CS1007 lecture #4 notes

thu 31 jan 2002

- news
- data types and storage
- variables and assignment
- binary numbers and arithmetic
- ASCII
- reading: *ch 2.1-2.4*

news.

- always check class web: *http://www.columbia.edu/~cs1007*
- homework #1 is due today
- recitation lists will be posted on the web in the next few days
- if you haven't signed up yet, email me and the TA
- TAs will also have office hours in the TA room in Mudd
- hours will be added on the human help link

data and storage.

- last week we talked about output
- programs = objects + methods
- objects = data
- data must be *stored*
- all storage is numeric (0's and 1's)

memory.

- think of the computer's memory as a bunch of boxes
- inside each box, there is a number
- you give each box a name
  ⇒ defining a *variable*
- example:

program code:	*computer's memory:*
`int x;`	x → $\boxed{}$

variables.

- variables have:
  - name
  - type
  - value
- naming rules:
  - names may contain letters and/or numbers
  - but cannot begin with a number
  - names may also contain underscore (_) and dollar sign ($)
  - underscore is used frequently; dollar sign is not too common in Java
  - can be of any length
  - cannot use Java keywords
  - Java is *case-sensitive!!*

primitive data types.

- numeric

byte	8 bits	$-128 = -2^7$	$127 = 2^7 - 1$
short	16 bits	$-32{,}768 = -2^{15}$	$32{,}767 = 2^{15} - 1$
int	32 bits	-2^{31}	$2^{31} - 1$
long	64 bits	-2^{63}	$2^{63} - 1$
float	32 bits	≈ -3.4E+38, 7 sig dig	≈ 3.4E+38, 7 sig dig
double	64 bits	≈ -1.7E+308, 15 sig dig	≈ 1.7E+308, 15 sig dig

- boolean

boolean	1 bit

- character

char	16 bits

- 7 bits for ASCII
- 8 bits for extended ASCII
- 16 bits for Unicode

assignment.

- = is the assignment operator
- example:

program code:

```
int x; // declaration
x = 19; // assignment
```

or

```
int x = 19;
```

computer's memory:

x → $\boxed{19}$

storage is binary.

x → $\boxed{19}$

is really stored like this:

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1

this is base 2!

$19_{10} = 10011_2$

remember bases?

base 10:

$$
\begin{aligned}
362 &= (2 * 1) + (6 * 10) + (3 * 100) \\
&= (2 * 10^0) + (6 * 10^1) + (3 * 10^2)
\end{aligned}
$$

base 2:

$$
\begin{aligned}
1 &= 2^0 = 1 \\
10 &= 2^1 = 2 \\
100 &= 2^2 = 4 \\
1000 &= 2^3 = 8 \\
10000 &= 2^4 = 16
\end{aligned}
$$

...

so

$$
\begin{aligned}
10011_2 &= (1 * 2^0) + (1 * 2^1) + (0 * 2^2) + (0 * 2^3) + (1 * 2^4) \\
&= (1 * 1) + (1 * 2) + (0 * 4) + (0 * 8) + (1 * 16) \\
&= 19_{10}
\end{aligned}
$$

base conversion: 2 to 10.

$1010100_2 =$

	=	=
$(0 * 2^0)$	$(0 * 1)$	0
$+ (0 * 2^1)$	$+ (0 * 2)$	+ 0
$+ (1 * 2^2)$	$+ (1 * 4)$	+ 4
$+ (0 * 2^3)$	$+ (0 * 8)$	+ 0
$+ (1 * 2^4)$	$+ (1 * 16)$	+ 16
$+ (0 * 2^5)$	$+ (0 * 32)$	+ 0
$+ (1 * 2^6)$	$+ (1 * 64)$	+ 64

$= 84_{10}$

base conversion: 10 to 2.

$84_{10} =$

84 / 2	= 42	rem 0
42 / 2	= 21	rem 0
21 / 2	= 10	rem 1
10 / 2	= 5	rem 0
5 / 2	= 2	rem 1
2 / 2	= 1	rem 0
1 / 2	= 0	rem 1

$\Rightarrow 1010100_2$

two tricks.

base 8 (octal):

000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

base 16 (hexadecimal, “hex”):

0000	0	1000	8
0001	1	1001	9
0010	2	1010	A (10)
0011	3	1011	B (11)
0100	4	1100	C (12)
0101	5	1101	D (13)
0110	6	1110	E (14)
0111	7	1111	F (15)

- replace each octal (or hex) digit with the 3 (or 4) digit binary
- replace every 3 (or 4) binary digits with one octal (or hex) digit

back to storage.

x → $\boxed{19}$

is really stored like this:

31	30	...	7	6	5	4	3	2	1	0
0	0	...	0	0	0	1	0	0	1	1

- bits are numbered, from right to left, starting with 0
- highest (rightmost, “most significant”) bit is *sign* bit

ASCII.

- ASCII = American Standard Code for Information Interchange
- characters are stored as numbers
- standard table defines 128 characters
- example:

```
char c = 'A';
```

‘A’ = $65_{10} = 01000001_2$

c →

7	6	5	4	3	2	1	0
0	1	0	0	0	0	0	1