

Matlab API reference:

Constants: pi, eps, inf, NaN, realmax, realmin

Math: cos(), sin(), tan(), log(), log10(), log2(), exp(), sqrt(), abs(), angle(), conj(), imag(), real(), complex(re,im)

Round & remainder: fix(), floor(), ceil(), round(), mod(num,den), rem(num,den),

Graphics: plot(x,y,c), title(), plot3(), semilogx(), semilogy(), loglog(), grid(), text(), xlabel(), ylabel(), axis(), legend(), meshgrid(), mesh(), surf(), surfc(), colormap(), shading(), colorbar(), colormap(), pcolor(), caxis(), hold()

Array creation: eye(), ones(), zeros(), rand(), randn(), linspace(), logspace()

Array manipulation: triu(), tril(), fliplr(), flipud(), diag(), rot90(), reshape(), size(), length()

Matrix: det(), trace(), rand(), inv()

Strings: char(), double(), strcmp(), strcat(), upper(), lower()

Polynomials: polyval(p,x), polyfit(x,y,n), roots(p), conv(p1,p2), deconv(p1,p2)

1. Matlab Concepts and Syntax

(A) For each of the following questions, write a single Matlab statement to accomplish what is requested.

- (i) Create a row vector containing the sequence of numbers: 0 2 4 6 ... 24.

- (ii) Create a column vector containing: 15.2, $\sqrt{3}$, $\sin(2.4\pi)$, $\log(4.21)$.

- (iii) Store your last name in a cell array called "roll" in location 12.

- (iv) Convert Celsius temperatures in columns 5 & 7 of an array "data" to Fahrenheit.

- (v) Solve for column vector, \mathbf{x} , in the matrix equation where \mathbf{C} is a square matrix, \mathbf{I} is the identity matrix and \mathbf{b} is a column vector of the same size as \mathbf{x} : $\mathbf{C}\mathbf{x} - \mathbf{I}\mathbf{x} + \mathbf{b} = 0$

(B) Given $C = \begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$, $G = \begin{bmatrix} 4 & 3 \\ 2 & 1 \end{bmatrix}$, $a = \begin{bmatrix} 10 \\ 20 \end{bmatrix}$, $b = [30 \quad 40]$ what is the result of executing the following commands:

(i) $C .* G$

(ii) $G' * a$

(iii) $a * b$

(iv) $G ./ C$

(v) $b * a$

2. Program Control

Use the most effective (readable and efficient) branching and looping code to accomplish the following:

- (A) Given a GPA between 0 – 4.0, compute the equivalent letter grade (A=4.0, B=3.0...)
- (B) Prompt a user to enter weights and continue computing a running summation until a negative value is entered.
- (C) Fill a vector, y , with $y = 1 - e^{-t}$ at 0.1 sec intervals from 0 to 4.9 sec followed by the values $y = -1 + e^{-t}$ at 0.1 sec intervals from 5 to 10 sec.
- (D) Fill a row vector, a , of length, N , with values starting with 1 and incrementing each successive value by an additive factor r . Now use this to construct an array, A , with M rows with each row increased by a multiplicative factor, p . Assume M , N , p and r are assigned values.

3. Matlab m-functions

(A) The following are short answer concept questions:

(i) Are variables defined within an m-function available for use in other scripts or m-functions? Explain.

(ii) Can multiple variables be returned by an m-function? Explain.

(B) A point in what is called “homogeneous space” is defined by 4 coordinates, (x^*, y^*, z^*, h) . Consider a set of N such points stored in an array with 4 columns and N rows (each point is stored in a row). In order to compute the point location in 3D space we must divide the x^* , y^* , z^* values of a point by its h value. In an equation: $[x^* \ y^* \ z^* \ h] \rightarrow [x^*/h \ y^*/h \ z^*/h \ 1] = [x \ y \ z \ 1]$. Construct an m-function called “project3D” that will consume a single $4 \times N$ array of homogeneous points and return the same array but now for 3D space where the 4th column is all 1’s. Consider that N is arbitrary and not provided as an argument.

4. Plotting and Data Visualization

- (A) We are told that the equation: $r = 2 \cos(3\theta)$ defines a flower when plotted for $0 \leq \theta \leq 2\pi$. Write a Matlab script to find out if this is true. Make sure the plot is fully labeled and titled. How many petals do you think the “flower” has?
- (B) A “sombbrero” can be defined by the surface: $z(x,y) = \sin(r)/r$ for $0 \leq \theta \leq 2\pi$. Construct a script to plot this function as a smoothly colored surface over the range: $0 \leq r \leq 6$ and $0 \leq \theta \leq 2\pi$ using at least 50 points in each coordinate direction. The colormap should be based on the z values. The maximum credit will be given for code that makes the best use of Matlab’s array operations. Note that $\sin(0)/0 = 1$ but Matlab will compute NaN; you can ignore this problem (or fix it by replacing $r=0$ with $r=\text{eps}$).

5. Sorting

Show the steps required to sort the following set of numbers using the techniques below. You must show all the intermediate sets generated during each process.

23	1	6	42	35	17	8	13
----	---	---	----	----	----	---	----

(A) Merge Sort

(B) Quick Sort

6. Object Oriented Programming

(A) True or False: For each of the following statements, if the statement is true, write T. If it is false, write F, and in the space provided, write the correct information to replace the underlined word(s).

(i). ___ A for loop must execute the body of the code at least once.

Replacement: _____

(ii). ___ If you pass an object to `System.out.println(...)`, its constructor is automatically called.

Replacement: _____

(iii). ___ The modifier static identifies an attribute or method belonging to the class rather than individual objects.

Replacement: _____

(iv). ___ It is permissible for a class to contain more than one method with the same name.

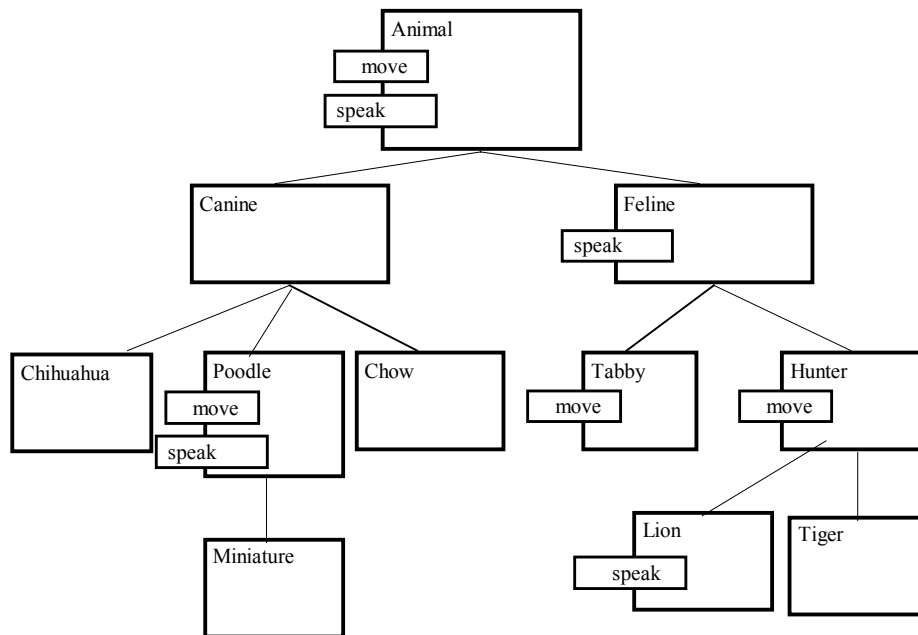
Replacement: _____

(v). ___ Java graphic components can be added to other components.

Replacement: _____

(continued on next page)

(B) Consider the following class hierarchy and answer the questions below:



(i) If you have a Lion object, check the “move” method would it actually use.

- Animal.move() Hunter.move() Tabby.move()

(ii) If you have a Feline object, which “move” method would it actually use?

- Animal.move() Tabby.move() Hunter.move()

(iii) Check the classes that are superclasses of Tiger.

- Hunter Tabby Feline Animal

(iv) You have the following code:

```
Animal a = new Lion();
a.speak();
```

What happens?

- Animal.speak() Lion.speak() Java exception

(v) You have the following code:

```
Miniature p = new Canine();
p.speak();
```

What happens?

- Canine.speak() Poodle.speak() Java exception

7. Java Graphics

Consider the following code:

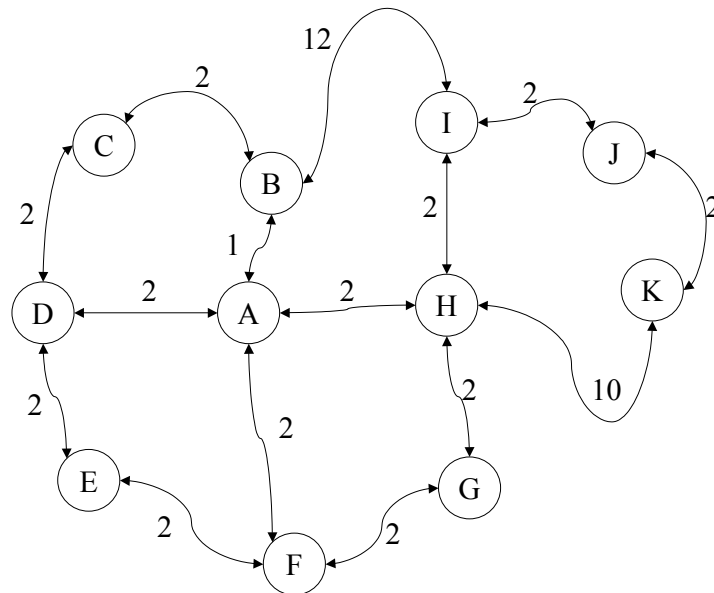
```
import java.awt.*;
import javax.swing.*;
public class GUI {
    public static void main(String[] args) {
        JFrame jf = new JFrame("GUI");
        Container c = jf.getContentPane();
        c.setLayout(new BorderLayout());
        c.add(new JButton("Up"), BorderLayout.NORTH);
        c.add(new JButton("Down"), BorderLayout.SOUTH);
        c.add(new JButton("Left"), BorderLayout.WEST);
        c.add(new JButton("Right"), BorderLayout.EAST);
        JPanel jp = new JPanel();
        jp.setLayout(new FlowLayout());
        jp.add(new JButton("Yes"));
        jp.add(new JButton("Maybe"));
        jp.add(new JButton("Sometimes"));
        jp.add(new JButton("Never"));
        c.add(jp, BorderLayout.CENTER);
        jf.setSize(600, 300);
        jf.show();
    }
}
```

(A) Sketch the picture when this code is run:



8. Searching a graph

Atlanta's streets were laid out by following indian trails through the woods, as illustrated in the following picture. We need to find the best route from A to K.



- (A) We first try a Depth-First Search (DFS), selecting the next destination in alphabetical order. What is the final path of a DFS from A to K? What is the total cost of that path?
- (B) Hmmmm – we suspect that might not be the best path and decide to try Breadth-First Search (BFS) instead, still using alphabetical selection. What is the final path and cost of that result?
- (C) We're sure that's not the best path; so you try a Greedy search (select the next destination by the least cost of travel to it). What is the final path and cost of that result?
- (D) What is the best path and cost of that result? What technique could possibly extract that path from this graph? Explain briefly.

9. Tracing

Consider the following code saved in a file called `Child.java`:

```
class Parent {
    int age;
    String name;
    public Parent(String n){
        name = n;
        age = 42;
        printIt("parent constructor ");
    }

    public String toString() {
        return name + " (age: " + age + ")";
    }

    public void printIt(String str){
        System.out.println(str + this);
    }
}
// -----
public class Child extends Parent{
    public Child(String n, int v){
        super(n);
        age = v;
        printIt("child constructor ");
    }

    public static void main(String[] args) {
        Child fred = new Child("Fred", 11);
        Parent sally = new Parent("Sally");
        System.out.println(fred + " is a child of " + sally);
    }
}
```

(A) Will it compile correctly using `>>! javac Child.java`?

(B) If not, indicate the error(s) and correct the code above.

(C) If it will compile, what will be the result if you ran the `Child` class using `>>! java Child`?

10. True or False

For each of the following statements, if the statement is true, write T. If it is false, write F and in the space provided, write the correct information to replace the underlined word(s).

A. ____ All child classes have direct access to the parent's private data types and methods.

Replacement: _____

B. ____ Dynamic binding allows the Java Virtual Machine to choose the most appropriate method at run-time.

Replacement: _____

C. ____ A Stack is a FIFO data structure.

Replacement: _____

D. ____ Casting is the only way to gain access to a method in the parent class that you have redefined in the child class.

Replacement: _____

E. ____ The constructor of a class runs only when a new object is created.

Replacement: _____

11. Coding

You are given the following class that contains a queue of integers. As you can see, the constructor enqueues the following set of numbers:

12, 0, 41, -3, 5, -1, 999, 17

Write the method **averageRainfall()** that will dequeue each number in turn from the queue until the 999 is retrieved. These are amounts of rainfall. Negative numbers are clearly a mistake. Your method should return the average of the positive numbers in the list. You do not need to be concerned about emptying the queue. (Hint: The average is the total of the positive numbers divided by the average of just the positive numbers.)

```
public class Rainfall {
    Queue q;

    public Rainfall() {
        q = new Queue();
    }

    public void add(int value) {
        q.enqueue(value);
    }

    public double averageRainfall() {

}

}

public static void main(String[] args) {
    Rainfall rnf = new Rainfall();
    rnf.add(12);
    rnf.add(0);
    rnf.add(41);
    rnf.add(-3);
    rnf.add(5);
    rnf.add(-1);
    rnf.add(999);
    rnf.add(17);
    System.out.println( "Average rainfall is: " + rnf.averageRainfall() );
} // end of main(String[] args)
} // end of class Rainfall
```

12. Graphics

The following code is the `paintComponent()` method for a canvas. In the space below, sketch the resulting picture. Label each significant location with its coordinates.

```
public void paintComponent(Graphics g) {  
  
    Dimension d;  
    int x[] = { 300, 450, 150};  
    int y[] = { 50, 250, 250};  
  
    g.setColor(Color.white);  
    d = getSize();  
    g.fillRect(0, 0, d.width, d.height);  
    g.setColor(Color.red);  
    g.fillRect(200, 75, 30, 200);  
    g.fillRect(175, 250, 250, 250);  
                                g.setColor(new Color(150,50,0));  
    g.fillRect(90, 300, 20, 200);  
    g.setColor(Color.green);  
    g.fillOval(50, 250, 100, 100);  
    g.setColor(Color.black);  
    g.fillPolygon(x, y, 3);  
}
```

13. Matching Terms

Choose the most appropriate definition for the following terms:

Ans	Term	Definition
	Object Oriented Programming	A. The ability of a method to elicit different behavior depending on the specific object on which it is invoked.
	Main method	B. Getting a lot of stuff from Grannie.
	Inheritance	C. Blueprint for behavior.
	Polymorphism	D. Program started by Matlab.
	FIFO	E. Selecting the most specific method for an object at run-time.
	Class	F. Selecting the method for an object at compile-time.
	Dynamic Binding	G. The design of a Stack
		H. Description of the methods you could invoke on an object.
		I. A programming style that encapsulates data items with the methods that manipulate them.
		J. Program started by >> !java.
		K. Simulating objects in the real world
		L. The design of a Queue
		M. The means of extending existing classes by adding methods and data.
		N. Specific instance containing data.

15. Matlab Concepts

Matlab defines a polynomial by storing the coefficients in a vector starting with the highest degree term and finishing with the constant term. Thus, the polynomial: $x^2 - 3x + 2$ is stored in Matlab as $p = [1 -3 2]$. Write an m-function that will accept two polynomials, $p1$ and $p2$, and compute their sum, $p3$. Your function should be used as:

```
p3 = psum(p1, p2)
```

As an example, if $p1 = [2 1]$ and $p2 = [1 -3 2]$, then $p3 = [1 -1 3]$.

16. M Functions

Write an m-function that will compute the array product, $C = A .* B$. Your function should accept A and B and return C as follows: `C = amult(A, B)`. Make sure your function checks that A & B are of the same size and issue an error message if not.

17. Matlab Scripts

Write a script that requests the user to enter a course average and will then compute a letter grade using IF statements. Assume that the “curve” to use is stored in a structure where: `grade.A = 90`, `grade.B = 80`, `grade.C = 70`, `grade.D = 60`, `grade.F = 0`

18. Matlab Code Analysis

The following table contains a number of different functions. You are to match up the function letter (A – G) with the description of what it does shown below.

<pre>function res = funcA(x) if x==0 res = 1; else res = x.*funcA(x-1); end</pre>	<pre>function res = funcB(a) b=mod(a,5); if b ~= 0 res = 0; else res = 1; end</pre>
<pre>function res = funcC(cc) A=dlmread(cc,'\t'); A(1:4,:)=[]; loc=find(A(:,5)>=0); res=A(loc,:);</pre>	<pre>function res = funcD(M) [a,b]=size(M); kk=min([a,b]); res = 0; for k=1:kk res = res + M(k,k); end</pre>
<pre>function res = funcE(raw) res(1) = {date}; res(2) = {raw(:,1)}; res(3) = {raw(:,2)}; res(7) = {raw(:,3)}; res(4) = {raw(:,4)-mean(raw(:,4))};</pre>	<pre>function res=funcF(F,x0,x1,t) y0=feval(F,x0); while abs(x1-x0) > t xmid=(x0+x1)./2; ymid=feval(func,xmid); if y0.*ymid < 0 x1=xmid; % else x0=xmid; end end res=x0;</pre>
<pre>function res = funcG(L,m1,m2,x) if m1==m2 res = m1; else; m = fix((m1+m2)./2); if x <= L(m) res = funcG(L,m1,m,x); else res = funcG(L,m+1,m2,x); end end</pre>	

- _____ Reads a tab delimited text file and returns an array containing all data for which column #5 is greater than zero.
- _____ Computes the sum of the elements along the main diagonal of an array
- _____ Computes the factorial function recursively
- _____ Extracts data from a cell array and returns it to the caller
- _____ Finds the root of a function using the bisection method

19. Matlab concepts

- (a) Matlab's basic data type (class) is the "array." Name as many other data types (subclasses) as you can.
- (b) Which Matlab data types can be used to store ANY of the data types?
- (c) Given an array created with the following statement: $A = \text{pi} .* \text{rand}(8, 8)$, write Matlab statements to:
- extract the 3rd column into variable x
 - find the sum of the diagonal elements and assign to y
 - if the A matrix is symmetric (that is if it is equal to its transpose), assign variable sym=1, otherwise =0
- (d) Given $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, $B = \begin{bmatrix} 40 & 10 \\ 30 & 20 \end{bmatrix}$, $x = [1 \ 2]$, $y = \begin{Bmatrix} 3 \\ 4 \end{Bmatrix}$ what is the result of executing:
- $A .* B$
 - $A * B$
 - $B ./ A$
 - $x * y$
 - $y * x$
- (e) What is the difference between $\text{eye}(4, 4) \setminus A$ and $A \setminus \text{eye}(4, 4)$ where A is a nonsingular 4x4 matrix?
- (f) You are given a vector (row). Construct Matlab code to shift all elements left by N positions.
(ex: for N=3, $[1 \ 2 \ 3 \ 4 \ 5 \ 6] \gg [4 \ 5 \ 6 \ 1 \ 2 \ 3]$).

20. Matlab programs

- (a) The following FOR loop computes $y(k)$. Rewrite it to avoid using the FOR loop and instead use Matlab's vector operators.
- ```
for k = 1:61
 t = 6.*pi.*(k-1)./60;
 y(k) = 5.*sin(t) - 3.*cos(2.*t);
end
```

- (b) Consider this algorithm: Given  $N$  (positive integer), if  $N$  is even, divide by 2, otherwise multiply by 3 and add 1 to compute a new value of  $N$ . Repeat this until the answer is 1. Write a Matlab program to compute this and to display at the end of the program: (i) the total number of iterations required, and (ii) the successive values of  $N$  in a row vector.

**21. Matlab functions**

- (a) Describe the differences in namespaces (workspaces) for a script and a function in Matlab.
- (b) Write a Matlab function, `polyadd(p1, p2)` that will add together two polynomials defined using Matlab's polynomial representation (i.e.,  $x^2 + 3x + 2 \rightarrow [1 \ 3 \ 2]$ ). You must assume the polynomials can be of different degrees and that not all terms may be present (nonzero). (i.e., if `p1=[1 3 2]`, `p2=[2 1]`, then `p=polyadd(p1,p2)` yields `p=[1 5 3]`.)

**22. Plotting and data visualization**

- (a) Write a Matlab script to plot the three functions:  $f_1(x) = 0.2x^2$ ,  $f_2(x) = \sin^2(x)$ ,  $f_3(x) = e^{-0.2x}$  for  $0 \leq x \leq 3.5$  using at least 50 points. Make each curve a different color and create axis labels and a legend.

- (b) Construct a Matlab script to plot the surface defined by  $z = c \sin(2\pi axy)$  where  $a=3$ ,  $c=0.25$  over  $-1 \leq x, y \leq +1$ . Explain what you must do (or show code) to create a surface with smooth (interpolated) coloring.

**23. Structures and cell arrays**

- (a) Write Matlab statements that will create the 5<sup>th</sup> element in a structure array, `student(5)`, containing:
- ```
name = George Burdell
SID = 123456789
prism = gta0000a
class = sophomore
term = 200301
```
- (b) Now add an additional nested structure called “classes” where for the above student you should store for `classes(3)`:
- ```
name = COE1361
section = C
instructor = Craig
exams = [72, 91, 88]
final = 93
```
- (c) Write Matlab code to compute the course grade for George using:  $grade = 0.4 * final + 0.6 * (midterm\ average)$  and save this in a new field in `classes(3)` called “grade.”
- (d) We could actually use a cell array to implement a simple stack in Matlab because a cell array can contain any type of data and arrays can easily be extended dynamically. Consider the m-function, `push(s, data)` that adds scalar numeric data to a stack, `s`, (assume `s` has already been created with another “constructor” function) and returns the new stack, `s`.
- ```
function s = push(s, data)
s = [s; data];
```
- Modify this so `s` is a cell array and the data can then be any valid Matlab data type (arrays, strings, struct’s, other cell arrays, etc). You can assume also that the stack, `s`, has already been created by a “constructor” function.

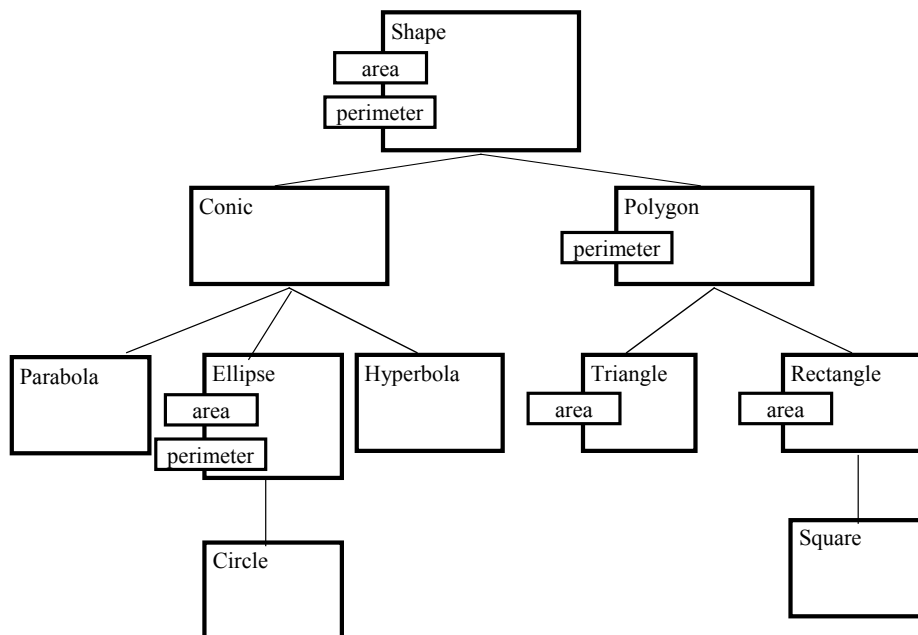
24. OO questions

a) What is an "object-oriented" programming language?

b) What is the difference between a class and an object?

c) Is it legal to have two methods with the same name in the same class? Why?

d) Consider the following class hierarchy:



- (i) If you have a Circle object, which “area” method would it actually use?
- (ii) If you have a Square object, which “**perimeter**” method would it actually use?
- (iii) From the diagram, name the classes that are superclasses of Triangle.
- (iv) If you asked for the area of a Parabola object, which method would be used? Why?
- e) explain the following terms:
- (i) static:
- (ii) constructor:
- (iii) accessor:
- (iii) modifier:
- f) briefly discuss the concept of Polymorphism in the context of a collection of Shapes.

25. Java Graphics

a) Name the three basic component types that make up a Java Swing graphics application. State their purpose and give an example of each.

1. Component:

Purpose:

Example:

2. Component:

Purpose:

Example:

3. Component:

Purpose:

Example:

b) Consider the following code fragment:

```
public void paintComponent(Graphics g) {  
    g.setColor(Color.green);  
    g.fillPolygon({ 80, 220, 200, 100 },  
                 { 100, 100, 120, 120 }, 4);  
    g.setColor(Color.black);  
    g.drawLine( 150, 10, 150, 100 );  
    g.drawLine( 100, 100, 150, 20 );  
    g.drawLine( 150, 20, 200, 100 );  
}
```

Hint: `fillPolygon(...)` consumes three parameters: an array of x values, an array of y values and the number of points in the polygon. It automatically closes the polygon if the first and last points are not the same.

(i) when would such a module normally run?

(ii) sketch the picture being drawn.

26. Java Code

Consider the following code:

```
public class SCoord {
    public double x;
    public double y;

    public SCoord( SCoord p ) {
        x = p.x;
        y = p.y;
    }
    // ----- A -----
    public SCoord( double px, double py ) {
        x = px;
        y = py;
    }

    public SCoord sum(SCoord c) {
        return new SCoord( x + c.x, y + c.y );
    }

    public void shift(SCoord c) {
        x = x + c.x;
        y = y + c.y;
    }

    public double distance(SCoord c) {
        double dx = x - c.x;
        double dy = y - c.y;

        return Math.sqrt((dx*dx) + (dy*dy));
    }

    public String toString() {
        return "[ " + x + ", " + y + " ]";
    }

    public static void main(String args[]) {
        SCoord a = new SCoord( 1, 2 );
        SCoord b = new SCoord( 3, 4 );
        SCoord c = a.sum(b);
        System.out.println("distance from " + a + " to " + c
            + " is " + a.distance(c) );
        a.shift(b);
        System.out.println("a is now " + a + " and b is now " + b );
    }
}
```

a) is the code module following the marker // ----- A ----- legal? Explain.

b) what would be displayed in the Matlab command window if you entered the following:

```
> !java SCoord
```

c) we need to add to the SCoord class a method called *scale* that consumes a number (typed double) produces a new SCoord object with both x and y multiplied by that number. Write the method in the space below, and write a large ← B on the listing above indicating where it should be inserted.

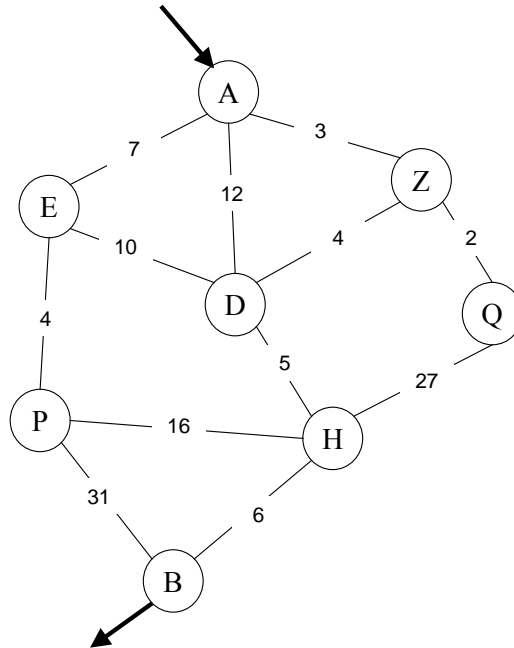
d) we need to test the new *scale* method by adding code in the main module. Write in the space below the line necessary to test it by printing out the result of scaling the SCoord a by a factor of 3. Write a large ← C on the listing above indicating where this line should be inserted.

e) write below the resulting output when you again enter this in the command window:

```
> !java SCoord
```

27. Searching a graph

It's a well known fact that pirates love treasure. Captain Jim has asked you to draw up a course from the following undirected graph of interconnected islands. He wants to go from island A to island B.



- a) He first suggests a Breadth-First Search (BFS), selecting adjacent islands in alphabetical order. What is the final path of a BFS from A to B? What is the total cost of that path?
- b) Hmm – he suspects that might not be the best path and suggests you try Depth-First Search (DFS) instead, still using alphabetical selection. What is the final path and cost of that result?
- c) Look out – he's sure that's not the best path; being pirates, you naturally suggest a Greedy search (select the next island by the least cost of travel to it). What is the final path and cost of that result?
- d) "Avast, ye swabs!" he yells, (pirate for "No, you idiot!") "I can see the best path with me own eyes!" What is the best path and cost of that result? What technique could possibly extract that path from this graph? Explain briefly.

28. Short answers

a). Compare the function of the Matlab “save” command and the “dlmwrite” function.

b) Give an example of polymorphism in Matlab.

c) (i) What is the file extension of Matlab data files?

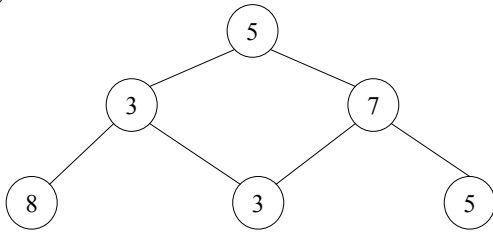
(ii) What is the file extension of Matlab script files?

(iii) What is the file extension for a file containing a compiled Java file?

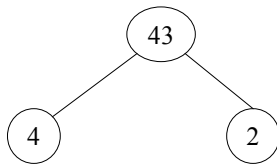
(iv) What is the file extension for a file containing java source code?

d) Which of the following is not a binary tree and why?

i)



ii)

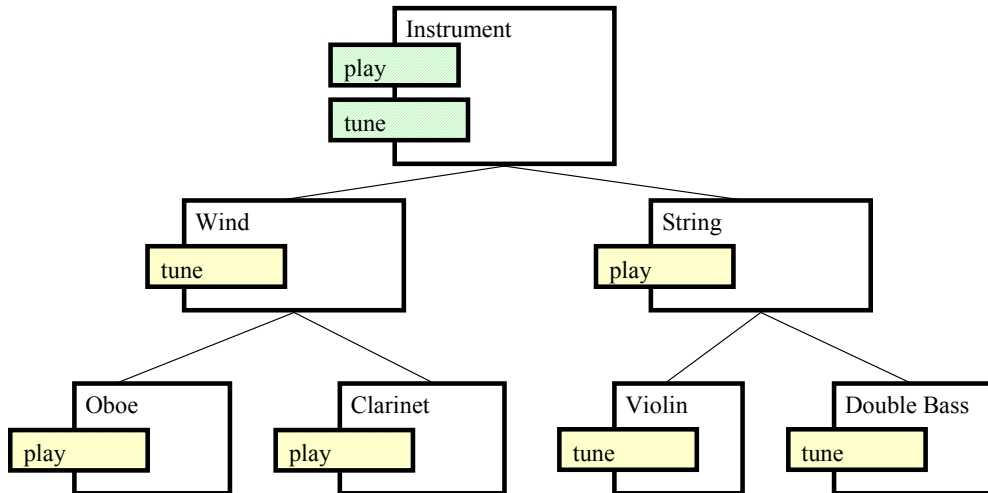


iii)



30. Inheritance

Consider the following class hierarchy:



- If you have an Oboe object, which “**play**” method would it actually use?
- If you have a Violin object, which “**play**” method would it actually use?
- From the diagram, name a class that is a superclass of String.

31. Code

Consider the following code and answer the questions (a through f), each of which pertains to the code immediately following the question

```
public class SearchStack {

    private ListNode head;
    private int ID;
    // a. what does static mean?
    private static int numberOfStacks = 0;

    // b. What is this thing called? When does it run?
    public SearchStack() {
        head = null;
        ID = ++numberOfStacks;
    }

    public void push(Object o) { ... } // left out the guts
    public boolean isEmpty() { return (head == null); }

    public Object pop() throws Exception {
        if(isEmpty())
            // c. What is happening here?
            throw new Exception("Stack pop underflow");
        Object res = head.data;
        head = head.next;
        return res;
    };

    // d. what is this method for?
    public String toString() {
        String res = "SearchStack(" + ID + ")\n";
        ListNode here = head;

        while ( here != null ) {
            // e. Why does this line of code work?
            res = res + here.data + "\n";
            here = here.next;
        }
        return res;
    }

    public static void main(String[] args) {
        // f. what is the function of new?
        SearchStack s = new SearchStack();

        System.out.println("Empty stack is " + s);
        s.push("Fred");
        System.out.println("With Fred on it: " + s);
        s.push("Lucy");
        System.out.println("With Fred and Lucy on it: " + s);
    }
}
```

```
}  
}
```

g. In your MatLab command window, what happens when you type:

```
>> my_S_queue = SearchStack()
```

h. What should you have typed?

i. Why is this different from typing the following?

```
>> !java SearchStack
```

l. What will you see in the command window when you type

```
>> !java SearchStack
```

32. Extra Credit

If you're finished early and bored, write a new method for the SearchStack class that will look and see if a specific object is in the stack. It will consume an Object and return a boolean result.