CSCE 240: Advanced Programming Techniques

Lecture 20: Advanced Input/ Output, Operators, HW5 Given

PROF. BIPLAV SRIVASTAVA, AI INSTITUTE

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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 20

- Introduction Section
  - Recap of Lecture 19
- Main Section
  - Concept: Buffering continued
  - Concept: Operator overloading
  - Task: Project – PA #4 due
  - HW5 given
- Concluding Section
  - About next lecture – Lecture 21
  - Ask me anything

Introduction Section

Recap of Lecture 19

- We looked at function pointers and function arrays
- We looked at testing strategies and considerations in a small problem - FN
- Reviewed PA4

Announcements

- Course in Fall 2024

CSCE 581 - Trusted Artificial Intelligence (3 Credits)
AI Trust – responsible/ethical technology, fairness/ lack of bias, explanations (XAI), machine learning, reasoning, software testing, data quality and provenance, tools and projects.

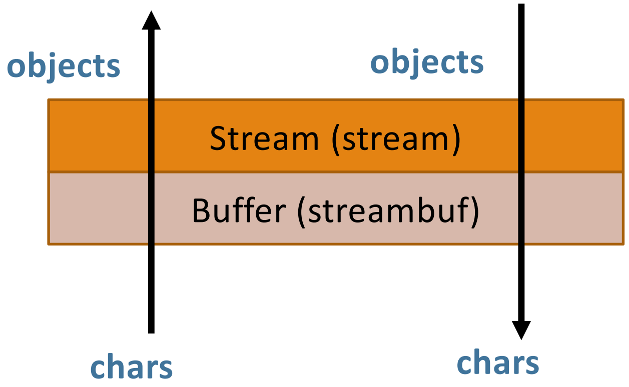
Prerequisites: C or better in CSCE 240 and CSCE 350
Prerequisite or Corequisite: D or better in CSCE 330

Main Section

Concept: Adv. I/O – Buffering (Continued)

Why Buffer Input or Output

- 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



- 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

Operations on Stream

- Position
  - **get**: position of the next character to be fetched into the sequence (extraction)
  - **put**: position of the next character to be deposited into the sequence (insertion)
- Operations
  - **seek**: move pointer with a given offset
  - **tell**: inform about the position of pointer

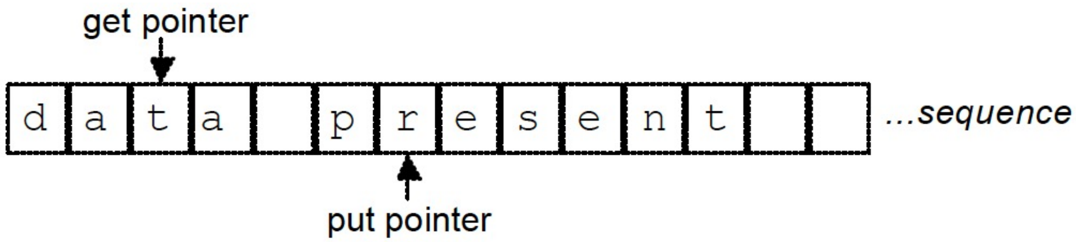


Image credit: C++ Essentials, Sharam Hekmat

Code Examples

- Steam write operations (option – 4)
- Reading and writing
  - with no buffering (option – 5)
  - with buffer size same as file length; extremely memory efficient (option – 6)

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

Discussion on Streams and Buffers

- Streams give a very convenient interface over I/O
  - Hides details of the physical systems (disks, displays, printer, string, web-connected resource)
  - But performance can be a challenge
- Buffers give a way to manage performance
  - Relies on differential speeds of access of I/O devices
  - Design issues about size of buffers, practical issues of initialization of content, flushing content (write situation)

In-Class Programming

- Implement time and benchmark file reading for data from different companies (e.g., your two from project)
- What can you do to speed up reading?
- What about writing?

```
int main ()

auto start = std::chrono::steady_clock::now();  // measures start time
// .....   // core processing


auto  end = std::chrono::steady_clock::now(); // measures end time

 // prints result


 // prints time elapsed
```

Concept: Operator Overloading

Operator Overloading – What

- Overloading happens when we have multiple functions of the same name
  - Functions distinguished by signature, i.e., parameters and return types
  - Constructors are the common form of overloaded functions

- Operator overloading
  - When operators are overloaded
  - Examples: <<, >>, [], +, - , …

Operator Overloading - Why

- Commonly used with user defined types / classes
- Provide convenience to user, improve usability
- Avoid meaningless / error-prone behavior, especially when operator behavior is inherited due to class hierarchy

Example 1 – Strings

- Suppose you are working with text. Can be in any human language.
  - You want to refer to strings and their relationships to each other
  - **Example**: combining two strings
- String representation:
  - Array of characters
- Operation
  - +, -, …

Example 2 – Point and Operations

- Suppose you are working in Geometry. Can be in any dimension.
  - You want to refer to points and their relationships with each other
  - **Example**: a point that is twice away from another point, with respect to a reference
- Point representation: 2-D: Cartesian Geometry
  - (x, y)
  - (angle, distance)
- Operation
  - +, -

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

Argument: 7

Class Exercise – 10 Mins

- Implement operators
  - * with a Point argument: multiples x and y of two points (self and argument) respectively, respectively
  - ^ with an int argument: raises x to-the-power of the passed point argument, i.e., y

Home Work 5

Due Tuesday, March 26, 2024

Home Work (#5) – C++ - Background

- A *factorial* is a function that multiplies a number by every number below it. For a number N, it is denoted N!
  - Example: 4! = 4 x 3 x 2 x 1 = 24
- Factorial notation is used in many problems dealing with permutations and combinations
- Note:
  - 0! = 1
  - 1! = 1

- *Combination*: Number of ways **r** items can be selected from a set of size **n** where the order of picking does not matter
  - Example: Handshakes between 6 people = $C^{6}{}_{2}$
  - = (6!) / (2! * 4!) = (6 * 5 * 4!) / (2! * 4!) = 15
- Note:
  - r is smaller than n

$$_nC_r = \frac{n!}{r!(n-r)!}$$

Credit: https://en.wikipedia.org/wiki/Combination

Home Work (#5) – C++ - Requirement

- So, write a program named: ***FactorialFun***
- It will support inputs/ arguments in three formats:
  - N: number // to find factorial of N
  - N: number, r: number // to find C^N_r
  - N: number, r: number, “compare” // to find N! and C^N_r and tell which computation is faster.
- Output:
  - Value // computed value
  - Time taken // time for processing

    OR
  - Comparison report in the format on right
- **Variants**
  - Have numeric (int) arguments
  - Stretch
    - Have string arguments
    - Have a combination

Example invocation

```
>  FactorialFun 4
24
Time for processing: 0.023 seconds


>  FactorialFun 6 2
15
Time for processing: 0.0034 seconds

>  FactorialFun 6 2 compare
6! is 240, took : 0.0034 seconds
C^6_2 is 15, took : 0.0043 seconds
Time for processing C^6_2 is more.
```

Home Work (#5) – C++ - Code Design

- Create test cases, i.e., input/ output pairs, to test for boundary conditions
- Use exception to handle likely errors – user may give any input

Discussion: Course Project

Course Project – Knowing About Companies

- **Project**: Develop collaborative assistants (chatbots) that offer useful information about companies
- Specifically, use the EDGAR dataset on companies at: https://www.sec.gov/edgar/searchedgar/companysearch.
  - For Apple, it is: https://www.sec.gov/edgar/browse/?CIK=320193&owner=exclude
- **Each student will choose two companies (from thousand available).**
- Programming assignment programs will: (1) extract data about two companies from 10-k, (2) process it, (3) make content available in a command-line interface, (4) handle any user query and (5) report on interaction statistics.

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
  - Understand query and company of interest
  - Match to the closest supported query
    - ***Intents***: [Parts and Items] **+ 3 more**
    - Also, add a confidence estimate
  - If confidence greater than a threshold and if the company is supported
    - 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 ***IBM***” or “What are the risk factor for ***IBM***?” => (Part 1), or (Part 1: Item 2), accordingly
    - “What markets does ***IBM*** operate in?”, “Are there aby disclosures from ***IBM***?” => (Part 2)
    - “who are the directors? ” => (Part 3: Item ..) // assume company, or tell of all companies, or ask …
    - “Tell me about ***IBM’s*** statements” => (Part 4)
    - …
    - “**Tell me everything**” => ***Give all information extracted***

Intents: [Parts and intents] +
tell everything, chitchat and quit

Content Reference: Queries for (Answers) Data We Have

- What does the (company) do? // Answers in Part 1
  - What is the (company's) business?
  - What are (company's) risk factors?
  - What does (company) own?
  - …
- Where does (company) operate? // Answers in Part 2
  - What has (company) disclosed?
- How is (company) structured? // Answers in Part 3
  - Who is (company's) CEO?
  - How much does (person) earn?
  - …
- What was in (company) statements? // Answers in Part 4
  - …

Concepts: 10-K, Parts, Items

Parts

- Part 1: Business Background and Risks
  - Item 1: Business
  - Item 2: Risk factors
  - Item 3: Properties
  - Item 4: Legal Proceedings
- Part 2: Operations and Disclosures
  - .. Market
  - .. Disclosures
- Part 3: Company Structure
  - Directors
  - Compensation
- Part 4: Financial Statements
  - Statements

Hint: Programming Assignment # 4

- Goal: **make an utterance to intent query mapper [**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 intents in Q **// 3 + financial doc info type**
    - 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
  - Classes
  - Exceptions
  - UML Diagrams

Concluding Section

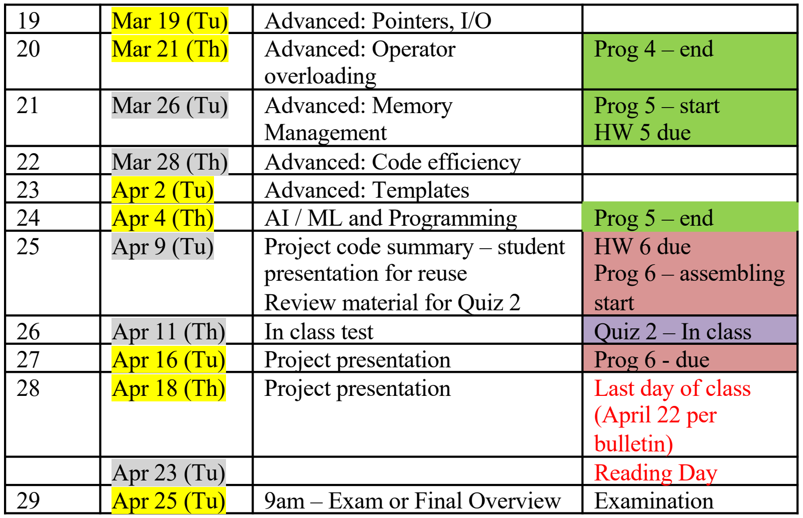
Lecture 20: Concluding Comments

- We looked at buffering for inputs and outputs
- We looked at operator overloading
- Both useful across OO programming languages
- PA4 due

About Next Lecture – Lecture 21

Lecture 21: Advanced: Memory Mgmt

- Fixed memory
  - Vectors
  - Arrays
- Dynamic memory
  - List
  - User defined types
- Freeing memory
- HW 5 due
- PA 5 starts



19	Mar 19 (Tu)	Advanced: Pointers, I/O	
20	Mar 21 (Th)	Advanced: Operator overloading	Prog 4 – end
21	Mar 26 (Tu)	Advanced: Memory Management	Prog 5 – start HW 5 due
22	Mar 28 (Th)	Advanced: Code efficiency	
23	Apr 2 (Tu)	Advanced: Templates	
24	Apr 4 (Th)	AI / ML and Programming	Prog 5 – end
25	Apr 9 (Tu)	Project code summary – student presentation for reuse Review material for Quiz 2	HW 6 due Prog 6 – assembling start
26	Apr 11 (Th)	In class test	Quiz 2 – In class
27	Apr 16 (Tu)	Project presentation	Prog 6 - due
28	Apr 18 (Th)	Project presentation	Last day of class (April 22 per bulletin)
	Apr 23 (Tu)		Reading Day
29	Apr 25 (Tu)	9am – Exam or Final Overview	Examination