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| Module Name | **Computational Intelligence** |
| Module Responsibility | *Prof. Dr. Martin Golz* |
| |  |  |  | | --- | --- | --- | | Qualification Targets | *The students will get the opportunity to* | | | - | *Analyse typical problems of sub-symbolic data and knowledge processing,* | | - | *Conceive the process chain of adaptive data analytics,* | | - | *Comprehend and apply methods of the process chain,* | | - | *Comprehend and apply methods of validation,* | | - | *Know basic assumptions and models of empirical inference,* | | - | *Know some of the mathematical background issues.* |  |  |  |  |  |  | | --- | --- | --- | --- | --- | | ***Contents*** | ***Know &***  ***Comprehend*** | ***Apply*** | ***Analyse & Evaluate*** | ***Synthesise*** | | *Basics of statistical inference* | X |  |  |  | | *Process chain of adaptive data analytics* | X | X | X |  | | *Statistical learning theory* | X |  |  |  | | *Multivariate regression analysis* | X | X | X |  | | *Linear discriminant analysis* | X | X | X |  | | *Kernel function discriminant analysis* | X | X | X |  | | *Linear and non-linear adaptive filtering* | X | X | X |  | | *Deep learning* | X | X | X |  | | |
| Module Contents | *1. Introduction*  *1.1.*  *Five types of statistical inference*  *1.2.*  *Typical applications*  *1.3.*  *Process chain*  *2. Statistical learning theory*  *2.1.*  *Empirical risk minimisation*  *2.2.*  *PAC learning*  *2.3.*  *General learning model*  *2.4.*  *Learning with uniform convergence*  *2.5.*  *Bias complexity trade-off*  *2.6.*  *Vapnik Chervonenkis dimension*  *3. Multivariate, linear regression analysis*  *3.1.*  *Introduction*  *3.2.*  *Model*  *3.3.*  *Principle of maximal a-posteriori probability*  *4. Linear discriminant analysis (LDA)*  *4.1.*  *Introduction*  *4.2.*  *Multi-class LDA*  *4.3.*  *Least squares LDA*  *4.4.*  *Fisher LDA*  *5. Kernel function discriminant analysis*  *5.1.*  *Introduction*  *5.2.*  *Theorem of Cover*  *5.3.*  *Dual representation*  *5.4.*  *Generation of kernel functions*  *5.5.*  *Radial basis function networks*  *5.6.*  *Recursive least squares minimisation*  *5.7.*  *Gaussian processes*  *5.8.*  *Applications*  *6. Adaptive Filter*  *6.1.*  *Linear adaptive filtering*  *6.1.1. Least squares algorithm (LS)*  *6.1.2. Recursive LS algorithm (RLS)* |

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|  | *6.1.3. Extended RLS algorithm (Ex-RLS)*  *6.2.*  *Non-linear adaptive filtering*  *6.2.1. Reproducing kernel Hilbert space (RKHS)*  *6.2.2. Kernel function LS filtering*  *6.3.*  *Applications*  *7. Deep learning*  *7.1.*  *Characterisation*  *7.2.*  *Representation learning*  *7.3.*  *Deep auto-encoder*  *7.4.*  *Restricted Boltzmann machines*  *7.5.*  *Applications* |
| Teaching methods | - *Frontal lectures with*  o *Digital presentation slides,*  o *Demonstration programs*  - *Exercises held in the computer pool*  o *Programming with MATLAB*  o *Clarification of open issues* |
| Requirements for Participation | *No formal suppositions*  *Basic knowledge in linear algebra, analysis, statistics* |
| Literature | *The following books are recommended:*  - *Nielsen (2015) Neural networks and deep learning. Determination press* - *Mohri, Rostamizadeh (2012) Foundations of machine learning. MIT press* - *Bishop (2006) Pattern recognition & machine learning. Springer*  - *Duda, Hart, Stork (2001) Pattern classification. Wiley* |
| Applicability | *This module is an obligatory subject.*  *An appropriation to similar majors is possible under stipulation of their examination regulations.* |
| Effort / Total Workload | *180 hours, including 60hours in presence and 120 hours self-instruction* |
| ECTS / Emphasis of the Grade for the final Grade | *5 CP (Emphasis of the Grade for the final Grade 5/120)* |
| Performance Record | *Oral examination (30 minutes)* |
| Semester | *2nd Semester* |
| Frequency of Occurrence | *Once a year* |
| Duration | *One semester* |
| Type of Course | *Obligatory subject* |