Lecture 1: Course Introduction

CSE 29: Systems Programming and Software Tools

Aaron Schulman (Shalev)

Lecture 1 Overview

- Introduce Staff
- Class overview
- Jumping right into Systems Programming

Personnel

- Instructor: Aaron Schulman
  - Office hours on the course website

- **5 TAs and 13+1 tutors shared across both classes:**

TAs:
Elena Tomson
Sarah Balatbat
Abijit Jayachandran
Kevin Ly
Nathan Parekh,

Tutors:
Antara Chhabra
Sahil Dalal
Miles Davis
Anika Dontu
Andy Huang
Arush Kamdar
Sriharsha Kavuri
Kyra Lee
Jinchen Luo
Deven Speyrer
Khoa Ta
Aidan Tjon
Gogo Zhou

Who am I?


Former skateboarder
Networking Researcher
Dad
Hacker
Swimmer

Course Website / Syllabus

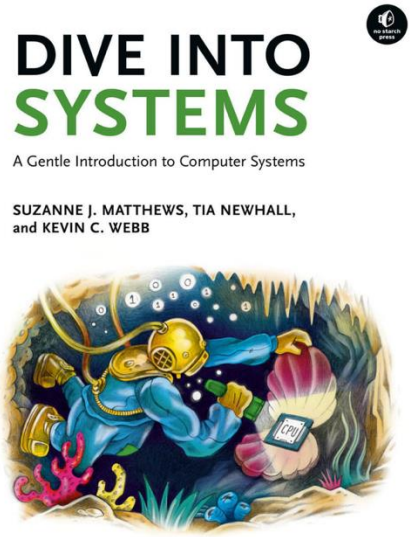
https://cse29.site

We want you to be social and learn

- Class **will not** be podcast
- Lecture attendance contributes to “social learning”
- Lecture slides posted to website immediately after class

Lectures can be supplemented with:
“Dive into Systems” Textbook

HTML freely available at:
https://diveintosystems.org/book/



Expected Outcomes

Students who complete this course will be able to:

- **Learn how each function call makes the world's computers come alive!**

- Describe how a single C program runs on a computer
- Read, write, debug, and test C programs
- Use software tools to work with C programs (e.g., GDB - GNU Debugger)
- Control a computer from the terminal
- Use effective programming practices like incremental development, debugging, testing
- Describe how multiple programs can run at the same time on a computer
- Learn how to avoid basic security vulnerabilities in low-level code

Logistics

- *Big Assignments* Due on even weeks [2, 4, 6, 8, 10]
- Labs *every week*
- Exams weeks [4, 8, 10] (45min)
  - Taken in your lab sections. You need to go to the labs.
- Multiple tries!
  - Assignments: Resubmit ~2 weeks after deadline to improve score
  - Exams: Finals week exam makeups (2hr)
- Discussion
  - Go over assignments

Large Language Model Policy

- You should not use AI to generate code or prose for work in this class.
  - WHY?
    Programming on your own is like swimming for health and fitness, not transportation.
- A boat can get you to your destination faster than swimming.
  Fitness (e.g., swimming) is all about internal changes, not the destination.
  Similarly, programming internally changes you through learning.

  …plus, exams require that you program on your own.

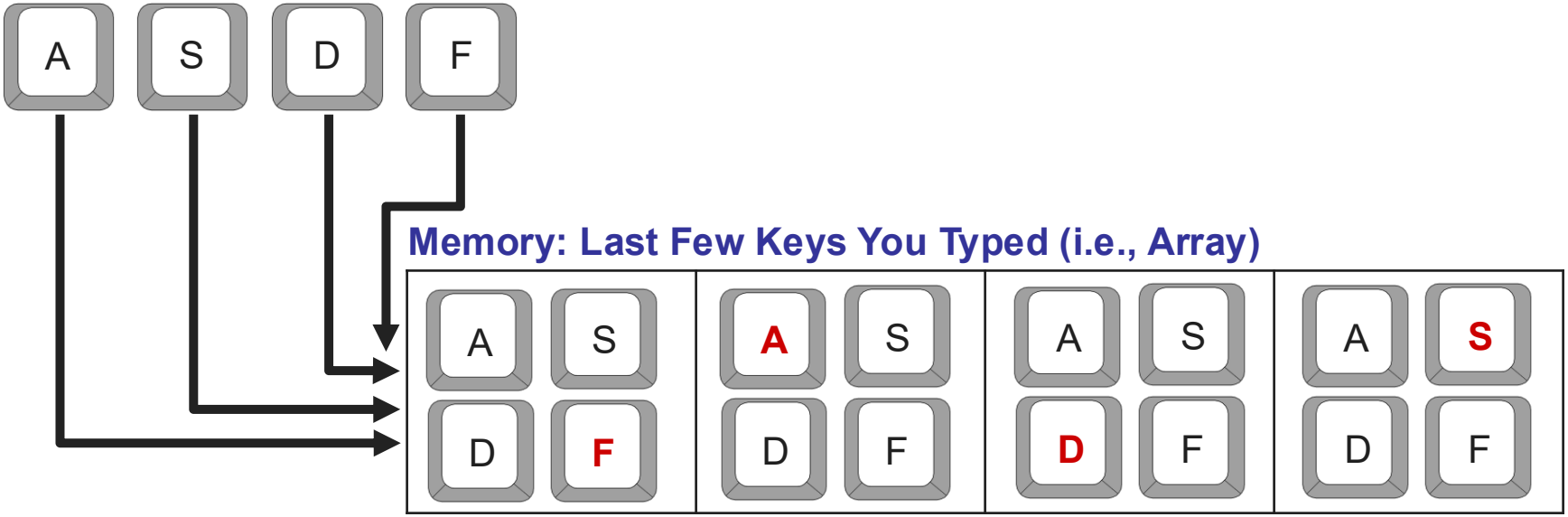
Week 0 Announcements

- Lab attendance is **required** and teaching **terminal-based tooling** happens there, make sure to go to lab
- Assignments, quizzes, and other things with deadlines will start in week 1
- Try to sign into PrarieLearn (https://us.prairielearn.com/)
  - Quizzes and Exams will use the PrarieLearn platform

Demo

How do we store a string of characters inside a computer?

Storing characters typed on a keyboard



How do computers store characters?

SRAM Cell: Stores state of a single bit [1 or 0]

Cheap!

- Made of sand (silicon)

Fast!

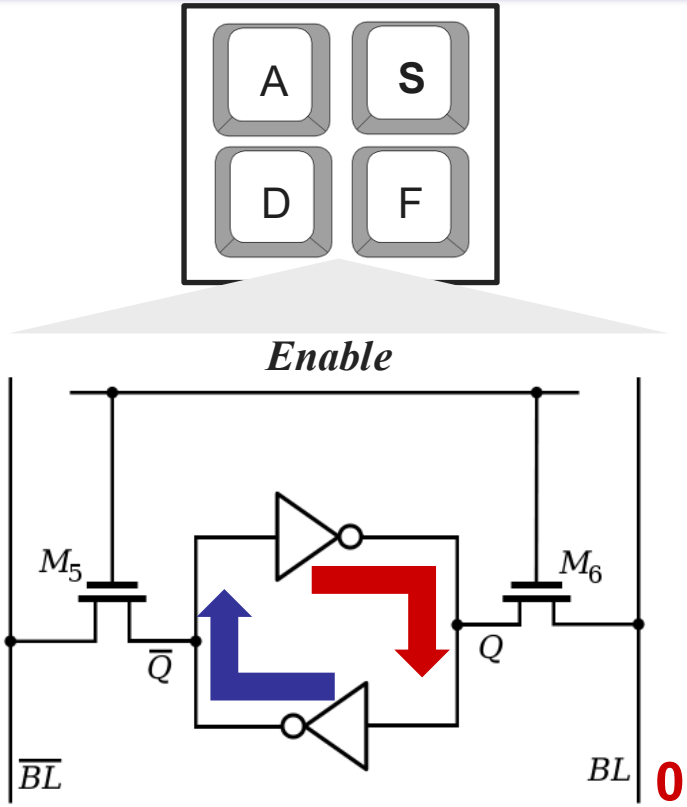
- Read/write billions of times per second

Accurate!

- Nearly always correctly returns the stored bit

Small!

- We can fit billions of them inside of a computer chip



How do we represent characters as bits?

1. Each character is assigned a number that represents it
   - ASCII Encoding: [**0-127]** represents all English Characters

2. Each number is assigned a set of bits that represent it
   - Binary numbering system

ASCII Table

Dec	Hx	Oct	Char	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
0	0	000	NUL (null)	32	20	040		Space	64	40	100	@	@	96	60	140	`	`
1	1	001	SOH (start of heading)	33	21	041	!	!	65	41	101	A	A	97	61	141	a	a
2	2	002	STX (start of text)	34	22	042	"	"	66	42	102	B	B	98	62	142	b	b
3	3	003	ETX (end of text)	35	23	043	#	#	67	43	103	C	C	99	63	143	c	c
4	4	004	EOT (end of transmission)	36	24	044	$	$	68	44	104	D	D	100	64	144	d	d
5	5	005	ENQ (enquiry)	37	25	045	%	%	69	45	105	E	E	101	65	145	e	e
6	6	006	ACK (acknowledge)	38	26	046	&	&	70	46	106	F	F	102	66	146	f	f
7	7	007	BEL (bell)	39	27	047	'	'	71	47	107	G	G	103	67	147	g	g
8	8	010	BS (backspace)	40	28	050	(	(	72	48	110	H	H	104	68	150	h	h
9	9	011	TAB (horizontal tab)	41	29	051	)	)	73	49	111	I	I	105	69	151	i	i
10	A	012	LF (NL line feed, new line)	42	2A	052	*	*	74	4A	112	J	J	106	6A	152	j	j
11	B	013	VT (vertical tab)	43	2B	053	+	+	75	4B	113	K	K	107	6B	153	k	k
12	C	014	FF (NP form feed, new page)	44	2C	054	,	,	76	4C	114	L	L	108	6C	154	l	l
13	D	015	CR (carriage return)	45	2D	055	-	-	77	4D	115	M	M	109	6D	155	m	m
14	E	016	SO (shift out)	46	2E	056	.	.	78	4E	116	N	N	110	6E	156	n	n
15	F	017	SI (shift in)	47	2F	057	/	/	79	4F	117	O	O	111	6F	157	o	o
16	10	020	DLE (data link escape)	48	30	060	0	0	80	50	120	P	P	112	70	160	p	p
17	11	021	DC1 (device control 1)	49	31	061	1	1	81	51	121	Q	Q	113	71	161	q	q
18	12	022	DC2 (device control 2)	50	32	062	2	2	82	52	122	R	R	114	72	162	r	r
19	13	023	DC3 (device control 3)	51	33	063	3	3	83	53	123	S	S	115	73	163	s	s
20	14	024	DC4 (device control 4)	52	34	064	4	4	84	54	124	T	T	116	74	164	t	t
21	15	025	NAK (negative acknowledge)	53	35	065	5	5	85	55	125	U	U	117	75	165	u	u
22	16	026	SYN (synchronous idle)	54	36	066	6	6	86	56	126	V	V	118	76	166	v	v
23	17	027	ETB (end of trans. block)	55	37	067	7	7	87	57	127	W	W	119	77	167	w	w
24	18	030	CAN (cancel)	56	38	070	8	8	88	58	130	X	X	120	78	170	x	x
25	19	031	EM (end of medium)	57	39	071	9	9	89	59	131	Y	Y	121	79	171	y	y
26	1A	032	SUB (substitute)	58	3A	072	:	:	90	5A	132	Z	Z	122	7A	172	z	z
27	1B	033	ESC (escape)	59	3B	073	;	;	91	5B	133	[	[	123	7B	173	{	{
28	1C	034	FS (file separator)	60	3C	074	<	<	92	5C	134	\	\	124	7C	174			|
29	1D	035	GS (group separator)	61	3D	075	=	=	93	5D	135	]	]	125	7D	175	}	}
30	1E	036	RS (record separator)	62	3E	076	>	>	94	5E	136	^	^	126	7E	176	~	~
31	1F	037	US (unit separator)	63	3F	077	?	?	95	5F	137	_	_	127	7F	177	&#127;	DEL

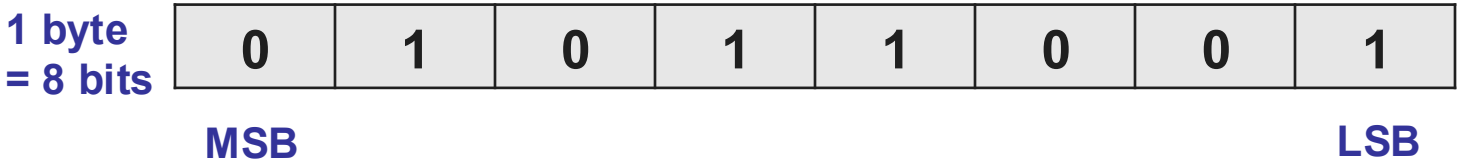
Source: www.LookupTables.com

Logically, how is a number represented?

Two (Binary) electrical states:

High	Low
on	*off*
1	**0**

A number is an *array* of RAM cells with binary states:



What does each index of a bit array mean?

1 byte = 8 bits

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

MSB **LSB**

Live Coding

1. How do you represent a character in a computer?

2. How do you access arrays of characters in C

Lecture Review Questions

1. How do you represent an “A” in a computer?
2. Name one other person in the class you have met
3. What is your biggest question about CSE29?