CS 1037
Computer Science Fundamentals II

Part Four:
Memory Maps

MEMORY MAPPING

```
char a, b, c;
```

Label	Address	Value
	399	
	400	
	401	
	402	
	403	
	404	
	405	
	406	
	…	

MEMORY MAPPING

```
char a, b, c;
```

Label	Address	Value	Binary
	399		
	400		
	401		
	402		
	403		
	404		
	405		
	406		
	…		

MEMORY MAPPING

```
char a, b, c; /* char - 1 byte each */
```

Label	Address	Value
	399	
a	400	
b	401	
c	402	
	403	
	404	
	405	
	406	
	…	

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
```

note: not necessarily **contiguous**
assigned to locations that are 'free' and available for the size required.

Label	Address	Value
	399	
	400	
a	401	
	402	
c	403	
	404	
	405	
b	406	
	…	

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
```

Label	Address	Value	Binary
	399		
a	400		
b	401		
c	402		
	403		
	404		
	405		
	406		
	…		

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
a = 7;        /* (0000 0111) */
```

Label	Address	Value
	399	
a	400	7
b	401	
c	402	
	403	
	404	
	405	
	406	
	…	

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
a = 7;        /* (0000 0111) */
```

Label	Address	Value
	399	
a	400	7
b	401	
c	402	
	403	
	404	
	405	
	406	
	…	

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
a = 7;        /* (0000 0111) */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401		
c	402		
	403		
	404		
	405		
	406		
	…		

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
a = 7;        /* (0000 0111) */
b = -13;      /* (1111 0011) */
```

Label	Address	Value	Binary
	399		
a	400	7	
b	401	-13	1111 0011
c	402		
	403		
	404		
	405		
	406		
	…		

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
a = 7;        /* (0000 0111) */
b = -13;      /* (1111 0011) */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	1111 0011
c	402		
	403		
	404		
	405		
	406		
	…		

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
a = 7;        /* (0000 0111) */
b = -13;      /* (1111 0011) */
c = 0;        /* (0000 0000) */
```

Label	Address	Value	Binary
	399		
a	400	7	
b	401	-13	1111 0011
c	402	0	0000 0000
	403		
	404		
	405		
	406		
	…		

MEMORY MAPPING

```
char a, b, c; /* char – 1 byte each */
a = 7;        /* (0000 0111) */
b = -13;      /* (1111 0011) */
c = 0;        /* (0000 0000) */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	1111 0011
c	402	0	0000 0000
	403		
	404		
	405		
	406		
	…		

MEMORY MAPPING

Label	Address	Value	Binary
	399		
	400		
	401		
	402		
	403		
	404		
	405		
	406		
	407		
	408		
	409		
	410		
	411		
	412		
	413		
	414		
	415		
	416		
	417		
	418		
	…		

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */
```

decimal 7 = binary 000 0111

Label	Address	Value	Binary
	399		
a	400	7	
	401		
	402		
	403		
	404		
	405		
	406		
	407		
	408		
	409		
	410		
	411		
	412		
	413		
	414		
	415		
	416		
	417		
	418		
	…		

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
	401		
	402		
	403		
	404		
	405		
	406		
	407		
	408		
	409		
	410		
	411		
	412		
	413		
	414		
	415		
	416		
	417		
	418		
	…		

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */

int b = -13;
/* int: 4 bytes */
```

decimal -13 = binary 1111 1111 1111 1111 1111 1111 1111 0011

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	
	402		
	403		
	404		
	405		
	406		
	407		
	408		
	409		
	410		
	411		
	412		
	413		
	414		
	415		
	416		
	417		
	418		
	...		

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */

int b = -13;
/* int: 4 bytes */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	1111 1111
	402		1111 1111
	403		1111 1111
	404		1111 0011
	405		
	406		
	407		
	408		
	409		
	410		
	411		
	412		
	413		
	414		
	415		
	416		
	417		
	418		
	...		

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */

int b = -13;
/* int: 4 bytes */

float c = 0.1;
/* float: 4 bytes */
```

decimal 0.1 = binary 0011 1110 0000 0000 0000 0000 0000 0000

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	1111 1111
	402		1111 1111
	403		1111 1111
	404		1111 0011
c	405	0.1	
	406		
	407		
	408		
	409		
	410		
	411		
	412		
	413		
	414		
	415		
	416		
	417		
	418		
	...		

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */

int b = -13;
/* int: 4 bytes */

float c = 0.1;
/* float: 4 bytes */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	1111 1111
	402		1111 1111
	403		1111 1111
	404		1111 0011
c	405	0.1	0011 1110
	406		0000 0000
	407		0000 0000
	408		0000 0000
	409		
	410		
	411		
	412		
	413		
	414		
	415		
	416		
	417		
	418		
	...		

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */

int b = -13;
/* int: 4 bytes */

float c = 0.1;
/* float: 4 bytes */

double d = 42.5;
/* double: 8 bytes */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	1111 1111
	402		1111 1111
	403		1111 1111
	404		1111 0011
c	405	0.1	0011 1110
	406		0000 0000
	407		0000 0000
	408		0000 0000
d	409	42.5	
	410		
	414		
	415		
	416		
	417		
	418		
	...		

decimal 42.5 =
binary 0100 0000 0100 0101 0100 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */

int b = -13;
/* int: 4 bytes */

float c = 0.1;
/* float: 4 bytes */

double d = 42.5;
/* double: 8 bytes */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	1111 1111
	402		1111 1111
	403		1111 1111
	404		1111 0011
c	405	0.1	0011 1110
	406		0000 0000
	407		0000 0000
	408		0000 0000
d	409	42.5	0100 0000
	410		0100 0101
	411		0100 0000
	412		0000 0000
	413		0000 0000
	414		0000 0000
	415		0000 0000
	416		0000 0000
	417		
	418		
	...		

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */

int b = -13;
/* int: 4 bytes */

float c = 0.1;
/* float: 4 bytes */

double d = 42.5;
/* double: 8 bytes */
```

Label	Address	Value	Binary
	3		
a	4		
b	4		
	4		
	4		
	4		
c	4		
	4		
	4		
	4		
d	4		
	410		0100 0101
	411		0100 0000
	412		0000 0000
	413		0000 0000
	414		0000 0000
	415		0000 0000
	416		0000 0000
	417		
	418		
	...		

397 - 1 0 1 1 1 0 0 1	398 - 1 0 1 1 1 0 0 1	399 - 1 0 1 1 1 0 0 1
400 - 0 0 0 0 0 0 1 1	401 - 1 1 1 1 1 0 0 1	402 - 1 1 0 0 0 0 0 0
403 - 0 1 0 1 0 1 1 1	404 - 1 0 1 0 1 1 0 1	405 - 1 0 0 0 1 1 0 1
406 - 1 1 1 0 0 1 1 0	407 - 1 1 1 0 0 1 1 0	408 - 1 1 0 0 0 1 1 0
409 - 0 0 1 0 0 0 1 1	410 - 1 0 1 1 0 0 1 1	411 - 1 1 0 0 1 1 0 1
412 - 1 0 1 1 1 0 0 1	413 - 1 0 1 1 1 0 0 1	414 - 1 1 0 0 0 1 1 0
415 - 1 1 1 0 0 1 1 0	416 - 1 1 1 0 0 1 1 0	417 - 1 1 0 0 0 1 1 0
418 - 0 1 0 1 0 1 1 1	419 - 1 0 1 0 1 1 1 0	420 - 1 1 0 1 0 0 1 1
421 - 1 0 1 1 1 0 0 1	422 - 1 0 1 1 1 0 0 1	423 - 1 1 0 0 0 1 1 0

MEMORY MAPPING

```
char a = 7;
/* char: 1 byte */

int b = -13;
/* int: 4 bytes */

float c = 0.1;
/* float: 4 bytes */

double d = 42.5;
/* double: 8 bytes */
```

Label	Address	Value	Binary
	399		
a	400	7	0000 0111
b	401	-13	1111 1111
	402		1111 1111
	403		1111 1111
	404		1111 0011
c	405	0.1	0011 1110
	406		0000 0000
	407		0000 0000
	408		0000 0000
d	409	42.5	0100 0000
	410		0100 0101
	411		0100 0000
	412		0000 0000
	413		0000 0000
	414		0000 0000
	415		0000 0000
	416		0000 0000
	417		
	418		
	...		

MEMORY MAPPING

```
char a;
int b;
float c;
double d;

a = 7;        /* 1 byte */
b = -13;      /* 4 bytes */
c = 0.1;      /* 4 bytes */
d= 42.5;      /* 8 bytes */
```

A BETTER WAY OF VISUALIZING THE MAP:

Label	Address	Value
	399	
a	400	7
b	401 - 404	-13
c	405 - 408	0.1
d	409 - 416	42.5
	417	
	418	
	419	
	…	

MEMORY MAPPING

```
char a;
```

ALLOCATION NOT NECESSARILY CONTIGOUS:

Label	Address	Value
	399	
a	400	
	…	
	…	
	…	
	…	
	…	
	…	
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
```

ALLOCATION NOT NECESSARILY CONTIGOUS:

Label	Address	Value
	399	
a	400	
	…	
	…	
	…	
b	510 - 513	
	…	
	…	
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
float c;
```

ALLOCATION NOT NECESSARILY CONTIGOUS:

Label	Address	Value
	399	
a	400	
	…	
	…	
	…	
b	510 - 513	
	…	
c	605 - 608	
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
float c;
double d;
```

ALLOCATION NOT NECESSARILY CONTIGOUS:

Label	Address	Value
	399	
a	400	
	…	
d	409 - 416	
	…	
b	510 - 513	
	…	
c	605 - 608	
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
float c;
double d;

a = 7;          /* 1 byte */
```

ALLOCATION NOT NECESSARILY CONTIGOUS:

Label	Address	Value
	399	
a	400	7
	…	
d	409 - 416	
	…	
b	510 - 513	
	…	
c	605 - 608	
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
float c;
double d;

a = 7;          /* 1 byte */
b = -13;        /* 4 bytes */
```

ALLOCATION NOT NECESSARILY CONTIGOUS:

Label	Address	Value
	399	
a	400	7
	…	
d	409 - 416	
	…	
b	510 - 513	-13
	…	
c	605 - 608	
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
float c;
double d;

a = 7;          /* 1 byte */
b = -13;        /* 4 bytes */
c = 0.1;        /* 4 bytes */
```

ALLOCATION NOT NECESSARILY CONTIGOUS:

Label	Address	Value
	399	
a	400	7
	…	
d	409 - 416	
	…	
b	510 - 513	-13
	…	
c	605 - 608	0.1
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
float c;
double d;

a = 7;        /* 1 byte */
b = -13;      /* 4 bytes */
c = 0.1;      /* 4 bytes */
d = 42.5;     /* 8 bytes */
```

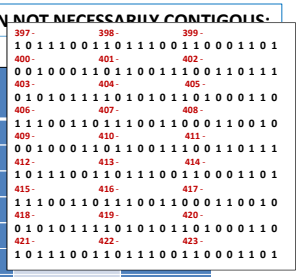
ALLOCATION NOT NECESSARILY CONTIGOUS:

Label	Address	Value
	399	
a	400	7
	…	
d	409 - 416	42.5
	…	
b	510 - 513	-13
	…	
c	605 - 608	0.1
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
float c;
double d;

a = 7;        /* 1 byte */
b = -13;      /* 4 bytes */
c = 0.1;      /* 4 bytes */
d = 42.5;     /* 8 bytes */
```

ALLOCATION NOT NECESSARILY CONTIGOUS:



Label	Address	Value
	399	
a	400	7
	…	
d	409 - 416	42.5
	…	
b	510 - 513	-13
	…	
c	605 - 608	0.1
	…	
	…	
	…	
	…	

MEMORY MAPPING

```
char a;
int b;
float c;
double d;
```

VARIABLE DECLARATION VS. VARIABLE DEFINITION:

VARIABLE DECLARATION:
the variable is only declared and allocated a block of memory but still has no value

Label	Address	Value
	399	
a	400	
	…	
d	409 - 416	
	…	
b	510 - 513	
	…	
c	605 - 608	
	…	
	…	
	…	
	…	

MEMORY MAPPING

VARIABLE DECLARATION VS. VARIABLE DEFINITION:

```
a = 7;        /* 1 byte */
b = -13;      /* 4 bytes */
c = 0.1;      /* 4 bytes */
d = 42.5;     /* 8 bytes */
```

VARIABLE DEFINITION:
to assign or initialize it with some specific value

Label	Address	Value
	399	
a	400	7
	…	
d	409 - 416	42.5
	…	
b	510 - 513	-13
	…	
c	605 - 608	0.1
	…	
	…	
	…	
	…	

MEMORY MAPPING

Scalar Variables versus Aggregate Variables

So far, the only variables we've seen are **scalar**: capable of holding a single data item.

C also supports **aggregate** variables, which can store collections of values.

There are two kinds of aggregates in C: **arrays** and **structures**.

We will start by looking at one-dimensional arrays,
which play a much bigger role in C than do multidimensional arrays.

An array is a data structure containing a number of data values, all of which have the same type.

These values, known as elements, can be individually selected by their position within the array.

The elements of a one-dimensional array a are conceptually arranged
one after another in a single row (or column):

MEMORY MAPPING

Scalar Variables versus Aggregate Variables

To declare an array, we must specify the type of the array's elements and the number of elements:

```
int a[10];
```

The elements may be of any type; the length of the array can be any (integer) constant expression.

An array, like any other variable, can be given an initial value at the time it's declared.
The most common form of array initializer is a list of constant expressions enclosed in braces and separated by commas:

```
int a[10] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};
```

If the initializer is shorter than the array, the remaining elements of the array are given the value 0:

```
int a[10] = {1, 2, 3, 4, 5, 6};
/* initial value of a is {1, 2, 3, 4, 5, 6, 0, 0, 0, 0} */
```

If an initializer is present, the length of the array may be omitted:

```
int a[] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};
```

The compiler uses the length of the initializer to determine how long the array is.

MEMORY MAPPING [ARRAYS]

```
int a[2];
/* int: 4 bytes */
```

ALLOCATION FOR EACH INDIVIDUAL ARRAY MUST BE CONTIGOUS:

Label	Address	Value	
a[0]	400 - 403		int a[2];
a[1]	404 - 407		

MEMORY MAPPING [ARRAYS]

```
int a[2];
/* int: 4 bytes */

float b[3];
/* float: 4 bytes */
```

Label	Address	Value	
a[0]	400 - 403		int a[2];
a[1]	404 - 407		
b[0]	408 - 411		float b[3];
b[1]	412 - 415		
b[2]	416 - 419		

MEMORY MAPPING [ARRAYS]

```
int a[2];
/* int: 4 bytes */

float b[3];
/* float: 4 bytes */

double c[4];
/* double: 8 bytes */
```

Label	Address	Value	
a[0]	400 - 403		int a[2];
a[1]	404 - 407		
b[0]	408 - 411		float b[3];
b[1]	412 - 415		
b[2]	416 - 419		
c[0]	420 - 427		double c[4];
c[1]	428 - 435		
c[2]	436 - 443		
c[3]	444 - 451		

MEMORY MAPPING [ARRAYS]

```
int a[2];
/* int: 4 bytes */

float b[3];
/* float: 4 bytes */

double c[4];
/* double: 8 bytes */

char d[6];
 /* char: 1 byte */
```

Label	Address	Value	
a[0]	400 - 403		int a[2];
a[1]	404 - 407		
b[0]	408 - 411		float b[3];
b[1]	412 - 415		
b[2]	416 - 419		
c[0]	420 - 427		double c[4];
c[1]	428 - 435		
c[2]	436 - 443		
c[3]	444 - 451		
d[0]	452		char d[6];
d[1]	453		
d[2]	454		
d[3]	455		
d[4]	456		
d[5]	457		

MEMORY MAPPING [ARRAYS]

```
int a[2] = {37, 52};
/* int: 4 bytes */
```

ALLOCATION FOR EACH INDIVIDUAL ARRAY MUST BE CONTIGOUS:

Label	Address	Value	
a[0]	400 - 403	37	int a[2];
a[1]	404 - 407	52	

MEMORY MAPPING [ARRAYS]

```
int a[2] = {37, 52};
/* int: 4 bytes */

float b[3] = {26, 54};
/* float: 4 bytes */
```

Label	Address	Value	
a[0]	400 - 403	37	int a[2];
a[1]	404 - 407	52	
b[0]	408 - 411	26	float b[3];
b[1]	412 - 415	54	
b[2]	416 - 419	0	

MEMORY MAPPING [ARRAYS]

```
int a[2] = {37, 52};
/* int: 4 bytes */

float b[3] = {26, 54};
/* float: 4 bytes */

double c[4];
/* double: 8 bytes */
```

Label	Address	Value	
a[0]	400 - 403	37	int a[2];
a[1]	404 - 407	52	
b[0]	408 - 411	26	float b[3];
b[1]	412 - 415	54	
b[2]	416 - 419	0	
c[0]	420 - 427	?	double c[4];
c[1]	428 - 435	?	
c[2]	436 - 443	?	
c[3]	444 - 451	?	

MEMORY MAPPING [ARRAYS]

```
int a[2] = {37, 52};
/* int: 4 bytes */

float b[3] = {26, 54};
/* float: 4 bytes */

double c[4];
/* double: 8 bytes */

char d[6];
 /* char: 1 byte */
```

Label	Address	Value	
a[0]	400 - 403	37	int a[2];
a[1]	404 - 407	52	
b[0]	408 - 411	26	float b[3];
b[1]	412 - 415	54	
b[2]	416 - 419	0	
c[0]	420 - 427	?	double c[4];
c[1]	428 - 435	?	
c[2]	436 - 443	?	
c[3]	444 - 451	?	
d[0]	452	?	char d[6];
d[1]	453	?	
d[2]	454	?	
d[3]	455	?	
d[4]	456	?	
d[5]	457	?	
	•••		

MEMORY MAPPING [ARRAYS]

```
int a[2] = {37, 52};
/* int: 4 bytes */

float b[3] = {26, 54};
/* float: 4 bytes */

double c[4];
/* double: 8 bytes */

char d[6];
 /* char: 1 byte */

c[2] = 14.7;
```

Label	Address	Value	
a[0]	400 - 403	37	int a[2];
a[1]	404 - 407	52	
b[0]	408 - 411	26	float b[3];
b[1]	412 - 415	54	
b[2]	416 - 419	0	
c[0]	420 - 427	?	double c[4];
c[1]	428 - 435	?	
c[2]	436 - 443	14.7	
c[3]	444 - 451	?	
d[0]	452	?	char d[6];
d[1]	453	?	
d[2]	454	?	
d[3]	455	?	
d[4]	456	?	
d[5]	457	?	
	•••		

MEMORY MAPPING [ARRAYS]

```
int a[2] = {37, 52};
/* int: 4 bytes */

float b[3] = {26, 54};
/* float: 4 bytes */

double c[4];
/* double: 8 bytes */

char d[6];
 /* char: 1 byte */

c[2] = 14.7;

d[4] = 'a';
```

Label	Address	Value	
a[0]	400 - 403	37	int a[2];
a[1]	404 - 407	52	
b[0]	408 - 411	26	float b[3];
b[1]	412 - 415	54	
b[2]	416 - 419	0	
c[0]	420 - 427	?	double c[4];
c[1]	428 - 435	?	
c[2]	436 - 443	14.7	
c[3]	444 - 451	?	
d[0]	452	?	char d[6];
d[1]	453	?	
d[2]	454	?	
d[3]	455	?	
d[4]	456	a	
d[5]	457	?	
	•••		

MEMORY MAPPING [ARRAYS]

```
int a[2] = {37, 52};
/* int: 4 bytes */

float b[3] = {26, 54};
/* float: 4 bytes */

double c[4];
/* double: 8 bytes */

char d[6];
 /* char: 1 byte */

c[2] = 14.7;

d[4] = 'a';

/* BUT !now what happens if:
(because - this will compile
 and run) */

b[4] = 15.9;
/* memory location 424-427 */
```

Label	Address	Value	
a[0]	400 - 403	37	int a[2];
a[1]	404 - 407	52	
b[0]	408 - 411	26	float b[3];
b[1]	412 - 415	54	
b[2]	416 - 419	0	
c[0]	420 424 - 427	? 15.9	double c[4];
c[1]	428 - 435	?	
c[2]	436 - 443	14.7	
c[3]	444 - 451	?	
d[0]	452	?	char d[6];
d[1]	453	?	
d[2]	454	?	
d[3]	455	?	
d[4]	456	a	
d[5]	457	?	
	•••		

MEMORY MAPPING [ARRAYS]

```
int a[2] = {37, 52};
/* int: 4 bytes */

float b[3] = {26, 54};
/* float: 4 bytes */

double c[4];
/* double: 8 bytes */

char d[6];
 /* char: 1 byte */

c[2] = 14.7;

d[4] = 'a';

/* OR !! This */

b[3333] = 15.9;
/* memory location 15205 */
```

run time error :
out of program allowed bounds

Label	Address	Value	
a[0]	400 - 403	37	int a[2];
a[1]	404 - 407	52	
b[0]	408 - 411	26	float b[3];
b[1]	412 - 415	54	
b[2]	416 - 419	0	
c[0]	420 - 427	?	double c[4];
c[1]	428 - 435	?	
c[2]	436 - 443	14.7	
c[3]	444 - 451	?	
d[0]	452	?	char d[6];
d[1]	453	?	
d[2]	454	?	
d[3]	455	?	
d[4]	456	a	
d[5]	457	?	
b[3333]	15205	15.9	

MEMORY MAPPING [ARRAYS]

If an initializer is present, the length of the array may be omitted:

```
int a[] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};
```

The compiler uses the length of the initializer to determine how long the array is.

Label	Address	Value
a[0]	400 - 403	1
a[1]	404 - 407	2
a[2]	408 - 411	3
a[3]	412 - 415	4
a[4]	416 - 417	5
a[5]	420 - 421	6
a[6]	424 - 425	7
a[7]	428 - 431	8
a[8]	432 - 435	9
a[9]	436 - 439	10

MEMORY MAPPING [ARRAYS – MULTIDIMENSIONAL]

```
int a[3][2];
/* a 3 by 2 table */
/* 3 rows and 2 columns */
/* 6 cells of 4 bytes each */
/* caution: never a[3,2] */
```

	0	1
0	0 0	0 1
1	1 0	1 1
2	2 0	2 1

Label	Address	Value
a[0][0]	400 - 403	
a[0][1]	404 - 407	
a[1][0]	408 - 411	
a[1][1]	412 - 415	
a[2][0]	416 - 419	
a[2][1]	420 - 423	

C stores arrays in ***row-major order,*** with row 0 first, then row 1, and so forth. (sort of ….)

MEMORY MAPPING [ARRAYS – MULTIDIMENSIONAL]

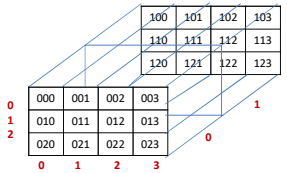
```
int a[3][2];
/* a 3 by 2 table */

a[0][1] = 7;
a[1][0] = 13;
```

	0	1
0		(7)
1	(13)	
2		

Label	Address	Value
a[0][0]	400 - 403	
a[0][1]	404 - 407	7
a[1][0]	408 - 411	13
a[1][1]	412 - 415	
a[2][0]	416 - 419	
a[2][1]	420 - 423	

MEMORY MAPPING [ARRAYS – THREE DIMENSIONAL]

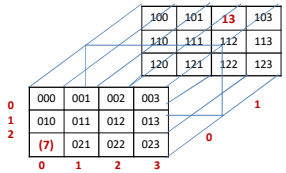
```
int b[2][3][4];
/* a 2 by 3 by 4 table */
/* 2 layers 3 rows 4 columns */
/* 24 cells of 4 bytes each */
```



Label	Address	Value	Label	Address	Value
b[0][0][0]	400 - 403		b[1][0][0]	448 – 451	
b[0][0][1]	404 - 407		b[1][0][1]	452 – 455	
b[0][0][2]	408 - 411		b[1][0][2]	456 – 459	
b[0][0][3]	412 - 415		b[1][0][3]	460 – 463	
b[0][1][0]	416 - 419		b[1][1][0]	464 – 467	
b[0][1][1]	420 - 423		b[1][1][1]	468 – 471	
b[0][1][2]	424 – 427		b[1][1][2]	472 – 475	
b[0][1][3]	428 – 431		b[1][1][3]	476 – 479	
b[0][2][0]	432 – 435		b[1][2][0]	480 – 483	
b[0][2][1]	436 – 439		b[1][2][1]	484 – 485	
b[0][2][2]	440 – 443		b[1][2][2]	488 – 491	
b[0][2][3]	444 - 447		b[1][2][3]	492 - 495	

MEMORY MAPPING [ARRAYS – THREE DIMENSIONAL]

```
int b[2][3][4];
/* a 2 by 3 by 4 table */

 b[0] [2] [0] = 7;
 b[1] [0] [2] = 13;
```



Label	Address	Value	Label	Address	Value
b[0][0][0]	400 - 403		b[1][0][0]	448 – 451	
b[0][0][1]	404 - 407		b[1][0][1]	452 – 455	
b[0][0][2]	408 - 411		b[1][0][2]	456 – 459	13
b[0][0][3]	412 - 415		b[1][0][3]	460 – 463	
b[0][1][0]	416 - 419		b[1][1][0]	464 – 467	
b[0][1][1]	420 - 423		b[1][1][1]	468 – 471	
b[0][1][2]	424 – 427		b[1][1][2]	472 – 475	
b[0][1][3]	428 – 431		b[1][1][3]	476 – 479	
b[0][2][0]	432 – 435	7	b[1][2][0]	480 – 483	
b[0][2][1]	436 – 439		b[1][2][1]	484 – 485	
b[0][2][2]	440 – 443		b[1][2][2]	488 – 491	
b[0][2][3]	444 - 447		b[1][2][3]	492 - 495	

MEMORY MAPPING [VARIABLE LENGTH ARRAYS]

```
int n = 3;
int a[n+1];
/* int: 4 bytes */
```

ARRAY SIZE DETERMINED AT RUN TIME

Label	Address	Value
a[0]	400 - 403	
a[1]	404 - 407	
a[2]	408 - 411	
a[3]	412 - 415	

```
int a[n+1];
```

MEMORY MAPPING [STRINGS – A SPECIAL ARRAY OF CHARACTERS]

```
char d[8]
/* char: 1 byte */
```

ARRAY OF CHARACTERS IS NOT A STRING

Label	Address	Value	
d[0]	400		char d[8];
d[1]	401		
d[2]	402		
d[3]	403		
d[4]	404		
d[5]	405		
d[6]	406		
d[7]	407		

MEMORY MAPPING [STRINGS – A SPECIAL ARRAY OF CHARACTERS]

```
char d[8]
/* char: 1 byte */

d[0] = 'H'
d[1] = 'e';
d[2] = 'l;
d[3] = 'l;
d[4] = 'o';
```

ARRAY OF CHARACTERS IS NOT A STRING

Label	Address	Value	
d[0]	400	H	char d[8];
d[1]	401	e	
d[2]	402	l	
d[3]	403	l	
d[4]	404	o	
d[5]	405		
d[6]	406		
d[7]	407		

MEMORY MAPPING [STRINGS – A SPECIAL ARRAY OF CHARACTERS]

```
char d[8]
/* char: 1 byte */

d[0] = 'H'
d[1] = 'e';
d[2] = 'l;
d[3] = 'l;
d[4] = 'o';
d[5] = '\0';
```

ARRAY OF CHARACTERS IS NOT A STRING
-> until '\0' is assigned (the NULL character)

Label	Address	Value	
d[0]	400	H	char d[8];
d[1]	401	e	
d[2]	402	l	
d[3]	403	l	
d[4]	404	o	
d[5]	405	\0	
d[6]	406		
d[7]	407		

STRINGS:
(array of char : terminated with null)

MEMORY MAPPING [STRINGS – A SPECIAL ARRAY OF CHARACTERS]

```
char d[8] = "Magic";
/* char: 1 byte */
```

STRING ARRAY assigned a VALUE

Label	Address	Value	
d[0]	400	M	char d[8];
d[1]	401	a	
d[2]	402	g	
d[3]	403	i	
d[4]	404	c	
d[5]	405	\0	
d[6]	406	0	
d[7]	407	0	

STRINGS:
(when assigned within quotes automatically terminated with null)

STRINGS (SIZE):
(the size of the string at d is: 5
- not 8.
MORE ON THIS LATER…)

MEMORY MAPPING [STRINGS – A SPECIAL ARRAY OF CHARACTERS]

```
char d[] = "Code";
/* char: 1 byte */
```

STRING ARRAY assigned a VALUE

Label	Address	Value
d[0]	400	C
d[1]	401	o
d[2]	402	d
d[3]	403	e
d[4]	404	\0

`char d[8];`

STRINGS:
(when no size specified – array of characters automatically assigned just enough memory for characters PLUS the terminating NULL)

STRINGS (SIZE):
(the size of the string at d is: 5
MORE ON THIS LATER…)