Discussion 2

- Functions
- Comparing equality of floating point values
- Complex Numbers
  - complex()
  - polar()
- Matrices and linear algebra

Functions

- Function Prototype
  ```
  return_type function_name ( { argument_type [argument_name] ,} );
  ```
- Function Definition
  ```
  return_type function_name ( {argument_type [argument_name] ,} )
  {
   statements;
   return return_value;
  }
  ```
- Common Errors
  - return_value type does not match return_type
  - Function name for prototype does not match definition
  - Argument types in prototype do not match those in definition

Function Example: Function Definition

```
int is_prime(int num); /* Define this function later */

/* This function returns '1' if input argument is prime. Otherwise, it returns
 * zero. */
int is_prime(int num)
{
  int i;
  for(i = 2; i < (sqrt(num) + 1); i++) {
    if ( (num % i) == 0) { // If this is zero, then the number cannot be prime
      return 0;
    }
  }
  return 1;
}
```

Function Example: Function Usage

```
int main()
{
  int num_primes = 0;
  int i = 1;
  int n;
  printf("Which prime number do you wish to find? : ");
  scanf("%d", &n);
  printf("Calculating...\n");
  for(i = 1; num_primes < n; i++) {
    /* For each iteration, check whether i is prime. If it
is, increment
     * our variable keeping track of the number of primes */
    if( is_prime(i) ) {
      num_primes++;
    }
  }

  i--;
  printf("The prime is %d\n", i);
  return 0;
}
```

Function Example: Output

```
$ ch ./nth_prime.c
Which prime number do you wish to find? : 100
Calculating...
The prime is 541
$ ch ./nth_prime.c
Which prime number do you wish to find? : 200
Calculating...
The prime is 1223
$
```

Floating Point Numbers

- Note that the standard equality operator, “==”, is rarely used with floating point numbers.
- Due to rounding and precision errors, two floating point numbers may not evaluate to being equal on a digital computer, although they may be equal from a mathematical standpoint.

Floating Point Numbers

- The preferred way to test the equality of floating point numbers on a computer is by using code similar to the following:

```
#include <math.h> /* For FLT_EPSILON */
float x1, x2;
/* ... */
/* Test to see if x1 == x2 */
if (fabs(x1-x2) < FLT_EPSILON) ) {
   /* Code to perform if x1 == x2 */
}
```

Floating Point Numbers

- Different floating point types have different epsilons:
- float : FLT_EPSILON
- double : DBL_EPSILON
- long double: LDBL_EPSILON
- They are all defined in <math.h>

Complex Numbers

- There are two commonly used methods for initializing complex numbers.
  - The complex() function initializes a complex number by specifying its real and imaginary parts.
  - The polar() function initializes a complex number by specifying its magnitude and angle.

Complex Numbers

- Example
  - Write a program to determine the real part, imaginary part, magnitude, and phase angle of the following equation:

$$z = \frac{1+2\mathrm{i}}{3-4\mathrm{i}} + (5-6\mathrm{i})(7+8\mathrm{i})e^{i\pi/2}$$

Complex Numbers

```
/************************
 *   File: ex4.c        *
 * Author: Yu-Cheng Chou *
 *   Date: 2007/1/24    *
 ************************/
#include <stdio.h>
#include <tgmath.h>
#include <complex.h>

int main() {
    double complex z;

    /* The following two lines are equivalent */
    z = complex(1, 2)/complex(3, -4) + complex(5, -6)*complex(7, 8) + exp(I*M_PI/2);
    //z = complex(1, 2)/complex(3, -4) + complex(5, -6)*complex(7, 8) + polar(1, M_PI/2);

    printf("real(z) = %.3f\n", real(z));
    printf("imag(z) = %.3f\n", imag(z));
    printf("abs(z) = %.3f\n", abs(z));
    printf("carg(z) = %.3f\n", carg(z));

    return 0;
}
```

Complex Numbers

```
$ ch ./ex4_complex_numbers2.c
real(z) = 82.800
imag(z) = -0.600
abs(z) = 82.802
carg(z) = -0.007
$
```

Matrices and Linear Algebra

- Computational arrays may be initialized in Ch with the 'array' keyword
- Computational arrays may be added, subtracted, multiplied, and divided with each other. Each operation is performed as matrix operations.

Matrices and Linear Algebra

- Example:
  - Find x = 2ABb + Ab given the following:

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

$$B = \begin{bmatrix} 3 & 4 \\ 1 & 2 \end{bmatrix}$$

$$b = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

Matrices and Linear Algebra

```
/*************************
 *   File: ex6.ch        *
 * Author: Yu-Cheng Chou *
 *   Date: 2007/1/24     *
 *************************/
#include <stdio.h>
#include <array.h>

int main()
{
    array int A[2][2] = {1, 2, 3, 4},
              B[2][2] = {3, 4, 1, 2},
              b[2][1] = {1, 2},
              x[2][1];

    x = 2*A*B*b + A*b;

    printf("x =\n%d\n", x);

    return 0;
}
```

Matrices and Linear Algebra

- Example Output

```
$ ch ./ex6_matrix_operations.ch
x =
47
117
$
```