CSE 3302/5307 Programming Language Concepts

Homework 9 - Fall 2025

Due Date: Oct. 20, 2025, 9:00PM Central Time

Name:_____ UTA ID:_____

Problem1 - 50%

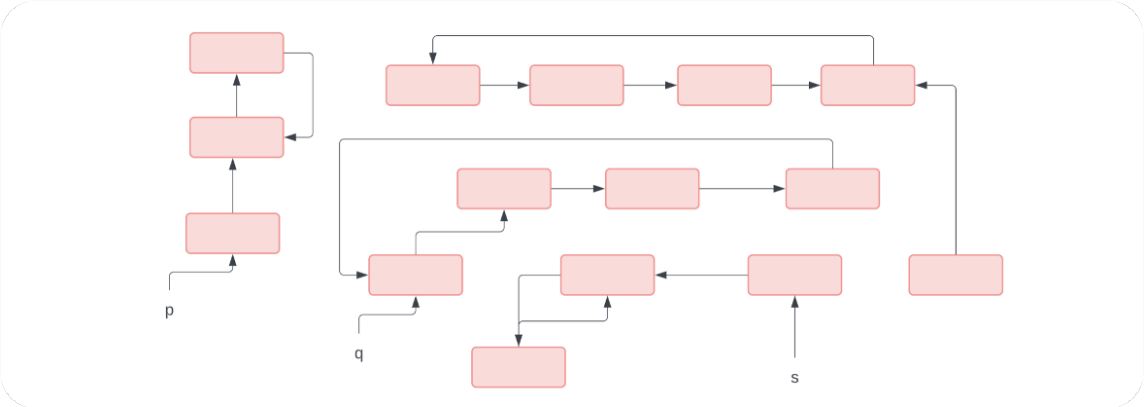

Figure 1: Heap Configuration

Consider the heap configuration shown for allocated memory words. The heap is in total 100B in this case and one memory word is 4B.

a) Compute the amount of memory leaked for this configuration

b) Mark the nodes that will be added to the free_list after reference counting

c) Compute the amount of memory leaked after each of reference counting and mark and sweep

d) How does mark and sweep detect the cycle although it is not in the reference graph?

e) Mention a set of conditions under which reference counting could be viewed to be significantly better than mark and sweep

Problem2 - 20%

In Cheney's algorithm, the memory words in the from_space are mapped in a consistent and contiguous sense to the to_space. If that's the case, why is it necessary to store the forward addresses while mapping?

Problem3 - 30%

Here is a definition of the less-than-or-equal-to judgement for natural numbers:

Judgement Form: $\vdash leq\ n_1\ n_2$

Rules:

$$\frac{n_2\ nat}{\vdash leq\ Z\ n_2} \quad \text{(Z-Leq)}$$

$$\frac{\vdash leq\ n_1\ n_2}{\vdash leq\ (S\ n_1)\ (S\ n_2)} \quad \text{(S-Leq)}$$

a) Use the *leq* judgement to define a new judgement with the form

$$\vdash ascend\ l$$

that is valid whenever the elements of l are in ascending order (duplicates are allowed). For example, these judgements are valid:

$$\vdash ascend\ cons(Z, cons(Z, cons(S\ S\ S\ Z, cons(S\ S\ S\ S\ S\ S\ Z, nil))))$$

$$\vdash ascend\ nil$$

$$\vdash ascend\ cons(S\ S\ Z, nil)$$

This judgement is not valid:

$$\vdash ascend\ cons(Z, cons(S\ S\ Z, cons(S\ Z, nil)))$$

b) Consider the judgement $\vdash dup\ l_1\ l_2$ and its rules:

$$\frac{}{\vdash dup\ nil\ nil} \quad \text{(Nil-Dup)}$$

$$\frac{\vdash dup\ l_1\ l_2}{\vdash dup\ cons(n, l_1)\ cons(n, cons(n, l_2))} \quad \text{(Cons-Dup)}$$

Prove: If $\vdash ascend\ l_1$ and $\vdash dup\ l_1\ l_2$ then $\vdash ascend\ l_2$.