Competence coverage matrix

GHENT UNIVERSITY

Master of Science in Bioinformatics

Engineering

Academic year 2021-2022

Legend:
T=teaching methods
E=evaluation methods

			General Courses						Courses Related to the Main Subject																					Master's Dissertation
			C003694 Statistical Genomics	C003695 Applied High-throughput Analysis	C003696 Genome Biology	C004000 Integrative Biology	C003698 Design Project	C004122 Capita Selecta in Bioinformatics	E017930 Parallel and Distributed Software Systems	C003711 Computational Challenges in Bioinformatics	E061330 Machine Learning	E004120 Optimisation Techniques	E034140 Parallel Computer Systems	E016330 Artificial Intelligence	F000918 Deep Learning	E061340 Machine-learning Based Natural Language Processing	E016340 Probabilistic Graphical Models	E003600 Information Theory	E019400 Information Security	E017822 Software Architecture	E092621 Modelling of Physiological Systems	E074011 Quantitative Cell and Tissue Analysis	E003421 Estimation and Decision Techniques	C003399 Computerintensive Statistical Methods	E018210 Big Data Science	C003712 Cellular and Molecular Biology	C003713 Introduction to Bioinformatics	C003720 Master's Dissertation
Competence in one or more scientific disciplines	Having advanced knowledge of mathematics, informatics, machine learning and statistical techniques and their application within bioinformatics and systems biology.	T 10 E 9	T E	T E		T E					T E	T E		T E	T E				T E					T E	T				
	Having knowledge of experimental techniques for the generation of 'omics' data.	T 3 E 3		T E		T E																T E						
	Understanding the specificities of ' bioinformatics' and 'systems biology' in relation to its composing subdomains i.e. having insights in the interdisciplinary character of the research domain.	T 5 E 5		T E	T E	T E				T E																	T E	
	Application of basic statistical, computer science and other data analysis techniques to solve well-delineated problems (skill).	T 11 E 9	T E	T E		T					T E	T E	T E	T E		T E		T E					T E	T				
	Having an overview of the most important methods in computational biology.	T 5 E 5			T E	T E				T E						T E											T E	
	Having insight in the way bioinformatics evolves (fastly evolving domain).	T 4 E 4		T E	T E	T E													T E										
	Knowledge of software-engineering techniques and advanced programming skills.	T 4 E 4								T E				T E		T E		T E										
	Advanced knowledge of data structures and algorithms for the application of well delineated problems.	T 3 E 3								T E			T E	T E														
	Broad knowledge of the bioinformatics application domain.	T 3 E 3		T E		T E																					T E	
	Broad knowledge of the genetics and molecular biology.	T 3 E 3																				T E				T E	T E	
Scientific competence	Implement previously described models and methods to solve a bioinformatics problem.	T 4 E 4				T E	T E			T E																		T E
	Design novel analysis tools and methods to solve a new bioinformatics problem.	T 4 E 3					T E			T E								T									T E
	Design the proper simulation studies to evaluate state-of-the-art methods.	T 5 E 5					T E			T E			T E			T E											T E
	Recognize a biological problem and determine the proper method to solve it with a bioinformatics approach.	T 6 E 6		T E	T E		T E															T E				T E	T E
	Interpret the results of a model or simulation from a computational or biological point of view.	T 3 E 3					T E															T E					T E
Intellectual competence	Define a complex systems biology problem and subdivide this in subproblems.	T 7 E 7		T E	T E	T E	T E							T E		T E											T E
	Choosing the most appropriate principles to solve each of the subproblems, if needed in collaboration with experts in each of the subdomains (informatics, statistics).	T 5 E 4		T E		T	T E												T E								T E
	Make a well-educated choice between the theoretical ly most elegant and most prag matic method s and estimate the effects of appr oximations on the final results.	T 10 E 9	T E	T E		T E	T E						T E	T E				T E	T E					T				T E
	Showing an active attitude towards life- long learning.	T 8 E 6	T E		T	T	T E								T E				T E							T E		T E
Competence in collaboration and communication	Communicate in English in the own domain.	T 15 E 15	T E		T E	T E	T E				T E	T E	T E	T E		T E		T E	T E			T E	T E				T E	T E
	Work in a project driven way: formulating goals and focused reporting , taking into account the end goals, the development trajectory and the background of the vocational field (bioinformaticians, biologists, clinicians, statisticians, computer scientists).	T 5 E 4	T E				T E											T E				T E						T
	Function as a member of a team in a multidisciplinary environment and as starting manager.	T 5 E 5	T E		T E		T E											T E										T E
	Oral, written and graphical reporting on a scientific topic and placing it in a broader framework.	T 7 E 6					T E						T E					T E	T E			T E		T				T E
Competence in social responsibility	Having an insight in the ethical questions raised by the fastly evolving domain of bioinformatics and systems biology (persona lized medicine, successful aging , sustainable agriculture, synthetic biology , …).	T 4 E 4		T E		T E	T E																					T E
	Being aware of the social and bioethical discussions that relate to the data and the analysis results.	T 3 E 2		T E		T									T E													
	Taking into account the running ethical norms in scientific research (e.g. dealing with patient data).	T 4 E 2		T E		T													T			T E						
Professional competences	Gaining insight into the complexity of the problem with quantitative methods.	T 9 E 8		T E			T E			T E			T E					T E	T E			T E		T				T E
	Formalize a biological problem taking into account the properties of the data and the assumptions of the method.	T 4 E 4	T E				T E															T E						T E
	Extract useful infor mation from abun dant, incomplete and contradictory data.	T 10 E 9		T E			T E				T E	T E		T E				T E	T E				T E	T				T E
	Test the results of complex calculations and approximations.	T 5 E 4					T E							T E				T E						T				T E
	Have attention for running times, performance, memory requirements and user-friendliness of the algorithms and bioinformatics tools.	T 9 E 8					T E			T E	T E	T E		T E		T E							T E	T				T E
	Have attention for aspects such as reliability and confidence during storage and transmissions of big data.	T 5 E 2					T							T E				T E	T									T

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Legend:
T=teaching methods
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Professional competences	Having an insight in the understanding and role of entrepreneurship.	T 2 E 1					T E																				T
	Show attitude of perseverance, innovation and added value creation.	T 5 E 5					T E					T E		T E					T E								T E
	Plan and execute in an independent and results-driven way an engineering project at the level of a beginning professional.	T 3 E 3		T E			T E																				T E
			W 8 E 8	W 16 E 16	W 8 E 7	W 16 E 11	W 23 E 22			W 9 E 9	W 5 E 5	W 6 E 6	W 7 E 7	W 12 E 12	W 3 E 3	W 7 E 7		W 13 E 12	W 11 E 9			W 10 E 10	W 5 E 5	W 8		W 3 E 3	W 5 E 5	W 23 E 20

<< CMBIOI1.1 Having advanced knowledge of mathematics, informatics, machine learning and statistical techniques and their application within bioinformatics and systems biology.

Competence in one or more scientific disciplines

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003694 Statistical Genomics	group work seminar: practical PC room classes lecture	written examination with open questions report	Extract information on the statistical algorithms in high-throughput data analysis pipelines from research papers. Choose statistical methods that are appropriate for a) assessing biological/biomedical research questions using 'omics data and b) the data characteristics of specific high-troughput technologies. Critically evaluate and interpret statistical methods used in primary research articles. Port statistical concepts introduced in the lecture to other high-throughput platforms and/or applications. Assess statistical significance in the context of multipe testing. Preprocess, analyze, visualize and interpret 'omics experiments using existing statistical data-analysis pipelines and software. Identify different sources of variability in high-throughput 'omics experiments.
C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Knowledge of the different steps of the full omics analytical pipeline and how they are linked in a multidisciplinary fashion.
C004000 Integrative Biology	lecture seminar: practical PC room classes	open book examination	Being able to construct a model to understand a complex biological problem. Being able to implement a tool given the description in a paper. Understanding the concepts of network inference, motif detection, data integration. Recognize analysis techniques underlying bioinformatics tools.
E061330 Machine Learning	guided self-study lecture	participation report	Understand and critically evaluate the techniques presented in scientific literature on machine learning. Understand the fundamental principles and challenges of machine learning. Analyse a new machine learning problem and address it by correctly applying the principles of machine learning and selecting suitable common machine learning models. Implement simple machine learning models and correctly apply machine learning libraries for more advanced techniques. Understand the mathematical background of some common and advanced machine learning models.
E004120 Optimisation Techniques	guided self-study seminar: coached exercises project lecture	written examination report open book examination	Understanding concepts such as relaxation, dualisation of constraints, partial solutions... Having insight into the possible solutions and the possible locations of optima. Having insight into algorithms and the conditions under which they can be applied. Being able to develop an algorithm starting from basic principles.
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	written examination report	Know and apply principles of logic deduction and reasoning, and techniques for action planning. Know and apply principles of reasoning under uncertainty, using Bayesian networks and other graphical models, including Hidden Markov Models and dynamic networks. Know and apply basic principles of inductive learning and reasoning. Understand and apply basic principles of reinforcement learning and understand how these lead to the design of rational autonomous agents. Know and apply search strategies for complex problem solving. Structure and represent knowledge with predicates, rules, description logic. Make rational decisions by combining probability and utility theories.
F000918 Deep Learning	group work seminar: practical PC room classes lecture	written examination with open questions report assignment participation	Understand the structure and properties of basic neural network types (fully connected, convolutional, recurrent, dense) and their applications. **Only for 6 credits version:** Use Deep Learning with industrially relevant complex data (e.g., images, audio, video, text), applying state-of-the art techniques based on literature and online sources. Be able too systematically design and optimise of standard deep neural network architectures in Keras and analyse of their performance, reliability and robustness. Determine when and how to use Deep Learning for solving complex problems with economical relevance (marketing and/or R&D). Understand scientific literature about applications of Deep Learning. Validating the results of one's own research in comparison with the state-of-the-art for similar problems.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.

E003421 Estimation and Decision Techniques	guided self-study seminar: coached exercises lecture	written examination open book examination	Cast estimation or detection problems into a mathematical model. Weigh the pro's and con's of the different paradigms. Develop an intuitive feeling for the resulting solution. Determine (or approximate) the performance of receiver structures. Determine optimal receiver structures.
C003399 Computerintensive Statistical Methods	lecture		The student can use specialized software in order to correctly and efficiently perform statistical calculations, and to critically validate the conclusions obtained through this analysis. The student can report accurately on the design, conduct, analysis, and conclusions of statistical studies. Have advanced knowledge of a wide range of computer intensive statistical methods for designing studies and analysing data. The student can express clearly the assumptions on which conclusions are based, by performing a Monte Carlo study that systematically and critically investigates the assumptions underlying the analysis approach.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Understanding the application domains of high-throughput omics research, the generation of these data and the implications regarding bias and variance.
C004000 Integrative Biology	lecture	written examination	Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis.
E074011 Quantitative Cell and Tissue Analysis	lecture online lecture online discussion group microteaching	written examination	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Knowledge of the different steps of the full omics analytical pipeline and how they are linked in a multidisciplinary fashion.
C003696 Genome Biology	lecture seminar: practical PC room classes	written examination with open questions peer assessment assignment	Overview of the most important computational methods for sequence/genome analysis. Communication in an interdisciplinary context. Understanding bioinformatics as a fastly evolving discipline. Critical reading of state of the art literature. Recognize analysis techniques underlying bioinformatics tools. Functioning as member if a team in a multidisciplinary environment. Being able to independently read and analyse a genomics paper that combines biological results with advanced data-analysis. Being able to apply the most important computational methods (understanding their background and understanding why they are being used).
C004000 Integrative Biology	lecture	written examination open book examination	Being able to construct a model to understand a complex biological problem. Functioning as a member of a multidisciplinaire environment. Communication in an interdisciplinary context. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline. Being able to apply a tool given the available documentation and literature. Being able to implement a tool given the description in a paper. Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis. Understanding the concepts of network inference, motif detection, data integration. Recognize analysis techniques underlying bioinformatics tools. Being aware of ethical and confidentionality aspects of some bioinformatics applications.
C003711 Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
C003713 Introduction to Bioinformatics	lecture	written examination with open questions	To recognize that bioinformatics is an interdisciplinary field.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003694 Statistical Genomics	group work seminar: practical PC room classes	written examination with open questions report	Correctly interpret and report the analysis results. Formulate the conclusions of the data analysis with respect to the subject matter research question. Choose statistical methods that are appropriate for a) assessing biological/biomedical research questions using ‘omics data and b) the data characteristics of specific high-troughput technologies. Port statistical concepts introduced in the lecture to other high-throughput platforms and/or applications. Assess statistical significance in the context of multipe testing. Preprocess, analyze, visualize and interpret ‘omics experiments using existing statistical data-analysis pipelines and software. Identify different sources of variability in high-throughput ‘omics experiments. Extract information on the statistical algorithms in high-throughput data analysis pipelines from research papers.
C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Apply fundamental knowledge of different subdomains (statistics, (bio)informatics) to plan and perform a complex data-analytical project at a professional level, taking into account financial, computational and other limitations.
C004000 Integrative Biology	lecture seminar: practical PC room classes		Recognize analysis techniques underlying bioinformatics tools. Understanding the concepts of network inference, motif detection, data integration.
E061330 Machine Learning	guided self-study lecture	participation report	Implement simple machine learning models and correctly apply machine learning libraries for more advanced techniques. Understand the fundamental principles and challenges of machine learning. Analyse a new machine learning problem and address it by correctly applying the principles of machine learning and selecting suitable common machine learning models.
E004120 Optimisation Techniques	guided self-study seminar: coached exercises project lecture	written examination report open book examination	Understanding concepts such as relaxation, dualisation of constraints, partial solutions... Having insight into the possible solutions and the possible locations of optima. Having insight into algorithms and the conditions under which they can be applied. Being able to develop an algorithm starting from basic principles.
E034140 Parallel Computer Systems	lecture seminar: coached exercises	written examination report open book examination	Understand and be able to describe the architecture and their impact on performance of superscalar processor architectures, shared-memory multiprocessors, multi-threading, datacenters, supercomputers. Understand and be able to describe the impact of technology on parallel computer systems.
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	written examination report	Know and apply principles of logic deduction and reasoning, and techniques for action planning. Know and apply principles of reasoning under uncertainty, using Bayesian networks and other graphical models, including Hidden Markov Models and dynamic networks. Know and apply basic principles of inductive learning and reasoning. Understand and apply basic principles of reinforcement learning and understand how these lead to the design of rational autonomous agents. Know and apply search strategies for complex problem solving. Structure and represent knowledge with predicates, rules, description logic. Make rational decisions by combining probability and utility theories.
E061340 Machine-learning Based Natural Language Processing	lecture practicum	written examination report	Implement and evaluate an NLP application using Python Know the basic NLP tasks and the methods to address them (e.g., text preprocessing, language modeling, parsing, sequence tagging, text classification, sequence-to-sequence tasks) Explain, apply and evaluate methods for NLP-based applications such as named entity recognition, machine translation, sentence classification, and information extraction. Explain and understand various types (e.g., intrinsic vs extrinsic) and measures of evaluation. Have insight in models for NLP problems based on learned representations (such as word embeddings) and neural network building blocks.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
E003421 Estimation and Decision Techniques	guided self-study seminar: coached exercises lecture	written examination open book examination	Cast estimation or detection problems into a mathematical model. Weigh the pro's and con's of the different paradigms. Develop an intuitive feeling for the resulting solution. Determine (or approximate) the performance of receiver structures. Determine optimal receiver structures.
C003399 Computerintensive Statistical Methods	lecture		The student can use specialized software in order to correctly and efficiently perform statistical calculations, and to critically validate the conclusions obtained through this analysis. The student can report accurately on the design, conduct, analysis, and conclusions of statistical studies. Have advanced knowledge of a wide range of computer intensive statistical methods for designing studies and analysing data. The student can express clearly the assumptions on which conclusions are based, by performing a Monte Carlo study that systematically and critically investigates the assumptions underlying the analysis approach.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003696 Genome Biology	lecture seminar: practical PC room classes	written examination with open questions peer assessment assignment	Overview of the most important computational methods for sequence/genome analysis. Communication in an interdisciplinary context. Understanding bioinformatics as a fastly evolving discipline. Critical reading of state of the art literature. Recognize analysis techniques underlying bioinformatics tools. Functioning as member if a team in a multidisciplinary environment. Being able to independently read and analyse a genomics paper that combines biological results with advanced data-analysis. Being able to apply the most important computational methods (understanding their background and understanding why they are being used).
C004000 Integrative Biology	lecture	written examination open book examination	Being able to construct a model to understand a complex biological problem. Critical reading attitude towards the domain. Being able to apply a tool given the available documentation and literature. Being able to implement a tool given the description in a paper. Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis. Understanding the concepts of network inference, motif detection, data integration. Recognize analysis techniques underlying bioinformatics tools.
C003711 Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
E061340 Machine-learning Based Natural Language Processing	lecture	written examination	Have insight in models for NLP problems based on learned representations (such as word embeddings) and neural network building blocks. Know the basic NLP tasks and the methods to address them (e.g., text preprocessing, language modeling, parsing, sequence tagging, text classification, sequence-to-sequence tasks) Explain, apply and evaluate methods for NLP-based applications such as named entity recognition, machine translation, sentence classification, and information extraction. Explain and understand various types (e.g., intrinsic vs extrinsic) and measures of evaluation.
C003713 Introduction to Bioinformatics	lecture seminar: practical PC room classes	written examination with open questions	To be able to apply the most important sequence alignment techniques. To know the most important problems in bioinformatics and their applications. To know the most important biological databases.

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003695 Applied High-throughput Analysis	lecture	open book examination oral examination	Have insight into the fast evolution of omics technologies and associated required bioinformatics solutions, and how this will/may have major implications for society for several important application domains such as medicine, food production and ecology.
C003696 Genome Biology	lecture seminar: practical PC room classes	written examination with open questions peer assessment assignment	Overview of the most important computational methods for sequence/genome analysis. Communication in an interdisciplinary context. Understanding bioinformatics as a fastly evolving discipline. Critical reading of state of the art literature. Recognize analysis techniques underlying bioinformatics tools. Functioning as member if a team in a multidisciplinary environment. Being able to independently read and analyse a genomics paper that combines biological results with advanced data-analysis. Being able to apply the most important computational methods (understanding their background and understanding why they are being used).
C004000 Integrative Biology	lecture	written examination open book examination	Being aware of ethical and confidentionality aspects of some bioinformatics applications. Functioning as a member of a multidisciplinaire environment. Communication in an interdisciplinary context. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline. Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).

Course		Teaching methods	Evaluation methods	Course learning outcome
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C003711	Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
E016330	Artificial Intelligence	seminar: practical PC room classes	report	Make rational decisions by combining probability and utility theories. Know and apply principles of reasoning under uncertainty, using Bayesian networks and other graphical models, including Hidden Markov Models and dynamic networks. Know and apply basic principles of inductive learning and reasoning. Understand and apply basic principles of reinforcement learning and understand how these lead to the design of rational autonomous agents. Know and apply search strategies for complex problem solving.
E061340	Machine-learning Based Natural Language Processing	practicum	report	Implement and evaluate an NLP application using Python
E003600	Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003711 Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
E034140 Parallel Computer Systems	lecture seminar: coached exercises	written examination report open book examination	Understand and be able to describe the architecture and their impact on performance of superscalar processor architectures, shared-memory multiprocessors, multi-threading, datacenters, supercomputers. Understand and be able to describe the impact of technology on parallel computer systems.
E016330 Artificial Intelligence	lecture	written examination	Know and apply principles of logic deduction and reasoning, and techniques for action planning. Know and apply search strategies for complex problem solving. Structure and represent knowledge with predicates, rules, description logic.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Understanding the application domains of high-throughput omics research, the generation of these data and the implications regarding bias and variance.
C004000 Integrative Biology	lecture online seminar: coached exercises online lecture seminar: practical PC room classes	written examination report open book examination	Being able to construct a model to understand a complex biological problem. Functioning as a member of a multidisciplinaire environment. Communication in an interdisciplinary context. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline. Being able to apply a tool given the available documentation and literature. Being able to implement a tool given the description in a paper. Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis. Understanding the concepts of network inference, motif detection, data integration. Recognize analysis techniques underlying bioinformatics tools. Being aware of ethical and confidentionality aspects of some bioinformatics applications.
C003713 Introduction to Bioinformatics	lecture seminar: practical PC room classes	written examination with open questions	To know the most important biological concepts. To know the most important problems in bioinformatics and their applications.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E074011 Quantitative Cell and Tissue Analysis	demonstration online lecture practicum online discussion group microteaching lecture	written examination report participation	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes
C003712 Cellular and Molecular Biology	lecture microteaching	written examination	Broad knowledge of cell biology, molecular biology and genetics. Communication skills in English. Positive attitude toward lifelong learning. To be able absorb knowledge of an unfamiliar domain in an independent way.
C003713 Introduction to Bioinformatics	lecture	written examination with open questions	To know the most important biological concepts.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C004000 Integrative Biology	seminar: practical PC room classes online seminar: coached exercises	written examination report open book examination	Being able to implement a tool given the description in a paper. Critical reading attitude towards the domain. Being able to apply a tool given the available documentation and literature.
C003698 Design Project	PDE tutorial project	assignment	Design and implement new concepts in an independent fashion; Being able to learn new things in an independent manner, using scientific literature;
C003711 Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to carry out a critical literature study; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies;

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003698 Design Project	PDE tutorial project	assignment	Design and implement new concepts in an independent fashion;
C003711 Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture		Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to carry out a critical literature study; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies;

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003698 Design Project	PDE tutorial project	assignment	Analysis and interpretation of results;
C003711 Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
E034140 Parallel Computer Systems	lecture seminar: coached exercises	report	Understand and be able to describe the architecture and their impact on performance of superscalar processor architectures, shared-memory multiprocessors, multi-threading, datacenters, supercomputers. Understand and be able to describe the impact of technology on parallel computer systems.
E061340 Machine-learning Based Natural Language Processing	practicum	report	Implement and evaluate an NLP application using Python
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to carry out a critical literature study; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies;

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	To critically select and evaluate methods for high-throughput data-analysis. Critical selection, evaluation and application of methods for high-throughput data (pre) processing.
C003696 Genome Biology	lecture seminar: practical PC room classes	written examination with open questions peer assessment assignment	Overview of the most important computational methods for sequence/genome analysis. Communication in an interdisciplinary context. Understanding bioinformatics as a fastly evolving discipline. Critical reading of state of the art literature. Recognize analysis techniques underlying bioinformatics tools. Functioning as member if a team in a multidisciplinary environment. Being able to independently read and analyse a genomics paper that combines biological results with advanced data-analysis. Being able to apply the most important computational methods (understanding their background and understanding why they are being used).
C003698 Design Project	PDE tutorial project	assignment	Formalization of a complex biological problem;
E074011 Quantitative Cell and Tissue Analysis	demonstration online lecture practicum online discussion group microteaching lecture	written examination report participation	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes
C003713 Introduction to Bioinformatics	lecture seminar: practical PC room classes	written examination with open questions	To be able to apply the most important sequence alignment techniques. To recognize that bioinformatics is an interdisciplinary field. To know the most important problems in bioinformatics and their applications. To be able to recognize certain biological problems and the appropriate bioinformatics tool to solve it. To know the most important biological concepts. To know the most important biological databases.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to carry out a critical literature study; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies;

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003698 Design Project	PDE tutorial project	assignment	Analysis and interpretation of results;
E074011 Quantitative Cell and Tissue Analysis	demonstration online lecture practicum online discussion group microteaching lecture	written examination report participation	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Divide the omics analytical pipeline into separate steps and critically select the most appropriate methodology to solve each of these steps, taking into account both the practical applicability and the limitations/consequences of each methodology.
C003696 Genome Biology	lecture seminar: practical PC room classes	written examination with open questions peer assessment assignment	Overview of the most important computational methods for sequence/genome analysis. Communication in an interdisciplinary context. Understanding bioinformatics as a fastly evolving discipline. Critical reading of state of the art literature. Recognize analysis techniques underlying bioinformatics tools. Functioning as member if a team in a multidisciplinary environment. Being able to independently read and analyse a genomics paper that combines biological results with advanced data-analysis. Being able to apply the most important computational methods (understanding their background and understanding why they are being used).
C004000 Integrative Biology	lecture seminar: practical PC room classes	written examination open book examination	Being able to construct a model to understand a complex biological problem. Functioning as a member of a multidisciplinaire environment. Communication in an interdisciplinary context. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline. Being able to apply a tool given the available documentation and literature. Being able to implement a tool given the description in a paper. Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis. Understanding the concepts of network inference, motif detection, data integration. Recognize analysis techniques underlying bioinformatics tools. Being aware of ethical and confidentionality aspects of some bioinformatics applications.
C003698 Design Project	PDE tutorial project	assignment	Subdivision of complex problems in bioinformatics;
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	written examination report	Know and apply search strategies for complex problem solving.
E061340 Machine-learning Based Natural Language Processing	lecture practicum	written examination report	Explain and understand various types (e.g., intrinsic vs extrinsic) and measures of evaluation. Know the basic NLP tasks and the methods to address them (e.g., text preprocessing, language modeling, parsing, sequence tagging, text classification, sequence-to-sequence tasks)
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Divide the omics analytical pipeline into separate steps and critically select the most appropriate methodology to solve each of these steps, taking into account both the practical applicability and the limitations/consequences of each methodology.
C004000 Integrative Biology	lecture seminar: practical PC room classes		Being able to construct a model to understand a complex biological problem. Functioning as a member of a multidisciplinaire environment. Communication in an interdisciplinary context. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline. Being able to apply a tool given the available documentation and literature. Being able to implement a tool given the description in a paper. Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis. Understanding the concepts of network inference, motif detection, data integration. Recognize analysis techniques underlying bioinformatics tools. Being aware of ethical and confidentionality aspects of some bioinformatics applications.
C003698 Design Project	PDE tutorial project	assignment	Formalization of a complex biological problem; Solving part of the problem by using a combination of methods and material described in scientific literature;
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003694 Statistical Genomics	group work seminar: practical PC room classes lecture	written examination with open questions report	Critically evaluate and interpret statistical methods used in primary research articles. Choose statistical methods that are appropriate for a) assessing biological/biomedical research questions using 'omics data and b) the data characteristics of specific high-troughput technologies.
C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Divide the omics analytical pipeline into separate steps and critically select the most appropriate methodology to solve each of these steps, taking into account both the practical applicability and the limitations/consequences of each methodology.
C004000 Integrative Biology	lecture seminar: practical PC room classes	written examination open book examination	Being able to construct a model to understand a complex biological problem. Functioning as a member of a multidisciplinaire environment. Communication in an interdisciplinary context. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline. Being able to apply a tool given the available documentation and literature. Being able to implement a tool given the description in a paper. Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis. Understanding the concepts of network inference, motif detection, data integration. Recognize analysis techniques underlying bioinformatics tools. Being aware of ethical and confidentionality aspects of some bioinformatics applications.
C003698 Design Project	PDE tutorial project	assignment	Formalization of a complex biological problem; Solving part of the problem by using a combination of methods and material described in scientific literature;
E034140 Parallel Computer Systems	lecture seminar: coached exercises	written examination report open book examination	Understand and be able to describe the architecture and their impact on performance of superscalar processor architectures, shared-memory multiprocessors, multi-threading, datacenters, supercomputers. Understand and be able to describe the impact of technology on parallel computer systems.
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	written examination report	Make rational decisions by combining probability and utility theories. Know and apply basic principles of inductive learning and reasoning. Understand and apply basic principles of reinforcement learning and understand how these lead to the design of rational autonomous agents. Know and apply search strategies for complex problem solving.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
C003399 Computerintensive Statistical Methods	lecture		The student can use specialized software in order to correctly and efficiently perform statistical calculations, and to critically validate the conclusions obtained through this analysis. The student can report accurately on the design, conduct, analysis, and conclusions of statistical studies. Have advanced knowledge of a wide range of computer intensive statistical methods for designing studies and analysing data. The student can express clearly the assumptions on which conclusions are based, by performing a Monte Carlo study that systematically and critically investigates the assumptions underlying the analysis approach.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003694 Statistical Genomics	group work lecture	report	Extract information on the statistical algorithms in high-throughput data analysis pipelines from research papers.
C003696 Genome Biology	lecture seminar: practical PC room classes		Overview of the most important computational methods for sequence/genome analysis. Communication in an interdisciplinary context. Understanding bioinformatics as a fastly evolving discipline. Critical reading of state of the art literature. Recognize analysis techniques underlying bioinformatics tools. Functioning as member if a team in a multidisciplinary environment. Being able to independently read and analyse a genomics paper that combines biological results with advanced data-analysis. Being able to apply the most important computational methods (understanding their background and understanding why they are being used).
C004000 Integrative Biology	lecture seminar: practical PC room classes		Being able to construct a model to understand a complex biological problem. Functioning as a member of a multidisciplinaire environment. Communication in an interdisciplinary context. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline. Being able to apply a tool given the available documentation and literature. Being able to implement a tool given the description in a paper. Being able to independently read and analyse a systems biology paper that combines biological results with advanced data-analysis. Understanding the concepts of network inference, motif detection, data integration. Recognize analysis techniques underlying bioinformatics tools. Being aware of ethical and confidentionality aspects of some bioinformatics applications.
C003698 Design Project	PDE tutorial project	assignment	Being able to learn new things in an independent manner, using scientific literature;
F000918 Deep Learning	group work	participation assignment	**Only for 6 credits version:** Use Deep Learning with industrially relevant complex data (e.g., images, audio, video, text), applying state-of-the art techniques based on literature and online sources.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
C003712 Cellular and Molecular Biology	lecture microteaching	written examination	Broad knowledge of cell biology, molecular biology and genetics. Communication skills in English. Positive attitude toward lifelong learning. To be able absorb knowledge of an unfamiliar domain in an independent way.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003694 Statistical Genomics	group work seminar: practical PC room classes	report	Correctly interpret and report the analysis results. Formulate the conclusions of the data analysis with respect to the subject matter research question.
C003696 Genome Biology	lecture seminar: practical PC room classes	written examination with open questions peer assessment assignment	Overview of the most important computational methods for sequence/genome analysis. Communication in an interdisciplinary context. Understanding bioinformatics as a fastly evolving discipline. Critical reading of state of the art literature. Recognize analysis techniques underlying bioinformatics tools. Functioning as member if a team in a multidisciplinary environment. Being able to independently read and analyse a genomics paper that combines biological results with advanced data-analysis. Being able to apply the most important computational methods (understanding their background and understanding why they are being used).
C004000 Integrative Biology	lecture	written examination	Communication in an interdisciplinary context. Functioning as a member of a multidisciplinaire environment.
C003698 Design Project	PDE tutorial project	assignment	Communication in English;
E061330 Machine Learning	guided self-study lecture	participation report	Understand and critically evaluate the techniques presented in scientific literature on machine learning. Understand the fundamental principles and challenges of machine learning. Analyse a new machine learning problem and address it by correctly applying the principles of machine learning and selecting suitable common machine learning models. Implement simple machine learning models and correctly apply machine learning libraries for more advanced techniques. Understand the mathematical background of some common and advanced machine learning models.
E004120 Optimisation Techniques	guided self-study seminar: coached exercises project lecture	written examination report open book examination	Understanding concepts such as relaxation, dualisation of constraints, partial solutions... Having insight into the possible solutions and the possible locations of optima. Having insight into algorithms and the conditions under which they can be applied. Being able to develop an algorithm starting from basic principles.
E034140 Parallel Computer Systems	lecture seminar: coached exercises	written examination report open book examination	Understand and be able to describe the architecture and their impact on performance of superscalar processor architectures, shared-memory multiprocessors, multi-threading, datacenters, supercomputers. Understand and be able to describe the impact of technology on parallel computer systems.
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	written examination report	Know and apply principles of logic deduction and reasoning, and techniques for action planning. Know and apply principles of reasoning under uncertainty, using Bayesian networks and other graphical models, including Hidden Markov Models and dynamic networks. Know and apply basic principles of inductive learning and reasoning. Understand and apply basic principles of reinforcement learning and understand how these lead to the design of rational autonomous agents. Know and apply search strategies for complex problem solving. Structure and represent knowledge with predicates, rules, description logic. Make rational decisions by combining probability and utility theories.
E061340 Machine-learning Based Natural Language Processing	lecture practicum	written examination report	Implement and evaluate an NLP application using Python Know the basic NLP tasks and the methods to address them (e.g., text preprocessing, language modeling, parsing, sequence tagging, text classification, sequence-to-sequence tasks) Explain, apply and evaluate methods for NLP-based applications such as named entity recognition, machine translation, sentence classification, and information extraction. Explain and understand various types (e.g., intrinsic vs extrinsic) and measures of evaluation. Have insight in models for NLP problems based on learned representations (such as word embeddings) and neural network building blocks.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
E074011 Quantitative Cell and Tissue Analysis	demonstration online lecture practicum online discussion group microteaching lecture	written examination report participation	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes
E003421 Estimation and Decision Techniques	guided self-study seminar: coached exercises lecture	written examination open book examination	Cast estimation or detection problems into a mathematical model. Weigh the pro's and con's of the different paradigms. Develop an intuitive feeling for the resulting solution. Determine (or approximate) the performance of receiver structures. Determine optimal receiver structures.
C003712 Cellular and Molecular Biology	lecture microteaching	written examination	Broad knowledge of cell biology, molecular biology and genetics. Communication skills in English. Positive attitude toward lifelong learning. To be able absorb knowledge of an unfamiliar domain in an independent way.

C003720	Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003694 Statistical Genomics	group work	report	Correctly interpret and report the analysis results. Formulate the conclusions of the data analysis with respect to the subject matter research question. Choose statistical methods that are appropriate for a) assessing biological/biomedical research questions using 'omics data and b) the data characteristics of specific high-troughput technologies. Critically evaluate and interpret statistical methods used in primary research articles. Port statistical concepts introduced in the lecture to other high-throughput platforms and/or applications. Preprocess, analyze, visualize and interpret 'omics experiments using existing statistical data-analysis pipelines and software. Extract information on the statistical algorithms in high-throughput data analysis pipelines from research papers.
C003698 Design Project	PDE tutorial project	assignment	Basic project management skills: formulation of goals, reporting, end goals and methodological trajectory;
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
E074011 Quantitative Cell and Tissue Analysis	demonstration practicum microteaching	participation report	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes
C003720 Master's Dissertation	master's dissertation		The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003694 Statistical Genomics	group work	report	Correctly interpret and report the analysis results. Formulate the conclusions of the data analysis with respect to the subject matter research question. Choose statistical methods that are appropriate for a) assessing biological/biomedical research questions using 'omics data and b) the data characteristics of specific high-troughput technologies. Critically evaluate and interpret statistical methods used in primary research articles. Port statistical concepts introduced in the lecture to other high-throughput platforms and/or applications. Preprocess, analyze, visualize and interpret 'omics experiments using existing statistical data-analysis pipelines and software. Extract information on the statistical algorithms in high-throughput data analysis pipelines from research papers.
C003696 Genome Biology	lecture seminar: practical PC room classes	written examination with open questions peer assessment assignment	Overview of the most important computational methods for sequence/genome analysis. Communication in an interdisciplinary context. Understanding bioinformatics as a fastly evolving discipline. Critical reading of state of the art literature. Recognize analysis techniques underlying bioinformatics tools. Functioning as member if a team in a multidisciplinary environment. Being able to independently read and analyse a genomics paper that combines biological results with advanced data-analysis. Being able to apply the most important computational methods (understanding their background and understanding why they are being used).
C003698 Design Project	PDE tutorial project	assignment peer assessment	Functioning as part of team in a multidisciplinary environment and initial management skills;
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003698 Design Project	PDE tutorial project	assignment	Written, oral and graphical reporting on a technical or scientific subject;
E034140 Parallel Computer Systems	lecture seminar: coached exercises	written examination report open book examination	Understand and be able to describe the architecture and their impact on performance of superscalar processor architectures, shared-memory multiprocessors, multi-threading, datacenters, supercomputers. Understand and be able to describe the impact of technology on parallel computer systems.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
E074011 Quantitative Cell and Tissue Analysis	demonstration online lecture practicum online discussion group microteaching lecture	written examination report participation	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes
C003399 Computerintensive Statistical Methods	lecture		The student can use specialized software in order to correctly and efficiently perform statistical calculations, and to critically validate the conclusions obtained through this analysis. The student can report accurately on the design, conduct, analysis, and conclusions of statistical studies. Have advanced knowledge of a wide range of computer intensive statistical methods for designing studies and analysing data. The student can express clearly the assumptions on which conclusions are based, by performing a Monte Carlo study that systematically and critically investigates the assumptions underlying the analysis approach.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003695 Applied High-throughput Analysis	lecture	open book examination assignment oral examination	Have insight into the fast evolution of omics technologies and associated required bioinformatics solutions, and how this will/may have major implications for society for several important application domains such as medicine, food production and ecology.
C004000 Integrative Biology	lecture seminar: practical PC room classes	written examination open book examination	Being aware of ethical and confidentionality aspects of some bioinformatics applications. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline.
C003698 Design Project	PDE tutorial project	assignment peer assessment	Communication in English; Being able to learn new things in an independent manner, using scientific literature; Mindset towards valorization; Analysis and interpretation of results; Design and implement new concepts in an independent fashion; Solving part of the problem by using a combination of methods and material described in scientific literature; Formalization of a complex biological problem; Subdivision of complex problems in bioinformatics; Written, oral and graphical reporting on a technical or scientific subject; Functioning as part of team in a multidisciplinary environment and initial management skills; Basic project management skills: formulation of goals, reporting, end goals and methodological trajectory;
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003695 Applied High-throughput Analysis	lecture	open book examination oral examination	Have insight into the fast evolution of omics technologies and associated required bioinformatics solutions, and how this will/may have major implications for society for several important application domains such as medicine, food production and ecology.
C004000 Integrative Biology	lecture		Being able to construct a model to understand a complex biological problem. Critical reading attitude towards the domain. Understanding bioinformatics is a fastly evolving discipline. Being aware of ethical and confidentionality aspects of some bioinformatics applications.
F000918 Deep Learning	lecture seminar: practical PC room classes	report	Determine when and how to use Deep Learning for solving complex problems with economical relevance (marketing and/or R&D). Be able too systematically design and optimise of standard deep neural network architectures in Keras and analyse of their performance, reliability and robustness.

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C003695 Applied High-throughput Analysis	lecture	open book examination oral examination	Have insight into the fast evolution of omics technologies and associated required bioinformatics solutions, and how this will/may have major implications for society for several important application domains such as medicine, food production and ecology.
C004000 Integrative Biology	lecture		Being aware of ethical and confidentionality aspects of some bioinformatics applications.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture		Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
E074011 Quantitative Cell and Tissue Analysis	demonstration online lecture practicum online discussion group microteaching lecture	written examination report participation	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes

Course	Teaching methods	Evaluation methods	Course learning outcome
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C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Infer knowledge from complex high-throughput data using quantitative methods.
C003698 Design Project	PDE tutorial project	assignment	Formalization of a complex biological problem;
C003711 Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
E034140 Parallel Computer Systems	lecture seminar: coached exercises	report	Understand and be able to describe the architecture and their impact on performance of superscalar processor architectures, shared-memory multiprocessors, multi-threading, datacenters, supercomputers. Understand and be able to describe the impact of technology on parallel computer systems.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
E074011 Quantitative Cell and Tissue Analysis	demonstration online lecture practicum online discussion group microteaching lecture	written examination report participation	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes
C003399 Computerintensive Statistical Methods	lecture		The student can use specialized software in order to correctly and efficiently perform statistical calculations, and to critically validate the conclusions obtained through this analysis. The student can report accurately on the design, conduct, analysis, and conclusions of statistical studies. Have advanced knowledge of a wide range of computer intensive statistical methods for designing studies and analysing data. The student can express clearly the assumptions on which conclusions are based, by performing a Monte Carlo study that investigates the assumptions underlying the analysis approach.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003694 Statistical Genomics	group work seminar: practical PC room classes lecture	written examination with open questions report	Correctly interpret and report the analysis results. Formulate the conclusions of the data analysis with respect to the subject matter research question. Choose statistical methods that are appropriate for a) assessing biological/biomedical research questions using ‘omics data and b) the data characteristics of specific high-troughput technologies. Port statistical concepts introduced in the lecture to other high-throughput platforms and/or applications.
C003698 Design Project	PDE tutorial project	assignment	Formalization of a complex biological problem;
E074011 Quantitative Cell and Tissue Analysis	demonstration online lecture practicum online discussion group microteaching lecture	written examination report participation	Understand the working principles of techniques to culture cells and tissues Understand the relation between cell composition and cell function as inferred from the above mentioned technique Understand various quantitative techniques for the quantitative analysis of cell morphology, cell properties, structure and function and be able to apply quantitative analysis Understanding of histology and histological techniques and being able to interpret histological coupes
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003695 Applied High-throughput Analysis	lecture seminar: practical PC room classes	open book examination assignment oral examination	Infer knowledge from complex high-throughput data using quantitative methods.
C003698 Design Project	PDE tutorial project	assignment	Analysis and interpretation of results;
E061330 Machine Learning	guided self-study lecture	participation report	Implement simple machine learning models and correctly apply machine learning libraries for more advanced techniques. Understand the fundamental principles and challenges of machine learning. Analyse a new machine learning problem and address it by correctly applying the principles of machine learning and selecting suitable common machine learning models.
E004120 Optimisation Techniques	guided self-study seminar: coached exercises project lecture	written examination report open book examination	Understanding concepts such as relaxation, dualisation of constraints, partial solutions... Having insight into the possible solutions and the possible locations of optima. Having insight into algorithms and the conditions under which they can be applied. Being able to develop an algorithm starting from basic principles.
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	written examination report	Make rational decisions by combining probability and utility theories. Know and apply basic principles of inductive learning and reasoning. Know and apply search strategies for complex problem solving.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
E003421 Estimation and Decision Techniques	guided self-study seminar: coached exercises lecture	written examination open book examination	Cast estimation or detection problems into a mathematical model. Weigh the pro's and con's of the different paradigms. Develop an intuitive feeling for the resulting solution. Determine (or approximate) the performance of receiver structures. Determine optimal receiver structures.
C003399 Computerintensive Statistical Methods	lecture		The student can use specialized software in order to correctly and efficiently perform statistical calculations, and to critically validate the conclusions obtained through this analysis. The student can report accurately on the design, conduct, analysis, and conclusions of statistical studies. Have advanced knowledge of a wide range of computer intensive statistical methods for designing studies and analysing data. The student can express clearly the assumptions on which conclusions are based, by performing a Monte Carlo study that systematically and critically investigates the assumptions underlying the analysis approach.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003698 Design Project	PDE tutorial project	assignment peer assessment	Written, oral and graphical reporting on a technical or scientific subject; Being able to learn new things in an independent manner, using scientific literature; Mindset towards valorization; Analysis and interpretation of results; Design and implement new concepts in an independent fashion; Solving part of the problem by using a combination of methods and material described in scientific literature; Formalization of a complex biological problem; Subdivision of complex problems in bioinformatics;
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	written examination report	Make rational decisions by combining probability and utility theories. Know and apply principles of reasoning under uncertainty, using Bayesian networks and other graphical models, including Hidden Markov Models and dynamic networks. Know and apply basic principles of inductive learning and reasoning. Understand and apply basic principles of reinforcement learning and understand how these lead to the design of rational autonomous agents. Know and apply search strategies for complex problem solving.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
C003399 Computerintensive Statistical Methods	lecture		The student can use specialized software in order to correctly and efficiently perform statistical calculations, and to critically validate the conclusions obtained through this analysis. The student can report accurately on the design, conduct, analysis, and conclusions of statistical studies. Have advanced knowledge of a wide range of computer intensive statistical methods for designing studies and analysing data. The student can express clearly the assumptions on which conclusions are based, by performing a Monte Carlo study that systematically and critically investigates the assumptions underlying the analysis approach.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
C003698 Design Project	PDE tutorial project	assignment peer assessment	Communication in English; Being able to learn new things in an independent manner, using scientific literature; Mindset towards valorization; Analysis and interpretation of results; Design and implement new concepts in an independent fashion; Solving part of the problem by using a combination of methods and material described in scientific literature; Formalization of a complex biological problem; Subdivision of complex problems in bioinformatics; Written, oral and graphical reporting on a technical or scientific subject; Functioning as part of team in a multidisciplinary environment and initial management skills; Basic project management skills: formulation of goals, reporting, end goals and methodological trajectory;
C003711 Computational Challenges in Bioinformatics	lecture seminar: coached exercises self-reliant study activities project	open book examination report skills test	To understand the commonly used data structures and algorithms that are commonly used in bioinformatics applications. To understand the tradeoffs between performance, memory footprint and accuracy. To spend enough time on the design and the computational complexity evaluation prior to the actual implementation of software. To take into account the computational feasibility when critically assessing several algorithmic approaches. Being able to design advanced algorithms and software implementations based on standard data structures and algorithms. Being able to estimate the runtime and memory footprint based on the computational complexity of the underlying algorithm and the size of the problem. To understand the most important computationally intensive problems in bioinformatics and the existing solutions (or heuristics) to solve them.
E061330 Machine Learning	guided self-study lecture	participation report	Understand the mathematical background of some common and advanced machine learning models. Understand the fundamental principles and challenges of machine learning. Analyse a new machine learning problem and address it by correctly applying the principles of machine learning and selecting suitable common machine learning models. Implement simple machine learning models and correctly apply machine learning libraries for more advanced techniques.
E004120 Optimisation Techniques	guided self-study seminar: coached exercises project lecture	written examination report open book examination	Understanding concepts such as relaxation, dualisation of constraints, partial solutions... Having insight into the possible solutions and the possible locations of optima. Having insight into algorithms and the conditions under which they can be applied. Being able to develop an algorithm starting from basic principles.
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	report	Understand and apply basic principles of reinforcement learning and understand how these lead to the design of rational autonomous agents. Know and apply basic principles of inductive learning and reasoning.
E061340 Machine-learning Based Natural Language Processing	lecture practicum	written examination report	Have insight in models for NLP problems based on learned representations (such as word embeddings) and neural network building blocks. Explain, apply and evaluate methods for NLP-based applications such as named entity recognition, machine translation, sentence classification, and information extraction.
E003421 Estimation and Decision Techniques	guided self-study seminar: coached exercises lecture	written examination open book examination	Cast estimation or detection problems into a mathematical model. Weigh the pro's and con's of the different paradigms. Develop an intuitive feeling for the resulting solution. Determine (or approximate) the performance of receiver structures. Determine optimal receiver structures.
C003399 Computerintensive Statistical Methods	lecture		The student can use specialized software in order to correctly and efficiently perform statistical calculations, and to critically validate the conclusions obtained through this analysis. The student can report accurately on the design, conduct, analysis, and conclusions of statistical studies. Have advanced knowledge of a wide range of computer intensive statistical methods for designing studies and analysing data. The student can express clearly the assumptions on which conclusions are based, by performing a Monte Carlo study that systematically and critically investigates the assumptions underlying the analysis approach.
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003698 Design Project	PDE tutorial project		Communication in English; Being able to learn new things in an independent manner, using scientific literature; Mindset towards valorization; Analysis and interpretation of results; Design and implement new concepts in an independent fashion; Solving part of the problem by using a combination of methods and material described in scientific literature; Formalization of a complex biological problem; Subdivision of complex problems in bioinformatics; Written, oral and graphical reporting on a technical or scientific subject; Functioning as part of team in a multidisciplinary environment and initial management skills; Basic project management skills: formulation of goals, reporting, end goals and methodological trajectory;
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	written examination report	Make rational decisions by combining probability and utility theories. Know and apply principles of reasoning under uncertainty, using Bayesian networks and other graphical models, including Hidden Markov Models and dynamic networks. Know and apply search strategies for complex problem solving.
E003600 Information Theory	guided self-study seminar: coached exercises project lecture	open book examination report	Compute theoretical bounds for source and channel coding. Compute performance. Apply error detection and error correction for soft and hard decoding. Apply Viterbi decoding. Recognize the graphical representation of codes. Analyse hard and soft decoding. Compute the optimal quantizer. Use lossless and lossy source coding.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture		Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
C003720 Master's Dissertation	master's dissertation		The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003698 Design Project	PDE tutorial project	assignment	Mindset towards valorization;
C003720 Master's Dissertation	master's dissertation		The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003698 Design Project	PDE tutorial project	assignment	Basic project management skills: formulation of goals, reporting, end goals and methodological trajectory;
E004120 Optimisation Techniques	guided self-study seminar: coached exercises project lecture	written examination report open book examination	Understanding concepts such as relaxation, dualisation of constraints, partial solutions... Having insight into the possible solutions and the possible locations of optima. Having insight into algorithms and the conditions under which they can be applied. Being able to develop an algorithm starting from basic principles.
E016330 Artificial Intelligence	lecture seminar: practical PC room classes	report	Make rational decisions by combining probability and utility theories. Know and apply principles of reasoning under uncertainty, using Bayesian networks and other graphical models, including Hidden Markov Models and dynamic networks. Know and apply basic principles of inductive learning and reasoning. Understand and apply basic principles of reinforcement learning and understand how these lead to the design of rational autonomous agents. Know and apply search strategies for complex problem solving.
E019400 Information Security	guided self-study seminar: coached exercises project practicum lecture	open book examination report oral examination	Recognising the social and legal aspects of information security. Understanding security services (confidentiality, authentication, etc.). Using security mechanisms to achieve security functions. Recognising the complexity of achieving good information security. Estimating the necessary resources to crack cryptographic security mechanisms. Understanding the operation of security mechanisms (encryption, Firewall, biometry, etc.).
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);

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C003695 Applied High-throughput Analysis	seminar: practical PC room classes	assignment	Apply fundamental knowledge of different subdomains (statistics, (bio)informatics) to plan and perform a complex data-analytical project at a professional level, taking into account financial, computational and other limitations.
C003698 Design Project	PDE tutorial project	assignment	Basic project management skills: formulation of goals, reporting, end goals and methodological trajectory;
C003720 Master's Dissertation	master's dissertation	oral examination assignment participation	The student has to be able to define a research problem by translating a biological problem into an engineering problem; The student has to be able to argue in a well founded manner during the discussion. The student has to be able to give a clear oral presentation of the results of the work; The student has to be able to show the necessary independence, motivation, dedication and initiative while obtaining final competences 1-8, and function well within the research group while doing so; The student has to be able to draw up a final manuscript - scientific report; The student has to be able to make a concise synthesis in English; The student has to be able to process, analyze and interpret data (both from models, experiments or simulation studies) in a correct and critical way, taking into account both computational and biological aspects; critically evaluate the outcome of the data analysis and, where possible, compare with approximating predictions; The student has to be able to collect data meticulously, also from simulation studies; The student has to be able to carry out a critical literature study; The student has to be able to set up an appropriate methodology for the research questions (or product to be developed): split up the problem into the relevant subproblems, search for/select and implement the best suited principles/methods for these subproblems, or create novel tools and methods if necessary. Combine these tools/methods successfully to tackle the main research problem, taking into account the limitations and specific properties of the data (e.g. performace on large data sets, speed of transmission, confidentiality issues, statistical properties, ethical problems, ...). If different methods appear to be suitable, set up the appropriate simulation studies to evaluate the different (including newly developed) methods; The student has to be able to formulate clear research questions and/or desired properties of a certain bioinformatics product or service (if applicable);