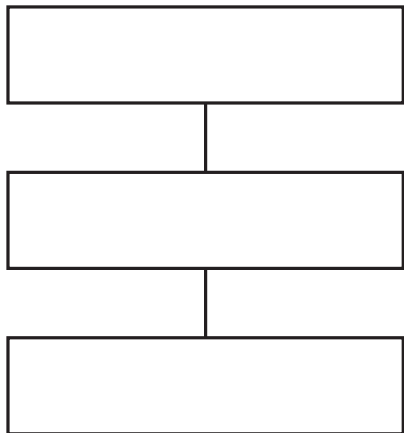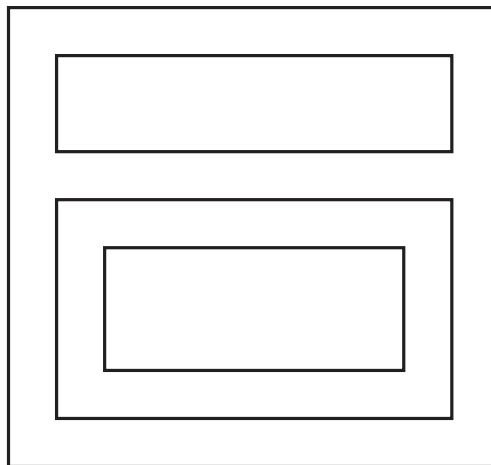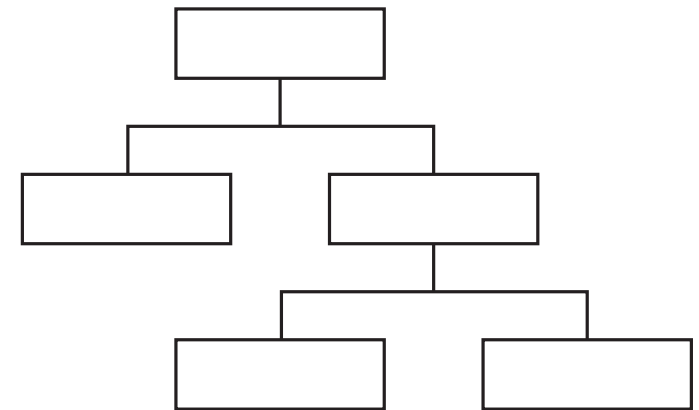# Computer Systems

Abstraction

- Suppression of detail to show the essence of the matter

- An outline structure

- Division of responsibility through a chain of command

- Subdivision of a system into smaller subsystems
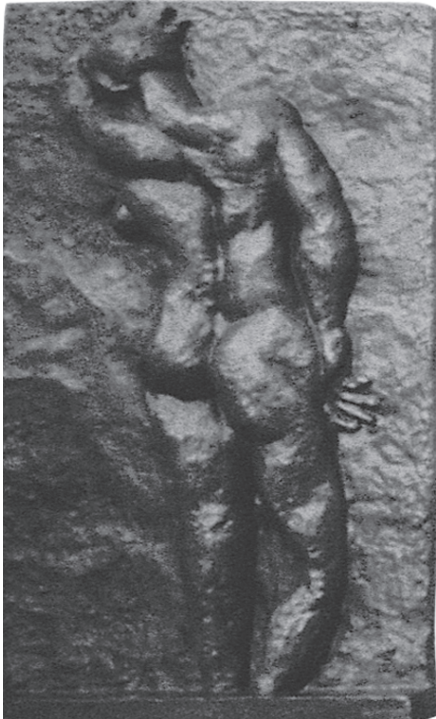
Figure 1.1

(a) A level diagram.

(b) A nesting diagram.

(c) A hierarchy, or tree, diagram.

Henri Matisse

The Back I
1909

The Back II
1913

The Back III
1917

The Back IV
1930

Figure 1.3

Figure 1.4
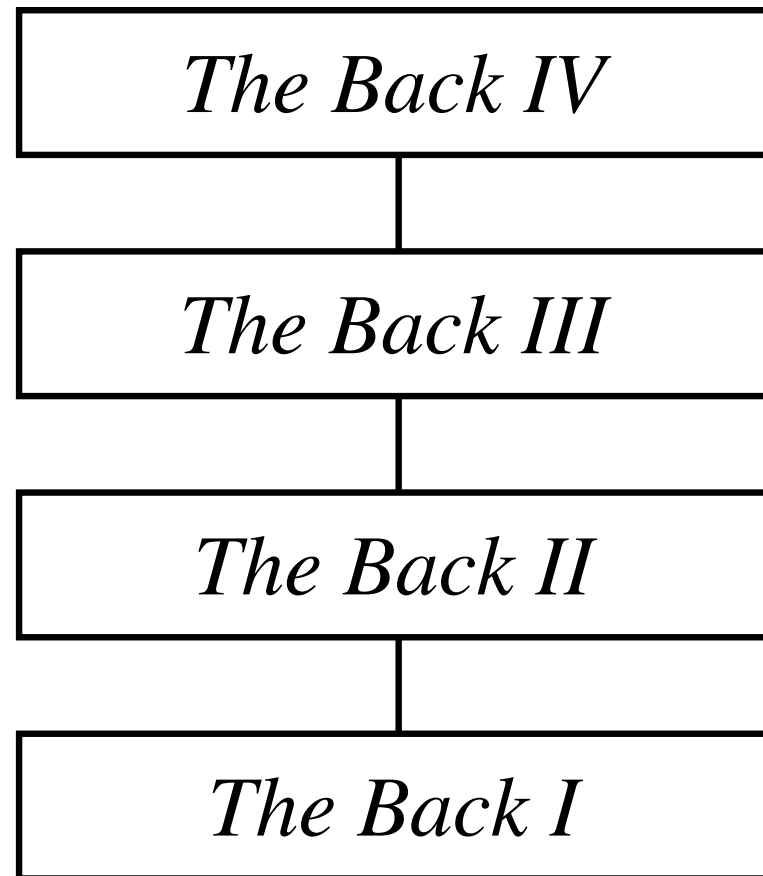
United States Constitution
   Article I. Legislative Department
       Section 1. Congress

       ...

       Section 10. Powers Prohibited to States
   Article II. Executive Department

       ...

   Article III. Judicial Department
   Article IV. The States and the Federal
       Government
   Article V. Amendments
   Article VI. General Provisions
   Article VII. Ratification of the Constitution

Figure 1.5


```
                        ┌─────────────────┐
                        │   President     │
                        │  Corporation    │
                        └─────────────────┘
```

Vice President College Div. — Vice President High School Div. — Vice President Elementary Div. — Vice President Professional Books

Director Marketing — Manager Manufacturing — Editor in Chief

Manager Advertising — Manager Marketing — Manager NE Region Sales — Manager South Region Sales — Manager West Region Sales

Figure 1.6

```
┌─────────────────┐
│  4-Star General │
│      Army       │
└─────────────────┘
┌─────────────────┐
│  3-Star General │
│   Army Corps    │
└─────────────────┘
┌─────────────────┐
│  2-Star General │
│    Division     │
└─────────────────┘
┌─────────────────┐
│  1-Star General │
│     Brigade     │
└─────────────────┘
┌─────────────────┐
│     Colonel     │
│    Regiment     │
└─────────────────┘
┌─────────────────┐
│ Lieutenant Colonel │
│    Battalion    │
└─────────────────┘
┌─────────────────┐
│     Captain     │
│     Company     │
└─────────────────┘
┌─────────────────┐
│    Lieutenant   │
│     Platoon     │
└─────────────────┘
┌─────────────────┐
│     Sergeant    │
│      Squad      │
└─────────────────┘
```

Figure 1.7

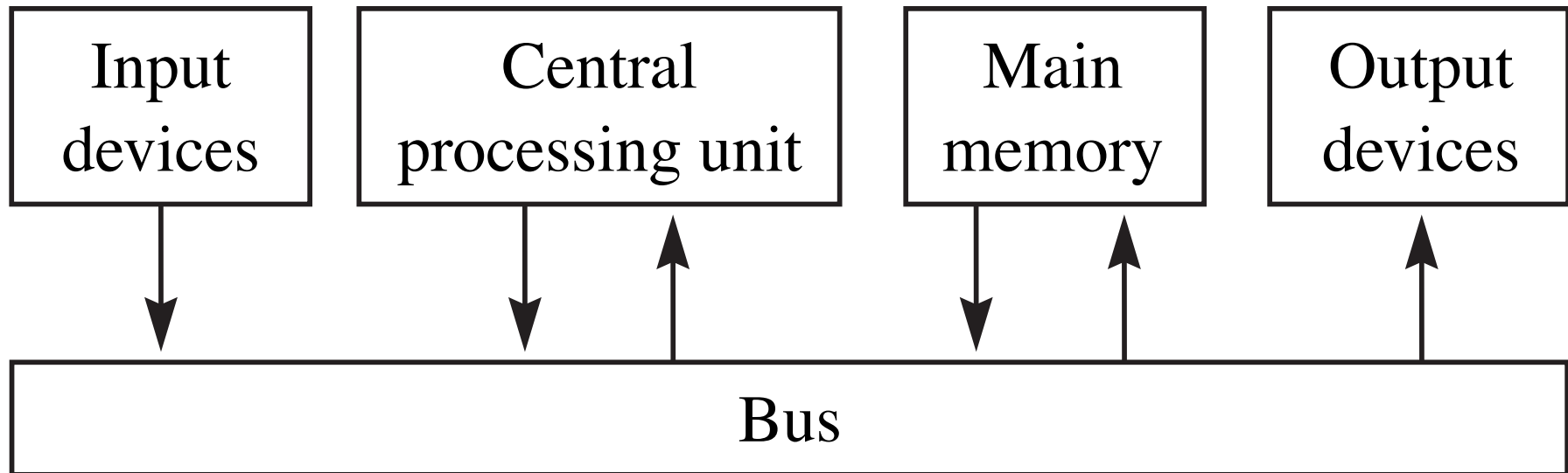|	
7	Application level
6	High-order language level
5	Assembly level
4	Operating system level
3	Instruction set architecture level
2	Microcode level
1	Logic gate level

Some HOL6 languages

- *FORTRAN*   Formula Translator

- *BASIC*   Beginners All-purpose Symbolic Instruction Code

- *C++*   A popular general-purpose language

- *LISP*   List processing

- *Java*   For World Wide Web browsers

Figure 1.8

Input → Processing → Output

Figure 1.9

Input devices	Central processing unit	Main memory	Output devices

Bus

Figure 1.10

Multiple	Prefix	Abbrev.
10^{15}	peta-	P
10^{12}	tera-	T
10^{9}	giga-	G
10^{6}	mega-	M
10^{3}	kilo-	K
10^{-3}	milli-	m
10^{-6}	micro-	μ
10^{-9}	nano-	n
10^{-12}	pico-	p

(a) Prefixes for powers of 10.

Prefix	Computer science value
peta-	$2^{50} = 1,125,899,906,842,624$
tera-	$2^{40} = 1,099,511,627,776$
giga-	$2^{30} = 1,073,741,824$
mega-	$2^{20} = 1,048,576$
kilo-	$2^{10} = 1,024$

(b) Computer science values of the large prefixes.

Input devices

- Keyboards

- Disk drives

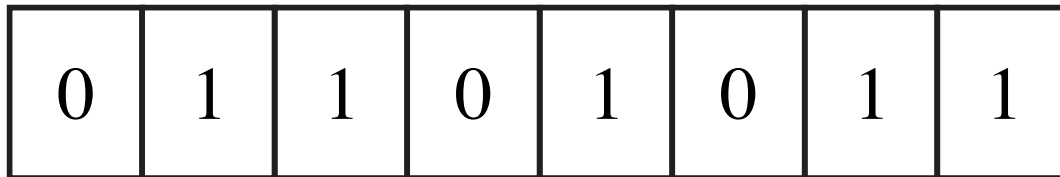- Magnetic tape drives

- Mouse devices

- Bar code readers

Figure 1.11

| In | CPU | Mem | Out |
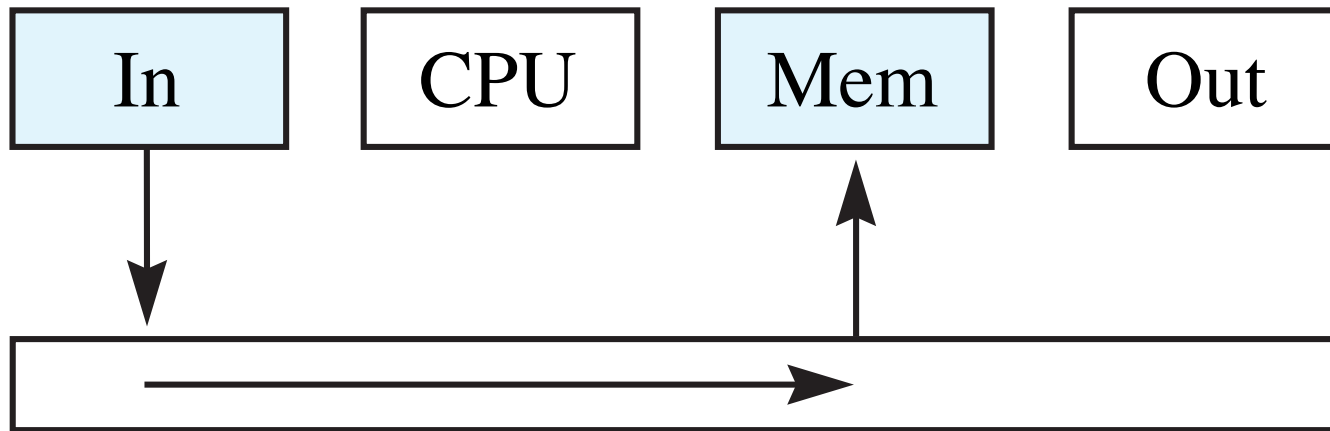
In   input devices

CPU   central processing unit

Mem   main memory

Out   output devices

Figure 1.12

(a) Storage for an eight-bit byte.

0	1	1	0	1	0	1	1

(b) The bit pattern for the character 'k.'

Figure 1.13

Computer Systems
FOURTH EDITION
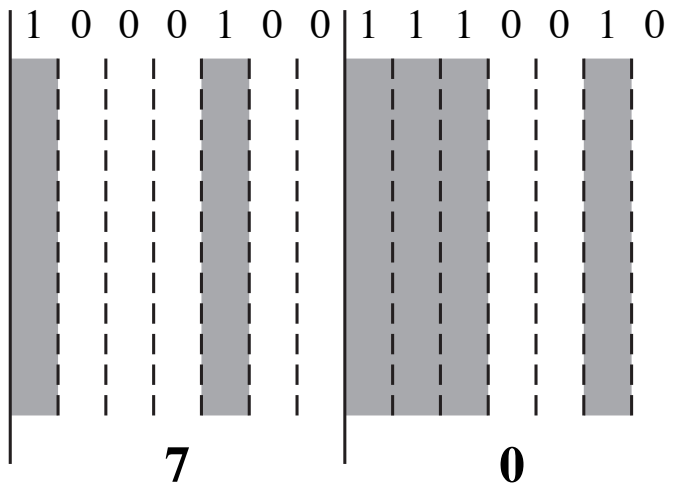
1 0 0 0 1 0 0	1 1 1 0 0 1 0
7	**0**

Decimal value	Left chars.	Right chars.
0	0001101	1110010
1	0011001	1100110
2	0010011	1101100
3	0111101	1000010
4	0100011	1011100
5	0110001	1001110
6	0101111	1010000
7	0111011	1000100
8	0110111	1001000
9	0001011	1110100

Output devices

- Disk drives

- Magnetic tape drives

- Screens

- Printers

Figure 1.16

Figure 1.17

Figure 1.18

In	CPU	Mem	Out
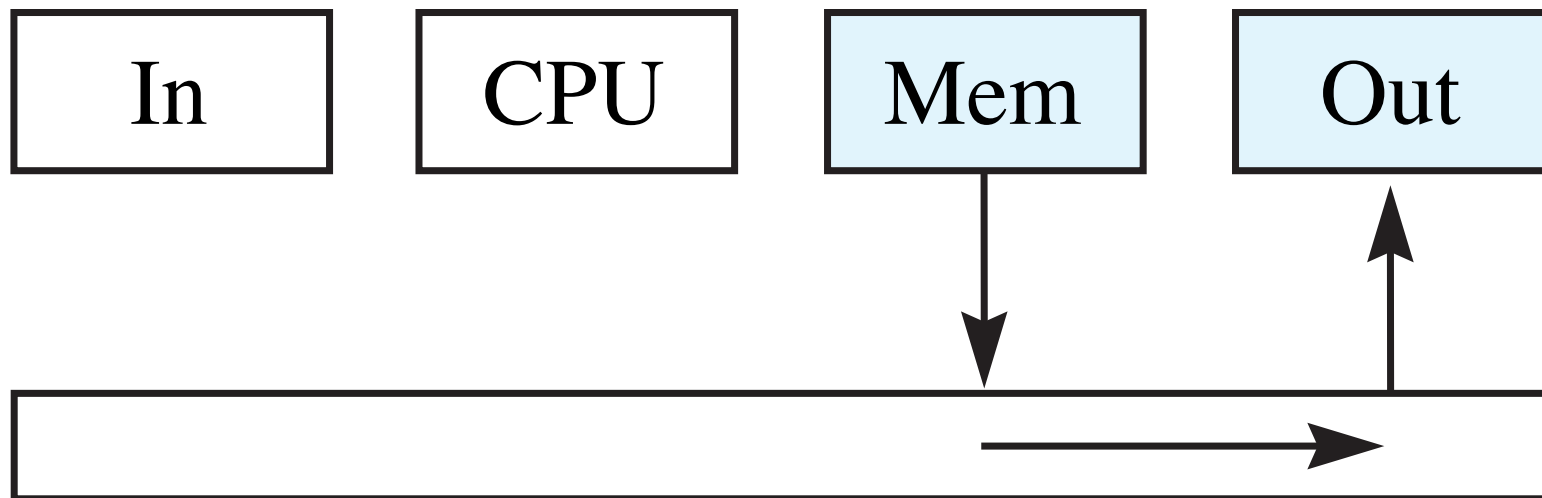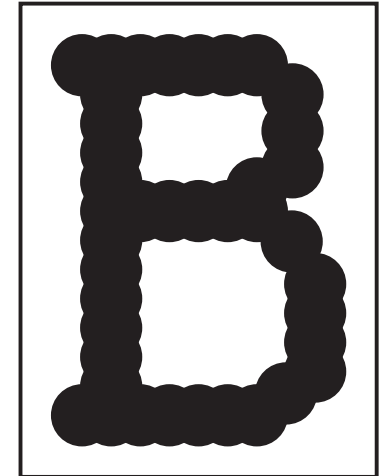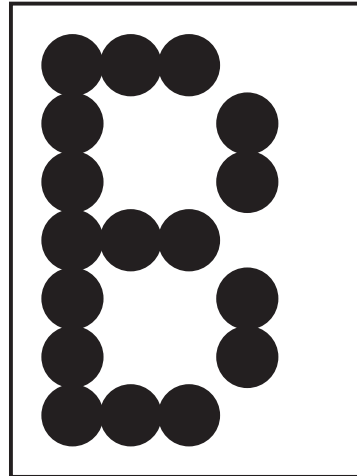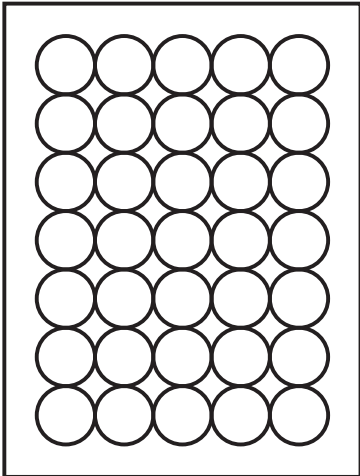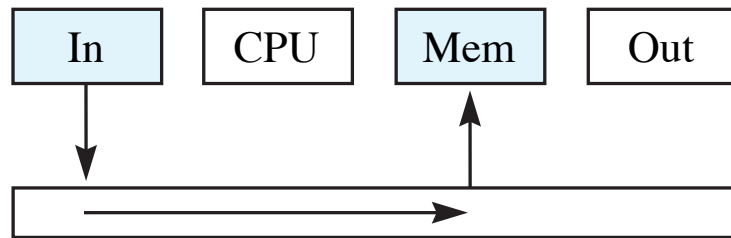
(a) First data flows from the input device into main memory.

In	CPU	Mem	Out
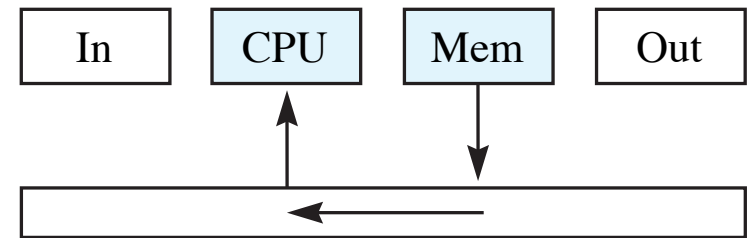
(b) Next the CPU brings the data into its registers for processing.

In	CPU	Mem	Out
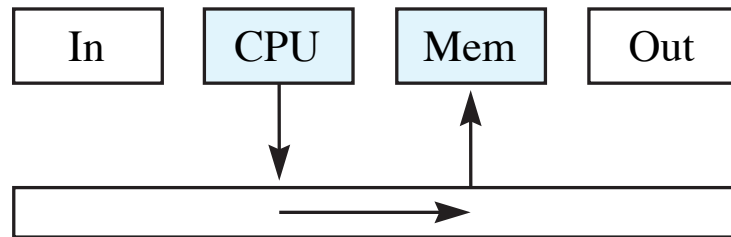
(c) Then the CPU sends the processed data back to memory.

In	CPU	Mem	Out
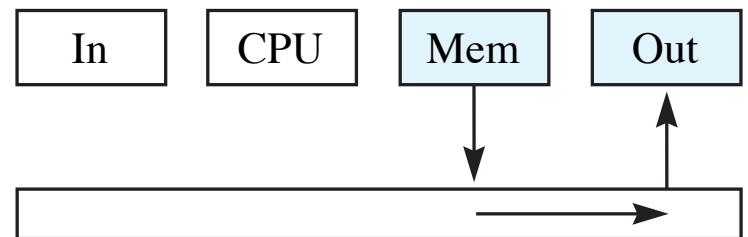
(d) Finally the results go to the output device.

Software

- Algorithm

  ‣ A set of instructions that, when carried out in the proper sequence, solves a problem in a finite amount of time

- Program

  ‣ An algorithm written for execution on a computer

Figure 1.19

Ingredients

      3 slightly beaten eggs

      $\frac{1}{4}$ cup sugar

      2 cups milk, scalded

      $\frac{1}{2}$ teaspoon vanilla

Algorithm

      Combine eggs, sugar, and $\frac{1}{4}$ teaspoon salt.

      Slowly stir in slightly cooled milk.

      Cook in double boiler over hot, not boiling, water, stirring constantly.

      As soon as custard coats metal spoon, remove from heat.

      Cool at once—place pan in cold water and stir a minute or two.

      Add vanilla.

      Chill.

Functions of an operating system

- File management

- Memory management

- Processor management

Types of information contained in files

- Documents

- Programs

- Data

Typical operating system commands

- List the names of the files from the directory

- Delete a file from the disk

- Change the name of a file

- Print the contents of a file

- Execute an applications program

Figure 1.20

(a) Analysis—The input and processing are given. The output is to be determined.

(b) Design—The input and desired output are given. The processing is to be determined.

Relational database systems

- *Relation*   A table

- *Attribute*   A column

- *Tuple*   A row

- *Domain*   The set of all possible values of an attribute

Figure 1.21

Sor

S.Name	S.Class	S.Major	S.State
Beth	Soph	Hist	TX
Nancy	Jr	Math	NY
Robin	Sr	Hist	CA
Allison	Soph	Math	AZ
Lulwa	Sr	CompSci	CA

Figure 1.21
(Continued)

Frat

F.Name	F.Major	F.State
Emile	PolySci	CA
Sam	CompSci	WA
Ron	Math	OR
Mehdi	Math	CA
David	English	AZ
Jeff	Hist	TX
Craig	English	CA
Gary	CompSci	CA

Figure 1.22

Query

- List Ron's home state

Result1

F.State
OR

Figure 1.22
(Continued)

Query

- List all the sophomores in the sorority

Result2

S.Name
Beth
Allison

Figure 1.22
(Continued)

Query

- List those sorority and fraternity members who have the same major, and what that common major is

Figure 1.22
(Continued)

Result3

S.Name	F.Name	Major
Beth	Jeff	Hist
Nancy	Ron	Math
Nancy	Mehdi	Math
Robin	Jeff	Hist
Allison	Ron	Math
Allison	Mehdi	Math
Lulwa	Sam	CompSci
Lulwa	Gary	CompSci

Figure 1.23

Input   Processing   Output

```
┌──────────┐          ╭─────────╮          ┌──────────┐
│ Database │  ──────▶ │  Query  │  ──────▶ │  Result  │
└──────────┘          ╰─────────╯          └──────────┘
```
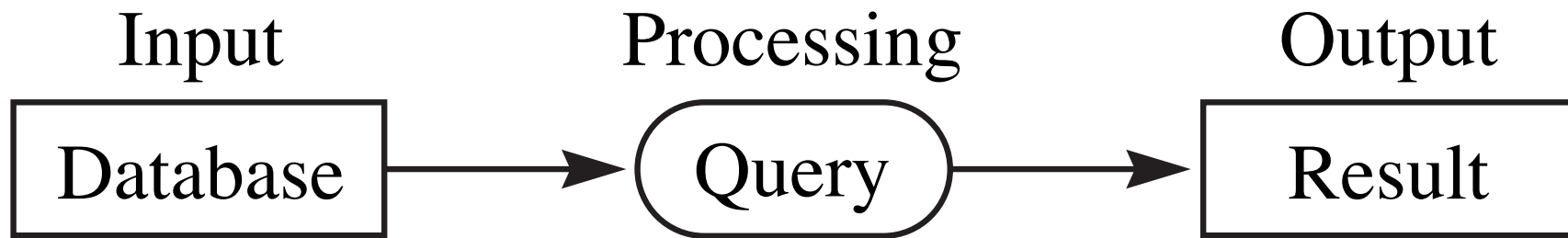
Database operators

- `select`   Takes a set of rows

- `project`   Takes a set of columns

- `join`   Combines tuples from two tables with a common column

Figure 1.24(a)

- select Frat where F.Major = English giving Temp1

Temp1

F.Name	F.Major	F.State
David	English	AZ
Craig	English	CA

Figure 1.24(b)

- project Sor over S.Name giving Temp2

Temp2

F.Name
David
Craig

Figure 1.24(c)

- project Sor over (S.Class, S.State) giving Temp3

Temp3

S.Class	S.State
Soph	TX
Jr	NY
Sr	CA
Soph	AZ

Figure 1.25

- join Sor and Frat over Major giving Temp4

Temp4

S.Name	S.Class	S.State	Major	F.Name	F.State
Beth	Soph	TX	Hist	Jeff	TX
Nancy	Jr	NY	Math	Ron	OR
Nancy	Jr	NY	Math	Mehdi	CA
Robin	Sr	CA	Hist	Jeff	TX
Allison	Soph	AZ	Math	Ron	OR
Allison	Soph	AZ	Math	Mehdi	CA
Lulwa	Sr	CA	CompSci	Sam	WA
Lulwa	Sr	CA	CompSci	Gary	CA

Query

- List Ron's home state

```
select Frat where F.Name = Ron
giving Temp5

project Temp5 over F.State
giving Result1
```

Query

- List all the sophomores in the sorority

```
select Sor where S.Class = Soph
giving Temp6

project Temp6 over S.Name
giving Result2
```

Query

- List those sorority and fraternity members who have the same major, and what that common major is

```
join Sor and Frat over Major
giving Temp4

project Temp4 over (S.Name,
F.Name, Major)giving Result3
```