Examination and Academic Regulations for the Master's Program in Data Engineering and Analytics at Technical University of Munich

(The German version from 15 October 2018)

15 October 2018

Readable version as amended from 11 October 2019

In accordance with Art. 13 (1) sentence 2 in conjunction with Art. 58 (1) sentence 1, Art. 61 (2) sentence 1 and Art. 43 (5) of the Bayerisches Hochschulgesetz (BayHSchG) [Bavarian Higher Education Act] the Technische Universität München issues the following Examination and Academic Regulations (*Fachprüfungs- und Studienordnung, FPSO*):

The English version is provided merely as a convenience and is not intended to be a legally binding document.

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§ 34
Applicability, Academic Titles

(1) [1]The Examination and Academic Regulations for the Master's program in Data Engineering and Analytics (FPSO) complement the General Academic and Examination Regulations for Bachelor's and Master's programs at Technical University of Munich (APSO) from March 2011 as amended. [2]The APSO shall have precedence.

(2) [1]Upon successful completion of the Master's examination the degree "Master of Science" ("M.Sc.") is awarded. [2]The academic title may also be used with the name of the university "(TUM)".

§ 35
Commencement of Studies, Standard Duration of Study, ECTS

(1) Commencement of the Master's program in Data Engineering and Analytics at the Technische Universität München is possible in the winter semester or summer semester.

(2) [1]The number of classes in required and elective subjects needed to obtain the Master's degree is 90 credits (61 weekly hours per semester) spread over three semesters. [2]Furthermore, a maximum of six months (30 credits) is added for the completion of the Master's thesis pursuant to § 46. [3]The number of examinations in required and elective subjects to be completed in the Data Engineering and Analytics Master's program according to Appendix 1 is a minimum of 120 credits. [4]The standard duration of study for the Master's program will be a total of four semesters.

§ 36
Eligibility Requirements

(1) Eligibility for the Master's program in Data Engineering and Analytics is demonstrated by:

1. a qualified Bachelor's degree of at least six semesters or an equivalent degree in Informatics or Mathematics with Informatics as a minor or comparable programs obtained from a domestic or foreign university,

2. an adequate knowledge of the English language; students whose language of instruction is not English must demonstrate proficiency through an acknowledged language test such as "Test of English as a Foreign Language" (TOEFL) (at least 88 points), "International English Language Testing System" (IELTS) (at least 6.5 points), or "Cambridge Main Suite of English Examinations"; a Bachelor's thesis written in English can also be accepted as proof of adequate knowledge of the English language,

3. applicants who obtained their first degree in one of the following countries, must demonstrate specialized knowledge through a "Graduate Record Examination (GRE) General Test" or a "Graduate Aptitude Test in Engineering" (GATE): China, Bangladesh, India, Iran, Pakistan; for applicants with a first degree from a country that is not a signatory state of the Convention on the Recognition of Qualifications concerning Higher Education in the European Region from 11 April 1997 (henceforth referred to as Lisbon Convention) a submission of the test pursuant to sentence 1 is recommended

as it will be requested in case of substantial differences in regard to the competencies proven by the first degree pursuant to subsection 2; the request will not be necessary in case of degrees from the signatory states of the Lisbon Convention; details concerning the completion of the test will be announced in time on the webpages of the Department of Informatics,

4. passing of the Aptitude Assessment pursuant to Appendix 2.

(2) A degree is considered a qualified degree within the meaning of subsection 1 if there are no essential differences with regard to the acquired competencies (learning outcomes) obtained through the Bachelor's programs at Technische Universität München specified in subsection 1, no.1, and if these acquired competencies correspond to the subject-specific requirements of the Master's program.

(3) [1]The assessment according to subsection 2 will be performed on the basis of the required modules of the Bachelor's programs in Informatics resp. Mathematics with Informatics as a minor at Technische Universität München, specified in appendix 3. [2]If certain examination results are missing for the assessment, the Aptitude Assessment Committee pursuant to Appendix 2 no. 3 may require that the candidates demonstrate eligibility pursuant to subsection 1 by taking those examinations as additional Fundamentals Exams pursuant to Appendix 2 no. 5.1.3. [3]The candidate must be informed thereof after review of the documentation during the first stage of the Aptitude Assessment. [4]Should the assessment of a candidate's competencies result in deductions according to sentence 1 and Appendix 2 no. 5.1.1. no. 1, sentence 4 of 14 or more credits in the modules "Fundamentals of Algorithms and Data Structures", "Introduction to Theory of Computation", "Discrete Structures", "Linear Algebra for Informatics", "Analysis for Informatics" and "Discrete Probability Theory" of the Bachelor's program in Informatics, a qualified degree according to subsection 1 is not existent. [5]Should the assessment of a candidate's competencies result in deductions according to sentence 1 and Appendix 2 no. 5.1.1. no. 1 sentence 4 of 12 or more credits in the modules "Introduction to Informatics 1", "Fundamentals of Algorithms and Data Structures" and "Fundamentals of Databases" of the Bachelor's program in Mathematics with Informatics as a minor, a qualified degree according to subsection 1 is not existent.

(4) The comparability of programs, the subject-specific aptitude as well as the recognition of competencies in the course of the assessment of degrees acquired from foreign institutions will be decided upon by the Aptitude Assessment Committee in compliance with Art. 63 of the Bayerisches Hochschulgesetz [Bavarian Higher Education Act].

§ 37
Modular Structure, Module Examination, Courses, Course Specialization, Language of Instruction

(1) [1]General provisions concerning modules and courses are set forth in §§ 6 and 8 of the APSO. [2]For any changes to the stipulated module provisions § 12 (8) of the APSO shall apply.

(2) The curriculum listing the required and elective courses is included in Appendix 4.

(3) [1]The language of instruction of the Master's program Data Engineering and Analytics is English. [2]In case specific modules are taught completely or partially in German, this is

indicated in Appendix 1. [3]Students who did not provide a proof of proficiency in German for the application, are admitted on condition to complete at least one module providing integrative knowledge of the German language within the first two semesters of their studies. [4]The course offer will be published by the examination board according to local practice. [5]Voluntarily completed extra-curricular modules by the TUM Language Center will be recognized.

§ 37a
Study abroad program

[1]A stay abroad at a foreign university within a subject-specific relation to the Master's program in Data Engineering and Analysis for one semester is recommended. [2]A consult with the International Affairs Delegate of the Department of Informatics should forego the stay abroad.

§ 38
Examination Deadlines, Progress Monitoring, Failure to Meet Deadlines

(1) Examination deadlines, progress monitoring, and failure to meet deadlines are governed by § 10 of the APSO.

(2) [1]At least one of the module examinations from the sections A and B as listed in Appendix 1 must be successfully completed by the end of the second semester. [2]In the event of failure to meet deadlines § 10 (5) of the APSO shall apply.

§ 39
Examination Board

Pursuant to § 29 of the APSO the board responsible for all decisions concerning examination matters shall be the Examination Board of the Department of Informatics of the Technische Universität München.

§ 40
Recognition of Periods of Study, Coursework and Examination Results

The recognition of periods of study, coursework and examination results is governed by the provisions of § 16 of the APSO.

§ 41
Continuous Assessment Procedure, Forms of Examination

(1) Pursuant to § 12 and 13 of the APSO valid types of examination in this program of studies are, besides written and oral exams, in particular laboratory exercises, practical exercises ("Testate", if applicable), reports, project works, presentations, learning portfolios, scientific elaborations and exam courses.

a) [1]A **written exam** is a supervised written test that shall prove the ability to recognize and understand problems and to find ways of their solution in a limited amount of time using specified methods and predefined auxiliaries. [2]The duration of written exams is governed by § 12 (7) of the APSO. [3]It shall be proven that (in a limited amount of time with given methods and predefined auxiliaries) problems

can be recognized and understood, ways of their solution can be found and, if necessary, applied.

b) [1]**Laboratory exercises** are, depending on the respective discipline, experiments, measurements, fieldwork, field exercises etc. with the objective of implementation, analysis and gain of knowledge. [2]Elements are for example: description of the processes and the respective theoretical foundations including study of scientific literature, preparation and implementation of experiments, if applicable necessary calculations, their documentation, evaluation and interpretation of results in regard to acquirable knowledge. [3]Additionally a presentation may be part of the project in order to examine the communicative competence of presenting scientific topics to an audience. [4]Details concerning the particular laboratory exercise and the required qualifications are listed in the module description.

c) [1]An **exercise ("Testate", if applicable)** is the practical processing of given assignments (e.g. mathematical problems, programming exercises, modeling exercises etc.) with the objective of applying theoretical contents to solve application-oriented problems. [2]It serves to prove knowledge of facts and details as well as knowledge of their application. [3]The practical exercise may be conducted in written, oral or electronic form. [4]Possible forms of examination are homework, exercise sheets, programming exercises, (electronic) tests, exercises as part of practical courses etc. [5]Details concerning the particular practical exercise and the required qualifications are listed in the module description.

d) [1]A **report** is a written elaboration and summary of a study process with the objective of describing the acquired knowledge in a structured way and analyzing the results in the context of a module. [2]The report shall prove the ability to understand and reproduce the main aspects in a written form. [3]Possible forms of reports are for example field trip reports, practical course reports, labor reports etc. [4]Additionally a presentation may be part of the project in order to examine the communicative competence of presenting scientific topics to an audience.

e) [1]In the course of a **project work**, a project assignment shall be completed as a defined objective within a predefined period of time and using suitable auxiliaries. This should be accomplished in several phases (initiation, problem definition, distribution of roles, idea generation, development of success criteria, decision-making, implementation, presentation, written evaluation). [2]Additionally a presentation may be part of the project to examine the communicative competence of presenting scientific topics to an audience. [3]The components of the project work and the required qualifications are listed in the module description. [4]The project work may also be conducted in form of teamwork. [5]This is intended to prove that exercises can be solved in a team. [6]The individual contribution to be assessed as an examination achievement must be individually recognizable and assessable. [7]The same applies to the individual contribution to the group performance.

f) [1]A **research paper** is a written examination where a student autonomously works on a challenging scientific or respectively scientific-application-oriented problem with scientific methods of the particular discipline. [2]It is intended to prove that such problem in line with the intended study results of the respective module can be tackled on a scientific basis and according to the principles of academic work – from analysis to conception to realization. [3]Possible forms, differing in their

aspiration level, are position paper, abstract, essay, study work, seminar paper etc. [4]A scientific elaboration may be supported by a presentation and a colloquium to check the communicative competence regarding presenting scientific topics to an audience. [5]In this case, also the involvement in the discussion about the work and presentation of other participants may be part of the evaluation. [6]Detailed components of the particular scientific elaboration and the required qualifications are listed in the module description.

g) [1]A **presentation** is a systematic, structured oral performance visually supported by suitable media (e.g. beamer, slides, posters, videos) which illustrates and summarizes specific topics or results and reduces complex issues to the essential. [2]The presentation shall prove the capacity of working out a certain topic within a predefined time so that it may be presented in a clear and comprehensive way to an audience. [3]Also it shall be proven that questions, suggestions and points of discussion by the audience in reference to the particular topic are handled competently. [4]The presentation may be supported by a short written workup. [5]The presentation may be accomplished as team or single-person work. [6]The contribution assessed as examination must be individually recognizable and assessable. [7]This also must hold for the particular contribution to the group performance.

h) [1]An **oral exam** is a time-limited examination dialogue about certain topics and concrete questions to be answered. [2]By oral examination it shall be proven that the qualification objectives listed in the module descriptions are achieved, that connections between the examination subjects were recognized and that particular problems can be classified with respect to these coherences. [3]The oral exam may be accomplished as individual or group examination. [4]The duration of oral exams is governed by § 13 (2) of the APSO.

i) [1]A **learning portfolio** is a written exposition of the student's own works selected by predefined criteria with the object of proving the learning progress and the performance level at a specific time and regarding to a defined content. [2]The choice of the specific works as well as their connection to the learning progress and their informative content for achieving the qualification have to be explained. [3]By a learning portfolio it shall be proven that the learning progress is handled responsibly and that the qualification objectives listed in the module descriptions are achieved. [4]Depending on the module description, possible components of successful self-monitoring of the learning portfolio are especially application-oriented papers, websites, web blogs, bibliographies, analyses, discussion papers and graphic preparations of specific issues. [5]Detailed components of the particular learning portfolio and the required qualifications are listed in the module description.

j) [1]Within the **Exam Course**, several elements have to be completed within one examination. [2]Contrary to a partial module examination, the examination will be conducted in an organizationally (spatially resp. temporally) connected manner. [3]Examination elements are a number of different forms of examinations that in their entirety capture the overall competency profile of the module. [4]Examination elements can also be forms of examinations pursuant to the letters a) to i). [5]The entire duration of an examination shall be specified in the module catalogue, type of examination and duration of the individual examination elements shall be specified in the module description.

(2) [1]The module examinations will, as a rule, be taken concurrently with the program. [2]Type and duration of module examinations are provided for in Appendix 1. [3]In the event of divergence from those provisions, § 12 (8) of the APSO must be complied with. [4]The assessment of the module examination is governed by § 17 of the APSO. [5]Grade weights of partial module examinations correspond to the weighting factors as assigned in Appendix 1.

(3) Upon request of a student and with the agreement of the examiners, examinations may be taken in a different language than the course language.

§ 42
Registration for and Admission to the Master's Examination

(1) Students who are enrolled in the Master's program in Data Engineering and Analytics are deemed admitted to the module examinations of the Master's examination.

(2) [1]Registration requirements for required and elective module examinations are stipulated in § 15 (1) of the APSO. [2]The registration requirements for repeat examinations for failed required modules are stipulated in § 15 (2) of the APSO.

§ 43
Scope of the Master's Examination

(1) The Master's examination consists of:
    1. The module examinations in the corresponding modules pursuant to subsection 2,
    2. The Master's thesis pursuant to § 46.

(2) [1]The module examinations are listed in Appendix 1. [2]Pursuant to Appendix 1, module examinations in required modules in the scope of 31 credits and module examinations in elective modules of at least 59 credits must be completed. [3]The selection of modules must be in compliance with § 8 (2) of the APSO.

§ 44
Repeat Examinations, Failed Examinations

(1) [1]The repetition of examinations is governed by § 24 of the APSO. [2]The repeat examination for a module examination administered at the end of the lecture period and not passed, as a rule must be taken no later than by the end of the first week of the lecture period of the following semester. [3]In derogation of sentence 2, the date of repeat examinations of examinations that are not offered by the Department of Informatics has to comply with the regulations of the offering department.

(2) Failure of examinations is governed by § 23 of the APSO.

§ 45
Coursework

[1]Instead of the examinations to be taken in elective modules pursuant to § 43 (2) sentence 2, successful completion of coursework may be required. [2]In this case the number of credits to be earned through examinations in elective courses pursuant to § 43 (2), sentence 2 will be reduced accordingly.

§ 45 a
Multiple-Choice Test

The accomplishment of Multiple-Choice Procedures is governed by § 12a of the APSO.

§ 46
Master's Thesis

(1) [1]As part of the Master's examination, each student must write a Master's thesis pursuant to § 18 of the APSO. [2]The Master's thesis topic may be assigned and supervised by thesis supervisors of the Department of Informatics or by thesis supervisors with related subject areas from other departments of the Technische Universität München. [3]The thesis supervisors pursuant to sentence 2 are appointed by the examination board.

(2) Work on the Master's thesis should commence after successful completion of all module examinations.

(3) [1]The period of time between topic assignment and submission of the completed Master's thesis must not exceed six months. [2]The Master's thesis is deemed taken and not passed, if it is not delivered in time and without accepted solid reasons pursuant to § 10 (7) of the APSO. [3]The Master's thesis may be written in either the German or the English language.

(4) [1]The completion of the Master's thesis consists of a written composition and a lecture on its content. [2]The lecture does not affect the grading. [3]For the module Master's Thesis 30 credits will be assigned.

(5) [1]If the Master's thesis was not graded with at least "sufficient" (4.0), it may be repeated once with a new topic. [2]Students must renew their application for admission within six weeks from receipt of the notification of the result (Bescheid).

§ 47
Passing and Assessment of the Master's Examination

(1) The Master's examination is deemed passed when all examinations required for the Master's examination pursuant to § 43 (1) have been passed and a plus credits account of at least 120 credits has been achieved.

(2) [1]The grade for a module will be calculated according to § 17 of the APSO. [2]The overall grade for the Master's examination will be calculated as the weighted grade average of the modules according to § 43 (2) and the Master's thesis. [3]The grade weights of the individual modules correspond to the credits assigned to each module. [4]The final result will be expressed by an attribute according to § 17 of the APSO.

§ 48
Degree Certificate, Diploma, Diploma Supplement

[1]If the Master's examination was passed, a degree certificate, a diploma, and a diploma supplement including a transcript of records are to be issued in compliance with § 25 (1) and § 26 APSO. [2]The degree certificate will be dated on the day when all examination and coursework requirements have been fulfilled.

§ 49
Entry into Force

(1) [1]These Examination and Academic Regulations shall enter into force on 1 October 2019. [2]They shall apply to all students who commence their studies in the Data Engineering and Analytics Master's program at Technical University of Munich as of the winter semester 2019/20. [3]Divergent to sentence 1, Appendix 2: Aptitude Assessment shall apply to all students who commence their studies at Technical University of Munich as of summer semester 2019.

(2) [1]At the same time, the Examination and Academic Regulations for the Master's program in Data Engineering and Analytics as of 10 June 2016, last amended by no. 33 of the Summary Changes concerning the aptitude assessment committee of the Master's programs of Technical University of Munich as of 25 April 2018, shall cease to be in effect. [2]Students who started their academic studies at Technical University of Munich prior to winter semester 2018/19 will complete their studies according to the Examination and Academic Regulations pursuant to sentence 1.

APPENDIX 1: Examination Modules

Remarks:
- SWS = Semesterwochenstunden = weekly hours per semester; V = Vorlesung = lecture; Ü = Übung = exercise; P = Praktikum = practical course; S = Seminar
- In the column "Duration of examination", the duration of written examinations is specified in minutes. Pursuant to the APSO, the concrete extent of project works and scientific elaborations is listed in the module description.
- The examination board can add further Elective Modules to the Elective Course Catalog temporarily or permanently. Modifications will be made available on the websites of the Department of Informatics at the beginning of the semester.

A Required Modules (31 Credits):

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
IN2326	Foundations in Data Engineering	WiSe	4V+2Ü	8	Written exam	90-150	English
MA4800	Foundations in Data Analysis	SoSe	4V+2Ü	8	Written exam	90	English
IN2107	Master's seminar	WiSe / SoSe	2S	5	Research Paper		English/ German
IN2106	Master's practical course	WiSe / SoSe	6P	10	Project work		English/ German

B Elective Modules – Data Engineering and Analytics (53 Credits)

A total of 53 credits must be earned from the elective modules in B1.1, B1.2, B2.1, B2.2, B3 and from elective modules in the elective modules catalogue of the Master's program in Informatics. The modules must meet the following conditions:

1. B1.1 Data Engineering, B2.1 Data Analytics, B3 Data Analysis:
   A total of at least 15 credits must be earned from these three areas, whereas at least one module must be chosen from each one of them.
2. B1.2 Advanced Topics in Data Engineering, B2.2 Special Topics in Analytics:
   A total of at least 25 credits must be earned from these two areas, whereas one of the chosen modules must be either IN2169 "Guided Reseach" or IN2328 "Application-oriented project".

Elective Modules marked by * or resp. ** require prior mathematical knowledge that slightly resp. noticeably extends beyond the level necessary for admission or the level taught within the course "Foundations in Data Analysis". Students without a Bachelor's degree in Mathematics are recommended to consult the corresponding module descriptions (especially the recommended qualifications) and, if applicable, an academic advisor before attending these courses.

B1.1 Data Engineering

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
IN2140	Advanced Concepts of Distributed Databases	WiSe	1V+2P	4	Project work		English/ German
IN2219	Query Optimization	WiSe	3V+2Ü	6	Written exam	90 -150	English
IN2259	Distributed Systems	WiSe	3V+1Ü	5	Written exam	75 – 125	English
IN2118	Database Systems on Modern CPU Architecture	SoSe	3V+2Ü	6	Written exam	90-150	English
IN2209	IT Security	WiSe	4V+1Ü	7	Written exam	105-175	German
IN2147	Parallel Programming	SoSe	2V+2Ü	5	Written exam	75-120	English

B1.2 Advanced Topics in Data Engineering

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
IN2097	Advanced Computer Networking	WiSe	3V+1Ü	5	Written exam	75 –125	English
IN2169	Guided Research	WiSe/ SoSe		10	Research paper		English
IN2328	Application-oriented project	WiSe/ SoSe		10	Project work		English/ German

B2.1 Data Analytics

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
IN2028	Business Analytics	WiSe	2V+2Ü	5	Written exam	75 - 125	English

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
IN2064	Machine Learning	WiSe	4V+2Ü	8	Written exam	120 -180	English
IN2062	Techniques in Artificial Intelligence	WiSe	3V+1Ü	5	Written exam	75 – 125	English
IN2026	Visual Data Analytics	WiSe	3V+1Ü	5	Written exam	60 – 90	English
IN2124	Basic Methods for Imaging and Visualization	WiSe	2V+2Ü	5	Written exam	75 - 125	English
IN2010	Modelling and Simulation	SoSe	4V+2Ü	8	Written exam	120 – 180	German

B2.2 Special Topics in Data Analytics

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
MA4502	Combinatorial Optimization *	SoSe	2V+1Ü	5	Written exam	60	English
MA4503	Modern Methods in Nonlinear Optimization *	SoSe	2V+1Ü	5	Written exam	60	English
MA4406	Probability on Graphs *	SoSe	2V+1Ü	5	Written exam	60	English
MA5417	Large Deviations *	irregular	2V+1Ü	5	Written exam	60	English
MA4064	Fourier Analysis *	irregular	2V+1Ü	5	Written exam	60	English
MA4408	Markov Processes **	SoSe	4V+2Ü	9	Written exam	90	English
IN2001	Algorithms for Scientific Computing	SoSe	4V+2Ü	8	Written exam	120 – 180	English
IN2011	Parallel Algorithms	WiSe	4V+2Ü	8	Written exam	120 - 180	English
IN2323	Mining Massive Datasets	WiSe	2V+2Ü	5	Written exam	75 - 125	English
EI7223	Information Retrieval in High Dimensional Data	WiSe	2V+2Ü+3P	6	Oral exam + exercise (weighted 2:1)	30	English/ German

B3 Data Analysis

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
MA2504	Fundamentals of Convex Optimization	SoSe	4V+2Ü	9	Written exam	90	English
MA2409	Probability Theory *	SoSe	4V+2Ü	9	Written exam	90	English
MA3001	Functional Analysis **	WiSe	4V+2Ü	9	Written exam	90	English
MA4401	Applied Regression	WiSe	2V+1Ü	5	Written exam	60	English
MA3503	Nonlinear	WiSe	2V+1Ü	5	Written	60	English

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
	Optimization: Advanced *				exam		
MA3502	Discrete Optimization*	WiSe	2V+1Ü	5	Written exam	60	English

C Master's Thesis

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
IN2327	Master's Thesis	4.		30	Research paper		English/ German

D Elective Modules – Support Electives (6 Credits):

D1 Support Electives

A total of at least 3 credits must be earned from the following elective modules of the elective course catalog – support electives from the Master's program of Informatics:

ID	Module name	Sem.	SWS	Credits	Type of Examination	Duration of Exam.	Language
IN9044	Data Privacy	Irregular	2S	4	Research paper		German
WI000159	Business Plan – Basic Course (Business Idea and Market)	WiSe/ SoSe	2S	3	Project work		English
IN9006	Entrepreneurship for Small Software-oriented Enterprises	SoSe	1S	2	Presentation		English
IN9003	Informatics and Law	SoSe	2V	3	Written exam	60 – 90	German
IN9036	Master Your Thesis!	WiSe	2S	4	Research paper		English

The Elective Module Catalogue of the Support Electives will be complemented by modules offered at TUM Language Centre and the Carl von Linde-Academie which are published by the Examination Board on the Department's websites.

D2 Social and Political Aspects of Data Science

A total of at least 3 credits must be earned from the elective modules of the elective modules catalogue – Social and Political Aspects of Data Science of the Munich Center for Technology in Society (MCTS).

APPENDIX 2: Aptitude Assessment

Aptitude Assessment for the Master's program Data Engineering and Analytics at Technical University of Munich

1. **Purpose of the Assessment**

   [1]Eligibility for the Master's program Data Engineering and Analytics, in addition to the requirements pursuant to § 36 (1) no(s) 1 to 3, requires proof of aptitude pursuant to § 36 (1) no. 4 in accordance with the following provisions. [2]The special qualifications and skills of the candidates should correspond to the Data Engineering and Analytics profession. [3]Individual aptitude parameters are:

   1.1 Ability to do research work and/or basic research and methodological work;
   1.2 Expertise from undergraduate studies in Informatics or resp. expertise from undergraduate studies in Mathematics with Informatic as a minor;
   1.3 Ability to solve complex and difficult problems;
   1.4 Ability to abstract and transfer the Informatics methods in solving problems in the field of Data Engineering and Analytics.

2. **Aptitude Assessment Process**

   2.1 The aptitude assessment process will be held twice a year by the Department of Informatics of Technical University of Munich.

   2.2 [1]Applications for admission to the aptitude test together with the documents pursuant to 2.3.1 to 2.3.8 and § 36 (1) no 2 must be filed online by 31 May for the winter semester and by 30 November for the summer semester to Technical University of Munich (absolute deadlines). [2]Degree certificate and diploma as proof of Bachelor's degree obtained must be filed to the admissions office of Technical University of Munich no later than five weeks after the beginning of lectures. [3]Otherwise, pursuant to § 36 the enrollment to the Master's program is not yet possible.

   2.3 The application must include:

   2.3.1 a transcript of records containing modules of at least 120 credits, or resp. of two-thirds of the examinations necessary for the undergraduate degree in case of degrees not being subject to the "European Credit Transfer and Accumulation System" (ECTS); the transcript of records must be issued by the responsible examining authority or the responsible office of academic affairs,
   2.3.2 a curriculum vitae formatted as a table,
   2.3.3 a written statement of no more than 2 DIN A4 pages in German or English of the reasons for choosing the Master's program in Data Engineering and Analytics at Technical University of Munich in which the candidate explains those specific abilities that make him/her particularly qualified for the Master's program in Data Engineering and Analytics at Technical University of Munich; a candidate's exceptional commitment can e.g. be demonatrated by details on program-related vocational training, internships, stays abroad, or program-related further education beyond the attendance and course requirements of the Bachelor's program, if necessary by appropriate documentation,

   2.3.4 a written essay, in English or German, of approx. 1000 words in length; the chairperson of the committee may provide one topic or a selection of several topics

for this essay; the candidates must be informed of the topic(s) not later than 1 March resp. 1 September,

2.3.5 a declaration that both the statement of the reasons for choosing the program and the essay are the candidate's own work, and that the candidate has clearly identified any ideas taken from outside sources,

2.3.6 the underlying curriculum (e.g. module catalogue) of the undergraduate degree program,

2.3.7 the assignment of the applicant's modules derived from the transcript of records to the respective subject groups according to 5.1.1. no. 1 incl. a sworn statement of the correctness of the information provided,

2.3.8 a list of the applicant's best graded modules in the amount of 120 Credits (resp. two-thirds of the examinations necessary for the undergraduate degree) pursuant to 5.1.1 no. 2 incl. a sworn statement of the correctness of the information provided.

3. Aptitude Assessment Committee

3.1 [1]The aptitude test is administered by a committee that, as a rule, consists of the Dean of Studies in charge of the Master's program in Data Engineering and Analytics, at least two members of the professorial faculty and at least one member of the academic staff (wissenschaftlicher Mitarbeiter). [2]At least half of the committee members must be professorial faculty. [3]A representative of the student body shall be a part of the committee, in an advisory capacity.

3.2 [1]The members of the committee are appointed by the department council (Fakultätsrat) in consultation with the Dean of Studies. [2]At least one member of the professorial faculty is appointed as deputy member of the committee. [3]As a rule, the committee is chaired by the Dean of Studies. [4]Procedural regulations will be in accordance with Art. 41 of the BayHSchG as last amended.

3.3 [1]When the aptitude assessment committee takes up the assessment according to these Examination and Academic regulations, the revocable delegation of specific tasks to individual committee members is permitted. [2]When according to sentence 1 only one committee member excercises specific tasks, this member has to be a member of the professorial faculty. [3]When according to sentence 1 two or more committee members exercise specific tasks, at least half of the members have to be members of the professorial faculty. [4]The aptitude assessment committee ensures the appropiate distribution of tasks. [5]In case of an assessment scope for a criterion of the aptitude assessment, and in case that at least two members of the aptitude assessment committe take up the asssessment of this criterion, those members assess independently according to the indicated weighting, unless otherwise specified; the points total will be calculated as the arithmetic means of the individual assessments, rounded up to the nearest full point.

4 Admission to the Aptitude Assessment

4.1 Admission to the aptitude assessment requires that all documentation specified in no. 2.3 has been submitted in a timely and complete fashion.

4.2 Applicants who have fulfilled the requirements will be tested according to no 5.

4.3 [1]Applicants who are not admitted will receive a notification specifying the reasons and providing information on legal remedies. [2]Signatory power may be delegated.

5. The Aptitude Assessment Process

5.1 <u>First stage of the Aptitude Assessment Process</u>

5.1.1 [1]The committee will assess, on the basis of the written application documents required under no. 2.3, whether or not an applicant is suitable for a program pursuant to no. 1 (First stage of the aptitude assessment process). [2]For this purpose, the committee evaluates and grades the candidate's documentation on a scale ranging from 0 to 100 points, 0 being the worst and 100 the best possible result:

1. Academic qualification
[1]The curricular analysis is not conducted in the form of a schematic comparison of the modules, but rather on the basis of competencies. [2]It will encompass the fundamental subject groups of either the Bachelor's program in Informatics or the Bachelor's program in Mathematics with minor in Informatics listed in the table below.

Subject group Bachelor's program Informatics	Credits TUM
Informatics Fundamentals (Introduction to Informatics, Algorithms and Data Structures, Databases, Computer Architecture, Software Engineering, Operating Systems and System Software, Computer Networks and Distributed Systems, Theory of Computation)	52
Mathematics Fundamentals (Discrete Structures, Linear Algebra, Analysis, Discrete Probability)	30

Subject group Bachelor's program Mathematics with Informatics as a minor	Credits TUM
Mathematics Fundamentals (Linear Algebra and Discrete Structures, Calculus, Introduction to Probability Theory, additional basics, i.e. Algorithmic Discrete Mathematics, Introduction to Nonlinear Optimization, Basic Statistics)	52
Informatics Fundamentals (Introduction to Informatics and Programming, Algorithms and Data Structures, Databases, additional basics, i.e. Computer Architecture, Software Engineering, Operating Systems and System Software, Computer Networks and Distributed Systems, Theory of Computation)	30

[3]If there are no essential differences with regard to the acquired competencies (learning outcomes), the candidate will be awarded a maximum of 55points. [4]Missing competencies will be deducted in accordance with the credits of the corresponding modules of the Bachelor's program in Informatics or resp. Mathematics at the Technische Universität München. [5]There will be no negative points.

[6]Where a GRE or GATE test has to be submitted pursuant to § 36 (1) no. 3, it is assumed that, in case of succesful demonstration, there are no substantial differences regarding the level of competencies demonstrated by the undergraduate degree compared to the reference criteria set out in 5.1.1 no. 1 sentence 2 and that the curricular analysis will be conducted according to the abovementioned citeria.

2. Final grade

[1]For each tenth of a grade that the average grade determined for the examinations amounting to 120 credits (resp. two-thirds of the examinations necessary for the undergraduate degree) is better than 3.0, the applicant will be awarded one point. [2]The maximum number of points is 20. [3]There will be no negative points. [4]Where a degree was obtained outside of Germany, the grade will be converted according to what is referred to as „Bavarian formula" (bayerische Formel). [5]If the applicant, at the time he or she files the application, submits a final degree certificate showing more than 120 credits, the assessment will be made on the basis of the modules that were awarded the best grades, up to 120 credits (resp. two-thirds of the examinations necessary for the undergraduate degree). [6]The grade average is calculated from the graded module examinations up to 120 credits credits (resp. two-thirds of the examinations necessary for the undergraduate degree). [7]The overall grade average will be calculated as the weighted grade average of the modules. [8]The grade weights of the individual modules correspond to the credits assigned to each module. [9]For the calculation of grade, one decimal place will be taken into account, all further decimal places will be dropped without rounding.

3. Statement of reasons

[1]The applicant's written statement of purpose will be evaluated by two committee members and graded on a scale of 0 – 10 points. [2]The statement of reasons will be assessed using the following criteria:

1. Exceptional commitment:

    The applicant has relevant qualifications which exceed the knowledge and qualifications obtained at undergraduate degree level e.g. vocational training that is specific to the degree program, internships, stays abroad (cf. no. 2.3.3).

2. Specific qualification:
    The applicant is able to illustrate the connection between the specific personal qualification and the content of the degree program.

[3]The committee members assess each of both criteria independently, whereas the criteria will be weighted equally. [4]The points total will be calculated as the arithmetic mean of the individual assessments, rounded up to the nearest full point.

4. Essay

[1]The applicant's written essay will be evaluated by two committee members and graded on a scale of 0 – 15 points. [2]The essay will be assessed using the following criteria:

1. formal and coherent structure,
2. complete and correct in content, coherent argumentation,

3. academic foundation.

[3]The committee members assess each of the three criteria independently whereas the criteria will be weighted equally. [4]The points total will be calculated as the arithmetic mean of the individual assessments, rounded up to the nearest full point.

5.1.2   [1]The applicant's points total will be calculated as sum of the individual points awarded. [2]Decimal places must be rounded up.

5.1.3   [1]Applicants who have achieved at least 70 points will receive confirmation that they have passed the aptitude assessment test. [2]In those cases where it was determined according to § 36 (3) that some subject-specific requirements from undergraduate studies are missing, the committee may make admission subject to successful completion of Fundamentals Exams from the Bachelor's program in Informatics and Mathematics (so-called Brückenkurse) in the amount of a maximum of 30 credits. [3]These Fundamentals Exams must be taken successfully in the first year of study. [4]Failed Fundamentals Exams may be repeated within this period of time only once and at the next examination date. [5]The examination board may make the admission to individual module examinations dependent on the successful completion of the Fundamentals Exams.

5.1.4   [1]Unsuitable applicants with a points total of fewer than 50 points will receive a rejection notice, signed by the TUM Board of Management and specifying the reasons for rejection and providing information on legal remedies. [2]Signatory power may be delegated.

5.2   Second stage of the Aptitude Assessment Process

5.2.1   [1]The remaining applicants will be invited for an aptitude assessment interview. [2]In the second stage of the aptitude assessment process, the applicant's qualification at undergraduate level and the result of the assessment interview will be evaluated. [3]Interview appointments will be announced at least one week in advance. [4]Possible time slots for interviews must be announced before expiration of the application deadline. [5]The interview appointment must be kept by the applicant. [6]If the applicant is unable to attend an aptitude assessment interview due to reasons beyond his/her control, a later appointment may be scheduled upon an applicant's well-grounded request, but no later than two weeks before the beginning of classes.

5.2.2   [1]The aptitude assessment interview is to be held individually for each applicant. [2]The interview lasts at least 20 but not more than 30 minutes for each applicant and is held in both German and English, but may be completely in English upon request. [3]The interview will focus on the following topics:

1. Exceptional commitment that gives reason to expect that the level of capacity obtained at the undergrate degree level in general or at least concerning the area of specialization is exeeded noticeably:

   • Is there any specific qualification for a concrete specialization in the field of the degree program, proved by additional modules or non-university activities (e.g. membership or activities in relevant organizations) in that area?
   • Is there evidence of outstanding determination in the curriculum vitae (e.g. additional subject-related internships, relation between previous occupations and the degree program)?
   • Is there specific experience in research (e.g. specific research orientation in the previous academic studies, participation in research projects)?

2. Aptitude parameters according to no. 1.1 and 1.2:
- Presentation of subject-related expertise, previous main study focus,
- Qualifications acquired in the undergraduate degree program in the subject groups mentioned in 5.1.1.1,
- Subject of the final thesis

3. Communication skills:
- Ability to illustrate and discuss facts in a clear, fluent and accurate way,
- One's own thoughts and opinions are expressed precisely and comprehensive answers are structured logically during the interview,
- Questions relating to the first degree and / or the main study focus are answered terminologically correct and comprehensible at the same time,
- Statements are convincingly based on arguments and supported by reasonable examples.
- Questions regarding scientific topics as well as one's own competencies and expectations are understood without problem or if necessary clarified through further inquiry.

[4]The above topics may cover the documentation submitted pursuant to 2.3. [5]Any subject-specific academic knowledge that is to be taught in the Master's program in Data Engineering and Analytics will not affect the decision. [6]With the applicant's approval, a representative of the student body may sit in on the interview.

5.2.3 [1]The aptitude assessment interview will be conducted by at least two members of the committee. [2]The committee members will grade each of the three topics set out in no. 5.2.2 independently, each with the same weighting. [3]Each member will grade the result of the interview on a scale from 0 to 45, 0 being the worst and 45 being the best possible result. [4]The points total will be calculated as the arithmetic mean of the individual points. [5]The result will be rounded up to the nearest full point.

5.2.4 [1]The applicant's points total in the second stage will be calculated as the sum of all points obtained under 5.2.3 and the points under 5.1.1.1 (academic qualification) and 5.1.1.2 (grade). [2]Applicants with 70 or more points will be deemed suitable.

5.2.5 [1]The applicant will be notified of the result of the aptitude test determined by the committee in writing - where applicable, subject to the requirements determined in stage 1, 5.1.3 (2). [2]The notice must be signed by the TUM Board of Management. [3]Signatory power may be delegated. [4]A rejection notice must specify the reasons for the rejection and provide information on legal remedies.

5.2.6 Admissions to the Master's program in Data Engineering and Analytics shall apply to all subsequent applications for this program.

6. Record

[1]The aptitude assessment process must be documented, including the date, duration and location of the assessment, the names of the committee members, the applicant's name, and the decision of the members of the committee as well as the overall result. [2]This record must contain the essential reasons for the decision and the topics discussed in the interview held with the applicants; these reasons and topics may be recorded in note form.

7. Repetition

Applicants who have failed the aptitude test for the Master's program in Data Engineering and Analytics may register for one repetition of the Aptitude Assessment Test.

APPENDIX 3: Foundations from the Bachelor's program in Informatics and Mathematics at the Technische Universität München

The following modules from the Bachelor's program in Informatics resp. Mathematics with Informatics as a minor will be taken into account for the assessment according to § 36 (3) if a qualified degree according to § 36 (1) is existent:

A Foundations from the Bachelor's program Informatics

ID	Module name	Credits
IN0001	Introduction to Informatics	6
IN0002	Fundamentals of Programming	6
IN0007	Fundamentals of Algorithms and Data Structures	6
IN0008	Fundamentals of Databases	6
IN0004	Introduction to Computer Organization and Technology - Computer Architecture	8
IN0006	Introduction to Software Engineering	6
IN0009	Basic Principles: Operating Systems and System Software	6
IN0010	Introduction to Computer Networking and Distributed Systems	6
IN0011	Introduction to Theory of Computation	8

ID	Module name	Credits
IN0015	Discrete Structures	8
MA0902	Analysis for Informatics	8
MA0901	Linear Algebra for Informatics	8
IN0018	Discrete Probability Theory	6

B Foundations from the Bachelor's program Mathematics with Informatics as a minor

ID	Module name	Credits
IN0001	Introduction to Informatics	6
IN0002	Fundamentals of Programming	6
IN0007	Fundamentals of Algorithms and Data Structures	6
IN0008	Fundamentals of Databases	6
IN0004	Introduction to Computer Organization and Technology - Computer Architecture	8
IN0006	Introduction to Software Engineering	6
IN0009	Basic Principles: Operating Systems and System Software	6
IN0010	Introduction to Computer Networking and Distributed Systems	6
IN0011	Introduction to Theory of Computation	8
MA1101	Linear Algebra and Discrete Structures 1	10
MA1102	Linear Algebra and Discrete Structures 2	10
MA1001	Analysis 1	10
MA1002	Analysis 2	10
MA1401	Introduction to Probability Theory	5
MA2501	Algorithmic Discrete Mathematics	5
MA2503	Introduction to Nonlinear Optimization	5
MA2402	Basic Statistics	5

APPENDIX 4: Curriculum

		Line of Specialization	Section of Appendix 1	CP	
	1	Foundations in Data Engineering (**start in winter semester**) or Foundations in Data Analysis (**start in summer semester**)	from section A	8	
		Data Engineering	from section B1.1	11	
		Special Topics in Data Analytics	from section B2.2	6	
		Data Analysis	from section B1.3	5	
				30	
	2	Foundations in Data Analysis (**start in winter semester**) or Foundations in Data Engineering (**start in summer semester**)	from section A1.1	8	
		Advanced Topics in Data Engineering	from section B1.2	7	
		Master's practical course	from section A	10	
		Master's seminar	from section A	5	
				30	
	3	Special Topics in Data Analytics	from section B2.2	8	
		Data Analytics	from section B2.1	6	
		Support Electives	from section C	6	
		Application project	from section B1.2	10	
				30	
	4	Master's Thesis		30	
				30	

This curriculum is valid for students enrolled in the winter semester as well as in the summer semester.