

Primitive Types

How to Store Data

Lecture Contents

- How to store different data
 - Computers only store zeros and ones!
- Java Primitive Types
- *AP Java Subset* Primitive Types

How to store numbers?

- Whole numbers
 - Just store as a binary string...

$$75 - 64 = 11$$

$$11 - 8 = 3$$

$$3 - 2 = 1$$

$$1 - 1 = 0$$

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

How to store numbers?

- Whole numbers
 - Just store as a binary string...
 - How many binary digits to use?



$$75 - 64 = 11$$

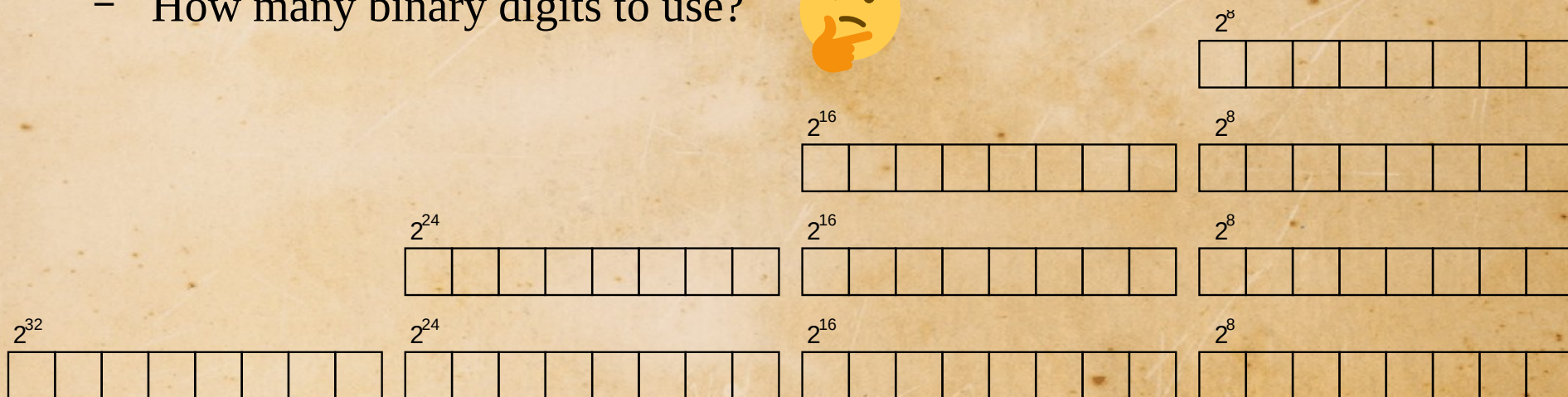
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- 



- 

2^o

--	--	--	--	--	--	--	--

2^{16}

--	--	--	--	--	--	--	--

2^8

--	--	--	--	--	--	--	--

2^{24}

$$2^{16}$$

--	--	--	--	--	--	--	--

$$2^8$$

--	--	--	--	--	--	--	--

2^{32}

--	--	--	--	--	--	--	--

$$\begin{array}{|c|c|c|c|c|c|c|c|} \hline & & & & & & & \\ \hline \end{array}$$

2^{16}

--	--	--	--	--	--	--	--

2^8							
-------	--	--	--	--	--	--	--

How to store numbers?

- Whole numbers
 - Just store as a binary string...
 - How many binary digits to use?
 - 8 bits $\rightarrow 2^8 = 256$
 - 16 bits $\rightarrow 2^{16} = 65536$
 - 32 bits $\rightarrow 2^{32} = 4,294,967,296$
 - ...but what about negative numbers?



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↑
sign bit



How to store numbers?

- Java integers

	bits	range
byte	8	-128 to +127
short	16	-32768 to +32767
int	32	-2,147,483,648 to +2,147,483,647
long	64	-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807

How to store numbers?

- AP Java Subset – we will only use **int**

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- In Java, `Integer.MIN_VALUE` = -2,147,483,648
and `Integer.MAX_VALUE` = +2,147,483,647
(no need to type these numbers!)

How to store numbers?

REMEMBER:

For *AP CSc A*, to store an *integer*, use the primitive type:

`int`

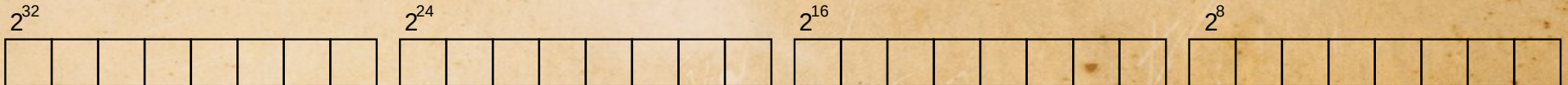
How to store numbers?

- What about numbers with decimals?

$$\pi = 3.1415926535897932384626433\dots$$

- What about huge numbers?
 - Avogadro's Number:

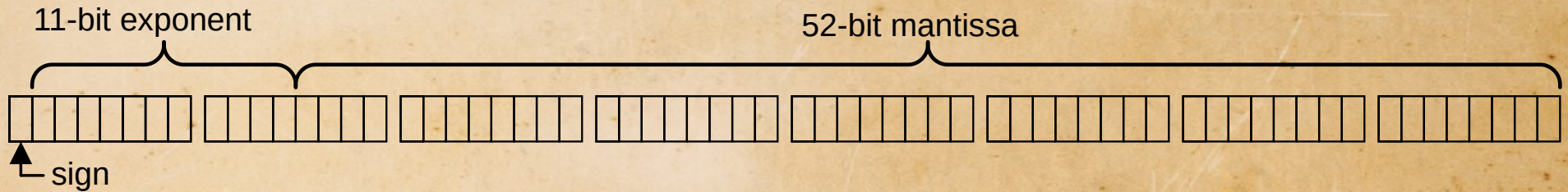
$$N_A = 6.02214076 \times 10^{23}$$



How to store numbers?

- What about huge numbers?
 - Scientific notation

$$\pm \textit{mantissa} \times 2^{\textit{exponent}}$$



How to store numbers?

- Java floating point numbers

	sign	exponent	mantissa
float	1	8	23
double	1	11	52

- Specification: *IEEE 754*

How to store numbers?

REMEMBER:

For AP CSc A, to store an real number, use the primitive type:

double

How to store text?

- How might we store: “Hello World!”
 - Character by character
 - Previously **ASCII** – *American Standard Code for Information Interchange* (1963)
 - Java uses **Unicode**
 - 16 bits, so 65536 different characters
 - Lower characters match with ASCII

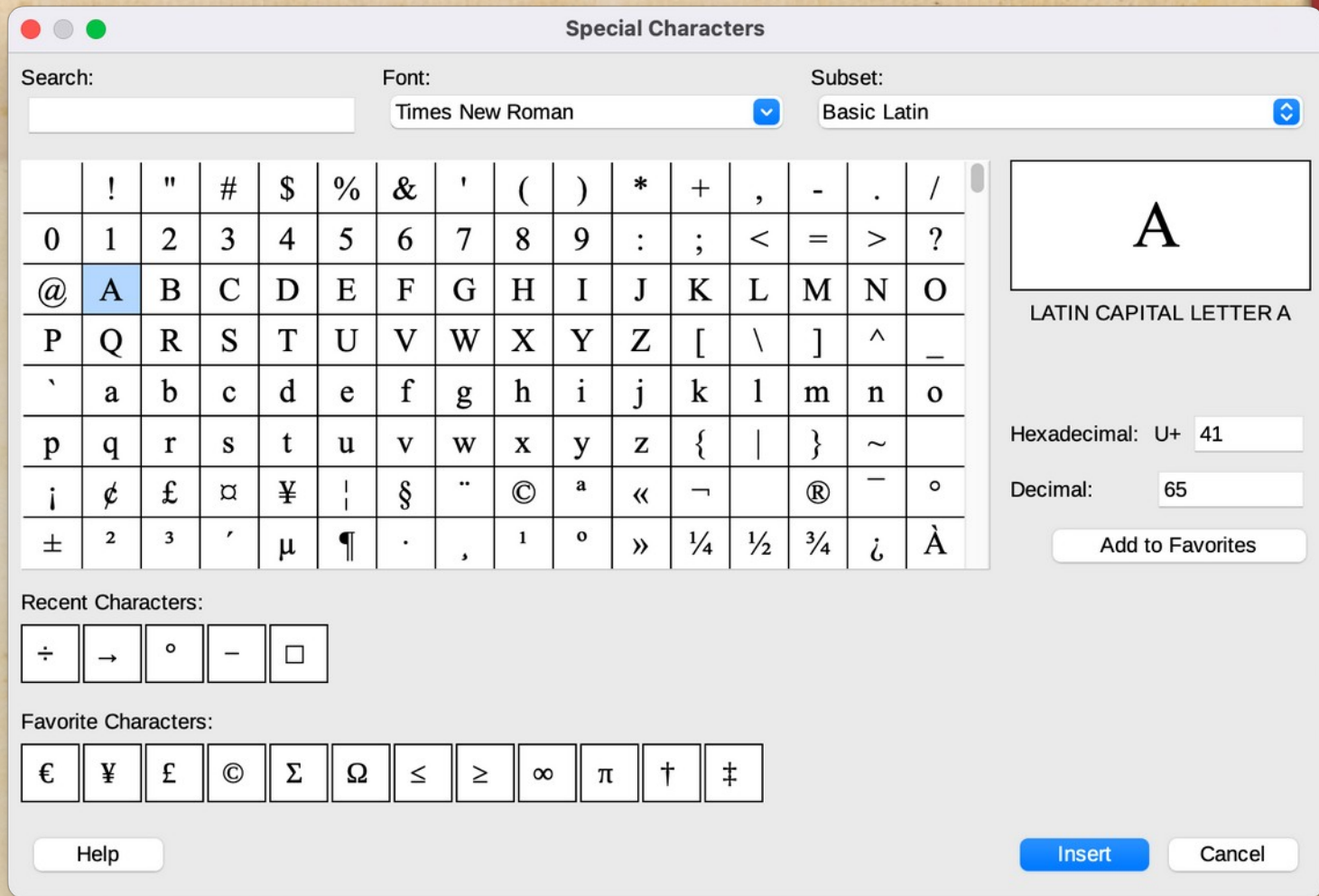
ASCII Character Codes in Hexadecimal

ASCII Character Set (0x20-0x7F)

hex	char	hex	char	hex	char	hex	char	hex	char	hex	char
20	space	30	0	40	@	50	P	60	`	70	p
21	!	31	1	41	A	51	Q	61	a	71	q
22	"	32	2	42	B	52	R	62	b	72	r
23	#	33	3	43	C	53	S	63	c	73	s
24	\$	34	4	44	D	54	T	64	d	74	t
25	%	35	5	45	E	55	U	65	e	75	u
26	&	36	6	46	F	56	V	66	f	76	v
27	'	37	7	47	G	57	W	67	g	77	w
28	(	38	8	48	H	58	X	68	h	78	x
29	)	39	9	49	I	59	Y	69	i	79	y
2A	*	3A	:	4A	J	5A	Z	6A	j	7A	z
2B	+	3B	;	4B	K	5B	[	6B	k	7B	{
2C	,	3C	<	4C	L	5C	\	6C	l	7C	
2D	-	3D	=	4D	M	5D	]	6D	m	7D	}
2E	.	3E	>	4E	N	5E	^	6E	n	7E	~
2F	/	3F	?	4F	O	5F	_	6F	o	7F	delete

USASCII code chart

b7 b6 b5 Bits b4 b3 b2 b1 Column Row					0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
					0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	\$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL



Java Primitive Types

- Integers
 - byte (1)
 - short (2)
 - int (4)
 - long (8)
- Real
 - float (4)
 - double (8)
- True/False
 - boolean (1 bit?)
- Letters
 - char (2)

AP Java Subset Primitive Types

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