3. Expressions

4. Expressions and Arithmetic

Expressions (1)

- Operator and operand
  - Symbol and object of operations
  - `5 + 10` `// binary`
  - `-x` `// unary`
  - `5 + 10/2` `// precedence`
  - `a = b = 2` `// associativity`
- Arithmetic operators
  - +, -, *, /, %(modulus)
- std::cin
  - Standard input stream
  - >>: extraction operator
  - int x;
  - std::cin >> x;

Expressions (2)

```
#include <iostream>
int main() {
   int value1, value2, sum;
   std::cout << "Please enter two integer values: ";
   std::cin >> value1 >> value2;
   sum = value1 + value2;
   std::cout << value1 << " + " << value2 << " = " << sum << '\n';

   std::cout << 10%3 << " " << 3%10 << '\n';

   char lower = 'd', upper = lower - 32;
   // upper = lower - ('a' - 'A');
   std::cout << upper << '\n';
}

// sum = value1 + value2;
// → value1 + value2
// → sum = (value1 + value2)
```

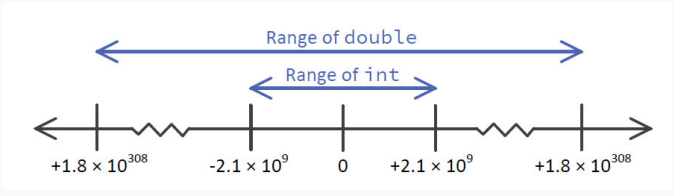

Mixed Type Expressions

```
int x = 4;
double y = 10.2, sum;
int sum2;

sum = x + y;
sum2 = sum;     // warning C4244, sum2 = static_cast<int>(sum);
                // (int)sum

enum class Shade { Dark, Dim, Light, Bright };
Shade color = Shade::Light;

std::cout << (int)color << std::endl;
std::cout << static_cast<int>(color) << std::endl;
```



Operator Precedence and Associativity

- Precedence
  - When an expression contains two different kinds of operators, which should be applied first?
- Associativity
  - When an expression contains two operators with the same precedence, which should be applied first?

Arity	Operator	Associativity
Unary	+, -	
Binary	*, /, %	Left
Binary	+, -	Left
Binary	=	Right

The operators in each row have a higher precedence than the operators below it.

Comments

- Comment
  - Annotation
  - Ignored by compilers and interpreters
- Single line comment
  - //
- Block comment
  - /*...*/

Formatting (1)

```
#include <iostream>
int
main
(){
int
x;x=
10
;
std
::
cout
<<
x
<<
'\n'
;}
```

```
#include <iostream>
int main(){int
x;x=10;std::cout<<x<<'\n';}
```

```
#include <iostream>
int main(){
   int x;
   x = 10;
   std::cout<<x<<'\n';
}
```


Formatting (2)

```
int main() {    // K&R style
  // body
}

int main()      // ANSI style
{
  // body
}

int main()      // Whitesmith style
  {
  // body
  }

int main() {    // Banner style
  // body
  }
```

Errors and Warnings (1)

- Compile-time error
  - Syntax error
  - Link error
- Run-time error
  - Invalid memory access
  - Memory leak
  - Division by zero
- Logic error (run-time error)
  - Wrong formula/output
  - Division by zero

Errors and Warnings (2)

- Compiler warnings
  - Uninitialized object (variable)
  - Narrowing conversion (`double` → `int`)

Arithmetic Examples (1)

```
#include <iostream>
int main() {
   double degreesF, degreesC;
   // Prompt user for temperature to convert
   std::cout << "Enter the temperature in degrees F: ";
   // Read in the user's input
   std::cin >> degreesF;
   // Perform the conversion
   degreesC = 5/9*(degreesF - 32);
   // Report the result
   std::cout << degreesC << '\n';
}
```

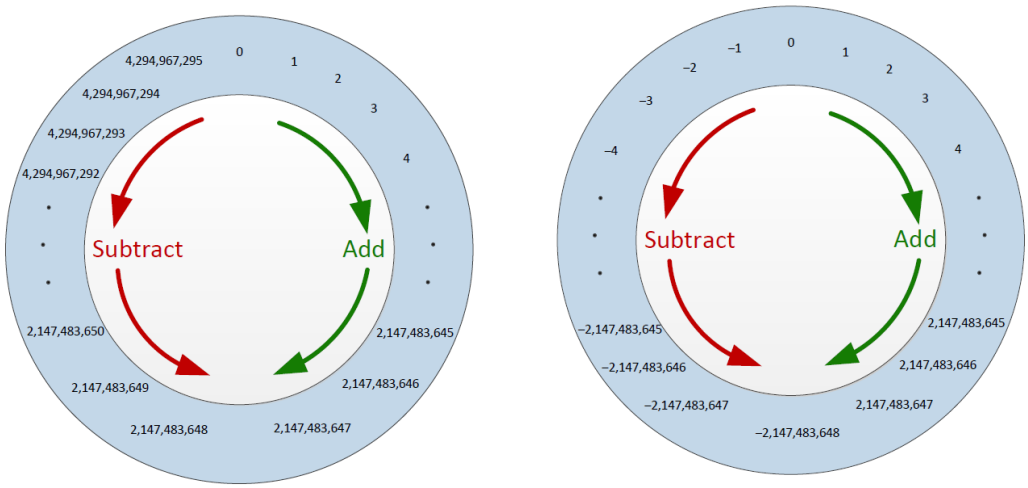

Arithmetic Examples (2)

```
#include <iostream>
int main() {
   int hours, minutes, seconds;
   std::cout << "Please enter the number of seconds:";
   std::cin >> seconds;

   hours = seconds / 3600;
   seconds = seconds % 3600;
   minutes = seconds / 60;
   seconds = seconds % 60;
   std::cout << hours << " hr, " << minutes << " min, "
      << seconds << " sec\n";
}
```

Integers vs. Floating-point Numbers (1)

- Computers store all data internally in binary form
- Integers
  - Overflow/underflow



Integers vs. Floating-point Numbers (2)

- Floating-point numbers
  - Sign, mantissa, exponent

$$+0.101\times 2^{11}$$

```
#include <iostream>
#include <iomanip>
int main() {
   double d1 = 2000.5;
   double d2 = 2000.0;
   std::cout << std::setprecision(16) << (d1 - d2) << '\n';
   // 0.5
   double d3 = 2000.58;
   double d4 = 2000.0;
   std::cout << std::setprecision(16) << (d3 - d4) << '\n';
   // 0.5799999999999272
}
```

Integers vs. Floating-point Numbers (3)

```
#include <iostream>
int main() {
  double one = 1.0, one_eighth = 1.0/8.0,
  zero = one - one_eighth - one_eighth - one_eighth
     - one_eighth - one_eighth - one_eighth - one_eighth - one_eighth;
  std::cout << "one = " << one << ", one_eighth = " << one_eighth
      << ", zero = " << zero << '\n';
} // one = 1, one_eighth = 0.125, zero = 0
```

```
#include <iostream>
int main() {
   double one = 1.0, one_fifth = 1.0/5.0,
   zero = one - one_fifth - one_fifth - one_fifth - one_fifth
      - one_fifth;
   std::cout << "one = " << one << ", one_fifth = " << one_fifth
      << ", zero = " << zero << '\n';
} // one = 1, one_fifth = 0.2, zero = 5.55112e-17
```


More Arithmetic Operators (1)

- Increment/decrement
  - `++x, x++, --x, x--`
  - Prefix, postfix
    - Prefix increment returns the value of a variable after it has been incremented.
    - Postfix increment returns the value of a variable before it has been incremented.

```
#include <iostream>
int main() {
   int x1 = 1, y1 = 10, x2 = 100, y2 = 1000;
   std::cout << "x1=" << x1 << ", y1=" << y1
      << ", x2=" << x2 << ", y2=" << y2 << '\n';
   y1 = x1++;
   std::cout << "x1=" << x1 << ", y1=" << y1
      << ", x2=" << x2 << ", y2=" << y2 << '\n';
   y2 = ++x2;
   std::cout << "x1=" << x1 << ", y1=" << y1
      << ", x2=" << x2 << ", y2=" << y2 << '\n';
}
```

More Arithmetic Operators (2)

- Assignment operators
  - `+=, -=, *=, /=, %=`
  - ```
    x = 5;
    x += 2;
    x *= 4+6;
    ```


Bitwise Operators

- Bitwise operators
  - `&, bitwise and`
  - `|, bitwise or`
  - `^, bitwise exclusive or`
  - `~, bitwise negation, unary operator`
  - `>>, shift right`
  - `<<, shift left`
  - `&=, |=, ^=, >>=, <<=`
    ```

Algorithms

```
#include <iostream>
int main() {
   double degreesF = 0, degreesC = 0;
   degreesC = 5.0/9*(degreesF - 32);
   std::cout << "Enter the temperature in degrees F: ";
   std::cin >> degreesF;
   std::cout << degreesC << '\n';
}
```

```
#include <iostream>
int main() {
   int x, y, t;

   t = x;
   x = y;
   y = t;
}
```