ECE 5801 - Introduction To Artificial Neural Networks, ECE-Elective-Fall semester 2009

2009-2011 Catalog Course Description:
General techniques and theory of neural networks, their applications and limitations. The course particularly addresses the design issues and learning algorithms for diverse areas of applications. (3hrs lecture)

Prerequisites:
(3 cr; A-F or Aud. Prereq-CS 1521, Math 3280, Stat 3611 or #, §4801)

Educational Goals:
Neural networks represent a technology that is rooted in many disciplines: neurosciences, mathematics, statistics, physics, computer science, and engineering. Neural networks find applications in such diverse fields as modeling, time series analysis, pattern recognition, signal processing, and control by virtue of an important property: the ability to learn from input data with or without a teacher. The intent of this course is to expose students to this new class of computational methods, providing alternative solutions to the traditional approaches.

The course covers basic neural models, networks, learning algorithms, and the paradigms that have been proven practical. Due to the introductory nature of this course, supervised and unsupervised learning algorithms are covered to an extent that does not require high levels of mathematical proofs and analysis. Learning algorithms are taught at the algorithm level, and the concepts are learned through hands-on implementation of computer simulations.

Feed-forward networks are extensively covered, which include multi-layer perceptrons, radial-basis functions, support vector machines, principal component analysis, self-organizing maps, information theoretical models, and temporal processing. Only limited amount of recurrent networks are covered. This course requires extensive work of computer simulations.

Course Outcomes (Student should …):
- Understand the basic neural models and networks and why they are formulated as mathematical models (a, c, e, j, k)
- Study various learning algorithms: error correction learning, memory based learning, Hebbian learning, Boltzman learning, statistical learning, competitive learning, etc. (a, b, e, m)
- Implement pattern recognition or decision making networks using the learned algorithms (a, b, c, e, l, m)
- Understand back-propagation, generalization, and cross-validation (a, b, e, m)
- Understand principal component analysis networks (a, b, c, e, m)
- Understand support vector machines (a, b, c, e, j, m)
- Understand self-organizing map and learning vector quantization (a, b, c, e, k, l, m)
- Understand information theoretic neural models (a, b, k, m)
- Understand temporal neural networks (a, b, c, e, k, l, m)
- Understand radial basis functions (a, b, c, e, k, l, m)
- Be able to write various neural network programs for applications and analyze the performance (a, b, c, g, l, m, m) (“a through n” are student outcomes)

Relationship to ECE Program Objectives:
- This course is one of the ECE technical elective courses that provide senior level students to an opportunity to explore advanced topics in computational models.
- Integrates advanced signal processing techniques and mathematic for solving complex problems
- Provides alternative solutions for data prediction, interpolation, estimation, and analysis
- Exposes students to entry-level graduate research topics
## ECE 5801 – Syllabus – Fall 2009

**Professor:** Dr. Taek Kwon, Office: 253 MWAH, Phone: 726-8211, Email: tkwon@d.umn.edu  
Office Hours: MWF 3:00-4:00PM, web: www.d.umn.edu/~tkwon

**Lecture Place & Time:** MWAH 191, 2:00-2:50PM MWF  
**Textbook:** Simon Haykin, *Neural Networks and Learning Machines*, 3rd Ed, Prentice Hall, 2009  
**Computer Usage:** Several projects will be assigned for neural network simulation and implementation. You may use any PC available from home or campus for the projects. Software: MS Visual Studio

**Assessment:** Projects and HW: 30%  Mid term: 35% Final: 35%

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<tr>
<th>Dates</th>
<th>Topics</th>
<th>Textbook</th>
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<tr>
<td>9/9,11</td>
<td>Introduction, neural models</td>
<td>Chap 1</td>
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<tr>
<td>9/14,16,18</td>
<td>Rosenblatt’s Perceptron</td>
<td>Chap 2</td>
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<td>9/21,23,25</td>
<td>LMS algorithms</td>
<td>Chap 3</td>
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<td>9/28,30,10/2</td>
<td>Multilayer perceptron, back propagation</td>
<td>Chap 4</td>
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<td>10/5,7,9</td>
<td>Cross validation, network pruning</td>
<td>Chap 4</td>
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<td>10/12,14,16</td>
<td>Radial basis function network</td>
<td>Chap 5</td>
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<td>10/19,21</td>
<td>Hybrid learning</td>
<td>Chap 5</td>
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<td>10/23</td>
<td><strong>Mid term exam</strong></td>
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<td>10/26,28,30</td>
<td>Support vector machines</td>
<td>Chap 6</td>
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<td>11/2,4,6</td>
<td>Regularization theory</td>
<td>Chap 7</td>
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<tr>
<td>11/9,11,13</td>
<td>Regularization theory cont.</td>
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<td>11/15,18,20</td>
<td>Principle component analysis</td>
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<td>Self-organizing feature map, Learning vector quantization</td>
<td>Chap 9</td>
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<td>11/30,12/2,4</td>
<td>Information theoretic models (Entropy, Mutual information)</td>
<td>Chap 10</td>
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<td>12/7,9,11</td>
<td>Information theoretic models cont.</td>
<td>Chap 10</td>
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<tr>
<td>12/14,16</td>
<td>Simulated annealing and TSP</td>
<td>Lecture Note</td>
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<td>12/17-22</td>
<td><strong>Final exam week</strong></td>
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**Outcomes addressed by this course:**
(a) An ability to apply knowledge of mathematics, science, and engineering  
(b) An ability to design and conduct experiments, as well as to analyze and interpret data  
(c) An ability to design a system, components, or process to meet desired needs  
(e) An ability to identify, formulate, and solve engineering problems  
(g) An ability to communicate effectively in writing and orally  
(h) The broad education necessary to understand the impact of engineering solutions in a global and societal context  
(j) A knowledge of contemporary issues  
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice  
(l) A knowledge of computer software and hardware as demonstrated by the Computer Science Minor embedded in the program  
(m) A knowledge of applied mathematics as demonstrated by students obtaining an Applied Math Minor with an appropriate selection of an advanced math course or an advanced ECE elective with appropriate mathematics content  
(n) An ability to work in a hands-on laboratory in most of the required courses

*Individuals who have any disability, either permanent or temporary, which might affect their ability to perform in the class, are encouraged to inform the instructor at the start of the semester. Adaptations may be made as required to provide for equitable participation*

Prepared by ___________________________________________  
Taek Mu Kwon