1 Background

The questions in this study guide are designed to be difficult and help you identify knowledge gaps that warrant further study. By request, this study guide is compiled to help you prepare for final exams. Instruction during the final week of lecture may or may not cover sections of this packet. Please use this as you see fit. We hope this helps you prepare for your CSCI 1300 final exam and future studies. This packet does its best to cover all topics of the course, but is not exhaustive. Supplement with additional material as you see fit.

We strongly recommend reviewing the following sections of your textbook "Brief C++ Late Objects" - Cay Horstmann, including the embedded "Self Check"s:

- Chapter 1 subsections: 2 - 4
- Chapter 2 subsections: 1 - 3, 5
- Chapter 3 subsections: 1 - 7
- Chapter 4 subsections: 1 - 3, 5, 6, 8 - 10
- Chapter 5 subsections: 1 - 10
- Chapter 6 subsections: 1 - 7
- Chapter 7 subsections: 3, 7
- Chapter 8 subsections: 1 - 4
- Chapter 9 subsections: 1 - 6, 9, 11

Some solutions will be provided in a solution document.

If you cannot think of a problem worth solving in the self-study section: ask a peer, ask a member of the course staff (in office hours or on EdStem), ask an AI that you trust.

In general, you should think about the following tasks for any given self-study.

1. Write out what you know about the topic. Identify what is tricky about this topic.
2. Define a problem to solve: draw a cartoon of the problem, define some expected input and result, confirm that the defined problem will address whatever is tricky about the topic.
3. After you have completed the work on paper, validate your work using your preferred coding environment. Prioritize paper studies first.
4. Decide if you need to study this further and construct additional study materials.

2 Compilation

1. Compilation
   (a) What is the shortest command used to compile a file named `driver.cpp`?

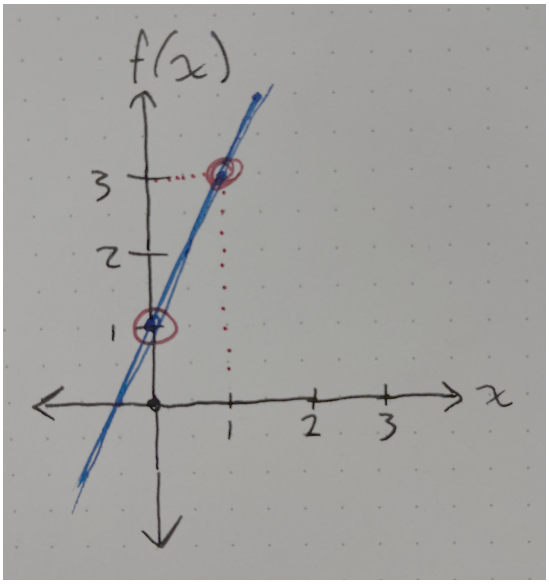
   (b) What if `driver.cpp` has the line `#include "className.h"`, following best practices for naming conventions, how do you correctly compile the driver file?

   (c) What flags should you also consider using? What is the purpose of each compilation flag?

   (d) Given that you have compiled the code, how do you execute the code from the command line?

2. Essentials:: For each of the following topics, in your own words: (1) define the principles of the topic (2) give one example of the topic (3) identify and explain any important nuances about the topic (4) decide for yourself if you need to study this particular topic further and seek resources for it (textbook, workbook, lecture documents, lecture videos, peers, EdStem, course staff, youtube, the open internet, and more). Use additional paper as needed.
   (a) essential types and their operations: bool, short, int, float, double, char, string
   (b) conditions (if/else-if/else) and switches
   (c) functions (pass-by-value vs pass-by-reference)
   (d) loops
   (e) arrays
   (f) streams (input vs output) (`getline` vs `>>`)
   (g) structs/instances
   (h) classes/objects
   (i) vectors
   (j) sorting
   (k) recursion

3. Writing Functions: Warm Up:: The questions on this page ask about the image provided (a function in graph form):



(a) What is the expected value of `f( 0 )`?

(b) What is the expected value of `f(f( 0 ))`?

(c) Is `f(f( 0 ))` a recursive call?

(d) What is the best representative type for `x` and `f(x)` if we wanted to write code about this?

(e) Author code for the pictured function. Use a function with a reasonable name and parameters as needed. Do not use `cin`:

(f) What library is used for testing? How do we include it in our code?

(g) Author assertions for `f( 0 )` and `f(f( 0 ))`

(h) Now that you've done this on paper, go check your work in a coding environment of your choosing.

4. Reading Functions: guided:: The questions on this page ask about the recursive `g` function defined below:

```
string g( string x )
{
    string y = "";
    switch ( x.length( ) % 3 ) {
    case 0:
        y += "Alpha";
        break;
    case 1:
        y += "Bravo";
        break;
    case 2:
        y += "Charlie";
        y = "break";
    case 3:
        y += "Delta";
    default:
        y = "Echo" + y;
    }
    return y;
}
```

(a) What is the value of `g( "" )` ?

(b) What is a good test for `g( "" )` ?

(c) What is a good test for `g( "3" )` ?

(d) What is a good test for `g( "ab" )` ?

(e) What is a good test for `g( "san" )` ?

(f) What are valid argument values for `x` that would get `g` to return the string `"EchoDelta"`? Describe the requirements of `x` in words.

5. Reading Functions: guided:: The questions on this page ask about the recursive `foo` function defined below:

```
string foo( string x ) {
    string result = "";
    if ( x != "" ) {
        istringstream y( x );
        string z, remaining;
        getline( y, z, ':' );
        getline( y, remaining );
        if ( z.length() % 2 == 0 ) {
            result = z + ">" + foo( remaining );
        } else {
            result = foo( remaining );
        }
    }
    return result;
}
```

(a) What is the base case of the `foo` function? What is a good test for this function call?

(b) What is expected result of `foo( "hi:there:sup:dude" )`?

(c) What is expected result of `foo( ":1:23" )`?

(d) In your own words, describe the goal of the `foo` function. This is looking for you to define your own understanding and is not looking for an exact answer.

(e) Write down notes about `getline` (shown above) vs `>>` (not shown).

6. Reading helper functions and writing functions: self-study Use the provided `isOdd` function to solve a more interesting problem of your own choosing. (hint provided at top of next page)

```
bool isOdd( int y ) {
    if ( y == 0 ) return false;
    // ask yourself if the ‘else‘ is necessary here
    else if ( y == 1 || y == -1 ) return true;
    if ( y > 0 ) return isOdd( y - 2 );
    return isOdd( y + 2 );
}
```

Ideas for approach:

(a) Describe the task that could call `isOdd`

(b) Define the task well and draw pictures of expected inputs and outputs

(c) write the a function to solve your task. Be sure to call `isOdd` in your function.

(d) now that you have completed this on paper, validate it in VSCode. Debug on paper as needed.

(a)

(c)

(b)

.

HINT FOR PREVIOUS PAGE: try appending a "." to strings that are odd length, try counting the number of odd values in an array (available in solutions code), try removing all odd values from a vector, try it with a loop, try it with recursion, try it with a vector of structs that have ints rather than just a vector of int (available in solutions code).

7. writing functions: self-study Use this page to work through a function (or collection of functions) of your own design. If you can't think of a problem worth solving with a function, ask a peer, ask a member of the course staff (in office hours or on EdStem), ask an AI that you trust. Consider the same kind of "ideas for approach" that are described on the previous page.

8. (static) arrays[ ]: guided:: The following questions rely on the provided code

```
void prependDont( string x[][2], unsigned int len ) {
    for ( unsigned int i = 0 ; i < len ; i++ ) {
        x[i][1] = x[i][0];
        x[i][0] = "Don't";
    }
}
void printMat( string x[][2], unsigned int len ) {
    for ( unsigned int row = 0 ; row < len ; row++ ) {
        for ( unsigned int col = 0 ; col < 2 ; col++ ) {
            if ( col != 0 ) { cout << " "; }
            cout << x[row][col];
        }
        cout << endl;
}   }
int main() {
    string mat[4][2] =  {
        { "stop", "overthinking" },
        { "think" }, { "procrastinate" }, { "give up" }
    };
    // YOUR CODE HERE
}
```

(a) What is the value of `mat[0][1][2]` for the `mat` defined in `main`?

(b) What does `prependDont` function do?

(c) What does the `printMat` function do?

(d) What do you need to write in `// YOUR CODE HERE` to produce the following result using both of the functions provided? (yes, it's a silly thing to do, but it is something you have the skills for)

```
Don't stop
think
```

9. (static) arrays[ ]: self study:: Construct your own problem and seek resources as needed. **Try to do something where the length matters and the use of pass-by-reference matters**

10. Vectors: guided:: This page explores the problem of removing every even indexed element from vector of structs through a function named `rmEvenIndices`. An example is given below.

```
struct Hand {
    int value;
    string details;
};
vector<Hand> table;
table.push_back( { 11, "double down" } );
table.push_back( { 17, "troublesome hand" } );
table.push_back( { 21, "blackjack" } );
table = rmEvenIndices( table ); // index 0 and index 2 removed
// remaining: { 17, "troublesome hand" }
```

(a) What are two or three good tests that you can write for the final `table` after `rmEvenIndices` is called shown above in a comment?

(b) Which of the following vector methods are likely helpful in solving `rmEvenIndices`: at, `begin`, `back`, `pop_back`, `push_back`, `insert`, and `erase`? Why? (not looking for exact answer, just getting out ideas.)

(c) Implement `rmEvenIndices`. Start with the function singature, move to psuedo-code and finally write a working function. It can be recursive, it can use as many or as few of the methods described. Aim for something that is easy to read.

11. Vectors: self study:: Construct your own problem and seek resources as needed. **to optimize study, find a problem that uses the methods not used in the previous problem.**

12. Streams: warm up::

(a) Describe the difference between and input stream and output stream.

(b) Describe the difference between the following:

- `x >> y`
- `getline( x, y )`
- `getline( x, y, z )`

(c) Let there be an input stream named `x` with the following data:

```
hello   my name is
Gregor
and more stuff is here
```

We run the following code:

```
string y0, y1, y2;
x >> y0; // y0 is "hello"
// CHANGE CODE
getline( x, y1, 'g' );  // y1 is "   my name is<NEW_LINE>Gre
getline( x, y2 );  // y2 is "or"
```

State in your own words why each of the following are true

- `y0` does not have a space at the end.
- `y1` has a three spaces at the beginning. (followup: what could you write in "CHANGE CODE" to remove that whitespace?)
- `y1` includes a newline in the middle of it
- `y1` doesn't end with the letter 'g'.
- `y2` doesn't begin with the letter 'g'.
- `y2` doesn't end with a newline.

(d) What is different about opening an `ifstream` vs an `ofstream`?

(e) Why is it important to close a file stream?

13. Streams: self study:: Construct your own problem and seek resources as needed.**NOTE: streams covered this semester include `iostream`, `fstream`, and `sstream`. Note the provided array problem tests `getline`, consider writing a problem that works with input and output streams and uses `>>` instead of `getline`.**
(hint provided at top of next page)

HINT FOR PREVIOUS PAGE Write a function, given two file names as strings, read data from the first file, write the data to the second file, but remove all lines which begin with the phrase "`COMMENT :`". Do not change the first file. Use best practices to open and close files.

14. Structs/Instances: warm up
    (a) Following best-practice in C++, should a `struct` contain member functions?

    (b) Following best-practice in C++, should a `struct` contain "private" data?

    (c) When passing a struct to a function, does it default to pass-by-value or pass-by-reference?

    (d) When passing an array of structs to a function, does it default to pass-by-value or pass-by-reference? Why?

    (e) When passing a struct to a function that contains an array as a data member, does it default to pass-by-value or pass-by-reference? Why?

    (f) Consider a struct that has an array as a data member accessed `instance.array`, when calling a function with argument `instance.array`, does it default to pass-by-value or pass-by-reference? Why?

    (g) When passing an array of structs to a function that contains an array as a data member, does it default to pass-by-value or pass-by-reference? Why?

15. Structs/Instances: self study:: Construct your own problem and seek resources as needed.

16. Classes/Objects: guided:: let us play a game with friends. Before reading further decide on who will be the "game lead(s)" and "adventurer(s)" (need at least one of each). Now, only the game lead(s) should read further....

    1. Opening dialog read by the game lead(s): "In the heart of the arcane sanctum, a series of ancient number glyphs lie etched into stone boxes, each pulsing faintly with enchanted light. A mysterious spell binds them—an enchantment I know well, yet am bound by oath and magic to speak nothing of its nature.
    Your quest is thus: brave the puzzle, unravel the pattern, and uncover the hidden magic woven within. Only through trial and cunning can you pierce the veil and reveal the secret of the spell. Will you accept this challenge, adventurer?" (credit ChatGPT)
    2. Explain to the adventurer(s) their available moves:
        (a) "explore a new glyph"
        (b) "view the glyph"
        (c) "apply pressure to the the glyph `<quantify with a number>`"
        (d) "reduce pressure to the the glyph `<quantify with a number>`"
        (e) attempt to describe the magic spell
    3. Don't share the following information with the adventurer(s). The game lead(s) available moves are as follows:
        (a) if the adventurer wishes to explore a new glyph, ignore all known number boxes, call the default constructor to make a new object to observe.
        (b) if the adventurer wishes to view the glyph, you must tell them the current number.
        (c) if the adventurer applies pressure to the glyph, you must call the setter with a positive number and apply the rules of the `_magic` function. Tell the player when you are ready to continue, but do not tell them the value of the glyph or show them any of your math.
        (d) if the adventurer reduces pressure to the glyph, you must call the setter with a negative number...
        (e) if the adventurer describes the magic spell incorrectly, you must tell them to keep playing the game. **Add any lore you wish.**
        (f) if the adventurer describes the magic spell correctly, make up your own ending for the game.
    4. all code is on the next page for the game lead(s) to use to facilitate the game.
    5. after the game ends, review the code together. Review topics like **default vs parameterized constructors**, **data members (attributes) vs member functions (methods)**, **public vs private (access modifiers)**, **getters vs setters**, **class vs object**, the differences in application and best practices between **struct vs class**. Write a **parameterized constructor** for the `NumBox` class that sets the value and calls the private `_magic` function.

```
class NumBox {
public:
    NumBox();
    float getValue( );
    void setValue( float value );
private:
    float _value;
    unsigned short _accessCount;
    void _magic( );
};
NumBox::NumBox() {
    _accessCount = 0;
    _value = 0;
}
float NumBox::getValue( ) {
    _accessCount++;
    return _value;
}
void NumBox::setValue( float value ) {
    _accessCount++;
    _value = value;
    _magic();
    return;
}
void NumBox::_magic( ) {
    int i = _value;
    if ( i % 2 == 1 ) _value = i - 1;
    // ADVANCED PLAY ONLY:
    // if ( i % 2 == 1 ) _value = _accessCount - 1;
    else _value = i;
    _value += 0.5;
}
// // >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
// ADVANCED PLAY ONLY: add this public member function.
// unsigned short NumBox::getAccessCount( ) {
//     // return _accessCount++;  // kind of advance post-increment...
//     unsigned short res = _accessCount;
//     _accessCount++;
//     return res;
// }  // <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
```

17. Classes/Objects: self study:: Construct your own problem and seek resources as needed. **NOTE: vectors and their member functions are great example of a well defined class. The `vector` class defines a series of member functions for you to use to access complex memory without having to worry about how the memory is handled**

18. nesting concepts: warmup
    (a) What data types default pass-by-reference?

    (b) What data types default pass-by-value?

    (c) What data types use dot-notation? Give an example.

    (d) What data types use bracket-notation? Give an example.

    (e) Following C++ best practice, how do you access data from a struct instance? Give an example.

    (f) Following C++ best practice, how do you access data from a object? Give an example.

19. Nesting concepts: self study:: Construct your own problem and seek resources as needed. **NOTE: any of the self-studies earlier in this packet are great candidates to practice nesting. A pinnacle problem to solve may involved a class that encapsulates a vector of 2-D arrays of structs that include strings resulting in accesses requirements like:**

    ```
    o.getVector().at( 0 )[ 1 ][ 2 ].stringMember[ 3 ];
    ```

    You could also consider having streams instead of strings at the final layer like:

    ```
    getline( o.getVector().at( 0 )[ 1 ][ 2 ].streamMember, someString, ':'  );
    ```

    Then consider different orderings of this nesting and various functions to deal with pass-by-reference vs pass-by-value behavior. Throw in a class for good measure.

    RECALL: The questions in this study guide are designed to be difficult and help you identify knowledge gaps that warrant further study.