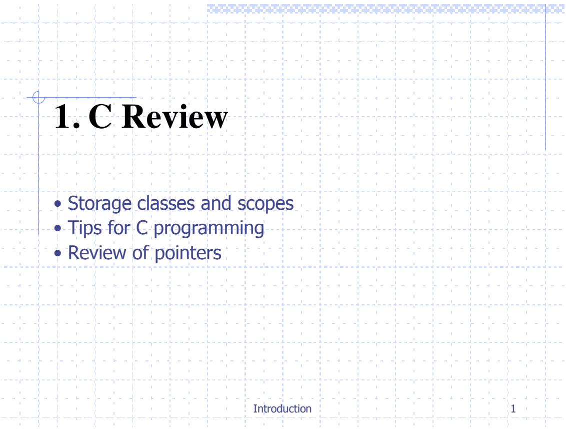
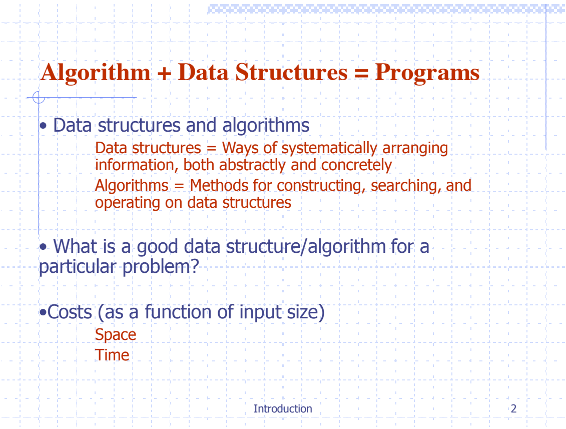


1. C Review

- Storage classes and scopes
- Tips for C programming
- Review of pointers

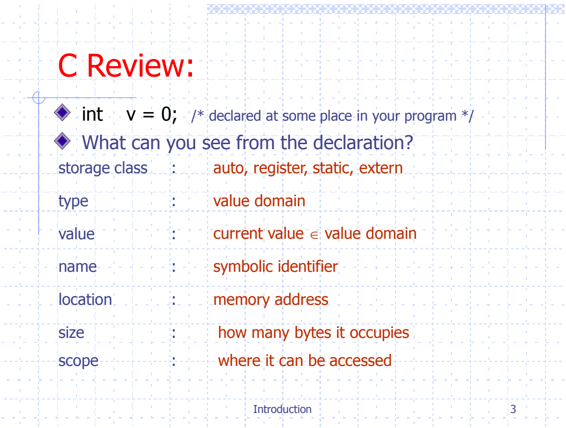


Algorithm + Data Structures = Programs

- Data structures and algorithms
  - Data structures = Ways of systematically arranging information, both abstractly and concretely
  - Algorithms = Methods for constructing, searching, and operating on data structures

- What is a good data structure/algorithm for a particular problem?

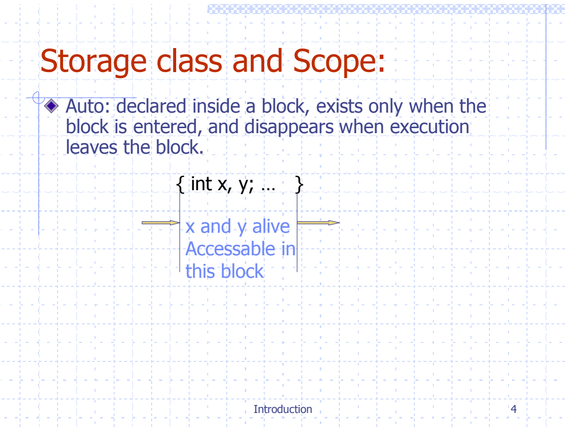
- Costs (as a function of input size)
  - Space
  - Time



C Review:

- int v = 0; /* declared at some place in your program */
- What can you see from the declaration?

storage class	:	auto, register, static, extern
type	:	value domain
value	:	current value ∊ value domain
name	:	symbolic identifier
location	:	memory address
size	:	how many bytes it occupies
scope	:	where it can be accessed

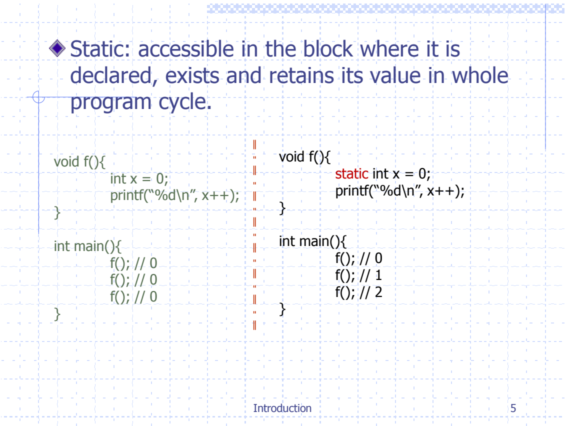


Storage class and Scope:

- Auto: declared inside a block, exists only when the block is entered, and disappears when execution leaves the block.

{ int x, y; … }

x and y alive
Accessable in
this block



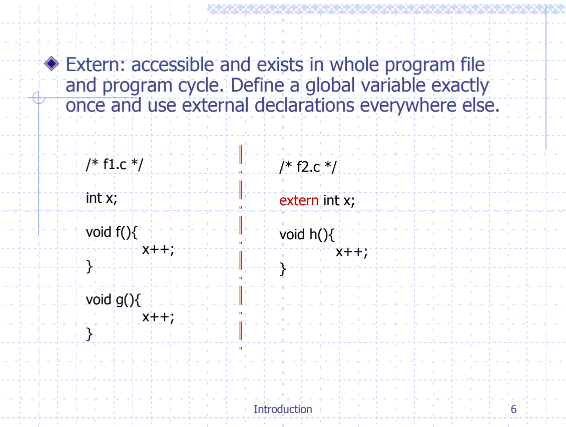
- Static: accessible in the block where it is declared, exists and retains its value in whole program cycle.

```
void f(){
        int x = 0;
        printf("%d\n", x++);
}

int main(){
        f(); // 0
        f(); // 0
        f(); // 0
}
```

```
void f(){
        static int x = 0;
        printf("%d\n", x++);
}

int main(){
        f(); // 0
        f(); // 1
        f(); // 2
}
```



- Extern: accessible and exists in whole program file and program cycle. Define a global variable exactly once and use external declarations everywhere else.

```
/* f1.c */

int x;

void f(){
        x++;
}

void g(){
        x++;
}
```

```
/* f2.c */

extern int x;

void h(){
        x++;
}
```

◆ Register: frequently used variables for efficiency purpose. Restrictions:

(1) can not take the address of a register variable,
(2) can not declare global register variables,
(3) a register variable must fit into a single machine word,
(4) the compiler may ignore register declaration.

```
/* search the given table to find the given key;
   return the index if found or –1 otherwise      */

int table_search(int a[], register int n, register int key){
            register int j;
            for (j = 0; j < n && a[j] != key; j++);
            return (j != n) ? j : -1;
}
```

Tips for C Programming:

- Do not change a loop variable inside a for loop block.
- All flow control primitives (if, else, while, for, do, switch, and case) should be followed by a block, even if it is empty.
- Statements following a case label should be terminated by a statement that exits the switch statement.
- All switch statements should have a default case.
- Use break and continue instead of goto.
- Do not have overly complex functions.
- Indent to show program structure (better readability).
- Parenthesize to resolve ambiguity.

```
? for (j = 0; j < n; j++){
  a[j] = j;
  for (k = j ; k < n; k++){
  if (a[j] < 5)
  a[k] = a[j];
  else
  a[k] = k;
  }
  }
```

```
for (j = 0; j < n; j++){
    a[j] = j;
    for (k = j ; k < n; k++){
          if (a[j] < 5)
                   a[k] = a[j];
          else
                   a[k] = k;
    }
}
```

? Leapyear = y % 4 == 0 && y % 100 ! = 0 ll y % 400 == 0;

Leapyear = ((y % 4 == 0) && (y % 100 != 0)) ll (y % 400 == 0);

- Break up complex expressions:

```
? *x += (*xp = (2 * k < (n – m) ? c[k+1] : d[k--]));

if  (2 * k < n – m)
        *xp = c[k+1];
else
        *xp = d[k--];
*x += *xp;
```

```
? child = (!LC && !RC) ? 0 : (!LC ? RC : LC);

if (LC == 0 && RC == 0)
        child = 0;
else if (LC == 0)
        child = RC;
else
        child = LC;
```

- **Common usage for consistency:**

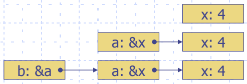
```
? j = 0;
  while (j <= n – 1)   a[j++] = 1;
? for ( j = 0; j < n; )   a[j++] = 1;
? for ( j = n; --j >= 0; ) a[j] = 1;

  /* common usage in C */
  for (j = 0; j < n; j++) a[j] = 1;

  /* standard loop for walking along a list */
  for (p = list; p != NULL; p = p->next) …
```

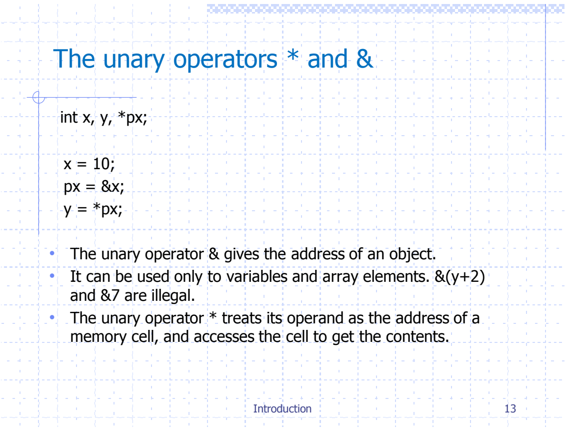
Review of pointers:

```
int x = 4;
int *a = &x;
int **b = &a;
```



x	4	a	addr(x)	b	addr(a)
&x	addr(x)	&a	addr(a)	&b	addr(b)
*x	illegal	*a	4	*b	addr(x)
*(&x)	4	**a	illegal	**b	4
				***b	illegal

*b == a == &x
**b == *a == x

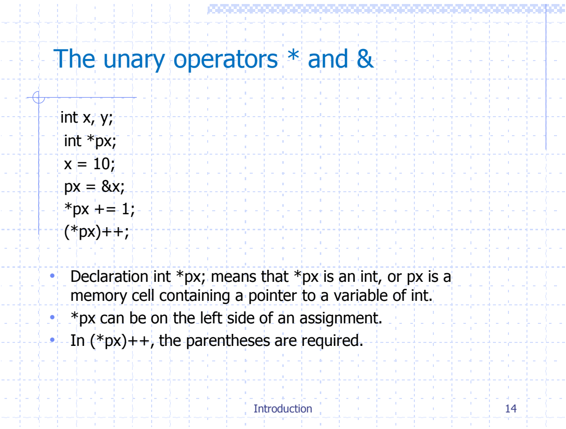


The unary operators * and &

```
int x, y, *px;

 x = 10;
 px = &x;
 y = *px;
```

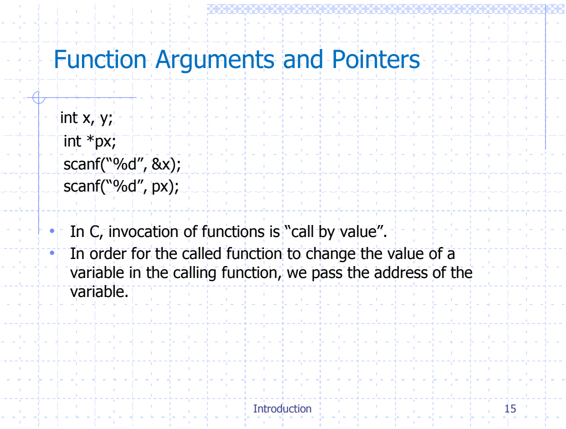
- The unary operator & gives the address of an object.
- It can be used only to variables and array elements. &(y+2) and &7 are illegal.
- The unary operator * treats its operand as the address of a memory cell, and accesses the cell to get the contents.



The unary operators * and &

```
int x, y;
 int *px;
 x = 10;
 px = &x;
 *px += 1;
 (*px)++;
```

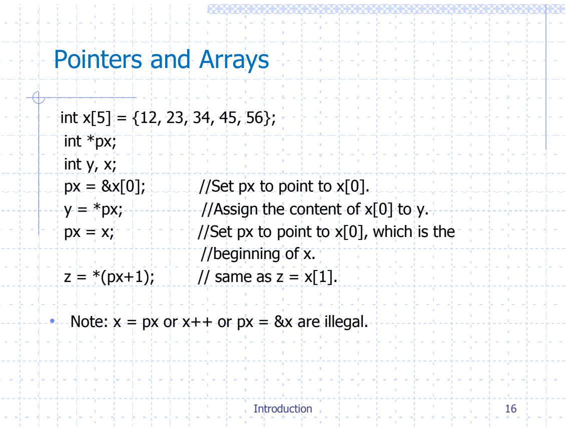
- Declaration int *px; means that *px is an int, or px is a memory cell containing a pointer to a variable of int.
- *px can be on the left side of an assignment.
- In (*px)++, the parentheses are required.



Function Arguments and Pointers

```
int x, y;
 int *px;
 scanf(“%d”, &x);
 scanf(“%d”, px);
```

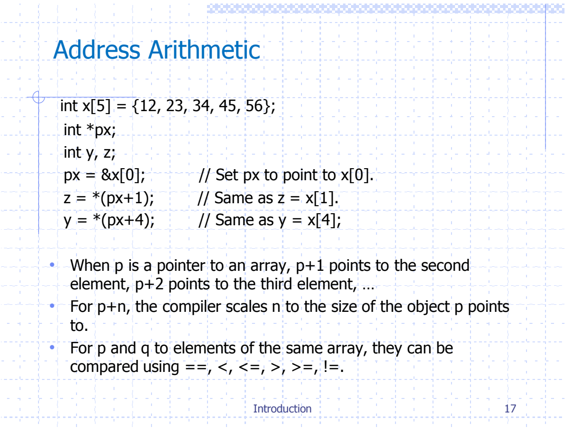
- In C, invocation of functions is “call by value”.
- In order for the called function to change the value of a variable in the calling function, we pass the address of the variable.



Pointers and Arrays

```
int x[5] = {12, 23, 34, 45, 56};
 int *px;
 int y, x;
 px = &x[0];         //Set px to point to x[0].
 y = *px;            //Assign the content of x[0] to y.
 px = x;             //Set px to point to x[0], which is the
                     //beginning of x.
 z = *(px+1);        // same as z = x[1].
```

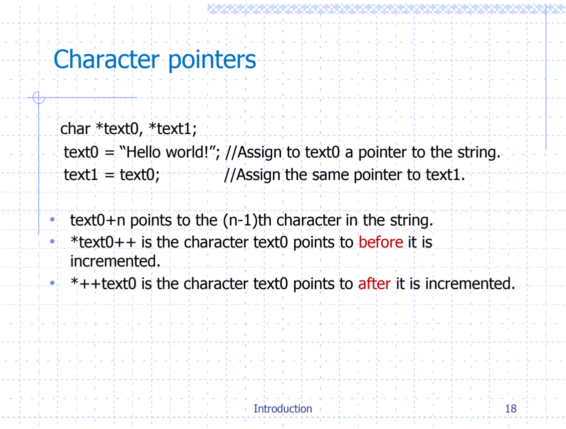
- Note: x = px or x++ or px = &x are illegal.



Address Arithmetic

```
int x[5] = {12, 23, 34, 45, 56};
 int *px;
 int y, z;
 px = &x[0];      // Set px to point to x[0].
 z = *(px+1);     // Same as z = x[1].
 y = *(px+4);     // Same as y = x[4];
```

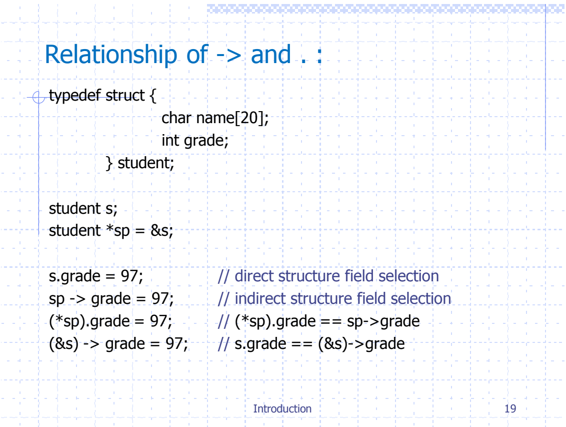
- When p is a pointer to an array, p+1 points to the second element, p+2 points to the third element, …
- For p+n, the compiler scales n to the size of the object p points to.
- For p and q to elements of the same array, they can be compared using ==, <, <=, >, >=, !=.



Character pointers

```
char *text0, *text1;
 text0 = “Hello world!”; //Assign to text0 a pointer to the string.
 text1 = text0;          //Assign the same pointer to text1.
```

- text0+n points to the (n-1)th character in the string.
- *text0++ is the character text0 points to before it is incremented.
- *++text0 is the character text0 points to after it is incremented.

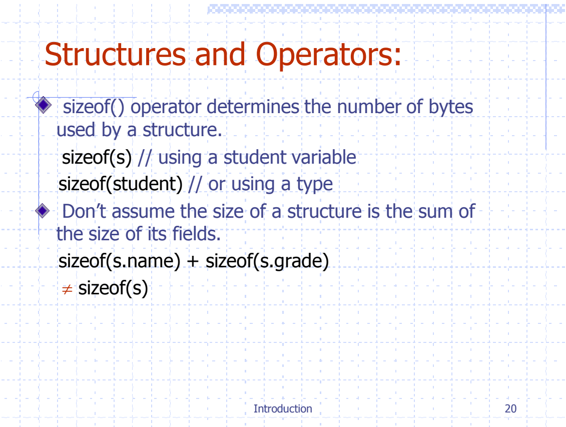


Relationship of -> and . :

```
typedef struct {
                    char name[20];
                    int grade;
          } student;

student s;
student *sp = &s;

s.grade = 97;            // direct structure field selection
sp -> grade = 97;        // indirect structure field selection
(*sp).grade = 97;        // (*sp).grade == sp->grade
(&s) -> grade = 97;      // s.grade == (&s)->grade
```



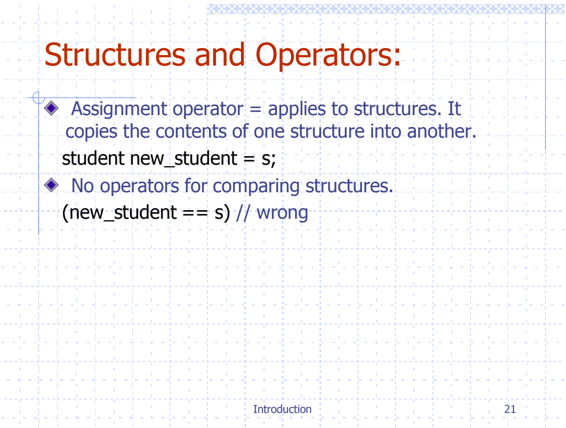
Structures and Operators:

- sizeof() operator determines the number of bytes used by a structure.

```
sizeof(s) // using a student variable
sizeof(student) // or using a type
```

- Don't assume the size of a structure is the sum of the size of its fields.

```
sizeof(s.name) + sizeof(s.grade)
 ≠ sizeof(s)
```



Structures and Operators:

- Assignment operator = applies to structures. It copies the contents of one structure into another.

```
student new_student = s;
```

- No operators for comparing structures.

```
(new_student == s) // wrong
```