1 Submission Instructions

- In the submission instructions, we mention your ASURITE ID several times. Your ASURITE ID is the user name you use to log in to ASU computer systems such as MyASU and Canvas, e.g., the instructor's ASURITE ID is kburger2. It is not the same as your 10-digit ASU ID number printed on your SunCard.
- Note that for each homework assignment, only some of the exercises will be graded. A list of the exercises that will be graded can be found on the homework assignment submission page in Canvas at *Modules* > *Homework 2 & Project 2* > *Module 4: Homework Assignment 2* > *HW2* submission page in Canvas.
- There are two primary reasons we grade only some of the exercises: first, this course has a large enrollment so there are many assignments to be graded. Second, in the accelerated time frame for online courses, we want to return graded homework assignments as quickly as we can.
- Please understand that it is time-consuming to manually grade assignments, particularly programming exercises, so it may take as long as one week to return scores. We will always try to return them sooner.
- Not grading all of the exercises does not mean that the ungraded exercises are unimportant or that you will not be tested on the concepts in the exercise. They are equally important as the graded exercises and the concepts you learn may be on the exams. Consequently, we **strongly recommend** that you complete *all* of the exercises.
- Some of your solutions must be submitted in a PDF document. To start the assignment, create a word processing document named **team-*n*-h2.*ext*** where *n* is team name and *ext* is likely .docx if you are using Microsoft Word or .odt if you are using Libre Office or Open Office. For example, if the team named EE is using Microsoft Word, then their document shall be named **team-ee-h2.docx**. If team AAA is using Libre Office, then their document shall be named **team-aaa-h2.odt**.
- Near the top of the document, please type the following information: (1) Your team name, e.g., **Team CC**; (2) The names, ASURITE ID's, and email addresses of each member of the team, e.g., **Kevin Burger, kburger2, asu.cse 205.ta@protonmail.com**; (3) The homework assignment number, e.g., **HW2** or **Homework 2.**
- For the graded **short-answer** and **description** exercises (e.g., see Exs. 3.2, 3.6, 3.7, 3.8, 3.10, 3.14, and 6.2), please neatly type your solutions in the document. Clearly number each exercise so there is no confusion for the grader.
- If an exercises ask you to write **Java code but does not request you submit your solution** in a separate Java source code file (e.g., see Exs. 3.6–3.7 and 3.15), copy-and-paste your code from your IDE or text editor into your word processing document. Make sure to neatly format your code, i.e., indentation.
- Please carefully read the instructions in Exs. 4.2–4.5 and 5.1–5.3 regarding submission of **complete Java programs** These two groups of exercises ask you to write complete programs, i.e., programs which we can build and run. We will be using an automated grading script to grade these exercises, so it is extremely important that you follow the exercise instructions—especially in regard to naming of things such as filenames, classnames, etc.—so your submission will not cause the script to fail, which would result in point deductions.
- When you are done with the document, please convert the document to **Adobe PDF format** and name the file **team-*n*-h2.pdf**, where *n* is your team name.
- Next, create an empty folder named **team-*n*-h2** and copy **team-*n*-h2.pdf** to this folder. Copy the requested **zip archives** containing Java source code files for Exs. 4.2–4.5 and 5.1–5.3 into this folder. (Note: Java source code files are the files with a *.java* file name extension; when you create the zip archives for these two groups of exercises, do not include the *.class* files in your zip archives as we do not need those.)
- Next, compress the **team-*n*-h2** folder creating a **zip archive** file named **team-*n*-h2.zip**. Upload **team-*n*-h2.zip** to Canvas using the *HW2* submission page prior to the assignment deadline
- Please consult the *Syllabus* > *Course Summary* section of Canvas for the assignment deadline. The deadline may also be found on the *HW2* project submission page.
- Please consult the course Syllabus for the late and academic integrity policies.

2 Learning Objectives

1. Properly use the accessibility specifiers public, protected, private in the design and implementation of an OO program.
2. Write Java code to override and overload methods.
3. Properly use inheritance in the design and implementation of an OO program.
4. Properly use polymorphism in the design and implementation of an OO program.
5. Know when to declare a class versus an interface. Declare and implement a Java interface.
6. Implement a GUI using the Java Swing library.

3 Objects, Classes, and Inheritance

3.1 Learning Objective: To effectively use accessor and mutator methods.

Problem: Is it required to provide an accessor and/or mutator method for every instance variable of a class? If yes, explain why this is required, and if no, explain why not.

3.2 Learning Objective: Superclass references and subclass objects; Subclass references and superclass objects.

Instructions: Type the solutions to sub-exercises (a)–(d) in your word processing document.

Problem: Suppose the class *Sub* extends *Sandwich*. Which of the following statements (a)–(d) are legal?

```
Sandwich x = new Sandwich();
Sub y = new Sub();

(a) x = y;
(b) y = x;
(c) Sub y = new Sandwich();
(d) Sandwich x = new Sub();
```

3.3 Learning Objective: To understand the relationship between superclass and subclass attributes.

Problem: True or False? A subclass declaration will generally contain declarations for instance variables that are specific to objects of that subclass, i.e., those instance variables represent attributes that are not part of superclass objects.

3.4 Learning Objective: To understand the relationship between superclass and subclass attributes.

Problem: True or False? A superclass declaration will generally contain declarations for instance variables that are specific to objects of that superclass, i.e., those instance variables represent attributes that are not part of subclass objects.

3.5 Learning Objectives: To understand the accessibility relationships among superclasses and subclasses.

Problem: Consider classes `C1`, `C2`, and `C3`. Answer the following questions. Regarding a class's instance variables, by "directly accessible," we mean that if we are executing, say, `c2Method1()`, is it syntactically legal to write a statement that accesses, say, instance variable `x3` of class `C1`? For example, in `c2Method1()`, is `--x3;` a legal statement? Similarly, regarding a class's instance methods, by "callable", we mean that if we are executing, say, `c3Method2()`, is it syntactically legal to write a statement `c1Method2();` to call that method which is declared in `C1`?

```
class C1 {
   public int x1;
   protected int x2;
   private int x3;
   public void c1Method1() {}
   protected void c1Method2() {}
   private void c1Method3() {}
}
```

```
class C2 extends C1 {
    public int y1;
    protected int y2;
    private int y3;
    public void c2Method1() {}
    protected void c2Method2() {}
    private void c2Method3() {}
}
```

```
class C3 extends C2 {
    public int z1;
    protected int z2;
    private int z3;
    public void c3Method1() {}
    protected void c3Method2() {}
    private void c3Method3() {}
}
```

1. Which instance variables `x1`, `x2`, `x3` declared in `C1` are directly accessible in `c1Method1()`?
2. Which of the same variables mentioned in #1 are directly accessible in `c1Method2()`?
3. Using the same variables, which are directly accessible in `c1Method3()`?

4. Which instance variables `x1`, `x2`, `x3` declared in `C1` are directly accessible in `c2Method1()`?
5. Same variables, in `c2Method2()`?
6. Same variables, in `c2Method3()`?

7. Which instance variables `x1`, `x2`, `x3` declared in `C1` are directly accessible in `c3Method1()`?
8. Same variables, in `c3Method2()`?
9. Same variables, in `c3Method3()`?

10. Which instance variables `y1`, `y2`, `y3` declared in `C2` are directly accessible in `c1Method1()`?
11. In `c1Method2()`?
12. In `c1Method3()`?

13. Which instance variables `z1`, `z2`, `z3` declared in `C3` are directly accessible in `c1Method1()`?
14. Same variables, in `c1Method2()`?
15. Same variables, in `c1Method3()`?

16. Which instance methods `c1Method1()`, `c1Method2()`, `c1Method3()` are callable from `c2Method1()`?
17. Which `C1` methods are callable from `c2Method2()`?
18. Which `C1` methods are callable from `c2Method3()`?

19. Which instance methods `c1Method1()`, `c1Method2()`, `c1Method3()` are callable from `c3Method1()`?
20. Which `C1` methods are callable from `c3Method2()`?
21. Which `C1` methods are callable from `c3Method3()`?

22. Which instance methods `c2Method1()`, `c2Method2()`, `c2Method3()` are callable from `c1Method1()`?
23. Which `C2` methods are callable from `c1Method2()`?
24. Which `C2` methods are callable from `c1Method3()`?

25. A `C1` object is created as a block of memory. Within that block of memory, how many instance variables exist?
26. A `C2` object is created as a block of memory. Within that block of memory, how many instance variables exist?
27. A `C3` object is created as a block of memory. Within that block of memory, how many instance variables exist?

3.6 Learning Objective: To effectively write and call overloaded methods.

Instructions: Type the solution in your word processing document.

Problem: Explain what an overloaded method is and give an example by writing some Java code.

3.7 Learning Objective: To effectively write and call overridden methods.

Instructions: Type the solution in your word processing document.

Problem: Explain what an overridden method is and give an example by writing some Java code.

3.8 Learning Objective: To recognize when accidental overloading occurs and how to write Java code to prevent it.

Instructions: Type the solution in your word processing document.

Problem: Explain what accidental overloading is and the preferred Java method for preventing it.

3.9 Learning Objective: To effectively write and call overridden methods.

Problem: If an overridden method in a subclass needs to call the overridden superclass method, how is this accomplished?

3.10 Learning Objective: To effectively write and call overloaded methods.

Instructions: Type the solution in your word processing document.

Problem: True or False? It is legal to write a method in a class which overloads another method declared in the same class. Explain.

3.11 Learning Objective: To effectively write and call overridden methods.

Problem: True or False? It is legal to write a method in a class which overrides another method declared in the same class. Explain.

3.12 Learning Objective: To effectively write and call overloaded methods.

Problem: True or False? It is legal in a subclass to write a method which overloads a method declared in the superclass. Explain.

3.13 Learning Objective: To effectively write and call overridden methods.

Problem: True or False? It is legal to write a method in a subclass which overrides a method declared in the superclass. Explain.

3.14 *This exercise was eliminated but left here so the remaining exercise numbers would not change.*

3.15 Learning Objective: To effectively write and call overridden methods.

Problem: True or False? It is legal to write a method in a superclass which overrides a method declared in a subclass. Explain.

3.16 Learning Objective: To effectively call superclass constructors from a subclass constructor.

Problem: In a subclass constructor, the superclass default constructor is automatically called before the statements of the subclass constructor begin executing. Suppose we wish to call a different superclass constructor (i.e., not the default constructor) from the subclass constructor. Explain how this is accomplished and give a Java example.

3.17 Explain how an abstract class differs in at least one way from a concrete class.

4 Objects, Classes, Polymorphism, and Interfaces

Learning Objectives: The objectives for Exercises 4.1–4.5 are to effectively declare and implement Java interfaces and to understand and properly use polymorphism.

Instructions: You will submit this program for grading. Create an empty folder named *h2_45*. Copy *Amphibian.java*, *Bee.java*, *Cat.java, Cricket.java, Dog.java*, *Frog.java, Insect.java*, *Main.java*, *MakesSound.java*, and *Mammal.java* to *h2_45*. Do not include any *.class* files in *h2_45* as we will build your program for grading. Then compress *h2_45* creating a zip archive named *h2_45.zip*. Include *h2_45.zip* in your *team-n-h2.zip* zip archive that you submit for grading.

4.1 Problem: The Homework 2 zip archive contains a folder *cse205-h2/src/h2_45* containing the source code for the *MakesSound* interface and the *Mammal*, *Cat*, *Dog*, *Insect*, and *Cricket* classes discussed in the Module 3 video lecture for *Interfaces : Section 6*. In this lecture, we discussed an example program that implements an inheritance hierarchy (*Mammal* is the superclass of *Cat* and *Dog*; *Insect* is the superclass of *Cricket*). Which method or methods in this program are called polymorphically?

4.2 See the instructions in Ex. 4.5 for what to submit for grading. Name your Java source code file *Bee.java*. Write the Java code to declare a new class *Bee* which is a subclass of *Insect*. The sound made by a *Bee* is "Buzz".

4.3 See the instructions in Ex. 4.5 for what to submit for grading. Name your Java source code file *Amphibian.java*. Write the Java code to declare a new abstract class *Amphibian* that implements the *MakesSound* interface.

4.4 See the instructions in Ex. 4.5 for what to submit for grading. Name your Java source code file *Frog.java*. Write the Java code to declare a new class *Frog* which is a subclass of *Amphibian*. The sound made by a *Frog* is "Ribbet".

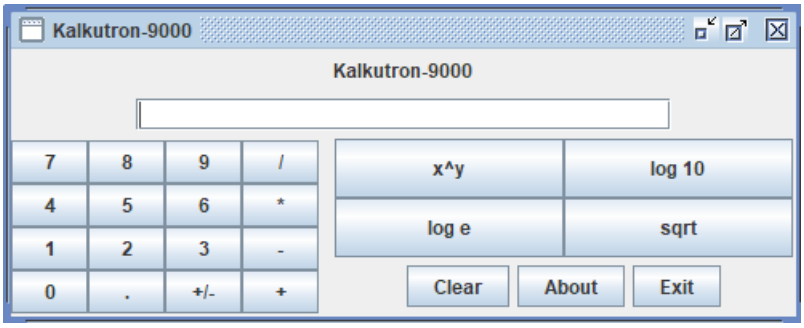
4.5 To complete this exercise, you must first complete Exs. 4.2–4.4. Then, modify the *run*() method of *Main* and add a few *Bee*s and *Frog*s to the *critters* list. Build your program and verify that it works correctly, i.e., that each critter makes the correct sound.

5 GUI Programming

Learning Objectives: To implement a simple GUI using the Java Swing graphics library. To implement functionality to detect and respond to user interface events.

Instructions: You will submit this program for grading. Create an empty folder named h*2_51*. Copy *Main.java* and *View.java* to *h2_51*. Do not include any *.class* files in *h2_51* as we will build your program for grading. Then compress *h2_51* creating a zip archive named *h2_51.zip*. Include *h2_51.zip* in your *team-n-h2.zip* zip archive that you submit for grading.

5.1 The Homework 2 zip archive contains a folder *cse205-h2/src/h2_51* containing two source code files named *Main.java* and *View.java*. *Main* is implemented for you. For Exs. 5.1–5.3 you will modify the *View* class to implement a GUI interface for a calculator as shown below. The calculator will not be fully functional, i.e, it will not perform arithmetic; the primary learning objective of these exercises is to learn how to implement a GUI in Java using the Swing library. For this particular exercise, modify *View.java* in the places where the code is not completed (indicated by ??? symbols in *View*) and implement the code as specified by the comments so when the program is run, the calculator GUI shown below will appear.



5.2 Complete the code in *actionPerformed*() so when the Exit button is clicked, the application will terminate.

5.3 Complete the code in *actionPerformed*() so when the About button is clicked, the application will display this about dialog where you are to put your own name in the location where *Put your name here* is displayed.

6 Nested Classes

6.1 Learning Objective: To effectively use inner classes.

Problem: Explain what an inner class is.

6.2 Learning Objective: To effectively use local and inner classes.

Instructions: Type the solution in your word processing document.

Problem: Explain how a local class differs from an inner class.

6.3 Learning Objective: To properly use anonymous, inner, and local classes.

Problem: Explain how an anonymous class differs from an inner and local class.