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CSCE 240: Advanced Programming Techniques
Lecture 9: Object Oriented Concepts - Inheritance

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8TH FEBRUARY 2022

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 9

- Introduction Section
  - Recap of Lecture 8
  - TA and SI Updates
- Main Section
  - Concept: Inheritance
  - Discussion: Home work #3 – due in Class 10
  - Discussion: Prog. Assignment #2 and Project discussion
- Concluding Section
  - About next lecture – Lecture 10
  - Ask me anything

Introduction Section

Recap of Lecture 8

- We relooked at relationships between classes
- We discussed code organization – header and implementation files, when to separate
- We discussed programming assignment (PA) #1 due that day

About Programming Languages in Course

- C++ is the main language for the course.
  - Used to demonstrate concepts and expect everyone to know it at the level that they can do peer evaluation and testing of each other's code in **home assignments**.
  - **For projects and programming assignments**, students have option to code in Java or Python as well.
- Cross-language understanding of concepts
  - Code in multiple languages is sometimes shown to demonstrate generality of concepts and specific peculiarities in implementation
  - UML diagrams will used to conveyed cross-language concepts as well

In quizzes,

- **Questions will be about concepts, pseudo-code and UML diagram**.
- C++ code fragments may be shown or asked to be written, but they do not have to be running code. The quizzes will be in class and can be done on paper or a text editor like Google doc.

Updates from TA, SU

- TA update: Yuxiang Sun (Cherry)
- SI update: Blake Seekings

Main Section

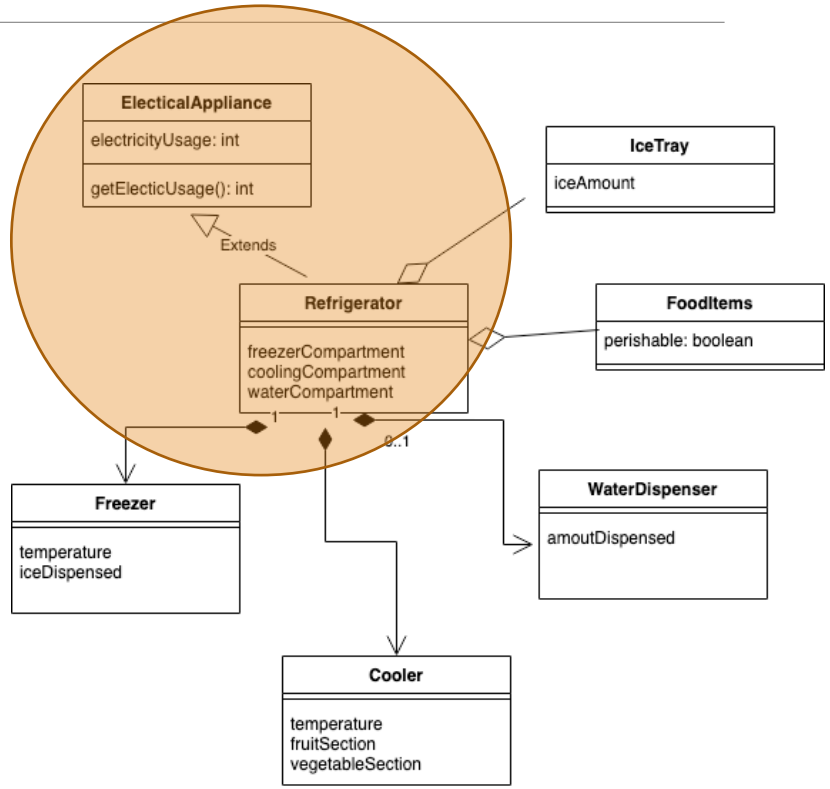
Concept: Inheritance

What is Inheritance ?

- A class “inheriting” or reusing **characteristics** from another, existing class
- Synonyms: subclassing, specialization, derived
- Analogy: child inheriting from a parent
  - “Course-CSCE-240” sub-class of “Course-Undergraduate”
  - “USA” specialization of “Country”
- What are characteristics
  - Data members
    - Enrollment, timing, syllabus: course domain
    - Capital, head-of-state, currency: country domain
  - Functions manipulating the data members

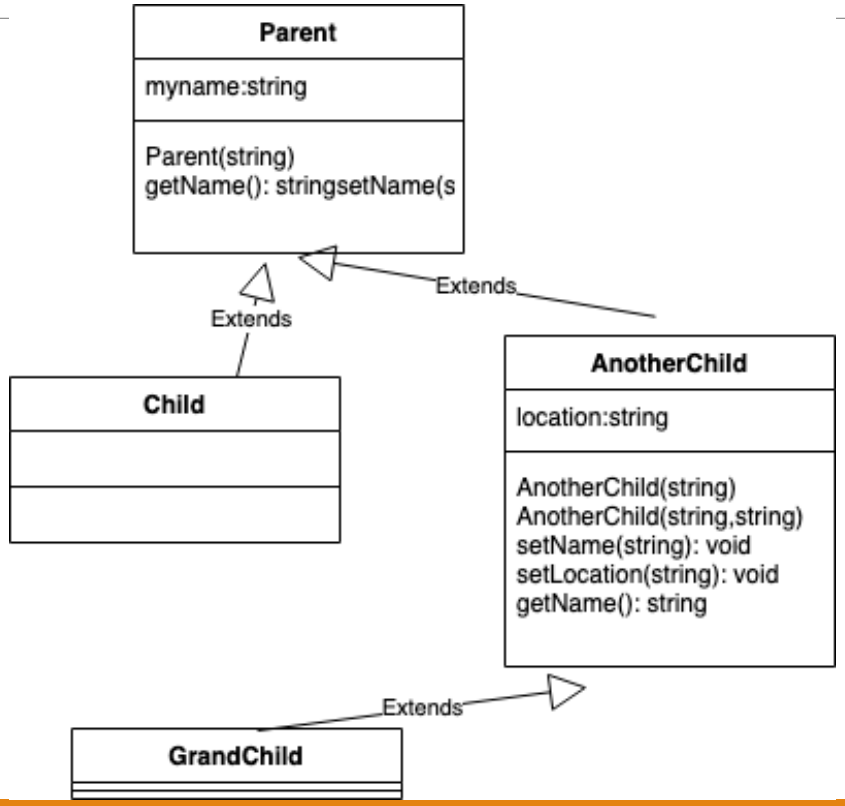
Why Use Inheritance ?

- Promote reuse
- Make code understandable, improve maintainability
- Promote security and data integrity
- Improve testing
- Improve code development productivity



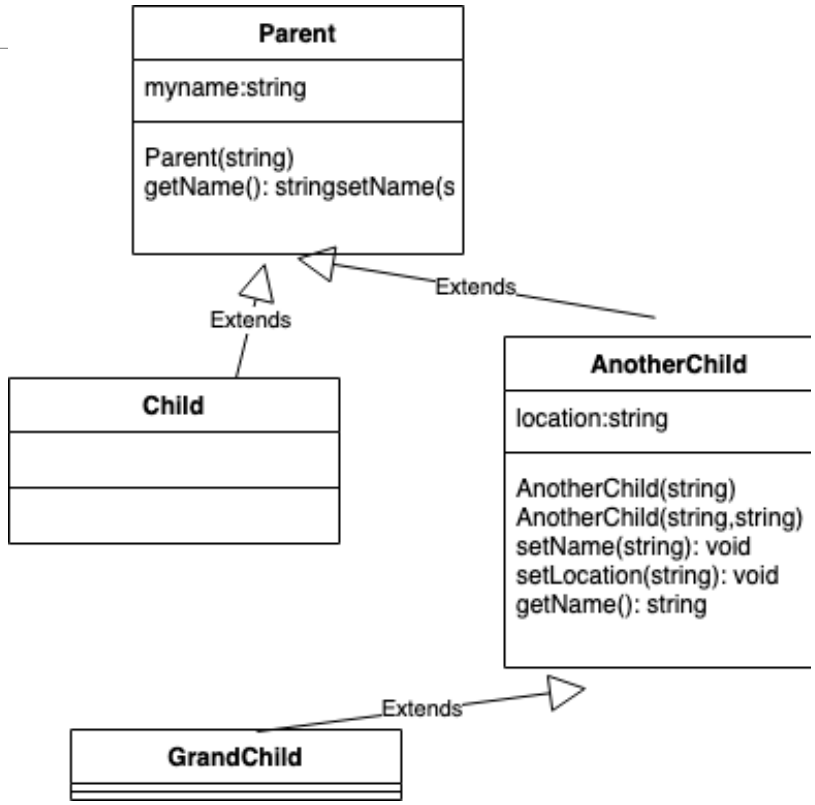
How to Use Inheritance ?

- Language independent syntax
- Illustration
  - 4 classes
  - 2 data members: myname, location
  - Access restrictions: private, protected, public



Notes on Inheritance

- Code for classes Child and GrandChild are minimal
  - Code reuse happens by default
- A child can override the behavior of its parent



Home Work 3

Due Thursday, Feb 10, 2022

Programming Home Work (#3) – C++

Home Work #2

- Write a program called GeometricPropertyCalculator.
  - The program reads an input file (called input.txt). Each line in the file contains dimensions of a geometric shape – rectangle, shape and triangle. Specifically:
    - For rectangle, it contains – RECTANGLE <length-in-cm> <breadth-in-cm>
    - For circle, it contains – CIRCLE <radius-in-cm>
    - For triangle, it contains – TRIANGLE <side-1-in-cm> <side-2-in-cm> <side-3-in-cm>
  - The user specifies the property to calculate as argument to the program: 1 for AREA and 2 for PERIMETER
  - The program writes output lines to an output file (called output.txt) for each shape that it reads and the property – AREA or PERIMETER.
    - For example, for RECTANGLE and property as AREA, the program should write – RECTANGLE AREA <calculated value>
  - Write GeometricPropertyCalculator in C++
    - It should support RECTANGLE, CIRCLE and TRIANGLE
    - It should support properties AREA and PERIMETER
    - If there is insufficient information, the program should give an error. E.g. TRIANGLE AREA "Not enough information to calculate"

Home Work #3

- Build a program called **OOGeometricPropertyCalculator**
  - Your new code will do the same as Home Work#2 but with OO design
  - It will have **4 classes: Shape – the parent, and its three children - Rectangle, Circle and Triangle**
  - Shape will have three members: **area**, **perimeter** and **errorMessage**; and at least **three functions getArea(), getPerimeter() and getErrorMessage().**
  - In your code, there will be a utility file (OOGeometricPropertyCalculator.cpp) with main() and will call the classes and functions. You can choose to have one or more files for the classes.
    (E.g, For the 4 classes, 4 headers + 4 .cpp files).
  - **You will also draw UML class diagrams for it**
- Functionality Reminder
  - The user specifies the property to calculate as argument to the program: 1 for AREA and 2 for PERIMETER
  - The program writes output lines to an output file (called output.txt) for each shape that it reads and the property – AREA or PERIMETER.

Programming Home Work (#3) – C++

- Code guidelines for the OO code you will write
  - Have sub-directories in your folder
    - src sub-folder, (or code) for code
    - data sub-folder, for input.txt and output.txt
    - doc sub-folder, for documentation on what the code does or sample output.

- In documentation
  - **Have a UML class diagram for the classes**
  - Observe how long was the code earlier and now. If you have to add a new functionality (like getVertices() to get all the vertices in a shape), how easy or hard will it be in HW2 code or HW3 code?

Discussion: Course Project

Course Project – Assembling of Prog. Assignments

- **Project**: Develop collaborative assistants (chatbots) that offer innovative and ethical solutions to real-world problems ! *(Based on competition - https://sites.google.com/view/casy-2-0-track1/contest)*
- Specifically, **the project will be building a chatbot that can answer questions about a South Carolina member of state legislature from**: https://www.scstatehouse.gov/member.php?chamber=H
  - Each student will choose a district (from 122 available).
  - Programming assignment programs will: (1) extract data from the district, (2) process it, (3) make content available in a command-line interface, (4) handle any user query and (5) report on interaction statistics.

PA: Code Reviewing Rubric Used

- Look out for
  - Can one understand what the code is doing ?
  - Can one explain the code to someone else (non-coder) ?
  - Can one spot possible issues without running it?
    - Are the variables initialized ?
    - Are files closed?
    - Is their unnecessary code bloat ?
- What not to judge
  - Usage of language features, unless they are inappropriate

Assign rating (out of 100 -/+)
- -100: code not available
- -80: code with major issues
- -60: code with minor issues
- -20:
- 0: (full marks): no issues
- +20: special features

PA: Code Testing Rubric Used

- Look out for
  - Does the program run as the coder wanted it to be (specification) ?
  - Does the program run as the instructor wanted it to be (requirement - customer) ?
  - Does the program terminate abruptly ?
  - Is there a hardcoding of directory ? Paths should be relative to code base directory.
  - Any special feature?
- What not to judge
  - Length of documentation. It can just be short and accurate.
  - Person writing the code

Assign rating (out of 100 -/+)
- -100: code not available
- -80: code with major issues (e.g., abnormal termination, incomplete features)
- -60: code with minor issues
- -20:
- (full marks): no issues
- +20: special features

Core Programs Needed for Project

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

Programming Assignment # 2

- Goal: **process extracted text based on questions**
  - Language of choice: Any from the three (C++, Java, Python)
- Program should do the following:
  - Take input from a local file with whose content is obtained from Prog#1 (when district name given as input)
  - Given an information type as input, the program will return its content
    - Examples: Contact Information, personal information, voting records
    - Input type can be given as command line argument.
      Examples:
      - prog2processor –t "Contact Information"
      - prog2processor –t "Contact Information:name" // Get person's name
  - For demonstrating that your program works, have a file called "test_output.txt" showing the set of supported commandline options and output in the doc folder.
- Code organization
  - Create a folder in your GitHub called "prog2-processor"
  - Have sub-folders: src (or code), data, doc, test
  - Write a 1-page report in ./doc sub-folder
  - Send a confirmation that code is done to instructor and TA, and update Google sheet

- Contact Information (Type-I1)
  - Name
  - Region
  - Addresses: Columbia, Home
  - Phone: Business, Home
- Personal Information (Type-I2)
- Committee Assignments (Type-I3)
- Sponsored Bills in the House (Type-I4)
- Voting Record (Type-I5)
- **Service in Public Office (Type-I6)**

Example: Representative Information

Input:

prog2processor –t “Contact Information:name” // Get person’s name

Output:

Terry Alexander

- Contact Information (Type-I1)
- Personal Information (Type-I2)
- Committee Assignments (Type-I3)
- Sponsored Bills in the House (Type-I4)
- Voting Record (Type-I5)
- Service in Public Office (Type-I6)

Representative Terry Alexander

Democrat - Florence
District 59 - Darlington & Florence Counties - **Map**

Columbia Address
314C Blatt Bldg.
Columbia 29201

Home Address
1646 Harris Court
Florence 29501

Business Phone (803) 734-3004

Home Phone (843) 665-7321

Send message to Representative Alexander

Personal Information

- Education Consultant & Pastor
- Residing at 1646 Harris Court, Florence
- Born January 23, 1955 in Florence
- Son of the late James and Adell Alexander
- Durham Business College, A.D., 1976
- Francis Marion University, B.A., 1991
- Howard University School of Divinity, M. Div., 1998
- Married to Starlee Davis Alexander, 2 children, Terrell McClain and Matthew
- Pastor, Wayside Chapel Baptist Church
- Career Development Consultant
- Adjunct Professor of Religion, Limestone College
- Pee Dee Regional Council of Governments
- Past President, Habitat for Humanity, Board of Directors
- Charter member, The Florence Breakfast Rotary Club
- Past President, Boys and Girls Club of Florence
- Boy Scouts of the Pee Dee Executive Boards
- Florence Branch, NAACP, past President
- Mercy Medicine Board
- Pee Dee Chapter American Red Cross
- 100 Black Men of the Pee Dee
- Kappa Alpha Psi Fraternity, Inc.
- Francis Marion Society
- National Association of County Officials
- National Association of Black County Officials
- South Carolina Association of Black County Officials
- South Carolina Association of Guidance Counselors
- South Carolina Alliance of Black Educators

Committee Assignments

- **Education and Public Works, *2nd V.C.***
- **Regulations and Admin. Procedures**

Sponsored Bills in the House

- Primary Sponsor: (•) Yes ( ) No
- Search Session: 2021-2022 (124) Find Bills

Voting Record

- Search Session: 2021-2022 (124) Find Votes

Service In Public Office

- Florence County Council, 1990-06, District Number 3
- House of Representatives, 2007 - Present

Concluding Section

Lecture 9: Concluding Comments

- We looked at inheritance relationship among classes
- Home Work #3 – due Feb 10
- Prog. Assignment #2 - due Feb 22

About Next Lecture – Lecture 10

Lecture 10: Object Oriented - Polymorphism

- OO – Polymorphism.
- Regular expressions – needed for project 2
- Home work 3 will be peer reviewed in class

8	**Feb 3 (Th)**	**Code org (C++)**	**Prog 1 - end**
9	Feb 8 (Tu)	OO – inheritance	Prog 2 - start
10	Feb 10 (Th)	OO - polymorphism	HW 3 due
11	Feb 15 (Tu)	In class test	Quiz 1 – In class