



MACQUARIE
University

Department of Computing

ITEC625 Fundamentals of Computer Science
Workshop - Variables and Operators

Learning outcomes

This weeks workshop is about understanding variables and operators.

1. Twos complement

Convert the following negative decimal numbers to binary assuming storage is in 1 byte and the first bit is used for sign:

- a. -50
- b. -8
- c. -99

Solution:

- a. -50 = 11001110
- b. -8 = 11111000
- c. -99 = 10011101

2. Storage

Can the following values be stored correctly in the data type assigned to them? If so, state the complete bit-pattern that the following variables are stored as, in the memory.

```
short b = 28;
int c = 53;
byte a = 130;
long d = 65536;
short e = -203;
```

Solution:

```
short b = 28; //valid, 00000000 00011100
int c = 53;
//valid, 00000000 00000000 00000000 00110101
byte a = 130; //invalid
long d = 65536;
//valid, 00000000 00000000 00000000 00000000
```

```
//      00000000 00000001 00000000 00000000
short e = -203; //valid, 11111111 00110101
```

3. Number systems

Convert each of the following decimal numbers into binary, quinary (base-5) and nonary (base-9)

- a. 8
- b. 29
- c. 52

Solution:

- a. 8 in binary: 1000, in quinary: 13, in nonary: 8
- b. 29 in binary: 11101, in quinary: 104, in nonary: 32
- c. 52 in binary: 110100, in quinary: 202, in nonary: 57

4. Converting to power of source base

In the lectures, we demonstrated a way to convert an integer n from base- p to base- q when $q = p^k$ (k being an integer more than 1).

EXAMPLE 1:

$n = 11101010$, $p = 2$, $q = 8$
 $q = 2^3$, therefore, $k = 3$
Split n in groups of 3 (starting from right side)

11 101 010

Pad the first group if incomplete with 0s.

011 101 010

Convert each group to decimal individually.

3 5 2

Put it together. That's the number in base 8.

Hence, 11101010 in base-2 = 352 in base-8.

EXAMPLE 2:

$n = 10201221$

$p = 3$

$q = 9$

$q = 3^2$, therefore, $k = 2$

Split n in groups of 2 (starting from right side)

10 20 12 21

Pad the first group if incomplete with 0s - not applicable

Convert each group to decimal individually.

3 6 5 7

Put it together. That's the number in base 9.

Hence, 10201221 in base-3 = 3657 in base-9.

Convert the following numbers (source and destination bases provided):

- a. 11100010 in base-2 to base-4
- b. 11100010 in base-2 to base-8
- c. 11100010 in base-2 to base-16
- d. 120100121 in base-3 to base-9
- e. 310223201 in base-4 to base-16

Solution:

- a. 11100010 in base-2 = 3202 in base-4
- b. 11100010 in base-2 = 342 in base-8
- c. 11100010 in base-2 = $e2$ in base-16
- d. 120100121 in base-3 = 16317 in base-9
- e. 310223201 in base-4 = $34ae1$ base-16

5. Converting from power of destination base

Now we'll do the opposite - convert an integer n from base- q to base- p when $q = p^k$ (k being an integer more than 1).

EXAMPLE 1:

$n = e8f2$

$q = 16$

$p = 2$

$q = 2^4$, therefore, $k = 4$

Convert each symbol to decimal and then to base p .

e	8	f	2
14	8	15	2
1110	1000	1111	10

Pad with leading zeroes to make groups of size k (4)

1110 1000 1111 0010

Put it together

1110100011110010

That’s your number in base-p (2)

Hence, e8f2 in base-16 = 1110100011110010 in base-2.

Convert the following numbers (source and destination bases provided):

- a. 5073 in base-9 to base-3
- b. abc123 in base-16 to base-2

Solution:

- a. 5073 in base-9 = 12002110 in base-3
- b. abc123 in base-16 = 10101011 11000001 00100011 base-2

6. **Expressions**

An expression is an operation evaluating to a specific value.

What are the values of the following arithmetic expressions?

- a. 17/5
- b. 1.0 + 16/5
- c. (1.0 + 16)/5
- d. 3 * ((2 + 5) / (4 - 1) + 17 % 5)

Solution:

- a. 17/5 = 3
- b. 1.0 + 16/5 = 4.0
- c. (1.0 + 16)/5 = 3.4
- d. 3 * ((2 + 5) / (4 - 1) + 17 % 5) = 12

7. **Boolean expressions**

What are the values of the following boolean expressions?

- a. true && false
- b. true && (false || true)

- c. `true || false`
- d. `false || !(true || false)`
- e. `(5 >= 0 && (5 <= 2 || 5 <= 10))`

Solution:

- a. `true && false = false`
- b. `true && (false || true) = true`
- c. `true || false = true`
- d. `false || !(true || false) = false`
- e. `(5 >= 0 && (5 <= 2 || 5 <= 10)) = true`

8. Bitwise operations

An expression is an operation evaluating to a specific value.

What are the values of the following bitwise operations?

- a. `21 & 19`
- b. `21 | 19`
- c. `21 ^ 19`
- d. `12 << 2`
- e. `12 >> 2`

Solution:

- a. `21 & 19 = 17`
- b. `21 | 19 = 23`
- c. `21 ^ 19 = 6`
- d. `12 << 2 = 48`
- e. `12 >> 2 = 3`

9. Java program

Consider the following scenario:

John takes 5 hours to paint 3 square meters while Jenny takes 15 hours to paint 7 square meters.

If they work together, how much time will they need to paint a wall whose area is 56 square meters? Also determine how much area John paints and how much area Jenny paints.

First devise a solution on paper and verify your solution by ensuring that:

`(area painted by john in determined time) +
(area painted by jenny in the same determined time) = total area (56)`

Then, write a java program in Eclipse that solves the following problem.

IMPORTANT: Think about the types you'll use to store these values?

Solution:

- a. Calculate area that John can paint in an hour and area that Jenny can paint in an hour.
- b. Calculate the total area they can paint in an hour working together.
- c. Using this and the total area that needs to be painted, compute the number of hours they should work together.
- d. Calculate area painted by John and Jenny individually in that time.

```
public class Painting {  
    public static void main(String[] args) {  
        double johnTotalTime = 5;  
        double johnTotalArea = 3;  
        double jennyTotalTime = 15;  
        double jennyTotalArea = 7;  
        double totalArea = 56;  
  
        double johnAreaPerHour = johnTotalArea/johnTotalTime;  
        double jennyAreaPerHour = jennyTotalArea/jennyTotalTime;  
        double totalAreaPerHour = johnAreaPerHour + jennyAreaPerHour;  
  
        double totalTime = totalArea/totalAreaPerHour;  
  
        System.out.println("Total_time_taken: "+totalTime);  
  
        double areaPaintedByJohn = johnAreaPerHour*totalTime;  
        double areaPaintedByJenny = jennyAreaPerHour*totalTime;  
  
        System.out.println("Area_painted_by_John: "+areaPaintedByJohn);  
        System.out.println("Area_painted_by_Jenny: "+areaPaintedByJenny);  
    }  
}
```