He was also the project leader for the visit to Utrecht University and the VU University Amsterdam. During the other site visits, drs. Titia Buising was the project leader. To ensure continuity, both project leaders frequently held consultations. The coordinator was also present at the final meeting of all visits within the cluster.

The committee that assessed the bachelor's programme Lifestyle Informatics and the master's programme Artificial Intelligence consisted of:

- Prof. drs. dr. L.J.M. (Leon) Rothkrantz (chairman);
- Prof. dr. T. J. (Tim) Grant;
- Drs. M.J. den Uyl;
- Prof. dr. L. (Luc) De Raedt;
- Y. (Yfke) Dulek (student member).

The VU University Amsterdam board and the Accreditation Organisation of the Netherlands and Flanders (NVAO) approved the composition of the assessment committee. Appendix 1 contains the CVs of the members of the committee.

The committee was supported by drs. H.A.T. (Hans) Wilbrink, who acted as secretary. Appendix 1 contains the curricula vitae of the members of the committee.

Working method of the assessment committee

Preparation
To prepare for the site visits, the coordinator first checked the quality and completeness of the self-evaluation reports produced by the programmes and forwarded them to the participating committee members. They read the reports and formulated questions about their contents. The coordinator collected the questions and arranged them according to topic and/or interview partner. As well as the critical reflections, the committee members read a total of 15 theses for each programme. The theses were randomly chosen from a list of graduates of the last two completed academic years, while covering a range of grades and supervisors.

On 14 March 2013 the Artificial Intelligence committee held a preliminary meeting, during which the committee was formally installed and its tasks and working methods were discussed. The proposed Domain-Specific Reference Framework for Artificial Intelligence was also accepted (see Appendix 3).

Site visit
The coordinator prepared timetables for the site visit in consultation with the committee chair and the participating institutions. The timetable for the visit for the bachelor's and master's programme at VU University Amsterdam is included as Appendix 2.

Prior to the visit the committee asked the programmes to select representative interview partners. The underlying idea was to exchange thoughts with students, lecturers and supervisors of all participating programmes. Well in advance of the visit, the committee received a list of the selected interview partners for its approval. During the visit, it spoke to faculty and programme management staff, students, lecturers, members of the programme and examination committees, and alumni.

During the visit, the committee examined material it had requested and gave students and lecturers the opportunity – outside the set interviews – to talk informally to the committee during a consultation hour. One request was received for this option.

The committee used the final part of the visit for an internal meeting to discuss the findings. The visit was concluded with a public oral presentation of the preliminary impressions and general observations by the chair.

Report
After the site visit, the project secretary wrote a draft report based on the findings of the committee. It was first read and commented upon by the committee members. Then it was sent to the Faculty to check for factual irregularities. Any comments from the Faculty were discussed with the chair of the assessment committee and, if necessary, with the other committee members. After that, the report was finalised.

Decision rules
In accordance with the NVAO's Assessment framework for limited programme assessments (as of 22 November 2011), the committee used the following definitions for the assessment of both the standards and the programme as a whole.

Generic quality
The quality that can reasonably be expected in an international perspective from a higher education bachelor's or master's programme.

Unsatisfactory
The programme does not meet the current generic quality standards and shows serious shortcomings in several areas.

Satisfactory
The programme meets the current generic quality standards and shows an acceptable level across its entire spectrum.

Good
The programme systematically surpasses the current generic quality standards across its entire spectrum.

Excellent
The programme systematically well surpasses the current generic quality standards across its entire spectrum and is regarded as an (inter)national example.

Summary judgement bachelor's programme Lifestyle Informatics and master's programma Artificial Intelligence

This report reflects the findings and considerations of the panel on the bachelor's programme Lifestyle Informatics and the master's programme in Artificial Intelligence at VU University Amsterdam. The evaluation of the panel is based on information provided in the critical reflections and the selected theses, additional documentation and interviews conducted during the site visit. The panel noted both positive aspects and aspects which could be improved. Taking those aspects into consideration, the panel decided that both programmes fulfill the requirements of the criteria set by NVAO which are the conditions for accreditation.

Bachelor's programme Lifestyle Informatics

Standard 1: Intended learning outcomes
The bachelor's programme Lifestyle Informatics (LI) replaced the bachelor's programme in Artificial Intelligence in 2009. The curriculum is designed to attract – apart from students with a more 'traditional' AI profile – students with exact talents, who are also interested in human functioning and society. The programme rests on the exact sciences as a basis for techniques that are useful in developing intelligent applications and the human sciences, and on the human sciences as a basis for an understanding of human functioning and wellbeing. As a bridge between these two streams the so-called modelling stream ties them together which aims to achieve the depth that is required to analyse and design scientifically justifiable smart systems.

The committee considers the content, level and orientation of the bachelor's programme Lifestyle Informatics satisfactory for an academic bachelor in the field of Artificial Intelligence. The committee appreciates the efforts made to develop a new curriculum that is more attractive to students who are capable with respect to exact science, but may not primarily have a technical scope of interest. The committee does point out however, that the exact science aspect of bachelor's programme LI is concise to such a degree that the minimum requirements of an academic programme within the realm of Artificial Intelligence are reached. The committee established that the programme is academically oriented towards a scientific career or a position as a professional in business and organisation.

Standard 2: Teaching-learning environment
The bachelor's programme Lifestyle Informatics offers a multidisciplinary programme focusing on intelligent support of human wellbeing and functioning in physical, mental and social respects. The curriculum is divided into four interacting streams: the *Human Sciences stream*, which covers relevant topics from health, psychological and social sciences; the *Artificial Intelligence and Informatics stream*, which covers relevant topics from artificial intelligence and informatics; the *Modelling stream*, which focuses on modelling techniques and skills, thereby integrating human sciences and exact sciences; and the *Integration Projects stream*, which allows students to learn in more depth how domain models can be integrated in software systems in order to make them human-aware so that they can provide support in a knowledgeable, smart manner.

The committee established that the bachelor's programme offers a limited amount of exact sciences; it concluded that the exact sciences are satisfactorily present in the curriculum, but are rather hidden and should not be reduced anymore. Intended learning outcomes are

satisfactorily incorporated into the bachelor curriculum. According to the committee, the programme management is still searching for the optimal coherence of the curriculum.

Development of academic skills and attitude is adequate in the programme. The study load for the bachelor's programme is acceptable, although differences in this respect were noticed between courses. The committee was enthusiastic about the teaching staff. Many have a BKO, all are active in research and full professors are already involved in the first year of the programme. The committee recommends to pay attention to the didactic concept. It should be clearly defined which concept is used; subsequently, this should be communicated to all stakeholders. Programme specific facilities, student guidance and quality assurance are satisfactory. Based on those findings, the committee established that the bachelor's programme fulfills the requirements for the teaching and learning environment.

Standard 3: Assessment and achieved learning outcomes
The VU Faculty of Sciences has one central Examination Board (EB), subdivided in several domain-related committees – including one for all bachelor's and master's programmes of the Computer Science Department. The EB has also created an Assessment Committee which is mandated to develop the assessment policy.

The committee concluded that the assessment system for the bachelor's programme is adequate, but that the introduction of an assessment policy was rather late. Only recently the programme started with the implementation of this policy. The committee finds that the EB could have been more proactive in this aspect and should not have waited until the policy was imposed top-down.

Until 2012 the bachelor's programme allowed students to write a thesis that did not necessarily study a research question. The 'bachelor referaat' did not have the academic quality that could be expected of a bachelor thesis. However, the current bachelor thesis was considered to be adequate for a bachelor's programme in artificial intelligence and is up to standard for an academic bachelor level.

Master's programme Artificial Intelligence

Standard 1: Intended learning outcomes
The master's programme in Artificial Intelligence (AI) is a scientific programme that is designed to provide students with a practical understanding of the position of the field of Artificial Intelligence within a broad scientific, philosophic and social context. It aims to provide students with the knowledge, experience and insights needed to prepare them for further education as a scientific researcher as well as to offer a solid basis for a career in business at an academic level. Students in the master's programme can choose between four specialisations: Intelligent Systems Design (ISD), Web Science (WS), Human Ambience (HA), and Cognitive Science (CogSci).

The committee considers the content, level and orientation of the masters' programme Artificial Intelligence as satisfactory for an academic master in the field of Artificial Intelligence. The committee was pleased to note that multidisciplinarity of the field of AI is reflected in intended learning outcomes, which cover general learning outcomes as well as specific learning outcomes attached the specialisations of the programme. The committee established that the programme is academically oriented towards a scientific career or a position as a professional in business and organisation.

Standard 2: Teaching-learning environment
The master's programme Artificial Intelligence has four specialisations: *Intelligent Systems Design, Web Science, Human Ambience* and *Cognitive Science*. All four specialisations have a core set of courses (*Evolutionary Computing, Knowledge Engineering,* and *Model-based Intelligent Environments*) which originate from the three AI research groups in the department. This core is designed to give students an overview of the core topics in Artificial Intelligence at master's level. This core set is embedded in the compulsory courses of the different specialisations and makes up the basic structure of the curriculum in combination with one or more sets of constrained choices and electives.

The committee has established that each specialisation is coherent and well chosen with respect to the expertise of staff members. The committee could clearly establish the translation of intended learning outcomes into the curriculum. The committee was impressed by the community of learners, formed by staff members and master students, with a lot of attention being paid to research skills and academic training. The committee was enthusiastic about the teaching staff. Many have a BKO, all are active in research and full professors are already involved in the first year of the bachelor's programme.

The committee recommends to pay attention to the didactic concept. It should be clearly defined which concept is used; subsequently, this should be communicated to all stakeholders. The study load was evenly spread in the programme. Programme specific facilities, student guidance and quality assurance are satisfactory. Based on those findings, the committee has established that the master's programme more than fulfills the requirements for this standard.

Standard 3: Assessment and achieved learning outcomes
The VU Faculty of Sciences has one central Examination Board (EB), subdivided in several domain-related committees – including one for all bachelor's and master's programmes of the Computer Science Department. The EB has also created an Assessment Committee which is mandated to develop the assessment policy.

The committee concluded that the assessment system for the master's programme is adequate, but that the introduction of an assessment policy was rather late. Only recently the programme started with the implementation of this policy. The committee finds that the EB could have been more proactive in this aspect and should not have waited until the policy was imposed top-down.

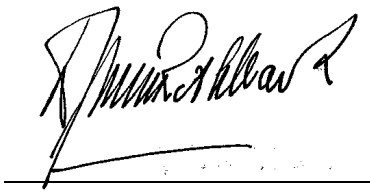
Theses for the master's programme were of good quality. The committee appreciated the fact that the multidisciplinary and artificial intelligence aspects were clearly visible in nearly all theses.

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

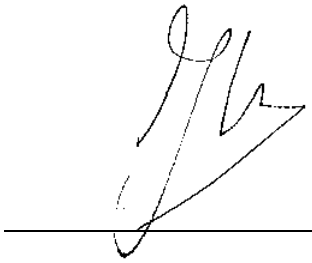
Bachelor's programme Lifestyle Informatics:	
Standard 1: Intended learning outcomes	satisfactory
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment and achieved learning outcomes	satisfactory
General conclusion	satisfactory
Master's programme Artificial Intelligence:	
Standard 1: Intended learning outcomes	satisfactory
Standard 2: Teaching-learning environment	good
Standard 3: Assessment and achieved learning outcomes	satisfactory
General conclusion	satisfactory

The chair and the secretary of the committee hereby declare that all members of the committee 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: 6 December 2013.



Prof. drs. Dr. L.J.M. Rothkrantz



drs. H.A.T. Wilbrink

Description of the standards from the Assessment framework for limited programme assessments

Standard 1: Intended learning outcomes

The intended learning outcomes of the programme have been concretised with regard to content, level and orientation; they meet international requirements.

Explanation:
As for level and orientation (bachelor's or master's; professional or academic), the intended learning outcomes fit into the Dutch qualifications framework. In addition, they tie in with the international perspective of the requirements currently set by the professional field and the discipline with regard to the contents of the programme.

Findings

Domain specific frame of reference
Traditionally, researchers in the field of artificial intelligence (AI) are concerned with the study of cognitive processes that play a role in human perception, reasoning and action, and building intelligent systems for human modelling. This implies that the field of artificial intelligence is closely related to other disciplines such as computer science, mathematics, psychology, linguistics and philosophy. In 2006, the collaborating artificial intelligence programmes in the Netherlands (KION) composed a domain-specific reference framework (hereafter: the framework, see Appendix 2) which presented the content and learning outcomes of the bachelor's and master's programmes in artificial intelligence. The framework forms the common basis for all programmes in artificial intelligence and for specifying the intended learning outcomes of the different programmes in this cluster visitation. The committee noted that in general all assessed programmes meet the intended learning outcomes described in the framework to a greater or lesser degree. For example, all programmes pay sufficient attention to the basic knowledge and skills of artificial intelligence. However, there is a variation in the extent to which the different programmes offer students deepening or broadening of the field. In addition, almost all programmes take the liberty of highlighting certain topics and adding parts of new disciplines. The committee noted that some misunderstanding arises because the different programmes give different interpretations of the concept of artificial intelligence. The concept of 'intelligence' as used in the framework can be interpreted in different ways. A clear operational definition, or description, is desirable according to the committee. Furthermore, the distinction in the framework between the intended learning outcomes at the bachelor's and master's level is not always clear. The gradual / incremental aspect of knowledge and skills could be elaborated on more in the framework. This could also prevent the divergence of the AI programmes on this matter.

Profile and orientation
The bachelor's programme Lifestyle Informatics (LI) replaced the bachelor's programme in Artificial Intelligence in 2009. The new name of the programme, Lifestyle Informatics is quite distinct from the other bachelor's programmes within the framework (Appendix 3) and reflects the new curriculum and the rationale behind it. The curriculum was designed to attract not only the traditional students in AI with merely exact talents. It is aimed, as the committee corroborated during several interviews with management and staff, at students with exact talents, who are also interested in human functioning and society and should explicitly appeal to female students as well as male students. The design process of the new programme was carried out in cooperation with a special advisory board, using input from the workfield and external research was conducted to test the appeal of the new programme for

prospective students. The committee learned that the programme was deliberately aimed at meeting the needs of a technologically changing society. As the management explained, the multidisciplinarity of the new programme is the answer to these societal needs and the needs of a wide spectrum of scientific disciplines. The committee has indeed established that the programme is multidisciplinary. The committee also established that the programme is rather singular compared to equivalent programmes in Artificial Intelligence at other Dutch universities. Internationally, a comparison is even harder to make. Lifestyle informatics might develop into a new trend; on the other hand, VU University risks to have anticipated on a trend that might not follow through.

The bachelor's programme LI rests on two scientific disciplines: the exact sciences and the human sciences. The exact sciences provide a basis for techniques that are useful in developing intelligent applications. The human sciences provide a basis for an understanding of human functioning and wellbeing. As a bridge between these two streams the so-called modelling stream ties them together which aims to achieve the depth that is required to analyse and design scientifically justifiable smart systems. The programme aims to achieve a balance between a sufficiently broad scope and integration in modelling with sufficient depth, in the sense of formalisation and technical design and development. The bachelor's programme focuses on human-directed scientific knowledge, for example form health, psychological and social sciences and with a main focus on specific elements of the exact sciences, in particular artificial intelligence and informatics.

The committee has established, after extensive research, that the bachelor's programme meets the requirements of an academic bachelor. The programme is oriented towards a scientific career or a position as a professional in business and organisation. The committee is convinced that the programme is research oriented, especially since the programme has put more emphasis on research skills from 2012 onwards. The committee does point out however, that the exact science aspect of bachelor's programme LI is concise to such a degree that the minimum requirements of an academic programme within the realm of exact science are reached. The committee strongly advises the management of the programme to monitor closely if this restricted role of the exact sciences is sufficient to guarantee students the required skills to continue their studies in a wide range of technical masters. Given the excellent academic reputation of the teaching staff (described in more detail in chapter 2.3), the committee is confident that their scientific quality will reflect in the scientific level of the programme.

The committee is aware of the fact that the programme Lifestyle Informatics is relatively new and still developing and is confident that the programme management is aware of the consequences for the programme's final qualifications. The committee established that the final qualifications of the bachelors' programme are rather general and only briefly mentioned in the study guide. The committee advises the programme to elaborate its final qualifications. The committee ascertained that the final qualifications are based on the Dublin descriptors and framework, but points out that according to the framework, the share of the exact sciences in these final qualifications is rather succinct. The committee feels that the transition to LI allows for some repositioning towards the KION framework, but has detected only the minimal required core of the field of Artificial Intelligence in this bachelor's programme.

The *master's programme* in Artificial Intelligence (AI) is a scientific programme that aims to provide students with the knowledge, experience and insights needed to autonomously carry out their professional duties. The programme is designed to prepare students for further education as a scientific researcher as well as to offer a solid basis for a career in business at

an academic level. The programme furthermore wants to provide a practical understanding of the position of the field of Artificial Intelligence within a broad scientific, philosophic and social context, as the committee established.

Within the broad field of Artificial Intelligence, the master's programme has chosen a (limited) number of thematic foci, connected to its research expertise: Agent Systems, Computational Intelligence, Knowledge Representation and Reasoning. The aim of the master's programme is to extend and enhance the knowledge and skills of the bachelors' level and, by concentrating on a limited sub area within the field of Artificial Intelligence, to provide academic specialisation. Students in the master's programme can choose between four specialisations: Intelligent Systems Design (ISD), Web Science (WS), Human Ambience (HA), and Cognitive Science (CogSci). The first three of these specialisations are connected with the aforementioned AI research groups. The fourth specialisation is carried out in a collaboration between the Agent Systems group and the Faculty of Psychology and Education. The committee is satisfied that the chosen foci are appropriate for the field of Artificial Intelligence. Furthermore, the committee established that the masters' programme and its foci are clearly connected to and aimed at scientific research, fitting for an academic master.

The intended learning outcomes have been formulated in consultation with the framework, the committee established. Also, the level of the programmes is in line with the Dublin descriptors. The level and orientation of the programme are suitable for an academic masters' programme. The committee has established that the programme, like the bachelor's programme LI, is multidisciplinary in its focus on research methods. The committee was pleased to note the differentiation between more general learning outcomes and specific outcomes, embodying the multidisciplinary field of Artificial Intelligence. Each of the four specialisations of the master's programme carry their own set of requirements, next to the overall intended learning outcomes. The committee feels that these requirements are more than adequate for each specialisation and are complementary to the intended learning outcomes of the whole programme.

Considerations

The committee considers the content, level and orientation of the bachelor's programme Lifestyle Informatics satisfactory for an academic bachelor in the field of Artificial Intelligence. The committee appreciates the efforts made to develop a new curriculum that is more attractive to students who are capable with respect to exact science, but may not primarily have a technical scope of interest. The committee does point out however, that the exact science aspect of bachelor's programme LI is concise to such a degree that the minimum requirements of an academic programme within the realm of Artificial Intelligence are reached. The committee advises strongly to monitor closely the feasibility of the programme Lifestyle Informatics in relation to master's programmes in the exact sciences. Given the excellent academic reputation of the teaching staff, the committee is confident that their scientific quality will reflect in the scientific level of the programme.

The committee considers the content, level and orientation of the masters' programme Artificial Intelligence as satisfactory for an academic master in the field of Artificial Intelligence. The committee was pleased to note that multidisciplinarity of the field of AI is reflected in intended learning outcomes, which cover general learning outcomes as well as specific learning outcomes attached the specialisations of the programme.

Regarding the intended learning outcomes, the committee established that both programmes are academically oriented towards a scientific career or a position as a professional in business and organisation.

Conclusion

Bachelor's programme Lifestyle Informatics: the committee assesses Standard 1 as satisfactory.
Master's programme Artificial Intelligence: the committee assesses Standard 1 as satisfactory.

Standard 2: Teaching-learning environment

The curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes.

Explanation:
The contents and structure of the curriculum enable the students admitted to achieve the intended learning outcomes. The quality of the staff and of the programme-specific services and facilities is essential to that end. Curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

Findings

In this standard the curriculum (design, coherence and translation of intended learning outcomes) of the programmes are examined. In addition, the didactic concept, staff and facilities and programme specific quality assurance are discussed.

Curriculum
Education at VU University Amsterdam is organised in two semesters, and typical courses are 6 EC. A semester consists of two periods of eight weeks and a third and final period of four weeks. Students follow two courses in the longer periods and one course in the short periods. In the short four-week periods a more practical and intensive course is scheduled.

An overview of the *bachelor* curriculum is provided in Appendix 4.

The three years bachelor's programme Lifestyle Informatics offers a multidisciplinary programme focusing on intelligent support of human wellbeing and functioning in physical, mental and social respects. The curriculum is divided into four interacting streams. The *Human Sciences stream* covers relevant topics from health, psychological and social sciences. The *Artificial Intelligence and Informatics stream* covers relevant topics from artificial intelligence and informatics. A *Modelling stream* has been included that focuses on modelling techniques and skills thereby integrating human sciences and exact sciences. This stream is designed to enable students to take (informally described) topics from the Human Sciences stream and methods and techniques from the Artificial Intelligence and Informatics and glue them together in formalised domain models that are suitable for formal analysis and use within smart application systems. Within the *Integration Projects stream* students learn in more depth how such domain models can be integrated in software systems in order to make them human-aware so that they can provide support in a knowledgeable, smart manner. They analyse problems in societal application areas and integrate the other ingredients of the curriculum to design and implement solutions.

The Human Sciences stream fills 20% of the curriculum (excluding the minor), the Modelling stream 16%, the Artificial Intelligence and Informatics stream 36%, and the Integration Projects stream 16%. Moreover, general academic subjects in which, for example, ethical and philosophical issues are addressed, take up 12%. The minor takes up 20% (30 EC) of the overall curriculum. Students interested in deepening their technical knowledge and skills may choose for a minor in Artificial Intelligence or Informatics offered by the Faculty of Sciences, whereas students that want to enhance their knowledge of the human sciences may choose a minor offered by some of the other faculties, in areas such as psychology, health, social networks, sports, etc. The bachelor thesis (12 ec) is conducted at the end of the curriculum.

Students in the first year have more intensive supervision than in the later years. In courses like Introduction to Programming, a student assistant is assigned per group of twelve students, who keeps track of their individual work. At the end of the bachelor's programme students independently do their Bachelor project under supervision of a staff member.

The committee established that in the bachelors' curriculum the element of the exact sciences is limited. The view of students on the field of AI is limited. For example, the committee would have expected an introduction into the field of AI. Furthermore, a separate course on autonomous systems would have been helpful. The courses related to mathematics and informatics are concise seen in the context of the field of Artificial Intelligence, according to the committee. The committee appreciated that the programme sees the field of AI as multidisciplinary, which is incorporated into in the courses of the curriculum, but advises the programme to make the specific AI element more visible in the courses of the bachelors' curriculum.

The committee found that the coherence of the bachelors' programme was not yet fully established. This was corroborated by the students, interviewed by the committee, who mentioned the difficulties they encountered caused by ad hoc changes in the curriculum and insufficient applicable information. The committee was assured by the programme that these difficulties were noticed by the management and were part of the start up phase of the programme. Also, the students indicated that the overall feasibility of the programme is good. The committee is therefore confident that the coherence of the curriculum is being settled. The committee found that students appreciate the multidisciplinarity of the programme, but is also aware of the minor technical component compared to other bachelors' programmes in AI. Theoretically, the technical component is nicely incorporated into the different courses. However, in practice this is not yet fully established.

The committee established that the intended learning outcomes are translated into the curriculum, as was demonstrated in the critical reflection. The committee would like to see a more detailed description of the intended learning outcomes, though, at course level for all courses, especially where academic skills are concerned. The committee also noted that a significant part (50%) of the bachelors' curriculum is obtained from a range of other programmes, e.g. Psychology. This supposes a high level of flexibility of bachelor students LI who have to adapt to other programmes, which raised some difficulties, the committee learned from the students. The committee advises the programme to limit the number of shared courses and concentrate the curriculum more on courses which are for AI students only.

The committee assessed the studyload and concluded that the programme is feasible, perhaps a bit easy at certain parts. There seems to be a difference in level between courses. Some courses are considered easy, while other courses (e.g. mathematics) are problematic for many students. According to the committee, this is the direct result of the profile of the programme, which attracts students that not aspire the exact sciences.

The *master's programme* Artificial Intelligence has four specialisations: *Intelligent Systems Design, Web Science, Human Ambience* and *Cognitive Science*. All four specialisations have a core set of courses (*Evolutionary Computing, Knowledge Engineering,* and *Model-based Intelligent Environments*) which originate from the three AI research groups in the department. This core is aimed to give students an overview of the core topics in Artificial Intelligence at master's level. This core set is embedded in the compulsory courses of the different specialisations and makes up the basic structure of the curriculum in combination with one or more sets of constrained

choices and electives. Another part of the compulsory courses is the Master Project which is the finalisation of the curriculum. An overview of the curricula of the four master specialisations is given in Appendix 4.

The committee found that the master's curriculum is well balanced and clearly designed around the four specialisations. The committee was pleased to note that the intended learning outcomes are translated into the curriculum on a general level and at the level of each of the four specialisations. The committee established that although the four specialisations do not form one programme, each specialisation, including the core elements, is coherent on its own. The committee was pleased to notice that the programme has taken up one of the recommendations by the previous committee and reduced the number of specialisations. The four chosen specialisations are logically chosen.

The courses in the curriculum are connected to research topics of the staff. The committee was especially pleased to note that master students and staff together form a community of learners, which is supported by the attention paid to research skills and academic training. The linking of a student to a research group for his or her Master Project strongly stimulates this community of learners. The committee established that there's a major technical component in the curriculum, fitting for the field of Artificial Intelligence. This particular element was mentioned as very useful by the alumni, whom the committee interviewed.

The committee concluded that the intended learning outcomes, which are different for each of the four specialisations, are adequately translated into the curricula. This was demonstrated in the critical reflection.

According to the committee, studyload is acceptable. In contrast to the bachelor's programme, the workload is more evenly spread across the courses. Students mentioned that the technical aspects in courses are still the most difficult, but doable and valuable. This is corroborated by the committee.

Didactic concept
VU University sees education as a 'community of learners'. One of the five characteristics of this community of learners is that 'students will get familiar with the culture of research and the practice as academic professional'. This is reflected in the way courses are taught and students are approached. An important factor in reaching this goal is the participation of active researchers in the programme. The curriculum of the bachelor's programme is based on a problem-oriented perspective. The master's programme adds a technique-oriented perspective. The committee learned that this didactic concept actually is based on the general principle of research based teaching and that the concept is still being developed at this stage. The committee furthermore established that this educational vision is yet not widely known amongst staff and virtually unknown amongst students. The committee stresses therefore the need to clarify the didactic concept, especially since the committee learned that a general restatement of the concept is taking place already at faculty level, anticipating the planned merger of the science faculties of the VU and the University of Amsterdam.

For each course the form of tuition corresponds to the didactic aims of the course. The teachers use different teaching formats in order to stimulate students. Courses are built from a mixture of the following formats: lectures, group tutorials, supervised practical work, projects, and seminars. This mixture of different teaching formats should enable students to acquire knowledge and insight by getting familiar with different ways of communication, in a group or as an individual, by writing a report or giving a presentation. In such an

environment students get acquainted with the academic culture, collaboration and communication. The committee established that the programmes use a diverse array of work forms, which are appreciated by the students, and finds these fitting for both curricula.

Staff
The committee was happy to see that all staff members participate in monthly staff meetings (docteams) to discuss the day-to-day running of courses, the relationship between courses, and short-term developments in the programmes. Course evaluations are also discussed. The committee learned that the docteam is complementary to the curriculum committee. The meetings are held separately for bachelor year 1, bachelor year 2-3 and the master's programme. The committee learned during the interviews that the meetings enhance awareness of cross-curriculum issues, which is very recommendable. The overall didactic qualities of staff are impressive, as was enthusiastically corroborated by the students. The committee also established this based on the fact that all members of staff, with a few exceptions, are BKO-qualified. All but one teacher holds a PhD and almost all regular staff are active researchers, which safeguards the scientific qualities as well, according to the committee. The committee has noted that the teaching staff holds excellent academic qualifications in the field of Artificial Intelligence.

The committee was also very pleased to note that full professors are actively involved in teaching from the first bachelor semester onwards. The very commendable commitment of the staff of both programmes to teaching and the students was established clearly by the committee, and corroborated fully during the interviews with students. The committee was also pleased to note that the members of staff are aware of the academic role model they represent and all try to install the academic attitude into their students, for example by involving them in their own research. The committee appreciates the way members of staff manage the considerable workload and yet remain very approachable and committed to the students, as the students themselves confirmed.

Facilities and programme-specific quality assurance
For students in both programmes a dedicated high-tech laboratory, INTERTAIN Lab, is available. The lab facilitates research that focuses on the use and effects of technology by and on humans. Several courses in the Bachelor Lifestyle Informatics also make use of the facilities in the lab, for example, Human Computer Interaction course, as well as the research groups at masters' level. The committee was impressed by these lab facilities and pleased to note that students and staff are making very good use of it.

Considerations

The bachelor's programme LI offers a multidisciplinary programme with focus on intelligent support of human well-being and functioning in physical, mental and social aspects. The committee established that the bachelor's programme offers a limited amount of exact sciences. Deliberation by the committee led to the conclusion that the exact sciences are satisfactorily present in the curriculum, but are rather hidden and should not be reduced anymore. Intended learning outcomes are satisfactorily incorporated into the bachelor curriculum. According to the committee, the programme management is still searching for the optimal coherence of the curriculum. Partly this is the result of students having to follow courses that are scheduled by other bachelor's programmes (e.g. Psychology). The committee observes an increase in coherence and stimulates the programme to develop more courses for its own students.

The master's programme Artificial Intelligence consists of four specialisations, which are all well described and have a common core. Each specialisation is coherent and well chosen with respect to the expertise of staff members. The committee could clearly establish the translation of intended learning outcomes into the curriculum.

For both programmes the committee recommends to pay attention to the didactic concept. It should be clearly defined which concept is used and subsequently this should be communicated to all stakeholders.

Development of academic skills and attitude is adequate in the bachelor's programme. Quite early in the programme students get acquainted with research methods within different courses. The committee stimulates the bachelor's programme to more explicitly mention this to the students. The committee was impressed by the community of learners, formed by staff members and master students, with a lot of attention being paid to research skills and academic training.

Study load for the bachelor's programme is acceptable, although differences in this respect were noticed between courses. The study load was more evenly spread in the master's programme.

Both for the bachelor and master's programme, the committee was enthusiastic about the teaching staff. Many have a BKO, all are active in research and full professors are already involved in the first year of the bachelor's programme. Although workload for teaching staff is high, students were positive about the approachability of staff members.

Programme specific facilities, student guidance and quality assurance are satisfactory for both programmes.

The committee established that the bachelor's programme fulfils the requirements for the teaching and learning environment, while the master's programme more than fulfils the requirements for this standard.

Conclusions

Bachelor's programme Lifestyle Informatics: the committee assesses Standard 2 as satisfactory.
Master's programme Artificial Intelligence: the committee assesses Standard 2 as good.

Standard 3: Assessment and achieved learning outcomes

The programme has an adequate assessment system in place and demonstrates that the intended learning outcomes are achieved.

Explanation:
The level achieved is demonstrated by interim and final tests, final projects and the performance of graduates in actual practice or in post-graduate programmes. The tests and assessments are valid, reliable and transparent to the students.

Findings

Assessments
The bachelor's and the master's programmes both use *Handbook Quality Assurance VU* which gives guidelines for topics such as how to set up valid tests and assessments, as well as faculty guidelines.

The committee was provided upon request with the current versions of the assessment policy (*VU-breed kader Toetsbeleid* and its *Implementation within the Faculty of Exact Sciences*) for both programmes after the site visit and concluded that this policy is basically adequate. The committee advises to continue the development of this assessment policy, which is now aimed at implementation at programme level.

The different forms of assessment contribute to the realisation of the intended learning outcomes of both programmes, the committee established. Most courses use multiple assessment forms in order to stimulate the student to be actively involved in the learning process. Written exams are aimed at testing the student's insight and knowledge about the course. Reports and presentations are aimed to test knowledge and insight but also the student's ability to communicate and to present the acquired knowledge and insight in a clear and scientific manner. Practical work and assignments are used to test the student's problem solving abilities and can have the form of programming or modelling assignments.

The Faculty of Sciences has one central Examination Board (EB), subdivided in domain-related committees. One such sub-committee exists for all bachelor and master's programmes of the Computer Science Department, which handles all matters regarding the bachelor's programme and masters' programme. The committee also learned that the EB has created an Assessment Committee which is mandated to develop the assessment policy.

The committee learned that every course is assessed according to the four eyes principle. Apart from the examiner, a second examiner is consulted for validation. The committee was also pleased to read that the EB provides a yearly report. The committee is convinced that the EB performs its task to check if the assessments and awarded diplomas are of the right quality and level. The committee established that the EB performs the tasks as described in the Law on Higher Education, but is of the opinion that the EB could be more proactive. The assessment policy is being implemented top down, and was only very recently taken up at programme level. For example, assessment forms for thesis work were not introduced until 2013 and implementation is not yet complete.

Realisation final qualifications
The committee has read a total of twenty-five *bachelor theses* and found that until 2012 the bachelor thesis (then 'bachelor referaat') in some cases consisted of a literature study without any application of research, which was on average graded exceptionally high. In this 'Bachelor

referaat' students were supposed to show the culmination of their knowledge and academic skills. Supervision of all 'bachelor referaat' projects was done by one staff member, who based the assessments on the students' learning process rather than on the quality of content of the resulting 'bachelor referaat'.

From the academic year 2012 on, the Bachelor referaat has changed into a Bachelor Project of 12 EC in combination with a Seminar Critical Thinking of 6 EC. The Bachelor Project is done under supervision of a staff member and students can directly participate in a research project of the supervisor. The Bachelor Project is graded on three elements: project, thesis and presentation. The project part is graded on quality, skill, independence and more. The thesis part is graded on contents, structure, and scientific question. The presentation part is evaluated based on context, contents, quality of the presentation. These projects can either be done at a company under supervision of a staff member or by direct participation in a research project of one of the staff members from the four specialisations of the Artificial Intelligence Master.

The committee underlines the fact that every thesis should be academic in both form and content, with a clear link with field of Artificial Intelligence. The committee established that the former format of the bachelor's thesis (bachelor referaat) was not clearly defined, a fact also confirmed by the students, which made comparison between theses sometimes rather difficult and led to a disproportionate high number of theses which are, according to the committee, only minimally satisfactory for the level of academic bachelors in the field of Artificial Intelligence. However, the committee has established that the theses in their current form are up to standard for an academic bachelor level. The committee furthermore underlines the importance of the use of assessment forms accompanying the bachelor theses. The committee established that these forms are only being used since the current academic year and urges the programme to swiftly finalize implementation.

The committee concludes that graduated Lifestyle Informatics students are able to fulfil the intended learning outcomes by completing all courses.

The committee has read a selection of fifteen *master theses*. The master thesis is seen by the programme management as the culmination point of all courses in the programme. One of the elements of the Master Project is participation in the KIM ('Kunstmatige Intelligentie Middagen') meetings where students on two occasions present their Master Project, which is appreciated by the committee. The Master Project is always graded by two supervisors, with one as the second reader, and in case of an external Master Project a third supervisor from the external party. However, sometimes, if the external supervisor has sufficient experience, he may act as the second reader. Students are graded on three main components that can be related to the Dublin descriptors. Firstly, the student's quality, skill and independence in carrying out the project are graded. Secondly, the thesis is graded on contents, structure and scientific question. Thirdly, the presentation is graded based on context, contents and quality of the presentation.

Graduated Artificial Intelligence students have attained the intended learning outcomes as can be concluded from the quality of their Master Projects. The committee was impressed by the scientific quality of the theses it has read. Especially the connection with the research was appreciated. Theses the committee read were clearly multidisciplinary and topics were related to the AI discipline.

Considerations

For both programmes the committee concluded that the assessment system is adequate, but that the introduction of an assessment policy was rather late. Only recently the programmes started with the implementation of this policy. The committee finds that the EB could have been more proactive in this aspect and should not have waited until the policy was imposed top-down.

Until 2012 the bachelor's programme allowed students to write a thesis that did not necessarily study a research question. The 'bachelor referaat' did not have the academic quality that could be expected of a bachelor thesis. However, the current bachelor thesis was considered to be adequate for a bachelor's programme in artificial intelligence and is up to standard for an academic bachelor level. Theses for the master's programme were of good quality. The committee appreciated the fact that the multidisciplinary and artificial intelligence aspects were clearly visible in nearly all theses.

Conclusion

Bachelor's programme Lifestyle Informatics: the committee assesses Standard 3 as 'satisfactory'.
Master's programme Artificial Intelligence: the committee assesses Standard 3 as 'satisfactory'.

General conclusion

Conclusion

The committee assesses the *bachelor's programme Lifestyle Informatics* as 'satisfactory'.
The committee assesses the *master's programme Artificial Intelligence* as 'satisfactory'.

Appendices

Appendix 1: Curricula vitae of the members of the assessment committee

Prof. dr. Leon Rothkrantz studied Mathematics at the University of Utrecht from 1967-1971. Next he started his PhD study at the University of Amsterdam under supervision of Prof Freudenthal and Prof. Van Est. He finished his PhD study in 1980. In the meantime he worked as a teacher Mathematics at "de Nieuwe Lerarenopleiding" at Delft. From 1980 he worked as a student counselor at Delft University of Technology. From that time he started a second study psychology at the University of Leiden and finished this study in 1990. From that time he worked as an Assistant Professor and later as an Associate Professor Artificial Intelligence at Delft University of Technology (DUT) in the group Knowledge Based Systems headed by Prof Koppelaar. Since 1998 he worked as a Professor Sensor Systems at The Netherlands Defence Academy (NLDA). In 2011 he retired from DUT and in 2013 also from the NLDA.
Leon Rothkrantz supervised more than 150 MSc. students and 15 PhD students. He published more than 200 scientific papers in Journals and Conference Proceedings. He was involved in many National and European Research and Educational Projects. He is honoured with golden medals from the Technical University of Prague and the Military Academy from Brno.

Prof. dr. Luc De Raedt studied and worked at the KU Leuven between 1986 and 1999. He completed his PhD in Computer Science at that same university in 1991. From 1999 to 2006 he was professor Machine Learning and Natural Language Acquisition at the Albert Ludwigs University in Freiburg, Germany. Since 2006 he is back at his *alma mater* the KU Leuven as research professor. His research concerns Artificial Intelligence, specifically the dealing with structured information, the use of declarative logic and probabilistic languages and the constraint programming of machine learning and data mining. De Raedt was a coordinator of various European projects, concerning 'probabilistic inductive logical programming' and 'inductive constraint programming'. He was chairman of various international conferences, among which the European and International Machine Learning Conference (1994, 2001, 2005) and the European Conference on Artificial Intelligence (2012). He is a member of the editorial board of journals in the domain of Artificial Intelligence. He was nominated Fellow of the European Coordinating Committee for Artificial Intelligence in 2005. De Raedt is an experienced teacher, having taught at the universities of Leuven, Freiburg, Basel, Namur and Sienna. At the University of Freiburg, he was the director of the international Master of Science Master's programme in Applied Computer Science.

Yfke Dulek obtained her Bsc degree in Artificial Intelligence at Utrecht University in 2013, and is currently working towards an Msc degree in Logics at the same university. She graduated in 2009 from the Stedelijk Gymnasium Leiden. During her school years she obtained a Certificate in Advanced English at Cambridge University, and participated in the Leiden Advanced Pre-university Programme for Top Students in Molecular Science and Technology at Leiden University. She has teaching experience at the 'pre-gymnasium College' teaching Latin and Chemistry to primary school children; as remedial teacher at Stichting Studiebegeleiding Leiden and a student assistant for various bachelor courses at the UU Artificial Intelligence bachelor's programme. She was the secretary in the executive committee of the Artificial Intelligence student society USCKI Incognito, and continues to be an active member of this society.

Prof. em. Tim Grant is retired but still an active scientific researcher in the fields of network-enabled Command & Control systems, offensive cyber operations, and agent-based simulation. His last appointment was as full professor of Operational ICT & Communications within the Faculty of Military Sciences at the Netherlands Defence Academy. Tim's research takes a socio-technical viewpoint, across the military, manned spaceflight, emergency management, and motorway control domains, in collaboration with other researchers and subject matter experts worldwide. He currently co-supervises two PhD students. His career covered 20 years as a military officer in the (British) Royal Air Force, 17 years experience in Atos Origin (IT industry), and 10 years experience in academia (including a visiting professorship at the University of Pretoria, South Africa). Tim Grant has a BSc in Aeronautical Engineering (Bristol University, UK), a Masters-level Defence Fellowship (Brunel University, UK), and a PhD in Artificial Intelligence (Maastricht University, NL).

Marten den Uyl MSc obtained an MSc in cognitive psychology in 1978 from University of Amsterdam. From 1978 till 1987 Den Uyl worked in various areas of psychological research at University of Amsterdam and Stanford University, including text understanding, psychophysics and judgment theory, ethnic attitude, emotion theory, connectionist modeling.
In 2001, Den Uyl founded VicarVision, a company active in computer vision, and ParaBots which focuses on websearch and tesmining. In 2007, VicarVision introduced the FaceReader, the first vision system able to evaluate basic emotional expressions –even for unknown persons- in real time. FaceReader is currently in use in well over 200 academic research groups. VicarVision coordinates the TNO SBIT project "Patroonherkenning voorkomt loos alarm" and is a coordinating partner in the "Watching people Security Services" project which is field testing the integration of advanced intelligent camera surveillance technologies from a number of partners, including TNO. In 2004, ParaBots introduced the Xenon system for fiscal web search and inspection, which is currently used by tax authorities in more than half a dozen countries in Europe and America for inspection of e-commerce activities on the web. Den Uyl's companies have participated in well over 20 EU and nationally granted R&D projects in AI and Den Uyl has (co-)authored many dozens of papers and reports on AI technologies.

Appendix 2: Domain-specific framework of reference

Frame of reference Bachelor and Master programmes in Artificial Intelligence
The Dutch perspective
January 16, 2013

This document is an update of the 2006 Frame of Reference as developed by the KION[1] task force on Curricula for Artificial Intelligence, which was based on:

- Computing Curricula 2013 Strawman Draft for Computer Science developed by the Joint Task Force on Computing Curricula, IEEE Computer Society and the Association for Computing Machinery[2].
- The Onderwijs- en Examenregelingen (OER) of the bachelor and master programmes in Artificial Intelligence administered by the Dutch Universities.
- Tuning Educational Structures in Europe[3].

1 Introduction

This document is an update of the 2006 frame of reference for the Dutch University programmes included in the category Artificial Intelligence of the Dutch register of higher education programmes (CROHO)[4]. This frame of reference defines the fields covered by the term Artificial Intelligence as well as the common goals and final qualifications of these programmes.

Artificial Intelligence is a relatively young field. The birth of Artificial Intelligence research is often dated in 1956, when the founding fathers of AI met at the Dartmouth Conference. The history of teaching Artificial Intelligence as a separate discipline is much shorter still, starting in the Netherlands in the early '90's. Consequently, a frame of reference for Artificial Intelligence is still actively developing both in the national and the international context. This document formulates the current Dutch consensus on a national frame of reference for Artificial Intelligence in the Netherlands.

Intelligence is often defined as the ability to reason with knowledge, to plan and to coordinate, to solve problems, to perceive, to learn and to understand language and ideas. Originally these are typical properties and phenomena associated with the human brain, but they can also be investigated without direct reference to the natural system. Both ways of studying intelligence either can or must use computational modelling. The term Artificial Intelligence as used in this document refers to the study of intelligence, whether artificial or natural, by computational means.

KION: Artificial Intelligence in the Netherlands

The current Dutch Artificial Intelligence programmes were mostly started in the nineties in an interdisciplinary context. Originally they were known under a variety of names such as Cognitive Science (Cognitiewetenschap), Applied Cognitive Science (Technische Cognitiewetenschap), Knowledge Technology (Kennistechnologie), Cognitive Artificial Intelligence (Cognitieve Kunstmatige Intelligentie) as well as Artificial Intelligence (Kunstmatige Intelligentie).

[1] Kunstmatige Intelligentie Opleidingen Nederland
[2] http://www.acm.org/education/ (last visited on November 1st, 2012)
[3] http://www.unideusto.org/tuning/ (last visited on November 1st, 2012)
[4] Centraal Register Opleidingen Hoger Onderwijs

In 1999, the number of recognized labels in the CROHO was reduced, and the aforementioned study programmes were united under the name *Artificial Intelligence*[5]. Initially, this was an administrative matter that did not influence the content of the curricula. It did mean, however, that from then on cognitive science (as the study of natural intelligence) and artificial intelligence (as a formal approach to intelligence) were shared under the heading of Artificial Intelligence. The abovementioned definition of Artificial Intelligence as the study of natural and/or artificial intelligence by computational means was then agreed upon. The KION (Kunstmatige Intelligentie Opleidingen in Nederland) was formed as a discussion and cooperation platform for the united programmes.

Starting in 2002, all university-level study programmes in the Netherlands were divided into a bachelor and a master phase. KION took this as an opportunity to agree upon a common kernel of subjects that would be constituent of every Dutch Artificial Intelligence bachelor programme, with the aim of advancing an adequate fit of all Dutch bachelor programmes to all Dutch master requirements.

Aim of this document

Now that the Dutch Artificial Intelligence programmes are coming up for accreditation in 2013, KION feels that the essence of the 2006 Frame of Reference is still valid, but an update is called for. However, this document is not intended purely as a description of the current status quo. Rather, it aims to provide an account of what an Artificial Intelligence programme should provide as a minimum (the communal requirements for every study programme called Artificial Intelligence), and how it can extend this basis to distinguish itself from other Artificial Intelligence programmes.

Agreement among the Dutch Artificial Intelligence programmes upon the contents of this document will advance both the equivalence of these programmes, and the understanding on existing and possible profiles within Artificial Intelligence programmes. Moreover, it is hoped that this document will also be a starting point for setting international standards for Artificial Intelligence programmes that, to our knowledge, do as yet still not exist.

2. Programme characteristics

This section describes definitions regarding the build-up of bachelor and master programs.

Areas, courses, modules, and topics

A bachelor programme in Artificial intelligence is organized hierarchically into three levels. The highest level of the hierarchy is the area, which represents a particular disciplinary subfield. The areas are broken down into smaller divisions called modules, which represent individual thematic units within an area. A module may be implemented as a complete course, be covered in part of a course, or contain elements from several courses. Each module is further subdivided into a set of topics, which are the lowest level of the hierarchy. The modules that implement the particular programme (or curriculum) are together referred as the 'body of knowledge'.

Core and elective courses

By insisting on a broad consensus in the definition of the core, we hope to keep the core as *small* as possible, giving institutions the freedom to tailor the elective components of the curriculum in ways that meet their individual needs. The core is thus not a complete programme. Because the core is defined as minimal, it does not, by itself, constitute a

[5] In Dutch: Kunstmatige Intelligentie

complete undergraduate curriculum. Every undergraduate programme must include additional elective courses from the body of knowledge. This report does not define what those courses should be, but does enumerate options in terms of modules.

Assessing the time required to cover a course

To give readers a sense of the time required to cover a particular course, a metric must be defined that establishes a standard of measurement. No standard measure is recognized throughout the world, but within the European Community agreement has been reached upon a uniform European Credit Transfer System[6] (EC) in which study load is measured in European Credits (ECs). One EC stands for 28 hours of study time and a full year of study is standardized at 60 EC. In this document, we shall use the EC metric as the standard of measurement for study load.

Coping with change

An essential requirement of any Artificial Intelligence degree is that it should enable graduates to cope with—and even benefit from—the rapid change that is a continuing feature of the field. But how does one achieve this goal in practice? At one level, the pace of change represents a challenge to academic staff who must continually update courses and equipment. At another level, however, it suggests a shift in pedagogy away from the transmission of specific material, which will quickly become dated, toward modes of instruction that encourage students to acquire knowledge and skills on their own.

Fundamentally, teaching students to cope with change requires instilling in those students an attitude that promotes continued study throughout a career. To this end, an Artificial Intelligence curriculum must strive to meet the following challenges:

- Adopt a teaching methodology that emphasizes learning as opposed to teaching, with students continually being challenged to think independently.
- Assign challenging and imaginative exercises that encourage student initiative.
- Present a sound framework with appropriate theory that ensures that the education is sustainable.
- Ensure that equipment and teaching materials remain up to date.
- Make students aware of information resources and appropriate strategies for staying current in the field.
- Encourage cooperative learning and the use of communication technologies to promote group interaction.
- Convince students of the need for continuing professional development to promote lifelong learning.

3. Shared identity

Common role

Apart from the roles academics usually perform in society students of Artificial Intelligence are educated to enrich society with the benefits a formalization of intelligence and intelligent phenomena can provide. In particular this entails that an alumnus of Artificial Intelligence can contribute to the understanding and exploitation of natural and artificial intelligence. This may lead to new technologies but it may also enrich designs, products, and services with intelligence so that they are more effective, more reliable, more efficient, safer, and often

[6] http://ec.europa.eu/comm/education/programmes/socrates/ects/index_en.html (last visited on September 1st, 2012)

require less natural resources. This role, in combination with the interdisciplinary nature of the field, requires the Artificial Intelligence alumnus to be able to contribute to interdisciplinary teams and, in many cases function as an intermediate who facilitates the interaction of (other) domain specialists.

Common requirements

Artificial Intelligence is a broad discipline and many approaches to the study of intelligent phenomena are justified and fruitful. Curricula are therefore often different from their siblings in emphasis, goals, and capabilities of their graduates. Yet they have much in common. Any reputable Artificial Intelligence program should include each of the following aspects:

- Essential and foundational underpinnings of the core aspects of intelligence. These must be founded on empirical efforts and based on a formal theory, and they may address professional values and principles. Regardless of their form or focus, the underpinnings must highlight those essential aspects of the discipline that remain unaltered in the face of technological change. The discipline's foundation provides a touchstone that transcends time and circumstances, giving a sense of permanence and stability to its educational mission. Students must have a thorough grounding in that foundation.
- A foundation in the core concepts of modelling and algorithms for implementing intelligence. The construction and use of models (simplified, abstracted and dynamic representations of some phenomenon in reality) is common to many sciences. In Artificial Intelligence, however, model building is central: the field of Artificial Intelligence may actually be defined as trying to model aspects of (formal or natural) intelligence and knowledge. Moreover, models within Artificial Intelligence have specific characteristic: they are computational and therefore necessarily formal. Artificial Intelligence-graduates must therefore be able to work with (computational) models at different levels of abstraction and understand the recursive nature of models in Artificial Intelligence. This foundation has a number of layers:
  - An understanding of, and appreciation for, many of the diverse aspects of intelligence, models of intelligent phenomena, and of algorithms that describe intelligent processes.
  - Skills to model intelligent phenomena and appreciate the abilities and limitation of these models, if appropriate in comparison with a natural example.
  - Skills to model and implement intelligent phenomena on a computer, in particular skills to work with algorithms and data-structures in software.
  - Skills to design and build systems that are robust, reliable, and appropriate for their intended audience.
- An understanding of the possibilities and limitations of what intelligent systems can and cannot do. This foundation has a number of levels:
  - An understanding of what current state-of-the-art can and cannot accomplish, if appropriate in combination with the accomplishment of the natural system that inspired it;
  - An understanding of the limitations of intelligent systems, including the difference between what they are inherently incapable of doing versus what may be accomplished via future science and technology;
  - The impact of deploying technological solutions and interventions on individuals, organizations, and society.
- The identification and acquisition of non-technical skills, including interpersonal communication skills, team skills, and management skills as appropriate to the discipline.

To have value, learning experiences must build such skills (not just convey that they are important) and teach skills that are transferable to new situations.
- Exposure to an appropriate range of applications and case studies that connect theory and skills learned in academia to real-world occurrences to explicate their relevance and utility.
- Attention to professional, legal and ethical issues such that students acquire, develop and demonstrate attitudes and priorities that honour, protect, and enhance the profession's ethical stature and standing.
- Demonstration that each student has integrated the various elements of the undergraduate experience by undertaking, completing, and presenting a capstone project.

Shared background for bachelor programmes

Similar to alumni of programmes such as Physics, Computer Science, and Psychology, all Artificial Intelligence bachelors are expected to share a certain amount of support knowledge, domain specific knowledge, specialized domain knowledge, and a set of skills. The content mentioned below ensures a firm common basis that enables AI bachelors of any Dutch university admission to any Dutch Master programme in AI. At the same time, it allows for a wide range of individual and/or institute specific specialisation. The list is an update (extension) of the shared programme agreed upon by the KION platform in 2006.

Common core between AI bachelor degree programmes

The following topics and skills are part of each of the bachelor programmes, either as a dedicated course or as a substantial topic within one or more courses.

Artificial Intelligence modules

- Autonomous systems
- Cognitive psychology
- Computational linguistics
- History of Artificial Intelligence
- Human-computer interaction
- Knowledge representation and reasoning
- Machine learning
- Multi-agent systems
- Philosophy for Artificial Intelligence

Support modules

- Computer science
  - Programming
  - Data structures and algorithms
- Logic
- Mathematics
  - Calculus
  - Probability theory
  - Linear algebra
  - Statistics

Academic skills

Apart from curriculum specific skills, the bachelor program supports the development of a set of general academic skills. Even though they can be topics in specific modules, they are

generally addressed by the appropriate choice of work and assessment methods throughout the curriculum.

- Analytic skills
- Empirical methods
- Modelling
- Teamwork
- Written and oral communication, argumentation and presentation

Artificial Intelligence elective courses
The following list of modules is considered as representative of the AI field at this moment. Given that the different AI programs have different priorities in selecting topics, and assigning topics to either the Bachelor or Master, each Bachelor should offer a substantial subset of the following list as part of their Bachelor programme, either as specific course, or as a substantial part of a broader course.

- Cognitive modelling anArchitectures of cognition
- Data mining
- Information retrieval
- Language and speech technology
- Neural nets
- Genetic algorithms
- Probabilistic models
- Cognitive and computational neuroscience
- Perception (Computational and Natural)
- Robotics
- Reasoning under uncertainty
- Virtual reality and Gaming
- Web Intelligence
- Bio-informa

Bachelor programme Artificial Intelligence
This section is divided into two parts. Section 4.1 describes the roles that a bachelor ought to be able to perform in society. Section 4.2 describes the final qualifications that bachelors in Artificial Intelligence possess in order to fulfil these roles.Objectives
The objective of the bachelor programme is to provide students with a suitable basis for a further career, both in education as well as in employment. The bachelor must be prepared for a number of different roles and opportunities.

Access to master programmes
The bachelor provides the student with the specific knowledge and abilities, exemplified in the form of a bachelor diploma that allows the bachelor access to a master programme in Artificial Intelligence or other national or international masters, particularly in related disciplines.

Professional career
The bachelor prepares for a position in which the student can earn his or her own subsistence. In particular it prepares for:

- Supervised work on a national and international academic level;
- Positions in the modern high-tech society, such as functions in knowledge-intensive companies and knowledge intensive parts of the non-profit sector.

Academic skills
The bachelor provides sufficient training in (scientific) reasoning, conduct, and communication to reach internationally accepted standards of academic skills at that level.

Place in society
The bachelor programme provides the bachelor with the knowledge and tools needed to form an informed opinion of the meaning and impact of Artificial Intelligence, and an informed notion of the responsibilities of a specialist in this area.

Final qualifications

The objectives of the bachelor can be specified into final qualifications. To comply with international standards these qualifications are presented below in terms of the Dublin descriptors for the bachelor's profile[7]. Together these final qualifications must lead to alumni that exemplify the shared identity defined in section 3.

Knowledge and understanding
The bachelor demonstrates knowledge and understanding in a field of study that builds upon and supersedes their general secondary education. Knowledge and understanding is typically at a level at which the bachelor, whilst supported by advanced textbooks, is able to include some aspects at the forefront of their field of study.

Qualifications:
- Basic understanding of key areas in Artificial Intelligence in accordance with the shared identity.
- Advanced knowledge of at least one of the key areas in Artificial Intelligence, up to a level that without further requirements grants access to a master programme in this area.
- Knowledge of the symbolic approach to Artificial Intelligence.
- Knowledge of the numerical, non-symbolic, approach to Artificial Intelligence.
- Knowledge of the most important philosophical theories regarding the fundamental questions of AI as well as its ethical, legal and societal implications.
- Knowledge of the most important theories developed in the area of empirical sciences, particularly psychology.
- Expertise in constructing and evaluating computational models of cognitive processes and intelligent systems.

Applying knowledge and understanding
Bachelors can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems and/or designing systems within their field of study. They are able to analyse and model *prototypical* Artificial Intelligence problems by using *known* Artificial Intelligence methods and techniques.

[7] http://www.jointquality.org/ (last visited on September 1st, 2012)

Qualifications:

- The ability to understand, apply, formulate, and validate models from the domains of Artificial Intelligence.
- The ability to apply the symbolic approach to Artificial Intelligence.
- The ability to apply non-symbolic approaches to Artificial Intelligence.
- The ability to design, implement, and evaluate knowledge-intensive.
- The ability to apply tools from mathematics and logic.
- The ability to apply important programming languages used in Artificial Intelligence.
- Analytical approach to problem solving and design:
  - Ability to comprehend (design) problems and abstract their essentials.
  - Ability to construct and develop logical arguments with clear identification of assumptions and conclusions.
- The ability to submit an argument in the exact sciences (or humanities) to critical appraisal.
- Analytical and critical way of thought and ability to apply logical reasoning.
- Openness to interdisciplinary cooperation and ability to effectively participate therein as an academic professional.
- The ability to create an effective project plan for solving a prototypical Artificial Intelligent problem in a supervised context.
- Manage one's own learning and development, including time management and organizational skills.
- The ability to transpose academic knowledge and expertise into (inter)national social, professional and economic contexts.
- Readiness to address new problems in new areas, emerging from scientific and professional fields.

Making judgements

The bachelor has the ability to gather and interpret relevant data (typically within the field of study) and to formulate judgements that include reflection on relevant social, academic or ethical issues.

Qualifications:

- Ability to critically review results, arguments and problem statements from accepted perspectives in the field of Artificial Intelligence and neighbouring disciplines.
- Initial competence in search and critical processing of professional literature in Artificial Intelligence.
- Acquaintance with the standards of academic criticism.
- Awareness of, and responsible concerning, the ethical, normative and social consequences of developments in science and technology, particularly resulting from Artificial Intelligence.

Communication

The bachelor can communicate information, ideas, problems and solutions to audiences of both domain-specialist and a general audience.

Qualifications:

- Academically appropriate communicative skills; the bachelor can:
  - Communicate ideas effectively in written form and through the use of Information and Communication Technology,

- Make effective oral presentations, both formally and informally,
- Understand and offer constructive critiques of the presentations of others.

Learning skills
The bachelor has developed those learning skills that are necessary for a successful further study characterised by a high degree of autonomy (typically in the context of a master or a specialist profession).

Qualifications:
- Reflection on one's own style of thought and working methods and readiness to take the necessary corrective action.
- Recognize the need for continued learning throughout a professional career.

5. Master programme Artificial Intelligence
This section is divided into two parts. Section 5.1 describes the roles that a master ought to be able to perform in society. Section 5.2 describes the final qualifications that masters in Artificial Intelligence possess in order to fulfil these roles.

Objectives
The objective of the master programme is to provide students with a suitable basis for a further career, both in research as well as in the rest of society. The master must be prepared for a number of different roles and careers at key positions in society.

Access to PhD programmes
The master programme provides the student with the specific knowledge and abilities, exemplified in the form of a master diploma that allows the master access to a PhD programme in a broad range of disciplines, especially in Artificial Intelligence related disciplines.

Professional career
The master programme prepares for a position in which the student can earn his or her own subsistence. In particular it prepares for:

- Independent work on an academic level, especially at positions where many of the problems have not been addressed before and where solutions require scientific training
- Key positions in the modern high-tech society, such as higher functions in knowledge-intensive companies and knowledge-intensive parts of the non-profit sector

Academic skills
The master programme provides sufficient training in independent scientific reasoning, conduct, and communication to reach internationally accepted standards of academic skills at that level. Masters can communicate original ideas in their own language and in English to a public of specialists and non-specialists.

Place in society
The programme provides the master with the knowledge and tools needed to formulate an informed opinion about the meaning and impact of Artificial Intelligence in society. Masters are able to enrich society with results from contemporary research and oversee the consequences of proposed measures to society and are aware of their responsibility towards society.

Final qualifications

The objectives of the master can be specified into final qualifications. To comply with international standards these qualifications are presented below in terms of the Dublin descriptors for the master's profile[8]. Together these final qualifications must lead to alumni that exemplify the shared identity defined in section 3.

Knowledge and understanding

The master demonstrates knowledge and understanding in a field of study that builds upon and supersedes their bachelor degree. Knowledge, understanding, and abilities are typically at a level at which the master is able to formulate a feasible research plan in one's own specialisation.

Qualifications:

- Advanced understanding of key areas in Artificial Intelligence.
- Specialist knowledge of at least one of the key areas in Artificial Intelligence, up to a level that the master can appreciate the forefront of research in that field.
- The master is able to judge the quality of his of her work or the work of others from scientific literature.

Applying knowledge and understanding

Masters can apply their knowledge and understanding in a manner that indicates a scientific approach to their work or vocation. They are able to handle complex and ill-defined problems for which it is not a priori known if there is an appropriate solution, how to acquire the necessary information to solve the sub-problems involved, and for which there is no standard or reliable route to the solution.

Qualifications:

- The ability to formulate a project plan for an open problem in a field related to Artificial Intelligence in general and the own specialisation in particular.
- The ability to determine the feasibility of a proposal to lead to a solution or design as specified.
- The ability to contribute autonomously and with minimal supervision to an interdisciplinary project team and to profit from the abilities, the knowledge, and the contributions of other team members.
- The ability to choose, apply, formulate, and validate models, theories, hypotheses, and ideas from the domains of Artificial Intelligence.
- The ability to submit an argument in the exact sciences (or humanities) to critical appraisal and to incorporate its essence in the solution of Artificial Intelligence problems.
- The ability to translate academic knowledge and expertise into social, professional, economic, and ethical contexts;
- Awareness of, and responsibility concerning, the ethical, normative and social consequences of developments in science and technology, particularly resulting from original contributions.

Making judgements

The master is able to formulate an opinion or course of action on the basis of incomplete, limited and in part unreliable information.

[8] http://www.jointquality.org/ (last visited on September 1st, 2012)

Qualifications:

- Competence in the search and critical processing of all sources of information that help to solve an open and ill-defined problem.
- The ability to demonstrate a professional attitude conform the (international) scientific conduct in Artificial Intelligence.
- The ability to provide and receive academic criticism conform the standards in one specialism of Artificial Intelligence-research.
- The ability to formulate an opinion and to make judgements that include social and ethical responsibilities related to the application of one's own contributions.

Communication

The master can communicate information, ideas, problems and solutions to audiences of specialist in (other) research areas and to a general audience.

Qualifications:

- The master has academically appropriate communicative skills; s/he can:
  - Communicate original ideas effectively in written form,
  - Make effective oral presentations, both formally and informally, to a wide range of audiences
  - Understand and offer constructive critiques of the presentations of others.

Learning skills

The master has developed those learning skills that are necessary for a successful further career at the highest professional level. The master is able to detect missing knowledge and abilities and to deal with them appropriately.

Qualifications:

- Being able to reflect upon one's competences and knowledge and, if necessary, being able to take the appropriate corrective action.
- The ability to follow current (scientific) developments related to the professional environment.
- Showing an active attitude towards continued learning throughout a professional career.

6. International perspective

As stated in the introduction, this frame of reference is intended not only for the Dutch national context, but also to put the Dutch Artificial Intelligence programmes into an international perspective, and possibly to serve as a starting point for an internationally agreed frame of reference. The latter possibility is of course dependent upon international debate and agreement, and at this moment it is not clear how to bring this about, or whether it will in fact be possible. What we can and will do in this document is provide a comparison between the frame of reference as developed in the previous sections and a number of known related study programmes in other countries. In doing this, we hope to show that the developed frame of reference is up to par from an international perspective as well as the Dutch national one.

Having said this, we must immediately recognize that the Dutch national context appears to be rather special in that we only know of specialized bachelor-level Artificial Intelligence study programmes at one university outside the Netherlands, namely at Edinburgh (United Kingdom), which have a rather different programme structure than the Dutch (and general European) one. In our discussion of the Dutch frame of reference in international

perspective, we will therefore add to our comparison with the Edinburgh study programme by a comparison with bachelor programmes of study programmes in a related field, notably Cognitive Science. Furthermore, we will compare the Dutch bachelor qualifications with the requirements for enrolment in Artificial Intelligence master programmes in other countries.

A comparison of master programmes is tricky as well. Although, contrary to bachelor programmes, there are several well-known specialized Artificial Intelligence master programmes outside the Netherlands, study programmes at the master level are much more divergent than at the bachelor level. A comparison can therefore only be provided in global, subject-independent, terms.

We have drawn up both the bachelor and master comparisons based on the programme descriptions and course lists received from the involved Universities. However, for the purpose of conciseness, we have left out particular details of the programmes that are largely time-dependent and often change from year to year.

Comparison of bachelor programmes

The Artificial Intelligence bachelors in Edinburgh
Edinburgh University (United Kingdom) offers a range of bachelor degrees related to Artificial Intelligence, one of them in Artificial Intelligence as such, the others in combination with other disciplines (AI & Computer Science, AI & Mathematics, Cognitive Science). An ordinary bachelor degree consists of 3 years, however admittance to the (1-year) master programme can only be obtained by an honours degree, which takes a fourth year of study. In order to compare this system with the European standard of a 3-year bachelor and a 1-2-year master, we will take the honours year of the Edinburgh bachelor programme to be equivalent to the first year of a 2-year master degree in other European countries, and base our comparison of bachelor programmes on the first three years.

Comparison with the Dutch frame of reference
It should be pointed out that the (first three years of the) AI-related bachelors in Edinburgh show a large variation between them, and an extensive amount of (usually restricted) choices for particular courses within them. In fact, the communality between the Edinburgh Artificial Intelligence bachelors is smaller than communality within the Dutch framework. It seems that the wide variation in Edinburgh Artificial Intelligence related bachelor degrees actually means that the degrees themselves are much more specialized than the Dutch framework proposes, some of them having little or no (cognitive) psychology, others having no mathematics, etcetera. Areas such as philosophy appear not to be obligatory at all.

The Cognitive Science bachelors in Osnabrück and Linköping
Both the University of Osnabrück (Germany) and the University of Linköping (Sweden) offer a three-year (180 EC) bachelor's programme in Cognitive Science. The discipline of Cognitive Science is related to Artificial Intelligence, and may in fact be seen as a flavour of Artificial Intelligence, focused somewhat more towards Cognitive Psychology, and somewhat less towards Engineering. The same key knowledge and skills apply in Artificial Intelligence and in Cognitive Science.

Comparison with the Dutch frame of reference
Based on studying both programmes, we conclude that the Dutch frame of reference recognizes the same AI-specific areas as both Cognitive Science programmes outside the Netherlands. The Dutch frame of reference devotes as much or more attention to any of

these areas as any of those Cognitive Science programmes, with the exception of Cognitive Psychology in Linköping. Moreover, the recognition, in the Dutch frame of reference, that each individual study programme has a specific profile in addition to the communal areas appears to hold for both inspected study programmes outside the Netherlands as well.

Comparison of master programmes

Edinburgh
The Artificial Intelligence master programme in Edinburgh spans a full 12-month period and consists of two parts: taught and research. During the taught part (8 months), lectures, tutorials and group practicals are followed. The research part (4 months) consists of a major individual research project on which a dissertation is written. There is also the option of completing only the taught part, in which case, a Diploma will be awarded. MSc courses in Artificial Intelligence in Edinburgh are grouped in four major areas of specialisation:

- Intelligent robotics
- Knowledge management, representation and reasoning
- Learning from data
- Natural language processing

Comparison with the Dutch frame of reference
Comparing the Edinburgh programmes to the Dutch frame of reference, we can draw the following conclusions:

- The main Artificial Intelligence topics that are in the Dutch framework are also represented in the Edinburgh programmes (as shown in the four different identified areas of specialisation).
- The Edinburgh programmes are 1-year, whereas most Dutch Artificial Intelligence master programmes are 2-year programmes. However, the Edinburgh master programme requires a 4-year honours bachelor degree.
- The Edinburgh system knows a 'Diploma' whereas the Dutch system does not. As described above, this Diploma can be awarded after completing only the taught part of the course.
- The Edinburgh programme knows relatively little study load for practical work. Whereas the minimum length of a Dutch master-thesis ('afstudeerproject') is 30 ECs (half a year), the Edinburgh programme has 4 months for doing practical assignments.
- However, the practical work seems to be more research oriented, whereas in the Dutch programme there is also the option to do a final project in industry.

Stanford
Stanford has four majors in computer science: Computer Science, Computer System Engineering, Mathematical and Computational Sciences and Symbolic Systems. Symbolic Systems most closely relates to the Artificial Intelligence programmes in the Netherlands. Symbolic Systems is an interdisciplinary program that combines Computer Science, Psychology, Philosophy, and Linguistics in order to better understand cognition in both humans and machines. Viewing people and computers as symbol processors, the Symbolic Systems program explores the ways computers and people reason, perceive, and act. Within

the Symbolic Systems major, there is a core set of required classes; beyond this core, students choose an area of concentration in order to gain depth.[9]

Comparison with the Dutch frame of reference
Comparing the Stanford study programme to the Dutch frame of reference, we can draw the following conclusions:

- It is surprisingly difficult to find programme objectives, final qualifications etcetera in the available information. This information is mainly of subject-independent, administrative nature. For example "This programme prepares for entering a PhD programme".
- It was already mentioned that there is much variety between the master programmes – both in the Netherlands and abroad. This is also the case for the programmes at Stanford. But still, this variety is on the Computer Science level rather than the Artificial Intelligence level.
- The Stanford programmes seem to have a large freedom in elective courses. In other words, the core of compulsory courses is limited and students have select many elective courses.
- The Dutch framework has more formal subjects (logic etcetera) than the Symbolic Systems programme.

7. Concluding remarks

Artificial Intelligence is a developing field. Due to its relatively recent start as a coherent field of research, the term Artificial Intelligence does not have the stature of Physics, Psychology, or even Computer Science. Internationally, the study of natural and artificial intelligence with computational means is firmly, but usually not very visibly, embedded in the fabric of modern Universities.

Modern topics such as gaming, ambient intelligence, ambient awareness, and believable-agent systems are fashionable manifestations of Artificial Intelligence and these and future fashionable spin-offs of Artificial Intelligence will increasingly affect humans. Future challenges will force products, services, and even societies to react faster but remain reliable, to be both flexible and effective, be both efficient and versatile, and to utilize natural resources with maximal benefit. Making the most of this combination of conflicting demands, which is very much at the core of in the concept of *intelligence*.

The Dutch situation is special because of the existence of Artificial Intelligence bachelor and master programs on most of the general universities. This offers the Netherlands a competitive advantage, consistent with its main economic strategy to remain one of the leading "knowledge intensive" economies. This frame of reference explicates how the bachelor and master programmes in Artificial Intelligence of Dutch universities contribute to educate alumni that will take a leading role in meeting these future challenges.

[9] http://symsys.stanford.edu/courses (last visited on September 5th, 2012)

Appendix 3: Intended learning outcomes

Bachelor's programme Lifestyle Informatics

The intended learning outcomes for the bachelor study Lifestyle Informatics are:

- The bachelor has knowledge and understanding of the core concepts of Informatics and Artificial Intelligence.
- The bachelor has knowledge and understanding of the core concepts of psychology.
- The bachelor has knowledge and understanding of the modelling techniques needed for formalisation and modelling of processes concerning human action and reasoning, and, more specifically, the bachelor has knowledge and understanding of social, psychological and health aspects relevant to the design of models in such a context.
- The bachelor has sufficient knowledge and understanding of knowledge representation and automated processes on these representations.
- The bachelor has sufficient knowledge and understanding of methods and techniques concerning collective intelligence.
- The bachelor is familiar with the scientific methods for knowledge acquisition in the area of human and informatics directed sciences.
- The bachelor has extensive knowledge and understanding of the application of modern technology in society.
- The bachelor has sufficient knowledge and understanding of the multi-disciplinary area of human and informatics directed sciences to make a justified choice for a master study.
- The bachelor is able to collaborate in projects and teams and has experience in this. In particular, the bachelor has proven to be able to set up a project of modest size, and to bring this to a successful end, thereby making use of supervision.
- The bachelor is aware of the possibilities on the employment market after successfully finishing the bachelor study.
- The bachelor is aware of the role in society of the multidisciplinary area of human- and informatics-directed sciences, including the related ethical aspects. Is aware of the further development and scientific char- acter of this area, and is able to use this in reflection on his/her own performance.
- The bachelor can communicate and report in oral and written formats about subjects in the area.
- The bachelor has learning skills needed for successfully participating in a scientific master study.

Master's programme Artificial Intelligence

A graduate with a Master Diploma in Artificial Intelligence:

- Has a solid academic knowledge of and insight in the field of Artificial Intelligence, including the required background knowledge from other disciplines, which builds upon and goes beyond the level of a bachelor degree in Artificial Intelligence;
- Has knowledge, insight and skills of a specialist nature in at least one area of Artificial Intelligence (for additional requirements, see each specialisa- tion separately);
- Is able to acquire specialist knowledge, insights and skills in other areas of Artificial Intelligence within a reasonable period of time;

- Has acquired practical skills in relevant sub areas of the field of Artificial Intelligence at an academic level;
- Is aware of the applications of Artificial Intelligence in general and of the chosen specialisation in particular and is able to apply his/her knowledge and skills to new or otherwise unknown problems;
- Is capable of designing a project plan on the basis of a realistic problem description in thefield of Artificial Intelligence, and to contribute to its progress with original solutions;
- Is able to consult and use the (international) professional literature in the relevant sub areas of Artificial Intelligence;
- Is able to analyse and evaluate scientific results, and to use them to draw conclusions;
- Is able to function in professional situations where scientific knowledge and skills in Artificial Intelligence are required;
- Has developed a critical, scientific attitude and is aware of the societal aspects of Artificial Intelligence;
- Is able to communicate with others at a professional level and to give clear oral and written presentations of the results of his/her work;
- Is well prepared for a scientific education at the level of PhD or for fur- ther post-academic education as a professional computer scientist.

The Master in Artificial Intelligence is divided into four specialisations:

- ISD Intelligent Systems Design
- WS Web Science
- HA Human Ambience
- CogSci Cognitive Science

Each of these specialisations has its own specific set of requirements, on top of the general requirements listed above.

Beyond the general requirements of an AI Master, the graduate of Intelligent Systems Design:

- Is able to apply methods for knowledge acquisition, modelling and manage- ment;
- Has an overview of the literature and practice in the area of organisation dynamics and self-organisation;
- Has mastered methods and techniques for modelling various types of organ- isations and their dynamics, e.g. for simulation and experimentation;
- Is able to methodically design AI systems;
- Is capable of conducting application-directed AI research in combination with other fields of research.

Beyond the general requirements of an AI Master, the graduate of the Web Science variant:

- Has an overview of the literature and practice in the area of Web Science;
- Has mastered methods and techniques for using the Web as a means of studying other disciplines;
- Has knowledge on technological, economic and social aspects of the Web;
- Is capable of applying AI techniques and methods for Web Science.

Beyond the general requirements of an AI Master, the graduate of Human Ambience:

- Has an overview of the literature and practice in the area of Ambient Intelligence and Ubiquitous and Pervasive Computing technology;
- Has basic knowledge of physiological, psychological, or social aspects of human functioning that can be exploited in Ambient Intelligent Systems;
- Is able to apply modelling techniques for the design of intelligent applications using Ubiquitous and Pervasive Computing technology to support hu- man functioning;
- Is able to apply verification and validation techniques to evaluate the behaviour of Ambient Intelligent Systems.

Beyond the general requirements of an AI Master, the graduate of Cognitive Science variant:

- Has basic knowledge of both disciplines (AI and Psychology);
- Has knowledge of the experimental methods and findings from the study of cognitive psychology on behaviour;
- Can apply empirical methods to improve the understanding of neurobiological processes and phenomena;
- Is capable of modelling behaviour to obtain possibilities for simulation and further analysis, exploiting the powers and limits of various representations, coupled with studies of computational mechanisms;
- Is capable of modelling at the level of neural networks.

Appendix 4: Overview of the curricula

Bachelor's programme Lifestyle Informatics

		%	EC	Year 1	Year 2	Year 3
A	Human Sciences	20	30	12	12	6
B	Modelling	16	24	12	12	
C	Artificial Intelligence and Informatics	36	54	24	24	6
D	Integrative projects	16	24	6	6	12
E	General Academic subjects	12	18	6	6	6
F	Minor		30			30
Totals		100	180	60	60	60

A	**Human Sciences**		**30**	**12**	**12**	**6**
	Health and Behaviour			6		
	Introduction to Psychology and its Methods			6		
	Cognitive Psychology				6	
	Medical Process Second Line				6	
	Text Mining					6
B	**Modelling**		**24**	**12**	**12**	
	Introduction Lifestyle Informatics			3		
	Introduction Modelling and Simulation			6		
	Problem Solving			3		
	Empirical Methods				6	
	Integrative Modelling				6	
C	**Artificial Intelligence and Informatics**		**54**	**24**	**24**	**6**
	Introduction Programming			6		
	Logic and Sets			6		
	Pervasive Computing			6		
	Web Technology			6		
	Databases				6	
	Human-Computer Interaction				6	
	Intelligent Systems				6	
	Multimedia Authoring				6	
	Machine Learning					6
D	**Integrative Projects**		**24**	**6**	**6**	**12**
	LI Project year 1			6		
	LI Project year 2				6	
	Bachelor Project LI					12
E	**General academic subjects**		**18**	**6**	**6**	**6**
	Academic English			6		
	Philosophy				3	
	History of Science/Societal Aspects of Science				3	
	Seminar Critical Thinking					6
F	**Minor**		**30**			**30**
Totals			180	60	60	60

Master's programme Artificial Intelligence

Track: Intelligent System Design

	Course name	Credits	Period
Compulsory	Advanced Selforganisation	6	2
	Datamining Techniques	6	5
	Evolutionary Computing	6	1
	Intelligent Web Applications	6	4
	Knowledge Engineering	6	2+3
	Master Project	30	
	Model-based Intelligent Environments	6	3
	Research Methods	6	2,5
Choice 1	Advanced Information Retrieval	6	4
	Experimental Design and Data Analysis	6	5
	Automated Reasoning in AI	6	5
	Neural Networks	6	1
	The Social Web	6	4

Web Science

	Course name	Credits	Period
Core	Experimental Design and Data Analysis	6	5
	Evolutionary Computing	6	1
	Knowledge Engineering	6	2+3
	Master Project	30	
	Model-based Intelligent Environments	6	3
	Research Methods	6	2,5
Technical	Advanced Information Retrieval	6	4
	Intelligent Web Applications	6	4
	Automated Reasoning in AI	6	5
	The Social Web	6	4
	Datamining Techniques	6	5
Application	Business semantics	6	5
	E-Business Innovation	6	1
	E-Commerce Law	6	5
	Social Networks (Advanced Network Analysis, Annual Seminar in Organizations?)	6	
	Knowledge and Media	6	2

Human Ambience

	Course name	Credits	Period
Compulsory	Behaviour Dynamics	6	2
	Comparative Modeling	6	6
	Evolutionary Computing	6	1
	Experimental Design and Data Analysis	6	5
	Human Ambience Innovation	6	1
	Knowledge Engineering	6	2+3
	Master Project	30	

	Course name	Credits	Period
	Model-based Intelligent Environments	6	3
	Research Methods	6	2,5
Choice 1	Advanced Information Retrieval	6	4
	Advanced Selforganisation	6	2
	Knowledge and Media	6	2
	Intelligent Web Applications	6	4
	Advanced Logic	6	4

Cognitive Science

	Course name	Credits	Period
Compulsory	Brain Imaging	6	5
	Evolutionary Computing	6	1
	Human Information Processing	6	5
	Knowledge Engineering	6	2+3
	Master Project	30	
	Model-based Intelligent Environments	6	3
	Neural Models of Cognitive Processes	6	2
	Research methods	6	2,5
	Seminar Cognitive Neuroscience	6	1
	Special Topics Cognitive Science	6	any
	Thinking and Deciding	6	2
Recommended electives	Advanced statistics for experimentation	6	
	Behaviour Dynamics	6	2
	Human Ambience Innovation	6	1
	Internet Programming	6	1
	Memory and Disorders	6	2
	Mini-master project	6	any
	Perception	6	5
	Review paper	6	any
	Seminar Attention	6	3

Appendix 5: Quantitative data regarding the programmes

Data on intake, transfers and graduates

Bacherlor's programme Lifestyle Informatics

Number of fulltime students enrolled per cohort in the BSc Lifestyle Informatics programme

Cohort	Total	Male	Female
02/ 03	20	18	2
03/ 04	26	23	3
04/ 05	36	34	2
05/ 06	25	21	4
06/ 07	22	21	1
07/ 08	23	16	7
08/ 09	19	15	4
09/ 10	19	14	5
10/ 11	40	26	14
11/ 12	29	21	8
12/ 13	37	15	22

Total number of fulltime students enrolled in the BSc Lifestyle Informatics programme

Year	Total	Male	Female
02/ 03	24	20	4
03/ 04	102	85	17
04/ 05	118	104	14
05/ 06	114	102	12
06/ 07	100	90	10
07/ 08	103	89	14
08/ 09	91	79	12
09/ 10	82	68	14
10/ 11	91	69	22
11/ 12	99	74	25
12/ 13	108	67	41

Number of graduated students in the BSc Lifestyle Informatics programme

Year	VU
02/ 03	6
03/ 04	17
04/ 05	14
05/ 06	15
06/ 07	13
07/ 08	18
08/ 09	14
09/ 10	14
10/ 11	8
11/ 12	14

Master's programme Artificial Intelligence

Number of fulltime students enrolled per cohort in the MSc Artificial Intelligence programme

Cohort	Total	Male	Female
02/ 03	9	8	1
03/ 04	21	16	5
04/ 05	14	13	1
05/ 06	12	8	4
06/ 07	25	20	5
07/ 08	19	14	5
08/ 09	23	17	6
09/ 10	28	27	1
10/ 11	23	20	3
11/ 12	14	10	4
12/ 13	16	10	6

Total number of fulltime students enrolled in the MSc Artificial Intelligence programme

Year	Total	Male	Female
02/ 03	3	3	0
03/ 04	18	17	1
04/ 05	24	18	6
05/ 06	29	21	8
06/ 07	33	25	8
07/ 08	42	34	8
08/ 09	46	37	9
09/ 10	52	44	8
10/ 11	65	57	8
11/ 12	58	49	9
12/ 13	55	40	15

Number of graduated students in the MSc Artificial Intelligence programme

Year	VU
02/ 03	
03/ 04	5
04/ 05	12
05/ 06	12
06/ 07	12
07/ 08	11
08/ 09	18
09/ 10	11
10/ 11	18
11/ 12	19

Teacher-student ratio

Bachelor's programme Lifestyle Informatics
The Computer Science Department has 33 fte (148 people) for teaching in the three Bachelor and five master's programmes of the Department. The total number of students is approximately 725.

Staff level (March 2013) of the Computer Science Department

	N	Fte	N	Fte	N	Fte	Teaching	Fte
Position	**male**	**male**	**female**	**female**	**m+f**	**m+f**	**fraction***	**teaching**
HL	14	11,7	0	0,0	14	11,7	0,4	4,7
UHD	6	3,5	3	2,8	9	6,3	0,4	2,5
UD	12	9,9	5	4,6	17	14,5	0,4	5,8
Teacher	3	2,2	2	1,3	5	3,5	0,8	2,8
Researcher	30	24,9	5	4,1	35	29,0	0,2	5,8
PhD student	38	37,8	11	11,0	49	48,8	0,1	4,9
Student ass.	13	3,4	6	1,5	19	4,9	1,0	4,9
Total					**148**	**119**		**31**

* units of account declared by VU University / VSNU

The number of students in the bachelor's programme Lifestyle Informatics is 108 (March 2013). In this programme approximately 35 staff are involved in teaching. They also teach in other curricula.

Master's Programme Artificial Intelligence

Staff level (March 2013) of AI research (three groups)

Function	N	Fte	N	Fte	N	Fte	Teaching	Fte
	male	**male**	**female**	**female**	**m+f**	**m+f**	**fraction***	**teaching**
HL	3	3,0	0	0,0	3	3,0	0,4	1,2
UHD	0	0	1	0,8	1	0,8	0,4	0,3
UD	5	3,7	2	1,8	9	5,5	0,4	2,2
Teacher			1	0,5	1	0,5	0,8	0,4
Researcher	12	11,6	1	1,0	13	12,6	0,2	7,0
PhD student	6	6,0	5	5,0	11	11,0	0,1	1,1
Total					**38**	**35,4**		**12**

The number of students in the master's programme Artificial Intelligence is 55 (March 2013). In this programme 38 staff are involved. They also teach in other curricula

Quality of the teaching staff

Graad	Master	PhD	BKO
Percentage	100 %	97 %	68 %

Average amount of face-to-face instruction per stage of the study programme

Bachelor's programme Lifestyle Informatics

On average per week

Year 1	Year 2	Year 3
15	13,5	6

Master's programme Artificial Intelligence

On average per week:

Year 1		Year 2	
Sem. 1	**Sem. 2**	**Sem. 3**	**Sem. 4**
8	8	8	1*

* During the last semester, students are working on their Master Project.

Appendix 6: Programme of the site visit

Maandag 10 juni

10.00	13.00	Startbijeenkomst (inloopspreekuur) en lunch
13.00	14.00	**Management (inhoudelijk verantwoordelijken)** Maarten van Steen (afdelingshoofd), Guus Schreiber (opleidingsdirecteur), Johan Vermeer (onderwijsdirecteur FEW), Hubertus Irth (decaan FEW)
14.00	14.15	Pauze
14.15	15.00	**Studenten B LI** Ali Moussi Yonne de Bruijn Suzanne Tolmeijer Ayesha van der Woensel Roxanne Robijns Imane Haltout
15.00	15.45	**Docenten B LI** Roel de Vrijer Michel Klein Evert Haasdijk Frank van Harmelen Jan Treur Natalie van der Wal Hennie van der Vliet
15.45	16.00	Pauze
16.00	16.45	**Studenten M AI** Sanne Vrijenhoek Floris den Hengst Fredrik de Vree
16.45	17.30	**Docenten M AI** Annette ten Teije Tibor Bosse Martijn Meeter Frank van Harmelen Guszti Eiben Jan Treur
17.30	17.45	Pauze
17.45	18.30	**Alumni** Jesper Hoeksema Julienka Mollée Thomas Alderse Baas

Dinsdag 11 juni

9.00	9.45	**Opleidingscommissie** Stefan Schlobach (voorzitter) Evert Haasdijk (lid) Michel Klein (lid) Sanne Vrijenhoek (student) Roxanne Robijns (student) Fleur Venneker (student)
9.45	10.30	**Examencommissie en studentadviseur** Mark Hoogendoorn (secretaris excie) Tibor Bosse (voormalig secretaris excie) Hans van Vliet (voorzitter excie) Jaap Heringa (voorzitter excie FEW) Vera Stebletsova (studieadviseur) Natalia Silvis (studieadviseur)
10.30	10.45	Pauze
10.45	11.30	Voorbereiden eindgesprek (alleen commissie)
11.30	12.30	**Eindgesprek (formeel verantwoordelijken)** Maarten van Steen (afdelingshoofd), Guus Schreiber (opleidingsdirecteur), Johan Vermeer (onderwijsdirecteur FEW), Hubertus Irth (decaan FEW) Wan Fokkink (aankomend opleidingsdirecteur)
12.30	13.00	Lunch en mogelijkheid tot rondleiding
13.00	15.30	Vaststellen bevindingen (alleen commissie)
15.30	15.45	Presentatie bevindingen, daarna informele afsluiting

Appendix 7: Theses and documents studied by the committee

Prior to the site visit, the committee studied the theses of the students with the following student numbers:

Bacherlor's programma Lifestyle Informatics

1757539	1702424	1770195	1827677	1899082
1484699	1717723	1862847	1767305	1842730
1719971	1822225	1707507	1893424	1997424
1636855	1427148	1822187	1765140	1707531
1720007	1473689	1758993	1985302	1734008

Masster's programme Artificial Intelligence

1628100	1877232	1329804	1691155	1557017
2000644	1561278	2005441	1329685	1561251
1473417	2000423	1473328	1615491	1427156

During the site visit, the committee studied, among other things, the following documents (partly as hard copies, partly via the institute's electronic learning environment):

- Information material;
- Books and syllabi, readers, study guides;
- Examples of projects, portfolios, research reports of students;
- Thesis regulations and guidelines for completing assignments;
- Regulations/manuals;
- Examination regulations;
- Key materials (exams, test instructions, key policies, etc.) with model answers;
- Recent reports of the Programme Committee, Examination Committee, annual education, bachelor-master transitional arrangements;
- Teaching and curriculum evaluations, student satisfaction monitor(s), etc.;
- Alumni surveys;
- Material of the study associations;
- Annual reports (education, research, last three years).

Appendix 8: Declarations of independence

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ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: León Rothkrantz

PRIVÉ ADRES: Ir. Werffstraat 19
2722 AR Zoetermeer

IS ALS DESKUNDIGE / ~~SECRETARIS~~ GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Kunstmatige Intelligentie

AANGEVRAAGD DOOR DE INSTELLING:

RUG/UU/RU/UT/UvA/VU

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

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nederlands-vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Utrecht DATUM: 14 maart 2013

HANDTEKENING:

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nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Timothy John Gralt

PRIVÉ ADRES: Koningin Wilhelminastraat 13
3405 XP Benschop

IS ALS DESKUNDIGE / ~~SECRETARIS~~ GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Kunstmatige Intelligentie

AANGEVRAAGD DOOR DE INSTELLING:

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VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Bergschop

DATUM: 14 maart 2013

HANDTEKENING: T.J. Gracht

nvao
nederlands-vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: M. J. den Uyl

PRIVÉ ADRES: Courbetstraat 29
1077 ZS Amsterdam

IS ALS DESKUNDIGE / ~~SECRETARIS~~ GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Kunstmatige Intelligentie

AANGEVRAAGD DOOR DE INSTELLING:

UU / UvA / VU

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VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Utrecht DATUM: 14 maart 2013

HANDTEKENING:

2

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ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: DE RAEDT, Luc

PRIVÉ ADRES: LEDEBEEKHOF 4
9070 Destelbergen
BELGIË

IS ALS DESKUNDIGE / ~~SECRETARIS~~ GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Kunstmatige Intelligentie

AANGEVRAAGD DOOR DE INSTELLING:

UU/UvA/VU

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VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Deskelbrugge

DATUM: 13/3/2013

HANDTEKENING:

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ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Yfke Marie Dulek

PRIVÉ ADRES: Cambridgelaan 617
3584 DM
Utrecht

IS ALS DESKUNDIGE / ~~SECRETARIS~~ GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

kunstmatige intelligentie

AANGEVRAAGD DOOR DE INSTELLING:

UU / UvA / VU

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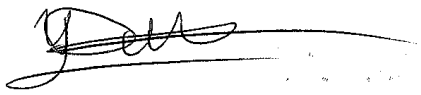
VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Utrecht DATUM: 14-03-2013

HANDTEKENING:



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ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: H.A.T. Wilbrink

ADRES: Oude Vest 191
2312 XX Leiden

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING: Kunstmatige Intelligentie

ZIE BIJLAGE

AANGEVRAAGD DOOR DE INSTELLING: RUG/UU/RU/UM/UvA/VU

ZIE BIJLAGE

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

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PLAATS: Utrecht DATUM: 14/03/2013

HANDTEKENING: