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CSCE 240: Advanced Programming Techniques
Lecture 19: Advanced Pointers, Input/ Output

PROF. BIPLAV SRIVASTAVA, AI INSTITUTE

21ST MARCH 2023

Carolinian Creed: "I will practice personal and academic integrity."

Credits: Some material reused with permission of Dr. Jeremy Lewis. Others used as cited with thanks.

Organization of Lecture 19

- Introduction Section
  - Recap of Lecture 18
  - Class Pulse Survey
- Main Section
  - Concept: Pointer arrays
  - Concept: Function Pointers
  - Concept: Buffering
  - Task: Project – PA #4 ongoing – check on issues
- Concluding Section
  - About next lecture – Lecture 20
  - Ask me anything

Introduction Section

Recap of Lecture 18

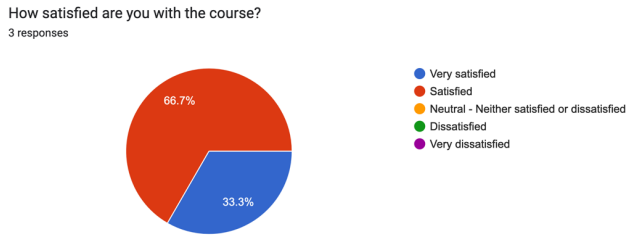
- We reviewed HW 5
- We looked at pointers
  - Pointers and references
  - Pointer arrays
  - Pointer based swapping of numbers and user-defined types
- Checked on PA 4, due on Thursday (March 23, 2023)

Course Mid-Point Pulse Survey

a) Do you like the pace of the course ? - **Y**

b) Do you like the content on which the course is focusing? - **Y**

c) Should the number of HWs be reduced? - **N**



d) What more topic(s) will you like to be covered? - [Open ended]

Pointers, multi-threading, [and additionally - AI and ML]

e) Want changed? Any other feedback? - [Open ended]

HWs on Thurs/review on Tues (more time), grading of HW, somewhat more focus on coding,

"I like the class", "This course is structured well, I feel like I am learning concepts while working towards a larger goal."

Participation: 50%

Actions on Survey

- Course process
  - HW6 will be on a Thursday
- Material changes
  - One lecture on AI/ML
  - Class-appropriate new material on multi-threading

Main Section

Concept: Pointers – Advanced (Contd.)

Function Pointers

- Functions can be treated as data
  - Passed using pointers
  - Selected dynamically and iterated
- Example
  - **int** (*f_ptr)(**int**, **int**); // declaring a function variable
  - f_ptr = &add; // assigning a value, i.e., function – add here - which matches the function signature
    // i.e., arguments and return type
  - f_ptr(a, b) // invoking the function

Function Arrays

- Group of functions can be manipulated in an array

- Example
  - **int** (*f[3])(**int**, **int**); // Declaring variable

  - f[0] = &add; // Assigning
  - f[1] = &multiply; // Assigning
  - f[2] = &subtract; // Assigning

  - f[i](a, b) // Invoking

Review: Pointers and Examples

- int *a; // a is a pointer to int
- int **a; // a is a pointer to a pointer to a
- int *a[10]; // a is an array of size 10 of pointer to integers
- int (*a)[10]; // a is a pointer to an array of size 10 to integers
- char *(*fp)(int, float *); // fp is a pointer to a function, passing an integer and a pointer to a float,
  // returning a pointer to a char

Code: https://github.com/biplav-s/course-adv-proglang/blob/main/sample-code/CandC%2B%2B/Class17and18_TestingAdvPointers/src/Class17and18_TestingAdvPointers.cpp
Arguments: 1 through 6

Practical Advice: http://c-faq.com/decl/spiral.anderson.html

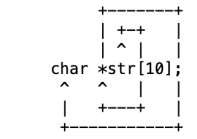
Tip for Deciphering Pointer Statements

There are three simple steps to follow:

Starting with the unknown element, move in a spiral/clockwise direction; when ecountering the following elements replace them with the corresponding english statements:

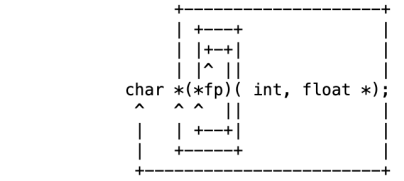
1. [X] or [] => Array X size of... or Array undefined size of... (type1, type2) => function passing type1 and type2 returning... * => pointer(s) to...
2. Keep doing this in a spiral/clockwise direction until all tokens have been covered.
3. Always resolve anything in parenthesis first!

Example #1: Simple declaration



``str is an array 10 of pointers to char''

Example #2: Pointer to Function declaration



``fp is a pointer to a function passing an int and a pointer to float returning a pointer to a char''

Credit - Practical Advice: http://c-faq.com/decl/spiral.anderson.html

Further Exploration

- Tutorials
  - https://www.cplusplus.com/doc/tutorial/pointers/
  - https://www.cprogramming.com/tutorial/function-pointers.html

- Books
  - The Annotated C++ manual, https://www.stroustrup.com/arm.html
  - The C++ Programming Language (4th Edition), Addison-Wesley ISBN 978-0321563842. May 2013, https://www.stroustrup.com/C++.html
  - Fundamentals of C++ Programming , by Richard L. Halterman https://archive.org/details/2018FundamentalsOfCppProgramming/page/n333/mode/2up

Concept: Adv. I/O - Buffering

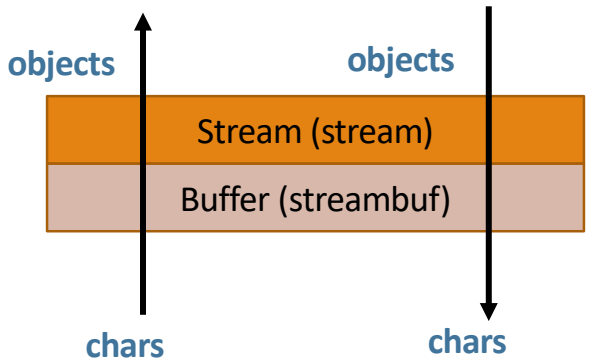
I/O and Memory Organization

- Computer has access to both memory (temporary storage) and disk (permanent storage)
- Properties
  - Faster to write data to memory than to disk.
  - Faster to write one block of N bytes to disk in a single operation than it is to write N bytes of data one byte at a time using N operations

Credit: Fundamentals of Programming C++, Richard L. Halterman

Why Buffer Input or Output

- Improve performance by leveraging characteristics of memory
  - Better to allocate / free memory in storage-appropriate blocks rather than what programmer wants
  - Do it while providing convenient abstraction



- Developer has to be aware of
  - buffer size // impacts I/O performance or memory usage
  - Initial and last values // In case last chunk is less than buffer size
  - Clearing off of the buffer // Affects what is read/ written at the end; flush the values
- Buffered reading/ writing supported in most languages

Code Examples

- Buffering in C style
- Buffering in C++, with streams

Code: https://github.com/biplav-s/course-adv-proglang/blob/main/sample-code/CandC%2B%2B/Class19To22_AdvTopics/src/Class19To22_AdvTopics.cpp
Arguments: 0 through 3

Discussion: Course Project

Course Project – Building and Assembling of Prog. Assignments in Health

- **Project**: Develop collaborative assistants (chatbots) that offer useful information about diseases
- Specifically, use the CDC dataset on diseases at: https://wwwnc.cdc.gov/travel/diseases
  - For polio, it is: https://wwwnc.cdc.gov/travel/diseases/poliomyelitis
  - Each student will choose two diseases (from 47 available).
  - Each student will also use data about the disease from WebMD. Example for polio - https://www.webmd.com/children/what-is-polio
  - Programming assignment programs will: (1) extract data about a disease from two sites, (2) process it, (3) make content available in a command-line interface, (4) handle any user query and (5) report on interaction statistics.
- *Other sources for disease information are possible. Example – NIH https://www.ninds.nih.gov/health-information/disorders*

Core Programs Needed for Project

- Prog 1: extract data from the district **[prog1-extractor]**
- Prog 2: process it (extracted data) based on questions **[prog2processor]**
- Prog 3: make content available in a command-line interface **[prog3-ui]**
- **Prog 4: handle any user query [prog4-userintent2querymapper]**
- Prog 5: report statistics on interaction of a session, across session

Objective in Programming Assignment # 4:
Remove Requirement on User to Know Supported Queries!

- Until now, use needed to know what the program supports.
- **Can the system adapt rather than ask the user to adapt ?**

- **Approach Suggested**
  - Take user's utterance
  - Match to the closest supported query (I1-I12 + 2 more) and a confidence estimate
  - If confidence greater than a threshold
    - Run the query,
  - Otherwise
    - Ask user to re-phrase and ask again

- Program should do the following:
  - Run in an infinite loop until the user wants to quit
  - Handle any user response
    - **[#1]** User can quit by typing "Quit" or "quit" or just "q"
    - User can enter any other text and the program has to handle it. The program should write back what the user entered and say – "I do not know this information".
  - Handle known user query
    - "Tell me about the disease", "What is ***malaria***?" => (Type-I1)
    - "What can I do after travel?" => (Type-I4)
    - "what is the treatment? " => (Type-I10)
    - "Tell me about ***malaria*** vaccine" => (Type-12)
    - …
    - "**Tell me everything**" => ***Give all information extracted***

14 intents: I1 to I12, tell everything and quit

Programming Assignment # 4

- Goal: **make an utterance to query** [Name: **prog4-userintent2querymapper**]

- Program may do the following – pseudo-code
  - Run in an infinite loop until the user wants to quit
  - Get a user utterance. We will call it u
  - See if u matches to supported queries in Q **// 14 until now**
    - Split u into words
    - For each information type – supported query q - in Q
      - Split q into words - w
      - Check how many words of u and w match **// one can also consider partial match**
      - Compute a percentage of match
    - q_i: let this be the query with the highest match percentage
    - If q_i > 0.7 **// 0.7: parameter**
      - Consider it to be the query. Inform user and execute; give information (result)
    - Else
      - Tell user cannot understand u. Example: rephrase and try again.

Programming Assignment # 4

- Code organization
  - Create a folder in your GitHub called "**prog4-userintent2querymapper**"
  - Have sub-folders: src (or code), data, doc, test
  - Write a 1-page report in ./doc sub-folder
  - Put a log of system interacting in ./test
  - Send a confirmation that code is done by updating Google sheet; optionally, send email to instructor

- Use concepts learned in class
  - Exceptions

Concluding Section

Lecture 19: Concluding Comments

- We looked at class survey results and made some changes
- We looked at function pointers and function arrays
- Re-looked at I/O and discussed buffering
- Checked on PA4, due on Thursday (March 24, 2022)

About Next Lecture – Lecture 20

Lecture 20: Advanced: Operator Overloading

- Adv I/O
  - Buffered writing
- Adv: operator overloading
- Prog 4 ends

	Mar 7 (Tu)		Spring break – No class
	Mar 9 (Th)		Spring break – No class
17	Mar 14 (Tu)	Testing strategies	Prog 4 - start
18	Mar 16 (Th)	Advanced: Pointers	HW 5 due
19	Mar 21 (Tu)	Advanced: Pointers, I/O	
20	Mar 23 (Th)	Advanced: Operator overloading	Prog 4 - end
21	Mar 28 (Tu)	Advanced: Memory Management	Prog 5 - start