CS 31 Discussion 1J

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WEEK 4: FUNCTIONS, ARRAYS AND PROJECT3

Recap

- Strings
  - Characters and Strings
- Functions
  - Built-in vs user-defined
  - Function declaration, definition, and call
  - Parameter passing: Pass by value

Discussion Objectives

Review and practice things covered during lectures

- Functions
  - Call by value
  - Call by reference
- Coding examples
- Project3
  - Required Functions
  - Pseudocode

Practicing from worksheet4

Time for you to ask questions!

Functions

```
#include <iostream>

// function declaration
return_type func_name (param_1_type param_1_name,
param_2_type param_2_name, ...);

int main() {
    // function call
    return_type var_x = func_name (arg_1, arg_2, ...);
}

/*
 * Note: The top level comment above a function
 * goes here using the multi-line comment, and usually
 * should describe the function's input and output.
 */
return_type func_name (param_1_type param_1_name,
param_2_type param_2_name, ...) {
    // func_name do stuff
}
```

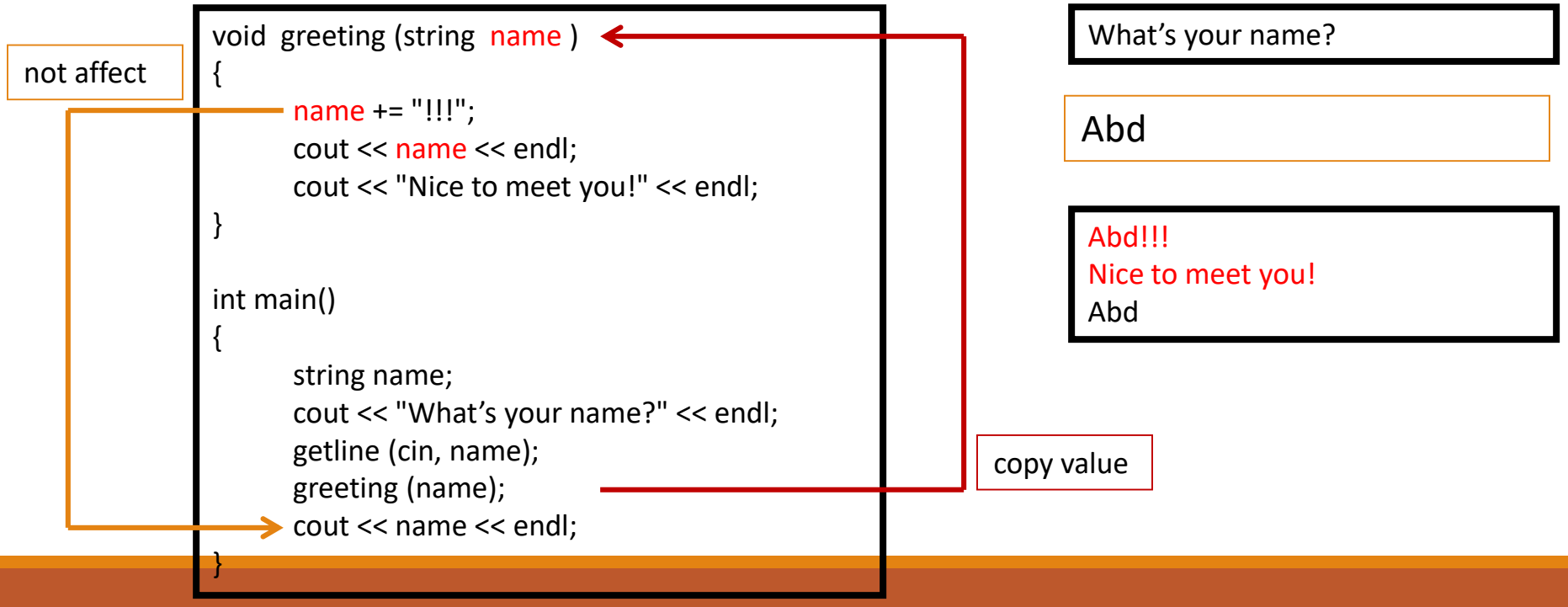
Functions (Cont'd)

```
// function prototype for foo
int foo(int x);

int main() {
    cout << foo(2) << endl;
    cout << foo(0) << endl;
}

// function implementation for foo
int foo(int x) {
    x *= 2;
    if (x < 100)
        return foo(x);
    return x;
}
```

Passing arguments by value

passing by values into functions

- Doesn't not allow you to access/modify variables outside
- values of arguments exist only in functions



Passing Arguments by Reference

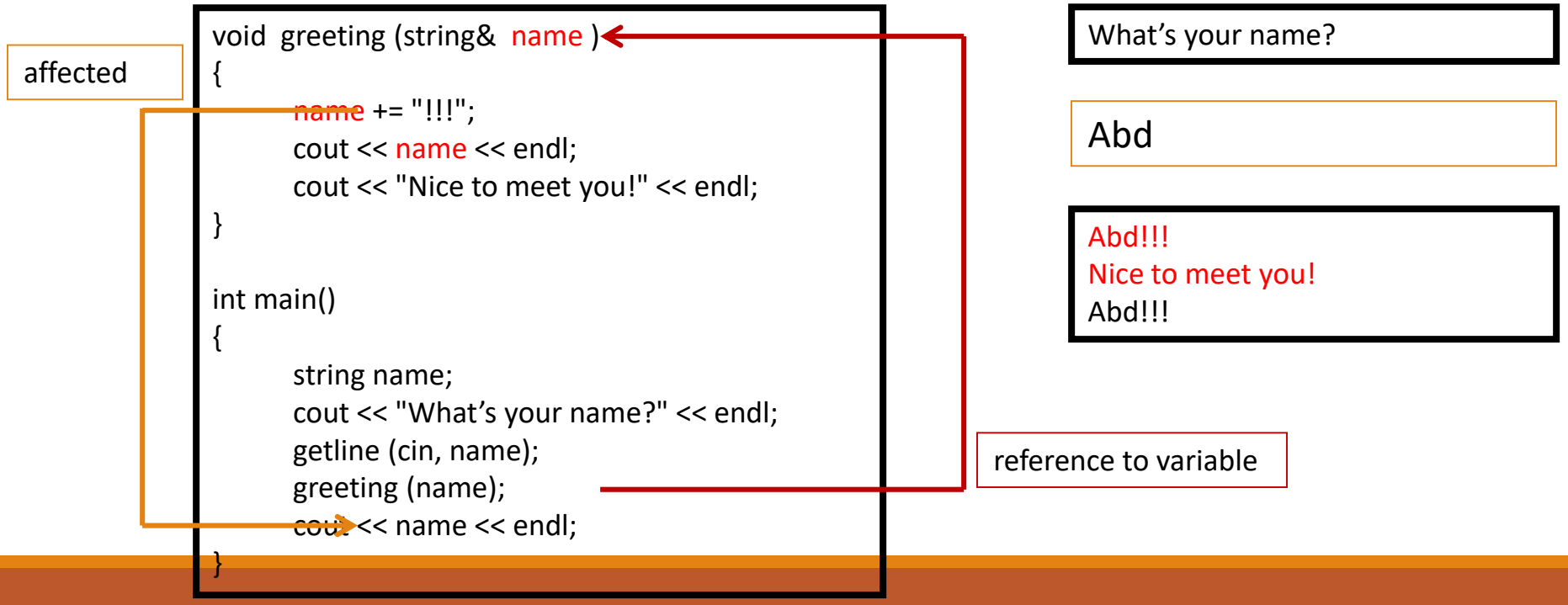
```
#include <iostream>
using namespace std;

void duplicate (int& a, int& b, int& c)
 {
        a*=2;
        b*=2;
        c*=2;
        }

int main ()
 {
        int x=1, y=3, z=7;
        duplicate (x, y, z);

        cout << "x=" << x << ", y=" << y << ", z=" << z;

        return 0;
        }
```

x=2, y=6, z=14

Passing Arguments by Reference

passing in reference to a variable into functions

- allow you to access/modify variables outside



Convert letter to integer

Define a function

```
int convert(char number)
{
    switch (number)
    {
        case '0':
            return 0;
        case '1':
            return 1;
        case '2':
            return 2;
        case '3':
            return 3;
        case '4':
            return 4;
        case '5':
            return 5;
        case '6':
            return 6;
        case '7':
            return 7;
        case '8':
            return 8;
        case '9':
            return 9;
    }
}
```

Convert 1 or 2-digit string to integer

```
int main()
{string str = "12";
int num;

for (size_t i=0; i<str.length(); i++)
{
        if (isdigit(str.at(i)))
        {
                        if (isdigit(str.at(i+1)))
                {
                        num = 10*convert(str.at(i)) + convert(str.at(i+1));
                        i+=1;
                }
                else
                {
                        num = convert(str.at(i));
                }
        }
}
cout << num << endl;
}
```

Incremental Development

- While solving a problem, start thinking from the smallest portion of the problem and try to solve that.
- Incrementally develop the solution for the main problem.

Algorithm of incremental development:

1. Start from a simple solution and build on top of that solution.
2. Add a little more
3. Test to make sure the updated version works fine
4. Repeat 2 and 3 until the complete solution covering all possible test cases is implemented

String processing

`#include <string>`

Operation	What it does	Example
`string s = "hello";` `string s = "!!!";`	Declare strings s and s2	
`s.length()` or `s.size()`	Return the length of s	`cout << s.size(); // prints 5`

`s[i]` or `s.at[i]`	Return i-th character. (`i` should be integer between 0 and size-1 (inclusive))	`cout << s[1]; // prints 'e'`
		`cout << s.at(0); // prints 'h'`

`s + s2`	Concatenate two strings	`cout << s + s2; // prints "hello!!!"`

`#include <cctype>`

Operation	What it does
`char c;`	Declare a character c
`isspace(c)`	True if c is a whitespace character
`isalpha(c)`	True if c is a letter
`isdigit(c)`	True if c is a digit
`islower(c)`	True is c is a lowercase letter
`isupper(c)`	True if c is a uppercase letter

String processing

In order to process characters in a string,

E.g., `string str = "123AFb32#@sd";`

```
^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^
```

```
for (int i = 0; i < str.size(); i++) {
  char ch = str[i]; // do something to ch
}
```

for loop

```
int i = 0;
while(i < str.size()){
  char ch = str[i]; // do something to ch
  i++;
}
```

while loop

String processing

Question: count the number of digits and letters in the string `str`.

str	#digit	#letter
“ABC12@cd”	2	5
“sd#12#12”	4	2

Operation	What it does
`char c;`	Declare a character c
`isspace(c)`	True if c is a whitespace character
`isalpha(c)`	True if c is a letter
`isdigit(c)`	True if c is a digit
`islower(c)`	True is c is a lowercase letter
`isupper(c)`	True if c is a uppercase letter

String processing

Question: given a string, filter out all non-letter characters, and print out the new string which is concatenated by all the letters left.

E.g., `string str = “123AFb32#@sd”;` “Afbsd”

```
string concatLetter(string str);
```

```
#include <string>
```

Operation	What it does	Example
`s + s2`	Concatenate two strings	`cout << s + s2; // prints “hello!!!”`

```
#include <cctype>
```

Operation	What it does
`isalpha(c)`	True if c is a letter
`isdigit(c)`	True if c is a digit

String processing

Question: You are writing a program to filter out the illegal date records in the database, and return the number of legal records in December.

The legal date string:

- `year`(4 digits) `month`(3 letters, all UPPERCASE) `day` (1/2 digits).

The `month` is guaranteed to be all uppercase letters.

Only care about number of characters!

```
int filterCount(string str);
```

str	Y/N
1993DEC3	Y
2004DEC52	Y
12MAR3	N
2012AU15	N
2016OCT2	N

2

Characters and Integers

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

Source: www.LookupTables.com

ASCII code

char	int
'0'	48
'1'	49
'2'	50
'3'	51
'4'	52
'5'	53
'6'	54
'7'	55
'8'	56
'9'	57

'0' is not mapped to 0!
However, the integer code for chars '0' through '9' are contiguous.

Characters and Integers

char	int
‘0’	48
‘1’	49
‘2’	50
‘3’	51
‘4’	52
‘5’	53
‘6’	54
‘7’	55
‘8’	56
‘9’	57

```
char ch = '0';
ch++; // ch is '1'
int a = ch - '0'; // a is 1
ch += 7; // ch is '8'
a = ch - '0'; // a is 8
```

Characters and Integers

Question: Given a string `str` which contains several digits (0-9), how do you derive the integer value that it represents?

```
int cast(string str)
```

str	return value
“123”	123
“45”	45

Hint:

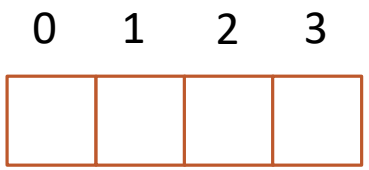
- ‘4’ -> int a = ‘4’ – ‘0’; // a is 4
- ‘5’ -> int a = ‘5’ – ‘0’; // a is 5
- 45 = 4*10 + 5

Array

Declare an array

- <type> <name>[size]

```
int a[4];
```



`a[i]` is an `i`-th variable in the array `a`.

`size` should must be a positive integer constant.

```
int a[4];
```

```
const int N = 10;
int a[N];
```

You can treat each element of the array as a variable.

```
x[3] = 5;
x[1]++;
cout << x[i] << endl;
```

Initialization of an Array

```
int a[5] = {1, 2, 3, 5, 7};
int a[] = {1, 2, 3, 5, 7};
```

You cannot set the size to what's less than the number of elements in the initialization statement.

However, it is okay to set the size to what's more than the number of elements in the initialization statement.

```
int a[3] = {1, 2, 3, 5, 7}; // (right/wrong?)
int a[10] = {1, 2, 3, 5, 7}; // (right/wrong?)
```

Common mistakes

```
int a[10];
for (int i = 0; i < a.size(); i++) {
  ...
}
```

No `size()` function is defined for arrays.

```
const int SIZE = 10;
int a[SIZE];
for (int i = 0; i < SIZE; i++) {
  ...
}
```

Common mistakes

Out-of-range access not allowed!

```
int a[10];
a[15] = 5; // error
a[-10] = 4; // error
a[9] = 10; // okay
```

Array

Multi-dimensional arrays

```
int i[ROWS][COLUMNS];

int i[ROWS][COLUMNS] = {
       {row_00, row_01, ...},
       {row_10, row11, ...},
       ...,
       {row_i0, row_i1, ...}};

some2DArray[i][j];
```

```
#include <iostream>

using namespace std;
int main () {
  int i[][3] = {
    {1, 2, 3},
    {4, 5, 6},
    {20, -1, 0} };
}
```

Arrays in a Function

```
void fibo10(int fib[]);
```

Note that the size of fib is not specified, you can explicitly pass the size in the function.

```
void fibo10(int fib[], int n);
```

Now after you learnt about 2D arrays.

```
void fibo10(int fib[][], int n);
```

Project3: Three Functions

bool isValidAnimalParkString(string animalparkString)

This function returns true if its parameter is a well-formed animal park string as described above, or false otherwise.

int dogsLeft(string animalparkString)

If the parameter is a well-formed animal park string, this function should return the number of dogs (both puppies and adult dogs) left after the string is fully processed. If the parameter is not a valid animal park string, return -1.

int catsLeft(string animalparkString)

If the parameter is a well-formed animal park string, this function should return the number of cats (both kittens and adult cats) left after the string is fully processed. If the parameter is not a valid animal park string, return -1.

int peopleLeft(string animalparkString)

If the parameter is a well-formed animal park string, this function should return the number of people (both children and adults) left after the string is fully processed. If the parameter is not a valid animal park string, return -1.

Pseudocode

Pseudocode is usually a more effective means of communicating an algorithm than a narrative paragraph. It should not be merely a statement-by-statement rephrasing of the code.

Examples of PSEUDOCODE

```
1.  if (score is greater than or equal to 90)
        grade is A
2.  if (hours worked are less than or equal to 40)
        wages = rate * hours
    Otherwise
        wages = (rate * 40) + 1.5 * (rate * (hours -40))
3.  if (temperature is greater than 20 degrees and it is not raining)
        go to play golf!
```

Equivalent C++ code:

```
1.  if (score >= 90)
        cout << "Grade: " << 'A' << endl;
2. if (Hours <= 40)
        wages = rate * Hours;
   else if (Hours > 40)
        wages = (rate*40) + 1.5 * (rate * (Hours -40));
3. if ((temp > 20) && (!(raining))
        cout << "go out to play golf! ";
```

Thanks!

Questions?

Today's discussion slides can be found at

https://github.com/zubaerimran/W20-CS31-1J/blob/master/week4/winter20_cs31_w4.pdf

Some of the materials presented have been taken from previous TA discussions