REVIEW 1

CS A250 – C++ Programming II

WHAT ARE WE REVIEWING?

- Prerequisite for this course: **CS A150**

- This presentation will *only* <u>outline</u> important **key points** that are **needed** for this class.
  - It is your responsibility to review any topic from **CS A150** not covered in this class's reviews.
  - This review contains a collection of items that you need to keep in mind when coding to avoid **losing points**.

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OBJECTIVES

- Items that will be reviewed:
  - Identifiers
  - Literals vs. constants
  - Arithmetic precision, type casting, and decimal format
  - Shorthand notation / Prefix and postfix
  - The optional else
  - Conditional operator
  - Functions and passing parameters
  - Function overloading
  - Arrays and vectors: capacity, size and number of elements
  - The **const** modifier for parameters

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IDENTIFIERS, LITERALS AND CONSTANTS

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IDENTIFIERS

- An **identifier** is a name given to a variable, a constant, a function, an object, a class…

```
int myInteger = 3;

vector<int> myVector;

MyClass myObject;
```

- Identifiers in C++ are **case-sensitive**

GOOD PROGRAMMING PRACTICE

- To improve **readability**:

  - Choose <u>meaningful</u> identifiers

  - Do <u>not</u> abbreviate

  - Follow the <u>standards</u> we discussed for this class

    (see syllabus)

LITERAL DATA

- **Literals**
  - Examples:
    - 2   // Literal constant **int**
    - 5.75   // Literal constant **double**
    - 'Z'   // Literal constant **char**
    - "Hello World"   // Literal constant **string**

- **Cannot change** values during execution

- Called "literals" because you "literally" type them in your program!

CONSTANTS

- Literals are "OK", but provide little meaning
  - For example, seeing the number 24 throughout your code, tells nothing about what it represents

- Use named **constants** instead

```
const int NUMBER_OF_STUDENTS = 24;
```

  - Use all CAPITAL_LETTERS separated by an underscore for **identifiers** that refer to **constants**.

  - **Added benefit:** changes to value can be done in one fix

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WHICH ONE TO USE?

- Use a **literal** if
  - You are using that value only once
  - The value will never change (weeks in a year)
- If you use a **literal**, always provide a comment to explain what the value represents
  - Example: Dividing a salary by 52 weeks
    - Can leave "52" because it is used only once, but need to comment about what it represents.
- Use a **global constant** if the value will be used more than once AND/OR the value might need to be changed in the future
  - Example: An interest rate

ABOUT GLOBAL VARIABLES…

- Do NOT use them!
- <u>Only</u> **global *constants*** will be allowed!

NUMBERS

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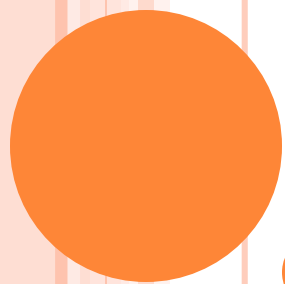
ARITHMETIC PRECISION

- Precision of calculations
  - VERY important consideration!
  - Expressions in C++ might not evaluate as you would "expect"!
  - "Highest-order operand" determines type of arithmetic "precision" performed
  - Common error!

  (see examples on next slide)

ARITHMETIC PRECISION (CONT.)

- Examples:
  - **17 / 5** evaluates to **3** in C++
    - Both operands are **integers**
    - Integer division is performed and gives incorrect result

  - **17.0 / 5** equals **3.4** in C++
    - **Double** "precision" division is performed

  - The following performs ***integer*** division, giving a result of 0

```cpp
int n1 = 1,
    n2 = 2;
cout << (n1/ n2);
```

(more…)

ARITHMETIC PRECISION (CONT.)

- Calculations done "one-by-one"
  - **1 / 2 / 3.0 / 4** performs 3 separate divisions
    - First→ **1 / 2**   equals 0
    - Then→ **0 / 3.0**   equals 0.0
    - Then→ **0.0 / 4**   equals 0.0!

- So changing just "one operand" in a large expression can lead to incorrect results
  - Must keep in mind all individual calculations that will be performed during evaluation!
  - Do NOT trust your program…
    - Trust your <u>calculator</u>

TYPE CASTING

- **Casting** for variables
  - Can add ".0" to literals to force precision arithmetic

  ```
  cout << (5.0 / 2) << endl;
  ```

  - Can use `static_cast<type>` for variables
    - Casting is only temporary → variable **num** will stay an **integer**

  ```
  int num = 2;
  double x = static_cast<double>(num) / 2;
  ```

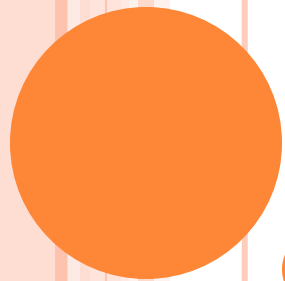- Do **NOT** use ~~(double)num~~

FORMATTING DECIMALS

- Decimal format is <u>only</u> for output
- Option 1:

```
cout.setf(ios::fixed);
cout.setf(ios::showpoint);  //shows point even if 0
cout.precision(2);          //shows 2 decimals
```

- Option 2:

```
#include <iomanip>
...
cout << fixed << showpoint << setprecision(2);
```

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Shorthand Notation

SHORTHAND NOTATIONS

- Use them!

EXAMPLE	EQUIVALENT TO
count += 2;	count = count + 2;
total -= discount;	total = total - discount;
bonus *= 2;	bonus = bonus * 2;
time /= rushFactor;	time = time/rushFactor;
change %= 100;	change = change % 100;
amount *= cnt1 + cnt2;	amount = amount * (cnt1 + cnt2);

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PREFIX AND POSTFIX

- **Post-Increment**

  ```
  int n1 = 3;
  int n2 = n1++;
  ```

  - Uses current value of variable, THEN increments it

- **Pre-Increment**

  ```
  int n1 = 3;
  int n2 = ++n1;
  ```

  - Increments variable first, THEN uses new value

- No difference if "alone" in statement:

  ```
  n1++;
  ++n1;
  ```

  they both give the same result.

PREFIX IN EXPRESSIONS

```cpp
int firstNumber = 2,
    secondNumber = 3;

while (++firstNumber < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

firstNumber = 2

What is the output?

PREFIX IN EXPRESSIONS (CONT.)

```
int firstNumber = 2,
    secondNumber = 3;

while (++firstNumber < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

```
firstNumber = 2 3
```

This happens first and **firstNumber** is incremented by 1.

PREFIX IN EXPRESSIONS (CONT.)

```
int firstNumber = 2,
    secondNumber = 3;

while (++firstNumber < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

```
firstNumber = 3

3 < 3 ? FALSE
```

Comparison happens next.

PREFIX IN EXPRESSIONS (CONT.)

```
int firstNumber = 2,
    secondNumber = 3;

while (++firstNumber < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

`firstNumber = 3`

Condition is false and body
of loop will <u>not</u> be executed.

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PREFIX IN EXPRESSIONS (CONT.)

```
int firstNumber = 2,
    secondNumber = 3;

while (++firstNumber < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

firstNumber = 3

Program continues and prints value of **firstNumber.**

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PREFIX IN EXPRESSIONS (CONT.)

```cpp
int firstNumber = 2,
    secondNumber = 3;

while (++firstNumber < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

`firstNumber = 3`

OUTPUT:

3

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POSTFIX IN EXPRESSIONS

```cpp
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

`firstNumber = 2`

What is the output?

POSTFIX IN EXPRESSIONS (CONT.)

```cpp
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

```
firstNumber = 2

2 < 3 ? TRUE
```

The whole condition is evaluated first.

POSTFIX IN EXPRESSIONS (CONT.)

```
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

`firstNumber = 2 3`

The value of `firstNumber` is incremented by 1.

POSTFIX IN EXPRESSIONS (CONT.)

```cpp
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

firstNumber = 3

Body of loop is executed.

OUTPUT:

3

POSTFIX IN EXPRESSIONS (CONT.)

```
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
       cout << firstNumber << endl;
}
cout << firstNumber;
```

firstNumber = 3

3 < 3 ? FALSE

Condition is evaluated again.

OUTPUT:

3

POSTFIX IN EXPRESSIONS (CONT.)

```
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

firstNumber = ~~3~~ 4

The value of **firstNumber** is incremented by 1.

OUTPUT:

3

```
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

firstNumber = 4

Condition is false and body of loop will <u>not</u> be executed.

OUTPUT:

3

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POSTFIX IN EXPRESSIONS (CONT.)

```cpp
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

firstNumber = 4

Program continues and prints value of **firstNumber** again.

```
OUTPUT:

3
4
```

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Prefix and Postfix

○ As we saw, prefix and postfix **<u>might</u>** change the results of the statement.

```cpp
int firstNumber = 2,
    secondNumber = 3;

while (++firstNumber < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```
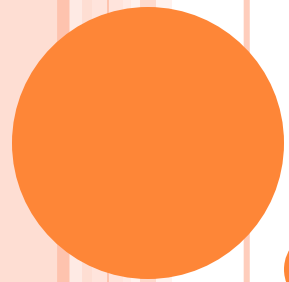
OUTPUT:

3

```cpp
int firstNumber = 2,
    secondNumber = 3;

while (firstNumber++ < secondNumber)
{
        cout << firstNumber << endl;
}
cout << firstNumber;
```

OUTPUT:

3
4

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CONDITIONS

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THE OPTIONAL ELSE

- In an **if** statement, **else** clause is *optional*

    - If, in the **false** branch (**else**), you want "nothing" to happen → <u>leave it out</u>

    - Example:

    ```
    if (sales >= minimum)
            salary += bonus;
    cout << "Salary = " << salary;
    ```

    - **Note:**

        - Nothing to do for **false** condition, so there is <u>**no**</u> **else** clause!

        - Execution continues with **cout** statement

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CONDITIONAL OPERATOR

- **Conditional operator**, also called "**ternary operator**"
  - Essentially "shorthand if-else" operator

  ```
  if (n1 > n2)
          max = n1;
  else
          max = n2;
  ```

  - Can be written:

  ```
  max = (n1 > n2) ? n1 : n2;
  ```

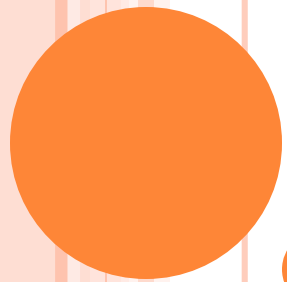 - "?" and ":" form the "**ternary**" operator

CONDITIONAL OPERATOR

- **Avoid** using the **conditional operator** in an output expression, because misplacing parenthesis can produce unwanted results:

```
cout << ( ( grade < 60 ) ? "fail" : "pass" );
        // prints pass or fail


cout << ( grade < 60 ) ? "fail" : "pass";
        // prints 1 or 0


cout << grade < 60 ? "fail" : "pass";
        // error: compares cout to 60
```

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FUNCTIONS

FUNCTIONS

- Two types:
  - **void**
    - Does **not** return a value

    > Do **<u>NOT</u>** exit from a **void** function using
    >   **return;**
    > Find an elegant way to terminate the execution of the function.

  - **return a value**
    - In C++
      - Only <u>one value</u> can be returned
      - <u>Cannot</u> return arrays
      - <u>Cannot</u> return functions

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FUNCTION DECLARATION

- **Function declaration**
  - Syntax

  > **return_type funcName (parameter_list);**

  - Goes *before* **main( )** function
  - May or may not have parameters
    - Although there is no need for parameter names, it improves readability to include names.
  - Comments go before *or* after function declaration
  - Also known as **function prototypes**

FUNCTION DEFINITIONS

- **Function definition**
  - **Syntax**

  > **return_type funcName (parameter_list)**
  >
  > **{**
  >
  >   *// body*
  >
  > **}**

  - Goes *after* the **main( )** function
  - May or may not have a parameter list
  - **Parameters** are **automatic objects**
    - They are destroyed when execution of the function terminates, just like **local variables**

ARGUMENT PASSING

- The type of **parameter** determines the interaction between the **parameter** and its **argument**

  - If the **parameter** is **passed by reference**
    - Parameter is bound to its argument

  - If the **parameter** is **passed by value**
    - The value is copied

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PASSING ARGUMENTS BY VALUE

- When passing arguments by **value**, any changes made to the function **parameter** will not change the **argument**.

```cpp
void myFunction (int n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

int **n**

3

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PASSING ARGUMENTS BY VALUE (CONT.)

○ When passing arguments by **value**, any changes made to the function **parameter** will not change the **argument**.

```cpp
void myFunction (int n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

int **n**

3

call to **myFunction (3)**

PASSING ARGUMENTS BY VALUE (CONT.)

○ When passing arguments by **value**, any changes made to the function **parameter** will not change the **argument**.

```
void myFunction (int n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

a local copy of **n** is created

int **n**

3

int **n**

3

PASSING ARGUMENTS BY VALUE (CONT.)

- When passing arguments by **value**, any changes made to the function **parameter** will not change the **argument**.

```
void myFunction (int n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

local variable **n** is incremented

int **n**
4

int **n**
3

PASSING ARGUMENTS BY VALUE (CONT.)

- When passing arguments by **value**, any changes made to the function **parameter** will not change the **argument**.

```cpp
void myFunction (int n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

cout statement is executed

int **n**
4

int **n**
3

OUTPUT:

4

PASSING ARGUMENTS BY VALUE (CONT.)

- When passing arguments by **value**, any changes made to the function **parameter** will not change the **argument**.

```cpp
void myFunction (int n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

function execution is terminated and all local variables are destroyed

OUTPUT:

4

int **n**

3

PASSING ARGUMENTS BY VALUE (CONT.)

- When passing arguments by **value**, any changes made to the function **parameter** will not change the **argument**.

```cpp
void myFunction (int n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

OUTPUT:

4
3

int **n**

3

return to function call
and print **n** again

PASSING ARGUMENTS BY REFERENCE

- When **passing by reference**

  - **Address** of argument is passed

  - Caller's data can be modified by called function

  - Typically used
    - For input function to retrieve data for caller, data is then "given" to caller
    - When more than one value needs to be returned

  - Specified by **ampersand** (**&**) after type in parameter list

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PASSING ARGUMENTS BY REFERENCE

- When passing arguments by **reference**, any changes made to the function **parameter** will change the **argument**.

```cpp
void myFunction (int& n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

int **n**

3

PASSING ARGUMENTS BY REFERENCE (CONT.)

- When passing arguments by **reference**, any changes made to the function **parameter** will change the **argument**.

```cpp
void myFunction (int& n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

int **n**

3

call to **myFunction (3)**

PASSING ARGUMENTS BY REFERENCE (CONT.)

○ When passing arguments by **reference**, any changes made to the function **parameter** will change the **argument**.

```cpp
void myFunction (int& n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

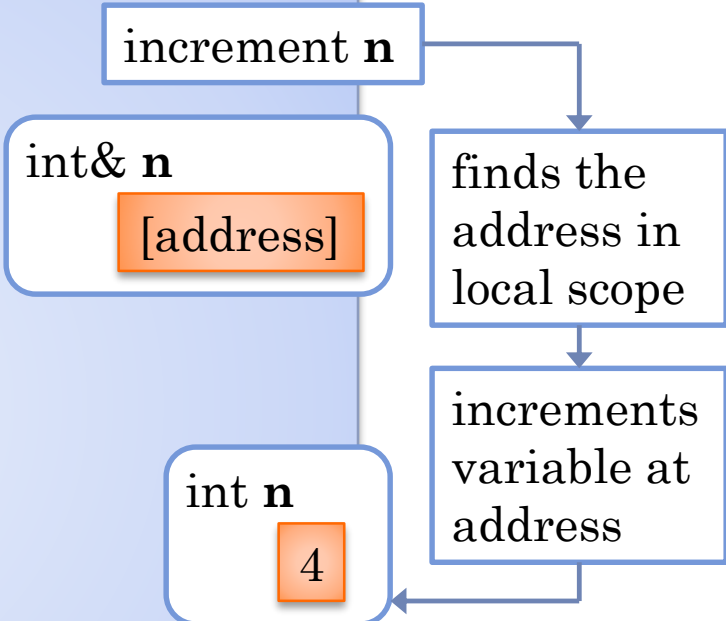address of **n** is passed

int& **n**

[address]

int **n**

3

PASSING ARGUMENTS BY REFERENCE (CONT.)

- When passing arguments by **reference**, any changes made to the function **parameter** will change the **argument**.

```
void myFunction (int& n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

increment **n**

int& **n**

[address]

finds the address in local scope

int **n**

4

increments variable at address

PASSING ARGUMENTS BY REFERENCE (CONT.)

- When passing arguments by **reference**, any changes made to the function **parameter** will change the **argument**.

```
void myFunction (int& n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

cout statement is executed

int& **n**

[address]

int **n**

4

OUTPUT:

4

PASSING ARGUMENTS BY REFERENCE (CONT.)

- When passing arguments by **reference**, any changes made to the function **parameter** will change the **argument**.

```cpp
void myFunction (int& n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

function execution is terminated and all local variables are destroyed

OUTPUT:

4

int **n**

4

PASSING ARGUMENTS BY REFERENCE (CONT.)

- When passing arguments by **reference**, any changes made to the function **parameter** will change the **argument**.

```cpp
void myFunction (int& n)
{
        ++n;
        cout << n << endl;
}
int main( )
{
        int n = 3;
        myFunction(n);
        cout << n;
        ...
}
```

int **n**

4

OUTPUT:

4
4

return to function call
and print **n** again

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EXAMPLE

- **Project:** parameter_passing

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FUNCTION OVERLOADING

- **Overloaded functions** have
  - **Same** function **name**
  - **Different parameter** lists
  - Two **separate** function **declarations**/**definitions**
  - Function "**signature**"
    - Function name & parameter list
    - Must be "unique" for each function definition
  - Allows same task performed on different data

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FUNCTION OVERLOADING (CONT.)

- Example:

```
double compute( double n1, double n2);
double compute( double n1, double n2, double n3);
double compute( int n1, double n2);
```

- The above functions have the same name but have parameters that differ in numbers and/or types.

- **Careful**: *Return type* does **not** matter

ARRAYS AND VECTORS

Capacity, size, and number of elements

CAPACITY, SIZE, AND NUMBER OF ELEMENTS

- **Arrays** are frequently **partially filled**.
- Need to differentiate the **physical length** of the array from the actual **number of elements** that occupy the array.
- We will use the following conventions:
  - The **capacity** to define the **physical length** of the array
  - The **number of elements** to define the total number of **items stored** in the array.

- We will **<u>NOT</u>** use "size" when referring to arrays.

CAPACITY OF STATIC ARRAYS

- Capacity of **static arrays** <u>must</u> be defined at **compilation time**
  - <u>Always</u> use defined/named **constant** for array capacity

```
const int CAPACITY = 5;

...

int score[CAPACITY];
```

VECTOR SIZE

- The **STL vector class** defines **size** as the **number of elements** stored in the vector.
- If using a loop, **avoid** calling the function size inside the loop and use a variable instead

```
int size = static_cast<int>( v.size() );

for (int i = 0; i < size; ++i)
    cout << v[i] << " ";
```

Function size() returns an **unsigned int**, but we can **cast** it to an **int**.

Reference, Value and `const` Modifier for Parameters

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THE `const` MODIFIER FOR PARAMETERS

- **Reference arguments** inherently "dangerous"
  - Caller's data can be changed
  - Often this is desired, sometimes not

- Use the `const` modifier to "protect" data

- So, when should you use **&** and when `const`?

WHEN TO PASS BY REFERENCE (&)?

- When passing **objects**
  - They are **large**; no need to make another copy
  - Example: strings, vectors, objects of classes you created

```
void someFunction(string& name, MyClass& obj)
{
    // does something
}
```

WHEN TO PASS BY REFERENCE? (CONT.)

- When passing **variables** that need to be **changed** and **retain** their new value after the function is done

```cpp
double calculatePayCheck()
{
    double payRate = 0.0, hours = 0.0;
    getInfo(payRate, hours);
    return (payRate * hours);
}
void getInfo(double& payRate, double& hours)
{
    cout << "Enter pay rate and total hours worked: ";
    cin >> payRate >> hours;
}
```

The value of **payRate** and **hours** will be determined by the user and they need to send the information back to the function calling.

WHEN TO USE `const`?

- **IF** you are passing by reference (**&**)
  - **AND** the value passed by the parameter should **<u>not</u>** be modified inside the function
    - **THEN** use `const`

```cpp
void printVector(const vector<int>& v)
{
    int size = static_cast<int>( v.size() );

    for (int i = 0; i < size; ++i)
        cout << v[i] << " ";
}
```

PASSING ARRAYS

- **Careful! Arrays** are automatically **passed by reference**, but **<u>no</u> &** is used!
  - Need to use **const** when necessary
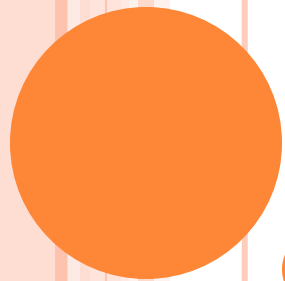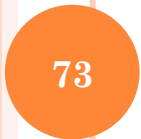
```
void fillArray(int a[], int numOfElem)
{
    for (int i = 0; i < numOfElem; ++i)
        a[i] = i + 1;
}
void printArray(const int a[], int numOfElem)
{
    for (int i = 0; i < numOfElem; ++i)
        cout << a[i] << " ";
}
```

Array will be modified. Cannot use **const**.

Array should **not** be modified. Use **const**.

EXAMPLES

- **Project:** arrays
- **Project:** vectors

GOOD PROGRAMMING

CHANGING FLOW OF CONTROL

❖ ❖ ❖ **IMPORTANT** ❖ ❖ ❖

Do **NOT** use:

- **break** (<u>except</u> on **switch** statements) and/or

- **continue** in any of the exercises and /or programming exams

Choose an elegant way to exit **loops** and **functions.**

A Few Rules

- When **creating a new VS project**
  - Name your project "**Project**"
    - You should rename the folder later
    - If the project name is too long, files might not be transfer when you turn in your project
  - Name the file that contains the main( ) function "**Main.cpp**"
    - We will be exchanging files; therefore, we ALL need to use same naming conventions
  - Do **NOT** forget the **name header**
    - You will lose points if you do
    - Make sure has the same format shown on the syllabus

A FEW RULES (CONT.)

- When **coding**:
  - Leave a **space** in between operators
  - Leave a **line** in between blocks of code
  - Split statements to **avoid horizontal scrolling**
  - Improve readability when writing decimal numbers:

    0.0 instead of .0

    3.0 instead of 3

  - Write code that is easy to read and understand
    - You are not going to look "cool" if you write some code that is difficult to read
  - Declare variables only <u>right before</u> you need them, instead of listing them at the beginning of the function

ARE YOU DETAIL ORIENTED?

- As a **programmer**, you need to:

  - Make sure your program is **readable**

  - Choose an implementation that makes your code **efficient**

  - **Follow instructions** carefully

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END REVIEW 1