# Assignment 4

# (Memory management and Garbage Collection)

Study the basic concepts of memory management and garbage collection in operating systems: Heap management, allocation and de-allocation of memory, garbage collection methods such as reference counting, mark and sweep methods. Following are study materials for the basics of memory management and garbage collection.

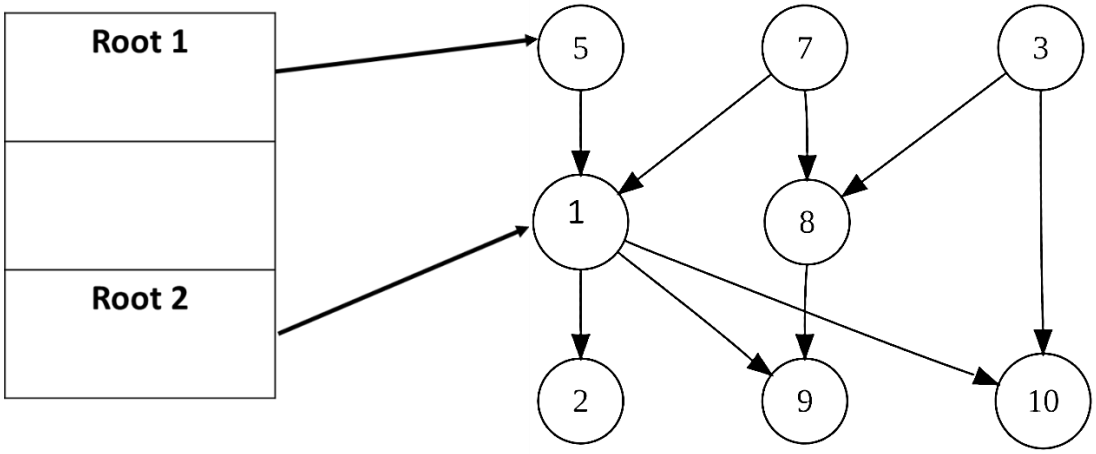
- Book- Operating Systems: Three Easy Pieces:
  - Free space management - https://pages.cs.wisc.edu/~remzi/OSTEP/vm-freespace.pdf

- Garbage Collection (Reference Counting, Mark and Sweep method)
  - 1. https://groups.seas.harvard.edu/courses/cs153/2019fa/lectures/Lec25-Garbage-collection.pdf
  - 2. https://www.cs.cornell.edu/courses/cs4120/2022sp/lectures/36gc/lec38-sp19.pdf
  - 3. Mark Sweep method - https://en.wikipedia.org/wiki/Tracing_garbage_collection#Na%C3%AFve_mark-and-sweep

- **Note: Students can use the concepts and codes related to heap memory management assignment done in the CPL course this semester.**

**Problem 1**: (**10 Marks**)

Create a simulator for the heap management schema using linked list as shown in the given figure. The program output should display the adjacency matrix for the above schema for each Root 1 and Root 2 separately.




I. After the creation of the heap management schema, write a code and implement the following garbage collection methods to find the garbage nodes in the given heap.

1. Reference Counting method

2. Mark and Sweep method (mark all the nodes of the tree using constant space (i.e. without using either recursion or a stack)

Display the output for both the methods in the form of the adjacency matrix separately. Also show the garbage nodes that are no longer required.

II. For the garbage nodes, implement the merge memory technique of free space management and make sure that the adjacent blocks are merged together. Display the size of the freed and merged memory in terms of bytes.

III. Upload your complete code to the github repository that you created in assignment 2 and provide the link in gradescope.

## Submission instructions

1. For this assignment, you will have to record a demonstration video as per the instructions given. Also students has to provide the git-hub link of their complete code in the submit link given in gradescope. There will be separate link in gradescope available, where you can provide the github link of your code apart from the video submission link. The evaluation will be based on the demonstration video and the separate code link provided.

2. To create the videos, you may either use screen recording software from your laptop or record with a video camera/smartphone. Make sure voice is audible during the videos.

3. Preferably, the video length should be of around **10-12 minutes**. Keep your video precise and avoid any unnecessarily long explanations.

4. For submitting your explanation videos, you would need to log in to your student on https://www.gradescope.com/. Once you log in, browse to **'CSP 202 (Software Lab II)**' course and submit your explanation video and link for **'Assignment 4'**. In the assignment 4, there will be two separate links for Video and link submission, so make sure you upload the correct answers.

5. To upload the video, select your video file using 'select file(s)' option and then use 'save answer' button to load the video. This step will take time, so wait for the upload to complete. After this, you should see a 'Download' button for the video file, this shows that your video is uploaded successfully. Post successful upload, submit your answer with 'Submit & View Submission' button.

6. For any issues with submission or discrepancies, contact the Teaching Assistants (TA) (details given below).

7. The assignment submission will open on Date **01/04/2022 6.00 AM** and will close on Date **15/04/2022 11.59 PM.** Late submissions will be allowed till **18/04/2022**, **11:59 PM** but with **a penalty of 2 marks**. After this no submissions will be accepted on any grounds unless explicit permission has been obtained for any unavoidable circumstances, well in advance.

8. **Faculty Coordinator: Dr.Praveen Kumar**
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