Admin

- Today's topics
  - Linked lists, recursive data, intro to algorithm analysis & big-O
- Reading
  - linked lists Ch 9.5(sort of), handout #21
  - algorithms, big O Ch 7
- No cafe today after class :-(
  - Due to undergrad council meeting

Printing list

```
void PrintEntry(Entry *entry)
{
  cout << entry->name << " " << entry->phone << endl;
}

void PrintList(Entry *list)
{
  for (Entry *cur = list; cur!= NULL; cur = cur->next)
      PrintEntry(cur);
}
```

- Idiomatic loop to iterate over list, compare to
  `for (int i = 0; i < n; i++)`

A recursive twist on printing

```
void PrintList(Entry *list)
{
  for (Entry *cur = list; cur!= NULL; cur = cur->next)
       PrintEntry(cur);
}
```

Iteration replaced with recursion:

```
void PrintList(Entry *list)
{
  if (list != NULL) {
     PrintEntry(list);
     PrintList(list->next);
  }
}
```

What happens if we switch the order of these two lines?

Recursive data -> recursive ops

- Natural to operate on linked list recursively
  - List divides into first node and rest of list
  - Base case: empty list
  - Recursive case: handle first node, recur on rest

```
int Length(Entry *list)
{
  if (list == NULL)
    return 0;
  else
    return 1 + Length(list->next);
}
```

```
void Deallocate(Entry *list)
{
  if (list != NULL) {
    Deallocate(list->next);
    delete list;
  }
}
```

Watch the pointers!

- (Decompose function to add node to front of list, mods shown in blue)

```
void Prepend(Entry *ent, Entry *first)
{
    ent->next = first;
    first = ent;             // BUGGY!
}

Entry *BuildAddressBook()
{
   Entry *listHead = NULL;
   while (true)  {
      Entry *newOne = GetNewEntry();
      if (newOne == NULL) break;
      Prepend(newOne, listHead);
   }
   return listHead;
}
```

Passing pointer by reference

- (Tiny modification in blue saves the day!)

```
void Prepend(Entry *ent, Entry * & first)
{
    ent->next = first;
    first = ent;
}

Entry *BuildAddressBook()
{
   Entry *listHead = NULL;
   while (true)  {
      Entry *newOne = GetNewEntry();
      if (newOne == NULL) break;
      Prepend(newOne, listHead);
   }
   return listHead;
}
```

Array vs linked list

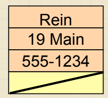
- Array/vector stores elements in contiguous memory
  - + Fast, direct access by index
  - - Insert/remove requires shuffling
  - - Cannot easily grow/shrink (must copy over contents)
- Linked list wires elements together using pointers
  - + Insert/remove only requires re-wiring pointers
  - + Each element individually allocated, easy to grow/shrink
  - - Must traverse links to access elements

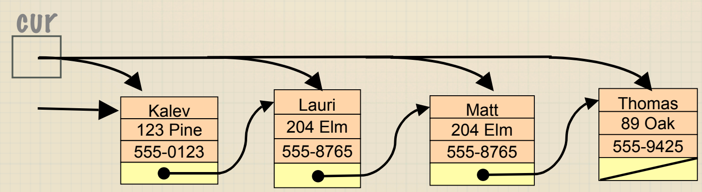
Insert in sorted order

- Traverse list to find the position to insert
  - What is true after the loop exits?

```
void InsertSorted(Entry * &list, Entry * newOne)
{
    Entry *cur;

    for (cur=list; cur!= NULL; cur=cur->next){
        if (newOne->name < cur->name) break;
    }
```

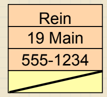




Insert in sorted order

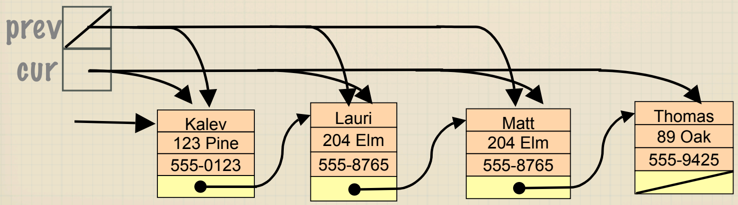
◇ Drag previous pointer (one behind cur)

- prev/cur move down list in parallel, one node apart




```
void InsertSorted(Entry * &list, Entry * newOne)
{
    Entry *cur, *prev = NULL;

    for (cur=list; cur!= NULL; cur=cur->next){
        if (newOne->name < cur->name) break;
        prev = cur;
    }
    // what are possible values for prev?
```



Insert in sorted order

```
void InsertSorted(Entry * &list, Entry * newOne)
{
    Entry *cur, *prev = NULL;

    for (cur=list; cur!= NULL; cur=cur->next){
        if (newOne->name < cur->name) break;
        prev = cur;
    }

    newOne->next = cur;     // splice outgoing ptr
    if (prev != NULL)
        prev->next = newOne; // splice incoming ptr
    else
        list = newOne;        // note special case!
}
```

Recursive insert

```
void InsertSorted(Entry * & list, Entry * newOne)
{
    if (list == NULL|| newOne->name < list->name){
      newOne->next = list;
      list = newOne;
   } else {
      InsertSorted(list->next, newOne);
    }
}
```

◇ Wow!

- Elegant, direct expression of algorithm
- Dense use of pointers and recursion