Computational Intelligence: Methods and Applications

Lecture 1
Organization and overview

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What is it all about?

- Many engineering and scientific problems may be solved by using numerical algorithms; theory is known, equations formulated, either analytical or numerical solutions are required. Any examples?

  Such problems require high-performance computing, but no intelligence: just press the key and wait for an answer.

- Other problems may be easily formulated, but all algorithms solving them may be NP hard, requiring almost infinite amount of computations to solve complex cases.
  Any examples?

- Yet other problems have no algorithms at all!
  Any examples?

- Problems, for which effective algorithms cannot be formulated require intelligence to solve them.

What this course covers

This is a list of topics covered:

- Computational Intelligence overview, sources of inspiration, types of adaptive (learning) systems, types of applications. (~2 h)

- Visualization and exploratory data analysis:
  few variables, direct visualization, Principal Component Analysis (PCA), Multidimensional Scaling (MDS), Self-Organized Mappings (SOM), parallel coordinates and other visualization algorithms.(~9 h)

- Theory: overview of statistical approaches to learning, bias-variance decomposition, expectation maximization algorithm, model selection, evaluation of results, ROC curves. (~5 h)

What this course covers (cont)

- Introduction to Yale/WEKA and GhostMiner software packages, presentation of algorithms available in these packages (~5 h)

- Statistical algorithms: discriminant analysis - linear (LDA), Fisher (FDA), regularized (RDA), probabilistic data modeling, kernel methods (~5 h)

- Density estimation, expectation maximization, RBF and SFN networks, and rule induction (~4 h)

- Similarity based methods, generation of prototypes, similarity functions, separability criteria (~2 h)

- Improving CI models: boosting, stacking, ensemble learning, meta-learning, using information theory and other approaches for selection of relevant features (~6 h)

Some left-out topics

There are separate courses at NTU on related topics:

- Fuzzy modeling and neurofuzzy systems (mentioned briefly).
- Graphical approaches, Bayesian causal networks, network computing (mentioned briefly).
- Independent Component Analysis (will be mentioned)
- Neural algorithms will be briefly mentioned, but not including spiking neurons for image or signal analysis.
- Sequence analysis, time series.
- Algorithms specific to bioinformatics: strings, trees, dynamical programming.
- Statistical and NLP approaches to text/information retrieval and categorization.
- Evolutionary approaches to optimization, ant and particle swarm algorithms, algorithms inspired by immune-system.
- Many uncertainty theory approaches
- and many others topics useful for CI ...

Time & place & evaluation

- Thursday, 6:30-9:30, LT 9.
- Should we have just one break or two breaks?

- Total number of lecture hours: 39 hours
- Course WWW page: edveNTUre H6429 course and my WWW page for the course.

- Evaluation:
  - two assignments: visualization and classification
  - exam (restricted open book)

  Assignments are important!
  Zero points for assignments will reduce your grade!

Personal information

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Detailed information, CV, papers and lecture notes, project descriptions, photos from many conferences etc, are at WWW:

Google: Duch,
or http://www.is.umk.pl/~duch/

Local page: http://www.ntu.edu.sg/home/aswduch/
This course page is linked to mine.
Local email: aswduch @ the NTU server ntu.edu.sg

Your information

Please send me by email or using edveNTUre this info:

Name: ???
Background: ???
Courses related to this one: ???
Interest (science only, please): ???
Expectations –what would you like to learn: ???
Ideas to improve the course: ???

Questions should be asked frequently!

Please send me your questions by email, so that I could add more detailed explanations to my lecture notes.
All questions are displayed and answered on the Q/A page.

Recommended books

3 best books covering foundations and various aspects of CI (with strong statistical bias)

- R.O. Duda, P.E. Hart, D.G. Stork, Pattern Classification (2nd Edition), J Wiley 2000
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- T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning. Springer 2001.
- A. Webb, Statistical Pattern Recognition. Wiley, 2-nd ed. 2002

Other useful books

- V. Kecman, Learning and soft computing, MIT Press 2001
  Good intro book on neural, SVM and fuzzy subjects, detailed explanations, many problems.
- D. Hand, H. Mannila, P. Smyth, Principles of Data Mining, MIT Press 2001
  Quite general data mining introduction.
- I.H. Witten, E. Frank, Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations. Morgan Kaufmann 1999
  WEKA intro, but algorithm description is very sketchy.
- J. P. Marques De Sa, Pattern Recognition: Concepts, Methods, and Applications. Springer 2001.
  Small book, but useful overview.
- Amit Konar, Computational Intelligence. Principles, Techniques and Applications. Springer 2005.
  New book covering many advanced CI subject.