

EE 689: COMPUTATIONAL INTELLIGENCE and NEURAL LEARNING
Fall 2023

6 – 9:40 pm Wednesday

Professor Kosko
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Summary: This seminar-style course presents modern neural learning and computational intelligence techniques with a special focus on probabilistic descriptions and *research creativity*. Topics include deep learning, wetware and hardware, adaptive pattern classification, fuzzy XAI function approximation, and other hybrid machine-learning systems. Applications in signal processing and statistics (including financial engineering). The instructor will provide supplemental notes and software. Students will work in groups to prepare and present a final project that applies computational intelligence techniques to an approved original problem that merits publication.

Note: Enrollment requires instructor approval

Strongly Recommended: Kosko, B., *Nanotime*, Lume Books (digital second edition), 2019
Kosko, B., *Fuzzy Engineering*, Prentice Hall, 1997
Kosko, B., *Neural Networks and Fuzzy Systems*, Prentice Hall, 1992
Note: The above two texts available as a bound copy in the bookstore.

Recommended: Efron, B., Hastie, T., *Computer Age Statistical Inference: Algorithms, Evidence, and Data Science*, Cambridge University Press, 2016
Bishop, C., *Pattern Recognition and Machine Learning*, Springer, 2006
Hedman, S., *A First Course in Logic: Model Theory, Proof Theory, Computability, and Complexity*, Oxford University Press, 2008

COURSE OUTLINE

Aug 23: Computational intelligence. Brains. Feedforward and feedback nets.
Aug 30: Nerves. Feedback stability and uncertainty. Multilayer perceptrons.
Sep 6: Regression and classification. Probable inference. Discounting.
Sep 13: Rules and explainable AI (XAI). Probability framework: Mixtures.
Sep 20: AI and patents. Backpropagation probability. Expectation-Maximization.
Sep 27: Midterm I. Backpropagation as EM hill climbing. Noise boosting.
Oct 4: Additive model. Topology of function approximation. Mixture rules.
Oct 9: Expert fusion. SAM supervised learning. Generalized mixture learning.
Note: This is a *Monday* at 6 pm
Oct 18: Approximator statistics. Bayesian inference. Project proposals due.
Oct 25: SDEs. Bayesian regression nets. Recurrent backpropagation.
Nov 1: Midterm II. Unsupervised and competitive learning. Adversarial nets.
Nov 8: Adaptive resonance. Neural vector quantization. MCMC and annealing.
Nov 15: Gradient systems. Operant conditioning. Feedback causal models.
Nov 22: No class: Thanksgiving holiday.
Nov 29: Project presentations. Mandatory attendance.

GRADING PROCEDURE

1. **Midterms.** Two midterms. Each worth 25 points. Seminar format may apply.
2. **Homework.** Checked and recorded. Not graded. A perfect set of worked homework problems can earn 10 points. Lesser homework sets earn fewer points. Grade stays as is if only some homework turned in. How much homework counts for how many points lies at the discretion of the instructor and teaching assistant. Students may discuss the homework problems among themselves but each student must work his or her own problems. Cheating warrants a course grade of F.
3. **Project.** Well prepared and presented project worth 50 points. Exceptional projects can earn an automatic course grade of A. Hence: *Project excellence trumps all else.* Projects must have the instructor's written approval. Failure to present a project on schedule results in automatic course grade of F. Project evaluation at discretion of instructor and teaching assistant. View project as the final exam.
4. **Course Grade.** 100 points possible in course.

A	if	90 - 100
B	if	80 - 89
C	if	70 - 79
D	if	60 - 69
F	if	0 - 59
5. **Cheating.** Not tolerated. Common errors in homework and exams can count as written evidence of cheating. Penalty ranges from F on exam to F in course to recommended expulsion.
6. **Statement for Students with Disabilities.** Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.
7. **Statement on Academic Integrity.** USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus*, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the

recommended sanctions are located in Appendix A:

<http://www.usc.edu/dept/publications/SCAMPUS/gov/>. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.

8. Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu> or to the *Department of Public Safety* <http://capsnet.usc.edu/departments/departments-public-safety/online-forms/contact-us>. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage <http://sarc.usc.edu> describes reporting options and other resources.

9. Support Systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.