

***CS-228: Discrete Structures II:  
REPRESENTATION of NUMBERS  
in DIGITAL COMPUTERS:  
SUMMARY***

*Charles Abzug, Ph.D.*  
Department of Computer Science  
James Madison University  
Harrisonburg, VA 22807

Voice Phone: *540-568-8746*; Cell Phone: *443-956-9424*  
E-mail: *abzugcx@JMU.edu* OR *CharlesAbzug@ACM.org*  
Home Page: *http://www.cs.jmu.edu/users/abzugcx*

© 2006 Charles Abzug

# Basic Binary Numbers I

Exponent $n$	Power of 2	Value of $2^n$
0	$2^0$	1
1	$2^1$	2
2	$2^2$	4
3	$2^3$	8
4	$2^4$	16
5	$2^5$	32
6	$2^6$	64
7	$2^7$	128
8	$2^8$	256
9	$2^9$	512

# Basic Binary Numbers II

Exponent $n$	Power of 2	Value of $2^n$
0	$2^0$	1
1	$2^1$	2
2	$2^2$	4
3	$2^3$	8
4	$2^4$	16
5	$2^5$	32
6	$2^6$	64
7	$2^7$	128
8	$2^8$	256
9	$2^9$	512

Exponent $n$	Power of 2	Value of $2^n$
10	$2^{10}$	1,024
11	$2^{11}$	2,048
12	$2^{12}$	4,096
13	$2^{13}$	8,192
14	$2^{14}$	16,384
15	$2^{15}$	32,768
16	$2^{16}$	65,536
17	$2^{17}$	131,072
18	$2^{18}$	262,144
19	$2^{19}$	524,288

# Standard Notation of Integers in Traditional Science

Traditional Scientific		
Multipli- cation Factor	Name	Sym- bol
$10^3$	kilo	k
$10^6$	Mega	M
$10^9$	Giga	G
$10^{12}$	Tera	T
$10^{15}$	Peta	P
$10^{18}$	Exa	E
$10^{21}$	Zetta	Z
$10^{24}$	Yotta	Y

# Notation of Numbers in Computer Science: Integers

Traditional Scientific			Computer Science	
Multipli- cation Factor	Name	Sym- bol	Multipli- cation Factor	Magnitude
$10^3$	kilo	k	$2^{10}$	1,024
$10^6$	Mega	M	$2^{20}$	1,048,576
$10^9$	Giga	G	$2^{30}$	1,073,741,824
$10^{12}$	Tera	T	$2^{40}$	1,099,511,627,776
$10^{15}$	Peta	P	$2^{50}$	1,125,899,906,842,624
$10^{18}$	Exa	E	$2^{60}$	1,152,921,504,606,846,976
$10^{21}$	Zetta	Z	$2^{70}$	1,180,591,620,717,411,303,424
$10^{24}$	Yotta	Y	$2^{80}$	1,208,925,819,614,629,174,706,176

# Notation of Numbers in Computer Science: Integers

Traditional Scientific			Computer Science			
Multiplication Factor	Name	Symbol	Name	Symbol	Multiplication Factor	Magnitude
$10^3$	kilo	k	Kibi	Ki	$2^{10}$	1,024
$10^6$	Mega	M	Mebi	Mi	$2^{20}$	1,048,576
$10^9$	Giga	G	Gibi	Gi	$2^{30}$	1,073,741,824
$10^{12}$	Tera	T	Tebi	Ti	$2^{40}$	1,099,511,627,776
$10^{15}$	Peta	P	Pebi	Pi	$2^{50}$	1,125,899,906,842,624
$10^{18}$	Exa	E	Exbi	Ei	$2^{60}$	1,152,921,504,606,846,976
$10^{21}$	Zetta	Z	Zebi(?)	Zi(?)	$2^{70}$	1,180,591,620,717,411,303,424
$10^{24}$	Yotta	Y	Yobi(?)	Yi(?)	$2^{80}$	1,208,925,819,614,629,174,706,176

# Notation of Numbers in Computer Science: Fractions

Multiplication Factor in non-CS Scientific Notation	Computer Science			
	Name	Sym-bol	Multipli-cation Factor	Magnitude
$10^{-3}$	milli	m	$2^{-10}$	1.0/1,024
$10^{-6}$	micro	$\mu$	$2^{-20}$	1.0/1,048,576
$10^{-9}$	nano	n	$2^{-30}$	1.0/1,073,741,824
$10^{-12}$	pico	p	$2^{-40}$	1.0/1,099,511,627,776
$10^{-15}$	femto	f	$2^{-50}$	1.0/1,125,899,906,842,624
$10^{-18}$	atto	a	$2^{-60}$	1.0/1,152,921,504,606,846,976
$10^{-21}$	zepto	z	$2^{-70}$	1.0/1,180,591,620,717,411,303,424
$10^{-24}$	yocto	y	$2^{-80}$	1.0/1,208,925,819,614,629,174,706,176

# Notation of Numbers in Computer Science: Integers:- WHAT YOU NEED TO REMEMBER

Multiplication Factor in non-CS Scientific Notation			Computer Science	
	Name	Sym- bol	Multipli- cation Factor	Magnitude
$10^3$	kilo	k	$2^{10}$	1,024
$10^6$	Mega	M	$2^{20}$	
$10^9$	Giga	G	$2^{30}$	
$10^{12}$	Tera	T	$2^{40}$	
$10^{15}$	Peta	P	$2^{50}$	
$10^{18}$	Exa	E	$2^{60}$	
$10^{21}$			$2^{70}$	
$10^{24}$			$2^{80}$	



# Notation of Numbers in Computer Science: Fractions:- WHAT YOU NEED TO REMEMBER

Multiplication Factor in non-CS Scientific Notation				Computer Science
	Name	Sym- bol	Multipli- cation Factor	Magnitude
$10^{-3}$	milli	m	$2^{-10}$	1.0/1,024
$10^{-6}$	micro	$\mu$	$2^{-20}$	
$10^{-9}$	nano	n	$2^{-30}$	
$10^{-12}$	pico	p	$2^{-40}$	
$10^{-15}$	femto	f	$2^{-50}$	
$10^{-18}$			$2^{-60}$	
$10^{-21}$			$2^{-70}$	
$10^{-24}$			$2^{-80}$	

## Dubious Metrics

<i>Base Quantity</i>		<i>Equivalent</i>
$10^{12}$ dactyls	=	1 teradactyl
$10^9$ piccolos	=	1 gigolo
$10^6$ airs	=	1 millionair
$10^{-12}$ dillies	=	1 picodilly
$10^{12}$ bulls	=	1 terabull
$2 \times 10^3$ mockingbirds	=	2 kilo mockingbird

# References on Notation of Orders of Magnitude

- *Systeme Internationale (SI)*: International System of Units  
<http://physics.nist.gov/cuu/Units/introduction.html>
- New *Systeme Internationale (SI)* Prefixes for Binary Numbers:  
<http://physics.nist.gov/cuu/Units/binary.html>

Representation		Decimal Value Represented			
Hex	Binary	Unsigned (Non-Explicitly-Signed)	Ones' Complement	Two's Complement	Signed-Magnitude
0	0000	0	+0	0 ("+"0)	+0
1	0001	1	+1	+1	+1
2	0010	2	+2	+2	+2
3	0011	3	+3	+3	+3
4	0100	4	+4	+4	+4
5	0101	5	+5	+5	+5
6	0110	6	+6	+6	+6
7	0111	7	+7	+7	+7
8	1000	8	-7	-8	-0
9	1001	9	-6	-7	-1
A	1010	10	-5	-6	-2
B	1011	11	-4	-5	-3
C	1100	12	-3	-4	-4
D	1101	13	-2	-3	-5
E	1110	14	-1	-2	-6
F	1111	15	-0	-1	-7

Representation		Decimal Value Represented		
Hex	Binary	Unsigned (Non-Explicitly-Signed)	Excess-7	Excess-8
0	0000	0	-7	-8
1	0001	1	-6	-7
2	0010	2	-5	-6
3	0011	3	-4	-5
4	0100	4	-3	-4
5	0101	5	-2	-3
6	0110	6	-1	-2
7	0111	7	0 ("+"0)	-1
8	1000	8	+1	0 ("+"0)
9	1001	9	+2	+1
A	1010	10	+3	+2
B	1011	11	+4	+3
C	1100	12	+5	+4
D	1101	13	+6	+5
E	1110	14	+7	+6
F	1111	15	+8	+7

**END**