Lecture 9.2: Overview

- Data Structures
  - Pointers
    - Pointer definition
    - Pointer initialization, assignment
    - Pointer dereferencing
  - Pointer arithmetic
    - Increment, decrement
  - Pointer comparison

Pointers

- *Pointers* are variables whose values are *addresses*
  - The *"address-of"* operator (**&**) returns a pointer!
- Pointer Definition
  - The unary ***** operator indicates a pointer type in a definition

```
int x = 42;          /* regular integer variable */
int *p;              /* pointer to an integer */
```

- Pointer initialization or assignment
  - A pointer may be set to the "address-of" another variable

```
p = &x;              /* p points to x */
```

  - A pointer may be set to **0** (points to no object)

```
p = 0;               /* p points to no object */
```

  - A pointer may be set to **NULL** (points to "NULL" object)

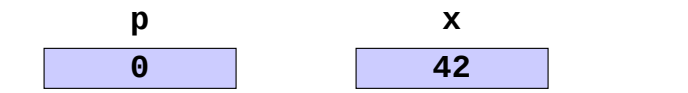
```
#include <stdio.h>   /* defines NULL as 0 */
p = NULL;            /* p points to no object */
```

Pointers

- Pointer Dereferencing
  - The unary ***** operator dereferences a pointer to the value it points to (*"content-of"* operator)

```
#include <stdio.h>

int  x = 42;   /* regular integer variable */
int *p = NULL; /* pointer to an integer */
```



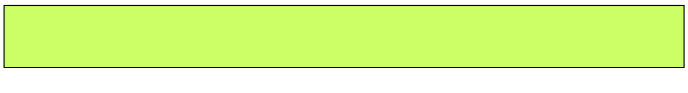
Pointers

- Pointer Dereferencing
  - The unary ***** operator dereferences a pointer to the value it points to ("content-of" operator)

```
#include <stdio.h>

int  x = 42;   /* regular integer variable */
int *p = NULL; /* pointer to an integer */

p = &x;        /* make p point to x */
```



Pointers

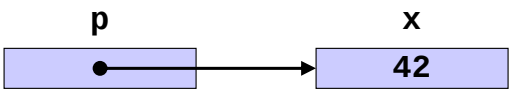
- Pointer Dereferencing
  - The unary * operator dereferences a pointer to the value it points to ("content-of" operator)

```
#include <stdio.h>

int  x = 42;   /* regular integer variable */
int *p = NULL; /* pointer to an integer */

p = &x;        /* make p point to x */
printf("x is %d, content of p is %d\n", x, *p);
```

```
x is 42, content of p is 42
```



Pointers

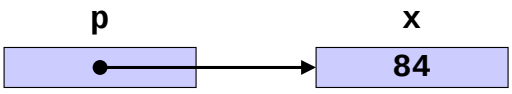
- Pointer Dereferencing
  - The unary * operator dereferences a pointer to the value it points to ("content-of" operator)

```
#include <stdio.h>

int  x = 42;   /* regular integer variable */
int *p = NULL; /* pointer to an integer */

p = &x;        /* make p point to x */
printf("x is %d, content of p is %d\n", x, *p);
*p = 2 * *p;   /* multiply content of p by 2 */
printf("x is %d, content of p is %d\n", x, *p);
```

```
x is 42, content of p is 42
x is 84, content of p is 84
```



Pointers

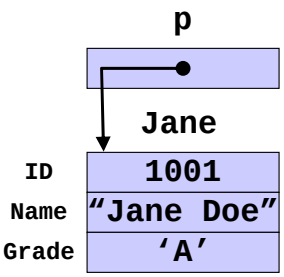
- Pointer Dereferencing
  - The **->** operator dereferences a pointer to a structure to the content of a structure member

```
struct Student
{  int  ID;
   char Name[40];
   char Grade;
};

struct Student Jane =
{1001, "Jane Doe", 'A'};

struct Student *p = &Jane;

void PrintStudent(void)
{
   printf("ID:    %d\n", p->ID);
   printf("Name:  %s\n", p->Name);
   printf("Grade: %c\n", p->Grade);
}
```




```
ID:    1001
Name:  Jane Doe
Grade: A
```


Pointers

- Pointer Arithmetic
  - Pointers pointing into arrays may be ...
    - ... incremented to point to the next array element
    - ... decremented to point to the previous array element

```
int x[5] = {10,20,30,40,50}; /* array of 5 integers */
int *p;                      /* pointer to integer */

p = &x[1];                   /* point p to x[1] */
printf("%d, ", *p);          /* print content of p */
```

```
20,
```

Pointers

- Pointer Arithmetic
  - Pointers pointing into arrays may be ...
    - ... incremented to point to the next array element
    - ... decremented to point to the previous array element

```
int x[5] = {10,20,30,40,50}; /* array of 5 integers */
int *p;                      /* pointer to integer */

p = &x[1];                   /* point p to x[1] */
printf("%d, ", *p);          /* print content of p */
p++;                         /* increment p by 1 */
printf("%d, ", *p);          /* print content of p */
```

```
20, 30,
```


Pointers

- Pointer Arithmetic
  - Pointers pointing into arrays may be ...
    - ... incremented to point to the next array element
    - ... decremented to point to the previous array element

```
int x[5] = {10,20,30,40,50}; /* array of 5 integers */
int *p;                      /* pointer to integer */

p = &x[1];                   /* point p to x[1] */
printf("%d, ", *p);          /* print content of p */
p++;                         /* increment p by 1 */
printf("%d, ", *p);          /* print content of p */
p--;                         /* decrement p by 1 */
printf("%d, ", *p);          /* print content of p */
```

```
20, 30, 20,
```

Pointers

- Pointer Arithmetic
  - Pointers pointing into arrays may be ...
    - ... incremented to point to the next array element
    - ... decremented to point to the previous array element

```
int x[5] = {10,20,30,40,50}; /* array of 5 integers */
int *p;                      /* pointer to integer */

p = &x[1];                   /* point p to x[1] */
printf("%d, ", *p);          /* print content of p */
p++;                         /* increment p by 1 */
printf("%d, ", *p);          /* print content of p */
p--;                         /* decrement p by 1 */
printf("%d, ", *p);          /* print content of p */
p += 2;                      /* increment p by 2 */
printf("%d, ", *p);          /* print content of p */
```

```
20, 30, 20, 40,
```


Pointers

- Pointer Comparison
  - Pointers may be compared for equality
    - operators **==** and **!=** are useful to determine *identity*
    - operators **<**, **<=**, **>=**, and **>** are *not* applicable

```
int x[5] = {10,20,10,20,10}; /* array of 5 integers */
int *p1, *p2;                /* pointers to integer */

p1 = &x[1]; p2 = &x[3];      /* point to x[1], x[3] */

if (p1 == p2)
  { printf("p1 and p2 are identical!\n");
   }
if (*p1 == *p2)
  { printf("Contents of p1 and p2 are the same!\n");
   }
```

```
Contents of p1 and p2 are the same!
```

Pointers

- Pointer Comparison
  - Pointers may be compared for equality
    - operators **==** and **!=** are useful to determine *identity*
    - operators **<**, **<=**, **>=**, and **>** are *not* applicable

```
int x[5] = {10,20,10,20,10}; /* array of 5 integers */
int *p1, *p2;                /* pointers to integer */

p1 = &x[1]; p2 = &x[3];      /* point to x[1], x[3] */
p1 += 2;                     /* increment p1 by 2 */
if (p1 == p2)
  { printf("p1 and p2 are identical!\n");
   }
if (*p1 == *p2)
  { printf("Contents of p1 and p2 are the same!\n");
   }
```

```
p1 and p2 are identical!
Contents of p1 and p2 are the same!
```