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Review of last week's content

- What is an array?
- What are the main differences between an array and a string?
- Comment the C code to explain what is happening.

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ACS126 Computing and Systems Design

Lecture 11. Pointers

Department of Automatic Control
and Systems Engineering

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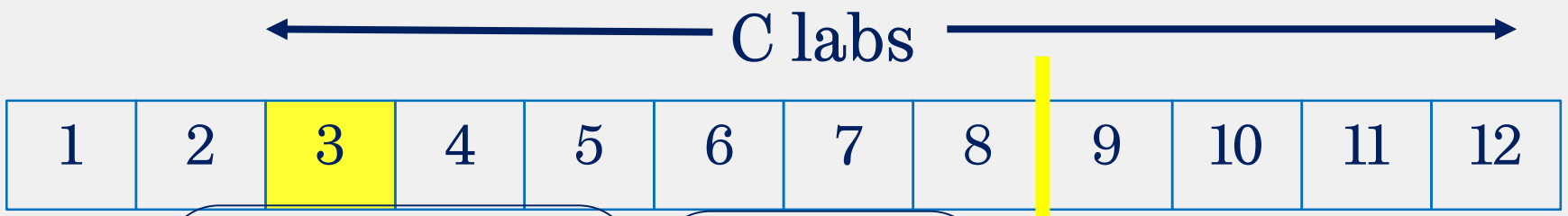
Module roadmap



Arrays and Strings, Pointers, Modular program design, Functions and passing parameters

Robot software due

Arrays and pointers, Multi-dimensional arrays, Dynamic memory, allocation Structures, Arrays of structures

C program due

Switch-case, Recursion, Putting it all together – using tools for problem solving.

Module review and exam pre-paration

C program due

Exam

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Learning Outcomes

At the end of this session, you should be able to:

- Explain what a pointer is,
- Use pointers in simple C programs
- Use pointers with arrays and strings

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What is a Pointer?

- A pointer is a variable containing the address (in memory) of a variable, i.e. a pointer holds the memory location where a variable is stored.
- A pointer is declared to point to a particular type of variable. A declaration of a pointer gives the type and the variable name preceded by an '*'.
- Examples:

```
int *ptrA;     // ptrA is a pointer to an int variable
char *ptrB;    // ptrB is a pointer to a char variable
float *ptrC;   // ptrC is a pointer to a float variable
```

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Working with Pointer Variables

```
int *ptrA;      /* ptrA is a pointer to an int variable */
int A;
```

...would result in

We don't yet know where ptrA points.

The names A and ptrA imply that we want ptrA to point to A, but we need to explicitly tell the C compiler this.

The & address operator is used to get the address of A. We can then set ptrA equal to the address of A:

```
ptrA = &A;
```

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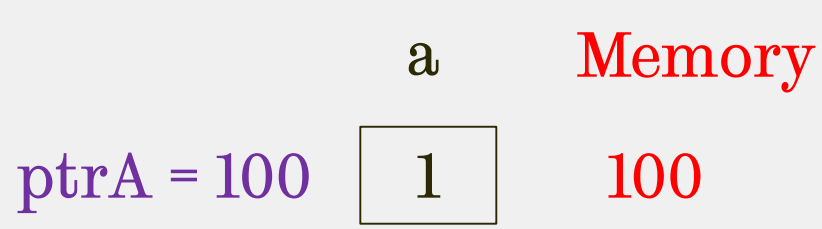
Using Pointers

```
int a=1;
int *ptrA;
ptrA = &a;
```



To get or set the contents of the memory location which a pointer points to, use the dereferencing operator *.

```
printf("Element of variable a is %d\n", *ptrA);
```

```
*ptrA = 25; /* sets the contents at memory location ptrA to 25 */
```

```
int B = *ptrA; /* the integers A and B now both equal 25 */
```

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Working with Pointer Variables

Notice that:

- in a declaration, * is used to declare a pointer (eg, int *ptrA),
- in an assignment statement, * is used to dereference a pointer (*ptrA = 25)
  - Dereference means to get the contents of the memory location.

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Example: Using Pointers

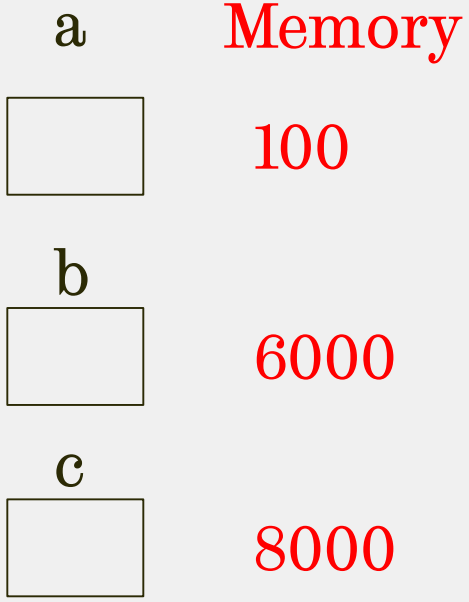
```
int a=1;
int *ptrA;
ptrA = &a;

float b=3.5;
```

//Add your code for pointer ptrB

```
char c='!';
```

//Add your code for pointer ptrB



Dereferencing: use

`*ptrA,*ptrB,*ptrC.`

What are ptrA, *ptrA, ptrB, *ptrB, ptrC, *ptrC?

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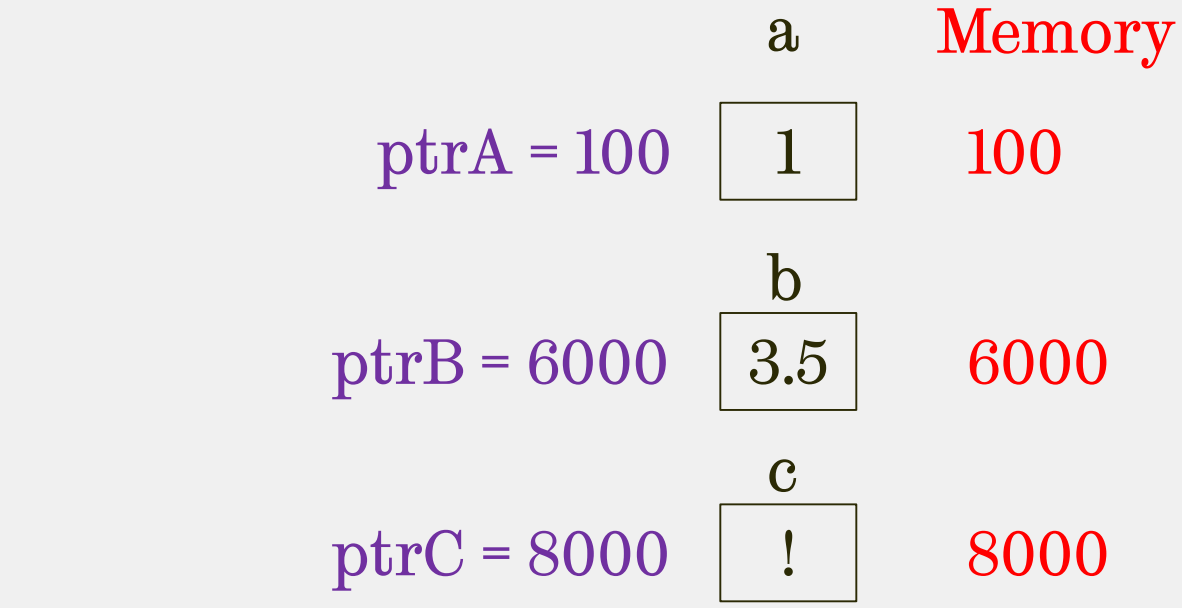
Solution: Using Pointers

```
int a=1;
int *ptrA;
ptrA = &a;

float b=3.5;
float *ptrB;
ptrB = &b;

char c='!';
char *ptrC;
ptrC = &c;
```



Dereferencing: use `*ptrA, *ptrB, *ptrC.`

*ptrA = 1, *ptrB=3.5, *ptrC='!'

Example: Using Pointers

```
#include <stdio.h>
main(){

    char c = 'A';    /* from the ASCII table, this is 41 hex. */
    char *ptrC;
    ptrC = &c;

    printf("Element is %c\n",c);
    printf("Address is %x\n",ptrC);
    printf("Using pointers:\n");
    printf("Element is %c and in hex it is %x\n",*ptrC,
                                                 *ptrC);
}
```

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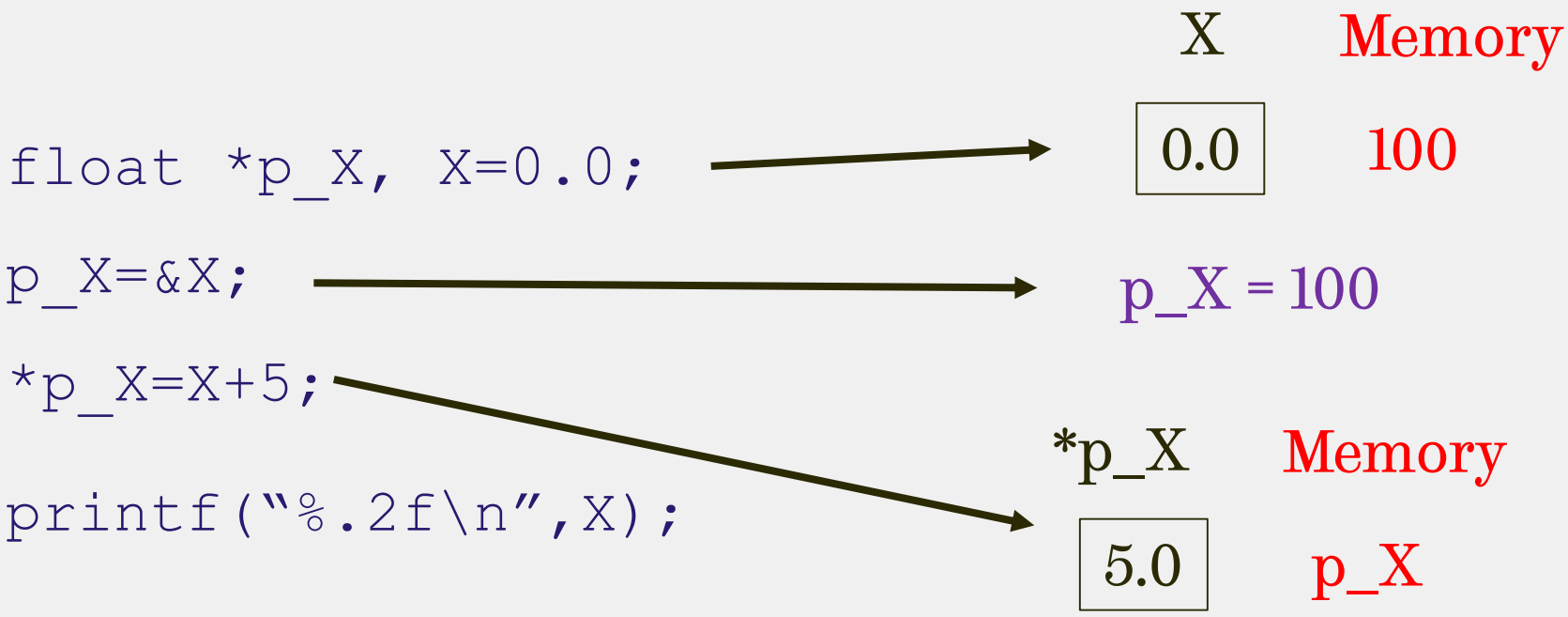
Example



What would be printed?

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Working with Pointer Variables

- When would you want to use pointers to access memory locations, rather than manipulating variables directly?
  - Mainly used when passing parameters to functions.
  - Can be used as part of dynamic allocation of memory.
  - Can be used as an alternative way of accessing array contents.
- Pointer variables can be used with +, -, ++, -- (that is, you can add to, subtract from and increment and decrement an address)

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Pointers and Arrays

- An array is stored in a block of contiguous memory locations.
- **The array name on its own is a pointer to the first location in the array (eg, A[0]).** This can be used in assignment statements **iff** it is assigned to a pointer variable of the same base type.

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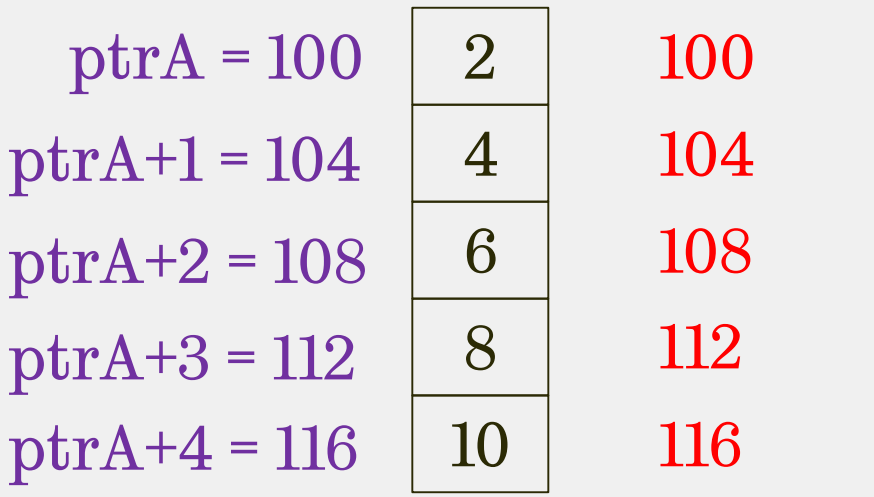
Using Pointers with Arrays

```
int a[]={2,4,6,8,10};
int *ptrA;
ptrA = a;
```



Dereferencing: use `*ptr`.

e.g.

```
for(i=0;i<5;i++){
     printf("The elements of the array are
     %d\n", *(ptrA+i)); }
```

Example

- What gets printed to the screen?

```
int array[]={0,2,4,8,16},*pA, *pB;

pA=array;

pB=array+3;

printf("array: %d %d %d %d %d; *pA %d,
  *pB %d", array[0], array[1],
  array[2], array[3], array[4], *pA,
  *pB);
```

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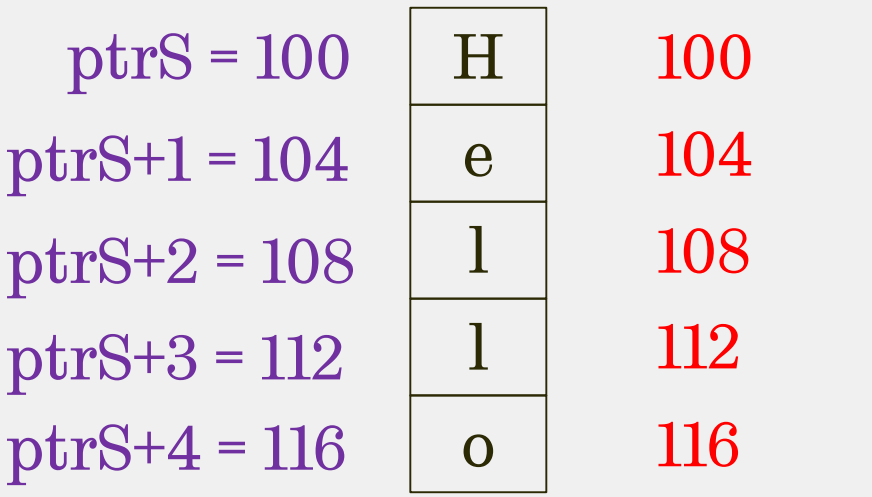
Using Pointers with Strings

```
char s[6]="Hello";
int *ptrS;
ptrS = s;
```



e.g.

```
printf("The string is %s", ptrS);
```

The implementation of printf() sees the "%s", assumes that the corresponding argument is a pointer to char, and uses that pointer to traverse the string and print it.

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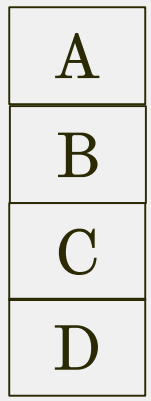
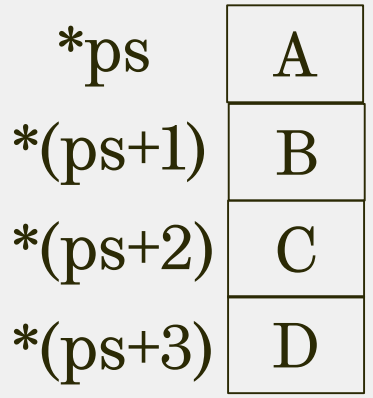
What Would be Printed?

```
char string[25],*ps;

scanf("%s",string);
/* say you enter ABCD */

ps=string;

printf("%c\n",*(ps+2));
```



ps = 100



Example Program with Pointers

```
#include <stdio.h>
main()
{
  int list1[10]={10,20,30,40,50,60,70,80,90,100};
  char list2[10];
  int *plist1;
  char *plist2;
  int i;
  plist1=list1;
  plist2=list2;
  scanf("%s",list2); //assume you enter abcdefghij
  for(i=0; i<10; i++)
  {
     printf("%c %d\n",*(plist2+i), *(plist1+i));
  }
  printf("%s\n", plist2);
}
```

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Learning Outcomes

At the end of this session, you should be able to:

- Explain what a pointer is,
  - A pointer is a variable containing the address (in memory) of a variable.
- Use pointers in simple C programs

```
int a=1;
int *ptrA;
ptrA = &a;
```

dereferencing operator:

```
*ptrA = 2;
```

- Use pointers with arrays and strings

```
int a[]={2,4,6,8,10};
int *ptrA;
ptrA = a;
```

```
char s[6]="Hello";
char *ptrS;
ptrS = s;
```