



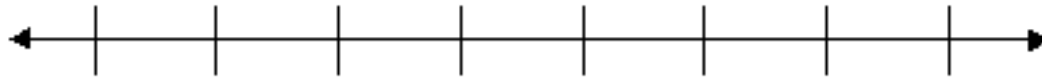
CS 149

Professor: Kevin Molloy

(adapted from slides originally developed by Alvin Chao)

Circle math

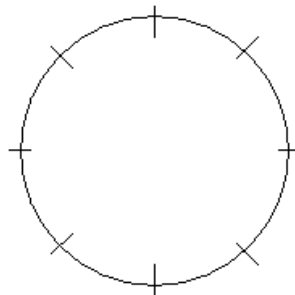
- Counting on a Line:



- $x+a$ moves you a units to the right of x
- $x-b$ moves you b units to the left of x

- Counting on a Circle

- $(x+a)$ moves you a units clockwise of x
- $(x-b)$ moves you b units counterclockwise of x





Clock Arithmetic

- Background:
 - A 24-hour clock (00 - 23)
- It is now 17. What time will it be in 12 hours?
- The Naive Approach:
 - $17+12$ is 29. So, we have advanced a day. That means the time is actually $29-24$ or 5.
- A Shortcoming of this Approach:
 - We might advance more than one day! (For example, advancing 93 hours from now.)



Clock Arithmetic(contd.)

- A Better Way
 - Use arithmetic on a circle(that goes from 0 to 23)
- Using int variables and % (modulo operator)
 - $\text{future} = (\text{current} + \text{change}) \% 24;$



Other Time/Date examples

- Minutes
 - Go from 0 to 59
 - Be mindful if you also need to count hours(which can be calculated using integer division).
- Days of the Week (0 to 6)
- Months of the Year (0 to 11 not 1 to 12)
- Weights: Ounces (0 – 15) then use pounds
 - Pounds (0 – 1999) then use tons
- Distances:
 - Inches (0 – 11) then use feet
 - Feet(0 – 2) then use yards
 - Yards (0 – 5279) then use miles



Another time example

“Twenty-nine days” means the same thing as “Four weeks and one day”. If **days** is a Java integer variable containing some number of days, develop expressions for:

- The number of weeks in days (4 in the example above).
- The number of days that are left over. (1 in the example above).



Even/Odd Numbers

- Definition
 - A number is even if it can be divided by 2 with no remainder
- Observe
 - If we think of all numbers as being either even or odd we can conceptualize this as a circle with two items in the cycle.
 - We can use the `%` operator to do this.
 - Does $x \% 2$ equal 0?



Cycling through a Set

- Examples
 - Turn-taking by different # of players
 - Cycling through a set of colors
 - Repeating a set of instructions
- Observation
 - An element in a set can be identified by its number
 - If we start at 0 and let n be the cardinality in the set then we can use $\text{index} = (\text{index} + 1) \% n$



Divisibility: Census Example

- Background: The U.S. Census Bureau conducts a census every 10 years (in years ending with a zero)
- Problem: Find the previous census year for a given year
- Using / :
 - $\text{censusYear} = (\text{year} / 10) * 10;$



Digit Manipulation

- Note an int value is 'atomic' meaning it has no sub-parts.
- Many times we want to find the ones digit or tens digit of a number.
- Get the left-most digits
 - Use integer division (i.e. /)
 - Use a right-side operand of 10^{N-n}
- Get the right-most digits
 - Use remainder after division (i.e. %)
 - Use a rightside operand of 10^n



In practice

- Retrieving the Left-Most n Digits:
 - The left-most digit of 7198 is $7198 / 1000$
 - The left-most two digits of 531768 are $531768 / 10000$
- Retrieving the Right-Most n Digits:
 - The right-most digit of 7198 is $7198 \% 10$
 - The right-most two digits of 531768 are $531768 \% 100$



Operations

- An *operator* is a symbol indicating that an operation is to be performed on one or more operands
- An *operand* can be a variable, literal, or expression
- Number of Operands:
 - A *unary* operator has one operand
 - A *binary* operator has two operands
 - A *ternary* operator has three operands



Binary Operators

- Numeric Operations and Operators:
 - Addition (+)
 - Subtraction (-)
 - Multiplication (*)
 - Division (/)
 - Integer Division (/)
 - Modulo (%)
- Operands
 - Best practices would say these should be the same type but Java sometimes varies these types



Unary Operators

- Operations and Operators:
 - "Positive" (+)
 - Negative (-)
 - Increment (++)
 - Decrement (--)
- Operand:
 - A numeric type

- **Acknowledgements**

Parts of this activity are based on materials developed by David Bernstein

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