

# 15-213

*“The course that gives CMU its Zip!”*

## Integers

### Sep 3, 2002

### Topics

- Numeric Encodings
  - Unsigned & Two's complement
- Programming Implications
  - C promotion rules
- Basic operations
  - Addition, negation, multiplication
- Programming Implications
  - Consequences of overflow
  - Using shifts to perform power-of-2 multiply/divide

# C Puzzles

- Taken from old exams
- Assume machine with 32 bit word size, two's complement integers
- For each of the following C expressions, either:
  - Argue that is true for all argument values
  - Give example where not true

## Initialization

```
int x = foo();  
int y = bar();  
unsigned ux = x;  
unsigned uy = y;
```

$$\bullet \quad x < 0 \quad \Rightarrow \quad ((x*2) < 0)$$

$$\bullet \quad ux \geq 0$$

$$\bullet \quad x \& 7 == 7 \quad \Rightarrow \quad (x \ll 30) < 0$$

$$\bullet \quad ux > -1$$

$$\bullet \quad x > y \quad \Rightarrow \quad -x < -y$$

$$\bullet \quad x * x \geq 0$$

$$\bullet \quad x > 0 \ \&\& \ y > 0 \quad \Rightarrow \quad x + y > 0$$

$$\bullet \quad x \geq 0 \quad \Rightarrow \quad -x \leq 0$$

$$\bullet \quad x \leq 0 \quad \Rightarrow \quad -x \geq 0 \quad 15-213, F'02$$

# C Puzzle Answers

- Assume machine with 32 bit word size, two's comp. integers
- *TMin* makes a good counterexample in many cases

<code>x &lt; 0</code>	$\Rightarrow$	<code>((x*2) &lt; 0)</code>	False: <i>TMin</i>
<code>ux &gt;= 0</code>			True: $0 = UMin$
<code>x &amp; 7 == 7</code>	$\Rightarrow$	<code>(x&lt;&lt;30) &lt; 0</code>	True: $x_1 = 1$
<code>ux &gt; -1</code>			False: $0$
<code>x &gt; y</code>	$\Rightarrow$	<code>-x &lt; -y</code>	False: $-1, TMin$
<code>x * x &gt;= 0</code>			False: $30426$
<code>x &gt; 0 &amp;&amp; y &gt; 0</code>	$\Rightarrow$	<code>x + y &gt; 0</code>	False: <i>TMax</i> , <i>TMax</i>
<code>x &gt;= 0</code>	$\Rightarrow$	<code>-x &lt;= 0</code>	True: $-TMax < 0$
<code>x &lt;= 0</code>	$\Rightarrow$	<code>-x &gt;= 0</code>	False: <i>TMin</i>