BSc Data Science for Global Challenges

Follow-up report on conditions set by the NVAO

WAGENINGEN
UNIVERSITY & RESEARCH

21 July 2025

Contents

Executive summary

In January 2025, the Dutch-Flemish Accreditation Organisation (NVAO) gave a positive advice for the academic accreditation to the BSc programme Data Science for Global Challenges, under the condition that three key areas be improved within six months. This report outlines how the programme has addressed these conditions.

Condition 1. Integration of ELSA and soft skills

To meet the requirement for explicit integration of Ethical, Legal, and Societal Aspects (ELSA) and soft skills (such as communication), the programme introduced **structured academic skills trajectories** aligned with the Wageningen University (WU) skills programme. The following four skills are now core to the programme:

- Ethics, Dilemmas and ELSA;
- Presenting;
- Collaboration;
- Bridge Building (interdisciplinarity).

Each skill is embedded in multiple courses, with **clear learning outcomes, learning activities and a build-up in the attained level** of the skill. Descriptions of subskills and attainment levels were customised or developed. A **skills coordinator** has been appointed to monitor and align skills implementation both between the courses and with the learning outcomes of the programme.

Condition 2. Addressing deficiencies in Mathematics and Biology

To ensure that students from diverse backgrounds can meet the programme's academic demands, the following measures are taken:

- We **tightened the admission requirements**: Only students with sufficient prior education in mathematics and beta subjects are now eligible. Applicants with a VWO Culture & Society profile are no longer eligible.
- **Levelling strategy**: Specific courses—Mathematics 1 and Statistics 1—are offered to address differences in knowledge between students who took Mathematics A and B in secondary school that are relevant to the programme. These are based on a **proven approach** used in other WU programmes with similar academic demands.

Evidence from longstanding experience confirms the effectiveness of this approach in bridging initial knowledge gaps, ensuring a programme feasible for students from various backgrounds.

Condition 3. Assessment of interdisciplinary learning and skills

To strengthen assessment of the skills, **custom rubric templates** were developed based on the descriptions of the **skills and their attainment levels**. These are tailored to use within the courses of the BSc Data Science for Global Challenges.

Moreover, a **programme specific BSc thesis rubric** has been developed to include explicit assessment criteria for ELSA, Bridge-building skills and Communication.

Examples are provided of how constructive alignment between the learning outcomes, learning activities and assessment – a key principle from the WU-broad assessment policy – is realised in the programme.

Introduction

On January 22 2025, the Dutch Flemish Accreditation Organisation (NVAO) gave a positive advice with conditions for the academic accreditation of the BSc Data Science for Global Challenges, with the expectation that the following conditions will be met within six months:

1. Ensure the explicit integration of ethical, legal, and societal aspects (ELSA), as well as soft skills such as communication, throughout the curriculum;
2. Implement a strategy to address deficiencies in Mathematics and/or Biology to ensure equal opportunities for all students. The learning objectives must be achievable for all admitted students within the standard study duration and with a reasonable study effort.
3. Explicate how interdisciplinary learning, ELSA and bridge-building skills, including communication, are assessed in the programme.

We value and highly appreciate the constructive feedback from the accreditation panel which was translated into these three conditions. We recognise the need to redesign elements of the programme to meet the conditions and to provide a better programme for future students. We are convinced that the redesign process which we followed with the programme team in the last 6 months to meet the three conditions have considerably improved the quality of the programme. In this report we outline how we addressed the conditions that have been set by the accreditation panel.
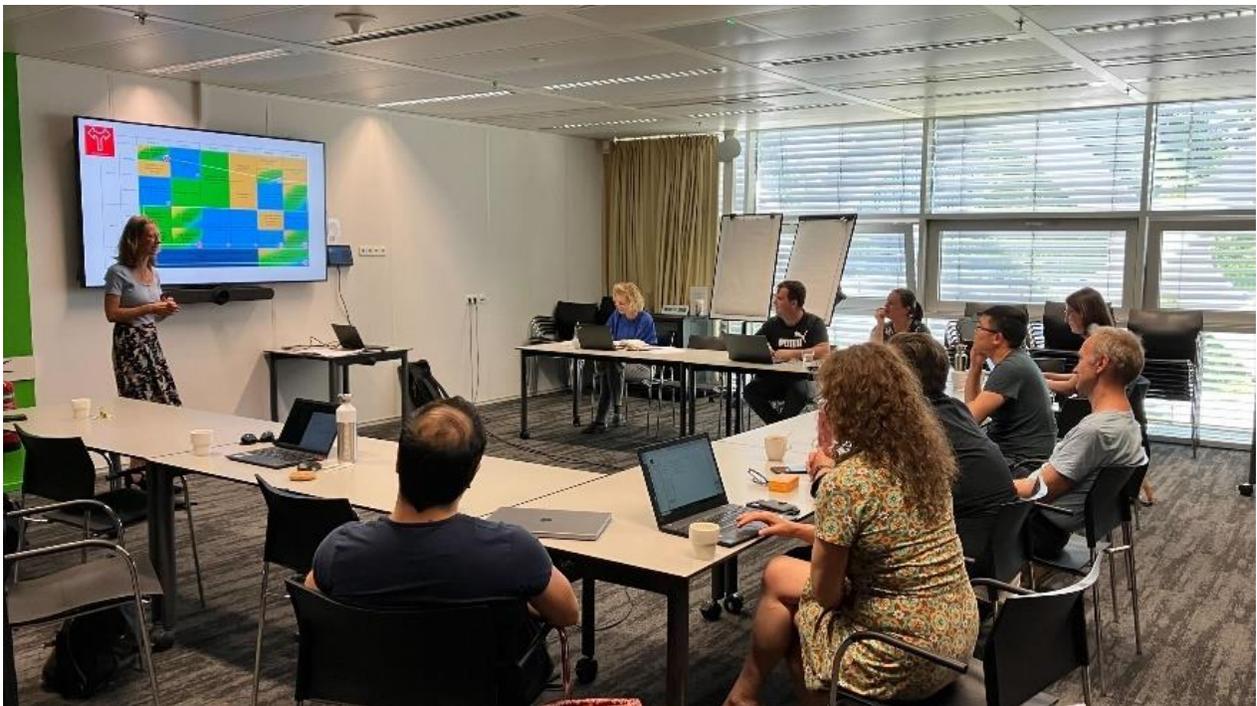

Figure 1: Programme management, teaching staff and experts from the Teaching and Learning Centre collaborating on adressing the conditions set by the NVAO.

Condition 1: ELSA and soft skills in the curriculum

Ensure the explicit integration of ethical, legal, and societal aspects (ELSA), as well as soft skills such as communication, throughout the curriculum

To comply to the first condition, we have translated the conditions set by the NVAO into skills and corresponding learning activities as described in this chapter, fitting within the WU-broad skills programme, and adapted them where it was necessary. The WU skills programme is a long-term endeavour within WU with the aim to create and strengthen continuous academic skills learning trajectories in the bachelor curricula and ensure their visible presence in education. The implementation of the skills have recently become mandatory. In our 2025 Vision for Education, we have also set the ambition to further strengthen the integration of skills in courses and the core curriculum.[1]

Since January 2025, both financial means for the implementation and structural support from Wageningen University became available. The process from the pilot phase to making the skills mandatory for all BSc programmes – including the needed accommodations such as financial means - ran parallel with creating the BSc Data Science for Global Challenges. Therefore, the skills were not (explicitly) part of the new programme at the time of the initial accreditation. By making use of the skills programme, we benefit from the WU-broad policy, support and materials (such as guidelines). Within the skills programme, 16 WU-broad academic skills are set up. Programmes can pick which skills they deem most important (core skills) and somewhat important (supporting skills). Furthermore, programmes can adjust these general skills to better fit the programme or even set up programme-specific skills. For more information about the skills programme, including descriptions of the sixteen WU-broad skills, see appendix 1.

Core skills for the BSc Data Science for Global Challenges

To translate the accreditation conditions into skills trajectories, we have created a working group consisting of key teaching staff involved in the new bachelor programme, programme management and experts from our Teaching and Learning Centre, including skills support experts. Together, we set up recognisable learning trajectories for the explicit integration of ELSA and soft skills into the curriculum. We have translated the conditions set by the NVAO in four skills which we identified as core skills for BSc Data Science for Global Challenges:[2]

- **Ethics, dilemmas and ELSA**[3]
- **Presenting** as part of soft skills
- **Collaboration** as part of soft skills
- **Bridge building** as part of soft skills

These skills with the corresponding learning activities in courses ensure the explicit integration of ELSA, soft skills including communication and interdisciplinarity. We have chosen to make trajectories that are clearly recognisable and distinctive for students and staff. This means that sometimes the names of the skills trajectories deviate from terms used in the report from the NVAO on the conditions. In our approach, we see presenting, collaboration and bridge building as soft skills including communication as

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[1] See Vision for Education (2025)

[2] Within the skills programme, all BSc programmes select a number of skills as core skills and supporting skills. Apart from these four skills, we have also identified other skills as either core or supporting, such as (scientific) writing and social embeddedness. In this report, we only discuss the four skills that are mentioned here, since we deem these most important to comply to the conditions set by the NVAO.

[3] This skill includes both general ethics (as is the case in the WU-broad skills for ethics) and ethical aspects for data science and AI, specifically. Therefore, we have chosen to reflect this in the name as well, even though this may seem redundant.

stated in the NVAO report. We have translated interdisciplinarity in bridge building, as described in the four-stage model (based on the 10-step process for interdisciplinary research by Allen F. Repko).[4] This means that remarks from the NVAO report on either interdisciplinarity or bridge building are both addressed in the bridge building skill.

For all four of these skills, we have mapped out the trajectory in the curriculum (see Figure 2). Each skill has three attainment levels and several subskills. As a framework to be used throughout the programme, detailed descriptions of intended learning outcomes at three attainment levels were defined for ELSA, bridge building, presenting and collaboration skills (see overview in appendix 2). For the learning trajectories as mapped out by the working group, we have defined which attainment level is reached in the courses that together form the trajectory.

The courses that are explicitly part of the trajectories, and are therefore labelled as such in Figure 2, are courses specific to the BSc Data Science for Global Challenges programme. The programme is the "owner" of those courses and can therefore to the largest extent define the content of the course. At Wageningen University, we have a 'supply-and-demand' model where programmes request and then share the courses. More general courses (such as Mathematics, Statistics or Cell Biology) are shared with many programmes. With this many programmes, changes in these courses are less feasible as they need to be discussed and accommodated by all programmes. For the trajectories, we have therefore focused on the courses that are either specifically set up for the BSc Data Science for Global Challenges or are for the largest part accounted for by the programme.

Figure 2: Curriculum with skills and attainment levels. This figure only indicate the courses that are explicitly part of the skills trajectories are depicted. As explained in the paragraph 'Core skills for the BSc Data Science for Global Challenges', there are more courses that teach these skills (e.g. Artificial Intelligence in the second year).

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[4] See A four-stage model for interdisciplinary learning - Educational Development & Training - Utrecht University

Although only the courses labelled in Figure 2 are explicitly part of the designed skills learning trajectories, many skills are also (implicitly) taught in other courses. For instance, in the courses that are part of the learning trajectory 'collaboration', specific instruction is provided on how to collaborate, often including some type of (peer) feedback and assessment. However, in many other courses, students perform group work, thereby practicing these skills in a different setting.

To ensure and align the actual teaching and assessment of the skills in courses, and especially those skills related to ELSA and soft skills as set out in the NVAO conditions, the BSc Data Science for Global Challenges programme has appointed a skills coordinator (0.2 fte), for which funding is available until at least 2030. The skills coordinator has already been involved in the redesign process to comply with the NVAO conditions and has the task to monitor the skills trajectories, both in the courses where skills are explicitly part of it and in courses where the skills are (for now) implicit. The skills coordinator supports the programme by monitoring, aligning the skills in the courses with the programme learning outcomes and making sure the programme specific skills learning trajectories are being implemented and assessed. The skills coordinator receives support in this from WU Teaching and Learning Centre and exchanges experiences and best practices with skill coordinators active in other Wageningen University degree programmes.

Ethics, dilemmas and ELSA skills

The skill 'ethics, dilemmas and ELSA' is based on the WU-skill '(practical) ethics and dilemmas' (as described in appendix 1), with adjustments especially focusing on ELSA to better fit the core of the BSc Data science for Global Challenges programme. In the overview in Figure 3 the learning trajectory for the skill 'ethics, dilemmas and ELSA' is mapped out. This trajectory focuses on biases in data sets, ELSA, ethical reflections, one's own values and ethical data management (including the FAIR principles). The trajectory starts in the introduction courses with attainment level 1, where in course Data Science for Global Challenges 1 the focus is on the ethical and societal considerations. The course Data Science for

Ethics, dilemmas and ELSA

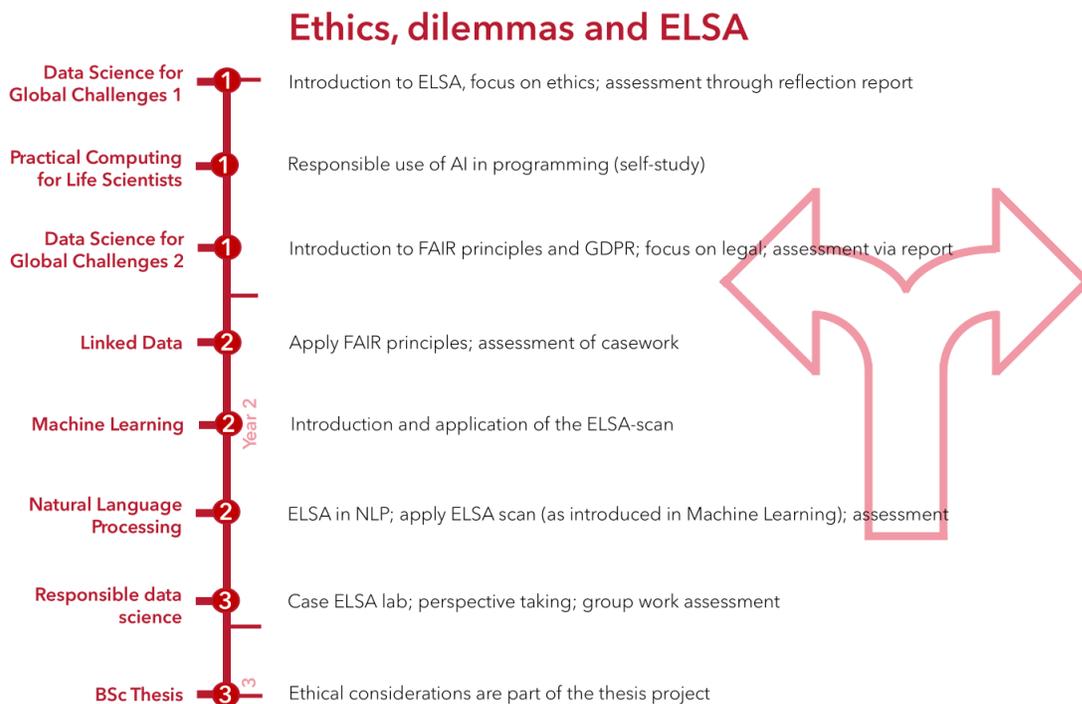| Course	Level	Description
Data Science for Global Challenges 1	1	Introduction to ELSA, focus on ethics; assessment through reflection report
Practical Computing for Life Scientists	1	Responsible use of AI in programming (self-study)
Data Science for Global Challenges 2	1	Introduction to FAIR principles and GDPR; focus on legal; assessment via report
Linked Data	2	Apply FAIR principles; assessment of casework
Machine Learning	2	Introduction and application of the ELSA-scan
Natural Language Processing	2	ELSA in NLP; apply ELSA scan (as introduced in Machine Learning); assessment
Responsible data science	3	Case ELSA lab; perspective taking; group work assessment
BSc Thesis	3	Ethical considerations are part of the thesis project

Figure 3: Overview of skills trajectory 'ethics, dilemmas and ELSA'. On the left all courses with specific attention to this skill are depicted, on the right the elements of the skill taught in that course.

Global Challenges 2 focuses on the legal aspects. In year 2, students build upon this and apply ELSA and FAIR data principles to case studies. For example, students work with the ELSA scan, which is introduced in Machine Learning (see Box 1). The ELSA scan will also be used in the next course: Natural Language Processing. Students work on different techniques and different cases, and thereby learn how to apply the ELSA scan under new circumstances. The final attainment level will be reached at the end of the second year, during the course 'Responsible Data Science'. Students also use this skill in the BSc Thesis. Depending on the project, students can decide (together with their supervisors) which method fits best for incorporating ELSA (e.g. the ELSA scan). For several courses, an ELSA related learning outcome has been added to ensure the learning activities and assessment[5] will remain an integral part of the course, independent of the involved teaching staff. Specifically for ELSA, the following learning outcomes were added:

Course	Learning outcomes (adapted or added)
Data Science for Global Challenges 1	Identify ethical, legal and societal aspects of data science applications in life science domains
Data Science for Global Challenges 2	Recognize the need for responsible data management principles (such as FAIR) during research projects and also ethical, legal and societal aspects (ELSA)
Natural Language Processing	Evaluate ethical, legal and societal aspects (ELSA) when applying NLP in WUR domains

In several other courses attention is paid to ELSA as well. This is not explicitly part of the designed learning trajectory, but does provide students with extra practice moments or new application domains. For example, in the course Artificial Intelligence one of the learning outcomes is "Recognize various ethics and governance to ensure responsible development and deployment of AI systems" (see course guide in appendix 3) and several learning activities relating to ethics of AI are there handled.

Box 1: ELSA scan in Machine Learning course

In the second year, students take the course Machine Learning, which deals with algorithms that predict certain outputs (such as crop yields or traits) given previously unseen input data. This course discusses the theory of different methods for regression, classification, and clustering and the their application in different fields of agricultural and life sciences (see appendix 3 for course guide). Within this course, there is a lecture and tutorial on ELSA, provided by lecturers from the Philosophy group.

During the lecture, students learn about ethics in AI and data science: why is it important and what does it entail? Furthermore, the ELSA scan is introduced. This is a method to scan AI technology to identify any risks in an early development stage to mitigate them and to take opportunities to better align to sustainability objectives, based on ten questions.* During the tutorial, students first practice on a case by answering three of the questions from the ELSA scan. After plenary feedback, students have time to work out the entire ELSA scan about their own case (see appendix 4 for tutorial and practice case). The answers will be part of the case report they hand in at the end of the course. The ELSA reflection in the report is also assessed.

* van Hilten, M., Ryan, M., Blok, V., & de Roo, N. (2025). *Ethical, Legal and Social Aspects (ELSA) for AI: An assessment tool for Agri-food. Smart Agricultural Technology, 10*, Article 100710. https://doi.org/10.1016/j.atech.2024.100710

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[5] The assessment is elaborated upon in condition 3.

Presenting

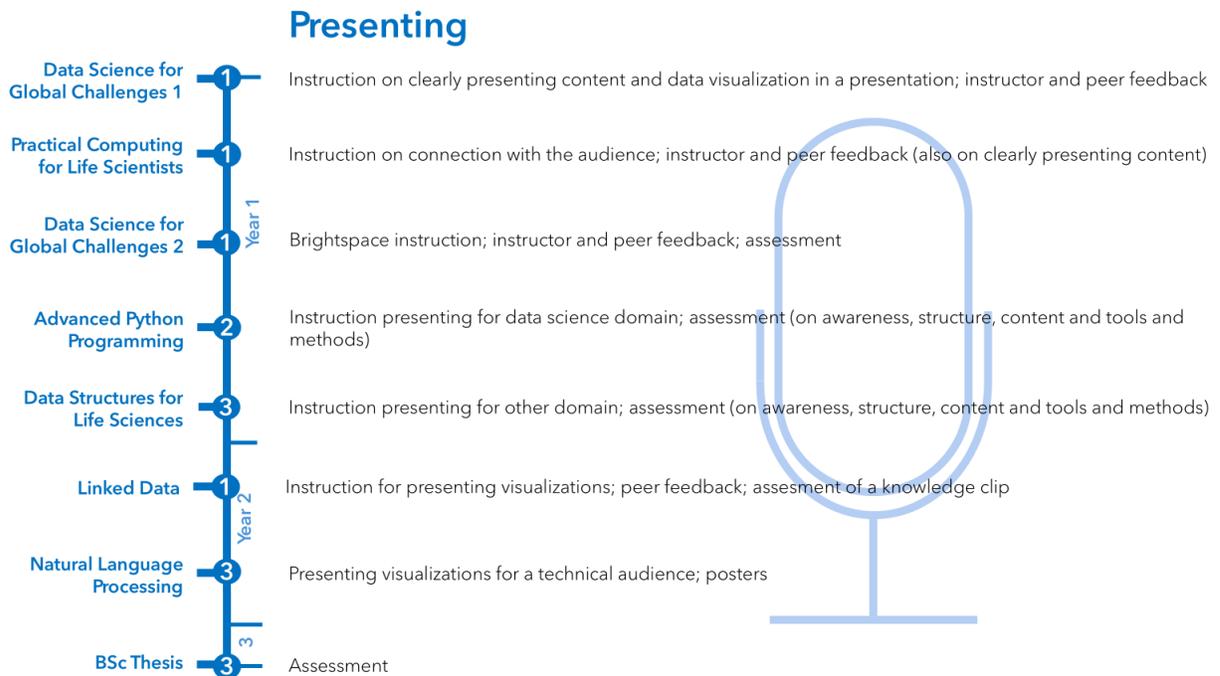| Course	Level	Description
Data Science for Global Challenges 1	1	Instruction on clearly presenting content and data visualization in a presentation; instructor and peer feedback
Practical Computing for Life Scientists	1	Instruction on connection with the audience; instructor and peer feedback (also on clearly presenting content)
Data Science for Global Challenges 2	1	Brightspace instruction; instructor and peer feedback; assessment
Advanced Python Programming	2	Instruction presenting for data science domain; assessment (on awareness, structure, content and tools and methods)
Data Structures for Life Sciences	3	Instruction presenting for other domain; assessment (on awareness, structure, content and tools and methods)
Linked Data	1	Instruction for presenting visualizations; peer feedback; assesment of a knowledge clip
Natural Language Processing	3	Presenting visualizations for a technical audience; posters
BSc Thesis	3	Assessment

Figure 4: Overview of skills trajectory 'presenting'. On the left all courses with specific attention to this skill are depicted, on the right, the elements of the skill taught in that course.

Presenting skills

In the overview in Figure 4, the learning trajectory for the skill 'presenting' is mapped out. In this trajectory, attention is paid to connecting with the audience, structuring the presentation, using visual aids (such as illustrations and quotations) and data visualisation. The trajectory starts in the first period of the first year, both in Data Science for Global Challenges 1, 2 (see Box 2) and Practical Computing for Life Scienctists. Later in the first year, students make a distinction between presenting to data scientists (in Advanced Python Programming) and to scientists from other domains (in Data Structures for Life Sciences). Attainment level 3 of this skill will thereby be reached at the end of the first year. In the second year, students will still work on their presentation skills, often in other forms. The teaching staff of Linked Data is currently adapting the course to add making and presenting a knowledge clip as a learning activity for students, offering them a different setting to work on their presenting skills. In

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Box 2: Presenting in Data Science for Global Challenges 1 & 2

In the two courses Data Science for Global Challenges 1 & 2, students work on the skills presenting. In both courses, they need to present the case they have been working on to the other students. During course 1, instruction is provided on how to visualise data during a lecture, and student practice this in an assignment. Instructions on presenting are provided in the online learning environment. Depending on the level of this skill in students, plenary instructions are provided as well. In the second course, students get the same assignment, but then with more complex cases.

All cases are from different life sciences domains. Since the students have no life science background yet, they need to explain both the life sciences and the data science of their specific case to a general audience, taking into consideration the background of the audience and adapting the presentation accordingly. The presentation is assessed by the lecturers, with a focus on connecting to the audience and data visualisation. Students also provide peer feedback, which is assessed in the report.

Collaboration

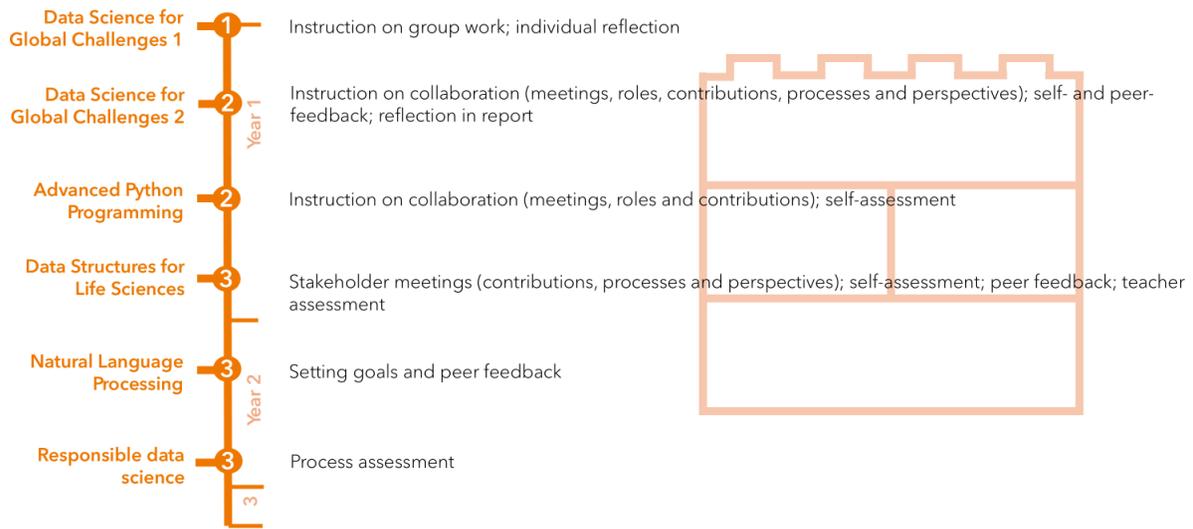| Course	Level	Elements
Data Science for Global Challenges 1	1	Instruction on group work; individual reflection
Data Science for Global Challenges 2	2	Instruction on collaboration (meetings, roles, contributions, processes and perspectives); self- and peer-feedback; reflection in report
Advanced Python Programming	2	Instruction on collaboration (meetings, roles and contributions); self-assessment
Data Structures for Life Sciences	3	Stakeholder meetings (contributions, processes and perspectives); self-assessment; peer feedback; teacher assessment
Natural Language Processing	3	Setting goals and peer feedback
Responsible data science	3	Process assessment

Figure 5: Overview of skills trajectory 'collaboration'. On the left all courses with specific attention to this skill are depicted, on the right the elements of the skill taught in that course.

Natural Language Processing, the students will present their work on a poster. Students will also use this skill in the BSc Thesis when they present their work at the end of the project.

The skill presenting is also reflected in course learning outcomes. Often, these concern one of the subskills instead of aiming to teach all aspects of the presenting skill. For instance, in Data Structures for Life Sciences course the following learning outcome is defined: "Communicate about data structures and findings with stakeholders in the domains of food, health or environment". This learning outcome reflects the subskills 'awareness of public'. In the course Big Data for Life Sciences, a learning outcome fits the subskills 'Tools and methods for getting your message across' and 'Data visualization in a presentation': "Communicate meaningful patterns in data through data visualisation, reporting, presentation and documentation." Since the trajectory consists of multiple courses, together these courses ensure the teaching in the entire trajectory.

Collaboration skills

In the overview in Figure 5, the learning trajectory for the skill 'collaboration' is mapped out. In this trajectory, attention is paid to group work and meetings, structuring and integrating input, listening, asking clarifying questions, discussing constructively, dealing with group processes and being open to multiple perspectives and integrating these. Students start with this trajectory in Data Science for Global Challenges 1, where they get instruction on group work and have to reflect on their own role. In Data Science for Global Challenges 2 and Advanced Python Programming, students get further instruction, with a focus on how to collaborate effectively. Student reach attainment level 3 in Data Structures for Life Sciences, where they as a group conduct stakeholder meetings (see box 3). In Natural Language Processing and Responsible Data Science, students apply this skill in a new setting (e.g. specific to ELSA lab).

Learning outcomes with collaboration aspects can be found in different courses. For example, Data Science for Global Challenges 2 has the learning outcome: "Conduct basic collaborative (including bridge building skills) data science research projects in the life sciences domains of food, health and

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Box 3: Stakeholder meetings in Data Structures for Life Scientists

At the end of the first year, students take the interdisciplinary course Data Structure for Life Scientists. The course builds on programming skills and provides a solid foundation in data structures and algorithms, with an emphasis on real-world applications in food, health, and the environment (see appendix 3 for course guide). Students work in groups of 3 or 4 on a case, offered by an expert from a life sciences domain. The case is a problem from the life sciences domain, which has to be solved using data science techniques.

Students get instructions on how to work effectively in a group. Students also need to collaborate with the expert; first to understand the problem, later to clearly explain their data-driven solution. To better understand the challenges in collaborating with someone from the life sciences domain, a plenary interview is held with the expert. Students can ask questions on e.g. how they experience collaborations with data scientists, which role bridge builders can take and how to communicate effectively.

environment and communicate the findings to diverse audiences". Also in courses outside of the learning trajectory, attention is paid to collaboration. For instance, in Cell Biology there is a learning outcome specifically on the subskill 'contributing to the discussion process-wise': "Lead a group discussion".

Bridge building skill

The 'bridge building' skill is a programme-specific skill which has been created to explicate interdisciplinarity throughout the curriculum. As mentioned in the application and information dossier, we refer to interdisciplinarity as bridge building, where the four stage model for interdisciplinarity forms the basis.[6] The four stages are recognizable in the description of the subskills and attainment levels (see appendix 2): disciplinary grounding, perspective taking, finding common ground and integration. Figure 6 provides an overview of the Bridge-building skill learning trajectory throughout the curriculum.

Already in the first courses (Data Science for Global Challenges 1 and Practical Computing for Life Scientists), students start with this learning trajectory. In these courses, students are presented with examples and guest presentations of bridge building in order to get them acquainted with these types of cases. Students will encounter more complex cases in Data Science for Global Challenges 2 and work on these themselves. In Data Structures for Life sciences, they actively take on this role as a bridge builder, by helping case owner from the life sciences domain to solve their problem using data. Where in this course students focus on explaining data science to a life scientist, in the course Linked Data, they do the reverse, i.e. communicate their solution within a life science domain to data scientists. In Natural Language Processing students also work on all stages of interdisciplinarity, but now with NLP techniques and methods. Students explicitly bring together the ethics, dilemma's and ELSA skill and the bridge building skill in Responsible Data Science. Naturally, bridge building also is a major aspect of the BSc Thesis which focuses on integration of data science and life sciences. This is guaranteed by a compulsory thesis co-supervision by two researchers: one from Data Science and another from Life Science application domain

To strengthen this learning trajectory, we have added a specific learning outcome for the course Data Science for Global Science 1:

Course	Learning outcome (adapted or added)
Data Science for Global Challenges 1	Recognize, as bridge builders, the different designs of basic data science research projects in the life science domains of food, health and environment and communicate the results

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[6] https://www.uu.nl/onderwijs/onderwijsadvies-training/publicaties/kennisdossier-hoger-onderwijs/four-stage-model

Bridge building

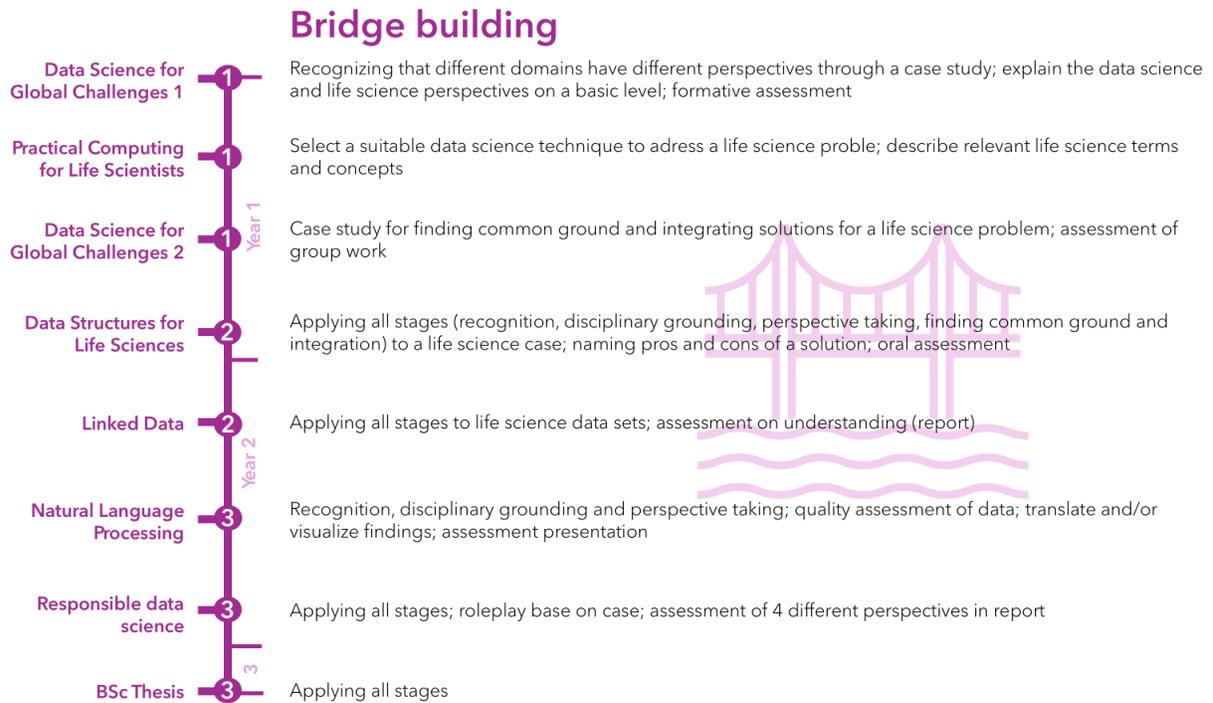| Course	Skill elements
Data Science for Global Challenges 1 ①	Recognizing that different domains have different perspectives through a case study; explain the data science and life science perspectives on a basic level; formative assessment
Practical Computing for Life Scientists ①	Select a suitable data science technique to adress a life science proble; describe relevant life science terms and concepts
Data Science for Global Challenges 2 ①	Case study for finding common ground and integrating solutions for a life science problem; assessment of group work
Data Structures for Life Sciences ②	Applying all stages (recognition, disciplinary grounding, perspective taking, finding common ground and integration) to a life science case; naming pros and cons of a solution; oral assessment
Linked Data ②	Applying all stages to life science data sets; assessment on understanding (report)
Natural Language Processing ③	Recognition, disciplinary grounding and perspective taking; quality assessment of data; translate and/or visualize findings; assessment presentation
Responsible data science ③	Applying all stages; roleplay base on case; assessment of 4 different perspectives in report
BSc Thesis ③	Applying all stages

Figure 6: Overview of skills trajectory 'bridge building'. On the left all courses with specific attention to this skill are depicted. On the right, the elements of the skill taught in that course.

Condition 2: Address deficiencies in mathematics and/or biology

Implement a strategy to address deficiencies in Mathematics and/or Biology to ensure equal opportunities for all students. The learning objectives must be achievable for all admitted students within the standard study duration and with a reasonable study effort.

The second condition set by the NVAO is on the wide range of students to be admitted to the programme: Dutch VWO diploma in Nature & Health (N&G), Nature & Technology (N&T) or Economics & Society (E&M) profiles, as well as those with a Culture & Society (C&M) profile with Mathematics A or B. The panel raised concerns about the feasibility for student who are not bèta-oriented, with too high demand in biology and mathematics of the programme. To address this condition, we took the following two measures: we have tightened the admission requirements and sharpened the strategy to address deficiencies.

Admission requirements

The programme management has reconsidered the entry requirements of the programme, striving for a balance between appealing to a broad range of students and equal opportunities. The vision of the programme is to also appeal to students who may not see themselves as true data scientists, but envision themselves working in data science to address global challenges. This is endorsed by the LANDSCAPE report.[7] However, the programme management acknowledges the concern of the panel. Therefore, after careful reconsideration and consultation between the programme management and other stakeholders (e.g. Admission Policy Committee and the legal department), we have decided to tighten the admission requirements. Students with Dutch VWO diploma in Nature & Health (N&G) and Nature & Technology (N&T) are still eligible with no further requirements. Students with a Culture & Society (C&M) profile are no longer eligible. Students with a profile in Economics & Society (E&M) are eligible if they also took at least one of the subjects Biology, Chemistry or Physics. International students with an equivalent background are also eligible.

With this new admission requirements, all students have taken at least one other subject in which mathematics and/or statistics plays an important role (such as Chemistry or Economics) besides Mathematics A or B. Furthermore, all students have at least taken one subject in the bèta domain (either Biology, Chemistry or Physics), ensuring they are sufficiently bèta-oriented to fit the profile of the programme. This means that the learning objectives are achievable for all admitted students. As recommended by the panel, the programme team also ensures that prospective students clearly understand what the programme entails, including the fact that the programme is bèta-oriented. This is communicated on the website,[8] during recruitment and information sessions, such as open days and student-for-a-day-activities. An already appointed programme study adviser plays a key role here.

Strategy to address deficiencies

By adjusting the admission requirements, we have ensured more equal opportunities between students. The need to address deficiencies in mathematics and/or biology within the programme has therefore become less crucial. However, we still acknowledge that there will be some differences, most notably between students with Mathematics A and students with Mathematics B. Following the concern of the panel, we consulted the WU Mathematics and Statistics Group (Biometris) and programme directors of programmes that aim to achieve the same level of mathematics and statistics as BSc Data Science for Global Challenges and that admit students with either Mathematics A or B. Differences in Mathematics

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[7] See https://www.4tu.nl/over_4tu/publicaties/adviesrapport-landscape-1-1.pdf
[8] See https://www.wur.nl/en/education-programmes/bachelor/bsc-programmes/bsc-data-science.htm

(A or B) are levelled by offering courses Mathematics 1[9] and Statistics 1 in period 1 of the first year. The strategy is as follows:

- Students who took Mathematics A in secondary school follow the course Mathematics 1. The goal of this course is not to cover all topics of secondary school Mathematics B, but rather to focus on the topics necessary for continuation courses (Mathematics 2 and 3, both later in the first year). This includes (among others) exponential functions, logarithms, differentiation techniques and integrals. Topics from secondary school Mathematics B that are less relevant in the education Wageningen University offers (such as proofs in Euclidian geometry) are not covered. Moreover, a large portion of the time in this course is spent on rote training of the relevant techniques. With this strategy, students with Mathematics A acquire the necessary mathematical knowledge and skills to make the programme feasible.
- For students who took Mathematics B in secondary school, a similar approach is in place. These students follow the course Statistics 1, which focuses on topics in statistics which are part of Mathematics A, but also needed for continuation courses. This includes topics such as data collection, descriptive statistics, probability calculus, binomial and normal distributions and hypothesis testing.

This strategy to bring all students to the necessary level of knowledge and skills in mathematics and statistics is a proven one. Mathematics 1 and Statistics 1 already run for 15 years and are also part of other technical BSc programmes at Wageningen University, such as Food Technology and Agrotechnology. These programmes have the same level of end terms related to Mathematics and Statistics as the BSc Data Science for Global Challenges. In our experience, after finishing Mathematics 1, students are able to successfully finish follow-up courses such as Mathematics 2 and 3, and Statistics 2 and Advanced Statistics later in their programme. Several students also successfully follow and pass even more advanced courses, like Multivariate Mathematics Applied or Stochastic Differential Equations.

> "Almost 15 years of experience with Mathematics 1 in Wageningen taught us that these students are indeed able to successfully finish Mathematics 2 and 3, later in their programme. Nor do we see a difference in the dropout rate between students with Mathematics A or B in more advanced courses, such as Bayesian Statistics and Statistics for Data Scientists."
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> - Ir. Saskia Burgers, Coordinator Education Mathematics and Statistics Group (Biometris)

> "In the BSc Food Technology, students with Mathematics A take Mathematics 1, 2, and 3 in the first year, just like in BDS. In addition, there is a 6-credit course called Mathematical Concepts for Food Technology in the second year, and students apply their skills in, for example, the Food Engineering courses. So, students have to do quite a lot of mathematics, and by completing Mathematics 1 and 2, all students acquire sufficient mathematical knowledge to pass the follow-up courses. We see that students who have completed a university of applied sciences (hbo) degree and start our Mathematical Concepts for Food Technology course in a minor without having taken Mathematics B in secondary school run into problems because they lack the basics. We do not see this problem among BSc Food Technology students that did not take Mathematics B but followed our first-year programme with Mathematics 1, 2, and 3."
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> - Dr. ir. Jenneke Heising, programme director BSc Food Technology

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[9] From September 2025 onwards, the names of the mathematics courses will change to better reflect the content. In this report, we will use the current names as these are also used in the Information and Application dossier. The names of Mathematics 1, 2 and 3 change to, respectively, Mathematics Applied: Introduction, Mathematics Applied: Linear Algebra and Mathematics Applied: Analysis.

Condition 3: Assessment of interdisciplinary learning, ELSA and bridge-building skills, including communication

Explicate how interdisciplinary learning, ELSA and bridge-building skills, including communication, are assessed in the programme.

The third condition concerns the assessment of interdisciplinary learning, ELSA and bridge-building skills, including communication. The panel complimented the assessment policy of Wageningen University, but found the translation to the programme limited and stated that the rubrics remain generic and lack specific tailoring to address assessment of interdisciplinary learning, ELSA and bridge-building skills, including communication. The programme management acknowledges these points and took the following actions to address this condition:

1. ELSA, bridge building, presenting and collaboration were defined as core skills for the programme with detailed descriptions at three attainment levels as a framework to be used throughout the programme (see condition 1 for further explanation on the skills programme and appendices 1 and 2);
2. Rubric templates are set up for the skills per attainment level, and are used by the course coordinators to incorporate them in the assessment strategy of their course (see appendix 5). An example of such incorporation can be seen in appendix 6 and 7;
3. The rubric for the BSc thesis is tailored to the programme, including the explicit assessment of ELSA, communication and bridge building aspects (see appendix 8).

The Wageningen University assessment policy is based on constructive alignment principles: intended learning outcomes, learning and teaching activities, and assessment form a cohesive structure to support effective student learning (see Figure 7). In this chapter, we show how assessment in the programme aligns with the learning outcomes and learning activities as described in the Information and Application Dossier and earlier in this report for condition 1.

Table 1 outlines where the four skills (ethics, dilemmas and ELSA, presenting, collaboration and bridge building) are assessed in courses. In addition to the summative assessments shown in table 1, there are also several non-graded formative assessment moments throughout the programme, where students get input to help them further develop their skills. The course Advanced Python Programming for instance includes a self-assessment on collaboration skills, and a presentation try-out with peer-feedback. Another example is the Responsible Data Science course, where students do a role play exercise on perspectives that gives insight in their bridge building skills.
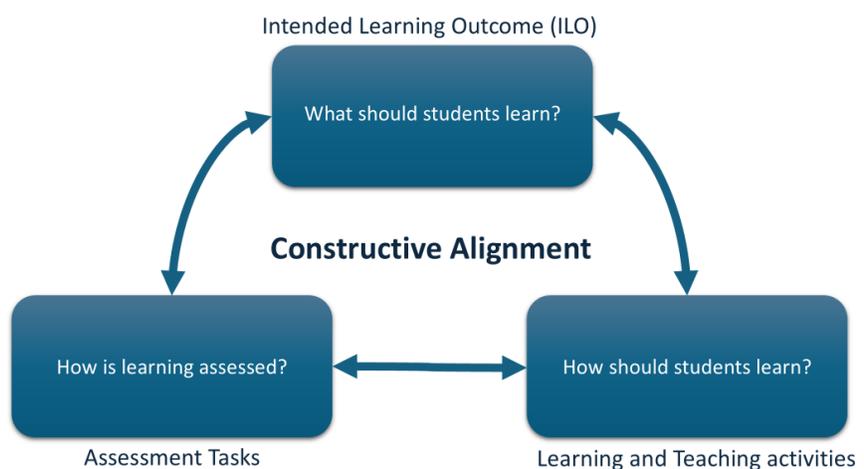

Figure 7: Constructive alignment.

Course	ELSA	Presenting	Collaboration	Bridge building
Data Science for Global Challenges 1	Ethical consideration case and personal reflection in report	Instructor and peer feedback	Individual reflection in report	Report of case study
Data Science for Global Challenges 2	Reflection on legal aspects of case work in report	Instructor and peer feedback	Reflection in report	Group work report
Advanced Python Programming		Project presentation		
Data Structures for Life Sciences		Project presentation	Project report assignment	Project presentation and oral exam
Linked Data	FAIR principles of case work in report	Peer feedback leading to assessment of knowledge clip (pass/fail)		Analysis of different perspectives in report
Machine Learning	Reflection in report			
Natural Language Processing	Reflection in report and poster presentation	Poster presentation		Report and poster presentation
Responsible Data Science	Project report focused on ELSA by design		Reflection group process in report	Project report
BSc Thesis	Report, presentation and defence	Final presentation and defence		Report, presentation and defence

Table 1: Overview of summative assessment of skills.
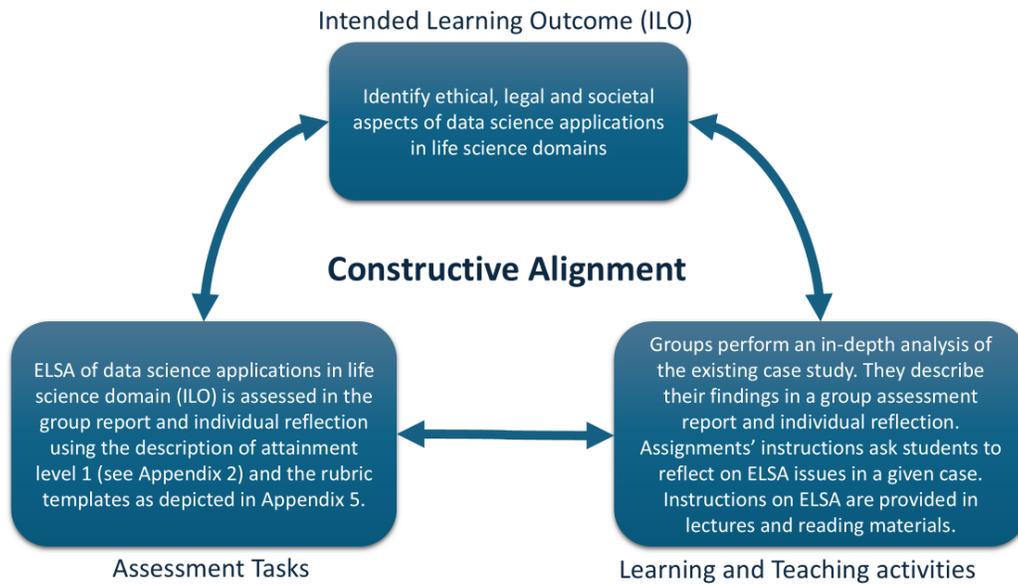
Rubrics for skills: constructive alignment throughout the curriculum

The skills attainment level descriptions (appendix 2) provide the framework for assessment of the four skills at a programme level. For each skill we developed rubric templates to serve as a guideline for course coordinators (see appendix 5). Course coordinators will use these rubric templates to incorporate relevant elements in their course assessment strategy. By using these rubric templates, we pursue three key objectives:

1. Alignment of the assessment of skills throughout the curriculum, since in all courses of a trajectory, the same type of criteria are used which build upon each other for consecutive attainment levels.
2. Constructive alignment of the learning outcomes, learning activities and assessment, since they are all three based on the same description of the skills.
3. Constructive alignment of assessment with the tasks and context of the specific courses, by translating and enriching the rubric templates with criteria and performance descriptors that match the course.

In Figure 8, we show two examples of how constructive alignment is achieved in the courses.

Assessing ELSA in course Data Science for Global Challenges 1

Intended Learning Outcome (ILO)

Identify ethical, legal and societal aspects of data science applications in life science domains

Constructive Alignment

ELSA of data science applications in life science domain (ILO) is assessed in the group report and individual reflection using the description of attainment level 1 (see Appendix 2) and the rubric templates as depicted in Appendix 5.

Groups perform an in-depth analysis of the existing case study. They describe their findings in a group assessment report and individual reflection. Assignments' instructions ask students to reflect on ELSA issues in a given case. Instructions on ELSA are provided in lectures and reading materials.

Assessment Tasks

Learning and Teaching activities

Assessing Bridge Building skills in Data Structures for Life Sciences

Intended Learning Outcome (ILO)

Communicate about data structures and findings with stakeholders in the domains of food, health or environment (Bridge building skills)

Constructive Alignment

The ILOs will be assessed during the group presentation and the individual oral test. The oral test uses the rubric template (see appendix 5) for assessing Bridge Building skills, which is further expanded to also include technical knowledge (see Appendix 7).

Students get instructions on how to work effectively in a group. Students collaborate in the group assignment with the expert, first to understand the problem, and later to clearly explain their data-driven solution. To better understand the challenges on collaborating with someone from the life sciences domain, a plenary interview is held with the expert. Students ask questions on e.g. how they experience collaborations with data scientists, which role bridge builders can take and how to communicate effectively.

Assessment Tasks

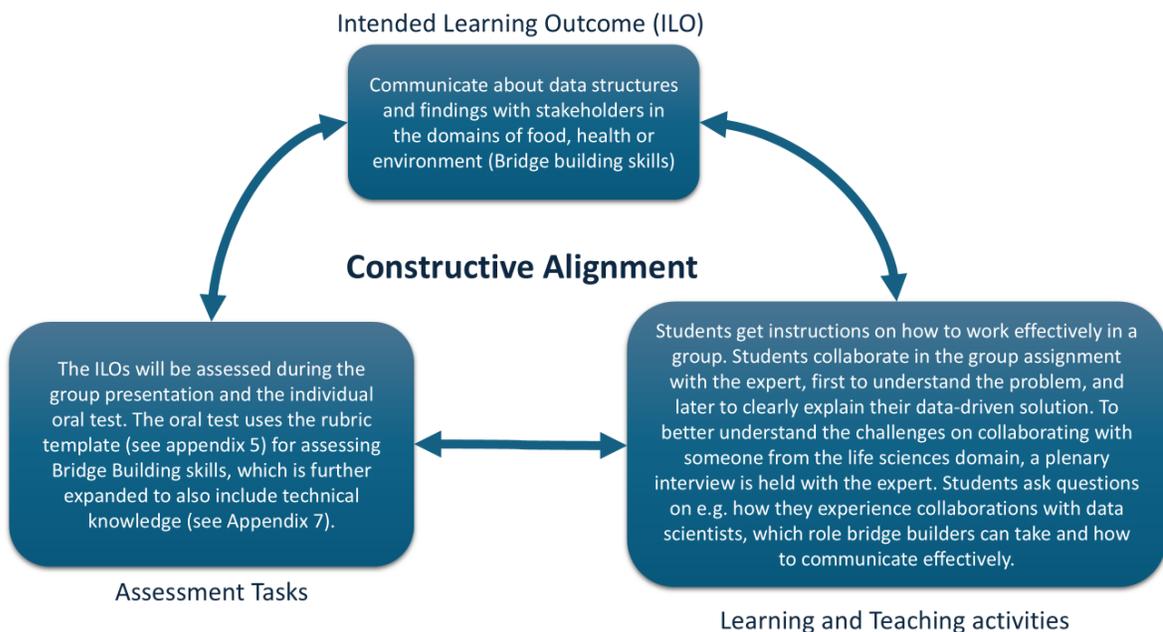**Learning and Teaching activities**

Figure 8: Constructive alignment of ELSA in Data Science for Global Challenges 1 and bridge building skills in Data Structures for Life Sciences.

Below, we give two examples of assessment from courses that are part of one or more skills trajectories.

Presenting in Data Science for Global Challenges 1 and 2

In the two courses Data Science for Global Challenges 1 & 2, students work on the skill presenting: they present their case work to their fellow students (see Box 2 for a more detailed description). Appendix 6 provides the rubric for assessing the presenting skills in these courses. Students reach attainment level 1 of the presenting skill. Therefore, the rubric is based on the rubric template 'Presenting – Attainment level 1' in appendix 5, with adjustments to align with the learning outcomes and learning activities of the course.

Students need to explain both the life sciences and the data science case angles to the audience. Since they all have cases from different life sciences domains, their audience has no background in the specific domain of their case. Therefore, awareness of the background of the audience and adapting the presentation accordingly are separate criteria in the rubric for presenting in these courses, while other criteria are less important and thus merged into one criterion. Furthermore, criteria on time management and non-verbal communication are added.

Oral exam in Data Structures for Life Sciences

In the course Data Structures for Life Sciences (last course of the first year) students are assessed on the skills presenting and bridge building. This course teaches certain programming skills but also emphasizes on interdisciplinary problem-solving. It thereby prepares students to deal with typical problems data scientists would encounter when solving domain-specific problems (see appendix 3 for the course description).

Part of the assessment strategy for this course is an individual oral exam. The rubric for this exam contains criteria on the data science methods and techniques but also on bridge building. Students reach attainment level 3 of the bridge building skill, so the rubric template 'Bridge building – Attainment level 3' in appendix 5 is used to set up the rubric of the oral exam. The rubric is based on a point scale, which is than converted to a grade (see appendix 7 for the complete rubric). Adjustments to the rubric template are made based on the learning outcomes and learning activities of the course. For instance, the perspective taking has been adjusted to two criteria, since 'actively asking for other perspectives' is assessed in a different parts of the assessment strategy. Furthermore, the criterion on biases and assumptions is here linked to the case. See example below:

Rubric: bridge building – Attainment level 3 *See appendix 5*	
Criterion	**Description**
Perspective Taking	Explain the data science perspective and actively ask for other perspectives.
	Be able to explain clearly and exhaustively life science perspectives.
	Explicate biases, assumptions and limitations of data science and life sciences.

Rubric: oral exam Data Structures for Life Sciences *See appendix 7*	
Criterion	**10 points**
Explain both perspectives	Fully describe the data science and life science perspectives.
Addressing biases and/or assumptions	Can address biases and/or assumptions relevant to their specific case and fully explain the effects.

BSc thesis

The panel explicitly mentioned the general thesis rubric as a concern. This rubric has been refined by incorporating explicitly how ELSA, communication and bridge building skills are assessed. For presenting, a specific rubric was already part of the assessment. This rubric has also been updated to fit the BSc Data Science for Global Challenges. See appendix 8 for the thesis assessment form and rubrics.

ELSA has been added to the rubric both for the research competence (A4; critical and self-reflective capacity, A6 Analysis and processing data), and the report (B5; critical discussion). For presenting, the rubric criterion on the use of media and visualization is adjusted to explicitly include data visualization tailored to the audience.

The bridge building skill is assessed in separate criteria in different parts of the rubric. The bridge building competence is added as an explicit research competence (A7 Bridge building competence), where students are assessed on their ability to use perspectives from life sciences and data science to develop new approaches or insights. For the report (part B), students are explicitly assessed on the integration of data science and life sciences for the problem definition and research set-up (B1). This is also reflected in the criteria for the theoretical underpinning (B2), the clarity of argumentations and conclusions (B4) and the knowledge of the domain in the final discussion (D1).

In Table 2, an overview is provided of all criteria that assess ELSA, bridge building and communication skills (either as the entire criterion or part of the criterion), including the adjustments made. The complete BSc thesis rubric can be found in appendix 8.

*Table 2: overview of criteria for the BSc thesis with regard to assessment of ELSA, bridge building and communication skills. Newly added parts are in **bold**.*

Part of rubric	Skill	Criterion
A) Research Competence		
4. Critical and self-reflective capacity	ELSA	Student is able to point out most of the strengths and weaknesses of the research (plan) **including ELSA** and is able to give some constructive suggestions for improvement.
6. Analysis and processing data	ELSA	Student is able to organize and clean the data using state-of-art methods, perform advanced and original analyses that contribute to the research question, taking into consideration **all ELSA aspects**.
7. Bridge building competence	Bridge building	Student pro-actively seeks and deliberately uses **perspectives from both data science and life science application domain,** and translates these in new approaches in the problem-solving process and new insights.
B) Report		
1. Problem definition & research set-up	Bridge building & communication	How **data science and life science application domain are integrated** in this project and what impact this has on the project's approach is clearly explained.
2. Theoretical underpinning and use of literature	Bridge building	Clear, complete and coherent overview of relevant theories. Exactly tailored to the project at hand. There is a good balance between **theories relating to the life science application domain and data science related theories.**
4. Clarity of argumentation and conclusions	Bridge building & communication	The **link between the data science and life science** application domain is convincingly explained, disciplinary insights are integrated, resulting in a new or reconciled understanding.

5. Critical discussion	ELSA	Student is able to identify all possible weaknesses in the research and to indicate which weaknesses affect the conclusions most. All relevant **ELSA aspects** are an integral part of the discussion, impacts and consequences are convincingly explained.
C) Presentation		
Content	Communication	The audience understands my presentation and it is innovative for them, because I **adapt my presentation to the audience and the content is in line with their prior knowledge**. I am able to adapt my explanation during the presentation when it shows that people find it too difficult or easy.
Use of media and data visualisation	Communication	My slides are visually appealing, clear and effectively highlight the strengths of my research. The graphics and tables I use are supportive and well-chosen. **Relevant and various data visualisations are applied and tailored to the specific aim and audience.**
D) Final discussion		
1. Knowledge study domain	Bridge building & communication	Student is well on top of subjects discussed in thesis: not only does he understand but he is also aware of current discussions in the literature related to the thesis topic. **Student is able to discuss the new understanding resulting from the integration of data science and life science application domain insights/methods.**

Conclusion

To meet the conditions set by the NVAO, several actions have been taken by the BSc Data Science for Global Challenges programme management. Together with the teaching staff, Teaching and Learning Centre and education policy advisers we have redesigned the curriculum and course content by setting up learning trajectories for four skills:

- Ethics, dilemmas and ELSA
- Presenting
- Collaboration
- Bridge building (interdisciplinarity)

Special attention has been paid to relevant learning activities and assessment methods throughout multiple courses, with a logical buildup.

Furthermore, the admission requirements have been made stricter, safeguarding the balance between appealing to a diverse group of (prospective) students while still ensuring the feasibility of the programme for all admitted students. Additionally, the proven strategy in other programmes to deal with the differences between Mathematics A and B has been implemented.

We have also improved the assessment quality for interdisciplinary learning (bridge building), ELSA and communication skills. Skills attainment level descriptions were developed that provide the framework for assessment of the four skills at programme level. For each skill we developed rubric templates to serve as a guideline for course coordinators. Course coordinators will use these rubric templates to incorporate relevant elements in their course assessment strategy. These rubrics foster constructive alignment between the learning outcomes, learning activities and the assessment. We have also improved the BSc Thesis rubric, tailoring it to the BSc Data Science for Global Challenges by incorporating important aspects such as ELSA and bridge building skills.

The programme management recognises the complexity of assessing interdisciplinary learning and soft skills. Therefore WU-broad, multiple actions are currently taken to experiment with new forms of assessment in more realistic, less standardised settings (as ambitioned in our assessment policy). Wageningen University is also funding PhD research on these topics, of which the results are expected to be implemented in our regular degree programmes (including the BSc Data science for Global Challenges). Furthermore, other skills trajectories relevant for the programme are explicated in the curriculum, such as information literacy, social embeddedness and (scientific) writing.

As recommended by the panel, we will keep close contact with the professional field by setting up a professional field committee. This committee will provide the programme with input to keep it aligned with labour market needs and to monitor the innovations in the field. In the new WU education governance model the role of such a professional field has explicitly been defined, and the programme director is in charge to set it up.

We also recognize and will implement other recommendations mentioned by the accreditation panel. The programme has already appointed a full-time study advisor who also plays a role in clarifying expectations about the programme to prospective students via open days and matching activities before the students enter the programme.

The programme management feels confident to start with this new BSc programme and looks forward to educating and delivering data scientists, who can bridge data science and life sciences.

Appendices

Appendix 1: Skills trajectories

Introduction

In 2019 Wageningen University & Research (WU) set the ambition to make skills learning trajectories an explicitly integrated component of all bachelor's degree programmes by 2025. To achieve this goal, the BSc Skills Learning Trajectories project was launched. The aim of this project was to create and strengthen continuous skills learning trajectories in the curricula of all bachelor's programmes at WU and ensure their visible presence in education. A steering group oversees the project and implementation.

WU has identified four clusters, comprising sixteen fundamental skills (see overview on the next pages). Furthermore, a support structure for identifying, implementing and visualizing the skills is put in place. Supportive guidelines were created that really serve educational professionals, enhancing collaborative development and shared learning, and offering and unlocking support, expertise and existing practices. These efforts contributed to visibility, presence, and integration of these generic skills across all bachelor's programmes.

Pilots for implementation in programmes (2020-2024)

While a university-wide set of generic skills was defined, individual programmes could emphasise those skills most relevant to their field (core skills) or even add their own programme-specific skills. Each programme was given the flexibility to focus on specific skills that aligned with their unique disciplinary needs and future career prospects of their students. This allowed each programme to maintain its individuality while contributing to the broader educational mission.

In an earlier phase of the project, all courses within a programme were analysed on the presence of skills, thereby defining a "fingerprint". This provided valuable insights and served as a starting point. The next step was defining a skills profile. This is designed to help programmes define their own approach to the intensity and focus of skills integration within their curriculum. It distinguishes between core skills, supportive skills, and implicitly taught skills, while also indicating the final attainment level for each skill. Core skills are explicitly taught, assessed, and clearly recognised by students, forming an integral part of a programme's learning outcomes. A document with learning outcomes for each skill was set up (see appendix 2 for the relevant skills for BSc Data Science for Global Challenges) and guidelines for design and implementation of skills trajectories were developed.

Continuing implementation (2025 onwards)

Since January 2025, two WU broad skills coordinators are appointed in WU's Teaching and Learning Centre. They coordinate the programme university wide, by e.g. improving guidelines and sharing best practices. There is also funding available for each programme team to assign someone the task of implementing skills within the programme. This can be e.g. a lecturer or study adviser, who's task is to align the learning trajectories within the curriculum. The actual teaching of the skills is still embedded in courses, provided by multiple lecturers.

At the moment, the steering group is evaluating the skills framework to take into account the use and implications of AI. This is still a work in progress, but concerns most likely both the use of AI within a skill (e.g. using AI to find scientific information) and skills related to AI (e.g. proper prompting).

Communication

Communicating ideas, problems, and solutions (verbally and in writing), aimed at an audience of both specialists and non-specialists in the field of [...], in a clear and structured manner, with a concise line of reasoning and effective arguments, both in Dutch and in Academic English.

Academic English: Understand lectures, debates and texts and use a sufficient range of English language to give clear descriptions, express viewpoints and develop arguments, using a good range of academic vocabulary for matters connected to their field.

Argumentation and reasoning: Construct a logical and persuasive argument, use evidence, clear reasoning and critical thinking to communicate and persuade the audience effectively, while considering different points of view and anticipating potential objections and counterarguments.

Presenting: Deliver a clear and structured presentation, in connection with the audience and supported by suitable (visual) tools and non-verbal communication to get the content and message across.

Writing: Write a clear and structured text, appropriate for the specific goal and target, supported by relevant sources and supporting elements (tables, figures and appendices).

Personal development

Reflecting upon personal knowledge, skills, attitudes, and (entrepreneurial) functioning, both individually and in a (multidisciplinary) team. Planning your own learning path, asking and giving constructive feedback, and using the valuable feedback for product and skill improvement in the field of [...].

Collaboration: Collaborate effectively in a (multidisciplinary) team to perform project-based work, by structuring meetings, executing different team roles and tasks and being open to multiple perspectives.

Feedback: Proactively seek feedback and use the valuable feedback to enhance learning and results.

Entrepreneurial skills: Apply and integrate concepts and theories to select, test and refine ideas that create value for others and to develop, design, test and/or implement new solutions (knowledge, product or process).

Reflection: Identify, analyse and evaluate own experiences, actions, thoughts, feelings and outcomes to gain insights, to enhance learning and to develop alternative behaviour.

Personal leadership: Take responsibility for one's own actions, decisions, and outcomes. Set goals, make plans, and take action to achieve those goals. Be accountable for one's own learning and development and take steps to continuously improve skills and knowledge.

Research

Analysing an issue in the field of [...] by defining a research problem, planning research, searching and reviewing literature, mining, collecting, processing and interpreting data, and putting the results in a wider context in order to develop new knowledge, a new product or a new process.

Researching: Identify a potential research problem and develop and execute a research plan in which a problem definition, research questions, hypothesis, set-up and data analysis are described in relation to relevant literature.

Information literacy: Search, find, evaluate, select, manage, and communicate scientific information.

Data: Apply appropriate methods and techniques to mine, collect, process, analyse, interpret and visualise relevant data, putting the results and its presentation in a wider context.

Responsibility

Understanding and investigating complexities and implications of scientific knowledge and societal issues in the field of [...]. Being aware of, defining, and discussing your own position and the position and background of stakeholders to utilise diversity and develop solutions to positively impact society.

Diversity and inclusivity: Explain differences in behaviour and communication as related to cultures and values, interact with others, suspend judgment, being aware of one's position and utilise diversity in a study context.

Practical ethics and dilemmas: Identify, assess, explain and judge ethical and societal issues and implications that may arise, and define and discuss one's position and values with well-argued choices.

Philosophy of science: Judge research publications by critically reflecting on problems, theories and concepts, research design, approaches, methodologies and results and recognise the limits of scientific knowledge.

Social embeddedness and impact: Understand and investigate place, function, concerns and complexities of one's study domain within society, and the position and interaction of stakeholders to develop solutions for positive impact.

Appendix 2: Descriptions of subskills and attainment levels

Ethics, dilemma's and ELSA

Identify, assess, explain and judge ethical and societal issues and implications that may arise, define and discuss one's position and values with well-argued choices and manage data in a correct and ethical way.

	Attainment level 1	Attainment level 2	Attainment level 3
1. Ethical dilemmas and practical ethics, and ELSA (cognition)	Identify ethical dilemmas when dealing with data such as biases in data sets, privacy and explainability. Recognise ELSA (Ethical, Legal and Societal Aspects).	Identify ethical dilemmas when dealing with data. Consider ELSA to unravel ethical dilemmas.	Identify ethical dimensions of data science and apply ELSA in a specific problem context.
2. Ethical reflection (skill)	Define one's position in ethical issues and formulate arguments for and against that position. Reflect on ethical dilemmas when dealing with data.	Apply level 1 and discuss positions in ethical issues with others. Reflect on the consequences when making choices regarding ethical dilemmas.	Apply levels 1 and 2 and present well-argued choices, and critically reflect on the quality of the ethical deliberation that led to these choices.
3. Personal ethics (attitude)	Acknowledge that ethical dilemmas call upon one's own values.	Apply level 1 and be able to critically reflect on one's values and explore how these may be adaptable to change.	Apply levels 1 and 2 and be ready to reconsider or adjust one's values in the light of ethical dilemmas.
4. Ethical data management	List the key concepts underlying the FAIR principles for good data management (findable, accessible, interoperable, reusable). If working with personal or sensitive data recall good practices (e.g., ethical principles, GDPR).	Explain the key concepts underlying the FAIR principles for good data management. If working with personal or sensitive data apply principles of ethical research.	Apply the relevant key concepts underlying the FAIR principles for good data management in a specific context. Describe domain specific data management challenges (e.g. large volumes of data, interoperability, data security).

Presenting

Deliver a clear and structured presentation, in connection with the audience and supported by suitable (data visualisation) tools to get the content and message across.

	Attainment level 1	Attainment level 2	Attainment level 3
1. Awareness of public (connection with the audience)	Connect with the target audience. Signal cues from the audience (verbal or written) and answer questions.	Connect with the target audience. Adapt the presentation/ visualization to the audience when they invite to do so or provide feedback.	Connect with the target audience. Adapt the presentation/ visualization to the audience.
2. Structuring (including explanation thereof and goal setting)	Structure the presentation, using an introduction, body, conclusion. Provide a legenda or other tools/ guidelines to interpret the data.	Structure the presentation, using an introduction, body, conclusion, and match this structure to the goal and the transitions. Provide a well-structured legenda and/or explanation to interpret the data.	Structure the presentation, using a specific type of structure that matches the goal, and choose the transitions so they flow smoothly, e.g. by using key words. Provide a well-structured legenda and/or explanation to interpret the data.
3. Clearly present content	Clearly present the main points. Explain the content supported by notes or slides.	Clearly present the main points and secondary ideas. Explain the content clearly with support of the notes or slides.	Show that they master the content well enough to present main and secondary ideas. Explain the content in a clear and enthusiastic way and hardly look at the notes or slides.
4. Tools and methods for getting your message across (visual aids)	Use basic supporting materials and visual aids (media, examples, illustrations, statistics, quotations) to get the message across.	Use a variety of supporting materials and visual aids (media, explanations, examples, illustrations, statistics, analogies, quotations) to get the message across supportively.	Use a variety of supporting materials and visual aids (media, explanations, examples, illustrations, statistics, analogies, quotations) to get the message across in an appealing way.
5. Data visualization in a presentation	Select from a given list relevant basic data visualisation methods for the domain (e.g. graphs, maps, 3D models).	Given a specific aim and audience, choose relevant data visualization methods and tools.	Given specific data and purpose, apply relevant data visualisation. Indicate how specific visualisation methods may influence interpretation.

Collaboration

Collaborate effectively in a (multidisciplinary) team to perform project-based work, by structuring meetings, executing different team roles and tasks and being open to multiple perspectives.

	Attainment level 1	Attainment level 2	Attainment level 3
1. Structuring meetings and group work (setting objectives)	Structure meetings and group work when assigned a group assignment.	Structure meetings and group work and set objectives guided by the teacher.	Structure meetings and group work and set objectives on their own.
2. Executing team role and corresponding tasks (chair, secretary, member)	Describe the team roles and corresponding tasks and explain the value and importance of each role.	Execute at least one of the group roles and corresponding tasks supported by the group members.	Execute all group roles and corresponding tasks supported by the group members.
3. Contributing to the discussion content-wise	Select input from different sources and share this information with the group.	Select input from different sources and share the relevant information with the group.	Structure this information for the group to integrate all relevant input.
4. Contributing to the discussion process-wise (listening, speaking, argumenting)	Listen (pro-)actively and ask clarifying questions when needed. Speak up and give arguments for own input.	Listen (pro-)actively and ask clarifying questions when needed. Speak up and give arguments for own input and discuss constructively when different opinions arise.	Listen (pro-)actively and ask clarifying questions when needed. Speak up and give arguments for own input, discuss constructively when different opinions arise and involve all group members in the discussion.
5. Dealing with group processes	Recognize the group dynamics and recognize their own role in that.	Explain the group dynamics and acknowledge their own role in that. Stay engaged during all peaks and troughs, with the intention to continuously contribute to the group process in an effective way.	Analyse the group dynamics and consciously choose their own role in that. Address diversity, conflict or decision-making, with the intention to resolve it.
6. Being open to multiple perspectives and showing a learning attitude	Show an open attitude towards different perspectives of group members.	Show an open attitude towards different perspectives of group members and listen actively to understand these perspectives.	Show an open attitude towards different perspectives of group members and listen actively to learn from these perspectives. Where relevant, integrate perspectives.

Bridge building

Take a position as a data science bridge builder by recognizing your role, having disciplinary knowledge from both data science and life science application domains, incorporate not only data science but also life science perspectives, find common ground between perspectives to be able to integrate data science with life science insights.

	Attainment level 1	Attainment level 2	Attainment level 3
0. Recognition	Know the different stages of interdisciplinarity (disciplinary grounding, perspective taking, finding common ground and integrating).	Recognise the different stages of interdisciplinarity and know your role as a bridge builder within these stages.	Apply the different stages of interdisciplinarity and take on your role as a bridge builder within these stages.
1. Disciplinary grounding	Explain why in a given case the data science method/technique from a proposed set is suitable to address the life science problem. Describe basic life science terms and concepts relevant to the problem.	Select a suitable data science method/technique to address the life science problem. Clearly describe the life science terms and concepts relevant to the problem.	Justify which data science methods and techniques are suitable to address the life science problem. Clearly and exhaustively describe the life science terms and concepts relevant to the problem
2. Perspective taking	Explain the data science perspective and listen to other perspectives. Be able to explain on a basic level life science perspective(s).	Explain the data science perspective and listen to other perspectives. Be able to explain some life science perspectives. Recognize biases, assumptions and limitations of data science and life sciences.	Explain the data science perspective and actively ask for other perspectives. Be able to explain clearly and exhaustively life science perspectives. Explicate biases, assumptions and limitations of data science and life sciences.
3. Finding common ground	Recognise how different disciplinary perspectives and approaches are used in a given case.	Use different disciplinary perspectives and approaches in the problem-solving process. Explain common ground between disciplines.	Value and deliberately use different disciplinary perspectives and approaches in the problem-solving process. Explain common ground between disciplines.
4. Integration	Describe which elements from data science and life science were integrated in a given case	Integrate the data science and life science insights resulting in a new or reconciled understanding. The new insights are applied to the problem or case, providing new directions for solutions or answers.	Integrate and apply data science and life science insights/methods resulting in a new or reconciled understanding. Evaluation of the strengths and weaknesses of the integrated approach has been provided.

Appendix 3: Course guides

In the table below, links to all course guides are provided. These may differ from the course guides in the information and application dossier, since in that dossier the course guides of 2024-2025 were incorporated. Each year, course guides are revised and when necessary updated. One of these changes include the names of the Mathematics courses in the first year: Mathematics 1, 2 and 3 changed to Mathematics Applied: Introduction, Linear Algebra and Analysis.

Code	Name	Credits	Phase	Periods
BIF21806	Practical Computing for Life Scientists	6	Year 1	Period 1 afternoon
HNH12303	Data Science for Global Challenges 1	3	Year 1	Period 1 first half morning
MAT14803	Mathematics Applied: Introduction	3	Year 1	Period 1 second half morning
MAT15303	Statistics 1	3	Year 1	Period 1 second half morning
INF22306	Programming in Python	6	Year 1	Period 2 morning
CBI10306	Cell Biology	6	Year 1	Period 2 afternoon
GRS10306	Introduction Geo-information Science	6	Year 1	Period 3 whole day
AIN20303	Data Science for Global Challenges 2	3	Year 1	Period 4 afternoon
MAT15403	Statistics 2	3	Year 1	Period 4 morning
INF23806	Advanced Python Programming	6	Year 1	Period 5 afternoon
MAT15103	Mathematics Applied: Analysis	3	Year 1	Period 5 first half morning
MAT15203	Mathematics Applied: Linear Algebra	3	Year 1	Period 5 second half morning
INF23306	Data Structures for Life Sciences	6	Year 1	Period 6 afternoon
MAT20306	Advanced Statistics	6	Year 1	Period 6 morning
BIF20306	Introduction to Bioinformatics	6	Year 2	Period 1 morning
HNH24806	Introduction to Epidemiology and Public Health	6	Year 2	Period 1 afternoon
INF33806	Big Data	6	Year 2	Period 2 morning
INF35806	Linked Data for Life Sciences	6	Year 2	Period 2 afternoon
INF36306	Artificial Intelligence	6	Year 2	Period 3 whole day
FTE35306	Machine Learning	6	Year 2	Period 4 whole day
MAT34806	Bayesian Data Analysis	6	Year 2	Period 5 morning
ORL20306	Decision Science 1	6	Year 2	Period 5 morning
AIN20806	Natural Language Processing	6	Year 2	Period 5 afternoon
CPT23506	Responsible Data Science	6	Year 2	Period 6 afternoon
FTE27306	Machine Vision	6	Year 2	Period 6 morning
YDS80324	BSc Thesis Data Science for Global Challenges	24	Year 3	Academic_Year

ELSA in ML

Prof. Vincent Blok, Dr. Hao Wang, Dr. Roel Veraart, Luuk Stellinga

Beforehand: Opinion Polls

1. I think ethical, legal and societal matters of AI are important to think about as a (future) developer

2. AI will fundamentally change the world in 20 years

3. AI in agri-food will help overcome future challenges in food production (climate, war, pandemics, etc.)

4. AI will make economic practice more sustainable

5. In general, AI will benefit mankind more than harm it

Schedule

- **Hour 1**   (14:00 – 14:50)
  - Introduction
  - Work on example case in groups
  - Plenary feedback

- **Hour 2**   (15:05 – 16:00)
  - Look at 10 ELSA questions on handout
  - Work on these in context of your own case for this course
  - Plenary reflections

ELSA in Partnership of Agricultural Data

Support use cases on ethical, legal and social aspects (ELSA) – issues & opportunities

Capacity building to handle ELSA aspects and thus strengthen capacities of the partnership to adopt and work with ELSA related topics

Support partners and their stakeholders to understand and communicate socio-economic factors

Improve the capacity of innovators to adapt to the evolving legal system

Strengthen the capacity of policymakers to evaluate the effectiveness of new regulations on data and AI

Figure 1: A colourful illustration of ELSA lab process used for communication with the public and stakeholders.
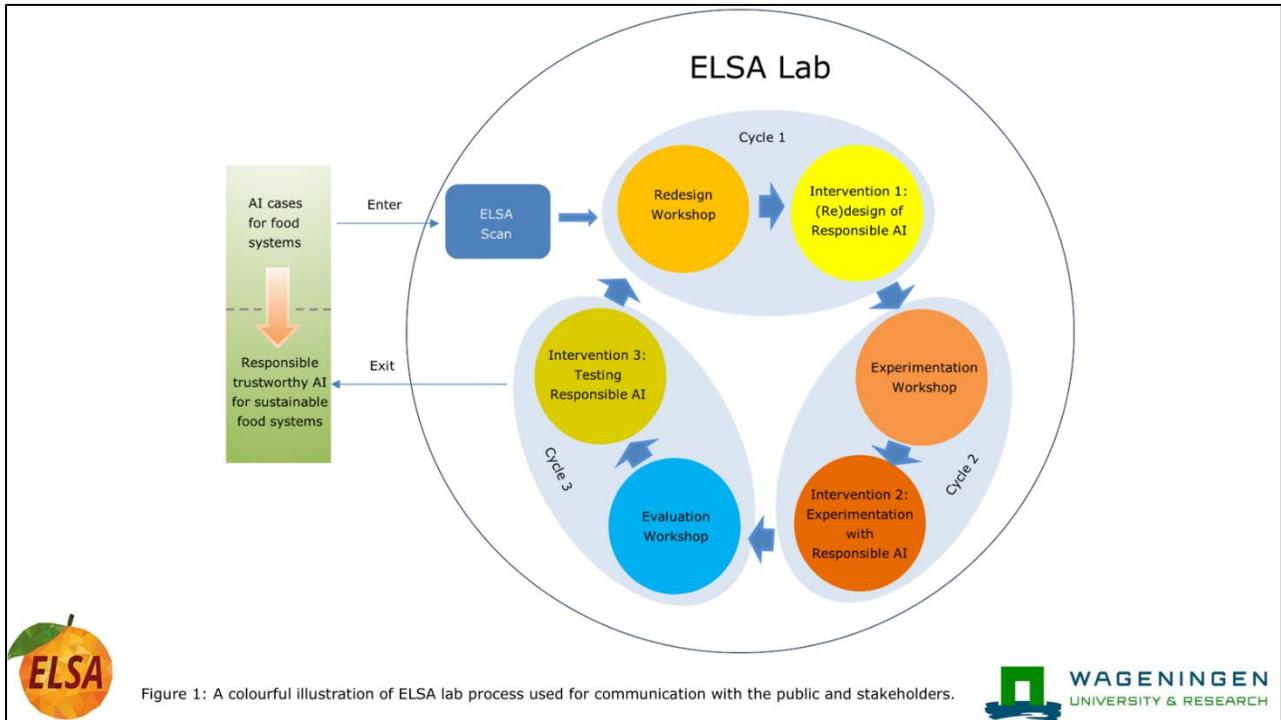
Group work

Form groups of 3 - 4

Read case details (handout)

± 30 minutes to answer 3 ELSA questions (handout)

Plenary feedback

Case: Decision Support System

DATA-DRIVEN FARMER-IN-THE-LOOP DECISION-SUPPORT SYSTEM (DSS)	SUPPORT EFFECTIVE AND RESPONSIBLE DECISION MAKING FOR TREATMENT OF DAIRY	RECOMMENDATION OF SUITABLE TREATMENT PROCEDURES FOR MASTITIS DISEASE IN DAIRY CATTLE	FARMER WILL PROVIDE THE ACTUAL TREATMENT

ELSA AI for Sustainable Food Systems
Ethical, Legal, Societal Aspects

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Examples of ELSA Aspects for case

Ethical: The AI technology should be understandable not just for technical experts, but also for non-computer scientists like veterinarians and farmers.

Legal: Identify liability aspects when harm occurs from AI decisions; AI designer, farmer, or otherwise?

Social: The AI technology may affect labour; e.g. veterinerians.

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Plenary Feedback

Provide answers per question:
Insights, doubts, design-choices or even possible solutions

And we will briefly discuss

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Social	Sustainability, animal welfare	AI should both include animal welfare and give users the freedom to choose. Users should take responsibility if they decide not to follow the recommendations.
Ethical	Beneficence	AI can improve efficiency in use of resources, which can benefit businesses (e.g. less energy and waste). It can also make the decision-making process more effective.
Ethical	Justice and fairness	Fully aware of issues like distributive justice and unfair social structures, and how AI can sometimes reinforce them. However, the AI developer is more focused on the technical side—like ensuring unbiased algorithms and data training models.
Ethical	Transparency	Make sure the AI technology has documentation that gives stakeholders full access to descriptions of the algorithm. Still a challenge to understandably for non-computer scientists like veterinarians and farmers.
Ethical	Autonomy	This AI isn't fully automatic—it ensures an important level of interaction with stakeholders based on the use scenario. So, the AI can make automatic recommendations, but it's ultimately up to humans to decide which recommendation they want to follow.
Social	Labour	Veterinarians may be the biggest group affected by the AI technology. More research is needed to understand how the interaction of vets with farmers happen in practice in order to understand how AI assists treatment.
Legal	Liability	The AI developer looks at three levels of responsibility: developing AI responsibly, using it responsibly, and considering liability in the veterinarian field even when AI isn't being developed or used.
Legal	Regulation and policy	Fully aware of the importance of legal compliance and working to embed it into the AI design. This includes things like data regulations and the issue of data ownership.
Ethical	Ethical, Industrialization	AI has become part of our everyday life, which in this sense doesn't feel disruptive anymore. But at the same time, we are in the middle of big digital transformation that needs interdisciplinary collaboration to make it more responsible.

Group work

- This time, the assignment is related to the official course groups

- You can work in smaller groups

- Study the handout

- Start analysing the 10 questions in the context of your course case

- We will walk around to help

- Prepare to present

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10 Questions for ELSA Scan Interview

Category	ELSA aspect(s)	Question
General	ELSA general self assessment	What ethical, legal and social aspects of AI in agri-food come to mind in relation to the AI technology?
Social	Sustainability, animal welfare	How does the AI technology prioritize the welfare of animals, plants, and the environment alongside human interests and profits to promote sustainable agriculture?
Ethical	Beneficence	How do agri-food stakeholders benefit from the AI technology?
Ethical	Justice and fairness	How does the AI technology ensure fairness for agri-food stakeholders?
Ethical	Transparency	How is the AI technology understandable and explainable to stakeholders in agri-food?
Ethical	Freedom and autonomy	To which extent is the AI technology working autonomously and how much control do agri-food stakeholders have?
Social	Labour	How does the AI technology affect the employment in the local agri-food community?
Legal	Liability	How is liability organised when considering actions taken by the AI technology for agri-food?
Legal	Data and AI regulations	To which extent does the organisation take AI regulation and policy into account for the agri-food domain?
Social	Industrialization	How can the AI technology potentially disrupt the entire agri-food sector?

Plenary Reflection

For each question, have somebody present the findings:

Per small group, present how you started answering Question X

Briefly elaborate on the ELSA aspect of the question
(sustainability, labour, autonomy, transparency, etc.)
 in relation to the case you are working on as a group

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ELSA Aspects in agri-food from literature

Ethical	Legal	Social
Transparency	Privacy law and data protection	Sustainability
Justice and fairness		Animal welfare
Bias and discrimination	Data ownership and data governance	Industrialization
Beneficence		Impact on gender, class, race
Non-maleficence	Liability	Impact on societal views of food production
Freedom and autonomy	Human rights	
Privacy	Standardisation and Protocols	Labour
Responsibility	Data and AI regulations	Power asymmetries
	AI code of conduct and guidelines	Costs and other economic aspects

ELSA AI for Sustainable Food Systems
Ethical, Legal, Societal Aspects

Van Hilten et al. (2025) "Ethical, Legal and Social Aspects for AI: an assessment tool for Agri-food"

37

Practice exercise
Case: AI in decision support systems for dairy farmers

Case Name	AI in decision support systems for dairy farmers
Organisation	Wageningen University (WU)
Background	Despite the advances concerning diagnostic procedures, mastitis is still the most frequent and costly disease in dairy farms, with significant negative impacts on profitability and animal welfare (Cheng & Han, 2020). The search for suitable treatments demands the identification, classification, and prediction of their efficacy considering multiple variables and dimensions (i.e., animal welfare, operational costs, estimated profits, and environmental conditions). Artificial intelligence and machine learning, accompanied by user-friendly human-computer interaction and cognitively effective visualization techniques, have been providing the foundation for the creation of decision-support systems (DSSs) that enable the analysis of multiple variables at the same time. Whereas the development of data-driven DSSs has made great progress in controlled and experimental settings, their effective adoption in real-world applications is still challenging.
Case description	Data-driven farmer-in-the-loop decision-support system (DSS) to support effective and responsible decision making for treatment of dairy. The DSS will be designed and implemented in generic terms, but its validation will rely on the recommendation of suitable treatment procedures for mastitis disease in dairy cattle. The farmer will provide the actual treatment. Knowledge graphs will be used to identify Ethical, Legal and Social aspects from data sources. The outcome is a data-driven farmer-in-the-loop decision-support system (DSS) for treatment recommendation is operational and validated in the field with stakeholders.
AI development stage	Define / Design

Group 1	Group 2	Group 3
How could agri-food stakeholders benefit from this AI technology? Who may not be able to benefit from it? Ethical	How could this AI technology ensure fairness for agri-food stakeholders? Could it be used unfairly (injustices)? Ethical	How autonomous should this AI technology be? What kind of control should be implemented into it? What levels of autonomy or control are important for these solutions (and why)? Ethical
How could this AI technology prioritize the welfare of animals, plants, and the environment alongside human interests and profits to promote sustainable agriculture? Social	What benefits could be derived from making this AI technology more explainable/understandable to its users? How could the developers ensure that this AI technology is understandable and explainable? Ethical	How will this AI technology affect employment? What if it is adopted at scale, will this positively or negatively impact labour in the sector (why and how)? How does the AI solution affect the employment in the local agri-food community? Social
How might this AI technology create liability/responsibility issues? Legal	What type of legal challenges may arise from deploying this AI technology? What types of legislation and policy should the creators of this AI technology consider (and why)? Legal	How disruptive could this AI technology (or technologies like it) be on the sector? Is this something we should be afraid of/respond to (and why)? Ethical

Appendix 5: Rubric templates for the four programme-specific skills

For ELSA, bridge building skills, collaboration and presenting in the BSc Data Science in Global Challenges programme (appendix 2), the example templates in this appendix show how, starting from these attainment level descriptions, rubrics are derived to be used for skills assessment in courses. Rubrics are adapted to the specific tasks and context of the course by specifying assessment criteria and performance descriptions for the different scoring-levels. Examples of such rubrics are provided in appendix 6 and 7.

The rubric template variant 1 uses a 1-10 grading scale for scoring. Weighing of criteria can be added to fit the tasks and context in the course. If a less fine-grained scale is better suited, a set-up as in template variant 2 can be used. The number of scoring-levels and points/weighing is adapted to the tasks and context in the course.

Here example templates are shown for Bridge Building skills at attainment level 3 and Presenting skills at attainment level 1. Similar templates exist for the other attainment levels, and for ELSA and collaboration skills and their attainment levels as given in appendix 2.

Presenting – Attainment level 1- rubric template variant 1

	Presenting **Attainment level 1**	*(Weight)*	Fail 1-5	Basic 6	Good 7-8	Excellent 9-10
1. Awareness of public (connection with the audience)	Connect with the target audience.					
	Signal cues from the audience (verbal or written) and answer questions.					
2. Structuring (including explanation thereof and goal setting)	Structure the presentation, using an introduction, body, conclusion.					
	Provide a legenda or other tools/ guidelines to interpret the data					
3. Clearly present content	Clearly present the main points.					
	Explain the content supported by notes or slides.					
4. Tools and methods for getting your message across (visual aids)	Use basic supporting materials and visual aids (media, examples, illustrations, statistics, quotations) to get the message across.					

5. Data visualization in a presentation	Select from a given list relevant basic data visualisation methods for the domain (e.g. graphs, maps, 3D models).					

Presenting – Attainment level 1- rubric template variant 2

	Presenting **Attainment level 1**	*(Weight)*	**Insufficient** *(e.g. 4 points)*	**Adequate** *(e.g. 7 points)*	**Very good** *(e.g. 10 points)*
1. Awareness of public (connection with the audience)	Connect with the target audience.				
	Signal cues from the audience (verbal or written) and answer questions.				
2. Structuring (including explanation thereof and goal setting)	Structure the presentation, using an introduction, body, conclusion.				
	Provide a legenda or other tools/ guidelines to interpret the data				
3. Clearly present content	Clearly present the main points.				
	Explain the content supported by notes or slides.				
4. Tools and methods for getting your message across (visual aids)	Use basic supporting materials and visual aids (media, examples, illustrations, statistics, quotations) to get the message across.				
5. Data visualization in a presentation	Select from a given list relevant basic data visualisation methods for the domain (e.g. graphs, maps, 3D models).				

Bridge Building – Attainment level 3- rubric template variant 1

	Bridge building **Attainment level 3**	*(Weight)*	Fail 1-5	Basic 6	Good 7-8	Excellent 9-10
0. Recognition	Apply the different stages of interdisciplinarity and take on your role as a bridge builder within these stages.					
1. Disciplinary grounding	Justify which data science methods and techniques are suitable to address the life science problem.					
	Clearly and exhaustively describe the life science terms and concepts relevant to the problem					
2. Perspective taking	Explain the data science perspective and actively ask for other perspectives.					
	Be able to explain clearly and exhaustively life science perspectives.					
	Explicate biases, assumptions and limitations of data science and life sciences.					
3. Finding common ground	Value and deliberately use different disciplinary perspectives and approaches in the problem-solving process.					
	Explain common ground between disciplines.					
4. Integration	Integrate and apply data science and life science insights/methods resulting in a new or reconciled understanding.					
	Evaluation of the strengths and weaknesses of the integrated approach has been provided.					

Bridge Building – Attainment level 3- rubric template variant 2

	Bridge building Attainment level 3	(Weight)	Insufficient (e.g. 4 points)	Adequate (e.g. 7 points)	Very good (e.g. 10 points)
0. Recognition	Apply the different stages of interdisciplinarity and take on your role as a bridge builder within these stages.				
1. Disciplinary grounding	Justify which data science methods and techniques are suitable to address the life science problem.				
	Clearly and exhaustively describe the life science terms and concepts relevant to the problem.				
2. Perspective taking	Explain the data science perspective and actively ask for other perspectives.				
	Be able to explain clearly and exhaustively life science perspectives.				
	Explicate biases, assumptions and limitations of data science and life sciences.				
3. Finding common ground	Value and deliberately use different disciplinary perspectives and approaches in the problem-solving process.				
	Explain common ground between disciplines.				
4. Integration	Integrate and apply data science and life science insights/methods resulting in a new or reconciled understanding.				
	Evaluation of the strengths and weaknesses of the integrated approach has been provided.				

Appendix 6: Rubric presenting skills Data Science for Global Challenges 1 & 2

Theme	1–5	6	7–8	9–10
1. Awareness of the Public and their background (Connection with the Audience)	Fails to engage the audience. Fails to take into consideration audience background	Attempts to connect with the audience. Partly takes into consideration audience background	Connects with the non-domain expert audience. Takes into consideration audience background, partly adapts presentation.	Connects effectively with the non-domain expert audience. Takes into consideration audience background and adapts presentation accordingly
	Ignores or misinterprets audience cues. Does not respond to questions.	Responds to questions with limited clarity. Little argumentation is given	Answers questions clearly with minor lapses. Argumentation is clear with minor lapses.	Accurately signals and responds to audience cues. Answers questions confidently. Argumentation is clear.
2. Structuring (Including Explanation and Goal Setting)	Presentation lacks clear structure. No clear introduction, body, or conclusion. No guidance for interpreting data.	Basic structure is present. Limited tools or guidance for data interpretation.	Presentation is structured with clear sections. Provides some tools or guidelines for interpreting data.	Well-structured presentation with clear introduction, body, and conclusion. Provides legenda or tools to interpret data effectively.
3. Clearly Present Content	Main points are unclear. Content is confusing or unsupported by notes/slides.	Main points are presented. Notes/slides are used inconsistently.	Main points are clear. Content is explained with the support of notes or slides.	Main points are clearly presented. Content is well explained and effectively supported by notes or slides.
4. Tools and Methods for Getting Message Across (Visual Aids)	Does not use visual aids or uses them ineffectively. Message is unclear.	Uses basic visual aids with limited effectiveness or relevance.	Uses appropriate visual aids (e.g., media, examples, statistics) to support the message.	Effectively uses a variety of visual aids (media, examples, illustrations, statistics, quotations) to enhance the message.
5. Data Visualization in a Presentation	Fails to select or use relevant data visualization methods.	Selects basic data visualizations.	Selects relevant data visualizations from a given	Selects and uses relevant basic data visualization methods for the domain (e.g.,

	Visuals are unclear or inappropriate.		list. Visuals are mostly clear and appropriate.	graphs, maps, 3D models) effectively.
6. Time management	Does not finish in time. Does not manage to address all elements of the presentation.	Finish in time.	Finishes in time. Time is allocated to the different elements, but not always well-balanced.	Finishes in time. Presentation is well balanced, with the right time allocated to the different elements.
7. Non-verbal communication	Delivery techniques are ineffective, distracting, or absent. Presentation is difficult to follow and lacks clarity or engagement.	Some delivery techniques are applied. Presentation could be clearer or with more engagement.	Generally uses appropriate delivery techniques that support the message, with minor inconsistencies. Presentation is clear and mostly engaging.	Uses delivery techniques (posture, gestures, eye contact, use of voice) that support the verbal message and make the presentation understandable. Demonstrates confidence, clarity, and strong audience engagement.

Appendix 7: Rubric oral exam Data Structures for Life Sciences with specific assessment of technical knowledge and bridge building skills

No.	Weight*	Practical	0 points	6 points	8 points	10 points
			Given a case from a domain (as discussed during the practicals), a student is asked to select appropriate method for finding a solution			
1	1	Method selection	Fails to select a suitable method	Selects appropriate method, but with limited/insufficient justification	Selects appropriate method, justification with some minor omissions	Selects appropriate method, with proper justification
2	1.5	Data structure	Fails to identify the data structure used in the selected method	Identify (but not fully describe and justify) the data structure used in the selected method	Identify and describe (but not fully justify) the data structure used in the selected method	Identify, describe and justify the data structure used in the selected method
3	1.5	Algorithm	Fails to identify the algorithm used in the selected method	Identify (but not fully describe and justify) the algorithm used in the selected method	Identify and describe (but not fully justify) the algorithm used in the selected method	Identify, describe and justify the algorithm used in the selected method
4	0.5	Describing life science concepts	Fails to describe relevant life science concepts	Describe some life science concepts and terms	Describes all relevant life science concepts and terms, but with some omissions or small mistakes	Describes all relevant life science concepts and terms
5	0.5	Solution integration	Fails to explain the added value of a data science solution to a life science problem	Explains some aspects of how the data science method (contributes to) solving the life science problem	Explains how the data science method (contributes to) solving the life science problem, with some minor omissions or mistakes in the reasoning	Explains how the data science method (contributes to) solving the life science problem
	5					
No.	Weight	Case	*Based on the case, as executed by the student during the casework, the student is asked to explain some of the reasoning and logics behind their proposed solution*			
6	2	Data structure	Fails to identify the data structure used in the method selected in the casework	Identify (but not fully describe and justify) the data structure used in the	Identify and describe (but not fully justify) the data structure used in the method selected in the casework	Identify, describe and justify the data structure used in the method selected in the casework

No.	Weight					
				method selected in the casework			
7	2	Algorithm	Fails to identify the algorithm used in the method selected in the casework	Identify (but not fully describe and justify) the algorithm used in the method selected in the casework	Identify and describe (but not fully justify) the algorithm used in the method selected in the casework	Identify, describe and justify the algorithm used in the method selected in the casework
8	1	Explain both perspectives	Fails to fully describe the data science perspective and/or fails to elaborate on the life science perspective	Fully describe the data science perspective, acknowledges the data science perspective, but fails to elaborate on the life science perspective	Fully describe the data science perspective, acknowledges the data science perspective, but only manages to elaborate on some separate aspects of the life science perspective	Fully describe the data science and life science perspectives
9	1	Linking perspectives	Fails to link the data science and life science perspectives	Addresses the link between the data science and life science perspectives, but fail to describe any differences or common ground	Addresses the link between the data science and life science perspectives, and describe either differences or common ground	Addresses the link between the data science and life science perspectives, and describe both differences and common ground
10	1	Addressing biases and/or assumptions	Fails to address biases and/or assumptions	Can point out some biases and/or assumptions	Can address biases and/or assumptions relevant to their specific case and explain some of the effects	Can address biases and/or assumptions relevant to their specific case and fully explain the effects
11	1	Solution integration	Fails to explain the added value of a data science solution to a life science problem	Explains a few aspects of how the data science method (contributes to) solving the life science problem	Explains how the data science method (contributes to) solving the life science problem, but with some minor gaps or mistake in the reasoning	Explains how the data science method (contributes to) solving the life science problem
	8					
No.	Weight	Attitude	*Assess the student based on their ability to take a bridge builder attitude and see whether they acknowledge the four steps of bridge building (disciplinary grounding, perspective taking, finding common ground and integrating solutions)*			
12	1	Recognition of the bridge builder perspective	Fails to recognise stages of interdisciplinarity or misunderstands their role as a bridge builder.	Recognises some stages of interdisciplinarity but shows limited understanding of their role	Recognises most stages of interdisciplinarity and describes their role with some clarity	Recognises the different stages of interdisciplinarity and knows their role as a

						bridge builder within these stages

* The calculation from weight to a grade is not yet incorporated.

Appendix 8: Thesis rubric

Assessment BSc thesis Wageningen University for BDS

Complete all light-green cells in this form (use decimal point or comma, depending on the language setting)

3 letter code(s) of supervising chair group(s)	
Name student	
Student number	
BSc programme	BSc Data Science...
Course code BSc thesis	YDS-80324 BSc Thesis Data Science
BSc thesis project combines data science and:	
Short title BSc thesis	
Date examination	Signature (ink)
Assessor	replace with name of assessor
second Assessor	replace with name of optional 2nd assessor

Supervisor: please send the signed form (no electronic signature) to programme-team BDS, p/a Helix, Bode 62 or as a scan to bds@wur.nl
Note on weighting the assessment criteria: In this form, e.g. A1-A6 are automatically averaged into a total grade for A_Research Competencies.
However, the assessor/examiner can when conditional require this deviate from the average and determine the overall grade for A, B and D. Therefore these boxes are green.

Assessment Criteria	Grading Mark 1-10	Relative weight *
A Research competencies (min pass mark 5.5)		40%
1 Initiative, pro-activity and creativity		
2 Commitment and perseverance		
3 Time management		
4 Critical and self reflective capacity		0,0
5 Handling supervisor's comments		
6 Analysis and processing of data		
7 Bridge building competence		
B Report (min pass mark 5.5)		45%
1 Problem definition & research set-up		
2 Theoretical underpinning and use of literature		
3 Description of methods and analysis		0,0
4 Clarity of argumentation and conclusions		
5 Critical discussion		
6 Writing skills incl. correct quoting		
C Presentation (min pass mark 5.5)		5%
Grade for presentation, provided by programme team to supervisor		0,0
D Final discussion (min pass mark 5.5)		10%
1 Knowledge of study domain		0,0
2 Defence of thesis		

Student Charter 2024-2025 - WUR

Non-rounded GRADE	0,000
FINAL GRADE	0,0

Comments by supervisor

Note: all criteria A-D have to be graded sufficient (>=5.5) to pass the BSc-thesis

Comments by examiner/ second reviewer

Newly added (elements of) the criteria relating to the conditions are depicted in **bold**.

A) Research competence					
1. Initiative, pro-activity and creativity					
1, 2 or 3	4 or 5	6	7	8	9 or 10
Student shows no initiative or ideas at all.	Student picks up some initiatives and/or ideas suggested by others (e.g. supervisor), but the selection is not motivated.	Student shows some initiative and/or together with the supervisor develops one or two ideas on minor parts of the research.	Student initiates discussions on ideas with supervisor and develops one or two own ideas on minor parts of the research.	Student has his own creative ideas on hypothesis formulation, design or data processing.	Student develops innovative hypotheses, research methods and/or data-analysis methods.
2. Commitment and perseverance					
1, 2 or 3	4 or 5	6	7	8	9 or 10
Student is not motivated. Student escapes work and gives up regularly.	Student has little motivation. Tends to be distracted easily. Has given up once or twice.	Student is motivated at times, but often, sees the work as a compulsory task. Is distracted from thesis work now and then.	The student is motivated. Overcomes an occasional setback with help of the supervisor.	The student is motivated and/or overcomes an occasional setback on his own and considers the work as his "own" project.	The student is very motivated, goes at length to get the most out of the project.
3. Time management					
1, 2 or 3	4 or 5	6	7	8	9 or 10
No planning is made.	Planning is without any detail, not feasible and backup strategies are lacking.	Planning is somewhat concrete but not feasible and backup strategies are lacking.	Planning is quite concrete, but some aspects of the planning are not feasible and backup strategies are insufficient.	Planning is quite concrete and feasible, but backup strategies are insufficient.	Planning is concrete and feasible and backup strategies are sufficient.
Final version of BSc-thesis or presentation hugely overdue (without a valid reason).	Final version of BSc-thesis or oral presentation at one-two months overdue (without a valid reason).	Final version of BSc-thesis or oral presentation at most a month overdue (without valid reason).	Final version of BSc-thesis or oral presentation at most two weeks overdue (without valid reasons).	Final version of BSc-thesis or oral presentation at most one week overdue (without valid reasons).	Final version of BSc-thesis or oral presentation finished within planned period.
4. Critical and self-reflective capacity					
1, 2 or 3	4 or 5	6	7	8	9 or 10

Student doesn't realize the occurrence of strengths and weaknesses of the research (plan).	Student is not able to point out strengths and weaknesses of the research (plan).	Student is able to point out some strengths and weaknesses of the research (plan), **including some ELSA aspects.**	Student is able to point out many of the strengths and weaknesses of the research (plan), **including ELSA aspects.**	Student is able to point out most of the strengths and weaknesses of the research (plan), **including ELSA aspects.**	Student is able to point out most of the strengths and weaknesses of the research (plan**) including ELSA and is able to give some constructive suggestions for improvement.**

5. Handling supervisor's comments

1, 2 or 3	4 or 5	6	7	8	9 or 10
Student does not pick up suggestions and ideas of the supervisor.	The supervisor needs to act as an instructor and constantly needs to suggest solutions for problems.	Student incorporates some of the comments of the supervisor, but ignores others without arguments.	Student incorporates most or all of the supervisor's comments.	Supervisor's comments are weighed by the student and asked for when needed.	Supervisor's comments are critically weighed by the student and asked for when needed, also from other staff members or students.

6. Analysis and processing data

1, 2 or 3	4 or 5	6	7	8	9 or 10
Student is lost when using data. Is not able to use any appropriate data-processing program.	Student is able to organize and clean the data, but is not able to do simple analyses and/or the way the data are used does not clearly contribute to answering of the research questions.	Student is able to organize and clean the data using basic methods, perform basic analyses that contribute to the research question, **and include some ELSA aspects.**	Student is able to organize and clean the data using commonly used methods and perform some advanced analyses that contribute to the research question, **taking into consideration almost all ELSA aspects.**	Student is able to organize and clean the data using relevant methods, perform advanced and original analyses that contribute to the research question, **taking into consideration all ELSA aspects.**	Student is able to organize and clean the data using state-of-art methods, perform advanced and original analyses that contribute to the research question, **taking into consideration all ELSA aspects.**

7. Bridge building competence

1, 2 or 3	4 or 5	6	7	8	9 or 10

Student does not identify perspectives from both data science and life science application domain in the problem-solving process.	**Student identifies perspectives from both data science and life science application domain in the problem-solving process, but does not use these in their project.**	**Student identifies perspectives from both data science and life science application domain in the problem-solving process. Student needs guidance to use these in their project.**	**Student identifies and deliberately uses perspectives from both data science and life science application domain in the problem-solving process.**	**Student identifies and deliberately uses perspectives from both data science and life science application domain, and translates these in new approaches in the problem-solving process and/or new insights.**	**Student pro-actively seeks and deliberately uses perspectives from both data science and life science application domain, and translates these in new approaches in the problem-solving process and new insights.**

B) Report					
1. Problem definition & research set-up					
1, 2 or 3	4 or 5	6	7	8	9 or 10
There is no researchable research question and the delineation of the research is absent.	Most research questions are unclear, or not researchable and the delineation of the research is weak..	The research questions are mostly clear but could have been defined sharper at some points.	The research questions and the delineation are mostly clear but could have been defined sharper at some points.	The research questions are clear and attainable and the delineation is clear.	The research questions are clear and formulated to-the-point and limits of the research are well-defined.
No link is made to existing research on the topic. No research context is described.	The context of the topic at hand is described in broad terms but there is no link between what is known and what will be researched.	The link between the thesis research and existing research does not go beyond the information provided by the supervisor.	Context of the research is defined well, with input from the student. There is a link between the context and research questions.	Context of the research is defined sharply and to-the-point. Research questions emerge directly from the described context.	Research is positioned sharply in the relevant scientific field. Student is able to indicate the novelty and innovation of the research.
The link between data science and life science application domain in the project is not made at all.	**The link between data science and life science application domain in the project is not made explicit.**	**The link between data science and life science application domain in the project is mentioned.**	**The link between data science and life science application domain in the project is well described.**	**How data science and life science application domain are connected in this specific project is clearly explained.**	**How data science and life science application domain are integrated in this project and what impact this has on the project's approach is clearly explained.**
2. Theoretical underpinning and use of literature					
1, 2 or 3	4 or 5	6	7	8	9 or 10

No discussion of underlying theories.	There is some discussion of underlying theories, but the description shows serious errors.	Student has found the relevant theories, but the description has not been tailored to the project at hand or shows occasional errors. **There is an imbalance between theories relating to the lifes science application domain and data science related theories.**	Student has found the relevant theories, and has been partially successful in tailoring the description to the project at hand. Few errors occur. **There is some balance between theories relating to the life science application domain and data science related theories.**	Student has found the relevant theories, makes a synthesis of those, and has been successful in tailoring the description to the project at hand. **There is a good balance between theories relating to the life science application domain and data science related theories.**	Clear, complete and coherent overview of relevant theories. Exactly tailored to the project at hand. **There is a good balance between theories relating to the life science application domain and data science related theories.**
No peer-reviewed/primary scientific papers in reference list except for those already suggested by the supervisor	Only a couple of peer-reviewed papers in reference list.	Some peer-reviewed papers in reference list but also a significant body of gray literature.	Relevant peer-reviewed papers in reference list but also some gray literature or textbooks. Some included references are less relevant.	Mostly peer-reviewed papers or specialized monographs in reference list. An occasional reference may be less relevant.	Almost exclusively peer-reviewed papers in reference list or specialized monographs All papers included are relevant.
3. Description of methods and analysis					
1, 2 or 3	4 or 5	6	7	8	9 or 10
No description of methods and analysis of the information/data.	Insufficient information on methods and insufficient analysis of the information.	Some aspects of the project regarding methods and analysis of information are described insufficiently. Used methods and analysis of data/information are not always appropriate.	Description of methods and analysis of information/data is lacking in a number of places. Used methods and analysis of data/information mostly appropriate.	Description of methods and analysis of information/data is mostly complete, but some details are lacking. Used methods and analysis of data/information are appropriate.	Description of methods used and analysis of the data/information is appropriate, complete and clear.
4. Clarity of argumentation and conclusions					
1, 2 or 3	4 or 5	6	7	8	9 or 10

No link between research questions, results and conclusions.	Conclusions are drawn, but in many cases these are only partial answers to the research question. Conclusions merely repeat results or conclusions are not substantiated by results.	Conclusions are linked to the research questions, but not all questions are addressed. Some conclusions are not substantiated by results or merely repeat results.	Most conclusions well-linked to research questions and substantiated by results. Conclusions mostly formulated clearly but some vagueness in wording.	Clear link between research questions and conclusions. All conclusions substantiated by results. Conclusions are formulated exact.	Clear link between research questions and conclusions. Conclusions substantiated by results. Conclusions are formulated exact and concise. Conclusions are grouped/ordered in a logical way.
The link between data science and life science application domain is not made at all.	**The link between data science and life science application domain is not made explicit.**	**The link between data science and life science application domain is mentioned.**	**The link between data science and life science application domain is made explicit**	**The link between data science and life science application domain is convincingly explained, disciplinary insights are connected to one another.**	**The link between data science and life science application domain is convincingly explained, disciplinary insights are integrated, resulting in a new or reconciled understanding.**
No recommendations given.	Recommendations are absent or trivial.	Some recommendations are given, but the link of those to the conclusions is not always clear.	Recommendations are well-linked to the conclusions.	Recommendations are to-the-point, well-linked to the conclusions and original.	Recommendations are to-the-point, well-linked to the conclusions, original and are extensive enough to serve as project description for a new thesis project.
5. Critical discussion					
1, 2 or 3	4 or 5	6	7	8	9 or 10
No discussion and/or reflection on the research. Discussion only touches trivial or very general points of criticism. **ELSA aspects are ignored.**	Student identifies only some possible weaknesses and/or points at weaknesses which are in reality irrelevant or non-existent. **ELSA aspects**	Student indicates most weaknesses in the research, but does not weigh their impact on the main results relative to each other. **Some ELSA aspects**	Student indicates most weaknesses in the research and is able to weigh their impact on the main results relative to each other. **The most relevant but not all**	Student indicates all weaknesses in the research and weighs them relative to each other. Furthermore, (better) alternatives for the methods used are	Student is able to identify all possible weaknesses in the research and to indicate which weaknesses affect the conclusions most. **All relevant ELSA**

1, 2 or 3	4 or 5	6	7	8	9 or 10
are ignored or not made explicit.	mentioned in general terms.	ELSA aspects are described in the context of the project.	indicated. **All relevant ELSA aspects are described in the context of the project.**		**aspects are an integral part of the discussion, impacts and consequences are convincingly explained.**
No confrontation with existing literature.	Some confrontation with existing literature but incomplete and irrelevant.	Some confrontation with existing literature, some relevance.	Student identifies only most obvious conflicts and correspondences with existing literature. Student tries to describe the added value of his study but does not relate this to existing research.	Student shows minor and major conflicts and correspondences with literature and can identify the added value of his research relative to existing literature.	Student critically confronts results to existing literature and in case of conflicts is able to weigh own results relative to existing literature. Student is able to identify the contribution of his work to the development of scientific concepts.

6. Writing skills including correct quoting

1, 2 or 3	4 or 5	6	7	8	9 or 10
BSc thesis badly structured. In many cases information appears in wrong locations. Level of detail is inappropriate throughout.	Main structure incorrect in some places, and placement of material in different chapters illogical in many places. Level of detail varies widely (information missing, or irrelevant information given).	Main structure is correct, but lower-level hierarchy of sections is not logical in places. Some sections have overlapping functions leading to ambiguity in placement of information. Level of detail varies widely (information missing, or irrelevant information given).	Main structure is correct, but placement of material in different chapters illogical in places. Level of detail inappropriate in a number of places (irrelevant information given).	Most sections have a clear and unique function. Hierarchy of sections is mostly correct. Ordering of sections is mostly logical. All information occurs at the correct place, with few exceptions. In most places level of detail is appropriate.	Well-structured: each section has a clear and unique function. Hierarchy of sections is correct. Ordering of sections is logical. All information occurs at the correct place. Level of detail is appropriate throughout.
Formulations in the text are often incorrect/inexact inhibiting a correct interpretation of the text.	Vagueness and/or inexactness in wording occurs regularly and it affects the interpretation of the text.	The text is ambiguous in some places but this does not always inhibit a correct interpretation of the text.	Formulations in text are predominantly clear and exact. BSc thesis report could have been written more concisely.	Formulations in text are clear and exact, as well as concise.	*Textual* quality of thesis is such that it could be acceptable for a peer-reviewed journal.

English incorrect and unreadable. Spelling and grammar errors too many to count.	English incorrect and very hard to read. Spelling and grammar errors so numerous that they make the thesis almost impossible to understand.	English somehow correct but not pleasant to read. Spelling and grammar errors numerous.	English basically correct and readable. Spelling and grammar errors present but at acceptable quantities.	English correct and pleasant to read. Some spelling and grammar errors.	English fluent and pleasant to read. Few spelling and grammar errors. English is (almost) at the level of what is written in peer-reviewed journals.
Student is often inconsequent in references in the text and/or reference list or often references are lacking.	Student is often inconsistent in references in the text and/or reference list or often references are lacking.	Student is sometimes inconsistent in references in the text and/or reference list or sometimes references are lacking.	Student is sometimes inconsistent in references in the text and/or reference list.	Student uses a consistent format for references in the text and reference list.	Student uses a consistent format for references in the text and reference list.

D) Final discussion					
1. Knowledge study domain					
1, 2 or 3	4 or 5	6	7	8	9 or 10
Student does not master the most basic knowledge (even below the starting level for the thesis). **Student cannot explain the integration of data science and life science application domain elements.**	The student does not understand all of the subject matter discussed in the thesis. **Student can describe only with help some simple aspects of integration of data science and life science application domain elements.**	The student understands the subject matter of the thesis on a textbook level. **Student can describe elements from data science and life science application domain integration in a project.**	The student understands the subject matter of the thesis on a textbook level and realizes the importance of literature without using it. **Student is able to discuss the application of integration of data science and life science application domain but not the new insights/methods.**	The student understands the subject matter of the thesis including the literature used in the thesis. **Student is able to discuss the application of integration of data science and life science application domain and with help describe a few new insights/methods.**	Student is well on top of subjects discussed in thesis: not only does he understand but he is also aware of current discussions in the literature related to the thesis topic. **Student is able to discuss the new understanding resulting from the integration of data science and life science application domain insights/methods.**
2. Defence of thesis					
1, 2 or 3	4 or 5	6	7	8	9 or 10

Student is not able to defend/discuss the thesis. The student does not master the contents	The student has difficulty to explain the subject matter of the thesis.	Student is able to defend the thesis. Student mostly masters the contents of what they wrote, but for a limited number of items they are not able to explain what they did, or why.	Student is able to defend her thesis. Student master the contents of what they wrote, but not beyond that. Is not able to place thesis in scientific or practical context. .	Student is able to defend his thesis, including indications where the work could have been done better. Student is able to place thesis in either scientific or practical context.	Student is able to freely discuss the contents of the thesis and to place the thesis in the context of current scientific literature and practical contexts.

C) Presentation[10]					
	-- (2)	- (4)	+/- (6)	+ (8)	++ (10)	Grade
Authenticity (10%)	I am not yet aware of my own presentation style and I kind of recite my presentation.	I am only partly aware of my own presentation style and occasionally, that style is reflected in my presentation.	I am aware of my own presentation style and occasionally, I use that style to convey my content.	I am aware of my own presentation style and I use that style to clearly convey the essence of my presentation.	Through my own presentation style, I make a natural connection with the audience and explain the content clearly in ways that are memorable for the audience.	
Non-verbal behaviour (20%) - Eye contact - Posture - Use of voice*	I often look at my notes / elsewhere.	Sometimes I have eye contact with the audience, but I regularly look at my notes / elsewhere.	Most of the time I look into the audience, regularly I make eye contact. Every now and then, I look at my notes / elsewhere.	I look into the audience and have eye contact with them. I do this by looking at people. I hardly look at my notes/elsewhere.	I look into the audience and have eye contact with them. I do this by consciously looking at people, making eye contact and calmly looking around me.	

[10] This rubric is also used for peer assessment during the presentations and therefore uses a different set-up to accommodate this.

	My posture is unstable and closed. I do not make any functional movements and hand gestures.	Sometimes, my posture is stable and relaxed. I hardly make functional movements and hand gestures.	Most of the time, my posture is stable and my upper body is relaxed. Not all movements and hand gestures I make contribute to my presentation.	My posture is stable and open. My upper body is relaxed. Gestures I make are functional hand gestures and movements that contribute to my presentation.	My posture is stable, active and open. I am standing firmly on two feet and my upper body is relaxed. My movements and functional hand gestures clarify the focus of what I am telling and contribute to a vivid presentation.	
	In terms of using my voice, I hardly present fluidly. I show none of the 4 points below during my presentation.*	In terms of using my voice, I only present fluidly sometimes. I show 1 out of the 4 points below during my presentation.*	In terms of using my voice, I present fluidly now and then. I show 3 out of the 4 points below during my presentation.*	In terms of using my voice, I present fluidly most of the time. I show the 4 points below during my presentation.*	In terms of using my voice, I present fluidly. I show the 4 points below during my presentation and I vary consciously.*	
Structure (20%) *- Scientific goal and transitions* *- Introduction and conclusion ^*	I do not mention the goal of my presentation or thesis research. The structure and transitions of the presentation are unclear and do not match its goal.	I mention the goal of my presentation or thesis research. The structure and transitions of the presentation seem unclear and hardly match its goal.	I mention the goal of my presentation and thesis research. Overall, the scientific structure and transitions of the presentation match its goal.	I make clear what the goal of my presentation and thesis research is. Overall, the scientific structure and transitions of the presentation match its goal well.	In an inspiring way, I make clear what the importance and relevance of my thesis research is. The scientific structure is fully integrated and the different parts are well-balanced, emphasizing the most important findings of the research. Transitions of the presentation are smooth and logical, therefore the presentation is easy to follow.	
	None of the 3 points below is included in my introduction and conclusion. I do not pay any attention to a suitable introduction and conclusion.^	1 out of the 3 points below is included in my introduction and conclusion. I pay some attention to a suitable introduction and conclusion.^	2 out of the 3 points below are included in my introduction and conclusion. I pay sufficient attention to a suitable introduction and conclusion.^	All 3 points below are included in my introduction and conclusion. I pay sufficient attention to a suitable and inspiring introduction and conclusion.^	All 3 points below are included in my introduction and conclusion. I pay extra attention to a creative and inspiring introduction and conclusion that makes remembering the important findings easy.^	
Content (20%) *- Mastery in*	By not being able to present in a clear and enthusiastic	By not always being able to present in a clear and enthusiastic	By being able to present in a clear and enthusiastic way most	By being able to present in a clear and enthusiastic way, I show	By being able to present in a clear, fluid, enthusiastic and innovative way, I show that I	

presentation and discussion - Connection with the audience	way, I show that I do not master my content. I do not answer any questions appropriately.	way, I show that I do not really master my content. I answer only the simple questions in an appropriate way.	of the time, I show that I master my content fairly. I answer most of the relevant questions in an appropriate way.	that I master my content. I illustrate and use examples to make my content easily understandable. I answer the relevant questions clearly and in an appropriate way.	master my content. I illustrate difficult concepts and results in a clarifying and tangible manner. I can easily give different sorts of examples for the concepts I explain. I give appropriate, clear and to-the-point answers to all questions. I use the questions to convey more details of the research and to highlight the importance of the findings.	
	The audience does not understand my presentation, because I do not adapt it to them and the content is not in line with their prior knowledge.	The audience partly understands my presentation or is not engaged, because I do not adapt it to them and the content is not really in line with their prior knowledge.	The audience understands my presentation, because I adapt it to them only sometimes and the content is fairly in line with their prior knowledge.	The audience understands and gains knowledge from my presentation, because I adapt it to them and the content is in line with their prior knowledge.	The audience understands my presentation and it is innovative for them, because I adapt my presentation to the audience and the content is in line with their prior knowledge. I am able to adapt my explanation during the presentation when it shows that people find it too difficult or easy.	
Use of media and data visualisation (20%) *- Design of slides and graphics - Use of slides*	My slides are unclear and contain insufficient, incorrect or unnecessary information. The graphics and tables I use are unclear. **No data visualisation methods are used.**	My slides are clear, but contain only a part of the necessary information and hardly support my presentation. The graphics and tables I use are somewhat clear. **Some data visualisation methods are used but incorrectly.**	My slides are clear, contain the necessary information and support my presentation point by point. The graphics and tables I use are understandable. **Relevant basic data visualisation methods for the domain are correctly used.**	My slides are visually appealing, clear and support my presentation. The graphics and tables I use are supportive and understandable. **Relevant data visualisation methods and techniques are used given specific aim and audience.**	My slides are visually appealing, clear and effectively highlight the strengths of my research. The graphics and tables I use are supportive and well-chosen. **Relevant and various data visualisations are applied and tailored to specific aim and audience.**	
	I only look at my slides and rely on them completely. I do not explain the graphics and tables.	I often look at my slides and/or sometimes they take me by surprise. I explain the graphics and tables partly.	I sometimes look at my slides, because I need them for the structure of my presentation. I explain the graphics and tables.	My main focus is with the audience. I only look at my slides when I elaborate on something. I explain the graphics and tables clearly.	I can present without using my slides. I explain the graphics and tables clearly and guide the audience how to read the slides.	

Time management (10%)	Bad timing (way too short or going on and on till stopped by supervisor or chairman).	Bad timing (way too short or much longer than planned).	Timing marginally okay, but rushing or killing time in the end.	Timing more or less okay, no rushing or killing time.	Presentation finished well in time. All time is used to convey the essence but in such a way that there is room for flexible time-management.	

* Use of voice:	^ *Introduction:*	^ *Conclusion:*
- clear articulation;	- arouses the interest of the audience;	- is announced;
- appropriate use of volume;	- shows the importance of the presentation;	- consists of a summary and conclusion;
- appropriate use of pace (including breaks);	- clarifies what the audience can expect (time, response, structure).	- contains a 'take-home message'.
- appropriate use of intonation.		