Simple Mathematical Expressions

- We've seen simple mathematical expressions
  - Only two *operands*, data being operated on
  - Only one *operator*, denoting operation to perform
- Special rules
  - Dividing integers
  - Mixing floating point and integer operands
- What about more operands and operators?
- How does mixing data types work?
Suppose you have the statement
\[
\text{avgTemp} = \text{FREEZE_PT} + \text{BOIL_PT} / 2.0;
\]
Is \(\text{FREEZE_PT} + \text{BOIL_PT}\) calculated first?
Or, is \(\text{BOIL_PT} / 2.0\) calculated first?
In order to answer the question, \emph{precedence} must be defined for operations.

**Precedence rules for C++**

<table>
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<th>Order of evaluation</th>
<th>Operations (from left to right)</th>
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<td>Unary +, Unary -</td>
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<td>3)</td>
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<td>4)</td>
<td>(+ -)</td>
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Complex Mathematical Expressions

- According to precedence rules, \( \frac{\text{BOIL}_\text{PT}}{2.0} \) is evaluated first.
  - This probably is not what was intended. Instead, write
    \[
    \text{avgTemp} = \frac{(\text{FREEZE}_\text{PT} + \text{BOIL}_\text{PT})}{2.0};
    \]

Complex Mathematical Expression

- Using precedence, a complex expression can be evaluated as many simple expressions.
- A useful tool for evaluating complex expressions is an *evaluation tree*.
  \[
  \text{avgTemp} = \frac{(\text{FREEZE}_\text{PT} + \text{BOIL}_\text{PT})}{2.0};
  \]
Evaluation Tree (Example)

avgTemp = FREEZE_PT + BOIL_PT / 2.0;

Evaluation Tree (Example)

avgTemp = (FREEZE_PT + BOIL_PT) / 2.0;
Evaluation Tree (Example and Exercise)

```
int a, b, c;
double x, y;

c = a / b + x * y;
c = a / (b + x) * y;
```

Complex Expressions (Exercises)

- Write C++ expressions for
  
  \[ b^2 - 4ac \]
  \[ a + b - c \]
  \[ a \cdot -(b + c) \]
  \[ a + b \]
  \[ c + d \]
  \[ \frac{1}{1 + y^2} \]
Complex Expressions (Exercises)

- Draw evaluation trees for the following

```java
int a, b, c;
double x, y, z;
a = 3; b = 5; x = 1.3; y = 2.7;

z = a * a + b;
c = a - x * b + y;
c = x + a % b;
z = (x + y) / a - b * -y;
```