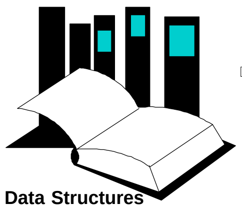
Preconditions and Postconditions



Data Structures
and Other Objects
Using C++

- An important topic: **preconditions** and **postconditions**.
- They are a method of specifying what a function accomplishes.

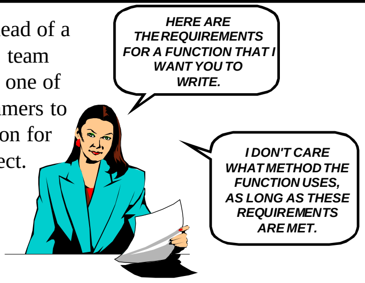
Preconditions and Postconditions

Frequently a programmer must communicate precisely **what** a function accomplishes, without any indication of **how** the function does its work.

Can you think of a situation where this would occur ?

Example

- You are the head of a programming team and you want one of your programmers to write a function for part of a project.


HERE ARE THE REQUIREMENTS FOR A FUNCTION THAT I WANT YOU TO WRITE.
I DON'T CARE WHAT METHOD THE FUNCTION USES, AS LONG AS THESE REQUIREMENTS ARE MET.

What are Preconditions and Postconditions?

- One way to specify such requirements is with a pair of statements about the function.
- The **precondition** statement indicates what must be true before the function is called.
- The **postcondition** statement indicates what will be true when the function finishes its work.

Example

```
void write_sqrt( double x)

//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.



  ...
```

Example

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```

- The precondition and postcondition appear as comments in your program.
- They are usually placed after the function's parameter list.

Example

```
void write_sqrt( double x)

//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.
```

❐ In this example, the precondition requires that

x >= 0

be true whenever the function is called.

Example

Which of these function calls meet the precondition ?

```
write_sqrt( -10 );
write_sqrt( 0 );
write_sqrt( 5.6 );
```

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write_sqrt( -10 );
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The second and third calls are fine, since the argument is greater than or equal to zero.

Example

Which of these function calls meet the precondition ?

```
write_sqrt( -10 );
write_sqrt( 0 );
write_sqrt( 5.6 );
```

But the first call violates the precondition, since the argument is less than zero.

Example

```
void write_sqrt( double x)

//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.
```

❐ The postcondition always indicates what work the function has accomplished. In this case, when the function returns the square root of **x** has been written.

Another Example

```
bool is_vowel( char letter )
//   Precondition:  letter is an uppercase or
//   lowercase letter (in the range 'A' ... 'Z' or 'a' ... 'z') .
//   Postcondition:  The value returned by the
//   function is true if Letter is a vowel;
//   otherwise the value returned by the function is
//   false.

   . . .
```

Another Example

What values will be returned by these function calls ?

```
is_vowel( 'A' );
is_vowel(' Z' );
is_vowel( '?' );
```

Another Example

What values will be returned by these function calls ?

```
is_vowel( 'A' );
is_vowel(' Z' );
is_vowel( '?' );
```

true

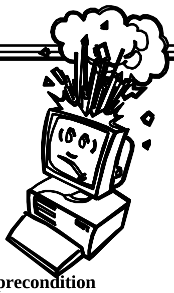
false

Nobody knows, because the precondition has been violated.

Another Example

What values will be returned by these function calls ?

```
is_vowel( '?' );
```



Violating the precondition might even crash the computer.

Always make sure the precondition is valid . . .

- The programmer who calls the function is responsible for **ensuring that the precondition is valid** when the function is called.

AT THIS POINT, MY PROGRAM CALLS YOUR FUNCTION, AND I MAKE SURE THAT THE PRECONDITION IS VALID.

. . . so the postcondition becomes true at the function's end.

- The programmer who writes the function counts on the precondition being valid, and **ensures that the postcondition becomes true** at the function's end.

THEN MY FUNCTION WILL EXECUTE, AND WHEN IT IS DONE, THE POSTCONDITION WILL BE TRUE. I GUARANTEE IT.

A Quiz

Suppose that you call a function, and you neglect to make sure that the precondition is valid. Who is responsible if this inadvertently causes a 40-day flood or other disaster?

① You

② The programmer who wrote that torrential function

③ Noah

A Quiz

Suppose that you call a function, and you neglect to make sure that the precondition is valid.
Who is responsible if this inadvertently causes a 40-day flood or other disaster?

① You

The programmer who calls a function is responsible for ensuring that the precondition is valid.

On the other hand, careful programmers also follow these rules:

❒ When you write a function, you should make every effort to detect when a precondition has been violated.

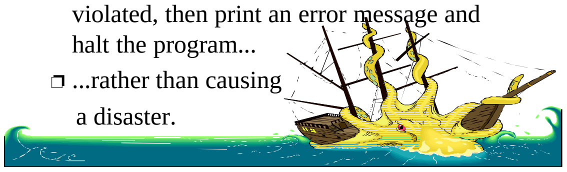
❒ If you detect that a precondition has been violated, then print an error message and halt the program.

On the other hand, careful programmers also follow these rules:

❒ When you write a function, you should make every effort to detect when a precondition has been violated.

❒ If you detect that a precondition has been violated, then print an error message and halt the program...

❒ ...rather than causing a disaster.



Example

```
void write_sqrt( double x)
//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.
{
    assert(x >= 0);

    ...
```

❒ The assert function (described in Section 1.1) is useful for detecting violations of a precondition.

Advantages of Using Preconditions and Postconditions

❒ Succinctly describes the behavior of a function...

❒ ... without cluttering up your thinking with details of how the function works.

❒ At a later point, you may reimplement the function in a new way ...

❒ ... but programs (which only depend on the precondition/postcondition) will still work with no changes.

Summary

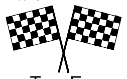
Precondition

❒ The programmer who calls a function ensures that the precondition is valid.

❒ The programmer who writes a function can bank on the precondition being true when the function begins execution.

Postcondition

❒ The programmer who writes a function ensures that the postcondition is true when the function finishes executing.



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