**Update on ICT electives**

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All PT-graduates have direct access to the master HTI, regardless of the courses in the elective space. PT-ICT students who may be interested to continue their studies in the direction of Data Science, Artificial Intelligence or Computer Science can have direct access if they choose suitable electives. Of course, those electives are highly relevant for the continuation in HTI as well.

This document provides an overview of the relevant courses and elective packages for PT-ICT students. The first four section focuses on relevant master programs, the last few sections on elective packages offered by Data Science and Computer Science. We conclude with a table of the mentioned courses with reference to the mentioned masters and elective packages.

Some remarks for all students:

* + Check the OER requirements regarding your elective space [here](https://educationguide.tue.nl/programs/bachelor-college/majors/psychology-technology/curriculum/overview-elective-courses-and-packages/oer-requirements-elective-space/?L=2).
  + In addition to the 20 ec obligatory courses of your track, you need to choose 15 ec additional engineering courses. Preferably this is a complete elective package as listed [here](https://educationguide.tue.nl/programs/bachelor-college/elective-courses/a-z-electives/) because of the coherence and level of the courses.
  + Engineering courses are courses with course codes 2xxxx – 8xxxx and the Jxxxx courses that are taught by Computer Science.
  + As packages in the ICT domain may contain courses that are also an obligatory part of the ICT-track you may need to combine an elective package with another related course. This document describes some options to do so. You may combine upto 15 ec for one elective package and upto 25 ec for two elective packages. You always need to ask permission of the Examination Committee (EC-IS), see [here](https://educationguide.tue.nl/programs/bachelor-college/majors/psychology-technology/exam-committee-is/).
  + If you consider to proceed after your bachelor to a computer science or data science related master, you may choose to combine the courses you need for direct access in your elective space. This is a good motivation to ask the examination committee for approval of your package. Also via this [link](https://educationguide.tue.nl/programs/bachelor-college/majors/psychology-technology/exam-committee-is/).
  + In case you consider another master than HTI, always check the entrance requirements at the website of that particular master. Ask the FTC (the departmental admission committee) of the program whether you will be accepted already in an early stage. This is free, there are no obligations to actually start and you know how to change your electives in case that is needed.

**MSc Data Science and Entrepeneurship (DS&E)**

**The two-year Master's program Data Science and Entrepreneurship is a joint master by Tilburg University and Eindhoven University of Technology and therefore a truly interdisciplinary business-technology-analytics program.** Links to the master at the [JADS page](https://www.jads.nl/data-science-master-programs-overview.html) and the [TU/e site](https://www.tue.nl/en/education/graduate-school/master-data-science-and-entrepreneurship/).

*Data Science for IE&IS*, see [here](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/JADS%20Coherent%20package%20voor%20BSc%20TBK%20en%20PT%202019.pdf). For PT-ICT two courses:

* + JBI020 Foundations of Computing Q2-E (level 2). This course is required for direct admission to the JADS master program.
  + JBI030 Data Mining Q3-E (level 2). This course is required for direct admission to the JADS master program.

Those two courses can be completed by courses from [Data Modelling Foundations](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Data%20Modeling%20Foundations%202019.pdf) and/or [Computer Science Essentials](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Computer_science_essentials.pdf).

* *Data Modelling Foundations*
  + 2DBI00 Linear Algebra Q4-E (level 1)
  + 2ID70 Data intensive systems & applications Q3-D (level 3)
* *Computer Science Essentials*
  + 2IL50 Data structures Q3-B (level 2)
  + 2IO90 DBL Algorithms Q3-D (level 2) Last year taught 2019-2020.

**MSc Data Science and Artificial Intelligence (DS&AI)**

The Master DS&AI is intended for students interested in studying and combining advanced data analysis techniques with AI methods and techniques, in order to understand, use and develop intelligent systems to support and strengthen the human intellect. Link to the [digital study guide](https://studiegids.tue.nl/opleidingen/graduate-school/special-masters-tracks/data-science-in-engineering/dsie-track-of-computer-science-and-engineering/?L=) and [TU/e site](https://www.tue.nl/en/education/graduate-school/master-data-science-and-artificial-intelligence/).

The intended launch will be September 2020. Currently, students enroll for the master Data Science in Engineering. The DSiE master is embedded as a special track within the Computer Science and Engineering (CSE) master.

Admission DS and AI

* Logic and Set Theory (2ITS60)
* Linear Algebra (2DBI00)
* Probability and Statistics (2DI90), check overlap
* Algorithms and Data Structures (2IL50)
* Data-Modeling and Databases (2ID50)
* (Object-oriented) Programming and applying programming for problem solving (2IP90)
* (Data)Visualization (JBI100)
* Data Mining/Machine Learning (2IIG0)

PT-ICT students take 2DBI00, 2IL50, JBI100 and 2IIG0 in addition

* Linear Algebra (2DBI00) Q4-E level 1
* Algorithms and Data Structures (2IL50) Q3-B (level 2)
* Visualization (JBI100), Q2-D level 2
* Data Mining/Machine Learning (2IIG0), Q2-C level 3

**MSc Data Science in Engineering (DSiE)**

Technological and societal changes have led to an explosion of digitally available data. Exploiting this data to its fullest extent, in order to improve decision making, increase productivity, and deepen our understanding of scientific questions, is one of today's major challenges. Data science is an emerging discipline that aims to address this challenge. It is a multi-disciplinary domain, where computer science and mathematics play crucial roles, complemented with human-technology interaction, business models and operations management expertise and skills. Link to the [digital study guide](https://studiegids.tue.nl/opleidingen/graduate-school/special-masters-tracks/data-science-in-engineering/dsie-track-of-computer-science-and-engineering/?L=) and [TU/e site](https://www.tue.nl/en/education/graduate-school/mastertrack-data-science-in-engineering/)

Admission DSiE

Admissions to the DSiE MSc requires basic working knowledge and skills in the following subjects, as acquired in approved Bachelors level coursework:

* logic and set theory (2ITS60),
* linear algebra (2DBI00),
* data modeling and databases (2ID50),
* calculus-based statistics and probability (2DI90), check overlap
* data structures and algorithms (2IL50 )
* 2IIG0/JBI030 Data mining and machine learning OR Data Mining.

PT-ICT students take 2DBI00, 2IL50, and 2ILC0 in addition

* Linear Algebra (2DBI00) Q4-E level 1
* Data Structures (2IL50) Q3-B (level 2)
* Algorithms 2ILC0 Q1-C level 3

**MSc Computer Science and Engineering (CSE)**

The Master program in Computer Science and Engineering (CSE) gives a broad view of computer science from both a scientific and an engineering perspective, and provides ample opportunities for specialization. The program offers three different streams: Software Science, Systems Science, and Web Science and the possibility to follow a program partly outside these streams, for instance to prepare for getting a teaching degree. Each stream has a core program of five courses. There is a large list of stream electives from which you should choose some courses to prepare for your master project. There is also ample room in the program to choose electives from outside your stream. Apart from the three streams there are also two special tracks: Data Science in Engineering and Information Security Technology.

Links to [digital study guide](https://studiegids.tue.nl/opleidingen/graduate-school/masters-programs/computer-science-and-engineering/?L=) and [TU/e site](https://www.tue.nl/en/education/graduate-school/master-computer-science-and-engineering/).

Admission to CSE

* 2WBB0, Calculus
* 2IT60, Logic and Set Theory
* 2IP90/JBI010, Programming
* 2ID50, Data modeling and databases OR JBI050 Data management for data analytics\*
* 2WF20, Linear algebra OR 2DBI00 Linear algebra and applications
* 2IPC0, Programming methods
* 2IL50, Data structures (ideally should be followed by 2ILC0 Algorithms)
* 2IT90, Automata, language theory and complexity \*
* 2IIG0, Data mining and machine learning OR JBI030 Data Mining

PT-ICT students take 2DBI00, 2IPC0, 2IL50, 2IT90 and 2IIG0 in addition.

* Linear Algebra (2DBI00) Q4-E level 1
* Programming methods (2IPC0) Q2-b Level 3
* Data Structures (2IL50) Q3-B (level 2)
* Automata, language theory and complexity (2IT90) Q1-B level 2
* Data Mining/Machine Learning (2IIG0), Q2-C level 3

NB Two related courses that fit nicely in CSE but are not strictly recommended:

* 2IT80 Introduction discrete structures Q2-E level 1
* 2IX20 Software Specification Q3-E level 3

There are several possibilities to be admitted to CSE:

1. The courses can be taken as electives during the student's current non-CS TU/e bachelor.
2. When bachelor is obtained and maximum 6 out of these courses left, the student could follow them as a pre-master program.
3. When bachelor is obtained and maximum 3 out of these courses left, the student could follow them as homologation courses as part of the master program.

The second and third option should be discussed in advance with an academic advisor for masters in Computer Science and approved by the CS admission committee.

**Overview of relevant packages on the A-Z page**

[Computer Science Essentials](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Computer_science_essentials.pdf). 2IP90 Programming and 2ID50 Data modeling and databases are already part of the PT-ICT track. If you choose this package, this counts as 10 ec, you do not meet the requirement of 15 ec technical courses yet:

* + 2IL50 Data structures and
  + 2IO90 DBL Algorithms (course last time in 2020-2021). As an alternative students could take 2IT80 before 2IL50 and/or 2IT90 after 2IL50.

[Analysis of information systems for Industrial Engineering](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/AnalysisOfInfSystems-ie-sept2019.pdf), an in-depth package of four courses.

Analysis of information, data, and knowledge is increasingly important, with broad application across science, engineering, society, and industry. To tackle these challenges, knowledge and skills in the management, mining, and analysis of (big) data collections is necessary. This elective package provides deeper study of the foundations and applications of analysis of data and information systems.

* + JBI100 Visualization, Q2-D level 2
  + 2IIG0 Data Mining/Machine Learning, Q2-C level 3
  + 2IOI0 DBL Process mining Q3-C level 2
  + 2ID70 Data-intensive systems and applications Q3-D level 3 (2IP90, 2IL50 en 2ID50 recommended prior knowledge; affinity with learning new programming languages)

[Interactive Intelligent Systems](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Interactive_intelligent_systems_2016-2017.pdf)

* + 2ID90 Artificial Intelligence (the second course) is offered in 2019-2020 for the last time. The complete package cannot be taken anymore.
  + 2IOE0 DBL (the third course) can only be taken if both 2IV60 and 2ID90 are completed.
  + 2IV60 Computer Graphics remains a good free elective. Please note that linear algebra (2DBI00 or 2DE20) is required prior knowledge.
  + 2IIG0 Data Mining and Machine Learning is a new free elective that can be taken; 2IPC0 (Programming Methods); 2ILC0 (Algorithms) may be necessary/helpful.
  + In 2021-2022 a new second course will be developed in the area of Software; the DBL will be updated based on that new course and the new complete package will be launched by then.

[Data Science for IE&IS](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/JADS%20Coherent%20package%20voor%20BSc%20TBK%20en%20PT%202019.pdf)

This coherent package provides students with the basic knowledge on data science including programming, databases and machine learning techniques. This coherent package largely covers the requirements on data science courses necessary for the direct admission of students majoring Industrial Engineering or Innovation Sciences to the master “Data Science and Entrepreneurship” in JADS, Den Bosch. JADS is the Joint Graduate School of Tilburg University and Eindhoven University of Technology (see [www.jads.nl](http://www.jads.nl) for more information).

1. JBI020 Foundations of Computing Q2-E level 2
2. JBI030 Data Mining Q3-E level 2

If you choose this package, this counts as 10 ec, you do not meet the requirement of 15 ec technical courses yet.

[Data modelling Foundations](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Data%20Modeling%20Foundations%202019.pdf)

This elective package is for students in the bachelor program Data Science and other programs (except the bachelor program Computer Science), who are interested in the master program Data Science in Engineering (DSiE). The courses in this package are required prior knowledge for enrollment in this master program. Students are only admissible in the master program DSiE if they have successfully completed both the packages (1) Data modeling foundations and (2) Algorithms.

1. Linear algebra and applications (2DBI00), Q4(E) level 1
2. 2ID70 Data-intensive systems and applications Q3-D level 3 (2IP90, 2IL50 en 2ID50 recommended prior knowledge; affinity with learning new programming languages)

If you choose this package, this counts as 10 ec, you do not meet the requirement of 15 ec technical courses yet. 2IL50 Data structures fits well here.

**Individual electives**

* + 2IV60 Computer Graphics remains a good free elective. Please note that linear algebra (2DBI00 or 2DE20) is required prior knowledge.
  + 2IT80 Introduction discrete structures Q2-E level 1
  + 2IX20 Software Specification Q3-E level 3
  + 2IIG0 Data Mining and Machine Learning is a new free elective that can be taken, Q2-C level 3; 2IPC0 (Programming Methods); 2ILC0 (Algorithms) may be necessary/helpful.
  + 2IS60 App programming for the last time in 2018-2019. Course is replaced by 2IS50 Software Development for Engineers, a follow-up course of 2IAB0 Data Analytics for Engineers.
  + 2IS50 Software Development for Engineers is allowed in combination with 0HV120 Programming for PT, but not allowed in combination with 0HV120 Programming for PT and 2IP90 Programming. The list with [overlap courses](https://educationguide.tue.nl/programs/bachelor-college/elective-courses/overlap-courses/) will be updated accordingly.

