

Announcements

- Program #3
 - Due Tuesday at 8pm
- Reading
 - Chapter 17 (Today)
 - skip 17.5.4
 - Chapter 13 (Thursday)

Implementation Hiding

- Goals

- Export a public API
- Hide details of implementation
 - allows implementation to evolve
 - better able to reason about a large system
 - don't need to know how it works, just that it works
 - protects IP in implementation
- Get the right abstractions
 - This is the hardest part!

- Techniques

- No implementation code in header files
- Careful use of pointer definitions
 - use opaque pointers

Opaque Pointer Types

- Generic Pointers
 - make API return **void*** pointers
 - lacks type checking
 - useful for building containers
 - such as maps, sets, etc.
 - Example:
 - `void *createTable();`
 - `addItem(void *table, void *data);`
- Pointers to structs (struct definitions are hidden)
 - Public header files define API and pointer to abstract types
 - API users only see public header files
 - Private header files define actual structures
 - Include public header files
 - Visible to modules implementing the API

Information Hiding Example

- Project #3 revisited
 - (but don't change project 3 – this is just another model)
- Change ast.h (to be the public header)

```
struct __node;  
typedef struct __node ASTnode;
```

- Create astP.h (private header)

```
struct __node {  
    nodeType type;  
    struct __node *left;  
    struct __node *right;  
    int value;  
    operatorType operator;  
    char *name;  
};
```

Containers vs. APIs

- Containers

- designed to hold a collection of the same or similar objects
- provide common access to stored items

- API

- encapsulates a useful bit of functionality
- Example: AST's in project #3
- May use containers to store information

Common Container Abstractions

- Stack
 - Last-in/first-out semantics (LIFO)
 - Push and pop are operations
- Queue
 - First-in/first-out semantics (FIFO)
 - Enqueue and dequeue are only operations normally
- Table (really a variation on a map)
 - Storage of keyword, values
 - Supports insert, lookup, delete

Table Container

- Can have many underlying implementations
 - Arrays
 - Linked list
 - Hash table (open or chained)
 - Trees (many different trees possible)
- Each implementation has performance attributes
 - How much space is required ?
 - How efficient is insert vs. lookup vs. delete ?
 - Implementation time vs. amount of time/space saved ?
- No single right implementation for all purposes
 - Project #4 explores two alternative implementations

Designing a Good API

- Why it matters:
 - Can always change a bad implementation
 - Changing an API impacts all users
- Elements of a good design
 - Can be easily used for many different purposes
 - Focus on key ideas, not how they work
 - Lookup/Store data **NOT** insert into tree
 - Logical units of work with each function call
 - Simple (and common) things should be easy
 - add convenience functions if needed
 - functions that can be expressed using others in API
- Elements of a bad design
 - Exposes aspects of the implementation
 - Abstractions don't match the common usage pattern

A Bad API Example

```
typedef struct {  
    float real;  
    float imaginary;  
} complexNumber;
```

```
complexNumber *createComplex();  
float getRealPart(complexNumber *num);  
float getImaginaryPart(complexNumber *num);  
void setNumber(complexNumber *num, float real, float imaginary);
```

- Hides nothing
- Provides little (to no) value added beyond struct

More Elements of good API Design

- Consistent Return Values across functions
 - 0 is always success
 - negative is always failure
- Consistent parameters
 - use the same names for the same things in different functions
 - how copy semantics are handled
 - are strings copied when passed to API