Chapter 1

Self-Review

Exercises 1.1 Fill in the blanks in each of the following statements:

a) Computers process data under the control of sets of instructions called **programs**.

b) The key logical units of the computer are the **input unit, output unit, memory unit, arithmetic and logic unit (ALU), central processing unit (CPU), and secondary storage unit**.

c) The three types of languages are **machine language, assembly language, and high-level language**.

d) The programs that translate high-level language programs into machine language are called **compilers**.

e) **Android** is an operating system for mobile devices based on the Linux kernel and Java.

f) **Beta** software is generally feature complete, (supposedly) bug-free, and ready for use by the community.

g) The Wii Remote, as well as many smartphones, use a(n) **accelerometer**, which allows the device to respond to motion.

**1.2 Java Environment**

a) The **java** command from the JDK executes a Java application.

b) The **javac** command from the JDK compiles a Java program.

c) A Java source code file must end with the **.java** file extension.

d) When a Java program is compiled, the file produced by the compiler ends with the **.class** file extension.

e) The file produced by the Java compiler contains **bytecode** that is executed by the Java Virtual Machine.

**1.3 Object-Oriented Concepts**

a) Objects enable the design practice of **encapsulation**—although they may know how to communicate with one another across well-defined interfaces, they normally are not allowed to know how other objects are implemented.

b) Java programmers concentrate on creating **classes**, which contain fields and the set of methods that manipulate those fields and provide services to clients.

c) The process of analyzing and designing a system from an object-oriented point of view is called **object-oriented analysis and design (OOAD)**.

d) A new class of objects can be created conveniently by **inheritance**—the new class (called the subclass) starts with the characteristics of an existing class (called the superclass), possibly customizing them and adding unique characteristics of its own.

e) **UML (Unified Modeling Language)** is a graphical language that allows people who design software systems to use an industry-standard notation to represent them.

f) The size, shape, color, and weight of an object are considered **attributes** of the object’s class.

**1.4 Computer System Components**

a) The logical unit that receives information from outside the computer for use by the computer is the **input unit**.

b) The process of instructing the computer to solve a problem is called **programming**.

c) **Assembly language** is a type of computer language that uses English-like abbreviations for machine-language instructions.

d) **Output unit** is a logical unit that sends information that has already been processed by the computer to various devices so that it may be used outside the computer.

e) **Memory unit** and **secondary storage unit** are logical units of the computer that retain information.

f) **Arithmetic and logic unit (ALU)** is a logical unit of the computer that performs calculations.

g) **Arithmetic and logic unit (ALU)** is a logical unit of the computer that makes logical decisions.

h) **High-level** languages are most convenient to the programmer for writing programs quickly and easily.

i) The only language a computer can directly understand is that computer’s **machine language**.

j) **Central processing unit (CPU)** is a logical unit of the computer that coordinates the activities of all the other logical units.

**1.5 Programming Languages and Networking**

a) The **Java** programming language is now used to develop large-scale enterprise applications, enhance the functionality of web servers, provide applications for consumer devices, and for many other purposes.

b) **C** initially became widely known as the development language of the UNIX operating system.

c) The **Transmission Control Protocol (TCP)** ensures that messages, consisting of sequentially numbered pieces called bytes, are properly routed from sender to receiver, arrive intact, and are assembled in the correct order.

d) The **C++** programming language was developed by Bjarne Stroustrup in the early 1980s at Bell Laboratories.

### ****1.6 Java Program Execution and Development****

a) Java programs normally go through five phases— **edit, compile, load, verify, and execute**.

b) A(n) **Integrated Development Environment (IDE)** provides many tools that support the software development process, such as editors for writing and editing programs, debuggers for locating logic errors in programs, and many other features.

c) The command java invokes the **Java Virtual Machine (JVM)**, which executes Java programs.

d) A(n) **virtual machine (VM)** is a software application that simulates a computer but hides the underlying operating system and hardware from the programs that interact with it.

e) The **class loader** takes the .class files containing the program’s bytecodes and transfers them to primary memory.

f) The **bytecode verifier** examines bytecodes to ensure that they’re valid.

### ****1.6 Fill in the blanks:****

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**1.7 Java's Two Compilation Phases**

1. **Compilation:**
   * The **Java compiler (javac)** converts the source code (.java file) into **bytecode** (.class file).
   * Bytecode is a special format that can run on any system with a Java Virtual Machine (JVM).
2. **Execution:**
   * The **JVM** reads the bytecode and runs the program.
   * The **JIT (Just-In-Time) compiler** may convert bytecode into machine code for faster execution.

**1.8 Applying Java OOP Concepts to a Wristwatch**

A wristwatch can be understood using **Object-Oriented Programming (OOP) concepts** in Java:

1. **Object:**
   * A wristwatch is an **object** in programming, just like it is in the real world.
   * It has characteristics (attributes) and actions (behaviors).
2. **Attributes (Fields/Properties):**
   * These define the watch’s state, such as:
     + time (current time)
     + brand (e.g., "Casio")
     + color (e.g., "Black")
     + batteryLevel (remaining power)
3. **Behaviors (Methods):**
   * Watches can perform actions, such as:
     + setTime(int hour, int minute) – Set the time
     + showTime() – Display the current time
     + startTimer() – Start a stopwatch
     + ringAlarm() – Activate the alarm
4. **Class:**
   * A **class** defines the blueprint for creating watches.
   * Example:

java

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class Watch {

String brand;

String color;

int batteryLevel;

void showTime() {

System.out.println("Displaying current time...");

}

}

1. **Inheritance:**
   * A wristwatch can have different types, like **alarm watches** or **smartwatches**.
   * An **alarm watch** extends the basic Watch class:

java

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class AlarmWatch extends Watch {

void setAlarm(int hour, int minute) {

System.out.println("Alarm set for " + hour + ":" + minute);

}

}

1. **Modeling:**
   * We use **UML diagrams** and Java classes to model real-world watches in a software system.
2. **Messages (Method Calls):**
   * Objects communicate by calling methods. Example:

java

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myWatch.setTime(10, 30);

myWatch.showTime();

1. **Encapsulation:**
   * Data (attributes) is **private**, and we use **getters and setters** to access them:

java

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class Watch {

private int batteryLevel;

public int getBatteryLevel() {

return batteryLevel;

}

public void setBatteryLevel(int level) {

this.batteryLevel = level;

}

}

1. **Interface:**
   * Different watches can share common behaviors using an **interface**:

java

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interface SmartFunctions {

void connectToPhone();

void trackSteps();

}

class SmartWatch extends Watch implements SmartFunctions {

public void connectToPhone() {

System.out.println("Connected to phone.");

}

public void trackSteps() {

System.out.println("Tracking steps...");

}

}

1. **Information Hiding:**

* Internal details (like how the time is stored) are **hidden** from users, exposing only necessary functions.
* Example: The user calls showTime(), but they don’t know how the watch processes time internally.

**Making a Difference**

***1.9 (Test-Drive: Carbon Footprint Calculator)***

Calculating your carbon footprint involves assessing the total greenhouse gas (GHG) emissions resulting from your daily activities, such as energy consumption, transportation, and waste production. This measurement is typically expressed in equivalent tons of carbon dioxide (CO₂e). ​[Plan A](https://plana.earth/academy/calculate-company-carbon-footprint?utm_source=chatgpt.com)

**Key Components of a Personal Carbon Footprint:**

1. **Home Energy Usage:**
   * **Electricity Consumption:** Measured in kilowatt-hours (kWh).​
   * **Heating Fuels:** Natural gas, oil, or other fuels, measured in appropriate units (e.g., cubic meters for gas).​
2. **Transportation:**
   * **Vehicle Travel:** Total annual mileage and fuel type.​[Just Energy](https://justenergy.com/blog/how-to-calculate-your-carbon-footprint/?utm_source=chatgpt.com)
   * **Air Travel:** Number and length of flights taken annually.​[US EPA](https://www.epa.gov/ghgemissions/carbon-footprint-calculator?utm_source=chatgpt.com)
3. **Waste Production:**
   * Amount of waste generated and recycling practices.​

**Formulas for Estimating Carbon Footprint:**

To estimate your carbon footprint, multiply your activity data by relevant emission factors. Here's a simplified approach:​[Brightly](https://www.brightlysoftware.com/blog/calculate-carbon-footprint?utm_source=chatgpt.com)

1. **Electricity Usage:**
   * Multiply your monthly electricity consumption (in kWh) by an emission factor (e.g., 105). ​[Just Energy](https://justenergy.com/blog/how-to-calculate-your-carbon-footprint/?utm_source=chatgpt.com)
2. **Heating Fuels:**
   * Multiply your monthly natural gas or oil consumption by its respective emission factor.​[Business Energy Scotland](https://businessenergyscotland.org/guides/how-calculate-your-businesss-carbon-footprint/?utm_source=chatgpt.com)
3. **Vehicle Travel:**
   * Multiply your total annual vehicle mileage by an emission factor (e.g., 0.79).​[Just Energy](https://justenergy.com/blog/how-to-calculate-your-carbon-footprint/?utm_source=chatgpt.com)
4. **Air Travel:**
   * Multiply the number of short flights (less than 4 hours) by an emission factor (e.g., 1,100).​[Just Energy](https://justenergy.com/blog/how-to-calculate-your-carbon-footprint/?utm_source=chatgpt.com)
   * Multiply the number of long flights (more than 4 hours) by a higher emission factor (e.g., 4,400).​
5. **Waste and Recycling:**
   * Add specific values if you do not recycle certain materials (e.g., 184 for not recycling newspapers).​[Just Energy](https://justenergy.com/blog/how-to-calculate-your-carbon-footprint/?utm_source=chatgpt.com)

**Online Carbon Footprint Calculators:**

For a more precise assessment, consider using online calculators that account for various factors:​

* **TerraPass Carbon Footprint Calculator:** Offers a comprehensive tool to calculate emissions from home energy, transportation, and waste.​[US EPA+1Plan A+1](https://www.epa.gov/ghgemissions/carbon-footprint-calculator?utm_source=chatgpt.com)
* **CarbonFootprint.com Calculator:** Provides detailed calculations for individuals and businesses, covering various emission sources. ​
* **EPA's Carbon Footprint Calculator:** Estimates emissions based on home energy, transportation, and waste, tailored to U.S. residents. ​[US EPA+1Plan A+1](https://www.epa.gov/ghgemissions/carbon-footprint-calculator?utm_source=chatgpt.com)

**Developing Your Own Carbon Footprint Calculator:**

When creating your own calculator, consider the following steps:​

1. **Define Emission Sources:** Identify all relevant activities contributing to GHG emissions.​[Plan A](https://plana.earth/academy/calculate-company-carbon-footprint?utm_source=chatgpt.com)
2. **Collect Activity Data:** Gather accurate data on energy consumption, travel, and waste.​
3. **Apply Emission Factors:** Use standardized factors to convert activity data into CO₂e emissions.​[Arbor+1Brightly+1](https://www.arbor.eco/blog/how-to-calculate-the-carbon-footprint-of-a-product?utm_source=chatgpt.com)
4. **Sum Emissions:** Aggregate emissions from all sources to determine the total carbon footprint.

**1.10** (Test-Drive: Body Mass Index Calculator)

​The Body Mass Index (BMI) is a widely used measure to assess whether an individual has a healthy body weight relative to their height. It's calculated by dividing a person's weight by the square of their height. The formula differs based on the measurement system used:​

**1. Metric Units:**

BMI=Weight (kg)Height (m)2\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}BMI=Height (m)2Weight (kg)​​

**2. Imperial Units:**

BMI=Weight (lb)Height (in)2×703\text{BMI} = \frac{\text{Weight (lb)}}{\text{Height (in)}^2} \times 703BMI=Height (in)2Weight (lb)​×703​

The factor 703 adjusts the calculation for the use of pounds and inches. ​

**BMI Categories:**

According to the World Health Organization (WHO), BMI is categorized as follows:​

* **Underweight:** BMI less than 18.5​
* **Normal weight:** BMI 18.5–24.9​
* **Overweight:** BMI 25–29.9​
* **Obesity:** BMI 30 or greater​

**Limitations of BMI:**

While BMI is a useful screening tool, it has limitations:​

* **Does Not Differentiate Between Weight Sources:** BMI does not distinguish between weight from fat and weight from muscle. Therefore, individuals with high muscle mass, such as athletes, may have a high BMI without excess body fat. ​
* **Does Not Consider Fat Distribution:** BMI does not account for the distribution of body fat, which is an important factor in health risk assessment.​

**Alternative Measures:**

Given these limitations, other measurements are sometimes used alongside BMI:​

* **Waist Circumference:** Assesses abdominal fat, which is a predictor of risk for obesity-related diseases.​
* **Waist-to-Hip Ratio:** Evaluates fat distribution by comparing the circumference of the waist to that of the hips.​

**Online BMI Calculators:**

For quick assessments, several online tools are available:​

* **National Heart, Lung, and Blood Institute (NHLBI) BMI Calculator:** <https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmicalc.htm>​
* **Cleveland Clinic BMI Calculator:** <https://my.clevelandclinic.org/health/articles/9464-body-mass-index-bmi>​[Cleveland Clinic](https://my.clevelandclinic.org/health/articles/9464-body-mass-index-bmi?utm_source=chatgpt.com)

**Recent Discussions on BMI:**

Recent studies and expert opinions have highlighted the need to move beyond BMI as the sole indicator of health:​

* **Critique of BMI's Accuracy:**​

Researchers have argued that BMI does not accurately reflect an individual's health status, particularly for those with high muscle mass or varying fat distribution. ​

* **Recommendations for Alternative Assessments:**​

Experts suggest incorporating additional measurements, such as waist circumference and body fat percentage, to provide a more comprehensive health assessment. ​[New York Post](https://nypost.com/2025/01/21/health/bmi-is-wrong-way-to-measure-obesity-researchers-say-heres-what-they-recommend-instead/?utm_source=chatgpt.com)

In summary, while BMI is a convenient and widely used tool for assessing body weight relative to height, it's important to consider its limitations and use it alongside other measurements for a more accurate evaluation of an individual's health.

**1.11 Attributes of Hybrid Vehicles**

Hybrid vehicles combine internal combustion engines with electric motors to enhance fuel efficiency and reduce emissions. Analyzing popular hybrid models reveals several key attributes:​

* **Fuel Efficiency:**
  + *City Miles Per Gallon (MPG):* Hybrids often achieve higher MPG in city driving due to regenerative braking and electric assistance. For instance, the Toyota Prius offers 54 MPG in the city. ​[Cartelligent](https://cartelligent.com/what-were-our-most-popular-hybrid-vehicles/?utm_source=chatgpt.com" \t "_blank)
  + *Highway MPG:* Highway efficiency varies; the Prius achieves 50 MPG on highways. ​[Edmunds+13universalenglish.org+13Rabbit with a Red Pen+13](https://universalenglish.org/gendered-english-words/?utm_source=chatgpt.com)
* **Battery Attributes:**
  + *Type:* Common types include Nickel-Metal Hydride (NiMH) and Lithium-Ion (Li-ion).​
  + *Capacity:* Measured in kilowatt-hours (kWh), indicating energy storage.​
  + *Weight:* Varies by model; impacts vehicle weight and efficiency.​
* **Electric Motor Power:** Measured in kilowatts (kW), indicating the motor's contribution to propulsion.​
* **Total System Horsepower:** Combined output of the engine and electric motor.​
* **Charging Options (for Plug-in Hybrids):**
  + *Charging Time:* Time to fully charge the battery.​
  + *Charging Ports:* Compatibility with various charging stations.​[Writing Center UNC+3Latest news & breaking headlines+3Kbb.com+3](https://www.thetimes.co.uk/article/ryanair-sued-over-lack-of-gender-neutral-greeting-on-booking-site-m83983jxq?utm_source=chatgpt.com)
* **Emissions Ratings:** Certification levels indicating environmental impact.​[Car and Driver+5Edmunds+5Cartelligent+5](https://www.edmunds.com/hybrid/?utm_source=chatgpt.com)

**1.12 Gender Neutrality Algorithm**

To create a program that replaces gender-specific words with gender-neutral alternatives, follow this algorithm:​[Edmunds](https://www.edmunds.com/hybrid/?utm_source=chatgpt.com)

1. **Compile a Replacement Dictionary:** Create a mapping of gendered terms to neutral counterparts, e.g., "wife" → "spouse," "husband" → "spouse," "man" → "person," "woman" → "person," "daughter" → "child," "son" → "child."​
2. **Tokenize the Text:** Split the paragraph into words and punctuation.​
3. **Iterate Through Tokens:**
   * For each word, check if it's in the replacement dictionary.​
   * If found, replace it with the neutral term.​
4. **Handle Compound Words:** Check for gendered terms within compound words (e.g., "sportswoman"). If found, replace the gendered part ("woman") with the neutral equivalent ("person") to form "sportsperson."​
5. **Reconstruct the Paragraph:** Combine the tokens back into a coherent paragraph.​

**Avoiding Issues Like "woperchild":**

To prevent incorrect replacements such as "woperchild" from "woman," ensure the program:​

* **Matches Whole Words:** Only replace standalone words, not substrings within other words.​
* **Uses Context-Aware Replacement:** Recognize word boundaries and avoid partial replacements.