English Title
Foundations of Business Data Analytics: Architectures, Statistics and Programming (T)

Course responsible:
Raghava Rao Mukkamala

Teacher(s):
Raghava Rao Mukkamala

Learning objectives
To achieve the grade 12, students should meet the following learning objectives with no or only minor mistakes or errors:

- Summarize different fundamental concepts, techniques and methods of big data processing
- Describe and analyse various architectures and platforms for big data processing
- Design and implement interactive programs using Python programming language using its appropriate linguistic features.
- Demonstrate understanding of imperative, declarative and object oriented language features of Python language and know when it is appropriate to use each.
- Write programs in Python programming language that make use of external libraries, APIs, etc.
- Demonstrate basic understanding of mathematical and statistical foundations needed for data mining and machine learning.

Course prerequisites
Even though there are no prerequisites for this course, it is recommended to have some experience with programming and understanding basic statistics. Moreover, this course is a demanding course as the students will learn new technologies, methods, Python programming language and therefore it requires an interest in and commitment to hands-on learning.

Examination
Text Analytics:

Exam ECTS	7,5
Examination form	Oral exam based on written assignment
Individual or group exam	Individual exam
Size of written product	Max. 15 pages
Assignment type	Project
Duration	Written product to be submitted on specified date and time.
Grading scale	7-step scale
Examiner(s)	Internal examiner and second internal examiner
Exam period	Winter
Make-up exam/re-exam	Same examination form as the ordinary exam

Course content and structure

This course provides an introduction to three main areas: big data architectures/platforms, Python programming and mathematical/statistical foundations.
Furthermore, this course provides knowledge about

- Fundamental concepts, methods and techniques of big data
- Architectures and platforms for big data processing such Hadoop, Spark, distributed file systems
- Introduction to Python programming language such as programming basics, Boolean algebra, choice, repetition
- Functions, classes, modules, data structures and collections in Python language
- Consuming external APIs and open source libraries to develop programs
- Algorithm Design and Recursion
- Elementary probability theory, Bayes theorem, standard distributions, Bayesian statistics, fundamentals of Linear Algebra
- Information theory, entropy, mutual information

Furthermore, the course provides the students with practical hands-on experience on many of the topics listed above. After completing the course the students will be able to apply and use various programming constructs in Python language and also a good understanding of big data architectures and foundational mathematical/statistical theories that are required for data science courses.

Teaching methods

The course consists of 12x2 lectures, 12x2 exercises, and 5 assignments and will have teaching assistant providing technical support for assignments and course projects. The teaching block will be of 4 hours (8-12:00 or 12-16:00) with 2 lectures of 50-minutes and each lecture is followed by an exercise session of 50-minutes.

The presented theories, concepts and methods should be applied in practice and exercise sessions. The students work in the entire semester on a mini project displaying the understanding of the concepts presented in the lectures and exercises. CBS Learn is used for sharing documents, slides, exercises etc. as well as for interactive lessons if applicable.

Student workload

Lectures	24 hours
Exercises	24 hours
Prepare to class	48 hours
Project work & report	100 hours
Exam and prepare	10 hours

Expected literature

Textbooks:

Zelle, John M. Python programming: an introduction to computer science. Franklin, Beedle & Associates, Inc., 2004.

Manning, Christopher D., and Hinrich Schütze. Foundations of statistical natural language processing. Vol. 999. Cambridge: MIT press, 1999.

Furht, Borko, and Flavio Villanustre. *Big Data Technologies and Applications*. Springer, 2016.

Notes, articles, chapters and webpages will be handed out/made available during the course

Innovation and Strategy in the Digital Economy

English Title

Innovation and Strategy in the Digital Economy

Course responsible:

Lars Bo Jeppesen

Teacher(s):

Lars Bo Jeppesen

Learning objectives

To achieve the grade 12, students should meet the following learning objectives with no or only minor mistakes or errors: After successfully completing the course, the student should be able to:

- Understand the current debates around innovation in the digital economy, strategy, as it relates to digital economy and data.
- Explain how digital changes and the availability of data transform the business landscape.
- Discuss relevant theories and explain their assumptions, causal dynamics and processes.
- Assess the role of data in business innovation and specify success and failure factors.
- Understand central concepts around management in the context of digital businesses.
- Discuss ethical issues of the digital economy and organizations' use of data.

Course prerequisites

Master level students – all lines allowed, also external students from Danish and International Universities.

Examination

Innovation and Strategy in the Digital Economy:

Exam ECTS	7,5
Examination form	4 hours individual written exam – Open Book
Individual or group exam	Individual exam
Size of written product	Approx. 6 pages
Assignment type	Answer questions
Duration	4 hours
Grading scale	7-step scale
Examiner(s)	Two internal examiners
Exam period	Winter
Make-up exam/re-exam	Same examination form as the ordinary exam

Course content and structure

This course will give students an introduction to central issues of innovation and

strategy in the digital economy. It forms the background for the study of data in the business context. The growth of the digital economy is predicting a data rich future and a transformation of the business landscape with implications for existing firm, entrepreneurial ventures, and individual workers. In some of the most dynamic sectors of the modern economy, such as, apps for smartphones, video games, media content, scientific and technical problems solving, companies' overall performance already rely on data, setting requiring a whole new set of skills and organizational capabilities. The course will develop the conceptual foundations, frameworks and methods for analyzing the relationships between communities, crowds, and firms. It introduces student to the process of digital transformation. The course gives students a systematic basis for assessing the economic potential of different sorts of data and organizational imperatives to unlocking that potential. The first part of the course introduces business models of the digital economy. The latter part will focus on organizing in a data rich business context. Topics will include:

- Digital economy and innovation
- Digital business models and strategy
- The role of crowds in generating innovation and predictions.
- Crowdsourcing, crowd funding, collaborative innovation
- Digital platforms
- Managing organizations in a data rich future
- Data networks and markets
- Assessment of data potential

Teaching methods

The course will employ a variety of teaching forms, including lectures, interactive case based sessions, hands-on exercises, and guest lectures by practitioners.

Student workload

Teaching	33 hours
Preparation	93 hours
Exam	80 hours

Further Information

This course is part of the minor Data in business

Expected literature

Boudreau K, Lakhani K. 2013. Using the crowd as an innovation partner. Harvard Business Review 91(4): 60-69, 140.
Burtch et al 2013: An Empirical examination of the antecedents and consequences of contribution patterns in Crowd-funded markets, Information Systems Research 24, 3: 499-519
Chen, H., Chiang RHL. VC. Storey, 2012, Business Intelligence And Analytics: From Big Data To Big Impact, MIS Quarterly 36 (4), pp. 1165-1188
Edelman, B., 2012, Using Internet Data for Economic Research, Journal of Economic Perspectives 26 (2) pp. 189–206
Greenstein, S., Lerner J., S Stern, 2013 Digitization, innovation, and copyright: What is the agenda? Strategic Organization, (11) 110. 110-121
Jeppesen, LB & Frederiksen, L 2006, 'Why Do Users Contribute to Firm-Hosted

User Communities?: The Case of Computer-Controlled Music Instruments' Organization Science, 17 (1), pp. 45-63.
Varian, H. R., Computer Mediated Transactions, March 6, 2010; http://people.ischool.berkeley.edu/~hal/Papers/2010/cmt.pdf
Varian, Hal, Beyond Big Data. http://people.ischool.berkeley.edu/~hal/Papers/2013/BeyondBigDataPaperFINAL.pdf
von Hippel, 2005 Democratizing Innovation, MIT Press
Yoo Y, Boland R, Lyytinen K, Majchrzak A. 2012. Organizing for innovation in a digital world. Organization Science 23(5):1398–1408.

Cases:

Austin, Lakhani, Yi, Data.gov: Matching Government Data with Rapid Innovation, Harvard Business School Case 2010.
Lakhani, Karim R., and Zahra Kanji. Threadless: The Business of Community: Harvard Business School Video Case 608-707, June 2008
Lakhani, Karim R., From Community to platform, Harvard Business School Electronic Case, Spring 2014
Lakhani, Karim, D.A. Garvin, E Lonstein, TopCoder (A): Developing Software through Crowdsourcing, Harvard Business School Case 2010.

English Title
Visual Analytics (T)

Course responsible:
Ravi Vatrapu

Teacher(s):
Ravi Vatrapu

Learning objectives
To achieve the grade 12, students should meet the following learning objectives with no or only minor mistakes or errors:

- Characterize the phenomena of visual analytics
- Summarize different fundamental concepts, techniques and methods of visual analytics
- Analyze and apply different visual analytics techniques for big/business datasets in organizational contexts
- Understand the linkages between business intelligence and visual analytics and the potential benefits for organizations
- Critically assess the ethical and legal issues in applying visual analytics
- Summarize the application areas, trends, and challenges in visual analysis

Course prerequisites
This course requires beginner skills in Excel or other spreadsheets

Examination

Text Analytics:	
Exam ECTS	7,5
Examination form	Oral exam based on written assignment
Individual or group exam	Individual exam
Size of written product	Max. 15 pages
Assignment type	Project
Duration	Written product to be submitted on specified date and time.
Grading scale	7-step scale
Examiner(s)	Internal examiner and second internal examiner
Exam period	Summer
Make-up exam/re-exam	Same examination form as the ordinary exam

Course content and structure

Teaching methods

The course consists of 12x2 lectures, 12x2 exercises, and 5 assignments and will have teaching assistant providing technical support for assignments and course projects. The teaching block will be of 4 hours (8-12:00 or 12-16:00) with 2 lectures of 50-minutes and each lecture is followed by an exercise session of 50-minutes.

The presented theories, concepts and methods should be applied in practice and exercise sessions. The students work in the entire semester on a mini project displaying the understanding of the concepts presented in the lectures and exercises. CBS Learn is used for sharing documents, slides, exercises etc. as well as for interactive lessons if applicable.

Student workload

Lectures	24 hours
Exercises	24 hours
Prepare to class	48 hours
Project work & report	100 hours
Exam and prepare	10 hours

Expected literature

Few, S. (2007). Data Visualization: Past, Present, and Future. *IBM Cognos Innovation Center*, http://perceptualedge.com/articles/Whitepapers/Data_Visualization.pdf.

Flesch, B. (2014). *Design, Development and Evaluation of a Big Data Analytics Dashboard*. Master Thesis. Copenhagen Business School. Frederiksberg.

Heer, J., Bostock, M., & Ogievetsky, V. (2010). A tour through the visualization zoo. *Commun. ACM, 53*(6), 59-67.

Le Pape, M., & Vatrapu, R. (2009). An experimental study of field dependency in altered Gz environments *Proceedings of the 27th international Conference on Human Factors in Computing Systems (Boston, MA, USA, April 04 - 09, 2009). CHI '09* (pp. 1255-1264). New York, NY: ACM.

Pantazos, K., Lauesen, S., & Vatrapu, R. (2013). End-User Development of Information Visualization. In Y. Dittrich, M. Burnett, A. Mørch, & D. Redmiles (Eds.), *End-User Development* (Vol. 7897, pp. 104-119): Springer Berlin Heidelberg.

Pantazos, K., & Vatrapu, R. (2016). Enhancing the Professional Vision of Teachers: A Physiological Study of Teaching Analytics Dashboards of Students' Repertory Grid Exercises in Business Education. . *Proceedings of HICSS 2016, IEEE Press*.

Vatrapu, R., Reimann, P., Bull, S., & Johnson, M. (2013). *An eye-tracking study of notational, informational, and emotional aspects of learning analytics representations*. Paper presented at the Proceedings of the Third International Conference on Learning Analytics and Knowledge, Leuven, Belgium.

Ware, C. (2013). *Information visualization: perception for design* (Third ed.): Elsevier.

English Title
Data Economics (T)

Course responsible:
Ioanna Constantiou

Teacher(s):
Ioanna Constantiou

Learning objectives
To achieve the grade 12, students should meet the following learning objectives with no or only minor mistakes or errors:
During the course, the students will develop analytical skills and abilities to assess market developments, and thereby, improve their capabilities to engage in individual and group decision making under uncertainty and solve specific business problems. Upon completion of the course the students will be able to develop and present concrete solutions to market problems and advise firms about how to deal with datafication challenges and opportunities.

- Explain the role of information and data in economic theories and strategy tools
- Explain how datafication influences markets, and firms through examples based on business cases or sectoral analysis.
- Use a set of theoretical tools to analyse the impact of datafication in the markets
- Identify and reflect upon the strategic implications of digital transformation for the different market players

Course prerequisites
This course requires a fundamental understanding of business economics and strategy.

Examination
Text Analytics:

Exam ECTS	7,5
Examination form	Oral exam based on written assignment
Individual or group exam	Individual exam
Size of written product	Max. 15 pages
Assignment type	Project
Duration	Written product to be submitted on specified date and time.
Grading scale	7-step scale
Examiner(s)	Internal examiner and second internal examiner
Exam period	Summer
Make-up exam/re-exam	Same examination form as the ordinary exam

Course content and structure

The major theories of economics of information, network economics and business economics will be the building blocks of this course. The course will start by presenting that are prominent for managing information and data, efficiently, and for analysing business strategies of digitalization. Then, selected issues with wide impact on firm's strategy and market analysis will be presented. Indicative examples include pricing of information goods, auction design, economic effects of datafication and digitalization on business processes, products, and services and their economic impacts in terms of business models, competitive advantages, and market valuation. It will also cover topics such as customization, personalization, micro-targeting, network effects, switching costs.

Teaching methods

The course will be conducted in sessions of three time-slots (3x45). Each session is strongly based on students' participation. Following the introduction, each session includes lectures presenting specific theoretical issues, practical examples to further the understanding of the theory as well as students' participation in the discussions about specific business cases. CBS Learn is used for sharing documents, slides, exercises etc. as well as for interactive lessons if applicable.

Student workload

Lectures	30 hours
Prepare to class	60 hours
Project work & report	100 hours
Exam and prepare	30 hours

Expected literature

Textbooks:
DOUMA, Sytse; SCHREUDER, Hein *Economic approaches to organizations*. Pearson Education, 6th Eidtion (2017).

Notes, articles, chapters and webpages will be handed out/made available during the course

Course title: Predictive Analytics
Semester: Spring 2019

Course responsible:
Lisbeth la Cour

Teacher(s):
Lisbeth la Cour (LLC)

Course description:

Predictive analytics is a field that potentially can provide managers with very valuable tools for decision making. Both for sales variables of firms but also for financial variables like stock prices forecasting models and methods may be of interest, and during the course we will discuss challenges in relation to preparing relevant data for forecasting, choosing well-suited models for analysis and we offer a range of tools for evaluation the forecasting performance of the models we present. In one of the lectures we introduce a tool that can be very helpful for model selection if 'Big Data' is available.
This course is designed to provide both a theoretical foundation for predictive modeling but also hand-on experience with analyzing economic data. The models presented in the course will belong to different fields of statistics but in all cases the predictive power of the models will be in focus. Introducing statistical tool allows us to not only come up with an actual forecast of an economic variable of interest (think e.g. of sales) but also to assess the uncertainty of the forecast. Before a proper model can be selected it is of interest to discuss issues about data availability and also data reliability. Such topics are often not very much discussed in the text book but providing the students with examples of the types of challenges one may encounter – based on the research of the teachers – will try to fill this gap. In one of the lectures we introduce a tool that can be very helpful for model selection if 'Big Data' is available.

Learning objectives:

To achieve the grade of 12, students should meet the following learning objectives only with no og minor mistakes or errors. By the end of the course the students should demonstrate:

- Explain the concepts, models and methods introduced during the course.
- Identify and perform an academically founded forecasting analysis in practice (including taking relevant theoretical relationships into account) using the tools introduced during the course.
- Discuss and solve any important problems encountered in relation to the analysis.
- Evaluate the forecasts of the analysis.
- Report/communicate the results and conclusion of the analysis both if the reader is a statistician/econometrician and if reader is e.g. a CEO.
- Evaluate a forecasting analysis conducted by another person/researcher.
- Use a statistical analysis software package for the analysis (e.g. R or SAS or?) and demonstrate that you can interpret and evaluate the output from the software package.

Teaching methods:
Lectures, in-class exercises during lectures, exercise classes with tools training.
Feedback on a continuous basis

Student workload:

Class lectures:	24 hours
Exercise classes:	24 hours
Class preparation incl. home assignments:	101 hours
Exam and exam preparation:	76 hours
TOTAL:	225 hours

Indicative literature:

See back of the document.

Examination:

Predictive Analytics:	
Exam ECTS:	7.5 ECTS
Examination form:	Home assignment (written) followed by an oral exam, 20 min.
Individual or group exam:	Group exam. 3 students per group.
Size of written product:	Max. 15 pages
Assignment type:	Written assignment
Duration:	Written product will be submitted on specified date and time.
Grading scale:	7-step scale
Examiner(s):	Internal examiner and second internal examiner
Exam period:	Spring
Make-up/re-exam:	Same examination form as the ordinary.

Courseplan – Spring 2019 (suggested)

Lecture	Teacher	Topic	Learning objectives	Readings
Week 5 Lecture # 1	LLC?	Introduction	A mixture of all	HA: 1-2
Week 6 Lecture # 2	LLC?	Basic concepts	A mixture of all	HA: 2
Week 7 Lecture # 3	LLC?	Regression	A mixture of all	HA: 4-5
Week 8 Lecture # 4	LLC?	Regression	A mixture of all	HA: 4-5
Week 9 Lecture # 5	LLC?	Time series	A mixture of all	HA: 7
Week 10 Lecture # 6	LLC?	Time series	A mixture of all	HA: 8
Week 11 Lecture # 7	LLC?	Time series	A mixture of all	HA: 8
Week 12 Lecture # 8	LLC?	VAR models	A mixture of all	HA: 9
Week 13 Lecture # 9	LLC?	Model selection	A mixture of all	DH
Week 14 Lecture # 10	LLC?	Logit models	A mixture of all	V: 7
Week 15 Lecture # 11	LLC?	Logit models	A mixture of all	V: 7
Week 17 Lecture # 12	LLC?	Summary, Q&A	A mixture of all	BCV paper
Exercise classes				
Week 5 Exercise # 1	NN?	Intro, software	A mixture of all	
Week 6 Exercise # 2	NN?	Descriptive statistics, graphs	A mixture of all	
Week 7 Exercise # 3	NN?	Regression	A mixture of all	Assignment 1
Week 8 Exercise # 4	NN?	Regression	A mixture of all	
Week 9 Exercise # 5	NN?	Time series	A mixture of all	Assignment 2
Week 10 Exercise # 6	NN?	Time series	A mixture of all	
Week 11 Exercise # 7	NN?	Time series	A mixture of all	Assignment3
Week 12 Exercise # 8	NN?	VAR models	A mixture of all	
Week 13 Exercise # 9	NN?	Model selection	A mixture of all	Assignment 4
Week 14 Exercise # 10	NN?	Logit models	A mixture of all	
Week 15 Exercise # 11	NN?	Logit models	A mixture of all	Assignment 5
Week 17 Exercise # 12	NN?	Summary, Q&A	A mixture of all	

Literature

Books and articles:

Buus Lassen, N., la Cour, L., Vatrapu, R. (2017), 'Predictive Analytics with Social Media data' in Sloan & Quan-Haase ed. The SAGE Handbook of Social Media Research Methods, Chapter 20, pp 328-341 (BCV)

Hyndman, R.J & Athanasopoulos, G (2014): Forecasting: principles and Practice (maybe a 2nd edition will arrive) (HA)

Verbeek, M. (2012): A Guide to Modern Econometrics. 4th edition (or newer) (V)

Doornik, J.A. & Hendry, D.F. (2014): Statistical model selection with 'Big Data'. University of Oxford, Department of Economics, Discussion Paper Series, # 735 (or more recent text in this spirit). (DH)

English Title
Text Analytics (T)

Course responsible:
Raghava Rao Mukkamala

Teacher(s):
Raghava Rao Mukkamala

Learning objectives
To achieve the grade 12, students should meet the following learning objectives with no or only minor mistakes or errors:

- Characterize the phenomena of text analytics
- Summarize different fundamental concepts, techniques and methods of text analytics
- Analyze and apply different text analytics techniques for big/business datasets in organizational contexts
- Understand the linkages between business intelligence and text analytics and the potential benefits for organizations
- Critically assess the ethical and legal issues in applying text analytics
- Summarize the application areas, trends, and challenges in text analysis

Course prerequisites
This course requires a fundamental understanding of programming in Python language as achieved in, or comparable to, Foundations of Business Data Analytics: Architectures, Statistics and Programming course from 1st semester of Cand.Merc.IT (Data Science).

Examination
Text Analytics:

Exam ECTS	7,5
Examination form	Oral exam based on written assignment
Individual or group exam	Individual exam
Size of written product	Max. 15 pages
Assignment type	Project
Duration	Written product to be submitted on specified date and time.
Grading scale	7-step scale
Examiner(s)	Internal examiner and second internal examiner
Exam period	Summer
Make-up exam/re-exam	Same examination form as the ordinary exam

Course content and structure

The course provides knowledge of various concepts, techniques and methods related to text analytics. Furthermore, it introduces

- Basics of Natural Language Processing (NLP) such as POS-tagging, Entity recognition
- Machine learning for NLP such as Hidden Markov Models
- Text classification,
- Unsupervised methods for NLP and latent models.
- Word-embeddings and Word Vectors
- Neural Networks for NLP and Neural Language Models
- Semantic textual similarity
- Word-sense disambiguation
- Text summarization

Furthermore, the course provides the students with practical hands-on experience on text analytics using open source machine learning libraries such as scikit-learn, Natural Language Toolkit (NLTK) in Python programming language. After completing the course the students will be able to apply and use various NLP techniques such as sentiment/emotion analysis opinion mining etc. on textual documents/ text corpora.

Teaching methods

The course consists of 12x2 lectures, 12x2 exercises, and 5 assignments and will have teaching assistant providing technical support for assignments and course projects. The teaching block will be of 4 hours (8-12:00 or 12-16:00) with 2 lectures of 50-minutes and each lecture is followed by an exercise session of 50-minutes.

The presented theories, concepts and methods should be applied in practice and exercise sessions. The students work in the entire semester on a mini project displaying the understanding of the concepts presented in the lectures and exercises. CBS Learn is used for sharing documents, slides, exercises etc. as well as for interactive lessons if applicable.

Student workload

Lectures	24 hours
Exercises	24 hours
Prepare to class	48 hours
Project work & report	100 hours
Exam and prepare	10 hours

Expected literature

Textbooks:

Jurafsky, D., & Martin, J. H. (2009). Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition. Upper Saddle River, N.J: Pearson Prentice Hall.

Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural Language Processing. MIT Press, Cambridge, MA, USA.

Notes, articles, chapters and webpages will be handed out/made available during the course