CMSC 636 Neural Nets and Deep Learning

Spring 2022, Instructor: Dr. Milos Manic, http://www.people.vcu.edu/~mmanic

Class Paper Instructions

Class paper:

- **Class paper:** The class paper is mandatory. In addition, this exercise will prepare you for future publishing process.
- **Class paper topic:** Neural networks techniques are known by their ability to deal with wide range of problems, such as classification, prediction, approximation, even when the outcome is not known. Students with different backgrounds may be interested in different problems. Examples include implementation of certain algorithmic solutions, modeling, classification, prediction, etc. You may want to do a preliminary literature search first.
- **Type of paper:** Class paper can be more research (theoretical) or project (applied) oriented.
- **Format:** Formatting should be according to an IEEE conference guidelines. It should be composed of title, abstract, introduction, problem definition, proposed solution, experimental/testing, conclusion, and future directions (see the "CMSC636_IEEEPaperTemplate.docx").
  This template is based on the:
  - IEEE Computer Society call for papers and publishing instructions;
  - IEEE Author Tools *page* with Template for IEEE Transactions with template in *MS Word* or *pdf* format and WIN and MAC Bibilography *file*
- **Submission:** Please follow these rules when submitting your paper:
  - Please compile all your results into a **single** file!
  - In email, use the proper subject line and signature as stated in course web page.
  - Include the same signature on every page of your assignment.
  - Use the following convention for naming the file: "PaperDraftNN_*FamilyName.xxx*", NN being the number of the paper draft.
- **General tip:** After you choose a problem, give a problem definition on a general level first. Then decompose it to feasible components and tackle one after another. In other words, put some boundaries on a problem and keep it reasonably difficult for a given deadline.
- **Teaming up:**
  - Select a project manager (PM) for your team first. PM will be submitting paper drafts and communicating with Instructor while keeping all team members in cc. All team members need to be in the loop, so my replies would be reaching the whole team.
  - Paper title page will contain the names of all team members, followed by a brief note on labor distribution (who is doing what).
- **First draft**
  - Deliverable: brief outline, up to one page long. It should include:
    - working title,
    - author(s) contact info

- short abstract, and
- problem description (problem statement). It is very important to provide as precise as possible problem statement. I would encourage providing both narrative and mathematical problem description.

- Formatting: at this point, your deliverable should look like an abstract you would submit to an IEEE conference (please refer to format specifications from above).
- Content: Initial proposal should be limited to a problem description. At this stage, a problem statement is a main task. You may describe a set of related problems instead of a single problem. At this point in the course, you should have a good feel for problems where neural networks will be a superior solution. However, an elaborate discussion on possible neural algorithms should be left for the second draft. I will also be assisting you in identifying neural network based solution(s) that would be a good fit for your problem.
- Topics: Any application related to learning, adaptive control, classification, pattern recognition, and many others would be a good choice (see some ideas listed below). I am hesitant to force you into a list of topics – I would rather see you coming up with something along the line of your current project problems, thesis or dissertation, or something you would be simply interested in working on. I will be happy to discuss topics with you - feel free to contact me anytime.
- Expected paper completeness at this stage [%]=25%

- **Second draft**
  - Deliverable: in addition to the content from the first draft, detailed literature (background) review should be performed for this phase.
  - Formatting: you are planning on publishing your paper at IEEE conference, so the formatting applies accordingly.
  - Based on literature review that you have done, you should elaborate on other comparative approaches to the same problem. This is important because: 1) it documents that you understand the current state of the art of your particular problem; 2) helps you identify deficiencies with current solution approaches. These deficiencies you will be attempting to alleviate.
  - This draft should contain updated problem description. The survey of existing solutions needs to be referenced. You may start elaborating on steps you are planning on taking with regards to your problem solution.
  - This will be a more elaborate paper, but not more than 2-4 pages long. At this point, you will have the following components of your paper:
    - title (revised, if necessary)
    - author(s) contact info
    - abstract
    - I. Introduction and background (literature review)
    - II. Problem statement (updated)

        - V. References
    - At this point a solution proposal does not need to be presented.
    - Division of work in team: please clearly state the division of work within a team (the work performed by each team member).
    - Expected paper completeness at this stage [%]=50%

- **Third draft**
    - Deliverable: in addition to previous draft, it should contain a technique (or selection of techniques), you are planning on using to solve the selected problem (III. Solution proposal section). The solution(s) will entail specific learning algorithms, architectures, discussion on advantages and disadvantages of each, etc.
    - Formatting: IEEE conference formatting.
    - This will be a more elaborate paper, but not more than 5-6 pages long. At this point, you will have the following components of your paper:
        - title (revised, if necessary)
        - author(s) contact info
        - abstract
        - I. Introduction and background (literature review)
        - II. Problem statement (refined, in necessary)
        - *III. Solution proposal*
        - V. References
    - At this point a final solution and experiments do not need to be present.
    - Division of work in team: please clearly state the division of work within a team (the work performed by each team member).
    - Expected paper completeness at this stage [%]=75%

- **Final draft**
    - Deliverables:
        1. Final, complete paper, up to ten pages. It should contain detailed solution and experimental work. You should include test examples (learning & test patterns), architecture description, discussion on robustness of your solution. You should also include future work directions, problems that you may want to tackle in next paper.
        2. Your presentation slides may be posted on class web site.
        3. At this point, you will have the complete paper:

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Class Paper Instructions

- title (revised, if necessary)
- author(s) contact info
- abstract
- I. Introduction and background (literature review)
- II. Problem statement (refined, in necessary)
- III. Solution (description)
- *IV. Test results*
- V. References

4. Please submit copies of papers/books used in your research.
5. Please name your paper and slides like this: "PaperFinal_*FamilyName.xxx*" and "*Presentation_FamilyName.xxx*".
6. Expected paper completeness at this stage [%]=100%

- **Presentations:** during last sessions of the course.
  - Each of you will present your project and we will all discuss it. You should use this discussion to finalize your project paper and hopefully publish it at some conference.
  - Presentation: please limit your presentation to 10min+5min for discussion. Along with final version you should email me your slides so I can post them on our course web page. This way others will be able to read about your project and prepare questions. Please print out all project papers & presentations before coming to the final session.
- **Paper topic - some ideas**
  - These are some of the topics of papers from previous years. These will give you some examples of what applications can be targeted.
  - Past offering of the course:
    1. Cryptographic neural networks (synchronization of neural networks for secure key exchange)
    2. Attentiveness Recognition using EEG
    3. Sequence-based prediction of protein crystallization using deep feature representation
    4. Solving Tic-Tac-Toe Problem using a Neural Network
    5. Marginalized Denoising Autoencoders (improving Stacked Denoising Autoencoders) for feature selection
    6. Epileptic spike detection using ANNs
    7. Autoencode pretraining (enabling deeper learning)
    8. Neural Network Ensemble-based Classification using Spark
    9. Reccurent reinforcement learning for trading multiple stocks
    10. Abstract Thought Based Brain Computer Interfaces (EEG & Brain Computer Interfaces)
    11. Exploiting the Resiliency of Neural Networks to Improve Scalability

12. Rapid Estimation of Non-Rigid Tissue Deformation and Patient Motion Using Convolutional Neural Networks (estimate degree of deformation in local image volumes; develop representative data sets for training and test data generation)

- Pattern recognition
    1. Deep learning for image, video, sound, text, time series predictions
    2. Pattern Recognition and Conversion of Japanese Hiragana to Roman Characters
    3. Using Neural Networks to Identify Disordered Regions for Protein Alignments
    4. Networks for handwritten digit OCR
    5. Artificial Neural Network For Automated Prediction of Popularity of Digitized Images
    6. Pattern Classification Of Numericals By Neural Networks
    7. Pattern recognition using Hopfield associative memories
    8. Feedforward ANN for bipolar pattern recognition
- Clustering
    1. Deep learning for classifications, clustering, and predictions
    2. Good Vibrations: Investigating Neural Network Applications in Prognostics of Jet Engine Ball Bearings
    3. Single Neuron Classification of Non-Linearly Separable Data
- Combination with GA
    1. Evolving Neural Networks Using Particle Swarms
    2. CBAC Optimization for Artificial Neural Network (Cluster Based Averaged Crossover to converge in Particle swarm time)
- ECE problems
    1. A/D Converters using the NNs
    2. A Study of Advancements Made in Circuit Efficiency Using Threshold Logic
    3. An Artificial Neural Network Approach for Detecting High-Impedance Faults on Three Phase Four-Wire Distribution Circuits
    4. Neural protective relay for a circuit breaker.
    5. HDL modeling of neural networks
- Cyber security
    1. Artificial Neural Networks for Intrusion Detection
- CE/ME problems
    1. Bed Load Sediment Transport Estimation Using Artificial Neural Networks
    2. Use of Artificial Neural Networks (ANN) in a Stream flow Prediction
    3. Implementing a Neural Network System to Solve the Inverse Kinematics of a Biologically Inspired Robotic Cat Leg
    4. Neural Network Application In Engineering Principle
    5. Biodiesel Blend Level Sensing from the Ultraviolet Absorption Spectra with Application of Neural Network
- Intelligent controllers
    1. Road recognition for an autonomous vehicle
    2. Control of Underwater Autonomous Vehicles Using Neural Networks