COMPUTATIONAL INTELLIGENCE

PROJECT CLASSES

Final Computational Intelligence Project Proposals

AGH



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Final CI Projects



- In the second part of this course, each student implements one selected final project.
- The chosen final project should deepen the acquired knowledge and allow for gaining professional skills and experience in developing and using computational intelligence methods in practice.
- All project topics will be gradually presented during lectures that go along with the project classes.
- Each student can choose a project from the presented list of project proposals or propose their proposal of the final project and agree on its scope with the tutor.
- The goal is the development of a complex CI system by each course participant.
- During the project implementation, it is possible to ask the tutor for advise and support to clarify expectation and finalize the project with flying colors.
- Finally, all laboratory classes and final projects should be presented during the last lecture and project classes in the semester (10-12 min. for the presentation and discussion) to all course attendants and the tutor before being finally evaluated.



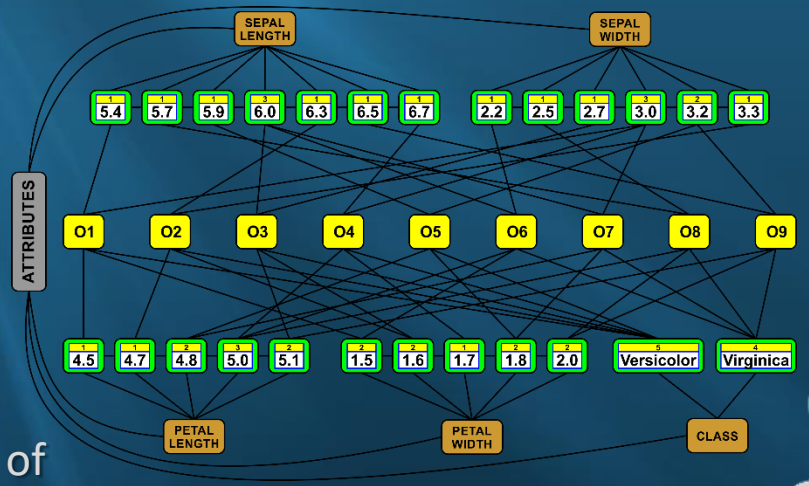


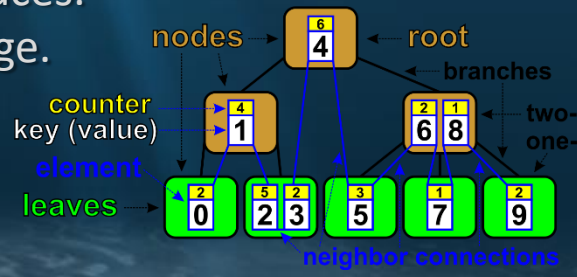
Final Project Proposal 1

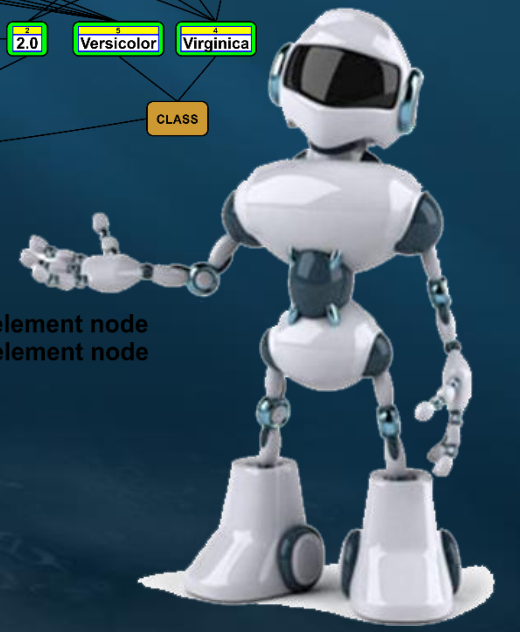


Associative Graph Data Structure (AGDS) Used for Data Representation, Recognition, Clustering, Classification, and Reasoning.

- ✓ Implement and use an associative graph data structure AGDS for representation of various datasets (tables of records or several tables of related records) using AVB+trees to optimize access to the data and objects stored in this structure.
- ✓ Try to use this structure to find out various vertical relations between objects: averages, medians, sums, counts, minima, maxima, interesting clusters, sort them due to their similarity, or try to find out objects that meet user criteria that can be variously defined.
- ✓ Compare the time efficiencies of various operations.
- ✓ Implement methods which allow for fast inference and retrieval of selected groups of objects on 3-4 non-trivial sample datasets.
- ✓ Demonstrate the way how it is working using a graphical visualization of these network states after being stimulated and the results it produces. You can use a preferable graphical library and programming language.
- ✓ Prepare a final presentation of your project and its results.
- ✓ Draw conclusions during your final presentation of the project.







Well-done projects can be expanded to a Master's thesis.

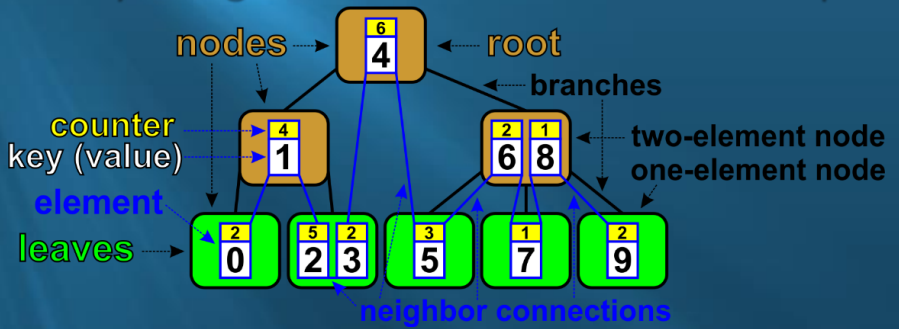


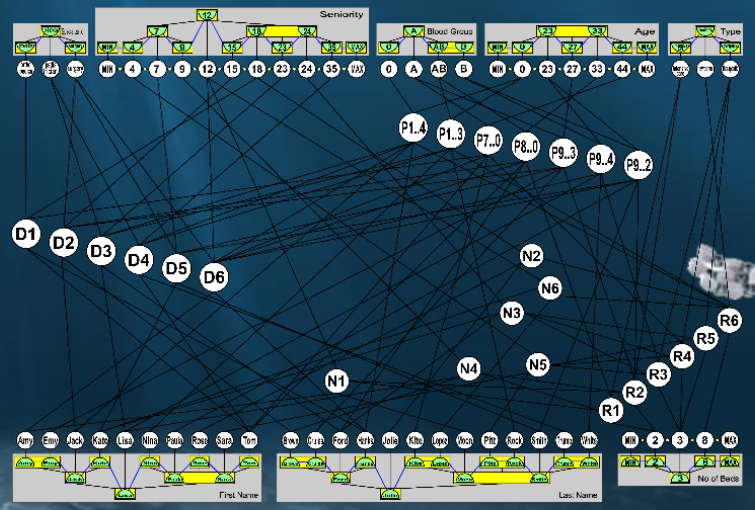
Final Project Proposal 2



Associative Transformation and Representation of Databases using Deep Associative Neural Networks DASNG for Inferences.

- ✓ Implement a deep associative-semantic neuronal graph DASNG (possibly using AVB-trees or AVB+trees to represent and access attribute data efficiently or another efficient solution).
- ✓ Implement methods which allow for fast retrieval of all related or similar objects and groups of objects.
- ✓ Use a non-trivial database or databases containing at least several tables connected using 1:N and N:M relations.
- ✓ Use this neuronal graph for fast search and filter (SELECT) of objects meeting the criteria sets defined by a user.
- ✓ Demonstrate the way how it is working using a simple graphical visualization of this network states after being stimulated and the results it produces. You can use any known library for drawing graphs and any graphical library for visualization.
- ✓ Prepare a final presentation of your project and its results.
- ✓ Draw conclusions during your final presentation of the project.







Well-done projects can be expanded to a Master's thesis.

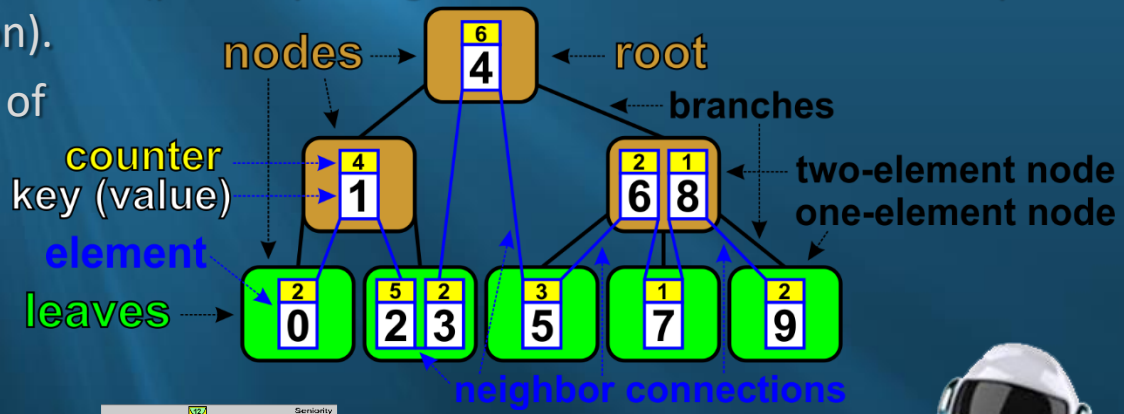


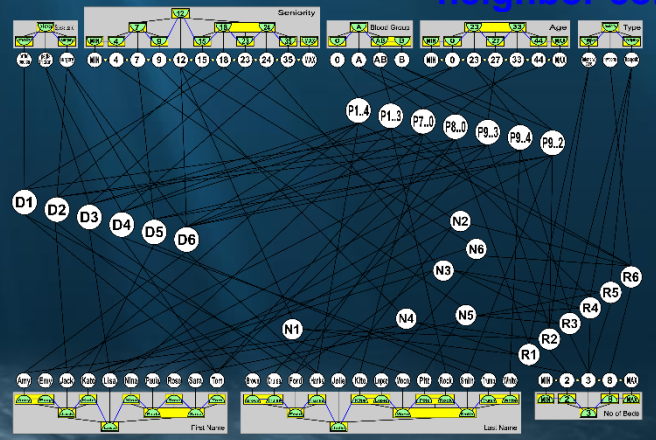
Final Project Proposal 3



Associative Representation of Databases using Multi-associative Graph Data-Relation Structure (MAGDRS) for Inferences.

- ✓ Implement a multi-associative graph data-relations structure MAGDRS (generalization of AGDS, similar structure to DASNG) to represent 3-4 non-trivial databases in the associative form (possibly using AVB-trees or AVB+trees to represent and access attribute data efficiently or another efficient solution).
- ✓ Use this associative structure for fast search and filter (SELECT) of objects meeting the criteria sets defined by a user.
- ✓ Implement methods which allow for fast retrieval of all related or similar objects and groups of objects.
- ✓ Use a non-trivial database or databases containing at least several tables connected using 1:N and N:M relations.
- ✓ Demonstrate the way how it is working using a simple graphical visualization of this structure intermediate and final results.
  You can use any known library for drawing graphs.
- ✓ Prepare a final presentation of your project and its results.
- ✓ Draw conclusions during your final presentation of the project.







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Final Project Proposal 4



Active Associative Data Representation and Automatic Inference using AANG Neural Networks.

- ✓ Implement and build an active associative neuronal graph AANG using an associative sort algorithm ASSORT-2.
- ✓ Use this neuronal graph for fast defining of classes for any given criteria by a user.
- ✓ Implement methods which allow for fast retrieval of similar objects to any given object, their group or any given combination of attribute values or their ranges by stimulating this network appropriately.
- ✓ Use 2 or 3 training data sets to demonstrate the way how it is working.
- ✓ Implement a simple graphical visualization of the network states during stimulation and the results. You can use any known library for drawing graphs.
- ✓ Prepare final presentation of your project and its results.
- ✓ Draw conclusions during your final presentation of the project.



Well-done projects can be expanded to a Master's thesis.



Final Project Proposal 5



Deep Convolutional Neural Network to Recognize and Classify Data.

- ✓ Implement a deep convolutional neural network (CNN) for training the chosen non-trivial dataset. Implement and compare different output layers (e.g. soft-max, MLP). Allow for creation of various configurations of layers of various kinds, check various activation functions and find out the best architectures for given datasets.
- ✓ Use various extensions to get better results: transfer learning and data augmentation - compare the results for different approaches and draw conclusions!
- ✓ Use this neural network for recognition and classification of objects from 3 – 4 training datasets, and try to achieve quality results! Compare results to other sources and results.
- ✓ Use various training data to demonstrate the way how it is working and use a graphical visualization of this network after being stimulated and the results it produces. You can use any known graphics library.
- ✓ Prepare a final presentation of your project and its results.
- ✓ Draw conclusions during your final presentation of the project.
- ✓ When using TensorFlow or Keras libraries take care about your contribution in the project, do not use built-in functions only, but try to implement some parts of the solution yourself!



Well-done projects can be expanded to a Master's thesis.



Final Project Proposal 6



Recurrent Neural Network to Recognize and Classify Sequential Data.

- ✓ Implement a recurrent neural network (RNN) for training the chosen non-trivial dataset consisting of sequential data (EKG signals, voice etc). Implement and compare different connections between neurons.
- ✓ Use this neural network for recognition and classification of objects from 3 – 4 training datasets, and try to achieve quality results! Compare results to other sources and results.
- ✓ Use various training data to demonstrate the way how it is working and use a graphical visualization of this network after being stimulated and the results it produces. You can use any known graphics library.
- ✓ Prepare a final presentation of your project and its results.
- ✓ Draw conclusions during your final presentation of the project.
- ✓ When using TensorFlow or Keras libraries take care about your contribution in the project, do not use built-in functions only, but try to implement some parts of the solution yourself!



Well-done projects can be expanded to a Master's thesis.



Final Project Proposal 7



LSTM Neural Network to Recognize and Classify Sequential Data.

- ✓ Implement a Long Short Term Memory (LSTM) for training the chosen non-trivial dataset consisting of sequential data (EKG signals, voice etc). Implement and compare different connections between neurons.
- ✓ Use this neural network for recognition and classification of objects from 3 – 4 training datasets, and try to achieve quality results! Compare results to other sources and results.
- ✓ Use various training data to demonstrate the way how it is working and use a graphical visualization of this network after being stimulated and the results it produces. You can use any known graphics library.
- ✓ Prepare a final presentation of your project and its results.
- ✓ Draw conclusions during your final presentation of the project.
- ✓ When using TensorFlow or Keras libraries take care about your contribution in the project, do not use built-in functions only, but try to implement some parts of the solution yourself!



Well-done projects can be expanded to a Master's thesis.



Final Project Proposal 8



(I'm still working on the next project proposals.)

- ✓ Implement ...
- ✓ Use ...
- ✓ Compare results ...
- ✓ Use various training data to demonstrate the way how it is working and use a graphical visualization of this network after being stimulated and the results it produces. You can use any known graphics library.
- ✓ Prepare a final presentation of your project and its results.
- ✓ Draw conclusions during your final presentation of the project.



Well-done projects can be expanded to a Master's thesis.



Master's Theses & CI Job Offers



Well-done projects can be further developed and expanded to:

- Master's theses
- PhD research and dissertations
- Scientific Papers prepared with an assistance of the tutor.

Moreover, the students whose projects will be very well done can be recommended for beneficial positions in the interesting business CI and AI projects, e.g.: http://home.agh.edu.pl/~horzyk/research/CooperationJobOffers.php .





What will be evaluated?



All tasks during laboratory and project classes should finished with a creation and development of a personal, complex CI system which:

- ✓Possibly comprises all realized laboratory tasks and a selected final project task.
- ✓Have a unified common interface for reading input data from text, spreadsheet, xml, or database files containing training data.
- ✓Have a unified graphical output interface for presentation of output data, achieved results, structures of neural networks or other models as well as possibly animated intermediate training and evaluation stages to clarify the way of how the structure and parameters are created and modified in the given adaptation process.
- ✓Have clearly implemented algorithms and data structures realized with state-of-the-art, good programming practices, rules, and a selected object programming model (MVC, MVVM, etc.)
- ✓Students initiatives will be appreciated.





Final Projects and Grades



All application have to be implemented in one of the top programming object languages: C#, C++, Java, Python, or PHP and if necessary supplemented by the use of a database. Take into account that in the laboratory room there are only MS Visual Studio and Python available, so if you wish to perform your classes in the other programming language you are responsible for the possibility to work in it. Students can also work on their own laptops during these classes if it is more convenient for them.

All final projects should be presented to all participants (about 10-12 min.) during the last project classes in the semester. Therefore, prepare the final presentation of used methods, data structures, achieved results etc. Draw some valuable conclusions and summaries. Inspire us, give advice and suggestions! Describe abilities of your CI system and show us how it works and develops solutions for some sample training data. Interpret and possibly compare achieved results to other checked approaches or methods.

All final complete projects (including the developed CI system with a source code of all modules, a compiled application, training data, databases, presentations etc.) **should be sent to the lecturer at the end of the semester** because the lecturer is obligated to store them during at least a year as a proof of the grades given to students.



Hence, only the sent complete projects will be finally evaluated and students will be graded!

Well done projects can be afterward further developed to Master's theses.

This course is not an easy one but the acquired knowledge and skills should be valuable!



Literature and References





ACADEMIC WEBSITE - ADRIAN HORZYK, PhD, DSc., PROF. AGH

AGH University of Science and Technology in Cracow, Poland
Faculty of Electrical Engineering, Automatics, Computer Science and Biomedical Engineering
Department of Biocybernetics and Biomedical Engineering, Field of Biocybernetics

AGH

NEW LECTURES

- From Data To Intelligence, Knowledge, and Cognition
- Artificial Neural Networks of the 1st and 2nd Generations
- Associative Knowledge-Based Models and Networks for Intelligent Reasoning, AGDS, AVB+trees
- Machine Learning Strategies
- Unsupervised Competitive Learning and Kohonen's Self-Organizing Maps SOM

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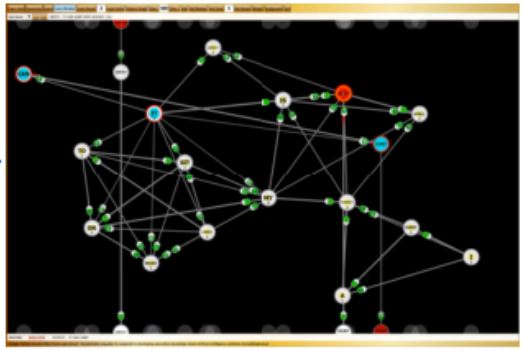
- Introduction to Artificial and Computational Intelligence
- Artificial Neural Networks, Multilayer Perceptron MLP, and Backpropagation BP
- Autoencoders and Feature Extraction
- Unsupervised Training and Self Organizing Maps SOM
- Associative Data Structures and Associative Neural Graphs

COMPUTATIONAL INTELLIGENCE

This course includes 28 lectures, 14 laboratory classes, and 14 project classes.

What is this course about?



This course is intended to give students a broad overview and deep knowledge about popular solutions and efficient neural network models as well as to learn how to construct and train intelligent learning systems in order to use them in everyday life and work. During the course we will deal with the popular and most efficient models and methods of neural networks, fuzzy systems and other learning systems that enable us to find specific highly generalizing models solving difficult tasks. We will also tackle with various CI and AI problems and work with various data and try to model their structures in such a way to optimize operations on them throughout making data available without necessity to search for them. This is a unique feature of associative structures and systems. These models and methods will allow us to form and represent knowledge in a modern and very efficient way which will enable us to mine it and automatically draw conclusions. You will be also able to understand solutions associated with various tasks of motivated learning and cognitive intelligence.

Maybe you would like to take part in IT competitions (e.g. Kaggle) and win a large sum of money?!



Today, computational intelligence (CI), machine learning (ML), data mining (DM), and artificial intelligence (AI) achieved already a lot! We have many interesting methods, models and computational tools which let us adapt CI models to many practical tasks. The CI professionals can earn even a six-figure salary for their work, but it is only a tip of the iceberg! We can still achieve a great development in artificial intelligence can be still far more intelligent than we meet today. Today, we rather develop intelligently adapting computational tools than real artificial intelligence! Artificial Intelligence (AI) can do much more and without so much effort from the people's point of view. It must be embodied and equipped with some smartly motivational mechanisms and associative properties (known from our brains) which let it achieve an adequate level.

http://home.agh.edu.pl/~horzyk/lectures/ahdydci.php