ARRAY & FUNCTIONS

Assuming that you have already had the basics in:

- **simple control structure including nested loops**
- **Basic understanding of primitive data types.**
- **Know about what ASCII table**.

ARRAY

Take the construction like this:

```
<data type> variable[ number  of elements ]
```

store homogeneous elements at contiguous locations

Simple example:

Simple declaration and initialization for 1-D array

```
int arr[5];      // data size of "int" * 5
```

```
for (i=0; i< 5; i++)
   arr[i] = i*2;
```

Bad habit to hard code the "5". Use "sizeof(…)

```
sizeof(int) == 4
sizeof (arr) = 4*5
# of elements = sizeof(arr) / sizeof(arr[0])
```

```
for (i=0; i< sizeof(arr) / sizeof(arr[0]); i++)
   arr[i] =  <something>;
```

More samples:

```
char arr[ ] = {'c','o','d','e','\0'};
char arr[ ] = "code";
int arr[100] = 0;
int  arr[100]  =  1;    // hmm… watch out . this does not set every element to 1, every byte to 1 instead.
```

Pay attention to the boundary

e.g. int arr[4];

valid : arr[3] = 5;

invalid : arr[4] = 5;

Sample code

```
void main()
{
        float mass[5] = { 10, 14, 20, 50, -10 };
        float sum = 0.0;
        int i;
        cout << "average of ";
        for (i = 0; i < 5; i++)
        {
                cout << mass[i] << ", ";
                sum = sum + mass[i];
        }
        cout << " = " << sum / i << endl;
}
```

Simple declaration and initialization for 2D array	int arr[2][3]; // data size of arr = 2x3x4
	valid: int arr[2][3] = { { 0, 0, 1 }, { 0, 0, 2 } };
	valid: int arr[ ][3] = { { 0, 0, 1 }, { 0, 0, 2 } };
	invalid: int arr[2][ ] = { { 0, 0, 1 }, { 0, 0, 2 } };

ENUMERATION TYPE

Take the following macros: #define NORTH 0 #define SOUTH 1 #define EAST 2 #define WEST 3 e.g. int wind_direction = NO;	Use Enumeration instead: enum Directions { NORTH, SOUTH, EAST, WEST}; Directions dir; Valid : dir = NORTH; dir = WEST ; dir = (Directions)3; Bad : dir = (Directions) 4;
use it with array	e.g. : char directions[WEST]; sizeof(directions) is 3 char directions[WEST+1]; sizeof(directions) is 4 char directions[][10] = { "NORTH", "EAST", "SOUTH", "WEST" }; sizeof(directions) == 40

TIME COMPLEXITY USING ARRAY:

Accessing Time:	O(1) [This is possible because elements are stored at contiguous locations]
Search Time:	O(n) for Sequential Search: O(log n) for Binary Search [If Array is sorted]
Insertion Time:	O(n) BUT Each insertion requires shifting all of the elements after the element! NOT Good!
Deletion Time:	O(n) BUT Each insertion requires shifting all of the elements after the element! NOT Good!

FUNCTIONS

Take the construction like this:

```
<data type> function_name(list of parameters){  expressions }
```

Simple example:

Example 1	void doWork()
	{
	….
	return; // does not return any value
	}

Example 2	float sum(float data[ ] , int num)
	{ int i;
	float total=0.0;
	for (i=0 ; i<num; i++){
	total = total + data[i];
	}
	return total;
	}

Example 3	float calArea(float a, float b, char kind)
	{
	float area;
	switch (kind):
	{
	case 's' : area = a * b;
	break;
	case 't' : area = a * b / 2.0;
	break;
	…
	}
	return area;
	}

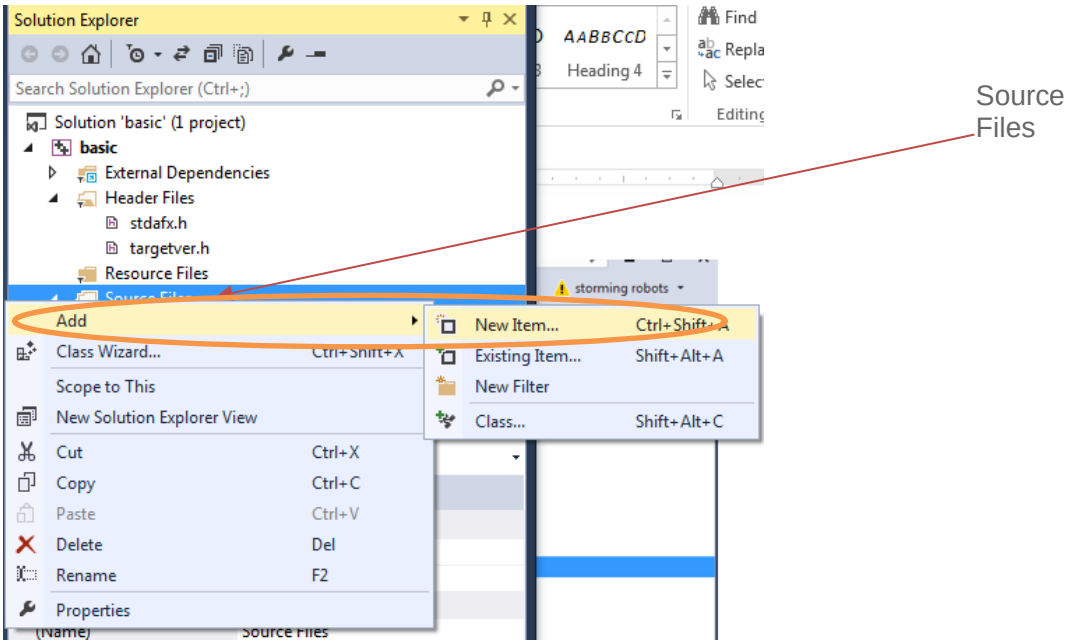
Example 4	Use the Object struct sample above:
	
	float calForce(Object ob)
	{
	return (ob.velocity/ ob.time)* ob.mass;
	}
	
	void main()
	{
	Object bots[2] = { { 50, 9.5, 10.5 }, { 20, 20, 5.5 } };
	for(int i = 0; i< 2; i++)
	cout << "object-" << i << ": " << calForce(bots[i[) << endl;
	}

Example 5	typedef struct Child { char name[7]; char gender; int age;

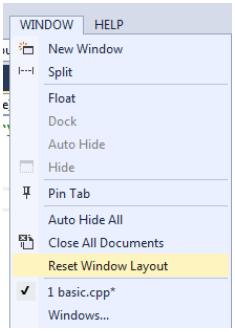
```
void setChild(int a, char s[], char g)
{
        strcpy( name, s, sizeof(name) );
    gender = g;
        age = a;
}
} Child;


void main()
{
        Child ct;
        ct.setChild(10, 'f', 20);
        printf ("%d\n", ct.gender);

}
```

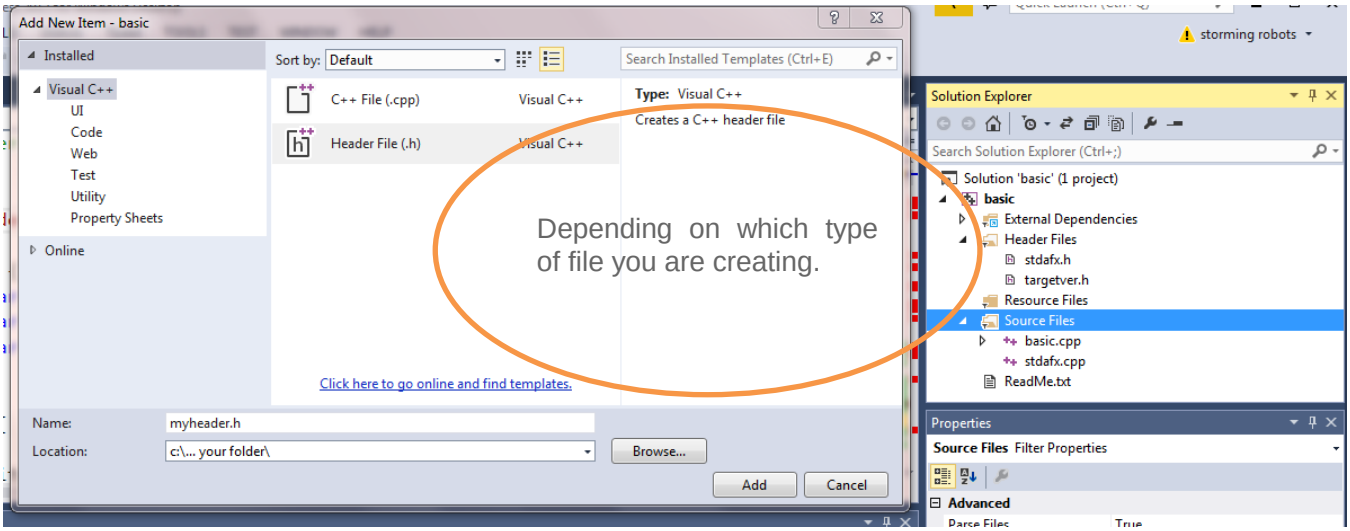
COLLECTION OF PROGRAMS AND HEADERS

How to add header and new programs into your project using Visual Studio Express:



If you do not see this Solution Explorer, do :




Add New Item - basic
Installed
Visual C++
UI
Code
Web
Test
Utility
Property Sheets
Online
Sort by: Default
Search Installed Templates (Ctrl+E)
C++ File (.cpp)
Visual C++
Header File (.h)
Visual C++
Type: Visual C++
Creates a C++ header file
Depending on which type of file you are creating.
Click here to go online and find templates.
Name: myheader.h
Location: c:\... your folder\
Browse...
Add
Cancel
storming robots
Solution Explorer
Search Solution Explorer (Ctrl+;)
Solution 'basic' (1 project)
basic
External Dependencies
Header Files
stdafx.h
targetver.h
Resource Files
Source Files
basic.cpp
stdafx.cpp
ReadMe.txt
Properties
Source Files Filter Properties
Advanced

EXERCISES :

1) Reverse the value stored in an array of x[…].
   Reverse the list of value; e.g.

   X[...] contains 10,4,1, 9. After the function reverse(…)
   X[...] contains 9,1,4,10

2) Define an array char a[26] and fill this array with values 'a', 'b', 'c', to 'z' in a simple loop with only one expression. This expression should not contain any numeric constant.

   e.g.

   for (i=0; i<sizeof(a); i++)
   the expression goes here….

   Yes. Only one!

   Tip: remember ASCII? .. see the table at the bottom of this document.

3) Write a program which translates a word to a score, like Scrabble, except much fewer variation.
   - a,e,i,o,u,y will be worth 5 each.
   - q,x,z will be worth 20 each.
   - All other letters will be worth 10 each.
   - Any upper case will be worth 2 more.
   - E.g. Ahha is worth 32 (7 + 10 + 10 + 5)

   e.g. : char word[ ] = "Ahha";

   Tips:

   - Your program should use "switch" statements to determine the score and display " Ahha gives 32 "
   - Use intrinsic functions : tolower() and/or toupper(). E.g.
   - #include <ctype.h>

     …

     word[i]= tolower(word[i]);

     // this will change a single character word[i] to lower case . If it is already lower case, nothing will change.

4) Given:

```
#define MAXR       25
#define MAXC      20

int abc[MAXR][MAXC];

void main()
{
…
int rows =  <write expression here to generate the number of rows of abc> ;
```

int cols = <write expression here to generate the number of columns of abc>

// however, you cannot use "MAX", cannot hardcode any numeric constants…
Tips: sizeof(abc) == the capacity of the whole field.
sizeof(abc[0]) == the capacity of a single row
sizeof(abc[0][0]) == a single element

5) Use the following code segment:

```
for (i=N, i<=NW; i++)                    // where N and NW are part of an enum value
    printf(" %s == %d\n", directions[i] ,  go[i],);

    // e.g. directions[N] should contain "North", directions[NW] should contain "NorthWest".
```

to generate display:

North == 0 degrees
NorthEast == 45 degrees
East == 90 degrees

West == 270 degrees
NorthWest == 315 degrees

Tip : Review the Enumeration Type sample above.

6) Mr. Smith has 10 children. Each one was born 2 years apart. Just so happen that their gender alternate as well, i.e. boy, girl, boy, girl, etc. The oldest one is 30 years old, and is a daughter. Also, Mr. Smith is not so creative with names. He simply use "Beth" for girls, and "Dennis" for boys. Each additional child will simply have the same name attached with one of the vowels – a, e, i, o, u. This is how:

   - First daughter's name is Betha. The subsequent ones will be Bethe, followed by Bethi, Betho, and Bethu. - First son's name is Dennisa. The next one is Dennise… etc.
   - Display all of like the following:

```
Child Name Age
==============================
Daughter   Betha        30
Son        Dennisa      28
Daughter   Bethe        26
Son        Dennise      24
Daughter   Bethi        22
Son        Dennisi      20
Daughter   Betho        18
Son        Denniso      16
Daughter   Bethu        14
Son        Dennisu      12
```

Note:

Main body of your code cannot exceed 5 expressions (can be a compound expression). i.e. not counting main( ), headers, { , etc.

You can even do this with one expression, ie. One line ended with ";".

Tip: design a few arrays to hold the a,e,i,o,u,, another variable array to hold Dennis and Beth, etc.,

7) Here is a block of cells with their corresponding slot number. Yellow area indicates the row and column numbers.

   The array can be: int cells[MAX_X][MAX_Y] where MAX_X = 4 and MAX_Y = 6

	0	1	2	3	4	5
0	1	2	3	4	5	6
1	7	8	9	10	11	12
2	13	14	15	16	17	18
3	19	20	21	22	23	24

   Write a program to print out the all values of within all cells like the table above. (You can skip the column numbers).

   Sample output:

```
Cell (2,5) =  18
```

8) Write a program to calculate factorial of a number. Make this a function: int factorial(int n).

9) Write a program to calculate fibonacci of a number. Make this a function: int Fibonacci(int n).

10) Write the Sieve of Eratosthenes Prime number generator to generate all primes under N number which are entered as command line argument.

    To test:

    a) Display all primes under 100.
    b) Count # of primes under 1000000.

11) Use Ex.9, ask user for an max count input. Your code will produce the actual count of prime numbers under your input.

    Input : Enter the Max count: 10000

    Output: total # of prime numbers = 1229

12) Use Ex.9, ask user for nth prime to look for.

    Input : Enter the Nth: 10000

    Output: the prime number = 104,729

13) Use Ex.9, ask user for an max count input. Your code will produce the actual count of prime numbers under your input.

14) Write a very short program to do the following :

```
1  99 bottles of drink on the wall, 99 bottles of drink!
2  So take one down, pass it around, 98 more bottles of drink on the wall!
3  98 bottles of drink on the wall, 98 bottles of drink!
4  So take one down, pass it around, 97 more bottles of drink on the wall!
5  97 bottles of drink on the wall, 97 bottles of drink!
6  So take one down, pass it around, 96 more bottles of drink on the wall!
7  ...
8  3 bottles of drink on the wall, 3 bottles of drink!
9  So take one down, pass it around, 2 more bottles of drink on the wall!
10 2 more bottles of drink on the wall, 2 more bottles of drink!
11 So take one down, pass it around, 1 more bottle of drink on the wall!
12 1 bottle of drink on the wall, 1 bottle of drink!
13 So take it down, pass it around, no more bottles of drink on the wall!
```

15) Create your own library file and header file containing functions and global variables, if any. Steps:

    i) Convert 3 programs into individual functions, including:
        a) int factorial(int input)
        b) int fib(int count).
        c) int generatePrime(int) :
            i. Returns the actual value of the Nth prime number.
            ii. Parameters:
                int : the Nth prime number, this is from user input
        d) int Scrabble(char [], int)
            i. Return : score value
            ii. Parameters:
                char [ ] : array of characters from user input

int : the length of this array

ii) Move all your new data types and header includes in a header file *.h.
iii) Add these as new items into your "Source Files" list.
iv) Rebuild your project.
v) Prompt user which exercise he/she wants to run. Test it. :

16) Display a number in binary: void displayBinary(int number)
   i. Return : none
   ii. Parameters:

   Int number : the number from user input

   e.g. if displayBinary(16), the output should look like 10000 .

17) Anagrams Set Problem. Write a program to display all the words and their matching anagram set number. For example:

Your words list:

char words[ ] [100] = { "aaabc", " cbaad", "aadbc", "cbaaa", "cdcdcd", "dccdcd", "abcaa" };

Your program displays:

aaabc	1
cbaad	2
aadbc	2
cbaaa	1
cdcdcd	3
abcaa	1
dccdcd	3

ASCII TABLE

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