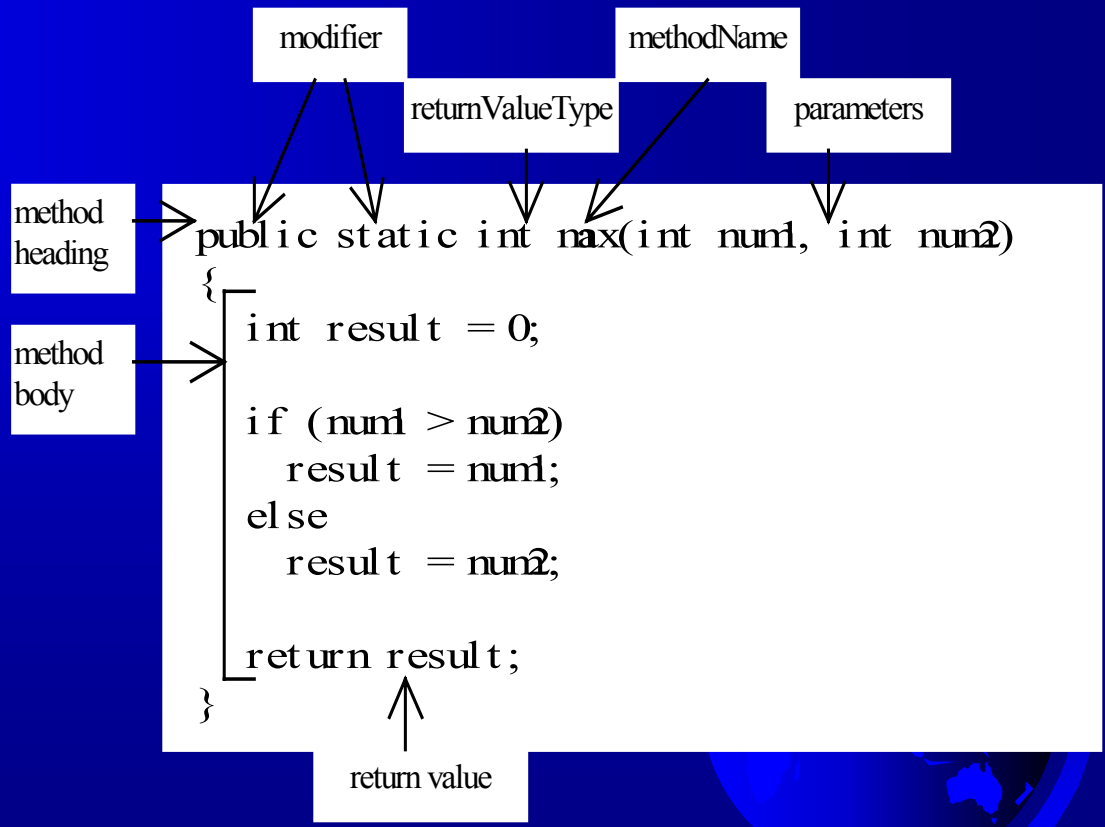
Chapter 4: Methods

- Introducing Methods
- Declaring Methods
- Calling Methods
- Passing Parameters
- Pass by Value
- Overloading Methods
- Method Abstraction
- The `Math` Class
- Recursion (Optional)

Introducing Methods

A method is a collection of statements that are grouped together to perform an operation.

Method Structure

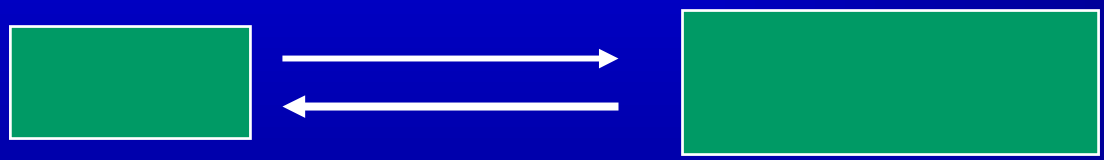


Declaring Methods

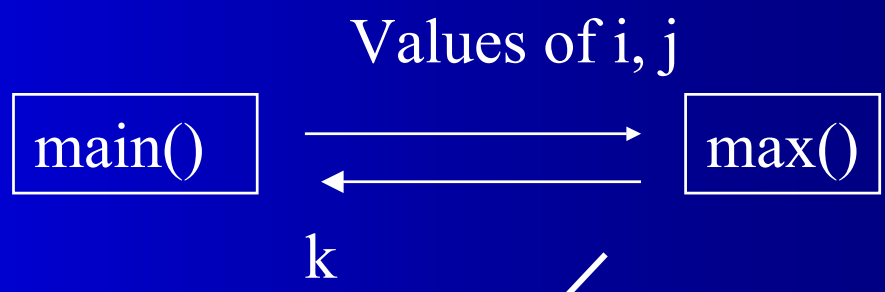
```
public static int max(int num1,
  int num2)
{
   if (num1 > num2)
      return num1;
   else
      return num2;
}
```

Calling Methods

- A method can be called from another method. It is named as called method. The method call other method is named as calling method.

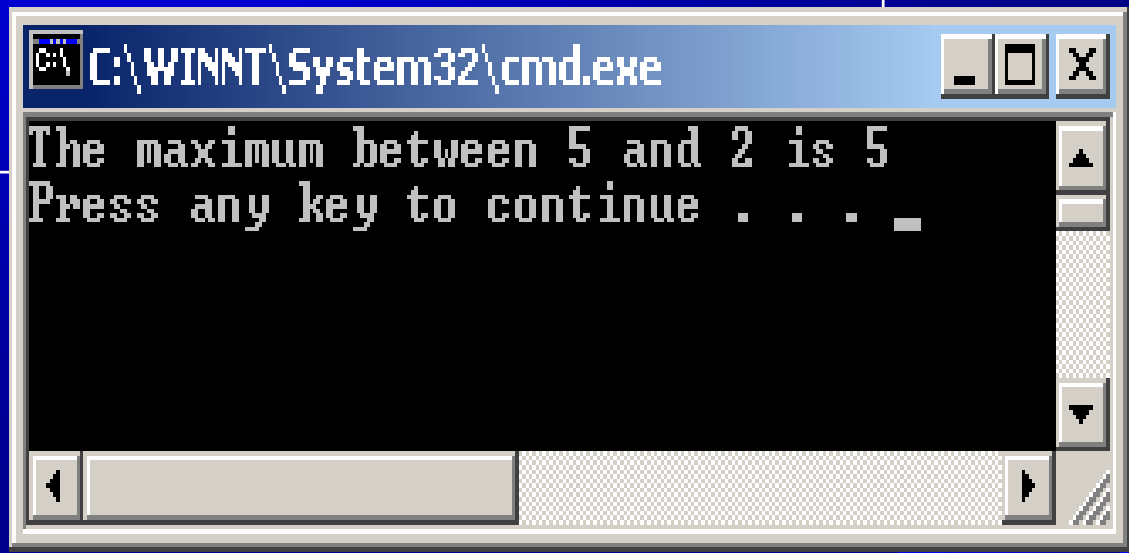


- Example 4.1 Testing the `max` method
- This program demonstrates calling a method max to return the largest of the `int` values




```
public class TestMax
{
  // Main method
  public static void main(String[] args)
  {
    int i = 5;
    int j = 2;
    int k = max(i, j);
    System.out.println("The maximum between " + i +
      " and " + j + " is " + k);
  }
```

```
// A method for finding a max between two numbers
 static int max(int num1, int num2)
 {
   if (num1 > num2)
     return num1;
   else
     return num2;
 }
}
```



Passing Parameters

In calling method:

```
nPrintln("List my name is seven times.", 7);
```

In called method definition

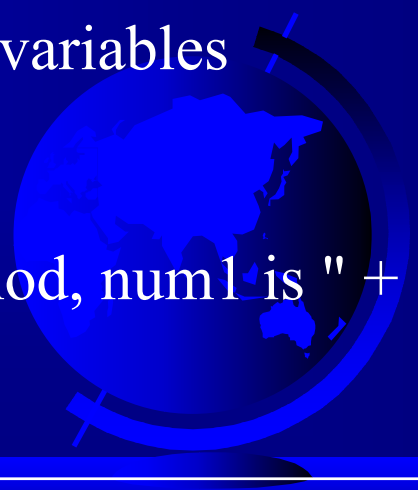
```
void nPrintln(String message, int n)
{
  for (int i=0; i<n; i++)
    System.out.println(message);
}
```

Pass by Value

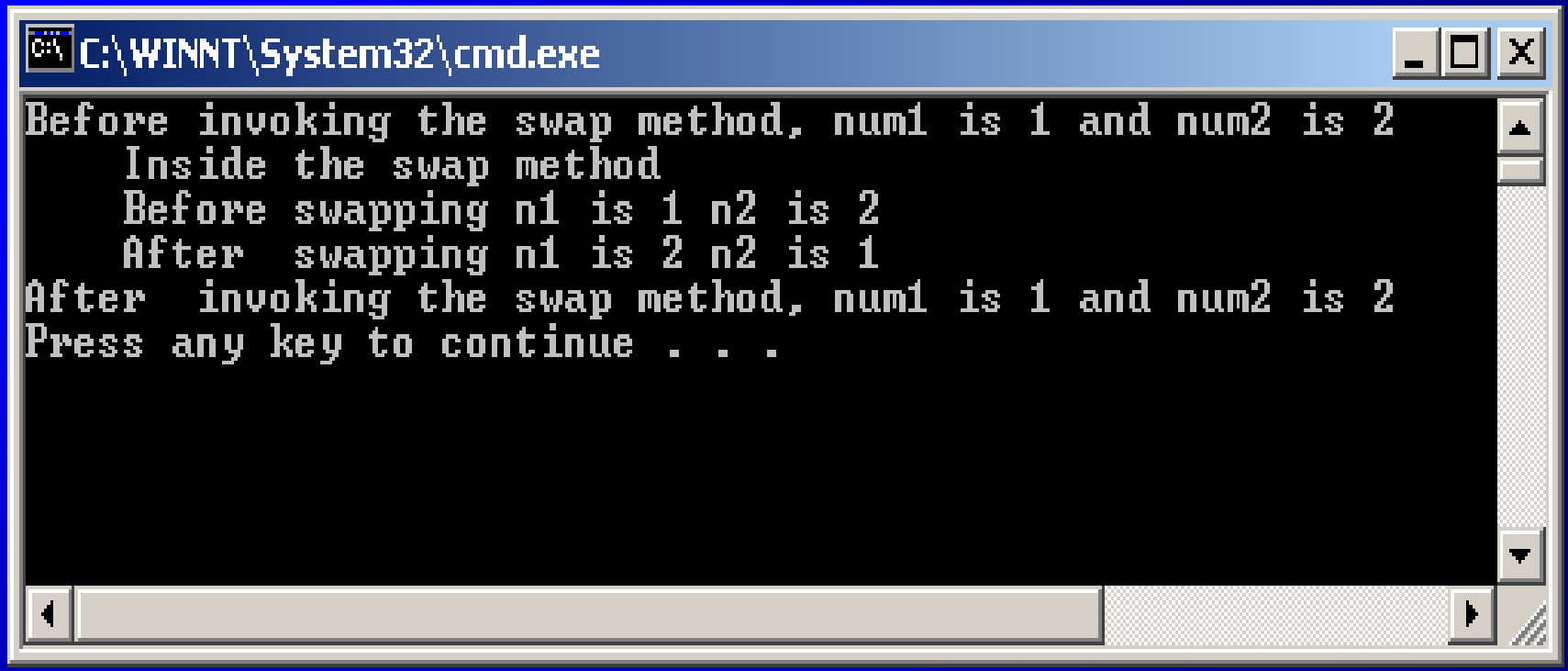
Example 4.2 Testing Pass by value

This program demonstrates passing values to the methods.

```
// TestPassByValue.java: Demonstrate passing values to methods
public class TestPassByValue
{
  public static void main(String[] args)
  {
    // Declare and initialize variables
    int num1 = 1;
    int num2 = 2;
    System.out.println("Before invoking the swap method, num1 is " +
      num1 + " and num2 is " + num2);

    // Invoke the swap method to attempt to swap two variables
    swap(num1, num2);

    System.out.println("After  invoking the swap method, num1 is " +
      num1 + " and num2 is " + num2);
  }
```



```
// TestPassByValue.java: Demonstrate passing values to methods

  // The method for swapping two variables
  static void swap(int n1, int n2)
  {
    System.out.println("    Inside the swap method");
    System.out.println("    Before swapping n1 is " + n1
      + " n2 is " + n2);
    // Swapping n1 with n2
    int temp = n1;
    n1 = n2;
    n2 = temp;

    System.out.println("    After  swapping n1 is " + n1
      + " n2 is " + n2);
  }
}
```


C:\WINNT\System32\cmd.exe
Before invoking the swap method, num1 is 1 and num2 is 2
Inside the swap method
Before swapping n1 is 1 n2 is 2
After swapping n1 is 2 n2 is 1
After invoking the swap method, num1 is 1 and num2 is 2
Press any key to continue . . .

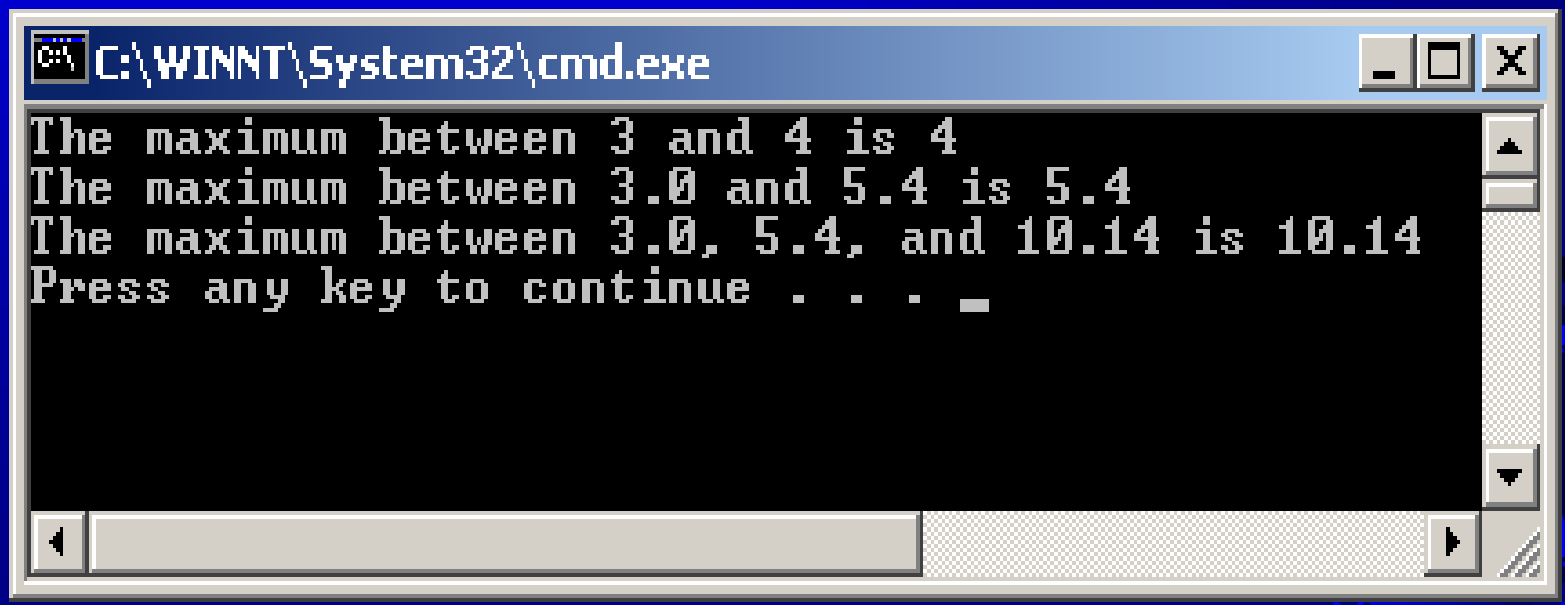
Overloading Methods

- Multiple method can share with same name
- Example 4.3 Overloading three `max` Methods

```
// TestMethodOverloading.java: Demonstrate method overloading
public class TestMethodOverloading
{
  // Main method
  public static void main(String[] args)
  {
    // Invoke the max method with int parameters
    System.out.println("The maximum between 3 and 4 is "
      + max(3, 4));
// Invoke the max method with the double parameters
    System.out.println("The maximum between 3.0 and 5.4 is "
      + max(3.0, 5.4));

    // Invoke the max method with three double parameters
    System.out.println("The maximum between 3.0, 5.4, and 10.14 is "
      + max(3.0, 5.4, 10.14));
  }
```

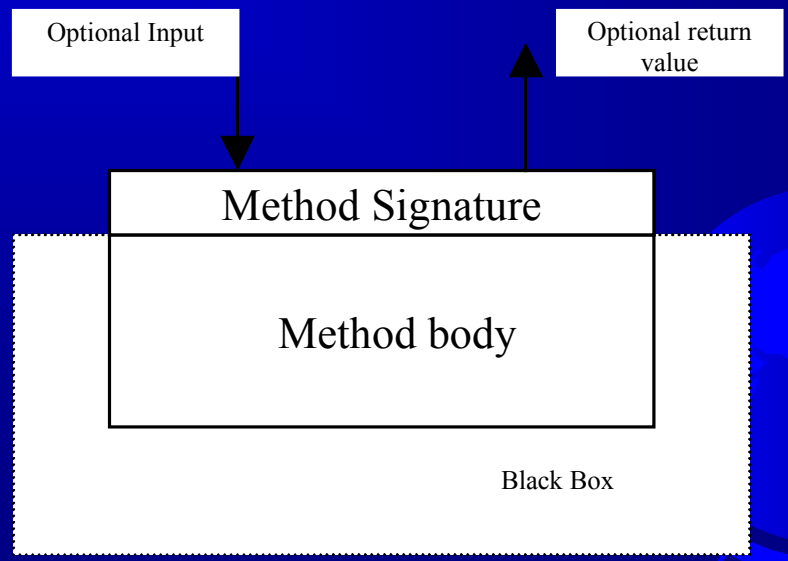
```
// Find the max between two int values
 static int max(int num1, int num2)
 {
   if (num1 > num2)
     return num1;
   else
     return num2;
 }

 // Find the max between two double values
 static double max(double num1, double num2)
 {
   if (num1 > num2)
     return num1;
   else
     return num2;
 }
```

```
  // Find the max among three double values
  static double max(double num1, double num2, double num3)
  {
    return max(max(num1, num2), num3);
  }
}
```



Method Abstraction

You can think of the method body as a black box that contains the detailed implementation for the method. System.out.println(), or MyInput.readDouble()



The `Math` Class

- Class constants:
  - `PI`
  - `E`
- Class methods:
  - Trigonometric Methods
  - Exponent Methods
  - Miscellaneous

Trigonometric Methods

- `sin(double a)`
- `cos(double a)`
- `tan(double a)`
- `acos(double a)`
- `asin(double a)`
- `atan(double a)`

Exponent Methods

- `exp(double a)`

  Returns `e` raised to the power of `a`.

- `log(double a)`

  Returns the natural logarithm of `a`.

- `pow(double a, double b)`

  Returns `a` raised to the power of `b`.

- `sqrt(double a)`

  Returns the square root of `a`.

Miscellaneous Methods

- `max(a, b)` and `min(a, b)`

  Returns the maximum or minimum of two parameters.

- `abs(a)`

  Returns the absolute value of the parameter.

- `random()`

  Returns a random `double` value in the range [0.0, 1.0).

Using Math Methods

Example 4.4 Computing Mean and Standard Deviation

Generate 10 random numbers and compute the mean and standard deviation

$$mean = \frac{\sum_{i=1}^{n} x_i}{n}$$

$$deviation = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - mean}{n-1}}$$

```
// ComputeMeanDeviation.java: Demonstrate using the math methods
public class ComputeMeanDeviation
{
  // Main method
  public static void main(String[] args)
  {
    int number = 0; // Store a random number
    double sum = 0; // Store the sum of the numbers
    double squareSum = 0; // Store the sum of the squares

    // Create 10 numbers, find its sum, and its square sum
    for (int i=1; i<=10; i++)
    {
      // Generate a new random number
      number = (int)Math.round(Math.random()*1000);
      System.out.println(number);
```

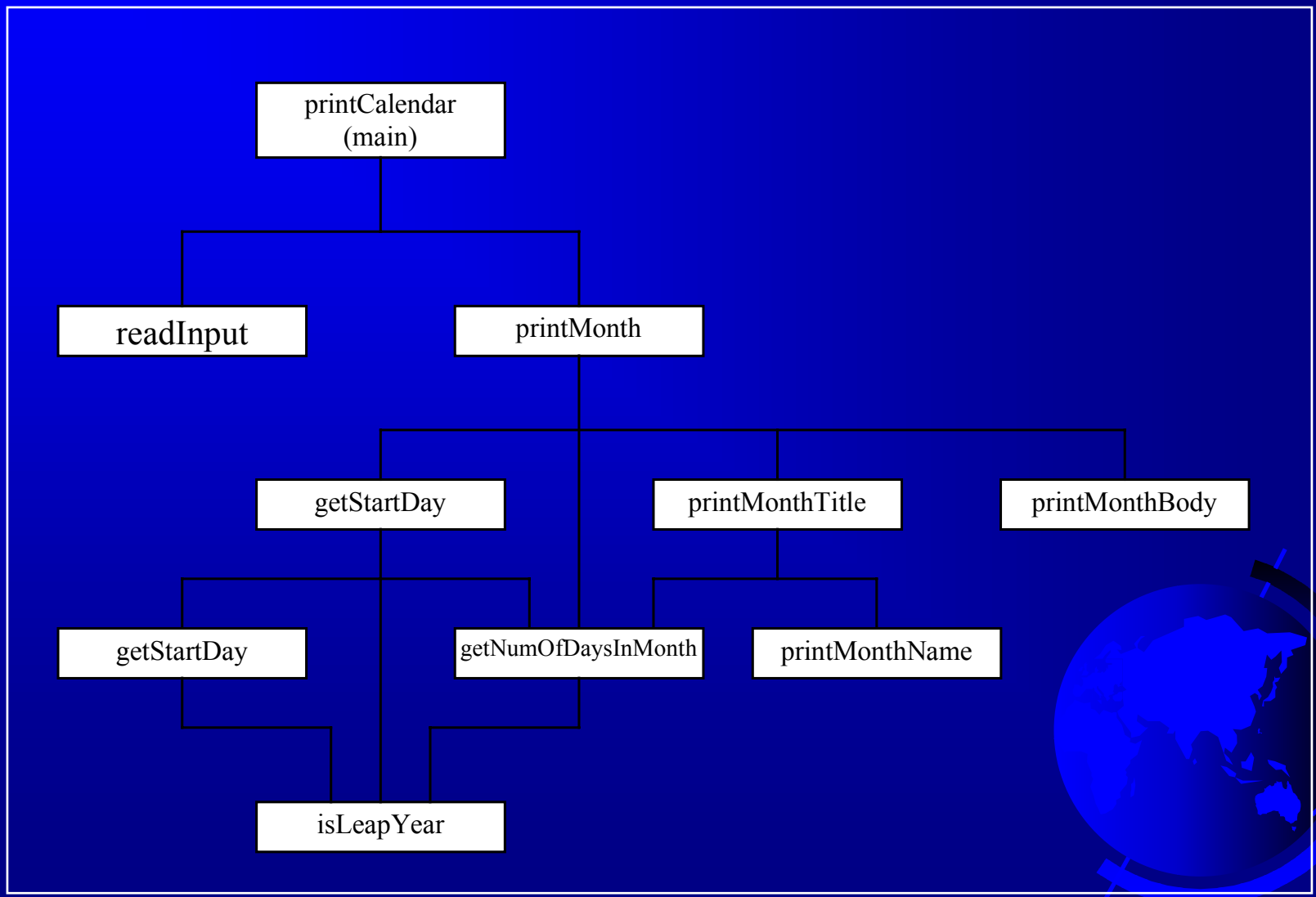
```
// Add the number to sum
      sum += number;
      // Add the square of the number to squareSum
      squareSum += Math.pow(number, 2); // Same as number*number;
    }
    // Find mean
    double mean = sum/10;

    // Find standard deviation
    double deviation = Math.sqrt((squareSum - mean)/(10 - 1));

    // Display result
    System.out.println("The mean is " + mean);
    System.out.println("The standard deviation is " + deviation);
  }
}
```

Case Studies

Example 4.5 Displaying Calendars

The program reads in the month and year and displays the calendar for a given month of the year.

Design Diagram



```
// PrintCalendar.java: Print a calendar for a given month in a year
public class PrintCalendar
{
  // Main method
  public static void main(String[] args)
  {
    // The user enters year and month
    System.out.print("Enter full year: ");
    int year = MyInput.readInt();
    System.out.print("Enter month in number between 1 and 12: ");
    int month = MyInput.readInt();

    // Print calendar for the month of the year
    printMonth(year, month);
  }
```

```
// Print the calendar for a month in a year
 static void printMonth(int year, int month)
 {
   // Get start day of the week for the first date in the month
   int startDay = getStartDay(year, month);

   // Get number of days in the month
   int numOfDaysInMonth = getNumOfDaysInMonth(year, month);

   // Print headings
   printMonthTitle(year, month);

   // Print body
   printMonthBody(startDay, numOfDaysInMonth);
 }
```

```
// Get the start day of the first day in a month
 static int getStartDay(int year, int month)
 {
   // Get total number of days since 1/1/1800
   int startDay1800 = 3;
   long totalNumOfDays = getTotalNumOfDays(year, month);

   // Return the start day
   return (int)((totalNumOfDays + startDay1800) % 7);
 }
```

```
// Get the total number of days since Jan 1, 1800
 static long getTotalNumOfDays(int year, int month)
 {
   long total = 0;

   // Get the total days from 1800 to year -1
   for (int i = 1800; i < year; i++)
   if (isLeapYear(i))
     total = total + 366;
   else
     total = total + 365;

   // Add days from Jan to the month prior to the calendar month
   for (int i = 1; i < month; i++)
     total = total + getNumOfDaysInMonth(year, i);
   return total;
 }
```

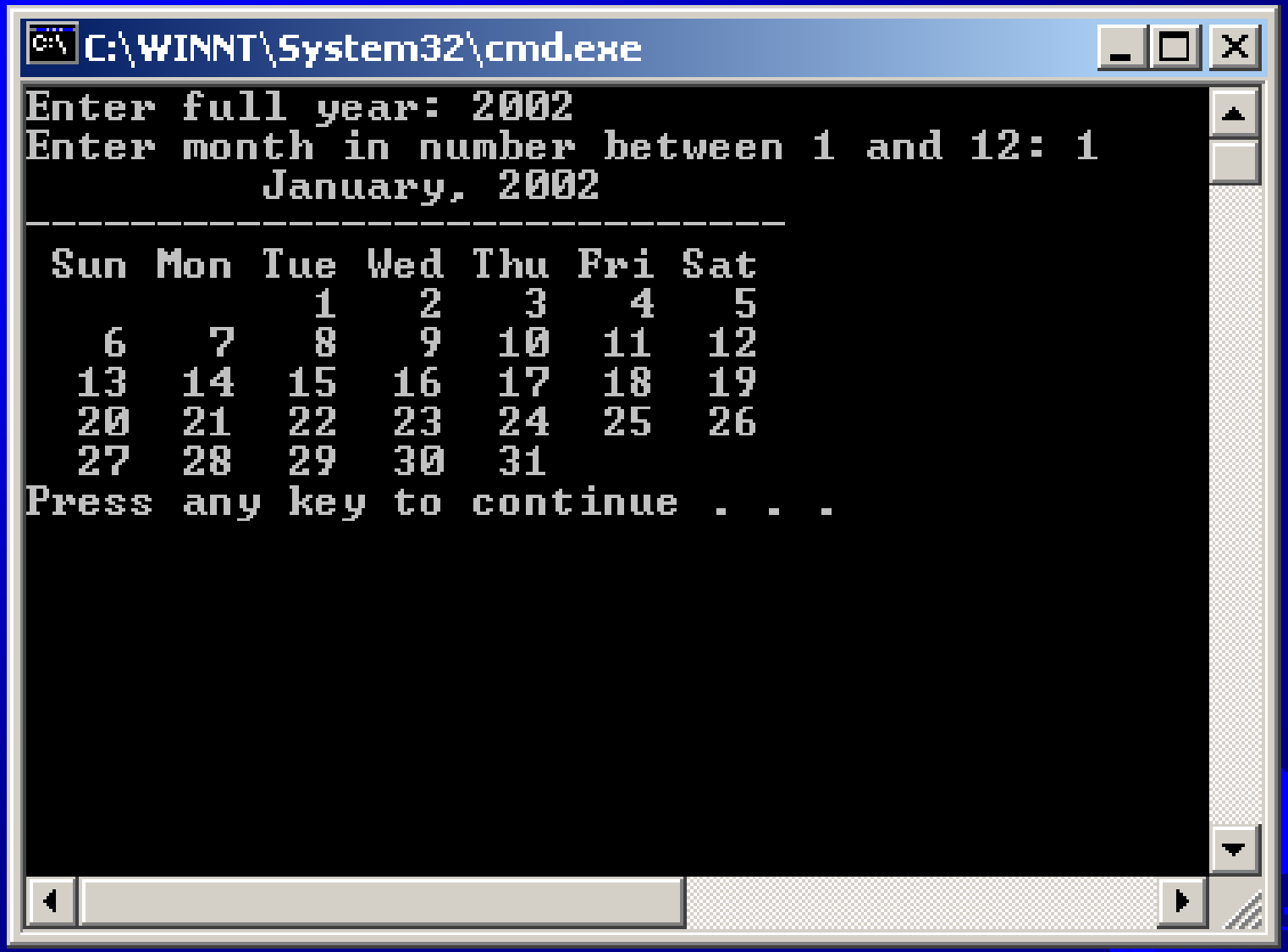
```
// Get the number of days in a month
 static int getNumOfDaysInMonth(int year, int month)
 {
   if (month == 1 || month==3 || month == 5 || month == 7 ||
     month == 8 || month == 10 || month == 12)
     return 31;

   if (month == 4 || month == 6 || month == 9 || month == 11)
     return 30;

   if (month == 2)
     if (isLeapYear(year))
       return 29;
     else
       return 28;
   return 0; // If month is incorrect.
 }
```

```
// Determine if it is a leap year
  static boolean isLeapYear(int year)
  {
    if ((year % 400 == 0) || ((year % 4 == 0) && (year % 100 != 0)))
      return true;

    return false;
  }

  // Print month body
  static void printMonthBody(int startDay, int numOfDaysInMonth)
  {
    // Pad space before the first day of the month
    int i = 0;
    for (i = 0; i < startDay; i++)
      System.out.print("    ");
```

```
for (i = 1; i <= numOfDaysInMonth; i++)
    {
     if (i < 10)
       System.out.print("   " + i);
     else
       System.out.print("  " + i);

     if ((i + startDay) % 7 == 0)
       System.out.println();
    }

   System.out.println();
  }
```

```
// Print the month title, i.e. May, 1999
  static void printMonthTitle(int year, int month)
  {
    System.out.println("         "+getMonthName(month)+", "+year);
    System.out.println("---------------------------");
    System.out.println(" Sun Mon Tue Wed Thu Fri Sat");
  }

  // Get the English name for the month
  static String getMonthName(int month)
  {
    String monthName = null;
    switch (month)
    {
      case 1: monthName = "January"; break;
      case 2: monthName = "February"; break;
      case 3: monthName = "March"; break;
```

```
    case 4: monthName = "April"; break;
     case 5: monthName = "May"; break;
     case 6: monthName = "June"; break;
     case 7: monthName = "July"; break;
     case 8: monthName = "August"; break;
     case 9: monthName = "September"; break;
     case 10: monthName = "October"; break;
     case 11: monthName = "November"; break;
     case 12: monthName = "December";
    }

    return monthName;
  }
}
```


C:\WINNT\System32\cmd.exe
Enter full year: 2002
Enter month in number between 1 and 12: 1
January, 2002
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4 5
6 7 8 9 10 11 12
13 14 15 16 17 18 19
20 21 22 23 24 25 26
27 28 29 30 31
Press any key to continue . . .

Recursion (Optional)

Example 4.6 Computing Factorial

0!=1

1!=1

2!=2x1!=1

3!=3x2x1=6

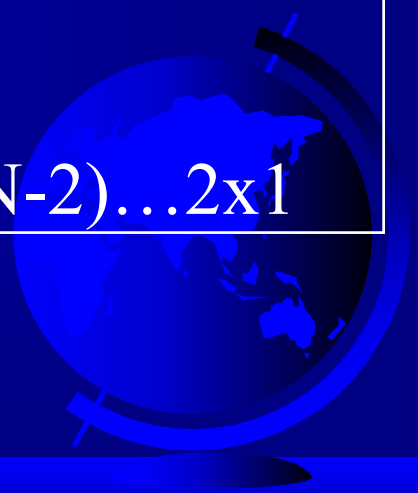
4!=4x3!=4x3x2x1=24

…

N!=Nx(N-1)!=Nx(N-1)x(N-2)!=Nx(N-1)x(N-2)…2x1

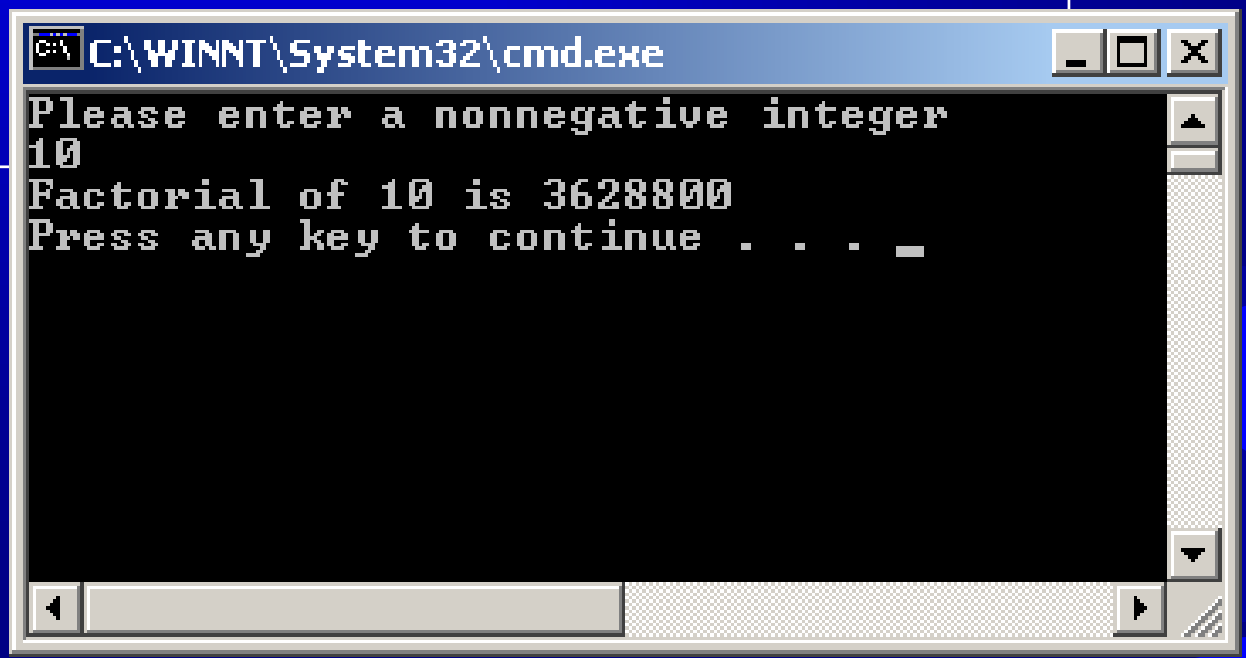
factorial(0) = 1;

factorial(n) = n*factorial(n-1);



```
// ComputeFactorial.java: Compute factorial of an integer
public class ComputeFactorial
{
  public static void main(String[] args)
  {
    // Prompt the user to enter an integer
    System.out.println("Please enter a nonnegative integer");
    int n = MyInput.readInt();

    System.out.println("Factorial of " + n + " is " + factorial(n));
  }
```

```
// Recursive method for computing factorial of n
  static long factorial(int n)
  {
    if (n == 0) // Stopping condition
      return 1;
    else
      return n*factorial(n-1); // Call factorial recursively
  }
}
```



Fibonnaci Numbers

Example 4.7 Computing Finonacci Numbers

Find Fibonacci numbers using recursion.

fib(0) = 1;

fib(1) =1;

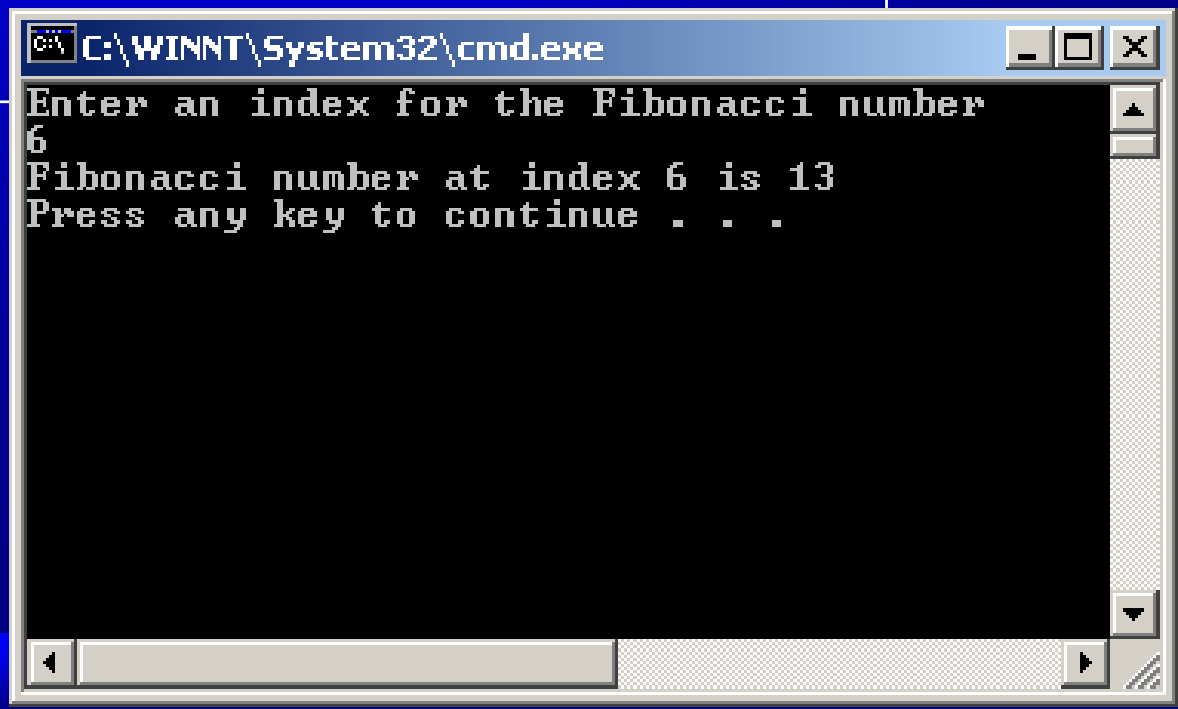
fib(2)=fib(1)+fib(0);

fib(3)=fib(2)+fib(1);

fib(n) = fib(n-2) + fib(n-1); n>=2

```
// ComputeFibonacci.java: Find a Fibonacci number for a given index
public class ComputeFibonacci
{
  // Main method
  public static void main(String args[])
  {
    // Read the index
    System.out.println("Enter an index for the Fibonacci number");
    int n = MyInput.readInt();

    // Find and display the Fibonacci number
    System.out.println("Fibonacci number at index " + n +
      " is "+fib(n));
  }
```

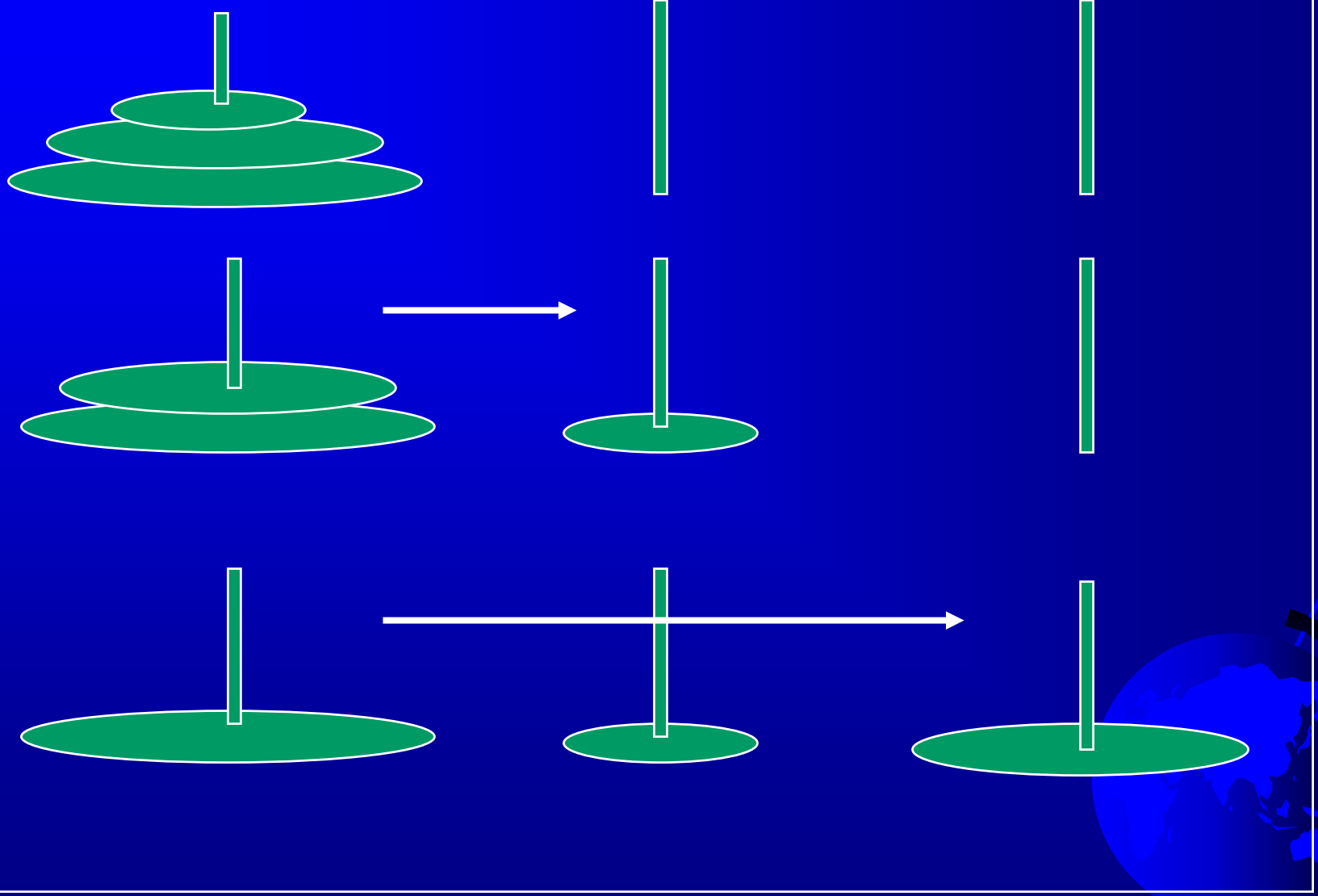
```
// The method for finding the Fibonacci number
public static long fib(long n)
{
  if ((n==0)||(n==1))  // Stopping condition
    return 1;
  else  // Reduction and recursive calls
    return fib(n-1) + fib(n-2);
}
}
```

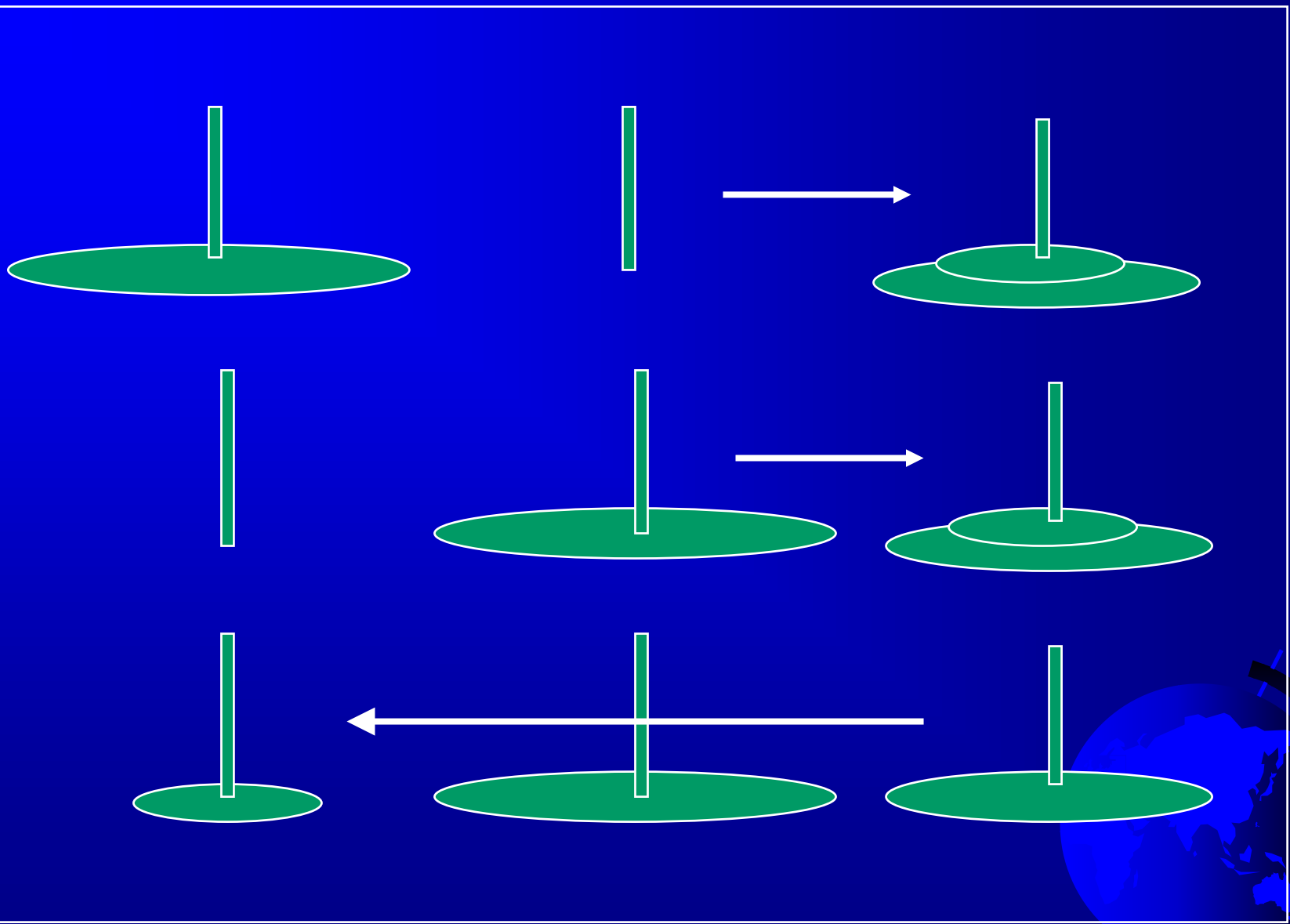


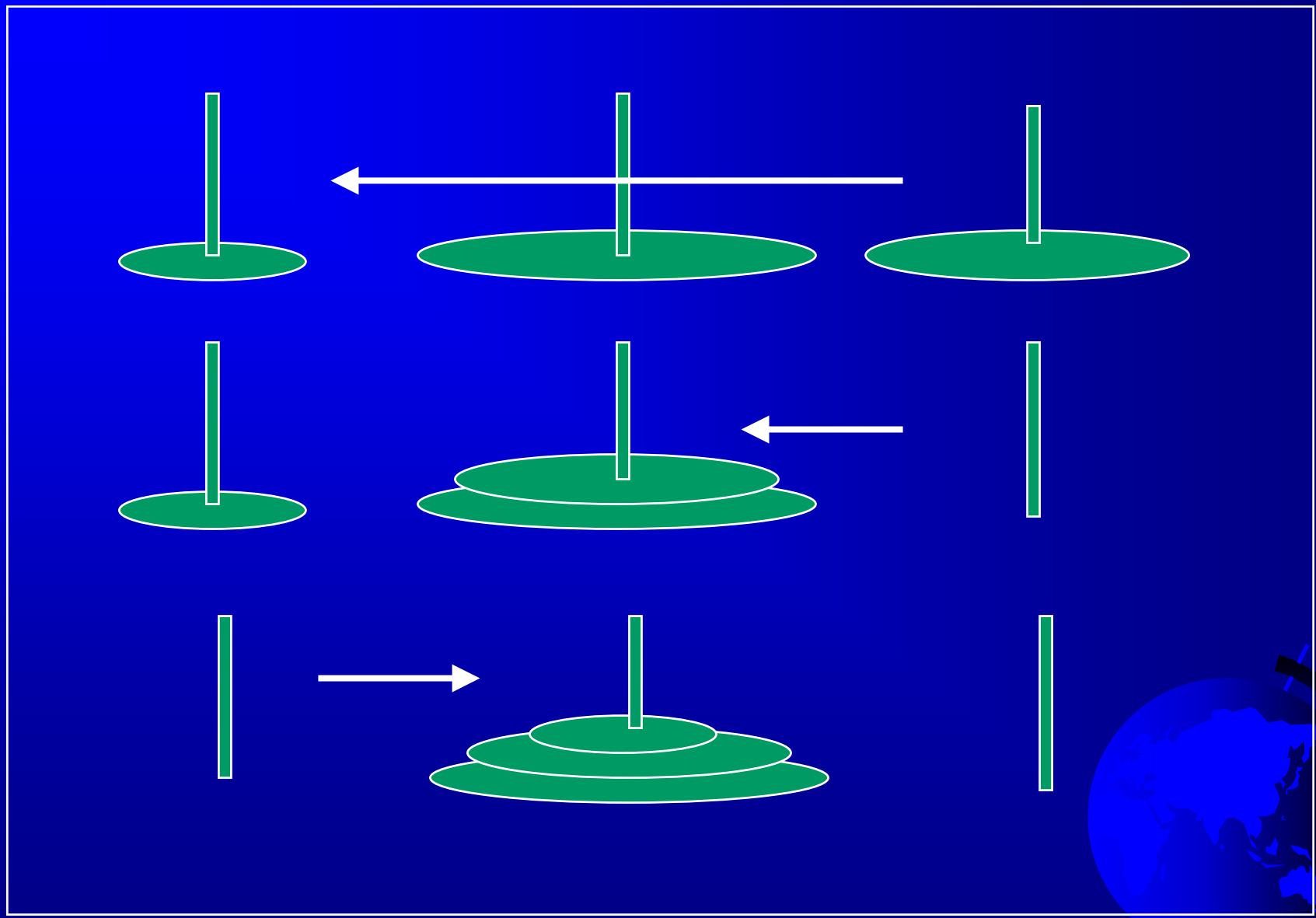
Towers of Hanoi

Example 4.8 Solving the Towers of Hanoi Problem

Solve the towers of Hanoi problem.

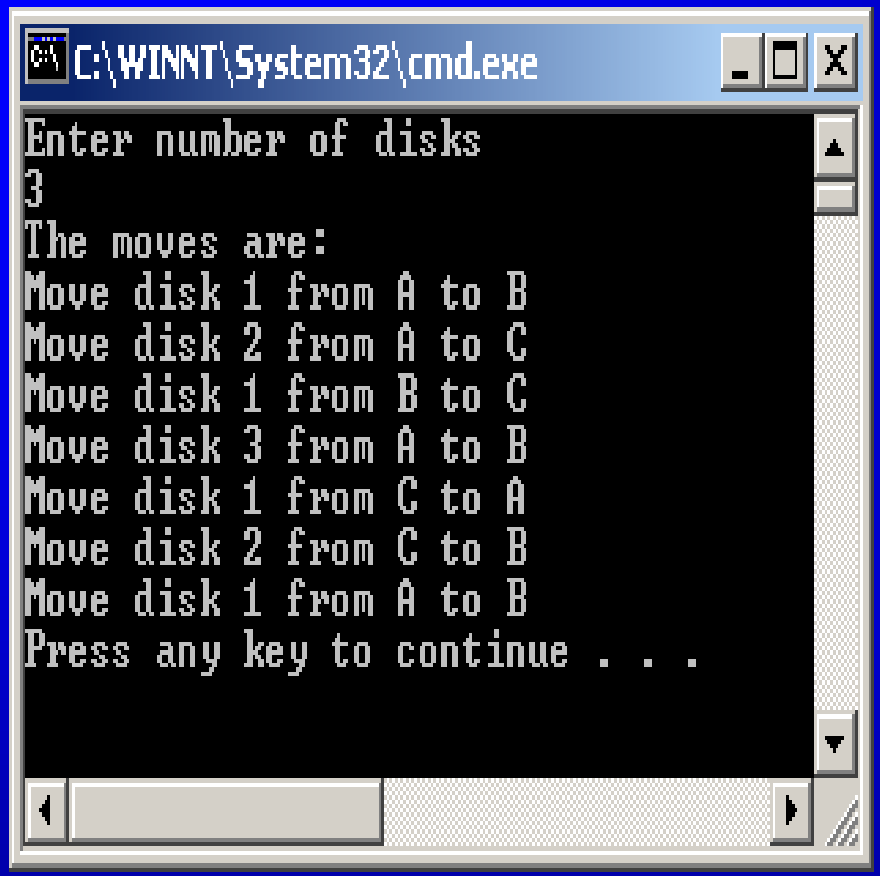


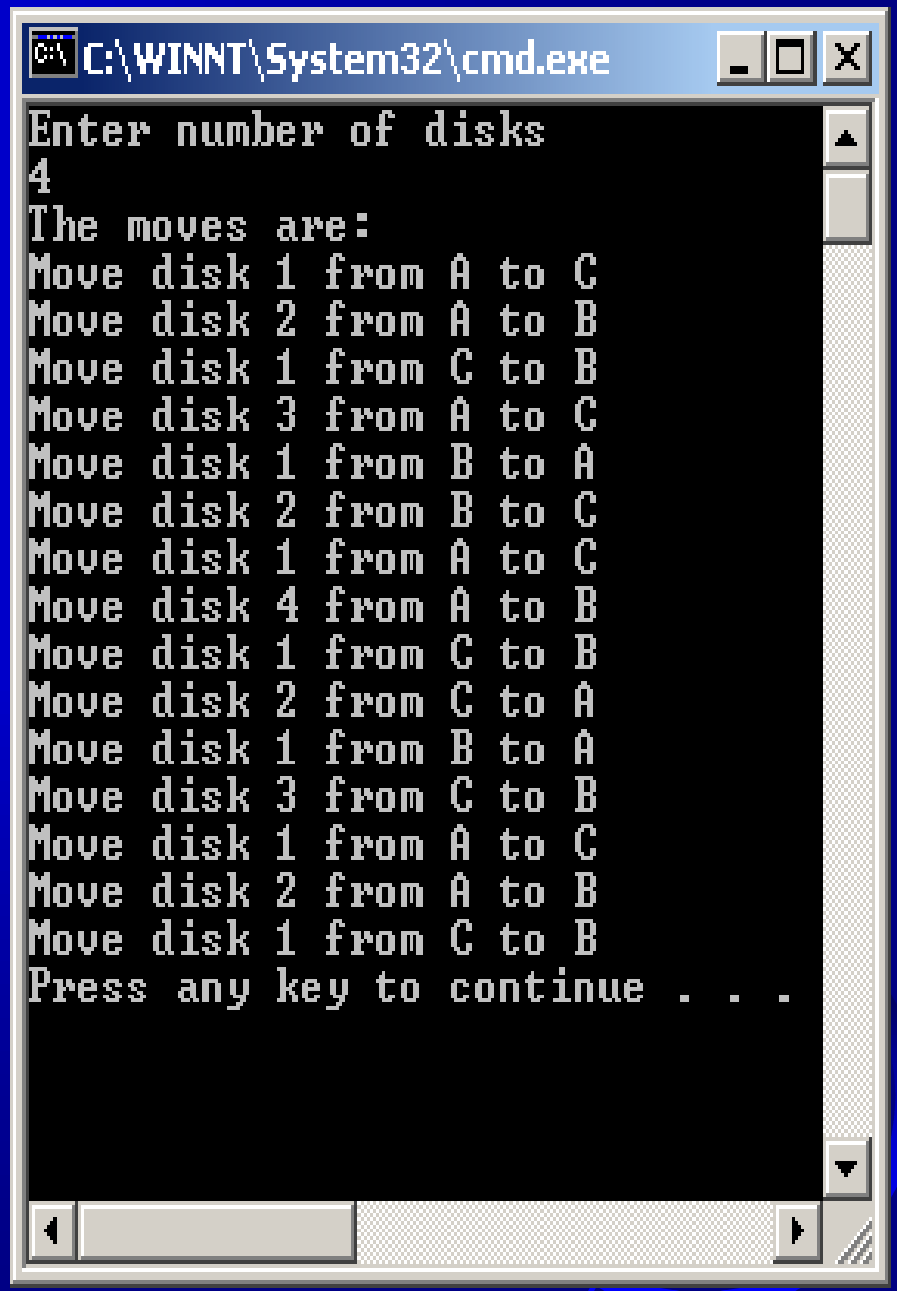




```
// TowersOfHanoi.java: Find solutions for
// the Towers of Hanoi problem
public class TowersOfHanoi
{
  // Main method
  public static void main(String[] args)
  {
    // Read number of disks, n
    System.out.println("Enter number of disks");
    int n = MyInput.readInt();

    // Find the solution recursively
    System.out.println("The moves are:");
    moveDisks(n, 'A', 'B', 'C');
  }
```

```
// The method for finding the solution to move n disks
  // from fromTower to toTower with auxTower
  public static void moveDisks(int n, char fromTower,
    char toTower, char auxTower)
  {
    if (n==1) // Stopping condition
      System.out.println("Move disk " + n + " from " +
        fromTower+" to " + toTower);
    else
    {
      moveDisks(n-1, fromTower, auxTower, toTower);
      System.out.println("Move disk " + n + " from " +
        fromTower + " to " + toTower);
      moveDisks(n-1, auxTower, toTower, fromTower);
    }
  }
}
```


C:\WINNT\System32\cmd.exe
Enter number of disks
3
The moves are:
Move disk 1 from A to B
Move disk 2 from A to C
Move disk 1 from B to C
Move disk 3 from A to B
Move disk 1 from C to A
Move disk 2 from C to B
Move disk 1 from A to B
Press any key to continue . . .


C:\WINNT\System32\cmd.exe
Enter number of disks
4
The moves are:
Move disk 1 from A to C
Move disk 2 from A to B
Move disk 1 from C to B
Move disk 3 from A to C
Move disk 1 from B to A
Move disk 2 from B to C
Move disk 1 from A to C
Move disk 4 from A to B
Move disk 1 from C to B
Move disk 2 from C to A
Move disk 1 from B to A
Move disk 3 from C to B
Move disk 1 from A to C
Move disk 2 from A to B
Move disk 1 from C to B
Press any key to continue . . .