مبانی برنامه نویسی

Introduction to computers and C

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Introduction

- Software (the C instructions you write, which are also called **code)**
- Hardware (computers and related devices)

Computer Organization

- Input units (keyboards, touch screens, mice and touchpads, microphone, webcam, …)

- Output units (Monitor, printer, internet, speaker, …)

- Memory unit
  - RAM (Random Access Memory)
    - Bit: smallest store space, either 0 or 1
    - Byte: a byte is 8 bit
    - 128 GB of RAM

Unit	Bytes	Which is approximately
1 kilobyte (KB)	1024 bytes	10^3 bytes (1024 bytes exactly)
1 megabyte (MB)	1024 kilobytes	10^6 (1,000,000) bytes
1 gigabyte (GB)	1024 megabytes	10^9 (1,000,000,000) bytes
1 terabyte (TB)	1024 gigabytes	10^{12} (1,000,000,000,000) bytes
1 petabyte (PB)	1024 terabytes	10^{15} (1,000,000,000,000,000) bytes
1 exabyte (EB)	1024 petabytes	10^{18} (1,000,000,000,000,000,000) bytes
1 zettabyte (ZB)	1024 exabytes	10^{21} (1,000,000,000,000,000,000,000) bytes

Computer Organization

- ALU (Arithmetic and logic unit)
  - Add, subtract, multiply, division
  - Make decisions: comparing two items from the memory unit to determine whether they're equal
  - In today's systems, the ALU is part of the CPU

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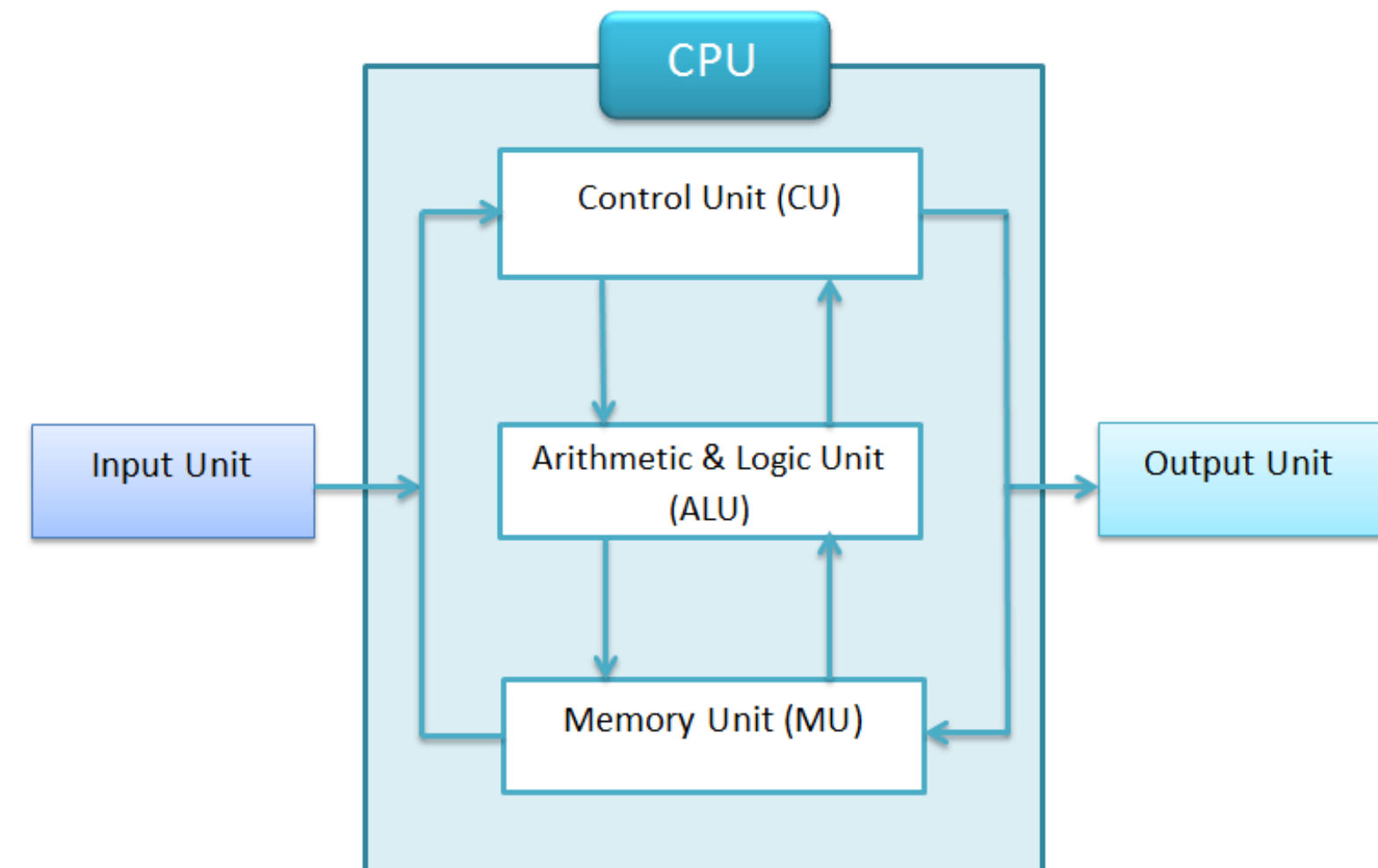
Computer Organization

- CPU (Central Processing Unit)
  - This "administrative" section coordinates and supervises the operation of the other; The CPU tells:
    - the input unit when to read information into the memory unit,
    - the ALU when to use information from the memory unit in calculations
    - the output unit when to send information from the memory unit to specific output devices.
  - A **dual-core processor** has two CPUs, a **quad-core processor** has four and an **octa-core processor** has eight

Computer Organization

- **Secondary Storage Unit**
  - Information on secondary storage devices is **persistent**—it's preserved even when the computer's power is turned off.
  - SSD(solid-state drives)
  - USB flash drives
  - HDD (hard disk drive)

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Data hierarchy

- **Bits**
  - a digit that can assume one of *two* values—and is a computer's smallest data item. It can have the value 0 or 1.

- **Characters**
  - Digits, letters and special symbols are known as **characters**.
  - **decimal digits** (0–9), **letters** (A–Z and a–z) and **special symbols** such as \$ @ % & * ( ) – + " : ; , ? /
  - C uses the **ASCII (American Standard Code for Information Interchange)** character set by default.
  - C also supports **Unicode®** characters

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

The ASCII Character Set

- **Fields**
  - **fields** are composed of characters or bytes: a person's name, person's age
- **Records**
  - Several related fields can be used to compose a **record**. the record for an employee might consist of the following fields:
    - Employee identification number (a whole number).
    - Name (a group of characters).
    - Address (a group of characters).
    - Hourly pay rate (a number with a decimal point).

- Files:
  - a file contains arbitrary data in arbitrary formats.
- Databases:
  - A **database** is a collection of data organized for easy access and manipulation.

Machine Languages, Assembly Languages and High-Level Languages

- **Machine Languages:**
- **Assembly Languages and Assemblers**
- **High-Level Languages and Compilers**

Machine Languages, Assembly Languages and High-Level Languages

Machine Code	Assembly Code	C code

B8 05 00 00 00   ; mov eax, 5
BB 03 00 00 00   ; mov ebx, 3
01 D8   ; add eax, ebx
B8 01 00 00 00   ; mov eax, 1
CD 80   ; int 0x80
	section .text
	global _start
	
	_start:
	   mov eax, 5 ; Store 5 in register eax
	   mov ebx, 3 ; Store 3 in register ebx
	   add eax, ebx ; Add ebx to eax (eax = eax + ebx)
		int main() {
		   int a = 5;
		   int b = 3;
		   int result = a + b;
		   return result;
		}

دانشکد

Operating Systems

- **Windows**
  - In the mid-1980s, Microsoft developed the **Windows operating system**, consisting of a graphical user interface built on top of DOS (Disk Operating System)

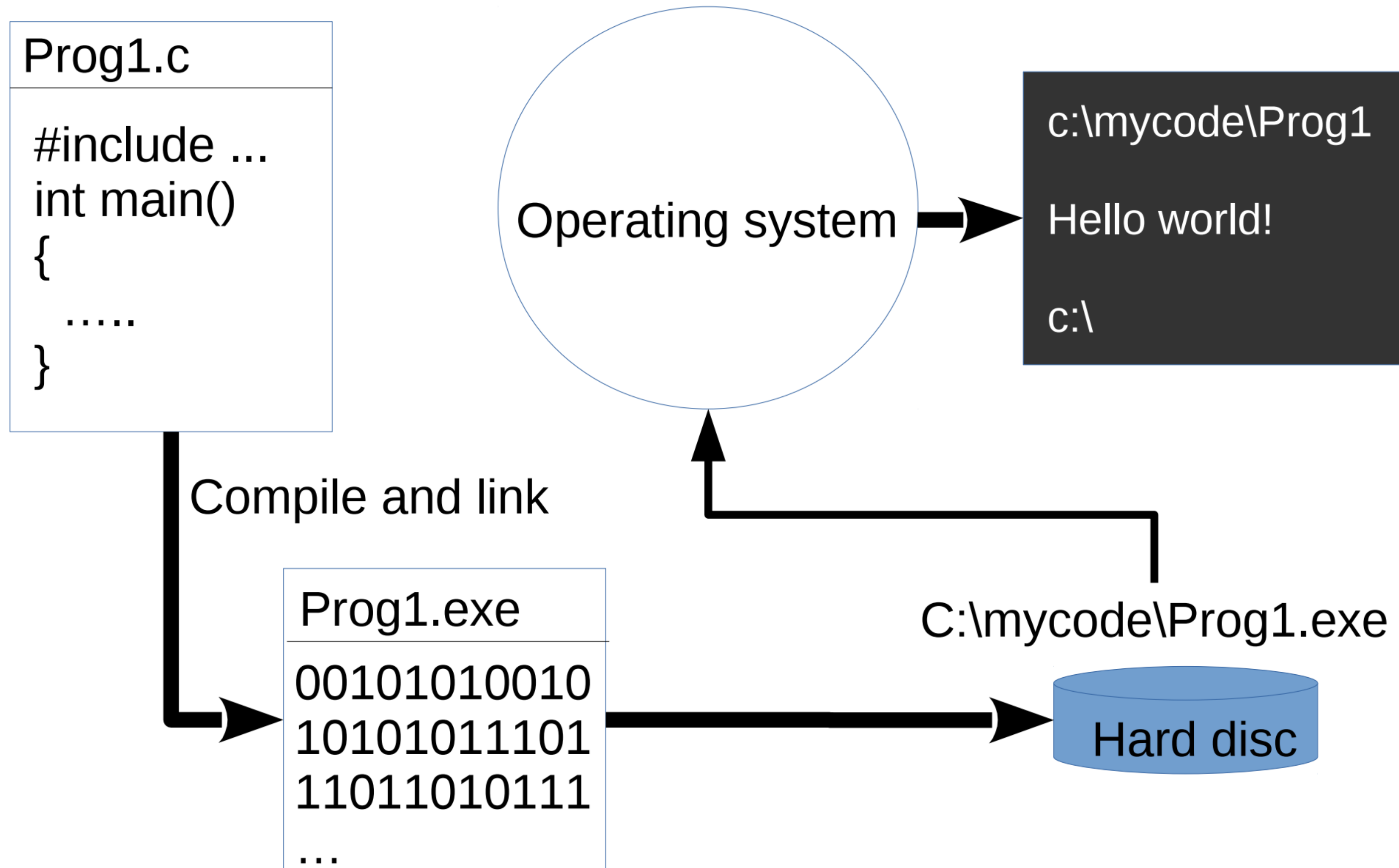- **Linux—An Open-Source Operating System**
- **Apple's macOS and Apple's iOS for iPhone® and iPad® Devices**
- **Google's Android**

The C Programming Language

- The C language was evolved from B by Dennis Ritchie at Bell Laboratories and was originally implemented in 1972

- **Built for Performance**
  - C is widely used to develop systems that demand performance, such as operating systems, embedded systems, real-time systems and communications systems
  - Today's popular desktop operating systems—Windows, macOS and Linux—are partially written in C.
  - Many popular applications are partially written in C, including popular web browsers (e.g., Google Chrome and Mozilla Firefox), database management systems (e.g., Microsoft SQL Server, Oracle and MySQL) and more.

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The life-time of a computer program

Prog1.c

```
#include ...
int main()
{
  .....
}
```

Compile and link

Prog1.exe

```
00101010010
10101011101
11011010111
…
```

Operating system

c:\mycode\Prog1

Hello world!

c:\

C:\mycode\Prog1.exe

Hard disc

Basics of a Typical C Program Development Process

- **Phases of C Programs:**

  1. **Edit**

  2. **Preprocess**

  3. **Compile**

  4. **Link**

  5. **Load**

  6. **Execute**

Editor ↔ Disk — Program is created in the editor and stored on disk.

Preprocessor ↔ Disk — Preprocessor program processes the code.

Compiler ↔ Disk — Compiler creates object code and storesi it on disk.

Linker ↔ Disk — Linker links the object code with the libraries

Loader → Primary Memory; Disk → Loader — Loader puts program in memory.

CPU ↔ Primary Memory — CPU takes each instruction and executes it, possibly storing new data values as the program executes.
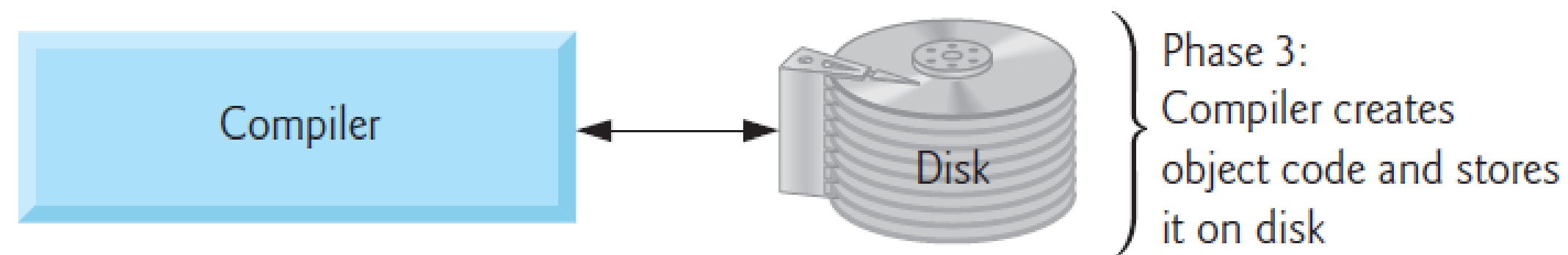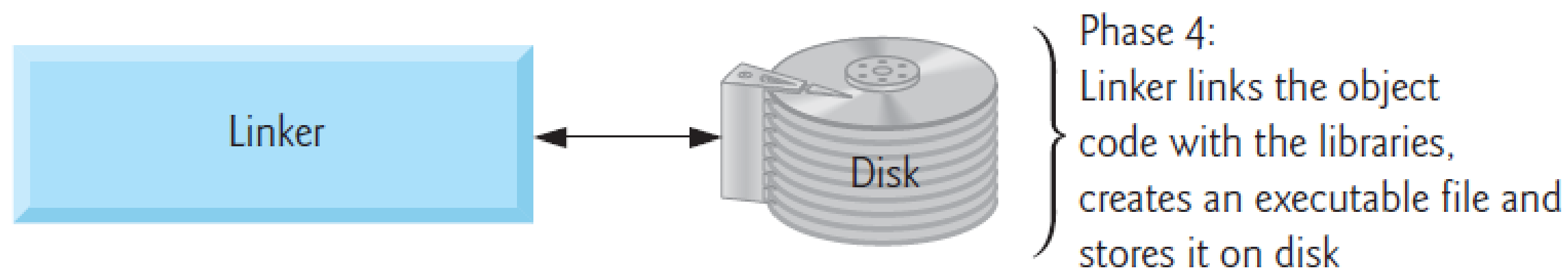
C Program development
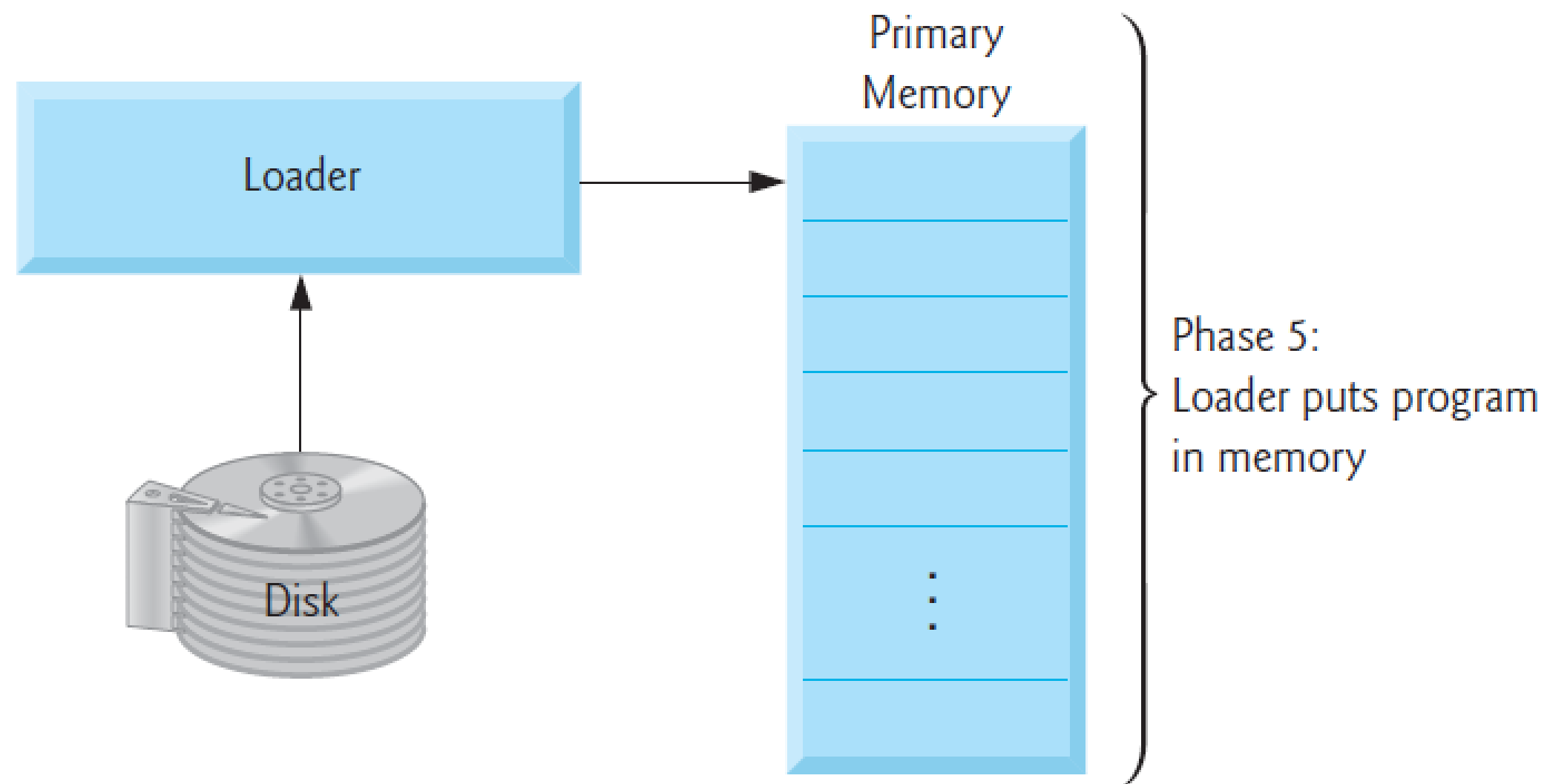
- **Phase 1: Creating a Program**
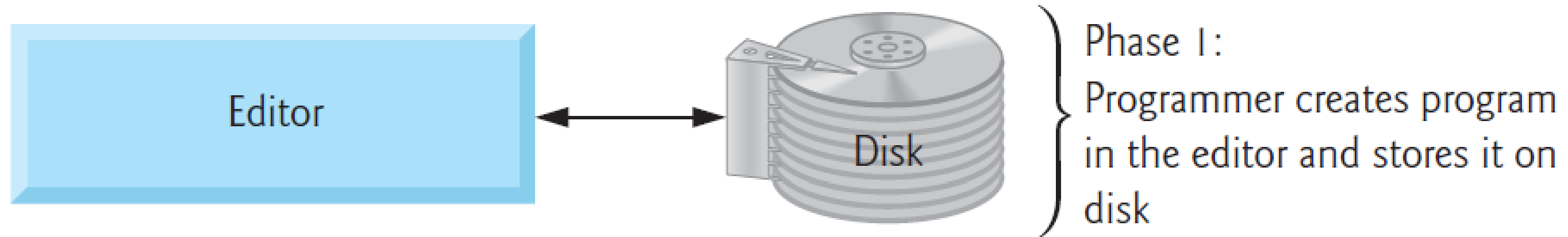
- Phase 2 and 3: Preprocessing and Compiling a C Program:
The compiler translates the C program into machine-language code
(also referred to as **object code**).

Compiler

Disk

Phase 3:
Compiler creates
object code and stores
it on disk

- Linking: C programs typically use functions defined elsewhere, such as in the standard libraries, open-source libraries or private libraries of a particular project. The object code produced by the C compiler typically contains "holes" due to these missing parts. A **linker** links a program's object code with the code for the missing functions to produce an **executable image** (with no missing pieces).

Linker

Disk

Phase 4:
Linker links the object code with the libraries, creates an executable file and stores it on disk

- Phase 5: Loading

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- Phase 6: Execution

Primary
Memory

CPU

Phase 6:
CPU takes each
instruction and
executes it, possibly
storing new data
values as the program
executes