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GNG 1106
Fundamentals of Engineering Computation

Lab 6 – Winter 2016

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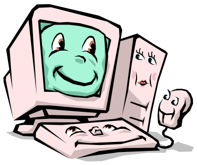


Lab 6 Review of Functions and Arrays

Programming aspects to get familiarized with:

- Working with Functions.
- Review the use of arrays.

Complete the exercises and show your working program to the TA for extra marks to be used to adjust your midterm exam.

A. Exercise : Simple Functions – Calculating Velocity and Displacement (2 marks)

Statement of the problem

Develop a program that requests from the user the initial velocity at time 0, v_0, and the acceleration, a, of an object travelling in a straight line and a time t (greater than 0). From these values, the program shall calculate the displacement, x, and the velocity, v, of the object after time t.

Background:

The following equations are well known relationships between the constant acceleration a, velocity v, and displacement x of an object that travels in a single direction (x).

$$v = v_0 + at \qquad \text{Equation 1}$$

$$x = v_0 t + \frac{1}{2}at^2 \qquad \text{Equation 2}$$

where a is a constant acceleration in m/s^2,
v is the velocity in m/s,
x is the displacement in m,
v_0 is the initial velocity at time t_0.

Design:

- The program should be developed with 3 functions, **`main`**, **`calculateVelocity`**, and **`calculateDisplacement`**.
- In the main function, prompt the user to obtain the initial velocity, acceleration, and time t. Call the other functions to compute displacement and velocity, and print the results. (Hint: start with the program from **assignment 1** posted with this lab and modify it to add the two functions as described in the next points).
- Create two functions, **`calculateVelocity`** which calculates the velocity at a given time, and the other **`calculateDisplacement`** which calculates velocity.
- Both functions have the same three parameters: the initial velocity, the acceleration, and time.
- **`calculateVelocity`** returns the velocity, v, of the object at time t.
- **`calculateDisplacement`** returns the displacement, x, of the object at time t.

Test Cases

Velocity (m/s) and displacement (meters) after a time t (seconds) can be calculates given an initial velocity v0 (m/s) and constant acceleration (m/s2) with the equations given in Step 2.

The following table provides test cases that can be used for testing the software.

Time t (seconds)	Initial Velocity v0 (m/s)	Acceleration (m/s)	Velocity (m/s)	Displacement x (m)
10	1	0	1.00	10.00
0.5	0	250	125.00	31.25
120	60	1.2	204.00	15,840.00
0	60	1.2	60.00	0.00

Develop your program and show your TA your working program with one of the above test cases.

B. Exercise: Functions with arrays – Calculating Velocity and Displacement (3 marks)

Modify the program from Exercise A to have the function **`calculateVelocity`** and **`calculateDisplacement`** fill in an array of 100 points according to the following design:

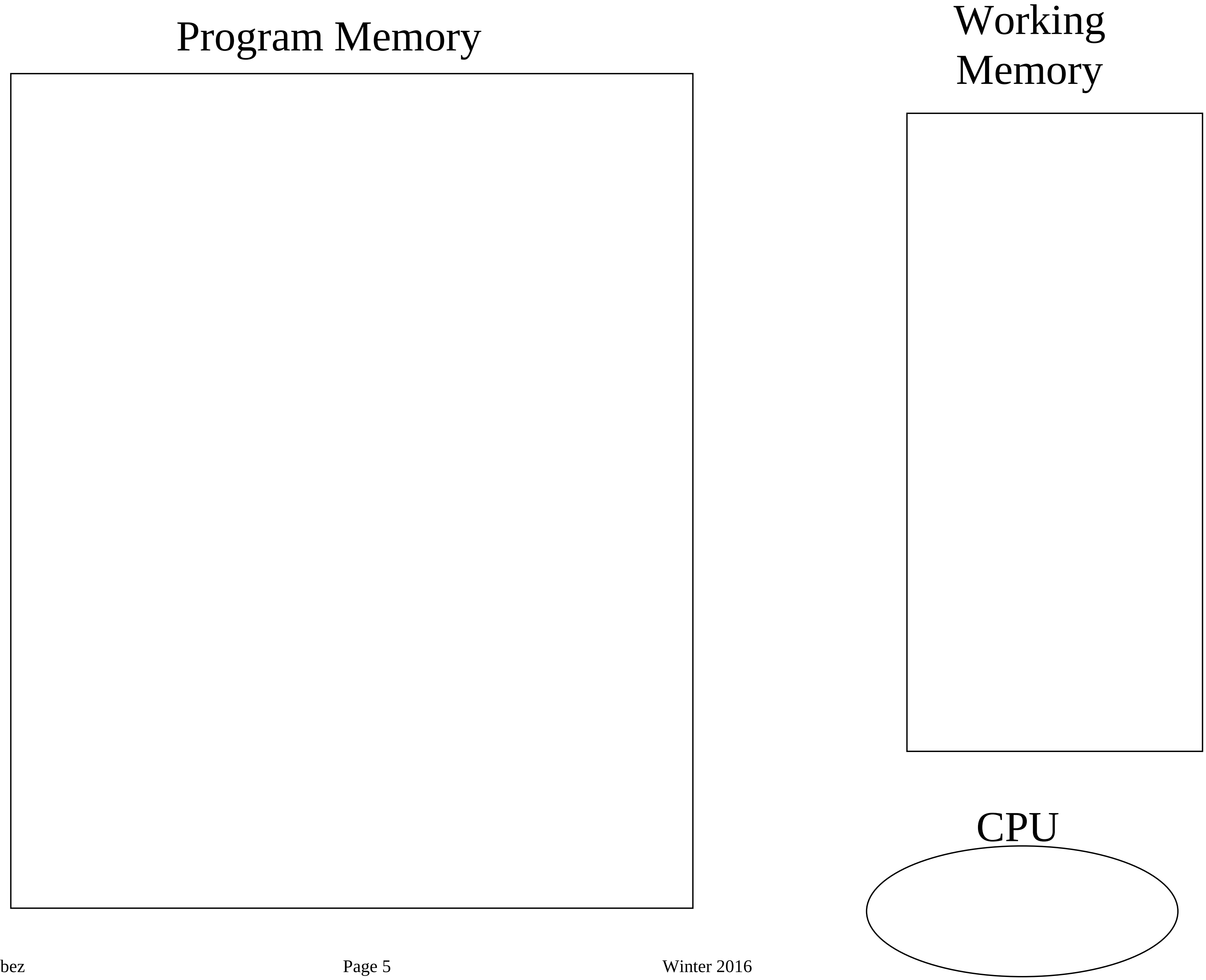
- Define the symbolic constant **`N`** as 100 (number of points to compute).
- In main
  - Prompt the user to obtain the initial velocity, acceleration, and final time **`tfinal`**.
  - Create three arrays, **`tArr`**, **`xArr`**, and **`vArr`** of size **`N`**.
  - Call the **`calculateTime`** function to fill in **`tArr`**.
  - Call **`calculateDisplacement`** function to fill in **`xArr`**.
  - Call **`calculateVelocity`** function to fill in **`vArr`**.
  - Open the file "Results.txt" and save the results (i.e. time, velocity and displacement) in a table form.

- Create another function, **`calculateTime`**, to fill in the time array as follows:
  - Parameters: final time (**`tfinal`**), reference to a time array (**`tarr`**), number of elements in the array (**`n`**)
  - Define an increment, **`inc`**, that is set to **`tfinal/n`**.
  - Traverse the array to fill in time values starting at 0 and incrementing by **`inc`** for each element in the array.
- Modify the **`calculateVelocity`** function as follows:
  - Parameters: initial velocity (**`v0`**), acceleration (**`a`**), reference to a time array (**`tarr`**), reference to a velocity array (**`varr`**), number of elements in the array (**`n`**, note that the symbolic constant **`N`** is not used in by this function.
  - For each time element in the time array, calculate the velocity and store it in the velocity array at the same index position (use a loop to traverse the arrays).
- Modify the **`calculateDisplacement`** function as follows:
  - Parameters: initial velocity (**`v0`**), acceleration (**`a`**), reference to a time array (**`tarr`**), reference to a velocity array (**`xarr`**), number of elements in the array (**`n`**, note that the symbolic constant **`N`** is not used in by this function.
  - For each time element in the time array, calculate the displacement and store it in the displacement array at the same index position (use a loop to traverse the arrays).

Develop your program and show your TA your working program with one of the test cases from Exercise A.

C. Exercise: Functions with arrays – Calculating Velocity and Displacement

If you have time, modify the program from Exercise B to plot the change in velocity and displacement using the plplot libraries. This exercise is optional.



Program Memory

Working Memory

CPU