

## Teaching Statement

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Prof. Siskind has redesigned the curriculum for ECE47300, an undergraduate course in AI. The traditional AI curriculum, which focusses on search, automated reasoning, and planning, is less relevant for today's ECE undergraduates. AI is primarily a research enterprise. Most undergrads find training in AI of little relevance to their anticipated career in industry. Thus, Prof. Siskind has redesigned the curriculum for ECE47300 to focus on material that is relevant to preparing ECE undergrads for an industrial career. This includes styles of programming that are not covered in other ECE courses: functional programming and symbolic manipulation. Prof. Siskind has chosen to retain the focus on functional programming and symbolic manipulation, and not refocus the course on current fads like deep learning, because these fundamental skills can be applied much more broadly across all of computer engineering and have stood the test of time. Since the computer engineering curriculum at Purdue is focussed primarily on hardware design, students otherwise lack adequate preparation in software and algorithm design. Retaining the traditional focus on functional programming and symbolic manipulation affords the opportunity to give students the sorely needed opportunity to expand their programming experiences with programming styles and algorithmic content to which they would otherwise not be exposed to. This provides lasting career-long value that would not be provided by teaching students to use canned tools to train a classifier with backpropagation.

In this redesigned course, many techniques and algorithms from AI are taught within the context of solving ECE problems, instead of traditional AI problems. For example, the concept of evaluation is taught by having the students write an evaluator for Boolean expressions, rather than an evaluator for LISP. The concept of rewrite systems is taught by having the students write a simplifier for Boolean expressions, rather than an expert system. The concept of resolution is taught by having the students write a system that uses resolution to find faults in a digital circuit rather than to prove theorems.

The redesigned course focuses on algorithms: evaluation, pattern matching and rewrite systems, constraint satisfaction, and automated reasoning techniques like semantic tableaux, resolution, and congruence closure. It is difficult for students to become fluent in these algorithms solely from the lectures. Thus, the problem sets have the students implement most of the algorithms taught in lecture.

Significant effort has gone into preparing the problem sets. It is not feasible for students to implement the material taught in lecture without a prepared infrastructure. There would simply be too much code to write over the course of a semester. Thus, Prof. Siskind has prepared a framework for each problem set that includes three components: (a) the low-level data-structure manipulation routines, (b) a search engine, and (c) a GUI that handles I/O and often animates the algorithm in operation. Within this framework, students need only implement the concept-rich portion of material taught in class. Having students write code that interoperates with a larger system teaches them how to read and understand APIs and write code that conforms to specifications. Prof. Siskind makes this course material available to other instructors, including ones at Georgia Tech and the University of Washington.

In 2010, Prof. Siskind redesigned the curriculum for ECE57000, a graduate course in AI. As part of the revised course requirements, students do a term paper/project/presentation. Students select and read three papers published within the past three years in a conference or journal in AI, broadly construed to include AI, computer vision, natural-language processing, robotics, machine learning, cognitive science, and neuroscience. They then implement the ideas in one of them and write a six-page term paper in AAI submission format, three pages of which present a review and critique of the three papers that they read and three pages of which describe their implementation and the experiments/evaluation that they performed. Upon completion, they present a 12- to 25-minute conference-style PowerPoint presentation to the class, half of which presents a review and critique of the three papers that they read and half of which discusses their implementation and evaluation. Inter alia, this has been used to satisfy the CS department Communication Requirement for MS students posted at <https://www.cs.purdue.edu/graduate/curriculum/masters.html#communication>.

In 2016 and 2017, Prof. Siskind further redesigned the curriculum for ECE57000 to focus on machine learning in general and deep learning in particular. The lectures contain newly developed material that teaches the fundamentals of forward and reverse mode automatic differentiation, teaches back propagation and training of neural networks using automatic differentiation, and teaches the fundamentals of object detection in computer vision using convolutional neural networks. Newly designed problem sets for this course have students learn to use multiple deep learning frameworks, including TORCH and CAFFE, in multiple programming languages, including LUA and PYTHON, and build complete end-to-end systems to do classification using multilayer perceptrons, object classification using convolutional neural networks, and object detection and localization using proposal-general mechanisms together with object classifiers. This is in addition to the term paper/project/presentation discussed above.

#### Teaching Evaluations

	Spring (undergraduate ECE47300)				Fall (graduate ECE57000)			
	course		instructor		course		instructor	
2002	2.42/4	(2.80)	2.93/4	(3.11)	2.88/4	(3.14)	2.72/4	(3.41)
2003	3.02/4	(2.86)	3.42/4	(3.16)	2.94/4	(3.24)	3.31/4	(3.50)
2004	2.31/4	(2.87)	2.27/4	(3.14)	3.50/4	(3.19)	3.60/4	(3.39)
2005	3.35/4	(2.77)	3.47/4	(3.04)	3.56/4	(3.04)	3.71/4	(3.36)
2006	3.81/5	(3.67)	3.73/5	(4.01)	4.77/5	(4.04)	5.00/5	(4.26)
2007	2.38/5	(3.63)	2.94/5	(4.07)	4.82/5	(4.08)	5.00/5	(4.32)
2008	4.29/5	(3.76)	4.64/5	(4.16)	4.8/5		4.8/5	
2009	4.8/5		4.6/5		4.8/5		5.0/5	
2010	4.7/5		4.7/5		4.8/5		4.9/5	
2011	3.7/5		4.3/5		4.8/5		4.9/5	
2012	4.7/5		4.8/5		4.7/5		4.8/5	
2013	4.9/5		4.9/5		4.8/5		4.9/5	
2014	4.2/5		4.8/5		4.7/5		4.8/5	
2015	4.8/5		4.8/5		4.4/5		4.6/5	
2016	4.8/5		4.8/5		3.8/5		4.3/5	
2017	4.5/5		4.8/5		4.3/5		4.5/5	
2018	5.0/5		5.0/5					

Numbers for Spring 2002–Fall 2005 are course and instructor means (out of 4). Numbers in parenthesis are departmental average means for corresponding undergraduate or graduate lecture courses. Numbers for Spring 2006–Spring 2008 are course and instructor means (out of 5). Numbers in parenthesis are departmental average means for corresponding undergraduate or graduate lecture courses. Numbers for Fall 2008–Spring 2018 are the medians for the “Overall” questions (out of 5). Departmental average “Overall” medians are not provided to instructors.

#### PhD students graduated

Andrei Barbu, December 2013, postdoc MIT.  
 Siddharth Narayanaswamy, May 2014, postdoc Stanford, postdoc Oxford.  
 Daniel Paul Barrett, May 2016, Sandia National Laboratory.  
 Scott Alan Bronikowski, May 2016, General Motors.  
 Haonan Yu, May 2016, Baidu.

#### MS students graduated

Vamsi Vytla, May 2005, Schlumberger, Lawrence Berkeley Laboratory.  
 Pranay Gupta, December 2005, Google.

ECE49600 students

Abhilasha Bhargav, Fall 2002, PhD Purdue CS, Intel.  
Keith Henderson, Fall 2002, MS Berkeley, Lawrence Livermore Laboratory.  
Ross Beranek, Fall 2007.  
Iheukwumere Onwuka, Fall 2007, Spring 2008.  
Seongwoon Ko, Fall 2010, MS Columbia.  
Colin Graber, Spring 2015, PhD student UIUC.

ECE47300 honors contracts

Jordan R. Glassley, Spring 2013.  
Colin Graber, Spring 2014, PhD student UIUC.

Other independent study students

Alejandrina Cristià, LING59000, Spring 2008, PhD Purdue Linguistics, Laboratoire de Sciences Cognitives et Psycholinguistique, Centre National de la Recherche Scientifique, ENS-DEC, EHESS.  
Tsz Kwan Lam, LING69000, Spring 2013, PhD Purdue Linguistics, Chinese University of Hong Kong.  
Charles Roger Bradley, LING69900, Summer 2016.

SURF (summer undergraduate research fellowship) students paid

James J. Sherman, Jr., 2003, MS Maryland.  
Vamsi Vytla, 2003, Schlumberger, Lawrence Berkeley Laboratory.  
Andrei Barbu, 2006, postdoc MIT.  
Shami Didla, 2006.  
Sarah Fortune, 2006.  
Anchal Dube, 2008, MS Cornell.  
Isaac P. Jones, 2009, MS CMU.  
Brian Jay Thomas, 2009, MS Brown, Facebook.

Visiting graduate students paid by Mind's Eye

The following visiting graduate students were paid under the DARPA Mind's Eye cooperative agreement. Waggoner was a coauthor on a paper published in CVPR (2012). Salvi and Waggoner were coauthors on a paper published in UAI (2012).

Jeff Johnson, Indiana University, December 2010.  
Dhaval Salvi, University of South Carolina, December 2010–January 2011.  
Jarrell Waggoner, University of South Carolina, December 2010–January 2011.

Undergraduate students paid by Mind's Eye

The following undergraduate students were paid under the DARPA Mind's Eye cooperative agreement in winter 2010. They were all coauthors on a paper published in UAI (2012).

Alexander Bridge  
Dan Coroian  
Sam Mussman, Google.  
Lara Schmidt  
Jiangnan Shangguan  
Jinliang Wei, PhD student CMU.  
Yifan Yin

The following undergraduate student from University of Pennsylvania was paid under the DARPA Mind's Eye cooperative agreement during the summers of 2011, 2012, 2013, and 2014. He was a coauthor on a paper published in UAI (2012).

Zachary J. Burchill, PhD student Rochester.

Other undergraduate students paid

Vamsi Vytla, Summer 2002, Fall 2002, Spring 2003, Schlumberger, Lawrence Berkeley Laboratory.

Abhilasha Bhargav, Summer 2002, Fall 2002, Spring 2003, PhD Purdue CS, Intel.

Bingrui Foo, Summer 2003, Fall 2003, Uber.

Pranay Gupta, Summer 2003, Google.

Anchal Dube, Fall 2008, Spring 2009, MS Cornell.

Brian Jay Thomas, Fall 2009, Spring 2010, MS Brown, Facebook.

Other graduate students mentored on an *ad hoc* basis

Min Lu

Shawn Alan Brownfield

Rezwanuzzaman Chowdhury

Padmini Jaikumar

Aaron Michaux

Ryan Buffington

Tommy Y. Chang

David Schwartzman Cohenca

Anantha P. Raghuraman, MS Purdue.

Xiran Wang

Sarvesh Vijay Pradhan, MS Purdue.

Abdullah Bader Alshaibani

Vikas Dhiman, PhD student University of Michigan.

Other undergraduate students mentored on an *ad hoc* basis

Jason duFair

Blake Matheny, Google.

Jeremy Tryba

Rajat Agarwal

Seth Benjamin, BS student Columbia.

Stephen Michael James Bulley

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