Christof Teuscher

ECE 410/510: Hardware for AI and ML

Course organization and details

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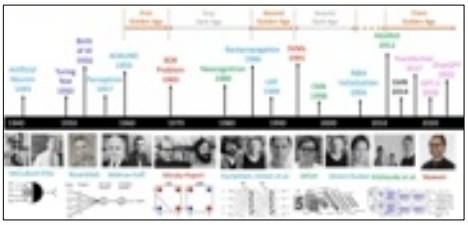
THIS IS AN EXPERIMENT

Anything can change anytime.
Failure is an option.
Students will not be carrying the risk.

Once upon a time…

Systems Science & ECE professor George Lendaris retired in 2011. With him, the one and only neural network course we offered died because there was not enough interest.

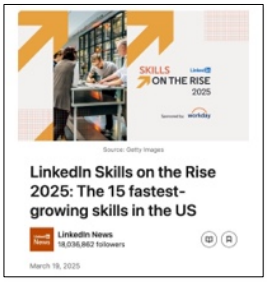


https://medium.com/@lmpo/a-brief-history-of-ai-with-deep-learning-26f7948bc87b

2016
ECE 586

Why this course?

Why this course?



1. AI Literacy

Why it's on the rise: As AI rapidly transforms industries, companies are increasingly looking for professionals with the ability to understand and utilize tools harnessing that technology for business purposes.[4] | **Most common job titles:** Software Engineer, Product Manager, Chief Executive Officer | **Most common industries:** Technology and Internet, Higher Education, IT Services and IT Consulting

https://www.linkedin.com/pulse/linkedin-skills-rise-2025-15-fastest-growing-us-linkedin-news-hy0le

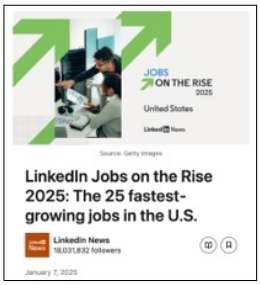
SKILLS ON THE RISE

LinkedIn

Engineering

1	LLM Development & Application
2	People Management
3	Agile Problem Solving
4	AI Strategy
5	Azure SQL
6	Communication
7	Cloud Applications
8	Technical Documentation
9	Scikit-Learn
10	Matplotlib

AI recruitment machines map out workers' career paths



Source: Getty Images

LinkedIn Jobs on the Rise 2025: The 25 fastest-growing jobs in the U.S.

LinkedIn News
18,031,832 followers

January 7, 2025

1 Artificial Intelligence Engineer

What they do: Artificial intelligence engineers design, develop and implement AI models and algorithms to optimize processes and solve complex problems. | **Most common skills:** Large Language Models (LLM), Natural Language Processing (NLP), PyTorch | **Most common industries:** Technology and Internet, IT Services and IT Consulting, Computers and Electronics Manufacturing | **Where the most jobs are:** San Francisco, New York City, Boston | **Current gender distribution:** 20% female, 80% male | **Median years of prior experience:** 3.6 | **Top roles transitioned from:** Full Stack Engineer, Research Assistant, Data Scientist | **Flexible work availability:** 35.5% remote, 27.3% hybrid

https://www.linkedin.com/pulse/linkedin-jobs-rise-2025-25-fastest-growing-us-linkedin-news-gryie

5 Travel Advisor

Can also be known as Travel Agent

What they do: Travel advisors help plan and book travel arrangements — including transportation, accommodations and activities — based on clients' preferences and budgets. | **Most common skills:** Travel Planning, Travel Writing, Social Media Marketing | **Most common industries:** Travel Arrangements, Hospitality, Insurance | **Where the most jobs are:** New York City, Los Angeles, Miami | **Current gender distribution:** 80% female, 20% male | **Median years of prior experience:** 4.7 | **Top roles transitioned from:** Sales Specialist, Customer Service Representative, Administrative Assistant | **Flex work availability:** 26.7% remote, 4.9% hybrid

https://www.linkedin.com/pulse/linkedin-jobs-rise-2025-25-fastest-growing-us-linkedin-news-gryie

Nearly two-thirds of professionals are overwhelmed by workplace change

Published on Oct 2, 2024 | Categories: Latin America, North America, Europe, Middle East, Australia, Asia, Africa, Company News, Data and Insights

LinkedIn Corporate Communications

Professionals recognize experience alone isn't enough

Although important, 56% acknowledge that experience alone isn't enough. While 36% of people say continuous learning is critical in getting ahead and 46% say they need guidance on the skills needed to navigate workplace change.

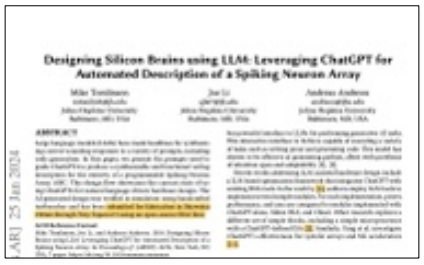
At the same time, just 37% feel they can rely on their manager to help navigate periods of change in their job, and only 51% think their company's leadership is helping them keep pace with changes. A third are unsure what information to trust about career growth, highlighting that today's workers need more help finding their path forward than ever before.

LinkedIn tips for adapting to change and staying ahead:

1. **Stay on top of change:** Topics like AI and hybrid work are changing constantly. By staying up to date with the latest news and insights from trusted experts, such as LinkedIn Top Voices, you can better understand how these developments impact your daily work and what they might look like in the future. Staying current can help you avoid feeling overwhelmed and more in control.
2. **Adopt a growth mindset:** Change is hard and it's okay to feel nervous, so try to approach the process with an open mind. With a willingness to learn, you can build knowledge in areas that will make navigating change easier. Take AI, for instance. Practicing prompt writing or using AI to take meeting notes will make it easier to use these tools in the future. LinkedIn has unlocked a series of Learning Courses such as Building an Adaptability Mindset in the Age of AI for free until November 25, 2024 and is also offering two complimentary professional certificates on Gen AI until the end of 2025.
3. **Embrace bitesize learning:** Find easier ways to acquire new skills and knowledge so continuous learning feels more manageable. Professionals find short-form video the most helpful and engaging when looking for information (46%) – and it's rapidly growing on LinkedIn, with video uploads up 34% year-over-year.

https://news.linkedin.com/2024/October/overwhelmed-by-workplace-change

Inspiration and course design



Designing Silicon Brains using LLM: Leveraging ChatGPT for Automated Description of a Spiking Neuron Array

Mike Tzelepis, Joe Li, Andreas Andreou

Johns Hopkins University, Baltimore, MD, USA

ABSTRACT

I. INTRODUCTION

II. Related Work

III. Methodology

IV. Results

V. Discussion

VI. Conclusion

REFERENCES

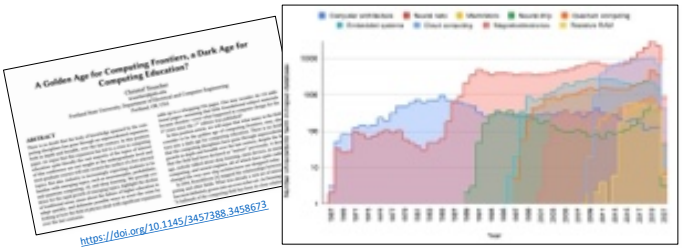
ARI 29 Jan 2024

https://arxiv.org/abs/2402.10920

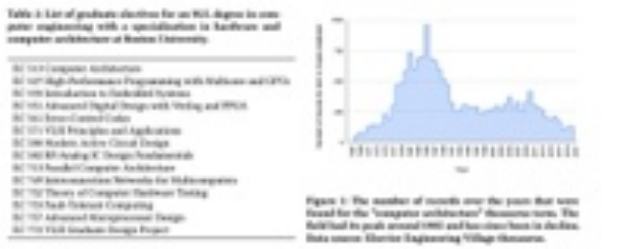
How do we teach cutting-edge new technology?

Nothing seems linear and predictable
Everything is complex
Everything is connected
Everything moves fast

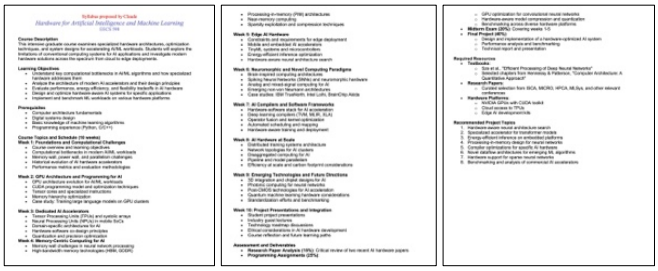
The need for new educational approaches



https://doi.org/10.1145/3457388.3458673



Let's ask Claude…



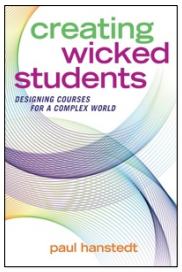
Pillars this class is built on

You! **Foundations** **Co-design** **LLM** **Experimentation**

What's the role of education?

- **The old model**:
  - `knowledge + skills = success`
  - Domain-specific compartmentalization + professor with authority + lectures + fixed curriculum + assessment → **terminal degree**
- **The new model**:
  - creative thinking
  - complex problem solving
  - the ability to learn
  - emotional intelligence

  → **learning never ends**



What is a wicked student?

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Let's talk about the fine print…

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My assumptions and expectations

- Intrinsically motivated to learn about this subject.
- Willing to be challenged and to get out of your comfort zone.
- Willing to show up and put in the work.
- Willing to not take shortcuts.
- Always does a little more rather than a little less.

"In science, if you know what you are doing, you should not be doing it.

In engineering, if you do not know what you are doing, you should not be doing it."

— Richard W. Hamming, **The Art of Doing Science and Engineering: Learning to Learn**.

A word about prerequisites

Recommendations:
- Undergraduate: ECE 371 and ECE 351
- Graduate: ECE 485

Ideal knowledge:
- Python or other language
- Github
- Advanced computer architecture, incl. GPUs
- FPGAs
- Analog and digital circuits
- Verilog, SystemVerilog
- AI prompt engineering

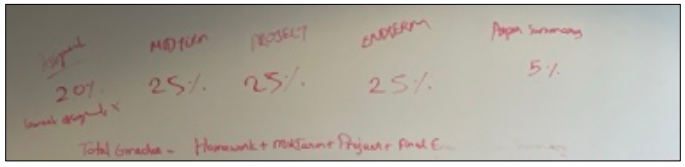
Learning goals

- Prepare you for a complex, fast-moving, constantly-changing world.
- Understand the principles and tools for SW/HW co-design.
- Understand the foundations of neural networks.
- Understand the foundations of Large Language Models (LLMs).
- Understand the foundations of specialized hardware for AI/ML, such as GPUs, TPU, FPGAs, and neuromorphic architectures.
- Capable of mapping algorithms onto hardware.
- Capable of evaluating HW designs.
- Capable of optimizing HW designs through co-design for computational power, efficiency, and flexibility.
- Capable of using modern SW and HW tools for designing and using specialized HW for AI/ML.

What this class is not

- Not a class about LLM, AI, ML, ANN, etc.
- …

Traditional grading



This course is entirely self-graded

Why is that good for you?
- Puts you in the driver seat
- Learn how to advocate for yourself.
- Learn how to document and sell your progress/contributions.
- Prepares you for performance evaluations in industry.
- An opportunity to shine in your own way.

What is my role in this?
- Ensure integrity of the process.
- Intervene if necessary (over-/under-estimation of performance)

This course is entirely self-graded

How will this work?

- Throughout this course, you will **document and keep track** of all your creations and contributions (e.g., Github, Wiki, Slack, etc.)
- At the end the term, you will write a **recommendation letter** for yourself.
- The letter will serve as a self-evaluation.
- You will assign yourself a grade based on your contributions.
- Effort doesn't count. You need to earn your grade with tangle products. Move your own needle!

Additional perks

- I will assess your performance holistically throughout the term using Google's GRAD system:
  - Transformative Impact (TI)
  - Outstanding Impact (OI)
  - Significant Impact (SI)
  - Moderate Impact (MI)
  - Not Enough Impact (NE)
- Think of this as your "probation period." You want to get hired, so act accordingly.
- **OI students can ask me for a LinkedIn recommendation.**
- **TI students can ask me for a recommendation letter.**
- **Selected TI students may be offered a summer GRA position.**

Will there be exams and quizzes?

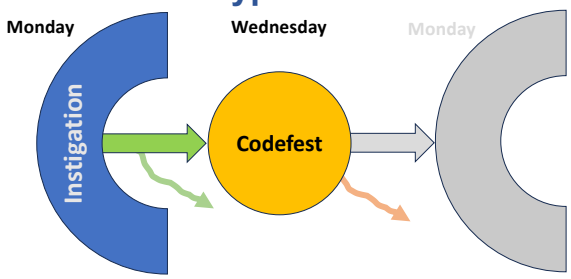
Goal: provide you with opportunities to shine and stand out.

- Weekly questions and problems.
- Final optional oral examinations?

What will we do?

You will each (co-)design, test, evaluate, etc. an AI/ML accelerator for a large class-wide chiplet design.

A typical week

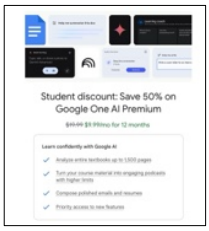


Tentative course plan

Week	Date	Session	Activity	Description
1	Mar 31	Mon	In-class	Introduction, class organization, topic overview
	Apr 2	Wed	In-class	Codefest
2	Apr 7	Mon	In-class	Introduction to selected modern AI/ML algorithms: CNN, DNN, LLMs, etc.
	Apr 9	Wed	In-class	Codefest
3	Apr 14	Mon	In-class	HW/SW co-design: methods, tools, optimizations, workloads
	Apr 16	Wed	In-class	Codefest
4	Apr 21	Mon	In-class	Introduction to specialized HW architectures: GPU, TPU, FPGA, ASIC, neuromorphic circuits
	Apr 23	Wed	In-class	Codefest
5	Apr 28	Mon	In-class	Mapping AI/ML algorithms onto specialized HW through co-design
	Apr 30	Wed	In-class	Codefest
6	May 5	Mon	In-class	Metrics, evaluation, and benchmarking of SW/HW mappings
	May 7	Wed	In-class	Codefest
7	May 12	Mon	In-class	Optimizing SW/HW mappings for computational and energy efficiency
	May 14	Wed	In-class	Codefest
8	May 19	Mon	In-class	Neuromorphic hardware and neural engines
	May 21	Wed	In-class	Codefest
9	May 26	Mon	No class	Memorial Day
	May 28	Wed	In-class	Codefest
10	Jun 2	Mon	In-class	Emerging technologies and developing future cutting-edge AI/ML hardware
	Jun 4	Wed	In-class	Codefest

What will you need?

- **Access to your favorite LLM**. No pro subscription required, but recommended.
- Ability to bring and work on a **laptop**.



What model should I use?

AI tools advice

Before relying heavily on any AI tool, test it on problems/topics/etc. for which you're an expert.

This simple exercise will allow you:

- Calibrate your expectations of the tool's knowledge depth.
- Understand its strengths and limitations.
- Build intuition about its reliability on various topics
- Set a baseline for how much verification you'll need in unfamiliar areas.

How to get help?

- **E-mail:** teuscher@pdx.edu
- **Office hours:** https://www.teuscher-lab.com/officehour

Practice the “campsite rule”

Your presence should make this classroom a better place.

- **Engage**: listen, participate, contribute, do your share. Play fair.
- **Focus**: no side conversations, no laptop and phone addiction, no work for other classes.
- **Be present**: show up, be on time.
- **Challenge yourself**: do always a little more instead of just the bare minimum. Up your game, set high standards for yourself. Produce work that you can be proud of.
- **Help others** to be successful. That includes your team.
- **Willingness to learn**: have a growth mindset, intellectual humility and ambition.
- **Be in charge**: Put yourself in the driver’s seat, assume responsibility.

Participate in an educational study and publication

- **Now**: complete an initial skills/knowledge assessment.
- **End of term**: complete the same survey.

- Agree to have your deliverables/products assessed.
- Participate in a focus group at the end of the term.

- **Why participate?**
  - Help to make this a better class for future students
  - Be part of the change
  - Co-author a publication?

Prep for Wednesday

- Bring your laptop
- Accept the Slack invite (to be sent)
- Create a wiki account (to be shared)
- Github (to be shared)

- Reading:
  - Designing Silicon Brains using LLM: Leveraging ChatGPT for Automated Description of a Spiking Neuron Array, https://arxiv.org/abs/2402.10920