Program of Studies:	**Master Program Bioinformatics**
Name of the module:	**Database Systems**
Abbreviation:	**I-M-3**
Subtitle:	Core lecture
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester / at least once every two years
Responsible lecturer:	Prof. Dr. Jens Dittrich
Lecturer:	Prof. Dr. Jens Dittrich
Language:	English
Level of the unit/ Mandatory or not	Graduate course / mandatory elective
Course type/weekly hours:	Lecture 4 h (weekly; this class may be run as a flipped classroom, i.e. 2 hours may be replaced by self-study of videos/papers; the other 2 hours may be used to run a group exercise supervised by the professor called "the LAB") Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: - motivation for databases and database management systems; - the relational data model; - relational query languages, particularly relational algebra and SQL; - solid programming skills in Java and/or C++ - undergrade courses in algorithms and data structures, concurrent programming

Aims/Competences to be developed:	- Database systems are the backbone of most modern information systems and a core technology without which today's economy -- as well as many other aspects of our lifes -- would be impossible in their present forms. The course teaches the architectural and algorithmic foundations of modern database management systems (DBMS), focussing on database systems internals rather than applications. Emphasis is made on robust and time-tested techniques that have led databases to be considered a mature technology and one of the greatest success stories in computer science. At the same time, opportunities for exciting research in this field will be pointed out. - In the exercise part of the course, important components of a DBMS will be treated and where possible implemented and their performance evaluated. The goal of this is to work with the techniques introduced in the lecture and to understand them and their practical implications to a depth that would not be attainable by purely theoretical study. -
Content:	The course "Database Systems" will introduce students to the internal workings of a DBMS, in particular - storage media (disk, flash, main memory, caches, and any other future storage medium) - data managing architectures (DBMS, streams, file systems, clouds, appliances) - storage management (DB-file systems, raw devices, write-strategies, differential files, buffer management) - data layouts (horizontal and vertical partitioning, columns, hybrid mappings, compression, defragmentation) - indexing (one- and multidimensional, tree-structured, hash-, partition-based, bulk-loading and external sorting, differentail indexing, read- and write-optimized indexing, data warehouse indexing, main-memory indeses, sparse and dense, dirc and indirect, clustered and unclustered, main memory versus disk and/or flash-based) - processing models (operator model, pipeline models, push and pull, block-based iteration, vectorization, query compilation) - processing implementations (join algorithms for relational data, grouping and erly aggregation, filtering) - query processing (scanning, plan computtion, SIMD) - query optimization (wuery rewrite, cost models, cost-based optimization, join order, join graph, plan enumeration) - data recover (single versus multiple instance, logging, ARIES)

	- parallelization of data and queries (horizontal and vertical partitioning, sharde-nothing, replication, distributed query processsing, NoSQL, Map Reduce, Hadoop and/or similar and/or future systems) - read-optimized systems concepts (search engines, data warehouses, OLAP) - write-optimized system concempts (OLTP, streaming data) - management of geographical data (GIS, google maps and similar tools)
Assessment/Exams:	- Passing a two-hour written exam at the end of the semester - Successful demonstration of programming project (teams of up to three students are allowed); the project may be integrated to be part of the weekle assignments Grades are based on written exam; 50% in weekly assignments (in paper and additionally paper or electroni quizzes) must be passed to participate in the final and repetiton exams. A repetition exam takes place during the last two weeks before the start of lectures in the following semester. Grade: will be determined based on project, midterm and best of endterm and re-exam.
Literature:	will be announced on the course web site