Announcements

● Assignment 1 posted on course website
  ○ https://coursys.sfu.ca/2019sp-cmpt-125-d1/pages/
  ○ Hard copy due before class next Wednesday (Jan. 16)
  ○ You may write or type your solutions

● No late submissions allowed
  ○ Lowest mark assignment will be omitted
Lecture 3

Today:

- Data, pointers
- Functions in C
- Performance Measurements of Code
Data vs Pointers (Review)

● Besides its data and its type, a variable needs a memory location to place the data.
  ○ the variable’s address (a number)
  ○ each variable has a distinct address, i.e., they may not overlap

● The C language allows programs to store and manipulate these addresses
  ○ called a pointer
Pointer Operations in C

```c
int main() {
    int area = 25;
    Int * pArea = &area;

    printf("area = %d\n", area);
    printf("pArea = %ld\n", pArea);
    printf("pArea = %lx\n", pArea);
}
```

Output:

- area = 25
- pArea = 140734562585432
- pArea = 7fff519c4b58

- a “*” in front of the var name means pointer
- the “&” operator means “address of”
- saw before when using `scanf("%d", &var);`
Pointer Operations in C

```c
int main ( ) {
    int area = 0;
    Int * pArea = &area;

    *pArea = 25;
    printf("area = %d\n", area);
    *pArea = *pArea + 50;
    printf("area = %d\n", *pArea);
}
```

- the "*" operator means dereference
  - use / modify the data where the pointer points
  - "Value of"
Pointer Operations - Recap

- Remember the difference between:
  - the data (variable)
  - the address (pointer)

Use “&” (Address of)

Use “*” (Value of)

Q. How are these operators related to each other?
Functions

- Define functions outside of main program
  - `main()` is itself a function!
- Anatomy of a function:

```c
int gcd(int a, int b) {
    while (b != 0) {
        int tmp = b;
        b = a % b;
        a = tmp;
    }
    return a;
}
```

Pass By Value

- All functions in C pass parameters by value
  - call the subroutine, and it gets its own copy
    - each copy within its own *scope*
  - avoids *side-effects*: calling a function should not (unexpectedly) modify its parameters

- All functions in Python pass parameters by reference

- Java is a mix
int gcd(int a, int b) {
    while (b != 0) {
        int tmp = b;
        b = a % b;
        a = tmp;
    }
    return a;
}

int main() {
    int a = 481, b = 910, result = 0;
    result = gcd(a, b);
    printf("gcd(%d,%d) = %d\n", a, b, result);
}
Pointers as Parameters

To modify variables outside of scope, pass a pointer to that variable

```c
void swap(int a, int b) {
    int tmp = a;
    a = b;
    b = tmp;
    return;
}

int main ( ) {
    int a = 5, b = 12;
    swap(a, b);
}

This won't change the values of \texttt{a, b} in the \texttt{main} routine. Only locally.
```

```c
void swap(int *a, int *b) {
    int tmp = *a;
    *a = *b;
    *b = tmp;
    return;
}

int main ( ) {
    int a = 5, b = 12;
    swap(&a, &b);
}

Pass pointers to the integers instead, and use \texttt{*a} and \texttt{*b} (dereference) to access their values.
```
Functions - Summary

- Functions in C have similar syntax and operation to functions in Python
- Exceptions:
  - must define the types of all parameters
  - must define the type of return value
  - all parameters are pass by value
- Pass a pointer to modify a caller’s variable

Any questions?
How Good is Your Code?

• Several measures of “good”-ness:

• Is it . . . :
  ○ correct? (bug-free)
  ○ reliable?
  ○ efficient?
  ○ affordable?
  ○ maintainable?
  ○ easy to use?
How Good is Your Algorithm?

• Efficiency is the primary focus
• Computers consume 2 major resources:
  ▪ time
  ▪ space (as in memory)
• Lately, time has become the most precious
  ▪ memory is fairly cheap
  ▪ memory is usually not a constraint
Performance Measurement

Two Options:

1. Time the code when it runs on a variety of inputs
   - plot graphs + predict behaviour
   - hardware dependent

2. Count the number of operations (steps) your algorithm performs
   - plot graphs OR derive functions OR . . .
   - . . . use the big-O estimate
   - hardware independent