CS 261 – Data Structures

C – Compilation Process

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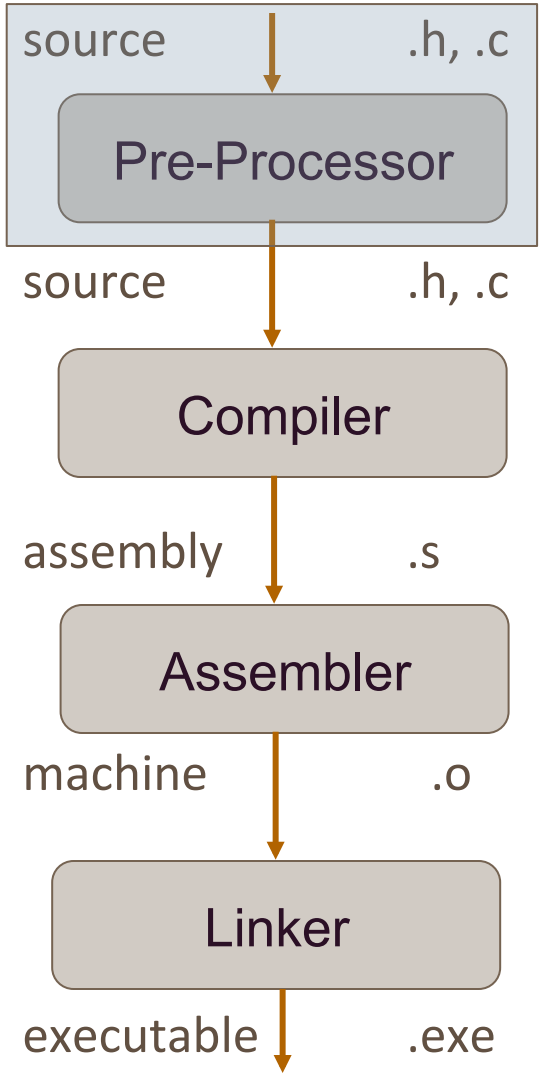
Compilation Process



Remove Comments

Replace Pre-processor directives (#). For example, #include copies the header file

Conditional compilation

```
#include<stdio.h>
int main(void) {
    printf("Hello world!\n");
}
```

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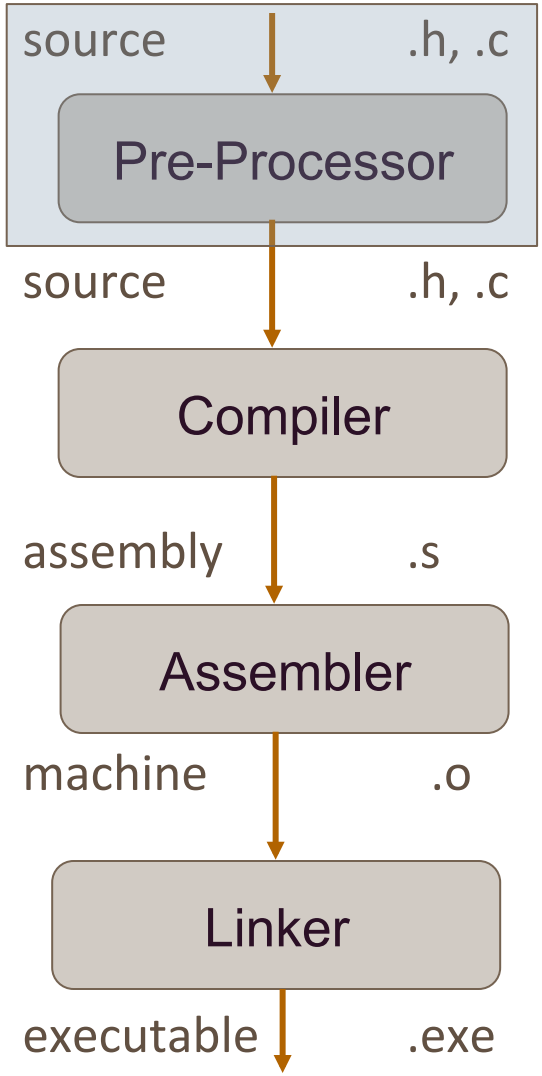
Compilation Process



Take resulting source code and compiles to assembly code (.s)

```
gcc -g -S -Wall -std=c99 -c main.c
```

Machine level code that manipulates memory and processor

```
.section    __TEXT,__text,regular,pure_instructions
        .globl      _main
        .align      4, 0x90
_main:
Leh_func_begin1:
        pushq %rbp
Ltmp0:
        movq  %rsp, %rbp
Ltmp1:
        subq  $16, %rsp
Ltmp2:
        movl  %edi, %eax
        movl  %eax, -4(%rbp)
        movq  %rsi, -16(%rbp)
        leaq  L_.str(%rip), %rax
        movq  %rax, %rdi
        callq _puts
        addq  $16, %rsp
        popq  %rbp
        ret
```

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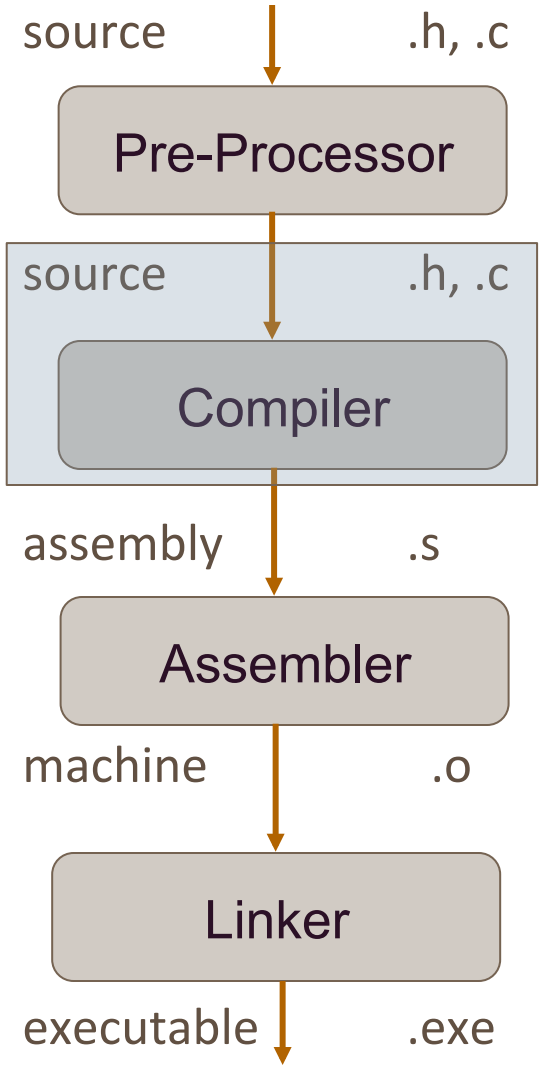
Compilation Process



Assembler generates object code (.o) from the assembly code.

Object code is in binary and can't be viewed with a text reader

```
gcc –c main.c
gcc – c dynArr.c
```

Pre-process, compile, assemble

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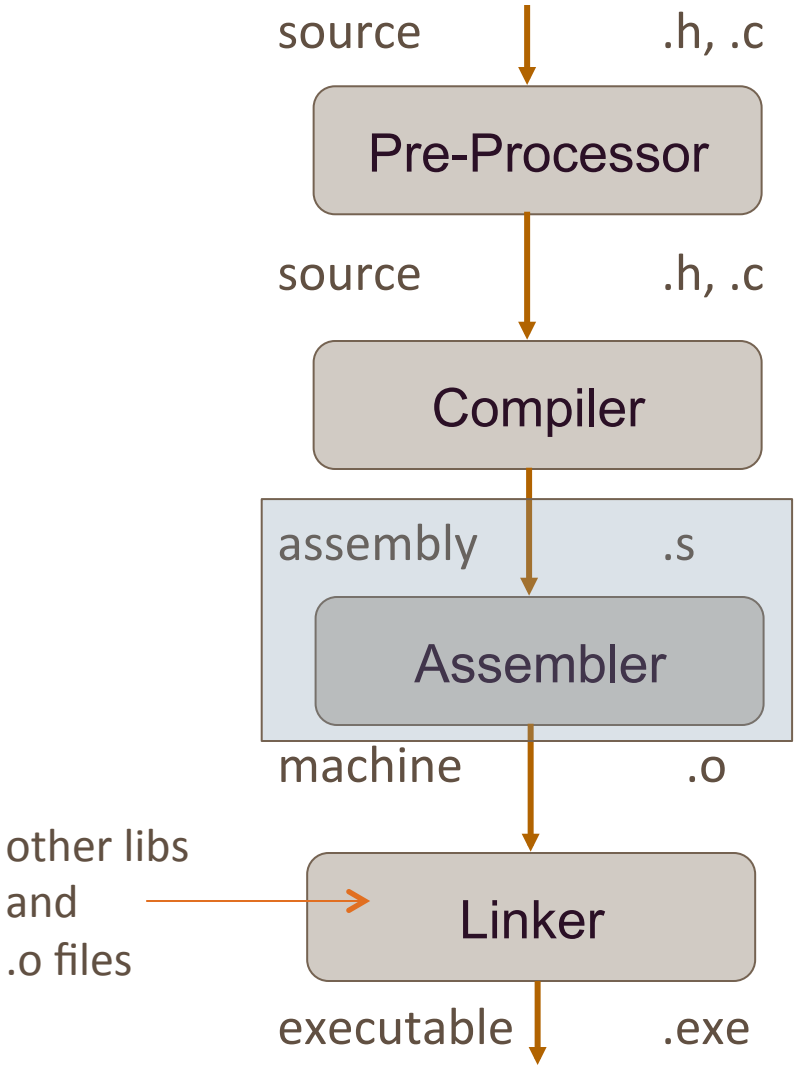
Compilation Process



The Linker pulls together your object code with libraries that you're using in your program.

In this case, we use 'printf', so it will pull in the c standard library

The result is the executable

```
#include<stdio.h>

int main(void) {

    printf("Hello world!\n");

}
```

gcc –o prog main.o dynArr.o

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Separation of Interface and Implementation

Header files (*.h) have declarations and function prototypes (ie. interfaces)

Implementation files (*.c) have implementation source

A prototype is function header but no body (promise that the code will be linked in later)

```
int max(int a, int b);/* Function prototype */
```

Function prototypes must be terminated with a semicolon.

Allows us to 'hide' implementation in pre-compiled .o files

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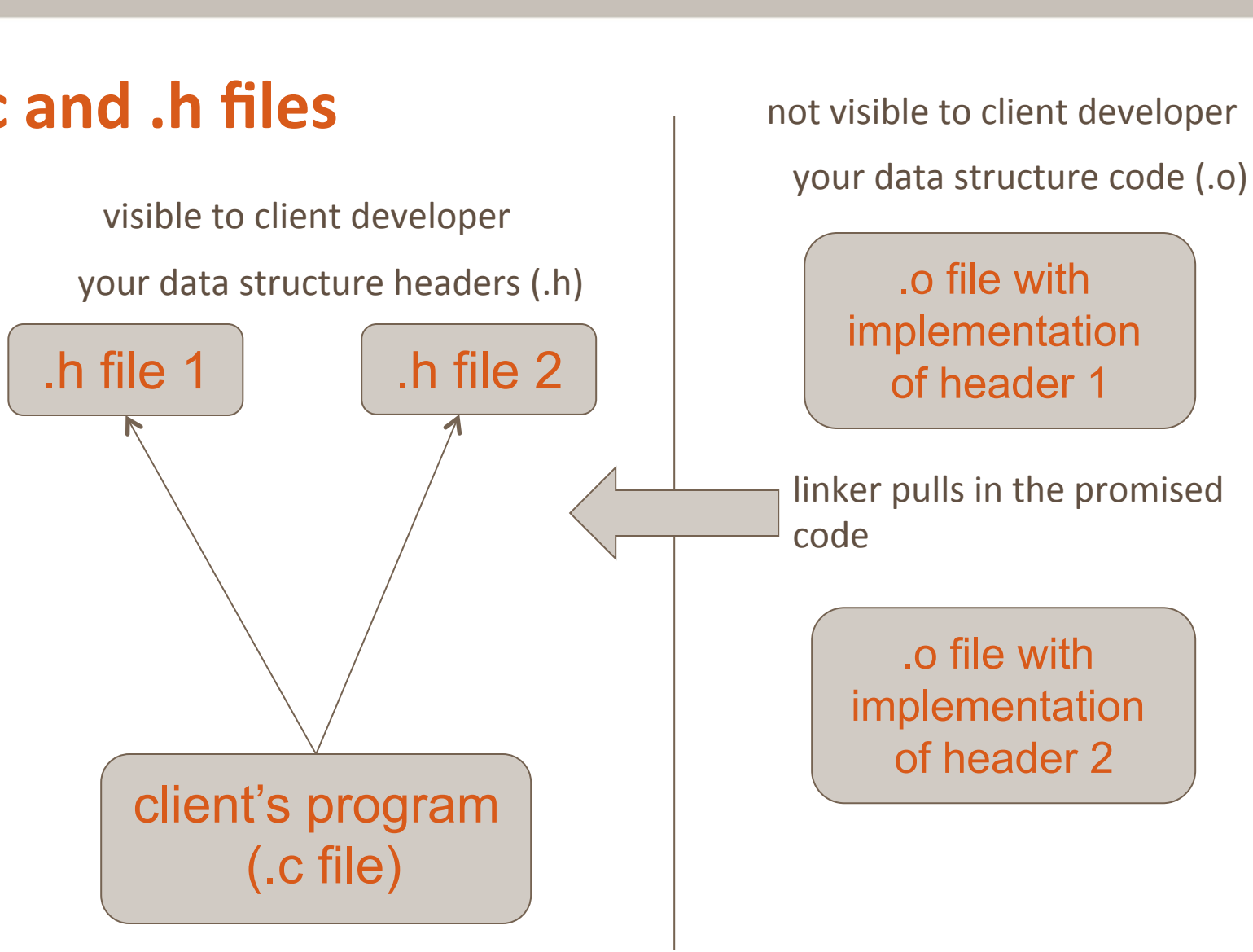
Source Files - arrayBagStack.h

```
# ifndef ArrayBagStack
# define ArrayBagStack

# define TYPE int
# define EQ(a, b) (a == b)

/* prototype for the struct, which is hidden away in the .c file */
struct arrayBagStack;

/* Bag Interface */
struct arrayBagStack *createArray();
void initArray (struct arrayBagStack * b);
void addArray (struct arrayBagStack * b, TYPE v);
int containsArray (struct arrayBagStack * b, TYPE v);
void removeArray (struct arrayBagStack * b, TYPE v);
int sizeArray (struct arrayBagStack * b);

/* Stack Interface */
void pushArray (struct arrayBagStack * b, TYPE v);
TYPE topArray (struct arrayBagStack * b);
void popArray (struct arrayBagStack * b);
int isEmptyArray (struct arrayBagStack * b);
```

Source Files - arrayBagStack.c

```c
#include "arrayBagStack.h"
#include <assert.h>
#include <stdlib.h>
#include <stdio.h>

struct arrayBagStack
{
    TYPE data[100];
    int count;
};


/* Bag Interface */

/* This function allocates space for an arrayBagStack structure! */
struct arrayBagStack * createArray()
{
    struct arrayBagStack * b = malloc(sizeof(struct arrayBagStack));

    return b;
}

void initArray (struct arrayBagStack *b)
{
```

.c and .h files



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Tips: Ensuring Declarations Seen only Once

```
/* Header file for foo.h */
#ifndef BIG_COMPLEX_NAME
#define BIG_COMPLEX_NAME
…
/* Rest of foo.h file. */
#endif
```

Conditionally compiled code!!!

If `foo.h` is included more than once (e.g., through other included files), it only gets inserted into the source (.c) file once

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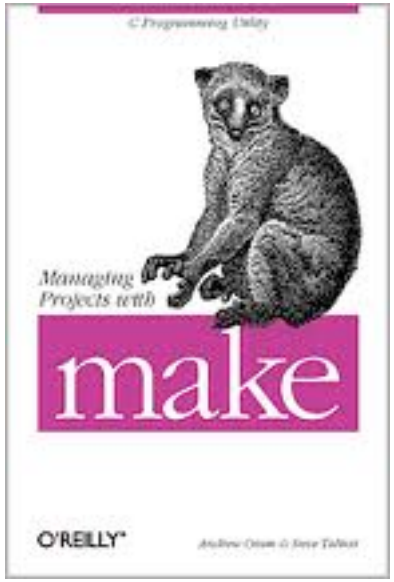
GCC And Make



Managing Projects with make, 2nd Edition
The Power of GNU make for Building Anything
By Andy Oram, Steve Talbott
Publisher: O'Reilly Media
Released: October 1991
Pages: 168

Also, see the class website for much more on gcc, make and c-programming in general

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