Structured Writing for Professionals

English 170
Stanford University, Fall 2025
Mihail Eric

The Modern Software Developer

CS146S
Stanford University, Fall 2025
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Introduction and How LLMs are Made

State of the World: 2025

Reuters
World Business Markets Sustainability Legal Commentary Technology Investigations

AI startups revolutionize coding industry, leading to sky-high valuations

By Anna Tong and Krystal Hu

June 3, 2025 6:46 PM PDT · Updated June 3, 2025

Meta's Zuckerberg pledges hundreds of billions for AI data centers in superintelligence push

14 February 2025

EDUCATION

Dancing with digital partners: The creative revolution of generative AI

FINANCIAL TIMES

US COMPANIES TECH MARKETS CLIMATE OPINION LEX WORK & CAREERS LIFE & ARTS HTSI

Opinion **Artificial intelligence**

At work, a quiet AI revolution is under way

Bad News

"**~95%** of our code is written using Windsurf's agent Cascade and the passive coding feature, Windsurf Tab."

- Windsurf team

Anthropic's CEO says that in 3 to 6 months, AI will be writing 90% of the code software developers were in charge of

Google chief scientist predicts AI could perform at the level of a junior coder in a year

MAJOR	UNEMPLOYMENT RATE	UNDEREMPLOYMENT RATE	MEDIAN WAGE EARLY CAREER	MEDIAN WAGE MID-CAREER	SHARE WITH GRADUATE DEGREE
ACCOUNTING	1.9%	17.9%	$60,000	$88,000	32.9%
ADVERTISING AND PUBLIC RELATIONS	3.5%	34.1%	$56,000	$89,000	20.7%
AEROSPACE ENGINEERING	1.4%	18.8%	$76,000	$125,000	51.5%
AGRICULTURE	1.2%	42.4%	$50,000	$75,000	19.9%
ANIMAL AND PLANT SCIENCES	1.0%	53.2%	$43,000	$70,000	35.6%
ANTHROPOLOGY	9.4%	55.9%	$42,000	$70,000	46.7%
ARCHITECTURE	4.3%	30.8%	$52,000	$80,000	40.8%
ART HISTORY	3.0%	46.9%	$45,000	$71,000	47.9%
BIOCHEMISTRY	3.3%	44.4%	$52,000	$89,000	70.8%
BIOLOGY	3.0%	45.6%	$47,000	$80,000	63.4%
BUSINESS ANALYTICS	2.4%	27.2%	$70,000	$100,000	25.6%
BUSINESS MANAGEMENT	4.0%	51.3%	$55,000	$80,000	25.3%
CHEMICAL ENGINEERING	2.0%	16.5%	$80,000	$120,000	47.8%
CHEMISTRY	6.1%	40.6%	$55,000	$90,000	65.5%
CIVIL ENGINEERING	1.0%	20.2%	$71,000	$100,000	39.9%
COMMERCIAL ART & GRAPHIC DESIGN	7.2%	34.7%	$48,000	$75,000	11.3%
COMMUNICATIONS	4.5%	52.3%	$52,000	$85,000	23.5%
COMPUTER ENGINEERING	7.5%	17.0%	$80,000	$122,000	40.0%
COMPUTER SCIENCE	6.1%	16.5%	$80,000	$115,000	32.8%

Good News

- Software developers have the potential to be more productive than they have ever been in history
- With AI coding an engineer can pick up tech stacks and tools at an unprecedented pace
- You won't be replaced by AI. You'll be replaced by a competent engineer who knows how to use AI.

The Modern Software Developer

This is **not** the "vibe coding" class

10 weeks in 2 slides

The Takeaway

- Human-agent engineering
  - Focus on the skills that are not yet replaced by AI systems
  - Business understanding
  - Become the tech lead
- LLMs are only as good as you are
  - Good context leads to good code
  - If you can't understand your codebase, neither will an LLM

The Takeaway
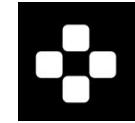
- Read and review **a lot** of code
    - Learn to discern good from bad, wrong software
    - Have good taste
- Experiment aggressively
    - There are no established software patterns yet
    - Everyone is still figuring it out
    - This class will introduce many workflows and tools - figure out what works for you

Course Logistics

- A bit about me
  - Stanford undergrad/grad
  - Head of AI at a stealth startup in the sales space
  - Built first LLMs at Amazon Alexa
  - Founded and sold an ML education startup
  - Founded a YC-backed AI coding company
- 1 awesome CA
  - Febie Lin

Course Logistics

- https://themodernsoftware.dev
- Lectures
  - Mon/Fri 8:30-9:20 am
- Deliverables
  - 9 assignments (1x/week) focusing on lecture material practice
    - https://github.com/mihail911/modern-software-dev-assignments
  - 1 final open-ended project in which you will exercise AI coding principles we cover
- Grading
  - 80/15/5 breakdown for project/assignments/participation
- Something pretty awesome
  - Guest lectures from founders leading top AI developer startups today
  - $100s of millions raised, billions in valuation
 - Don't miss these talks!
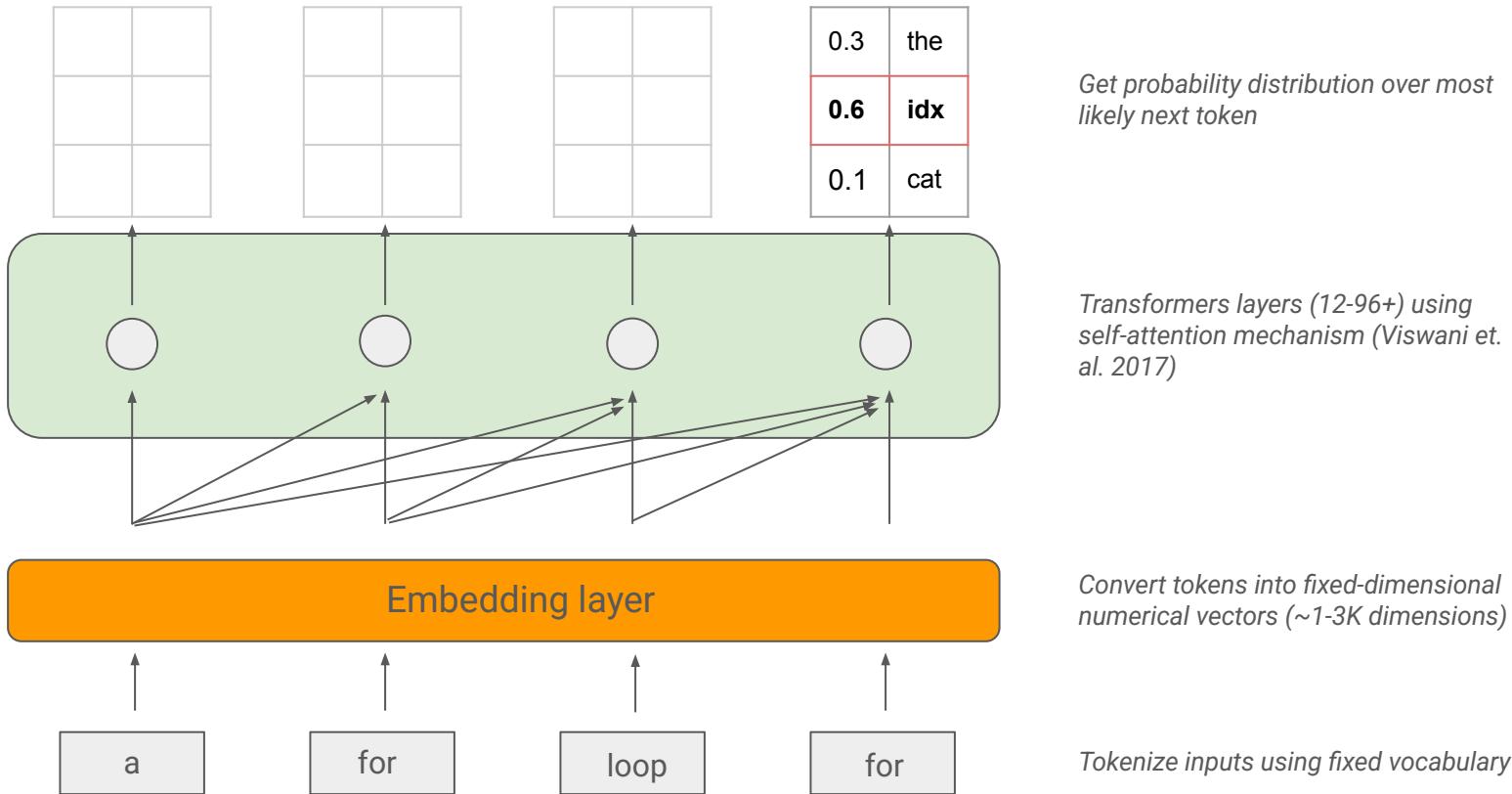
Basics

- LLMs (large language models) are autoregressive models for next-token prediction

$$P(x_1, x_2, \ldots, x_T) = \prod_{t=1}^{T} P(x_t | x_1, x_2, \ldots, x_{t-1})$$

$$\downarrow$$

$$P(\text{write}, \text{a}, \text{for}, \text{loop}, \text{for}, \text{idx}, \text{in}, \text{range} \ldots) = P(\text{range} | \text{write}, \text{a}, \text{for}, \text{loop}, \text{for}, \text{idx}, \text{in}) \cdot P(\text{in} | \text{write}, \text{a}, \text{for}, \text{loop}, \text{for}, \text{idx}) \cdot \ldots \cdot P(\text{a} | \text{write}) \cdot P(\text{write})$$

Basics

0.3	the
0.6	**idx**
0.1	cat

Get probability distribution over most likely next token

Transformers layers (12-96+) using self-attention mechanism (Viswani et. al. 2017)

Embedding layer

Convert tokens into fixed-dimensional numerical vectors (~1-3K dimensions)

a	for	loop	for

Tokenize inputs using fixed vocabulary

Training Process

- Stage 1
  - Self-supervised pretraining
  - Teach the model notion of language on a variety of often public data sources
  - 100s of billions to trillion+ tokens (language and code)
  - Common Crawl, Wikipedia, StackExchange, Public Github repos
  - *Write a for loop* → **that could be used in a piece of code**
- Stage 2
  - Supervised finetuning
  - Teach model to follow instructions
  - High-quality, curated prompt-response pairs (*"what is the capital of Croatia"* -> *"Zagreb is the capital"*)
  - Tens of thousands to 100s of thousands of pairs
  - *Write a for loop* → **ok here's a for loop…**
- Stage 3
  - Preferencing tuning
  - Align model outputs with human preferences (helpfulness, correctness, readability)
  - Collect pairs of outputs for same prompt and train reward model to predict preferred output
  - Tens of thousands to 100s of thousands of human-labeled comparisons
  - *Write a for loop* → **for idx in range(10):**

Training Process

- Reasoning models
  - Extend training with chain-of-thought reasoning traces
  - Tool-use integration
  - Get human preferences on reasoning steps
  - Reinforcement learning to learn how to evaluate reasoning traces, backtrack, etc
- Size
  - GPT-3/Claude 3.5 Sonnet - 175B parameters
  - LLaMA 3.1 - 405B parameters
  - GPT-4 - 1.8T (reported)

In practice

- Strengths
  - Expert-level code completion
  - Code understanding
  - Code fixing
- Limitations
  - Hallucinations
    - Generating non-existent/out-of-date APIs (mitigated with robust context engineering)
  - Context window limits
    - ~100-200K tokens but not all are created equal
  - Latency
    - Seconds to minutes per request depending on task (plan and delegate accordingly)
  - Cost
    - $1-3 per million input tokens, $10+ per million output tokens for best models

Questions?