C language – syntax

- Syntax
  - rules of the grammar
  - vocabulary recognized by the language
  - ANSI standard
    - American National Standards Institute
- Semantics
  - the meaning of what is being said

Syntax vs Semantics Examples

- The monster scared Jon.
  - syntactically valid
- Jon scared the monster.
  - syntactically valid
  - says something different than the first.
- Jon sat in the chair.
  - syntactically valid
- The chair sat in Jon.
  - syntactically valid
  - questionable in semantics
- The in sat. Chair Jon
  - Syntactically invalid
  - no semantic interpretation from this available at all
Program Errors

- Incorrect Syntax
  - The compiler gives error message at that spot and refuses to compile it.
  - The compiler gives warning message at that spot but still compiles it.
  - The compiler gives error or warning message at a spot later in the file.
- Incorrect Semantics
  - Program does nothing when run
  - Program does nothing useful when run
  - Program does the "wrong" thing when run
  - Program "crashes" or "hangs" when running

Basic Program Structure

- a program must be comprised of 1 or more functions
  - function = named program part for performing a specific task
  - must be 1 and only 1 function named **main**
    - controls everything else
    - starts there and determines who gets to go when
    - for now this is the only function you'll design

Functions: Definition and Use

- Syntax of a function definition:
  ```
  func_type funct_name(list_of_parameters):
  
  funct_body
  ```
- Example of a complete program:
  ```
  int main()
  
  printf("this is a complete program\n");
  ```
- Syntax of a function call:
  ```
  funct_name(list_of_arguments);
  ```
- Example of a function call:
  ```
  printf("This is a complete program\n");
  ```
Functions: Identified by Name

- Identifiers
  - Used to name functions, variables, etc.
  - String of alphabetic characters, numeric digits and the underscore
  - Case sensitive
  - Can not start with a numeric digit
  - Must be a unique name

Identifier examples

- cmsc106
- CMSC106
- cmsc_106
- cmsc.106
- _cmsc_106
- 106cmsc
- _106_cmsc_
- cmsc 106
- 106

printf function call details

```c
#include <stdio.h>
int main()
    {printf("this is a complete program\n");}
```

- printf writes its parameter/argument to the screen
- printf is defined in a library so it needs:
  ```c
  #include <stdio.h>
  ```
- The string argument to printf must be enclosed in " "
  (double quotes)
- prints string argument exactly as it appears - except escape sequences
  - i.e. \n (carriage return) which can appear anywhere between " "
Function Return

```c
#include <stdio.h>
int main()
{
    printf("this is a complete program\n");
    return 0;
}
```

- every function should end with a return statement that returns its "return value" to the caller
- main returns to the operating system
- 0 as a return value from main means "all is well"

Readability Issues

- **Comments**
  - /* comment */
  - ignored by compiler
  - for human reader
  - multiple lines is fine
  - used to explain what it is doing and/or how
  - can not be nested
  - every function needs a comment to tell its use and purpose
  - every place it would help the readability comments should be included

- **Spacing**
  - vertical spacing
  - horizontal spacing
  - also ignored by the compiler and for the human reader
  - should accurately reflect the meaning and flow

Spacing Issues

- white-space needed for readability (space, tab, end-of-line)
- Horizontal Spacing: INDENTING
- Vertical Spacing: BLANK LINES
- White-space does not matter to compiler
  - except between " "
  - except inside of words (or identifiers)
- Any amount of white space can appear between program components.
- Poor style
  - compiler doesn't care.
  - random indent statements.
  - lines longer than screen (or printer) width
  - if it doesn't accurately reflect program meaning or flow
  - See examples on-line
Data types

- first two basic data types:
  - int
  - float

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>?</td>
<td>amount</td>
</tr>
</tbody>
</table>

memory |      |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>?</td>
<td>grand_total</td>
</tr>
<tr>
<td></td>
<td>tax</td>
</tr>
</tbody>
</table>

values random when first declared

Assignment Statement

- variable name = value;

Semantics
- when executed, the right side is calculated and
- the result is stored in variable on left
- a = b;
- previous value of left-side variable is lost

left side must be a variable
right side can be:
- a number (literal)
- a variable
- an expression
- right side's value unchanged (copy)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initialization

- Combines Declaration and Assignment

Semantics
- When a variable space is first being allocated the value is immediately put in
- a variable of the type and name given is created and given the value of the right hand side
- int a = 6;
- new variable comes into existence
- variable of that name can not already exist in
  - the current scope
  - a number (literal)
  - a variable
  - an expression
  - right side's value unchanged (copy)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#include <stdio.h>
main()
{
    declarations
    statements
    return 0;
}

#include <stdio.h>

main()
{
    declarations
    statements
    return 0;
}

e.g.: int amount = 7;
      grand_total = 125;
      float tax = 0.05;

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example

- Trace this program’s variables in memory

```c
#include <stdio.h>
int main() {
    int num = 3, num2;
    num2 = 17;
    num2 = num;
    return 0;
}
```

- Problem Solving: Exchanging variables’ values
  - any variable can only hold one value at a time
  - assigning a value to a variable causes its previous value to be lost
  - Must use a “temporary” variable to exchange.

Printf – The rest of the story

- Printing Variables
  - Syntax of printf:
    - `printf("literal string");` or
    - `printf("format control string", list of variables);`
  - format control string must have a format specifier for each variable in list
  - format specifiers:
    - `%d` - print as an integer
    - `%f` - print as a real number
  - Example of printf for values:
    - `printf("num is %d and num2 is %d\n", num, num2);`

More escape sequences

- `\n` new line
- `\t` advances cursor to next tab stop
- `\r` carriage return
- `\b` backspace
- `\a` beep
- `\"` "
- `\` \n
examples:
- `printf("Jan\n\tPlane\n");` | `printf("\n\n\")`;
- output: Jan
  Plane
Symbolic constants

```c
#define NAME value
```

- gives a name to a constant value

```c
#define BOILING 212
```

- no semicolon because it is not a C statement it handled by the preprocessor
- convention: to distinguish constant names they are written in all uppercase letters
- (ex: constants.c)

Data Types

- Integer Family
  - char typically 8 bits
  - short typically 16 bits
  - int typically 32 or 64 bits
  - long typically 32 or 64 bits
  - long long typically 64 bits
  - All are signed by default, but can be made unsigned
    - unsigned int typically 0 to 4,294,967,295
  - Literals
    - Decimal (255), Hex (0x255), signed (-255)
    - Character ('a', '
')
    - Don't be stingy with size, when in doubt use a larger size
- Floating Point
  - float, double, long double
  - Literals (3.14159, 1E10, 25., 6.023e23)
- Character and String Literals
  - Character Literals: 'a', '9', '
'
  - String Literals: "a long dull string", "
", ""

sizeof and limits of types

- ANSI only specifies minimum amount of space for a specified type – not an exact
- `sizeof()`
  - operator – returns the number of bytes when passed a type or a variable as the operand (in parentheses
  - grace.umd.edu: it returns an unsigned int on one system and a long int on the other
  - casting of types needed because of inconsistancy
    - `printf("%d",(int)(sizeof(float)));`
    - cast does not modify the type of the operand – it just returns a value of the type indicated
- (ex: testsizes.c)